2020 Operating System Project 1 - Process Scheduling

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Design

使用兩顆 CPU, CPU 0用作排程, CPU 1用來跑子程式.

Process

讀取 input data,將每個 process 按照 ready time 排列

建立 child processes,並為其分配 CPU 和設定 priority

Queue

為 Round-Robin 規則下,run 完的 process 如果還要運行就要重新排隊,每一個重新排隊的都需要排在 Queue 最後.

Scheduling

讀取 input data,將每個 process 按照 ready time 排列

建立 child processes,並為其分配 CPU 和設定 priority

當有 process 在跑的時候,check 是否已經完成

檢查是否有 process 已經 ready 準備要運行

將 CPU 交給下一個要運行的 Process,如果換人就要 content switch

process 運行完一個 Unit time 之後 process 剩下的時間減去 Unit time

重複步驟直到跑完所有 Processes

按照四種不同的 scheduling policy 進行排程,從而得知下一個要運行的 child process

System Calls

兩個自己的 syscalls，需要放入 linux/kernel 資料夾與 kernel 一同編譯。

334 my_gettime
335 my_dprint

用 getnstimeofday 來讀取當前時間戳 asmlinkage long sys_my_gettime(void) { static

const long giga = 1000000000; struct timespec _t; getnstimeofday(&_t); return (_t.tv_sec*giga + _t.tv_nsec); }

用來 printkl 來 print dmesg asmlinkage void sys_my_dprint(int pid,long start_time,

long end_time) { static const long giga = 1000000000; printk("[Project1] %d %ld.%09ld %ld.%09ld\n", pid, start_time / giga, start_time % giga, end_time / giga, end_time % giga); return; }

Experiment and Results

Environment Platform OS Kernel Virtualbox 6.1 on win10

Ubuntu 16.04 Linux 4.14.25

First In First Out （FIFO）

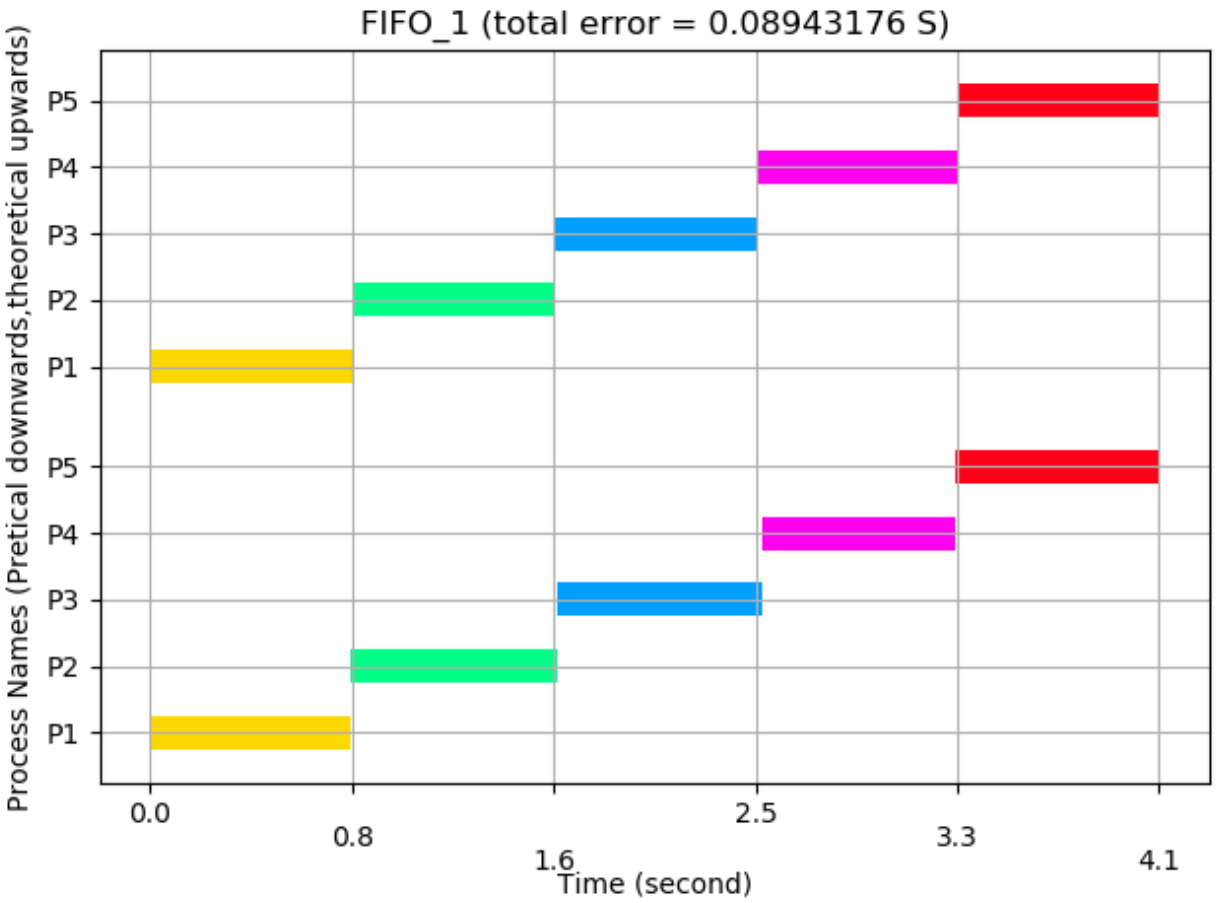
Test Data 1

FIFO 5 P1 0 500 P2 0 500 P3 0 500 P4 0 500 P5 0 500

Exclusion Result

[3999.001639] [Project1] 2647 1588168462.496226788 1588168463.313589004
[3999.839055] [Project1] 2648 1588168463.313712051 1588168464.150971127
[4000.675117] [Project1] 2649 1588168464.151094442 1588168464.986999186
[4001.525969] [Project1] 2650 1588168464.987171502 1588168465.837815910
[4002.342739] [Project1] 2651 1588168465.838098292 1588168466.654552204

Comparison of Theoretical and Pretical Results



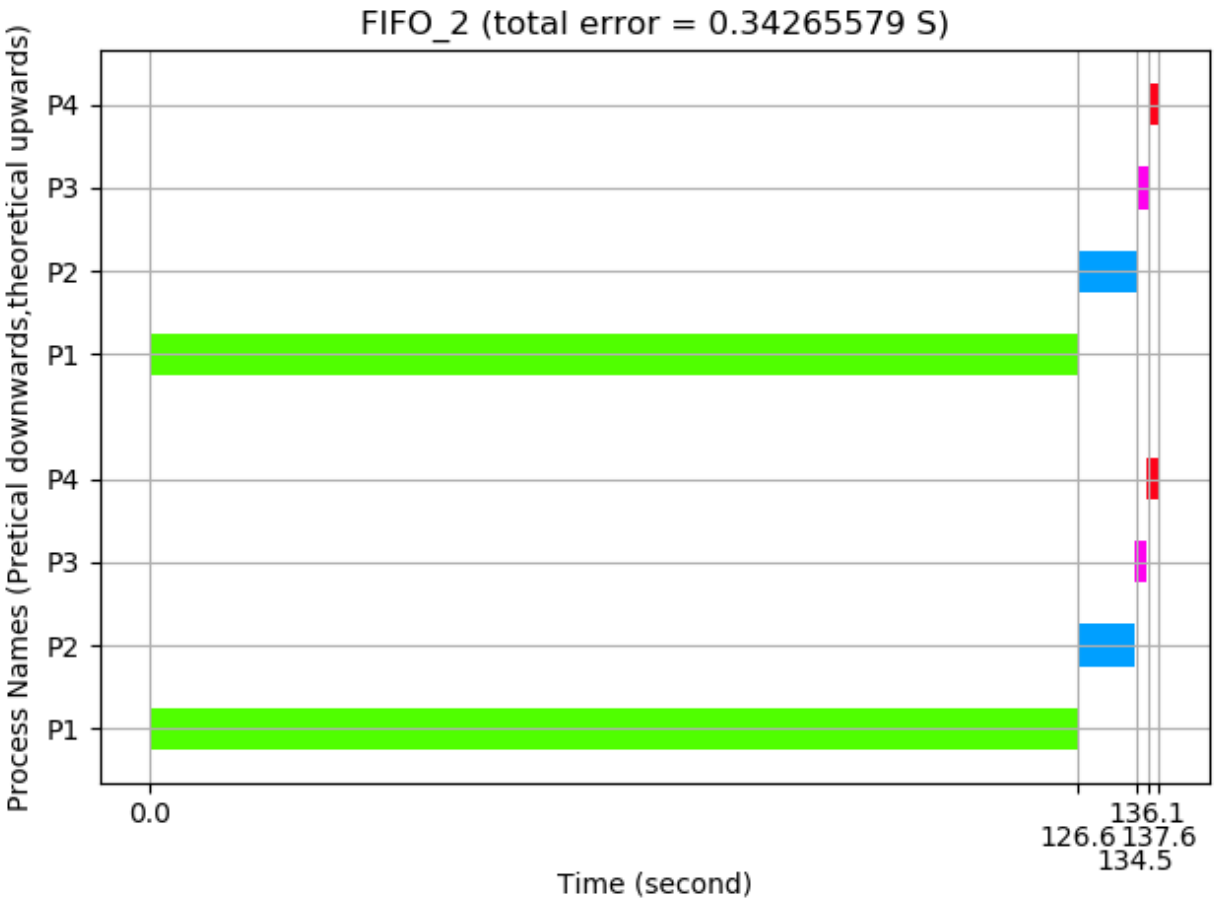
Test Data 2

FIFO 4 P1 0 80000 P2 100 5000 P3 200 1000 P4 300 1000

Exclusion Result

[4137.248056] [Project1] 2659 1588168466.665424981 1588168601.554405701
[4145.349248] [Project1] 2660 1588168601.554547696 1588168609.655599126
[4146.967657] [Project1] 2661 1588168609.655724017 1588168611.274006429
[4148.611852] [Project1] 2662 1588168611.274133536 1588168612.918200852

