Introduction to SQL

Data Infrastructure IRAP Training
6/27/2016

Agenda

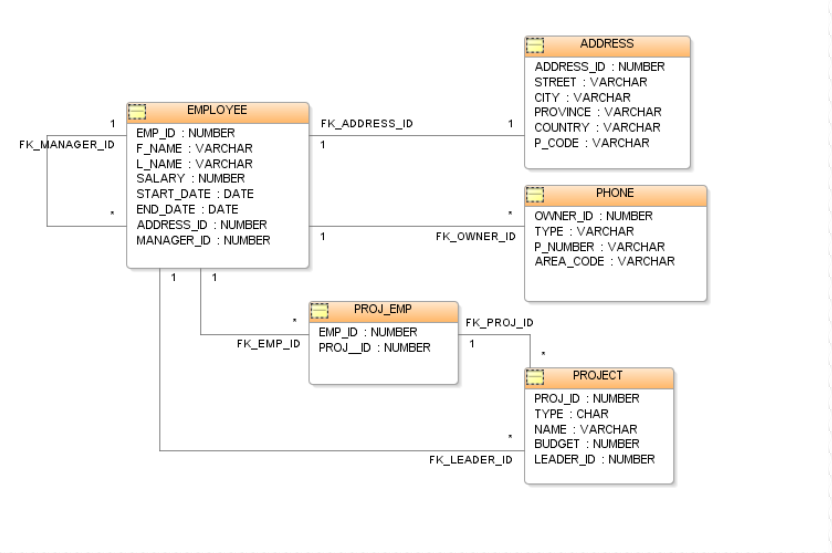
- UCDW Database Models
- Integrity Constraints
- Training Database
- SQL Defined
  - Types of SQL Languages
- SQL Basics
- Simple SELECT
  - SELECT with Aliases
  - SELECT with Conditions/Rules
  - SELECT with Comparison Operators – Not equal to, Equal to, Less than, Greater than, Less than or equal to, Greater than or equal to
  - SELECT with Compound Conditions – AND, OR, IN, NOT, BETWEEN, NOT BETWEEN, LIKE, NOT LIKE, EXISTS, NOT EXISTS Operators
  - SELECT with Group By, Order By and Having Clauses
  - SELECT with Concatenated Fields
- Joins
  - Inner Join
  - Left Join
  - Right Join
  - Full Join

UCDW Database Models

Relational and Dimensional Models

UCDW Database Models

- Database Models
  - Data Model
  - Data Structure
  - Integrity Constraints
- UCDW Database Models
  - Relational Data Modeling
    - Relational Structure
    - UCDW Base Layer
  - Dimensional Data Modeling
    - Dimensional Structure
    - UCDW BI (Business Intelligence) Layer



Relational vs. Dimensional Models

- Data is stored in relational database system
- Several tables and chains of relationships between them
- Volatile
- Data is normalized
- Detailed level of transactional data

- Data is stored in multi-dimensional databases
- Few facts are connected to dimension tables
- Non-volatile
- Data is de-normalized
- Summarized transactional data (aggregates and measures) used in business decisions

Relational Data Modeling	Dimensional Data Modeling

Relational Databases

- Collection of **tables** and **relationships**
- Tables contain **rows** and **columns** or **attributes**
- Includes **integrity constraints**
- Includes **domains** – set of possible values for a given attribute

Relational Data Structure

Hypothetical Relational Database Model

PubID	Publisher	PubAddress
03-4472822	Random House	123 4th Stree, New York
04-7733903	Wiley and Sons	45 Lincoln Blvd, Chicago
03-4859223	O'Reilly Press	77 Boston Ave, Cambridge
03-3920886	City Lights Books	99 Market, San Francisco

AuthorID	AuthorName	AuthorBDay
345-28-2938	Haile Selassie	14-Aug-92
392-48-9965	Joe Blow	14-Mar-15
454-22-4012	Sally Hemmings	12-Sep-70
663-59-1254	Hannah Arendt	12-Mar-06

ISBN	AuthorID	PubID	Date	Title
1-34532-482-1	345-28-2938	03-4472822	1990	Cold Fusion for Dummies
1-38482-995-1	392-48-9965	04-7733903	1985	Macrame and Straw Tying
2-35921-499-4	454-22-4012	03-4859223	1852	Fluid Dynamics of Aquaducts
1-38278-293-4	663-59-1254	03-3920886	1967	Beads, Baskets & Revolution

