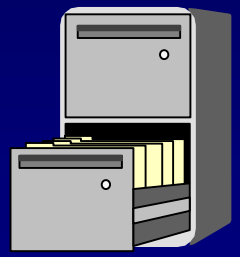
File Structures

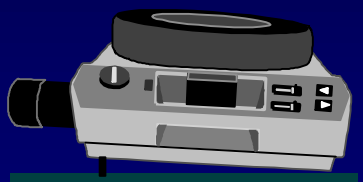
An Introduction



สมชาย ประสิทธิ์จูตระกูล

Outline

- Introduction
- Basic Concepts
- Secondary Storage
- Sequential Files
- Direct Files
- Indexed Files
- Tree-Based Files
- Multilist & Inverted Files



Managing Large Quantities of Data

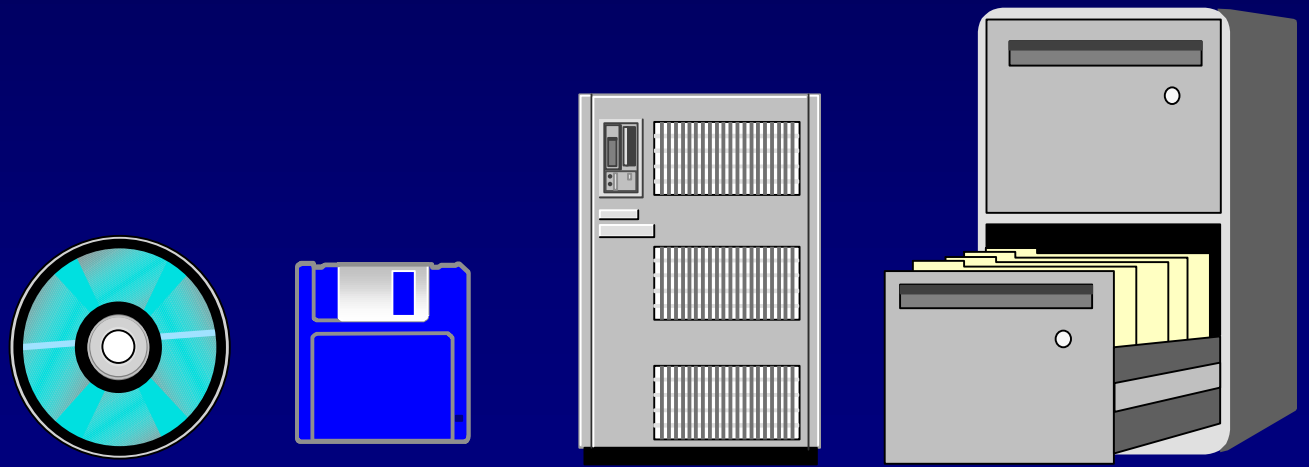
- Accessed by multiple people and programs
- Kept on external storage devices
- Always reliably available for processing
- Rapidly accessible when information is needed

Speed & Capacity

- Disks are slow.
  - RAM ≈100 ns
  - Disk ≈10 ms
- Disks provide enormous capacity.
  - RAM ≈10 MB (volatile)
  - Disk ≈1000 MB (nonvolatile)

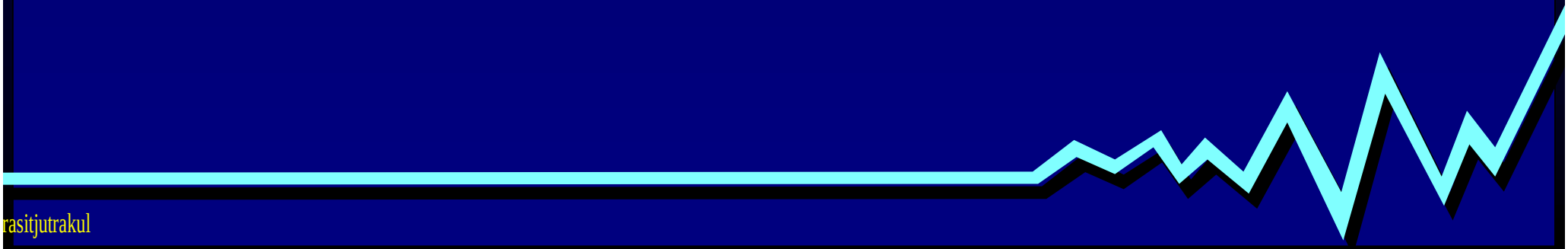
Design Goal

Minimizing disk accesses for files that keep changing in content and size.



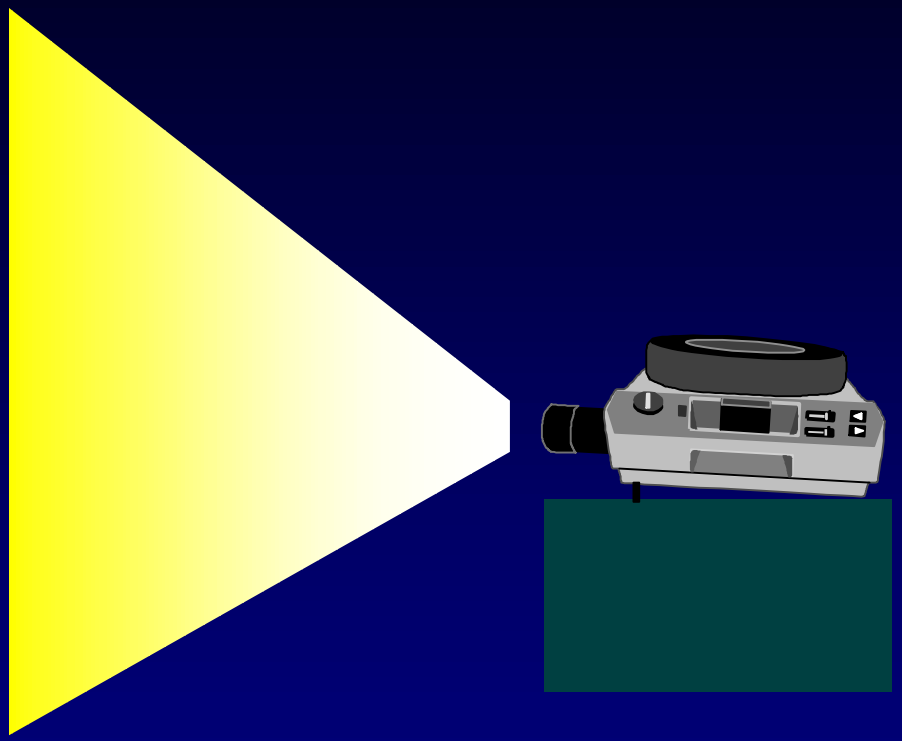
A Short History

- 1950s : Sequential access + indexes
- 1960s : Tree Structures
- 1970s : B-tree
- 1980s : Extendible Hashing

