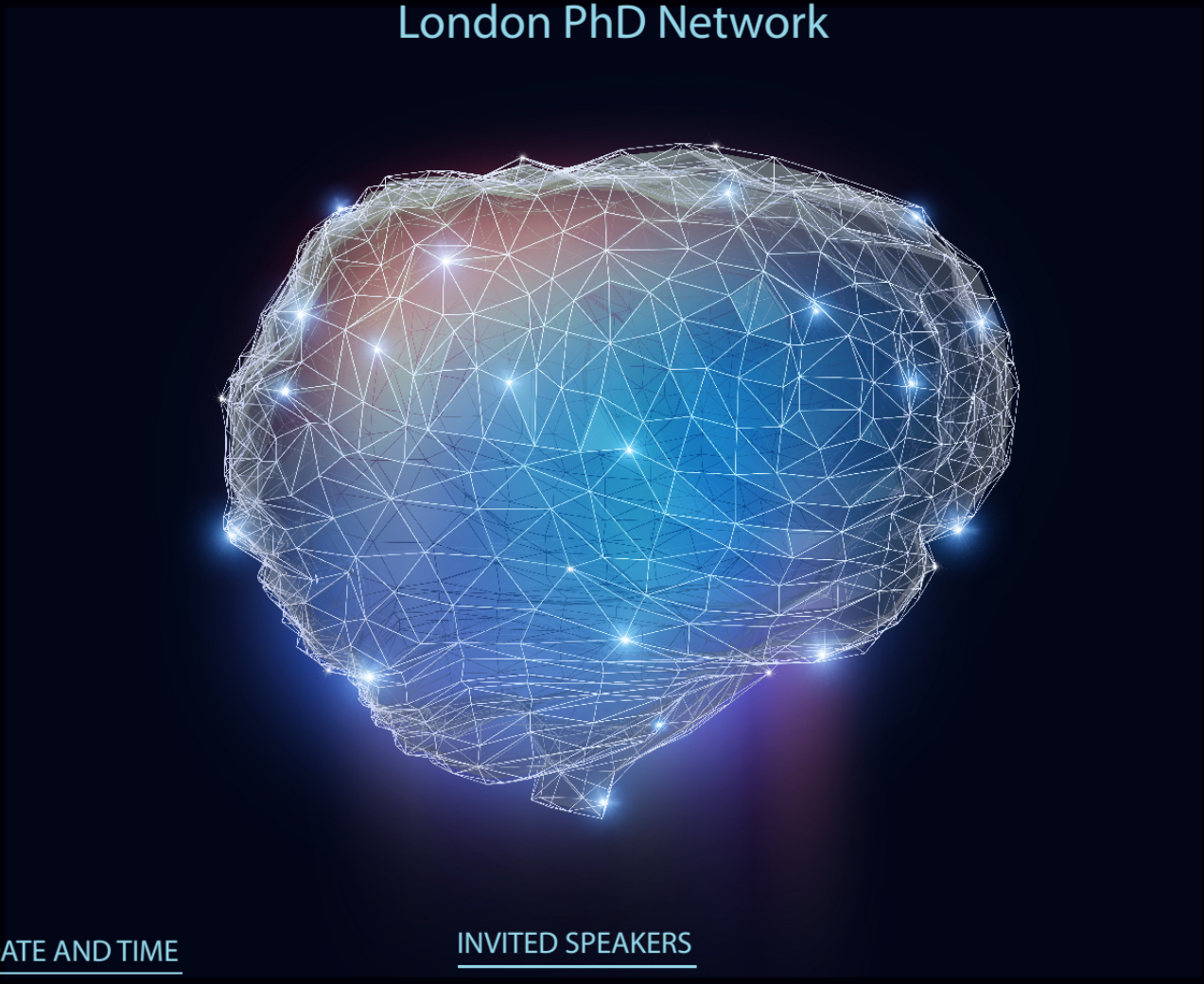
# SYMPOSIUM ON ARTIFICIAL INTELLIGENCE

## London PhD Network



### DATE AND TIME

Mon 12 February 2018
13:00 – 18:00 GMT

### LOCATION

Francis Crick Institute
1 Midland Road
London
NW1 1AT

Registration &
Poster Competition
£100 Prize

### INVITED SPEAKERS

Prof. David Jones:
"Applications of AI in Bioinformatics"
Dr. Bjoern Schuller:
"Deep Learning for Health & Wellbeing"
Dr. Raia Hadsell:
"Deep Reinforcement Learning & Real World Challenges"
Dr. Amir Saffari:
"Machine Learning for Accelerated Scientific Discovery"
Dr. Spiros Denaxas:
"Methods and tools for using electronic health records for research"
Mr. Hao Dong:
"Tutorial on Deep Learning Development Platforms"

DeepMind
Colorado State University
Cardiff University
Royal Holloway University of London
King's College London
ICR The Institute of Cancer Research
LPN 伦敦博士联盟
Imperial College London
University of Cambridge
MRC Laboratory of Molecular Biology
University of Plymouth
The Francis Crick Institute
FEI
UCL
UBC The University of British Columbia
Queen Mary University of London
Coventry University

