Defining a Database Schema

`CREATE TABLE` name (list of elements).

- Principal elements are attributes and their types, but key declarations and constraints also appear.
- Similar `CREATE` X commands for other schema elements X: views, indexes, assertions, triggers, domains.
  - Assertions and domains not in Oracle 7.3.2.
- "`DROP` X name" deletes the created element of kind X with that name.

Example

```
CREATE TABLE Sells (
    bar CHAR(20),
    beer VARCHAR(20),
    price real
);

DROP TABLE Sells;
```

Types

1. int or integer.
2. real or float.
3. `CHAR(`n`)` = fixed length character string, padded with "pad characters."
4. `VARCHAR(`n`)` = variable-length strings up to n characters.
5. `BIT(`n`)` = bit string of length n.
   - Not in Oracle 7.3.2.
6. Dates. SQL2 form is `DATE 'yyyy-mm-dd'`
   - Oracle uses a different format — to be explained.
7. Times. Form is `TIME 'hh:mm:ss[.ss...]'` in SQL2.

Oracle Default Dates (Used at Stanford)

Format `'dd-mon-yy'`

Example

```
CREATE TABLE Days (
    d DATE
);

INSERT INTO Days
VALUES('06-nov-97');
```

- Oracle function `to_date` converts a specified format into default format.

```
INSERT INTO Days
VALUES(to_date('2000-01-01',
        'yyyy-mm-dd'));
```

- Stored in our system as `'01-jan-00'`.
  - ❖ Now do you believe there is a "year 2000" problem?

Declaring Keys

Use `PRIMARY KEY` or `UNIQUE`.

- Oracle 7.3.2 treats these as synonyms.
- But only one primary key, many "uniques" allowed.
- SQL2 allows implementations to create an index (data structure to speed access given a key value) only in response to `PRIMARY KEY`.
  - ✦ But Oracle creates indexes for both.
- Two places to declare:
  1. After an attribute's type, if the attribute is a key by itself.
  2. As a separate element.
  - ✦ Essential if key is > 1 attribute.

Example

```
CREATE TABLE Sells (
    bar CHAR(20),
    beer VARCHAR(20),
    price real,
    PRIMARY KEY(bar,beer)
);
```

- On the Stanford Oracle system for this class, there is a separate data area on a separate disk for indexes.
    - Speeds access — two heads are better than one.
    - Thus, you must follow any implicit index-creating statement like "primary key," by:

```
USING INDEX TABLESPACE csindx
```

Example

```
CREATE TABLE Beers (
    name CHAR(20) UNIQUE
        USING INDEX TABLESPACE csindx,
    manf CHAR(20)
);
```

Other Properties You Can Give to Attributes

1. `NOT NULL` = every tuple must have a real value for this attribute.

2. `DEFAULT` value = a value to use whenever no other value of this attribute is known.

Example

```
CREATE TABLE Drinkers (
    name CHAR(30) PRIMARY KEY
        USING INDEX TABLESPACE csindx,
    addr CHAR(50)
            DEFAULT '123 Sesame St',
    phone CHAR(16)
);
```

```
INSERT INTO Drinkers(name)
VALUES('Sally')
```

results in the following tuple:

name	addr	phone
Sally	123 Sesame St.	NULL

- Primary key is by default not `NULL`.
- This insert is legal.
    - OK to list a subset of the attributes and values for only this subset.
- But if we had declared

  ```
  phone CHAR(16) NOT NULL
  ```

  then the insertion could not be made.

Changing Columns

Add an attribute of relation R with

`ALTER TABLE` R `ADD` <column declaration>;

Example

```
ALTER TABLE Bars ADD phone CHAR(16)
          DEFAULT 'unlisted';
```

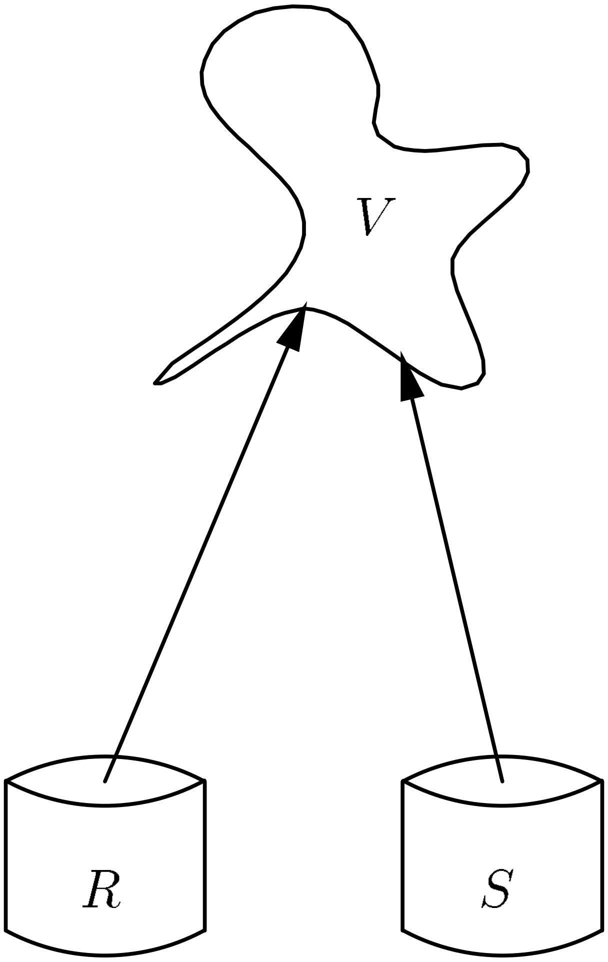
- SQL2 allows columns to be dropped, e.g.,

  ```
  ALTER TABLE Bars DROP license;
  ```

