

## COMPUTER SCIENCE TRIPOS Part IA – 2019 – Paper 1

### 8 Algorithms (fms27)

- (a) Consider a Binary Search Tree. Imagine inserting the keys  $0, 1, 2, \dots, n$  (in that order) into the data structure, assumed initially empty.
- (i) Draw a picture of the data structure after the insertion of keys up to  $n = 9$  included. [2 marks]
- (ii) Clearly explain, with a picture if helpful, how the data structure will evolve for arbitrary  $n$ , and derive the worst-case time complexity for the whole operation of inserting the  $n + 1$  keys. [2 marks]
- (b) Repeat (a)(i) and (a)(ii) for a 2-3-4 tree, with some scratch work showing the crucial intermediate stages. [2+2 marks]
- (c) ... and for a B-tree with  $t = 3$ , again showing the crucial intermediate stages. [2+2 marks]
- (d) ... and for a hash table of size 7 that resolves collisions by chaining. [2+2 marks]
- (e) ... and for a binary min-heap. [2+2 marks]