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. *et al.* Cellpose: a generalist algorithm for cellular segmentation. *Nat Methods* **18**, 100–106 (2021).	https://www.nature.com/articles/s41592-020-01018-x	Segmentation, Tools, Deep Learning
Archit, A., Freckmann, L., Nair, S. *et al.* Segment Anything for Microscopy. *Nat Methods* **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." *arXiv preprint arXiv:2010.11929* (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 *International Conference on Medical image computing and computer-assisted intervention* (pp. 234-241). Cham: Springer international publishing.	https://arxiv.org/pdf/1505.04597	U-Net, Deep Learning, Biomedical image segmentation

Citation	Link	Keywords
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. *arXiv preprint arXiv:1804.03999*.	https://arxiv.org/pdf/1804.03999	Attention U-Net
Jiang, J., Chen, X., Tian, G. and Liu, Y., 2023, April. ViG-UNet: vision graph neural networks for medical image segmentation. In *2023 IEEE 20th International Symposium on Biomedical Imaging (ISBI)* (pp. 1-5). IEEE.	https://arxiv.org/pdf/2306.04905	Graph neural networks, U-Net
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. *Nature medicine*, *25*(6), pp.954-961.	https://mlgdansk.pl/wp-content/uploads/2019/06/MLGdansk63_27.05.19_End-to-end_lung_cancer_screening_with_three-dimens.pdf	Deep Learning (3D), lung cancer detection, computed tomography
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. *Nature*, *577*(7788), pp.89-94.	https://www.nature.com/articles/s41586-019-1799-6	AI system for breast cancer screening
Chen, T., Kornblith, S., Swersky, K., Norouzi, M. and Hinton, G.E., 2020. Big self-supervised models are strong semi-supervised learners. *Advances in neural information processing systems*, *33*, pp.22243-22255.	https://proceedings.neurips.cc/paper_files/paper/2020/file/fcbc95ccdd551da181207c0c1400c655-Paper.pdf	Big self-supervised models
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 *Proceedings of the IEEE/CVF international conference on computer vision* (pp. 3478-3488).	https://openaccess.thecvf.com/content/ICCV2021/papers/Azizi_Big_Self-Supervised_Models_Advance_Medical_Image_Classification_ICCV_2021_paper.pdf	Big self-supervised models
Zhao, L., Jia, C., Ma, J., Shao, Y., Liu, Z. and Yuan, H., 2023. Medical image segmentation based on self-supervised hybrid fusion network. *Frontiers in Oncology*, *13*, p.1109786.	https://pmc.ncbi.nlm.nih.gov/articles/PMC10141651/pdf/fonc-13-1109786.pdf	Self-supervised medical image segmentation

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