

Using Robotnačka in Research and Education

Pavel Petrovič, Richard Balogh, Andrej Lúčny, Ronald Weiss

Dept of Computer and Information Science, NTNU, Trondheim
 Institute of Control and Industrial Informatics, FEI STU Bratislava
 Microstep-MIS, Bratislava

Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava

ppetrovic@acm.org, balogh@elf.stuba.sk, andy@microstep-mis.com, ronald@microstep-mis.com

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

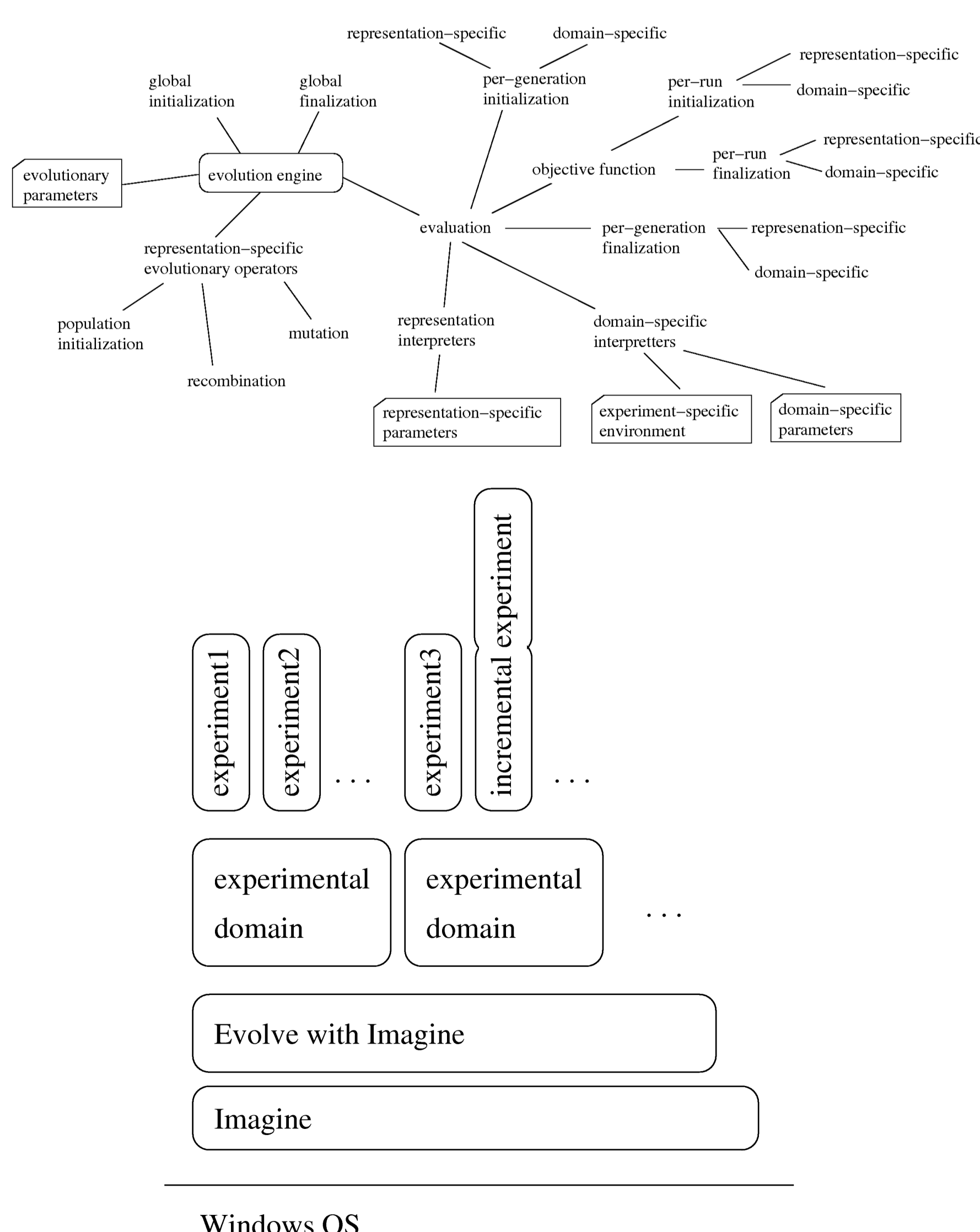


Figure 1: The architecture and deployment of *Evolve with Imagine*.

