

A Study On Similarity Of Websites Of Management Institutes Using Data Mining Tools

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INTRODUCTION

The World Wide Web has played an important role in presenting the data, even from geographically distant locations, easily accessible to users all over the world. A website is a collection of web pages, consisting of text and images that provide information about a particular topic or organization, twenty four hours a day and seven days a week (*Bhattacharjee and Gupta, 2008*). Today, it's a big challenge for management institutes to stay upgraded in the global educational environment. Most of the management institutes provide information about students, courses, faculty, staff and facilities available and other details through their websites and accordingly market themselves. All this information is useful for the students, guardians, scholars as they get a bird's eye view about the institute. Having a website helps the administration of any institute to provide information about their services- namely admission, results, rules, placement, etc. and accordingly, diminishes the work load of the employees to a great extent.

In India, there are many government and privately run management institutes. Every year, these management institutes are ranked by All India Council of Technical Education (AICTE) based on the institute's Intellectual Capital, Admission and Placements, Infrastructure, Industry Interface and Governance, etc. The proposed study is based on information contained in the websites of 21 top management institutes that were ranked by AICTE in the year 2008. The information provided on the websites of the management institutes was classified into some categories and under each category, many attributes are considered. If particular information is provided on the institute's website, then it is coded as "1" and otherwise "0". In the study, independence between the categories are assumed. The main aim of this paper is to develop a Paired Similarity Index (PSI) to study the similarity between any two websites of the studied management institutes.

OBJECTIVES OF THE STUDY

The objectives of the proposed study are as follows –

1. To develop a Paired Similarity Index (PSI) (for non-mutually exclusive cases) by extending an earlier work due to Erlich, Gelbard and Spiegler (2002).
2. To study the similarity of websites of management institutes of India by using the proposed PSI.

METHODOLOGY

The different management institutes considered for the study are as follows IIM Ahmedabad (IIMA), IIM Bangalore (IIMB), IIM Calcutta (IIMC), ISB Hyderabad (ISBH), IIM Lucknow (IIML), XLRI Jamshedpur (XLRIJ), FMS Delhi (FMSD), IIM Indore (IIMI), IIM Kozhikode (IIMK), IIFT Delhi (IIFTD), SP Jain Mumbai (SPJM), MDI Gurgaon (MDIG), JBIMS Mumbai (JBIMSM), NMIMS Mumbai (NMIMSM), IMT Ghaziabad (IMTG), NITIE Mumbai (NITIE), SIBM Pune (SIBMP), XIMB Bhubaneswar (XIMBB), TISS Mumbai (TISSM), IIT Mumbai (IITM) and IIT Delhi (IITD). Following the website of IIM Ahmedabad, the best management institute of India, as per AICTE ranking, the information provided on the websites is classified into eight categories viz,

1. Admission procedure
2. Library facilities
3. Students
4. Other facilities (Hostel, sports, etc.)
5. Faculty search
6. Research and Development
7. Alumni Association
8. Placement

Under each of these categories, many attributes are considered, details of which are provided in the **Appendix-A**. The availability of information about any attribute, in a given website is expressed by an indicator variable. The relevant data was collected from the websites of the management institutes in the month of August, 2009.

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REVIEW OF LITERATURE

A review about some works related to data mining tools using binary data can be found in storage and retrieval considerations of binary data base by Spiegler and Mayaan (1985), Fayyad, Haussler and Stolorz (1996) (data classification), data clustering is given by Jain, Murty and Flynn (1999), Gelbard and Spiegler (2000) (data clustering). Erlich et al. (2002) developed a model for similarity and clustering by means of binary representation for mutually exclusive cases.

PSI FOR BINARY DATA

Erlich, Gelbard and Spiegler (2002) proposed a data mining method by means of binary representation for determining pair similarity index between any two entities. Here, we have a collection of websites of management institutes. The information content on the websites is subdivided into some broad categories. Under each category, we consider some attributes. Then for each category under each website, we construct a binary vector that represents the presence (1) or absence (0) of its attributes. In this context, the measure of similarity as proposed by Erlich et al. can be explained as follows–

Suppose that for each website 'i' ($i=1, 2, \dots, n$) we have 'm' categories. For each category j ($j=1, 2, \dots, m$) we have p_j attributes. The value p_j is called as the domain size of the jth category. They define the binary representation

vector of length, $P = \sum_{j=1}^m p_j$ (the length of domain category vector), for each website 'i' ($i=1, 2, \dots, n$) in the following way –

