

1

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Question-1

Total no of students: 12

Sort the numbers

12

13

15

16

17

18

19

20

21

22

25

28

$$\text{sum of all numbers} = \frac{226}{12}$$

$(x_i - \bar{x})^2$	number - mean	mean
-6.83	-6.83	18.83
-5.83	-5.83	
-3.83	-3.83	
-2.83	-2.83	
-1.83	-1.83	
-0.83	-0.83	
0.17	0.17	
1.17	1.17	
2.17	2.17	
3.17	3.17	
4.17	4.17	
5.17	5.17	
6.17	6.17	
7.17	7.17	
8.17	8.17	
9.17	9.17	
10.17	10.17	
11.17	11.17	
12.17	12.17	
13.17	13.17	
14.17	14.17	
15.17	15.17	
16.17	16.17	
17.17	17.17	
18.17	18.17	
19.17	19.17	
20.17	20.17	
21.17	21.17	
22.17	22.17	
25.17	25.17	
28.17	28.17	
245.6188		

a.i) compute mean

$$\text{mean} = \frac{\text{sum of all values}}{\text{no of values}}, \bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

$$\text{mean} = \frac{226}{12} = 18.83$$

a.ii) median

$$\text{median} = \frac{x_{\frac{n}{2}} + x_{\frac{n}{2}+1}}{2} = \frac{18+19}{2} = 18.50$$

= 18.50 //

(2)

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Range = maximum - minimum

$$= 28 - 12 = \underline{16}$$

$$\text{Sample Variance } s^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}$$

Refer to page 1  
for calculation

$$= \frac{245.6668}{12-1}$$

$$= \underline{22.33345}$$

$$IQR = Q_3 - Q_1 \quad Q_3 \text{ is the third quartile}$$

$Q_1$  is the first quartile

$$Q_3 = \text{upper half of median} = \frac{21+22}{2} = \underline{21.5}$$

$$Q_1 = \text{lower half of median} = \frac{15+16}{2} = \underline{15.5}$$

$$IQR = 21.5 - 15.5 = \underline{6}$$

$$\text{Lower fence} = Q_1 + (1.5 \times IQR) = 15.5 + (1.5 \times 6) = \underline{20.5}$$

$$\text{Upper fence} = Q_3 + (1.5 \times IQR) = 21.5 + (1.5 \times 6) = \underline{30.5}$$

b.) Outliers =

The data value is (12-28), all are within lower fence (20.5) and upper fence (30.5), hence the data set has no outliers.

Question-2

Subjects	Probability of Passing (P)	Probability of Failing $P' = 1 - P$
A	$P(A) = \frac{4}{5}$	$P(A') = \frac{1}{5}$
B	$P(B) = \frac{3}{4}$	$P(B') = \frac{1}{4}$
C	$P(C) = \frac{5}{6}$	$P(C') = \frac{1}{6}$
D	$P(D) = \frac{2}{3}$	$P(D') = \frac{1}{3}$

Probability of Qualifies : must pass A and atleast 2 other subjects

Pass in all 4      Fail D      Fail B      Fail C      Subjcts  
 $(A, B, C, D)$        $(A, B, C)$        $(A, C, D)$        $(A, B, D)$

$$P(Q) = P(A) \times P(\text{at least } B, C, D)$$

$$= P(B) \times P(C) \times P(D)$$

$$= \frac{3}{4} \times \frac{5}{6} \times \frac{2}{3}$$

$$= \frac{30}{72} = \frac{5}{12} //$$

Scenario ② passes 2 subjects and 1 fails

$$\text{Pass } B, C, \text{ Fail } D - P(B) \times P(C) \times P(D') = \frac{3}{4} \times \frac{5}{6} \times \frac{1}{3} =$$

$$\text{Pass } B, D, \text{ Fail } C - P(B) \times P(D) \times P(C') = \frac{3}{4} \times \frac{2}{3} \times \frac{1}{6} =$$

$$\text{Pass } C, D, \text{ Fail } B - P(C) \times P(D) \times P(B') = \frac{5}{6} \times \frac{2}{3} \times \frac{1}{4} =$$

$$= \frac{15}{72} + \frac{6}{72} + \frac{10}{72} = \frac{31}{72} //$$

(A)

$$P(\text{at least } B, C, D)$$

Probability of at least 2 = Pass all 3, E, D + either B, C, D fails

$$= \frac{5}{12} + \frac{31}{72}$$

$$= \frac{61}{72}$$

Final quantity  $P(\text{qualifies}) = P(A) \times P(\text{at least } B, C, D)$

$$= \frac{4}{5} \times \frac{61}{72}$$

$$= \frac{244}{360}$$

$$= \frac{122}{180}$$

Probability of student qualifies. =  $\frac{61}{90}$

Question-3

(5)

