# CSCI 551 HW5

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due by 11:59 PM on T 12/3/2019

1   Problem 1 (Sung P7.1)

Using the 2-approximation algorithm, we found a parsimony tree of parsimony length 5 (upper figure). We think that the maximum parsimony tree is of length 4 (lower figure). The 2-approximation algorithm found a tree whose parsimony length was less than two times worse than that of the most parsimonious tree.
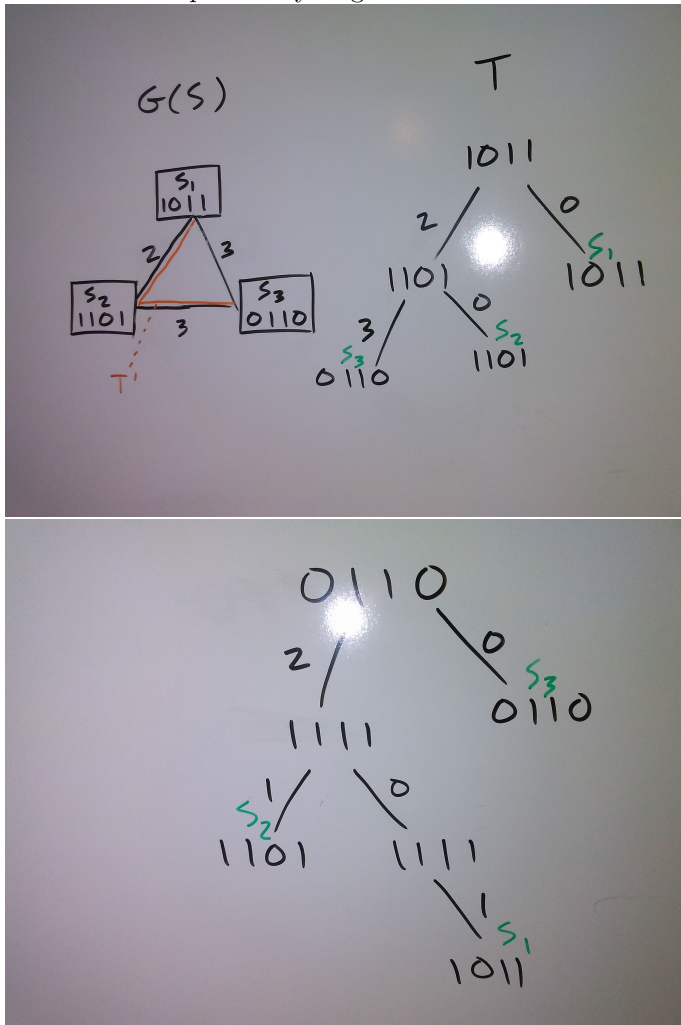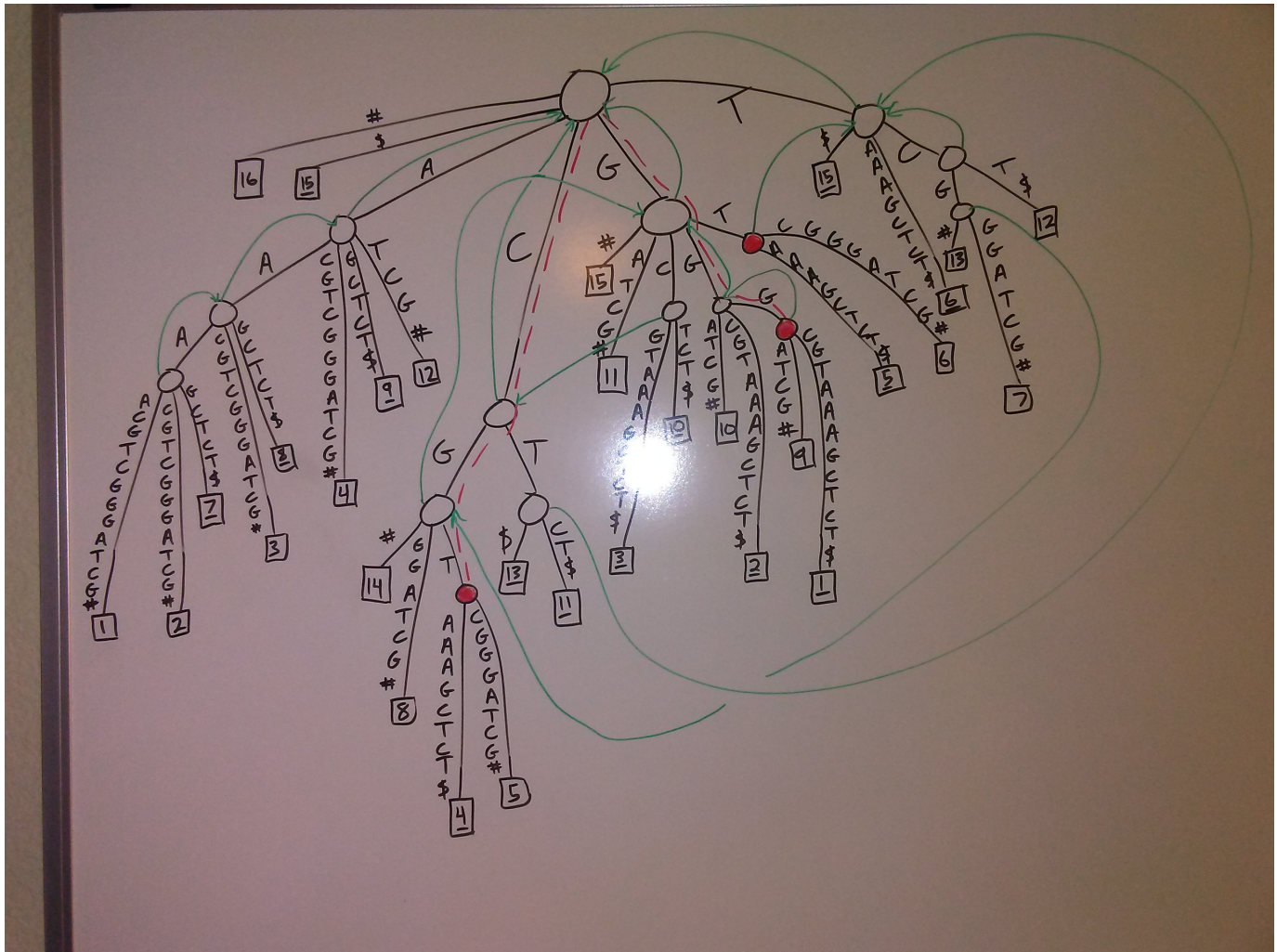
2 Problem 2 (Sung P7.3)

