Data Structures in The Real World: Databases & Expert Systems

- Databases are the lifeblood of E-Commerce & Medical Info Systems
  - **Examples:**
    - Given a key (credit card number) find the account record.
    - Given a patient ID, find the most recent X-rays.
  - **Problem:** Mismatch of disk access and main memory:
    - Main Memory access < 10 nanosec ($10^{-8}$ sec)
    - Disk access < 10 millisec ($10^{-2}$ sec)
  - **Solution:** Use data structures and algorithms to overcome mismatch:
    - B-Tree is a balanced multi-way search tree of order $N$: $\leq N$ children
    - Keys in left child are less than parent’s key, keys in right child are $\geq$
    - Within a node: keys are in sorted order $\Rightarrow$ use binary search.

- Result: only 3 disk accesses to find any one of 100 million records:
  - 100 children per node; 4 level tree; $10^{+8} = 100$ million.
  - All leaves are at same level (3 below root); keep root in memory.
Banks Merge: combine common accounts

- Combine accounts from Bank-A and Bank-B for matching Social Security Numbers:
  - Create two Hash Table indices of SS# and account info for each bank, using common hash function.
  - Merge hash tables and combine entries - is database “Hash-Join”
  - Also could do with one hash table.
Expert Systems and Decision Making

- Decision Trees and Game Trees - actually graphs.

- *Node* for each *decision* (or game position).

- *Branch/*edge for each *choice* (or game move).
  - Weight on edge is "*cost*" of that choice.
  - Value in leaf is profit/*benefit* of reaching that goal (win/loose).

- *Path* from root to a leaf is the *plan* or *solution*.
  - *Optimize* the cost or likelihood of success.

- Overall graph is the ‘*decision space*’ or ‘*plan space*’.

- Another example:
  - Rule-based Expert Systems use a ‘Rete net’ *graph* to represent the interdependent rules, and to determine which rules can be executed when.