Concept of Data Base

Database Management System (DBMS)

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- Collection of interrelated data
- Set of programs to access the data
- DBMS contains information about a particular enterprise
- DBMS provides an environment that is both convenient and efficient to use.
- Database Applications:
  - Banking: all transactions
  - Airlines: reservations, schedules
  - Universities: registration, grades
  - Sales: customers, products, purchases
  - Manufacturing: production, inventory, orders, supply chain
  - Human resources: employee records, salaries, tax deductions
- Databases touch all aspects of our lives

Levels of Abstraction

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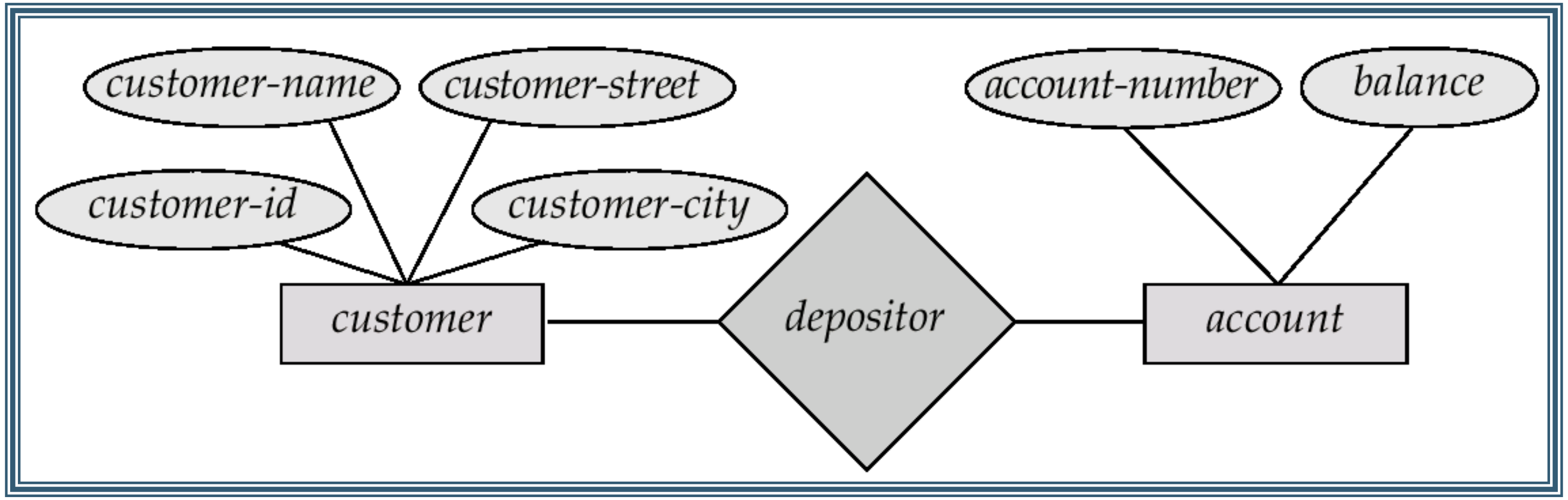
- Physical level describes how a record (e.g., customer) is stored.
- Logical level: describes data stored in database, and the relationships among the data.
-
```
type customer = record
        name : string;
        street : string;
        city : integer;
end;
```
- View level: application programs hide details of data types. Views can also hide information (e.g., salary) for security purposes.

Data Models

- A collection of tools for describing
  - data
  - data relationships
  - data semantics
  - data constraints
- Entity-Relationship model
- Relational model
- Other models:
  - object-oriented model
  - semi-structured data models
  - Older models: network model and hierarchical model

Entity-Relationship Model

- Example of schema in the entity-relationship model



Entity Relationship Model (Cont.)

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- E-R model of real world
  - Entities (objects)
    - E.g. customers, accounts, bank branch
  - Relationships between entities
    - E.g. Account A-101 is held by customer Johnson
    - Relationship set depositor associates customers with accounts
- Widely used for database design
  - Database design in E-R model usually converted to design in the relational model (coming up next) which is used for storage and processing

Relational Model

- Example

Attributes

Customer-id	*customer-name*	*customer-street*	*customer-city*	*account-number*
192-83-7465	Johnson	Alma	Palo Alto	A-101
019-28-3746	Smith	North	Rye	A-215
192-83-7465	Johnson	Alma	Palo Alto	A-201
321-12-3123	Jones	Main	Harrison	A-217
019-28-3746	Smith	North	Rye	A-201

