FCFS CPU scheduler Code and Report

Project objective: To learn more about OS CPU scheduling through a hands-on simulation programming experience. To simulate, compare, and evaluate CPU scheduling algorithms using a consistent set of data.

Names:

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Date:

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C++

1. Provide clear instructions on how to compile, build, and run the simulator (this will indicate that the application has been tested and works on the engineering student desktop)

Launch Video Studio

- Click Create New Product.
- Select Console App.
- Click Next.
- Enter pertinent information to start project (Name, Location, Etc.)
- Click Create
- Copy source code from text file and paste in .cpp file (override all previous text)
- Build project (Build Menu -> Build [Name]).
- ➤ Run project (Debug Menu -> Start Without Debugging).

2. Introduction

This program was meant to model the FCFS CPU scheduling algorithm to demonstrate a complete understanding of various scheduling algorithm like FCFS. This program was developed in C++ using structs and other various data structures and concepts to organize and properly process data. The expected results of this scheduling algorithm were those represented in the completed Gantt chart and my understanding of the FCFS algorithm. The program seemed to be straightforward, but I encountered a host of issues that were a result of my failure to make reasonable considerations. I had issues making sure that after every run information was accurate and properly processed but eventually, I was able to work through them with the use of online resources like GeeksforGeeks and the C++ STL library which gave me an insightful understanding of things I was previously unsure of with C++.

3. Insert one table that includes the entire simulation results for CPU Utilization, Response Time (RT), Waiting Time (WT), Turnaround Time (TT) PER PROCESS and Averages for both FCFS(710 time units) and SJF (810 time units)

Process (FCFS Results)	RT (Response Time)	WT (Wait Time)	TT (Turnaround Time)
P1	0	298	583
P2	6	233	647
P3	25	249	512
P4	37	231	657
P5	48	298	620
P6	64	243	599
P7	84	315	710
P8	87	341	684
AVG	43.875	276	626.5
CPU Utilization		95.3521%	•
SJF (FCFS Results)	RT (Response Time)	WT (Wait Time)	TT (Turnaround Time)
P1	3	65	350
P2	104	230	644

P3	20	117	380	
P4	9	79	505	
P5	79	216	538	
P6	431	454	810	
P7	0	60	455	
P8	41	121	464	
AVG	85.875	167.75	518.25	
CPU Utilization		82.35%		

- 4. Answer the following questions in full sentences with a brief explanation, IN YOUR OWN WORDS:
 - a. Which algorithm (FCFS or SJF) has the best (highest) CPU utilization, why do you think that algorithm has a higher CPU utilization?

FCFS has the best CPU utilization. I think that this algorithm has higher CPU utilization because there are less context switches as is no preemption.

b. How many context switches are in the simulation of FCFS?

There are 71 context switches in the simulation of FCFS.

c. How many context switches are in the simulation of SJF?

There are 76 context switches in the simulation of SJF.

d. How does the number of context switches effect the performance of the algorithm?

More context switches negatively affect the performance of the algorithm as context switch time is pure overhead and thus the system does not do any useful work.

e. Which algorithm (FCFS or SJF) has the lowest average waiting time?

The algorithm with the lowest average waiting time is SJF.

f. Which algorithm (FCFS or SJF) has the lowest average response time?

The algorithm with the lowest average response time is FCFS.

g. Which algorithm (FCFS or SJF) has the lowest average turnaround time?

The algorithm with the lowest average turnaround time is SJF.

5. Insert a partial or complete Gantt chart for FCFS.

	P	1		P	2		P3			P	4		P:	5		Pe	,		P7	7		P8	
	CPU	1/0		CPU	1/0		CPU	I/O		CPU	1/0		CPU	1/0		CPU	1/0		CPU	1/0		CPU,	1/0
,	1	X	١,	119	98		112	14		n	98		. 16	2/2		20	1		3	ممو		1/5	50
47	9	8	1/3	16	32	81	5	61	93	/	M	956	y 6	X	115	22	30	131	7	24	152	4	23
139	5	26	165	17	29	138	3	29	194	6	45	169	12	31		25	29		6	34		11	31
	4	22		6	44		7	45		8	51		14	26		11	44		5	54		4	31
	3	41		8	34		8	54		4	61		13	31		17	34		4	24		3	47
	6	45		21	34		11	44		13	54		16	18		18	31		7	44		5	21
	4	27		19	39		9			11	61		12	21		6	22		6	54		8	31
	8	27		10	31					10			10	33		15			5	21		6	44
	3			7									11						6	43		9	
																			4				
	P1		72	2	P 3		P4	1	P5	17	6		P 7	7	8	7	1	7	3	1	2	75	P4
D		6		25		37	!	48		64		84	۶	37		102	1	111		117	1	33	148 15

