Lecture 2 – Program flow, Conditionals, Loops
https://cw.fel.cvut.cz/wiki/courses/be5b33prg/start

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• Problem formulation (input / output)

• Formalism (math?)

• Algorithm (steps)

• Implementation (engineering)

• Testing (are we good?)
• We use variables to **remember** things!

• The assignment statement gives a value to a variable

• Do not confuse `=` and `==`!

  = is **assignment** token such that **name_of_variable** = **value**

  `==` is operator to **test equality**

• Key property of a variable that **we can change its value**

• Naming convention: **with freedom comes responsibility!**
The longer life the longer name: `very_long_name_of_my_var`

The more important the longer name

Meaningful name does not add the meaning just by itself, the code must do this!

Illegal name causes a syntax error

Capitals: `Variable` vs `variable`
Python keywords have **special** purpose
Always choose names **meaningful** to human readers
Use **comments (#)** and **blank lines** to improve readability

**source** [http://openbookproject.net/thinkcs/python/english3e/variables_expressions_statements.html](http://openbookproject.net/thinkcs/python/english3e/variables_expressions_statements.html)
### Built-in Functions

<table>
<thead>
<tr>
<th>Function</th>
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</thead>
<tbody>
<tr>
<td>abs()</td>
<td>dict()</td>
<td>help()</td>
<td>min()</td>
<td>setattr()</td>
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<tr>
<td>all()</td>
<td>dir()</td>
<td>hex()</td>
<td>next()</td>
<td>slice()</td>
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<td>any()</td>
<td>divmod()</td>
<td>id()</td>
<td>object()</td>
<td>sorted()</td>
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<td>ascii()</td>
<td>enumerate()</td>
<td>input()</td>
<td>oct()</td>
<td>staticmethod()</td>
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<td>bin()</td>
<td>eval()</td>
<td>int()</td>
<td>open()</td>
<td>str()</td>
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<td>bool()</td>
<td>exec()</td>
<td>isinstance()</td>
<td>ord()</td>
<td>sum()</td>
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<td>bytearray()</td>
<td>filter()</td>
<td>issubclass()</td>
<td>pow()</td>
<td>super()</td>
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<td>bytes()</td>
<td>float()</td>
<td>iter()</td>
<td>print()</td>
<td>tuple()</td>
</tr>
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<td>callable()</td>
<td>format()</td>
<td>len()</td>
<td>property()</td>
<td>type()</td>
</tr>
<tr>
<td>chr()</td>
<td>frozenset()</td>
<td>list()</td>
<td>range()</td>
<td>vars()</td>
</tr>
<tr>
<td>classmethod()</td>
<td>getattr()</td>
<td>locals()</td>
<td>repr()</td>
<td>zip()</td>
</tr>
<tr>
<td>compile()</td>
<td>globals()</td>
<td>map()</td>
<td>reversed()</td>
<td><strong>import</strong>()</td>
</tr>
<tr>
<td>complex()</td>
<td>hasattr()</td>
<td>max()</td>
<td>round()</td>
<td></td>
</tr>
<tr>
<td>delattr()</td>
<td>hash()</td>
<td>memoryview()</td>
<td>set()</td>
<td></td>
</tr>
</tbody>
</table>

- **Built-in functions have** **special** **purpose**
- **Study** [https://docs.python.org/3.4/library/functions.html](https://docs.python.org/3.4/library/functions.html)

Source: [http://openbookproject.net/thinkcs/python/english3e/variables_expressions_statements.html](http://openbookproject.net/thinkcs/python/english3e/variables_expressions_statements.html)
• Integers (int) 1, 10, 124
• Strings (str) "Hello, World!"
• Float (float) 1.0, 9.999

• Strings in Python can be enclosed in either single quotes (') or double quotes ("), or three of each ("" or """")

source [http://openbookproject.net/thinkcs/python/english3e/variables_expressions_statements.html](http://openbookproject.net/thinkcs/python/english3e/variables_expressions_statements.html)
• OPERAND OPERATOR OPERAND
• Operators are special tokens that represent computations like addition, subtraction, multiplication, division etc
• The values the operator uses are called operands
• When a variable name appears in the place of an operand, it is replaced with its value before the operation is performed
• Division / vs floor division //

