FACULTY
OF INFORMATICS
Masaryk University

3D super-resolution with machine learning

PV162 project

Michal Jankovič, supervisor: doc. RNDr. David Svoboda, Ph.D.

Structure

- Problem introduction
- Method description
- Evaluation

Problem introduction

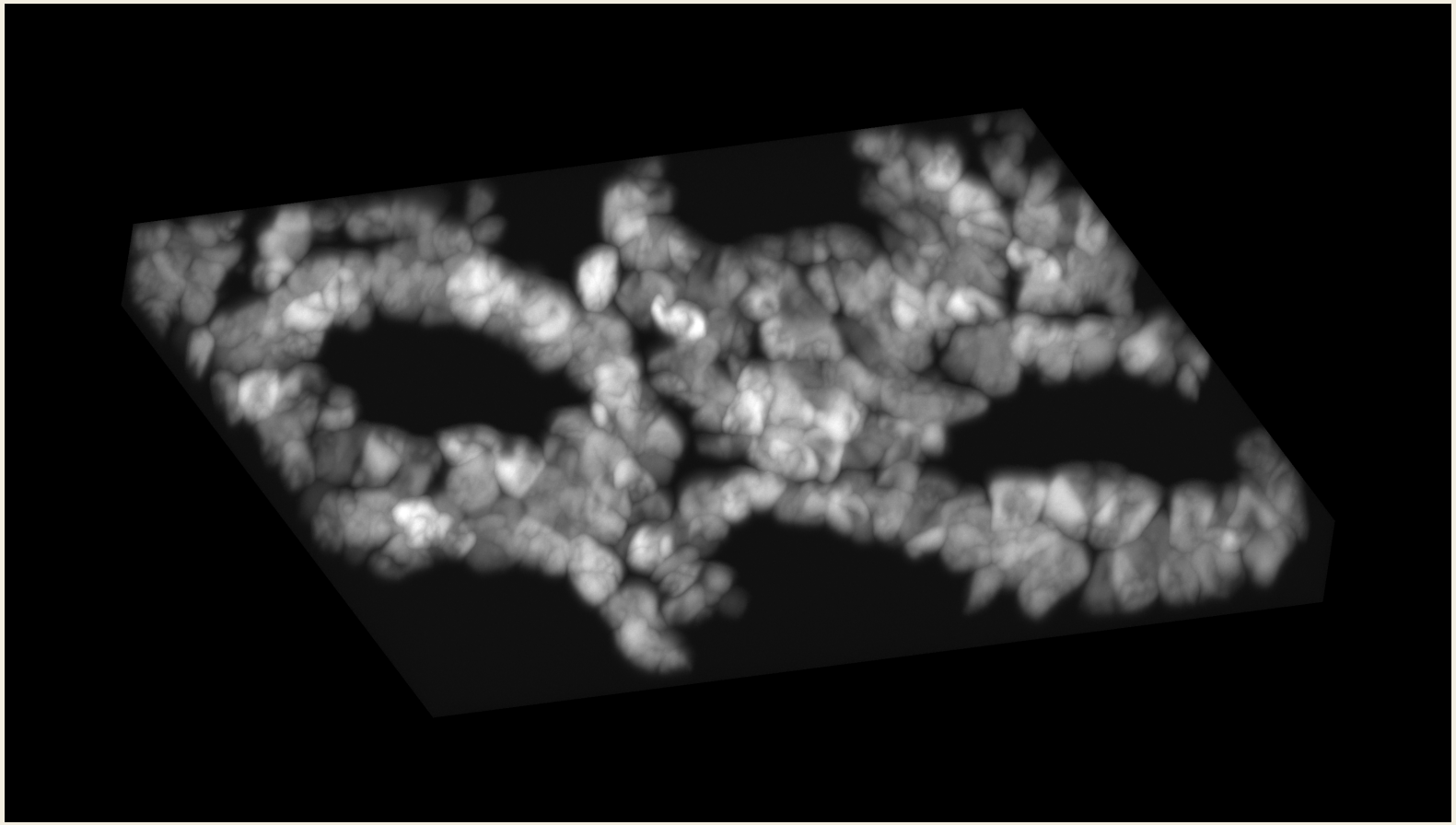
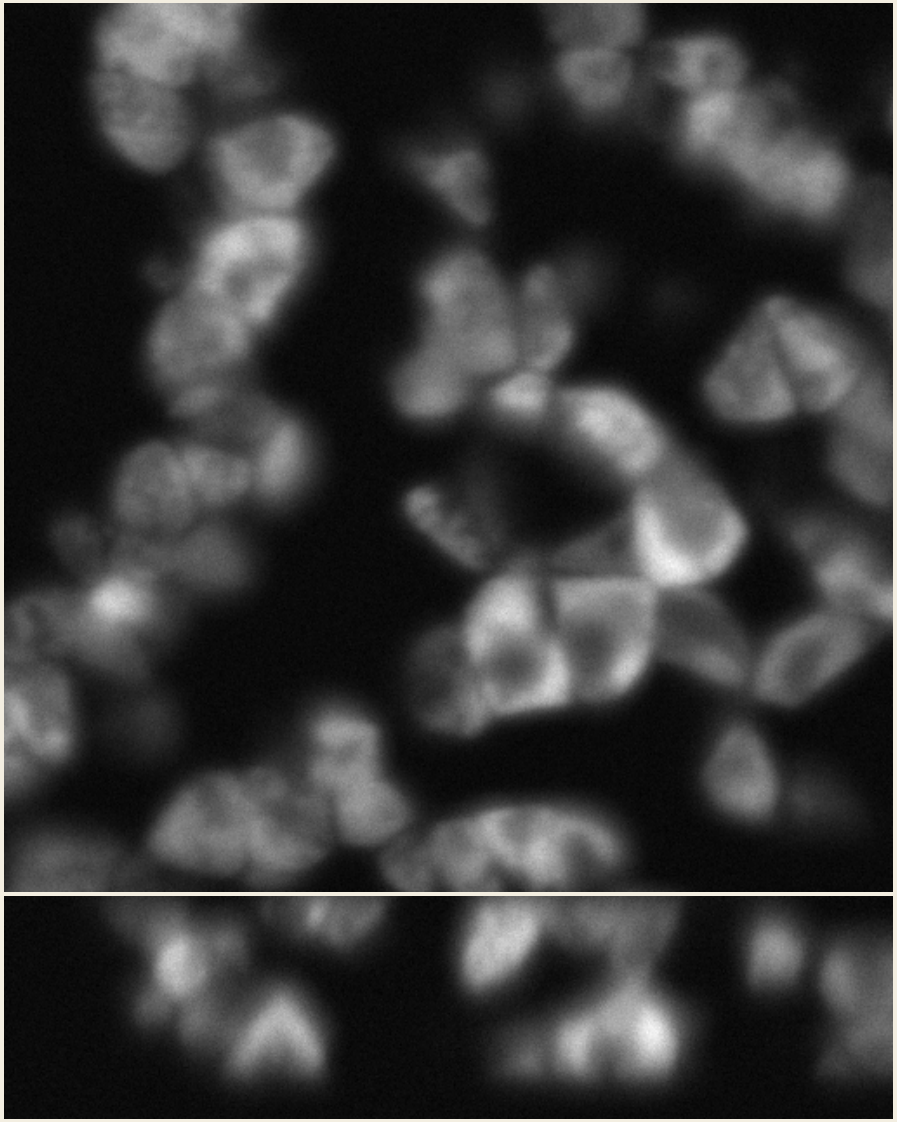


