HW #1, EE16A

#1

a)

Smoothie	Score
Banana Berry	$6\frac{1}{3}$
Caribbean Passion	$6\frac{1}{3}$
Mango-a-gogo	$6\frac{4}{5}$
Strawberries Wild	$5\frac{2}{3}$

BB: $\frac{1}{3}x_s + \frac{1}{3}x_b + \frac{1}{3}x_{bb} = 6\frac{1}{3} = 19/3$

CP: $\frac{1}{3}x_s + \frac{1}{3}x_b + \frac{1}{3}x_m = 6\frac{1}{3} = 19/3$

MG: $\frac{2}{5}x_b + \frac{3}{5}x_m = 6\frac{4}{5} = 34/5$

SW: $\frac{2}{3}x_s + \frac{1}{3}x_b = 5\frac{2}{3} = 17/3$

$$\begin{array}{cccc} s & b & m & bb \end{array}$$

$$\left[\begin{array}{cccc|c} \frac{1}{3} & \frac{1}{3} & 0 & \frac{1}{3} & 19/3 \\ \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 0 & 19/3 \\ 0 & \frac{2}{5} & \frac{3}{5} & 0 & 34/5 \\ \frac{2}{3} & \frac{1}{3} & 0 & 0 & 17/3 \end{array}\right] = \left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 19 \\ 1 & 1 & 1 & 0 & 19 \\ 0 & 2 & 3 & 0 & 34 \\ 2 & 1 & 0 & 0 & 17 \end{array}\right]$$

R2 = R2 − R1

$$\left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 19 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 2 & 3 & 0 & 34 \\ 2 & 1 & 0 & 0 & 17 \end{array}\right]$$

R4 = [R4 − 2(R1)](−1)

$$\left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 19 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 2 & 3 & 0 & 34 \\ 0 & 1 & 0 & 2 & 21 \end{array}\right]$$

R2 ⇄ R4

$$\left[\begin{array}{cccc|c} 1 & 1 & 0 & 1 & 19 \\ 0 & 1 & 0 & 2 & 21 \\ 0 & 2 & 3 & 0 & 34 \\ 0 & 0 & 1 & -1 & 0 \end{array}\right]$$

R1 = R1 − R2

$$\left[\begin{array}{cccc|c} 1 & 0 & 0 & -1 & -2 \\ 0 & 1 & 0 & 2 & 21 \\ 0 & 2 & 3 & 0 & 34 \\ 0 & 0 & 1 & -1 & 0 \end{array}\right]$$

R3 = R3 − 2(R2)

$$\left[\begin{array}{cccc|c} 1 & 0 & 0 & -1 & -2 \\ 0 & 1 & 0 & 2 & 21 \\ 0 & 0 & 3 & -4 & -8 \\ 0 & 0 & 1 & -1 & 0 \end{array}\right]$$

R3 = [R3 − 4(R4)](−1)

$$\left[\begin{array}{cccc|c} 1 & 0 & 0 & -1 & -2 \\ 0 & 1 & 0 & 2 & 21 \\ 0 & 0 & 1 & 0 & 8 \\ 0 & 0 & 1 & -1 & 0 \end{array}\right]$$

R4 = (R4 − R3)(−1)

$$\left[\begin{array}{cccc|c} 1 & 0 & 0 & -1 & -2 \\ 0 & 1 & 0 & 2 & 21 \\ 0 & 0 & 1 & 0 & 8 \\ 0 & 0 & 0 & 1 & 8 \end{array}\right]$$

R2 = R2 − 2(R4)

$$\left[\begin{array}{cccc|c} 1 & 0 & 0 & -1 & -2 \\ 0 & 1 & 0 & 0 & 5 \\ 0 & 0 & 1 & 0 & 8 \\ 0 & 0 & 0 & 1 & 8 \end{array}\right]$$

R1 = R1 + R4

$$\left[\begin{array}{cccc|c} 1 & 0 & 0 & 0 & 6 \\ 0 & 1 & 0 & 0 & 5 \\ 0 & 0 & 1 & 0 & 8 \\ 0 & 0 & 0 & 1 & 8 \end{array}\right]$$

Strawberries = 6
Bananas = 5
Mango = 8
Blueberries = 8

b) Any combo of mango and blueberries that adds up to 1 cup. The score would be 8.

#2

a) $a\ln(66) + b\ln(198) + c\ln(55) + d\ln(132) = R_1 = \ln(\log_{0.95} 0.8450) + 25.66$
$a\ln(61) + b\ln(180) + c\ln(47) + d\ln(124) = R_2 = \ln(\log_{0.95} 0.8892) + 25.66$
$a\ln(60) + b\ln(180) + c\ln(50) + d\ln(120) = R_3 = \ln(\log_{0.95} 0.9060) + 25.66$
$a\ln(23) + b\ln(132) + c\ln(45) + d\ln(132) = R_4 = \ln(\log_{0.95} 0.9895) + 25.66$

