Add some post its!

Press N to create your own sticky notes

Hello! :)

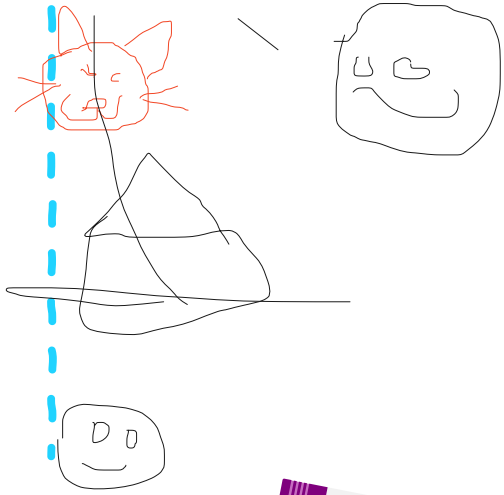
Good day

Bonjour

Buongiorno

Draw something

Press P to create your art



Write something

Press T to express your thoughts

Hi I'm Pete

Name?

Where you work?

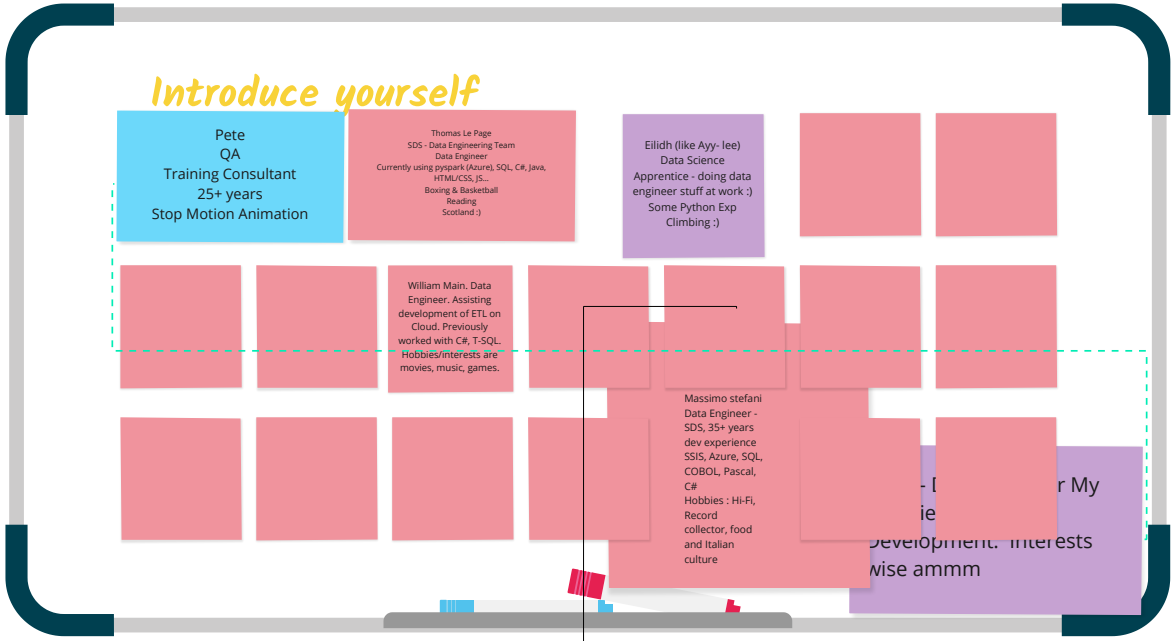
What you do?

Programming experience?

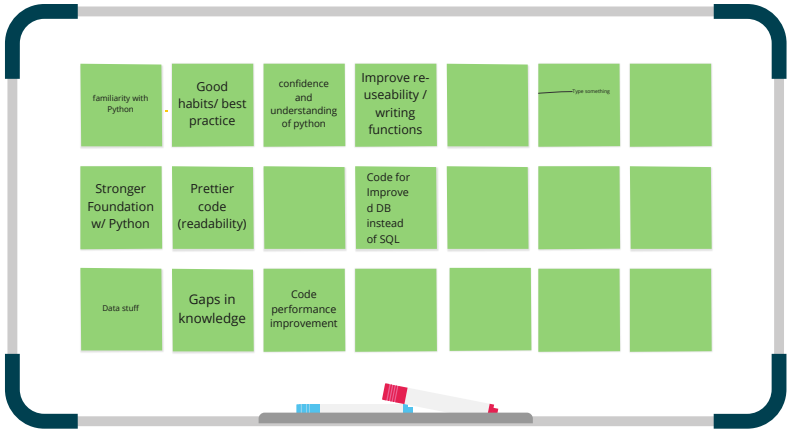
Sports?

Hobbies?

Interests?



Any specific goals for the course?



Group Learners into BreakoutGroups: Shoe/Pram/Swallow/Coconuts

HOW MANY Monty Python References -Count them during the course!!

And your TEAMS for the QUEST!

Excalibur

Castle Greyskull

Scott

Brave Knight

European Swallows

Peasants

William

Brave Horses

Massimo

Questions & Comments

`<Questions for tutor and open to all students who go here..`

Kanban

To do 10	In progress 1	Done 0
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Code shared by tutor

`<Code shared by tutor will go here...`

Link for Project Starter Files:
[QACS-TL/Python_TL_Lab_Starter_Files (github.com)]

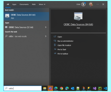
Link for Demo Code:
[QACS-TL/Python_TL_Demos (github.com)]

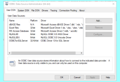
Link for Lab Solutions:
[QACS-TL/Python_TL_Lab_Sols (github.com)]

Accessing SQL Server Demo code

```
#! /bin/python
# Name: demo_sqlite.py
# Author:     QA2.0, Pete Behague
# Revision:   v1.0
# Description: This program will demonstrate how to connect to a SQLite database
# file, create a table, insert and query rows using the SQLite3 module/API.
"""
  Create and populate a SQLite database file.
"""
import sys
import pyodbc
import pymssql
import os

def main():
    """ Create, Insert and query all rows in database """
    # Connect into SQLite database file.
    # App can use one of two different packages to access SQL Server database, pyodbc or pymssql
    # db_conn = pyodbc.connect(r"Driver={ODBC Driver 13 for SQL Server};Server=(local);Database=PythonMovies;UID=Fred;PWD=Pa$$w0rd;")
    db_conn = pymssql.connect(server=r"(local)", database="PythonMovies", user="Fred", password="Pa$$w0rd")
    # Open a cursor to store
    cur = db_conn.cursor()

    # Create a movies table if it doesn't already exist.
    # The "IF object_id..." logic is Microsoft SQL Server specific and won't work for SQLite
    cur.execute("IF object_id('movies', 'U') is null CREATE TABLE movies (id int identity(1, 1) PRIMARY KEY,name TEXT,year INTEGER,rating INTEGER
)")
    db_conn.commit()  # Commit Changes to database.

    # Loop and write users favourite movies to database file.
    while True:
        movie = input("Enter name of movie (q=quit): ")
        if movie.lower() == "q": break
        year = input(f"Enter year of release for {movie}: ")
        rating = input(f"Enter your rating for {movie} (1-10): ")

        # cur.execute("INSERT INTO movies (name,year,rating) VALUES(?,?,?)", (movie, year, rating))
        cur.execute(f"INSERT INTO movies (name,year,rating) VALUES('{movie}',{year},{rating})")
        print("1 row inserted")

        db_conn.commit()  # Commit Changes to database.

    # Query, fetch and display all rows from database file.
    cur.execute("""SELECT * FROM movies""")
    rows = cur.fetchall()
    for row in rows:
        print(row)

    db_conn.close() # Close database connection.
    return None


if __name__ == "__main__":
    main()
    sys.exit(0)
```

Setting up an ODBC data source:





Explanation of standard relational database API

[PEP 249 – Python Database API Specification v2.0 | peps.python.org]

Code shared by learner

`<Code shared by learner will go here...`

Course Aims (or Vision, if you prefer!)

The aim of the course is to provide learners with the background necessary to create, test, secure and deploy a functioning single page ReactJS application, so that they are able to identify the component hierarchy, how data flows within the application, provide suitable UIs through routing components and make calls to external APIs to retrieve or send data.

Learning Objectives

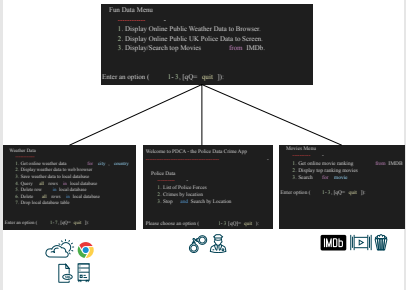
The objectives for this course are:

- To develop an understanding of how ReactJS applications are constructed and tested using JSX syntax and components in a hierarchy
- To develop a level of competence in creating and testing ReactJS components that use JSX, props, state and lifecycle hooks
- To develop knowledge and competency in utilising external data sources and APIs in ReactJS applications and how to handle asynchronous data
- To introduce an appreciation of how ReactJS creates single page applications through the use of pre-defined routing components
- To demonstrate how ReactJS applications are built, bundled, tested and deployed using in-built and other CI/CD techniques
- To develop an awareness of how ReactJS applications can handle security concerns such as user authentication and sessions

Learning Outcomes

By the end of this course, learners will be able to:

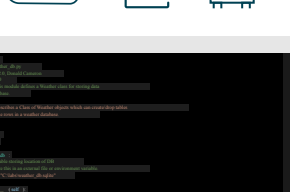
- Identify, design, create and test reusable ReactJS JSX components in a hierarchical structure that construct a user interface for a given purpose
- Utilise props, state and standard ReactJS hooks to manage and consume data or user inputs within a ReactJS application
- Initiate and handle asynchronous calls to external APIs for data required, consumed or provided by the application
- Implement a single page application by defining a routing structure using components from the 'react-router' package
- Build, Test and Deploy a ReactJS application through a CI/CD pipeline
- Use authentication techniques, such as JWT, to ensure that access to certain areas of the application are restricted to authorised users only




```python
#! /bin/python
# Name:        menu.py
# Author:      QA2.0. Donald Cameron
# Revision:    v1.0
# Description: Fun demo for QA2.0 Python LIVE
"""
    Docstring: A fun program to allow users to choose from an
    interesting and eclectic list of options including getting the
    latest weather or crime reports from an area, getting the latest
    top 250 movies and interacting with SQLite databases.
    And a little 8_Object_Oriented_Programming for extra fun!
"""
import    sys
import   police_data
import   weather_data
import   movies

menu =   """
    Fun Data Menu
    -------------
    1. Display Online Public Weather Data to Browser.
    2. Display Online Public UK Police Data to Screen.
    3. Display/Search top Movies from IMDb.

"""

def   top_level_menu    ():
        """Top Level Menu function for displaying crime, weather and movie data """
        while   True :
            print   ( menu)
            option   =   input   ( "Enter an option (1-3, [qQ=quit]): "                )
            if   option   ==   "1" :
                weather_data   .weather_menu()
            elif    option   ==   "2" :
                police_data   .police_menu()
            elif   option   ==   "3" :
                movies .menu()
            elif    option   . lower  ()  ==    "q" :
                print   ( "Quitting.."        )
                break
            else :
                print   ( "Invalid option"        )
        return    None

def   main ():
    """ Program can be run directly """
    top_level_menu    ()
    return    None

if   __name__   ==   "__main__"   :
    main ()
    sys . exit   ( 0 )
```

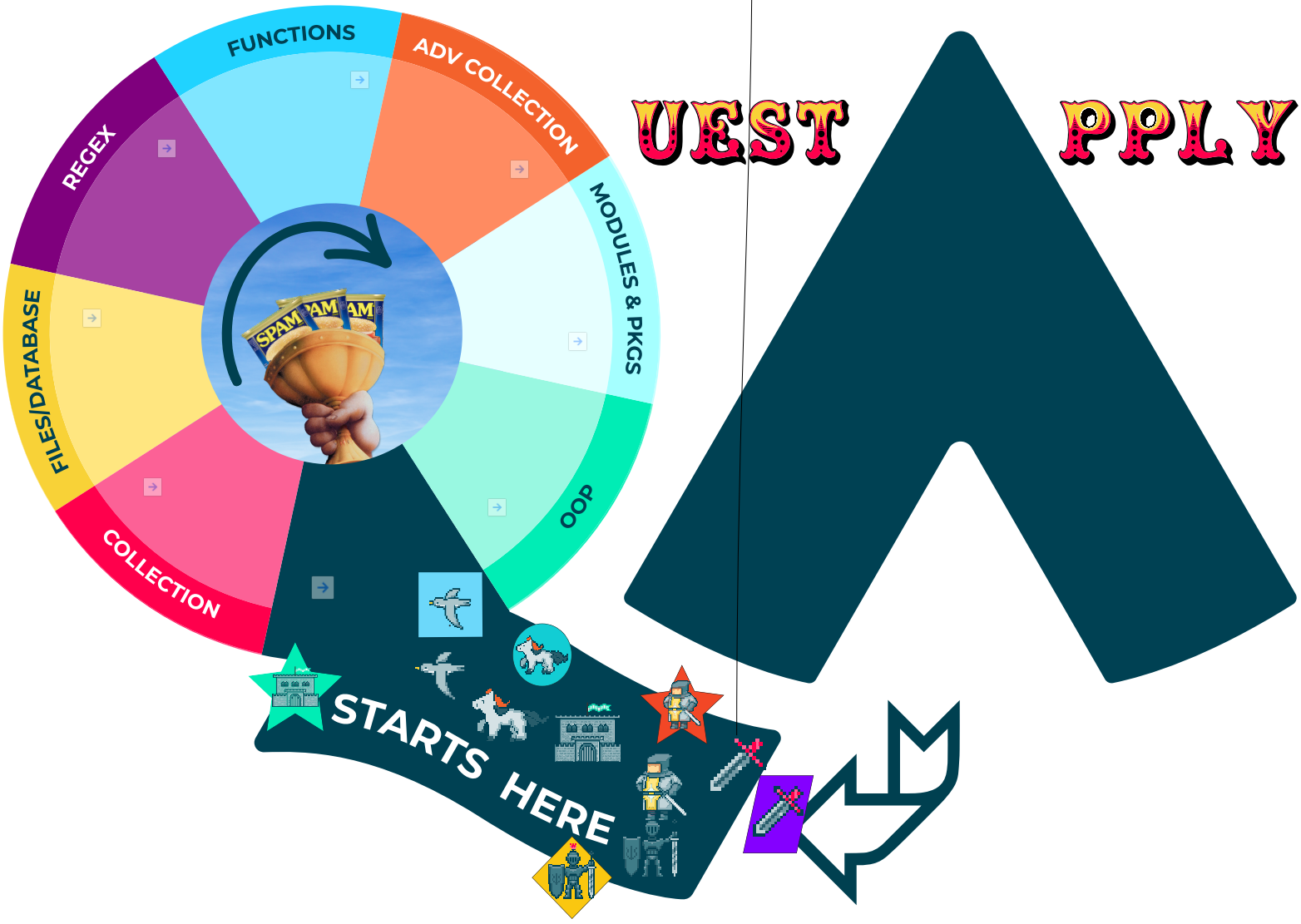
```python
#! /bin/python
# Name:        weather_data.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: Prompt user for city/country and then will get the online weather
#              from openweather.com, and the latest police incidents from
#              and either: display info in browser tab, save to DB or save to excel file.
#
# Requires:    This program requires a free API key to access online weather

"""
  Get, display and save weather data for a city.
"""

# Required libraries.
import sys
import re     # Provides regexp support
import webbrowser     # Provides functions for opening and displaying html content to web browsers.
import requests
import weather_db
import datetime

menu = """
  Weather Data
  ------------
  1. Get online weather data for city, country
  2. Display weather data to web browser
  3. Save weather data to local database
  4. Query all rows in local database
  5. Delete row in local database
  6. Delete all rows in local database
  7. Drop local database table

"""

# 8-wind compass rose
compass = [ "North" , "North East" , "East" , "South East" , "South" , "South West" ,
            "West" , "North West" , "North" ]

# API KEY ONLY TO BE USED IN CLASSROOM DEMONSTRATIONS!
# PLEASE subscribe at https://openweathermap.org/api for your own API-KEY.
# API_KEY = os.environ.get("OPEN_WEATHER_API")
API_KEY= "396a2d3386e07f92777ed7fee73f7c67"          # For testing... and to be removed.


def get_weather ():
    """ Get weather for a given city, country and return dict """

    city = input ("Please enter a city (eg. london): " ) or "london"
    country = input ("Please enter a country (eg. gb/uk): " ) or "gb"

    base_url = r"http://api.openweathermap.org/data/2.5/weather ?"
    full_url = f"{base_url }q={city }, {country },&appid= {API_KEY}"

    try :
        weather_data = requests .get (full_url )
        w_data = weather_data .json ()
    except Exception as err :
        # if there was an error opening the url then return error
        print (f"Error: {err . args }", file =sys . stderr )
        return "Error opening url"
    else :
        # if weather_data has message 'city not found' from web server then city is invalid.
        if re . search (r"city not found" , weather_data . text ):
            print ("City Not found" , file =sys . stderr )
            return None

    # return the weather condition as a dict.
    return w_data


def display_weather ( forecast :' dict ' )-> ' None' :
    """ Format and display weather information to a browser tab """
    # Parse fields from forecast dictionary.
    city = forecast [ "name" ]
    country = forecast [ "sys" ][ "country" ]
    desc = forecast [ "weather" ][ 0][ "description" ]
    icon = forecast [ "weather" ][ 0][ "icon" ]
    icon_url = f"http://openweathermap.org/img/wn/ {icon }@2x.png"
    temp = forecast [ "main" ][ "temp" ]
    humidity = forecast [ "main" ][ "humidity" ]
    speed = forecast [ "wind" ][ "speed" ]
    compass_idx = round ( forecast [ "wind" ][ "deg" ] // 45)
    direction = compass [ compass_idx ]
    feels_like = forecast [ "main" ][ "feels_like" ]
    now = datetime . datetime . now()
    time = now. strftime ( "%H:%M:%S")

    # Use CODE from DIGITAL to convert KELVIN to Celsius and add degrees symbol.

    # Format fields into html string plus optional WIDGET
    outlook = f"""
   <html>
     <head><title>Weather for {city }</title></head>
     <body><p><a> Weather for {city }, {country } at {time }</a></p></body>
     <body><p><tr> Weather is {desc } <IMG SRC=" {icon_url }" ALT="Weather" WIDTH=64 HEIGHT=64> </tr></p></body>
     <body><p> Temp is {temp } but feels like {feels_like } </p></body>
     <body><p> Wind is {speed } towards {direction }</p></body>
     <body><p> Humidity is {humidity } </p></body>
     <body></body>
   </html>
  """

    # write forecast to html file
    try :
        f_html = open ('weather.html' , 'w' )
        f_html . write ( outlook )
        f_html . close ()
    except Exception as err :
        print (f"Error: {err . args }", file =sys . stderr )

    # display weather forecast to new web browser tab
    try :
        webbrowser . open_new_tab ("weather.html" )
    except webbrowser . Error as err :
        print ( err , file =sys . stderr )
    return None

def weather_menu ():
    """ Menu for Weather Data """
    data = weather_db .Weather_db()        # Instantiate DB object
    city_w = {}
    while True :
        print ( menu)
        option = input ( "Enter an option (1-7, [qQ=quit]): " )
        if option == "1" :
            city_w = get_weather ()
        elif option == "2" :
            if city_w :
                display_weather ( city_w )
            else :
                print ( "No weather downloaded" )
        elif option == "3" :
            data .create_table()
            data .insert_row( table_name ="weather" , city =f" {city_w ['name' ]}"
             ,                  country =f" {city_w ['sys' ][ 'country' ]}"
             ,                  wind_direction =f" {city_w ['wind' ][ 'deg' ]}"
             ,                  temp =f" {city_w ['main' ][ 'temp' ]}")
            data .commit()
        elif option == "4" :
            data .query_all()
        elif option == "5" :
            row = input ( "Choose a RowID to delete? " )
            data .delete_row( row)
            data .commit()
        elif option == "6" :
            data .delete_all_rows()
            data .commit()
        elif option == "7" :
            data .drop_table()
        elif option . lower () == "q" :
            print ( "Quitting..." )
            break
        else :
            print ( "Invalid option" )

    return None

def main ():
    """ This module can be run directly to retrieve weather data """
    weather_menu ()
    return None

if __name__ == "__main__" :
    main ()
    sys . exit ( 0)
```

```
#! /bin/python
# Name:       police_data.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: This program will allow the user to retrieve publicly
# available Police Forces, crime and stop and search information for
# specific areas using simple HTTP GET requests.
"""
   Docstring: This program/module will..
"""
import  webbrowser
import  requests
import  sys
import  pprint

app_name = "Welcome to PDCA - the Police Data Crime App"
menu = """
   Police Data
   -----------
   1. List of Police Forces
   2. Crimes by location
   3. Stop and Search by Location

"""
base_url = r "https://data.police.uk/api/"

def getPoliceForces ():
    """ Display List of Police forces """
    try :
        full_url = base_url + "forces"
        force_data = requests . get ( full_url ) # HTTP GET url page.

        for force in force_data . json ():
            print ( f" {force ['id' ]:>30s} : {force ['name' ]:<20s} ")
        print ()
    except Exception as err :
        print ( f "Error, cannot retrieve info: [ {err }]" , file =sys . stderr )
    return None

def getCrimeByLoc ():
    """ Display Police Crime data for a specific lat/long """
    date = input ( "Enter a date (YYYY-MM): " )
    location = input ( "Enter a Lat/Long (eg. 51.506/-0.075 [London Bridge]): " )
    if not location :
        lat = "51.506"
        lon = "-0.075"
    else :
        lat , lon = location . split ( "/" )

    try :
        full_url = base_url + "crimes-at-location?lat=" + lat + "&lng=" + lon + "&date=" + date
        crime_data = requests . get ( full_url )
        for crime in crime_data . json ():
            print ( f" {crime ['category' ]}, {crime ['location_type' ]}, "
                    f" {crime ['outcome_status' ]['category' ] if crime ['outcome_status' ] else 'No Investigation' }, "
                    f" {crime ['location' ]['street' ]['name' ]}")
        print ()
    except Exception as err :
        print ( f "Error, {err . args }", file =sys . stderr )
        return None

    return None

def getStopByArea ():
    """ Display Police Stop Data for a specific lat/long """
    date = input ( "Enter a date (YYYY-MM): " )
    location = input ( "Enter a Lat/Long (eg. 51.506/-0.075 [London Bridge]): " )
    if not location :
        lat = "51.506"
        lon = "-0.075"
    else :
        lat , lon = location . split ( "/" )

    try :
        full_url = base_url + "stops-street?lat=" + lat + "&lng=" + lon + "&date=" + date
        stops_data = requests . get ( full_url )
        for crime in stops_data . json ():
            print ( f" {crime ['object_of_search' ]!s} : "
                    f" {crime ['gender' ]} ( {crime ['age_range' ]}), {crime ['type' ]}, "
                    f" {crime ['location' ]['street' ]['name' ]}")
        print ()
    except Exception as err :
        print ( f "Error {err . args }", file =sys . stderr )
        return None
    finally :
        print ()

    return None

def police_menu ():
    """ Menu for Police Crime Data """
    while True :
        print ( app_name )
        print ( "-" * len ( app_name ))
        print ( menu)

        option = input ( "Please choose an option (1-3 [qQ]=quit):" )
        if option == "1" :
            getPoliceForces ()
        elif option == "2" :
            getCrimeByLoc ()
        elif option == "3" :
            getStopByArea ()
        elif option . lower () == "q" :
            break
        else :
            print ( "Invalid option" )

    return None

def main ():
    """ This module can be run directly to retrieve police crime data """
    police_menu ()
    return None

if __name__ == "__main__" :
    main ()
    sys . exit ( 0 )
```




```
# Encryption
# Name:        weather_db.py
# Author:      QA2.0, Donald Cameron
# Version:     v1.0
# Description: This module defines a Weather class for storing data
# in a python3 database.
"""
    This module describes a Class of Weather objects which can create/drop/alter
    and insert/delete rows in a weather database.
"""
import  sqlite3
import  sqlite3
import  pprint

class    Weather_db:
    # Class variable storing location of DB
    # Could store this in an external file or environment variable
    DB_LOC =  "C:\\labs\\weather_db.sqlite"

    def    __init__ ( self ):
        try:
            self.__db_conn =  sqlite3.connect ( Weather_db.DB_LOC)
            self.cur =  self.__db_conn.cursor ()
        except  Exception as  err :
                print  ( "Initialization")
                # No return as not explicitly called


    def  create_table  ( self ,  table_name ="weather" ):
        self.cur.execute  ("""CREATE TABLE IF NOT EXISTS  {table_name
            } (id      INTEGER PRIMARY KEY
            ,city      VARCHAR(140)
            ,country   VARCHAR(50)
            ,date      DATE DEFAULT CURRENT_DATE
            ,description VARCHAR(50)
            ,temp      FLOAT
            ,humidity  FLOAT
            ,wind_speed FLOAT
            ,wind_direction VARCHAR(2)
            );""".format(table_name = table_name))
        return  None


    def  drop_table  ( self ,  table_name ="weather" ):
        """ Drop table if exists """
        option =  input ("Are you sure you want to drop  {table_name} ( Y/n)?" )
        if  option  ==  'Y':
            self.cur.execute  ("""DROP TABLE IF EXISTS  {table_name  }""".
            return  None


    def  query_all  ( self ,  table_name ="weather" ):
        """ Query and return all rows in dictionary( to output)"""
        sql = ( "SELECT * FROM {table_name  }".
        try:
            self.cur.execute ( sql )
            rows =  self.cur.fetchall  ()
            for  row  in  rows:
                print  (row)
        except  Exception as  err :
            print  ( f"Error accessing  {table_name  } | { err  } | \n ", file =sys.stderr  )

        return  None


    def  insert_row  ( self ,  table_name ="weather"  ** kwargs ):
        """ Insert new row into weather db table """
        weather =  { 'id' :  None, 'city' :  None, 'country' :  None,
                     'date' :  'DEFAULT', 'description' :  'N/A' ,  'temp' :  None,
                     'humidity' :  None,  'wind_speed' :  None,  'wind_direction' :  None}
        weather .update ( kwargs )
        pprint .pprint ( weather )
        sql = ("INSERT INTO  {table_name  } VALUES (? ,? ,? ,? ,? ,? ,? ,?)".
        try:
            self.cur.execute ( sql ,  weather ['id' ],  weather ['city' ],  weather ['country' ],
                               weather ['date' ],  weather ['description' ],  weather ['temp' ],
                               weather ['humidity' ],  weather ['wind_speed' ],  weather ['wind_direction'  ] )
        except  Exception as  err :
            print  ( f"Cannot insert row,  {err  }", file =sys.stderr  )

        return  None


    def  delete_row  ( self ,  row_id  ,table_name ="weather" ):
        """ Delete one row into weather db table """
        try:
            sql =  f"DELETE FROM {table_name  } WHERE id= {row_id  }"
            self.cur.execute ( sql )
        except  Exception as  err :
            print  ( f"Error accessing  {table_name  } | { err  } | \n ", file =sys.stderr  )
        return  None


    def  delete_all_rows  ( self ,  table_name ="weather" ):
        """ Delete all rows in the the table """
        try:
            sql =  f"DELETE FROM {table_name  }"
            self.cur.execute ( sql )
        except  Exception as  err :
            print  ( f"Error accessing  {table_name  } | { err  } | \n ", file =sys.stderr  )
        return  None


    def  commit ( self ):
        """ Commit changes to database """
        self.__db_conn.commit ()
        return  None


    def  close  ( self ):
        self.__db_conn.close ()
        return  None

# Example of operator overloading
    def  __str__ ( self ):
        """ Return name of DB connection as str """
        try:
            self.__db_conn
            return  f"DB still connected"
        else :
            return  f"DB not connected"

    def  __del__ ( self ):
        """ Close connection automatically when object is deleted """
        self.__db_conn.close ()
        return  None
```

