MCR Graduate Conference 2024

Celebrating Research at Jesus College

9 March 2024
Jesus College Cambridge

Keynote Speech 1

10.30-11.00
Frankopan Hall

Simulated Intimacies

Dr Siddharth Soni

Lecturer in Literature and Digital Culture
University of Southampton

The lecture considers the multiple ways in which (digital) simulation of intimacy is proposed as an antidote to loneliness, whether this is animatronic robots that produce intelligible sounds, Cognitive Behavioural Therapy apps like Woebot, or full-fledged artificial companions like Replika, that are based on foundational language models. What form of a computational therapeutic this is, and what 'form' of the human does it project on all of us? Using a wide array of scholarship in literature, psychology, and philosophy of mind and cognition, as well as discourse surrounding two germane moments, a) responses to Joseph Weizenbaum's 1966 'chatter bot' ELIZA and b) those to Ishiguro's artificial friend 'Klara' in the 2021 novel *Klara and the Sun* (2021), I will attempt, in this lecture, to examine the politics of 'simulated' intimacy.

Role of Non-Muscle Myosin in Peripheral Actin Network Remodelling at Mitotic Exit

Jeanne Lefévère-Laoide,[1*] Ewa Paluch[1]
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Keywords: *Cell biology, cell division, cytoskeleton, actomyosin cortex, live microscopy.*

The shape of a cell is paramount to its life, as it enables it to achieve the functions for which is it specialised. Cell shape heavily relies on an ensemble of proteins called the cytoskeleton – the cell's skeleton – which is a dynamic scaffold of filaments located under the cell membrane to support it. Both the microscopic architecture and the dynamics of the cytoskeleton affect cell shape at a local and global level. My project looks at the subset of the cytoskeleton made up of the protein actin.

Here, I use the cell shape transition occurring at the end of cell division (mitosis) as a model to observe how active remodelling of actin architecture drives these changes in cell shape. During mitosis, most cells round up to allow for the division machinery to take place at the centre of the cell, supported by a change in the architecture and contractility of the cell's actin cortex (Taubenberger et al., 2020). Contractility within the actin cytoskeleton is mediated by a molecular motor called non-muscle myosin (Salbreux et al., 2012). At the end of mitosis, cells spread out again.

In this work, I focus on the role of myosin in actin cytoskeleton architecture remodelling at cells exit from mitosis, through a combination of 2D and 3D live-cell microscopy and mechanical approaches. I look at non-muscle myosin II through the double lens of contractility and protrusivity (Betapudi, 2010). Overall, this work arches over molecular and cellular scales to provide an understanding of the cytoskeletal network remodelling occurring at mitotic ex1t.1,ubC0.12a1 0 0 .

DNA nano actuator

Thieme Schmidt[1*]

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Poster Presentations
12:00-13:00
Elena Hall

Katrina Rorhus
Reevaluating Archaeological Types: A Case Study from Cueva de la Cocina, Spain

Kiran Kang
Safety and efficacy of very high-power short duration (vhpsd) radiofrequency ablation in a UK cohort using the qdot micro catheter

Sara Crozier
Life of volcanic crystals revealed by variations in Fe isotopes

Fiamma Berardi
Magnetic and magnetocaloric performances of frustrated fcc lanthanide oxides

Shrey Shah
Crunching the Numbers of In Vivo Bite Forces: Evaluating the Safety of Post-Surgical Dietary Advice

Danielle Sicotte
Chemical Characterization of Archaeobotanical Charred Remains

Alex Gower
Early Theoretical Results in the Operational Mechanism of Oscillator Ising Machines

Leonie Lorenz

model for

Reevaluating Archaeological Types: A Case Study from Cueva de la Cocina, Spain

Katrina Rorhus[1]*

Safety and efficacy of very high-power short duration (vhpsd) radiofrequency ablation in a UK cohort using the qdot micro catheter

Kiran Kang,[1*] Dr.Sarah Zeriouh ,[1,2], Dr. Claire Martin[2]

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Life of volcanic crystals revealed by variations in Fe isotopes

Sara Crozier,[1*] Helen Williams,[1] Simon Matthews,[2] Oli Shorttle[1]
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[2] Institute of Earth Sciences, School of Engineering and Natural Sciences, University of Iceland, Iceland.

