Discussion 4

Scheduling

10/09/24

Staff

Announcements

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Homework 2 Due	Homework 3 Release Project 1 Due Turn in Peer Evals	Project 2 Release				
					Project 2 Design Doc Due	

Scheduling

Scheduling

Scheduling is the process of deciding which threads are given access to resources from moment to moment.

- Usually pertains to CPU but can be anything (e.g disk access)

For simplification, assume each user has one single-threaded program, and these programs are independent of each other.

Goals and Criteria

Minimize completion time

- Completion time is the combination of the waiting time plus the run time of a process.
- Crucial for time sensitive tasks (e.g. I/O)

Maximize throughput

- **Throughput** is the rate at which tasks are completed.
- Related but not the same as completion time
- Need to minimize overhead (e.g. context switching), using resources efficiently.

Maintain fairness

- **Fairness** refers to sharing resources in some equitable manner.
- Not very well defined.
- Usually contradicts minimizing completion time.

Definitions

Wait time:

- The total time a process spends on the ready queue

Response time:

- The total time it takes for a process to finish its execution

Completion time:

- Same as response time

These definitions vary from textbook to textbook, instructor to instructor, etc., but we will be using these

First Come First Serve (FCFS)

First come first serve (FCFS) schedule tasks in the order they arrive.

Simple to implement.

Good for throughput since it minimizes overhead of context switching.

Average completion time can very significantly according to arrival order.

Suffers from **Convoy effect** where short tasks get stuck behind long tasks.

Shortest Job First (SJF) / Shortest Remaining Time First (SRTF)

Shortest job first (SJF) schedules the shortest task first.

Shortest remaining time first (SRTF) is a preemptive version of SJF.

- Preempt resource if a task arrives and has a shorter completion time than the current running task.

Provably optimal for minimizing average completion time for non-preemptive, preemptive policies, respectively.

Involves the impossible idea of knowing how long a task is going to take.

Round Robin (RR)

Round robin (RR) schedules tasks such that each take turn using the resource for a small amount of time known as the **time quantum** (q).

- After q expires, task is preempted and added to the end of the ready queue.

Large q → resembles FCFS, small q → lots of interleavings.

- Need q to be large with respect to context switching otherwise suffers from low throughput.

Ensures fairness in terms of sharing resources.

- n tasks → each task gets 1/n amount of resource, will not wait for more than (n-1)q time units.

Small scheduling quantum increases completion time.

Multi-Level Feedback Queue (MLFQ)

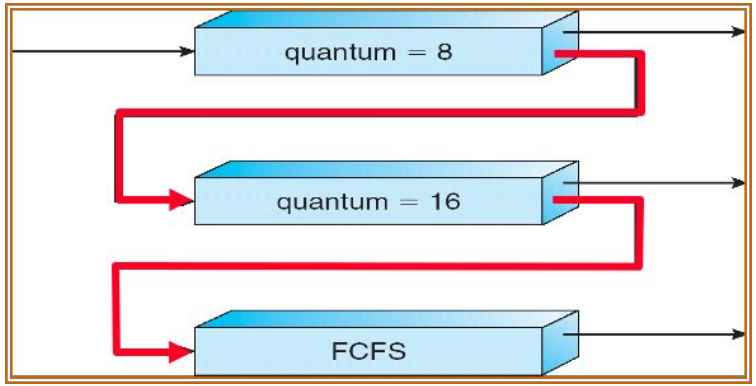
Multi-level feedback queue (MLFQ) uses multiple queues which each have a different priority.

- Each queue has its own scheduling policy.

Task starts at the highest priority queue and moves down to the next queue .

- Uses up resource → move down a level.
- Does not use up all resource → move up a level

Ensures long running tasks (e.g. CPU bound) don't hog all resources while short running tasks (e.g. I/O bound) will remain at higher priority.



Round Robin T/F

1. The average wait time is less than that of FCFS for the same workload.

2. If a quantum is constantly updated to become the number of cpu ticks since boot, RR becomes FCFS.

3. Ideally, you should set the time quanta of round robin generally to be significantly smaller than the average CPU burst time of a task.

