Midterm Practice Exam

CS 4390/5390

October 13, 2019

1. Given the table below which was created using the Smith-Waterman algorithm for local alignment, (a) identify the local alignment score, and (b) perform trace-back to find the optimal alignment.

		T	T	A	C	T	G	T	G	T
	0	0	0	0	0	0	0	0	0	0
C	0	0	0	0	↖5	←4.5	←4	←3.5	←3	←2.5
A	0	0	0	↖5	←↑4.5	↖←↑4	↖←↑3.5	↖←↑3	↖←↑2.5	↖←↑2
C	0	0	0	↑4.5	↖10	←9.5	←9	←8.5	←8	←7.5
C	0	0	0	↑4	↖↑9.5	↖←↑9	↖←↑8.5	↖←↑8	↖←↑7.5	↖←↑7
C	0	0	0	↑3.5	↖↑9	↖←↑8.5	↖←↑8	↖←↑7.5	↖←↑7	↖←↑6.5
C	0	0	0	↑3	↖↑8.5	↖←↑8	↖←↑7.5	↖←↑7	↖←↑6.5	↖←↑6
T	0	↖5	↖5	←4.5	↑7.5	↖13.5	←13	↖←12.5	←12	↖←11.5
G	0	↑4.5	↑4.5	↖←↑4	↑7	↑13	↖18.5	←18	↖←17.5	←17
T	0	↖5	↖9.5	←9	←8.5	↑12.5	↑18	↖23.5	←23	↖←22.5
G	0	↑4.5	↑9	↖←↑8.5	↖←↑8	↑12	↖↑17.5	↑23	↖28.5	←28

Optimal Local Alignment Score:

Optimal Local Alignment (note not all of the spaced will be used)

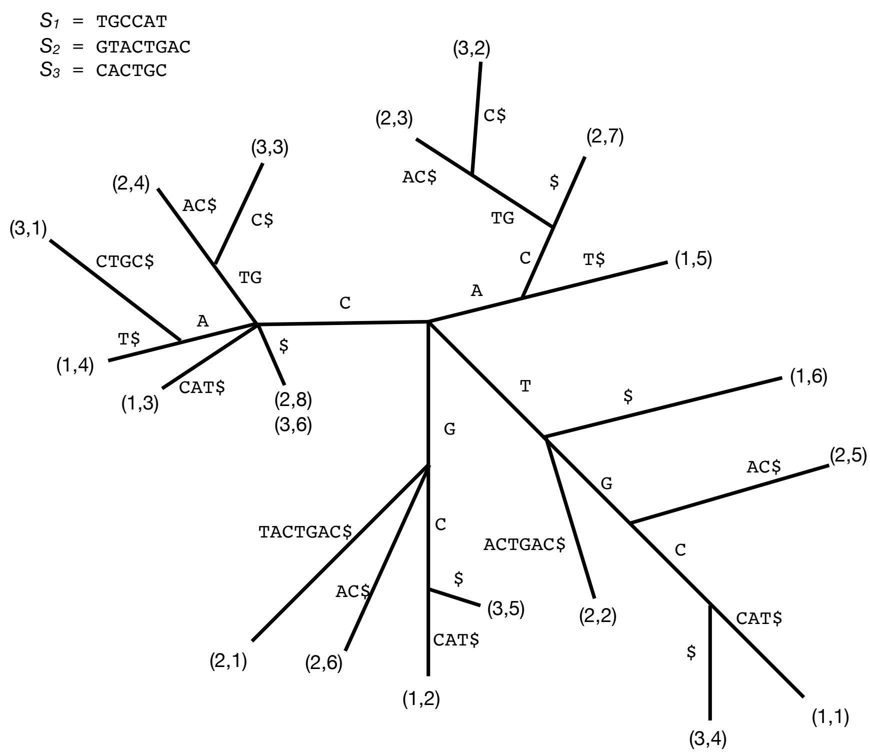
2. Given the Needleman-Wunsch table below, find the optimal global alignment for the two sequences.

