Teaching Performance Modeling in the Era of 280 characters Information

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University of Rome Tor Vergata, IT

InfQ, November 23rd 2018, Milano, Italy

(WEPPE 2017, April 23rd, L'Aquila, Italy)

Outline

the beginning

the search

a teaching map

- **where**
- **what**

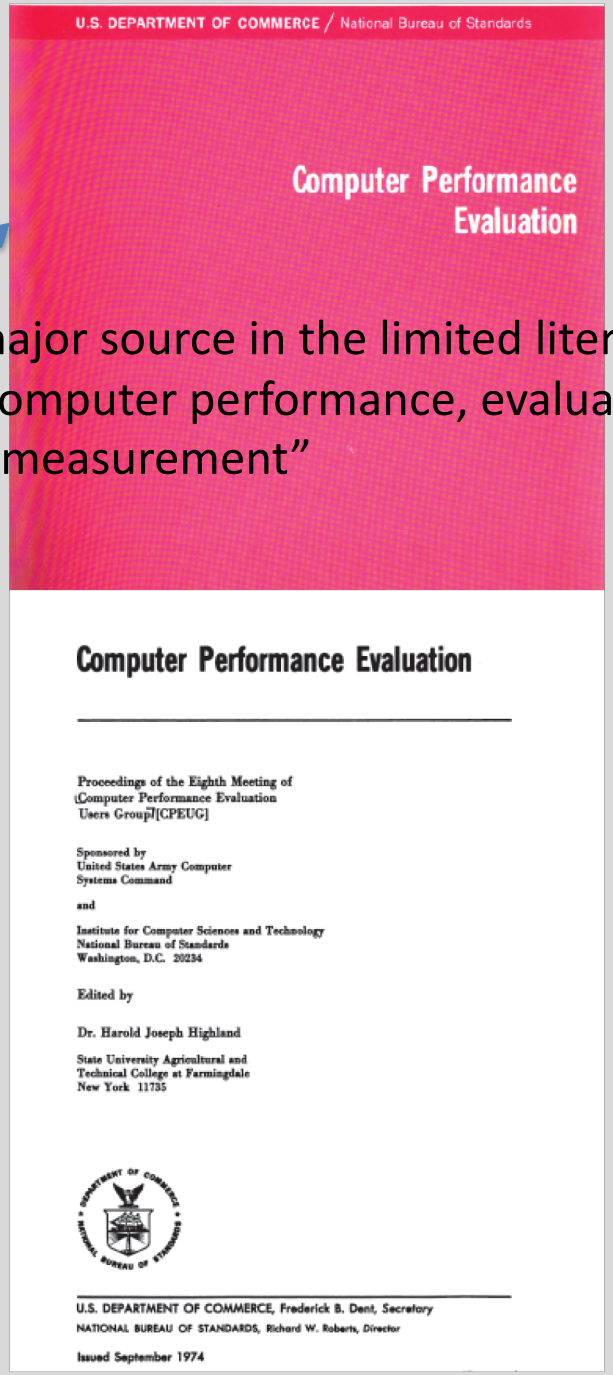
crisis (?)

reasoning about

The beginning

1971
Federal Information Processing Standards (FIPS) Task Group 10 – Computer Component and Systems Performance Evaluation:
Computer Performance Evaluation User's Group (CPEUG)

1972
International Federation for Information Processing (IFIP)
Technical Committee 7
System Modeling and Optimization:
WG 7.3 Computer System Modeling



"a major source in the limited literature on computer performance, evaluation and measurement"

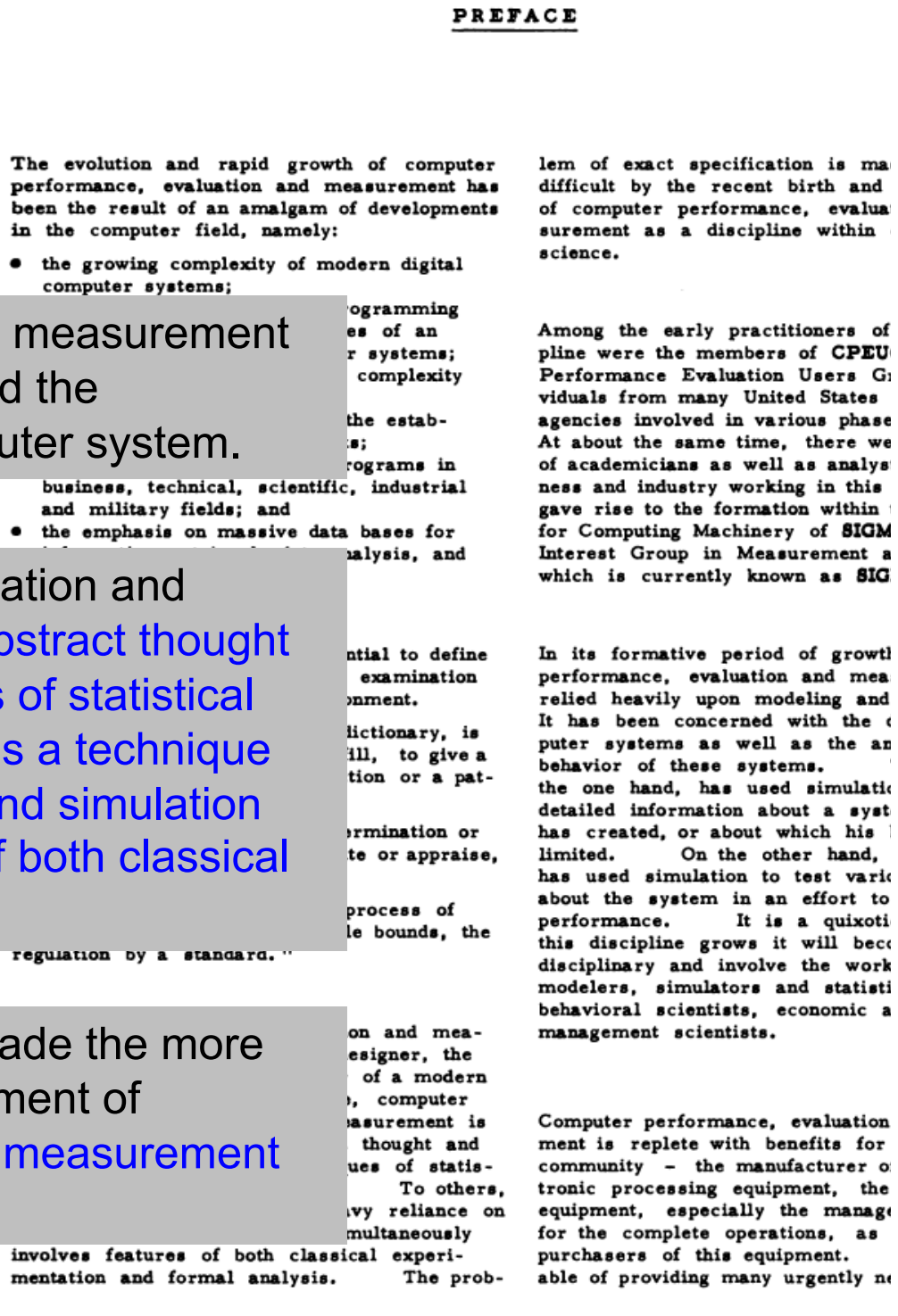
1974

The beginning

Computer performance, evaluation and measurement is now vital to the designer, the user and the management-owner of a modern computer system.

