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Study of Prediction of Student Academic Outcomes Using Machine Learning and Deep Learning Model

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ABSTRACT

A prominent area of focus in modern research in education is using ML models to predict student outcomes for academic success. The explosive generation of educational data that might be triggered by a technological learning environment fosters improved learning experiences. This review paper examines the literature on the use of Machine Learning (ML) and Deep Learning (DL) models for the prediction of student academic performance. The study discusses many of the ML and DL algorithms such as Random Forest (RF), Decision Tree (DT), Support Vector Machine (SVM), and Deep Neural Networks (DNN) to find their comparison on the prediction of student performance.

Findings have been highlighted for better accuracy by DL models such as Gated Recurrent Neural Networks and DNN, which have even reached over 99%. This paper would provide insights for teachers and policymakers on optimizing instructional strategy and improving student achievement by using predictive analytics. Then, future studies will need to concentrate on the real time integration of data and dynamic model development to achieve more accurate predictions.

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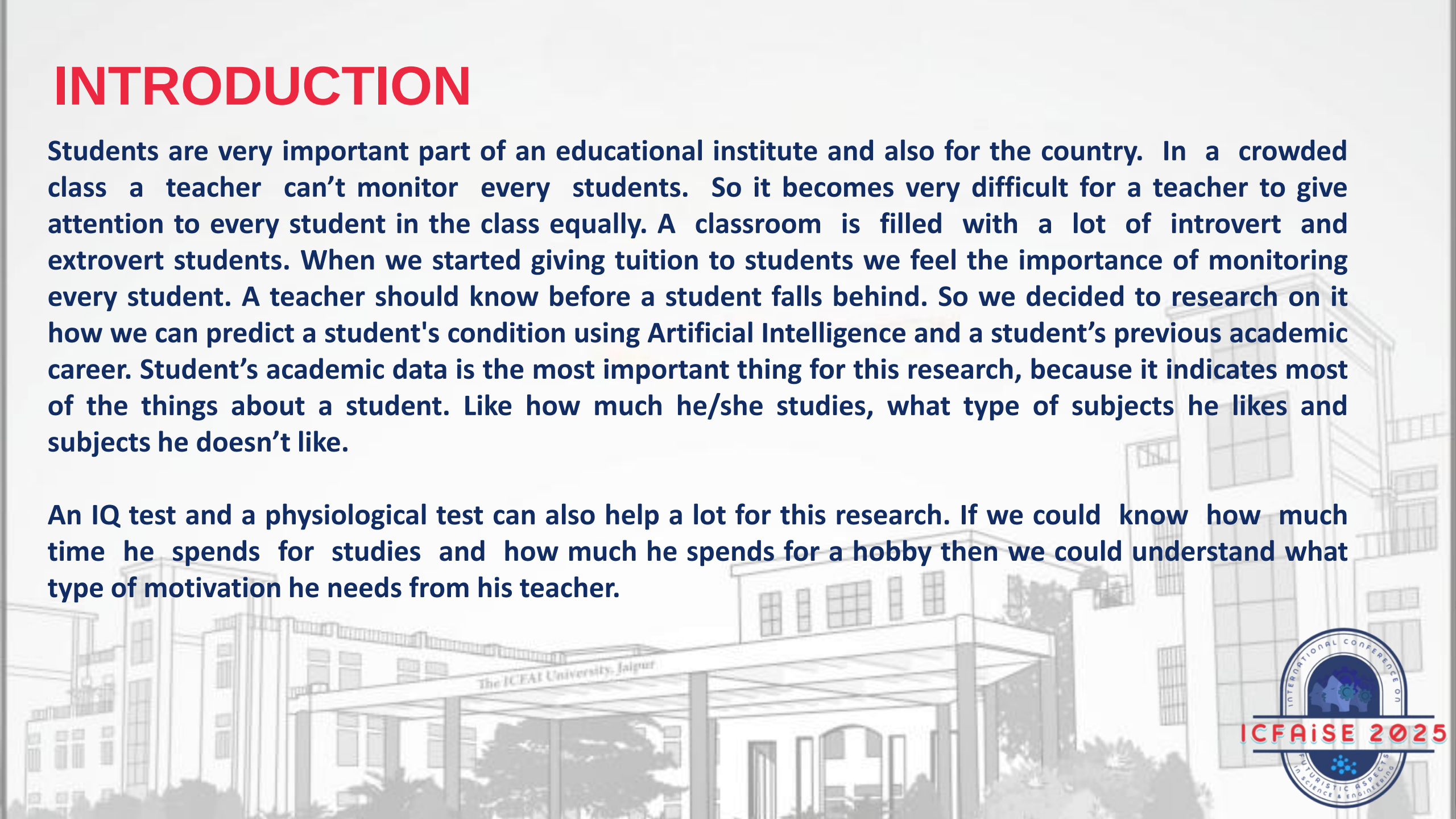
INTRODUCTION

