Evolutionary algorithm

for autonomous cleaning robot

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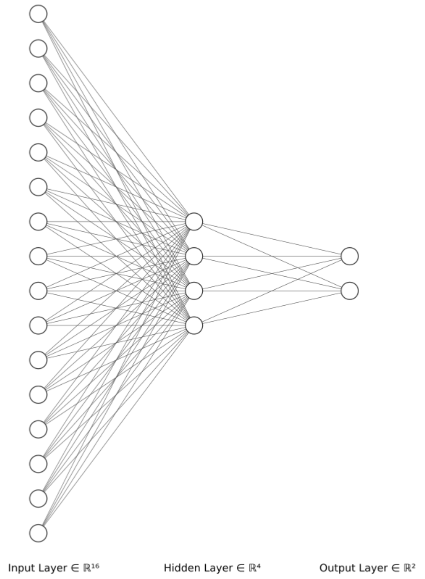
1. **Control**



- controller is neural network with architecture
    - 16 input nodes (12 sensory inputs, 4 recurrent inputs)
    - 4 hidden nodes
    - 2 output nodes (left and right motor velocities)
- activation function is tanh
- recurrent nodes are initialized with random values between 1 and maximum sensor reach

2. **Morphology**

We used our own mobile robot simulator which was developed for the previous assignment.

3. **Genetic representation**
    - binary representation
    - weights (0.01-0.001) encoded, first with integers between 10 and 100 which are then encoded as 7-digit binary numbers
    - entire genotype → 72 weights as 504-digit binary numbers (consists of 64 weights (12 for sensory inputs, 4 for recurrent inputs to 4 hidden nodes) for input/hidden layer and 8 weights for hidden/output layer)

4. **Population size**
    - population size = 30

5. **Initialization (of genotypes)**
    - random distribution between 0.01 and 0.001

6. **Fitness function**
    - maximizing cleaned area, punishment of wall collisions (value sensor = 0)
    - fitness = $\frac{cleaned\ area}{total\ area} * \prod_{i}^{n*s} \frac{value\ sensor\ i}{max\ sensor\ reach}$

with n as number sensors, s as number steps in simulation, total area as room area.

7. **Selection and reproduction**
    - truncated rank based selection: n_best_percentage = 0.8
    - generational replacement, in case of uneven population size, use more copies of best performing individuals

8. **Crossover and mutation**
    - crossover_percentage = 0.2
    - mutation_percentage = 0.05
    - crossover:
        - use random individuals
        - split at random position and switch bits
    - mutation:
        - flip random bit
        - in case this results in illegal weight (representation): generate random weight and turn this weight into binary representation

9. **Stop criterion**
    - terminates after stagnating fitness for 5 generations