# MATH 578A Programming Assignment #1
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- **Summary**

    As the memory-length and time-length curves show, when the lengths of the both sequences are 15,935, the running time is 8.284 seconds, and the memory is 1.18 GB. Thus, as the two sequences become longer, the biggest problem of this global alignment algorithm is computer memory.

- **Code and executable file**

    galign.exe
    Alignment.cpp
    GlobalAlignment.cpp
    Makefile
    Alignment.h
    GlobalAlignment.h
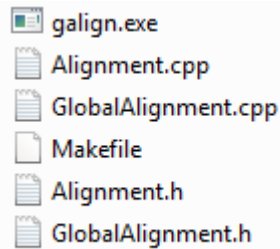
- **Compiler**

    MinGW GCC 4.7.2

    >g++ -o galign.exe Alignment.cpp GlobalAlignment.cpp

- **Running Environment**

    Windows 7 Professional
    Processor: Inter(R) Core(TM) 2 Duo CPU T6570 @2.10GHz 2.10GHz
    Installed memory (RAM): 2.00 GB

- **Results of test examples**

1) Result of the first example:

2) Result of the second example:

3) Part result of the third example:


```
C:\Windows\system32\cmd.exe

acgccctaaacgatggatgctagttgttggagggcttagtctctccagtaatgcagctaacgcattaagcatcccgcctg
    |||    ||| ||||| || ||   |  ||||  ||   |||| ||     | ||  ||||||| |||  ||||| ||||
acgctgtaaacgatgcacacttggtgtt-aatcg-aaag-gt-t--agtaccgaagctaacgtgttaagtgtgccgcctg

gggagtacggtcgcaagattaaaactcaaaggaatagacggggacccgcacaagcggtggagcangtggtttaattcgan
|||||| | |||||||| || |||||||||||||| || ||||| ||||||||||||||||||| |||||||||||||||
gggagtatgttcgcaagaatgaaactcaaaggaattgacggggcccgcacaagcggtggagcatgtggtttaattcgat

nnnacacgaagaaccttacctaggcttgacattgagagaat-ccgctagaaatagtggagtgtctagcttgctagacctt
    ||||||||||||||| |||||||||||| |||| |||  |||||| ||||| || ||| |||||||||| || || |
gatacgcgaggaaccttaccagggcttgacatatacaggatatagttagagata-acta-ttccccgtttg--gggtc-t

gaaaacaggtgctgcacggctgtcgtcagctcgtgtcgtgagatgttgggttaagtcccgcaacgagcgcaaccccnttt
|| |||||||||||||| ||||||||||||||||| ||||| |||| ||||||||||||||||||||||||||||| ||
gtatacaggtgctgcatggttgtcgtcagctcgtgccgtgaggtgtcgggttaagtcccgcaacgagcgcaacccttgtt

cttagttgctaacaggttatgctgagaactctaaggatactgcctccg-taaggaggaggaaggtggggacgacgtcaag
  |  || |||||||  ||  ||||||| ||||| ||||| || ||||| |||| |||||| |||| ||||||||||||||
gtctgttaccagcatgtaaagatggggactcagacgagactgccggtgataagccggaggaaggtgaggatgacgtcaaa

tcatcatggcccttacg-cctagggctacacacgtgctacaatggggtgcacaaagagaagcaatactgtgaagtggagc
||||||||||||||||  ||| ||||||||||||||||||||||||| ||||||||||| || ||| |||||||||||||
tcatcatggcccttatgtcct-gggctacacacgtgctacaatggcctgtacaaagcgatgcgaaacagtgatgtgaagc

caatcttca-aaa-cacctctcagttcggattgtaggctgcaactcgcctgcatgaagctggaatcgctagtaatcgcaa
||||  |||   |  || ||||||||||| |||| |||| |||||||| |||  |||||| ||||||||||||||||||||
aaaac-gcagaaagcaggtctcagtccagattgaagtctgaaactcggcttcatgaagttggaatcgctagtaatcgtat

atcagccatgttgcggtgaatacgttcccgggtcttgtactcaccgcccgtcacaccatgggagttgtgtttgccttaag
|||||   ||| |||||||||||||||  |   ||   || |  ||    |   ||    ||              ||   |
atcag-aatgatacggtgaatacgtt--c---tc--g---------g---g------cc--------------ttg---t-a-

tcaggatgctaaattggctactgcccacggcacacacagcgactgggg
||   |  |   |  |   |  | ||  ||   |   |       |||
-c---a--c---a----c--c-g-cc-c-g--------tc-ac-----

Alignment score:    1438
% of Identity: 69.22%
Running time: 0.08s
Memory used: 9704.97 kilobytes

E:\coding\workspace\Alignment>
```

- **Running Time and Memory used**

    I randomly generated 13 pairs dataset to test the running time and memory used in different length of sequences. The two sequences have the same length in all the 13 datasets. The results are shown in Table 1. Figure 1 and 2 are the plots of the memory and running time used in different length of sequences, respectively. The running time is calculated by the deviation of the end and the start of alignment algorithm. The memory is the sum of memory used in array s and l, sequence U, V, and the alignment results rU and rV.

