Evaluating an intelligent business system with a fuzzy multi-criteria approach

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Abstract

In this ever changing business structure, Intelligent Business System (IBS) is one of the survivals of a company, and the functions of information technology (IT) are becoming increasingly important. Evaluating the appropriate IBS for required conditions is the critical strategic decisions in formulating a business strategy. Although a number of factors were found to be influential in the choice of IBS. IBS evaluation is an inherently uncertain activity. To deal with the uncertainty in decision making, a fuzzy multi criteria decision making (FMCDM) method is adopted. This study presents an empirical approach of BIS evaluation and a real life evaluation process is presented to illustrate the effectiveness of the approach.

Keywords: Intelligent Business Systems, MCDM, Fuzzy AHP, Fuzzy TOPSIS

1. Introduction

Business intelligence systems meet the technical and business requirements of customers. Intelligent Business Systems (IBS) enables a fully-integrated, “all-in-one” solution and support better business decision making. The IBS and information technologies (IT) are often recognized as key process of competition [1]. Business software market has a continuous expansion and IBS performs many tasks that cannot simply be measured by monetary units so a detailed evaluation should be considered [2]. A proper IBS selection is a very important issue for every industry due to the fact that improper system selection can negatively affect the overall performance and productivity of an overall process. Evaluating the new system is a time consuming and difficult process, requiring advanced knowledge and deep experience. For a proper and effective evaluation, the decision maker may need a large amount of data to be analyzed and many factors to be considered.

While building an IBS, decision-makers are faced with the challenge of selecting the most efficient information system. The evaluation of a few BIS at the same time with limited resources is impossible. Thus, BIS selection becomes an efficient resources allocation procedure. In this resource allocation problem, the evaluation process of alternatives brings some difficulties. The major problem is the consideration of multiple objectives which are generally conflicting with each other and measured in different scales. Büyüközkan presented an evaluation model based on fuzzy multi-criteria decision making method for software development projects [3]. Collier presented a methodology for evaluating and selecting data mining software as a business intelligent system [4].

We will use the term BIS evaluation throughout this study to denote evaluation of various aspects of systems. Probably the most typical problem in system evaluation is the selection of one among many software products for the accomplishment of a specific task. Hence, this study focuses on applications of a multi-criteria decision making (MCDM) evaluation framework to cope with this issue. Therefore, this study utilizes a MCDM method using FAHP to determine the importance weights of evaluation criteria which has been widely used for evaluation [5], and fuzzy TOPSIS to obtain the performance ratings of the feasible alternatives in linguistic values parameterized with triangular fuzzy numbers.

2. Methodology

In this study, we first base evaluation criteria indicators, and then have an interview with the experts in IT departments of companies to modify the list. A questionnaire is designed using the conventional AHP questionnaire format, and then distributed to managers of IT departments. The feedbacks are analyzed through a constructed FAHP program to obtain the relative importance of criteria.

The use of fuzzy set theory allows us to incorporate unquantifiable information, incomplete information, non-obtainable information, and partially ignorant facts into the decision model. When decision data are

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precisely known, they should not be faced into a fuzzy format in the decision analysis. Applications of fuzzy sets within the field of decision making have, for the most part, consisted of extensions or fuzzifications of the classical theories of decision making. While decision-making under conditions of risk and uncertainty have been modeled by probabilistic decision theories and by game theories, fuzzy decision theories attempt to deal with the vagueness or fuzziness inherent in subjective or imprecise determinations of preferences, constraints, and goals [6].

One of the multi-criteria decision methods is the analytic hierarchy process. The purpose of the AHP is to provide vector of weights expressing the relative importance of the transportation alternatives for each criterion. AHP requires four steps: (1) structuring the hierarchy of criteria and alternatives for evaluation; (2) assessing the decision-makers' evaluations by pairwise comparisons; (3) using the eigenvector method to yield priorities for criteria and for alternatives by criteria; and (4) synthesizing the priorities of the alternatives by criteria into composite measures to arrive at set of ratings for the alternatives [7].

Then we use the fuzzy TOPSIS (technique for order performance by similarity to ideal solution) to fit human thinking under actual environment. According to this technique, the best alternative would be the one that is nearest to the positive-ideal solution and farthest from the negative ideal solution. To avoid an unreasonably large number of pairwise comparisons, the fuzzy TOPSIS is employed to achieve the final ranking results. The paper continues with descriptions of proposed methods in section 2, and proposed model is used in real life example in section 3 and conclusion part comes in section 4.

