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by R F

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UNIT LEADER

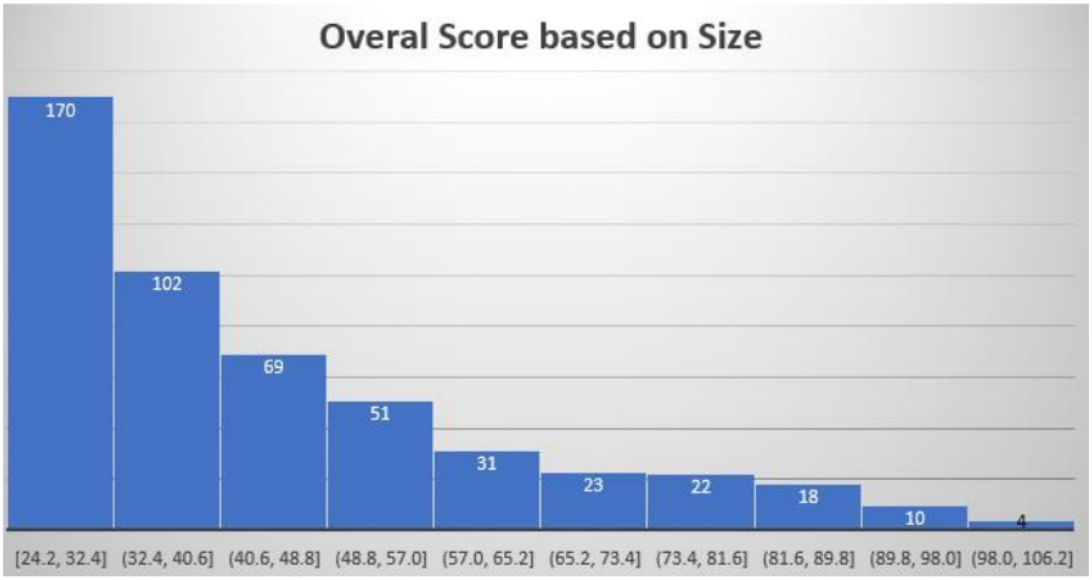
School of Computer Science and Engineering

PROBLEM 1

1)) Overall Scaled Score

i. Use suitable summary statistics (e.g., mean, min, max, mode, median, 1st and 3rd quartile) and chart(s) to analyze the distribution of the overall score.

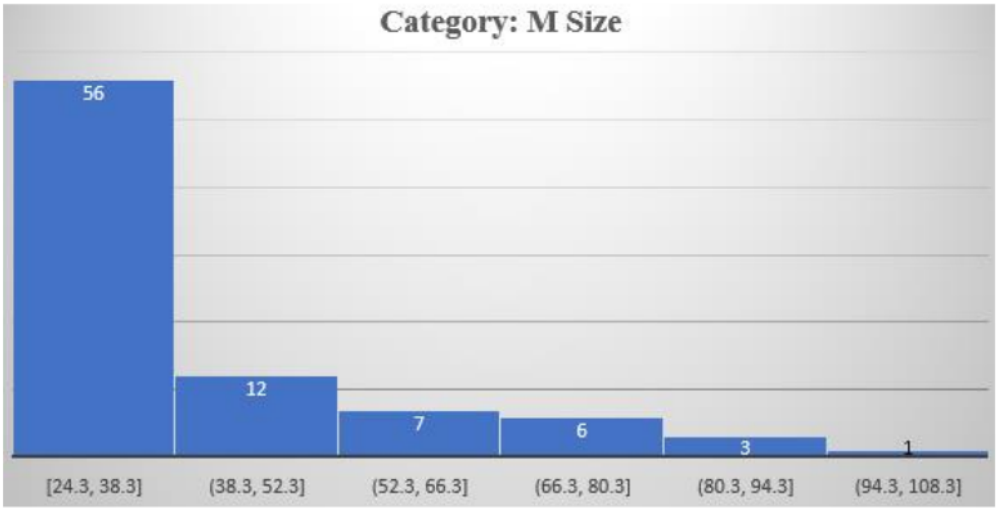
Summary Statistics	
Mean	44.6194
Median	38.55
Mode	29.9
Min	24.2
Max	100
3rd quartile	98.5
1st quartile	24.2



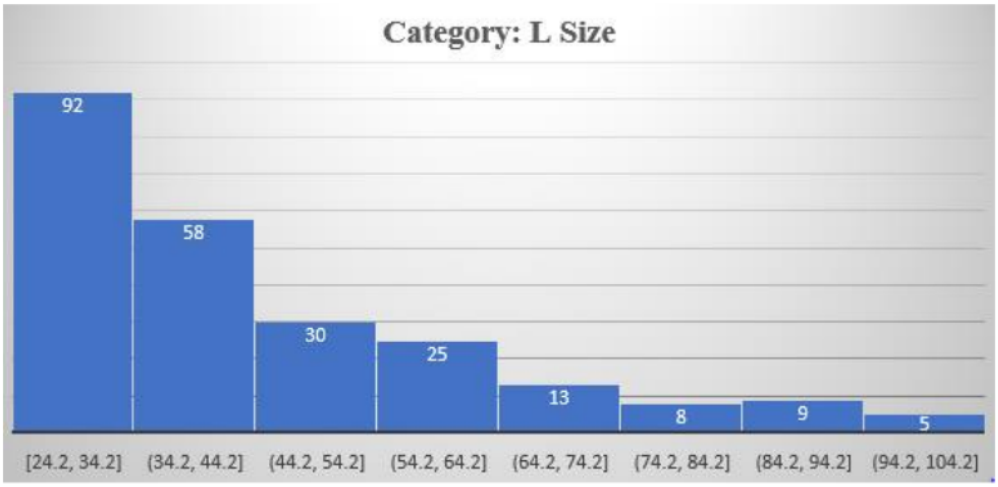
Histogram analysis reveals that the overall score distribution is abnormally skewed to the right. In addition, if we take the middle value (62.1) and average it with the extremes (100 and 24.2), we get a total of 62.1. It is skewed because it is significantly different from the mean value (44.6194).

