Laboratoire de Spectrochimie Infrarouge et Raman

Spatial, temporal and spatio-temporal preprocessing for improved super-resolution fluorescence imaging

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LASIR

http://lasir.univ-lille1.fr

- Super-sesolutionaljuogescence imaging -



- Super-resolution fluorescence imaging -







- Signals in super-resolution fluorescence microscopy data -

Spatial mode

Temporal mode



e.g. Autofluorescence

Bleaching



1000

- Signals in super-resolution fluorescence microscopy data -



Single-molecule signals:

Point-like emittersBlinking

(spatial mode) (temporal mode)

High-frequency information in space and time

Other signals:

- Spatial structures
- Bleaching

(spatial mode) (temporal mode)

"Smooth" structures in space and time



- Temporal preprocessing -

Whittaker smoothing

D: matrix of differences

 $\min \|\mathbf{y} - \boldsymbol{\mu}\|^2 + \lambda \|\mathbf{D}\boldsymbol{\mu}\|^2 \longrightarrow \boldsymbol{\mu} = (\mathbf{I} + \lambda \mathbf{D}'\mathbf{D})^{-1}\mathbf{y} \qquad \mathbf{D}_{3,7 \text{ splines}} = \begin{pmatrix} -1 & 3 & -3 & 1 & 0 & 0 & 0 \\ 0 & -1 & 3 & -3 & 1 & 0 & 0 \\ 0 & 0 & -1 & 3 & -3 & 1 & 0 \\ 0 & 0 & 0 & -1 & 3 & -3 & 1 \end{pmatrix}$



- Temporal preprocessing -

Raw data



Preprocessed data





- Temporal preprocessing -



Hela cells labeled with Dreiklang proteins (EPFL, Switzerland)

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Whittaker smoothing

$$min \|\mathbf{y} - \boldsymbol{\mu}\|^2 + \lambda \|\mathbf{D}\boldsymbol{\mu}\|^2 \longrightarrow \boldsymbol{\mu} = (\mathbf{I} + \lambda \mathbf{D}'\mathbf{D})^{-1}\mathbf{y}$$

Weighted least squares with P-splines





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Chimiométrie XIX, 30th January, 2018

W: asymmetric weights

 $w_i = 1 - p$ if $y_i \le \mu_i$

if $y_i \ge \mu_i$

 $W_i = p$

(Whittaker; 1923) (Eilers; 2003)

(de Rooi et al.; 2013)





Raw data







SPIDER

Super-resolved image



Hela cells labeled with DakaP Dronpa (KU Leuven, Belgium)





SPIDERawndeaw data



SPIDER eprocepsedestated data





- Spatio-temporal preprocessing -

Spatial preprocessing:





Time (frames)

Spatio-temporal preprocessing:

Smooth surface





Bg(x,y,k) = **M(x,y)** * a(k)



- Conclusions -

- Preprocessing super-resolution fluorescence data depends on assumptions
 - **Sparsity** for spatial approaches
 - Independent blinking for stochastic approaches



Thank you for your attention



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