

교육과 AI 기술

최근 연구 현황과 분야별 흐름을 중심으로



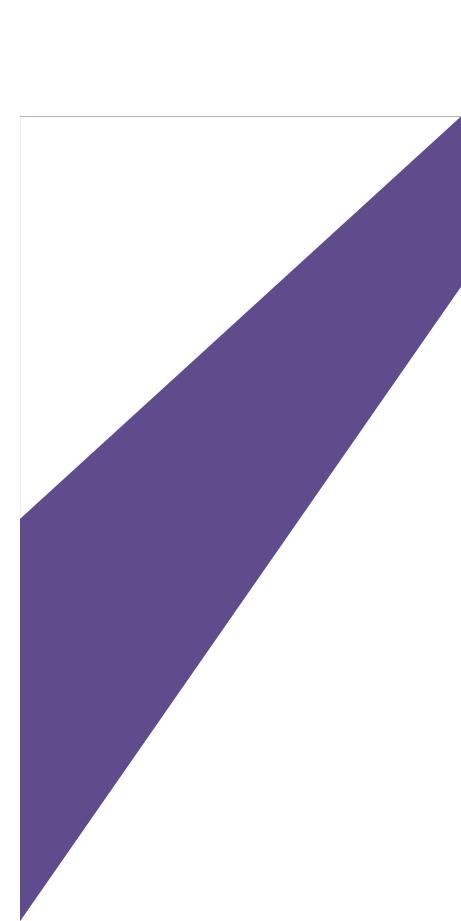
이주진

(현) 카카오브레인 재직 중

(현) 연세대학교 재학 중 (수학, 전기전자공학)

2017 SW Maestro 기술 인증 (과기정통부, 개인화 수학 교육 PoC)

2016 삼성 드림클래스 대표강사

- 
- 
- ① 교육 AI 관련 학회**
 - ② 세부 분야와 연구 소개**
 - ③ 에듀테크와 미래 교육**

교육 AI 관련 학회

CV

컴퓨터 비전

NLP

자연어 처리

RL

강화학습

대부분이 NLP!

교육 AI 관련 학회

NLP 중심 학회

ACL

EMNLP

BEA (워크샵)

