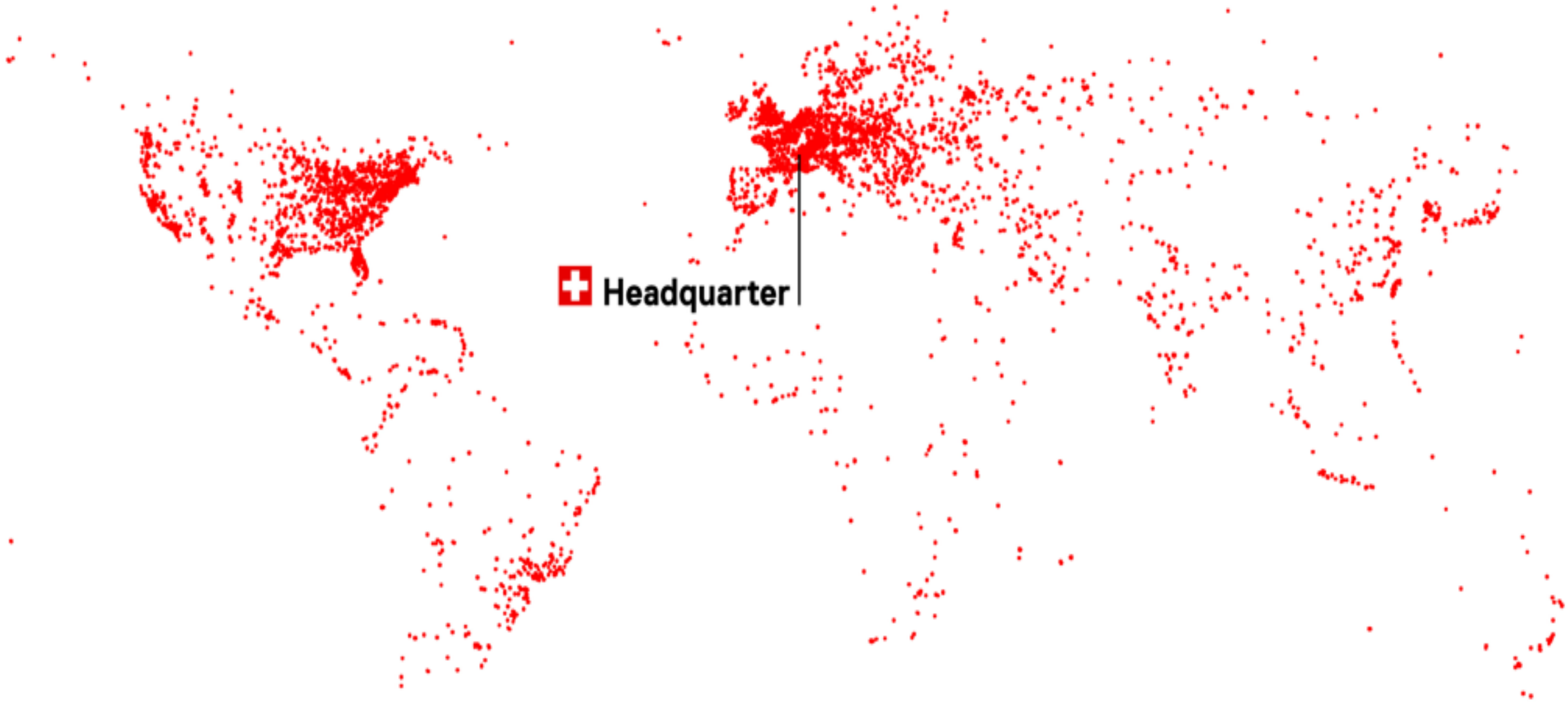
Education as a computational science

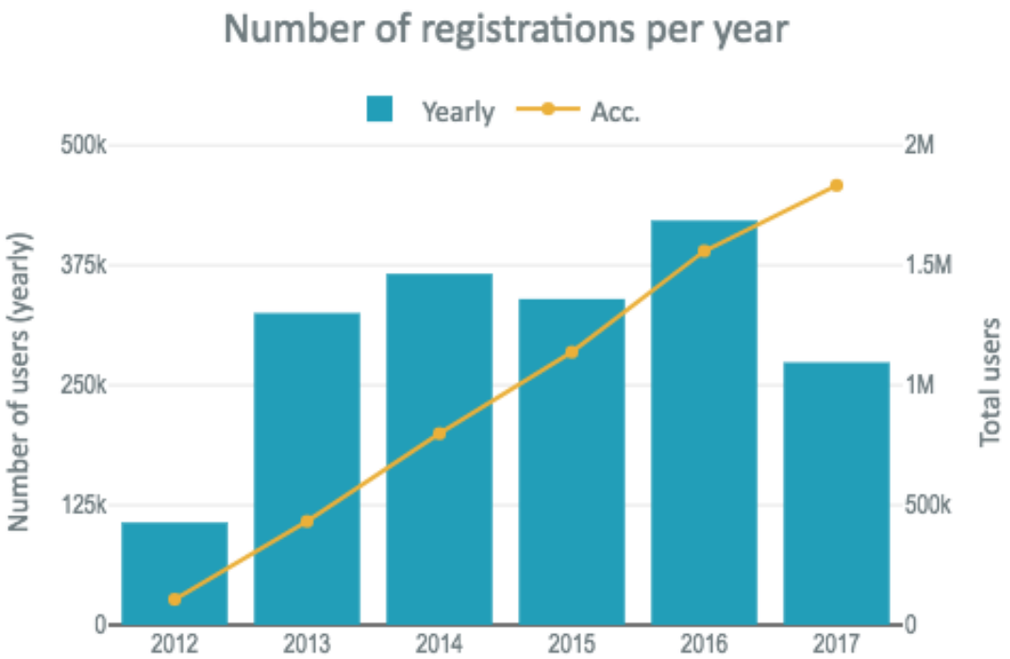
Pierre Dillenbourg, EPFL

EPFL CAMPUS