Keywords: Fe isotopes, storage, mush, diffusion, kinetic.

The upper mantle exhibits chemical and isotopic heterogeneity, with iron isotopes serving as vital indicators for distinguishing mantle source lithologies. However, conventional equilibrium mass-dependent stable iron isotope fractionation models fail to capture the full extent of natural variation, suggesting contribution from disequilibrium processes like kinetic isotope exchange via inter-mineral diffusion or open system transfer (Soderman, 2022).

Diffusion induces fractionation as isotopes diffuse at varying rates based on their masses. The assumption of diffusion ubiquity is crucial in

Crunching the Numbers of In Vivo Bite Forces: Evaluating the Safety of Post-Surgical Dietary Advice

Shrey Shah[1,2*], Sven Wilhelm Odelberg[3], Adrian Kearns[3],
Vijayrajan Santhanam[3], Michael Sutcliffe[1]

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Keywords: Oral and Maxillofacial Surgery, Masticatory Forces, Mandibular Fixation, Plate Failure, Dietary Guidelines

Surgical implant fixation of jawbone discontinuities is one of the most common techniques employed in mandibular surgery. This project aims to create a custom medical device to measure the force produced when masticating different food items, to provide data-backed post-surgical dietary guidelines and to assess implant impact. Current research lacks information on the impact of different foods on the stresses exerted on mandibular plates.

To surgically treat discontinuities in the jawbone, bone fragments are fixated using plates and screws, minimising movement, and allowing bone remodelling and repair - it typically takes six weeks to regain full load-bearing strength.[1] During this phase, excessive jaw, like mastication, loading poses a significant risk by potentially compromising the bone fixation of screws, leading to deformation, plate failure, and displacement of the bony segment out of ideal fracture alignment.[2]

To minimise risk, patients are advised to follow post-surgical `soft food' diets during the initial healing phase, focusing on consuming easily chewable foods or liquids; however, current guidelines are anecdotal, vague, and contradictory, potentially exposing patients to the risk of plate failures from excessive masticatory forces.[3]

My project involves developing a minimally intrusive force sensor mouth splint to record the forces required to masticate different food items and designing a Finite Element Model to establish critical

Chemical Characterization of Archaeobotanical Charred Remains

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Early Theoretical Results in the Operational Mechanism of Oscillator Ising Machines

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Keywords: *Artificial Intelligence, Combinatorial Optimization, Unconventional Computing, Ising Machines, Neuromorphic Computing*

Oscillator Ising Machines are a type of Ising machine i.e. their aim is to optimise the Ising Hamiltonian, an NP-complete problem whose efficient solution in the general case would allow for efficient solutions of all NP-hard problems which would be significant in the fields of optimisation and AI.

OIMs optimise the Ising Hamiltonian by exploiting the dynamics of coupled self-sustaining nonlinear oscillator networks. In essence, the (J_{ij}, h_i) variables of the Ising problem are mapped onto the coupling strengths between oscillators i and j, and a sub-harmonic injection locking procedure is used to discretise the oscillator phases into sets of oscillators which are in phase and anti-phase with respect to the driving oscillation (corresponding to $s_i = \pm 1$). The equilibrium phase configuration can then be shown to locally optimise the Ising Hamiltonian. One major advantage of OIMs is that they are hardware-agnostic and can be practically realised using many different types of physical oscillator. This notably includes implementations using CMOS integrated circuits, a low-power and easily miniaturisable/scalable technology with extremely well established development and manufacturing processes. Initial empirical results suggested OIMs (and simulations of OIMs) demonstrated state-of-the-art performance in solving frustrated loop and MAX-CUT Ising problems.

