THE UNIVERSITY OF MELBOURNE

#CISDC17

School of Computing and Information Systems
5th Annual Doctoral Colloquium
19 July 2017

Proceedings

@cis_dc

fb.me/melbcisdc

cis.unimelb.edu.au/colloquium

Welcome

In a June article, the Financial Review described the technology industry as having adjacent markets in almost every other industry. This is no less evident than the breadth of research topics being pursued in the School of Computing and Information Systems. Parallel to this permeation of technology is the increasing importance of interdisciplinary research collaborations.

This is precisely the reason why the annual Doctoral Colloquium (DC) is a key event in the School. Now on its fifth year, the DC provides an avenue for students to present exciting new developments in their research, while setting the stage for students to develop networks with their colleagues and explore new, adjacent research areas. From route planning for hitchhikers, to habitat conservation and biocuration, there is certainly no dearth of diverse, impactful research within the School.

This year, we have strived to make the Colloquium even more inclusive of researchers of all stages, from students pre-Candidature all the way to those close to submitting their thesis. For instance our new 3-Minute presentations cater to early-stage researchers, while allowing later-stage researchers the chance to sharpen their communication skills. Meanwhile the paper track provides students with clear proposals a chance to present significant milestones in their work, and the poster track allows students to identify a pertinent aspect of their research and present with the advantages of using clear, organised visuals.

The topic of our Keynote Speech, on doing research that makes a difference, was conceptualised by Dr. Sarah Dods and furthers the DC's objective of providing relevant material to students. Dr. Dods, the General Manager for eHealth Solutions at Telstra Health, has research and industry experience.

An additional benefit of the DC is the opportunity for students to connect with our industry and academic partners. In turn, it allows our partners to touch base with many of the School's latest research areas, and support our pursuit of high quality research. This year we are delighted to be supported by Microsoft Australia, Google, Melbourne School of Engineering, Melbourne Bioinformatics, Billcap, Microsoft Research Centre for Social Natural User Interfaces, Melbourne Networked Society Institute, Australian Computer Society, Deloitte, and Rome2Rio.

The success of this Colloquium is of course due to the hard work of CIS staff who have worked with us in planning, organising, and executing key components of the event. We are particularly grateful to Rhonda Smithies, Julie Ireland, Jan Schroeder, Andrew Turpin, and Tony Wirth for their countless, invaluable assistance. We are especially grateful to our Head of School, Justin Zobel, for his dedicated guidance and support. Finally, we would like to extend our gratitude to our volunteers for their passion, ideas, energy and hard work.

With the impressive research presentations, the exciting sponsor-supported prizes, and the entire School gathered together as one community, the DC promises to be an engaging and meaningful event for all.

We welcome you to your 2017 Doctoral Colloquium.

Your CISDC17 Organising Committee

Organising Committee

Gerardo Luis Dimaguila

Conference Chair

Mazino Onibere

Programme Chair

Peter Eze

Website, Registration & Volunteer Coordinator

Neil Marchant

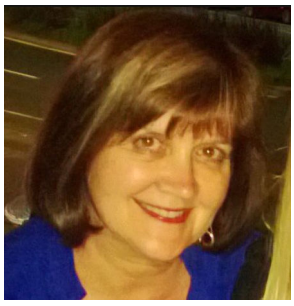
Treasurer & Logistics Coordinator

Carlos Andres Agudelo Serna

Marketing & Public Relations Coordinator

Jan Schroeder

Academic Coordinator

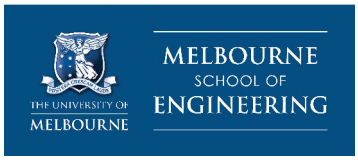


Rhonda Smithies

School Administrative Coordinator

Sponsors

Top Sponsors



Sponsors

Keynote Address

Customer is not a dirty word (and why you need them to do research that makes a difference)

Dr Sarah Dods – General Manager for eHealth Solutions with Telstra Health

Abstract

Most of us want to do something in our work that makes a difference. In research, we believe the difference we make is from solving problems—big or small. The challenge is that our solutions don't make a difference unless they get out of the lab—and that happens through a customer. A significant gap between academic and corporate thinking is the articulation of problems and solutions in a way that is meaningful to customers and a market.

This presentation will discuss this gap, and suggest strategies to close it. Sarah will look to provide research students with insights on how to ask the right questions to find out who their customer is: who values the solution to the problem being tackled, and what the solution needs to look like for them to be able to use it. Drawing on examples from her own experiences, she will walk through how research and development can lead to introducing new products in a market.

Biography

Dr Sarah Dods is the General Manager for eHealth Solutions with Telstra Health, a new arm of Telstra with a mission to make healthcare simpler, developing solutions to build a better connected health system. Her portfolio includes tools to improve the accuracy and currency of health provider information across hospitals and healthcare organisations; and secure messaging solutions to facilitate the safe exchange of discharge summaries, referrals and other patient information across the health system.

Dr Dods was previously with CSIRO in various roles, including implementing CSIRO's new entrepreneurship and innovation program (CSIRO ON), and leading research programs into the Digital Economy, and Health Service Delivery. Her career spans Australia's innovation system across high-tech startups, public and private research organisations, telecoms, IT & resources innovation, business development and commercialisation. This smorgasbord includes 13 years as an academic, researching optical broadband network engineering (think NBN), which culminated in co-founding Monitoring Division, NICTA's first Victorian spin out.

Sarah's deep passion is in realising economic and social value from technology advances; to bridge the gap between research challenges, market opportunities, and implementable solutions to create value

and make a difference for everyday Australians and our businesses. She is a fan of life-long learning, a believer in the value of diversity, and an incurable optimist.

Dr Dods' qualifications include a BSc (Hons) in Physics and a PhD in Electrical and Electronic Engineering, both from the University of Melbourne. She is a graduate member of the Australian Institute of Company Directors, and a Senior Member of the IEEE. Sarah is also a Member of the Australian National Committee to the IEC (Standards Australia) since 2016, and is a State and National Judge for the iAwards Australia since 2014.

Awards Listing

Paper Track

Best Paper

Deloitte Best Paper Award

Microsoft Research Centre for SocialNUI Honourable Mention Award

School of CIS Honourable Mention Award

Melbourne Networked Society Institute Special Paper Award

Best Presentation

Microsoft Best Presentation Award

Microsoft Honourable Mention Award

Microsoft Honourable Mention Award

Poster Track

Rome2Rio Best Poster Award

School of CIS Honourable Mention Award

School of CIS Honourable Mention Award

Three-Minute Track

Australian Computing Society Best Three-Minute Presentation

School of CIS Honourable Mention Award

School of CIS Honourable Mention Award

Contents

Welcome

Organising Committee

Sponsors

Keynote Address

Awards Listing

Paper Session 1

A: Data and Knowledge

Fei Liu, Trevor Cohn, Timothy Baldwin
Memory-Enhanced Conditional Random Fields for Thread Discourse Structure Prediction 2

Yitong Li, Trevor Cohn, Timothy Baldwin
Multi-task Adversarial Representation Learning for Text Classification 3

Nitika Mathur
Sequencing effects in Natural Language Processing annotations 4

Aili Shen, Jianzhong Qi, Rui Zhang
Quality Assessment of Wikipedia Articles 5

Neil Marchant, Benjamin Rubinstein
OASIS: An efficient evaluation method for entity resolution 6

Milad Chenaghlou, Masud Moshtaghi, Christopher Leckie, Mahsa Salehi
Data Stream Clustering in Non-Stationary Environments 7

B: People and Organisations

Dana Mckay
What I talk about when I talk about (library shelf) browsing 8

Melissa J. Rogerson
Boardgames Rule(s) 9

Hasan Shahid Ferdous
Forget the Salt, Pass the iPad: Technology at Mealtimes 10

Luthfi Ramadani, Sherah Kurnia, Christoph Breidbach
An Interdisciplinary Perspective of Nation-Wide Health Information Systems Implementation in Developing Countries 11

Jongkil Jeong, Sherah Kurnia, Daniel Samson and Sara Cullen
The psychological contract and its impact on relationship quality in ICT outsourcing 12

C: Platforms and Systems

Eman Alatawi, Tim Miller, Harald Sondergaard
Combining Metamorphic Testing and Dynamic Symbolic Execution for effective test inputs generation 13

Li Li, Sarah Erfani, Christopher Leckie
A Novel Contrast Pattern Mining Methods for Analyzing Retail Datasets 14

Ronal Singh
Communication Decisions with Shared Mental Models 15

Muhammad Hafizhuddin Hilman, Maria Alejandra Rodriguez, Rajkumar Buyya
Budget-constrained Resource Provisioning and Scheduling Algorithms for Scientific Workflow in Cloud Environments 16

Farzad Khodadadi
Power-Efficient Resource Provisioning in Hybrid Datacentres Using Micro Servers 17

Muhammed Tawfiqul Islam, Shanika Karunasekera, Rajkumar Buyya
Deadline-Aware Cost-Optimized Cloud Resource Estimation for Big Data Applications 18

Paper Session 2

A: Data and Knowledge

Qingyu Chen, Justin Zobel, Karin Verspoor
Biocuration experts on the impact of duplication and other data quality issues in biological databases 20

Xin Li, Kathleen Gray, Karin Verspoor
Using Learning Analytics to Understand Health Professionals' Informal Learning in Online Social Networks 21

Yixin Xu, Jianzhong Qi, Renata Borovica-Garjic, Yu Sun, Rui Zhang
Reverse Nearest Neighbour Heatmap in Spatial networks 22

Jiayuan He, Jianzhong Qi, Rui Zhang
Efficient Indexing and Querying of Periodic Data 23

B: Data and Knowledge

Stephan Gloeckner, Salla Eliisa Toikkanen, Richard Sinnott
The Trade-Offs in Data Trustworthiness and Data Completeness in Clinical Research Registries 24

Yang Lu, Richard Sinnott, Karin Verspoor, Udaya Parampalli
Effective Preservation of Privacy During Record Linkage 25

Mahtab Mirmomeni, Lars Kulik, James Bailey
Activity recognition of post-surgery patients through data analytics on time-series data from wearable sensors 26

Sehrish Kanwal, Andrew Lonie, Richard Sinnott
Reproducibility of Computational Genomic Workflows 27

C: People and Organisations/Platforms and Systems

Sarah Webber, Wally Smith, Marcus Carter, Frank Vetere
Zoo Visitors Kinecting with Orangutans 28

Deepti Aggarwal
SoPhy: A Wearable Technology for Effective Video Consultations of Physiotherapy 29

Aleck Macnally, Nir Lipovetzky, Adrian Pearce, Miquel Ramirez
Planning for Transparency 30

Sadegh Motallebi, Ramamohanarao Kotagiri, Egemen Tanin
Towards a Unified System for Navigation Advice and Traffic Management 31

Papers not presented

Naghmeh Sharikzadeh
Using Avatars for Visualizing Personal Health Records 33

Fraser Allison
Voice interaction with virtual characters 34

Carlos Andres Agudelo Serna
Knowledge Leakage Risk: Towards a Capability Maturity Model 35

Mazino Onibere, Atif Ahmad, Sean B. Maynard
Information Security Strategizing, Capability, and Organisational Performance 36

Poster Session

Craig Horne, Sean B. Maynard, Atif Ahmad
A Poster on Information Security Strategy Model 38

Mohammadhossein Sherkat, Tim Miller, Antonette Mendoza, Rachel Burrows
Emotional Requirements in People-Oriented Software Engineering 39

Ziying Yang
Pairwise Preference Relevance Judgments from Crowdsourcing 40

Sadia Nawaz, James Bailey, Gregor Kennedy
Sensor-free confusion detection in digital learning environments 41

Chenxu Zhao, Rui Zhang, Jianzhong Qi
Web Document Clustering Based on Structure and Style Similarity 42

Sami Alkhatib
Privacy and the Internet of Things (IoT) monitoring solutions for older adults: A systematic review . . 43

Zhanna Sarsenbayeva
Situational Impairments to Mobile Interaction 44

Namrata Srivastava, James Bailey, Sarah Erfani
Exploring Eye-Tracking technology in predicting subjective states of students in a digital learning environment 45

Unni Krishnan, Alistair Moffat, Justin Zobel
What is "Query Auto Compl"? 46

Abdulaziz Murad
Design Considerations for a Virtual Community of Practice for Health Practitioners: A Learner Centred Design Approach 47

Joshua Newn
Investigating Intent Recognition Through Gaze Awareness in User Interfaces 48

Atlarelang Basetsana Kesiilwe
Evaluating the impact of IT in an Emergency Department through a time based comparison of IT based clinical activities vs non-IT based clinical activities 49

Ge Yao, Udaya Parampalli
Transformation from the Fibonacci NLFSR to the Galois NLFSR with Minimal Delay 50

Stephanie James
Improving Information Security Governance in Organisations 51

Doris Hoogeveen, Karin Verspoor, Timothy Baldwin
Detecting False Duplicate Questions in Community Question-Answering Archives 52

Martin Reinoso
Designing Challenges in Animated 3D Whiteboard using Augmented Reality 53

Oscar Correa, Ramamohanarao Kotagiri, Lars Kulik and Egemen Tanin
Ride-Sharing beats Ride-Sourcing through Hot-Spots 54

Three-Minute Thesis Session

Peter Eze
Spread Spectrum Medical Image Watermarking in the Spatial Domain 56

Oleksii Vedernikov
Stochastic route planning for hitchhiking 56

Yiqing Zhang
Understanding publications in researchers' homepages 56

Niels van Berkel
Longitudinal Human and Digital Sensing Using Mobile Technology 57

Romina Carrasco
Empowering my avatar to be myself 57

Patrick Vicky
Authentication through Message Hiding in Frequency Domain 57

Timoci O'Connor
An exploration of mobile phone functionality, feedback and associated factors that influence outcomes of public health interventions 58

Diego De Uña
Minimizing Landscape Resistance for Habitat Conservation 58

Yousef Kowsar
Detecting Interval of Recurrence in Time Series 58

Peter Chan
Thermography as a Novel Modality for Contactless Patient Monitoring 59

Mohammad Oloomi, Thomas Conway, Justin Zobel
A More Accurate DNA Sequencing with Multimapping Resolution 59

Humza Naseer
Security Analytics 59

Gerardo Luis Dimaguila
Influence of Person-Generated Health Data on Patient Attitudes or Behaviours: A Kinect-type Neuro-rehabilitation Programme 60

Adel Foda
Grounded Knowledge for Language Understanding 60
Anitya Nijhara
Group dynamics in an Information Security Risk Management context: a study of Risk Perceptions . . 60
Fraser Allison
How Do We Talk to Virtual Characters? 60

Author Index

Paper Session 1

Memory-Enhanced Conditional Random Fields for Thread Discourse Structure Prediction

[Extended Abstract]

Fei Liu, Trevor Cohn and Timothy Baldwin
The University of Melbourne, Victoria, Australia
fliu3@student.unimelb.edu.au, tcohn@unimel.edu.au,tb@ldwin.net

ABSTRACT

In this paper, we present a novel method for classifying discourse act and link structure in online discussions. The model we introduce is one based on `Conditional Random Fields` (`CRF`s) and augmented with external memory. Experiments on an online technical help forums dataset show significant improvements over existing approaches, setting a new state-of-the-art.

CCS Concepts

•Computing methodologies → Natural language processing;

Keywords

Thread discourse structure; Conditional Random Fields; Memory Networks

1. INTRODUCTION

Online discussion forums form a valuable source for people seeking to resolve their information needs. However, relevant information is often hidden in the complex structure of such forum threads, making one's access difficult. Previous approaches frame threads as sequences and model them with `Conditional Random Fields` (`CRF`s) [2]. While `CRF`s generate fair performance, they are restricted to focus on features associated with the current step. In the context of thread discourse structure prediction, it is not necessarily true that the sequence presents a linear structure (i.e., a post may be in reply to either a neighbouring one or one far eariler). It is therefore essential that a model is capable of coping with long distance dependencies.

In this work, we present a novel method, integrating external memory mechanisms into `CRF`s, thereby enabling the model to look beyond localised features and have access to the whole sequence. This is inspired by the recently introduced Memory Networks [3]. Experiments on a help forum dataset where the goal is to predict the thread discourse and link structure demonstrate the effectiveness of the proposed model compared with existing approaches, setting a new state-of-the-art.

2. TASK & MODEL

The task is defined as follows: given a list of preceding posts $p_1, \ldots, p_{t-1}$ and the current post p_t, the goal is to classify not only the link (relationships) between posts but also the dialogue act (DA, type of relationship) of each link.

Table 1: Post/thread level Link and DA F-scores

Model	Link	DA	Joint
`CRFSGD` [2]	82.3/65.4	73.4/57.1	66.5/52.4
`MaltParser` [2]	85.0/**69.5**	75.7/**56.5**	70.6/**54.0**
`ME-CRF`	**86.1**/68.6	**77.9**/56.2	**72.0**/52.1

The proposed model extends `CRF`s by integrating external memory and is therefore named `Memory-Enhanced Conditional Random Fields` (`ME-CRF`s). Specifically, with preceding posts stored in the memory in the form of $\boldsymbol{p}_1, \ldots, \boldsymbol{p}_{t-1}$, where $\boldsymbol{p}_i = \Phi(p_i)$ and $\Phi(\cdot)$ is an encoding function, `ME-CRF`s determine the relationship (link) of p_t to p_i for $i \in 1, t-1$ by an attention mechanism: $a_i = \text{softmax}(\boldsymbol{p}_t^\top \boldsymbol{p}_i)$, resulting in higher weight for similar/relevant post pairs. Once the attention weights have been computed, the information stored in the memory is incroporated in the form of weighted sum: $\boldsymbol{m} = \sum_i a_i \boldsymbol{p}_i$ and is added back to form the input to the `CRF`: $\boldsymbol{p}'_t = \boldsymbol{p}_t + \boldsymbol{m}$. The model is trained to optimise the loss function: $\mathcal{L}(\theta) = \sum_{i=1}^{T} \log P(y_i | \boldsymbol{p}'_i; \theta)$ where T is the length of the sequence, y_i the ground truth DA label and θ the set of all parameters in a `ME-CRF` including the `CRF` transition matrix and weights.

3. EXPERIMENTS AND RESULTS

The experiments results are presented in Table 1. We benchmark against the work in [2] where two models, `CRFSGD` and `MaltParser`, are explored on the help forum dataset described in [1]. As can be observed, `ME-CRF` achieves state of the art results, superior to both baselines.

4. CONCLUSION

In this paper, we have described `Memory-Enhanced Conditional Random Fields` and applied it to the task of thread discourse structure prediction. Experiments demonstrate the effective of the proposed model.

5. REFERENCES

[1] S. N. Kim, L. Wang, and T. Baldwin. Tagging and linking web forum posts. In *Proc. CoNLL*, pages 192–202, Uppsala, Sweden, 2010.

[2] L. Wang. *Knowledge discovery and extraction of domain-specific web data*. PhD thesis, The University of Melbourne, 2014.

[3] J. Weston, S. Chopra, and A. Bordes. Memory networks. In *Proc. ICLR*, San Diego, USA, 2015.

Multi-task Adversarial Representation Learning for Text Classification

[Extended Abstract]

Yitong Li, Trevor Cohn and Timothy Baldwin
The University of Melbourne
yitongl4@student.unimelb.edu.au, {tcohn,tbaldwin}@unimelb.edu.au

ABSTRACT

Neural networks have been studied in multi-task learning, where models focus on learning task-invariant representations shared by all the tasks. However, traditional approaches are prone to learn noisy presentations. In this paper, we introduce adversarial learning to multi-task framework, by regularising the shared and private presentations. We prove the advantages of our methods across several text classification datasets, parameterized by the state-of-the-art convolutional neural models.

CCS Concepts

•**Computing methodologies** → **Multi-task learning;** *Natural language processing;* **Adversarial learning;**

Keywords

Multi-task learning; Adversarial learning; Text classification

1. INTRODUCTION

Multi-task learning is an effective approach to improve single tasks by jointly learning additional helpful tasks. Recently, many deep multi-task models have been studied [4] by dividing the task features into shared and public spaces.

However, the main challenge of this approach is it can learn unnecessary or even task-specific knowledge in the shared representation. To address this problem, we borrow ideas from generative adversarial nets [2] and adversarial training [1]. Specifically, we add a task discriminator D on the top of shared feature layer to learn which task the generated feature comes from. In the meantime, the feature "generator" tries to fool D and to learn task-invariant representation.

2. MULTI-TASK FRAMEWORK

Our framework learns both shared and each of task-specific presentations by Convolutional Neural Networks (CNNs) [3]. Then, several regularizers over learned representations are used to constrain these presentation.

Convolutional Neural Nets.

The CNN operates at the sentence level by first concatenating the word embeddings into the sentence embedding $\mathbf{E}$. Second, multiple 1-d convolutional filters with t-window size are applied to $\mathbf{E}$. Third, MaxPooling is applied over each set of filter outputs, generating a fixed-size sentence representation $\mathbf{R}$.

Multi-task learning.

For multi-task setting, each instance $\mathbf{x}$ from task t results into a shared representation $\mathbf{R}_\text{s}$ and a task-specific representation $\mathbf{R}_\text{t}$, through the shared and task-specific CNNs respectively. The concatenation of them is fed into a Softmax layer to generate the prediction distribution. We minimize the loss function L defined by CrossEntropy between the predictions and ground-truth, using Adam Optimizer.

In order to learn robust task-invariant representation, we apply orthogonality constraints and the adversarial loss

$$L_{orth} = \|\mathbf{R}_\text{s} \cdot \mathbf{R}_\text{t}\|_F^2$$

$$L_{adv} = \min_{\theta_s} \left(\max_{\theta_D} \log(D[\mathbf{R}_\text{s}(\mathbf{x})]) \right),$$

where D is a perceptron layer over the $\mathbf{R}_\text{s}$, measuring the log probability of $\mathbf{R}_\text{s}$ belonging to task t, θ_s and θ_D are model parameters.

Finally, we optimize the following new loss

$$\mathscr{L} = L + \lambda L_{orth} + \mu L_{adv}.$$

3. EXPERIMENTS

We evaluate our method over text classification datasets, including Customer review dataset (CR), Sentence polarity dataset, Subjectivity dataset and Stanford Sentiment Treebank. Results are shown in Table 1.

Methods	$\mathbf{R}_\text{t}$	$\mathbf{R}_\text{s}$	L	$L + L_{orth}$	$\mathscr{L}$
Acc	83.0	82.4	82.5	83.5	**84.3**

Table 1: Accuracy(%) over CR

4. REFERENCES

[1] Y. Ganin, E. Ustinova, H. Ajakan, P. Germain, H. Larochelle, F. Laviolette, M. Marchand, and V. Lempitsky. Domain-adversarial training of neural networks. *JMLR*, 2016.

[2] I. J. Goodfellow, J. Pouget-Abadie, M. Mirza, B. Xu, D. Warde-Farley, S. Ozair, A. C. Courville, and Y. Bengio. Generative adversarial nets. In *NIPS 27*, 2014.

[3] Y. Kim. Convolutional neural networks for sentence classification. In *Proceedings of EMNLP*, 2014.

[4] P. Liu, X. Qiu, and X. Huang. Deep multi-task learning with shared memory for text classification. In *Proceedings of EMNLP*, 2016.

Sequencing effects in Natural Language Processing annotations
[Extended Abstract]

Nitika Mathur
nmathur@student.unimelb.edu.au

ABSTRACT

Manual data annotation is a vital component of NLP research. In this paper, we explore one possible effect which can bias annotations: sequencing effects, i.e. the order in which the items are presented for evaluation. We show clear evidence of this bias using auto-correlation studies over three different datasets. We then recommend a simple way to minimise sequence effects.

CCS Concepts

•Computing methodologies → Natural language processing;

Keywords

Cognitive Bias; Natural Language Processing; Annotations

1. INTRODUCTION

NLP research relies heavily on annotated datasets, and the design of the annotation task can influence the decisions made by annotators in subtle ways. When collecting NLP annotations, care is usually taken to ensure that the annotations are of high quality. Crowdsourcing has emerged as a cheaper, faster alternative to expert NLP annotations. In most annotation exercises, the order of presentation of instances is randomised to remove bias due to similarities in topic, style and vocabulary.

However, when obtaining repeat annotations for quality control purposes, it is common practise for all annotators to see the instances in the same order. This can give rise to sequence effects, which can affect any other inferences made from the data including aggregated assessment or inferences about individual annotators (such as their overall quality or individual thresholds). For example, having assigned one label to an instance, the annotator may be less (or more) likely to assign the same label to the next. During rating tasks, seeing a low quality item may affect the score given to the next item either positively or negatively.

2. EXPERIMENTS

We analyse several crowdsourced datasets, including both binary and continuous annotation tasks: recognising textual entailment (RTE), temporal ordering of events, affective text analysis [2] and machine translation evaluation [1]. We use a linear model to check for a significant positive or negative autocorrelation in each dataset.

We found significant sequencing effects across all datasets: a negative autocorrelation in the RTE, temporal and affective text analysis annotation datasets, and a positive autocorrelation in the MT evaluation dataset. These effects were much more muted for affective text analysis, perhaps due to the nature of the annotation task whereby annotations of one emotion are separated by six other annotations, thus limiting the potential for sequencing effects.

MT judgements are subjective, and when people are asked to rate translations, they need time to calibrate their scale. We found that sequential bias decreases as they annotate more sentences in the HIT, indicating a learning effect. Since the ordering of the systems is random, system scores obtained by averaging scores of all sentences translated by the system would be unbiased, assuming a sufficiently large sample of sentences. Thus we do not expect sequential bias to have a marked effect on system rankings or other macro-level conclusions on the basis of this data. However, the scores of individual translations remain biased, which augurs poorly for the use of these annotations at the sentence level, such as when used in error analysis, for training automatic metrics or human-in-the-loop discriminative training.

3. CONCLUSION

This study has shown that sequence bias is real, and can distort evaluation and annotation exercises with crowdworkers. Sequence problems can be easily addressed by adequate randomisation – providing each individual worker with a separate dataset that has been randomised, such that no two workers see the same ordered data. In this way sequence bias effects can be considered as independent noise sources, rather than a systematic bias, and consequently the aggregate results over several workers will remain unbiased. We limited our scope to binary and continuous responses, however it is likely that sequence effects are prevalent for multinomial and structured outputs, e.g., in discourse and parsing, where priming is known to have a significant effect. Another important question for future work is whether sequential bias is detectable in expert annotators, not just crowd workers.

4. REFERENCES

[1] Y. Graham, N. Mathur, and T. Baldwin. Accurate evaluation of segment-level machine translation metrics. In *Proceedings of the 2015 Conference of the North American Chapter of the Association for Computational Linguistics Human Language Technologies*, Denver, Colorado, 2015.

[2] R. Snow, B. O'Connor, D. Jurafsky, and A. Y. Ng. Cheap and fast—but is it good?: Evaluating non-expert annotations for natural language tasks. In *Proceedings of the Conference on Empirical Methods in Natural Language Processing*, EMNLP '08, pages 254–263, Stroudsburg, PA, USA, 2008. Association for Computational Linguistics.

Quality Assessment of Wikipedia Articles

[Extended Abstract]

Aili Shen
School of Computing and Information Systems
The University of Melbourne
ailis@student.unimelb.edu.au

Jianzhong Qi
School of Computing and Information Systems
The University of Melbourne
jianzhong.qi@unimelb.edu.au

Rui Zhang
School of Computing and Information Systems
The University of Melbourne
rui.zhang@unimelb.edu.au

ABSTRACT

As one of the largest open knowledge repository, Wikipedia is an important source of information. However, studies have shown that quality of Wikipedia articles varies. Assessing the quality of Wikipedia articles is important for directing readers to high quality articles and suggesting contributors to improve low quality articles. We propose an automatic quality assessment method by combining neural network learned features with human extracted features. Experimental results show that our proposed approach achieves a 6.5% better accuracy than those of state-of-the-art approaches.

CCS Concepts

•**Information systems** → **Digital libraries and archives;**

Keywords

Wikipedia Articles; Quality Assessment; Neural Network

1. INTRODUCTION

Wikipedia has attracted a large number of users due to its rich information and wide coverage of topics. However, the quality of Wikipedia articles is inconsistent. An automatic article quality assessment approach is needed because of the large number of articles and their high updating frequency. We propose such a method in the paper.

2. RELATED WORK

Under the assumption that article quality depends not only on the structure of an article, but also on how well the article is written, Dang *et al.* [1] added 9 readability scores to the structure feature set and used random forest (RF) to classify article quality.

Recently, Dang and Ignat [2] used *Paragraph Vector* to represent articles. Then, the learned representations of articles are fed into a 4 hidden layer neural network to classify articles by their quality.

3. PROPOSED APPROACH

We use a bidirectional LSTM (bi-LSTM) to get representations of documents. Then the learned features are concatenated with human extracted features (such as number of references, whether the article has a infobox or not, and number of difficult words) as the final representation of documents, which is used as features for quality classification.

4. EXPERIMENTAL RESULTS

We compare our approach with the state-of-the-art approaches. The approach proposed by Dang and Ignat [1] is denoted as RF. The deep learning based approach proposed by Dang and Ignat [2] is denoted as Doc2Vec. The parameters of RF and Doc2Vec are set as described in their corresponding papers. Our approach combining bi-LSTM learned representation with human extracted features is denoted as bi-LSTM$^+$.

Table 1: Comparisons with state-of-the-art approaches.

	Dataset1	Dataset2	Dataset3
RF	**63.70%**	58.63%	61.71%
Doc2Vec	59.84%	54.98%	61.46%
bi-LSTM$^+$	63.59%	**58.98%**	**68.17%**

From Table 1, we see that on Dataset1 and Dataset2, bi-LSTM$^+$ is as competitive as RF: RF gains a 0.11% higher accuracy on Dataset1 while bi-LSTM$^+$ gains a 0.35% higher accuracy on Dataset2. However, on Dataset3, bi-LSTM$^+$ gains a 6.5% higher accuracy than that of RF. Doc2Vec always has a lower accuracy than that of bi-LSTM$^+$.

