Assignment 1

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Computational Biology CS904

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Task 1

The two resulting alignments are:
-CAA-AGAC-CTGAAGAGCCAGTGGACTCCACCCCACTT-T-CTGGTCTGACCAATT-

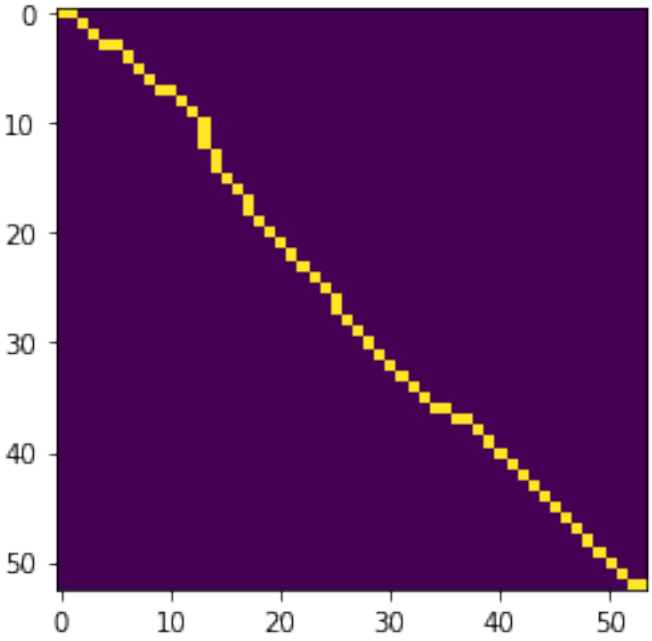
ACCACACTCTCTG–G-GCT-GACCAATT-ACAGCGCTTCTACAGAACTGAAGACTCC

The alignment score is 22.5.

A section of the Needleman-Wunsch matrix is shown below the full matrix can be seen when running the code. The path traversed is also shown as a sequence starting in the bottom right and moving to the top left.

```
[[ -0.   -0.5  -1.  ... -25.5 -26.  -26.5]
 [ -0.5   0.    0.5 ... -24.  -24.5 -25. ]
 [ -1.    0.5   0.  ... -22.5 -23.  -23.5]
 ...
 [-25.  -23.5 -22.  ...  21.5  21.   20.5]
 [-25.5 -24.  -22.5 ...  23.   22.5  22. ]
 [-26.  -24.5 -23.  ...  22.5  23.   22.5]]
[[52, 53], [52, 52], [51, 51], [50, 50], [49, 49], [48, 48], [47, 47], [46, 4
6], [45, 45], [44, 44], [43, 43], [42, 42], [41, 41], [40, 40], [39, 39], [3
8, 38], [37, 37], [37, 36], [36, 35], [36, 34], [35, 33], [34, 32], [33, 31],
[32, 30], [31, 29], [30, 28], [29, 27], [28, 26], [27, 25], [26, 25], [25, 2
4], [24, 23], [23, 22], [22, 21], [21, 20], [20, 19], [19, 18], [18, 17], [1
7, 17], [16, 16], [15, 15], [14, 14], [13, 14], [12, 13], [11, 13], [10, 13],
[9, 12], [8, 11], [7, 10], [7, 9], [6, 8], [5, 7], [4, 6], [3, 5], [3, 4],
[2, 3], [1, 2], [0, 1], [0, 0]]
```

Image of the path:



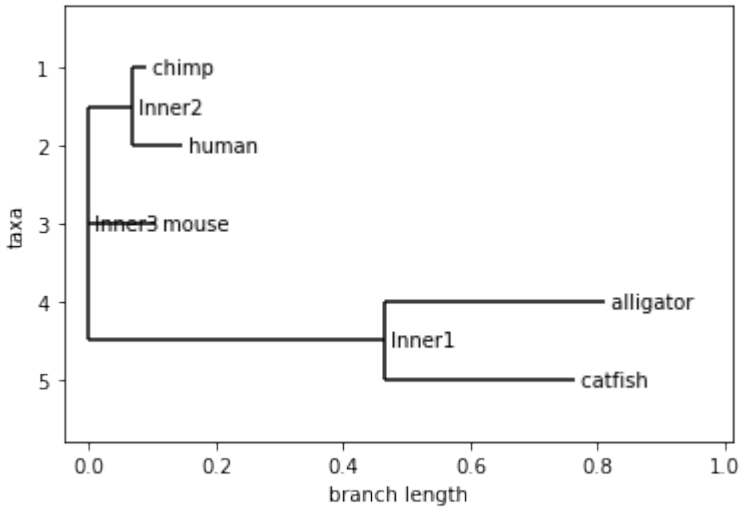
Task 2

The distance matrix is shown below.

```
[[0.         0.2606383  0.09917355 0.9045045  0.94527363]
 [0.2606383  0.         0.18617021 0.86535009 0.9205298 ]
 [0.09917355 0.18617021 0.         0.86846847 0.91059603]
 [0.9045045  0.86535009 0.86846847 0.         0.64788732]
 [0.94527363 0.9205298  0.91059603 0.64788732 0.        ]]
```

