OS HW4

mutex & semaphore

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Deadline: 2022/1/8 (Sat) PM11:55

Tasks

1. Series

    1-1. Series - 1 (30%)

    1-2. Series - 2 (20%)

2. Pi (30%)
3. Report (20%)

1-1. Series -1

- Calculate the total number of occurrences of each number in the series.
- Values in series: [0, 1, 2]
- Use multi-thread(**1~4**) and mutex/semaphore

```
Ex.
Input：    4
           15
           120201202011021

Output：
           0: 5
           1: 5
           2: 5
```

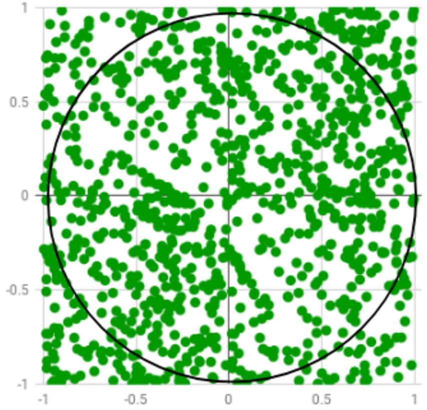
1-2. Series -2

- Calculate the total number of occurrences of each number in the series.
- Values in series: [0, 1, 2]
- Use multi-thread(**3**) and mutex/semaphore.

```
Ex.
Input：
          15
          120201202011021

Output：
          0: 5
          1: 5
          2: 5
```

2. Pi

- Estimate the value of Pi using Monte Carlo.
- The "Monte Carlo Method" is a method of solving problems using statistics.



- Algorithm reference:

https://www.geeksforgeeks.org/es ɔnte-carlo/

Synchronization - mutex lock

- Header
  `#include <pthread.h>`
- Declare: (global variable)
  `pthread_mutex_t mutex = PTHREAD_MUTEX_INITIALIZER;`
- Functions:
  - `pthread_mutex_lock()`
  - `pthread_mutex_unlock()`
  - `pthread_mutex_trylock()`

Synchronization - semaphore

- Header
  `#include <pthread.h>`
- Declare: (global variable)
  `pthread_cond_t cond = PTHREAD_COND_INITIALIZER;`
- Functions:
  - `pthread_cond_wait()`
  - `pthread_cond_signal()`
  - `pthread_cond_broadcast()`

- Header
  `#include <semaphore.h>`
- Declare: (global variable)
  `sem_t sem;`
- Functions:
  - `sem_post()`
  - `sem_wait()`
  - `sem_close()`

Series - 1 (30%) - Restrictions:

1. You should use only **ONE** global array of size 3 to update number counts.

   ```
   long long counts[3] = {}; // datatype and variable name can be any.
   ```

2. You should update the counts values each time you process the string.

   NOT count the numbers by threads, and update it to global variables at the end of thread.

   ```
   (O) for(int i=begin; i<end; i++) counts[arr[i] - '0'] += 1;
   ```

   ```
   (X) for(int i=begin; i<end; i++) localc[arr[i] - '0'] += 1;
       for(int i=0; i<3; i++)       counts[i] += localc[i];
   ```

   of course you can use **mutex** or **semaphore** to prevent race condition.

Series - 1 (30%) - input / output:

- Input

Number of threads (1 ~ 4) ->
Series length (1 ~ 10^8) ->
The series ->

```
3
15
120201202011021
```

$$\begin{tikzcd}
12020 \arrow[d] & 12020 \arrow[d] & 11021 \arrow[d] \\
\text{Thread1} & \text{Thread2} & \text{Thread3}
\end{tikzcd}$$

Each thread is responsible for 1/n of the series.
n = number of threads

- Output

0:(space)counts[0](newline)
1:(space)
…(newline)

```
0: 5
1: 5
2: 5
```

```
    Compile with:
$ g++ -o hw4_1_1 hw4_1_1.c –lpthread
    Test with:
$ ./hw4_1_1 < input.txt > my_ans.txt
    Check answer:
$ ./diff -w -b -B answer.txt my_ans.txt
```

Series - 2 (20%) - Restrictions:

1. You should use only **ONE** global array of size 3 to update number counts. (same as above)

```
long long counts[3] = {}; // datatype and variable name can be any.
```

2. You should update the counts values each time you process the string.

   NOT count the numbers by threads, and update it to global variables at the end of thread.

```
(O) for(int i=begin; i<end; i++) counts[arr[i] - '0'] += 1;
```

(same as above)

```
(X) for(int i=begin; i<end; i++) localc[arr[i] - '0'] += 1;
    for(int i=0; i<3; i++)        counts[i] += localc[i];
```

   of course you can use **mutex** or **semaphore** to prevent race condition.