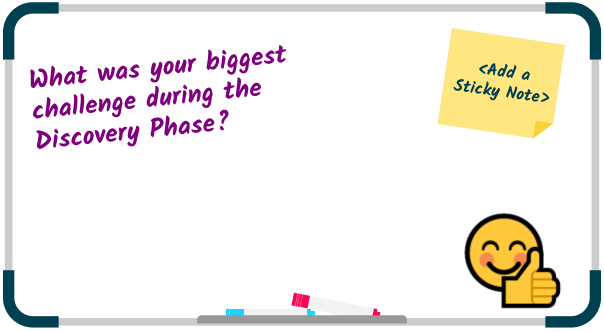
```
#! /bin/python
# Name:     movies.py
# Author:   QA2.0, Donald Cameron
# Revision:  v1.0
# Description: This program will download the top 250 movies from IMDB
# and will allow the user to display the top-n ranked movies or search for
# for their favourite movies.
"""
  Download and display the Top 250 Movies Data from IMDB.
"""
import   sys
import   imdb
import   re

movie_menu =  """
   Movies Menu

  1. Get online movie ranking from IMDB
  2. Display top ranking movies
  3. Search for movie
"""
def   get_movies   ():
    """ Get the top 250 movies online from IMDb """
    ia  =  imdb.IMDb()
    movies  =  []

    for   rank ,  movie  in  enumerate  ( ia. get_top250_movies(),        start  =1 ):
            movies [ rank ] =   str  ( movie)

    return     movies

def   display_movies    ( movies ,  top ):
    """ Display top movies in a given dict """
    if   not   movies :
        print   ( "No movies"    )
    else :
        for   rank  ,  name  in   movies  .items()  :
            print   ( " {:rank  >4d}  .   {name:<30s}  " )
            if   str  ( rank ) ==    int  ( top  )    :  break
    return     None

def   search_movies    ( pattern  =r" "  ,  movies =None):
    """ Search for pattern in a given dict of movies """
    if   movies   is   None:
        movies  =  []
    if   movies :
        for   rank  ,  name  in   movies   .items   ():
            n =   re  .search   ( pattern   ,  name,   re  .IGNORECAS):
            if   n:
                print   ( " {:rank  >4d}    {name:<30s}  " )
    else :
        print   ( "No movies to search"       )
    return     None

def   menu( ):
    """ Movie Menu """
    films   =  {}
    while   True :
        print   ( movie_menu )
        option   =   input   ( "Enter option (1-3, [q]Q=quit]): "                )
        if   option   ==  "1":
            films   =   get_movies   ()
        elif   option   ==  "2":
            max =   input   ( "How many top movies do you want [default=250] "                )
            if   not   max   :  max =   250
            display_movies     ( films  ,  max)
        elif   option   ==  "3":
            pattern   =   input  ( "Enter Regex search pattern: "                )
            search_movies    ( pattern   ,  films  )
        elif   option   .lower  () ==   "q"  :
            break
        else :
            print   ( "Invalid option"       )

    return     None

def   main ( ):
    menu( )
    return     None

if   __name__   ==   "__main__"  :
    main ( )
    sys  .exit  ( 0)
```


FUNCTIONS
ADV COLLECTION
MODULES & PKGS
OOP
COLLECTION
FILES/DATABASE
REGEX
SPAM
QUEST
PPLY
STARTS HERE

Digital Phase Activities

These activities should have been completed as part of the Digital Phase of your learning

Course Introduction	if, elif and else	len(), min(), max(0) and sum()
Introduction to Python 3	Indentation and 4 spaces	Mutable and immutable
IDLE & REPL prompt	Comparison operators	Repetition using while and for loops
Variables & objects	Boolean and 'in' operators	Introduction to file handling and 'with'
Comments	Unicode and special chars	Reading and writing text files
PEP 8 Style Guide	str indexing and slicing	Reading and writing csv files
keyboard inpu()	str concatenation and repetition	Reading and writing to DB files
int, float, str, list and booleans	str methods	Introduction to user functions
type(), dir() and help()	str formatting using f-strings	Introduction to Python Std Library
Casting/conversion	Collections introduction	Importing Modules
Math and string operators	Tuples, lists, dict and sets	Introduction to Unit Testing
Flow control/decision making	Collection indexing and slicing	Introduction to Error Handling



Mini Lab

Refresh digital concepts before main Quest

15 mins

During your Digital Phase you completed labs for a simple conversion tool for converting temperatures from Celsius to Fahrenheit. It is common to create simple tools for reading, converting and formatting text data.

In this mini-lab, you will be reading text data from a csv file and displaying the formatted weather information to the screen. You will need to create user functions for converting the temperature from Celsius to Fahrenheit and the wind speed from km/hr to mph.

Items to consider in your solution:-

1. PEP8 compliance, shebang line and comments.
2. User input for the filename.
3. Appropriate use of flow control.
4. Reading from a text file.
5. Use of error handling where necessary.
6. String formatting using f-strings.
7. Optional use of library module.

```
edinburgh,548206,8.3,868
london,8961989,10.8,690
paris,11078546,11.7,720
rome,4278350,15.8,878
washington,7766925,13.7,1088
berlin,3567000,10.1,669
buenos aires,15258000,17.3,1112
bangkok,10722815,27.7,1207
cape town,4709990,16.4,621
wellington,381900,12.5,926
beijing,20896820,12.7,566
```

```
          City     Pop      Rainfall  Temp
-----------------------------------------
     Edinburgh: 548206     46.940" 34.17°F
       London: 8961989     51.440" 27.17°F
        Paris: 11078546    53.060" 28.35°F
         Rome: 4278350     60.440" 34.57°F
   Washington: 7766925     56.660" 42.83°F
       Berlin: 3567000     50.180" 26.34°F
 Buenos Aires: 15258000    63.140" 43.78°F
      Bangkok: 10722815    81.860" 47.52°F
   Cape Town: 4709990      61.520" 24.45°F
   Wellington: 381900      54.500" 36.46°F
      Beijing: 20896820    54.860" 22.28°F
-----------------------------------------
```

```
edinburgh,548206,8.3,868
london,8961989,10.8,690
paris,11078546,11.7,720
rome,4278350,15.8,878
washington,7766925,13.7,1088
berlin,3567000,10.1,669
buenos aires,15258000,17.3,1112
bangkok,10722815,27.7,1207
cape town,4709990,16.4,621
wellington,381900,12.5,926
beijing,20896820,12.7,566
```

City	Pop	Rainfall	Temp
Edinburgh:	548206	46.940"	34.17°F
London:	8961989	51.440"	27.17°F
Paris:	11078546	53.060"	28.35°F
Rome:	4278350	60.440"	34.57°F
Washington:	7766925	56.660"	42.83°F
Berlin:	3567000	50.180"	26.34°F
Buenos Aires:	15258000	63.140"	43.78°F
Bangkok:	10722815	81.860"	47.52°F
Cape Town:	4709990	61.520"	24.45°F
Wellington:	381900	54.500"	36.46°F
Beijing:	20896820	54.860"	22.28°F

Mini Lab Solution/s

Refresh digital concepts before main Quest

```
#! /bin/python
# Name:        demo_mini_lab.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will review the topics covered in
# the QA 2.0 Digital session including objects, string handling,
# file interaction, flow control, simple exception handling.
"""
   Display City weather information.
"""

def   c_to_f  ( temp ):
      """ Return temp in Fahrenheit """
      return    ( float   ( temp ) *   9/ 5 ) +   32

def   mm_to_inch  ( height  ):
      """ Return precipitation in inches """
      return     float   ( height  )/ 25.4


file   =  input  ( "Enter filename: "          )

try  :
      # Open file handle for Reading in Text mode.
      with   open ( file   ,  mode="rt"  )  as   fh_in  :
            # Print header line.
            print   ( f"{'City'    :>15s}    {'Pop'   :^10s}    {'Rainfall'      :^8s}    {'Temp'  :^8s}  " )
            print   ( "-" *  43 )

            for   line    in   fh_in  :
                  (          city  ,  pop,   temp ,   rain  ) =   line  .  split   ( "," )  # Split str into list.
                  temp_f  =   c_to_f  ( temp )  # Convert into celsius.
                  rain_i   =   mm_to_inch ( rain  )  # Convert into inches.
                  print   ( f"{city  . title    () :>15s} :   {pop :<10s}  "
                              f"   {temp_f  :<5.1f}    \N{double prime}     "
                              f"   {rain_i   :>5.2f}    \N{degree fahrenheit}          " )
            # Automatically close file handle.
      print   ( "-" *  43 )
except  :
      print   ( f "Error - could not open file                  {file    }" )
```

```
#! /bin/python
# Name:        demo_mini_lab_csv.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will review the topics covered in
# the QA 2.0 Digital session including objects, string handling,
# file interaction, flow control, simple exception handling
# and importing.
"""
   Display City weather information.
"""
import    csv

def   c_to_f  ( temp ):
      """ Return temp in Fahrenheit """
      return    ( float   ( temp ) *   9/ 5 ) +   32

def   mm_to_inch  ( height  ):
      """ Return precipitation in inches """
      return     float   ( height  )/ 25.4


file   =  input  ( "Enter filename: "          )

try  :
      # Open file handle for Reading in Text mode.
      with   open ( file   ,  mode="rt"  )  as   csvfile    :
            # Print header line.
            print   ( f"{'City'    :>15s}    {'Pop'   :^10s}    {'Rainfall'      :^8s}    {'Temp'  :^8s}  " )
            print   ( "-" *  43 )

            rows =   csv . reader   ( csvfile    ,  delimiter    =',' )
            for   line    in   rows :
                  (          city  ,  pop,   temp ,   rain  ) =   line
                  temp_f  =   c_to_f  ( temp )  # Convert into celsius.
                  rain_i   =   mm_to_inch ( rain  )  # Convert into inches.
                  print   ( f"{city  . title    () :>15s} :   {pop :<10s}  "
                              f"   {temp_f  :<5.1f}    \N{double prime}     "
                              f"   {rain_i   :>5.2f}    \N{degree fahrenheit}          " )
            # Automatically close file handle.
      print   ( "-" *  43 )
except  :
      print   ( f "Error - could not open file                  {file    }" )
```

```
#! /bin/python
# Name:        demo_mini_lab.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will review the topics covered in
# the QA 2.0 Digital session including objects, string handling,
# file interaction, flow control, simple exception handling.
"""
   Display City weather information.
"""

def   c_to_f  ( temp ):
      """ Return temp in Fahrenheit """
      return    (  float   ( temp ) *    9/ 5) +    32

def   mm_to_inch  ( height   ):
      """ Return precipitation in inches """
      return      float   ( height   )/  25.4



file    =   input  ( "Enter filename: "          )

try  :
      # Open file handle for Reading in Text mode.
      with    open ( file    ,   mode="rt"   )   as   fh_in  :
            # Print header line.
            print   ( f "{'City'     :>15s}    {'Pop'   :^10s}    {'Rainfall'       :^8s}    {'Temp'   :^8s}  ")
            print   ( "-"   *   43)

            for   line    in   fh_in   :
        (             city   ,   pop ,   temp ,   rain   ) =    line   . split    ( "," )   # Split str into list.
                  temp_f   =   c_to_f   ( temp )   # Convert into celsius.
                  rain_i     =   mm_to_inch  ( rain   )   # Convert into inches.
                  print   ( f "{city    . title     () :>15s}   :   {pop :<10s}   "
                              f"   {temp_f   :<5.3f}    \N{double prime}       "
                              f"   {rain_i    :>5.2f}    \N{degree fahrenheit}          ")
            # Automatically close file handle.
      print   ( "-"   *   43 )
except   :
      print   ( f "Error - could not open file                  {file    }" )
```

```
#! /bin/python
# Name:        demo_mini_lab_csv.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will review the topics covered in
# the QA 2.0 Digital session including objects, string handling,
# file interaction, flow control, simple exception handling
# and importing.
"""
   Display City weather information.
"""
import    csv

def   c_to_f   ( temp ):
      """ Return temp in Fahrenheit """
      return    (  float   ( temp ) *    9/ 5) +    32

def   mm_to_inch  ( height   ):
      """ Return precipitation in inches """
      return      float   ( height   )/  25.4


file    =   input   ( "Enter filename: "          )

try  :
      # Open file handle for Reading in Text mode.
      with    open ( file    ,    mode="rt"    )    as    csvfile     :
            # Print header line.
            print   ( f "{'City'     :>15s}     {'Pop'    :^10s}     {'Rainfall'       :^8s}     {'Temp'   :^8s}   " )
            print   ( "-"   *    43 )

            rows =    csv . reader    ( csvfile     ,    delimiter     =','    )
            for    line     in    rows :
        (              city    ,    pop ,    temp ,    rain    ) =    line
                  temp_f   =    c_to_f   ( temp )   # Convert into celsius.
                  rain_i     =    mm_to_inch  ( rain    )   # Convert into inches.
                  print    ( f "{ city    . title     () :>15s}    :    {pop :<10s}   "
                              f"   {temp_f  :<5.3f}     \N{double prime}      "
                              f"   {rain_i    :>5.2f}     \N{degree fahrenheit}          " )
            # Automatically close file handle.
      print   ( "-"   *    43 )
except   :
      print    ( f "Error - could not open file                    {file    }" )
```

Questions...

Now is your chance to clear up loose ends from the Digital Phase

Short Question & Review

<Add a Sticky Note>

PyCharm

Lets get ready to code

Download Community Edition from here:
https://www.jetbrains.com/pycharm/download/#section=windows
Documentation for PyCharm can be found here:
https://www.jetbrains.com/help/pycharm/quick-start-guide.html

PyCharm is a dedicated Python IDE providing more functionality and tools and more engaging experience for developers including project management, virtual environments and GitHub integration.

3 Editions

- Community - Free
- Professional (data Science and version control)
- Edu (Learning)

Multi-platform

Cool Features

- Python shell command line with colour coded highlighting and error messages
- Multi-tab text editor with colour coded highlighting, auto indentation and completion
- Search and replace tool
- Powerful debugger with breakpoints
- Support virtual environments
- Support Projects and Packages
- Integrated support for GitHub, Mercurial and Subversion etc.

PyCharm

Lets get ready to code

Mostly everything you do in **PyCharm** revolves around **Projects**.

They act as a basis for grouping related code, allowing refactoring/renaming within the group, better management of modules etc.

Start Pycharm CE (Community Edition)

Create a new Project and choose folder location inside **C:\labs.**

Select VirtualEnv to create an isolated install of Python with its own Interpreter and modules.

Choose a Base Interpreter and select Inherit Global Site Packages box.

File>**Settings**

File>Settings>Editor>**Font**

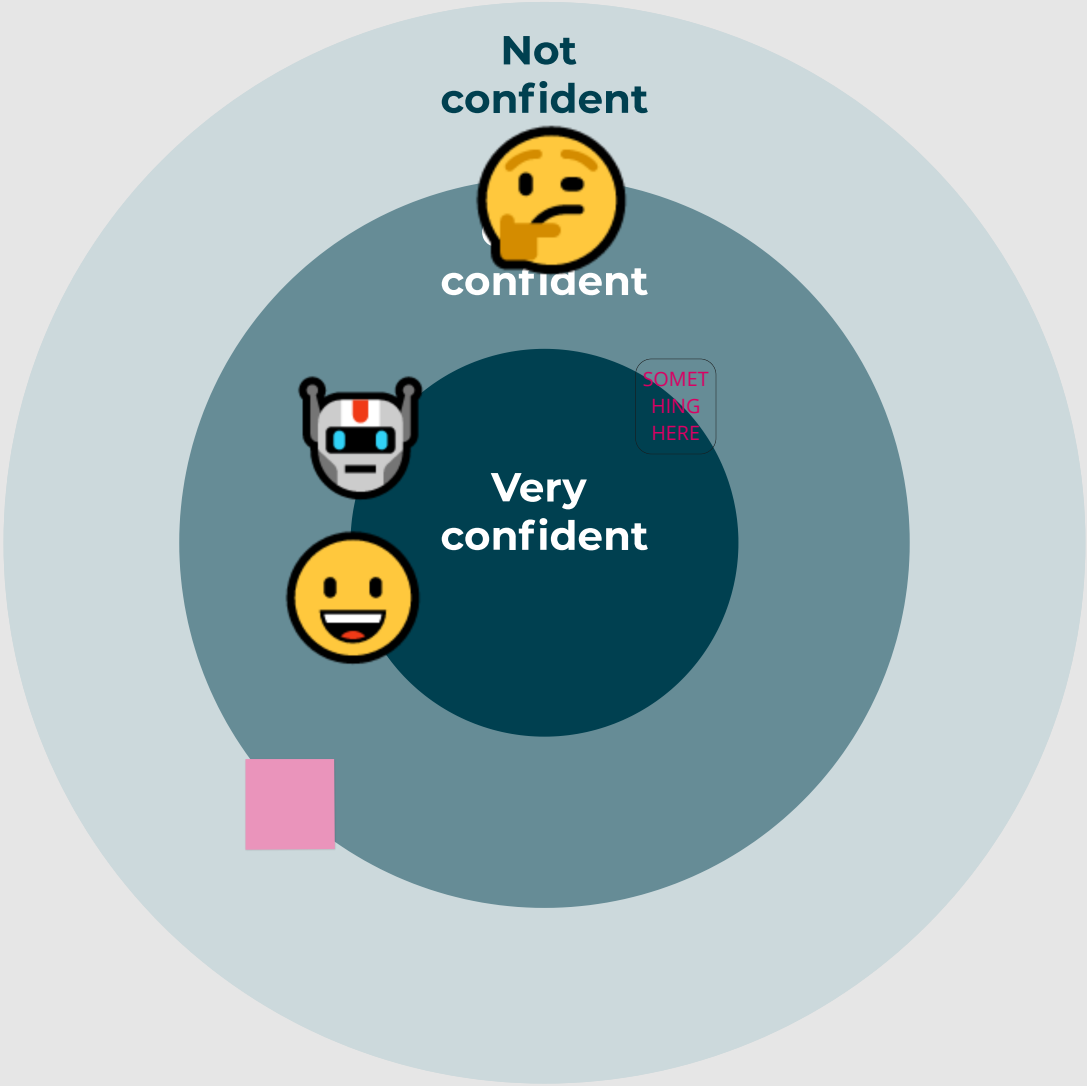
File>Settings>Editor>Font>**Color Scheme**

File>Settings>Editor>Font>File and Code Templates>**Python**

Review Navigation Bar and Editor.

Project>New>**Python File**

Compile and run script. 



Back to the quest

Collections

Storing things in an ordered or unordered way

Where do I put all these things?

Tuples LISTS DICTIONARIES SETS

COLLECTIONS

Ordered Collections

Ordered collection of characters
Immutable = Read Only
Index using [n] and [-n]
Slicing using [start:end]
message = "hello world"
Convert to string using str()

Ordered collection of objects
Mutable = Read/Write
Index using [n] and [-n]
Slicing using [start:end]
knights = ['eric', 'john', 'terry']
Dynamic and flexible (many methods)
Convert to list using list()

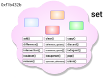
Ordered collection of objects
Immutable = Read Only
Index using [n] and [-n]
Slicing using [start:end]
knights = ;eric', 'john', 'terry'
Simple and fast
Convert to tuple using tuple()

Ordered collection of single bytes/raw binary
Mutable = Read/Write
Index using [n] and [-n]
Slicing using [start:end]
ba_message= bytearray([0x680a, 0x6f, 0x6c])
Dynamic and flexible (many methods)
Convert to array of bytes using bytearray()

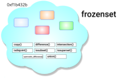
Ordered collection of single bytes/raw binary
Immutable = Read Only
Index using [n] and [-n]
Slicing using [start:end]
message = b"hello world"
Convert to bytes using bytes()

Unordered Collections

Unordered/ordered(Py3.6) collection of characters
Mutable = Read/write
Index using ['key']
Keys are unique
Dynamic and faster searching
cities = {'Glasgow': 19, 'Inverness': 21}
Convert to dictionary using dict()

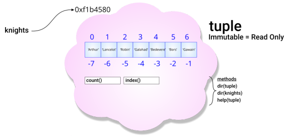


Unordered collection of objects
Mutable = Read/Write
No indexes
Objects are unique (no duplicates)
Can combine with other sets using SET operators
knights = {'eric', 'john', 'terry', 'terry'}
Convert to set using set()



Unordered collection of objects
Immutable = Read Only
No indexes
Objects are unique (no duplicates)
Can combine with other sets using SET operators
knights = frozenset({'eric', 'john', 'terry', 'terry'})
Convert to frozen set using frozenset()

TUPLES

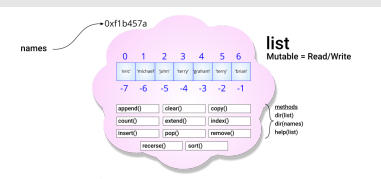


Try these statements at the Python shell and explain what is happening?

```
>>> a = 10
>>> b = a
>>> (a, b) = (b, a)
>>> print(a)
>>> print(b)
>>> (a, b, c) = range(0, 3)
>>> print(a, b, c)
>>> (a, b, c) = (10, 20, 30, 40, 50)
>>> (a, b, *c) = (10, 20, 30, 40, 50) # This is called unpacking and is useful when LHS and RHS are not in balance.
>>> print(a, b)
>>> print(c)
>>> comment = ("Tis but a scratch")
>>> print(type(comment))
>>> comment = ("Tis but a scratch", )
>>> print(type(comment))
```

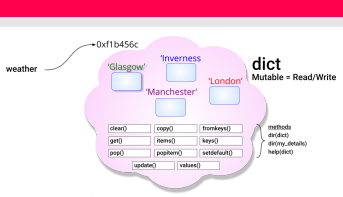
```
#! /bin/python
# Name:    demo_tuples.py
# Author:  QA2.0, Donald Cameron
# Revision:  v1.0
# Description: This program will demonstrate how to create and access a tuple
# which is an Immutable (Read-only) Ordered Collection of objects.
"""
  Creating, indexing and accessing objects within a Tuple.
"""
import sys

def main():
    """ """
    scottish_bands = ("The Proclaimers", "Franz Ferdinand", "Primal Scream"
                      , "Simple Minds")

    print(f"Scottish bands is of {type(scottish_bands)}")
    print(f"There are {len(scottish_bands)} bands in {scottish_bands}.")

    # We can Index[] and Slice [start:end] a tuple.
    print(f"The 1st band is {scottish_bands[0]}")
    print(f"The last band is {scottish_bands[-1]}")
    print(f"First three bands = {scottish_bands[0:3]}")

    try:
        # But cannot modify a Tuple as it is immutable.
        # Try this without the try/except block.
        scottish_bands[2] = "Deacon Blue"
    except TypeError:
        print("Cannot modify a Tuple")

    print(f"Primal Scream exists {scottish_bands.count('Primal Scream')} "
          f"at index {scottish_bands.index('Primal Scream')}")
    return None


if __name__ == "__main__":
    main()
    sys.exit(0)
```

LISTS




```
#! /bin/python
# Name:         demo_lists.py
# Author:       GA2.0, Donald Cameron
# Revision:     v1.0
# Description: This program will demonstrate how to create, grow, shrink and access
# objects within a list.
"""
    Playing with a list of numeric (numbers) and non-numeric (movie titles) data.
"""
import    sys

def   main ():
    """ Create, grow, shrink and play with lists (numeric and non-numeric) """
    numbers = [  250,  32,  46,  9,  31,  79,  121 ]
    movies  = [  'Local Hero'  ,  'Gregory's Girl'  ,  'Shallow Grave'  ]

    # A few cool built-in functions for finding, length, smallest
    # largest and sum of numbers.
    print  ( f"Length of numbers =          {len ( numbers )}" )
    print  ( f"Smallest number =            {min( numbers )}" )
    print  ( f"Largest number =             {max( numbers )}" )
    print  ( f"Sum of numbers =             {sum( numbers )}" )

    # Some of these functions (Not sum) can also be used on non-numeric data.
    print  ( f"Number of movies =          {len ( movies )}" )
    print  ( f"1st movie in char order =   {min( movies )}" )
    print  ( f"Last movie in char order =  {max( movies )}" )

    # We can Index and Slice [start:end] lists.
    print  ( f"1st movie =                 {movies [ 0]}" )
    print  ( f"Last movie =                {movies [- 1]}" )
    print  ( f"Last three movies =         {movies [- 3:]}" )

    # Let's try some list methods for adding to the lhs, rhs
    # and within the list. List will be re-indexed if required.
    movies . append ( 'Trainspotting'     )  # Append one object to RHS.
    movies . extend ( ['Braveo'  ,  'Braveheart'     ])  # Extend multiple objects to RHS.
    movies . insert  ( 0,  'Comfort & Joy'  )  # Insert one object to LHS (before index 0).
    movies . insert  ( 3,  'The Angel's Share'     )  # Insert on object before index 3.
    print  ( f"Scottish movies =          {movies :}" )

    # Let's try some list methods for removing from lhs, rhs
    # and within the list. List will be re-indexed if required.
    last   = movies . pop()  # Last object removed and optionally returned.
    first  = movies . pop( 0 )  # First object removed and optionally returned.
    movies . pop( 3)  # Remove object at index 3.
    print  ( f"Scottish movies =          {movies :}" )

    # movies.clear() # Empties List.
    # films = movies.copy()# Copies List.
    # Notice how print parameters can span across lines.
    print  ( f"I spotted Trainspotting          {movies . count ( 'Trainspotting'      )} "
             f"at index          {movies . index ( 'Trainspotting'      )} ")

    # The built-in sorted function returns a sorted list.
    print  ( f"Movies sorted =             {sorted  ( movies ,  key =str  ,  reverse  =False  )}")
    print  ( f"Movies sorted =             {sorted  ( movies ,  key =str  ,  reverse  =True  )}")
    print  ( f"Movies sorted =             {sorted  ( movies ,  key =len  )}" )  # Bespoke sort.

    movies . sort  ()  # Sorts list in place.
    movies . reverse  ()  # Reverses list in place.
    movies . remove ( 'Trainspotting'      )

    print  ( f"List of movies =            {movies }" )  # Saturday night viewing.
    return    None

if   __name__  ==  "__main__" :
    main()
    sys . exit  ( 0)
```