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• Evaluation depends on the rules of precedence:
  1. Parentheses (for order, readability)
  2. Exponentiation
  3. Multiplication and Division
  4. Addition and Subtraction
• Order **left-to-right** evaluation on the same level, with the exception of exponentiation (***)

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• The modulus operator works on **integers** (integer expressions)
• Definition: modulus is the **remainder** when the first number is divided by the second
• Modulus operator is a percent sign `%`
• Syntax is the same as for other operators
• The same **precedence** as the **multiplication** operator

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Functions, `int()`, `float()` and `str()` convert their arguments into types `int`, `float` and `str` respectively.

- The type converter `float()` can turn an `integer`, a `float`, or a syntactically legal `string` into a float.
- The type converter `str()` turns its argument into a string.
- One symbol can have different meaning depending on the data type(s) - *try & explore & understand*

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• You cannot perform mathematical operations on strings, even if the strings look like numbers
• The + operator represents concatenation, not addition
• The * operator also works on strings; it performs repetition (one of the operands has to be a string; the other has to be an integer)

source: http://openbookproject.net/thinkcs/python/english3e/variables_expressions_statements.html
• Built-in function to get input from a user:

```python
input("Message to the user!")
```

• User input is stored as **string**
• Combine with type conversion

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• Combination of the elements of a program: variables, expressions, statements, and function calls
• One of the most useful features of programming languages
• Take small building blocks and compose them into larger chunks

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The variable **friend** at line 1 is the **loop variable**
- Lines 2 and 3 are the **loop body**
- The loop body is **always indented**
- The indentation determines exactly what statements are “in the body of the loop”
- At the end of each execution of the body of the loop, Python returns to the **for** statement, to see if there are more items to be handled, and to assign the next one to the loop variable

Source: [http://openbookproject.net/thinkcs/python/english3e/hello_little_turtles.html](http://openbookproject.net/thinkcs/python/english3e/hello_little_turtles.html)
On each iteration or pass of the loop:

- Check to see if there are still more items to be processed
- If there are none left (the terminating condition of the loop) the loop has finished
- If there are items still to be processed, the loop variable is updated to refer to the next item in the list
- Program execution continues at the next statement after the loop body
- To explore: early break, or for – else loop

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• Control flow (control of the flow of execution of the program)
• As program executes, the interpreter always keeps track of which statement is about to be executed
• Control flow until now has been strictly top to bottom, one statement at a time, the for loop changes this!

source: http://openbookproject.net/thinkcs/python/english3e/hello_little_turtles.html
**CONDITIONAL EXECUTION**

```python
if BOOLEAN EXPRESSION:
    STATEMENTS_1  # Executed if condition evaluates to True
else:
    STATEMENTS_2  # Executed if condition evaluates to False
```

- **Condition IF – ELSE**
- Conditional statement – the ability to check conditions and change the behavior of the program accordingly

source: [http://openbookproject.net/thinkcs/python/english3e/conditionals.html](http://openbookproject.net/thinkcs/python/english3e/conditionals.html)
• Condition **IF only**
• No ELSE statement
• To control flow only for specific condition

```python
if x < 0:
    print("The negative number ", x, " is not valid here.")
x = 42
print("I've decided to use the number 42 instead.")
print("The square root of ", x, "is", math.sqrt(x))
```

source: [http://openbookproject.net/thinkcs/python/english3e/conditionals.html](http://openbookproject.net/thinkcs/python/english3e/conditionals.html)
• Condition chaining
  **IF – ELIF – ELSE**

• Recommendation: handle all distinctive options by separate condition, use else to handle all other

source: http://openbookproject.net/thinkcs/python/english3e/conditionals.html
• Nesting conditions builds hierarchy of decisions (decision trees)
• Nesting may reduce readability and clarity

source [http://openbookproject.net/thinkcs/python/english3e/conditionals.html](http://openbookproject.net/thinkcs/python/english3e/conditionals.html)
• Early return / early break
• Can be used to speed-up code execution
• Special condition: **FOR – ELSE**