ii. Use suitable summary statistics (e.g., mean, min, max, mode, median, 1st and 3rd quartile) and chart(s) to compare the overall score based on Size.

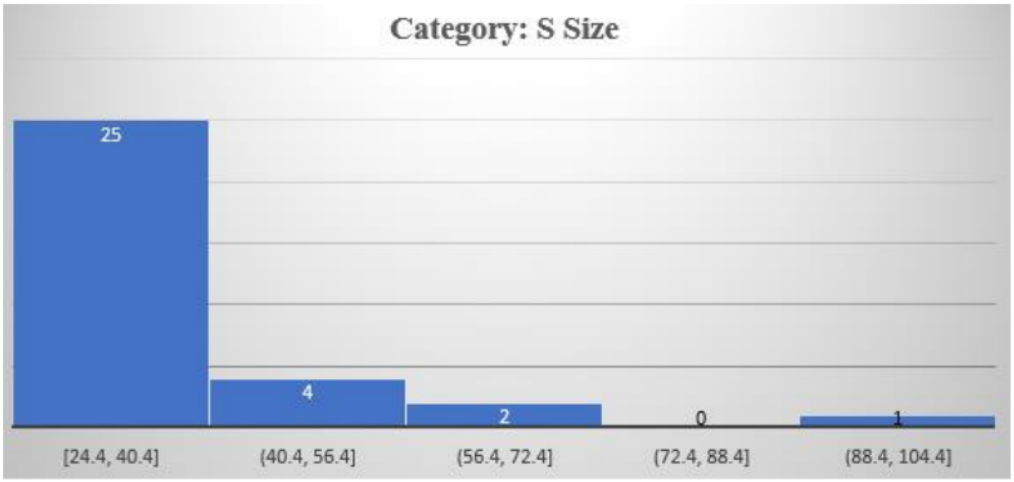
	M	*L*	*S*	*XL*
Mean	45	44.2	36.3	49.6
Max	100	98.8	97	95
Min	24.5	24.2	24.4	24.2
Median	35.4	38.4	30.3	45.4
1st Quartile	28.3	29.875	27.975	34.2
3rd Quartile	45.7	54.225	38.9	63.65



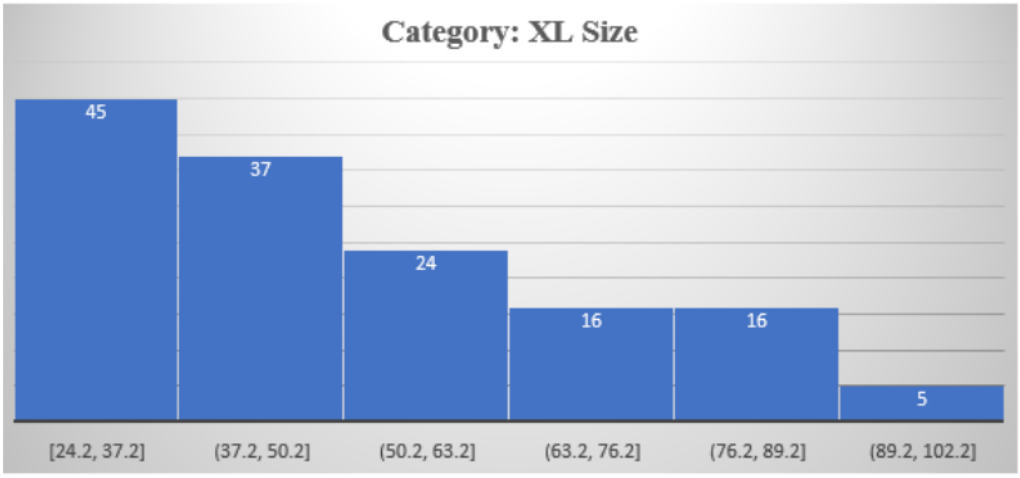
The M size category table has a right-skewed distribution with a median of 62 and a mean of 40.5. This indicates that the data is not normally distributed.



The chart shows that the L-size category's distribution is still heavily skewed to the right. The average of the min and max is 61.5, whereas the mean is 44.2, which further proves the right skewness.



The chart shows that the data is positively skewed, and it also includes an outlier at the gap.

