ALGORITHMS AND INFORMATION SYSTEMS (CT102)

Dr. M. Mc Gettrick

Time allowed: *one* hour.
Attempt *three* questions.

1. Write down (step by step) the position of each letter in the word DUBLIN when sorted using **insertion sort**. Exactly how many comparisons are required in this insertion sort? Sketch why the best case behaviour of this sorting algorithm is $\mathbf{O}(n)$.

2. (a) Write (in pseudocode) an algorithm that calculates x^n (for any number x and any positive integer n) using the idea of **binary powering**.

   (b) Explain why it may take more time for this algorithm to calculate 11^{31} than 11^{32}.

3. In a **Knapsack** problem we have to chose amongst certain items to fit in to a limited capacity container. Suppose we have five (5) items, labelled A, B, C, D and E, and only one of each item is available. The following gives the weight (in kilograms) and value (in kilo euro) of each item:

	A	B	C	D	E
weight	5	7	4	8	2
value	9	12	7	16	5

   (a) Suppose the weight capacity of the container is nine (9) kilograms. Calculate which items we would chose using a **greedy strategy** based on

   i. minimizing the weight
   ii. maximizing the value
   iii. maximizing the value/weight ratio

   From observation, does any of these approaches give the best answer (if so, state which one: if not state the best answer)?

   (b) Repeat the calculations in part (a) for a container with capacity sixteen (16) kilograms.

4. (a) Consider the graph described by the sets $V = \{A, B, C, D, E, F\}$ and $E = \{(B, C), (C, E), (E, F), (F, D), (D, E), (F, C), (D, C)\}$

   i. Draw the graph
   ii. State whether or not it is
      A. cyclic
      B. connected

   (b) Suppose we have an algorithm A1 which is $\mathbf{O}(n)$ and an algorithm A2 which is $\mathbf{O}(2^n)$. For an input of $n = 300,000$ both algorithms run in 1,100,000 seconds. Calculate approximately (to the nearest second) how long you would expect each algorithm to run for an input of $n = 300,003$.

Beannachtaí na Nollag oraibh go leir