IST 1025

Introduction to Programming

Making Choices with **`if`** Statements

Control Structures

- Sequencing - run one statement after another
- Iteration (loops) - run a given sequence of statements several times
- Decision: Choose or skip some instructions

Conditional Statements

- Check for the presence or absence of a condition in the environment
- Take the appropriate actions
- Involves making a choice

Asking Questions

- Is the number greater than 0?
- Is the password correct?
- Are we at the end of the list?
- Does the file exist?
- Is the number evenly divisible by 2?

Answers: Boolean Expressions

- Literals: **`True`**, **`False`**
- Variables
- Results of comparisons
- Results of logical operations

Comparisons

```
>>> x = 2
>>> x == 2
True
>>> x < 3
True
>>> x > 4
False
```

Operators are **==**, **!=**, **<**, **>**, **<=**, **>=**

== means equals, **=** means assignment

!= means not equal to

Example: Absolute Value

- $|x| = -x$ if $x < 0$, or x otherwise
- Write code that converts a number *x* to its absolute value

Use an `if` Statement

```
If x is less than 0
   Set x to -x
```

Use an **`if`** Statement

```
if x < 0:
    x = -x
```

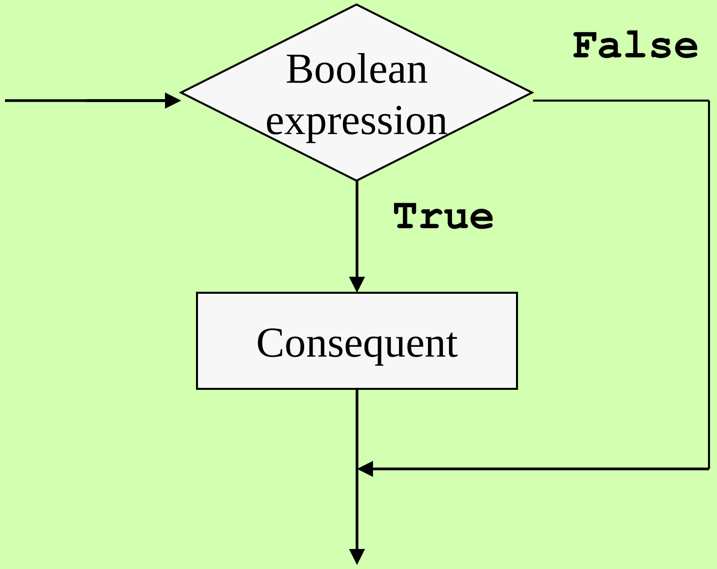
Also called a *one-way* **`if`** statement

If the comparison returns **`True`**, run the nested statement

Otherwise, do nothing

```
if <Boolean expression>:                 # The condition
    <sequence of statements>             # The consequent
```

Behavior of One-Way **`if`** Statement



```
if <Boolean expression>:              # The condition
    <sequence of statements>          # The consequent
```

Example: Checking User Inputs

- A program will work only for inputs > 0
- All other numbers should be rejected with an error message
- Only the positive inputs can be processed

The Area of a Circle

```python
import math

radius = float(input('Enter the radius: '))
area = math.pi * radius ** 2
print(area)
```

This version allows negative inputs to be used - very bad!

Use an `if-else` Statement

```python
import math

radius = float(input('Enter the radius: '))
if radius <= 0:
    print('ERROR: Input number must be positive! ')
else:
    area = math.pi * radius ** 2
    print(area)
```

This version checks the input and traps errors before they can cause damage

The program responds gracefully with an error message

Syntax of `if-else` Statement

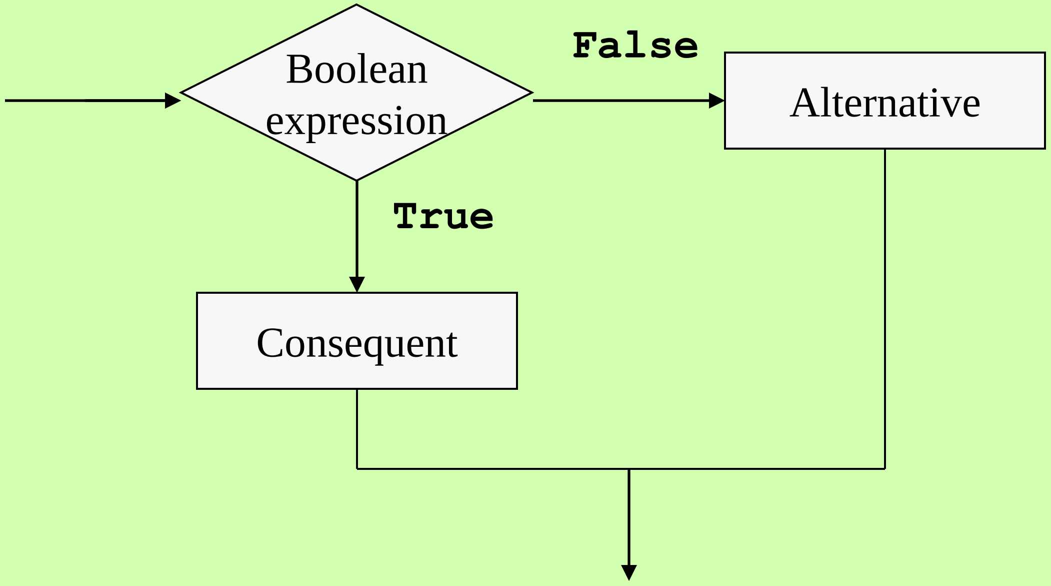
```
import math

radius = float(input('Enter the radius: '))
if radius <= 0:
    print('ERROR: Input number must be positive! ')
else:
    area = math.pi * radius ** 2
    print(area)
```

```
if <Boolean expression>:                   # The condition
    <sequence of statements>               # The consequent
else:
    <sequence of statements>               # The alternative
```