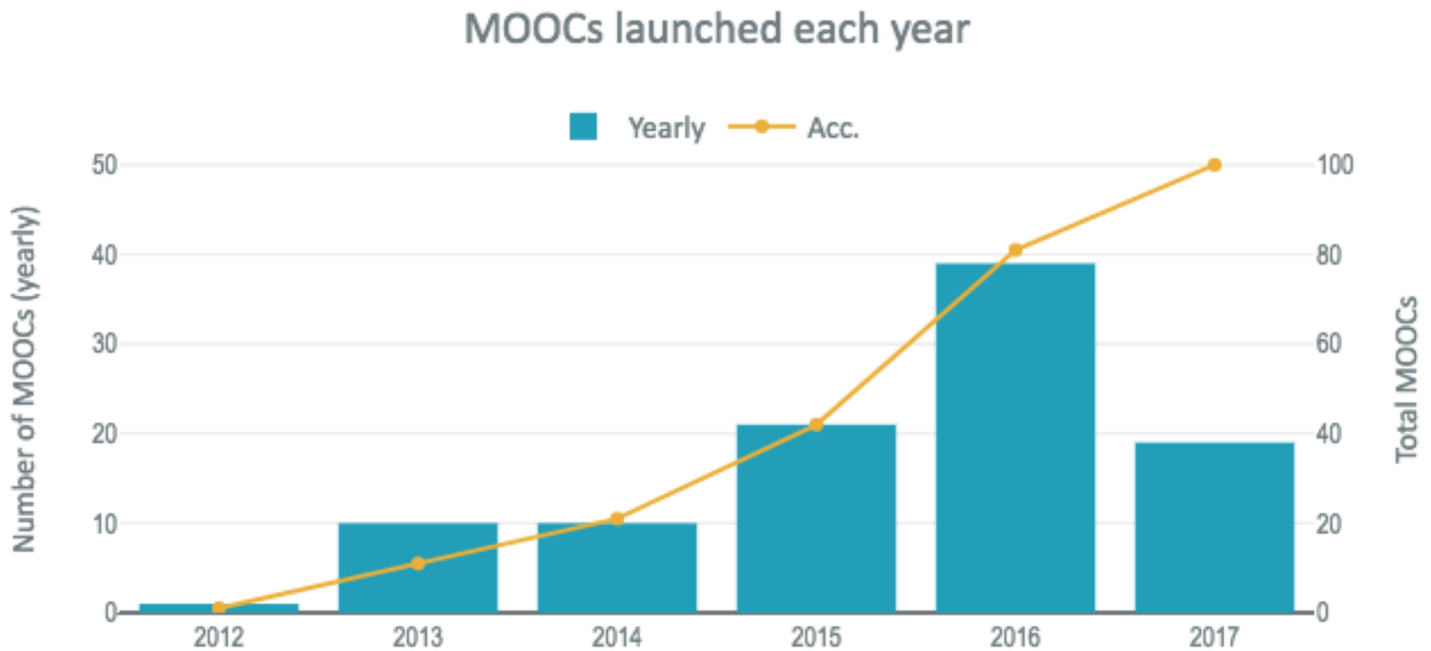


EPFL MOOCS: 1’908’876

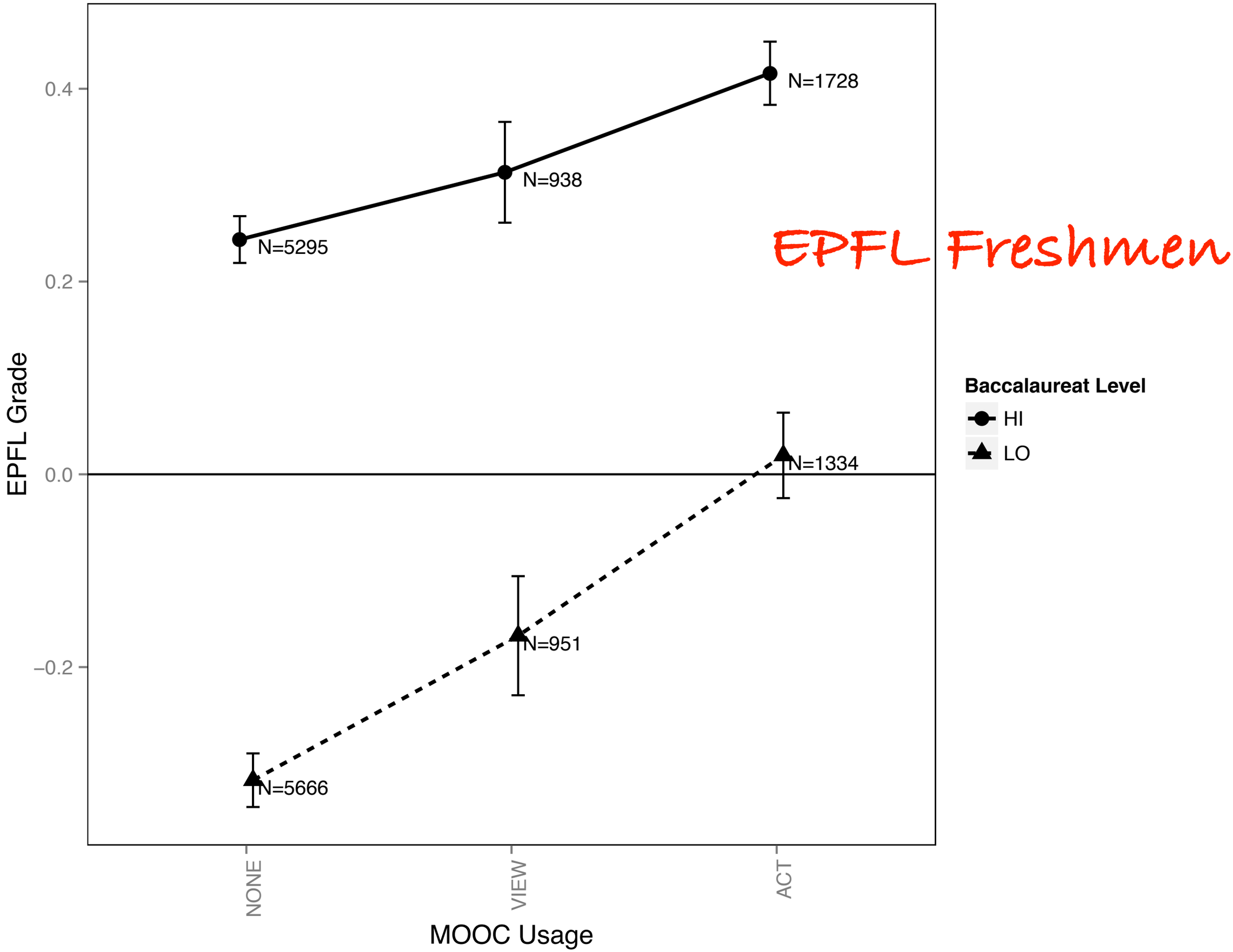
Hype is over but MOOCs continue to grow ….



