Organization of Records in Blocks

Read Sec. 4.2 Riguzzi et al. Sistemi Informativi

Slides derived from those by Hector Garcia-Molina

Topic

- How to lay out records on blocks

To represent:

- Integer (short): 2 bytes

  e.g., 35 is

00000000	00100011

- Real, floating point

  n bits for mantissa, *m* for exponent….

To represent:

- Characters

  $\rightarrow$ various coding schemes suggested,
  most popular is ascii

  Example:
  A: 1000001
  a: 1100001
  5: 0110101
  LF: 0001010

To represent:

- Boolean

  e.g., TRUE 1111 1111

  FALSE 0000 0000

- Application specific

  e.g., RED $\rightarrow$ 1 GREEN $\rightarrow$ 3

  BLUE $\rightarrow$ 2 YELLOW $\rightarrow$ 4 ...

$\Rightarrow$ Can we use less than 1 byte/code?

Yes, but only if desperate...

To represent:

- Dates

  e.g.: - Integer, # days since Jan 1, 1900

  - 8 characters, YYYYMMDD

  - 7 characters, YYYYDDD

    (not YYMMDD! Why?)

- Time

  e.g. - Integer, seconds since midnight

  - characters, HHMMSSFF

To represent:

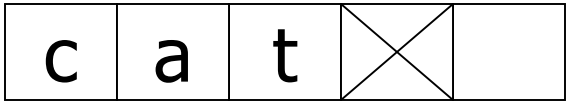
- Fixed length characters strings (CHAR(n)):
  - n bytes
  - If the value is shorter, fill the array with a *pad* charater, whose 8-bit code is not one of the legal characters for SQL strings

c	a	t	X	X	X

To represent:

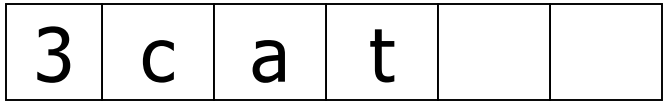
- Variable-length characters strings (CHAR VARYING(n)): n+1 bytes max
  - Null terminated

    e.g.,



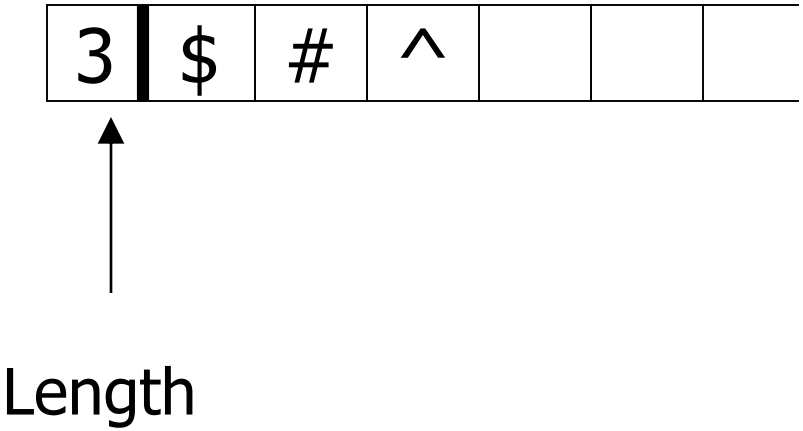
  - Length given

    e.g.,



To represent:

