COE 402
Computer Systems Performance Evaluation

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Computer Engineering Department

KFUPM

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Administrative

- Office hours
  - SSMT, 12:00-1:00 PM, 22/144
  - By appointment: ubaroudi@kfupm.edu.sa or (03) 860-4283
- For updated information, frequently visit the class URL:
  - webcourses.kfupm.edu.sa

المفاتيح العشرة للنجاح الدراسي

- الطموح كنز لا يُفنى : لا يسعى للنجاح من لا يملك طموحاً
- العطاء يساوي الأخذ : النجاح عمل وجد وتضحية وصبر منح
- غير رأيك في نفسك : الإنسان يملك طاقات كبيرة وقوى خفية يحتاج أن يزيل عنها غبار التقصير والكسل ..
- النجاح هو ما تصنعه (فكر بالنجاح - أحب النجاح ...).. الناجحون لا ينجحون وهم جالسون لاهون ينتظرون النجاح
- الفشل مجرد حدث ..
- املأ نفسك بالإيمان والأمل : الإيمان بالله أساس كل نجاح .. وهو النور الذي يضيء لصاحبه الطريق ..
- اكتشف مواهبك واستفد منها
- الدراسة متعة .. طريق للنجاح : المرحلة الدراسية من أمتع لحظات الحياة .. ولا يعرف متعتها إلا من مر بها والتحق بغيرها .. متعة التعلم لا تضاهيها متعة في الحياة ..
- الناجحون يثقون دائماً في قدرتهم على النجاح
- النجاح والتفوق = 1% إلهام وخيال + 99% جهد واجتهاد

أبيت سهران الدجى وتبيتَه   نوماً وتَبْغِي بعد ذاك لَحاقي

Course Objectives

- This course covers following broad topics
    - Computer system performance evaluation methodologies
    - Measurement-based performance evaluation
    - Experimental design
    - Analytic (queuing) and simulation models and their analyses

- What is expected from the students
    - Understand the "science" before practicing the "art"
    - Analyze real computer system workloads (case studies)
    - Learn to use tools (e.g., matlab, opnet, etc.) and at least one language to analyze data (e.g., awk, perl, or even C/C++)
    - Learn to conduct all aspects of a performance study and write a report about it (term paper)

Grading policy:

- Homework and programming assignments (15%);
- Quizzes 10% **(EVERY other Tuesday)**
- Project 20%
- Exam–I (March 25th , 2005) 15%
- Exam-II (May 6th , 2005) 15%
- Comprehensive Final Exam 25%

General Policy

- *Check your exam schedule carefully. NO MAKE-UP EXAM will be given.*

- *NO LATE HOMEWORK will be accepted.*

- Minimum penalty for cheating is 0 for the homework/project/exam where it occurs.

- Exceeding **6 absences** without official excuse means DN grade automatically

- No WP grade will be given for poorly performing students

- *You are responsible for all the materials covered in the class. So, it is your responsibility to find out what has been covered in those unattended classes.*

Course Syllabus

- Overview of performance evaluation
- Measurement techniques and tools
  - Workload selection, monitoring, characterization, and analysis
  - Measurement-based analysis techniques and tools
  - Case study
- Experiment design and analysis
  - Selection of experimental factors and their variations; and confidence intervals
  - Case study
- Computer system modeling and analysis
  - Simulation modeling
    - Random number generation and analysis, simulation techniques/tools, and analysis of results
  - Analytical modeling
    - Basic queuing theory, queuing networks and their application to computer systems, operational laws, mean value analysis, and analysis of results
  - Case study

Resources

- Text
    - The Art of Computer System Performance Analysis by Raj Jain, John Wiely, 1991.
- Additional Material
    - Handouts
    - Posted on class WebCT

Why Evaluate Performance?

- Performance is central to computer systems
  - New hardware is typically faster than the existing one
  - New software is supposed to be "better" than the existing one
  - New protocol is proposed for better resource utilization
- Competition demands efficient products
  - Marketing a product that is slower than its competitors is hard
  - Highly efficient products can cut cost for customer
- Performance is central to any R&D effort
  - Need to compare similar architectures, algorithms, systems, etc.
  - Determine the efficacy of new designs
  - Understand the differences between different systems
- Let's look at three typical real life scenarios of performance evaluation…

Scenario # 1: Selecting a Desktop

- Various vendors provide a range of hardware
  - Range of CPUs: low-end to high-end
  - Range of RAM: 64M, 128M, 256M, 512M, etc.
  - IDE vs. SCSI disks
  - NIC: 10/100, GigabitEthernet card, etc.
  - Display: 8M, 16M, 32M, etc. video RAMS
  - CD/DVD/CD-R
- Selection criteria: "best" machine within your budget
- Things that help
  - Define or quantify "best"
  - Determine your application needs
    - Reading mail or using word processor does not require high-end h/w
    - Running simulations might require powerful CPU, large RAM, or both
  - Consider benchmark result (e.g., SPEC benchmark)
  - Make trade-offs within you budget
- A very simple performance analysis scenario
  - Common-sense can lead to right results

Scenario # 2: Designing a New Cache

- You need to compare your latest design of cache X with existing cache design Y
- Your approach
  - You are to use your company's simulator
  - You need to compare the two caches under identical conditions
  - You need a workload to simulate the real operating conditions
- Workload selection
  - What level of abstraction: memory access trace, assembly program, or high-level language program
  - What type of instruction mix: synthetic workload, benchmark programs, or real applications
  - What type of experiment design: cache parameter selection, number of experiments, and comparison of results
- Formal performance evaluation background is a valuable asset in such specialized application scenarios

Scenario # 3: More Common Case

- Determine specs for your company's latest web server product
    - Your manager needs to tell the press how great this product is
    - Also, he needs to know where his products stand wrt his competitor's products
    - You are asked to use only measurement-based tests
- Marketing Department's response
    - Select test conditions under which your company's product shines
    - Result: web server is at least 10 times faster than closest competitor's published performance!
- Engineering Department's response
    - Select one or more industry standard benchmarks
    - Select a range of operating conditions (be honest!)
    - Determine under what conditions your product is better/worse and why
    - Communicate with developers to fix performance bugs
- Knowing the whole truth will help your company as well as the customer
    - You should be familiar with relevant techniques and tools to contribute
    - You need diverse skills: architecture, OS, analysis tools, C/C++

Typical Performance Evaluation Cases

- Performance evaluation techniques and tools will by handy for following cases:
    - Select a computer
    - Select an operating system
    - Select a TCP/IP implementation for an OS
    - Select a hard drive for a set of clusters
    - Select a proxy server for an ISP
    - Select a local network architecture
    - Select experiments for your next research paper…
- All these cases may look unique
    - However, methodologies and tools may be common
    - It is an art to design and undertake a performance study