The seminar 1b: Introduction into the subject Autonomous Systems

Objectives of the seminar:

- NetLogo examples

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Multi-agent system is a collection of autonomous individual entities called agents. The fundamental agents behave reactively, proactively, autonomously (without the intervention(s) of huma(s)) to solve particular problem. These systems can be modelled and programmed by various development tools. We can divide them into the two basic groups:

Multi-agent frameworks: a group of programming libraries providing collection of classes with attributes and methods which can be used for MAS-based software development.

- Examples:
  - JADE programming platform (Java)
  - Swarm

Stand-alone simulation tools: this group of environments propose the interface for coding, debugging, testing, design of the GUI or tools for data analysis.

- Examples:
  - MASON (Java)
  - Repast Simphony (Java, Groovy, Relogo)
  - AnyLogic (Java)
  - NetLogo (NetLogo syntax – dialect of the Logo language)

During our seminars we are not going to program the multi-agent systems at all. MAS-based programming is a part of the different subject called **Complex systems** or **Game Theory**. We are going to prepare "only" the analysis and the design of the multi-agent system with the semi-formal conceptual language that is called **AML** (The Agent Modelling Language) in the **StarUML** environment.

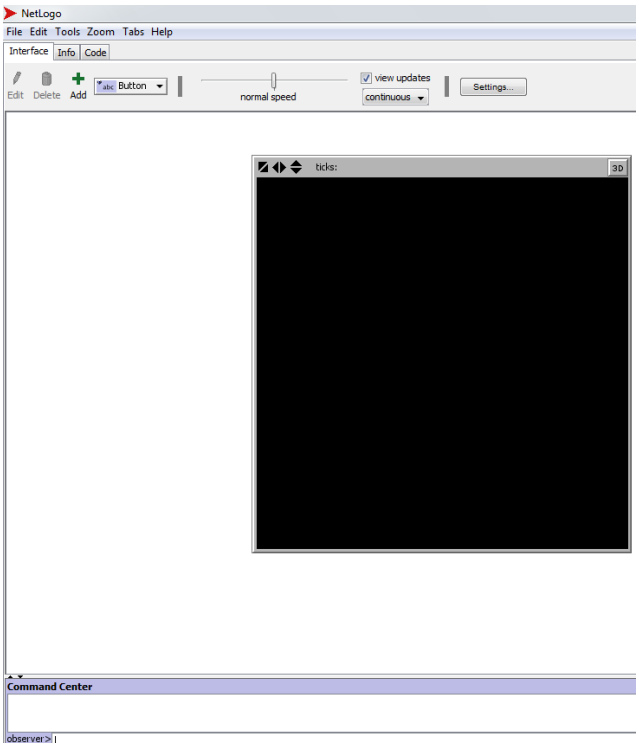
For better explanation and imagination, what the multi-agent system is, during this seminar we will play with couple of examples of MAS-based models which are developed in the NetLogo tool. This tool is installed in the school computers or couple of them is available online on the following address: https://www.netlogoweb.org/launch#https://www.netlogoweb.org/assets/modelslib/Curricular%20Models/Connected%20Chemistry/Connected%20Chemistry%20Gas%20Combustion.nlogo. I recommend to use the desktop version of the NetLogo. Running the models is much faster in comparison to the online version and not all models are available in this online version. You can also freely install the NetLogo tool into your home computers.

Tasks:

1. **Run the NetLogo:** run the NetLogo.exe file

You will see the following screen with three main tabs, see figure below:

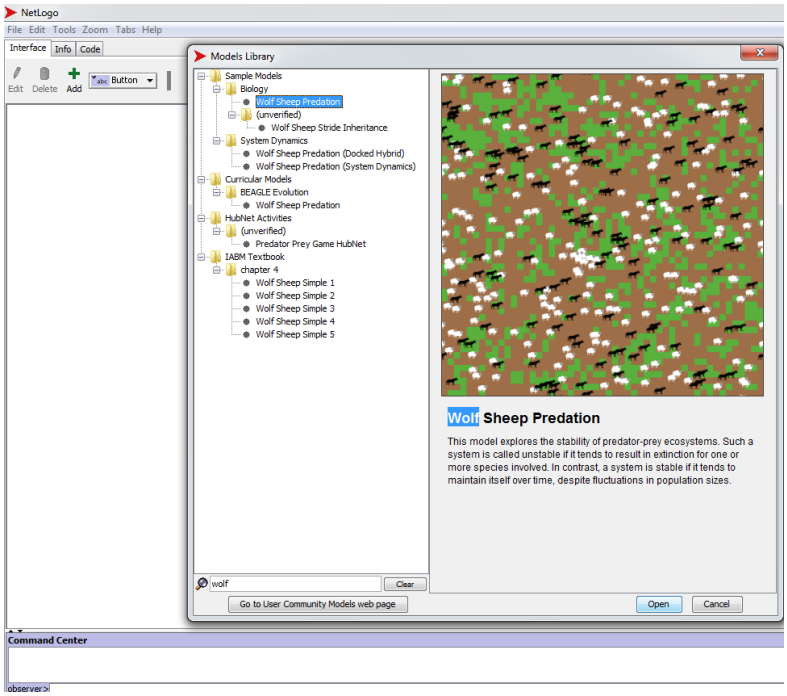
- **Interface**: the section for GUI specification,
- **Info**: the section for the documentation preparation,
- **Code**: the section for the implementation of the programming code.