Round Robin T/F

1. The average wait time is less than that of FCFS for the same workload.

   False. Generally not true when the time quantum is small.

FCFS

	A	A	A	B	B	B	C	C	C
Wait Times	0			3			6		
Average	3								

RR (q=1)

	A	B	C	A	B	C	A	B	C
Wait Times	0	1	2	2	2	2	2	2	2
Average	5								

2. If a quantum is constantly updated to become the number of cpu ticks since boot, RR becomes FCFS.

3. Ideally, you should set the time quanta of round robin generally to be significantly smaller than the average CPU burst time of a task.

Round Robin T/F

1. The average wait time is less than that of FCFS for the same workload.

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FCFS

	A	A	A	B	B	B	C	C	C
Wait Times	0			3			6		
Average	3								

RR (q=1)

	A	B	C	A	B	C	A	B	C
Wait Times	0	1	2	2	2	2	2	2	2
Average	5								

2. If a quantum is constantly updated to become the number of cpu ticks since boot, RR becomes FCFS.

   True. Quantum never gets used for any task since it always increases as the task progresses.

3. Ideally, you should set the time quanta of round robin generally to be significantly smaller than the average CPU burst time of a task.

Round Robin T/F

1. The average wait time is less than that of FCFS for the same workload.

   False. Generally not true when the time quantum is small.

FCFS

	A	A	A	B	B	B	C	C	C
Wait Times	0			3			6		
Average	3								

RR (q=1)

	A	B	C	A	B	C	A	B	C
Wait Times	0	1	2	2	2	2	2	2	2
Average	5								

2. If a quantum is constantly updated to become the number of cpu ticks since boot, RR becomes FCFS.

   True. Quantum never gets used for any task since it always increases as the task progresses.

3. Ideally, you should set the time quanta of round robin generally to be significantly smaller than the average CPU burst time of a task.

   False. This results in poor turnaround time since tasks have to wait multiple cycles for their turns. Ideally, you'd want the quanta to be large enough to absorb most CPU bursts, but small enough to prevent short-running tasks being starved by long ones.

Round Robin T/F

4. Cache performance is likely to improve relative to FCFS.

5. If no new threads are entering the system all threads will get a chance to run in the cpu every `QUANTA*SECONDS_PER_TICK*NUMTHREADS` seconds, assuming `QUANTA` is in ticks.

Round Robin T/F

4. Cache performance is likely to improve relative to FCFS.

   False. RR usually results in more context switches when compared to FCFS, meaning the cache will have more misses.

5. If no new threads are entering the system all threads will get a chance to run in the cpu every `QUANTA*SECONDS_PER_TICK*NUMTHREADS` seconds, assuming `QUANTA` is in ticks.

Round Robin T/F

4. Cache performance is likely to improve relative to FCFS.

   False. RR usually results in more context switches when compared to FCFS, meaning the cache will have more misses.

5. If no new threads are entering the system all threads will get a chance to run in the cpu every `QUANTA*SECONDS_PER_TICK*NUMTHREADS` seconds, assuming `QUANTA` is in ticks.

   False. There exists context switching overhead.

Life Ain’t Fair

Suppose the following threads (priorities given in parentheses) arrive in the ready queue at the clock ticks shown. Assume all threads arrive unblocked and that each takes 5 clock ticks to finish executing. Assume threads arrive in the queue at the beginning of the time slices shown and are ready to be scheduled in that same clock tick. This means you update the ready queue with the arrival before you schedule/execute that clock tick. Assume you only have one physical CPU.

Determine the order and time allocations of execution for each given scheduler scenario.

- RR (q = 3)
- SRTF
- Strict priority scheduling with preemptions.

Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	
1	
2	
3	
4	
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6	
7	
8	
9	
10	
11	
12	
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Queue

Quantum	3

Remaining	
Name	Time
Taj	5
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	
1	
2	
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6	
7	
8	
9	
10	
11	
12	
13	
14	
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Queue
Taj

Quantum	3

Remaining	
Name	Time
Taj	5
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	
2	
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6	
7	
8	
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12	
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Queue

Quantum	2

Remaining	
Name	Time
Taj	4
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	
3	
4	
5	
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13	
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Queue

Quantum	1

Remaining	
Name	Time
Taj	3
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
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Queue
Kevin

Quantum	1

Remaining	
Name	Time
Taj	3
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

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RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
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Queue
Kevin

Quantum	0

Remaining	
Name	Time
Taj	2
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

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	Just before time
	At time

Time	Thread
0	Taj
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Queue
Kevin
Neil

Quantum	0

Remaining	
Name	Time
Taj	2
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
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	At time

Time	Thread
0	Taj
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Queue
Kevin
Neil
Taj

Quantum	3

Remaining	
Name	Time
Taj	2
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
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0	Taj
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Queue
Neil
Taj

Quantum	2

Remaining	
Name	Time
Taj	2
Kevin	4
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
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8		
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RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
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Queue
Neil
Taj

Quantum	1

Remaining	
Name	Time
Taj	2
Kevin	3
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
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	At time

Queue
Neil
Taj
Akshat

Quantum	1

Remaining	
Name	Time
Taj	2
Kevin	3
Neil	5
Akshat	5
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Arrivals		
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Queue
Neil
Taj
Akshat

Quantum	0

Remaining	
Name	Time
Taj	2
Kevin	2
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
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4		
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Time	Thread
0	Taj
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	Just before time
	At time

Queue
Neil
Taj
Akshat
Kevin

Quantum	3

Remaining	
Name	Time
Taj	2
Kevin	2
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
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Queue
Taj
Akshat
Kevin

Quantum	2

Remaining	
Name	Time
Taj	2
Kevin	2
Neil	4
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
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Queue
Taj
Akshat
Kevin
William

Quantum	2

Remaining	
Name	Time
Taj	2
Kevin	2
Neil	4
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
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Queue
Taj
Akshat
Kevin
William

Quantum	1

Remaining	
Name	Time
Taj	2
Kevin	2
Neil	3
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
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Queue
Taj
Akshat
Kevin
William

Quantum	0

Remaining	
Name	Time
Taj	2
Kevin	2
Neil	2
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
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Queue
Taj
Akshat
Kevin
William
Alina

Quantum	0

Remaining	
Name	Time
Taj	2
Kevin	2
Neil	2
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
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	At time

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Queue
Taj
Akshat
Kevin
William
Alina
Neil

Quantum	3

Remaining	
Name	Time
Taj	2
Kevin	2
Neil	2
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
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RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	
11	
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13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
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Queue
Akshat
Kevin
William
Alina
Neil

Quantum	2

Remaining	
Name	Time
Taj	1
Kevin	2
Neil	2
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	
12	
13	
14	
15	
16	
17	
18	
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21	
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26	
27	
28	
29	
30	

Queue
Akshat
Kevin
William
Alina
Neil

Quantum	1

Remaining	
Name	Time
Taj	0
Kevin	2
Neil	2
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	
12	
13	
14	
15	
16	
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21	
22	
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28	
29	
30	

Queue
Akshat
Kevin
William
Alina
Neil

Quantum	3

Remaining	
Name	Time
Taj	0
Kevin	2
Neil	2
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	
13	
14	
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16	
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20	
21	
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26	
27	
28	
29	
30	

Queue
Kevin
William
Alina
Neil

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	2
Neil	2
Akshat	4
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	
14	
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16	
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30	

Queue
Kevin
William
Alina
Neil

Quantum	1

Remaining	
Name	Time
Taj	0
Kevin	2
Neil	2
Akshat	3
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	
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Queue
Kevin
William
Alina
Neil

Quantum	0

Remaining	
Name	Time
Taj	0
Kevin	2
Neil	2
Akshat	2
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	
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Queue
Kevin
William
Alina
Neil
Akshat

Quantum	3

Remaining	
Name	Time
Taj	0
Kevin	2
Neil	2
Akshat	2
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	
16	
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Queue
William
Alina
Neil
Akshat

