Habib University
CSE 351 - Artificial Intelligence
Fall' 2019
Assignment 1

40 Points

Objective:

The objective of this assignment is to give students hands-on experience with Search and Optimization and make them understand the inner working of some search and optimization techniques.

Question 1 – Problem Solving via Search [25 Points]

You have to do a generic implementation of A* algorithm that can solve variety of search problems. The task is divided into following parts:

a) Framing a Problem [10 points]

An interface of Search problems is provided to you in the form of an abstract base class in python[1] which contains following functions:

- getStartState
- isGoalState
- getSuccessors
- getCostOfActions
- getHeuristic

You have to formulate the following two problems as search problems by implementing the given interface for both of them.

8-Puzzle Problem

8-puzzle consists of an area divided into a 3*3 grid. Each cell of the grid represents a tile numbered from 1 to 8 (in any order) with one tile being empty. A tile that is next to the empty cell can be moved into the empty space, leaving its previous position empty in turn. The aim of the puzzle is to achieve a given configuration of tiles from a given (different) configuration by sliding the individual tiles around the grid as described above.
Some supporting code for 8 puzzle is provided with this assignment.

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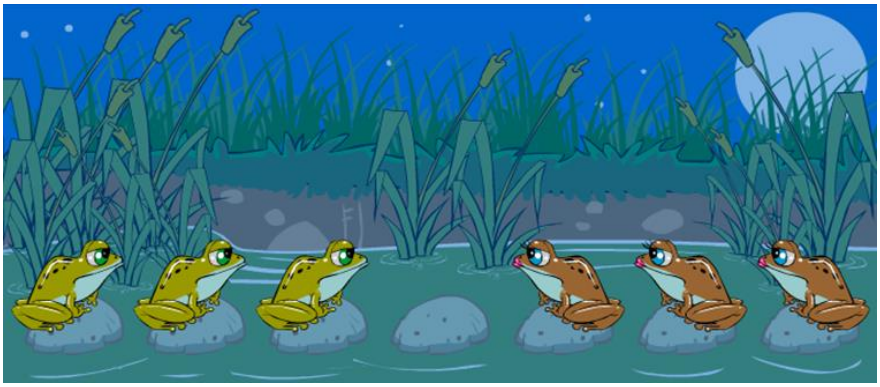
[1] Some resources for this assignment have been taken from `http://ai.berkeley.edu`.

Jumping Frogs

The puzzle involves seven rocks and six frogs. See Fig. 1. The seven rocks are laid out in a horizontal line and numbered left to right. The six frogs are evenly divided into a green trio and a brown trio. The green frogs sit on Rocks 1, 2, and 3, facing right. The brown frogs sit on Rocks 5, 6, and 7, facing left. Rock 4 is vacant.



The challenge is to transpose the trios, jumping the green frogs to Rocks 5, 6, and 7 and the brown frogs to Rocks 1, 2, and 3. Their movement is restricted. A frog can only jump forward, either hopping to a vacant rock one place ahead (cost =1) or leaping over its neighbor frog to a vacant rock two places ahead (cost = 2).

b) Solving a Search Problem [09 points]

Develop your search agent that takes a Search Problem and return its solution using A* algorithm. The same implementation should be used to solve both problems given in part (a).

c) Knowing A* [06 Points]

i. Why is it important to have admissible heuristic in A* to ensure optimality?

ii. In addition to admissibility, A* also requires monotonicity in graph based problems. You are required to do some reading to understand monotonicity requirement of A*. Describe it in your own words.

Question 2 – Optimization [15 Points]

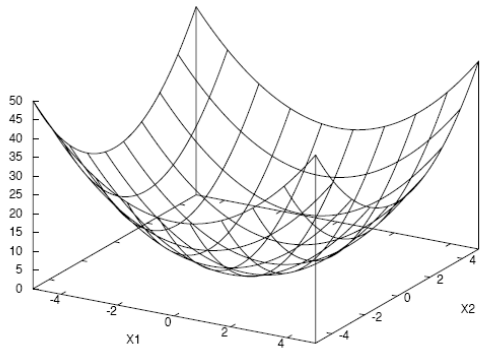
a) Simulated Annealing [10 points]

Implement Simulated Annealing algorithm to find global maximum/minimum of any function. The following functions will be used as examples:

The range of x and y can be seen in plots below. Make sure that you are handling boundary values appropriately.

