TAL AI LAB
好未来人工智能实验室

Building The Next Generation of Smart Classroom

Challenges and Opportunities in AI + Education

好未来AI Lab负责人 **刘子韬**

TAL 好未来

每 个 人 的 好 未 来

好未来是一个以智慧教育和开放平台为主体，
以素质教育和课外辅导为载体，
在全球范围内服务公办教育，助力民办教育，
探索未来教育新模式的科技教育公司。

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好未来用AI和科技赋能教育

更优质的
教学内容

更有效的
教学体验

更科学的
评测体系

更公平的
教育资源

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Learning Environments

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Classroom Environments

V.S.

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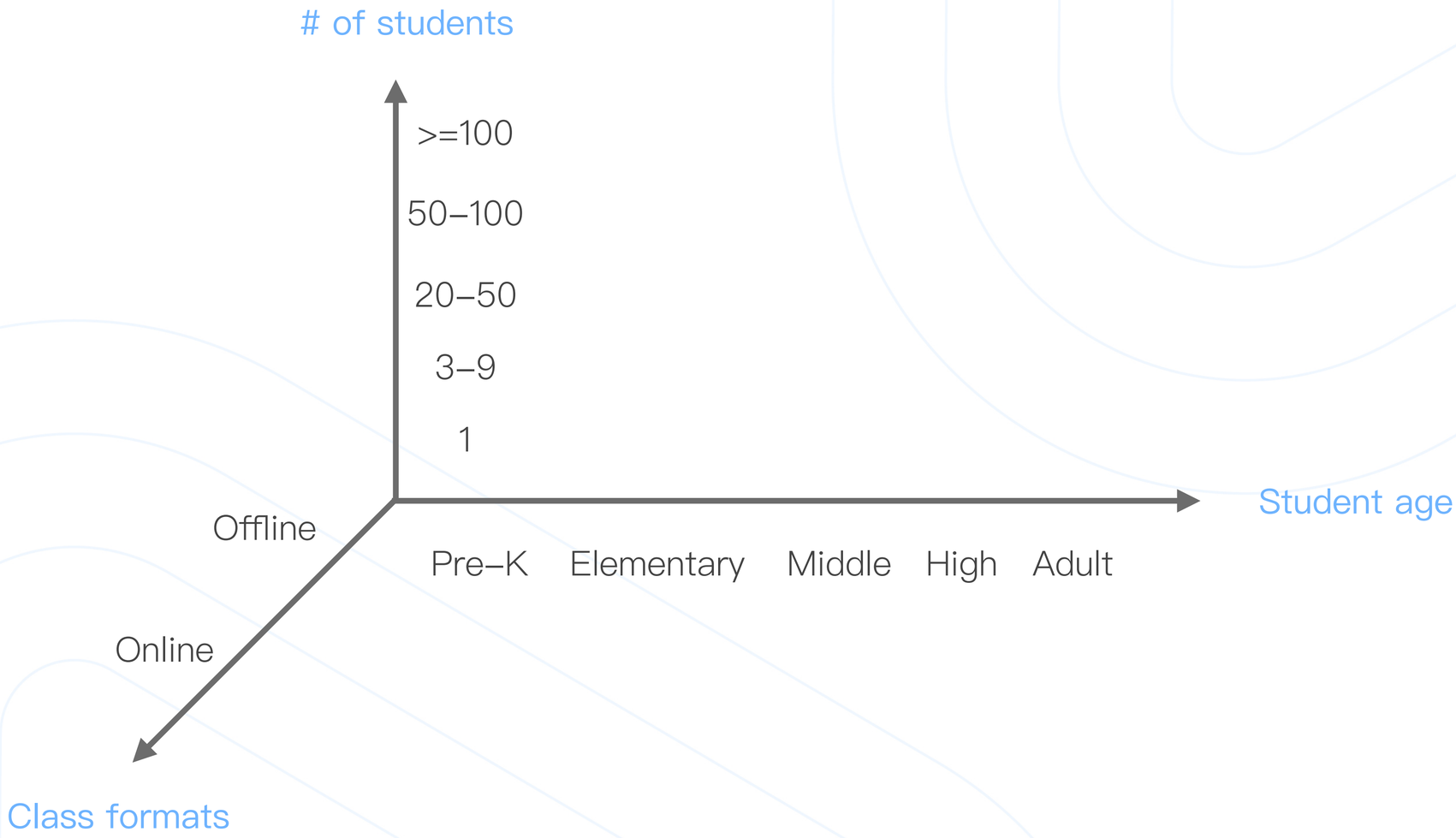
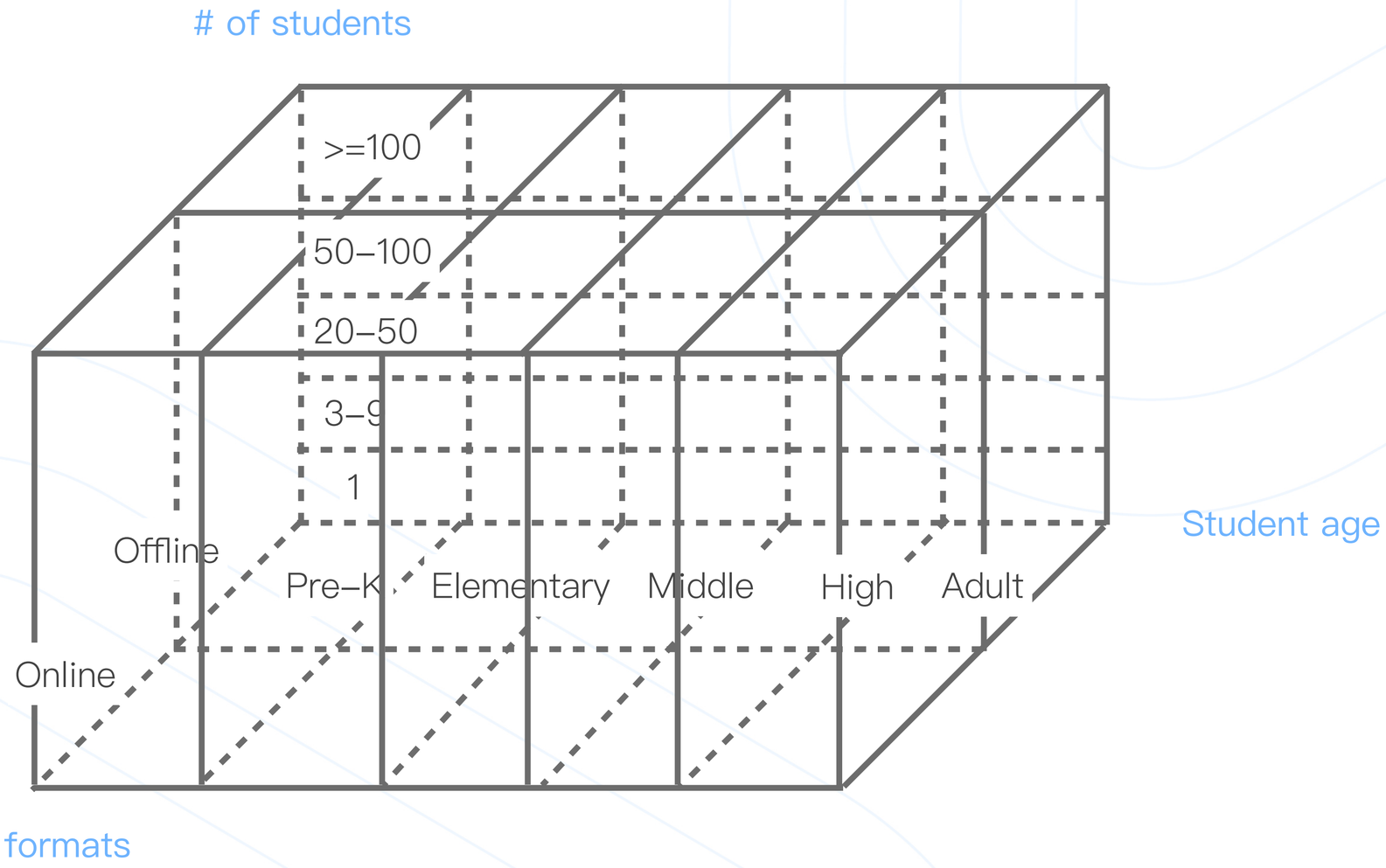
Learning Environments