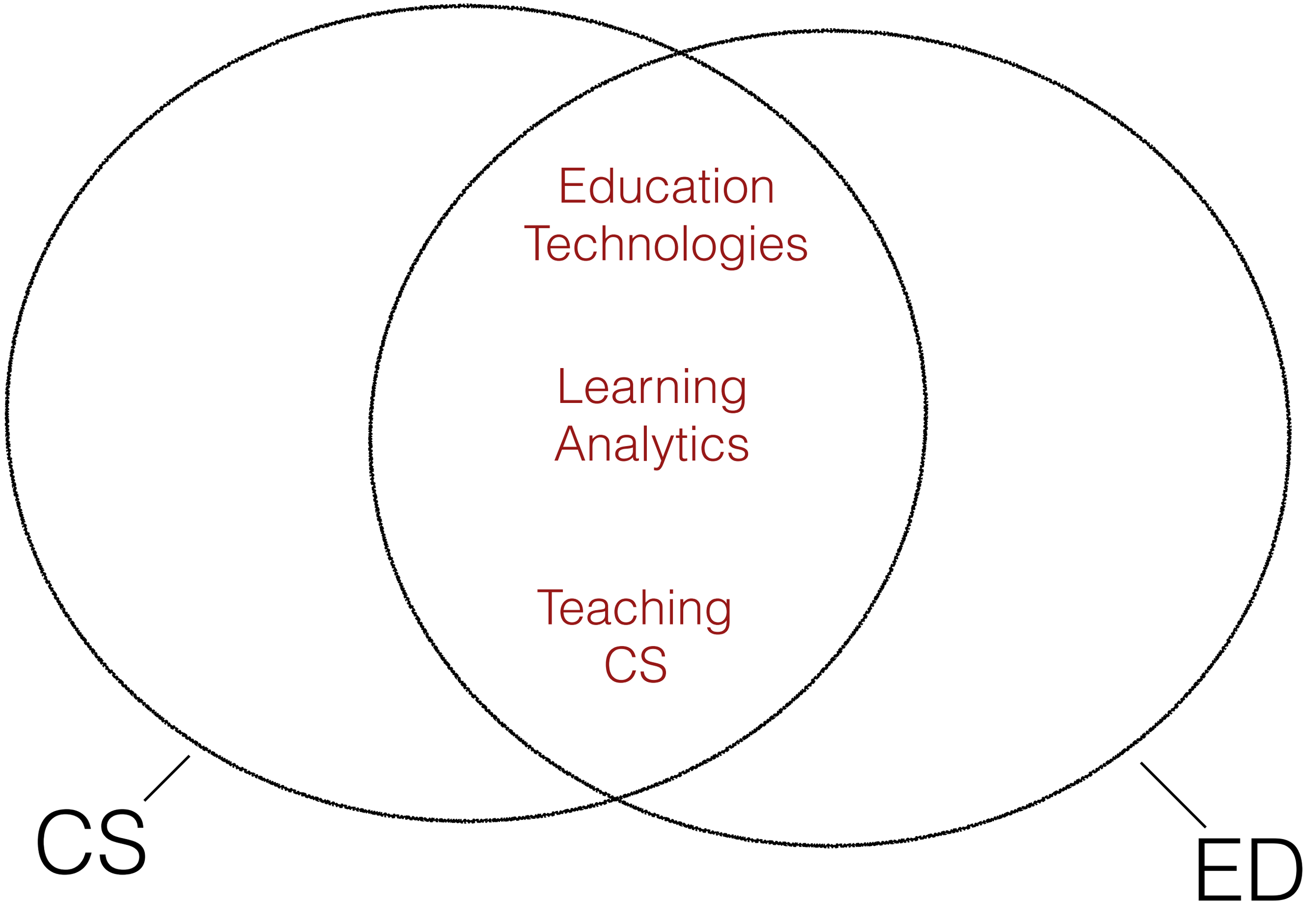
1’815’471 Registrations
97‘510 Passed



77 Courses Online
35 Courses In Preparation

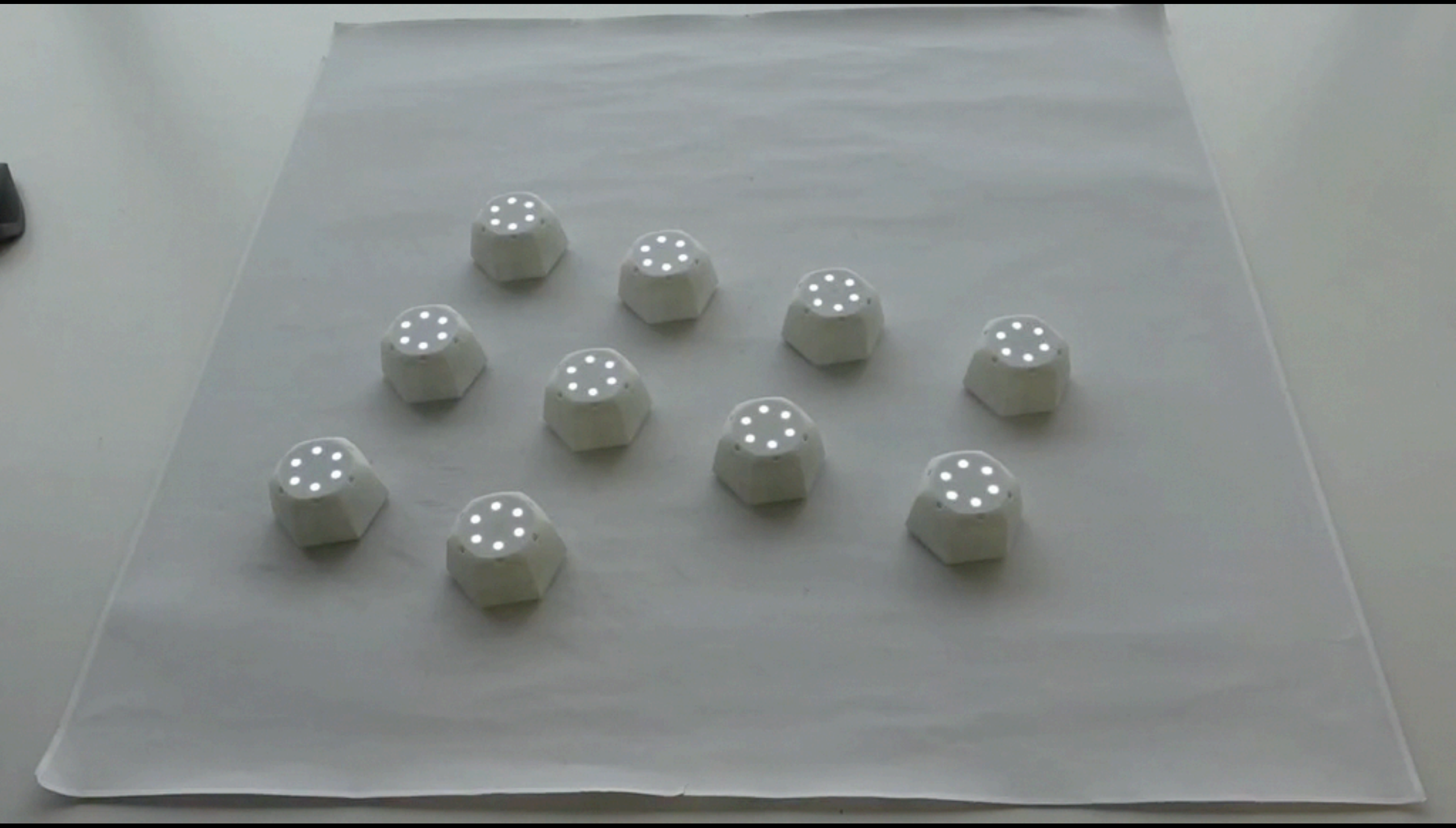


Patrick Jermann, Francisco Pinto (EPFL CEDE)


Education
Technologies
Learning
Analytics
Teaching
CS
CS
ED

e-learning ??????????

Pierre Dillenbourg, EPFL



Swarm Cellulo (Ayberk Ozgur, Wafa Johal, P. DIllenbourg)

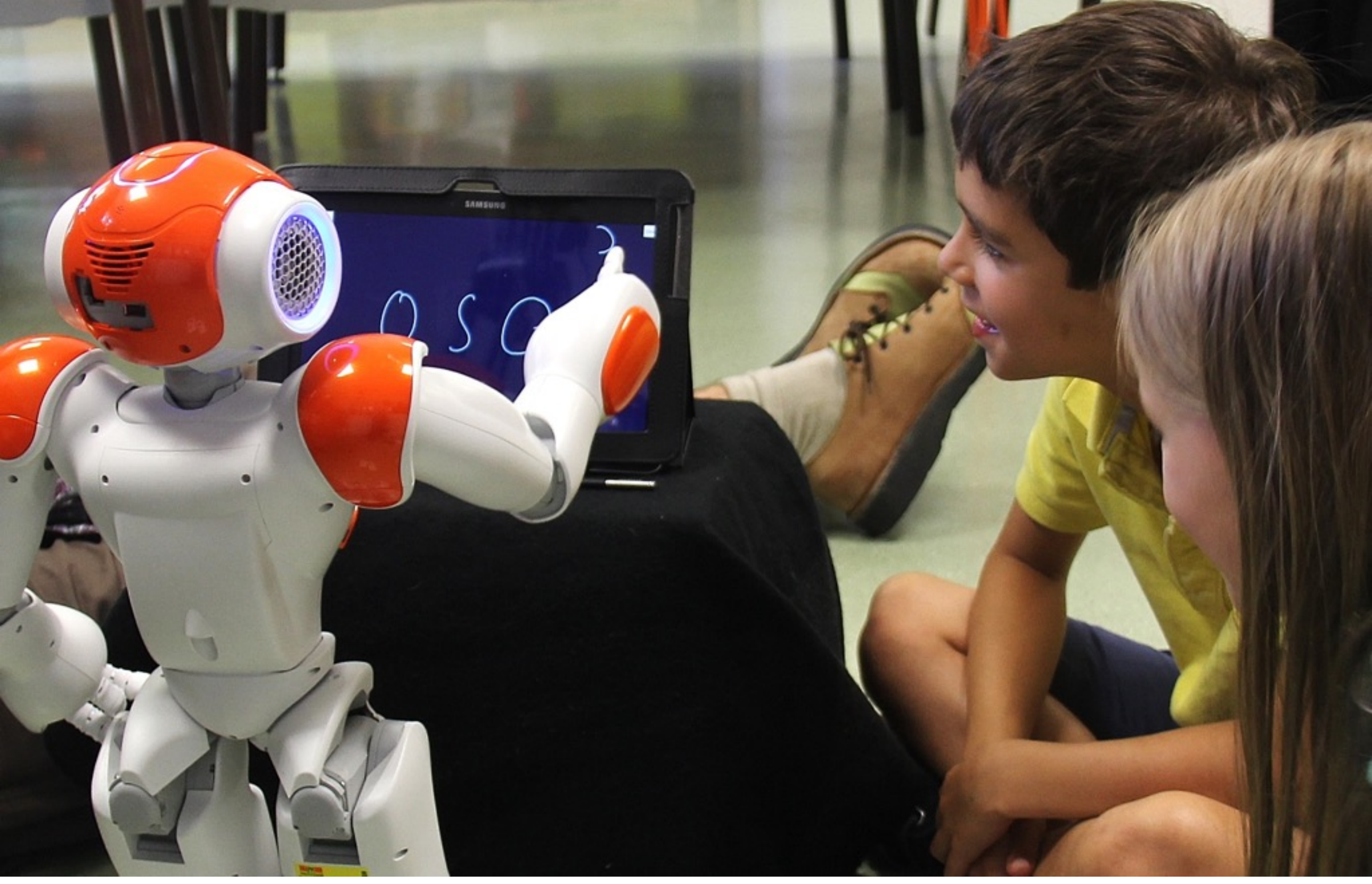
Swarm

Interactions

CS

ED

Education Technologies



robotics Swiss National Centre of Competence in Research

Johal, Lemaignan, Asselborn, Jacq, Billard, Paiva, Dillenbourg

Swarm

Interactions

Teachable

Agents

CS

ED

Education Technologies

Education
Technologies

Learning Analytics

Teaching
CS

CS

ED

learning Analytics

predict, classify, decide, 'explain'

