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IT FDN 110 A Au 22: Foundations Of Programming: Python

Assignment 08

Classes and Objects

# Introduction

The goal of this project is to build a custom class to collect, hold, and report data about products. Names and prices will be retrieved from a text file, before creating instances of the class created for each product. Also, a user will be able to add display the existing data, add new products, and save the data back to a text file.

A partial program has been provided to start from. The necessary structure exists, but operational code has been omitted in several places so it will not run as it currently exists. So we will need to map the logic for the existing code, identify where it is lacking, and develop the logic and code to make it work.

# Designing the program

Examining the starter file, the logic flow looks like this - with areas where code is missing is indicated.

* Data
  + declare variables and constants
  + class Product
    - *MISSING CODE*
* Processing
  + class FileProcesser
  + Process data from a file
    - *MISSING CODE*
  + Process data to a file
    - *MISSING CODE*
* Presentation (Input/Output)
  + class IO
    - def print\_menu\_items
      * print list of options to screen
    - Get user’s choice
      * *MISSING CODE*
    - Show the current data from the file to user
      * *MISSING CODE*
    - Get product data from the user
      * *MISSING CODE*
* Main Body of Script
  + Load data from file into a list of product objects when script starts
    - *MISSING CODE*
  + Show user a menu of options
    - *MISSING CODE*
  + Get user’s menu option choice
    - *MISSING CODE*
    - Show user current data in the list of product objects
      * *MISSING CODE*
    - Let user add data to the list of product objects
      * *MISSING CODE*
    - Let user save current data to file and exit program
      * *MISSING CODE*

As the program is already divided into classes, we will address the updates for each class separately to make it easier to follow the changes as they are introduced.

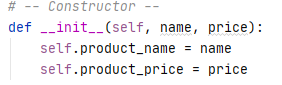
### The Product class

First, we will create a Product class to define a data structure that will serve as an example from which Objects (instances of the Product class) will be built. (*Python Classes and Objects,* (September 8, 2022). Retrieved December 6, 2022, from <https://www.geeksforgeeks.org/python-classes-and-objects/>) (External link). Within the class, the code will include a constructor to initialize the object’s attributes, properties to modify those attributes, and methods to control how the objects interact with the main program.

Since the goal is to create a simple list of products and their price, the only interaction we will control is the output format when the Class data is called for display. So the logic for the definition of the class looks something like this:

* class Product
  + Receive name and price from main program
  + Initiate the attributes with the given values
  + Process the user given data to match the data type and format of the attributes
  + Define how the attributes will be displayed

Each object should have a unique combination of name and price when created, so a parameterized constructor will be used (*Constructor in Python with Examples*, (n.d.). Retrieved December 6, 2022, from <https://pythongeeks.org/constructor-in-python/>) (External Link). By defining the \_\_init\_\_() method inside the class and using the argument self, we can assign the values given by the user to the memory address of the object we are creating like this:

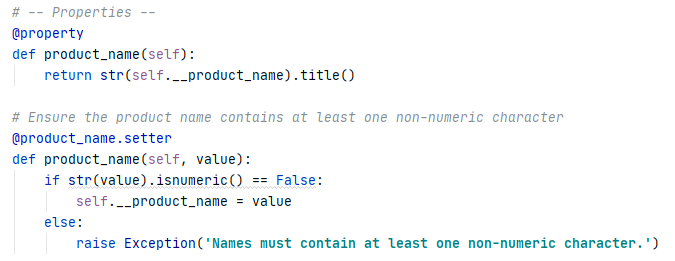


***Figure 1: Product class constructor***

Each time the class used to create an object, a new memory location is assigned the given values. Allowing objects with identical structure, but unique attributes, to be generated without modifying the template.

If we could be certain the users will always input the data the way we want, nothing else should be needed. However, to be safe, it would be better to provide a means to ensure the data is in the correct format by either using input masking (which may work for a program with either a web or graphic interface) or by modifying the data after it’s passed into the class (which should work with a web, graphic, or consoler interface).