		T	T	A	C	T	G	T	G	T
	0	←-0.5	←-1	←-1.5	←-2	←-2.5	←-3	←-3.5	←-4	←-4.5
C	↑-0.5	↖←↑-1	↖←↑-1.5	↖←↑-2	↖3.5	←3	←2.5	←2	←1.5	←1
A	↑-1	↖←↑-1.5	↖←↑-2	↖3.5	←↑3	↖←↑2.5	↖←↑2	↖←↑1.5	↖←↑1	↖←↑0.5
C	↑-1.5	↖←↑-2	↖←↑-2.5	↑3	↖8.5	←8	←7.5	←7	←6.5	←6
C	↑-2	↖←↑-2.5	↖←↑-3	↑2.5	↖↑8	↖←↑7.5	↖←↑7	↖←↑6.5	↖←↑6	↖←↑5.5
C	↑-2.5	↖←↑-3	↖←↑-3.5	↑2	↖↑7.5	↖←↑7	↖←↑6.5	↖←↑6	↖←↑5.5	↖←↑5
C	↑-3	↖←↑-3.5	↖←↑-4	↑1.5	↖↑7	↖←↑6.5	↖←↑6	↖←↑5.5	↖←↑5	↖←↑4.5
T	↑-3.5	↖2	↖←1.5	←↑1	↑6.5	↖12	←11.5	↖←11	←10.5	↖←10
G	↑-4	↑1.5	↖←↑1	↖←↑0.5	↑6	↑11.5	↖17	←16.5	↖←16	←15.5
T	↑-4.5	↖↑1	↖6.5	←6	←↑5.5	↖↑11	↑16.5	↖22	←21.5	↖←21
G	↑-5	↑0.5	↑6	↖←↑5.5	↖←↑5	↑10.5	↖↑16	↑21.5	↖27	←26.5

Optimal Global Alignment (note not all of the spaced will be used)

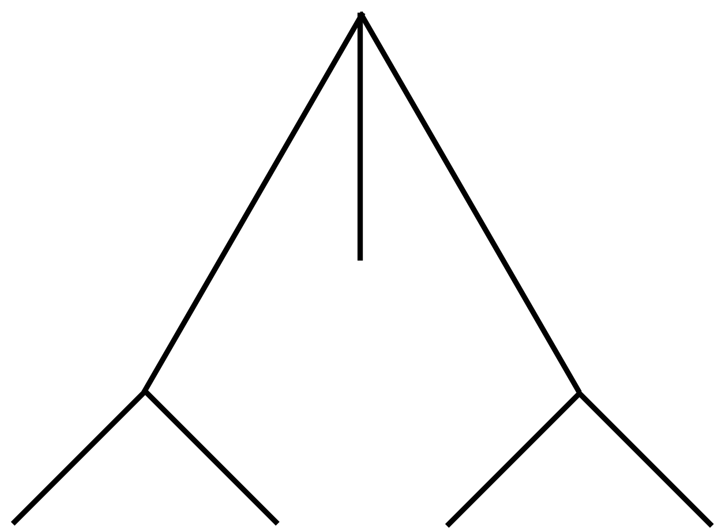
3. (a) Compute the Z-Values for `ACTAACTAAC`. (b) how are the values of $Z_2, Z_3, ...Z_{i-1}$ used in computing Z_i. (c) what does the value of Z_i mean?

4. From the suffix tree below: (a) determine if the string ACTG is in the input set of sequences, and explain your reasoning; and (b) find the longest common substring between the set of sequences, and explain your reasoning.



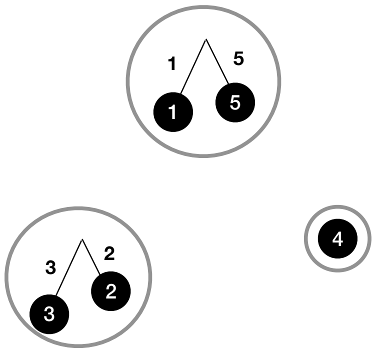
5. Place all of the ultrametric labels (leaves and node values) on the tree below, using the given table of distances.

	A	B	C	D	E
A	0	12	12	12	7
B		0	12	3	12
C			0	12	12
D				0	12
E					0



6. Given the partial neighbor-joining procedure, complete the tree.

	$\{1,5\}$	$\{2,3\}$	$\{4\}$
$\{1,5\}$		6	4
$\{2,3\}$	6		8
$\{4\}$	4	8	



7. What is the sum-of-pairs score of the following multiple sequence alignment using the global scoring with affine scoring model with the following parameters:

match	10
mismatch	-3
indel	-1
gap	-3

```
ACCTGCC
-C-TGCA
AGCGGCA
ACCT--A
```

8. Given the pairwise alignments between the 4 sequences, and using sequence B as the star-center, create the multiple alignment using the center-star method.

A: `GATG-TGCCG`	B: `CCTGCT-GCAG`	B: `CCTGCT-GCAG`
B: `CCTGCTGCAG`	C: `CC-GCTAGCAG`	D: `CCTG-TAG--G`

9. How would we modify the Smith-Waterman algorithm if we wanted to find a disjoint set of substrings of S to align to a substring of T.

   For example when aligning $S =$GGAGCGGCTTGG with $T =$AAAACCTTTT, an optimal alignment would align $S[3..5] \cdot S[8..10]$ to $T[3...8]$:

   AGCCTT
   AACCTT.

   The concept can be though of as "skipping" $S[6..7]$ when computing the optimal local alignment. Note that the $\cdot$ operator is for concatenation.