

**BAYESIAN INFERENCE & RANKING OF FACTORS AFFECTING  
STUDENT ACADEMIC PERFORMANCE  
USING METHOD OF PAIRED COMPARISON**

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**ABSTRACT**

A sensitive issue all over the world is student academic performance. Like other countries Pakistan is also facing the same problem since a long time. A variety of researches have recognized several condition and situation that explore various factors that affecting the students' academic performance. The objective of this research has to identifying the important influencing factors of affecting students' academic performance and rank over them. This research considers the Bayesian inference for the factors affecting the students' academic performance. Bayes' estimators are computed which reflects the overall worth probabilities for each factors. The ranking is done and posterior predictive probabilities are computed for each of the twenty one pairs of factors affecting the students' academic performance for future single comparisons of each pair. Results for analysis are computed in C language and programs coding are designed for seven parameters' inference. Furthermore' to ensure the appropriateness of the model, the goodness of fit criteria is used as used by Aslam (2002). The model ensures good fit for the data i.e. factors affecting the students' academic performance. The research aims to play a dynamic role in overcoming such type of national level problem of factors affecting the students' academic performance by providing the preferences probabilities which reflects ranking of each of the factor.

**KEY WORDS**

Bayesian Inference, Uniform prior, Bradley-Terry Model.

**1. INTRODUCTION**

In this research work focuses on the analysis of factors affecting the student academic performance and ranked them. Chapter 1 gives a brief account on student academic performance. The former portion includes the concepts of methodologies used in analysis.

In Chapter 2 the review of literature is discusses. Chapter 3 includes the material and methods; method of paired comparison, Bayesian analysis including posterior distribution, posterior mean, posterior predictive probabilities and model goodness of fit.

In Chapter 4 analysis is carried out for the data collected from students of University of Gujrat. Estimates for posterior mean, posterior predictive probabilities and testing of hypothesis for goodness of model is obtained using programs designed in C+ language for seven objects shown in appendices. Furthermore, conclusion and discussion is produced with recommendation for further research. Following is the brief introduction about the area of study as below;

### **1.1 Student Performance**

Galiher (2006) and Darling (2005), to measured student performance used GPA because they want to check main focus in on the student presentation for the specific semester. Some other researchers also used test results or prior year result since they are studying presentation for the exact issue or year (Hijazi and Naqvi, 2006 and Hake, 1998).

### **1.2 Learning Facility**

Karemera (2003) concluded that academic background and the facilities of library, computer lab and etc., is meaningfully connected with significantly and students' performance with in this organization. He found a positive effect of high school performance and school success With regard to background variables; there is no significant association between family income level and academic performance of the student.

### **1.3 Social Media**

Today Social media is very popular to describe different types of communication plat forms and electronic ways of interact with each other's. Social media includes such tools like electronic blogs, audio and video tools (e.g., YouTube), Internet chat rooms, and computer texting, and social networking websites. All of the previous tools are used to interact with each other's. One study concluded that those born between 1965-1979 ('Generation X') used 13 hours of social media per day; those born between 1980-1989 ('Net Generation') used 19 hours of social media per day; and those born between 1990-1999 ('I Generation') used 20 hours of social media per day (Rosen, 2011).

## **2. BAYESIAN INFERENCE OF THE MODEL**

In this chapter, all the results of the study are discussed according to data analysis technique. These results are discusses in the light of given literature and conclusion are drawn on the basis of these results.

In this chapter the data is investigated by Bayesian technique. Posterior means using Uniform prior distribution is gained. The posterior predictive probabilities are calculated for future single comparisons of each pair of factors affecting students' academic performance. The model goodness of fit is also obtained. Results are shown in the respective table with interpretation. The data is collected from students of university of Gujrat.