A Sample Relational Database

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customer-id	*customer-name*	*customer-street*	*customer-city*
192-83-7465	Johnson	12 Alma St.	Palo Alto
019-28-3746	Smith	4 North St.	Rye
677-89-9011	Hayes	3 Main St.	Harrison
182-73-6091	Turner	123 Putnam Ave.	Stamford
321-12-3123	Jones	100 Main St.	Harrison
336-66-9999	Lindsay	175 Park Ave.	Pittsfield
019-28-3746	Smith	72 North St.	Rye

(a) The *customer* table

account-number	*balance*
A-101	500
A-215	700
A-102	400
A-305	350
A-201	900
A-217	750
A-222	700

(b) The *account* table

customer-id	*account-number*
192-83-7465	A-101
192-83-7465	A-201
019-28-3746	A-215
677-89-9011	A-102
182-73-6091	A-305
321-12-3123	A-217
336-66-9999	A-222
019-28-3746	A-201

(c) The *depositor* table

SQL

- SQL: widely used non-procedural language
  - E.g. find the name of the customer with customer-id 192-83-7465

```
select   customer.customer-name
from     customer
where    customer.customer-id = '192-83-7465'
```

  - E.g. find the balances of all accounts held by the customer with customer-id 192-83-7465

```
select   account.balance
from     depositor, account
where    depositor.customer-id = '192-83-7465' and
         depositor.account-number = account.account-number
```

- Application programs generally access databases through one of
  - Language extensions to allow embedded SQL
  - Application program interface (e.g. ODBC/JDBC) which allow SQL queries to be sent to a database

Database Users

- Users are differentiated by the way they expect to interact with the system
- Application programmers – interact with system through DML calls
- Sophisticated users – form requests in a database query language
- Specialized users – write specialized database applications that do not fit into the traditional data processing framework
- Naïve users – invoke one of the permanent application programs that have been written previously
  - E.g. people accessing database over the web, bank tellers, clerical staff

Database Administrator

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- Coordinates all the activities of the database system; the database administrator has a good understanding of the enterprise’s information resources and needs.
- Database administrator's duties include:
  - Schema definition
  - Storage structure and access method definition
  - Schema and physical organization modification
  - Granting user authority to access the database
  - Specifying integrity constraints
  - Acting as liaison with users
  - Monitoring performance and responding to changes in requirements

Database Management System

Why we need database?

- Without database GIS is cartography (electronic map)
- No database No spatial analysis

Database and GIS

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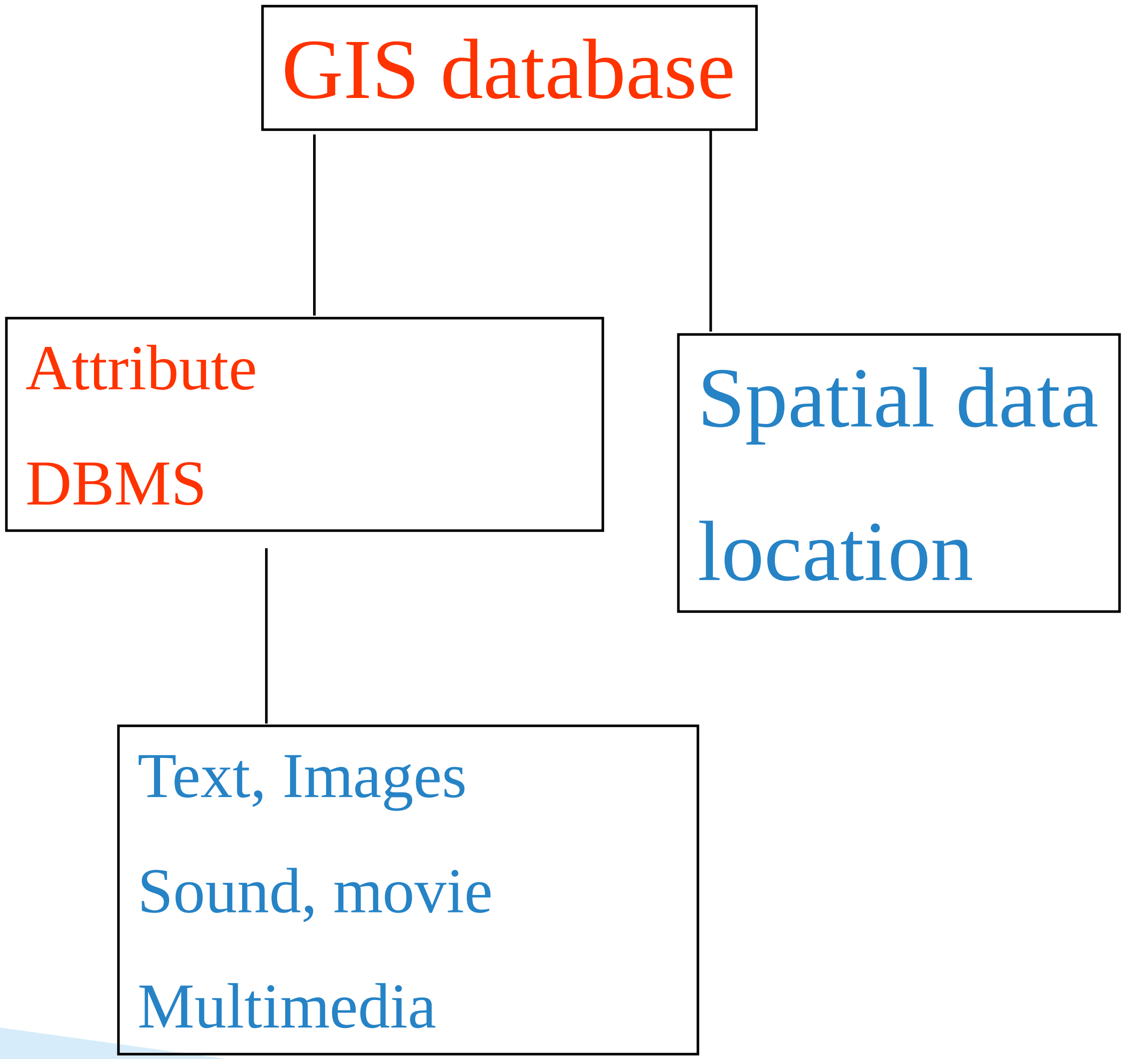

