UDRC Summer School Programme – 26th June to 29th June 2017, Surrey University

	Statistical Signal Processing **Monday 26th June***	**Radar Processing and Tracking** **Tuesday 27th June**	**Machine Learning** **Wednesday 28th June****	**Source Separation and Beamforming** **Thursday 29th June**
08:30	Coffee	Coffee	Coffee	Coffee
09:00	**Introduction and Target Localisation:** Discussion of target localisation as exemplar application for the day's material. **Probability and Random Variables:** Probability and classic paradoxes; random variables; probability transformations; statistical descriptors; central limit theorem; Monte Carlo methods; generating random variables. **Classical Estimation Theory**: Basic concepts; properties of estimators; Cramér–Rao lower bounds; maximum likelihood; Bayes theorem; least squares. The theory will be linked to a "breakdown" of the localization problem. *James Hopgood, University of Edinburgh*	**Introduction to Radar Signal Processing:** Basic Radar principles; data collection; Doppler processing, matched filter, pulse compression, ambiguity function (AF), coherent processing, demos. *Christos Ilioudis, Strathclyde University*	**Introduction to machine learning:** Basic concepts; problem formulation: data, labels, objective function, constraints, regularization; examples in pattern classification; kernel PCA and KDA, Support Vector Machines, neural networks (NN). *Josef Kittler, University of Surrey*	**Introduction to source separation:** Instantaneous and convolutive mixing models; block and sequential blind source separation algorithms; applications. *Jonathon Chambers, Newcastle University*
10.00		**Space-time Adaptive Processing (STAP) -** Using J.Ward's Tech. Report 1015 (1994) as a guide: Airborne Array Radar Signal Environment, Space-Time Processing Fundamentals, Airborne Radar Clutter Signal, STAP Performance Evaluation, MatLab Demos. *Ilias Konsoulas, Hellenic Air Force*	**Deep neural networks I:** Introduction; Simple Feed Forward Neural Network architecture; How to train Neural Network; Backpropagation theory; Introduction to Convolutional Neural Networks. *Muhammad Rana, University of Surrey*	**Principal component analysis (PCA):** Independent component analysis (ICA); independent vector analysis (IVA); algorithms and tutorial examples. *Mohsen Naqvi, Newcastle University*
11:00	Refreshments	Refreshments	Refreshments	Refreshments
11:30	**Introduction to Detection Theory:** Using the results from the first session, consider classic parameter detection. **Introduction to Random Processes:** Ensembles, statistical descriptors; input-output system relationships; system identification; introduction to spectral representations. *James Hopgood, University of Edinburgh*	**The Kalman filter:** An introduction to Bayesian filtering through the example of the Kalman filter. *Daniel Clark, Heriot-Watt University*	**Deep neural networks II:** Deep learning architectures; Key factors behind deep learning; Residual Neural Networks; Latest developments in neural Network architectures. Some applications as examples of deep learning. *Muhammad Rana, University of Surrey*	**Convolutive source separation:** Exploiting signal properties; nonstationarity and sparsity; and deep learning algorithms and tutorial examples. *Wenwu Wang, University of Surrey*
13:00	Lunch	Lunch	Lunch	Lunch
14:00	**Optimal and Adaptive Filtering of stochastic processes:** Spectral representations of stochastic processes; Optimal Wiener filtering; Adaptive processing for optimal filtering in practice; LMS and RLS algorithms, application examples. **Optimal detection of signals:** Application examples, Optimal tests in the white and colored noise cases. *Murat Uney, University of Edinburgh*	**Sequential Monte Carlo Methods:** Particle filtering and extensions for engineering applications. *Flávio Eler de Melo, Heriot-Watt University*	**Deep neural networks III:** Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), and their applications in computer vision and natural language processing. Practical issues in using popular deep learning libraries including Caffe, Torch, TensorFlow, Matconvnet. *Fei Yan, University of Surrey*	**Polynomial matrices and decompositions:** Tutorial examples. *Stephan Weiss, University of Strathclyde*
15:30	Refreshments	Refreshments	Refreshments	Refreshments
16:00 – 17:00	**Examples, Applications, and Closing Remarks:** Worked examples and application areas of presented theory. Summary of topics for further study, e.g.: state-space models, Kalman filter; Chapman-Kolgomorov equation. Summary and conclusions of key points from the day. *Murat Uney and James Hopgood, University of Edinburgh*	**Beyond the PHD filter**: Multi-target tracking for scenarios with a high variance in the number of detections. *Isabel Schlangen, Heriot-Watt University*	**Machine learning in anomaly detection** Concept of anomaly; Anomaly as an outlier of a statistical distribution. Anomaly detection. Anomaly detection in graphs. Application to anomaly in communication networks. *Radek Marik, Czech Technical University Prague*	**Beamforming and source localization:** Tutorial examples on beamforming and source localisation *Stephan Weiss, University of Strathclyde*

***Monday 26th June 2017 at 5:30pm: Local drink and cheese tasting (outside the lecture theatre)**
****Wednesday 28th June 2017 at 7.30pm: Summer school dinner at the Thai Terrace, Guildford**

Links:
Space-time Adaptive Processing (STAP) – MatLab code