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## N°26 Simulation of Multicellular Systems

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The theory of complex systems has become more and more relevant over the last thirty years to understand concepts such as emergence and self-organization and their role in biological, physical, chemical and social systems. The use of an Individual-Based approach to model and simulate complex systems has proved to be an efficient way, both in research and teaching, of manipulating these complex systems. We use this Individual-Based approach to propose tools and methods for biologists to create realistic models and simulations of complex biological systems in order to (1) grasp the complexity of these systems, (2) test hypothesis and investigate dynamical systems that otherwise could not be systematically investigated. Among our previous works with biologists, we can mention a large scale tissue morphogenesis simulation based on a flexible biomechanical cell model [1], and a simulation of cellular deformation and migration [3]. We also designed an intuitive software [3] aimed at biologists for teaching and research, that does not require any skills in computer programming. In particular, a specific graphical user interface allows to create in a simple way bottom-up models where unexpected behaviours can emerge from simple interacting entities, and test hypothesis by creating various simulations. This software has been successfully used in middle schools, high schools and universities since 2010.

[1] A. Jeannin-Girardon, P. Ballet and V. Rodin, “Large scale tissue morphogenesis simulation on heterogenous systems based on a flexible biomechanical cell model”, IEEE/ACM Transactions on Computational Biology and Bioinformatics, 2015.

[2] A. Sarr, A. Fronville and V. Rodin, “Morphogenesis Model for Systematic Simulation of Forms’ Co-evolution with Constraints: Application to Mitosis”, 3rd International Conference on Theory and Practice of Natural Computing, Granada (Spain), Lecture Notes in Computer Science (LNCS), Springer, 2014.

[3] http://virtulab.univ-brest.fr