Learning Environments



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Rich Educational Data

of students

Student age

Class formats

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Rich Educational Data

Pre-class

In-class

Post-class

Students

Instructors

Administrators

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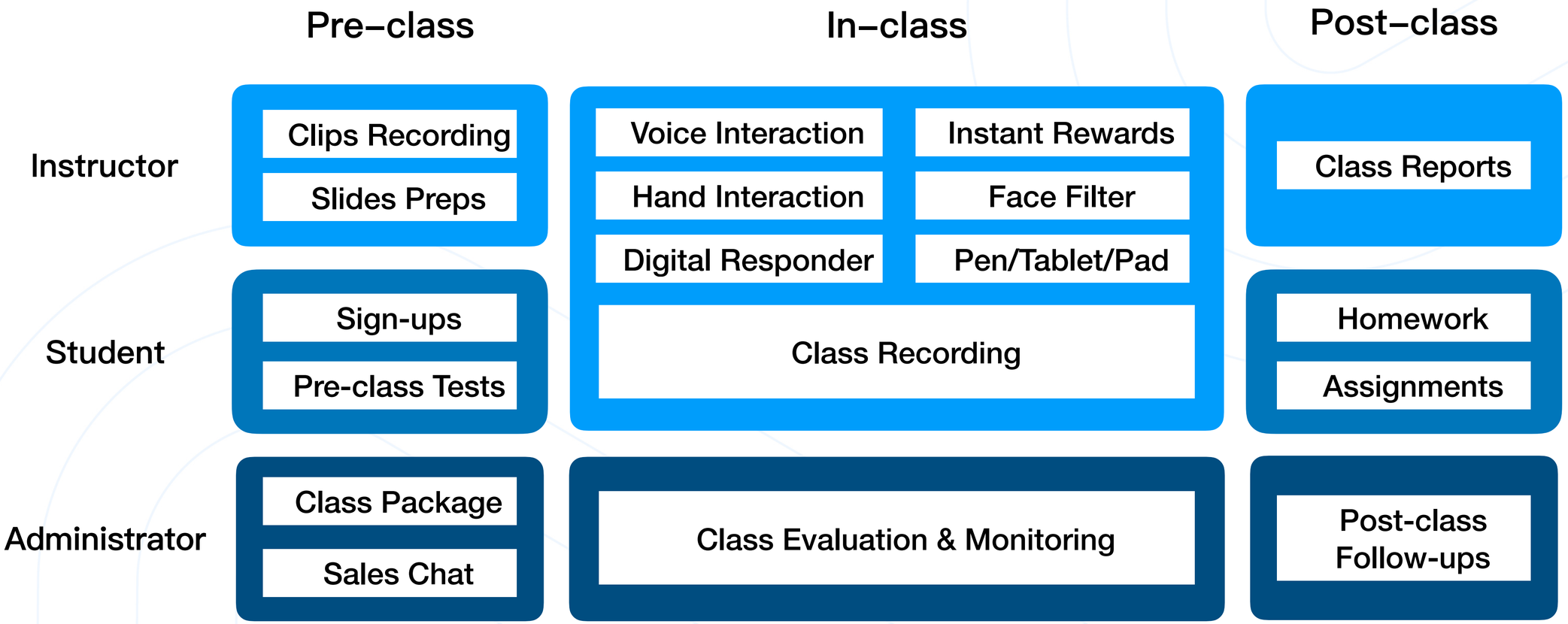
Rich Educational Data



