**Machine Learning for Synthetic Aperture Radar**

**Agenda**

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| 2nd November 2021 | |
| 13:30 – 13:50 | **Introduction and welcome**  *Victoria Nockles, The Alan Turing Institute* |
| 13:50 – 14:10 | **Machine learning for unsupervised, automatic detection of transient phenomena in InSAR time-series**  *Rich Walters, Anza Shakeel University of Durham*  The detection and measurement of transient episodes of crustal deformation from global InSAR datasets is crucial for a wide range of solid earth and natural hazard applications. We have developed a new, unsupervised and “deformation-agnostic” deep-learning model, based on an anomaly-detection framework. Our model learns the “normal” spatio-temporal pattern of noise in sets of unwrapped interferograms, and therefore identifies any transient deformation phenomena that deviate from this pattern as “anomalies”. We have leveraged the unique 3D structure of the interferogram stack through a model architecture built around a bespoke autoencoder, which includes convolutional and LSTM layers, as well as a neural network that acts as a bridge between encoder and decoder. Our model can successfully detect and isolate synthetic and real deformation signals with lengthscale > ~600 m and magnitude > ~ 4 cm in InSAR datasets, with high overall accuracy and true positive rate. |
| 14:10 – 14:30 | ***Using independent component analysis (ICA) with time-series of InSAR to monitor volcanoes***  *Matthew Gaddes, Andy Hooper, Susanna Ebmeier University of Leeds*  The Earth’s subaerial volcanoes pose a variety of threats, yet the vast majority remain unmonitored.  However, with the advent of the latest synthetic aperture radar (SAR) satellites, interferometric SAR has evolved into a tool that can be used to monitor the majority of these volcanoes.  Whilst challenges such as the automatic and timely creation of interferograms have been addressed, further developments are required to construct a comprehensive monitoring algorithm that is able to automate the detection of unrest.  To monitor volcanoes using SAR data, we have previously published work on using independent components analysis (ICA) within our ICASAR Python package to isolate volcanic deformation signals in InSAR time series, and on using our LiCSAlert Python package to detect changes in these signals.  Here, we present results of a 2nd version of the ICASAR algorithm that is able to detect deformation signals of smaller magnitude.  We demonstrate ICASAR using a time series of Sentinel-1 interferograms that image Campi Flegrei (Italy), as this volcano has a relatively dense network of deformation measurements derived from global navigation satellite systems (GNSS) that can be used for validation.  We also compare the results of removing atmospheric noise using ICASAR to results obtained using a spatially constant and linear phase-elevation ratio, and by using corrections derived from weather models.  As the ICASAR algorithm is used by the LiCSAlert algorithm to characterise the baseline behaviour of a volcano, we also discuss how the previously described results affect the LiCSAlert algorithm, and report on progress of our work towards routine global monitoring using LiCSAlert*.* |
| 14:30 – 14:40 | **Applications of image processing and computer vision to InSAR data**  *Pui Anantrasirichai, University of Bristol*  This talk will present current technologies of image processing and computer vision, originally proposed for natural images that can be adapted to InSAR images. The techniques include supervised and unsupervised deep learning for object detection, matrix completion and deep image prior for spatial interpolation to restore sparse data, and image denoising for mitigating atmospheric effects. |
| 14:40 – 15:00 | **Coffee Break** |
| 15:00 – 15:20 | **Cranfield University Ground-Based SAR Laboratory**  *Daniel Andre, Cranfield University*  The Ground-Based Synthetic Aperture Radar (SAR) laboratory at Cranfield University provides an indoor flexible SAR measurement capability, where scenes of interest can be setup for measurement. A range of SAR modes can be investigated including fully polarimetric, multistatic, interferometric, and 3D SAR. This talk will describe the capability and present a range of results from recent experiments. |
| 15:20 – 15:40 | **Transfer Learning for Measured Data Limited Synthetic Aperture Radar Automatic Target Recognition**  *Dr Majumder* |
| 15:40 – 16:30 | **Discussions** |