# Home assignment 2, Simulation

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# 1 Task 1

## 1.1 Program Configuration Settings

There are 8 settings that the configuration is able to set, each one has a default value in case it is missing from the configuration file. The settings are described in table 1

| Setting | Default Value | Description |
|---------|---------------|-------------|
| ts | 4000 | The average exponential sleep time between transmissions for the sensor towers. |
| tp | 1 | The time it takes to transmit a transmission. |
| r | 7 | The radius of the sensor towers. |
| n | 2000 | The amount of sensor towers. |
| lb | 1 | The minimum amount of sleep after sensing another transmission for a smart tower. |
| ub | 1 | The maximum amount of sleep after sensing another transmission for a smart tower. |
| runs | 1 | The amount of simulation runs, (used to derive $\mu$ and $\sigma$). |
| smart | false | Decides if strategy one or strategy two is used. |

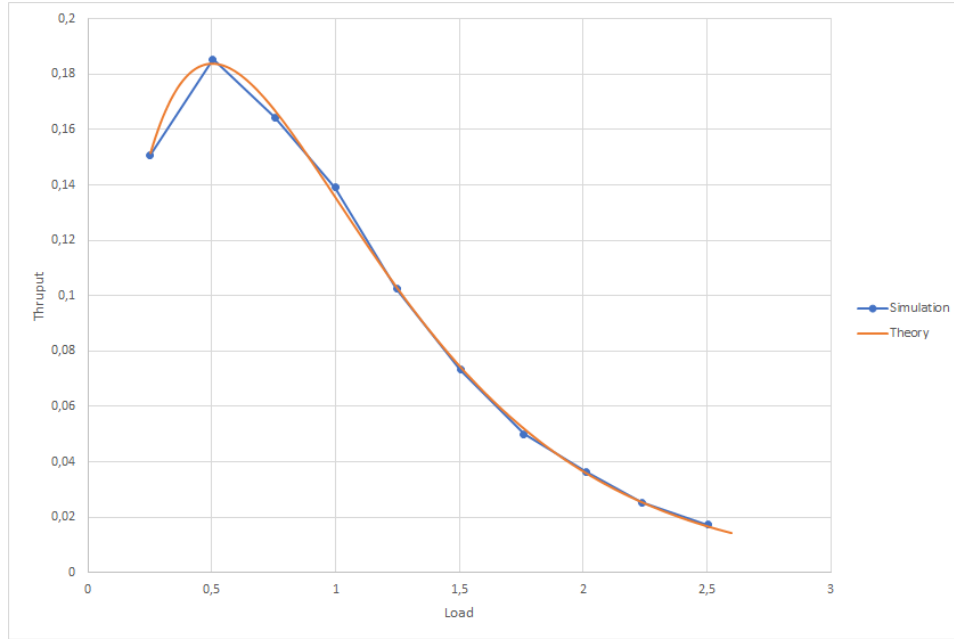Table 1: Configuration settings for task 1.

## 1.2 Subtask A



Figure 1: Theoretical value and Simulated values of Throughput vs Load

As we can see in figure 1 we are very close to the theoretical values given by
$T_{put} = \lambda_p T_p e^{-2\lambda_p T_p}$

## 1.3 Subtask B

| Number of towers | Packet loss | Packet loss STD |
|:---:|:---:|:---:|
| 1000 | 0,3836 | 0,0089 |
| 2000 | 0,6266 | 0,0133 |
| 3000 | 0,7844 | 0,0118 |
| 4000 | 0,8651 | 0,0053 |
| 5000 | 0,9182 | 0,0029 |
| 6000 | 0,9507 | 0,0025 |
| 7000 | 0,9693 | 0,0026 |
| 8000 | 0,9823 | 0,0021 |
| 9000 | 0,9878 | 0,0017 |
| 10000 | 0,9932 | 0,0012 |

Table 2: Numeric value of packet-loss.

There is no use in plotting the values since our STD is to small to be seen in a graph.