# LPN Symposium on Artificial Intelligence

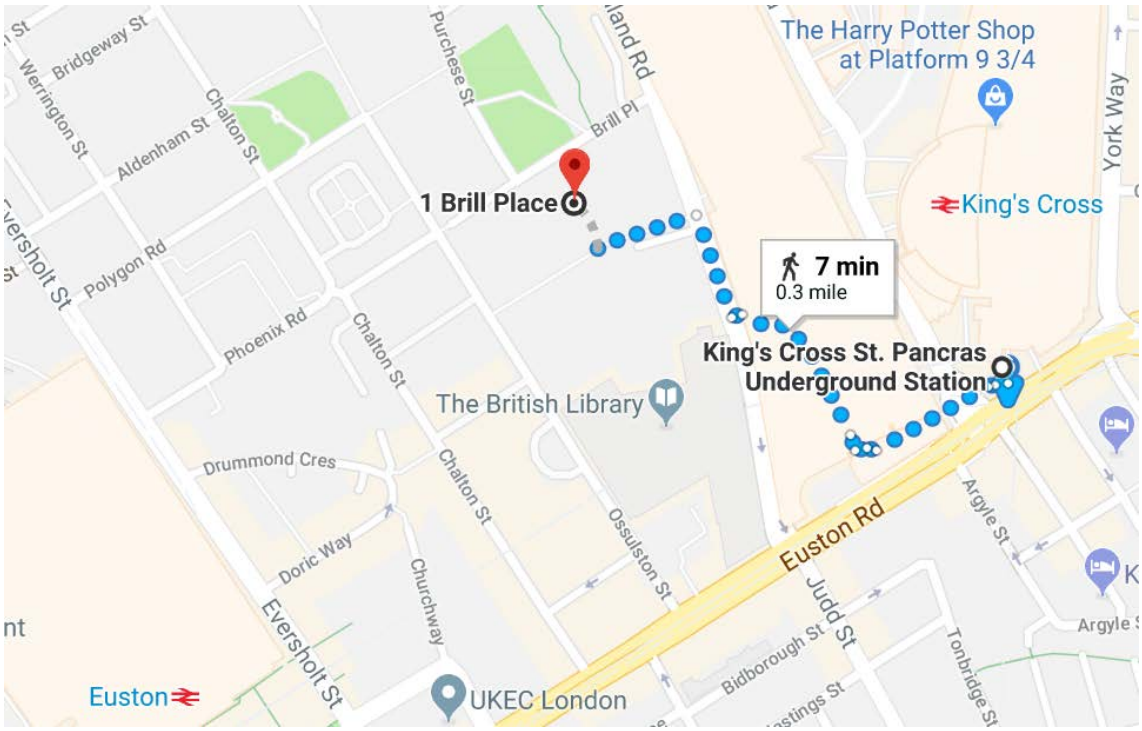
Humans have great expectations for artificial intelligence (A.I.), giving it endless reverie. So far, A.I. has passed several winter, and finally ushered in a new spring. In this boom, with the help of big data and high-performance computing, A.I. is developing rapidly and has continuously brought about breakthroughs in various fields, from AlphaGo to self-driving cars, from image classification to speech recognition. These unprecedented breakthroughs demonstrate that A.I. is profoundly transforming the world, affecting our daily life, as well as becoming a commanding height for science and technology in major powers.

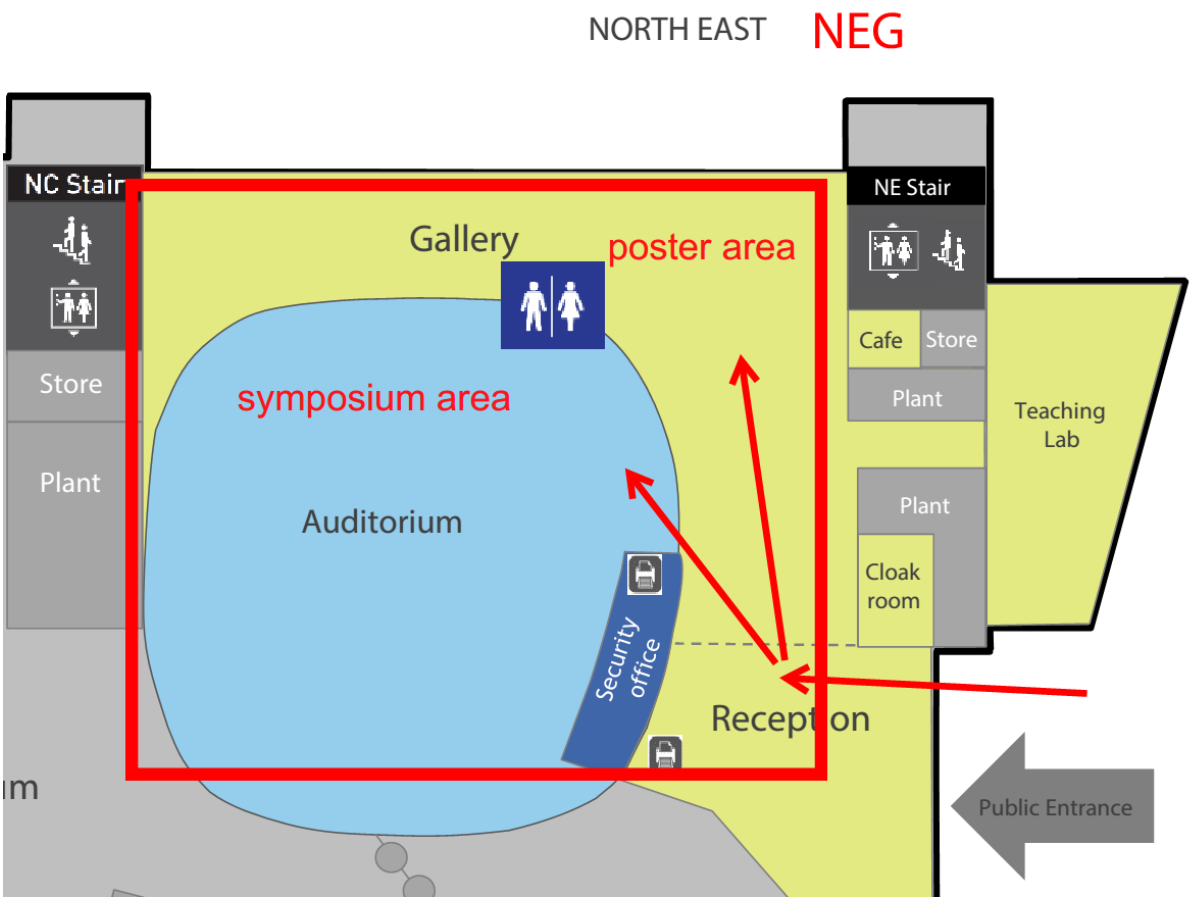
Why is A.I. so powerful? What will it subvert? Can A.I. revolutionize the way we conduct research? Can it provide us with a new perspective to help humans explore the unknown world? How can A.I. help in scientific discoveries and engineering development? … In this symposium, we will bring together researchers in the areas of Medicine, Science and Engineering to present their frontier works and show the possibilities of using A.I. in research. Join us for free to explore the potential and risk of A.I. !