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

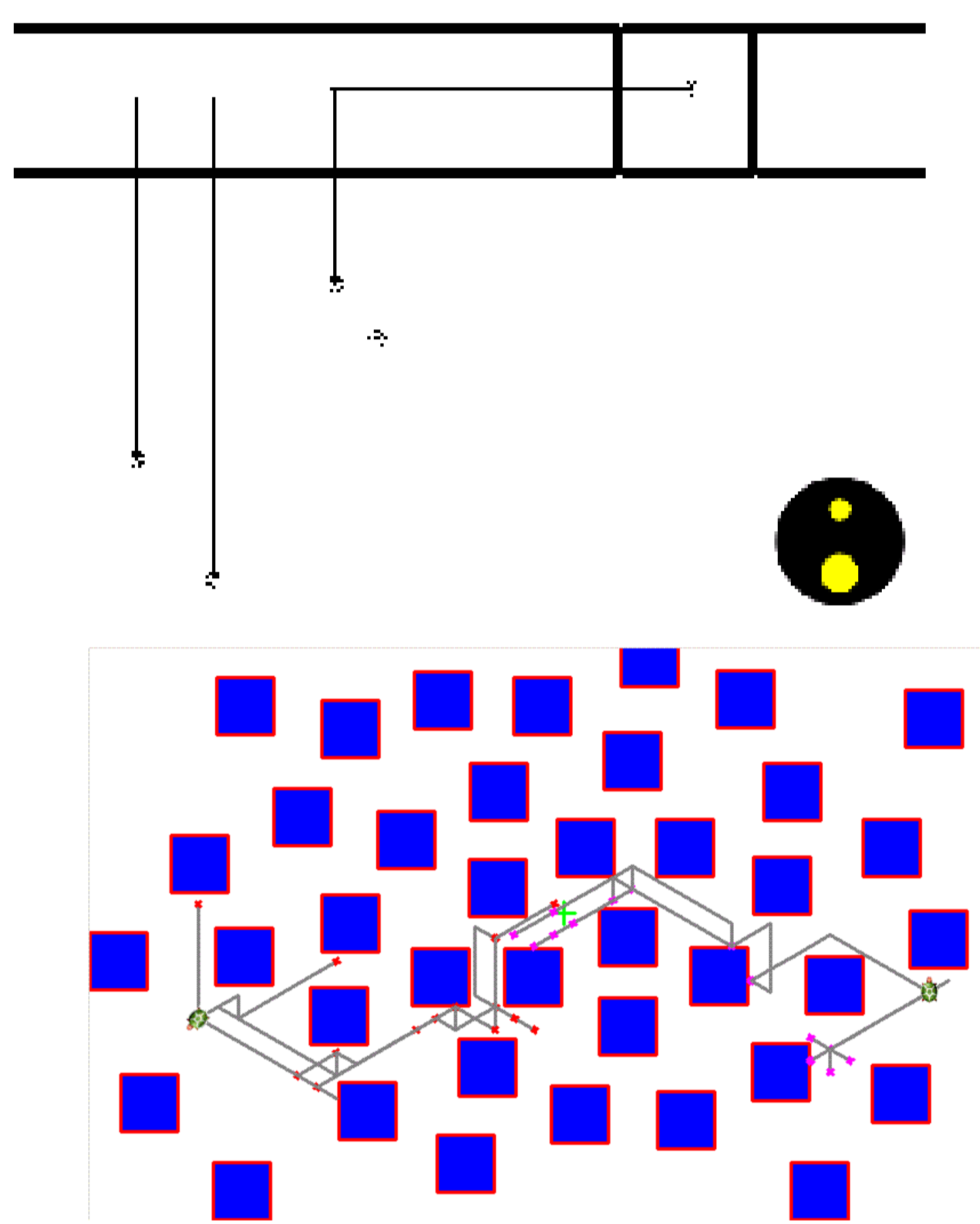


Figure 2: Resulting evolved homing and target approaching behaviours.

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*).