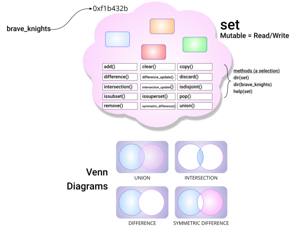
DICTIONARIES



Since 2016, Python 3.6 stores dictionaries as ordered - in the order that the key: objects are assigned, but this may change in a future implementation, so don't assume!

```
#! /usr/bin/python
# Name:       demo_dictionaries.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: This program will demonstrate how to create, grow and shrink
# dictionaries and use keys and iterator for loops to access objects within.
# Dictionaries are mutable collections that can store multiple objects and
# access using UNIQUE keys.
"""
  Weather Program to store and display average (temp, precipitation and humidity)
  for UK cities in 2020.
"""
import   sys
import   pprint

def   main():
    """ Display weather info for uk cities """

    # Create a dictionary to store annual average weather information
    # (Mean Temp, Precipitation, Humidity) for UK Cities in 2020.
    weather   = {  'Glasgow'    : [  9,   53.6 ,   87 ],
                   'London'     : [  12,   49.7 ,   81 ],
                   'Edinburgh'  : [  9,   37.9 ,   81 ],
                   'Manchester'  : [  7,   35.8 ,   86 ],
                   'Thurso'     : [  6, 89.6 ,   85 ]
    }

    # Add two new key: objects to weather dictionary
    weather  [ 'Southampton'   ] = [  8,   28.4 ,   93 ]
    weather  [ 'Inverness'     ] = [  6,   23.5 ,   83 ]

    # weather.clear() # Empty dictionary
    # w_info = weather.copy() # Copy dictionary
    weather   .pop ( 'Thurso'     ,  False  ) # Remove Thurso as not a City.
    # weather.popitem() # Remove next key object found.

    print   ( f"Number of cities recorded =          {len ( weather  ) }" )
    print   ( f"Weather info for Glasgow =          {weather   [ 'Glasgow'   ] }" )
    print   ( f"Average precipitation =          {weather   [ 'Glasgow'   ][ 1 ] } mm")

    # ITERATE through the key and objects within the dict.
    # keys() returns a VIEW into next key.
    for   city   in   weather   .keys ():
        print   ( f" { city  } average =       {weather   [ city  ] } ")

    # ITERATE through the values within the dict.
    # values() returns a VIEW into the next value.
    for   w_info   in   weather   .values ():
        print   ( f" { w_info  } " )

    # ITERATE through the (values, objects) within the dict.
    # items() returns a VIEW into the next pair of (key, value).
    for   city  ,  w_info   in   weather   .items ():
        print   ( f" { city  }  weather info =       { w_info  }" )
    return   None

if   __name__   ==   "__main__" :
    main ()
    sys   .exit   ( 0 )
```

SETS



There are many Brave Knights who would also like to be Lumberjacks and vice-versa, so we will attempt to combine sets of Knights and sets of Lumberjacks using common SET operators and methods.

```
#! /bin/python
# Name:       demo_dictionaries.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: This program will demonstrate how to create, grow and shrink
# and combine sets using SET operators and methods.
# Sets are mutable collections that store multiple UNIQUE objects (with no keys).
"""
  The joy of SETS!
"""
import sys

def main():
    """ Combining collections of Brave Knights and Lumber Jacks """
    # Create two sets, one with objects and one empty.
    brave_knights = {'donald', 'brian', 'terry', 'eric', 'michael'}
    lumber_jacks = set() # Creates an empty set.

    # Sets are Mutable so can be grown (add) and shrunk(pop/remove).
    brave_knights.add('john')
    brave_knights.add('terry') # Sets automatically remove duplicates!
    lumber_jacks.add('donald')
    lumber_jacks.add('michael')
    lumber_jacks.add('graham')

    # brave_knights.pop() # Remove next object found.
    # brave_knights.remove('') # Remove object by name.

    # Sets can be combined using operators or methods. Remember Venn diagrams?
    # Combine SETS using SET methods.
    print(f"Brave Knights and Lumber Jacks = {brave_knights.union(lumber_jacks)}")
    print(f"Brave Lumber Knights = {brave_knights.intersection(lumber_jacks)}")
    print(f"Strictly Brave Knights ONLY = {brave_knights.difference(lumber_jacks)}")
    print(f"Everyone BUT Brave Lumber Knights = {brave_knights.symmetric_difference(lumber_jacks)}")
    print("-" * 60)
    # Combine SETS using SET operators.
    print(f"Brave Knights and Lumber Jacks = {brave_knights | lumber_jacks}")
    print(f"Brave Lumber Knights = {brave_knights & lumber_jacks}")
    print(f"Strictly Brave Knights ONLY = {brave_knights - lumber_jacks}")
    print(f"Everyone BUT Brave Lumber Knights = {brave_knights ^ lumber_jacks}")
    return None

if __name__ == "__main__":
    main()
    sys.exit(0)
```

Quiz

Collections Knowledge Check

5-10 mins

1. Name three ordered and two unordered collections?

Ordered?

string
list
tuple

Unordered

sets
dictionary

2. Is a tuple mutable?

No

3. The joy of sets! What would be printed from the following code?

```
>>> scottish_movies = {"Gregory's Girl", "Local Hero", "Comfort and Joy", "That Sinking Feeling"}
>>> fav_movies = {"The Hobbit", "Local Hero", "The Lord of the Rings"}
>>> print(scottish_movies & fav_movies)
```

{local hero}

4. Fill in the blanks:

Dictionaries have unique keys

Sets have unique elements

5. What would be printed from the following c

```
>>> movies = "Gregory's Girl", "Local Hero", "Comfort and Joy", "That
>>> x, *y, z = movies
>>> print(y)
```

[local hero, comfort and joy]

6. Write the print statement from question 3 using set methods?

print(scottish_movies.intersection(fav_movies))

To be re

To be

To b

To be revealed

Exercises

30 mins

Collections - exercises for 'brave' Knights

1

Write a Python script called **C:\labs\lotto.py** that will generate and display 6 unique random lottery numbers between 1 and 50. Think about which Python data structure is best suited to store the numbers! Use the Python help() function to find out which function to use from the python standard library called random.

2

Create a new script in **C:\labs** called **topTen.py**

a. Read the top 250 movies from the **C:\labs\top250_movies.txt** file and store them in a list called movies.
b. Print out the top 10 with rankings (right justified 5 characters) followed by a colon and space followed by name of the film.
c. Print out the first and last movie.
d. Modify the code to allow the user to choose the top N to be displayed.

Collections - stretch exercises for Kings

3

Create a reusable user function called **get_movies** which returns all the movie data into a list called movies.

4

Create another function called **display_movies** which accepts two parameters - a list of movies, and number of movies to be displayed.

5

Create another function called **search_movies** which accepts a simple string (to search), and the list of movies to search.

6

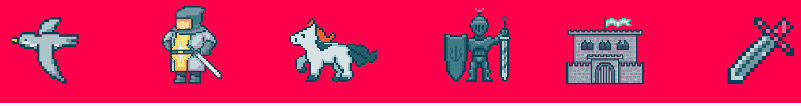
Now create a simple user menu which prompts the user for the following:

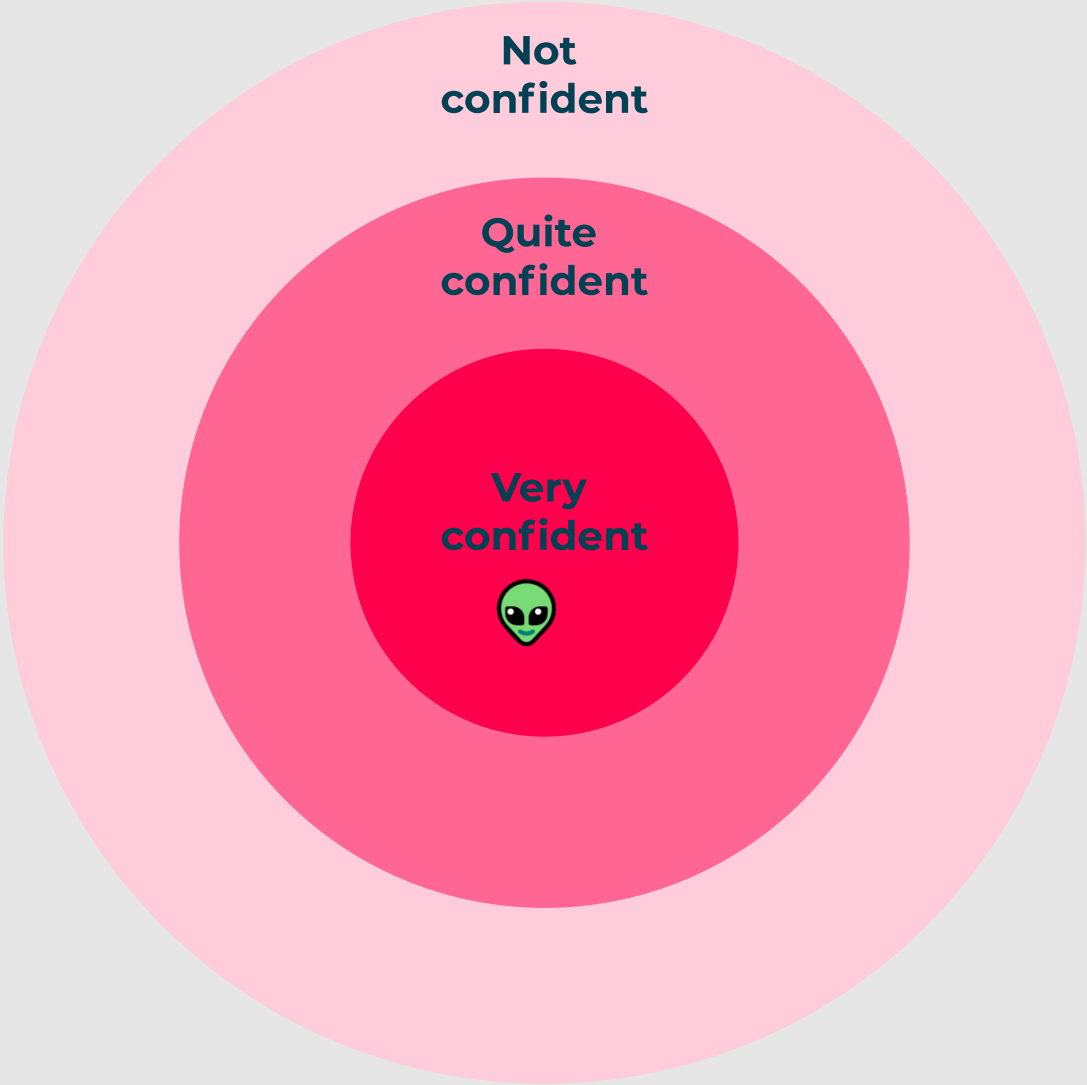
```
Movies Menu
----------------------
1. Get online movie ranking from IMDB
2. Display top ranking movies
3. Search for movie
Enter option (1-3, [qQ=quit]):
```

7

Extra kudos for having a main function and using the __name__ == "__main__" namespace trick.

Move your piece down as you complete the exercises





Back to the quest

Persistent Data

The Art of saving data to non-volatile storage

File Interaction Sequential Access

```
#! /bin/python
# Name:        demo_sequential_rw.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate how to Interact with the file
# system by opening/closing file handles for read, write and appending.
"""
   Write and read movie data to a text file.
"""
import    sys

def   main ():
      """ Demonstrate writing and reading to a text file. """
      movies  = {    'Donald'    : [  'Braveheart'      ,  'Brave'    ,  'Brigadoon'      ],
                     'Mira'    : [  'Matrix'      ,  'Mad Max'    ,  'Magnolia'      ],
                     'Sarah'    : [  'Seven'    ,  'Scream'    ,  'Saving Private Ryan'          ]
   }
      filename    =    r "C: \I   abs \movies.txt"          # Always use a raw string for paths.

      # Open file handle for WRITING in text mode.
      fh_out   =   open ( filename     ,  mode="wt" )

      # Iterate through Movie keys and write key: objects to file handle.
      for    name  in   movies . keys ():
            print   ( f " {name}:    {movies [ name] } ",    end =" \n " )
            fh_out  . write  ( f " {name}:    {movies  [ name] } \n " )  # Remember newline.
      fh_out   . close   ()    # Flush buffers and close file handle.

      # Open file handle for READING in text mode.
      fh_in   =   open ( filename     ,  mode="rt"    )

      # text = fh_in.read() # Read ENTIRE file into str object.
      # text = fh_in.read(30)  # Read NEXT 30 chars into str object.
      # text = fh_in.readline()  # Read NEXT line into str object.
      # print(text)

      # lines = fh_in.readlines()  # Read ENTIRE file into list object.
      # print(lines)
      # print(f"1st line = {lines[0]}")

      # Iterate through file handle and read one line at a time.
      # for name in open(filename, mode="wt"):
      for    name  in   fh_in   :
            print   ( name,   end ="" )
      fh_in   . close   ()     # Flush buffers and close file handle.
      return     None

if    __name__    ==    "__main__"   :
      main ()
      sys  . exit   ( 0 )
```

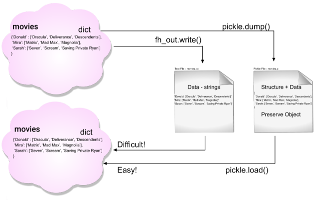
File Interaction TEXT Random Access

```
#! /bin/python
# Name:         demo_random_rw_text.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description: This program will demonstrate how to Interact with the
# file system by opening/closing file handles random reading using the
# seek() and tell() file handle methods.
"""
  Read movie data randomly from a TEXT file.
"""
import   sys

def   main ():
      """ Demonstrate random reading from a TEXT file. """

      filename   =   r "C: \I  abs  \movies.txt"        # Always use a raw string for paths.
      SOI =   0  # Start of file.
      CUI =   1  # Current Position (only on binary file).
      EOI =   2  # End of file (only on binary file).

      # Open file handle for READING in TEXT mode.
      fh_in   =   open ( filename   ,   mode="rt"   )

      # Seek to char position 50 from SOF and read next 30 chars.
      fh_in  . seek ( 50,   SOI)
      text   =   fh_in  . read  ( 30 )
      print   ( f "Text =     { text   } at position          { fh_in   . tell   () -      len ( text   ) } " )

      # Seek to char position 90 from SOF and read next 40 chars.
      fh_in  . seek ( 90,   SOI)
      text   =   fh_in  . read  ( 40 )
      print   ( f "Text =     { text   } at position          { fh_in   . tell   () -      len ( text   ) } " )

      fh_in  . close   ()     # Flush buffers and close file handle.
      return     None

if    __name__   ==   "__main__"   :
      main ()
      sys . exit   ( 0 )
```

File Interaction BINARY Random Access

```
#! /bin/python
# Name:        demo_random_rw_binary.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate how to Interact with the
# file system by opening/closing file handles random reading using the
# seek() and tell() file handle methods.
"""
  Read movie data randomly from a binary file.
"""
import    sys

def    main ():
    """ Demonstrate random reading from a BINARY file. """

    filename    =  r"C:\1  abs \movies.txt"        # Always use a raw string for paths.
    SOF =  0  # Start of file.
    CUI =  1  # Current Position.
    EOI =  2  # End of file.

    # Open file handle for READING in BINARY mode.
    fh_in  =  open ( filename  ,  mode="rb"  )

    # Seek to char position 50 from SOF and read next 30 bytes.
    fh_in . seek ( 50,  SOF)
    text  =  fh_in . read ( 30 )
    print  ( f "Text =    {text  } at position          {fh_in  . tell  () -    len ( text  ) } " )

    # Seek forwards 30 chars from current position and read next 40 bytes.
    fh_in . seek ( 30,  CUI)
    text  =  fh_in . read ( 40 )
    print  ( f "Text =    {text  } at position          {fh_in  . tell  () -    len ( text  ) } " )

    # Seek backwards 40 chars from EOF and read next 20 bytes.
    fh_in . seek (- 40,  EOI)
    text  =  fh_in . read ( 20 )
    print  ( f "Text =    {text  } at position          {fh_in  . tell  () -    len ( text  ) } " )

    fh_in . close  ()    # Flush buffers and close file handle.
    return    None

if   __name__   ==  "__main__"  :
    main ()
    sys . exit  ( 0 )
```

Pickle
an Object



Pickling converts any Python object, except functions, into a stream of bytes - preserving the Data plus its STRUCTURE!

Resultant pickle files can be written in a number of formats - this is called the pickle protocol and is a named parameter for the pickle dump function. Choose from:

- protocol=0 (ASCII for backwards compatability)
- protocol=1 (Binary)
- protocol=2 (Binary from Python 2.3)
- protocol=3 or pickle.DEFAULT_PROTOCOL (Binary from Python 3.0)
- protocol=4 or pickle.HIGHEST_PROTOCOL (Binary from Python 3.4)

```
#! /bin/python
# Name:      demo_pickle.py
# Author:    QA2.0, Donald Cameron
# Revision:  v1.0
# Description: This program will demonstrate how to preserve Python objects
# (data plus structure) to a file using the pickle module.
"""
  Preserve/Pickle ONE Python object to a file.
"""
import  sys
import  pickle
import  pprint

def  main ():
    """ Preserve and reload a Python object a file """
    # Create a dict to hold our favourite movies.
    movies  = {   'Donald'  : [  'Dracula'    ,  'Deliverance'     ,  'Descendants'    ],
                  'Mira'   : [  'Matrix'   ,  'Mad Max'  ,  'Magnolia'   ],
                  'Sarah'   : [  'Seven'  ,  'Scream'  ,  'Saving Private Ryan'        ]
  }

    # Open file handle in binary write mode for pickling.
    fh_out   =   open ( r "C: \l  abs \movies.p"    ,  "wb" )

    # Dump the movies dict to the pickle file using a chosen protocol.
    # pickle.dump(movies, fh_out, protocol=0) # ASCII
    # pickle.dump(movies, fh_out, protocol=4) # Binary space efficient.
    pickle   . dump( movies ,   fh_out  ,   pickle   . DEFAULT_PROTOC)  # protocol=3
    # pickle.dump(movies, fh_out, pickle.HIGHEST_PROTOCOL)  # protocol=4
    fh_out  . close  ()

    # Open file handle in binary read mode for pickling.
    fh_in   =   open ( r "C: \l  abs \movies.p"    ,   "rb"  )

    # Reload pickled dict from file back into memory.
    films   =   pickle   . load  ( fh_in  )
    fh_in  . close  ()

    # Display and compare the movies and films dict using the
    # Std Py library module pprint (pretty print)
    pprint   . pprint   ( movies )
    print   ( "-"   *   60 )
    pprint   . pprint   ( films  )
    return    None

if   __name__  ==  "__main__"  :
    main ()
    sys . exit  ( 0 )
```

Multiple objects on a Shelve

```
#! /usr/python
# Name:        demo_shelve.py
# Author:      OA2.H. Donald Cameron
# Revision     v1.0
# Description: This program will demonstrate how to preserve MULTIPLE
# Python objects to a file using the shelve module
"""
  Preserve/Pickle ONE Python object to a file.
"""
import   sys
import   shelve
import   pprint

def   main ():
    """ Preserve and reload multiple Python objects a file """
    # Create dictionaries to hold our favourite movies, tv series and music bands.
    movies  = [   'Donald'    ,  [   'Dracula'    ,   'Deliverance'     ,   'Descendants'    ],
                  'Mira'      ,  [   'Matrix'     ,   'Mad Max'     ,   'Magnolia'     ],
                  'Sarah'     ,  [   'Seven'      ,   'Scream'      ,   'Saving Private Ryan'     ]
    ]

    tv  = [   'Donald'    ,  [   'Dad's Army"     ,   "Dragon's Den"     ,   'Dallas'     ],
              'Mira'      ,  [   'MASH'     ,   'Masterchef'      ,   'Mythbusters'     ],
              'Sarah'     ,  [   'Scrubs'     ,   'Sesame Street'      ,   'Star Trek'     ]
    ]

    music  = [   'Donald'    ,  [   'David Bowie'     ,   'Deacon Blue'     ,   'Duran Duran'     ],
                 'Mira'      ,  [   'Metallica'     ,   'Madness'     ,   'Meatloaf'     ],
                 'Sarah'     ,  [   'S Club 7'     ,   'Spandau Ballet'     ,   'Spice Girls'     ]
    ]


    # Open file handle in preserving multiple objects.
    db =  shelve . open ( "C:  \ dbs  \ movies.db"  )

    # Write key  objects to shelve database.
    db[ 'movies' ] =  movies
    db[ 'tv' ] =  tv
    db[ 'music' ] =  music

    db . close  ()

    # Open the Shelve file handle again.
    db =  shelve . open ( "C:  \ dbs  \ movies.db"  )

    while   True :
        # Iterate through db and display  itemised keys.
        for   key  in  db :
            print  ( key )

        # Prompt user to choose key.
        db_key  =  input  ( "Choose a key to display or q(Q)--quit: "          )
        if   db_key . lower () == "q" :  break
        pprint . pprint  ( db[ db_key ])

    db . close  ()
    return   None

if   __name__  ==  "__main__" :
    main ()
    sys . exit  ( 0 )
```

Interacting with a DB

```
#! /bin/python
# Name:       demo_sqlite.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: This program will demonstrate how to connect to a SQLite database
# file, create a table, insert and query rows using the SQLite3 module/API.
"""
  Create and populate a SQLite database file.
"""
import  sys
import  sqlite3
import  os


def  main ():
    """ Create, Insert and query all rows in database """
    # Prompt user if they want to create or use existing database file.
    if  os . path  . isfile   ( r "C: \l  abs \movies_db.sqlite"      ):
        response  =  input  ( "Do you want to use existing SQLite file (y/n)? "               )
        if  response  . lower  () ==   "n" :
            os . remove ( r "C: \l  abs \movies_db.sqlite"      )

    # Connect into SQLite database file.
    db_conn  =  sqlite3   . connect  ( r "C: \l  abs \movies_db.sqlite"      )
    # Open a cursor to store
    cur  =  db_conn . cursor  ()

    # Create a movies table if it doesn't already exist.
    cur . execute  ( """CREATE TABLE IF NOT EXISTS movies
          ( id     INTEGER PRIMARY KEY
          ,name   TEXT
          ,year   DATE
          ,rating  INTEGER ) """                     )

    # Loop and write users favourite movies to database file.
    while  True :
        movie  =  input  ( "Enter name of movie (q=quit): "          )
        if  movie . lower () ==   "q" :  break
        year  =  input  ( f "Enter year of release for             { movie }: "  )
        rating   =  input  ( f "Enter your rating for            { movie } (1-10): "    )

        cur . execute  ( """INSERT INTO movies (name,year,rating) VALUES(?,?,?)"""            , (  movie ,  year ,  rating  ))
        print  ( "1 row inserted"     )

    db_conn . commit ()    # Commit Changes to database.

    # Query, fetch and display all rows from database file.
    cur . execute  ( """SELECT * FROM movies"""   )
    rows  =  cur . fetchall   ()
    for  row  in  rows :
        print  ( row )

    db_conn . close  ()  # Close database connection.
    return   None

if   __name__  ==  "__main__"  :
    main ()
    sys . exit  ( 0 )
```

Quiz

Persistent Data Knowledge Check

5-10 mins

1. What is the default mode for the built-in open() function?

"rt" = Read and Text mode

2. What is the default buffering mode for text files?

Line Buffering

3. Which methods are used for random access?

seek, read and tell

Can use mmap to map file into memory

4. Which Python standard library module preserves ONE Python object to a file?

Pickling

5. Which Python standard library module preserves MULTIPLE Python objects to a file?

Shelving

To be revealed

Exercises

35 mins

Persistent Storage - exercises for 'peasants'

1 **Open the file C:\labs\top250_movies.txt.** Notice it contains the top 250 movies as voted by IMDb online users.

2 Create a script called **display_movies.py** in the **C:\labs** folder that will **open** and retrieve the movies one at a time. Display the movies names and remember to **close** the file when finished. Use f-strings to display the movie information.

3 You may have noticed that the movie titles are in lower case. Modify the script so that each word of the movie title is capitalised.

4 Modify the script to display the ranking from 1 to 250 next to the movie title. Use the built-in enumerate() function to generate the ranking.

Persistent Storage - stretch exercises for Kings

5 Create a new script **C:\labs\movie_data.py**. Using the top 5 movies from the previous exercise, create a LIST called **movies** which has five dictionaries with the following keys "title", "director", and "year" released. Movie information can be found at https://www.imdb.com/.

Write a loop to iterate through the list of dictionaries. Write out the formatted movie information to a file called **C:\labs\top5_movie_info.txt.** Use the print function to write instead of the write() method.