교육 중심 학회

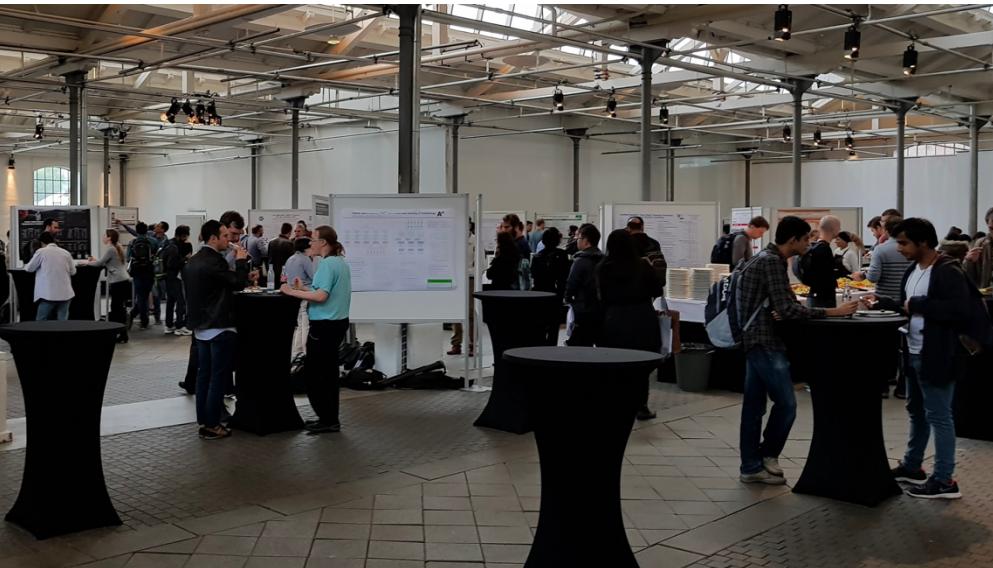
ICLS

L@S

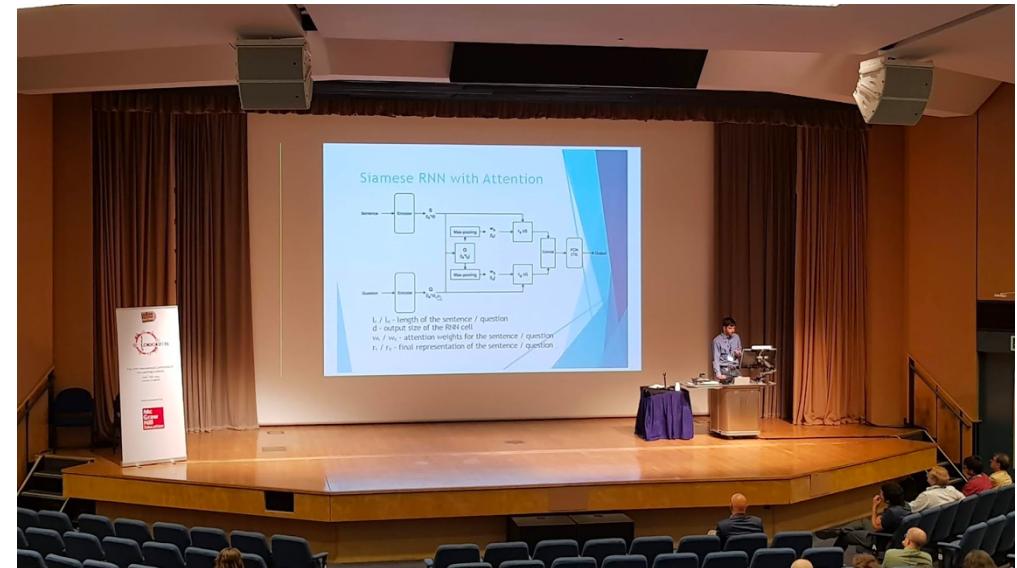
AIED

교육 AI 관련 학회

(가봤습니다)



EMNLP+BEA 2017



ICLS+L@S+AIED 2018

세부 분야

AI 개인화 교육을 위한 6가지 기술

모델링

문제와 학생을 이해하는 기술

평가 (진단)

학습 성취 여부를 진단
객관식을 넘어, 주관식+서술형까지 확장

추천

진단 결과를 바탕으로 다음 학습을 제안

상태 분석

학생의 현재 상태를 파악 (진전이 없는 등)
풀이의 변화, 스크롤, 안구 등을 활용 가능

상호작용

적정한 시점에 필요한 피드백을 제공
반대로 학생의 의견/질문을 받는 것도 중요

데이터 (서비스)

풍부한 데이터 수집이 가능한 서비스 UI/UX
AI 모델이 사용할 수 있도록 데이터 가공

문제의 이해

수학

자연어 수학 문제

What is 30 divided by half plus 10?

기계가 이해 가능한 형태

Tree, Equation, Operation, ...

정답 도출

$30/0.5 + 10 = 70$

EMNLP 2017

Beyond Sentential Semantic Parsing: Tackling the Math SAT with a Cascade of Tree Transducers

Allen AI - Project Euclid

Deep Neural Solver for Math Word Problems

Tencent AI Lab

Learning Fine-Grained Expressions to Solve Math Word Problems

Microsoft Research, Tencent AI Lab

EMNLP 2015

Solving Geometry Problems: Combining Text and Diagram Interpretation

Allen AI - Project Geos

ACL 2019

MathQA: Towards Interpretable Math Word Problem Solving with Operation-Based Formalisms