- DBMS is a collection of data (database) and programs to access that data.
- The goal of DBMS is to store, retrieve, and display information (attribute).

Key characteristics of DBMS

- Store large volume of database.
- Share data (access).
- Provide security (authorization).
- Remove redundancy (normalization)
- Provide concurrent access (different users at the same time).

Database Management Systems (DBMS)

- A DBMS is a computer programmed for creating, maintaining and accessing digital databases.
- There are a large number of commercial packages available for doing this.
- The DBMS provides the essential link between the GIS software, external data sources or graphics enhancing packages and any operations which the user might wish to perform.
- DBMS can work with different data types such as characters, numerals or dates; they have languages for describing or manipulating the data or for querying the database for particular pieces of information; they provide programming tools and they have particular file structures

The Main Features Required of a Database Management System

- To create data bases which are in a carefully structured and consistently logical format.
- To create new data bases.
- To extract data from the database in a variety of ways.
- To persistently and constantly execute any commands.
- To display data as required.
- To edit data in any requisite way.
- To sort data.
- To allow for the transfer of data between various software packages.
- To protect data against loss, unauthorized entry, copying and destruction.
- To protect against any inconsistencies which may result from multiple simultaneous use of the database.
- To be independent of particular hardware needs

Primary Key and Foreign Key

- Relational database use primary keys and foreign keys to allow mapping of information from one table to another
- A foreign key is column or group of columns in a table whose value matches those of the primary key of another table
- Values in primary key column must be unique

The main types of database models

- Object-based logical models: Are used to describe data at the conceptual and view level. Example of these are the Entity-Relationship model and object-oriented model
- Record-based logical models : Are used to describe data at the conceptual and view level. Example of these are: Network model, Hierarchical model, and relational model.
- Physical data models: Are used to describe data at the physical level (bytes and words). It is mainly deal with hardware.

DBMS structural/storage methods

- For a DBMS to be most effective it is important that the data is stored in an orderly way.
- There are basically Three types of DBMS structural/storage methods:
  - hierarchical
  - networked
  - relational.

storage methods (Hierarchical)

