Learning Machine Learning:

A Comparative Study of Aerospace Engineering and Computer Science Students

Junwon Yoon (5024722) – CSE3000 Research Project - Q2 2024

Delft University of Technology

Background

- Machine learning (ML) is a crucial tool in fields like business, healthcare, and aerospace engineering.
- Traditional ML education is geared toward computer science (CS) students but is increasingly relevant across disciplines.
- Teaching ML to non-CS students, such as aerospace engineering (AE) students, is challenging due to gaps in programming experience despite strong mathematical foundations.
- TU Delft CS students have an integrated curriculum that includes calculus, probability, linear algebra, and programming, enabling them to grasp ML concepts effectively.
- In contrast, TU Delft AE students often lack programming exposure, making it harder to apply theoretical ML concepts to real-world tasks like predictive maintenance and aerodynamic optimization.
- This study explores how mathematical knowledge influences ML learning outcomes and aims to propose strategies to support diverse learners.

Research Question

"How does prior math knowledge affect the learning of Machine Learning topics between CS and Aerospace students?"

Sub-questions:

- What is the relationship between mathematical foundations and ML learning outcomes?
- How do CS and AE students differ in their understanding of ML concepts?
- What teaching strategies are effective for AE students with limited programming experience?

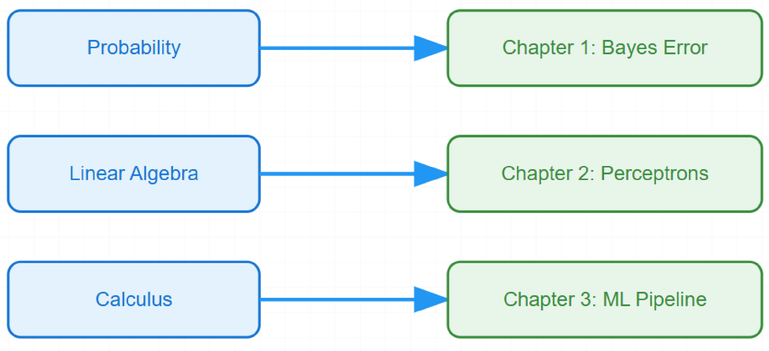


Figure: Linkage between Math assessment and ML tutorial

Methodology

Participant Recruitment: 20 students (10 CS, 10 AE) were recruited to ensure balanced representation.

Assessments:

- Initial math tests covered calculus, probability, and linear algebra.
- Post-tutorial ML test evaluated conceptual understanding and practical skills.

Tutorial Design:

- Interactive, step-by-step lessons on Bayes' Theorem, Perceptrons, and ML Pipelines.
- Real-world examples were included to for better understanding

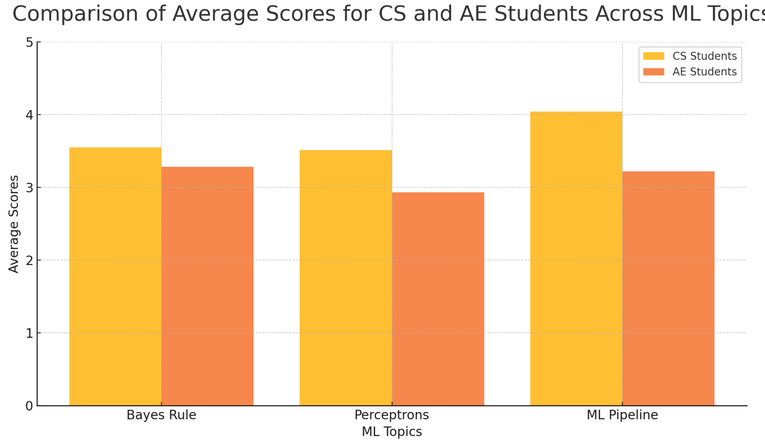
ML Assessment:

- A post-tutorial assessment was conducted to evaluate students' understanding of the ML topics covered during the study.
- The test consisted of both conceptual and practical questions, designed to measure: ML pipeline, Bayes' theorem, and Perceptrons.

Results: Quantitative Analysis

Key Findings:

- CS students outperformed AE students in all ML topics.
- Bayes Rule scores correlated strongly with probability knowledge ($r = 0.561$).
- Linear algebra proficiency was a key factor in understanding Perceptrons ($r = 0.440$).
- AE students required more time to complete tutorials, indicating a steeper learning curve.



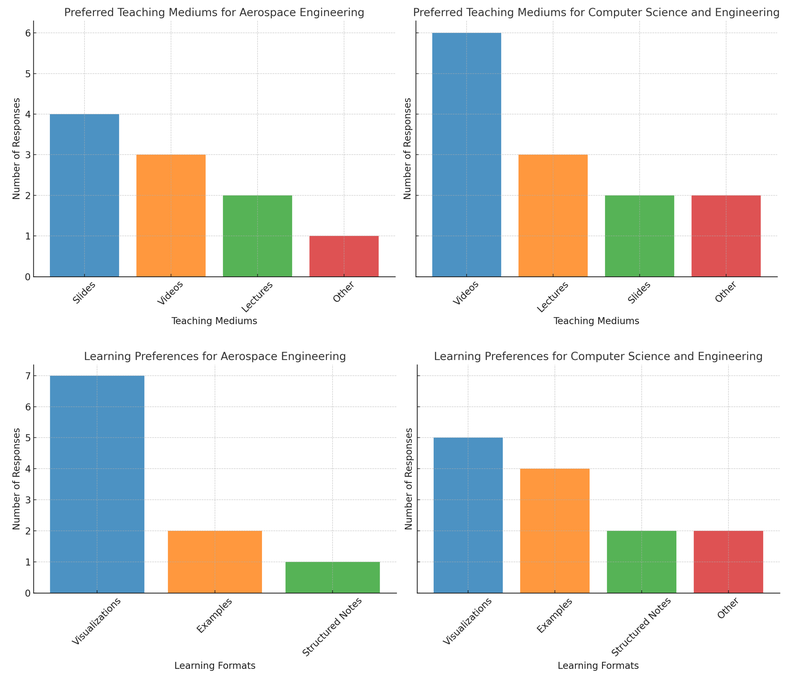
Results: Qualitative Insights

Learning Preferences:

- CS students preferred structured resources such as slides, textbooks, and coding exercises.
- AE students favored interactive formats like videos and hands-on tutorials with real-world applications.
- These differences suggest the need for blended instructional approaches to accommodate diverse learning preferences.

Instructional Implications:

- Tailored strategies, such as integrating practical, real-world content, can enhance AE students' learning experiences.
- Advanced, structured resources can further deepen CS students' understanding of ML concepts.



Discussion and Conclusion

Key Implications:

- Strong mathematical knowledge supports ML comprehension, but computer science knowledge adds up for sure.
- AE students benefit from contextualized, application-driven teaching strategies.
- Adaptive learning approaches could help address the varied preparation of interdisciplinary students.

Contact: j.yoon@student.tudelft.nl — Faculty of Computer Science, TU Delft