Integrity Constraints

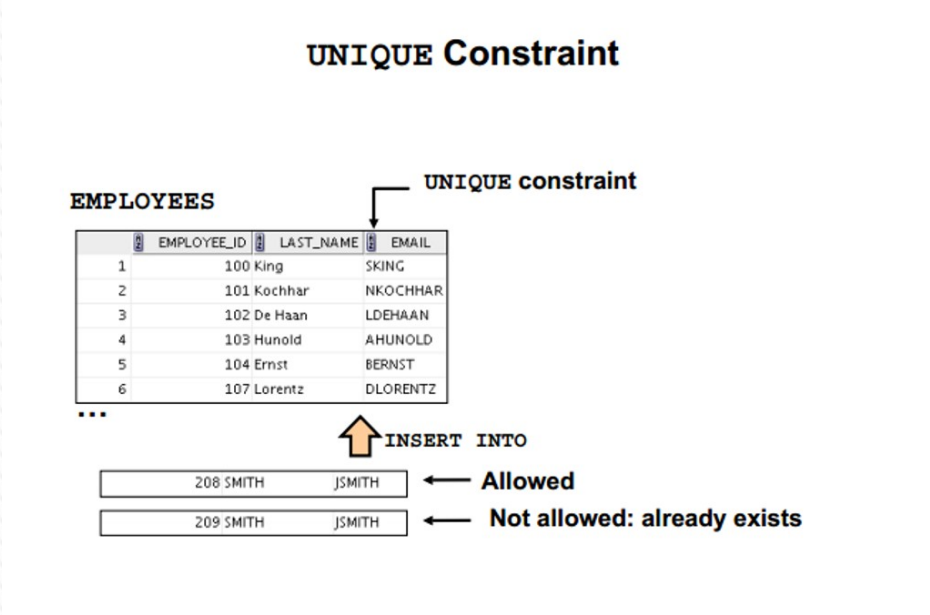
Constraints in UCDW

Integrity Constraints

- Ensures That:
  - Data conforms to guidelines specified by the Database Architect
  - Data is consistent and correct
  - Queries are optimized
  - Performance is adequate
- Constraint Types
  - Unique
  - Primary Key
  - Foreign Key
  - Check
  - Not Null

Unique Constraint

- Used to **enforce uniqueness** of a column or a combination of columns that is *not* the primary key
- Ensures that **all values in a column are different**
- Uniquely identifies each record in a table
- **Does not repeat**
- Multiple unique key constraints can be applied per table
- Unique constraints **allows NULL** values
- Example – **SSN** – unique constraint enforced in **STUDENT_D** dimension table

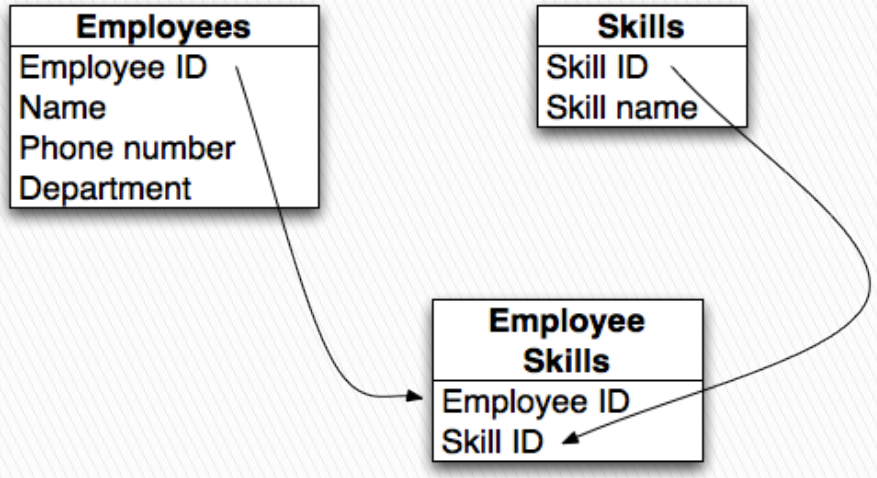


Primary Key Constraint

- Uniquely identifies a record/row in a table
- Ensures all values in a column are different
- Automatically has a unique constraint
- Does not repeat
- Only one per table
- Could be natural or surrogate
- Could be composite (made up of more than one column/attribute)
- Primary key constraints do not allow NULL values
- Example – AWRD_KEY – primary key constraint on the AWARD_D dimension table

Foreign Key Constraint

- Used to link two tables
- Refers to the primary key in another table
- Table containing a foreign key is called the child table
- Table containing the primary key is called the parent table
- Prevents actions that will violate relationship between tables
- Ensures that only valid data is inserted in child table
- Example – ACAD_SUB_T_KEY, STUD_KEY, CRSE_KEY and CRSE_ENRL_STAT_KEY are all foreign keys in the COURSE_ENROLLMENT_F fact table.



Check Constraint

- Used to limit the values that can be placed in a column
- Allowable values are defined from a logical expression
- Defined on a single column means only certain values are allowed
- Defined on a table means values in certain columns must be based on values in other columns in the row
- Example – STUD_IPEDS_GNDR_CD within STUDENT_D can only have values (F, M)

CHECK Constraint Example

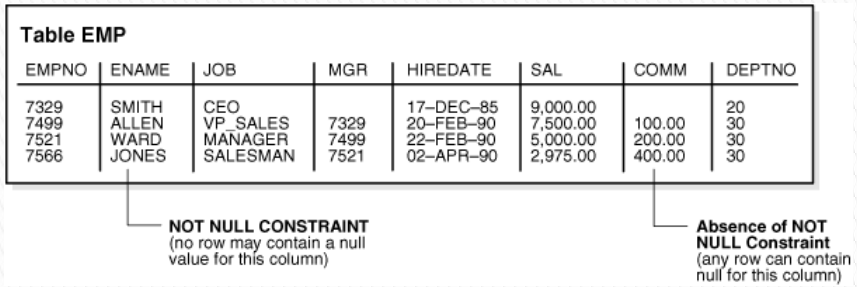
- This CHECK constraint ensures that a value entered for end_date is later than start_date.

```
CREATE TABLE copy_job_history
(employee_id NUMBER(6,0),
 start_date DATE,
 end_date DATE,
 job_id VARCHAR2(10),
 department_id NUMBER(4,0),
 CONSTRAINT cjhist_emp_id_st_date_pk
          PRIMARY KEY(employee_id, start_date),
CONSTRAINT cjhist_end_ck CHECK (end_date > start_date));
```

- As this CHECK CONSTRAINT is referencing two columns in the table, it MUST be defined at table level.

