The Octave queueing Package

Moreno Marzolla
moreno.marzolla@unibo.it
http://www.moreno.marzolla.name/

Department of Computer Science and Engineering, University of Bologna

QEST 2014, sep 8–10, 2014

Outline

What is queueing?

- Software package for Queueing Network and Markov chain analysis
- Written in GNU Octave (a free Matlab clone).
- Contains implementation of numerical algorithms for QN and MC analysis
- Free software (GPLv3+)

`http://octave.sourceforge.net/queueing/`

Functions Provided by the `queueing` Package

- Single-Station Queueing Systems
  - $M/M/1$, $M/M/m$, $M/M/\infty$, $M/M/1/K$, $M/M/m/K$, ...
- Product-Form Queueing Networks
  - MVA and Convolution algorithms
  - Steady-State analysis of Open, Closed and Mixed networks
  - Supports multiple job classes (subject to limitations for product-form)
  - Performance bounds (Asymptotic, Balanced Job, Geometric Bounds)
- Discrete- and Continuous-time Markov Chains
  - State occupancy probabilities
  - Expected number of visits
  - Time-averaged expected sojourn times
  - Mean Time to Absorption
  - First Passage Times

Why queueing?

- Modeling Environment

  The queueing package and GNU Octave can be used for rapid prototyping and iterative refinement of QN models; parametric performance studies can be done quickly since models are defined programmatically

- Reference implementations

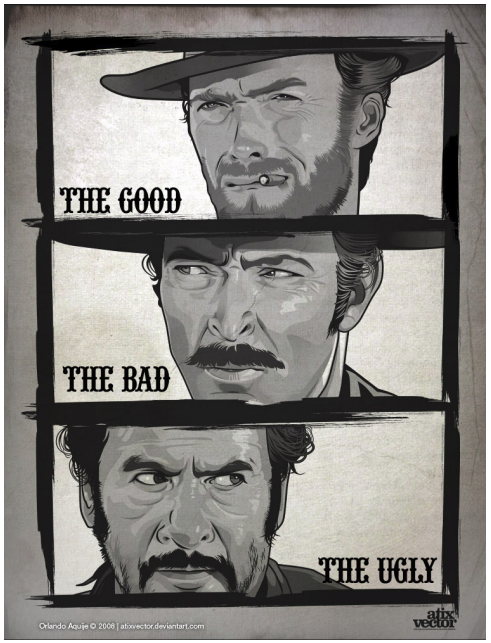
  The queueing package provides implementations of some common QN/MC algorithms, so that people do not have to reimplement the wheel

- Teaching

  queueing is being used in some Universities to teach performance modeling courses. Students can immediately put those algorithms at work to solve practical problems.

Limitations

- The Bad
  - No support for extended QNs (blocking, priorities, fork/join, passive resources...)
  - Efficiency and numerical stability issues with some algorithms (e.g., multiclass MVA, load-dependent service centers)
- The Ugly
  - No GUI; steep learning curve since all models must be defined programmatically



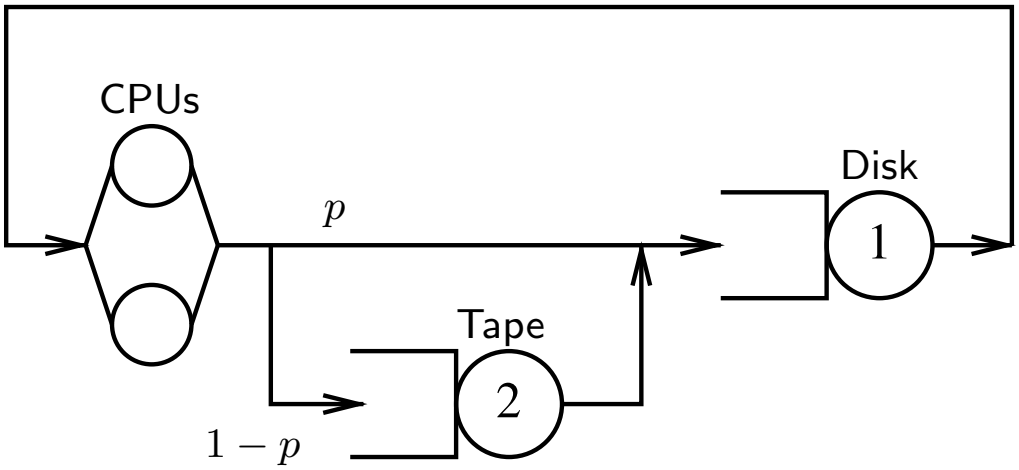
Installation and Usage

```
octave> pkg install -local -forge queueing

octave> pkg load queueing

octave> dtmc([0.5 0.5; 0.2 0.8])
ans =
      0.28571   0.71429

octave> help dtmc
-- Function File: P = dtmc (P)
-- Function File: P = dtmc (P, N, P0)
    Compute stationary or transient state occupancy
    probabilities for a discrete-time Markov chain.
    ...
```

Example: Compute Farm

Simple closed model of a scientific computing cluster

- N independent jobs process data stored in a tape library
- A disk cache is used to limit the access of the (slow) tapes
- A cache miss happens with probability $1 - p$ and requires to copy the data from tape to disk before the job is allowed to proceed



Compute Farm
Model Parameters

CPU burst $Z = 1000s$, average service time of tape $S_2 = 200s$.

For the same amount of money we can buy:

- fast disks (expensive, less disk space, lower cache hit rate), or
- slow disks (cheap, more disk space, higher cache hit rate).

