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Super-resolved Lasso

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Super-resolution of pointwise sources is of utmost importance in various areas of imaging sciences. Specific instances of this problem arise in single molecule fluorescence, spike sorting in neuroscience, astrophysical imaging, radar imaging, and nuclear resonance imaging. In all these applications, the Lasso method (also known as Basis Pursuit or l1-regularization) is the de facto baseline method for recovering sparse vectors from low-resolution measurements. This approach requires discretization of the domain, which leads to quantization artifacts and consequently, an overestimation of the number of sources. While grid-less methods, such as Prony-type methods or non-convex optimization over the source position, can mitigate this, the Lasso remains a strong baseline due to its versatility and simplicity. In this work, we introduce a simple extension of the Lasso, termed 'super-resolved Lasso"(SR-Lasso). Inspired by the Continuous Basis Pursuit (C-BP) method, our approach introduces an extra parameter to account for the shift of the sources between grid locations. Our method is more comprehensive than C-BP, accommodating both arbitrary real-valued or complex-valued sources. Furthermore, it can be solved similarly to the Lasso as it boils down to solving a group-Lasso problem. A notable advantage of SR-Lasso is its theoretical properties, akin to grid-less methods. Given a separation condition on the sources and a restriction on the shift magnitude outside the grid, SR-Lasso precisely estimates the correct number of sources. This is joint work with Gabriel Peyré

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