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Congestion Control in TCP

Mahdi Arghavani, Haibo Zhang, David Eyers

Transmission Control Protocol (TCP) is the dominant transport layer protocol for providing reliable end-to-end communication across the Internet. Due to the lack of availability of historical information about the network, TCP knows nothing about the network path throughput when a new connection is set up. The rate should be raised rapidly so as not to waste time by underutilizing the path, but also cautiously so as not to overshoot the appropriate bandwidth share, as this may impact the performance of other flows. Using exponential growth of the congestion window, TCP slow-start aims to quickly probe the throughput of the network path. Stopping this growth at the wrong time can affect the overall network performance. In this talk, an efficient mechanism to accurately and quickly detect when to stop this exponential growth is introduced. It reacts to the congestion window's size rather than more traditional congestion signals such as packet-loss and/or delay.

Full Digital Transmit Beamforming with Low RF Complexity for Large-scale mmWave MIMO system

Waqas Ahmad, Haibo Zhang, Yawen Chen

Conventional full digital transmit beamforming requires a separate Radio-Frequency (RF) chain per transmit antenna, which is not easy to realize for large-scale antenna systems due to the high hardware cost, system complexity and power consumption. We propose a new scheme that enables full digital transmit beamforming with low RF complexity. We consider a multiple-input–multiple-output (MIMO) system with N transmit antennas and M receive antennas where $N >> M$, and transmit antennas are connected to L RF chains, where $L < N$. In our scheme, transmit antennas are dynamically divided into L groups based on the multipath channel spatial correlation profile. The beamforming gain is achieved by letting highly correlated antennas in the same group. Each group of antennas is connected to one out of L RF chains and each group transmits an independent data stream. RF chain is designed in such a way that it independently preserves baseband signals of a group of antennas in a time-division-multiplexing (TDM) way. Our scheme is evaluated in simulations by comparing with full RF complexity digital transmit beamforming.

Simulation results demonstrate that, our proposal is suitable for doubly massive MIMO systems, particularly in line-of-sight (LOS) scenarios.

Accelerating Artificial Neural Networks on Optical Network-on-Chip (ONoC)

Travis Dai, Yawen Chen, Zhiyi Huang, Haibo Zhang

Artificial Neural Network (ANN) is one of the most important methods in artificial intelligence whereas the training of an ANN can take long time with high energy consumption in existing many-core systems. Network-on-Chip (ONoC), an emerging chip-scale optical interconnection technology, has great potential to accelerate

the training of an ANN with low transmission delay, low power consumption, and high throughput. However, existing methods based on Electrical Network-on-Chip (ENoC) cannot fit in ONoC because of the unique properties of ONoC. In this talk I will talk about the proposed fine-grained parallel computing model for accelerating ANN training on ONoC. And based on the proposed model, I will describe how to derive the optimal number of cores for each execution stage to minimize the total amount of time to complete one epoch of ANN training, and discuss the pros and cons of three mapping strategies in terms of hot-spot level, memory requirement, and energy efficiency.

Scaling LoRaWAN

James Walmesley, Haibo Zhang

LoRa and LoRaWAN are promising solutions to address the upcoming challenges that the Internet of Things (IoTs) presents. They can provide many of the desired characteristics such as long range transmission, low power use, and low device cost, but have an issue with network capacity. Scaling LoRaWAN networks for the capacity that the IoTs desires is the current challenge and I aim to improve current solutions to address this challenge. Since LoRaWAN is a new technology, research and development in this area are still in the early stage. Some work has focused on the fairness of collision probabilities across nodes in a network, aiming to improve the scalability of LoRaWAN. By extending an existing approach, I proposed a new parameter and transmission power allocation scheme for LoRaWAN networks. Simulation results show than my solution can achieve better performance than existing solutions.

Learning the Hierarchical Structure of Sequential Events

Daniel Slack, Ali Knott, Brendan McCane

The process of learning high-level representations of temporal sequences is integral to the functioning of the mammalian brain. However, the mechanics of this process are not currently well understood and remain a open area of study. Our previous work introduced a new biologically-inspired method for forming declarative representations of sequences based on the neocortex termed Self-Organising Temporal Pooling (SOTP). This network was shown to be capable of declaratively representing sequences with a consistent representation spanning every time step within the sequence. However, while SOTP is a complex network comprised of multiple networks chained together, SOTP is not hierarchically stackable and cannot form high-level representations. We introduce an extension to SOTP integrating Reinforcement Learning (RL) to this end, enabling the learning of deep hierarchical representations of sequences. We demonstrate the utility of this new method in forming high-level representations of simple shapes, with different layers in the hierarchy covering different levels of complexity from single lines to complete polygons.

