Today’s Outline

- **Admin:**
  - HW #5 Partner Selection - due TONIGHT, Nov 10 at 11:45pm – send email to Chris
  - Midterm #2, Wed Nov 17th.
  - HW #5 due Monday, Nov 22 at 11:45pm

- Memory Hierarchy and Locality

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Why do we need to know about the memory hierarchy/locality?

- One of the assumptions that Big-Oh makes is that all operations take the same amount of time.
- Is that really true?

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**Definitions**

- **Cycle** – (for our purposes) the time it takes to execute a single simple instruction. (ex. Add 2 registers together)
- **Memory Latency** – time it takes to access memory

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**Moore’s Law**

![Moore’s Law Graph](image-url)
Processor-Memory Performance Gap

- x86 CPU speed (100x over 10 years)

What can be done?

- **Goal**: Attempt to reduce the number of accesses to the slower levels.
- **How?**

Locality

**Temporal Locality** (locality in time) – If an item is referenced, it will tend to be referenced again soon.

**Spatial Locality** (locality in space) – If an item is referenced, items whose addresses are close by will tend to be referenced soon.

Caches

- Each level is a sub-set of the level below.

**Cache Hit** – address requested is in cache

**Cache Miss** – address requested is NOT in cache

**Cache line size** (chunk size) – the number of contiguous bytes that are moved into the cache at one time

Examples

\[
x = a + 6; \\
y = a + 5; \\
z = 8 * a;
\]

\[
x = a[0] + 6; \\
y = a[1] + 5; \\
z = 8 * a[2];
\]

Locality and Data Structures

- Which has (at least the potential for) better spatial locality, arrays or linked lists?