Complexity in social dynamics : from the micro to the macro
Exam projects

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Exam method

- Design a model based on the examples.
- Write a new program or adapt an existing one.
- Perform preliminary simulations, adapt the model.
- Decide what are the interesting observables and the control parameters. Try to perform automatic measurements on the range of control parameters.
- Produce some interesting graphs, write a short report illustrating the goals of the model and the conclusions from simulations.
- Produce a short (4-6 slides) presentation (one slide for the title and the name of participants, one for the model, one for the results and one for the conclusions.

Cellular automata

- How do cellular automata rule change with the topology of the graph?
- What does happen to the game of life if you add some noise?
- What does happen to a CA rule if you update only a fraction of the sites at the same time (synchronicity)?
- The Ising model is sequential. What does happen if you update all spins at the same time? (look at low temperatures).
- Try to explore rules with larger range (for instance, the rule can depend on the sum of 5 neighbors). What are the typical behaviors? Can you "classify" rules according with their behavior (for instance using the entropy of the generated configurations)?

Neural networks

- Backpropagation learning is a gradient search, but may be trapped in a spurious minimum. Find the parameters corresponding to this behavior and try to draw the "error" surface as a function of weights.
- One could study the behavior of lattice of perceptrons (or multi-layered perceptrons) instead of cellular automata, in which each perceptron takes its inputs from neighboring sites. What does happen to a homogeneous or a dishomogeneous population?
- Explore the behavior of the Hopfield model.
- Try to implement a Kohonen network for unsupervised learning.

Social systems 1

- Try to "port" some one-dimensional system to two dimensions, or to random graphs.
- Explore the behavior modifications of some system if you add a small number of "long range" connections (small world effect).
- Try toimplement a model of a leader preaching against the "system" using an Ising model in which a spin is fixed, and there is a global field in the opposite direction. Measure the average size of the leader group.
- Try to measure the correlations in some model (e.g., directed percolation or Ising). Plot the correlation function and compare it with an exponential. Derive the correlation length.

Social systems 2

- Try to obtain the mean-field equation for some model and compare it with the actual simulations.
- Model the spreading of an idea (similar to directed percolation) that is kept for some time after being forgotten. How does the percolation threshold change with memory?

Evolution and game theory

- Try to implement the Maslov-Zhang model of minority games.
- Develop an evolutional model for the evolution of cooperation.