# Day 2 Complete

May 26, 2023

Day 2

Application 1: Solving Equations

The following two equations seem similar, but equation 1 can be solved (for r) analytically (try it out!), but not equation 2!

$$10 = 5 \log \frac{r}{10}$$

$$10 = 5 \log \frac{r}{10} + 0.002r$$

We will use numerical methods to solve equation 2, more specifically, the iterative method.

[ ]:
```
# use iterative method to solve the problem 10=5log(r/10)+0.002r

import numpy as np
import matplotlib.pyplot as plt

# define the function
def f(r):
    return 10**(2-0.0004*r)*10
```

Rewrite the equation in the form of (try derive):

$$r = 10 \times 10^{2-0.0004r}$$

Then use 1000 as the initial value, run a 100 iteration

[ ]:
```
r = 1000
for i in range (20):
    r = f(r)
    print("Number of Iteration: ", i+1, " Value of r: ",  r)
```

```
Number of Iteration:  1  Value of r:  398.1071705534973
Number of Iteration:  2  Value of r:  693.0381335543425
Number of Iteration:  3  Value of r:  528.1833984276446
Number of Iteration:  4  Value of r:  614.7897817911412
Number of Iteration:  5  Value of r:  567.654502969976
Number of Iteration:  6  Value of r:  592.8409558305243
Number of Iteration:  7  Value of r:  579.2467658853818
```

```
Number of Iteration:  8  Value of r:  586.5449414464675
Number of Iteration:  9  Value of r:  582.6154851536324
Number of Iteration:  10  Value of r:  584.727885812272
Number of Iteration:  11  Value of r:  583.5913493623659
Number of Iteration:  12  Value of r:  584.2025660759019
Number of Iteration:  13  Value of r:  583.8737809787382
Number of Iteration:  14  Value of r:  584.0506177335104
Number of Iteration:  15  Value of r:  583.9554995961669
Number of Iteration:  16  Value of r:  584.006660451167
Number of Iteration:  17  Value of r:  583.9791421865931
Number of Iteration:  18  Value of r:  583.9939434763743
Number of Iteration:  19  Value of r:  583.985982238063
Number of Iteration:  20  Value of r:  583.9902643727103
```

Application 2: Monte Carlo Simulation

Let's use the numerical method to estimate the value of $\pi$. https://medium.com/the-modern-scientist/estimating-pi-using-monte-carlo-methods-dbdf26c888d6#:~:text=Multiply%20the%20ratio%20by%204%20to%20estimate%20the,circle%2C%20we%20can%

[ ]:
```
# display image
from IPython.display import Image
Image(url='https://demonstrations.wolfram.com/
 ↪ApproximatingPiByTheMonteCarloMethod/img/popup_2.png')
```

[ ]:
```
<IPython.core.display.Image object>
```

[ ]:
```
# use monte carlo method to estimate pi
import numpy as np
import matplotlib.pyplot as plt

# define the function
def f(x,y):
    return x**2+y**2

# define the number of points
n = 100

# generate random points
x = np.random.rand(n)
y = np.random.rand(n)

# calculate the number of points in the circle
count = 0
for i in range(n):
    if f(x[i],y[i]) <= 1:
        count += 1
```

```
# calculate pi

pi = 4*count/n
print(pi)
```

```
3.08
```

Application 3: Malaysia Population

Exercise: Let's Examine Malaysia Population!

