

UDRC-EURASIP Summer School Programme – 2019

	Statistical Signal Processing Monday 24th June	Tracking and Sensing Tuesday 25th June	Machine Learning Wednesday 26th June	Source Separation and Beamforming Thursday 27th June
08:30	Coffee	Coffee	Coffee	Coffee
09:00	<p>Introduction and Target Localisation: Discussion of active and passive target localisation as exemplar application for the day's material.</p> <p>Probability and Random Variables: Axioms of probability and classic paradoxes; scalar and vector random variables; probability transformations and applications; statistical descriptors; central limit theorem.</p> <p>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. <i>James Hopgood, University of Edinburgh</i></p>	<p>Overview of Multi-Target Tracking (MTT): Examples of detection methods, including matched filter. Sensor bias and registration issues. Discussion of typical assumptions used in MTT, observation models, motion models, state-space formulations. <i>Murat Uney, David Cormack, Heriot-Watt University, and James Hopgood</i></p>	<p>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).</p> <p>Deep Neural Networks I: Introduction; simple feed forward neural network architecture; how to train neural network; backpropagation theory; introduction to convolutional neural networks. <i>Sotirios Tsafaris, University of Edinburgh</i></p>	<p>Introduction to Array Processing: Discussion of applications, signal model, and assumptions.</p> <p>Narrowband array processing: steering vectors, angle or arrival (AoA) estimation, and beamforming.</p> <p>broadband processing via tap delay lines: broadband AoA estimation via coherent signal subspace methods; formulation of constraints for broadband beamforming and beamforming solutions. <i>Stephan Weiss, University of Strathclyde</i></p>
10:00	<p>estimators; Cramér–Rao lower bounds; maximum likelihood; Bayes theorem; least squares. The theory will be linked to a “breakdown” of the localization problem. <i>James Hopgood, University of Edinburgh</i></p>	<p>Single-Target Tracking: Introduction to the Chapman-Kolmogorov equation, Kalman filtering and its extensions (such as EKF, UKF), particle filtering. <i>David Cormack, Murat Uney, James Hopgood</i></p>		
10:30	Refreshments	Refreshments	Refreshments	Refreshments
11:00	<p>Introduction to Random Processes: Ensembles, statistical descriptors; input-output system relationships; system identification; introduction to spectral representations.</p> <p>Monte-Carlo Methods: Applications for integration and optimization, generating random variables, accept-reject and importance sampling, MCMC techniques. <i>Murat Uney (NATO) and James Hopgood</i></p>	<p>Single Target Tracking using Stone Soup: A Practical workshop for investigating and implementing single-target tracking using an open-source platform. <i>Paul Thomas, Jordi Barr, Steve Hiscocks, DSTL</i></p> <p>Wrap-up Session on Single-Target Tracking <i>Paul Thomas, James Hopgood</i></p>	<p>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. <i>Sen Wang, Heriot-Watt University</i></p>	<p>Source Separation and Beamforming Background: Application of linear algebra to array problems, including subspace decompositions, and robust beamforming. Adaptive signal processing for beamforming, with application to minimum variance distortionless response beamformer. <i>Ian Proudler, University of Strathclyde</i></p>
12:30	Lunch	Lunch	Lunch	Lunch
13:30	<p>Introduction to Hypothesis Testing and Detection Theory: Using the results from the first session, considers classic hypothesis testing, parameter detection.</p> <p>Optimal Detection of Signals: Application examples, Optimal tests in the white and colored (non-white) noise cases; detection in active sensing (coherence, long-time integration). <i>Murat Uney and João Mota, Heriot-Watt University</i></p>	<p>Classic Data Association for Multi-Target Tracking: Overview of classic data association techniques, including PDA and JPDA.</p> <p>Stone Soup for Data Association A Practical workshop for investigating data association using an open-source platform. <i>Paul Thomas, Jordi Barr, Steve Hiscocks</i></p>	<p>Deep Neural Networks III: Recurrent neural networks (RNN) and applications in vision and language processing; Deep learning on sparse data; Some practical examples using PyTorch. <i>Tim Hospedales, University of Edinburgh</i></p>	<p>Introduction to Polynomial Matrices: Formulation of broadband array problems using polynomial matrix notation, and motivation of polynomial matrix factorisations; polynomial matrix eigenvalue decomposition algorithms their characteristics. <i>John McWhirter, Cardiff University</i></p>
15:00	Refreshments	Refreshments	Refreshments	Refreshments
15:30 – 17:00	<p>Sparsity in Signal Processing: L1 optimisation problems, techniques for optimisation, including convexity, stochastic gradient descent. Applications of sparse signal processing. <i>João Mota, Heriot-Watt University</i></p> <p>Summary and Conclusions of Key Points from the Day. <i>João Mota and James Hopgood.</i></p>	<p>Random Finite Set and Vector Based Methods: A tour of modern multi-target tracking techniques, including recent advances in message passing methods, multi-scan techniques, and group tracking. <i>Murat Uney and David Cormack</i></p>	<p>Hands on with Deep Learning in MATLAB, <u>Abstract</u> <i>Musab Khawaja, Mathworks</i></p>	<p>Polynomial Matrix Applications: Broadband AoA estimation via polynomial matrix techniques; polynomial matrix-based broadband MVDR adaptive beamforming. <i>Stephan Weiss and Ian Proudler</i></p>

Monday 24th June 2017 at 5:30pm: Whisky Tasting

****Wednesday 26th June 2017 at 8pm: Summer school dinner at the Bridge Inn, Ratho (coach pick up at 7:30pm)**