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Centre for the Science of Learning & Technology

When Artificial Intelligence Meets Learning Analytics

Professor Barbara Wasson, Director

NAUS, 15 August 2019

CENTRE FOR THE SCIENCE OF LEARNING & TECHNOLOGY

SLATE.UIB.NO @SLATERESEARCH

- Established in 2016 by the Norwegian Ministry of Education & University of Bergen
- A national research and competence centre for the learning sciences
- SLATE carries out research that explores and clarifies concepts such **learning analytics**, **big and small data in education**, **adaptive learning**, **assessment for learning**, **innovation & creativity,** and **learning & technology**, in all facets of human learning
- Multidisciplinary → Interdisciplinary
- Conduct integrated research that will advance the frontiers of the sciences of learning, as well as inform education practice and policy

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Barbara Wasson
Professor, Director

Jorunn Viken
Head of Administration
Centre Manager

Ingunn Ness
Researcher
Theme Leader

Weiqin Chen
Professor II

Mohammad Khalil
Researcher

Kjetil Egelandsdal
PostDoc Researcher

Nina Morlandstø
Project Leader

Cecilie Hansen
Researcher
NORCE Technology, Partner

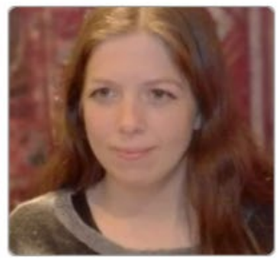
Jo Dugstad Wake
Researcher
NORCE Technology, Partner

Carlotta Negri
Data Scientist
NORCE Technology, Partner

Rosaline Barendregt
PhD candidate

Kamila Misiejuk
PhD candidate

Fay Wheldon
PhD candidate



Jeanette Samuelsen
PhD candidate

Joakim Vindenes
PhD candidate

Fredrik Sundt Breien
PhD candidate

Vlad Glaveanu
Professor, Webster University Geneva

Jeroen van Merriënb...
Professor, Maastricht University
Professor II

Kristin Børte
Senior Researcher

1Professor (+1)
3 Senior Researchers
1 Postdocs
6 PhD students
6 Masters students
2 Adjuncts (20%)
3 NORCE researchers/data scientist
Several affiliated faculty from UiB

Admin leader, ICT project leader, Programmer (from Sept)

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RESEARCH PROFILE

Learning Analytics – Research that explores the methods for measuring big and small data, analyses, visualisations and their use, and the design of volumetric data architectures optimised to support learning in a variety of learning contexts.

Creativity, Learning & Technology – Sociocultural and cognitive underpinnings of creativity, learning and technology and how innovation happens is critical for the advancement of new ideas in both school and business, in order to help business stay competitive and enable learners to cope with an uncertain future (i.e., 21st Century Skills).

Assessment Innovation & Theoretical Pedagogy – Research on formative assessment, governance, and policy, including scaffolding student & teacher competency and professional development, with an emphasis on how data-driven technologies can inform their practice.

Emerging Technologies & DATA – Research to understand how data is generated, collected, analysed, and interpreted to inform learning and its contexts (e.g., MOOCs, Immersive VR, Videos, Games).

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ARTIFICIAL INTELLIGENCE

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Artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.

ENCYCLOPÆDIA BRITANNICA

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Artificial intelligence (AI) enables computers and other automated systems to perform tasks that have historically required human cognition and what we typically consider human decision-making abilities.

US National Artificial Intelligence R&D Strategic Plan: 2019 U

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LEARNING

REASONING

PROBLEM-SOLVING

PERCEPTION

LANGUAGE

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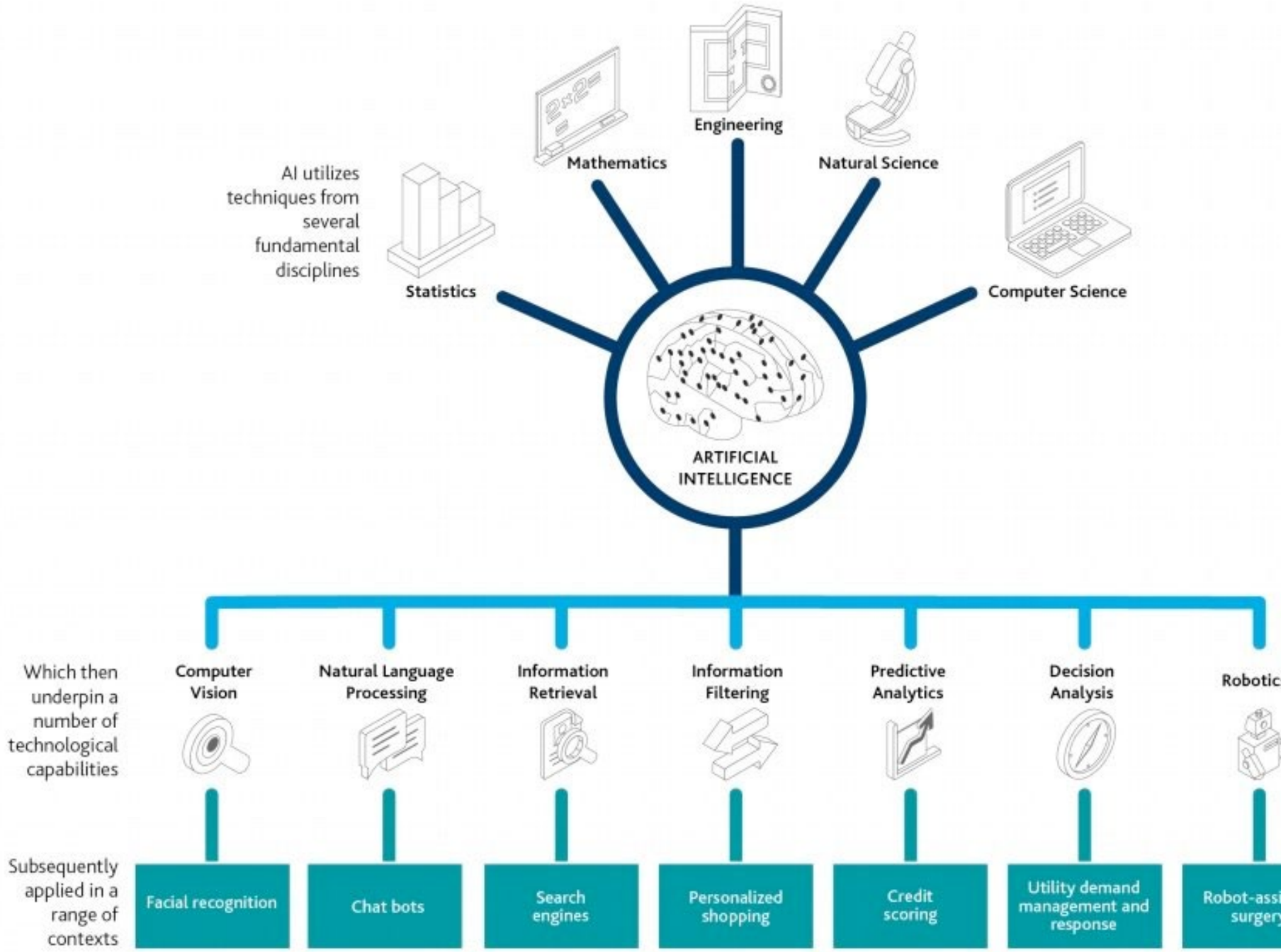

Fred Shir (meee-services.com)

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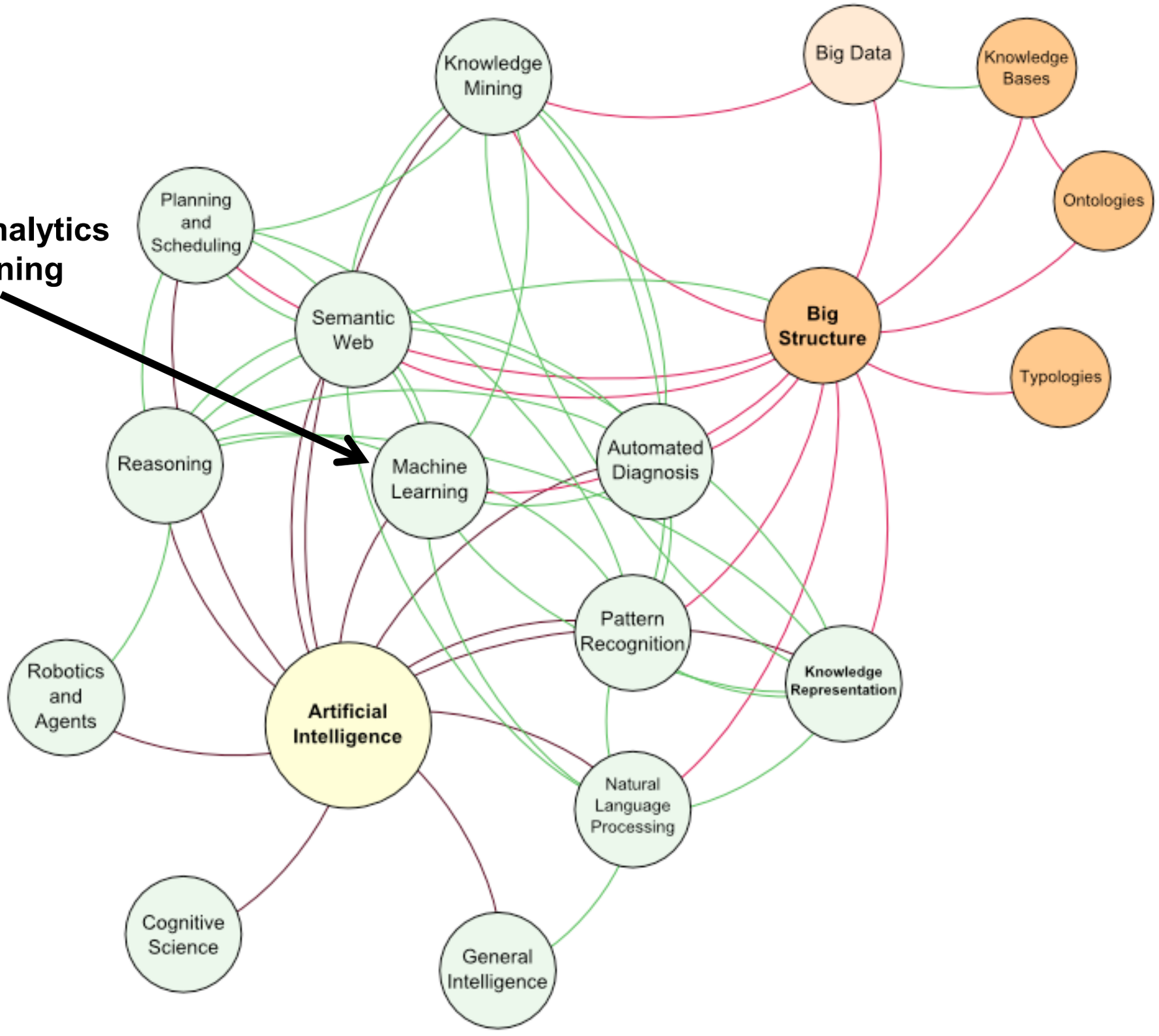
Predicitive Analytics
Deep Learning



http://www.mkbergman.com/1816/knowledge-based-artificial-intelligence/

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ARTIFICIAL INTELLIGENCE IN EDUCATION

