2018 OS - hw2

- Operating system 107 fall -

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Multi-Threading Programming

Example - Hello Thread!

hello_thread.c

```c
#include <stdio.h>
#include <pthread.h>
#include <unistd.h>

// child threading function
void* child(void* data){
    char *str = (char*) data; // get data "Child"
    int i;
    for(i=0;i<3;i++){
        printf("%s\n", str);// output every second
        sleep(1);
    }
    pthread_exit(NULL); // exit child thread
}

// main fuction
int main(void){
    // define thread variable
    pthread_t t;
    // create child thread
    pthread_create(&t,NULL,child,"Child");
    // main thread
    int i;
    for(i=0;i<3;i++){
        printf("Master\n"); // output "Master" every second
        sleep(1);
    }
    pthread_join(t,NULL);// wait for all child threading finished
    return 0;
}
```

Output

```
annliu@liude-MacBook-Pro:~/Desktop/OS_HW2$ gcc-4.9 hello_thread.c -lpthread -o hello_thread
annliu@liude-MacBook-Pro:~/Desktop/OS_HW2$ ./hello_thread
Master
Child
Master
Child
Master
Child
```

<pthread.h> library info
Ref:http://pubs.opengroup.org/onlinepubs/7908799/xsh/pthread.h.html

Tools for showing threads

- **NCTU Workstation** > top

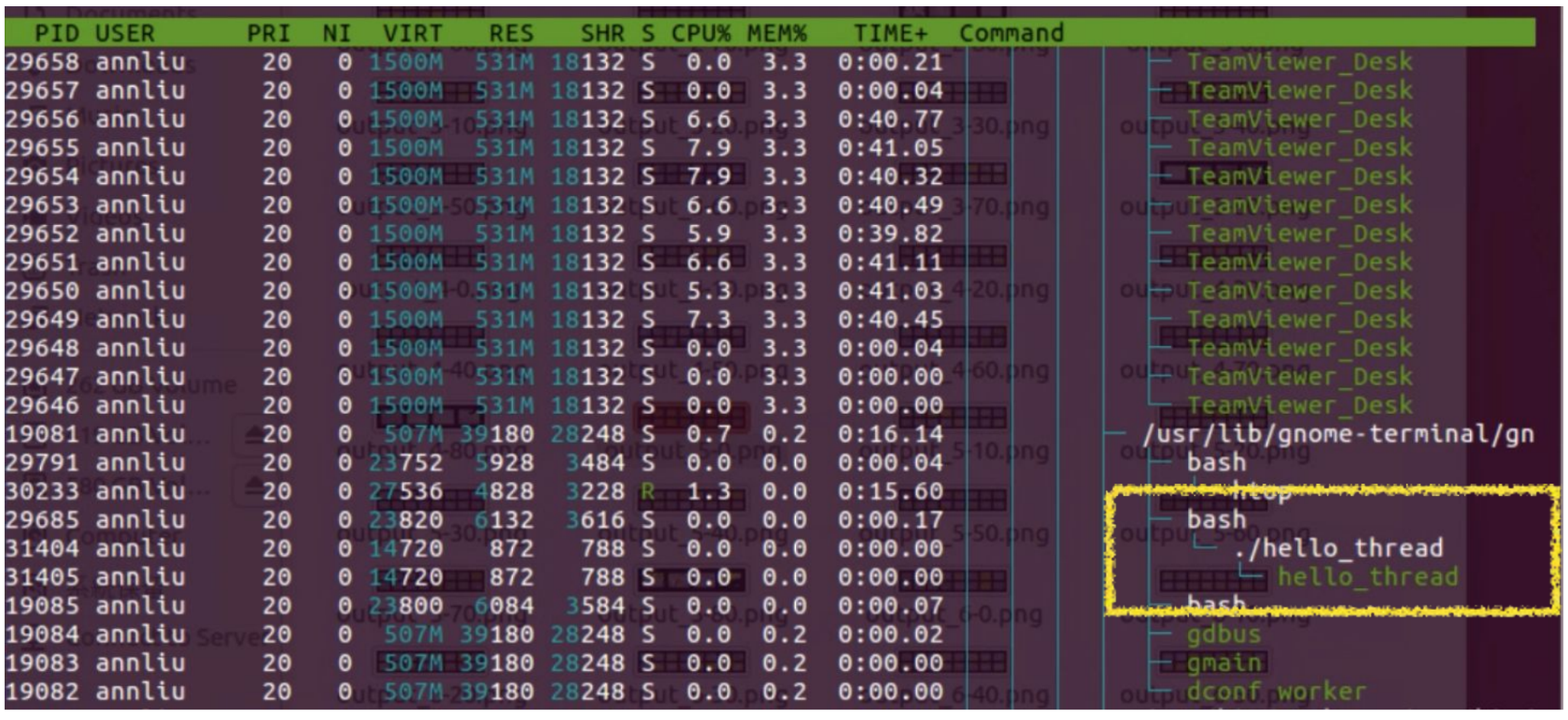
(THR means the num of threads under the process)

```
last pid: 37465;  load averages:  1.38,  1.31,  1.29                    up 26+08:09:14  09:32:45
740 processes: 2 running, 723 sleeping, 15 stopped
CPU:  0.0% user,  9.9% nice, 16.9% system,  0.1% interrupt, 73.1% idle
Mem: 131M Active, 1576M Inact, 67M Laundry, 12G Wired, 238M Buf, 1370M Free
ARC: 6678M Total, 4440M MFU, 1619M MRU, 32K Anon, 91M Header, 527M Other
     5373M Compressed, 13G Uncompressed, 2.44:1 Ratio
Swap: 2048M Total, 35M Used, 2013M Free, 1% Inuse

  PID USERNAME          THR PRI NICE   SIZE    RES STATE   C   TIME    WCPU COMMAND
14167 lucan19970907       1 123   20  6284K  2084K CPU3    3 627:20 100.40% shell
66363 tengwc10230         1  21    0  6284K  2080K fork    0  93:38   3.40% shell
37463 yliu1013            2  20    0  6592K  2308K nanslp  3   0:00   0.16% hello_thread
