Proposals for simulation projects

The following topics are only proposals for your simulations projects. It is up to you how to realize a scientific corresponding to the topic you choose (i.e. what you simulate, how you visualize it, etc.).

You can also choose a topic that is not represented in the list. It must be related to the topic of the course. In any case we ask you to discuss about your simulation project in advance (i.e. before you start to implement it) with one of the tutors.

1. **Car-following models**
   Poject: Implement one of the well known car following models for a single lane dense highway traffic. Design and create an Applet with which one can visualise and study the dynamics of the system as function of the parameters. Improve the model by adding a second or more (parallel) lanes.

   Examples for models:
   (a) Gazis–Herman–Rothery (GHR) models
   → M. Brackstone and M. McDonald, "Car-Following: A Historical Review" Transportation Research Part F: Traffic Psychology and Behaviour, 2(4), 1999 pp. 181–196.

   (b) Gipps' model
   → http://en.wikipedia.org/wiki/Gipps%27_Model

   (c) Intelligent driver models
   → http://en.wikipedia.org/wiki/Intelligent_driver_model

   (d) Spring-block model for highway traffic
   → Járai-Szabó, Ferenc, Bulcsú Sándor, and Zoltán Néda. "Spring-block model for a single-lane highway traffic." Central European Journal of Physics 9.4 (2011): 1002-1009.
   → Ferenc Járai-Szabó, Zoltán Néda, "Earthquake model describes traffic jams caused by imperfect driving styles", Physica A, 391 (22), 5727-5738, 2012

2. **Cellular automaton**

   Project: Use a cellular automaton model for traffic simulation. Design and create an Applet with which one can visualise and study the dynamics of the system as function of the parameters.

   Example:
   (a) Rule 184 for traffic flow
   → http://en.wikipedia.org/wiki/Rule_184

   (b) Biham–Middleton–Levine traffic models - cellular autamaton
   → http://en.wikipedia.org/wiki/Biham%E2%80%93Middleton%E2%80%93Levine_traffic_model

3. **Synchronization phenomena**

Project: Study the synchronization of metronomes as a function of the coupling constant. Create an Applet and visualise the phenomena.

Examples for models:

(a) Two metronomes

→ http://salt.uaa.alaska.edu/physics_public/metro.html

→ Pantaleone, James. "Synchronization of metronomes." American Journal of Physics 70.10 (2002): 992-1000.

(b) Realistic model for metronomes placed on a circular dic

→ Boda, Sz, et al. "The rhythm of coupled metronomes." The European Physical Journal B 86.6 (2013): 1-9.

→ Boda, Sz, et al. "Kuramoto-type phase transition with metronomes." European Journal of Physics 34.6 (2013): 1451.

4. **Self-organized pedestrian crowd dynamics**

Project: Consider a pedestrian crowd dynamics model. Create an Applet and visualise the dynamics of multidirectional pedestrian streams or intersecting pedestrian streams.

References:

→ Helbing, Dirk, et al. "Self-organized pedestrian crowd dynamics: Experiments, simulations, and design solutions." Transportation science 39.1 (2005): 1-24.

→ Helbing, Dirk, Illés Farkas, and Tamas Vicsek. "Simulating dynamical features of escape panic." Nature 407.6803 (2000): 487-490.

5. **Pattern formation in reaction-diffusion systems**

Project: Consider the Gray-Scott reaction-diffusion model. Create an interactive simulation to visualize the dynamics of the model such that one can change parameters in order to see different patterns.

References:

→ John E. Pearson: "Complex Patterns in a Simple System", Science Vol. 261