



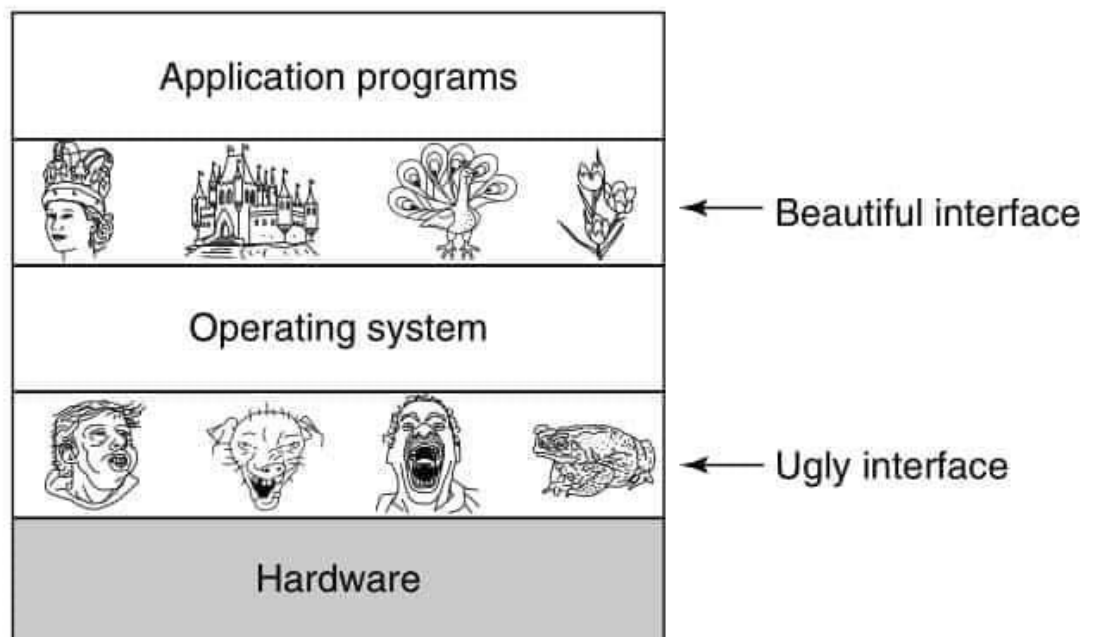
Assignment 2

Scheduling: SJF variations and Round-Robin comparison

Kyritsis Spyridon 2697

Stoltidis Alexandros 2824

Koutsoukis Nikolaos 2907



Project Description

The goal of this project is to implement a Shortest Job First scheduling (SJF) algorithm. The algorithm will be implemented in two variations.

The first variation calculates the expected burst time of a given process and chooses the process with the smallest expected burst for scheduling.

The second variation calculates a value called the Goodness value that also takes into account the time each process has spent waiting on the ready queue and it also chooses the process with the smallest goodness value for scheduling.

Ultimately, we will compare these two implementations with a Round-Robin scheduler. The Round-Robin scheduler as well as the VM we will be running the experiments on have been provided by the assignment.

Part A

For part A we implemented the expected burst variation of the SJF scheduler. The expected burst value is calculated by the equation:

$$ExpBurst_i = \frac{Burst_{i-1} * ExpBurst_{i-1}}{a - 1}, \text{ where } a \text{ is given to be } 0.5$$

$Burst_{i-1}$ is the last known burst time of the process, $ExpBurst_{i-1}$ is the last calculated value of the expected burst and α is an aging coefficient.

Part B

For part B we implemented the Goodness variation of the SJF scheduler. The goodness value is calculated by the following equation:

$$Goodness(k)_i = \frac{1 + Exp_Burst(k)_i}{\min_{m=0}^N (1 + Exp_Burst(m)_i)} * \frac{\max_{m=0}^N (1 + WaitingInRQ(m)_i)}{1 + WaitingInRQ(k)_i}$$

where N is the number of processes in the Waiting Queue and k is the current process in the i^{th} time interval.

Part C

For part C we created a few test cases in the scripting language that the given VM understands to in order to test our two implementations versus the given Round-Robin scheduler. We run tests for the following scenarios:

- Non-Interactive processes only,
- Interactive processes only and,
- A mixture of interactive and non-interactive processes.

Each of the above scenarios were run for all 3 scheduler implementations for tasks that had their work duration parameters set to a:

- Small number (100) and a,
- Large number (600).