Path Planning of UAV Swarms for Collision Avoidance

Shuangyao Huang, Haibo Zhang, Zhiyi Huang

In this project, we propose a collisions avoidance method for UAV swarms on two dimensional plane that 1) avoids collisions with obstacles, 2) avoids collisions among swarm members and 3) requires minimum energy consumption of the swarm. Our method consists of an Artificial Potential Field (APF) part that provides environmental awareness and a Particle Swarm Planning (PSO) part that optimizes trajectories for UAV swarms.

Transfer Learning: Data Imbalance, Uncertainty and Hyperparameter tuning using parallel optimization.

Pascal Omondiagbe, Sherlock Licorish, Stephen MacDonell

Traditional machine learning (ML) algorithms are designed with the assumption that the training and testing data are drawn from the same input feature/data distribution. In dealing with real-world scenarios, this assumption may not always be true and this could lead to different marginal and/or conditional probability distributions. If this occurs, most ML methods need to be rebuilt by using labelled training data drawn from a similar distribution. This is expensive and task consuming process and sometimes the data from similar distribution may not be available. Transfer Learning (TL) methods are often used to overcome this problem. The performance of a TL method could be degraded due to various factors such as having dissimilar/noisy source data and/or when dealing with data imbalance. Furthermore, as these TL methods are sometimes used in combination with standard ML methods, it becomes difficult to effectively tune both model's hyperparameters concurrently. This research aims to explore ways of reducing negative transfer in TL when faced with these factors and incorporate uncertainty. We also aim to introduce a systematic approach to turn these TL methods. This talk will present a proposed TL taxonomy to help understand TL's method better. Then, a proposed approach to deal with imbalance data taken from a different distribution will be presented. Lastly, my proposed plans for future work will be briefly introduced.

Simulated study with Expectation in Collective Action

Abira Sengupta, Stephen Cranefield, Jeremy Pitt

Collective action refers to the joint action of several self-interested individuals with the aim to achieve some social gain through cooperation. A problem arises in collective action when group members are not trusting with each other because there is a conflict between individual and collective interest so members of the group are behaving in a non-cooperating manner. Game theory is based on different solution concepts such as Nash equilibriam, which is computationally expensive and does not confirm with human social behaviour. To begin with, we are studying the Plain/Plateau Scenario, where the government's main goal is to maximise social welfare. The government deliberately restricts its options by adopting rules that

constrain its actions in certain circumstances. This creates a clear and credible expectation of the citizens that they will not be bailed out if they choose to live in the flood plain and their house is damaged by the flood. These concepts then are modelled more generally using the CASP simulation tool. An event calculus is an important feature of CASP, which can express how some actions can have social effects such as creating expectations. When CASP agents choose their actions, they may take these social expectations into account in their reasoning.

Probabilistic model of decision making on expectation and common knowledge

Sriashalya Srivathsan, Stephen Cranefield, Jeremy Pitt

Expectations and common knowledge play a vital role at the social level when people join for collective action. Expectations encode our experience and social knowledge and inform our practical reasoning. Common knowledge can be explained as information known by everyone and everyone knows that every other person knows it. Based on the work of Ober, who analysed the success of ancient Athens which was the result of its shared commitments, social values, and specific procedural rules, we define a probabilistic model of a specific prosecution against an Athenian trader who neglected to contribute to the country when it was in a crisis. We intend to investigate how this model can be implemented for agents' reasoning in terms of expectation and common knowledge in order to make decisions.