Students are very important part of an educational institute and also for the country. In a crowded class a teacher can't monitor every students. So it becomes very difficult for a teacher to give attention to every student in the class equally. A classroom is filled with a lot of introvert and extrovert students. When we started giving tuition to students we feel the importance of monitoring every student. A teacher should know before a student falls behind. So we decided to research on it how we can predict a student's condition using Artificial Intelligence and a student's previous academic career. Student's academic data is the most important thing for this research, because it indicates most of the things about a student. Like how much he/she studies, what type of subjects he likes and subjects he doesn't like.

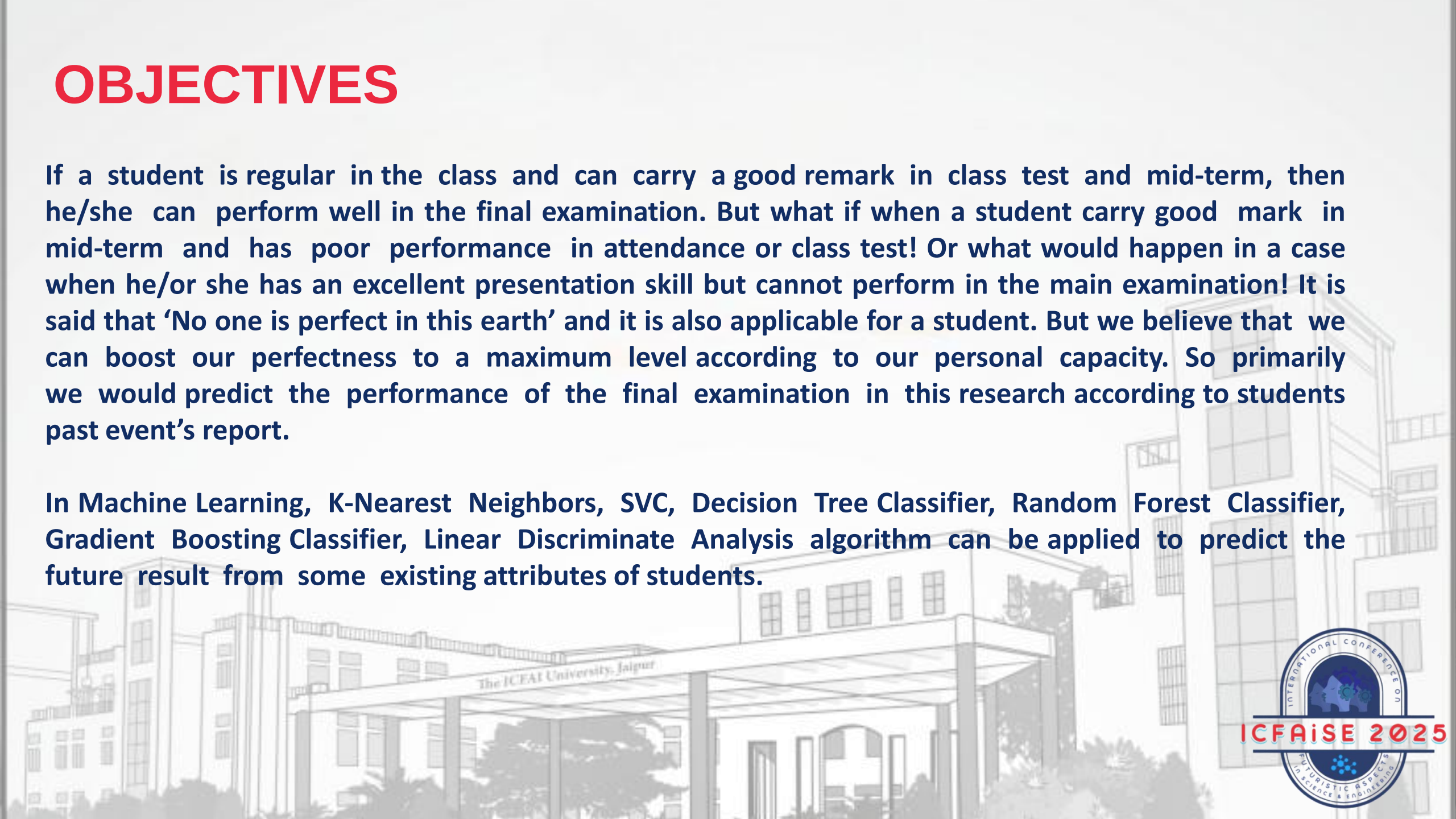
An IQ test and a physiological test can also help a lot for this research. If we could know how much time he spends for studies and how much he spends for a hobby then we could understand what type of motivation he needs from his teacher.