Not Null Constraint

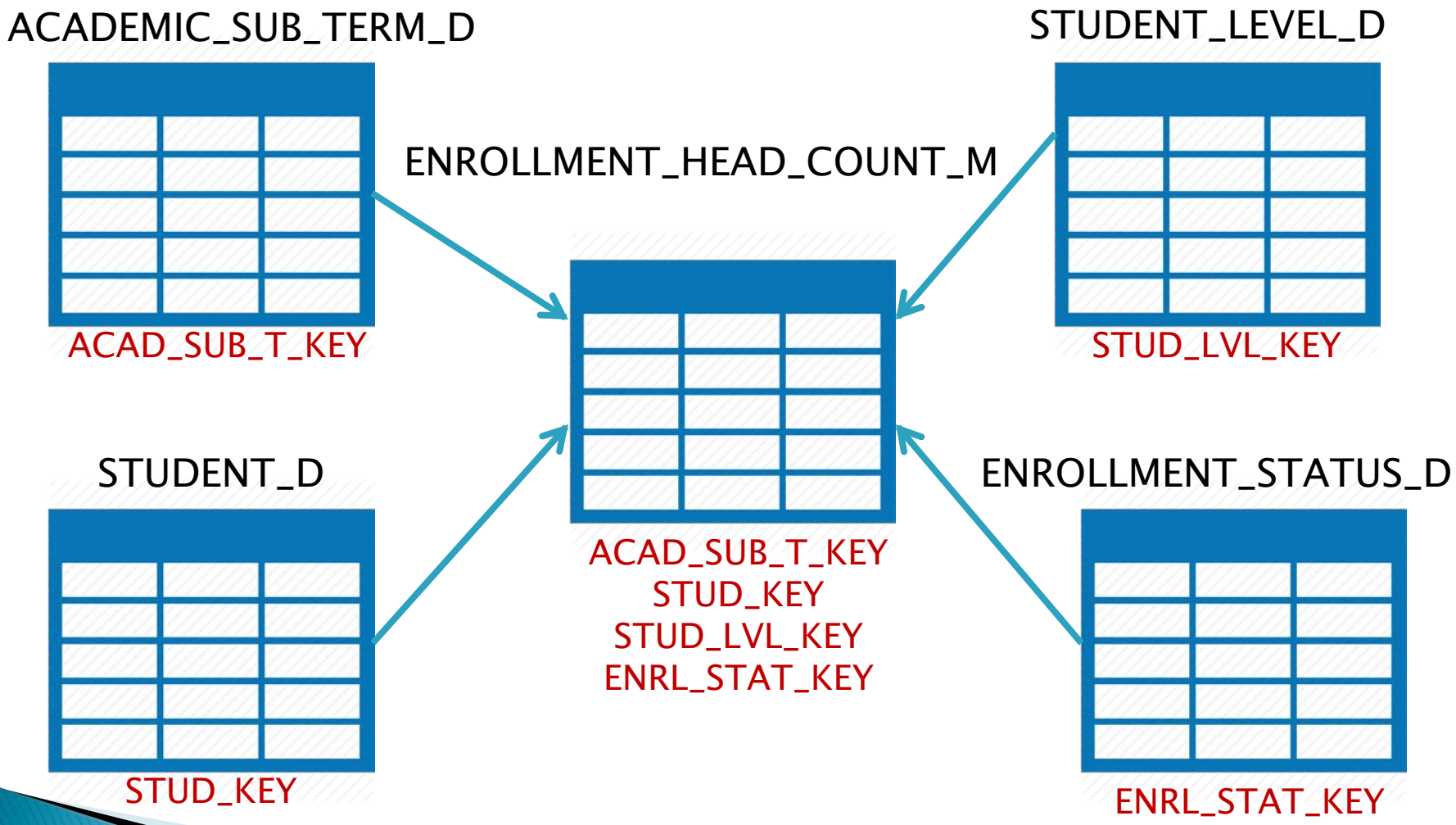
- Requires that every row has a value for the NOT NULL column
- Enforces a field to always contain a value
- Example – STUD_FST_NAM and STUD_LST_NAME cannot be NULL in the STUDENT_D dimension table



