

Systems Biology of Immunology Seminar

This is a resource for students in the Systems Biology of Immunology Seminar in our group. Here we have listed a number of papers that are suggestions for your presentation.

- [Paper suggestions: image analysis](#)
- [Paper suggestions: modeling](#)

Paper suggestions: image analysis

Here you can find a list of suggested papers that involve image analysis. You can also find suitable papers on your own (ask Thilo Figge).

If you are unhappy with a paper you can always ask Thilo Figge to look for a replacement topic.

You will have to write a one-page summary of the paper and send it to Thilo Figge a few days before your presentation.

Deep Learning in Microscopy

Citation	Link	Keywords
Stringer, C., Wang, T., Michaelos, M. <i>et al.</i> Cellpose: a generalist algorithm for cellular segmentation. <i>Nat Methods</i> 18 , 100–106 (2021).	https://www.nature.com/articles/s41592-020-01018-x	Segmentation, Tools, Deep Learning
Archit, A., Freckmann, L., Nair, S. <i>et al.</i> Segment Anything for Microscopy. <i>Nat Methods</i> 22 , 579–591 (2025).	https://www.nature.com/articles/s41592-024-02580-4	Segmentation, Tools, Deep Learning
Dosovitskiy, Alexey. "An image is worth 16x16 words: Transformers for image recognition at scale." <i>arXiv preprint arXiv:2010.11929</i> (2020).	https://arxiv.org/pdf/2010.11929/1000	Deep Learning
Ronneberger, O., Fischer, P. and Brox, T., 2015, October. U-net: Convolutional networks for biomedical image segmentation. In <i>International Conference on Medical image computing and computer-assisted intervention</i> (pp. 234-241). Cham: Springer international publishing.	https://arxiv.org/pdf/1505.04597	U-Net, Deep Learning, Biomedical image segmentation

Citation	Link	Keywords
<p>Oktay, O., Schlemper, J., Folgoc, L.L., Lee, M., Heinrich, M., Misawa, K., Mori, K., McDonagh, S., Hammerla, N.Y., Kainz, B. and Glocker, B., 2018. Attention u-net: Learning where to look for the pancreas. <i>arXiv preprint arXiv:1804.03999</i>.</p>	<p>https://arxiv.org/pdf/1804.03999</p>	<p>Attention U-Net</p>
<p>Jiang, J., Chen, X., Tian, G. and Liu, Y., 2023, April. ViG-UNet: vision graph neural networks for medical image segmentation. In <i>2023 IEEE 20th International Symposium on Biomedical Imaging (ISBI)</i> (pp. 1-5). IEEE.</p>	<p>https://arxiv.org/pdf/2306.04905</p>	<p>Graph neural networks, U-Net</p>
<p>Ardila, D., Kiraly, A.P., Bharadwaj, S., Choi, B., Reicher, J.J., Peng, L., Tse, D., Etemadi, M., Ye, W., Corrado, G. and Naidich, D.P., 2019. End-to-end lung cancer screening with three-dimensional deep learning on low-dose chest computed tomography. <i>Nature medicine</i>, 25(6), pp.954-961.</p>	<p>https://mlgdansk.pl/wp-content/uploads/2019/06/MLGdansk63_27.05.19_End-to-end_lung_cancer_screening_with_three-dimens.pdf</p>	<p>Deep Learning (3D), lung cancer detection, computed tomography</p>
<p>McKinney, S.M., Sieniek, M., Godbole, V., Godwin, J., Antropova, N., Ashrafian, H., Back, T., Chesus, M., Corrado, G.S., Darzi, A. and Etemadi, M., 2020. International evaluation of an AI system for breast cancer screening. <i>Nature</i>, 577(7788), pp.89-94.</p>	<p>https://www.nature.com/articles/s41586-019-1799-6</p>	<p>AI system for breast cancer screening</p>
<p>Chen, T., Kornblith, S., Swersky, K., Norouzi, M. and Hinton, G.E., 2020. Big self-supervised models are strong semi-supervised learners. <i>Advances in neural information processing systems</i>, 33, pp.22243-22255.</p>	<p>https://proceedings.neurips.cc/paper_files/paper/2020/file/fcbc95ccdd551da181207c0c1400c655-Paper.pdf</p>	<p>Big self-supervised models</p>
<p>Azizi, S., Mustafa, B., Ryan, F., Beaver, Z., Freyberg, J., Deaton, J., Loh, A., Karthikesalingam, A., Kornblith, S., Chen, T. and Natarajan, V., 2021. Big self-supervised models advance medical image classification. In <i>Proceedings of the IEEE/CVF international conference on computer vision</i> (pp. 3478-3488).</p>	<p>https://openaccess.thecvf.com/content/ICCV2021/papers/Azizi_Big_Self-Supervised_Models_Advance_Medical_Image_Classification_ICCV_2021_paper.pdf</p>	<p>Big self-supervised models</p>
<p>Zhao, L., Jia, C., Ma, J., Shao, Y., Liu, Z. and Yuan, H., 2023. Medical image segmentation based on self-supervised hybrid fusion network. <i>Frontiers in Oncology</i>, 13, p.1109786.</p>	<p>https://pmc.ncbi.nlm.nih.gov/articles/PMC10141651/pdf/fonc-13-1109786.pdf</p>	<p>Self-supervised medical image segmentation</p>