Norm entrepreneurship by proposing local coordination plans

Amritha Menon, Stephen Cranefield, Tony Bastin Roy Savarimuthu

The principal focus of normative multi agent systems in a distributed environment is coordination, competition and cooperation using established norms. Most work hitherto studies norms that are provided to agents as part of their specification or distributed from centralized agents. Diverging from this line of thought, we aim at modelling a multi agent environment focusing on peer-to-peer interaction by providing the agents a freedom to initiate norm creation at demanding situations. In order to achieve this, we blend probabilistic planning with norms in a multi-agent system and investigate the notion of "norm entrepreneur". A norm entrepreneur is considered to be an agent in the environment who proposes a local coordination plan (potential norm) to cope with an interference of another agent in their normal course of action. This work investigates how agents can identify a potential interference and propose local coordination plans which can be considered by other agents and propagated to form norms at a later stage.

Norm violation identification in Stack Overflow comments

Jithin Cheriyan, Tony Savarimuthu, Stephen Cranefield

Norms are behavioural expectations in communities. Online communities are also expected to abide by the established practices that are expressed in the code of

conduct of a system. Even though community authorities continuously prompt their users to follow the regulations, it is observed that hate speech and abusive language usage are on the rise. In this paper, we quantify and analyze the patterns of violations of normative behaviour among the users of Stack Overflow (SO) - a well-known technical question-answer site for professionals and enthusiast programmers, while posting a comment. Even though the site has been dedicated to technical problem solving and debugging, hate speech as well as posting offensive comments make the community "toxic". By identifying and minimising various patterns of norm violations in different SO communities, the community would become less toxic and thereby the community can engage more effectively in its goal of knowledge sharing. Moreover, through automatic detection of such comments, the authors can be warned by the moderators, so that it is less likely to be repeated, thereby the reputation of the site and community can be improved. Based on the comments extracted from two different data sources on SO, this work first presents a taxonomy of norms that are violated. Second, it demonstrates the sanctions for certain norm violations. Third, it proposes a recommendation system that can be used to warn users that they are about to violate a norm. This can help achieve norm adherence in online communities.

Forcing Neural Networks to Behave using Interpretability Methods

Craig Thomas, Lech Szymanski

Neural Networks are excellent machine learning models, however, they are "black boxes" that are hard to understand. The field of Neural Network Interpretability attempts to explain why these models make the decisions they do. In my research I combine Interpretability methods with network training methods to guide the network to behave the way we want it to behave. Rather than training only to maximise accuracy, I train them while enforcing a constraint that the network's behaviour interpretation matches our expert human expectations, improving our understanding and trust of the model.

Interdisciplinary research at academic institutions

Maryam Nakhoda, Sander Zwanenburg, Peter Whigham

Interdisciplinary research (IDR) is a growing trend in academic institutions, which has roots in a change in the academic community and research funders' approach in the late 1960s to become problem-oriented and application-oriented. Interdisciplinary collaboration has been the origin of significant scientific discoveries, such as DNA which involved scientists from biology, chemistry, genetics, physics, mathematics, and computer science. Also, new challenges seek answers beyond the boundaries of one field of knowledge such as environmental and health issues, particularly the recent COVID-19 crisis. Nevertheless, there exist paradoxical approaches towards engaging in interdisciplinary research in academic communities that we address to offer a synthesis for the use of researchers. Up to the present, various perceptions

of the meaning of interdisciplinary research have been pointed out in the literature. To build a body of knowledge around IDR, this project firstly leads to a conceptualization that will be a basis for consequent investigations such as measurement, evolution analysis, and testing hypothesis. Interdisciplinary research is operationalized using bibliometric data from Web of Science and Scopus, around research systems like papers, people, departments, and institutions. As references convey the idea of relating research areas by a given publication, this can be a way to examine the integration of areas of knowledge, reflecting the diversity of the source discipline.

Semi-Supervised Semantic Segmentation for Medical Images with GAN-based Perturbation

Robert Hou, Jeremiah Deng

It is a challenging task for semantic segmentation of medical images. In this work, we introduce a GAN-based semi-supervised architecture for retina vessel semantic segmentation. Extensive experiments demonstrate our framework is efficient on DRIVE, STARE and CHASE_DB1 retina fundus images, and achieve the competitive performance compared to state-of-the-art methods.