**Date:** 12-02-2018, 13:00 – 20:00 p.m.
**Location:** Francis Crick Institute, 1 Midland Rd, Kings Cross, London NW1 1AT
**Website:** https://www.eventbrite.com/e/london-phd-network-symposithm-on-artificial-intelligence-tickets-41644458697
**Organizers: London PhD Network, Crick AI Club**

**Chairs:**
Bidan Huang b.huang@imperial.ac.uk, Aylin Cakiroglu aylin.cakiroglu@crick.ac.uk
Pingfan Song uceeong@ucl.ac.uk , Huanfa Chen huanfa.chen@ucl.ac.uk

**Map:** Francis Crick Institute, 1 Midland Rd, Kings Cross, London NW1 1AT



# Agenda

| | |
|---|---|
| 13:00 - 13:30 | Registration |
| 13:30 - 13:50 | Welcome and Introduction |
| 13:50 - 14:00 | **Mr. Sunan Jiang: "China's latest progress in science, technology and innovation Sino-British cooperation prospects "**<br>*Minister Counsellor for Science and Technology at the Chinese Embassy in U.K.* |
| 14:00 - 14:40 | **Dr. Bjoern Schuller: "Deep Learning for Health & Wellbeing"**<br>*Head of the Chair of Embedded Intelligence for Health Care and Wellbeing, University of Augsburg & Reader, Imperial College London & CEO and Co-Founder of audEERING GmbH* |
| 14:40 - 15:20 | **Prof. David Jones: "Applications of AI in Bioinformatics"**<br>*Head of the Bioinformatics Group in the Department of Computer Science, University College London & Director of the Bloomsbury Centre for Bioinformatics* |
| 15:20 - 16:20 | Poster Session and Tea Break |
| 16:20 - 17:00 | **Dr. Raia Hadsell: "Deep Reinforcement Learning & Real World Challenges"**<br>*Research scientist on the Deep Learning team at DeepMind* |
| 17:00 - 17:40 | **Dr. Amir Saffari: "Machine Learning for Accelerated Scientific Discovery"**<br>*Director of Applied AI at BenevolentAI* |
| 17:40 - 18:20 | **Dr. Spiros Denaxas: "Methods and tools for using electronic health records for research"**<br>*Senior Lecturer in the Institute of Health Informatics, University College London* |
| 18:20 - 19:00 | **Mr. Hao Dong: "Tutorial on Deep Learning Development Platforms"**<br>*PhD student at Data Science Institute, Imperial College London* |
| 19:00 - 20:00 | Awards and Closing Ceremony |

**Mr. Sunan Jiang**

**Minister Counsellor for Science and Technology at the Chinese Embassy in U.K.**

**Topic:**
**China's latest progress in science, technology and innovation Sino-British cooperation prospects**

**http://www.chinese-embassy.org.uk**

## Introduction

Mr. Sunan JIANG is the Minister Counsellor for Science and Technology, the Chinese Embassy in the UK. He has been dedicated to Science and Technology management and international scientific and technological exchange and cooperation over the years.

From 1994 to 2015, Mr. JIANG worked successively as Second Secretary for Science and Technology in the Chinese Embassy in Sweden, Consul (First Secretary) for Science and Technology in Chinese Consulate General in Chicago, Consultant in the Department of International Cooperation, Director and then Deputy Director General in the Department of Personnel of the Ministry of Science and Technology of China.

**Prof. David Jones**

**University College London**
**& Francis Crick Institute**

**Topic:**

**Applications of AI in Bioinformatics**

**https://www.crick.ac.uk/research/a-z-researchers/researchers-d-j/david-jones/**

## Profile:

David Jones is the Director of the Bloomsbury Centre for Bioinformatics, a joint research centre between UCL and Birkbeck College. His lab aims to develop and apply state-of-the-art mathematical and computer science techniques to problems now arising in the life sciences, particularly those driven by the post-genomic era.

David's main research interests include protein structure prediction and analysis, simulations of protein folding, applications of Hidden Markov Models, transmembrane protein analysis, machine learning applications in bioinformatics, biological text mining, de novo protein design methodology, and genome analysis including the application of intelligent software agents. He is also the author of a number of very well-known bioinformatics applications: THREADER, GenTHREADER, PSIPRED and MEMSAT, and was one of the original co-authors of the CATH protein structure classification scheme (along with Profs. Christine Orengo and Janet Thornton). David was also a co-founder of Inpharmatica Ltd., which was founded in 1998 as a spin-out company from University College London and acquired by Galapagos NV in 2007. The company used a combination of bioinformatics and chemoinformatics to look at the relationships between the structure and function of proteins, and the binding of chemical groups to these proteins leading to the discovery of novel drugs.

**Dr. Bjoern Schuller**

**Imperial College London**

**Topic:**
**Deep learning for Health Care and Wellbeing**

**https://www.doc.ic.ac.uk/~bschulle/**

## Profile:

Björn W. Schuller heads Imperial College London's Group on Language Audio & Music (GLAM), is a CEO of audEERING, and a Full Professor at University of Augsburg/Germany in CS. He further holds a Visiting Professorship at the Harbin Institute of Technology/China. He received his diploma, doctoral, and habilitation degrees from TUM in Munich/Germany in EE/IT. Previous positions of his include Full Professor at the University of Passau/Germany and Visiting Professor, Associate, and Scientist at VGTU/Lithuania, University of Geneva/Switzerland, Joanneum Research/Austria, Marche Polytechnic University/Italy, and CNRS-LIMSI/France. His 700+ technical publications (17000+ citations, h-index 63) focus on machine intelligence for audio and signal analysis. He is a Fellow of the IEEE, the Editor in Chief of the IEEE Transactions on Affective Computing, a General Chair of ACII 2019 in Cambridge, and a Technical Chair of Interspeech2019 among various further roles. He received a range of awards including being honoured as one of 40 extraordinary scientists under the age of 40 by the World Economic Forum in 2015. In 2017, his company secured the 1st place as “Innovator of The Year” of the Digital Marketing Innovation World Cup 2017. His research has garnered over 10 million GBP in extramural funding including an ERC Starting Grant. Advisory board activities comprise his role as consultant of global enterprises such as HUAWEI and SAMSUNG and start-ups such as SensAura Tech and fluent.ai.

