ICOM 6115: COMPUTER SYSTEMS PERFORMANCE MEASUREMENT AND EVALUATION
Fall 2006
Syllabus

***Instructor**: Nayda G. Santiago, Nayda.Santiago@ece.uprm.edu, S-215*
***Time and Location**: To be arranged*
***Credits**:* 3
***Prerequisite**:* Knowledge on computer architecture and programming skills
***Course Objectives**:*

- Learn the fundamental techniques for measuring, simulating, and analyzing computer system performance.
- Learn to use appropriate statistical techniques to compare systems and interpret measured data.
- Learn how to develop and apply measurement tools and techniques.
- Learn how to use analytical modeling.
- Learn how to appropriately design experiments.
- Learn how to develop and use various types of simulations.
- Learn to choose an appropriate performance evaluation technique.

Required texts:

1. *Measuring Computer Performance: A Practitioner's Guide*, David J. Lilja, Cambridge University Press, 2000
2. Papers from the supplemental reading list. These papers are accessible through the IEEE digital library web site. If any of the papers are not available, the instructor will provide them.

Grading:

Homework 25%
Quizzes 25%
Project proposal 3%
Annotated bibliography 5%
Project presentation 10%
Attendance at project presentations 2%
Final project report 30%

Homework assignments. All homework assignments will be posted on the class web page. All assignments are due at the start of class on the indicated due date.

Quizzes. Several short (approx. 30 minute) quizzes will be given in class. There will be no make-up quizzes given. However, I will remove the lowest quiz score when computing final grades.

Project. The details of the course project will be described later. It will mostly consist on the evaluation and/or tuning of the performance of an application on a particular computing platform.

Class E-mail List:

Please add your name to the class e-mail list using the link on the class web page. It is very important that you add yourself to this list since some of the information for this class will be distributed via email.

Expected Course Outline

Introduction
- Measurement, simulation, analytical modeling
- Performance metrics
- Metric selection

Interpretation of measured data
- Measures of central tendency and variability
- Measurement errors and confidence intervals
- Comparing two alternatives
- ANOVA test

Measurement tools and techniques
- Timing, profiling, and tracing
- Benchmarking and Amdahl's Law
- Benchmark programs

Modeling
- Queueing analysis
- Design of experiments
- Regression models
- Additional models

Simulation
- Types of simulations
- Verification and validation

Project

Supplemental Reading List

1. Pradip Bose and Thomas M. Conte, "Performance Analysis and Its Impact on Design," *IEEE Computer*, Vol. 31, No. 5, May 1998, pp. 41-49.
2. P. J. Fleming and J. J. Wallace, "How Not To Lie With Statistics: The Correct Way To Summarize Benchmark Results," *Comm. ACM*, Vol. 29, No. 3, March 1986, pp. 218-221.
3. James E. Smith, "Characterizing Computer Performance with a Single Number," *Comm. ACM*, October 1988, pp. 1202-1206.
4. John R. Mashey, ‘‘War of the Benchmark Means: Time for a Truce,’’ *ACM SIGARCH Computer Architecture News*, Vol. 32, No. 4, September, 2004, pp. 1-14
5. J. L. Gustafson and Q. O. Snell, "HINT: A NewWay to Measure Computer Performance," *Hawaii International Conference on System Sciences*, 1995, pp. II:392-401.
6. John L. Henning, "SPEC CPU2000: Measuring CPU Performance in the NewMillennium," *IEEE Computer*, Vol. 33, No. 7, July 2000, pp. 28-35.
7. Daniel Citron, John Hennessy, David Patterson, and Guri Sohi, ‘‘The Use and Abuse of SPEC: An ISCA Panel,’’ *IEEE Micro*, July/August, 2003 Vol. 23, No. 4, pp. 73-77.
8. AJ KleinOsowski and David J. Lilja, ‘‘MinneSPEC: A New SPEC Workload for Simulation-Based Computer Architecture Research,’’ *Computer Architecture Letters*, Volume 1, June, 2002 pp. 10-13. (http://www.cs.virginia.edu/˜tcca/2002paps.html)
9. Lieven Eeckhout, Hans Vandierendonck, Koen De Bosschere, ‘‘Designing Computer Architecture Research Workloads,’’ *IEEE Computer*, February 2003, Vol. 36, No. 2, pp. 65-71. 10. Joshua J. Yi, David J. Lilja, and Douglas M. Hawkins, ‘‘A Statistically Rigorous Approach for Improving Simulation Methodology,’’ *International Symposium on High-Performance Computer Architecture (HPCA)*, February, 2003, pp. 281-291.