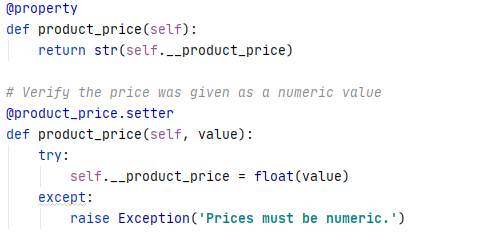
By creating Properties within in the class, we can perform actions on the data to ensure the data is either in or converted to the correct formats before the class is created (Ramos, Leodanis Pozo (n.d.). *Python’s property(): Add Managed Attributes to Your Classes*, <https://realpython.com/python-property/>) (External link).



***Figure 2: Product name property***

In the code above the first property (product\_name(self)) allows the program to access the product\_name value stored in the Object, while the @product\_name.setter allows the program to modify this value. Before the Object is created the attribute has no inherent value, but this second property (the setter) checks the input from the user to verify it’s not all numbers, and if so assigns the value to the product\_name attribute that was created by the constructor.

For the product\_price we want to convert the value to a float before assigning it to the Object. By wrapping the conversion and assignment in a try…except statement, and throw a custom exception if the conversion fails.



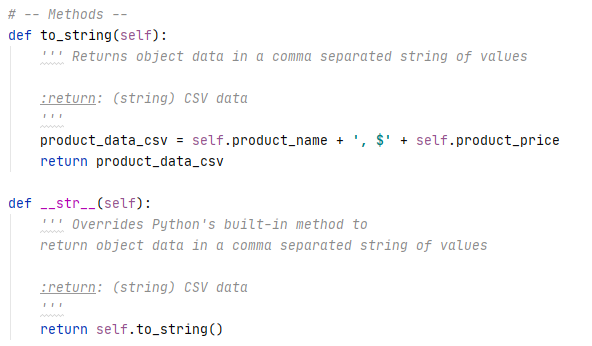
***Figure 3: Product price property***

This will cause an exception if the user includes any currency symbol in the input, but we will address that when adding new data, before calling the Product class.

The final piece to be added to the Product class is the methods (functions within the class) to provide action to perform on the internal data we’ve defined. We will add a new method to format the data and override a built-in method to display the data as we’ve defined.

The to\_string method uses the self reference to extract name and price from the current object’s memory location – then combines them into a variable so the value can be passed to other methods. We can add a currency indicator to be included in the output.

By default, the class includes a built-in \_\_str\_\_ method that when called will display the memory location for the given instance when invoked by the print statement (print(<object>) or print(<object>.\_\_str\_ ) (Introduction to the Python \_\_str\_\_ method (n.d.). Retrieved December 7, 2022 from <https://www.pythontutorial.net/python-oop/python-__str__/>) (External link). We can override this behavior by reusing the name and providing our own code.



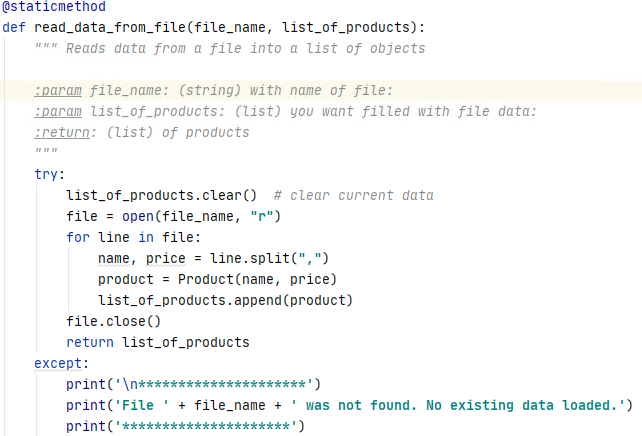
***Figure 4: Product class methods***

Now when the \_\_str\_\_ method is invoked, it in turn calls the to\_string method to build the string from the attributes and returns that value to the screen. If there were additional attributes, only those addressed in the to\_string method would be returned – so this method can be used to make it simpler for the user to get the values you want them to see without knowing the internal structure of the class/object.