## 1.4   Subtask C



Figure 2: Theoretical value vs simulated value, using strategy 2

Instead of being near the theoretical value we outperformed it with a lower amount
of towers. The greater the number of towers the less we saw this increase, as seen
in figure 2.

| Success rate | Loss rate | Load | Throughput | ts | tp | radius | n | lb | ub |
|---|---|---|---|---|---|---|---|---|---|
| 0,4281 | 0,5719 | 0,4992 | 0,2136 | 4000 | 1 | 7 | 2000 | 0,00 | 1,00 |
| 0,4468 | 0,5532 | 0,4999 | 0,2233 | 4000 | 1 | 7 | 2000 | 0,00 | 1,20 |
| 0,4577 | 0,5423 | 0,4925 | 0,2254 | 4000 | 1 | 7 | 2000 | 0,00 | 1,40 |
| 0,4538 | 0,5462 | 0,4994 | 0,2266 | 4000 | 1 | 7 | 2000 | 0,00 | 1,60 |
| 0,4608 | 0,5392 | 0,4970 | 0,2290 | 4000 | 1 | 7 | 2000 | 0,00 | 1,80 |
| 0,4625 | 0,5375 | 0,5003 | 0,2314 | 4000 | 1 | 7 | 2000 | 0,00 | 2,00 |
| 0,4449 | 0,5551 | 0,5004 | 0,2226 | 4000 | 1 | 7 | 2000 | 0,20 | 1,00 |
| 0,4590 | 0,5410 | 0,5005 | 0,2297 | 4000 | 1 | 7 | 2000 | 0,20 | 1,20 |
| 0,4644 | 0,5356 | 0,4992 | 0,2318 | 4000 | 1 | 7 | 2000 | 0,20 | 1,40 |
| 0,4697 | 0,5303 | 0,4951 | 0,2325 | 4000 | 1 | 7 | 2000 | 0,20 | 1,60 |
| 0,4748 | 0,5252 | 0,4977 | 0,2363 | 4000 | 1 | 7 | 2000 | 0,20 | 1,80 |
| 0,4693 | 0,5307 | 0,5016 | 0,2354 | 4000 | 1 | 7 | 2000 | 0,20 | 2,00 |
| 0,4629 | 0,5371 | 0,5043 | 0,2334 | 4000 | 1 | 7 | 2000 | 0,40 | 1,00 |
| 0,4728 | 0,5272 | 0,4987 | 0,2358 | 4000 | 1 | 7 | 2000 | 0,40 | 1,20 |
| 0,4833 | 0,5167 | 0,4939 | 0,2386 | 4000 | 1 | 7 | 2000 | 0,40 | 1,40 |
| 0,4805 | 0,5195 | 0,4979 | 0,2392 | 4000 | 1 | 7 | 2000 | 0,40 | 1,60 |
| 0,4799 | 0,5201 | 0,4990 | 0,2395 | 4000 | 1 | 7 | 2000 | 0,40 | 1,80 |
| 0,4762 | 0,5238 | 0,5020 | 0,2391 | 4000 | 1 | 7 | 2000 | 0,40 | 2,00 |
| 0,4805 | 0,5195 | 0,4989 | 0,2397 | 4000 | 1 | 7 | 2000 | 0,60 | 1,00 |
| 0,4876 | 0,5124 | 0,5003 | 0,2439 | 4000 | 1 | 7 | 2000 | 0,60 | 1,20 |
| 0,4934 | 0,5066 | 0,5003 | 0,2468 | 4000 | 1 | 7 | 2000 | 0,60 | 1,40 |
| 0,4885 | 0,5115 | 0,5036 | 0,2460 | 4000 | 1 | 7 | 2000 | 0,60 | 1,60 |
| 0,4896 | 0,5104 | 0,4975 | 0,2435 | 4000 | 1 | 7 | 2000 | 0,60 | 1,80 |
| 0,4857 | 0,5143 | 0,5009 | 0,2432 | 4000 | 1 | 7 | 2000 | 0,60 | 2,00 |
| 0,4938 | 0,5062 | 0,4979 | 0,2458 | 4000 | 1 | 7 | 2000 | 0,80 | 1,00 |
| 0,4984 | 0,5016 | 0,4988 | 0,2486 | 4000 | 1 | 7 | 2000 | 0,80 | 1,20 |
| 0,4884 | 0,5116 | 0,5025 | 0,2454 | 4000 | 1 | 7 | 2000 | 0,80 | 1,40 |
| 0,4926 | 0,5074 | 0,5037 | 0,2481 | 4000 | 1 | 7 | 2000 | 0,80 | 1,60 |
| 0,4863 | 0,5137 | 0,5027 | 0,2444 | 4000 | 1 | 7 | 2000 | 0,80 | 1,80 |
| 0,4955 | 0,5045 | 0,4994 | 0,2475 | 4000 | 1 | 7 | 2000 | 0,80 | 2,00 |
| 0,5096 | 0,4904 | 0,5002 | 0,2548 | 4000 | 1 | 7 | 2000 | 1,00 | 1,00 |
| 0,4991 | 0,5009 | 0,5042 | 0,2516 | 4000 | 1 | 7 | 2000 | 1,00 | 1,20 |
| 0,5018 | 0,4982 | 0,4954 | 0,2485 | 4000 | 1 | 7 | 2000 | 1,00 | 1,40 |
| 0,4906 | 0,5094 | 0,4987 | 0,2447 | 4000 | 1 | 7 | 2000 | 1,00 | 1,60 |
| 0,4926 | 0,5074 | 0,4983 | 0,2454 | 4000 | 1 | 7 | 2000 | 1,00 | 1,80 |
| 0,4890 | 0,5110 | 0,4977 | 0,2434 | 4000 | 1 | 7 | 2000 | 1,00 | 2,00 |