11. T. Sherwood, E. Perelman, G. Hamerly, and B. Calder, ‘‘Automatically Characterizing Large Scale Program Behavior,’’ *International Conference on Architectural Support for Programming Languages and Operating Systems*, 2002, pp. 45-57.
12. R. E. Wunderlich, T. F. Wenisch, B. Falsafi, J. C. Hoe, ‘‘SMARTS: Accelerating Microarchitecture Simulation via Rigorous Statistical Sampling,’’ *International Symposium on Computer Architecture*, 2003, pp. 84-95.
13. Lieven Eeckhout, Sebastien Nussbaum, James E. Smith, and Koen De Bosschere, ‘‘Statistical Simulation: Adding Efficiency to the Computer Designer’s Toolbox,’’ *IEEE Micro*, Sept-Oct, 2003, Vol. 23, No. 5, pp. 26-38.
14. B. Black and J. Shen, ‘‘Calibration of Microprocessor Performance Models,’’ *IEEE Computer*, Vol. 31, No. 5, May 1998, pp. 59-65.
15. P. P. Pande, C. Grecu, M. Jones, A. Ivanov, and R. Saleh, “Performance Evaluation and design trade-offs for network-on-chip interconnect architectures”, *IEEE Transactions on Computers*, Vol 54, No 8, August 2005, pp 1025-1040.

Additional References:

1. A performance evaluation method for optimizing embedded applications, Grunewald, M. Niemann, J.-C. Ruckert, U., System-on-Chip for Real-Time Applications, 2003. Proceedings. The 3rd IEEE International Workshop on 30 June-2 July 2003, pp 10 - 15
2. Performance Evaluation of a PC-based Active Router and Analysis of an Active Secure FTP Application, Fragkiadakis, A.G. Parish, D.J., Network Computing and Applications, Fourth IEEE International Symposium on 27-29 July 2005, pp. 283 - 286
3. Performance evaluation of software RAID vs. hardware RAID for Parallel Virtual File System, Hsieh, J. Stanton, C. Ali, R. , Parallel and Distributed Systems, 2002. Proceedings. Ninth International Conference on 17-20 Dec. 2002, pp 307 - 313
4. Internet traffic measurement, Williamson, C., Internet Computing, IEEE, Nov.-Dec. 2001, Volume: 5 , Issue: 6, pp 70 - 74
5. Software resource architecture and performance evaluation of software architectures, Woodside, C.M. , System Sciences, 2001. Proceedings of the 34th Annual Hawaii International Conference on Jan 3-6 2001, 10 pp.
6. Comparative Performance Evaluation for Information Distribution Methods in Satellite-based Sensor Networks, Bisio, I. Marchese, M. Portomauro, G. Mursia, A., Wireless Communication Systems, 2005. 2nd International Symposium on 5-7 Sept. 2005, pp 719 - 723
7. Performance evaluation of load-balanced clustering of wireless sensor networks, Gupta, G. Younis, M., Telecommunications, 2003. ICT 2003. 10th International Conference on 23 Feb.-1 March 2003, Volume: 2, pp 1577 - 1583 vol.2
8. An Experiment on Performance Study of IEEE 802.15.4 Wireless Networks, Jin-Shyan Lee, Emerging Technologies and Factory Automation, 2005. ETFA 2005. 10th IEEE Conference on 19-22 Sept. 2005, Volume: 2, pp 451 - 458
9. COTS cluster-based sort-last rendering: performance evaluation and pipelined implementation, Cavin, X. Mion, C. Filbois, A., Visualization, 2005. VIS 05. IEEE, 23-28 Oct. 2005, pp 111 - 118
10. Closing the gap: CPU and FPGA trends in sustainable floating-point BLAS performance, Underwood, K.D. Hemmert, K.S., Field-Programmable Custom Computing Machines, 2004. FCCM 2004. 12th Annual IEEE Symposium on 20-23 April 2004, pp 219 - 228