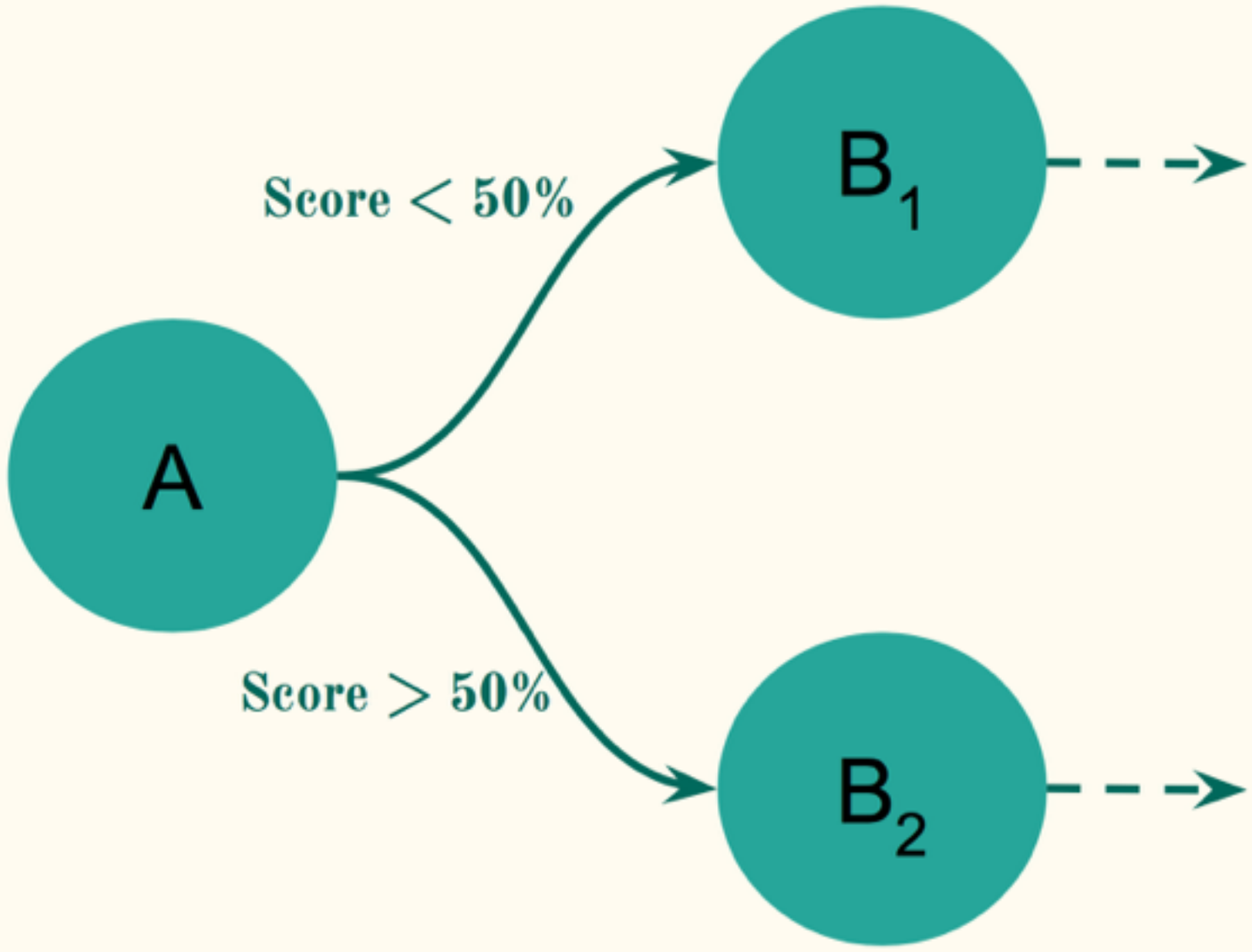
SVM, KMC, DNN, RNN, 2AM, POMDP

Computational Models

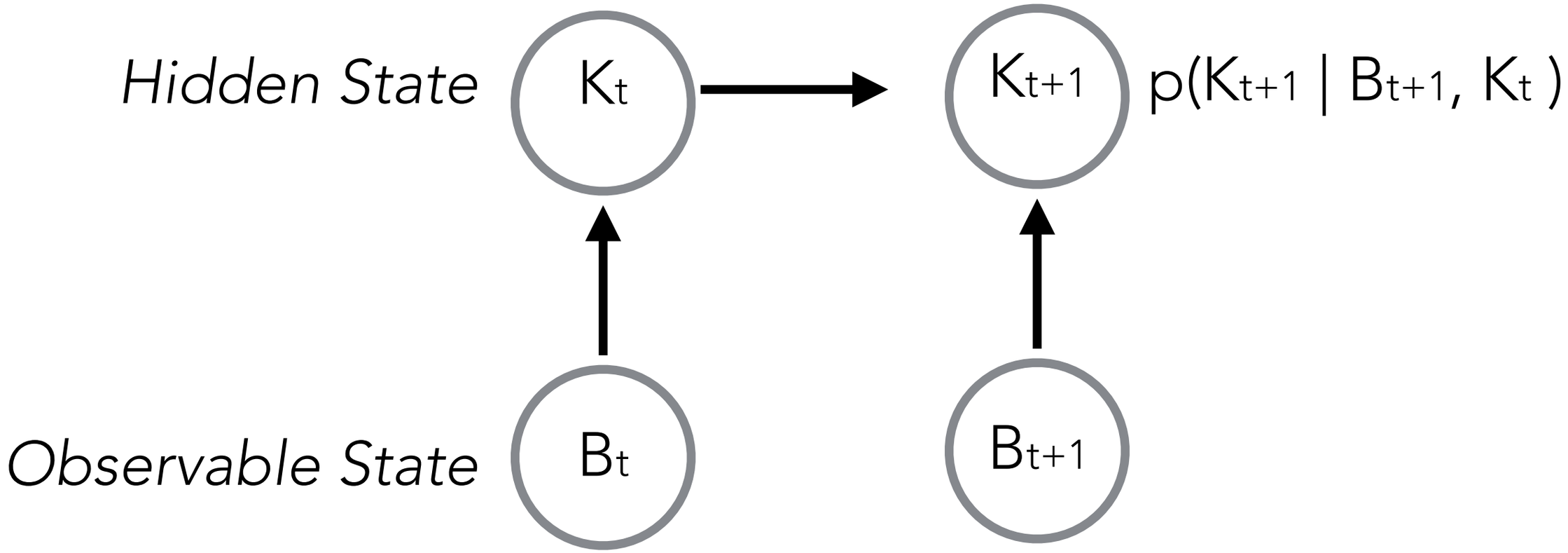
Education Research

Pierre Dillenbourg, EPFL

Adaptive systems



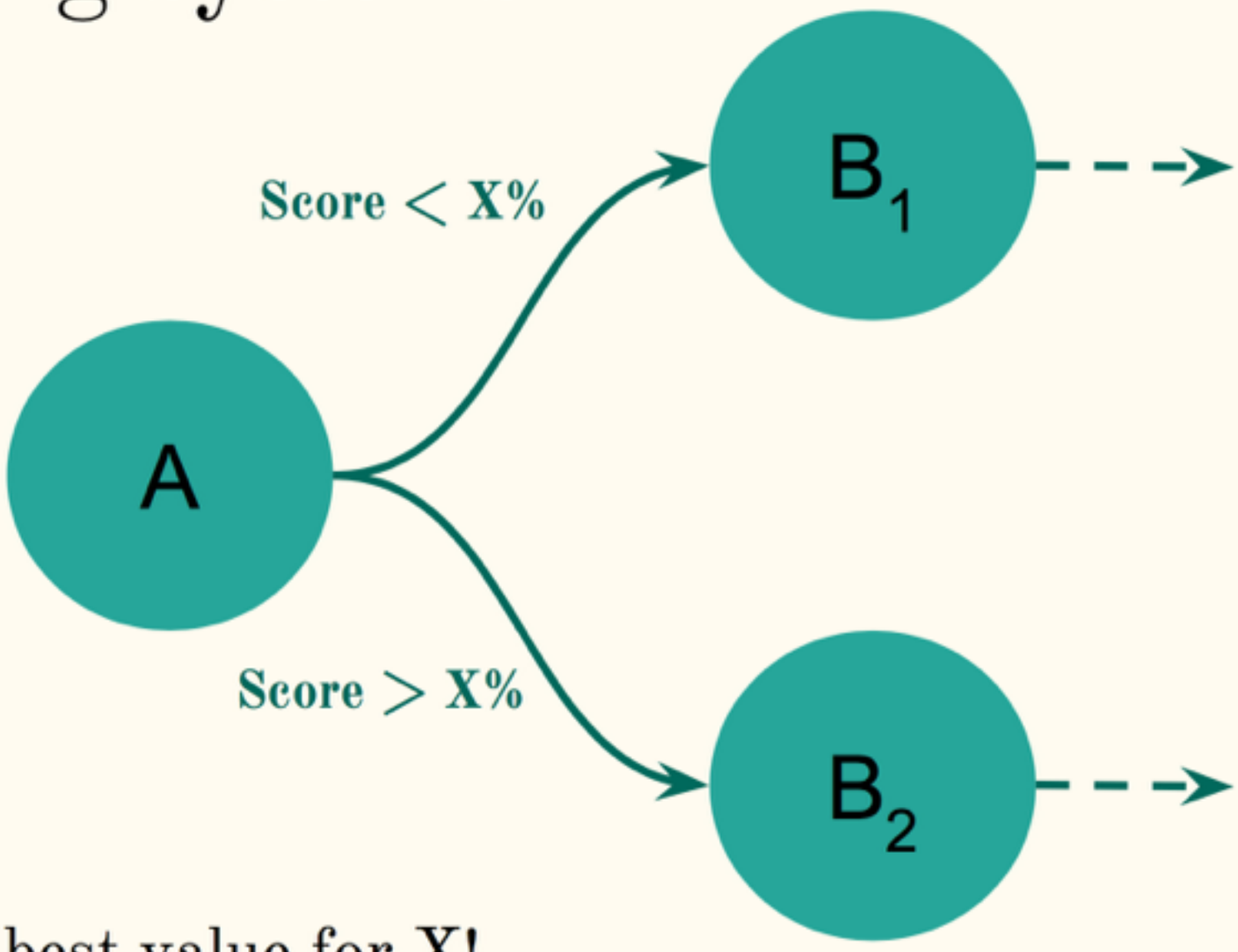
Bayesian Knowledge Tracing



$p(K_t = \text{'skill-x'} \mid B_t = \text{'correct answer'}) = 1 - \text{Guess}$

$p(K_t = \text{'skill-X'} \mid B_t = \text{'incorrect answer'}) = 0 + \text{Slip}$

Self-Improving systems



Find the best value for X!

Improve the management of education systems

Computational Models

Education Research

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What about modeling learning

outsider technology-based environments ?

Campus Analytics

pre-requisites p(Succeed (CS243) | Failed (CS201))

carreer p(Salary > T | {INF201, MA203,INF233,..})

recommender 78% of those who select CS243 also selected CS411

.....

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how deep ?

Relevant Behavioral Abstractions

(Features)

Computati
els

