Functions

ENDG 233 – Programming with Data

Instructor: Dean Richert

Introduction to programming
Creating and running Python programs in JupyterLab
Programming style
Variables, operators, and basic data structures
Flow control (if, else, for, etc.)

Advanced data structures
Data manipulation
Data visualization
Algorithms

* I would like to acknowledge the recommendations provided by chatGPT in developing this lesson. The content and ideas have been validated by me.

Learning outcomes and outline

At the end of this lesson and accompanying active learning session you will be able to:

1. **Motivate** the use of functions in computer programming
2. **Define functions** in Python and the variants available
3. Call or **invoke functions** in Python
4. Understand some of the common **misconceptions** relative to Python functions, including the **distinction** between function definition and invocation
5. Apply your understanding of functions to decision-making using **machine learning**

Introduction

What is a function?

Ans: A chunk or block of code that **receives** information, **performs** tasks, and **reports** results back

Introduction

Why do we use function in programming?

1. Code reuse 2. Modularity 3. Readability

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2. **Modularity**
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1. Code reuse
2. Modularity
3. **Readability**

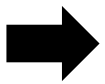
```
[1]: # Create a list of numbers
numbers = [5, 10, 15, 20, 25]

# Calculate the mean of the numbers
total = 0
for num in numbers:
    total += num
mean = total / len(numbers)

# Calculate the sum of the squared differences
sum_squared_diff = 0
for num in numbers:
    diff = num - mean
    squared_diff = diff ** 2
    sum_squared_diff += squared_diff

# Calculate the variance
variance = sum_squared_diff / (len(numbers) - 1)

# Calculate the standard deviation
std_deviation = variance ** 0.5
```



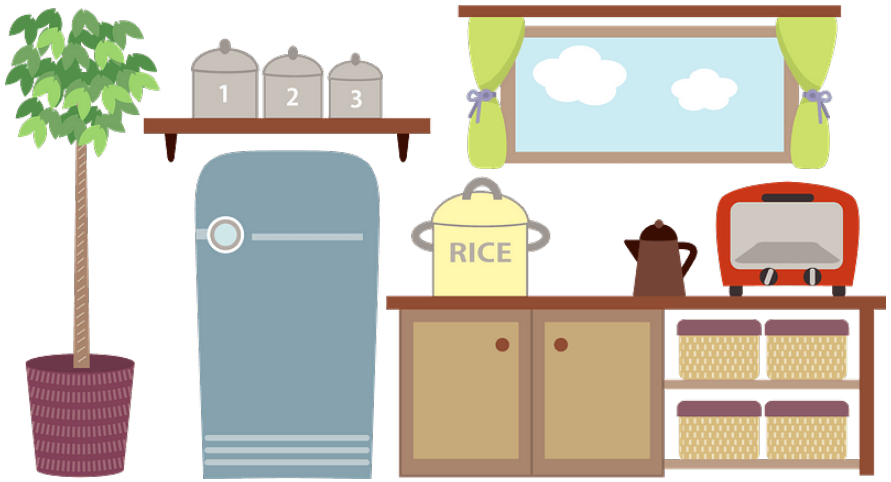
```
[4]: # Create a list of numbers
numbers = [5, 10, 15, 20, 25]

[5]: # Calculate the mean of the numbers
mean = calculate_mean(numbers)

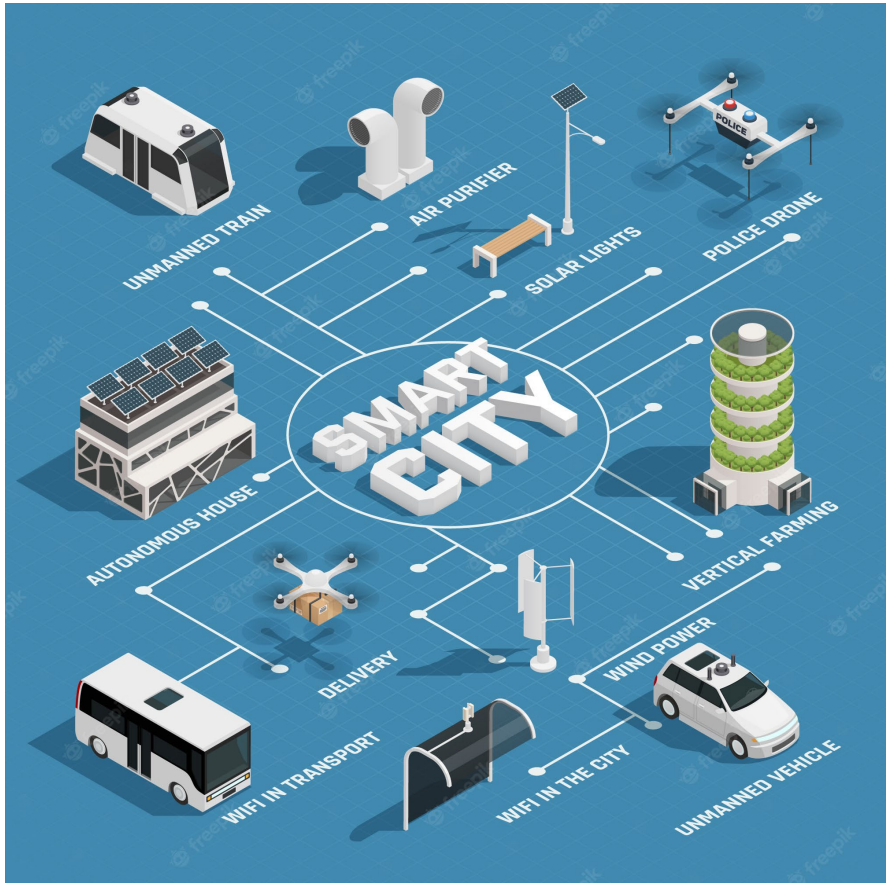
[6]: # Calculate the standard deviation
variance = calculate_variance(numbers)
```

