Algorithms Overview (6 pages; 22/11/23)

Purposes of algorithms

Q1 (i) By performing traces, or otherwise, establish what the following algorithm achieves.

10 Input $\boldsymbol{N}$

20 $\boldsymbol{e = 0.0001}$

30 $\boldsymbol{L = 1000}$

40 $\boldsymbol{F = 0}$

50 $\boldsymbol{x = \frac{N}{2}}$

60 $\boldsymbol{y = \frac{N}{x}}$

70 $\boldsymbol{z = x}$

80 $\boldsymbol{x = \frac{x+y}{2}}$

90 If $\boldsymbol{|x - z| < e}$ Then Goto 130

100 $\boldsymbol{F = F + 1}$

110 If $\boldsymbol{F > L}$ Then Goto 140

120 Goto 60

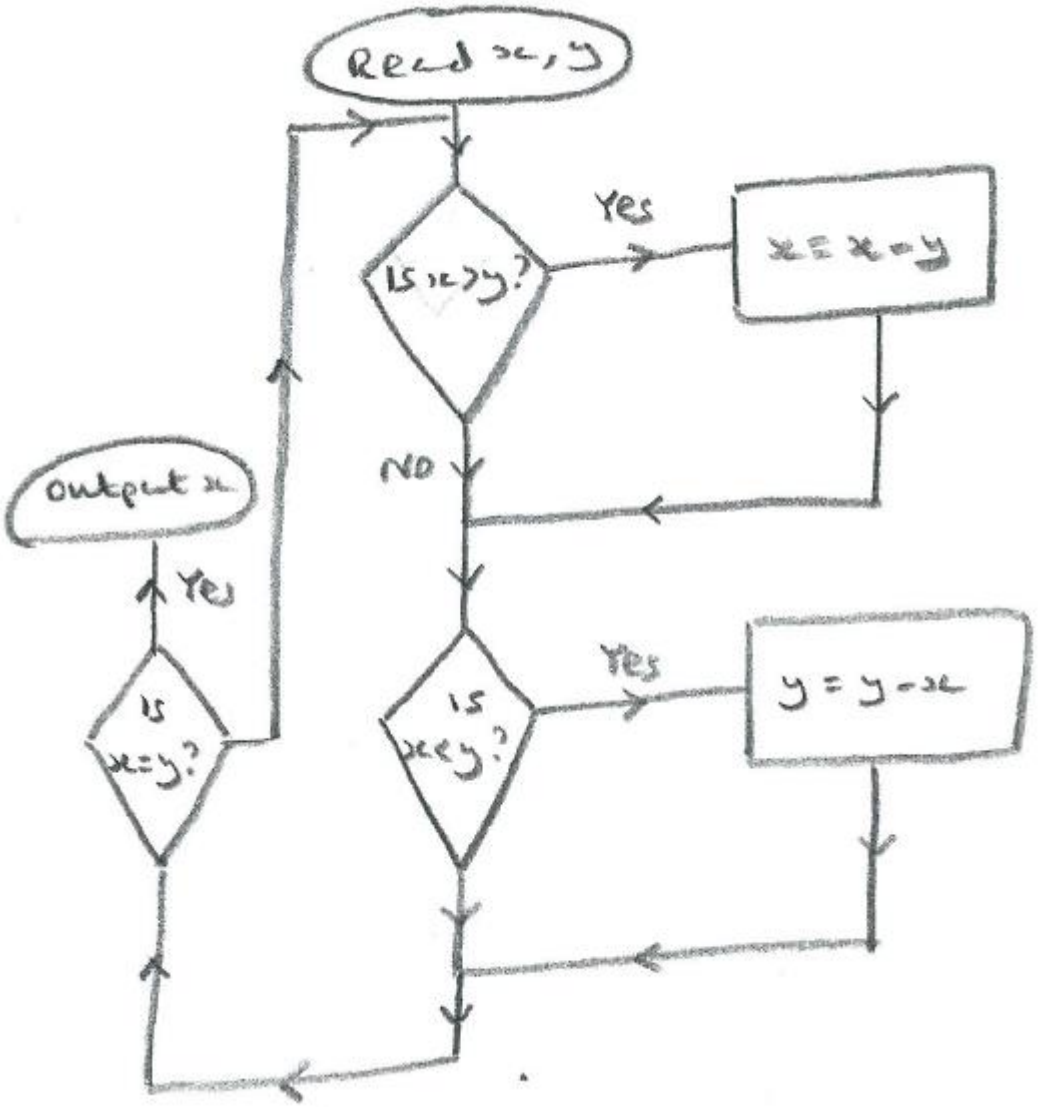
130 Print $\boldsymbol{x}$

140 Print "End"

150 END

(ii) What roles do ***e***, **F and *L*** play in the algorithm?

