9-3-17

EE16A - F17

Homework 1

1 Administrivia:

To be eligible for midterm clobbering, we need to attend at least 75% of all discussion (not including 1st week of class) and submit no more than 1 late assignment (could be hw itself or self grade) or contribute by posting or answering relevant technical questions on Piazza at least 10 times over the course of the semester.

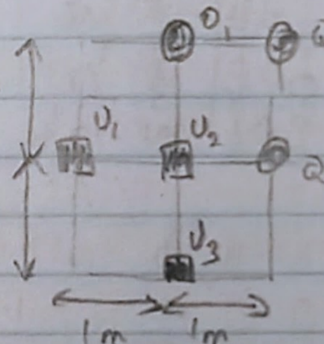
2 PRACTICE Finding Charges from Potential Measurements

$U = k\dfrac{Q}{r}$ 3 point charges $Q_1, Q_2, Q_3 \rightarrow$ known

3 measurements U_1, U_2, U_3

r = meters away

k = constant



$$U_1 = \frac{kQ_1}{\sqrt{2}} + \frac{kQ_2}{\sqrt{5}} + \frac{kQ_3}{2}$$

$$U_3 = \frac{kQ_1}{2} + \frac{kQ_2}{\sqrt{5}} + \frac{kQ_3}{\sqrt{2}}$$

$$U_2 = k\frac{Q_1}{1} + k\frac{Q_2}{\sqrt{2}} + k\frac{Q_3}{1}$$

$$U_1 = k\left(\frac{4+3\sqrt{5}+\sqrt{10}}{2\sqrt{5}}\right)$$

$$U_2 = k\left(\frac{2+4\sqrt{2}}{\sqrt{2}}\right)$$

$$U_3 = k\left(\frac{4+\sqrt{5}+3\sqrt{10}}{2\sqrt{5}}\right)$$

```
import numpy as np
a = np.array([
    [1/√2  1/√5  1/2]
    [1     1/√2  1  ]
    [1/2   1/√5  1/√2]
])
b = np.array([y1, y2, y3])
x = np.linalg.solve(a, b)
```

Q_1 charge = 1

Q_2 charge = 2

Q_3 charge = 3

3 Sahai's Optimal Smoothies

Smoothie = $\frac{1}{2}$ Greek Yogurt + $\frac{1}{8}$ vanilla soy + $\frac{1}{2}$ crushed ice + 1 cup mystery fruit.

A

Banana Berry (BB) $6\frac{2}{3} = \frac{1}{3}x_1 + \frac{1}{3}x_2 + 0x_3 + \frac{1}{3}x_4$

Carribean Passion (CP) $6\frac{2}{3} = \frac{1}{3}x_1 + \frac{1}{3}x_2 + \frac{1}{3}x_3 + 0x_4$

(Mango a go go (MGG) $7\frac{2}{5} = 0x_1 + \frac{2}{5}x_2 + \frac{3}{5}x_3 + 0x_4$

Strawberries Wild (SW). $5\frac{2}{3} = \frac{2}{3}x_1 + \frac{1}{3}x_2 + 0x_3 + 0x_4$

x_1 - strawberries x_2 - bananas

x_3 mango x_4 blueberries

$$\left[\begin{array}{cccc|c} \frac{1}{3} & \frac{1}{3} & 0 & \frac{1}{3} & \frac{20}{3} \\ \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 0 & \frac{20}{3} \\ 0 & \frac{2}{5} & \frac{3}{5} & 0 & \frac{37}{5} \\ \frac{2}{3} & \frac{1}{3} & 0 & 0 & \frac{17}{3} \end{array}\right] \quad \begin{array}{l} R1 = R1 \times 3 \\ R2 = R2 \times 3 \\ R3 = R3 \times 5 \\ R4 = R4 \times 3 \end{array} \quad \left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 20 \\ 1 & 1 & 1 & 0 & 20 \\ 0 & 2 & 3 & 0 & 37 \\ 2 & 1 & 0 & 0 & 17 \end{array}\right] \begin{array}{l} R1-R2 \\ \\ \\ 2R1-R4 \end{array}$$

$$\left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 20 \\ 0 & 0 & -1 & 1 & 0 \\ 0 & 2 & 3 & 0 & 37 \\ 0 & 1 & 0 & 2 & 23 \end{array}\right] \quad \begin{array}{l} R2 = -1R2 \\ R3 = 2R4 - R3 \end{array} \quad \left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 20 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & -3 & 4 & 9 \\ 0 & 1 & 0 & 2 & 23 \end{array}\right] \begin{array}{l} \\ \\ 3R2+R3 \\ \\ \end{array}$$

