OS Project1 – Processing Scheduling

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1 Program

1.1 Process Scheduler

`main.c`

- Read input(scheduling policy, process info)
- Qucik Sort by process's ready_time

`scheduler_xxx.c`

- There are four policies for processes to run
  FIFO
  RR
  SJF
  PSJF
- Call `procecc_control.c` to control processing
  `fork()` the process we want to run
  control the priority of each process to use CPU

`process_control.c`

- provide tools that are used in `scheduler_xxx.c`
- `TIME_UNIT()`: the function to determine the time unit by running 10^6 times in a while loop
- `assign_core()`: call system call `sched_setaffinity()` to make process run under a particular core
- `proc_create()` : create process and write a self-defined dmesg
- `proc_kickout()`: stop the process by lowering its priority
- `proc_resume()`: resume the process by increasing its priority

1.2 Kernel Version

- Linux version 4.14.25
- `sys_printstring()` write a string with process info into the system log

Note: The way I add the system call in the kernel is the same as HW1.

2 Theoretical and Actual Results

- Test Machine: `Intel core i7 8th gen`
- Time unit: 0.001554701 sec

→ `pid` finish at `converted time unit` unit

Test data	Theoretical Output	Actual Output
FIFO_1	Process P1, start at 0	3424 finish at 485.736573846 unit
	Process P1, end at 500	3425 finish at 980.905900368 unit
	Process P2, end at 1000	3426 finish at 1461.715031122 unit
	Process P3, end at 1500	3427 finish at 1946.308579230 unit
	Process P4, end at 2000	3428 finish at 2444.064672573 unit
	Process P5, end at 2500	
FIFO_2	Process P1, start at 0	4452 finish at 84406.981498050 unit
	Process P1, end at 80000	4521 finish at 90173.906469475 unit
	Process P2, end at 85000	4548 finish at 91316.874097334 unit
	Process P3, end at 86000	4549 finish at 92512.112585635 unit
	Process P4, end at 87000	
FIFO_3	Process P1, start at 0	4556 finish at 9257.123189603 unit
	Process P1, end at 8000	4561 finish at 14339.640996564 unit
	Process P2, end at 13000	4562 finish at 17347.222201568 unit
	Process P3, end at 16000	4565 finish at 18351.444951151 unit
	Process P4, end at 17000	4566 finish at 19389.861876335 unit
	Process P5, end at 18000	4567 finish at 20448.637328978 unit
	Process P6, end at 19000	4568 finish at 24696.159936862 unit
	Process P7, end at 23000	
FIFO_4	Process P1, start at 0	4575 finish at 2086.384625082 unit
	Process P1, end at 2000	4576 finish at 2625.954913517 unit
	Process P2, end at 2500	4577 finish at 2856.162099979 unit
	Process P3, end at 2700	4578 finish at 3466.169091034 unit
	Process P4, end at 3200	
FIFO_5	Process P1, start at 0	4585 finish at 9075.302293495 unit
	Process P1, end at 8000	4588 finish at 14130.979037126 unit
	Process P2, end at 13000	4591 finish at 17084.718282164 unit
	Process P3, end at 16000	4594 finish at 18103.857425318 unit
	Process P4, end at 17000	4595 finish at 19152.551340096 unit
	Process P5, end at 18000	4596 finish at 20199.738197891 unit
	Process P6, end at 19000	4597 finish at 24326.516274833 unit
	Process P7, end at 23000	

Test data	Theoretical Output	Actual Output
RR_1	Process P1, start at 0	4605 finish at 510.346704607 unit
	Process P1, end at 500	4606 finish at 1025.679448331 unit
	Process P2, end at 1000	4607 finish at 1542.941161676 unit
	Process P3, end at 1500	4608 finish at 2062.947046409 unit
	Process P4, end at 2000	4609 finish at 2571.760456833 unit
	Process P5, end at 2500	
RR_2	Process P1, start at 600	4618 finish at 8378.416026618 unit
	Process P1, end at 8100	4619 finish at 10090.853654818 unit
	Process P2, end at 9600	
RR_3	Process P1, start at 1200	3448 finish at 19610.678614730 unit
	Process P3, end at 18200	3446 finish at 21820.329870502 unit
	Process P1, end at 20200	3447 finish at 22364.146018430 unit
	Process P2, end at 20700	3451 finish at 30552.211318446 unit
	Process P6, end at 28200	3450 finish at 32717.099372162 unit
	Process P5, end at 30200	3449 finish at 33844.725553016 unit
	Process P4, end at 31200	
RR_4	Process P1, start at 0	4807 finish at 5648.120694590 unit
	Process P4, end at 5500	4808 finish at 6154.098238182 unit
	Process P5, end at 6000	4809 finish at 6672.370182433 unit
	Process P6, end at 6500	4806 finish at 15412.297893292 unit
	Process P3, end at 14500	4810 finish at 19425.506268407 unit
	Process P7, end at 18000	4805 finish at 21678.530898867 unit
	Process P2, end at 20000	4804 finish at 25155.471437916 unit
	Process P1, end at 23000	
RR_5	Process P1, start at 0	4983 finish at 6411.939687438 unit
	Process P4, end at 5500	4992 finish at 6956.81977950 unit
	Process P5, end at 6000	4993 finish at 7564.649735865 unit
	Process P6, end at 6500	4982 finish at 16850.864070969 unit
	Process P3, end at 14500	4995 finish at 20968.000982182 unit
	Process P7, end at 18000	4981 finish at 23265.532381467 unit
	Process P2, end at 20000	4980 finish at 26642.967339700 unit
	Process P1, end at 23000	