INTELLIGENT TUTORING SYSTEMS

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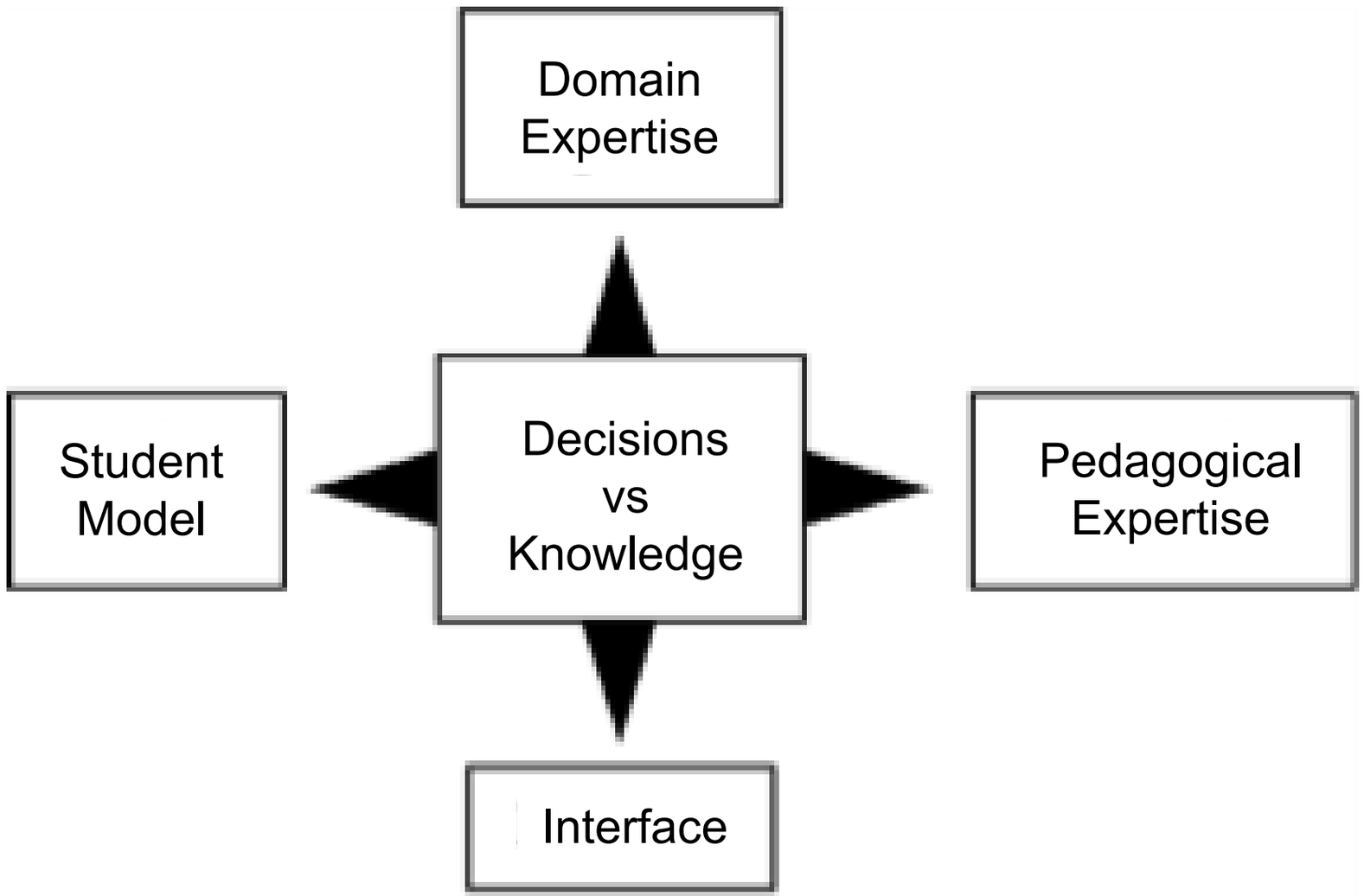


individualise learning & interact with the student based on a deep understanding of the students behaviour

Knowledge Model

rules about how to decide what to do next (reasoning)

or

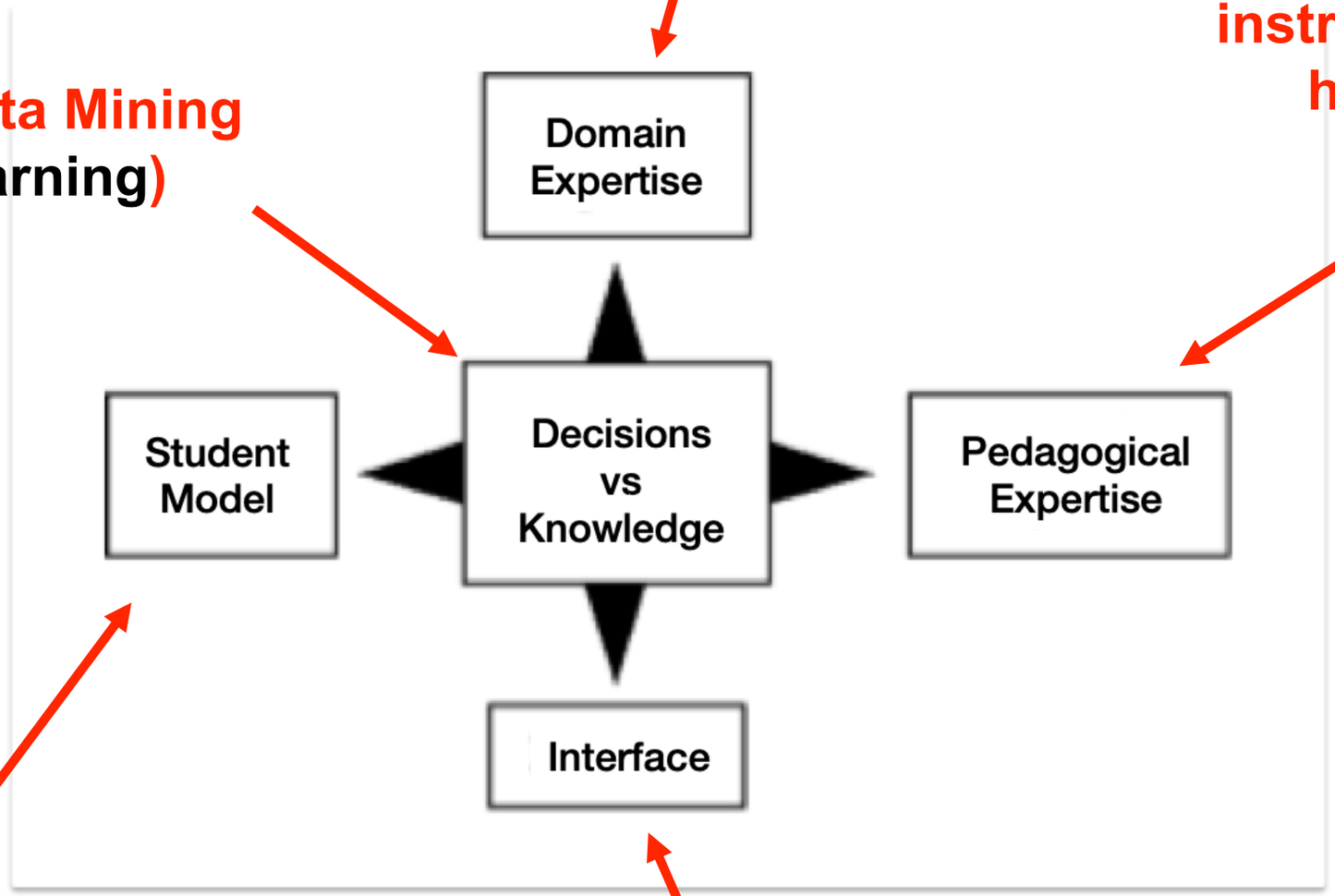
Educational Data Mining (machine learning)

Knowledge Model (knowledge representation)

content, simulation (problem-solving)

Knowledge Model

instructional sequencing, hints, interrupting, feedback, … (planning)



Knowledge Model

what student knows and does not know (reasoning)

collects data about student's interaction with the ITS (natural languge understanding)

track the "mental steps" of the learner during problem-solving

diagnose misconceptions

estimate the learner's understanding of the domain

provide timely guidance, feedback, and explanations

promote productive learning behaviours
(self-regulation, self-monitoring, and self-explanation)

prescribe learning activities at the level of difficulty
& with the content most appropriate for the learner

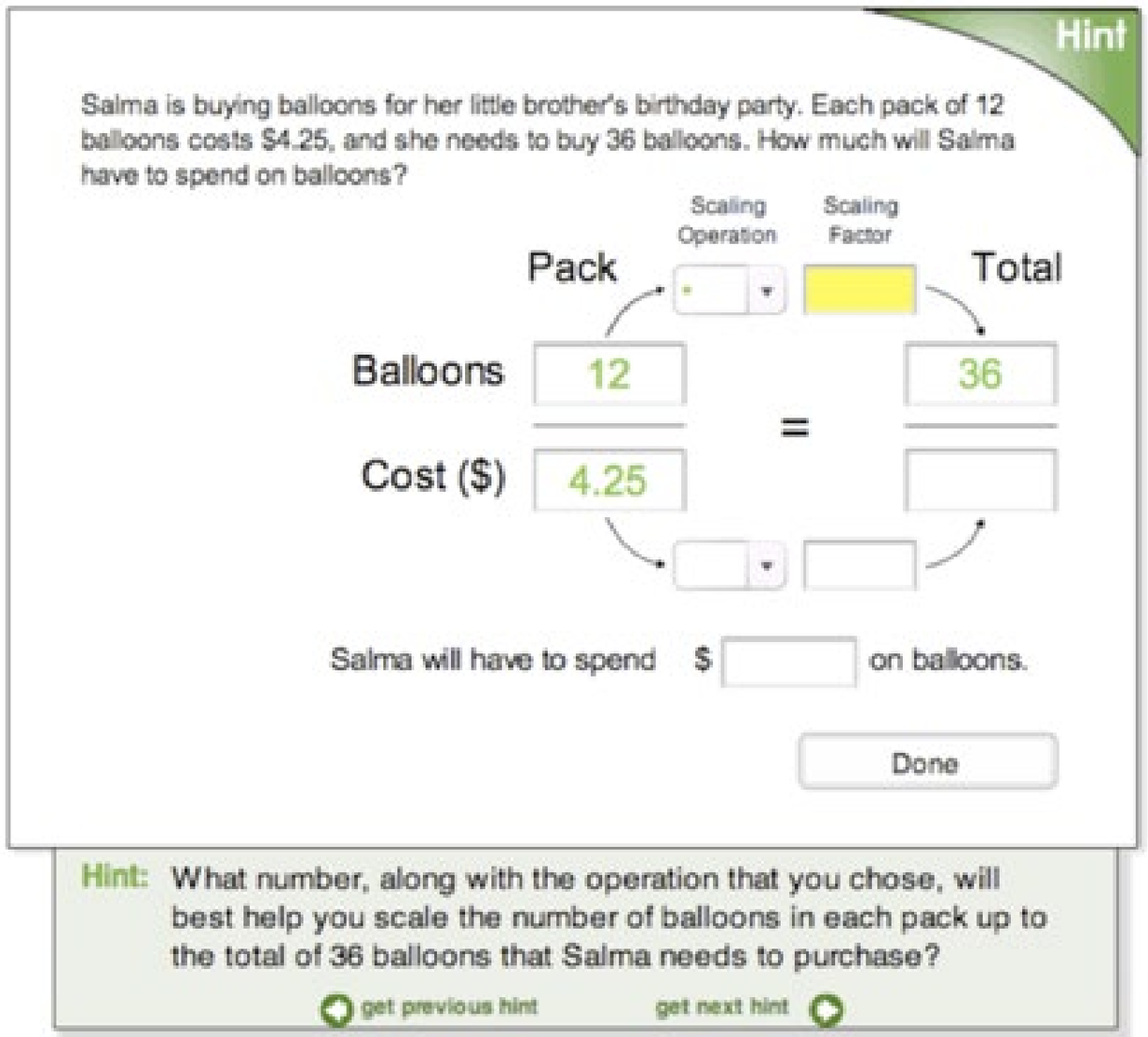
ITS: COGNITIVE TUTORS

(e.g., Anderson et al, 1985, 1995; Koedinger et al. 1997, 2016; Aleven et al. 2009)

- online computer tutoring, complete with hints, immediate feedback, dynamic scaffolding, and online reports for teachers

- Pane et al. (2014) studied effect in middle (8700 students) and high schools (16 800 students) over 7 states

➡ 8 percentiles increase for high school students **in second year of use**



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INQ-ITS: PERSONALISED ONLINE LABS

(e.g., Gobert et al, 2013 …; Dickler, R., Li, H., & Gobert, J. (2019)

inqits.com

Inq-ITS' assessment algorithms have been validated with thousands of students and match human scoring with approximately 95 percent accuracy

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LEARNING ANALYTICS

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"LEARNING ANALYTICS is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs"