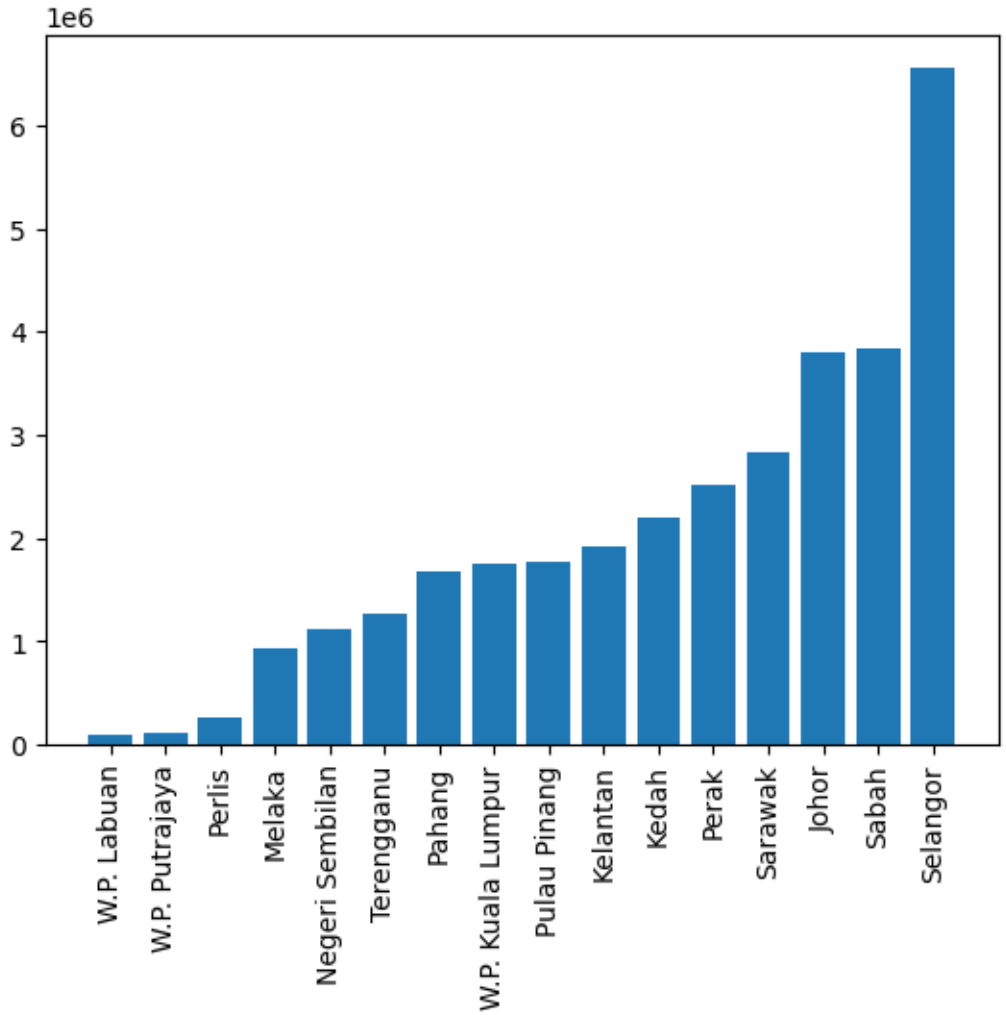
[ ]:
```
# get malaysia population data from kaggle website

# import pandas as pd
import pandas as pd
import wget

url = 'https://raw.githubusercontent.com/MoH-Malaysia/covid19-public/main/
 ↪static/population.csv'
populationfile = wget.download(url)
df = pd.read_csv(populationfile)
df.head()
```

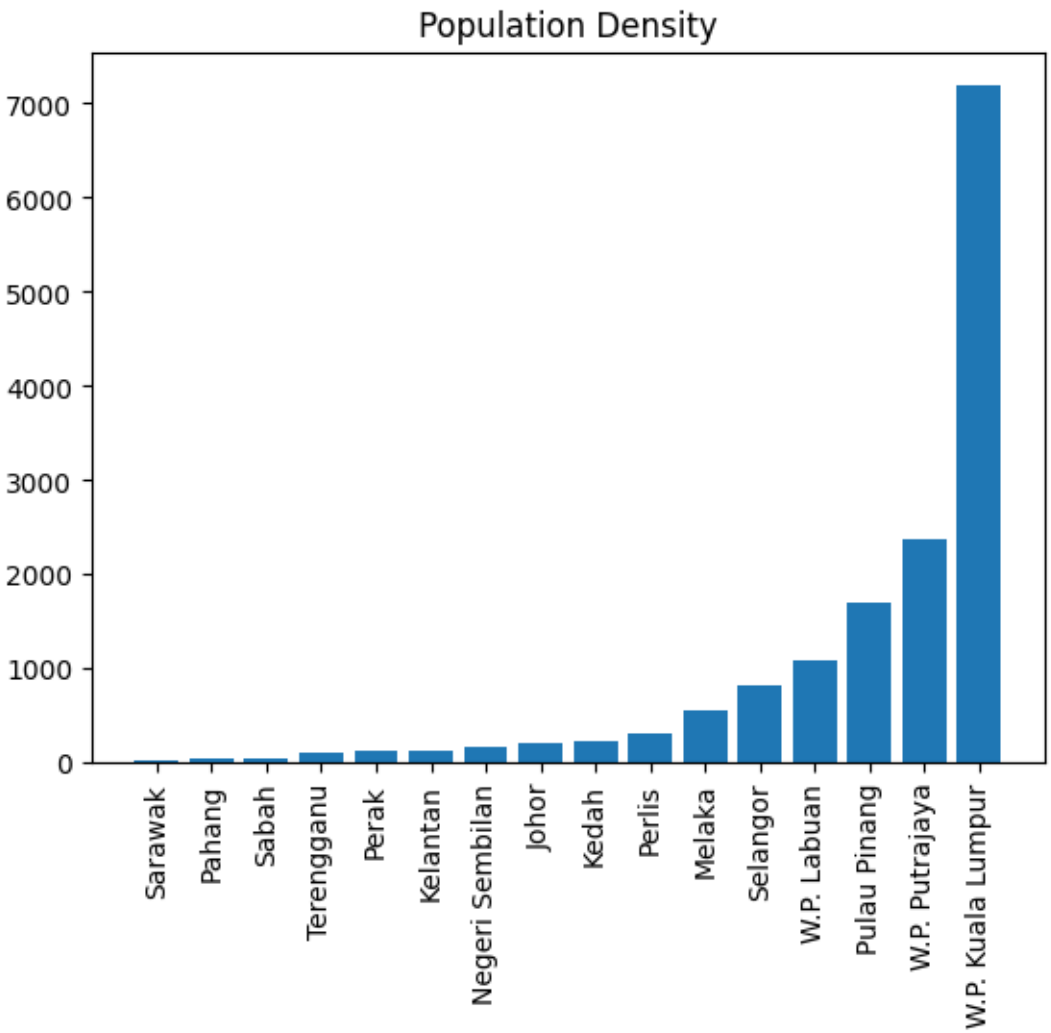
[ ]:

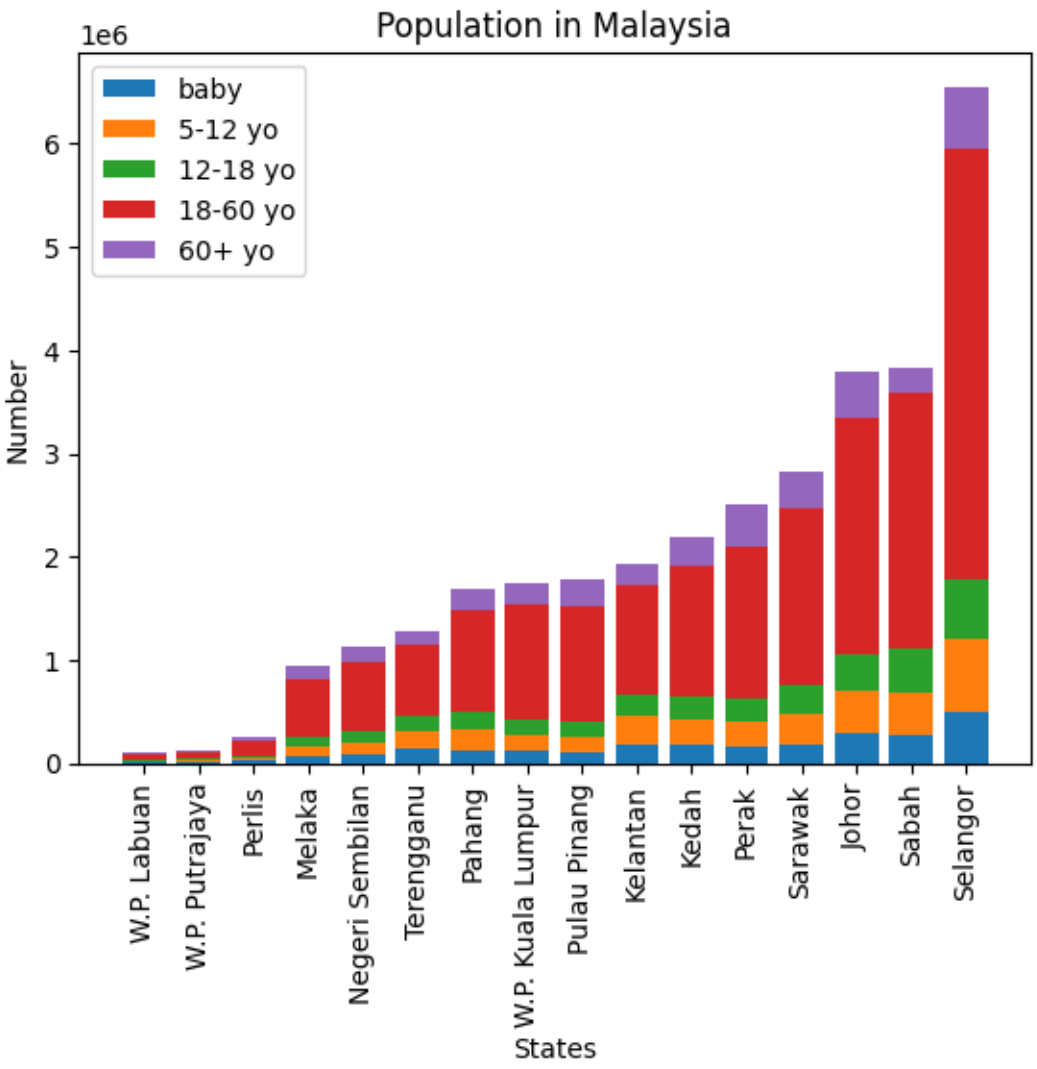
| | state | idxs | pop | pop_18 | pop_60 | pop_12 | pop_5 |
|---|---|---|---|---|---|---|---|
| 0 | Malaysia | 0 | 32657100 | 23528200 | 3649000 | 3111400 | 3550500 |
| 1 | Klang Valley | 17 | 8417800 | 6181800 | 827600 | 719000 | 895100 |
| 2 | Johor | 1 | 3794200 | 2733400 | 445600 | 353900 | 409800 |
| 3 | Kedah | 2 | 2193600 | 1554800 | 282300 | 209700 | 254100 |
| 4 | Kelantan | 3 | 1928900 | 1258700 | 202100 | 211200 | 271700 |

