CSC 240

2 – SET THEORY

WHAT IS A SET?

All SVU Students

All Harry Potter Books

Harry Potter Books written by J.K. Rowling

SVU Students who have read a Harry Potter book

Cars in the SVU parking lot right now

WHAT IS A SET?

> "A set is a finite or infinite collection of objects in which order has no significance, and multiplicity is generally also ignored."
>
> – Stover, Christopher and Weisstein, Eric W. "Set." From *MathWorld*--A Wolfram Web Resource. http://mathworld.wolfram.com/Set.html

WHAT IS A SET?

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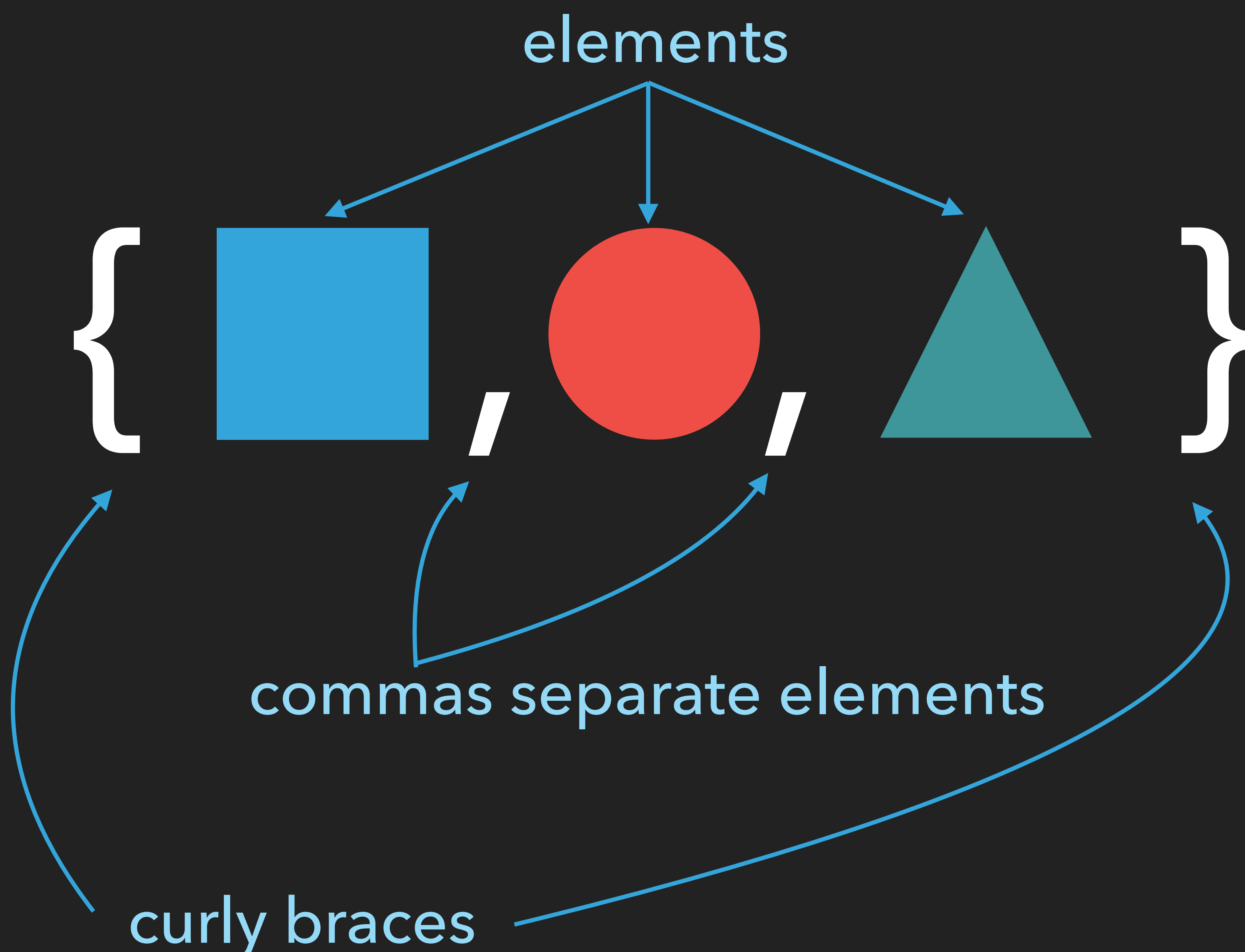

