UDRC-EURASIP Summer School

The Summer School took place in the last week in June 2019. There were 78 people attending, with a 50:50 split between industry and academia, representing 29 different organisations. Applicants were from UK, Germany, Kazakhstan, France Netherlands, Sweden and Norway. The EURASIP funding will go towards the catering for each day of the Summer School.

24th – 27th June 2019 at Heriot-Watt University
- Statistical Signal Processing
- Sensing and Tracking
- Machine Learning
- Source Separation and Beamforming

We had lecturers from the universities of Edinburgh, Strathclyde and Heriot-Watt. There was also a Stone Soup Tracking tutorial delivered in collaboration between Edinburgh University and Dstl and a Mathworks tutorial delivered by Mathworks.

People who attended the Summer school fed back that they really enjoyed it. A few of their comments are: below:

- **Really enjoyed each day; the lectures were all well suited to my level of experience**
- **High level of content, informing attendees of concepts and state-of-the-art**
- **Stone soup tutorial was good**
- **All very relevant, thanks for a great week**

Summer School applicants enjoying a break from lectures

UDRC-EURASIP Summer School
24 - 27 June, 2019
Post-Graduate Centre
Heriot-Watt University
Edinburgh

IMPORTANT DATES

Application for UDRC Summer School

- Deadline for Applications: 27 March 2019
- Notification of Application: 10 April 2019

This four day school is for researchers in industry, defence and academia with an interest in Signal Processing for Defence and a knowledge of Mathematics/Statistics at Masters level.

Summer School Programme

Monday 24 June	Statistical Signal Processing
Tuesday 25 June	Sensing and Tracking
Wednesday 26 June	Machine Learning
Thursday 27 June	Source Separation and Beamforming

This summer school is delivered under the University Defence Research Collaboration (UDRC) in Signal Processing in the information Age and is funded by EPSRC and Dstl.

Expressions of interest – email janet.forbes@ed.ac.uk
More information – http://mod-udrc.org/udrc-eurasip-summer-school-2019

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	**Introduction and Target Localisation:** Discussion of active and passive target localisation as exemplar application for the day's material. **Probability and Random Variables:** Axioms of probability and classic paradoxes; scalar and vector random variables; probability transformations and applications; statistical descriptors; central limit theorem.	**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. *David Cormack, Heriot-Watt University, and James Hopgood*	**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). **Deep Neural Networks I:** Introduction; simple feed forward neural network architecture; how to train neural network; backpropagation theory; introduction to convolutional neural networks. *Sotirios Tsaftaris, University of Edinburgh*	**Introduction to Array Processing:** Discussion of applications, signal model, and assumptions. Narrowband array processing: steering vectors, angle or arrival (AoA0estimation, and beamforming. broadband processing via tap delay lines: broadband AoA estimation via coherent signal subspace methods; formulation of constraints for broadband beamforming and beamforming solutions. *Stephan Weiss, University of Strathclyde*
10.00	**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*	**Single-Target Tracking:** Introduction to the Chapman-Kolgomorov equation, Kalman filtering and its extensions (such as EKF, UKF), particle filtering. *David Cormack, James Hopgood*		
10:30	Refreshments	Refreshments	Refreshments	Refreshments
11:00	**Introduction to Random Processes:** Ensembles, statistical descriptors; input-output system relationships; system identification; introduction to spectral representations. **Monte-Carlo Methods:** Applications for integration and optimization, generating random variables, accept-reject and importance sampling, MCMC techniques. *James Hopgood*	**Single Target Tracking using Stone Soup:** A Practical workshop for investigating and implementing single-target tracking using an open-source platform. *Jordi Barr, Steve Hiscocks, Dstl* **Wrap-up Session on Single-Target Tracking** *Jordi Barr, James Hopgood*	**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. *Sen Wang, Heriot-Watt University*	**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. *Ian Proudler, University of Strathclyde*
12:30	Lunch	Lunch	Lunch	Lunch
13:30	**Introduction to Hypothesis Testing and Detection Theory:** Using the results from the first session, considers classic hypothesis testing, parameter detection. **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). *João Mota, Heriot-Watt University*	**Classic Data Association for Multi-Target Tracking:** Overview of classic data association techniques, including PDA and JPDA. **Stone Soup for Data Association** A Practical workshop for investigating data association using an open-source platform. *Jordi Barr, Steve Hiscocks*	**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. *Tim Hospedales, University of Edinburgh*	**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. *Fraser Coutts, University of Edinburgh*
15:00	Refreshments	Refreshments	Refreshments	Refreshments
15:30 – 17:00	**Sparsity in Signal Processing:** L1 optimisation problems, techniques for optimisation, including convexity, stochastic gradient descent. Applications of sparse signal processing. *João Mota, Heriot-Watt University* **Summary and Conclusions of Key Points from the Day.** *João Mota and James Hopgood.*	**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. *David Cormack*	**Hands on with Deep Learning in MATLAB, <u>Abstract</u>** *Martina Sciola, Mathworks*	**Polynomial Matrix Applications:** Broadband AoA estimation via polymomial matrix techniques; polynomial matrix-based broadband MVDR adaptive beamforming. *Stephan Weiss and Ian Proudler*

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)**