$x_{ijk} = 1$, if the information about the kth attribute belonging to the jth category is available in the ith website.
 $= 0$, otherwise

where $i = 1, 2, \dots, n, j = 1, 2, \dots, m$ and $k = 1, 2, \dots, p_j$

The mutual exclusivity property for each category over its domain was assumed. Using binary representation, Erlich et al. (2002) defined a pair similarity index (PSI) as follows –

$$PSI = PSI(i_1, i_2) = \frac{sa(i_1, i_2)}{m} \quad (1)$$

$$\text{where } m = \sum_{j=1}^m \sum_{k=1}^{p_j} x_{ijk} \text{ and } sa(i_1, i_2) = \sum_{j=1}^m \sum_{k=1}^{p_j} x_{i_1 j k} = \sum_{j=1}^m \sum_{k=1}^{p_j} x_{i_2 j k}$$

Now for each category j, if a website can attain maximum possible of its p_j domain values (i.e. when the mutually exclusivity property is not satisfied for each category over its domain), then the range of pair similarity index (PSI) given by Erlich *et al.* (2002) is greater than one (i.e. $PSI > 1$). If the value of PSI is greater than one, then it is difficult to determine the similarity measure between websites of any two management institutes. Therefore, we cannot designate absolute similarity between any two websites in case of binary representation using (1). So, we develop a new pair similarity index, as the ratio between the number of similar attribute values of any two websites and the length of the domain attribute vector to overcome the above mentioned difficulties for non-mutually exclusive cases. Thus, we redefine the PSI for any two websites i_1 and i_2 is as follows –

$$PSI = \frac{sa(i_1, i_2)}{p} \quad (2)$$

$$\text{where } p = \sum_{j=1}^m p_j \text{ and } sa(i_1, i_2) = \sum_{j=1}^m \sum_{k=1}^{p_j} x_{i_1 j k} = \sum_{j=1}^m \sum_{k=1}^{p_j} x_{i_2 j k}$$

Now, the similarity index range becomes $0 \leq PSI \leq 1$. Where $PSI = 1$ denotes absolute similarity and $PSI = 0$ denotes absolute diversity between any two websites of the management institutes.

Example: Let us take the binary representation vectors for the management institute i_1 =IIMA and i_2 =IIMB from Appendix-B. In order to calculate the Paired Similarity Index for any two management institutes, first we calculate $sa(i_1, i_2)$.

$$sa(i_1, i_2) = \sum_{j=1}^8 \sum_{\substack{k=1 \\ x_{1jk}=x_{2jk}}}^{41} x_{1jk} = 24 \quad (3)$$

and therefore using (2)

$$PSI = \frac{sa(i_1, i_2)}{p} = \frac{24}{41} = 0.585$$

Since the value of PSI lies between 0 and 1, so this value of 0.585 indicates very negligible similarity between the websites of IIMA and IIMB.

Similarly, the PSI values for all the pairs of management institutes formed for the 21 management institutes were calculated. The results of the corresponding pair similarity index matrix can be seen in Appendix-C.

PSI AND OTHER SIMILARITY INDEXES (FOR NON-MUTUALLY EXCLUSIVE CASES)

A comparison of the proposed Paired Similarity Index (PSI) with other similarity indexes used in binary representation viz, Hamming Distance (HD) proposed by Illingworth, Glaser and Pyle (1983) and Paired Attribute Distance (PAD) proposed by Gelbard and Spiegler (2000) are as follows.

COMPARING WITH HD

For two binary vectors b_1 and b_2 , of length p , the HD between two vectors is defined as –

$$HD(b_1, b_2) = b_1 \oplus b_2$$

where $\oplus$ denotes the logical operation XOR (Exclusive OR)

Gelbard and Spiegler (2000) give the normalized index based on HD by S_{HD} and it's defined as –

$$S_{HD}(b_1, b_2) = 1 - \frac{HD(b_1, b_2)}{p} = \frac{p - HD(b_1, b_2)}{p}$$

where $0 \leq S_{HD}(b_1, b_2) \leq 1$

and $HD(b_1, b_2)$ is the number of 1's in the vector b_1 and b_2 .

However, Erlich et al. (2002) already proved that the normalized similarity index S_{HD} given by Gelbard and Spiegler (2000) gives an incorrect measure to study the similarities of any two websites of management institutes in binary representation.