Empty NetLogo model

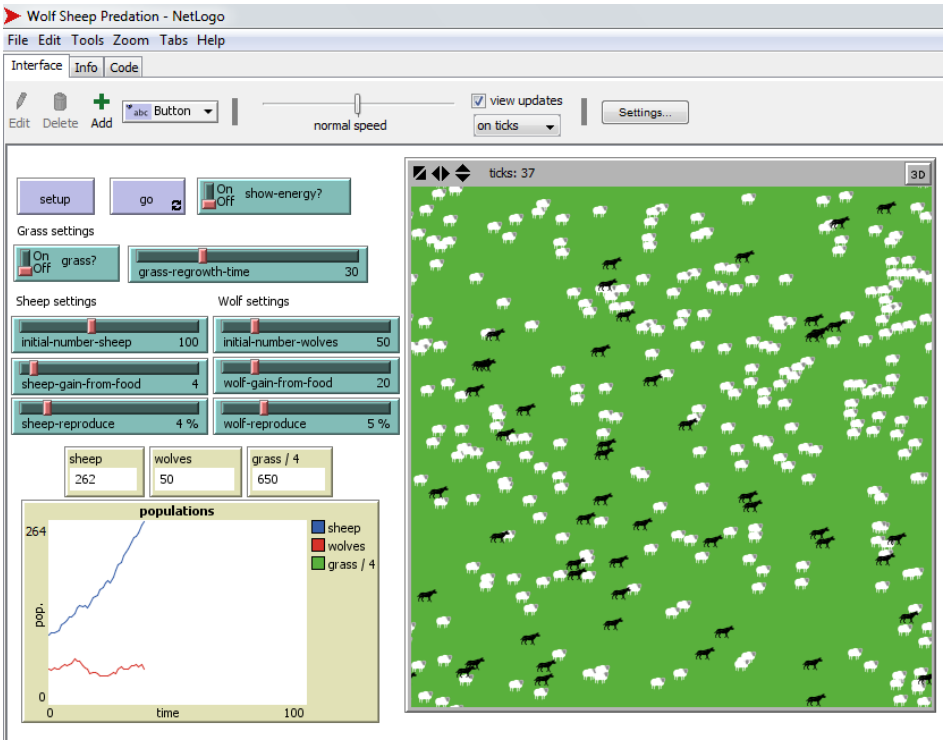
2. Open the Wolf-Sheep Predation model

Go into the main menu of the NetLogo/File/Models library and open it.



Models library – Wolf-Sheep Predation model

You will see the GUI of the model consisting of various buttons, sliders, monitors, …, and the small screen where you can see the visualisation of the model, i. e. behaviour of your agents and the environment, see figure below. Various setting tools are used for setting up your model parameters. You can investigate what can happen with your model if you set the parameters in a particular way, e. g. what can happen if the grass (Grass settings) will not be available for animals.



Openned NetLogo model – Wolf-Sheep Predation

3. Run the model

Majority of the NetLogo-based models disposes the two main buttons: **Setup** (used for setting parameters into initial values) and **Go** (used for running the model). Try to set the model with particular values for the parameters and click on the Go button. You can see that your model "is alive" ☺ The model consist of the following entities:

Agents of the model:

- wolves (black colour) and sheeps (white colour)
  - In the NetLogo dialect the agents are represented by **Turtles** agents ☺
- green grass playing the role of the environment
  - In the NetLogo dialect the environment is represented by the agent called **Patch**
- "invisible agent" called **Observer**: This agent is invisible in the NetLogo. It plays the role (we can say) of the supervisor which is able to control the model and give the orders to the agents – turtles and patches, e. g. it is able to change their colour, position, behaviour.

4. **Investigate what can happen with your model if you set the parameters in a particular way.**
   Tip: Info tab can be used as a guidance what is the purpose of the model, what you can set up in the model, etc. Look also into this section.

5. **Run the next models of the NetLogo tool** and investigate the models by setting of their parameters
   Tips:
   - Biology: AIDS, Ants, Flocking, …
   - Computer Science: Painted Desert Challenge, Cellular Automata (Life), …
   - Earth Science: Grand Canyon, …
   - Games: Pacman, …
   - Social science: TrafficGrid, …

Project tip: *NetLogo models can be the inspiration for your project. You can select particular topic that is modelled by the NetLogo and propose analysis and design for these models. If you select this way for your project, consult the suitability of the NetLogo model for analysis/design with your teacher.*

End of the seminar

Exercises:

- Try to run and experiment with the above mentioned NetLogo models.

The most important keywords

- Multi-agent system
- Agent
- MAS-based development tools
- NetLogo
  - Turtle
  - Patch
  - Observer