Updating the Content
of
Performance Analysis Textbooks

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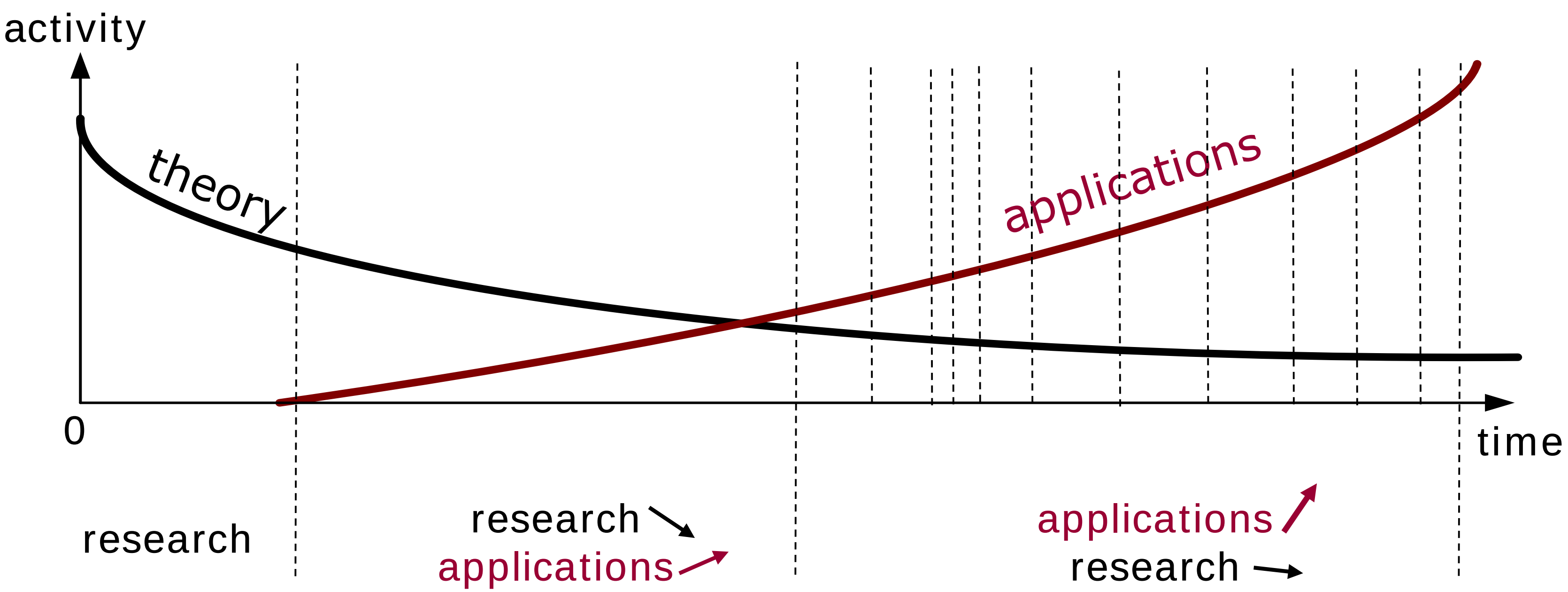
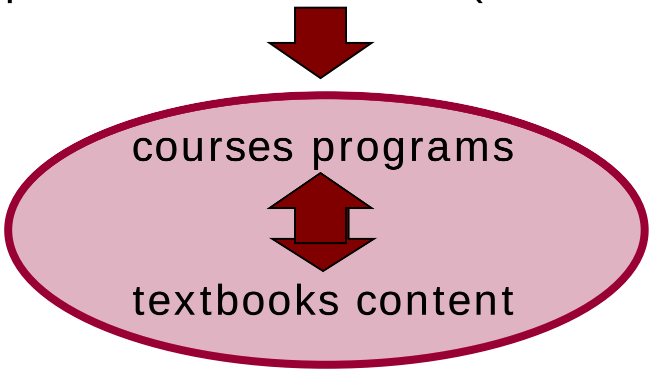
Outline

- Evolution of PE discipline
  - Prior to 1970
  - 1970 – 1980
  - 1980 – 2000
  - The last 20 years
- Evolution of PE textbooks
  - Prior to 1960
  - 1960 - 1980
  - 1980 – 2020
- 2021 Learning PE Through Applications