Figure: Synthetic 3D image of human colon tissue[1]

[1] https://cbia.fi.muni.cz/datasets/

Data (XY / XZ slice)



Anisotropic resolution

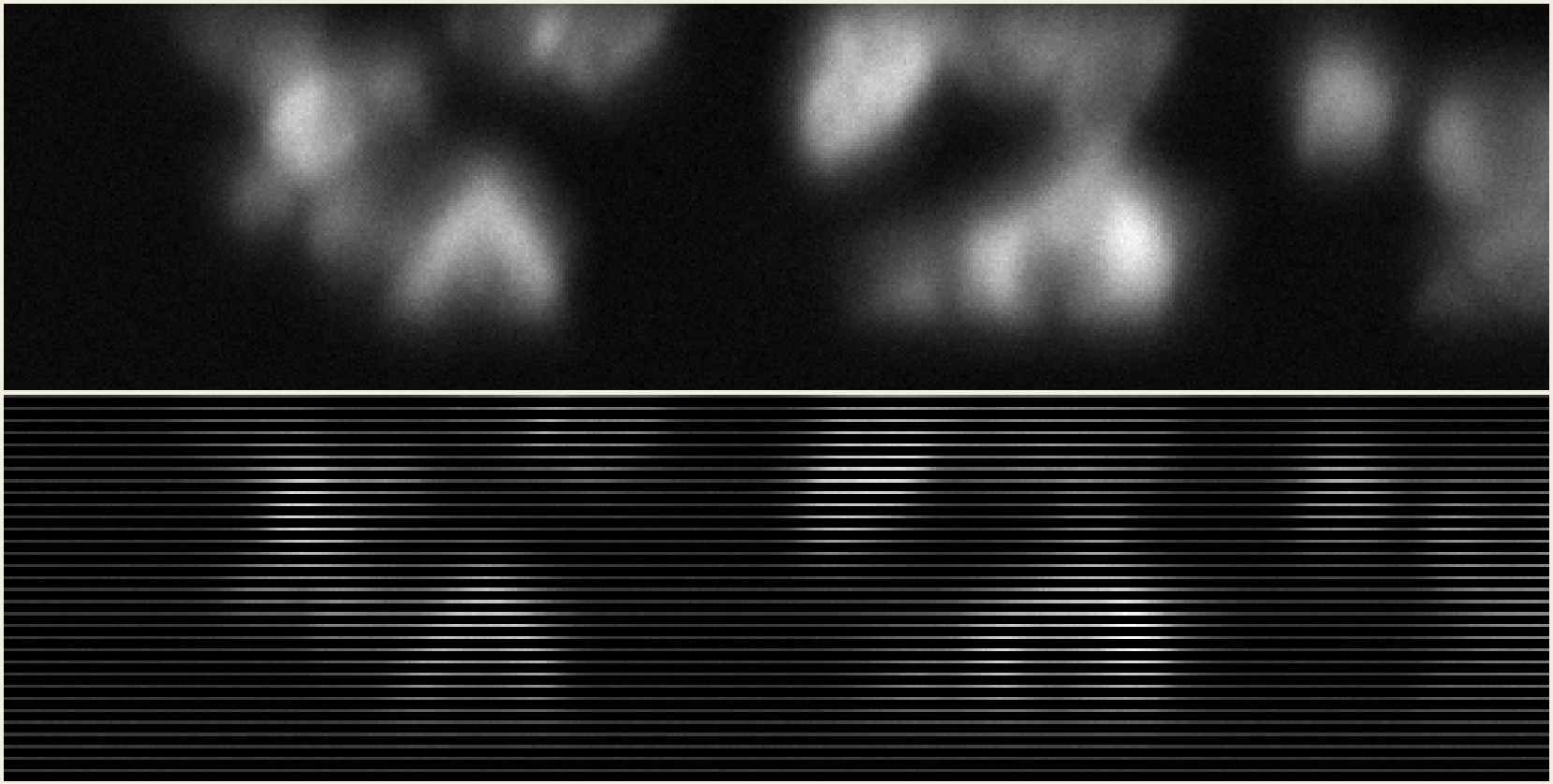


Figure: Above - original HR XZ slice. Below - XZ slice downsampled 4x; missing rows are shown blacked out

B-spline interpolation

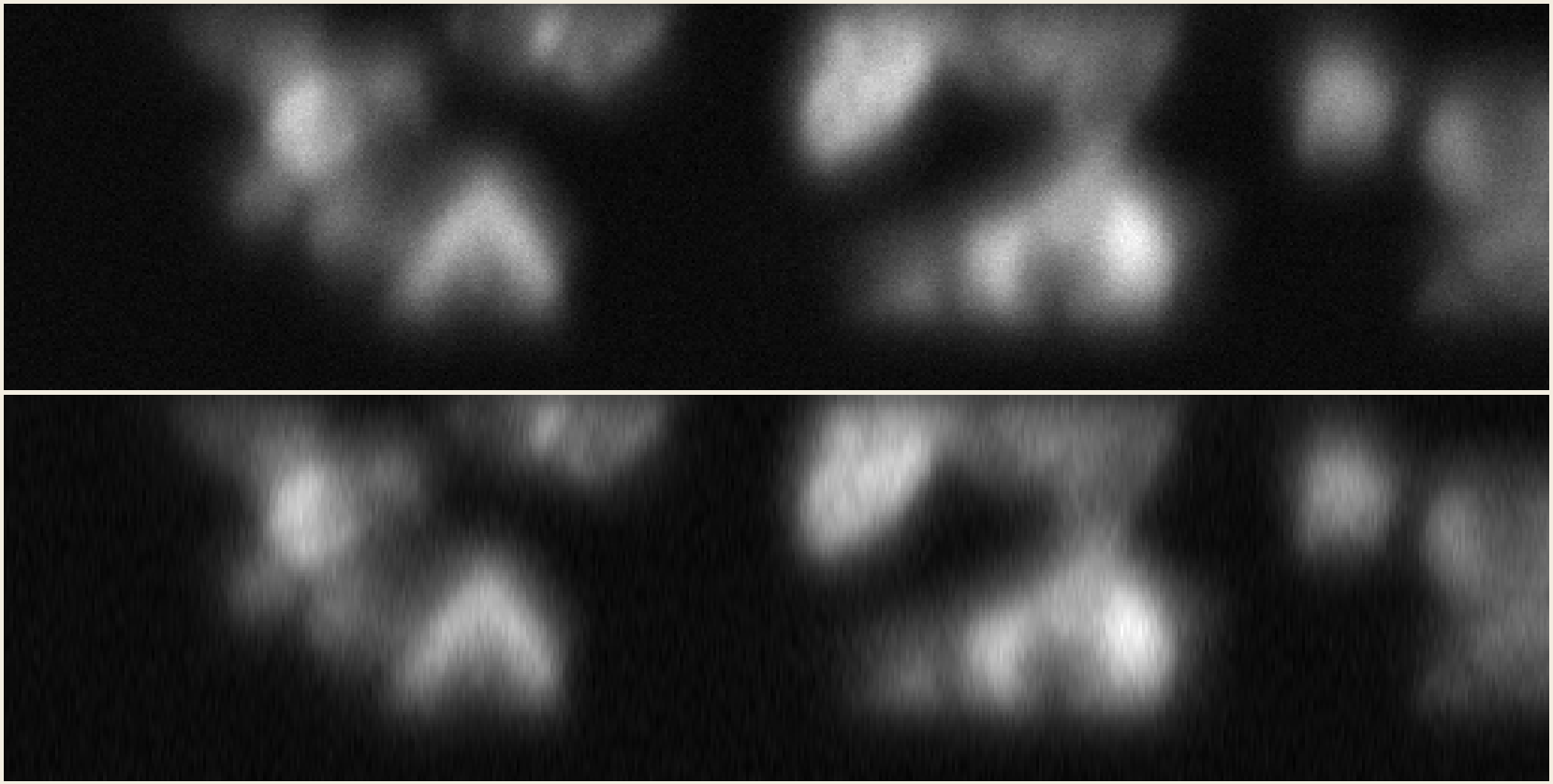


Figure: Above - original HR XZ slice. Below - LR XZ-slice restored with B-spline interpolation

