Introduction

About course

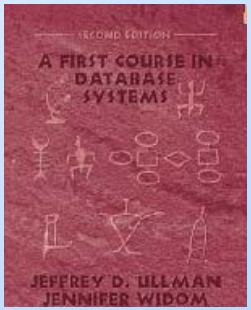
Relational Model, Schemas, SQL

Semistructured Model, XML

Textbook

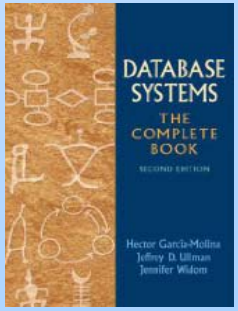
- *A First Course in Database Systems*

  Jeff Ullman, and Jennifer Widom



- *Database Systems: Complete Book*

  Hector Garcia-Molina, Jeff Ullman, and Jennifer Widom.



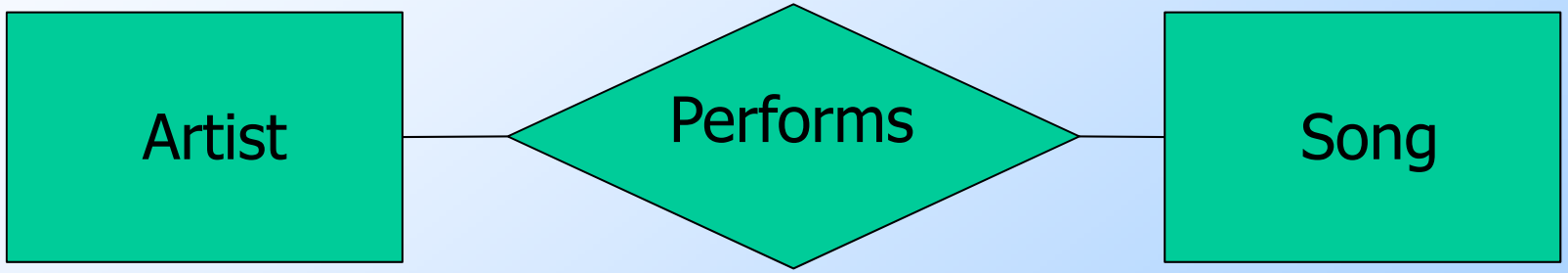
- *Veri Tabanı Sistemleri*

  Ünal Yarımağan

Content

- Design of databases.
  - E/R model, relational model, semistructured model, XML, UML, ODL.
- Database programming.
  - SQL, XPath, XQuery, Relational algebra, Datalog.

ER Model



Content

- **XPath** (XML Path Language) is a language for selecting nodes from an XML document

XPath

//türkü[@yöresi=”Giresun”]/@uzunluk

```
<mp3>
      <başlık> Türk Halk Müziği </başlık>
       <sanatçı>
         <ad> Taner </ad>
         <soyadı> Tezcan </soyadı>
       </sanatçı>
      <türkü yöresi="Giresun" uzunluk =”4:02”>
                Giresun Kayıkları </türkü>
      <türkü yöresi="Giresun" uzunluk =”3:52”>
                Bir Fındığın İçini </türkü>
      <türkü yöresi="Trabzon" uzunluk =”5:10”>
                Trabzon Ninnileri </türkü>
</mp3>
```

Content

- **XQuery** is a query language (with some programming language features) that is designed to query collections of XML data

XQuery

```
for $s in doc(“mp3.xml”)/mp3/sanatçı
     return  <isim> {$s/ad} </isim>
```

Do You Know SQL?

- Explain the difference between:

```
SELECT b
FROM R
WHERE a<10 OR a>=10;
```

and

```
SELECT b
FROM R;
```

a	b
5	20
10	30
20	40
…	…

R

And How About These?

