CSCE 110
Programming I

David Kebo Hougninou

Basics of Python

Decision-making statements
Conditional Execution and Flags

Instructions can be made to execute conditionally

<table>
<thead>
<tr>
<th>CMP</th>
<th>r3,#0</th>
<th>CMP</th>
<th>r3,#0</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEQ</td>
<td>skip</td>
<td>ADDNE</td>
<td>r0,r1,r2</td>
</tr>
<tr>
<td>ADD</td>
<td>r0,r1,r2</td>
<td>ADD</td>
<td>r0,r1,r2</td>
</tr>
</tbody>
</table>

skip
Conditional Codes Examples

C source code

```c
if (r0 == 0) {
    r1 = r1 + 1;
} else {
    r2 = r2 + 1;
}
```

unconditional

```c
CMP r0, #0
BNE else
ADD r1, r1, #1
end
else
    ADD r2, r2, #1
end
```

- 5 instructions

conditional

```c
CMP r0, #0
ADDEQ r1, r1, #1
ADDNE r2, r2, #1
...
```

- 3 instructions

Conditional Execution

![Conditional Execution Diagram](image)

Conditional / Selection
Conditional Execution

```
if <condition>:
    <do this>
```

Indentation is mandatory

One tab

Conditional / Selection

```
if <condition>:
    <do this>
else:
    <do that>
```
### Activity

```python
x = int(input('Enter the value of x: '))
if (x > 100):
    print('A')
else:
    print('B')
print('C')
```

**What is the expected output for the following values of x?**

<table>
<thead>
<tr>
<th>Input</th>
<th>Expected output</th>
</tr>
</thead>
<tbody>
<tr>
<td>x = 150</td>
<td>A C</td>
</tr>
<tr>
<td>x = 100</td>
<td>B C</td>
</tr>
<tr>
<td>x = 98</td>
<td>B C</td>
</tr>
<tr>
<td>x = 0</td>
<td>B C</td>
</tr>
</tbody>
</table>

### Activity solution

```python
x = int(input('Enter the value of x: '))
if (x > 100):
    print('A')
else:
    print('B')
print('C')
```

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</thead>
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<tr>
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<td>A C</td>
</tr>
<tr>
<td>x = 100</td>
<td>B C</td>
</tr>
<tr>
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</tr>
<tr>
<td>x = 0</td>
<td>B C</td>
</tr>
</tbody>
</table>
Activity

```python
x = int(input('Enter the value of x: '))
if (x > 100):
    print('A')
else:
    print('B')
    print('C')
```

What is the expected output for the following values of x?

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</tr>
</thead>
<tbody>
<tr>
<td>x = 150</td>
<td>A</td>
</tr>
<tr>
<td>x = 100</td>
<td>B</td>
</tr>
<tr>
<td>x = 98</td>
<td>B</td>
</tr>
<tr>
<td>x = 0</td>
<td>B</td>
</tr>
</tbody>
</table>

Activity solution

```python
x = int(input('Enter the value of x: '))
if (x > 100):
    print('A')
else:
    print('B')
    print('C')
```

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</tr>
</thead>
<tbody>
<tr>
<td>x = 150</td>
<td>A</td>
</tr>
<tr>
<td>x = 100</td>
<td>B</td>
</tr>
<tr>
<td>x = 98</td>
<td>B</td>
</tr>
<tr>
<td>x = 0</td>
<td>B</td>
</tr>
</tbody>
</table>
## Truth Value Testing

<table>
<thead>
<tr>
<th>False values</th>
<th>Truth values</th>
<th>Everything else</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>False</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'' - an empty string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[] - an empty list</td>
<td></td>
<td></td>
</tr>
<tr>
<td>{} - an empty dictionary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>() - an empty tuple</td>
<td></td>
<td></td>
</tr>
<tr>
<td>set() - an empty set</td>
<td></td>
<td></td>
</tr>
<tr>
<td>range(0) - an empty range</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Comparison Operators

<table>
<thead>
<tr>
<th>Description</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strictly less than</td>
<td>&lt;</td>
</tr>
<tr>
<td>Less than or equal to</td>
<td>&lt;=</td>
</tr>
<tr>
<td>Strictly greater than</td>
<td>&gt;</td>
</tr>
<tr>
<td>Greater than or equal</td>
<td>&gt;=</td>
</tr>
<tr>
<td>Equal to</td>
<td>==</td>
</tr>
<tr>
<td>Not equal to</td>
<td>!=</td>
</tr>
</tbody>
</table>
Comparison Operators

- Comparison Operators:
  - `=`, `>=`, `<`, `!`

- Value 1: `Comparison Operator`
- Value 2:

- True or False

Python shell examples:

```python
>>> 9 < 100
True
>>> 10 != 15
True
>>> 10 == 15
False
```
### Activity 3

What is the expected output for the following values of $x$?