University of Washington, Allen AI

IEEE 2018

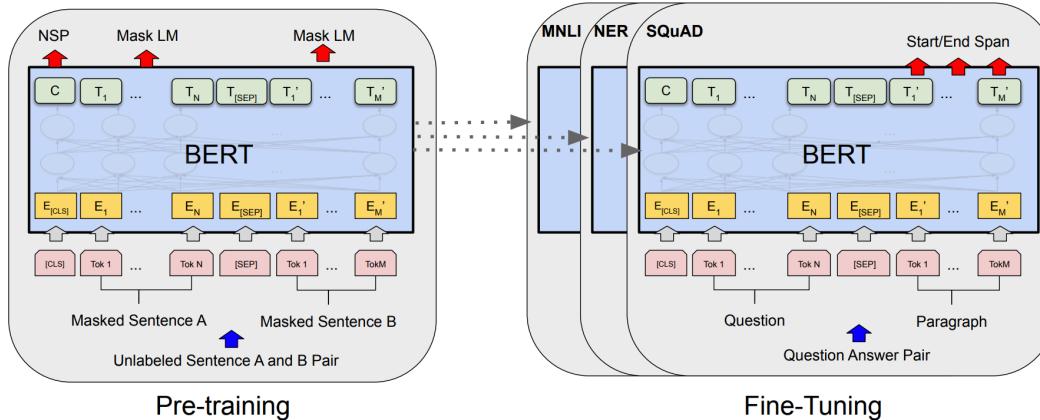
The Gap of Semantic Parsing: A Survey on Automatic Math Word Problem Solvers

Review Paper, arXiv 1808.07290

문제의 이해

영어

영어 문제의 이해 = 영어 텍스트의 이해



We notice a man in a kayak and a yellow helmet coming in from the left. As he approaches, his kayak...

- a) has a frozen body of water and begins to flood water.
- b) slides down the ski slope towards another section of the city.
- c) flips upside - down.
- d) is reflected in the bucket in a narrow choppy river.

The person blows the leaves from a grass area using the blower. The blower...

- a) puts the trimming product over her face in another section.
- b) is seen up close with different attachments and settings featured.
- c) continues to blow mulch all over the yard several times.
- d) blows beside them on the grass.

EMNLP 2018

SWAG: A Large-Scale Adversarial Dataset for Grounded Commonsense Inference / Allen AI - Project Mosaic

arXiv 2018

BERT: Pre-training of deep bidirectional transformers for language understanding / Google

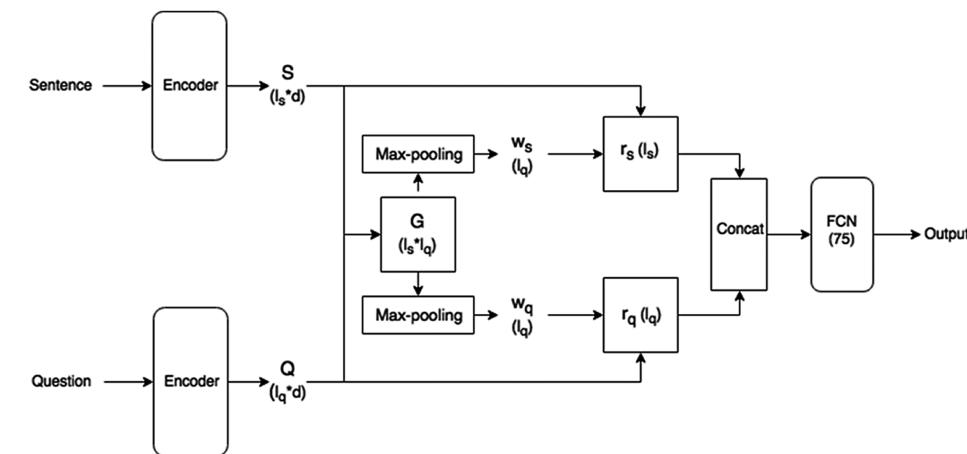
문제의 이해

문제의 퀄리티

문제의 질문 깊이 분류 w/ Encoder + Attentive Pooling

Table 1. The modified Graesser Person question taxonomy from Kopp et al. [28].

