2008 Paper 10 Question 9

Data Structures and Algorithms

(*a*) Take an initially empty hash table with five slots, with hash function $h(x) = x \bmod 5$, and with collisions resolved by chaining. Draw a sketch of what happens when inserting the following sequence of keys into it: `35, 2, 18, 6, 3, 10, 8, 5`.
[You are not requested to draw the intermediate stages as separate figures, nor to show all the fields of each entry in detail.] [3 marks]

(*b*) Repeat part (*a*) but with the following three changes: the hash table now has ten slots, the hash function is $h(x) = x \bmod 10$, and collisions are resolved by linear probing. [3 marks]

(*c*) Imagine a hash table implementation where collisions are resolved by chaining but all the data stays within the slots of the original table. All entries not containing key–value pairs are marked with a Boolean flag and linked together into a free list.

(*i*) Give clear explanations on how to implement the `set(key, value)` method in expected constant time, highlighting notable points and using high-level pseudocode where appropriate. Make use of doubly-linked lists if necessary. [8 marks]

(*ii*) Assume the hash table has 5 slots, is initially empty and uses the hash function $h(x) = x \bmod 5$. Draw five diagrams of the hash table representing the initially empty state and then the table after the insertion of each of the following key–value pairs: `(2, A), (2, C), (12, T), (5, Z)`. In the final diagram, draw all the fields and pointers of all the entries. [6 marks]