

## **Robotics and Artificial Intelligence Winter School**

**29 January to 9 February 2018 at Imperial College London**

### **Session descriptions:**

#### **Introduction - Robotics and AI**

This session aims to introduce the current state of the art in robotics and artificial intelligence providing an overview of the challenges and potentials in robotics and AI.

This session will cover:

- Robots – history and future;
- Three laws of robotics;
- Autonomous robots;
- Surgical robotic Systems;
- Robotic System Design Considerations;

#### **Group Project Planning**

The aim of this session is to provide students with practical experience in developing an intelligent robotic system. The group project will enable the students to apply the knowledge learned in the lectures and create innovative approaches to develop systems for practical applications. We will introduce the overview and guideline of the group projects, available equipment/devices, and assessment criteria and expectations. We will also use this session for the students to form project groups.

This session will cover:

- Group project overview;
- Guideline of the group projects;
- Available equipment/devices for the projects;
- Assessment criteria and expectations;
- Forming multi-disciplinary project groups.

#### **Machine Learning - fundamentals**

The aim of this session is to provide students with an understanding of the concept of Machine Learning and the knowledge to apply machine learning techniques for practical applications.

This session will cover:

- Classification and Pattern Recognition;
- Machine Learning Algorithms;
- k-Nearest Neighbour (k-NN) Technique;
- k-means clustering technique;
- Decision tree;
- Random Forrest;
- Support Vector Machine;
- Genetic Algorithms.

#### **Artificial Neural Networks**

The aim of this session is to provide students with an understanding of the concept of Artificial Neural Network and students will learn how it can be applied to different applications.

This session will cover:

- Neuron model
- Convexity limitation
- Single and multiple layered perceptron
- Gradient Descent
- Back-propagation
- Self-Organising Map

### **Probabilistic Reasoning**

The aim of this session is to provide students with an understanding of Bayes Theorem and knowledge to apply the probabilistic approaches for classification problems.

This session will cover:

- Expectations;
- Bayes Theorem;
- Bayes Classifier;
- Maximum a Posteriori Estimation (MAP);
- Naïve Bayes Classifier;
- Expectation Maximisation;

### **Deep Learning**

The aim of this session is to provide students with an understanding of the concept of Deep Learning and knowledge to evaluate different deep learning approaches.

This session will cover:

- Autoencoder;
- Restricted Boltzmann Machine;
- Deep Neural Network;
- Deep Belief Network;
- Recurrent Network;
- Convolution Neural Networks;

### **Machine Vision and AI**

The aim of this session is to provide students with an understanding of the concept of machine vision, the underlying theories, how it can be applied for different applications, and how it is closely linked with AI.

This session will cover:

- Image processing;
- Computer Vision;
- Perception and Prior Knowledge;
- Computer Vision Processes;
- Filtering and Convolution;
- Edge detection;
- Graph searching;

### **Shape and Feature Recognition**

The aim of this session is to provide students with an understanding of the techniques and theories in shape and feature recognition.

This session will cover:

- Template matching;

- Shape Discriminants;
- Geometric features;
- Fourier Harmonics;
- Antialiasing;
- Texture features;

### **Image sequence processing**

The aim of this session is to provide students with an understanding of image sequence processing, and the techniques for extracting features and tracking objects from video images.

This session will cover:

- Feature detection;
- Interest Points in Vision;
- Corner detection and Harris Corner Detector;
- Shi-Tomasi Corner Detector;
- Tracking in Image Sequences;
- Lucas-Kanade Tracker and Multiscale implementation;
- Kalman filter;
- Extended Kalman filter.

### **3D Vision and Shape from X**

The aim of this session is to provide students with an understanding of 3D reconstruction using Shape from X techniques.

This session will cover:

- Depth recovery from time to adjacency;
- Optical Flow;
- Structure from Motion;
- Stereo vision;
- RANSAC;
- Visual SLAM;

## **Business Model Innovation**

This expert-led module facilitates students' understanding of how businesses differentiate and compete in global markets. Students learn to define and build business models and how to market ideas to establish competitive advantage.

Topics considered:

- Building and improving business models that drive growth and innovation
- Evaluating ideas to determine which to pursue
- Creating strategies to differentiate and market products/brands
- Leveraging market insights to strengthen competitive position
- Identifying the most appropriate marketing mix, considering: product, price and global position

At the end of the winter school students working in teams will identify an idea to develop robotic device or application, they will then present a business model and marketing plan for this idea. This exercise consolidates learning while inspiring potential ideas and solutions to real Global Challenges.

## **Effective Communication for Presentation**

This workshop will take you on a journey through fundamental principles of communication and presentation. Through interactive exercises, plenary and interaction you will learn more about your strengths and natural abilities, and how to perform at your higher level. The session will allow you to work experientially within a group setting and will give you exercises, ideas, tips and practises for inclusion in your presentations on the last day.

## **Silicon Roundabout and Tech City – London Walking Tour**

The UK's Digital industry is booming. It's epicentre – an unassuming roundabout in East London. Known as Silicon Roundabout or Tech City, this area of London is home to the world's third biggest start-up tech cluster and is currently snapping at the heels of New York City and San Francisco's tech scene. Last year Silicon Roundabout launched over 15,500 new businesses – nearly five times as many launched in Canary Wharf. It is also where some of the biggest tech companies in the world have put down roots, including heavy hitters Google and Amazon, alongside Zoopla, Asos, Moo, Spotify, Songkick.com, Mind Candy and more. But how did this tech start-up metropolis come about? Award-winning Insider London's walking tour offers an eye-opening educational insight into how Shoreditch spawned a tech monster to rival San Fran's Silicon Valley. Students will see where tomorrow's trends are created, where killer concepts are born, where tube carriages double as office space and the only place in the world where you can buy an alcoholic smoothie.