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COMPARATIVE PERFORMANCE ANALYSIS OF MACHINE LEARNING TECHNIQUES FOR PATTERN DETECTION IN STUDENT PSYCHOLOGICAL WELL-BEING

Abstract: *this paper focuses on the application of three data analysis techniques – decision trees, neural networks, and self-organising Kohonen maps – to identify internal dependencies in student psychological and academic well-being data. Based on the analysis of a dataset including student survey and academic records, the performance of these methods in classification and prediction is compared. The results emphasise the importance of method selection depending on the characteristics of the data and provide a basis for further research in the application of machine learning in educational psychology and student support services.*

Keywords: *Data Analysis, Machine Learning, Decision Trees, Neural Networks, Kohonen Maps, Student Well-being, Educational Analytics.*

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ ЭФФЕКТИВНОСТИ МЕТОДОВ МАШИННОГО ОБУЧЕНИЯ ДЛЯ ВЫЯВЛЕНИЯ ПАТТЕРНОВ ПСИХОЛОГИЧЕСКОГО БЛАГОПОЛУЧИЯ СТУДЕНТОВ

Аннотация: *в статье рассматривается применение трех методов анализа данных – деревьев решений, нейронных сетей и самоорганизующихся карт Кохонена – для выявления внутренних зависимостей в данных о психологическом и академическом благополучии студентов. На основе анализа набора данных, включающего результаты опросов студентов и их академические показатели, проводится сравнение эффективности данных методов в задачах классификации и прогнозирования. Результаты подчеркивают важность выбора метода в зависимости от характеристик данных и служат основой для дальнейших исследований в области применения машинного обучения в педагогической психологии и службах поддержки студентов.*

Ключевые слова: *анализ данных, машинное обучение, деревья решений, нейронные сети, карты Кохонена, благополучие студентов, образовательная аналитика.*

1. Introduction: in today's era, data analysis is becoming an indispensable tool for identifying patterns and predicting trends in student well-being. This study focuses on the application of three powerful data analysis techniques to uncover hidden dependencies related to academic burnout and psychological stress. Self-organising Kohonen maps can identify common characteristics in large amounts of survey data, making them a valuable tool for categorising students into risk groups. Neural networks, in turn, have been successfully applied to analyse complex, non-linear relationships between study load and mental health.

2. Research Methods: the dataset used in the study contains 1,328 records of university students. Each record includes attributes such as: Age, Study Load (hours/week), Sleep Hours, Screen Time, Extracurricular Involvement, and the target attribute indicating the presence (1) or absence (0) of severe academic burnout.

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Decision Trees provide a transparent decision structure, simplifying the interpretation of results for university psychologists. Kohonen Maps were used to cluster groups of students based on lifestyle parameters, facilitating the visualisation of risk profiles. Neural Networks were employed to automatically extract meaningful features and minimise prediction error for the target variable.

3. Result and Discussion: data were analysed using the three methods in Deductor software. Outputs evaluated: target (burnout risk), age, and study load.

Table 1

Error percentages

Methods	Target (Burnout), %	Age, %	Study Load, %
Decision tree	6.17	0	5.12
Kohonen maps	10.71	50.15	14.31
Neural Network	3.61	99.62	5.87

The neural network showed the best overall performance in predicting the presence of burnout (3.61% error). However, the high error rate in demographic regression indicates the need for specialized architectures. The decision tree showed high sensitivity to the target variable, meaning its structure is excellent at identifying the specific lifestyle dependencies that lead to burnout (e.g., the intersection of low sleep hours and high screen time). Kohonen maps successfully isolated distinct clusters of «at-risk» students based on behavioral similarities, though they struggled with precise regression tasks.

4. Conclusion: the neural network provides superior predictive power for identifying students at immediate risk of burnout. However, the decision tree offers the interpretability required for clinical and pedagogical interventions, allowing psychologists to understand why a student was flagged. Kohonen maps serve as an excellent exploratory tool for segmenting the student body into distinct psychological profiles. Future research should focus on ensemble methods that combine the predictive accuracy of neural networks with the rule-based transparency of decision trees to create holistic student support systems.

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