

DeconvTest: an in silico microscopy framework to evaluate the accuracy of deconvolution

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DeconvTest: in silico microscopy framework to evaluate the accuracy of deconvolution

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1. Introduction

- python-based simulation framework
- parallel computation
- compares performance of different deconvolution algorithms

2. Methods

Step 1: in silico microscopy

- cells of different size and shape
- Point spread functions (PSF) of different width (σ) and aspect ratio (ε)
- simulation parameters specified via a settings file
- downsampling to different voxel sizes
- caution and/or Poisson noise of different SNR

Step 2: Deconvolution

ImageJ / Fiji deconvolution plugins run from python in a parallel manner:

- DeconvolutionLab2 [1]
- Regularized Inverse Filter (RIF)
- DeconvolutionLab2 [1]
- Richardson-Lucy Total Variance (RLTV)
- Iterative Deconvolve 3D (DAMAS3) [2]

Step 3: Validation

Jaccard index: $J = \frac{A \cap B}{A \cup B}$

Sensitivity: $S = \frac{A \cap B}{A}$

Precision: $P = \frac{A \cap B}{B}$

Overlap error: $E_o = \frac{A \cup B - A \cap B}{A}$

Overdetection error: $O_d = \frac{A \cup B - A}{A}$

Underdetection error: $U_d = \frac{A \cup B - B}{A}$

3. Results

Influence of different parameters of in silico microscopy

Richardson-Lucy Total Variance (RLTV)

Comparison of deconvolution approaches and their settings

Regularized Inverse Filter (RIF)

Richardson-Lucy Total Variance (RLTV)

DAMAS3

Algorithm comparison

- Convolution: $f, g, x \rightarrow h$
- Inverse Filter: $F = \frac{1}{G}$
- Factor transform of f, g, h
- Regularized Inverse Filter (RIF): $F = W \cdot \frac{1}{G}$
- $W = \frac{1}{1 + \lambda |G|}$
- $\lambda = \text{inverse of } G$

Choosing optimal deconvolution settings

SNR = 2, SNR = 1, No noise

PSF = 1x1, 2x2, 3x3

4. Outlook

- Open source package on GitHub
- Include other types of input cells and PSFs
- Include further deconvolution algorithms

References

[1] Tang, S.H. et al. "DeconvolutionLab2: An open source software for deconvolution microscopy." *PLoS One* 10(12): e0145418 (2015).

[2] Schönberg, S. "A comparison of different fast algorithms for deconvolution." *Biomedical Optics Express* 5(12): 4500-4510 (2014).

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