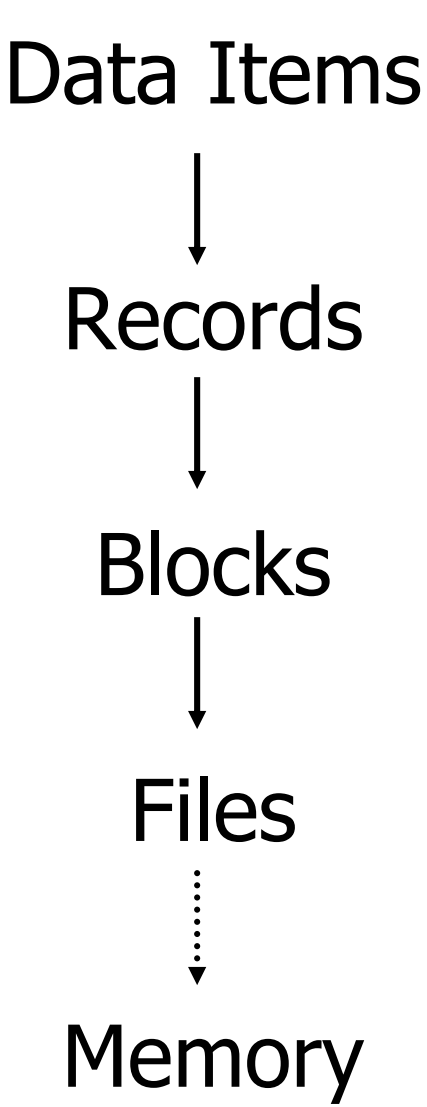
- BINARY VARYING(n)



Key Point

- Fixed length items
- Variable length items
  - usually length given at beginning

Overview



Types of records:

- Main choices:
  - FIXED vs VARIABLE LENGTH

A SCHEMA (not record) contains following information

- # fields
- type of each field
- order in record
- name of each field

Example: fixed length

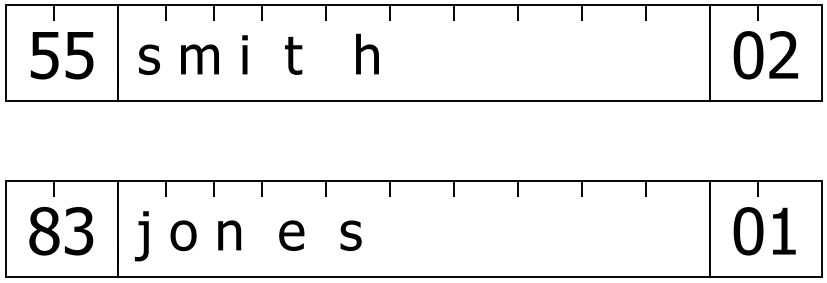
Employee record

(1) E#, 2 byte integer

(2) E.name, 10 char.