2.1. The fuzzy logic, fuzzy set theory and fuzzy numbers

Fuzzy set theory (FST) is a mathematical theory introduced by Zadeh to model uncertainty attributed to the vagueness and imprecision in real systems, particularly that of the human cognitive processes [8, 9]. The underlying logic of linguistic approach is that the truth-values are fuzzy sets and the rules of inference are approximate rather than exact [10]. Fuzzy logic allows us to make rational decisions in an environment of uncertainty, fuzziness and imprecision without losing the richness of verbal judgment [11]. FST resembles human reasoning in its use of approximate information and uncertainty to generate decisions. Fuzzy set theory has been widely developed and various generalizations have applied.

A fuzzy number is a special fuzzy set denoted as$F = \{(x, \mu_F(x), x \in R)\}$, where x takes values on the real line, $R: -\infty < x < +\infty$ and $\mu_F(x)$ is a continuous mapping from R to closed interval$[0, 1]$. In literature, there are several forms of fuzzy numbers and one of the most commonly used is the triangular fuzzy number (TFN). TFN $\widetilde{M}$ is represented by (l, m, u), and the membership function is defined as

$$\mu_{\widetilde{M}}(x) = \begin{cases} \frac{x-l}{m-l}, l \le x \le m \\ \frac{u-x}{u-m}, m \le x \le u \\ 0, otherwise \end{cases} \quad (1)$$

with $-\infty < l \le m \le u < \infty$ and the operational laws of two TFNs $\widetilde{M}_1 = (l_1, m_1, u_1)$ and $\widetilde{M}_2 = (l_2, m_2, u_2)$ as shown (Kaufmann and Gupta, 1991):

Fuzzy number addition and subtraction:

$$\widetilde{M}_1 \mp \widetilde{M}_2 = (l_1, m_1, u_1) \mp (l_2, m_2, u_2) = (l_1 \mp l_2, m_1 \mp m_2, u_1 \mp u_2). \quad (2)$$

Fuzzy number multiplication:

$$\widetilde{M}_1 \times \widetilde{M}_2 = (l_1, m_1, u_1) \times (l_2, m_2, u_2) = (l_1 \times l_2, m_1 \times m_2, u_1 \times u_2). \quad (3)$$

Fuzzy number inverse:

$$\widetilde{M}^{-1} = (l, m, u)^{-1} \cong \left(1/_u, 1/_m, 1/_l\right) \text{ for } l, m, u > 0.$$

The most possible value, the lower bound, and the upper bound of the fuzzy group weight of the criterion are given by the geometric mean, the smallest value, and the largest value. And the largest value of the individual weights, respectively. As a measure of central tendency, the geometric mean is well suited to represent the most possible value of a triangular fuzzy number. In addition to its merits for synthesizing ratio judgments as used in equation 1, the geometric mean is a meaningful way of dealing with situations where a consensus cannot be obtained and the group is not willing to compromise on a judgment [12].

Buckley showed how to derive the priorities from a set of fuzzy comparisons described by trapezoidal membership functions [13]. In practical applications, the triangular form of the membership function is used most often for representing fuzzy numbers that characterize linguistic information [14]. The popular use of TFN is mainly attributed to their simplicity in both concept and computation. Theoretically, the merits of using TFN in fuzzy modeling have been well justified [15]. With the simplest form of the membership function, triangular fuzzy numbers constitute an immediate solution to the optimization problems in fuzzy modeling [16].

2.2. Fuzzy AHP

The analytic hierarchy process, first introduced by Saaty [17], is one of the most used multi-criteria decision making methods. It is used to derive relative priorities on absolute scales from both discrete and continuous paired comparisons in multilevel hierarchic structures [18]. Laarhoven and Pedrycz extended AHP into fuzzy AHP, bringing the triangular fuzzy number of the fuzzy set theory directly into the pair-wise comparison matrix of the AHP [19]. In fuzzy AHP method the decision maker can specify preferences in the form of natural language or numerical value about the importance of each performance attribute.

Proposed methodology employs a Likert scale of fuzzy numbers and the 1-9 ratio scale (Table 1) has proven to an effective measurement scale for reflecting the qualitative information of a decision problem and for enabling the unknown weights to be approximated.