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Educational data is multimodal

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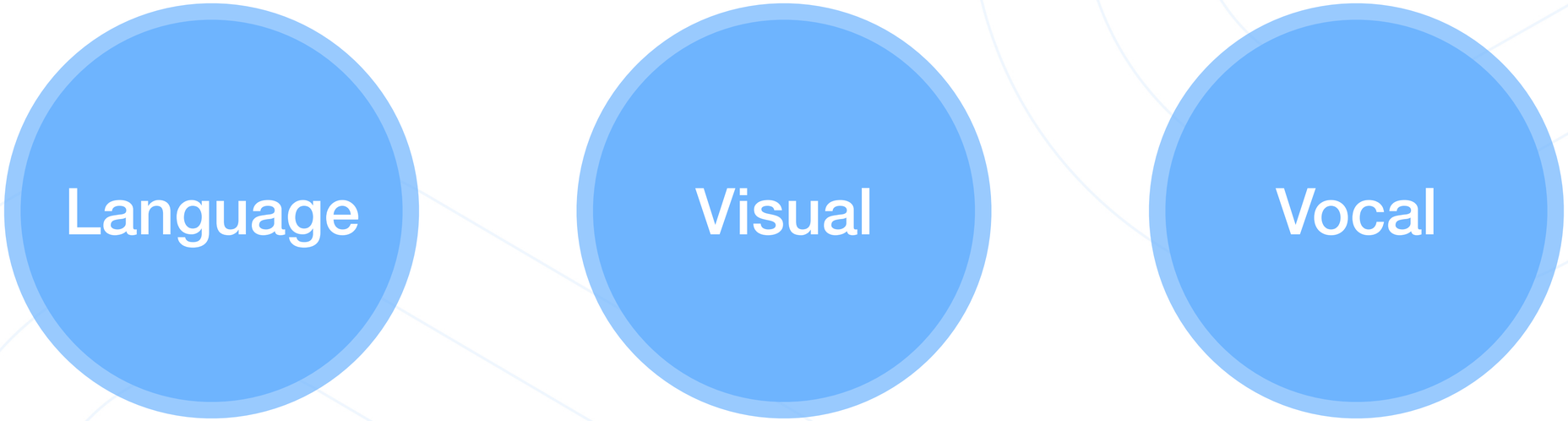
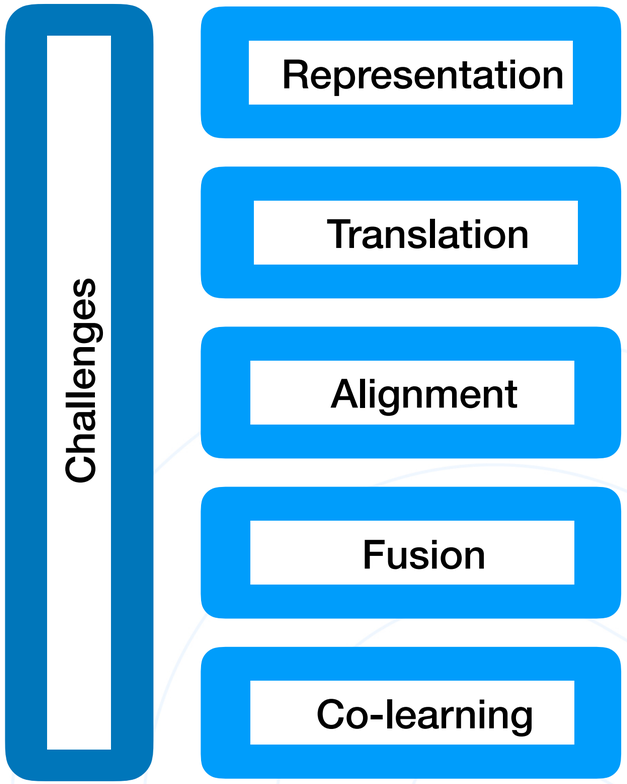
Multimodal Machine Learning



Multimodal Machine Learning



Learn how to represent and summarize multimodal data

Map data from one modality to another

Identify relations between (sub)elements from different modalities

Join information from modalities to perform a prediction

Transfer knowledge between modalities, their representation, and their predictive models

Baltrušaitis, T., Ahuja, C., & Morency, L. P. (2019). Multimodal machine learning: A survey and taxonomy. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *41*(2), 423-443.