### The FileProcessor class

The logic for the read function is very similar to that used for other projects. The most significant change is instead of assigning the values from the file into a dictionary – it will create an instance of the Product class, populating its attributes with the values from the file.

* + Process data from a file
    - Receive file name and product list from main program
    - If file exists
      * Open file in read mode
      * Read line from file
      * Call Product class to create object
      * Add object to product list
      * If not end of file
        + Go to Read line from file
      * Else
        + Close file
        + Return product list to main program



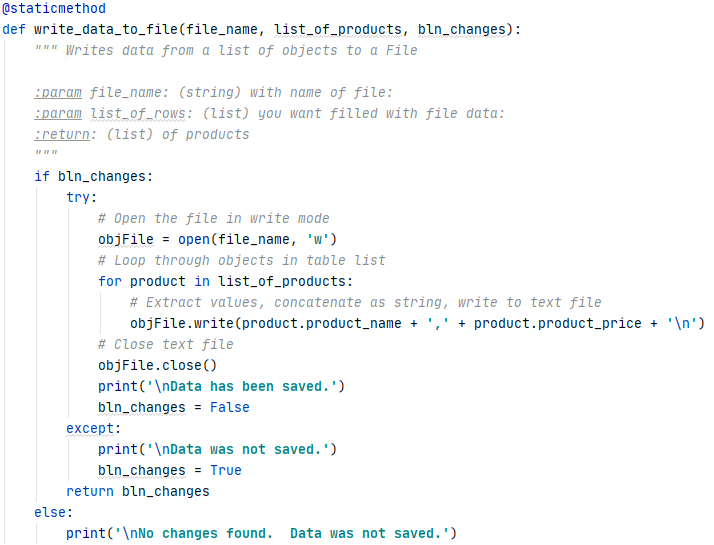
***Figure 5: Process data from a text file***

During each iteration of the for loop, the line product = Product(name, price) passes the new values to the class, where the constructor and properties create a new instance that is assigned to the object named product. Since the objects are then added to a list, they can be addressed individually using the list index, so for this application it’s not an issue they are given the same name. If they were not managed in some type of collection like this, it would be necessary to assign a unique identifier for each object.

Writing the data to a file also closely follows the flow used in other projects.

* + Process data to a file
    - Receive file name and product list from main program
    - Open file in write mode
    - Get object from list
      * Write product name and price to file
      * If not end of list
        + Go to Get object from list
      * Else
        + Close file

The notable difference is how the code access the values of the object’s properties. Similar to the dictionary, the values are addressed by the name – but in this case the format is <object>.<property> rather than <dictionary>[‘key value’].

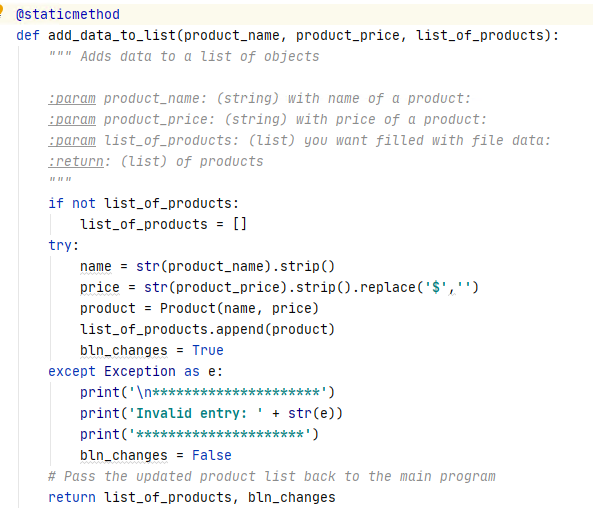


***Figure 6: Write data to a text file***

### The DataProcessor class

This class was not in the original file, but was added because the functionality doesn’t quite fit with the methods in the FileProcesser class.