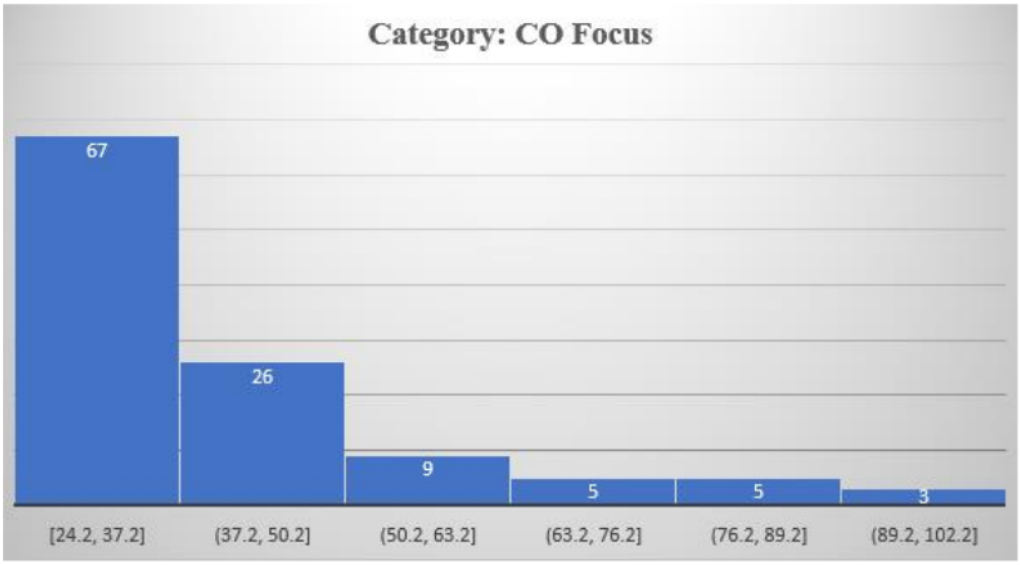


The above chart also shows that the XL Size group is skewed to the right.

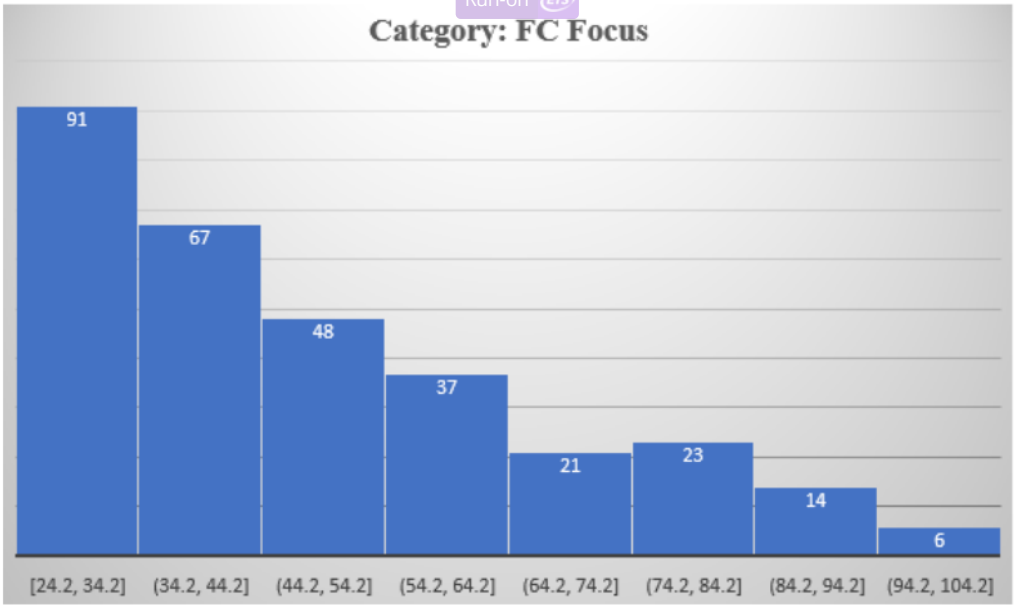
iii. Repeat the analysis in (ii) to compare the overall score based respectively on Subject Range (Focus), Research Intensity (Res.), and Age.

Subject Range (Focus)

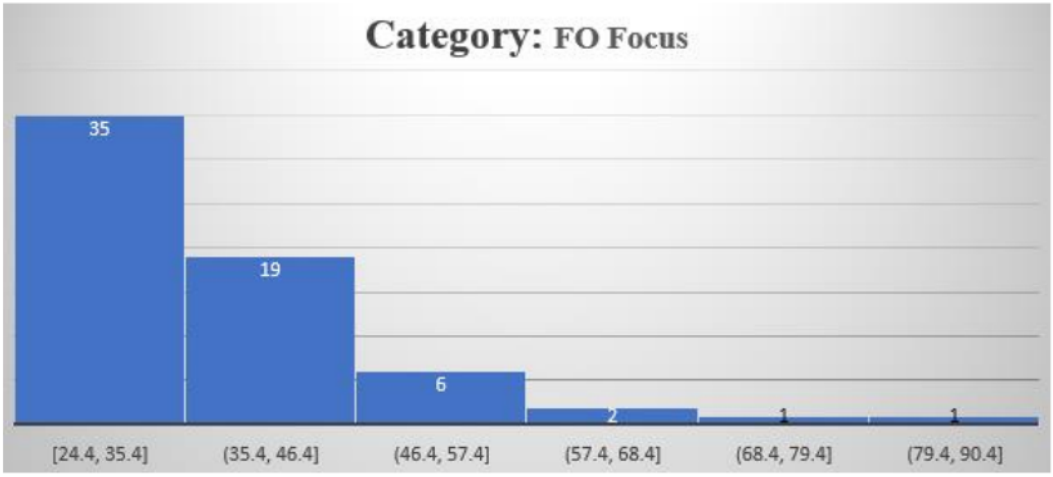
	CO	*FC*	*FO*	*SP*
Mean	40.4	48.2	37.4	34.5
Max	100.0	98.8	89.2	72.3
Min	24.2	24.2	24.4	24.6
Median	34.7	43.6	34.3	29.5
Mode	26.3	81.5	36.1	24.8
1st Quartile	28.15	31.65	29.1	26.375
3rd Quartile	45.15	59.3	41.4	36.325



