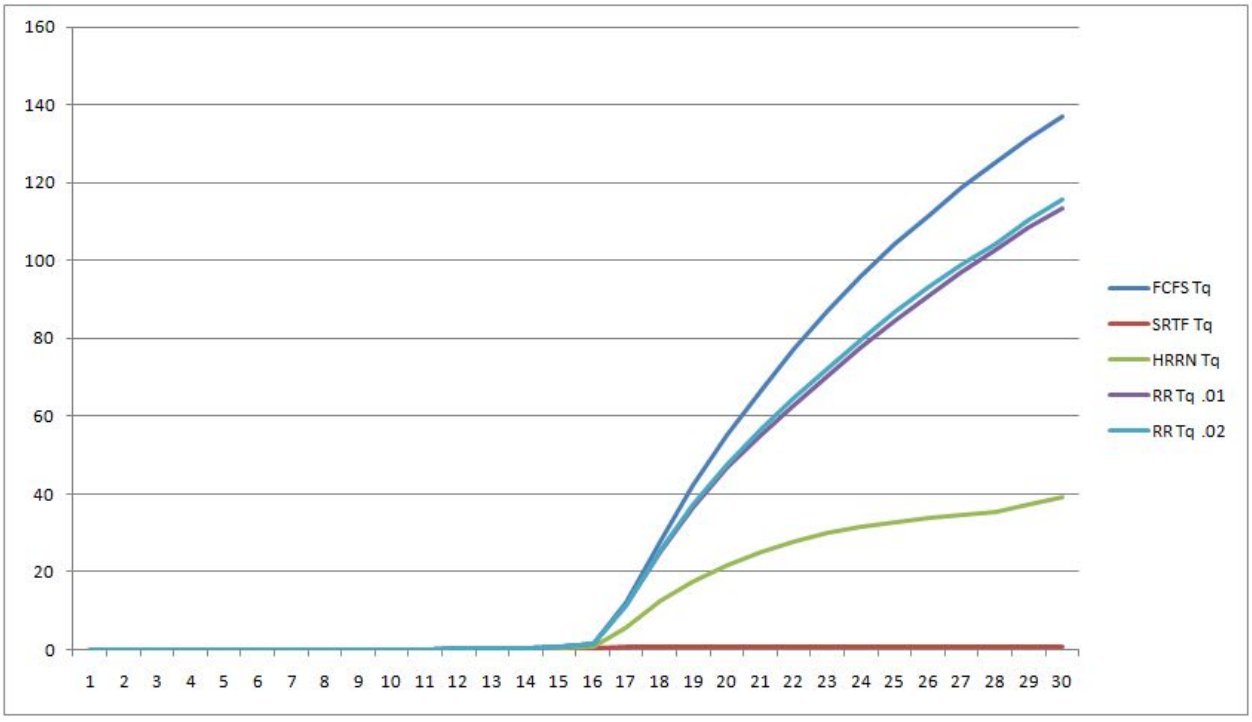
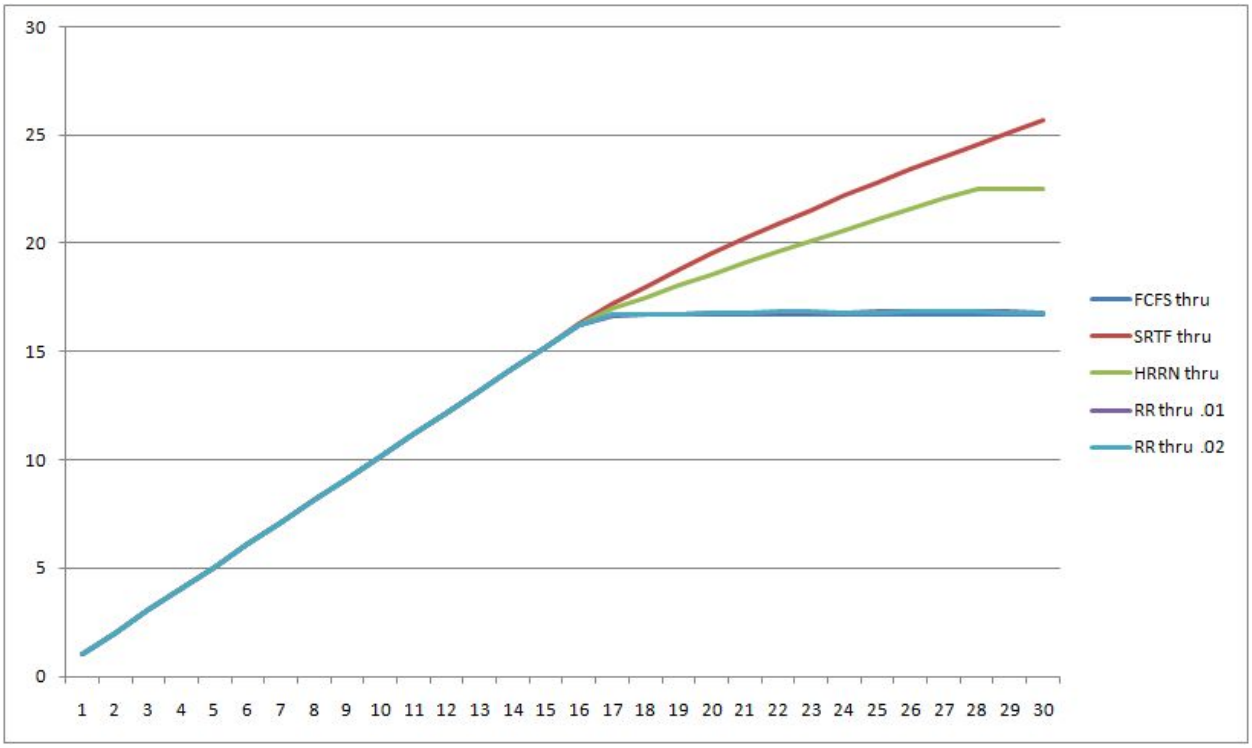
**Project 1 Report**
**Tyler Gates**