1st International Conference on Learning Analytics & Knowledge, 2011

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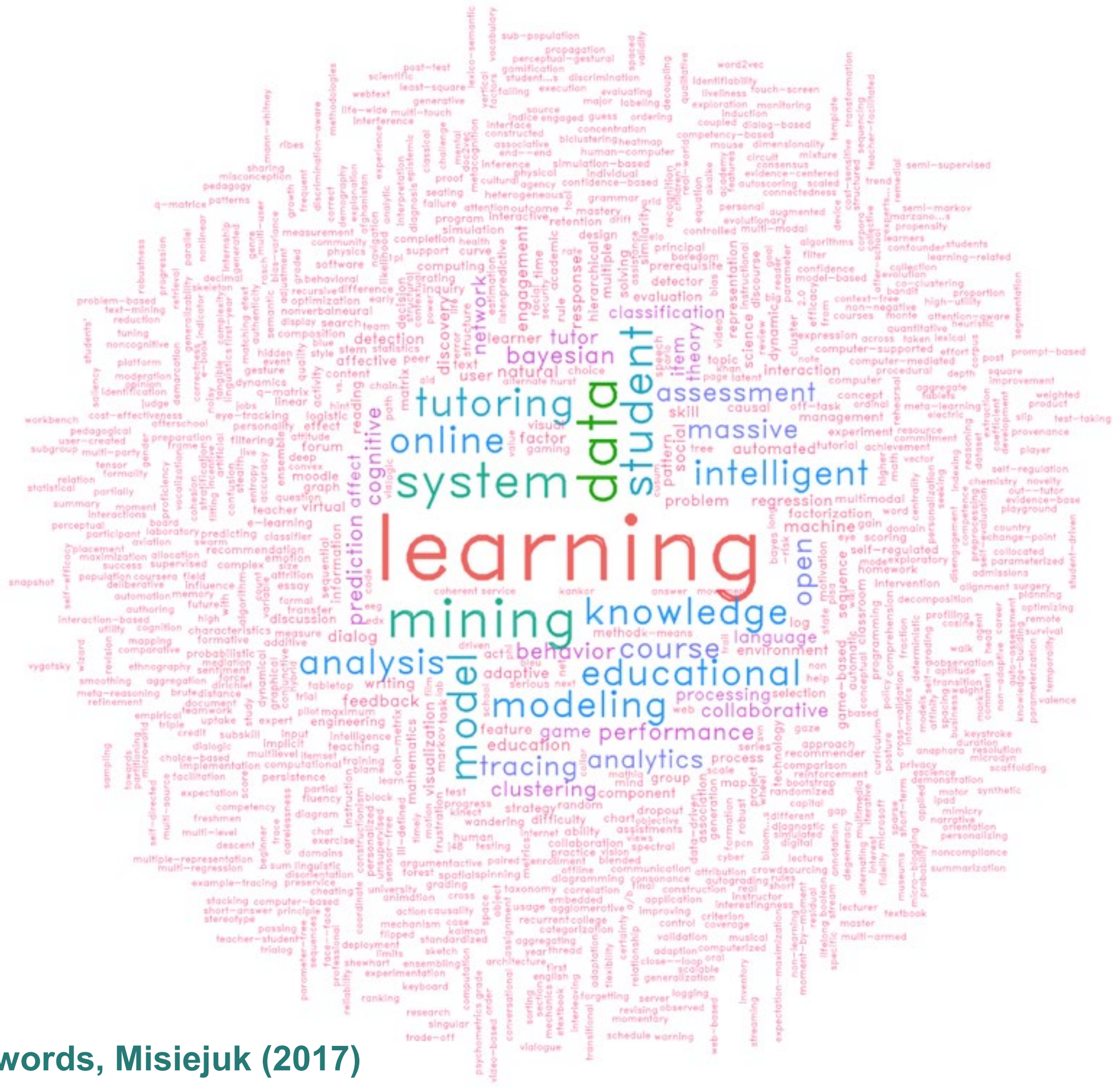

LAK Keywords, Misiejuk (2017)

LA AS A RESEARCH FIELD

Draws on several research fields:

- Technology Enhanced Learning
  - CSCL, Mobile learning, Online Learning …
  - AI in Education
    - Intelligent Tutoring Systems
    - Educational data mining (EDM)
- Learning Sciences
  - Psychology, Education, Computer Science, Neuroscience, …
- Big Data & Business Analytics

Learning Analytics & Knowledge (LAK)

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https://solaresearch.org/

SOCIETY for LEARNING ANALYTICS RESEARCH

FOUNDATION OF THE SOCIETY FOR LEARNING ANALYTICS RESEARCH

FIRST INTERNATIONAL CONFERENCE ON LEARNING ANALYTICS AND KNOWLEDGE **2011**

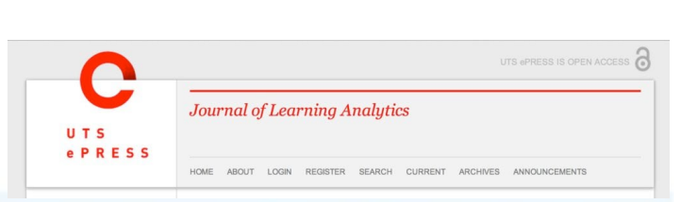
LAK'11

2012 FIRST FLARE EVENT

USA (PURDUE), UK (OU), AUSTRALIA (UT

FIRST LAK DATASET & CHALLENGE

FIRST LEARNING ANALYTICS SUMMER INSTITUTE **2013**



FIRST ISSUE OF JOURNAL OF LEARNING ANALYTICS

2014 START OF LEARNING ANALYTICS COMMUNITY EXCHANGE PROJECT

LACE

2017 LASI-NORDIC
Learning Analytics (Late) Summer Institute
September 28-29, 2017

2017

NORDIC LEARNING ANALYTICS SUMMER INSTITUTE 2019
Tallinn, 28-30 August

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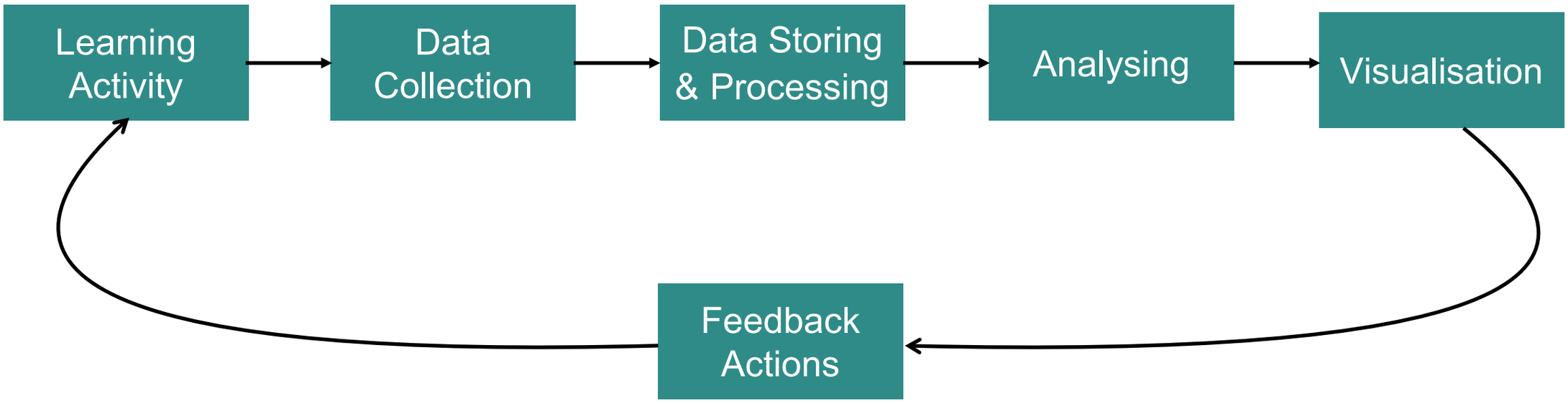

ISO/IEC JTC1/SC36 LA
Hoel, T., Chen, W., & Cho, Y-S (2016)

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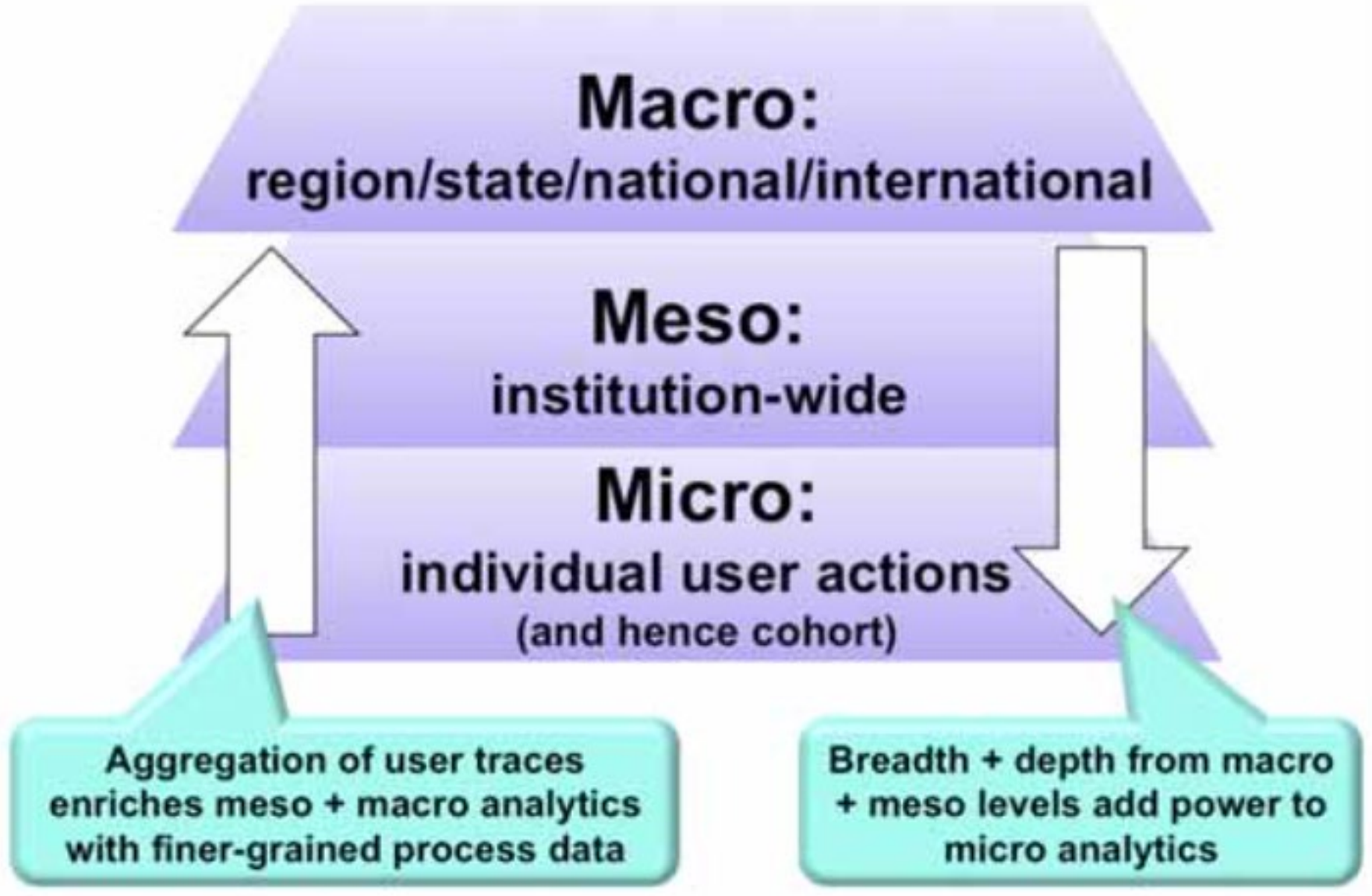
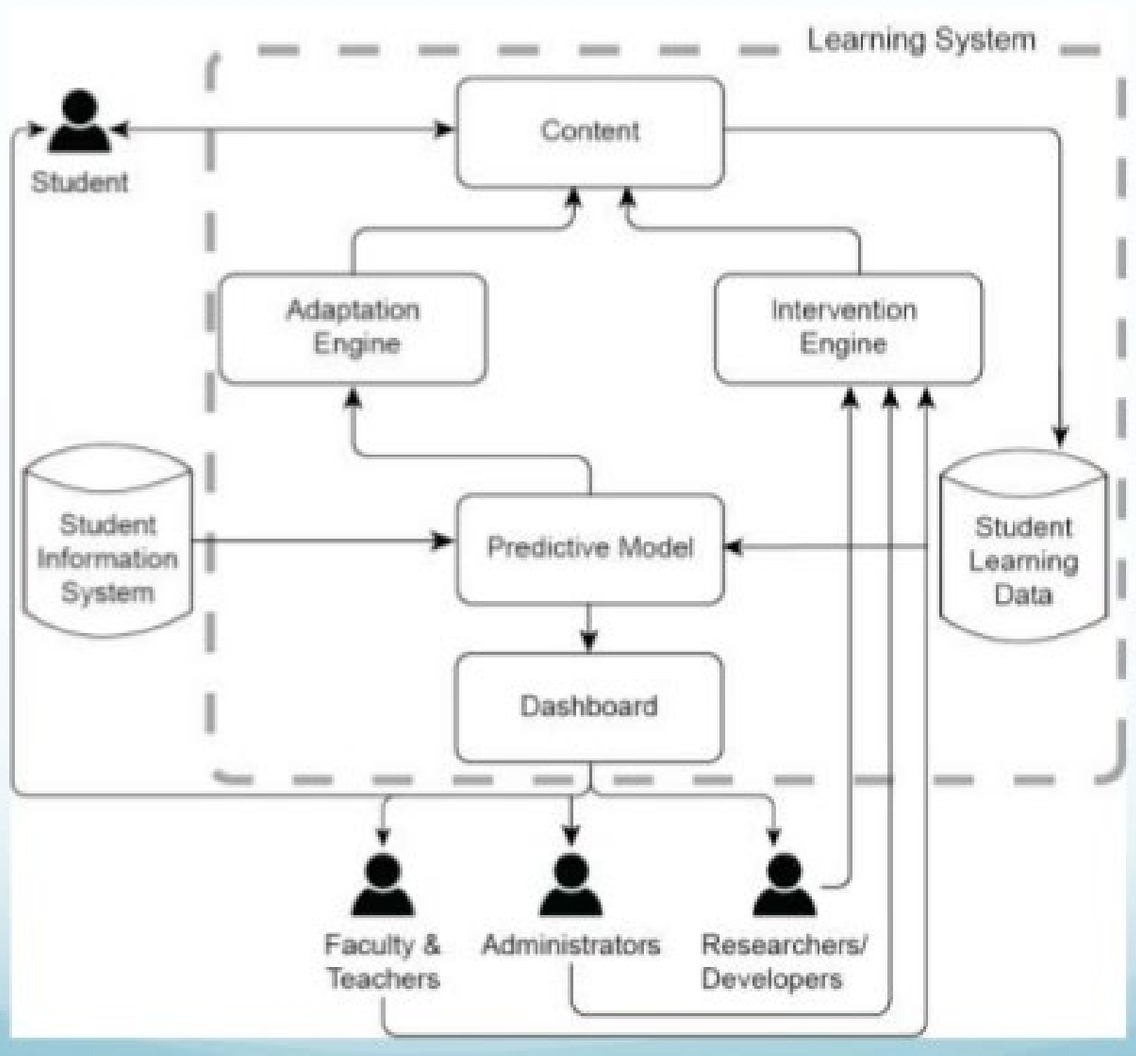
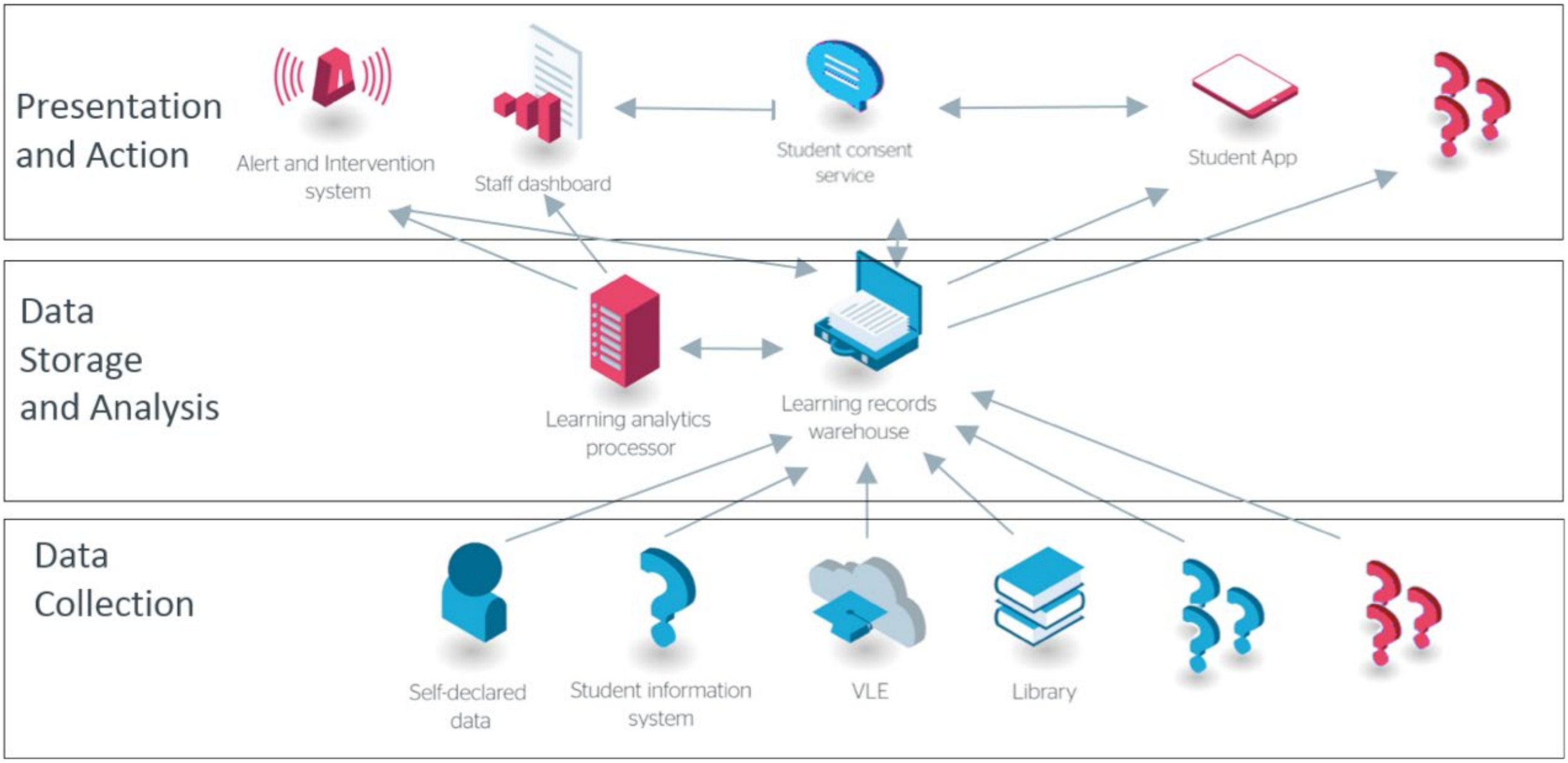