The dominance scale for pair-wise comparative judgment $\tilde{a}_{ij} \geq 1$

Table 1
Nine point intensity of importance scale

Linguistic Scale	Fuzzy Scale: TFN (l_{ij}, m_{ij}, u_{ij})	Reciprocal TFN
Extreme importance	(9, 9, 9)	(1/9, 1/9, 1/9)
Very, very importance	(7, 8, 9)	(1/9, 1/8, 1/7)
Very strong dem. importance	(6, 7, 8)	(1/8, 1/7, 1/6)
Strong plus	(5, 6, 7)	(1/7, 1/6, 1/5)
Strong importance	(4, 5, 6)	(1/6, 1/5, 1/4)
Moderate plus	(3, 4, 5)	(1/5, 1/4, 1/3)
Moderately importance	(2, 3, 4)	(1/4, 1/3, 1/2)
Weak	(1, 2, 3)	(1/3, 1/2, 1)
Equally importance	(1, 1, 1)	(1, 1, 1)

The procedure of the fuzzy AHP is described as follows:

1. Construct the hierarchical structure with decision criteria. Each decision maker is asked to express relative importance of two decision elements in the same group by a nine ratio scale.
2. Analyze consistency. Check to ensure the consistency of judgments in pair-wise comparison.
3. Construct fuzzy matrices. The scores of pair-wise comparison are transformed into linguistic variables, which represented by positive triangular fuzzy numbers in Table 1. The fuzzy reciprocal matrix is defined as [13];

$\tilde{R}^k = \left[\tilde{r}_{ij}\right]^k$, where (2)

$\tilde{R}^k$: a positive reciprocal matrix of decision maker k;

$\tilde{r}_{ij}$: relative importance between decision elements i and j; and

$\tilde{r}_{ij} = 1, \forall i = j$; and

$\tilde{r}_{ij} = \dfrac{1}{\tilde{r}_{ij}}, \forall i, j = 1,2, \dots, n.$

4. Calculate fuzzy weights.

In hierarchy process, a criterion is associated with a local weight and global weight. The local weight of a criterion is referred to weight relative to other criteria. The local weights are converted to global weights by making the weight of their corresponding super-criterion would be the geometric mean of these global weights. For a sufficiently large group size, the geometric mean guarantees the consistency of the aggregate judgment matrix, regardless of the consistency measures of the individual judgment matrices [20]. The use of geometric mean instead of arithmetic mean to derive the priority vectors from fuzzy pair-wise comparison matrices is one of the best suited approaches [13, 16, 21 - 24].

There are many fuzzy AHP methods proposed by various authors. These methods are systematic approaches to the alternative selection and justification problem by using the concepts of fuzzy set theory and hierarchical structure analysis. The earliest work in fuzzy AHP appeared in [25], which compared fuzzy ratios described by triangular membership functions. Chang [5] introduced a new approach for handling fuzzy AHP, with the use of triangular fuzzy numbers for pairwise comparison scale of fuzzy AHP.

2.3 The fuzzy TOPSIS method

We propose to use fuzzy TOPSIS method in the second stage of our study. The TOPSIS is widely used for tackling ranking problems in real situations, also this method is often criticized for its inability to adequately handle the inherent uncertainty and imprecision associated with the mapping of the decision maker's perception to crisp values [26]. Traditional TOPSIS uses personal judgments with crisp values however; in many practical cases decision maker might be reluctant or unable to assign crisp values to the comparison judgments [27]. Using crisp values can be problematic points in the evaluation process. Due to that incapability we propose a fuzzy set theory which allows the decision makers to incorporate unquantifiable information, incomplete information, non obtainable information and partially ignorant facts into decision model [28]. This study uses triangular fuzzy number for fuzzy TOPSIS. The reason behind using triangular fuzzy set is that it is intuitively easy for the decision-makers to use and calculate. In addition, it is widely used as a proven method to effective way for formulating decision problems where the information available is subjective and imprecise [29-33].

Step 1: Establish a decision matrix for the ranking.

Step 2: Calculate the normalized decision matrix $\boldsymbol{R}(= [r_{ij}])$. The normalized value r_{ij} is calculated as:

$r_{ij} = \dfrac{f_{ij}}{\sqrt{\sum_{j=1}^{n} f_{ij}^2}} = 1,2,, \dots, J; i = 1,2, \dots, n.$ (4)

Step 3: Calculate the weighted normalized decision matrix by multiplying the normalized value v_{ij} is calculated.