Also called a *two-way* `if` statement

Behavior of Two-Way `if` Statement



```
if <Boolean expression>:                # The condition
    <sequence of statements>            # The consequent
else:
    <sequence of statements>            # The alternative
```

More Input Checking

```
rate = int(input('Enter the interest rate[0-100]: '))
interest = principal * rate / 100
print('Your interest is', interest)
```

This version allows rates < 0 or rates > 100

Very bad!

More Input Checking

```
rate = int(input('Enter the interest rate[0-100]: '))
if rate < 0 or rate > 100:
     print('ERROR: Rate must be between 0 and 100!')
else:
    interest = principal * rate / 100
    print('Your interest is', interest)
```

Use comparisons and the *logical operator* **`or`** to restrict the rate to the legitimate values

The Logical Operators

```
<Boolean expression> or <Boolean Expression>

<Boolean expression> and <Boolean expression>

not <Boolean expression>
```

The Boolean expressions can be

- literals (**`True`** or **`False`**)
- variables
- comparisons
- Boolean function calls
- other expressions connected by logical operators

Truth Table for `or`

```
rate = -1

print(rate < 0 or rate > 100)
```

A	B	A or B
True	True	True
True	False	True
False	True	True
False	False	False

Python stops evaluating operands when enough info is available to determine the result (short-circuit evaluation)

Truth Table for `or`

```
rate = 160

print(rate < 0 or rate > 100)
```

A	B	A or B
True	True	True
True	False	True
False	True	True
False	False	False

In this case, both operands must be evaluated

Truth Table for `or`

```
rate = 50

print(rate < 0 or rate > 100)
```

A	B	A or B
True	True	True
True	False	True
False	True	True
False	False	False

In this case, likewise

Truth Table for **`and`**

```
rate = -1

print(rate >= 0 and rate <= 100)
```

A	B	A and B
True	True	True
True	False	False
False	True	False
False	False	False

The **`and`** operator uses short-circuit evaluation, too

Truth Table for **`not`**

```python
import os.path

filename = input('Enter the file name:  ')
if not os.path.isfile(filename):
    print('ERROR: File does not exist!')
else:
    # Process the file
```

A	not A
True	False
False	True

Precedence of Logical Operators

```
print(False or True and not True)

# Same as

print(False or (True and (not True)))
```

Ranking:

`not`	(logical negation)
`and`	(logical product)
`or`	(logical sum)

Mutiple Conditions

```
rate = int(input('Enter the interest rate[0-100]: '))
if rate < 0 or rate > 100:
    print('ERROR: Rate must be between 0 and 100!')
else:
   interest = principal * rate / 100
   print('Your interest is', interest)
```

Sometimes we need to nest conditional statements several layers deep. We see how to do that next.

Multiway `if` Statement

```python
rate = int(input('Enter the interest rate[0-100]: '))
if rate < 0:
    print('ERROR: Rate must be greater than 0!')
elif rate > 100:
    print('ERROR: Rate must be less than 101!')
else:
   interest = principal * rate / 100
   print('Your interest is', interest)
```

```
if <Boolean expression>:                # The first condition
    <sequence of statements>            # The first consequent
elif <Boolean expression>:              # The second condition
    <sequence of statements>            # The second consequent
…
else:
    <sequence of statements>            # The default alternative
```

Multiway `if` Statement

```
grade = int(input('Enter the numeric grade: '))

if grade >= 90:
    print('A')
elif grade >= 80:
    print('B')
elif grade >= 70:
    print('C')
else:
    print('F')
```

Exercise

A numeric grade should not be less than 0 or greater than 100. Rewrite the grader program so that it checks for invalid inputs and prints and error message; otherwise it prints the grade.