COMPARING WITH PAD

The PAD similarity index as described in Gelberd and Spiegler (2000) for two binary vectors b_1 and b_2 is given by –

$$PAD = \frac{2Nb_1b_2}{Nb_1 + Nb_2}$$

Where Nb_1 = the number of 1's in b_1

Nb_2 = the number of 1's in b_2

Nb_1b_2 = the number of 1's common to both b_1 and b_2

In our binary representation, we may have

$$Nb_1 = Nb_2 = \sum_{j=1}^m \sum_{k=1}^{p_j} x_{1jk} = p, \text{ for all 1's}$$

For instance, from Appendix-B, we consider the category “Admission” which has seven attributes. The corresponding binary representation of two institutes IIMA and IIMC for “Admission” are as follows –

$$b_1 = 1\ 1\ 1\ 0\ 0\ 1\ 0$$

$$b_2 = 1\ 1\ 1\ 1\ 1\ 1\ 0$$

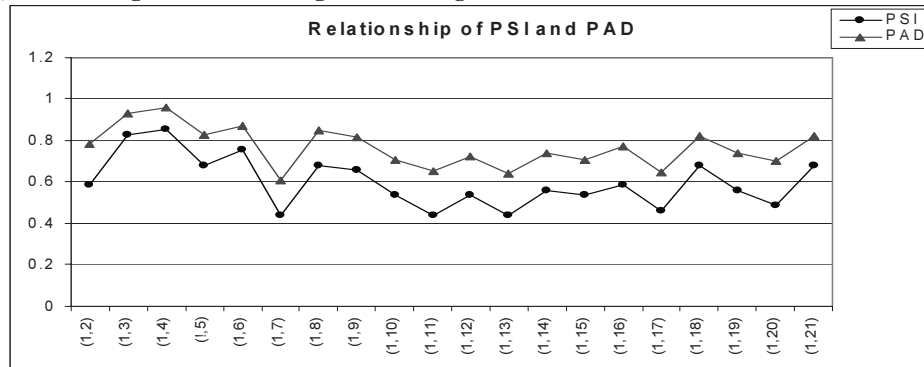
$$\text{then, } PAD = \frac{2*4}{4+6} = \frac{8}{10} = 0.8$$

Thus, the range of PAD is $0 \leq PAD \leq 1$. Therefore, in case of non-mutually exclusive cases, the range of PAD and PSI is similar to measure the similarity or dissimilarity between any two management institutes by means of binary representation. The PAD for all the management institutes formed for the 21 management institutes were calculated and the results of the corresponding PAD matrix can be seen in Appendix-D.

GRAPHICAL DISPLAY OF PSI AND PAD

Figure 1 provides the graphical representation of the values of similarity indices obtained under PSI and PAD for different pairs of institutes with IIMA common in all the pairs.

Figure 1 : Line Diagram Showing Difference Between PSI and PAD



The graph shows that the results obtained from the PSI generally remains less than those obtained under PAD.

RESULTS AND FINDINGS

From the PSI matrix, it has been noticed that the value of PSI for the management institutes IIMA-ISBH and IIMC-ISBH are 0.853 and IIMA-IIMC is 0.829. Therefore, we can conclude that the information contained on the websites of the management institutes IIMA-ISBH and IIMC-ISBH are more similar among all other management institutes and IIMA-IMC inhabits second position in case of similarity measure. The maximum dissimilarity was noted between the websites of JBIMSM-IITM, as their corresponding PSI value is 0.268. Also, the study found that the information provided on the websites of the management institutes has no relation with the rank of the institutes as evident from Appendix-C and Appendix-D.

CONCLUSION

This study generates a new approach to measure similarity or dissimilarity by means of binary representation. However, the proposed paired similarity index can handle a wide range of data types, continuous and multiple value domains. Handling of continuous data under this paired similarity index should be in categories. Deciding the number of categories is not a trivial problem by the choice of user. Also, weights may be taken for a different category and applied in this paired similarity index, which will add relative importance of the categories to the proposed index. The index can find its application in several other disciplines of social science, where similarity or dissimilarity needs to be measured.