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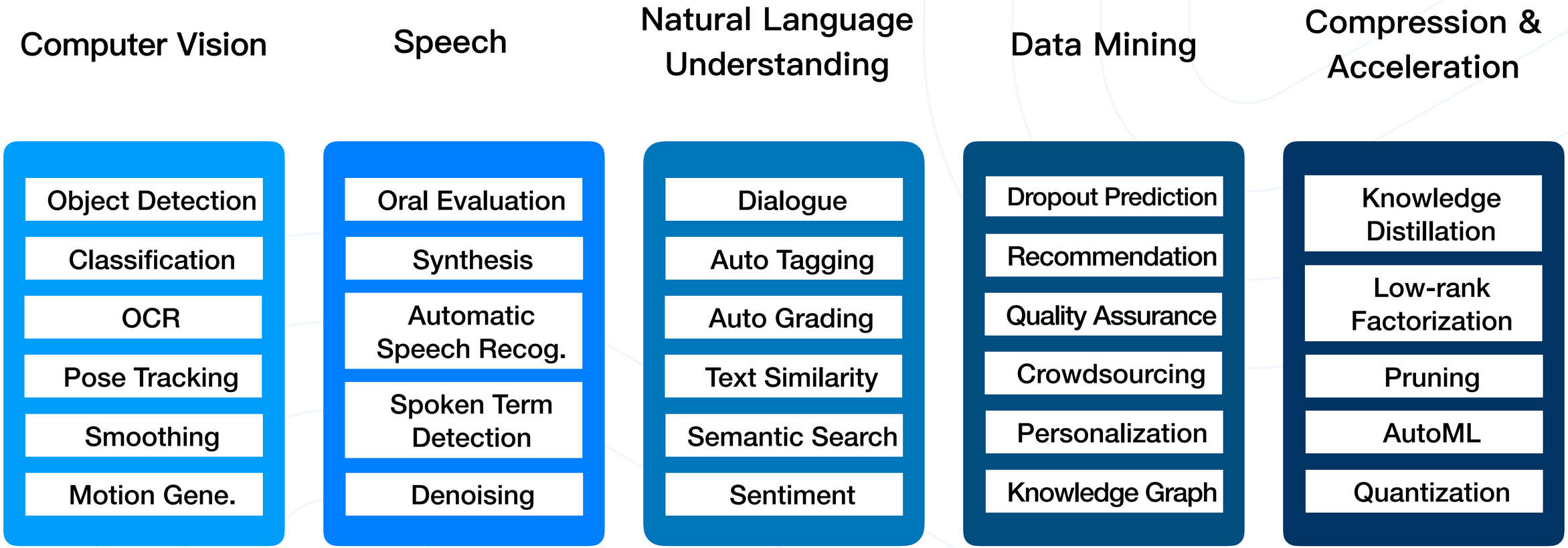
AI Stacks



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Challenges

- Small Data
- Heterogeneity
- Data Quality Issues
- Evaluation

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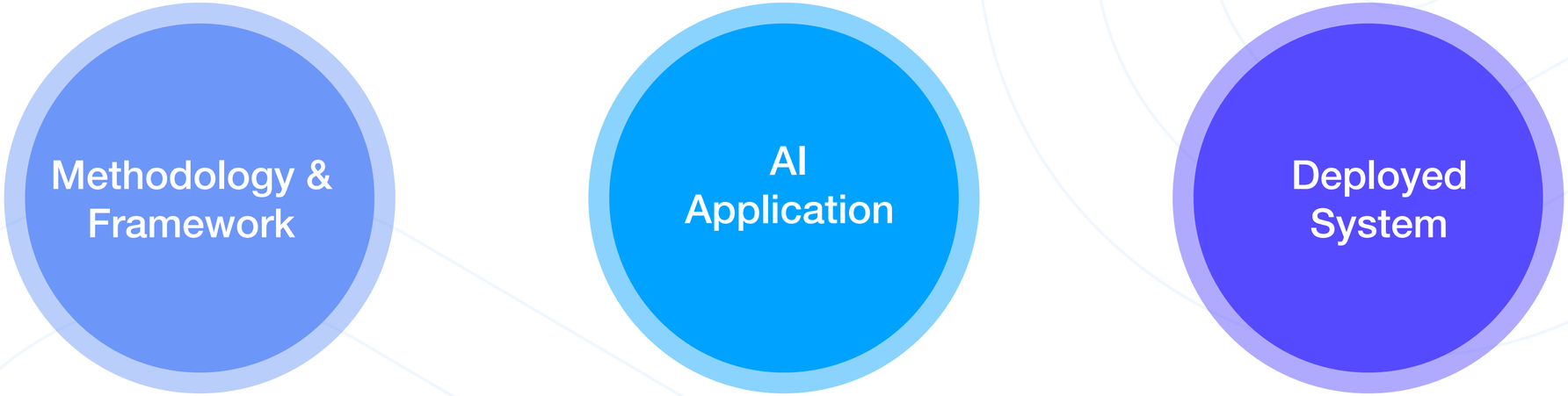
Our Work



Content

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Methodology& Framework

- **Recommender Systems with Heterogeneous Side Information**. T. Liu, Z. Wang, J. Tang, S. Yang, Z. Liu. WWW'19, International Conference on the World Wide Web, 2019.
- **Learning Effective Embeddings From Crowdsourced Labels: An Educational Case Study**. G. Xu, W. Ding, J. Tang, S. Yang, Z. Liu. ICDE'19: The 35th IEEE International Conference on Data Engineering, 2019.
- **Representation Learning from Limited Educational Data via Adaptive Hard Example Mining**. G. Xu, W. Fu, W. Ding, G. Huang, Z. Liu. Submitted.

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AI Application

- **Deep Knowledge Tracing with Side Information.** Z. Wang, X. Feng, J. Tang, G. Huang, Z. Liu. AIED'19: The 20th International Conference on Artificial Intelligence in Education, 2019.
- **Automatic Short Answer Grading via Multiway Attention Networks.** T. Liu, W. Ding, Z. Wang, J. Tang, G. Huang, Z. Liu. AIED'19: The 20th International Conference on Artificial Intelligence in Education, 2019.

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Deployed System

- **A Multimodal Alerting System for Online Class Quality Assurance.** J. Chen, H. Li, W. Wang, W. Ding, G. Huang, Z. Liu. AIED'19: The 20th International Conference on Artificial Intelligence in Education, 2019.
- **Dolphin: A Verbal Fluency Evaluation System for Elementary Education.** G. Xu, T. Liu, W. Fu, Y. Song, C. Guo, W. Ding, G. Huang, Z. Liu. Submitted.

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Learning From Crowdsourced Labels

Learning Effective Embeddings From Crowdsourced Labels: An Educational Case Study. G. Xu, W. Ding, J. Tang, S. Yang, Z. Liu. ICDE'19: The 35th IEEE International Conference on Data Engineering, 2019.

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Introduction

Learning representation is important!

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Introduction

Learning representation is important!

