

Boolean Logic

The primitive data type `boolean` has two values: `true` and `false`. Boolean expressions are built using *relational operators* and *conditional operators*.

Manager:

Recorder:

Presenter:

Reflector:

Content Learning Objectives

After completing this activity, students should be able to:

- Recognize the value of developing process skills.
- Evaluate boolean expressions with relational operators (<, >, <=, >=, ==, !=).
- Explain the difference between assignment (=) and equality (==) operators.
- Evaluate boolean expressions that involve comparisons with &&, ||, and !.

Process Skill Goals

During the activity, students should make progress toward:

- Evaluating complex logic expressions based on operator precedence. (Critical Thinking)



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Meta Activity: What Employers Want

The following data is from the *Job Outlook 2019* survey by the National Association of Colleges and Employers (NACE). A total of 172 organizations responded to the survey.

Attributes Employers Seek on a Candidate's Resume

| Attribute | % of respondents |
|--------------------------------|------------------|
| Ability to work in a team | 78.7% |
| Analytical/quantitative skills | 71.9% |
| Communication skills (verbal) | 67.4% |
| Communication skills (written) | 82.0% |
| Detail-oriented | 59.6% |
| Initiative | 74.2% |
| Leadership | 67.4% |
| Problem-solving skills | 80.9% |
| Strong work ethic | 70.8% |
| Technical skills | 59.6% |

Source: <https://www.naceweb.org/talent-acquisition/candidate-selection/>

Questions (10 min)

Start time:

1. What are the top three attributes that employers look for on a resume?
 - #1:
 - #2:
 - #3:
2. Describe the process your team used to answer to the previous question.
3. How is communication (written and verbal) related to problem solving and teamwork?
4. How does the team-based learning approach in this class help you develop these skills?

Model 1 Relational Operators

In the meta activity, you determined the top three attributes by comparing percentages. We can declare variables to represent these percentages in Java:

```
double written = 82.0;    // Communication skills (written)
double problem = 80.9;    // Problem-solving skills
double teamwork = 78.7;   // Ability to work in a team
```

In the table below, determine the result of each expression and identify the operator. The first five rows are completed for you. (Optional: Use *JShell* to check your work.)

| Expression | Result | Operator |
|---------------------|--------|----------|
| written | 82.0 | none |
| written > problem | true | > |
| problem < teamwork | false | < |
| teamwork = 79.5 | 79.5 | = |
| teamwork == 78.7 | false | == |
| 82.0 < written | | |
| 82.0 > written | | |
| 82.0 == written | | |
| problem == written | | |
| teamwork == problem | | |
| teamwork = problem | | |
| teamwork == problem | | |
| teamwork | | |

Questions (15 min)

Start time:

5. A *relational operator* compares two values; the result is either **true** or **false**. Identify the three relational operators used in the table above.

6. Explain why the same expression `teamwork == problem` resulted with two different values in the table.

7. What is the difference between = and == in Java?

8. The != relational operator means “not equals”. Give an example of a boolean expression that uses != and evaluates to false.

9. The >= relational operator means “greater than or equal to”. Give an example of a boolean expression that uses >= and evaluates to true.

10. Java has six relational operators. Only five have been shown, but you should be able to guess the sixth. List all six below, and explain briefly what each one means.

Model 2 Conditional Operators

Boolean expressions, like `written > problem` and `teamwork < 75.0`, can be combined using the *conditional operators*:

| Operator | Meaning |
|----------|---------|
| ! | not |
| && | and |
| | or |

For example, `written > problem && teamwork < 75.0` is false, because `teamwork` is not less than 75.0. (Both conditions need to be true in order for `&&` to be true.)

The following table summarizes the result of `&&`, `||`, and `!` for all possible inputs. The variables `p` and `q` represent conditions like `written > problem` and `teamwork < 75.0`.

| p | q | p && q | p q | !p |
|-------|-------|--------|--------|-------|
| false | false | false | false | true |
| false | true | false | true | true |
| true | false | false | true | false |
| true | true | true | true | false |

Questions (20 min)

Start time:

11. Consider the following variables:

```
double initiative = 74.2;
double analytical = 71.9;
double workEthic = 70.8;
boolean hired = true;
boolean fired = false;
```

What are the results (true or false) of the following expressions?

| Expression | Result |
|---------------------------------------|--------|
| !fired | |
| !(workEthic < initiative) | |
| workEthic < 71.0 && 71.0 < initiative | |
| initiative < 70.0 workEthic > 70.0 | |
| fired workEthic < 50.0 | |
| analytical < initiative && fired | |
| hired && !fired | |

12. Write a boolean expression that ...

- a) uses initiative, analytical, and !, and evaluates to false.
- b) uses analytical, workEthic, and !, and evaluates to true.
- c) uses any variable(s), and evaluates to false.
- d) uses any variable(s), and evaluates to true.

13. Using your answers to the previous question, write a boolean expression “p && q” where p is your answer to part a) and q is your answer to part b).

- a) Your expression:
- b) Result of p && q:

Relational operators (<, >, and ==) are evaluated before conditional operators (!, &&, and ||). When multiple conditional operators are used, Java evaluates ! first, then &&, and finally ||.

14. Show the intermediate result of each operator below. In other words, show your work as you evaluate the code in the same order that Java would.

`!(initiative < analytical) && workEthic > analytical`

| | Operator | Expression | Result |
|-----|----------|-------------------------|--------|
| 1st | < | initiative < analytical | false |
| 2nd | | | |
| 3rd | | | |
| 4th | | | |

15. Change the parentheses in the original expression (from the previous question) so that the `&&` is evaluated before the `!`. Then remove any unnecessary parentheses.

a) Expression:

b) New result:

16. Review the table from Model 2 for evaluating `&&` and `||`. Looking only at the p and `&&` columns, when is it necessary to examine q to determine how p `&&` q should be evaluated?

17. Review the table from Model 2 for evaluating `&&` and `||`. Looking only at the p and `||` columns, when is it necessary to examine q to determine how p `||` q should be evaluated?

18. In Java, `&&` and `||` are *short circuit* operators, meaning they evaluate only what is necessary. If the expression p is more likely to be true than the expression q, which one should you place on the left of each operator to avoid doing extra work?

a) left of the `&&` expression:

b) left of the `||` expression:

19. What is the result of the following expressions?

a) `1 + 0 > 0 && 1 / 0 > 0`

b) `1 + 0 > 0 || 1 / 0 > 0`