Buckingham Shum, S. (2012)
UNESCO Policy Brief, November 2012

EDM/LA Enables Adaptive Learning Systems



Bienkowski (2012)



Jisc Learning Analytics Architecture

https://analytics.jiscinvolve.org/wp/2016/06/28/a-technical-look-into-learning-analytics-data-and-visualisations/

TRADITIONAL EDUCATION DATA

Academic Information

Courses
Graduation
Grades
Completion
Enrolment

Teacher produced

Observation
Rubrics
Assignments
Assessment

Student produced

Homework
Learning work output

Assessment & Testing

Final exams
Tests
Interim assessment
Quizzes

Demographics

Age
Gender
Special needs
Family background

Behaviour

Attendance
Prog. participation

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NEW TYPES OF DATA

- Click steam (activity data)
- Audio
- Video
- Facial expressions
- Eye tracking
- Bio Sensors
- Location
- Air quality
- fMRI
- etc

Process data
→ to understand learning

Multimodal learning analytics

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EDUCATIONAL DATA

- **input data** (student characteristics, demographic data, etc)
- **process data** (generated during teaching, learning & assessment such as click data streams, sensor, eye tracking, etc)
- **content data** (curriculum, learning outcomes, resources, etc)
- **outcome data** (achievement data from tests, assessments, etc)

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Stakeholders

- Students & Teachers / Instructors
- Institutions / Leadership
- Policy Makers
- Researchers

Actions

- Reflective
- Adaptive
- Predictive

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ROLE OF LA

Patterns	• Insight into trends • Informed Feedback • Learning learning & Learning trajectories
Predictions	• Trends (dropouts, success ...) • Actions (early intervention)
Recommendations	• Learning and teaching actions • Pedagogical resources and activities

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LEARNER-CENTRIC

VS

LEARNING-CENTRIC ANALYTICS

Zach Stein, Harvard

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STATE OF THE FIELD REVIEW OF LEARNING ANALYTICS

Misiejuk & Wasson (2017)

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STATE OF THE FIELD REPORT ON LA

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STATE OF THE FIELD REPORT ON LA

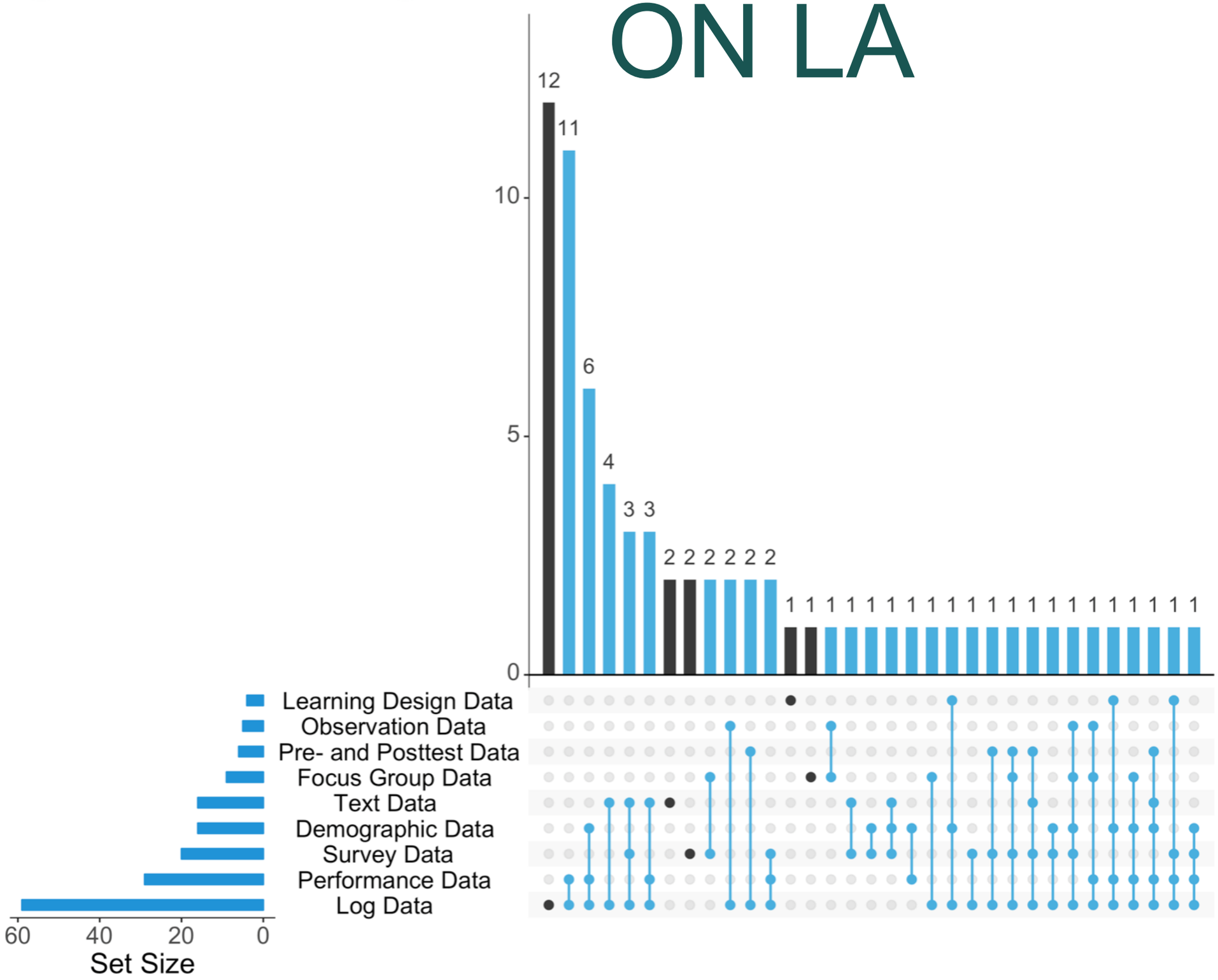

Figure 10 Sets and intersections of the data types

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STATE OF THE FIELD REPORT ON LA

Study Participants	Freq	%	Size	Freq	%
Learners	56	84%	50 <	9	16%
			50 – 100	9	16%
			100 – 500	18	32%
			500 – 1,000	6	11%
			1,000 – 10,000	5	9%
			10,000 – 50,000	2	4%
			>50,000	7	12%
Educators	4	6%			
Learners + Educators	7	10%			
Total	67				

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STATE OF THE FIELD REPORT ONLINE

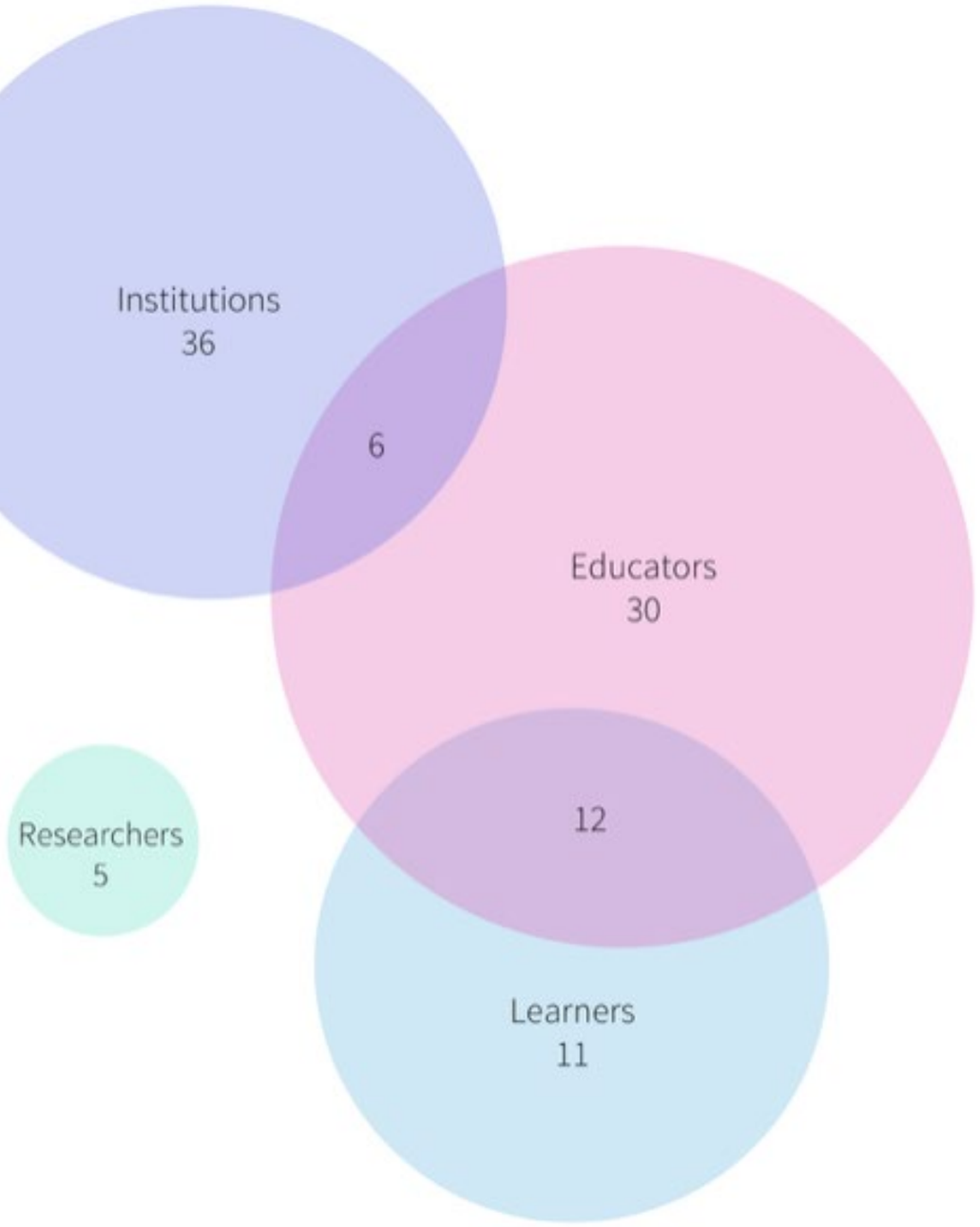

Figure 15 Venn diagram of the data clients

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STATE OF THE FIELD REPORT ON LA

