8 Algorithms (RKH-DJW)

A 2-3 tree is analogous to a 2-3-4 tree but has only 2-nodes and 3-nodes.

(*a*) Show in detail the steps to build a 2-3 tree from the sequence {7,3,9,8,11,10}. Highlight any procedural differences to building a 2-3-4 tree.   [7 marks]

(*b*) A red-black tree can be based on a 2-3 tree. An example *red violation* for such a structure is sketched below, with red nodes represented using unfilled circles.
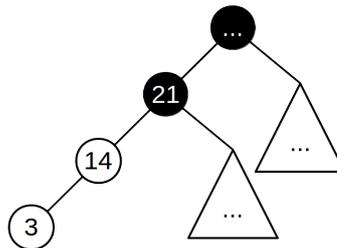
Sketch examples of the remaining red-violation cases, providing example values within the nodes. For each case, sketch its resolution, assuming each case occurs as a sub-tree of a larger tree.   [5 marks]

(*c*) Consider restricting the 2-3 variant of a red-black tree so that red nodes may only lie on the left of a parent.

(*i*) Discuss the effect this has on the search and insert performance. How does it impact the implementation?   [5 marks]

(*ii*) How does it affect the worst-case costs of finding the minimum and maximum values in the tree?   [3 marks]