Performance Evaluation of Computer Systems and Networks

Deficit Scheduler

Project 13

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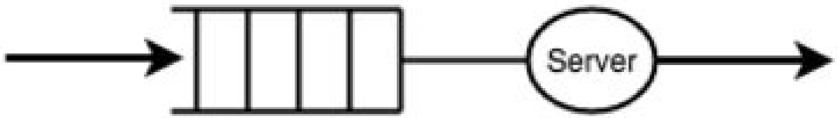
Model

FIFO Queue with some periods of inactivity called *vacations.*

Stability Condition



- Like an M/M/1 system

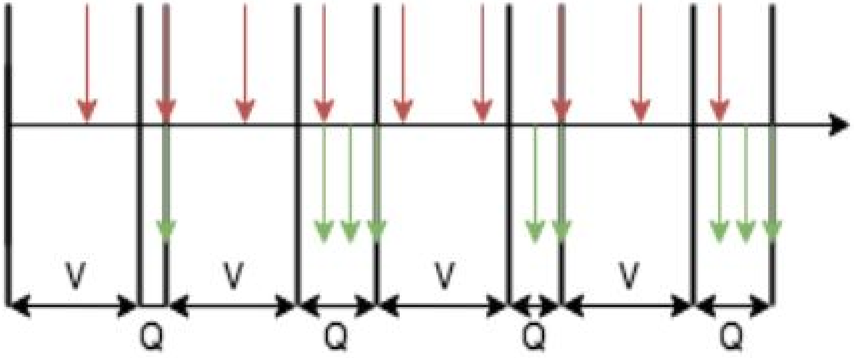
  $$t_i > t_s$$

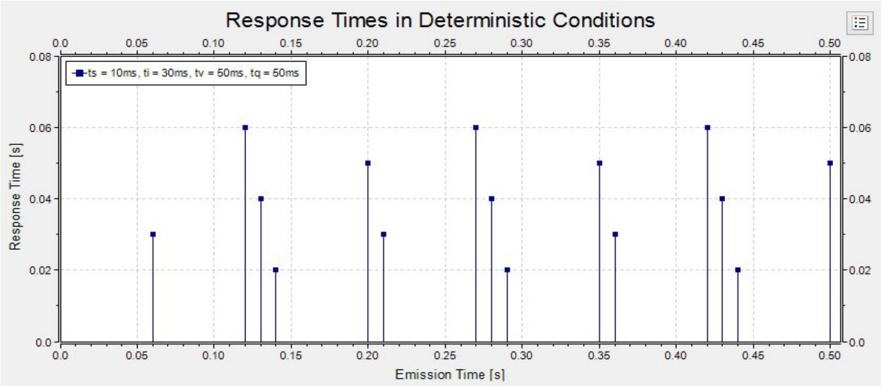
- The num. of jobs that the system can serve within a turn has to be larger than the number of jobs arrived during the previous vacation and the turn itself

  $$\frac{t_q}{t_s} > \frac{t_v}{t_i} + \frac{t_q}{t_i}$$

Deterministic Regime Tests

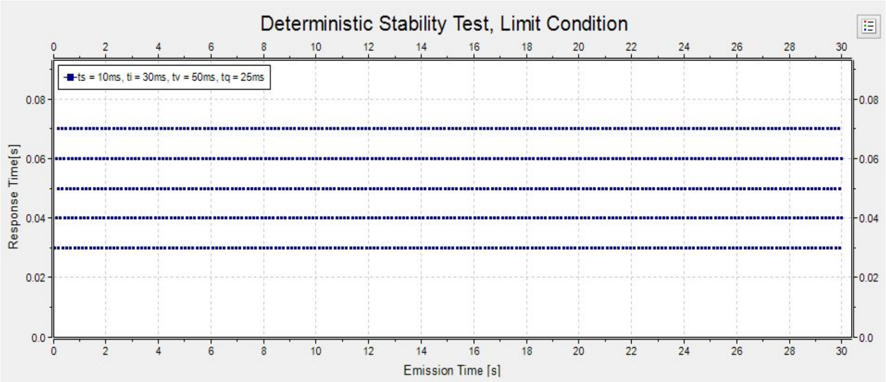
Output of the system tested against handmade computations