Year should be right justified 10 characters. Title should be proper-cased, and 30 characters left justified. And director right justified by 25 characters. For example:

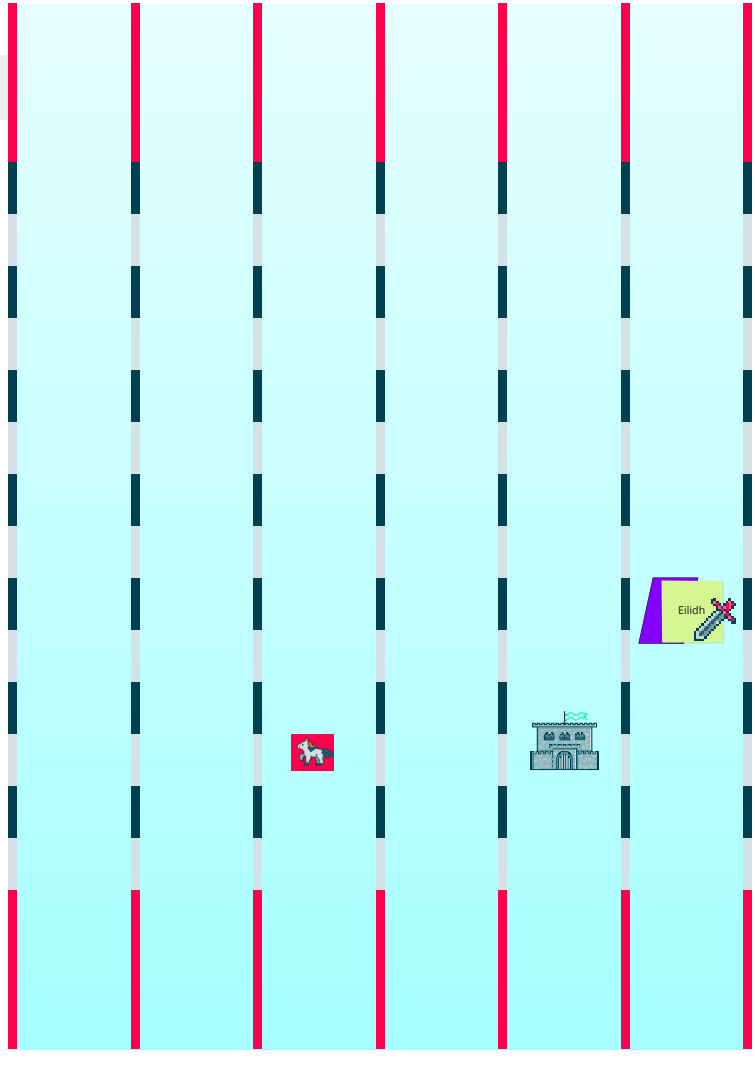
```
1994 - Title: The Shawshank Redemption     Director:          Frank Darabont
1972 - Title: The GodFather                Director:    Francis Ford Coppola
```

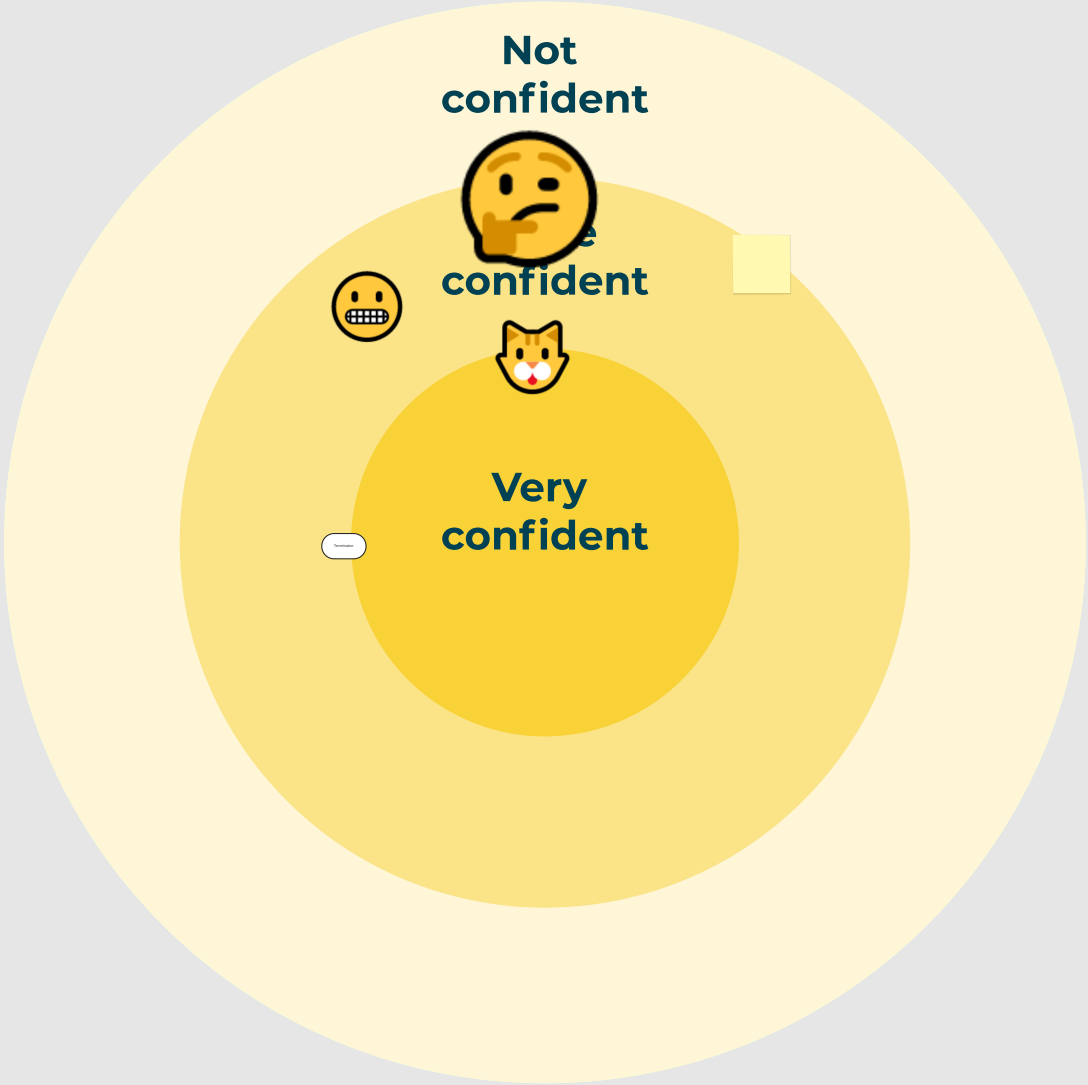
6 Think how about difficult it would be to reload this information back into a suitable Python data structure. Copy the **C:\labs\movie_data.py** file to **C:\labs\movie_dict.py** and modify the new script to **preserve** the movie list to a compressed pickle file called **C:\labs\top5movies.pgz**. Load the object back into memory and compare with the original movies dictionary [Hint: use pprint].

7 And now for something a little different.
Write a Python script called **C:\labs\display_unused_ports.py** that lists all the unused port numbers between 1 to 200 in the SERVICES file. This file is used by applications and TCP/IP to translate network service names into port numbers, for example, http and port 80. Your script should take into account which platform it is running on and select '/etc/services' on Linux and **'C:\WINDOWS\System32\drivers\etc\services'** on Windows.

Some hints to get you started:
- Test platform and use correct file
- Write code to iterate through file and display one line at a time
- Ignore blank lines and comments
- We've not met Regular Expressions yet, so consider using string splitting to isolate the number
- Extract port numbers (will have to convert to integer)
- Port numbers can be duplicated so store numbers in a suitable object which filters duplicates

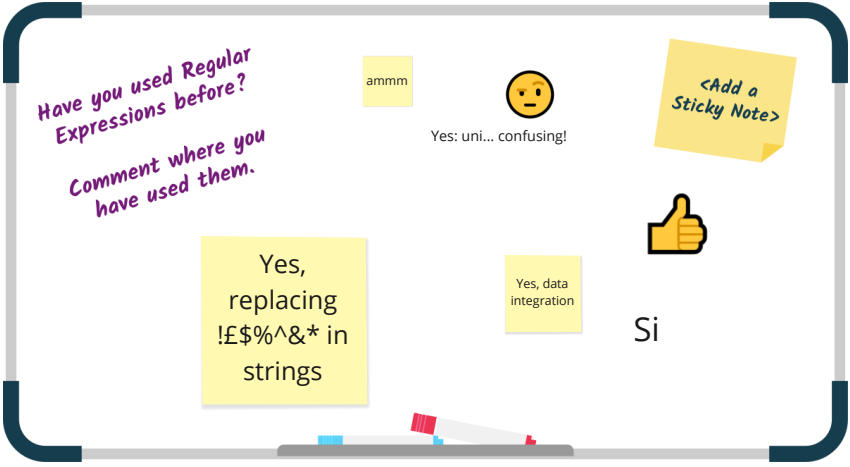
Move your piece down as you complete the exercises





Back to the quest

match groups
assertions
pre-compile
group basic end substitution
repetition
escape expressions
regex
groupings regular extended
alternation start
objects quantifiers



Basic Regex

Regular Expressions (Regex, or just RE) are used in many tools, sql and programming languages, and have their roots in Unix command line tools such as ed, ex, grep, sed, and awk. They provide a more extensive and powerful set of meta-characters for pattern matching and come in several dialects. The Python standard library module re.py provides matching functions and support for **Basic**, **Extended** and **Python** pattern characters.

To learn how to use Regex, we need to do two things - learn the theory behind the meta-characters, and then how to apply them using Python code.

The website https://regex101.com/ is useful for learning and testing your Python Regular Expressions.

Basic Regular Expressions B.R.E

Line Anchors

Start `^The`

End `ing$`

Single Char Class

Any char `^.ing$`

Any char `^.....$`

Single Char Range Class

Char set `^[rdz]ing$`

Char range `^[A-Z]ing$`

Char ranges `^[A-Za-z]ing$`

Char NOT set `^[^dz]ing$`

Multiple sets `[aeiou][aeiou][aeiou]`

Escape Char Class

Escape char `\.`

Repetition Class

0 or more `:[0-9]*:`

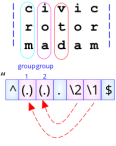
Limiting Repetition

Exact `:[0-9]{10}:`

Min, max `:[0-9]{10,20}:`

At least `:[0-9]{10,}:`

Grouping/Back Referrals



Extended RE

Extended Regular Expressions or E.R.E added some extra repetition chars (?+), groupings (rhubarb)+ and alternation (or).

Extended Regular Expressions E.R.E

Repetition Class

0 or more `" : [0-9] * : "`

0 or once `" : [0-9] ? : "`

1 or more `" : [0-9] + : "`

Alternation Class

or `" eric|graham|michael "`

Grouping

```
" a (bottle|glass|keg) of (lager|wine|beer) "
    " a bottle of lager "
    " a glass of wine "
    " a glass of beer "
```

Python Assertions/Escape chars

Escape Chars

Digit	\d	[0-9]	\D	[^0-9]
Word char	\w	[A-Za-z0-9]	\W	[^A-Za-z0-9]
Whitespace	\s	[\t\r\f\n]	\S	[^ \t\r\f\n]
Word boundary	\b	[\t\n,.';:"-+()!?]	\B	[^ \t\n,.';:"-+()!?]
Line anchors	\A	^	\Z	$

Regex Code

There are many online resources for learning Regular Expressions with Python. Here are a few to start with:
https://regex101.com/
https://pythex.org/
https://extendsclass.com/regex-tester.html
http://www.pyregex.com/

```
#! /bin/python
# Name:        demo_regex_1.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate how to match string
# data using Regular Expressions.
"""
    Search a given file using regular expressions and display
    matched lines.
"""
import    sys
import    re

def    main ():
    """ Demonstrate different 4_Regular_Expressions patterns """
    fh_in    =    open ( r "C:\1  abs\words"    ,    mode="rt"    )

    # Iterate through file handle
    for    line    in    fh_in    :
            # m = re.search(r"^the", line) # Match lines starting with 'the'.
            # m = re.search(r"ing$", line) # Match lines ending with 'ing'.
            # m = re.search(r"^[A-Z]", line)  # Match lines starting with a capital.
            # m = re.search(r"\.", line)  # Match lines with a dot.
            # m = re.search(r"[aeiou][aeiou][aeiou]", line)  # Match 3 consecutive vowels.
            # m = re.search(r"[aeiou]{5,}", line)  # Match at least 5 consecutive vowels.
            # m = re.search(r"^.....$", line)  # Match 19 char lines.
            # m = re.search(r"^.{19}$", line)  # Match 19 char lines.
            # m = re.search(r"^(.)(.)\2\1$", line)  # Match lines 5 char palindromes.
            # m = re.match(r"(.)(.)\2\1$", line)  # Match 5 char palindromes using match()
            m =    re . search    ( r "^ ( . ) .* \1  $" ,    line    )    # Match lines starting/ending with same char.

            if    m:
                print    ( line    ,    end ="" )

    fh_in    .  close    ()
    return    None

if    __name__    ==    "__main__"    :
    main ()
    sys . exit    ( 0 )
```

Regex Groups

The functions search(), match(), fullmatch(), sub(), and subn() either return None or an 're.Match' object if a pattern is matched. The match object has several methods for returning information about the pattern match.

- m.group() # Returns the matched pattern.
- m.start() # Returns the char position where pattern starts.
- m.group() # Returns the char position where the pattern ends.
- m.groups() # Returns a tuple of groupings, or error if no groupings in pattern.
- m.groups()[0] # Returns the 1st grouping from the tuple. Index = 0, grouping = 1st. Index = 1, grouping = 2nd.
- m.group(1) # Also returns the 1st grouping and is more Pythonic. That is, parameter = 1, grouping = 1st.

```
#! /bin/python
# Name:        demo_regex_2.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate how to match string
# data using Regular Expressions.
"""
  Search a given file using regular expressions and display
  matched lines and groupings.
"""
import  sys
import  re

def  main():
    """ Demonstrate 4_Regular_Expressions groupings """
    fh_in  =  open( r"C:\1_abs\words" , mode="rt" )

    # Iterate through file handle.
    for  line  in  fh_in :
        # Match 5 char palindromes.
        m =  re . search  ( r"^( . )( . )\2\1 $", line )  # Return None or RE Match object.
        if  m:
            # The match object m has several methods with info about the match.
            print  ( f"Matched  {m. group ()  } at char pos  {m. start  () } -  {m. end () }, "
                     f"with groups  {m. groups  () }, "
                     f"first group is  {m. groups  ()[  0] }, "   # Index tuple 0 = 1st
                     f"or  {m. group  ( 1) }" )  # More Pythonic way as 1 = 1st.

    fh_in  . close  ()
    return  None

if  __name__  ==  "__main__" :
    main()
    sys . exit  ( 0)
```

Pre-compile

Notice that in the previous demo we are compiling the pattern for every loop and line that is read from the file. So, if the file has 42k lines then the pattern will be compiled (into low level byte code) 42,000 times - even though the pattern never changes for the life of the loop and file handle.

In this case, there would be significant performance improvements in pre-compiling the pattern just once before the loop. The re.py module has a function called compile() which returns a Regex Object with the compiled pattern stored within. This object inherits the search(), match(), and fullmatch() functions.

```
#! /bin/python
# Name:        demo_regex_3.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate how to match string
# data using Regular Expressions and pre-compiling the pattern once.
"""
  Search a given file using regular expressions and display
  matched lines.
"""
import  sys
import  re

def  main():
    """ Display lines in a given file which match Regex """
    fh_in  =  open( r"C:\l  abs\words"  ,  mode="rt"  )

    # Pre-compile the pattern once if it does not change.
    reobj  =  re . compile  ( r"^.  {19} $")

    # Iterate through file handle
    for  line  in  fh_in  :
        # Pre-compiled pattern stored in reobj object.
        m =  reobj  . match ( line  )  # Return None or RE Match object.
        if  m:
            print  ( line  ,  end ="" )

    fh_in . close  ()
    return  None

if  __name__  ==  "__main__" :
    main()
    sys . exit  ( 0)
```

Substitution

The re.py module also provides two functions for performing substitutions within a string. The sub() function can search, make a change, and return a modified string. Whilst the subn() function returns a tuple of the modified string and the number of changes made. All the RE functions support optional flags.

Optional Flags

Long Name	Short Name	Embedded	Comment
re.IGNORECASE	re.I	(?i)	Case insensitive match
re.MULTILINE	re.M	(?m)	^ and $ match start and end of line
re.DOTALL	re.S	(?s)	Dot '.' also matches a newline "\n"
re.VERBOSE	re.X	(?x)	Whitespace is ignored within pattern - to allow embedded comments.

```
#! /bin/python
# Name:      demo_regex_4.py
# Author:    QA2.0, Donald Cameron
# Revision:  v1.0
# Description: This program will demonstrate how to match and substitute string
# data using the re.py module and the sub() and subn() functions. It will also
# introduce Regex flags such as ignore case.
"""
  Search and substitute strings using regular expressions.
"""
import   sys
import   re

def   main():
    """ Executed directly when run as a program """
    # This str object is storing login data for the root user from a
    # a file /etc/passwd on the Linux file system.
    line  =  "root:x:0:0:The root User:/root:/bin/sh"

    # The sub() function returns the modified string.
    line  =  re . sub ( r"[ rR ] oot   [ Uu] ser " , r "Administrator"      , line  )
    print  ( f "Modified line =          {line  }" )

    # The sub() function returns the modified string.
    line  =  re . sub ( r "/bin/sh"     , r "/bin/bash"     , line  )
    print  ( f "Modified line =          {line  }" )

    # 4. Regular_Expressions are GREEDY and match the largest pattern by default.
    line  =  "root:x:0:0:The root User:/root:/bin/sh"
    line  =  re . sub ( r"^ ( root )  .*[ ] ",  r "I am greedy"     , line  )
    print  ( f "Modified line =          {line  }" )

    # The subn() function returns a TUPLE of (modified string, num changes)
    line  =  "root:x:0:0:The root User:/root:/bin/sh"
(   line ,  num)=   re . subn ( r "[ rR ] oot " ,  r "Groot"  ,  line  )
    print  ( f "Modified line =          {line  } with   {num}  changes"  )

    # Search and replace string with optional RE flags (introduced Py3.1 )
    line  =  "root:x:0:0:The root User:/root:/bin/sh"
    # The optional flags can be set several different ways
    line  =  re . sub ( r "root user"      ,  r "Administrator"      ,  line  ,
                        flags  =re . IGNORECAS re . MULTILINE)
    line  =  re . sub ( r "root user"      ,  r "Administrator"      ,  line  ,  flags  =re . I| re . M)
    line  =  re . sub ( r " (?im)  root user"     ,  r "Administrator"      ,  line  )
    line  =  re . sub ( r "(?i:r  ) oot  ( ?i:u  ) ser" ,  r "Administrator"      ,  line  )  # Python 3.6
    print  ( f "Modified line =          {line  }" )

    return     None

if   __name__   ==   "__main__"  :
    main ()
    sys . exit  ( 0)
```

Quiz

Regular Expression Knowledge Check

5-10 mins

What does B.R.E and E.R.E stand for?

Basic Regular Expression & Extended Regular Expression

2. What prefix should you use with your Regex patterns?

the letter "r" (raw text). Its use nullifies escape characters.

3. Can you think of a better way to write the following pattern, which is 15 chars long?

r"^..............$"

r"^.{15}$"

4. Given this code, what will the pattern match?

```
>>> text = "Brave Sir Robin ran away. Bravely ran away away. When danger
reared it's ugly head, he bravely turned his tail and fled."
>>> m = re.search(r"(brave).*\1", text, flags=re.IGNORECASE)
>>> print(m.group())
```

Brave Sir Robin ran away. Bravely ran away away. When danger reared it's ugly head, he brave

* is the greedy quantifier (match as much as possible)
*? is the lazy quantifier

5. Given this code, what would be printed?

```
>>> text = "racecar"
>>> m = re.search(r"^(.)(.)(.).\3\2\1$", text)
>>> print(m.groups(), m.groups()[0], m.group(1))
```

('r', 'a', 'c') r r
regex compares first 3 chars with last 3 chars

Exercises

40 mins

Regular Expressions - exercises for 'brave' knights

1

For the following exercises, we will be installing the IMDbPY Python package (https://pypi.org/project/IMDbPY/). This package is used to retrieve and manage data of the IMDb online movie database about movies, people, characters and companies.

Install the IMDb Package, on command line or within Pycharm.
C:> pip install IMDbPY.

2

Load the script **C:\labs\top250starter.py** into Pycharm. This script imports the IMDb module and creates an IMDB HTTP access class for searching for movie information. Compile and run the script and confirm the output displays the top 250 movies.

3

Modify the script so that the movie names are displayed alongside their ranking from 1 to 250. Ensure the ranking is right justified to 4 characters so that the ':' is aligned. For example:

1: The Shawshank Redemption
2: The GodFather
..
99: North by Northwest

4

Using regular expressions, modify the script to prompt the user to enter their favourite movie and display its ranking, if found. Ensure that the case is ignored.

Regular Expressions - stretch exercises for Kings

5

Copy the top250.py script to a new file called search250.py in the C:\labs folder.

6

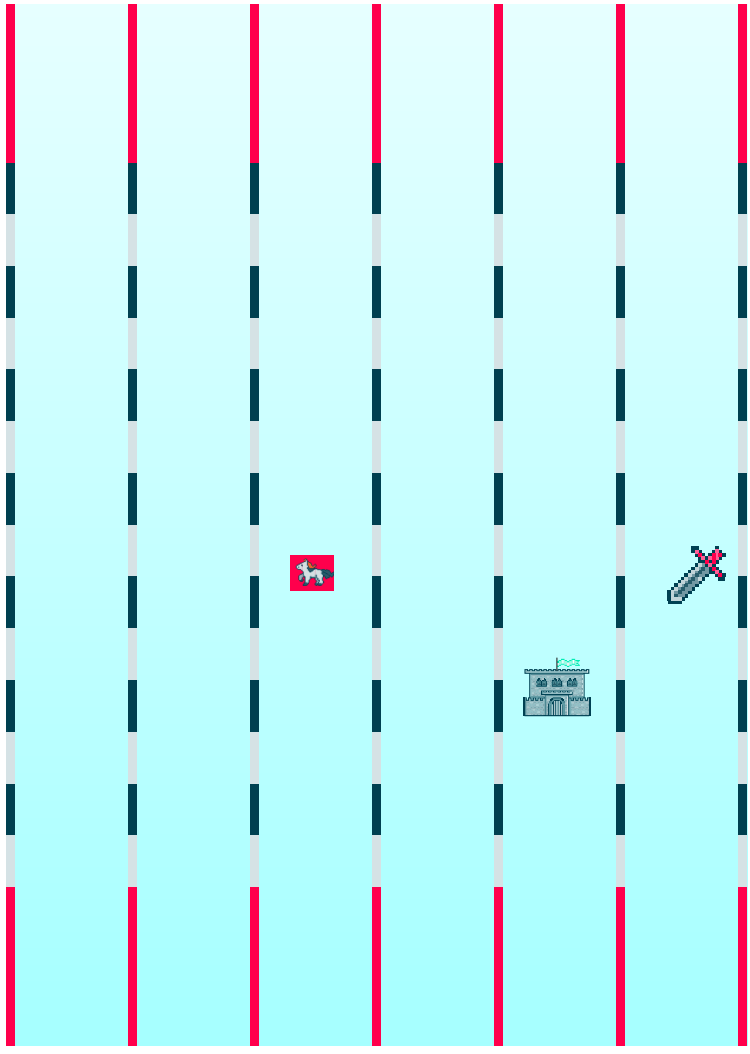
Modify the search250.py script so that it display the movies that match the following patterns and make a note of how many movies were matched for each. Ignore case for all matches.

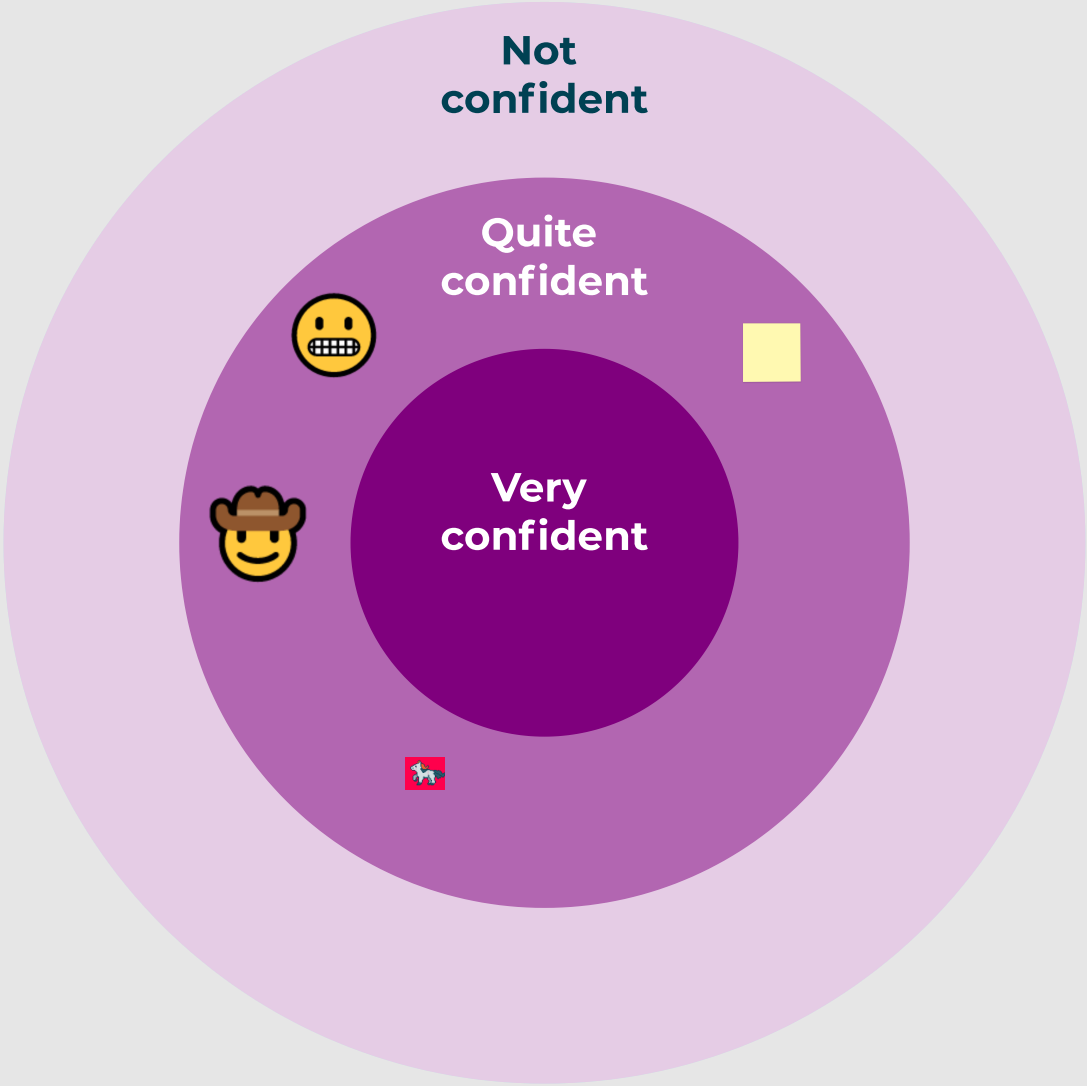
a. Movie names starting with 'the' (50)
b. Movies name with a digit in the name (11)
c. Movie names with 3 consecutive vowels (5)
d. Movie names starting and ending with the same char (15)

7

Remember the 'C:\labs\display_unused_ports.py' program from the previous lab which displays unused ports between 1 and 200? Modify the code to use Regular Expressions rather than string splitting to isolate and extract the port number.

Move your piece down as you complete the exercises





Back to the quest

Functions

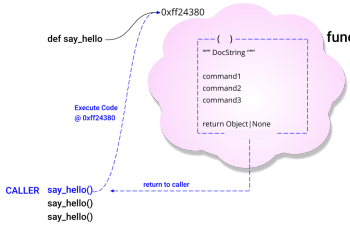
The Art of reusing named blocks of code

CODE REUSE

Functions

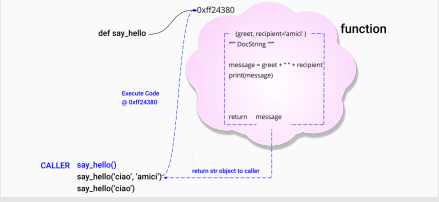
Earlier in the DIGITAL session, you learned about functions and how useful they are for making code sharable and reusable. You saw function definitions, passing parameters to a function, returning a value from a function, and documenting functions with docstrings.