Email	sender	contains link	spam
1	friend	ND	ND
2	unknown	yes	yes
3	friend	yes	ND
4	unknown	ND	ND
5	unknown	yes	yes

Total event - 5

$$\text{spam yes} - 2 = \text{probability of yes} = \frac{2}{5} = 0.4$$

$$\text{spam ND} - 3 = \text{probability of ND.} = \frac{3}{5} = 0.6$$

apply Laplace smoothing ( $\lambda = 1$  two possible classes)

$$\text{probability of spam yes} = \frac{2+1}{5+2} = \frac{3}{7}$$

$$\text{probability of spam ND} = \frac{3+1}{5+2} = \frac{4}{7}$$

conditional probabilities (with Laplace smoothing)

$$p(x=x | C=c) = \frac{\text{count} + 1}{\text{total class} + K}$$

$K = 2$  because each feature has 2 categories  
(friend/unknown) (yes/NO)

④

Spam Yes

Email (1, 5)

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Spam class (Count = 2) (spam yes)

Sender unknown

$$P(\text{unknown} \mid \text{spam}) = \frac{2+1}{2+2} = \frac{3}{4} = 0.75 //$$

contains link NO given spam

spam = Yes, link = NO = 0

Spam NO  $P(\text{NO link} \mid \text{spam}) = \frac{0+1}{2+2} = \frac{1}{4} = 0.25 //$

Email (1, 3, 1) count = 3

Sender = unknown given not-spam

Unknown sender = 1

Contain link YES = 1

Contain link NO = 2

$$P(\text{unknown} \mid \text{not-spam}) = \frac{1+1}{3+2} = \frac{2}{5} = 0.4 //$$

Contains link = NO given not-spam

$$P(\text{NO link} \mid \text{not-spam}) = \frac{2+1}{3+2} = \frac{3}{5} = 0.6 //$$

Naive Bayes posterior scores

Score for Spam			Not Spam		
0.6	0.75	0.25	0.6	0.4	0.6

$$0.6 \times 0.75 \times 0.25$$

$$0.075$$

Email is not spam

$$0.6 \times 0.4 \times 0.144$$

$$0.144$$

0.144 is high

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Question ④

capacitance ( $\mu F$ )		Box #			
	1	2	3		
0.1	35	25	40		100
0.5	75	95	70		240
1.0	60	10	65		135
Total	170	130	175		475

Baye's Theorem

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

 $P(A)$  - prior probability or $P(B)$  - total probability or B  
(overall possible event) $P(A|B)$  - probability of event A happening given B occurs $P(B|A)$  - probability of B occurring if A happens

Total probability  $P(B) = \sum_i P(B|A_i)P(A_i)$

i.) Capacitor  $0.1\mu F$  is selected, what is probability it comes from Box 3.

Condition probability of box(3) for  $0.1\mu F$  =  $\frac{40}{175}$

Total Probability

$$= \frac{1}{3} \left( \frac{35}{170} + \frac{25}{130} + \frac{40}{175} \right)$$

$$= \frac{1}{3} (0.20588 + 0.19231 + 0.22857) \\ = 0.20892$$

⑧

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Mur

$$\text{probability of box 3} = \frac{40}{173} \times \frac{1}{3}$$

$$= 0.0761828$$

$$= \frac{0.07619}{0.20892}$$

$$= 0.365$$

$$= 36.5\%$$

Answer)

ii.) if box 2 is selected, what is the probability that it has a capacitor of 0.5 μF?

$$= \frac{95}{130}$$

$$= 0.7308$$

answer = 73%.