The tree showing the distances is shown below.

```
Tree(rooted=False)
    Clade(branch_length=0, name='Inner3')
        Clade(branch_length=0.06925070694027219, name='Inner2')
            Clade(branch_length=0.022130550409562633, name='chimp')
            Clade(branch_length=0.07704300330944563, name='human')
        Clade(branch_length=0.1045667715193726, name='mouse')
        Clade(branch_length=0.4644295120543515, name='Inner1')
            Clade(branch_length=0.3469563947911287, name='alligator')
            Clade(branch_length=0.3009309291525333, name='catfish')
```



Task 3

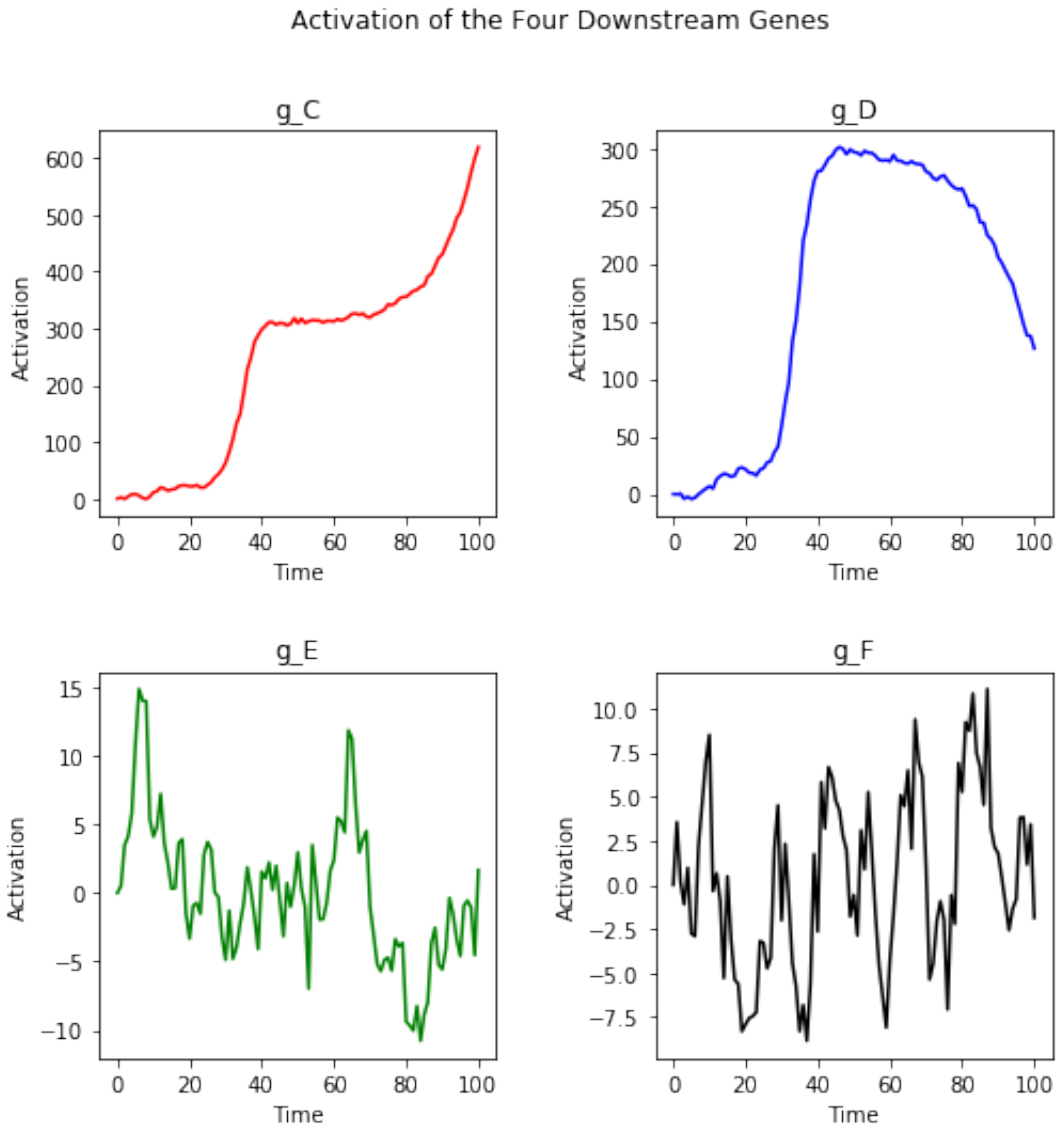
The matrix is not additive this is because the distance between the catfish and the human in the tree is,

$$0.0770 + 0.06925 + 0.4644 + 0.3009 = 0.91155 \neq 0.9045$$

which does not equal to the distance in the distance matrix which is 0.9045.

Task 4

A plot of the activation of the four downstream genes made from the toggle switch network as described in lectures.


Activation of the Four Downstream Genes
g_C
g_D
g_E
g_F
Activation
Time