B-spline interpolation

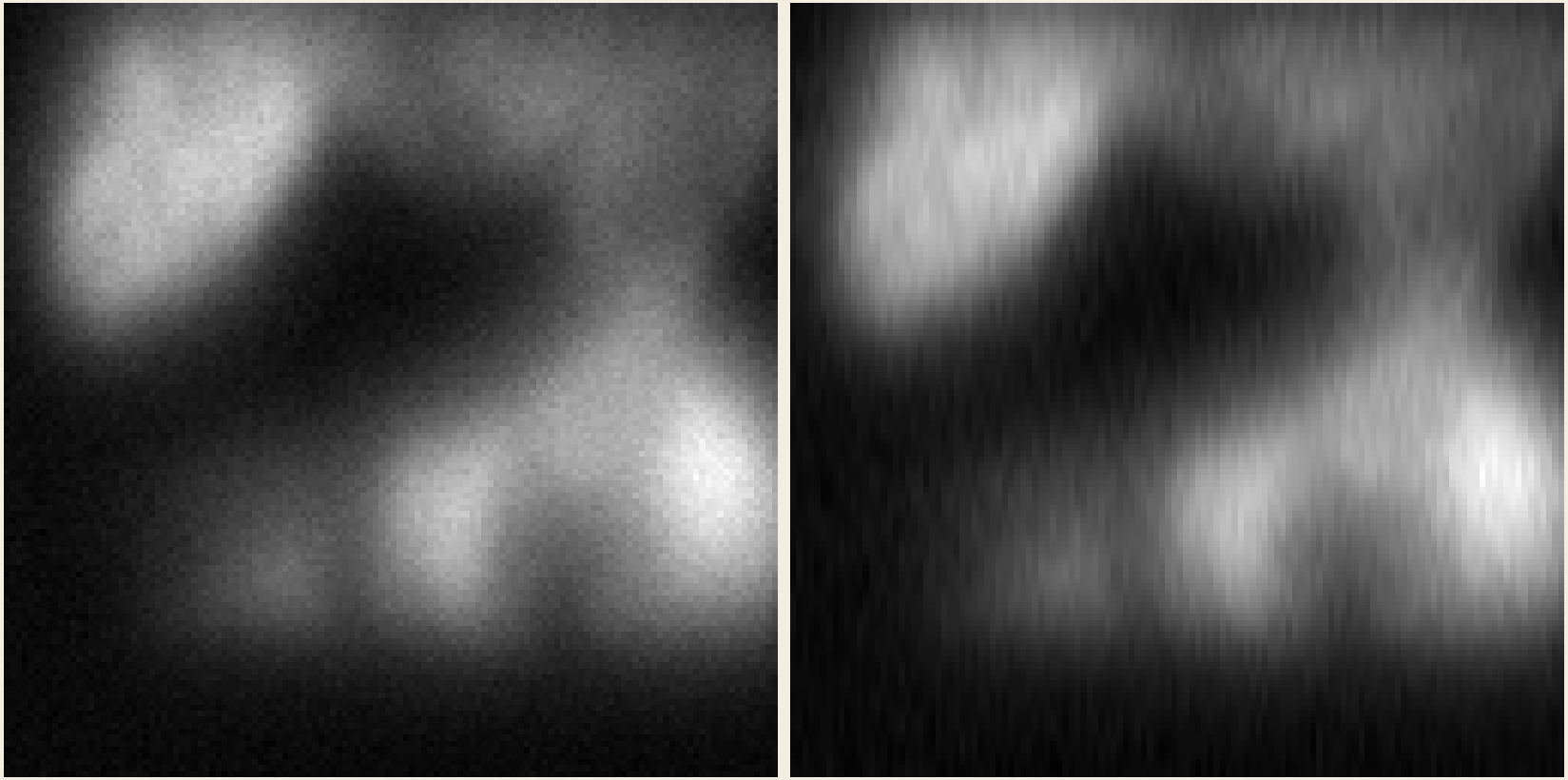
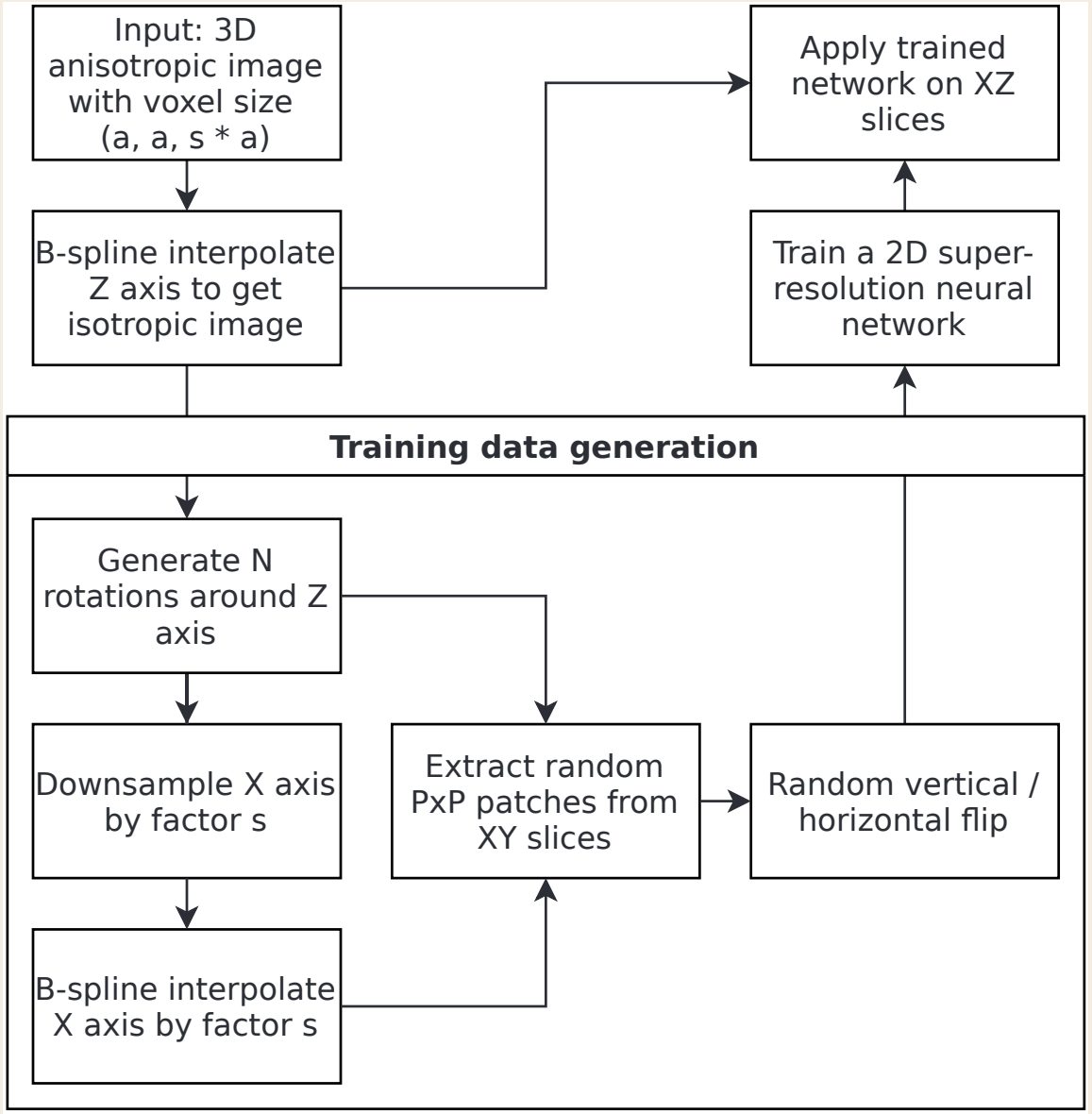