$$\left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 20 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 1 & 9 \\ 0 & 1 & 0 & 2 & 23 \end{array}\right] \quad \begin{array}{l} R1 = R1 - R4 + R3 \\ R2 = R2 + R3 \\ \\ R4 = R4 - 2R3 \end{array} \quad \left[\begin{array}{cccc|c} 1 & 0 & 0 & 0 & 6 \\ 0 & 0 & 1 & 0 & 9 \\ 0 & 0 & 0 & 1 & 9 \\ 0 & 1 & 0 & 0 & 5 \end{array}\right]$$

x_1 strawberry = 6, x_2 banana = 5, x_3 mango = 9 x_4 bluberry = 9

B Professor Sahai should put either 1 cup of mangoe or 1 cup of blueberries in Professor Alon's personal smoothie. The score for such a smoothie would be $9 \cdot 1 = \boxed{9}$

9-3-17
RB 16A - FA

Homework 1 (cont.)

4 The Framingham Risk Score

- cvd risk for females, smokers, not treated for HBP, not diabetic

$R = a \cdot \ln(\text{age (years)}) + b \cdot \ln(\text{total cholesterol (mg/dL)}) + c \cdot \ln(\text{HDL cholesterol (mg/dL)}) + d \cdot \ln(\text{SBP (mm Hg)})$

$p = 1 - 0.95^{e^{(R-25.66)}}$ $\quad \ln(1-p) = (e^{(R-25.66)})(\ln(0.95))$

A Eq 1

$1 - 0.95^{e^{(a \cdot \ln(66) + b \cdot \ln(198) + c \cdot \ln(55) + d \cdot \ln(132) - 25.66)}} = 0.155$

...

$$\begin{bmatrix} \ln(66) & \ln(198) & \ln(55) & \ln(132) \\ \ln(61) & \ln(180) & \ln(47) & \ln(124) \\ \ln(60) & \ln(180) & \ln(50) & \ln(120) \\ \ln(23) & \ln(132) & \ln(45) & \ln(132) \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} 0.1550 \\ 0.1108 \\ 0.0940 \\ 0.0165 \end{bmatrix}$$

Eq 2

$1 - 0.95^{e^{(a\ln(61) + b\ln(180) + c\ln(47) + d\ln(124) - 25.6)}} = 0.1108$

Eq 3

$1 - 0.95^{e^{(a\ln(60) + b\ln(180) + c\ln(50) + d\ln(120) - 25.6)}} = 0.0940$

Eq 4

$1 - 0.95^{e^{(a\ln(23) + b\ln(132) + c\ln(45) + d\ln(132) - 25.6)}} = 0.0165$

B IPython $\Rightarrow$ $a = [2.3096, 1.1701, -0.6945, 2.8196]$

5 Filtering out the Troll

$$\vec{m}_1 = \cos(\theta)\cdot\vec{a} + \cos(\psi)\cdot\vec{b} \quad \leftrightarrow$$
$$\vec{m}_2 = \sin(\theta)\cdot\vec{a} + \sin(\psi)\cdot\vec{b} \quad \updownarrow$$

A
$$\vec{m}_1 = \cos(45^\circ)\cdot\vec{a} + \cos(-30^\circ)\cdot\vec{b} = \sqrt{2}/2\cdot\vec{a} + \frac{\sqrt{3}}{2}\cdot\vec{b}$$
$$\vec{m}_2 = \sin(45^\circ)\cdot\vec{a} + \sin(-30^\circ)\cdot\vec{b} = \sqrt{2}/2\cdot\vec{a} + \frac{-1}{2}\cdot\vec{b}$$

B
$$\vec{m}_1 + \vec{m}_2\sqrt{3} = \left(\sqrt{2}/2 + \sqrt{3}\cdot\sqrt{2}/2\right)\vec{a} + \underbrace{\cancel{\left(\sqrt{3}/2 - \frac{1}{2}\cdot\sqrt{3}\right)}}_{0}\vec{b}$$

$$\vec{m}_1 + \vec{m}_2\sqrt{3} = \left(\frac{\sqrt{2}}{2} + \frac{\sqrt{6}}{2}\right)\vec{a}$$

$$\vec{a} = \frac{2(\vec{m}_1 + \vec{m}_2\sqrt{3})}{(\sqrt{2}+\sqrt{6})} = \underbrace{\left(\frac{2}{\sqrt{2}+\sqrt{6}}\right)}_{U}\vec{m}_1 + \underbrace{\left(\frac{2\sqrt{3}}{\sqrt{2}+\sqrt{6}}\right)}_{V}\vec{m}_2$$

C See IPython

The speaker says: All human beings are born free and equal in dignity and rights.

