Introduction to programming in Python

CSC 109 Lyon College @ Batesville High

August 19, 2023

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2 Entry survey

Welcome message:

> Welcome to CSC 109 Introduction to Programming in Python! We'll meet for our first session on Monday, August 21 at 11 AM. I don't know exactly where yet but I'll let you know before class.
>
> It would be great if you could fill in a short survey for me before class. It will help me prepare and it'll warm you up for the course. Here is the link: `https://forms.gle/vhEpfn4Nt4uNJxfH6Links` to an external site.. At the end of the survey is a short (100 secs) introduction to Python followed by a few quiz questions.
>
> The class will be highly interactive - you'll be programming almost the whole time. I've been told that you've got Chromebooks: please bring them with you to class.
>
> I'm looking forward to meeting you and to teaching this class - my first ever at a high school! If you need to know anything else before Monday, shoot me an email (birkenkrahe@lyon.edu) or send me a text (501-422-4725).
>
> Cheers, Marcus Birkenkrahe

PS. I am writing this in Canvas, Lyon's learning management system. You should try to login and you can take a look at the syllabus already.

3 Getting started

- ☐ Can you log into your Lyon GMail account?
- ☐ Can you see the GMail space "Python Chat"?
- ☐ Did you get my GMail invitation to join datacamp.com?
- ☐ Can you see your assignments in DataCamp?
- ☐ Can you log into lyon.instructure.com and see Canvas?
- ☐ Can you see my GitHub repo in github.com/birkenkrahe/py109?

4 Course overview

Course and instructor overview information. The original version of this lecture is on GitHub. There are changes for technical details[1].

- ☐ Who am I?: my first programming languages: BASIC, FORTRAN, C++; my first computer: TI/99. Learnt Python (properly) only this year.
- ☐ Why Python, why not?
- ☐ Which other languages do you know or have you heard about?
- ☐ What are you expectations for this course?
- ☐ What will you learn in this course?
- ☐ What will you learn in this course? - Programming paradigms, Python basics, data types, functions, scientific computing, plotting, data frame manipulation, control flow.

[1] Example: in the summer 2023 course when the material was created, we used Google Colaboratory, replit.com and IDLE, while in this course we will only use the online DataCamp Workspace platform.

- ☐ How will you be evaluated? - 25% each for weekly assignments, monthly sprint reviews, weekly tests and one final exam.
- ☐ Which tools are we going to use? - Canvas, GitHub, DataCamp assignments, DataCamp workspace (with AI coding assistance).
- ☐ Textbooks? See python.org for examples. I used mainly "Automate the boring stuff with Python" for the first iteration of this course, and now I'm going through multiple books whenever I need to.
- ☐ Infinite skills exercise: come up with three programs you would create if you had infinite programming skills and if you could build anything you wanted using any computer and Python.
- ☐ First assignment: "What are programming paradigms?" (DataCamp)
- ☐ Next: using the DataCamp coding platform.

5 Introducing DataCamp workspace

Our integrated development and interactive notebook environment is DataCamp workspace at workspace.datacamp.com. For more Python platforms, see the GitHub practice file: Command line, IDLE, Google Colaboratory, Kaggle, replit.com, etc.

- ☐ DataCamp workspace has a notebook interface with an IPython shell, a file manager, text cells with Markdown, auto-completion and many pre-installed packages. There is (free, for you) access to a Linux terminal, AI-assistance, and co-coding.
- ☐ More information about DataCamp workspace: tinyurl.com/bdzfpkzh
- ☐ Can you think of any reasons not to make it too convenient to develop, test and execute your programs? (Sounds crazy, right?) Is development and analysis speed the only goal?

  > *Answer:* the notebook and the graphical UI are additional levels between you and the machine. This is very convenient for quick exploration, but you don't learn much about the internals and the infrastructure. The problem with that is that infrastructure changes often and has a strong impact on performance - infrastructure knowledge is quickly becoming a secret science, and only the initiated have access.

☐ How do you feel about AI-assisted coding?

> How I feel about AI-assisted coding: I noticed the dementia-inducing effect that it has on me as an expert but I don't know if it might help you learn faster or more broadly, or not. When you have access to an AI, it is important to know what you can use it for, and to resist its allure continuously so that you don't become dependent. This could easily be said for any

6 Workspace demo - setup

☐ In DataCamp, open the `workspace` tab at the top to get to the workspace overview. You can also open this link to get directly to the workbook: tinyurl.com/WorkspaceDemoPython.

☐ If you're in the overview, take a look around: You have access to all shared workspaces, and you can limit the view to your own. You can view bookmarked workbooks (favorites). There is also a menu for "Code Alongs". Open `DataCamp Python Demo (problem)`.