Existing approaches rely on:

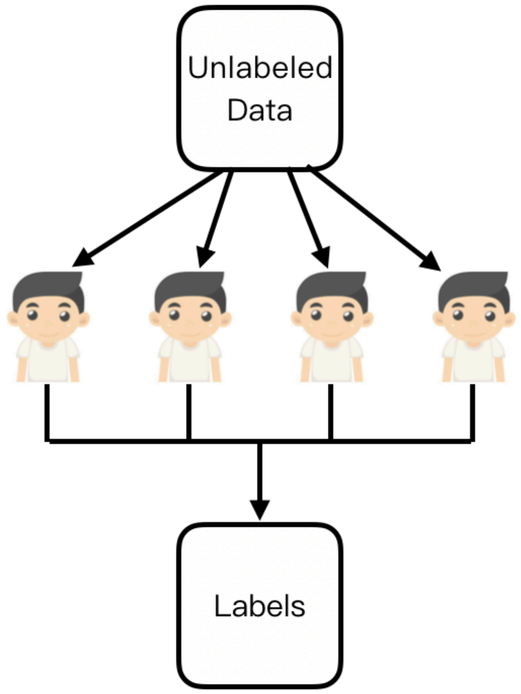
- **Massive** data
- **Accurate** labels

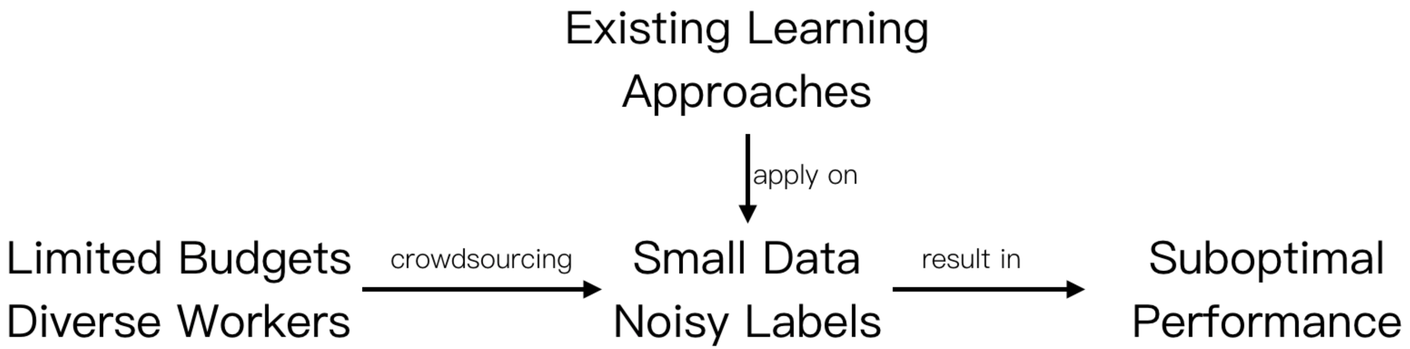
Real-world reality:

- **Limited** data
- **Noisy** labels

Introduction

How to obtain labeled data? **Crowdsourcing**





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Solution

Limited data + Noisy crowdsourced labels 

Robust representation

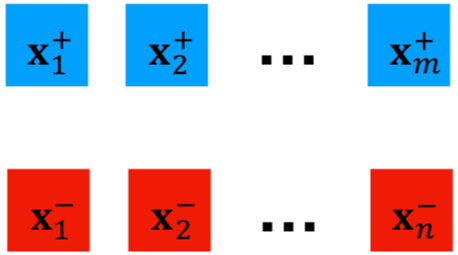
RLL: An unified framework to learn robust representation from small data and inconsistent labels

Grouping Based Architecture

Original data

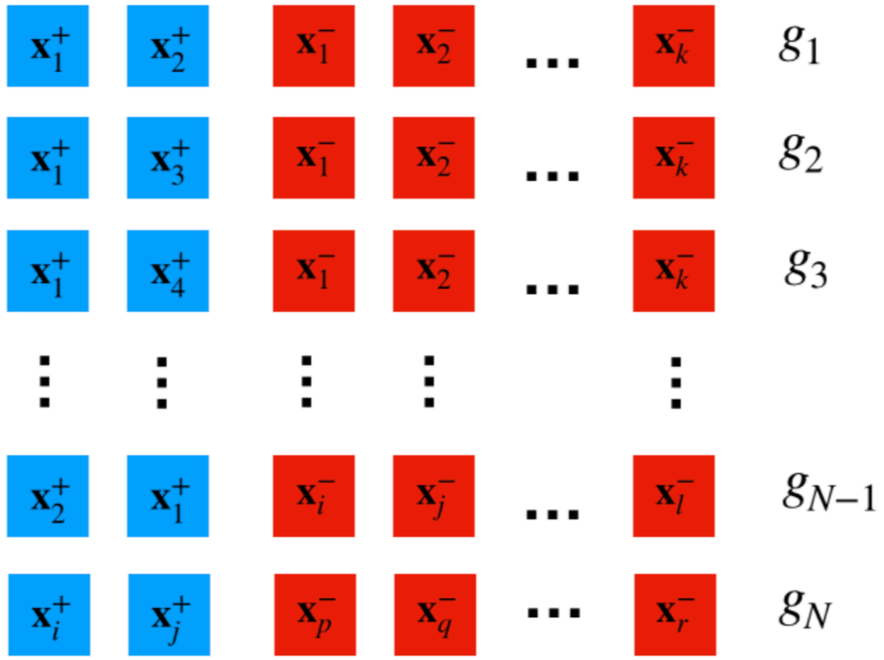
$$\mathcal{D}^+ = < \mathbf{x}_1^+, \mathbf{x}_2^+, \cdots, \mathbf{x}_m^+ >$$

$$\mathcal{D}^- = < \mathbf{x}_1^-, \mathbf{x}_2^-, \cdots, \mathbf{x}_n^- >$$



Pairing

Grouping data



Positive
Negative

Data size: $O(m+n)$

$$\mathbf{g}_i = < \mathbf{x}_i^+, \mathbf{x}_j^+, \mathbf{x}_1^-, \mathbf{x}_2^-, \cdots, \mathbf{x}_k^- >$$

$$\mathcal{G} = \{\mathbf{g}_1, \mathbf{g}_2, \cdots, \mathbf{g}_N\} \qquad O(|m|^2 \cdot |n|^k)$$

Substantially more data!