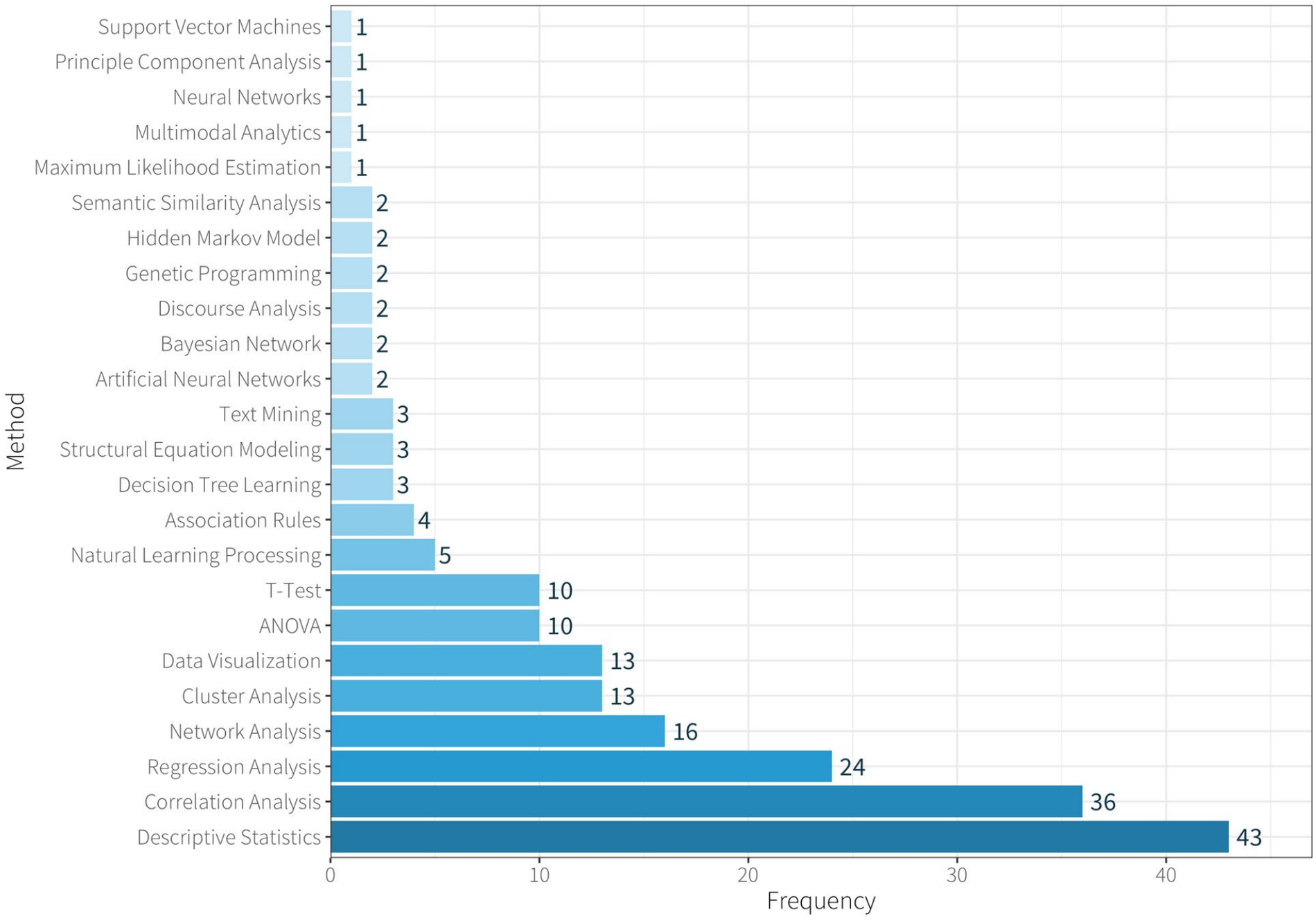

Figure 12 Method frequency

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STATE OF THE FIELD REPORT ON LA

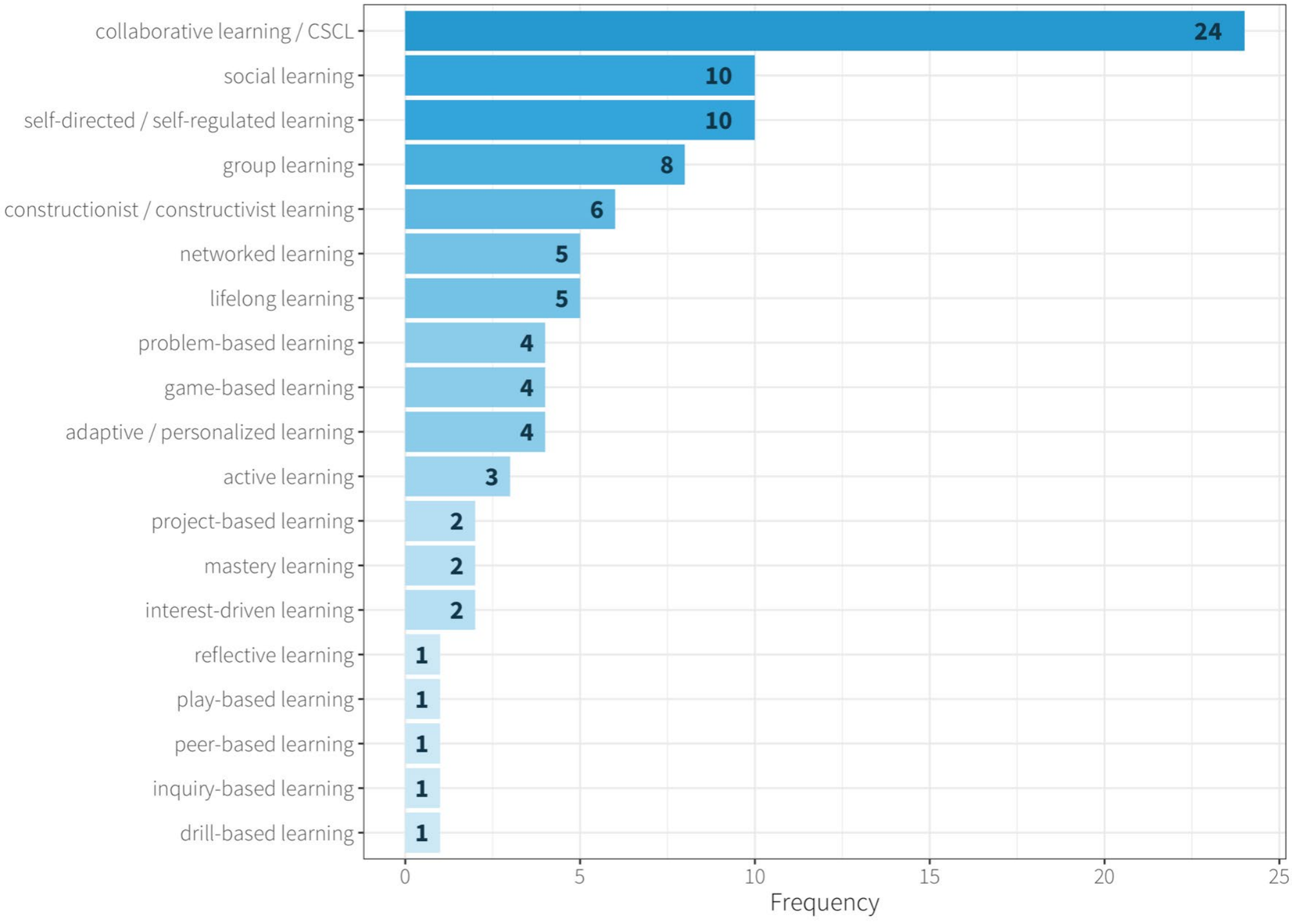

Figure 17 Pedagogical approach by frequency

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EXAMPLE: CORRELATION BETWEEN USER ACTIONS & FINAL GRADE

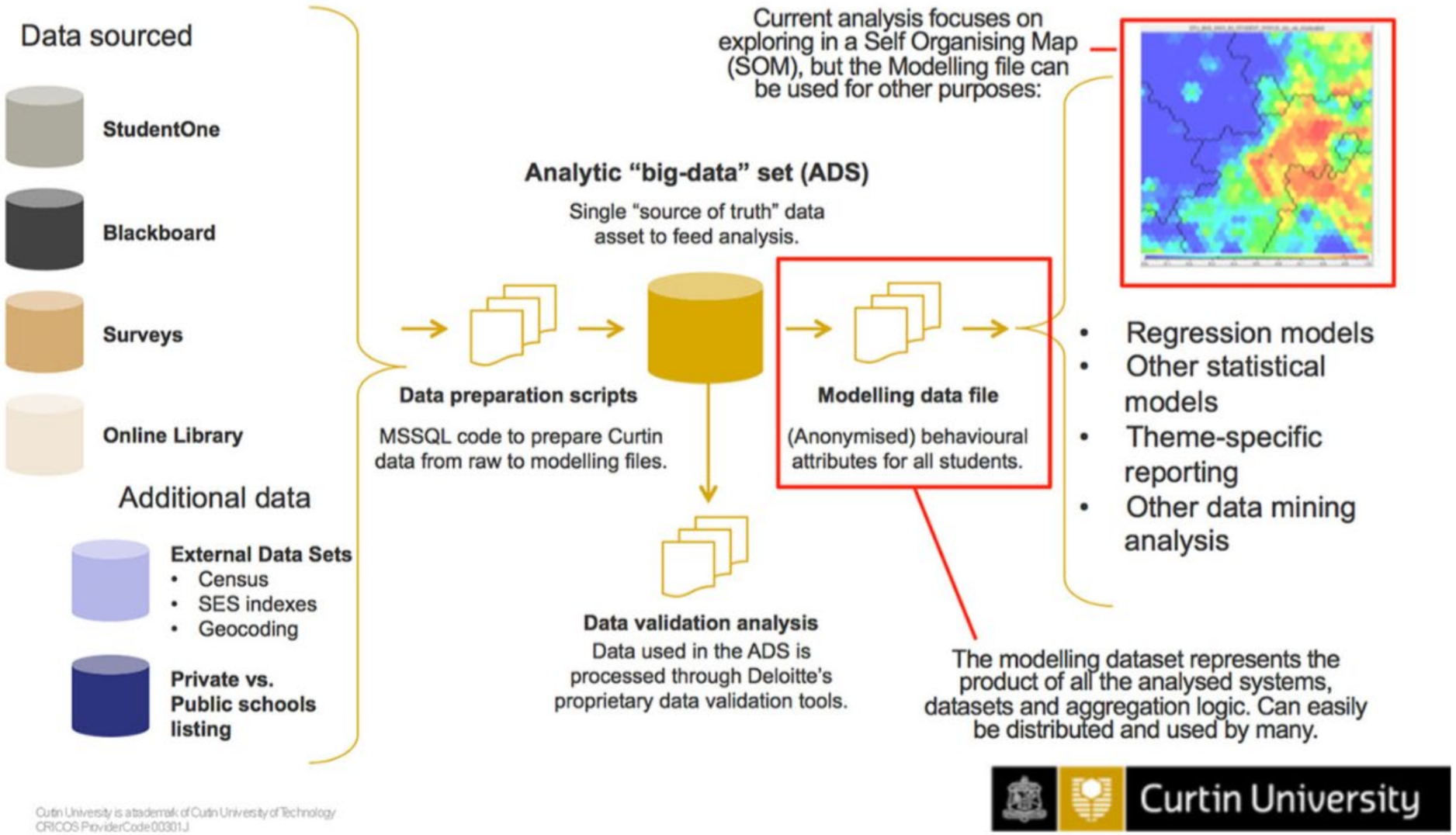

Fig. 4 Data sources, analytic data set (ADS) and self-organizing map

Gibson et al. (2016)