You can do more with functions! You will learn about different types of parameters, variable scope, the idea of annotating functions, lambda functions, and using functions as objects. This includes passing a function as a parameter and returning a function from another function.




```
#! /bin/python
# Name:        demo_user_functions.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate how to
# define, name and execute (reuse) user defined functions.
"""
  Displays greeting messages.
"""
import   sys

# Example of a user defined function
def   say_hello   ():
      """ Display the SAME GREETING to the SAME RECIPIENTS """
      message  =  "Hello"   +   " "   +   "World"
      print   ( message )
      return      None

def   main ():
      """ Main function """
      say_hello   ()   # CALLER - passes control to function say_hello().
      say_hello   ()   # Can reuse function.
      say_hello   ()
      say_hello   ()
      return      None

if    __name__   ==   "__main__"   :
      main ()
      sys . exit   ( 0 )
```

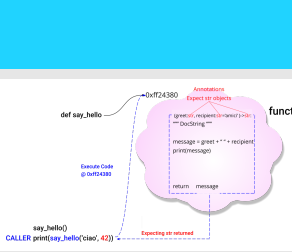
Parameters



User functions can optionally accept a finite number of parameters.
· Formal parameter names are defined within the parentheses of function declaration
· Actual values are passed in the CALLER's parentheses
· Literal values are passed by COPY/VALUE, e.g. (100, 200, 'hello')
· Named objects are passed by Reference, e.g. (pattern, filename). So changing a parameter within a function will alter the caller's object. To prevent this for lists and dictionaries, pass a slice of the structure. e.g. function_call(my_list[:]). It's a hack!
· Parameters can be assigned defaults, but following parameters must also have defaults
· Parameters can be passed as positional, named or a mix (positional followed by named)

```
#! /bin/python
# Name:        demo_user_functions_with_parameters.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate how to
# define, name, call and pass parameters in and return objects back.
"""
  Displays greeting messages.
"""
import  sys

# Example of a user defined function with parameter passing
# and optional defaults
def  say_hello  ( greeting  ="ciao"  ,  recipient  ="amici"  ):
    """ Display a given greeting to a recipients """

    # Converted parameters to strings for safety!
    message  =  str  ( greeting  )+  " " +  str  ( recipient  )
    print  ( message )

    # return None
    return  message

def  main ():
    """ Main function - say hello to our friends """

    say_hello  ( "Hello"  ,  "world"  )  # Positional parameter passing
    say_hello  ( greeting  ="Salutare"  ,  recipient  ="prieteni"  )  # Named parameter passing.
    say_hello  ( "Namaste"  ,  recipient  ="mere dost"  )  # Mixed parameter passing.
    say_hello  ( recipient  ="mes amis"  ,  greeting  ="Bonjour"  )  # Mixed in different order
    say_hello  ( "Nazdar"  ,  42)  # Try passing in an Integer!
    say_hello  ()

    # If the function returns an object we can then have the CALLER as
    # a r-value. That means on the RHS of an assignment or embedded within
    # a larger expression.
    # sum = say_hello()
    print  ( "Default message is  :say_hello  () " )

    return  None

if  __name__  ==  "__main__"  :
    main ()
    sys . exit  ( 0)
```

Annotations

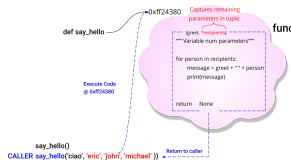


Function annotations were introduced in PEP 3107. They are used to provide additional information about the function, including what data types are expected for the input parameters and return value. They are like an embedded comment, but are more than a comment (which are ignored by the compiler). They are preserved in the function attribute __annotations__.

Annotations have no meaning except 'commenting in-code' of what types of data are hoped for. But 3rd party modules might use them for additional docstrings or for enforcing data type on parameters or return values. Python will remain a dynamically typed language!

```
#! /bin/python
# Name:        demo_user_functions_annotations.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate how to
# define, name, call and pass parameters in and return objects back.
"""
   Displays greeting messages.
"""
import   sys

# Example of a user function ANNOTATIONS (Py3.5, not enforced)
def   say_hello  ( greeting   : str  ="ciao"  ,  recipient    : str  ="amici"  )-> None:
    """ Display a given greeting to a recipients """

    # Annotations not enforced by Python so convert parameters
    # into strings for safety
    message  =  str  ( greeting  ) +  " "  +  str  ( recipient    )
    print  ( message  )

    # return None
    return     message


def   main ():
    """ Main function - say hello to our friends """

    say_hello  ( "Hello"  ,  "world"  )   # Positional parameter passing
    say_hello  ( greeting  ="Salutare"    ,  recipient    ="prieteni"     )   # Named parameter passing
    say_hello  ( "Namaste"  ,  recipient    ="more dost"   )   # Mixed parameter passing
    say_hello  ( recipient    ="mes amis"  ,  greeting   ="Bonjour"  )   # Mixed is different order
    say_hello  ( "Nazdar"  ,  42)  # Try passing in an Integer!
    say_hello  ()

    # If the function returns an object we can then have the CALLER as
    # a r-value. That means on the RHS of an assignment or embedded within
    # a larger expression.
    # num = say_hello()
    print  ( f"Default message is              {say_hello    () }" )

    # Attributes of functions can be displayed including annotations.
    print  ( f"Annotations for say_hello() =          {say_hello    .__annotations__   }" )

    return     None

if     __name__   ==   "__main__"  :
    main ()
    sys  .exit  (0)
```

Variadic Functions



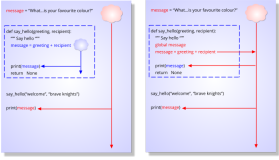
A **Variadic function** can accept a variable number of parameters. For example, the built-in function print() can accept any number of parameters. User functions can also accept variable number of parameters into either a **tuple** with a '*****' prefix or into a **dictionary** with a '******' prefix. This works in a similar way to unpacking as discussed with collections.

DEFINITION: def display_vat(**kwargs)
CALLER: display_vat(vatpc=15, gross=9.55, message='Summary') # Use named parameters when passing to a dict.

```
#! /bin/python
# Name:       demo_user_functions_variadic.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: This program will demonstrate how to
# define, name, call and pass parameters in and return None.
"""
  Displays greeting messages to ALL friends and foes.
"""
import    sys

# Example of a Variadic function.
def    say_hello    ( greeting    ="ciao"    ,*    recipients    ):
    """
    Accept a greeting string and variable number of recipients and
    display message to ALL recipients and returns None.
    """

    # Use an iterator for loop to iterate through objects in tuple.
    for    person    in    recipients    :
        message    =    str    ( greeting    ) +    " "    +    str    ( person    )
        print    ( message    )

    # return None
    return    None


def    main ():
    """ Main function - say hello to our friends """

    # Pass in a variable number of parameters to the function.
    say_hello    ( 'None shall pass'    ,    'green knight'    )
    say_hello    ( 'None shall pass'    ,    'green knight'    ,    'arthur'    ,    'patsy'    )

    return    None

if    __name__    ==    "__main__"    :
    main ()
    sys . exit    ( 0 )
```

Scope

Local Vs Global



Scope defines the **life** and **visibility** of a variable/object, in other words, what part of the code can see and use it. Python supports global scope and function/local scope. Global variables/objects are visible to the entire program including nested functions.

But if a value is assigned in the function before it is used, then it becomes a local variable (visible and lives for duration of function).
To change the value of an outer global variable within a function (frowned upon), declare the variable as **global**.

```
#! /bin/python
# Name:        demo_user_functions_scope.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate the scope (life + visibility)
# of variables/objects
"""
   Displays greeting local and global messages.
"""
import   sys

message  =  "What...is your favourite colour?"

# Example of a user defined function with parameter passing
# and optional defaults
def  say_hello  ( greeting   ="welcome"  ,  recipient    ="brave knights"     ):
    """ Display a given greeting to a recipients """

    # global message # Try executing with and without this line commented.

    # An assignment to message forces Python to create a new local object.
    message  =  str  ( greeting   ) +   " "   +  str  ( recipient    )
    print  ( message )

    # return None
    return    message

def   main ():
    """ Main function - say hello to our friends """
    say_hello   ()
    print   ( "function return is            {say_hello   () } " )
    print   ( message )

    return     None

if   __name__   ==  "__main__"  :
    main ()
    sys . exit  ( 0 )
```

Docstrings

HELP, I'm lost!

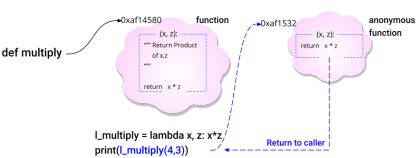
So have you been wondering why we have been putting tripled quoted strings in our programs and functions?
Well these are called DocStrings and usually appear immediately after the definition of a program/module, class, function or method.

Docstrings can be simple one-liners or multi-line and should not be descriptive (that is for # comments). Rather they must follow "Do this, return that" format. Multi-line docstrings can be more elaborate, and are described in PEP 257, and can include details about input parameters and return values. Docstrings for classes (later in LIVE) should summarise its behaviour and list public methods. The __doc__ attribute can be used to access docstrings.

And they are read by the Python help() function - so now you know where we are getting help from for our modules and functions!

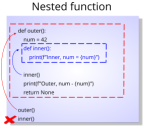
```
#! /usr/bin/python
# Name:         demo_user_functions_docstrings.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description:  This program will demonstrate another example of
# creating functions with DocStrings, parameter passing, return values.
"""
  Calculator program with Add, Divide and Multiply functionality.
"""
import   sys

def   multiply  ( x,  z)
    """
    Accepts two numeric parameters and return product.

    param x (int/float):  Integer or float
    param z (int/float):  Integer or float
    return (int/float):  Numeric product of x and z
    """
    return    x *  z

def   add ( x,  z)
    """
    Accepts two numeric parameters, adds them and returns sum.

    param x (int/float):  Integer or float
    param z (int/float):  Integer or float
    return (int/float):  Numeric of x summed with z
    """
    return    x +  z

def   divide  ( x,  z):
    """
    Accepts two numeric parameters, divides first by the second and returns result.

    param x (int/float):  Integer or float
    param z (int/float):  Integer or float
    return (str):  Fstring of x divided by z to 3 decimal places.
    """
    return    f" {x / z :.3f}  "

def   main ():
    """ Simple 1-line docstrings are ideal if the function is self explanatory """
    print  ( f"5 * 3 =     {multiply  ( 4,  3)}")
    print  ( f"4 + 3 =     {add( 4,  3)}")
    print  ( f"4 / 3 =     {divide  ( 4,  3)}")

    # An example of a docstring for the built-in print function.
    # print(print.__doc__)
    # An example of a docstring for the sys module.
    # print(sys.__doc__)
    # Displaying the docstring for user functions.
    print  ( multiply.__doc__)

    return    None

if   __name__  ==  "__main__":
    main ()
    sys.exit ( 0 )
```

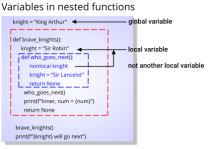
Lambda Functions




```
#! /bin/python
# Name:         demo_user_functions_lambda.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description: This program will demonstrate another example of
# creating functions using lambda (anonymous) functions.
# Simple one-line docstrings are used.
"""
   Calculator program with Add, Divide and Multiply functionality.
"""

import   sys

def   multiply   ( x,   z):
      """ Multiply two numeric parameters and return result """
      return      x *   z

def   add ( x,   z):
      """ Add two numeric parameters and return result """
      return      x +   z

def   divide   ( x,   z ):
      """ Divide two numeric parameters and return formatted str """
      return      f" { x / z : .3f}   "

def   main ():
      """ This is the main program function """
      print   ( f "4 * 3 =       { multiply   ( 4,   3) } ")
      print   ( f "4 + 3 =       { add ( 4,   3) } ")
      print   ( f "4 / 3 =       { divide   ( 4,   3) } ")

      # A lambda function is a small anonymous function that can take
      # multiple arguments but only has one expression. And is an alternative
      # way to defining simple functions without the 'def' statement.
      l_mul   =   lambda    x,   z:   x *   z
      l_add   =   lambda    x,   z:   x +   z
      l_div   =   lambda    x,   z:   f" { x/ z: .3f}   "

      print   ("-" *   20 )

      print   ( f "4 * 3 =       { l_mul ( 4,   3) } ")
      print   ( f "4 + 3 =       { l_add ( 4,   3) } ")
      print   ( f "4 / 3 =       { l_div ( 4,   3) } ")
      return      None

if   __name__   ==   "__main__" :
      main ()
      sys . exit   ( 0 )
```

Nested Functions





Python allows the nesting of functions inside each other, which not all languages support. It can be useful for simple reusable, recursive functions, function factories (a function can be returned from a function like any object) or for closures.

Like nested objects, functions follow the same scope rules. Nested functions can only be called within the function they are defined.

Python has a clean, safe, and dynamic way of managing variables/objects. As soon as you make an assignment, a new object is created - either a **GLOBAL** or a **LOCAL** (within a function). This mostly works well, but on occasion we might have nested functions, and we don't quite want to create a new variable and don't want to access the global variable either. This is where the **nonlocal** keyword proves useful to indicate the variable is referring to an enclosing (outer) scope variable.

```
#! /bin/python
# Name:        demo_user_functions_nonlocal.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate that Python supports nested
# functions global, local and not-so local variables.
"""
  Nested functions and scope.
"""
import  sys

knight  =  "King Arthur"

def  who_goes_next  ():
    """ Who is next to walk the bridge of death? """
    knight  =  "Sir Robin"      # Really?
    def  brave_knights  ():
        nonlocal  knight
        knight  =  "Sir Lancelot"       # Of course, Lancelot is far braver!
        return  None
    brave_knights  ()
    print  ( f"{knight  } will go next"       )
    return  None

def  main ():
    """ Who goes there? """
    who_goes_next  ()
    print  ( f"{knight  } will go next"       )
    return  None

if  __name__  ==  "__main__"  :
    main ()
    sys . exit  ( 0 )
```

Quiz

User Functions Knowledge Check

5-10 mins

1. What does (*,) at the beginning of the parameter list do?

*, trailing parameters are not "positional" and must be named
def my_function(x, *, y):
  do stuff

my_function(x = 10, y = 20)
my_function(2, y=4)
my_function(x=10, 4) # BANG

2. What is the output of the following function call?

```
>>> def my_func(num):
>>>     return num + 10
>>>
>>> my_func(10)
>>> print(num)
```

BANG (on print(num) line)

3. True of False: Python functions always return a value

True
(Python functions always return None unless explicit value)

4. What is the output of the following function call?

```
>> def display_info(**kwargs):
>>>     for z in kwargs:
>>>         print(z)

>>> display_info(movie="braveheart", year="1995")
```

movie
year

to print keys and values use:
def display_info(**kwargs):
  for k, v in kwargs.items() :
    print(k, v)

To

To be revealed

Exercises

35 mins

Functions - exercises for 'brave' knights

1

Write your own calculator program called '**C:\lab\calc.py**' with add, divide, multiply, subtract and modulus functions.

Test your functions by passing in the following parameters.

```
add(11, 5)
 divide(11,5)
 multiply(11, 5)
 subtract(11, 5)
 modulus(11, 5)
```

2

You did add Docstrings to your functions? If not, add appropriate Docstrings to each function. To test, start IDLE and load your script (File/Open), then run (<F5>). Then in Python Shell type:

```
>>> help(add)
  >>> help(multiply)
```

3

Modify the **calc.py** script to allow the add and multiply functions to accept a variable number of parameters. Test the modified functions by passing in the following parameters.

```
add(11, 5, 33, 15, 6.5)
 multiply(11, 5, 33, 15, 6.5)
```

Functions - stretch exercises for Kings

4

In the following exercises, you will use existing demonstrations and code, and improve by creating and using reusable functions.

Open the 'C:\labs\search250.py' script you created in the Regex section. Modify the script so that it has a reusable function called search_movie() which accepts one parameter - the Regex pattern to search. Test the function by calling it from the main() function with the same patterns from the previous lab exercises.

5

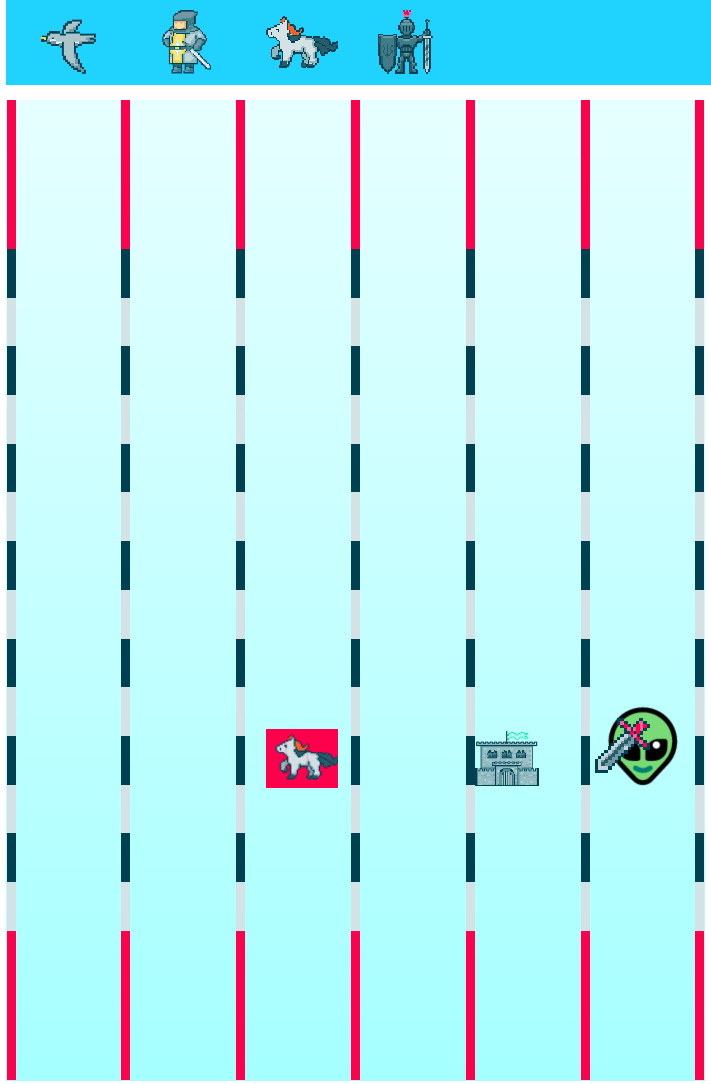
Open the 'C:\labs\searchWords.py' script. It searches for regular expressions patterns in the file 'C:\labs\words' and displays them to the Python shell. Modify the script and create a variadic function called search_pattern() which can accept one regex pattern followed by one or more files.

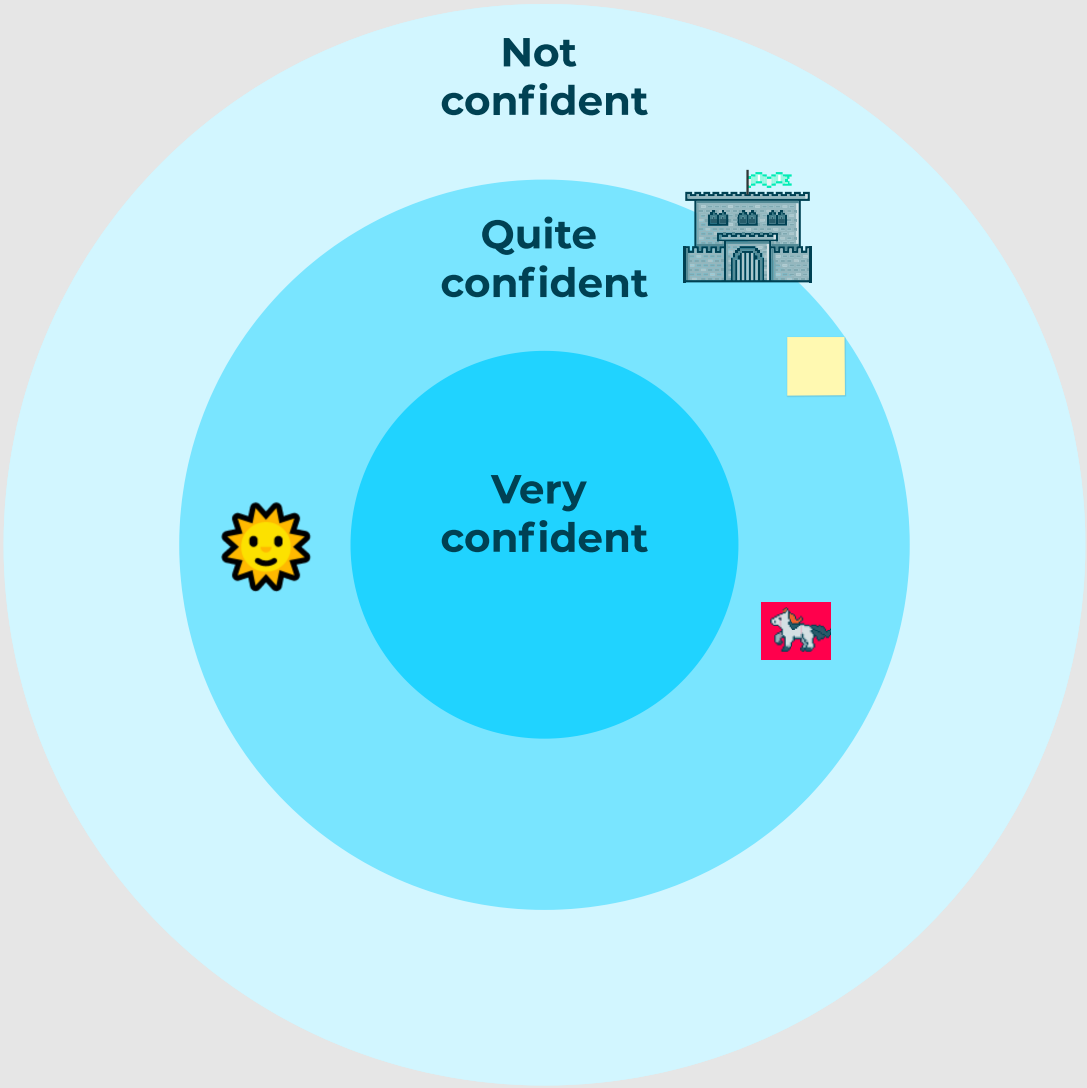
a. If no files are given, then default to 'C:\labs\words'.
b. Iterate through each file printing out lines that match.

Test with the following function calls in the main() function:-

```
search_pattern(r"^([A-Z]).*\1$")
  search_pattern(r"^([A-Z]).*\1$", r"C:\labs\words",  r"C:\labs\words")
```

Move your piece down as you complete the exercises



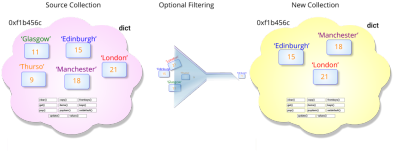


Back to the quest

Advanced Collections

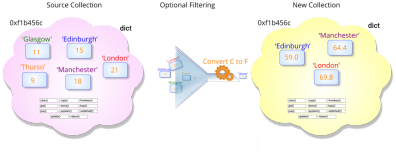
Interesting and cool things you can do with collections

FILTERING



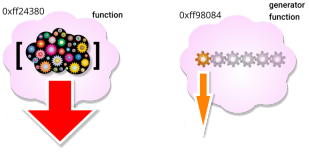

```
#! /bin/python
# Name:         demo_collections_comprehensions.py
# Author:       GA2.0 Donald Cameron
# Revision:     v1.0
# Description: This program will demonstrate how to filter collections using
# the built-in filter() function, lambda functions and comprehensions.
"""
    Filter collections of cities into warm cities in Celsius.
"""
import   sys

weather  = {  'Glasgow'    :  11 ,
              'London'     :  21,
              'Edinburgh'  :  15,
              'Manchester' :  18,
              'Thurso'     :  9
    }

def  filter_city     ( city  ):
    """ Filter cities by temp """
    if   weather  [ city ]>=  15:
        return    True
    else:
        return    False


def  main():
    """ Filter collection using filter(), lambda and comphensions """
    # For Loop plus source collection, optional if condition, and expression.
    warm_cities  = {}
    for  city  in  weather                          # Iterate for loop = collection
        if   weather  [ city ]>=  15:                   # Optional condition (filtering)
            warm_cities  [ city ]=  weather  [ city ]   # Expression
    print  ( f"1.Warm Cities =       {warm_cities  }")

    # For Loop plus source collection, optional if condition with user function, and expression.
    warm_cities  = {}
    for  city  in  weather
        if   filter_city     ( city ):
            warm_cities  [ city ]=  weather  [ city ]
    print  ( f"2.Warm Cities =       {warm_cities  }")

    # Built-in filter() function plus source collection, user function for filtering.
    warm_cities  =  list  ( filter  ( filter_city     ,  warm_cities   ))
    print  ( f"3.Warm Cities =       {warm_cities  }")

    # Built-in filter() function plus source collection, lambda function for filtering.
    wse_names =  list  ( filter  ( lambda  city :  weather  [city ]>=  15,  warm_cities   ))
    print  ( f"4.Warm Cities =       {wse_names }")

    # For Loop plus source collection, optional if condition, and expression. LIST comprehension.
    warm_cities  =[  city  for  city  in  weather  if  weather [ city ]>=  15 ]
    print  ( f"5.Warm Cities =       {warm_cities  }")

    # For Loop plus source collection, optional if condition, and expression. LIST comprehension.
    warm_cities  ={(  city ,  weather [ city ])  for  city  in  weather  if  weather [ city ]>=  15 }
    print  ( f"5.1.Warm Cities =     {warm_cities  }")

    # For Loop plus source collection, optional if condition, and expression. DICT comprehension.
    warm_cities  ={  city  :  weather  [ city ]  for  city  in  weather  if  weather [ city ]>=  15 }
    print  ( f"5.2.Warm Cities =     {warm_cities  }")

    # For Loop plus source collection, optional if condition, and expression. SET comprehension.
    warm_cities  ={  city  for  city  in  weather  if  weather [ city ]>=  15 }
    print  ( f"5.3.Warm Cities =     {warm_cities  }")

    return    None

if  __name__  ==  "__main__" :
    main();
    sys . exit ( 0)
```