Comparison of Theoretical and Pretical Results



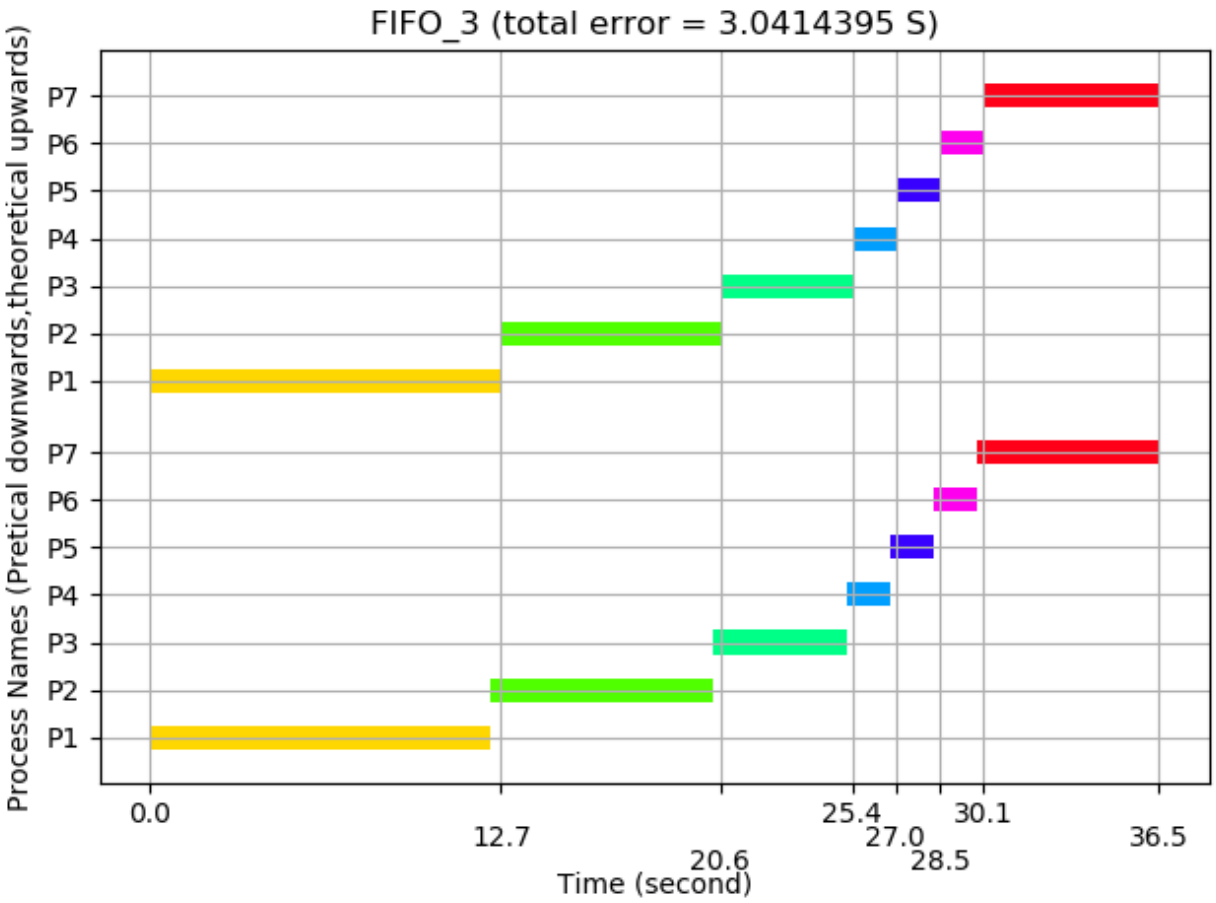
Test Data 3

FIFO 7 P1 0 8000 P2 200 5000 P3 300 3000 P4 400 1000 P5 500 1000 P6 500 1000 P7 600 4000

Exclusion Result

[4162.329934] [Project1] 2676 1588168612.929549667 1588168626.636273411
[4170.374733] [Project1] 2677 1588168626.636408431 1588168634.681060230
[4175.380045] [Project1] 2678 1588168634.681185265 1588168639.686362470
[4177.032926] [Project1] 2679 1588168639.686498069 1588168641.339239132
[4178.705258] [Project1] 2680 1588168641.339363096 1588168643.011568446
[4180.369589] [Project1] 2681 1588168643.011691793 1588168644.675895937
[4187.096760] [Project1] 2682 1588168644.676043260 1588168651.403048890

Comparison of Theoretical and Pretical Results



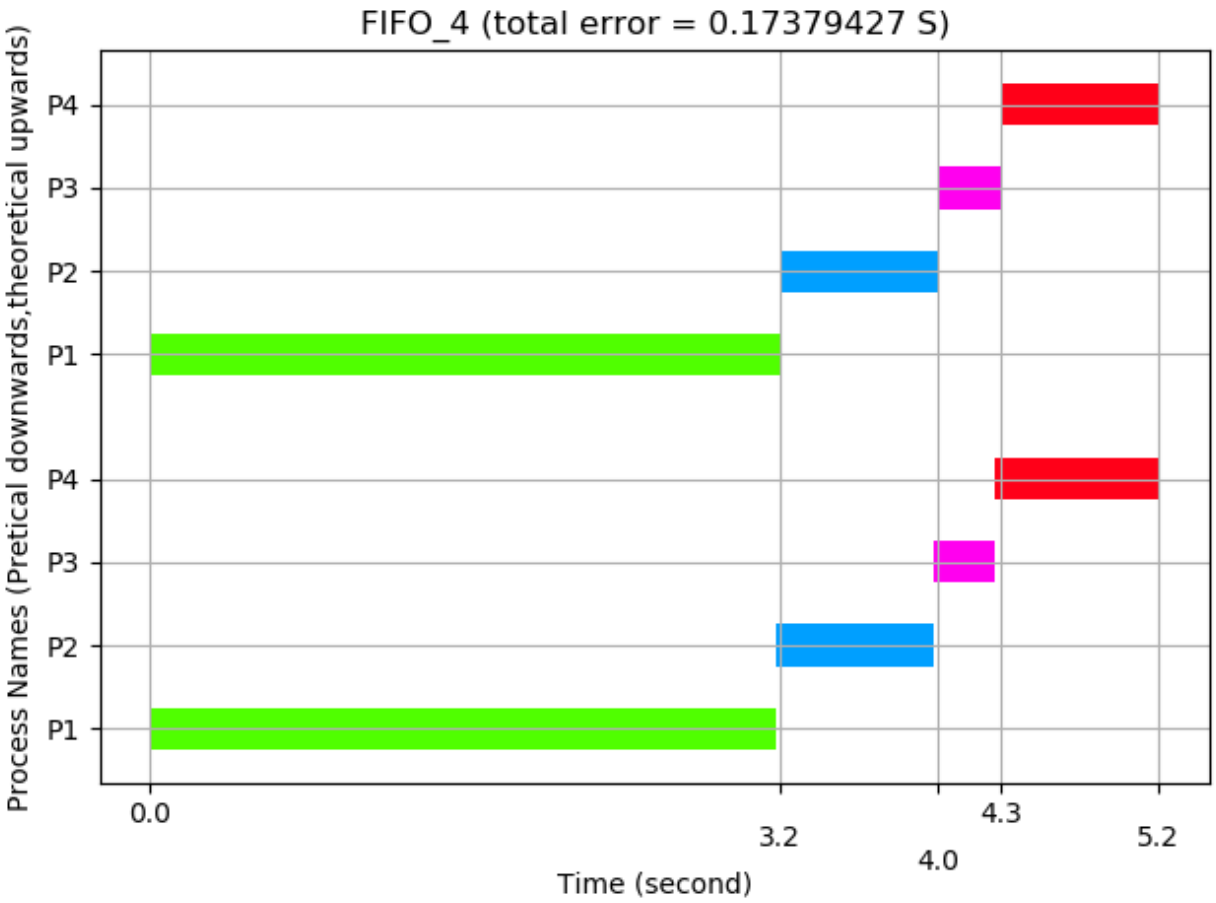
Test Data 4

FIFO 4 P1 0 2000 P2 500 500 P3 500 200 P4 1500 500

Exclusion Result

[4190.297946] [Project1] 2690 1588168651.414808157 1588168654.604226191
[4191.091461] [Project1] 2691 1588168654.604343397 1588168655.397738641
[4191.412277] [Project1] 2692 1588168655.397894474 1588168655.718553744
[4192.220176] [Project1] 2693 1588168655.718673694 1588168656.526449525

Comparison of Theoretical and Pretical Results



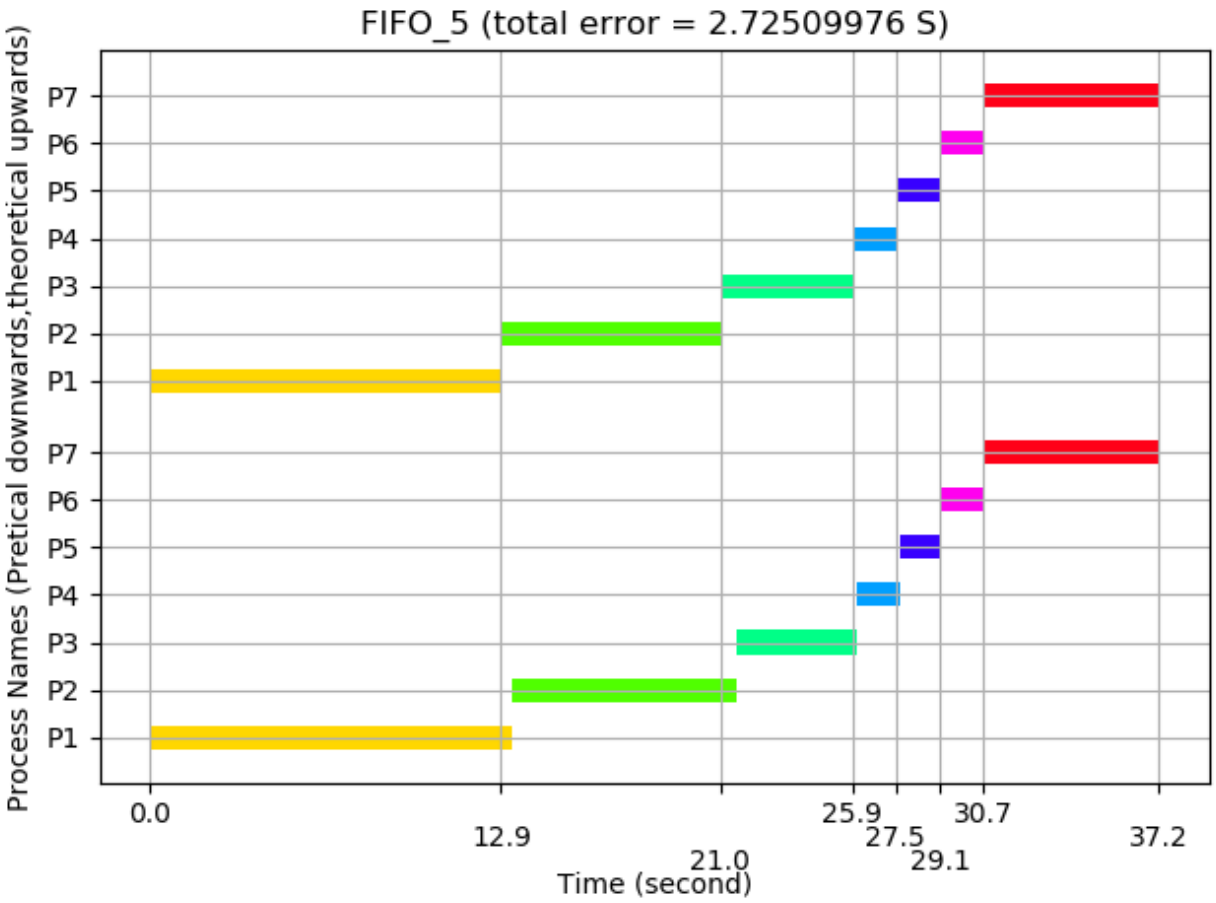
Test Data 5

FIFO 7 P1 0 8000 P2 200 5000 P3 200 3000 P4 400 1000 P5 400 1000 P6 600 1000 P7 600 4000

Exclusion Result

[4205.588340] [Project1] 2701 1588168656.538213131 1588168669.894567641
[4213.891166] [Project1] 2702 1588168669.894703158 1588168678.197359122
[4218.449547] [Project1] 2703 1588168678.197513418 1588168682.755719731
[4220.153260] [Project1] 2704 1588168682.755861868 1588168684.459423697
[4221.889144] [Project1] 2705 1588168684.459548296 1588168686.195299602
[4223.546254] [Project1] 2706 1588168686.195427609 1588168687.852402136
[4229.800881] [Project1] 2707 1588168687.852524843 1588168694.106996663