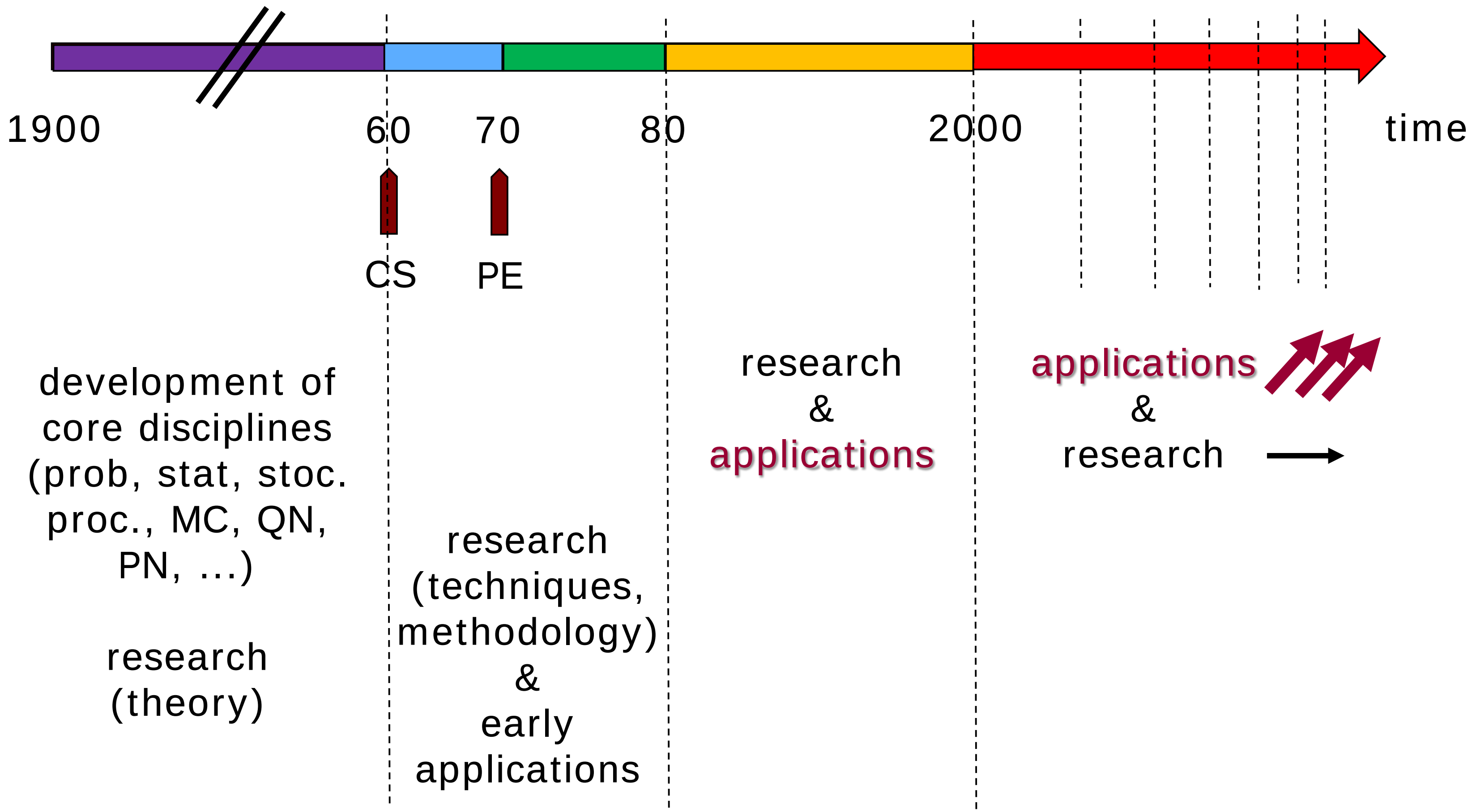
Phases in the evolution of a discipline



activity: research, research & early applications,
applications & research (balanced)



Evolution of Performance Evaluation (PE) discipline



Impact on titles of textbooks

1900-50s probability, stat., stochastic proc., Markov Ch., Queueing Networks, Petri Nets, ...
... ...
1975 Queueing Systems, Vol.1: Theory, Kleinrock
1976 Queueing Systems, Vol.2: Computer Applications, Kleinrock
1976 Fundamental laws of computer system performance, Buzen
1978 Computer Systems Performance Evaluation, Ferrari
1978 Modeling and Analysis: An introduction to PE Methodology, Kobayashi
1980 Computational algorithms for closed queueing networks, Bruell, Balbo
1981 Computer Systems Performance Modeling, Sauer, Chandy
... ...
1982 Probability and statistics with Reliability, Queuing and CS Applications, Trivedi
1983 Simulation of Computer Communication Systems, Sauer, Macnair
1983 Measurement and Tuning of Computer Systems, Ferrari, Serazzi, Zeigner
1984 Quantitative System Performance: Computer System Analysis using QN, Lazowska ...
1990 Performance Engineering of Software Systems, Smith
1990 The Art of Computer Systems Performance Analysis, Jain
1994 Capacity Planning and Performance Modeling, Menasce, Almeida, Dowdy
2000 Scaling for e-business, Menasce, Almeida
2002 Capacity Planning for Web Services: metrics, models, and methods, Menasce, Almeida
... ...
2006 Queueing Net. and Markov Ch.: Modeling and Perf.Evaluation with CS App., Bolch et.al
2008 Performance Modeling and Engineering, Xia Ed.
2010 Analytical Performance Modeling for Computer Systems, Tay
2010 Performance Evaluation of Computer and Communication Systems, Le Boudec
2013 Performance Modeling and Design of CS: Queueing Theory in Action, Harcol-Balter
2013 Prob., Stoc.Proc., Queueing Th.: the Math. of Computer Performance Modeling, Nelson
... ...