Level	Question categories from Graesser and Person Taxonomy [11]	Examples
Very shallow (1)	Verification, Disjunctive, Concept Completion, Quantification	Is 911 the emergency number everywhere?
Shallow (2)	Feature Specification, Definition, Example	What Constitutes an Emergency?
Deep (3)	Comparison Instrumental/procedural, enablement, Judgmental	Why are the majority from cell phones?
Very deep (4)	Interpretational, Antecedent, Consequence, Goal Orientation, Expectational	What happens if you call 911 in a non-emergency?



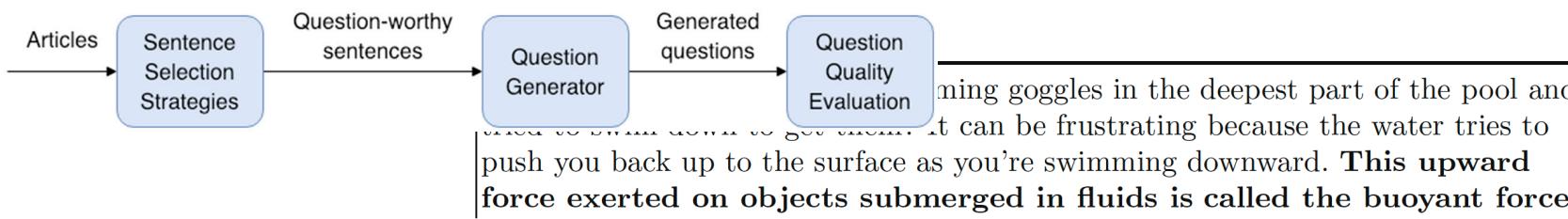
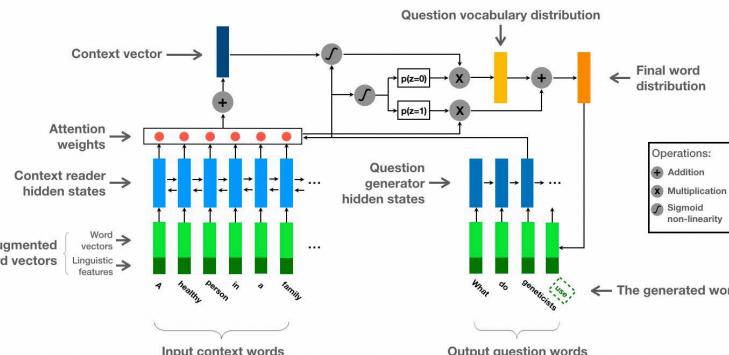
문제의 생성

Seq2Seq 기반

Context: A healthy person in a family in which some members suffer from a recessive genetic disorder may want to know if he or she has the disease-causing gene and what risk exists of passing the disorder on to his or her offspring. Of course, doing **a test cross in humans** is unethical and impractical. Instead, geneticists use **pedigree analysis** to study the inheritance pattern of human genetic diseases.

QG-Net: What is unethical in humans?

QG-Net: What do geneticists use to study the inheritance pattern of human genetic diseases?



L@S 2018

QG-Net: A Data-Driven Question Generation Model for Educational Content / Rice Univ., Princeton Univ., OpenStax