Education needs explainable AI

Education
Research

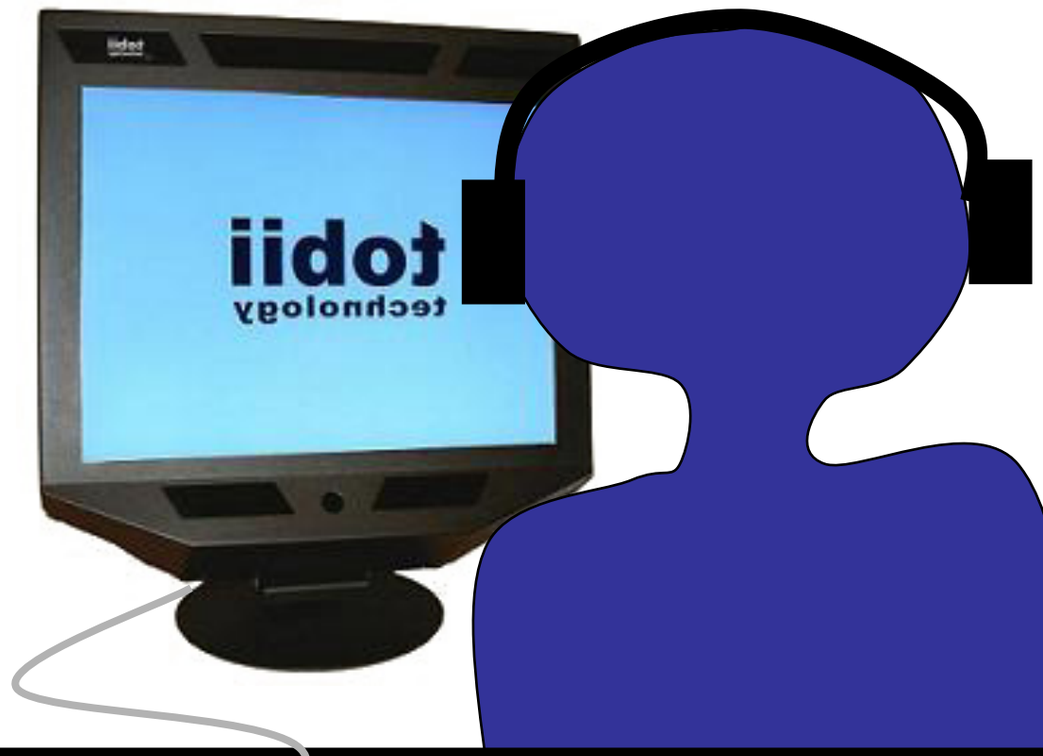
Pierre Dillenbourg, EPFL

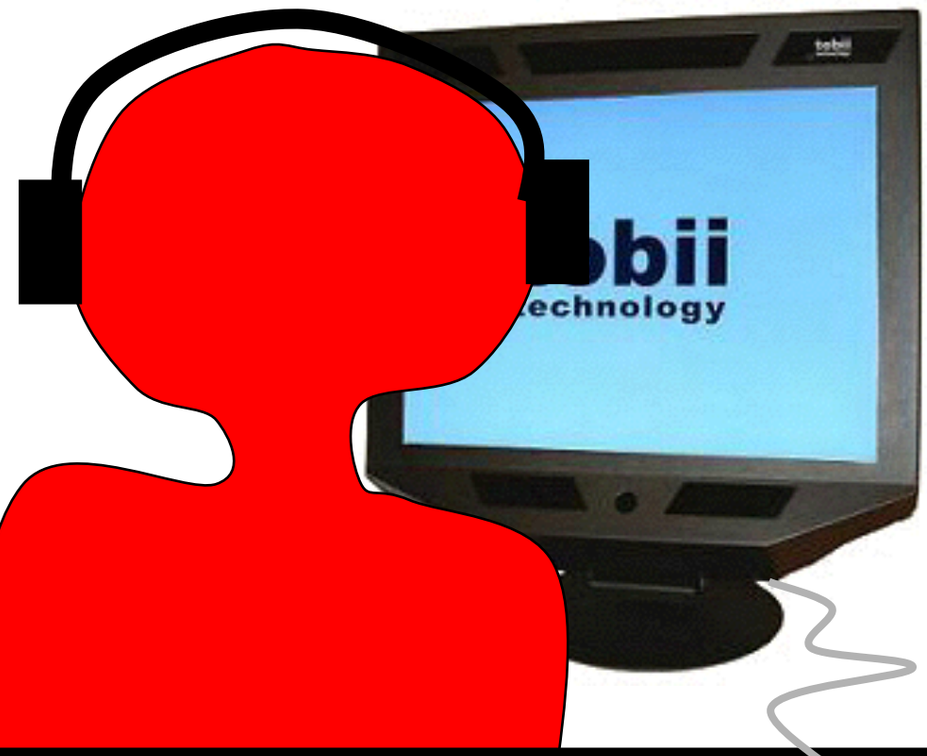
Relevant Behavioral Abstractions

(Features)

$$gaze(a) = f(gaze(b))$$

Gaze Recurrence





DUET - Dual Eye-Tracking
Pair programming experiment

Low gaze recurrence

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

P. Jermann, M.-A. Nüssli & P. Dillenbourg

Supported by the Swiss National Science Foundation
(grants #K-12K1-117909 and #PZ00P_126611)

DUET - Dual Eye-Tracking
Pair programming experiment

High gaze recurrence

P. Jermann, M.-A. Nüssli & P. Dillenbourg

Supported by the Swiss National Science Foundation
(grants #K-12K1-117909 and #PZ00P_126611)

Relevant Behavioral Abstractions

gaze(listener)=*f*(gaze(speaker))

Feature: *Gaze recurrence*

Context: *Collaborative learning*

Eye tracking experiment on MOOC Video

Following teacher's references

Gaze of students' watching Scala course by Prof. Martin Odersky (EPFL, Switzerland)

