CSC 396 : Introduction to Artificial Intelligence

Exam 1

March 11th - 13th, 2008

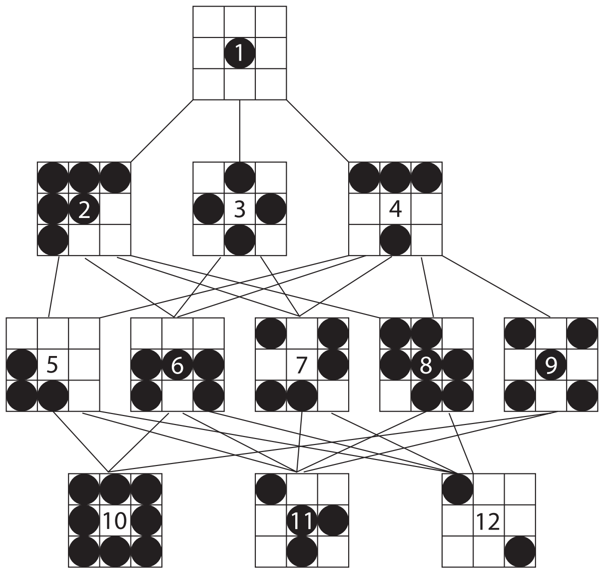
Name ————————————————————

Signature ———————————————————-

Honor Code

This is a take-home exam. You may use your book and lecture notes from class. You many not use the internet or other resources. You may not talk with any other students about this exam. This exam is due at 11:00 am on March 13th. Place it under my office door when you have finished the exam. You may use other sheets of paper as necessary. You must show your work for full credit.

1 Searching



A variant of the solitaire puzzle Lights Out has the state space above, with all symmetrical game states compressed into one. State 1 is the initial state, and state 10 is the goal state. An action is to select one i, j position, and reverse the state of each square in the ith row and jth column.

1.1

What is the order of nodes expanded in **Breadth First Search**? If there is a tie, order the nodes based on their numbering above.

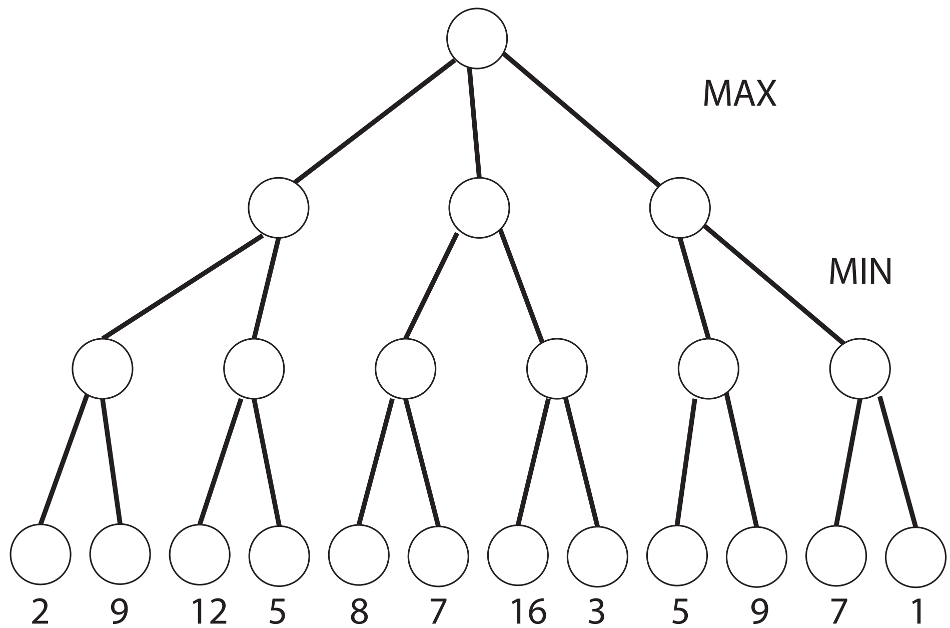
1.2

You are given an heuristic function $h(x) = 9$ - number of black squares. What is the order of nodes expanded in **Best First Search** using this heuristic? If there is a tie, order the nodes based on their numbering above.

1.3

Is this heuristic **admissible**? Why or why not?

2 Abstract Game Playing



Perform alpha-beta pruning on the above game tree, searching from left to right. Clearly mark all pruned paths and nodes, and report the optimal path.

3 Local Search

3.1

You are solving a *minimization* problem using Simulated Annealing. Our current node c has a score of 45. You randomly select a neighbor r with score 52. What is the probability of replacing c with r when the temperature is 47?

3.2

We are using an Evolutionary Algorithm for a *maximization* problem, and have the following population and evaluation scores:

Individual	Score
C	5
D	25
E	16
F	44
G	10

3.2.1

What is the probability of **B** being selected to reproduce during one round of Proportional Fitness Selection?

3.2.2

What is the probability of **B** being selected to reproduce during one round of Tournament Selection?

3.3

You are solving the Traveling Salesperson Problem with 7 cities, and have the following two solutions:

A = 1—2—3—4—5—6—7

B = 1—3—2—7—5—4—6

3.3.1

If we choose cut points after the first city and before the fifth city, what would be the result of using the OX crossover?

3.3.2

Generate one child using the ER crossover method.

4 Economic Game Theory

Two players A and B are playing a game with the following payoff matrix for player A:

	A1	A2
B1	4	-1
B2	-2	3

4.1

What is the optimal mixed strategy for player A?

4.2

What is the expected value for this optimal strategy?

5 The Bin-Packing Problem

The bin-packing problem is defined as follows: Suppose that we are given a set of n objects, where the size s_i of the ith object satisfies $0 < s_i < 1$. We wish to pack all the objects into the minimum number of unit-size bins. Each bin can hold any subset of the objects whose total size does not exceed 1. (From Cormen, et al.)

For example, with $n = 8$ and object sizes {.35, .67, .2, .17, .84, .45, .55, .04 },

A = 2, 3 — 1 — 4, 6 — 5, 8 — 7

B = 1, 3 — 2 — 4, 6, 8 — 5 — 7

represent legal solutions with 5 bins where each bin is delimited by the — symbol. An illegal solution of 4 bins would be

C = 1, 3, 7 — 2, 4 — 5 — 6, 8

since the total size of subset 1, 3, 7 in the first bin is .35 + .2 + .55 = 1.1.

In this problem you will design an Evolutionary Algorithm to solve the bin-packing problem, namely the evaluation function, mutation operator, and crossover operator. Your solution will be graded on the legality of your functions and operators as well as how well they work in coordination to solve the bin-packing problem.

5.1

Describe an *evaluation function* for this representation. Your function must distinguish between the solutions **A** and **B** in the example above.

5.2

What are the evaluation scores for **A** and **B**?

5.3

Describe a *mutation* operator that generates legal solutions for this representation.

5.4

Calculate the size of the neighborhood for your operator.

5.5

Demonstrate your operator by showing two possible neighbors of solution **A**.

5.6

Describe a legal **crossover** operator for this representation.

5.7

Demonstrate your operator on **A** and **B**.