6. Insert the calculated results that were produced by the simulation.

Finished

Total Time: 710 CPU Utilization: 95.3521%

Waiting Times	P1	P2	P3	P4	P5	P6	P7	P8
	298	227	224	194	250	179	231	254
Average Waiting:	232.125							
Turnaround Times	P1	P2	P3	P4	P5	P6	P7	P8
	583	641	487	620	572	535	626	597
Average Turnaround:	582.625							
Response Times	P1	P2	P3	P4	P5	P6	P7	P8
	0	6	25	37	48	64	84	87
Average Response:	43.8	_		<i>3,</i>	.0	0.	0.	07

7. Insert the FCFS Program Output. (Be mindful that spacing and tabbing is a bit off)

```
Current Time: 0
Now running: P1
_____
Ready Queue: Process Burst
         19
      Р2
      P3 12
      Р4
         11
      P5
         16
        20
      P6
      P7
         3
      P8 15
Now in I/O: Process
                Remaining I/O time
      [empty]
______
Completed: [empty]
Current Time: 6
Now running: P2
______
Ready Queue:
         Process Burst
      Р3
         12
      P4
         11
      Р5
         16
      Р6
         20
      P7
      P8 15
Now in I/O: Process
                Remaining I/O time
      P1 21
Completed: [empty]
Current Time: 25
Now running: P3
```

Ready Queue: Process Burst P4 11

```
20
      Ρ6
      P7
          3
         15
      Р8
______
Now in I/O: Process Remaining I/O time
      P1 2
      P2 48
Completed: [empty]
Current Time: 37
Now running: P4
Ready Queue: Process Burst
      Р1
      P5
         16
      P6
         20
      Р7
         3
         15
      P8
Now in I/O: Process
                Remaining I/O time
      P2 36
      P3 14
______
Completed: [empty]
Current Time: 48
Now running: P5
______
         Process Burst
Ready Queue:
      P1
      Р6
         20
      P7
         3
      P8
         15
Now in I/O: Process
                Remaining I/O time
      P2 25
      Р3
        3
       P4
        45
```

P5

16

Completed:	[emp	ty]	
Current Tim	ne: 6	4	
Now running	g: P6		
Ready Queue	e: P1	Process 9	Burst
	_	6	
	P7	3	
	P8	15	
Now in I/O:	· Proc	222	Remaining I/O time
110W 111 170.	P2	9	Nematiffing 170 cline
	P4	29	
	P5	22	
Completed:	[emp	t.v1	
oomprood.	[Omp	0,1,1	
Current Tir	me: 8	4	
Now running	g: P7		
Doods Ossas		Dwagag	Dunat
Ready Queue	e: P1	9	Burst
		16	
		6	
	P8	15	
Now in I/O:	: Proc	ess	Remaining I/O time
,	P4	9	
	P5		
	P6	31	
Completed:	[emp	ty]	

Current Time: 87

	: P8		
Ready Queue	: P1	Process 9	Burst
	P2 P3		
	P5	15	
Nov. in T/O.	Dr. 0		Demaining I/O time
NOW III 1/U:	P100		Remaining I/O time
	Р6	28	
	P7	44	
 Completed:	[emp	 .tvl	
Current Tim	e: 1	02	
Now running	: P1		
Ready Queue	:	Process	Burst
	P2		
	P3 P4		
		15	
Now in I/O:	Proc	ess 13	Remaining I/O time
	P7		
	P8	50	
Completed:			
Current Tim	e: 1	11	
Now running	: P3		
 Ready Queue	:	Process	Burst
	P2	16	
	P4	5 15	