To some, computer performance, evaluation and measurement is a tool, a marriage of abstract thought and logic combined with the techniques of statistical and quantitative methods. To others, it is a technique with very heavy reliance on modeling and simulation and simultaneously involves features of both classical experimentation and formal analysis.

The problem of exact specification is made the more difficult by the recent birth and development of computer performance, evaluation and measurement as a discipline within computer science



PREFACE

The evolution and rapid growth of computer performance, evaluation and measurement has been the result of an amalgam of developments in the computer field, namely:

- the growing complexity of modern digital computer systems;
- ...ogramming ...es of an ...r systems; ... complexity ... the estab- ...s; ...rograms in business, technical, scientific, industrial and military fields; and
- the emphasis on massive data bases for ...alysis, and

...ntial to define ... examination ...nment. ...lictionary, is ...ill, to give a ...tion or a pat- ...rmination or ...te or appraise, ...process of ...le bounds, the regulation by a standard."

...on and mea- ...esigner, the ... of a modern ..., computer ...asurement is ... thought and ...ues of statis- To others, ...vy reliance on ...multaneously involves features of both classical experimentation and formal analysis. The problem of exact specification is ma... difficult by the recent birth and ... of computer performance, evalua... surement as a discipline within ... science.

Among the early practitioners of ... pline were the members of CPEU... Performance Evaluation Users G... viduals from many United States ... agencies involved in various phase... At about the same time, there we... of academicians as well as analys... ness and industry working in this ... gave rise to the formation within ... for Computing Machinery of SIGM... Interest Group in Measurement a... which is currently known as SIG...

In its formative period of growth... performance, evaluation and mea... relied heavily upon modeling and ... It has been concerned with the ... puter systems as well as the an... behavior of these systems. ... the one hand, has used simulatio... detailed information about a syst... has created, or about which his ... limited. On the other hand, ... has used simulation to test vario... about the system in an effort to ... performance. It is a quixoti... this discipline grows it will beco... disciplinary and involve the work... modelers, simulators and statisti... behavioral scientists, economic a... management scientists.

Computer performance, evaluation ... ment is replete with benefits for ... community – the manufacturer o... tronic processing equipment, the ... equipment, especially the manage... for the complete operations, as ... purchasers of this equipment. ... able of providing many urgently ne...

v

sources

IFIP WG 7.3

http://www.ifip.org/index.php?option=com_content&task=view&id=185&Itemid=448

Program Committees

SIGMETRICS 2015, (ICPE, MAMA, MASCOTS, WEPPE) 2017

Some journal editorial boards

ACM TOMACS, TOMPECS

FRIENDS

INFQ the Italian group on Quantitative Methods in Informatics

> 300 web pages, > 60 email

the boundaries

Enclosure

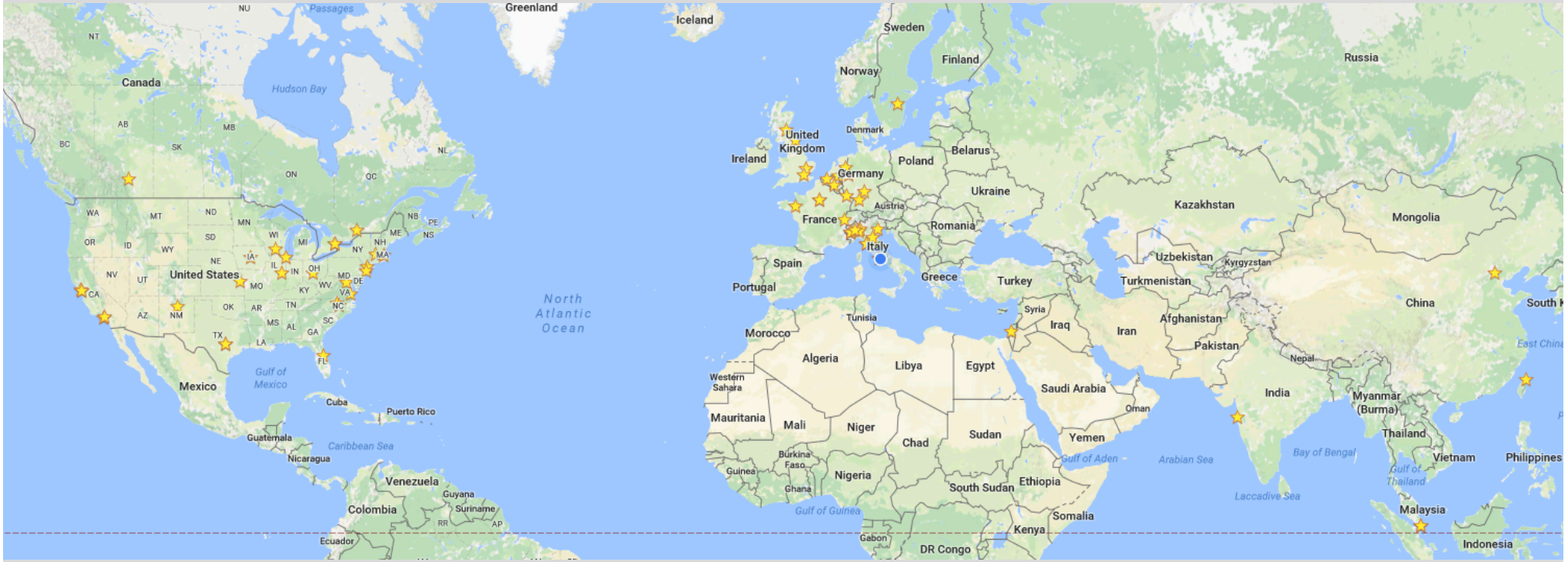
Performance Modeling courses

Excluded

Operations Research
Stochastic Processes (just)
Queueing Theory (just)
Simulation (just)