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APPENDIX – A

1. Admission • Prospectus • Doctoral Program • Full time Program • Part time Program • Fees per course • Contact Email • Information for foreign student	2. Library Facilities • Staff • Membership • Library layout • Rules & Regulations • Contact Email • Collection
3. Students • Role & Participation • Reservation • Financial Aid-program • Results • Fellowship • Student Union	4. Other Facilities • Hostel • Guest House • Medical • Sports • Award
5. Faculty Search • Name & Designation • School & Department • Research & Publication • List of Teachers	6. Research & Development • Faculty development program • Research & Publication • Management development program • Seminar/Workshop/Conference
7. Alumni Association • Alumni relation • Activities • Alumni search criteria • Contact Email	8. Placement • List of companies • Guidance • Brochure • Process • Contact Email

APPENDIX – B

	ADMISSION						
	Prospectus	Doctoral program	Full time program	Part time program	Fees per course	Contact E-mail	Information for foreign students
IIMA	1	1	1	0	0	1	0
IIMB	1	1	1	0	0	0	0
IIMC	1	1	1	1	1	1	0
ISBH	1	1	1	0	0	1	1
IIML	0	0	1	0	0	1	1
XLRIJ	1	1	1	1	0	0	1
FMSD	0	1	1	1	1	0	1
IIMI	1	1	1	0	0	1	1
IIMK	1	1	1	1	1	1	1
IIFTD	0	1	1	1	1	1	1
SPJM	0	1	1	0	1	1	0
MDIG	1	1	1	0	1	0	1
JBIMSM	0	1	1	1	1	1	0
NMIMSM	1	1	1	1	0	1	1
IMTG	1	1	1	1	1	1	0
NITIEM	1	1	1	0	1	1	0
SIBMP	0	0	1	0	1	1	1
XIMBB	1	1	1	1	1	1	1
TISSM	1	1	1	1	0	1	1
IITM	1	1	1	0	1	1	0
IITD	1	1	1	1	1	1	1

	LIBRARY					
	Staff	Membership	Library layout	Rules & Regulations	Contact E-mail	Collection
IIMA	1	1	1	1	1	1
IIMB	0	0	0	0	0	1
IIMC	1	1	1	1	1	1
ISBH	1	1	1	1	1	1
IIML	1	1	0	1	1	1
XLRIJ	1	1	1	1	1	1
FMSD	0	0	0	0	0	1
IIMI	0	1	0	0	1	1
IIMK	0	1	1	1	1	1
IIFTD	0	0	0	0	0	1
SPJM	0	0	0	0	0	1
MDIG	0	0	0	0	1	1
JBIMSM	0	0	0	0	0	1
NMIMSM	0	1	0	0	1	1
IMTG	0	1	0	1	1	1
NITIEM	0	0	0	0	1	1
SIBMP	0	0	0	0	0	0
XIMBB	1	1	0	1	1	1
TISSM	1	0	0	0	1	1
IITM	0	0	0	0	1	1
IITD	1	1	1	1	1	1

	PLACEMENT				
	List of companies	Guidance	Students Profile or Brochure	Process	Contact E-mail
IIMA	1	1	1	1	1
IIMB	0	0	0	1	0
IIMC	0	1	1	1	1
ISBH	1	1	1	1	1
IIML	1	1	0	1	1
XLRIJ	1	0	1	1	1
FMSD	0	0	0	1	1
IIMI	1	1	1	0	1
IIMK	1	0	0	1	1
IIFTD	1	0	1	1	1
SPJM	1	0	1	1	1
MDIG	1	0	1	1	1
JBIMSM	1	0	0	1	1
NMIMSM	1	0	1	1	1
IMTG	1	0	0	0	1
NITIEM	1	0	1	1	1
SIBMP	1	0	1	1	1
XIMBB	0	0	1	1	1
TISSM	0	0	0	0	0
IITM	0	1	1	0	1
IITD	1	0	0	0	0

	RESEARCH AND DEVELOPMENT			
	Faculty development program	Research & Publication	Management development program	Seminar/workshop/conference
IIMA	1	1	1	1
IIMB	1	1	1	1
IIMC	1	1	1	1
ISBH	1	1	1	1
IIML	1	1	1	1
XLRIJ	1	1	1	1
FMSD	0	1	1	1

IIMI	1	1	1	1
IIMK	1	1	1	1
IIFTD	0	1	1	0
SPJM	0	1	0	1
MDIG	0	1	1	1
JBIMSM	0	0	0	1
NMIMSM	1	1	1	1
IMTG	0	1	1	1
NITIEM	0	1	1	1
SIBMP	0	1	0	1
XIMBB	0	1	1	1
TISSM	0	1	0	1
IITM	0	1	1	1
IITD	0	1	1	1