Test data	Theoretical Output	Actual Output
SJF_1	Process P1, start at 0	5006 finish at 2281.772010180 unit
	Process P2, end at 2000	5008 finish at 3438.086374164 unit
	Process P3, end at 3000	5009 finish at 7614.980332552 unit
	Process P4, end at 7000	5012 finish at 14863.952316233 unit
	Process P1, end at 14000	
SJF_2	Process P1, start at 100	5021 finish at 204.206641662 unit
	Process P1, end at 200	5022 finish at 415.013099624 unit
	Process P3, end at 400	5023 finish at 4652.816536427 unit
	Process P2, end at 4400	5024 finish at 9127.460602392 unit
	Process P4, end at 8400	5027 finish at 17416.402991314 unit
	Process P5, end at 15400	
SJF_3	Process P1, start at 100	5035 finish at 3634.998585580 unit
	Process P1, end at 3100	5038 finish at 3647.183786464 unit
	Process P4, end at 3110	5039 finish at 3658.849893966 unit
	Process P5, end at 3120	5040 finish at 8241.251781532 unit
	Process P6, end at 7120	5041 finish at 12926.612061097 unit
	Process P7, end at 11120	5042 finish at 18074.142886638 unit
	Process P2, end at 16120	5047 finish at 25586.052202320 unit
	Process P3, end at 23120	5048 finish at 36228.300754292 unit
	Process P8, end at 32120	
SJF_4	Process P1, start at 0	3460 finish at 3437.192804252 unit
	Process P1, end at 3000	3461 finish at 4613.367211919 unit
	Process P2, end at 4000	3462 finish at 8901.694584435 unit
	Process P3, end at 8000	3463 finish at 9896.110092064 unit
	Process P5, end at 9000	3465 finish at 11903.187311217 unit
	Process P4, end at 11000	
SJF_5	Process P1, start at 0	5115 finish at 2344.904424709 unit
	Process P1, end at 2000	5116 finish at 2938.450997330 unit
	Process P2, end at 2500	5117 finish at 3552.274462420 unit
	Process P3, end at 3000	5118 finish at 4156.828788943 unit
	Process P4, end at 3500	

Test data	Theoretical Output	Actual Output
PSJF_1	Process P1, start at 0	5131 finish at 6697.899814176 unit
	Process P4, end at 6000	5130 finish at 11161.407140022 unit
	Process P3, end at 10000	5129 finish at 18086.808665460 unit
	Process P2, end at 16000	5126 finish at 28551.088576517 unit
	Process P1, end at 25000	
PSJF_2	Process P1, start at 0	3436 finish at 2175.936059731 uniti
	Process P2, end at 2000	3435 finish at 4362.575270100 unit
	Process P1, end at 4000	3438 finish at 7692.962945286 unit
	Process P4, end at 7000	3439 finish at 8909.415357679 unit
	Process P5, end at 8000	3437 finish at 12183.216554823 unit
	Process P3, end at 11000	
PSJF_3	Process P1, start at 0	5179 finish at 1136.862530480 unit
	Process P2, end at 1000	5180 finish at 1740.184813028 unit
	Process P3, end at 1500	5189 finish at 2307.620301910 unit
	Process P4, end at 2000	5177 finish at 4087.496793917 unit
	Process P1, end at 3500	
PSJF_4	Process P1, start at 0	5198 finish at 1249.491996210 unit
	Process P3, end at 1100	5197 finish at 3402.500999870 unit
	Process P2, end at 3000	5199 finish at 8057.667042730 unit
	Process P4, end at 7000	5202 finish at 15346.967091421 unit
	Process P1, end at 14000	
PSJF_5	Process P1, start at 100	5209 finish at 203.53058317 unit
	Process P1, end at 200	5210 finish at 411.019666160 unit
	Process P3, end at 400	5211 finish at 4385.296255035 unit
	Process P2, end at 4400	5214 finish at 8362.423893082 unit
	Process P4, end at 8400	5215 finish at 15976.963993076 unit
	Process P5, end at 15400	

Note: Whenever the ready time for the first process in nonzezro, we should shift the time units by their `ready_time`

Note: Some of the pid among these test data are not consistent. It is because they are chosen to run under the demo.

3 Analysis of Results

After running the program in the four different policies, the actual results mainly match the theoretical results, with the error lying in between $5\% - 15\%$.

- Working Load: There might be other programs running while executing the programs of the project. Using `sched_scheduler()` to control the ordering cannot ensure that our programs can be run with top priority. Even if we set the priority in `SCHED_FIFO` to the highest, there is no guarantee that the programs can share CPU with other system programs. Furthermore, how CPU loads instantaneously will also affect the finish time for the programs.
- The Variation of Time Unit: CPU has the ability to change clock rate, which can be adjusted to enhance the performance of CPU when there is heavily loading. If our CPU has such function, then the time unit we use may vary from time to time, leading to errors.

- The Synchronization between Parent Process and Children Process The scheduler programs and their children processes need to communicate by some ways, and the time difference when they communicate can cause error. For example, in the program, parents use `PIPE` to make children run, and use `waitpid()` to take over the finish of children. The communication info between sender and receiver can cause time difference, leading to the error.
  On top of that, child and parent process run under different core, while they use the same way to compute the time unit. Hence, if the cores for these two process have different work loading, these two processes may be asynchronized. Suppose the core for the child has light loading and finishes earlier than parent, the parent will call `waitpid()` at a later time. In this case, when the next child is going to run, it will be delayed due to the postponement of parent, leading to error in time.