Variational Bayesian Methods for Image Recovery and Beyond

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Image recovery is a field with a relatively long history. Beginning in the 1950s by focusing on restoring images acquired by spacecrafts, it became an active area of research and development due to its wide applicability and high interest from diverse scientific areas. Today, image recovery is a well-established field with many advanced theoretical frameworks and practical algorithms. However, there is a growing need for more advanced image recovery algorithms due to the proliferation of new applications.

Three specific areas of image recovery are today of high interest: The first one is image restoration and super-resolution, particularly for surveillance, remote sensing, medical and nano-imaging applications, improving the resolution of multi-spectral imaging, and fusing fMRI and EEG signals for source localization.

The second area is compressive sensing (CS). It has recently become very popular due to its important theoretical nature and wide area of applications. It reformulates the traditional sensing processes as a combination of acquisition and compression, and traditional decoding is replaced by recovery algorithms that exploit the underlying structure of the data. A large number of algorithms has been developed for CS recovery; with many interesting new applications being proposed everyday (e.g., single pixel camera), it is expected to remain a very active area of research and development.

Finally, the emerging area of computational photography has provided effective solutions to a number of photographic problems, and also resulted in novel methods for acquiring and processing images. By many researchers in academia and industry, computational photography is expected to replace traditional photography in the near future due to its enriched capabilities. Many problems in computational photography are related to image recovery problems. Therefore image recovery algorithms are efficiently utilized in solving many novel problems in computational photography. In addition, rather surprisingly, image recovery research is currently being utilized for designing new imaging hardware.

This talk will provide an overview of Variational Bayesian modelling and inference methods for image recovery and related areas, such as, computational photography, compressive sensing, and medical imaging based on the use of graphical models. Emphasis will be placed on the pros and cons of variational posterior distribution approximations, their relations to other inference models and their graphical meaning.