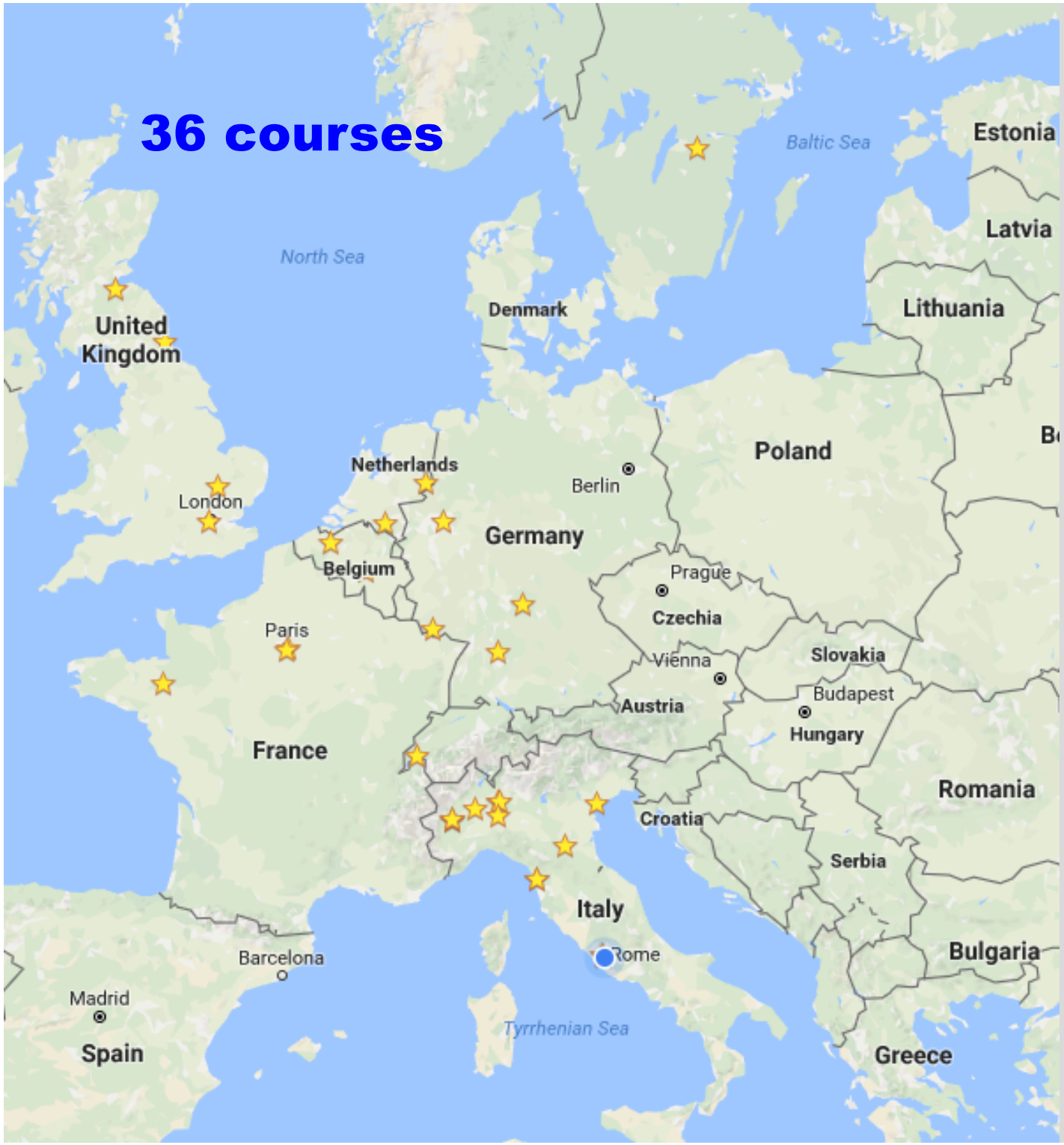
A teaching map (where)

About 70 courses
(currently teached in 2016/2017)



A teaching map (where)

26 courses



A teaching map (where)

A teaching map (where)