Comparison of Theoretical and Pretical Results



RR (Round-Robin)

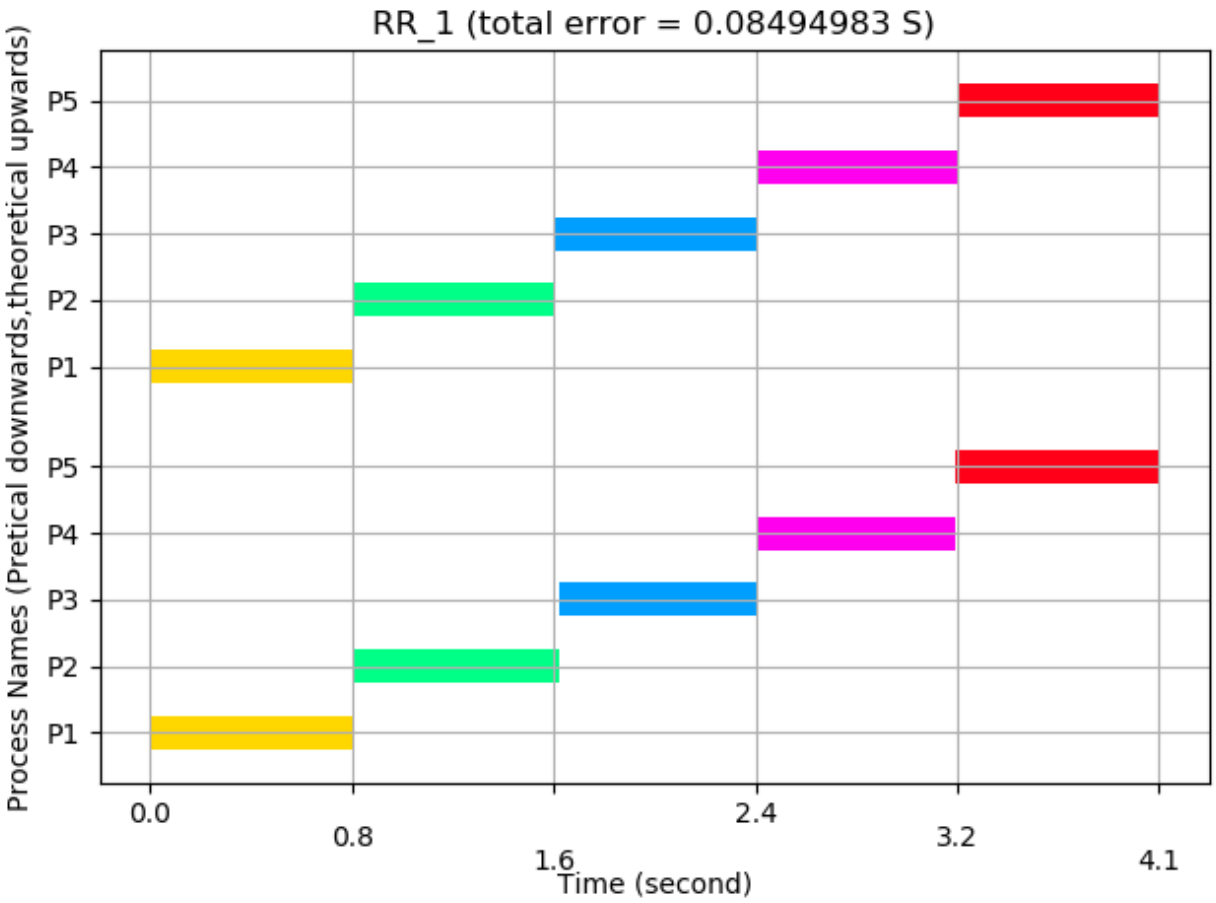
Test Data 1

RR 5 P1 0 500 P2 0 500 P3 0 500 P4 0 500 P5 0 500

Exclusion Result

[54830.434920] [Project1] 6516 1588463434.003792479 1588463434.814643441
[54831.237540] [Project1] 6517 1588463434.814774085 1588463435.617233846
[54832.035540] [Project1] 6518 1588463435.617509419 1588463436.415203469
[54832.861751] [Project1] 6519 1588463436.415418912 1588463437.241384394
[54833.665259] [Project1] 6520 1588463437.241512311 1588463438.044862113

Comparison of Theoretical and Pretical Results



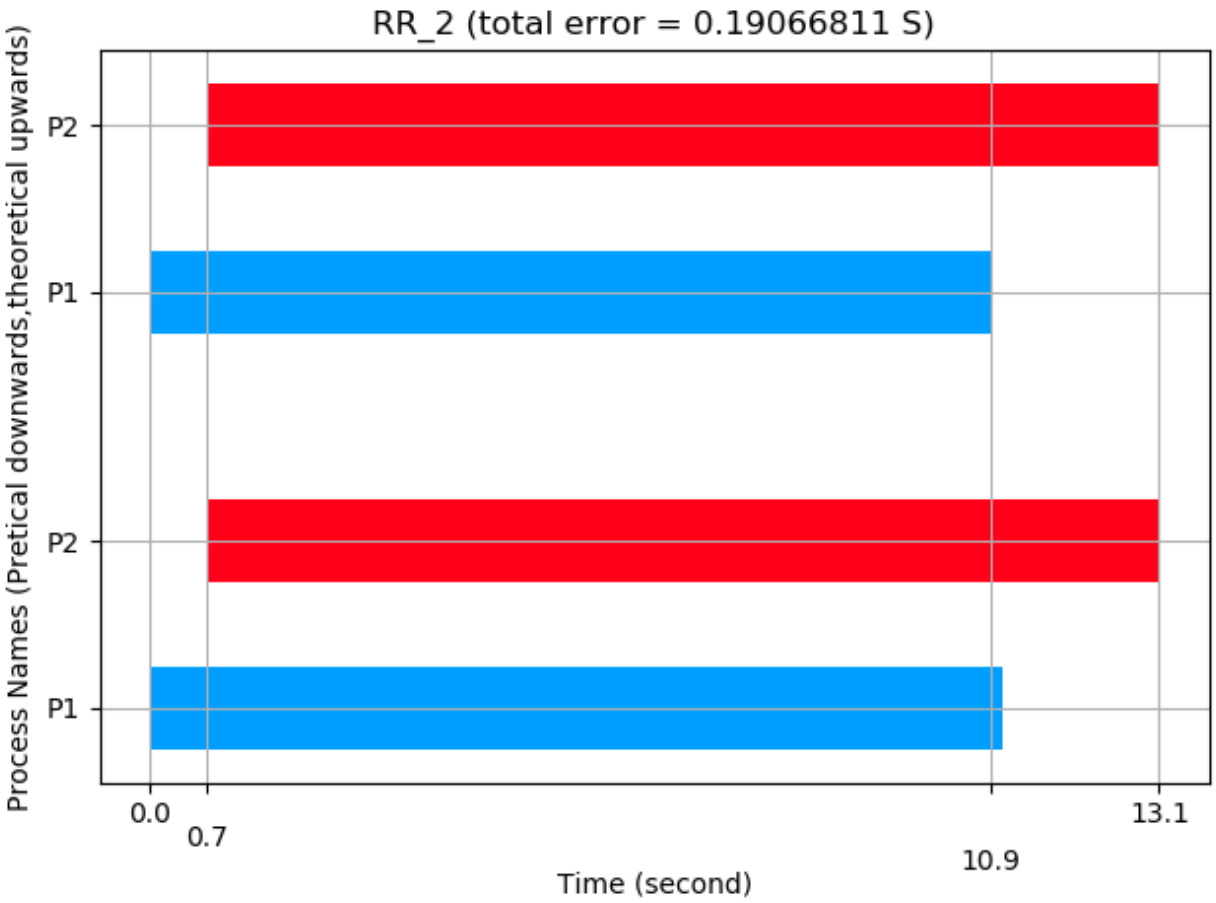
Test Data 2

RR 2 P1 600 4000 P2 800 5000

Exclusion Result

[54844.866886] [Project1] 6528 1588463438.963381619 1588463449.246067721
[54847.013452] [Project1] 6529 1588463439.665888262 1588463451.392554343

