Autonomous Intelligent Systems,
Institute for Computer Science VI, University of Bonn

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Exercises for Artificial Life (MA-INF 4201), SS11

Exercises sheet 9, due: Mon 27.06.2011

20.6.2011

Group	Name	55	56	57	58	59	60	Σ

Written examination: 19.7.2011, 10-12

The written examination will be on Tuesday 19 July 2011, 10:00 - 12:00, lecture hall 2. You will need 50% of the points from the assignments, and an active participation in the exercise groups to be admitted for the exam.

Assignment 55 (2 Points)

Name and describe (in one sentence each) all main parts of a SMPA architecture.

Assignment 56 (2 Points)

What part of the Braitenberg type 1 behavior benefits from a stochastic component?
Explain how the stochastic component is affecting the behavior.

Assignment 57 (1 Point)

Describe a situation where a vehicle with a type 3-a Braitenberg behavior is more favorable than a 2-b behavior.

Assignment 58 (2 Points)

Braitenberg type 3-b vehicles tend to have problems in corners.
Explain what the problems are, and describe in detail at least 2 stategies to circumvent this unwanted effect.

Assignment 59 (4 Points)

Describe the task of *Wall-Following* for an autonomous robot, and design a fitness function (useable for an evolutionary algorithm) that is capable of judging the quality of *Wall-Following* behavior.
How could a possible genome be structured to implement this behavior for a robot that has two proximity sensors facing to the right?

Assignment 60 (4 Points)

A Braitenberg type vehicle (two sensors and two motors) shall have the behavior to position itself directly in front of an object in the working distance d_w.
The working distance shall be maintained even if the object is moving away and if it moves towards the vehicle.
Describe the necessary structure of the vehicle including the Sensor-Motor mapping characteristics in brief words and using a sketch and a diagram.

Assignment 55 (2/2 points)

SMPA architectures are divided into four main parts:

- **Sense**: Take information from the sensors (I.e. one sensor has a very low distance)
- **Model**: Use the sensor data to model the world (I.e. low distance means close to an object. Maybe a forthcoming collision).
- **Plan**: Use the model to plan the next step (I.e. calculate a plan to avoid the forthcoming collision)
- **Act**: Execute the plan. (I.e. accelerate left motor to avoid collision)

Assignment 56 (2/2 points)

A type 1 Braitenberg vehicle in a perfect world could only driver forward or backward. Depending on the environment it would drive faster or slower. The stochastic component is responsible for slight random left or right turns of the vehicle (the motor). Only with that component the vehicle can do **exploration**.

Assignment 57 (1/1 points)

Imaging the vehicle is used as a minesweeper. The sensor measures the proximity to a mine, the type 3a vehicle would efficiently drive to it and stop in front of it while type 2b would run right through it and explode :)

Assignment 58 (2/2 points)
Braitenberg 3-b vehicles have the tendency to get stuck in corners with 2 possible outcomes:

- the vehicle proceeds to oscillate in the corner similar to type II cellular automata
- the vehicle stabilises at the local minima by facing the corner directly, similar to type I cellula automata

Possible strategies to circumvent this effect are largely based on 2 different approaches: using sensory information as input to actuators or collecting input for building a map or a representation of the world.

- The Nearness Diagram - By using some diagrams, the proximity of obstacles and areas of free space are identified and used to define a set of situations, and to implement laws of motion for each situation. This approach allows a vehicle to avoid a corner because the free walking areas lie outside of the corner.

Resource: http://tinyurl.com/5tcy8km

- The Elastic Band Concept - the concept of an elastic band represents a collision free path for the vehicle. The initial shape of the elastic is the free path generated by a planner. Subjected to artificial forces, the elastic band deforms in real time to a short and smooth path that maintains clearance from the obstacles. The elastic continues to deform as changes in the environment are detected by sensors, enabling the vehicle to accommodate uncertainties and react to unexpected and moving obstacles. Reliance on this method will allow the vehicle to avoid getting stuck in corners.

Reference: http://tinyurl.com/6feylqe

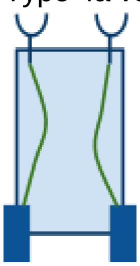
Assignment 59 (3/4 points)

The task of the mentioned wall following robot is to to follow the continuous wall on its right, including any bends and corners that it might contain. The robot has 2 sensors at the opposite ends of its right side. It has 2 pairs of wheels that are situated right below the sensors, both pairs of wheels turn at the same time with the same velocity.

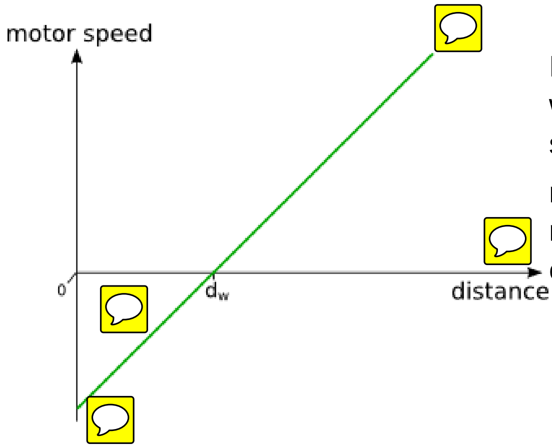
A genome x for such a robot consists of 2 variables that represent both the sensors: $x = \{x_1, x_2\}$. The best fitness is considered to be one where both sensors show the same distance from the wall, ie the smaller the difference between the readings of the two sensor readings, the better it is. Fitness function is hence: $f(x) = | x_1 - x_2 |$

Assignment 60 (2/4 points)

Type 4a vehicle with two sensors that measure the distance to the given object.



Sensor-Motor mapping:



If the vehicle is closer to the object then d_w the motor will have negative speed (drives backwards). If the sensor measures exactly the working distance, the motor stops. If the distance is higher than d_w the motor drives forward but slows down if the vehicle comes closer.

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jaana:
problems:
- the genome should also include the direction of movement, otherwise the robot will try to go as close to the wall as possible (scratch).

Better alternatives:

1) fn keeps the robot at a certain distance from the wall (unlike my solution):
(in case of distance sensor) $f(x) = \min(x1,x2) - |x1-x2|$
or (in case of proximity sensor)
$f(x) = \max(x1,x2) - |x1-x2|$

2) you could also implement the same above as an integral fn, ie punishing deviations from the ideal path: $f(x) = -A$

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jaana:
Problem: is supposed to be 3a vehicle