Intro to programming 9

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Today

- 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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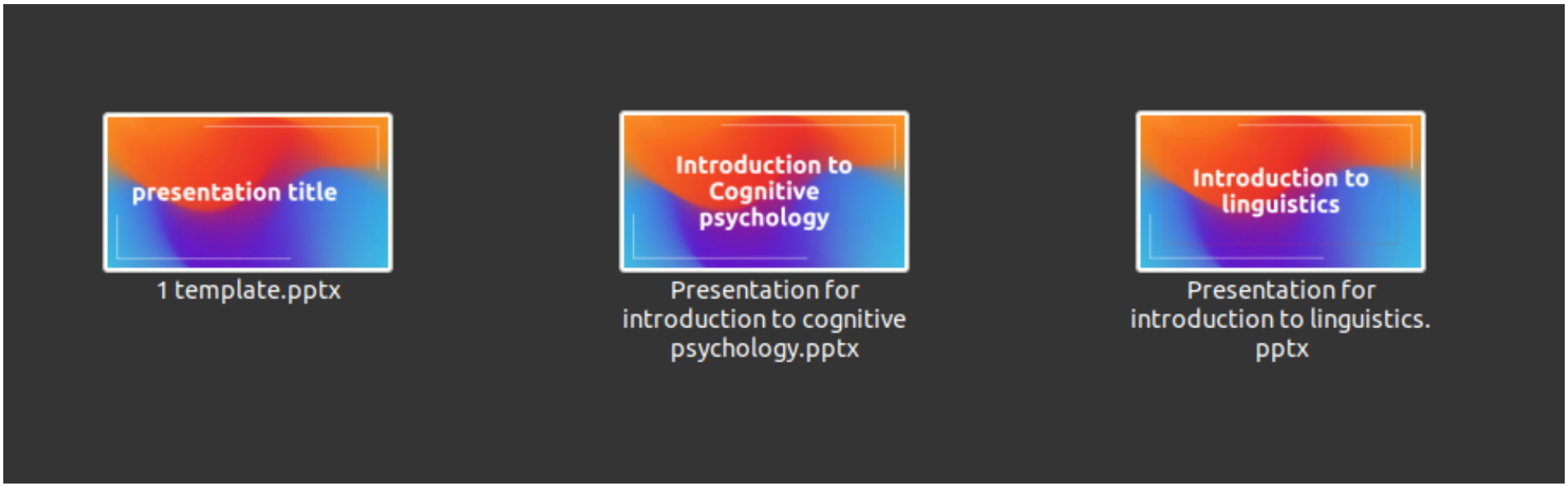
Object-Oriented Programming (OOP)

- 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)



Classes 2/3

- 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.

Classes 3/3

- 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

- 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

Method

- 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)
```

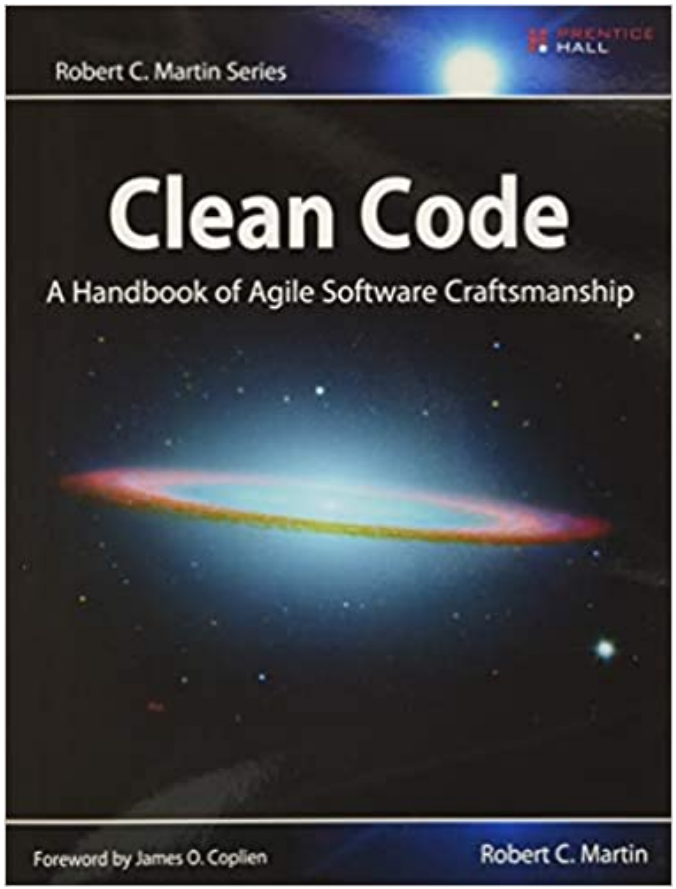
```
## purple
```

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
```