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

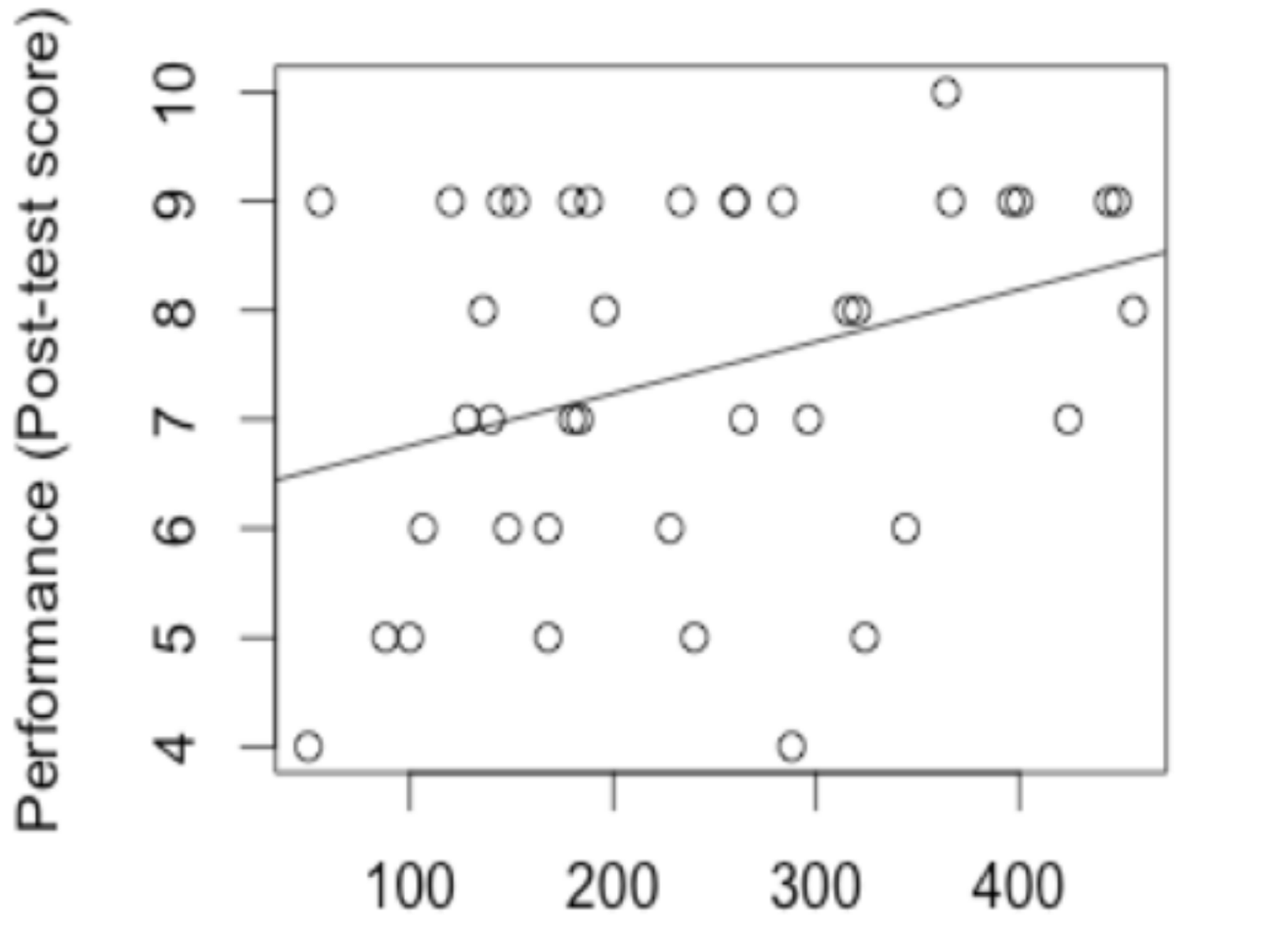
K. Sharma, P. Jermann, P. Dillenbourg

@ CHILI – http://chili.epfl.ch

Supported by the Swiss National Science Foundation
(Grants CR1211_132996 and PZ00P2_126611)

Relevant Behavioral Abstractions

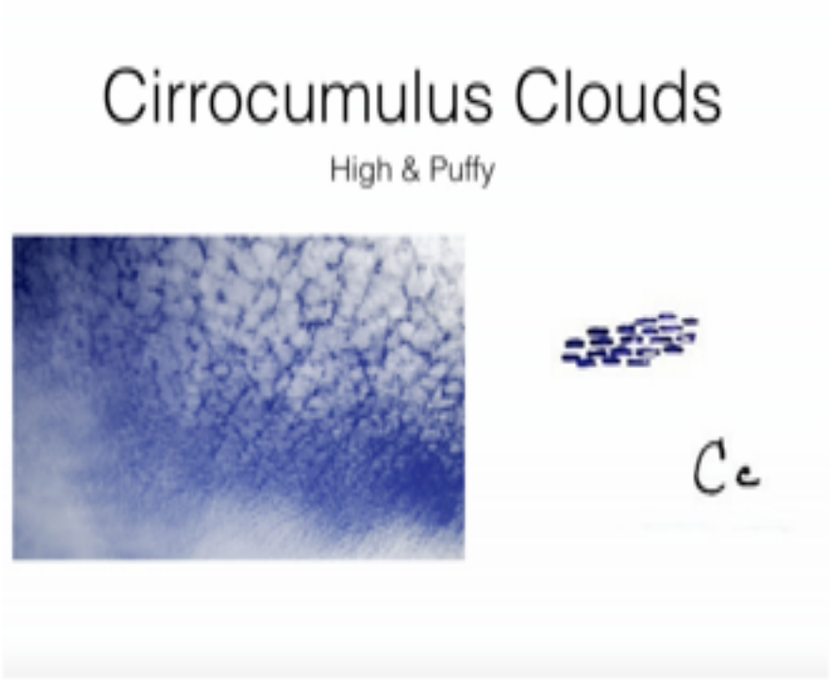
gaze (learner) = *f* (reference (teacher))