Figure: Left - original HR XZ slice. Right - LR XZ-slice restored with B-spline interpolation

The SMORE algorithm



EDSR

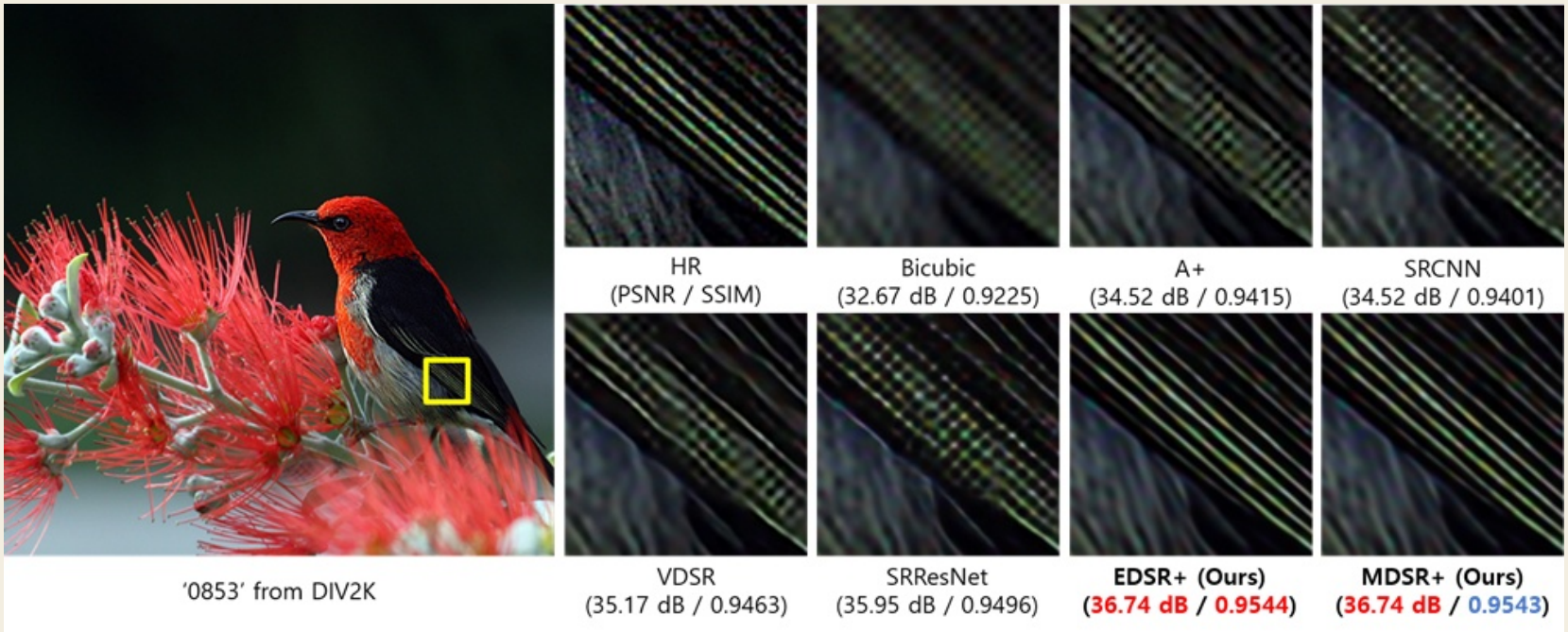


Figure: EDSR super-resolution neural net[2]