Now in I/O:	P6 P7 P8 P1	4 20 41 28	Remaining I/O time
Completed:	[empt	у]	
Current Tin	ne: 11	7	
Now running	g: P2		
Ready Queue	P4 P5	5	Burst
	P7 P8 P1 P3	14 35 22 21	Remaining I/O time
Completed:	[empt	у]	
Current Tim	ne: 13	3	
Now running			
Ready Queue	P4 P6 P7	Process	Burst
Now in I/O:	Proce P8 P1 P3		Remaining I/O time

Completed: [empty]

Current Time:	148	
Now running:	P4	
Ready Queue: P1 P3 P6	5 3 22	Burst
Now in I/O:Pr		Remaining I/O time
	17	
P5	21	
Completed: [e	mptvl	
Current Time:		
Now running:	P6 	
Ready Queue:	Process	Burst
P1 P3	5	
P7	7	
P8	4	
Now in I/O:Pr	ocess	Remaining I/O time
P2 P5	12	
P 4	41	
Completed: [e	mpty]	
Current Time:	175	
Now running:	P7	

Ready Queue	P1 P2	5 17 3 12	Burst
	P4 P6	19 30	Remaining I/O time
Completed:	[empt	у]	
Current Tim	ne: 18	2	
Now running			
	P1 P2 P5 P8	5 17 12	Burst
Now in I/O:	Proce P4 P6 P7	12	Remaining I/O time
Completed:	[empt	у]	
Current Tim	ne: 18	5	
Now running	յ։ P1		
	P2 P5 P8	17 12 4	Burst
Now in I/O:	Proce	 ss 9	Remaining I/O time

P6 20

	Р3	21 29	
Completed:			
Current Ti	me: 1	90	
Now runnin	g: P8		
		Process	Burst
 Now in I/O			Remaining I/O time
	P4 P6 P7	4 15	
	P7 P3	16 24	
	P1		
Completed:			
Current Ti	me: 1	94	
Now runnin	.g: P2		
Ready Queu	.e:	Process	Burst
	P4 P5	6 12	
 Now in I/O	 : Proc	cess	Remaining I/O time
	P6 P7	11 12	
	P3 P1	20	
Completed:	[emp	 >ty]	

P7 21

Current Time: 211 Now running: P5 Ready Queue: Process Burst Ρ4 P6 25 P7 6 Now in I/O: Process Remaining I/O time P3 Р1 P8 6 P2 29 Completed: [empty] Current Time: 223 Now running: P4 ______ Ready Queue: Process Burst Р1 P3 25 Р6 Р7 6 P8 11 ______ Now in I/O: Process Remaining I/O time P2 17 P5 31 ______ Completed: [empty] Current Time: 229 Now running: P6 Process P1 4 Ready Queue: Burst 7 Р3

P7 6

	FO	11	
Now in I/O:	Proce	299	Remaining I/O time
	P2	11	Nemaining 170 time
	P5	25	
	P4	45	
Completed:	[empt	ΞY]	
Current Tim	ie: 25	4	
Now running	: P7		
Ready Queue			Burst
		4 6	
		7	
		14	
	P8	11	
Now in I/O:		ess 20	Remaining I/O time
	P6		
Completed:	[empt	ΞΥ]	
Current Tim	e. 26	0	
		Ŭ	
Now running			
Ready Oueue	:	Process	Burst
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	P1	4	
	P2	6	
	P5	14	
		11	
Now in I/O:			Remaining I/O time
	P4	14	. 5
	P6	23	
	P7	34	

Current Ti			
Cullene ii	. Z	0 7	
Now runnin			
Ready Queu	e: P2 P5	Process	Burst
Now in I/O	: Proc P4 P6 P7		Remaining I/O time
Completed: Current Ti			
Current Ti	 me: 2 g: P8	 71	
Current Ti	me: 2 g: P8 e: P2	 71	
Current Ti	me: 2 g: P8 e: P2 P5 : Proc P4 P6 P7 P3	Process 6 14	