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	1
Neil	2
Akshat	2
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	
17	
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Queue
William
Alina
Neil
Akshat

Quantum	1

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	
17	
18	
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28	
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30	

Queue
William
Alina
Neil
Akshat

Quantum	3

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	
18	
19	
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26	
27	
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29	
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Queue
Alina
Neil
Akshat

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	4
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	
19	
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21	
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26	
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29	
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Queue
Alina
Neil
Akshat

Quantum	1

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	3
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	
20	
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29	
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Queue
Alina
Neil
Akshat

Quantum	0

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	2
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	
20	
21	
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29	
30	

Queue
Alina
Neil
Akshat
William

Quantum	3

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	2
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	
21	
22	
23	
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27	
28	
29	
30	

Queue
Neil
Akshat
William

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	2
Alina	4

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	
22	
23	
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25	
26	
27	
28	
29	
30	

Queue
Neil
Akshat
William

Quantum	1

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	2
Alina	3

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	
23	
24	
25	
26	
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28	
29	
30	

Queue
Neil
Akshat
William

Quantum	0

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	2
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	
23	
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29	
30	

Queue
Neil
Akshat
William
Alina

Quantum	3

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	2
Akshat	2
William	2
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	
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29	
30	

Queue
Akshat
William
Alina

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	1
Akshat	2
William	2
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	
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Queue
Akshat
William
Alina

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	2
William	2
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	
25	
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29	
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Queue
Akshat
William
Alina

Quantum	3

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	2
William	2
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	Akshat
25	
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27	
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29	
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Queue
William
Alina

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	1
William	2
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	Akshat
25	Akshat
26	
27	
28	
29	
30	

Queue
William
Alina

Quantum	1

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	0
William	2
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	Akshat
25	Akshat
26	
27	
28	
29	
30	

Queue
William
Alina

Quantum	3

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	0
William	2
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	Akshat
25	Akshat
26	William
27	
28	
29	
30	

Queue
Alina

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	0
William	1
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	Akshat
25	Akshat
26	William
27	William
28	
29	
30	

Queue
Alina

Quantum	1

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	0
William	0
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	Akshat
25	Akshat
26	William
27	William
28	
29	
30	

Queue
Alina

Quantum	3

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	0
William	0
Alina	2

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	Akshat
25	Akshat
26	William
27	William
28	Alina
29	
30	

Queue

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	0
William	0
Alina	1

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

RR (q=3)

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Kevin
4	Kevin
5	Kevin
6	Neil
7	Neil
8	Neil
9	Taj
10	Taj
11	Akshat
12	Akshat
13	Akshat
14	Kevin
15	Kevin
16	William
17	William
18	William
19	Alina
20	Alina
21	Alina
22	Neil
23	Neil
24	Akshat
25	Akshat
26	William
27	William
28	Alina
29	Alina
30	

Queue

Quantum	2

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	0
William	0
Alina	0

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

SRTF

	Just before time
	At time

Time	Thread
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
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22	
23	
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25	
26	
27	
28	
29	
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Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

SRTF

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Kevin
6	Kevin
7	Kevin
8	Kevin
9	Kevin
10	Neil
11	Neil
12	Neil
13	Neil
14	Neil
15	Akshat
16	Akshat
17	Akshat
18	Akshat
19	Akshat
20	William
21	William
22	William
23	William
24	William
25	Alina
26	Alina
27	Alina
28	Alina
29	Alina
30	

Each thread takes the same amount of time

↓

SRTF behaves like FCFS

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

Queue

Remaining	
Name	Time
Taj	5
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
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14	
15	
16	
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18	
19	
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21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

Queue
Taj

Remaining	
Name	Time
Taj	5
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
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18	
19	
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24	
25	
26	
27	
28	
29	
30	

Queue

Remaining	
Name	Time
Taj	4
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
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22	
23	
24	
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26	
27	
28	
29	
30	

Queue

Remaining	
Name	Time
Taj	3
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	
3	
4	
5	
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11	
12	
13	
14	
15	
16	
17	
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21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

