COMP 190-088
Systems Performance Analysis

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Role of Computing Systems

- Economy
  - Internet
  - Business-supporting software applications
    - Banks, Stock market, Databases and data analysis, …
- Health-care
  - Critical monitoring, diagnosis, and aid devices
  - Communications system
- Home/Consumer Device
  - Electronics, Appliances, Security systems, Cars
- Science, Advanced Technology, and Research
  - Internet
  - Space exploration
  - Genetic research

Critical dependence on computing systems!

Importance of System performance

- Historical examples of consequences of ignoring performance
  - Failure to fully **understand software performance issues** led to the aborted development of a new computer database system for the California Department of Motor Vehicles in 1994. The cost of abandonment was estimated to about $49 million.
  - The booster rockets on the space shuttle Challenger failed mechanically in 1986. The possibility of such a failure was known to NASA management but was ultimately ignored due, in part, to **underestimating the failure rates** by several orders of magnitude!
  - The Therac-25 medical electron accelerator caused two deaths in 1987 due to an **undetected software race condition**.

Important to understand system performance!

Systems Performance Analysis

- Systems
  - Software applications
  - Hardware devices
  - Distributed systems
- Performance Analysis

  Analysis of a System that results in information about the expected performance (output), resource usage (input) of a system and (possibly) that of its components.

How can System Performance Analysis help?

- Goal of system designers, users, and administrators:
  Achieve **highest** performance at **lowest** cost.
- Performance analysis (PA) is important to ensure that the alternative selected is best for:
  - Design of a system
  - Procurement of a system
  - Use of a system

Need basic knowledge of performance evaluation techniques

Examples problems that PA can help solve

- System Tuning
  - Determining an optimal value of a parameter
- Bottleneck Identification
  - Finding the performance bottleneck
- Workload Characterization
  - Characterizing the load on a system
- Capacity Planning
  - Determining the number and size of components
- Forecasting
  - Predicting performance with future loads/designs

Examples problems that PA can help solve

- Protection from ratio games
  - What metrics make sense?
- System Specification
  - Specifying performance requirements
- System Design
  - Evaluating design alternatives
- System Choice/Comparison
  - Comparing two or more commercial systems

PA skills very useful for careers in both industry and research!

What is involved in PA?

- Defining the system to be analyzed.
- Select appropriate evaluation techniques, performance metrics, and workloads for a system.
- Using simple queuing models to analyze the performance of a system/resource.
- Conducting performance measurements/monitoring.
- Design and implement simulation models
- Reducing number of monitoring/simulation experiments while isolating impact of and interaction between factors.
- Using proper statistical techniques to analyze results.
- Presenting the results in a meaningful/insightful manner.

Course Syllabus

- Performance evaluation methodologies
- Selection and characterization of metrics and workloads
- Measurements
  - Basic tools
- Analysis and visualization of measured data and results
- System Modeling
  - Simple Markovian models
- Simulations
  - Experimental design, random number generation, confidence intervals
- Case studies
  - PA of a web server, CPUs, disks, network interface, file system
  - Other applications through projects
- PA in the Research and Industrial community
  - Review of published research paper
  - Industry guest lectures

Books for Reference

- The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurements, Simulation, and Modeling
  R. Jain (1991)
- The Practical Performance Analyst,
  N. Gunther (2000)

Course Requirements

- Home assignments: 15%
  - Honor code
- Mid-term/Final: 35%
  - Focus on concepts
- Paper reading and review: 10%
  - Comparison of industry and research practices
- Project: 40%

Project

- Define a performance analysis problem on a system of your choice
- Example systems:
  - MySQL server, Quake server, Mpeg player/server, Compiler, …
- Conduct measurements
  - Analyze the data collected
- Simulate/Model the system
  - Predict and analyze performance
- Compare prediction to measured data
- Preferably, groups of 2
- Possibility of converting to an **honors project** and **summer research**
  - Let me know **soon** if you're interested

General Info

- Course number: COMP 190-088
- Course web page:
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