Now running: P2

	P4 P5	8 14	Burst
Now in I/O:			Remaining I/O time
	P6 P7	1	
	P 7		
	P1	11	
	P8	31	
Completed:	[emp	ty]	
Current Tim	ne: 28	38	
Now running	r: P5		
D 1 0		_	
	e: P4		Burst
	P6		
Now in T/O	Drog		Remaining I/O time
NOW III 1/O.			Kemaining 170 time
	P7 P3	24	
	P1	5	
	P8 P2	25 44	
	ΓZ	44	
Completed:	[emp	ty]	
Current Tim	ne: 30)2	
Now running	r: P4		
Ready Outous	٠.	Process	Burst
ready Queue	P1	3	Burst
	P6	11	
	P7	5	

Now in I/O: Process Remaining I/O time

	P2 P5	26	
Completed:			
	·		
Current Tim	ne: 31	0	
Now running			
NOW LUMMING	,. 10		
Ready Queue	P1 P7	Process 3 5	Burst
Now in I/O:	Р3	2	Remaining I/O time
	P8 P2	22	
	P5 P4		
		01	
		_	
Completed:	[empt	ΞΥ]	
	·		
Current Tim	ne: 32	1	
Now running			
Ready Queue	e: P3		Burst
	P7	5	
	P8	4	
Now in I/O:		ess 11	Remaining I/O time
	P5	7	
	P4 P6		
Completed:	[empt	-y]	

24		
Process	Burst	
4		
ess	Remaining I/O time	
8		
4		
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29		
Process	Burst	
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	Demaining I/O time	
	Remaining 1/0 cime	
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	8 4 ess 8 4 37 41 41 ty]	ess Remaining I/O time 8 4 37 41 41 41 ty] Process Burst 13 4 ess Remaining I/O time 3 32 36 36 36 54

eady Queue: Process F P2 8

Р8

18

Now in I/O: Process Remaining I/O time P4 24 P6 28 Р1 28 P7 46 P3 54 Completed: [empty] Current Time: 341 Now running: P5 ______ Ready Queue: Process Burst P2 8 ______ Now in I/O: Process Remaining I/O time P4 20 24 Р6 P1 24 P7 42 50 PЗ 31 Р8 ______ Completed: [empty] Current Time: 354 Now running: P2 ______ Ready Queue: Process Burst [empty] ______ Now in I/O: Process Remaining I/O time P4 7 Р6 11 Р1 11 29 Р7 PЗ 37

Completed: [empty]

Completed: [empty] Current Time: 362 Now running: P4 Ready Queue: Process Burst [empty] Now in I/O: Process Remaining I/O time P6 3 3 Р1 Р7 21 29 P3 Р8 10 P5 23 P2 34 ______ Completed: [empty] Current Time: 366 Now running: P1 ______ Ready Queue: Process P6 17 Burst ______ Now in I/O: Process Remaining I/O time P7 17 Р3 25 Р8 6 P5 19 P2 30

Current Time: 372 Now running: P6 Ready Queue: Process Burst Р8 ______ Now in I/O: Process Remaining I/O time P7 11 P3 19 P5 13 24 P2 P4 55 P1 45 Completed: [empty] Current Time: 389 Now running: P8 ______ Ready Queue: Process Burst P5 16 P7 4 Now in I/O: Process Remaining I/O time P3 2 P2 P4 38 P1 28 Р6 34 ______ Completed: [empty] Current Time: 392 Now running: P7 ______ Process P3 11 Ready Queue: Burst

P5

16

Now in I/O:	: Proce	ess	Remaining I/O time
	P2	4	
	P4	35	
	P1	25	
	P6	31	
	P8	47	
Completed:	[omnt]	
completed.	[emp c	- Ā 1	
Current Tir	ne: 39	6	
Now running	g: P5		
Ready Onena	.	Process	Burst
Ready Queue	P2	21	Dulse
	P3		
	1 5	11	
Now in I/O:	: Proce	ess	Remaining I/O time
	P4	31	
		21	
		27	
		43	
	P7	24	
Completed:	[empt	· v]	
compiceca:	[Chip c	· Ā 1	
Current Tir	ne: 41	2	
Now running	g: P3		
Ready Onena	.	Process	Burst
Ready Queue	P2	21	Duise
Now in I/O:			Remaining I/O time
		15	
		5	
	P6		
		27	
	P7		
	P5	18	