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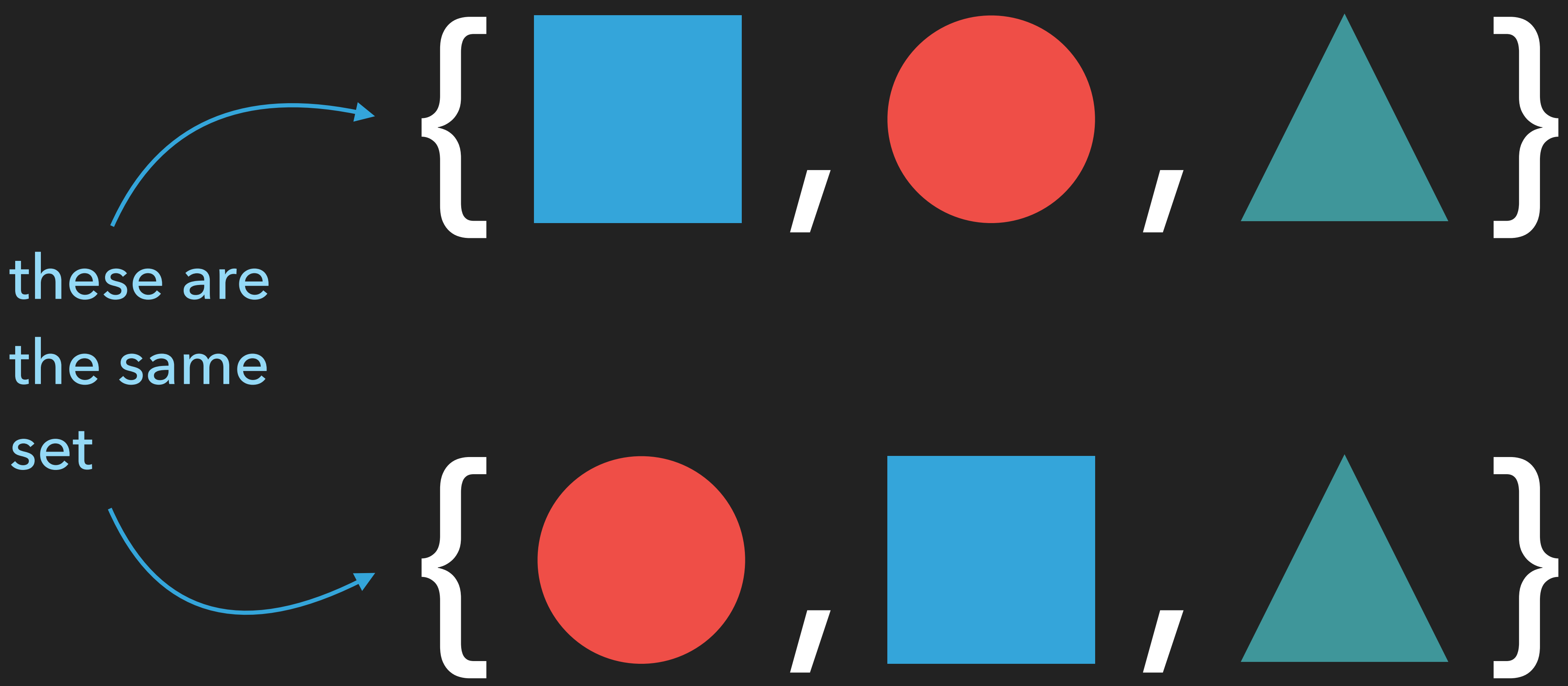

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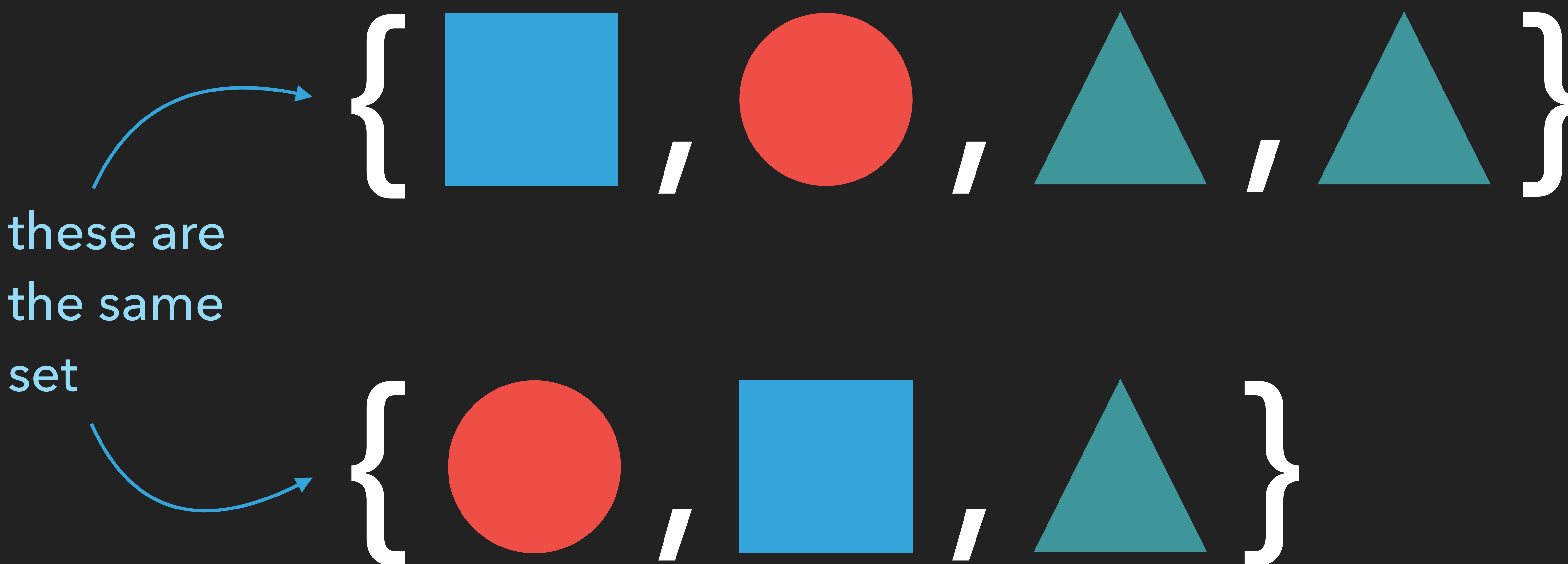