* Add data to list
  + Receive part name, price, and product list from main program
  + Remove dollar sign from price if present
  + Call Product class to create object
  + Add object to product list
  + Set change flag to True
  + Return product list and change flag to main program



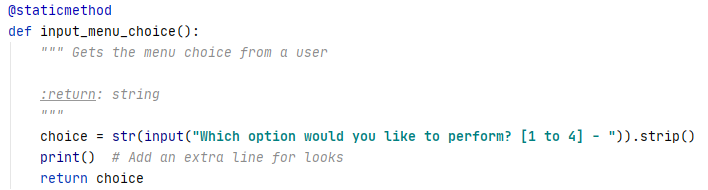
***Figure 7: Add new product to list in memory***

As mentioned previously, you can see this method uses a replace statement to remove the dollar sign from the value in product\_price before calling the Product class. If there is a chance the user may enter prices in other currencies, additional symbols could be added – but additional code would be required to capture, record, and report with the appropriate symbol.

### The IO class

Getting the user menu selection can be done with a simple input statement – we will account for invalid selections in the main program, so the value can be passed back without further processing.

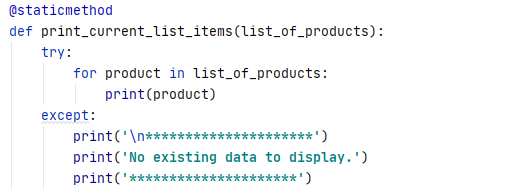
* + - Get user’s choice
      * choice = str(input("Which option would you like to perform? [1 to 4] - ")).strip()
      * Return choice to main program



***Figure 8: Get user selection from menu choices***

Because the methods in the class are controlling how the properties are displayed, we don’t need to address them individually – though we can, as shown previously in the write function. To display the data in the default format defined the class we can print it directly using print(product).

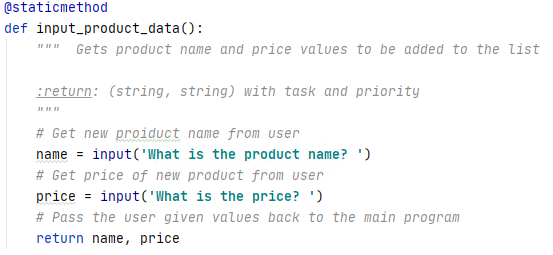
* + - Show the current data from the file to user
      * Receive product list
    - Get object from list
    - print(product)
    - if not end of file
      * Go to Get object from list



***Figure 9: Display the data in memory***

Between the add\_data\_to\_list method and the methods in the Product class we have already provided code manage incorrect data formats – so again, getting the product name and price from the user can be done with input and return statements similar to getting the menu selection.

* + - Get product data from the user
      * Request product name from user
      * Request product price from user
      * Return name and price to main program



***Figure 10: Get new product data***

### The main body of script

The classes and methods will be created but not run when the program is launched, so the main body will need to call the appropriate methods in turn, and as mentioned earlier also handle invalid inputs for the menu options.

* Load data from file into a list of product objects when script starts
  + Call FileProcessor.read\_data\_from\_file and assign value to lstOfProductObjects
* Show user a menu of options
  + Call IO.print\_menu\_items
* Get user’s menu option choice
  + Call IO.input\_menu\_choice
  + If show current data in the list of product objects
    - Call IO.print\_current\_list\_items
  + If add data to the list of product objects
    - Call IO.input\_product\_data
    - Call DataProcessor.add\_data\_to\_list
  + If save current data to file
    - FileProcessor.write\_data\_to\_file
  + If exit program
    - If change flag is True
      * Notify user of unsaved changes and give option to save
      * If Yes
        + Call FileProcessor.write\_data\_to\_file
      * Else
        + Display message that data was not saved
      * Close program
  + Else
    - Display invalid selection message
    - Go to Get user’s menu option choice

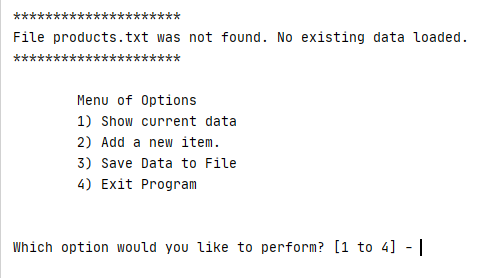


***Figure 11: Main program script***

# Running the program

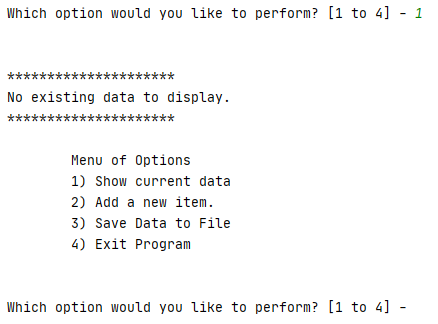
### Executing the program in Pycharm:

For the initial run the text file has been removed so that we can test the exception handler in the method to read the data from a file.



