

Intro to programming 10

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- Object-Oriented Programming in Python:
 - Classes
 - Objects
 - Methods
 - Constructors
- Clean Code

Object-Oriented Programming (OOP)

- Programming paradigm based of the concept of “objects”

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- Python has been developed with an “oriented-object” approach

Object-Oriented Programming (OOP)

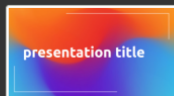
- Programming paradigm based of the concept of “objects”
- Python has been developed with an “oriented-object” approach
- It's not a Python thing. Other object-oriented languages includes: Java, C++, C#, R, PHP
...

Object-Oriented Programming (OOP)

- Programming paradigm based of the concept of “objects”
- Python has been developed with an “oriented-object” approach
- It's not a Python thing. Other object-oriented languages includes: Java, C++, C#, R, PHP ...
- OOP is defined around two key concepts that are **classes** and **objects**

Classes 1/3

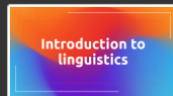
- Classes are templates for objects
- Example: You have a power point templates for all your presentations of articles with
 - a graphic chart
 - your font
 - your background image
 - all your slides with generic titles (Introduction, study 1, results study 1...)
- That templates in python is a class. A kind of general recipe that define a skeleton for every object (in our case a power point presentation for a class)



1 template.pptx



Presentation for
introduction to cognitive
psychology.pptx



Presentation for
introduction to linguistics.
pptx

- A class contains state and behavior
- State: is referring to data or variables. For example: your power point for your class of “introduction to Cognitive psychology” has:
 - a specific name
 - specific graphs
 - a number of pages
- Behavior: is a set of thing the class can do. For example: your power point can have
 - animations,
 - play sounds or videos.
 - This behavior is define in a method which is like a function but specific to classes.

- The creation of an object is called an **instantiation**. From your template of power point you'll create a new power point for presenting an article in your class of "introduction to evolutionary anthropology"
- That instantiation will have:
 - specific attributes (a name, a number of slides ...)
 - common methods (animations, videos, sounds ...) like the other objects

- Objects are instances of classes
- Objects can be stored in variable and its type is the class
- In our metaphor, one object is one specific power-point. For example the power point of your class of “introduction to Cognitive psychology”
- That power-point has the same structure and the same features and characteristics as the power point of your class of “introduction to Linguistics” yet the content differs.
- You can instantiate multiple objects from the same class.
- Those objects are independent

- As said before a method is part of the behavior of a class
- A method is very similar to a function but is part of a class when a function is independent
- It can:
 - modify an object's internal state of an object
 - call others methods or functions
 - return values
 - etc ...
- The only difference between function and method is that method belong to a class/object.

Create your class 1/2

```
class Rectangle:
    width = 3
    length = 2
    color = 'red'
    def calculate_area(self):
        return self.width * self.length
```

```
type(Rectangle)
```

```
## <class 'type'>
```

```
rect=Rectangle
```

```
print(rect.width)
```

```
## 3
```

```
print(Rectangle.calculate_area(rect))
```

```
## 6
```

- We can see the state:
 - width and height
- And the behavior, in this case the method `calculate_area`.

Create your class 2/2

```
class Rectangle:
    width = 3
    length = 2
    color = 'red'
    def calculate_area(self):
        return self.width * self.length

rect=Rectangle

print(rect.width)
```

```
## 3
```

```
print(Rectangle.calculate_area(rect))
```

```
## 6
```

- We can note the **self** that refers to its own class and its own variables
- **self** is always the first parameter in order to access all the object's attributes

Constructors

- Constructors are special methods. Every class has one and it's used to create an object
- We need to use **init**

```
class Rectangle:
    def __init__(self, width, length, color):
        self.width = width
        self.length = length
        self.color = color
    def calculate_area(self):
        return self.width * self.length
```

```
rect = Rectangle(3,2, "blue")
print(rect.width)
```

```
## 3
```

```
print(rect.calculate_area())
```

```
## 6
```

Instantiate an object 1/2

- You can use the constructor to instantiate an object

```
class Rectangle:
    def __init__(self, width, length, color):
        self.width = width
        self.length = length
        self.color = color
    def calculate_area(self):
        return self.width * self.length
rect = Rectangle(5,3,'red')

print(rect.width)
```

5

Instantiate an object 2/2

- You can select default variables
- Then you don't have specify the default variable

```
class Rectangle:
    def __init__(self, width, length, color='red'):
        self.width = width
        self.length = length
        self.color = color
    def calculate_area(self):
        return self.width * self.length
rect = Rectangle(5,3)

print(rect.width)
```

```
## 5
```


