OS 2020 Project1

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Environment

OS: $Ubuntu16.04$

GCC version: $5.4.0$

cmake version: $3.5.1$(minimum required: 2.8)

python version: $3.5.2$(for checking script, not necessary)

Virtual Hardware:

- $8GB$ RAM
- 6 Processors($Host$: $i7$-$8750H$, 6 Cores, 12 Threads)

I use cmake generator to generate the $Makefile$, it might can't run on other machine. If you want to compile by `make`. Please run `cmake .` first to get the newest $Makefile$. How to run is described in $Readme$.

Design

In this assignment, there are four part in my project: $main, process, scheduling$ and $priority\ queue$ respectively. I maintain a priority queue to make me scheduling more convenience. There are two kinds of priority, $process\ priority$ and $CPU\ priority$ respectively at the following description. One is my priority queue's priority, the other one is real CPU's priority(control by $sched\_setscheduler$).

My $process\ priority$ is determined by its policy. If the policy is RR or $FIFO$, the priority is constant. Else, the priority is $\frac{1}{\text{remain exec. time}}$ and it will update every $UNIT\ TIME$ if it is running. Hence, even in preemptive mode, it will be switched because the priority is update frequently. $CPU\ priority$ will be set to 99 if it is waked up, 1 if it is blocked.

1. Read the input and sort them by ready time.
2. $Parent(main)$ start to check whether there is someone ready. If so, push it into priority queue.
3. Run the top of priority queue, context switch to other by the policy.
4. When context switching, if there is someone running, $block$ it and $push$ it into queue. Then pop the top and $wakeup$ it.

5. If someone finish, $wait$ it to avoid zombie exist too long.

There are some general information in my queue. Only one strange point is there is $remain\_time$ and $available\_time$ in it. The reason is RR need to switch every $500\ UNIT\ TIME$. $available\_time$ is running remain time and $remain\_time$ is real remain time. After $available\_time$ reduce to 0, it need to change to other process. In other policy, this two will be the same.

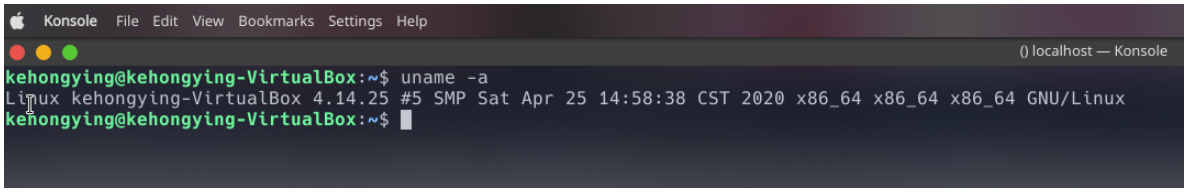
If the priority is the same($FIFO$ and RR), it will perform as a general queue(first in first out). If there is a process stop and a process in at the same time, I will deal with stopping process. For example, In `RR_4.txt`, $P1$ run until 500 and $P5, P6$ arrive at 500, too. Then $P1$ will push into the queue first, and $P5, P6$ is the following.

I use two cores to run $Parent$ and $Child\ process$ respectively. If we only use one, $Child\ process$ might be preempted by $Parent\ process$. This will cause the running time incorrect. So we need two cores to run them respectively. In $Parent$'s core, $main$'s $CPU\ priority$ is the highest to make sure it will be scheduled most frequently. When a process ready, It will be $fork()$ and $block$ immediately. When a process is $blocked$, it will be $assign$ to $Parent$'s core and reduce the $CPU\ priority$ to 1, which is much smaller than $main$. If it is its turn to run, it will be $assign$ to $Child$'s core and run. At the begin, $Child\ process$ is always in the $Child$'s core, there is a problem: in some time period, all of process in $Child\ process$ are blocked, which means they have the same $CPU\ priority$, some of them will be scheduled to run but it can't in fact. So in my method, all of blocked process will be placed in the $Parent$'s core, and all of them will not be scheduled because their $CPU\ priority$ is significant lower than $main$.

Even I use the above method to avoid child run in wrong time, I notice that some of them will sneak sometimes. This will cause they get the start time too early and the execution time we computed would be too long. So I set a new $while$ loop to check whether its $CPU\ priority$ has been rise or not. If not, it means that the process sneak and beacause parent hasn't let it run. It will be blocked in the loop until it wake up and rise the priority.

Kernel Version

I use $Linux\ 4.14.25$, which is same to $HW1$ and provided by the TA.