AIED 2019

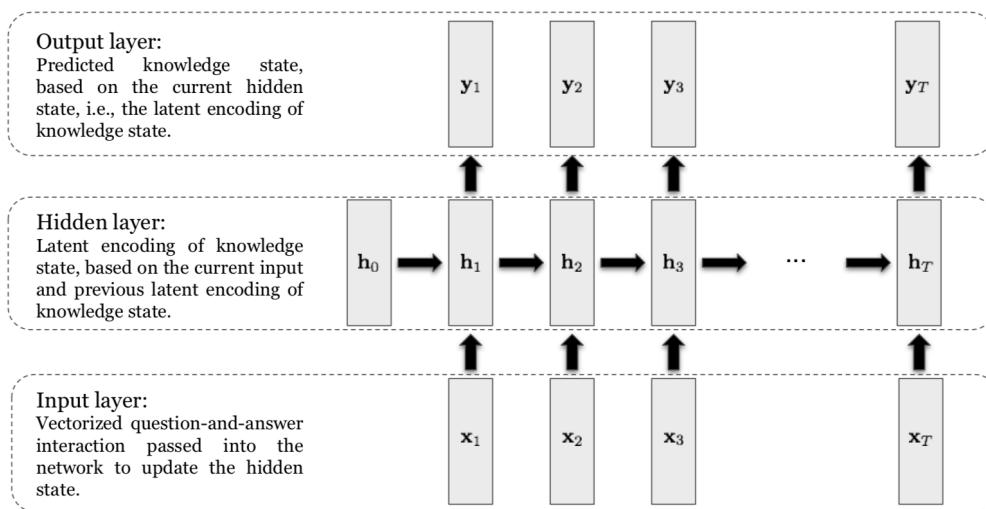
A Comparative Study on Question-Worthy Sentence Selection Strategies for Educational Question Generation / Monash University, Univ. of Fribourg

QG-Net
LSTM seq2seq w/ Attention

문제 생성을 위해
가장 적합한 문장 찾기

학생 성취도

학생의 정오 기록을 바탕으로 영역별 성취도 예측



각 스킬셋에 대한 성취도 확률 0~1
다음 문제의 one hot과 곱하여 Loss 계산

Vanila RNN or LSTM

ASSIST 데이터셋을 입력으로 활용
각 time step에서의 문제와 정답 여부 pair로 구성

단답형 답안 채점을 위한 BERT의 활용

BERT + SNLI Dataset을 바탕으로 Sentence Pair Classification이 된 것을 응용하여,
심리학 분야의 단답형 답안이 맞는지(CO), 틀린지(IC), 부분적으로 맞는지(PC) 분류

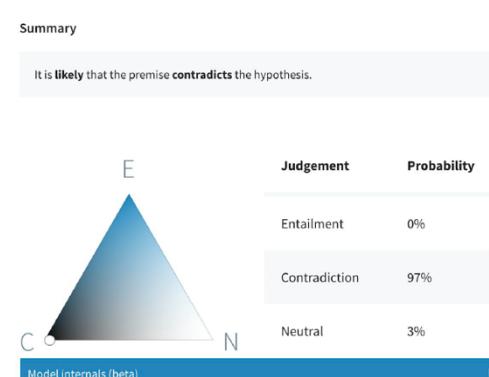
Textual Entailment

Textual Entailment (TE) takes a pair of sentences and predicts whether the facts in the first necessarily imply the facts in the second one. The AllenNLP toolkit provides the following TE visualization, which can be run for any TE model you develop. This page demonstrates a reimplementation of the decomposable attention model (Parikh et al., 2017), which was state of the art for the SNLI benchmark (short sentences about visual scenes) in 2016. Rather than pre-trained Glove vectors, this model uses ELMo embeddings, which are completely character based and improve performance by 2%

Enter text or Choose an example... ▾

Premise
Two women are wandering along the shore drinking iced tea.

