

COSC 455
Midterm #2 Review Sheet
Spring 2016

For all problems that ask for the execution of an algorithm, show all work. For all problems that ask to design an algorithm, show correctness.

0.) Consider encoding a data string containing $\Gamma = \{A, B, C, D, E, F, G\}$ with frequency (in percentage) $F = \{40, 10, 2, 20, 3, 5, 15\}$. Use Huffman prefix-free encoding and list the bit string symbols for each symbol in my alphabet. Draw the binary tree representation of the encoding.

1.) Given the strings

$x = \text{"SNOWY"}, y = \text{"SUNNY"}$

show the table that is created by running the edit distance algorithm introduced in class.

2.) Given the items:

- A, value = 12, size = 5
- B, value = 6, size = 3
- C, value = 5, size = 2
- D, value = 2, size = 1

Determine what items are chosen given a knapsack of size 21 using the knapsack without repetition algorithm.

3.) Define dynamic programming.

4.) Design a dynamic programming solution (via pseudocode) for the maximum contiguous subsequence sum problem. You should take in an array of integers, S , and output a list containing consecutive elements of S that has the maximum sum.

5.) Define linear programming.

6.) (Hillier and Liberman) The WorldLight Company produces two light fixtures (products 1 & 2) that require both metal frame parts and electrical components. Management wants to determine how many units of each product to produce so as to maximize profit. For each unit of product 1, 1 unit of frame parts and 2 units of electrical components are required. For each unit of product 2, 3 units of frame parts and 2 units of electrical components are required. The company has 200 units of frame parts, and 300 units of electrical components. Each unit of product 1 gives a profit of \$1, and each unit of product 2 gives a profit of \$2. Any excess over 60 units of product 2 brings no profit, so such an excess has been ruled out. Formulate this problem as a linear programming problem.

7.) (Dasgupta) A cargo plane can carry a maximum weight of 100 tons and a maximum volume of 60 cubic meters. There are three materials to be transported, and the cargo company may choose to carry any amount of each, up to the maximum available limits given below:

- Material 1 has density 2 tons/cubic meter, maximum available amount 40 cubic meters, and revenue \$1000 per cubic meter.
- Material 2 has density 1 ton/cubic meter, maximum available amount 20 cubic meters, and revenue \$1200 per cubic meter.
- Material 3 has density 3 tons/cubic meter, maximum available amount 30 cubic meters, and revenue \$2800 per cubic meter.

Formulate and solve via simplex.

8.) Define NP. Define NP-complete. What is a general-purpose approach to solving a NP problem?

9.) Show that vertex cover is NP-complete. A vertex cover is defined as a set $S \subseteq V$ such that every edge is incident (next to) a vertex in S . The problem is formulated as:

INSTANCE: Graph G , positive integer k

QUESTION: Does G have a vertex cover of size at most k ?