

**Review Article**

Student's CGPA Versus Skill Comparison in Bipolar Fuzzy Soft Domain

Md Shohel Babu

Department of Computer Science and Engineering, Southeast University, Dhaka, Bangladesh

Email address:

shohel.babu@seu.edu.bd

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Abstract: In the realm of education, traditional methods of evaluating students often fall short when it comes to assessing their true abilities and potential. Merely acquiring knowledge is insufficient in fulfilling the objectives of learning; it is imperative that students apply their skills and abilities effectively. The Bloom's Taxonomy, a renowned classification system, places a greater emphasis on the development of skills over the mere absorption of content. This research delves into the assessment of students, taking into account both their skills and the conventional CGPA (Cumulative Grade Point Average) system. This study introduces a novel approach by incorporating bipolar fuzzy soft numbers to establish a comprehensive ranking system. Bipolar fuzzy soft numbers provide a versatile and nuanced framework for evaluating students, considering not only their achievements but also their strengths and weaknesses. The research employs the bipolar fuzzy soft weighted arithmetic averaging operator to aggregate these multifaceted evaluations, resulting in a holistic ranking of students. The final phase of the study involves a comparative analysis of the rank list based on the conventional CGPA system and the one derived from the assessment of skills parameters. This comparison will shed light on the effectiveness of the traditional grading system versus a more skill-oriented approach, providing valuable insights for educators and institutions seeking to enhance their evaluation methods and better nurture their students' talents.

Keywords: Fuzzy Set, OBE Learning Domain, Bipolar Fuzzy Set, Bipolar Fuzzy Soft Number, Fuzzy Soft Matrix

1. Introduction

Lotfi A Zadeh [1] who first introduced the concept of fuzzy sets in 1965. A fuzzy set can be defined mathematically by assigning to each possible individual in the universe of discourse a value representing its grade of membership in the fuzzy set. These membership grades are represented by real number values ranging in the closed interval between 0 and 1. [2] A bipolar fuzzy set theory is introduced in $[-1,0] \times [0,1]$ for bipolar reasoning. Two types of bipolar α -level cuts are proposed. Resolutions of the two kinds of level sets are examined and the relationships are established. [3] The soft set theory offers a general mathematical tool for dealing with uncertain, fuzzy, and unclear objects. [7] Bipolar multi-fuzzy soft set and its operations are introduced, and a few of their properties are discussed. [8] They discuss a new application of the Bipolar fuzzy soft tool in considering many problems that

contain ambiguities. [11] They introduce a MADM method dependent on bipolar Pythagorean weighted average aggregation operators, and bipolar Pythagorean weighted geometric aggregation operators based on a bipolar Pythagorean fuzzy environment. [9] They have studied a new technique based on a generalized fuzzy soft set for the determination of the class ranking of students. [10] They guide the students in determining the best university and evaluating the factors affecting them while getting admission in a fuzzy soft environment. [12] In 1956, Benjamin Bloom developed a classification of levels of intellectual behavior important in learning, that became a taxonomy including three overlapping domains: cognitive, psychomotor, and affective. Cognitive learning is demonstrated by knowledge recall and intellectual skills: comprehending information, organizing ideas, analyzing and synthesizing data, applying knowledge, choosing among alternatives in problem-solving, and

evaluating ideas or actions. The main quest of this paper is to compare students' usual CGPA and some skills based on cognitive domain levels under a fuzzy environment using by bipolar fuzzy soft weighted arithmetic averaging (BFSWAA), operator. Then I will rank students based on the usual CGPA and skills that will help a company to recruit a fresh graduate.

2. Preliminaries

In this part, I will discuss precious information about fuzzy sets, bipolar fuzzy sets, fuzzy soft sets, and bipolar fuzzy soft numbers.

Definition 2.1. [1] Let U be a set & $U \neq \varnothing$. A fuzzy set μ of U is defined as a mapping $\mu: U \rightarrow [0,1]$, where $[0,1]$ is the usual interval of real numbers.

Definition 2.2. [4] A Bipolar fuzzy set B in the universe U is an object having the form $B = \{x, \mu^+, \mu^-: x \in U\}$ where $\mu^+: U \rightarrow [0,1]$ & $\mu^-: U \rightarrow [-1,0]$. Here μ^+ indicate the positive information & μ^- indicate the negative information.