[2] https://github.com/sanghyun-son/EDSR-PyTorch

Training

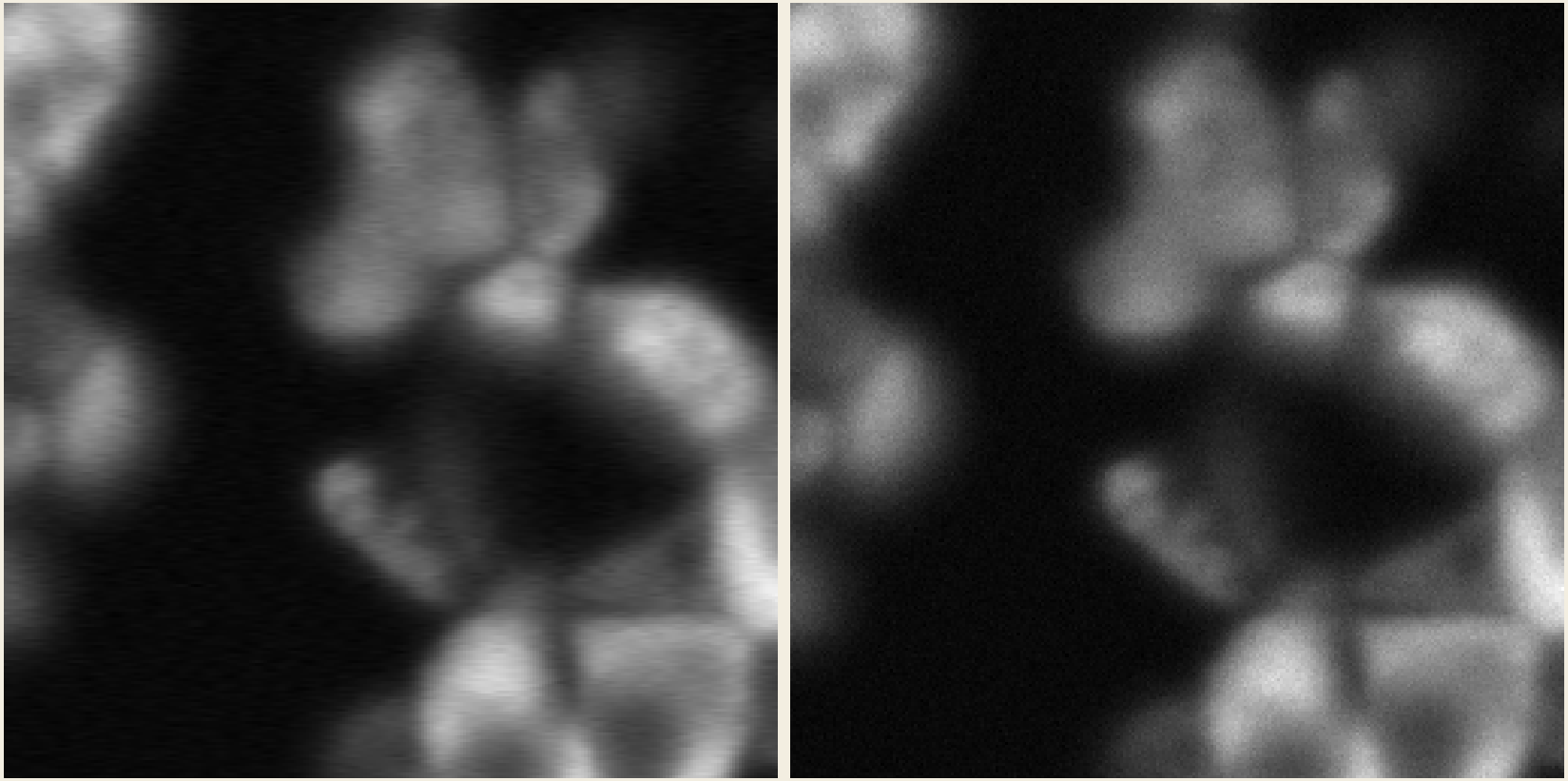


Figure: Right - XY slice. Left - XY slice downsampled and B-spline interpolated on the X axis

Training

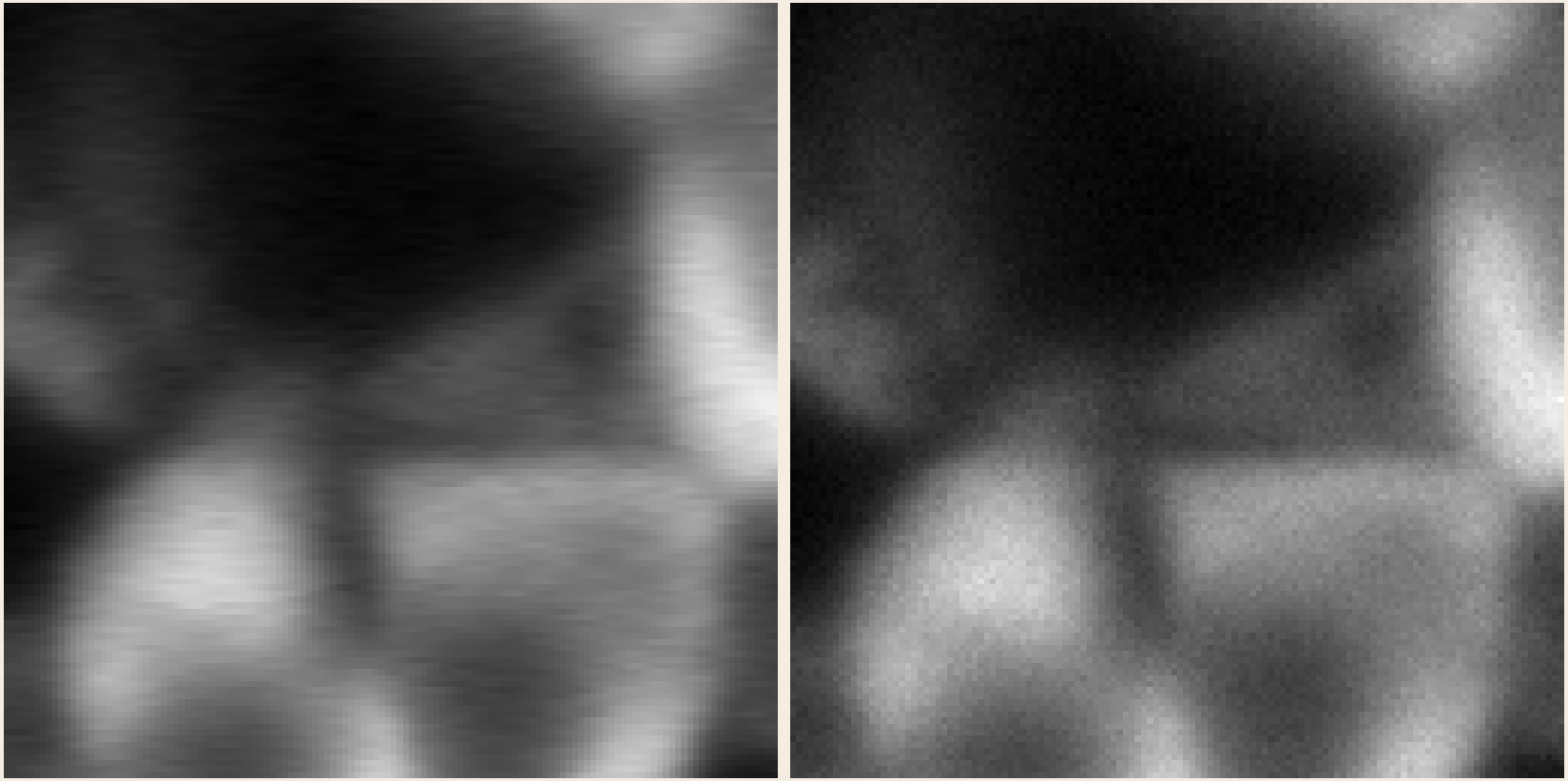


Figure: Right - XY slice. Left - XY slice downsampled and B-spline interpolated on the X axis