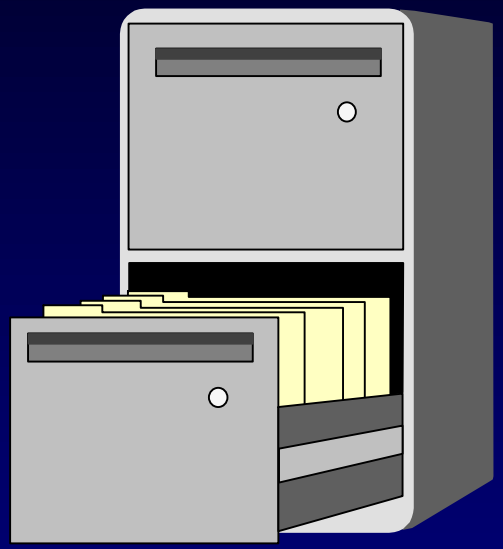


Basic Concept : Outline

- Files
- Records, Fields
- Keys
- Users
- File Processing
- File Design

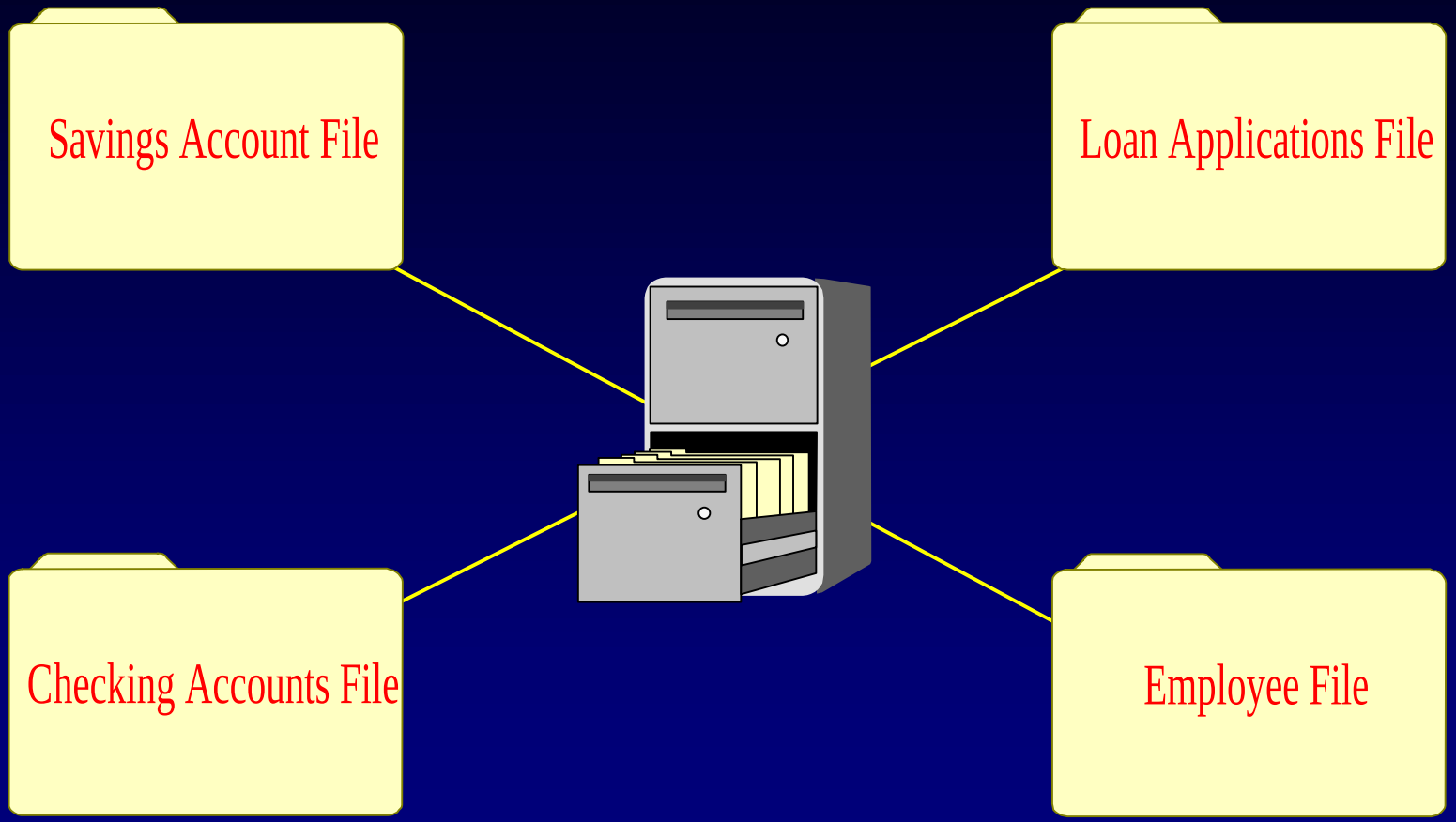


Filing System



- Size
- Persistence
- Sharability

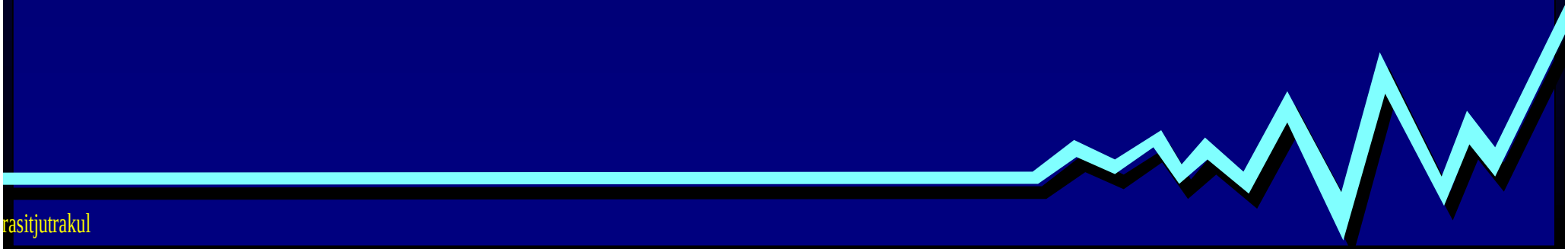
Files


Savings Account File
Loan Applications File
Checking Accounts File
Employee File

Records

Account	Name	Address	Balance
018-745-96	Thongdee	36 Sathon, 10600	25,250.93
108-964-09	Dundee	488 Rama 4, 10330	2,252.00
116-057-43	Yudee	56 Chareonkrung, 10210	99,768.25
248-922-88	Wangdee	102 Bantadthong, 10330	125,899.29
741-673-76	Dundee	77 Saphanluang, 10330	232.48

Checking Accounts File



Fields

Account	Name	Address	Balance
018-745-96	Thongdee	36 Sathon, 10600	25,250.93
108-964-09	Dundee	488 Rama 4, 10330	2,252.00
116-057-43	Yudee	56 Chareonkrung, 10210	99,768.25
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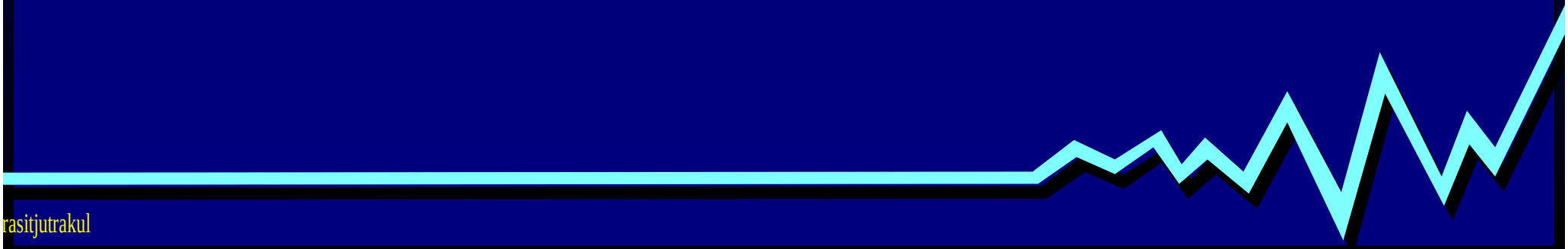
Checking Accounts File