Completed:			
Current Tim			
Ready Queue	P1 P6 P7	Process 4 18 7	Burst
Now in I/O:	Proc P4 P8 P5		Remaining I/O time
	ne: 4	44	
Ready Queue	P4 P5 P6 P7 P8	Process 13 12 18 7 5	Burst
Now in I/O:	: Proc		Remaining I/O time
Completed:			
Current Tim	ne: 4	48	

Now running: P7

Ready Onene	· •	Process	Burst
z z z z z z z z z z z z z z z z z z z	P4	13	
	P5	12	
	P6	1.8	
	P6 P8	5	
	10	5	
Now in T/O:	Proc	A S S	Remaining I/O time
110W 111 170.		19	Remaining 170 cime
	P2	30	
	P1	27	
	11	2 /	
Completed:	[emp	t v 1	
oompiood.	[Omp	011	
Current Tim	ne: 45	55	
Now running	r: P6		
-	,		
Ready Queue	:	Process	Burst
	P4	13	
	P5	12	
	P8		
Now in I/O:	Proc	ess	Remaining I/O time
	Р3	12	
	P2	23	
	P1	20	
	Р7	44	
Completed:	[emp	tyl	
1		<i>-</i>	
Current Tim	ne: 47	73	
Now running	g: P4		
_			
Ready Queue	:	Process	Burst
<u> </u>	Р3	9	
	P5	12	
	P8	5	

Now in I/O: Process Remaining I/O time

	P1	2	
	P7	26	
	P6	31	
	10	J1	
Completed:	[emn	1+ 17]	
compiceca.	[Cmp	, C <u>y</u>]	
Current Tim	ne• 4:	8.6	
Cull Circ III	I	0 0	
Now running	r• P5		
NOW TUITITIE	j. 13		
Ready Queue	e :	Process	Burst
2.00.007	P1		
		19	
		9	
		5	
	FO	J	
Now in I/O:	Proc	ess	Remaining I/O time
		13	
	P6		
	P4		
		0 1	
Completed:	ſemp	tvl	
	r andr	- 7 1	
Current Tim	ne: 4	98	
Now running	r: P8		
-	,		
Ready Queue	e:	Process	Burst
	P1		
	P2		
	Р3	9	
Now in I/O:	: Proc	ess	Remaining I/O time
	P7		
	Р6	6	
	P4	42	
	P5	21	
Completed:	[emp	ty]	
-	-	_	

P2 5

Current Time:	503	
Now running:	Р3	
Ready Queue:	Process	Burst
	. 8 2 19	
P7	6	
	5 1	Remaining I/O time
	37 5 16	
	3 21	
Completed: P3	} 	
Current Time:	512	
Now running:	P1	
Ready Queue:	Process	Burst
P2 P6	2 19 5 6	
P7		
Now in I/O: Pr		Remaining I/O time
P5	5 7	
P8	3 12	
Completed: P3		
Current Time:	520	
Now running:	P2	
Ready Queue:		Burst
P6	6	
P7	7 6	

Now in I/O:			Remaining I/O time
		20 4	
	P1	27	
Completed:	Р3		
Current Tim	ne: 53	9	
Now running	r: P7		
Ready Queue	٠ .	Process	Burst
neady gaede	P5	10	Daise
	P6 P8	6 8	
Now in I/O:	Droge	\ C C	Remaining I/O time
NOW III 1/O.	P4	1	Remaining 1/0 Cime
	P1 P2		
	D 2		
Completed:	P3 		
Current Tim	ne: 54	5	
Now running	r: P6		
Ready Oueue	:	Process	Burst
1 ~	P4 P5	11	
		8	
Now in I/O:	Proce	2 55	Remaining I/O time
110W 111 170.	P1	2	nemaining 1/0 cine
	P2 P7		
Completed	DЗ		
Completed:			