Definition 2.3. [3] Let U be the initial universe, and E be the set of parameters. $A \subset E$ and $P(U)$ be the power set of U . Then (F, A) is defined as a soft set, where $F: A \rightarrow P(U)$.

Definition 2.4. [14] Let U be the initial universe, and E be the set of parameters. $A \subset E$ and $\tilde{\mu}(U)$ is the collection of all fuzzy subset of U . Then (F, A) is defined as a fuzzy soft set, where $F: A \rightarrow \tilde{\mu}(U)$.

Example 2.5. Let $S = \{S_1, S_2, S_3, S_4, S_5, S_6\}$ be the set of six students under consideration and $E = \{P_1, P_2, P_3, P_4, P_5\}$ be the set of parameters, where P_1 = Ability to remember facts without understanding, P_2 = Ability to understand and interpret learned information, P_3 = Ability to use learned material in new situations, P_4 = Ability to integrate different concepts to form a new structure, P_5 = Ability to judge the value of materials for the given purpose. And $A = \{P_1, P_2, P_3\} \subseteq E$ & let $(F, A) = F(P_i)$, then

$$F(P_1) = \{(S_1, 0.7, -0.6), (S_2, 0.3, -0.2), (S_3, 0.8, -0.1), (S_4, 0.5, -0.3), (S_5, 0.9, -0.1), (S_6, 0.8, -0.1)\}$$

$$F(P_2) = \{(S_1, 0.5, -0.4), (S_2, 0.5, -0.4), (S_3, 0.9, -0.2), (S_4, 0.8, -0.2), (S_5, 0.4, -0.4), (S_6, 0.5, -0.3)\}$$

$$F(P_3) = \{(S_1, 0.7, -0.2), (S_2, 0.6, -0.2), (S_3, 0.8, -0.2), (S_4, 0.6, -0.3), (S_5, 0.6, -0.4), (S_6, 0.5, -0.4)\}$$

For the sake of clarity, I denote $\mathbb{F}_{P_t}(x_s) = \{(x_s, \mu_t^+(x_s), \mu_t^-(x_s)): x_s \in S\}$ i.e., $\mathbb{F}_{P_{st}} = \langle \mu_{st}^+, \mu_{st}^- \rangle$ is called bipolar fuzzy soft number. For the application purpose, I need to define score function for the ranking it. For this the score function of $\mathbb{F}_{P_{st}}$ is defined as follows

$$\phi(\mathbb{F}_{P_{st}}) = \mu_{st}^+ + \mu_{st}^- \quad (1)$$

Where $\phi(\mathbb{F}_{P_{st}}) \in [-1, 1]$. From definition it is clear that larger the $\phi(\mathbb{F}_{P_{st}})$, the larger is bipolar fuzzy soft number $\mathbb{F}_{P_{st}}$.

3. Methodology

In this part, [8] I will review aggregation operator bipolar fuzzy soft weighted arithmetic averaging operator for bipolar

$$F(P_1) = \{(S_1, 0.7), (S_2, 0.3), (S_3, 0.8), (S_4, 0.5), (S_5, 0.9), (S_6, 0.8)\}$$

$$F(P_2) = \{(S_1, 0.5), (S_2, 0.5), (S_3, 0.9), (S_4, 0.8), (S_5, 0.4), (S_6, 0.5)\}$$

$$F(P_3) = \{(S_1, 0.7), (S_2, 0.6), (S_3, 0.8), (S_4, 0.6), (S_5, 0.6), (S_6, 0.5)\}$$

Definition 2.6. [8] A bipolar fuzzy set is defined over the universe U as

$$F = \{(x, \mu^+(x), \mu^-(x)): \forall x \in U\},$$

where $\mu^+(x): U \rightarrow [0, 1]$ represents positive membership degree to satisfy corresponding property of an element x to a bipolar fuzzy set and $\mu^-(x): U \rightarrow [-1, 0]$ represent negative membership degree to satisfy counter-property of an element x to a bipolar fuzzy set, such that $-1 \leq \mu^+(x) + \mu^-(x) \leq 1$; $\forall x \in U$. The set $\langle \mu^+, \mu^- \rangle$ is denote bipolar fuzzy numbers.