Files & Records

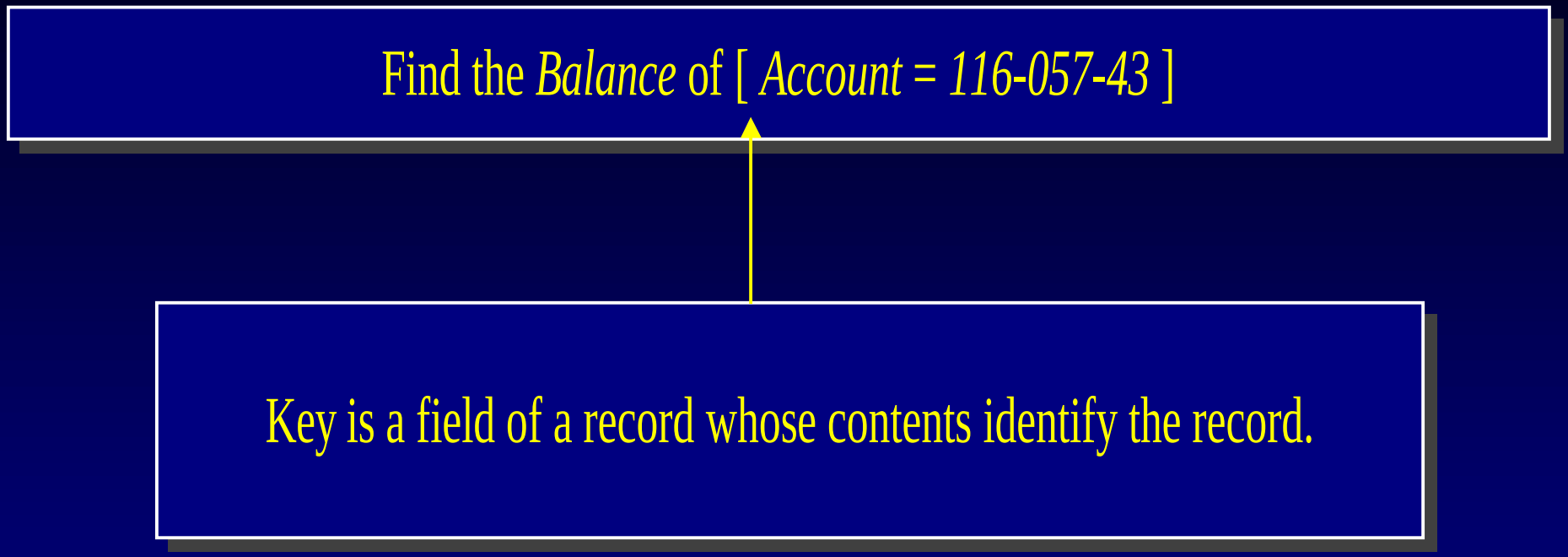
- A file is a collection of records of the same type.
- A record is a collection of related fields.

Keys

Find the *Balance* of [*Account = 116-057-43*]

- Locate the Checking Account file.
- Access the record whose contents of the *Account* field = 116-057-43.
- Retrieve the record from the file.
- Examine the contents of the *Balance* field.

Keys


Find the *Balance* of [*Account = 116-057-43*]
Key is a field of a record whose contents identify the record.

Primary Keys

Account	Name	Address	Balance
018-745-96	Thongdee	36 Sathon, 10600	25,250.93
108-964-09	Dundee	488 Rama 4, 10330	2,252.00
116-057-43	Yudee	56 Chareonkrung, 10210	99,768.25
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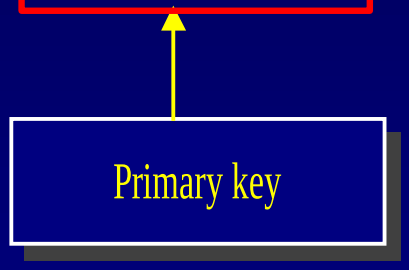
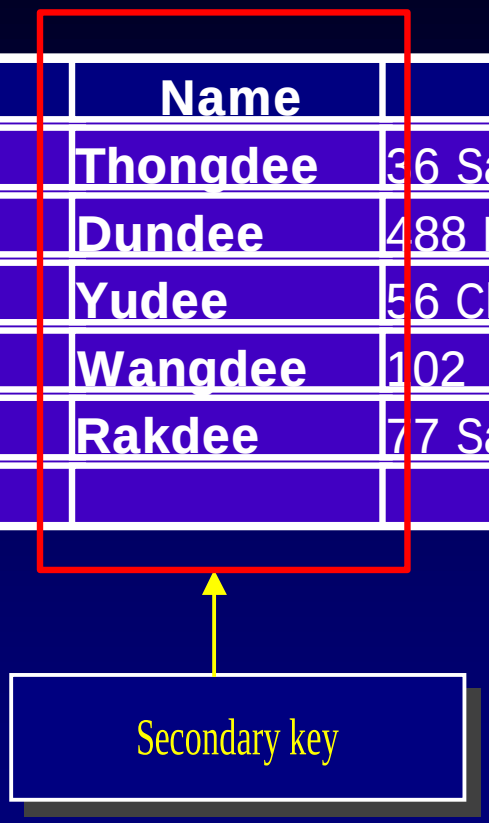


A primary key is a field that *uniquely* identify the record.

Secondary Keys

Account	Name	Address	Balance
018-745-96	**Thongdee**	36 Sathon, 10600	25,250.93
108-964-09	**Dundee**	488 Rama 4, 10330	2,252.00
116-057-43	**Yudee**	56 Chareonkrung, 10210	99,768.25
248-922-88	**Wangdee**	102 Bantadthong, 10330	125,899.29
741-673-76	**Rakdee**	77 Saphanluang, 10330	232.48