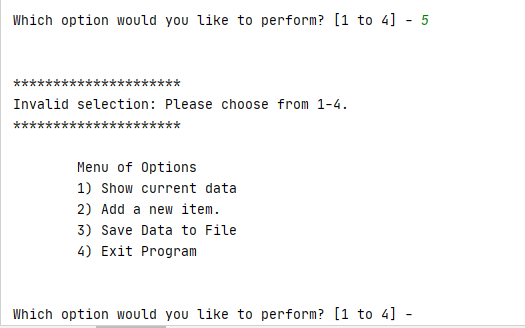
***Figure 12: No data file available***

With no data to load, if the user tries to display the current data the program would crash. So another exception handler was included in the display method.



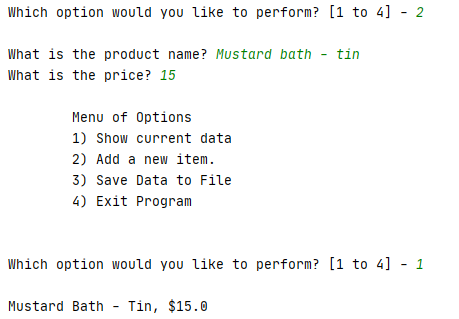
***Figure 13: Attempt to display data with no data loaded***

Though not using an exception handler this time - the program also notifies the user if they select an invalid option from the menu.



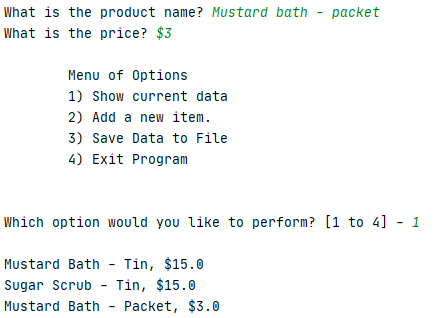
***Figure 14: Invalid menu selection***

Selecting option 2, we can see the program works for a single entry in the following example.



***Figure 15: Add a new product, and display data***

Adding a few more entries, to verify it can handle multiple products:

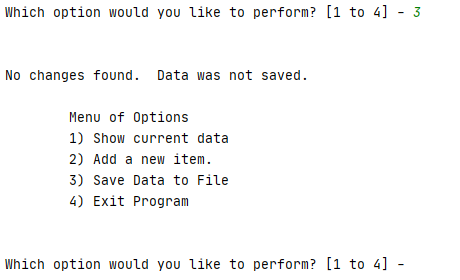


***Figure 16: Add more products***

You will notice in this example the dollar sign was included in the price input, but in the previous example it was not included. However, in both cases the dollar sign does appear in the output.

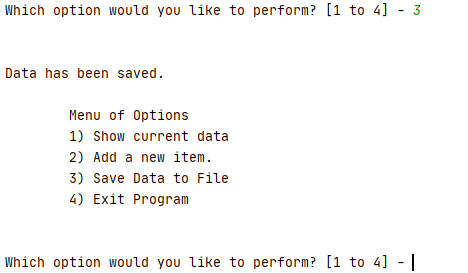
This is because the add\_data\_to\_list method contains a replace statement to remove the dollar sign (if present) before handing the values off to the Product class. Within the Product class the price value is converted from a string to a float, which causes extra leading and trailing spaces to be dropped – so the program will accept a price that is all digits or contains a dollar sign, even if there are spaces between the symbol and the numbers.

By including the variable bln\_changes, we have a flag that can be used to identify if there are unsaved change in the dataset. If the user does not enter any data it remains at the default value of None, and when the user tries to save I notifies them there were no changes and no data was saved.