Definition 2.7. [15] Let U be the initial universe, and E be the set of parameters. $A \subset E$. Let $F: A \rightarrow BF^U$, where BF^U is the collection of all bipolar fuzzy subsets of U . Then (F, A) is called bipolar fuzzy soft set over a universe U . It is defined by $(F, A) = \mathbb{F}(P_i)$

$$\mathbb{F}(P_i) = \{(S_i, \mu^+(S_i), \mu^-(S_i)): \forall S_i \in U, \forall P_i \in A\}$$

Example 2.8. Let $S = \{S_1, S_2, S_3, S_4, S_5, S_6\}$ be the set of six students under consideration and $E = \{P_1, P_2, P_3, P_4, P_5\}$ be the set of parameters, where P_1 = Ability to remember facts without understanding, P_2 = Ability to understand and interpret learned information, P_3 = Ability to use learned material in new situations, P_4 = Ability to integrate different concepts to form a new structure, P_5 = Ability to judge the value of materials for the given purpose. And $A = \{P_1, P_2, P_3\} \subseteq E$, Then

fuzzy soft numbers.

Let $\mathbb{F}_{P_{st}} = \langle \mu_{st}^+, \mu_{st}^- \rangle$ ($s = 1, 2, 3, \dots, m; t = 1, 2, 3, \dots, n$) be the collection of bipolar fuzzy soft number, θ_t is the weight vector for the parameter & W_s is the weight vector for teachers, hold the following conditions, $\theta_t \geq 0, W_s \geq 0$ such that $\sum \theta_t = 1$ & $\sum W_s = 1$.

Then accumulated value of them using bipolar fuzzy soft weighted arithmetic averaging (BFSWAA) operator is also bipolar fuzzy soft numbers, and

$$BFSWAA(\mathbb{F}_{P_{11}}, \mathbb{F}_{P_{12}}, \mathbb{F}_{P_{13}}, \dots, \mathbb{F}_{P_{mn}}) = \langle 1 - \prod_{t=1}^n (\prod_{s=1}^m (1 - \mu_{st}^+)^{W_s})^{\theta_t} \rangle \quad (2)$$

4. Real Life Problem

From the Department of CSE, Southeast University I have selected five teachers who were common course teachers for

the students being studied. The names of the teachers are Tashreef Muhammad (T_1), Sakib Mahmud (T_2), Md. Shafiur Raihan Shafi (T_3), Rifat Ahommed (T_4) and Md. Shohel Babu (T_5). The names of the students are Yeamin Akon (S_1), Md. Amin-Ur- Rashid (S_2), Tariqul Islam Shihab (S_3), Tarek Abdullah Miraj (S_4), Sadia (S_5) and Sarara Jaman Riya (S_6). Let $T = \{T_1, T_2, T_3, T_4, T_5\}$ be the set of teachers who are going to evaluate the skill of the students $S = \{S_1, S_2, S_3, S_4, S_5, S_6\}$ under the set of parameters $P = \{P_1, P_2, P_3, P_4, P_5\}$. Where P_1 = Ability to remember facts without understanding, P_2 = Ability to understand and interpret learned information, P_3 = Ability to use learned material in new situations, P_4 = Ability to integrate different concepts to form a new structure, P_5 = Ability to

judge the value of materials for the given purpose. Let $w = (0.3, 0.2, 0.1, 0.1, 0.3)$ be the weight vectors of teachers. I have set the weight as 0.3 for teachers T_1 & T_5 because they have conducted more than two courses, for teacher T_2 the weight is 0.2 because he has conducted two courses and for teachers T_3 & T_4 the weight vectors are 0.1 because they have conducted a single course. Again, let $\theta = (0.1, 0.18, 0.2, 0.25, 0.27)$ be the weight vectors of the parameters. If we use common sense then according to the description of the parameters P_5 will get more weight than P_4 and so on. The rating of the teachers is in the form of BFSNs $F_{P_{st}} = (\mu_{st}^+, \mu_{st}^-)_{5 \times 5}$ for all parameters are given below.

Table 1. Bipolar Fuzzy Soft matrix for student S_1 .