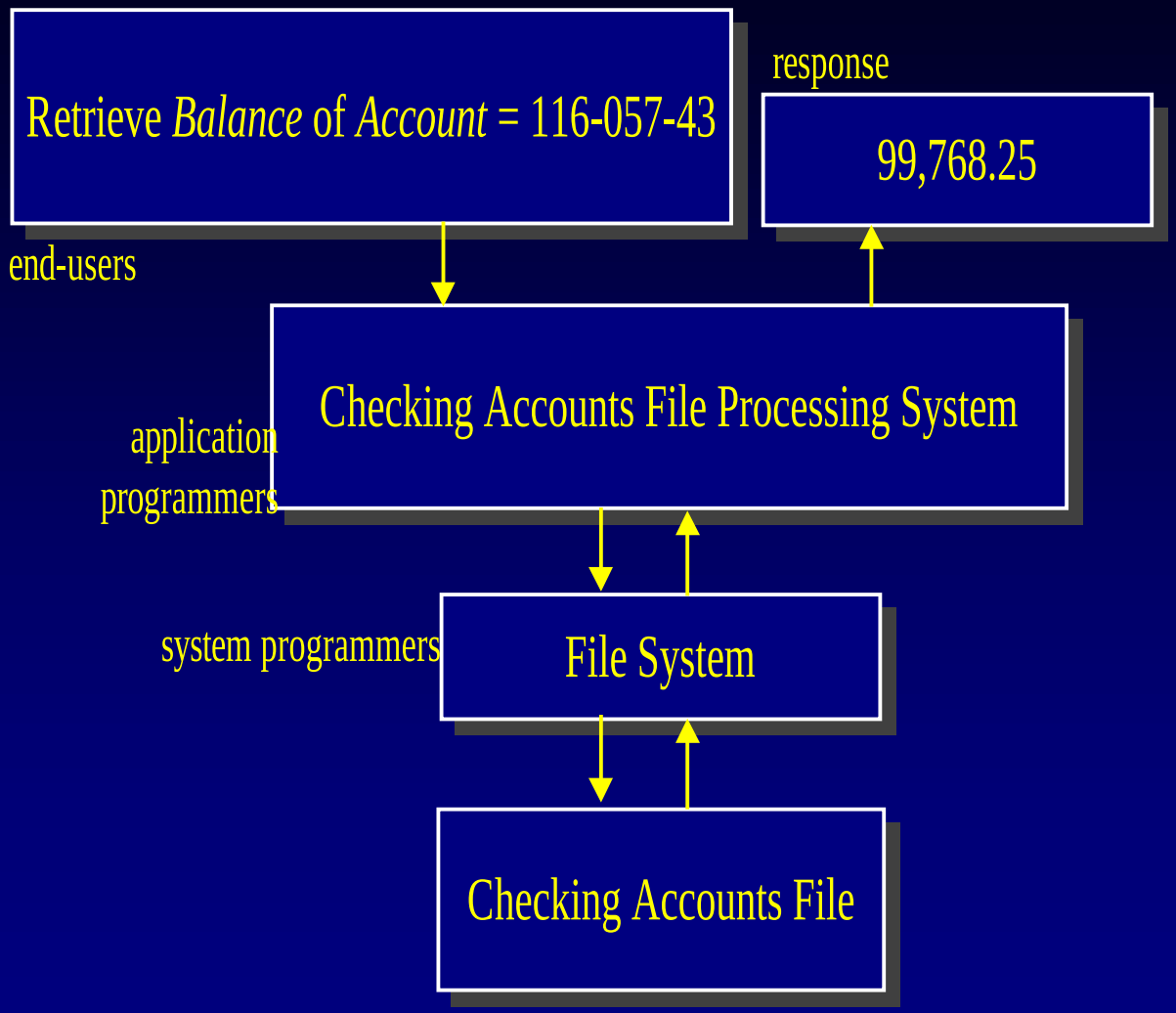


A secondary key is a field that does identify the record, but this identification is not unique.

Users

- End-users
- Application programmers
- System programmers

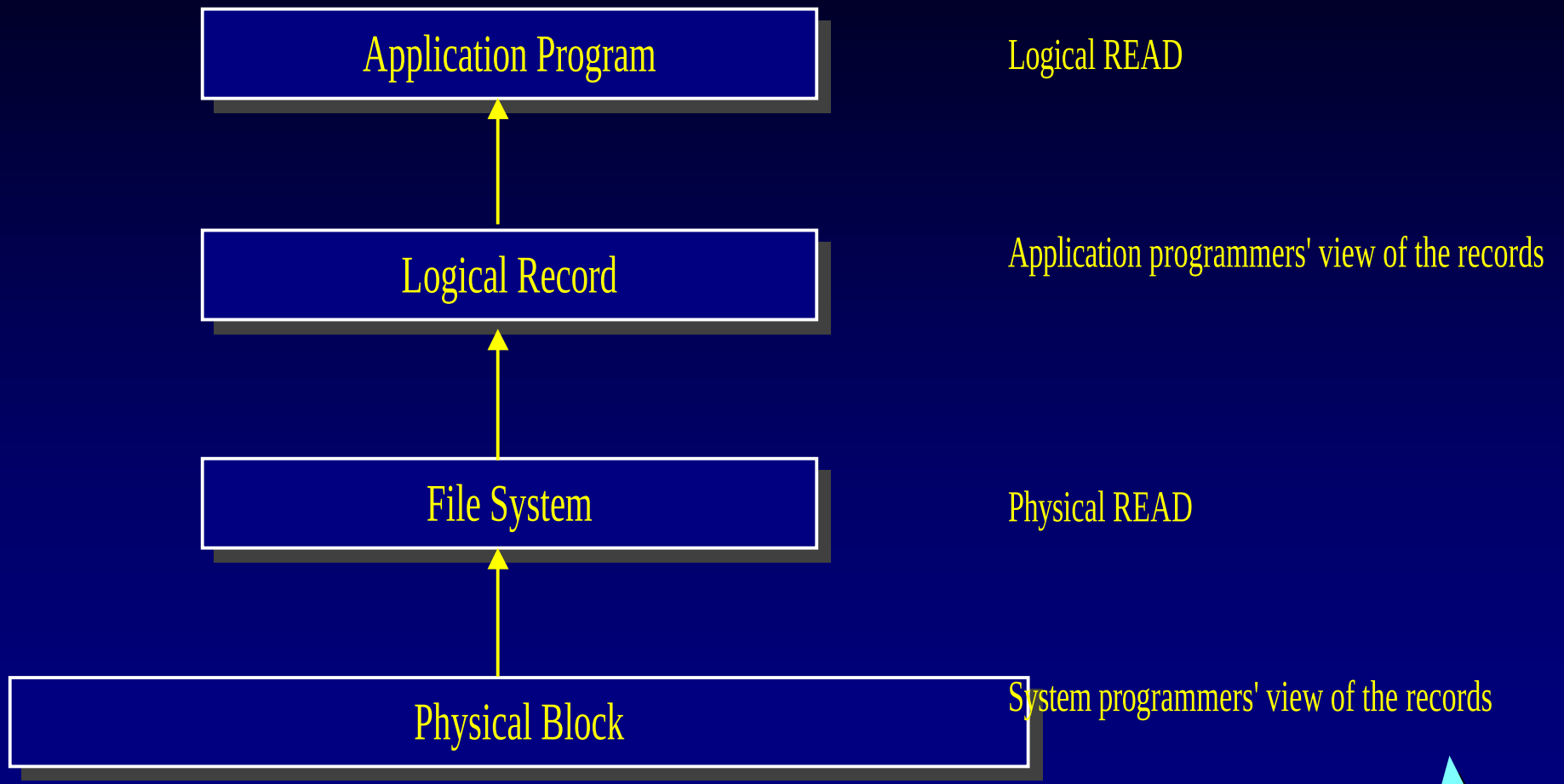
File Processing Systems



Users' Concerns

- End-users
  - receive accurate information.
- Application programmers
  - aware of the file organization, record structure, and access mechanisms.
- System programmers
  - aware of the available tools and resources to enhance the file system efficiency.