	STUDENTS					
	Role & participation	Reservation	Financial Aid program	Academic Results	Fellowship	Students' union
IIMA	1	1	1	0	1	0
IIMB	1	0	1	0	1	1
IIMC	1	1	1	1	1	1
ISBH	1	0	1	0	1	1
IIML	1	0	0	0	0	1
XLRIJ	1	0	1	1	1	1
FMSD	1	1	0	1	0	1
IIMI	1	1	0	0	0	1
IIMK	1	1	1	0	1	0
IIFTD	1	1	0	0	0	1
SPJM	1	0	0	0	0	0
MDIG	1	0	0	1	0	0
JBIMSM	1	0	0	0	0	0
NMIMSM	1	0	0	0	0	1
IMTG	1	0	0	1	0	1
NITIEM	1	1	0	0	1	1
SIBMP	1	1	0	1	1	1
XIMBB	1	0	1	0	1	1
TISSM	1	1	1	0	1	1
IITM	1	0	0	0	1	0
IITD	1	1	0	0	1	1

	ALUMNI			
	Alumni relation	Activities	Alumni search criteria	Contact e-mail
IIMA	1	1	1	1
IIMB	1	1	1	1
IIMC	1	1	1	1
ISBH	1	1	1	1
IIML	1	1	1	1
XLRIJ	1	1	1	1
FMSD	1	1	1	1
IIMI	0	1	0	1
IIMK	0	0	0	0
IIFTD	1	1	1	1
SPJM	1	1	1	1
MDIG	0	1	1	1
JBIMSM	1	1	1	1

NMIMSM	0	0	0	0
IMTG	0	1	0	0
NITIEM	0	0	0	0
SIBMP	1	1	1	1
XIMBB	1	1	1	1
TISSM	1	1	0	1
IITM	0	0	0	0
IITD	1	1	1	1

	FACULTY			
	Name & Designation	School & Department	Research & publication	Teachers' list
IIMA	1	1	1	1
IIMB	1	1	1	1
IIMC	1	1	1	1
ISBH	1	1	1	1
IIML	1	1	1	1
XLRIJ	1	1	1	1
FMSD	0	0	1	0
IIMI	1	1	1	1
IIMK	1	1	1	1
IIFTD	0	0	1	1
SPJM	0	0	1	1
MDIG	1	1	1	1
JBIMSM	1	0	0	1
NMIMSM	1	1	1	1
IMTG	1	1	1	1
NITIEM	1	1	1	1
SIBMP	0	0	0	1
XIMBB	1	1	1	1
TISSM	1	1	1	1
IITM	0	0	1	1
IITD	1	0	1	1

	FACILITIES				
	Hostel	Guest House	Medical	Sports	Awards
IIMA	1	1	1	1	1
IIMB	1	1	0	1	1
IIMC	1	1	1	1	1
ISBH	1	1	1	1	1
IIML	1	1	0	1	0
XLRIJ	1	0	0	1	1
FMSD	1	0	0	1	1
IIMI	1	1	1	1	1
IIMK	1	1	0	1	0
IIFTD	1	1	0	1	1
SPJM	1	0	0	0	0
MDIG	1	0	0	1	0
JBIMSM	1	0	0	1	1
NMIMSM	1	0	1	0	1
IMTG	1	0	0	1	1
NITIEM	1	1	0	1	1
SIBMP	1	0	0	1	1
XIMBB	1	0	0	1	0
TISSM	1	0	1	1	0
IITM	1	1	1	1	0
IITD	1	1	1	1	0

PSI MATRIX (APPENDIX - C)