OBJECTIVES

If a student is regular in the class and can carry a good remark in class test and mid-term, then he/she can perform well in the final examination. But what if when a student carry good mark in mid-term and has poor performance in attendance or class test! Or what would happen in a case when he/or she has an excellent presentation skill but cannot perform in the main examination! It is said that 'No one is perfect in this earth' and it is also applicable for a student. But we believe that we can boost our perfectness to a maximum level according to our personal capacity. So primarily we would predict the performance of the final examination in this research according to students past event's report.

In Machine Learning, K-Nearest Neighbors, SVC, Decision Tree Classifier, Random Forest Classifier, Gradient Boosting Classifier, Linear Discriminate Analysis algorithm can be applied to predict the future result from some existing attributes of students.



MACHINE LEARNING

Machine learning is a part of man-made reasoning (AI) and software engineering which centers around the utilization of information and Algorithm to mimic the way that human learn, bit by bit working on its precision. ML algorithms fabricate a model in light of test information, known as preparing information, to make forecasts without being expressly modified to do as such. ML algorithms are utilized in a wide assortment of utilizations, like medication, discourse acknowledgment and PC vision. ML approaches are customarily isolated into three general classifications, contingent upon the idea of the sign or input accessible to the learning framework. Administered learning, solo learning, and Reinforcement learning are the three classifications of machine learning. ML is a part of artificial intelligence (AI) and software engineering which centers around the utilization of information and Algorithm to mimic the way that human learn, bit by bit working on its precision. ML algorithms fabricate a model in light of test information, known as preparing information, to make forecasts without being expressly modified to do as such. AI calculations are utilized in a wide assortment of utilizations, like medication, discourse acknowledgment and PC vision. ML algorithms are customarily isolated into three general classifications, contingent upon the idea of the sign or input accessible to the learning framework. Administered learning, solo learning, and Reinforcement learning are the three classifications of AI.

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LITRATURE REVIEW

Author Name	Paper Title	Methods/Techniques used	Advantages	Limitations
Farhood et al., (2024) [1]	Random Forest, Decision Tree, SVM, KNN, Logistic & Linear Regression, XGBoost, CNN, Gradient Boosted NN	Used two evaluation methods to see if students passed or failed the final exam	Tested a wide variety of Models for a comprehensive comparison	Accuracy and performance of models presented Significant challenges
Alnomay et al., (2024) [2]	Regression, Supervised Learning	Predicted final GPA using past grades, with Linear and Bagging Regression performing best	Helps identify students needing early academic support	Relies mostly on GPA data, which may not capture the full picture of student performance
Bhushan et al., (2024) [3]	Regression, Classification, Deep Learning	Found deep learning models to be the most accurate in predicting SGPA	Effective at predicting outcomes based on behavior and habits	Results depend heavily on the attributes used for the predictions