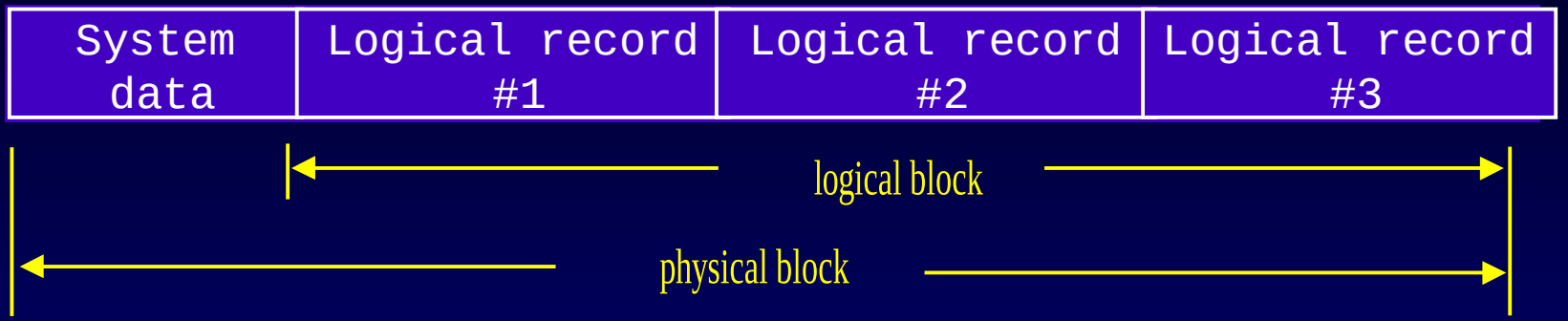
Data Transfer



Logical Records

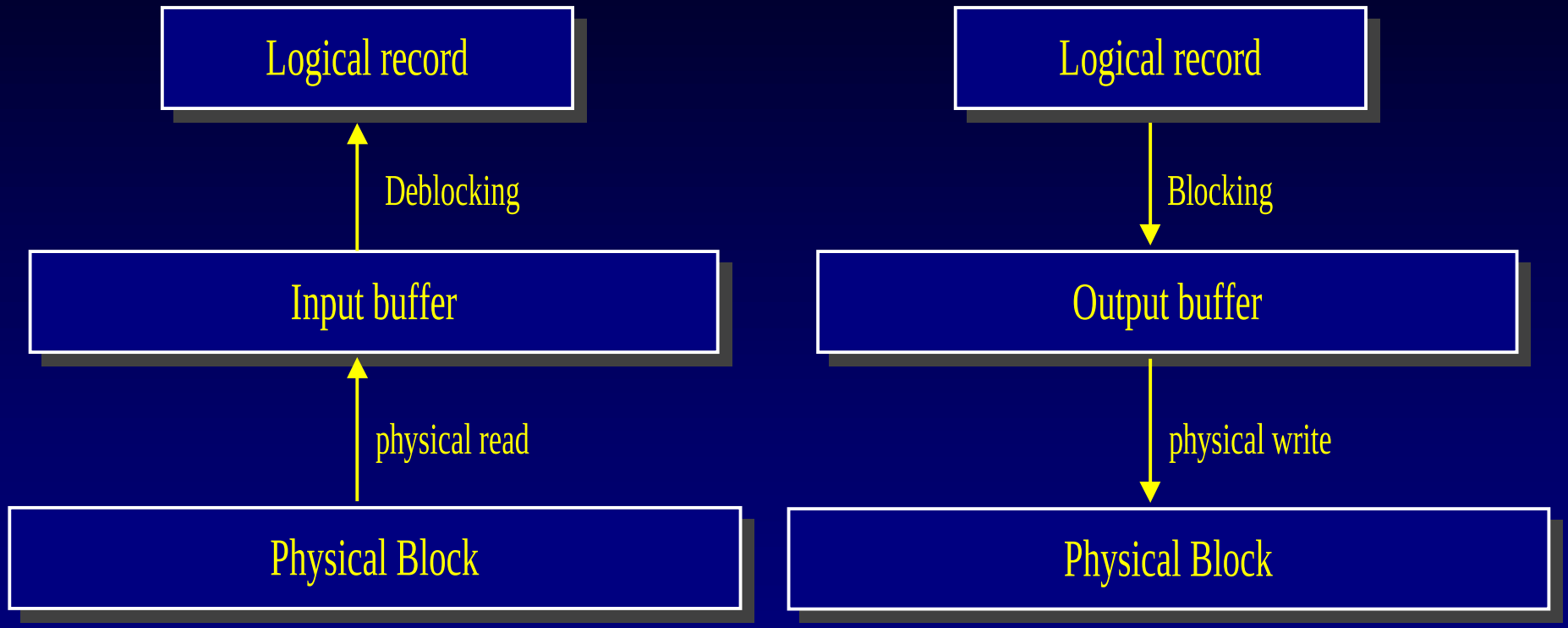
```
typedef struct customerTag {
        int     iAccount;
        char    szName[20];
        char    szAddress[50];
        float   fBalance;
} recCustomer;

recCustomer    CustomerRecord;
```

