

# Data Science Going further

Stéphane Marchand-Maillet

Department of Computer Science



UNIVERSITÉ  
DE GENÈVE

FACULTÉ DES SCIENCES



Master en Sciences Informatiques - Autumn semester

# Beyond these models

## Important topics

- ★ Non-linear dimension reduction, manifold learning
- UMAP, t-SNE, LLE, IsoMap, Laplacian Eigenmaps, Diffusion maps, principal curves, ...
- ★ Social Network Analysis
- ★ Machine Learning for data modeling
- VAE, GAN, flows, Transformers, ...

# References I

- [1] Albert-László Barabási. *Network Science*. Cambridge University Press, 2016. (available online).
- [2] Robert Beinert, Arian Bërdëllima, Manuel Gräf, and Gabriele Steidl. On the dynamical system of principal curves in  $\mathbb{R}^d$ . *CoRR*, abs/2108.00227, 2021.
- [3] Mikhail Belkin and Partha Niyogi. Laplacian eigenmaps for dimensionality reduction and data representation. *Neural Computation*, 15(6):1373–1396, 2003.
- [4] Mikhail Belkin and Partha Niyogi. Convergence of laplacian eigenmaps. In B. Schölkopf, J. Platt, and T. Hoffman, editors, *Advances in Neural Information Processing Systems*, volume 19. MIT Press, 2007.
- [5] Ingwer Borg and Patrick J. F. Groenen. *Modern Multidimensional Scaling: Theory and Applications*. Springer, second edition, 2005.
- [6] Ronald R. Coifman and Stéphane Lafon. Diffusion maps. *Applied and Computational Harmonic Analysis*, 21(1):5–30, 2006. Special Issue: Diffusion Maps and Wavelets.
- [7] I. Goodfellow, Y. Bengio, and A. Courville. *Deep Learning*. Adaptive computation and machine learning. MIT Press, 2016.
- [8] Trevor Hastie and Werner Stuetzle. Principal curves. *Journal of the American Statistical Association*, 84(406):502–516, 1989.

## References II

- [9] Leland McInnes, John Healy, and James Melville. UMAP: Uniform manifold approximation and projection for dimension reduction. *CoRR*, abs/1802.033426, 2018.
- [10] Sam T. Roweis and Lawrence K. Saul. Nonlinear dimensionality reduction by locally linear embedding. *Science*, 290(5500):2323–2326, 2000.
- [11] Tim Sainburg, Leland McInnes, and Timothy Q. Gentner. Parametric UMAP: learning embeddings with deep neural networks for representation and semi-supervised learning. *CoRR*, abs/2009.12981, 2020.
- [12] Ke Sun, Jun Wang, Alexandros Kalousis, and Stephane Marchand-Maillet. Space-time local embeddings. In *Proceedings of Advances in Neural Information Processing Systems 28 (NIPS 2015), Montreal, Canada, December 2015*, 2015.
- [13] Joshua B. Tenenbaum, Vin de Silva, and John C. Langford. A global geometric framework for nonlinear dimensionality reduction. *Science*, 290(5500):2319–2323, 2000.
- [14] Laurens van der Maaten and Geoffrey Hinton. Visualizing data using t-SNE. *Journal of Machine Learning Research*, 9:2579–2605, 2008.

# License



The text of this document and its illustrations are published under the  
Creative Commons BY-NC-SA 4.0 International License.