Comparison of Theoretical and Pretical Results



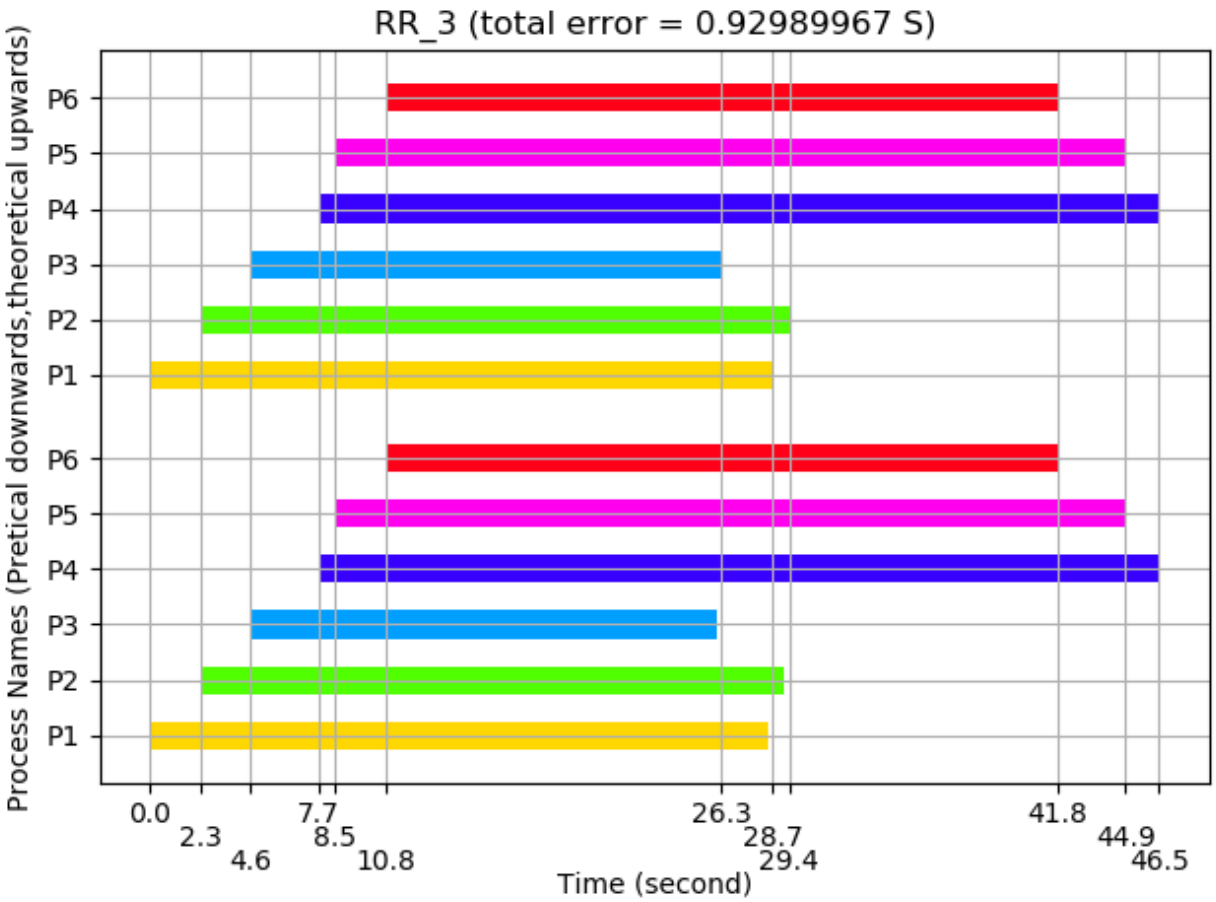
Test Data 3

RR 6 P1 1200 5000 P2 2400 4000 P3 3600 3000 P4 4800 7000 P5 5200 6000 P6 5800 5000

Exclusion Result

[54875.915005] [Project1] 6539 1588463458.035894605 1588463480.293023291
[54878.337812] [Project1] 6537 1588463453.165872189 1588463482.715739986
[54879.156523] [Project1] 6538 1588463455.604825187 1588463483.534420839
[54892.005051] [Project1] 6542 1588463464.506074134 1588463496.382467171
[54895.207012] [Project1] 6541 1588463462.093728878 1588463499.584307871
[54896.801968] [Project1] 6540 1588463461.283394090 1588463501.179203450

Comparison of Theoretical and Pretical Results



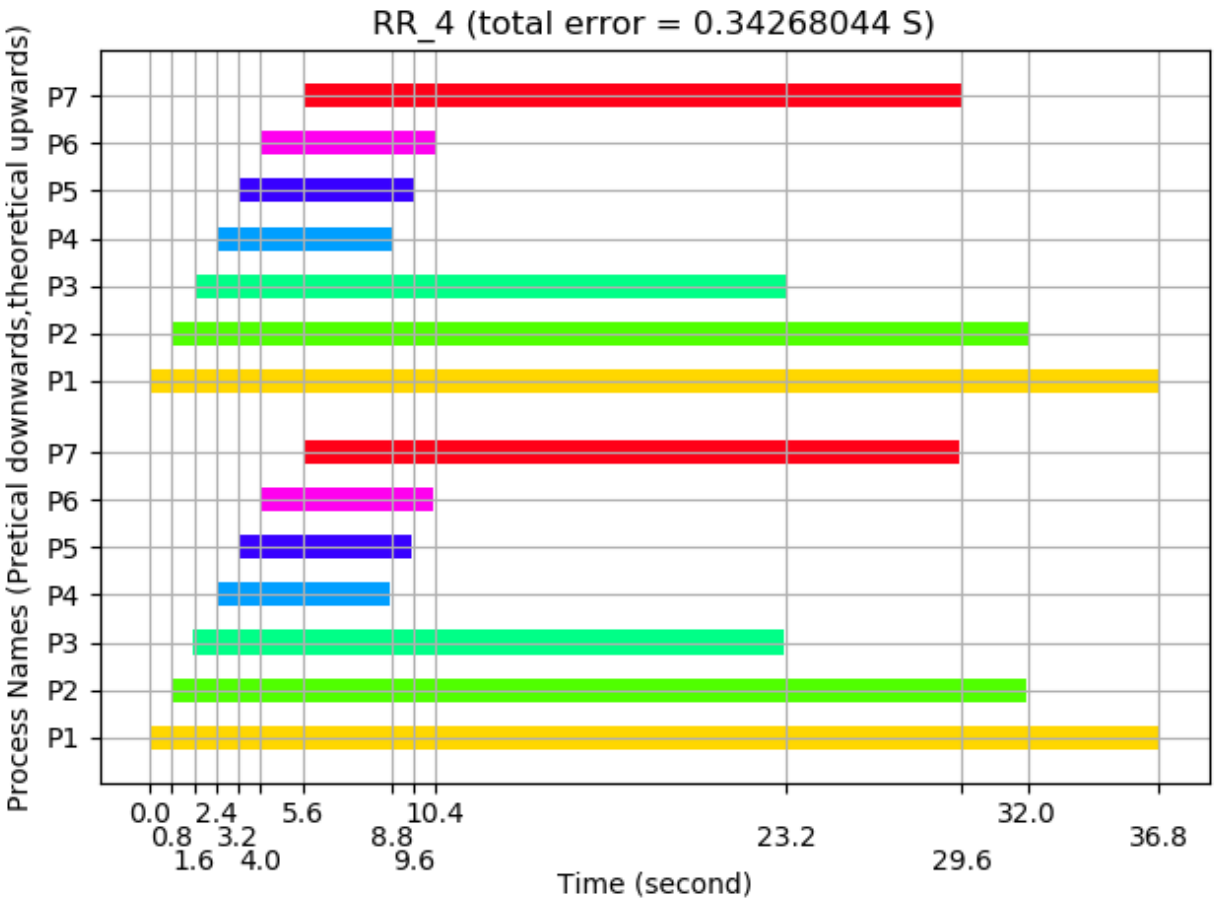
Test Data 4

RR 7 P1 0 8000 P2 200 5000 P3 300 3000 P4 400 1000 P5 500 1000 P6 500 1000 P7 600 4000

Exclusion Result

[54905.252998] [Project1] 6555 1588463503.546870305 1588463509.629917637
[54906.006637] [Project1] 6556 1588463504.277212861 1588463510.383528739
[54906.809081] [Project1] 6557 1588463505.016126956 1588463511.185942738
[54919.337979] [Project1] 6554 1588463502.747615538 1588463523.714371508
[54925.505099] [Project1] 6558 1588463506.605175954 1588463529.881260403
[54927.789155] [Project1] 6553 1588463501.986709999 1588463532.165230479
[54932.540967] [Project1] 6552 1588463501.191602339 1588463536.916864820

Comparison of Theoretical and Pretical Results



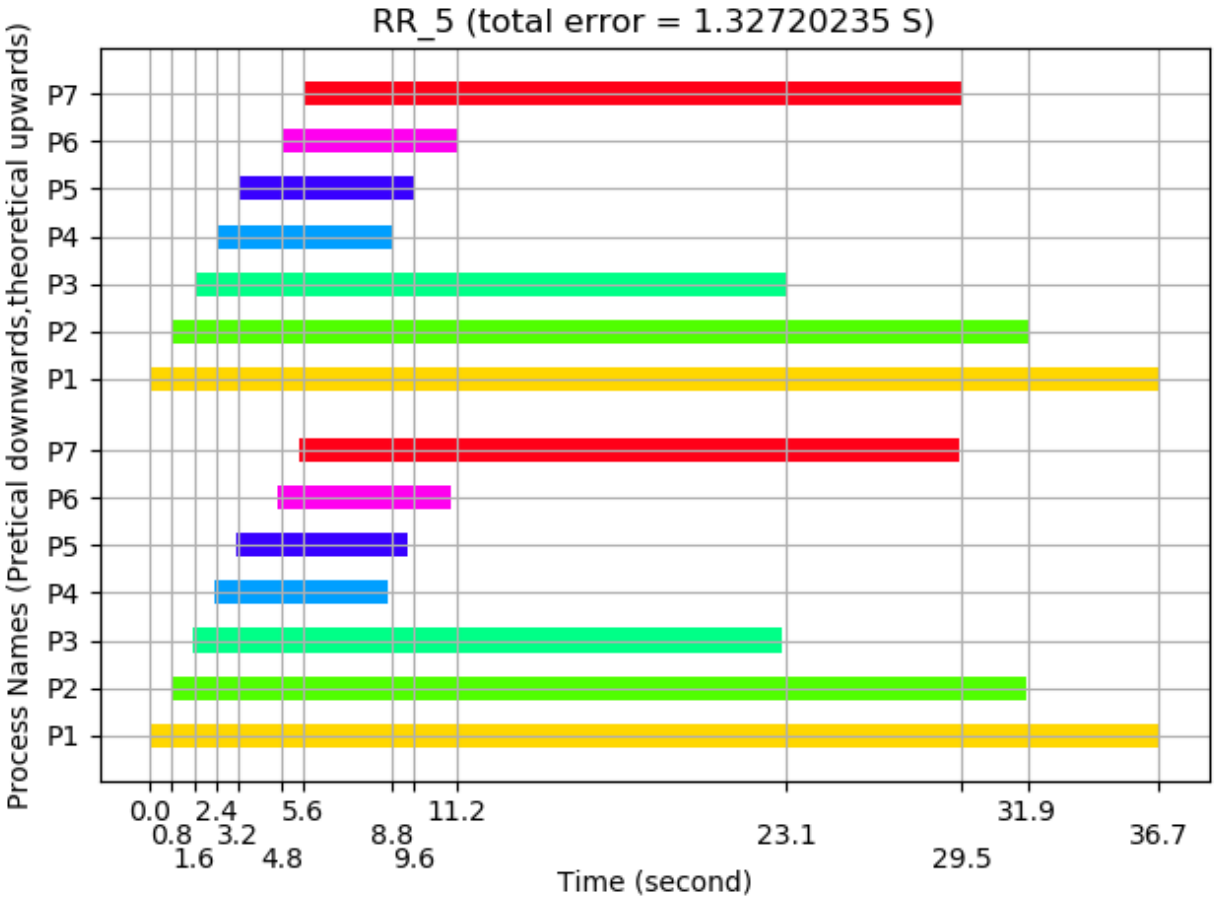
Test Data 5

RR 7 P1 0 8000 P2 200 5000 P3 200 3000 P4 400 1000 P5 400 1000 P6 600 1000 P7 600 4000

Exclusion Result

[54941.079202] [Project1] 6571 1588463539.224851385 1588463545.454779706
[54941.866280] [Project1] 6572 1588463540.019195717 1588463546.241828138
[54943.451460] [Project1] 6573 1588463541.599903863 1588463547.826949100
[54954.923413] [Project1] 6570 1588463538.450673955 1588463559.298472661
[54961.014771] [Project1] 6574 1588463542.379920021 1588463565.389602556
[54963.273948] [Project1] 6569 1588463537.703264248 1588463567.648695732
[54968.029107] [Project1] 6568 1588463536.928637852 1588463572.403676012

