Advanced Operating Systems – Course Overview

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Course Goal

- What is Operating System?
- You all took the Operating Systems course. Any topic(s) you wish to have deeper exploration?
- This course looks at advanced topics
  - some already quite mature while others are topics of current research.
  - relate directly to real-world computer systems and practical problems.

Topic #1 – Network Servers

- Online applications and concurrency management
- Performance modeling of network servers
- Request tracking and workload monitoring
- Replication and consistency management
- Server infrastructure at Google
  - Google file system, mapreduce, ...

Topic #1 Example

- Server request propagation [work with Chris Stewart]
**Topic #2 - I/O and storage systems**

- Storage device characterization
- Concurrent I/O
- Data consistency with journaling
- Data persistence for delayed writes

**Topic #2 Example**

Characterization of two SCSI disk drives

![Graph showing seek time and read throughput for two SCSI drives](image)

**Topic #3 - Performance measurement**

- Measurement of concurrent servers
  - target measure: response time, throughput, ...
  - measurement stability/scalability
- Measurement confidence
  - confidence intervals, hypothesis testing, t-test, ...
- Regression-based modeling
  - linear/polynomial fitting, exponential fitting, double-exponential/power-law fitting, ...
- Workload characterization and benchmarking

**Topic #3 Example - System Metric Comparison**

A metric (latency of a system call, number of outstanding I/O requests) is represented as a distribution of samples

![Probability density comparison](image)

- How to diff two distributions?
  - difference on expected means
  - earth mover's distance (difference in shape)
Topic #4 - Virtualization

- Virtual machine overview
- Virtual machine I/O processing
- Virtual machine memory management
- Virtual machine for manageability, reliability, data durability, ...

Topic #4 Example

- Virtual machine adjustment of memory allocation
  [work with Pin Lu]

- SPECweb99
- Index searching
- TPC-H

Topic #5 - System dependability

- Scalable model checking
- Anomaly detection and characterization
- Comprehensive anomaly depiction
- Error monitoring

Topic #5 Example

- Memory hardware errors
  [work with Xin Li and Michael Huang]
Topic #6 – Hardware-related issues

- OS utilization of processor hardware counters
- OS issues with multi-core processors
  - CPU scheduling
  - Cache space allocation

Assignments and the final project

- Probable assignments
  - computer system performance measurement
  - analysis of real system traces
  - some OS kernel work – likely related to the I/O system
- Final project
  - encouraged to do something you are interested
    (something directly related to your AI/theory research)
  - there will be some fallback options
- System programming (C/C++) and data processing (Perl)
- Turn in written reports
- No exams