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Empty and Universal Relations

1. What is a relation?

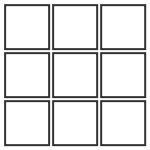
A **relation R** in a set A is a subset of **A × A**: a collection of ordered pairs chosen by a rule.

2. Empty relation

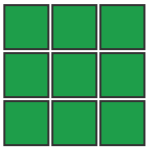
No element of A is related to any element of A: **R = empty set**. Example: A = students of a boys' school, R = {(a, b) : a is a sister of b}.

3. Universal relation

Each element of A is related to every element of A: **R = A × A**. Example: same A, R = {(a, b) : the difference between the heights of a and b is less than 3 metres}.



empty



universal

4. Trivial relations

Both are extreme cases, so they are called **trivial relations**. Every other relation lies between them.

Solved example

Q. A = {1, 2, 3}. Is R = {(a, b) : a + b = 10} empty or universal?
A. The largest possible sum is 3 + 3 = 6, so no pair passes: R is the **empty relation**.

Practice questions

1. (MCQ) A relation in A is a subset of (a) A (b) A × A (c) A + A (d) none
2. (Very short) If A has 4 elements, how many pairs does A × A have?
3. (Short) A = {1, 2, 3}. Is R = {(a, b) : |a − b| < 5} empty or universal?
4. (Very short) What are empty and universal relations together called?
5. (Numerical) If A has 3 elements, how many relations in A are possible?
6. (Short) Give an example of an empty relation on the students of a boys' school.

Answer key

1. (b).
2. 16.
3. Universal: every difference is at most 2.

4. Trivial relations.
5. $2^9 = 512$.
6. "a is a sister of b".

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