Physical Blocks

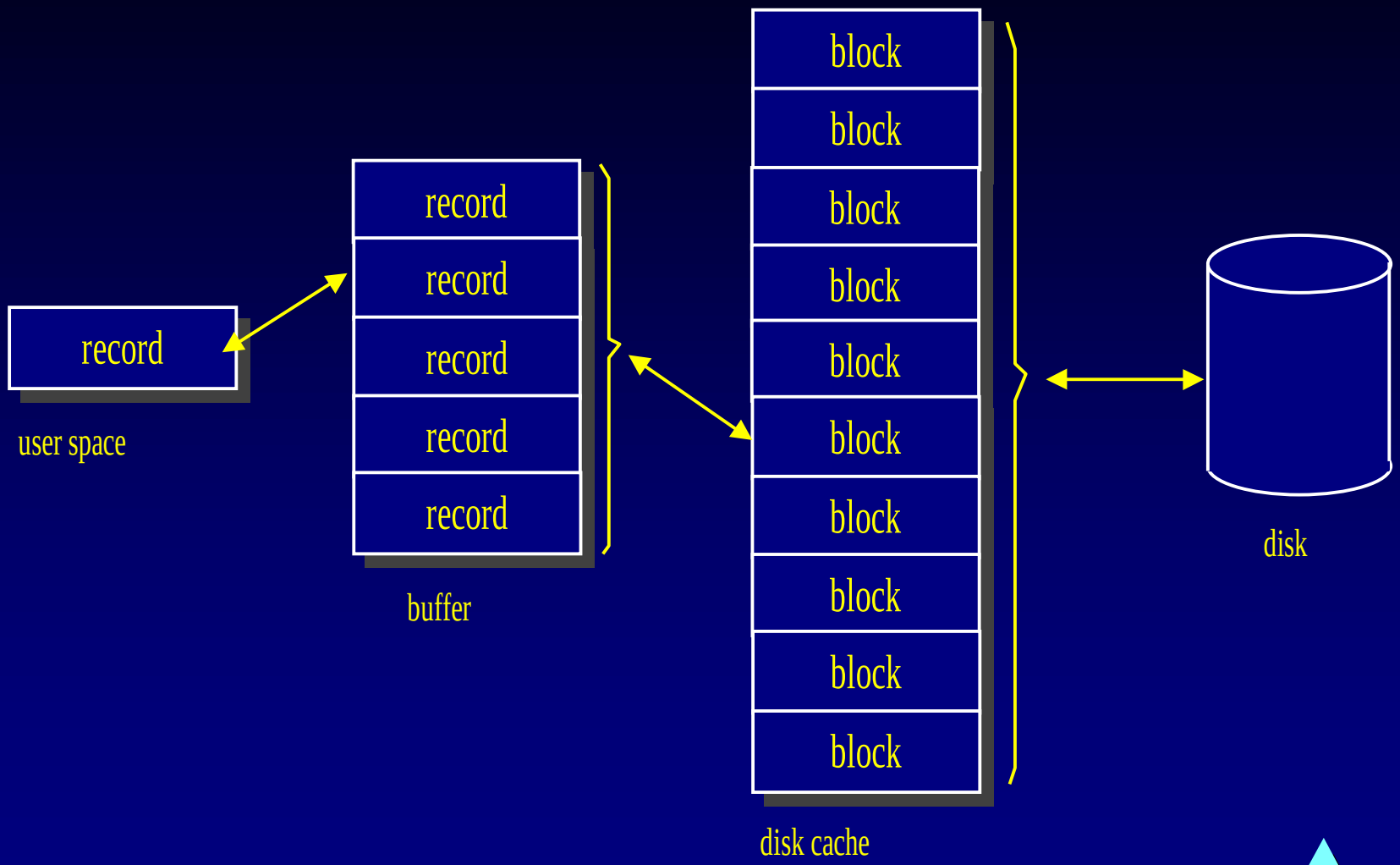


Blocking factor

Blocking & Deblocking



Disk Caching



Blocking Factor

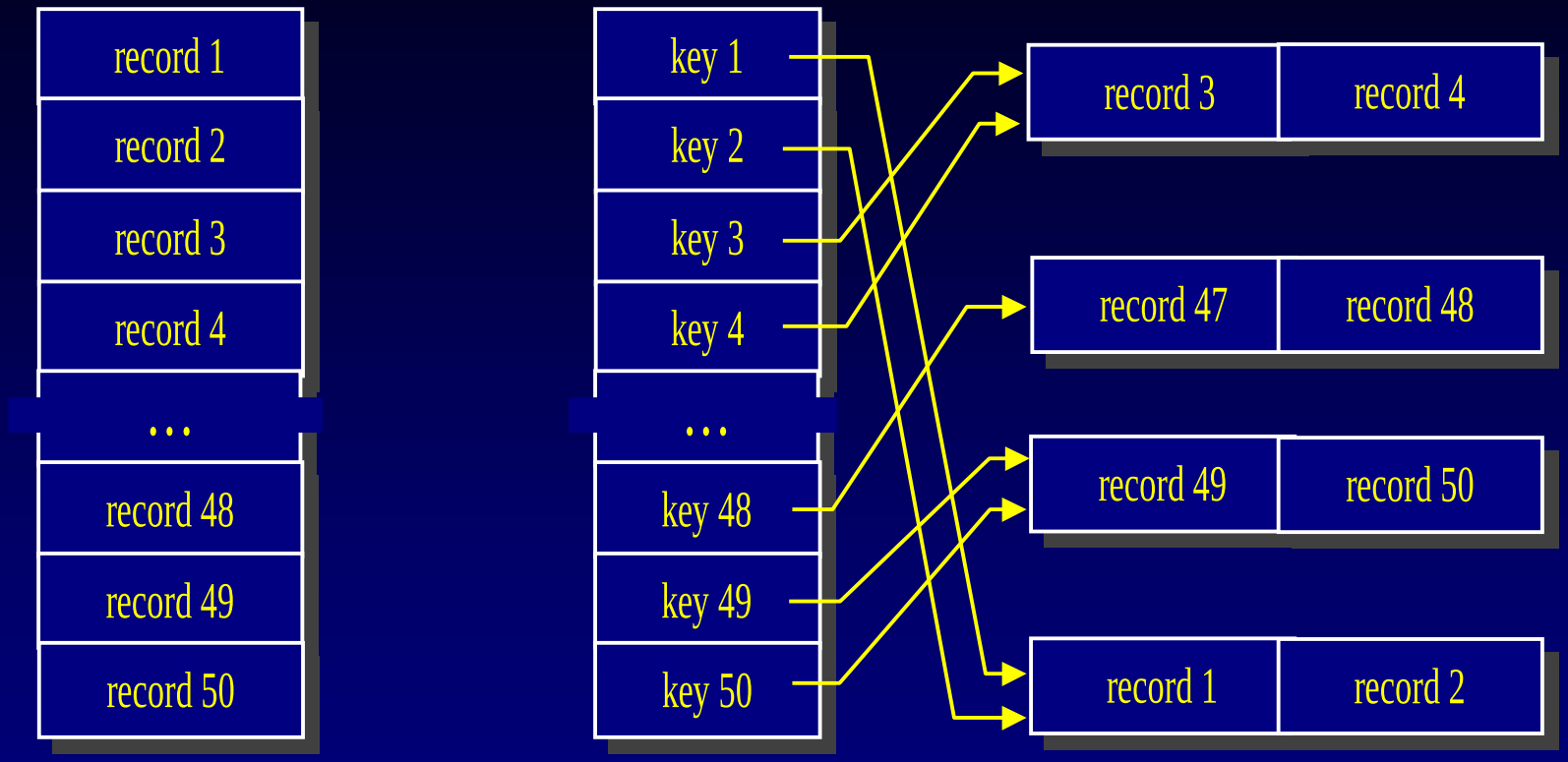
- Blocking factor vs # Block transfers
- Blocking factor vs Buffer size
- Optimal blocking factor

If the blocking factor were equal to the number of logical records then one could successfully argue that only one data transfer would be needed !!!

Logical & Physical File Structure

- Logical file structure
  - The organization of all logical records in the file.
- Physical file structure
  - The organization of all the physical blocks stored in secondary storage.