the bearings

Enclosure

Performance Modeling courses

General PM

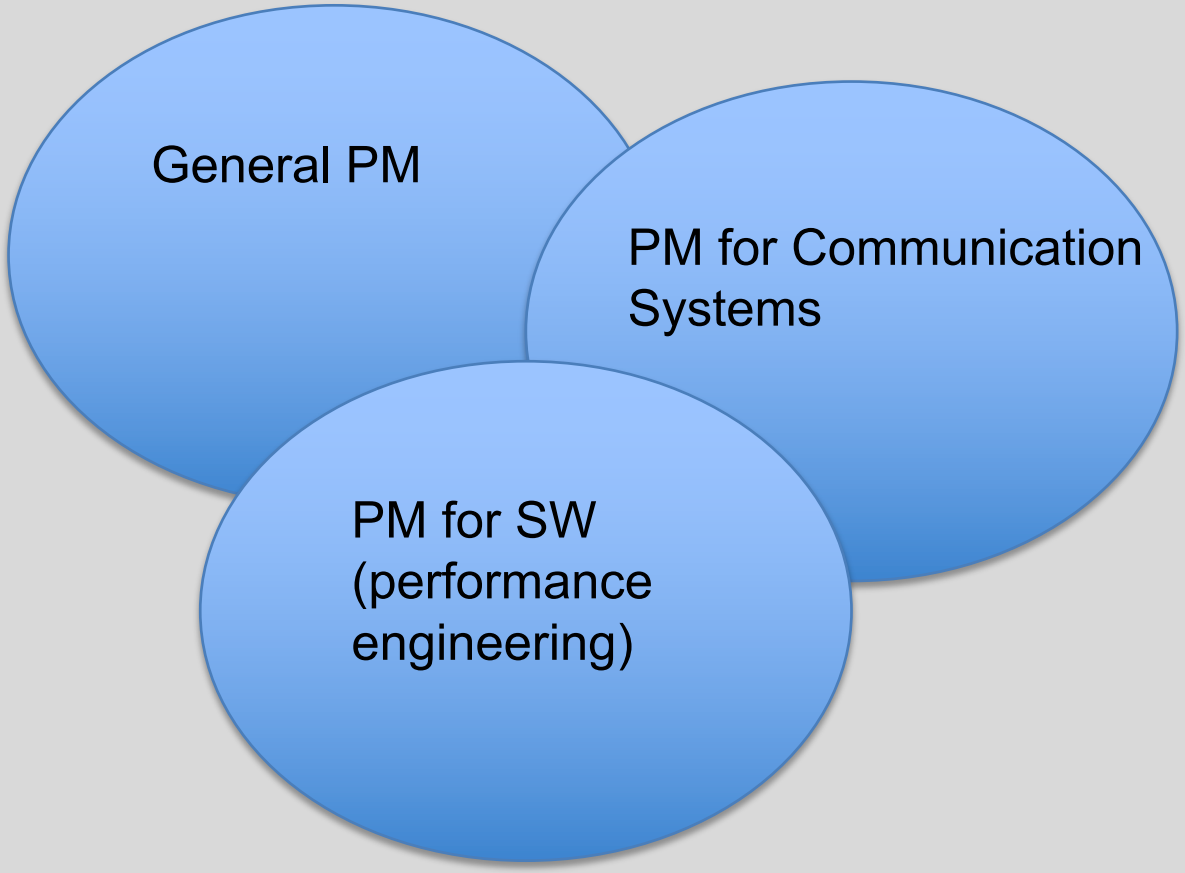
PM for Communication Systems

PM for SW (performance engineering)

the bearings

Enclosure

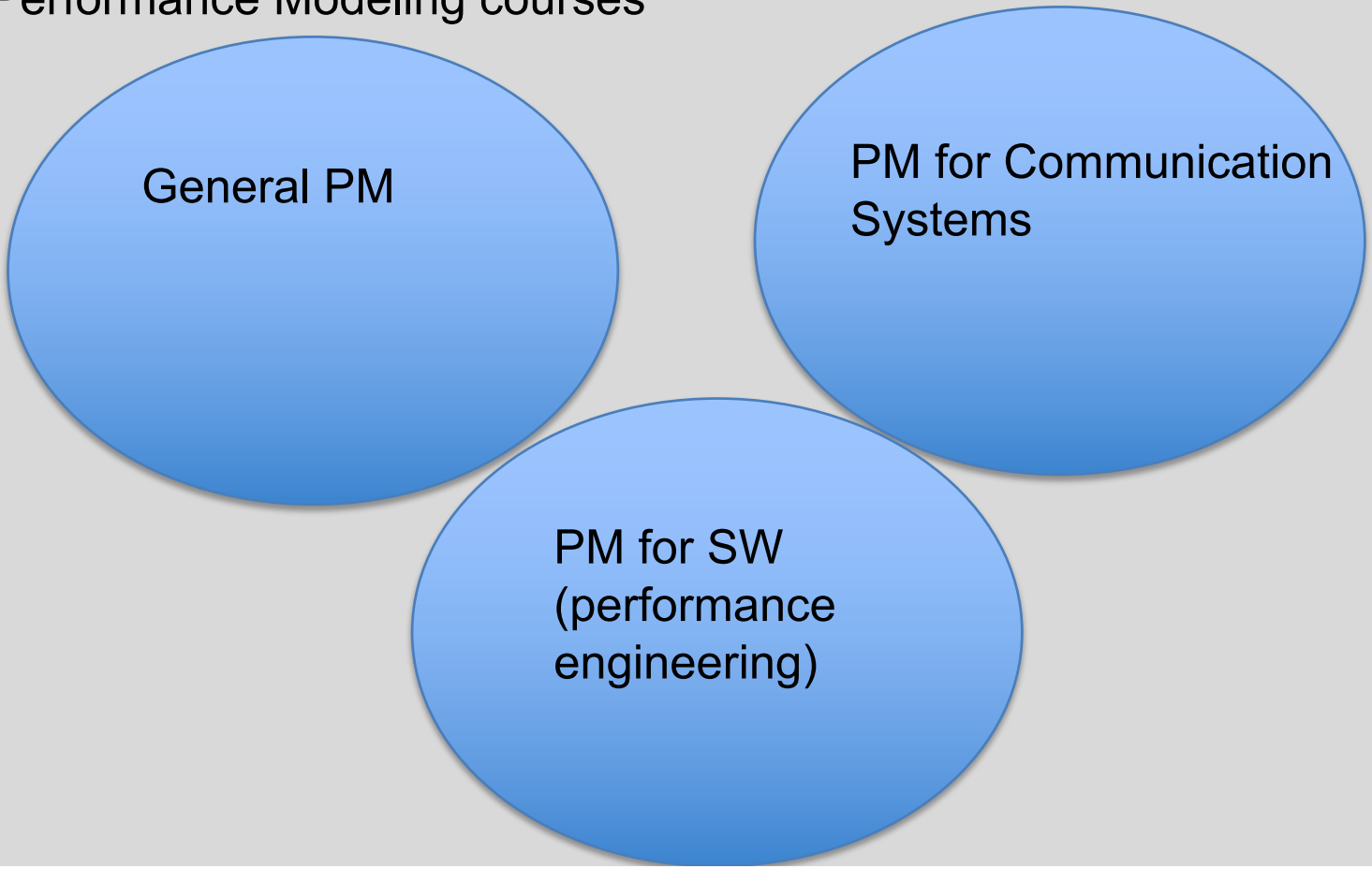
Performance Modeling courses



the bearings

Enclosure

Performance Modeling courses



General PM

Capacity Planning

Bruno Ciciani, "Sapienza" University of Rome, Italy

Computer Systems Analysis

David M. Nicol, University of Illinois, Urbana-Champaign, USA

Computer Systems Modelling

Richard Gibbens, University of Cambridge, United Kingdom

Computer Systems Performance Analysis

Teo Yong Meng, National University of Singapore, Singapore

Computer System Performance Evaluation

Daniel A. Menasce, George Mason University, USA

Computer Systems Performance Evaluation

Giuseppe Serazzi, Politecnico di Milano, Italy

Enterprise Digital Infrastructure

Maria Carla Calzarossa, University of Pavia, Italy

Introduction to Computer Performance Modeling

Harry Perros, George N. Rouskas, William J. Stewart, Do Y. Eun,
North Carolina state University, USA