Feature: *Withmeness*

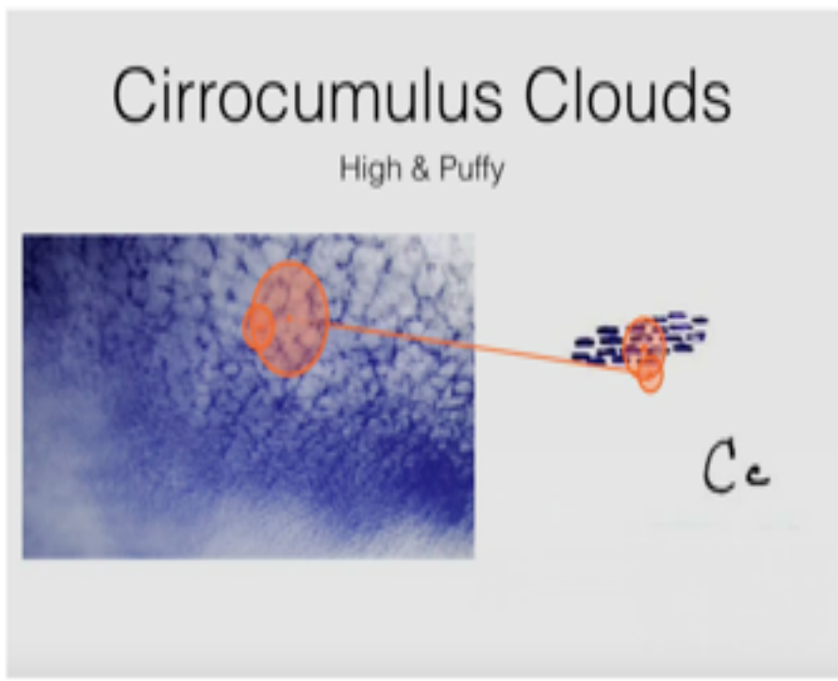
Context: *Lecturing*

No Visual Aid



Pointer

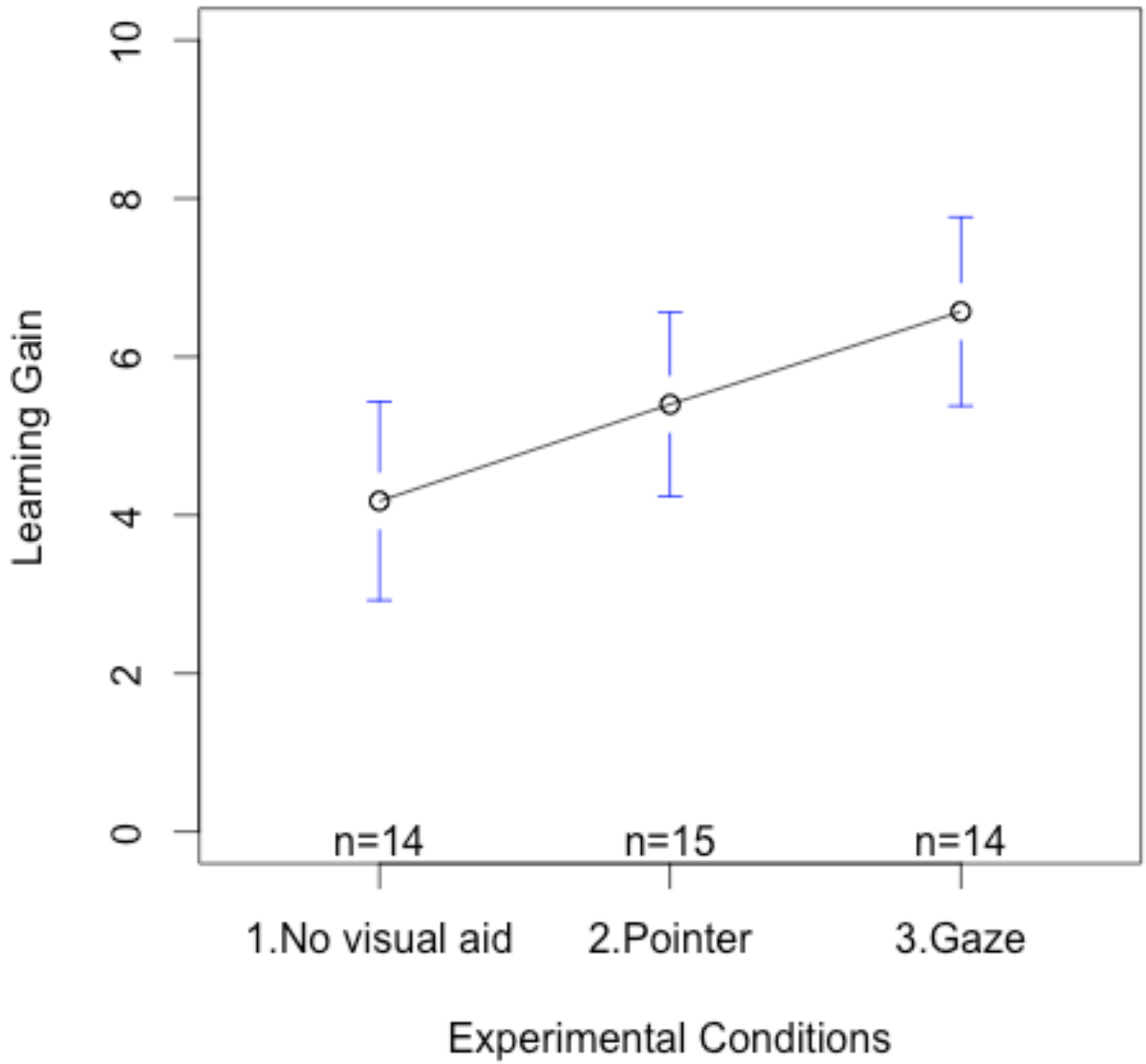
Gaze



"...they look like a bunch of little grains arranged together...typically a group of very small elements"

Sarah d'Angelo, Kshitij Sharma, Darren Gergle, Pierre Dillenbourg (2016)

Do finger-based or gaze-based deictics enhance learning ?



Sarah d'Angelo, Kshitij Sharma, Darren Gergle, Pierre Dillenbourg (2016)

Relevant Behavioral Abstractions

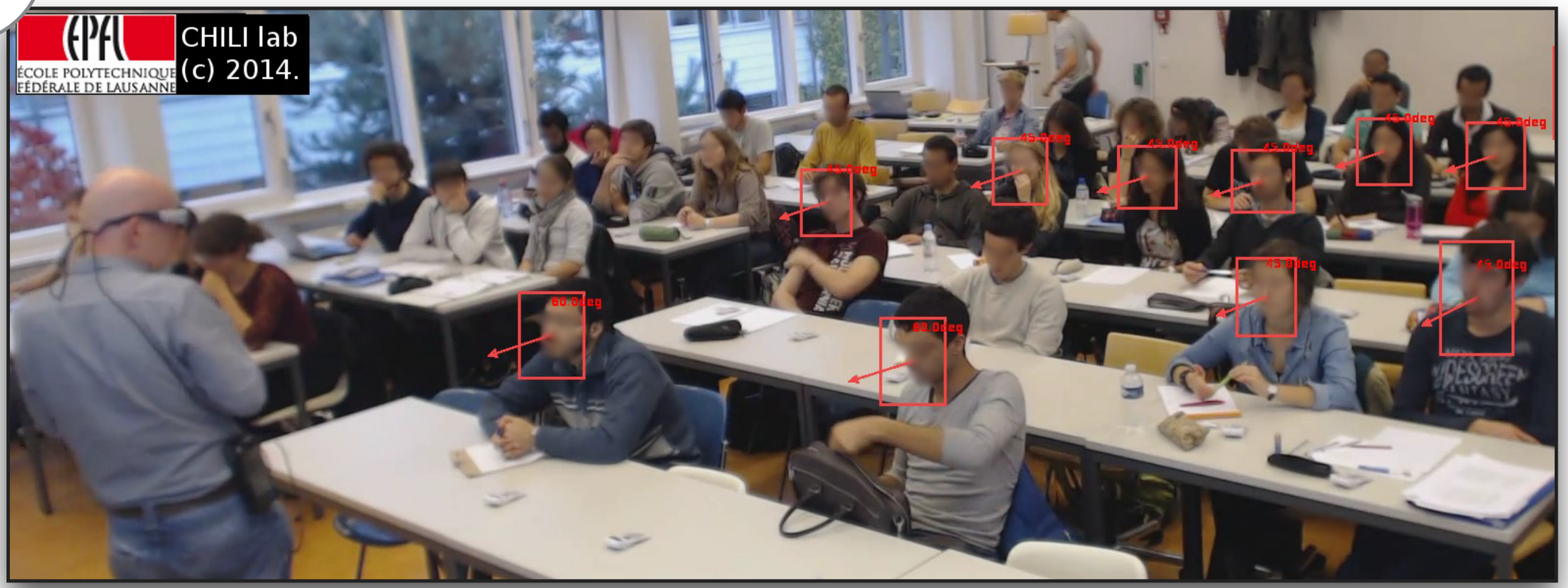
gaze (learner) = *f* (gaze (teacher))

Feature: *'Withmeness'*

Context: *Lecturing*

Modeling in the wild ?

K_t



B_t

Kernel	Features	Score	Cohen's kappa
RBF(c=1.31, g=0.0211)	Distance, Head travel norm., Num. still periods	61.86%	0.30
BF(c=1.21, g=0.11)	Period, Row, Head travel norm., Mean duration still	61.72%	0.32
3F(c=1.11, g=0.061)	Head travel norm., Mean duration still	60.42%	0.28
3F(c=1.4, g=0.04)	Period, Distance, Row, Mean duration still	59.23%	0.30

Raca, Tormey & Dillenbourg

Relevant Behavioral Abstractions

gaze (learner) = *f* (location (teacher))

Feature: *Head rotations*

Context: *Lecturing*

activity (teacher) = *f* (gaze (teacher))