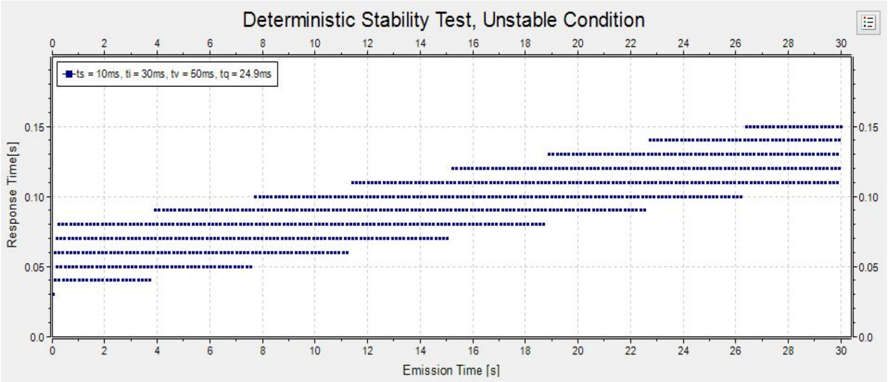




Deterministic Stability Test

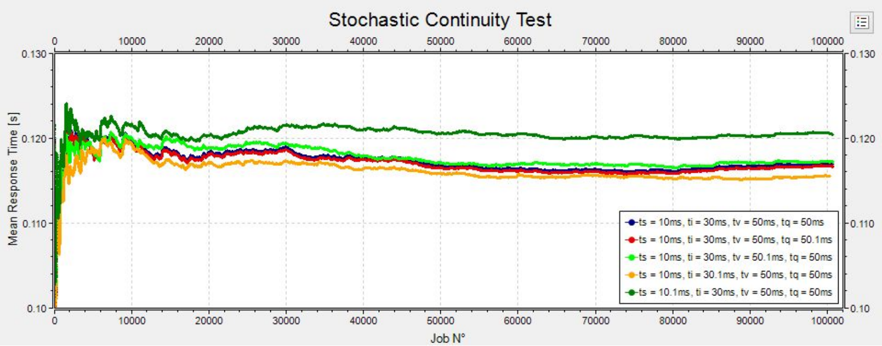
- Parameters set to the limit of the stability condition
- Slight change
- The system becomes unstable

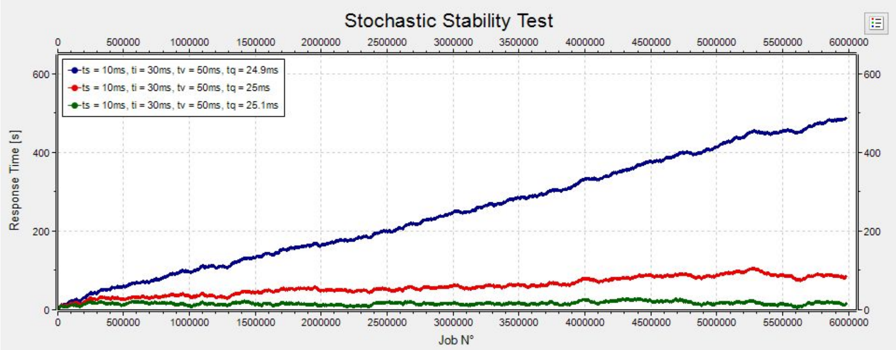


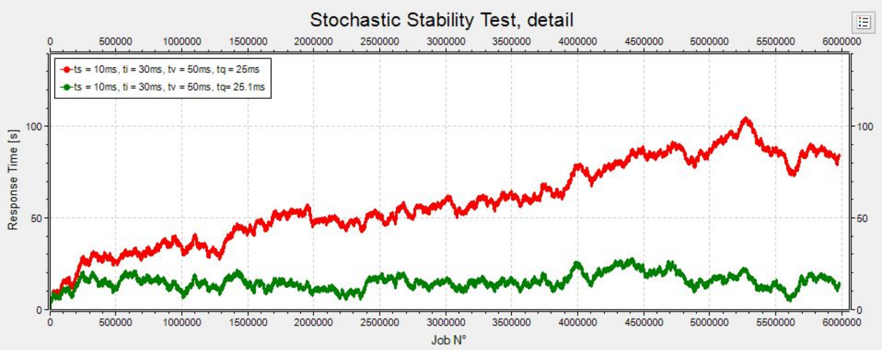


Stochastic Regime Tests

- Continuity test
- Stability test







Warm-Up and Simulation Duration Determination

- Simulation duration was set in order to gather 10^5 observations
- Warm-up time was set in order to remove the first 20000 observations
- Times computed as nt_i