Experience

I try to compute my $UNIT\ TIME$'s real running time by `TIME_MEASUREMENT.txt` first.

```
[44776.059868] [Project1] 21208 1587748963.619857647
1587748964.274602330
[44777.349069] [Project1] 21209 1587748964.913345998
1587748965.564012433
[44778.645695] [Project1] 21210 1587748966.206974267
1587748966.860845140
[44779.937994] [Project1] 21211 1587748967.504002550
1587748968.153351429
[44781.237663] [Project1] 21212 1587748968.801994671
1587748969.453229212
[44782.538066] [Project1] 21213 1587748970.102086563
1587748970.753843828
[44783.832348] [Project1] 21214 1587748971.399933335
1587748972.048330929
[44785.127501] [Project1] 21215 1587748972.692772317
1587748973.343692519
[44786.428768] [Project1] 21216 1587748973.988960985
1587748974.645167108
[44787.726037] [Project1] 21217 1587748975.290399680
1587748975.942646055
```

And I use a script to compute their real running time, which is in `check_file/` and usage is in $Readme$, we can get:

```
[0.         0.65474486] 0.6547448635101318
[1.2934885  1.94415498] 0.6506664752960205
[2.58711672 3.24098754] 0.6538708209991455
[3.88414502 4.533494  ] 0.6493489742279053
[5.18213701 5.83337164] 0.6512346267700195
[6.48222899 7.13398623] 0.6517572402954102
[7.78007579 8.42847347] 0.64839768409729
[9.07291484 9.72383499] 0.6509201526641846
[10.36910343 11.02530956] 0.6562061309814453
[11.67054224 12.32278848] 0.6522462368011475
```

The average running time is about $0.652s$ for $500\ UNIT\ TIME$. I'll assume it as my ideal time and compare with other test. My starting time is start at "real start to run" instead of "ready time". Hence, it is different to $around\ time$. There is some deviation can be caused by CPU is unstable in sometimes, other process(system process), and so on. Compare with my classmate, It seems that my deviation is

smaller. I think the reason is I give more cores to the virtual machine. There are more resource to compete. Then the cores I used has the lower probability to be preempted by real process.

I compute some test data's theoretical time and compare with real running time(normalize the start_time to 0):

```
#FIFO_3.txt
           theoretical                        experience
    start    finish    exec          start    finish    exec
P1    0      10.432   10.432           0      10.680   10.680
P2  10.432   16.952    6.520         10.713   17.365    6.652
P3  16.952   20.864    3.912         17.384   21.361    3.976
P4  20.864   22.168    1.304         21.376   22.703    1.327
P5  22.168   23.472    1.304         22.707   24.042    1.334
P6  23.472   24.776    1.304         24.044   25.377    1.333
P7  24.776   29.992    5.216         25.385   30.723    5.337

#RR_4.txt
           theoretical                        experience
    start    finish    exec          start    finish    exec
P1    0      29.992   29.992           0      30.744   30.744
P2   0.652   26.080   25.428          0.659   26.834   26.175
P3   1.304   18.908   17.604          1.309   19.483   18.174
P4   1.956    7.172    5.216          1.958    7.519    5.562
P5   3.260    8.476    5.216          3.260    8.821    5.561
P6   3.912    9.128    5.216          3.909    9.472    5.563
P7   4.564   24.123   19.559          4.917   24.885   19.968

#PSJF_1.txt
           theoretical                        experience
    start    finish    exec          start    finish    exec
P1    0      32.600   32.600           0      33.192   33.192
P2   1.304   20.864   19.560          1.314   21.197   19.883
P3   2.608   13.040   10.432          2.723   13.210   10.487
P4   3.912    7.824    3.912          4.057    7.990    3.933
```

We can notice that theoretical time usually faster than real time. The reason is in real world, there is lots of thing need to do. Besides the formal job, the process need to run lots of thing to check who ready, when to switch, waiting child process return, and so on. And this two policy will do lots of context switch, so the loading will be more heavy. Moreover, lots of system process will preempt the resource and these time will be counted in.

We can also find that $FIFO$'s has the smallest error because its loading is the lightest. It don't need to recompute the priority and don't need to context switch frequently. In contrast, RR and $PSJF$ need to switch more frequently and need to do float compute.

By this compare, It seems that my implement is not bad. I've run a script to check my time difference to the ideal time. The average time error is about 2%, and the maximum error isn't exceed 10%.