L. Prieto, K. Sharma, L. Kidzinsky, P. Dillenbourg

Education brings nice challenges

(1) Explainability

Computational Models

Education Research

Pierre Dillenbourg, EPFL

Education brings nice challenges

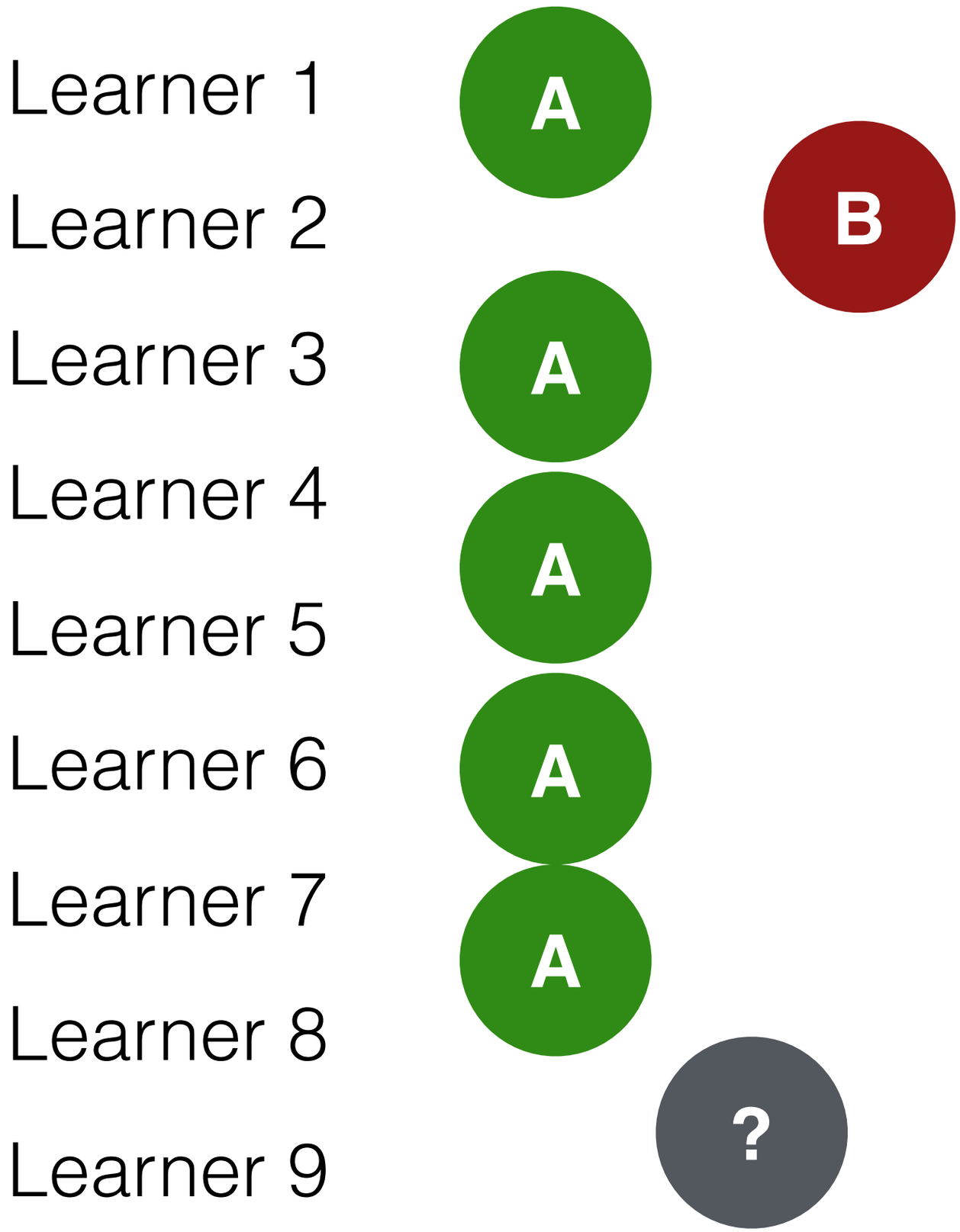
(2) Cold Start

Integrate expert's knowledge

Use simulation with synthetic students

Education brings nice challenges

(3) Exploration Exploitation Tradeoff



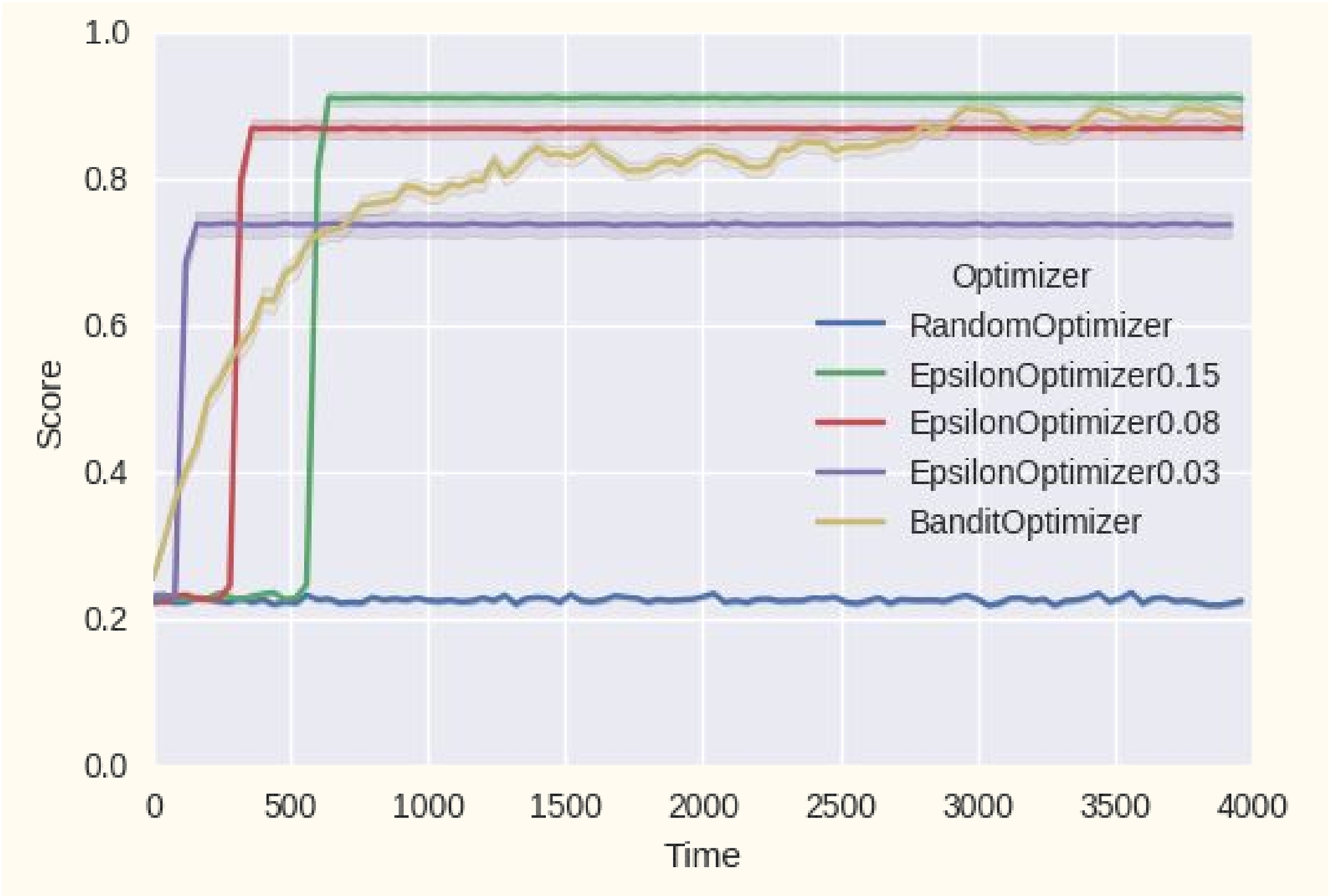
Education
Context

Explainable AI

Cold Start

Exploration/
Exploitation
Trade-OFF

Cohorte Simulations



Louis Faucon, Pierre Dillenbourg, EPFL

Education is a computational science

EPFL Center for Learning Sciences

EPFL
Innovation Park

digitalswitzerland

swisscom

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CVCI
CHAMBRE VAUDOISE DU COMMERCE ET DE L'INDUSTRIE

SWISS

EdTech Collider

FONDATION HENRIMOSER

JACOBS FOUNDATION
Our Promise to Youth

TOTALYMAGE

we are play lab

coorpacademy

Dybuster

Klewel
the webcasting company

GOODWALL

NEOCOSMO

PocketCampus

Calerga

LANTERA solutions

LEARNING SEVEN

MAT RIX

mobsya

better study

EKSTRA REALITY

LANTERA solutions

headswap

GalliLearn

MOBILE TIC.com

tthf media

Happy Numbers

UbiSim

taskbase

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE EXTENSION SCHOOL

bulbee
Swipe to learn.

GRAASP

Si

IDEAO

Innova Kids

educabay
Key to unlimited academic knowledge

Rosie

LABSTER

lillup
lead your life

Simpliquity

SpeakUP

SLX
Swiss Learning Exchange

ayaru

Little Vista

LEDsafari

Test We.

Center Learning Sciences

MOOCs

Collider

Compu. Thinking

Lake of Piaget

EPFL Digital Education Ecosystem

Social Sciences

Education
Psychology
Sociology
Ethnology
Anthropology
Economics
Political Sciences
Linguistics
History
Demography
Management
.....

Humanities

Modern Languages
Old Language
Littérature
Philosophy
Religion
Art
Musicology
Museology
History
....

This is not one science !!!

And….

Education

- Docimology
- Didactics
- Instructional Psychology
- Instructional Design
- **Learning Technologies**
- History of Education
- Sociology of Education
- Economy of Education
- Special Education

Psychology

- Cognitive psychology
- Social psychology
- Psychometry
- Clinical psychology
- Differential Psychology
- Developmental Psychology

Sociology