

Using Robotnačka in Research and Education

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Abstract

This poster presents our experiences in three different ways. Firstly, we have implemented *Evolve with Imagine*, a software package for running evolutionary experiments in *Imagine Logo*. Thanks to the possibility to steer the robots directly from *Imagine*, we can evolve robot behaviours using our package. Secondly, we have designed a set of student exercises for the course on *Mobile Robotics at Slovak Technical University in Bratislava*. Finally, research multi-agent framework for *Robotnačka* robots based on the *Agent-Space* architecture was developed.

Keywords: *Robotnačka*, student exercises, evolutionary computation

1. Evolutionary Computation

- known optimization method,
- inspired from biology (Darwinian natural evolution)
- solves tasks that do not have fast algorithmic solution,
- based on parallel stochastic search iterating for many generations
- comes in different flavours (GP, GA, EP, ES, etc.)
- successfully used to solve different real-world problems (scheduling, routing, combinatorial problems, etc.)
- active research field with many open problems

2. Our focus

- automatic programming of robots through artificial evolution
- studying the properties of different representation types: finite state automata, program trees

3. Evolve with Imagine

- an interactive researcher's environment for running evolutionary experiments with *Imagine*
- benefits from
 - list representation is natural to Logo (used also in GP)
 - Logo being interpreter - i.e. easy to modify the code while running it to tune the parameters and behavior
 - easy visualization due to strong and easy graphics support in Logo
 - Logo can directly interface both to simulated and real *Robotnačka* robots

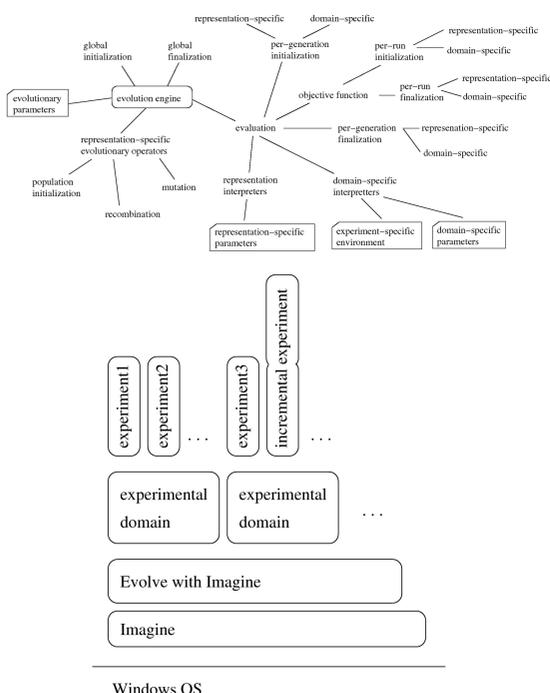


Figure 1: The architecture and deployment of *Evolve with Imagine*.

4. Evolutionary Experiments with Robotnačka

- comparing the program trees and finite state automata as representation for navigational and symbol manipulation tasks
- homing and target approaching behaviors (figures)
- investigating the incremental evolution method
- details in technical report

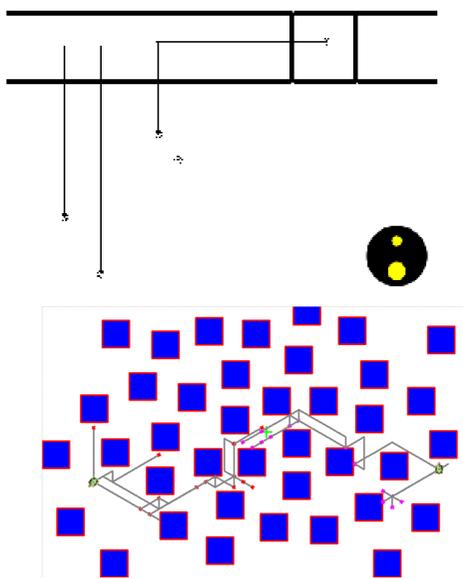


Figure 2: Resulting evolved homing and target approaching behaviours.

5. Mobile Robotics Exercises

- differential driven robot base with good mathematical model
- calculations of the required number of steps for specific trajectories (forward, right, spin, etc.)
- immediate verification with real robot
- many follow-up questions: precision, speed, feedback, more about the control of the stepper motors
- applied at the introductory robotics course at the STU in Bratislava, texts available online (URL - *Robotnačka*).

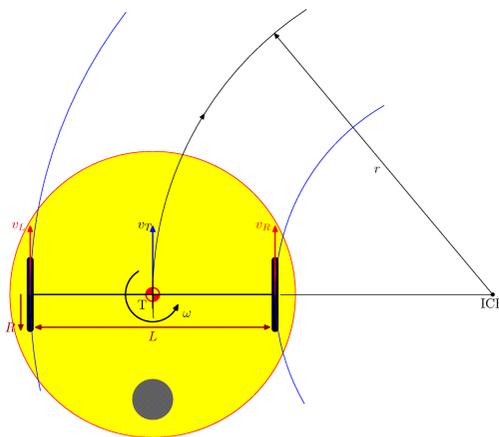


Figure 3: Model of the differential driven robot with different wheel speeds.

6. Robotic Laboratory Control System

- upgrades *Robotnačka* to advanced research experimental platform
- implemented in Java
- based on visual programming of *Agent-Space Architecture* (derived from Brooks's *Subsumption Architecture*) utilizing indirect communication of reactive agents

- publicly available through Remotely-Accessible Robotics Laboratory of *Robotika.SK*

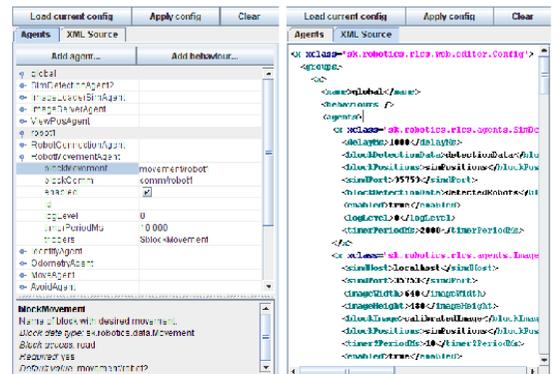


Figure 4: *RLCS Editor*: editing agents on the left, and corresponding XML representation on the right.

7. Conclusions

ROBOTNAČKA and Remotely-Accessible Robotics Laboratory are creative robotics platforms for education and research. We described the ways these platforms have been used by us for exactly these purposes.

Imagine Logo is a powerful programming language integrated environment that is suitable for fast prototyping for research projects. We designed and made real use of a software package for running and studying evolutionary algorithms (EA) in combination with the Remotely-Accessible Robotics Laboratory with *Robotnačka* turtle robot. Thanks to *Imagine*'s powerful and simple to use graphics engine, *Imagine* provided a robot simulator in an Evolutionary Robotics experiment and allowed quick and practical visualization of the results that helped in the analysis of the results. In addition, *Robotnačka* has been used in real exercises of university students of Mobile Robotics. We describe these exercises that are available on-line for the wider Internet community (URL - *Robotnačka*).

8. References

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