Comparison of Theoretical and Pretical Results



SJF (Shortest Job First)

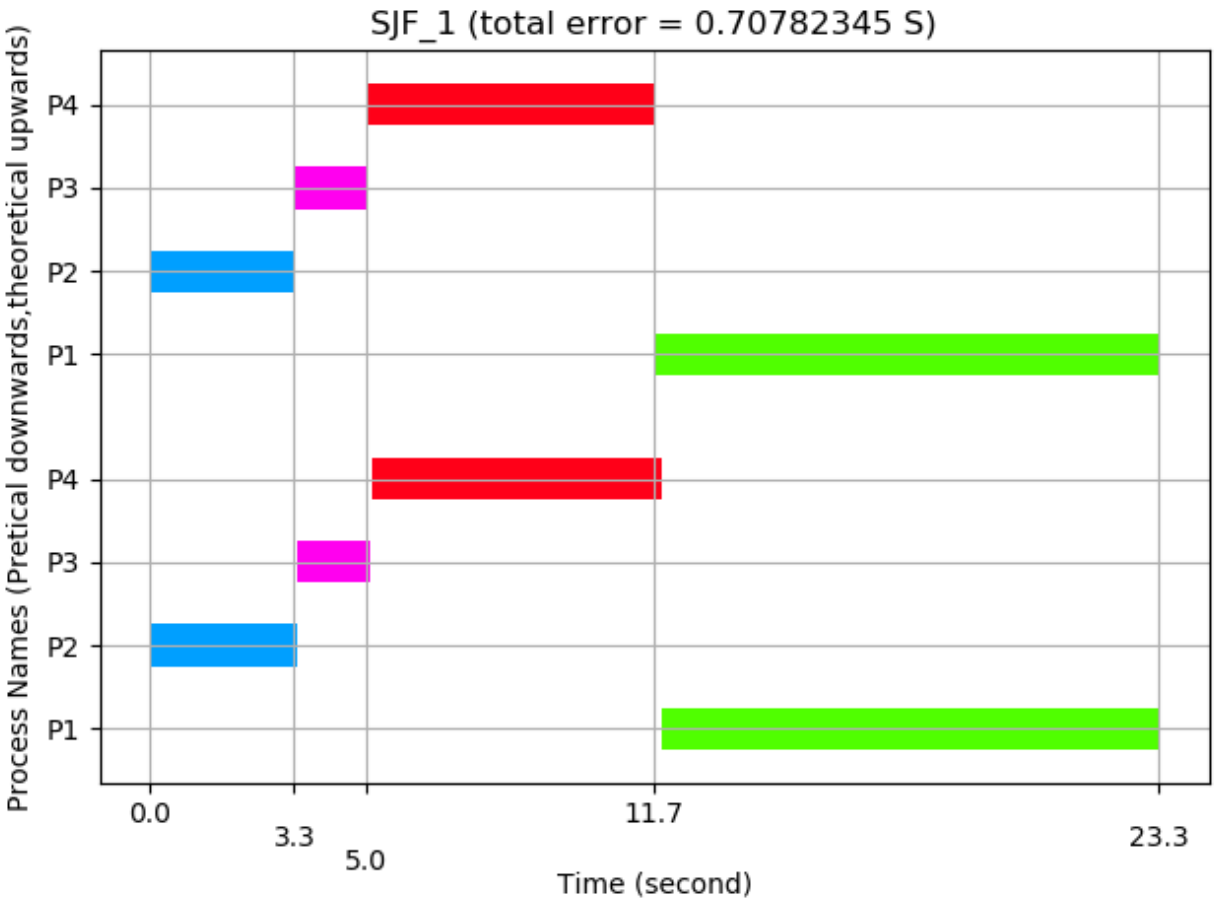
Test Data 1

SJF 4 P1 0 7000 P2 0 2000 P3 100 1000 P4 200 4000

Exclusion Result

[3765.983625] [Project1] 2522 1588168226.954558352 1588168230.305048211
[3767.652945] [Project1] 2523 1588168230.305194086 1588168231.974300075
[3774.514104] [Project1] 2524 1588168231.974428459 1588168238.835180271
[3786.270682] [Project1] 2521 1588168238.835308592 1588168250.591280946

Comparison of Theoretical and Pretical Results



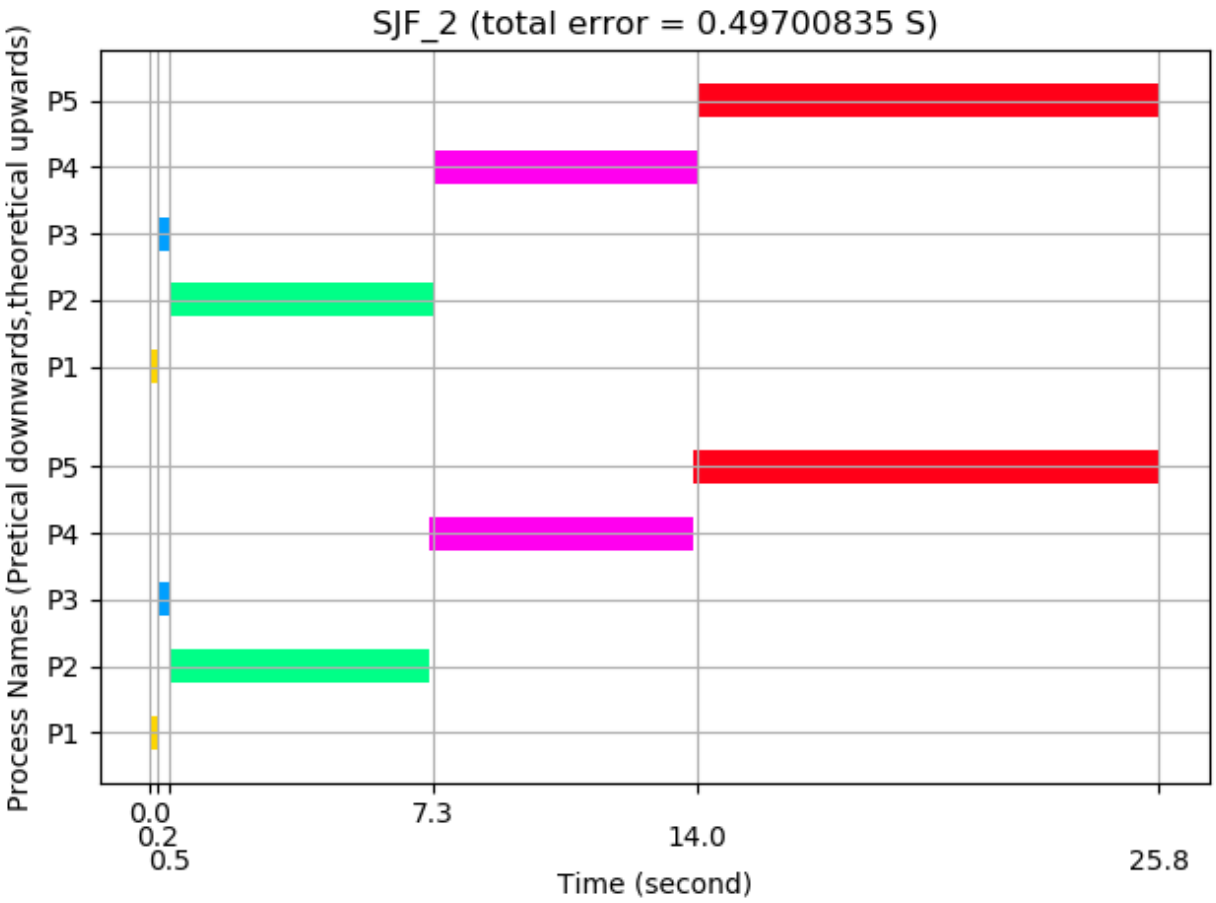
Test Data 2

SJF 5 P1 100 100 P2 100 4000 P3 200 200 P4 200 4000 P5 200 7000

Exclusion Result

[3786.561881] [Project1] 2534 1588168250.744927722 1588168250.882468040
[3786.845468] [Project1] 2536 1588168250.884163185 1588168251.166043474
[3792.494621] [Project1] 2535 1588168251.166166475 1588168256.814967352
[3798.297399] [Project1] 2537 1588168256.815149377 1588168262.617509196
[3809.386146] [Project1] 2538 1588168262.617713757 1588168273.705805114