Clean code: Overview 3/4

```python
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))
```

Clean code: Overview 4/4

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

- Example

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- 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)
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- [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

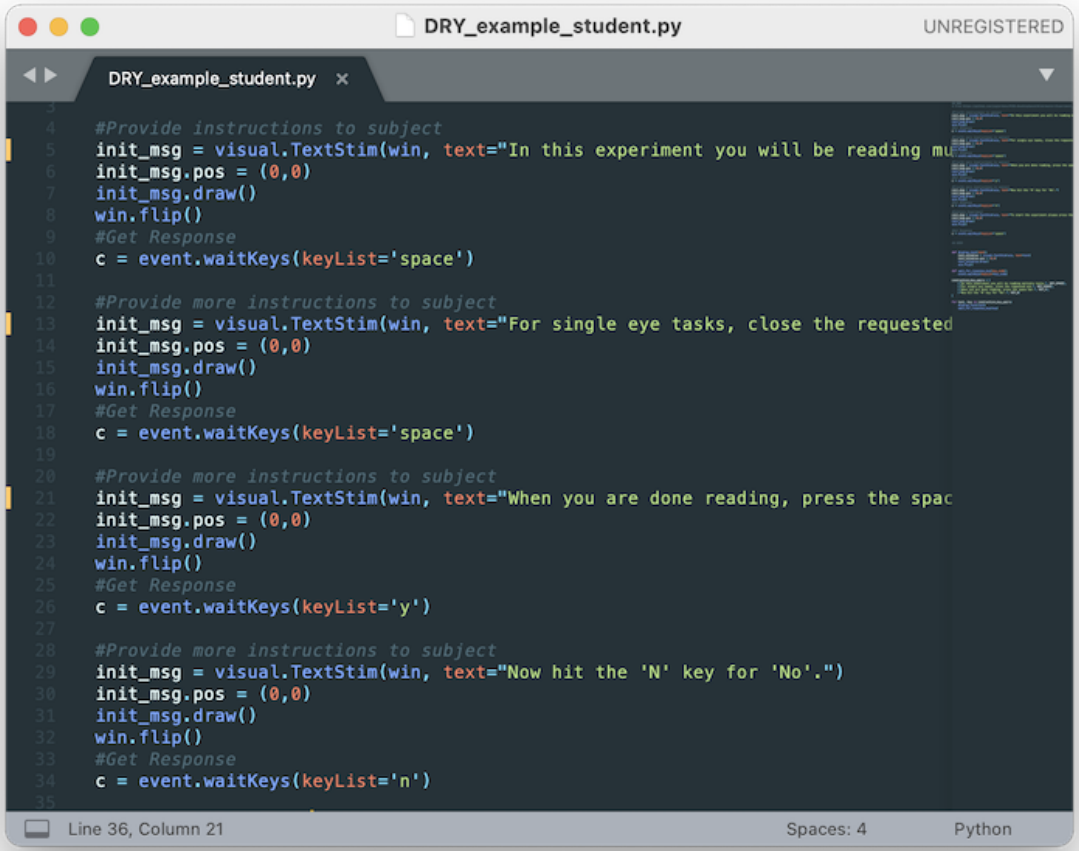
  This solution has the added benefit to remove side-effects from the function.