Teacher	P_1	P_2	P_3	P_4	P_5
T_1	$\langle 0.7, -0.6 \rangle$	$\langle 0.5, -0.4 \rangle$	$\langle 0.7, -0.2 \rangle$	$\langle 0.5, -0.4 \rangle$	$\langle 0.4, -0.8 \rangle$
T_2	$\langle 0.5, -0.5 \rangle$	$\langle 0.6, -0.2 \rangle$	$\langle 0.5, -0.5 \rangle$	$\langle 0.6, -0.2 \rangle$	$\langle 0.6, -0.6 \rangle$
T_3	$\langle 0.7, -0.25 \rangle$	$\langle 0.6, -0.35 \rangle$	$\langle 0.65, -0.3 \rangle$	$\langle 0.55, -0.4 \rangle$	$\langle 0.75, -0.2 \rangle$
T_4	$\langle 0.5, -0.4 \rangle$	$\langle 0.6, -0.5 \rangle$	$\langle 0.6, -0.4 \rangle$	$\langle 0.6, -0.3 \rangle$	$\langle 0.7, -0.2 \rangle$
T_5	$\langle 0.6, -0.3 \rangle$	$\langle 0.7, -0.4 \rangle$	$\langle 0.6, -0.3 \rangle$	$\langle 0.4, -0.5 \rangle$	$\langle 0.4, -0.5 \rangle$

Table 2. Bipolar Fuzzy Soft matrix for student S_2 .

Teacher	P_1	P_2	P_3	P_4	P_5
T_1	$\langle 0.3, -0.2 \rangle$	$\langle 0.5, -0.4 \rangle$	$\langle 0.6, -0.2 \rangle$	$\langle 0.3, -0.7 \rangle$	$\langle 0.7, -0.2 \rangle$
T_2	$\langle 0.4, -0.5 \rangle$	$\langle 0.7, -0.2 \rangle$	$\langle 0.5, -0.4 \rangle$	$\langle 0.7, -0.2 \rangle$	$\langle 0.7, -0.2 \rangle$
T_3	$\langle 0.8, -0.5 \rangle$	$\langle 0.8, -0.15 \rangle$	$\langle 0.8, -0.15 \rangle$	$\langle 0.8, -0.15 \rangle$	$\langle 0.85, -0.1 \rangle$
T_4	$\langle 0.5, -0.4 \rangle$	$\langle 0.5, -0.4 \rangle$	$\langle 0.4, -0.5 \rangle$	$\langle 0.4, -0.5 \rangle$	$\langle 0.6, -0.3 \rangle$
T_5	$\langle 0.7, -0.2 \rangle$	$\langle 0.7, -0.3 \rangle$	$\langle 0.7, -0.2 \rangle$	$\langle 0.4, -0.6 \rangle$	$\langle 0.5, -0.4 \rangle$

Table 3. Bipolar Fuzzy Soft matrix for student S_3 .

Teacher	P_1	P_2	P_3	P_4	P_5
T_1	$\langle 0.8, -0.1 \rangle$	$\langle 0.9, -0.2 \rangle$	$\langle 0.8, -0.2 \rangle$	$\langle 0.8, -0.1 \rangle$	$\langle 0.7, -0.1 \rangle$
T_2	$\langle 0.2, -0.8 \rangle$	$\langle 0.8, -0.2 \rangle$	$\langle 0.8, -0.2 \rangle$	$\langle 0.8, -0.2 \rangle$	$\langle 0.8, -0.2 \rangle$
T_3	$\langle 0.75, -0.2 \rangle$	$\langle 0.8, -0.15 \rangle$	$\langle 0.8, -0.15 \rangle$	$\langle 0.85, -0.1 \rangle$	$\langle 0.8, -0.15 \rangle$
T_4	$\langle 0.4, -0.6 \rangle$	$\langle 0.8, -0.3 \rangle$	$\langle 0.7, -0.4 \rangle$	$\langle 0.7, -0.4 \rangle$	$\langle 0.7, -0.2 \rangle$
T_5	$\langle 0.3, -0.5 \rangle$	$\langle 0.7, -0.2 \rangle$	$\langle 0.8, -0.3 \rangle$	$\langle 0.6, -0.3 \rangle$	$\langle 0.6, -0.3 \rangle$

Table 4. Bipolar Fuzzy Soft matrix for student S_4 .