	IIMA	IIMB	IIMC	ISBH	IIML	XLRIJ	FMSD	IIMI	IIMK	IIFTD	SPJM	MDIG	JBIMSM	NMIMSM	IMTG	NITTEM	SIBMP	XIMBB	TISSM	IITM
IIMB	0.585	-																		
IIMC	0.829	0.609	-																	
ISBH	0.853	0.609	0.853	-																
IIML	0.682	0.487	0.658	0.707	-															
XLRIJ	0.756	0.536	0.804	0.804	0.634	-														
FMSD	0.439	0.414	0.536	0.463	0.414	0.512	-													
IIMI	0.682	0.487	0.658	0.707	0.561	0.609	0.414	-												
IIMK	0.658	0.463	0.658	0.658	0.536	0.634	0.39	0.56	-											
IIFTD	0.536	0.439	0.585	0.56	0.487	0.536	0.512	0.463	0.463	-										
SPJM	0.439	0.341	0.439	0.439	0.39	0.463	0.365	0.365	0.341	0.439	-									
MDIG	0.536	0.439	0.56	0.56	0.487	0.585	0.439	0.512	0.487	0.463	0.414	-								
JBIMSM	0.439	0.365	0.463	0.439	0.39	0.439	0.39	0.365	0.365	0.439	0.365	0.39	-							
NMIMSM	0.56	0.414	0.585	0.609	0.56	0.585	0.365	0.585	0.536	0.439	0.341	0.463	0.341	-						
IMTG	0.536	0.414	0.609	0.56	0.487	0.585	0.414	0.536	0.536	0.439	0.341	0.487	0.39	0.512	-					
NITTEM	0.585	0.463	0.609	0.585	0.463	0.536	0.39	0.56	0.56	0.463	0.365	0.487	0.365	0.512	0.512	-				
SIBMP	0.463	0.365	0.512	0.487	0.39	0.487	0.439	0.414	0.365	0.487	0.39	0.414	0.39	0.341	0.365	0.414	-			
XIMBB	0.682	0.536	0.756	0.731	0.609	0.756	0.487	0.56	0.609	0.536	0.463	0.56	0.439	0.536	0.56	0.536	0.463	-		
TISSM	0.56	0.487	0.609	0.585	0.463	0.487	0.39	0.512	0.487	0.414	0.317	0.414	0.341	0.439	0.439	0.439	0.365	0.585	-	
IITM	0.487	0.341	0.512	0.487	0.365	0.39	0.292	0.463	0.439	0.365	0.317	0.39	0.268	0.39	0.39	0.463	0.292	0.439	0.365	-
IITD	0.682	0.487	0.731	0.707	0.585	0.658	0.463	0.585	0.609	0.536	0.39	0.487	0.414	0.487	0.536	0.512	0.414	0.658	0.585	0.439

PAD MATRIX (APPENDIX - D)

	IIMA	IIMB	IIMC	ISBH	IIML	XLRIJ	FMSD	IIMI	IIMK	IIFTD	SPJM	MDIG	JBIMSM	NMIMSM	IMTG	NITTEM	SIBMP	XIMBB	TISSM	IITM
IIMB	0.786	-																		
IIMC	0.933	0.781	-																	
ISBH	0.958	0.806	0.921	-																
IIML	0.83	0.74	0.794	0.878	-															
XLRIJ	0.873	0.8	0.891	0.916	0.812	-														
FMSD	0.61	0.708	0.709	0.633	0.653	0.724	-													
IIMI	0.848	0.727	0.811	0.865	0.813	0.769	0.614	-												
IIMK	0.818	0.609	0.811	0.805	0.745	0.80	0.603	0.766	-											
IIFTD	0.709	0.705	0.738	0.730	0.727	0.721	0.857	0.75	0.678	-										
SPJM	0.654	0.636	0.620	0.642	0.666	0.629	0.714	0.612	0.571	0.80	-									
MDIG	0.723	0.72	0.718	0.741	0.74	0.80	0.75	0.763	0.727	0.745	0.772	-								
JBIMSM	0.642	0.666	0.644	0.631	0.653	0.654	0.744	0.60	0.60	0.782	0.820	0.711	-							
NMIMSM	0.741	0.666	0.738	0.793	0.727	0.786	0.612	0.857	0.785	0.692	0.622	0.745	0.608	-						
IMTG	0.709	0.666	0.769	0.73	0.727	0.786	0.693	0.785	0.785	0.692	0.622	0.784	0.695	0.807	-					
NITTEM	0.774	0.745	0.769	0.761	0.690	0.721	0.653	0.821	0.821	0.769	0.666	0.784	0.652	0.807	0.807	-				
SIBMP	0.644	0.625	0.677	0.666	0.653	0.689	0.782	0.641	0.566	0.816	0.761	0.708	0.744	0.571	0.612	0.693	-			
XIMBB	0.823	0.771	0.873	0.869	0.819	0.895	0.727	0.741	0.806	0.758	0.705	0.807	0.692	0.758	0.793	0.758	0.690	-		
TISSM	0.741	0.745	0.769	0.761	0.690	0.754	0.653	0.75	0.714	0.653	0.577	0.666	0.608	0.692	0.692	0.692	0.612	0.827	-	
IITM	0.701	0.608	0.70	0.689	0.60	0.571	0.545	0.745	0.784	0.638	0.650	0.695	0.536	0.680	0.680	0.808	0.545	0.679	0.638	-
IITD	0.823	0.701	0.845	0.840	0.786	0.805	0.690	0.774	0.806	0.758	0.627	0.701	0.653	0.689	0.758	0.724	0.654	0.843	0.827	0.679