REPORT 2016-17

Mathematical imaging, image processing and computer vision have become fundamental for gaining information on various aspects in medicine, the sciences, and technology. The computation, visualisation and the automatic processing of (digital) images such as consumers' digital cameras, from industrial installations, as well as from visualizing (material or tissue) properties which are accessible only indirectly through measurements, are ubiquitous in both imaging and vision communities. Though both are multidisciplinary fields, yet, these two related communities often run their own networking activities. The INI programme in VMV brought researchers and practitioners together to review and work on the state of the arts models, methods, algorithms and applications. Participants found this networking and programme opportunities particularly useful and interactions really fruitful.

The VMV programme has several highlights

1) We had three main academic workshops in the programme that highlighted recent research in convex and non-convex large-scale optimisation in imaging, model- and data-driven imaging including current mathematical approaches for machine learning in imaging, and a workshop on shape spaces and geometric flows. These workshops attracted more than one hundred international experts from mathematics, engineering and computer science, and a large number of early career researchers in these fields.

2) We ran several user-engagement days with industry and academic experts from imaging-rich application domains such as biomedicine, archaeology, satellite imaging, and earth sciences. Among these were a workshop co-organised with the Turing Gateway to mathematics, a satellite-workshop on imaging in the life sciences at the University of Warwick, an IMA conference on inverse problems and three Schlumberger satellite workshops at Schlumberger Gould Research that explored the synergies between research in Schlumberger and research topics in the VMV programme.

3) Our Rothschild public lecture was given by Professor Joachim Weickert on Image Compression with Differential Equations and attracted a high volume of participants.

4) The recent success of deep neural networks, also for several image analysis and processing problems, had a clear effect on our programme. VMV participants, coming from mathematical fields like statistics, inverse problems, partial differential equations and numerical analysis, are getting increasingly interested in understanding convolutional neural networks, throwing more light onto the mathematics behind CNNs. Discussions in the INI common areas and talks in the VMV workshops were often about the topic of deep learning in imaging.

5) Early career participants profited from three short courses given by internationally renowned experts. Martin Burger gave a course on biomedical imaging, Martin Holler on higher-order total variation regularisation and Mila Nikolova on non-convex minimizers. It is equally pleasing to hear several Early career researchers giving seminars between workshops.

During the programme, several participants were invited to give lectures in other UK Universities such as UCL, Imperial, Oxford, Liverpool, Bath, Nottingham, Bournemouth, Edinburgh and some participants have started new collaborations.

The dominating themes emerging through the programme are (i) nonlinear optimization (which is what we predicted) and (ii) machine and learning frameworks (not predicted initially) coupled with VMV researches that prove to be a successful way forward. Both themes are closely related to Big Data. It suggests that the field of VMV is thriving and the future is bright. Various funders have schemes to fund researches in these directions.

Indeed, we have planned several follow up activities

- A special journal issue dedicated to the programme topics;
- A proceedings book planned to celebrate the research achievements;
- A planned conference to further increase the Impact;

- A INI review workshop is planned to follow up the new projects ideas.