# Numerical Methods

## Python Overview

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# Variables

- A variable can be used to store a certain value or object
- Variables are *typed dynamically*

```
[20]
1  a = 7   # a is an integer
2  print(a)
```
✓ 0.0s

```
7
```

```
[21]
1  a = a * 0.3     # a is now a float
2  print(a)
```
✓ 0.0s

```
2.1
```

# Lists

- Store multiple items in a single variable
- Lists are one of 4 built-in data types in Python used to store collections of data, the other 3 are Tuple, Set, and Dictionary
- List items are indexed, the first item has index [0], the second item has index [1] etc.

# Lists

```
[30]
1  a = [1.0, 2.0, 3.0, 4.0, 5.0]   # Create a list
2  a.append(6.0)                   # Append 6.0 to list
3  print(a)
```

✓ 0.0s

```
[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]
```

```
[31]
1  print(len(a))    # Determine length of list
```

✓ 0.0s

```
6
```

```
[33]
1  a[2:4] = [1.0, 1.0]     # Modify selected element
2  print(a)
```

✓ 0.0s

```
[1.0, 2.0, 1.0, 1.0, 5.0, 6.0]
```

# Arithmetic Operators

| | |
|---|---|
| + | Addition |
| - | Subtraction |
| * | Multiplication |
| / | Division |
| ** | Exponentiation |
| % | Modular Division |

# Numpy

- Numerical Python
- General-purpose array-processing package
- Fundamental package for scientific computing with Python

# Numpy

[11]
```
1 import numpy as np
```
✓ 1.3s

[34]
```
1 # 1d array
2 a = np.array([1.0, 2.0, 3.0, 4.0, 5.0])
3 print(a)
```
✓ 0.0s

```
[1. 2. 3. 4. 5.]
```

[35]
```
1 # 2d array
2 b = np.array([[1.0, 2.0], [3.0, 4.0]])
3 print(b)
```
✓ 0.0s

```
[[1. 2.]
 [3. 4.]]
```

[36]
```
1 # finding mean
2 print(np.mean(a))
```
✓ 0.0s

```
3.0
```

# Practice : Harmonic Series

$$\sum_{n=1}^{\infty} \frac{1}{n} = 1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \cdots$$

# Practice : Harmonic Mean

$$H = \frac{n}{\sum_{i=1}^{n} \frac{1}{x_i}}$$

$$H = \frac{n}{\frac{1}{x_1} + \frac{1}{x_2} + \frac{1}{x_3} + \ldots + \frac{1}{x_n}}$$

# Numpy

Some useful numpy functions :

| | |
|---|---|
| np.zeros((m, n)) | Creates an m x n array with 0s |
| np.ones((m, n)) | Creates an m x n array with 1s |
| np.eye(n) | Creates an Identity Matrix |
| np.diag(V) | Creates a Diagonal Matrix |
| np.rand() | Uniform random number array |
| np.randn() | Gaussian random number array |

# Pyplot

- Matplotlib is a plotting library for creating static, animated, and interactive visualizations in Python
- Pyplot is a Matplotlib module which provides a MATLAB-like interface
- The various plots we can utilize using Pyplot are **Line Plot, Histogram, Scatter, 3D Plot, Image, Contour, and Polar**

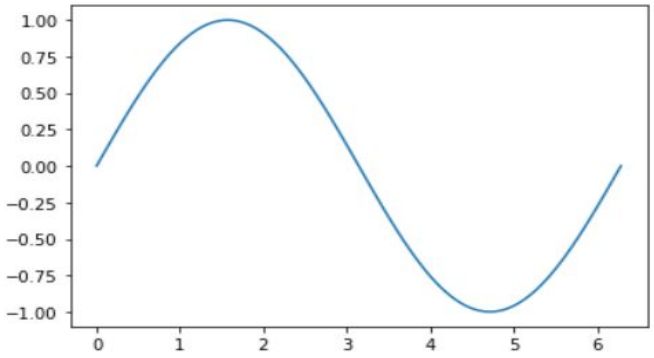
# Pyplot

```
[49]
```

```python
import matplotlib.pyplot as plt

x = np.linspace(0, 2 * np.pi, 100)
y = np.sin(x)
plt.plot(x, y)
plt.show()
```

✓ 3.8s



# Practice : Plot the formula

$$y = ut - \frac{1}{2}gt^2$$

# Practice : Derivative

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$