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A NEW MATHEMATICAL MODEL OF MUTUALLY COMPLEMENTARY FOR CORPORATE ALLIANCES

: SELECTION OF OPTIMAL PARTNERS USING EIGHT CHARACTERISTICS

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Overview -1-

- A new mathematical model for choosing a business strategy and selecting business partners, so-called corporate alliances

- Uses the real corporate data of 152 Japanese companies based on eight characteristics. (May 2008 – March 2015)

- These characteristics and the relationships can be described
  as a one-dimensional matrix and a bipolar vector.

- The strength between two companies can be expressed as the distance from the maximum point

Overview -2-

- Model implemented in Python
- By the proposed model,we can calculate the mutually complementary strength and the related coefficient as a value.
- We have achieved to make the relationships in corporates alliances computational.

Problems in Past Research

- No mathematical model in past research of corporate alliances

- Impossible to calculate the relationship between two companies in a corporate alliance as a value.

Concept of the Mutually Complementary Mathematical Model

- A corporate alliance is mutually complementary relationship by using each company's strengths and weaknesses.

- The hypothesis of a corporate alliance in this study is satisfied when the mutually complementary relationship is strong.

- The strengths of company A will complement the weaknesses of company B, and vice versa.

8 Scored Characteristics

- Characteristics representing strengths and weaknesses:

  (1) Sales Capability
  (2) Technical Ability
  (3) Creativity of Ideas
  (4) Capital Resources
  (5) Human Resources
  (6) Production Capacity
  (7) Branding and Credibility
  (8) Flexibility of Organization

- Rating is from 1 to 5 (5 is the strongest)

Expressing the Relationship of the Strengths and Weaknesses Mathematically

- These characteristics of each company are shown as **a one-dimensional matrix.**

- As an example,

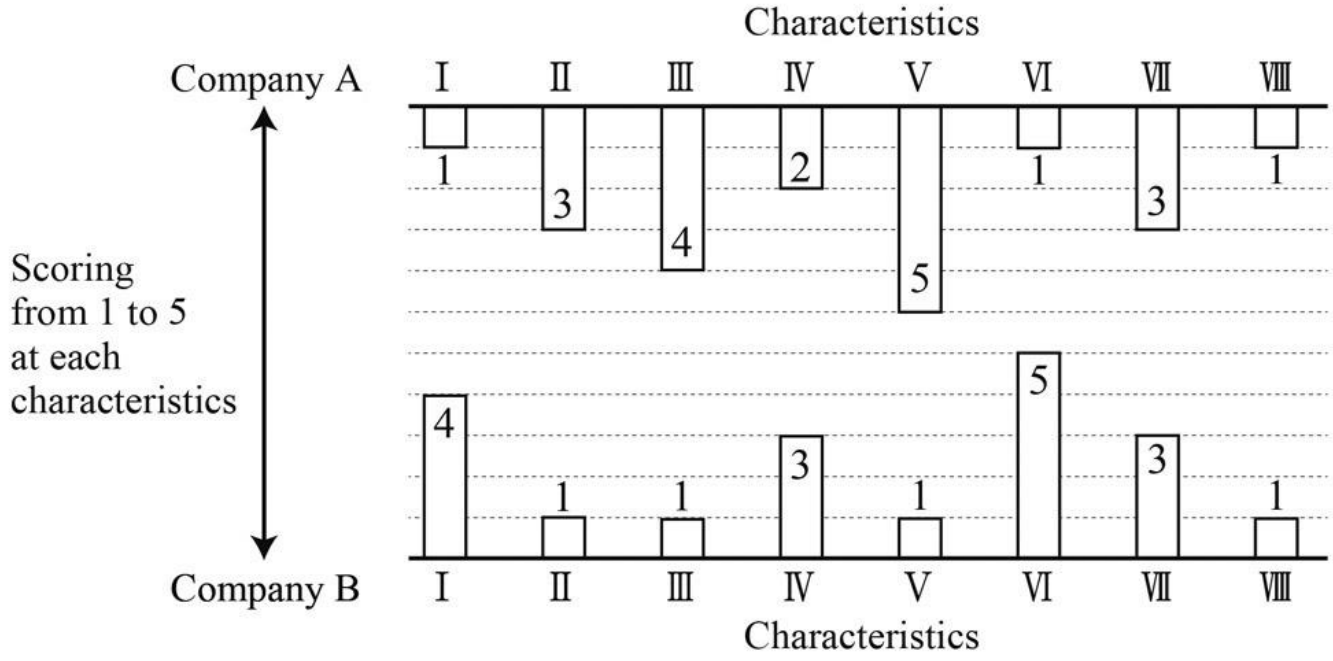
Company A **a=(1, 3, 4, 2, 5, 1, 3, 1)**

