# Security Issues

- Defining authorized access to data / privileges

  *(who may access/change what?)*

- Enforcing authorized access (efficiently)

  *Both with internal logical controls (intra system)*

  *and against unauthorized access to system itself*

- Privilege hierarchy
- Access logs – audit trail
- Encryption
- Statistical databases

# Privileges

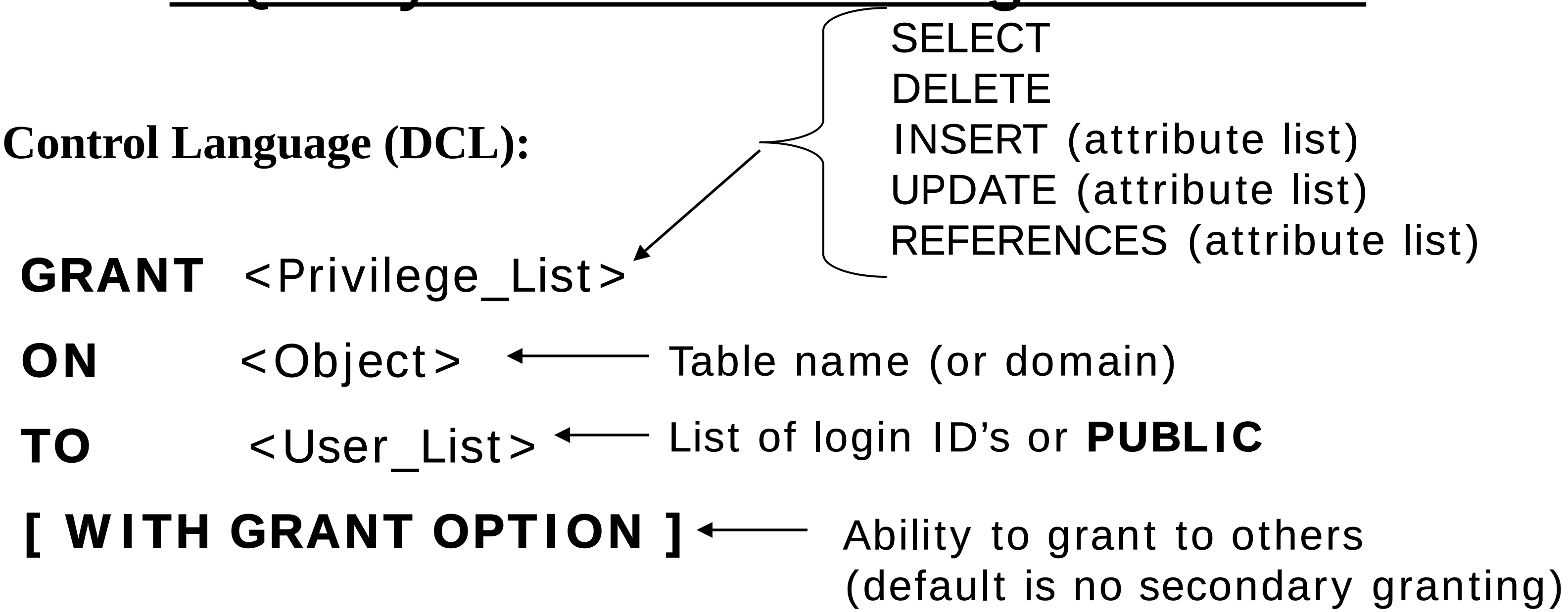
- Ability to:
  - Access
  - Add
  - Change
  - Reference

    objects in the database

- *May be:*
  - *Granted*
  - *Revoked*
  - *Inherited (recursively)*

# SQL Syntax for Privilege Control

**Data Control Language (DCL):**



**GRANT** <Privilege_List>

**ON** <Object>

**TO** <User_List>

**[ WITH GRANT OPTION ]**

SELECT
DELETE
INSERT (attribute list)
UPDATE (attribute list)
REFERENCES (attribute list)

Table name (or domain)

List of login ID's or **PUBLIC**

Ability to grant to others
(default is no secondary granting)

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**TO** <User_List> ← List of login ID's or **PUBLIC**

