Operations on sets

Things you need to learn:

The following operations on sets:

- Union of two sets: $A \cup B$;
- Intersection of two sets: $A \cap B$;
- Difference of two sets: $A - B$;
- Complement of a given set: A^c.

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Note that the union is sometimes also called the sum and the intersection is sometimes called the product.

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- If $A \subseteq B$ and $B \subseteq A$, then $A = B$.

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- If $A \subseteq B$ and $B \subseteq C$, then $A \subseteq C$.

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You may find this analogous to $\leq$ and $<$ operators.

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If $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$, then $A \cup B = \{1, 2, 3, 4\}$

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- If $A \subseteq B$, then $A \cap B = A$;

In particular:

- $\emptyset \cup A = A$;
- $\emptyset \cap A = \emptyset$;

Difference

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If $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$, then $A - B = \{1\}$, but $B - A = \{4\}$

Example 1

Let $A = \{1, 2, 3, 4, 5, 6, 7\}$ and $B = \{2, 4, 6, 8, 10\}$.
Find $A \cup B$, $A \cap B$, $A - B$ and $B - A$.

Example 1

$A \cup B$ denotes all elements that are in at least one of A or B, so we have:

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Note: $1 \notin A \cap B$, since 1 does not belong to B. Similarly $8 \notin A \cap B$, since 8 does not belong to A.

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$$A - B = \{1, 3, 5, 7\}$$

Note: $2 \notin A - B$, since 2 belongs to B, so we excluded it. Also $9 \notin A - B$, since 9 wasn't in A in the first place.

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$B - A$ is difference between B and A, it's the set of all elements in B that are not in A. We have:

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Note: $6 \notin B - A$, since 6 is in A, so we excluded it. And $9 \notin B - A$, since 9 wasn't in B.

Complement

Usually in a given problem we have a set U - the universal set, which denotes all elements that are considered for the given problem. Note that we have: $A \subseteq U$ for any set A.

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We can then define the complement of a set A, denoted A^c, as all element that are not in A.

Note that $A^c = U - A$.

Example 2

Let U be the set of positive integers less than 10 and $A = \{2, 3, 5, 7\}$ and $B = \{2, 4, 6, 8\}$.

Find A^c, B^c, $A^c \cap B^c$.

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$$A^c = \{1, 4, 6, 8, 9\}$$

Note: $2 \notin A^c$, since 2 is an element of A and in A^c we want elements that are not in A. On the other hand $12 \notin A^c$, since 12 does not belong to our universal set, so we don't even consider it.

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B^c is the complement of B, these are the elements that are not in B. We still need to remember about our universal set. We have:

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$$B^c = \{1, 3, 5, 7, 9\}$$

Note: $2 \notin B^c$, since 2 is in B and $12 \notin B^c$, since 12 does not belong to the universal set.

Zadanie 2

$A^c \cap B^c$ is the intersection of A^c and B^c. We know that:

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So the intersection of the above sets is:
$A^c \cap B^c = \{1, 9\}$

Exercise 1

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4\}$, $B = \{3, 6, 9\}$ and $C = \{6, 7, 8, 9\}$.

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$A \cap B = \{3\}$;

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Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

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Find:

$A \cup B$

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Find:

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$B - C = \{4, 6, 8, 10\}$

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\}$;

$A - C = \{1, 4, 6\}$;

$B - C = \{4, 6, 8, 10\}$

A^c

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\}$;

$A - C = \{1, 4, 6\}$;

$B - C = \{4, 6, 8, 10\}$

$A^c = \{8, 9, 10\}$;

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\}$;

$A - C = \{1, 4, 6\}$;

$B - C = \{4, 6, 8, 10\}$

$A^c = \{8, 9, 10\}$;

C^c

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\}$;

$A - C = \{1, 4, 6\}$;

$B - C = \{4, 6, 8, 10\}$

$A^c = \{8, 9, 10\}$;

$C^c = \{1, 4, 6, 8, 9, 10\}$;

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\}$;

$A - C = \{1, 4, 6\}$;

$B - C = \{4, 6, 8, 10\}$

$A^c = \{8, 9, 10\}$;

$C^c = \{1, 4, 6, 8, 9, 10\}$;

$A^c \cup C^c$

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\}$;

$A - C = \{1, 4, 6\}$;

$B - C = \{4, 6, 8, 10\}$

$A^c = \{8, 9, 10\}$;

$C^c = \{1, 4, 6, 8, 9, 10\}$;

$A^c \cup C^c = \{1, 4, 6, 8, 9, 10\}$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)^c$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\};$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C)$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

$(B \cap C) - A$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

$(B \cap C) - A = \emptyset$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

$(B \cap C) - A = \emptyset$

$A - (B \cup C)$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

$(B \cap C) - A = \emptyset$

$A - (B \cup C) = \{1\}$;

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

$(B \cap C) - A = \emptyset$

$A - (B \cup C) = \{1\}$;

$C^c - B^c$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

$(B \cap C) - A = \emptyset$

$A - (B \cup C) = \{1\}$;

$C^c - B^c = \{4, 6, 8, 10\}$;

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

$(B \cap C) - A = \emptyset$

$A - (B \cup C) = \{1\}$;

$C^c - B^c = \{4, 6, 8, 10\}$;

$(A^c \cup B) - C$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$(A \cap B)^c = \{1, 3, 5, 7, 8, 9, 10\}$;

$A^c \cap (B \cup C) = \{8, 10\}$;

$(B \cap C) - A = \emptyset$

$A - (B \cup C) = \{1\}$;

$C^c - B^c = \{4, 6, 8, 10\}$;

$(A^c \cup B) - C = \{4, 6, 8, 9, 10\}$

In case of any questions you can message me via Librus or MS Teams.