PE: the current situation *

- in the 70's PE officially became a separate discipline
- fifty years later there is a new world: centers with thousands of servers, millions of users, web services and apps for any need..
- today PE plays a crucial role in people's daily lives and in business that it has never had before

BUT ⬇

- the credits for teaching PE courses are decreasing
- the budgets for PE projects are squeezed
- the PE students are continuously reducing because
  - more attracted by courses with trendy names: ML, AI, Big Data ...
  - lack of interest (see next slides)

* see V. de Nitto Persone', *Teaching Performance Modeling in the era of millenials*, JOURNAL OF LATEX CLASS FILES, arXiv:arXiv:2001.08949v1 [cs.CY], Jan 2020.

common core to most books

- despite the differencies in emphasis of the various topics, there is a characteristic common to most textbooks: the large parts dedicated to the core disciplines (prob., stat., stoc. proc., Markov Chain, Queueing Net., Petri Nets, ...)
- the weight of the theoretical parts is almost always much greater than that of the applications
- furthermore, even to varying degrees, a good number of books dedicate (more or less consistent) parts to the description of obsolete notions/techniques/case studies

THUS ⬇

PE courses are often perceived as too theoretical and too far from reality

unbalanced growth of theoretical parts

- huge bulk of material (books, slides) on the core disciplines has been accumulated over decades (ready to be used)
- consequently, it takes a very short time to prepare a lesson on these topics (which prof have been teaching for years) compared to that necessary to prepare new lessons on apps
- rapid obsolescence of the practical applications compared to the stability over time of the basic notions of core disciplines
- tendency of some prof to demonstrate their deep knowledge by teaching an excessive amount of mathematical detail, often useless, leaving little time for lessons on other topics
- … … …

piggybacking old material in new books (legacy of the past)

reuse of old material, often useless or obsolete, is common

- e.g., some old algorithms and solution techniques are still taught but few (if any) students will implement them as there are tools open source that have these features

- SIMULATION: is the longest adopted technique for solving PE models, used from the 60s to today. First professional simulators appeared in the early 70s (Scert, Case, ...).
- Today highly reliable and efficient simulators are distributed open source, and thus very few students (if any) will need to implement a simulator
- but, several books still have chapters on the implementation of simulators and related problems: transients, conf.intervals, equilibrium, ... (and thus several lessons are devoted to them)

Learning PE Through Applications (LTA)

to build modeling skills it is necessary to accumulate experiences that can only be learned through trial and error work by solving problems of varying difficulties

- LTA introduce students gradually in PE topics by considering problems of increasing complexity
- concepts will be learned indirectly step by step (bottom-up) while solving problems
- unnecessary exposure of math concepts must be minimized
- lectures must be focused on PE topics; theoretical parts, if necessary, must be followed by case studies with their apps
- new data presentation techniques must be applied as much as possible, e.g., graphics , animations, ...