**[ WITH GRANT OPTION ]** ← Ability to grant to others (default is no secondary granting)

---

**For Example:**

**GRANT** SELECT
**ON** PRODUCT
**TO** PUBLIC

---

**GRANT** UPDATE (BonusPct)
**ON** SALES
**TO** SALES_MGR

---

**GRANT** DELETE
**ON** EMPLOYEE
**TO** PERSONNEL_MGR

# Additional Privileges

**CREATE** INDEX ← Why should this be a separate privilege?

**CREATE** TABLE

**CREATE** VIEW

**CREATE** TABLESPACE ← Space allocation (DBA)
**CREATE** USER

**CREATE** PROCEDURE ← Restricted separately because others can use with privileges of owner

ALSO **ALTER**, **DROP**, ...

# Granting Power to Grant Privileges

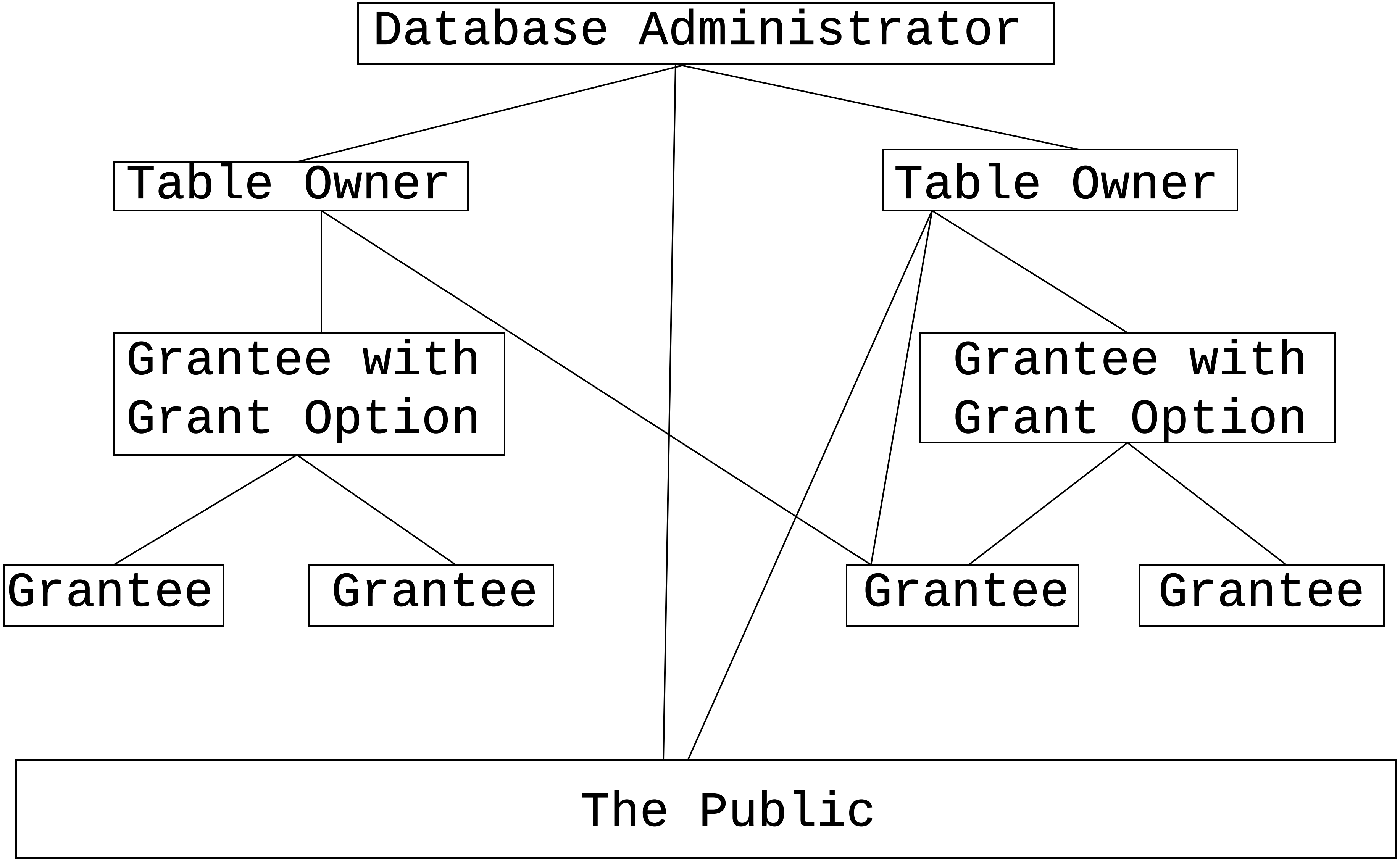
```
GRANT  UPDATE (Bonus_Pct)
ON     SALES
TO     SALES_MGR
WITH   GRANT OPTION
```