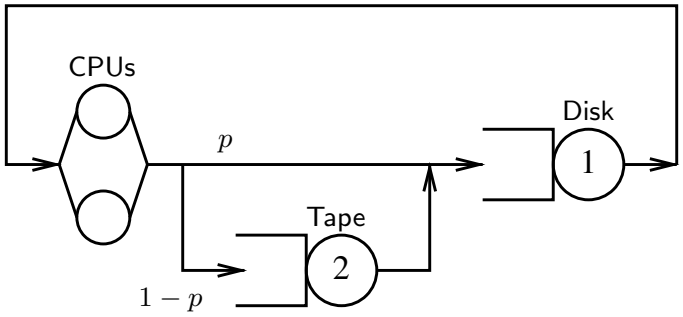
Case A: Slow disks

- Disk service time $S_1 = 1s$
- Cache hit rate $p = 0.9$

Case B: Fast disks

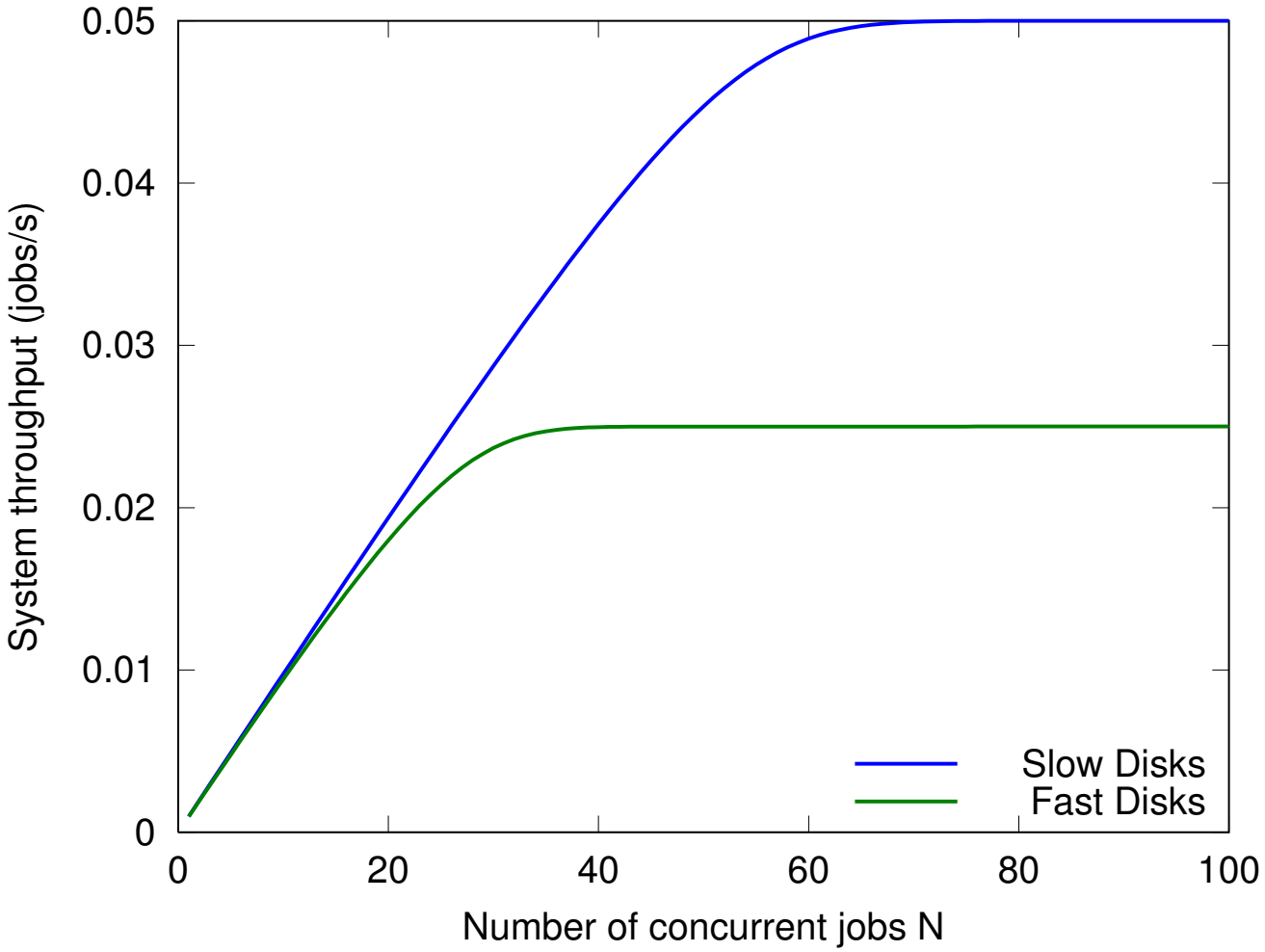
- Disk service time $S_1 = 0.9s$
- Cache hit rate $p = 0.8$

Compute Farm
Octave code




```
Z = 1000;

#### Scenario A: slow disks ####
SA = [1   200];   p = .9;   VA = qncsvisits( [p 1-p; 1 0 ] );

#### Scenario B: fast disks ####
SB = [0.9 200];   p = .8;   VB = qncsvisits( [p 1-p; 1 0 ] );

#### Solve models ####
XA = XB = zeros(1,100);
for n=1:100
  [U R Q X] = qncsmva(n, SA, VA, 1, Z);   XA(n) = X(1)/VA(1);
  [U R Q X] = qncsmva(n, SB, VB, 1, Z);   XB(n) = X(1)/VB(1);
endfor
```

Compute Farm
Results



Conclusions

The `queueing` package is a collection of functions implemented in GNU Octave to analyze Markov chains and product-form Queueing Networks

The `queueing` package is being used by researchers, practitioners and teachers to support their activity

Most wanted extension: support for non product-form QNs

`http://octave.sourceforge.net/queueing/`