Model based analysis and optimization

Peter Buchholz, University of Dortmund, Germany

Modeling and analysis of embedded and distributed systems

Peter Buchholz, University of Dortmund, Germany

General PM

Modeling and evaluation of systems

Marie-Ange Remiche, University of Namur, Belgium

Modeling and Performance Evaluation

Vishal Misra, Columbia University, USA

Modeling and Simulation

Verena Wolf, University of Saarbrücken, Germany

Modelli e linguaggi di simulazione

Giuseppe Iazeolla, University of Rome Tor Vergata, Italy

Performance Engineering

Samuel Kounev, Karlsruhe Institute of technology, Wurzburg, Germany

Performance Evaluation

Jean-Yves Le Boudec, Ecole Politechnique Federale de Lausanna, Switzerland

Performance Evaluation

Philippe Nain, University of Massachusetts Amherst, USA

Performance Evaluation of Computer and Communication Systems

Cheng-Fu Chou, National Taiwan University, Taiwan

Performance Evaluation of Computer Systems

Marco Gribaudo, Politecnico di Milano, Como Campus, Italy

Performance Evaluation of Computer Systems and Networks

Varsha Apte, Indian Institute of Technology, India

General PM

Performance Evaluation of Computer Systems and Networks

Giovanni Stea, University of Pisa, Italy

Performance Modeling

Yong C. Tay, National Taiwan University, Taiwan

Performance Modeling

Yong C. Tay, Tembusu College National University of Singapore, Singapore

Performance Modeling of Computer Systems and Networks

Vittoria de Nitto Personè, University of Rome Tor Vergata, Italy

Performance Modelling

Jane Hillston, University of Edinburgh, Scotland

Quantitative Methods and Experimental Design in CS

Daniel A. Menasce, George Mason University, USA

Queueing Analysis and Simulation

Dieter Fiems, University of Ghent, Belgium

Queueing systems

Sem Borst, Jacques A.C. Resing, Eindhoven University of Technology, The Netherlands

Queueing Theory

Uri Yechiali, Tel Aviv University, Israel

Simulation

Evgenia Smirni, College of William & Mary, Virginia, USA

Simulation: Algorithms and Implementation

Gianfranco Balbo, Iowa State University, USA

General PM

Simulation and Modeling
Mart Molle, University of California, USA

Simulation and Modelling
Tony Field, Imperial College, United Kingdom

Simulation and Modelling
Gianfranco Balbo, University of Torino, Italy

Simulazione di sistemi
Lorenzo Donatiello, University of Bologna, Italy

Stochastic performance modelling
Onno J. Boxma, Maria Vlasiu, Eindhoven University of Technology, The Netherlands

System Availability modeling
Kishor Trivedi, Duke University, USA (3days course)

System Evaluation
Aad van Moorsel, Nigel Thomas, Newcastle University, United Kingdom

Systems Modelling and Analysis
Peter Marbach, University of Toronto, Canada

Systems Modelling And Simulation
Carey Williamson, University of Calgary, Canada

Valutazione delle Prestazioni
Giuliana Franceschinis, Andrea Bobbio, Università del Piemonte Orientale, Italy

23+	EU
12+	C&U
6	A
41	

PM for Communication Systems

Advanced Networking And Internet Modeling
- Francesco Lo Presti, University of Rome Tor Vergata, Italy

Advanced Performance Modeling
- Phone Lin, National Taiwan University, Taiwan

Advanced Topics in Computer Networks
- Konstantinos Psounis, University of Southern California, USA

Communication Networks
- Javad Ghaderi, Columbia University, USA

Design and Performance Evaluation of Network Services and Systems
- Do Y. Eun, North Carolina state University, USA

Étude des Grands Réseaux Stochastiques
- Philippe Robert, Université Pierre et Marie Curie, France

Introduction to Computer Networks
- Longbo Huang, Tsinghua University, China

Introduction to Computer Networks
- Peter Marbach, University of Toronto, Canada

Large-Scale Distributed Systems and Networks
- Niklas Carlsson, Linkoping University, Sweden

Modeling of Large Wireless Networks
- Francois Baccelli, University of Texas at Austin, USA

Network Analysis, Simulation, and Measurements
- Victor S. Frost, University of Kansas, USA

PM for Communication Systems

Network modelling and simulation
Marco Ajmone Marsan, Politecnico di Torino, Italy

Network Performance Analysis
Thomas Bonald, Telecom ParisTech, France

Performance Evaluation using Queueing Networks
Gerardo Rubino, Bruno Tuffin, Consortium SIF, France

Performance Modelling and Simulation
Paul J. Kühn, Andreas Kirstädter, University of Stuttgart, Germany

Performance Modelling of Computer Communication Networks
Nicolò Michelusi, Purdue University, USA

Random Processes in Communication and Control I
Randall Berry, Northestern University, USA

Simulazione e prestazioni delle reti
Andrea Marin, Ca' Foscari, University of Venice, Italy

Stochastic networks
Frank Kelly, University of Cambridge, United Kingdom

Stochastic networks
Johan S.H. van Leeuwaarden, Sem Borst, Eindhoven University of Technology, The Netherlands

The Art & Science of Quantitative Reasoning
Azer Bestavros, Boston University, USA

10+	EU
9+	C&U
2	A
21	

PM for SW

Design of High Performance Software
Greg Franks, Carleton University, Canada

High Performance Software
Shikharesh Majumdar, Carleton University, Canada

Modeling and Measurement of Software Performance
Diwakar Krishnamurthy, University of Calgary, Canada

Performance Engineering
Dorina Petriu, Carleton University, Canada

Requirements engineering and software architecture
André van Hoorn, University of Stuttgart, Germany

Safe and reliable software systems
André van Hoorn, University of Stuttgart, Germany

Software performance and scalability
Andrea Marin, Ca' Foscari, University of Venice, Italy

Software Performance Evaluation
Diwakar Krishnamurthy, University of Calgary, Canada

5+ Canada
3 EU
8

Business

Performance Dinamics Company

Neil J. Gunther, Castro Valley, California, USA
Guerrilla Capacity Planning Boot Camp
Guerrilla Capacity Planning: The Big Picture
Guerrilla Data Analysis Techniques