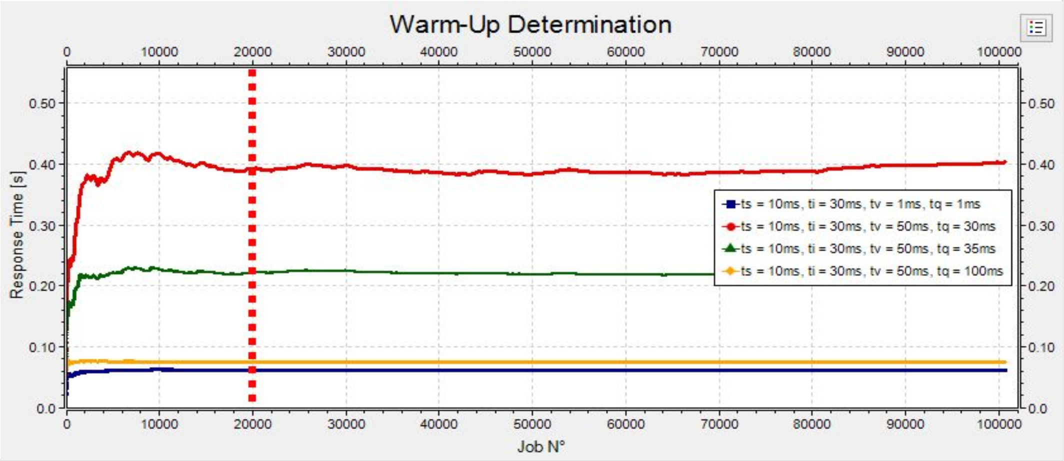
~ 10^0 ~ 10^{-1}

$$n = \left(\frac{z_{\alpha/2} S}{rX}\right)^2$$

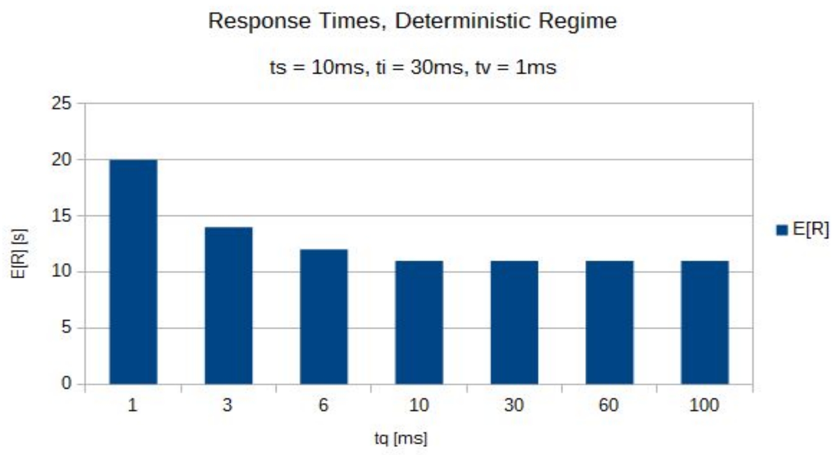
~ 10^4

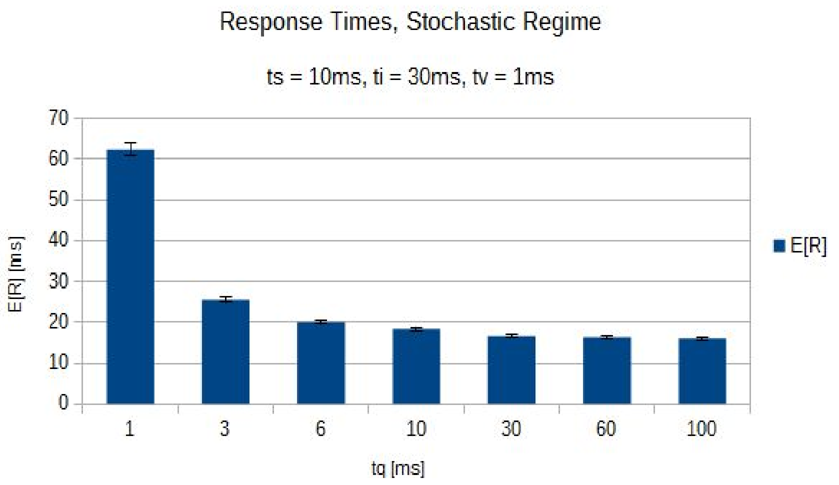
Considering further subsampling -> 10^5

~ 10^{-3}

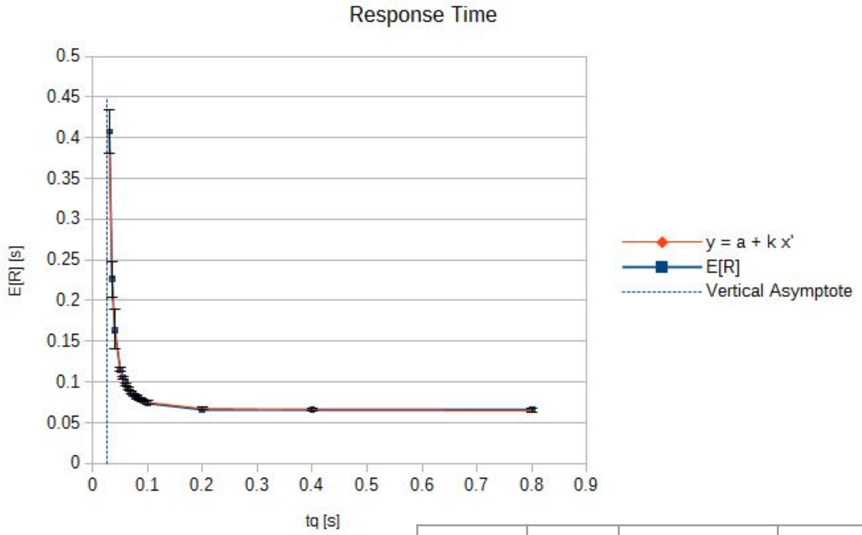


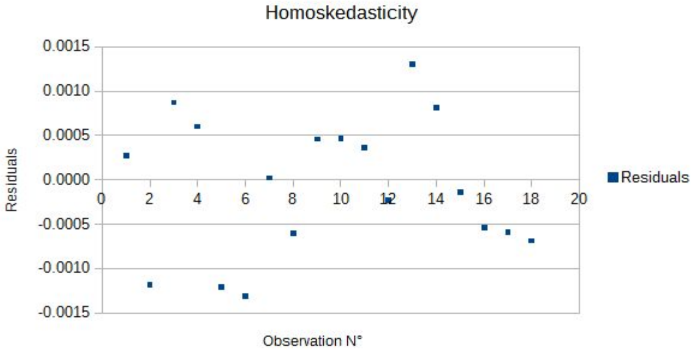
Results

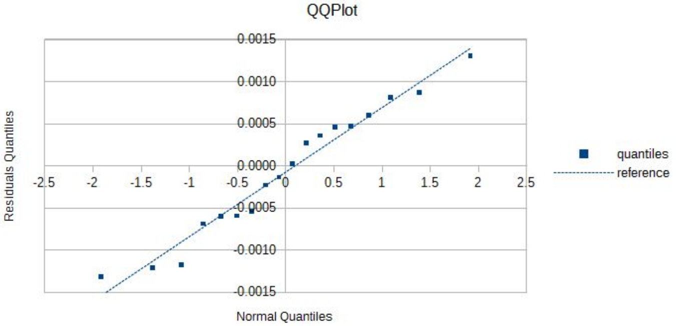

Response Times, Deterministic Regime
ts = 10ms, ti = 30ms, tv = 1ms
25
20
15
10
5
0
E[R] [s]
1
3
6
10
30
60
100
tq [ms]
E[R]


Response Times, Stochastic Regime
ts = 10ms, ti = 30ms, tv = 1ms
70
60
50
40
30
20
10
0
E[R] [ms]
1
3
6
10
30
60
100
tq [ms]
E[R]

Response Time in Function of t_q







$$x' = \frac{1}{x - b} \qquad x \leq 40ms$$

$$x' = \frac{1}{x^2 - b^2} \qquad x > 40ms$$

x	a	95% CI for a	k	95% CI for k
< 40ms	0.043	a ∓ 0.014	0.0018	k ∓ 0.0002
> 40ms	0.065	a ∓ 0.0001	0.000095	k ∓ 3E-06

Fitting (1)

- It is interesting to find a distribution that fits the data
- Response time of job j made up by two components:
    - Sum of service times of jobs before j and j itself, like in M/M/1 -> exponential
    - Delay due to vacations -> exponential

$$E[R] = \frac{1}{\lambda} \frac{\rho}{1-\rho} + V$$

    - Sum of two independent exponentials with different rate -> hypoexponential distribution