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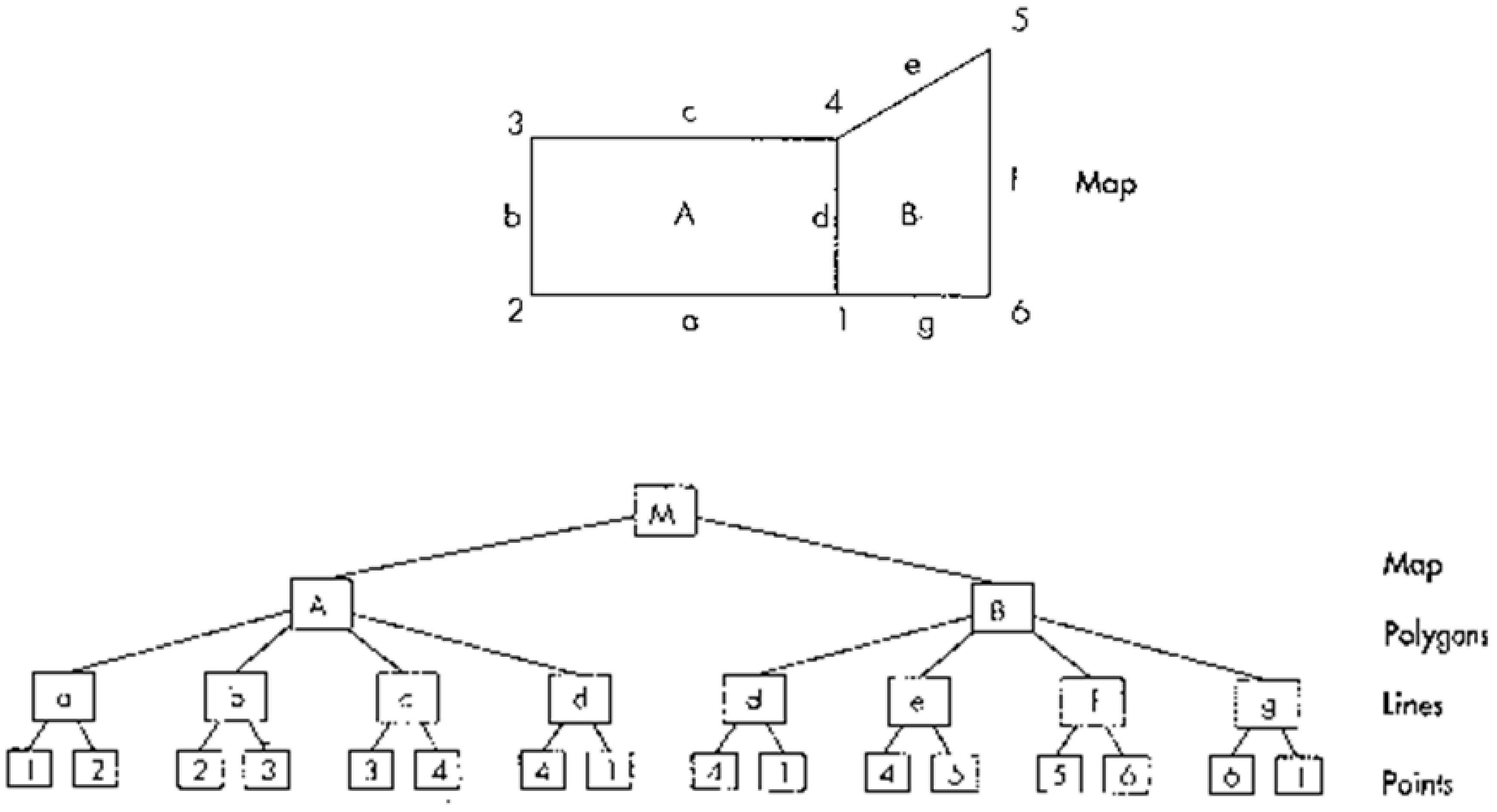
- (a) Hierarchical. In the hierarchical model each record can have a number of links to lower “levels”, but only one link to a higher level. The highest link is the “root”, lower levels are called “children” and levels above are called “parents”. Figure 6.13 shows a typical hierarchical data model for a hypothetical mapped area. Hierarchical data structures are easy to understand and to update or expand and they are useful where up and down searching is required, but they are not very good in circumstances where horizontal searching is carried out, i.e. where it might be necessary to locate all records which are at one level, since there are no connections at the same level.



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storage methods (Networked)