to implement LTA and improve PE acceptance

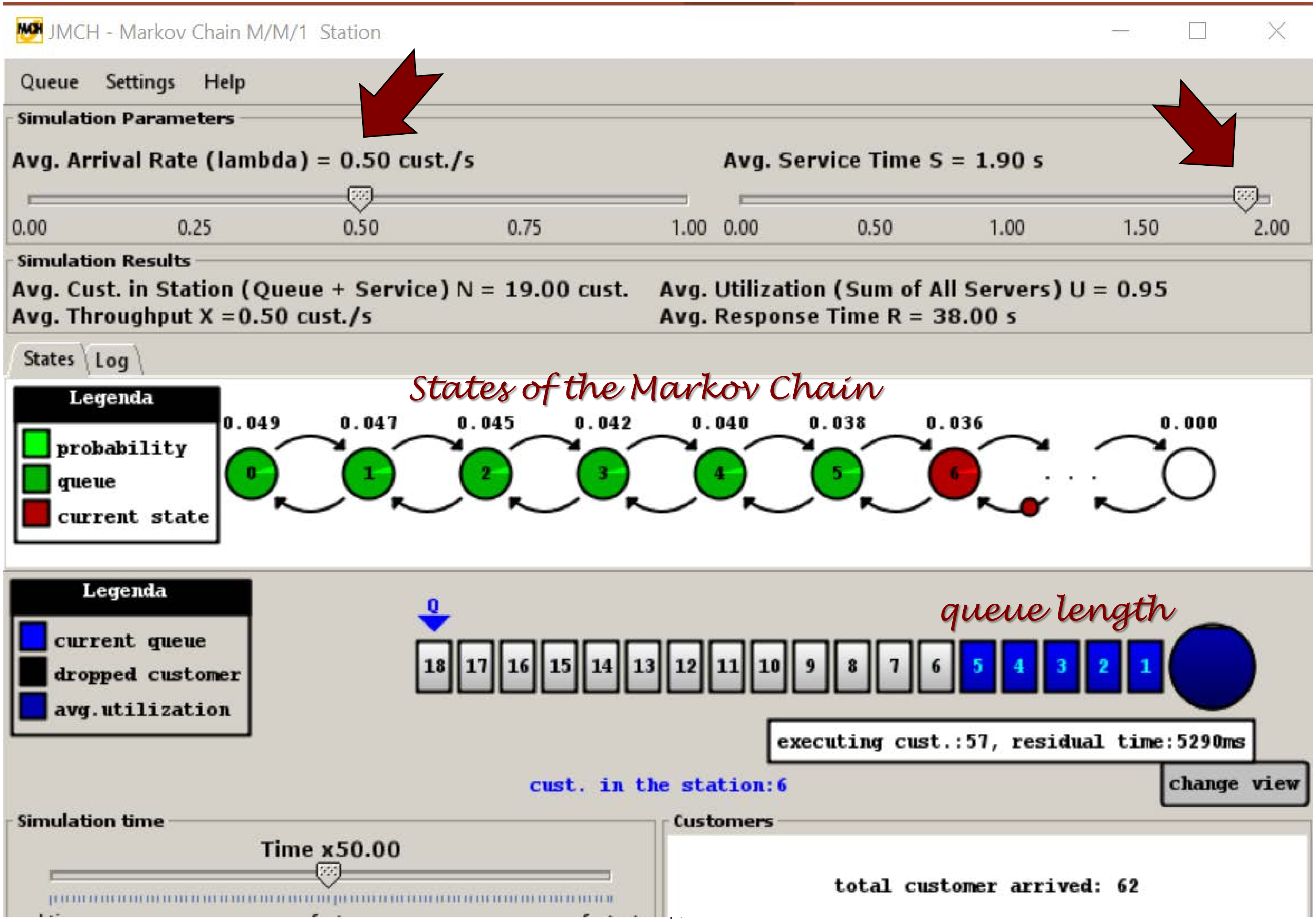
- drastic reduction of theoretical descriptions (of core disciplines and techniques) in textbooks and lessons
- describe applications by extracting from real case studies only the parts most relevant to performance (to reduce model complexity)
- PE problems facing industries cannot be described in detail in a course, but the most appropriate methodologies for their solutions can be taught
- a reference book with a collection of case studies of various modelling difficulties, solution techniques, methodologies, … , would be most welcome

and

- to attract students, integrate popular CS courses with few lessons on PE basic concepts and simple case studies

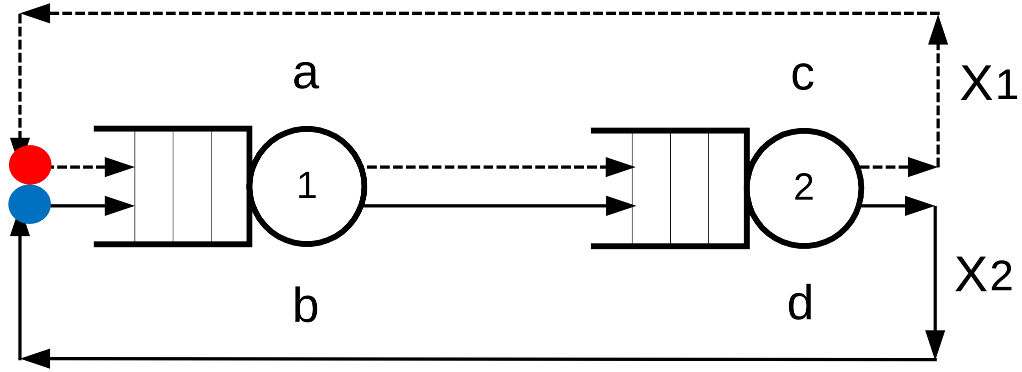
Animation 1: arrival and service rate, queue, JMCH