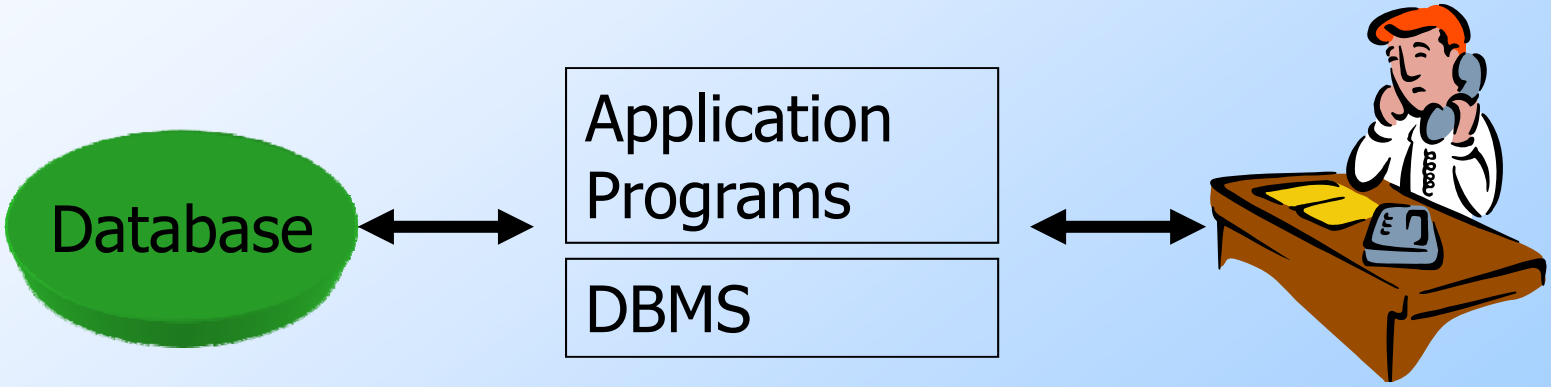
```
SELECT a
FROM R, S
WHERE R.b = S.b;

SELECT a
FROM R
WHERE b IN (SELECT b FROM S);
```

Course Requirements

1. Firstterm (30%, Classic)
2. Midterm (20%, Test)
3. Final (50%, Classic)

Database Processing



Interesting Stuff About Databases

- It used to be about boring stuff: employee records, bank records, etc.
- Today, the field covers all the largest sources of data, with many new ideas.
  - Web search.
  - Data mining.
  - Scientific and medical databases.
  - Integrating information.

More Interesting Stuff

- Database programming centers around limited programming languages.

Still More …

- You may not notice it, but databases are behind almost everything you do on the Web.
  - Google searches.
  - Queries at Amazon, eBay, etc.

And More…

- Databases often have unique concurrency-control problems
  - Many activities (transactions) at the database at all times.
  - Must not confuse actions, e.g., two withdrawals from the same account must each debit the account.

