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We pledge that we have abided by the Stevens Honor System

Experiment & Analysis

First, we ran the base case so we could have some numbers to compare to.

We started off trying out a small queue size of 1, which resulted in significantly smaller turn-around times and wait times , which makes sense since the smaller queue size forces the product to be consumed sooner on average. In our case, the queue size of 1 forces the product to be consumed as soon as it is inserted into the queue. The total time and the throughput stayed relatively the same.

Next, we tried out lots more consumers than producers, which also resulted in shorter turn-around times and wait times. The significantly larger number of consumers allows the products to be consumed very quickly, since more consumers are ready to consume than the producers are producing. The total time and the throughput stayed relatively the same.

We then tried lots more producers than consumers, which resulted in very large turn-around times and wait times. This makes sense because many producers are ready to produce and insert into the queue while the consumers are taking products out of the queue to consume at a slower pace. The total time stayed relatively the same, but the producer throughput was slightly larger. This makes sense because the producers will be done producing much earlier than the consumers will be done consuming.

In the case that there were a lot more consumers and producers than the base case, the total time was much shorter and the throughputs were much larger. However, the minimum turn-around times and the wait times were similar. The max times, on the other hand, were larger, which may have been caused by the queue size being smaller than the number of producers/consumers.

Next, we tried significantly increasing the number of products, which resulted in a much longer total time, but the throughputs were relatively the same. This makes sense because the rate at which the products are produced/consumed should stay the same when only the number of products has been increased. The turn-around times and the wait times were also higher on average. This makes sense because the large number of products makes it more likely for a single product to be stuck in the queue for a longer time before it is consumed.

Next, we tried the round robin algorithm with a very small quantum of 10. This resulted in an extremely high total time, turn-around times, and wait times. And extremely small throughputs. This makes sense because with such a small quantum, the process is wasting most of its time taking products out of the queue and inserting it back into the queue.

We then tried a higher quantum of 500, which resulted in generally higher total time, turn-around times, and wait times than the base case. The difference between the minimum and the maximum times are so large because the varying “lives” of the products allow them to be either consumed at once or consumed partially before being inserted back into the queue.