☐ Click on `Make Copy` to copy the workbook - rename the workspace to reflect your ownership, and save it to the `Account` "Lyon College Data Science Fall 2023".

☐ Go to the `Workspace overview` by clicking the symbol at the top left of your dashboard. You should now see your own workbook there. While you could only comment on my workbook , you can edit and run this one.

☐ If you do leave a comment, I will be notified via GMail and will respond as soon as I see the email and find the time.

7 Dashboard

☐ Our target data is the "unicorn company" dataset - we're going to analyse the data of companies with a valuation > USD 1 bn.

☐ The workspace has two main areas:

1. Left sidebar for work environment

2. Text, code and output cells or blocks in the center. Text cells can be edited, commented upon, AI-assisted, or deleted. Code cells can be run, commented upon, AI-assised, or deleted.
3. There are some extra choices at the top:
   - `View` > `Switch to JupyerLab` opens a launcher for a bunch of different apps. You'll see a more traditional view of your notebook. You can add tabs to get to a console, a notebook, a terminal etc.
   - `Run` > `Open Terminal` (CTRL-.) opens a terminal or command line interface (CLI) to enter commands for the shell. You can also enter some from within the notebook but this is much more convenient when you want to muck around with files.

☐ The purpose of the notebook format is that you can build a data report as you go along, including any idea or input, any code (in Python), and any output generated by your code.

☐ Finished notebooks can be published to registered DataCamp users only. To publish to a larger audience, you need to use Kaggle or Google Colaboratory, or another platform.

☐ You can always download your workbook = notebook + files to a with `File` > `Download`. Don't try this on Chromebook.

☐ Within data science (including AI, machine learning, data analysis) this interactive notebook format is the gold standard for data storytelling - developing and presenting data-driven computational insights to a human audience.

☐ Jupyter notebook (`.ipynb` files) are an open source standard so there is no lock-in: you can import and export notebooks to and from this platform, and if you lose access, no big deal. You can e.g. download and use a free, offline version of "Jupyter Lab" to your PC or work in another online environment.

8 Code along notebook

☐ To begin, you should have an editable copy of my workspace in your personal workspace: tinyurl.com/WorkspaceDemoPython.

☐ The practice file's text is complete but all code chunks are missing and you will have to add them as well as text blocks where needed.

☐ The demo involves:

1. Explaining how this works
2. Explaining the data set
3. Importing CSV data as a pandas data frame (a data table)
4. Viewing the unique values of company categories
5. Cleaning the data frame column for company categories
6. Grouping all records (rows) by industry category
7. Plotting the number of unicorn companies by industry category

☐ The code covers much of what you'll learn in this class. Don't get discouraged if you cannot follow in detail. Let it be a lesson and a motivation.

☐ A live solution of the workbook is available here: tinyurl.com/WorkspaceDemoPythonSolution. The published notebook is available, too: tinyurl.com/WorkspaceDemoPublic.

9 Understanding the sidebar

☐ Open the `Files` menu in the sidebar: you see the notebook (open) and the CSV file.

☐ Click on the three dots next to name of the CSV file to see different options.

☐ The option `Query in new SQL cell` opens a new code cell (at the very end of the notebook) with a SQL query command on all features (columns) of the CSV file. To execute this command, the CSV data are converted to a dataframe first.

☐ Create the SQL cell and run it, then press CTRL-Z twice to get back to the original notebook. You don't have to test the other option, `Load as DataFrame` because we're going to do this explicitly. But if you wanted to, this would create a Python cell with the commands to import the CSV data as a DataFrame.

☐ Click on the CSV file `unicorn_companies.csv` to open it.

☐ You see a headline with several features and 917 records of these features, one for each unicorn company. This is what is called 'raw' data: in a Comma-Separated-Values (CSV) file, all values are separated by commas. The first line is special: it contains the headers, the names for the different columns.

10 Importing a CSV file as a pandas `DataFrame`

☐ Get back to your notebook. Next to the CSV file, select `Copy path to clipboard`. Click on `Files` to close the menu. Now all you see is the (minimized) sidebar and the notebook.

☐ Code:

```
# import pandas
import pandas as pd
# read CSV file
df = pd.read_csv('unicorn_companies.csv')
# show data frame
df
```

☐ When you run this cell, either with the mouse or by entering CTRL-ENTER, the first 10 records of the DataFrame `df` and the headline with the features. You can also download the CSV dataset from here, and try to create a chart - better wait with that until you understand the data set better.