Introduction

Analogy of a function:



Engineering example:



Function Definition

Functions must be defined **before** they can be used!

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Anatomy of a function definition:

```
[ ]: def function_name(<parameters>):
         # Perform tasks here
         return <data>
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Function names should be lower case, meaningful, and have underscores to separate words

Function Definition

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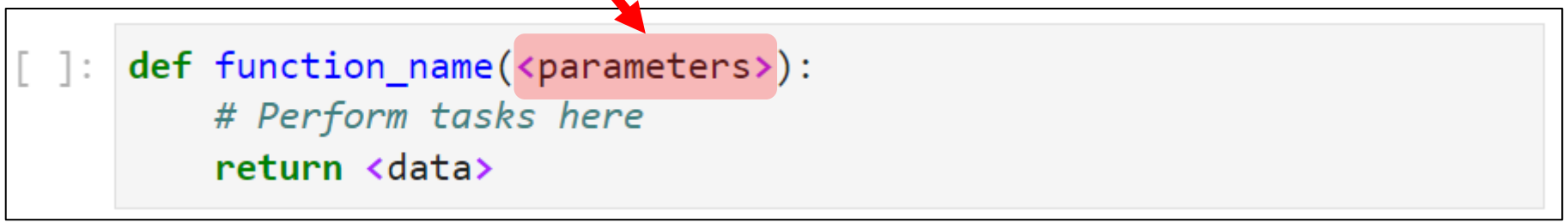
Anatomy of a function definition:

optional



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optional

Function Definition - Example

```
[1]: def is_even(number):
         print("determining if your number is even...")
         if number % 2 == 0:
             return True
         else:
             return False
```

Function Invocation

Functions must be called/invoked to execute its code!

[1]:
```
def add_numbers(a,b):
    sum = a + b
    return sum
```

[2]:
```
add_numbers(2,4)
```

[2]:
```
6
```

[3]:
```
num1 = 3
num2 = 5
result = add_numbers(num1,num2)
print(result + 7)
```