Table 1. Runing Time and Memory Used in different Sequence Length

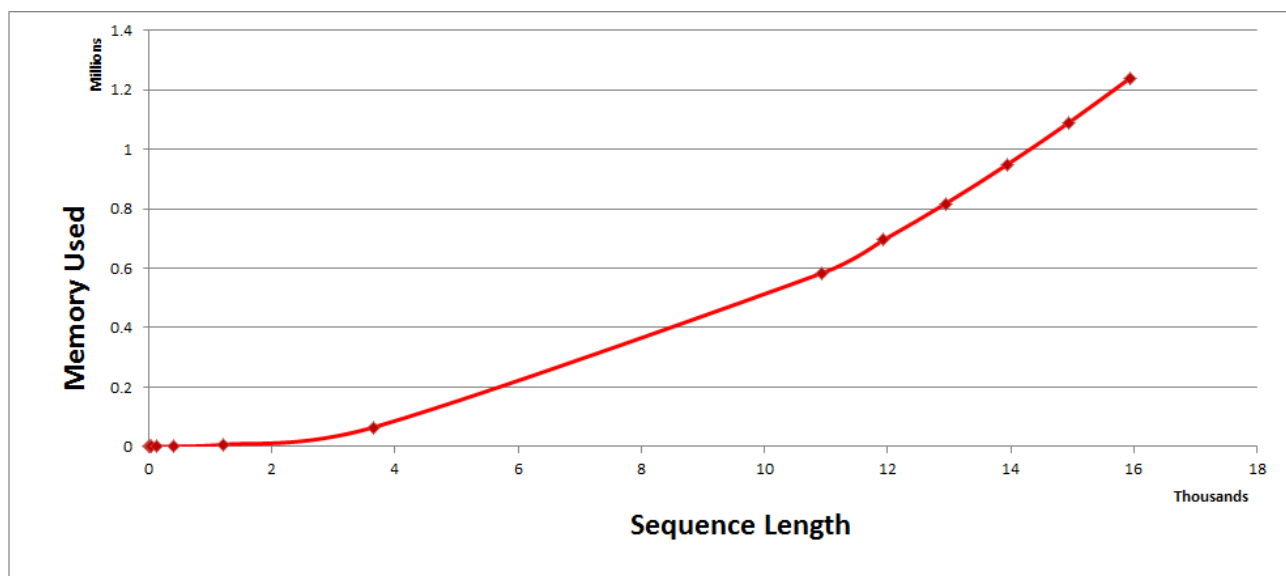| Sequence Length	5	15	45	135	405	1,215	3,645	10,935	11,935	12,935	13,935	14,935	15,935
Running Time (s)	0	0	0	0	0.015	0.063	0.483	4.306	4.898	5.60	6.443	7.395	8.284
Memory Used	0.20 KB	1.3 KB	10.51 KB	90.86 KB	806.50 KB	7.06 MB	63.40 MB	570.32 MB	679.39 MB	797.99 MB	926.13 MB	1.04 GB	1.18 GB

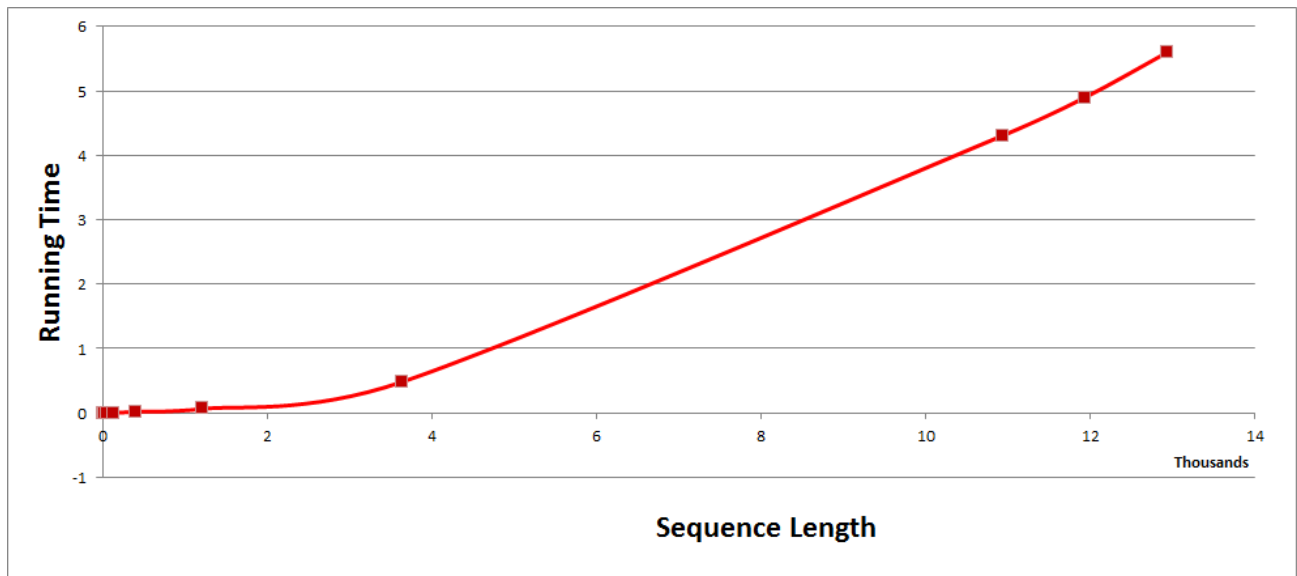**Figure 1 Memory Used in different Sequence Length**

Figure 2 Running Time in different Sequence Length

▪ **Running log**

Running log file records all run of galign.exe and the corresponding results.