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Joint L1-L2 Regularization for Inverse Scattering#

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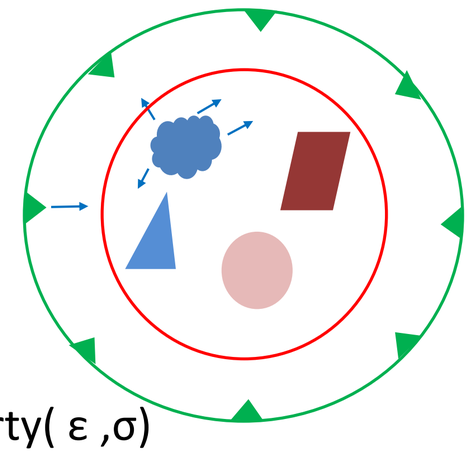
Background

Inverse scattering

- Estimates material electrical properties from the measured scattered field



General strategy

- Highly nonlinear problem
- Usually process with the iterative linearized approximation
- ill –posed, ill conditioned : need regularization

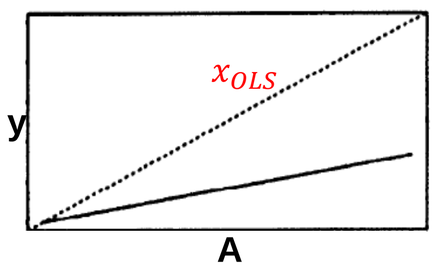
Applications

- Medical Imaging : tissue property(ε ,σ)
- Diffraction Tomography : η
- Buried Object Detection : soil moisture (ε ,σ)

Regularization

L2 Norm

- Smoothen the discontinuity
- scales the solution

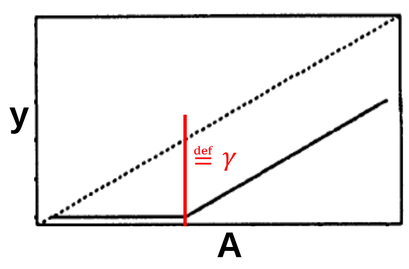


Orthonormal Case :

$$x = \frac{x_{OLS}}{1+\lambda}$$

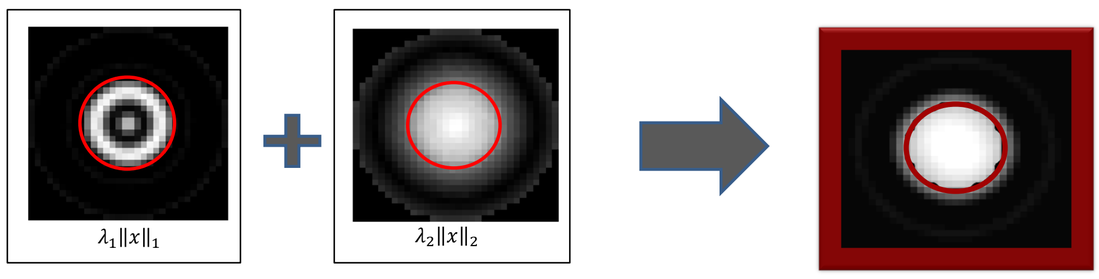
L1 Norm

- Preserves discontinuity
- translates the solution



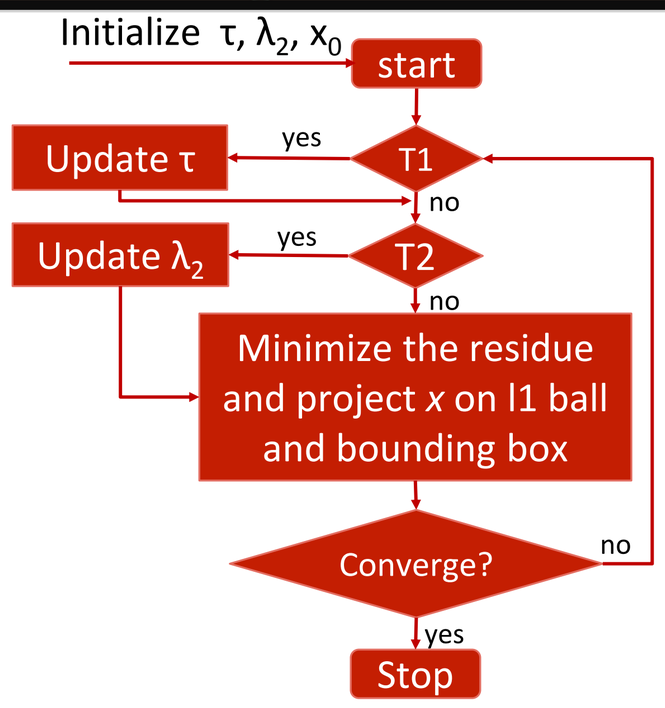
- Compressive sensing
- Applicability to inv. scattering?

Motivation

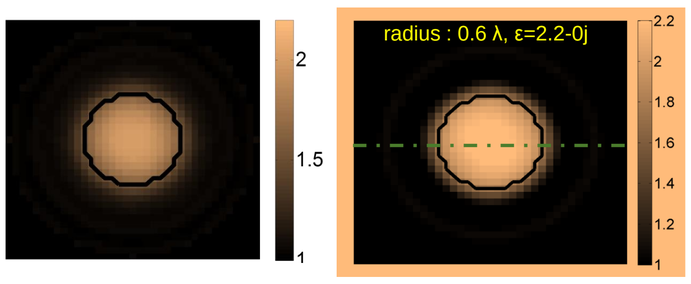


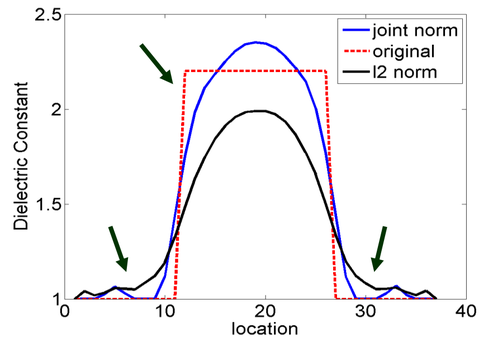
$$\mathbf{J(x) = \left|\left|Ax - y\right|\right|_2^2 + \lambda_2\left|\left|x\right|\right|_2^2 + \lambda_1\left|\left|x\right|\right|_1}$$

Algorithm

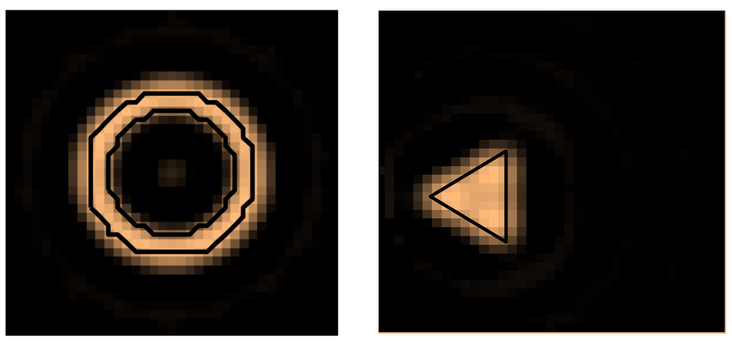


Simulation Results





Norm	Correctly classified	
	inside	Outside
L2 Norm	93.2%	45.05%
Joint Norm	100%	85.15%



Discussion & Future Work

- Developed the method for inverse scattering
  - Estimates the permittivity close to actual value, even for the background
  - Can utilize prior bound constraints
  - Systematic and modular framework
- Evaluate on 3D and real data

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