http://jmt.sourceforge.net JMT Tools



Animation 2: response time with two-class workload

2 customers, 2 classes, 2 resources



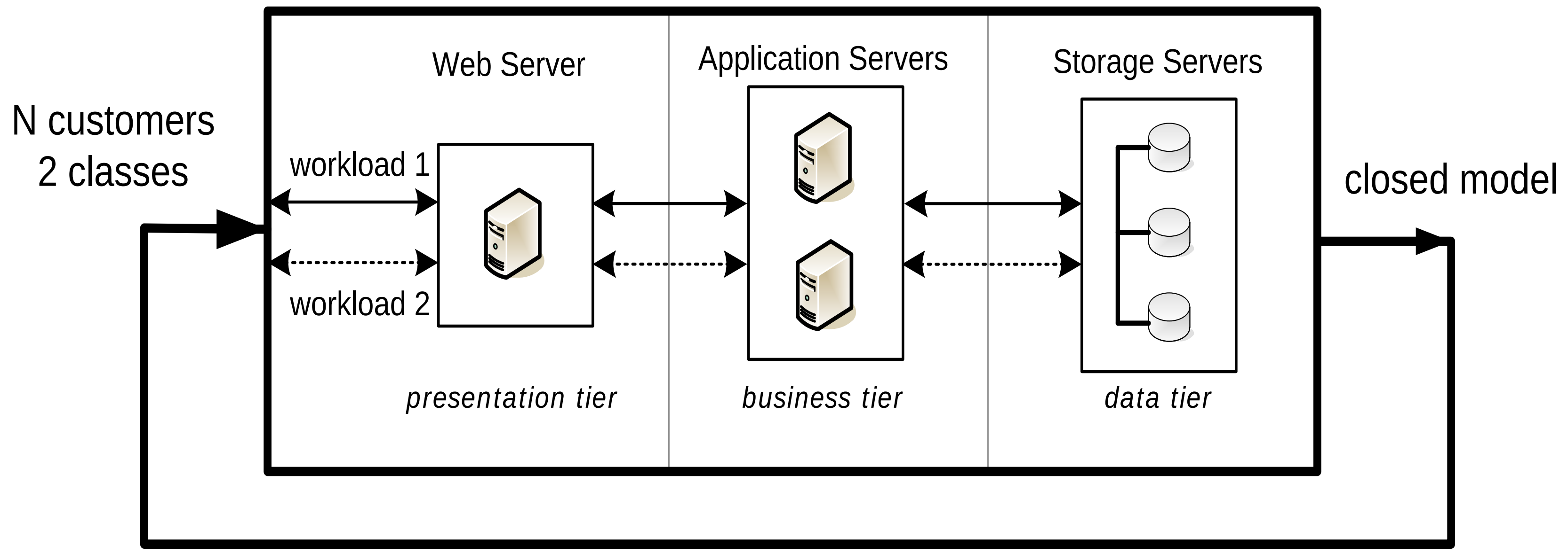
a, b, c, d
rates of execution

visual demo: system response time R is NOT the aritmetic mean but is the weighted mean of the response times of the classes (the weights are the relative throughputs)

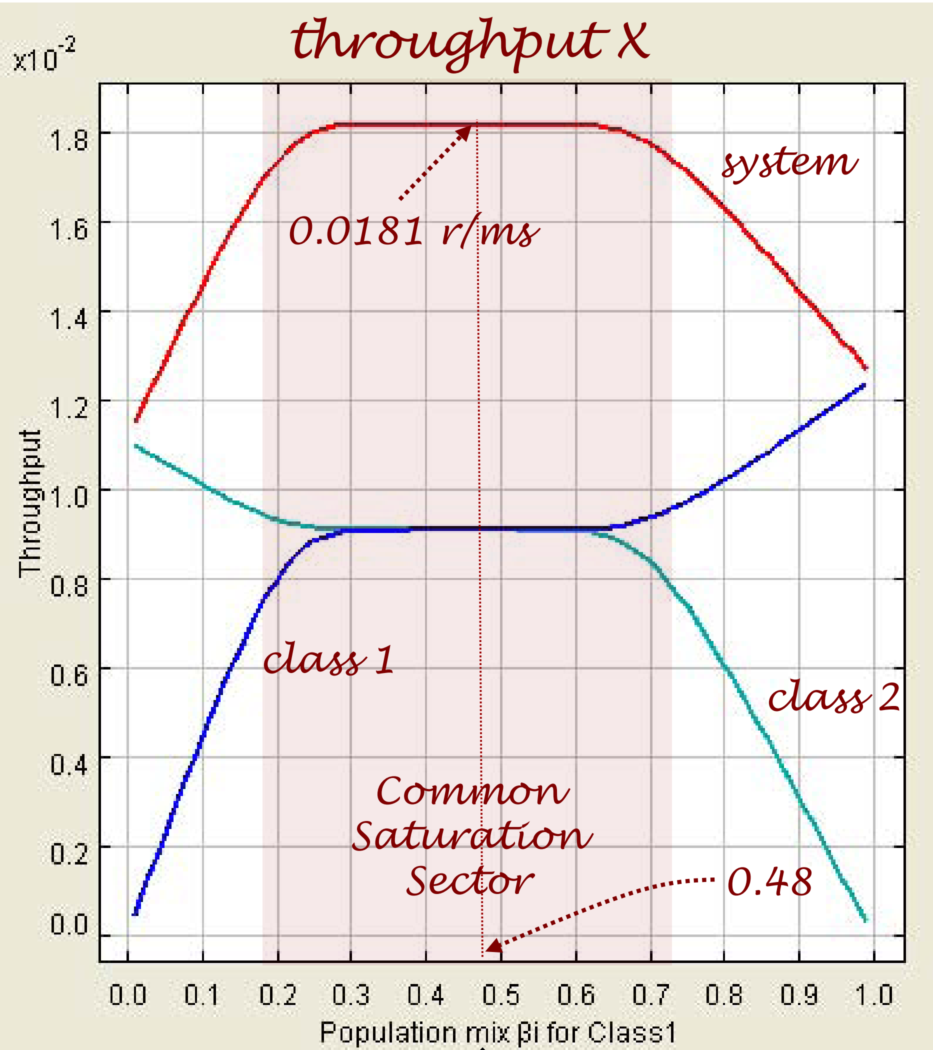
$$R_0 = R_1 \frac{X_1}{X_0} + R_2 \frac{X_2}{X_0}$$