**Dr. Raia Hadsell**

**Deepmind**

**Topic:**
**Deep Reinforcement Learning & Real World Challenges**

http://raiahadsell.com/index.html

## Profile:

Raia Hadsell is a research scientist on the Deep Learning team at DeepMind. She moved to London to join DeepMind in early 2014, feeling that her fundamental research interests in robotics, neural networks, and real world learning systems were well-aligned with the agenda of Demis, Shane, Koray, and other members of the original team.

Raia came to AI research obliquely. After an undergraduate degree in religion and philosophy from Reed College, she veered off-course and became a computer scientist. Raia's PhD with Yann LeCun, at NYU, focused on machine learning using Siamese neural nets (often called a 'triplet loss' today) and on deep learning for mobile robots in the wild. Her thesis, 'Learning Long-range vision for offroad robots', was awarded the Outstanding Dissertation award in 2009. Raia spent a post-doc at CMU Robotics Institute, working with Drew Bagnell and Martial Hebert, and then became a research scientist at SRI International, at the Vision and Robotics group in Princeton, NJ.

Raia's research at DeepMind focuses on a number of fundamental challenges in AGI, including continual and transfer learning, deep reinforcement learning, and neural models of navigation.

**Dr. Amir Saffari**

**BenevolentAI**

**Topic:**

**Machine Learning for Accelertated Scientific Discovery**

https://www.linkedin.com/in/amirsaffar

## Profile:

Amir Saffari has a PhD in Machine Learning and has been working in the field of Artificial Intelligence for more than 15 years, researching and developing ML based theory, applications, and, products. He's numerous publications in top-tier ML conferences and journals and most of his research has been released as open source software. He was part of Sony's R&D team and has been involved in a few ML startups. Currently, he is leading the ML team at Benevolent AI and is focused on creating ML based technology to accelerate scientific discovery.

**Dr. Spiros Denaxas**

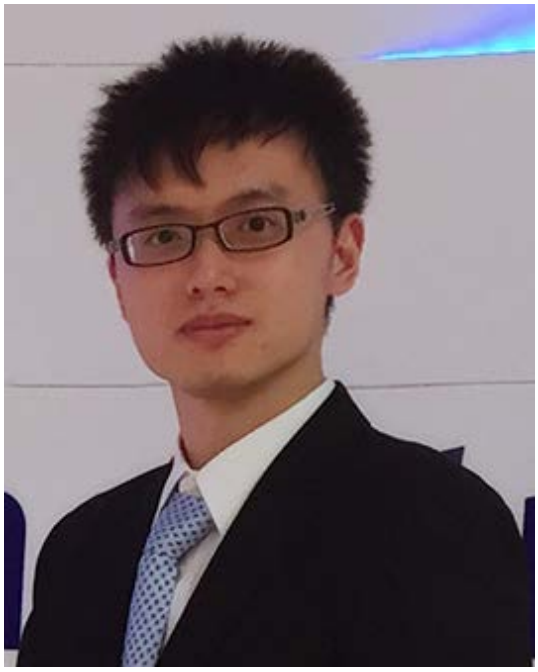
**University College London**

**Topic:**
**Methods and tools for using electronic health records for research**

**https://www.linkedin.com/in/spirosdenaxas/**

## Profile:

Spiros is an Associate Professor in Biomedical Informatics based at the Institute of Health Informatics. His lab's research focuses on creating and evaluating novel computational methods for risk prediction, data modelling, phenotyping and subphenotype discovery in structure electronic health records and other clinical and genomic data. He also run CALIBER, a translational research resource which links electronic health records from primary care, hospital care and national mortality registries for ~10m patients.



**Mr. Hao Dong**

**Imperial College London**

**Topic:**
**Tutorial on Deep Learning Development Platforms**

**https://zsdonghao.github.io/**

## Profile:

Hao Dong is a PhD student at the Department of Computing of Imperial College London under the supervision of Prof. Yike Guo and Prof. Paul M. Matthews. He is interested in Computer Vision and Deep Learning, he has publications on ICCV, TIFS, TMI, TNSRE, ACM MM and etc, all publications can be found on Google Scholar. He is an active reviewer of Neurocomputing, IEEE TIP and etc. He is the author of TensorLayer which won the Best Open Source Software Award of ACM MM 2017, he is also the founder of TensorLayer organization.

# Poster Session

| Author | Title | Institute |
|---|---|---|
| Yun Gu<br>y.gu16@imperial.ac.uk | Deep Geometric Parsing for Surgical Sutures | Imperial College London (IC) |
| Vanya Valindria<br>v.valindria15@imperial.ac.uk | Multi-modal Learning in Abdominal MRI and CT | Imperial College London (IC) |
| Kezhi Li<br>frostforest.ustc@gmail.com | Recurrent Neural Networks with Interpretable Cells Predict and Classify Worm Behaviour | Imperial College London (IC) |
| Nader Ganaba<br>nader.ganaba13@imperial.ac.uk | Applications of Poisson Geometry for Clustering and<br>Sampling Data on Manifolds | Imperial College London (IC) |
| Hao Dong,<br>hao.dong11@imperial.ac.uk | Semantic Image Synthesis via Adversarial Learning | Imperial College London (IC) |
| Mali Shen,<br>mali.shen09@imperial.ac.uk | Pulmonary Fissure Segmentation for Emphysema Patients | Imperial College London (IC) |
| Kyo-Sun Koo<br>kyo-sun.koo@kcl.ac.uk | When Autonomous Vehicles Meet Moral Uncertainty ---- A Rebuttal of Bhargava and Kim's Solution For Autonomous Vehicles Under Moral Uncertainty | Kings College London (KCL) |
| Yin Hang<br>hang.yin@epfl.ch | Towards Model-based Imitation and Control by Learning Latent Dynamics | École polytechnique fédérale de Lausanne (EPFL) |
| Prof. Noor Shaker<br>noor.shaker@gmail.com | Drug Discovery Disrupted: Quantum Physics meets Machine Learning | Co-founder & CEO \| GTN Ltd |