87658 caijli0814          1  35    0  6284K  2080K wait    0   1:22   0.07% sheel
36105 yliu1013            1  20    0 13640K  6068K pause   0   0:00   0.04% tcsh
22613 root                1  20    0  6424K  2628K select  1   4:12   0.03% syslogd
36104 yliu1013            1  20    0 33644K 28484K select  1   0:00   0.03% sshd
  369 root                1  20    0  9184K   664K select  0   3:38   0.01% devd
36698 yliu1013            1  20    0 33644K 28428K select  1   0:00   0.01% sshd
  683 root                1  20    0 12456K 12552K select  1   2:27   0.01% ntpd
  392 _pflogd             1  20    0  6688K  2088K bpf     3   1:44   0.00% pflogd
52066 linkp               1  20    0 16480K 12784K select  1   9:38   0.00% tmux
72905 ca043022            1  20    0 12384K  9360K select  0   0:56   0.00% tmux
39194 ca071042            1  20    0 10336K  7868K select  3   0:20   0.00% tmux
  754 root                1  20    0 12616K   844K nanslp  3   0:17   0.00% cron
77441 zjlin               1  20    0 33644K 28280K select  0   0:16   0.00% sshd
 2473 bohau0511097        1  20    0 33644K 28612K select  3   0:16   0.00% sshd
24576 linkp               1  20    0 62844K 47352K select  1   0:15   0.00% vim
  749 root                1  20    0 12852K  6332K select  1   0:14   0.00% sshd
  579 root                1  20    0 18592K  3732K select  0   0:12   0.00% ypbind
39209 kuohh               1  20    0 35692K 29776K select  1   0:11   0.00% sshd
 4642 hchou               1  20    0 35692K 29088K select  1   0:08   0.00% sshd
 8433 linkp               1  21    0 18032K  8784K ttyin   0   0:08   0.00% zsh
57406 linkp               1  20    0 64892K 47668K select  3   0:08   0.00% vim
26233 c0719803            1  20    0 12384K  8420K select  0   0:07   0.00% tmux
22320 cty                 1  20    0 12384K  7968K select  0   0:06   0.00% tmux
```

```
annliu — annliu@annliu-System-Product-Name: ~ — ssh yliu1013@bsd1.cs.nctu.edu.tw — 100×24
bsd1 [/u/gcs/106/0656126/2018_os_hw2] -yliu1013- ./hello_thread
Master
Child
Master
Child
```