(repeated elements are ignored)

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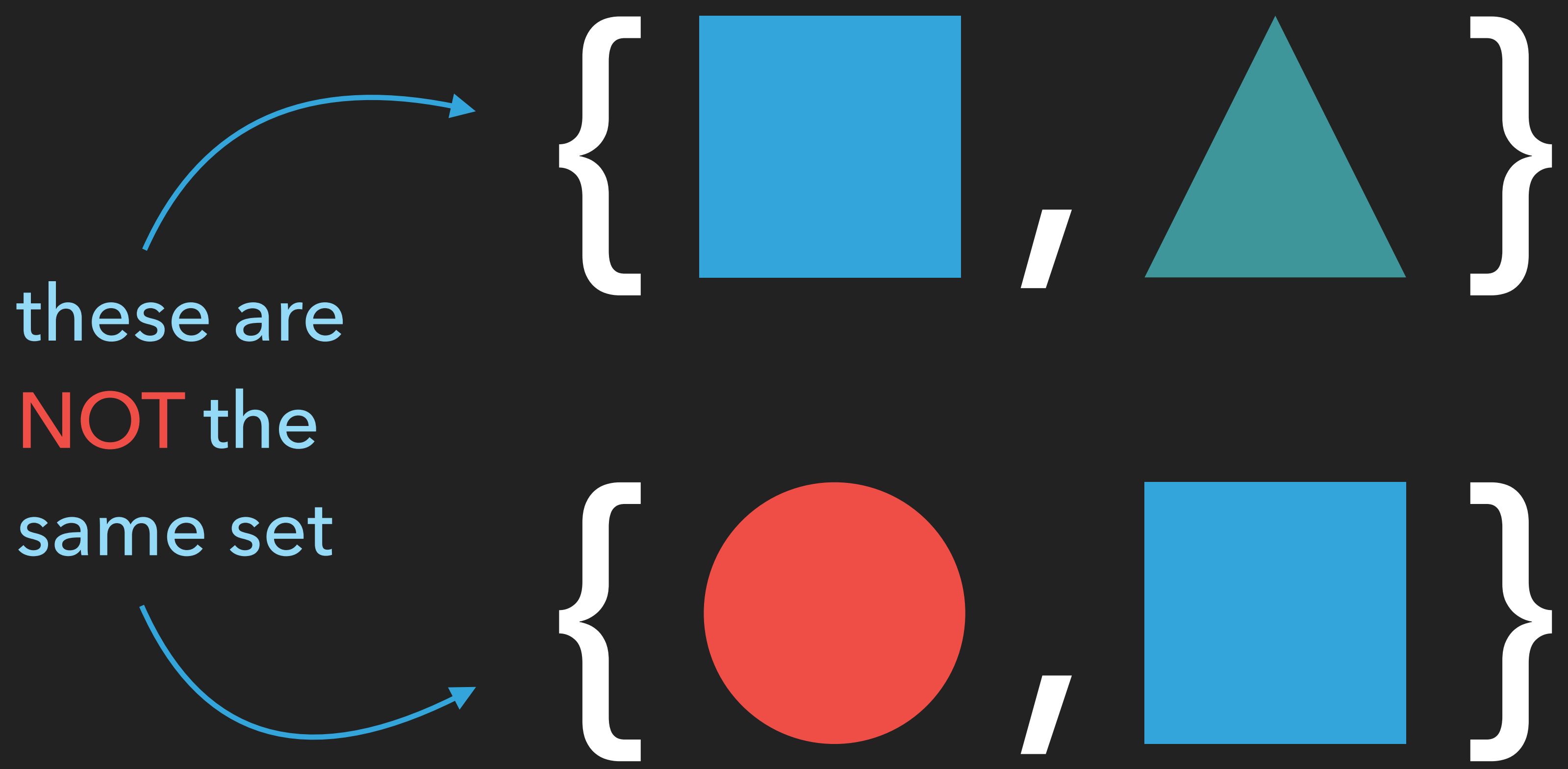
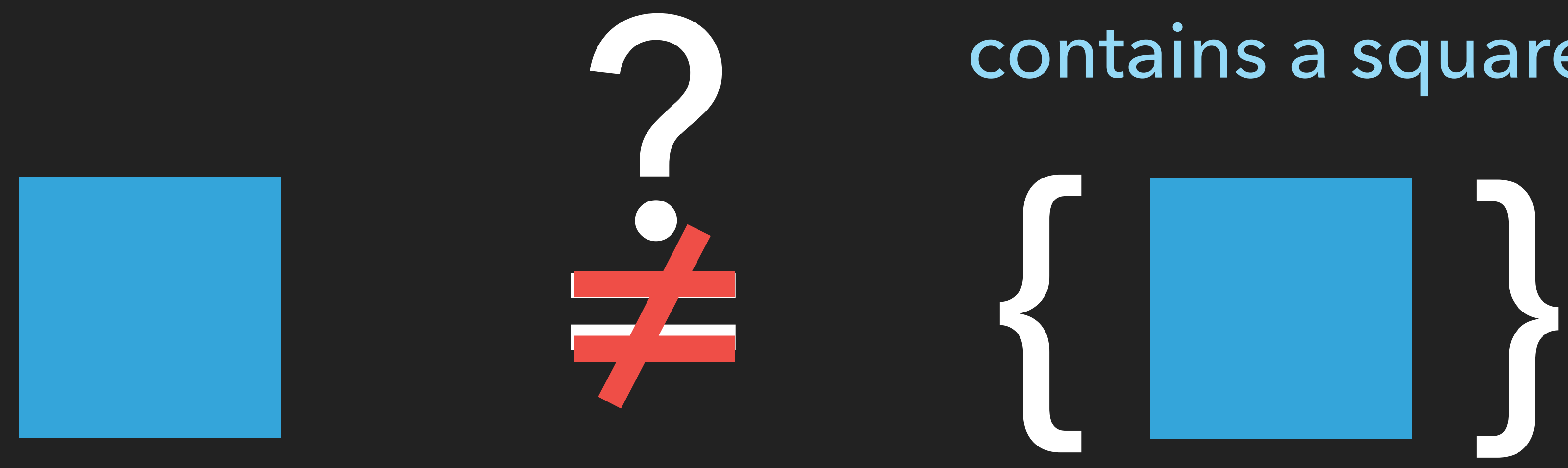


