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MATH. - NATURWISS. FAKULTÄT
FACHBEREICH INFORMATIK
KOGNITIVE SYSTEME · PROF. A. ZELL

Artificial Intelligence

Assignment 5

Assignment due by: 30.11.2016, Discussion: 6.12.2016

Question 1 AND - OR search trees (RBFS) (6 points)

Draw the AND - OR search trees that represent the two following situations. The states and actions should be visible on the trees. Use all the states and actions given on the tables. Feel free to add up to 5 more states and/or actions.

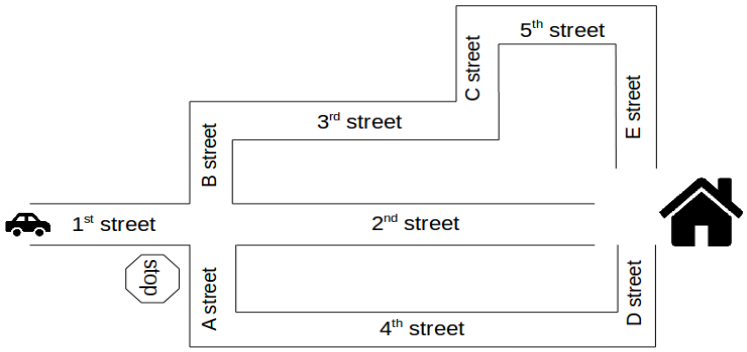

Table 1.

States	States	Actions
Driving on 1st street	Asking for a ride	Driving
Driving on 2nd street	Got the ride	Break
At stop signal	Without ride	In a ride
Crashed	Home	Walking

Table 2.

States	Actions
On x street	Right
home	Left

(a) You are an agent driving a car along 1st street, your goal is to get home. However, you are allowed to take only 2nd street. There is a stop signal at the intersection, where you have to decide if it is better to break or to continue driving. Take into account that in case you decide to continue, a car may come along A street. If you crash, you may either continue on your way or stop and ask for a ride. Table 1 describes your possible states and actions.

(b) You are an agent on 1st street whose goal is to get home, but cannot take 2nd street. However, sometimes your engine stops when you try to turn, thus you do not move (i.e. you do not change state). Table 2 specifies your possible states and actions, replace x street with the required street from the drawing. Use the state "On x street" either you are driving or still. The stop signal can be ignored.

Question 2 Newton's method (1+2+1+3=7 points)

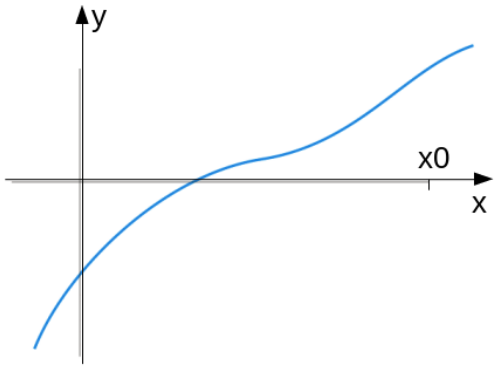

figure a

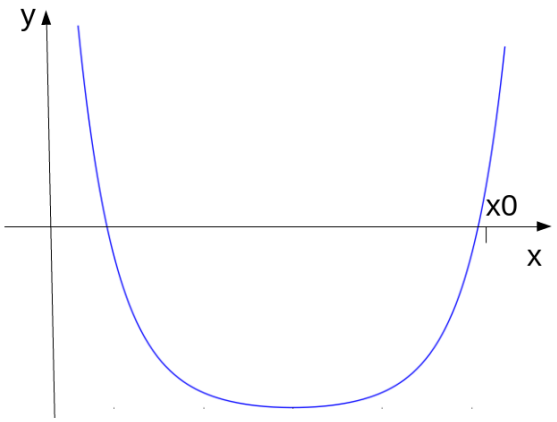

figure b

(a) Using the function displayed in the left figure, and without computation, draw the details of the first three steps of the Newton's method to find the root of the function.

(b) Using the function displayed in the right figure, and without computation, draw the details of the first three steps of the Newton's method to find the minimum of the function.

(c) Draw an example where Newton's method fails to converge to the root of a real valued function $y = f(x)$ with $x \in \mathbb{R}$.

(d) Detail the first two steps of Newton's method when trying to find the minimum of the following function:

$$f(x_1, x_2) = x_1^2 - x_1^3 + \exp(x_1) - \exp(-{x_2}^2) - 2\,\exp(-(x_2 - 7)^2) \qquad (1)$$

with $(x_1, x_2) \in \mathbb{R}^2$. Use the starting point $(x_1, x_2) = (-1, 0.1)$. For each step specify the gradient, the Hessian and the inverse of the Hessian of the function. What is the global minimum of this function? Is the Newton's method proposed converging to this minimum? If not, provide a starting point which allows to converge to the global minimum.

Question 3 Genetic Algorithms with LISP (4+3 = 7 points)

(a) Implement a genetic algorithm in LISP to solve the eight queens problem (as shown in the lecture slides). You should use the fitness function $f = 28 - \#\text{conflicts}$ (where conflicts are counted as in Chapter 4, Slide 8) and Roulette-Wheel selection for parents (probability of being chosen as a parent $p_i = \frac{f_i}{\sum_j f_j}$). The mutation rate should be such that on average, one queen moves in each configuration. *Hint:* you can use `(loop for i from 1 to population collect (make new child))` to make the new population, also `(random n)` returns a random integer from 0 to $n - 1$.

(b) Try out your algorithm with varying population sizes or try a different fitness function $f_{new} = f^2$ (or even higher exponents) to see what configuration on average gives the answer in the smallest amount of individuals (population size * number of generations). Report and explain your findings.