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Organization of data and knowledge bases

Lecture 3. Hierarchy Data Model

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CONTENTS

- Definition of the data model
- Hierarchy data structure
- Hierarchy data structure operations
- Integrity constraints
- Advantageous and drawbacks

Data model definition

- Data structure
- Operations
- Integrity constraints

schema – data description

instance – data value

data structure = schema + instance

data algebra = data structure + operations

data model = data algebra + integrity constraints

Field and Segment

Data field – elementary named data. Its instance is a data value.

Segment – is a named set of field names:

TEACHER (Name, Post, Address)

Graphic notation:

TEACHER

Name	Post	Address

Segment instance – ordered set of fields instances:

TEACHER

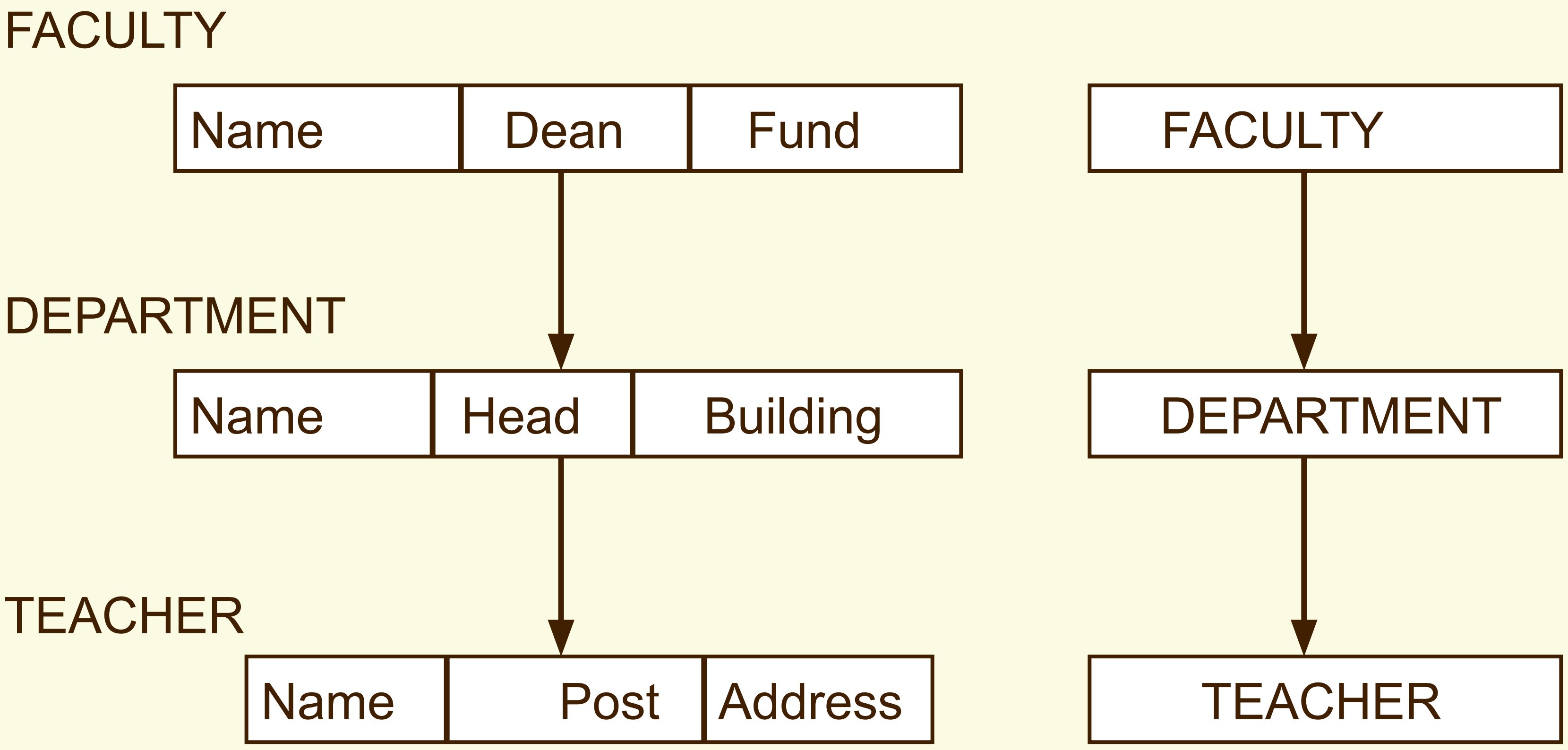
Johnson	professor	Kiev

Hierarchy Data Schema

It is hierarchy ordered set of segments with the following properties:

- every segment has 0 or 1 **parent** segment and 0 or more **child** segments;
- **root** do not have parent segment;
- **leaves** do not have child segments;
- **twin segments** have the same parent segment.