this is a set that
contains a square



this is a square

THE EMPTY SET

the symbol for the empty set

$$\varnothing$$

$$\{ \ \}$$

the empty set contains no elements

WHAT IS A SET?

$$\emptyset \overset{?}{\neq} \{ \emptyset \}$$

this is the empty set
a set which contains nothing

this is a set that contains one element. That element is the empty set.

$$\{\} \neq \{ \{\} \}$$

SET MEMBERSHIP

"…is an element of…"

SET MEMBERSHIP

"...is NOT an element of..."

SET MEMBERSHIP

- Sets are referred to by uppercase letters (A, B, S, etc…)
- Elements are usually referred to by lowercase letters (x, a, z, etc…)
- Given a set S and an element x, if x is an element of S, we would write:

$$x \in S$$

otherwise, we would write:

$$x \notin S$$

- Given ANY set S and ANY element x, either $x \in S$ or $x \notin S$.

FAMOUS SETS

- The set of natural numbers, $\mathbb{N}^+$ $\{1, 2, 3, \ldots\}$
- The *other* set of natural numbers, $\mathbb{N}$ $\{0, 1, 2, 3, \ldots\}$
- The set of integers, $\mathbb{Z}$ $\{\ldots, -2, -1, 0, 1, 2, \ldots\}$
- The set of all real numbers, $\mathbb{R}$

these are all *infinite* sets

Set builder notation is used to describe sets.

$$\mathbb{N} = \{\, x : x \in \mathbb{Z} \text{ and } x \geq 0 \,\}$$

"such that"

$$\mathbb{N} = \{\, x \mid x \in \mathbb{Z} \text{ and } x \geq 0 \,\}$$

The set of natural numbers, $\mathbb{N}$, is equal to the set of all x, where x is an integer and x is greater than or equal to 0.