5. CONCLUSIONS AND FUTURE WORK

We propose an approach to classify Wikipedia articles, which combines bi-LSTM learned features with human extracted features. Experimental results show that our approach achieves a 6.5% better accuracy than those of state-of-the-art approaches. Assessing Wikipedia article quality across multiple languages is our future direction.

6. REFERENCES

[1] Q. V. Dang and C. Ignat. Measuring quality of collaboratively edited documents: The case of wikipedia. In *2nd IEEE International Conference on Collaboration and Internet Computing, (CIC)*, pages 266–275, 2016.

[2] Q. V. Dang and C. Ignat. Quality assessment of wikipedia articles without feature engineering. In *Proceedings of the 16th ACM/IEEE-CS on Joint Conference on Digital Libraries, (JCDL)*, pages 27–30, 2016.

OASIS: An efficient evaluation method for entity resolution

[Extended Abstract]

Neil G. Marchant and Benjamin I. P. Rubinstein
School of Computing and Information Systems
University of Melbourne
{nmarchant,brubinstein}@unimelb.edu.au

ABSTRACT

We propose a novel method for evaluation of entity resolution called OASIS, based on sequential importance sampling. Experimental comparisons of OASIS with other sampling methods demonstrate significant reductions in labelling requirements of up to 83% without loss of accuracy.

CCS Concepts

•**Information systems** → **Entity resolution;**

Keywords

Entity resolution; evaluation; importance sampling; stratification; variance reduction; class imbalance

1. INTRODUCTION

Entity resolution (ER) is the problem of identifying matching records across two or more data sources. It is often a difficult problem to solve in practice, due to lack of shared keys, unreliable data and inhomogeneous data representations. As a result, ER systems are prone to making errors, and it is thus vital to accurately assess their performance prior to deployment.

The conventional approach to performance evaluation involves drawing a representative sample of record pairs (one from each data source) and asking a human to label the matches/non-matches. These human-provided labels are then used, together with the predictions made by the ER system, to compute a measure of the system's performance (e.g. precision, recall). However, this turns out to be costly due to the extreme class imbalance associated with ER. Since matches are so rare, a very large sample must be labelled in order to obtain accurate performance estimates.

2. AIM

Our goal is to reduce the onerous labelling requirements when evaluating ER systems. Concretely, we aim to develop an evaluation method that yields performance estimates which are (i) statistically consistent and (ii) have minimal variance, whilst at the same time minimising the amount of human labelling required. We focus on the F-measure in this work since it is commonly used and is resilient to class imbalance.

3. METHOD

We propose a method called OASIS—*Optimal Asymptotic Sequential Importance Sampling*. It involves sampling record pairs according to a biased sampling distribution, which is chosen so as to minimise the asymptotic variance of the F-measure estimates. As labels are retrieved for the sampled pairs, the biased sampling distribution is updated to approach optimality according to an underlying stratified Bayesian model. After collecting T labels, a consistent estimate of the α-weighted F-measure is obtained using:

$$\hat{F}_\alpha = \frac{\sum_{t=1}^{T} w_t \ell_t \hat{\ell}_t}{\alpha \sum_{t=1}^{T} w_t \hat{\ell}_t + (1-\alpha) \sum_{t=1}^{T} w_t \ell_t},$$

where index t denotes the order of the sampled pairs, ℓ_t is the true label of the t-th sample, $\hat{\ell}_t$ is the predicted label of the t-th sample, and w_t is the importance weight.

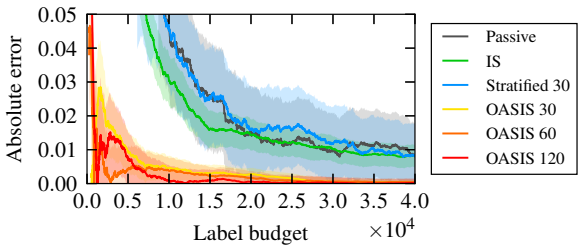


Figure 1: Expected absolute error in the F-measure estimate for four different sampling methods: passive, IS, stratified and OASIS. Bands are approximate 95% confidence intervals.

4. EXPERIMENTS & RESULTS

We ran experiments comparing the accuracy and labelling requirements of OASIS with three baseline methods: passive sampling, stratified sampling and importance sampling. The experiments were run on five ER datasets/systems, and the evaluation was repeated 1000 times for each method.

The results show that OASIS beats the baseline methods on all but one of the five datasets, both in terms of the absolute error of the estimate and the estimator variance. A selected result for the Amazon-GoogleProducts dataset is shown in Figure 1. It shows that the labelling requirements for OASIS are reduced by 83% compared to the previous state-of-the-art to achieve an expected error of 0.01.

5. REFERENCES

N. G. Marchant and B. I. P. Rubinstein. In Search of an Entity Resolution OASIS: Optimal Asymptotic Sequential Importance Sampling. *arXiv:1703.00617 [cs, stat]*, 2017.

Data Stream Clustering in Non-Stationary Environments

[Extended Abstract]

Milad Chenaghlou
University of Melbourne
Melbourne, Australia
mchenaghlou@student.unimelb.edu.au

Masud Moshtaghi
University of Melbourne
Melbourne, Australia
mosm@unimelb.edu.au

Christopher Leckie
University of Melbourne
Melbourne, Australia
caleckie@unimelb.edu.au

Mahsa Salehi
IBM Research
Melbourne, Australia
mahsalehi@au1.ibm.com

ABSTRACT

In this paper, we propose a clustering algorithm for non-stationary data streams that automatically identifies the number of clusters. It requires a single pass over the stream and we show that it outperforms the benchmark algorithms.

CCS Concepts

•Information systems → Clustering; Data stream mining;

Keywords

Data Streams; Clustering; Stream Mining

1. INTRODUCTION

The data stream model has emerged with the advances in hardware and software technologies that allowed large-scale data acquisition. One of the problems proposed for data streams is clustering which has a wide range of applications including Internet of Things (IoT), Wireless Sensor Networks (WSN) and computer network traffic monitoring.

In the streaming environments, algorithms have a partial view (sliding window) of the data and cannot keep an observation in memory for a long time. Besides, there are a few restrictions in this model that need to be considered: (1) Data points arrive continuously and there is no control on the ordering of which they arrive. (2) The size of the data stream is unbounded.

2. METHODOLOGY

We calculate the minimum buffer length (partial view) L needed to capture all the important information in the stream to cluster data. While it automatically determines the number of clusters, it is capable to detect anomalies.

One iteration of the algorithm is comprised of two steps. First, the algorithm verifies if the newly arrived observation $\boldsymbol{x}_{n+1}$ belongs to the clusters in the model, and if so, updates the selected clusters [2]. Second, the algorithm determines if the observations in the buffer that do not belong to the clusters in the model are anomalies or an emerging mixture cluster. The key to answer this question is the buffer length L. Having the right value for L the algorithm performs a batch clustering algorithm on the observations in the buffer to distinguish emerging mixture clusters from anomalies.

Caluclate L: The value of L is calculated from two numbers. The input parameter p which determines the minimum weight of a component in an emerging mixture cluster that the algorithm is capable to detect and the *sample size*. Sample size is calculated by defining an Elliptical Confidence Region (ECR) for the mean of the underlying component so that the cluster would be a representation of the component. The ECR A is calculated by

$$A = \left\{ \mu \in \mathbb{R}^d : (\bar{x} - \mu)\Sigma(\bar{x} - \mu)' < \frac{d}{q-d} F_{1-\alpha;d,q-d} \right\} \quad (1)$$

where μ is the mean of the underlying component, $\bar{x}$ is the sample mean, Σ is the covariance of the sample, d is the dimensionality of the data, q is the sample size, F is the F inverse cumulative distribution and α is the confidence level. In Equation 1, q is calculated such that the cluster covers at least half of the underlying component. Consequently, L is calculated by $L = (1/p) * q$.

3. RESULTS

To compare the quality of the clustering of the proposed method, we employ the Normalized Mutual Information measure (NMI_{max}) which calculates the rate of the similarity of the labels of the results of the algorithms with respect to the ground truth. We compared our algorithm with two baselines in the literature named as sequential KMeans and CluStream [1]. We used a subset of the *gas sensor array under dynamic gas mixtures* data set [1] and the results are presented in Table 1. The proposed method outperforms the other algorithms, while finishing under one minute.

Table 1: Results on real world dataset

Algorithm	**NMI_{max}**	**Time**(sec)
`Proposed Method`	**0.97**	22.77
`CluStream`	0.79	409
`Sequential KMeans`	0.52	**2.36**

4. REFERENCES

[1] C. C. Aggarwal et al. A framework for clustering evolving data streams. In *Proc. of the 29th Int. Conf. on Very Large Data Bases-Volume 29*, pages 81–92. VLDB Endowment, 2003.

[2] M. Moshtaghi et al. Evolving fuzzy rules for anomaly detection in data streams. *IEEE Transactions on Fuzzy Systems*, 23(3):688–700, 2015.

[1] https://goo.gl/KahTbw

What I talk about when I talk about (library shelf) browsing

[Extended Abstract]

Dana McKay
University of Melbourne
danamckay@gmail.com

ABSTRACT

Browsing is a key part of information seeking, particularly in the library. Despite it being a statistically significant access method, and something users report enjoying, there is little work on what information seekers actually do when they browse the shelves. In this paper we present an empirically grounded framework describing library browsing behaviour with a view to identifying key requirements for online browsing interfaces.

CCS Concepts

A• **Human-centered computing~Field studies • Information systems~Users and interactive retrieval**

Keywords

Browsing; libraries; HCI; information seeking; users

1. INTRODUCTION

Browsing is a fundamental part of library information behavior; it is well liked and has a statistically significant effect on what is retrieved [3]. Lack of browsing facility is one of the reasons readers give for not wanting to use ebooks [2], increasingly excluding them from many library offerings.

Surprisingly there is little research on the behaviours that comprise browsing. A study of early OPACs had some incidental discoveries about browsing [1]; a contemporaneous study created a descriptive framework of children's browsing [4], and a recent study applied that framework to adult browsing over the course of selecting a single book [2]. This paper describes a recent, formative examination of browsing that followed readers throughout their book selection process.

2. METHOD

This study was conducted using a situated observational approach; 31 randomly selected readers were observed choosing books in two libraries. Observations followed users throughout their book selection process; once readers had selected books they were interviewed about their actions, including their intention coming to the library, whether they had used search as part of their book selection strategy, and whether they had found what they were looking for. Data collection was handwritten notes transcribed into a spreadsheet. Data was analysed by two researchers using an inductive, qualitative approach, after three iterations inter-rater agreement was over 80% for all classes.

3. RESULTS

The first result of note is that nearly one third of readers did not browse; they selected their books or abandoned the shelves if they could not find them, and left.\

Browsing behaviour can be classified on a number of axes, including the presence or absence of search; the physical range over which readers browsed—a small or large area; the density they browsed within that range; readers actions with the larger stak, for example moving along and turning around; actions with individual shelves, such as marking a place with their fingers, book selection criteria; tool use and triage location.

The most interesting findings for digital design were placemarking behaviours (holding a place on the shelves or running fingers along a shelf), the prevalence of zooming in and out from the macro level of a whole stack to the micro level of a single book, and the massive range of books most readers browsed (usually more than one library stack).

4. DESIGN IMPLICATIONS

While—as we might expect—around one third of readers did not browse, two thirds of readers did. There are some existing online browsing systems (such as Ex-Libris' virtual browse or BookFish); arguably search results or recommender systems also present the opportunity to browse. These systems present a vastly smaller number of books than most browsers in our study examined, however, and do not offer seamless changes from macro view to micro view and back again. Equally readers cannot hold a place on the shelves while examining books, nor do they retain an at-a-glance way to remind themselves of alternatives while examining a candidate book. Each of these things needs to be incorporated into online browse if it is to offer a viable alternative to the physical shelves.

5. ACKNOWLEDGMENTS

We thank Swinburne Library and the State Library of Victoria for supporting this study

6. REFERENCES

[1] Hancock-Beaulieu, M., 1993. Evaluating the impact of an online library catalogue on subject searching at the catalogue and at the shelves. *J Doc 46*, 4, 318-338. DOI= http://doi.org/10.1108/eb026863.

[2] Hinze, A., Mckay, D., Vanderschantz, N., Timpany, C., and Cunningham, S.J., 2012. Book selection behavior in the physical library: implications for ebook collections. In *Proc JCDL '12* (Washington, DC), ACM, 305-314. DOI= http://doi.org/10.1145/2232817.2232874.

[3] Mckay, D., Smith, W., and Chang, S., 2014. Lend me some sugar: Borrowing rates of neighbouring books as evidence for browsing. In *Proc DL 2014* (London, UK), 145-154. DOI= http://doi.org/10.1109/JCDL.2014.6970161.

[4] Reutzel, D.R. and Gali, K., 1998. The Art of Children's Book Selection: A Labyrinth Unexplored. *Reading Psychology 19*, 1 (1998/01/01), 3-50. DOI= http://doi.org/10.1080/0270271980190101.

Boardgames Rule(s)

[Extended Abstract]

Melissa J. Rogerson
Interaction Design Lab, School of Computing & Information Systems
The University of Melbourne
Melissa.rogerson@unimelb.edu.au

ABSTRACT

In this paper, we examine the ways in which players negotiate, enact and interpret rules during boardgame play. We show that this is based not only on the game's formal documented ruleset but also on the cultural context of play. Based on a lab-based study in which we observed boardgamers at play, we describe some of the forms that this rules interpretation and negotiation can take, and present the process of interpreting and negotiating rules as a complex coordinative practice that supports and enables play.

CCS Concepts

Human-centered computing → **Human computer interaction (HCI)** → **Interaction paradigms** → **Collaborative interaction**

Keywords

Distributed cognition; situated cognition; boardgames; articulation work; cooperation; rules; coordination

1. INTRODUCTION

CSCW has long recognised the importance of studying offline as well as online cooperative work and play [1; 2]. In this paper, we discuss the "coordinative practices" [4] of boardgame play, examining how players negotiate, enact and interpret rules within the framework of the game. Rather than trying to describe a single foundational underlying ruleset, we seek to explore the relationship between the players, the supplied rules, and the way that those rules are enacted during play. We recognize that play itself exists within an "historically and culturally constituted" context [6] and that this itself affects the players' understanding of the rules of the game as well as their readiness and desire to adjust, negotiate and amend those rules.

2. BACKGROUND

Emergent rules – simple rules which allow for more complex interactions through the progress of the game – are often named as a key feature of modern boardgames [3]. But the game's rules must themselves be collaboratively understood by the players. Play incorporates "unstatable and unknowable" concepts including "fairness, sportsmanship and practicality" [5]; hence, it can be seen as an ongoing process of rules negotiation and redefinition.

3. METHOD

We conducted a series of six sessions in which a total of 30 participants were invited to play boardgames in a laboratory setting. Participants were aged between 18 and 61, with a median age of 40; 13 were female and 17 male. Participants rated their knowledge of boardgames relatively highly, with a mean of 6.85 out of 10. Each session ran for at least two hours; in several, participants chose to stay for longer. One participant in each session wore a mobile gaze tracker, which we used as a supplementary method for gathering data about the participants' experience and attention during play.

We observed and took notes during each session, and recordings were subsequently transcribed. Through re-watching the video recordings in conjunction with our notes and the transcripts, we identified key moments of rules interpretation and negotiation for detailed analysis.

4. FINDINGS AND CONCLUSION

Players work collaboratively to enforce and interpret the game rules, and may extend their context beyond what is originally foreseen in the game's codified ruleset, for example by appropriating other spaces and objects such as the lid of the game box, to support the play. We found evidence of renegotiated rules, for example in the act of "taking back" a turn of move; of imposed rules, for example when a player requires others to adopt a convention; of epistemic tasks such as sorting and ordering; of questioning and prompting as support for rules learning; of collaborative error resolution; and of more general didactic practices around teaching rules. Although one player in each session typically took on the role of game teacher, rules clarifications were made by other players as well. Our observations demonstrate that boardgame play requires deep and complex relationships between the players, the material game components, and the documented and negotiated ruleset.

5. ACKNOWLEDGMENTS

This work was supported by an Australian government Research Training Scholarship. We further gratefully acknowledge the support of the Microsoft Research Centre for Social NUI, and specifically of Martin Gibbs and Wally Smith.

6. REFERENCES

[1] Brown, B. and Bell, M., 2004. *CSCW at play: 'there' as a collaborative virtual environment*. In *Proceedings of the 2004 ACM conference on Computer supported cooperative work* ACM, 350-359.

[2] Hutchins, E.L., 1995. *Cognition in the Wild*. The MIT Press, Cambridge, MA.

[3] Pulsipher, L., 2006. The Essence of Euro-style Games. *The Games Journal*, Retrieved from http://thegamesjournal.com/articles/Essence.shtml.

[4] Schmidt, K. and Wagner, I., 2004. Ordering Systems: Coordinative Practices and Artifacts in Architectural Design and Planning. *Computer Supported Cooperative Work 13*, 349-408. Retrieved from.

[5] Sniderman, S., 2006 [1999]. Unwritten Rules. In *The game design reader: A rules of play anthology*, K. Salen and E. Zimmermann Eds. The MIT Press, Cambridge, Massachusetts, 476-502. Retrieved from.

[6] Suchman, L., 2007. *Human-Machine Reconfigurations: Plans and Situated Actions*. Cambridge University Press, Cambridge, UK.

Forget the Salt, Pass the iPad: Technology at Mealtimes

[Extended Abstract]

Hasan Shahid Ferdous
Microsoft Research Centre for Social NUI, Dept. of CIS, University of Melbourne
hferdous@student.unimelb.edu.au

ABSTRACT

This research aims to: (1) examine the everyday interactions of familial uses of technology around mealtimes and investigate how family members configure the dining space and the technologies within it; (2) understand how technologies are used and negotiated amongst family members and the influence of these technologies on the content and context of their interactions; (3) investigate how our everyday technologies can be used to enhance the familial experience of eating and create new experiences for togetherness.

CCS Concepts

•Human-centered computing → Empirical studies in collaborative and social computing;

Keywords

Family; mobile devices; togetherness; mealtimes.

1. INTRODUCTION

Family mealtimes are an important site for fostering togetherness, sharing everyday experiences, and nurturing family ties. Grimes and Harper [1] were one of the first few in HCI to discuss the creativity, endowment, relaxation, and nostalgia found in the togetherness of family meals. We extend this by exploring the ways in which a broader set of everyday technologies become implicated in the configuration of commensal practices and family relations at mealtimes. We investigate how a detailed understanding of commensality informs the design of new technologies and how such technologies reconfigure our practices of shared mealtimes.

2. FINDINGS

We began with an exploration of the current practices of personal and shared device usage during family meals and provided a rich picture of the family norms, interactions, limitations, and exceptions around it. Our field-study demonstrated how these technologies support familial conversation, provide relaxation, achieve satiety, and enable celebration, albeit not without occasional tension. The use of technology at family mealtime has traditionally been seen as working against the moral foundations of commensality. While aspects of these arguments remain apparent in our own observations, we also see important ways in which technologies can be meaningfully integrated into the social space of family mealtimes and thereby contribute to commensality.

These findings encouraged us to build upon the existing and widely available personal smart-devices. We designed and developed *Chorus*, an application that orchestrates the sharing of personal smart-devices of mealtime guests into a single shared display (Fig. 1). The aim here was to enable the sharing of personal content (e.g., photos, social media posts) for the collaborative construction of a mealtime experience. We aimed to derive practical insights into how technology can be designed as a part of commensal experience to support and configure the shared space, data, narratives, and subsequently, interactions. Our three week deployment with seven families in Australia and UK focused on (1) the changes and challenges brought about by such interventions on familial practices at mealtimes; (2) how technology could augment family interactions through sharing contents of personal and familial significance (3) how *Chorus* could support togetherness and in-depth discussion by combining resources from multiple devices; and (4) how *Chorus* helped to broach sensitive topics into conversation and encouraged participation from all members in the family.

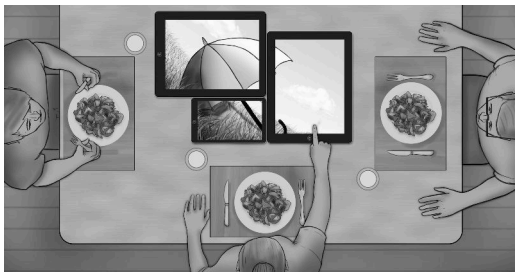


Figure 1: Chorus brings devices together to symbolize the communal aspects of commensality.

3. CONCLUSION

We offer novel understandings of the potential role of technology for commensality in the family home. The deployment of *Chorus* clearly showed how family members had focused on sharing content that signifies collective interest over personal ones and how the technology usage corresponded to various aspects of commensality. Overall, this research demonstrates that through sensitive design, deployment, and recognition of familial expectations, responsibilities, norms, and practices, personal smart-devices can be reconfigured to positively support and enhance the togetherness during family mealtimes.

4. REFERENCES

[1] A. Grimes and R. Harper. Celebratory technology: New directions for food research in HCI. In *Proc. CHI '08.*

An Interdisciplinary Perspective of Nation-Wide Health Information Systems Implementation in Developing Countries

[Extended Abstract]

Luthfi Ramadani[1]
University of Melbourne
lramadani@student.unimelb.edu.au

Sherah Kurnia
University of Melbourne
sherahk@unimelb.edu.au

Christoph Breidbach
University of Melbourne
christoph.breidbach@unimelb.edu.au

ABSTRACT
The implementation of nation-wide Health Information Systems (HIS) in developing country involves a complex and unique setting. The traditional technology-determinism research neglects the complex social structure which lead to unsustained project. In this study, we use service science perspective to uncover the complexity of healthcare ecosystems, ranging from unfolding the tangled relationship between social actors, redefining the concept of value as co-creation practices between social actors, and further investigating the transformation during HIS institutionalization. As such, this study offers a novel perspective on technology-enabled innovation in socio-technical ecosystems.

CCS Concepts
• Social and professional topics → Management of computing and information systems

Keywords
Health information systems; service science; institutions

1. INTRODUCTION
For decades, researchers have attempted to bring new technology to the developing countries. Our review on information systems (IS) literature suggests that the research on IS in developing countries is dominated by 'technology-transfer' perspective. This means that the researchers consider the deterministic impact of technology in the society. As such, the majority of the studies determined the success of the adoption of new technology merely based on users' 'use' and 'perceive of use', neglecting a more complex social construct that constrains a new innovation such as the relationship between beneficiaries, the tacit rules and norms, and their values. Consequently, through decades, this perspective lead to project failure or unsustained as the research failed to gain significant understanding of the complex social setting of developing countries [1].

2. RESEARCH AIMS AND QUESTIONS
This study seeks to explore the complexity of the context emanated in implementing HIS by adopting the related concepts from service science. The aims of this study are threefold: 1) to explicate the complexity of nation-wide healthcare ecosystems, 2) to investigate the relationship, motives, and resources of beneficiaries related to HIS implementation, and 3) to explore the interplay between technology innovation (HIS) with social change and transformation. The broad research question (RQ) proposed in this study is: "How does HIS transform the social structure of healthcare service ecosystems"? To find the answer of this overarching RQ, two interrelated research questions are formulated as follows: 1) How does HIS create new values to all beneficiaries? 2) How do actors create new practices to adopt HIS?

3. PRIORI CONSTRUCT
Service science has been widely-used in numerous interdisciplinary research ranging from marketing, innovation studies, health, and management [2]. The key constructs from service science used in this study are selected as follows. 1) *Value co-creation*; that values are perceived and co-created by multiple actors, 2) *Service ecosystems*; that the complexity of a nation-level healthcare system can be explicated through multilevel and nested social structure (macro, meso, and micro), 3) *Institutionalization of innovation*; that actors behave in certain pattern in institutionalizing a new innovation, determining the outcomes (success/failure) of the innovation.

4. PROPOSED METHOD
An exploratory in-depth case study will be adopted. This study uses the case of healthcare service ecosystems in Indonesia that is currently undergoing a major transformation through a nation-wide e-Health program. Interview and document review will be the main data collection method, which will be conducted according to the actors involved in initiating and using the new HIS from macro-level (policy and decision makers), meso-level (district government), and micro-level (health staff). An inductive interpretive data analysis will be used to generate theme and compare them with the literature. This method is chosen based on two reasons; our little knowledge on the case study context, and the infant and emerging state of service science field.

5. ACKNOWLEDGEMENTS
The author[1] would like to thanks The Indonesia Endowment Fund for Education (LPDP) for Beasiswa Pendidikan Indonesia (BPI).

6. REFERENCES
[1] S. Madon, S. Sahay, and R. Sudan, "E-Government Policy and Health Information Systems Implementation in Andhra Pradesh, India: Need for Articulation of Linkages Between the Macro and the Micro," *Inf. Soc.*, vol. 23, no. 5, pp. 327–344, 2007.

[2] S. L. Vargo and R. F. Lusch, "Service-dominant logic 2025," *Int. J. Res. Mark.*, vol. 34, no. 1, pp. 46–67, 2017.

THE PSYCHOLOGICAL CONTRACT AND ITS IMPACT ON RELATIONSHIP QUALITY IN ICT OUTSOURCING

[Extended Abstract]

Jongkil Jeong
University of Melbourne
jong.jeong@unimelb.edu.au

Sherah Kurnia
University of Melbourne
sherahk@unimelb.edu.au

Danny Samson
University of Melbourne
d.samson@unimelb.edu.au

Sara Cullen
The Cullen Group
scullen@cullengroup.com.au

ABSTRACT

Good outsourcing relationships go beyond just adhering to the contractual obligations and the completion of the project. Unspoken promises and unwritten obligations forged between a client and vendor must also be kept to ensure healthy relationships are maintained. However, these non-contractual aspects of an ITO agreement are hard to define and their impact on the relationship is also difficult to assess due to the subjective nature. To address this issue, a concept known as the Psychological Contract (PC) is used to explore the factors that influence how perceived promises and obligations which extend beyond the formal contract influence the ITO relationship. Employing multiple case studies, this study aims to illustrate how the fulfilment and/or breach of the conditions of the PC causes variance within the Relationship Quality (RQ) levels within inter-personal relationships established between project members working on an ITO project.

CCS Concepts

- **Social and professional topics → Computing and business; Applied computing → Psychology;**

Keywords

IT Outsourcing; Relationship Quality; Psychological Contract;

1. INTRODUCTION

Outcomes from ITO projects continue to remain poor with recent studies suggesting that 60% of organisations engaged in ITO did not believe it fulfilled its intended and predefined targets [1]. The reason for this lack of improvement is because ITO agreements have become more complex as they evolve from a cost saving activity to one which holds significant strategic and social importance for firms. In response to these changes, creating and maintaining a high level of Relationship Quality (RQ) which represents the degree of connectedness between parties to achieve specified goals is now considered an integral part of achieving successful outcomes. However, determining RQ has been a challenge due to its subjective and complex nature because it relies upon social factors that extend beyond the formal agreement [1].

To address this matter, a concept known as the Psychological Contract (PC) was introduced to better explain the ITO relationship [1]. The PC represents an individual's mental beliefs about their mutual obligations [1]. Due to the psychologically binding nature of the PC, the fulfilment and/or violation of these perceived obligations is considered to have a strong influence over the RQ levels in interpersonal relationships [1].

Unfortunately, the PC is still a under explored concept within ITO, due to gaps and issues caused by the uncertainty over how to define, measure and apply the PC. Therefore, the aim of this study is to improve the current understanding of the PC within the context of ITO, and to explore how the fulfilment and/or breach of the PC causes variance in the RQ levels within interpersonal ITO relationships.

2. RESEARCH DESIGN & METHOD

Figure 1 depicts the research framework to guide this study. The framework presents the PC as a construct and illustrates its connection to the RQ and its three components (trust; commitment and cooperation).

Based on the Social Exchange Theory (SET) as our theoretical lens, we argue that the fulfilment and or breach of the PC cause variance within the three components of RQ. This is because the PC creates a sense of accountability through its psychologically binding nature which determines the behaviour and attitudes an individual has on their working relationship.

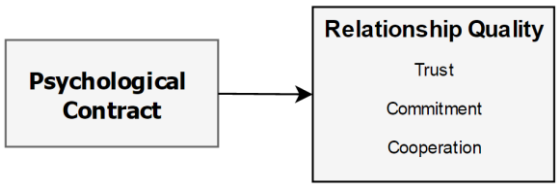


Figure 1: PC and RQ in ITO framework

Due to the complex nature of inter-personal relationships and a lack of in-depth studies exploring the PC in ITO, a qualitative research method was considered the most appropriate method for the purpose of this study. Guided by the research framework, this study employs multiple case studies involving client and vendor firms engaged in five different ITO agreements. Data are currently being collected through semi-structured interviews and a questionnaire involving individuals who have established everyday working relationships with individuals in the other party.

3. FINDINGS AND CONCLUSION

Based on the first in-depth case study, there are two important observations. The first is that every individual holds a unique PC based within the relationship her or she shares with each separate individual with whom a bi-party relationship has been formed. Secondly, the study suggests that the fulfilment and breach of the individual's PC did influence the RQ levels, but at varying strengths based on preexisting RQ levels.

In conclusion, as ITO continues to grow both in size and complexity, the role of the formal contract will diminish over time as it will be impossible to cover all the aspects of the working relationship. Therefore, firms must invest more time and effort to ensure that the PC is understood and fulfilled to ensure stronger levels of RQ moving forward.

4. REFERENCES

[1] C. Koh, S. Ang, D.W. Straub, IT outsourcing success: A psychological contract perspective, Information Systems Research, 15 (2004) 356-373.

Combining Metamorphic Testing and Dynamic Symbolic Execution for effective test inputs generation

[Extended Abstract]

Eman Alatawi
The University of Melbourne
e.alatawi@student.unimelb.edu.au

Tim Miller
The University of Melbourne
tmiller@unimelb.edu.au

Harald Søndergaard
The University of Melbourne
harald@unimelb.edu.au

ABSTRACT

Dynamic symbolic execution (DSE) is an approach for automatically generating test inputs from source code to test for properties such as buffer overflows and other security violations. A key limitation of DSE for fuzzing is that only generic properties are checked: many deviations from specified behaviour are not found. We propose a method to help mitigating this problem by combining DSE with *metamorphic testing* (MT) that uses domain-specific properties about program behaviour. Our experimental evaluation shows that DSE+MT improve the fault detection effectiveness of the generated test suites significantly.