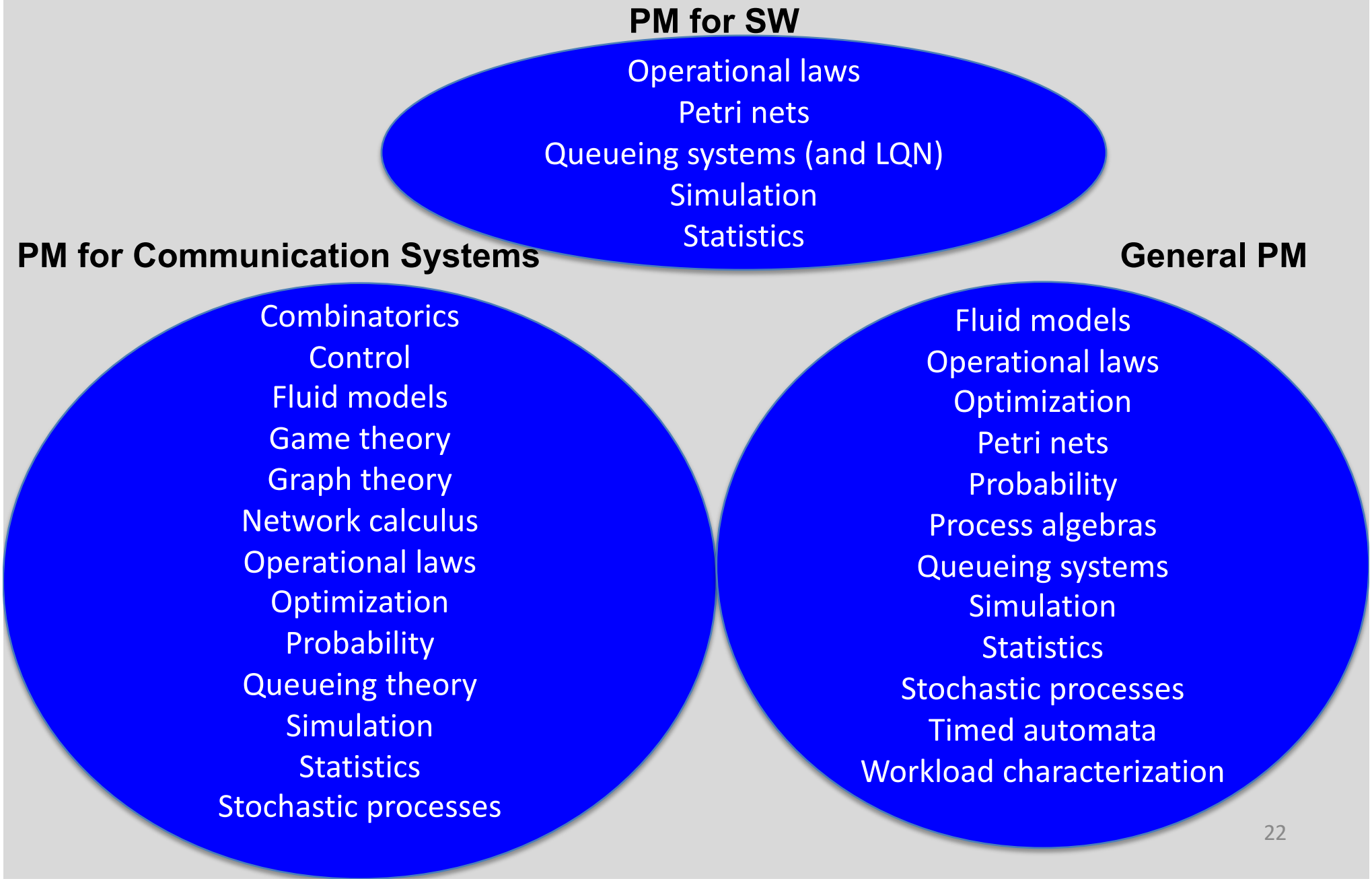
Performance Engineering Services Division

L&S Computer Technology, Inc.
Connie U. Smith, Santa Fe, New Mexico, USA
Performance Solutions: Solving Performance Problems Quickly and Effectively
Software Performance Engineering: Methods and Quantitative Techniques for Proactively Managing Software Performance
Performance Engineering Model Bootcamp™: Practical Techniques for Modeling Your Systems

Software Performance and Scalability Consulting LLC

André B. Bondi, Red Bank, New Jersey, USA
Foundations of Performance Engineering
Performance Requirements Engineering and Practice for Product Managers

A teaching map (what)



“Mutations”

Simonetta Balsamo, Ca’ Foscari, University of Venice, Italy
2015 Performance and Reliability of Computer Systems
2016 Computer networks, Cloud Computing and Distributed Systems

Konstantinos Psounis, University of Southern California, USA
?? Probabilistic Methods in Computer Systems Modelling,
2015 Probability for Electrical and Computer Engineers

Adam Wierman, Caltech, USA
2010 Analytic tools for system design
2015 Network performance analysis: The Fundamentals of Heavy Tails
2017 Networks: Structure & Economics http://courses.cms.caltech.edu/cs144/

“Mutations”

Cathy H. Xia, The Ohio State University, USA
2014 Performance Modeling and Simulation,
2015 Simulation for System Analytics and Decision-Making

Cliff C. Zou, University of Central Florida, USA
2014 Performance Models of Computers and Networks,
network security: Malware and Software Vulnerability Analysis, Cyber Operation Lab

John C.S. Lui, The Chinese University of Hong Kong, China
2009, Computer System Performance Evaluation
2017 Advanced Topics in Internet Technology, Fundamentals Machine Learning

Leana Golubchik, University of Southern California, USA
2004, Performance Evaluation
Boudewijn R. Haverkort, University of Twente, The Netherlands
2015, Performance Evaluation
Mary K. Vernon, The University of Wisconsin, USA
2010 Computer System Modeling Fundamentals
2011 Advanced Computer Systems Analysis Techniques

missing

Some PM courses (*general*) have been closed

Does the modeling approach have a value in itself for education?

???

Is it no more time to teach the **modeling principles** and **basic methodologies**?

Do we have to follow the **specialization** trend?

Do we need of a **new agenda** for PM courses?

Basic general PM courses

Move towards specialized PM courses

A look at CS2013

Computer Science Curricula 2013

Curriculum Guidelines for Undergraduate Degree Programs in Computer Science

Body of Knowledge

PD. Parallel and Distributed Computing

PD/Parallel Performance (Electives)

OS. Operating Systems

OS/System Performance Evaluation (Electives)

SF. Systems Fundamentals

SF/Evaluation 3 Core-Tier1 hours

SF/Resource Allocation and Scheduling 2 Core-Tier2 hours

SF/Quantitative Evaluation (Electives)

A look at CE2016

Computer Engineering Curricula 2016

CE2016

Curriculum Guidelines for Undergraduate Degree Programs in Computer Engineering

Body of Knowledge

CE-CAO Computer Architecture and Organization
[60 core hours]

CE-CAO-4 Measuring performance [3]

CE-NWK Computer Networks
[20 core hours]

CE-NWK-10 Performance evaluation

CE-SPE Systems and Project Engineering
[35 core hours]

CE-SPE-9 System architectural design and evaluation [4]

CE-SRM Systems Resource Management
[20 core hours]