Company B **b=(4, 1, 1, 3, 1, 5, 3, 1)**

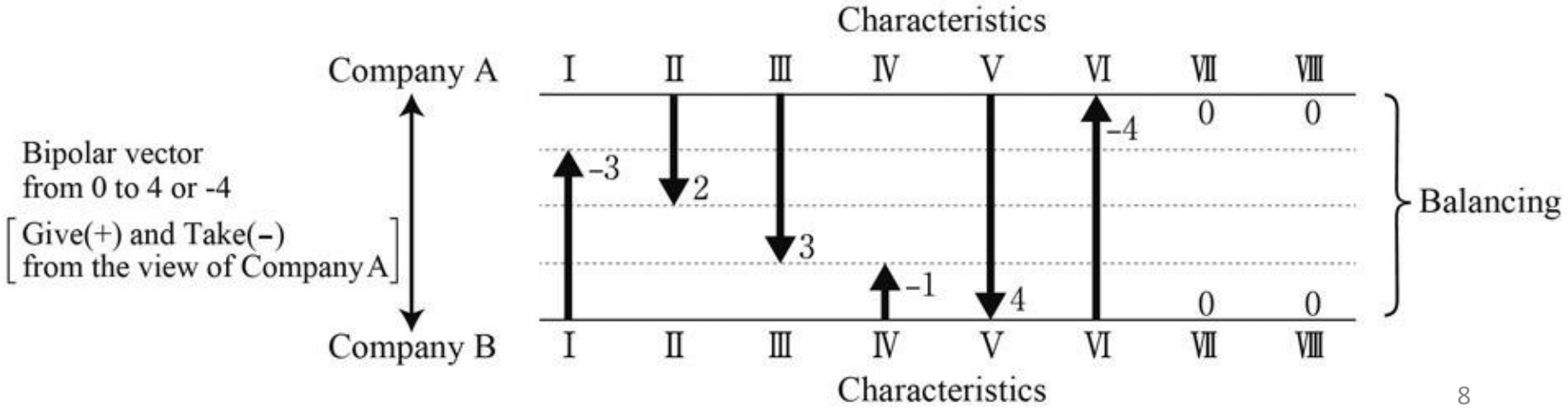
- Subtraction of two one-dimensional matrices shows the mutually complementary relationships between two companies. The relationships are shown as **a bipolar vector** for each characteristic with values ranging from 0 to 4 (positive or negative)

Company A – Company B

c = a-b = (-3, 2, 3, -1, 4, -4, 0, 0)



Company A − Company B
Subtraction



Summation of Positive Integers and that of Negative Integers

- In the example of Company A and Company B,
- Summation of positive integers (plus' bipolar vector)

  2+3+4=9

  This number shows the relationship that the strengths of company A will complement the weaknesses of company B.

- Summation of negative integers (minus' bipolar vector)

