UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"Reliability, Availability and Performance of Data Centers and Clouds"

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Short Abstract:

In this short course we will expose methods used in reliability, availability, performability and survivability modeling and analysis of systems in practice. Non-state-space solution methods are often used to solve reliability block diagrams, fault trees and reliability graphs. Relatively efficient algorithms are known to handle systems with hundreds of components and have been implemented in many software packages. We will show the usage of these model types through practical examples and via the software package SHARPE. Nevertheless many practical problems cannot be handled by such algorithms. Bounding algorithms are then used in such cases as was done for a major subsystem of Boeing 787. Non-state-space methods derive their efficiency from the independence assumption that is often violated in practice. State space methods based on Markov chains, stochastic Petri nets, semi-Markov and Markov regenerative processes can be used to capture various kinds of dependencies among system components. Markov models, Markov Reward models and stochastic Petri nets will be illustrated through practical problems and using the SHARPE software package. However, the resulting state space explosion severely restricts the size of the problems that can be solved. Hierarchical and fixed-point iterative methods provide a scalable alternative that combines the strengths of state space and non-state-space methods and have been extensively used to solve real-life problems. The use of hierarchical and fixed point iterative methods will be also illustrated via large system examples and the SHARPE software package.

Course Contents in brief:

- Reliability and Availability Modeling in Practice
- Markov Chains and Stochastic Petri Nets in Performance and Reliability Modeling
- Performance and Reliability of Clouds
- Software aging and rejuvenation; Software Fault Tolerance via Environmental Diversity

Total # of hours: 20

Day 1 8.30-13.30

covered subjects: Definitions, Reliability Block Diagrams, Fault Trees, Reliability Graphs with Applications and the use of the SHARPE software package

Day 2 8.30-13.30

covered subjects: Markov Chains and Stochastic Petri Nets in Performance and Reliability Modeling with Applications and the use of the SHARPE software package

Day 3 8.30-13.30

covered subjects: Performance, Availability, Power Modeling and Optimization of clouds

Day 4 8.30-13.30

covered subjects: Software reliability, software aging and rejuvenation; software Fault Tolerance via Environmental Diversity

Day 5 9.00-13.00

Final exam

References:

[1] Trivedi K. S., Prob. & Stat. with Rel., Que., and Comp. Sc. Appl., Wiley, 2001.

[2] Scalable Analytics for IaaS Cloud Availability, Ghosh R., Longo F., Frattini F., Russo S., Trivedi K. S., IEEE T. Cloud Computing, 2014.

[3] Fighting Bugs: Remove, Retry, Replicate and Rejuvenate, Grottke M. and Trivedi K. S., IEEE Computer, 2007.

[4] Availability Modeling of SIP Protocol on IBM WebSphere, Trivedi K. S., Wang D. , Hunt D., Rindos A. , Smith W. , and Vashaw B., Proc. PRDC 2008.

[5] Stochastic Model Driven Capacity Planning for an Infrastructure-as-a-Service Cloud, Ghosh R. , Longo F., Xia R., Naik V. and Trivedi K., IEEE Trans. On Services Computing, 2014.

[6] K. Trivedi, A. Bobbio and J. Muppala, Reliability and Availability Engineering, Cambridge Univ. Press, 2016

[7] R. Sahner, K. Trivedi and A. Puliafito, Performance and Reliability Analysis of Computer Systems: An Example-Based Approach Using the SHARPE Software Package, Kluwer, 1996

[8] Trivedi K. and Sahner R., SHARPE at the Age of Twenty two, ACM SIGMETRICS, Performance Evaluation Review, 2008

[9] Vaidyanathan K. and Trivedi K., A Comprehensive Model for Software Rejuvenation, IEEE-TDSC, 2005.

[10] Grottke, M.; Kim, D.S.; Nambiar, M.; Natella, R.; Mansharamani, R.; Trivedi, K.S. "Recovery from software failures caused by Mandelbugs." To appear in IEEE Transactions on Reliability, 2016.

CV of the Teacher

Kishor Trivedi holds the Hudson Chair in the Department of Electrical and Computer Engineering at Duke University, Durham, NC. He has been on the Duke faculty since 1975. He is the author of a well known text entitled, Probability and Statistics with Reliability, Queuing and Computer Science Applications, originally published by Prentice-

Hall; a thoroughly revised second edition (including its Indian edition) of this book is published by John Wiley in 2001. He has also published two other books entitled, Performance and Reliability Analysis of Computer Systems, published by Kluwer Academic Publishers and Queueing Networks and Markov Chains, John Wiley. He is a Fellow of the Institute of Electrical and Electronics Engineers. He has published over 500 articles and has supervised 46 Ph.D. dissertations. He is the recipient of IEEE Technical Achievement Award for his research on Software Aging and Rejuvenation. He works closely with industry (in particular, IBM, NEC, Huawei) in carrying out projects on reliability/availability and survivability analysis, software aging and rejuvenation, providing short courses on reliability, availability, performability evaluation and in the development and dissemination of software packages such as SHARPE and SPNP.

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*