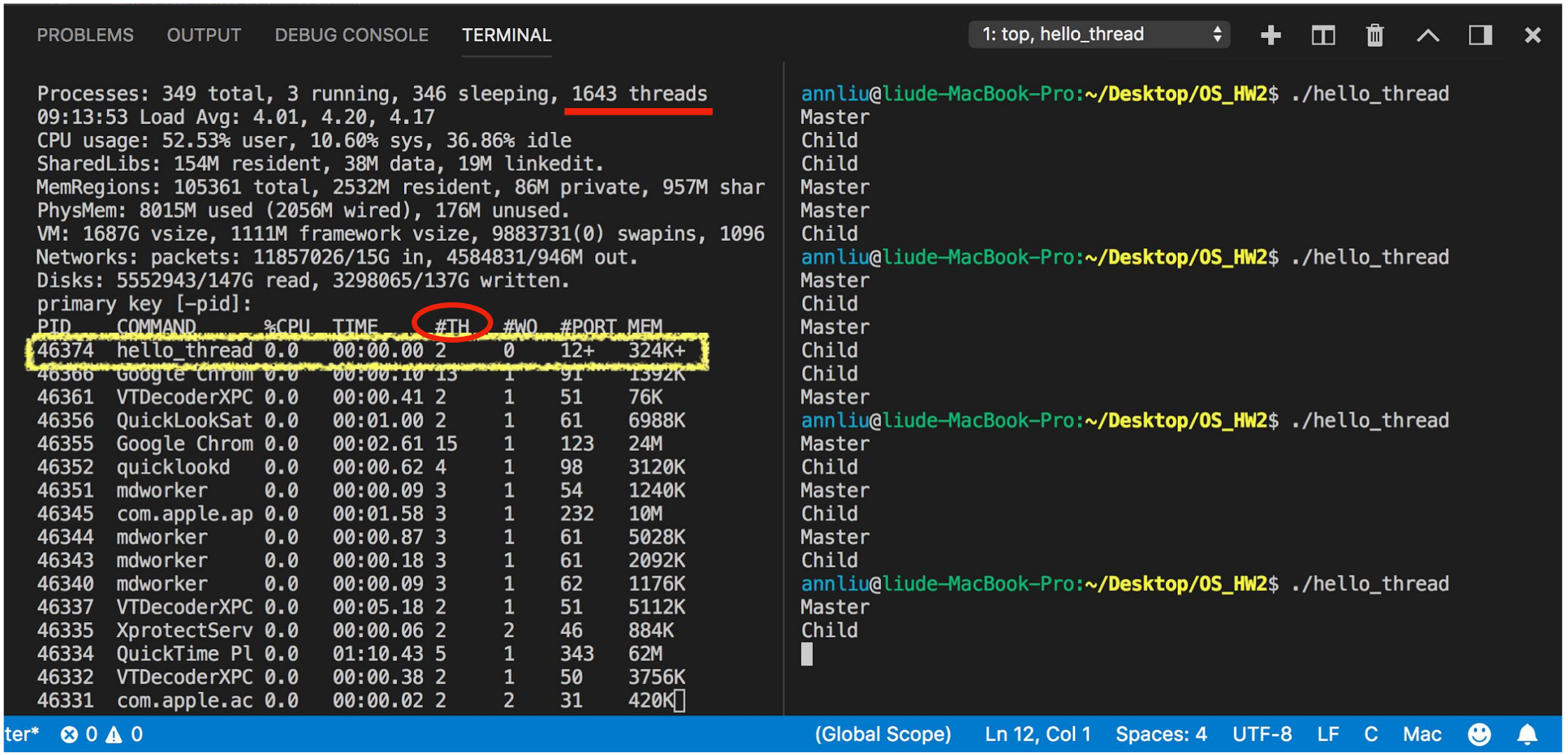
Tools for showing threads

- **Ubuntu** -> sudo apt-get install **htop**
  - - - **press <F2>** to enter htop setup menu.
  - - - Choose "Display option" under "Setup" column, and toggle on "Three view" and "Show custom thread names" options.
  - - - Presss <F10> to exit the setup.