3. You should output the result **by each thread in order**. (new)

   Output `"0: %d\n"` by thread 0, `"1: %d\n"` by thread 1, `"2: %d\n"` by thread 2.

   NOT output it in main region(all thread end).

Series - 2 (20%) - input / output:

- Input

Series length (1 ~ 10^8) ->
The series ->

```
15
120201202011021
```

$$\begin{tikzcd}
12020 \arrow[d] & 12020 \arrow[d] & 11021 \arrow[d] \\
\text{Thread1} & \text{Thread2} & \text{Thread3}
\end{tikzcd}$$

Each thread is responsible for 1/3 of the series.

- Output

0:(space)counts[0](newline)
1:(space)
...(newline)

```
0: 5
1: 5
2: 5
```

```
   Compile with:
$ g++ -o hw4_1_2 hw4_1_2.c –lpthread
   Test with:
$ ./hw4_1_2 < input.txt > my_ans.txt
   Check answer:
$ ./diff -w -b -B answer.txt my_ans.txt
```

Pi (30%) - Restrictions:

1. You should use only **ONE** global variable to update counts
   ```
   long long counts = 0; // datatype and variable name can be any.
   ```
2. You should update the counts values each time you process the string.
   NOT count the numbers by threads, and update it to global variables at the end of thread.
   ```
   (O) for(int i=begin; i<end; i++) if(point in circle) counts += 1;
   ```
   ```
   (X) for(int i=begin; i<end; i++) if(point in circle) localc += 1;
       counts += localc;
   ```

   of course you can use **mutex** or **semaphore** to prevent race condition.

Pi (30%) - input / output:

- Input

Number of threads (1 ~ 4) ->
Number of points (1 ~ 10^8) ->

```
4
100000
```

- Output

get:(space)counts(newline)
Pi:(space)result(newline)

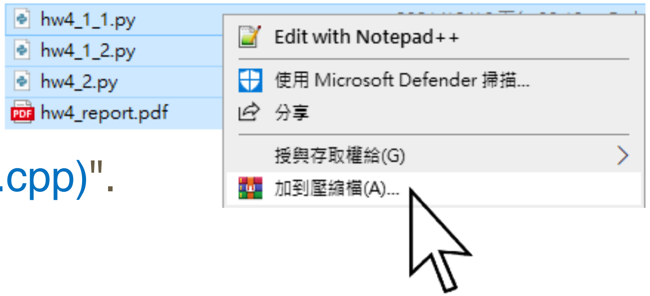
```
get: 78513
Pi: 3.14052
```

```
#include <stdlib.h>
// # include <cstdlib> in c++

// srand(), rand(), RAND_MAX

// ---------------------------- or

# include <random>
// Reference: https://www.cplusplus.com/reference/random/uniform_real_distribution/
```

```
    Compile with:
$ g++ -o hw4_2 hw4_2.c -lpthread
    Test with:
$ ./hw4_2 < input.txt > my_ans.txt
    Check answer:
$ no.
```

Requirements

1. You should write codes in c/c++.
2. Put all *.c(.cpp) source files and report(*.pdf) into same compressed file.
   The type of compressed file must be "zip".
3. The name of your compressed file must have the form of "studentID_OS_hw4.zip" and submit it without folder.
4. The name of .*c/*.cpp file must in the form of "hw4_1_1.c(.cpp)" & "hw4_1_2.c(.cpp)" & "hw4_2.c(.cpp)".
5. Report: format is in hw4_report.docx.
   And please **export to PDF** file(hw4_report.pdf) before submitting.



Grade

Total score: 100pts. COPY WILL GET 0 POINT!

- HW4 - 1 - 1 | HW4 - 1 - 2 | HW4 - 2 | report

  30 pts 20 pts 30 pts 20 pts

  (not meet the requirements(restrictions) will also **get 0 pts in that question**.

- Incorrect file form: -20 pts

  (Including the names of compressed file, .c(.cpp) files, report file type)

- Deadline: 2022/1/8 (Sat) PM11:55

  Late submission will get a **-20% point per day**

  e.g. write HW4 - 1 - 1 and HW4 - 1- 2 only, and submit it 2 days late will get:

  (30 + 20) * (100% - 2 * 20%) = 30 pts