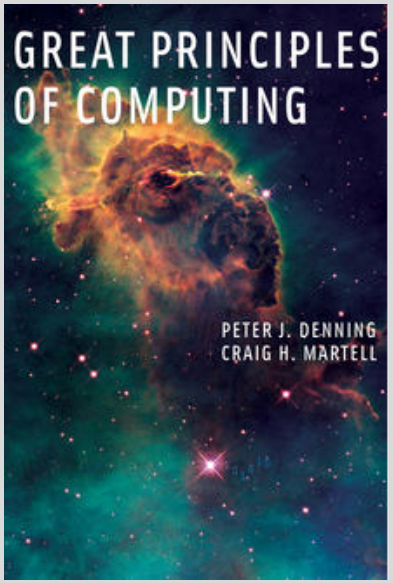
CE-SRM-7 System performance evaluation

specialization vs general

A short wide-ranging analysis of computing:

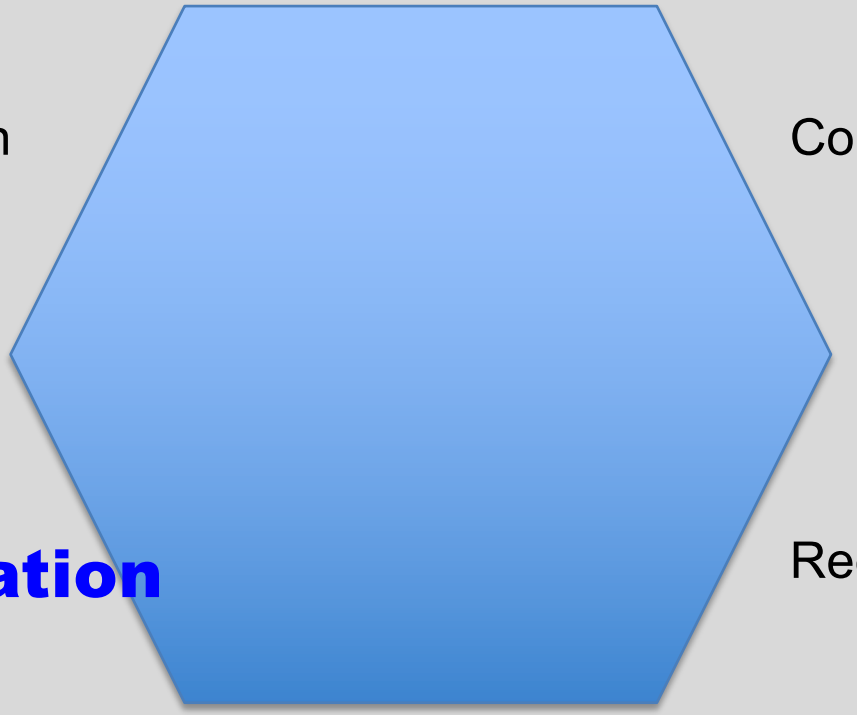
history, evolution, domains…

Identify the principles behind computing

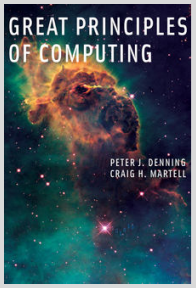


Great Principles of Computing
Peter J. Denning and Craig H. Martell,
2015

Principles categories

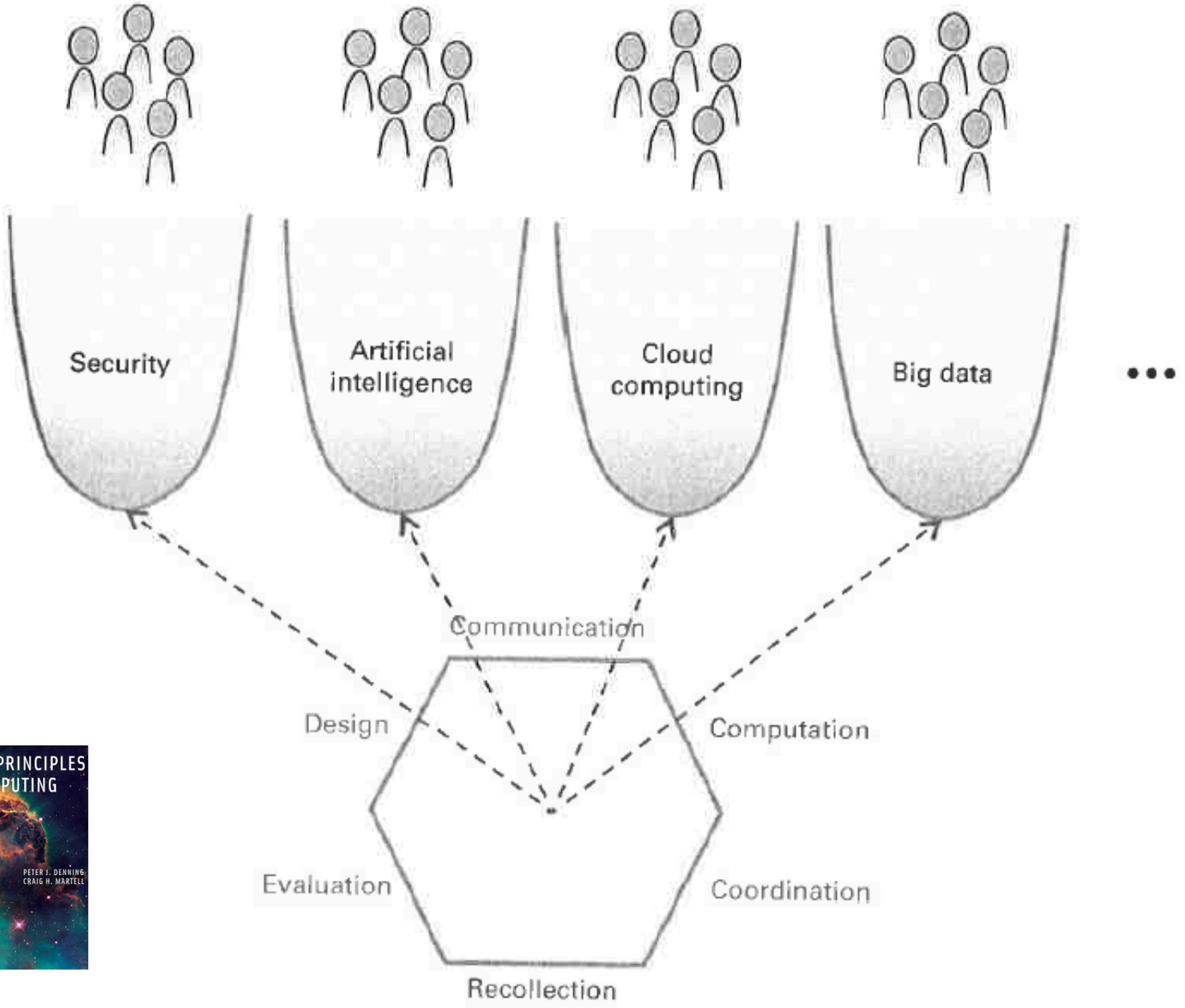


"The six categories do not divide the computing knowledge space into separete slices. They are like windows of a exagonal kiosk. Each window see the inside space in a distinctive way; but the same thing can be seen in more than one window."