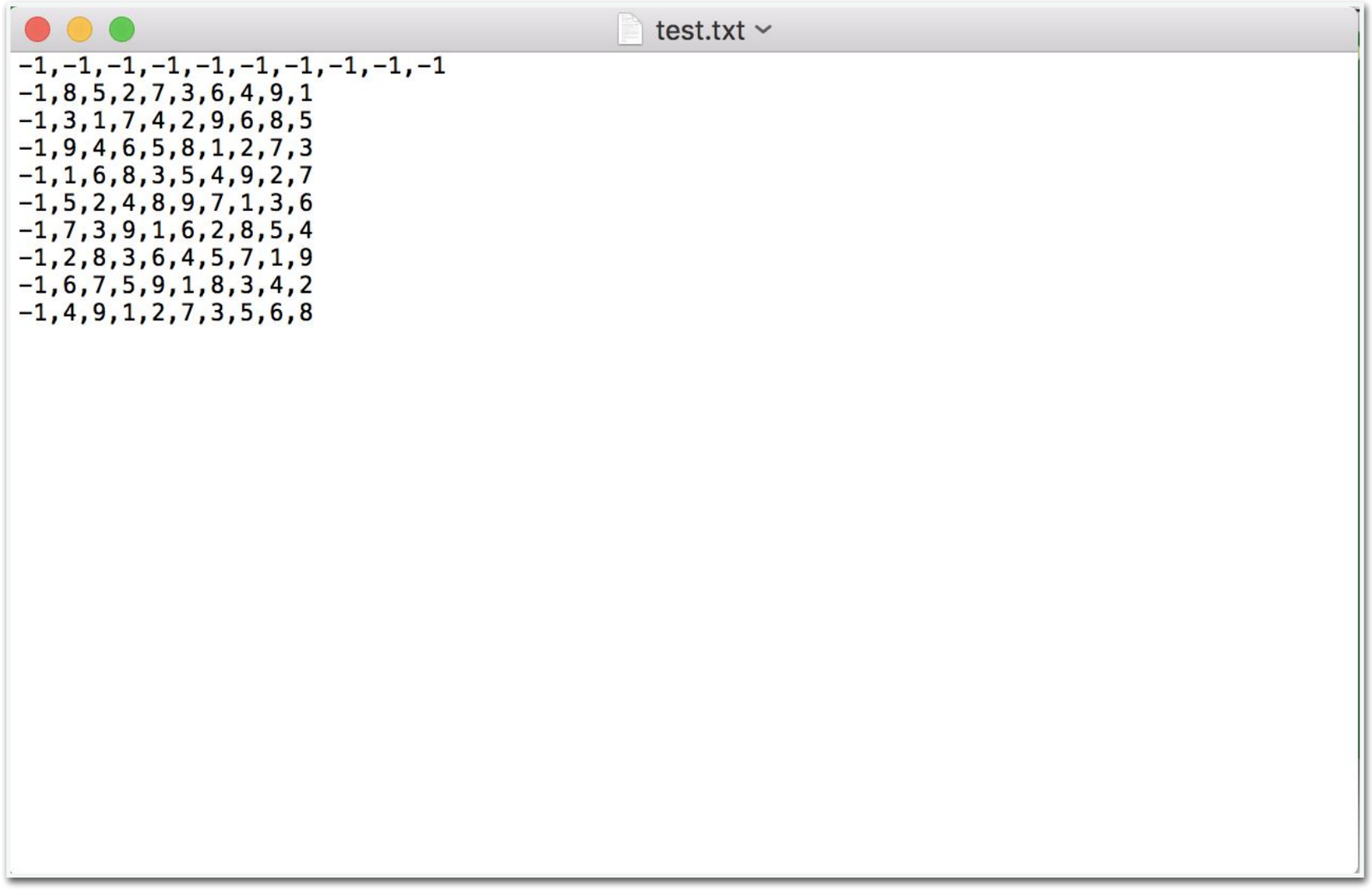
Tools for showing threads

- Mac -> Enter the terminal > top



Problem: Sum Checker-input

- Input file: test.txt (it contains a 2D array.) Ex. (-1 means the (x=0 or y=0) of the 2D array.)



Problem: Sum Checker-rules

- Given a 9x9 2D-array and each item of the array must be the digits 1 to 9.
- Sum of each row, column, and each of the nine sub-grids must be the same and every digits only show once.
- **Hint:**
  1. A thread to check that each sum of the rows.
  2. A thread to check that each sum of the cols.
  3. Nine threads to check each sum of the 3x3 sub-grids.