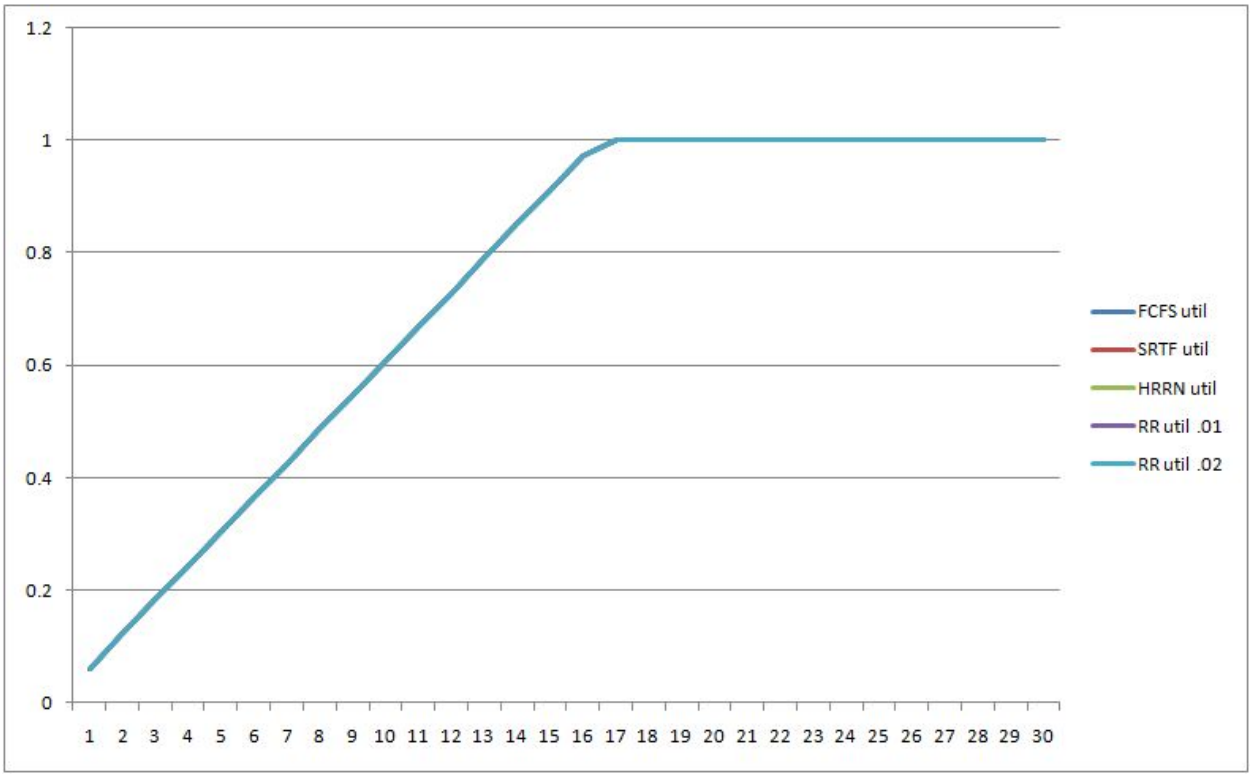
## DESCRIPTION

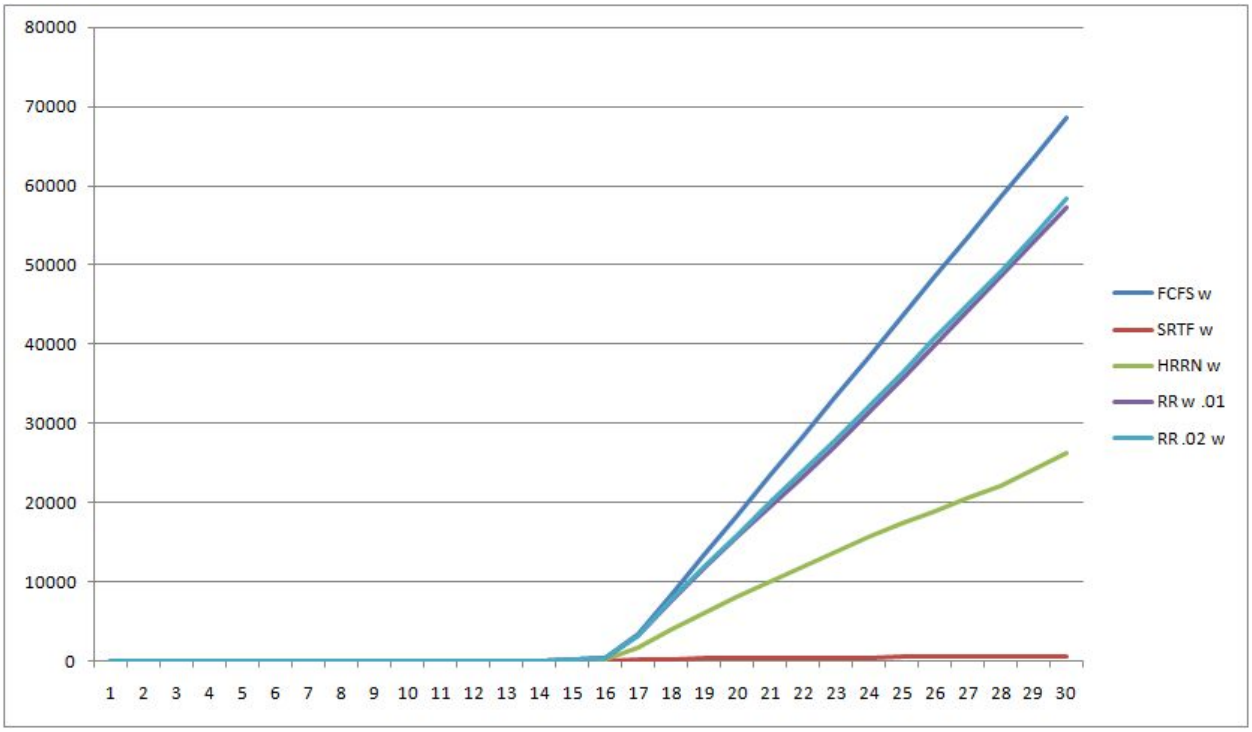
The goal of the project was to create a cpu process scheduler simulator and record our findings on turnaround times, total throughputs, CPU utilizations, and the average number of processes inside the ready queue. The project needed us to create two queues, one that stores the future arrival and departure of events, (processes), called the event queue, and one that stored processes that were waiting their turn for the CPU, called the ready queue. Each queue was composed of linked lists, The five different runs were for 5 different schedulers, First come first serve, shortest remaining time first, highest response ratio next, and round robin. Round robin was run twice with two different quantums, .01 and .02. Each process always used a .06 average service time. You can see the outcomes in the graphs and data below.