Imaging and image analysis in Biological Systems

Citation	Link	Keywords
van Ooijen, Hanna et al. A thermoplastic chip for 2D and 3D correlative assays combining screening and high-resolution imaging of immune cell responses. <i>Cell Reports Methods</i> , Volume 5, Issue 1, 100965	https://www.cell.com/cell-reports-methods/fulltext/S2667-2375(25)00001-3	imaging, microwell, correlative imaging, high-resolution, tumor microenvironment, natural killer cell
Wetzker, C. et al. (2025). A fluorescence lifetime separation approach for FLIM live-cell imaging. <i>Journal of Microscopy</i> , 1-16.	https://onlinelibrary.wiley.com/doi/full/10.1111/jmi.70036	FLIM, live cell imaging
Imaging of cellular dynamics from a whole organism to subcellular scale with self-driving, multiscale microscopy S Daetwyler, H Mazloom-Farsibaf, FY Zhou, D Segal, E Sapoznik, B Chen, ... <i>Nature methods</i> 22 (3), 569-578	https://pmc.ncbi.nlm.nih.gov/articles/PMC12039951/	multi-scale microscopy, zebrafish
Bray, Mark-Anthony, et al. "Cell Painting, a high-content image-based assay for morphological profiling using multiplexed fluorescent dyes." <i>Nature protocols</i> 11.9 (2016): 1757-1774.	https://www.nature.com/articles/nprot.2016.105	segmentation, data analysis, image based biology
Gardey E, et al. (2024) Selective uptake into inflamed human intestinal tissue and immune cell targeting by wormlike polymer micelles. <i>Small</i> 20(21), 2470162.	https://www.nature.com/articles/s41592-022-01744-4	inflammatory bowel disease (IBD), nanoparticles, shape control

