Transforming Education with Machine Learning

Practical Applications and Case Studies

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Summary: Classical ML in Education

- Supervised models (decision trees and ensembles, support vector machines, neural networks)
  - ▶ Dropout
  - ▶ Academic failure
  - ▶ Student performance
  - ▶ ...
- Unsupervised models (K-means clustering, hierarchical clustering, ...)
  - ▶ Grouping similar students according to learning patterns
  - ▶ ...

Summary: Advanced ML Systems

These systems include:

- ▶ Adaptive Educational System
- ▶ Dialogue Based Tutors
- ▶ Automated Grading
- ▶ Automated Content Creation
- ▶ Language Learning
- ▶ ...

Summary: Advanced ML Systems

Some approaches for predicting student performance and Knowledge Tracing:

- ▶ Bayesian Knowledge Tracing
- ▶ Deep Learning Knowledge Tracing, including:
    - ▶ Dynamic Key-Value Memory Network
    - ▶ Transformer-Based Approaches
    - ▶ Graph-Based Approaches

Summary: Deep Learning and Neural Networks

- ▶ **Neural networks** provide powerful tools to model complex data patterns in domains such as text, images, and audio. They are also capable of **generating new content** such as text and images.
- ▶ **Generative AI models** can offer substantial support for research tasks in fields like **education**, from item generation to automated essay and picture scoring.
- ▶ Their practical application offers much promise, but requires rigorous testing using methods outlined in this presentation and the exercises.

Summary: Limitations

- The proposed methods are specific to numerical outputs from NLP models.
- Lack of general benchmarks for comparing AI models in education.
- Just as educational tests have frameworks for reliability and validity, AI-based systems require standards for transparency, fairness, and ethical use.
- Current research:
  - Extend methods to non-numerical outputs (e.g., verbal feedback).
  - Develop benchmarks for essay scoring systems in education.
  - Develop guidelines for data representativity, fairness metrics, and systematic bias detection.

Summary: Conclusion

- Proposed methods to evaluate reliability, validity, and fairness in AI-based scoring.
- Empirical results demonstrate the utility of these methods.
- Contribution: Framework for integrating AI into educational assessments while adhering to testing standards.

Summary of Key Takeaways

▶ Transformer models and other neural networks offer great potential in education and related fields. Compared to classical statistical methods, they can directly use texts, pictures and other media as input.

▶ They can work on many tasks with near-human performance while being inexpensive.

▶ Their interpretation is not straightforward, and we need to evaluate their validity and fairness diligently.