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Homework 4

Overview

This program is a multi-threaded ASCII character counter. It receives a name of an ASCII text file from the command-line argument and then it will count the number of each kind of ASCII character in the file and output it. When receiving and loading the file, the program divides it equally so each thread can analyze a roughly equal amount of data. Structs are used to form partition bounds by assigning starting and ending positions (lower and upper bounds) and where to store the data in the 2 dimensional array. Once a thread is finished analyzing, it exits. The main thread waits for all threads are complete. Once all complete, it closes the file, adds all the partitions for an overall count, and prints the data. This program is made so it can run a read 5 times so it can calculate an average time. On the following pages are screenshots of the program reading the larg.txt file as well as data and charts of the average runtimes on 1, 2, 4, and 8 threads. The program was running on Linux Mint in Oracle VM VirtualBox on one core.

One execution of a single trail run of 4 threads

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```
emilio@vaxa ~ $ cd Desktop
emilio@vaxa ~/Desktop $ gcc -pthread -o hw hw4_eq.c
emilio@vaxa ~/Desktop $ ./hw large.txt
[TRIAL 1]
Using 4 threads:
523510 occurences of 0x0
524012 occurences of 0x1
524743 occurences of 0x2
524402 occurences of 0x3
524016 occurences of 0x4
524122 occurences of 0x5
525724 occurences of 0x6
523666 occurences of 0x7
525189 occurences of 0x8
523542 occurences of 0x9
524596 occurences of 0xa
523862 occurences of 0xb
524856 occurences of 0xc
524868 occurences of 0xd
523336 occurences of 0xe
524706 occurences of 0xf
523684 occurences of 0x10
523473 occurences of 0x11
524461 occurences of 0x12
523033 occurences of 0x13
523767 occurences of 0x14
524558 occurences of 0x15
524645 occurences of 0x16
526697 occurences of 0x17
523725 occurences of 0x18
525092 occurences of 0x19
525123 occurences of 0x1a
525316 occurences of 0x1b
522877 occurences of 0x1c
522779 occurences of 0x1d
524758 occurences of 0x1e
523793 occurences of 0x1f
525040 occurences of 0x20
523607 occurences of '!'
522091 occurences of '"'
524200 occurences of '#'
524299 occurences of '$'
523839 occurences of '%'
525043 occurences of '&'
525051 occurences of '''
524901 occurences of '('
523684 occurences of ')'
524785 occurences of '*'
524642 occurences of '+'
524454 occurences of ','
523658 occurences of '-'
524353 occurences of '.'
524125 occurences of '/'
524681 occurences of '0'
524228 occurences of '1'
524746 occurences of '2'
524782 occurences of '3'
523648 occurences of '4'
523095 occurences of '5'
524396 occurences of '6'
524664 occurences of '7'
522961 occurences of '8'
525731 occurences of '9'
523147 occurences of ':'
522335 occurences of ';'
524961 occurences of '<'
525970 occurences of '='
```

```
                          emilio@vaxa ~/Desktop                 —  +  ×

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524822 occurences of 'O'
523540 occurences of 'P'
524657 occurences of 'Q'
523456 occurences of 'R'
523673 occurences of 'S'
523923 occurences of 'T'
524110 occurences of 'U'
523477 occurences of 'V'
524457 occurences of 'W'
524305 occurences of 'X'
525008 occurences of 'Y'
525380 occurences of 'Z'
523846 occurences of '['
524273 occurences of '\'
525091 occurences of ']'
525270 occurences of '^'
523538 occurences of '_'
523834 occurences of '`'
524119 occurences of 'a'
523597 occurences of 'b'
524143 occurences of 'c'
523637 occurences of 'd'
524138 occurences of 'e'
524812 occurences of 'f'
524842 occurences of 'g'
525810 occurences of 'h'
523816 occurences of 'i'
523752 occurences of 'j'
524593 occurences of 'k'
524373 occurences of 'l'
523518 occurences of 'm'
525438 occurences of 'n'
523949 occurences of 'o'
525125 occurences of 'p'
524387 occurences of 'q'
524358 occurences of 'r'
524147 occurences of 's'
525101 occurences of 't'
524745 occurences of 'u'
523614 occurences of 'v'
523819 occurences of 'w'
523761 occurences of 'x'
524628 occurences of 'y'
525438 occurences of 'z'
524544 occurences of '{'
525516 occurences of '|'
524670 occurences of '}'
524959 occurences of '~'
524988 occurences of 0x7f
Time elapsed: 0.785661 seconds

