

# 2025 PROJECT

## Examination Procedure

The project will be in pairs. If necessary, the file to be submitted consists of a 5-page report, the program, and appendices. It will be rendered in a ZIP folder.

## Boolean network

Based on an article modeling a genetic and signaling network by a Boolean network,

- Simulate the Boolean network using a Boolean network simulation environment or by developing your Boolean network simulator/model
- Re-validate the items included in the part used to validate it
- Use the model to extend the results to a prediction.

## Example of articles

- Cohen, David PA, et al. "Mathematical modelling of molecular pathways enabling tumour cell invasion and migration." PLoS Comput Biol 11.11 (2015): e1004571
- Sahin, Özgür, et al. "Modeling ERBB receptor-regulated G1/S transition to find novel targets for de novo trastuzumab resistance." BMC systems biology 3.1 (2009): 1-20
- Traynard, Pauline, et al. "Logical model specification aided by model-checking techniques: application to the mammalian cell cycle regulation." Bioinformatics 32.17 (2016): i772-i780.
- Verlingue, Loic, et al. "A comprehensive approach to the molecular determinants of lifespan using a Boolean model of geroconversion." Aging cell 15.6 (2016): 1018-1026
- Dynamical Boolean Modeling of Immunogenic Cell DeathAndrea Checcoli 1, Jonathan G Pol 2 3, Aurelien Naldi 1, Vincent Noel 4 5 6, Emmanuel Barillot 4 5 6, Guido Kroemer 2 3 7 8 9, Denis Thieffry 1, Laurence Calzone 4 5 6, Gautier Stoll 2 3Affiliations expandPMID: 33281620 PMCID: PMC7690454 DOI: 10.3389/fphys.2020.590479 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7690454/>
- Logical modeling of lymphoid and myeloid cell specification and transdifferentiationSamuel Collombet 1, Chris van Oevelen 2, Jose Luis Sardina Ortega 2, Wassim Abou-Jaoudé 3, Bruno Di Stefano 2, Morgane Thomas-Chollier 3, Thomas Graf 4 5, Denis Thieffry 1Affiliations expandPMID: 28584084 PMCID: PMC5468615 DOI: 10.1073/pnas.1610622114 <https://www.pnas.org/content/pnas/114/23/5792.full.pdf>

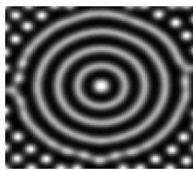
## Cellular automaton

Find an example of the use of cellular automata in biology. Compile a bibliography and develop a model, explaining your choices. The topics covered in the tutorials can be revisited but need to be explored in more depth, e.g. the SIR method or tumour growth.

## Agent-based models

The aim is to implant different biological systems, at different levels (bio-chemical, cellular, individual) using an agent-based approach. Using the reference article indicated for the level of your choice, program the model described therein and analyze it, in particular by varying the parameters of the model and studying their impact on its dynamics.

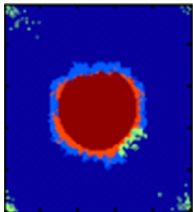
### Biochemical modeling



K. M. Page, P. K. Maini, N. A.M. Monk, "Complex pattern formation in reaction–diffusion systems with spatially varying parameters", in *Physica D*, 202 (2005) 95–115.

[https://www.ucl.ac.uk/~ucackmp/Publications\\_files/complexpattern.pdf](https://www.ucl.ac.uk/~ucackmp/Publications_files/complexpattern.pdf)

### Cell modeling



F. Pourhasanzade, S. H. Sabzpoushan, A. M. Alizadeh, E. Esmati. "An agent-based model of avascular tumor growth: Immune response tendency to prevent cancer development", in *SIMULATION: Transactions of The Society for Modeling and Simulation International*, 2017, Vol. 93(8), pp. 641-657.

[https://www.researchgate.net/publication/315475641\\_An\\_agent-based\\_model\\_of\\_avascular\\_tumor\\_growth\\_Immune\\_response\\_tendency\\_to\\_prevent\\_cancer\\_development](https://www.researchgate.net/publication/315475641_An_agent-based_model_of_avascular_tumor_growth_Immune_response_tendency_to_prevent_cancer_development)

### Individual modeling



J.-L. Deneubourg, S. Goss, N. Franks, A. Sendova-Franks, C. Detrain, L. Chrétien, "The dynamics of collective sorting robot-like ants and ant-like robots", in *Proceedings of the first international conference on simulation of adaptive behavior on From animals to animats*, 1990

[https://www.researchgate.net/profile/Nigel-Franks/publication/235362107\\_The\\_dynamics\\_of\\_collective\\_sorting\\_robot-like\\_ants\\_and\\_ant-like\\_robots](https://www.researchgate.net/profile/Nigel-Franks/publication/235362107_The_dynamics_of_collective_sorting_robot-like_ants_and_ant-like_robots)