Confidence Score Estimator

5 workers label examples
A case where labels are inconsistent

Example A

Example B

Positive
Negative

Treat confidence score as a random variable:

- Using maximum likelihood estimation (MLE):

$$MLE(\delta_i) = \sum_{j=1}^{d} y_{i,j}/d$$

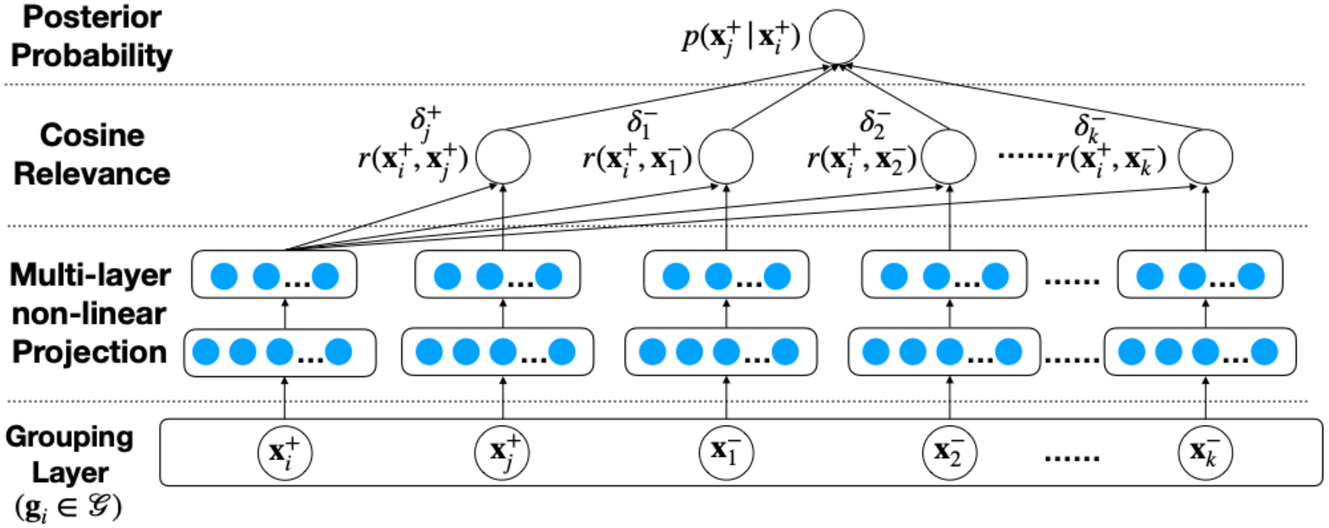
- Using Bayesian inference:

$$Bayesian(\delta_i) = \frac{\alpha + \sum_{j=1}^{d} y_{i,j}}{\alpha + \beta + d}$$

α and β are label class priors

RLL Framework

RLL = Grouping based strategy + Confidence estimator + Model learning



The overview of RLL framework

Integrate confidence into posterior probability:

$$\hat{p}(\mathbf{x}_j^+ | \mathbf{x}_i^+) = \frac{\exp\left(\eta \cdot \delta_j \cdot r(\mathbf{x}_i^+, \mathbf{x}_j^+)\right)}{\sum_{\mathbf{x}_* \in \mathbf{g}_i, \mathbf{x}_* \neq \mathbf{x}_i^+} \exp\left(\eta \cdot \delta_* \cdot r(\mathbf{x}_i^+, \mathbf{x}_*)\right)}$$

Loss function:

$$\mathcal{L}(\Omega) = -\sum_{i=1}^{n} \log p(\mathbf{x}_j^+ | \mathbf{x}_i^+)$$

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Automatic Short Answer Grading via Multiway Attention Networks