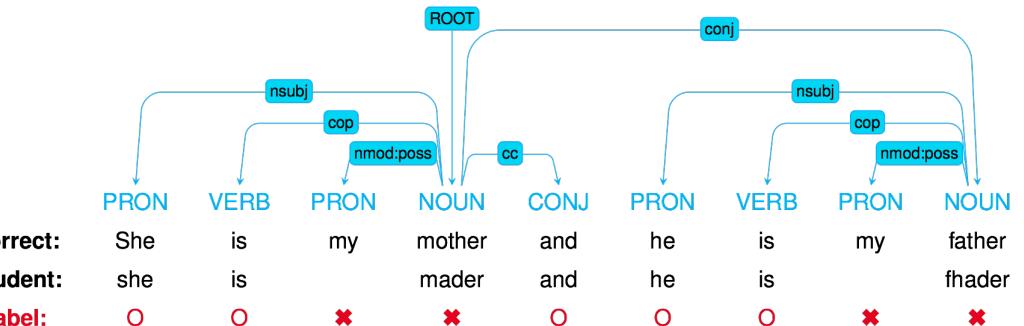
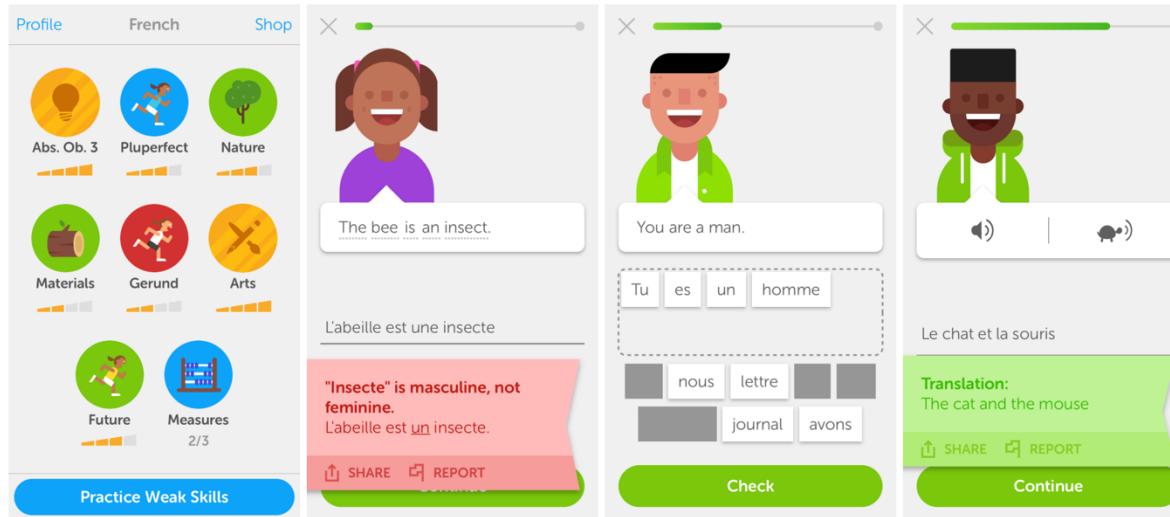
Hypothesis
Two women are sitting on a blanket near some rocks talking about politics.



Dataset	Class distribution			Train-test split	
	Training	Test			
SemEval-2013 [7]	4,459 (co)	5,307 (ic)	1,038 (cd)	4,969	540 (UA) 733 (UQ) 4,562 (UD)
Psychology domain 1	14,460 (co)	3,845 (pc)	1,790 (ic)	16,076	4,019
Psychology domain 2	12,295 (co)	2,495 (pc)	1,090 (ic)	12,704	3,176

평가

작문 / 번역 점수화



사용자의 번역 평가 : Ensemble of LSTM + GBDT

BEA 2017

A Large Scale Quantitative Exploration of Modeling Strategies for Content Scoring / ETS

BEA 2018

Duolingo Shared Task on Second Language Acquisition Modeling / Duolingo

문법이 잘못된 문장 교정

오픈소스 철자 교정기 + Copy-Augmented Transformer

예문 1

[입력] Also they would have an **opportunit**y being involved in **volontier** activity.
 [출력] Also, they would have an **opportunity** to be involved in **volunteer** work.

예문 2

[입력] Travel by bus is **exspensive**, **bored** and annoying.
 [출력] Travelling by bus is **expensive**, **boring** and annoying.