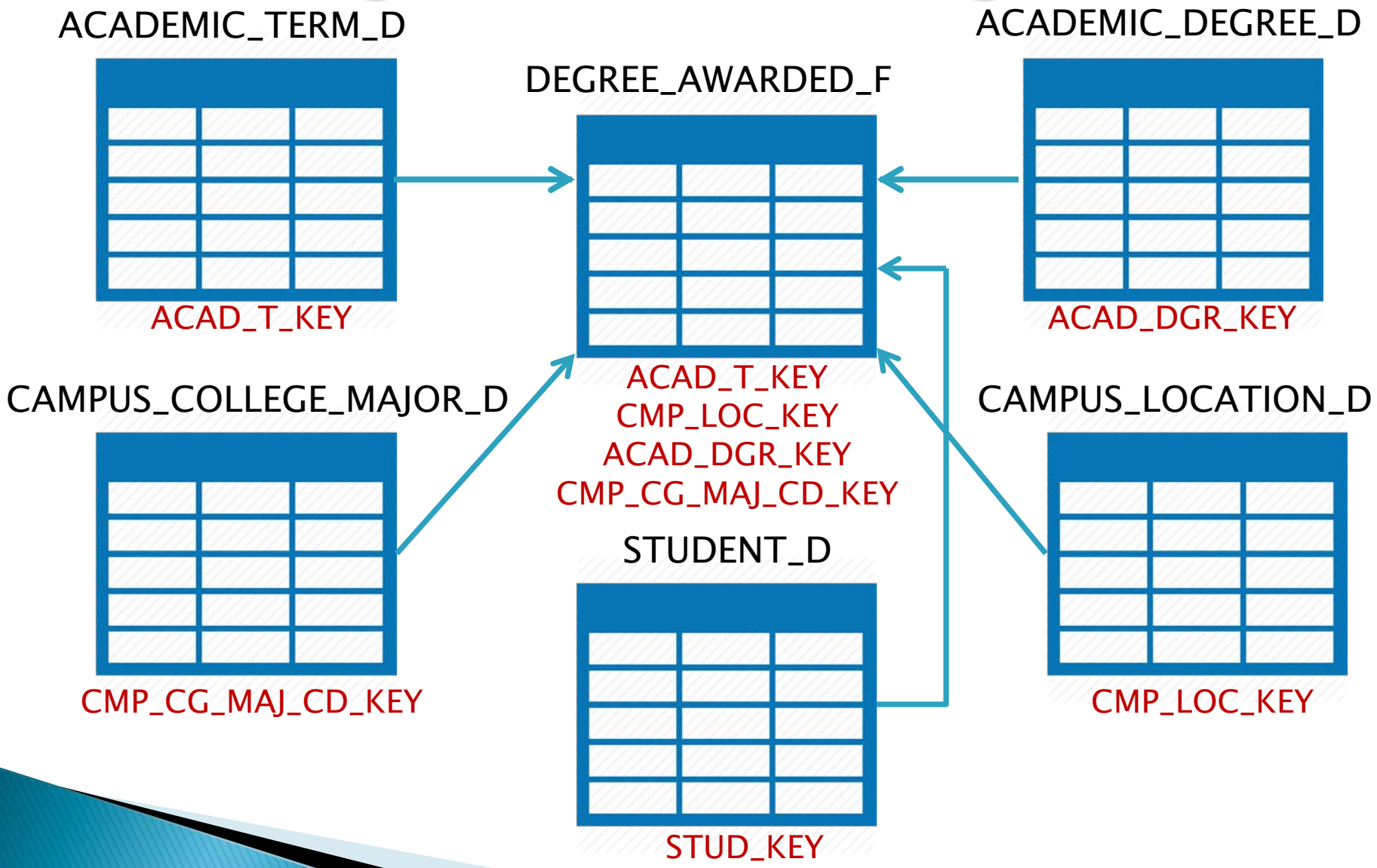
Training Database

Subset of UCDW Dimensions and Facts for Training

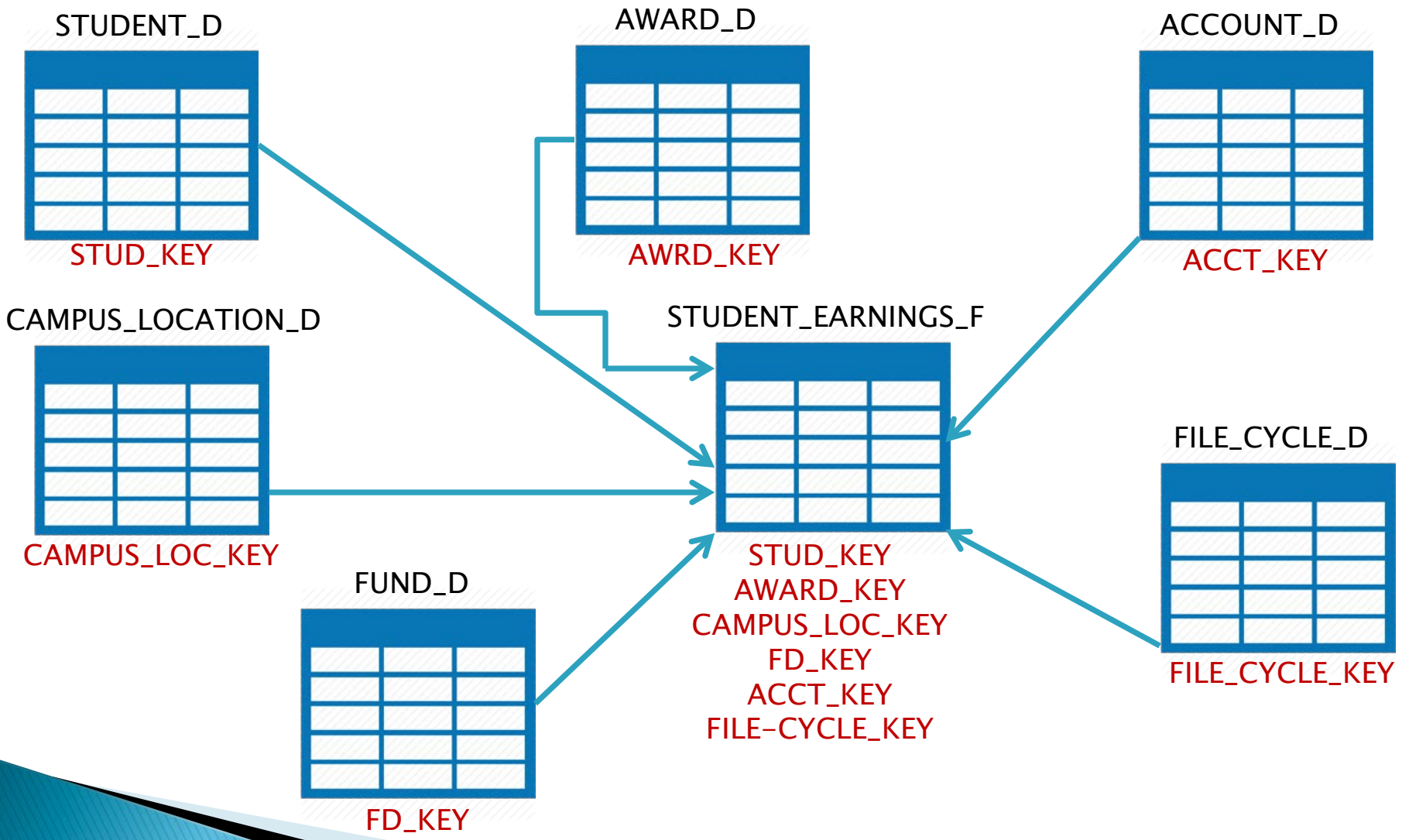
Training Database (Enrollment)