Step 4: Calculate the separation measures, using the n-dimension Euclidean distance. The separation of each alternative from the positive-ideal solution (D_j^*) is given as;

$$D_j^* = \sqrt{\sum_{i=1}^{n}\left(v_{ij} - v_i^*\right)^2} \; j = 1,2,\ldots,J \tag{5}$$

Similarly, the separation of each alternative from the negative-ideal solution $\left(D_j^-\right)$ is as follows:

$$D_j^- = \sqrt{\sum_{i=1}^{n}\left(v_{ij} - v_i^-\right)^2} \; j = 1,2,\ldots,J \tag{6}$$

Step 5: Calculate the relative closeness to the idea solution and rank the performance order. The relative closeness of the alternative A_j can be expressed as

$$CC_j^* = \frac{D_j^-}{D_j^* + D_j^-}, j = 1,2,\ldots,J, \tag{7}$$

where the CC_j^* index value lies between 0 and 1. The larger the index value means the better the performance of the alternatives.

According to briefly summarized TOPSIS above, fuzzy TOPSIS steps can be outlined as follows:

Step 1: Choose linguistic values $\left(\tilde{x}_{ij}, i = 1,2,\ldots,n, J = 1,2,\ldots,J\right)$ for alternatives with respect to criteria. The fuzzy linguistic rating $\left(\tilde{x}_{ij}\right)$ preserves the property that the ranges of normalized triangular fuzzy numbers belong to [0,1]; thus there is no need for normalization.

Step 2: Calculate the weighted normalized value $\tilde{v}_{ij}$ calculated.

Step 3: Identify positive-ideal (A^*) and negative ideal (A^-) solutions. The fuzzy positive-ideal solution $(FPIS, A^*)$ and the fuzzy negative-ideal solution $(FPIS, A^-)$ are shown in the following equations:

$$A^* = \{\tilde{v}_1^*, \tilde{v}_2^*, \ldots, \tilde{v}_i^*\} = \left\{\left(\max_j v_{ij} \mathrm{I} i \in I'\right) x \left(\min_j v_{ij} \mathrm{I} i \in I''\right)\right\}$$

where I' is associated with benefit criteria and I'' is associated with cost criteria.

Step 4: Calculate the distance of each alternative from A^* and A^- using the following equations:

$$D_j^* = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_i^*\right) j = 1,2,\ldots,J \tag{8}$$

$$D_j^- = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_i^-\right) j = 1,2,\ldots,J \tag{9}$$

Step 5: Calculate similarities to ideal solution.

$$CC_j = \frac{D_j^-}{D_j^* - D_j^-} \; j = 1,2,\ldots,J \tag{10}$$

Step 6: Rank preference order. Choose an alternative with maximumCC_j^*.

3. The proposed approach

The proposed approach for the evaluating an intelligent business system problem, composed of fuzzy AHP and fuzzy TOPSIS methods, consists of three basic stages: first, identify the criteria to be used in the model; second, fuzzy AHP computations; third, evaluation of alternatives with fuzzy TOPSIS and determination of the final rank.

Based on the concept of business intelligent systems, review of intelligent systems evaluation literature and interview with IT experts, an evaluation hierarchy is constructed. Three decision-makers that plan to select the proper intelligent business system. Alternative systems and the criteria which will be used in their evaluation are determined and fuzzy AHP formed. A questionnaire is designed with a conventional AHP questionnaire format (nine-point scale and pairwise comparison) based on the hierarchy. The weights of the criteria are calculated based on final comparison matrix and calculated weights of the criteria are approved by decision making team.

IBS ranks are determined by using fuzzy TOPSIS method in the last part. Linguistic values are used for evaluation of alternative systems in this part. The system having the maximum CC_j^* value is determined as the optimal IBS according to the calculations fuzzy TOPSIS.

3.1. A Numeric application of proposed model

The proposed model is applied to a real life problem in IT department. The procedure for evaluation proper IBS is listed below.

Step 1: Criteria to be considered in the evaluation of IBS are determined by the expert team and criteria and their definitions of importance given in Table 2.

Table 2
Evaluation criteria for the IBS

Main criteria	Sub Criteria
M1 Decision Management System	C1 Optimization model
	C2 Time series analysis
	C3 Structured text analysis
	C4 Numeric data analysis
	C5 Forecasting model
M2 Intelligent Text Mining	C6 Clustering
	C7 Classification
	C8 Profiling
	C9 Hyper linking
M3 Risk Management	C10 Credit system
	C11 Prediction

Those criteria were determined in a group decision study with experts in IT department according to need of proper IBS.