(3) Dept, 2 byte code

Schema



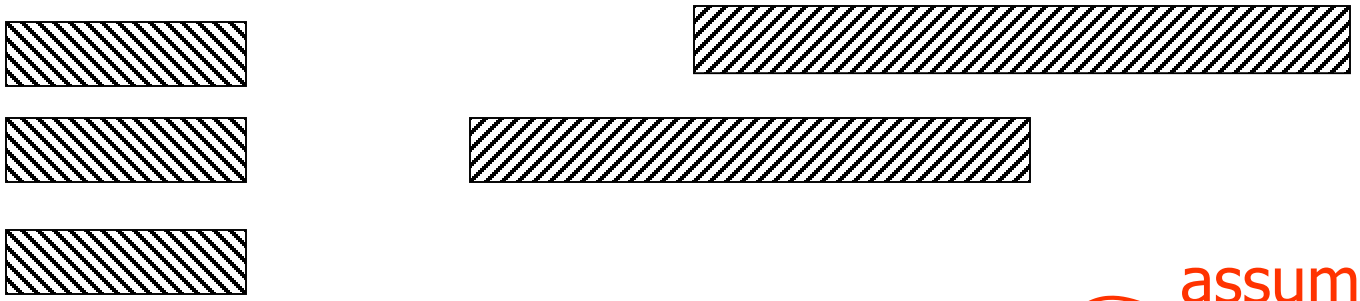
Records

Record header - data at beginning that describes record

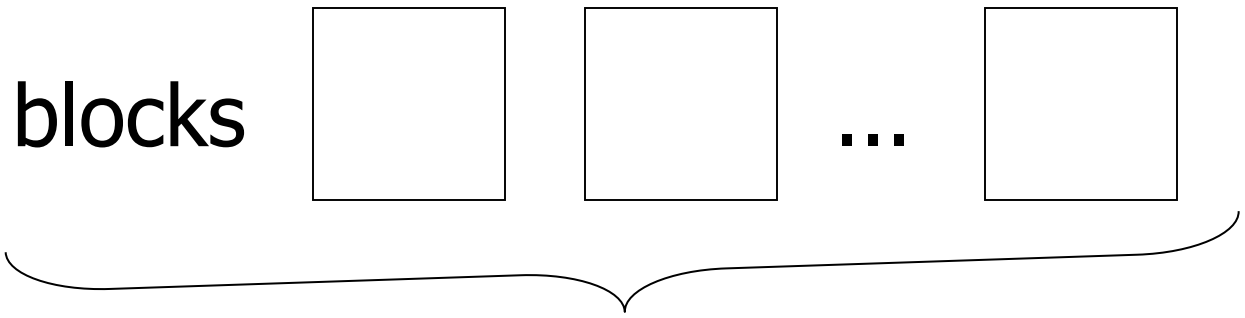
May contain:

- record type
- record length
- time stamp
- ...

Next: placing records into blocks



assume fixed length blocks



assume a single file (for now)

Options for storing records in blocks:

(1) separating records
(2) spanned vs. unspanned
(3) mixed record types – clustering
(4) split records
(5) indirection

(1) Separating records

Block

(a) no need to separate - fixed size recs.

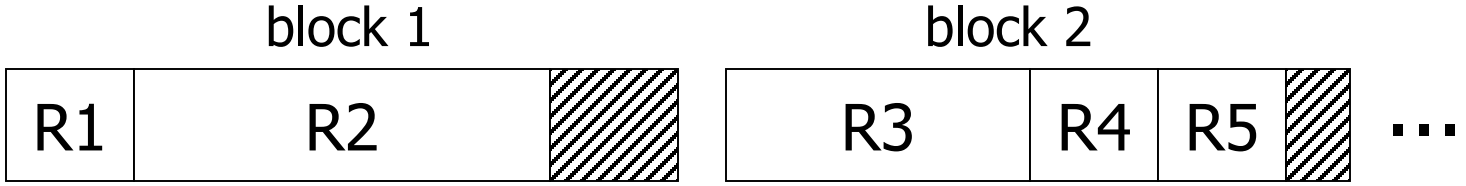
(b) special marker

(c) give record lengths (or offsets)