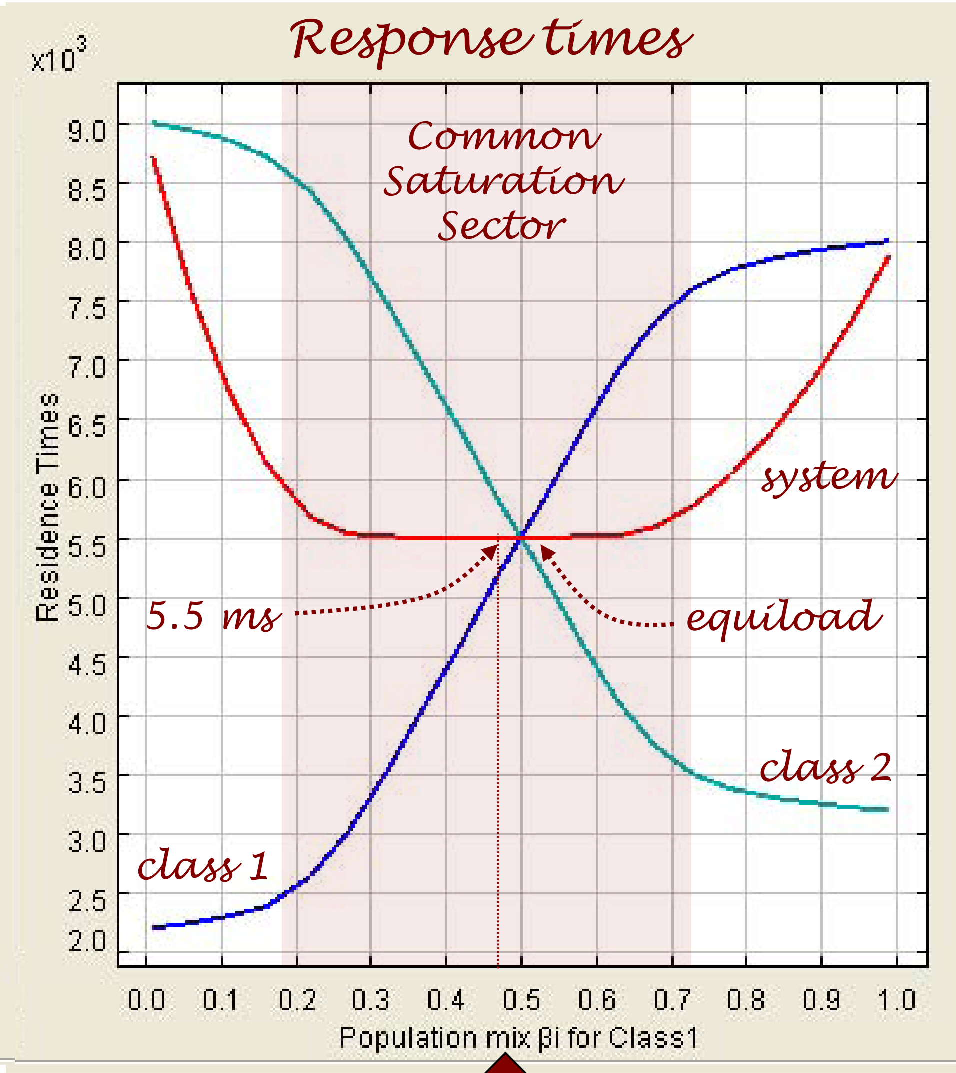
data center – 2 class workload

http://jmt.sourceforge.net

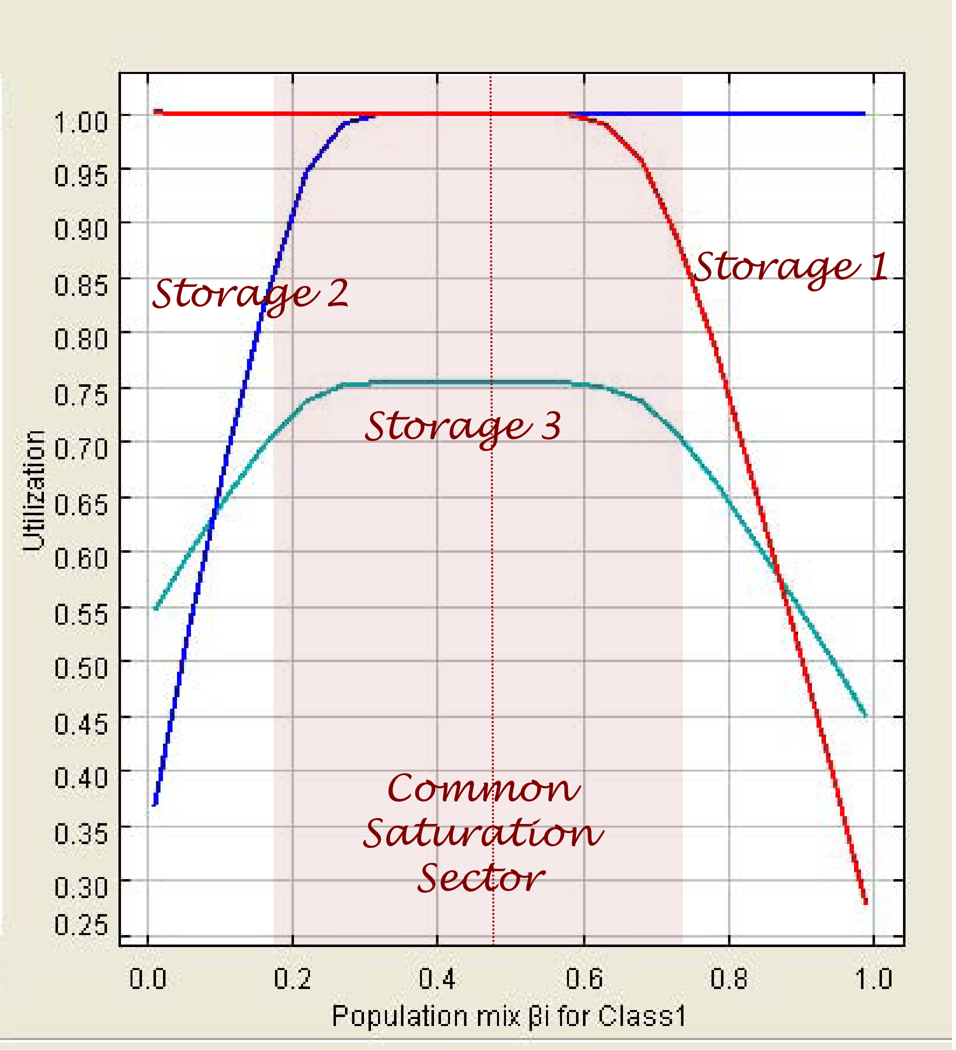


All possible workloads – JMVA (http://jmt.sourceforge.net)