Step 2: After determining the decision hierarchy, the weights of the criteria to be used in evaluation process are calculated by using fuzzy AHP method. In this phase, the experts in the expert team are given the task of forming individual pairwise comparison matrix by using the scale given in Table 2.

Geometric means of these values are found to obtain the pairwise comparison matrix on which there is a consensus (Table 3). The results obtained with the computation based on pairwise comparison matrix, are presented in Table 3.

Table 3
The pairwise comparison matrix (fuzzy numbers) and weighted results

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	weights
C1	(1,1,1)	(1,2.1,3)	(1,3,5)	(0.5,2.1,4)	(3,5,7)	(0.2,1.8,4)	(2,3.3,5.1)	(0.3,0.4,6)	(1,2.1,3)	(1.1,1.5,5)	(2.3,4,4.4)	**0.0124**
C2	(0.3, 0.8,1)	(1,1,1)	(1,3,5)	(0.2,0.9,3)	(1.1,1.5,5)	(0.8,1.8,5)	(0.3,0.5,1)	(0.2,2,3)	(1,2.3,3)	(1,1.2,3)	(0.7,2.1,5,1)	**0.0071**
C3	(0.2,0.3,1)	(0.2,0.3,1)	(1,1,1)	(1,2.1,3)	(0.3,0.5,1)	(1.7,1.9,2.6)	(4.5,5.7,6.3)	(1,1,1)	(3.1,4.5,6.7)	(2.1,3.1,3.9)	(4.2,5.1,6)	**0.1534**
C4	(0.2,0.4,2)	(0.3,1.1,5)	(0.3,0.4,1)	(1,1,1)	(0.6,1.1,2)	(3.3,4,5.2)	(0.2,0.8,.1.1)	(5.2,6.3,7.5)	(4.3,5.1,6)	(2,3.3,5.1)	(1,3,5)	**0.1984**
C5	(0.1,0.2,0.3)	(0.2,0.6,1)	(1,2,3)	(0.8,0.9,1.6)	(1,1,1)	(0.3,0.5,1)	(0.2,0.9,3)	(0.9, 2.4,3.1)	(1.8,3.4,4.4)	(5.6,6.1,7.3)	(0.2,1.1,2.9)	**0.2546**
C6	(0.2,0.5,5)	(0.2,0.5,1.2)	(0.3,0.5,0.5)	(0.1,0.2,0.3)	(1,2,3)	(1,1,1)	(1,1,1)	(3.5,4.7,6.1)	(0.6,2.1,3.3)	(2.5,3.3,3.9)	(0.6,1.4,2.2)	**0.0568**
C7	(0.1,0.3,0.5)	(1,2,3)	(0.1,0.1,0.2)	(0.9,1.2,5)	(0.3,1.1,5)	(1,1,1)	(1,1,1)	(0.7,2.1,5,1)	(2,3.3,5.1)	(3.3,4.2,5.3)	(0.6,1.3,2.1)	**0.1649**
C8	(0.1,2.5,3)	(0.3,0.5,5)	(1,1,1)	(0.1,0.1,0.1)	(0.3,0.4,1.1)	(0.1,0.2,0.2)	(0.1,0.4,1.4)	(1,1,1)	(0.2,0.3,0.9)	(1,1,1)	(0.7,1.3,2.2)	**0.0198**
C9	(0.3,0.4,1)	(0.3,0.4,1)	(0.1,0.2,0.3)	(0.1,0.1,0.2)	(0.2,0.2,0.5)	(0.3,0.4,1.6)	(0.1,0.3,0.5)	(1.1,3.3,5)	(1,1,1)	(0.8,1.5,5)	(0.6,1.1,2)	**0.1047**
C10	(0.2,0.6,1)	(0.3,0.8,1)	(0.2,0.3,0.4)	(0.1,0.3,0.5)	(0.1,0.1,0.1)	(0.2,0.3,0.4)	(0.1,0.2,0.3)	(1,1,1)	(0.2,0.6,1.2)	(1,1,1)	(0.2,0.9,3)	**0.0116**
C11	(0.2,0.2,	(1,0.6,1.4)	(0.1,0.1,0.2)	(0.2,0.3,1)	(0.3,0.9,5)	(0.4,0.7,1.6)	(0.4,0.7,1.4)	(0.4,0.7,1.4)	(0.5,0.9,1.6)	(0.3,1.1,5)	(1,1,1)	**0.0163**

The C5, C4, C7 and C3 criteria are found as a most important in IBS evaluation by fuzzy AHP. As we see in an IBS forecasting model takes an important role with numerical data analysis, classification and structured text analysis.