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|---|---|---|
| Silvia Rossi<br>s.rossi@ucl.ac.uk | Predicting User's navigation in VR | University College London (UCL) |
| Sephora Madjiheurem<br>sephora.madjiheurem.17@ucl.ac.uk | Chord2Vec: Learning musical chord embeddings | University College London (UCL) |
| Nafiseh Vahabi<br>nafiseh.vahabi.14@ucl.ac.uk | Analysis of Oil and Gas Big Data Using Artificial Intelligence | University College London (UCL) |
| Yin Bi<br>yin.bi.16@ucl.ac.uk | PIX2NVS: Parameterized Conversion of Pixel-Domain Video Frames to Neuromorphic Vision Streams | University College London (UCL) |
| Alhabib Abbas,<br>alhabib.abbas.13@ucl.ac.uk,<br>Aaron Chadha,<br>uceehad@ucl.ac.uk, | Video Classification With CNNs: Using The Codec As A Spatio-Temporal Activity Sensor | University College London (UCL) |
| Zahra Sabetsarvestani<br>zahra.sabetsarvestani.14@ucl.ac.uk | Cauchy Estimator For Entry-wise Matrix Completion | University College London (UCL) |
| Mengyang Chen<br>meng-yang.chen.14@ucl.ac.uk | Compressive Sensing with Side Information: How to Optimally Capture this Extra Information? | University College London (UCL) |
| Pingfan Song<br>uceeong@ucl.ac.uk | Multimodal Image Denoising and Image Super-Resolution via Joint Sparse Representations | University College London (UCL) |
| Pingfan Song<br>uceeong@ucl.ac.uk | CDLMRI: Coupled Dictionary Learning for multi-contrast MRI image reconstruction | University College London (UCL) |
| Ho-Cheung Ng<br>h.ng16@imperial.ac.uk | Real-time object detection and classification for high-speed asymmetric-detection time-stretch optical microscopy on FPGA | Imperial College London (IC) |

# Deep Geometric Parsing for Surgical Sutures

Yun Gu
y.gu16@imperial.ac.uk
Imperial College London (IC)

## Abstract

In robotic surgery, task automation and learning from demonstration combined with human supervision is an emerging trend for many new surgical robot platforms. One such task is automated anastomosis, which requires bimanual needle handling and suture detection. Due to the complexity of the surgical environment and varying patient anatomies, reliable suture detection is difficult, which is further complicated by occlusion and thread topologies. In this paper, we propose a multi-stage framework for suture thread detection based on deep learning. Fully convolutional neural networks are used to obtain the initial detection and the overlapping status of suture thread, which are later fused with the original image to learn a gradient road map of the thread. Based on the gradient road map, multiple segments of the thread are extracted and linked to form the whole thread using a curvilinear structure detector. Experiments on two different types of sutures demonstrate the accuracy of the proposed framework

# Multi-modal Learning in Abdominal MRI and CT

Vanya Valindria, Nick Pawlowski, Martin Rajchl, Ioannis Lavdas,
Eric O. Aboagye, Andrea G. Rockall, Daniel Rueckert, Ben Glocker
v.valindria15@imperial.ac.uk
Imperial College London (IC)

## Abstract

Deep-learning based methods have been widely used in medical image segmentation. However, the amount of training data strongly determines the overall performance. Most approaches are applied for a single imaging modality, e.g., brain MRI. In practice, it is often difficult to acquire sufficient training data of a certain imaging modality. In clinical practice, multiple imaging modalities are used to capture anatomical structures, such as major abdominal organs. For example, CT and MRI both give images of the abdominal organs, which the visual appearance is completely different because of the underlying physical principles of each imaging technique.

Our work investigates the effectiveness of learning from multi-modal images to improve the segmentation accuracy on each individual modality. In computer vision, previous work has shown that multi modal learning often provides better performance. All previous works on multi-modal segmentation used paired data, meaning that the images are acquired from the same subject and coregistered across modalities. In our case, all of the data are unpaired, obtained from different subjects and not registered to each other.

As part of our multi-modal segmentation study, we also conducted a traditional transfer learning method; pre-trained network in one modality and fine-tuning to the other modality. However, the problem with transfer learning is that it cannot fully leverage the shared information contained in both modalities, as the sequential training processes do not encourage that shared information is used.

Multi-modal learning focuses on gaining shared representations from multi-modal data. We aim to improve the shared representation by using an encoder-decoder architecture, to investigate which part of encoder or decoder should be shared across modalities. Hence, we exploit the feasibility of utilising shared representation in a dual-stream architecture to learn modality-independent features. To exploit the commonality among different modalities, streams of encoder/decoder are connected with each other via the shared latent representation.

Two baseline multi-organ segmentation networks are compared: FCN and U-Net based architectures. The FCN-based architecture can merge the features from different scales in the encoder which vary in semantic information. Meanwhile, it is more complex in U-Net architecture as the encoder feature maps needs to be concatenated with the upsampled feature maps from the decoder at every scale.

Experiments show that multi-modal learning can improve overall accuracy over modality-specific training. In FCN and U-NET segmentation, we can observe that multi-modal learning by dual-stream in encoder and encoder, generally improves the performance for all organ segmentations, compared to individual segmentation. Our multi-modal results on both MR and CT demonstrate improved state-of-the art segmentation accuracies, especially on varying organs such as spleen and kidneys. The power of learning shared representations from different datasets appears as a promising direction for future work.

# Recurrent Neural Networks with Interpretable Cells Predict and Classify Worm Behaviour

Kezhi Li
frostforest.ustc@gmail.com
Imperial College London (IC)

## Abstract

An important goal in behaviour analytics is to connect disease state or genome variation with observable differences in behaviour. Despite advances in sensor technology and imaging, informative behaviour quantification remains challenging. The nematode worm \emph{C.~elegans} provides a unique opportunity to test analysis approaches because of its small size, compact nervous system, and the availability of large databases of videos of freely behaving animals with known genetic differences. Despite its relative simplicity, there are still no reports of generative models that can capture essential differences between even well-described mutant strains. Here we show that a multilayer recurrent neuron network (RNN) can produce diverse behaviours that are difficult to distinguish from real worms' behaviour and that some of the artificial neurons in the RNN are interpretable and correlate with observable features such as body curvature, speed, and reversals. Although the RNN is not trained to perform classification, we find that artificial neuron responses provide features that improve on the state of the art in worm strain classification.