Hierarchy Data Schema (2)



FACULTY

Name | Dean | Fund

DEPARTMENT

Name | Head | Building

TEACHER

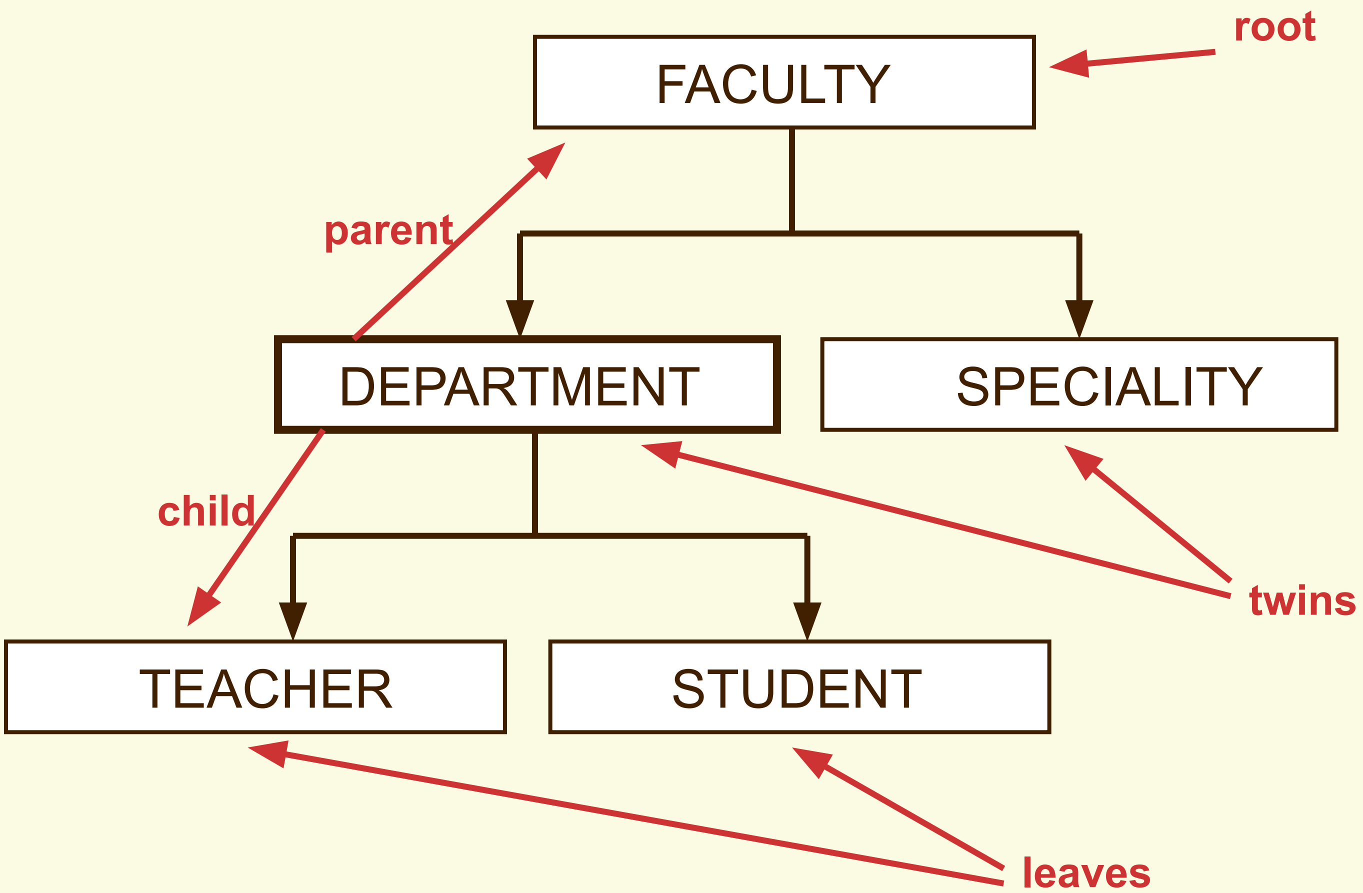
Name | Post | Address

FACULTY

DEPARTMENT

TEACHER

Hierarchy Data Schema (3)