- However, this statement is illegal in Oracle 7.3.2.

Views

An expression that describes a table without creating it.



- View definition form is:

  `CREATE VIEW` <name> `AS`
  <query>;

Example

The view `CanDrink` is the set of drinker-beer pairs such that the drinker frequents at least one bar that serves the beer.

```
CREATE VIEW CanDrink AS
    SELECT drinker, beer
    FROM Frequents, Sells
    WHERE Frequents.bar = Sells.bar;
```

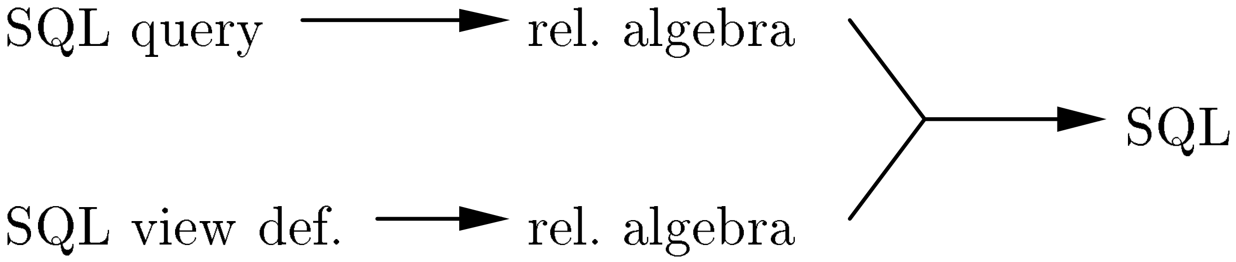
Querying Views

Treat the view as if it were a materialized relation.

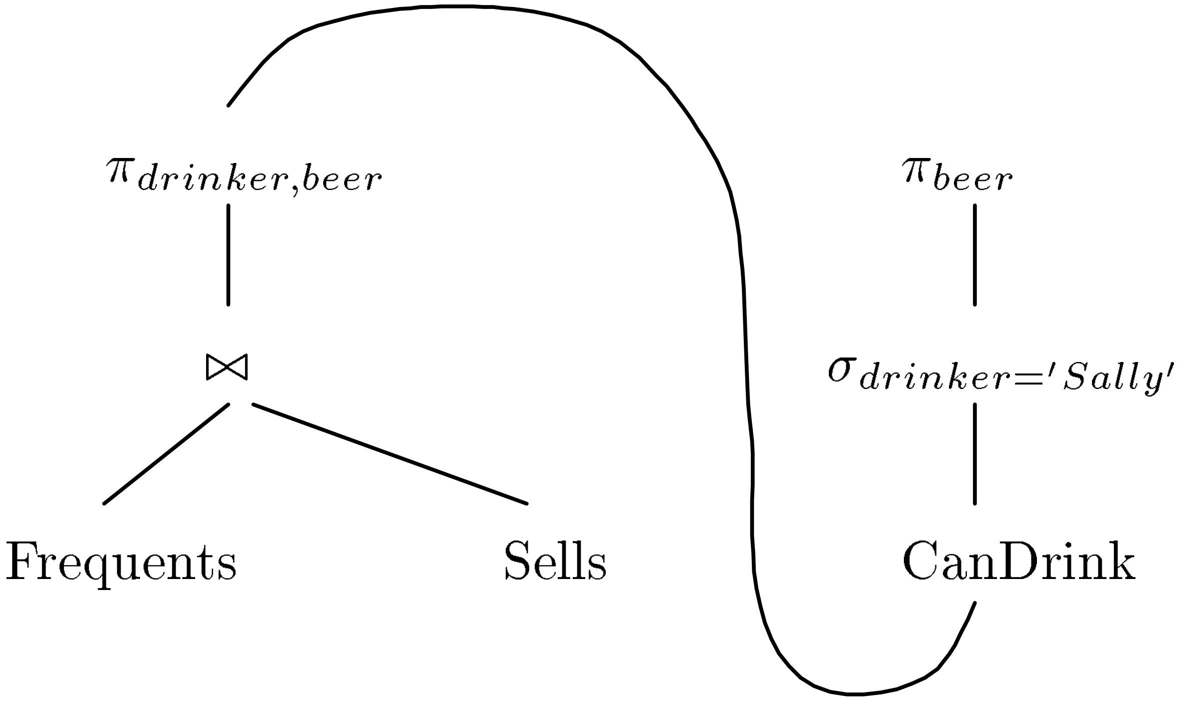
Example

```
SELECT beer
FROM CanDrink
WHERE drinker = 'Sally';
```