The parsimony length is 3. (The total number of mutations among all edges is 3.)
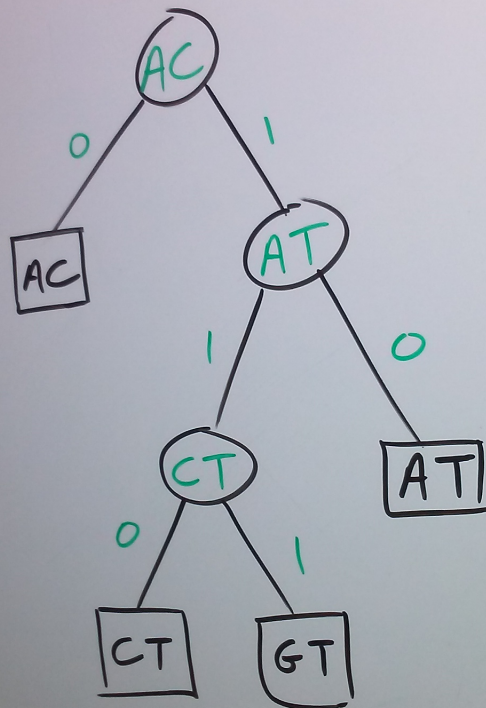
3   Problem 3 (Sung P7.4)

In the tree drawn for the previous problem, the lowest internal node was labeled CT. This internal node could just as easily have been labeled GT, which would have resulted in a tree with the same parsimony length.

