葉思泓 B05202066

作業系統 Project 1

壹. 設計

1. main.c
   - 讀入Input
   - 根據process的開始時間排序
   - 根據schedule policy呼叫不同的scheduler程式
2. scheduler_FIFO.c, scheduler_RR.c, scheduler_SJF.c, scheduler_PSJF.c
   - 以
3. process_control.c
   - 提供各個scheduler程式會使用到的工具
   - TIME_UNIT()：作業要求中以空轉一百萬次的迴圈當作時間的一單位的函式
   - assign_core() ：以呼叫system call sched_setaffinity()將process限定在某一核心執行
   - proc_create()：製造process
   - proc_kickout()：令該process停止執行
   - proc_resume()：令該process恢復執行

貳. 核心版本

1. Linux 4.14.25
2. 新增system call 333： _sys_printstring() 將任意字串寫入系統的log中

參. 實際與理論結果

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測試機器：Intel core i7 8th Gen

單位時間：0.001554701 sec

Test Data	Theoretical Output	Actual Output
FIFO_1	Process P1, start at 0 Process P1, end at 500 Process P2, end at 1000 Process P3, end at 1500 Process P4, end at 2000 Process P5, end at 2500	P1 finish at 534.763537168 unit P2 finish at 1079.911905247 unit P3 finish at 1609.250656557 unit P4 finish at 2142.755798703 unit P5 finish at 2690.752024344 unit
FIFO_2	Process P1, start at 0 Process P1, end at 80000 Process P2, end at 85000 Process P3, end at 86000 Process P4, end at 87000	P1 finish at 84406.981498050 unit P2 finish at 90173.906469475 unit P3 finish at 91316.874097334 unit P4 finish at 92512.112585635 unit
FIFO_3	Process P1, start at 0 Process P1, end at 8000 Process P2, end at 13000 Process P3, end at 16000 Process P4, end at 17000 Process P5, end at 18000 Process P6, end at 19000 Process P7, end at 23000	P1 finish at 9257.123189603 unit P2 finish at 14339.640996564 unit P3 finish at 17347.222201568 unit P4 finish at 18351.444951151 unit P5 finish at 19389.861876335 unit P6 finish at 20448.637328978 unit P7 finish at 24696.159936862 unit
FIFO_4	Process P1, start at 0 Process P1, end at 2000 Process P2, end at 2500 Process P3, end at 2700 Process P4, end at 3200	P1 finish at 2086.384625082 unit P2 finish at 2625.954913517 unit P3 finish at 2856.162099979 unit P4 finish at 3466.169091034 unit
FIFO_5	Process P1, start at 0 Process P1, end at 8000 Process P2, end at 13000 Process P3, end at 16000 Process P4, end at 17000 Process P5, end at 18000 Process P6, end at 19000 Process P7, end at 23000	P1 finish at 9075.302293495 unit P2 finish at 14130.979037126 unit P3 finish at 17084.718282164 unit P4 finish at 18103.857425318 unit P5 finish at 19152.551340096 unit P6 finish at 20199.738197891 unit P7 finish at 24326.516274833 unit
RR_1	Process P1, start at 0 Process P1, end at 500 Process P2, end at 1000 Process P3, end at 1500 Process P4, end at 2000 Process P5, end at 2500	P1 finish at 510.346704607 unit P2 finish at 1025.679448331 unit P3 finish at 1542.941161676 unit P4 finish at 2062.947046409 unit P5 finish at 2571.760456833 unit
RR_2	Process P1, start at 600 Process P1, end at 8100 Process P2, end at 9600	P1 finish at 8378.416026618 unit P2 finish at 10090.853654818 unit

Test Data	Theoretical Output	Actual Output
RR_3	Process P1, start at 0 Process P3, end at 17000 Process P1, end at 19000 Process P2, end at 19500 Process P6, end at 27000 Process P5, end at 29000 Process P4, end at 30000	P3 finish at 15797.428596881 unit P1 finish at 18007.079852653 unit P2 finish at 18550.896000581 unit P6 finish at 26738.961300597 unit P5 finish at 28903.849354313 unit P4 finish at 30031.475535167 unit
RR_4	Process P1, start at 0 Process P4, end at 5500 Process P5, end at 6000 Process P6, end at 6500 Process P3, end at 14500 Process P7, end at 18000 Process P2, end at 20000 Process P1, end at 23000	P4 finish at 4090.408259208 unit P5 finish at 4596.385802800 unit P6 finish at 5114.657747052 unit P3 finish at 13854.585457911 unit P7 finish at 17867.793833026 unit P2 finish at 20120.818463485 unit P1 finish at 23597.759002534 unit
RR_5	Process P1, start at 0 Process P4, end at 5500 Process P5, end at 6000 Process P6, end at 6500 Process P3, end at 14500 Process P7, end at 18000 Process P2, end at 20000 Process P1, end at 23000	P4 finish at 4685.359346266 unit P5 finish at 5230.230437878 unit P6 finish at 5838.069394693 unit P3 finish at 15124.283729797 unit P7 finish at 19241.420641010 unit P2 finish at 21538.952040295 unit P1 finish at 24916.386998528 unit
SJF_1	Process P1, start at 400 Process P2, end at 2400 Process P3, end at 3400 Process P4, end at 7400 Process P1, end at 14400	P2 finish at 2281.772010180 unit P3 finish at 3438.086374164 unit P4 finish at 7614.980332552 unit P1 finish at 14863.952316233 unit
SJF_2	Process P1, start at 100 Process P1, end at 200 Process P3, end at 400 Process P2, end at 4400 Process P4, end at 8400 Process P5, end at 15400	P1 finish at 104.206641662 unit P3 finish at 315.013099624 unit P2 finish at 4552.816536427 unit P4 finish at 9027.460602392 unit P5 finish at 17316.402991314 unit
SJF_3	Process P1, start at 100 Process P1, end at 3100 Process P4, end at 3110 Process P5, end at 3120 Process P6, end at 7120 Process P7, end at 11120 Process P2, end at 16120 Process P3, end at 23120 Process P8, end at 32120	P1 finish at 3534.998585580 unit P4 finish at 3547.183786464 unit P5 finish at 3558.849893966 unit P6 finish at 8141.251781532 unit P7 finish at 12826.612061097 unit P2 finish at 17974.142886638 unit P3 finish at 25486.052202320 unit P8 finish at 36128.300754292 unit
SJF_4	Process P1, start at 1000 Process P1, end at 4000 Process P2, end at 5000 Process P3, end at 9000 Process P5, end at 10000 Process P4, end at 12000	P1 finish at 3784.119790236 unit P2 finish at 5079.009284743 unit P3 finish at 9800.171407878 unit P5 finish at 10894.956488739 unit P4 finish at 13104.614502724 unit