11. High Performance Linear Algebra Operations on Reconfigurable Systems, Ling Zhuo Prasanna, V.K., Supercomputing, 2005. Proceedings of the ACM/IEEE SC 2005 Conference, 12-18 Nov. 2005, pp 2 - 12
12. Performance evaluation of secure concurrency control algorithm for multilevel secure distributed database system, Kaur, N. Singh, R. Sarje, A.K. Misra, M. Information Technology: Coding and Computing, 2005. ITCC 2005. International Conference on 4-6 April 2005, Volume: 1, pp 249 - 254 Vol. 1
13. Performance evaluation of QoS routing algorithms, Maalaoui, K. Belghith, A. Bonnin, J.-M. Tezeghdanti, M., Computer Systems and Applications, 2005. The 3rd ACS/IEEE International Conference on 2005, 66
14. A performance evaluation of a quorum-based state-machine replication algorithm for computing grids, Busca, J.-M. Bertier, M. Belkouch, F. Sens, P. Arantes, L., Computer Architecture and High Performance Computing, 2004. SBAC-PAD 2004. 16th Symposium on 27-29 Oct. 2004, pp 116 - 123
15. Performance evaluation in computational grid environments, Liang Peng See, S. Yueqin Jiang Jie Song Stoelwinder, A. Hoon Kang Neo, High Performance Computing and Grid in Asia Pacific Region, 2004. Proceedings. Seventh International Conference on 20-22 July 2004, pp 54 - 62
16. Design, implementation and performance evaluation of GridRPC programming middleware for a large-scale computational grid, Tanaka, Y. Takemiya, H. Nakada, N. Sekiguchi, S., Grid Computing, 2004. Proceedings. Fifth IEEE/ACM International Workshop on 8 Nov. 2004, pp 298 - 305
17. Performance evaluation of OmniRPC in a grid environment, Nakajima, Y. Sato, M. Boku, T. Takahashi, D. Gotoh, H., Applications and the Internet Workshops, 2004. SAINT 2004 Workshops. 2004 International Symposium on 26-30 Jan. 2004, pp 658 - 664
18. Athena: a real-time performance evaluation for distributed software with reliability constraints, Hai Jin Xia Xie Yunfa Li Zongfen Han Hao Chen, Parallel and Distributed Processing Symposium, 2004. Proceedings. 18th International 26-30 April 2004, pp 247
19. Experimental performance evaluation of job scheduling and processor allocation algorithms for grid computing on metacomputers, Li, K., Parallel and Distributed Processing Symposium, 2004. Proceedings. 18th International, 26-30 April 2004, pp 170
20. Parallel program performance evaluation and their behavior analysis on an OpenMP cluster, Fei Cai Shaogang Wu Longbing Zhang Zhiming Tang, Cluster Computing and the Grid, 2004. CCGrid 2004. IEEE International Symposium on 19-22 April 2004, pp 508 - 514
21. Performance evaluation on grids: directions, issues, and open problems, Nemeth, Z. Gombas, G. Balaton, Z., Parallel, Distributed and Network-Based Processing, 2004. Proceedings. 12th Euromicro Conference on 11-13 Feb. 2004, pp 290 - 297
22. A performance evaluation tool for RAID disk arrays, Thomasian, A. Han, C. Fu, G. Liu, C., Quantitative Evaluation of Systems, 2004. QEST 2004. Proceedings. First International Conference on 27-30 Sept. 2004, pp 8 - 17
23. Performance evaluation integration into object-oriented design process, Dubakov, S., Science and Technology, 2004. KORUS 2004. Proceedings. The 8th Russian-Korean International Symposium on 26 June-3 July 2004, Volume: 1, pp 22 - 24 vol. 1