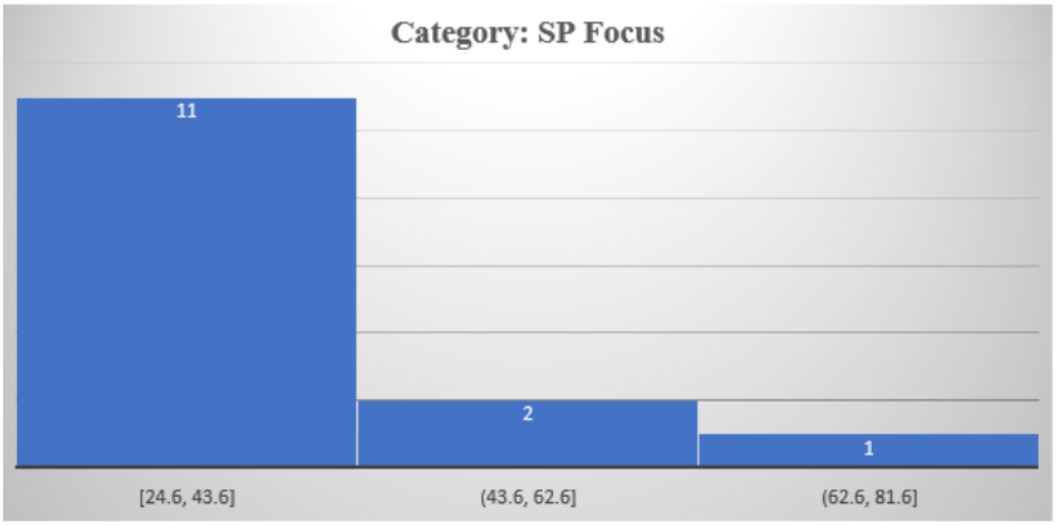
In the tables, we see that the CO Focus type has a rightwards data skew because the mode is lower than the median and the median is lower than the mean.



In the FC variety, right skewness is indicated because the median (61.5) is larger than the mode (48.2). The outcomes are displayed in the chart above.



The average of the FO type's minimum and maximum values is 35.8, which is larger than the mean value of 37.4. This value indicates positive skewness.



The SP type has positive skewness, as the average of the minimum and maximum values is larger than the mean (34.5). Here it is in the table below:

Research Intensity

	HI	*LO*	*MD*	*VH*
Mean	30.8	25.5	28.6	46.1
Min	24.4	24.8	25.5	24.2

Max	50.8	26.2	33.3	100.0
Mode	24.9	#N/A	#N/A	30.2
Median	28.1	25.5	27.7	40.0
1st Quartile	25.375	25.15	26.1	30.7
3rd Quartile	35.425	25.85	30.15	56.2

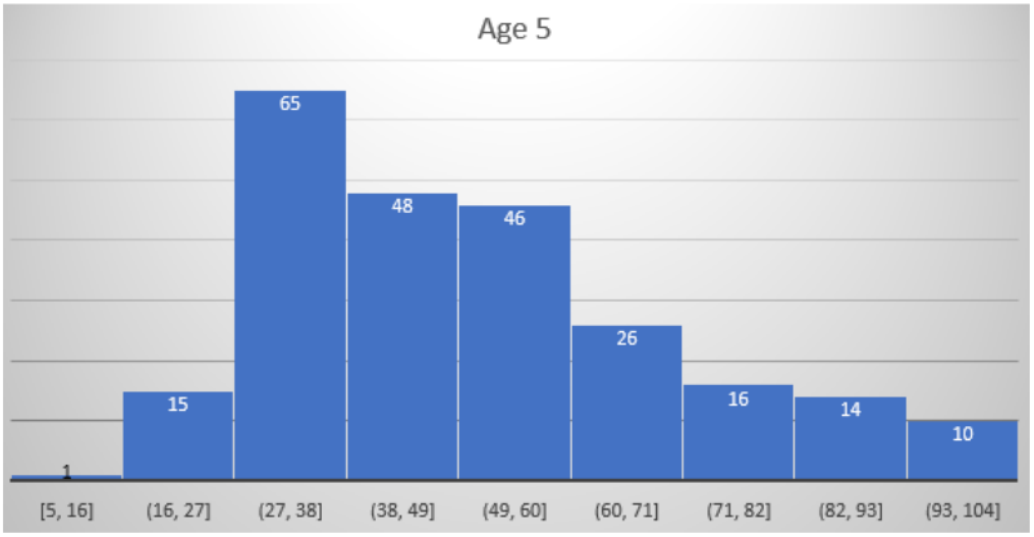
Since the mode is smaller than the median and the median is smaller than the mean, the HI distribution is right skewed. The subsequent graph illustrates this point.

