**Database Notes**

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**Notes-02**

**Concept of a Relation in Mathematics**

**Definitions:**

**Set:** A set is an unordered collection of objects.

* Remember: A set DOES NOT allow repeated elements.
* {a, b, c} is a set. {a, b, c, b} is NOT a set.
* {a, b, c} is the same set as {a, c, b} or {b, a, c}, etc.
* Elements of a set can be sets themselves: {{1,1},{2,4},{3,9},{4,16}} is a set.

**Bag:** A bag is an unordered collection of objects, but it allows repetition. Remember: repetition is allowed, but NOT required.

* Every set is also a bag. (Bag is a generalization of a set); but every bag is not necessarily a set.
* {a, b, b, c} is a bag but not a set.
* {a, b, c, d} is a set and hence it is also a bag.

**List:** A list is an ordered collection of objects. It allows repetition.

* {a, b, c} is a list. {a, b, c, b, a} is a list
* {a, b, c} is the same list as {a, b, c}. But {a, b, c} is NOT the same list as {b, a, c}.

**Concept of Subset:**

A is a subset of B if every member of A is also a member of B

**Equality of two Sets:**

A equals B if A is a subset of B and also B is a subset of A

**Operations on Sets:**

* **Union: A union B --** x belongs to A union B if x is a member of A, or x is a member of B or x is a member of both A and B (A U B)
* **Intersection: A intersection B --** x belongs to A intersection B if x is a member of both A and B ( A ∩ B)
* **Difference: A difference B --** x belongs to A difference B if x is a member of A, and x is NOT a member of B (A – B)

**Cartesian product of sets:** Let A and B be two sets. The **Cartesian product** of A and B, denoted by A × B, is the set of all ordered pairs (a, b) where a is a member of A and b is a member of B.

**Note:** If A has m elements in it and B has n elements in it, then A × B has m\*n ordered pairs in it.

A × B = { (a, b): a belongs to A, and b belongs to B}

If A = {1, 2, 3} and B = {x, y},

then

A × B = {(1, x), (1, y), (2, x), (2, y), (3, x), (3, y)}

**The definition of Cartesian product can be extended to any number of sets.**

If A = {p, q, r}, B = {1, 2}, C = {a, b}, then

A × B × C = { (p, 1, a), (p, 1, b), (p, 2, a), (p, 2, b),

(q, 1, a), (q, 1, b), (q, 2, a), (q, 2, b),

(r, 1, a), (r, 1, b), (r, 2, a), (r, 2, b)}

These are called triples. In general (x, y, z, a …) is called an n-tuple or just a tuple.

**Relation:** A relation between two sets A and B is simply any subset of the Cartesian product A × B. Remember: A relation is a “set” – therefore it is not ordered and does not allow repetitions. This definition can be extended to any number of sets. For example, a relation over three sets A, B and C is any subset of A × B × C.

Note: “Ordered” and “sorted” are two different things. A set is unordered. Sometimes we sort it according to some criteria.

**Function:** A function from a set A to a set B is a subset of A × B such that for every value in A, there is only one value from B associated with it.

**Examples:**

1. Let A = {1, 2, 3, 4, 5} and B = {1, 2, 3, 4, 5}

We know that A × B has 5\*5 = 25 elements.

Now consider the subset: {(1,2), (1,3), (1,4), (1,5), (2,3), (2,4),(2,5), (3,4), (3,5), (4,5)}

By definition, this is a relation. What can we call this relation? (LESS-THAN). This is NOT a function, because 1 is associated with 2, 3, 4, and 5.

2. Let

Men = {Barack, Bill, George},

Women = {Michelle, Hillary, Laura, Sasha, Chelsea, Jenna}.

Now if we make the Cartesian product Men × Women × Women, how many triples will it have? 3\*6\*6 = 108 triples. But consider this subset:

{(Barack, Michelle, Sasha),

(Bill, Hillary, Chelsea),

(George, Laura, Jenna) }

This is a relation. What can we call it? Family?

3. Squares: {{1, 1},{2, 4},{3, 9},{4,16}}

Pythagorean Triples: {(3, 4, 5), (5, 12, 13), (9, 12, 15), (8, 15, 17)}

Students: {(bob, barker, 20), (jane, austen, 19), (pat, smith, 21)}

**A relation can be represented as a table:** Each tuple becomes a row, k-th element of all tuple make the k-th column.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Squares:   |  |  | | --- | --- | | n | n-squared | | 1 | 1 | | 2 | 4 | | 3 | 9 | | 4 | 16 | | Pythagorean Triples   |  |  |  | | --- | --- | --- | | N1 | N2 | N3 | | 3 | 4 | 5 | | 5 | 12 | 13 | | 9 | 12 | 15 | | 8 | 15 | 17 | | Students   |  |  |  | | --- | --- | --- | | FirstName | LastName | Age | | Bob | Barker | 20 | | Jane | Austen | 19 | | Pat | Smith | 21 | |

**Relational Database Terminology:**

Relation = Table

Tuple = Row

Set = Domain (For example: numeric is the domain or set of all numbers)

Table: Contractors: This is a relation.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **Contractor** | **Phone** | **Street1** | **Street2** | **City** | **State** | **Zip** |
| 1 | KH Services | 213-444-1181 | 111 Pine |  | New York | NY | 12345 |
| 2 | Comstock Inc | 232-492-3383 | 1200 Comstock |  | New York | NY | 12345 |
| 3 | RB Partnership | 508-555-3233 | 1234 Elm |  | Highlands | CA | 94595 |

* ID is the set (domain) of positive integers {1,2,3, ….}
* Contractor is the set (domain) of all character strings (CHAR, VARCHAR), etc.
* If you make a Cartesian product of Numbers × Strings × Strings ×Strings × Strings … it will be an infinite set.
* We have a small subset, of 3 tuples (rows). This is the relation Contractors. In database terminology, we call it the Table: Contractors.
* It has 3 “rows” and 8 “columns” or “fields” or attributes. ID, Contractor, … are column (field or attribute) names.
* The information: ID is a number, Contractor is a string, etc. is called the “Meta Data”.

The information below is the actual data in the table.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | KH Services | 213-444-1181 | 111 Pine |  | New York | NY | 12345 |
| 2 | Comstock Inc | 232-492-3383 | 1200 Comstock |  | New York | NY | 12345 |