**Kennesaw State University**

**College of Computing and Software Engineering**

**DEPARTMENT OF COMPUTER SCIENCE**

**CS 3502 / Operating Systems / Section 01**

**Assignment 4**

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**Summary and Purpose of the Assignment**

The purpose of the assignment is to observe general behavior of a system with deadlock situations and solutions. We do so by using three different models. The first model always deadlocks. The second model applies the dis-allowance of the hold and waits condition as a solution to deadlock. The third model applies dis-allowance of the circular wait condition as a solution to deadlock.

**Results**

Philos Run 1

Psim3 project: Concurrent philosophers problem

Simulation date: Tue Oct 10 11:16:10 2017

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fork4 % usage: 0

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fork3 % usage: 0

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fork2 % usage: 0

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fork1 % usage: 0

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fork0 % usage: 0

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End of simulation Concurrent philosophers problem Tue Oct 10 11:16:10 2017

Philos Run 2

Psim3 project: Concurrent philosophers problem

Simulation date: Tue Oct 10 11:22:18 2017

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fork4 % usage: 0

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fork3 % usage: 0

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fork2 % usage: 0

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fork1 % usage: 0

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fork0 % usage: 0

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End of simulation Concurrent philosophers problem Tue Oct 10 11:22:18 2017

Philos Run 3

Psim3 project: Concurrent philosophers problem

Simulation date: Tue Oct 10 11:22:42 2017

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fork4 % usage: 0

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fork3 % usage: 0

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fork2 % usage: 0

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fork1 % usage: 0

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fork0 % usage: 0

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End of simulation Concurrent philosophers problem Tue Oct 10 11:22:42

Philos Changed Run

Psim3 project: Concurrent philosophers problem

Simulation date: Tue Oct 10 11:34:09 2017

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fork4 % usage: 0

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fork3 % usage: 0

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fork2 % usage: 0

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fork1 % usage: 0

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fork0 % usage: 0

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End of simulation Concurrent philosophers problem Tue Oct 10 11:34:09 2017

Philoscw Run 1

Psim3 project: Concurrent Philosophers Problem Circular Wait

Simulation date: Tue Oct 10 11:16:30 2017

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fork4 % usage: 0.556801 avg num items used: 1

% of time spent in res usage: 0.556801

% of time spent waiting: 0.328022

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fork3 % usage: 0.500854 avg num items used: 1

% of time spent in res usage: 0.500854

% of time spent waiting: 0.246361

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fork2 % usage: 0.531764 avg num items used: 1

% of time spent in res usage: 0.531764

% of time spent waiting: 0.225637

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fork1 % usage: 0.662798 avg num items used: 1

% of time spent in res usage: 0.662798

% of time spent waiting: 0.180088

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fork0 % usage: 0.862022 avg num items used: 1

% of time spent in res usage: 0.862022

% of time spent waiting: 0.58038

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Number of eating cycles phil 0 = 6

Total waiting interval to eat phil 0 = 55.2432

Number of eating cycles phil 1 = 7

Total waiting interval to eat phil 1 = 79.6078

Number of eating cycles phil 2 = 8

Total waiting interval to eat phil 2 = 57.8665

Number of eating cycles phil 3 = 7

Total waiting interval to eat phil 3 = 78.877

Number of eating cycles phil 4 = 9

Total waiting interval to eat phil 4 = 101.148

Average interval waiting to eat: 74.5484

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End of simulation Concurrent Philosophers Problem Circular Wait Tue Oct

Philoscw Run 2

Psim3 project: Concurrent Philosophers Problem Circular Wait

Simulation date: Tue Oct 10 11:23:16 2017

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fork4 % usage: 0.459724 avg num items used: 1

% of time spent in res usage: 0.459724

% of time spent waiting: 0.162468

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fork3 % usage: 0.766945 avg num items used: 1

% of time spent in res usage: 0.766945

% of time spent waiting: 0.338482

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fork2 % usage: 0.632485 avg num items used: 1

% of time spent in res usage: 0.632485

% of time spent waiting: 0.246155

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fork1 % usage: 0.731809 avg num items used: 1

% of time spent in res usage: 0.731809

% of time spent waiting: 0.365635

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fork0 % usage: 0.710797 avg num items used: 1

% of time spent in res usage: 0.710797

% of time spent waiting: 0.490823

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Number of eating cycles phil 0 = 6

Total waiting interval to eat phil 0 = 56.5811

Number of eating cycles phil 1 = 6

Total waiting interval to eat phil 1 = 115.506

Number of eating cycles phil 2 = 8

Total waiting interval to eat phil 2 = 56.036

Number of eating cycles phil 3 = 7

Total waiting interval to eat phil 3 = 73.9533

Number of eating cycles phil 4 = 6

Total waiting interval to eat phil 4 = 115.315

Average interval waiting to eat: 83.4782

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End of simulation Concurrent Philosophers Problem Circular Wait Tue Oct 10 11:23:16 2017