Inference

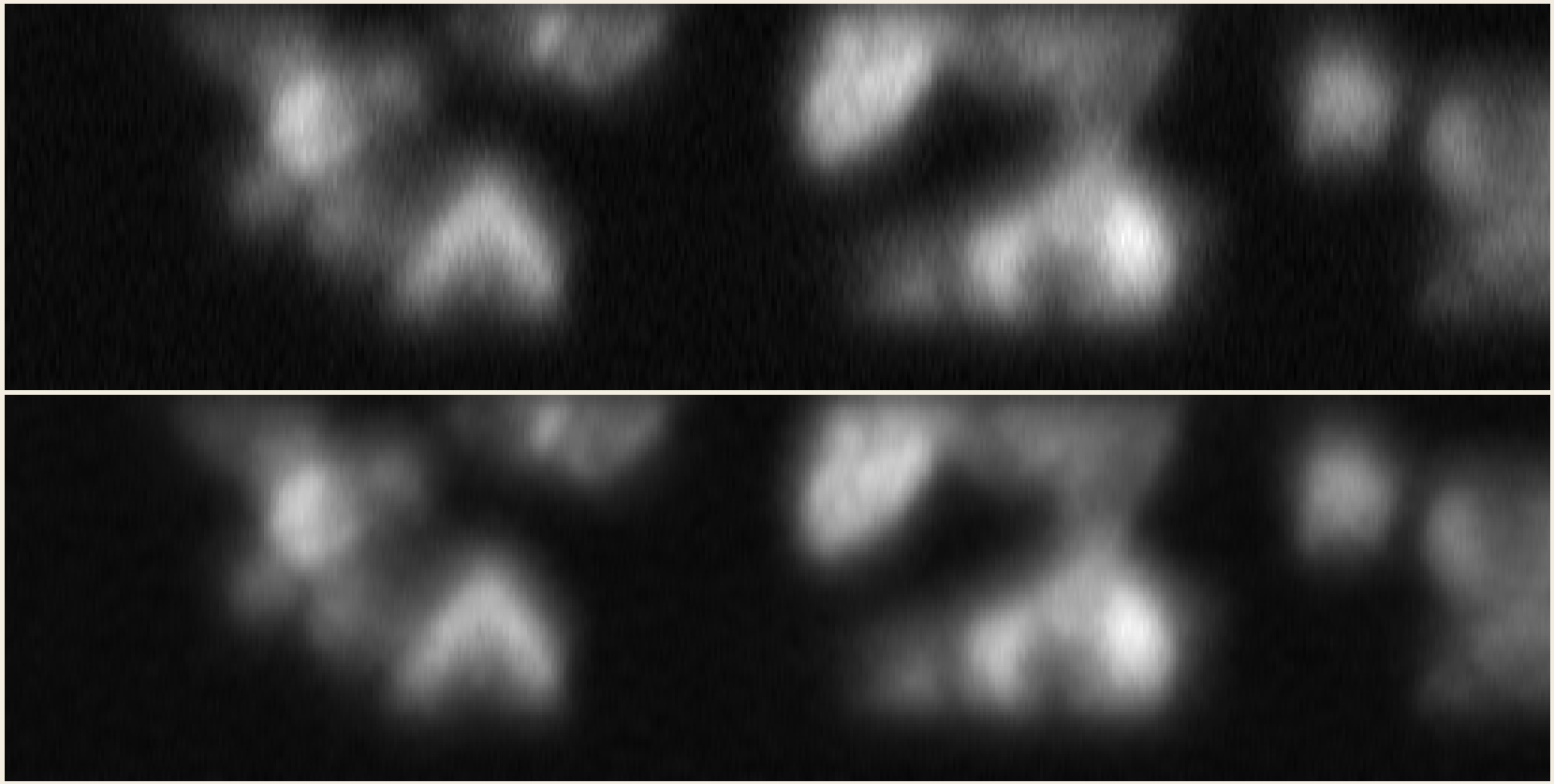


Figure: Above - XZ slice with B-spline interpolation. Below - XZ slice with SMORE interpolation

Inference

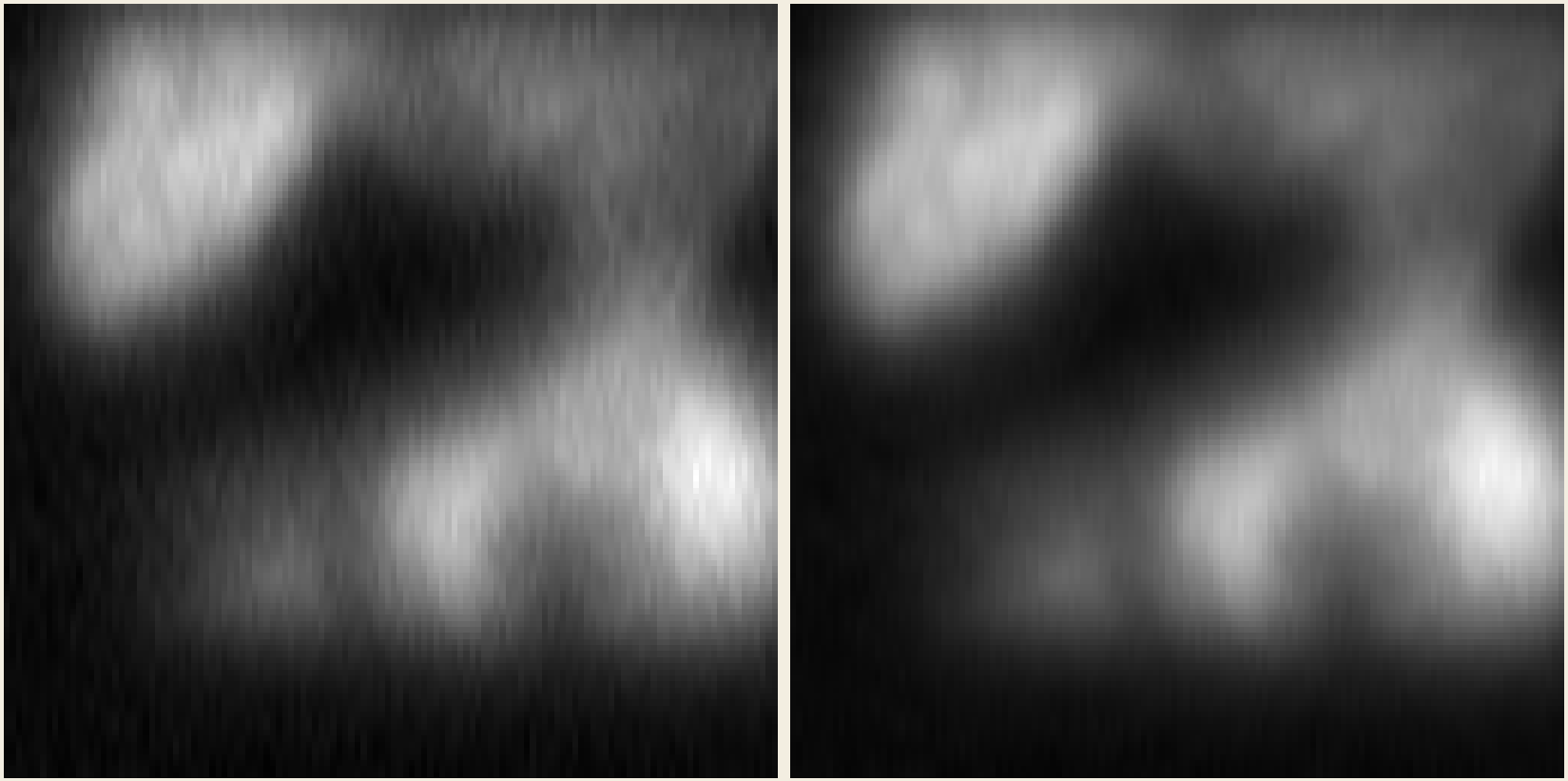


Figure: Left - XZ slice with B-spline interpolation. Right - XZ slice with SMORE interpolation