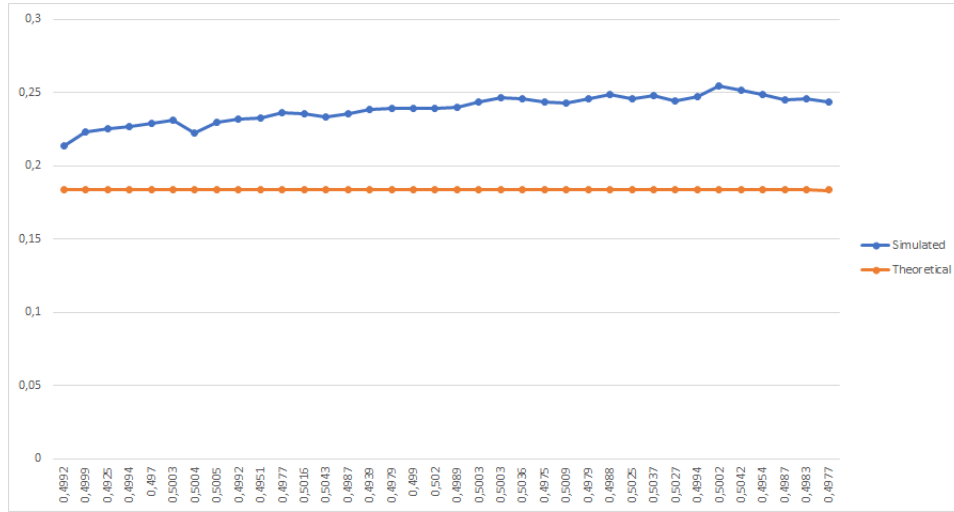Table 3: Varying settings and their mean values after 9 runs on each setting.

Figure 3: Theoretical vs simulated mean-values with varying lb and ub. The left most value is the first value in table 3 and the right most value is the last.

We can see from figure 3 that we get better values by having a lower and upper bound which seems to peak around $lb = 1$ & $ub = 1$
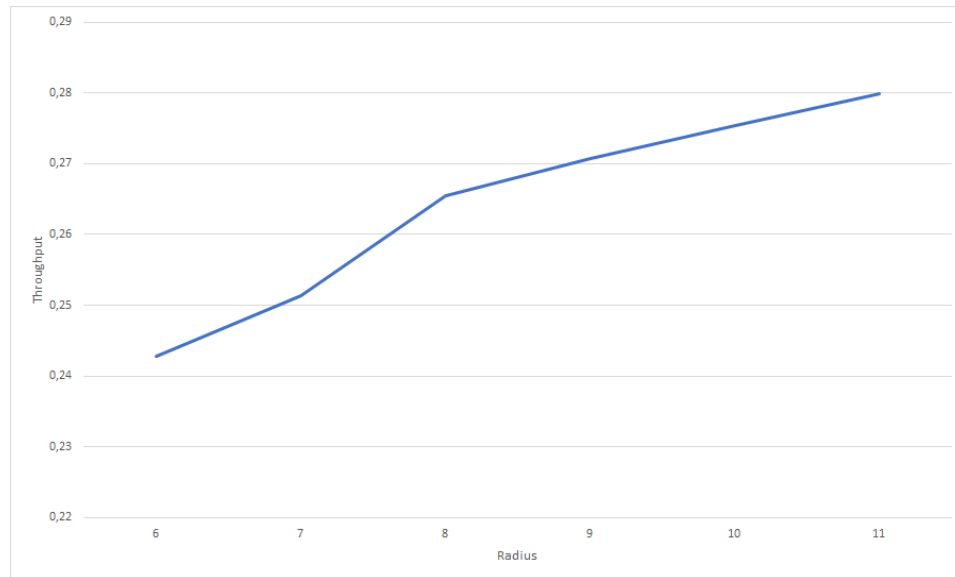
## 1.5 Subtask D



