
DATABASE

CSE3103 : Database

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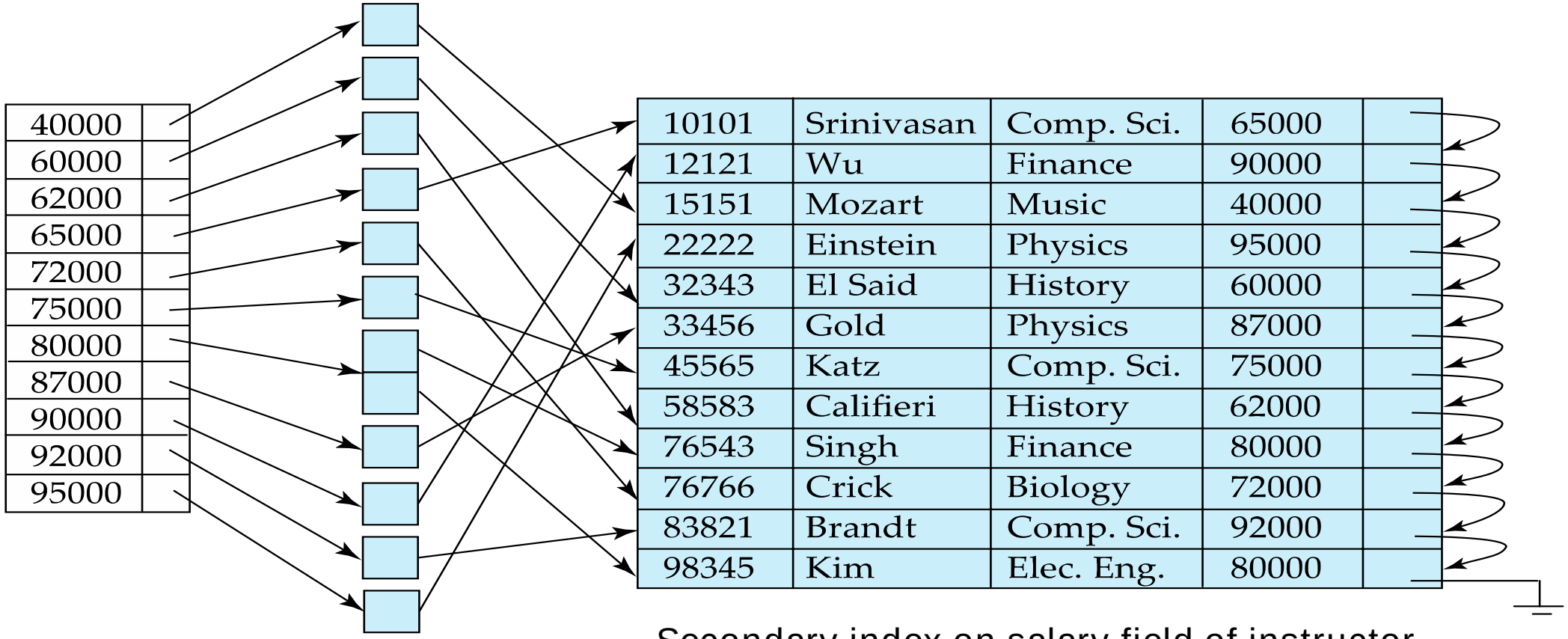
Secondary Indices

- Frequently, one wants to find all the records whose values in a certain field (which is not the search-key of the primary index) satisfy some condition.
  - Example 1: In the *instructor* relation stored sequentially by ID, we may want to find all instructors in a particular department
  - Example 2: as above, but where we want to find all instructors with a specified salary or with salary in a specified range of values
- We can have a secondary index with an index record for each search-key value

Secondary Indices Example



Secondary index on salary field of instructor

- Index record points to a bucket that contains pointers to all the actual records with that particular search-key value.
- Secondary indices have to be dense.