[ ]:
```
import pandas as pd
import matplotlib.pyplot as plt

population_table = pd.read_csv('population.csv')
population_table.loc[0]

no_malaysia = population_table[population_table['state'] != 'Malaysia']
only_states = no_malaysia[no_malaysia['state']!='Klang Valley']
only_states
population_table[population_table['pop'] > 5000000]
sorted_table = only_states.sort_values(by=['pop'])
x = sorted_table['state']
y = sorted_table['pop']
plt.bar(x,y)
plt.xticks(rotation=90)
plt.show()
sorted_table['pop18to60'] = sorted_table['pop_18'] - sorted_table['pop_60']
```

```
sorted_table['pop_baby'] = sorted_table['pop'] - sorted_table['pop_18'] -␣
 ↪sorted_table['pop_5'] - sorted_table['pop_12']
sorted_table
state_area =␣
 ↪[92,49,819,1712,6658,12950,35965,243,1049,15040,9492,21146,124450,19166,73621,7951]
sorted_table['area_of_state'] = state_area
sorted_table['pop_dens'] = sorted_table['pop'] / sorted_table['area_of_state']
sorted_table
sort_pop_dens_table = sorted_table.sort_values(by=['pop_dens'])
x = sort_pop_dens_table['state']
y = sort_pop_dens_table['pop_dens']

plt.bar(x,y)
plt.xticks(rotation=90)
# plt.ylim(0,3000)
plt.title('Population Density')
plt.show()
x = sorted_table['state']
y_baby = sorted_table['pop_baby']
y_children = sorted_table['pop_5']
y_teenager = sorted_table['pop_12']
y_adults = sorted_table['pop18to60']
y_elderly = sorted_table['pop_60']

plt.bar(x,y_baby, label='baby')
plt.bar(x,y_children, label="5-12 yo", bottom=y_baby)
plt.bar(x,y_teenager, label="12-18 yo", bottom=y_baby+y_children)
plt.bar(x,y_adults, label="18-60 yo", bottom=y_baby+y_children+y_teenager)
plt.bar(x,y_elderly, label="60+ yo",␣
 ↪bottom=y_baby+y_children+y_teenager+y_adults)


plt.xticks(rotation=90)
plt.legend()
plt.title('Population in Malaysia')
plt.ylabel("Number")
plt.xlabel("States")
plt.show()
```


1e6
6
5
4
3
2
1
0
W.P. Labuan
W.P. Putrajaya
Perlis
Melaka
Negeri Sembilan
Terengganu
Pahang
W.P. Kuala Lumpur
Pulau Pinang
Kelantan
Kedah
Perak
Sarawak
Johor
Sabah
Selangor


Population Density
7000
6000
5000
4000
3000
2000
1000
0
Sarawak
Pahang
Sabah
Terengganu
Perak
Kelantan
Negeri Sembilan
Johor
Kedah
Perlis
Melaka
Selangor
W.P. Labuan
Pulau Pinang
W.P. Putrajaya
W.P. Kuala Lumpur




Session 5: Conclusion and Next Steps - Review of what has been covered, and discussion of further resources and applications of Python in physics.