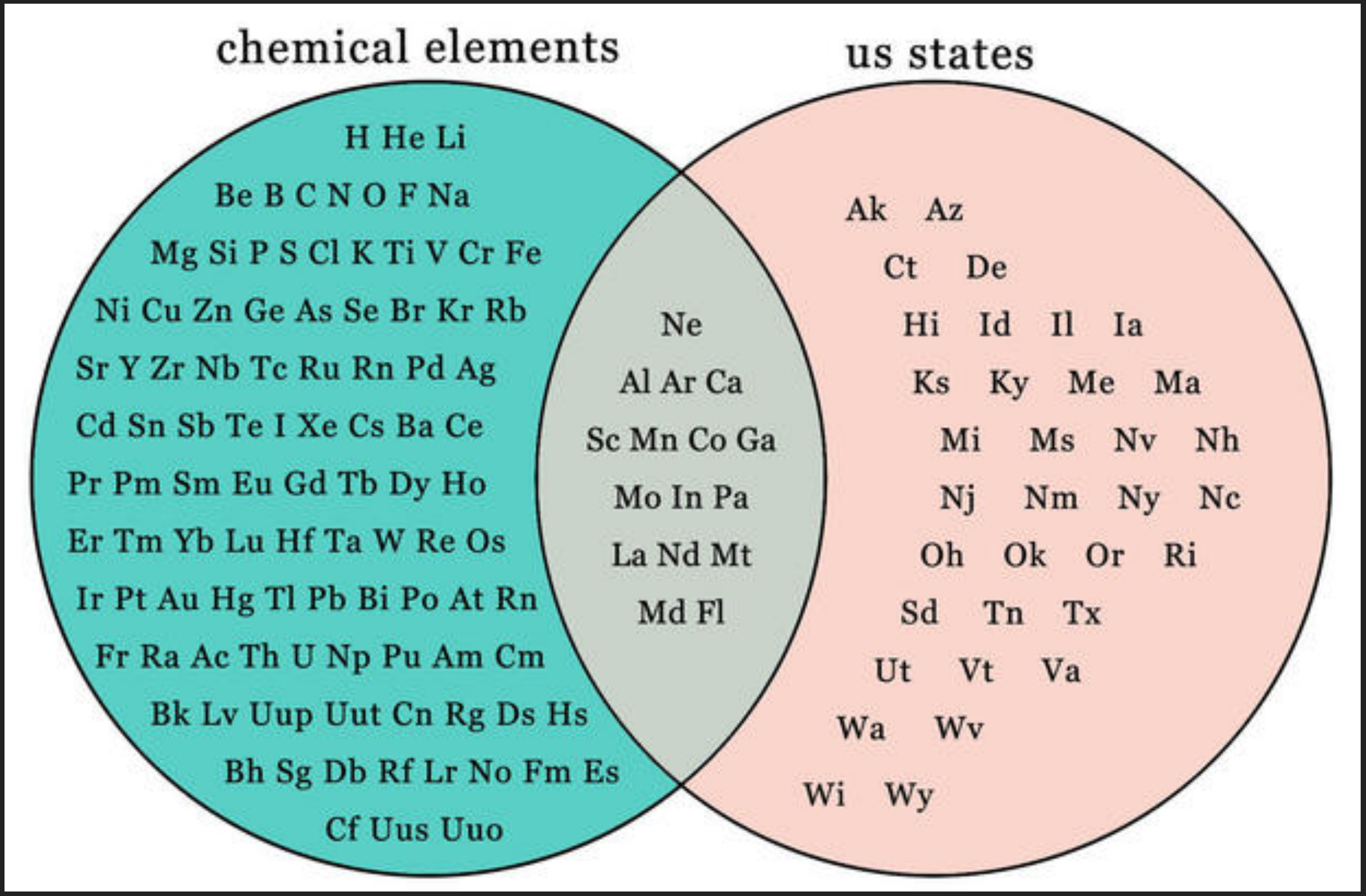
"and"