Current Time: 551

D 1		D	D
Ready Queue	∋: ₽1	Process 3	Burst
	P4	11	
	Р8	8	
Now in I/O		cess 27	Remaining I/O time
	P2 P7		
	P6		
Completed:	Р3		
Current Tir	me: 5	61	
Now running	g: P8		
			Burst
	P1		
	P4	11	
Now in I/O:	• Proc	2000	Remaining I/O time
		, , ,	Remaining 170 cime
, -		17	
,	P2	17 38	
	P2 P7 P6	38 12	
	P2 P7 P6	38	
	P2 P7 P6 P5	38 12 33	
	P2 P7 P6 P5	38 12 33	
Completed:	P2 P7 P6 P5	38 12 33	
Completed:	P2 P7 P6 P5	38 12 33	
Completed: Current Tir	P2 P7 P6 P5 P3 ne: 5	38 12 33 	
Completed: Current Tir	P2 P7 P6 P5 	38 12 33 	
Completed: Current Tir	P2 P7 P6 P5 	38 12 33 	
Completed: Current Tir Now running Ready Queue	P2 P7 P6 P5 P3 ne: 5 g: P4	38 12 33 	
Completed: Current Tir Now running Ready Queue	P2 P7 P6 P5 P3 me: 5 g: P4 P1	38 12 33 69 Process 3	Burst
Completed: Current Tir Now running Ready Queue	P2 P7 P6 P5 P3 ne: 5 g: P4 P1	38 12 33 69 Process 3	Burst

	25 31	
Completed: P3		
Current Time: 5	80	
Now running: P1		
Ready Queue: P2	Process	
P5 P8 P4	19 14 20 61	Remaining I/O time
Completed: P1		
Current Time: 5	83	
Now running: P6		
	10	
Now in I/O: Proc P7 P5 P8		Remaining I/O time
Completed: P1		
Current Time: 5	99	
Now running: P2		

Ready Queue: Process Burst P5 11 P7 5 Now in I/O: Process Remaining I/O time P8 1 P4 42 Completed: P1 P3 P6 Current Time: 609 Now running: P5 Ready Queue: Process Burst 5 P8 6 Now in I/O: Process Remaining I/O time P4 32 P2 31 Completed: P1 P3 P5 Р6 Current Time: 620 Now running: P7 Ready Queue: Process Burst P8 6 Now in I/O: Process Remaining I/O time P4 21 P2 20 Completed: P1 P3 P5 Р6

Current Time: 625

Now running: P8

Ready Queue	[empt	.y]					
Now in I/O:	Proce P4 P2 P7	ess 16 15					
Completed:	P1 	P3 	P5				
Current Tim	ne: 64						
Ready Queue	e: [empt		ess		Burst		
Now in I/O:	Proce P4 P7 P8	1.0		Remai	ining	I/O tir	me
Completed:	P1 	P2 	P3	P5 	P6 		·
Current Tim		7					
Ready Queue	:: [empt		ess		Burst	;	
Now in I/O:	Proce P7 P8	8		Remai	ining	 I/O tir	me
Completed:	P1	P2	P3	P4	P5	P6	

Current Time: 657 Now running: P7 Ready Queue: Process Burst P4 10 .______ Remaining I/O time Now in I/O: Process P8 27 Completed: P1 P2 P3 P4 P5 P6 Current Time: 663 Now running: P4 ______ Ready Queue: Process Burst [empty] ______ Now in I/O: Process Remaining I/O time P8 21 P7 43 ______ Completed: P1 P2 P3 P5 P6 Current Time: 675 Now running: P8 ______ Ready Queue: Process Burst [empty] ______ Now in I/O: Process Remaining I/O time P7 33 Completed: P1 P2 P3 P4 P5 P6

Current Time: 706

Now running: P7

Ready Queue: Process Burst

[empty]

Now in I/O: Process Remaining I/O time

Completed: P1 P2 P3 P4 P5 P6 P8

Finished

Total Time: 710

CPU Utilization: 95.3521%

Waiting Times P1 P2 P3 P4 P5 P6 P7 P8

298 233 249 231 298 243 315 341

Average Waiting: 276

Turnaround Times P1 P2 P3 P4 P5 P6 P7 P8

583 647 512 657 620 599 710 684

Average Turnaround: 626.5

Response Times P1 P2 P3 P4 P5 P6 P7 P8 0 6 25 37 48 64 84 87

Average Response: 43.875