Training Database (Degree)



Training Database)Financial Aid



SQL Languages

Types of SQL Languages

SQL Languages

- Standard for commands that define the different structures in a database
- Includes CREATE, ALTER and DROP commands
- Used by Data Architects and Database Administrators

Data Definition Language (DDL)

- Standards for commands that manipulate data in a database
- Includes SELECT, INSERT,
- UPDATE, and DELETE
- Used by IT and Business Users to manipulate and extract data

Data Manipulation Language (DML)

SQL Basics »

Basic SQL Statements

Basics of SQL

- SQL – Structured Query Language
- **Create** – create a data structure *
- **Select** – read one or more rows from a table
- **Insert** – add one or more rows to a table *
- **Delete** – remove one or more rows from a table *
- **Update** – change the value of one or more fields in a row or within a table *
- **Drop** – remove a data structure *

Basics of a Simple SELECT

You are asking for the location, student ID, first name, last name, date of birth, gender and current active flag of students

You want the data from the STUDENT_D dimension table

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
```

To get all columns from a table:

```
SELECT      *
FROM        STUD_BI.STUDENT_D
```

SELECT with Aliases

```
SELECT STUD_LOC_CMP_CD as
Campus_Location,
STUD_ID as Student_Identification_Number,
STUD_FST_NAM as First_Name,
STUD_LST_NAM as Last_Name,
STUD_DT_OF_BTH as Date_of_Birth,
STUD_GNDR_CD as Gender_Code,
STUD_GNDR_DESC as Gender_Description,
STUD_CUR_ACTV_FL as Current_Active_Flag
FROM STUD_BI.STUDENT_D
```

SELECT with Conditions/Rules

You are asking for the location, student ID, first name, last name, date of birth, gender and current active flag of students

You want the data from the STUDENT_D dimension table

You have a condition – the current active flag must be set to 'Y',

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
```

The WHERE clause evaluates to true or false

SELECT with Comparison Operators

```
SELECT    STUD_LOC_CMP_CD,
          STUD_ID,
          STUD_FST_NAM,
          STUD_LST_NAM,
          STUD_DT_OF_BTH,
          STUD_GNDR_CD
          STUD_CUR_ACTV_FL
FROM      STUD_BI.STUDENT_D
WHERE     STUD_CUR_ACTV_FL = 'Y'
AND       STUD_LOC_CMP_CD != '01'
AND       STUD_GNDR_CD <> 'F'
AND       STUD_DMSTC_FGN_CZ_STAT_CD = 'F'
```

Comparison operators include:

- <> or != Not Equal To
- = Equal to
- < Less than
- > Greater than
- <= or !> Less than or equal to (or not greater than)
- >= or !< Greater than or equal to (or not less than)

The AND operator joins two or more conditions. Returned rows must meet all conditions

SELECT with Compound Conditions

You are asking for the location, student ID, first name, last name, date of birth, gender and current active flag of students

You want the data from the STUDENT_D dimension table

You have three conditions – (1) the current active flag must be set to 'Y', (2) the location must be '01 – Berkeley' and (3) whether student is domestic or foreign

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
AND STUD_LOC_CMP_CD = '01'
AND
STUD_DMSTC_FGN_CZ_STAT_CD =
'F'
```

Logical Operators

AND, OR, NOT, IN, BETWEEN, LIKE, EXISTS

SELECT with AND & OR Operators

```
SELECT      STUD_LOC_CMP_CD,
            STUD_ID,
            STUD_FST_NAM,
            STUD_LST_NAM,
            STUD_DT_OF_BTH,
            STUD_GNDR_CD,
            STUD_GNDR_DESC,
            STUD_CUR_ACTV_FL
FROM        STUD_BI.STUDENT_D
WHERE       STUD_CUR_ACTV_FL = 'Y'
AND         STUD_LOC_CMP_CD IN ('01', '04')
AND         STUD_DMSTC_FGN_CZ_STAT_CD = 'F'
AND ((STUD_GNDR_CD = 'M' OR STUD_IPEDS_GNDR_CD = 'M')
OR (STUD_GNDR_IDNTY_CD = 'M' OR STUD_GNDR_AT_BTH_CD = 'M'))
```

AND mandates that all specified conditions must be met!

OR mandates that at least one condition must be met!

The OR operator joins two or more conditions but returns a row when ANY of the conditions are met.

SELECT with NOT Operator