$$\mathbb{N} = \{\, x \mid x \in \mathbb{Z} \wedge x \geq 0 \,\}$$

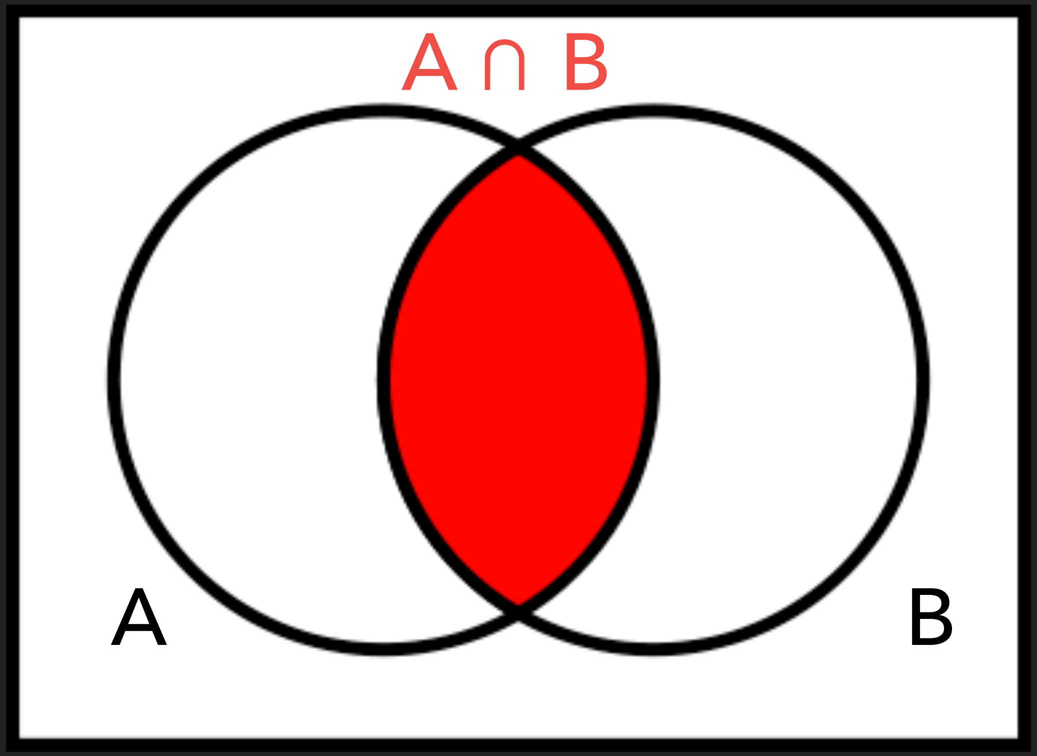
$$\mathbb{N} = \{\, x \in \mathbb{Z} \mid x \geq 0 \,\}$$