Executed by database administrator (DBA)

```
GRANT  UPDATE (Bonus_Pct)
ON     SALES
TO     ASST_SALES_MGR
```

Executed by SALES_MGR

# (Example) Privilege Hierarchy



# Revoking Privileges

*Optionally revokes just grant option*

*CREATE / INSERT / UPDATE / DELETE etc.*

**REVOKE [ GRANT OPTION FOR ]** <Privilege_List>

**ON** <Object>

**FROM** <User_List> **[ CASCADE ]**

*Also revoke privileges granted to user by others (recursively)*

# Use of Views in Access Control

```
CREATE VIEW Directory AS
     SELECT   lname, fname, address, phone
     FROM     Employee
     WHERE  unlisted = ‘F’
```

```
GRANT    SELECT
ON          DIRECTORY
TO          PUBLIC
```

*Note previous discussion on* ***Updates*** *with views (anomalies, null values, etc.)*

# Use of Views in Access Control

*Assume GRADES relation with attributes Fname,Lname,SSN,AS1,AS2 etc.*

```
CREATE VIEW Cucerzan_Grades AS
      SELECT   *, SUM(AS1 * .07 + AS2 * .07 + MIDTRM * .15) AVG
      FROM     GRADES
      WHERE  Lname = ‘Cucerzan’
```

```
GRANT    SELECT
ON        Cucerzan_Grades
TO         Cucerzan
```

```
GRANT    UPDATE
ON        Grades
TO         Kalowsky
```

# Encryption

- Logical privilege mechanisms may not be enough (especially against external intruders)

- Selection/Deletion/Projection etc. may work transparently without modification of database internals

- Problem:

# Encryption

- Logical privilege mechanisms may not be enough (especially against external intruders)
- Selection/Deletion/Projection etc. on individually encrypted attributes may work transparently without modification of database internals
- Problem:

  sorting / indexing

# Statistical Databases

- Protect confidentiality by only allowing access to statistical / aggregate information on *Averages*, *Counts*, *Sums*, *Std Deviations*, etc.

implementable with views

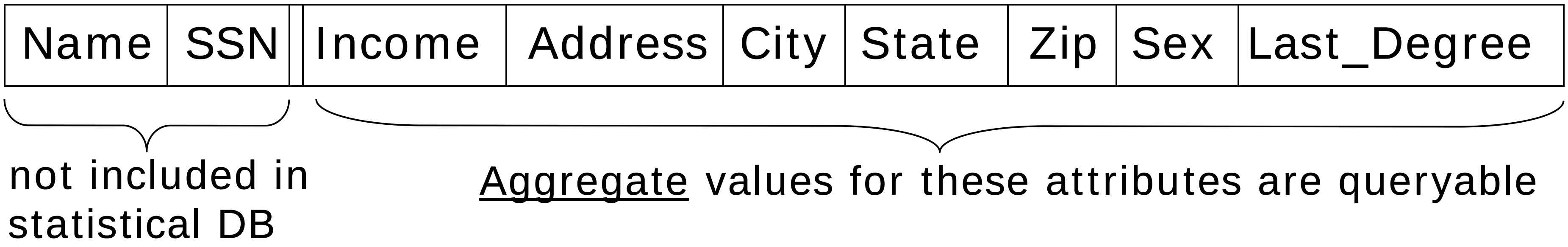
Statistical Queries

- Problem:

  Multiple queries can be formulated on aggregate values that enable **deduction of information about an individual**

# Deduction of Individual Info from Statistical DBs

**Person (relation):**



| Name | SSN | | Income | Address | City | State | Zip | Sex | Last_Degree |
|---|---|---|---|---|---|---|---|---|---|

not included in
statistical DB

Aggregate values for these attributes are queryable

*Example Query:*

```
SELECT Average(Income)
FROM   Person
WHERE Sex='F' AND LAST_DEGREE='PHD'
```

Problem: ???