Test Data	Theoretical Output	Actual Output
SJF_5	Process P1, start at 500 Process P1, end at 2500 Process P2, end at 3000 Process P3, end at 3500 Process P4, end at 4000	P1 finish at 2344.904424709 unit P2 finish at 2938.450997330 unit P3 finish at 3552.274462420 unit P4 finish at 4156.828788943 unit
PSJF_1	Process P1, start at 0 Process P4, end at 6000 Process P3, end at 10000 Process P2, end at 16000 Process P1, end at 25000	P4 finish at 3343.827703847 unit P3 finish at 7807.335029693 unit P2 finish at 14732.736555131 unit P1 finish at 25197.016466188 unit
PSJF_2	Process P1, start at 0 Process P2, end at 2000 Process P1, end at 4000 Process P4, end at 7000 Process P5, end at 8000 Process P3, end at 11000	P2 finish at 1098.698193414 unit P1 finish at 3285.337403783 unit P4 finish at 6615.725078970 unit P5 finish at 7832.177491363 unit P3 finish at 11105.978688506 unit
PSJF_3	Process P1, start at 0 Process P2, end at 1000 Process P3, end at 1500 Process P4, end at 2000 Process P1, end at 3500	P2 finish at 559.388600766 unit P3 finish at 1162.710883314 unit P4 finish at 1730.146372196 unit P1 finish at 3510.022864203 unit
PSJF_4	Process P1, start at 0 Process P3, end at 1100 Process P2, end at 3000 Process P4, end at 7000 Process P1, end at 14000	P3 finish at 1139.722113769 unit P2 finish at 3292.731117430 unit P4 finish at 7947.897160289 unit P1 finish at 15237.197208981 unit
PSJF_5	Process P1, start at 200 Process P1, end at 300 Process P3, end at 500 Process P2, end at 4500 Process P4, end at 8500 Process P5, end at 15500	P1 finish at 103.530548317 unit P3 finish at 311.019666160 unit P2 finish at 4285.296255035 unit P4 finish at 8262.423893082 unit P5 finish at 16076.963993076 unit

肆. 結果分析

就執行的順序而言，實驗結果和理論吻合，而程式結束的時間也大致符合預期，誤差皆在15%以內。而有關於誤差可能的來源，在此提出幾個可能性：

1. 工作負載

在執行實驗的同時，有餘電腦中仍有其他許多的程式在執行，而以sched_scheduler( ) 控制程序排程策略並沒有方法保證能讓程式最優先跑，即便以

SCHED_FIFO策略將優先度設為最高仍然不能保證需要和其他系統程式分享CPU，而每瞬間CPU的負載程度都會影像程式跑完的時間。

2. 時間單位的變動

現代的CPU都有變頻的功能，能在負載較高時調高CPU的時脈來調高效能，而如果在程式執行的過程變頻功能有啟用，則我們的單位時間就有可能會變動、進而造成誤差。

3. Parent Process 與 Children Process 之間的同步問題

由於scheduler的程式和其所產生的children process之間需要透過某些管道溝通，而這些管道多少會有點時間差，這個時間差也會成為誤差來源。舉例來說，在我的程式中，Parent是用PIPE來叫Child開始跑，而Child的結束是Parent由waitpid( )來接收，這之間由訊息產生到收到之間都會產生一點時間差，而造成誤差。

另外由於程式中指定Child和Parent process在不同的核心上跑，而兩者計算時間的方式是以跑相同數量的空轉迴圈來計算，兩者所在核心當時的工作負載量若不同也會造成兩者的不同步。假設Child process所在的核心負載較輕因而比較早跑完，但Parent process因為跑得比較慢因而比較晚呼叫waitpit( )，在這個狀況下雖然當前這個child process仍然會即使執行完畢，但結束之後下一個要跑的child process則會因為parent的延遲而比較晚開始，造成時間上的誤差。

伍. 註記

我的作業與同組同學一同完成，因此實驗結果與Demo影片相同會和部分的同學相同。