New theoretical results demonstrate that the dynamics of OIMs can be described as a stochastic gradient descent process on an energy landscape in an expanded XY rotor configuration space. In the case of static hyperparameters, this means that the equilibrium configuration probability distribution is Boltzmann, favouring globally low energy solutions for low temperatures (noise).

References:
[1] Wang, T. and Roychowdhury, J., 2019. OIM: Oscillator-based Ising machines for solving combinatorial optimisation problems. In *Unconventional Computation and Natural Computation: 18th International Conference, UCNC 2019, Tokyo, Japan, June 3 7, 2019, Proceedings 18* (pp. 232-256). Springer International Publishing.

Streptococcus pneumoniae:
A mathematical model for understanding the mechanisms and predicting the development

Leonie J. Lorenz

The effect of
disease: exploratory biomarker data from the AZA-PD clinical trial

Julia Greenland,[1*] Jonathan Holbrook[1], Reiss Pal[1], Lakmini Kahanawita[1], Lennart Spindler[1],
Marta Camacho[1], Caroline Williams-Gray[1]
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[1]

A phonetic study on rime merger in Beijing retroflex suffixation

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Keywords

Direct Thermal Management for Lithium-Ion Batteries

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Keywords: Batteries, Electric Vehicles, Lithium-Ion, Heat Transfer.

Faster charging of lithium-ion batteries is a major objective for overcoming motoristsqconcerns over electric vehicle range. However, fast charging generates large amounts of heat. High temperatures cause the batteries to degrade, lowering capacity and hence range. Low temperatures experienced in cold climates can also lead to degradation when charging or discharging. Hence, it is desirable to keep the battery temperature between 10-45°C.

Most electric cars today use indirect thermal management, where a physical barrier separates a water-based coolant, or other thermal management fluid, from the cells. The physical barrier increases thermal resistance, lowering heat transfer efficiency. Using a non-conductive or dielectric thermal management fluid means no physical barrier is required to provide electrical insulation. However, these fluids generally have less favourable physical properties for efficient heat transfer compared to water. We present some work quantifying the heat transfer performance of dielectric fluids and as part of a project to identify strategies for improvement.

Presentation Session 3
15:30-16:30
Frankopan Hall

Alastair Smith

Alice Paver
The influence of negative voice stereotypes on incorrect identifications in voice parades by witnesses

Oliver Wissett
Developing a fragment library for de novo design of Affibodies by fragment-based geometric deep-learning

Miraya McCoy

Ozan Zakariya

Alastair Smith[1*]
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The influence of negative voice stereotypes on incorrect identifications in voice parades by witnesses

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This research explores the factors influencing the erroneous choice of foil voices in voice parades; in particular, the impact of stereotypical judgments held by listeners. A voice parade is conducted when a victim or witness to a crime is asked to identify a perpetrator from a line-up amongst similar-sounding foils. Existing research indicates that voices are subject to negative judgments in forensic contexts, with some being perceived as sounding 'more guilty' of certain criminal offenses [1,2]. This study builds on the findings of previous studies, which identified instances of inaccurate selections in voice parades [3,4]. We hypothesise that voices frequently selected in target-absent parades receive more negative ratings than those less frequently chosen.

180 participants evaluated twelve voices from these earlier experiments: three target speakers and nine foils. Voices were rated on ten social traits and ten behaviours, including various crimes. Regression models revealed that the most-selected foils received significantly lower ratings on status and solidarity traits compared to the target speaker (fig 1). Moreover, they were rated significantly higher for the likelihood of criminal behaviours

Developing a fragment library for de novo design of Affibodies by fragment-based geometric deep-learning

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Keywords: *Affibody, Protein engineering, geometric deep learning, fragment learning*