Philoscw Run 3

Psim3 project: Concurrent Philosophers Problem Circular Wait

Simulation date: Tue Oct 10 11:23:36 2017

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fork4 % usage: 0.659965 avg num items used: 1

% of time spent in res usage: 0.659965

% of time spent waiting: 0.205604

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fork3 % usage: 0.601713 avg num items used: 1

% of time spent in res usage: 0.601713

% of time spent waiting: 0.178946

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fork2 % usage: 0.573066 avg num items used: 1

% of time spent in res usage: 0.573066

% of time spent waiting: 0.159425

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fork1 % usage: 0.555877 avg num items used: 1

% of time spent in res usage: 0.555877

% of time spent waiting: 0.239421

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fork0 % usage: 0.789044 avg num items used: 1

% of time spent in res usage: 0.789044

% of time spent waiting: 0.205668

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Number of eating cycles phil 0 = 7

Total waiting interval to eat phil 0 = 65.4609

Number of eating cycles phil 1 = 10

Total waiting interval to eat phil 1 = 60.5715

Number of eating cycles phil 2 = 5

Total waiting interval to eat phil 2 = 50.0044

Number of eating cycles phil 3 = 8

Total waiting interval to eat phil 3 = 46.4023

Number of eating cycles phil 4 = 6

Total waiting interval to eat phil 4 = 42.8266

Average interval waiting to eat: 53.0531

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End of simulation Concurrent Philosophers Problem Circular Wait Tue Oct 10 11:23:36 2017

Philoscw Changed Run

Psim3 project: Concurrent Philosophers Problem Circular Wait

Simulation date: Tue Oct 10 11:36:46 2017

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fork4 % usage: 0.612086 avg num items used: 1

% of time spent in res usage: 0.612086

% of time spent waiting: 0.206221

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fork3 % usage: 0.586073 avg num items used: 1

% of time spent in res usage: 0.586073

% of time spent waiting: 0.0851043

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fork2 % usage: 0.534857 avg num items used: 1

% of time spent in res usage: 0.534857

% of time spent waiting: 0.216176

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fork1 % usage: 0.738895 avg num items used: 1

% of time spent in res usage: 0.738895

% of time spent waiting: 0.251318

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fork0 % usage: 0.876426 avg num items used: 1

% of time spent in res usage: 0.876426

% of time spent waiting: 0.436318

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Number of eating cycles phil 0 = 7

Total waiting interval to eat phil 0 = 44.3356

Number of eating cycles phil 1 = 4

Total waiting interval to eat phil 1 = 48.2726

Number of eating cycles phil 2 = 7

Total waiting interval to eat phil 2 = 60.8238

Number of eating cycles phil 3 = 9

Total waiting interval to eat phil 3 = 53.7469

Number of eating cycles phil 4 = 9

Total waiting interval to eat phil 4 = 109.605

Average interval waiting to eat: 63.3568

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End of simulation Concurrent Philosophers Problem Circular Wait Tue Oct 10 11:36:46 2017

Philoshw Run 1

Psim3 project: Concurrent Philosophers - Hold & Wait

Simulation date: Tue Oct 10 11:16:50 2017

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Mutex % usage: 0

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fork4 % usage: 0.694444 avg num items used: 1

% of time spent in res usage: 0.694444

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fork3 % usage: 0.451315 avg num items used: 1

% of time spent in res usage: 0.451315

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fork2 % usage: 0.595196 avg num items used: 1

% of time spent in res usage: 0.595196

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fork1 % usage: 0.594862 avg num items used: 1

% of time spent in res usage: 0.594862

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fork0 % usage: 0.790328 avg num items used: 1

% of time spent in res usage: 0.790328

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Number of eat cycles Philosopher00 = 8

Total waiting time to eat Philosopher00 = 51.5933

Number of eat cycles Philosopher11 = 4

Total waiting time to eat Philosopher11 = 39.1107

Number of eat cycles Philosopher22 = 3

Total waiting time to eat Philosopher22 = 33.1776

Number of eat cycles Philosopher33 = 7

Total waiting time to eat Philosopher33 = 42.0506

Number of eat cycles Philosopher44 = 10

Total waiting time to eat Philosopher44 = 40.3901

Average time waiting to eat: 41.2644

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End of simulation Concurrent Philosophers - Hold & Wait Tue Oct 10 11:16:50 2017

Philoshw Run 2

Psim3 project: Concurrent Philosophers - Hold & Wait

Simulation date: Tue Oct 10 11:20:42 2017

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Mutex % usage: 0

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fork4 % usage: 0.642281 avg num items used: 1