```
15
```

[4]:
```
char1 = 'a'
char2 = 'b'
add_numbers(char1,char2)
```

[4]:
```
'ab'
```

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    sum = a + b
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char1 = 'a'
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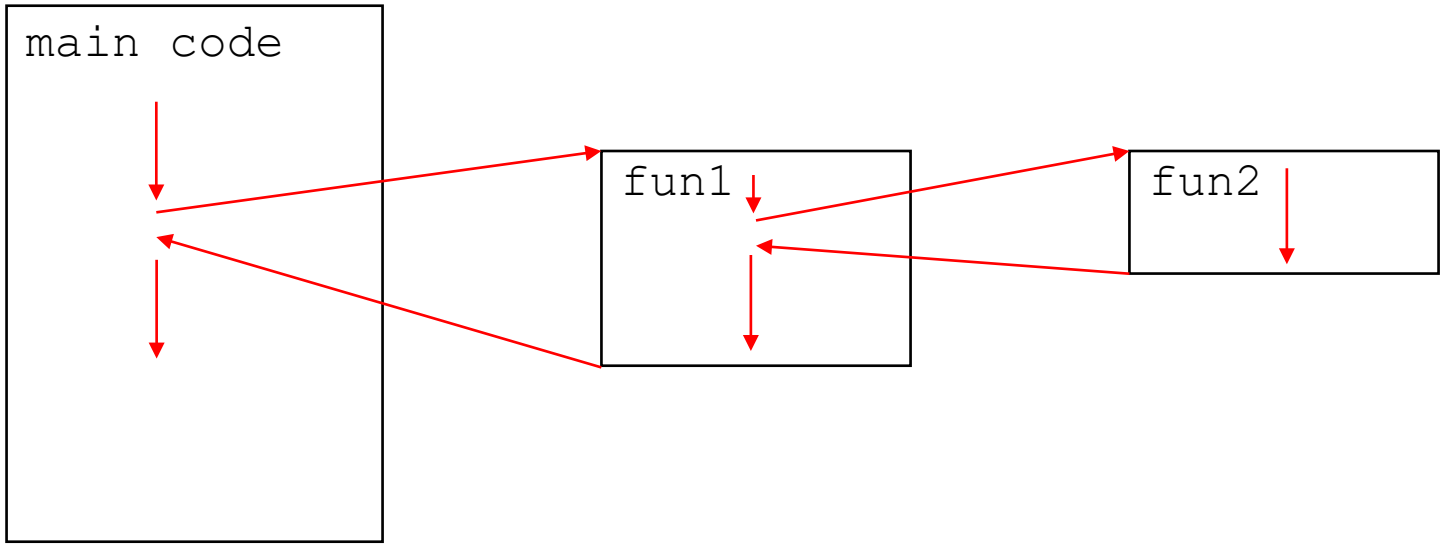
Function Invocation

Functions can call other functions (or even themselves)



Function Invocation

Functions can call other functions (or even themselves)

$$S^2 = \frac{\sum(x_i - \bar{x})^2}{n-1}$$

[1]:
```
def calculate_mean(numbers):
    # Calculate the mean of the numbers
    total = 0
    for num in numbers:
        total += num
    mean = total / len(numbers)
    return mean
```

[2]:
```
def calculate_variance(numbers):
    sum_squared_diff = 0
    for num in numbers:
        diff = num - calculate_mean(numbers)
        squared_diff = diff ** 2
        sum_squared_diff += squared_diff
    variance = sum_squared_diff / (len(numbers) - 1)
    return variance
```

[3]:
```
calculate_variance([5, 10, 15, 20, 25])
```

[3]:
```
62.5
```

Advanced topics

Multiple return values

[3]:
```
def get_statistics(data):
    mu = calculate_mean(data)
    var = calculate_variance(data)
    return mu, var
```

[4]:
```
mu, var = get_statistics([1,2,3,4,5])
```

[5]:
```
_, var = get_statistics([1,2,3,4,5])
```

Advanced topics

Multiple return values

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```
def get_statistics(data):
    mu = calculate_mean(data)
    var = calculate_variance(data)
    return mu, var
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mu, var = get_statistics([1,2,3,4,5])
```

[5]:
```
_, var = get_statistics([1,2,3,4,5])
```

Advanced topics

Keyword arguments allow parameters to be sent out of order

[1]:
```
def machine_status(pressure, temperature):
    if pressure > 65 or temperature > 220:
        print("warning")
    else:
        print("normal")
```

[2]:
```
machine_status(60,200)
```

```
normal
```

[3]:
```
machine_status(temperature = 200, pressure = 60)
```

```
normal
```

Advanced topics

Default argument values allow parameters to omitted

[1]:
```
def machine_info(serial_no, mfg = "Haas"):
    if serial_no[0] == '1':
        print("This is a " + mfg + " machine from before 2010")
    else:
        print("This is a " + mfg + " machine from 2010 or after")
```

[2]:
```
machine_info("123","Fanuc")
```

```
This is a Fanuc machine from before 2010
```

[3]:
```
machine_info("234")
```

```
This is a Haas machine from 2010 or after
```

Resources

- Programming with Mosh YouTube channel – Python Functions video
- W3Schools Python Functions page
  - For further study:
    - Arbitrary Arguments (`*args`)
    - Arbitrary Keyword Arguments (`**kwargs`)
    - `pass` statement
    - Recursion
- chatGPT to help with debugging or generating sample code