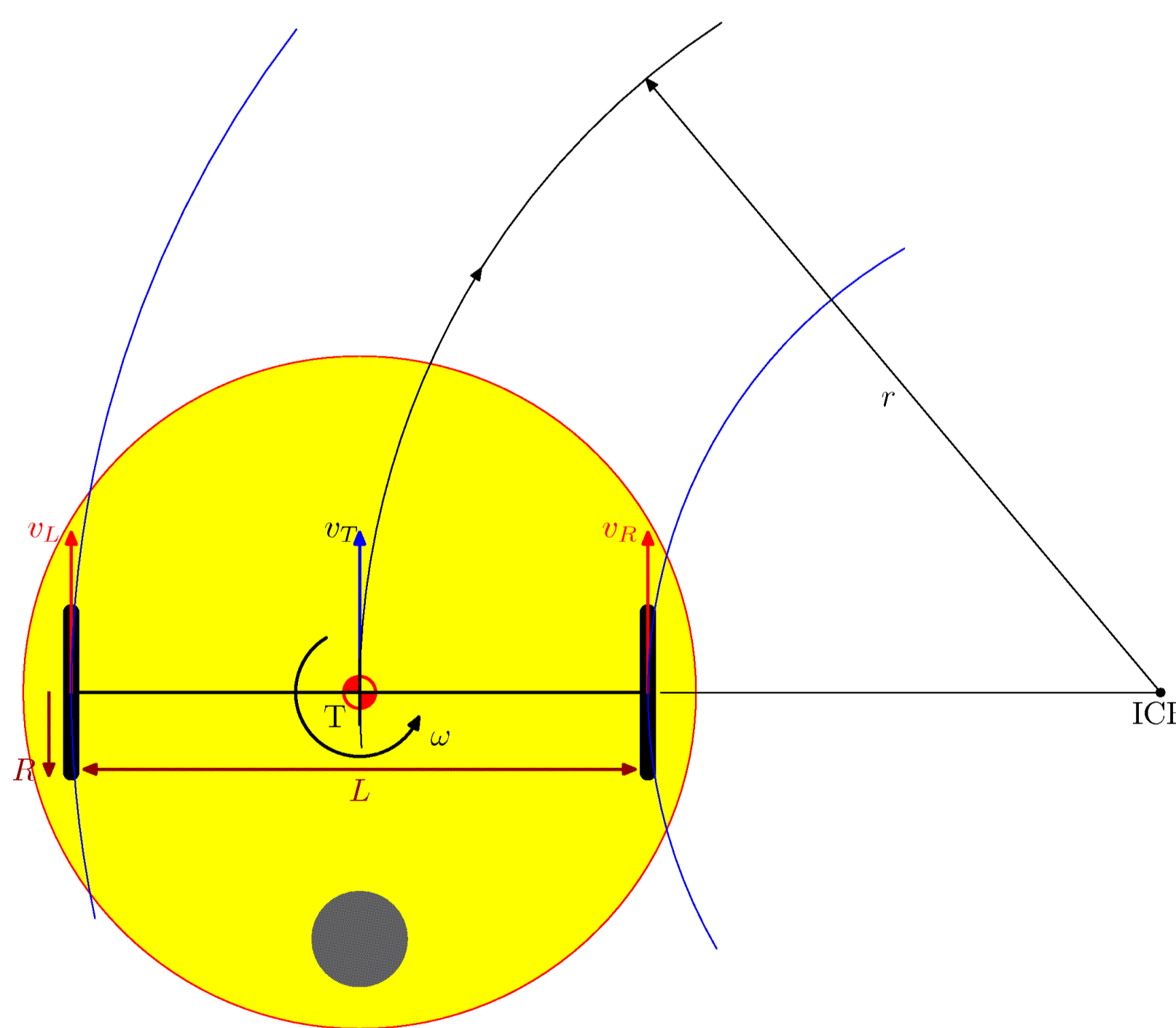


Figure 3: Model of the differential driven robot with different wheel speeds.