• Test conditions and **change the program behavior** depending on the outcome of the tests
• Boolean value is either **True** or **False**
• Named after the British mathematician, **George Boole**, who first formulated Boolean algebra

source [http://openbookproject.net/thinkcs/python/english3e/conditionals.html](http://openbookproject.net/thinkcs/python/english3e/conditionals.html)
Boolean expression is an expression that evaluates to produce a result which is a **Boolean value**

Six common **comparison operators** which all produce a bool result (different from the mathematical symbols)
• three logical operators, **and**, **or**, and **not**, that allow to build more complex expressions from simple Boolean expressions

• semantics (**meaning**) of these operators is similar to natural language equivalent

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Short-circuit evaluation:

- **OR** – if the expression on the left of the operator yields *True*, Python does not evaluate the expression on the right.
- **AND** – if the expression on the left yields *False*, Python does not evaluate the expression on the right.
- **Truth table** – list of all the possible inputs to give the results for the logical operators.

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Each of the six relational operators has a **logical opposite**

- Recommendation: **not** operators may reduce readability, use logical opposites instead

---

**operator** | **logical opposite**
--- | ---
== | !=
!= | ==
< | >=
<= | >
> | <=
>= | <

```python
if not (age >= 17):
    print("Hey, you're too young to get a driving licence!")
```

```python
if age < 17:
    print("Hey, you're too young to get a driving licence!")
```
**BOOLEAN ALGEBRA**

\[
\begin{align*}
  n \times 0 &= 0 \\
  x \text{ and } \text{False} &= \text{False} \\
  \text{False and } x &= \text{False} \\
  y \text{ and } x &= x \text{ and } y \\
  x \text{ and } \text{True} &= x \\
  \text{True and } x &= x \\
  x \text{ and } x &= x \\
  x \text{ or } \text{False} &= x \\
  \text{False or } x &= x \\
  y \text{ or } x &= x \text{ or } y \\
  x \text{ or } \text{True} &= \text{True} \\
  \text{True or } x &= \text{True} \\
  x \text{ or } x &= x \\
  \text{not (not } x) &= x
\end{align*}
\]

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De Morgan’s laws rules allow the expression of conjunctions and disjunctions in terms of each other via negation.

Example: suppose we can slay the dragon only if our magic sword is charged to 90% or higher and we have 100 or more energy units in our protective shield.

```python
if not ((sword_charge >= 0.90) and (shield_energy >= 100)):
    print("Your attack has no effect, the dragon fries you to a crisp!")
else:
    print("The dragon crumples in a heap. You rescue the gorgeous princess!")
```
DE MORGAN’S LAWS

```python
if (sword_charge < 0.90) or (shield_energy < 100):
    print("Your attack has no effect, the dragon fries you to a crisp!"")
else:
    print("The dragon crumples in a heap. You rescue the gorgeous princess!")
```

```python
if (sword_charge >= 0.90) and (shield_energy >= 100):
    print("The dragon crumples in a heap. You rescue the gorgeous princess!")
else:
    print("Your attack has no effect, the dragon fries you to a crisp!"")
```

- **Example**: suppose we can slay the dragon only if our magic sword is charged to 90% or higher and we have 100 or more energy units in our protective shield

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### Example

<table>
<thead>
<tr>
<th>p</th>
<th>q</th>
<th>r</th>
<th>((\text{not } (p \text{ and } q)) \text{ or } r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
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</table>

- **Example:** complete the table ..

source [http://openbookproject.net/thinkcs/python/english3e/conditionals.html](http://openbookproject.net/thinkcs/python/english3e/conditionals.html)
This lecture re-uses selected parts of the OPEN BOOK PROJECT
Learning with Python 3 (RLE)
http://openbookproject.net/thinkcs/python/english3e/index.html
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• by Peter Wentworth, Jeffrey Elkner, Allen B. Downey, and Chris Meyers
  (based on 2nd edition by Jeffrey Elkner, Allen B. Downey, and Chris Meyers)
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