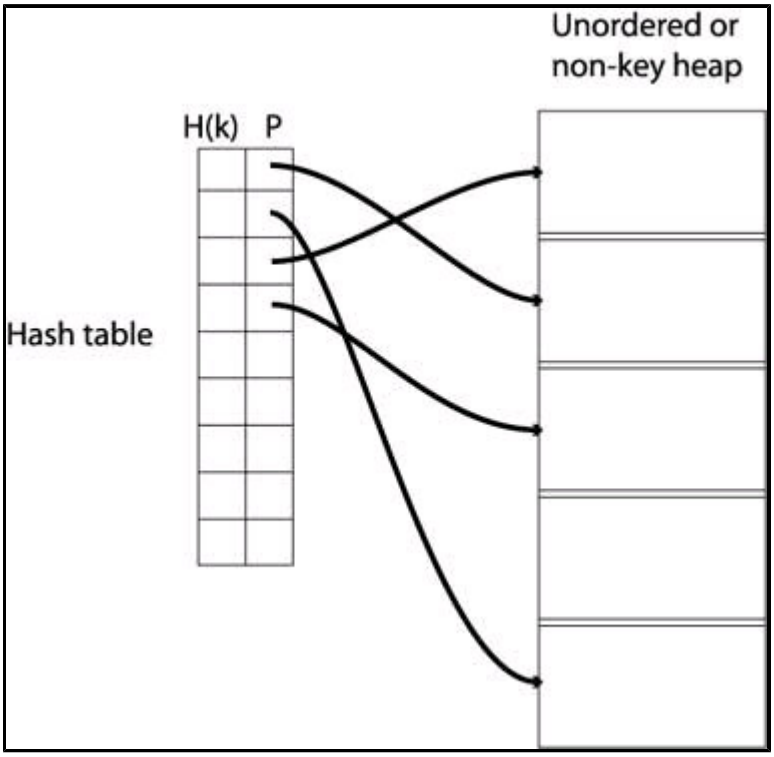
2.3. B-trees

In this lecture we look at...

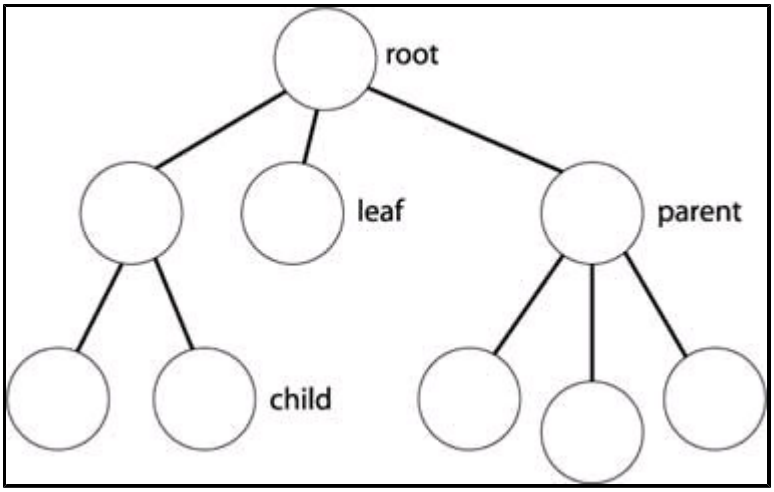
2.3.01. Hash tables

- Used to implement Indicies
- O(n) access
- Ordering Key Field (K) as argument to Hash function H()
- Address H(K) maps to pointer