Modify an object

```
class Rectangle:
    def __init__(self, width, length, color='red'):
        self.width = width
        self.length = length
        self.color = color
    def calculate_area(self):
        return self.width * self.length
```

```
rect = Rectangle(5,3)
```

```
print(rect.color)
```

```
## red
```

```
rect.color = "purple"
print(rect.color)
```

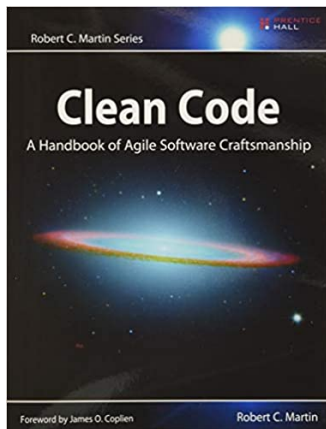
```
## purple
```

And beyond ... but not for now

- A class can have a parent class or superclass.
- The class with a parent is known as a subclass or child.
- That class inherits attributes from its parent.
- The child class can implement extra attributes on top of that which it inherits.

Clean code: Overview 1/4

The goal of clean code is to make your code **easy to understand** and **easy to change** !



Clean code: Overview 2/4

- Example with a former exercise with two taxi companies

```
def costs(d):  
    a = 4.8 + 1.15 * d  
    b = 3.2 + 1.20 * d  
    return (a, b)  
  
def cheap(d):  
    a, b = costs(d)  
    if a < b:  
        return 'A'  
    else:  
        return 'B'  
  
for d in range(30, 40):  
    print(cheap(d))
```

```
## B  
## B  
## A  
## A  
## A  
## A  
## A  
## A  
## A  
## A  
## A
```

Clean code: Overview 3/4

```
def costs(distance):  
    # Calculate the price with the fixed charge plus the charge for every km  
    initial_feeA = 4.8  
    initial_feeB = 3.2  
    fixed_fee_kmA = 1.15  
    fixed_fee_kmB = 1.2  
  
    price_A = initial_feeA + fixed_fee_kmA * distance  
    price_B = initial_feeB + fixed_fee_kmB * distance  
  
    return (price_A, price_B)  
  
def cheapest_company(distance):  
    # calculate the cost for every company with a certain distance  
    price_comp_a, price_comp_b = costs(distance)  
    if price_comp_a < price_comp_b:  
        return 'Company A'  
    else:  
        return 'Company B'  
  
    # print the distance from 30km to 50km  
    for d in range(30, 40):  
        print(f"{d} km -> " + cheapest_company(d))
```

Even bad code can function. But if code isn't clean, it can bring a development organization to its knees. Every year, countless hours and significant resources are lost because of poorly written code. But it doesn't have to be that way.

(<https://www.oreilly.com/library/view/clean-code-a/9780136083238/>)

- We will cover a set of rules or advises to write cleaner code that can be read and edited by other developers
- Clean code is unfortunately never a priority but is a healthy practice
- The clean code principle goes way beyond the scope of this course so bear in mind that we'll see only a small subset of the clean code principle.

Clean code: CC1. Use meaningful names 1/2

- Example:

```
w = x2 - x1
```

Clean code: CC1. Use meaningful names 1/2

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- What are *w*, *x1* and *x2*?

Clean code: CC1. Use meaningful names 1/2

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- What do they represent?

Clean code: CC1. Use meaningful names 1/2

- Example:

```
w = x2 - x1
```

- What are w , $x1$ and $x2$?
- What do they represent?
- What are they used for?

Clean code: CC1. Use meaningful names 1/2

- Example:

```
w = x2 - x1
```

- What are w , $x1$ and $x2$?
- What do they represent?
- What are they used for?
- Does “ w ” stand for “weight”, “window”, “word”, or is it just a symbol for a generic computation?

Clean code: CC1. Use meaningful names 2/2

- Instead one can write

```
width = x_right - x_left
```

- **Use meaningful names**

Clean code: CC1. Replace magic numbers 1/2

- Other example

```
width = x_right - x_left + 10
```

Clean code: CC1. Replace magic numbers 1/2

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width = x_right - x_left + 10
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- Where does '10' come from?

Clean code: CC1. Replace magic numbers 1/2

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width = x_right - x_left + 10
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- Where does '10' come from?
- What does it represent?

