Application of Machine Learning (ML) Models for Determining the Components of Emotional Intelligence

ASRIYAN ELINA[1], SARGSYAN SIRANUSH[2], AMIRKHANYAN DIANA[2]

[1]Faculty of Philosophy and Psychology
Yerevan State University
Yerevan, 0025, 1 Alex Manoogian
REPUBLIC OF ARMENIA

[2]Informatics and Applied Mathematics
Yerevan State University
Yerevan, 0025, 1 Alex Manoogian
REPUBLIC OF ARMENIA

Abstract: - Emotional intelligence (EI) refers to the ability to recognize, understand, and manage one's own emotions, as well as to perceive, interpret, and influence the emotions of others. This skill is essential for thoughtful behavior in both personal and professional domains. A high level of EI is particularly significant in the field of education, as it influences students' academic performance, social relationships, well-being, and career prospects.

The present article introduces a machine learning (ML)-based software package designed to assess and, if necessary, enhance the emotional intelligence of students. Within this software, a student's emotional quotient (EQ) is evaluated using Nicholas Hall's "Emotional Intelligence" questionnaire. Based on the resulting score, the system recommends individualized exercises aimed at improving specific components of EI, as defined by Daniel Goleman. The developed software thus provides a tool not only for identifying a user's EQ level but also for facilitating its targeted development when needed.

Key-Words: - Artificial Intelligence, Machine Learning, Emotional Intelligence, Emotional Quotient, Support Vector Machine, Neural Network, Python, education

Received: May 28, 2024. Revised: March 15, 2025. Accepted: April 16, 2025. Published: August 4, 2025.

1 Introduction

In recent years, Artificial Intelligence (AI) and **Machine Learning (ML)** technologies have gained significant traction across various fields, including education, psychology, and beyond. Machine Learning, as a key subfield of AI, enables the processing and analysis of large volumes of data, allowing for the identification of students' **Emotional Quotient (EQ)** and the development of appropriate methods for its enhancement.

During the course of their education, students encounter a variety of academic and personal challenges that may significantly impact their academic performance and engagement in the learning process. Naturally, the university years are both dynamic and formative, offering opportunities for professional development, acquisition of new knowledge, and the expansion of social networks. However, students in higher education institutions often face numerous difficulties, such as relocating, adapting to a new environment, and balancing work and study responsibilities [1]. **Emotional Intelligence (EI)** plays a crucial role in shaping students' academic outcomes, social interactions, and overall personal development [2].

The authors of the present study, working at Yerevan State University, have identified the necessity of developing and applying a software solution for the assessment and improvement of EI in order to support student success. ML-based EI

software tools can assist in determining students' EQ and in recommending effective strategies for its improvement.

2 Emotional Intelligence and Machine Learning

An individual is considered to possess emotional intelligence when they are aware of their own emotions, are able to regulate their emotional responses, manage social interactions effectively, and recognize the emotional states of others [3]. EI reflects whether a person is capable of coping with stress, regulating their work-life balance and overall well-being, and achieving improved academic performance [4], [5].

In the present study, we employed the classification framework of EI components proposed by American psychologist Daniel Goleman [6]. According to this model, EI comprises five interrelated components that collectively define an individual's emotional and social competencies. **Self-awareness** refers to the ability to recognize and understand one's own emotions, as well as to grasp how these emotions influence one's thoughts and behavior. **Self-regulation** is the capacity to manage and control those emotions, enabling individuals to restrain impulsive reactions and maintain emotional stability. **Motivation** describes the internal drive to pursue goals, strive for achievement, and persist in the face of challenges. **Empathy** is the ability to perceive, understand, and respond appropriately to the emotions of others, playing a key role in establishing meaningful interpersonal connections. Finally, **social skills** encompass effective communication, collaboration, and relationship-building abilities, which are grounded in prosocial behavior—that is, actions intended to benefit others, such as helping, sharing, cooperating, and showing concern or compassion.

These components function in an integrated manner and together contribute to the effective expression of emotional intelligence across various settings, including the educational environment.

Machine learning models enable systems to learn from data and make predictions without being explicitly programmed. The relevance of ML lies in its ability to process complex datasets and make decisions or predictions that would be difficult or even impossible to achieve through traditional programming approaches.