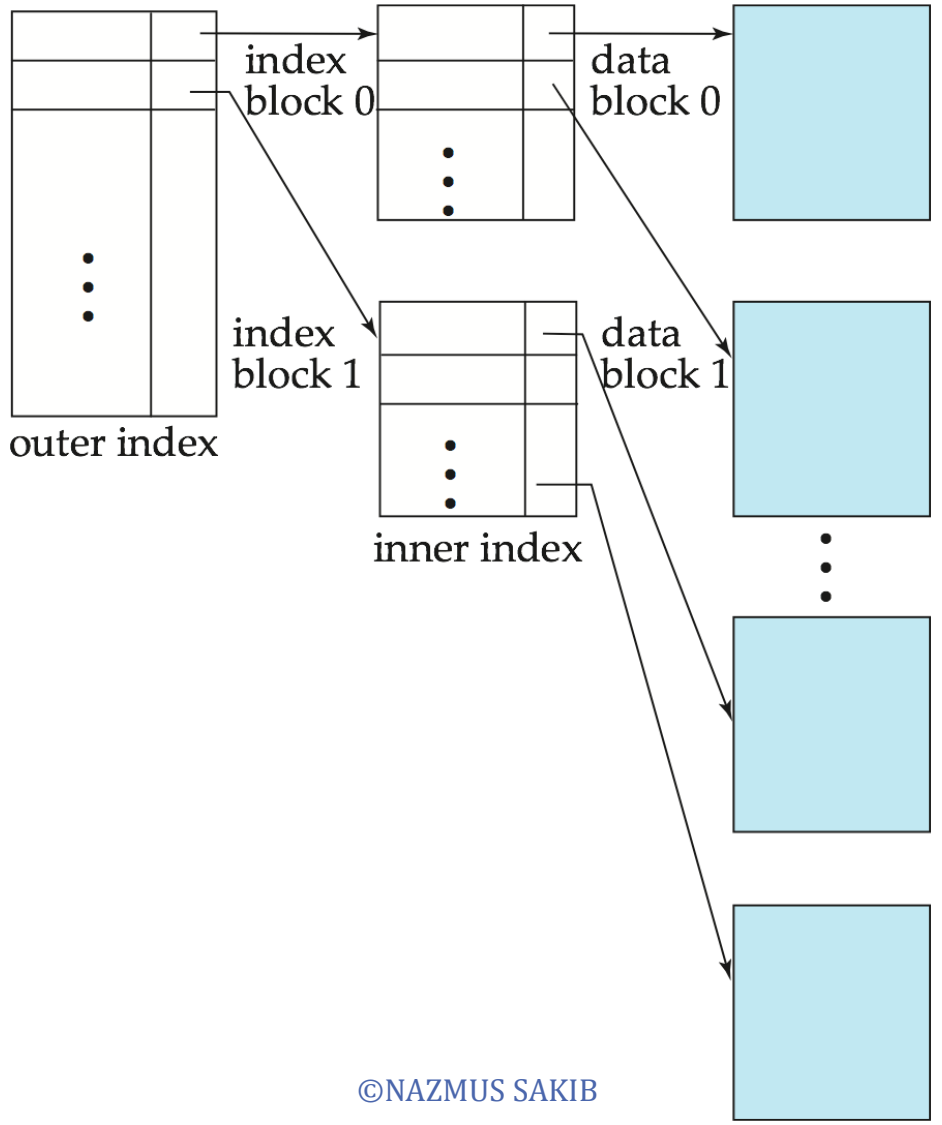
Primary and Secondary Indices

- Indices offer substantial benefits when searching for records.
- BUT: Updating indices imposes overhead on database modification --when a file is modified, every index on the file must be updated,
- Sequential scan using primary index is efficient, but a sequential scan using a secondary index is expensive
  - Each record access may fetch a new block from disk
  - Block fetch requires about 5 to 10 milliseconds, versus about 100 nanoseconds for memory access