Results

All results in terms of span-based correction. The system output used to generate these results is avai

1. Restricted Track

#	User	Team Name
1	romang	UEDIN-MS
2	yjchoe33	Kakao&Brain
3	goo2go	LAIX
4	HelenY	CAMB-CLED



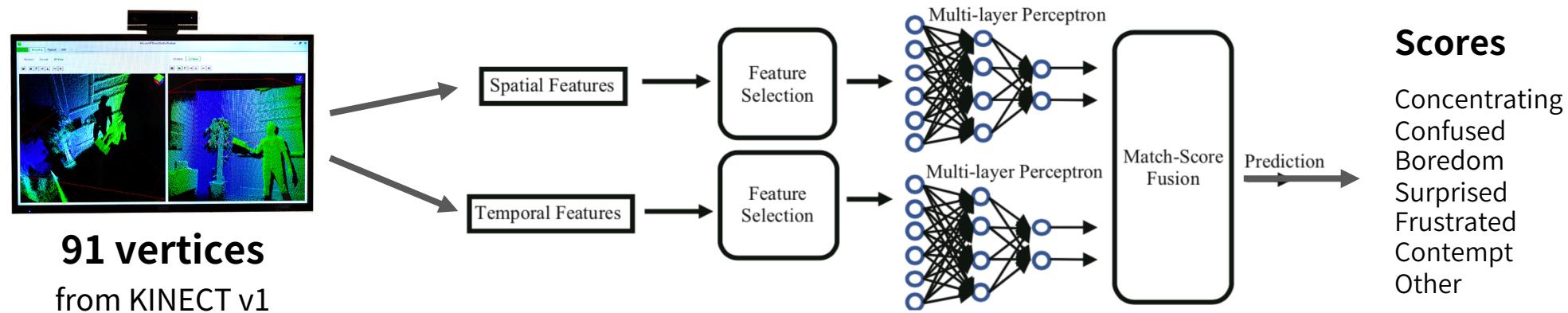
3. Low Resource Track

#	User	Team Name
1	romang	UEDIN-MS
2	JiyeonHam	Kakao&Brain
3	goo2go	LAIX
4	fs439	CAMB-CUED
5	arahusky	UFAL, Charles University, Prague
6	simonHFL	Siteimprove
7	Bohdan_Didenk	WebSpellChecker.com



상태 분석

스크롤, 안구, 포즈 등을 활용하여 학생의 상태를 실시간으로 파악



ICLS 2018

Is Scrolling Disrupting While Reading? / Vanderbilt Univ.

ICLS 2018

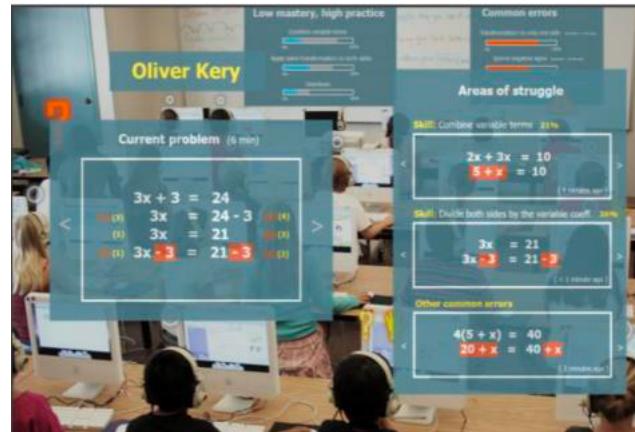
Interlacing Gaze and Actions to Explain the Debugging Process / NTNU, EPFL

AIED 2019

4D Affect Detection: Improving Frustration Detection in Game-Based Learning with Posture-Based Temporal Data Fusion / NCSU, U.S. Army, UPenn