Affibodies are a class of proteins derived from the B-domain of Staphylococcal protein A, also known as Z-domains [1]. Affibodies consist of 58 residues forming three -helices and can bind a wide range of protein targets by varying 13 residues across helix-1 and helix-2 [1]. Currently, Affibodies are created through multiple rounds of in vitro screening of large combinatorial genetic libraries – this is slow, costly, and does not allow for targeting of specific epitopes [1]. We aim to create a method using geometric deep learning (GDL) to determine Affibody sequences predicted to bind to a given epitope, which may overcome these limitations. Supervised deep-learning requires many labelled data (>106 datum). Unfortunately, there exist fewer than 20 experimentally solved structures.
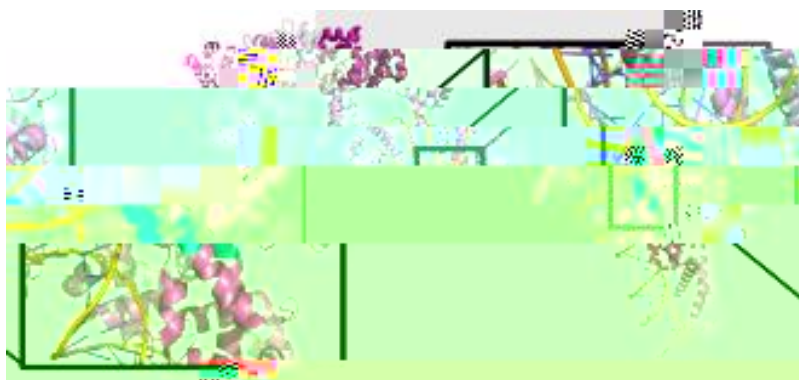
Here we present a general method for generating protein fragment libraries for GDL training. Protein fragments are small subsections of existing protein structures. Since the laws of physics are constant, fragments resembling Affibodies may be used to understand properties of Affibodies. This fact has previously been used to create novel antibodies by our lab [2]. To achieve this, we search through the structures of all solved protein structures for regions which are Affibody-like and then find their local interactome (the region inside the structure which is in contact with the matching region). Using this approach we have generated a large dataset of around ~500k fragments which is now being used to train models. This approach allows for the use of a highly specified dataset.

References:
[1] Ståhl, S., Gräslund, T., Eriksson Karlström, A., Frejd, F. Y., Nygren, P. Å., & Löfblom, J. (2017). Affibody Molecules in Biotechnological and Medical Applications. Trends in Biotechnology, 35(8), 691–712. https://doi.org/10.1016/j.tibtech.2017.04.007
[2] Aguilar Rangel, M., Bedwell, A., Costanzi, E., Taylor, R. J., Russo, R., Bernardes, G. J. L., Ricagno, S., Frydman, J., Vendruscolo, M., & Sormanni, P. (2022). Fragment-based computational design of antibodies targeting structured epitopes. Science Advances, 8(45). https://doi.org/10.1126/sciadv.abp9540

Decaydes of the New Worlde

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This research looks at the way in which an alchemical hermeneutics was employed in early colonial systems of exploitation, taking the neglected text, Richard Edens

Keynote Speech 2
16:30-17:00
Frankopan Hall

Dr Jonnie Penn
Associate Teaching Professor of AI Ethics and Society
University of Cambridge

Coined in 1955, the term ±Alqhas since been used to reference three entirely different schools of thought on how to manufacture cognition in non-biological material. By this view, the history of AI can be understood as a history of failure. Around these failures, however, the modern world has changed in ways that allowed new possibilities for the field: new data sources, sensors, labour norms, and expectations from surveillance and racialization. This talk connects milestones in ±Alqto longer histories of statecraft, the computer industry, the global finance industry, and empire. These complex histories provide rich evidence with which to calibrate speculation about AI and AI Ethics in the decades ahead.

Prize Giving Ceremony
17:00-17:30
Frankopan Hall

Drinks Reception
18:30-19:00
Masters Lodge

Conference Reunion Dinner
Tickets pre-purchased
19:00-21:00
Upper Hall