Work Duration per process	Non interactive					
	Small			Large		
	Round-Robin	Expected Burst SJF	Goodness SJF	Round-Robin	Expected Burst SJF	Goodness SJF
	Time to completion			Time to completion		
processName						
FIRST_NONINTERACTIVE	300,000,000.00	300,000,000.00	300,000,000.00	1,800,000,000.00	1,840,000,000.00	1,840,000,000.00
SECOND_NONINTERACTIVE	280,000,000.00	240,000,000.00	240,000,000.00	1,780,000,000.00	1,760,000,000.00	1,760,000,000.00
THIRD_NONINTERACTIVE	300,000,000.00	290,000,000.00	290,000,000.00	1,760,000,000.00	1,810,000,000.00	1,810,000,000.00
Mean time to completion	333,333,333.33	316,666,666.67	316,666,666.67	1,820,000,000.00	1,803,333,333.33	1,803,333,333.33

We notice that for small numbers of non-interactive processes the Expected Burst implementation and the Goodness implementation may give the same results. As the number of processes becomes larger the Goodness implementation is better.

Work Duration per process	Interactive					
	Small			Large		
	Round-Robin	Expected Burst SJF	Goodness SJF	Round-Robin	Expected Burst SJF	Goodness SJF
	Time to completion			Time to completion		
processName						
FIRST_NONINTERACTIVE	470,000,000.00	470,000,000.00	450,000,000.00	3,520,000,000.00	3,040,000,000.00	3,120,000,000.00
SECOND_NONINTERACTIVE	420,000,000.00	450,000,000.00	300,000,000.00	2,810,000,000.00	2,220,000,000.00	2,500,000,000.00
THIRD_NONINTERACTIVE	480,000,000.00	450,000,000.00	460,000,000.00	4,940,000,000.00	3,680,000,000.00	3,630,000,000.00
FOURTH_INTERACTIVE	430,000,000.00	830,000,000.00	840,000,000.00	4,270,000,000.00	2,060,000,000.00	2,080,000,000.00
FIFTH_INTERACTIVE	1,450,000,000.00	830,000,000.00	340,000,000.00	2,910,000,000.00	3,410,000,000.00	3,890,000,000.00
Mean time to completion	690,000,000.00	646,000,000.00	518,000,000.00	3,730,000,000.00	2,922,000,000.00	3,084,000,000.00

For heavily interactive workloads and due to the randomness in the I/O delays the Goodness and Expected Burst implementations may vary in performance while in this case, still being better than the Round-Robin scheduler.

Work Duration per process	Complex					
	Small			Large		
	Round-Robin	Expected Burst SJF	Goodness SJF	Round-Robin	Expected Burst SJF	Goodness SJF
	Time to completion			Time to completion		
processName						
FIRST_NONINTERACTIVE	550,000,000.00	510,000,000.00	540,000,000.00	2,920,000,000.00	3,180,000,000.00	2,820,000,000.00
SECOND_NONINTERACTIVE	510,000,000.00	460,000,000.00	490,000,000.00	2,850,000,000.00	2,460,000,000.00	2,850,000,000.00
THIRD_NONINTERACTIVE	560,000,000.00	410,000,000.00	560,000,000.00	2,950,000,000.00	2,990,000,000.00	2,890,000,000.00
FOURTH_INTERACTIVE	580,000,000.00	560,000,000.00	820,000,000.00	4,010,000,000.00	4,650,000,000.00	4,030,000,000.00
FIFTH_INTERACTIVE	540,000,000.00	550,000,000.00	290,000,000.00	3,520,000,000.00	3,210,000,000.00	4,030,000,000.00
SIXTH_INTERACTIVE	720,000,000.00	820,000,000.00	550,000,000.00	3,950,000,000.00	4,550,000,000.00	3,470,000,000.00
Mean time to completion	616,666,666.67	591,666,666.67	581,666,666.67	3,406,666,666.67	3,546,666,666.67	3,388,333,333.33

The difference in performance between the Expected Burst and the Goodness implementation is smaller when the workload is mixed (both interactive and non-interactive processes). In this case the Goodness implementation performs better. It is worth mentioning that in heavily interactive and mixed workloads Round-Robin usually closes the gap.

We also tested basic non-interactive, interactive and complex processes with and without spawning children processes. These test cases were given with the assignment.

Work Duration per process	Basic Non Interactive		
	Small		
	Round-Robin	Expected Burst SJF	Goodness SJF
	Time to completion		
processName			
FIRST_NONINTERACTIVE:1	370,000,000.00	500,000,000.00	400,000,000.00
SECOND_NONINTERACTIVE:2	970,000,000.00	940,000,000.00	1,010,000,000.00
THIRD_NONINTERACTIVE:3	850,000,000.00	900,000,000.00	850,000,000.00
FOURTH_NONINTERACTIVE:4	1,890,000,000.00	1,730,000,000.00	1,790,000,000.00
FOURTH_NONINTERACTIVE:4->CHILD_ZERO_NONINTERACTIVE	1,190,000,000.00	1,200,000,000.00	1,060,000,000.00
FOURTH_NONINTERACTIVE:4->CHILD_ONE_NONINTERACTIVE	1,150,000,000.00	1,000,000,000.00	930,000,000.00
Mean time to completion	1,246,666,666.67	1,225,000,000.00	1,203,333,333.33