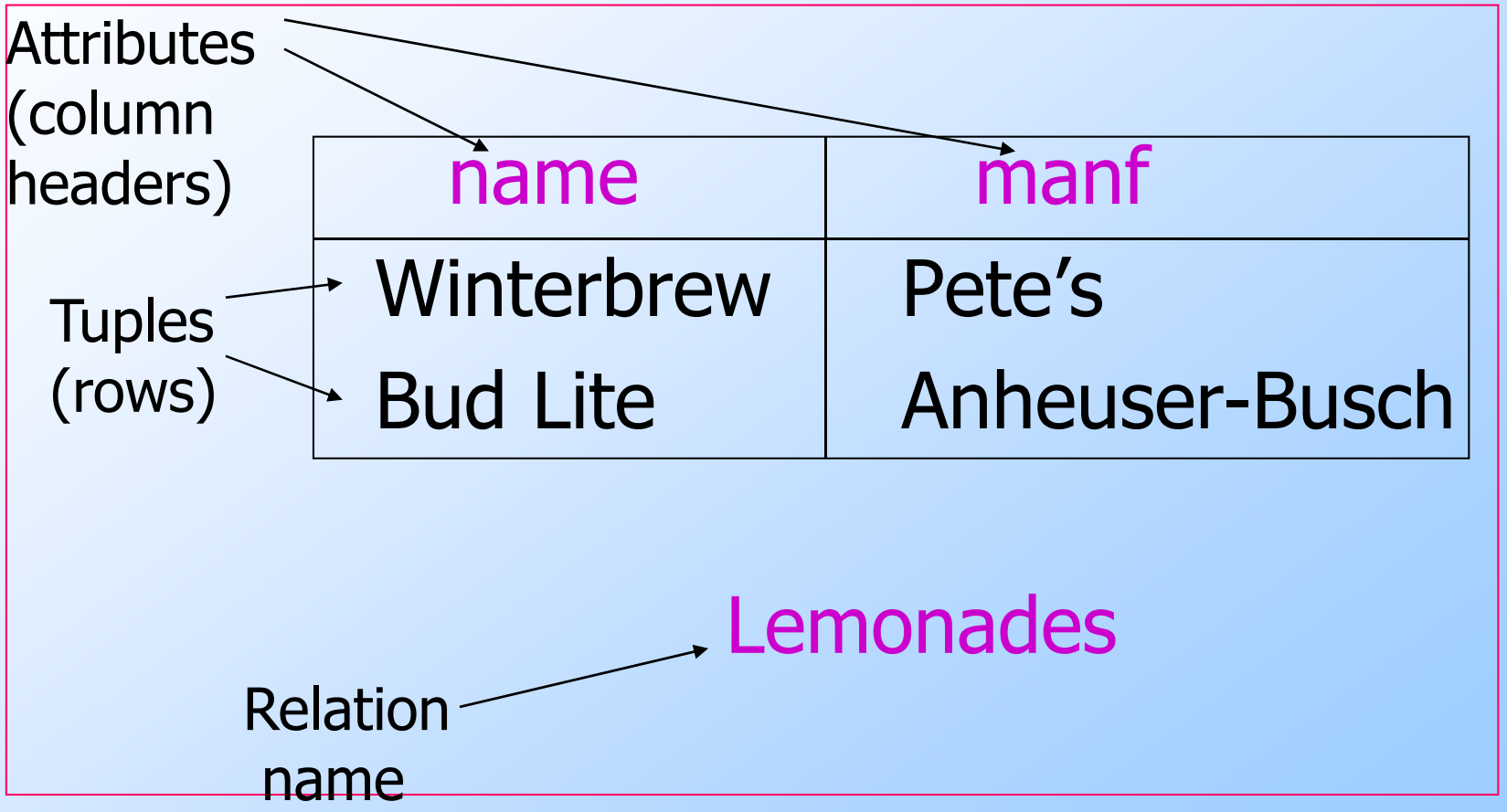
Advantages of DBMS

- Data Integrity
- Concurrency
- Data Security

What is a Data Model?

1. Mathematical representation of data.
   - Examples: relational model = tables; semistructured model = trees/graphs.
2. Operations on data.
3. Constraints.

A Relation is a Table



Schemas

- *Relation schema* = relation name and attribute list.
  - Optionally: types of attributes.
  - Example: Lemonades(name, manf) or Lemonades(name: string, manf: string)
- *Database* = collection of relations.
- *Database schema* = set of all relation schemas in the database.

Why Relations?

- Very simple model.
- *Often* matches how we think about data.
- Abstract model that underlies SQL, the most important database language today.

Our Running Example

Lemonades(name, manf)

Bars(name, addr, license)

Drinkers(name, addr, phone)

Likes(drinker, lemonade)

Sells(bar, lemonade, price)

Frequents(drinker, bar)

- Underline = *key* (tuples cannot have the same value in all key attributes).
  - Excellent example of a constraint.

Database Schemas in SQL

- SQL is primarily a query language, for getting information from a database.
- But SQL also includes a *data-definition* component for describing database schemas.

Creating (Declaring) a Relation

- Simplest form is:

```
CREATE TABLE <name> (
        <list of elements>
);
```

- To delete a relation:

```
DROP TABLE <name>;
```

Elements of Table Declarations

- Most basic element: an attribute and its type.
- The most common types are:
  - INT or INTEGER (synonyms).
  - REAL or FLOAT (synonyms).
  - CHAR(*n*) = fixed-length string of *n* characters.
  - VARCHAR(*n*) = variable-length string of up to *n* characters.

Example: Create Table

```
CREATE TABLE Sells (
    bar      CHAR(20),
    lemonade VARCHAR(20),
    price    REAL
);
```

SQL Values

- Integers and reals are represented as you would expect.
- Strings are too, except they require single quotes.
  - Two single quotes = real quote, e.g., `'Joe''s Bar'`.
- Any value can be NULL.

Dates and Times

- DATE and TIME are types in SQL.
- The form of a date value is:

  DATE 'yyyy-mm-dd'

  - Example: `DATE '2009-03-11'` for March 11, 2009.

Times as Values

- The form of a time value is:

  TIME 'hh:mm:ss'

  with an optional decimal point and fractions of a second following.
  - Example: `TIME '15:30:02.5'` = two and a half seconds after 3:30PM.

Declaring Keys

- An attribute or list of attributes may be declared PRIMARY KEY or UNIQUE.
- Either says that no two tuples of the relation may agree in all the attribute(s) on the list.
- There are a few distinctions to be mentioned later.

Declaring Single-Attribute Keys

- Place PRIMARY KEY or UNIQUE after the type in the declaration of the attribute.
- Example:

```
CREATE TABLE Lemonades (
    name    CHAR(20) UNIQUE,
    manf    CHAR(20)
);
```

Declaring Multiattribute Keys

- A key declaration can also be another element in the list of elements of a CREATE TABLE statement.
- This form is essential if the key consists of more than one attribute.
  - May be used even for one-attribute keys.