Perceived Supportiveness of Physical Activity related Apps

Wendy Wlasak, Sander Zwanenburg, Steven MacDonell, Brian Spisak

Since about half a year COVID-19 is holding the world in its grip and many researchers fear that it will worsen another pandemic we have been living with for a couple of year now: physical inactivity. One way of tackling the issue might be physical activity related devices and apps, which yield many advantages over traditional intervention approaches like wide reach, high scalability and lasting support. In my research I am looking at the perceived supportiveness of these devices and apps for long-term physical activity, using Self-Determination Theory as a theoretical framework. During the last half year I studied how people experience the physical activity related apps they are using and the activity they mainly use it for. Furthermore I investigated which impact COVID-19 had on the perceptions of the app and physical activity by conducting a follow up study. In this talk I will give you an overview over my research and present some of the results.

The complexity of computing the RNNI distance between phylogenetic trees

Lena Collienne, Alex Gavryushkin, David Bryant

Many popular algorithms for searching the space of leaf-labelled (phylogenetic) trees are based on tree rearrangement operations. Under any such operation, the problem is reduced to searching a graph where vertices are trees and (undirected) edges are given by pairs of trees connected by one rearrangement operation (sometimes

called a move). Most popular are the classical nearest neighbour interchange, subtree prune and regraft, and tree bisection and reconnection moves. The problem of computing distances, however, is NP-hard in each of these graphs, making tree inference and comparison algorithms challenging to design in practice. Although ranked phylogenetic trees are one of the central objects of interest in applications such as cancer research, immunology, and epidemiology, the computational complexity of the shortest path problem for these trees remained unsolved for decades. In this talk, we settle this problem for the ranked nearest neighbour interchange operation by establishing that the complexity depends on the weight difference between the two types of tree rearrangements (rank moves and edge moves), and varies from quadratic, which is the lowest possible complexity for this problem, to NP-hard, which is the highest. In particular, our result provides the first example of a phylogenetic tree rearrangement operation for which shortest paths, and hence the distance, can be computed efficiently. Specifically, our algorithm scales to trees with thousands of leaves (and likely hundreds of thousands if implemented efficiently). We also connect the problem of computing distances in our graph of ranked trees with the well-known version of this problem on unranked trees by introducing a parameter for the weight difference between move types. We propose to study a family of shortest path problems indexed by this parameter with computational complexity varying from quadratic to NP-hard.

Extended Bias and Variance Error Decomposition of Genetic Programming

Caitlin Owen, Grant Dick, Peter Whigham

The aim of my thesis is to define and apply a framework that decomposes the error associated with genetic programming (GP) into error due to bias, internal variance (error due to the variation between different runs of the GP algorithm) and external variance (error due to the variation between different training data samples). The success of changes or additions to the GP learning algorithm can then be assessed using the decomposed error, including how they perform in a trade-off between reducing error due to bias and error due to the two variance components. The behaviour and performance of training data augmentation, for synthetic and real-world datasets, are examined in order to stabilise the prediction error associated with Z-score standardised GP for symbolic regression. Changes to GP proposed in the literature can be assessed in terms of their predictive performance using this framework, allowing the proposed and actual effects of these methods to be compared.

Machine Augmented Approach to Support Data Integration and Knowledge Retrieval in Humanitarian Crisis Response

Aladdin Shamoug, Stephen Cranefield, Grant Dick

Response to humanitarian crises is a series of processes that aim at changing the state of the crisis theatres from damage and destruction to a state of relief and

recovery. It is a complex process of bringing back life to normality and easing the suffering of people who are affected by humanitarian crises. Those processes are carried out by humanitarian actors (UN, Red Cross, NGOs, etc.) to help people in coping with, and overcoming, the consequences of the crises. Humanitarian actors use diverse data structures to store and keep track of their activities. Having such information stored in different structures, designed for mere human consumption, makes it hard for machines to parse and process it. In absence of proper computing techniques to deal with such data, humanitarian actors and decision makers rely on "domain experts" to provide answers to their day-to-day questions. Those experts have experience from previous crises. They possess the knowledge and experience required by humanitarian actors to address humanitarian challenges. In this research we aim at developing adequate computing techniques, to augment the role of domain experts, using natural language processing, machine learning, and semantic web technologies. We used 53,158 historical humanitarian records in training an artificial neural network model to integrate, embed, and represent humanitarian data in a standard machine-oriented structure, and extract hidden knowledge from this model using geometrical distance measurement. The model has been developed in Keras TensorFlow, and trained to reduce a binary cross-entropy loss, using Adam optimiser. We tested and evaluated the model in two tasks: questions answering and documents classification. The qualitative evaluation of both tasks shows that the model was able to support data integration and knowledge inference in humanitarian crises.