Teacher	P_1	P_2	P_3	P_4	P_5
T_1	$\langle 0.5, -0.3 \rangle$	$\langle 0.8, -0.2 \rangle$	$\langle 0.6, -0.3 \rangle$	$\langle 0.7, -0.4 \rangle$	$\langle 0.6, -0.3 \rangle$
T_2	$\langle 0.2, -0.8 \rangle$	$\langle 0.8, -0.2 \rangle$	$\langle 0.5, -0.5 \rangle$	$\langle 0.6, -0.3 \rangle$	$\langle 0.8, -0.2 \rangle$
T_3	$\langle 0.8, -0.15 \rangle$	$\langle 0.9, -0.05 \rangle$	$\langle 0.9, -0.05 \rangle$	$\langle 0.9, -0.05 \rangle$	$\langle 0.9, -0.05 \rangle$
T_4	$\langle 0.5, -0.4 \rangle$	$\langle 0.5, -0.4 \rangle$	$\langle 0.4, -0.5 \rangle$	$\langle 0.3, -0.5 \rangle$	$\langle 0.5, -0.4 \rangle$
T_5	$\langle 0.4, -0.5 \rangle$	$\langle 0.8, -0.3 \rangle$	$\langle 0.6, -0.4 \rangle$	$\langle 0.5, -0.3 \rangle$	$\langle 0.7, -0.2 \rangle$

Table 5. Bipolar Fuzzy Soft matrix for student S_5 .

Teacher	P_1	P_2	P_3	P_4	P_5
T_1	$\langle 0.9, -0.1 \rangle$	$\langle 0.4, -0.4 \rangle$	$\langle 0.6, -0.4 \rangle$	$\langle 0.4, -0.5 \rangle$	$\langle 0.9, -0.1 \rangle$
T_2	$\langle 0.7, -0.2 \rangle$	$\langle 0.6, -0.3 \rangle$	$\langle 0.5, -0.5 \rangle$	$\langle 0.4, -0.4 \rangle$	$\langle 0.4, -0.2 \rangle$
T_3	$\langle 0.9, -0.5 \rangle$	$\langle 0.85, -0.1 \rangle$	$\langle 0.8, -0.15 \rangle$	$\langle 0.8, -0.15 \rangle$	$\langle 0.8, -0.15 \rangle$
T_4	$\langle 0.4, -0.6 \rangle$	$\langle 0.4, -0.5 \rangle$	$\langle 0.3, -0.6 \rangle$	$\langle 0.3, -0.6 \rangle$	$\langle 0.5, -0.7 \rangle$
T_5	$\langle 0.7, -0.3 \rangle$	$\langle 0.5, -0.3 \rangle$	$\langle 0.4, -0.6 \rangle$	$\langle 0.4, -0.5 \rangle$	$\langle 0.4, -0.5 \rangle$

Table 6. Bipolar Fuzzy Soft matrix for student S_6 .

Teacher	P_1	P_2	P_3	P_4	P_5
T_1	$\langle 0.8, -0.1 \rangle$	$\langle 0.5, -0.3 \rangle$	$\langle 0.5, -0.4 \rangle$	$\langle 0.4, -0.5 \rangle$	$\langle 0.6, -0.3 \rangle$
T_2	$\langle 0.8, -0.2 \rangle$	$\langle 0.5, -0.5 \rangle$	$\langle 0.4, -0.6 \rangle$	$\langle 0.2, -0.5 \rangle$	$\langle 0.3, -0.4 \rangle$
T_3	$\langle 0.7, -0.25 \rangle$	$\langle 0.6, -0.35 \rangle$	$\langle 0.65, -0.3 \rangle$	$\langle 0.55, -0.4 \rangle$	$\langle 0.7, -0.2 \rangle$
T_4	$\langle 0.4, -0.6 \rangle$	$\langle 0.3, -0.6 \rangle$	$\langle 0.2, -0.7 \rangle$	$\langle 0.2, -0.8 \rangle$	$\langle 0.3, -0.8 \rangle$
T_5	$\langle 0.4, -0.5 \rangle$	$\langle 0.4, -0.6 \rangle$	$\langle 0.3, -0.6 \rangle$	$\langle 0.3, -0.7 \rangle$	$\langle 0.3, -0.6 \rangle$

5. Calculation

The selected students are being evaluated by five teachers to give their rating in terms of bipolar fuzzy soft numbers and presented in Tables 1, 2, 3, 4, 5, 6 respectively for each student. Then the opinion of teachers for each students $S = \{S_1, S_2, S_3, S_4, S_5, S_6\}$ are accumulated by using equation (2) given as follows (I have applied python code to evaluate the accumulated value for each student):

Table 7. Calculation output.