‘C’ language is used for programming of complex integrations of seven factors given in the appendix. The data of paired comparisons for eight factor of students’ academic performance is given below in Table 1 as follow;

**Table 1**

<b>Pair of Factors</b>	<b>Nij</b>	<b>Nji</b>
Sm,Tf	70	30
Sm,Lf	62	38
Sm,Bf	62	38
Sm,Ab	59	41
Sm,Hf	52	48
Sm,Hf	57	43
Tf,Lf	48	52
Tf,Bf	48	52
Tf,Ab	49	51
Tf,Hf	54	46
Tf,Hf	49	51
Lf,Bf	45	55
Lf,Ab	58	42
Lf,Hf	56	44
Lf,Hf	46	54
Bf,Ab	50	50
Bf,Hf	47	53
Bf,Hf	41	59
Ab,Hf	61	39
Ab,Hf	49	51
Hf,Hf	62	38

From Table 1 ‘Sm’ denote the Social media, ‘Tf’ denote the Transport facility, ‘Lf’ denote the Learning facility, ‘Bf’ denote the Basic facility, ‘Ab’ denotes the Academic background, ‘Hf’ denote the Health facility, ‘Hf’ denote the Hygienic facility and ‘Ap’ denote the administrative professionalism. Nij denotes the number of preferences of 1<sup>st</sup> factor, and Nji denotes the number of preferences for 2<sup>nd</sup> factor for each pair of factors respectively.

## 2. POSTERIOR MEAN

**Table 2**

<b>Social Media</b>	<b>Transport Facility</b>	<b>Learning Facility</b>	<b>Basic Facility</b>	<b>Academic Background</b>	<b>Health Facility</b>	<b>Hygienic Facility</b>
0.21154	0.11555	0.14196	0.11787	0.13622	0.13622	0.14064

This table interprets the result of factors affecting students’ academic performance. That probability shows the preferences of students on factor affecting students’ academic

performance. Also display the within preference of the difference factors affecting students' academic performance that probability shows the preference of the factor affecting students' academic performance which one has most (least) probability attain that is the factor has more preferred from the students of University of Gujrat. That factor is greater who has maximum probability to achieve has strong roots because the students of university of Gujrat have preferred. In this table Social Media has the probability 0.21154 i.e. students of University of Gujrat preference of this factor are 21.54% out of 100%. Transport Facility has the probability 0.11555 i.e. Students of University of Gujrat preference of this factor are 11.55% out of 100%. Learning Facility has the probability 0.14196 i.e. students of University of Gujrat preference of this factor are 14.19% out of 100%. Basic Facility has the probability 0.11787 i.e. students of University of Gujrat preference of this factor are 11.78% out of 100%. Academic Background has the probability 0.13622 i.e. Students of University of Gujrat preference of this factor are 13.62% out of 100%. Health Facility has the probability 0.13622 i.e. students of University of Gujrat preference of this factor are 13.62% out of 100%. Heyganic Facility has the probability 0.14064 i.e. Students of University of Gujrat preference of this factor are 14.06% out of 100%.

### 3. RANKING OF FACTOR AFFECTING STUDENTS' SATISFACTION AMONG HOSTEL LIVING

**Table 3**

<b>Factors affecting students' Academic Performance</b>	<b>Expected Probabilities (<math>\theta_i</math>)</b>	<b>Rank</b>
Social Media	0.21154	(1)
Transport Facility	0.11555	(7)
Learning Facility	0.14196	(2)
Basic Facility	0.11787	(6)
Academic Background	0.13622	(4.5)
Health Facility	0.13622	(4.5)
Hygienic Facility	0.14064	(3)

This table shows the ranking of the factors affecting students' academic performance. The students of University of Gujrat more preferred the Social Media as an affecting factor that has the maximum probability of the preference that probability is 0.21154 so we give the first rank order of the Social Media and the second rank goes to the Learning Facility the preferences probability is 0.14196 that probability is less than the se Social Media so give the second rank and the further third, fourth, fifth, Sixth and seventh order is given to the according Hygienic Facility, Academic Background, Health Facility, Basic Facility and Transport Facility. In here rank of fourth and fifth are same so we and her rank and divide by two so we get 4.5 its average rank and put in the place of fourth and fifth rank. We also know that has less probability of the preferences of the first one so we gave the less order or rank to the first one. In this table we can see the more preferred affecting factor of students' academic performance is Social Media and have a strong position and that less preferred affecting factor of students' academic performance

is Transport Facility most students of University of Gujrat are not preferred that factor have a weak position. Expected probabilities of the preferences is a long term probabilities we know that the  $\sum \theta_i = 1$ .

