Lab 7 Profiling

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Q1: Notice the timing in the flat graph. How do you interpret that?

All the timing is 0. This is because we didn't use any input files.

Q2: Profile the program again and write the results in your report.

The report is attached at the end of this file. The timing in the flat graph is no longer all 0s.

Q3: From the flat profile, identify which function consumes the highest time percentage of the program execution time? Report the percentage.

From the Flat Profile provided, the function that uses the highest percentage of the program execution time is

```
__gnu_cxx::__enable_if<std::__is_char<char>::__value, bool>::__type
std::operator==<char>(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&)
```

This function consumes 32.30% of the total execution time.

From the Call Graph, the function that uses the highest percentage of the program execution time is find_print_add_records( ) as demonstrated below:

```
find_print_add_records(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >*,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >)
```

This function consumes 99.7% of the total execution time.

Q4: Deduce which function is the bottle-neck in the program?

The bottle neck function is the find_print_add_records() due to the search1 function call within that method.

Q5: From the flat profile, record the seconds per call (self and total) / (Weight and self-weight in Xcode - time profiler) for search1 function. Explain the values of self and total seconds per call.

Search1
Self Seconds: 0.53 s
Calls: 38948

Q6: Same for find, print, and add records functions.
find_print_addrecords()
Self Seconds: 0s
Calls: 2

Q7: Record the child function that is contributing most to the time of main function. Indicate the total amount it propagates to main.

find_print_add_records() is called directly by main and shows a significant time contribution. 2.17 seconds are being propagated into main from this function and its children. Therefore, find_print_add_records() is the child contributing to the execution the most in main.

Q8: Profile the program. Write in the results for different optimizations.

Optimization Level	Total Execution Time
O0	1.7s
O1	1.92
O2	1.86 s
O3	1.7s

Q9: How did the time percentages of each of the program functions change for the three different optimization levels? Interpret.

Summary of Time Percentages Across Optimization

Optimization Level -O0:
- __gnu_cxx::__enable_if...std::operator==: 32.87%
- search1: 16.60%
- sort1: 14.32%

Optimization Level -O1:
- sort1: 52.11%
- search1: 44.31%

Optimization Level -O2:
- sort1: 57.65%
- search1: 42.57%

Optimization Level -O3:
- search1: 54.81%
- sort1: 45.38%

Q10: What is the best optimization level for minimizing the execution time?
-O3 was the best optimization level for minimizing the execution time.

Q11: Profile your program and record the results in the report.

Combinations	Execution Time
Search 1 / Sort 1	1.7s
Search 1 / Sort 2	2.03s
Search 1 / Sort 3	.90s
Search 2 / Sort 1	.78s
Search 2 / Sort 2	1.59s
Search 2 / Sort 3	.01s

Q12: Which functions had the best performance in terms of execution time?

Search 2 Sort 3

Q13: Calculate the program enhancement percentage by the new function optimization?
(Orig - new) / orig *100

