

# UDRC Summer School Programme - 20<sup>th</sup> – 23<sup>rd</sup> July 2015, University of Surrey

	<b>Statistical Signal Processing</b> Monday 20 <sup>th</sup> July	<b>Tracking</b> Tuesday 21 <sup>st</sup> July	<b>Pattern Recognition and Classification</b> Wednesday 22 <sup>nd</sup> July	<b>Source Separation</b> Thursday 23 <sup>rd</sup> July
08:30	Coffee	Coffee	Coffee	Coffee
09:00	<b>Probability and Random Variables:</b> probability and some paradoxes; random variables; probability transformations; statistical descriptors; central limit theorem; Monte Carlo methods; generating random variables (James Hopgood, Edinburgh)	<b>Applications of multi-target tracking:</b> An overview of the range of different applications in need of solutions to multi-target tracking (Daniel Clark, Heriot-Watt)	<b>Introduction to pattern recognition and classification.</b> Basic concepts. Pattern recognition problem. Pattern recognition system. Elements of statistical decision theory. Parametric and nonparametric decision rules. kNN classifier. Distance, similarity, reconstruction. Similarity based classification. Classification via Sparse Representation. Classifier training and testing. Classifier error estimation. Multiple classifiers. (Josef Kittler, Surrey)	<b>Introduction to source separation:</b> instantaneous and convolutive mixing models; block and sequential blind source separation algorithms; applications (Wenwu Wang, Surrey)
10:00	<b>Classical Estimation Theory:</b> Basic concepts; properties of estimators; Cramer-Rao lower bounds; maximum likelihood; linear and non-linear least squares (James Hopgood, Edinburgh)	<b>The Particle Filter:</b> A solution to the problem of Bayesian estimation for nonlinear dynamical and observation models. (Jose Franco, Heriot-Watt)		<b>Principle component analysis (PCA);</b> independent component analysis (ICA); independent vector analysis (IVA); algorithms and tutorial examples (Mohsen Naqvi, Loughborough)
11:00	Refreshments	Refreshments	Refreshments	Refreshments
11:30	<b>Introduction to Random Processes:</b> Ensembles, statistical descriptors; input-output statistical relationships; system identification; special representations; Wiener filtering; state-space models (James R Hopgood and Murat Uney, Edinburgh)	<b>Distributed multi-sensor fusion:</b> How to fuse estimates from different sources. (Simon Julier, UCL)	<b>Dimensionality reduction.</b> Principal Component Analysis. Linear Discriminant Analysis. Kernel implementation of PCA and LDA. Kernel PCA and Kernel Discriminant Analysis. Spectral Regression KDA. Multiple kernel fusion. Feature selection. (Josef Kittler, Surrey)	<b>Frequency domain source separation:</b> exploiting signal properties; nonstationarity and sparsity; algorithms and tutorial examples (Wenwu Wang, Surrey)
13:00	Lunch	Lunch	Lunch	Lunch
14:00	<b>Adaptive Filtering and the Kalman Filter:</b> state-space models; introduction to adaptive signal processing; scalar Kalman filter (Murat Uney, Edinburgh).	<b>Multi-object Filtering:</b> The PHD Filter and Gaussian mixture implementations. (Daniel Clark, Heriot-Watt)	<b>Machine learning</b> (Support vector machines) (John Shawe-Taylor, UCL)	<b>Polynomial matrices and decompositions;</b> tutorial examples (Stephan Weiss, Strathclyde)
15:30	Refreshments	Refreshments	Refreshments	Refreshments
16:00 – 17:00	<b>Bayesian Estimation Theory and Examples:</b> Bayes's theorem; removal of nuisance parameters (marginalisation); general linear model; priors; MAP estimates; Chapman-Kolgomorov equation (Murat Uney and James Hopgood, Edinburgh)	<b>Recent advances in multi-object estimation:</b> New methods for target classification and sensor management. (Emmanuel Delande Heriot-Watt)	<b>Neural networks;</b> Deep learning architectures and algorithms (Mark Plumbley, Surrey)	<b>Beamforming and Source Separation Application Case Studies</b> (Stephan Weiss, Strathclyde)

Wine Tasting (Main Concourse, outside Lecture Theatre M) - Monday at 5:30pm

Summer School Dinner (The Angel Dining Rooms, 91 High Street, Guildford) - Wednesday at 7:30pm