Evaluation

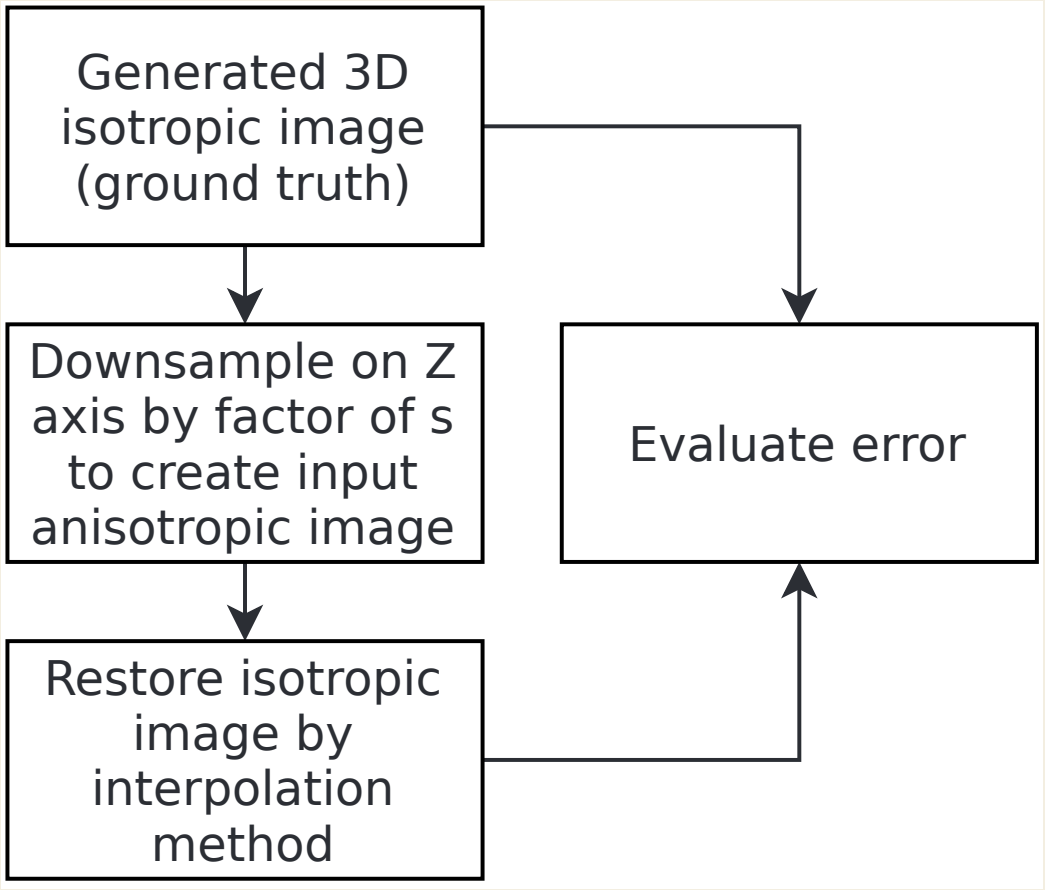


Figure: Evaluation schema

Evaluation

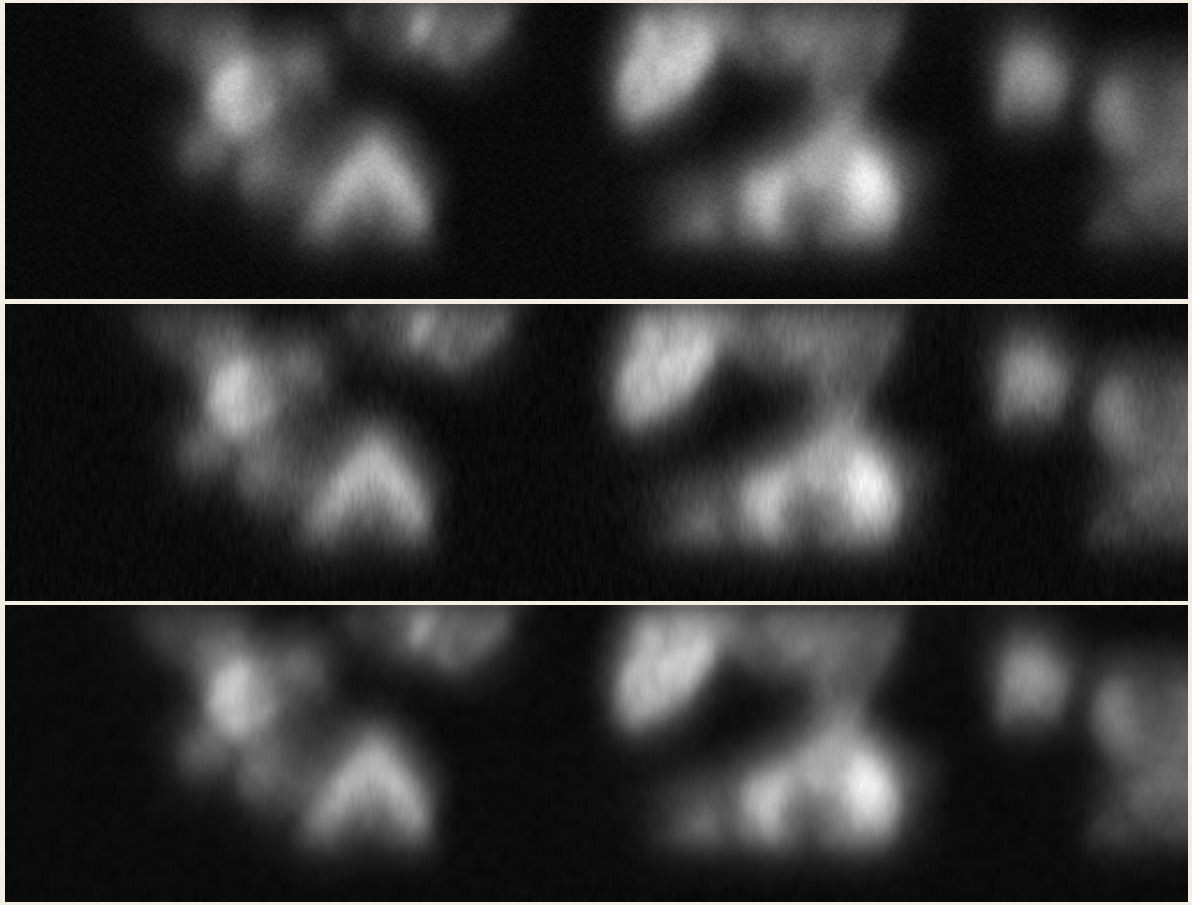


Figure: Above - ground truth XZ slice. Middle - B-spline interpolation. Below - SMORE interpolation