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*

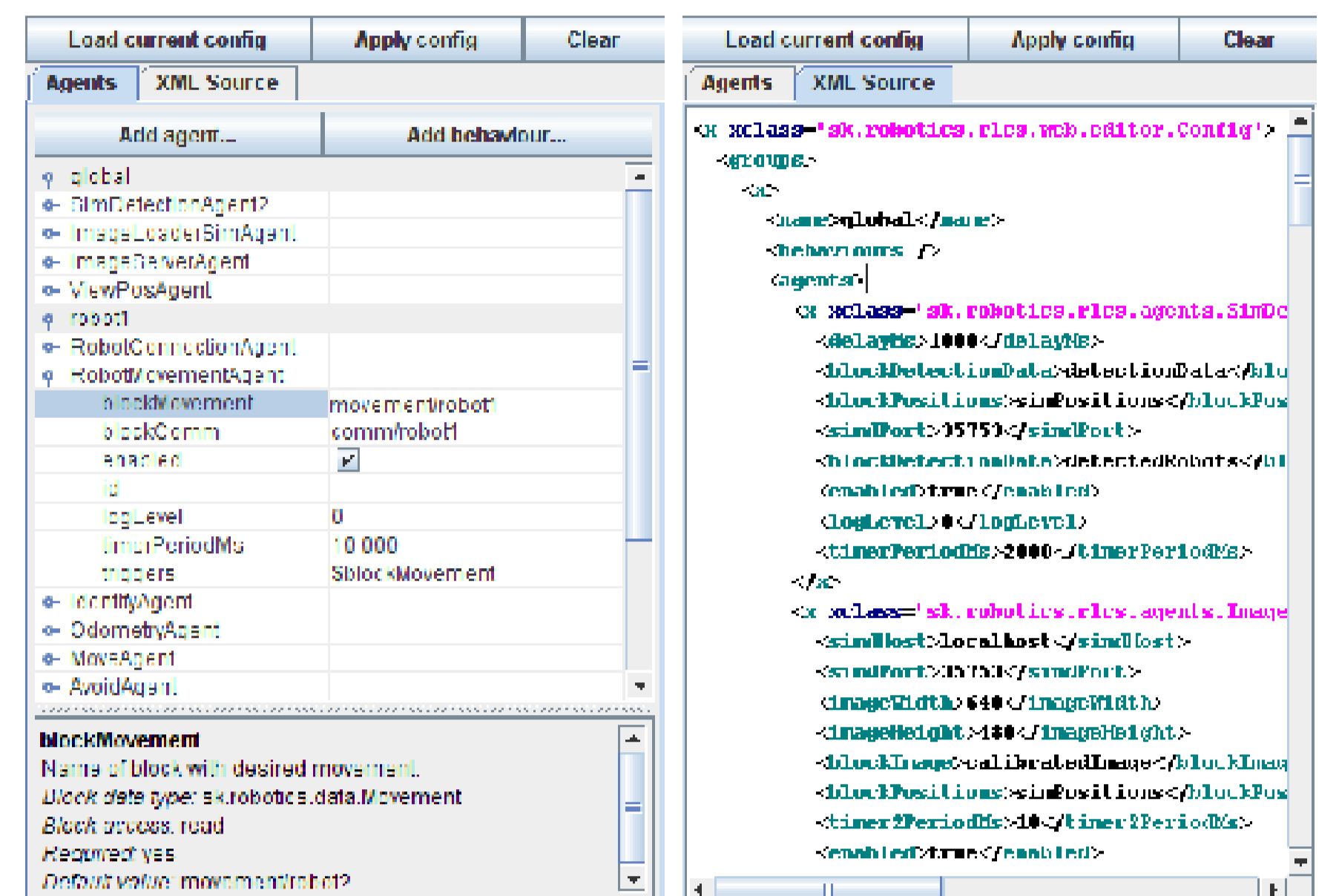


Figure 4: *RLCS Editor*: editing agents on the left, and corresponding XML representation on the right.

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

- Balogh, R. (2007) *Practical Kinematics of the Differential Driven Mobile Robot*. In Proceedings to Robteq 2007.
- Đurina, D. and Petrovič, P. and Balogh, R. (2006) *Robotnačka - The Drawing Robot*. In Proceedings to Robteq 2006.
- Koza, J. and Keane, M.A., and Streeter, M.J. and Mydlowec W. and Yu Jessen and Lanza G. (2003) *Genetic Programming IV: Routine Human-Competitive Machine Intelligence*. Kluwer Academic Publishers.
- Lúčny, A. (2005) *Building Intelligent Systems with Agent-Space Architecture*. PhD thesis. Faculty of Mathematics, Physics and Informatics, Bratislava.
- Petrovič, P. and Lúčny A. and Balogh R. and Đurina D. (2006) *Remotely-Accessible Robotics Laboratory*. In Proceedings to Robteq 2006.
- Petrovič, P. (2005) *Mathematics with Robotnačka and Imagine Logo*, Proceedings to Eurologo 2005.
- Petrovič, P. (2006) *Comparing Finite-State Automata Representation with GP-trees*, IDI Technical report 05/2006, Norwegian University of Science and Technology.
- Weiss, R. (2007) *Vizuálne programovanie riadiaceho systému pre kolóniu robotov*. Diploma thesis, Faculty of Mathematics, Physics and Informatics, Bratislava.
- URL - EI (2007) <http://wiki.robotika.sk/index.php/EI>
- URL - *Robotnačka* (2007) <http://wiki.robotika.sk/index.php/Robotnacka>

This work was supported by the KEGA 3 / 2399 / 04 grant.