CFS2160: Software Design and Development

02: Representing Things

Objects. Variables. Expressions.

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Recap: Jobs

Before next week, make sure you have:

- ➢ Got the book, and read the first two chapters.
- ➢ Started to work with PyCharm, using the Python console.
- ➢ Completed a Git tutorial.

And, optionally:

- ➢ Connected PyCharm to your GitHub account.
- ➢ Understood "Public" and "Private" Git repositories.

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As before, there is a lot here.

If you are in doubt, or can't work something out - Ask!

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From now on, 10 minutes of every lecture are kept for answering (anonymous) questions!

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Data Processing

Any computer program processes data.

Usually, this data represents "things" in the "real world".

So, a programmer's job consists of:

- ➢ Devising a way to represent real world things in a program.
- ➢ Writing code to manipulate this representation.
- ➢ Storing and/or displaying the results.

Representation

Some things are easy to represent with what we know so far:

- The number of eggs in a box is an integer.
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- A message is a string.

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Some more complex things are harder to represent:

- A person.
- A group of people (maybe a football team).
- A set of weather readings taken together at the same time.

Variables

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- `temperature = 16.5`

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In addition we noted that a variable has a *type*.

- `eggs` is an integer.
- `temperature` is a floating-point number.

Finally, we saw that every data type has a set of operations that manipulate its values.

Objects and Classes

Keen-eyed viewers will have noticed that when Python is asked what type a value is, it used the word "class":

```
>>> type (1)
<class 'int'>
```

In Python, everything (i.e. every variable) is an *Object*.

Objects of the same type are grouped into *Classes*.

A class can represent a simple number, or something more complex, like a person.

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This terminology will return when we move to Java.

In Python it's a bit more "behind the scenes".

Identifiers

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A good identifier includes information about the purpose of the object.

For example:

- ```
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  ```
  ```

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Identifier names follow conventions:

- ➢ Start with a lowercase letter.
- ➢ Are written in a consistent form:
  - ➢ `thisIsCamelCase`
  - ➢ `this_is_snake_case`

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Camel Case is usual in Java.

Snake Case is usual in Python.

Identifier Rules

Every language defines rules that determine what is valid as an identifier.

In Python, an identifier:

- ➢ Must start with a letter (or an underscore, but that has a special meaning).
- ➢ Can include letters, numbers, or underscores.
- ➢ Is case-sensitive.
- ➢ Can be any length.

In addition, every language has "reserved words" that have a special meaning, and cannot therefore be used as identifiers.

Naming Conventions

In addition, by *convention*, certain things in programs are named in particular ways.

This improves readability, and helps other programmers understand code.

Failing to follow conventions will confuse others.

By convention:

- `knights` is a variable.
- `Knights` is a class.
- `number_of_knights` is a variable, but `NUMBER_OF_KNIGHTS` is a constant.

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- `Knights` is a class.
- `number_of_knights` is a variable, l
  constant.

Python conventions for this (and much else) are in PEP 8.

https://www.python.org/dev/peps/pep-0008/

Reserved Words

A common "gotcha" (mistake for newcomers to a language) is to use a reserved word for an identifier.

Ways to avoid this are:

- Get a list of such words.
- Use an IDE with syntax highlighting.

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What happens if an error is made can depend on language, and precisely what sort of reserved word is used.

```
>>> for = 3
  File "<stdin>", line 1
    for = 3
        ^
SyntaxError: invalid syntax

>>> print = 3
>>> print
3
>>> print ('Hello')
Traceback (most recent call last):
  File "<stdin>", line 1, in
<module>
TypeError: 'int' object is not
callable
```

Reserved Words

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Ways to avoid this are:

If you get an odd error like these, a good thing to check first is whether the identifier is a reserved word.

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SyntaxError: invalid syntax

>>> print = 3
>>> print
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>>> print ('Hello')
Traceback (most recent call last):
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TypeError: 'int' object is not
callable
```

Other Types

There are other types available in Python.

```
>>> readings = [18, 12, 27, 8]
```

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What's going on here?

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>>> readings.sort ()
>>> readings
[8, 12, 18, 27]
```

Other Types

What's going on here?

```
>>> readings = [18, 12, 27, 8]

>>> max (readings)
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>>> readings.sort ()
>>> readings
[8, 12, 18, 27]

>>> sum (readings) / len (readings)
16.25
```

Other Types

The variable with identifier `readings` is a *list*.

A list contains a collection of values (objects), usually of the same type.

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>>> readings = [18, 12, 27, 8]

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Other Types

The variable with identifier `readings` is a *list*.

A list contains a collection of values (objects), usually of the same type.

So `readings` is a list of integers.

Which means there is a set of operations that will do various useful things with the list.

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(Technically, `readings` is a *composite* or *compound* data type.)

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Primitive Types

Most languages define a collection of basic types, usually called *primitive* types.

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(And one more, to represent not having a value.)

Primitive Types: Integers ('int')

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- ➢ **Integers.**
- ➢ Floating-point numbers.
- ➢ Booleans.
- ➢ Strings.

(And one more, to represent not having a value.)

An Integer is a whole number.

Operations include addition, division, modulus, etc.

Integers can be negative.

Usage:

```
>>> knights = 6
>>> brave_knights = knights - 1

>>> knights += 1
>>> knights -= 1
```

Primitive Types: Floating-Point ('float')

Most languages define a collection of basic types, usually called *primitive* types.

Python, as we have seen, defines four:

- ➢ Integers.
- ➢ **Floating-point numbers.**
- ➢ Booleans.
- ➢ Strings.