Detecting the target of sarcasm is hard

Pradeesh Parameswaran, Andrew Trotman

We describe our methods in trying to detect the target of sarcasm as part of ALTA 2019 shared task. We use combination of ensemble of classifiers and a rule-based system. Our team obtained a Dice-Sorensen Coefficient score of 0.37150, which placed 2nd in the public leader-board. Despite no team beating the baseline score for the private dataset, we present our findings and also some of the challenges and future improvements which can be used in order to tackle the problem.

Prioritising requests, bugs or enhancements pertaining to software products. Case study: Apps

Saurabh Malgaonkar, Sherlock Licorish, Tony Bastin, Roy Savarimuthu

Useful reviews pertaining to software products reflect bugs reported by the software's stakeholders along with requests or suggestions. One common example of such software product is an app and the popular apps on Google Play Store or Apple App Store usually tend to have numerous reviews. However, app developers face scalability challenges when identifying and converting useful reviews into an actionable knowledge by means of prioritisation and the problem to prioritise numerous useful reviews still persists. In this study, inspiration is taken from requirements prioritisation and app domains to identify and transform the numerous useful reviews present

in the vast pool of reviews into an actionable knowledge. The actionable knowledge is achieved through the means of extraction, classification and prioritisation of useful reviews for app developers. Furthermore, based on the achieved results, the generated actionable knowledge may assist the app developers in addressing prominent requests, bugs or suggestions pertaining to an app. This in turn would support the prolong sustainability of an app in the competitive app market.

Towards Improving the Quality of Mobile Apps

Chathrie Wimalasooriya, Sherlock Licorish, Daniel Alencar da Costa, Stephen MacDonell

New mobile applications are being developed and released continuously via app stores since the market for mobile devices is both growing and diversifying. The success of any mobile application depends on various quality attributes, as for any other software system. Managing quality attributes is not only a necessity, but also central to a company's survival in the competitive app market. In particular, reliability of mobile application is a key quality attribute since it considers failures such as frequent crashes and unresponsiveness during app operation. Such issues could easily make users frustrated, abandon apps and move to alternative apps. Over the past few years, software engineers and researchers have paid much attention towards improving reliability of mobile applications, however, problems still remain. This PhD project is aimed at understanding and improving the reliability of mobile apps. As the first step, we are conducting a systematic mapping study in order to understand the current state-of-the-research and identify problems and gaps in the area of mobile apps reliability. We will then investigate the identified problems empirically and develop a solution to address these problems. Next, we will evaluate our solution, provide benchmarking to assess app quality and propose further improvements. This presentation will cover a roadmap to my PhD project and the progress to date.

Situated Visualization to Enrich Sports Experience for on-site Spectators

Harley Paterson, Stefanie Zollmann, Holger Regenbrecht

TBA

Being Here, Being There, Being Anywhere: Presence in Mixed Reality

Tanh Tran, Holger Regenbrecht, Tobias Langlotz

Presence has been widely research in the Virtual Reality (VR) community. It commonly refers to the sense of "being there" or "non-mediation". However, there is still remained challenge on understanding this notion and phenomenon in mixed reality (MR). While virtual environments are completely virtual, MR environments

are the fusion between virtual and real entities. In this study, we examine all of previous studies on presence in the literature and discuss characteristics of mixed reality environments. In addition, we present our early attempt at defining the term of presence in MR.

The AR on-site Sports Spectating Experience

Wei Hong Lo, Stefanie Zollmann, Holger Regenbrecht

Currently, on-site live sports spectating does not offer too much to the user in terms of experience and statistics. The increasing amount of data collected in sports mostly goes into television broadcasts or sports statistics sites, neglecting on-site spectators. My research focuses on how to we visualize these data to on-site users through Mobile Augmented Reality (MAR), at the same time providing a cohesive user experience. The first part of the research focused on situated infographics on field, where visuals are place on the field to demonstrate their spatial relationships. In the next phase, I am looking into the interaction of users an the application. Through the goal of a buttonless interface, I will research appropriate methods to produce the best user interaction experience, possibly through context awareness camera ray cast pointers, where information should populate by prediction of what the users are interested at.