Clean code: CC1. Replace magic numbers 1/2

- Other example

```
width = x_right - x_left + 10
```

- Where does '10' come from?
- What does it represent?
- Can I change it? Is it a constant, a variable.

Clean code: CC1. Replace magic numbers 2/2

- Instead one can write

```
horizontal_margin = 10  
  
width = x_right - x_left + horizontal_margin
```

- **Replace magic numbers** with named parameters whatever the type of that parameters

Clean code: CC1. Function names should say what they do 1/2

- Example

```
def check_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

Clean code: CC1. Function names should say what they do 1/2

- Example

```
def check_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

- *A more accurate name would be*

```
def print_if_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

Clean code: CC1. Function names should say what they do 1/2

- Example

```
def check_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

- Misleading name: I don't expect “something to be checked” but something to be printed or not

- A more accurate name would be

```
def print_if_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

Clean code: CC1. Fear the ambiguous name 1/2

- Example

```
remove(l, n)
```

Clean code: CC1. Fear the ambiguous name 1/2

- Example

```
remove(l, n)
```

- What do you think this does? Ambiguous name:

Clean code: CC1. Fear the ambiguous name 1/2

- Example

```
remove(l, n)
```

- What do you think this does? Ambiguous name:
- Does it remove the element in *l* whose value is equal to *n*?

Clean code: CC1. Fear the ambiguous name 1/2

- Example

```
remove(l, n)
```

- What do you think this does? Ambiguous name:
- Does it remove the element in *l* whose value is equal to *n*?
- Or does it remove the element in *l* at index *n*?

Clean code: CC1. Fear the ambiguous name 2/2

- Example

```
remove_list_element_at_index(l, i)
```

Clean code: CC1. Fear the ambiguous name 2/2

- Example

```
remove_list_element_at_index(l, i)
```

- [CC1] Choose unambiguous names

Clean code: CC1. Fear the ambiguous name 2/2

- Example

```
remove_list_element_at_index(l, i)
```

- [CC1] Choose unambiguous names
- Clarity at the point of use is more important than brevity

Clean code: CC1. Fear the ambiguous name 2/2

- Example

```
remove_list_element_at_index(l, i)
```

- [CC1] Choose unambiguous names
- Clarity at the point of use is more important than brevity
- Include all the words needed to avoid ambiguity from the perspective of someone calling the function

Clean code: CC1. Fear the ambiguous name 2/2

- Example

```
remove_list_element_at_index(l, i)
```

- [CC1] Choose unambiguous names
- Clarity at the point of use is more important than brevity
- Include all the words needed to avoid ambiguity from the perspective of someone calling the function
- A general naming template: **verb_keywords** (the verb indicates what the function does, the keywords what parameters are expected)

Clean code: CC1. Use different words for different concepts 1/3

- Example: two function calls:

```
add_number(a , b)  
add_list(c, d)
```

- What do you expect from these function ?

Clean code: CC1. Use different words for different concepts 2/3

- The implementation of the functions:

```
def add_number(a , b):  
    return a + b
```

```
def add_list(l, e):  
    l.append(e)
```

-Confusing to use the same word “add” for the two functions: + in the first case, add calculates the addition + in the second case, add inserts an element + in the first case, add has no side effects, in the second, it does!

Clean code: CC1. Use different words for different concepts 3/3

- One way to remove the confusion:

```
def add_numbers(a , b):  
    return a + b  
  
def append_element_to_list(e, l):  
    l.append(e)
```

- Use different words for different concepts

Clean code: CC2. Functions should do one thing 1/3

- Let's revisit an earlier example:

```
def print_if_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

Clean code: CC2. Functions should do one thing 1/3

- Let's revisit an earlier example:

```
def print_if_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

- This function does two things:

Clean code: CC2. Functions should do one thing 1/3

- Let's revisit an earlier example:

```
def print_if_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

- This function does two things:
 - Calculating whether an integer is divisible by another

Clean code: CC2. Functions should do one thing 1/3

- Let's revisit an earlier example:

```
def print_if_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

- This function does two things:
 - Calculating whether an integer is divisible by another
 - Printing conditionally on the result

Clean code: CC2. Functions should do one thing 1/3

- Let's revisit an earlier example:

```
def print_if_divisible(n, divisor):  
    if (n % divisor == 0):  
        print(n, ' is divisible by ', divisor)
```

- This function does two things:
 - Calculating whether an integer is divisible by another
 - Printing conditionally on the result
- These are two conceptually distinct operations. There is no good reason for them to be done in the same function.

Clean code: CC2. Functions should do one thing 2/3

A solution:

```
def is_divisible(n, divisor):  
    return (n % divisor == 0)
```

- [CC2] Functions should do one thing

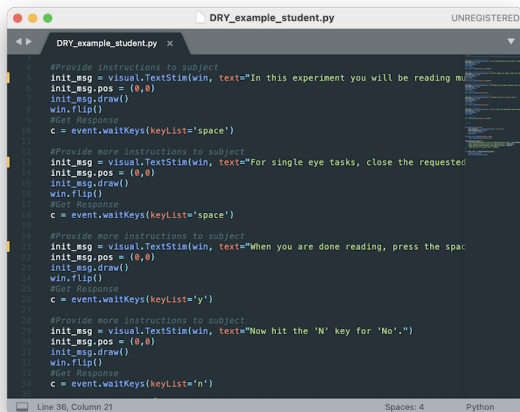
This solution has the added benefit to remove side-effects from the function.

Clean code: CC2. Functions should do one thing 3/3

- CC2. Create functions that do one thing
 - A lot of programming is about chunking
 - Chunking means grouping elements together in a meaningful named chunk (e.g. with a function) that you can manipulate as one conceptual unit
 - These chunks help you reason about your program and control its intellectual complexity

Clean code: CC3. DRY: Don't Repeat Yourself 1/3

- Example

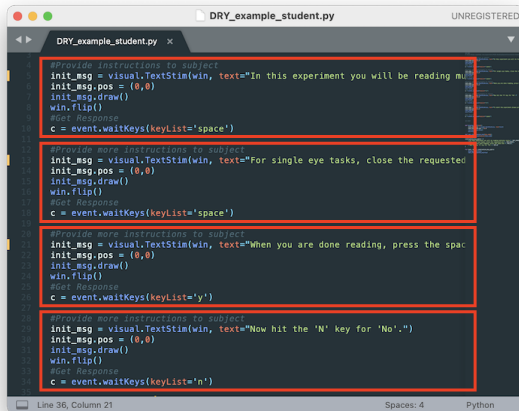


The screenshot shows a code editor window titled 'DRY_example_student.py' with a status bar indicating 'UNREGISTERED'. The code is a Python script for a simple experiment, but it contains significant repetition. It consists of four identical blocks of code, each separated by a comment: '#Provide instructions to subject'. Each block includes the following lines: `init_msg = visual.TextStim(win, text="In this experiment you will be reading mu`, `init_msg.pos = (0,0)`, `init_msg.draw()`, `win.flip()`, `#Get Response`, and `c = event.waitKeys(keyList='space')`. The repetition of these blocks is a clear violation of the DRY principle. The editor shows line numbers from 1 to 35, and the status bar at the bottom indicates 'Line 36, Column 21', 'Spaces: 4', and 'Python'.

```
1  # Provide instructions to subject
2  init_msg = visual.TextStim(win, text="In this experiment you will be reading mu
3  init_msg.pos = (0,0)
4  init_msg.draw()
5  win.flip()
6  #Get Response
7  c = event.waitKeys(keyList='space')
8
9  #Provide more instructions to subject
10 init_msg = visual.TextStim(win, text="For single eye tasks, close the requested
11 init_msg.pos = (0,0)
12 init_msg.draw()
13 win.flip()
14 #Get Response
15 c = event.waitKeys(keyList='space')
16
17 #Provide more instructions to subject
18 init_msg = visual.TextStim(win, text="When you are done reading, press the spac
19 init_msg.pos = (0,0)
20 init_msg.draw()
21 win.flip()
22 #Get Response
23 c = event.waitKeys(keyList='y')
24
25 #Provide more instructions to subject
26 init_msg = visual.TextStim(win, text="Now hit the 'N' key for 'No'.")
27 init_msg.pos = (0,0)
28 init_msg.draw()
29 win.flip()
30 #Get Response
31 c = event.waitKeys(keyList='n')
32
33
34
35
```

- What's wrong?

Clean code: CC3. DRY: Don't Repeat Yourself 2/3

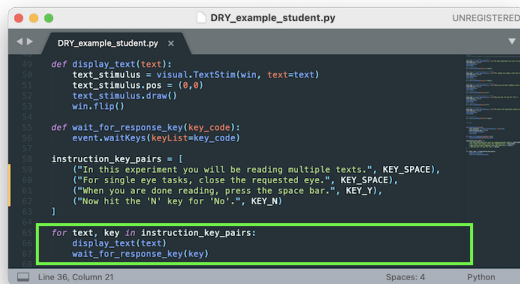