```
SELECT      STUD_LOC_CMP_CD,
            STUD_ID,
            STUD_FST_NAM,
            STUD_LST_NAM,
            STUD_DT_OF_BTH,
            STUD_GNDR_CD,
            STUD_GNDR_DESC,
            STUD_CUR_ACTV_FL
FROM        STUD_BI.STUDENT_D
WHERE       STUD_CUR_ACTV_FL = 'Y'
AND   STUD_LOC_CMP_CD NOT IN ('01', '04', '06', '02', '07', '08')
AND   STUD_DMSTC_FGN_CZ_STAT_CD = 'F'
AND   ((STUD_GNDR_CD = 'M' OR STUD_IPEDS_GNDR_CD = 'M')
OR     (STUD_GNDR_IDNTY_CD = 'M' OR STUD_GNDR_AT_BTH_CD
= 'M'))
```

Use NOT to negate selection criteria

Sometimes it's easier to specify what you don't want by using the NOT operator

SELECT with IN Operator

You are asking for the location, student ID, first name, last name, date of birth, gender, citizenship status and current active flag of students

You want the data from the STUDENT_D dimension table

You have three conditions – (1) the current active flag must be set to 'Y', (2) the location must be '01 – Berkeley' and (3) the citizenship status code has to one of a predefined set of values

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CZ_STAT_CD,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
AND STUD_LOC_CMP_CD = '01'
AND STUD_CZ_STAT_CD IN ('US',
'PR', 'RF', 'AM', 'AP', 'AS', 'DA', ' ')
```

SELECT with BETWEEN Operator

You are asking for the location, student ID, first name, last name, date of birth, gender, citizenship status and current active flag of students

You want the data from the STUDENT_D dimension table

You have three conditions – (1) the current active flag must be set to 'Y', (2) the location must be '01 – Berkeley' and (3) the date of birth is not between January 8th 1971 and January 8th 1991

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CZ_STAT_CD,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
AND STUD_LOC_CMP_CD = '01'
AND STUD_DT_OF_BTH BETWEEN
'01-08-1971' AND '01-08-1991'
```

SELECT with NOT BETWEEN Operator

You are asking for the location, student ID, first name, last name, date of birth, gender, citizenship status and current active flag of students

You want the data from the STUDENT_D dimension table

You have three conditions – (1) the current active flag must be set to 'Y', (2) the location must be '01 – Berkeley' and (3) the date of birth is between January 8th 1971 and January 8th 1991

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CZ_STAT_CD,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
AND STUD_LOC_CMP_CD = '01'
AND STUD_DT_OF_BTH NOT
BETWEEN '01-08-1971' AND '01-
08-1991'
```

SELECT with LIKE Operator

You are asking for the location, student ID, first name, last name, date of birth, gender, citizenship status and current active flag of students

You want the data from the STUDENT_D dimension table

You have three conditions – (1) the current active flag must be set to 'Y', (2) the location must be '01 – Berkeley' and (3) the last name starts with the characters 'DELM'

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CZ_STAT_CD,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
AND STUD_LOC_CMP_CD = '01'
AND STUD_LST_NAM LIKE
('DELM%')
```

SELECT with LIKE Operator

You are asking for the location, student ID, first name, last name, date of birth, gender, citizenship status and current active flag of students

You want the data from the STUDENT_D dimension table

You have three conditions – (1) the current active flag must be set to 'Y', (2) the location must be '01 – Berkeley' and (3) the last name starts with the characters 'DELM'. The number of characters after the DELM is specified in this example.

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CZ_STAT_CD,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
AND STUD_LOC_CMP_CD = '01'
AND STUD_LST_NAM LIKE
('DELM___')
```

SELECT with NOT LIKE Operator

You are asking for the location, student ID, first name, last name, date of birth, gender, citizenship status and current active flag of students

You want the data from the STUDENT_D dimension table

You have three conditions – (1) the current active flag must be set to 'Y', (2) the location must be '01 – Berkeley' and (3) the last name does not start with the characters 'DELM'

```
SELECT STUD_LOC_CMP_CD,
STUD_ID,
STUD_FST_NAM,
STUD_LST_NAM,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CZ_STAT_CD,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
AND STUD_LOC_CMP_CD = '01'
AND STUD_LST_NAM NOT LIKE
('DELM%')
```

SELECT with EXISTS Operator

```
SELECT      CMP_LOC_LOC1_CD,
            CMP_LOC_LOC1_SHRT_DESC,
            CMP_LOC_LOC1_LNG_DESC,
            CMP_LOC_LOC1_MXD_CASE_LNG_DESC,
            CMP_LOC_LOC1_ABRV_DESC
FROM        STUD_BI.CAMPUS_LOCATION_D
WHERE       EXISTS ( SELECT     STUD_LOC_CMP_CD
                     FROM       STUD_BI.STUDENT_D
                     WHERE      STUD_CUR_ACTV_FL = 'Y'
                     AND        STUD_LOC_CMP_CD IN ('01',
                                    '03', '05', '07', '09')
AND
        STUD_BI.CAMPUS_LOCATION_D.CMP_LOC_LOC1_CD
            = STUD_BI.STUDENT_D.STUD_LOC_CMP_CD)
ORDER BY    CMP_LOC_LOC1_CD
```