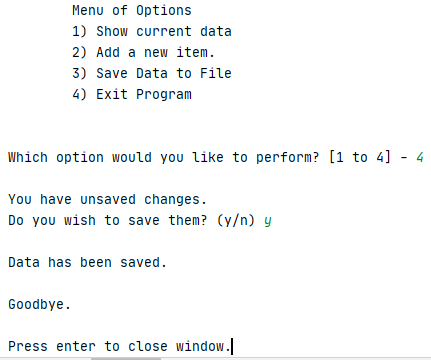


***Figure 17: Attempt to save without making changes***

When the user adds a new item, the add\_data\_to\_list method resets the value of bln\_changes to True so the user can save the data. If they attempt to exit before saving, they get notification of the unsaved changes and an option to save before the program closes. Once the data has been saved, bln\_changes is set to False to indicate the data in memory matches the data in the file.

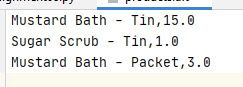


***Figure 18: Attempt to save after making changes***



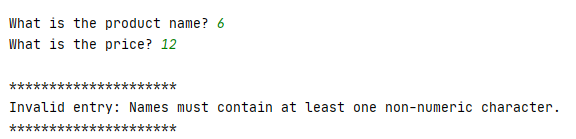
***Figure 19: Exit before saving***

Checking the text file to ensure the data was saved, we see the following.

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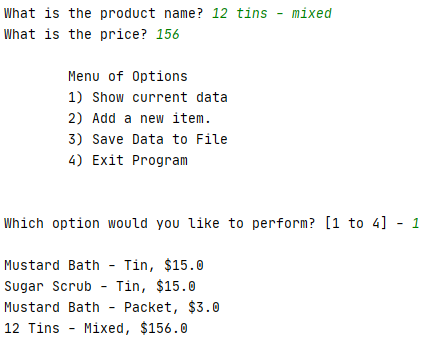
***Figure 20: Verify contents of text file***

So far everything appears to be working – but what if the user gives invalid values? Within the Product class we required that the product name contain at least one non-numeric character. If we try to enter a number for the name we see the following.



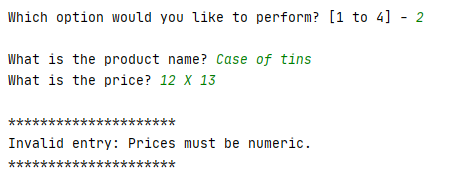
***Figure 21: Invalid product name***

However, we can still include numbers in the name, as long as it contains some non-numeric characters.



***Figure 22: Mixed alpha numeric product name***

For the price, we specified the value must contain only numbers (with the exception of the dollar sign as previously mentioned) – so if instead of explicitly giving the price, the user intends to calculate it later and enters something like this:

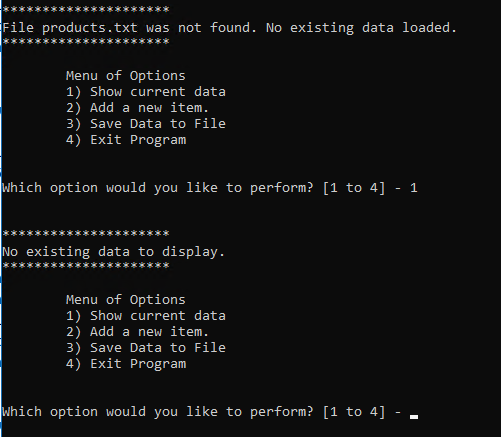


***Figure 23: Invalid product price***

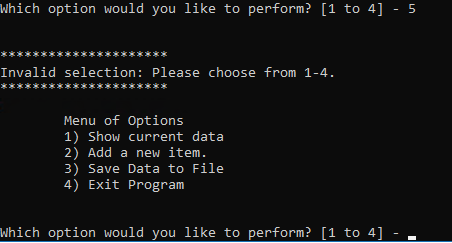
We see the program rejects the entry as intended.