☐ Though the data look quite clean and appealing, a table view is not the best way to get an overview - there are many records.

11 Viewing `unique` column (`pd.Series`) data

☐ For investment purposes, the `Category` column or feature is most interesting: this is the type of company. How many of these types are there?

☐ To print out all unique categories, we can use the `unique` function, which will return all unique entries in the `Category` column if we index the data frame accordingly:

```
help(pd.unique)
```

☐ There's a lot of information in this helpfile. You can look for help using `?` or the `help` function:

```
?pd.unique
help(pd.unique)
```

12 Testing the AI coding assistant

☐ This is a good place to show off your `AI` assistant: you may not know how to look for help for `unique`. Entering `help(unique)` or `?unique` will give an useless (to the beginner) error message: `Object 'unique' not found.`

☐ Add an `AI` code block. The assistant will ask you for a prompt. For simple questions like these, almost any prompt will do, e.g. `I need help for the function ‘unique‘.` The marks around `unique` will help the computer understand that you mean a command (these marks are also used for coding font markdown in text blocks).

☐ The information given by the AI is pretty exhausting and does not quite fit our problem - the issue is our prompt. Below the block you find another input field `Tell our AI what to do...` - Enter another prompt:

```
I need the docstring for the function ‘pd.unique‘.
```

This time, we get a better but still quite verbose answer in a code block that is automatically executed.

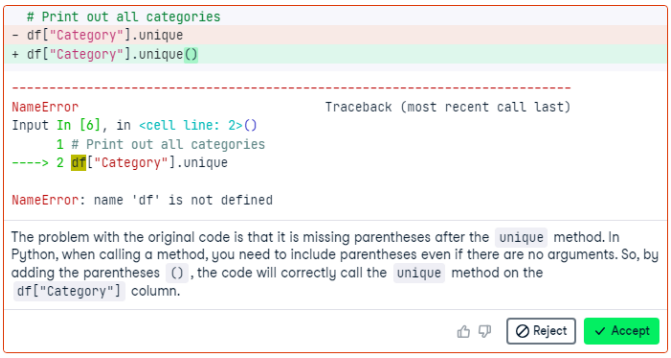
☐ We only want a short explanation that an absolute beginner can understand. Let's ask for that directly:

> As an absolute beginner in Python, I need a very short explanation of what ‘pd.unique‘ does and how I can use it on a column of a data frame.

☐ Let's apply this knowledge to the `'Category'` column but instead of using the functional notation `pd.unique(series)`, let's use the dot operator:

```
df["Category"].unique()
```

☐ To test the AI yet again, remove the parentheses after the function call to `unique`. This yields an error. At the bottom of the output, you can click on `Fix & explain`.



☐ The first part of the AI response is correct - the parentheses are reconstituted. But then a `NameError` is unnecessarily generated because the AI does not have access to the Python environment, which includes the user-defined data frame `df`. To correct this, you need to re-run the respective code and re-run this block thereafter!

☐ These experiments show that we're still quite far away from getting fully relieved of our coding burdens. This was (much) more work than necessary. A simple Google search ("Explain pd.unique in Python") yields a quicker and better answer:

> "The unique function in pandas is used to find the unique values from a series. A series is a single column of a data frame. We can use the unique function on any possible set of elements in Python. It can be used on a series of strings, integers, tuples, or mixed elements."

13 Back to viewing the unique `'Category'` values

☐ To remove the extraneous information about data types in the printout (`array`) and print the list one item per line, you can also use a for loop or a *list comprehension*:

```
# Print out all categories - one per line
for category in df['Category'].unique():
```

```
  print(category)
# With a list comprehensionN
[print(i) for i in df["Category"].unique()];
```

- ☐ Here, we generate a new line with `print` for every unique record of the column. The semi-colon at the end stops a bunch of `None` values to be printed afterwards (an IPython artefact).
- ☐ You can see that there are duplicates because of typos (`Finttech`) and capitalization (`Artificial Intelligence`). Let's remove the ambiguities.

14 Clean data frame column `Category`

- ☐ We can use `df.replace` to replace one value by another value inside our dataframe. We do not need to repeat the command but we can append methods to one another:

```
df_clean = df.replace(to_replace='Artificial intelligence',
                      value='Artificial Intelligence')\
             .replace(to_replace='Finttech',
                      value='Fintech')
```

15 Share editing rights

- ☐ One of the neater properties of DataCamp Workspace is the ability to share your notebook and edit synchronously like in GoogleDocs.
- ☐ Click on the sharing sign at the top and share **editing** access with your neighbor by using his/her email. Also, reduce "General access" to "Disable access" - now nobody except those you invite via email can see your file.
- ☐ You have to use the person's email used for DataCamp - make sure it's their Lyon College email. Once they've been invited, you can let them access to edit, view, comment or remove their access.
- ☐ Print the new dataframe `df_clean` in each other's notebooks by adding a new code block with the command `df_clean`.
- ☐ Once this is done, `Remove` access from your workspace for the other person.

