COMP1021
Introduction to Computer Science

Text and File Handling

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Outcomes

- After completing this presentation, you are expected to be able to:
  1. Use the tab character and newline character to output text using the print command
  2. Write code to write content to a text file
  3. Write code to read content from a text file

Handling Files

- In this presentation we will look at file handling:
  - How to save data to a file
  - How to load data from a file
- The first things we need to do are to understand:
  - The *tab* character
  - The *end-of-line* character
- Later we will also need to learn about *whitespace*

The Tab Character

- In computer programming, we use `\t` in a string to represent a tab character
  - Remember in programming, a *string* simply mean 'text'
- A tab character moves the text after the tab character horizontally, to a particular position
- When you look at it in a text viewing program, it will show things being nicely lined up in columns, to make a nice visual display
- Let's look at some examples of using tabs for nice formatting in columns

Using Tabs for Lining up Columns

```
print("Pythagoras' constant is\t1.41421")
print("Theodorus' constant is\t1.73205")
print("Golden ratio is\t\t1.61803")
print("pi is\t\t\t3.14159")
print("e is\t\t\t2.71828")
```

The tab characters move the horizontal position to these locations

```
Pythagoras' constant is 1.41421
Theodorus' constant is  1.73205
Golden ratio is         1.61803
pi is                   3.14159
e is                    2.71828
>>>
```

Another Example of Using Tabs

- Here's another example of using tab characters

```
for x in range(5):
    print( "\t" * x + "hello")
```

`*` has a higher *precedence* (discussed elsewhere) than `+` so it is handled first

```
hello
        hello
                hello
                        hello
                                hello
```

The first value generated by `range(5)` *is zero, so there's no tab here*

Using Tabs in a File Format

- When handling files, a tab character is often used to separate things inside the file
- For example, we can put the position of some turtles inside a text file
- Each position uses 2 numbers: the x and y values
- We need to separate the two numbers inside the file
- To do that we will use a tab character (although we could use other characters if we wanted to, such as a space)

Here a tab character is used to separate the two numbers in the file

```
32.0	2.0
```

The Newline Character

- The other thing we have to understand is the newline character (sometimes called the 'end of line' character)
- In computer programming, we use `\n` in a string to represent the newline character
- The newline character basically means 'go to the next line'
- By default, `print()` adds a new line character to whatever you ask it to display

An Example of Using the Newline Character

- A newline character is automatically added by `print()` at the end

```
print("Hello!\nI am Python!\nHow are you?")
```

```
Hello!
I am Python!
How are you?
>>>
```


Another Example

- Here we turn off the default behaviour of print, to make the example easier to understand

```
for x in range(5):
    print( "hello" + "\n" * x, end="")
```

```
hellohello
hello

hello


hello


>>>
```

** has a higher precedence than + so this part is done first*

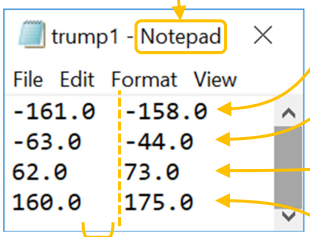
The first value generated by `range(5)` is zero, so there's no end-of-line character here

Reading and Writing Data

- Let's use the jigsaw lab for our example
- We will make code which saves the positions of all the jigsaw pieces (the turtles) into a text file
- And we will make code which loads all the jigsaw position data from the text file, and moves the turtles back to those positions
- This is very helpful: for example, imagine you have been working on a jigsaw with 49 pieces
- Save the jigsaw positions to a file, come back maybe a week later, load the jigsaw positions from the file, then carry on doing the jigsaw

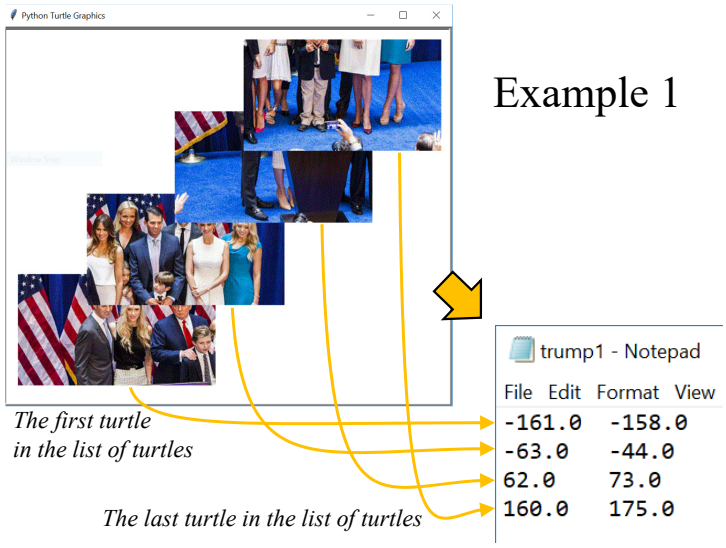
The File We Will Make

- 'Notepad' is a simple program on Windows computers which lets you open and look at text files