FILTERING +



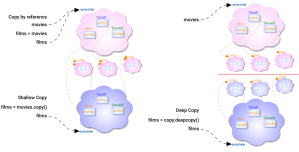

```
#! /usr/python
# Name:         demo_collections_comprehensions_plus_c2f.py
# Author:       QA2.0. Donald Cameron
# Revision:     v1.0
# Description:  This program will demonstrate how to filter collections using
# the built-in filter() function, lambda functions and comprehensions.
"""
  Filter collections of cities into warm cities in fahrenett.
"""
import    sys

weather   = {  'Glasgow'     : 11,
               'London'      : 21,
               'Edinburgh'   : 15,
               'Manchester'  : 18,
               'Thurso'      : 9
            }

def  filter_city    ( city ):
    """ Filter cities by temp """
    if   weather [ city ]  >=   15 :
         return   True
    else :
         return   False

def  c2f ( temp ):
    """ Accept temp in celsius and return temp in fahrenheit"""
    return   (  temp *  9/ 5) +  32

def   main ():
    """ Filter collection using filter(), lambda and comprehensions """
    # For Loop plus source collection, optional if condition, and expression.
    warm_cities   = []
    for   city   in  weather :  # Iterator for loop = collection.
          if  weather [ city ]  >=   15 :  # Optional condition (filtering)
              warm_cities  [ city ]=  c2f ( weather [ city ] )   # c2f Expression.
    print  ( " 1.Warm Cities =          "warm_cities  )"

    # For Loop plus source collection, optional if condition with user function, and expression.
    warm_cities   = []
    for   city   in  weather :
          if  filter_city     ( city ):
              warm_cities  [ city ]=  c2f ( weather [ city ] )
    print  ( " 2.Warm Cities =          "warm_cities  )"

    # Built-in filter() function plus source collection, user function for filtering.
    warm_cities   =  list  ( filter    ( filter_city      ,  warm_cities   ))
    print  ( " 3.Warm Cities =          "warm_cities  )"

    # Built-in filter() function plus source collection, lambda function for filtering.
    warm_cities   =  list  ( filter  ( lambda  city :  weather [ city ]  >=  15,   warm_cities   ))
    print  ( " 4.Warm Cities =          "warm_cities  )"

    # For Loop plus source collection, optional if condition, and expression. LIST comprehension.
    warm_cities   =[   c2f ( weather [ city ])  for  city   in  weather   if  weather [ city ]  >=  15 ]
    print  ( " 5.Warm Cities =          "warm_cities  )"

    # For Loop plus source collection, optional if condition, and expression. LIST comprehension.
    warm_cities   =[ (   city  ,   c2f ( weather [ city ])  for  city   in  weather   if  weather [ city ]  >=  15 ]
    print  ( " 5.1 Warm Cities =          "warm_cities  )"

    # For Loop plus source collection, optional if condition, and expression. DICT comprehension.
    warm_cities   =[   city  :  c2f ( weather [ city ])  for  city   in  weather   if  weather [ city ]  >=  15 ]
    print  ( " 5.2 Warm Cities =          "warm_cities  )"

    # For Loop plus source collection, optional if condition, and expression. SET comprehension.
    warm_cities   =[   city  for  city   in  weather   if  weather [ city ]  >=  15 ]
    print  ( " 5.3 Warm Cities =          "warm_cities  )"

    return   None

if    name__   ==  " main__ " :
    main ()
    sys . exit  ( 0 )
```

GENERATING




```
#! /bin/python
# Name:         demo_collections_generator_functions.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description: This program will demonstrate how to generate a collection of
# numbers using generator functions.
"""
  Generate and display collection of numbers lazily.
"""
import    sys

def   get_numbers   ():
    """ Return an ENTIRE list of numbers """
    print   ( "Executing get_numbers() "          )
    numbers   = [ ]
    for   x  in   range  ( 0,   10 ):
        numbers . append  ( x )
    return    numbers

def   generate_numbers    ():
    """ GENERATE one object/number at a time = Lazy List """
    print   ( "Executing generate numbers() "          )
    for   x  in   range  ( 0,   10 ):
        yield   x

def   generate_numbers2    ():
    """ GENERATE one object/number at a time = Lazy List
    using a return and list comprehension, eek! """
    print   ( "Executing generate numbers2() "          )
    return   [   x  for   x  in   range ( 0,   10)  if   x%2==0 ]

def   main ():
    """ Generate collection of numbers """

    # Try each of those with large numbers for range()
    for   z  in   get_numbers    ():
        print   ( z )

    for   z  in   generate_numbers    ():
        print   ( z )

    for   z  in   generate_numbers2    ():
        print   ( z )


    # Alternative ways to use a generator function and access a lazy
    # list using the builtin next() function and combined with a while loop.
    gen =   generate_numbers    ()
    while   True :
        num =   next  ( gen ,   -1)
        if   num!=-1 :
            print   ( num)
        else:
            break

    # Alternatively, manually get the next() object...
    gen =   generate_numbers    ()
    num1 =   next  ( gen ,   False )
    num2 =   next  ( gen ,   False )
    num3 =   next  ( gen ,   False )

    print   ( num1,   num2,  num3)
    return    None

if    __name__   ==   "__main__ ":
    main ()
    sys . exit  ( 0 )
```

COPYING




```python
#! /bin/python
# Name:         demo_collections_copying.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description: This program will demonstrate how to copy collections
# by memory reference, shallow copy and deep copy.
"""
    Copying 2_Collections.
"""
import sys
import pprint
import copy


def main():
    """ Copy 2_Collections """
    movies = { 'Donald': ['Dracula', 'Deliverance', 'Descendants'],
               'Mira': ['Matrix', 'Mad Max', 'Magnolia'],
               'Sarah': ['Seven', 'Scream','Saving Private Ryan']
    }

    # Comment each of the following on at a time!
    films = movies # Copy by memory reference
    # films = movies.copy() # Shallow Copy, nested objects shared.
    # films = copy.deepcopy(movies) # Deep copy to all levels.

    movies['Mira'][1] = 'Magnificent Seven'
    movies['Brian'] = ['Braveheart', 'Brave', 'Babe']

    pprint.pprint(movies)
    print("-" * 60)
    pprint.pprint(films)
    return None


if __name__ == "__main__":
    main()
    sys.exit(0)
```

Quiz

Advanced Collections Knowledge Check

5-10 mins

1. **What type of comprehension is this, and what would it return?**

```
>>> [ num for num in range(0, 10) if num % 2 == 0 and num % 4 == 0]
```

Answer: [0, 4, 8] # it's a List Comprehension

To b

aled

e to google that!) would be displayed?

```
'john', 'terry', 'graham']
name) <= 5 }
```

Answer: {'eric', 'terry', 'john'} # 3 Displayed

3. **Would this sequence of commands return True or False**

```
>>> movies = {'Cruella': '2021', 'Mulan': '2020', 'Mary Poppins Returns': '2018'}
>>> films = movies.copy()
>>> movies['Mulan'] = 1998
>>> films == movies
```

Answer: False # Shallow Copy. Movies was changed after the copy.

Exercises

35 mins

Advanced Collections - exercises for 'brave' knights

1

You should be familiar with the built-in range() function that generates a sequence of integers from a start point to a stop point with an optional step increment.

```
 range(stop) # default start=0, step=1
    range(start, stop[, step])
```

Unfortunately, it only works with integers. In this exercise, we will create our own simple version of the built-in range() function but for floating point numbers. Create a new script 'C:\labs\gen.py' with a generator function called frange() which accepts at least two parameters (start, stop) and an optional parameter with default (step=0.25)). Be wary of the possibility of a step = zero being passed in!

```
    frange(start, stop[, step=0.25])
```

Test with the following calls in main():

```
  print(list(frange(1.1, 3)))
  print(list(frange(1, 3, 0.33)))
  print(list(frange(1, 3, 1)))  # Should print [1.0, 2.0].
  print(list(frange(3, 1)))   # Should print an empty list.
  print(list(frange(1, 3, 0)))  # Should print an empty list.
  print(list(frange(-1, -0.5, 0.1)))
  print(frange(1, 2))     # Should print <generator object frange at 0x....>

  for num in frange(3.142, 12):
```

2

Modify your 'c:\labs\gen.py' script and enhance your frange() function so that it can accept only one parameter that acts as the stop of the sequence. The starting value for the range should then default to 0, with step set to 0.25.

Test the function with the following code in main():

```
    result1 = list(frange(0, 3.5, 0.25))
    result2 = list(frange(3.5))
    if result1 == result2:
      print("Default worked!")
    else:
      print(f"Oops! {result1} not equal to {result2}")
```

Advanced Collections - stretch exercises for Kings

3

Did you notice any inaccuracies in the numbers in the previous exercises? This is expected and is the nature of using floating points. They are so serious that this code should not be used in a production environment. A solution is to use the decimal module from the Python Standard library. This has a decimal.Decimal class constructor that converts integers/strings to Decimal objects - do this for all the parameters (start, stop and step) AND then convert the value to be yielded back to a float.

Modify your script 'C:\labs\gen.py' and frange() function to use the decimal module. The test results should be more sensible! Test using same calls in question 4.

Move your piece down as you complete the exercises

Not confident

Quite confident

Very confident

Back to the quest

Packages, Modules, Namespaces

Let's take CODE REUSE up a level

- **Modularity**
- **Building a Package**
- **Is is a program or a module?**
- **Namespaces - one honking great idea!**
- **The __main__ namespace trick**
- **Profiling**
- **Doc Testing**
- **Unit Testing**

Modules & Packages

Modular programming is the process of breaking down a large complex problem into separate, smaller and more manageable subtasks or modules. These simpler individual modules can then be completed (possibly in parallel for larger teams) and then glued back together like building blocks.

There are several advantages to using a modularised approach including:
- **Simplicity**: a module typically focuses on one small part of the problem and is easier to design and code.
- **Maintainability**: module are independent and designed, coded, debugged and tested and modified with impacting others.
- **Reusability:** modules can be reused across projects and programs. The 'Holy Grail'!
- **Scoping**: modules can have a separate namespace (honking great idea) avoiding conflicts with identifier names.

Python supports **Packages**, **Modules** and **Functions** that all promote the concept of modularisation.

There are three ways to define a module to be used in Python:
1. It can be written in Python itself with a .py suffix. This is the most common and the one we will focus on.
2. It can be written in C and loaded dynamically at run-time. The re module uses this!
3. A built-in module is intrinsically contained with the compiler, e.g. built-ins.

Python Package
Technically, a Python Package is just another module with sub-modules, sub-packages and a __path__ attribute. So importing a module or package is really just the same. But if you are looking for a definition - then a regular Package is NAMED directory with a logical group of files, modules, sub-folders AND a file called __init__.py. If the __init__.py is missing then its called a Namespace package.

In general, sub-modules and sub-packages are not imported when a package is imported. The __init__.py can be used to include all or any sub-modules or sub-packages. It can also contain global constants and functions and can also be empty!

Python automatically stores compiled python modules in a **__pycache__** folder which is found in the Package directory or Python install directory. When you are importing a module, including Python Standard Library modules, it is the pre-compiled modules with a suffix .pyc which are loaded, reducing the time to compile. If the .py module file has a newer timestamp then it is re-compiled and copied back in to the __pycache__ folder.

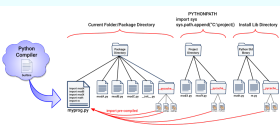
Finding Modules

The Python interpreter finds the modules - as a built-in, in the current or package directory, in a list of directories defined in the PYTHONPATH environment variable, or an installation-dependent list of directories configured during Python install.

On Linux, $ export PYTHONPATH="${PYTHONPATH}:${HOME}/python/lib:/projectX/lib"
On Windows, [Right Click]Computer > Properties >Advanced System Settings > Environment Variables >System Variables >New

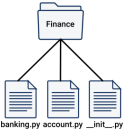
Within a program,
```
>>> import sys
>>> sys.path.append(r"C:\labs\projects\Proj_X")
>>> print(sys.path)
```

Importing a Package, and then a sub-package (from the current package),
```
>>> import my_package
>>> from . import my_sub_package
```



Creating Package

Packages are a logical group of modules that share the same directory and namespace and help avoid naming collisions using the **dot notation** - in a similar way that hierarchical file systems can have files with the same names but with a different pathname. Packages can be created and named in Pycharm, and a new directory will be created with the __init__.py.

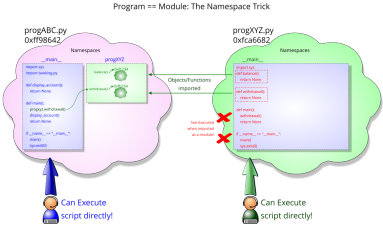



```
#! /bin/python
# Name:        banking.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This module defines several functions for banking app.
"""
    Manages Bank accounts with deposits and withdrawals.
"""
import   sys

def   deposit   ( balance   ):
    """ Deposit monies into bank account """
    amount   =   float   ( input   ( "Please enter amount to be added: "                ))
    balance   +=   amount
    print   ( f "Deposited:     { amount }. " )
    return   balance

def   withdraw   ( balance   ):
    """ Withdraw monies from bank account """
    amount   =   float   ( input   ( "Please enter amount to withdraw: "                ))
    balance   -=   amount
    print   ( f " { amount }  withdrawn. "       )
    return   balance

def   main ():
    """ Withdraw and deposit monies """
    bank_balance   =   0
    print   ( f "Welcome to mBA (mini Bank Account) App"              )

    while   True :
        menu   =   f"""
        mBA Menu
        --------
        Current Balance                 { bank_balance     }
        1. Deposit monies.
        2. Withdraw monies.
    """
        print   ( menu)
        option   =   input   ( "Enter option (1-2, q=quit): "              )
        if   option   ==   "1" :
            bank_balance   =   deposit   ( bank_balance     )
        elif   option   ==   "2" :
            bank_balance   =   withdraw   ( bank_balance     )
        elif   option . lower ( ) ==   "q" :
            break
        else :
            print   ( "Invalid option"       )

    print   ( "Thanks for using the mBA app."              )
    return   None

if   __name__   ==   "__main__"   :
    main ( )
    sys . exit  ( 0 )
```

Packages & Namespaces


```
#! /bin/python
# Name:         account.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description: This is MBA - Minions Banking App used by millions of minions!.
"""
  Withdraw, Deposit and Display banking information.
"""

import   sys
import   banking
# from bank_account import *    # TRY THIS!

def   display_info    ( bal ,   scode ):
      """ Display bank account info """
      print   ( f"Current balance = £          {bal  :.2f}   , sort code =          {scode } ")
      return      None

def   main ():
      """ Withdraw, deposit and display bank account information """
      bank_balance     =   34_500.23
      sort_code     =   "80-45-37"

      print   ( "Welcome to MBA - Minions Banking App"          )
      name =   input  ( "Enter your name: "          )  title    ()
      while   True :
            menu =    f"""
      Menu Options
      ------------
      1. Display Balance
      2. Deposit monies
      3. Withdraw monies
      """
            print   ( menu)
            option    =   input  ( "Enter option (1-3, q=quit): "              )
            if    option     ==    "1" :
                  display_info     ( bank_balance     ,    sort_code     )
            elif     option     ==    "2" :
                  bank_balance     =    banking  .deposit(     bank_balance     )
            elif     option     ==    "3" :
                  bank_balance     =    banking  .withdraw(    bank_balance     )
            elif     option    .lower  ()  ==     "q" :
                  break
            else :
                  print    ( "Invalid option"          )

      print    ( f"Thank you      {name}  for using our app!"          )
      return      None

if     __name__     ==    "__main__"  :
      main ()
      sys  .exit  ( 0)
```

Namespace Trick



Have you noticed the **__name__ == "__main__"** test we have been using in conjunction with a main() function? It's called the namespace trick and allows your script to act as a module and your module to act as a script. In other words, it allows the user to execute the module directly as a script, and also import the module into another script without executing the main() function!

It's also part of structuring our python scripts correctly. Continue using it! Oh, and always end your script with an error code, 0 indicates zero errors and any other integer (1-255) indicates an error code! This exit code is passed back to the calling program and indicates success or failure of your script.

Importing - the different ways

`import bank_account` `bank_account.deposit()`	Safer and traceable
`import sys, re, bank_account`	PEP8 disapproves!

`import sys`
`import re`
`import bank_account`
	PEP8 approves!

`import bank_account as b_acc` `b_acc.deposit()`	Module alias
`from bank_account import *`	BANG! Namespace Collision
`from bank_account import deposit`	Safer, be careful!
`from bank_account import (desposit as dp)` `dp()`	Confusing

Profiling

Performance & Quality

```python
#! /bin/python
# Name:       demo_profiling_before.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: This program will demonstrate how to benchmark/profile code
# to improve performance and quality using the cProfile module.
"""
   Search a given file using regular expressions and display
   matched lines. Analyse performance of code change,
"""
import sys
import re

def search_pattern (pattern, file =r "C: \l abs\words" ):
    """ Display lines in a given file which match 4_Regular_Expressions """
    fh_in = open ( file , mode="rt" )

    for line in fh_in :
        n = re . search (pattern , line ) # Return None or RE Match object.
        if n:
            print (line , end ="" )
    fh_in . close ()
    return None

def main ():
    """ Demonstrate different 4_Regular_Expressions patterns """
    search_pattern (r "^. {19} $" ) # Match lines with exactly 19 chars.
    return None

if __name__ == "__main__" :
    import cProfile
    cProfile . run ( "main()" ) # Display stats to console.
    # cProfile.run("main()", "stats.prof") # Write stats to file.
    sys . exit ( 0 )
```

.analyse before

```python
#! /bin/python
# Name:       demo_profiling_after.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: This program will demonstrate how to benchmark/profile code
# to improve performance and quality using the cProfile module.
"""
   Search a given file using regular expressions and display
   matched lines. Analyse performance of code change,
"""
import sys
import re

def search_pattern (pattern , file =r "C: \l abs\words" ):
    """ Display lines in a given file which match 4_Regular_Expressions """
    fh_in = open ( file , mode="rt" )
    reobj = re . compile ( pattern )

    for line in fh_in :
        n = reobj . search ( line ) # Return None or RE Match object.
        if n:
            print ( line , end ="" )
    fh_in . close ()
    return None

def main ():
    """ Demonstrate different 4_Regular_Expressions patterns """
    search_pattern (r "^. {19} $" ) # Match lines with exactly 19 chars.
    return None

if __name__ == "__main__" :
    import cProfile
    cProfile . run ( "main()" ) # Display stats to console.
    # cProfile.run("main()", "stats.prof") # Write stats to file.
    sys . exit ( 0 )
```

..analyse after

The Python Standard Library module **'cProfile'** can be used to understand the way your code behaves and is especially useful with large and complex programs. In its simplest form, the output generated will tell you how many calls each of your functions and methods received, and how long was spent executing each function (by line number and file/module name).

The analysis can be displayed to screen or written to a statistics file using a second parameter for the cProfile.run() function.

To analyse the statistics file:

```
C:\labs> python -m pstats stats.prof
% stats
```

Doc Testing

Automated Doc testing

The **doctest** module searches for text that looks like interactive Python sessions in the Docstrings, and then executes those sessions to verify that they work as shown. This is useful for checking that a module's Docstrings are up to date, for regression testing when code changes and to embed a tutorial within the documentation.

Test in interactive Python session.
>>> add(4, 3)
7

Copy and paste into function Docstring.

```
#! /usr/python
# Name:        demo_doctesting.py
# Author:      Q.M.2.B. Donald Cameron
# Revision:    v1.0
# Description: This program will demonstrate another example of
# creating functions with Docstrings, parameter passing, return values.
"""
  Calculator program with Add, Divide and Multiply functionality.
"""
import   sys

def   multiply  ( x,  z):
    """
  Accepts two numeric parameters and return product.
      >>> multiply(4, 3)
  12

  :param x (int/float):  Integer or float
  :param z (int/float):  Integer or float
  :return (int/float): Numeric product of x and z
  """
      return    x *  z

def   add ( x,  z):
    """
  Accepts two numeric parameters, adds them and returns sum.
      >>> add(4,3)
  7

  :param x (int/float):  Integer or float
  :param z (int/float):  Integer or float
  :return (int/float): Numeric of x summed with z
  """
      return    x +  z

def   divide  ( x,  z):
    """
  Accepts two numeric parameters, divides first by the second and returns result.
      >>> divide(4, 3)
  '1.333'
      >>> divide(4, 0)
  Traceback (most recent call last):
  ZeroDivisionError: division by zero

  :param x (int/float):  Integer or float
  :param z (int/float):  Integer or float
  :return (str):  f-string of x divided by z to 3 decimal places.
  """
      return    f"{x / z: .3f}"

def   main ():
    """ Simple Line docstrings are ideal if the function is self explanatory """
      print  ( f"4 * 3 =      {multiply  ( 4,  3) }")
      print  ( f"4 + 3 =      {add ( 4,  3) }")
      print  ( f"4 / 3 =      {divide  ( 4,  3) }")
      # print(f"4 / 3 = {divide(4, 0)}")

      print  ( multiply  . __doc__ )
      return    None

if  __name__  ==  "__main__" :
    import   doctest
    doctest . testmod ()
    main ()
    sys . exit  ( 0 )
```

Unit Testing

Unit testing your code is an essential part of the software development life cycle. As code is written or modified, it must be tested before deployment and existing code must be retested (regression testing) to ensure that the software still behaves as expected (i.e. no unwanted side effects).

Most programmers have done some form of testing, with exploratory testing the most natural. Exploring the code to find bugs, issues, invalid inputs but without a plan. Manual testing is more formal, as it incorporates a list of all the features to test, different inputs and expected results. And every time a change is made, we have to go manually go through the list again. And the fun ends!

Automated testing is more thorough and dependable with far better results. In this case, the plan of tests is scripted. Python comes with a set of tools and libraries to help create automated tests. Testing is a huge topic in programming and Python but we will learn to create and execute a basic test using the Python Standard Library **unittest** module.

Unit testing, as the name implies is about a smaller test that checks a single component. If you are testing multiple components then that is **integration testing**. In unit testing, when we are calling a single function with parameters, this is called a test step. And when we are checking the results, this is called a test assertion. Python already has an **assert()** function.

```
>>> assert sum([10, 20, 50]) == 80, "Should be 80"  # Returns an AssertionError and "Should be 80" if fails.
>>> assert sum((1, 1, 1]) == 3, "Should be 3" # Returns an AssertionError and "Should be 80" if fails.
```

This can then be incorporated in function code:

```
from demo_calculator import add, multiply
def test_sum():
    assert add(10, 20) == 30, "Should be 30"

def test_multiply():
    assert multiply(10, 20) == 200, "Should be 200"

if __name__ == "__main__":
    test_sum()
    test_multiply()
```

This is ok for simple checks, but for multiple failures we need a test runner which is a special app designed for running tests and validating output etc. The **unittest** module has both a **test framework** and **runner**. The initial difference is we put our tests into classes as methods (which we introduce in the next session!) and use special assertion methods from the module rather than the built-in assert function.

```
#! /bin/python
# Name:         demo_unittest_calc.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description: This program will demonstrate another example of
# creating functions with DocStrings, parameter passing, return values.
"""
Calculator program with Add, Divide and Multiply functionality.
"""
import    unittest
from  demo_calculator        import   add, multiply, divide

class    TestCalculator       ( unittest     .  TestCase   ):
    def   test_add    ( self   ):
            self   .  assertEqual     ( 7, add(    4,    3))

    def   test_multiply       ( self   ):
            self   .  assertEqual     ( 12, multiply(       4,    3))

    def   test_divide      ( self   ):
            self   .  assertEqual     ( '1.333'     , divide(     4,    3))


if    __name__    ==    "__main__"   :
    unittest     . main ()
```

Quiz

To be revealed

mespaces Knowledge Check

5-10 mins

1. Name the command used to load a Python module?

import

2. Fill in the blank.

Python modules have a .py suffix?

3. How does the Python compiler know when to recompile a Python Standard Library module?

- [ ] a. Module Name
- [X] b. Timestamps
- [ ] c. File size
- [ ] d. Importing using: from math import sin

?

4. Given a module called banking.py which has a function called deposit().

Choose from the following, the code which would work:

- [ ] a. from banking.py import deposit
  deposit(100)
- [ ] b. import deposit from banking
  banking.deposit(200)
- [X] c. import banking
  banking.deposit(300)
- [ ] d. from banking import deposit
  banking.deposit(400)

5. Name the file which is created when a new Package is created?

__init__.py

To be rev

6. True/False? Does this statement satisfy PEP8 requirements?

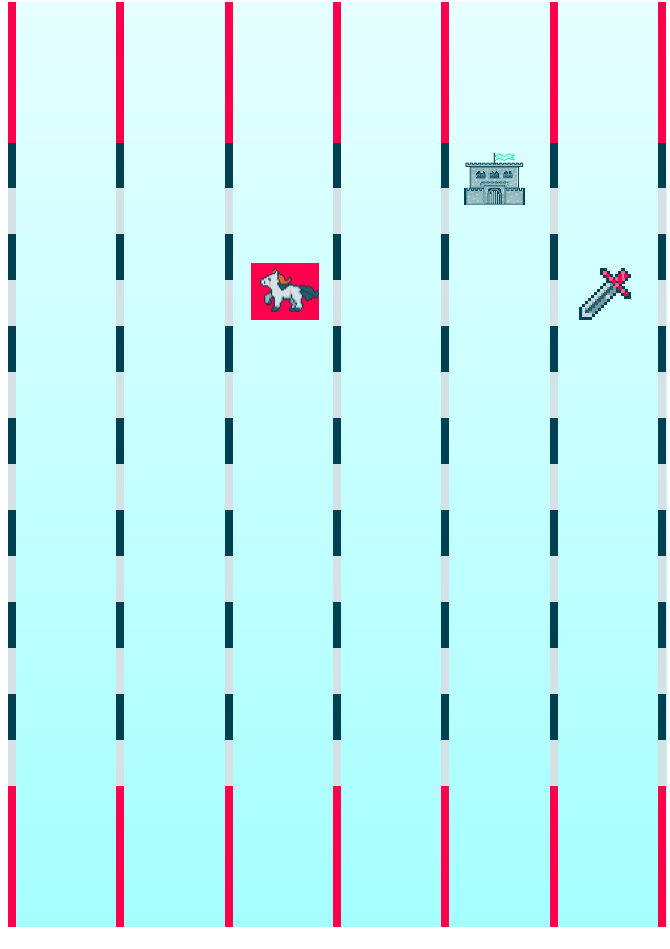
```
>>> import sys, math, banking
```

False, (should import each on a separate line)

Exercises

30 mins

Move your piece down as you complete the exercises



Modules & Packages - exercises for 'brave' knights

1

In this exercise, we are going to pull together some of the scripts and functions that you have already written and load them in as modules to a top-level menu program.

Create a new script **'C:\labs\menu.py'** that imports the appropriate functions from earlier lab exercises.

The script should display a menu like the following diagram, be contained within an infinite loop, and have a mechanism to quit out of the menu and the script. You should only import the functions that are required, which means you may have to modify the modules so that they have appropriate separate functions (and not solely a main() function).