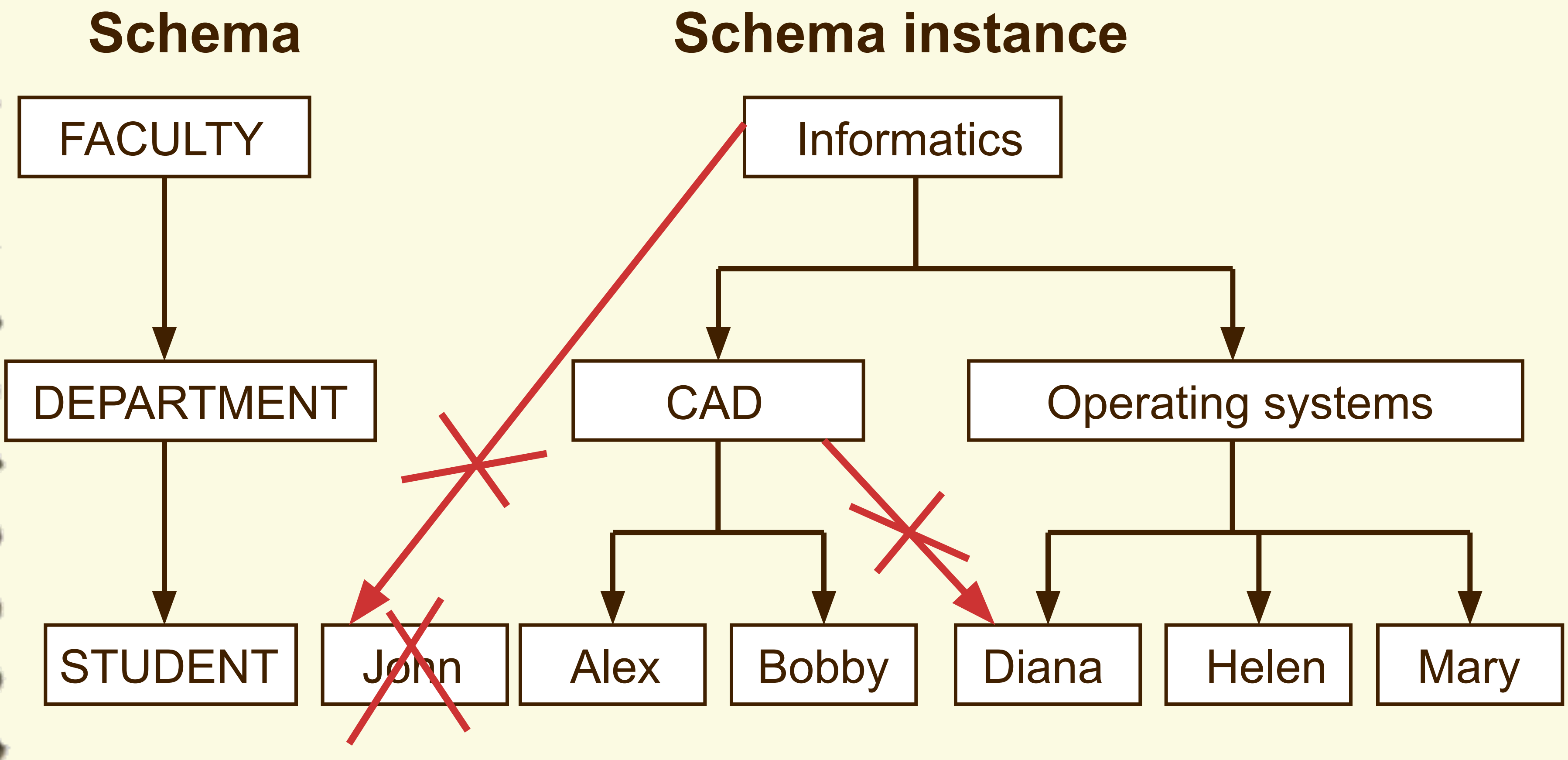
Hierarchy Schema Instance (1)

Hierarchy Schema Instance – it is one instance of the root segment and 0 or more instances of the child segments for each instance of the parent segment.