Students	Accumulated value using equation (2)	The value of score functions using equation (1)
S_1	$\langle 0.5684, -0.3835 \rangle$	0.1849
S_2	$\langle 0.6084, -0.2930 \rangle$	0.3154
S_3	$\langle 0.7493, -0.2098 \rangle$	0.5395
S_4	$\langle 0.6793, -0.2573 \rangle$	0.4220
S_5	$\langle 0.6016, -0.3186 \rangle$	0.2830
S_6	$\langle 0.4517, -0.4435 \rangle$	0.0083

Ranking of the students $S_1, S_2, S_3, S_4, S_5, S_6$ based on the value of score functions of the overall bipolar fuzzy soft number as $S_3 > S_4 > S_2 > S_5 > S_1 > S_6$. Therefore, S_3 is the most skilled student among the selected students under parameters.

6. CGPA Versus Skill Comparison

I have collected the CGPA for the students $S_1, S_2, S_3, S_4, S_5, S_6$ up to spring 2023 semester form UMS (University Management System; <https://ums.seu.edu.bd>) of Southeast University, Dhaka, Bangladesh. The information is given in

the table 8:

Table 8. CGPA of selected students.

Students	CGPA out of 4
Yeamin Akhon (S_1) ID: 2022000000054	3.56
Md. Aminur-Ur-Rashid (S_2) ID: 2022000000058	3.84
Tariqul Islam Shihab (S_3) ID: 2022000000047	3.45
Tarek Abdullah Miraj (S_4) ID: 2022000000057	3.88
Sadia (S_5) 2022000000029	3.75
Sarara Jaman Riya (S_6) 2022000000053	3.45

Ranking of the students $S_1, S_2, S_3, S_4, S_5, S_6$ based on the CGPA value is $S_4 > S_2 > S_5 > S_1$ & $S_3 = S_6$.

Therefore, S_4 is the best student among the selected students based on CGPA.

7. Graphical Explanation

Pictorial display is the best way to interpret information for researcher & reviewer. The reader can easily understand the result at a glance. At first, I have drawn a graph to represent positive rating for all parameters of students that got from teachers as well as for negative rating. Then to understand the ranking at a glance I have drawn a graph of score function, from that everyone will understand which student is best.