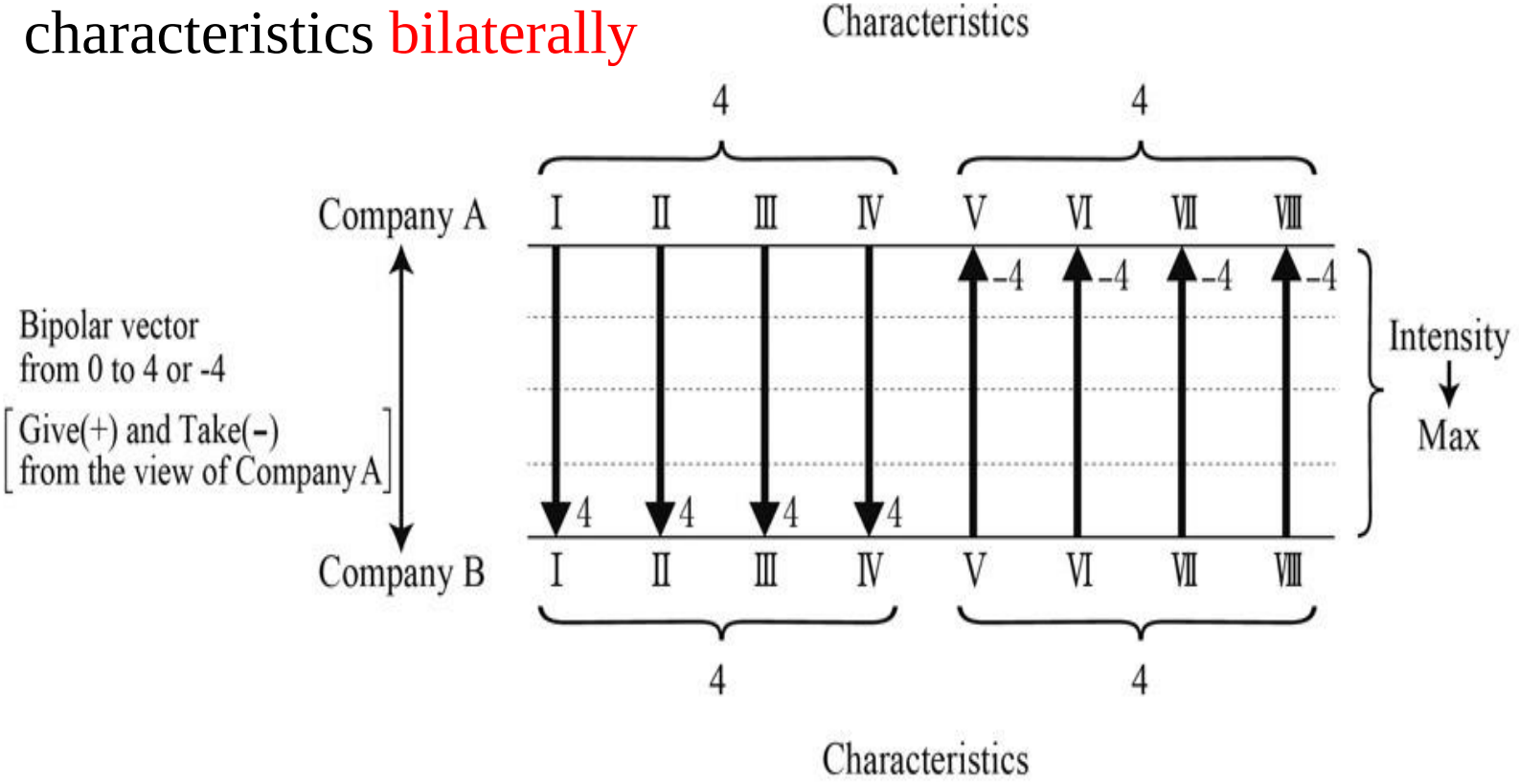
  -3+(-1)+(-4)=-8

  This number shows the relationship that the strengths of company B will complement the weaknesses of company A.

- The two numbers shows the mutually complementary relationship.

How to Determine the Maximum Mutually Complementary Relationship

- Taking a 2 sets of 4 characteristics with a maximum value of each.
- (8 characteristics / 2) * Max length of 4 = (16,-16)
- Longest possible bipolar vector from half the number of characteristics bilaterally