## GRAPHS




30
25
20
15
10
5
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
FCFS thru
SRTF thru
HRRN thru
RR thru .01
RR thru .02


1.2
1
0.8
0.6
0.4
0.2
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
FCFS util
SRTF util
HRRN util
RR util .01
RR util .02




**DATA**

| FCFS | lamda | avg turnaround time | total throughput | CPU utilization | # of processes in queue |
|---|---|---|---|---|---|
| | 1 | 0.0637481 | 1.01652 | 0.0607972 | 0.004 |
| | 2 | 0.0681992 | 2.03304 | 0.1216 | 0.0341086 |
| | 3 | 0.0733327 | 3.04956 | 0.182397 | 0.123709 |
| | 4 | 0.0793499 | 4.06607 | 0.243192 | 0.317792 |
| | 5 | 0.0864773 | 5.08258 | 0.30399 | 0.677678 |
| | 6 | 0.0950162 | 6.09909 | 0.36479 | 1.28833 |
| | 7 | 0.105198 | 7.11557 | 0.425589 | 2.2607 |
| | 8 | 0.118267 | 8.13207 | 0.486385 | 3.80297 |

| | | | | |
|---|---|---|---|---|
| 9 | 0.134735 | 9.14834 | 0.54717 | 6.16883 |
| 10 | 0.156019 | 10.1632 | 0.607869 | 9.77775 |
| 11 | 0.185181 | 11.1776 | 0.668542 | 15.4147 |
| 12 | 0.229984 | 12.1917 | 0.729196 | 24.8964 |
| 13 | 0.297459 | 13.2054 | 0.789825 | 40.8025 |
| 14 | 0.419557 | 14.2188 | 0.850437 | 71.6121 |
| 15 | 0.643221 | 15.2318 | 0.911023 | 133.296 |
| 16 | 1.43602 | 16.2446 | 0.971597 | 357.695 |
| 17 | 12.0186 | 16.7098 | 0.999425 | 3397.09 |
| 18 | 27.7222 | 16.7194 | 1 | 8325.02 |
| 19 | 42.0776 | 16.7194 | 1 | 13347.8 |
| 20 | 54.9982 | 16.7194 | 1 | 18370.9 |
| 21 | 66.6879 | 16.7194 | 1 | 23393.9 |
| 22 | 77.3144 | 16.7194 | 1 | 28416.6 |
| 23 | 87.0176 | 16.7194 | 1 | 33439.7 |
| 24 | 95.9116 | 16.7194 | 1 | 38462.5 |
| 25 | 104.094 | 16.7194 | 1 | 43485.1 |
| 26 | 111.647 | 16.7194 | 1 | 48508.2 |
| 27 | 118.641 | 16.7194 | 1 | 53531.3 |
| 28 | 125.135 | 16.7194 | 1 | 58554.3 |
| 29 | 131.182 | 16.7194 | 1 | 63577.4 |
| 30 | 136.825 | 16.7194 | 1 | 68600.2 |

| SRTF | lamda | avg turn around time | total throughput | CPU utilization | # of processes in queue |
|---|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 1 | 0.0617001 | 1.01652 | 0.0607972 | 0.00542016 |
| 2 | 0.0638323 | 2.03304 | 0.1216 | 0.0428009 |
| 3 | 0.0661383 | 3.04956 | 0.182397 | 0.144652 |
| 4 | 0.068798 | 4.06607 | 0.243192 | 0.343992 |
| 5 | 0.0717895 | 5.08258 | 0.30399 | 0.672683 |
| 6 | 0.0752257 | 6.09909 | 0.36479 | 1.17264 |
| 7 | 0.0791023 | 7.11557 | 0.425589 | 1.86039 |
| 8 | 0.0841076 | 8.13207 | 0.486385 | 2.87044 |
| 9 | 0.0900451 | 9.14834 | 0.54717 | 4.26308 |
| 10 | 0.0975712 | 10.1632 | 0.607869 | 6.17144 |
| 11 | 0.106845 | 11.1785 | 0.668515 | 8.7672 |
| 12 | 0.120175 | 12.1945 | 0.729128 | 12.5755 |
| 13 | 0.138862 | 13.2103 | 0.789747 | 18.1061 |
| 14 | 0.170953 | 14.2256 | 0.850365 | 27.6393 |
| 15 | 0.22505 | 15.2404 | 0.910973 | 44.3102 |
| 16 | 0.38232 | 16.2562 | 0.971577 | 91.6196 |
| 17 | 0.717728 | 17.1963 | 0.999409 | 201.27 |
| 18 | 0.788076 | 17.9899 | 1 | 246.056 |
| 19 | 0.890701 | 18.7542 | 1 | 307.785 |
| 20 | 0.90736 | 19.5168 | 1 | 344.023 |
| 21 | 0.831882 | 20.2099 | 1 | 342.455 |
| 22 | 0.864472 | 20.8633 | 1 | 385.652 |
| 23 | 0.887718 | 21.5319 | 1 | 428.165 |
| 24 | 0.894844 | 22.191 | 1 | 464.673 |
| 25 | 0.898502 | 22.8083 | 1 | 500.042 |
| 26 | 0.844871 | 23.4124 | 1 | 501.414 |