TA Training

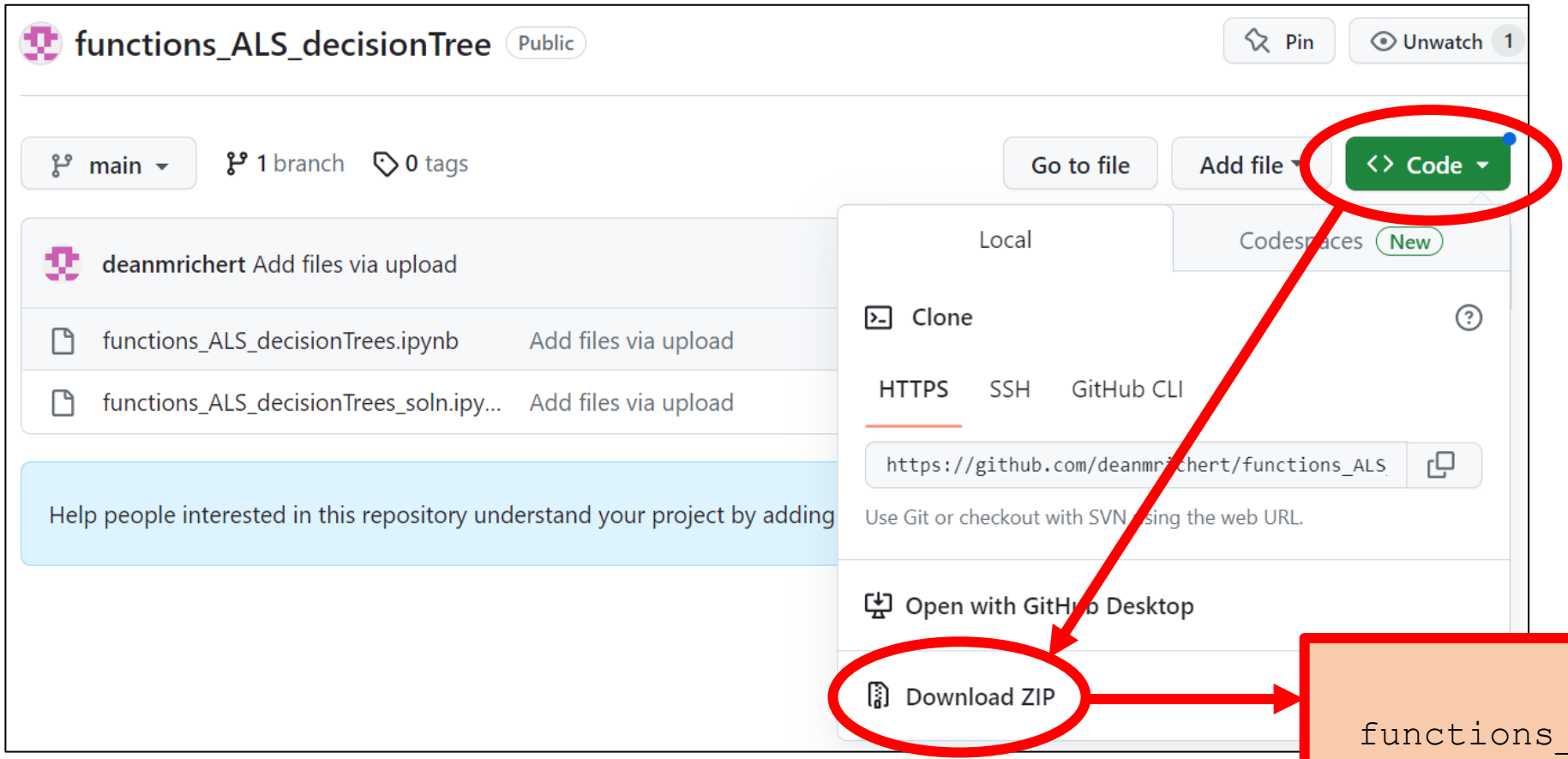
Expectations:

- Circulate among the groups to ensure that they are on the right track and answer any questions they may have.
    - Make sure you visit every group, but manage your time to keep all groups at the same pace.
- Engage the group in discussion, asking them comprehension checking questions.
- Students should not be using their phones or computers for unrelated activities. Let the instructor know if students are not engaging in the ALS.