Modules & Packages - stretch exercises for Kings

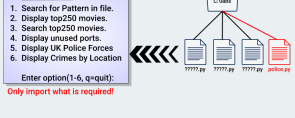
2

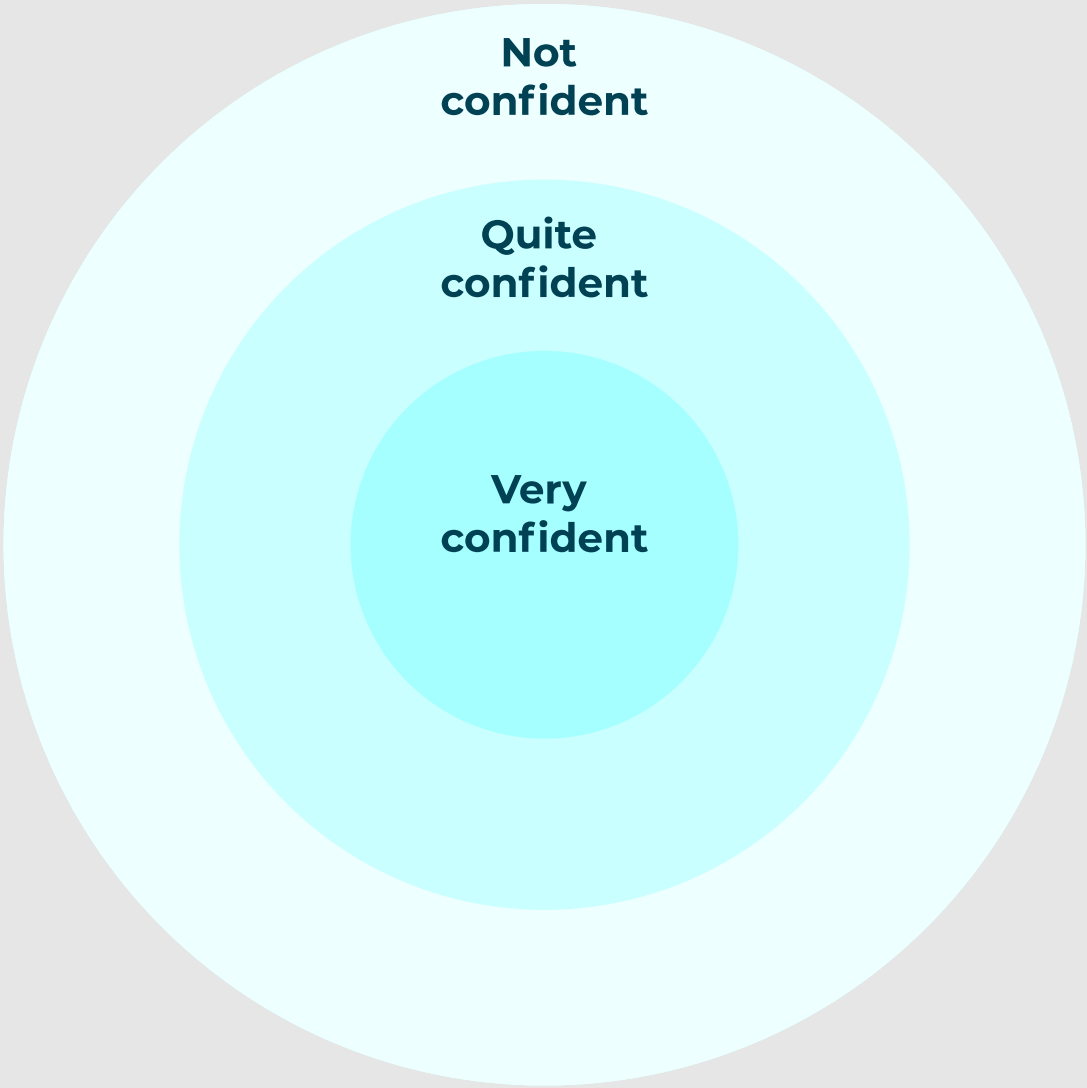
Sadly even Kings, when looking for the holy Grail, can be arrested by the police. So we are going to really stretch you in this exercise. Write a new module called '**c:\labs\police_data.py**'. Create two functions, once called **getPoliceForces()** which returns a list of Police Forces in England, and the other **getCrimeByLoc()** which returns a list of Crimes by location (given as latitude/longitude).

This data can be accessed from "https://data.police.uk/api/" by sending **HTTP GET** requests. The Python standard library requests module can be used to send the HTTP GET requests.

Some sample code for each function is below and https://data.police.uk/docs/ for help. Don't worry if you run out of time, this could be one for the evening! Extra Kudos for exception handling. [Hint: the FUN demos might help here]

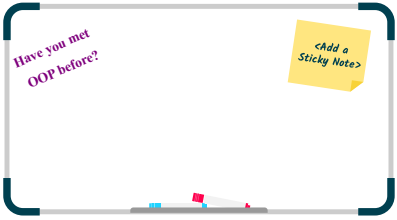
```
base_url = r"https://data.police.uk/api/"

full_url = base_url + "forces"
force_data = requests.get(full_url)

full_url = base_url + "crimes-at-location?lat=" + lat + "&lng=" + lon + "&date=" + date
crime_data = requests.get(full_url)
```





Back to the quest

- Benefits of OOP
- Defining a Class
- Getter/Setter methods
- Encapsulation
- Inheritance
- Decorators
- Instantiation
- Duck Typing
- Properties
- Polymorphism



OOP

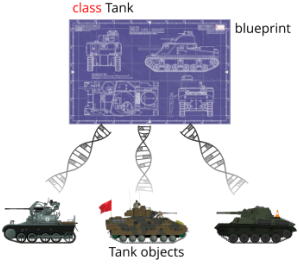
Object-oriented programming (OOP) is a computer programming model of structuring a program by bundling related properties and behaviours into individual objects.

In traditional or procedural programming, if we wanted to write a game with tanks, jeeps and trucks (as well as buildings, trees and lakes) we would have to describe everything as a separate variables and each thing would have to have a collection of functions describing what each thing can do. So tank1 would have a variable (data) and lots of functions (tank1_accel, tank1_decel, tank1_rotate_left etc). And we would have to replicate this for all tanks (and all other things). And we end up with a rather large source code file/s and lots of replicated code.

OOP recognises that in all walks of life (and programming) there is a lot of replication, for example, bank accounts, chess boards, online games etc. So in OOP, we create one blueprint called a **class** for each thing, such as a bank account, a pawn or a tank. And the class acts as a template for creating similar **objects**, but these objects are created at runtime in memory (when they are needed) and the source code file remains smaller and simpler.

You have already seen that Python has built-in classes such as str, int, list, dict and set. Each of these has attributes (data) and things it can do to itself (methods). The type() function tells you what type an object is and the dir() function displays a directory of the attributes and method names. And in your program you can create as many instances of str objects as you want based on the str class.

Python provides tools for creating our classes (of anything) with data and methods. And we can instantiate as many objects of this class as we need. In our demonstrations, we are going to bypass bank accounts and chess pieces and create Tank objects!



Defining classes

A few tips when creating a class:
· A class is declared using class, and membership is by indentation
· "class names use the CapWords convention" – PEP008
· Methods are declared as functions within that class, the first argument passed is the object.
· The constructor, called when a new object is created is called __init__
· The destructor is called __del__ but it's rarely required and unreliable.
· Classes are usually declared in a file with the same name as the class, with .py appended
· A docstring is a string literal that occurs as the first statement in a module, function, class, or method definition.

```
# Description
# Status     : Unit 10
# Author     : QA2 @ Donald Cameron
# Revision   : v1.0
# Description: This module describes a class of Tank for
# an online game.
"""
    Derived class of Tank
"""

class   Tank :

    _game_version   =  "1.0.42"     # Global class variable.

    def   _init__ ( self ,  country ,  model ):
        self   country  =  country
        self   model  =  model
        self   _speed  =  0
        self   _direction   =  0
        self   _location   =  [ 0,  0,  0 ]
        self   _shells   =  20
        self   _health   =  100
        # Implicitly called so we do not return.

    def   accel ( self ,  increase  ):
        self  _speed  +=  increase
        return   None

    def   decel ( self ,  decrease  ):
        self  _speed  -=  decrease
        return   None

    def   rotate_left   ( self ,  degrees  ):
        self  _direction   -=  degrees  %  360
        return   None

    def   rotate_right   ( self ,  degrees  ):
        self  _direction   +=  degrees  %  360

    def   shoot ( self  ):
        self   _shells   -=  1
        return   None

    def   take_damage  ( self ,  amount ):
        self  _health  -=  amount
        return   None

    #### EXTRA CODE for SPECIAL METHODS ####

    # It Example of Operator overloading
    def   __add__ ( self ,  other  ):
        return   self  _health  +  other  _health

    # Example of Duck Typing, Quack like a str object
    def   __str__ ( self  ):
        return  f"Health=  { self  _health  }, speed=  { self  _speed  }, shells=  { self  _shells  }"

    # Example of a GETTER method.
    def  get_health   ( self  ):
        return   self  _health

    # Example of a SETTER method
    def  set_health   ( self ,  newhealth  ):
        self  _health   =  newhealth
        return   None

    #### EXTRA CODE for special PROPERTIES. ####

    # Property function is wrapping the two methods with one name/interface
    tank_health   =  property  ( get_health  ,  set_health  )

    #### EXTRA CODE for DECORATORS ####

    # Wrapping the Identical Named Methods with a DECORATOR to indicate when
    # they should be used. DECORATORS = PYTHON3.7
    @property
    def  tank_health   ( self ):
        return   self  _health

    # Example of a SETTER method.
    @tank_health  .setter
    def  tank_health  ( self ,  newhealth  ):
        self  _health   =  newhealth
        return   None

    @classmethod
    def  get_version   ( cls ):
        return   f"Game version    : { cls  _game_version  }"
```

Instantiation

Once the class has been created (usually in its own module file). We then need to import the class and create **instances** of the class - in this case, we need to 'spawn' new tank **objects** in memory.

Once an instance of an object has been created, that object **inherits** the attributes (data) and behaviour (methods) of the class its based on. If any of the attributes or methods have an underscore prefix in their name, it identifies them as private and local to the class/object and should not be accessed outside the object. This is called **encapsulation** (hidden in a capsule). Using a double underscore prefix mangles the identifier by prefixing the name with _modulename.

Attributes and methods are accessed in the same way we access methods for built-in Python objects, using the dot notation, for example str.upper().

Another important features of OOP is **polymorphism** (many forms) that allows us to perform a single action in different ways. For example, we could have Tank, Jeep and Helicopter objects which all have a shoot() method - but each shoots in a different way!

We can use the built-in functions type() and dir() to get information on a Tank object and isinstance() can check whether an object belongs to a class. For example, isinstance(robin_tank, Tank).

```
#! /bin/python
# Name:         instances.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description: This is an ultra realistic computer game with Tanks!
"""
  Game of Tanks!
"""

import   sys
import   tank

def   main():
    """ Main game """
    # Instantiate 3 new Tank objects.
    lancelot_tank    =  tank.Tank(  "German"  ,  "Tiger"  )
    arthur_tank      =  tank.Tank(  "British"  ,  "Churchill"  )
    robin_tank       =  tank.Tank(  "American"  ,  "Sherman"  )

    # .. and the game begins.
    lancelot_tank.accel(  41 )
    arthur_tank.accel(  33 )

    robin_tank.rotate_left(  385 )
    robin_tank.accel(  15 )
    robin_tank.shoot()

    # ...and success!
    lancelot_tank.take_damage(  40 )
    arthur_tank.take_damage(  62 )

    # And now for some game visuals! Well at least a print statement!
    print  ( f"Health of Lancelot's Tank =  {lancelot_tank._health  }" )  # Why is this POOR Code?

    return  None

if  __name__  ==  "__main__" :
    main()
    sys.exit(0)
```

Special methods

In Python you will find special methods which start and end with double underscores. They are called **Magic methods** or **dunders**. They are not meant to be called directly are invoked internally from the class when a certain action occurs, For example, when you add two objects of the same class using the '+' operator, then internally the __add__() method will be called.

When we create a new object based on a class, the __new__() method is called immediately followed by the __init__() to initialise it. We rarely have to override __new__() in our class definitions, but we usually always override __init__() to initialise new objects.

Some more magic methods that can be overridden:

__len__(self)	Implement the len() function
__str__(self)	Returns a string object when the object is converted into a string.
__add__	+ Object can be used with 'add' operator.
__sub__	- Object can be used with 'minus' operator.
__eq__	== Object can be compared using the equality operator.
__ge__	>= Object can be compared using the 'greater or equal' operator.
__lt__	< Object can be compare using the 'less then' operator.

```
#! /bin/python
# Name:        demo_special_methods.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This is an ultra realistic computer game with Tanks!
"""
  Game of Tanks!
"""

import    sys
import   tank

def   main ():
    """ Main game """
    # Instantiate 3 new Tank objects:
    lancelot_tank    =  tank .Tank(  "German"    ,  "Tiger"    )
    arthur_tank      =  tank .Tank(  "British"   ,  "Churchill"    )
    robin_tank    =  tank .Tank(  "American"  ,  "Sherman"   )

    # ... and the game begins.
    lancelot_tank     .accel(    41 )
    arthur_tank       .accel(    33 )

    robin_tank     .rotate_left(      385 )
    robin_tank     .accel(    15 )
    robin_tank     .shoot()

    #  ...and success!
    lancelot_tank     .take_damage(    40 )
    arthur_tank       .take_damage(    62 )

    # And now for some game visuals! Well at least a print statement!
    print   ( f "Health of Lancelot's Tank =          {lancelot_tank      ._health    }" )  # Why is this POOR Code?

    # Example of Operator Overloading.
    print   ( f "Status of Lancelot's and Arthur's Tanks =                {lancelot_tank      +   arthur_tank     }" )

    # Example of Duck Typing. Tank can now Quack like a str!
    print   ( f "Status of Lancelot's Tank:          {lancelot_tank      }" )

    return     None

if    __name__    ==   "__main__"  :
    main ()
    sys . exit  ( 0 )
```

Getter & Setter Methods

In Object Oriented Programming we often want to keep the data belonging to an object private and manage what can access or modify our data. For example in a game you would not want other Tank objects knowing of your location and dire health as they would likely sneak up on you. We can limit what data is accessed using the dunder prefix but this is only a convention amongst fellow programmers and not enforced by the language.

The answer is special methods for **accessing** and **mutating** the data, more commonly called **Getter** and **Setter** methods. These methods control access and changes to the objects data, perhaps checking if you're a friendly tank or updating your health if you have received a health boost?

```
#! /bin/python
# Name:        demo_getter_setter_methods.py
# Author:      QA2.0, Donald Cameron
# Revision:    v1.0
# Description: This is an ultra realistic computer game with Tanks!
"""
  Game of Tanks!
"""

import   sys
import   tank

def   main ():
    """ Main game """
    # Instantiate 3 new Tank objects
    lancelot_tank    =  tank .Tank( "German" ,  "Tiger"  )
    arthur_tank      =  tank .Tank( "British"  ,  "Churchill"  )
    robin_tank       =  tank .Tank( "American"  ,  "Sherman"  )

    # .. and the game begins.
    lancelot_tank    .accel(  41)
    arthur_tank      .accel(  33)

    robin_tank    .rotate_left(  385 )
    robin_tank    .accel(  15)
    robin_tank    .shoot()

    # ..and success!
    lancelot_tank    .take_damage(  40)
    arthur_tank      .take_damage(  62)

    # And now for some game visuals! Well at least a print statement!
    print  ( f "Health of Lancelot's Tank =  {lancelot_tank    ._health   } " )  # Why is this POOR Code?

    # Example of Operator Overloading
    print  ( f "Status of Lancelot's and Arthur's Tanks =  {lancelot_tank    +  arthur_tank    } " )

    # Example of Duck Typing, Tank can now Quack like a str!
    print  ( f "Status of Lancelot's Tank:  {lancelot_tank    } " )

    # Lancelot has received a health boost!
    # Update and get health directly from private objects! Ugly and Poor!
    lancelot_tank    ._health =  90
    print  ( f "Lancelot's new health is  {lancelot_tank    ._health   } " )

    # Examples of special GETTER and SETTER methods.
    # Internal methods accessing private data = better!
    lancelot_tank    .set_health(  100 )
    print  ( f "Lancelot's new health is  {lancelot_tank    .get_health()   } " )

    return   None

if   __name__   ==  "__main__" :
    main ()
    sys .exit  ( 0)
```

Property function

Getter and Setter methods are good for managing access to private data within an object, but you likely have to use multiple different names for them and parameters are passed within parentheses.

As an alternative, Python has a built-in **property()** function that when applied to a method, it makes it behave like a variable interface with access, assignment and deletion properties (and an optional documenting property). Or in OOP speak, with getter, setter and deleter actions.

For example, if we want to access the health of a tank, assign or delete a value to the health of a tank using just one interface/variable name:

tank_health = property(get_health, set_health, del_health, doc_health)

```
#  /bin/python
# Name:         demo_properties.py
# Author:       QA2.0, Donald Cameron
# Revision:     v1.0
# Description: This is an ultra realistic computer game with Tanks!
"""
  Game of Tanks!
"""

import   sys
import   tank

def   main ():
    """ Main game """
    # Instantiate 3 new Tank objects
    lancelot_tank     =  tank.Tank(  "German" ,   "Tiger"    )
    arthur_tank     =  tank.Tank(  "British"    ,   "Churchill"    )
    robin_tank     =  tank.Tank(  "American"    ,   "Sherman"    )

    #    and the game begins
    lancelot_tank.     accel(    41 )
    arthur_tank.     accel(    33 )

    robin_tank.    rotate_left(      385 )
    robin_tank.    accel(    15 )
    robin_tank.    shoot()

    #    and success!
    lancelot_tank.     take_damage(     40 )
    arthur_tank.     take_damage(     62 )

    # And now for some game visuals! Well at least a print statement!
    print  ( f"Health of Lancelot's Tank =                {lancelot_tank.     _health    } ")  # Why is this POOR Code?

    # Example of Operator Overloading
    print  ( f"Status of Lancelot's and Arthur's Tanks =                {lancelot_tank     +  arthur_tank    } ")

    # Example of Duck Typing. Tank can now Quack like a str!
    print  ( f"Status of Lancelot's Tank:                {lancelot_tank    } ")

    # Lancelot has received a health boost!
    # Update and get health directly from private objects? Ugly and Poor!
    lancelot_tank.     _health =     90
    print  ( f"Lancelot's new health is                {lancelot_tank.     _health    } ")

    # Examples of special GETTER and SETTER methods.
    # Internal methods accessing private data = better!
    lancelot_tank.     set_health(     100 )
    print  ( f"Lancelot's new health is                {lancelot_tank.     get_health()    } ")

    # Using a property interface with one name
    lancelot_tank.     tank_health =     101
    print  ( f"Lancelot's new health is                {lancelot_tank.     tank_health    } ")
    return    None

if    __name__    ==    "__main__" :
    main ()
    sys .  exit  ( 0 )
```

Decorators

A Python **decorator** is a **function** that takes another function and extends the behaviour of the latter function without explicitly modifying it. For example, the **@property** decorator is a built-in decorator for the property() function and can use the following three decorators - @property, @<function-name>.setter, @<function-name>.deleter.

All the following three methods have the same name (overloaded) but we define when we use each one by decorating it a property function, one as a getter, one as a setter and the other as a deleter.

```
@property
def tank_health(self):
    return self._health

@tank_health.setter
def tank_health(self, newhealth):
    self._health = newhealth
    return None

@tank_health.deleter
def tank_health(self):
    del self._health
    return None
```

```
#! /bin/python
# Name:        demo_properties.py
# Author:      GAZ, fl, Donald Cameron
# Revision:    v1.0
# Description: This is an ultra realistic computer game with Tanks!
"""
  Game of Tanks!!
"""

import   sys
import   tank

def   main():
    """ Main game """
    # Instantiate 3 new Tank objects
    lancelot_tank    =   tank.Tank(  "German" ,  "Tiger"   )
    arthur_tank      =   tank.Tank(  "British"    ,  "Churchill"    )
    robin_tank       =   tank.Tank(  "American"    ,  "Sherman"   )

    # ..and the game begins
    lancelot_tank.accel(   41)
    arthur_tank.accel(   33)

    robin_tank.rotate_left(   38.5)
    robin_tank.accel(   15)
    robin_tank.shoot()

    # ..and success!
    lancelot_tank.take_damage(   40)
    arthur_tank.take_damage(   62)

    # And now for some game visuals! Well at least a print statement!
    print  ( "Health of Lancelot's Tank =                 "+lancelot_tank._health  + " ) # Why is this POOR Code?

    # Example of Operator Overloading
    print  ( "Status of Lancelot's and Arthur's Tanks =                 "+lancelot_tank  +  arthur_tank  + " )

    # Example of Duck Typing. Tank can now Quack like a str!
    print  ( " Status of Lancelot's Tank:                 "+lancelot_tank  + " )

    # Lancelot has received a health boost!
    # Update, and get health directly from private objects! Ugly and Poor!
    lancelot_tank._health =   90
    print  ( "Lancelot's new health is                 "+lancelot_tank._health  + " )

    # Examples of special GETTER and SETTER methods
    # Internal methods accessing private data = better!
    lancelot_tank.set_health(   100 )
    print  ( "Lancelot's new health is                 "+lancelot_tank.get_health()  + " )

    # Using a property interface with one name
    lancelot_tank.tank_health =   101
    print  ( "Lancelot's new health is                 "+lancelot_tank.tank_health  + " )

    # And testing our class method decorator
    print  ( tank.Tank.get_version() )
    return   None

if   __name__   ==  "__main__":
    main()
    sys.exit( 0 )
```

Inheritance

Have you noticed that some objects in the world have got similar attributes and behaviours? For example, jeeps and trucks do similar things as tanks such as accelerate, decelerate, and turn left and right. Current accounts have got similarities to deposit and savings accounts. In chess pawns, rooks, knights have all got similar properties like colour, position on board, and have similar behaviours such as move forward or move back.

This could lead to replication of data and methods and you would be 'a very naughty boy' in the OO world if you did this. So OOP supports the concept of Inheritance, and indeed multi-inheritance, where an object can be **Derived** from one or more **Base** or **Parent** classes, and will inherit the data and methods from the Base class.

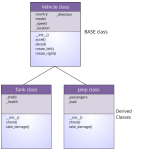
The derived or child class has all the methods and properties of the parent class, but you can add or change them.

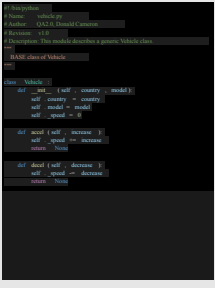
For example, we could have a Vehicle base class, and Tanks, Jeeps and Trucks could all inherit from this one parent - thus reducing the replication of code and effort.

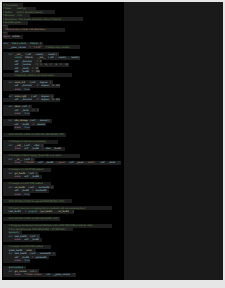
You might also find a class that is almost what you need, but you can't change it. If you want a string class that's slightly different from Python's str class, you can't actually change Python yourself, but could inherit from str and add new methods.

In Python, it is very common to derive our own classes from Python classes.

A useful method for classes is **issubclass()** which checks whether a class is a subclass of another class.







Quiz

OOP, Classes and Objects Knowledge Check

5-10 mins

1. Fill in the blank.

In OOP, a class is a [blueprint/template] for an object.

In a Python class definition, functions are called?

- [ ] a. functions
- [X] b. methods
- [ ] c. accessors
- [ ] d. attributes

3. Which is the correct way to instantiate a new knight based on this class?

```
class Knight:
def __init__(self, colour, bravery):
        self.name = f"{colour} knight"
        self.bravery = bravery
```

- [ ] a. Knight()
- [ ] b. Knight("Green", 4, "pepperami")
- [X] c. Knight("Black", 10)
- [ ] d. Knight.__init__("Green", 4)

4. True or False - a class can inherit from multiple base classes?

True - But needs extreme care, beware the diamond problem

To be revealed

Exercises

35 mins

Move your piece down as you complete the exercises

OOP - exercises for stupidly brave Black Knights

1

ercise you are going to open an existing module called 'c:\labs\movieDB.py' which will contain le class called MovieDB. It will have the following attributes and methods:

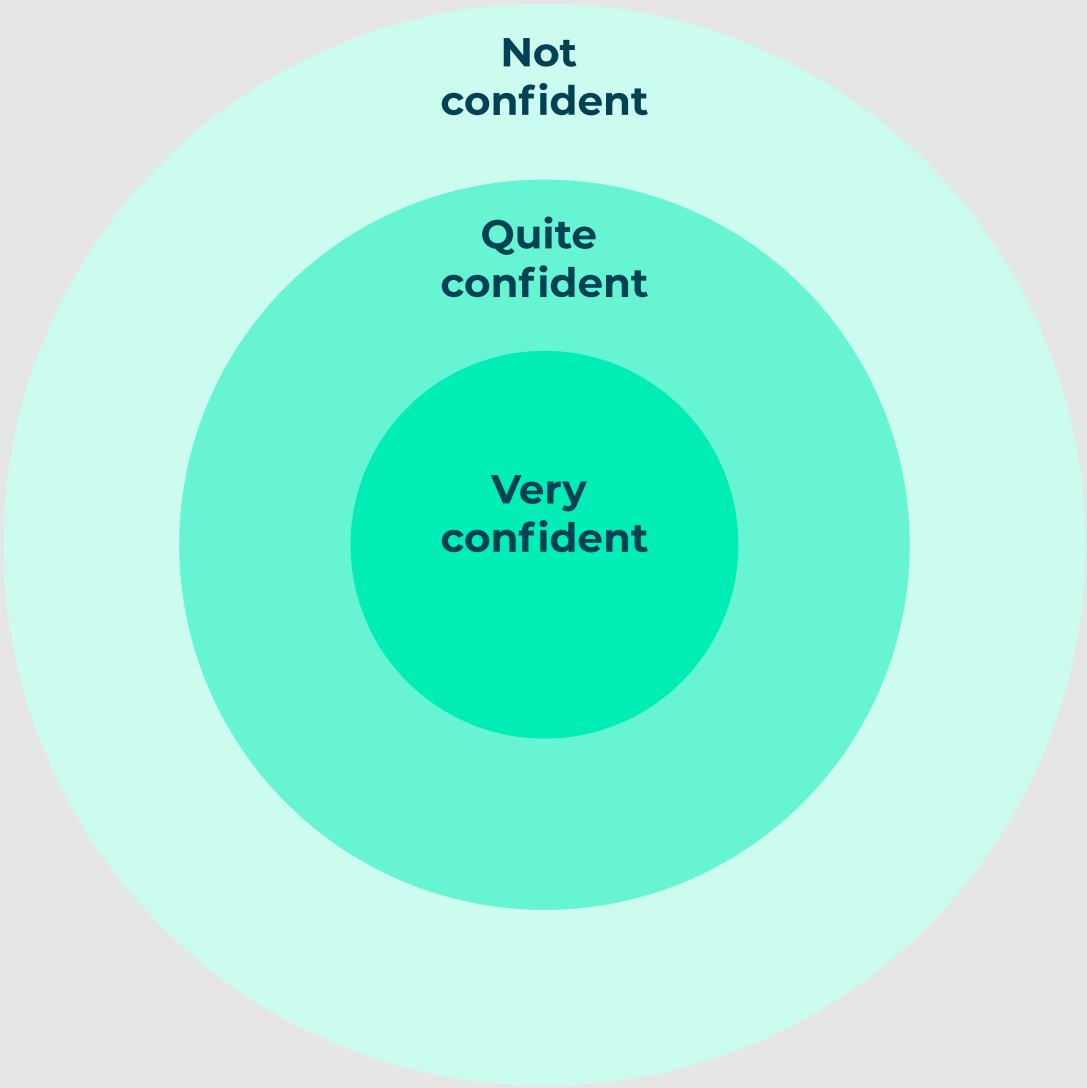
We have provided some of the code already for creating the class, opening and closing the DB connection and created a new table if required. The DB is a SQLite3 database called "C:\labs\movie_db_sqlite"

You have to create new methods for inserting new rows, delete existing rows, query all rows and commit all changes.

```
#! /usr/bin/python
# Author: QA2.0 LIVE, V1.0
# Description: This module defines a class called MovieDB for creating objects
# that can interact with a SQLite3 database file.
"""
 MovieDB class.
"""
import sqlite3

class MovieDB:
 # Class variable storing location of DB
   DB_LOC = "C:\labs\wmovie_db.sqlite"

   def __init__(self):
      try:
         self.__db_conn = sqlite3.connect(MovieDB.DB_LOC)
         self.cur = self.__db_conn.cursor()
      except Exception as err:
         raise ValueError
      # No return as not explicitly called.


   def create_table(self, table_name="movies"):
      self.cur.execute(f"""CREATE TABLE IF NOT EXISTS movies
                ( id       INTEGER PRIMARY KEY
                ,title     VARCHAR(30)
                ,year      VARCHAR(30)
   ,rating INTEGER
                ) """)
      return None

   def commit(self):
      """ Commit changes to database """
      self.__db_conn.commit()
      return None

   def __del__(self):
      """ Close connection automatically when object is deleted """
      self.__db_conn.close()
      return None
```

2

Write a simple program to import and test the MovieDB class.