(And one more, to represent not having a value.)

A Floating-point number has a decimal part.

Operations include addition, division, etc.

Floating-point numbers can be negative.

Usage:

```
>>> swallow_speed = 12.2
```

```
>>> swallow_speed *= 0.5
>>> swallow_speed /= 2.0
```

Primitive Types: Booleans ('bool')

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- Floating-point numbers.
- **Booleans.**
- Strings.

(And one more, to represent not having a value.)

A Boolean value is either True, or False.

Operations include AND, OR, NOT.

Usage:

```
>>> brave_knight = False
>>> brave_knight = not True

>>> bold_knight = True
>>> brave_knight and bold_knight
False
```

Primitive Types: Strings ('str')

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- Integers.
- Floating-point numbers.
- Booleans.
- **Strings.**

(And one more, to represent not having a value.)

A string is any sequence of characters.

Operations include addition, multiplication.

Plus many string-specific operations.

Usage:

```
>>> name = "Sir Robin"
>>> full_name = "Brave " + name

>>> name.find ('r')
2
```

Primitive Types: None ('NoneType')

Most languages define a collection of basic types, usually called *primitive* types.

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- ➢ Integers.
- ➢ Floating-point numbers.
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- ➢ Strings.

(And one more, to represent not having a value.)

This is the case where a variable has no value.

The variable does *exist* but it contains no value.

The value it does contain is None.

Usage:

```
>>> nothing = None

>>> type (nothing)
<class 'NoneType'>
>>> not nothing
True
```

Complete Programs

We now have almost enough to write a complete program.

We can:

- ➢ Store values in appropriate variables.
- ➢ Manipulate the values.
- ➢ Display the results.
  - ➢ (The `print` statement.)

One thing remains: how to get some input from our user?

Complete Programs

We now have almost enough to write a complete program.

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One thing remains: how to get some input from

A program is a collection of *statements*.
We have statements to manipulate values, and to display results.
We need one more …

Need Input

The `input` statement takes a value from the keyboard, and assigns it to a variable.

Optionally, it also displays a message to the user:

- ➢ `name = input ('Good Morning. What is your name? ')`
- ➢ `eggs = input ('How many eggs have you got? ')`

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➢ name = input ('Good Morning. What is your name? ')
➢ eggs = input ('How many eggs have you got? ')
```

The value is *always* read as a string, so if a number is needed it must be converted:

```
➢ eggs = int (input ('How many eggs have you got? '))
```

Take a close look at the brackets!

Need Input

The `input` statement takes a value from the key

Note that if the user enters something that is not an integer, a *run-time error* will happen.

We'll see how to handle those later.

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Take a close look at the brackets!

A Complete Program

"Our students take five exams.

The results are all whole numbers, between 0 and 100.

The final mark they get is the average of the five results.

We need a program to read the student's name, and their five results, then calculate the average, and finally display the final mark."

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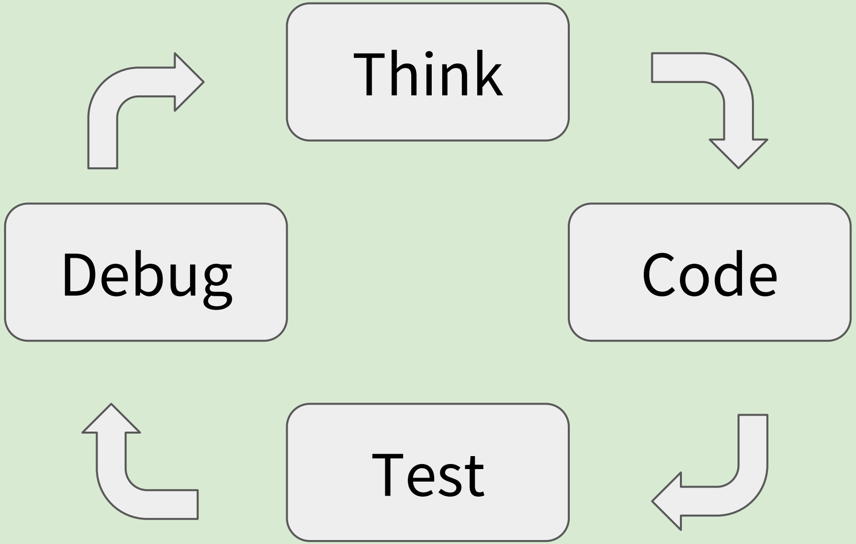

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We can break the problem down to something like:

1. Read the student's name.
2. Read the five results, one at a time.
3. Find the total of the results, and divide by five to get the average.
4. Display the student's name along with their average.

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Important

We are writing this program with the Python we have met so far. So the result is really not the best way to do it!

```
name = input ('Enter the student\'s name: ')

mark_1 = int (input ('Enter first result:  '))
mark_2 = int (input ('Enter second result: '))
mark_3 = int (input ('Enter third result:  '))
mark_4 = int (input ('Enter fourth result: '))
mark_5 = int (input ('Enter fifth result:  '))

total_marks = mark_1 + mark_2 + mark_3 + mark_4 + mark_5

average_mark = total_marks / 5

print ()
print ('Final Mark for ' + name + ' is ' + str (average_mark))
```

PyCharm Demo and Question Time

Jobs

From now on, the pace is going to quicken!

Before next week:

- Read Units 0, 1 and 2 from the book.
  - (We are currently somewhere in Unit 2.)
- Implement the "Capstone Project" from the end of Unit 1.
- Practice, practice, practice!