CCS Concepts

•**Software and its engineering** → *Software testing and debugging;*

Keywords

Dynamic symbolic execution; metamorphic testing

1. INTRODUCTION

Dynamic symbolic execution (DSE) [3] has been proposed as one way to generate tests automatically from source code. Given a program and an input, DSE uses *symbolic execution* to record how the input affects the control flow in the program. The result is a path constraint – a logic formula – that is used to generate tests until a specified form of coverage is achieved.

Problem. While this use of DSE for fuzzing has proved valuable at finding security faults. One of the major limitations of fuzzing is that it detects only *generic* faults: faults such as exceptions, buffer overflows, or violation of specific security properties; or it requires assertions in the program's code. The approach does not reveal faults that are *domain specific* [1]. For that, a test oracle would be needed, and when available, it can increase the value of running a DSE tool. However, in practice, good test oracles are rarely available. Hence, this task is often done manually, if at all.

Approach. In this paper, we combine DSE test generation with *Metamorphic Testing (MT)* [2]. MT is a technique that aims to mitigate the problem of oracle unavailability in software testing by using existing test suites (*source tests*) to generate *follow-up* tests based on a set of required properties of the targeted functionality of the program. These properties, called *metamorphic relations (MRs)* are expressed as a relationship between the program inputs, and their corresponding outputs. When a program is found to violate one of these relations, it signals an error in the program or the relation itself. As an example, consider a function that sorts a sequence of integers in ascending order. Given source test input – an array of integers – we can generate a follow-up test by randomly permuting the elements of the array. When we run the program on both inputs, the outputs should be identical. In this case, the input relation is permutation, while the output relation, is the identity relation.

Our hypothesis is that using metamorphic testing increases the ability of a DSE test suite to find more domain specific faults, and execute some previously-uncovered segments.

2. EVALUATION AND RESULTS

We undertook a controlled experiment comparing the effectiveness of DSE based on code coverage and mutation score using seven collections of programs from different application areas. We generated test suites from the programs using two DSE tools, jCUTE and Pex, and we used mutation analysis to estimate the fault-finding effectiveness of the test suites under three conditions: (a) using no test oracle; (b) using a metamorphic test oracle; and (c) using a "golden" test oracle, which is the original, non-mutated version of the program. Because metamorphic testing creates additional test inputs, we also controlled for the increased test suite size by running the extended test suite using all three oracles [1].

The results of the study indicate that, while the increase in coverage is limited, combining DSE and MT can significantly increase coverage in programs with data types that are difficult to reason about symbolically–in those cases, DSE effectiveness is limited. Further, metamorphic testing has the potential to increase the fault-detecting ability of a DSE-generated test suite considerably.

3. REFERENCES

[1] E. Alatawi, T. Miller, and H. Søndergaard. Using metamorphic testing to improve dynamic symbolic execution. In *Proc. 24th Australasian Software Engineering Conference*, pages 38–47. IEEE Comp. Soc., 2015.

[2] T. Y. Chen, S. C. Cheung, and S. M. Yiu. Metamorphic testing: A new approach for generating next test cases. Technical Report HKUST-CS98-01, Hong Kong University of Science and Technology, 1998.

[3] P. Godefroid, M. Levin, and D. Molnar. Automated whitebox fuzz testing. In *Proc. Network and Distributed System Security Symposium*, volume 8, pages 151–166. The Internet Soc., 2008.

A Novel Contrast Pattern Mining Methods for Analyzing Retail Datasets

Li Li
University of Melbourne
lli10@student.unimelb.edu.au

Sarah Erfani
University of Melbourne
sarah.erfani@unimelb.edu.au

Christopher Leckie
University of Melbourne
caleckie@unimelb.edu.au

ABSTRACT

Contrast patterns have been successfully applied to many data mining domains, such as prediction, classification and clustering. In a retail environment, shop managers may be interested in finding the relationships or differences between sales data and customers' behavior. However, none of the previous studies has considered extracting contrast patterns from different types of datasets. In this paper, we introduce a new type of contrast pattern, Conditional Contrast Patterns (CCPs), which are a subset of traditional Contrast Patterns (CPs) in one kind of dataset conditioned on a property of these patterns in another kind of dataset. We evaluate our proposed method in comparison with other two methods (Brute force and Apriori-based methods) on a synthetic dataset as well as a real-life retail dataset, which includes transactions and customer's pathes. The results show that CCPs are more informative and actionable for decision makers than normal CPs, and our proposed algorithm has the best performance in terms of efficiency.

CCS Concepts

•**Information systems applications** → **Data analytics**; •**Applied computing** → *Information integration and interoperability;*

Keywords

conditional contrast patterns; contrast data mining; customer behavior analysis

1. INTRODUCTION

Contrast data mining aims to quantify and describe the differences between two given multivariate datasets, where a contrast pattern is defined as a pattern that occurs frequently in one dataset and infrequently in the second dataset [1]. However, current research in the literature cannot answer questions like *"If we have data from multiple types of data sources, how can we extract interesting patterns by considering different datasets at the same time?"* or *"Can we find patterns where there has been a big change in one type of dataset but not much of change in the other?"*.

In this paper, our main contributions are: 1) We introduce and define a novel class of pattern, called Conditional Contrast Patterns (CCPs). It can be more *informative* and *instructive* for decision makers since it utilizes *information from additional related data sources*. 2) We propose a conditional contrast pattern tree [2] based method for mining CCPs. 3) We evaluate our method and compare its performance with two baseline methods (brute-force and Apriori-based methods) on a synthetic dataset as well as a real life retail dataset, which includes the transaction data and customer behavior of each customer in a retail store in Melbourne. The results demonstrate the efficiency and practicality of our proposed method.

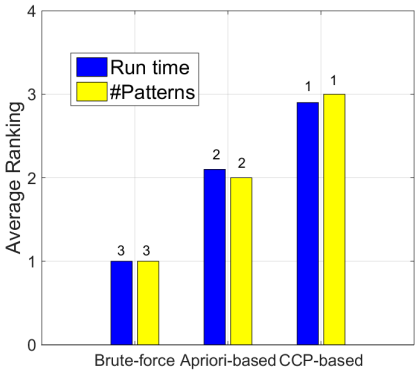


Figure 1: Comparison of rankings of three methods for 2 metrics. The number on the top of the bars indicates the ranking of the algorithm, from the best(1) to worst(3) for each given measure. The ranking is determined for all datasets and finally an average is calculated as the mean of all rankings

2. RESULTS

The results of our method compared with two other methods in terms of efficiency and the number of patterns are shown in Figure 1.

3. REFERENCES

[1] S. D. Bay and M. J. Pazzani. Detecting change in categorical data: Mining contrast sets. In *Proceedings of the fifth ACM SIGKDD international conference on Knowledge discovery and data mining*, pages 302–306. ACM, 1999.

[2] H. Fan and K. Ramamohanarao. Fast discovery and the generalization of strong jumping emerging patterns for building compact and accurate classifiers. *IEEE Transactions on Knowledge and Data Engineering*, 18(6):721–737, 2006.

Communication Decisions with Shared Mental Models

[Extended Abstract]

Ronal Singh
School of Computing and Systems
University of Melbourne
ronals@student.unimelb.edu.au

ABSTRACT

Highly interdependent activities require teams to be inter-predictable. Skilled teams become inter-predictable through *common ground*, which refers to the pertinent mutual knowledge, beliefs, and assumptions that support interdependent actions in the context of a given joint activity. This notion of common ground aligns well with the research on *shared mental models* (SMM). In this paper, we present a method for agents to make their communication decisions to establish SMM. SMM comprises components, such as world knowledge and intentions. Different types of information may be required to support effective coordination in different situations. Reasoning about communicating the right SMM components may allow agents to be effective teammates.

CCS Concepts

•**Computing methodologies** → **Cooperation and coordination;** Multi-agent systems;

Keywords

Shared Mental Models; Communication; Teamwork

1. INTRODUCTION

Shared mental models has been defined as: "knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and, in turn, coordinate their actions and adapt their behaviour to demands of the task and other team members" [2]. Some recent studies have also investigated SMM for artificial agent teams and human-agent teams [4]. Effective communication protocols facilitate the development of SMM. As such it is imperative for agents to establish common ground with team members through effective communication so that intentions and actions are mutually understood and expected [3, 1]. A major gap in literature is the identification of the type, amount, and rate of information [3]. In this paper, we explore a mechanism that utilises automated planning technology to enable agents to choose their communication actions based on SMM.

2. COMMUNICATION ALGORITHM

Agents are provided a set of messages G. Each message $g \in G$ has $PRE(g)$, which identifies message preconditions, and $EFF(g)$, which identifies the beliefs or intentions to be communicated. Algorithm 1 allows agents to make communication decisions. Using a copy of the mental state of each agent, new plans are generated for each possible goal of the other agents. Agents communicate if a message results in quicker plans for the other agent. In case of multiple candidate messages, the *score* function is used to rank the messages. The message with the highest expected utility, EU, will be selected for transmission.

```
1  EU_max = 0.0
2  selectedMessage = null
3  foreach msg ∈ messages do
4  |  foreach ag ∈ otherAgents do
5  |  |  oACopy = getMentalStateCopy(ag)
6  |  |  plans = simulateMsgEffs(oACopy, msg)
7  |  |  EU_msg = score(plans)
8  |  |  if EU_msg > EU_max then
9  |  |  |  EU_max > EU_msg
10 |  |  |  selectedMessage = msg
11 |  |  end
12 |  end
13 end
14 return selectedMessage
```

Algorithm 1: Algorithm for selecting world knowledge.

3. ACKNOWLEDGMENTS

Sincere thanks to my supervisors, Prof Liz Sonenberg and Dr Tim Miller for their support and guidance.

4. REFERENCES

[1] M. J. Barnes, J. Y. C. Chen, and S. Hill. Humans and autonomy: Implications of shared decision-making for military operations humans and autonomy: Implications of shared decision-making for military operations. 2017.

[2] J. A. Cannon-Bowers, E. Salas, and S. Converse. Shared mental models in expert team decision making. In J. Castellan, N. John, editor, *Individual and group decision making: Current issues*, pages 221–246. Hillsdale, NJ:Lawrence Erlbaum., 1993.

[3] K. E. Schaefer, E. R. Straub, J. Y. Chen, J. Putney, and A. Evans. Communicating intent to develop shared situation awareness and engender trust in human-agent teams. *Cognitive Systems Research*, 2017.

[4] R. Singh, L. Sonenberg, and T. Miller. *Communication and Shared Mental Models for Teams Performing Interdependent Tasks*, pages 163–179. Springer International Publishing, Cham, 2016.

Budget-constrained Resource Provisioning and Scheduling Algorithms for Scientific Workflows in Cloud Environments

[Extended Abstract]

Muhammad Hafizhuddin Hilman, Maria Alejandra Rodriguez and Rajkumar Buyya
CLOUDS Laboratory, School of Computing & Information System, The University of Melbourne
hilmanm@student.unimelb.edu.au, {marodriguez, rbuyya}@unimelb.edu.au

ABSTRACT

The deployment of large scale scientific workflow into cloud computing is popularly explored. Infrastructure as a Service (IaaS) Clouds offer flexible access to the resources (i.e., virtual machines) required for the execution of scientific workflows. This flexibility leads to a trade-off between two conflicting Quality of Service (QoS) requirements: time and cost. Majority of works in this area focus on meeting the deadline while minimizing the cost and few of them exploiting the budget spending to minimize the makespan. In this paper, we propose the Fastest-First Task-based Distribution (FFTD) and Slowest-First Task-based Distribution (SFTD), budget distribution algorithms designed to minimize the makespan with budget constraint. Our simulation results demonstrate that FFTD can meet the budget constraint and achieve lower makespan when compared to state-of-the-art budget distribution algorithm.

CCS Concepts

•Networks → Cloud computing; •Software and its engineering → Scheduling;

Keywords

Scientific Workflows; Resource Provisioning; Scheduling; Cloud Computing

1. INTRODUCTION

E-Science experiments have been drawing people's attention after The LIGO project successfully found gravitational waves. These experiments are generally composed of multiple scientific applications linked together, as workflows. They are large-scale applications and cloud computing has become popular for their deployment in particular. However, this leads to a trade-off between two important QoS parameters: time and cost. Thus, provisioning algorithms that can decide the type and number of VMs required by a workflow execution and scheduling algorithms capable of efficiently mapping the tasks to the resources while considering time and cost are essential. We propose the Fastest-First Task-Based Distribution (FFTD) and Slowest-First Task-Based Distribution (SFTD), budget distribution algorithms that aim to meet the budget constraint and minimize the makespan by distributing a portion of the budget to individual tasks and spending it only when idle time slots on VMs cannot be reused.

2. THE ALGORITHMS

We modify the EPSM algorithm [1] to a budget-constrained scheduling algorithm. Our budget distribution algorithms work by distributing the workflow budget into each individual tasks based on the execution order estimation. The order is defined by allocating the tasks into levels and sort them in each level based on The Earliest Finish Time (EFT). FFTD allocates the fastest resources within the budget to the earliest tasks while SFTD spends the slowest resources to as much tasks as possible and upgrade the allocation whenever all tasks got a share and still exists a leftover. The scheduling algorithm updates the status of budget spending whenever a task finished by recalculating the real cost and upgrading or downgrading the allocated budget for the following tasks.

3. RESULTS AND CONCLUSION

We compare our algorithms with Budget Distribution Trickling All In (BDT-AI) [2]. BDT-AI is a dynamic level-based algorithm that has the same objectives as our algorithms. We use CloudSim to model the cloud environment and a synthetic workflow with 100 tasks based on a real application from earthquake sciences (CyberShake) as a benchmark. To evaluate the performance, we use 10 different budget ranging from tighest to more relaxed ones. We use cost / budget ratio and makespan as a performance metric to evaluate the algorithms.

Generally, all algorithms are able to meet the budget constraint despite in the tighest budget, FFTD and BDT-AI violate the limit by an insignificant margin. In 80% of the cases, FFTD produced lower makespan than SFTD and BDT-AI. Meanwhile in the tighest budget, SFTD shown the lowest cost/budget ratio and makespan.

4. REFERENCES

[1] M. A. Rodriguez and R. Buyya, "Scheduling dynamic workloads in multi-tenant scientific workflow as a service platforms," *Future Generation Computer Systems*, 2017.

[2] V. Arabnejad, K. Bubendorfer, and B. Ng, "Budget distribution strategies for scientific workflow scheduling in commercial clouds," in *Proceedings of IEEE 12th International Conference on e-Science*. IEEE, 2016, pp. 137–146.

Power-Efficient Resource Provisioning in Hybrid Datacentres Using Micro Servers

[Extended Abstract]

Farzad Khodadadi
Department of Computing and Information Systems, University of Melbourne
fkhodadadi@student.unimelb.edu.au

ABSTRACT

Power consumption in datacenters has significantly increased in recent years, mainly due to increase in demand from customers and advancements in underlying technologies that have augmented cloud computing's accessibility and efficiency. In this paper, we utilize low-power edge devices introduced in Fog computing notation and combine them with high capacity conventional servers to reduce overall power consumption. Our proposed resource provisioning algorithm analyses input workloads and clusters them into relevant groups, then predicts future demand based on the observed history and allocates resources using a power-efficient approach that minimizes total power consumption.

CCS Concepts

Software and its engineering → Cloud computing

Keywords

Internet of Things, hybrid datacenter, power, fog computing, resource provisioning

1. INTRODUCTION

According to a study by US government in 2014, national data centers consumed 70 billion kilo-watt-hours of electricity in 2014, which accumulates for 2% of USA's total energy consumption [1]. Furthermore, the study demonstrates a four-percent increase in datacenters energy consumption from 2010 to 2014 and signals a ninety-percent growth compared to 10 years ago.

On the other hand, with advent of mobile computing and Internet of Things (IoT), embedded CPUs and micro servers are dominating the market because of their low-power energy profile, ease of scalability, and cost efficiency. Sensor-class micro servers have less computing, memory, and storage capacity, but their power consumption can be as low as 1 Watt, compared to 30-50 Watts required for operating a typical Dell PowerEdge R620 server [2]. Leveraging the CloudSim simulator, it is shown that a cluster of micro servers can handle parallel and none compute-intensive tasks better than a cluster of powerful servers that consume substantially more energy to perform the same tasks.

2. SYSTEM ARCHITECTURE

Most of the architectures for cloud- based solutions include cloud in the middle layer, where it stands between data or sensor layer and the application layer. However, with the emergence of Fog computing, devices at the network's edge have gained substantial importance. Our proposed architecture consists of the following layers and components:

Sensing layer: Sensors, smart devices, and any other source of data, such as human being, reside in this layer.

Edge layer: Devices with computational capability that are connected to the network and are capable of processing information and communicating with the cloud are placed in this layer.

Cloud layer: Data generated or forwarded by other two bottom layers is processed in this layer. Here, a resource provisioning entity is responsible for allocating resources to incoming requests based on available resources and optimization parameters that are provided as its input.

Available resources responsible for executing tasks can benefit from running similar tasks rather than executing a mixed workload. For this purpose, we leverage the K-means algorithm to create groups of tasks with similar execution requirements (memory, CPU, network bandwidth).

3. PERFORMANCE EVALUATION

In our assessment, tasks are classified into compute, memory, or network intensive groups and then based on their demand category, resource scheduler optimally allocates resources to them to reduce overall power consumption. Figure 1 depicts the amount of power consumed when executing different number of tasks in CloudSim. It is also shown that by using virtual machine migration within the power-packed cluster of servers, total energy saving can be further increased.

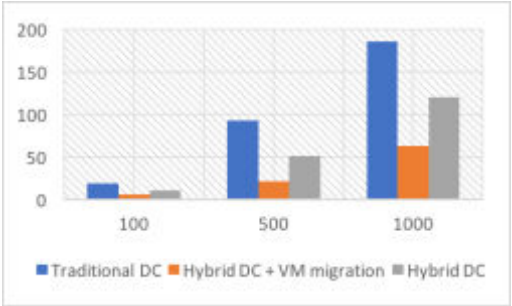


Figure 1. Power consumption (kWh) comparison of traditional, hybrid, and our proposed hybrid+VM migration algorithm

4. REFERENCES

[1] A. Shehabi, S. J. Smith, D. A. Sartor, R. E. Brown, M. Herrlin, J. G. Koomey, E. R. Masanet, N. Horner, I. L. Azevedo, and W. Lintner, "United states data center energy usage report," 06/2016 2016.

[2] Y. Zhao, S. Li, S. Hu, H. Wang, S. Yao, H. Shao, and T. Abdelzaher, "An experimental evaluation of datacenter workloads on low-power embedded micro servers," Proceedings of the VLDB Endowment, vol. 9, no. 9, pp. 696–707, 2016.

Deadline-Aware Cost-Optimized Cloud Resource Estimation for Big Data Applications

[Extended Abstract]

Muhammed Tawfiqul Islam, Shanika Karunasekera and Rajkumar Buyya
CLOUDS Laboratory, School of Computing and Information Systems, The University of Melbourne
muhammedi@student.unimelb.edu.au,{karus,rbuyya}@unimelb.edu.au

ABSTRACT

Cloud provides affordable and flexible computing resources. Therefore, it is easier to deploy and maintain a cluster for big data processing frameworks like Hadoop-MapReduce[1], Spark[2] etc. in cloud. However, it is challenging to incorporate user-specific SLA requirements in these type of clusters. In this paper, we propose a resource estimation framework for distributed batch-based applications in Apache Spark.

CCS Concepts

•**Networks** → **Cloud Computing;** •**Software and its engineering** → *Resource Estimation;*

Keywords

Cloud Computing, Big Data, Apache Spark, Resource Estimation, Optimization

1. INTRODUCTION

Now-a-days it is very common to use big data processing frameworks like Hadoop-MapReduce, Apache Spark to process huge amount of data. As it is difficult to maintain a local cluster to deploy big data applications, creating a big data cluster using cloud resources is becoming more popular. However, from user's perspective, it is very difficult to impose any SLA requirements. In addition, framework-specific default or static resource allocation schemes often lead to poor resource utilization which affects the user SLA. In this work, we propose a resource estimation model for Apache Spark. In addition, we also propose a cost optimization model which utilizes resource estimates to select an optimal deadline-based cost effective resource configuration for a big data application.

2. PROPOSED APPROACH

2.1 Resource Estimation

In our proposed approach, we modelled the resource consumption of an application in terms of executors (execution unit for an application comprising of CPU, memory). In our system, we have a profiler module which collects the execution times of an application for different size of input workloads in multiple resource configurations (different number of executors). Then a prediction model is made to predict the application time for any size of input and resource configuration.

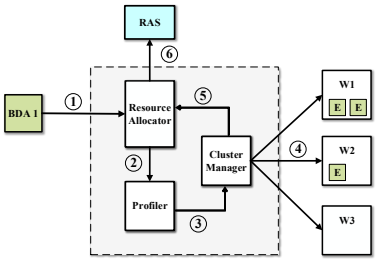


Figure 1: System Architecture

2.2 Cost Optimization

We have modelled the problem of executor cost optimization as a non-linear constraint optimization problem. The output of this model is the minimum number of executors to use for an application without violating user-specified deadline.

3. RESULTS AND CONCLUSION

We evaluate our model with three different types of application: WordCount, Sort and PageRank. The mean relative error (RE) of the prediction model for application execution times is less than 5%.

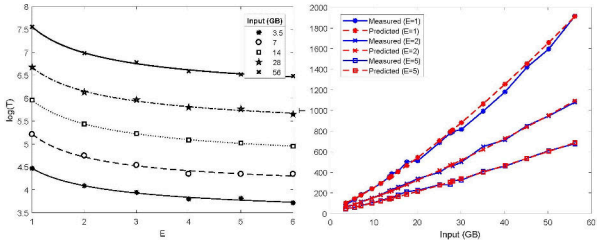


Figure 2: (a) Execution Time Modelling (b) Prediction Results (Sort Application)

4. REFERENCES

[1] J. Dean and S. Ghemawat. Mapreduce: simplified data processing on large clusters. *Communications of the ACM*, 2008.

[2] M. Zaharia, M. Chowdhury, M. J. Franklin, S. Shenker, and I. Stoica. Spark: Cluster computing with working sets. *HotCloud*, 2010.

Paper Session 2

Biocuration experts on the impact of duplication and other data quality issues in biological databases

[Extended Abstract]

Qingyu Chen Justin Zobel Karin Verspoor
University of Melbourne
qingyuc1@student.unimelb.edu.au
{jzobel, karin.verspoor}@unimelb.edu.au

ABSTRACT

We present opinions from over twenty practitioners who have domain expertise on biological database related studies. The opinions detail characteristics, impacts and solutions of duplication in biological databases and generalise to other data quality issues. It also reveals that a broader community effort is needed to facilitate thorough biocuration.

CCS Concepts

•Information systems → Deduplication; Data cleaning; Entity resolution; •Applied computing → Bioinformatics;

Keywords

Duplicate detection; Bioinformatics; Data curation

1. INTRODUCTION

The volume of biological database records is growing at an unprecedented rate, populated by complex records drawn from heterogeneous sources [1]. Biocuration is the key mechanism that is used to ensure the underlying data quality. A specific challenge is duplication, that is, the presence of redundant or inconsistent records. The characteristics (which records are duplicates), impacts (why duplicates are significant), and solutions (how to address duplication) are not well understood; the related studies are neither recent nor comprehensive. Here we present the opinions of over 20 experts and practitioners on the topic.

2. METHOD AND RESULT

We surveyed over 20 practitioners on the questions of duplicates and their impact. These practitioners are from diverse backgrounds (experimental biology, bioinformatics, computer science etc), with a range of kinds of affiliation (such as service providers, universities, and institutes) but all have domain expertise. The first part of the survey asked three primary questions: (1). What are duplicates? We asked practitioners what records they think should be regarded as duplicated; (2). Why care about duplicates? We asked practitioners what impacts duplicates have and (3). How to manage duplicates? We asked practitioners if, and how, duplicates should be resolved. The survey further extended to broader quality issues. It asked what data quality issues have been observed in biological databases and why care about data quality. Finally we interviewed curation leader from UniProtKB as a specific case study.

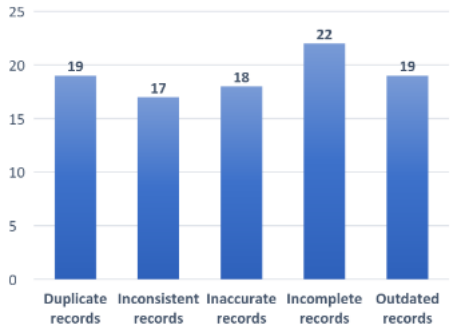


Figure 1: Practitioners observe diverse quality issues.

The results reveal that survey participants feel that (1) Duplicate records have diverse types, not merely similar or identical; (2) The negative impacts of duplicates are severe; its positive impacts only reply on the prerequisite that duplicates have been correctly labelled; (3) Future duplicate detection methods need to be more precise, scalable and robust. The investigation on other quality issues shows that data quality issues are diverse, as illustrated in Figure 1.

Overall, our survey of individual practitioners showed that duplication in biological databases is of concern: its characteristics are diverse and complex, its impacts cover almost all stages of database creation and analysis, and methods for managing the problem of duplication have significant limitations. The responses relating to general data quality further show that data quality issues go well beyond duplication. Curation – dedicated effort to ensure that biological databases represent accurate and up-to-date scientific knowledge – is an effective tool for addressing quality issues. However, manual curation alone is not sufficient to resolve all data quality problems due to rapidly growing data volumes in a context of limited resources. A broader community effort is required to manage data quality and to provide support to facilitate data quality and curation.

3. REFERENCES

[1] A. D. Baxevanis and A. Bateman. The importance of biological databases in biological discovery. *Current protocols in bioinformatics*, pages 1–1, 2015.

Using Learning Analytics to Understand Health Professionals' Informal Learning in Online Social Networks

[Extended Abstract]

Xin Li
School of Computing and Information Systems
xinl5@student.unimelb.edu.au

Kathleen Gray
School of Computing and Information Systems
kathleen.gray@unimelb.edu.au

Karin Verspoor
School of Computing and Information Systems
karin.verspoor@unimelb.edu.au

ABSTRACT

This research investigates how learning analytics may be served as a method for understanding the process of informal learning in online social networks for health professionals. This research is based on a multi-method design that employs a set of analytics methods including social network analysis, topic modelling, and context analysis to investigate the learning interaction, learning content and context of learning within a large online discussion forum for health professionals. Using these methods, we identify the key considerations for improving the learning process in online social networks for health professionals.

CCS Concepts

• **Information systems → Data analytics**

Keywords

Learning analytics, social learning, networked learning, informal learning, health professional education

1. INTRODUCTION

Online Social Networks (OSNs) have been increasingly used by health professionals to communicate, collaborate and share ideas with each other [1]. This activity can be thought of as a type of informal learning, thus OSNs have important implications for ongoing efforts to support the Continuing Professional Development (CPD) in the health profession [2]. Some of these OSNs are open only to health professional members. In such OSNs the nature and scope of the learning that is occurring are neither well described nor transparent. The challenge of understanding the learning occurring in OSNs makes it difficult to design and facilitate this type of learning [3]. The objective of our research is to examine how learning analytics may serve as a method for understanding the process of learning in OSNs for health professionals.

2. METHODS

A case study strategy was used to gain in-depth understanding of the process of learning occurring in an online discussion forum for health professionals. This research is based on a multi-method design that employs a set of analytics methods to investigate different components of the learning process including: social network analysis to understand learning interaction, topic modeling to understand learning content, and context analysis to understand learning context.

3. RESULTS

The level of interaction is low in general and it decreases over time. A small number of users were engaged; their patterns of interaction indicate that they preferred to seeking information or building connections. They were interested in discussing clinical topics including those related to their practices, enabling them to share practical and experiential knowledge and providing opportunities for benchmarking; as well, the non-clinical topics include controversial topics and address the latest news and advanced information in the field.

4. CONCLUSION

Using learning analytics methods, this research identifies the key considerations for improving the informal learning of health professionals in OSNs, which include: 1) offering learning topic that is practical, specific, and reliable to help them address their learning needs; 2) providing personalisation by capturing the context of learning including information relates to learner characteristics and environment; 3) providing support to the management of connections and target interactions that help exploit learning opportunities; and 4) facilitating learning discussion by scaffolding learning experience.

The analytics methods employed in this research are shown to be useful to understand the learning process in an OSN. SNA identifies the patterns of interaction and thus can contribute to understanding what the health professionals are trying to achieve in an OSN. Topic modelling help efficiently discover the learning topics discussed in a specific OSN, so as to discern the emerging learning needs. Context analysis help understand the unique learning context of a specific OSN that enhances the understanding of learning interaction and content.

Future research may further investigate the process of learning using other novel analytics methods, as well as develop learning interventions that provide real-time analysis and monitoring to improve the learning experience in OSNs for health professionals.

5. REFERENCES

[1] McGowan, B.S., et al., *Understanding the Factors That Influence the Adoption and Meaningful Use of Social Media by Physicians to Share Medical Information.* Journal of Medical Internet Research, 2012. **14**(5).

[2] Sandars, J., P. Jaye, and K. Walsh, *Networked Learning in Continuing Medical Education: New Directions For The Evaluation of Effectiveness Perspective* in *Network-Based Continuing Medical Education: Social Media and Professional Development*, T. G., Editor. 2014, Nova Science: New York. p. 89-100.

[3] Institute of Medicine, *Redesigning Continuing Education in the Health Professions*. 2010, National Academies Press: Washington, DC.

Reverse Nearest Neighbour Heatmap in Spatial networks

[Extended Abstract]

Yixin Xu[1], Jianzhong Qi[2], Renata Borovica-Gajic[2], Yu Sun[1], Rui Zhang[2]
School of Computing and Information Systems, The University of Melbourne
[1] {yixinx3, yus1}@student.unimelb.edu.au
[2] {jianzhong.qi, renata.borovica, rui.zhang}@unimelb.edu.au

ABSTRACT

Given a set of facility points and a set of client points, the reverse nearest neighbor (RNN) query of a new facility point q returns all client points that consider q as the nearest facility point. Most existing work focuses on RNN queries of a single query point. However, it is also important to provide a global view of the RNN sets of all points in a space. In this study, we are interested in computing an RNN heatmap for a spatial network, i.e., we compute the RNN set size for every point in the spatial network. We propose an algorithm for this problem via progressively labelling the network edges with their RNNs. Initial experimental results confirm the effectiveness of the proposed algorithm.