Example: Multiattribute Key

- The bar and lemonade together are the key for Sells:

```
CREATE TABLE Sells (
    bar      CHAR(20),
    lemonade VARCHAR(20),
    price    REAL,
    PRIMARY KEY (bar, lemonade)
);
```

PRIMARY KEY vs. UNIQUE

1. There can be only one PRIMARY KEY for a relation, but several UNIQUE attributes.
2. No attribute of a PRIMARY KEY can ever be NULL in any tuple. But attributes declared UNIQUE may have NULL's, and there may be several tuples with NULL.

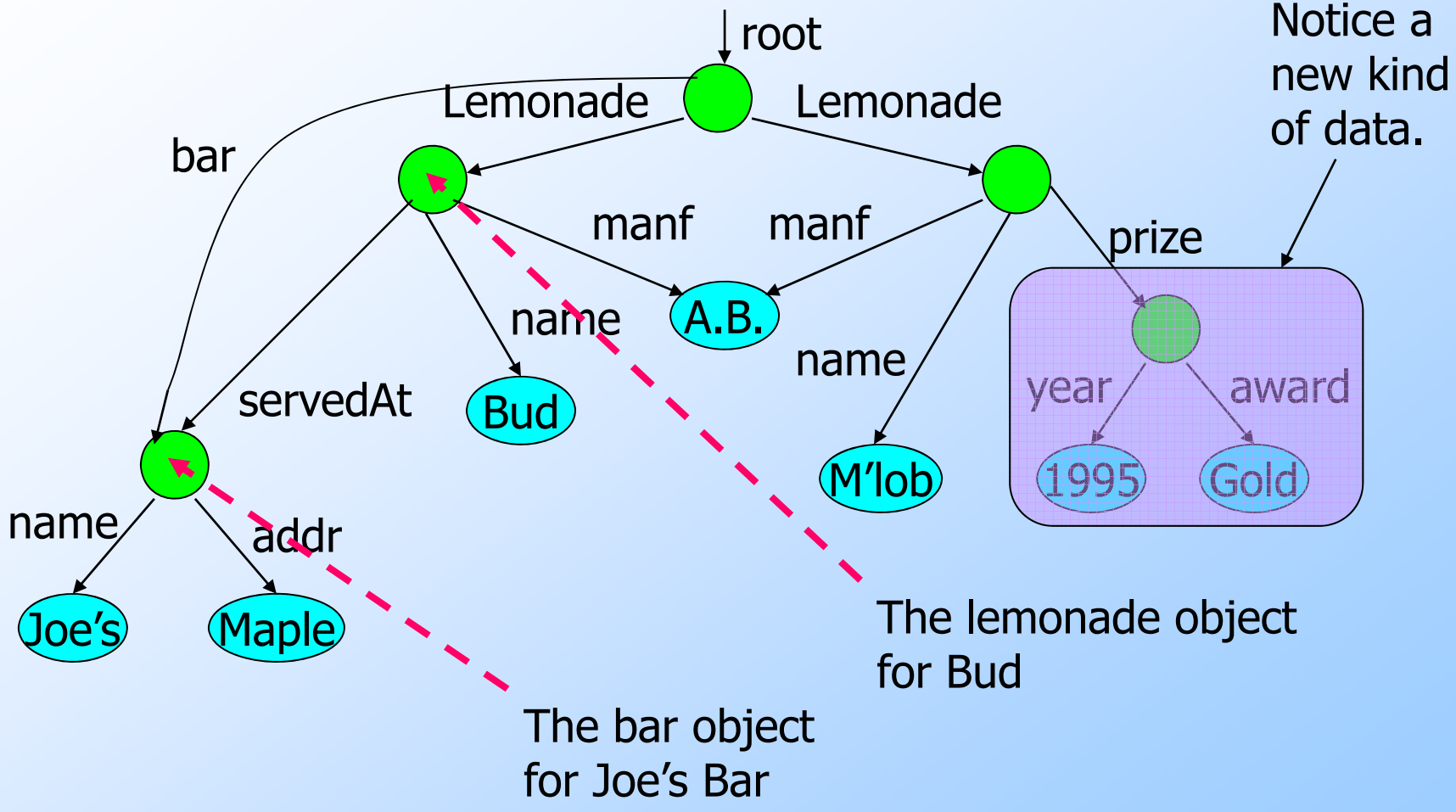
Semistructured Data

- Another data model, based on trees.
- Motivation: flexible representation of data.
- Motivation: sharing of *documents* among systems and databases.