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LITRATURE REVIEW

Author Name	Paper Title	Methods/Techniques used	Advantages	Limitations
Baniata et al., (2024) [4]	Gated Recurrent Neural Network (GRU)	Achieved an impressive 99.70% accuracy in identifying students needing support	Very high accuracy and useful for educational support systems	Tested only on a specific dataset, which may limit generalization.
Alshamaila et al., (2024) [5]	Deep Learning (Convolution)	Addressed class imbalance and showed strong performance in predicting student excellence	Effectively handled class imbalance issues	Oversampling and under sampling techniques could introduce bias
Chen et al., (2023) [6]	Random Forest, Decision Tree, Artificial Neural Network	Random Forest was the best overall model across multiple tasks.	Worked well across different educational tasks	Other models had less consistent generalization

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LITRATURE REVIEW

Author Name	Paper Title	Methods/Techniques used	Advantages	Limitations
Nayak et al., (2023) [7]	Decision Tree, Naïve Bayes, Random Forest, MLP	The optimized MLP model reached 97.08% accuracy with feature selection	Highly accurate model with behavioral insights	Behavioral data was essential for the highest accuracy.
Korchi et al., (2023) [8]	J48, RF, LR, KNN, XGBoost, DNN	DNN model performed best, with a high accuracy of 99.97%	Exceptional accuracy for predicting grades.	Focused mainly on regression techniques, limiting the scope for classification tasks
Yağcı et al., (2022) [9]	Random Forest, SVM, Logistic Regression, Naïve Bayes, KNN	Midterm grades predicted final Results with around 70-75% accuracy	Simple model that provides early performance insights	Lower accuracy Compared to other more complex models

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LITRATURE REVIEW

Author Name	Paper Title	Methods/Techniques used	Advantages	Limitations
Li et al., (2022) [10]	LSTM, 2D Convolutional Networks	Excelled in predicting student performance using behavior data	Great at handling time-series and correlating different behaviors	Focused more on behavior data than academic grades
Olabanjo et al., (2022) [11]	RBFNN, PCA	Achieved 86.59% accuracy for predicting pass/fail rates	Balanced sensitivity and specificity	Limited to secondary school data, making it less applicable to higher education
Ojajuni et al., (2021) [12]	Random Forest, SVM, XGBoost, Gradient Boosting, DL	XGBoost achieved 97.12% accuracy in predicting academic outcomes.	Highlighted key social and demographic factors affecting success	Focus on XGBoost limited comparison with other advanced models

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LITRATURE REVIEW

Author Name	Paper Title	Methods/Techniques used	Advantages	Limitations
Neha et al., (2021) [13]	Deep Neural Network	Showed better accuracy than traditional models in predicting student success	Effective in earlystage performance predictions	Focus on certain Indicators may not provide a holistic view
Hussain et al., (2021) [14]	Deep Learning, Linear Regression	Deep learning out performed linear regression in terms of prediction error	Tuned parameters helped solve overfitting issues	Challenges arise With smaller datasets
Aslam et al., (2021) [15]	Deep Learning (SMOTE)	Achieved high Accuracy for Portuguese and Mathematics courses	Handled class imbalance effectively, with good precision and recall	Techniques for handling imbalance might affect real-world applications

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Analysis of machine learning techniques for Student performance predictions

Author & Reference	Techniques Utilized	Accuracy
Farhood et al., (2024) [18]	Logistic and Linear Regression, and LASSO	91.39%
Baniata et al., (2024) [21]	GRU	99.70%
Nayak et al., (2023) [24]	MLP	97.08%
Korchi et al., (2023) [25]	Deep Neural Network	99.97%
Yağcı et al., (2022) [26]	Random Forest, SVM, Logistic Regression, Naïve Bayes, KNN	75%
Olabanjo et al., (2022) [28]	RBFNN	86.59%
Ojajuni et al., (2021) [29]	XGBoost	97.12%
Aslam et al., (2021) [32]	Deep Learning (SMOTE: synthetic minority oversampling technique)	96.4%