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EXAMPLE: MEASURING STUDENT PERFORMANCE

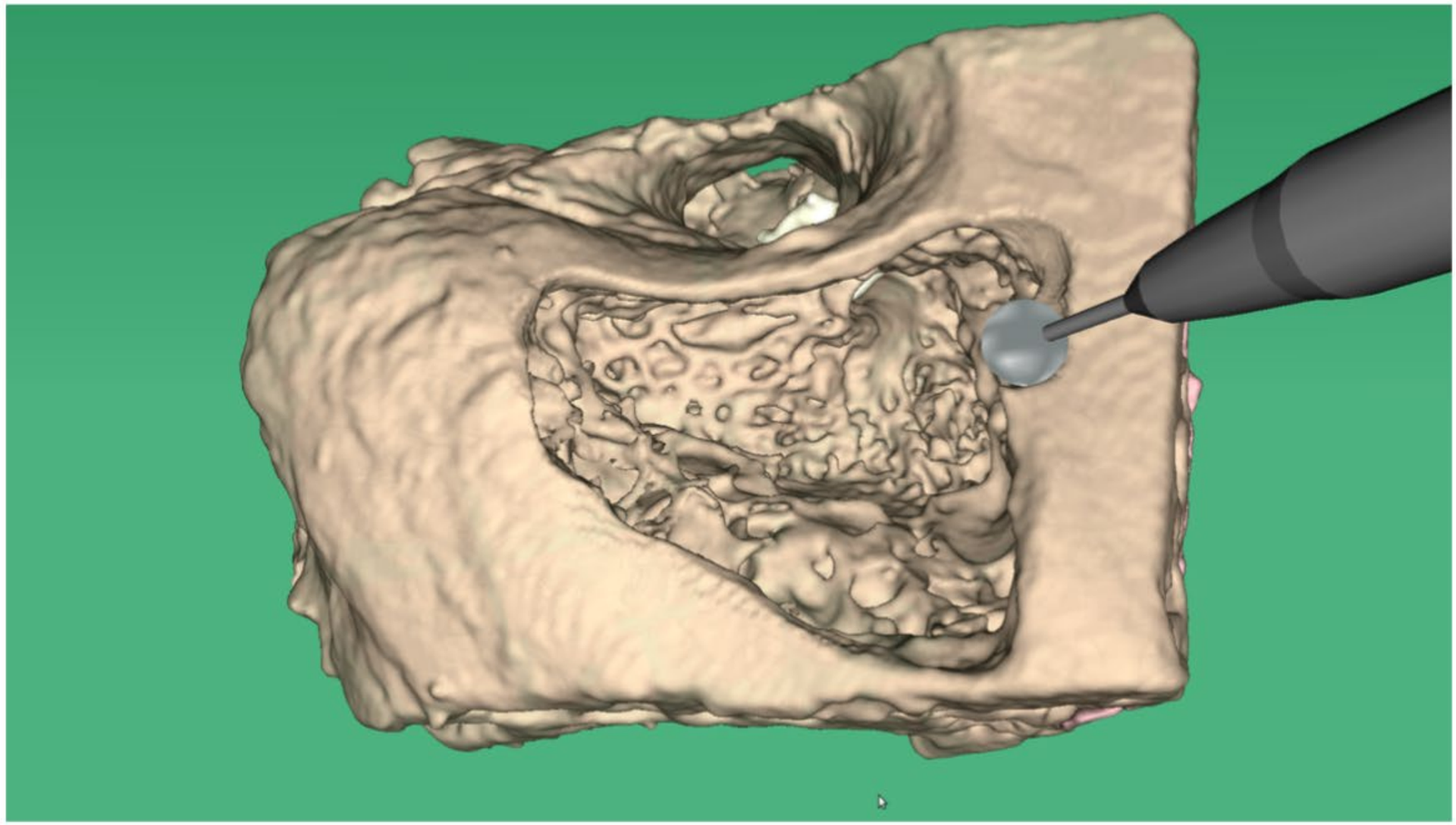

Figure 2: The simulation environment showing the drill and a partially dissected temporal bone

Kennedy et al. (2013)

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EXAMPLE: DROPOUT PREDICTOR, INTERVENTION

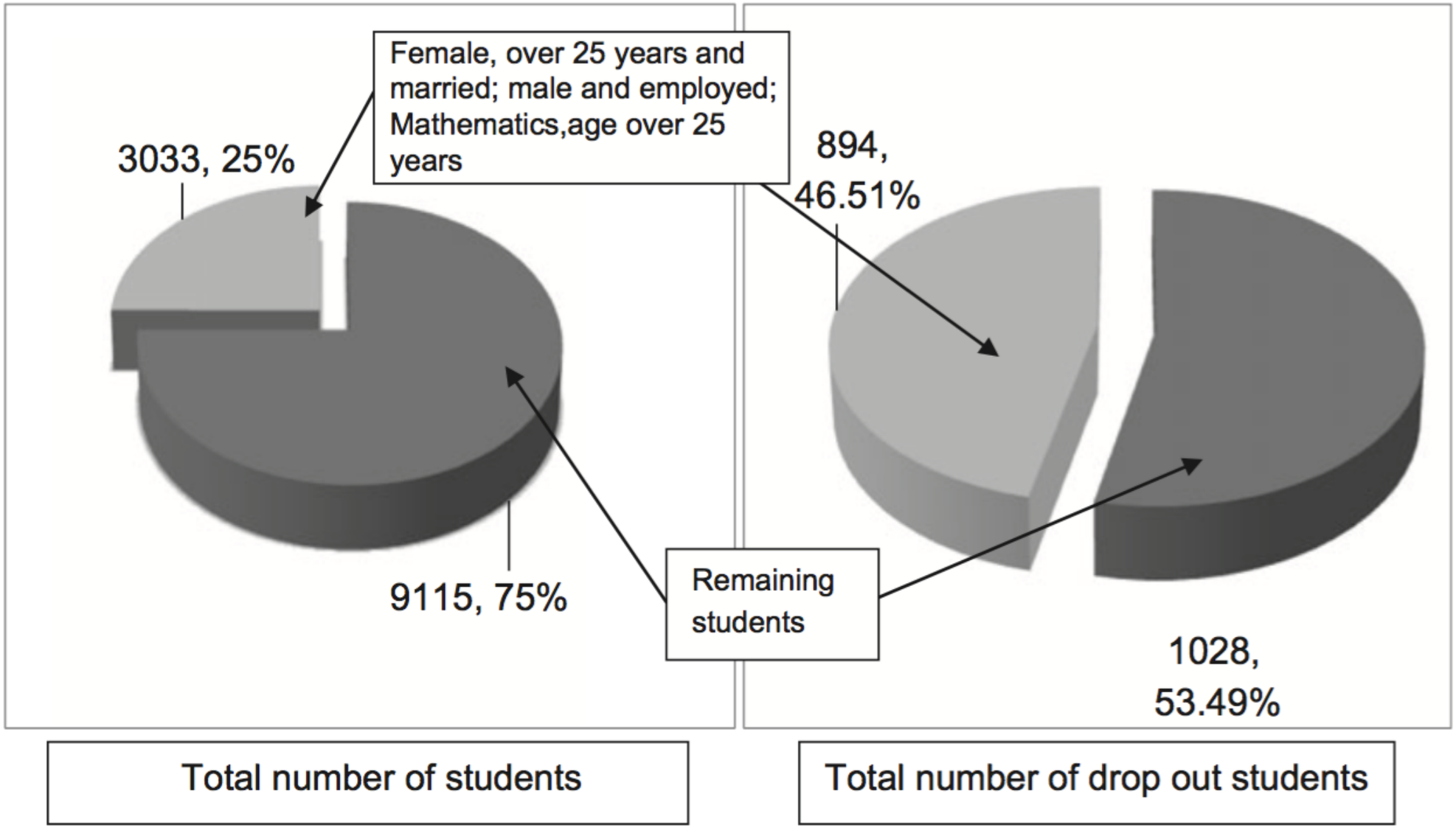

Figure 1. Graphical representation of synthesis of observations.

Yasmin (2013)

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EXAMPLE: DATA VISUALISATION, ACTIVITY ENGAGEMENT

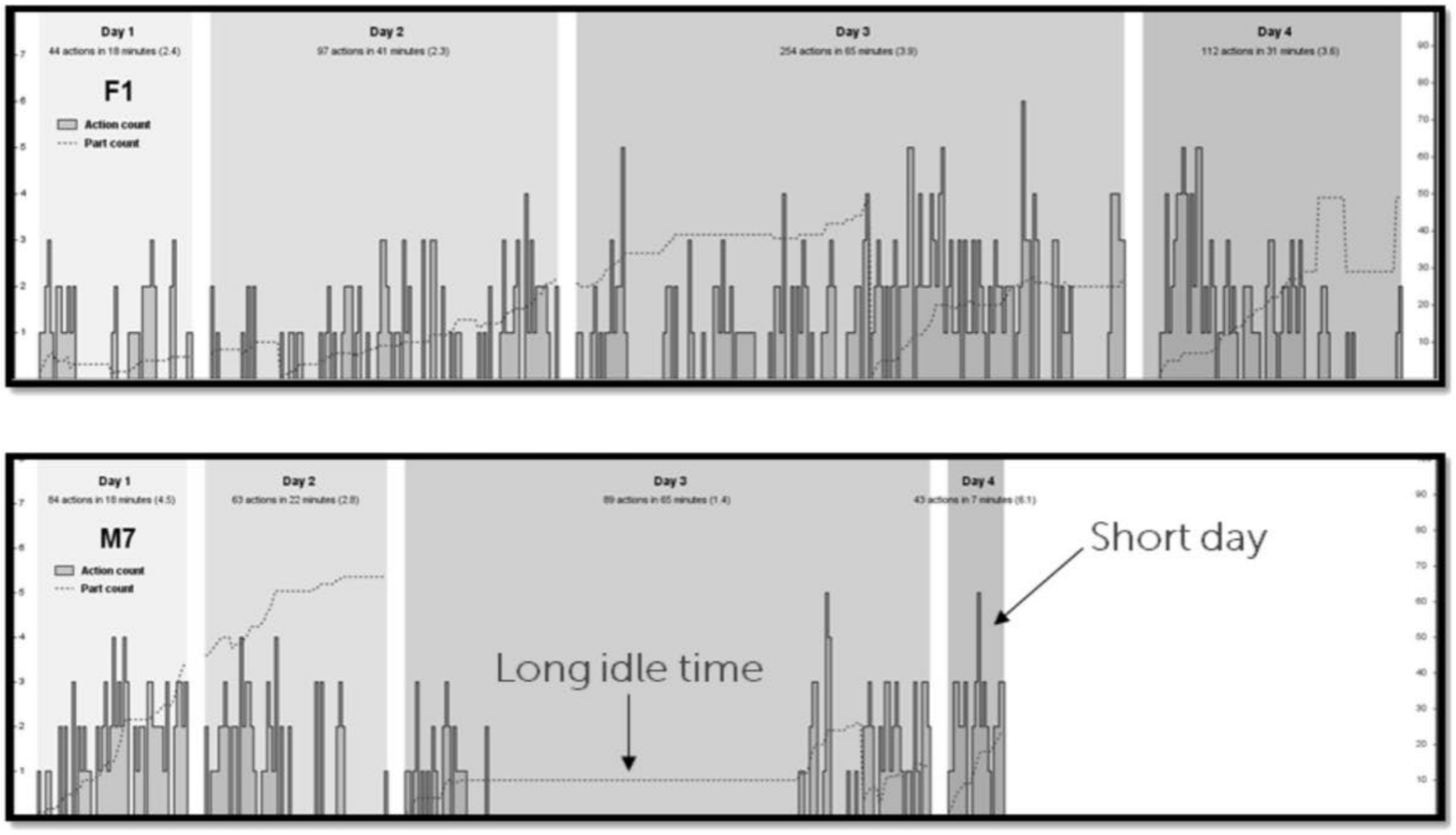

Fig. 6. Time series analysis: A comparison of an engaged student (F1) with a disengaged student (M7). The results conform to our classroom observations.