Graphs of Semistructured Data

- Nodes = objects.
- Labels on arcs (like attribute names).
- Atomic values at leaf nodes (nodes with no arcs out).
- Flexibility: no restriction on:
  - Labels out of a node.
  - Number of successors with a given label.

Example: Data Graph



XML

- XML = *Extensible Markup Language*.
- While HTML uses tags for formatting (e.g., "italic"), XML uses tags for semantics (e.g., "this is an address").
- Key idea: create tag sets for a domain (e.g., genomics), and translate all data into properly tagged XML documents.

XML Documents

- Start the document with a *declaration*, surrounded by <?xml ... ?> .
- Typical:

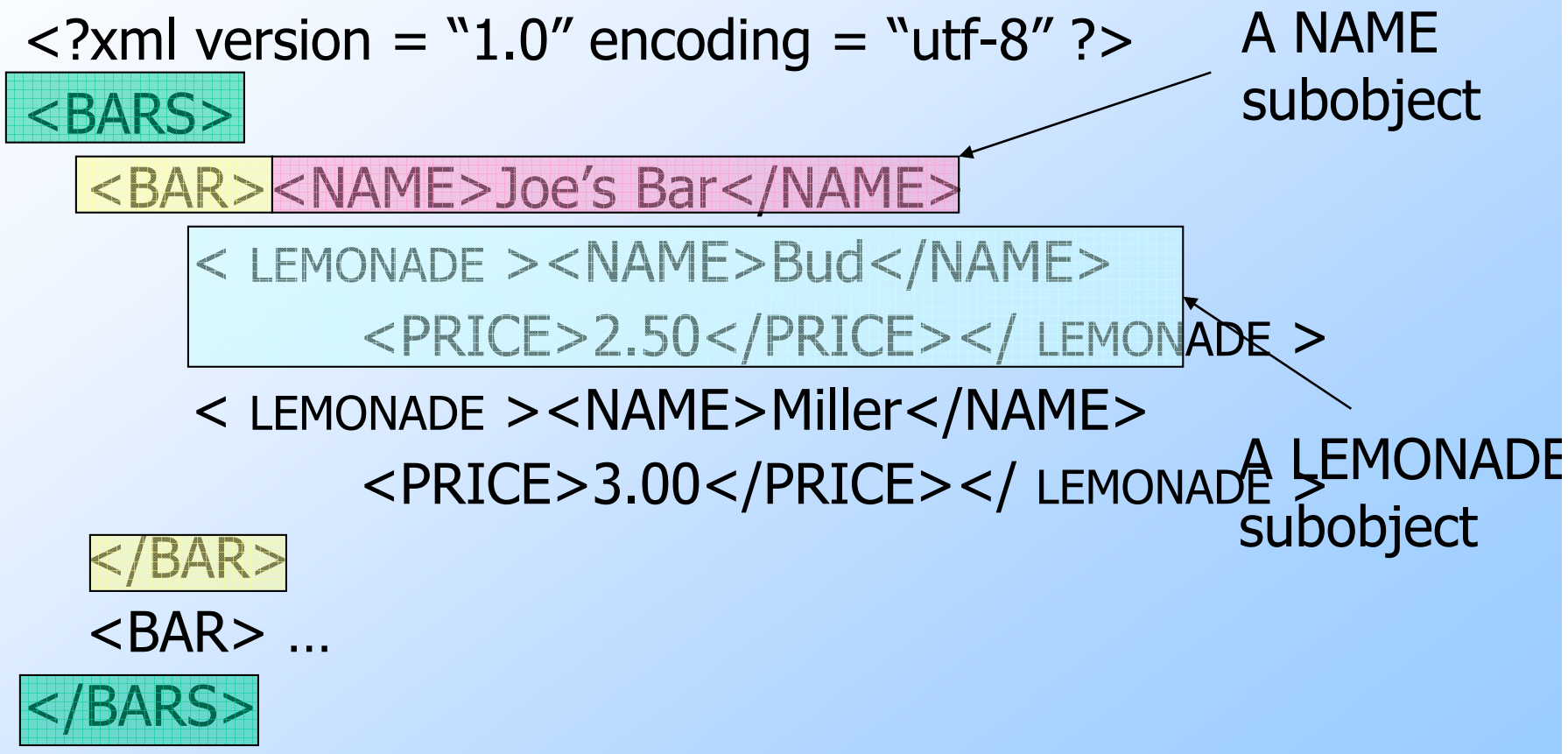
```
<?xml version = “1.0” encoding
  = “utf-8” ?>
```

- Balance of document is a *root tag* surrounding nested tags.