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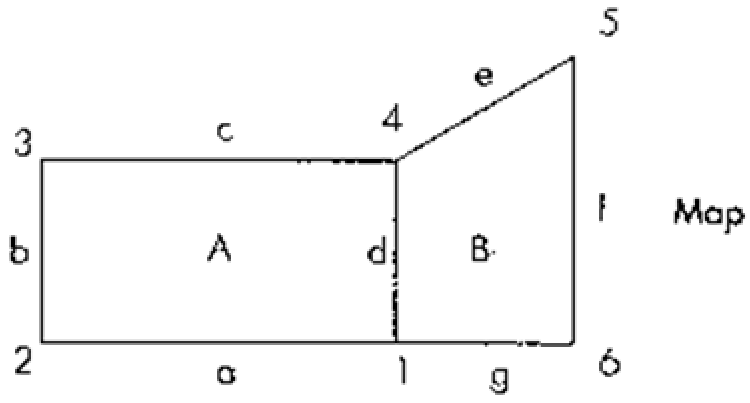
- (b) Networked. This is similar to the hierarchical data model but here it is possible to have more than one parent, and thus many-to-many relationships can be found. Figure 6.14 shows that a networked database structure can be analogous to a communications network where there may be many linkages between any combinations of centres. This type of data structure makes good use of the available data, with rapid connections being possible, but it is difficult to create and maintain. Both hierarchical and networked structures are now seldom used in GIS's.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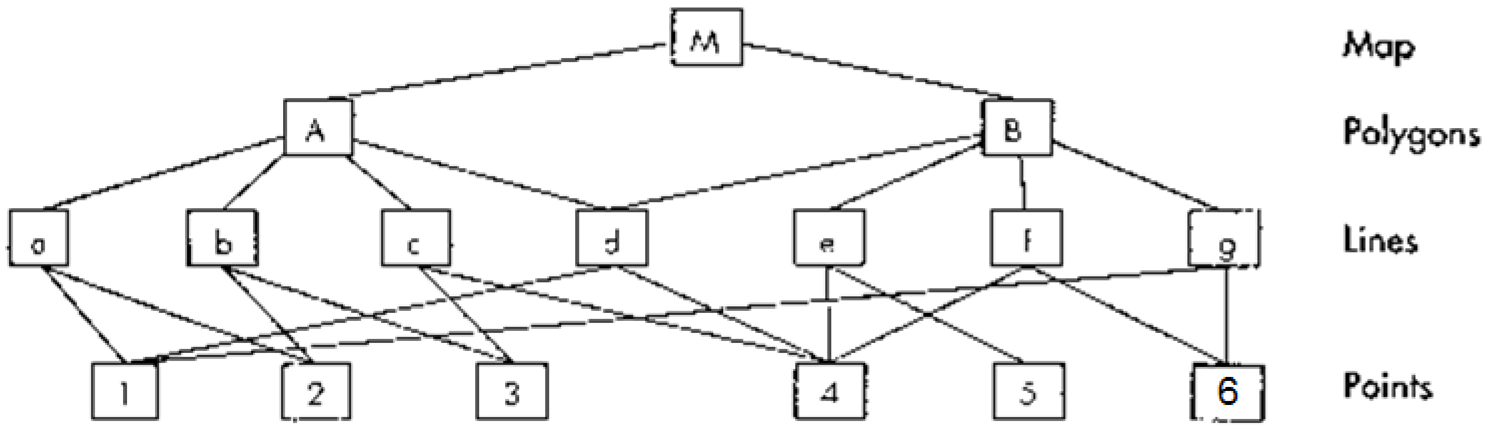
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storage methods (Relational)

- (c) Relational. Here data is organized in a series of tables, each of which contains one type of record.
- The rows of the tables correspond to records and the columns to fields of the records.
- Each table in the database will be linked by a common field, otherwise called a unique identifier (or a key attribute).
- Data is extracted from the database by defining the relationship which is appropriate to the query being asked. This could well involve the use of relational algorithms in order to construct new tables if required.

Relationships between Tables

- One-to-One
- One-to-Many
- Many-to-Many

One-to-One

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NAME	AREA	POP1990
Caroline	331.8066	27035
Talbot	238.2847	30549
Dorchester	534.1747	30236
Wicomico	383.3481	74339
Worcester	457.6503	35028
Somerset	269.267	23440

NAME	POP1997
Caroline	29424
Talbot	32565
Dorchester	29953
Wicomico	79716
Worcester	41885
Somerset	24251

NAME	AREA	POP1990	POP1997
Caroline	331.8066	27035	29424
Talbot	238.2847	30549	32565
Dorchester	534.1747	30236	29953
Wicomico	383.3481	74339	79716
Worcester	457.6503	35028	41885
Somerset	269.267	23440	24251

- Relational Database Example (1-M)

Complexes table

comp_name	N.Shops	N.Banks
Kotraya	444	70
H.Plaza	555	47
Komtar	622	43

Primary Key

Owner table

comp_name	shop_owner
Kotraya	ALi
Kotraya	Tan
Kotraya	Lee
Kotraya	Raman
Kotraya	Nora

Foreign Key

One-to-Many

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Agri	Mollett
Nat Sci	Ruby

Advisor	Name
Shorter	Aaron
Ruby	Brian
Mollett	Devin
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