**Speaker:** Chrysoula Tsogka

**Title :** The Noise Collector for sparse recovery in high dimensions

## Abstract

We are interested in imaging sparse scenes, accurately, using limited and noisy data. Such imaging problems arise in many areas such as medical imaging, structural biology, radar and geophysics. Both the passive and the active array imaging problems with or without multiple scattering can be reduced to finding the solution of the linear system $\mathcal{A}\rho = b_0 + e$, where $e$ is the noise. It is well known, that a sparse solution of this system can be found efficiently with an $\ell_1$-norm minimization approach,

$$\rho_* = \arg\min_{\rho} \|\rho\|_{\ell_1}, \text{ subject to } \mathcal{A}\rho = b_0 + e, \tag{1}$$

if the data is noiseless. However, determining $\rho$ from data corrupted by noise is still a challenging problem. For optimal results, current approaches need to tune parameters that depend on the level of noise, which is often difficult to be estimated in practice. In this talk, the Noise Collector [1, 2], a new parameter-free, $\ell_1$ norm minimization approach will be presented. We introduce a *no-phantom* weight $\tau$ and the Noise Collector matrix $\mathcal{C}$, and solve instead of (1), the augmented system

$$\begin{array}{l}(\rho_\tau, \eta_\tau) = \arg\min_{\rho,\eta} \left(\tau\|\rho\|_{\ell_1} + \|\eta\|_{\ell_1}\right), \\ \text{subject to } \mathcal{A}\rho + \mathcal{C}\eta = b_0 + e,\end{array} \tag{2}$$

The Noise Collector has a zero false discovery rate (no false positives) for any level of noise, with probability that tends to one as the dimension of $b_0$ increases to infinity and provides exact support recovery when the noise is not too large. A Fast Noise Collector Algorithm has been implemented which makes the computational cost of solving the minimization problem comparable to the original one. The effectiveness of the method will be demonstrated in imaging applications.

## References

[1] M. Moscoso, A. Novikov, G. Papanicolaou and C.Tsogka, Imaging with highly incomplete and corrupted data, *Inverse Problems*, 36(3), p. 035010, 2020. https://doi.org/10.1088/1361-6420/ab5a21

[2] M. Moscoso, A. Novikov, G. Papanicolaou and C.Tsogka, The Noise Collector for sparse recovery in high dimensions, Proceedings of the National Academy of Sciences, 117 (21), p. 11226-11232, 2020. https://doi.org/10.1073/pnas.1913995117