<table>
<thead>
<tr>
<th>Input</th>
<th>Expected output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2^2 &lt; 3*2$</td>
<td>True</td>
</tr>
<tr>
<td>$9^0.5  != 3$</td>
<td>False</td>
</tr>
<tr>
<td>$size = 10$</td>
<td></td>
</tr>
<tr>
<td>$2*size &lt; size$</td>
<td>False</td>
</tr>
<tr>
<td>$1089%10 == 89$</td>
<td>False</td>
</tr>
<tr>
<td><code>len(&quot;eight&quot;) == 8</code></td>
<td>False</td>
</tr>
<tr>
<td><code>bool(&quot;&quot;) == False</code></td>
<td>True</td>
</tr>
</tbody>
</table>

### Activity solution

What is the expected output for the following values of $x$?

<table>
<thead>
<tr>
<th>Input</th>
<th>Expected output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2^2 &lt; 3*2$</td>
<td>True</td>
</tr>
<tr>
<td>$9^0.5  != 3$</td>
<td>False</td>
</tr>
<tr>
<td>$size = 10$</td>
<td></td>
</tr>
<tr>
<td>$2*size &lt; size$</td>
<td>False</td>
</tr>
<tr>
<td>$1089%10 == 89$</td>
<td>False</td>
</tr>
<tr>
<td><code>len(&quot;eight&quot;) == 8</code></td>
<td>False</td>
</tr>
<tr>
<td><code>bool(&quot;&quot;) == False</code></td>
<td>True</td>
</tr>
</tbody>
</table>
Logical Operators

<table>
<thead>
<tr>
<th>Description</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical AND</td>
<td>and</td>
</tr>
<tr>
<td>Logical OR</td>
<td>or</td>
</tr>
<tr>
<td>Logical NOT</td>
<td>not</td>
</tr>
</tbody>
</table>

Logical Operators

Value 1  Logical Operator and or not  Value 2

True or False
Logical operators

and, or, not

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>A and B</th>
</tr>
</thead>
<tbody>
<tr>
<td>False</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>False</td>
<td>True</td>
<td>False</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>True</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>A or B</th>
</tr>
</thead>
<tbody>
<tr>
<td>False</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>False</td>
<td>True</td>
<td>True</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>True</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A</th>
<th>not A</th>
</tr>
</thead>
<tbody>
<tr>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
</tr>
</tbody>
</table>

Python shell examples.

```python
>>> True and True
True
>>> True and False
False
>>> (False or True) and True
True
>>> not True
False
>>> 10 < 5 or 15 != 60
True
```

Conjunctive operators are best used with Boolean values.
### Membership Operators

<table>
<thead>
<tr>
<th>Description</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>True if a variable is in the sequence; false otherwise.</td>
<td>in</td>
</tr>
<tr>
<td>True if a variable is not in the specified sequence; false otherwise.</td>
<td>not in</td>
</tr>
</tbody>
</table>

### Operators precedence

<table>
<thead>
<tr>
<th>Operator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>**</td>
<td>Exponentiation (raise to the power)</td>
</tr>
<tr>
<td>-</td>
<td>minus</td>
</tr>
<tr>
<td>* / % //</td>
<td>Multiplication, division, remainder and floor division</td>
</tr>
<tr>
<td>+ -</td>
<td>Addition and subtraction</td>
</tr>
<tr>
<td>&lt;,&lt;=,&gt;,&gt;=,==, !=</td>
<td>Comparison</td>
</tr>
<tr>
<td>not</td>
<td>not logical</td>
</tr>
<tr>
<td>and</td>
<td>and logical</td>
</tr>
<tr>
<td>or</td>
<td>or logical</td>
</tr>
</tbody>
</table>
Example

Write a Python program to implement one of Einstein’s favorite puzzles:

1. Enter a 3 digit number. The first and last digit differ by at least two.
   e.g. 442 is correct but 244 is not since the first and last digit differ by -2.
2. Reverse the input.
3. Subtract the reversed number from the original number.
4. Reverse the difference.
5. Add the difference to the reversed difference.
6. The sum should be 1089.