# Applications of Poisson Geometry for Clustering and Sampling Data on Manifolds

Nader Ganaba
nader.ganaba13@imperial.ac.uk
Imperial College London (IC)

## Abstract

In this work we show how a class of geometric integrators known as Poisson integrators can be used to tackle problems in artificial intelligence and machine learning on manifolds. Poisson integrators rely on Poisson geometry which in turn deals with Poisson systems and they are a generalisation of Hamiltonian systems. The idea behind using Poisson systems is to treat probability density of the data as a Hamiltonian function [1], however, unlike standard Hamiltonian systems where they are defined on an even-dimensional manifold, Poisson systems can belong to manifolds of any dimension, even infinite dimensions. The reason of using such systems is to address the limitations of the standard methods, such as hybrid MCMC, Nonlinear dimensionality reduction techniques and K-means based clustering, in dealing with problems where the geometry of the data is important. The Poisson schemes used in this work are discussed in [2, 3].

We present three problems: data clustering on a sphere, Markov chain Monte Carlo using Poisson dynamics and a swarm based algorithm for solving optimisation problems. The main focus of this work is the data clustering on a sphere problem and we present results of the scheme for the spiral clustering on a sphere, S2 manifold, benchmark test. We also show how such method can be used to sampling from a distribution on a sphere, thus sample data more accurately and realistically. In final part, we formulation the swarm based algorithm in the language of Poisson systems to solve optimisation problems efficiently and rapidly. The standard swarm based algorithms require regularisation of the scheme or otherwise the solution would not converge, while we show that our formulation does not suffer from such pathology.

Keywords Poisson geometry, geometric integrators, Poisson system based clustering, Poisson based MCMC, Hamilton-Jacobi theory

References

[1] D. Casagrande, M. Sassano, and A. Astolfi, “Hamiltonian-based clustering: Algorithms for static and dynamic clustering in data mining and image processing,” IEEE Control Systems, vol. 32, no. 4, pp. 74–91, 2012.

[2] G. Zhong and J. E. Marsden, “Lie-poisson hamilton-jacobi theory and lie-poisson integrators,” Physics Letters A, vol. 133, no. 3, pp. 134–139, 1988.

[3] N. Ganaba, “Stochastic Lie-Poisson-Hamilton-Jacobi Theory.” In preparation, 2018.

# Semantic Image Synthesis via Adversarial Learning

Hao Dong
hao.dong11@imperial.ac.uk
Imperial College London (IC)

## Abstract

Human has imagination that enables us to visually imagine new things in our mind. For example, you could easily imagine how green sky or blue sun looks like even if you never actually see it.

In this paper, we attempt to make machine be able to imagine. We want the machine to semantically modify existing images via natural language descriptions, into images that never exist in practice.

# Pulmonary Fissure Segmentation for Emphysema Patients

Mali Shen
mali.shen09@imperial.ac.uk
Imperial College London (IC)

## Abstract

Recent advances in bronchoscopic lung volume reduction offer new therapies for patients with emphysema and hyperinflation. Delineating pulmonary fissures, the thin boundaries between lobes, is the pivotal step in quantifying lobar volumes and fissure integrity for treatment planning and post-operative assessment. The existing fissure segmentation methods often rely on the standard lung anatomy, using hand-crafted features or atlas- based segmentation techniques. In this poster, we propose a fissure segmentation approach based on deep learning. Fissures are segmented on the sagittal view using 2D U-Net. The detected fissure mask is then used as input for lobe segmentation using 3D watershed. The validation results on an emphysema cohort show that the proposed method provides good segmentation accuracy for both pulmonary fissures and lobes.

# When Autonomous Vehicles Meet Moral Uncertainty

## ---- A Rebuttal of Bhargava and Kim's Solution For Autonomous Vehicles Under Moral Uncertainty

Kyo-Sun Koo
kyo-sun.koo@kcl.ac.uk
Kings College London (KCL)

## Abstract

Autonomous vehicles might encounter a situation closely resembles the trolley problem. Look at the following scenario.

Suppose an autonomous vehicle is about to hit a bus and then to cause the death of twenty-five passengers in it. However, the vehicle recognizes that it can swerve into, say, right direction, thereby avoid hitting the bus, although, unfortunately, there are five pedestrians over there who will be definitely dead.

It is normatively uncertain how the vehicle should be set to act when being at such kind of situation in which there is a moral uncertainty. While it will take very long time to find the objective answer or it is impossible to find it, Bhargava and Kim (B&K) have recently offered a seemingly very promising proposal to solve the question of how the vehicle in the scenario should be programmed to act, which is inspired by Andrew Sepielli's solution to the problem of moral uncertainty (Bhargava and Kim 2017). If the proposal were convincing, it would remove at least one ethical barrier of a wide introduction of autonomous vehicles to roads. Therefore, this proposal is worth investigating.

In this poster, I shall critically engage with B&K's proposal. Particularly, I shall focus on criticizing a specific debatable suggestion of it that it is possible to compare moral values across different moral views by re-describing the situation associated with moral uncertainty, because the force of the proposal depends significantly on this suggestion.

I shall first provide the reason why I find that the analogous re-statement they employ cannot offer a method to compare moral value across discrete moral views: (1) the analogy fails to offer a litmus-test of consequentialist's moral view; (2) the solution fails to provide a way to measure the difference in moral value between two options the vehicle has from one moral view. I shall second rebut Sepiellis' re-statement of the moral belief of one who faces a traditional trolley problem, since this re-statement is markedly different from B&K's re-description and thus someone might expect that B&K's solution would become convincing if they utilized Sepilelli's one. I shall point out that Sepielli overlooks that (1) it is impossible to fit killing within letting die from a non-consequential perspective and that (2) there is no guarantee that the value of one death from one moral perspective is same as the value of one death from another moral perspective. Therefore, I shall conclude that B&K fails to work out the problem of how an autonomous vehicle should be set to act when encountering a situation in which there is a moral uncertainty.