Q7 By performing traces, or otherwise, establish what the following algorithm achieves.



Q8 By performing traces, or otherwise, establish what the following algorithm achieves.

Step 1: Two positive integers are entered.

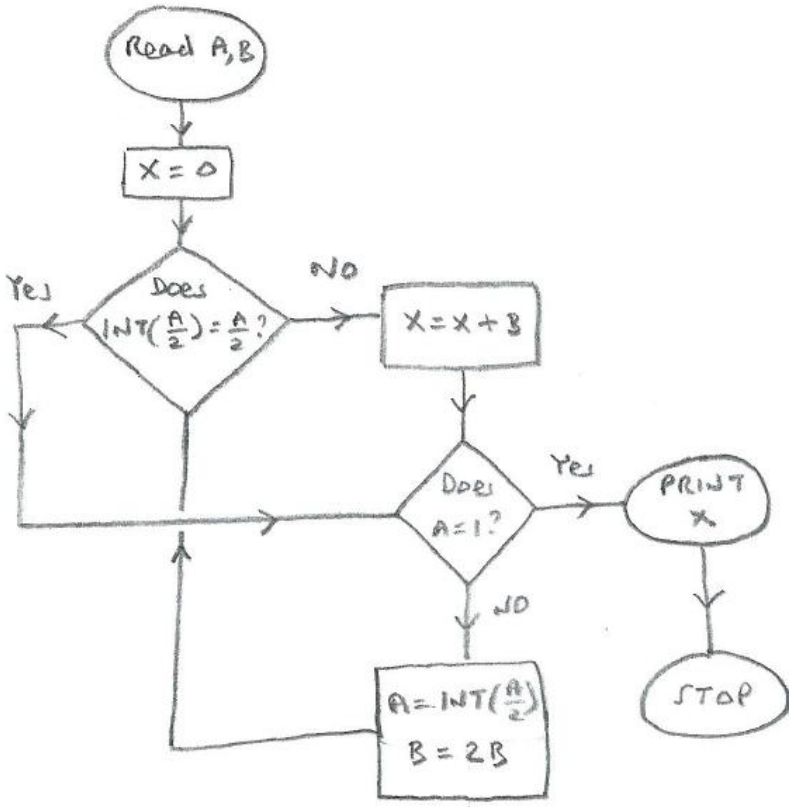
Step 2: If the two numbers are equal, then output their common value. Otherwise go to Step 3.

Step 3: Divide the larger number by the smaller one (possibly with a remainder). Then go to Step 4.

Step 4: If the division from Step 3 is exact, then output the divisor [ie the number that we are dividing by]. Otherwise go to Step 5.

Step 5: If the division carried out in Step 3 is not exact, then let the divisor and the remainder be the two new numbers, and go to Step 3.

Q9 Perform some traces for the following flowchart, in order to establish its purpose.



Bin Packing

Q3 A library needs to store away some of its books (to make way for more computers). Each of the storage boxes can contain 100 books. The shelves to be stored have the following contents, and each shelf has to be stored in a single box.

Photography: 7 books
Fiction: 45 books
Pastimes: 13 books
History: 27 books
Art: 6 books
Computers: 19 books
Biographies: 44 books
Self-help: 15 books
Science : 21 books

(i) Apply the First-fit algorithm.
(ii) Apply the First-fit Decreasing algorithm.
(iii) Apply the Full bins method.

Q5 [E]

If the First Fit Decreasing method produces 54 | 3222 | 2 , with bins of size 10, what can be said about the other possible Bin Packing methods?

Q6 [M]

n items are to be packed in bins (all of a certain - unspecified - size) using the First Fit Decreasing algorithm. If the number of comparisons is to be used as a measure of the complexity of the algorithm, determine this complexity in the worst case.

Sorting

Q2 Use the Quick Sort algorithm to sort the following items into increasing order.

7 45 13 27 6 19 44 15 21

Q4 A list of n numbers is sorted by making passes through an algorithm.To make a pass, compare the 1st and 2nd numbers. If necessary, swap them so that the 1st number is less than or equal to the 2nd number. Then repeat with the 2nd and 3rd numbers, and so on until the $(n-1)$st and nth numbers have been dealt with.

Repeat until a pass occurs with no swaps.

What are the minimum and maximum number of comparisons that are required?