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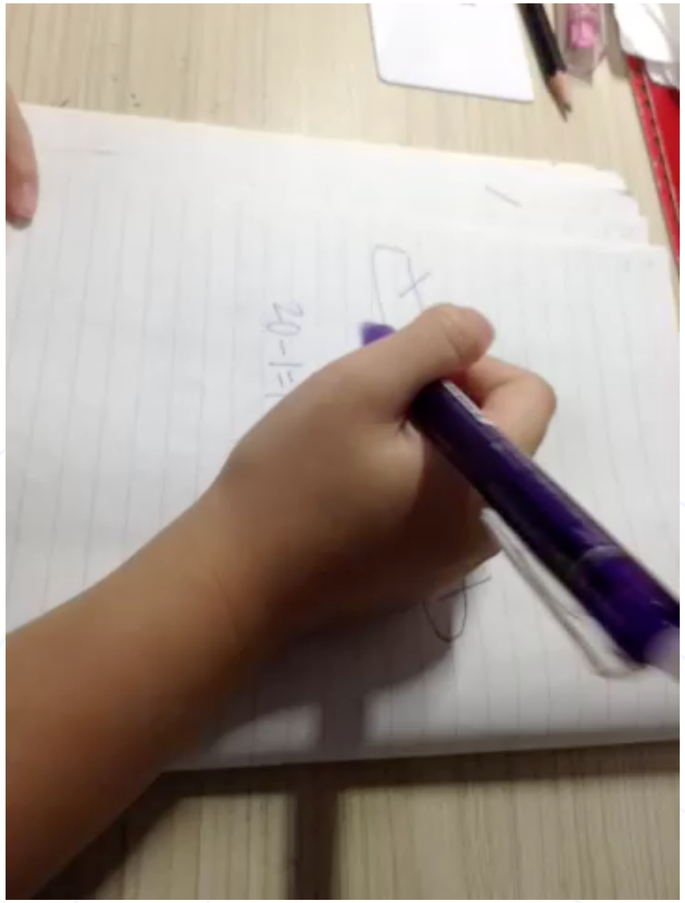
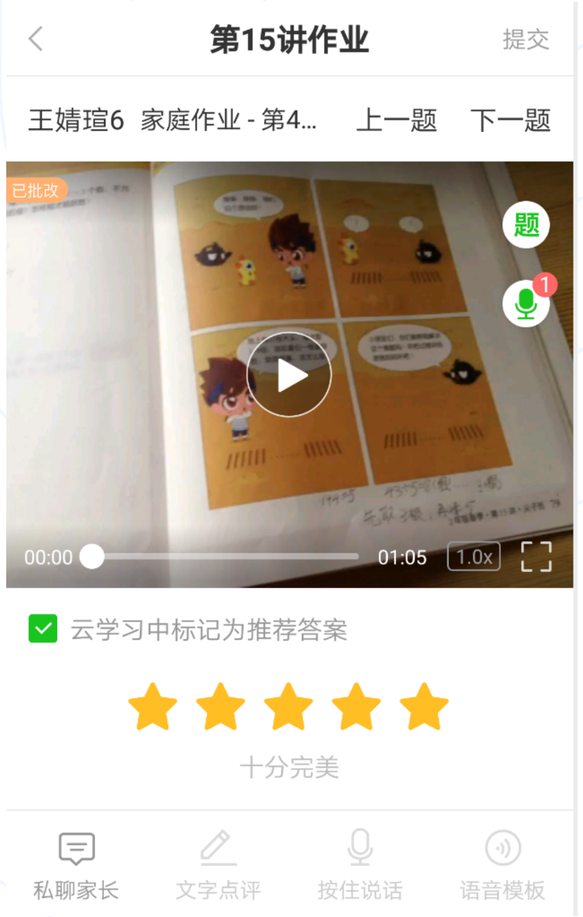
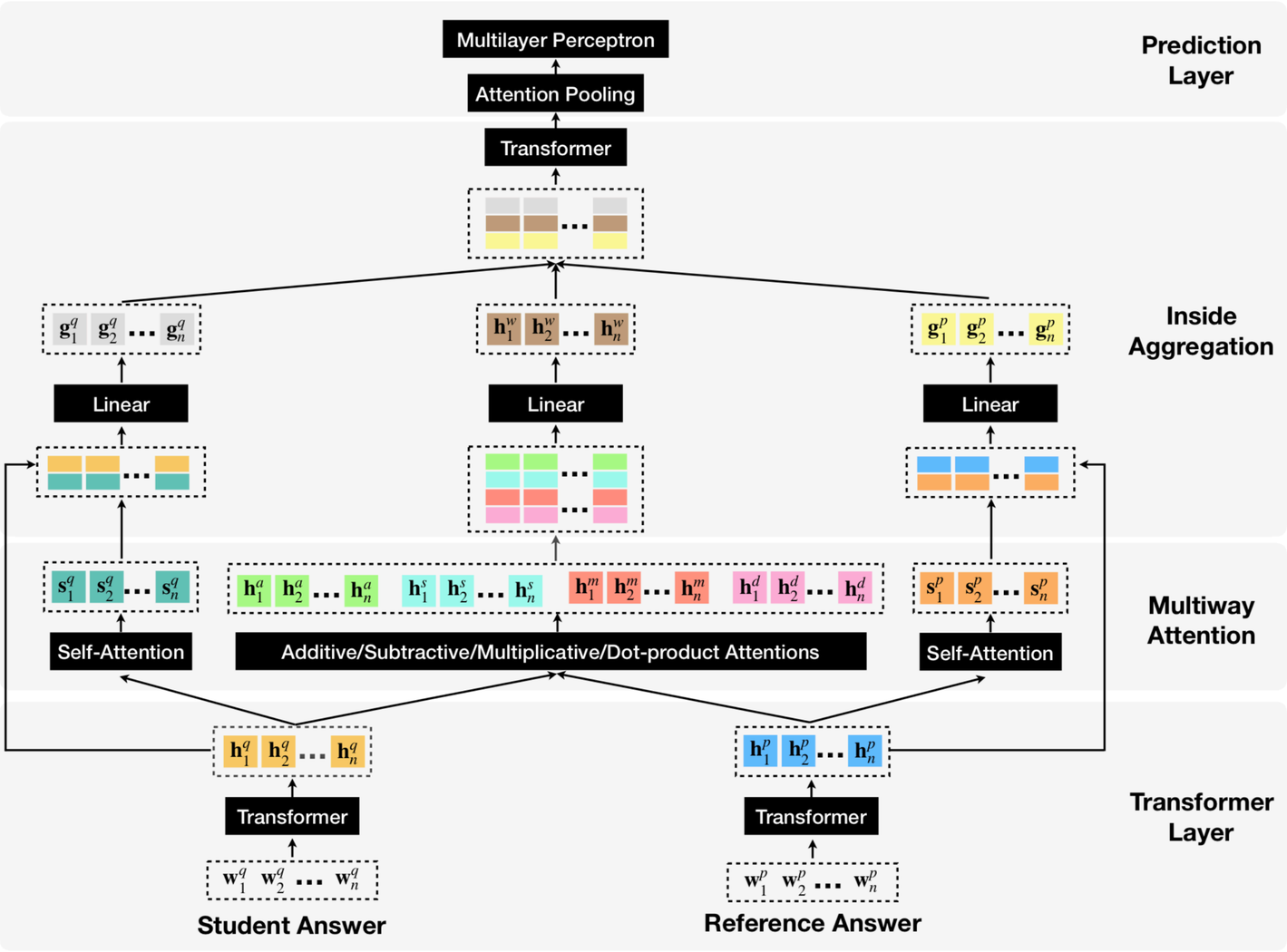
Introduction



★ + 评价



Our Solution



Dataset

We collect 120,000 pairs of student answers and questions. Each labeled with binary value indicating whether the student has the right answer.