Emotional intelligence and its components can be enhanced not only through psychological interventions but also by employing ML-based software systems [7]. In this study, both classification and clustering models of machine learning were used to develop software tools for assessing and improving EI. The collected data were processed and transformed into datasets suitable for pattern recognition, where **Support Vector Machines (SVM)** and **Neural Networks (NN)** were applied. The SVM model was employed to evaluate the individual components of EI, while the NN model was utilized to recommend personalized training exercises aimed at improving specific EI components for each user.

The analysis revealed a growing trend in the application of ML techniques for the evaluation and enhancement of emotional intelligence.

3 Description of the Development Phases of the Software Package

This study on the assessment and improvement of emotional intelligence was conducted in two main stages. In the first phase, 300 students from Yerevan State University participated in the "Emotional Intelligence" test developed by Nicholas Hall. This method was chosen to identify each student's capabilities in managing their emotional domain, particularly their interpersonal relationships, emotional awareness, and decision-making behavior.

The method identifies five core factors: emotional awareness, emotional regulation, self-motivation (volitional emotional control), empathy (recognition of others' emotions), and the ability to influence others. The study was carried out using an online questionnaire, which was distributed to students from various faculties. The collected results were digitized and used as training data for machine learning algorithms.

Python was selected as the programming language for software development due to its extensive libraries and tools for machine learning. Several key functions were implemented, including *display_instructions(); collect_responses(); calculate_scores();* and *display_results();* The *display_instructions();* function provided the user with detailed information about the objectives and rules of the test, explained the scoring scale (from −3 to +3), and guided the proper completion of the questionnaire. Responses were gathered using the *collect_responses();* function, which required users

to input values within the allowed range and validated the accuracy of their inputs. Final scoring was performed by the *calculate_scores();* function, which applied a classification key to compute individual indicators for each EI component, such as empathy and self-motivation. The final results were visualized using the *display_results();* function, with the help of the matplotlib and seaborn libraries.

The processed data served as a training dataset for machine learning algorithms. To model the expression of each EI component, the Support Vector Machine (SVM) method was selected as a supervised learning model. SVM builds a hyperplane or a set of hyperplanes that can be used for classification, regression, or other tasks. In this study, SVM was implemented to determine classification accuracy for each EI component.

Each participant was represented by a descriptor vector $X(x_1, x_2, x_3, x_4)$, where x_1 corresponds to age, x_2 to gender, x_3 to level of education, and x_4 to field of study. The responses to questionnaire items Q1–Q30 were digitized using a scale from −3 to +3, and these served as input data. Classification was conducted for each EI component within a range of [−18; +18], which allowed for the distinction between low, medium, and high levels of expression. Based on this training, the model gained the ability to predict the expression levels of EI components in new individuals, based on their questionnaire responses.

For training the model, a dataset consisting of labeled examples was used, with each example assigned to one of the classification categories. The data was split into training (80%) and testing (20%) sets. The SVM algorithm then built a model capable of classifying new data points into the appropriate categories.

In the second phase of the study, exercises aimed at improving the various components of emotional intelligence were developed and tested over 21 days with both experimental and control groups. These exercises were then integrated into the software package, which, using machine learning models, provided personalized tasks based on the student's level of emotional intelligence. The goal was to enhance emotional awareness through structured exercises.

Additionally, a Neural Network (NN) model was implemented in the software package. This model analyzed the students' responses to improvement tasks and classified emotions by intensity. If a user's answers significantly deviated from likely correct responses, the exercises were repeated—21 times for low, and 10 times for medium levels of emotional awareness. The input data included initial EI test scores and the results of emotion classification tasks.

The model learned patterns from the data, compared user responses against predefined standards, and determined whether the student could progress to the next level. This integrated approach demonstrated that machine learning techniques can play a significant role in both diagnosing and enhancing emotional intelligence in educational settings.

4 Description of the Software Package Performance Results

As a result of the study, it was revealed that students generally demonstrate a below-average level of emotional intelligence. The mean score for the emotional awareness component was 10.16, while the lowest score was recorded for the emotional regulation component, with a mean value of only 2.04 (see Table 1). This indicates that students are relatively more aware of their own emotions and feelings and are capable of recognizing and identifying them. However, they show significant difficulties in managing and regulating their emotional responses.

These findings suggest that there is a clear need to strengthen students' self-regulation mechanisms, which in turn will enable them to better manage emotionally challenging situations and maintain control over their emotional reactions.

The results of the testing are summarized in Table 1.