CCS Concepts

•**Information systems** → **Database query processing;** *Query optimization;* •**Human-centered computing** → **Heat maps;** *Geographic visualization;*

Keywords

Reverse nearest neighbour; spatial network; visualization

1 Introduction

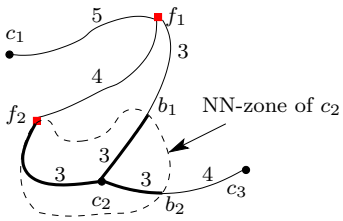
Finding a location that can attract the most clients is an important factor when a company opens a new branch. Various issues may affect client attraction. We focus on the travel distance factor. Intuitively, clients tend to be attracted to their nearest facilities such as supermarkets and post offices. The reverse nearest neighbor (RNN) set of a location consists of all clients that consider this location as the nearest neighbour. For example, in Figure 1, the RNN set of f_1 is $\{c_1\}$ while the RNN set of f_2 is $\{c_2, c_3\}$. The size of the RNN set indicates the attractiveness of a location. We call this number the *influence value* of the location.

To provide an overview of the influence values of all the locations in the data space, we propose to construct an *Reverse nearest neighbour heatmap* (RNNHM) of the whole space. The RNNHM gives decision-makers more freedom to explore the space. In this paper, we focus on *RNNHM in spatial networks*. We propose an algorithm to compute RNNHM that leverages the unique property of spatial networks and RNN queries.

2 Problem Formulation

Reverse nearest neighbour heatmap in a spatial network. Given a set of points O representing clients and a set of points F representing facilities, the reverse nearest neighbour heatmap problem computes the RNN size for every point in the spatial network.

Nearest neighbour zone. In spatial networks, the nearest neighbour zone (NN-zone) of a client $c \in O$ consists of all points which are nearer to c than the existing nearest neighbour of c. If a new facility f is built within the NN-zone of c, the client c will regard f as the new nearest facility. For example, in Figure 1, the bold edge segments represent the NN-zone of c_2. If a new facility f is built at a point on the bold edge segments, the nearest facility of c_2 will become f. The reverse nearest neighbour of a query point q can be retrieved by finding NN-zones that cover q.



facility	RNN
f_1	c_1
f_2	c_2, c_3

Figure 1: Example of RNN and NN-zone

3 The Algorithm

Our algorithm to compute an RNNHM has two phases: 1) find nearest neighbours for all clients. 2) label NN-zones for all clients.

In the first phase, we use an algorithm named IER [1] to find the nearest facility of every client. Meanwhile, we record the distance between every client and its nearest facility.

In the second phase, we label NN-zones for all clients by labelling edge segments within these zones. For a client c, we first find all edge segments within its NN-zone by progressively expand the zone following the adjacent edges. During this process, we label the edge segments reached with the client c, i.e., we add c to the RNN sets of the edge segments. Take c_2 in Figure 1 as an example, we label the NN-zone of c_2 by inserting c_2 to the RNN sets of the bold segments.

4 Research Plan

Our initial experiments confirm that the proposed algorithm is effective. For future work, we plan to study the efficiency issue of the algorithm. In particular, we plan to seek for possible ways to label the edge segments together with computing the nearest facilities of the clients.

5 References

[1] D. Papadias, J. Zhang, N. Mamoulis, and Y. Tao. Query processing in spatial network databases. In *VLDB*, pages 802–813, 2003.

Efficient Indexing and Querying of Periodic Data

[Extended Abstract]

Jiayuan He, Jianzhong Qi, Rui Zhang
University of Melbourne
hjhe@student.unimelb.edu.au
{jianzhong.qi, rui.zhang}@unimelb.edu.au

ABSTRACT

Periodic data is a common type of data in our daily lives. We propose a new formalism to represent periodic data, the *time-remainder representation*, for efficient querying of this type of data. Given a dataset with N periodic events each of which consists of n recurrences, using the proposed representation, the time and space costs for processing a range query are $O(\log N)$ and $O(N)$, respectively, whereas using traditional methods, the query time and space costs are $O(N \cdot n)$ and $O(\log(N \cdot n))$, respectively.

CCS Concepts

•**Information systems** → *Temporal data;*

Keywords

Temporal database; Time representation; Scheduling

1. INTRODUCTION

In this paper, we focus on efficient indexing techniques for a particular type of temporal data, i.e., periodic data. We refer to periodic data as temporal events that repeat at same time intervals over a period of time. This type of data exists in many fields such as recurring calendar events, repeated sensor reads, etc. Assume a database with N periodic events, each of which repeats for n times. A range query returns the event recurrences that overlap the query time range. Using standard indexing and querying techniques, a range query takes $O(N \cdot n)$ space and $O(\log(N \cdot n))$ time to process. We propose a new representation of periodic data – *time-remainder representation*. With this new representation, we reduce the space cost to $O(N)$ and the time cost to $O(\log N)$.

2. TIME-REMAINDER REPRESENTATION

We use a two-dimensional coordinate system, the *Time-Remainder (TR)* coordinate system. Assume a periodic event ev_i of which each occurrence is a time point on the time line. It starts at s_i, ends at e_i, and has a cycle of c. In the TR coordinate system, ev_i is represented by its time frame ($[s_i, e_i]$) on the *Time* dimension. On the *Remainder* dimension, it is represented as the remainder of its time stamp of each occurance (s_i mod c). Intuitively, we can treat the *time* of the representation as the cycles covered by ev_i and the *remainder* as the offset of ev_i within each cycle. Thus, the overall time coverage of ev_i is represented as the area $time \times remainder$. Based on this representation, we use an multi-version b-tree (MVBT) to index a set of N periodic events for query processing. Figure 1 gives an example of the representation.

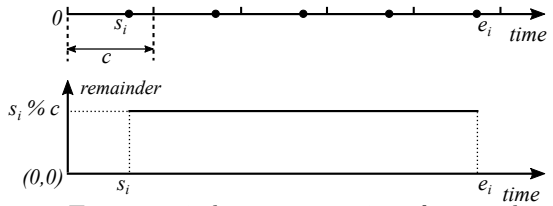
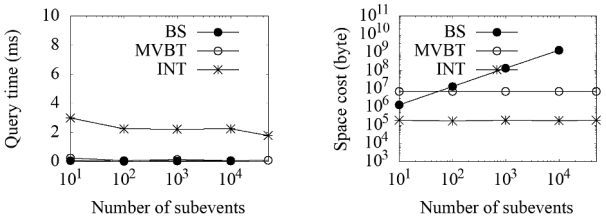


Figure 1: Time-remainder representation of a periodic event



(a) Query time (b) Space cost

Figure 2: Impact of n on periodic events

3. RESULTS

We conduct the experiments on a desktop computer with a 3.4 GHz Intel Core i7-2600 CPU, 24 GB memory, and 64-bit Windows operating system. We implement all the algorithms in Java. We use a synthetic dataset where the events are evenly distributed on the timeline. We set the number of periodic events as 1,000 and vary the number of recurrences, denoted as n. We compare our MVBT based algorithm with two algorithms: a binary search (BS) algorithm using an AVL tree to index every recurrence of the events, and an algorithm adapted from a previous work [1], named the *intensional algorithm (INT)*. As Fig. 2 shows, BS and the MVBT based algorithm are both fast. However, in terms of space cost, our MVBT based algorithm takes around 7 MB and does not change with n while the space cost of the BS algorithm increases rapidly with n. Meanwhile, INT has higher space and time costs than the MVBT based algorithm.

4. CONCLUSION

We propose a novel representation, the TR representation, to represent periodic data. With the proposed representation, we avoid storing the repetitions of periodic data and thus, significantly reduce the space and query cost.

5. REFERENCES

[1] P. Terenziani, B. Stantic, A. Bottrighi, and A. Sattar. An intensional approach for periodic data in relational databases. *Journal of Intelligent Information Systems*, 41(2):151–186, 2013.

The Trade-Offs in Data Trustworthiness and Data Completeness in Clinical Research Registries

[Extended Abstract]

Stephan Glöckner
School of Computing and Information Systems, University of Melbourne & Department of Epidemiology, Helmholtz Centre for Infection Research, Germany
sglockner@student.unimelb.edu.au

Salla E. Toikkanen
Department of Epidemiology, Helmholtz Centre for Infection Research, Germany
salla.toikkanen@thl.fi

Prof. Richard O. Sinnott
School of Computing and Information Systems, University of Melbourne
rsinnott@unimelb.edu.au

ABSTRACT

Different types of data sources for biomedical research have intrinsic limits including their trustworthiness. More recently collected data is likely to have a higher degree of trustworthiness, but potentially lower level of completeness. In this abstract and presentation we explore this phenomenon in the context of a clinical study.

CCS Concepts

• Social and professional topics → Quality assurance • Software and its engineering → Completeness

Keywords

Data Trustworthiness, Data Completeness, Data Quality Assurance

1. INTRODUCTION

Clinical research registries rely on high quality source data to both support research and strengthen trial conclusions. The majority of historic data sources are paper-based records containing patient information. With the increasing amount of available data, a timely integration into clinical and public health research has to be considered. These data can be electronically data captured e.g. from (a) mobile apps, (b) wearable sensors or (c) user created content (e.g. Wikipedia, twitter, weather underground). Because of the intrinsic limits of these sources, the assessment of data trustworthiness (DT) is crucial and has to be implemented into research environments ideally including data quality feedback to users [1,2]. DT can depend on the type of source (e.g. paper, digitized record or mobile app), the originating user (e.g. researcher, patient, clinician), the origin, (e.g. centre or country), the device type (e.g. mobile phone, tablet or desktop pc) and the time of data collection.

We investigated DT from the perspective of time collection and data completeness (DC) within two clinical research data repositories in order to study how these vary a) in time and b) between registries built for specific trials and for general research. We selected DC as a second data quality dimension to investigate the impact of time on DC.

2. METHOD

We used data from the ENSAT Pheo (European Network for the Study on Adrenal Tumours - Pheochromocytoma) registry and PMT (Prospective Monoamine-producing Tumor Study) registry. PMT is a study within the ENSAT consortium and therefore part of the ENSAT-CANCER registry. DC was calculated as the percentage representing the average completeness of the entire registry. DT was calculated based on the age of the record information, where a higher percentage indicated newer records. The DC and DT of Pheo study records from PMT and ENSAT Pheo were statistically compared.

3. RESULTS

We analyzed 2715 records (989 PMT and 1726 non-PMT) with an average DC of 16.9% (16.1% PMT, SD=10.2% and 18.2% non-PMT, SD=10.3%) and an average DT of 88.8% (87.7% PMT, SD=7.7% and 90.6% non-PMT, SD=13.8%). Linear regression showed a statistically significantly decreasing trend in DC over time of the data collection for PMT records (coeff. -0.17, $p<0.001$). For non-PMT records, the linear trend was not significant (coeff. -0.03, $p=0.116$) (see Fig. 1).

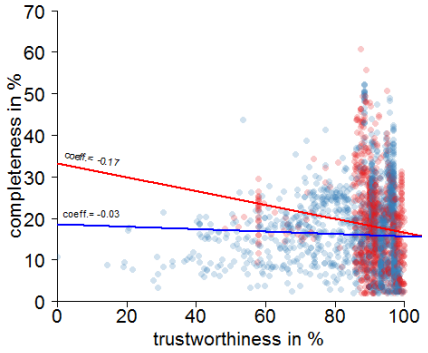


Figure 1. DC by DT of PMT (red) and ENSAT Pheo (blue) records

4. CONCLUSIONS

Our results indicate that older data has higher DC, especially in data collected for the PMT trial. Although research should be conducted in timely manner, the newest information often has lower DC and can lead to erroneous conclusions. It is important to investigate and take into account the time lag in which relevant information is updated in clinical registries. In this exploration of DT, only the age of records was considered. Other dimensions of DT need to be also explored.

5. ACKNOWLEDGMENTS

Our thanks to Prof Graeme Eisenhofer and Anthony Stell for permission to use data from the PMT and ENSAT registries.

6. REFERENCES

1. Stephan Glöckner and Richard Sinnott. 2015. Web-based Feedback as a Tool for Data Quality Improvement in Biomedical Research. In *Proceedings of the 3rd Annual Doctoral Colloquium Computer and Information Systems Melbourne*, 28.
2. Marcel Salathé. 2016. Digital Pharmacovigilance and Disease Surveillance: Combining Traditional and Big-Data Systems for Better Public Health. *Journal of Infectious Diseases* 214, suppl 4: S399–S403. https://doi.org/10.1093/infdis/jiw281

Effective Preservation of Privacy During Record Linkage

[Extended Abstract]

Yang Lu
University of Melbourne
luy4@student.unimelb.edu.au

Richard O. Sinnott
University of Melbourne
rsinnott@unimelb.edu.au

Karin Verspoor
University of Melbourne
karin.verspoor@unimelb.edu.au

Udaya Parampalli
University of Melbourne
udaya@unimelb.edu.au

ABSTRACT

Record linkage is a technique for integrating data from potentially multiple sources where direct access to data is not allowed due to security and privacy considerations. To avoid privacy leakage from and over-modifications of raw data, we propose *semantic-based linkage k-anonymity* (SLA) as an effective solution to de-identifying clinical record linkage.

CCS Concepts

• Information systems → Database management system, Data mining; • Security and privacy → Human and societal aspects of security and privacy.

Keywords

Record linkage; k-anonymity; semantic reasoning

1. INTRODUCTION

Record linkage has been recognised as a key approach to support in-depth research on areas including public health and individual well-being. For instance, the Centre for Health Record Linkage (CHeReL, http://www.cherel.org.au/) relies on probabilistic matching of demographic data to create linked health records across the New South Wales and Australian Capital Territory. Due to the sensitivities of individual records, linkage needs to check privacy risks before releasing data to applicants. To avoid latent risks caused by skewed attributes, we design a semantic model to preserve individual privacy while reducing information loss by data modifications (e.g. generalisation).

2. METHOD

Sweeney (2002) proposed that *k-anonymity* processing quasi-identifiers (QIs) of data may lead to 'over generalisation' when dealing with linkage data sets [1]. Based on the fact that most linkage cases do not include all local patients and thus not all modifying data for privacy-preserving purposes needs to be used, we propose the *linkage k-anonymity* (LA) by which only obfuscated individuals in a released linkage set are required to be indistinguishable from at least *k-1* other individuals in the local dataset. To the inference disclosure issue, however, the general solutions involve ruling out risky associations from previous linked data releases. Originally applied to discover associations from transaction records [2], the association rule mining approach is adopted to deal with anonymised linkage. As a consequence, the *semantic-based linkage k-anonymity* (SLA) workflow contains functional components used to satisfy both requirements (shown in Figure 1). Specially, associations identified from the 'previous release' become the input of semantic reasoning for 'current linkage'.

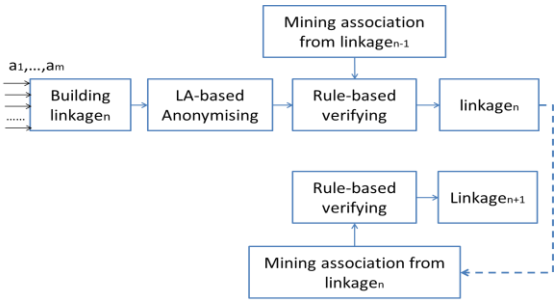


Figure 1. Workflow in SLA

3. EXPERIMENT

The scenario underpinning this work uses data collected from 1000 patients involved in the Australasian Diabetes Data Network (http://www.addn.org.au/) and 1850 individuals from the VicHealth population survey (https://www.vichealth.vic.gov.au/) undertaken in 2015. The experiment considers the case where 500 individuals are in both data sets. After using *LA* and *SLA* on linkage sets, the performances are evaluated by comparing the average disclosure risk and sum of squared error (SSE) respectively [3]. The result shows *LA* is able to preserve more details while it runs a higher risk of re-identification than using *SLA*. Although the verification of *SLA* results in more data generalisation, the major improvement in data quality is due to the linkage *QI* attribute filter.

4. CONCLUSION

We designed an approach for *semantic-based linkage k-anonymity* (*SLA*) based on linkage properties. In the future, we will explore semantic approaches for privacy preserving record linkage (PPRL) where higher accuracy linkage is expected.

5. REFERENCES

[1] L. Sweeney. 2002. *k-anonymity: A model for protecting privacy.* International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 10(5), 557-570. DOI= http://doi.acm.org/10.1142/S0218488502001648

[2] Agrawal, R., Imieliński, T., & Swami, A. 1993. *Mining association rules between sets of items in large databases.* ACM SIGMOD Record. 22(2), 207-216. ACM. DOI= http://doi.acm.org/10.1145/170035.170072

[3] J. Domingo-Ferrer, A. Martínez-Ballesté, J. M. Mateo-Sanz & F. Sebé. 2006. *Efficient multivariate data-oriented micro-aggregation*. The VLDB Journal—The International Journal on Very Large Data Bases, 15(4), 355-369. DOI= http://doi.acm.org/10.1007/s00778-006-0007-0

Activity recognition of post-surgery patients through data analytics on time-series data from wearable sensors

[Extended Abstract]

Mahtab Mirmomeni
PhD Student, The University of Melbourne
m.mirmomeni@student.unimelb.edu.au

Lars Kulik
The University of Melbourne
lkulik@unimelb.edu.au

James Bailey
The University of Melbourne
baileyj@unimelb.edu.au

ABSTRACT

Data analytic techniques on time-series data from wearable sensors can be successfully utilized for activity recognition [2, 3]. An important application area is physiotherapy. A key activity that a physiotherapist is interested in is to detect whether or not a patient who has undergone knee surgery is adhering to their rehabilitation exercises. Currently, the standard method to keep track of the exercises is through a patient's own logs. In this paper, we present a solution for automatically determining to what extent patients have adhered to their exercises. We use motif discovery techniques on the data from accelerometers that are worn on patients' ankles. Our results show that we are able to identify exercises with a very high accuracy.

CCS Concepts

• Machine learning → Unsupervised learning → Motif Discovery

Keywords

Time-series Data analysis, Motif Discovery, Matrix Profile, Wearable sensors, Accelerometers, Physiotherapy, Activity recognition

1. INTRODUCTION

Rehabilitation exercises are an essential part of recovery post knee surgeries. Between physiotherapy sessions, patients are required to do a set of rehabilitation exercises at home to help accelerate recovery and restore movement. Currently, patients are sent home with a log book to keep track of their rehabilitation exercises. However physiotherapists have discovered that patients are not always adhering to their exercises. In this research project, we have partnered with the Physiotherapy department at the University of Melbourne, who have designed a study to send patients home with accelometers worn on their ankles and record their periods of activity. Our goal is to automatically identify whether or not a patient has done their exercise through mining the activity periods, epochs, looking for regions that an exercise has occurred.

The dataset contains activities of 27 patients, over a couple of weeks. Each patient has been tasked with four different types of exercise. The accelerometer's angle with respect to x axis, which is of interest in this context, has been captured, in a number of records. Each record has a number of epochs, which have been labeled as having exercise or not. Each epoch, is a signal, presented as time-series. An exercise marks a repeating motif in the time-series.

One of the latest methods recently published on discovering motifs in time-series data is the *matrix profile* [1]. A matrix profile is a representation of the time-series, that at each point on the time-series, returns the distance between a motif of size m, to its nearest neighbor.

In this research project we have used the matrix profile to find the repeating regions of the time-series epochs that correspond to an exercise.

2. Method and Results

In order to find whether an epochs contains exercise or not, we have calculated the matrix profile for each epochs, for a motif of size m. We then processed the matrix profile, by averaging the points on the matrix profile in a window of size w, and comparing the average to a threshold t. If the average is below the threshold, we mark that epochs as containing an exercise.

To select the motif size m and window size w, we used a range of values for m and window size using training data from patients 1 and 2. The best values were found to be m=100, w=200. Using these parameters the matrix profile was calculated and processed for the rest of the data, the test set. We changed the threshold from 0 to 10 by 0.1 and calculated the Area under the Curve, AUC. On the test set, with 857 exercise epochs and 2881, non-exercises epochs, the AUC is equal to 0.977. Our results show that we can classify exercise epochs from non-exercise epochs with high accuracy, with the AUC being close to 1.

To verify our results, we added white Gaussian noise in different proportions to the data and recalculated the matrix profile for the noisy data. Our results showed that as we increase the noise, AUC decreases.

3. Future Work

Our next step in this research project is to identify the location that an exercise has occurred to be able to classify which exercise has been performed.

4. ACKNOWLEDGMENTS

Our thanks to Mr Tim Wrigley from Physiotherapy department of the University of Melbourne, for providing us with the data of this study and the insights from a physiotherapist's perspective.

5. REFERENCES

[1] Yeh, Chin-Chia Michael, et al. "Matrix Profile I: All Pairs Similarity Joins for Time Series: A Unifying View that Includes Motifs, Discords and Shapelets." IEEE ICDM. 2016.

[2] Banaee, Hadi, Mobyen Uddin Ahmed, and Amy Loutfi. "Data mining for wearable sensors in health monitoring systems: a review of recent trends and challenges." Sensors 13.12 (2013): 17472-17500.

[3] Attal, Ferhat, et al. "Physical human activity recognition using wearable sensors." Sensors 15.12 (2015): 31314-31338.

Reproducibility of Computational Genomic Workflows

[Extended Abstract]

Sehrish Kanwal
The University of Melbourne
kanwals@unimelb.edu.au

Andrew Lonie
The University of Melbourne
alonie@unimelb.edu.au

Richard Sinnott
The University of Melbourne
rsinnott@unimelb.edu.au

ABSTRACT

Reproducibility is one of the core principles for any scientific workflow and remains a challenge, which is not fully addressed. This is due to incomplete understanding of reproducibility requirements and assumptions of workflow definition approaches. Furthermore, reproducing, adapting or even repeating a bioinformatics workflow in any environment requires substantial technical knowledge of the workflow execution environment, resolving analysis assumptions and rigorous compliance with reproducibility requirements. This work proposes recommendations and an approach using Common Workflow Language to tackle this.

CCS Concepts

•**Applied Computing** → **Life and medical sciences (Bioinformatics);**

Keywords

Reproducibility; Workflows; Assumptions; Requirements

1. INTRODUCTION

Faced with the complexity of genomic datasets, enormous numbers of computational bioinformatics tools and workflow systems have emerged. Reproducibility is one of the core principles for any scientific effort as knowledge is built upon foundations of theory and experiments, subsequently verified and extended through open science.

Considerable efforts, resources and time is lost by being unable to reproduce already existing knowledge. This has been called a 'reproducibility crisis' [1].

2. CASE STUDY

In this research, we have characterized widely used genomic data analysis workflow systems on the basis of approaches available to workflow definition and implementation. We have investigated an exemplar [3, 4, 2] from the characterized approaches to implement a complex but widely deployed genomic data analysis workflow to empirically study reproducibility requirements of *insilico* studies.

3. RESULTS

Through pragmatic analysis of the case study, we identified assumptions implicit in the exemplar approaches that ultimately produce insufficient documentation of workflow requirements resulting in failed execution of the workflow.

We propose comprehensive reproducibility requirements that play a major role in minimizing assumptions and understanding what is required for reproducibility of insilico genomic experiments. Further, we have classified these requirements using the definitions from literature to propose a reproducibility range framework Figure 1.

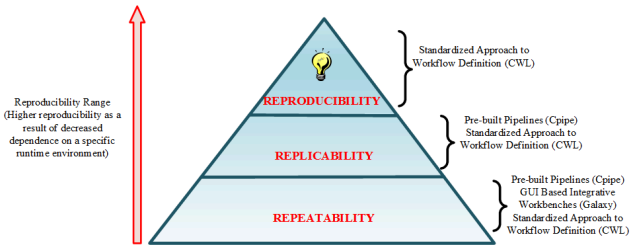


Figure 1: Reproducibility range framework and the corresponding exemplars from workflow definition and implementation approaches

4. CONCLUSION

We propose a set of requirements that aim to mitigate the assumptions of the workflow approaches and guide the scientific community to accomplish reproducible science, to ultimately address the reproducibility crisis. We have also developed a framework to characterize requirements according to critical aspects needed to be catered for achieving reproducibility of computational genomic workflows. The framework suggests the highest level of reproducibility is supported by approaches that make the least assumptions with respect to a specific runtime environment.

5. REFERENCES

[1] M. Baker. 1,500 scientists lift the lid on reproducibility. *Nature*, 533(7604):452–454, 2016.

[2] P. A. N. T. M. R. Crusoe et al. Portable workflow and tool descriptions with the cwl (common workflow language), 2015.

[3] J. Goecks, A. Nekrutenko, J. Taylor, et al. Galaxy: a comprehensive approach for supporting accessible, reproducible, and transparent computational research in the life sciences. *Genome Biol*, 11(8):R86, 2010.

[4] S. P. Sadedin, H. Dashnow, et al. Cpipe: a shared variant detection pipeline designed for diagnostic settings. *Genome medicine*, 7(1):1, 2015.

Zoo Visitors Kinecting with Orangutans

[Extended Abstract]

Sarah Webber, Wally Smith, Marcus Carter, Frank Vetere
Microsoft Research Centre for SocialNUI, School of Computing and Information Systems, University of Melbourne
{s.webber, wsmith, marcusc, f.vetere}@unimelb.edu.au

ABSTRACT

Conservation and publicity campaigns produced by zoos sometimes include depictions of animals using digital technology. To investigate people's responses to animal-computer interaction we designed and studied an interactive installation for orangutans at a zoo. Observations and interviews with visitors who saw orangutans use the installation indicate that people responded with *cognitive, affective* and *motor* empathy for the animals. These responses draw attention to the *anthropic frame* provided by digital technology, and the need to balance species-specific design with existing human-computer interface design conventions.

CCS Concepts

Human centred computing → Empirical studies in HCI

Keywords

Empathy; zoos; animal-computer interaction; primates.

1. INTRODUCTION

A principal aim of modern zoos aim is to inspire concern for conservation by fostering people's sense of connection with animals [3]. Several organisations have identified the educational and visitor engagement potential of animals using digital technology, such as touchscreens [4]. However, technology use by animals could attract controversy, in a climate of shifting public attitudes towards animal exhibits [1]. To date, researchers have given scant attention to human perceptions of animal-computer interaction (ACI). This study offers insights into zoo visitors' responses to orangutans using digital technology, emerging from interviews with visitors conducted during the trial of digital enrichment for orangutans at Melbourne Zoo.

2. SYSTEM DESIGN

Design was informed by conceptions of empathy which distinguish *cognitive empathy*: an intellectual response in which one imagines others' thoughts and feelings; *emotional empathy*: affective or compassionate responses to others' emotional states; and *motor empathy*: the response that leads one to mimic or represent internally others' movements, postures and facial expressions [2]. We deployed a Microsoft Kinect sensor and projector to create a large 'touchscreen' interface on the floor of the orangutan enclosure. We developed software which responded to 'touch' with any body part or object [5]. Through design workshops we identified strategies for evoking visitors' empathy and, from these, developed four applications for the installation, which were offered to the orangutans throughout the trial.

3. RESEARCH METHODS

The system was trialled at the orangutan enclosure on several occasions over the course of 4 weeks. We interviewed 25 visitors who observed the system in use. Through an iterative coding process, we identified and categorised key concepts related to emotive responses to the animals and the technology.

4. FINDINGS

Orangutans' varied forms of engagement with the installation resulted in visitors' reflections on the animals' cognitive engagement, affective states and welfare needs. Many visitors' responses indicated *cognitive empathy*. Such responses included observations about the animals' intentions, their enjoyment of the experience, and the learning processes involved. *Emotional empathy* was evident in visitors' preponderant consideration of the animal welfare implications of the installation. *Motor empathy* is suggested by children's physically playful responses, observed by researchers and commented on by participants.

5. CONCLUSION

We surmise firstly that digital technology establishes an *anthropic frame* in which observers interpret animals' interactions. Secondly, findings suggest that animals' cognitive states and intentions are made apparent by ACI technology which is to some extent familiar to human observers, but also caters to the species' specific needs. Finally, the indication that motor empathy may be evoked by watching physical forms of interaction has important implications for both ACI and HCI research and design.

6. ACKNOWLEDGMENTS

The authors are grateful for the generous support of collaborators at Zoos Victoria. Sarah Webber was supported by an Australian Government Research Training Program Scholarship and a Top-Up Scholarship from the Microsoft Research Centre for SocialNUI at The University of Melbourne.

7. REFERENCES

1. Ballantyne, R., Packer, J., Hughes, K., and Dierking, L. Conservation learning in wildlife tourism settings: lessons from research in zoos and aquariums. *Environmental Education Research 13*, 3 (2007), 367–383.
2. Batson, C.D. These things called empathy: Eight related but distinct phenomena. In J. Decety and W. Ickes, eds., *The social neuroscience of empathy*. MIT Press, Cambridge, MA, 2009, 3–15.
3. Falk, J.H., Reinhard, E.M., Vernon, C.L., Bronnenkant, K., and Deans, N.L. *Why Zoos & Aquariums Matter: Assessing the Impact of a Visit to a Zoo or Aquarium*. Association of Zoos and Aquariums, 2007.
4. Perdue, B.M., Clay, A.W., Gaalema, D.E., Maple, T.L., and Stoinski, T.S. Technology at the zoo: the influence of a touchscreen computer on orangutans and zoo visitors. *Zoo Biology 31*, 1 (2012), 27–39.
5. Wilson, A.D. Using a Depth Camera As a Touch Sensor. *ACM International Conference on Interactive Tabletops and Surfaces*, ACM (2010), 69–72.

SoPhy: A Wearable Technology for Effective Video Consultations of Physiotherapy

[Extended Abstract]

Deepti Aggarwal
Microsoft Research Center for SocialNUI
University of Melbourne, Australia
daggarwal@student.unimelb.edu.au

Abstract

This paper presents the design and laboratory evaluation of a wearable technology *SoPhy*, that is designed to support lower limb assessment in video consultations of physiotherapy.