# Towards Model-based Imitation and Control by Learning Latent Dynamics

Yin Hang
hang.yin@epfl.ch
École polytechnique fédérale de Lausanne (EPFL)

## Abstract

We tackle the problem of learning dynamics towards model-based robot learning and control. We target high-dimensional unstructured dynamics data, aiming to address practical challenges faced by traditional pipelines. The proposed approach leverages the progress in variational Bayes and recurrent neural networks to learn a latent space. The interested dynamical relations can be compactly represented and modeled in the extracted space. Different from existing works, our model allows to learn with errors back-propagated through time, yielding a method featuring efficient inference for filtering, predicting and synthesizing sensory patterns with partial observability. We further propose to perform tractable imitation learning in the latent feature space and employ inference models in prediction-based control. The model is validated in three tasks: 1) learning and synthesizing diverse handwriting image sequences; 2) a benchmark of reconstructing and predicting bouncing balls; 3) a robot observes rolling-ball examples and uses the knowledge for mastering a ball-striking task with a partial visual input.

# Drug Discovery Disrupted: Quantum Physics meets Machine Learning

Prof. Noor Shaker
noor.shaker@gmail.com
Co-founder & CEO | GTN Ltd

## Abstract

Whenever a disease is identified, a new journey into the "chemical space" starts seeking a medicine that could become useful in contending diseases. The journey takes approximately 15 years and costs $2.6bn, and starts with a process to filter millions of molecules to identify the promising hundreds with high potential to become medicines. Around 99% of selected leads fail later in the process due to inaccurate prediction of behaviour and the limited pool from which they were sampled.

We, at GTN Ltd are addressing the main bottlenecks in drug discovery by innovating a cutting-edge technology with the potential to disrupt prediction and discovery of chemical compounds. We are building the software for computational simulation, testing and generation of chemical compounds with accuracy that surpasses what currently exists. With our innovation, we are bringing together more than 20 years of experience in advanced Machine Learning (ML) and Quantum Physics (QP) to implement unique and very advanced solutions.

To address the main issues, our technology provides the following solutions: (1) improve representation of molecules to allow better understanding of behaviour and prediction of activities and (2) efficient custom machine learning models to allow search and discovery of novel chemical structures in the astronomically huge drug-like space.

# Predicting User's navigation in VR

Silvia Rossi
s.rossi@ucl.ac.uk
University College London (UCL)

## Abstract

Virtual Reality (VR) applications target high-quality and zero-latency scene navigation to provide users with a full-immersion sensation. In the literature, there are many solutions to efficiently transmit VR content over limited resources providing a better user experience. In our previous work, for example, we proposed a navigation-aware strategy for 360° video adaptive streaming [1] that aims at optimizing the quality of the displayed portion of the video (i.e. viewport). However, to actually benefit from adaptive streaming strategies it is essential to predict the user attention and therefore the most likely viewport. While many recent works have investigated user attention prediction, they usually neglect the spherical geometry of the 360-degree video content. In this work, we show the importance in working on the spherical domain rather than on the projected one.

[1] Rossi S, Toni L. Navigation-aware adaptive streaming strategies for omnidirectional video. InMultimedia Signal Processing (MMSP), 2017 IEEE 19th International Workshop on 2017 Oct 16 (pp. 1-6). IEEE.

# Chord2Vec: Learning musical chord embeddings

Sephora Madjiheurem
sephora.madjiheurem.17@ucl.ac.uk
University College London (UCL)

## Abstract

In natural language processing, the well-known Skip-gram model learns vector representations of words that carry meaningful syntactic and semantic information. In our work, we investigate whether similar high-quality embeddings can be found for symbolic music data. We introduce three NLP inspired models to learn vector representations of chords and we evaluate their performance. We show that an adaptation of the sequence-to-sequence model is by far superior to the other proposed model.

[1] Sephora Madjiheurem, Lizhen Qu, and Christian Walder. Chord2Vec: Learning musical chord embeddings. In Proceedings of the Constructive Machine Learning Workshop at 30th Conference on Neural Information Processing Systems (NIPS'2016), Barcelona, Spain, December 2016.

# Analysis of Oil and Gas Big Data Using Artificial Intelligence

Nafiseh Vahabi
nafiseh.vahabi.14@ucl.ac.uk
University College London (UCL)

## Abstract

Monitoring in-well flow is essential for the oil and gas industry to manage the oil field. The flow surveillance identifies the well condition allowing optimization of the quality and volume of oil or gas production and saving costs for the oil companies. The well operators need to know the type of fluid in the pipe, the combination and ratio of each fluid in multi phase flow regimes (e.g. gas, oil, water), the settings of Inflow Control Valves (ICVs) which control the flow rate in the main pipe and from several side branching pipes coming from different underground reservoirs. The well operators also need to know the speed and direction of the fluid flow at each point down the well. Distributed Acoustic Fiber optic Sensors alongside or inside the well pipe are used to collect acoustic data as a function of time from effective acoustic sensors spaced by about a meter or less along thousands of kilometers of oil and gas well. The size of collected sound data from sensors is more than a Tera byte which can be analyzed successfully using Artificial Intelligence Machine Learning algorithms.

# PIX2NVS: Parameterized Conversion of Pixel-Domain Video Frames to Neuromorphic Vision Streams

Yin Bi
yin.bi.16@ucl.ac.uk
University College London (UCL)

## Abstract

We propose and make available a generic pixel-to-neuromorphic vision stream (PIX2NVS) framework in order to allow for the generation of neuromorphic data streams from conventional pixel-domain video frames. In order to quantify the accuracy of our framework against experimentally derived NVS data from previous work, we also propose and validate two metrics, the Chamfer distance and _-repeatability. The most important application of PIX2NVS will be in the generation of artificial NVS from large annotated video frame collections used in machine learning research, e.g., YouTube- 8M, YFCC100m, YouTube-Bounding Boxes, thereby transferring these datasets to the neuromorphic domain.

# Video Classification With CNNs: Using The Codec As A Spatio-Temporal Activity Sensor

Alhabib Abbas, alhabib.abbas.13@ucl.ac.uk, University College London (UCL)
Aaron Chadha, uceehad@ucl.ac.uk, University College London (UCL)

## Abstract

We investigate video classification via a two-stream convolutional neural network (CNN) design that directly ingests information extracted from compressed video bitstreams. Our approach begins with the observation that all modern video codecs divide the input frames into macroblocks (MBs). We demonstrate that selective access to MB motion vector (MV) information within compressed video bitstreams can also provide for selective, motion-adaptive, MB pixel decoding (a.k.a., MB texture decoding). This in turn allows for the derivation of spatio-temporal video activity regions at extremely high speed in comparison to conventional full-frame decoding followed by optical flow estimation. In order to evaluate the accuracy of a video classification framework based on such activity data, we independently train two CNN architectures on MB texture and MV correspondences and then fuse their scores to derive the final classification of each test video. Evaluation on two standard datasets shows that the proposed approach is competitive to the best two-stream video classification approaches found in the literature. At the same time: (i) a CPU-based realization of our input extraction is found to be three orders of magnitude faster than GPU-based optical flow methods, (ii) the spatial CNN evaluates on the sparsely decoded frames very sparingly.

