Evolutionary Robotics
Prof. Dario Floreano

E3 Laboratory Exercises

Body-Brain Co-evolution

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Goal.

To further familiarize yourself with the RoboGen software suite by performing a body-brain evolution. The completely evolved from scratch robot has to locomote as fast as possible.

Learning objectives.

By the end of this laboratory you should have learned something about:

- Gaining experience co-evolving controllers and morphologies.
- Learning about some of the body-evolution options provided with RoboGen.
- How simple changes of the simulated environment (for example friction) can affect robot evolution

Assignments.

- Go through the provided PDF instruction file during the laboratory class

Getting Started

Step 1: Create a folder named Exercise3 (without space) in ~/Robogen/Exercises directory already present on the lab computer. To do this, you can open a terminal and execute the following command:

```
mkdir -p ~/Robogen/Exercises/Exercise3
```

Download the zip file provided in moodle named Exercise3 and extract it inside this folder.

In **"**Build a Robot" section, it is possible to manually define the body and brain of a robot or upload an existing robot body-brain file (e.g. name.robot.txt). For this exericise3, the Robot file, ***simpleRobot.robot.txt*** and **conf.sim.txt** will be used as a robot file and simulation configuration respectively.

Step 1.1

Today, you will explore the basics of evolving morphologies:

Look at the Evolution settings section where the configuration file **conf.evol.txt** is pre-selected. This configuration will have the Evolution Mode as **Full**, which will evolve both brain and body together. When there is no Robot file specified, your population will start from a random collection of morphologies using the specified allowed parts. Alternatively, you can choose to

have a initial robot, that will be randomly mutated to generate the initial population. Additional parameters are:

- *numInitialParts*=MIN:MAX defines the possible sizes of these initial morphologies
- The *addBodyPart* defines what body parts are allowed to be included
    - In the example, this is set to All, so all possible body parts are allowed to be included
        - Think about why including all body parts may not always be the best idea
    - Change this to specify just particular body parts (on separate lines), this can take either the Character Code, or name of the Body Part. For example:
        - *addBodyPart=FixedBrick*
        - *addBodyPart=ActiveHinge*
        - *addBodyPart=PassiveHinge*
- Try evolving some basic morphologies with **conf.evol.txt** file! We recommend starting with a small number of initial components (say 4 or 5), and only allowing a small subset of components at first.
- Familiarize yourself with the other parameters controlling the mutation operators for morphological evolution
    - http://robogen.org/docs/evolution-configuration/#Evolution_client_settings
    - For example try adjusting the probabilities of adding body parts, swapping subtrees, modifying parameters, etc.

Be aware: getting good results with full evolution may take some time.

- You may need to use **larger population sizes**, experiment with the replacement strategy and tournament-size and run for many generations. **You could not be able to see good results already during the class, but you can discuss with your team partners about strategies and how to perform other evolutions during the week.**

Step 2

The evolution of a robot will be strongly affected by the simulated environment. Therefore, if some parameters in the simulator configuration file are changed, the results can be quite different. In this class you can experiment with the effect of different ground friction in the evolution of a robot.

Note: The full documentation for defining simulator configuration file is available http://robogen.org/docs/evolution-configuration/#Simulator_settings

terrainFriction – this specifies the coefficient of friction between the robot and the terrain

Try setting the value of terrainFriction to 10 (This setting could represent a very muddy terrain the robot must move in) and run a simulation using:

simpleRobot.robot.txt as the Robot description file, and **conf.sim.txt** as the Configuration file. Do

you notice differences in the robot's behavior?

Now you can try evolving a robot that moves as fast as it can (with racing as scenario) in a terrain with friction coefficient of 10.

Step 3 (optional)

If your robot is able to navigate well on a flat ground with different frictions, you could try to evolve a new robot in different mazes (**maze1.arena.txt** and **maze2.arena.txt**) to locomote as fast as possible overcoming obstacles.

Exercise 4

Now let's consider that the robot you evolve should be used to explore Antartica. After friction analysis you found that the effective friction coefficient is **0.04**. Now try to evolve a robot that can walk as much as it can in the flat (with no obstacles) surface of Antarctica. The result you get on the platform is how far the robot moves in 30 seconds on an Antarctica-like terrain.

Good luck with your evolution!