6 Homework Process and Study Group.
- Daniel Janbay 3032013999
- worked on this homework with friends online and checked answers in person. Discussed how to approach problem without giving any solution

7 Vedaank's "PC Master Race" Optimal PC's

Often, students at Berkeley need new computers that are much faster than their laptops, however many are inexperienced in the art of building computers. Each PC has RAM, a case, adequate cooling ... etc and a magic combo of 3 parts (CPU, GPU, and HDD/SSD)

A lot of students don't know what they want so they are asked to test 3 different configurations of comparable value. The parts are listed below as a percentage of funds. The maximum one may spend on a PC is $1000.

Parts	Business	"Gaming"	Balanced	Productivity
RAM	2/3	0	1/3	1/3
SSD	1/3	2/5	1/3	1/3
GPU	0	3/5	1/3	0
CPU	0	0	0	1/3

Each customer has a score of 0-10 for each part and the total score of each PC is computed by multiplying itself to the value of that component. Then I calculate a special computer for each student. 0 means min, 10 is max

Andrew was interested in making a computer so he came in and tried the 4 pre built configurations and scored them.

Business	$5\frac{2}{3}$
Gaming	$7\frac{2}{5}$
Productivity	$6\frac{2}{3}$
Balanced	$6\frac{2}{3}$

A - Find Andrew's rating for each part?

B - What will be Andrew's Dream PC?

*Keep in mind, the minimum price of CPU's is 200, GPU's is 200, SSD is 100, and RAM is 100

Solution 7

Andrew's dream PC: x_1 CPU, x_2 GPU, x_3 SSD, x_4 RAM

Gaming $7\frac{2}{5}$
Productivity $6\frac{2}{3}$
Balanced $6\frac{2}{3}$
Business $5\frac{2}{3}$

(A)

P $x_1(\frac{1}{3}) + x_2(\frac{1}{3}) + x_3(0) + x_4(\frac{1}{3}) = 20/3$

Ba $x_1(\frac{1}{3}) + x_2(1/3) + x_3(\frac{1}{3}) + x_4(0) = 20/3$

Ga $x_1(0) + x_2(2/5) + x_3(3/5) + x_4(0) = 37/5$

Bu $x_1(2/3) + x_2(1/3) + x_3(0) + x_4(0) = 17/3$

$$\begin{array}{l} \text{Productivity} \\ \text{Balanced} \\ \text{Gaming} \\ \text{Business} \end{array} \left[\begin{array}{cccc|c} 1/3 & 1/3 & 0 & 1/3 & 20/3 \\ 1/3 & 1/3 & 1/3 & 0 & 20/3 \\ 0 & 2/5 & 3/5 & 0 & 37/5 \\ 2/3 & 1/3 & 0 & 0 & 17/3 \end{array}\right] \begin{array}{l} R1\times 3 \\ R2\times 3 \\ R3\times 5 \\ R4\times 3 \end{array} \left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 20 \\ 1 & 1 & 1 & 0 & 20 \\ 0 & 2 & 3 & 0 & 37 \\ 2 & 1 & 0 & 0 & 17 \end{array}\right] \begin{array}{l} \\ R1-R2 \\ \\ 2R1-R4 \end{array}$$

(B)

$$\left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 20 \\ 0 & 0 & -1 & 1 & 0 \\ 0 & 2 & 3 & 0 & 37 \\ 0 & 1 & 0 & 2 & 23 \end{array}\right] \begin{array}{l} \\ R2 = -R2 \\ R3 = 2R4 - R3 \\ \\ \end{array} \left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 20 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & -3 & 4 & 9 \\ 0 & 1 & 0 & 2 & 23 \end{array}\right] \begin{array}{l} \\ \\ 3R2+R3 \\ \\ \end{array}$$

$$\begin{array}{ccccc} \text{RAM} & \text{SSD} & \text{GPU} & \text{CPU} & \\ \end{array}$$

$$\left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 20 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 1 & 9 \\ 0 & 1 & 0 & 2 & 23 \end{array}\right] \begin{array}{l} R_1 = R_1 - R_4 + R_3 \\ R_2 = R_2 + R_3 \\ \\ R_4 = R_4 - 2R_3 \end{array} \left[\begin{array}{cccc|c} 1 & 0 & 0 & 0 & 6 \\ 0 & 0 & 1 & 0 & 9 \\ 0 & 0 & 0 & 1 & 9 \\ 0 & 1 & 0 & 0 & 5 \end{array}\right]$$

SSD score = 5, GPU score = 9, CPU score = 9, RAM score = 6

B Andrews Dream PC. → \$1000

SSD req.
RAM req.
CPU req.
GPU req.