Queue
Kevin

Remaining	
Name	Time
Taj	3
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	
4	
5	
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12	
13	
14	
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16	
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22	
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25	
26	
27	
28	
29	
30	

Queue
Kevin

Remaining	
Name	Time
Taj	2
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	
4	
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26	
27	
28	
29	
30	

Queue
Neil
Kevin

Remaining	
Name	Time
Taj	2
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	
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27	
28	
29	
30	

Queue
Neil
Kevin

Remaining	
Name	Time
Taj	1
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	
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25	
26	
27	
28	
29	
30	

Queue
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	
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23	
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26	
27	
28	
29	
30	

Queue
Akshat
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	5
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	
7	
8	
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10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

Queue
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	4
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
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22	
23	
24	
25	
26	
27	
28	
29	
30	

Queue
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	3
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	
8	
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10	
11	
12	
13	
14	
15	
16	
17	
18	
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23	
24	
25	
26	
27	
28	
29	
30	

Queue
William
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	3
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	
8	
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10	
11	
12	
13	
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16	
17	
18	
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27	
28	
29	
30	

Queue
William
Akshat
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	3
William	5
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	William
8	
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10	
11	
12	
13	
14	
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16	
17	
18	
19	
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27	
28	
29	
30	

Queue
Akshat
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	3
William	4
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	William
8	William
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
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21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

Queue
Akshat
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	3
William	3
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	William
8	William
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
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25	
26	
27	
28	
29	
30	

Queue
Alina
Akshat
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	3
William	3
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	William
8	William
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

Queue
Alina
William
Akshat
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	3
William	3
Alina	5

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain’t Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	William
8	William
9	Alina
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

Queue
William
Akshat
Neil
Kevin

Remaining	
Name	Time
Taj	0
Kevin	5
Neil	5
Akshat	3
William	3
Alina	4

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Life Ain't Fair

Preemptive Priority

	Just before time
	At time

Time	Thread
0	Taj
1	Taj
2	Taj
3	Taj
4	Taj
5	Akshat
6	Akshat
7	William
8	William
9	Alina
10	Alina
11	Alina
12	Alina
13	Alina
14	William
15	William
16	William
17	Akshat
18	Akshat
19	Akshat
20	Neil
21	Neil
22	Neil
23	Neil
24	Neil
25	Kevin
26	Kevin
27	Kevin
28	Kevin
29	Kevin
30	

No more threads arrive

↓

Threads complete in order of priority

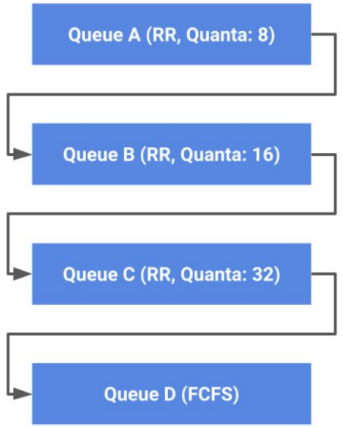
Queue

Remaining	
Name	Time
Taj	0
Kevin	0
Neil	0
Akshat	0
William	0
Alina	0

Arrivals		
Time	Name	Priority
0	Taj	7
1		
2	Kevin	1
3	Neil	3
4		
5	Akshat	5
6		
7	William	11
8		
9	Alina	14

Bitcoin Mining

You are a Bitcoin miner, and you've developed an algorithm that can run on an unsuspecting machine and mine Bitcoin. You now need to write a program that will run your mining algorithm forever. While you want your mining job to be scheduled often, you also don't want to attract too much suspicion from system users or administrators. Fortunately, you know that the machines you're targeting use a MLFQ algorithm to schedule jobs, outlined below.