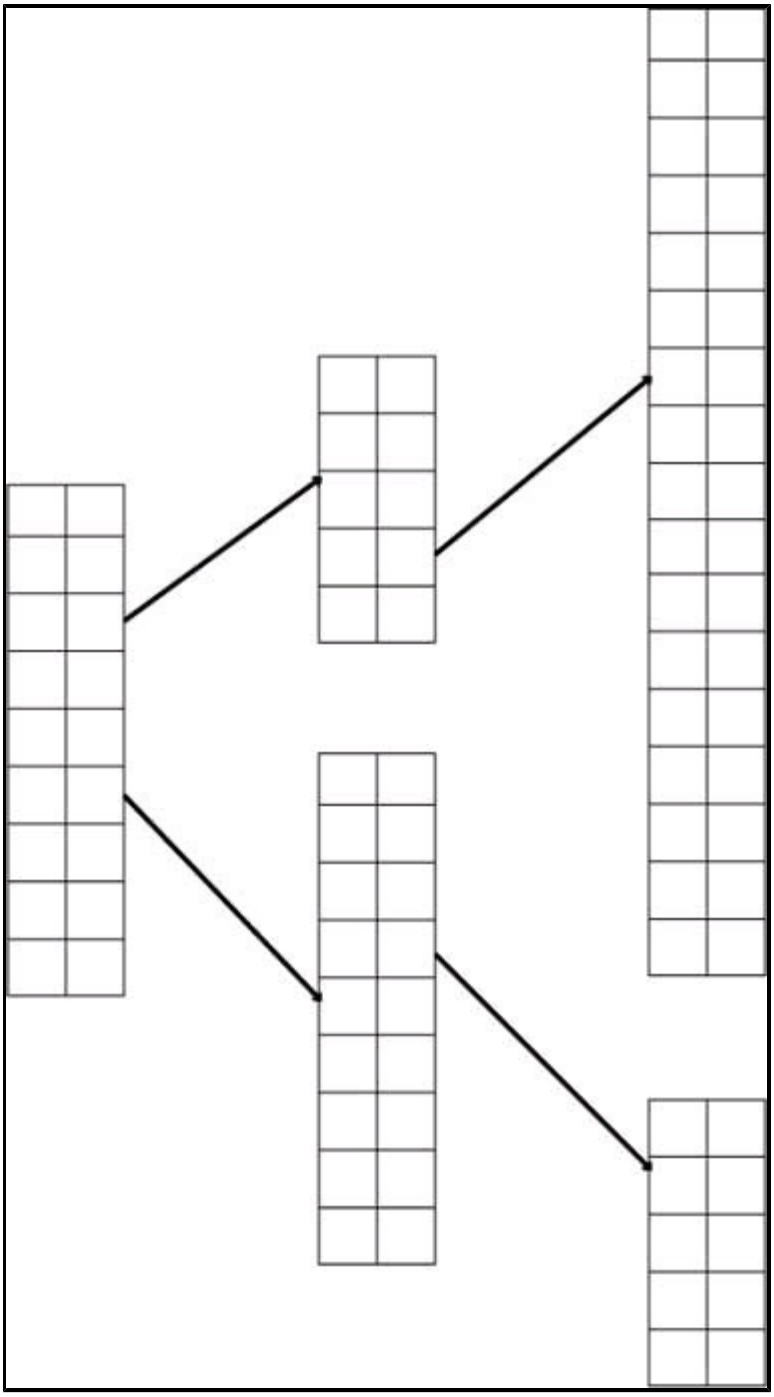
2.3.02. Tree structure

- Tree revision
- Node based
- Branching nodes/leaf nodes
- Parent/child nodes
- Root node
- Cardinality



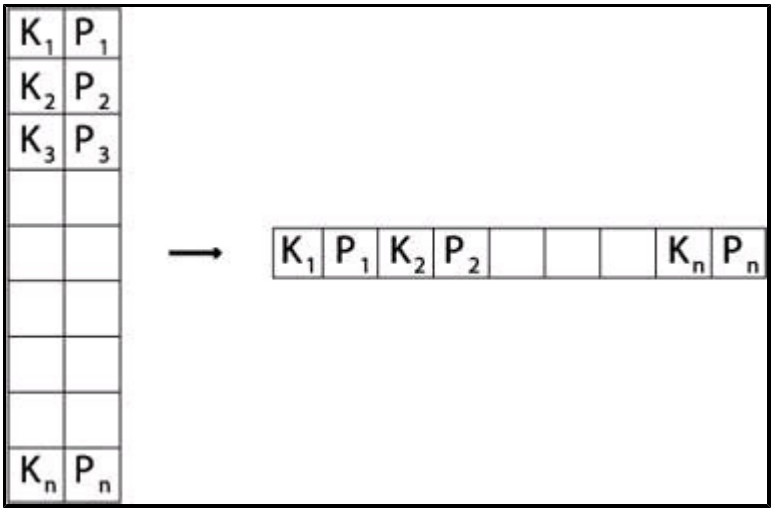
2.3.03. Multi-level indices

- Multi-level indices
- One index indexes another
- Implemented by multiple hash-tables
- <H(k),P> pairs
- *(data far right)*



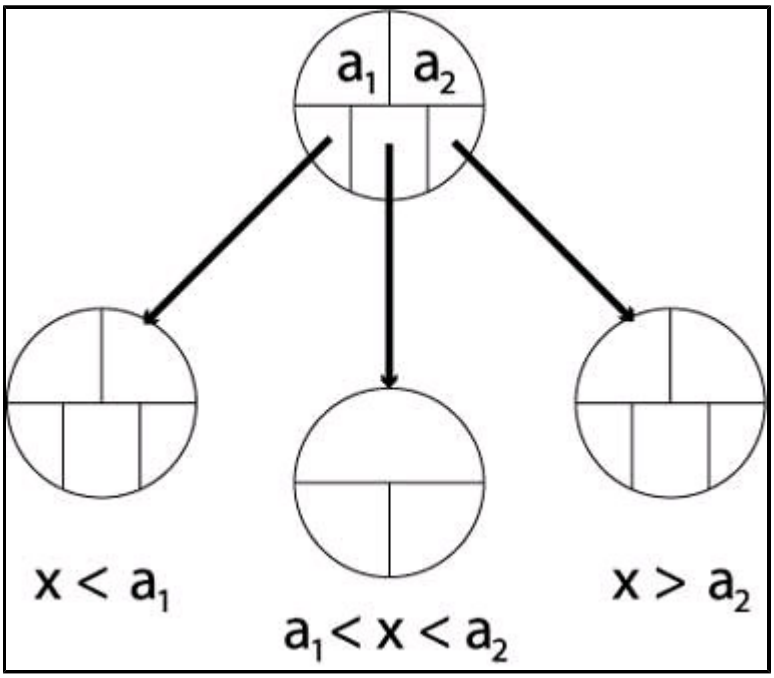
2.3.04. Index zipping

- Collapsing a single index
- Two columns become one
- <H(k),P> pairs sequentially stored
- Common in the Elmasri