Comparison of Theoretical and Pretical Results



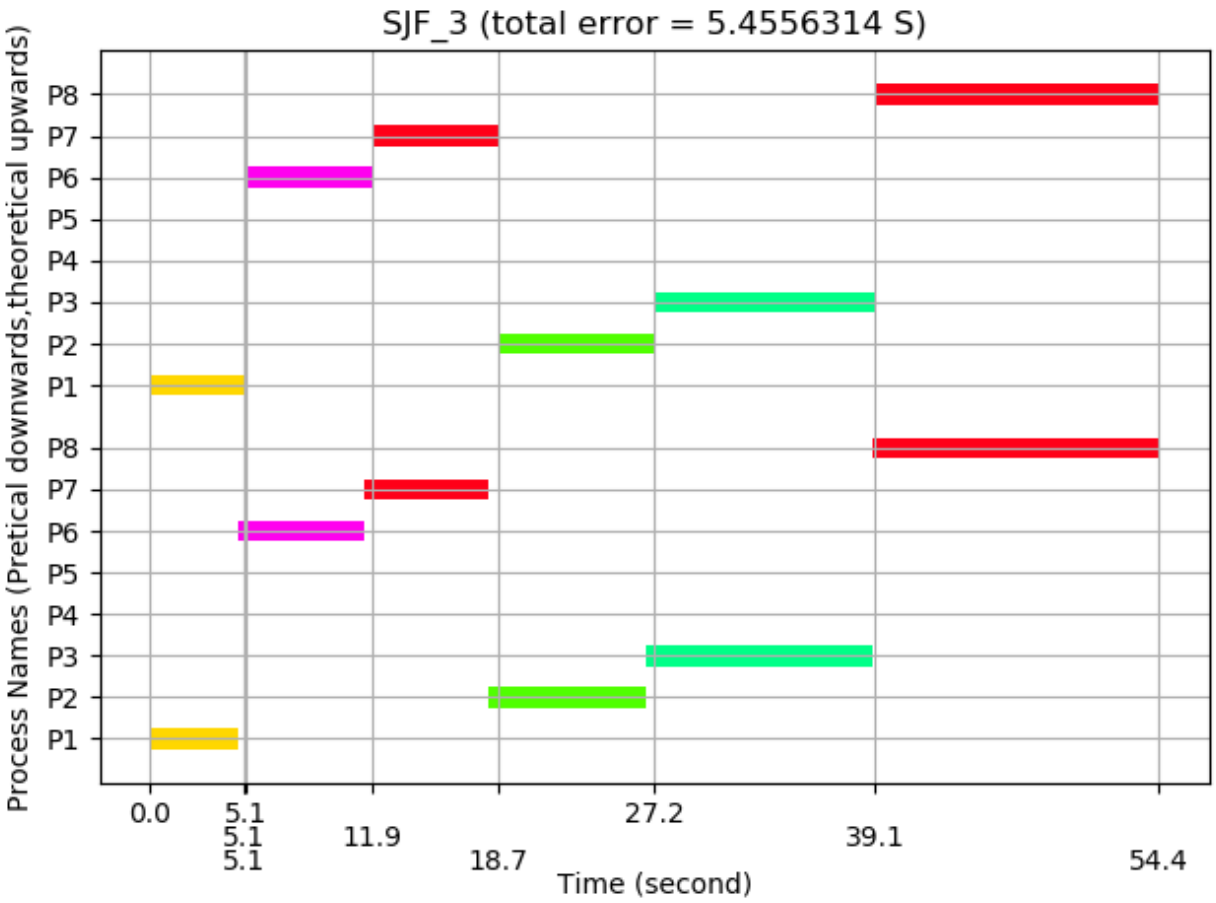
Test Data 3

SJF 8 P1 100 3000 P2 100 5000 P3 100 7000 P4 200 10 P5 200 10 P6 300 4000 P7 400 4000 P8 500 9000

Exclusion Result

[3814.503513] [Project1] 2546 1588168273.863863245 1588168278.822964384
[3814.520351] [Project1] 2549 1588168278.823126113 1588168278.839801302
[3814.535997] [Project1] 2550 1588168278.839986493 1588168278.855448418
[3821.031143] [Project1] 2551 1588168278.855562824 1588168285.350329673
[3827.749584] [Project1] 2552 1588168285.350816721 1588168292.068497834
[3835.887565] [Project1] 2547 1588168292.068630251 1588168300.206147578
[3847.365435] [Project1] 2548 1588168300.206290881 1588168311.683551576
[3862.149434] [Project1] 2553 1588168311.683682669 1588168326.466949704

Comparison of Theoretical and Pretical Results



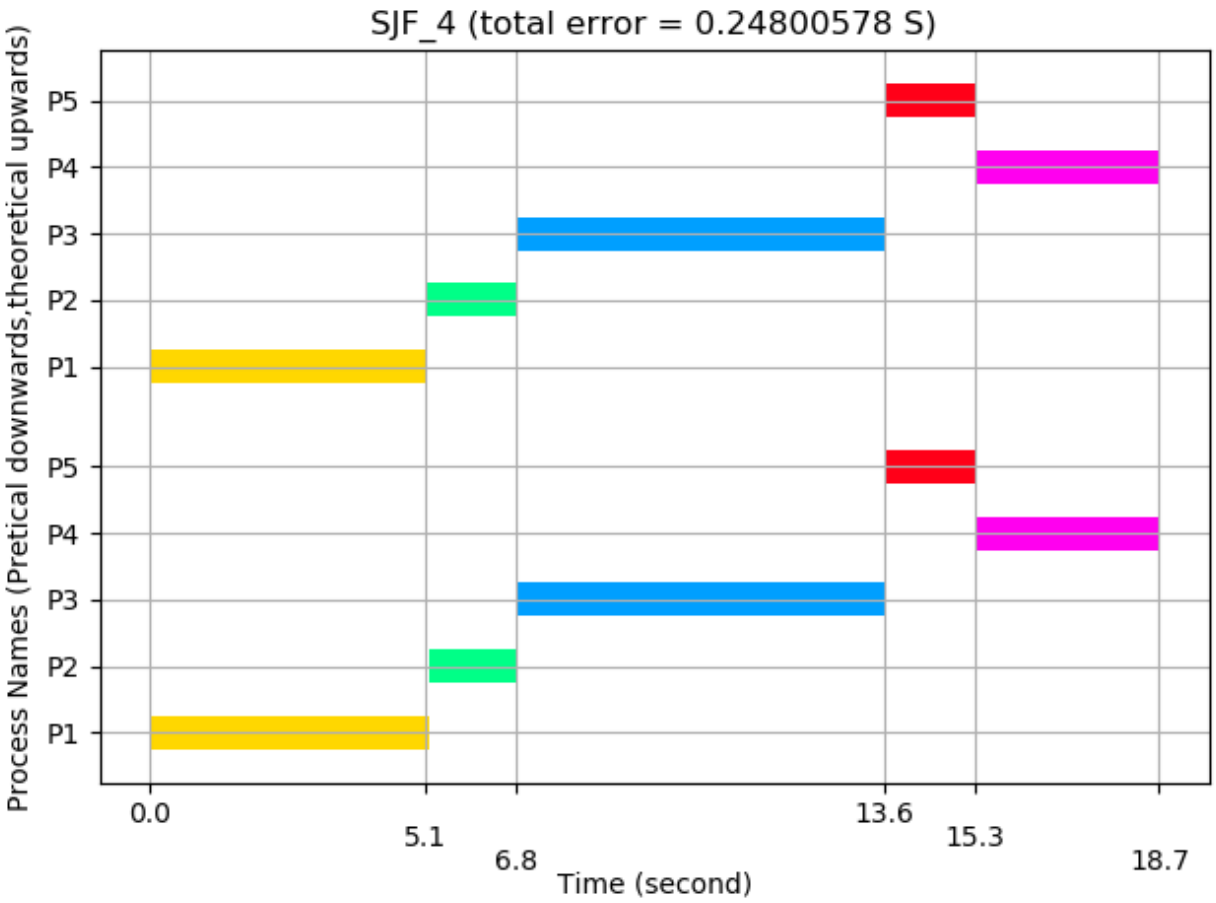
Test Data 4

SJF 5 P1 0 3000 P2 1000 1000 P3 2000 4000 P4 5000 2000 P5 7000 1000

Exclusion Result

[3867.236918] [Project1] 2563 1588168326.481374039 1588168331.554226504
[3868.807832] [Project1] 2564 1588168331.554368176 1588168333.125076231
[3874.867014] [Project1] 2565 1588168333.125712900 1588168339.184011566
[3876.406792] [Project1] 2567 1588168339.184429197 1588168340.723727941
[3879.764819] [Project1] 2566 1588168340.723941473 1588168344.081617662

Comparison of Theoretical and Pretical Results



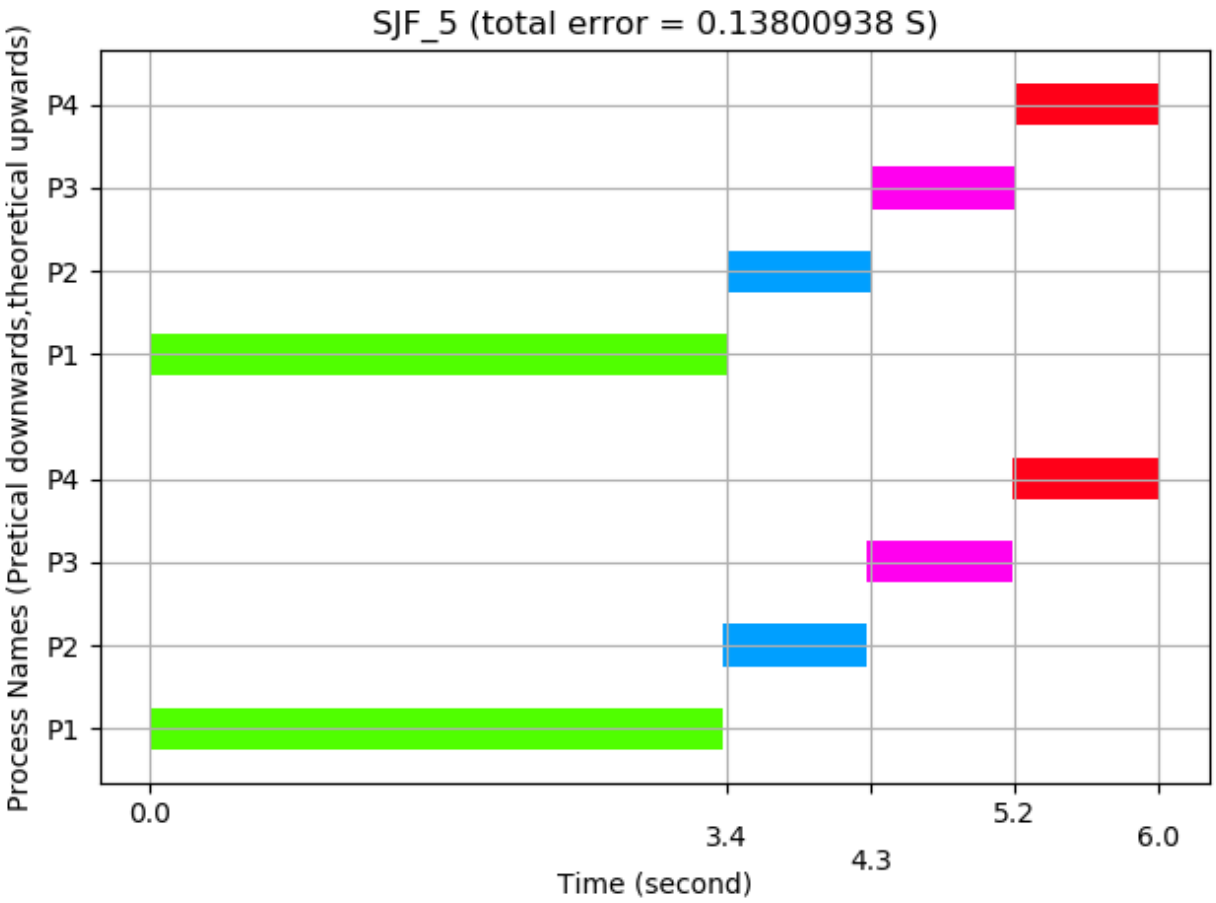
Test Data 5

SJF 4 P1 0 2000 P2 500 500 P3 1000 500 P4 1500 500

Exclusion Result

[3882.954626] [Project1] 2575 1588168344.092670505 1588168347.271295043
[3883.779132] [Project1] 2576 1588168347.271431682 1588168348.095767885
[3884.601899] [Project1] 2577 1588168348.095896804 1588168348.918501367
[3885.462978] [Project1] 2578 1588168348.918630081 1588168349.779545250