BASE CASE

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INPUT PARAMETERS

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# Producers: 4

# Consumers: 4

# Products: 100

Queue Size: 10

Scheduling: FCFS

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PERFORMANCE ANALYSIS

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1. Total Time 2531.239990

Turn-around Times MIN: 0.677979

MAX: 6.165039

AVG: 4.111396

Wait Times MIN: 0.057861

MAX: 5.948975

AVG: 3.845327

Producer Throughput: 2370.545509

Consumer Throughput: 2370.379744

2. Total Time 2534.218994

Turn-around Times MIN: 1.979980

MAX: 14.245850

AVG: 8.578596

Wait Times MIN: 1.630127

MAX: 14.083008

AVG: 8.309438

Producer Throughput: 2374.620088

Consumer Throughput: 2367.593335

3. Total Time 2526.439941

Turn-around Times MIN: 1.020020

MAX: 4.998047

AVG: 2.933816

Wait Times MIN: 0.961914

MAX: 4.797119

AVG: 2.685317

Producer Throughput: 2375.143566

Consumer Throughput: 2374.883290

SMALL QUEUE SIZE

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INPUT PARAMETERS

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# Producers: 4

# Consumers: 4

# Products: 100

Queue Size: 1

Scheduling: FCFS

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PERFORMANCE ANALYSIS

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Total Time 2530.583008

Turn-around Times MIN: 0.119873

MAX: 5.684082

AVG: 1.860332

Wait Times MIN: 0.076904

MAX: 5.319092

AVG: 1.621648

Producer Throughput: 2374.135142

Consumer Throughput: 2370.995135

Total Time 2529.371826

Turn-around Times MIN: 0.209961

MAX: 3.713135

AVG: 1.149316

Wait Times MIN: 0.071045

MAX: 3.563965

AVG: 0.891936

Producer Throughput: 2372.267406

Consumer Throughput: 2372.130478

Total Time 2530.099121

Turn-around Times MIN: 0.211914

MAX: 2.447021

AVG: 0.933660

Wait Times MIN: 0.083008

MAX: 2.091064

AVG: 0.682080

Producer Throughput: 2371.562099

Consumer Throughput: 2371.448593

LOTS MORE CONSUMERS

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INPUT PARAMETERS

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# Producers: 4

# Consumers: 100

# Products: 100

Queue Size: 10

Scheduling: FCFS

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PERFORMANCE ANALYSIS

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1. Total Time 2539.681152

Turn-around Times MIN: 0.103027

MAX: 1.574951

AVG: 0.550742

Wait Times MIN: 0.041992

MAX: 1.141846

AVG: 0.288865

Producer Throughput: 2368.486638

Consumer Throughput: 2362.501291

2. Total Time 2536.196045

Turn-around Times MIN: 0.072021

MAX: 1.355957

AVG: 0.537192

Wait Times MIN: 0.039795

MAX: 1.072021

AVG: 0.280417

Producer Throughput: 2369.878017

Consumer Throughput: 2365.747716

3. Total Time 2529.786133

Turn-around Times MIN: 0.075195

MAX: 1.301025

AVG: 0.550144

Wait Times MIN: 0.041016

MAX: 1.258057

AVG: 0.282871

Producer Throughput: 2379.671701

Consumer Throughput: 2371.741991

LOTS MORE PRODUCERS

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INPUT PARAMETERS

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# Producers: 100

# Consumers: 4

# Products: 100

Queue Size: 10

Scheduling: FCFS

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PERFORMANCE ANALYSIS

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1. Total Time 2539.359131

Turn-around Times MIN: 10.645996

MAX: 304.657959

AVG: 235.040332

Wait Times MIN: 10.404053

MAX: 304.334961

AVG: 234.796436

Producer Throughput: 2561.631706

Consumer Throughput: 2362.800884

2. Total Time 2537.425049

Turn-around Times MIN: 7.733154

MAX: 301.755127

AVG: 234.833135

Wait Times MIN: 7.593018

MAX: 301.670166

AVG: 234.578469

Producer Throughput: 2561.034551

Consumer Throughput: 2364.601864

3. Total Time 2537.689941

Turn-around Times MIN: 6.842041

MAX: 303.123047

AVG: 234.834614

Wait Times MIN: 6.712891

MAX: 302.763916

AVG: 234.593896

Producer Throughput: 2565.031202

Consumer Throughput: 2364.355039

LOTS OF PRODUCERS AND CONSUMERS

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INPUT PARAMETERS

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# Producers: 100

# Consumers: 100

# Products: 100

Queue Size: 10

Scheduling: FCFS

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PERFORMANCE ANALYSIS

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Total Time 197.667969

Turn-around Times MIN: 0.204834

MAX: 13.498047

AVG: 6.296973

Wait Times MIN: 0.041016

MAX: 13.136963

AVG: 6.073032

Producer Throughput: 30813.944012

Consumer Throughput: 30353.931585

Total Time 196.637939

Turn-around Times MIN: 0.147949

MAX: 13.835938

AVG: 5.196589

Wait Times MIN: 0.036865

MAX: 13.573975

AVG: 4.972334

Producer Throughput: 30832.809542

Consumer Throughput: 30512.931618

Total Time 196.481934

Turn-around Times MIN: 0.218994

MAX: 11.922852

AVG: 4.696738

Wait Times MIN: 0.038086

MAX: 11.608887

AVG: 4.485688

Producer Throughput: 30767.843997

Consumer Throughput: 30537.158762

A LOT OF PRODUCTS

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INPUT PARAMETERS

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# Producers: 4

# Consumers: 4

# Products: 500

Queue Size: 10

Scheduling: FCFS

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PERFORMANCE ANALYSIS

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1. Total Time 12610.213135

Turn-around Times MIN: 1.369141

MAX: 25.969971

AVG: 10.955040

Wait Times MIN: 1.068115

MAX: 25.520020

AVG: 10.691965

Producer Throughput: 2382.704405

Consumer Throughput: 2379.024024

2. Total Time 12641.647949

Turn-around Times MIN: 1.170898

MAX: 52.848877

AVG: 20.424678

Wait Times MIN: 0.967041

MAX: 52.270996

AVG: 20.169528

Producer Throughput: 2381.791114

Consumer Throughput: 2373.108326

3. Total Time 12627.948975

Turn-around Times MIN: 0.351074

MAX: 34.875977

AVG: 11.646852

Wait Times MIN: 0.181885

MAX: 34.201904

AVG: 11.397385

Producer Throughput: 2380.974895

Consumer Throughput: 2375.682707

ROUND ROBIN (SMALL QUANTUM)

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INPUT PARAMETERS

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# Producers: 4

# Consumers: 4

# Products: 100

Queue Size: 10

Scheduling: RR (Q: 10)

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PERFORMANCE ANALYSIS

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1. Total Time 136420.699951

Turn-around Times MIN: 1003.290039

MAX: 25582.102051

AVG: 13306.328640

Wait Times MIN: 1003.255615

MAX: 25580.800293

AVG: 13305.672322

Producer Throughput: 46.987265

Consumer Throughput: 43.981595

2. Total Time 128395.570068

Turn-around Times MIN: 298.330078

MAX: 25865.910156

AVG: 12600.346147

Wait Times MIN: 298.329102

MAX: 25864.674805

AVG: 12599.751824

Producer Throughput: 48.822320

Consumer Throughput: 46.730584

3. Total Time 131806.838867

Turn-around Times MIN: 704.571045

MAX: 25577.719971

AVG: 12807.595442

Wait Times MIN: 704.516113

MAX: 25576.676025

AVG: 12806.994971

Producer Throughput: 48.201740

Consumer Throughput: 45.521158

ROUND ROBIN (LARGE QUANTUM)

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INPUT PARAMETERS

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# Producers: 4

# Consumers: 4

# Products: 100

Queue Size: 10

Scheduling: RR (Q: 500)

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PERFORMANCE ANALYSIS

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1. Total Time 4033.019043

Turn-around Times MIN: 1.241943

MAX: 803.730957

AVG: 357.691370

Wait Times MIN: 1.166016

MAX: 803.061035

AVG: 357.418708

Producer Throughput: 1608.461281

Consumer Throughput: 1487.719234

2. Total Time 4023.540039

Turn-around Times MIN: 0.370117

MAX: 802.161133

AVG: 333.831912

Wait Times MIN: 0.335938

MAX: 801.694824

AVG: 333.600139

Producer Throughput: 1653.182649

Consumer Throughput: 1491.224131

3. Total Time 3832.450928

Turn-around Times MIN: 1.382080

MAX: 605.327148

AVG: 333.528521

Wait Times MIN: 1.307129

MAX: 604.818115

AVG: 333.274250

Producer Throughput: 1699.348963

Consumer Throughput: 1565.577776