CCS Concepts

• Human-centered computing → Human Computer Interaction; Interaction design; Empirical Studies

Keywords

Video-mediated communication; Clinical Consultations; Physiotherapy; Bodily Communication; Wearable Technology

1. INTRODUCTION

Physiotherapists are increasingly using video conferencing tools to conduct consultations over-a-distance. Such consultations are called as video consultations [3]. My previous study [1] highlighted the challenges faced by physiotherapists in understanding the patient's movements over video. E.g., a wide range of bodily cues, such as weight distribution and range of movements were not available to physiotherapists during video consultations. Lower limb movements were particularly, more challenging because video consultations are configured around upper torso. Absence of bodily cues reduced clinician's confidence in assessing their patient's progress, and consequently, they recommended less specific treatment (in terms of exercises) during video consultations than face-to-face consultations.

This research, therefore, aims to enhance the ability of physiotherapists in assessing and treating patients with lower limb issues during video consultations. I have designed a wearable technology *SoPhy* that captures and presents three key aspects of lower body movements: foot orientation, range of movement and weight distribution. *SoPhy* consists of two parts: a pair of socks with sensors attached that the patients wear during exercising; and a web-interface that visualizes the captured information to physiotherapists in real-time (refer Figure 1).

2. LABORATORY EVALUATION

After designing *SoPhy*, I conducted a laboratory study to investigate how *SoPhy* helps physiotherapists in assessing patients with lower limb movement over video [2]. I simulated the setting of video consultations across two rooms in the lab. The study was conducted with postgraduate physiotherapy students of our university: 10 students acted out as physiotherapists, whereas 1 student consistently acted out as different patients in the study. Skype was used to set up communication across two rooms.

The study followed 2X2 factorial design, where each participant (mock-physiotherapist) was assigned to all conditions. The two factors were: *consultation technology* (*with SoPhy* and *without SoPhy*), and *pain levels* (*extreme pain* and *low pain*). In terms of tasks, mock patient performed a set of lower limb exercises based on the given patient persona. On the other hand, participants assessed the patient for these exercises. Moreover, mixed method approach was utilized to get detailed understanding of the use of *SoPhy*.

Figure 1: Design of *SoPhy*: (a) a pair of sensor embedded socks for patients to wear, and (b) a web-interface that presents movement data to physiotherapists in real-time.

The study highlighted that *SoPhy* increased the confidence of participants in assessing lower limb exercises like squats. Additionally, participants required fewer repetitions of exercises to assess patients when using *SoPhy*. Moreover, information related to weight distribution was appreciated the most, as patterns of weight bearing are challenging to observe even in face-to-face setting. Seeing weight distribution not only between the feet but also across each foot provided significant details on the patient's movements, and boosted their confidence in assessing the patient.

3. CONCLUSION

This study indicates that *SoPhy* enhanced the efficacy of video consultations by assisting physiotherapists in making informed assessment. This study aims to inspire the design of future video consultation systems that can effectively support bodily communication between patients and physiotherapists.

4. REFERENCES

[1] Aggarwal, D., Ploderer, B., Vetere, F., Bradford, M., & Hoang, T. 2016. Doctor, Can You See My Squats?: Understanding Bodily Communication in Video Consultations for Physiotherapy. In *Proc. DIS '16*, ACM.

[2] Aggarwal, D., Zhang, W., Hoang, T., Ploderer, B., Vetere, F., & Bradford, M. 2017. SoPhy: A Wearable Technology for Lower Limb Assessment in Video Consultations of Physiotherapy. In *Proc. CHI'17,* ACM.

[3] Yellowlees, P . 2005. Successfully developing a telemedicine system. In *Telemedicine and Telecare*, 11, 331-336.

Planning for Transparency

[Extended Abstract]

Aleck MacNally, Nir Lipovetzky, Adrian Pearce, Miquel Ramirez
School of Computing and Information Science, University of Melbourne
amacnally@student.unimelb.edu.au
{nir.lipovetzky,adrianrp,miguel.ramirez}@unimelb.edu.au

ABSTRACT

We define *planning for transparency* as the problem of planning to achieve a goal with minimal ambiguity for outside observers. Both an optimal method for solving this problem, and an efficient approximation are presented.

CCS Concepts

•**Computing methodologies** → **Planning for deterministic actions;**

Keywords

Automated Planning; Plan Recognition; Human-Robot Interaction

1. INTRODUCTION

With increasing reliance on automated systems, the importance of research into human-robot interaction becomes ever more pronounced. The need for shared knowledge between robots and humans was made clear by the research of Stubbs, Wettergreen and Hinds [4], who found that within a robot-human team the ambiguity of the robot's decision making process caused an increasing number of conflicts as the robot became more autonomous. It is therefore important that within these teams, humans have a reasonable understanding of the robot's decision making process.

This research proposes a method by which we can implicitly communicate information to outside observers by actions that are unambiguous and understandable. This is termed *transparent planning*.

2. PROBLEM STATEMENT

We model a *transparent planning* problem with the following framework. An agent α is being observed by agent β. β believes that α is attempting to complete one goal out of a candidate goal-set, but does not know which goal. After every action executed by α, β will update its beliefs about α's true goal. This is stored as a probability distribution. α must therefore produce a plan which achieves its goal and minimises the ambiguity in β's beliefs.

Figure 1 shows a problem from the *Grid* domain in which an agent, planning transparently, travels from the initial state marked as a triangle to the goal state marked with a circle. The candidate goal-set consists of the four squares. The graph on the right shows how the probabilities derived from a plan recognition function, change with each new observation for each goal.

3. PROPOSED METHODS

For a problem represented in the STRIPS framework [1] we define a state model whose states are the Cartesian product of the states of the given model and belief states of an observer. We define the transition function as a combination of the STRIPS transition function and a given plan recognition algorithm. We can then plan optimally over this state space with breath-first search. Due to the large amount of states an approximate method has been formulated.

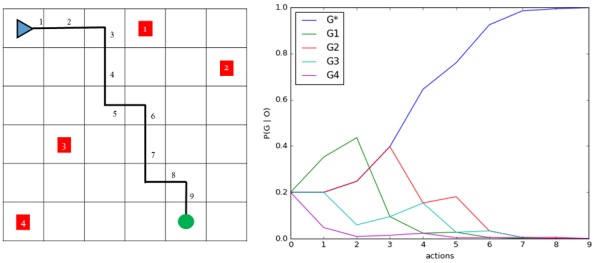


Figure 1: Grid showing actions taken by an agent planning transparently and corresponding goal probabilities.

This method transforms the problem into a net-benefit planning problem [1], which can be solved with on-line planning in real-time as action-selection mechanisms returning one action at a time instead of the full plan. The proposed algorithm is a variant of the Monte Carlo Tree Search Algorithm [1], where the Best-First Width Search algorithm [2] is used instead of regret minimisation as the *tree policy* and a plan ambiguity measure is used instead of a *rollout policy*.

4. EVALUATION

This method has been implemented, using the plan recognition algorithm of Ramirez and Geffner [3], and evaluated over a range of domains. It was found that the presented method was five times better at conveying the goal of the agent then a regular planner.

5. REFERENCES

[1] H. Geffner and B. Bonet. A concise introduction to models and methods for automated planning. *Synthesis Lectures on A.I. and Machine Learning*, 8(1):1–141, 2013.

[2] N. Lipovetzky and H. Geffner. Best-first width search: Exploration and exploitation in classical planning. 2017.

[3] M. Ramirez and H. Geffner. Probabilistic plan recognition using off-the-shelf classical planners. In *AAAI, 11:15/7, Atlanta, USA*, pages 1121–1126, 2010.

[4] K. Stubbs, D. Wettergreen, and P. H. Hinds. Autonomy and common ground in human-robot interaction: A field study. *Intelligent Systems, IEEE*, 22(2):42–50, 2007.

Towards a Unified System for Navigation Advice and Traffic Management

[Extended Abstract]

Sadegh Motallebi
University of Melbourne
s.motallebi@student.unimelb.edu.au

Ramamohanarao Kotagiri
University of Melbourne
kotagiri@unimelb.edu.au

Egemen Tanin
University of Melbourne
etanin@unimelb.edu.au

ABSTRACT

Self-driving cars are next generation of cars which will change driving paradigm significantly. They require to know just the passengers' destination, and passengers do not need to involve in route planning. Therefore, navigation systems and traffic lights scheduling systems by collaborating can provide efficient traffic management system. By knowing all of the "Source-Destination" pairs, a unified system can optimize routes and traffic lights to minimize travel time. This system can also provide simultaneously emergency corridors for high priority vehicles such as police cars, fire engines, and ambulances when required.

CCS Concepts

•**Applied computing** → **Transportation;**

Keywords

self-driving Cars, Automated Cars, Navigation System, Traffic Optimization

1. INTRODUCTION

Automated driving are classified into six categories by SAE [1]. Full-automation Level, the last level of automation, expresses that cars have no human drivers anymore, and all actions are automated and controlled by own cars. So, self-driving cars are placed in full-automation level. Evidence indicates that full-automation cars will be available in the near future [2]. They can affect the current driving paradigm totally.

In new paradigm, passengers just need to give their destination to cars, and their journey will start without knowing "how" to reach to it. It is a significant change which leads to new opportunities for navigation systems and traffic lights scheduling optimization.

Currently, navigation systems and traffic optimization are considered separately. Navigation systems are defined based on user optimum which aims to suggest fastest routes for each user according to road network and current traffic conditions. When drivers are cars, actions are deterministic. Moreover, they obey the routing of navigation systems. Thus, current state of arts navigation systems optimized for single drivers, for example Google maps and Here [1], will not be decent choices anymore. Due to suggesting same route for all of cars that have same Source-Destination at a time, they can create congestion instead of giving fastest (best) route to cars.

In traffic optimization, research involves with proposing efficient and effective algorithms for traffic light signaling in order to improve traffic congestion and/or decrease average travel time. Although, there are researches that try to optimize traffic light switching times for whole system rather than local optimization for each traffic light, they do not consider car routes for the models due to lack of real-time data. So, it is quite possible that suggestions of navigation systems do not consistent with traffic lights programs which could make new congestions. By self-driving cars, this challenge will be diminished since they always will communicate with navigation systems and obey the suggested routes.

In this regard, traffic lights scheduling and navigation systems need to be considered as a unified system. The unified system has two dependent component, traffic optimization and navigation system; and a feedback loop in which the outcome of each component feeds back the other component as an input. Thanks to having all routes of cars, traffic optimization component can consider the whole traffic of cars rather than local optimization for one or some of them independently. Moreover, the navigation system component can provide better suggestions due to having access to the valuable information about the traffic network, i.e., traffic lights scheduling.

This paper demonstrates new perspective to the navigation of self-driving cars in the near future. It introduces a new paradigm of driving and according to its requirements defines a unified navigation system for automated cars. Self-driving cars will be much more deterministic than human drivers. So, optimizing traffic will be improved significantly by knowing the journey routes. In this regard, traffic light signalling and the behavior of cars will be considered as parts of an integrated system which its aim is navigation.

[1] https://wego.here.com

2. REFERENCES

[1] G. Dimitrakopoulos. The future: Towards autonomous driving. In *Current Technologies in Vehicular Communication*, pages 113–121. Springer, 2017.

[2] F. Lambert. *Elon Musk clarifies Tesla's plan for level 5 fully autonomous driving: 2 years away from sleeping in the car*, 2017. https://electrek.co/2017/04/29/elon-musk-tesla-plan-level-5-full-autonomous-driving/.

Papers not presented

Using Avatars for Visualizing Personal Health Records

[Extended Abstract]

Naghmeh Sharikzadeh
School of Computing and Information Systems, The University of Melbourne
nasharikzadeh@student.unimelb.edu.au

ABSTRACT

Medical avatars can visualize medical information of a person by incorporating dynamic mathematical models of human body as well as frequently updated health data from individuals' personal devices and their personal health records. The use of avatars has proven beneficial in medical practice and training. However, the impact of medical avatars on patients' experience and patients' engagement with personal health records is under researched. This pilot study explores patients' and practitioners' perspectives on personal health records to inform the participatory design of avatars. The pilot study contributes to an ongoing project that is exploring the potential role of avatars for visualizing individuals' personal health records.

CCS Concepts

• **Human centered computing→ Information visualization**
• **Human centered computing → User studies**

Keywords

Avatar; personal health record; visualization; participatory design

1. INTRODUCTION

In modern healthcare, individual patients are presented with a wealth of medical information about themselves. Modern models of healthcare suggest individuals should be meaningfully engaged with maintaining their health. This requires patients to be empowered in understanding the complexity of their medical records. Personal Health Records (PHRs) are intended to assist with this. PHRs are secure online summaries of individuals' health and medical histories, including their diagnoses, allergies, procedures, medications, etc. In spite of the important role PHRs can potentially play in empowering patients, the adoption rate of PHRs has been a challenge [2; 3]. Despite patients' general willingness to have electronic access to their medical records, research shows that patients' low textual, technical and health literacy are major inhibiting factors in adoption of PHRs [7].

On the other hand, research suggests medical avatars are the next evolutionary step beyond PHRs [1]. There is evidence indicating that intuitive representation of personal medical data and images, in the form of two- or three-dimensional medical graphical avatars can enhance patients' understanding of complex medical information in marginalized groups, such as people with mental disabilities [5], chronic conditions [6], and senior adults [4]. However, research is scarce on whether using medical avatars as a way of visualizing PHRs can enhance patients' understanding of complex medical information and thus increase their engagement and empowerment in their healthcare.

2. RESEARCH CONDUCT

This pilot study is a qualitative exploratory approach based on semi-structured interviews with up to 10 general practitioners and up to 20 patients, over the age of 18, in Australia who have used medical or allied health care at least twice in the past 12 months and have registered with Australian PHR system, My Health Record (MyHR). Practitioners' and patients' views on MyHR, its benefits and barriers of use, and their views about medical avatars will be sought during the interviews. The interviews will be recorded and the video of a prototype personal medical avatar will be shown to the participants. Collected audio data will be transcribed, de-identified, and coded using thematic analysis approach. The themes will be developed for thesis writing and publication and to inform next phases of this research. The study is currently waiting Ethics Approval from the Human Research Committee before participants can be recruited.

3. ACKNOWLEDGEMENTS

The author is immensely grateful to her supervision panel Dr Jenny Waycott, Associate Professor Reeva Lederman, and Associate Professor Kathleen Gray for their continuous support and contribution of their invaluable ideas in conducting this research.

4. REFERENCES

[1] Buchan, I., 2011. Informatics for healthcare systems. *Healthcare management*, 1-28.
[2] Daniels, A., 2016. eHealth the digital elephant in the dispensary. *Australian Pharmacist 35*, 5, 28.
[3] Ford, E.W., Hesse, B.W., and Huerta, T.R., 2016. Personal health record use in the United States: forecasting future adoption levels. *Journal of Medical Internet Research 18*, 3.
[4] Given, L.M., Grotkowski, A., Fletcher, Q., and Ruecker, S., 2010. Customizable avatars for a health information system: An exploratory design. *Proceedings of the ASIST Annual Meeting 47*. DOI= http://dx.doi.org/10.1002/meet.14504701460.
[5] Hall, V., Conboy-Hill, S., and Taylor, D., 2011. Using virtual reality to provide health care information to people with intellectual disabilities: acceptability, usability, and potential utility. *Journal of Medical Internet Research 13*, 4, e91.
[6] Hoybye, M.T., Vesterby, M., and Jorgensen, L.B., 2016. Producing patient-avatar identification in animation video information on spinal anesthesia by different narrative strategies. *Health Informatics Journal 22*, 2 (Jun), 370-382. DOI= http://dx.doi.org/10.1177/1460458214560636.
[7] Showell, C., 2017. Barriers to the use of personal health records by patients: a structured review. *PeerJ 5*, e3268.

Voice Interaction with Virtual Characters

[Extended Abstract]

Fraser Allison
Interaction Design Lab, School of Computing and Information Systems
The University of Melbourne
fallison@student.unimelb.edu.au

ABSTRACT

This PhD examines the design and user experience of voice interfaces that use a virtual character as an interface metaphor. It comprises a historical study of the history of voice interaction in digital games, two observational lab studies of users interacting with virtual characters using natural language, and a qualitative analysis of YouTube videos of users interacting with virtual characters through voice. In total, the PhD will provide a detailed account of how users respond to the virtual character interface metaphor that has become the standard for new voice interfaces.

CCS Concepts

• **Human-centered computing** → **Interaction design**
• **Software and its engineering** → **Interactive games**

Keywords

Voice interaction; conversational agents; digital games

1. INTRODUCTION

In a few short years, the voice interface has been transformed from a niche technology with a brittle user experience to a dependable and commonplace feature of our smartphones, vehicles, games and homes. After decades of slow development and disappointing progress, the combination of big data, machine learning and networked computing have enabled dramatic improvements in each of the core technologies underpinning the voice interface: speech recognition, speech synthesis and natural language understanding. A strong trend has emerged for voice interfaces to be presented as a dialogic artificial intelligence (AI) complete with a name and virtual persona, as heralded by Apple's Siri and recently championed by Amazon's Alexa.

This development has left human-computer interaction (HCI) researchers somewhat behind the action, as the study of user experiences of voice interfaces was neglected for a time following years of technical challenges and disappointing progress [3]. It is this paucity of academic understanding of voice interaction experiences that my PhD research seeks to address.

My research explores a particular facet of the modern voice interface: the experience of speaking to virtual characters. I begin with an investigation of voice interaction in digital games. Games have a long history of experimentation with voice interaction, beginning in the 1970s and maturing alongside online gaming, voice chat systems and personal networked devices. Games are a particularly informative use context both because they are primarily concerned with enjoyable user experiences, and because they are the domain in which virtual characters and AI have received the most attention as interaction design challenges. These factors make games an ideal starting point for understanding today's AI-driven virtual-character-based voice interfaces.

My first study [1] is a historical analysis of the history of voice interaction in digital games, from predecessor technologies in the form of voice interaction toys in the 1910s, through the earliest digital voice interaction games in research labs of the 1970s, to the commercialised mass-market products of today. My analysis shows that the use of voice interaction in digital games has followed a tidal pattern; rising and falling in seven distinct phases in response to new platforms and enabling technologies. I also note characteristic differences in the way Japanese and Western game developers have used voice interaction to create different types of relationships between players and in-game characters.

The next component of my research has involved a series of direct studies of how people engage with autonomous and semi-autonomous characters in online virtual environments. In my second study [2], I presented users with a Wizard-of-Oz prototype of a virtually embodied AI bot in Minecraft, and observed their spontaneous interactions with it under two conditions: with and without natural language input. I am currently conducting my third study, a qualitative analysis of YouTube videos in which users engage in voice interaction with virtual characters, as a form of unobtrusive observational research on how players engage with voice interfaces. Finally, I am planning a quasi-experimental lab study in which users will interact with virtual characters under different interface conditions, including voice and text input, to determine how their behaviour towards a virtual-character interface differs in each case.

2. ACKNOWLEDGEMENTS

This work has been supported by the Microsoft Research Centre for Social Natural User Interfaces and the Australian Government Research Training Program Scholarship.

3. REFERENCES

[1] Allison, F., Carter, M. and Gibbs, M. 2016. A History of Voice Interaction in Games. In *DiGRA/FDG '16 - Abstract Proceedings of the First International Joint Conference of DiGRA and FDG.*

[2] Allison, F., Luger, E. and Hofmann, K., 2017, May. Spontaneous Interactions with a Virtually Embodied Intelligent Assistant in Minecraft. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 2337-2344). ACM.

[3] Aylett, M. P., Kristensson, P. O., Whittaker, S. Vazquez-Alvarez, Y. 2014. None of a CHInd: Relationship Counselling for HCI and Speech Technology. In *CHI '14 Extended Abstracts on Human Factors in Computing Systems* (pp. 749–760). New York: ACM. https://doi.org/10.1145/2559206.2578868

Knowledge Leakage Risk: Towards a Capability Maturity Model

[Extended Abstract]

Carlos Andres Agudelo Serna, Rachelle Bosua, Sean B. Maynard, Atif Ahmad
School of Computing and Information systems.
The University of Melbourne
{cagudelo, rachelle.bosua, seanbm, atif}@unimelb.edu.au

ABSTRACT

Information and knowledge leakage has become a significant security risk to Australian organizations. Each security incident in Australian business cost an average US$2.8 million. Australian organizations spend the second most worldwide (US$1.2 million each on average) on investigating and assessing information breaches. The leakage of sensitive organizational information occurs through different avenues, such as social media, cloud computing and mobile devices. In this study, we (1) analyze the knowledge leakage risk (KLR) caused by the use of mobile devices in knowledge-intensive Australian organizations, (2) present a conceptual research model to explain the determinants that influence KLR through the use of mobile devices grounded in the literature, (3) conduct interviews with security and knowledge managers to understand what strategies they use to mitigate KLR caused by the use of mobile devices, (4) use content analysis and the conceptual model to frame the preliminary findings from the interviews, and (5) develop a preliminary maturity model based on the findings from interviews.

CCS Concepts

• Security and privacy → Systems security→ Human and societal aspects of security and privacy → Social aspects of security and privacy;

Keywords

Capability Maturity Model, Knowledge management, knowledge leakage, knowledge leakage risk, mobile context, mobile device.

1. INTRODUCTION

Recent literature shows how organizations struggle with leakage of sensitive organizational information across various avenues, such as social media, cloud computing and portable data devices (Ahmad et al. 2014, 2015). Although much of the literature has focused on technical aspects of leakage (i.e., data and information), scant research has been conducted on knowledge leakage through mobile devices in particular (Agudelo et al. 2015).

Although the use of mobile devices (whether employee or organization owned) has shown to be convenient, it comes at a high security cost. Mobile devices used by workers in knowledge-sharing activities poses a problem for confidentiality. Often occurring as a result of employee's security (*mis*)behaviours. Therefore, we argue that the focus should shift from technological (e.g., firewall, antivirus, and compartmentalization) and formal (i.e., policies, standards and procedures) controls to human factors (Agudelo et al. 2015, 2016; Ahmad et al. 2014).

Whether deliberately, or inadvertently, workers are usually more responsible than hackers for breaches of information. In fact, research has shown that the culture and people within an organisation are just as likely to be the source of data leakage.

In this empirical study, we address the gap found in the literature and in practice by undertaking an exploratory study conducting a series of interviews with information security and knowledge experts in a number of knowledge-intensive organizations in Australia, addressing the following research question:

- *How can knowledge-intensive organizations in Australia mitigate the knowledge leakage risk (KLR) caused by the use of mobile devices?*

To answer this question, we develop a preliminary capability maturity model based on CMMI and mobile context taxonomy grouping the controls into three contexts (i.e., Human, Organizational and Technological).

2. CAPABILITY MATURITY MODEL ARCHITECTURE

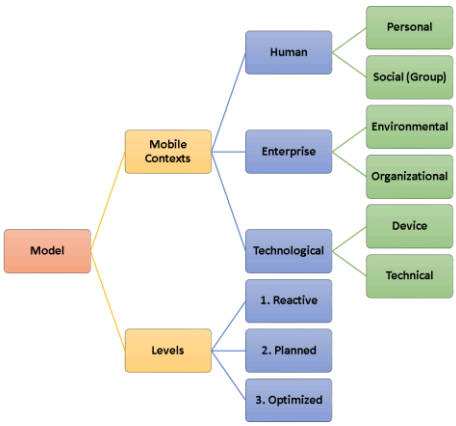


Figure 1. Capability Maturity Model Architecture to assess Knowledge Leakage Risk in Organizations caused by the use of mobile devices.

3. REFERENCES

[1] Agudelo, C. A., Bosua, R., Ahmad, A., & Maynard, S. B. (2015). Understanding Knowledge Leakage & BYOD (Bring Your Own Device): A Mobile Worker Perspective. The 26th Australasian Conference on Information Systems - ACIS2015, 1–13.

[2] Agudelo, C. A., Bosua, R., Ahmad, A., & Maynard, S. B. Mitigating Knowledge Leakage Risk in Organizations through Mobile Devices: A Contextual Approach.

Information Security Strategizing, Capability, and Organisational Performance

[Extended Abstract]

Mazino Onibere
University of Melbourne
monibere@student.unimelb.edu.au

Atif Ahmad
University of Melbourne
atif@unimelb.edu.au

Sean Maynard
University of Melbourne
Seanbm@unimelb.edu.au

ABSTRACT

Organisations are not just operating in a highly competitive, dynamic and economically challenging business landscape, but also in a highly sophisticated and rapidly evolving security threat landscape. Therefore, just as the organisations formulate and implement business strategies to survive and thrive in the market landscape, they must also develop novel information security strategies commensurate with prevailing threat landscape. In this research we seek to move beyond information security's traditional inward looking paradigm of protection of information technology resources, and explore how organisations can improve their performance and sustain competitive advantage by developing an information security capability, embedded within the very fabric of the organisation. We will draw insights from the strategic management literature, particularly from the Resource Based View (RBV) and the dynamic capabilities perspective, to develop and articulate the information security capability construct. We will then proceed to develop and empirically test a model that depicts the relationship between this construct and organisational performance.

CCS Concepts

• Social and professional topics → Management of computing and information systems • Security and privacy → Formal methods and theory of security

Keywords

Information Security; Information Security Strategy; Information Security Capability; Resource Based View; Dynamic Capability; Organisational Performance

1. INTRODUCTION

Organisations are not just operating in a highly competitive, dynamic and economically challenging market landscape, but also in a highly sophisticated and dynamic security threat landscape that exposes its information infrastructure to a range of security risks. Therefore, just as the organisations formulate and implement business strategies to survive and thrive in the market landscape, they must also develop novel information security strategies that are commensurate with prevailing security threat landscape. Organisations may suffer reputational damage, loss of revenue, costs arising from breaches of confidentiality agreements and loss of productivity as a result of leakage of sensitive information [1]. Organisations that desire not only to survive, but thrive, must develop and implement organisational-level information security strategies that integrate and embed information security within the fabric of the organisation. They must consciously develop and cultivate an organizational-level information Security capability.

2. RESEARCH GAP

A review of security literature reveals an apparent lack of strategic perspective in the field of information security management (ISM), and scant reference to an organisational level information security capability and its relationship to organizational performance.

3. RESEARCH AIM

This research looks to strategic management literature and attempts to draw insights from concepts such as the Resource Based View (RBV), and the dynamic capabilities perspective. It seeks to 1) define and describe an organisational Information Security capability, 2) to develop a strategic model that links resources with this capability, and then 3) empirically demonstrate its relationship to organizational performance.

4. Information Security Capability and Organisational Performance

An organisation's information security (InfoSec) capability underpins and drives its InfoSec strategizing activities and InfoSec operations. InfoSec strategizing, on the other hand, through allocation of resources, develops or diminishes InfoSec capability. The proposed model in figure 1 illustrates how InfoSec strategizing and InfoSec operations directly affect organisational performance. Organisational performance refers to the extent to which organisations are able to produce and accomplish business objectives, and efficiently and effectively provide value for their various stakeholders [2].

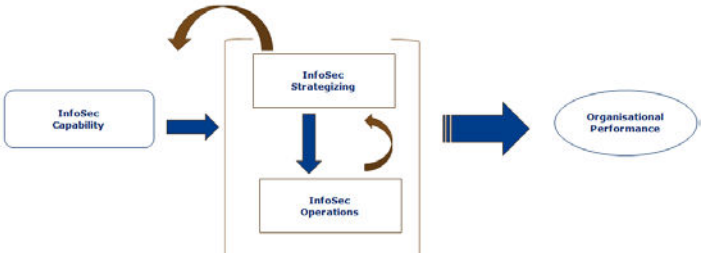


Figure 1. InfoSec Capability and Organisational Performance.

5. REFERENCES

[1] Ahmad, A., Bosua, R., and Scheepers, R. 2014. Protecting organizational competitive advantage: A knowledge leakage perspective. *Computers & Security*, 42, 27-39. DOI= http://dx.doi.org/10.1016/j.cose.2014.01.001

[2] Hall, J. H., Sarkani, S., & Mazzuchi, T. A. (2011). Impacts of organizational capabilities in information security. Information Management & Computer Security, 19(3), 155-176. doi:10.1108/09685221111153546

Poster Session

A Poster on Information Security Strategy Model

Craig Horne, PhD Researcher
The University of Melbourne, Parkville, Victoria, Australia

ABSTRACT

An information security incident can have significant organisational repercussions, including loss of customer trust, regulatory penalties, and leakage of trade secrets. With increasing dependence on information, organisations need to take a strategic approach to its protection. A lack of strategic-level knowledge available to practitioners exists about the protection of an organisation's information, the appropriate employment of security controls and the risks associated with outsourcing the storage of information. This prevents executive level decision-makers from taking appropriate steps to lower the risk to their organisation's information from threats. More research is required to understand how organisations can select a strategy to reduce risks to its information. This research proposes a novel theoretical model of information security strategy and describes the results of a study. The results of the study validate and refine the model. Our conclusion is that appropriate selection of an information security strategy will lower overall risk to an organisation's information.

PROBLEM

Some recent events of global significance highlight the importance of this research:

- Internal threats: Edward Snowden, 2013

  Edward Snowden is a former systems administrator for the Central Intelligence Agency (CIA) and a counterintelligence trainer at the US Defense Intelligence Agency (DIA). In June 2013, he came to international attention after disclosing to several media outlets **thousands** of classified documents that he acquired while working as an NSA contractor. Snowden's release of NSA material was called the most significant leak in US history.

- External threats: Sony, 2011

  The PlayStation Network outage was the result of an "external intrusion" on Sony's PlayStation Network and Qriocity services, in which personal details from approximately 77 million accounts were stolen. The attack occurred in April 2011 and forced Sony to completely turn off the PlayStation Network. On May 4 Sony confirmed that personally identifiable information from each of the **77 million accounts** appeared to have been stolen. The outage lasted 24 days and on May 23, 2011 Sony stated that the outage costs were $171 million.