(1.7 - .01) / (1.7) * 100 = 59% enhancement

Question 2

```
Flat profile:

Each sample counts as 0.01 seconds.
  %   cumulative   self              self     total
 time   seconds   seconds    calls   s/call   s/call  name
 32.30      0.97     0.97 647482750     0.00     0.00
__gnu_cxx::__enable_if<std::__is_char<char>::__value, bool>::__type
std::operator==<char>(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&)
 17.65      1.50     0.53        2     0.27     0.42
sort1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int)
 17.65      2.03     0.53    38948     0.00     0.00
search1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >)
 12.99      2.43     0.39 647482750     0.00     0.00  bool
std::operator!=<char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&)
 10.32      2.74     0.31 379465206     0.00     0.00  bool
std::operator< <char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&)
  8.99      3.01     0.27 108224639     0.00     0.00
std::char_traits<char>::compare(char const*, char const*, unsigned
long)
  0.33      3.02     0.01        1     0.01     0.01
_GLOBAL__sub_I__Z7search1PNSt7__cxx1112basic_stringIcSt11char_traitsIc
ESaIcEEEiS4_
  0.00      3.02     0.00    38931     0.00     0.00  void
std::swap<char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >&)
  0.00      3.02     0.00        2     0.00     1.08
find_print_add_records(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >*,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >)
  0.00      3.02     0.00        2     0.00     0.00
readFile(std::__cxx11::basic_string<char, std::char_traits<char>,
```

```
std::allocator<char> >, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >*)
  0.00      3.02     0.00        1     0.00     0.00
_GLOBAL__sub_I__Z8readFileNSt7__cxx1112basic_stringIcSt11char_traitsIc
ESaIcEEEPS4_
  0.00      3.02     0.00        1     0.00     0.00
__static_initialization_and_destruction_0(int, int)
  0.00      3.02     0.00        1     0.00     0.00
__static_initialization_and_destruction_0(int, int)

 %         the percentage of the total running time of the
time       program used by this function.

cumulative a running sum of the number of seconds accounted
 seconds   for by this function and those listed above it.

 self      the number of seconds accounted for by this
seconds    function alone.  This is the major sort for this
           listing.

calls      the number of times this function was invoked, if
           this function is profiled, else blank.

 self      the average number of milliseconds spent in this
ms/call    function per call, if this function is profiled,
       else blank.

 total     the average number of milliseconds spent in this
ms/call    function and its descendents per call, if this
       function is profiled, else blank.

name       the name of the function.  This is the minor sort
           for this listing. The index shows the location of
       the function in the gprof listing. If the index is
       in parenthesis it shows where it would appear in
       the gprof listing if it were to be printed.


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             Call graph (explanation follows)
```

```
granularity: each sample hit covers 2 byte(s) for 0.33% of 3.02
seconds

index % time    self  children    called     name
                                                 <spontaneous>
[1]     99.7    0.00    3.01                 main [1]
                0.00    2.17       2/2
find_print_add_records(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >*,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >) [3]
                0.53    0.31       2/2
sort1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int) [6]
                0.00    0.00       2/2
readFile(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >*) [18]
-----------------------------------------------
                0.53    1.63   38948/38948
find_print_add_records(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >*,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >) [3]
[2]     71.8    0.53    1.63   38948
search1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >) [2]
                0.39    1.24 647482750/647482750     bool
std::operator!=<char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&) [4]
-----------------------------------------------
                0.00    2.17       2/2           main [1]
[3]     71.8    0.00    2.17       2
find_print_add_records(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >*,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >) [3]
                0.53    1.63   38948/38948
search1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >) [2]
-----------------------------------------------
```

```
                0.39    1.24 647482750/647482750
search1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >) [2]
[4]     54.2    0.39    1.24 647482750         bool std::operator!
=<char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&) [4]
                0.97    0.27 647482750/647482750
__gnu_cxx::__enable_if<std::__is_char<char>::__value, bool>::__type
std::operator==<char>(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&) [5]
-----------------------------------------------
                0.97    0.27 647482750/647482750     bool
std::operator!=<char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&) [4]
[5]     41.2    0.97    0.27 647482750
__gnu_cxx::__enable_if<std::__is_char<char>::__value, bool>::__type
std::operator==<char>(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&) [5]
                0.27    0.00 108224639/108224639
std::char_traits<char>::compare(char const*, char const*, unsigned
long) [8]
-----------------------------------------------
                0.53    0.31       2/2           main [1]
[6]     27.9    0.53    0.31       2
sort1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int) [6]
                0.31    0.00 379465206/379465206     bool
std::operator< <char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&) [7]
                0.00    0.00   38931/38931       void std::swap<char,
std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >&) [17]
-----------------------------------------------
                0.31    0.00 379465206/379465206
sort1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int) [6]
```

```
[7]     10.3    0.31    0.00 379465206         bool std::operator<
<char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&) [7]
-----------------------------------------------
                0.27    0.00 108224639/108224639
__gnu_cxx::__enable_if<std::__is_char<char>::__value, bool>::__type
std::operator==<char>(std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> > const&,
std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> > const&) [5]
[8]      9.0    0.27    0.00 108224639
std::char_traits<char>::compare(char const*, char const*, unsigned
long) [8]
-----------------------------------------------
                0.01    0.00       1/1           __libc_csu_init [10]
[9]      0.3    0.01    0.00       1
_GLOBAL__sub_I__Z7search1PNSt7__cxx1112basic_stringIcSt11char_traitsIc
ESaIcEEEiS4_ [9]
                0.00    0.00       1/1
__static_initialization_and_destruction_0(int, int) [21]
-----------------------------------------------
                                                 <spontaneous>
[10]     0.3    0.00    0.01                 __libc_csu_init [10]
                0.01    0.00       1/1
_GLOBAL__sub_I__Z7search1PNSt7__cxx1112basic_stringIcSt11char_traitsIc
ESaIcEEEiS4_ [9]
                0.00    0.00       1/1
_GLOBAL__sub_I__Z8readFileNSt7__cxx1112basic_stringIcSt11char_traitsIc
ESaIcEEEPS4_ [19]
-----------------------------------------------
                0.00    0.00   38931/38931
sort1(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >*, int) [6]
[17]     0.0    0.00    0.00   38931         void std::swap<char,
std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >&) [17]
-----------------------------------------------
                0.00    0.00       2/2           main [1]
[18]     0.0    0.00    0.00       2
readFile(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >*) [18]
-----------------------------------------------
                0.00    0.00       1/1           __libc_csu_init [10]
```

```
[19]     0.0    0.00    0.00       1
_GLOBAL__sub_I__Z8readFileNSt7__cxx1112basic_stringIcSt11char_traitsIc
ESaIcEEEPS4_ [19]
                0.00    0.00       1/1
__static_initialization_and_destruction_0(int, int) [20]
-----------------------------------------------
                0.00    0.00       1/1
_GLOBAL__sub_I__Z8readFileNSt7__cxx1112basic_stringIcSt11char_traitsIc
ESaIcEEEPS4_ [19]
[20]     0.0    0.00    0.00       1
__static_initialization_and_destruction_0(int, int) [20]
-----------------------------------------------
                0.00    0.00       1/1
_GLOBAL__sub_I__Z7search1PNSt7__cxx1112basic_stringIcSt11char_traitsIc
ESaIcEEEiS4_ [9]
[21]     0.0    0.00    0.00       1
__static_initialization_and_destruction_0(int, int) [21]
-----------------------------------------------
```