Solutions: https://github.com/deanmrichert/functions_ALS_TAresources

Active Learning Session – Getting Started

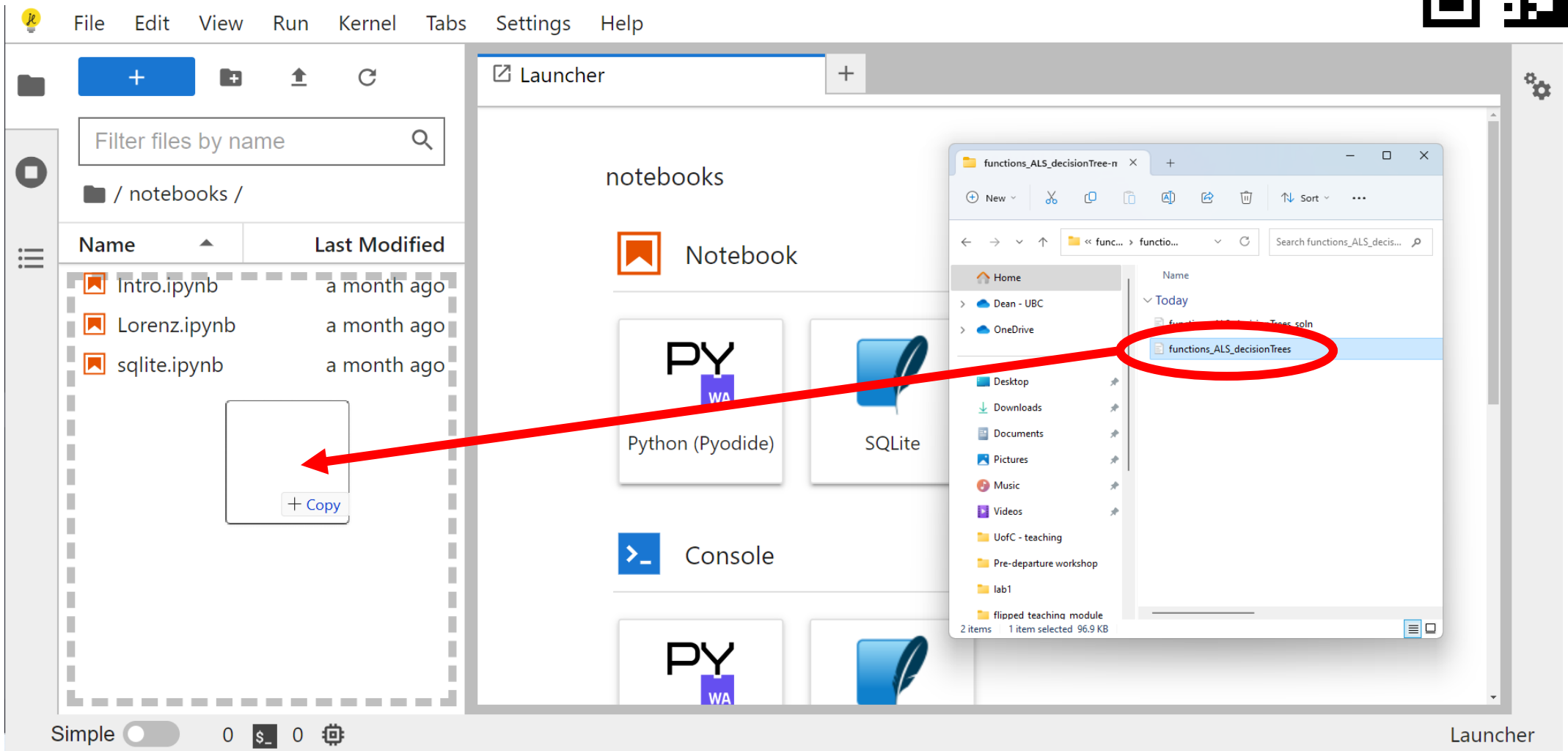
1. Download the JupyterLab Notebook from https://bit.ly/3K6MSGr



Extract `functions_ALS_decisionTrees.ipynb`

Active Learning Session – Getting Started

2. Open the web-based JupyterLab from https://bit.ly/3NYUtc9



Active Learning Session – Getting Started

3. Basic idea behind JupyterLab:

```
[3]: print("Hello World")

     Hello World

[2]: a = 1
     b = 2
     a + b

[2]: 3

[1]: print("Did this run first?")

     Did this run first?
```

- Code cells are standalone chunks of code
- Code cells can be executed in any order, not just the order they appear
- The order in which code cells are executed are shown in square brackets [*] to the left of code cells
- Outputs appear below code cells and can be cleared by right-clicking on a cell and selecting “Clear Outputs”

Active Learning Session – Getting Started

4. General instructions for using JupyterLab