

CISC-365\*  
Test #4  
March 26, 2019

Student Number (Required) \_\_\_\_\_

Name (Optional) \_\_\_\_\_

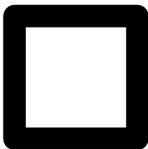
This is a closed book test. You may not refer to any resources.

This is a 50 minute test.

Please write your answers in ink. Pencil answers will be marked, **but will not be re-marked under any circumstances.**

The test will be marked out of 50.

Question 1	/15
Question 2	/35
<b>TOTAL</b>	<b>/50</b>



By writing my initials in this box, I authorize Dr. Dawes to destroy this test paper if I have not picked it up by April 30, 2019.

*"If you don't go out on the branch, you're never going to get the best fruit"*

*Sarah Parish*

### Question 1 (15 marks)

Suppose we are solving a minimization problem using the Branch and Bound technique. Let  $P$  be a **partial solution**, and let  $l$  and  $u$  be the lower and upper bounds computed for  $P$ .

(a) [5 marks] Is it possible for some full solution that expands on  $P$  to have an actual cost  $x$  where  $x > \text{Global Upper Bound } U$ ? Explain your answer.

(b) [5 marks] Is it possible for a partial solution  $P'$  that expands on  $P$  to have bounds  $l'$  and  $u'$  such that  $l' < l$ ? Explain your answer.

(c) [5 marks] Is it possible for a partial solution  $P'$  that expands on  $P$  to have bounds  $l'$  and  $u'$  such that  $l' > u'$  ? Explain your answer.

Question 2 (35 marks):

You have accepted the job of coordinating a camping trip for a group of Canadian politicians. You are providing them with tents – each tent can accommodate exactly **four** campers. Your task is to divide the campers into groups of four. Fortunately the group contains 32 members so you know you will need exactly eight tents. The tents are numbered 1 to 8.

Unfortunately the members of the group don't like each other very much. You have been provided with a matrix  $A$  that records the levels of dislike between the individuals.  $A[i,j]$  = the level to which Person  $i$  dislikes Person  $j$ . Note that it is not necessarily true that  $A[i,j] = A[j,i]$ . The values in  $A$  are all in the range  $[1 .. 10]$

The Unhappiness in a tent is the sum of the dislike values each person in a tent feels towards the other three people in the tent. The Group Unhappiness is the **maximum** of the Unhappiness of all the tents. For example if the Unhappiness values for the tents are  $\{18, 24, 16, 19, 12, 17, 33, 27\}$  then the Group Unhappiness is 33.

In this question you will design a Branch and Bound algorithm to find the assignment of campers to tents that **minimizes** the Group Unhappiness.

For most parts of this question there are several possible answers. Answers that show deeper understanding of Branch and Bound methods will earn higher grades.

- (a) [4 marks] Suppose there is a predefined function  $F(P,t)$  that returns the Unhappiness of tent  $t$  in solution  $P$ . Using this function, write code or pseudo-code to compute the Group Unhappiness for any solution  $P$ .

(b) [5 marks] Characterize your solution method as a sequence of decisions. Explain your reasoning.

(c) [6 marks] How will you compute the initial value of the *Global Upper Bound  $U$* ? Explain your reasoning.

(d) [6 marks] How will you compute the Cost So Far for partial solutions?  
Explain your reasoning.

(e) [8 marks] How will you compute the Guaranteed Future Costs for partial solutions? Explain your reasoning.

(f) [6 marks] How will you compute the Feasible Future Costs for partial solutions? Explain your reasoning.