[TRIAL 2]
Using 4 threads:
523510 occurences of 0x0
524012 occurences of 0x1
524743 occurences of 0x2
524402 occurences of 0x3
524016 occurences of 0x4
524122 occurences of 0x5
525724 occurences of 0x6
523666 occurences of 0x7
525189 occurences of 0x8
523542 occurences of 0x9
524596 occurences of 0xa
523862 occurences of 0xb
524856 occurences of 0xc
524868 occurences of 0xd
```

1 Thread

```
emilio@vaxa ~/Desktop                              _  +  ×
File  Edit  View  Search  Terminal  Help
524387 occurences of 'q'
524358 occurences of 'r'
524147 occurences of 's'
525101 occurences of 't'
524745 occurences of 'u'
523614 occurences of 'v'
523819 occurences of 'w'
523761 occurences of 'x'
524628 occurences of 'y'
525438 occurences of 'z'
524544 occurences of '{'
525516 occurences of '|'
524670 occurences of '}'
524959 occurences of '~'
524988 occurences of 0x7f
Time elapsed: 0.453010 seconds

Trial: 1 took 0.628595 seconds
Trial: 2 took 0.498047 seconds
Trial: 3 took 0.491292 seconds
Trial: 4 took 0.458361 seconds
Trial: 5 took 0.453010 seconds
Average: 0.505861 seconds
emilio@vaxa ~/Desktop $
```

2 Threads

```
emilio@vaxa ~/Desktop                              _  +  ×
File  Edit  View  Search  Terminal  Help
524387 occurences of 'q'
524358 occurences of 'r'
524147 occurences of 's'
525101 occurences of 't'
524745 occurences of 'u'
523614 occurences of 'v'
523819 occurences of 'w'
523761 occurences of 'x'
524628 occurences of 'y'
525438 occurences of 'z'
524544 occurences of '{'
525516 occurences of '|'
524670 occurences of '}'
524959 occurences of '~'
524988 occurences of 0x7f
Time elapsed: 0.641366 seconds

Trial: 1 took 0.678146 seconds
Trial: 2 took 0.621761 seconds
Trial: 3 took 0.645351 seconds
Trial: 4 took 0.628310 seconds
Trial: 5 took 0.641366 seconds
Average: 0.642987 seconds
emilio@vaxa ~/Desktop $
```

4 Threads

```
emilio@vaxa ~/Desktop

File   Edit   View   Search   Terminal   Help

524544 occurences of '{'
525516 occurences of '|'
524670 occurences of '}'
524959 occurences of '~'
524988 occurences of 0x7f
Time elapsed: 0.691090 seconds

Trial: 1 took 0.785661 seconds
Trial: 2 took 0.719532 seconds
Trial: 3 took 0.722461 seconds
Trial: 4 took 0.692942 seconds
Trial: 5 took 0.691090 seconds
Average: 0.722337 seconds
emilio@vaxa ~/Desktop $
```

8 Threads

```
emilio@vaxa ~/Desktop

File   Edit   View   Search   Terminal   Help

524387 occurences of 'q'
524358 occurences of 'r'
524147 occurences of 's'
525101 occurences of 't'
524745 occurences of 'u'
523614 occurences of 'v'
523819 occurences of 'w'
523761 occurences of 'x'
524628 occurences of 'y'
525438 occurences of 'z'
524544 occurences of '{'
525516 occurences of '|'
524670 occurences of '}'
524959 occurences of '~'
524988 occurences of 0x7f
Time elapsed: 0.770388 seconds

Trial: 1 took 0.804404 seconds
Trial: 2 took 0.748509 seconds
Trial: 3 took 0.755063 seconds
Trial: 4 took 0.746257 seconds
Trial: 5 took 0.770388 seconds
Average: 0.764924 seconds
emilio@vaxa ~/Desktop $
```

From the data, we can see that as the threads increase, the average runtimes increase. However, the increase in runtime becomes negligible as the threads increase. While the difference between 1 and 2 threads is ~0.1 seconds, we can see that the difference between 4 and 8 threads is only ~0.04 seconds, which is negligible. It seems as the graph evolves, the difference in runtimes becomes smaller, almost creating a plateau in the graph.

Threads	Average Runtimes
1	0.505861
2	0.642987
4	0.722337
8	0.764924