Xie et al., 2014

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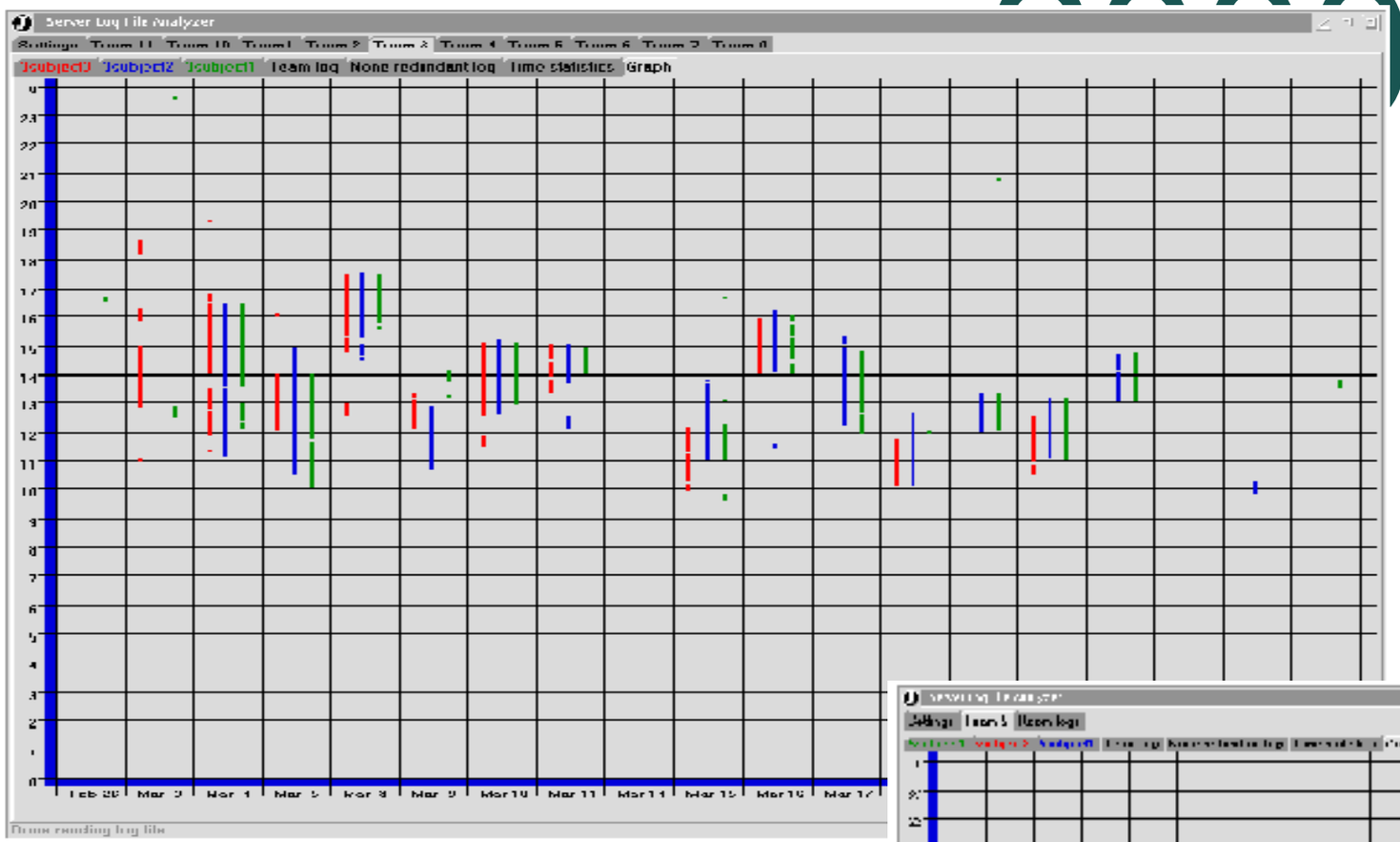
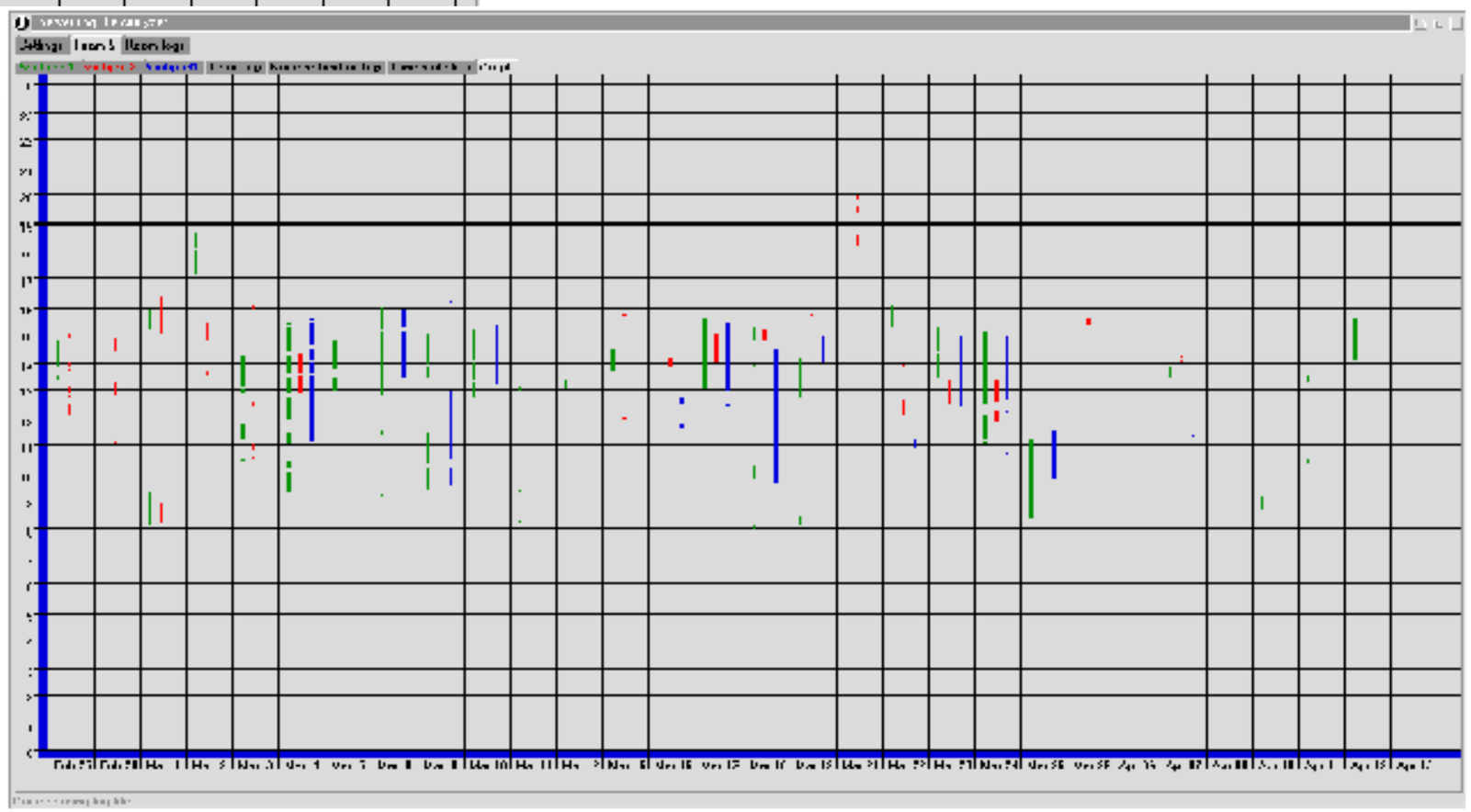
EDMEDIA 1999 & 2000





Meistad, Ø., & Wasson, B. (2000)**. Using server-logs to support collaborative telelearning research**. In J. Bourdeau & R. Heller (Eds.), Proceedings of Educational Multimedia & Educational Telecom ’2000, Charlottesville, VA: AACE, 679-683.

EXAMPLE: MODELS OF EMOTION

Figure 2: Flow chart of process used to detect frustration

Figure 4: Flow of rules for the detection of boredom

Leony et al. (2015)

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EXAMPLE: TOPICS & PARTICIPATION

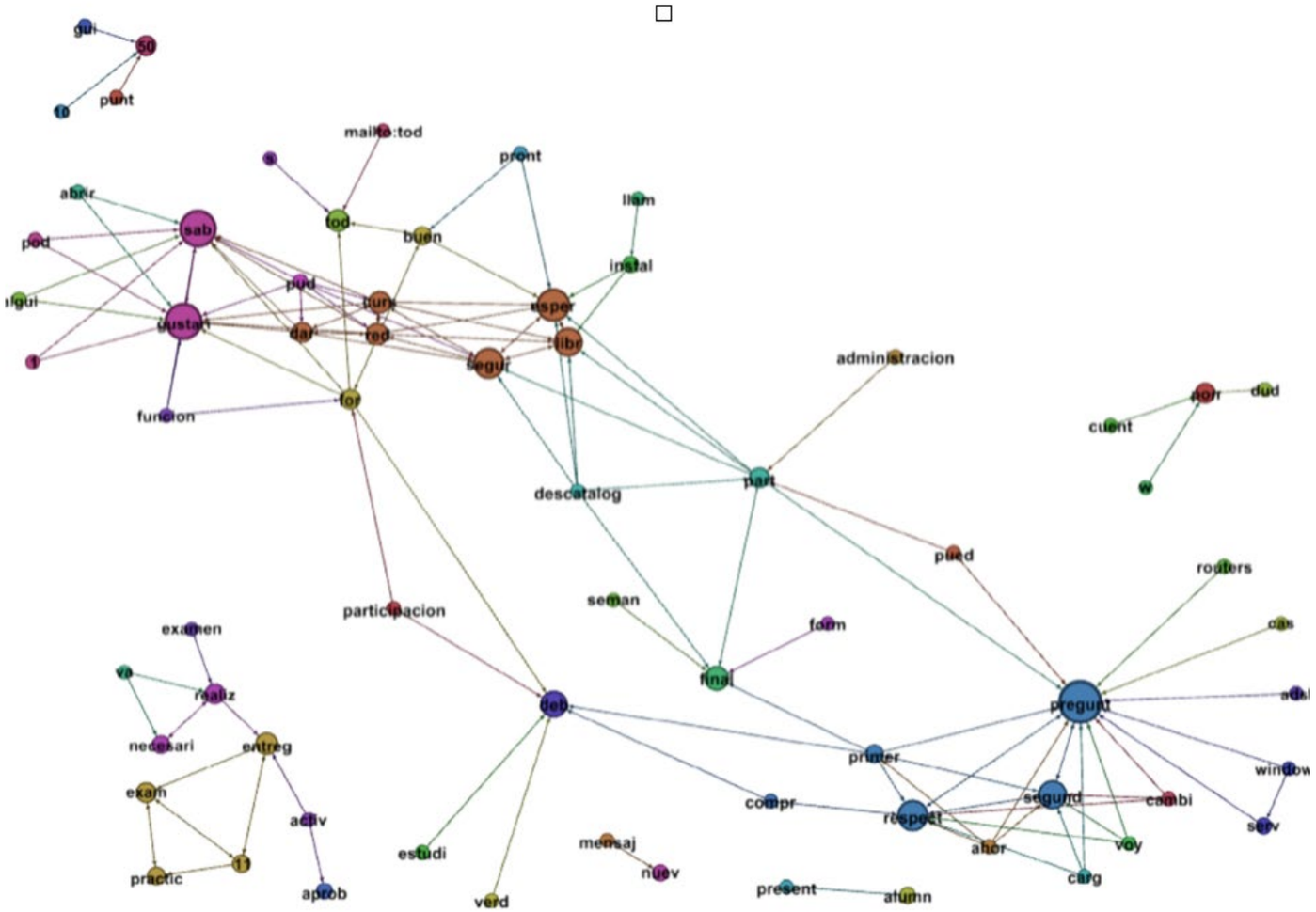

Fig. 5. Topic network deployed from the *Student* forum (course 2011–2012).

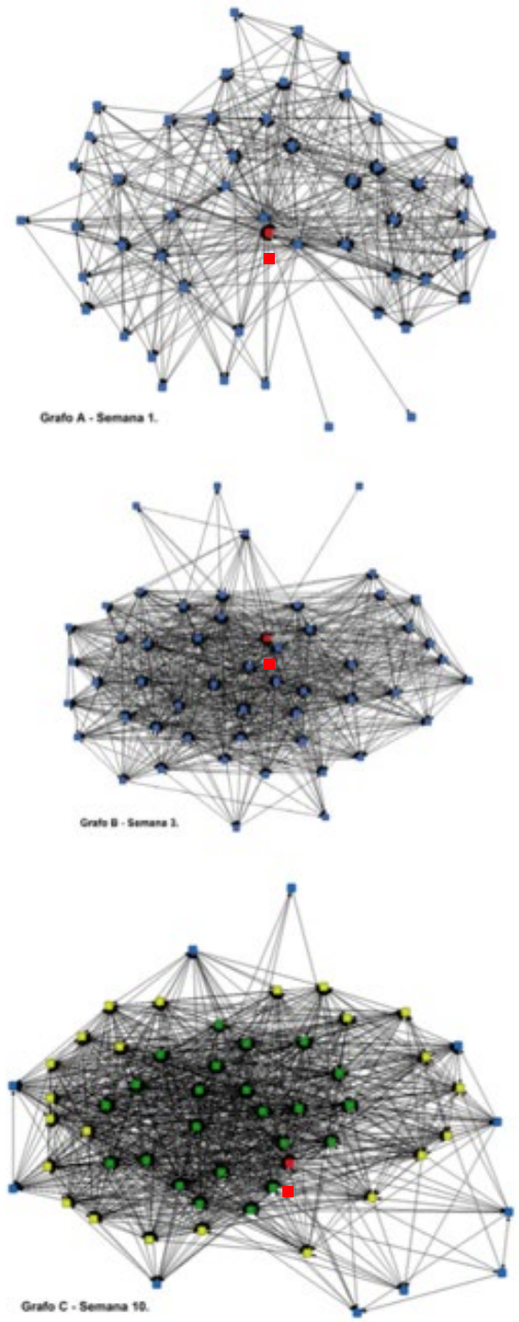

Figure 1: Evolution of the social network in the subject of «Educational Technology» in (A) the first week, (B) the third week, and (C) the tenth week of the course.

