CMSC 420: Fall 2022

Solutions to Homework 4

Solution 1: The solutions are shown in Figs. 1–4. In the case of `insert(9)`, it has a sibling that can absorb an extra key and so we do a key rotation. In the case of `insert(2)`, the sibling is full, so we split the node. (We present two versions. In Fig. 2 we present the right-heavy split version discussed in the lecture notes and in Fig. 3 we present the left-heavy version.) This causes the parent to split, which results in the creation of a new root. In the case of `delete(22)`, the sibling node cannot provide a key, so we merge these nodes together.

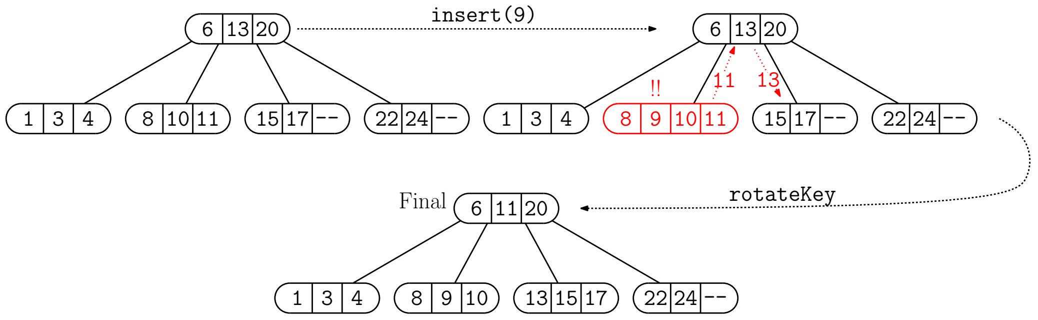

Figure 1: Solution to Problem 1(a): `insert(9)`.

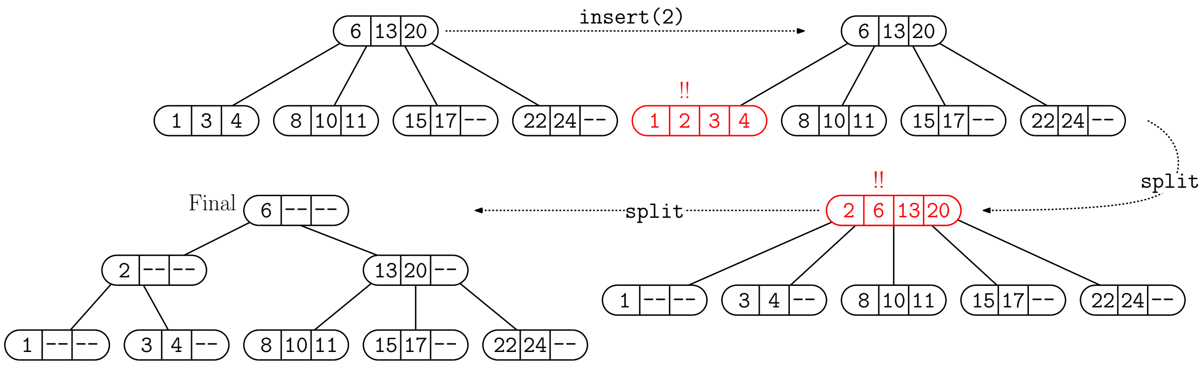

Figure 2: Solution to Problem 1(b): `insert(2)`. Right-heavy version.

Solution 2: See Fig. 5. The substring identifiers are shown (in suffix order) in the upper left. They are sorted lexicographically in the lower left. The final suffix tree is shown on the right.

Solution 3:

(a) The next available block of sufficient size is the block of size 8 at address 32. It is split into two blocks of size 4, and then the block at 32 is split into two blocks of size 2. The block of size 2 is returned, leaving the block of size 2 at 34, and the block of size 4 at 36 (see Fig. 6).

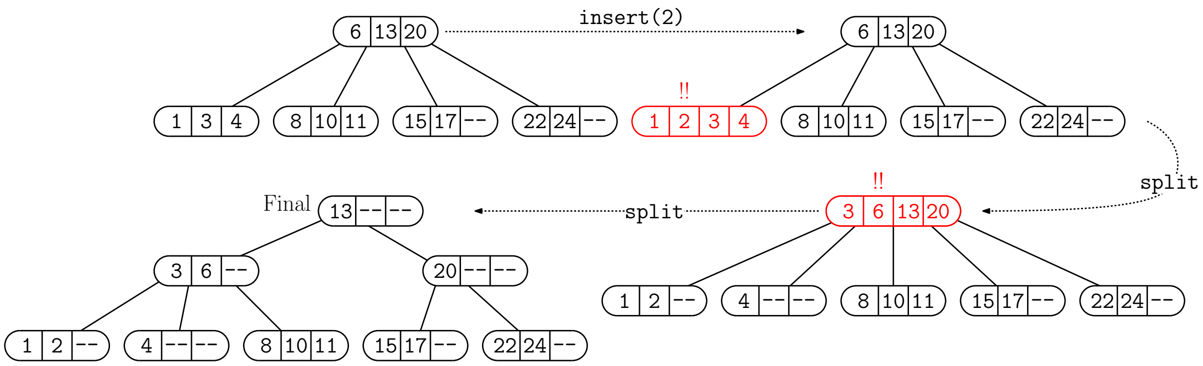

Figure 3: Solution to Problem 1(b): `insert(2)`. Left-heavy version.