Integrity constraints:

- Every instance of a segment is connected with the only instance of its parent segment.
- Instance of any segment cannot exist without connection to the instance of its parent segment.

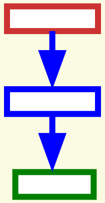
Hierarchy Schema Instance (2)



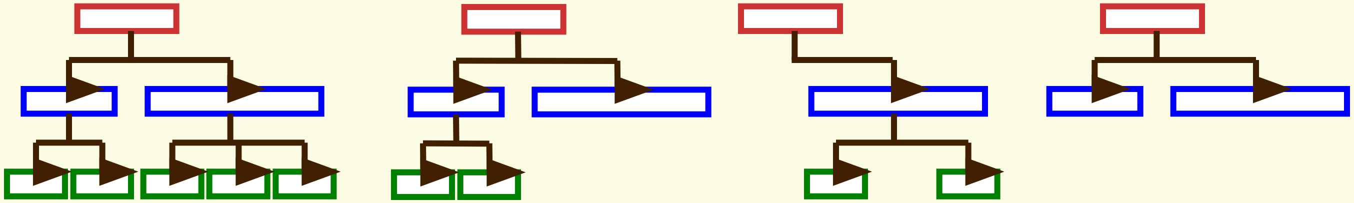
Hierarchy Data Structure

Hierarchy data structure is a collection of hierarchy data schema and a set of instances of this schema.

Schema

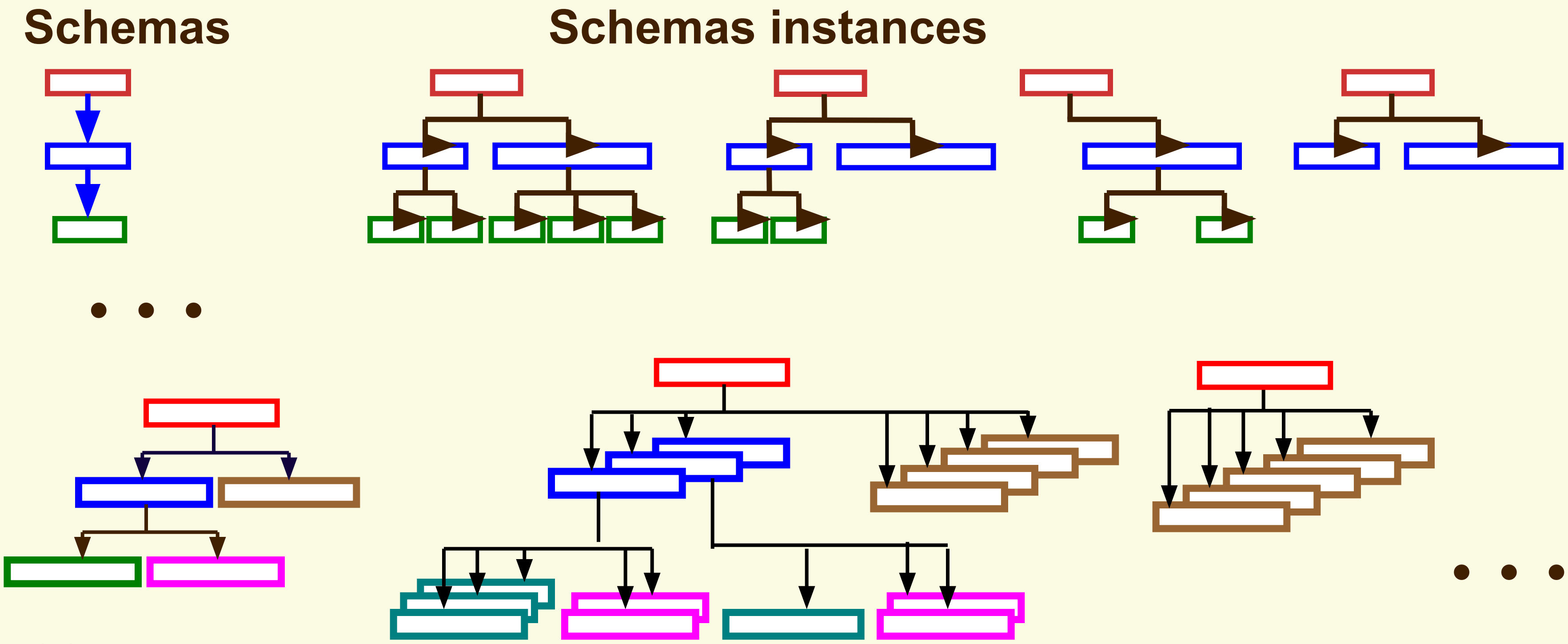


Schema instances



Hierarchy Data Base

Hierarchy data base is a set of hierarchy data structures.



