# COMPRESSED SENSING: FROM THEORY TO DEEP LEARNING

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Compressed Sensing surprisingly predicts that high-dimensional vectors which allow a sparse representation by a suitable basis or, more generally, a frame, can be recovered from what was previously considered highly incomplete linear measurements by using efficient algorithms. To incorporate the sparsifying system (basis/frame) into the recovery algorithm, an $\ell_1$-analysis-minimization strategy is often pursued, which is very successful, for instance, for multiscale systems.

In the first part of this lecture, we will discuss a generalized notion of sparsity, which allows for the first time to derive very precise theoretical recovery guarantees for $\ell_1$-analysis-minimization, enabling accurate predictions of its sample complexity based on the Gram matrix of the analysis operator. Our findings surprisingly defy conventional wisdom which promotes the sparsity of analysis coefficients as the crucial quantity to study.

However, in certain applications due to a lack of data classical compressed sensing strategies fail as in limited-angle computed tomography. For such situations we will present a general strategy to combine $\ell_1$-analysis-minimization with deep learning, with maximal control on the recovery procedure by targeting the learning only to the "invisible" part of the data.

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