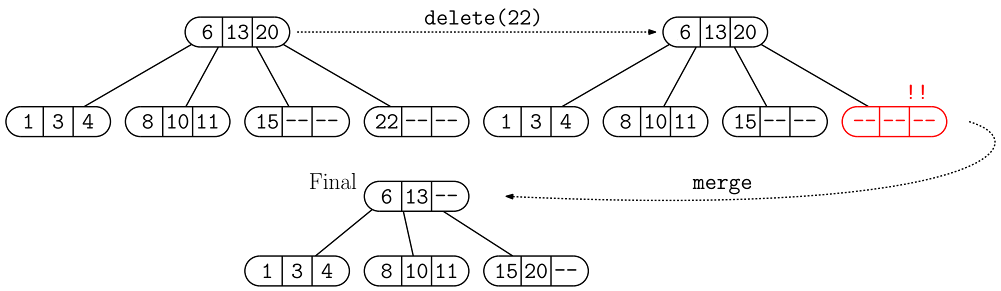

Figure 4: Solution to Problem 1(c): `delete(22)`.

	0	1	2	3	4	5	6	7	8	9	10	11
Text:	a	a	b	a	b	a	a	b	a	a	b	$

Index	Substring ID	Index	Substring ID
0	aabab	6	abaab$
1	abab	7	baab$
2	bab	8	aab$
3	abaaba	9	ab$
4	baaba	10	b$
5	aabaa	11	$

Index	Substring ID	Index	Substring ID
5	aabaa	9	ab$
0	aabab	4	baaba
8	aab$	7	baab$
3	abaaba	2	bab
6	abaab$	10	b$
1	abab	11	$

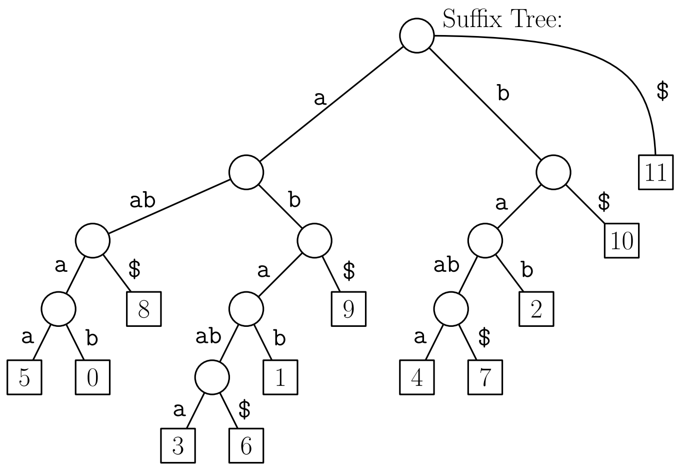

Figure 5: Suffix tree.

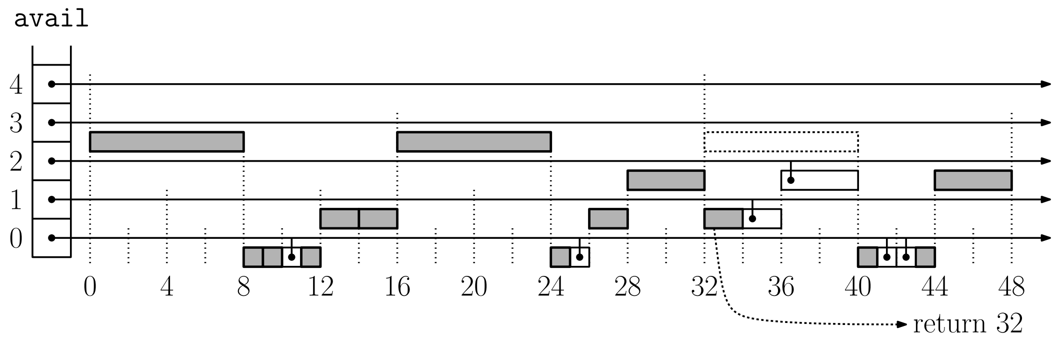

Figure 6: Buddy system allocation.

(b) Starting 24, we merge with the buddy at 25 to form a block of size 2 at 24. This is merged with its buddy at 26, resulting in a block of size 4 at 24. This is merged with its buddy at 28, resulting in a block of size 8 at 24.This is then merged with its buddy at 16, resulting in a block of size 16 at 16. (Note that the block of size 8 at 32 is not a buddy.) See Fig. 7

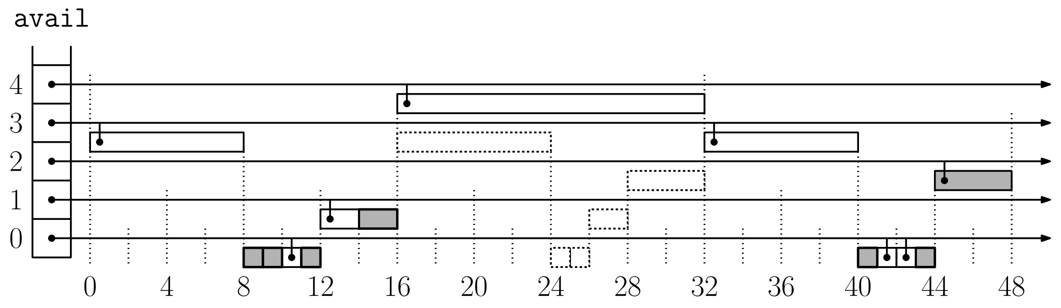

Figure 7: Buddy system deallocation.