

Outline

- 1 **Working with Python**
- 2 Basic Programming with Python
- 3 Programming with Containers
- 4 Defining Functions

Working with Python Environments

- Spyder: Editor + Variable Explorer + IPython console
 - `%run yourpythonfile.py`
 - Ref:
<https://www.youtube.com/watch?v=zYNRqVimU3Q>
- Jupyter Notebook: “REPL” in a browser
 - Ref:
<https://www.youtube.com/watch?v=HW29067qVWk>
- Python Prompt/Shell: Use in lecture
 - Ref:
https://www.youtube.com/watch?v=kXbpB5_ywDw

Estimate: 20 minutes

Using Python as a Calculator

Warn ups (Estimate: 10 minutes)

- `from math import *`
- Question: How do you know that functions have been loaded from the library `math`?
- Question: How to get help on a particular function, e.g. `sin`

Solving high school problems by (i) **express them in Python** (ii) run the Python command and get the “numerical” answer:

- $\cos 15^\circ \cdot |\cos 225^\circ| - \sin 315^\circ \cdot |\cos 105^\circ|$
- In a triangle $\triangle ABC$, $\cos A = \frac{2}{5} \sqrt{5}$, $\cos B = \frac{3}{10} \sqrt{10}$, find C (in degree).

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Creating a Table of Mathematical Functions

- Print a table with x , $\sin x$, $\sin 2x$ and $\cos x$. The variable x ranges from π to π and increases by 0.01.
- Save the table with x , $\sin x$, $\sin 2x$ and $\cos x$ to a text file.
- View the data using a spreadsheet program

Estimate: 30 minutes

Truth Table with For Loops

Write a Python script to generate the truth table for the following statement

$$q \wedge \sim (\sim p \rightarrow r).$$

Estimate: 30 minutes

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Combinatorics (without repetition)

We often encounter combinations in real-life: E.g. if we are given a set $\{A, B, C, D\}$, how many possible 2-combinations can be have?

We can have $4 \times 3/2 = 6$ 2-combinations: $\{A, B\}$, $\{A, C\}$, $\{A, D\}$, $\{B, C\}$, $\{B, D\}$, $\{C, D\}$

Question: How can you list them in Python?

Estimate: 15 minutes

https://en.wikipedia.org/wiki/Combination#Number_of_k-combinations

Finding “Powerset” using Combinatorics

Can you list all the elements of the powerset of the set $\{A, B, C, D\}$ using Python???

Estimate: 15 minutes

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Defining Functions

In this part, we learn to define functions for formulae that we have encountered in pre-university study as well as the basic formula found in probability and statistics and how to get an approximation to non-linear equation.

Defining Functions (cont)

A triangle ABC , its area $|\triangle ABC|$ can be calculated by the following formulae:

$$|\triangle ABC| = \frac{1}{2}ab \sin C \quad \text{or}$$

$$|\triangle ABC| = \sqrt{s(s-a)(s-b)(s-c)}, \quad s = \frac{a+b+c}{2}.$$

The cosine rules and sine rule of the triangle are given below

$$a^2 = b^2 + c^2 - 2bc \cos A,$$

$$b^2 = a^2 + c^2 - 2ac \cos B,$$

$$c^2 = a^2 + b^2 - 2ab \cos C,$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}.$$

Defining Functions (cont)

Implement them as Python functions. Given a triangle $\triangle PQR$ with $PQ = 16.1\text{cm}$, $PR = 14.2\text{cm}$ and $QR = 28.7\text{cm}$. Find the following values using Python (Be very careful, all Python trigonometric functions only work with the radian unit.)

- 1 $\angle QPR$ (display your result in degree)
- 2 $\angle PQR$ (display your result in degree)
- 3 length of the bisector of angle QPR .
- 4 Find the area of the triangle.

Estimate: 30 minutes

Practical: Solving Nonlinear Equation

Solve the nonlinear equation $x = \frac{1}{2}(e^{x/2} + x)$ using Python.

Estimate: 10 minutes

Array in List Containers

- How to express a matrix in 2D? Example:

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \quad B = \begin{bmatrix} 3 & 5 & 6 & 7 \\ 4 & 6 & 3 & 2 \\ 5 & -3 & 1 & 1 \end{bmatrix}$$

- Implement the matrix multiplication.
- Implement a function to print matrix.
- Use your implementation perform the multiplication AB and print out the answer.

Estimate: 40 minutes

Practical: Tic Tac Toe

Purpose: Appreciate the breaking down of program to small functions and learn a bit about “game AI”.

```
drawBoard(theBoard)
if turn == 'player':
    move = getPlayerMove(theBoard)
    makeMove(theBoard, playerLetter, move)
else:
    move = getComputerMove(theBoard, computerLetter)
    makeMove(theBoard, computerLetter, move)
```

Ref:

<http://inventwithpython.com/chapter10.html>

Estimate: 40 minutes

Practical: Tic Tac Toe (cont)

The AI's algorithm will have the following steps:

- 1 See if there's a move the computer can make that will win the game. If there is, take that move.
- 2 See if there's a move the player can make that will cause the computer to lose the game. If there is, move there to block the player.
- 3 Check if any of the corner spaces (spaces 1, 3, 7, or 9) are free. If so, move there. If no corner piece is free, then go to next step.
- 4 Check if the centre is free.
- 5 Move on any of the side pieces (spaces 2, 4, 6, or 8). There are no more steps, because if the execution reaches this step the side spaces are the only spaces left.