Table 1. Summary and Mean Results of the Testing

Emotional Intelligence Component	*Minimum Value*	*Maximum Value*	*Mean Value*	*Standard Deviation*
Emotional Awareness	-2	18	10.16	4.451
Emotion Regulation	-13	18	2.04	7.155
Self-Motivation	-8	18	6.90	5.884
Empathy	-6	18	8.93	5.088
Recognition of Others' Emotions	-3	18	9.94	4.231

As a result of testing the developed software package, the machine learning models were able to successfully distinguish students' levels of emotional intelligence (EQ). The classification accuracy graph of the SVM model is presented below, where it can be

observed that the *emotional awareness* component was predicted with the highest accuracy (Fig.1).

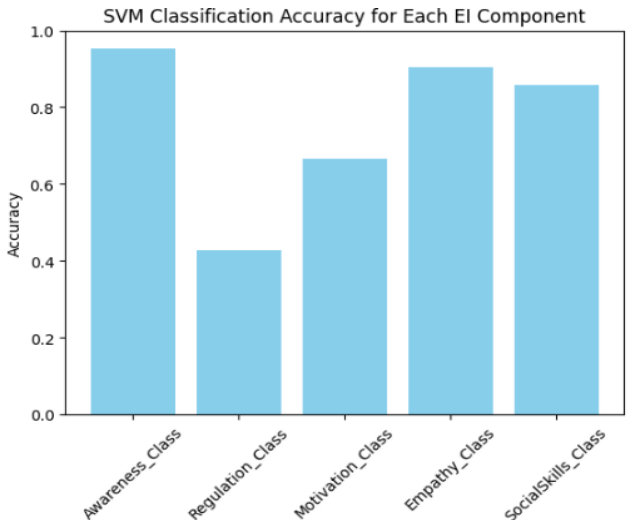

Fig.1 Classification Accuracy Graph of the SVM Model

To form the dataset for the NN model, data collected from students were used, including the results of the initial emotional intelligence assessment, responses to the developmental exercises, and the outcomes of the emotional intensity categorization tasks. The data underwent preprocessing, including cleaning, min-max normalization, and balancing steps to optimize model training.

During the training and validation phases, the dataset was split into 80% for training, 10% for validation, and 10% for testing. The model was trained over 50 epochs, and an early stopping mechanism was applied to prevent overfitting (Fig.2, Fig.3).

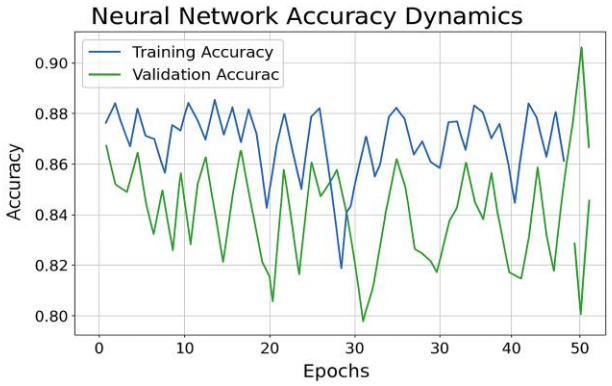

Fig.2 Dynamics of Neural Network Accuracy

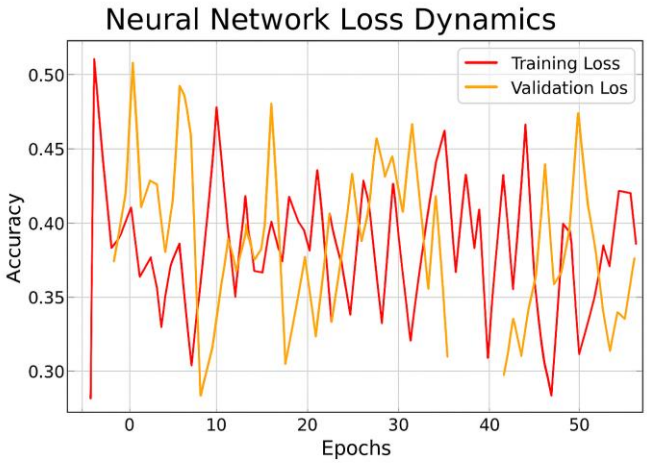

Fig.3 Neural Network Loss Dynamics

The NN model achieved an accuracy of 89% on the test data. Notably high performance was observed in classifying and improving students with medium levels of emotional intelligence (Fig.4).