Tags

- Tags, as in HTML, are normally matched pairs, as <FOO> ... </FOO>.
  - Optional single tag <FOO/>.
- Tags may be nested arbitrarily.
- XML tags are case sensitive.

Example: an XML Document



Attributes

- Like HTML, the opening tag in XML can have atttribute = value pairs.
- Attributes also allow linking among elements (discussed later).

Bars, Using Attributes

```
<?xml version = "1.0" encoding = "utf-8" ?>
<BARS>
   <BAR name = "Joe's Bar">
      < LEMONADE name = "Bud" price = 2.50 />
      < LEMONADE name = "Miller" price = 3.00 />
   </BAR>
   <BAR> ...
</BARS>
```

name and price are attributes

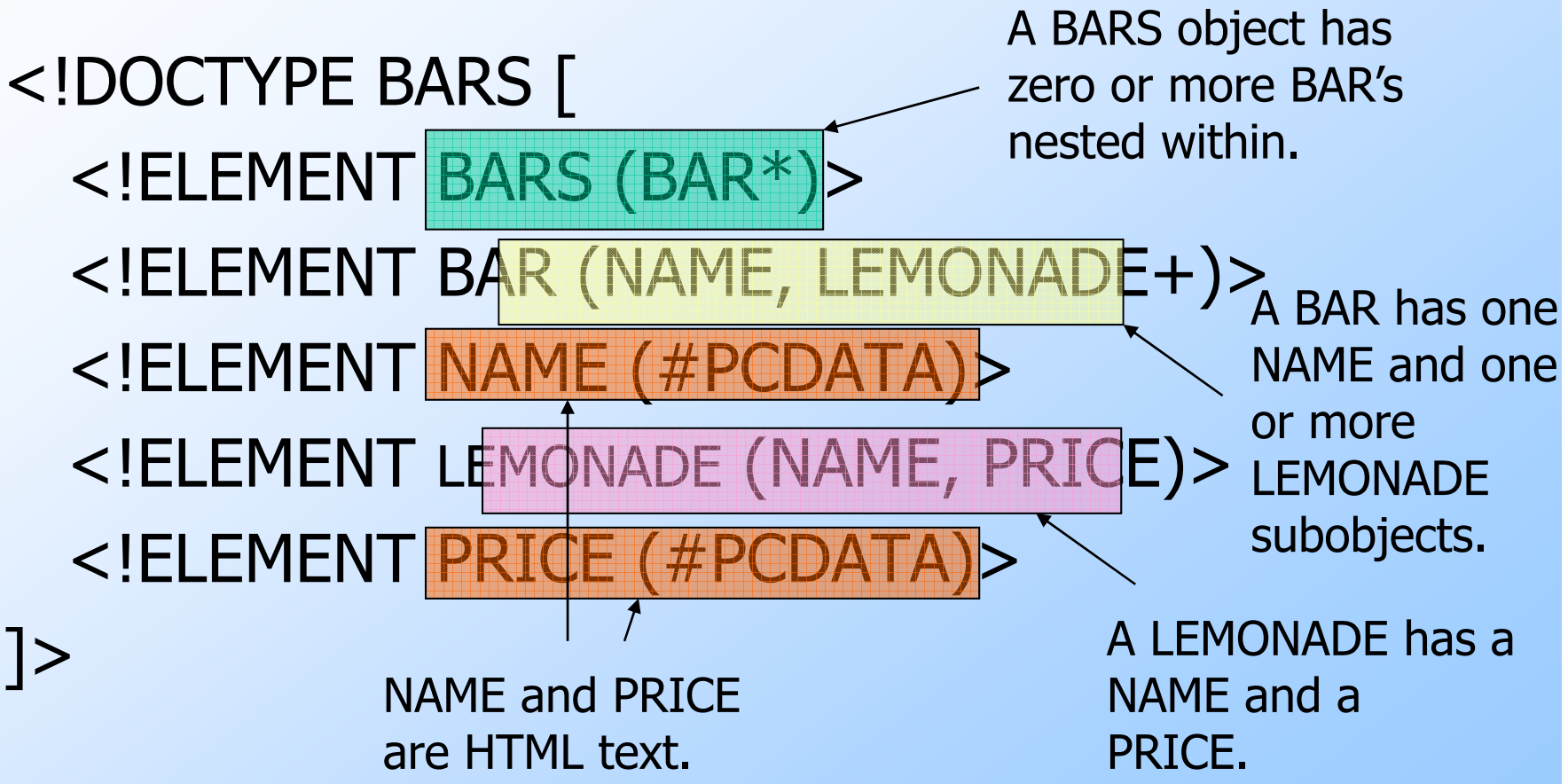
Notice Lemonade elements have only opening tags with attributes.