Evaluation

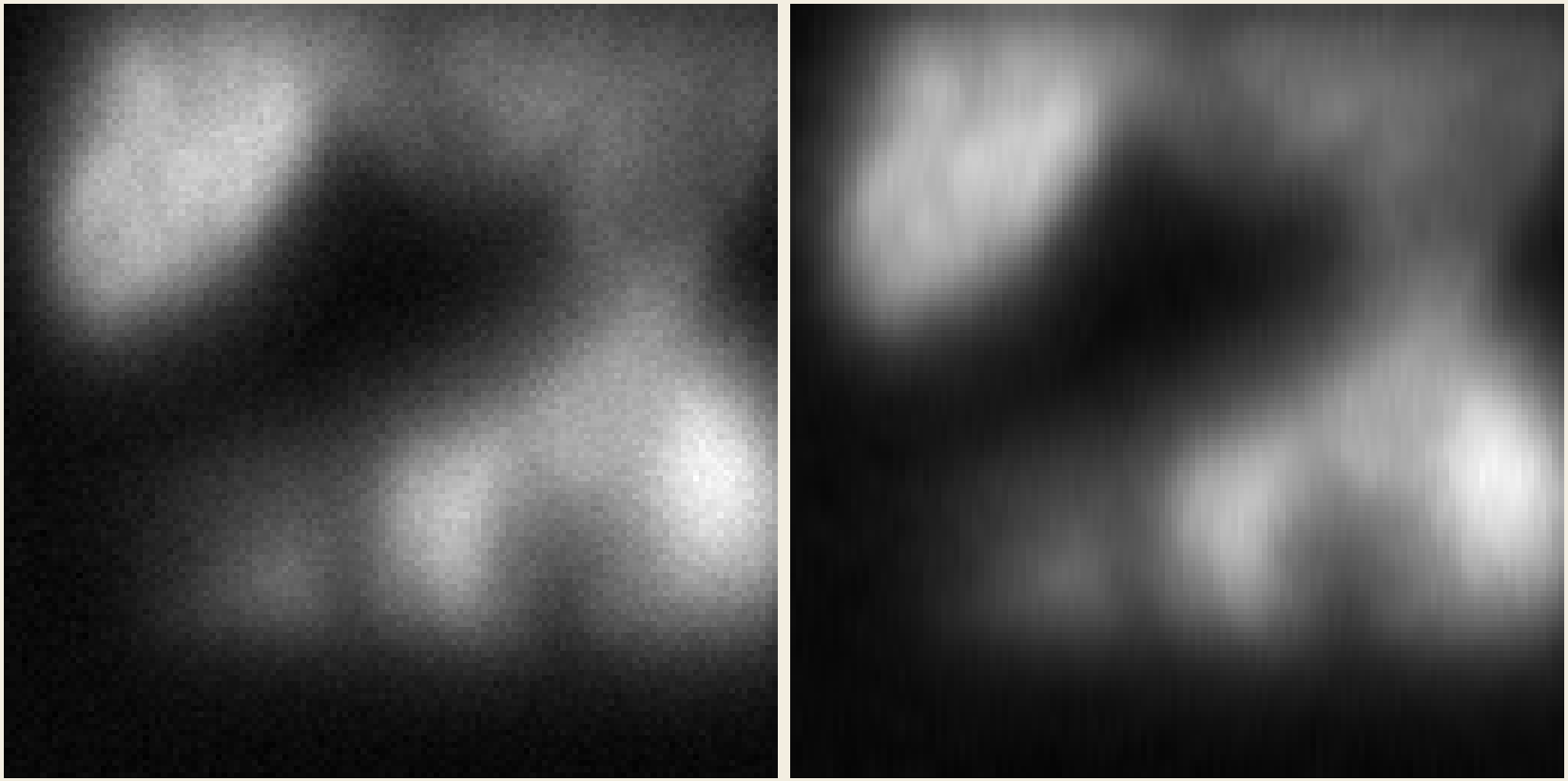


Figure: Left - ground truth XZ slice. Right - SMORE interpolation

Evaluation - mean square error

	MSE
B-spline	29.722795
SMORE	23.115702

Table: Mean square error of interpolation method applied to LR image, vs the HR ground truth

Evaluation - absolute difference

Figure: Above - absolute difference of GT and B-spline interpolation. Below - absolute difference of GT and SMORE interpolation

Evaluation - absolute difference

Figure: Left - absolute difference of GT and B-spline interpolation. Right - absolute difference of GT and SMORE interpolation

Evaluation - absolute difference histogram

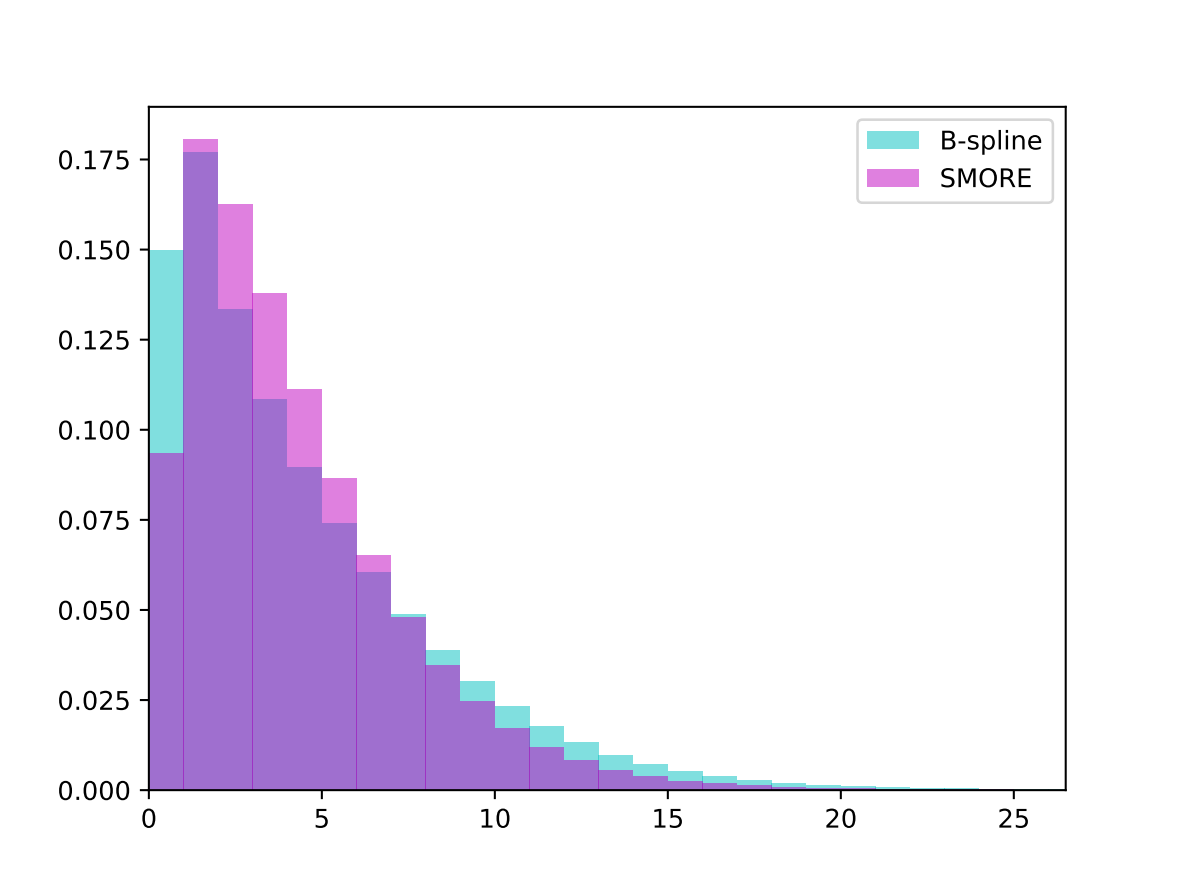


Figure: Histogram of absolute difference to ground truth for B-spline and SMORE interpolation

Sources

- Colon tissue dataset - Svoboda D., Homola O., Stejskal S. Generation of 3D Digital Phantoms of Colon Tissue, In International Conference on Image Analysis and Recognition - ICIAR 2011, Part II, LNCS 6754, Berlin, Heidelberg: Springer-Verlag, pp 31-39, June 2011, ISBN 978-3-642-21595-7
- SMORE algorithm - Zhao, Can, et al. "SMORE: A self-supervised anti-aliasing and super-resolution algorithm for MRI using deep learning." IEEE transactions on medical imaging 40.3 (2020): 805-817.
- EDSR network - Bee Lim, Sanghyun Son, Heewon Kim, Seungjun Nah, and Kyoung Mu Lee, "Enhanced Deep Residual Networks for Single Image Super-Resolution," 2nd NTIRE: New Trends in Image Restoration and Enhancement workshop and challenge on image super-resolution in conjunction with CVPR 2017