Back to the quest

Solutions

5 mins

Quiz

1. Name three ordered and two unordered collections?

Ordered?

str,
tuple,
list

Unordered

dict,
set

2. Is a tuple mutable?

True X

False

3. The joy of sets! What would be printed from the following code?

```
>>> scottish_movies = {'Gregory's Girl', 'Local Hero', 'Comfort and Joy', 'That Sinking Feeling'}
>>> fav_movies = {'The Matrix', 'Local Hero', 'The Lord of the Rings'}
>>> print(scottish_movies & fav_movies)
```

{'Local Hero'}

4. Fill in the blanks:

Dictionaries have unique : Keys

Sets have unique : Objects

5. What would be printed from the following code?

```
>>> movies = {'Gregory's Girl', 'Local Hero', 'Comfort and Joy', 'That Sinking Feeling'}
>>> 'a' in 'a, e, i' movies
>>> print(a)
```

{'Local Hero', 'Comfort and Joy'}

6. Write the print statement from question 5 using set methods?

print(scottish_movies.intersection(fav_movies)

1

```
#!/usr/python
# Name:     lotto.py
# Author:   QA2 0, Donald Cameron
# Revision:  v1.0
# Description: Generates 6 Random Unique Lottery numbers
"""
  Lottery number generator. Good luck and remember your maxim!
"""

import   sys
import   random

def  main ():
    """ The Main Program """
    lotto  =  set ()  # Did we mention we want Unique numbers!
    while  len ( lotto )  <  6 :
        num  =  random . randint  ( 1,  50 )
        lotto . add ( num )

    print  ( "Lottery numbers =          {lotto  }" )
    return   None

if  __name__  ==  "__main__" :
    main ()
    sys . exit  ( 0 )
```

2

```
#! /usr/python
# Name:     top10.py
# Author:   QA2 0, Donald Cameron
# Revision:  v1.0
# Description: Display top movies
"""
  Top movies and Rankings
"""

import   sys

def  main ():
    movies  =  []

    fh_in  =  open ( "C:  \\ abs \\  sql250_movies.txt"  ,  mode="rt"  )
    movies  =  fh_in . readlines  ()  # Read movies into list
    fh_in  .  close  ()

    for  rank ,  movie  in  enumerate  ( movies ,  start  =1):
        print  ( f" { rank  =4d}  :  {movie  }",  end="" )
        if  rank  ==10  :break

    print  ( f"First movie =          {movies [ 0 ] }",  end="" )
    print  ( f"Last movie =          {movies [- 1 ] }",  end="\n" )

    topN  =  int  ( input  ("Choose TopN movies: "       ))
    for  rank ,  movie  in  enumerate  ( movies ,  start  =1):
        print  ( f" { rank  =4d}  :  {movie  }",  end="" )
        if  rank  ==topN  :break
    return   None

if  __name__  ==  "__main__" :
    main ()
    sys . exit  ( 0 )
```

3-7

```
#! /usr/python
# Name:     topTen_stretch.py
# Author:   QA2 0, Donald Cameron
# Revision:  v1.0
# Description: Display top movies
"""
  Top movies and Rankings
"""

import   sys

def  get_movies  ():
    fh_in  =  open ( r"C:  \\ abs \\  sql250_movies.txt"  ,  mode="rt"  )
    movies  =  fh_in . readlines  ()
    fh_in  .  close  ()
    return   movies

def  display_movies  ( movies ,  topN ):
    for  rank ,  movie  in  enumerate  ( movies ,  start  =1):
        print  ( f" { rank  =4d}  :  {movie  }",  end="" )
        if  rank  ==  topN  :  break
    return   None

def  search_movies  ( text ,  movies ):
    for  rank ,  movie  in  enumerate  ( movies ,  start  =1):
        if  text  in  movie :
            print  ( f" { rank  =4d}  :  {movie  }",  end="" )
    return   None

def  main ():
    movies  =  []
    while  True :
        main =  """
    Menu Options
    ____________
    1. Get online movie ranking from IMDB
    2. Display top ranking movies
    3. Search for movie
    """
        print  ( menu)
        option  =  input  ("Enter option: "       )
        if  option  ==  "1" :
            movies  =  get_movies  ()
        elif  option  ==  "2" :
            topN  =  int  ( input  ("Choose topN movies:"       ))
            display_movies  ( movies ,  topN)
        elif  option  ==  "3" :
            text  =  input  ("Enter movie to search:"       )
            search_movies  ( text ,  movies )
    return   None

if  __name__  ==  "__main__" :
    main ()
    sys.exit(      0)
```

Solutions

5mins

Quiz

1. What is the default mode for the built-in open() function?

"rt" [Read and Text mode]

2. What is the default buffering mode for text files?

Line buffering

3. Which methods are used for random access?

.seek() and .tell()

4. Which Python standard library module preserves ONE Python object to a file?

pickle.py

5. Which Python standard library module preserves MULTIPLE Python objects to a file?

shelve.py

1-4

5

6

7

Solutions

5 mins

Quiz

1. What does B.R.E and E.R.E stand for?

Basic and Extended Regular Expressions

2. What prefix should you use with your Regex patterns?

r"pattern" for Raw pattern strings,

3. Can you think of a better way to write the following pattern, which is 15 chars long?

r"^...............$"

r"^.{15}$"

4. Given this code, what will the pattern match?

```
>>> text = "Brave Sir Robin ran away. Bravely ran away away. When danger
reared it's ugly head, he bravely turned his tail and fled."
>>> m = re.search(r"(brave).*\1", text, flags=re.IGNORECASE)
>>> print(m.group())
```

Brave Sir Robin ran away. Bravely ran away away. When danger reared it’s ugly head, he brave

5. Given this code, what would be printed?

```
>>> text = "racecar"
>>> m = re.search(r"^(.)(.)(.).\3\2\1$", text)
>>> print(m.groups(), m.groups()[0], m.group(1))
```

('r', 'a', 'c') r r

```
#! /bin/python
# Name:       top250.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: Download the top 250 movies chosen by IMDb users.
"""
   Download and display online movie information.
"""
import sys
import imdb
import re

def main():
    ia = imdb.IMDb()

    pattern = input("Enter movie search string: ")

    for rank, movie in enumerate(ia.get_top250_movies(), start=1):
        n = re.search(pattern, str(movie), re.IGNORECASE)
        if n:
            print(f"{rank:>4}: {movie}")

    return None

if __name__ == "__main__":
    main()
    sys.exit(0)
```

5-6

```
#! /bin/python
# Name:       search250.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: Download the top 250 movies chosen by IMDb users.
"""
   Download and display online movie information.
"""
import sys
import imdb
import re

def main():
    ia = imdb.IMDb()
    count = 0
    for rank, movie in enumerate(ia.get_top250_movies(), start=1):
        # pattern = r"^the" # 50 lines.
        # pattern = r"[0-9]"  # 11 lines.
        # pattern = r"[aeiou]{3}"  # 5 lines.
        # pattern = r"^(.).*\1$" # 15 lines.
        # pattern = r"^[^a-zA-Z]+$"  # 1 line.
        # pattern = r"monty"  # 1 lines.
        pattern = r"\s+(\w+)\s+.*\1\s+"    # 8 lines.

        n = re.search(pattern, str(movie), re.IGNORECASE)
        if n:
            print(f"{rank:>4}: {movie}")
            count += 1
    print(f"Matched {count} lines")

    return None

if __name__ == "__main__":
    main()
    sys.exit(0)
```

7

```
#! /bin/python
# Name:       display_unused_ports.py
# Author:     QA2.0, Donald Cameron
# Revision:   v1.0
# Description: Display all the unused ports in the SERVICES file.
"""
   Display unused next ports from the SERVICES file.
"""
import sys
import re

def main():
    if sys.platform == "win32":
        filename = r"C:\WINDOWS\System32\drivers\etc\services"
    else:
        filename = r"/etc/services"

    # Open file handle for reading in text mode.
    fh_in = open(filename, mode="rt")
    all_ports = set(range(1, 201))
    used_ports = set()

    # Iterate through file handle and read the services.
    for line in fh_in:
        # Search for lines only containing digits followed
        # by / and (tcp or udp). Use groupings to extract.
        n = re.search(r"(\d+)/(tcp|udp)", line)
        if n:
            port = int(n.group(1))
            if port <= 200:
                used_ports.add(port)

    print(f"All ports = {all_ports}")
    print(f"Used ports = {used_ports}")
    print(f"Unused ports = {all_ports - used_ports}")

    fh_in.close()
    return None

if __name__ == "__main__":
    main()
    sys.exit(0)
```

Solutions

5 mins

Quiz

1. What does (*,) at the beginning of the parameter list do?

Enforce named parameter passing.

2. What is the output of the following function call?

```
>>> def my_func(num):
>>> return num + 10
>>>
>>> my_func(10)
>>> print(num)
```

NameError: name 'num' is not defined

3. True of False. Do Python functions always return a value?

True
(Python functions always return None unless explicit value)

4. What is the output of the following function call?

```
>> def display_info(**kwargs):
>>> for z in kwargs:
>>> print(z)

>>> display_info(movie="braveheart", year="1995")
```

movie
year

1-3

```
#! /bin/python
# Name:      calc.py
# Author:    QA2.0, Donald Cameron
# Revision:  v1.0
# Description: A Calculator program
"""
   Calculator program with add, divide, multiply,
   subtract and modulus functionality.
"""
import sys

def add ( x,  z):
    """ Return sum of x and z """
    return   x + z

def divide  ( x,  z):
    """ Return x divided by z to 3 decimal places """
    return   x/ z

def multiply  ( x,  z):
    """ Return product of x and z """
    return   x *  z

def subtract  ( x,  z):
    """ Return difference of x and z  """
    return   x -  z

def modulus ( x,  z):
    """ Return remainder of x divided by z """
    return   x %  z

# Solution for Question 7
# def add(*numbers):
#    """ Return sum of all parameters """
#    return sum(numbers)

# def multiply(*numbers):
#    """ Return the product of all parameters """
#    product = 1
#    for num in numbers:
#        product *= num
#    return product

def main ():
    """ This is the main program function """
    print  ( f "11 + 5 =   {add ( 11 ,  5) } " )
    print  ( f "11 / 5 =   {divide  ( 11,  5) } " )
    print  ( f "11 * 5 =   {multiply  ( 11,  5) } " )
    print  ( f "11 - 5 =   {subtract  ( 11,  5) } " )
    print  ( f "11 % 5 =   {modulus ( 11,  5) } " )

    # print(f"11 + 5 = {add(11, 5, 33, 15, 6.5)}")
    # print(f"11 * 5 = {multiply(11, 5, 33, 15, 6.5)}")
    return    None

if   __name__  ==  "__main__"  :
    main ()
    sys . exit  ( 0 )
```

4

```
#! /bin/python
# Name:      search250.py
# Author:    QA2.0, Donald Cameron
# Revision:  v1.0
# Description: Download the top 250 movies chosen by IMDb users.
"""
  Download and display online movie information.
"""
import   sys
import  imdb
import   re

def  search_movie   ( pattern   ):
    """ Search for a Regex pattern in the top 250 movies """
    ia  =  imdb .IMDb()
    count  =  0
    for  rank ,  movie  in  enumerate  ( ia .get_top250_movies(),        start  =1):
        m =  re . search  ( pattern   ,  str  ( movie ),  re . IGNORECASE)
        if  m:
            print  ( f" {rank  :>4} :  {movie } ")
            count  +=  1
    print  ( f "Matched   {count  } lines"    )
    return   None

def  main ():
    """ The Main Program """
    search_movie   ( r "^the"   )  # 50 lines.
    search_movie   ( r "[ 0-9 ] ")    # 11 lines.
    search_movie   ( r "[ aeiou  ] {3} " )    # 5 lines.
    search_movie   ( r "^ ( . ) . *\1 $")  # 15 lines.
    search_movie   ( r "^ [^ a-zA-Z  ]+$")    # 1 line.
    search_movie   ( r "monty"  )    # 1 lines.
    search_movie   ( r "\s  +( \w+) \s +. *\1  \s +")    # 8 lines.
    return    None

if   __name__   ==   "__main__"  :
    main ()
    sys . exit  ( 0)
```

5

```
#! /bin/python
# Name:      searchWords.py
# Author:    QA2.0, Donald Cameron
# Revision:  v1.0
# Description: Search and display lines in multiple files using
# Regular expressions
"""
  Pattern searching Tool
"""

import   sys
import   re

def  search_pattern     ( pattern   ,*  files   ):
    """ Search for Regex patterns in multiple file/s """
    if  not  files   :  files   =(  r "C: \l  abs\words"   ,)
    for  file   in  files   :
        fh_in  =  open ( file  ,  mode="rt"  )
        for  line   in  fh_in  :
            m =  re . search  ( pattern   ,  line  )
            if   m:
                print  ( line  ,  end ="" )

        fh_in  . close  ()

    return    None

def  main ():
    """ Main Program """
    search_pattern     ( r "^ ([  A-Z]) . *\1 $" )
    #search_pattern(r"^([A-Z]).*\1$", r"C:\labs\words", r"C:\labs\words")
    return    None

if  __name__  ==  "__main__"  :
    main ()
    sys . exit  ( 0)
```

Solutions

5 mins

Quiz

1. Can you think of a better way to write the following pattern, which is 15 chars long?

```
>>> [ num for num in range(0, 10) if num %2 == 0 and num % 4 == 0]
```

[0, 4, 8] # List Comprehension

2. Can you think of a better way to write the following pattern, which is 15 chars long?

```
>>> gumbys = ['eric', 'michael', 'terry', 'john', 'terry', 'graham']
>>> ( name for name in gumbys if len(name) == 5 )
```

('eric', 'terry', 'john') # 3 Displayed

3. Can you think of a better way to write the following pattern, which is 15 chars long?

```
>>> movies = ['Cruella', '2021', 'Mulan', '2020', 'Mary Poppins Returns', '2018']
>>> films = movies.copy()
>>> movies[1]='Mulan'] = '1998
>>> films == movies
```

False # Shallow Copy. Movies was changed after the copy.

1

```
# Description :
# Name :      gen2.py
# Author :    Q.A.S. Donald Cameron
# Revision :  v1.0
# Description: Floating point version of the built-in range()
# function.
"""
  Generate a sequence of floating point numbers.
  frange(start, stop [,step=0.25])
"""
import sys

def frange ( start ,  stop =None, step =0.25 ):
    """ Generate a sequence of floating point numbers."""
    if  stop == 0:  return  []
    cur = float ( start )
    while  cur <  stop :
        yield  cur
        cur += step

def  main():
    """ The Main Program """
    print ( list  ( frange ( 1.1 ,  1.9)))
    print ( list  ( frange ( 1 ,  3 ,  0.33 )))
    print ( list  ( frange ( 1 ,  3 ,  1)))  # Should return [ 1.0, 2.0 ], not [ 1, 2]
    print ( list  ( frange ( 1 ,  1)))  # Should return an empty list
    print ( list  ( frange ( 0 ,  3 ,  0.5 ,  0.1 )))
    print ( frange ( 1 ,  2 ))  # Should print <generator object frange at 0x..

    for  num  in  frange ( 3.142 ,  12):
        print ( f" { num :0.2f} ")
    return  None

if  __name__ == " __main__ ":
    main()
    sys . exit ( 0)
```

2

```
# Description :
# Name :      gen2.py
# Author :    Q.A.S. Donald Cameron
# Revision :  v1.0
# Description: Floating point version of the built-in range()
# function. Improved version using Decimal module. Can accept ONE parameter
"""
  Generate a sequence of floating point numbers.
  frange([start,] stop, [step=0.25])
"""
import  sys

def  frange ( start ,  stop =None, step =0.25 ):
    """ Generate a sequence of floating point numbers """
    if  stop == 0:  return  []
    if  stop == None:
        stop =  start
        cur =  0.0
    else :
        cur =  float  ( start  )

    while  cur <  stop :
        yield  cur
        cur += step

def  main ():
    """ The Main Program """
    result1  =  list  ( frange  ( 0,  3.5 ,  0.25  ))
    result2  =  list  ( frange  ( 3.5 ))

    if  result1  ==  result2 :
        print  ( "Default worked!" )
    else :
        print  ( "Oops!  {result1}  not equal to  {result2}  " )

    return  None

if  __name__ == " __main__ ":
    main ()
    sys . exit ( 0)
```

3

```
#! /usr/bin/python
# Name :      gen3.py
# Author :    Q.A.S. Donald Cameron
# Revision :  v1.0
# Description: Floating point version of the built-in range()
# function. Improved version using Decimal module.
"""
  Generate a sequence of accurate floating point numbers.
  frange([start,] stop, [step=0.25])
"""
import  sys
import  decimal

def  frange ( start ,  stop =None, step =0.25 ):
    """ Generate a sequence of floating point numbers """
    if  stop == 0:  return  []
    step =  decimal . Decimal ( str ( step ))

    if  stop == None:
        stop =  decimal . Decimal ( str  ( start  ))
        cur =  decimal . Decimal ( 0)
    else :
        stop =  decimal . Decimal ( str  ( stop ))
        cur =  decimal . Decimal ( str  ( start ))

    while  cur <  stop :
        yield  float  ( cur )
        cur  +=  step

def  main ():
    """ The Main Program """
    print  ( list  ( frange  ( 1.1 ,  3.9))
    print  ( list  ( frange  ( 1 ,  3 ,  0.33 ))
    print  ( list  ( frange  ( 1 ,  3 ,  1))  # Should return [ 1.0, 2.0], not [ 1, 2]
    print  ( list  ( frange  ( 3,  1))  # Should return an empty list
    print  ( list  ( frange  ( 1 ,  1 ,  0))  # Should return an empty list
    print  ( list  ( frange  ( -1 ,  - 0.5 ,  0.1 ))
    print  ( frange  ( 1 ,  2 ))  # Should print <generator object frange at 0x..

    for  num  in  frange  ( 3.142 ,  12):
        print  ( f" { num :0.2f} ")
    return  None

if  __name__ == " __main__ " :
    main ()
    sys . exit ( 0)
```

Solutions

5 mins

Quiz

1. Name the command used to load a Python module?

import

2. Fill in the blank.

Python modules have a .py suffix? suffix?

3. How does the Python compiler know when to recompile a Python Standard Library module?

- [ ] a. Module Name
- [X] b. Timestamps
- [ ] c. File size
- [ ] d. Importing using: from math import sin

4. Given a module called banking.py which has a function called deposit().

Choose from the following, the code which would work:

- [ ] a. from banking.py import deposit
  deposit(100)
- [ ] b. import deposit from banking
  banking.deposit(200)
- [X] c. import banking
  banking.deposit(300)
- [ ] d. from banking import deposit
  banking.deposit(400)

5. Name the file which is created when a new Package is created?

__init__.py

6. True/False? Does this statement satisfy PEP8 requirements?

```
>>> import sys, math, banking
```

True [ ] False [X]

```
# PEP9 recommends import on separate lines
```

1

```python
#! /bin/python
# Name:      menu.py
# Author:    QA2.0, Donald Cameron
# Revision:  v1.0
# Description: Top level menu program.
"""
  Menu of reusable functions.
"""
import sys
from searchWords import search_pattern        # Option 1.
from display_movies import display_top250     # Option 2.
from search250 import search_movie            # Option 3.
from display_unused_ports import unused_ports # Option 4.

def main ():
    """ The Main Program """
    menu = """
    Menu Options
    ------------
    1. Search for pattern in file
    2. Display top250 movies
    3. Search top250 movies
    4. Display unused ports

  """
    while True :
        print ( menu)
        option = input ( "Enter option (1-4, q=quit): " )
        if option == "1" :
            pattern = input ( "Enter search pattern: " )
      search_pattern( pattern )
        elif option == "2" :
      display_top250()
        elif option == "3" :
            pattern = input ( "Enter search pattern: " )
      search_movie( pattern )
        elif option == "4" :
      unused_ports()
        elif option . lower () == "q" :
            break
        else :
            print ( "Invalid option" )
    return None

if __name__ == "__main__" :
    main ()
    sys . exit ( 0)
```

2

```python
#! /bin/python
# Name:      police_data.py
# Author:    QA2.0, Donald Cameron
# Revision:  v1.0
# Description: Get online Police Data.
"""
  Get and display Online Police Crime Data
"""
import sys
import requests

def getPoliceForces ():
    """ Get List of English Police Forces by Region """
    base_url = r "https://data.police.uk/api/"
    full_url = base_url + "forces"
    force_data = requests . get ( full_url ) # HTTP GET url page.

    for force in force_data . json ():
        print ( f " { force [ 'id' ] :>30s} : { force [ 'name' ] :<20s} " )
    print ()
    return None

def getCrimeByLoc ():
    """ Display Police Crime data for a specific lat/long """
    date = input ( "Enter a date (eg. 2021-07): " ) or "2021-07"
    lat = input ( "Enter a Latitude (eg. 51.506): " ) or "51.506"
    lon = input ( "Enter a Longitude (eg. -0.075): " ) or "-0.075"

    base_url = r "https://data.police.uk/api/"
    full_url = base_url + "crimes-at-location?lat=" + lat + "&lng=" + lon + "&date=" + date
    crime_data = requests . get ( full_url )
    for crime in crime_data . json ():
        print ( f " {crime [ 'category' ] } , {crime [ 'location_type' ] } , "
                f " {crime [ 'outcome_status' ][ 'category' ] if crime [ 'outcome_status' ] else 'No Investigation' } , "
                f " {crime [ 'location' ][ 'street' ][ 'name' ] } " )
    print ()
    return None

def main ():
    """ The Main Program """
    menu = """
    Police Data
    ----------
    1. List of Police Forces
    2. Crimes by location

  """
    while True :
        print ( menu)
        option = input ( "Enter option (1-2, q=quit): " )

        if option == "1" :
            getPoliceForces ()
        elif option == "2" :
            getCrimeByLoc ()
        elif option . lower () == "q" :
            break
        else :
            print ( "Invalid option" )
    return None

if __name__ == "__main__" :
    main ()
    sys . exit ( 0)
```

Solutions

5 mins

Quiz

1. Fill in the blank.

In OOP, a class is a blueprint/template for an object.

2. Which is the correct way to instantiate a new knight based on this class?

```
class Knight:
def __init__(self, colour, bravery):
        self.name = f"{colour} knight"
        self.bravery = bravery
```

- a. Knight()
- b. Knight("Green", 4, "pepperami")
- X c. Knight("Black", 10)
- d. Knight.__init__("Green", 4)

In a Python class definition, functions are called?

- a. functions
- X b. methods
- c. accessors
- d. attributes

4. True of False - can a class inherit from multiple base classes?

True X False

1

```
# Description
# Name:         test_movieDB.py
# Author:       QA2.4: Donald Cameron
# Revision:     v1.0
# Description: This module defines a class called MovieDB for creating objects
# that can interact with a SQLite3 database file.
"""
MovieDB class
"""
import    sqlite3

class  MovieDB:
    # Class variable storing location of DB
    DB_LOC = "C:\\db\\movie_db.sqlite"

    def __init__ ( self ):
        try:
            self.__db_conn = sqlite3.connect ( MovieDB.DB_LOC)
            self.__cur = self.__db_conn.cursor ()
        except  Exception  as  err :
            raise  ValueError ( err )
        # No return as init explicitly called

    def  create_table  ( self , table_name = "movies" ):
        self.__cur.execute ( f"""CREATE TABLE IF NOT EXISTS movies
                ( id      INTEGER PRIMARY KEY
                , title   VARCHAR(30)
                , year    VARCHAR(30)
                , rating  INTEGER ) """
                )
        return  None

    def  insert_row  ( self , id_ , title_ , year_ , rating_ , table_name_ ="movies" ):
        """ Insert new item into db table """
        sql = f "INSERT INTO  {table_name_}  VALUES ( ?, ?, ?, ?)"
        self.__cur.execute ( sql , ( id_ , title_ , year_ , rating_ ))
        return  None

    def  delete_row ( self , row_id_ , table_name_ ="movies" ):
        """ Delete row from db table """
        sql = f "DELETE FROM  {table_name_}  WHERE id=:row_id "
        self.__cur.execute ( sql , { sql } )
        return  None

    def  query_all_rows ( self , table_name ="movies" ):
        """ Delete row from db table """
        sql = f "SELECT * FROM  {table_name_}"
        self.__cur.execute ( sql )

        rows = self.__cur.fetchall ()
        for  row  in  rows :
            print ( row )
        return  None

    def  commit( self ):
        """ Commit changes to database """
        self.__db_conn.commit ();
        return  None

    def  __del__ ( self ):
        """ Close connection automatically when object is deleted"""
        self.__db_conn.close ()
        return  None
```

2

```
# Description
# Name:         test_movieDB.py
# Author:       QA2.4: Donald Cameron
# Revision:     v1.0
# Description: Instantiate and test our MovieDB objects.
"""
Store and Retrieve movie data to db using a MovieDB object.
"""
import    sys
import    movieDB

def  main ():
    """ The Main Program """
    movies = movieDB.MovieDB() # Instantiate MovieDB object
    movies.create_table()
    movies.insert_row(  1,  'Rome'    ,  '2012'  ,  10)
    movies.insert_row(  2,  'Braveheart'  ,  '1995'  ,  10)
    movies.insert_row(  3,  'Babe'  ,  '1995'  ,  10)
    movies.commit()
    movies.query_all_rows()
    movies.delete_row(  1)
    movies.delete_row(  2)
    movies.delete_row(  3)
    movies.commit()
    return  None

if  __name__ == "__main__":
    main ()
    sys.exit (0)
```

PYTHON IN PRACTICE

Apply Activity:

Workplace Application Plan

Any questions?

- Review all questions in the Apply Phase documentation
- Ensure you have completed all of the relevant elements
- If you haven't done so already, discuss your plan with your line manager
- Complete the Apply work
- Reflect on your experience
- Once you have completed all the required steps confirm this has been done and have this validated by your line manager
- Finally, submit your work
- We will then check your submission, mark your activity as complete and issue you with your **Python in Practice** badge.

Good luck!