2.3.05. B-tree

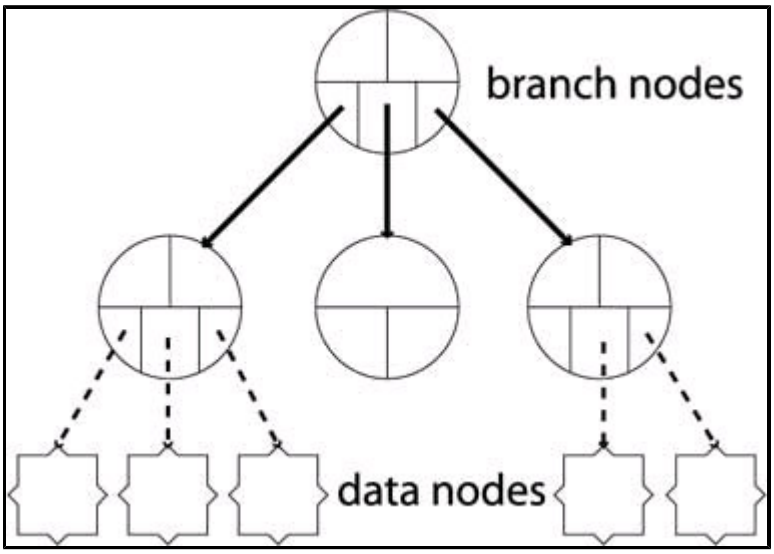
- Paritioning structure
- Each node contains keys & pointers
- Pointers can be:
  - Node pointers - to child nodes
  - Data pointers - to records in heap
- Number of keys = Number of pointers - 1
- Every node in the tree is identical



2.3.06. B+ trees

- Similar to B-trees
- Different types of nodes

    - Branching nodes
    - Leaf nodes
- Each branching node has:
- At most U children (max U)
- At least L children (min L)
- U = 2L, or U = 2L-1

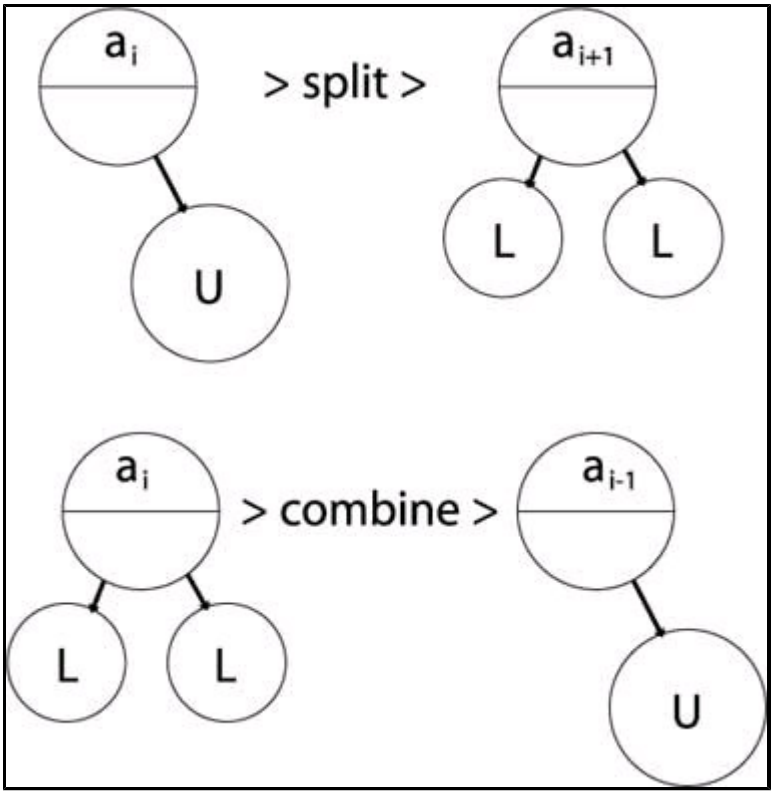


2.3.07. Properties of B+ trees

- Balanced
- All leaf nodes at same level
- Record search takes same time for every record
- Partitioning needs to be comprehensive
- B-tree: $a_1 < x < a_2$
- B+tree: $a_1 <= x <= a_2$
- Why?
    - because all data for partition values must be in the lowest level of the tree

2.3.08. B+ tree operations

- Insert operation cascades from bottom
- Rules: node can contain U children (max)
- Node combine
    - Legal if child nodes contain L children
    - Parent loses one key/paritition value
- Node split
    - Legal if node contains U children
    - Parent node gains one key/partition value
        - Can cause cascade up tree & rebalancing


a_i
> split >
a_{i+1}
U
L
L
a_i
> combine >
a_{i-1}
L
L
U