 This table describes the call tree of the program, and was sorted by
 the total amount of time spent in each function and its children.

 Each entry in this table consists of several lines. The line with
the
 index number at the left hand margin lists the current function.
 The lines above it list the functions that called this function,
 and the lines below it list the functions this one called.
 This line lists:
     index   A unique number given to each element of the table.
        Index numbers are sorted numerically.
        The index number is printed next to every function name so
        it is easier to look up where the function is in the table.

     % time This is the percentage of the `total' time that was spent
        in this function and its children. Note that due to
        different viewpoints, functions excluded by options, etc,
        these numbers will NOT add up to 100%.

     self   This is the total amount of time spent in this function.

     children   This is the total amount of time propagated into this
        function by its children.

     called This is the number of times the function was called.
        If the function called itself recursively, the number
        only includes non-recursive calls, and is followed by
        a `+' and the number of recursive calls.

     name   The name of the current function. The index number is

printed after it. If the function is a member of a cycle, the cycle number is printed between the function's name and the index number.

For the function's parents, the fields have the following meanings:

self This is the amount of time that was propagated directly from the function into this parent.

children This is the amount of time that was propagated from the function's children into this parent.

called This is the number of times this parent called the function `/' the total number of times the function was called. Recursive calls to the function are not included in the number after the `/'.

name This is the name of the parent. The parent's index number is printed after it. If the parent is a member of a cycle, the cycle number is printed between the name and the index number.

If the parents of the function cannot be determined, the word `<spontaneous>' is printed in the `name' field, and all the other fields are blank.

For the function's children, the fields have the following meanings:

self This is the amount of time that was propagated directly from the child into the function.

children This is the amount of time that was propagated from the child's children to the function.

called This is the number of times the function called this child `/' the total number of times the child was called. Recursive calls by the child are not listed in the number after the `/'.

name This is the name of the child. The child's index number is printed after it. If the child is a member of a cycle, the cycle number is printed between the name and the index number.

If there are any cycles (circles) in the call graph, there is an entry for the cycle-as-a-whole. This entry shows who called the cycle (as parents) and the members of the cycle (as children.)

 The `+' recursive calls entry shows the number of function calls that
 were internal to the cycle, and the calls entry for each member
shows,
 for that member, how many times it was called from other members of
 the cycle.

Index by function name

```
  [20] __static_initialization_and_destruction_0(int, int) [8]
std::char_traits<char>::compare(char const*, char const*, unsigned
long)
  [21] __static_initialization_and_destruction_0(int, int) [17] void
std::swap<char, std::char_traits<char>, std::allocator<char>
>(std::__cxx11::basic_string<char, std::char_traits<char>,
std::allocator<char> >&, std::__cxx11::basic_string<char,
std::char_traits<char>, std::allocator<char> >&)
```