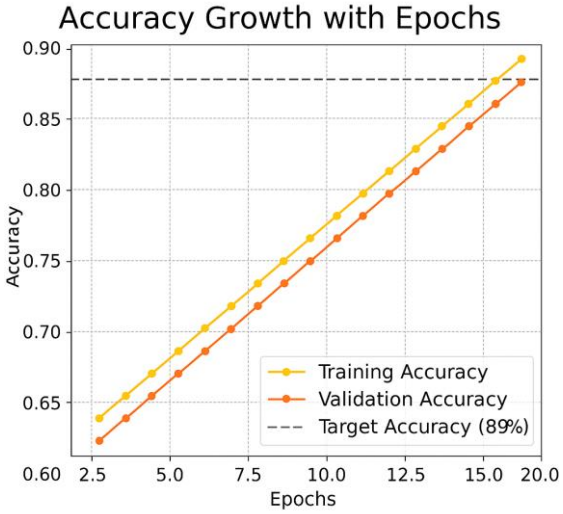

Fig.4 Accuracy Chart of the NN Model

This approach enables the continuous adjustment of exercise difficulty levels in accordance with the user's current emotional abilities, thereby ensuring adaptive learning for the user [9], [10].

5 Conclusion

In the present work, a machine learning-based software package was developed, designed to assess users' emotional intelligence and, when necessary, to support its improvement. The integration of machine learning into the processes of emotional

intelligence assessment and prediction allows for the development of intelligent systems capable of identifying patterns of dependency between EI components and generating personalized, adaptive development scenarios. This approach enhances the effectiveness of emotional development tools in educational and other applied contexts.

The results obtained from using the developed EI software package demonstrated that ML models, particularly Support Vector Machines and Neural Networks, can serve as effective tools for improving EQ. The performance of the EI software package was evaluated based on the classification accuracy of the implemented ML models.

Using this system, adaptive development scenarios were generated for 50 students with low EQ levels and implemented over a period of 21 days (a timeframe recognized in psychology as sufficient for producing measurable changes in emotional intelligence). Upon retesting, the students demonstrated a 15–20% improvement in their EQ scores.

In future studies, we plan to expand the dataset for use across various educational systems. The modular structure of the EI software package ensures flexibility, enabling integration of other ML models that may further improve the accuracy of EI assessment, as well as potential combination with psychologist-led EI development programs.

The developed software is intended for integration into the faculty's educational process to improve the quality of interaction between students and instructors. In the long term, it may also be implemented in other educational institutions and personal development centers to support the emotional intelligence growth of users.

References:

[1] Grigoryan A., Serobyan A., Khachatryan N., Development and Psychometric Analysis of the Questionnaire on Students' Life Difficulties, *Bulletin of Yerevan University E: Philosophy, Psychology*, Vol.13, No.2 (38), 2022, pp. 63-74.

[2] Abdo Hasan Al-Qadri, Wei Zhao, Emotional Intelligence and Students' Academic Achievement, *Problems of Education in the 21st Century*, No.3, 2022, pp. 360-380.

[3] Cliffe J., Emotional Intelligence: A Study of Female Secondary School Head-Teachers, *Educational Management Administration & Leadership*, Vol.39, No.2, 2011, pp. 205-218.

[4] Bao X., Xue S., Kong F., Dispositional Mindfulness and Perceived Stress: The Role of Emotional Intelligence, *Personality and Individual Differences*, Vol.78, 2015, pp. 48-52.

[5] Beath A. P., Jones M. P., Fitness J., Predicting Distress via Emotion Regulation and Coping: Measurement Variance in Trait EI Scales, *Personality and Individual Differences*, Vol.84, 2015, pp. 45-51.

[6] Goleman D., *Emotional Intelligence: Why It Can Matter More Than IQ*, Bantam Books, 1995.

[7] Dollmat K. S., Abdullah N. A., Machine Learning in Emotional Intelligence Studies: A Survey, *Behaviour & Information Technology*, Vol.41, No.7, 2022, pp. 1485-1502.

[8] Wang L. (Ed.), Support Vector Machines: Theory and Applications, *Springer Science & Business Media*, Vol.177, 2005, pp. 347

[9] Herpertz S., Schütz A., Nezlek J., Enhancing Emotion Perception, a Fundamental Component of Emotional Intelligence: Using Multiple-Group SEM to Evaluate a Training Program, *Personality and Individual Differences*, Vol.95, 2016, pp. 11-19.

[10] Petrides K. V., Mikolajczak M., Mavroveli S., Sanchez-Ruiz M. J., Furnham A., Pérez-González J. C., Developments in Trait Emotional Intelligence Research, *Emotion Review*, Vol.8, No.4, 2016, pp. 335-341.