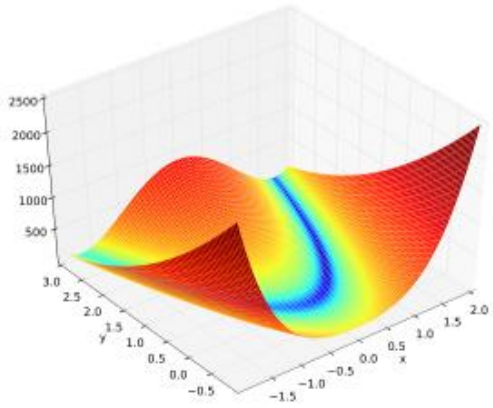
Sphere Function

$$f(x, y) = x^2 + y^2$$
$$-5 \leq x, y \leq 5$$



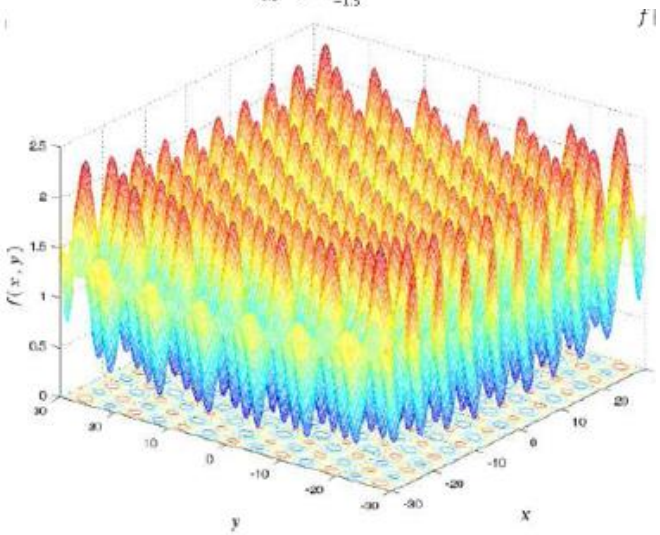
Rosenbrock Function

$$f(x, y) = 100 * (x^2 - y)^2 + (1 - x)^2$$
$$-2 \leq x \leq 2, -1 \leq y \leq 3$$



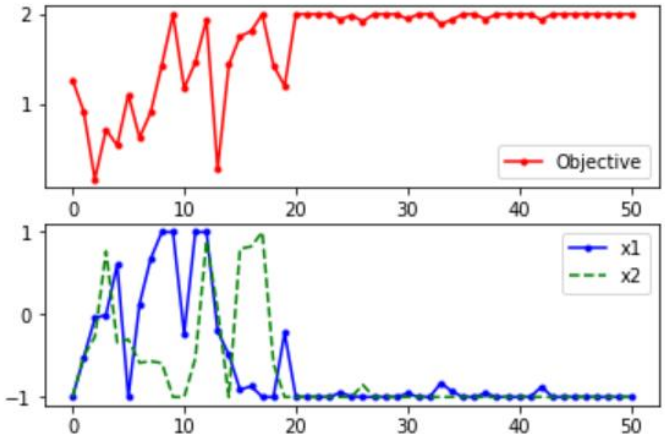
Griewank Function

$$f(x,y) = \frac{x^2+y^2}{4000} - \cos(x)\cos\left(\frac{y}{\sqrt{2}}\right) + 1$$



b) Plotting Graphs [05 point]

You are required to give visibility of execution of your SA algorithm by plotting graphs of **x**,**y** and **f** as shown below. You can use matplotlib library in python to plot these graphs.



c) Search vs Optimization [05 points]

What difference do you see between Search and Optimization problems? Give five real-world examples of both types of problems.

Submission Instructions

Submissions will be made on the LMS by the due date (announced on LMS). No email submission will be accepted. The submitted file should be in the form of a ZIP file named as **<studentid>_Ass1** containing separate files/folders named Q1 and Q2 for the source code of both questions. The zip file will also contain a pdf answering theory questions (Q1-c and Q2-c).