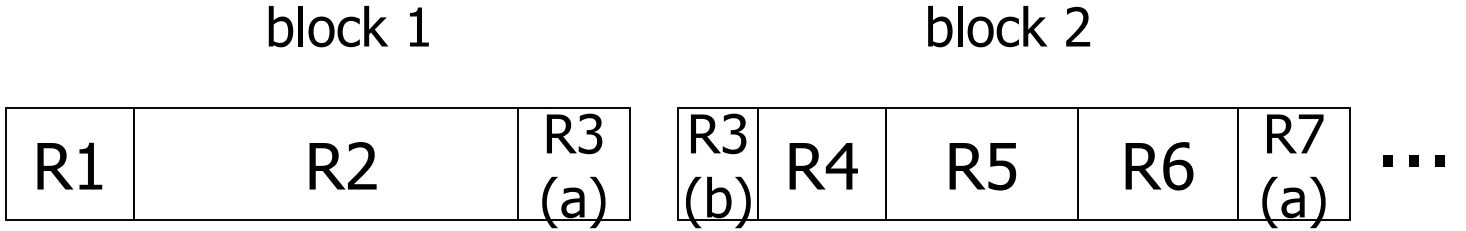
- within each record
- in block header

(2) Spanned vs. Unspanned

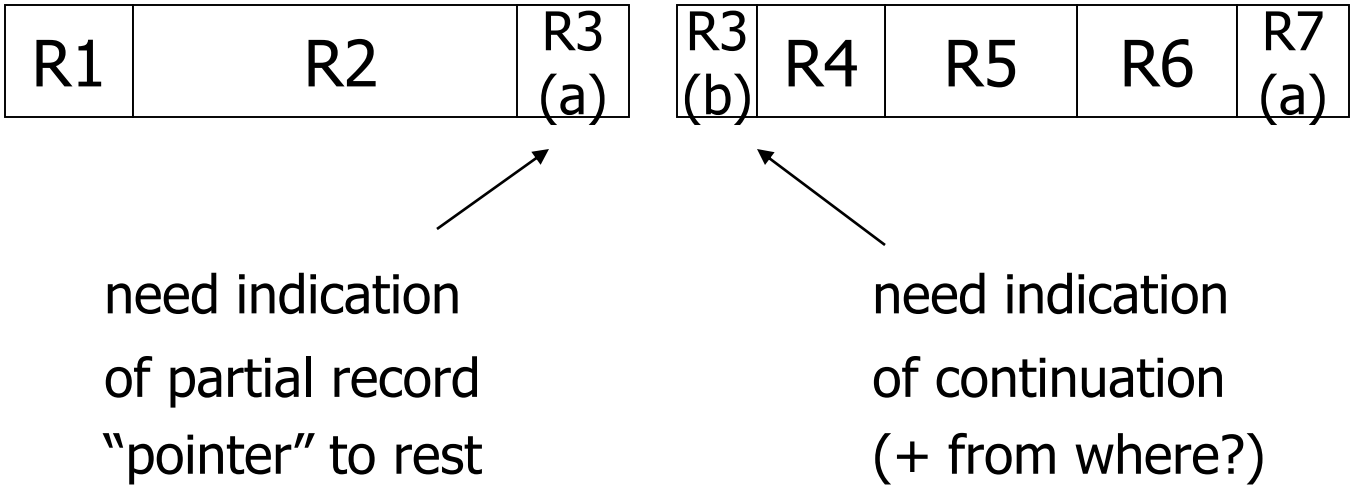
- Unspanned: records must be within one block



- Spanned



With spanned records:



Spanned vs. unspanned:

- Unspanned is much simpler, but may waste space…
- Spanned essential if

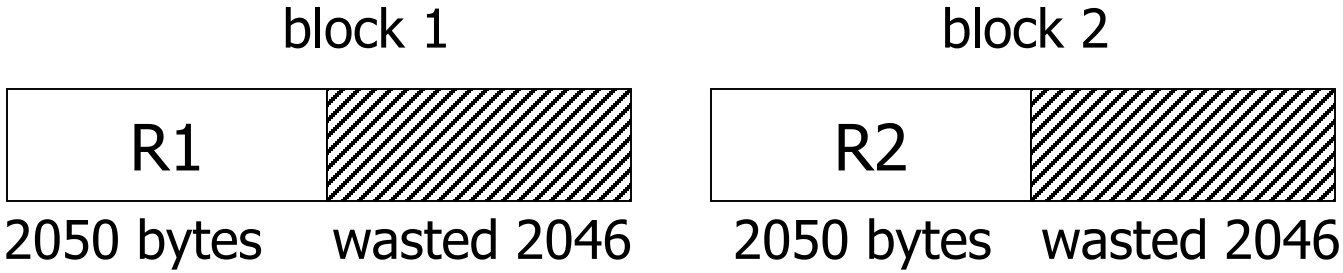
  record size > block size

Example

10^6 records

each of size 2,050 bytes (fixed)

block size = 4096 bytes

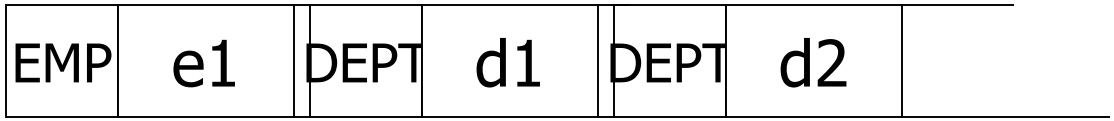


- Total wasted = 2×10^9 Utiliz = 50%
- Total space = 4×10^9

(3) Mixed record types

- Mixed - records of different types
  (e.g. EMPLOYEE, DEPT)
  allowed in same block

e.g., a block



Why do we want to mix?