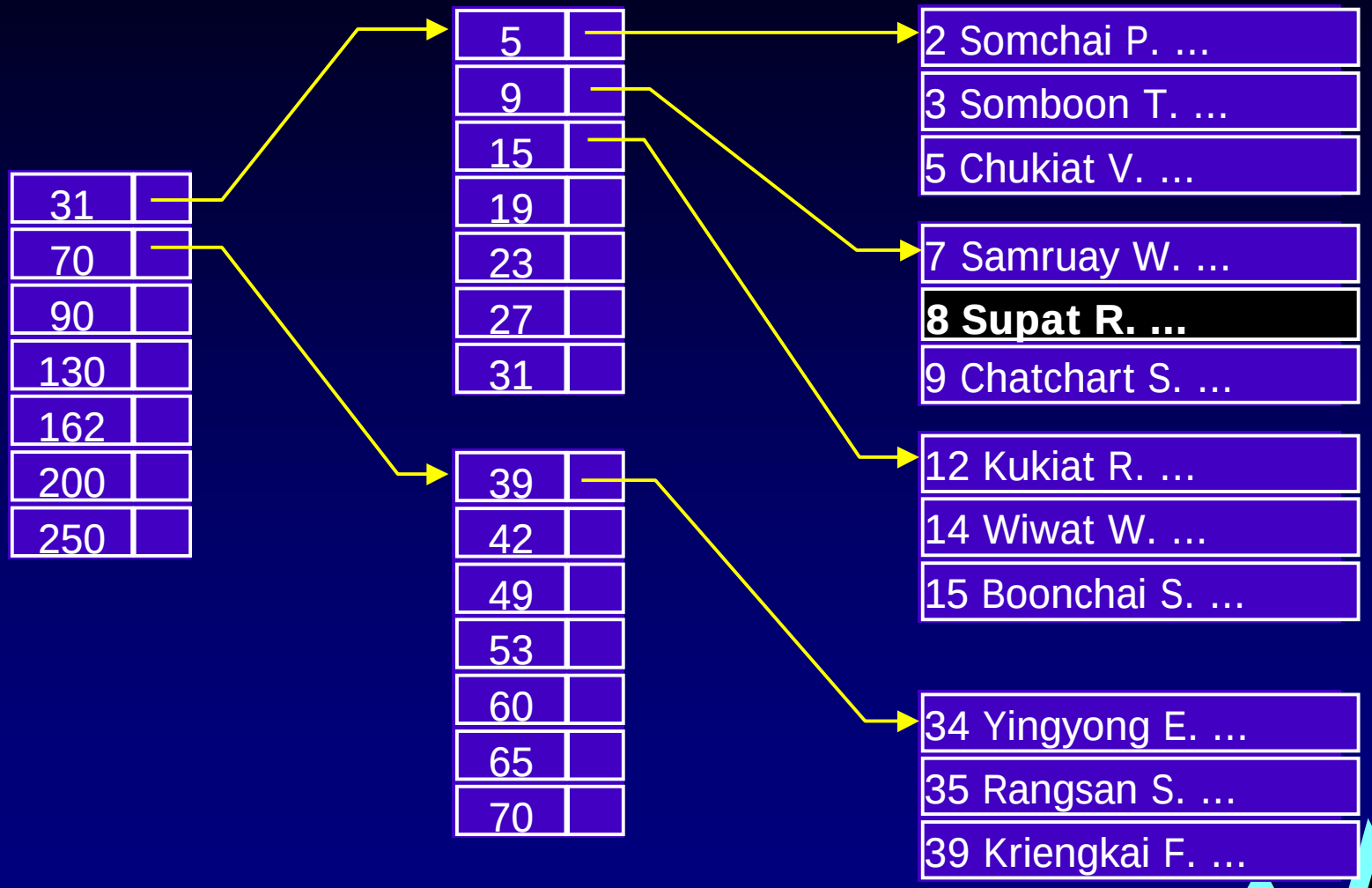
Logical & Physical File Structure



sequential file

physical linked sequential file

Access Path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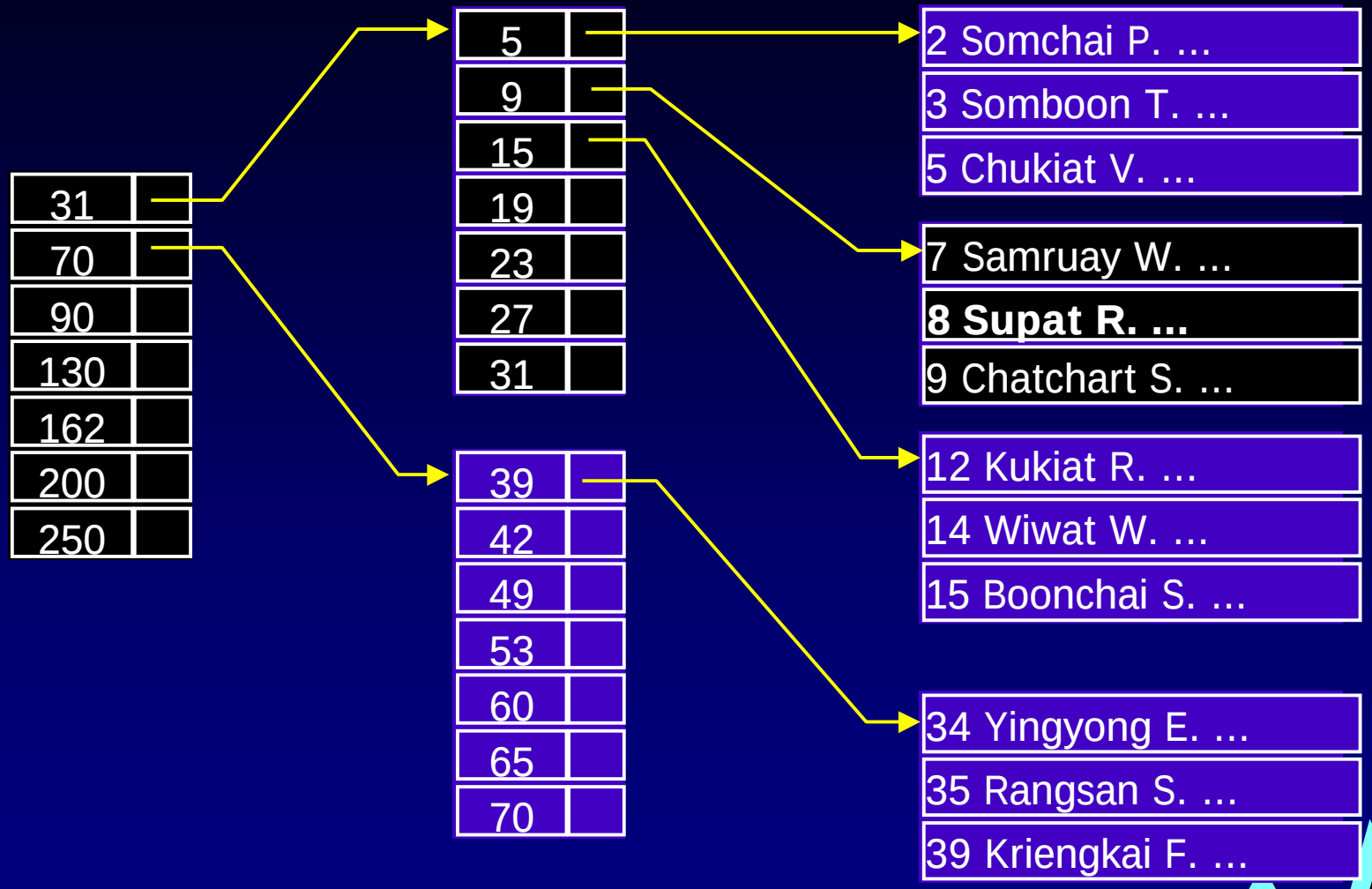
2 Somchai P. ...
3 Somboon T. ...
5 Chukiat V. ...
7 Samruay W. ...
8 Supat R. ...
9 Chatchart S. ...
12 Kukiat R. ...
14 Wiwat W. ...
15 Boonchai S. ...
34 Yingyong E. ...
35 Rangsan S. ...
39 Kriengkai F. ...