SELECT with NOT EXISTS Operator

```
SELECT      CMP_LOC_LOC1_CD,
            CMP_LOC_LOC1_SHRT_DESC,
            CMP_LOC_LOC1_LNG_DESC,
            CMP_LOC_LOC1_MXD_CASE_LNG_DESC,
            CMP_LOC_LOC1_ABRV_DESC
FROM              STUD_BI.CAMPUS_LOCATION_D
WHERE       NOT EXISTS ( SELECT  STUD_LOC_CMP_CD,
                         FROM    STUD_BI.STUDENT_D
                         WHERE   STUD_CUR_ACTV_FL = 'Y'
                         AND     STUD_LOC_CMP_CD IN ('01',
                                 '03', '05', '07', '09')
AND         STUD_BI.CAMPUS_LOCATION_D.CMP_LOC_LOC1_CD
                = STUD_BI.STUDENT_D.STUD_LOC_CMP_CD)
ORDER BY    CMP_LOC_LOC1_CD
```

SELECT with GROUP BY Clause

You are asking for the location, gender, citizenship status (domestic or foreign) and a count of students

You want the data from the STUDENT_D dimension table

You have one condition – the current active flag must be set to 'Y'

Because you have a group/aggregate function (COUNT), you must include a GROUP BY clause to group the result-set

```
SELECT STUD_LOC_CMP_CD,
STUD_GNDR_DESC,
STUD_DMSTC_FGN_CZ_STAT_CD,
COUNT (DISTINCT STUD_ID) as
Student_Count
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
GROUP BY STUD_LOC_CMP_CD,
STUD_GNDR_DESC,
STUD_DMSTC_FGN_CZ_STAT_CD
```

SELECT with ORDER BY Clause

You are asking for the location, gender, citizenship status (domestic or foreign) and a count of students

You want the data from the STUDENT_D dimension table

You have one condition – the current active flag must be set to 'Y'

You have a group by clause because of the aggregate function COUNT

You have an order by clause to sort the results using campus location in descending order

```
SELECT STUD_LOC_CMP_CD,
STUD_GNDR_DESC,
STUD_DMSTC_FGN_CZ_STAT_CD,
COUNT (DISTINCT STUD_ID) as
Student_Count
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
GROUP BY STUD_LOC_CMP_CD,
STUD_GNDR_DESC,
STUD_DMSTC_FGN_CZ_STAT_CD
ORDER BY STUD_LOC_CMP_CD
DESC
```

SELECT with HAVING Clause

You are asking for a count of students by campus location. The DISTINCT keyword eliminates duplicates

You want the data from the STUDENT_D dimension table

You have one condition – the current active flag must be set to 'Y'

You have a group by clause because of the aggregate function COUNT

Because you have an aggregate function, you need a HAVING clause for your condition

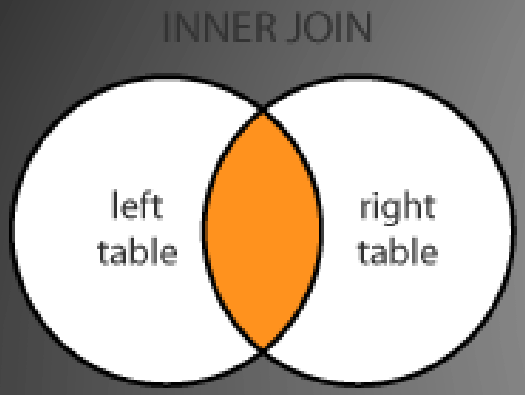
```
SELECT STUD_LOC_CMP_CD,
COUNT (DISTINCT STUD_ID) as
Student_Count
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
GROUP BY STUD_LOC_CMP_CD
HAVING COUNT(DISTINCT
STUD_ID) > 20000
ORDER BY STUD_LOC_CMP_CD ASC
```

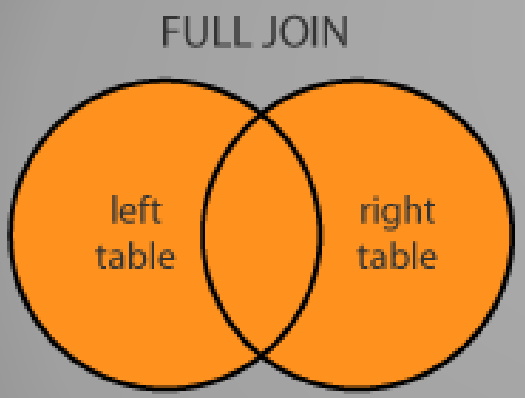
You have an ORDER BY clause to sort the results using campus location in ascending order

