PROBLEM STATEMENT

Robotics: Common subject in Engineering degrees
Cognitive Robotics: Now covered in Postgraduate programs
Reinforcement Learning (RL): Decision-Making Machine learning
Q-learning algorithm: Simple, effective and well-known RL algorithm

Q-learning method for a NXT mobile robot
Evolved from Wander-1

APPROACH

Materials
LEGOMINDSTORMSNXT Education Base Set

Obstacle-avoidance wandering tasks
Wander -1:
- no contact
- both contacts
- right bumper contact
- left bumper contact

Actuators
- move forward
- move backward
- left-turn
- right-turn

Wander -2:
- one contact from Wander 1
- both contacts from Wander 1

Wander -3:
- one contact from Wander 2
- both contacts from Wander 2

Scenarios
A 70 cm / 105 cm
B 200 cm
C 125 cm

Developed work
Offline Design & Simulation
- Assembly
- Modeling
- Simulation
- Parameters Tuning

Offline Q-learning Template
Octave / Matlab

Robot implementation
Q-learning on robot
CPU limitations studies:
Overflow & Precision losses
Robot vs Simulation analysis
Parameters Optimization

Q-learning pseudocode

GOAL:
Develop a teaching framework integrating:
- Q-learning
- Practical activities
- Real Mobile Robots

Allowing the students to get a better understanding of the robotic learning problem

RESULTS

Q-learning method for a NXT mobile robot
All learning tasks were performed successfully leading to an optimal or pseudo-optimal policy

Benefits for students
- Simulation templates
  Allow a thorough analysis of the Q-learning parameters
- Real Robot templates
  Easily adapted to different tasks with minimal changes
- Q-learning on robot
  Get a complete vision of the learning problem filling the gap between theory and practice

Optimal parameters

Rewards
1. moved forward (no collide)
2. turned (no collide)
3. one bumper collides
4. both bumber collides

Parameter
Value
Robot Speed 50 (of [0,100])
Step Time 250 ms
Number of Steps 1000
Exploration e-greedy 30%
Discount rate γ 0.9
Learning rate α 0.12
FP 10200 (4 decimals)
Q-matrix cell size 4 bytes (long)