DTD's (Document Type Definitions)

- A grammatical notation for describing allowed use of tags.
- Definition form:

```
<!DOCTYPE <root tag> [
  <!ELEMENT <name>(<components>)>
  . . . more elements . . .
]>
```

Example: DTD


<!DOCTYPE BARS [
<!ELEMENT BARS (BAR*)>
<!ELEMENT BAR (NAME, LEMONADE+)>
<!ELEMENT NAME (#PCDATA)>
<!ELEMENT LEMONADE (NAME, PRICE)>
<!ELEMENT PRICE (#PCDATA)>
]>
A BARS object has zero or more BAR's nested within.
A BAR has one NAME and one or more LEMONADE subobjects.
A LEMONADE has a NAME and a PRICE.
NAME and PRICE are HTML text.

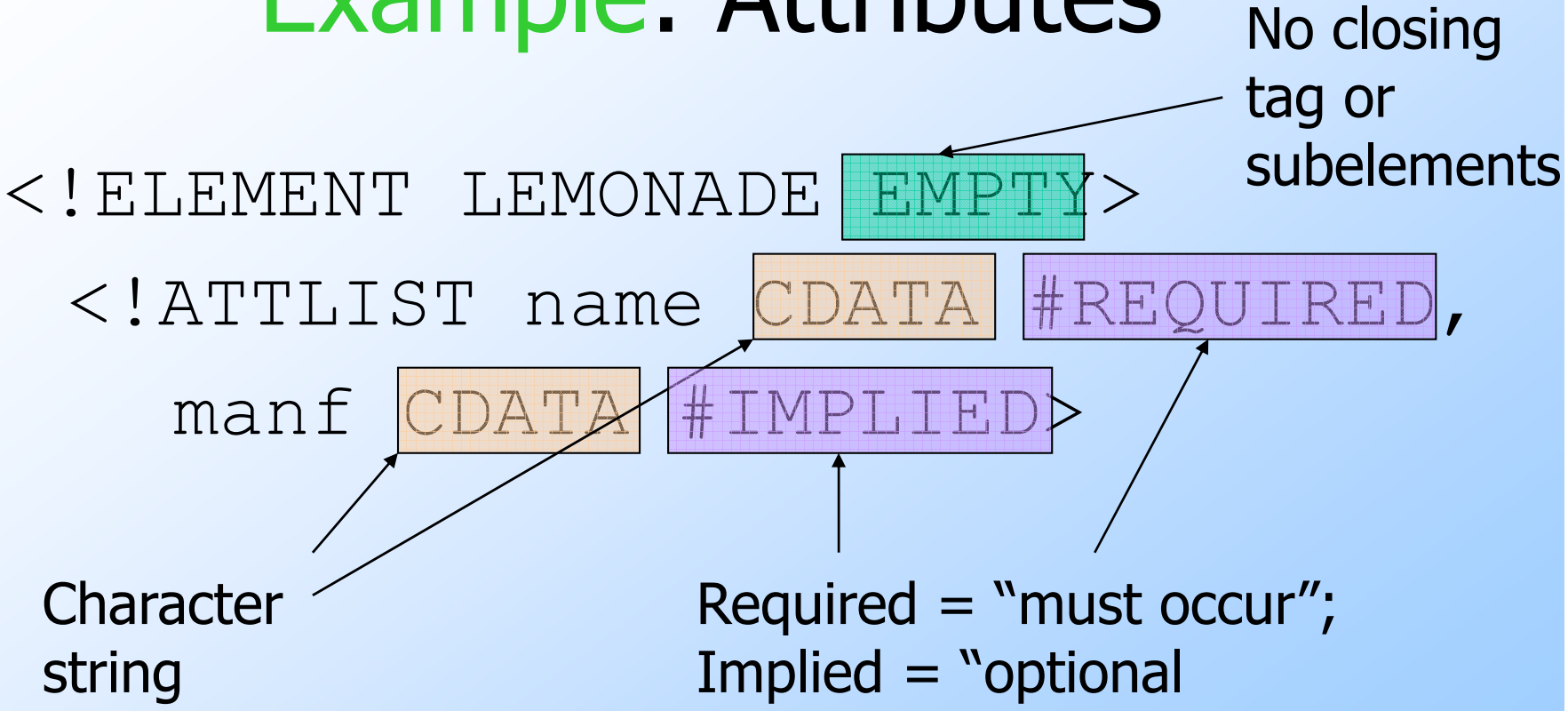
Attributes

- Opening tags in XML can have *attributes*.
- In a DTD,

`<!ATTLIST` *E* `. . . >`

declares an attribute for element *E*, along with its datatype.