Comparison of Theoretical and Pretical Results



Preemptive Shortest Job First（PSJF）

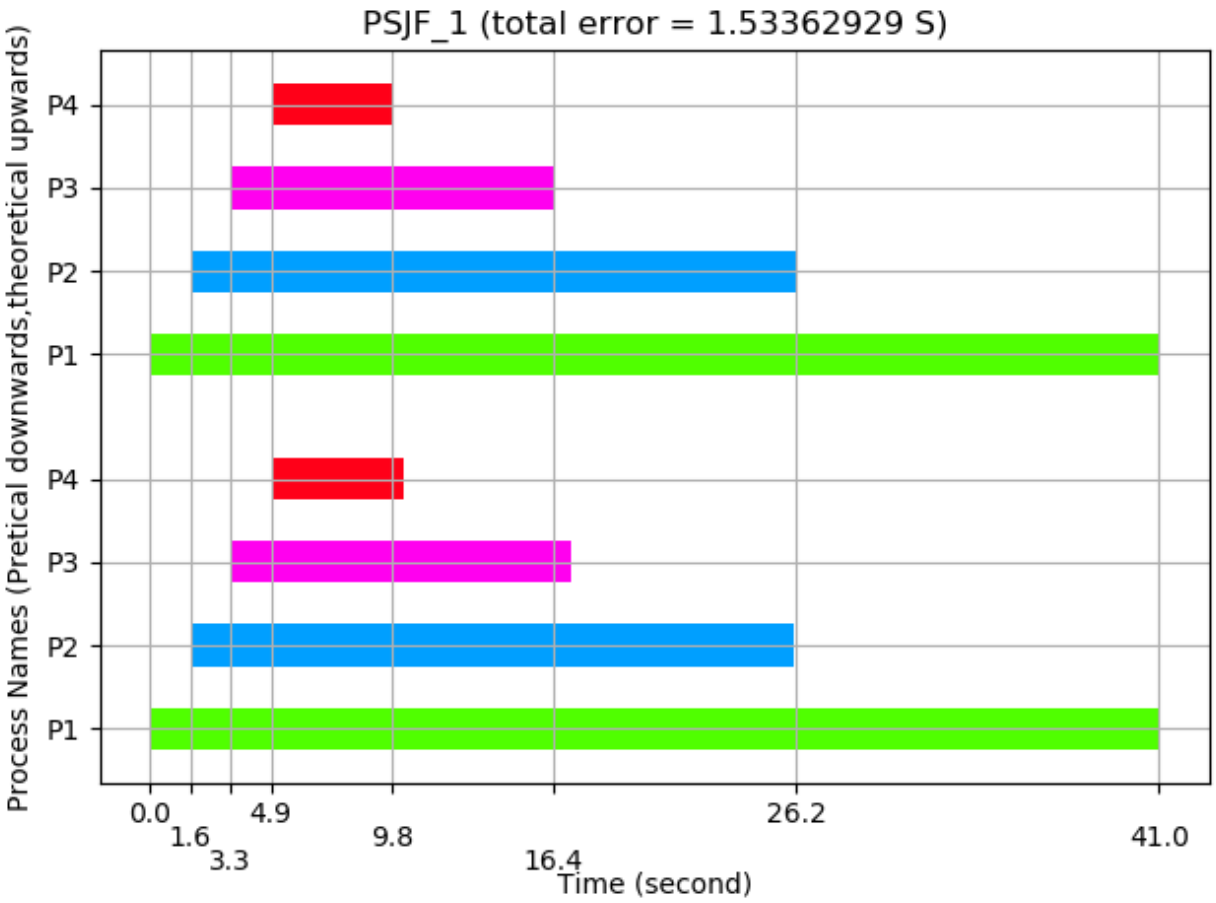
Test Data 1

PSJF 4 P1 0 10000 P2 1000 7000 P3 2000 5000 P4 3000 3000

Exclusion Result

[3895.237368] [Project1] 2589 1588168354.697952554 1588168359.553537881
[3901.503196] [Project1] 2588 1588168353.044345510 1588168365.819111444
[3911.030351] [Project1] 2587 1588168351.439450196 1588168375.345879032
[3925.549427] [Project1] 2586 1588168349.791059823 1588168389.864364762

Comparison of Theoretical and Pretical Results



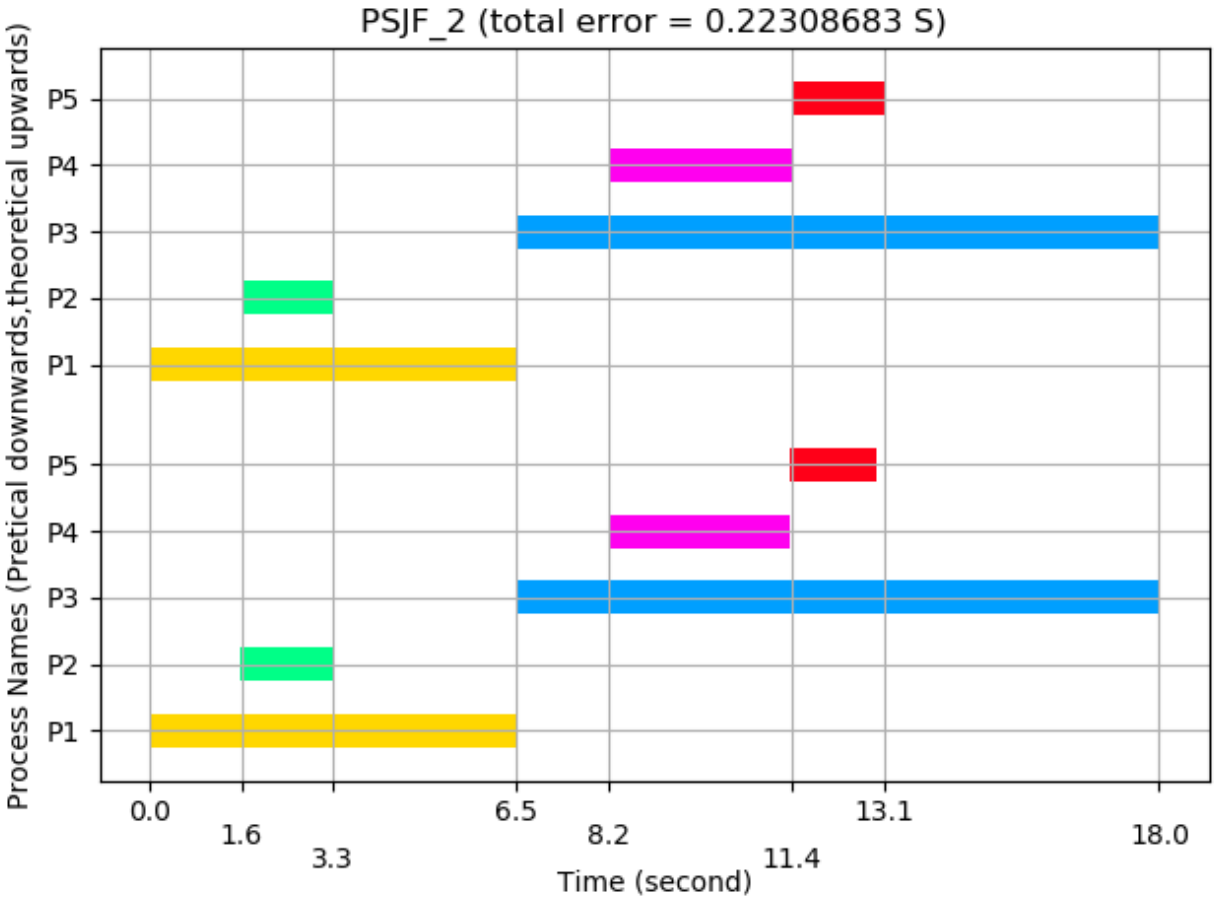
Test Data 2

PSJF 5 P1 0 3000 P2 1000 1000 P3 2000 4000 P4 5000 2000 P5 7000 1000

Exclusion Result

[3928.807554] [Project1] 2600 1588168391.507021802 1588168393.122358970
[3932.197447] [Project1] 2599 1588168389.874888729 1588168396.512113653
[3937.211036] [Project1] 2602 1588168398.196267289 1588168401.525498956
[3938.857241] [Project1] 2603 1588168401.526978091 1588168403.171636682
[3943.701520] [Project1] 2601 1588168396.512244847 1588168408.015718653

Comparison of Theoretical and Pretical Results



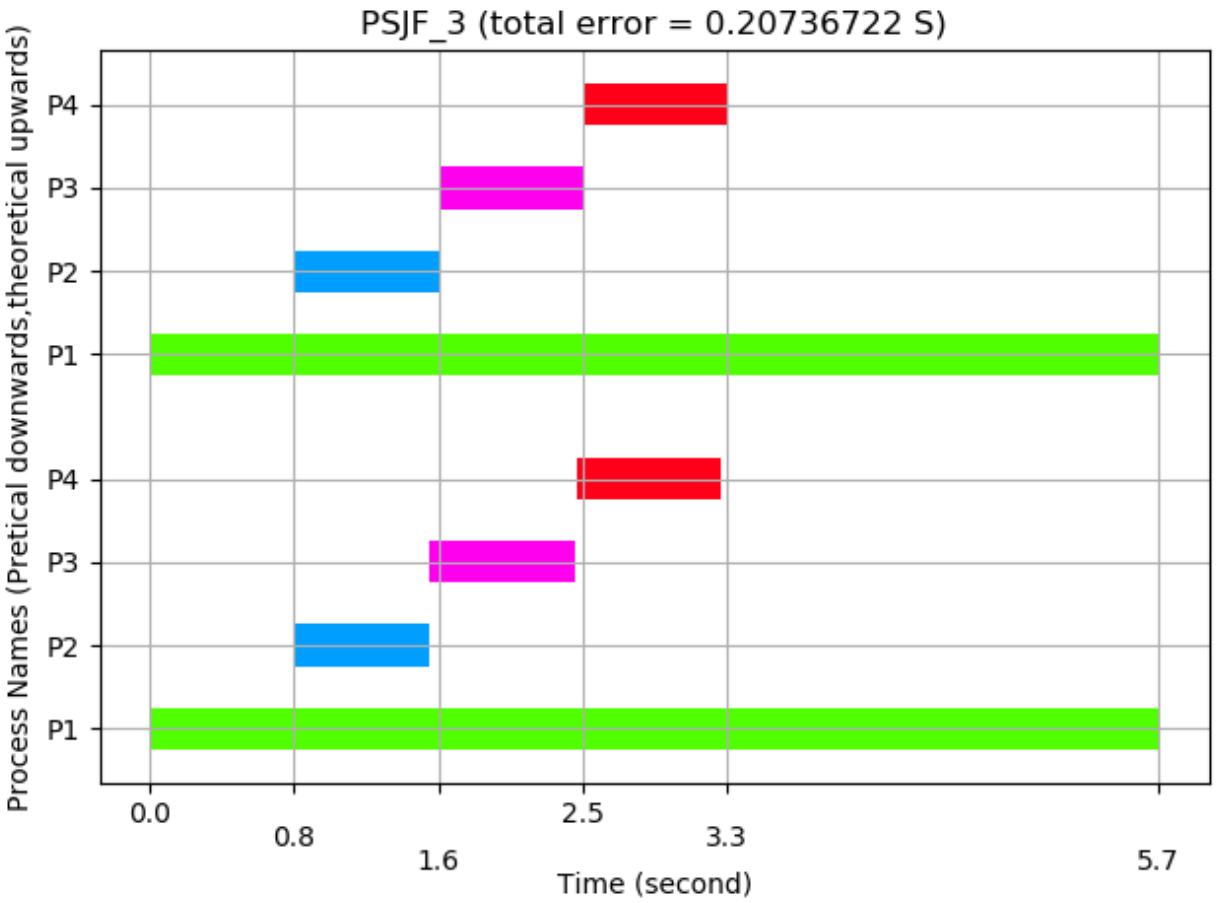
Test Data 3

PSJF 4 P1 0 2000 P2 500 500 P3 1000 500 P4 1500 500

Exclusion Result

[3945.321407] [Project1] 2612 1588168408.855796587 1588168409.635540611
[3946.072594] [Project1] 2613 1588168409.637421286 1588168410.386696315
[3946.893506] [Project1] 2614 1588168410.388225868 1588168411.207575397
[3949.356089] [Project1] 2611 1588168408.026120606 1588168413.670057886