Computational Glasses for Saliency

Jonathan Sutton, Tobias Langlotz, Holger Regenbrecht

A recently developed field of research is computational glasses. This research field looks to introduce computational near eye optics and displays into users' views in order to aid and augment the human visual system. This presentation will cover computational glasses as they pertain to our research and our current work looking into Visual Guidance. Augmented Reality has been used to highlight physical objects for users, traditionally using overlays such as arrows and outlines. Whilst these can be very effective, they can also be obtrusive and obstructive, cluttering the users view and potentially occluding information. Our work looks to manipulate the visual saliency of objects in the users view in order to achieve highlighting and draw attention to them, whilst looking to mitigate the aforementioned drawbacks. Although not a new concept, saliency modulation has for the most part been restricted to screen-based applications working on images and videos. This presentation will also cover some prior work done on Computational Glasses as visual aids for Colour Vision Deficiency and a subsequent study on using a less constrained system than traditionally demonstrated.

Interfaces for a Māori Mixed Reality Telepresence Communication

Noel Park, Holger Regenbrecht, Robert Lindeman, Steven Mills

Currently over 85% of Māori live away from their rural iwi community. As more career opportunities emerge, more Māori are expected to relocate to large urban areas. In the future, urbanized Māori will have little or no contact with their Iwi and its associated knowledge, language, history, stories, whakapapa, and culture. As part of this project, I will investigate how we can use a voxel telepresence technology and design a user interface fit for helping Māori and future generations to reconnect with their Iwi.

First-Personalised Immersive Mixed Reality

Stuart Duncan, Holger Regenbrecht, Tobias Langlotz

Strong virtual body ownership is required for many applications of immersive display technology. The body ownership illusion is contingent on agency over the virtual body and viewing the body from a first-person perspective. Furthermore the illusion is strengthened when the visual appearance of the virtual body matches the users real body. We present a novel system that fuses RGB-D data from stationary cameras with data from HMD-mounted cameras to create a first-person-complete reconstruction of the user. Our use of HMD-mounted cameras avoids problems with self-occlusion inherent in many outside-in reconstruction systems without requiring a large number of cameras or a prior model of the human body.

Adaptive Business Intelligence

Song Han, Peter Whigham

As the development of the information system, enterprises have gained numerous information from their day-to-day operation. However, the abundant information has not led to better decision making and higher profitability because the enterprise cannot dig up the treasure hidden in the data. The difficulty keeps the value of data unrevealed is related to various reasons: the continually changing environment, the business process is heavily constrained, and the business is multi-objectives. As a result, enterprises must find an optimal solution from numerous candidates on time. Although the management has realized the gap, there is no empirical framework guide enterprise to address the complex business problem. I have been studying adaptive business intelligence, which provides an end-to-end framework that allows enterprises to gain knowledge and improve decision making based on the precious data they own. The adaptive business intelligence consists of four core modules: the data mining module finds relationships and patterns in enterprise operation, the prediction module estimates the future value at a particular point in time, and the optimization provides an optimal answer in nearly real-time, and the adaptability feed modules above with ever-changing data. With these four core components,

the adaptive business intelligence enhances enterprises decision making in the time-changing and complex business environment.

Potential Barriers to Computer Science Education in NZ High Schools

Chamindi Samarasekara, Claudia Ott, Anthony Robins

New Zealand (NZ) introduced a rigorous computer science (CS) curriculum equipped with new achievement standards to their high school qualification, namely the university entrance National Certificate of Educational Achievement (NCEA) examination in the year 2011 with the aim of addressing the issue of staff shortage in the computing industry. Schools and teachers are given the authority to decide whether they should teach CS for NCEA, what standards to teach and how to teach and assess those standards which may vary on the availability of resources to each school. Although many barriers to high schools CS education have been already identified together with feasible solutions, it is necessary to explore these issues in a broader context, by giving consideration to recent developments in the area, such as the introduction of revised CS and programming achievement standards to high school digital technologies curriculum. In this research we aim at identifying the potential barriers that prevent students from learning CS and programming at NZ high schools, building up a framework to increase equitable access by eliminating barriers and to communicate our findings with stakeholders using contemporary data visualization techniques.