



Lab#1

Problem#1:

- If $X = \{a, b, c, d, e\}$, $Y = \{a, c, e, f, g, h\}$, $Z = \{c, g, m, n\}$
Find:

- $X \cup Y =$
- $X \cup Y \cup Z =$
- $Y \cup \emptyset =$
- $X \cap Y =$
- $Y \cap Z =$
- $Z \cap \emptyset =$
- $X - Y =$
- $Y - X =$
- $Z - X =$
- $X - X =$
- $X \times Y =$
- $Z \times Y =$
- $|X| =$
- $|Z \times Y| =$
- Is $a \in X$?
- Is $X \subseteq Y$?

Solution:

- $X \cup Y = \{a, b, c, d, e, f, g, h\}$
- $X \cup Y \cup Z = \{a, b, c, d, e, f, g, h, m, n\}$
- $Y \cup \emptyset = Y = \{a, c, e, f, g, h\}$
- $X \cap Y = \{a, c, e\}$
- $Y \cap Z = \{c, g\}$
- $Z \cap \emptyset = \emptyset$
- $X - Y = \{b, d\}$
- $Y - X = \{f, g, h\}$
- $Z - X = \{g, m, n\}$
- $X - X = \emptyset$
- $X \times Y = \{(a,a), (a,c), (a,e), (a,f), (a,g), (a,h), (b,a), \dots, (e,h)\}$
- $Z \times Y = \{(c,a), (c,c), (c,e), (c,f), (c,g), (c,h), (g,a), \dots, (n,h)\}$
- $|X| = 5$
- $|Z \times Y| = 24$
- Is $a \in X$? True
- Is $X \subseteq Y$? False

Problem#2:

- If $a=\text{hello}$, $b=\text{world}$, $c=0$, $d=\Lambda$

Find:

- $|a| =$
- $|c| =$
- $|d| =$
- $ab =$
- $bd =$
- $a^R =$
- $ab^R =$
- $|ad| =$
- $|bc| =$

Solution:

- $|a| = 5$
- $|c| = 1$
- $|d| = 0$
- $ab = \text{helloworld}$
- $bd = \text{world}$
- $a^R = \text{olleh}$
- $ab^R = \text{hellodlrow}$
- $|ad| = |a| + |d| = 5 + 0 = 5$
- $|bc| = |b| + |c| = 5 + 1 = 6$

Notes

1. $\forall x [Px]$ = every x is p

Example: "Every dog is happy"

Correct Solution: $\forall x \text{ dog}(x) \rightarrow \text{happy}(x)$

Means that for every x, if x is a dog, then x is happy

Wrong solution: $\forall x [\text{dog}(x) \wedge \text{happy}(x)]$

Means that for every x, x is a dog and x is happy

2. $\sim \text{for all } (x)$ = there exist ($\sim x$)

$\sim \text{there exist}(x)$ = for all ($\sim x$)

$\sim \text{for all } (x) \neq \text{for all } (\sim x)$

$\sim \text{there exist } (x) \neq \text{there exist } (\sim x)$

Example: "Nobody likes taxes"

Solution: $\neg \exists x \text{ likes } (x, \text{taxes})$

Or: $\forall x \text{ dislikes}(x, \text{taxes})$

Problem#3:

- Define a predicate for the following:
 - I. Ali is a student
 - II. Mary loves flowers
 - III. All volleyball players are tall
 - IV. There a person who makes noise
 - V. Everyone likes fries
 - VI. Nobody hates fun
 - VII. Carols is happier than Sue, but sadder than Fred
 - VIII. James is a troublemaker when Kevin dislikes him.
 - IX. John didn't study but he is lucky.
 - X. All cats and dogs are animals.

Solution:

- Ali is a student
 - $\text{Student}(\text{Ali})$
- Mary loves flowers
 - $\text{Loves}(\text{Mary}, \text{flowers})$
- All volleyball players are tall
 - $\forall X \text{ play}(X, \text{volleyball}) \rightarrow \text{tall}(X)$

- There a person who makes noise
 - $\exists X \text{ makes}(X, \text{noise})$
- Everyone likes fries
 - $\forall X \text{ likes}(X, \text{fries})$
- Nobody hates fun
 - $\neg \exists X \text{ hates}(X, \text{fun})$
- Carols is happier than Sue, but sadder than Fred
 - $H(x,y) = x \text{ is happier than } y$
 - $S(x,y) = x \text{ is sadder than } y$
 - $H(\text{carols}, \text{sue}) \wedge S(\text{carlos}, \text{fred})$
- James is a troublemaker when Kevin dislikes him.
 - $\text{dislikes}(\text{kevin}, \text{james}) \rightarrow \text{troublemaker}(\text{james})$
- John didn't study but he is lucky.
 - $\neg \text{study}(\text{john}) \wedge \text{lucky}(\text{john})$
- All cats and dogs are animals
 - $\forall X \forall Y \text{ cat}(X) \wedge \text{dog}(Y) \rightarrow \text{animals}(X) \wedge \text{animals}(Y)$