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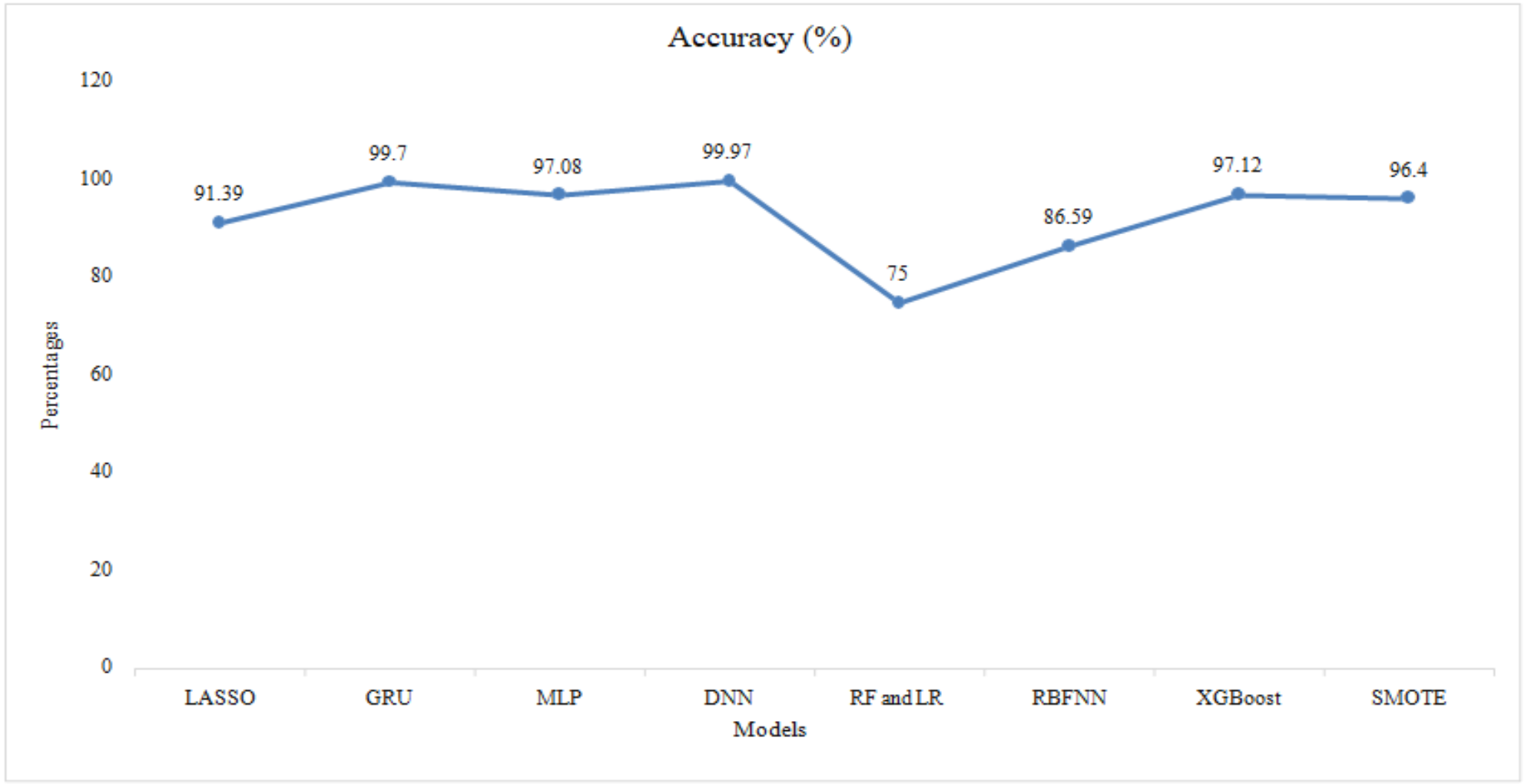
Analysis of machine learning techniques for Student performance predictions using Graph



shows accuracy differences between different machine learning techniques that were applied to predict the academic performance of students. This graph represents a comparison based on accuracy of the several literatures which are studies during this review. Deep learning models, DNN and GRU, revealed the highest accuracy rates for these analyses.