Figure 4: Throughput vs radius

As seen in figure 4 we can see our throughput steadily increases as the radius increases, this is due to a tower hearing more of the others in order to not overlap their transmissions.

# 2 Task 2

## 2.1 Program Configuration Settings

There are 5 settings that the configuration is able to set, each one has a default value in case it is missing from the configuration file. The settings are described in table 4.

| Setting | Default Value | Description |
|---------|---------------|-------------|
| minSpeed | 2 | The slowest speed a student may have in m/s. |
| maxSpeed | 2 | The fastest speed a student may have in m/s. |
| n | 20 | The total number of students in the room. |
| size | 20 | The dimensions of the square room in m. |
| runs | 1000 | Number of iterations to run |

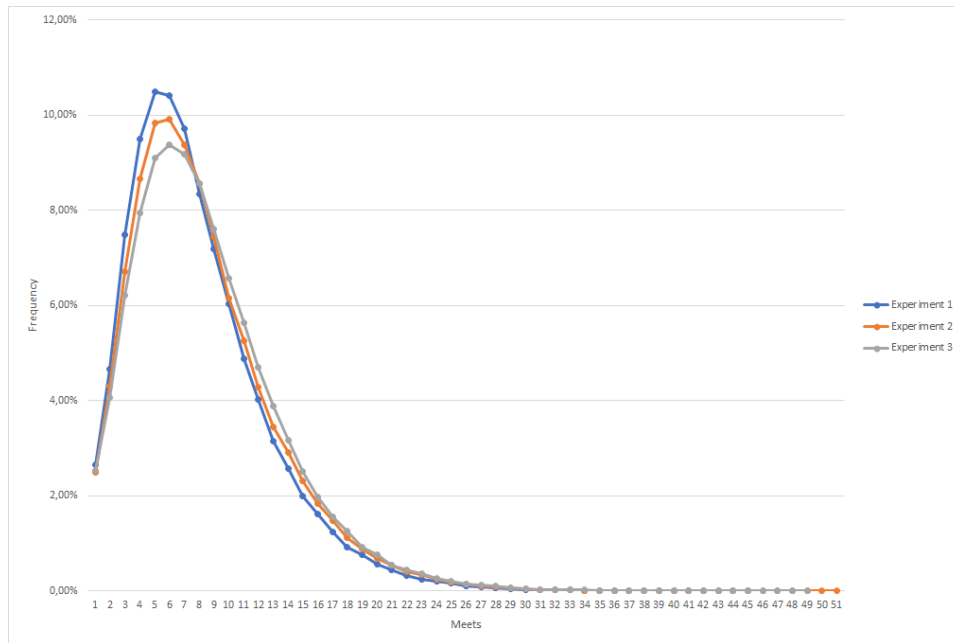Table 4: Configuration settings for task 2.

## 2.2 Experiments



Figure 5: A graph showing the relation between meeting someone x number of times and how likely it is.

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| Experiment | Time $\mu$ (min) | Time $\sigma$ (min) | CI Interval (95%) |
|---|---|---|---|
| 1 | 203,48 | 44,87 | 200,70 - 206,27 |
| 2 | 195,15 | 42,86 | 192,49 - 197,81 |
| 3 | 202,3 | 45,85 | 199,46 - 205,14 |

Table 5: The statistics for the amount of time before all students have met. In minutes

When the students all walk faster they should encounter each other slightly faster. And this can be seen in Experiment 2. However varying the speed around the same average like in Experiment 3 seems to counter the increase in speed.