Your program should test if the user entered a three digits number.
If the number doesn’t have three digits the program should display the message ‘The input is not valid’.
Example: solution

```python
number = input('Enter a number of 3 digits: ')
number_reverse = number[::-1]
result = int(number) - int(number_reverse)
result_reverse = str(result)[::-1]
total = int(result) + int(result_reverse)
print('The output is ',total)
```

Example: solution

```python
number = input('Enter a number of 3 digits: ')
if (len(number) == 3):
    number_reverse = number[::-1]
    result = int(number) - int(number_reverse)
    result_reverse = str(result)[::-1]
    total = int(result) + int(result_reverse)
    print('The output is ',total)
else:
    print('The input is not valid. You should enter a 3 digit number. ')
```
Example: solution

```python
number = input('Enter a number of 3 digits: ')
if (len(number) == 3):
    number_reverse = number[::-1]
    result = int(number) - int(number_reverse)
    result_reverse = str(result)[::-1]
    total = int(result) + int(result_reverse)
    print('The output is ', total)
else:
    print('The input is not valid. You should enter a 3 digit number. ')
```

Example: solution

```python
number = int(input('Enter a number of 3 digits: '))
# Testing the input
if ((number>=100) and (number<=999)):
    # Reversing the number
    h = number // 100
    t = (number % 100)//10
    o = number % 10
    number_reverse = o*100 + t*10 + h
    result = number - number_reverse
    # Reversing the number
    h = result // 100
    t = (result % 100)//10
    o = result % 10
    result_reverse = o*100 + t*10 + h
    total = result + result_reverse
    print('The output is ', total)
else:
    print('The input is not valid. You should enter a 3 digit number.')
```
Example

Consider a second degree polynomial or Quadratic equation in the form:

\[ ax^2 + bx + c = 0 \]

Write a program to test if a quadratic equation has real roots.

Conditional Execution

if <condition 1>:
    <do this 1>
else:
    if <condition 2>:
        <do this 2>
    else:
        <do that>
Example

How to test if a quadratic equation has real roots?

Example: discriminant

\[ x^2 + 3x + 2 = 0 \]
\[ a = 1, \ b = 3, \ c = 2 \]
\[ \Delta = b^2 - 4ac = 3^2 - (4 \times 1 \times 2) = 1 \]
Consider a second degree polynomial or Quadratic equation in the form:

\[ ax^2 + bx + c = 0 \]

Write a program to compute the number of real roots of a quadratic equation.
Example

How can I test the number of real roots of a quadratic equation?

\[ ax^2 + bx + c = 0 \]
is \( b^2 - 4ac \geq 0 \)

Example

```python
1 a = int(input('Enter a: '))
2 b = int(input('Enter b: '))
3 c = int(input('Enter c: '))
4 d = b**2 - 4*a*c
5 if (d > 0):
   6     print('2 real roots')
   7     print('1 real root')
7 else:
   8     if (d == 0):
   9         print('1 real root')
10     else:
11         print('None')
```
Example

For equation: \( x^2 + 3x + 2 = 0 \)
What is the execution order of this program?
What is the output of this program?

Execution order: 1, 2, 3, 4, 5, 6
Output: 2 real roots

```
1 a = int(input('Enter a: '))
2 b = int(input('Enter b: '))
3 c = int(input('Enter c: '))
4 d = b**2 - 4*a*c
5 if (d > 0):
6     print('2 real roots')
7 else:
8     if (d == 0):
9         print('1 real root')
10    else:
11       print('None')
```

Activity 4.1

For equation: \( x^2 + 2x + 1 = 0 \)
What is the execution order of this program?
What is the output of this program?

Execution order:
Output:
Activity 4.1 solution

For equation: $x^2 + 2x + 1 = 0$

What is the execution order of this program?

What is the output of this program?

Execution order: 1, 2, 3, 4, 5, 7, 8, 9

Output: 1 real root

Activity 4.2

For equation: $x^2 + 2x + 2 = 0$

What is the execution order of this program?

What is the output of this program?

Execution order:

Output:
Activity 4.2 solution

For equation: \( x^2 + 2x + 2 = 0 \)

What is the execution order of this program?