Comparison of Theoretical and Pretical Results



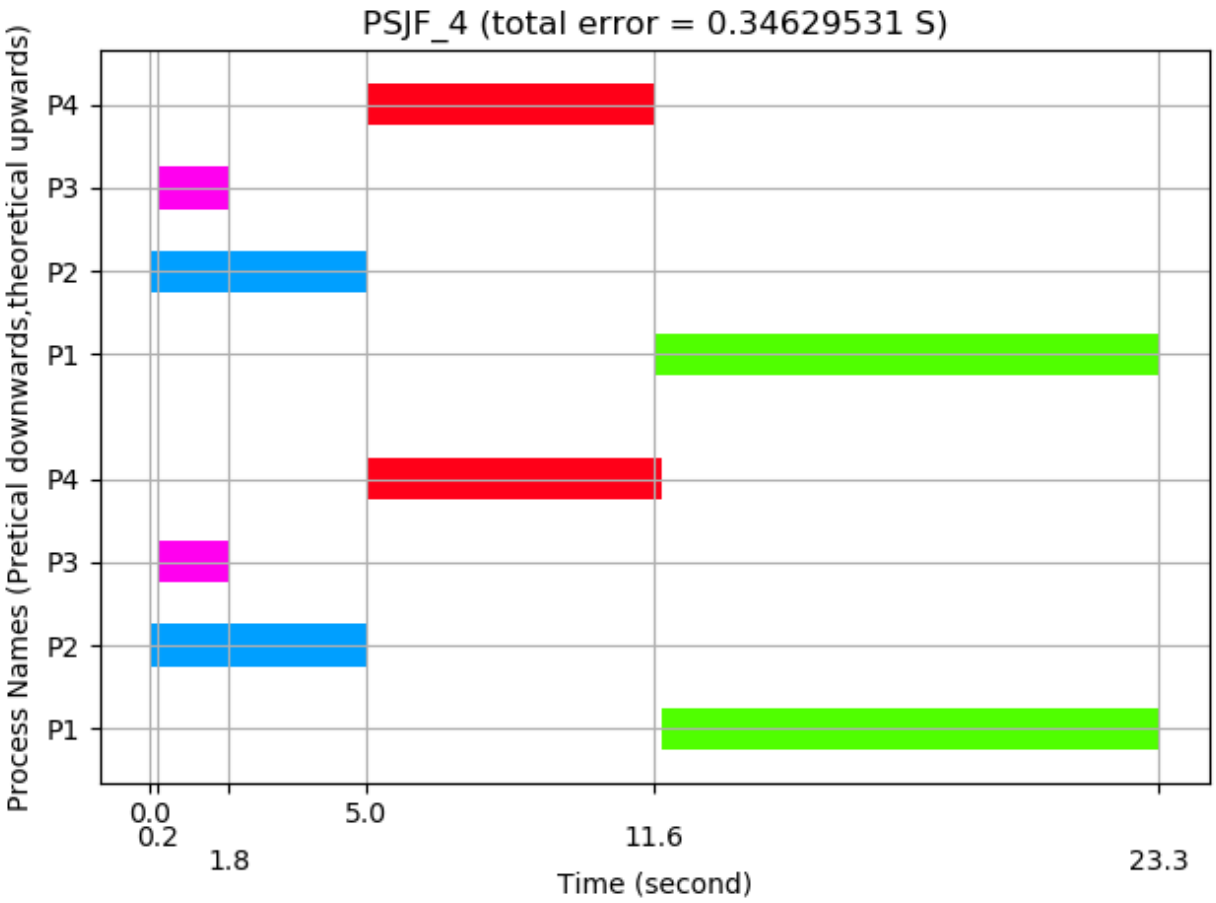
Test Data 4

PSJF 4 P1 0 7000 P2 0 2000 P3 100 1000 P4 200 4000

Exclusion Result

[3951.191765] [Project1] 2624 1588168413.839951428 1588168415.505659485
[3954.414490] [Project1] 2623 1588168413.680532190 1588168418.728253268
[3961.024168] [Project1] 2625 1588168418.728384321 1588168425.337662486
[3972.555337] [Project1] 2622 1588168425.337793976 1588168436.868362374

Comparison of Theoretical and Pretical Results



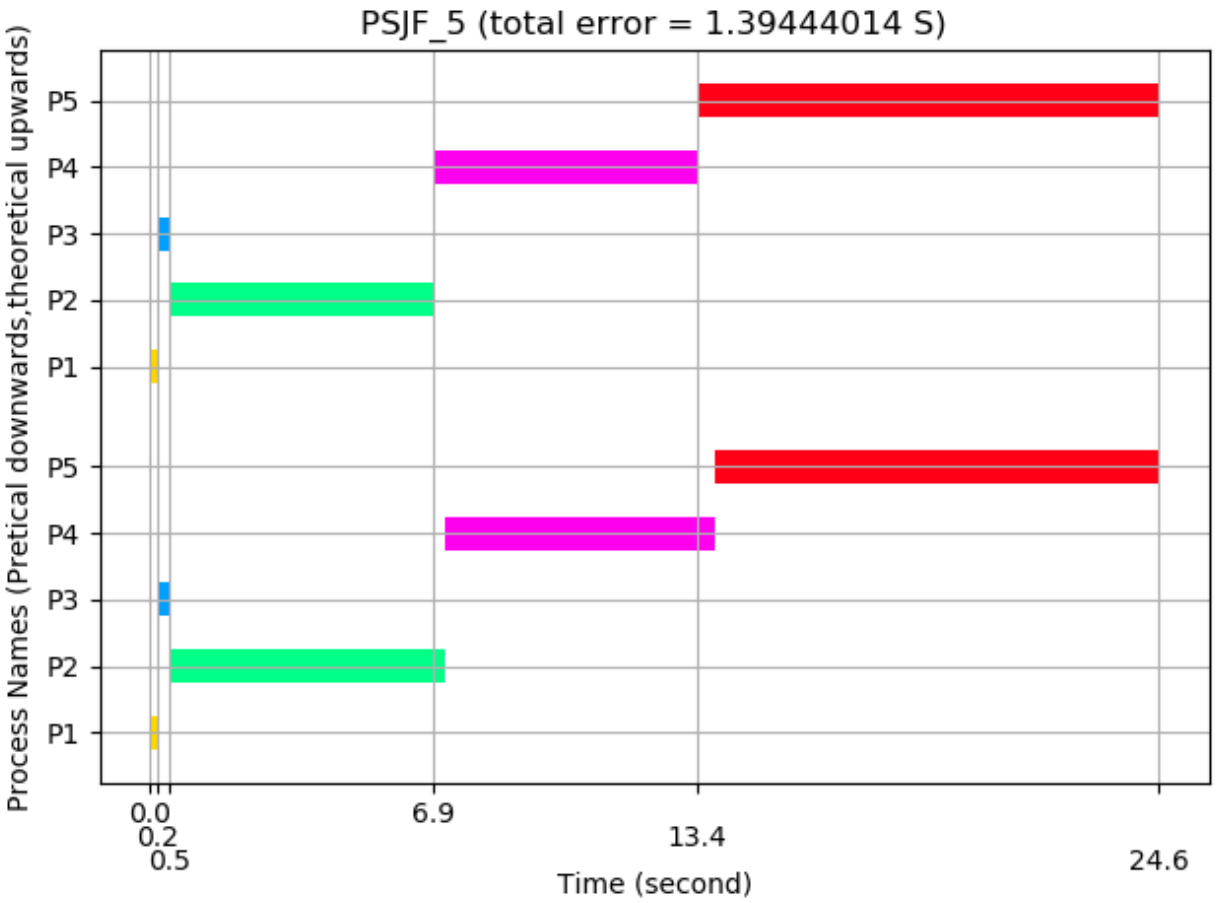
Test Data 5

PSJF 5 P1 100 100 P2 100 4000 P3 200 200 P4 200 4000 P5 200 7000

Exclusion Result

[3972.870730] [Project1] 2635 1588168437.014183349 1588168437.183743326
[3973.161501] [Project1] 2637 1588168437.185412355 1588168437.474502248
[3979.621266] [Project1] 2636 1588168437.474628456 1588168443.934003933
[3986.377239] [Project1] 2638 1588168443.934134972 1588168450.689702203
[3998.173417] [Project1] 2639 1588168450.689835431 1588168462.485400909

Comparison of Theoretical and Pretical Results



Conclusion

發現每一個 process 在 run 的時間都比理論值要長，即使是 FIFO 中第一個 process 的 running time，也會比其需要的時間長。推測可能的原因是：

Project1的運行環境於 virtual box 中，virtual box 為原生系統的一個應用程式，其無法完全占用物理 CPU

與前一個原因相似，

在兩次用 timer 計時之間的 code,除了 run process 還會做一些別的事情. void execute_unit_time(){ volatile unsigned long i; for(i=0;i<UNIT_TIME;i++); }

在理論值中沒有考慮 turn around 的時間,而實際中在 processes 切換的時候需要短暫占用 CPU.

Running Process 的時候,只是一個 for loop,不知道 CPU 和 compiler 會不會偷偷做一些黑魔法.

Reference:

測量 Linux 内核中函数的执行时间: https://www.codenong.com/4655711/

繪圖程式參考自:

https://github.com/wangyenjen/OS-Project-1/blob/master/report.md