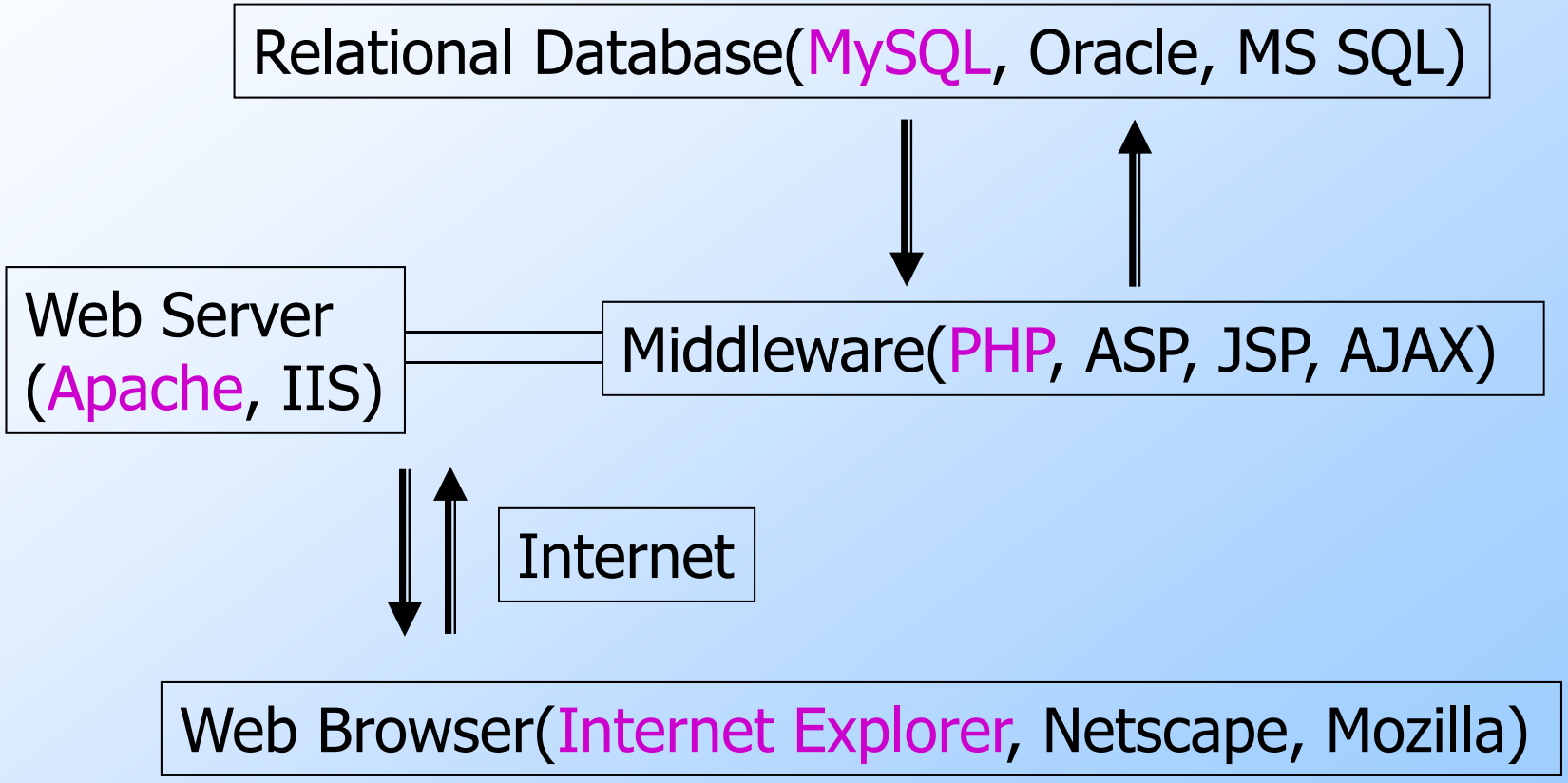
Example: Attributes



Example use:

< LEMONADE name="Bud" />

Architecture of Web Applications



Apache, MySQL, PHP on Windows (WAMP)