What is the output of this program?

Execution order: 1, 2, 3, 4, 5, 7, 8, 10, 11

Output: None

Conditional Execution

If you need more than two conditions (if-else), then use the `elif` statement.

```python
if <condition>:
    <do this>
elif <condition2>:
    <do this2>
elif <condition3>:
    <do this3>
else:
    <do that>
```
Conditional Execution

Same algorithm - different implementation

```python
1 a = int(input('Enter a: '))
2 b = int(input('Enter b: '))
3 c = int(input('Enter c: '))
4 d = b**2 - 4*a*c
5 if (d > 0):
6     print('2 real roots')
7 else:
8     if (d == 0):
9         print('1 real root')
10    else:
11       print('None')
```

Example

Write a program that computes the letter grade of a student given her score grade.

<table>
<thead>
<tr>
<th>Score Grade</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>'A'</td>
</tr>
<tr>
<td>80-89</td>
<td>'B'</td>
</tr>
<tr>
<td>70-79</td>
<td>'C'</td>
</tr>
<tr>
<td>60-69</td>
<td>'D'</td>
</tr>
<tr>
<td>&lt;= 59</td>
<td>'F'</td>
</tr>
</tbody>
</table>
How many conditions does the program test?

5
Conditional Execution

```python
score = int(input('Enter your score: '))

if score >= 90:
    letter = 'A'
else:
    if score >= 80:
        letter = 'B'
    else:
        if score >= 70:
            letter = 'C'
        else:
            if score >= 60:
                letter = 'D'
            else:
                letter = 'F'

print ('Letter grade:', letter)
```

How many conditions does the program test? It depends on the score!

What is the execution order for a score of 94?

What is the execution order for a score of 83?
Conditional Execution

If you need more than two conditions (if-else), then use the if-elif-else statement.

With this statement, you can have as many elif statement as needed.

```python
if <condition>:
    <do this>
elif <condition2>:
    <do this2>
elif <condition3>:
    <do this3>
else:
    <do that>
```

---

What is the execution order for a score of 64?
Activity 4.3

```python
score = int(input('Enter your score: '))
if score >= 90:
    letter = 'A'
elif score >= 80:
    letter = 'B'
elif score >= 70:
    letter = 'C'
elif score >= 60:
    letter = 'D'
else:
    letter = 'F'
print ('Letter grade:', letter)
```

a. What is the execution order for a score of 94?
b. What is the execution order for a score of 70?
c. What is the execution order for a score of 0?

Activity 4.3 solution

```python
score = int(input('Enter your score: '))
if score >= 90:
    letter = 'A'
elif score >= 80:
    letter = 'B'
elif score >= 70:
    letter = 'C'
elif score >= 60:
    letter = 'D'
else:
    letter = 'F'
print ('Letter grade:', letter)
```

What is the execution order for a score of 94?
Execution order: 1, 3, 4, 14
Output: A
Example

Write a program that asks for a year and classify the year as **leap year** or **not leap year**.

Leap years are divisible by 4.

However, years divisible by 100 are not leap years unless they are also divisible by 400.
Example

```python
year = int(input('Enter the year: '))
if (year % 4 == 0):
    if (year % 100 == 0):
        if (year % 400 == 0):
            print('Leap Year')
        else:
            print('Not Leap Year')
    else:
        print('Leap Year')
else:
    print('Not Leap Year')
```
Example solution

```python
year = int(input('Enter the year: '))
if (year % 4 != 0):
    print('Not a leap year')
else:
    if (year % 100 != 0):
        print('Leap Year')
    else:
        if (year % 400 != 0):
            print('Not Leap Year')
        else:
            print('Leap Year')
```

Example solution

```python
year = int(input('Enter the year: '))
if (year % 4 != 0):
    print('Not a leap year')
elif (year % 100 != 0):
    print('Leap Year')
elif (year % 400 != 0):
    print('Not Leap Year')
else:
    print('Leap Year')
```
Preferred solution

```python
year = int(input('Enter the year: '))
if (year % 4 == 0 and year %100 != 0) or (year % 400 == 0):
    print('Leap year')
else:
    print('Not Leap Year')
```

References

3. Python Basic Operators: [https://www.tutorialspoint.com/python/python_basic_operators.htm](https://www.tutorialspoint.com/python/python_basic_operators.htm)