

# Null Values. SQL Constraints

CS430/630  
Lecture 10

# Null Values

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- ▶ Field values in a tuple may sometimes be
  - ▶ **unknown**: e.g., a rating has not been assigned, or a new column is added to the table
  - ▶ **inapplicable**: e.g., CEO has no manager, single person has no spouse
- ▶ SQL provides a special value **NULL** for such situations
  - ▶ Special operators **IS NULL, IS NOT NULL**  
SELECT \* FROM Sailors WHERE rating **IS NOT NULL**
  - ▶ Note: **NULL** must not be used as constant in expressions!
  - ▶ A field can be declared as **NOT NULL**, means NULL values are not allowed (by default, PK fields are NOT NULL)



# Dealing with Null Values

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- ▶ The presence of **NULL** complicates some issues
  - ▶ **NULL op value** has as result **NULL** (op is +,-,\*,/)
  - ▶ What does *rating*>8 evaluate to if *rating* is equal to **NULL** ?
  - ▶ Answer: **unknown**
- ▶ **3-valued logic**: true, false and **unknown**
  - ▶ Recall that WHERE eliminates rows that don't evaluate to true
  - ▶ What about **AND**, **OR** and **NOT** connectives?
    - unknown AND true = unknown
    - unknown OR false = unknown
    - NOT unknown = unknown
  - ▶ Also, **<NULL\_value> = <NULL\_value>** is unknown!



# Null Values and Aggregates

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- ▶ The `COUNT(*)` result includes tuples with `NULL`
- ▶ `COUNT(A)` only counts tuples where value of attribute `A` is not `NULL`
- ▶ All other aggregates skip `NULL` values (if aggregate is on the field that is `NULL`)
  - ▶ If all values are `NULL` on the aggregated field, the result of aggregate is also `NULL` (except `COUNT` which returns 0)



# Null Values and Aggregates

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Following two queries **DO NOT RETURN SAME RESULT** if there are **NULLs** (in field *name*):

```
SELECT COUNT(*) FROM Sailors S
```

```
SELECT COUNT(S.name) FROM Sailors S
```

Following two queries **DO NOT RETURN SAME RESULT** if there are **NULLs** (in field *rating*):

```
SELECT COUNT(*) FROM Sailors S
```

```
SELECT COUNT(*) FROM Sailors  
WHERE (rating>8) OR (rating <= 8)
```

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# Null Values and Duplicates

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- ▶ Comparing two NULL values gives as result **unknown**
- ▶ But there are **anomalies** when checking for duplicates!
  - ▶ NULL values are considered equal in this case!
  - ▶ Two tuples are duplicates if they match in all non-NULL attributes
- ▶ Implications for DISTINCT, UNIQUE subqueries, set operations!
  - ▶ Tuples with NULL in some group-by attributes placed in same group if all non-NULL group-by attributes match!
  - ▶ DISTINCT: if multiple tuples have equal values in all non-NULL attributes only one of them is output



# Outer Joins

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- ▶ Include in join result non-matching tuples
- ▶ Result tuple padded with NULL values
- ▶ Variants
  - ▶ FULL: non-matching tuples in both relations included in result
  - ▶ LEFT: only non-matching tuples in left relation included in result
  - ▶ RIGHT: only non-matching tuples in right relation included in result



# Outer Joins

*Sailors*

<u>sid</u>	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0

*Reserves*

<u>sid</u>	<u>bid</u>	<u>day</u>
22	101	10/10/96
58	103	11/12/96

SELECT sid, sname, rating, age, bid, day  
FROM Sailors **NATURAL LEFT OUTER JOIN** Reserves

<u>sid</u>	sname	rating	age	bid	day
22	dustin	7	45.0	101	10/10/96
31	lubber	8	55.5	NULL	NULL
58	rusty	10	35.0	103	11/12/96





# Join Expressions

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- ▶ SQL shorthands for expressions we already saw

Cross Product:

Sailors **CROSS JOIN** Reserves

Condition Join:

Sailors **JOIN** Reserves **ON** **<condition>**

Natural Join:

Sailors **NATURAL JOIN** Reserves

Usage Example:

```
SELECT *
```

```
FROM Sailors JOIN Reserves ON Sailors.sid=Reserves.sid
```

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# Integrity Constraints (Review)

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- ▶ An IC describes conditions that every *legal instance* of a relation must satisfy.
  - ▶ Inserts/deletes/updates that violate IC's are disallowed.
- ▶ Types of IC's:
  - ▶ domain constraints
    - ▶ Field values must be of right type - always enforced
  - ▶ primary key constraints
  - ▶ foreign key constraints
  - ▶ general constraints



# Sample Schema

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ENROLLED	
SID	CID
1	1
1	2
2	2
2	4
3	1
3	3
4	4

STUDENT			
SID	SNAME	MAJOR	AGE
1	Alice	CS	22
2	Bob	Economics	24
3	Carl	CS	32
4	Denise	History	24

COURSE			
CID	CNAME	ROOM	FID
1	Java	100	2
2	Micro	203	1
3	C	100	3
4	US Hist.	201	1



# Enforcing Referential Integrity

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- ▶ What should be done if an *Enrolled* tuple with a non-existent student id is inserted?
  - ▶ *Reject the insert!*
- ▶ What should be done if a *Students* tuple is deleted?
  - ▶ Delete all *Enrolled* tuples that refer to it
    - ▶ Correct as far as IC is concerned, but data is lost!
  - ▶ Disallow deletion of a *Students* tuple that is referred to
    - ▶ More appropriate in practice
  - ▶ Set sid in *Enrolled* tuples that refer to it to a *default sid*
    - ▶ Or, set it to NULL

# Referential Integrity in SQL

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- ▶ SQL/92 and SQL:1999 support all options on deletes and updates.

- ▶ Default is **NO ACTION** (*delete/update is rejected*)
- ▶ **CASCADE** (delete/update all tuples that refer to deleted/updated tuple)
- ▶ **SET NULL / SET DEFAULT** (sets foreign key value of referencing tuple)

```
CREATE TABLE Enrolled
(sid CHAR(20) default '00',
cid CHAR(20),
grade CHAR(2),
PRIMARY KEY (sid,cid),
FOREIGN KEY (sid)
REFERENCES Students (sid)
ON DELETE SET DEFAULT
ON UPDATE CASCADE)
```

# Complex Constraints: **CHECK** clause

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- ▶ Useful when more general ICs than keys are involved
- ▶ Can use queries to express constraint
- ▶ Constraints can be named
- ▶ Not checked if table is empty!
- ▶ Standalone **CHECK** for single table only!

```
CREATE TABLE Sailors
  ( sid INTEGER,
    sname CHAR(10),
    rating INTEGER,
    age REAL,
    PRIMARY KEY (sid),
    CONSTRAINT RatingRange
    CHECK ( rating >= 1
            AND rating <= 10 )
  )
```



# Complex Constraints: Assertions

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- ▶ *Number of boats plus number of sailors is < 100*
- ▶ Not associated with a particular table
  - ▶ Constraint may apply to multiple tables!

```
CREATE ASSERTION smallClub
CHECK
(
  (SELECT COUNT (S.sid) FROM Sailors S)
  +
  (SELECT COUNT (B.bid) FROM Boats B) < 100
)
```