- Physical threats: Bank of New York Mellon, 2008

  In February 2008, BNY Mellon sent 10 unencrypted backup tapes to a storage facility. When the storage firm's truck arrived at the facility, however, only nine tapes were still on board. The missing tape contained social security numbers and bank account information on **4.5 million customers**. Coincidentally the bank retrenched 1,800 staff and received $3Billion in emergency relief funding from US Treasury later that year.

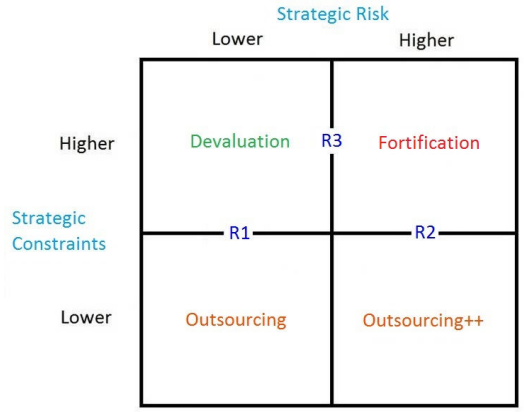
What if Edward Snowden had worked for your organisation and leaked your trade secrets to the world?

What if your organisation was hit with an unexpected bill for $171 Million in costs due to an external security breach?

What are the customer trust and brand value implications for Bank of NY Mellon by not keeping secret customer details safe?

METHODOLOGY

- The literature review (published in ACIS and AJIS) consider the critical points of current knowledge including substantive findings, as well as theoretical thematic contributions to information security strategy.
- We adapt Porter's (1980) strategic model of three generic competitive strategies to information security and now seek proof, hence this research follows a deductive approach. The ontology is nominalist, epistemology is constructivism, and theoretical perspective is interpretivism. Methods include interviews and document analysis.
- Data collection via interviews from a significant number of Chief Information Security Officers and security leaders from organisations in Australia was used to generate primary data which was then analysed. Information security strategy documents if they existed were also requested and analysed. The data collection focused on organisational information, strategic documents, inherent risk, controls, contextual factors, outcomes and stakeholders.
- Every interview was audio recorded and then transcribed verbatim. We then imported the transcriptions and strategy documents into the qualitative analysis tool NVIVO and coded the content into nodes, which are the key concepts identified in the data.



PROPOSED MODEL

- Our theory argues that the combination of strategic organisational information with extrinsic organisational constraints guides the selection of an appropriate information security strategy.
- The model constructs and relationships are:
- *Strategic Risk* refers to the inherent risk associated with information.
- *Strategic Constraints* refer to the external factors that might preclude an organisation from outsourcing the management of its information.
- The terms *Fortification* and *Devaluation* are terms used by one of the research subjects during interview (in vivo) and were employed during model formation.
- The *Devaluation* construct describes the active decision taken by organisations to lower the perceived inherent risk to the information-based resources held by it, either by lowering the classification of information, reducing the volume of information, or by archiving or deleting information.
- The *Fortification* construct describes the phenomenon where the perceived inherent risk of threats to information held by an organisation cannot be lowered and must remain at a high level.
- The *Outsourcing* construct aims to share the responsibility for risk to information with an external vendor.
- Outsourcing ICT infrastructure can take the form of cheap and efficient public cloud (denoted by *Outsourcing*) or more secure and resilient dedicated ICT infrastructure, managed by a third party, with scalable security controls available (denoted by *Outsourcing++*).
- The relationship between Devaluation and Outsourcing (**R1**) contends that organisations can lower the costs involved in protecting secret information from threats and further reduce expenses by Outsourcing.
- The relationship between Fortification and Outsourcing (**R2**) asserts that it may not be possible for an organisation to afford the myriad of security controls that are required to protect all its strategic information.
- The relationship between Devaluation and Fortification (**R3**) argues that they are not mutually exclusive and can be combined.

CONTACT

- Craig Horne
- E: chorne@student.unimelb.edu.au
- T: (03) 8344 1573
- Supervisors: Dr. Sean Maynard, Dr. Atif Ahmad
- Feedback welcome

Emotional Requirements in People-Oriented Software Engineering

Mohammadhossein Sherkat
Supervisors: Tim Miller, Antonette Mendoza, Rachel Burrows
School of Computing and Information Systems, University of Melbourne

THE UNIVERSITY OF MELBOURNE

2017 RHD Colloquium

Problem Statement

It is now being realized that users beyond functions and usability have emotional requirements that influence their experience with software systems. To ensure emotional requirements are incorporated into design, it is important that system designers have an appropriate method for collecting emotional needs.
Emotional requirements are difficult to identify, unstructured and often have a high level of ambiguity, and addressing them in design is not straightforward. Accordingly a key question at the heart of successful requirements engineering activities is *"How can we get a better understanding of users' emotional requirements in order to meet the software system's intended use?"* To answer this question, this study proposes a novel framework entitled "***User Emotional Attachment Framework***" that is based on existing models and theories of emotional attachment.

Proposed Framework

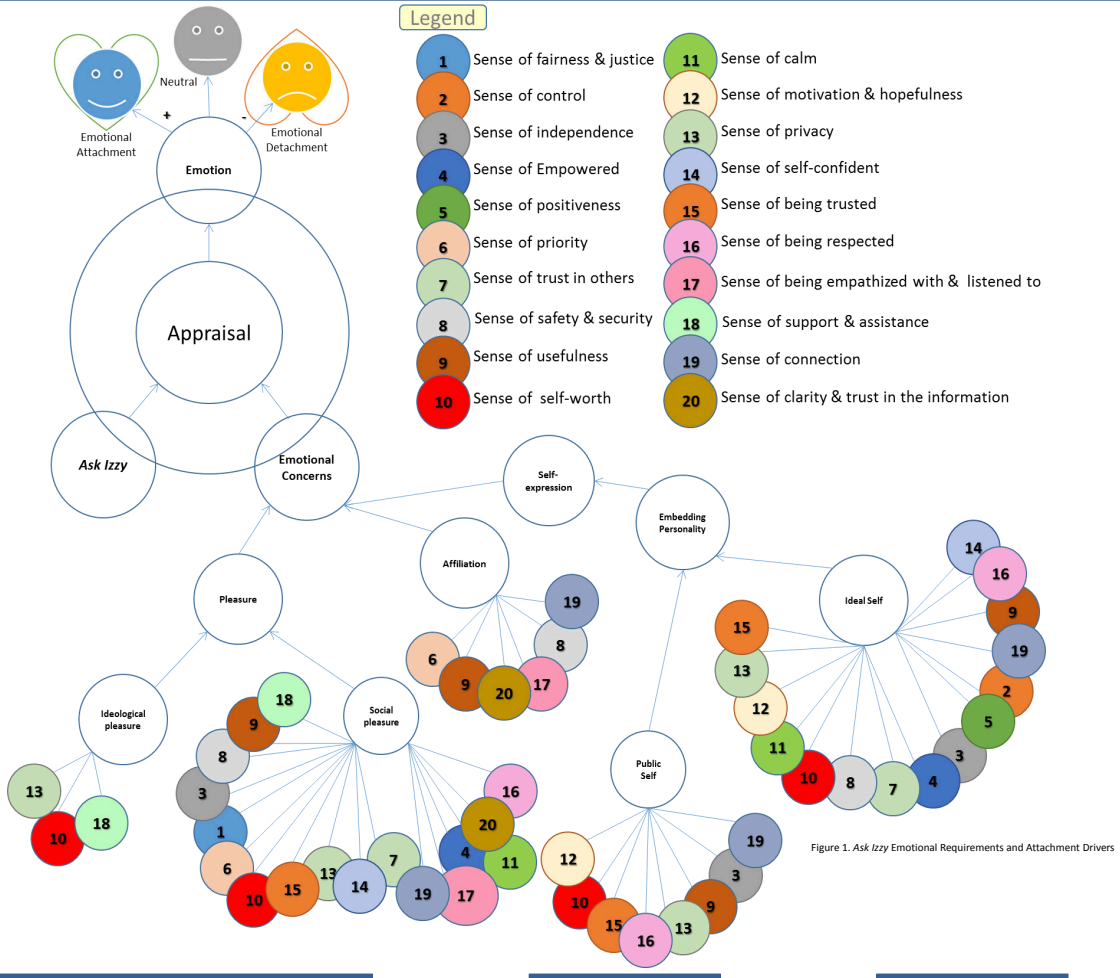


Figure 1. *Ask Izzy* Emotional Requirements and Attachment Drivers

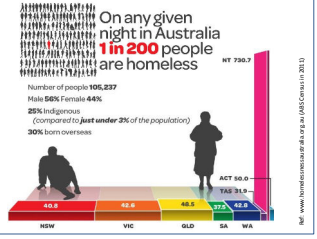
User Emotional Attachment Factors

Using *Appraisal Theory*, we found the following factors that echo forming users emotional attachment:

- **Self-expression**: People are interested to have a distinct personal identity from others in the form of 1) **Ideal-Self**: a person users would like to be and, 2) **Public-Self**: the image that users would like other people have of them.
- **Affiliation**: People desire to have relationship, to be connected, joined, associated, and involved with others.
- **Memories**: People would like to maintain a sense of the past, happy moments in life or remind people, occasions, places etc.
- **Pleasure**: People desire to have pleasure and happiness as the primary or most aim of their life in different forms such as 1) feeling better social interaction and social status - **Social Pleasure**, 2) following their values and beliefs - **Ideological Pleasure**, and 3) feeling sense of realism - **Physical Pleasure.**

Case Study

To demonstrate the framework in use, emotional requirements are elicited for a software application that aims to provide help for homeless people in Australia called ***Ask Izzy***.

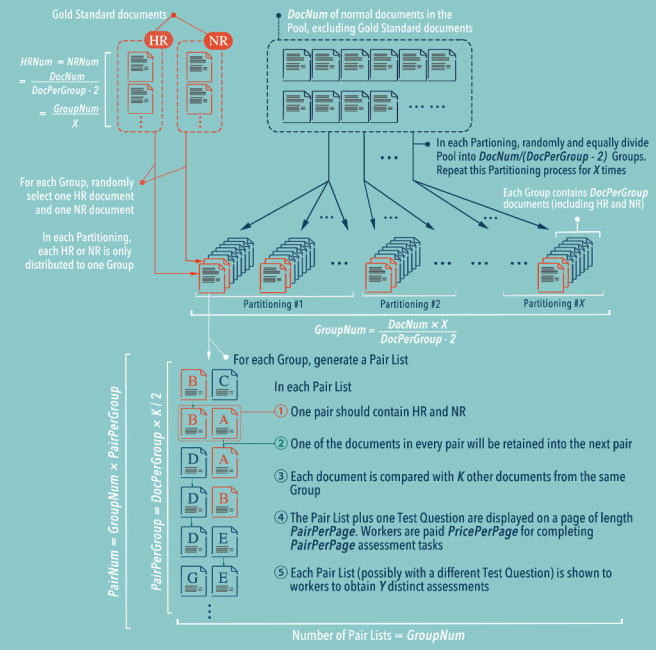


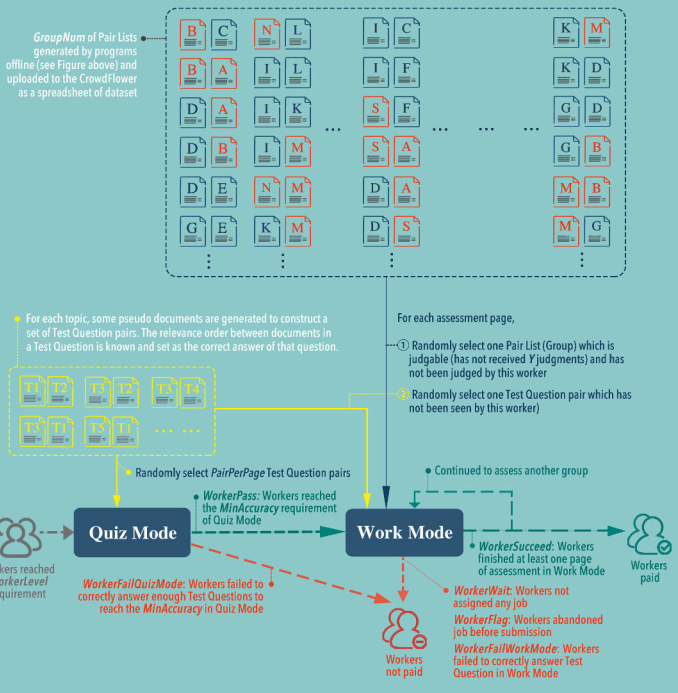
Results

The results indicate that the User Emotional Attachment Framework has the potential to help designers uncover additional emotional requirements as well as provide valuable insights into these emotional requirements. The results of our case study show also that the root of majority of homeless people emotional requirements goes back to their needs for expressing personal identity as well as seeking pleasure.

PAIRWISE PREFERENCE RELEVANCE JUDGMENTS FROM CROWDSOURCING

We are going to use the Pairwise Preference technique to collect relevance judgments for Information Retrieval Evaluation from a crowdsourcing platform. Preference judgments record which document is considered to be more relevant of a document pair.





Background

System: e.g. Google, Bing, ...
Topic (query): user's information need
Document: retrieved and ranked by systems

Text collection: documents and topics
Relevance Judgments: Ordinal scales

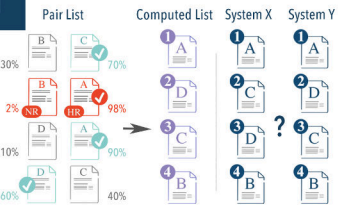
binary (0 or 1); Sormunen (N, M, R, H); multi-level (0,1, 2, 3,...); ...

Topic	Doc	Rel (binary)	Rel (Sormunen)
402	A	1	H
402	B	0	N
402	C	1	R
402	D	1	R
...	...	...	...

Pairwise Preference

Current problems and challenges

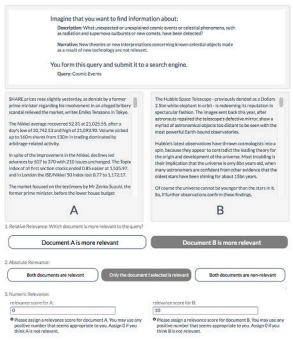
- Judgments are assessed by a limited number of expensive experts, not practical users
- Judgment variations
  - users' perceptions of relevance are different
  - individual factors: gender, age, background, ...
  - assessment criteria drift in varying degreesas more documents are judged
  - hard to pick a single absolute relevance scale for assessors
- Problemtic tied judgments



The noise of assessments can be reduced by

- Making the judgment task easier using pairwise preferences
- Obtaining multiple assessments

Methodology



Three levels of quality control

1. Pre-task Tests
   - *WorkerLevel* requirement on CrowdFlower
   - *MinAccuracy* of Quiz Mode containing Test Questions need to be archieved
2. Embedded Tests
   - Pass the validation (answers within one pair need to be consistent)
   - *TimePerPage* requirement
3. Gold Standard Check

Four levels of judgments (pairwise preference, NIST binary, Sormunen and Magnitude Estimation) comparison on:

1. document relevance score
2. document pair ordering
3. system ordering
4. costs

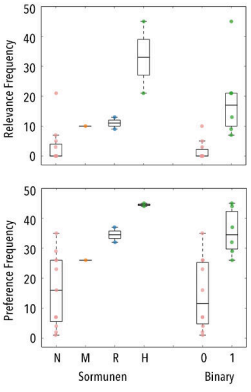
Results

Doc	Relevance Frequency	Preference Frequency	Sormunen	Binary
FT922-11525	45	45	3	1
FT943-14095	21	29	0	1
FT944-128	21	44	3	1
FT941-17652	13	32	2	1
FT932-5036	10	10	1	0
FBIS3-42555	9	37	2	1
FBIS3-42518	7	26	0	1
FT941-14251	5	23	0	0
FBIS3-41454	3	16	0	0
FT942-5875	0	35	0	0
FT922-8685	0	26	0	0
FT921-6788	0	4	0	0
FT933-16663	0	2	0	0
FT931-17077	0	7	0	0
FBIS3-2493	0	1	0	0
LA012289-0015	0	7	0	0

Tau	Sormunen	Binary
Relevance Freqency	0.687	0.730
Preference Frequency	0.643	0.623
Sormunen	–	0.618

Pairwise Preference	Sormunen	Binary
agree	37	36
disagree	3	0
both relevant	0	9
both irrelevant	32	27

DocNum	14
HRNum, NRNum	2
DocPerGroup	8
X, K	3
GroupNum	6
PricePerPage	$0.13
Y	5
Pairs Per Doc	9
Judgments Per Doc	45
Total Cost	$3.90



School of Computing and Information Systems
University of Melbourne

Ziying Yang
ziying.yang@unimelb.edu.au

Sensor-free confusion detection in digital learning environment

Sadia Nawaz – Computing and Information Systems (CIS), Learning Analytics
Advisors: James Bailey (CIS), Gregor Kennedy (CSHE)

Motivation

Face to face communication:

Digital communication:
A teacher teaches a class not a student

Emotional oscillations (harmful)

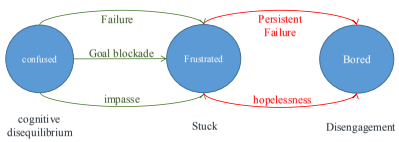


Fig. Goal appraisal theory and context of boredom

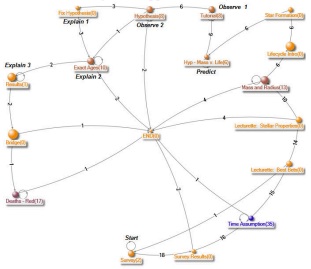


Fig. Pathways of learners with (possible) confusion, frustration and boredom

Emotional oscillations (useful)

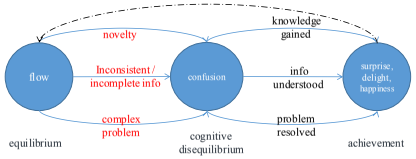


Fig. – Goal appraisal theory and confusion resolution

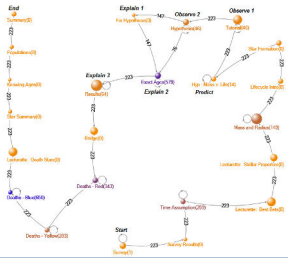


Fig. Pathways of learners with (possible) confusion resolution

Confusion and inter-disciplinarity

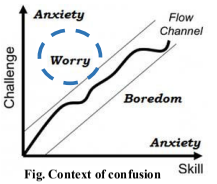
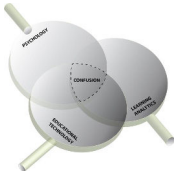


Fig. Context of confusion



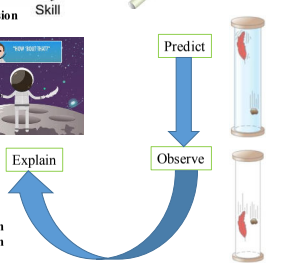


Fig. Predict-observe-explain protocol and confusion detection

Stellar Lifecycle screen flow

Cluster analysis

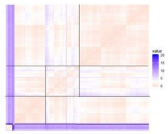


Fig: Ordered dissimilarity image ODI – 'Global Local Outlier Free' stellar data Pink: high similarity | blue: low similarity

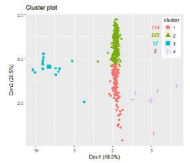
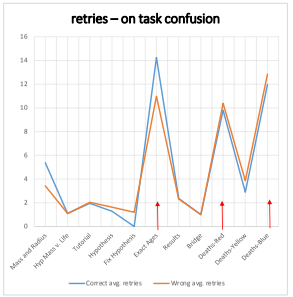


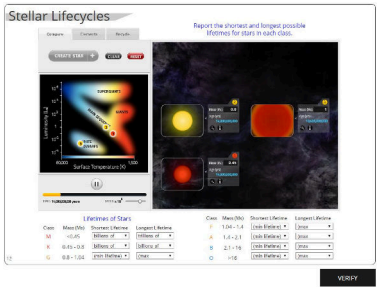
Fig: Cluster plot for K-means clustering (k = 4) – 'Global Local Outlier Free' stellar data

Table: Basic statistics of 'Stellar Lifecycle' module (4 clusters case)

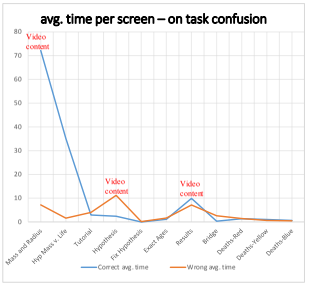
Statistics	Cluster 1	Cluster 2	Cluster 3	Cluster 4
avg. tutorial score	12	12	1.76	8.6
std dev(tutorial score)	0	0	1.59	1.96
avg. question score	0.2	0.37	0.12	0.25
std dev(question score)	0.04	0.07	0.06	0.04
avg. lesson attempts (retries)	1	1	1.06	2.2
std dev(lesson attempts)	0	0	0.24	0.4
avg. lesson completions	1	0.996	0	1.2
std dev(lesson completions)	0	0.07	0	0.4
avg. questions attempts	61.95	33.05	13.47	42.6
std. dev(question attempts)	16.08	5.78	9.85	6.5
avg. questions completed	22.51	22.49	7.29	39.8
std dev(questions completed)	0.68	0.68	4.53	5.15
avg. correct questions	18.54	18.53	5.29	31.4
std dev(correct questions)	0.61	0.61	3.19	4.88
avg. mins_on_lesson	95.93	99.91	41.35	147.2
std dev(mins_on_lesson)	54.66	48.75	58.57	51.72
Total entries (unique entries)	114	223	17	5

On task confusion





On task confusion



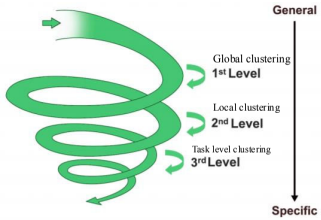


Fig. Iterative data analysis (level-specificity flow)
ajet 2004, 20(1), 18-32

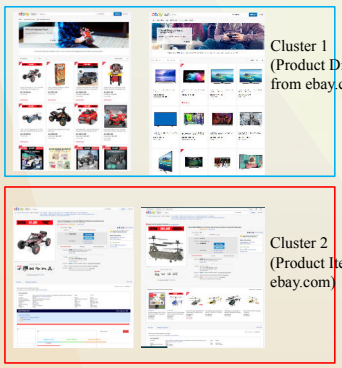
Web Document Clustering Based on Structure and Style Similarity

Chenxu Zhao; Rui Zhang; Jianzhong Qi

Department of Computing and Information System, University of Melbourne

Introduction

Web document clustering is a critical research topic which has many real world applications, such as fast web information retrieval and document organisation. For example, a modern web search engine can return enormous web documents. It is a valid requirement to organise these documents and help users browse them efficiently. Clustering web document based on structure and style similarity can group look-and-feel similar web documents into the same cluster.

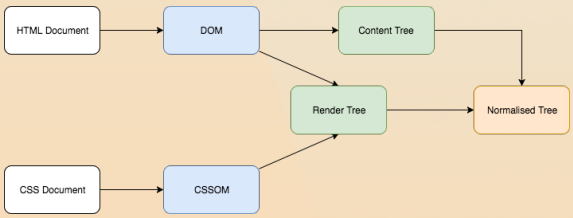


Example of Clustering Results Based on Structure and Style Similarity

Methodology

- **Normalised Tree**

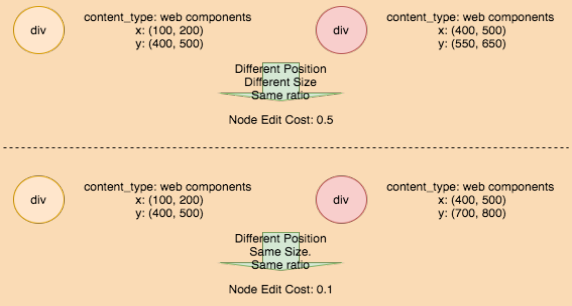
Our method purposes to calculate a normalised tree which integrates the DOM, CSSDOM and content. The node in a normalised tree records the text content attributes, tag, HTML attributes and layout, etc.



Workflow of Constructing Normalised Tree

- **Web Document Similarity**

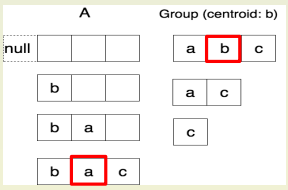
Our method then measures the normalised tree similarity which is calculated by the tree edit distance. We purpose to calculate the cost of node edit operations in a sophisticated method which integrates the style and structure.



Example of Measuring the Style Similarity

	a	b	c	null
a	1	0.8	0.5	0.1
b	0.8	1	0.7	0.15
c	0.5	0.7	1	0.05
null	0.1	0.15	0.05	1

Similarity Matrix



Calculating a New Centroid

- **Greed K-Means Clustering Algorithm**

Our method purposes to use K-Means to cluster web documents. We use a greedy algorithm to calculate the centroid.

The key steps of the algorithm is (as shown in above images):

- Select K points as the initial centroids.
- Assign all points to the closest centroid.
- For every group, define the group length as n. Firstly, give a new array A. Then, find the document and remove it from the group whose similarity between itself and a null tree is the maximum among all documents in the same group. Find the document which has the maximum similarity between itself and A[i]. Repeat last step until A's length is n. The centroid of the array is assigned as a new centroid.
- Repeated last to steps until the centroid does not change.

Contributions

- Measure the style similarity with sophisticated analysis of CSSOM.
- Consider more features, such as the content type and HTML attributes.
- Integrate the structure and similarity score instead of giving a weight.
- Greedy K-Means clustering algorithm.

References

- Serge Abiteboul. Querying semi-structured data. *Database TheoryâĂŤICDT'97*, pages 1–18, 1997.
- Oren Zamir and Oren Etzioni. Web document clustering: A feasibility demonstration. In *Proceedings of the 21st annual international ACM SIGIR conference on Research and development in information retrieval*, pages 46–54. ACM, 1998.
- Kaizhong Zhang and Dennis Shasha. Simple fast algorithms for the editing distance between trees and related problems. *SIAM journal on computing*, 18(6):1245–1262, 1989.

Contact

Chenxu Zhao
University of Melbourne
Email: chenxuz@student.unimelb.edu.au

Privacy and the Internet of Things (IoT) monitoring solutions for older adults: A systematic review

Sami Alkhatib, PhD Student
The University of Melbourne, School of Computing and Information Systems

BACKGROUND

- Demographic changes and the growing trend of "ageing in place", where more people choose to live at home for longer as they age, raised concerns for governments about how to best provide care services to older adults living at their homes
- New technologies, including IoT (connected objects) are being used to monitor older adults' safety and well-being living in their homes
- IoT-based monitoring solutions are designed to operate in the older adults' private places. This raises questions about what are the privacy implications of monitoring older adults at their homes? And how is research on IoT and aged care addressing privacy issues?

OBJECTIVE

To conduct a systematic review on the current academic literature highlighting privacy as a challenge in IoT solutions for monitoring older adults. The aim of this study is to shed light on how these studies conceptualised privacy in IoT solutions for monitoring older adults.

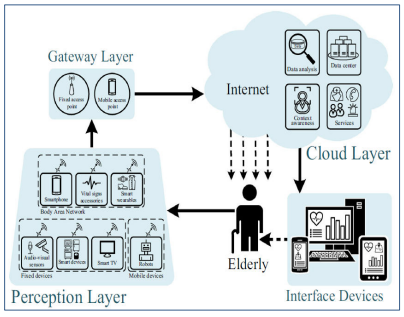


Figure 1. IoT-based elderly monitoring system architecture (from, I. Azimi et al, 2016)

METHODOLGY

METHODOLGY

key words used:

- Privacy
- "Older adults" OR "Aging adults" OR "Elderly" OR " Older population" OR "Older people" OR "Older society"
- "Internet of Things" OR "Ambient Assisted Living" OR "Pervasive" OR "Ubiquitous" OR "Body Sensors"
- "Health" OR "Healthcare"
- "Monitoring" OR "Surveillance"

RESULTS

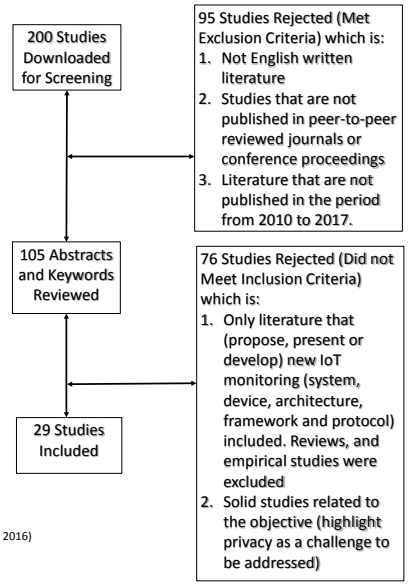


Table 1. Activities that impose threat on older adults' privacy

Data Security: Risks of attacking collected, transferred and stored data (e.g. Hacking, Man in the middle, Replay)
Data Accessibility: Access control (Only authorised people, devices and services should access data)
Breach of Confidentiality: Not to keep personal data confidential
Data Secondary usage: To use data in a different purpose without the individuals' consent
Identification: The ability to link data to a particular individual
Intrusion: To disturb a person's preference of solitude
Surveillance: To collect data without a person's knowledge or consent

RESULTS

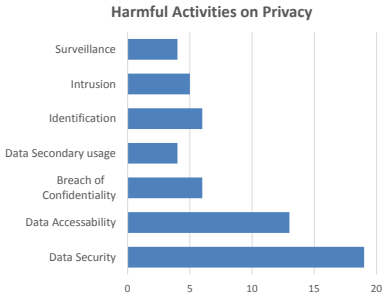


Chart 1. Harmful Activities on Privacy

- The most highlighted risk on the privacy of older adults was "Data Security"; 19 studies out of 29 mentioned it as a major challenge that needs to be addressed
- "Data Accessibility" is the second highest risk on the privacy of older adults, presented in 13 studies out of 29
- "Surveillance" and "Data Secondary Usage" were the least presented in the 29 studies reviewed, only 4 papers mentioned them as activities that impose risk on older adults' privacy

CONCLUSION

- Different studies narrow their understanding of privacy into what is believed to be a variety of harmful activities on older adults' privacy
- The concepts of privacy and security were used interchangeably in the reviewed literature. Thus, most of the studies highlighted data security risks and accessibility as the major challenges on older adults' privacy. This might be due to the fact that these studies present technical systems and are performed by authors with various disciplinary backgrounds
- Empirical findings are required to further explore older adults' privacy concerns and the limitations of the proposed IoT monitoring solutions in addressing these concerns.