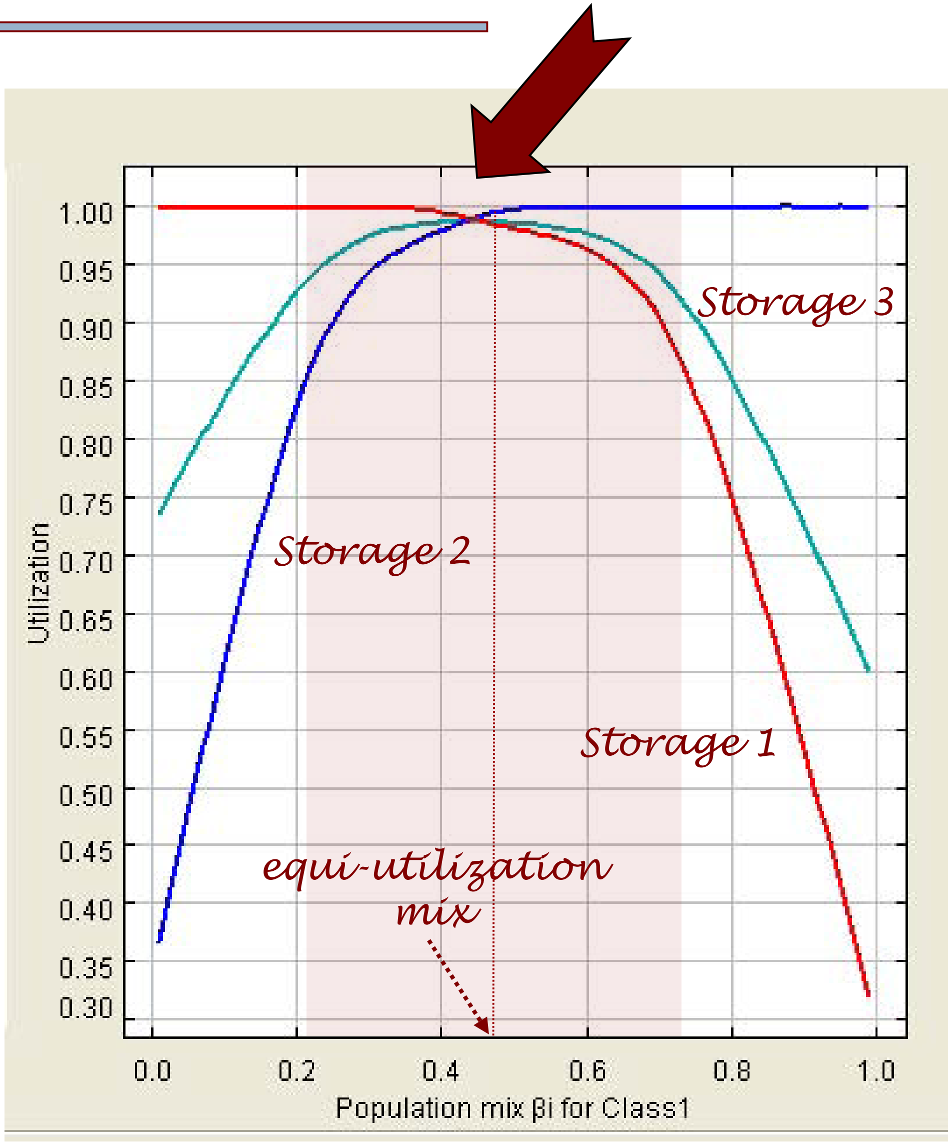




Optimal load - JMVA (http://jmt.sourceforge.net)



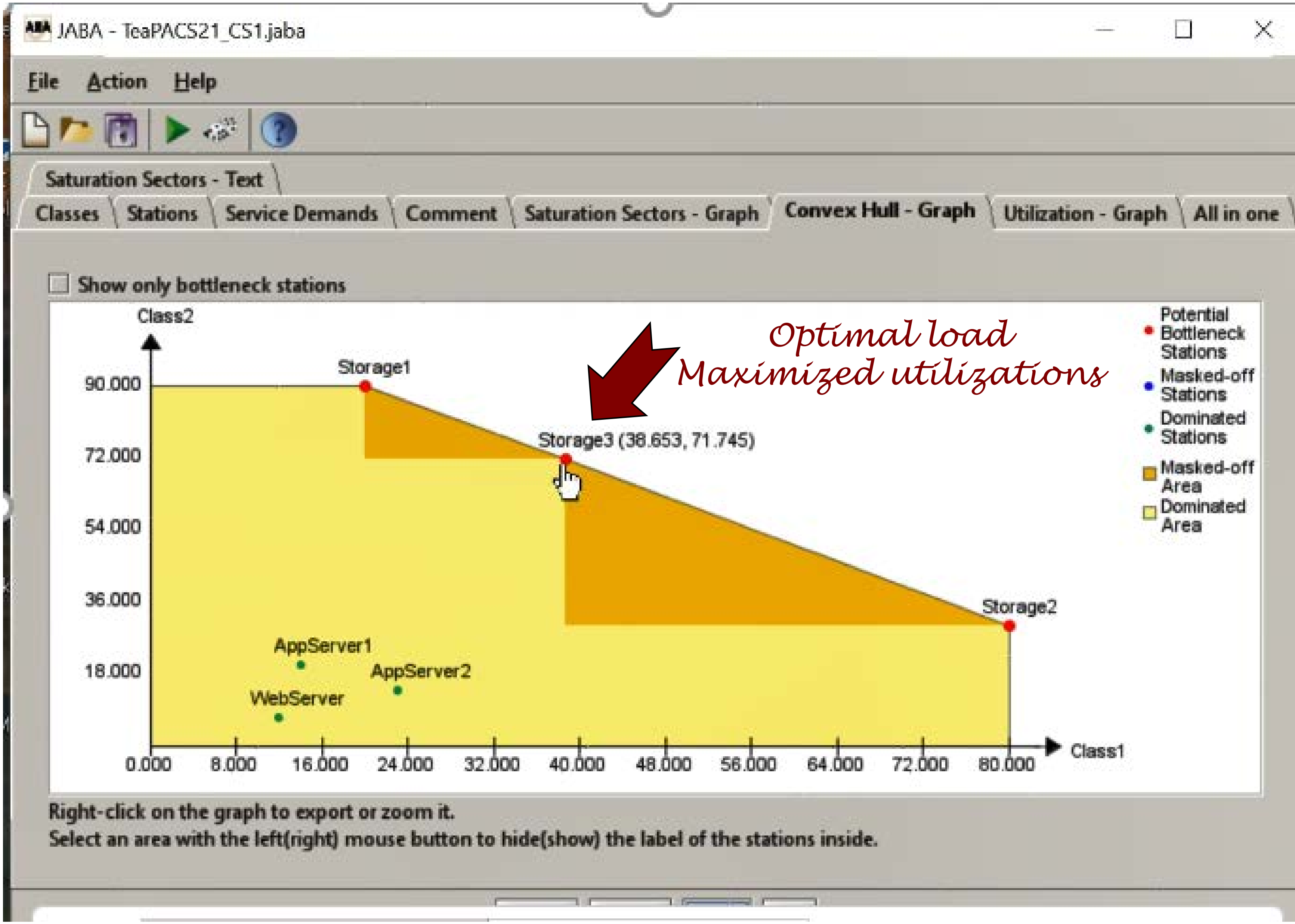
Utilizations



Maximized Utilizations

Animation 3: bottleneck identification – JABA

http://jmt.sourceforge.net JMT Tools



The FUTURE !!!

Applied Performance Engineering

Learning PE Through Applications