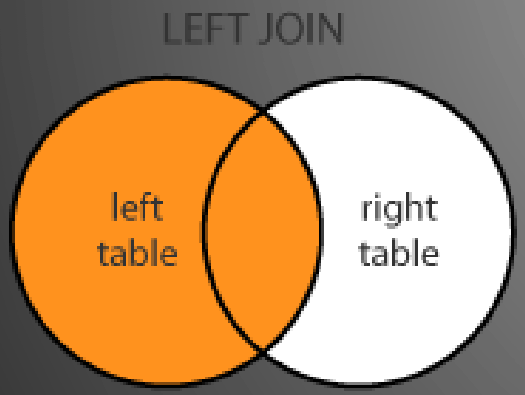
SELECT with Concatenated Fields

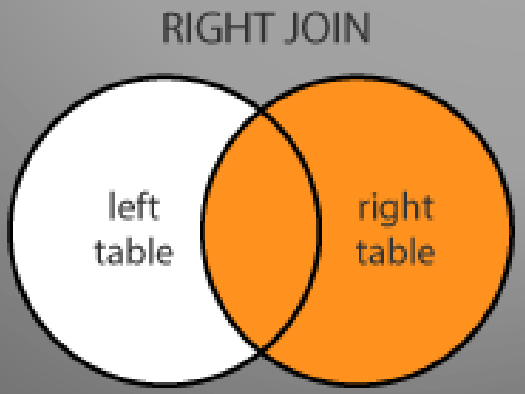
It may be necessary to concatenate campus location with student ID to join different content areas. For reporting purposes, you may also want to concatenate the last name with the first name to combine the fields into one

```
SELECT STUD_LOC_CMP_CD || STUD_ID
as Student_Identification_Number,
STUD_LST_NAM || ','|| ' '
||STUD_FST_NAM as Student_Name,
STUD_DT_OF_BTH,
STUD_GNDR_CD,
STUD_GNDR_DESC,
STUD_CZ_STAT_CD,
STUD_CUR_ACTV_FL
FROM STUD_BI.STUDENT_D
WHERE STUD_CUR_ACTV_FL = 'Y'
AND STUD_LOC_CMP_CD = '01'
AND STUD_DT_OF_BTH BETWEEN '01-
08-1971' AND '01-08-1991'
```







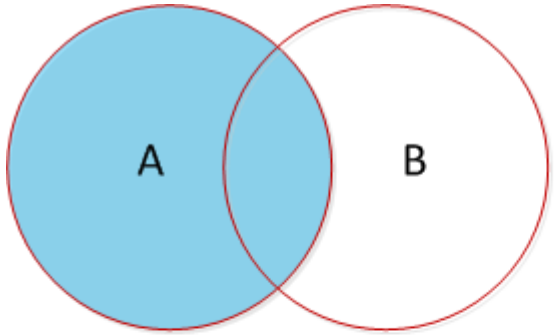


Simple Joins »

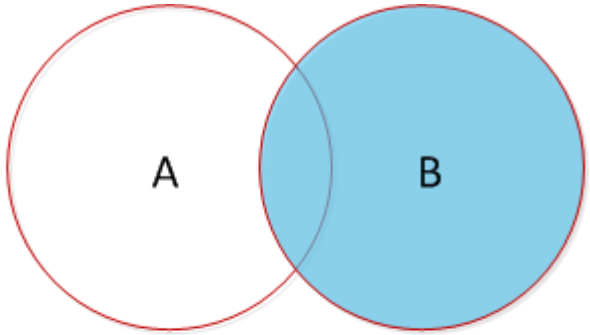
Joining Dimensions and Fact Tables

Joins

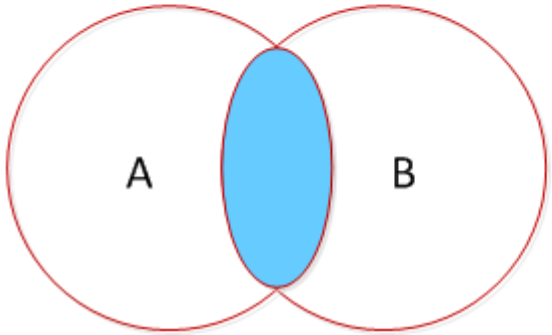
Left Join



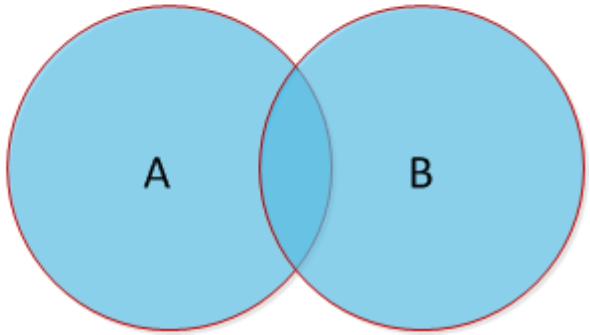
Right Join



Inner Join

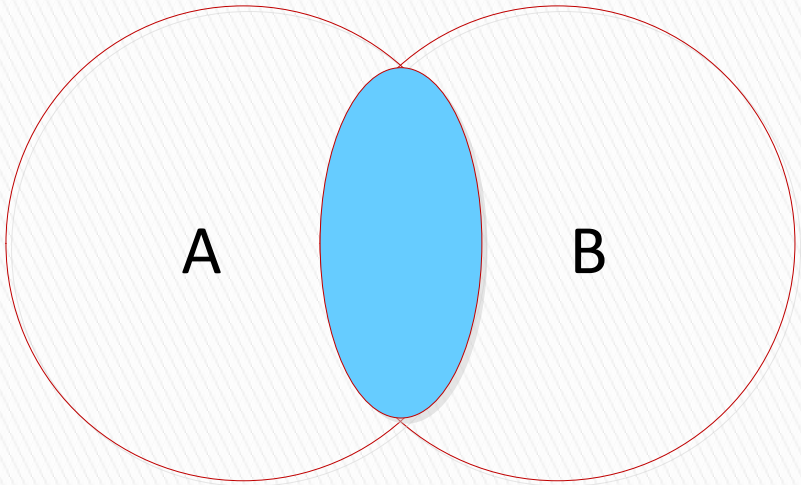


Full Join



Inner Joins

- An inner join returns all records at the intersection of table A and table B



Next Step: Intermediate SQL

- Joins
- Sub-Queries
- Views
- Inline View
- UNION, UNION ALL, INTERSECT, MINUS
- WITH
- CASE Statements
- DECODE Function
- Aggregate Functions
- Date Functions
- Character Functions