There is no dominant value, or mode, in LO distributions. Normality is demonstrated by the mean value of 25.5, which is the average of the minimum and maximum values. This is due to the fact that there are only two examples of this LO type in the data.

The right skewness in the data is demonstrated by the VH type, where the mode is less than the median and the median is less than the mean.

Age

Ages	*1*	*2*	*3*	*4*	*5*
Mean	55.3	35.0	38.5	41.5	50.8
Min	27.6	24.2	24.4	24.3	24.4
Max	83.8	55.9	92.7	90.1	100.0
Median	55.7	32.7	33.7	37.2	46.8
Mode	#N/A	#N/A	33.7	29.8	54.5
1st Quantile	37.475	27.35	28	29.8	34.825
3rd Quantile	71.775	41.925	42.05	48.4	62.15
Mean	55.3	35.0	38.5	41.5	50.8



iv. Determine confidence intervals for the mean overall score by Size, Subject Range (Focus), Research Intensity (Res.), and Age

The confidence interval is represented by Upper and Lower bounds.

Size

Confidence Interval	M	L	S	XL
alpha	0.05	0.05	0.05	0.05
stdev	17.89074	18.46144	14.96243	18.95913
n	85	240	32	143
Sample mean	40.5	44.3	36.3	49.6
Marginal error	3.803356	2.335651	5.184121	3.107409
Upper bound	44.3	46.6	41.5	52.7
Lower bound	36.7	42.0	31.1	46.5

Subject Range

Confidence Interval	CO	FC	FO	SP
alpha	0.05	0.05	0.05	0.05
stdev	17.36852	13.6674	12.43242	13.33109
n	115	307	64	14
Sample mean	40.4	48.2	37.4	34.5
Marginal error	3.174403	1.52885	3.045888	6.983125
Upper bound	43.6	49.7	40.4	41.4
Lower bound	37.3	46.6	34.3	27.5

Research Intensity

Confidence Interval	HI	LO	MD	VH
alpha	0.05	0.05	0.05	0.05
stdev	6.720172	0.989949	3.522783	18.87543
n	40	2	4	453
Sample mean	30.8	25.5	28.6	46.1
Marginal error	2.082565	1.371975	3.452264	1.738184
Upper bound	32.9	26.9	32.0	47.8
Lower bound	28.7	24.1	25.1	44.4

Age

Confidence Interval	1	2	3	4
alpha	0.05	0.05	0.05	0.05
stdev	21.7416	9.989824	16.07533	15.8862
n	8	12	55	137
Sample mean	55.3	35.0	38.5	41.5
Marginal error	15.06588	5.652171	4.248412	2.66016
Upper bound	70.3	40.7	42.8	44.2
Lower bound	40.2	29.4	34.3	38.9

v. Using appropriate hypothesis tests, help BUG finds out whether there is a significant difference in overall score between:

1. New (Less than ten years old) and Historic (100 years old and more) Universities

2. Small (Fewer than 5,000 students) and Extra Large (More than 30,000 students) Universities

H_0: $\mu_S = \mu_{XL}$

H_1: $\mu_S \neq \mu_{XL}$

t-Test: Two-Sample Assuming Unequal Variances

	Small 1	*Extra Large 2*
Mean	36.275	49.63846
Variance	223.8742	359.4486
Observations	32	143
Hypothesized Mean Difference	0	
df	56	
t Stat	-4.33347	
P(T<=t) one-tail	3.08E-05	
t Critical one-tail	1.672522	
P(T<=t) two-tail	6.16E-05	
t Critical two-tail	2.003241	

We reject the null hypothesis and conclude that there is a statistically significant difference between the overall score means of Small and Extra-Large Universities because the p-value is less than our significance level of 0.05.

3. Specialist (2 or fewer faculty areas) and Full comprehensive (All 5 faculty areas + medical school) Universities

H_0: $\mu_{sp} = \mu_{fc}$

H_1: $\mu_{sp} \neq \mu_{fc}$

	Specialist	*Full Comprehensive*
Mean	34.4571429	48.15732899
Variance	177.718022	380.9599706
Observations	14	307
Hypothesized Mean Difference	0	
df	16	
t Stat	-3.670051	
P(T<=t) one-tail	0.0010346	
t Critical one-tail	1.74588368	
P(T<=t) two-tail	0.0020692	
t Critical two-tail	2.1199053	

We can conclude that there is a statistically significant difference between the overall score means of Special and Full Comprehensive universities because the p-value is less than 0.05.

b) Scaled Overall Score by continents.

i. Add a variable named Continent to indicate which continent each University is located – you may want to use the file countryContinent.xlsx to this effect.

ii. Use suitable charts to compare the overall score by Continent.

The American Continent has the highest overall score, followed by the Europe continent. The Continent with the least overall score is Oceania.

c) Relationships between variables.

i. Calculate all correlation coefficients where appropriate.

Correlation Coefficient of Academic Reputation vs Overall Score

	Academic Reputation Score	*Overall Score*
Academic Reputation Score	1	
Overall Score	0.895281648	1

Therefore, there is a strong connection between Academic Reputation Score and Overall Score, as indicated by the high correlation coefficient of 0.8953 between the two sets of variables mentioned above.

