Local Regularization for Inverse Problems (EEG)

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Introduction

Motivation

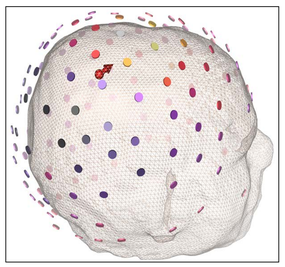
- Global regularization in EEG source localization doesn't take into account local geometry and features
- This global regularization often requires an exhaustive search for an optimal parameter

Goal

- Develop a local regularization method for more accurate EEG source localization.
- Develop an automatic parameter selection for EEG regularization.

EEG Source Localization

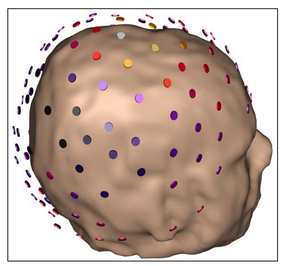
Sources

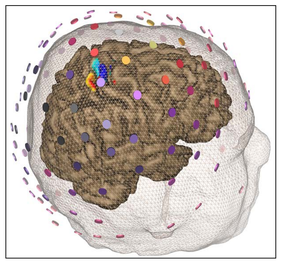


Forward

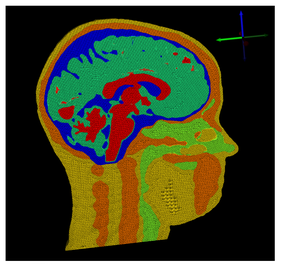
Inverse

Measurements

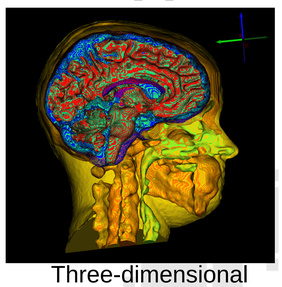




60.2 M Elements [1]



Three-dimensional tetrahedral mesh

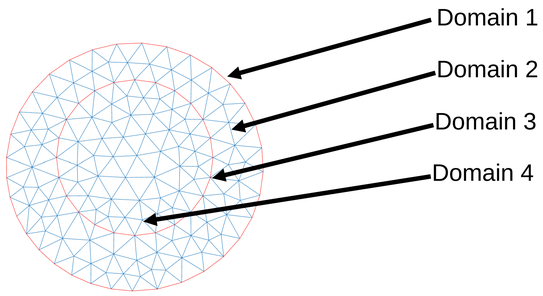


Three-dimensional surface mesh

Methods

Domain subdivision[2]

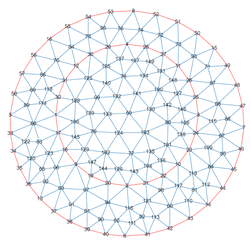
- Divide domain and apply different regularization to each domain



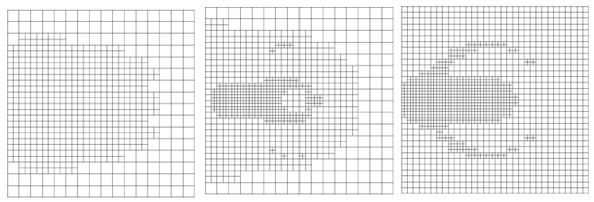
Simplified head model

Spatial dependent parameter

- Regularization function defined at every node
- Mesh refinement based on information content [3]