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|---|---|---|---|---|---|
| | 27 | 0.820615 | 23.998 | 1 | 518.445 |
| | 28 | 0.857643 | 24.5649 | 1 | 576.232 |
| | 29 | 0.852463 | 25.1121 | 1 | 606.8 |
| | 30 | 0.877554 | 25.6649 | 1 | 661.144 |

| HRRN | lamda | avg turn around time | total throughput | CPU utilization | # of processes in queue |
|---|---|---|---|---|---|
| | 1 | 0.0637474 | 1.01652 | 0.0607972 | 0.00400178 |
| | 2 | 0.0681497 | 2.03304 | 0.1216 | 0.0339075 |
| | 3 | 0.0731383 | 3.04956 | 0.182397 | 0.121931 |
| | 4 | 0.0789534 | 4.06607 | 0.243192 | 0.311343 |
| | 5 | 0.0854163 | 5.08258 | 0.30399 | 0.650714 |
| | 6 | 0.0929066 | 6.09909 | 0.36479 | 1.21113 |
| | 7 | 0.101474 | 7.11557 | 0.425589 | 2.0752 |
| | 8 | 0.111733 | 8.13207 | 0.486385 | 3.37787 |
| | 9 | 0.12391 | 9.14834 | 0.54717 | 5.2776 |
| | 10 | 0.139256 | 10.1632 | 0.607869 | 8.07413 |
| | 11 | 0.158909 | 11.1776 | 0.668542 | 12.1844 |
| | 12 | 0.187457 | 12.1917 | 0.729196 | 18.6746 |
| | 13 | 0.22724 | 13.2054 | 0.789825 | 28.7427 |
| | 14 | 0.292573 | 14.2229 | 0.850394 | 46.3517 |
| | 15 | 0.411493 | 15.2364 | 0.910996 | 80.3799 |
| | 16 | 0.81413 | 16.2498 | 0.971588 | 196.127 |
| | 17 | 5.80998 | 16.9785 | 0.999416 | 1659.96 |
| | 18 | 12.3879 | 17.5185 | 1 | 3888.29 |
| | 19 | 17.6443 | 18.0635 | 1 | 6036.65 |

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|---|---|---|---|---|
| 20 | 21.84 | 18.5793 | 1 | 8095.5 |
| 21 | 25.1957 | 19.0965 | 1 | 10083.2 |
| 22 | 27.8535 | 19.6084 | 1 | 11993.6 |
| 23 | 29.944 | 20.118 | 1 | 13832.5 |
| 24 | 31.6339 | 20.5949 | 1 | 15612 |
| 25 | 32.9229 | 21.0665 | 1 | 17314.3 |
| 26 | 33.8083 | 21.5679 | 1 | 18932.7 |
| 27 | 34.5174 | 22.0556 | 1 | 20528.3 |
| 28 | 35.221 | 22.4901 | 1 | 22151.7 |
| 29 | 37.1836 | 22.4901 | 1 | 24222.8 |
| 30 | 39.0215 | 22.4847 | 1 | 26291.7 |

| RR q=.01 | lamda | avg turn around time | total throughput | CPU utilization | # of processes in queue |
|---|---|---|---|---|---|
| | 1 | 0.0636409 | 1.01652 | 0.0607972 | 0.0596823 |
| | 2 | 0.0680697 | 2.03304 | 0.1216 | 0.256958 |
| | 3 | 0.0731573 | 3.04956 | 0.182397 | 0.624874 |
| | 4 | 0.0790584 | 4.06607 | 0.243192 | 1.20683 |
| | 5 | 0.0860427 | 5.08258 | 0.30399 | 2.06321 |
| | 6 | 0.0942372 | 6.09909 | 0.36479 | 3.27086 |
| | 7 | 0.103913 | 7.11557 | 0.425589 | 4.93398 |
| | 8 | 0.116816 | 8.13207 | 0.486385 | 7.28373 |
| | 9 | 0.133092 | 9.14834 | 0.54717 | 10.5581 |
| | 10 | 0.154254 | 10.1629 | 0.607881 | 15.1828 |
| | 11 | 0.183614 | 11.1774 | 0.66855 | 21.978 |

