

## **Computational modelling of complex systems**

### **Learning Objectives:**

Complex systems are characterized by specific properties and lean on transverse concepts in the various sciences. We shall study in this course, how it is possible to model them, allowing these properties to be expressed through simulations, via algorithms and computer programs. Various formalisms will be considered to propose formal reconstructions of these systems and their properties. We shall be interested in particular in the mutual impacts between their topology and their dynamics, so allowing revealing measurement or controlling tools. Each of the used formalisms will be illustrated by concrete application cases. The platform Netlogo will be studied and used to implement simulations clarifying the theoretical concepts

### **Prerequisites:**

EDO, Graphs and interaction networks courses of Master-1 degree

### **Detailed Description of the Course:**

- Context and concepts of the natural and artificial complex systems and their modelling;
- Cellular Automata and applications;
- Individual-based modelling; Multiagent Systems ; Swarm Intelligence
- Models coupling, hybrid models (equation-based and agent-based);
- Complex networks modelling: topology, measures and dynamics;
- Netlogo platform in practice; implementation of the presented models.

### **Textbooks & Further Reading:**

1. M.A Aziz-Alaoui et C. Bertelle (ed), « From System Complexity to Emergent Properties », Springer Verlag, 2009
2. A.-L. Barabasi, « Network Science », Cambridge University Press, 2016
3. R. Benkirane, « La complexité, vertiges et promesses », Editions le pommier, 2006
4. E. Bonabeau, M. Dorigo, G. Theraulaz, « Swarm Intelligence », Oxford University Press, 1999
5. P. Collard, S. Verel, M. Clergue, « Systèmes complexes, une introduction par la pratique », Presses polytechniques et universitaires romandes, 2013
6. N. Gilbert, « Agent-Based Models », Sage Publication, 2008
7. E. Morin, « Introduction à la pensée complexe », édition du Seuil, 2005
8. S.F. Railsback, V. Grimm, « Agent Based and Individual Based Modelling », Princeton University Press, 2012
9. L. Sanders (ed), « Models in Spatial Analysis », ISTE, 2007
10. J.-P. Treuil, A. Drogoul, J.D. Zucker, « Modélisation à base d'objets », Dunod, 2008