Semantics of View Use

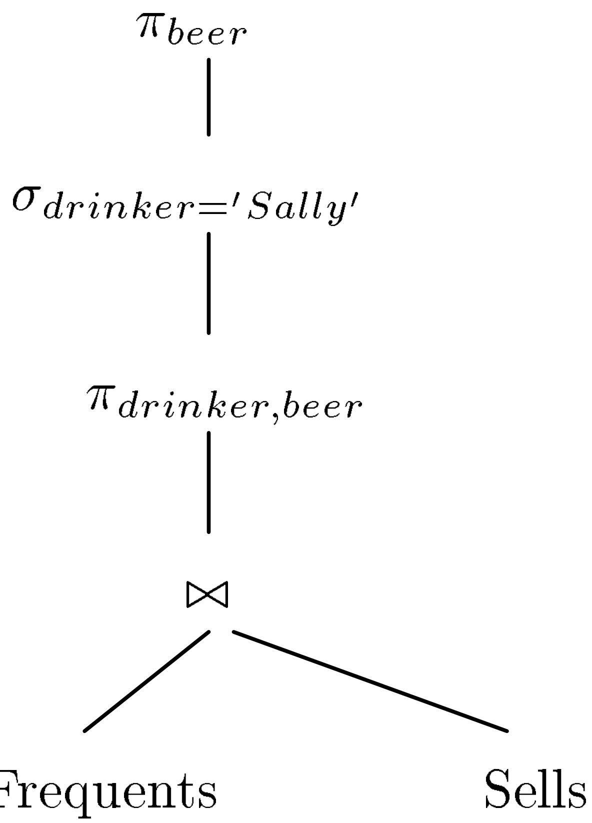


Example



`CanDrink` `Query`

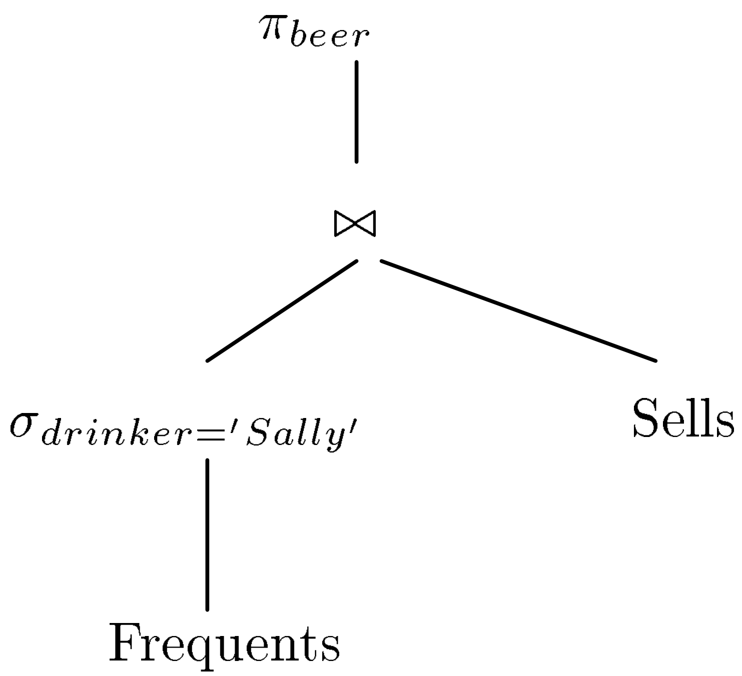
Compose


π_{beer}
$\sigma_{drinker='Sally'}$
$\pi_{drinker,beer}$
$\bowtie$
Frequents
Sells

Optimize Query

1. Push selections down tree.

2. Eliminate unnecessary projections.



Nulls

In place of a value in a tuple's component.

- Interpretation is not exactly "missing value."
- There could be many reasons why no value is present, e.g., "value inappropriate."

Comparing Nulls to Values

- 3rd truth value `UNKNOWN`.

Example

bar	beer	price
Joe's bar	Bud	`NULL`

```
SELECT bar
FROM Sells
WHERE price < 2.00 OR price >= 2.00;
      ------------    -------------
       UNKNOWN         UNKNOWN
       ------------------------
                UNKNOWN
```

3-Valued Logic

Think of true = 1; false = 0, and unknown = 1/2. Then:

- AND = min.
- OR = max.
- NOT(x) = $1 - x$.

Some Key Laws Fail to Hold

Example: Law of the excluded middle, i.e.,

$$p \texttt{ OR NOT } p \texttt{ = TRUE}$$

- For 3-valued logic: if p = unknown, then left side = max(1/2,(1-1/2)) = $1/2 \neq 1$.
- Like bag algebra, there is no way known to make 3-valued logic conform to all the laws we expect for sets/2-valued logic, respectively.