### Executing in a Terminal window:

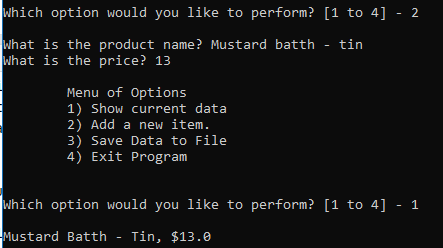
Deleting the products.txt file and running the code in a console window we see the following interactions.



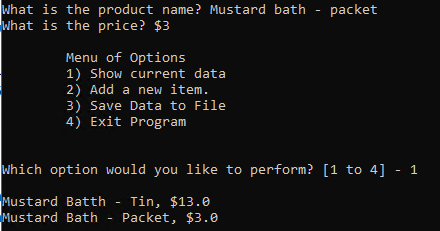
***Figure 24: No file available, and display empty list***



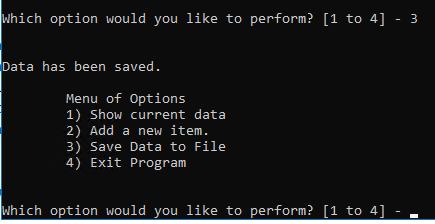
***Figure 25: Invalid menu selection***



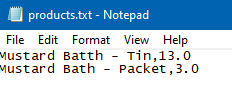
***Figure 26: Add new product (no dollar sign) and display***



***Figure 27: Add new product (with dollar sign) and display***

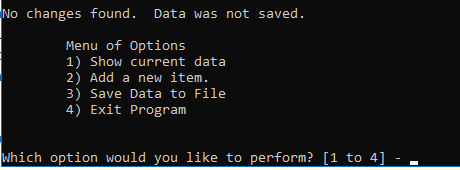


***Figure 28: Save data***

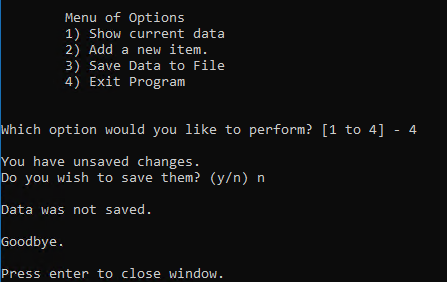


***Figure 29: Verify contents of text file***

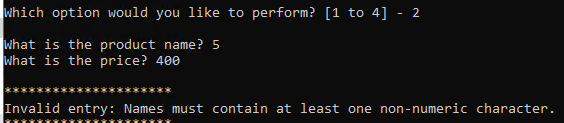
While the misspelling was not intentional – it was left in to help show that we are not using the previous text file, and program is saving as it should.



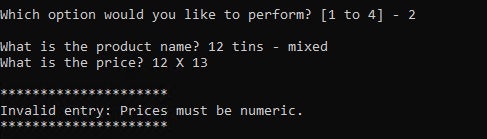
***Figure 30: Save without making changes***



***Figure 31: Exit without saving***

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***Figure 32: Invalid product name***

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***Figure 33: Invalid price***

Everything appears to be working the same as it did in Pycharm.

# Summary

In this project we created a simple class to collect, reformat and report data for a product.

Using a constructor and the self reference, the attributes given by the user or read from a file were used to create new instances using the class as a template to ensure they had a common structure and behavior, while still existing as separate objects within memory.

Within the class, properties were created to validate and modify the incoming data so that it matched the types intended for the individual elements without explicitly constraining the user inputs.

Finally, methods were created to define a custom output format, and override a built-in method and allow the custom output to be displayed when the object is called by the print statement.

While the example used was quite simple, it still demonstrated some of the benefits of using a class to define a common structure for creating data object. Though it doesn’t demonstrate the behavior of inheritance (*Python Inheritance* (n.d.) Retrieved December 7, 2022 from <https://www.w3schools.com/python/python_inheritance.asp>) (External site) – it’s not too difficult to understand how we could create new classes based on this one, then add attributes or override methods similar to the way it was done here. The common traits (properties and methods) would be defined once in the base class, while specialized attributes are introduced in derived classes so they are only applied to those products where they are applicable.