16 Grouping data by column values

- ☐ To find out how many unicorn companies are there in each `Category` (aka industry), we group the corresponding records using the function `pd.DataFrame.groupby`. The command in the code cell below performs several operations on the `df_clean` dataframe:

- ☐ We use three functions: `df.groupby()` on the `Category` column (ChatGPT summary), `size` to extract the number of records in each group, and `sort_values` to sort the result in descending order:

```
category_counts =\
    df_clean.groupby(by = 'Category', as_index=False)\
            .size()\
            .sort_values(by=['size'])
```

- ☐ `groupby(by = 'Category', as_index = False)`: This groups the dataframe by the `'Category'` column. The `as_index = False` parameter ensures that the resulting groups retain `'Category'` as a column rather than using it as an index.

- ☐ `size()`: After grouping, this function is used to compute the size of each group. In the context of `groupby`, the `size()` function returns a `pd.Series` (a vector or 1-dim array) with the number of items in each group. This is essentially a count of rows for each `'Category'`.

- ☐ `.sort_values(by=['size'])`: This sorts the resulting `pd.Series` based on the size/count.

- ☐ Now, when you use the `size()` function with `groupby`, the resulting `pd.Series` will have the counts of each group as its values. When you sort this and convert it back into a dataframe (which happens implicitly because of `as_index=False`), the counts become a new column. By default, this column is named `size` – hence the creation of a new column named `size` in the output.

- ☐ The result, `category_counts`, is a pandas data frame with two columns sorted by size of group rather than alphabetically. When you let Colab suggest a graph, you get a line plot, a histogram (distribution) and a time series. `type` returns the data structure of its argument, and `pd.DataFrame.shape` is an attribute of the dataframe that contains its dimensions.

```
# show the data type of category_counts
print(type(category_counts))
# show the dimension of category counts
print(category_counts.shape)
```

17 Plotting data

☐ The result, `category_counts`, is a pandas data frame with two columns sorted by size of group rather than alphabetically. When you let Colab suggest a graph, you get a line plot, a histogram (distribution) and a time series. `type` returns the data structure of its argument, and `pd.DataFrame.shape` is an attribute of the dataframe that contains its dimensions.

☐ There are many different graphics packages available. The one most often mentioned is `matplotlib`. It is a great package to get a quick overview but you usually need to customize the graphs quite a bit before they look publishable.

Instead, we use the `plotly` package, which has an express module that does most of the heavy lifting for us. All it needs is the data and the names of the x and y column, and a title:

```
# import plotly.express
import plotly.express as px
# Create a bar plot of category group size vs. category
px.bar(category_counts,
     x = 'Category',
     y = 'size',
     title='Unicorn company distribution across industries')
```

☐ `plotly` is a plotting library, and `plotly.express` is a module to provide a range of plot types quickly (ChatGPT help and online doc).

☐ Compare the result when using `matplotlib.pyplot`: instead of one line, we need several lines of code to get a similarly appealing result. However, as I said, for quick data exploration, this is the way to go.

```
# import matplotlib.pyplot
import matplotlib.pyplot as plt
# plot category group size vs. Category
```

```
plt.bar(category_counts['Category'],
       category_counts['size'])
# rotate the x ticks by 90 degrees to make them readable
plt.xticks(rotation=-90)
# add a title
plt.title("Unicorn company distribution across industries")
# label the y-axis
plt.ylabel('Frequency')
# draw a grid to increase readability
plt.grid()
# show the final plot
plt.show()
```

18 Workspace - Summary

- Workspace offers Jupyter notebooks in Python, R and SQL.
- WS Notebooks contain text, code, output ("literate programming").
- WS Notebooks have pre-installed libraries and sample data
- WS notebooks run an IPython shell
- WS notebooks can be downloaded/uploaded as `.ipynb` files
- WS notebooks can be shared with other [DataCamp] users
- WS notebooks can be published to [DataCamp] portfolios

19 References

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References formatted in AMA style

- The names of all authors are inverted (the last name precedes the initials of the first and middle names).
- All authors are separated by a comma, except for the last two authors, which are separated by an ampersand (&).
- The title of the work is followed by the name of the website or publisher.
- The publication year follows the publisher and is followed by the access date.
- The URL is the final component of the citation.