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USER-FRIENDLY BUILDING OF RECONSTRUCTION ALGORITHMS FOR SOLVING INVERSE PROBLEMS

Laurène Donati[⋆], *Emmanuel Soubies*[†], *Thanh-An Pham*[⋆], *Michael Unser*[⋆]

[⋆]Biomedical Imaging Group, EPFL, Switzerland
[†]IRIT, Université de Toulouse, CNRS, France

ABSTRACT

Imaging scientists nowadays commonly relies on the deployment of sophisticated algorithms to recover an object of interest $\mathbf{x} \in \mathbb{R}^N$ from measurements $\mathbf{y} \in \mathbb{R}^M$. These quantities are linked according to

$$\mathbf{y} = \mathbf{H}\mathbf{x} + \mathbf{n},$$

where $\mathbf{H} \in \mathbb{R}^{M \times N}$ is a matrix that models the imaging system, and $\mathbf{n} \in \mathbb{R}^M$ is some error term.

The classical approach to address this inverse problem and recover an estimated solution $\widehat{\mathbf{x}}$ consists in solving

$$\widehat{\mathbf{x}} = \underset{\mathbf{x}}{\operatorname{argmin}} \big\{ \mathcal{D}(\mathbf{H}\mathbf{x}, \mathbf{y}) + \lambda \mathcal{R}(\mathbf{x}) \big\} \qquad (1)$$

where $\mathcal{D} : \mathbb{R}^M \times \mathbb{R}^M \to \mathbb{R}$ is a data-fidelity metric, while $\mathcal{R} : \mathbb{R}^N \to \mathbb{R}$ enforces the regularization of the solution.

To this end, we recently developed GlobalBioIm[1], an open-source Matlab® library that standardizes the resolution of a wide range of imaging problems [1]. This toolbox gives access to cutting-edge reconstruction algorithms, and can be extended to new modalities and methods by combining elementary modules. The versatility and efficiency of GlobalBioIm have been highlighted in a series of recent high-impact works [2, 3, 4].

Driven by these encouraging applications, we have devoted our efforts towards improving the usability of GlobalBioIm by those with limited expertise in inverse problems and optimization theory. The outcome is a new user-friendly Matlab interface (Figure 1) that allows non-experts to intuitively build tailored reconstruction algorithms with minimal effort.

Our hope is that this new tool will encourage the use of more robust variational reconstruction frameworks in a wider-range of imaging applications.

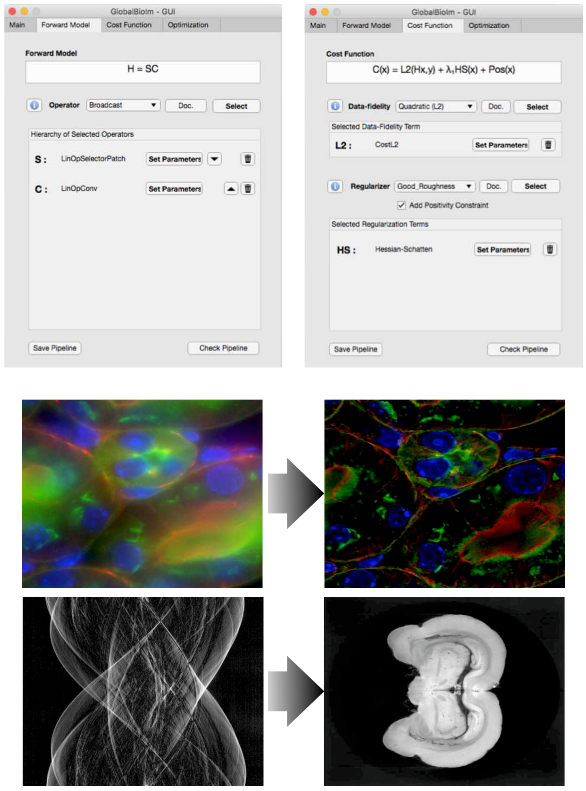

Fig. 1: The new GlobalBioIm GUI (top, 2 out of 4 panels here) can be used to solve various inverse problems (bottom).

1. REFERENCES

[1] Emmanuel Soubies et al., "Pocket guide to solve inverse problems with globalbioim," *Inverse Problems*, 2019.

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[3] Chin-Lin Chen et al., "Imaging neural activity in the ventral nerve cord of behaving adult drosophila," *Nature communications*, vol. 9, no. 1, pp. 4390, 2018.

[4] Emmanuel Soubies et al., "Nanometric axial resolution of fibronectin assembly units achieved with an efficient reconstruction approach for multi-angle-tirf microscopy," *Scientific reports*, vol. 9, no. 1, pp. 1926, 2019.

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[1]http://bigwww.epfl.ch/algorithms/globalbioim/