```
DRY_example_student.py x UNREGISTERED
DRY_example_student.py x
4 #Provide instructions to subject
5 init_msg = visual.TextStim(win, text="In this experiment you will be reading mu
6 init_msg.pos = (0,0)
7 init_msg.draw()
8 win.flip()
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11
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30 init_msg.pos = (0,0)
31 init_msg.draw()
32 win.flip()
33 #Get Response
34 c = event.waitKeys(keyList='n')
```

- What's wrong? Code duplication.
- Why is it wrong?

Clean code: CC3. DRY: Don't Repeat Yourself 3/3

- It makes code hard to change.
- One solution



```
DRY_example_student.py x UNREGISTERED
DRY_example_student.py x
49 def display_text(text):
50     text_stimulus = visual.TextStim(win, text=text)
51     text_stimulus.pos = (0,0)
52     text_stimulus.draw()
53     win.flip()
54
55 def wait_for_response_key(key_code):
56     event.waitKeys(keyList=key_code)
57
58 instruction_key_pairs = [
59     ("In this experiment you will be reading multiple texts.", KEY_SPACE),
60     ("For single eye tasks, close the requested eye.", KEY_SPACE),
61     ("When you are done reading, press the space bar.", KEY_Y),
62     ("Now hit the 'N' key for 'No'.", KEY_N)
63 ]
64
65 for text, key in instruction_key_pairs:
66     display_text(text)
67     wait_for_response_key(key)
68
```

Line 36, Column 21 Spaces: 4 Python

Clean code: CC4. Explain yourself in code, not comments 1/4

- Example

```
def distance_points(couple1,couple2):  
    """Function controlling the distance between points  
    for our collection of random points"""  
    return math.sqrt((couple1[0]-couple2[0])**2+(couple1[1]-couple2[1])**2)
```

Clean code: CC4. Explain yourself in code, not comments 2/4

- Misleading comment. It does not accurately describe what the function does.

```
def distance_points(couple1,couple2):  
    """Function controlling the distance between points  
    for our collection of random points"""  
    return math.sqrt((couple1[0]-couple2[0])**2+(couple1[1]-couple2[1])**2)
```

- An alternative:

```
def distance_between_points(point_1, point_2):  
    return math.sqrt((couple1[0]-couple2[0])**2+(couple1[1]-couple2[1])**2)
```

- Does this need any comments?

Clean code: CC4. Comments do not make up for bad code 1/3

- Example

```
if shuffledtarg_dist[i][1] == 1: ### IF TARGET ###  
    # [some code ...]  
elif shuffledtarg_dist[i][1] == 0: ### IF DISTRACTOR ###  
    # [some other code ...]
```

- Why do we need such comments next to if and elif?

Clean code: CC4. Explain yourself in code, not comments 2/3

- Good intentions, but bad approach

```
if shuffledtarg_dist[i][1] == 1: ### IF TARGET ###  
    # [some code ...]  
elif shuffledtarg_dist[i][1] == 0: ### IF DISTRACTOR ###  
    # [some other code ...]
```

- Comments do not make up for bad code

```
if stimulus_type == STIMULUS_TYPE_TARGET:  
    # [some code ...]  
elif stimulus_type == STIMULUS_TYPE_DISTRACTOR:  
    # [some other code ...]
```

- Clear and expressive code with few comments is superior to obscure code with lots of comments

Clean code: CC4. Explain yourself in code, not comments 3/3

```
if shuffledtarg_dist[i][1] == 1: ### IF TARGET ###  
    # [some code ...]  
elif shuffledtarg_dist[i][1] == 0: ### IF DISTRACTOR ###  
    # [some other code ...]
```

- An even better solution

```
if is_target(stimulus):  
    # [some code ...]  
elif is_distractor(stimulus):  
    # [some other code ...]
```

- [CC4] Clear and expressive code with few comments is superior to obscure code with lots of comments
- Does this need any comments?

Clean code: Summary

The goal is to make code easy to understand and easy to change.

- CC1 Use meaningful names:
 - Reveal purpose. Replace magic numbers. Say what functions do. Reveal/Avoid side-effects. Remove ambiguity. Use different words for different concepts. Use the appropriate level of description.
- CC2 Create functions that do one thing.
- CC3 DRY: Don't Repeat Yourself.
- CC4 Explain yourself in code, not comments.