

Homework 1

1 Administhivia:

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

$$U = k \frac{Q}{r}$$

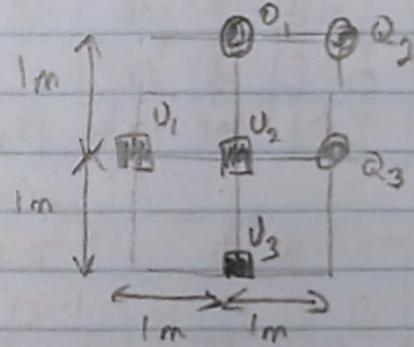
3 point charges $Q_1, Q_2, Q_3 \rightarrow$ known
3 measurements U_1, U_2, U_3

r = meters away
 k = constant

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

$$U_2 = \frac{kQ_1}{2} + \frac{kQ_2}{\sqrt{5}} + \frac{kQ_3}{\sqrt{2}}$$

$$U_3 = kQ_1 + \frac{kQ_2}{\sqrt{2}} + \frac{kQ_3}{1}$$



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

import numpy as np

$$\begin{aligned} a &= np.array([& \\ & [\sqrt{2}, \sqrt{5}, \frac{1}{2}] & \\ & [1, \frac{1}{2}, 1] & \\ & [\frac{1}{2}, \sqrt{5}, \frac{1}{2}] & \\ &]) \end{aligned}$$

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

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

$$b = np.array([y1, y2, y3])$$

$$x = np.linalg.solve(a, b)$$

$$Q_1 \text{ charge} = 1$$

$$Q_2 \text{ charge} = 2$$

$$Q_3 \text{ charge} = 3$$

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)	$6\frac{2}{3} = \frac{1}{3}x_1 + \frac{1}{3}x_2 + 0x_3 + \frac{1}{3}x_4$
	Caribbean Passion (CP)	$6\frac{2}{3} = \frac{1}{3}x_1 + \frac{1}{3}x_2 + \frac{1}{3}x_3 + 0x_4$
	Mango Go Go (MGG)	$7\frac{2}{5} = 0x_1 + \frac{2}{5}x_2 + \frac{3}{5}x_3 + 0x_4$
	Strawberry Wad (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	

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

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

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

$$x_1 \text{ strawberry} = 6, x_2 \text{ banana} = 5, x_3 \text{ mango} = 9, x_4 \text{ blueberry} = 9$$

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

Homework | (cont.)

4 The Framingham Risk Score

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

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

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

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

$$\begin{bmatrix} \ln(66) & \ln(198) & \ln(55) & \ln(132) \\ \ln(61) & \ln(180) & \ln(47) & \ln(129) \\ \ln(60) & \ln(180) & \ln(50) & \ln(120) \\ \ln(23) & \ln(132) & \ln(45) & \ln(132) \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} 0.1550 \\ 0.1108 \\ 0.0940 \\ 0.0165 \end{bmatrix}$$

$$B \stackrel{e^2}{=} \frac{(a \ln(61) + b \ln(180) + c \ln(47) + d \ln(129) - 25.6)}{1 - 0.95^e} = 0.1108$$

$$B \stackrel{e^3}{=} \frac{(a \ln(60) + b \ln(180) + c \ln(50) + d \ln(120) - 25.6)}{1 - 0.95^e} = 0.0940$$

$$B \stackrel{e^4}{=} \frac{(a \ln(23) + b \ln(132) + c \ln(45) + d \ln(132) - 25.6)}{1 - 0.95^e} = 0.0165$$

$$B \quad \text{IPython} \Rightarrow a = [2.3096, 1.1701, -0.6945, 2.8196]$$

5 Filtering out the Troll.

$$\vec{m}_1 = \cos(\theta) \cdot \hat{a} + \cos(\psi) \cdot \hat{b} \quad \Leftrightarrow$$

$$\vec{m}_2 = \sin(\theta) \cdot \hat{a} + \sin(\psi) \cdot \hat{b} \quad \Downarrow$$

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

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

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

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

C | See IPython

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

6 Homework Process and Study Graph.

- Daniel Tanbay 3032013999

- Worked on this homework with friends online and checked answers in person. Discussed how to approach problem without giving a solution

7 Vedaank's "PC Magician Race" Optimal PCs

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 2/3
Gaming	7 2/5
Productivity	6 2/3
Balanced	6 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 2

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Andrew's dream PC:

x_1 , CPU	Gaming	$7\frac{2}{5}$
x_2 , GPU	Productivity	$6\frac{2}{3}$
x_3 , SSD	Balanced	$6\frac{2}{3}$
x_4 , RAM	Business	$5\frac{2}{3}$

(A)

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

$$Ba: x_1 \left(\frac{1}{2}\right) + x_2 \left(\frac{1}{2}\right) + x_3 \left(\frac{1}{3}\right) + x_4 \left(0\right) = 20/3$$

$$Co: x_1 \left(0\right) + x_2 \left(\frac{2}{5}\right) + x_3 \left(\frac{3}{5}\right) + x_4 \left(0\right) = 37/5$$

$$Bu: x_1 \left(\frac{1}{3}\right) + x_2 \left(\frac{1}{2}\right) + x_3 \left(0\right) + x_4 \left(0\right) = 17/3$$

Productivity

y_1	y_2	y_3	y_4	y_5	y_6	y_7	y_8	y_9	y_{10}	y_{11}	y_{12}	y_{13}
y_3	y_3	0	y_3	$20/3$	12×3	1	1	0	1	20		
y_3	y_3	y_3	0	$20/3$	12×3	1	1	1	0	20	21-22	
0	$2/5$	$3/5$	0	$37/5$	12×5	6	2	3	0	37		
y_3	y_3	0	0	$17/3$	4×3	2	1	0	0	17	201-204	

Balanced

Balanced

Gaming

Business

(B)

1	1	0	1	20		1	1	0	1	20	
0	0	-1	1	0	$R_2 \rightarrow -R_2$	0	0	-1	1	0	
0	2	3	0	37	$R_3 \rightarrow R_3 - R_4 - R_2$	-	0	0	-34	9	3R2+R3
0	1	0	2	83		0	1	0	2	23	
RAM	SSD	GPU	CPU								

1	1	0	1	20	$R_1 \rightarrow R_1 - R_2 - R_3 + R_4$	1	0	0	0	6
0	0	-1	1	0	$R_2 \rightarrow R_2 + R_3$	0	0	1	0	9
0	0	0	1	9		0	0	0	1	9
0	1	0	2	23	$R_4 \rightarrow R_4 - 2R_3$	0	1	0	0	5

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

B Andrew's Dream PC. $\rightarrow \$1000$

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 reduce his real dream PC.

SSD 100
RAM 100
CPU 200
GPU 600