How to Calculate the Maximum Mutually Complimentary Relationship as a value

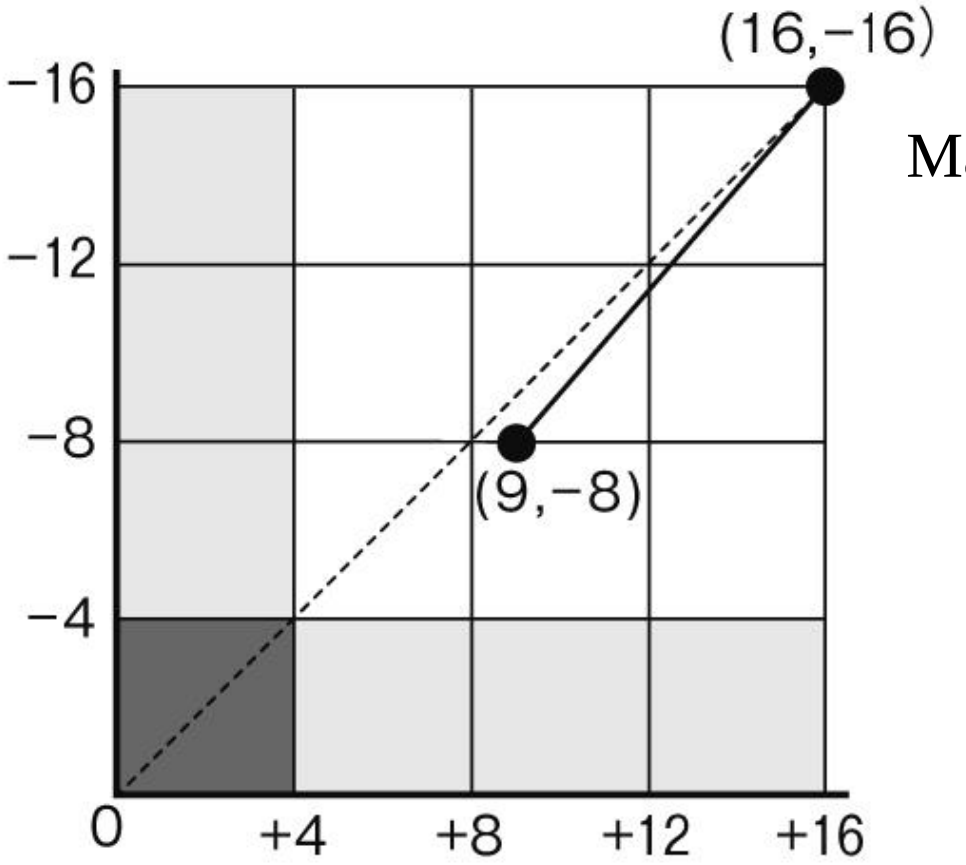
- The maximum value of the mutually complementary strength of (16,-16) is shown as the distance from (0, -0) to (16, -16), which becomes

$$\sqrt{(16-0)^2+(-16+0)^2}=22.62$$

- Therefore, the mutually complementary strength is a value between 0 and 22.62.

The Strength Expressed as the Distance from the Maximum Point

The strengths of the mutually complimentary are expressed by measuring the distance from the strongest mutually complimentary point.



Maximum Point

Calculating Mutually Complementary Strength

- As an example, with a mutually complementary strength of (9,-8) it is possible to calculate the distance from (16,-16) by means of subtraction from the maximum value.

$$\sqrt{(16-9)^2+(-16-(-8))^2}=10.63$$

- Since larger values indicate a stronger relationship, in order to more easily handle this indicator, we invert the magnitudes to ensure we are subtracting from the maximum value.

$$\sqrt{(16-0)^2+(-16+0)^2}-\sqrt{(16-9)^2+(-16-(-8))^2}=11.99$$

General Formula of the Mutually Complementary Strength

- The mutually complementary strength can be expressed by the following formula:

$$\sqrt{2 \times \left(\frac{4 \times len(c)}{2}\right)^2} - \sqrt{\left(\frac{4 \times len(c)}{2} - plus\right)^2 + \left(\frac{-4 \times len(c)}{2} - minus\right)^2}$$

len(c) = number of characteristics

plus = Σ (positive integers)

minus= Σ (negative integers).

General Formula of the Mutually Complementary Strength Coefficient

- When this value is normalized to a value between zero and one, it becomes easier to handle.
- The mutually complementary strength coefficient can be calculated from the following formula:

$$1 - \frac{\sqrt{\left(\frac{4\times len(c)}{2} - plus\right)^2 + \left(\frac{-4\times len(c)}{2} - minus\right)^2}}{\sqrt{2\times\left(\frac{4\times len(c)}{2}\right)^2}}$$