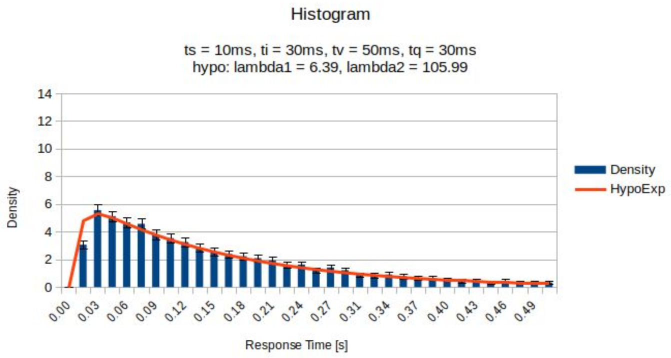
PDF: $f(x) = \frac{\lambda_1 \lambda_2}{\lambda_1 - \lambda_2}(e^{-x\lambda_2} - e^{-x\lambda_1})$

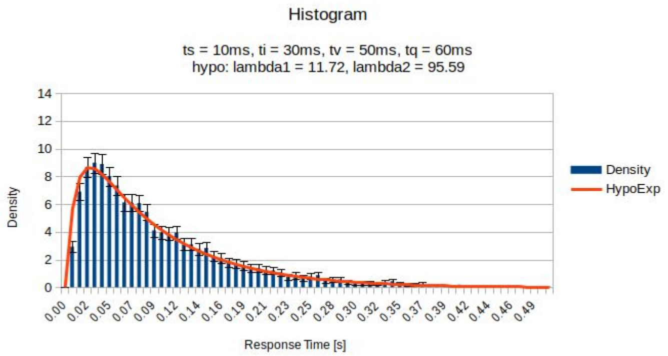
MLE:

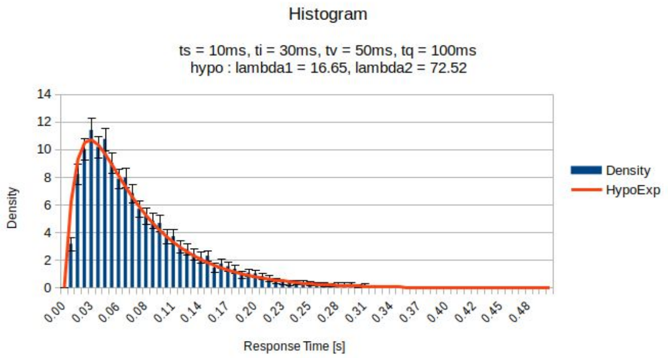
$$\lambda_1 = \frac{2}{\bar{x}}\left[1 + \sqrt{1 + 2(c^2 - 1)}\right]^{-1}$$

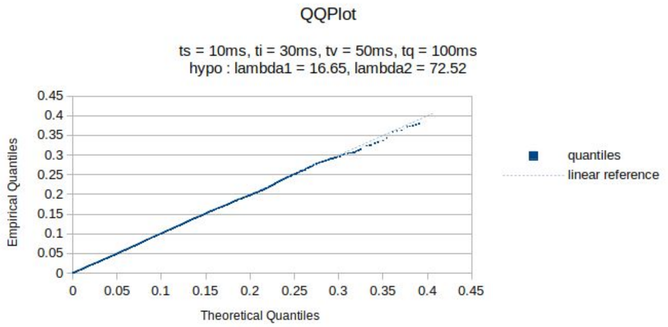
$$\lambda_2 = \frac{2}{\bar{x}}\left[1 - \sqrt{1 + 2(c^2 - 1)}\right]^{-1}$$

Fitting (2)


Histogram
ts = 10ms, ti = 30ms, tv = 50ms, tq = 30ms
hypo: lambda1 = 6.39, lambda2 = 105.99
Density
Response Time [s]
Density
HypoExp


Histogram
ts = 10ms, ti = 30ms, tv = 50ms, tq = 60ms
hypo: lambda1 = 11.72, lambda2 = 95.59
Density
Response Time [s]
Density
HypoExp


Histogram
ts = 10ms, ti = 30ms, tv = 50ms, tq = 100ms
hypo : lambda1 = 16.65, lambda2 = 72.52
Density
Response Time [s]
Density
HypoExp


QQPlot
ts = 10ms, ti = 30ms, tv = 50ms, tq = 100ms
hypo : lambda1 = 16.65, lambda2 = 72.52
Empirical Quantiles
Theoretical Quantiles
quantiles
linear reference