Access Path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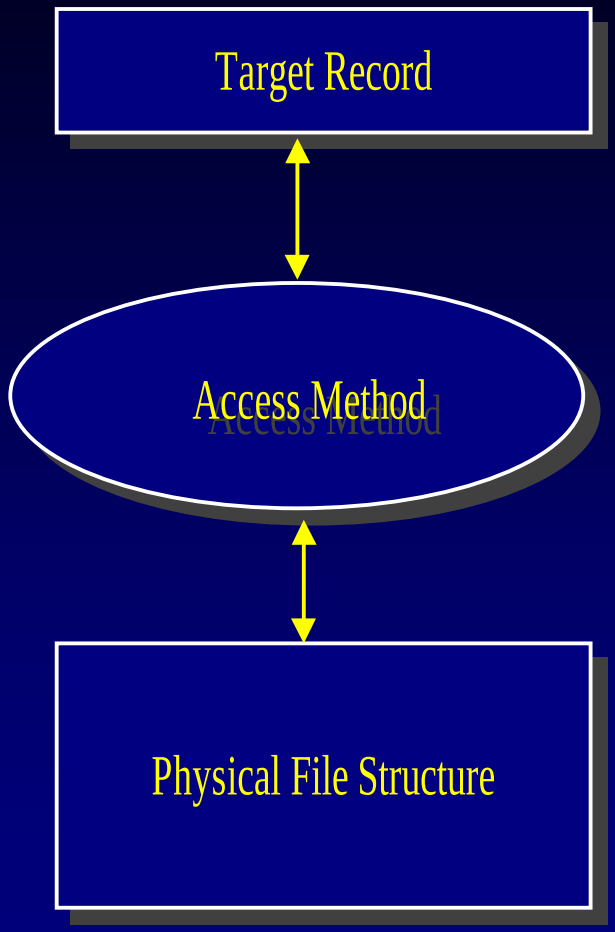
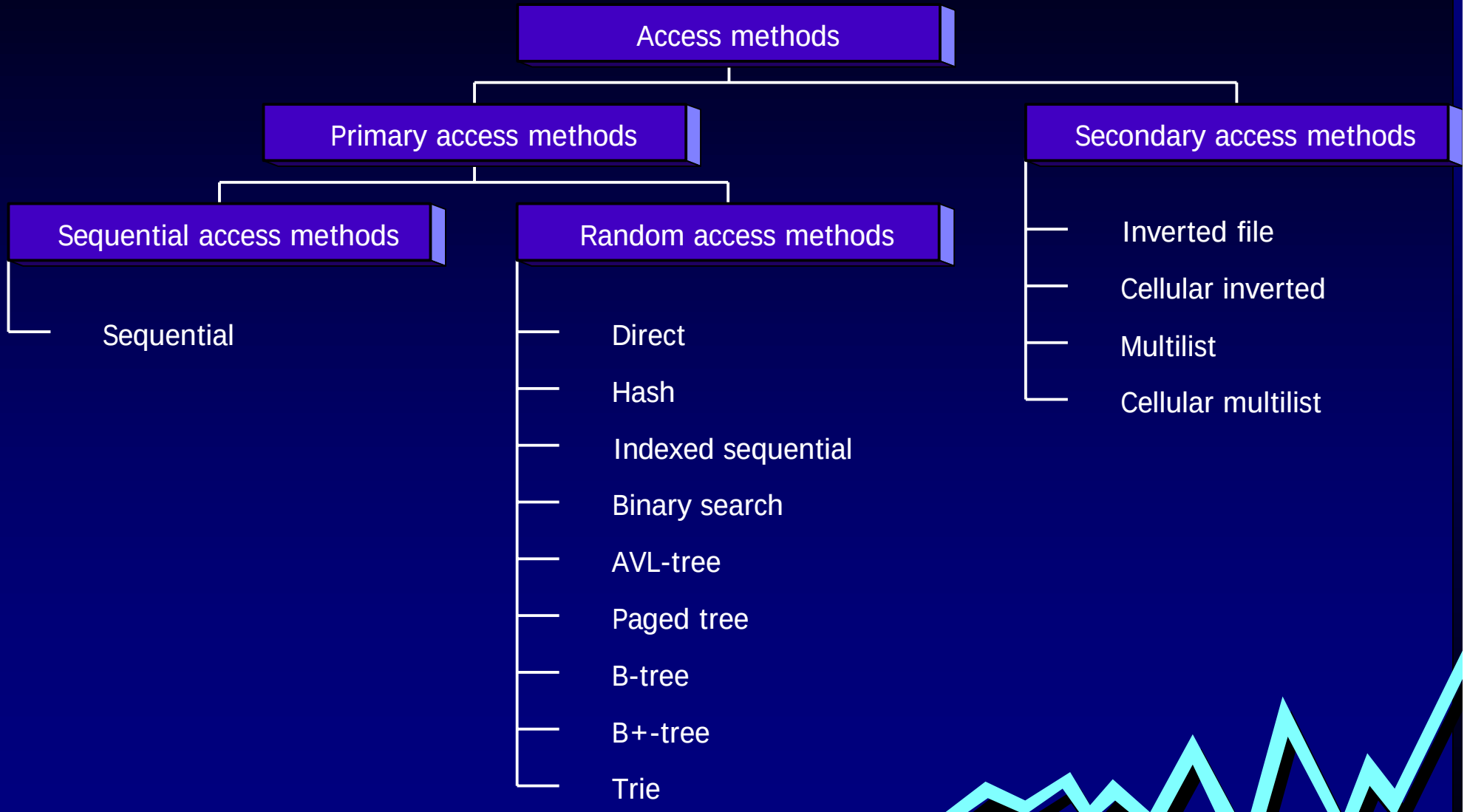
Access Methods



Classification of Access Methods

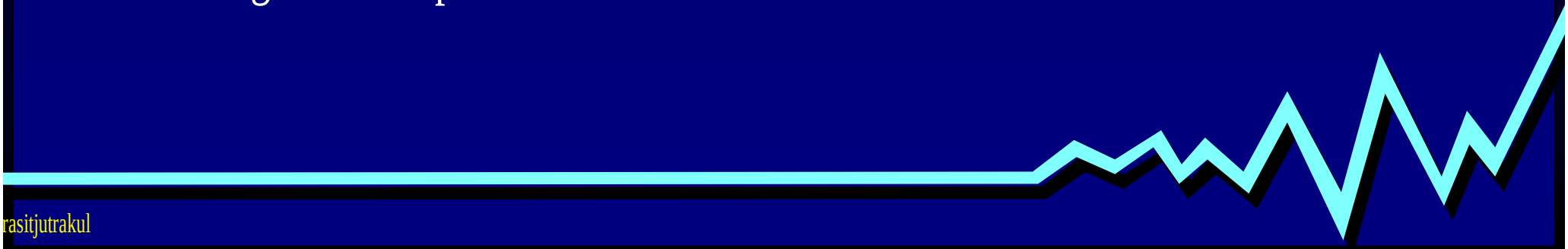


File Design

- Logical file design
  - select one of the available file organizations
  - design a new file organization
- Physical file design
  - design the physical file

File Design

- Selection of blocking factor
- Allocation of the I/O buffers
- Size of the physical file
- Organization of the physical blocks
- Design or selection of the access method
- Selection of the primary key
- File growth
- Reorganization point



File Operations

- *RetrieveAll*
- *Batch*
- *RetrieveOne*
- *RetrieveNext*
- *RetrievePrevious*
- *InsertOne*
- *DeleteOne*
- *UpdateOne*
- *RetrieveFew*

Performance

- Response time
  - The type of allowable operations.
  - The frequency of each type of operation.

Ex. 95% **`Retrieve_One`**

5% **`Batch`**

Random or Sequential ?

Search length