Example

2	9	5	7	4	3	8	6	1
4	3	1	8	6	5	9	2	7
8	7	6	1	9	2	5	4	3
3	8	7	4	5	9	2	1	6
6	1	2	3	8	7	4	9	5
5	4	9	2	1	6	7	3	8
7	6	3	5	3	4	1	8	9
9	2	8	6	7	1	3	5	4
1	5	4	9	3	8	6	7	2

Rows

Columns

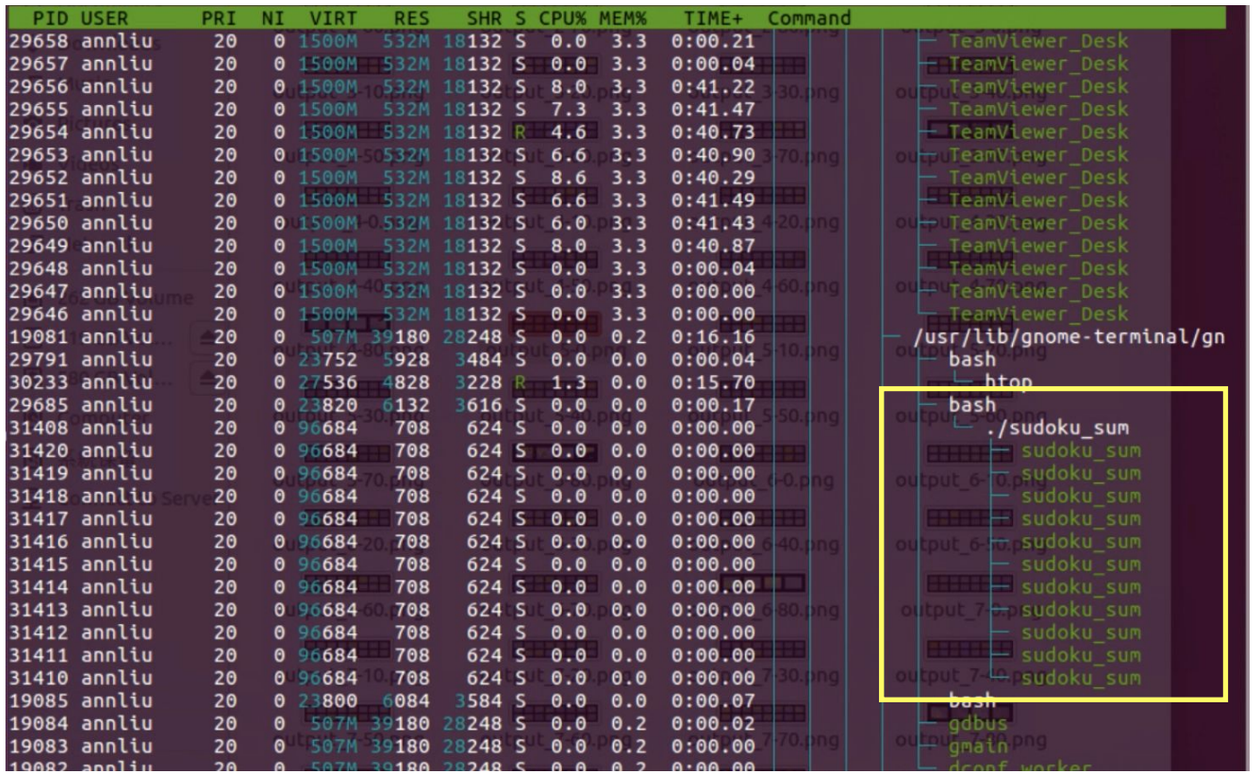
3x3 subgrids

Problem: Sum Checker-Output

Code output

```
annliu@liude-MacBook-Pro:~/Desktop/OS_HW2
$ ./sudoku_sum
========================
||   SUM    CHECKER   ||
========================
|8 ||5 ||2 ||7 ||3 ||6 ||4 ||9 ||1 |
_________________________________
|3 ||1 ||7 ||4 ||2 ||9 ||6 ||8 ||5 |
_________________________________
|9 ||4 ||6 ||5 ||8 ||1 ||2 ||7 ||3 |
_________________________________
|1 ||6 ||8 ||3 ||5 ||4 ||9 ||2 ||7 |
_________________________________
|5 ||2 ||4 ||8 ||9 ||7 ||1 ||3 ||6 |
_________________________________
|7 ||3 ||9 ||1 ||6 ||2 ||8 ||5 ||4 |
_________________________________
|2 ||8 ||3 ||6 ||4 ||5 ||7 ||1 ||9 |
_________________________________
|6 ||7 ||5 ||9 ||1 ||8 ||3 ||4 ||2 |
_________________________________
|4 ||9 ||1 ||2 ||7 ||3 ||5 ||6 ||8 |
_________________________________

Successful :)
```