The correlation coefficient of Employer Reputation Score vs Overall Score

	Overall Score	*Employer Reputation Score*
Overall Score	1	
Employer Reputation Score	0.775902923	1

In other words, there is a robust connection between the Employer Reputation Score and the Overall Score (r=0.776), indicating that the two are highly correlated.

The correlation coefficient of Faculty Student Score vs Overall Score

	Overall Score	*Faculty Student Score*
Overall Score	1	
Faculty Student Score	0.322265175	1

As the above-mentioned correlation coefficient of 0.0.322 demonstrates, the connection between the Faculty Student Score and the Overall Score is tenuous at best.

Overall, there is a strong connection between the Score per Faculty and the Total Score, as indicated by the high correlation coefficient (0.502) between the two variables.

The correlation coefficient of International Faculty Score vs Overall Score

	Overall Score	*International Faculty Score*
Overall Score	1	
International Faculty Score	0.350472555	1

A weak relationship exists between the International Faculty Score and the Overall Score (r=0.03505), indicating that there is a low degree of correlation between the two variables.

d) Model(s) to forecast overall score in terms of other variables

i. Develop a model using all variables. Comment on your results and potential issues.

The model did a good job of predicting outcomes with an adjusted R-Squared score of 0.99999. This indicates a high performance.

ii. Develop a model using only significant variables. Comment on your results and potential issues.

The model did a good job of predicting outcomes with an adjusted R-Squared score of 0.99998. This indicates a high performance.

iii. Develop a model using only the variables not used to calculate the overall score. Comment on your results

The model did a poor job of predicting outcomes with an adjusted R-Squared score of 0.42784. This indicates a low performance.

PROBLEM 2

a) What kind of model was developed? What was the aim(s) of the model?

Developed Model: A Decision Analysis Model

The purpose of the model was to facilitate discussions about important medical and orthopaedical decisions, such as whether or not to use antibiotic-loaded bone cement in total hip replacements, whether or not to perform surgery on the other hip of a patient with a slipped capital femoral epiphysis, and whether or not to perform a noncompartmental arthroplasty rather than a total knee replacement. Give a high-level summary of the choices, outcomes, and criteria you'll use to pick the best option.

b) Briefly describe the possible decision alternatives, outcomes, and criterion for selecting the best decision.

Possible Decision Alternatives

- Open Irrigation/Debridement
- Single Stage Exchange
- Two-Stage Exchange

Possible Outcomes

The outcomes were formed based on Toll and Quality of life.

Utilities	*Quality of life*
Open Irrigation/Debridement	0.86
One-stage exchange	0.82
Two-stage exchange	0.82
Resection arthroplasty	0.60

Disutility of Revision	*Toll*
Open Irrigation/Debridement	-0.1
One-stage exchange	-0.15
Two-stage exchange	-0.2

Criteria for selecting the best decision

An open debridement was shown to have a disutility of -0.1, which is on par with the figure used after a major THA. To account for two operations and an antibiotic spacer gap in between, it was projected that the disutility at the time of expected reimplantation during a two-stage exchange would be -0.2, double the value of initial THA. In this model, a one-step transaction deemed to fall within this range was assigned the value of -0.15 to account for it.

For a primary THA with no complications, the value found from the biggest series in the Clinical Research and Health Policy Research database was 0.86, but no research has evaluated the utilities for the specific end health states in this model. Repeat surgery to resolve infection leads in poorer quality of life than an uncomplicated THA, so a disutility toll was applied to the final quality-of-life estimate to account for this additional therapy (i.e., due to a repeat procedure, duration of treatment, and loss of income). They hypothesized that a successful open debridement would result in the same level of benefit as a straightforward THA (0.86). Yet, the assessed quality of life after a routine THA was reduced by 0.1 because to the repeat operation (to account for the morbidity of a second procedure).

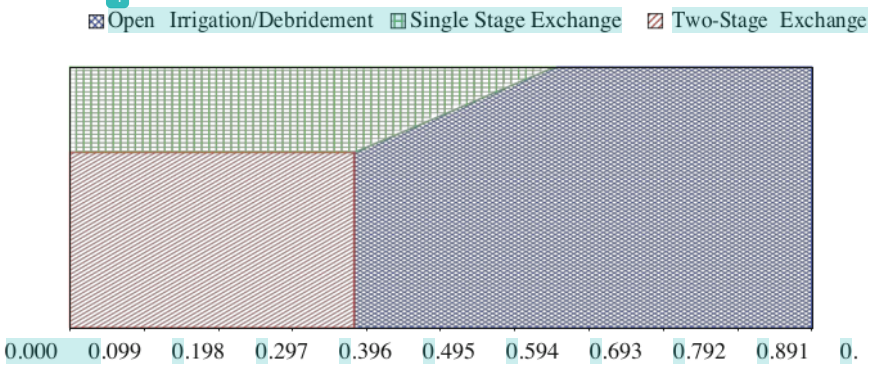
Therefore, the utility estimate (quality of life) after debridement for THA infection was 0.76 (utility of a simple THA minus disutility toll for debridement procedure). An examination of a patient getting a revision THA found that their quality of life was 0.82 [32]. Specifically comparing the benefits of single- and double-step transactions was not studied by the researchers. They found that patients recovering from sepsis-related THA, whether it be a first-time procedure or a revision, had a utility score of 0.82. They hypothesized that the additional treatment and the time spent with an inadequate hip prosthesis between the two procedures would reduce the patient's quality of life compared to a single exchange. To account for this difference, the disutility toll was subtracted from the final estimate of the quality-adjusted life year following each treatment, resulting in similar estimates for both one-stage and two-stage exchanges. Resection arthroplasty was evaluated, and found to be 0.60 effective.