# Cauchy Estimator For Entry-wise Matrix Completion

Zahra Sabetsarvestani
zahra.sabetsarvestani.14@ucl.ac.uk
University College London (UCL)

## Abstract

We address the problem of entry-wise low-rank matrix completion in the noisy observation model. More specifically, by characterizing the asymptotic distribution of the algebraic single entry estimator for local matrix completion, a newÂ noise robust estimator is proposed. Utilizing this estimator, we provide a new robust local matrix completion algorithm to outperform other classic methods in reconstructing large rectangular matrices. Our approach is motivated by the poor performance of other state-of-the-art matrix completion algorithms in this setting where we show that the sufficient conditions for unique reconstruction are not satisfied. The simulation results on synthetic and real data show that our algorithmÂ outperforms other state-of-the-art and baseline algorithms in matrix completion inÂ reconstructing rectangular matrices.

# Compressive Sensing with Side Information: How to Optimally Capture this Extra Information?

Mengyang Chen
meng-yang.chen.14@ucl.ac.uk
University College London (UCL)

## Abstract

This research studies how to optimally capture side information to aid in the reconstruction of high-dimensional signals from low-dimensional random linear and noisy measurements, by assuming that both the signal of interest and the side information signal are drawn from a joint Gaussian mixture model (GMM). In particular, we derive sufficient and (occasionally) necessary conditions on the number of linear measurements for the signal reconstruction minimum mean-squared error (MMSE) to approach zero in the low-noise regime; moreover, we also derive closed-form linear side information measurement designs for the reconstruction MMSE to approach zero in the low-noise regime. Our designs suggest that a linear projection kernel that optimally captures side information is such that it measures the attributes of side information that are maximally correlated with the signal of interest. A number of experiments both with synthetic and real data confirm that our theoretical results are very well aligned with numerical ones. Finally, we offer a case study associated with a panchromatic sharpening (pan-sharpening) application in the presence of compressive hyperspectral data that demonstrates that our proposed linear side information measurement designs can lead to reconstruction PSNR gains in excess of 2 dB over random linear measurement ones in this practical application.

# Multimodal Image Denoising and Image Super-Resolution via Joint Sparse Representations

Pingfan Song
uceeong@ucl.ac.uk
University College London (UCL)

## Abstract

In many practical applications, a certain scene is often observed by different sensors, producing images with different modalities, such as RGB and infrared modalities. It is observed that these different modalities exhibit favourable similarities represented by some structure features such as edges, corners. On the other hand, they also show some disparities, for example, different resolution and different robustness to noise. These observations motivate us to perform denosing and super-resolution for the modality of interest with another different modality as the guidance/ side information. For instance, we may improve the quality of noisy low-resolution infrared images via taking advantage of clean high-resolution RGB version for help. In order to address this problem, we propose to learn joint sparse representations for two modalities to capture the correlation priors among them. By capitalizing on the learned correlation prior and sparse prior, we develop joint sparse denosing and joint super-resolution approaches to achieve the image quality enhancement of one modality via incorporating another different modality as the guidance. Extensive experiments demonstrate that our approach brings notable benefits over state-of-the-art joint image processing approaches.

# CDLMRI: Coupled Dictionary Learning for multi-contrast MRI image reconstruction

Pingfan Song
uceeong@ucl.ac.uk
University College London (UCL)

## Abstract

Medical imaging tasks often involve multiple data modalities, such as T1/T2 weighted MRI image modalities, positron emission tomography (PET)/magnetic resonance imaging (MRI) modalities. These modalities capture information associated with the same underlying anatomy and are correlated by some structure similarities. In this work, we propose a novel framework, referred to as Coupled Dictionary Learning for multi-contrast MRI reconstruction (CDLMRI), to leverage an available guidance image to restore the targe image of a different modality. Our framework consists of three phases: coupled dictionary learning, coupled sparse denoising and enforcing k-space consistency. The first phase is to automatically learn a group of dictionaries that capture correlations among multiple modalities. By capitalizing on the learned dictionaries, the second phase performs joint sparse coding and shrinkage operation to purify the corrupted target image. The last phase enforces the consistency between the spectrum of the purified image and its k-space samples. The three phases alternate in a cycle manner to increasingly improve the quality of the target image. Experiments on both simulated and real MRI images demonstrate that incorporating guidance modality using our design brings notable benefits in the multimodal MRI reconstruction task.

# Real-time object detection and classification for high-speed asymmetric-detection time-stretch optical microscopy on FPGA

Ho-Cheung Ng
h.ng16@imperial.ac.uk
Imperial College London (IC)

## Abstract

A real-time object detection and classification system using FPGA developed for high-speed asymmetric time-stretched optical microscopy (ATOM) framework is presented. Due to the massive amount of data generated by optical frontend, storing the raw data for offline post-processing is slow and impractical for the targeted single cell analysis applications. The proposed FPGA solution eliminates the need to transfer and persist the entire raw data by processing low-level signals and forming high-level images in real-time. Objects of interest are detected and segmented from the image stream and a classifier subsequently performs high-level analysis on the segmented images. When compared with existing software-based post-processing workflow, this FPGA-based approach will improve both the number of objects captured per experiment and the overall end-to-end object classification performance. The system also allows co-optimization between optical system, low-level signal processing and image analytic in a unified environment that enables new scientific discoveries previously unachievable.

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## London PhD Network

The London PhD Network (LPN) is an academic association, aiming to encourage communications between young researchers in various areas, to foster learning, inspiration, and enhance connections.

## Crick AI Club

The Crick AI Club (CrAIC) hosts a seminar series and social networking events at the Francis Crick Institute which is open to any internal and external experts and novices in AI.