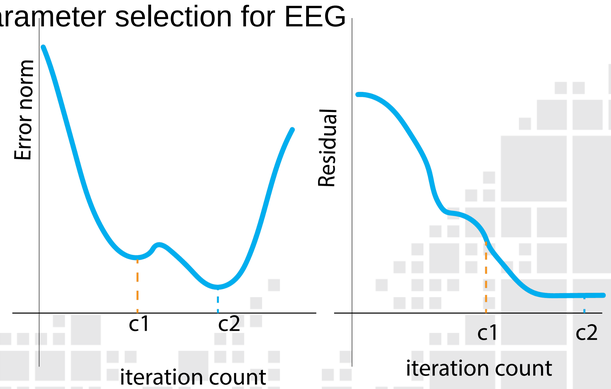
Simplified head model



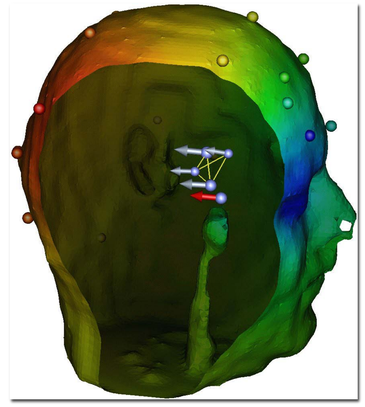
Mesh refinement

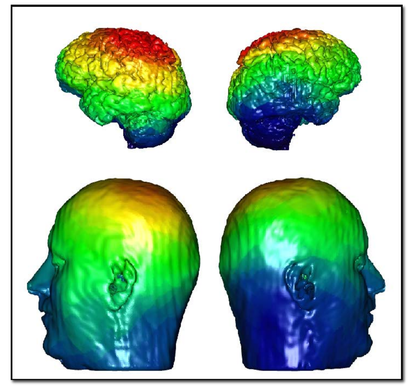
Iterative parameter selection

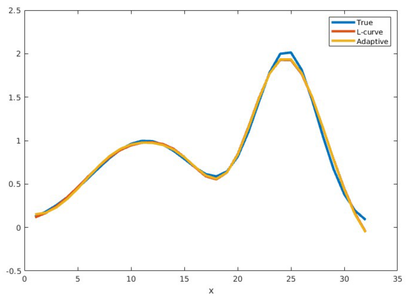
- Iterative and automatic parameter regularization parameter selection for EEG

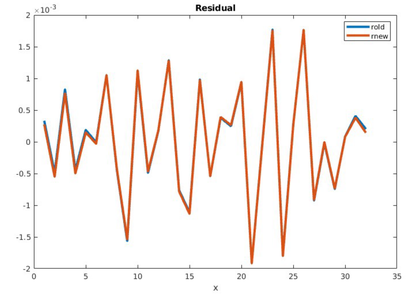


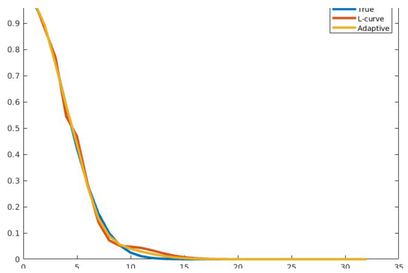
Results

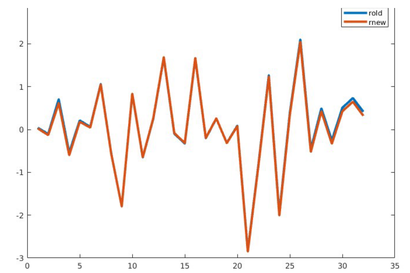


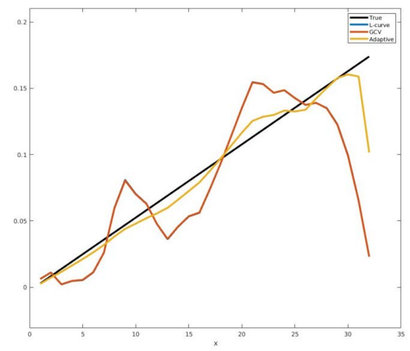


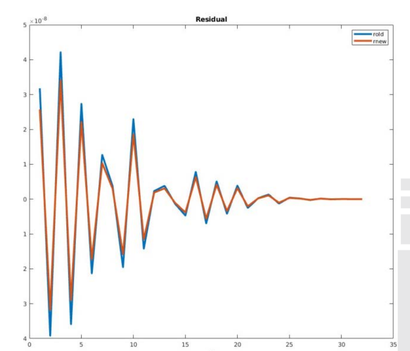












[1] Warner, A., Tate, J., Burton, B. and Johnson, C.R., 2019. A high-resolution head and brain computer model for forward and inverse EEG simulation. *bioRxiv*, p.552190.
[2] Johnson, C.R., 2001. Adaptive finite element and local regularization methods for the inverse ECG problem. *Inverse Problems in Electrocardiology*, pp.51-88.
[3] Bangerth, W., Johnson, C.R., Njeru, D.K. and Waanders, B.V.B., 2022. Estimating and using information in inverse problems. *arXiv preprint arXiv:2208.09095*.

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