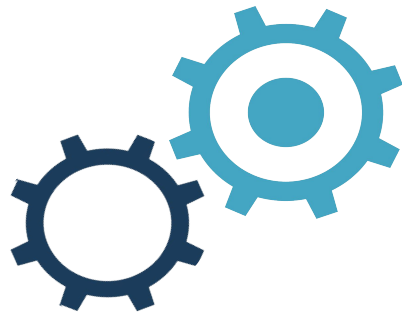# Sets

CS Fundamentals

What is a set

A set is a group of **<u>unique items</u>** from some domain or universal set of items

Some examples:

If the domain is all pets, one set in that domain could be: {dog, cat, bird}

If the domain is the characters in the string "The bee buzzed", the set of characters in that domain is {'T', 'h', 'e', 'b', 'u', 'z', 'd'}

Set Terminology

- Domain - the larger collection from which a set is a part

- Element - an item in a set

- Subset - one set is contained within another set (may contain the exact same elements)

- Proper subset - one set is contained within another set and does not contain all elements of its superset (they are not equal)

- Superset - one set contains another set

- Proper superset - one set contains another set and contains more than that subset (they are not equal)
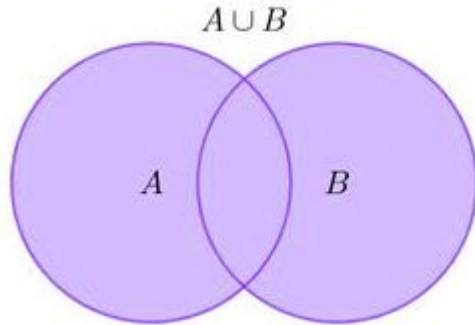
Combining sets - union(or)

Contains all elements that appear in either set (or)

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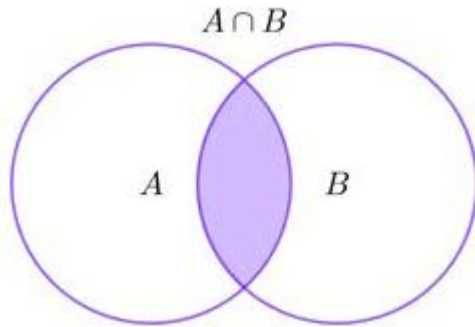
$B = \{3,4,5,6\}$

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

$A \cup B$

Combining sets - intersection (and)

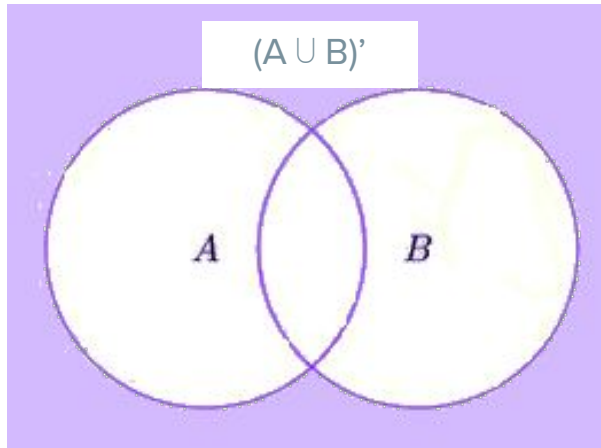Contains only the elements that appear in both sets (and)

A = {1,2,3,4}
B = {3,4,5,6}
A ∩ B = {3,4}

Combining sets - complement(not)

Elements in the domain that are in the domain and not in the set (not)

(A ∪ B)'

A   B

Domain: All natural numbers < 10
A = {1,2,3,4}
B = {3,4,5,6}
(A ∪ B)' = {7,8,9}
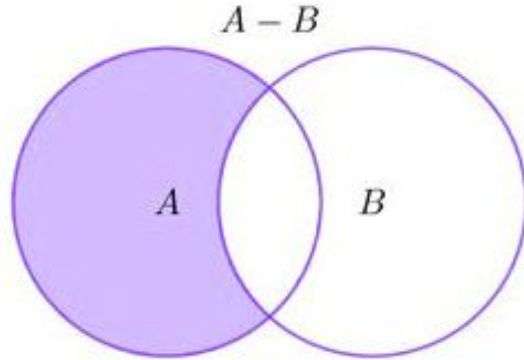
A' =   {5,6,7,8,9}

B' =   {1,2,7,8,9}

Combining sets - difference

All elements in one set that are not in another set

$A = \{1,2,3,4\}$

$B = \{3,4,5,6\}$

$A - B = \{1,2\}$

$B - A = \{5,6\}$

$A - B$

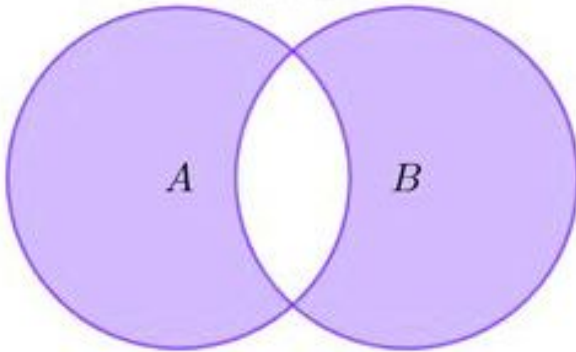A B

Combining sets - symmetric difference(xor)

All elements that are in either set but not in both (exclusive or)

$(A \cup B) - (A \cap B)$

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

What's another way to express this?

$(A - B) \cup (B - A)$

Example of Union, Intersection and Complement

A is all even numbers < 100

B is all even number >= 100

Domain is the set of all natural numbers (all positive integers)

A ∪ B =>   all positive even numbers (and 0 depending on who you ask)

A ∩ B =>   { } (the empty set)

What would complement of A ∪ B be?   all positive odd numbers

Examples of difference

A = {3,5,6}

B = {3,5,6,8}

A - B =   { } (empty set)

B - A =   {8}

Symmetric difference of B and A = {8}

Subset and superset

A = {1,2,3}   B = {1,2,3,4,5}

A is a proper subset of B   A ⊂ B

A is a subset of B   A ⊆ B

B is a proper superset of A   B ⊃ A

B is a superset of A   B ⊇ A

Some common domains and notations

Natural numbers

$\mathbb{N}$ = (Integers above zero)

Integers

$\mathbb{Z}$ = (All positive and negative whole numbers)

We can say that:

$\mathbb{Z} \supset \mathbb{N}$ (Integers are a proper superset of natural numbers)

$x \in \mathbb{N}$ (x is an element of the natural numbers)

Using set notation to describe a set

$A = \{x \mid x \in \mathbb{N}, x < 5\}$ => $A = \{1,2,3,4\}$

$A = \{x \mid x \in \mathbb{Z}, -3 < x < 3\}$ => $A = \{-2,-1,0,1,2\}$

$A = \{1,2,3\}, B = \{x \mid x \in \mathbb{N}, x < 10, x \notin A\}$ => $B = \{4,5,6,7,8,9\}$