the domain of x

VENN DIAGRAMS AND SET OPERATIONS



Intersection

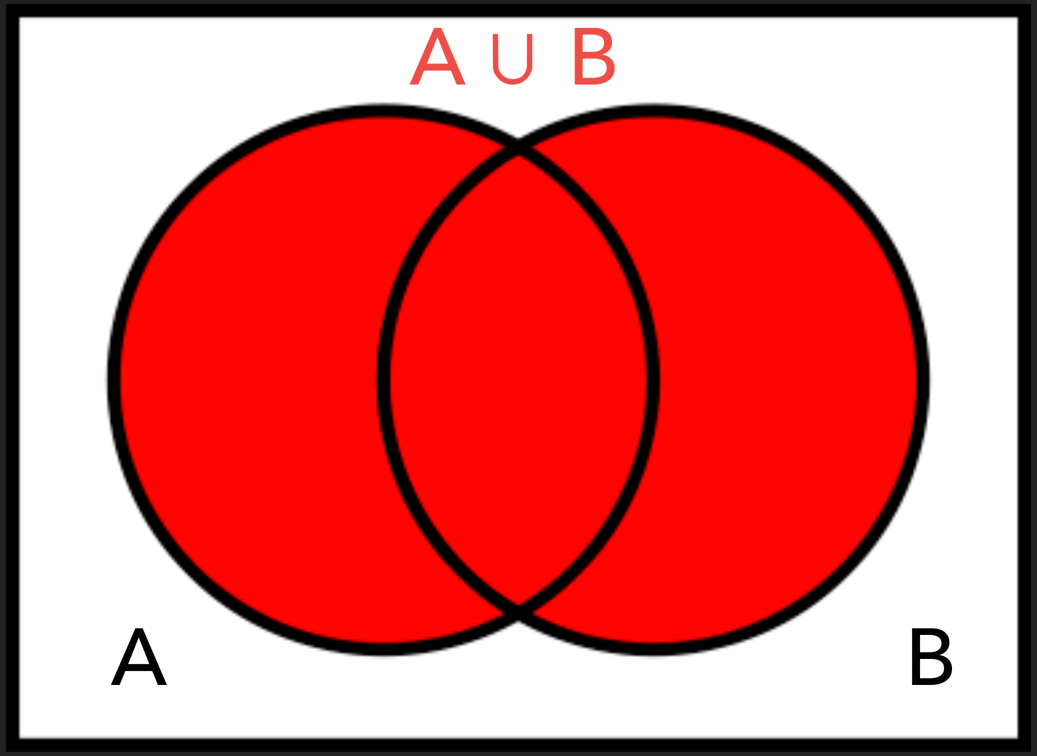


$A = \{1, 2, 3\}$ $C = \{1, 3, 5\}$

$B = \{1, 3, 5\}$ $D = \{2, 4, 6\}$

$A \cap B = \{1, 3\}$ $C \cap D = \{\ \} = \varnothing$

Union



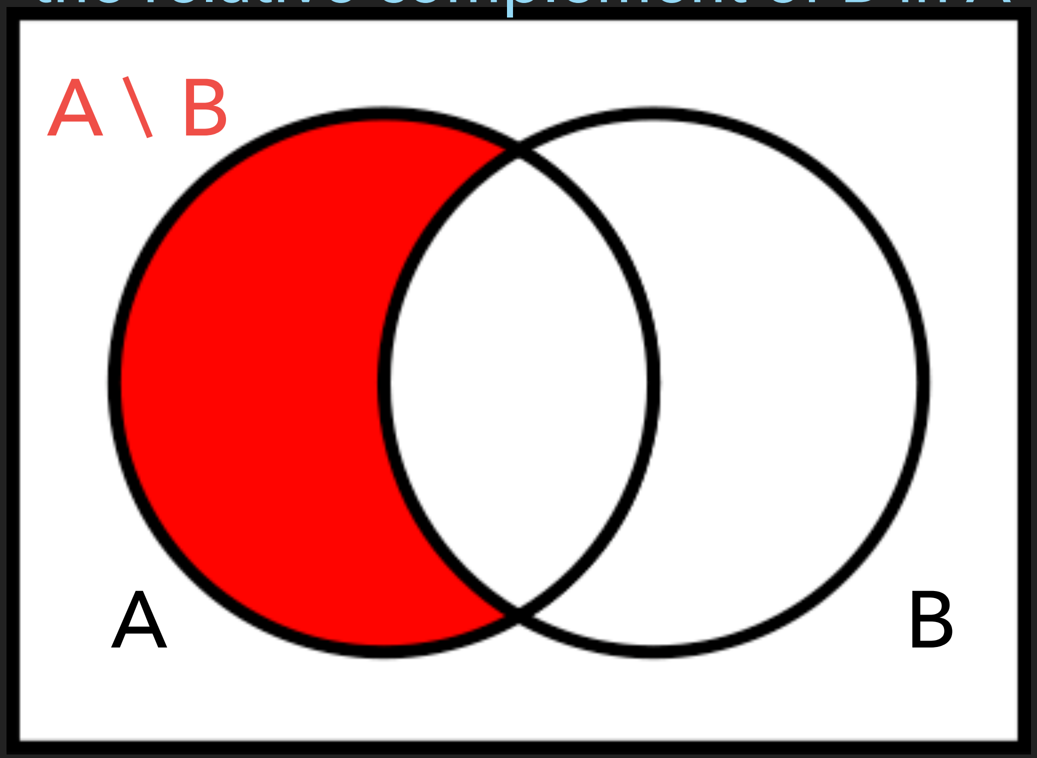
$A = \{1, 2, 3\}$ $C = \{1, 3, 5\}$

$B = \{1, 3, 5\}$ $D = \{2, 4, 6\}$

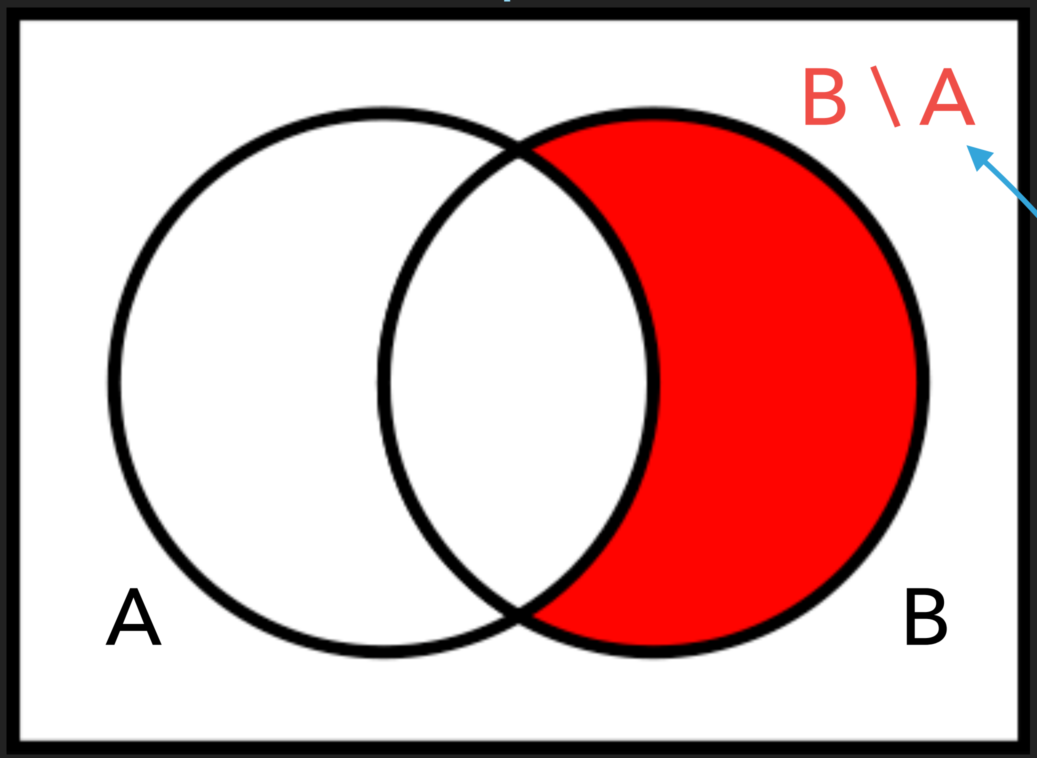
$A \cup B = \{1, 2, 3, 5\}$ $C \cup D = \{1, 2, 3, 4, 5, 6\}$