Tobarra et al., 2014; Gewerc-Barujel et al. (2014)

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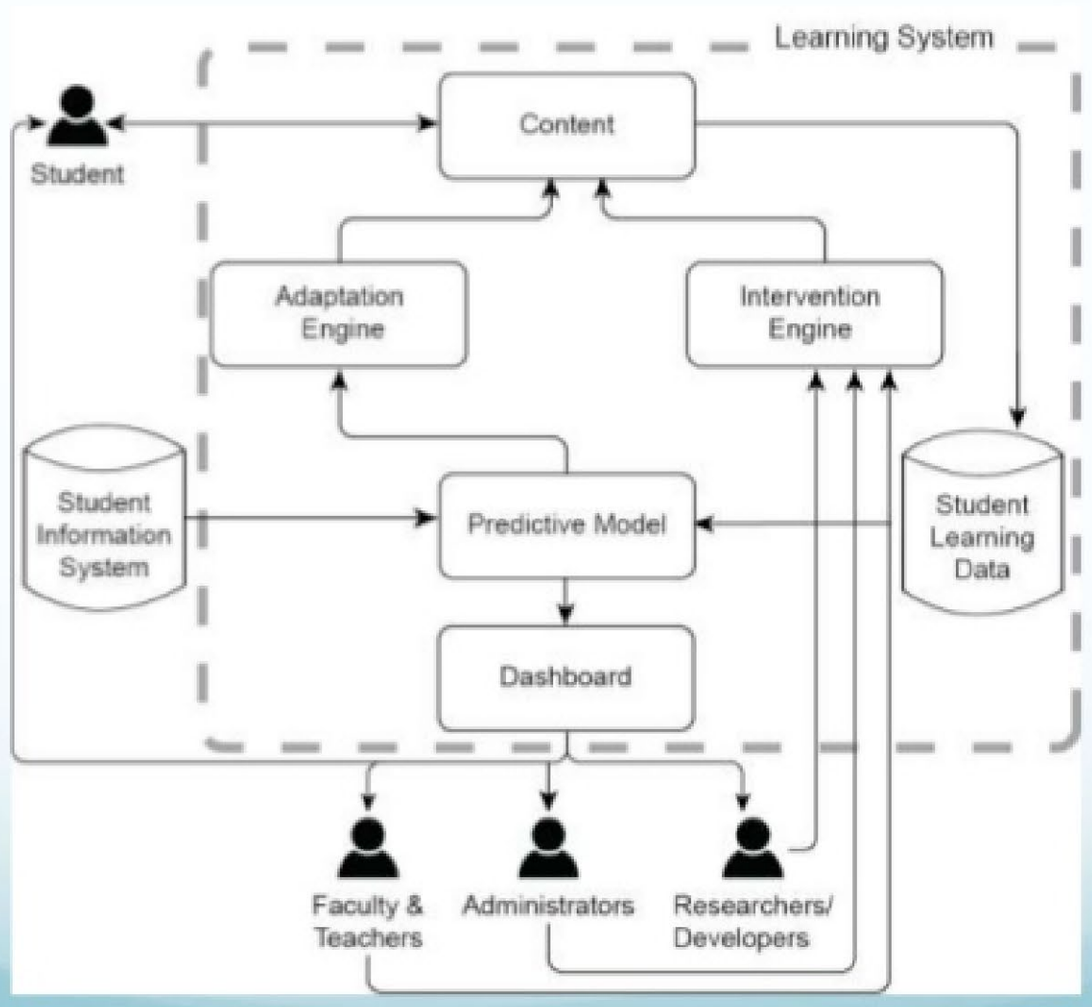
EDM/LA Enables Adaptive Learning Systems



Bienkowski, Feng & Means (2012)

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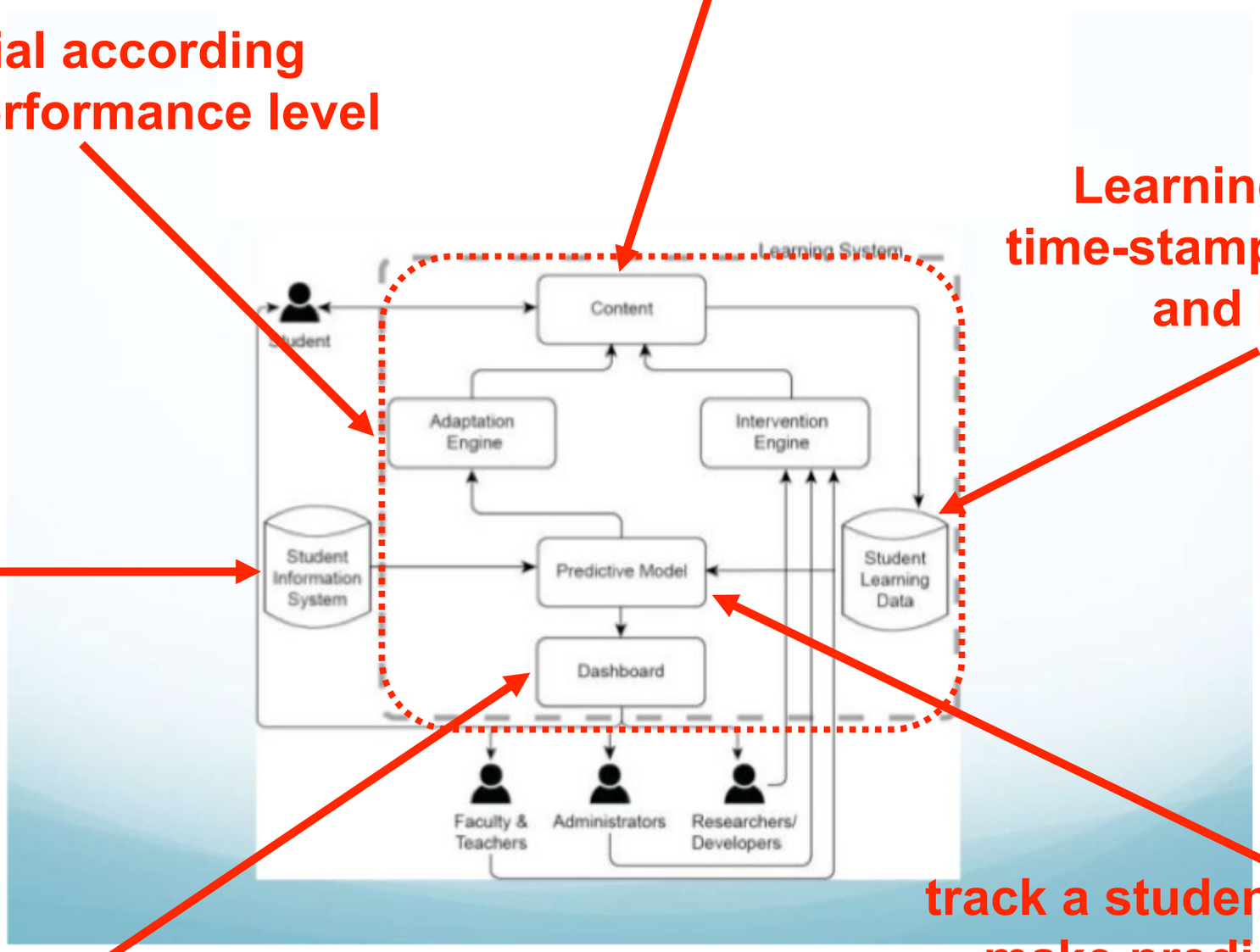
content management, maintenance, and delivery

deliver material according to a student's performance level



Learning Record Store time-stamped student input and behaviours

demographic data

visible feedback for various users (reporting service using output of predictive model)

track a student's progress & make predictions about future behaviours or performance (data mining & analytics)

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ALMat - STUDYING ADAPTIVE LEARNING IN SCHOOLS

GYLDENDAL'S MULTI-SMART ØVING

Powered by

KNEWTON

ARTIFICIAL INTELLIGENCE

&

LEARNING ANALYTICS

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AI: STUDENT MODEL (KNOWLEDGE MODEL)

VS

LA: PREDICTIVE MODEL BASED ON BEHAVIOURS (STATISTICAL MODEL)

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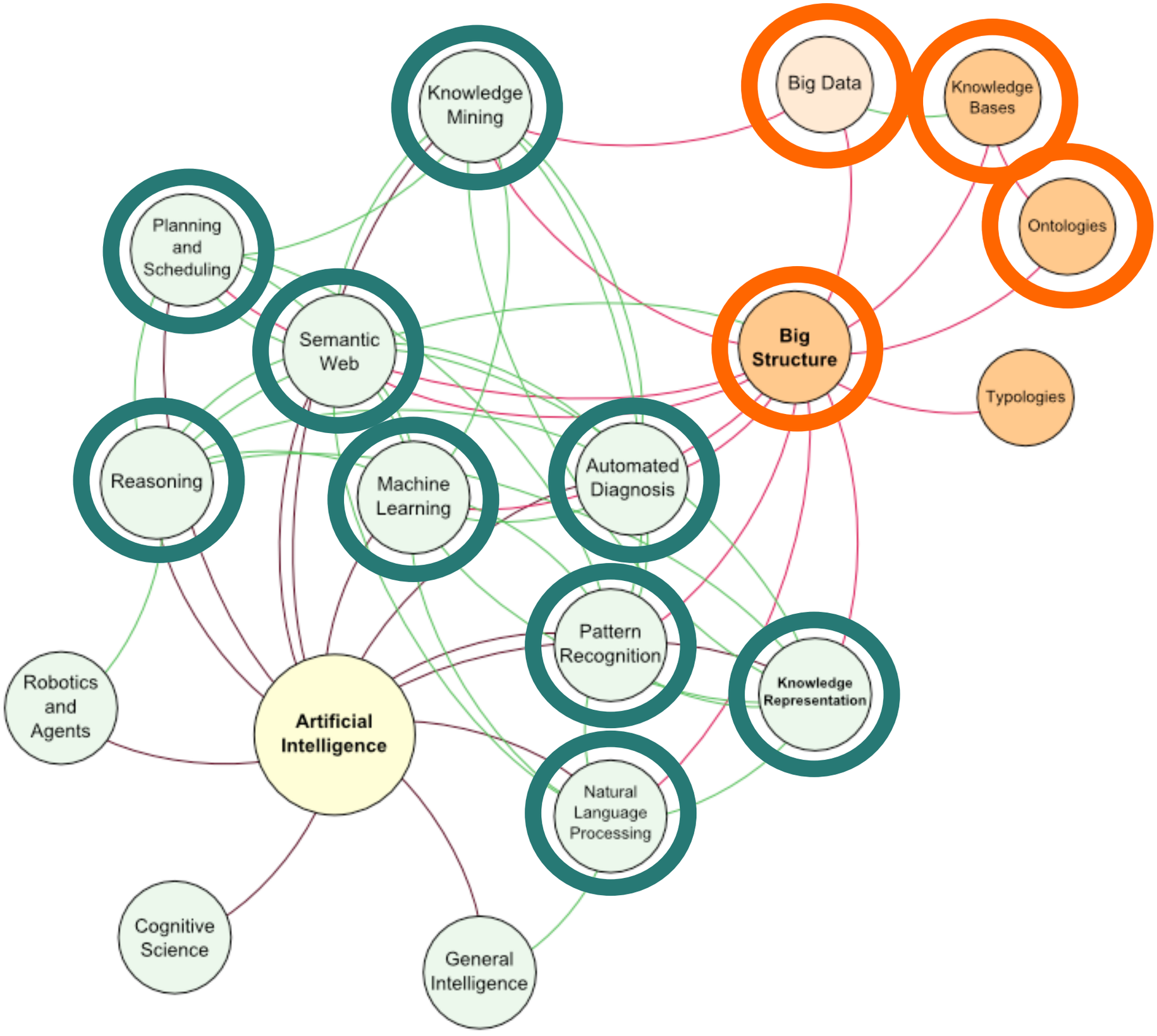

http://www.mkbergman.com/1816/knowledge-based-artificial-intelligence/

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DATA: ACCESS, PRIVACY

DATA: CONTEXT, EXPLANATION, REDUCTION

SCALEABILITY : INTEROPERABILITY, ALGORITHMIC TRANSFER

IMPACT: USEABLE, USED, LEARNING OUTCOMES

ETHICS

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