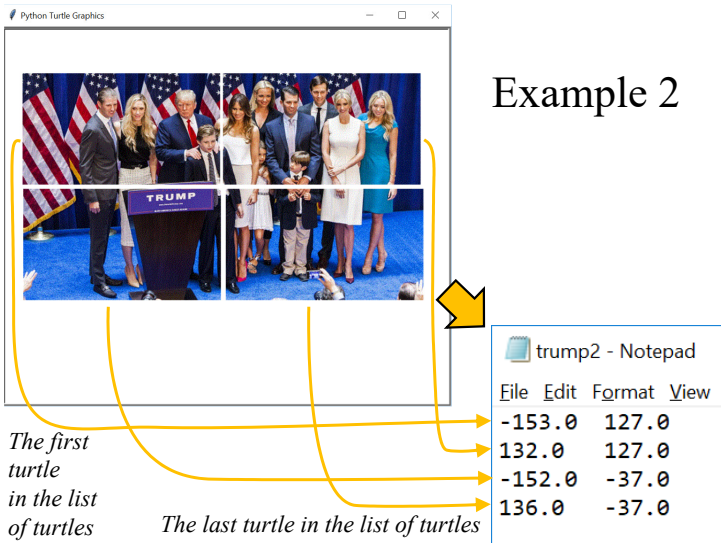


The tab character is between the two numbers, on each line

- The position of the first turtle in the list of turtles
- The position of the second turtle in the list
- The position of the third turtle in the list of turtles
- The position of the fourth turtle in the list of turtles



Example 1



Example 2

Writing the Turtle Positions

- Open the file in 'write as text' mode
- For every turtle in the list of turtles:
  - Create one line of text:
    - Convert the turtle x and y into strings
    - Put a tab between the x and y strings
    - Put an end-of-line character at the end
  - Write the line of text to the file
- Close the file

Some Useful Things to Remember

- You can get the x position of a turtle like this: *turtleName*`.xcor()`
- You can get the y position of a turtle like this: *turtleName*`.ycor()`
- Both of these give you the turtle position
- However, we are creating a text file, so we need to convert the values into strings before we put them in the file, we use `str()` for that

Creating One Line of the Text File

- In the following slide you can see we use this line of code to create the text:

```
one_line = str(thisTurtle.xcor()) + "\t" + \
    str(thisTurtle.ycor()) + "\n"
```

- Then the content of `one_line` will be like this:

```
-153.0\t127.0\n
```



```
filename=turtle.textinput("Save jigsaw positions", \
    "What is the jigsaw filename you want to create?")
myfile = open(filename, "wt") #Open the file for writing
# Now we go through each turtle in the list of turtles
for thisTurtle in allTurtles:

    # Make a string for one turtle, in the right format
    one_line = str(thisTurtle.xcor()) + "\t" + \
        str(thisTurtle.ycor()) + "\n"

    # Save the string to the file
    myfile.write(one_line)

# Close the file
myfile.close()
```

Use any name to 'point' to the file

Put a tab between the two text

Add the end-of-line character at the end of the line

It's possible to have several files open at the same time, so you need to say which file you are referring to

Reading the File

- We have finished looking at writing the file
- Now let's look at reading the file
- We will read x and y values from each line
- After we read the x and y values, we move the appropriate turtle to that position
- In other words, we are 'restoring' the position of every turtle
- There is one thing which we should learn about first, which is *whitespace*

What is Whitespace?

- 'Whitespace' means 'anything you can't see'
- So that means spaces, tabs and also end-of line characters
- We use `rstrip()` to remove whitespace
- `rstrip()` means 'strip (=remove) anything you can't see on the **r**ight side'

```
>>> text="hello       "
>>> text
'hello       '
>>> text.rstrip()
'hello'
>>> text="hello\n\n\n"
>>> text
'hello\n\n\n'
>>> text.rstrip()
'hello'
>>> text="hello\t\t\t\t"
>>> text
'hello\t\t\t\t'
>>> text.rstrip()
'hello'
>>> text="hello   \t\n \n\t\t\n"
>>> text
'hello   \t\n \n\t\t\n'
>>> text.rstrip()
'hello'
>>>
```

Handling One Line of the Text File

- If line of the text file is like this:

```
-153.0\t127.0\n
```

- To handle each line we have to do this:
  - Read the line
  - Dump the `\n` at the end of the line
  - Extract the two numbers, by separating the line into separate pieces wherever a `\t` is found
  - Then we can move the turtle to the correct place

Handling One Line of the Text File

- If `one_line` contains this:

```
-153.0\t127.0\n
```

- Then we do:

```
items = one_line.split("\t")
```

- Then `items` will contain this:

```
['-153.0', '127.0']
```

- So now we can e.g. extract the x value and convert it to a float:

```
x=float(items[0])
```

The Sequence For One Line

- This illustrates the series of operations for one line

```
>>> line="-153.0\t127.0\n"
>>> line=line.rstrip()
>>> print(line)
-153.0  127.0
>>> items=line.split("\t")
>>> print(items)
['-153.0', '127.0']
>>> x=float(items[0])
>>> y=float(items[1])
>>> print("The x value is", x)
The x value is -153.0
>>> print("The y value is", y)
The y value is 127.0
```

Reading the File

- Open the file in 'read' mode
- For every line in the file:
  - Read the line as a single string
  - Remove the end-of-line character `\n` from the end of the string using `rstrip()`
  - Convert the line into a list of two strings using `split("\t")`
  - Convert the x and y values from strings into floats
  - Move the turtle to the x and y values
- Close the file

```
filename=turtle.textinput("Load jigsaw positions", \
    "What is the jigsaw filename you want to load?")
myfile = open(filename, "r") # Open the file for reading
turtleIndex=0
for line in myfile:
        # Handle each line, one by one
        line = line.rstrip()    # Remove the end-of-line

        items = line.split("\t") # Separate the two items

        x=float(items[0])        # Convert x to a float
        y=float(items[1])        # Convert y to a float

        allTurtles[turtleIndex].goto(x, y) # Move turtle
        turtleIndex=turtleIndex+1 # Increase the index,
                                  # for the next turtle
myfile.close()  # We have finished, now close the file
```

You can use any variable name to 'point to' the file, it doesn't have to be the same one used before