In order to maximize his system, Andrew will use a \$100 SSD, \$100 of RAM, \$200 on CPU, and \$600 on his GPU in order to maximize his happiness and make his real dream PC.

EE16A: Homework 1

(PRACTICE) Problem 2: Finding Charges from Potential Measurements

In [1]:
```
import numpy as np
twoRoot = np.sqrt(2)
fiveRoot = np.sqrt(5)
tenRoot = np.sqrt(10)
oneOverTwoRoot = 1/twoRoot
oneOverFiveRoot = 1/fiveRoot
oneHalf = 1/2
one = 1
u1 = (4 + 3 * fiveRoot + tenRoot) / (2 * fiveRoot)
u2 = (2 + 4 * twoRoot) / twoRoot
u3 = (4 + fiveRoot + 3 * tenRoot) / (2 * fiveRoot)

a = np.array([
[oneOverTwoRoot, oneOverFiveRoot, oneHalf],
[one, oneOverTwoRoot, one],
[oneHalf, oneOverFiveRoot, oneOverTwoRoot]
])
b = np.array([u1, u2, u3])
x = np.linalg.solve(a, b)
x
```

Out[1]:
```
array([ 1.,  2.,  3.])
```

Problem 4: The Framingham Risk Score

In [25]:
```python
import numpy as np

p1 = 0.1550
p2 = 0.1108
p3 = 0.0940
p4 = 0.0105

R1 = np.log(np.log(1 - p1) / np.log(0.95)) + 25.66
R2 = np.log(np.log(1 - p2) / np.log(0.95)) + 25.66
R3 = np.log(np.log(1 - p3) / np.log(0.95)) + 25.66
R4 = np.log(np.log(1 - p4) / np.log(0.95)) + 25.66

a = np.array([
[np.log(66), np.log(198), np.log(55), np.log(132)],
[np.log(61), np.log(180), np.log(47), np.log(124)],
[np.log(60), np.log(180), np.log(50), np.log(120)],
[np.log(23), np.log(132), np.log(45), np.log(132)]
])
b = np.array([R1, R2, R3, R4])
x = np.linalg.solve(a, b)
x

# Tip: np.log works element-wise on an np.array
```

Out[25]:
```
array([ 2.30985691,  1.16955491, -0.69451695,  2.82002675])
```

Problem 5: Filtering Out The Troll

In [26]:
```python
import numpy as np
import matplotlib.pyplot as plt
import wave as wv
import scipy
from scipy import io
import scipy.io.wavfile
from scipy.io.wavfile import read
from IPython.display import Audio
import warnings
warnings.filterwarnings('ignore')
sound_file_1 = 'm1.wav'
sound_file_2 = 'm2.wav'
```

Let's listen to the recording of the first microphone (it can take some time to load the sound file).

In [27]:
```python
Audio(url='m1.wav', autoplay=False)
```

Out[27]:

And this is the recording of the second microphone (it can take some time to load the sound file).

In [28]:
```
Audio(url='m2.wav', autoplay=False)
```

Out[28]: 0:00

We read the first recording to the variable `corrupt1` and the second recording to `corrupt2`.

In [29]:
```
rate1,corrupt1 = scipy.io.wavfile.read('m1.wav')
rate2,corrupt2 = scipy.io.wavfile.read('m2.wav')
```

Enter the gains of the two recordings to get the clean speech.

Note: The square root of a number a can be written as `np.sqrt(a)` in IPython.

In [30]:
```
# enter the gains u (recording 1) and v (recording 2)
u = 2 / (np.sqrt(2) + np.sqrt(6))
v = (2 * np.sqrt(3)) / (np.sqrt(2) + np.sqrt(6))
```

Weighted combination of the two recordings:

In [31]:
```
s1 = u*corrupt1 + v*corrupt2
```

Let's listen to the resulting sound file (make sure your speaker's volume is not very high, the sound may be loud if things go wrong).

In [32]:
```
Audio(data=s1, rate=rate1)
```

Out[32]: 0:00 / 0:10