Multilevel Index

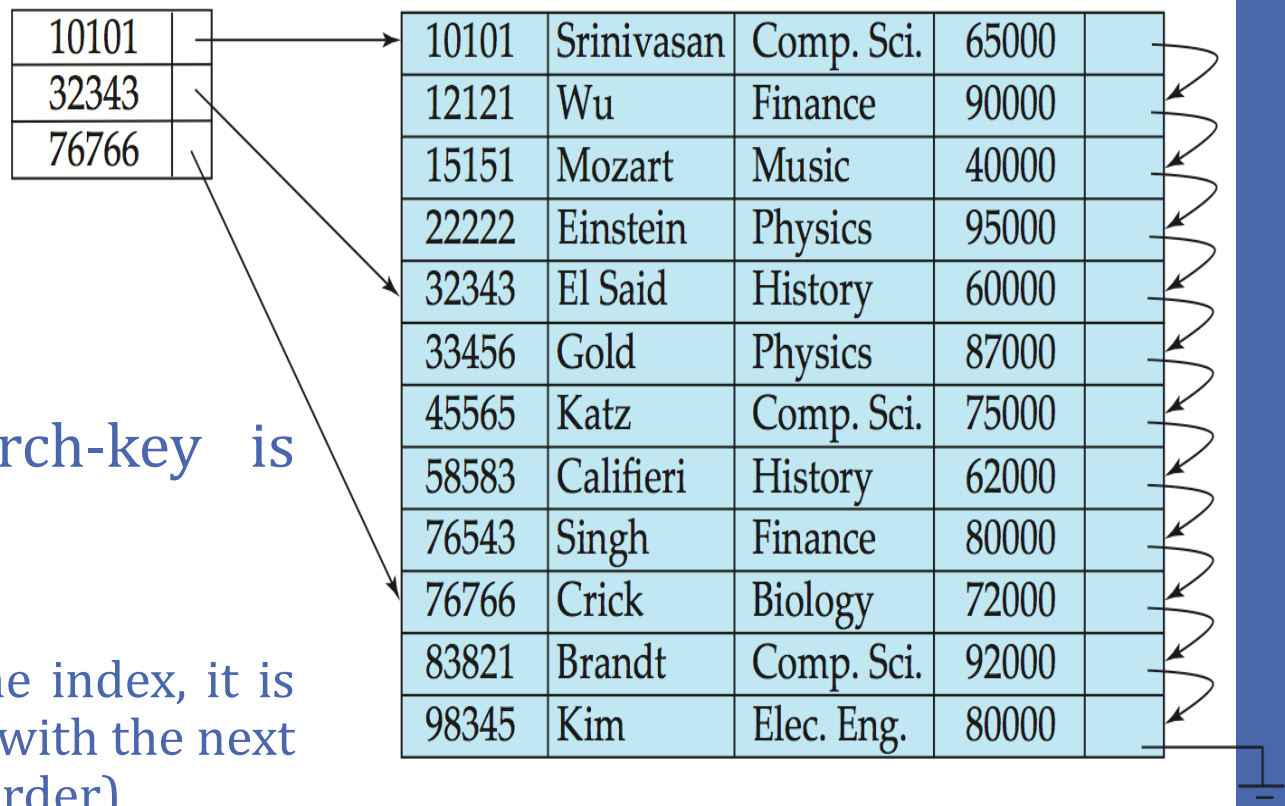
- If primary index does not fit in memory, access becomes expensive.
- Solution: treat primary index kept on disk as a sequential file and construct a sparse index on it.
  - outer index – a sparse index of primary index
  - inner index – the primary index file
- If even outer index is too large to fit in main memory, yet another level of index can be created, and so on.
- Indices at all levels must be updated on insertion or deletion from the file.

Multilevel Index (Cont.)



Index Update: Deletion

- If deleted record was the only record in the file with its particular search-key value, the search-key is deleted from the index also.



- **Single-level index entry deletion:**
  - **Dense indices** – deletion of search-key is similar to file record deletion.
  - **Sparse indices** –
    - if an entry for the search key exists in the index, it is deleted by replacing the entry in the index with the next search-key value in the file (in search-key order).
    - If the next search-key value already has an index entry, the entry is deleted instead of being replaced.

Index Update: Insertion

- **Single-level index insertion:**
  - Perform a lookup using the search-key value appearing in the record to be inserted.
  - **Dense indices –** if the search-key value does not appear in the index, insert it.
  - **Sparse indices –** if index stores an entry for each block of the file, no change needs to be made to the index unless a new block is created.
    - If a new block is created, the first search-key value appearing in the new block is inserted into the index.
- **Multilevel insertion and deletion:** algorithms are simple extensions of the single-level algorithms


DBMS
data
distributed
database
parallel
shared
system
architecture
network
processing
systems
Distributed
DBMSs
DDBMS
memory
processors
access
centralized
performance
multiple
sites
Parallel
processor
single
sometimes
local
may
fragments
typically
site
require
physically
users
applications
computers
nothing
Shared
technology
computer
disk
stored
logically
number
provide
decentralized
large
one
application
management
transparent
bottleneck
interconnection
Figure
administered
organizational
distinction
logical
development
definition
nodes
control
scalability
approach
improve
Database
within
machines
like
major
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across
reliability
eliminates
communication
distribution
computing
split
order
scalable
architectures
referred
operational
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structure
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System
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directly
com
Date
Management
makes
per
user
dis
way
incompatible
global
independently