Course Summary

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Computer Systems

System utilities
- shell
- vi
- make
- gdb

Programming language
- C
- S
- O
- a.out
- a
- .so

Linker
- Compiler
- Assembler
- Loader/Dynamic Linker

System call interface

Operating system
- I/O Networking
- File systems
- Processes/threads
- Virtual memory

Binary representation
- Byte ordering
- Instruction Set Architecture (ISA)
- Memory Management Unit (MMU)
- Pipelining

CPU
- Memory hierarchy
- Locality caching
Performance Issues

- There’s more to performance than asymptotic complexity.
  - Constant factors matter too!
    - Easily see 10:1 performance range depending on how code is written.
    - Must optimize at multiple levels: algorithm, data representation, procedures, and loops
  - Must understand system to optimize performance
    - How programs are compiled and executed.
    - How to measure program performance and identify bottlenecks.
    - How to improve performance without destroying code modularity and generality.
Well...

Well...

Well...

The end ??

No! It is the beginning of many important courses you MUST take!!!
Want More?

- **Computer Architectures**
  - How to design an Instruction Set Architecture (ISA)?
  - How to build a high performance processor?

- **Programming Languages**
  - Means for high-level programming

- **Compilers**
  - Bridging the Semantic Gap
  - Machine-independent optimizations
  - Machine-dependent optimizations

- **Operating Systems**
  - Provides system calls for application programming
  - Resource sharing & management: CPU, memory, devices, etc.

- **Computer Networks**
  - How to make the communication between machines work?

- **Database Systems**
  - One of serious applications that needs system-level support

- **Embedded Systems**
  - Special purpose
  - Limited resources
  - Low-power requirement

- **Distributed Systems**
  - Applications and services that span multiple computers
Last Reminder..

- Final exam
  - 6/17 (Wednesday) 15:00 – 17:00

- Thank you!