Work Duration per process	Basic Interactive		
	Small		
	Round-Robin	Expected Burst SJF	Goodness SJF
	Time to completion		
processName			
FIRST_INTERACTIVE	290,000,000.00	450,000,000.00	330,000,000.00
SECOND_INTERACTIVE	1,250,000,000.00	1,210,000,000.00	550,000,000.00
THIRD_INTERACTIVE	1,240,000,000.00	1,350,000,000.00	1,360,000,000.00
FOURTH_INTERACTIVE	2,610,000,000.00	3,000,000,000.00	3,900,000,000.00
FOURTH_INTERACTIVE->CHILD_ZERO_INTERACTIVE	1,400,000,000.00	2,030,000,000.00	2,990,000,000.00
FOURTH_INTERACTIVE->CHILD_ONE_INTERACTIVE	2,080,000,000.00	2,300,000,000.00	2,650,000,000.00
Mean time to completion	1,648,333,333.33	1,895,000,000.00	2,251,666,666.67

Work Duration per process	Basic Complex		
	Small		
	Round-Robin	Expected Burst SJF	Goodness SJF
processName	Time to completion		
FIRST_INTERACTIVE	4,140,000,000.00	3,640,000,000.00	3,440,000,000.00
SECOND_INTERACTIVE	820,000,000.00	400,000,000.00	580,000,000.00
THIRD_NONINTERACTIVE	200,000,000.00	300,000,000.00	890,000,000.00
FOURTH_NONINTERACTIVE	1,220,000,000.00	1,580,000,000.00	1,930,000,000.00
FOURTH_NONINTERACTIVE->CHILD_INTERACTIVE_ZERO	1,200,000,000.00	1,450,000,000.00	1,870,000,000.00
FOURTH_NONINTERACTIVE->CHILD_INTERACTIVE_ONE	700,000,000.00	1,070,000,000.00	570,000,000.00
Mean time to completion	1,983,333,333.33	2,006,666,666.67	2,146,666,666.67

These basic cases confirm our hypothesis about the non-interactive workloads while still giving non-conclusive results due to randomness.

I/O Randomness

Finally, we also experimented with random seeds on interactive processes to explore how randomness in the I/O calls affects our results.

To validate this, we created three more test cases with interactive tasks using three different seeds.

Seed Number	Seed Variation								
	Seed 220			Seed 310			Seed 345		
	Round-Robin	Expected Burst SJF	Goodness SJF	Round-Robin	Expected Burst SJF	Goodness SJF	Round-Robin	Expected Burst SJF	Goodness SJF
processName	Time to completion			Time to completion			Time to completion		
FIRST_INTERACTIVE	730,000,000.00	410,000,000.00	380,000,000.00	260,000,000.00	320,000,000.00	270,000,000.00	290,000,000.00	450,000,000.00	330,000,000.00
SECOND_INTERACTIVE	720,000,000.00	810,000,000.00	860,000,000.00	550,000,000.00	1,020,000,000.00	1,020,000,000.00	1,250,000,000.00	1,210,000,000.00	550,000,000.00
THIRD_INTERACTIVE	840,000,000.00	930,000,000.00	1,080,000,000.00	840,000,000.00	900,000,000.00	910,000,000.00	1,240,000,000.00	1,350,000,000.00	1,360,000,000.00
FOURTH_INTERACTIVE	4,950,000,000.00	3,280,000,000.00	2,130,000,000.00	2,490,000,000.00	2,480,000,000.00	3,240,000,000.00	2,610,000,000.00	3,000,000,000.00	3,900,000,000.00
FOURTH_INTERACTIVE->CHILD_ZERO_INTERACTIVE	1,350,000,000.00	860,000,000.00	2,000,000,000.00	750,000,000.00	1,440,000,000.00	1,070,000,000.00	1,400,000,000.00	2,030,000,000.00	2,990,000,000.00
FOURTH_INTERACTIVE->CHILD_ONE_INTERACTIVE	770,000,000.00	2,360,000,000.00	1,340,000,000.00	950,000,000.00	1,080,000,000.00	1,010,000,000.00	2,080,000,000.00	2,300,000,000.00	2,650,000,000.00
Mean time to completion	1,731,666,666.67	1,661,666,666.67	1,511,666,666.67	1,145,000,000.00	1,443,333,333.33	1,483,333,333.33	1,648,333,333.33	1,895,000,000.00	2,251,666,666.67

We noticed that sometimes interactive processes finish faster on the Expected Burst Implementation compared to the Goodness one, while the Round-Robin implementation is dominating most of the times.