#### 4. POSTERIOR PREDICTIVE PROBABILITIES FOR FACTOR EFFECTING STUDENT SATISFACTION AMONG HOSTEL LIVING

**Table 4**

<b>P(ij)</b>	<b>Estimate</b>	<b>P(ji)=1-P(ij)</b>	<b>Estimate</b>
P(12)	0.624923	P(21)	0.375077
P(13)	0.598166	P(31)	0.401834
P(14)	0.62041	P(41)	0.37959
P(15)	0.602632	P(51)	0.397368
P(16)	0.602632	P(61)	0.397368
P(17)	0.602632	P(71)	0.397368
P(23)	0.471843	P(32)	0.528157
P(24)	0.495189	P(42)	0.504811
P(25)	0.476481	P(52)	0.523519
P(26)	0.476481	P(62)	0.523519
P(27)	0.476481	P(72)	0.523519
P(34)	0.523359	P(43)	0.476641
P(35)	0.504651	P(53)	0.495349
P(36)	0.504651	P(63)	0.495349
P(37)	0.504651	P(73)	0.495349
P(45)	0.481283	P(54)	0.518717
P(46)	0.481283	P(64)	0.518717
P(47)	0.481283	P(74)	0.518717
P(56)	0.5	P(65)	0.5
P(57)	0.5	P(75)	0.5
P(67)	0.5	P(76)	0.5

From the above table we also see that in a single comparison the first factor is Social Media have 0.624923 probability an i.e. student of University of Gujrat preference of this factor is 62.49% out of 100%. Transport Facility has the probability 0.375077 i.e. students of University of Gujrat preference of this factor is 37.50%. From this single pair of factors affecting the students' academic performance we can see Social Media has greater preference than the Transport Facility. In second pair factors affecting students' academic performance Social Media has 0.598166 probability i.e. students of University of Gujrat preference of this factor is 59.81% out of 100%. Learning Facility has the probability 0.401834 an i.e. student of University of Gujrat preference of this factor is 40.18% and in this pair of factors affecting students' academic performance Social Media have greater preference than the Learning Facility. From the third pair of factors affecting the students' academic performance Social Media has 0.62041 probability i.e. students of University of Gujrat preference of this factor is 62.04% out of 100%. Basic Facility has the probability 0.37959 an i.e. student of University of Gujrat preference of this factor is

37.95% and in this pair of factors affecting students' academic performance Social Media have greater preference than the Basic Facility. From the four pair of factors affecting the students' academic performance Social Media has 0.602632 probability an i.e. student of University of Gujrat preference of this factor is 60.26% out of 100%. Academic Background has the probability 0.397368 an i.e. student of University of Gujrat preference of this factor is 39.73% and in this pair of factors affecting students' academic performance Social Media have greater preference than the Academic Background. From the five pair of factors affecting the students' academic performance Social Media has 0.602632 probability an i.e. student of University of Gujrat preference of this factor is 60.26% out of 100%. Health Facility has the probability 0.397368 an i.e. student of University of Gujrat preference of this factor is 39.73% and in this pair of factors affecting students' academic performance Social Media have greater preference than the Health Facility. From the next pair of factors affecting the students' academic performance Social Media has 0.602632 probability i.e. students of University of Gujrat preference of this factor is 60.26% out of 100%. Hygienic Facility has the probability 0.397368 an i.e. student of University of Gujrat preference of this factor is 39.73% and in this pair of factors affecting students' academic performance Social Media have greater preference than the Hygienic Facility.