REFERENCES:

1. Azimi, I., Rahmani, A. M., Liljeberg, P., & Tenhunen, H. (2016). Internet of things for remote elderly monitoring: a study from user-centered perspective. Journal of Ambient Intelligence and Humanized Computing, 1-17.
2. Jimenez, F., & Torres, R. (2015, November). Building an IoT-aware healthcare monitoring system. In Chilean Computer Science Society (SCCC), 2015 34th International Conference of the (pp. 1-4). IEEE.
3. Lie, M. L., Lindsay, S., & Brittain, K. (2016). Technology and trust: older people's perspectives of a home monitoring system. Ageing And Society, (7), 1501. doi:10.1017/S0144686X15000501
4. Mittelstadt, B. D., Fairweather, N. B., McBride, N., & Shaw, M. (2013). Privacy, risk and personal health monitoring. In ETHICOMP 2013 conference proceedings (pp. 340-351).
5. Solove, D. J. (2008). Understanding privacy.

Situational Impairments During Mobile Interaction

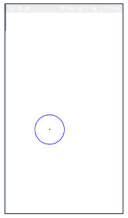
Zhanna Sarsenbayeva, PhD Candidate, Microsoft Research Centre for Social Natural User Interfaces, The University of Melbourne
z.sarsenbayeva@student.unimelb.edu.au

Motivation

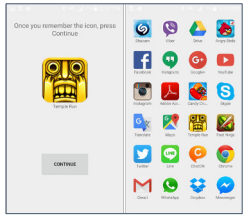
Previous work has highlighted how cold ambient temperature can cause people to become situationally impaired (physically and cognitively). In our work, we investigate the effect of acute cold exposure on vigilance and fine-motor movements during mobile interaction. We argue that a better understanding of situational impairments might increase our understanding of needs for improved accessibility and adaptive user interfaces [1].

Methods

We considered two primary sets of human functions that govern how people interact with mobile devices: physical and cognitive.
We measured physical performance with touch offset and time taken to press the target using TapCircle application.
We measured cognitive performance with time taken to find an app icon using FindIcon application.
We recorded finger temperature and smartphone battery temperature during the experiment.



TapCircle App



FindIcon App

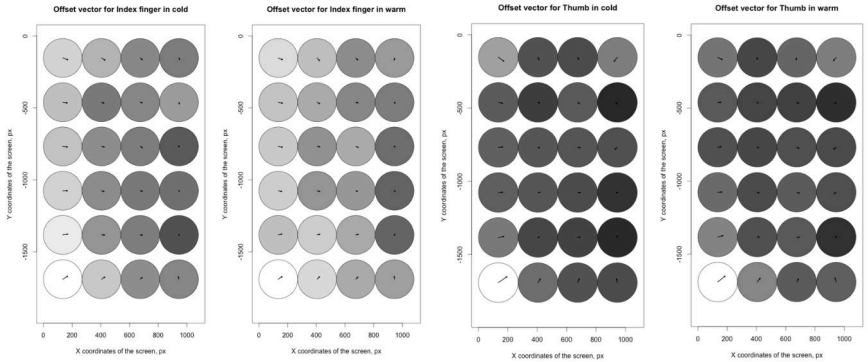
Two-handed Interaction mode

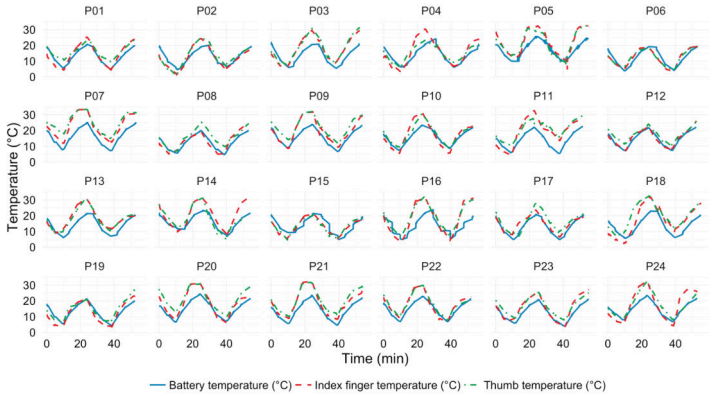
One-handed Interaction mode

Participant completing task in the cold chamber

Results

- Participants took less time to tap the circles in the warm room than in the cold chamber.
- The offset was smaller in the warm room (vs. the cold room).
- The offset size was larger for one-handed (vs. two-handed).
- Participants were significantly slower in memorising an icon in the cold than in the warm room.
- A positive correlation was observed between participants' finger temperatures and the phone's battery temperature.





Conclusion

- We found that in a cold environment the touch accuracy decreases, the target acquisition offset was significantly longer, and participants took significantly longer time to hit a target.
- We also found that there was a relationship between finger temperature and battery temperature, which implies that cold-induced situational impairments can be predicted using off-the-shelf smartphones.

Future work

We intend to investigate the effect of other situational impairments on mobile interaction, such as

Ambient Noise

Cognitive load/ Stress

Visual Impairments

References

[1] Jacob O. Wobbrock. 2006. The future of mobile device research in HCI. In *CHI 2006 workshop proceedings: what is the next generation of human-computer interaction*, 131-134.

Exploring Eye-Tracking technology in predicting subjective states of students in a digital learning environment

Namrata Srivastava (Ph.D Student, CIS (Learning Analytics))
Supervisors: James Bailey, Sarah Erfani, Jason Lodge and Eduardo Velloso

PROBLEM STATEMENT

In a digital learning environment, predicting subjective states of students while they are engaged in a learning task is a challenging problem. Due to human involvement, traditional measures like self-report questionnaire often lack validity and efficiency. Therefore, a machine which can record physiological and behavioural characteristics of the students are required for the research. ***Eye tracking technology has a great potential due to underlying eye-mind assumption.***

RESEARCH OBJECTIVES

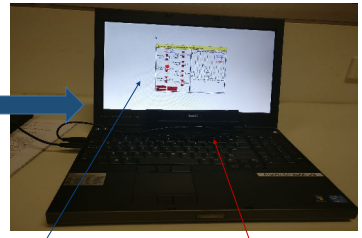
Research Proposal: Build a machine learning model, which can predict mental states of the students on the basis of their recorded eye-movements

Research Goal : Eye-trackers enabled classrooms to improve learning

DATA COLLECTION

Experimental Study

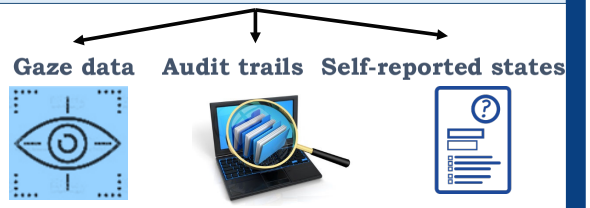
29 students



Blood Alcohol Concentration (BAC) Simulation

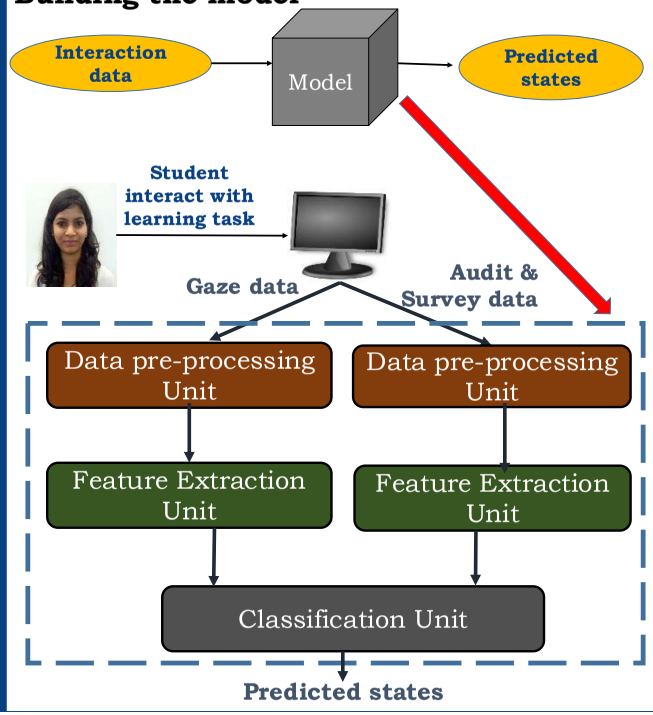
Eye-tracker

Recorded measures



METHODOLOGY

Building the model



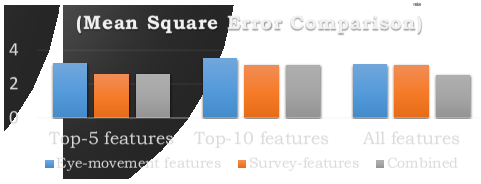
DATA ANALYSIS

Finding relationship between eye-movement features and subjective state "Challenge"

Positive correlated
Saccade absolute angle kurt
Saccade relative angle kurt

Negative correlated
Saccade relative angle SD
Saccade absolute angle SD

Top ranked features
Pupil diameter max
Amount of time deviated
Saccade duration mean
Saccade distance kurtosis
Pupil diameter skew



WHAT IS "QUERY AUTO COMPL"?

Unni Krishnan, Alistair Moffat, Justin Zobel
School of Computing and Information Systems
The University of Melbourne

QUERY AUTO COMPLETION

Suggesting a set of target queries as the user types in their query in the search box.

Steps

1. Choosing a set of candidate queries matching with query prefix [our focus]
2. Ranking the candidates to pick top-k.

MODES OF QUERY AUTO COMPLETION

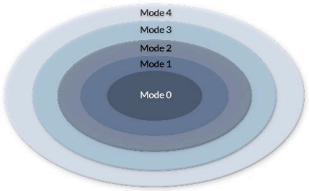
Mode 0 (AbsoluteMatch)
Choose the queries having an exact match with the query prefix.

Mode 1 (Prefix Match)
Candidates have the entered prefix as one of their prefixes.

Mode 2 (ContextPrefixMatch)
Split the query prefix into tokens and look for candidates containing them as a prefix of candidate tokens. This can be a strictly ordered matching (2a) or free order matching (2b).

Mode 3 (PatternMatch)
Similar to Mode 2, but choose candidate containing prefix tokens as a sub-string.

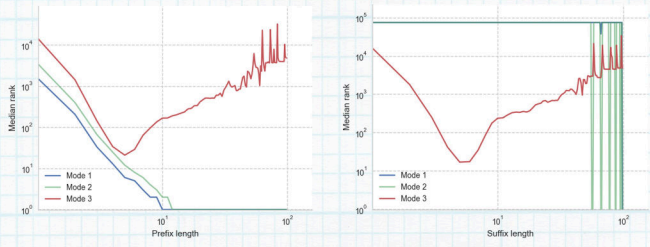
Mode 4 (RelaxedPatternMatch)
Relaxed Mode 3. Search for sub-strings within a given



Completions for the query "game of thrones" for each of the QAC modes

Prefix	Mode 0	Mode 1	Mode 2a	Mode 2b	Mode 3	Mode 4
game o	✗	✓	✓	✓	✓	✓
gam th	✗	✗	✓	✓	✓	✓
th gam	✗	✗	✗	✓	✓	✓
gam rone	✗	✗	✗	✗	✓	✓
gam thorn	✗	✗	✗	✗	✗	✓

Variation in rank of the completed query based on the order of entering the query pattern.



(a) Left to right (b) Right to left

RESEARCH DIRECTIONS

Cost of Implementation
Associated with each mode and choice of data structures, there is cost of building the indexes, cost of storing the indexes (memory and disk) and cost of querying.

Research questions
Using the most optimal data structure, what is the minimum cost you need to spend to implement a given QAC mode? Identify the best suited data structure for each of the modes.

What are the implications and usefulness of each modes? How does ranking vary with the order in which the prefix was entered?

Unni Krishnan
unnik@student.unimelb.edu.au

Design Considerations for a Virtual Community of Practice for Health Practitioners: A Learner Centred Design Approach

Abdulaziz Murad, Reeva Lederman, Rachelle Bosua, Shanton Chang,and John D Wark
The University of Melbourne, Australia

1. Motivation

In Information Systems, communities are naturally difficult to develop, manage, and sustain over time (Butler et al. 2014) especially in healthcare communities based on the learning that is transpiring (Li et al. 2016).

Current research focused on a medical view-point in behaviours in using Health VCoPs (Rolls et al. 2016).

2. Research Question

How do key individual and group Virtual Community of Practice (VCoP) design considerations impact on the sustained learning practices of practitioners in a Health VCoP?

3. Literature and Theory

A VCoP has three dimensions: Domain, Community, and Practice that explain the strength and effectiveness of social constructivism learning (Snyder and Wenger 2010).

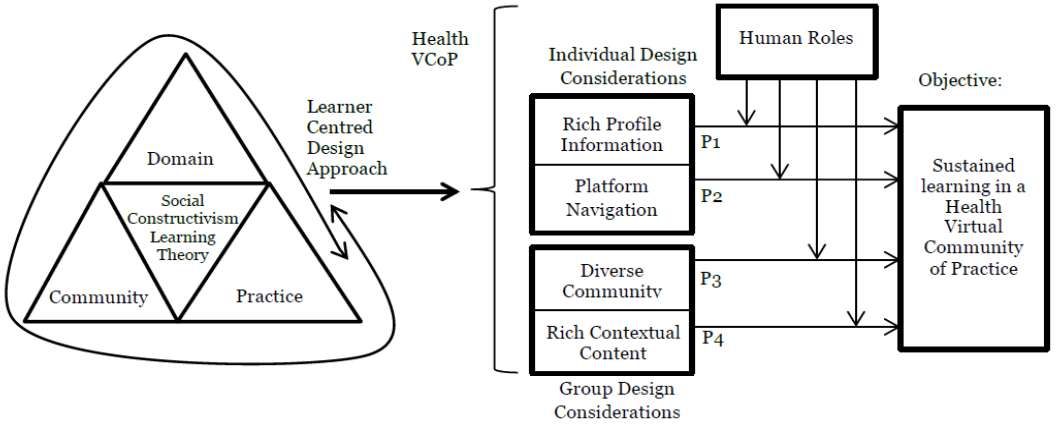
Designing needs to be distinct for individual and group learning (Wenger et al. 2002).

Learner Centred Design Approach assists in designing Social Constructivism Learning environments (Quintana et al 2000).

4. Research Methodology

Three major phases:
1) A detailed literature review;
2) Synthesis of a conceptual model of a Health VCoP design considerations;
3) Testing of the conceptual model through a series of in-depth qualitative interviews as part of case study work.

5. Conceptual Model



6. Research Aim and Implications

Design considerations as a set of guidelines for researchers and developers who want to design a Health VCoP.

A conceptual model that would lead to sustained learning in the Health VCoP.

Lead to an evaluation metric for current and future researchers that are developing their own Health VCoP.

Greater implications in observing, understanding, analysing, and evaluating the knowledge sharing that is ensuing between practitioners.

References

Butler, B. S., Bateman, P. J., Gray, P. H., and Diamant, E. I. 2014. "An Attraction-Selection-Attrition Theory of Online Community Size and Resilience," *Mis Quarterly* (38:3), pp. 699-728.

Li, X., Gray, K., Verspoor, K., and Barnett, S. 2016. "Analysing Health Professionals' Learning Interactions in Online Social Networks: A Social Network Analysis Approach," *arXiv preprint arXiv:1604.02883*).

Quintana, C., Krajcik, J., and Soloway, E. 2000. *Exploring a Structured Definition for Learner-Centered Design*, (B. Fishman & S. O'Connor-Divelbiss (Eds) ed.). Mahwah, NJ: Erlbaum: Fourth International Conference of the Learning Sciences.

Rolls, K., Hansen, M., Jackson, D., and Elliott, D. 2016. "How Health Care Professionals Use Social Media to Create Virtual Communities: An Integrative Review," *Journal of Medical Internet Research* (18:6).

Snyder, W. M., and Wenger, E. 2010. "Our World as a Learning System: A Communities-of-Practice Approach," in *Social Learning Systems and Communities of Practice*. Springer, pp. 107-124.

Wenger, E., McDermott, R. A., and Snyder, W. 2002. *Cultivating Communities of Practice: A Guide to Managing Knowledge*. Harvard Business Press.

INVESTIGATING INTENT RECOGNITION THROUGH GAZE AWARENESS IN USER INTERFACES

THE UNIVERSITY OF MELBOURNE | MICROSOFT RESEARCH CENTRE FOR SOCIALNUI NATURAL USER INTERFACES

Joshua Newn | Eduardo Velloso | Frank Vetere

OVERVIEW

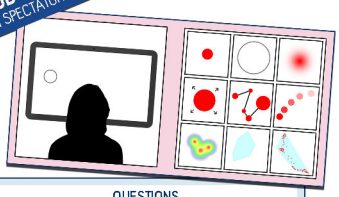
This research project explores the effects of gaze awareness by making gaze visible during competitive computer gameplay. Gaze awareness happens naturally in traditional multiplayer gameplay (e.g. board and card games) — typically to infer the intent of opposing players which in turn provide insight into potential strategies. By making gaze explicit, we open numerous questions surrounding intention and deception. This work explores multiple aspects of gaze in our chosen setting including how it is represented, perceived and consumed by different entities. Further, we explore deeper implications of the work such as the role of gaze in both Intelligent UIs and Theory of Mind.

BACKGROUND

Related works have shown that adaptive AI can change aspects of the game based on a player's eye movements and actions to enable positive gameplay experiences [4] or by implementing social gaze signals to increase immersion [3]. Similarly, human players can make real-time gameplay adaptions once gaze information is made visible. Multiplayer strategic games require continuous thought processing and frequent changes to strategies. By tracking eye movements and actions, we can gain a better understanding and insights into the mind of a player [1].

STUDY DESIGN

STUDY 1 — HUMAN SPECTATOR



QUESTIONS

How well are human spectators able to infer intent?

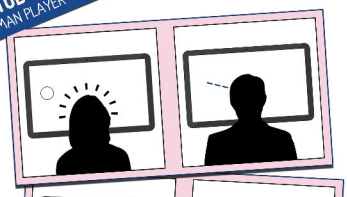
What characteristics of gaze representations enable humans to perform better in predicting intentions?

Does gaze representations have an influence on predicting intent in a competitive gameplay setting?

FINDINGS

Through a study with 27 participants, we found that human spectators have a remarkable ability to infer intent regardless of the representation shown. The overall results showed that a real-time heatmap performed best for inferring intent due to its ability to show an area of interest and directed attention.

STUDY 2 — HUMAN PLAYER



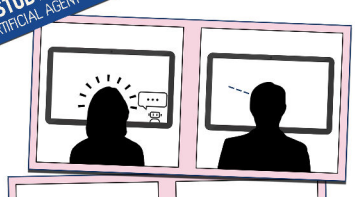
QUESTIONS

Can players infer intention from observing the gaze of another player during gameplay?

Does the awareness of being monitored enable and lead to deceptive behaviours?

Can a player disentangle between true intentions and deceptive intentions?

STUDY 3 — ARTIFICIAL AGENT



QUESTIONS

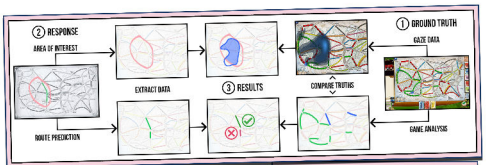
Can a gaze aware artificial agent make accurate and precise predictions in real-time? Can the agent outperform humans in making these predictions?

Would it possible for a human player to deceive a gaze aware artificial agent? Or alternatively, can a human player be deceived by the agent?

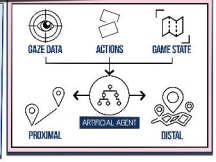
APPROACH

Ticket to Ride is a multiplayer boardgame where each player competes to claim train routes between cities. The gameplay involves a mixture strategies in which a player must hide from their opponent.

We selected the digital version of the board game **Ticket to Ride** as a use case for the project. For each study, we follow a strict protocol to which we subject participants to carefully considered conditions in order to answer our research questions. As part of the analysis in each study, we measure the performance of participants in uncovering the goals of their opponents by comparing the responses against the ground truth. As the project progresses, we record several data sets to inform the development of a gaze aware artificial agent to be evaluated in our final study.



By analysing the playthrough of the game, we are able to obtain the ground truth in which we can measure the participant's responses against. Ultimately, we are interested in the capabilities of a gaze aware artificial agent to perform 'mind reading' by predicting both proximal and distal intentions better than human beings.



CONTRIBUTIONS

By making gaze explicit and aware to entities in competitive gameplay settings, we open up numerous questions with regards to its broader role in Theory of Mind. This project aims to contribute a better understanding of gaze interaction between players and artificial agents, especially the notions of intention and deception through beliefs. The results from this project will provide new insights for AI and gaze interaction, and as well as playful experiences for gaze input in games [2].

REFERENCES

[1] Joshua Newn, Eduardo Velloso, Marcus Carter, and Frank Vetere. 2016. Exploring the Effects of Gaze Awareness on Multiplayer Gameplay. In *Proc. of CHI PLAY Companion '16*. ACM, NY, USA. 239-244. DOI: https://doi.org/10.1145/2968120.2987740

[2] Eduardo Velloso and Marcus Carter. 2016. The Emergence of EyePlay: A Survey of Eye Interaction in Games. In *Proc. of CHI PLAY '16*. ACM, NY, USA, 171-185. DOI: https://doi.org/10.1145/2967934.2968084

[3] Melodie Vidal, Remi Bismuth, Andreas Bulling, and Hans Gellersen. 2015. The Royal Corgi: Exploring Social Gaze Interaction for Immersive Gameplay. In *Proc. of CHI '15*. ACM, NY, USA, 115–124. DOI: http://dx.doi.org/10.1145/2702123.2702163

[4] Stefanie Wetzel, Katharina Spiel, and Sven Bertel. 2014. Dynamically Adapting an AI Game Engine Based on Players' Eye Movements and Strategies. In *Proc. of EICS '14*. ACM, NY, USA, 3–12. DOI: http://dx.doi.org/10.1145/2607023.2607029

Evaluating the impact of IT in an Emergency Department through a time based comparison of IT based clinical activities vs non-IT based clinical activities

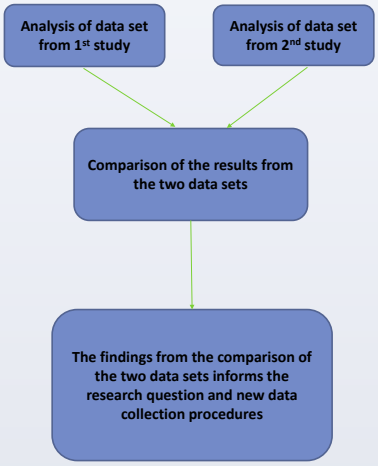
Atlarelang Basetsana Kesiilwe (akesiilwe@student.unimelb.edu.au)
Supervisors: Dr Reeva Lederman and Dr Suelette Dreyfus

Department of Computing and Information Systems
University of Melbourne

ABSTRACT

Studies on health information systems are often focused on assessing the usefulness and impact of such systems and lack insights into how much time is spent on technology supported clinical care activities vs non-technology supported clinical activities. This study is a time motion study aimed at evaluating the impact of an information system use in an emergency department (ED) by building on data from two previous studies (conducted in 2008 and 2012) that were conducted in the same setting. The study uses a single case study approach to measure technology use over a period of time and provide a comparison of technology based activities versus non-technology based activities using predefined activity categories to provide insights into the impact of IT in ED settings.

STUDY DESIGN



LITERATURE REVIEW

Information technology use in healthcare is seen as strategic in creating efficiencies and improvements that are cost effective and beneficial to patients (Shekelle, Morton & Keeler, 2006). The emergency department (ED) is different from other medical environments in that it is often chaotic as a result of a coexistence of inpatients, outpatients and critical patients where doctors are forced to multitask in order to promote patient safety and provide quality care (Fairbanks et al, 2010). Therefore, in EDs, health information technology is often implemented to support the dynamics and variations that exist in the reactive and adaptive emergency care environment (Bengtsson, & Lennartson, 2014).

It is important to understand how IT use affect time utilisation in the ED as this forms the basis for implementation of IT that is acceptable by the intended users as well as provide insights into how IT use affects the time spent in providing care to patients (Pizziferri et al, 2005). Time motion studies are often conducted in medical settings to quantify the time medical professionals spend in executing their tasks to determine how much time is spent on direct patient care as this promotes better patient care and patient satisfaction (Westbrook et al, 2011). Studying time as a resource and how it is distributed in a technologically supported environment allows insights into the impact of such technological advances on clinical workflows.

RESEARCH OBJECTIVE

This is a 3 stage study that uses previous studies as base to quantify the time spent on technology use and provide a comparison of technology based activities and non-technology based activities that are involved in the care of patients. Consultants will be shadowed and interviewed to gain insights into their work patterns and measure how time is spent on IT supported clinical activities versus non-IT supported clinical activities. This is important as it explains in detail IT use by looking at the duration and the activities and tasks that are performed and the findings will be useful in supporting decision making in IT acquisition and implementation in health care and specifically in an ED setting.

RESEARCH METHODOLOGY

The study uses a mixed methods case study based approach where both quantitative and qualitative methods will be employed to obtain the needed information. Using mixed methods provides an in-depth understanding of the results since the combined use of both the qualitative and quantitative methods in a single evaluation will yield results that a single approach may not yield and also because the limitations of using either method is offset by the other (Creswell & Clark 2011).

Quantitative data collection: continuous observations will be carried out by shadowing the consultants using a tablet that has a time stamp software to capture the activities being performed as well as to time the execution of the activities.

Qualitative data will be collected through structured interviews with the consultants that were shadowed during quantitative data collection.

SIGNIFICANCE

The study enables quantifying the useability of IT in a healthcare setting which is key in promoting successful health information technology implementation and adoption. Also as an observational study, this will enable a comprehensive description of the ED environment which is useful in evaluating future strategic interventions in the ED work place and such an analysis is valuable in understanding the IT productivity paradox in an ED setting.

REFERENCES

1. Bengtsson, K., & Lennartson, B. (2014). Patient coordination in emergency departments using an event-based information architecture. *In Emerging Technology and Factory Automation (ETFA)*, 2014 IEEE (pp. 1-6). IEEE.
2. Cresswell, J.W., & Clark, V.L.P., (2011), *Designing and Conducting Mixed Methods Research*, SAGE Publications Inc, California.
3. Creswell, J.W., (2014), *Research design: qualitative, quantitative, and mixed method approaches*. 4th Edition. Thousand Oaks, California: SAGE Publications, Inc
4. Pizziferri, L., Kittler, A. F., Volk, L. A., Honour, M. M., Gupta, S., Wang, S., ... & Bates, D. W. (2005). Primary care physician time utilization before and after implementation of an electronic health record: a time-motion study. *Journal of biomedical informatics*, *38*(3), 176-188.
5. Shekelle, P., Morton, S. C., & Keeler, E. B. (2006). Costs and benefits of health information technology, *Evidence Reports/Technology Assessments, No. 132*
6. Westbrook, J. I., Ampt, A., Kearney, L., & Rob, M. I. (2008). All in a day's work: an observational study to quantify how and with whom doctors on hospital wards spend their time. *Medical Journal of Australia*, *188*(9), 506.
7. Westbrook, J. I., Duffield, C., Li, L., & Creswick, N. J. (2011). How much time do nurses have for patients? A longitudinal study quantifying hospital nurses' patterns of task time distribution and interactions with health professionals. *BMC Health Services Research*, *11*(1), 319.

RESEARCH POSTER PRESENTATION DESIGN © 2015
www.PosterPresentations.com

Transformation from the Fibonacci NLFSR to the Galois NLFSR with Minimal Delay

Ge Yao, Udaya Paramparlli

Computing and Information Systems, University of Melbourne

INTRODUCTION

A Non-Linear Feedback Shift Register (NLFSR) can be implemented in two ways [1]: in the Fibonacci configuration (shown in Fig. 1) or in the Galois configuration (shown in Fig. 2). A transformation from the Fibonacci to the Galois NLFSR can potentially reduce the depth of the circuits implementing feedback. But this transformation is a one-to-many conversion, and the complexity of searching the fastest Galois NLFSR is $O(n^k)$ (in worst case) [2]. To address this problem, a cost functions to estimate the delay of a NLFSR after technology mapping has been introduced to find the best position for every product term in the feedback function.

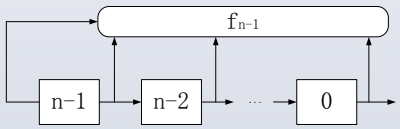


Fig. 1 The Fibonacci configuration of NLFSR

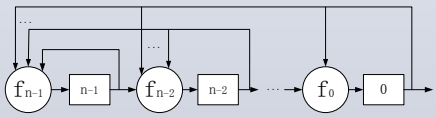


Fig. 2 The Galois configuration of NLFSR

METHODS

Algorithm 1. Estimate the cost of the delay of feedback functions

$F := \{f_i = x_{(i+1) mod\ n} | f_i$ is a feedback function for bit $i\}$

$P := \{p_j \mid p_j$ is a product term of the ANF of $f\}$

$C(f_i) = 0$

$C(p_j) := C(AND) \cdot \lceil log_2(|p_j|) \rceil$

$\tau = \max_{\forall p \in A_{g_{n-1}}} (\max_index(p) - \min_index(p))$

for each $p_j \in P$ *do*

$l_j := \min(\tau, n - 1 - \min_index(p_j))$

$h_j := \min(n - 1, \tau + n - 1 - \max_index(p_j))$

Find the lowest i in (l_j, h_j) that f_i to which no product term has shifted

Shift p_j to f_i or to f_{h_j} if all the functions has shifted product terms

$C(f_i) \mathrel{+}= C(XOR) + C(p_j)$

end for

$C(NLFSR) = max(C(f_i))$

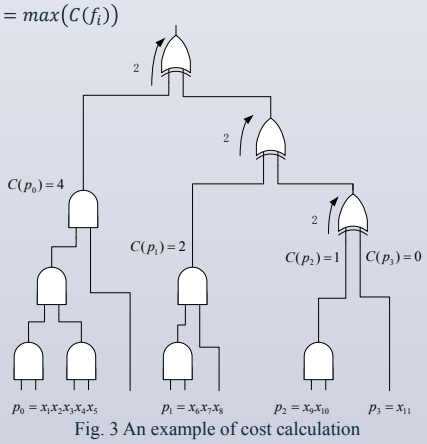


Fig. 3 An example of cost calculation

RESULTS

We apply Algorithm 1 to the regular Fibonacci NLFSR of the example in [1], the results in Fig. 4 show that the minimal cost of the Galois NLFSR is 4.