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|---|---|---|---|---|
| 12 | 0.228033 | 12.1907 | 0.729219 | 32.6472 |
| 13 | 0.294219 | 13.204 | 0.789847 | 49.668 |
| 14 | 0.414502 | 14.2194 | 0.85043 | 81.547 |
| 15 | 0.634206 | 15.2326 | 0.911018 | 143.798 |
| 16 | 1.42496 | 16.2479 | 0.971592 | 369.176 |
| 17 | 11.4774 | 16.6724 | 0.999427 | 3251.7 |
| 18 | 25.1008 | 16.7182 | 1 | 7552.25 |
| 19 | 36.6662 | 16.7333 | 1 | 11656.2 |
| 20 | 46.7016 | 16.7616 | 1 | 15654.8 |
| 21 | 55.0851 | 16.7734 | 1 | 19402.2 |
| 22 | 62.8189 | 16.7951 | 1 | 23210.1 |
| 23 | 70.4075 | 16.8043 | 1 | 27211.5 |
| 24 | 77.726 | 16.7957 | 1 | 31330 |
| 25 | 84.5238 | 16.8198 | 1 | 35540.8 |
| 26 | 90.9454 | 16.8282 | 1 | 39790.6 |
| 27 | 97.2156 | 16.8365 | 1 | 44191.9 |
| 28 | 102.9 | 16.8528 | 1 | 48555.5 |
| 29 | 108.353 | 16.8535 | 1 | 52956.6 |
| 30 | 113.508 | 16.8139 | 1 | 57254.1 |

| RR q=.02 | lamda | avg turn around time | total throughput | CPU utilization | # of processes in queue |
|---|---|---|---|---|---|
| | 1 | 0.0636531 | 1.01652 | 0.0607972 | 0.0550677 |
| | 2 | 0.0680756 | 2.03304 | 0.1216 | 0.23832 |
| | 3 | 0.0731823 | 3.04956 | 0.182397 | 0.582944 |

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|---|---|---|---|---|
| 4 | 0.0791106 | 4.06607 | 0.243192 | 1.13277 |
| 5 | 0.0860382 | 5.08258 | 0.30399 | 1.94592 |
| 6 | 0.0942369 | 6.09909 | 0.36479 | 3.10199 |
| 7 | 0.103903 | 7.11557 | 0.425589 | 4.70334 |
| 8 | 0.116647 | 8.13207 | 0.486385 | 6.97225 |
| 9 | 0.133041 | 9.14834 | 0.54717 | 10.1735 |
| 10 | 0.154151 | 10.1628 | 0.607885 | 14.7028 |
| 11 | 0.183511 | 11.1771 | 0.668557 | 21.3975 |
| 12 | 0.228158 | 12.1917 | 0.729196 | 31.9934 |
| 13 | 0.294394 | 13.203 | 0.789864 | 48.9039 |
| 14 | 0.414364 | 14.218 | 0.850445 | 80.5939 |
| 15 | 0.634547 | 15.2309 | 0.911028 | 142.806 |
| 16 | 1.42455 | 16.245 | 0.971597 | 367.806 |
| 17 | 11.5529 | 16.6788 | 0.999426 | 3273.06 |
| 18 | 25.4778 | 16.7335 | 1 | 7671.22 |
| 19 | 37.4295 | 16.7462 | 1 | 11906.5 |
| 20 | 47.5865 | 16.7504 | 1 | 15939.1 |
| 21 | 56.834 | 16.785 | 1 | 20030.4 |
| 22 | 64.6658 | 16.8262 | 1 | 23935 |
| 23 | 72.2087 | 16.8466 | 1 | 27976.1 |
| 24 | 79.4553 | 16.8181 | 1 | 32068.2 |
| 25 | 86.6303 | 16.7954 | 1 | 36372 |
| 26 | 93.2572 | 16.8283 | 1 | 40800.6 |
| 27 | 99.0119 | 16.8319 | 1 | 44994.5 |
| 28 | 104.291 | 16.8309 | 1 | 49146 |
| 29 | 110.273 | 16.8105 | 1 | 53755.6 |

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|---|---|---|---|---|
| **30** | **115.625** | **16.8151** | **1** | **58324.4** |