c) Using a suitable package such as Precision Tree, draw, for this problem, a decision tree such as the one in Figure 1. Include all relevant parameters.

d) Fold back the tree and determine the best option. Is it the same as in the paper? Justify why or why not

No. When compared to the analysis program, the paper's measurements are quite precise.

e) Undertake the same one-way and two-way sensitivity analyses as in the paper, as well as any additional sensitivity analysis as you see fit (justify). You might use graphics of your choice to display results. Comment on your results, in particular on: - how they compare with those in the paper - the usefulness of sensitivity analysis in decision analysis.



It's virtually an exact match to the paper results, however there are minor discrepancies in the predicted outcomes of treatment.

PROBLEM 3

1 a) Formulate a linear programming (LP) model algebraically to assist the company in minimizing the annual variable cost of meeting a demand for air conditioners. Solve using Excel Solver.

Solution

First, I divided the expected monthly demand for each conditioner by the cost of production in each region to arrive at the sums. I then minimized the annual variable cost using Excel Cover

b) The monthly fixed cost of operating a factory in each City is shown in the following table. Revise your formulation to minimize the monthly total (variable + fixed) cost of meeting the demand for air conditioners. Solve using Excel Solver.

I combined the monthly factory cost with the variable costs in the table below.

I next determined the overall expenses for the anticipated number of air conditioners in each region. I then made another column and added the costs associated with conditioners that had fixed manufacturer costs.

I then used Excel's solver to find the answer, which is as follows:

c) Additionally, at least 5,000 units of North demand must come from either City 1 or City 2. Revise your formulation in (b) to incorporate this constraint and solve using Excel Solver

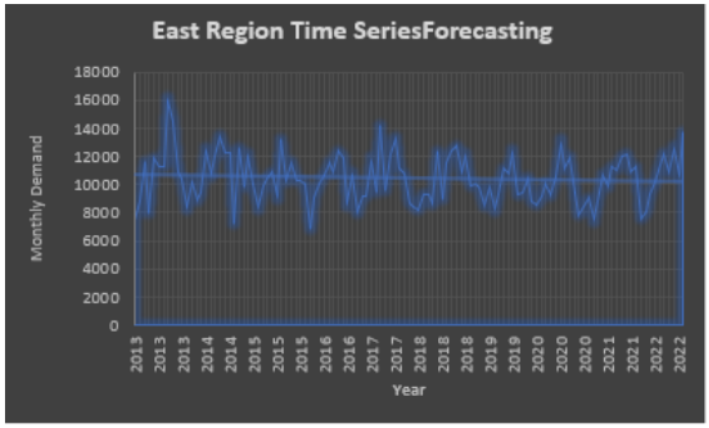
The result of multiplying 5000 by the 230 cost of City 1 is 1,150,000. Given that the value of 2645000 exceeds the minimal value necessary when considering the production costs of City, the solver is optimal. The solver is optimal for City 2 since the 5000 units account for 1,105,000, which is also less than 2,541,000.

d) The company has gathered historical data of the monthly demand for air conditioners over the past 9 years 9 months (since 2013)- see file Data_Pb3.xlsx.

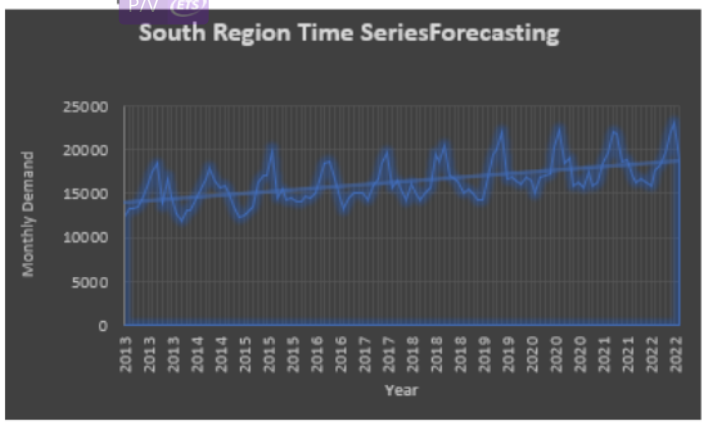
i. Exploring the time series for each region.

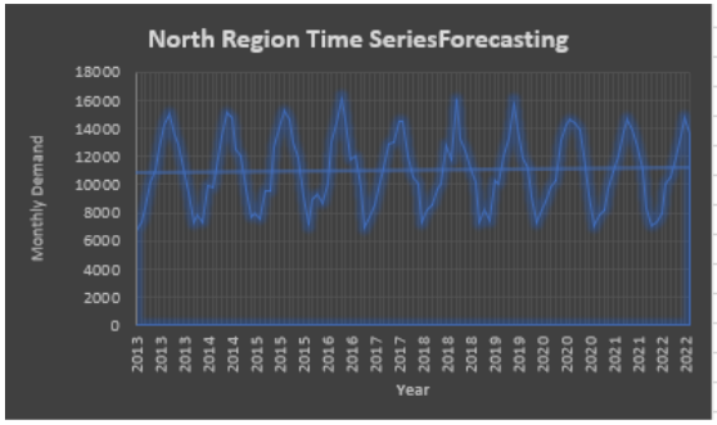
1. Plot the data for each region as time series

When the trend line is closely examined, the time series plot for the East Region shows some trending. As time goes on, the trend line generally tends to fall. Although some seasonality is present, it seems to be minimal.