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

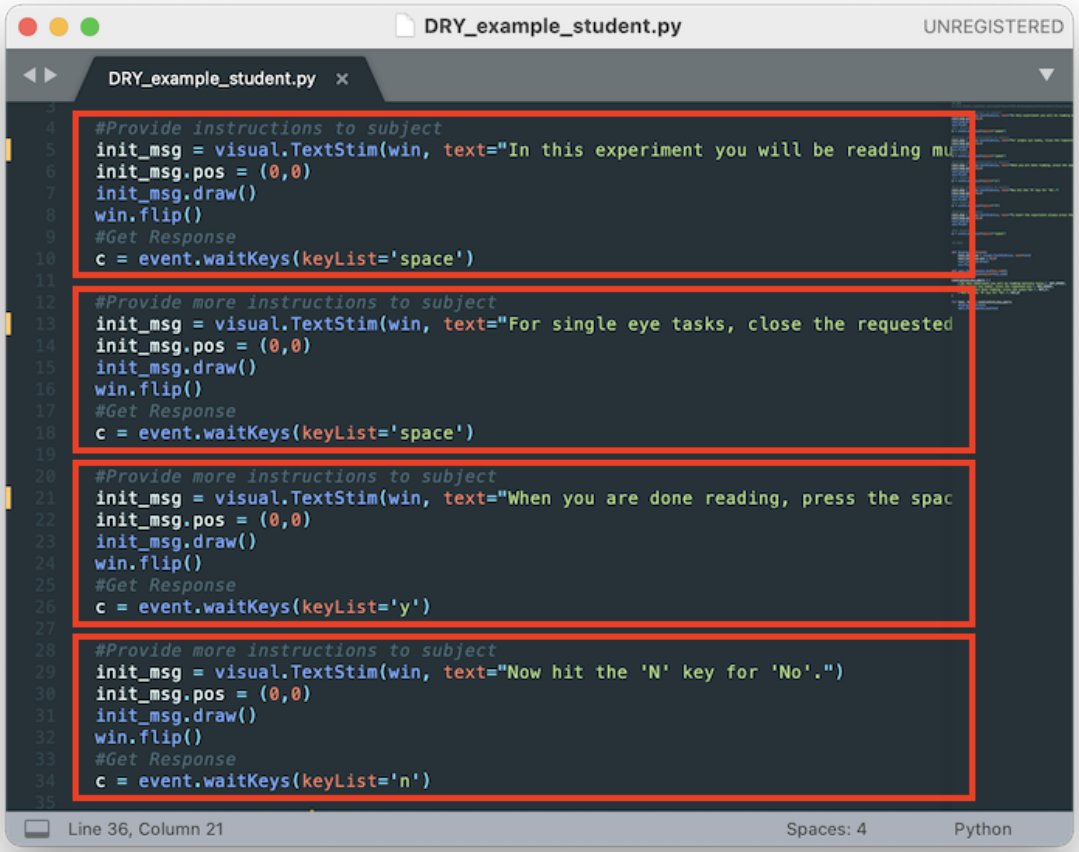
Clean code: CC3. DRY: Don't Repeat Yourself 1/3

- Example



- What's wrong?

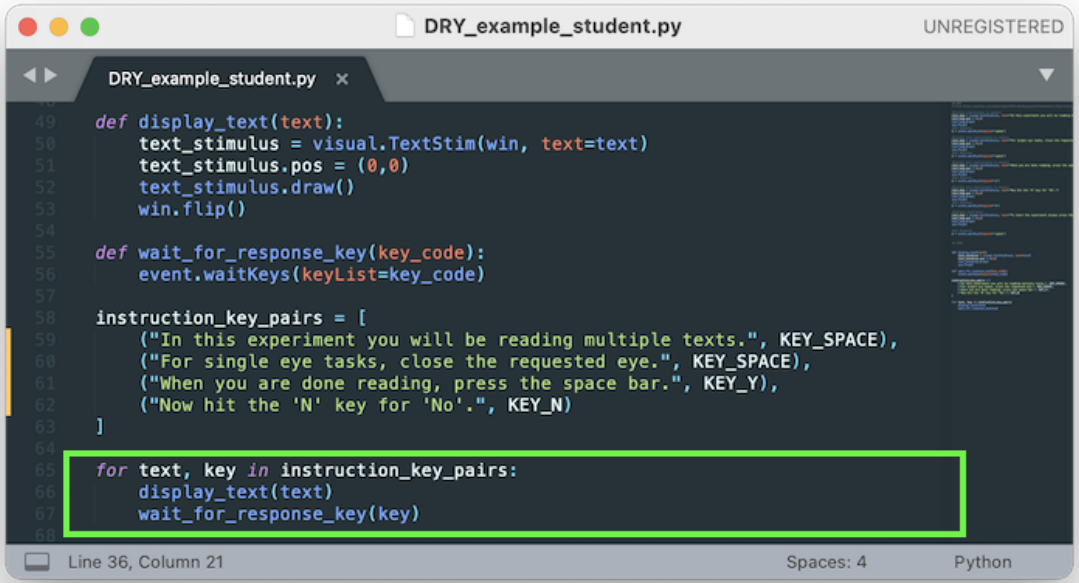
Clean code: CC3. DRY: Don't Repeat Yourself 2/3



- 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



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.