1.1 - Connecting "And", "Or", and "Not"

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Unit 2: Reasoning and Set Theory

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For the first few chapters, we’re going to be dealing largely with Statements. In mathematics, statements are wholly true, or wholly false. A statement cannot be judged true by one person and false by another; we would consider that to be an opinion.

For example, we could say, “Maple Ridge is a city in British Columbia.” This is a statement because it is **factual**. This statement also happens to be true.

We could also say, “Maple Ridge is located on the planet Jupiter.” Although this sentence is false, it is still factual which makes it a statement.

There are other sentences which we would not consider to be statements:

“Maple Ridge is the best place to live.” This is not factual, so it is an opinion. We would **not** consider this to be a statement.

“How do you get to the bus stop?” This is a question, so it is not a statement.

The “truth value” of a statement is determining if it is true or false.

Example

Determine whether each of the following is a statement, and what its truth value is:

4 is a prime number.

Statement. Truth value: False.

Driving a car is the best mode of transportation.

Opinon. No truth value.

If you double an integer, then you get an even integer.

Statement. Truth value: True.

We will be using the negation of statements in this chapter. The negation of a given statement is the exact opposite of that statement. Typically, we will accomplish this by using the word, “not,” either by adding it to, or removing it from an original statement.

For example, the negation of the statement, “The city of Maple Ridge is in Alberta,” can be “The city of Maple Ridge is **not** in Alberta.”

Note how the original statement was false, while the negation was true. This will always be the case with negations.

More specifically, a negation will always have the opposite truth value of the original statement.

Example

What is the negation of the statement, “It is 30 degrees outside today”

“It is not 30° outside today”

What is the negation of the statement, “It is not Tuesday today”

“It is Tuesday today.”

We can make one large statement by combining several other single statements. This is known as a compound statement.

Usually, we use the words "and" or "or" to accomplish this.

For example, "today is Tuesday and the current month is February," is a compound statement. Highlight or underline the two separate statements, just so we're clear.

We can also form a conjunction (which is a type of compound statement) using the word "and." A conjunction is formed using two or more statements, and it is only true if **both** original statements are true. In any other case, the conjunction is false.

Example

Form a conjunction using the statements, "Maple Ridge is a city," and, "the sky is blue."

"Maple Ridge is a city and the sky is blue"

Truth Value: True

Truth Value: True.

Is this conjunction true?

Both sub-statements are true, ∴ the conjunction is also true.

Example

Form a conjunction using the statements, "GSS is a school," and, "fish have fur."

"GSS is a school and fish have fur."

True

False

Is this conjunction true?

Even though one sub-statement is true, not all sub-statements are true. ∴ The conjunction is false.

The use of the word "or" in mathematics

In everyday speech, we use "or" in one of two ways.

Case 1

"For Billy to be accepted in to his university program, he needs to pass chemistry 12 **or** physics 12."

Billy can be accepted in to his program in three ways:

- He passes chemistry 12 only
- He passes physics 12 only
- He passes both chemistry 12 and physics 12

We say this is the "inclusive" use of the word "or."

Case 2

Jo says, "I'll take the bus or drive myself to work."

Jo can get to work in two ways:

- She takes the bus
- She drives herself

Jo can either take the bus, or drive herself, but **not both**.

We say this is the "exclusive" use of the word "or".

In mathematics, we will always use the inclusive version of "or."

We can make another kind of compound statement by joining two statements with "or." This is called a "disjunction."

For example, "Mason rolled a pair of dice and the sum of the numbers was even or odd," is a disjunction.

Since we are using the inclusive version of "or," a disjunction is only false if **both** statements are false, otherwise it is true.

Conjunction ("and")	Disjunction ("or")
True only when all sub-statements are true. **False only when one or more sub-statements are false.**	**True only when one or more sub-statements are true.** **False only when all sub-statements are false.**