CONCLUSION

An important topic of educational research that could greatly improve learning experiences and instructional tactics is the prediction of student academic results using ML and DL techniques. These models provide a quantitative framework for analyzing educational data, offering actionable insights that can be used to tailor teaching methods and improve student outcomes. This study explores the role of ML and DL in forecasting student academic performance, a topic of increasing relevance as educational data becomes more accessible and varied. The review thoroughly evaluates a range of ML and DL models, such as SVM, DNN, GRU, SMOTE, XGBoost etc., highlighting their potential to reshape educational approaches through accurate predictions.

It emphasizes the significance of diverse data inputs to enhance prediction accuracy and discusses the challenges faced, including model over fitting, concerns around data privacy, and ethical issues in using predictive analytics. Comparative results show that the DL models, DNN (99.97%) and GRU (99.7%), revealed the highest accuracy rates for these analyses among ML models. The paper recommends fostering ethical transparency and augmenting machine learning predictions with qualitative data, providing a valuable framework for educators and policymakers aiming to optimize educational outcomes using technology. Looking forward, the study suggests that future research should explore the integration of more real-time data sources and the development of dynamic models that can adapt to changing educational environments, potentially enhancing predictive accuracy and student engagement.

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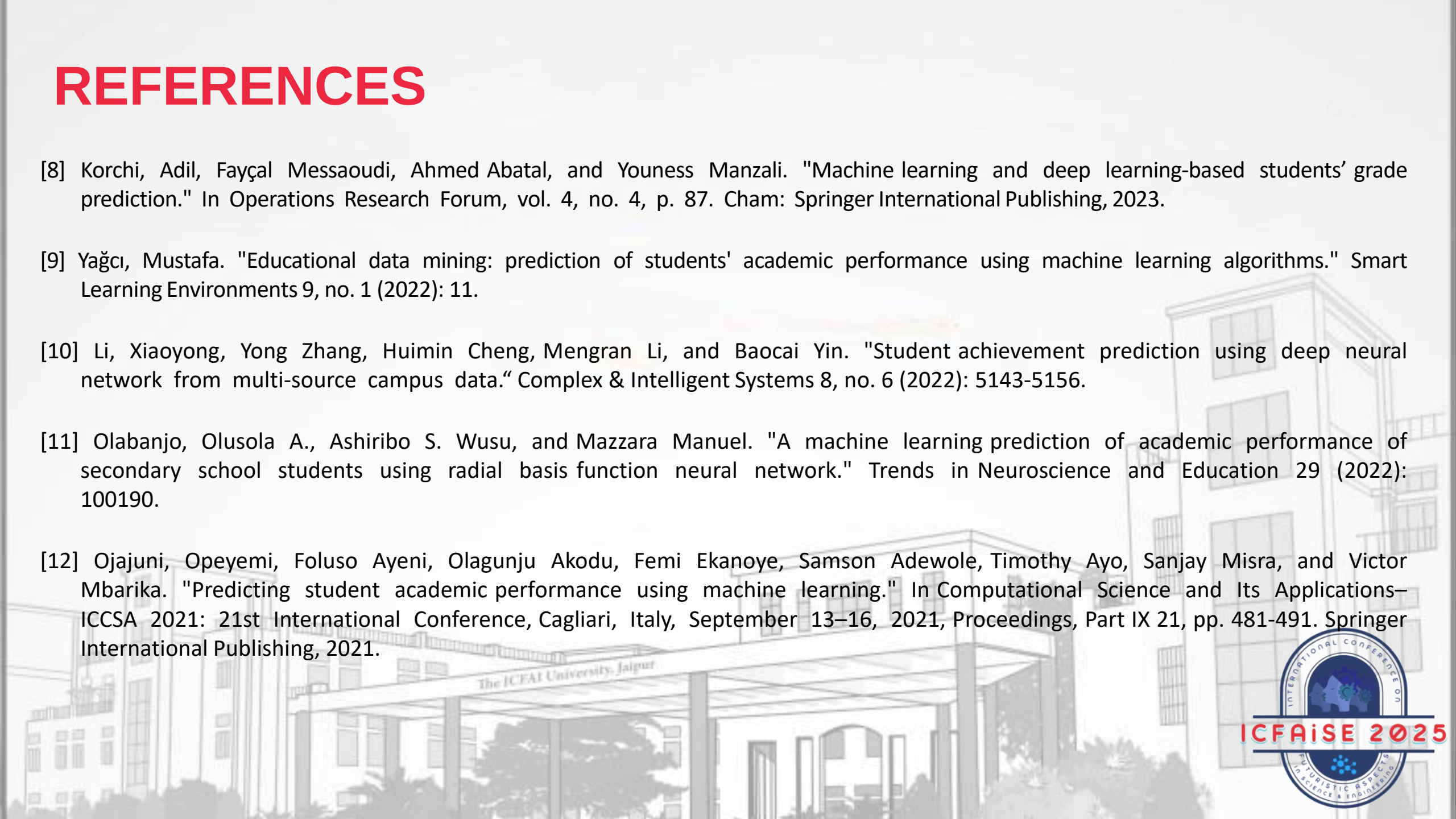