**(Observed and Expected Number of Preferences of Factor for hostel Students)**

**Table 5**

$X_{ij}$	$\hat{x}_{ij}$	$X_{ji}$	$\hat{x}_{ji}$
21	19.402	9	10.598
19	17.95248	11	12.04752
19	19.26535	11	10.73465
18	18.24879	12	11.75121
16	18.24879	14	11.75121
17	18.01976	13	11.98024
14	9.806223	16	12.04752
14	10.52336	16	10.73465
15	9.968081	15	11.75121
16	9.968081	14	11.75121
15	9.842978	15	11.98024
14	12.92857	16	10.73465
17	12.24638	13	11.75121
17	12.24638	13	11.75121
14	12.09268	16	11.98024
15	10.16822	15	11.75121
14	10.16822	16	11.75121
12	10.0406	18	11.98024
18	11.75121	12	11.75121
15	11.60373	15	11.98024
19	11.60373	11	16.38461

The null and alternative hypotheses are as follow

$H_0$ ; The model is good fit of the data

$H_1$ ; The model does not fit the data

We calculate the expected frequencies by the following formula

$$\widehat{x}_{ij} = r_{ij}(\omega_{ij})$$

For all  $i < j$

The level of significance is 5%

The test statistic follows the Chi-Square distribution as

$$\chi^2 = \sum_{i < j=1}^m \left\{ \frac{(x_{ij} - x_{ij})^2}{x_{ij}} + \frac{(x_{ji} - x_{ji})^2}{x_{ji}} \right\}$$

We follow the consideration by Aslam (2002) about the degree of freedom in which he considered the choice of degree of freedom by this formula  $d.f = m(m-2) = 48$

In table  $x_{ij}$  denoted the observed number of preference of Ith University compared with Jth University. Similarly  $x_{ji}$  denoted the observed number of preference for Jth University compared with Ith University. The term  $\widehat{x}_{ij}$  denotes the expected number of preference four<sup>th</sup> university compared with Jth University and  $\widehat{x}_{ji}$  denotes the expected number of preference for Jth University the Chi-Square test statistic value as

$$x_{cal}^2 = 48.62455249$$

The table value is  $x_{(0.05,35)}^2 = 49.4579$

Since the  $x_{cal}^2$  doesn't not fall in the criteria region that is

$$x_{cal}^2 \not\geq x_{(0.05,35)}^2$$

So as a conclusion we have no evidence to reject the null hypothesis. We conclude that the model is good fit the data.

#### 4. CONCLUSION

This study reveals the preferences of students of University of Gujrat for the factors influencing the students' academic performance and the ranking with predictive inference for factors affecting students' academic performance. To know the preference of the students of University of Gujrat is an important task for the students' academic performance. For factors of affecting students' academic performance ranks first. Paired comparison used Bayesian inferences via non-informative uniform prior for the analysis of the data. For this purpose C language is used for programming and results are generated for each program about estimation of parameters for posterior means and posterior predictive probabilities. The students of University of Gujrat most preferred the Social Media factor that has the highest worth probability, and the second rank goes to the Learning Facility that probability is less than one so give the second rank and the future third, fourth, fifth, sixth and seventh order is given to according Hygienic Facility,

Health Facility, Academic Background, Basic Facility and Transport Facility. The most preferred factor of the students' academic performance is Social Media most students of University of Gujrat preferred that factor and have a strong influence on the factors affecting students' academic performance and that less preferred that factor and have a weak influence on the factor affecting students' academic performance is Transport Facility most students of University of Gujrat are not preferred that factor and have a weak influence on affecting students' academic performance.

The research aims to play a dynamic role in overcoming the national level problem of factors affecting students' academic performance by providing the preferences probabilities which reflects ranking of each of the factor.

## 5. RECOMMENDATION

- In this paper paired comparisons methodology is considered. It can be further generalized to the multiple comparisons experimentations.
- In our study we analyzed the preferences of factors affecting the students' academic performance for which the opinions were collected from the students of University of Gujrat. In future research may be conduct from faculty.
- Ranking of factors of affecting students' academic performance within Pakistan students is done and can be attained for different countries facing that kind of problem.

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