Records that are frequently accessed together should be in the same block

CLUSTERING

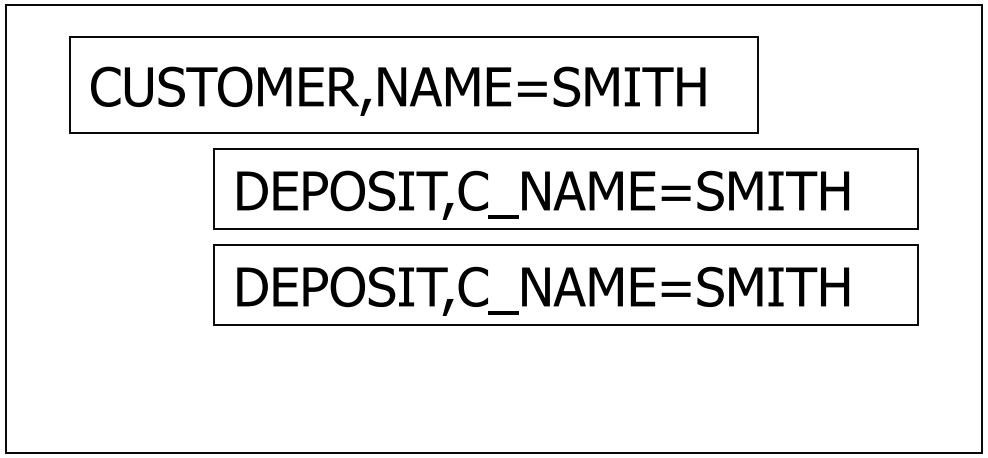
Compromise:

No mixing, but keep related records in same cylinder ...

Example

Q1: select A#, C_NAME, C_CITY, …
from DEPOSIT, CUSTOMER
where DEPOSIT.C_NAME =
CUSTOMER.NAME