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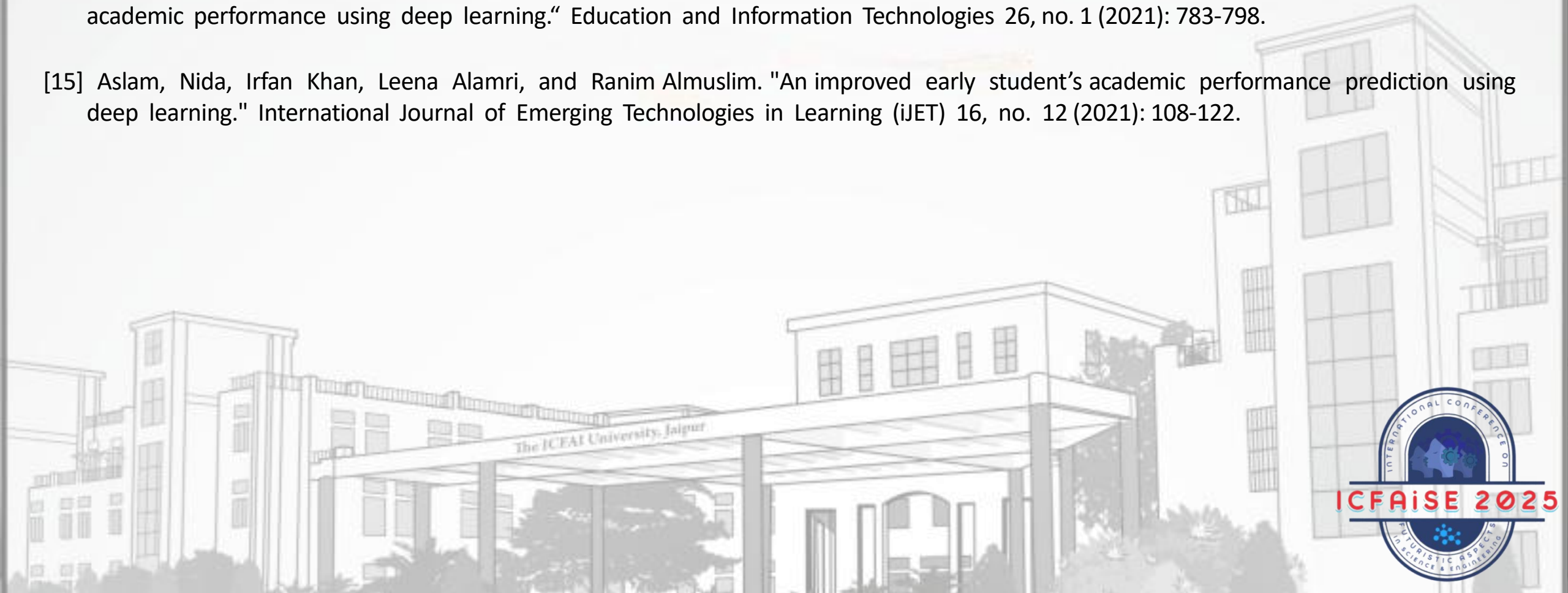

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Thank you

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