% of time spent in res usage: 0.642281

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fork3 % usage: 0.368224 avg num items used: 1

% of time spent in res usage: 0.368224

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fork2 % usage: 0.540677 avg num items used: 1

% of time spent in res usage: 0.540677

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fork1 % usage: 0.589085 avg num items used: 1

% of time spent in res usage: 0.589085

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fork0 % usage: 0.784417 avg num items used: 1

% of time spent in res usage: 0.784417

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Number of eat cycles Philosopher00 = 8

Total waiting time to eat Philosopher00 = 42.6445

Number of eat cycles Philosopher11 = 4

Total waiting time to eat Philosopher11 = 37.6481

Number of eat cycles Philosopher22 = 3

Total waiting time to eat Philosopher22 = 25.6967

Number of eat cycles Philosopher33 = 6

Total waiting time to eat Philosopher33 = 63.0504

Number of eat cycles Philosopher44 = 10

Total waiting time to eat Philosopher44 = 47.5908

Average time waiting to eat: 43.3261

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End of simulation Concurrent Philosophers - Hold & Wait Tue Oct 10 11:20:42 2017

Philoshw Run 3

Psim3 project: Concurrent Philosophers - Hold & Wait

Simulation date: Tue Oct 10 11:21:35 2017

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Mutex % usage: 0

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fork4 % usage: 0.691196 avg num items used: 1

% of time spent in res usage: 0.691196

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fork3 % usage: 0.426988 avg num items used: 1

% of time spent in res usage: 0.426988

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fork2 % usage: 0.547169 avg num items used: 1

% of time spent in res usage: 0.547169

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fork1 % usage: 0.52871 avg num items used: 1

% of time spent in res usage: 0.52871

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fork0 % usage: 0.800351 avg num items used: 1

% of time spent in res usage: 0.800351

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Number of eat cycles Philosopher00 = 8

Total waiting time to eat Philosopher00 = 51.1726

Number of eat cycles Philosopher11 = 3

Total waiting time to eat Philosopher11 = 58.0232

Number of eat cycles Philosopher22 = 3

Total waiting time to eat Philosopher22 = 9.95559

Number of eat cycles Philosopher33 = 7

Total waiting time to eat Philosopher33 = 58.6629

Number of eat cycles Philosopher44 = 10

Total waiting time to eat Philosopher44 = 30.5392

Average time waiting to eat: 41.6707

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End of simulation Concurrent Philosophers - Hold & Wait Tue Oct 10 11:21:35 2017

Philoshw Changed Run

Psim3 project: Concurrent Philosophers - Hold & Wait

Simulation date: Tue Oct 10 11:40:18 2017

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Mutex % usage: 0

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fork4 % usage: 0.703768 avg num items used: 1

% of time spent in res usage: 0.703768

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fork3 % usage: 0.453971 avg num items used: 1

% of time spent in res usage: 0.453971

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fork2 % usage: 0.598727 avg num items used: 1

% of time spent in res usage: 0.598727

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fork1 % usage: 0.630164 avg num items used: 1

% of time spent in res usage: 0.630164

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fork0 % usage: 0.80588 avg num items used: 1

% of time spent in res usage: 0.80588

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Number of eat cycles Philosopher00 = 7

Total waiting time to eat Philosopher00 = 38.2001

Number of eat cycles Philosopher11 = 4

Total waiting time to eat Philosopher11 = 37.446

Number of eat cycles Philosopher22 = 3

Total waiting time to eat Philosopher22 = 14.7005

Number of eat cycles Philosopher33 = 6

Total waiting time to eat Philosopher33 = 46.0357

Number of eat cycles Philosopher44 = 8

Total waiting time to eat Philosopher44 = 36.646

Average time waiting to eat: 34.6057

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End of simulation Concurrent Philosophers - Hold & Wait Tue Oct 10 11:40:18 2017

**Conclusion**

In conclusion we can see the affects of the different dis-allowances on the model. Doing so allows us to have a better understanding about the occurrence of deadlock and solutions that can be used to solve the issue.

**Assignment Questions**

1. What aspect of an operating system is the model representing?
   * The model represents the resource management of an OS. This deadlock model is an example of what can occur when more than one process needs access to a single resource.
2. What is noticeable in the dynamic behavior of the system?
   * It seemed that the utilization of the forks in the philoshw remained relatively consistent however the average time spent waiting for each philosopher had a very large margin across all simulation runs.
3. After changing some of the parameters in the model (the workload) and recompiling. What changes in the results do you notice?
   * In philoshw when the mean think time was increased the utilization of the forks increased. As well the average time spent waiting for a fork for each philosopher went down.
4. What other performance measures can this model compute?
   * The model computes average time waiting to eat, fork utilization as well as mutex usage.