Results

Table 1: ASAG performance comparison on a real-world K-12 dataset.

	LR	GBDT	TextCNN	Bi-Transformer	MaLSTM	MAN	Our
Accuracy	0.8297	0.8628	0.8772	0.8813	0.8825	0.8808	**0.8899**
AUC	0.8808	0.9287	0.9312	0.9335	0.9375	0.9365	**0.9444**

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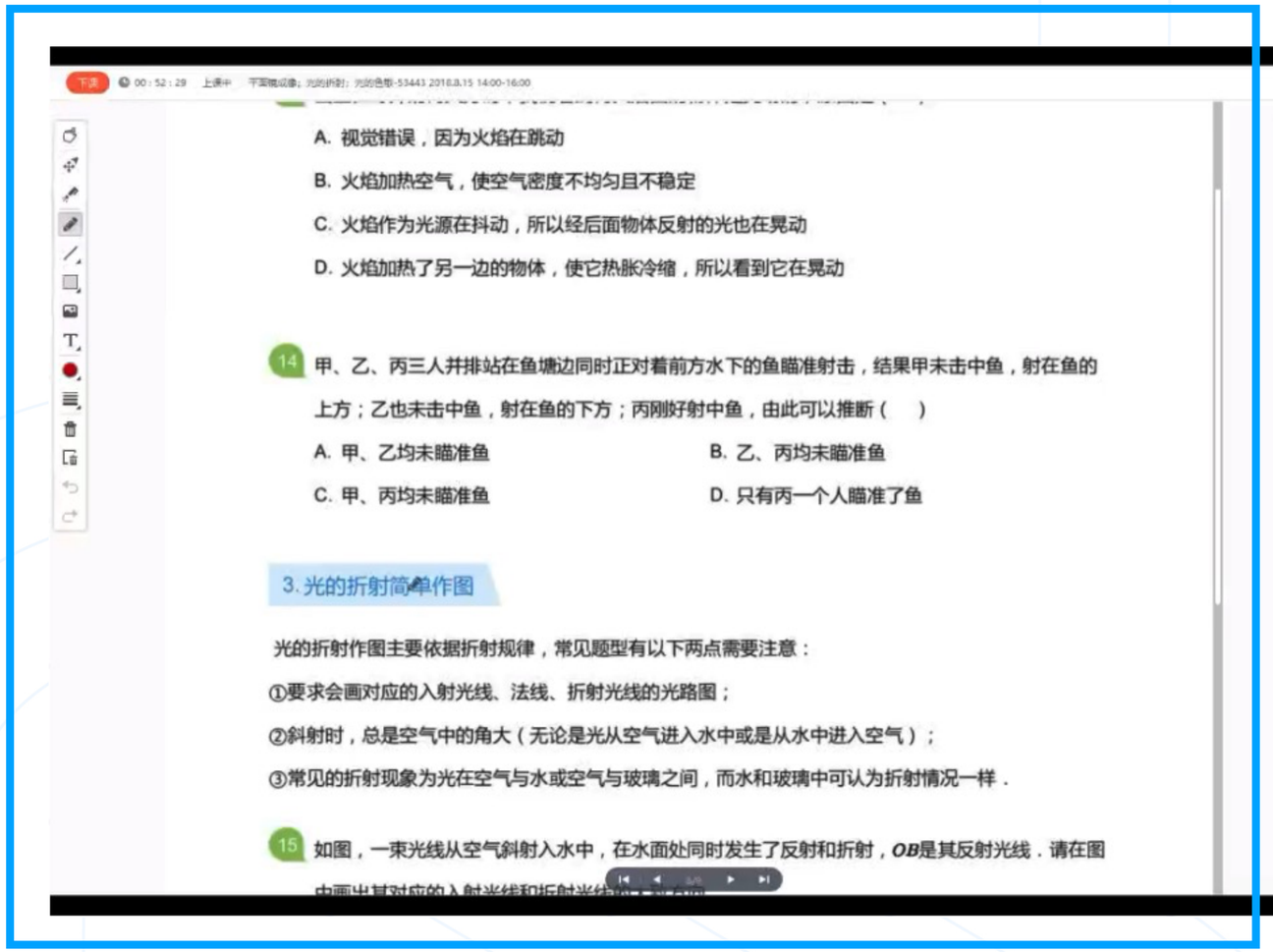
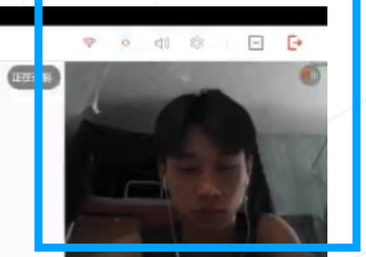
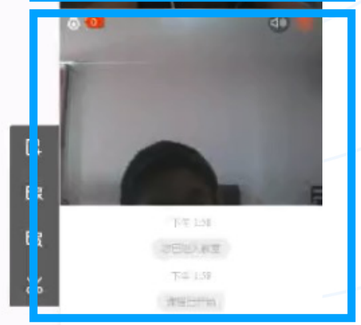
Introduction

Slides





Instructor



Student

Solution

	愿表达		勤动笔		善总结	
评价项	问答 AI分级	讲题 AI分级	笔记 AI分级	做题 老师分级	错误纠因 AI分级	导图PK AI分级
	提问	新方法见解	关联其他	独到简单方法	设法改进	拓展反思
	回答完整	独立完成	重点突出	完整做出	完成阐述	提炼重点
	回答不完整	辅助完成	完成记录	部分完成	指出原因	梳理归类
	不回答	不能完成	无笔记	无从下手	错因不明	无法画出

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AI + Education

Challenges and **MORE** opportunities!

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Thanks!