Positive marking of all parameters for the students

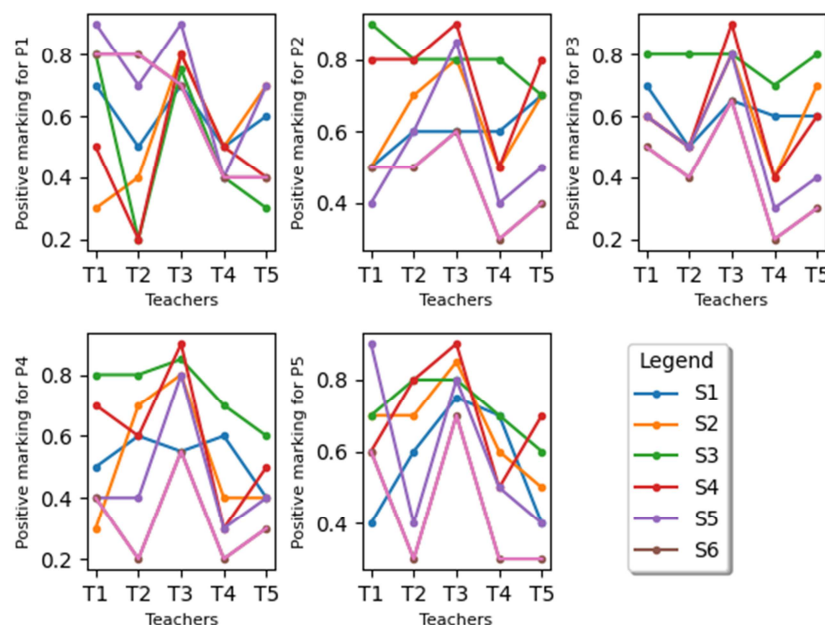
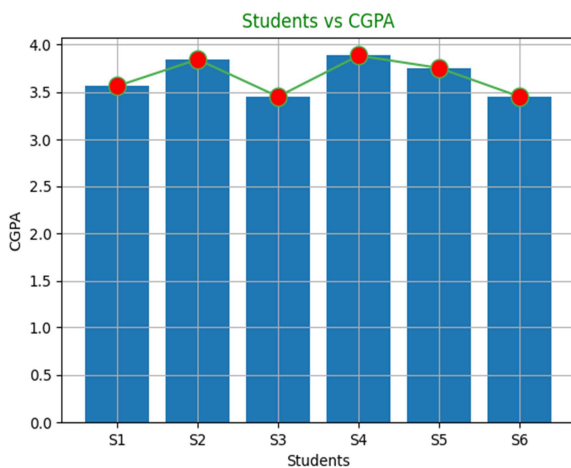
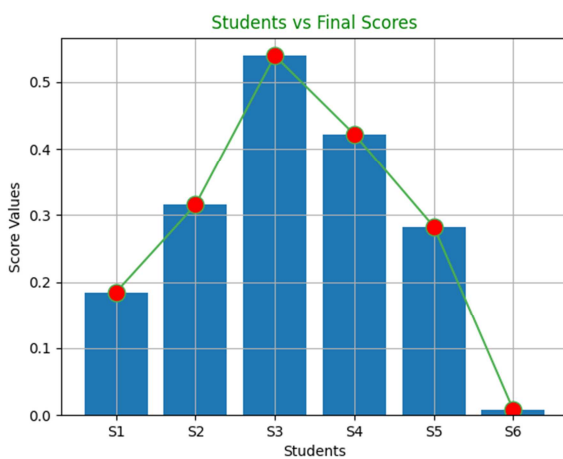
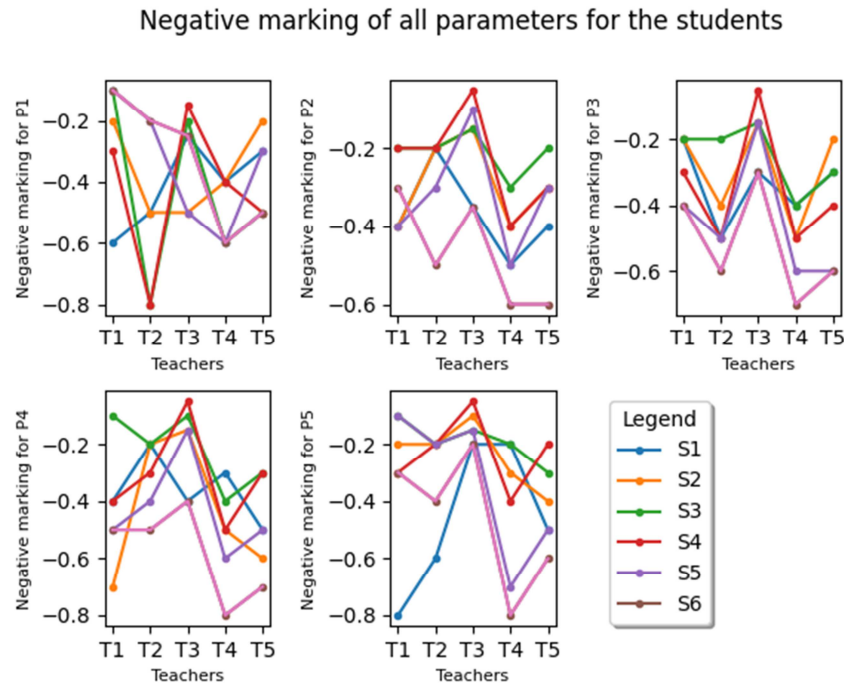


Figure 1. Positive marking.



8. Conclusion

Form the above numerical calculation & graphical presentation it is clear that if we compare the students based on the usual CGPA & skills the ranking is different. Also, the correlation between the value of score functions and CGPA is 0.281647, i.e. the value of score function is weakly related CGPA. My future plan is to make this comparison dynamic that is I want to include more teachers and students in this regard.

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