Schemas

Schemas instances

Hierarchy Data Structure Operations

- Data selection:
  - GET UNIQUE
  - GET NEXT
  - GET NEXT WITHIN PARENT
- Data manipulation:
  - INSERT
  - GET HOLD
  - REPLACE
  - DELETE

Data selection (1)

GET UNIQUE Direct access. It finds the first segment of the specified type that satisfies specified condition. Allows to fix initial position for the future sequential navigation in hierarchy structure.

Syntax:

```
GET UNIQUE <segment-type>
   [WHERE <condition>];
```

Example:

```
GET UNIQUE TEACHER
    WHERE FACULTY.Name    = "informatics" AND
       DEPARTMENT.Name = "SE" AND
          TEACHER.Post    = "professor";
```

Data selection (2)

GET NEXT

Sequential access. It selects the next segment located after the current segment. A default segment ordering is used.

Syntax:

```
GET NEXT <segment-type>
   [WHERE <condition>];
```

Example:

```
GET NEXT TEACHER
    WHERE FACULTY.Name    = "informatics" AND
       DEPARTMENT.Name = "SE" AND
          TEACHER.Post    = "professor";
```

Data selection (3)

Example. Select all professors of the mathematics department of the informatics faculty:

```
GET UNIQUE TEACHER
    WHERE FACULTY.Name    = "informatics" AND
       DEPARTMENT.Name = "mathematics" AND
          TEACHER.Post    = "professor";
...
NT: GET NEXT  TEACHER
    WHERE FACULTY.Name    = "informatics" AND
       DEPARTMENT.Name = "mathematics " AND
          TEACHER.Post    = "professor";
   ...
    goto NT
```

Data selection (4)

GET NEXT WITHIN PARENT

Sequential access to the segments within specified parent segment

Syntax:

```
GET NEXT WITHIN PARENT <тsegment-type>
             [WHERE <condition>];
```

Data manipulation (1)

INSERT – insertion of segment instances.

Example. Enter segment about CAD department of the informatics faculty and information about teacher Smith of this department.

```
DEPARTMENT.Name     = "CAD";
DEPARTMENT.Head     = "Nemiroff";
DEPARTMENT.Building = 3;
INSERT DEPARTMENT
    WHERE FACULTYT.Name = "informatics";

TEACHER.Name    = "Smith";
TEACHER.Post    = “assistant"
TEACHER.Address = "Shevchenko avenue 13/17";
INSERT TEACHER
    WHERE FACULTY.Name     = "informatics" AND
             DEPARTMENT.Name = "CAD";
```

Data manipulation (2)

GET HOLD – selection the segment to be replaced
REPLACE – segment replacing.

Example. Change address of the Smith teacher of the CAD department of the informatics faculty.

```
GET HOLD UNIQUE TEACHER
    WHERE = FACULTY.Name    = "informatics" AND
            DEPARTMENT.Name = "CAD" AND
            TEACHER.Name    = "Smith";

TEACHER.Address = " Teremkovskaya str. 1/19";

REPLACE;
```

Data manipulation (3)

GET HOLD – selection the segment to be deleted
DELETE – selected segment deletion.

Example. Delete segment about Smith teacher of the CAD department of the informatics faculty.

```
GET HOLD UNIQUE Teacher
    WHERE = Faculty.Name    = "informatics" AND
            DEPARTMENT.Name = "CAD" AND
            TEACHER.Name    = "Smith";

DELETE;
```

Hierarchy data model advantages

- Advanced low level facilities to control of data in external memory
- An opportunity of efficient usage of the memory
- An opportunity to implement an efficient application systems

Hierarchy data model disadvantages

- Low level of data query and manipulation language
- Asymmetric search of symmetric queries
- It is difficult to develop user "friendly " interface
- Anomalies of data insertion, deletion and updating
- Data duplication
- It is difficult to implement flexible mechanisms of data protection, integrity, consistency