4 Problem 4 (Sung P4.1)

Three internal nodes are marked which have exactly one leaf from S_1 and one leaf from S_2. However, the path label 'GT' is not of maximal length. ($S_1[5] = S_2[4] = $ 'C'.) So this path label is not a MUM. The other two path labels are MUMs, and both are of length at least 3. **So the set of MUMs are 'CGT' and 'GGG'.**

(Note that 'AAA' is not a MUM because it is not unique in S_1.)
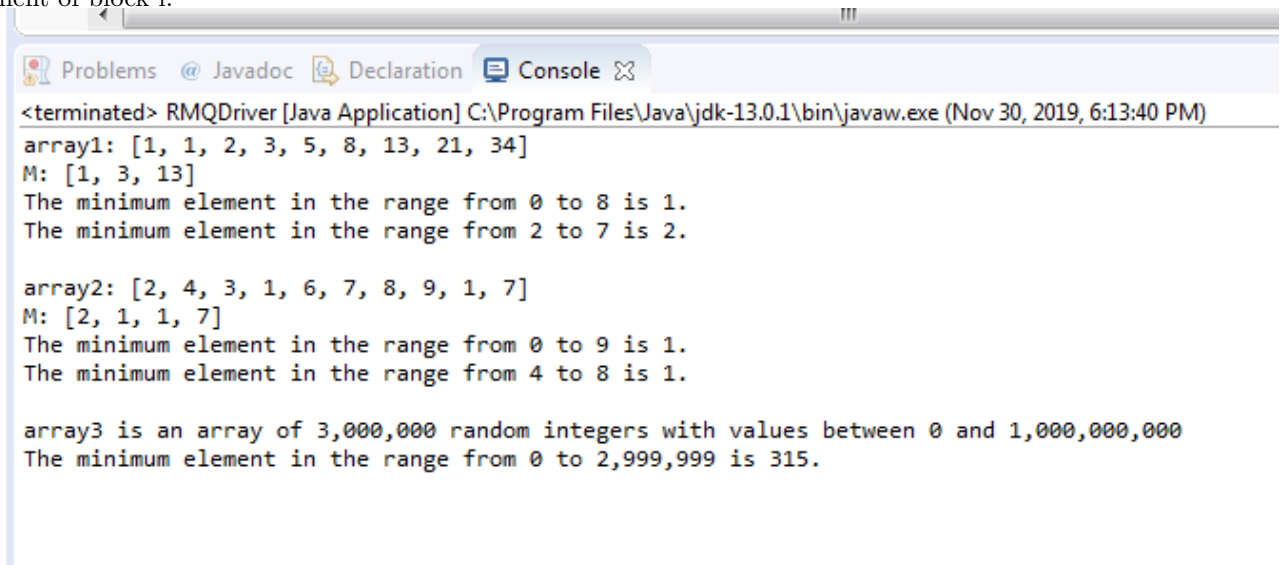
The suffix links are shown in green.

5 Problem 5 (Sung P4.2)

The reverse complement of S_1 is 'CGATCCCGACGTTTT' and the reverse complement of S_2 is 'AGAGCTT-TACGCCC'. Since 'CGT' is not unique in S_1 and its reverse complement, **the set of MUMs is now 'GGG'**.

6   Problem 6

Here is some sample output. We implemented the "block/square-root" approach. M[i] stores the minimum element of block i.

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Problems  @ Javadoc  Declaration  Console

<terminated> RMQDriver [Java Application] C:\Program Files\Java\jdk-13.0.1\bin\javaw.exe (Nov 30, 2019, 6:13:40 PM)
array1: [1, 1, 2, 3, 5, 8, 13, 21, 34]
M: [1, 3, 13]
The minimum element in the range from 0 to 8 is 1.
The minimum element in the range from 2 to 7 is 2.

array2: [2, 4, 3, 1, 6, 7, 8, 9, 1, 7]
M: [2, 1, 1, 7]
The minimum element in the range from 0 to 9 is 1.
The minimum element in the range from 4 to 8 is 1.

array3 is an array of 3,000,000 random integers with values between 0 and 1,000,000,000
The minimum element in the range from 0 to 2,999,999 is 315.
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