Set Difference

“the relative complement of B in A”



“the relative complement of A in B”



sometimes B - A

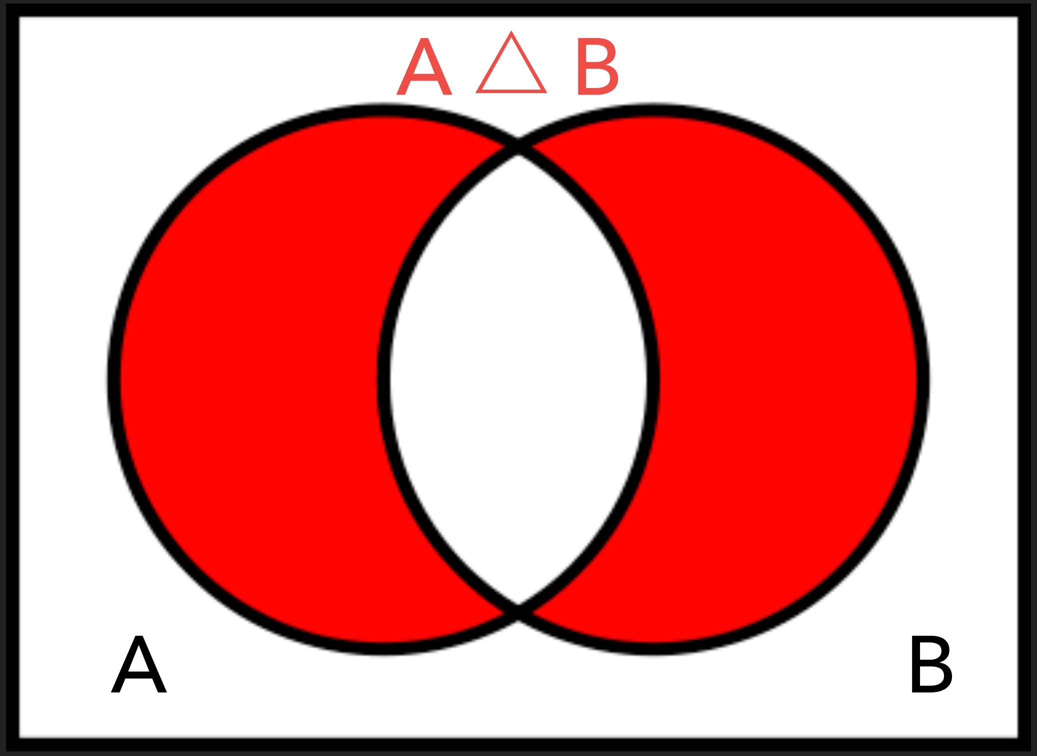
$A = \{1, 2, 3\}$ $C = \{1, 3, 5\}$

$B = \{1, 3, 5\}$ $D = \{2, 4, 6\}$

$A \setminus B = \{2\}$ $C \setminus D = \{1, 3, 5\}$

$B \setminus A = \{5\}$ $D \setminus C = \{2, 4, 6\}$

Symmetric Difference



sometimes $A \ominus B$

or $A \oplus B$

or $A \bigtriangledown B$

or $A \veebar B$

$A = \{1, 2, 3\}$ $\quad$ $C = \{1, 3, 5\}$

$B = \{1, 3, 5\}$ $\quad$ $D = \{2, 4, 6\}$

$A \triangle B = \{2, 5\}$ $\quad$ $C \triangle D = \{1, 2, 3, 4, 5, 6\}$

Cartesian Product / Cross Product

$A = \{1, 2, 3\}$

ordered pair

$(2, 1) \neq (1, 2)$

$B = \{1, 3, 5\}$

$$A \times B = \{ (1, 1), (1, 3), (1, 5), (2, 1), (2, 3), (2, 5), (3, 1), (3, 3), (3, 5)\}$$

$$A \times B \neq B \times A$$

$$B \times A = \{ (1, 1), (1, 2), (1, 3), (3, 1), (3, 2), (3, 3), (5, 1), (5, 2), (5, 3)\}$$

VENN DIAGRAMS AND SET OPERATIONS