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

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

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

$R - 25.66 = \ln(\log_{0.95}(1-p))$

$R = \ln(\log_{0.95}(1-p)) + 25.66$

$$\boxed{\begin{aligned} 4.1897a + 5.2883b + 4.0073c + 4.8828d &= 26.8489 \\ 4.1109a + 5.1930b + 3.8501c + 4.8203d &= 26.4883 \\ 4.0943a + 5.1930b + 3.9120c + 4.7875d &= 26.3147 \\ 3.1355a + 4.8828b + 3.8067c + 4.8828d &= 24.0791 \end{aligned}}$$

b) Used iPython

$$\boxed{\begin{aligned} a &= 2.3099 \\ b &= 1.1696 \\ c &= -0.6945 \\ d &= 2.8200 \end{aligned}}$$

#3

a) $\vec{m_1} = \cos(45°)\vec{a} + \cos(-30°)\vec{b}$

$\vec{m_2} = \sin(45°)\vec{a} + \sin(-30°)\vec{b}$

$$\boxed{\vec{m_1} = \frac{\vec{a}}{\sqrt{2}} + \frac{\sqrt{3}\vec{b}}{2}} \quad \boxed{\vec{m_2} = \frac{\vec{a}}{\sqrt{2}} - \frac{\vec{b}}{2}}$$

b) $\vec{m_1} - \frac{1}{\sqrt{2}}\vec{a} = \frac{\sqrt{3}}{2}\vec{b}$ $\quad$ $\vec{m_2} - \frac{1}{\sqrt{2}}\vec{a} = -\frac{1}{2}\vec{b}$

$\frac{2}{\sqrt{3}}\vec{m_1} - \frac{2}{\sqrt{6}}\vec{a} = \vec{b}$ $\quad$ $-2\vec{m_2} + \frac{2}{\sqrt{2}}\vec{a} = \vec{b}$

$$\frac{2}{\sqrt{3}}\vec{m_1} - \frac{2}{\sqrt{6}}\vec{a} = -2\vec{m_2} + \frac{2}{\sqrt{2}}\vec{a}$$

$$\frac{2}{\sqrt{3}}\vec{m_1} + 2\vec{m_2} = \left(\frac{2}{\sqrt{2}} + \frac{2}{\sqrt{6}}\right)\vec{a}$$

$$\frac{2}{\sqrt{3}}\vec{m_1} + 2\vec{m_2} = \frac{2\sqrt{3}+2}{\sqrt{6}}\vec{a}$$

$$\frac{\vec{m_1}}{\sqrt{3}} + \vec{m_2} = \frac{\sqrt{3}+1}{\sqrt{6}}\vec{a}$$

$$\left(\frac{\sqrt{6}}{\sqrt{3}+1}\right)\left(\frac{\vec{m_1}}{\sqrt{3}} + \vec{m_2}\right) = \vec{a}$$

$$\boxed{\vec{a} = \left(\frac{\sqrt{2}}{\sqrt{3}+1}\right)\left(\vec{m_1} + \sqrt{3}\,\vec{m_2}\right)}$$

$$\boxed{u = \frac{\sqrt{2}}{\sqrt{3}+1}} \quad \boxed{v = \frac{\sqrt{6}}{\sqrt{3}+1}}$$

c) "All human beings are born free & equal in dignity & rights."
—Article 1 of the UN's Universal Declaration of Human Rights

#4

Eric Chen #26307198
Dhruv Kathuria #3031790620
Divya Vijayan #3032002169

We compared our initial approaches to each problem prior to actually solving them.

EE16A: Homework 1

Problem 2: The Framingham Risk Score

In [15]:
```
# Tip: np.log works element-wise on an np.array

import numpy as np

main = np.log(np.array([[66,198,55,132], [61,180,47,124],
[60,180,50,120], [23,132,45,132]]))
Rs = np.log(np.log(np.array([0.8450, 0.8892, 0.9060, 0.9895]))/np.log(0.
95)) + 25.66
coefficients = np.around(np.linalg.solve(main, Rs), 4)

print('a is', coefficients[0])
print('b is', coefficients[1])
print('c is', coefficients[2])
print('d is', coefficients[3])
```

```
a is 2.3099
b is 1.1696
c is -0.6945
d is 2.82
```

Problem 3: Filtering out the troll

In [17]:
```
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 by the first microphone (it can take some time to load the sound file).

In [21]:
```
Audio(url='m1.wav', autoplay=False)
```

Out[21]:

0:00

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

In [22]:
```
Audio(url='m2.wav', autoplay=False)
```

Out[22]:

0:00

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

In [24]:
```
rate1,corrupt1 = scipy.io.wavfile.read('m1.wav')
rate2,corrupt2 = scipy.io.wavfile.read('m2.wav')
```

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

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

In [25]:
```
# enter the gains u to weight recording 1 and v to weight recording 2
u = np.sqrt(2)/(np.sqrt(3)+1)
v = np.sqrt(6)/(np.sqrt(3)+1)
```

Weighted combination of the two recordings

In [26]:
```
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 [27]:
```
Audio(data=s1, rate=rate1)
```

Out[27]:

0:00 / 0:10

(Practice) Problem 5: Finding Charges from Potential Measurements

In [ ]:
```
```