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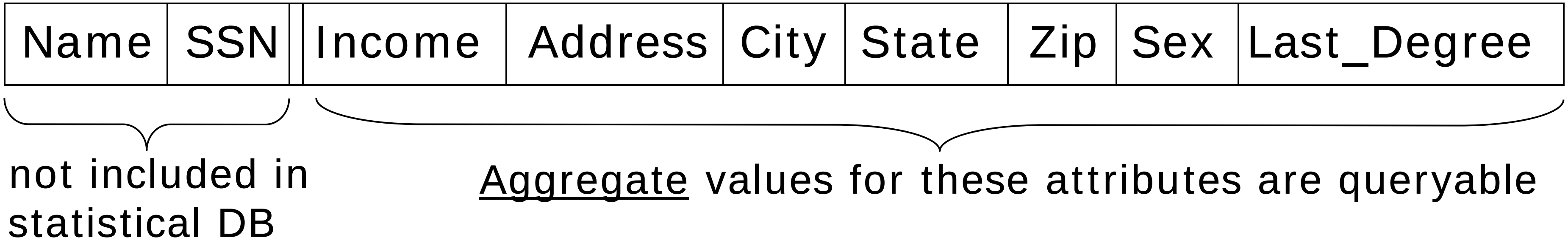
**Person (relation):**



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Problem:

- As selectional constraints become more specific, statistics may refer only to a few or one individual

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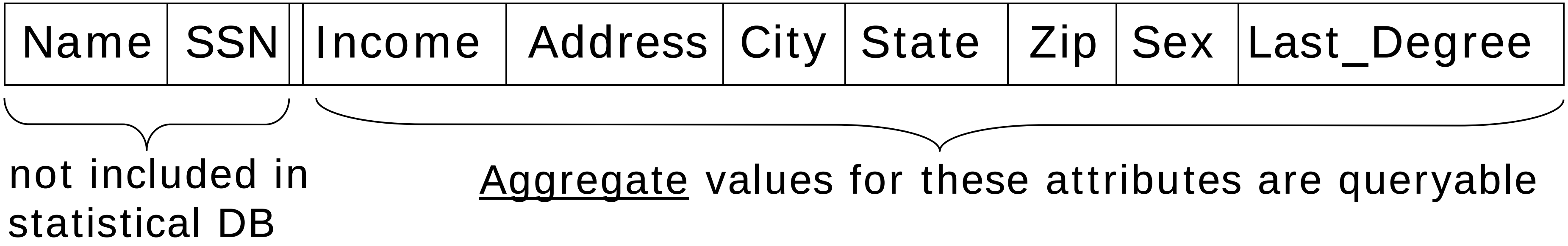

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```
SELECT Average(Income)
FROM   Person
WHERE Sex='F' AND LAST_DEGREE='PHD'
```

- As selectional constraints become more specific, statistics may refer only to a few or one individual

-
  ```
  SELECT Average(Income)
  FROM   Person
  WHERE Sex='F' AND ZIP='21238' AND LAST_DEGREE='PHD'
  ```

-
  ```
  SELECT Count(*)
  FROM  Person
  WHERE Sex='F' AND ZIP='21238' AND LAST_DEGREE='PHD'
  ```

*If count=1 then average is equal to individual*

# Deduction of Individual Info from Statistical DBs

- Don’t return answer if population on which the result is based is less than a threshold

- Don’t allow multiple queries on the same tuple population if (Previous result ∩ Current result) > *m* values
    - Q1: Sum(income) where Sex=‘F’ and Degree=‘PhD’ and age<30 and (Zip=21238 OR State=‘CA’)
    - Q2: Sum(income) where Sex=‘F’ and Degree=‘PhD’ and age<30 and (State=‘CA’)
    - Q1 ∩ Q2 = 1 tuple (zip=21238)

- Introduce minor noise in data to complicate solution by simultaneous equations