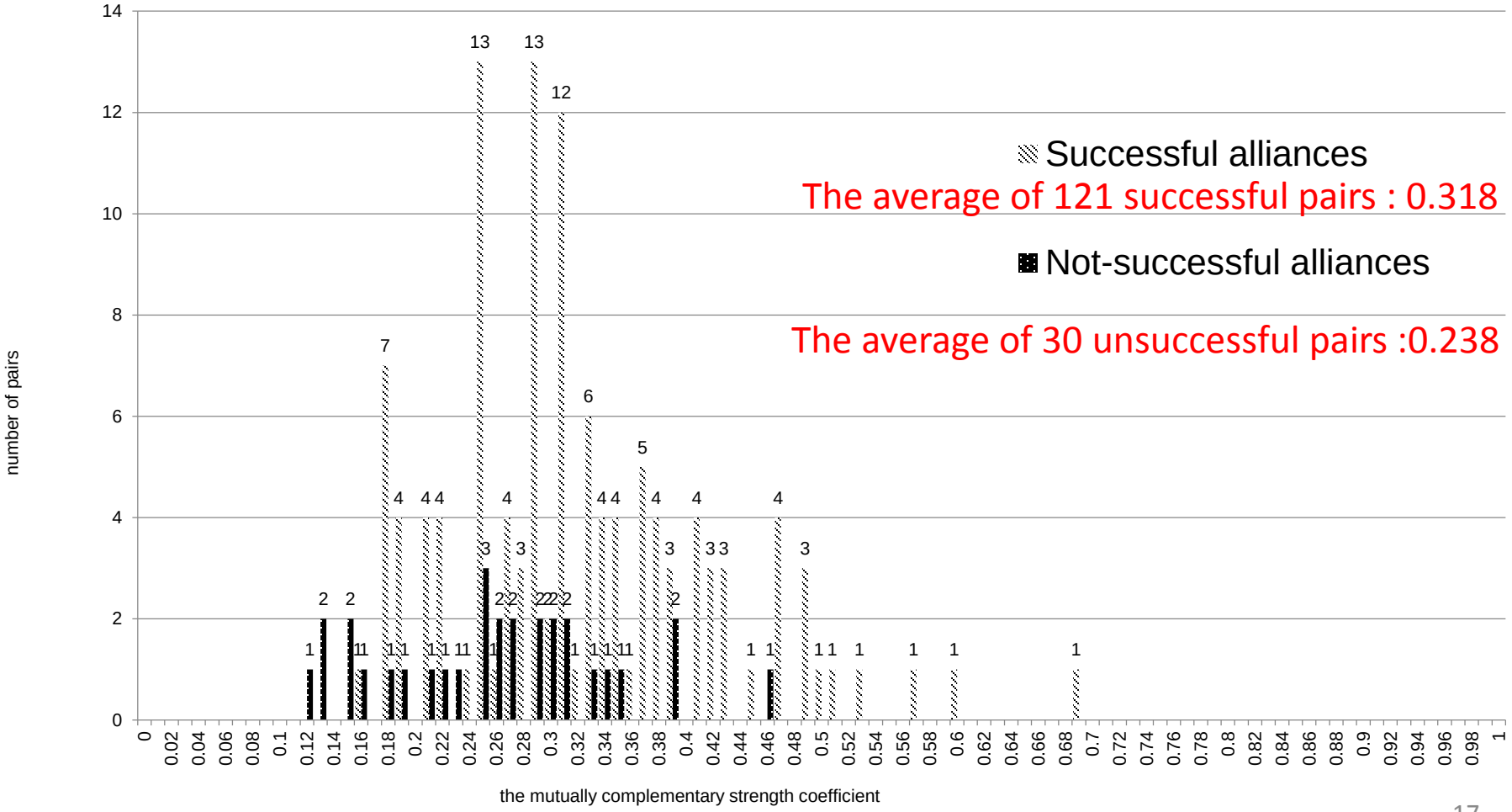
len(c) = number of characteristics
plus = Σ (positive integers)
minus = Σ (negative integers).

Programmatical of the Data from 152 Consulted Companies

- The calculation of the mutually complementary strength coefficient was executed by the open-source programming language “Python”.

Actual Results of the Data Implemented Using Pyhton

- The mutually complementary strength coefficient of successful and unsuccessful pairs in our data of 152 consulted companies



Selection of Optimal Partners

- **For example,**

  a = (1, 3, 4, 2, 5, 1, 3, 1)

  b = (4, 1, 1, 3, 1, 5, 3, 1)

  c = (3, 5, 2, 4, 2, 3, 5, 4)

- **Python program results**

  Strength of d (=a-b) =11.99

  Strength Coefficient of d (=a-b) =0.530

  Strength of e (=a-c) =11.22

  Strength Coefficient of e (=a-c) =0.496

  Strength of f (=b-c) =9.025

  Strength Coefficient of f (=b-c) =0.398

- **d(=a-b) > e(=a-c) > f(=b-c) Company A & Company B => the best**

Conclusion

- We have proposed a new mathematical model for corporate alliances.
- We have computated the mutually complementary strength coefficient.
- We confirmed this model with actual data of 152 companies by using Python.
- Using this model, we can determine which candidate(s) from multiple potential companies form the best alliance.
- The model can be applicable to human relationship matters concerning business teams or marriage pairings.