Mathematical Foundations for Computer Applications

Inference rules

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Inference rules

- An **argument** in propositional logic is a sequence of propositions.
- All but the final proposition in the argument are called **premises** and the final proposition is called the **conclusion.**
- An argument is valid if the truth of all its **premises implies that the conclusion** is **true.**

Valid Arguments in Propositional Logic

Example

- "If you have a current password, then you can log onto the network."
- "You have a current password."

Therefore,

- "You can log onto the network."

Valid Arguments in Propositional Logic

Let p to represent “You have a current password”

q to represent “You can log onto the network.”

Then, the argument has the form

$$\begin{array}{l} p \rightarrow q \\ p \\ \hline \therefore q \end{array}$$

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Rules of Inference.

Rule of Inference	*Tautology*	*Name*
p $p \rightarrow q$ $\therefore q$	$(p \wedge (p \rightarrow q)) \rightarrow q$	Modus ponens
$\neg q$ $p \rightarrow q$ $\therefore \neg p$	$(\neg q \wedge (p \rightarrow q)) \rightarrow \neg p$	Modus tollens
$p \rightarrow q$ $q \rightarrow r$ $\therefore p \rightarrow r$	$((p \rightarrow q) \wedge (q \rightarrow r)) \rightarrow (p \rightarrow r)$	Hypothetical syllogism
$p \vee q$ $\neg p$ $\therefore q$	$((p \vee q) \wedge \neg p) \rightarrow q$	Disjunctive syllogism

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Rules of Inference.

p $\therefore \overline{p \vee q}$	$p \rightarrow (p \vee q)$	Addition
$p \wedge q$ $\therefore \overline{p}$	$(p \wedge q) \rightarrow p$	Simplification
p q $\therefore \overline{p \wedge q}$	$((p) \wedge (q)) \rightarrow (p \wedge q)$	Conjunction
$p \vee q$ $\neg p \vee r$ $\therefore \overline{q \vee r}$	$((p \vee q) \wedge (\neg p \vee r)) \rightarrow (q \vee r)$	Resolution

Problems

1.State which rule of inference is the basis of the following argument: “It is below freezing now. Therefore, it is either below freezing or raining now.”

Solution: Let ***p*** be the proposition “It is below freezing now” and ***q*** the proposition “It is raining now.” Then this argument is of the form

$$\frac{p}{\therefore p \vee q}$$

- This is an argument that uses the **addition rule**.

Problems

2. State which rule of inference is the basis of the following argument: “It is below freezing and raining now. Therefore, it is below freezing now.”

Solution: Let p be the proposition “It is below freezing now,” and let q be the proposition “It is raining now.”

This argument is of the form

$$\frac{p \wedge q}{\therefore p}$$

- This argument uses the **simplification rule.**

Problems

3. State which rule of inference is used in the argument:

- If it rains today, then we will not have a barbecue today.
- If we do not have a barbecue today, then we will have a barbecue tomorrow.
- Therefore, if it rains today, then we will have a barbecue tomorrow.

Problems

- Let p be the proposition "It is raining today,"
- let q be the proposition "We will not have a barbecue today,"
- let r be the proposition "We will have a barbecue tomorrow."

$$\begin{array}{l} p \rightarrow q \\ q \rightarrow r \\ \hline \therefore p \rightarrow r \end{array}$$

- Hence, this argument is a **hypothetical syllogism.**

THANK YOU

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