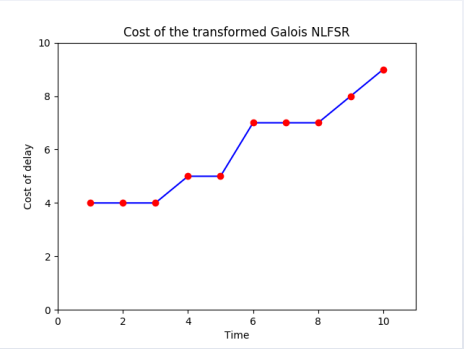


Fig. 4 Cost of Galois NLFSR

We also apply this algorithm to the Grain [2], it transforms the NLFSR to a Galois NLFSR with cost 11. We then modified the algorithm by shifting the product term to a random feedback function inside its border, and the results are shown in Fig. 5. After running the algorithm 1000 times, we get the minimal cost 7 and there are more than one such Galois NLFSR.

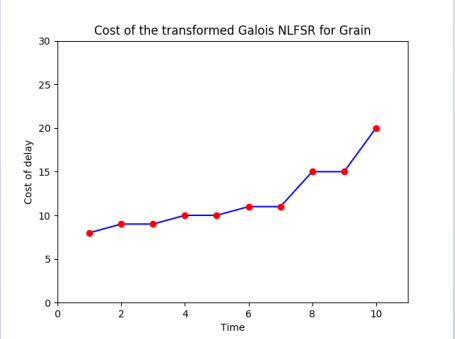


Fig. 5 Cost of Galois NLFSR for Grain

CONCLUSION

In this poster, we show how to transform a Fibonacci NLFSR into the Galois configuration. In order to identify the fastest Galois NLFSR which would minimize the delay of feedback functions, we introduced a cost function and a fast algorithm. The experimental results on the example from [1] and the stream cipher Grain-80 show that the presented approach is efficient and accurate for certain Galois NLFSR where every product term can be shifted to different feedback function.

REFERENCES

[1] Dubrova, E. "A transformation from the Fibonacci to the Galois NLFSRs", IEEE Transactions on Information Theory, pp. 5263-5271, November 2009.

[2] Chabloz, J.-M., Mansouri, S.S., Dubrova, E.: An algorithm for constructing a fastest galois nlfsr generating a given sequence. In: Carlet, C., Pott, A. (eds.) SETA 2010. LNCS, vol. 6338, pp. 41–54. Springer, Heidelberg (2010).

Improving Information Security Governance in organisations

When organisations think of Information Security, these are some of the reactions...

COMPLIANCE

Staying out of Jail

"Information security is a major priority at this company. We've done a lot of stupid things we don't want anyone to know about"

NECESSITY

SUPERHERO ELEMENT

Protecting our organisation

Regardless the motivation, Information Security Governance is often seen as the solution.

But... What is Information Security Governance?

Confidentiality, Integrity and Availability

Contingency Planning

Evaluate, Direct & Monitor

Decision allocation rights

Mitigating Risks

Compliance with legal requirements

Communications in relation to security

Security development

Governance Frameworks

Information Security Governance is about...

Spearheading security awareness and education

Establishing technical controls

Policies

Security operations

Management commitment and leadership

That looks so convoluted!

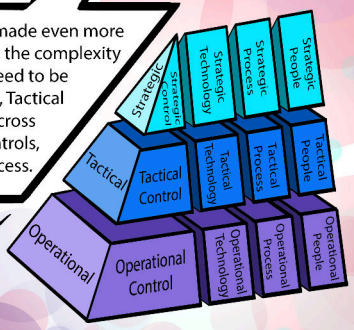
Yes! And you are right because:

- Information Security has been treated solely as a technology issue when it should be seen as a governance issue.

- There is no clear distinction between management and governance when it comes to Information Security.

- Information Security is a subset of Corporate Governance and is part of the Board's fiduciary duty, but it is often left to the CIO.

And this is made even more complicated with the complexity of decisions that need to be made at the Strategic, Tactical and Operational levels across domains encompassing Controls, Technology, People and Process.

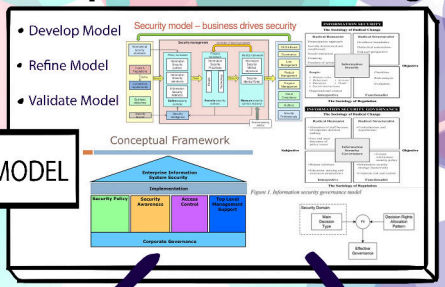


Therefore, organisations need to be able to **measure** their **Information Security Governance**.
As the old adage says...

Manage what you do not measure, you cannot

Anticipated Research Design

- Develop Model
- Refine Model
- Validate Model



Focus groups

Questionnaires

Intended Outcome

A better understanding on how will this improve Information Security Governance in organisations

AND most importantly...
Get me my PhD!

Supervised by
Dr Sean Maynard and Dr Atif Ahmad

THE UNIVERSITY OF MELBOURNE

Stephanie James
PhD Candidate

Abstract

One of the biggest frustrations of new users on forums is when they invest time in writing a question and within minutes it is flagged as a duplicate by a veteran user, while it is actually not. Instead, it is a similar question, asking for something slightly different.
In this work we show that such false duplicates can be detected automatically, but it is a difficult task. Text features alone are inadequate, and were outperformed considerably by meta-data features.

Data

	Closed as Dup	Reopened pairs
Train	28201 (96%)	1122 (4%)
Devel	9399 (96%)	376 (4%)
Test	9408 (96%)	380 (4%)

Detecting False Duplicate Questions in Community Question-Answering Archives

Doris Hoogeveen, Karin M. Verspoor, and Timothy Baldwin

dhoogeveen@student.unimelb.edu.au

THE UNIVERSITY OF MELBOURNE

1. User posts a question on the forum

2. Other user flags the new question as a duplicate of an archived question

3. Other users don't agree and vote to remove the duplicate flag

4. We consider such wrongly flagged questions

False Duplicates

5. Question: Can we identify such False Duplicates automatically?

Features

User features: e.g. reputation and behaviour features
Question features: e.g. length features, question quality features

Text features: doc2vec features, convolutional features, machine translation features

Question pair features: features related to the voters, time stamp features

Total: 57 meta-data features and 47 text based features

Conclusion

Text features alone are inadequate to model false duplicates. Meta-data features outperformed our text features considerably, showing that user- and question-level information can be successfully used to increase the predictive power of false duplicate detection models. When comparing the task of identifying falsely-labelled duplicate questions in cQA archives with regular duplicate question detection in the same archives, we found the false duplicate detection task to be more difficult.

For both tasks there is the heavy skew in the data, which adds to the challenge.

Results

Model	False duplicate detection	
	F1	ROC AUC
Majority baseline	0.000	0.500
Naive Bayes (meta-data only)	0.169	0.703
Random Forest (meta-data only)	0.683	**0.922**
SVM (meta-data only)	0.000	0.500
Logistic Regression (meta-data only)	0.285	0.791
Naive Bayes (meta-data + text)	0.160	0.702
Random Forest (meta-data + text)	**0.686**	0.908
Logistic Regression (meta-data + text)	0.204	0.561
Random Forest (text only)	0.000	0.634
Siamese network unbalanced (threshold = 0.8)	0.000	0.500
STS model [1] + Logistic Regression	0.079	0.561

References

[1] Jey Han Lau and Timothy Baldwin. 2016. An Empirical Evaluation of doc2vec with Practical Insights into Document Embedding Generation. In Proceedings of the 1st Workshop on Representation Learning for NLP (RepL4NLP), p.78–86.

Source of poster template: http://blog.felixbreuer.net/2010/10/24/poster.html

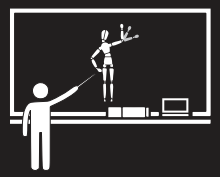
Designing Challenges in

Animated 3D Whiteboard

using Augmented Reality

Martin Reinoso
PhD Candidate
Microsoft Research Center for
Social Natural User Interfaces
The University of Melbourne
martin.reinoso@unimelb.edu.au

Whiteboard markers are one of the key annotation tools used in current classrooms. For 3D whiteboards (with animated 3D objects), markers have limitations, as information is lots from the 3D environment when interacting in 2D. The benefits in spatial knowledge using 3D displays push research to design interaction user-user by annotating virtual objects. In this study, I present some basic problems designers should take in to consideration when designing 3D systems for interaction.



MICROSOFT RESEARCH CENTRE FOR SOCIAL NUI NATURAL USER INTERFACES

Visual Aids

Teacher constantly refers to visual aids that are not part of what the student sees. Design new visual annotation that will enhance teacher's explanations in the classroom.

Operator

Clear communication between a teacher and the operator of the system is critical. Design tools which are easy to use so there is no need for an operator.

2D

3D

Interaction with 3D objects in a 2D environment is not a fluid process. Design tools that use the 3D environment, such as motion controllers for virtual reality, are a good start.

Movement

Objects with movements are difficult to annotate. Design annotation tools that do not rely on a precise click on the object, another option are tools that enable the object to be frozen while annotating.

Context

Annotation on objects should have an attachment point. If the object moves, the pointer should be updated so that annotations (labels) do not lose their meaning.

View Point

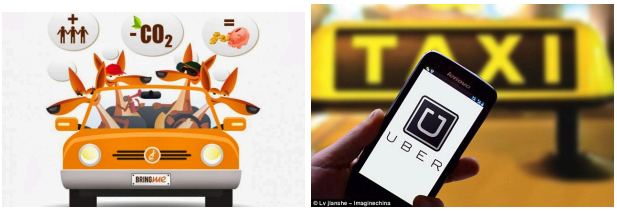
All users have the same view when using a whiteboard. Yet in 3D co-located collaboration, users cannot be in the same location. Designing personalized annotations for each user will allow them to have the same point of view regardless of their location.

Ride-Sharing beats Ride-Sourcing through Hot-Spots

Oscar Correa
oscarcg@student.unimelb.edu.au

THE UNIVERSITY OF MELBOURNE

Introduction



Ride-sharing companies do not offer true ride-sharing services. Instead, these companies offer a taxi-like service called ride-sourcing. Ride-sharing uptake has not been wide and the reasons point out to lack of convenience. We propose an enhanced model of ride-sharing through the inclusion of proper places to meet that we call **hot-spots**. Hot-spots are shown to be more convenient. We also introduce a new problem: **Constrained Variable Steiner Tree**. Finally, an effective and efficient solution to this problem is presented which outperforms the state-of-the-art.

Ride-Sharing more attractive (Part 1)

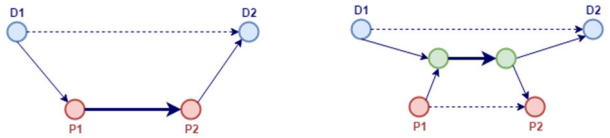


Figure 1: Ride-sharing with Hot-Spots

By the inclusion of Hot-spots: (a) Passengers are not picked up from their locations, (b) Critical mass is attained, and (c) Privacy is achieved by obfuscation.

Ride-Sharing more attractive (Part 2)

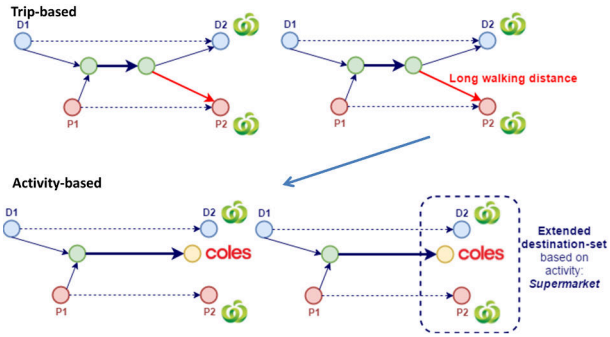


Figure 2: Trip-based vs Activity-based

Problem Definition (C-VST)

Given: A directed network $G = (V, A, c)$, the set of users U, the set of POIs P and the set of Hot-Spots H.
Find: An MDSF where the Steiner trees have disjoint subsets of U as leaves, the Steiner vertices must belong to H only, and each tree T has its root $p = argmin_{p' \in P} c(T)$

Results

Theorem: **kC-VST is NP-complete**

Corollary: **C-VST is NP-hard**

Results

Set of users — Candidate hot-spot

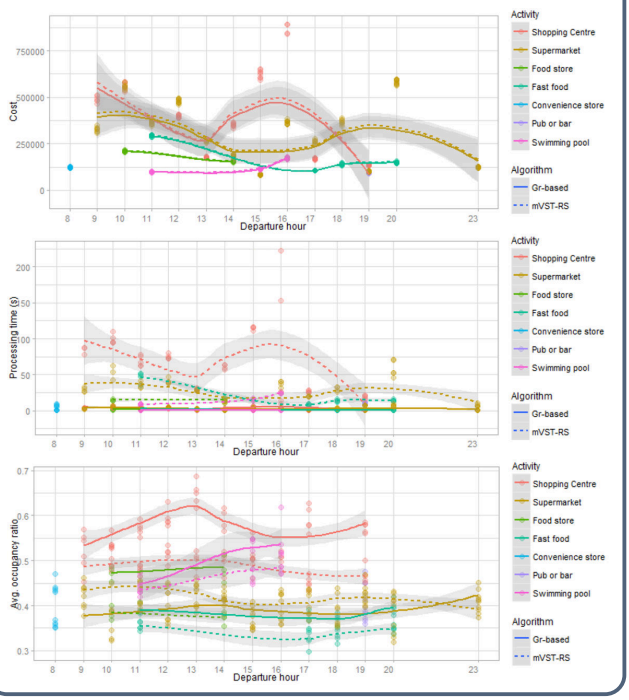
Theorem: **The set function $Gr(L, h)$ for a particular candidate hot-spot is nondecreasing under the update rule**

$$L_{k+1} = L_k\{t\} \text{ only if } \frac{1}{Gr(L_k, h)} < Lr(t, h)$$

$$where\ \ t = argmax_{w \in L_k} Lr(w, h)$$

Avoids combinatorial explosion when choosing among users when maximizing *Gr*

Experiments



Conclusions

Our key contributions:

- Activity Ride-Sharing with Hot-Spots is more convenient.
- Although its parametric complexity is reduced, **C-VST is still NP-hard**.
- Gain ratio is **monotonic nondecreasing** under a specific update rule.
- Our solution is **less time complex** than the baseline.
- Empirically is **up to 2 orders of magnitude faster**.
- It is not statistically significant **less costly**, yet it is on average.
- It is statistically significant **more convenient in terms of average occupancy ratio**.

Three-Minute Thesis Session

Three-Minute Thesis Abstracts

Spread Spectrum Medical Image Watermarking in the Spatial Domain

Peter Eze

More security is better and best security is yet to come. Adding watermarking on top of cryptography provides more security and doing this with spread spectrum technology even makes it better. This is required for secure transmission of health records in telemedicine. However, the challenge of balancing embedding capacity with security and medical image distortion is persistent. In this research I am exploring concepts from CDMA, voxel nature of medical images and the Kerckhoff's theorem of cryptography as applied to steganography in order to improve the quantity as well as the security of data embedded and transmitted via medical images. A key-based algorithm has been designed using these concepts in the spatial domain of watermarking. An SSIM of 0.9992 and PSNR of 57.12dB has been achieved at an embedding rate of 0.2329bpp. The computational complexity for authorised users and attackers are under investigation.

Stochastic route planning for hitchhiking

Oleksii Vedernikov

The main research question of this work is: for a given road network, time-dependent travel time distributions, start and destination points, how to efficiently find a time-adaptive strategy of lifts on it with the least expected travel time or minimizing the maximum possible travel time? To answer this question, we analyse various optimization and pruning techniques to reduce the computational time for a real-world scenario, utilizing the road networks and simulated traffic data from selected countries.

Understanding publications in researchers' homepages

Yiqing Zhang

Publication from researchers' homepages contains rich information, such as researcher's field of expertise, research interest and collaboration network. There are some alternative sources to obtain bibliography information, but they suffer from different kinds of problems. For example, open source bibliography dataset like DBLP suffers from name ambiguity problem. Commercial bibliography dataset, however, requires much human effort to maintain. Unlike the publications from research papers, the publication on personal webpages varies in styles and formats, and can appear in different locations on webpages. Our research aims to locate the publications precisely in personal webpages, and extract different fields with high accuracy from a publication string, such as author, title, venue, year. Despite the existence of alternative sources, being able to precisely extract publication information from freely available researchers' personal webpages is a fast and cost-effective way to collect up-to-date publication information.

Longitudinal Human and Digital Sensing Using Mobile Technology

Niels van Berkel

Modern smartphones provide unprecedented access to longitudinal and large-scale data on human behaviour through sensor data. This data can be collected in a real-world setting, resulting in a highly realistic data collection process. Up to this point, studies utilising smartphones have predominantly focused on the collection of data solely through the

use of such sensors. However, measurement of intrapsychic elements is notoriously difficult to obtain without human input. On the other hand, sensors are capable of capturing our direct surroundings in ways beyond human capability. Therefore, there is a clear opportunity in the combination of human and sensor data sensing techniques for any researcher interested in studying human behaviour. This combination of data sources often remains unattainable due to technological and methodological obstructions. This project seeks to answer how these two data sources can be successfully combined to increase the capabilities of mobile phones as a research tool on human behaviour.

Empowering my avatar to be myself

Romina Carrasco

As people get older, the opportunities for socializing diminish not only because the number of social ties is reduced but also as a consequence of corporeal barriers. Older adults may experience a stigma of the ageing body, mobility, hearing or vision constrains that limit their possibilities of socializing. However, the growing involvement of older adults in online games may be an initial way of addressing this situation. The way users are represented in these environments, as virtual visual avatars can provide older adults new ways to represent their bodies. These bodies offer opportunities for exploring new self-representations and also more familiar and enriched digital ways of expression as they use body gestures, gaze and voice. This talk will depict the story of how one of our online gamers (female, 68 years old) used her avatar to empower herself to help other people as she used to do in her real life.

Authentication through Message Hiding in Frequency Domain

Patrick Vicky

Steganography is the practice of hiding information inside a cover data, such as images, to make its presence undetectable. There are various methods in which a message can be inserted into an image; one approach is to use the least significant bit (LSB) of each pixel as carrier. Although simple, this technique is vulnerable to most types of attacks, such as addition of white noise or geometric manipulations. Another approach is to embed information in the frequency domain; for images, the Discrete Cosine Transform is typically used for conversion. The primary advantage of embedding in the frequency domain is its robustness. Despite being more resistant to tampering, one common disadvantage of this method is its low carrying capacity relative to the LSB method. Furthermore, in order to increase capacity, we often need to sacrifice imperceptibility of cover data. Our research focuses on message hiding as a means of authentication. Thus, our objective is to construct a method that is robust and maximises carrying capacity, while maintaining imperceptibility.

An exploration of mobile phone functionality, feedback and associated factors that influence outcomes of public health interventions

Timoci O'Connor

Feedback of information during the implementation of health promotion interventions is essential for changing risky lifestyle behaviours because of its influence on favourable intervention outcomes. Mobile technologies provide an opportunity for the provision of more targeted, personalised and real time feedback to "treat" the target behaviour (e.g., smoking, eating unhealthy) through the provision of relevant messages and information. However, there remains insufficient evidence to guide what matters most (to yield effectiveness) in terms of feedback intensity (low, moderate,

high), timing of feedback (dosage & frequency), content of feedback (generic, targeted, personalised), mobile device features that facilitate effective feedback (app, sms, voice) and contextual factors that affect feedback and intervention effectiveness. The primary aim of this research is to explore what works in the provision of feedback in behaviour change interventions that employ mobile technologies and elucidate how feedback and associated factors influence intervention outcomes. A secondary aim of this research is to describe and assess the behavioural functionality (features) of the mobile technologies employed in the interventions in relation to feedback. Recommendations will be developed for service providers interested in designing and implementing similar community-based interventions.

Minimizing Landscape Resistance for Habitat Conservation

Diego De Uña

Currently habitat loss is threatening species all over the globe. One of the major threats is habitat fragmentation, where animals have disrupted habitats with obstacles they need to go through. Landscape resistance is a measure of how isolated two main habitats are. The higher the resistance, the more isolation, and therefore the least chance of survival. In our work we tackle to problem of deciding which areas of the landscape need more to be improved more urgently subject to a budget such that the isolation level gets diminished to a minimum.

Detecting Interval of Recurrence in Time Series

Yousef Kowsar

Finding repeating patterns in time series data has many applications from green industry to sport and fitness. Any successful knowledge discovery approach for finding intervals of recurrence needs to overcome three main challenges: 1) differentiating noise from recurring patterns; 2) the changes of signal of recurrence over time both locally and globally 3) the identification of an interval of recurrence must be accomplished efficiently. In this 3 minute talk, I will represent the importance of finding recurring patterns in time series and show how we can extract these intervals from time series.

Thermography as a Novel Modality for Contactless Patient Monitoring

Peter Chan

Patient monitoring, both in health care settings and in the community, relies on the measurement of five vital signs, namely Temperature, Heart Rate, Respiratory Rate, Blood pressure, and Oxygen saturation. Changes in one or many of these vital signs is often suggesting of a deteriorating patient, who may require more prompt medical attention. Delays in the recognition of a deteriorating patient are a significant cause of morbidity and mortality in hospital. Monitoring of patients is resource and time intensive. Many monitoring devices are also invasive and cumbersome. Thermal imaging, or the measure of heat transfer, has been postulated as a potential means of monitoring patients as early as the 1980's, with barriers to uptake being the cost of the equipment and the processing power required to interpret the images. Recent advances in the technology have substantially reduced the cost of the equipment. Higher processing power has opened the possibility of the application of algorithms that can recognize vital signs in real time,

and therefore the potential early recognition of a deteriorating patient. This thesis aims to explore the use of contactless thermal imaging as a modality to assess the wellbeing of patients in a Critical Care Environment, and how heat transfer changes in various states of illness.

A More Accurate DNA Sequencing with Multimapping Resolution

Mohammad Oloomi, Thomas Conway, Justin Zobel

The high-throughput sequencing machines shear DNA randomly into many small fragments. The sequences of these fragments, referred to as reads, should be then assembled back together in order to construct the original sequence. In read mapping, a complete genome sequence is used as a reference genome and the short reads are mapped to this reference sequence. Most reads map uniquely to only location, however, some reads can be mapped to more than one location on the reference genome and create ambiguity as which location is the true origin of the read. We propose a new method for resolving multimappings that follows a holistic approach for selecting the correct location for each multiread. We show that our approach results in a more accurate read mapping and improves the accuracy of downstream analyses such as variant calling.

Security Analytics

Humza Naseer

Information security risk management (ISRM) is a continuous process that integrates identification and analysis of risks to which an organisation is exposed, assessment of likelihood of potential threats and their impact on the business, and deciding what actions need to be taken to eliminate or reduce risk to an acceptable level. My review of the literature highlights two trends in organizational practice of ISRM: (1) security risks are not analysed and monitored continuously and historically (2) security risks are assessed based on speculation rather than evidence. Business analytics (BA) provides organizations with a unique opportunity to develop specialised capabilities (security analytics) and thereby enable the practice of analytics-driven evidence-based decision making in ISRM. In this study, I utilize a contingent resource based view to develop a research model that explains how security analytics capabilities and ISRM capabilities indirectly influence enterprise security performance through mediating role of analytics-driven ISRM capabilities. Risk assessment complexity moderates the process by which security analytics capabilities and ISRM capabilities influence the enterprise security performance.

Influence of Person-Generated Health Data on Patient Attitudes or Behaviours: A Kinect-type Neuro-rehabilitation Programme

Gerardo Luis Dimaguila

Post-stroke rehabilitation systems using body-tracking technology Kinect have been developed as a response to the need for an effective home-based rehabilitation that requires less professional and financial resources. These systems may generate person-generated health data (PGHD): health, wellness and clinical data that people generate, record and analyse for themselves. While PGHD's importance for individual persons or patients have yet to be conceptually defined, several benefits have already been suggested, e.g., encouraging patients to be more involved in their care process, and improving their coordination with health teams. However, there is a lack of theoretical basis with regards to PGHD, i.e., there is no outcome measure or technique to understand the impact of PGHD on patients. This research

attempts to answer the question: What are the health-related effects of utilising person-generated health data, from patients using a body-tracking rehabilitation system?

Grounded Knowledge for Language Understanding

Adel Foda

The grounded cognition model posits that the human ability to understand and reason with language requires a capacity to transduce between amodal symbolic and modal physical representations of phenomena. Recent advances in deep neural networks have greatly enhanced the ability of computers to usefully represent physical data such as images, audio, and video, and certain methods have demonstrated a capacity for modal-amodal transduction explicitly. Inspired by these ideas, we investigate the potential of multi-modal deep learning to improve results on new and traditional linguistic understanding tasks, by considering such methods as generative adversarial networks, joint modal-semantic embeddings, and dynamic recurrent neural networks.

Group dynamics in an Information Security Risk Management context: a study of Risk Perceptions

Anitya Nijhara

A large body of management literature advocates the study of small groups as the primary decision making units in organisations. (Stoner, 1961; Yukl, 2002) Even so, a review of human-centred studies of Information Security Risks quickly reveals the concentration of research focus to an organizational level (Martins and Elofe, 2002; Chia, Maynard and Ruighaver, 2002) or an individual level (Bulgurcu, Cavusoglu and Benbasat, 2010; Chan, Woon & Kankanhalli, 2005). This paper is targeted at ISRM decision making in organizations—but with a focus on small groups. It discusses group compositions, individual risk perceptions and how they affect collective decisions regarding information security risk.

How Do We Talk to Virtual Characters?

Fraser Allison

In a few short years, the voice interface has gone from a marginal and lacklustre technology to a viable service with a growing presence in our lives. But how does this social mode of interaction, and the virtual-character metaphor that often accompanies it, affect the way we use our devices? My PhD looks at the design and use of voice interfaces in digital games, to understand how people converse with and think about virtual characters who listen when they speak.

Author Index

Abdulaziz Murad, 47
Adel Foda, 60
Adrian Pearce, 30
Aili Shen, 5
Aleck Macnally, 30
Alistair Moffat, 46
Andrew Lonie, 27
Anitya Nijhara, 60
Antonette Mendoza, 39
Atif Ahmad, 36, 38
Atlarelang Basetsana Kesiilwe, 49

Benjamin Rubinstein, 6

Carlos Andres Agudelo Serna, 35
Chenxu Zhao, 42
Christoph Breidbach, 11
Christopher Leckie, 7, 14
Craig Horne, 38

Dana Mckay, 8
Daniel Samson and Sara Cullen, 12
Deepti Aggarwal, 29
Diego De Uña, 58
Doris Hoogeveen, 52

Egemen Tanin, 31
Eman Alatawi, 13

Farzad Khodadadi, 17
Fei Liu, 2
Frank Vetere, 28
Fraser Allison, 34, 60

Ge Yao, 50
Gerardo Luis Dimaguila, 60
Gregor Kennedy, 41

Harald Sondergaard, 13
Hasan Shahid Ferdous, 10
Humza Naseer, 59

James Bailey, 26, 41, 45
Jianzhong Qi, 5, 22, 23, 42
Jiayuan He, 23
Jongkil Jeong, 12
Joshua Newn, 48
Justin Zobel, 20, 46, 59

Karin Verspoor, 20, 21, 25, 52
Kathleen Gray, 21

Lars Kulik, 26
Lars Kulik and Egemen Tanin, 54
Li Li, 14
Luthfi Ramadani, 11

Mahsa Salehi, 7
Mahtab Mirmomeni, 26
Marcus Carter, 28
Maria Alejandra Rodriguez, 16
Martin Reinoso, 53
Masud Moshtaghi, 7
Mazino Onibere, 36
Melissa J. Rogerson, 9
Milad Chenaghlou, 7
Miquel Ramirez, 30
Mohammad Oloomi, 59
Mohammadhossein Sherkat, 39
Muhammad Hafizhuddin Hilman, 16
Muhammed Tawfiqul Islam, 18

Naghmeh Sharikzadeh, 33
Namrata Srivastava, 45
Neil Marchant, 6
Niels van Berkel, 57
Nir Lipovetzky, 30
Nitika Mathur, 4

Oleksii Vedernikov, 56
Oscar Correa, 54

Patrick Vicky, 57

Peter Chan, 59
Peter Eze, 56

Qingyu Chen, 20

Rachel Burrows, 39
Rajkumar Buyya, 16, 18
Ramamohanarao Kotagiri, 31, 54
Renata Borovica-Garjic, 22
Richard Sinnott, 24, 25, 27
Romina Carrasco, 57
Ronal Singh, 15
Rui Zhang, 5, 22, 23, 42

Sadegh Motallebi, 31
Sadia Nawaz, 41
Salla Eliisa Toikkanen, 24
Sami Alkhatib, 43
Sarah Erfani, 14, 45
Sarah Webber, 28
Sean B. Maynard, 36, 38
Sehrish Kanwal, 27
Shanika Karunasekera, 18
Sherah Kurnia, 11, 12
Stephan Gloeckner, 24
Stephanie James, 51

Thomas Conway, 59
Tim Miller, 13, 39
Timoci O'Connor, 58
Timothy Baldwin, 2, 3, 52
Trevor Cohn, 2, 3

Udaya Parampalli, 25, 50
Unni Krishnan, 46

Wally Smith, 28

Xin Li, 21

Yang Lu, 25
Yiqing Zhang, 56
Yitong Li, 3
Yixin Xu, 22
Yousef Kowsar, 58
Yu Sun, 22

Zhanna Sarsenbayeva, 44
Ziying Yang, 40