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Exercise Sheet 2
Intelligent Systems - WS 23/24

Exercise 1: Questions

(Pkt.)

For the following claims, decide whether they are true or false. Give reasons for your decision.

(a) The depth-first search always expands at least as many nodes as the A* search with admissible heuristics.

(b) $h(n) = 0$ is an admissible heuristic for the 8-puzzle.

(c) The A* algorithm is usually not applicable in the field of robotics, since perceptions, states and actions are continuous.

(d) Breadth-first search is complete even if step costs of 0 are allowed.

(e) On a chessboard, a rook can move in a straight line vertically or horizontally any number of squares, but it cannot jump over other pieces. Manhattan distance is an admissible heuristic for the problem of moving the rook from square A to square B with the least number of moves.

Exercise 2: Tree Search

(Pkt.)

Imagine a state space in which the starting state is the number 1 and each state K has two successors: number $2K$ and $2K + 1$.

(a) Draw the state space for states 1 through 15.

(b) Assuming the target state is 11, in what order is node expansion performed using the following search algorithms?

(i) Breadth search

(ii) Limited depth search with $l = 2$

(iii) Iterative depth search

(c) Would a bidirectional search help here? What is the branching factor in each direction?

Exercise 3: Monte Carlo Tree Search

(Pkt.)

Use Monte Carlo Tree Search to find the largest entry in the following matrix. One action corresponds to selecting one of the four areas. Thus, to select an entry you need 3 actions.
You have a budget of exactly 11 rollouts. Choose $c = 5$ as your exploration hyperparameter.

30	33	39	38	32	34	55	53
41	50	49	54	42	45	62	66
32	41	44	49	40	40	55	58
45	45	46	59	49	52	64	65
37	37	43	44	38	42	53	54
48	51	48	58	46	52	64	71
40	45	43	57	45	58	56	65
50	48	58	59	59	66	70	77

Exercise 4: Monte Carlo Tree Search

(Pkt.)

Solve the OpenAI Gym domain *CartPole* (for one fixed seed) using Monte Carlo Tree Search.

Exercise 5: Questions

(Pkt.)

a. Use the matrix from exercise 3. Start from cell $(2, 5)$ and always greedily choose the best neighbor.

b. What happened and how does Tabu Search help prevent this?

c. At how many places of the Simulated Annealing algorithm is randomness used?

Exercise 6: Membership Functions (Fuzzy Sets)

(Pkt.)

The "fuzzyfication" of an input variable x is to be performed with the help of the fuzzy sets Z (zero), S (small), M (medium) and L (large). The membership functions $\mu(x)$ are tabulated as follows:

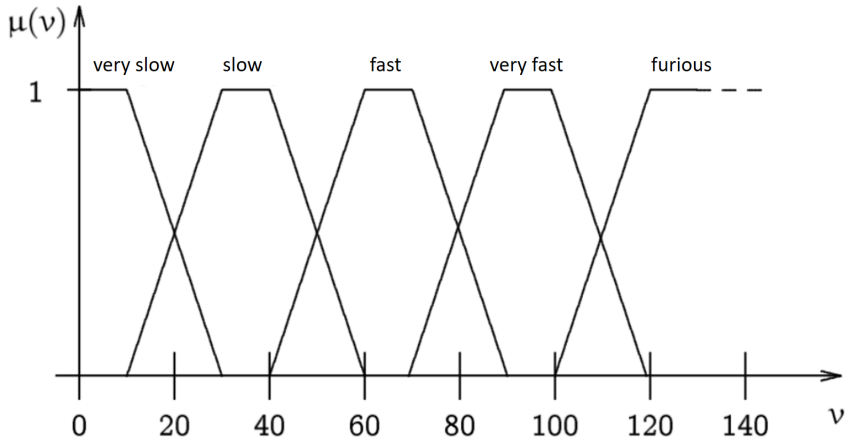
	0	1	2	3	4	5	6	7	8
Z	1	0	0	0	0	0	0	0	0
S	0	1	1	0.5	0	0	0	0	0
M	0	0	0	0.5	1	0.5	0	0	0
L	0	0	0	0	0	0.5	1	1	1

Draw the graphs of the membership functions and determine the membership measures for the input value $x = 3.5$. Assume that the sum of the memberships to the fuzzy sets for each input value is exactly 1.

Exercise 7: Fuzzy Operators

(Pkt.)

The speed v of a vehicle in a local area was “fuzzyfied” using the linguistic values very slow, slow, fast, very fast, furious. The following membership functions are used:



Specify the resulting fuzzy sets when the following operators are executed:

a. *very slow* OR *fast*

b. *slow* AND *fast*

c. NOT *fast*