a block



- If Q1 frequent, clustering good
- But if Q2 frequent

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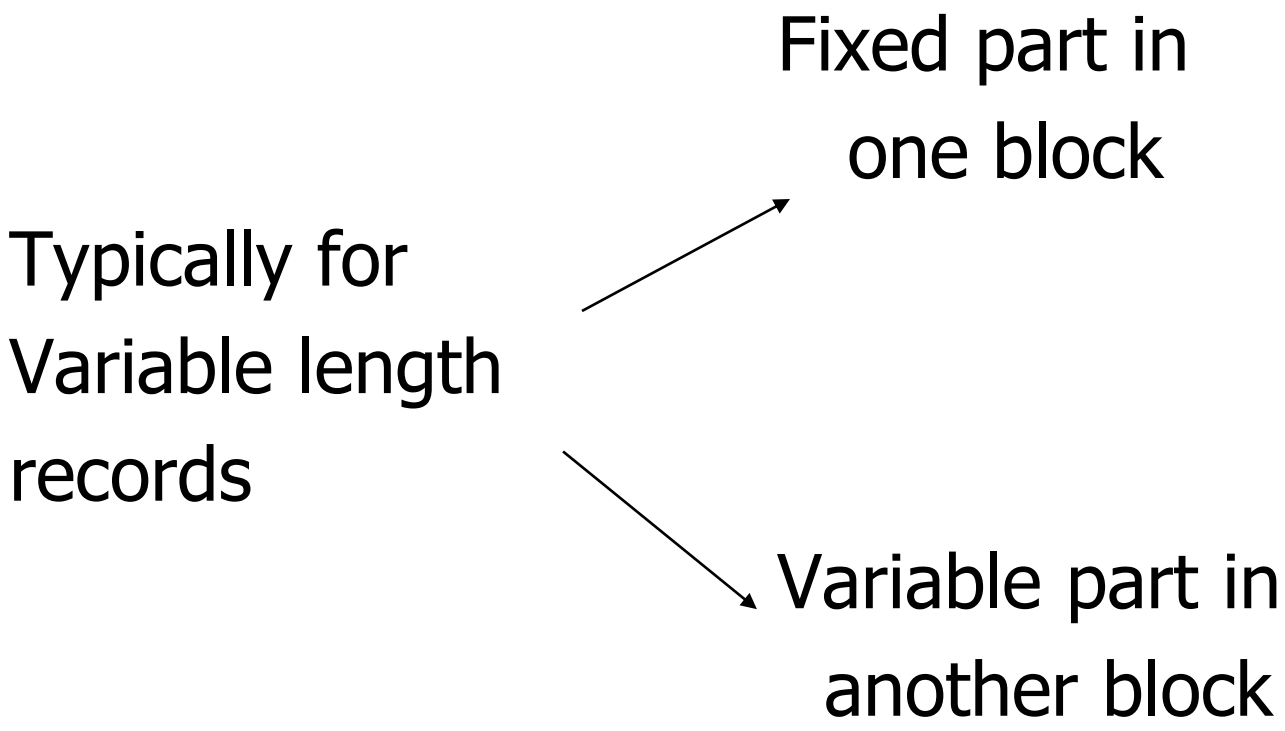
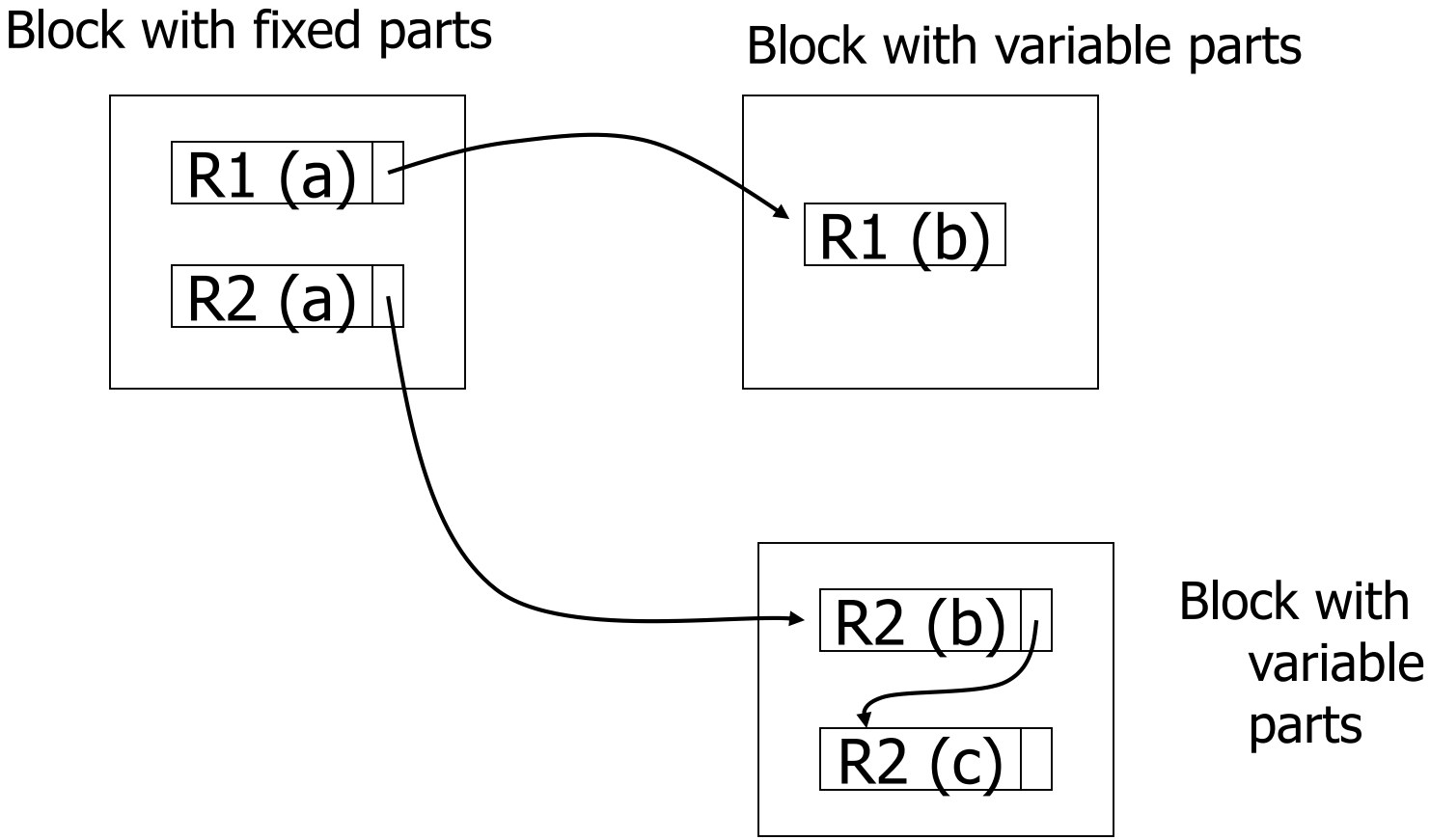
Q2:    SELECT *
       FROM CUSTOMER
```

CLUSTERING IS COUNTER PRODUCTIVE

(4) Split records




Block with fixed parts
Block with variable parts
R1 (a)
R2 (a)
R1 (b)
R2 (b)
R2 (c)
Block with variable parts

(5) Indirection

- How does one refer to records?

Many options:

Physical ⟷ Indirect

☆ Purely Physical