Check num of the threads under your process



Problem: Sum Checker- Time

Command: time ./exe

Multi-thread

```
annliu@liude-MacBook-Pro:~/Desktop/OS_HW2$ time ./su
doku_sum
======================
||  SUM   CHECKER  ||
======================
|8 ||5 ||2 ||7 ||3 ||6 ||4 ||9 ||1 |
______________________________________
|3 ||1 ||7 ||4 ||2 ||9 ||6 ||8 ||5 |
______________________________________
|9 ||4 ||6 ||5 ||8 ||1 ||2 ||7 ||3 |
______________________________________
|1 ||6 ||8 ||3 ||5 ||4 ||9 ||2 ||7 |
______________________________________
|5 ||2 ||4 ||8 ||9 ||7 ||1 ||3 ||6 |
______________________________________
|7 ||3 ||9 ||1 ||6 ||2 ||8 ||5 ||4 |
______________________________________
|2 ||8 ||3 ||6 ||4 ||5 ||7 ||1 ||9 |
______________________________________
|6 ||7 ||5 ||9 ||1 ||8 ||3 ||4 ||2 |
______________________________________
|4 ||9 ||1 ||2 ||7 ||3 ||5 ||6 ||8 |
______________________________________

Successful :)

real    0m1.015s
user    0m0.002s
sys     0m0.003s
```

V.S

Single thread

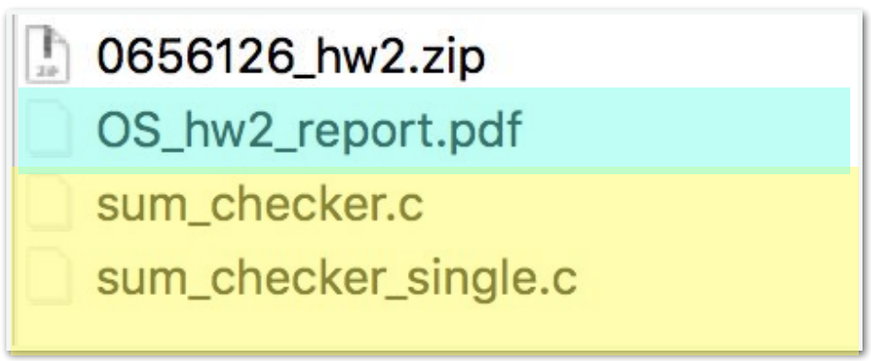
```
annliu@liude-MacBook-Pro:~/Desktop/OS_HW2$ time ./check_sum_s
======================
||  SUM   CHECKER  ||
======================
|8 ||5 ||2 ||7 ||3 ||6 ||4 ||9 ||1 |
______________________________________
|3 ||1 ||7 ||4 ||2 ||9 ||6 ||8 ||5 |
______________________________________
|9 ||4 ||6 ||5 ||8 ||1 ||2 ||7 ||3 |
______________________________________
|1 ||6 ||8 ||3 ||5 ||4 ||9 ||2 ||7 |
______________________________________
|5 ||2 ||4 ||8 ||9 ||7 ||1 ||3 ||6 |
______________________________________
|7 ||3 ||9 ||1 ||6 ||2 ||8 ||5 ||4 |
______________________________________
|2 ||8 ||3 ||6 ||4 ||5 ||7 ||1 ||9 |
______________________________________
|6 ||7 ||5 ||9 ||1 ||8 ||3 ||4 ||2 |
______________________________________
|4 ||9 ||1 ||2 ||7 ||3 ||5 ||6 ||8 |
______________________________________

Successful :)

real    0m11.024s
user    0m0.002s
sys     0m0.003s
```

Requirements

1. You can write codes in **C/C++.**
2. You need to hand in one single-thread version and the other multi-thread version. Put all of *.c or *.cpp source files and OS_hw2_report.pdf into same compressed file. The type of compressed file must be "studentID_hw2.zip" (ex. 010101_hw2.zip)
3. Use NCTU workstation as your environment

Deadline: 2018/10/28(日) PM 11:59

- Filename format sample



Grade

- Total score: 100 pts: **COPY WILL GET A 0 POINT!**

A. Input sample +10 pts

B. Two testing data + 10 pts (5 pts for each)

C. multithreading +40 pts

(report Q3: speed up= Ts/Tm ;

Ts:Time of single thread code ; Tm:Time of multi-thread code)

D. OS report (format OS_report.pdf) + 40 pts

E. **Incorrect filename format** will get -5 pts

- **Incorrect output format** will get -5 pts

DELAYED SUBMISSION WILL GET 0 POINT!