STEP 3: At this step we are able to evaluate of alternatives and determined the final rank using with fuzzy TOPSIS. IT Experts were asked to establish the decision matrix by comparing alternatives under each of the criteria separately. Fuzzy evaluation matrix established by the evaluation of alternative systems by linguistic variables in Table 4, is presented in Table 5.

Table 4
Linguistic values and fuzzy numbers

Linguistic values	Fuzzy numbers
Very low (VL)	(0, 0, 0.2)
Low (L)	(0, 0.2, 0.4)
Medium (M)	(0.2, 0.4, 0.6)
High (H)	(0.4, 0.6, 0.8)
Very high (VH)	(0.6, 0.8, 1)
Excellent (E)	(0.8, 1, 1)

Table 5
Fuzzy evaluation matrix for alternative IBS

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
A1	L	VH	E	H	M	L	M	M	M	H	VH
A2	M	LV	M	E	VH	M	H	H	M	E	H
A3	VH	VH	VH	L	H	M	H	M	M	L	E

Step 4: In Table 6, it is seen that the elements $\tilde{v}_{ij}, \forall_{i,j}$ are normalized positive triangular fuzzy numbers and their ranges belong to the closed interval $[0,1]$. Thus, we can define the fuzzy positive ideal solution (FPIS, A^*) and negative ideal solution and D^- can be calculated from Eq. (8) and (9). Final step solves the similarities to an ideal solution by Eq. (10).

Calculations are done for all alternatives and the results of fuzzy TOPSIS analyses are summarized in Table 7. Based on CC_j values, it is given the ranking of the alternatives in descending order. Although C5, C4, C7 and C3 have relevantly high weights, those criteria are not enough effect to take consideration in evaluation process. Proposed approach results indicate that A3 is the best alternative with CC value.

Table 7

Alternatives	D_j^*	D_j^-	CC_j	Rank
A1	3.276	2.343	0.4169	2
A2	3.923	2.464	0.3857	3
A3	3.322	2.542	0.4334	1

4. Conclusion

The IBS evaluation process is a strategic issue and has significant impacts to the efficiency of core business. Several alternatives must be considered and evaluated in terms of many different conflicting criteria. Thus, an effective evaluation approach is essential to improve decision quality. In our paper, we present a scientific framework to assess IBS, use fuzzy numbers to express linguistic values that consider the subjective judgments of evaluators and then adopts fuzzy multiple criteria decision making approach. The model was developed and tested for use IBS on decision phase. Finally, the proposed approach allows IT department to rapidly adjust an IBS to eliminate problematic phenomena and increase quality and process capability.

Table 6
Fuzzy weighted evaluation for the alternative IBS.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
A1	(0.005, 0.021, 0.032)	(0.178, 0.234, 0.299)	(0.032, 0.102, 0.164)	(0.038, 0.074, 0.111)	(0.093, 0.132, 0.149)	(0.078, 0.104, 0.130)	(0.176, 0.203, 0.274)	(0.030, 0.046, 0.060)	(0.103, 0.167, 0.211)	(0.101, 0.138, 0.184)	(0.096, 0.122, 0.165)
A2	(0,015, 0.030, 0.046)	(0,051, 0.121, 0.196)	(0.074, 0.123, 0.201)	(0.201, 0.264, 0.288)	(0.062, 0.111, 0.198)	(0.038, 0.099, 0.143)	(0.060, 0.094, 0.120)	(0.034, 0.088, 0.120)	(0.051, 0.072, 0.099)	(0.003, 0.020, 0.029)	(0.151, 0.202, 0.261)
A3	(0.046, 0.061, 0.076)	(0.012, 0.092, 0.119)	(0.023, 0.076, 0.122)	(0.124, 0.155, 0.186)	(0.202, 0.298, 0.344)	(0.052, 0.088, 0.102)	(0.324, 0.396, 0.455)	(0.092, 0.134, 0.179)	(0.021, 0.038, 0.052)	(0.133, 0.170, 0.201)	(0.124, 0.133, 0.160)

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