E.g., Record Address or ID =

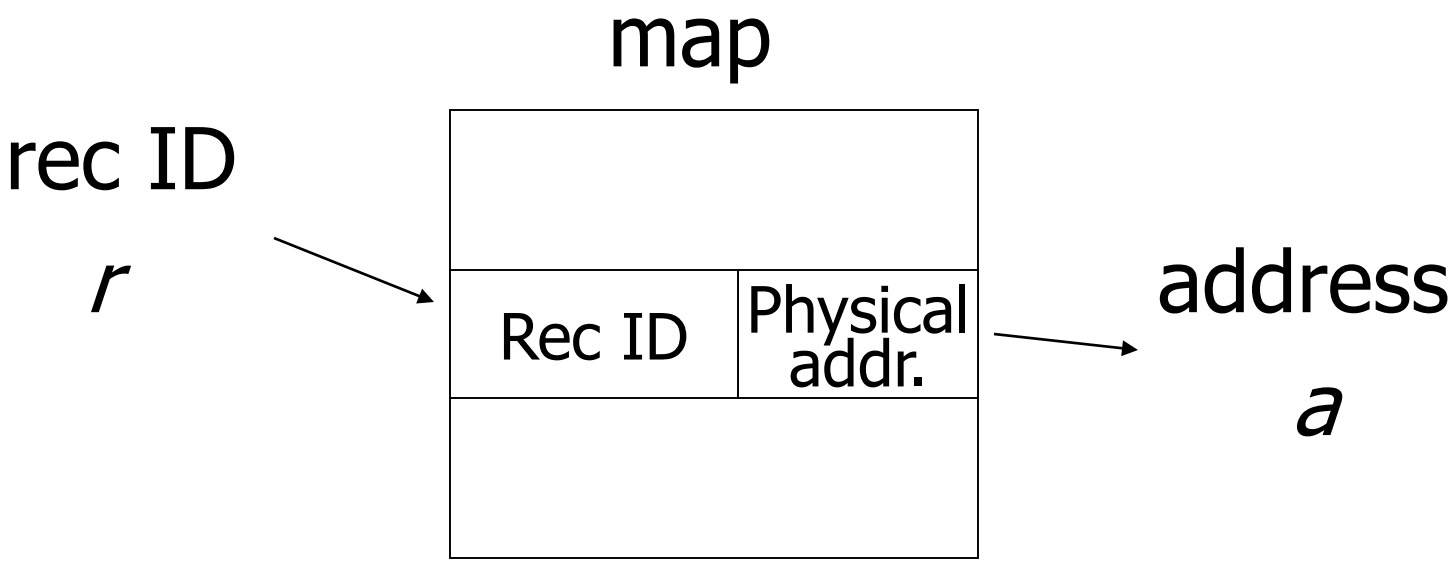
- Device ID
- Cylinder #
- Track #
- Block #

(Device ID, Cylinder #, Track # and Block # together: Block ID)

- Offset in block

☆ Fully Indirect

E.g., Record ID is arbitrary bit string

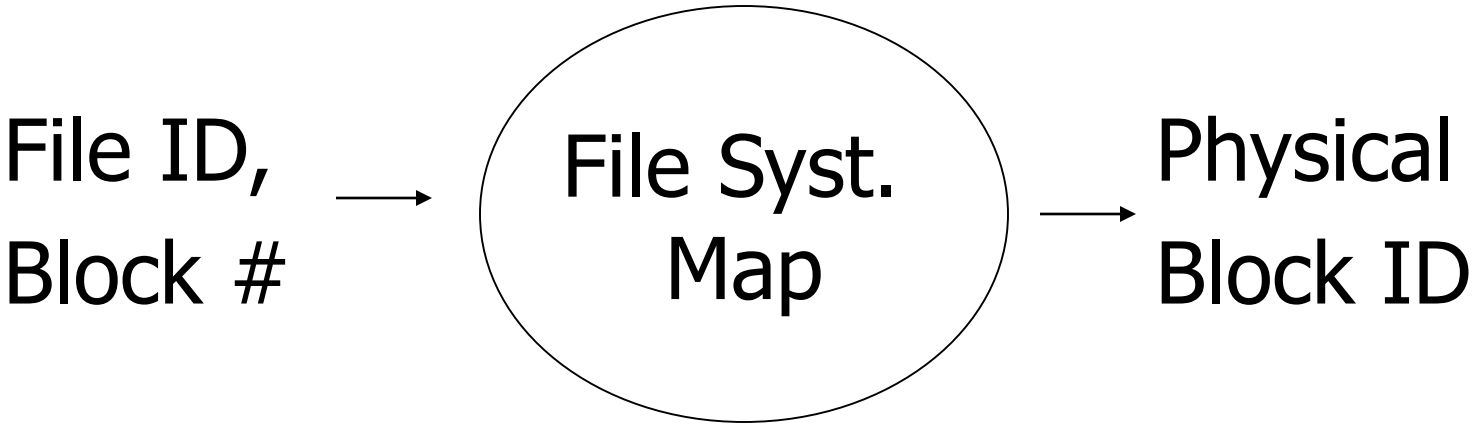


Tipical Use logical block #'s understood by file system

→ File ID

Block #

Offset in block



Block header - data at beginning that describes block

May contain:

- File ID (or RELATION or DB ID)
- This block ID
- Record directory
- Pointer to free space
- Type of block (e.g. contains recs type 4; is overflow, …)
- Pointer to other blocks "like it"
- Timestamp ...

Other Topic

Insertion/Deletion

Options for deletion:

(a) Immediately reclaim space

(b) Mark deleted

- May need chain of deleted records (for re-use)
- Need a way to mark:
  - special characters
  - delete field
  - in map

☆ As usual, many tradeoffs...

- How expensive is to move valid records to free space for immediate reclaim?
- How much space is wasted?
  - delete fields, free space chains,...