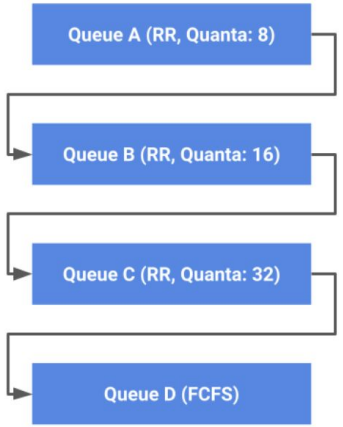


1. You decide that the best strategy is to guarantee that your mining job will always be placed on Queues B and C.
   Assume that the CPU-intensive mining algorithm you've developed can be run in 10 tick intervals. Implement your mining program, and explain your design. The only functions you should use are mine (which runs for 10 ticks) and printf. Assume that your job is initially placed on Queue B.

```
void mine_forever() {
  while(1) {
    ---------------
    ---------------
    ---------------
  }
}
```

Bitcoin Mining

You are a Bitcoin miner, and you've developed an algorithm that can run on an unsuspecting machine and mine Bitcoin. You now need to write a program that will run your mining algorithm forever. While you want your mining job to be scheduled often, you also don't want to attract too much suspicion from system users or administrators. Fortunately, you know that the machines you're targeting use a MLFQ algorithm to schedule jobs, outlined below.



1. You decide that the best strategy is to guarantee that your mining job will always be placed on Queues B and C.
   Assume that the CPU-intensive mining algorithm you've developed can be run in 10 tick intervals. Implement your mining program, and explain your design. The only functions you should use are mine (which runs for 10 ticks) and printf. Assume that your job is initially placed on Queue B.

```
void mine_forever() {
  while(1) {
    for (int i = 0; i < 4; i++)
      mine();
    _______________;
  }
}
```

Bitcoin Mining

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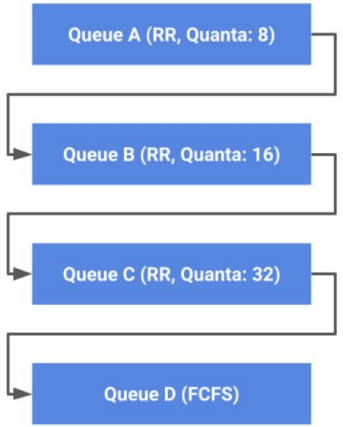

1. You decide that the best strategy is to guarantee that your mining job will always be placed on Queues B and C.
   Assume that the CPU-intensive mining algorithm you've developed can be run in 10 tick intervals. Implement your mining program, and explain your design. The only functions you should use are mine (which runs for 10 ticks) and printf (which runs for 0 ticks). Assume that your job is initially placed on Queue B.

```
void mine_forever() {
  while(1) {
    for (int i = 0; i < 3; i++)
      mine();
    printf("Not a bitcoin miner!!!");
  }
}
```

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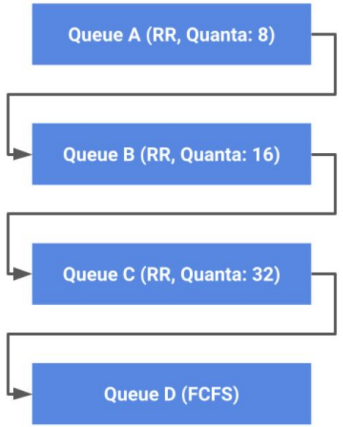
2. Explain why, regardless of how you implement your mining program, your job will never be placed on Queue A twice in a row.



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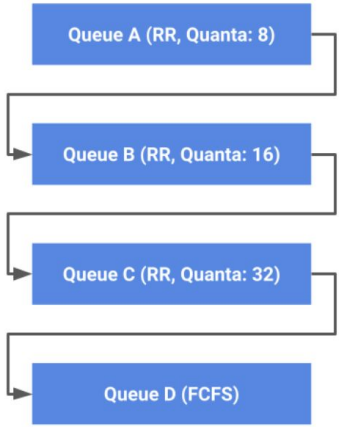

2. Explain why, regardless of how you implement your mining program, your job will never be placed on Queue A twice in a row.
   Since the mining algorithm can only be run in 10 tick intervals, any implementation will always exceed the Queue A quanta before the CPU can be voluntarily yielded. This will cause the job to be placed on Queue B, since the Queue A quanta expired.