computing domains

communities of practice

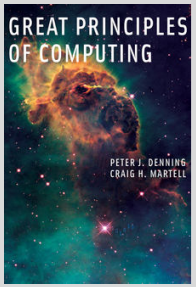


"I have strongly advocated that performance modeling and engineering are fundamental parts of computer science"
P. Denning

1. Computing
2. Domains

3. Information
4. Machines
5. Programming
6. Computation
7. Memory
8. **Parallelism**
9. **Queueing**
10. Design
11. Networking

Cooperative parallelism
Competitive parallelism



A broader issue

University as a utilitarian organization

Pursuit of knowledge immediately useful for the economy

Training of workers, leaving mostly on the side the education of human beings and citizens

Juan Carlos De Martin
Tuesday, February 28, 2017 at 12:00 pm
Berkman Klein Center for Internet & Society at Harvard University

Five Global Challenges and the Role of University
Berkman Faculty Associate, Juan Carlos De Martin
with Berkman Klein founder, Charlie Nesson

https://demartin.polito.it/node/190

A broader issue

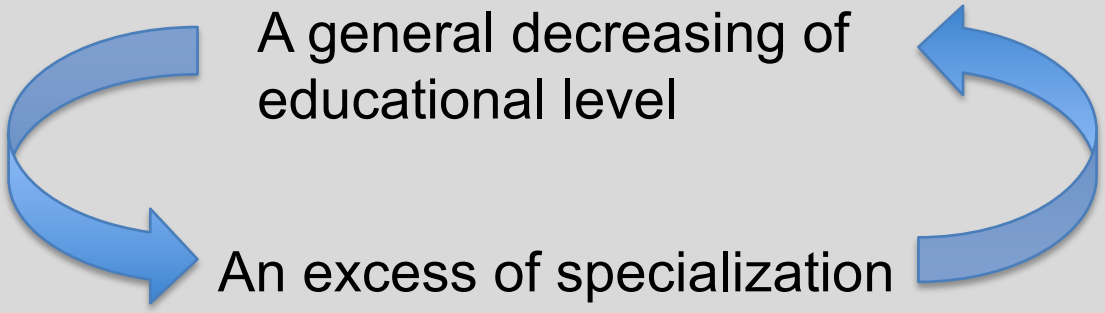
The aim of higher education

"The aim of higher education is not merely to prepare students for jobs. It is to prepare them to lead, innovate, and contribute meaningfully to the world around them"
SATISH K. TRIPATHI

"Higher learning can offer individuals and societies a depth and breadth of vision absent from the inevitably myopic present. Human beings need meaning, understanding and perspective as well as jobs.
The question should not be whether we can afford to believe in such purposes in these times, but whether we can afford not to."
DREW FAUST

"Humanity will need
knowledge (both old and new) more than ever before
people capable of interpreting, using, producing such knowledge more than ever before
that as many people as possible are critical thinkers"
JUAN CARLOS DE MARTIN

University as a utilitarian organization + crisis



In several fields, the negative effects start to be evident

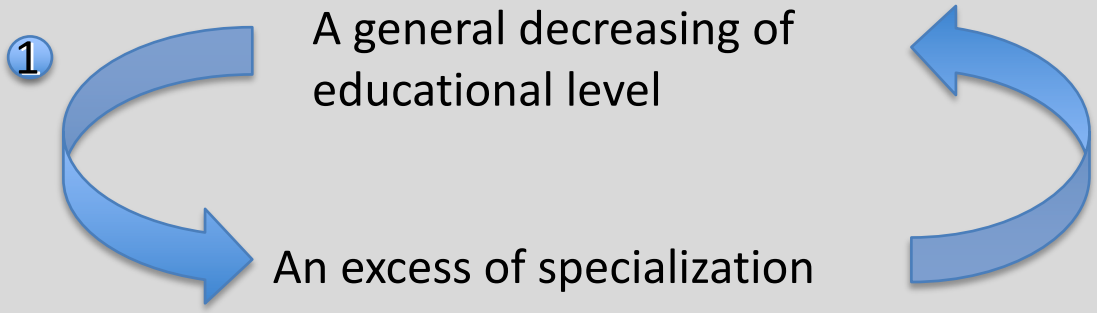
general lack of professionalism

general lack of ability to face with unexpected situation

I think this will lead to a route change

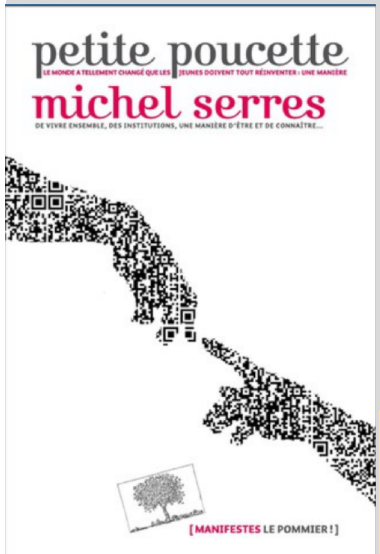
Last but not least

1. A general decreasing of educational level



An excess of specialization

2. Students are changed



Information is not knowledge

Need to transform the excess of information in Knowledge

Michel Serres
Thumbelina: the culture and technology of millennials

http://www.repubblica.it/cultura/2015/04/18/news/michel_serres_cari_filosofi_fermatei_danni_dell_ipertrofia_tecnologica_-112269911/

"Before to teach someone something, you must at least know him" (her)
Michel Serres

The conclusion

just a line of discussion

1. **The educational process is in crisis (and maybe PM too)**
   - economical crisis
   - students are changed
2. **The future needs of critical thinking** — political and social issue
3. **The modeling activity**
   - formalism
   - representation
   - interpretation
   - intuition

is a good training for critical thinking

Thanks

Giulietta
Nicola
Francesco

André Bondi
André van Hoorn
Gianfranco Balbo
Giuseppe Serazzi
Harry G. Perros
Peter Denning