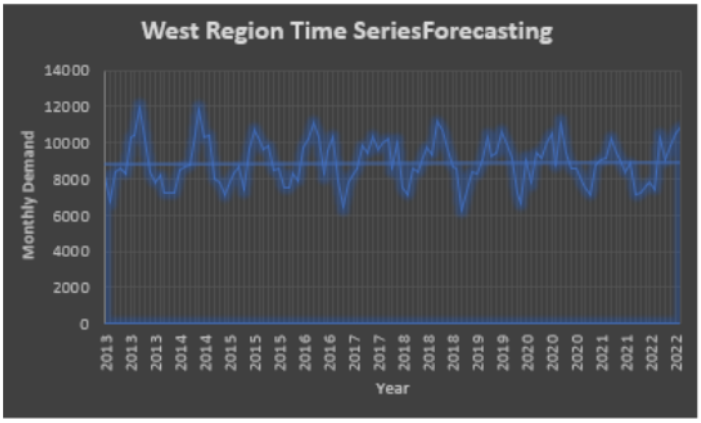


The South region's time series graphic shows an upward trend. Seasonality is also shown by a pattern (rising and decreasing).





Since the line is constant, the data show no trend. However, there is significant seasonality indicated by patterns of increasing and falling values.



The trend line is constant, thus there is no trend, however the pattern does show some seasonality.

3. If/Where relevant, calculate seasonal indexes for each region.

	East	*South*	*North*	*West*
Average	0429.4	16380.98	11005.98	8920.051
Total Average	11684			
Seasonal Indexes	0.89259	1.402	0.94197	0.76344

4. State with justification for each region what would be appropriate forecasting methods to forecast monthly demand until September 2023.

Due to non-stationarity, the Random Walk model would perform the best in the East Region.

Due to non-stationarity, the Random Walk model will work well in the South Region.

North Region - The Autoregressive model works well in this region because there is no stationarity and there appears to be a distinct pattern between the years that suggests some association.

Since there is no stationarity and the numbers are not particularly reliable, the Moving Average is the best model for the West Region. Although there is some pattern, it is difficult to spot, indicating that there is not a strong correlation between the data.

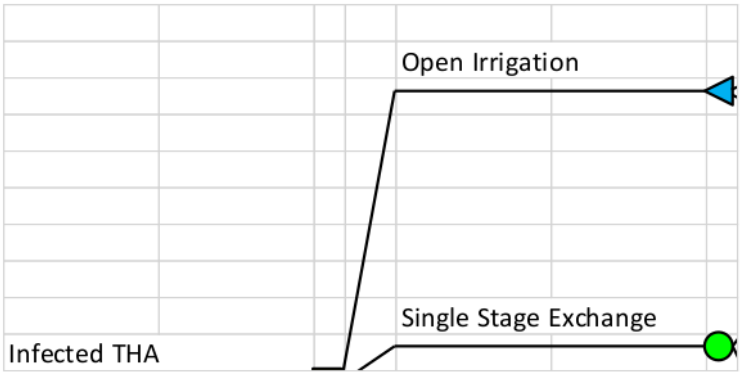
ii. Apply two appropriate forecasting methods for each region to forecast monthly demand between October 2022 and September 2023.

1. For each region, compare the performance of the two methods using MAE, RMSE, and MAPE.

Using Random Walk Method

Using Moving Average

APPENDIX PART


Open Irrigation
Single Stage Exchange
Infected THA

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PAGE 6

PAGE 7

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PAGE 8

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Missing "," You may need to place a comma after this word.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

S/V This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

S/V This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.

Article Error You may need to use an article before this word.

Run-on This sentence may be a run-on sentence. Proofread it to see if it contains too many independent clauses or contains independent clauses that have been combined without conjunctions or punctuation. Look at the "Writer's Handbook" for advice about correcting run-on sentences.

Frag. This sentence may be a fragment or may have incorrect punctuation. Proofread the sentence to be sure that it has correct punctuation and that it has an independent clause with a complete subject and predicate.

Article Error You may need to use an article before this word. Consider using the article **the**.

Article Error You may need to use an article before this word. Consider using the article **the**.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Prep. You may be using the wrong preposition.

Hyph. You may need to add a hyphen between these two words.

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Frag. This sentence may be a fragment or may have incorrect punctuation. Proofread the sentence to be sure that it has correct punctuation and that it has an independent clause with a complete subject and predicate.

Confused You have used **where** in this sentence. You may need to use **were** instead.

Frag. This sentence may be a fragment or may have incorrect punctuation. Proofread the sentence to be sure that it has correct punctuation and that it has an independent clause with a complete subject and predicate.

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Possessive You may need to use an apostrophe to show possession.

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P/V You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.

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Article Error You may need to remove this article.

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Article Error You may need to remove this article.

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P/V You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.

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