Paper suggestions: modeling

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Citation	Link	Keywords
Zitzmann C and Kaderali L (2018) Mathematical Analysis of Viral Replication Dynamics and Antiviral Treatment Strategies: From Basic Models to Age-Based Multi-Scale Modeling. <i>Front. Microbiol.</i> 9:1546. doi: 10.3389/fmicb.2018.01546	https://www.frontiersin.org/journals/microbiology/articles/10.3389/fmicb.2018.01546/full	mathematical modeling, viral kinetics, viral replication, human immunodeficiency virus, Hepatitis C virus, Influenza A virus, antiviral therapy, immune response
Almansour S, Dunster JL, Crofts JJ, Nelson MR (2024) Modelling the continuum of macrophage phenotypes and their role in inflammation, <i>Mathematical Biosciences</i> , Volume 377, 109289, ISSN 0025-5564, https://doi.org/10.1016/j.mbs.2024.109289 .	https://www.sciencedirect.com/science/article/pii/S0025556424001494	mathematical modeling, macrophages and inflammation, Bifurcation analysis, PDE
Chathoth K, Fostier L, Martin B, Baysse C, Mahé F (2022) A Multi-Skilled Mathematical Model of Bacterial Attachment in Initiation of Biofilms. <i>Microorganisms</i> ,10(4):686. https://doi.org/10.3390/microorganisms10040686	https://www.mdpi.com/2076-2607/10/4/686	biofilm, bacterial attachment, mathematical model, stochastic, 2D and 3D
Schmid N, Fernandes Del Pozo D, Waegeman W, Hasenauer J (2025) Assessment of uncertainty quantification in universal differential equations. <i>Philos Trans A Math Phys Eng Sci</i> ; 383(2293):20240444. doi:10.1098/rsta.2024.0444	https://pubmed.ncbi.nlm.nih.gov/40172556/	uncertainty quantification, universal differential equations, scientific machine learning

Citation	Link	Keywords
<p>Maddu S, Cheeseman BL, Sbalzarini IF, Müller CL (2022) Stability selection enables robust learning of differential equations from limited noisy data. <i>Proc. A</i>; 478 (2262): 20210916. https://doi.org/10.1098/rspa.2021.0916</p>	<p>https://royalsocietypublishing.org/rspa/article/478/2262/20210916/54488/Stability-selection-enables-robust-learning-of</p>	<p>stability selection, sparse regression, PDE identification</p>
<p>Heinrich V, Simpson WD 3rd, Francis EA (2017) Analytical Prediction of the Spatiotemporal Distribution of Chemoattractants around Their Source: Theory and Application to Complement-Mediated Chemotaxis. <i>Front Immunol.</i>; 8:578. Published 2017 May 26. doi:10.3389/fimmu.2017.00578</p>	<p>https://pmc.ncbi.nlm.nih.gov/articles/PMC5445147/</p>	<p>chemotaxis, reaction–diffusion, mathematical model, single-cell, host–pathogen</p>
<p>Niemann J-H, Klus S, Schütte C (2021) Data-driven model reduction of agent-based systems using the Koopman generator. <i>PLoS ONE</i> 16(5): e0250970. https://doi.org/10.1371/journal.pone.0250970</p>	<p>https://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0250970</p>	<p>ABM, PDEs, data-driven reduction</p>
<p>Lorenzi T, Painter KJ (2025) Pattern formation within phenotype-structured chemotactic populations. <i>Proc. A</i> 1; 481 (2324): 20250483. https://doi.org/10.1098/rspa.2025.0483</p>	<p>https://royalsocietypublishing.org/doi/abs/10.1098/rspa.2025.0483</p>	<p>PDEs, pattern formation, chemotaxis, non-local advection-diffusion-reaction eqs.</p>
<p>Kejie C, Kai-Rong O (2021) Random Walks of a Cell With Correlated Speed and Persistence Influenced by the Extracellular Topography, <i>Frontiers in Physics</i>, Volume 9, 10.3389/fphy.2021.719293</p>	<p>https://www.frontiersin.org/journals/physics/articles/10.3389/fphy.2021.719293/full</p>	<p>Random walks, complex environments, PRWs, Cell migration</p>
<p>Ohno K, Kobayashi Y, Uesaka M <i>et al.</i> (2021) A computational model of the epidermis with the deformable dermis and its application to skin diseases. <i>Sci Rep</i> 11, 13234. https://doi.org/10.1038/s41598-021-92540-1</p>	<p>https://www.nature.com/articles/s41598-021-92540-1</p>	<p>ABM, skin modelling, skin disease, cellular layer</p>