상호작용

HoloLens를 활용하여 학생들의 이해 상태를 실시간으로 파악, 적당한 대응 유도



-  **idle**
(no interactions in the software for 2 minutes or more)
-  **rapid attempts**
(many attempts or hint requests in quick succession)
-  **hint abuse or gaming the system**
(e.g., systematic guessing, or misuse or unnecessary use of the software's help resources)
-  **low local error**
(low recent error rate on current activity)
-  **high local error**
(high recent error rate on current activity)
-  **high error after hints**
(high error rate, even after using all hints on a given step)
-  **hint avoidance**
(not using hints, when they are likely needed)
-  **unproductive persistence**
(unlikely to master one or more skills)



세부 분야와 연구 소개

NLP 중심 학회

AI를 교육 분야에 적용

AI 교육
핵심 기술셋

학생/문제
모델링

평가
(진단)

추천

상태 분석

상호작용

데이터
(서비스)

ACL

EMNLP

BEA (워크샵)

교육 중심 학회

교육 개선에 AI를 도입

ICLS

L@S

AIED

에듀테크와 미래 교육

교육 중심 학회

ICLS

L@S AIED

현재의 교육 체계에서
개인화, MOOC 등으로 개선

에듀테크와 미래 교육

교육 중심 학회

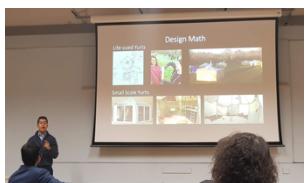
ICLS

L@S AIED

현재의 교육 체계에서
개인화, MOOC 등으로 개선



‘21세기 스킬’을 가르치기 위한 교육 실험들



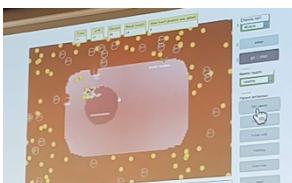
텐트 짓기로 기하학 학습



벌과 개미 역할 체험하기



텍스타일 코딩 프로젝트



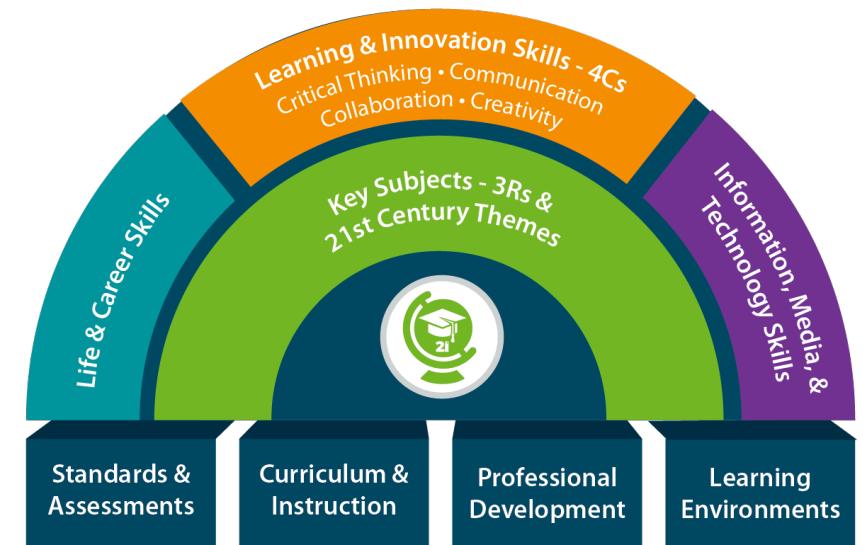
당뇨 세포 시뮬레이션

PBL

협력

몰입과 재미

리소스의 확장



© 2019, Battelle for Kids. All Rights Reserved.

Image References : p21 learning framework

에듀테크와 미래 교육

과목 간 경계를 넘나드는 PBL을 모든 개별 학생에 맞게 하려면...?

AI 교육
핵심 기술셋

학생/문제
모델링

상태 분석

평가
(진단)

상호작용

추천

데이터
(서비스)

필요한 기술셋은 똑같은데...





**AI 기술이 바꾸어 나갈
교육의 미래를 기대해봅니다!**



교육과 AI 기술

최근 연구 현황과 분야별 흐름을 중심으로