AI-supported Study Planning and Cohort Monitoring

A perspective on Learning Analytics and Collaboration

René Röpke

AI-supported study planning and cohort monitoring

The Project: **AIStudyBuddy**

The (large) project team

RWTH Aachen University:

- Prof. Dr.-Ing. Ulrik Schroeder, René Röpke, Sergej Görzen, Sven Judel and Tobias Johnen
  - Competencies: Learning Analytics and Application Development
- Prof. Dr. Gerhard Lakemeyer and Hayyan Helal
  - Competencies: Rule-based AI and Planning
- Prof. Dr. Wil van der Aalst, Miriam Wagner und Pouya Soudmand
  - Competencies: Process Mining and Data Science
- Dr. Malte Persike and Kevin Esser
  - Competencies: Project management

University Wuppertal (BUW):

- Prof. Dr. Kerstin Schneider, Dr. Monika Piegeler, Leandro Henao, Luis Rumert
  - Competencies: Economics of Education
- Dr. Simon Görtz, Joel Fuchs and Karin Brieger
  - Competencies: Data Clearing and Project management

Ruhr University Bochum (RUB):

- Prof. Dr. Maren Scheffel, Rike Carpentier and Johannes Wagner-Schiermeister
  - Competencies: Educational Data Science and Didactics
- Prof. Dr. Sebastian Weydner-Volkmann and Dominik Bär;
  - Competencies: Ethics
- Dr. Peter Salden, Jonas Leschke and Katharina Batz
  - Competencies: Project management

Study planning – Definition

- What is a study plan?
  - **Depiction of planned modules** in study program
  - Contains information about workload, credits, whether modules are mandatory or electives
- Supports students in planning their studies
  - How is the study program structured?
  - **When to take which module**?
  - How much work is a specific module?
  - What is mandatory? What choices do students have?
  - Which dependencies are to consider between modules?
- Planning on the **Macro level**
  - Alternatively: Timetable planning, exam planning (Micro)

Example plans

Bachelor Mechanical Engineering (RUB)

Modul	Modulbezeichnung	SWS	LP	1. Sem V	1. Sem Ü	2. Sem V	2. Sem Ü	3. Sem V	3. Sem Ü	4. Sem V	4. Sem Ü	5. Sem V	5. Sem Ü	6. Sem V	6. Sem Ü	7. Sem V	7. Sem Ü
	Mathematisch/Naturwissenschaftliche Grundlagen																
1	Höhere Mathematik A	6	8	4	2												
2	Höhere Mathematik B	6	8			4	2										
3	Höhere Mathematik C	4	5					2	2								
4	Numerische Mathematik	4	5					2	2								
5	Naturwissenschaftliche Grundlagen (Physik, Chemie)	4	5	2	2												
		24	**31**														
	Ingenieurwissenschaftliche Grundlagen																
6	Maschinenbau in der Praxis (Ringvorlesung)	4	2	2	0	2	0										
7	Mechanik A	7	9	3	4												
8	Mechanik B	6	8			3	3										
9	Mechanik C	4	5					2	2								
10	Werkstoffe - Grundlagen und Anwendungen mit Praktikum	8	8	3	1	3	1										
11	Konstruktionstechnik A	4	5	2	2												
12	Konstruktionstechnik B	4	5			2	2										
13	Konstruktionstechnik C	4	5					2	2								
14	Fertigungsverfahren	4	5			2	2										
15	Grundlagen der Thermodynamik	4	5					2	2								
16	Grundlagen der Informatik und Programmierung	8	10					2	2	2	2						
17	Grundlagen der Strömungsmechanik	4	5							2	2						
18	Elektrotechnik	6	7							4	2						
19	Grundlagen der Regelungstechnik	4	5							2	2						
20	Grundlagen der Messtechnik mit Praktikum	4	5							1	3						
21	Wärme- und Stoffübertragung	4	5									2	2				
		79	**94**														
	Ingenieurwissenschaftliche Anwendungen																
22	Schwerpunktmodule im Umfang von mindestens 35 Leistungspunkten. Die Wahl muss aus den	28	35										0				

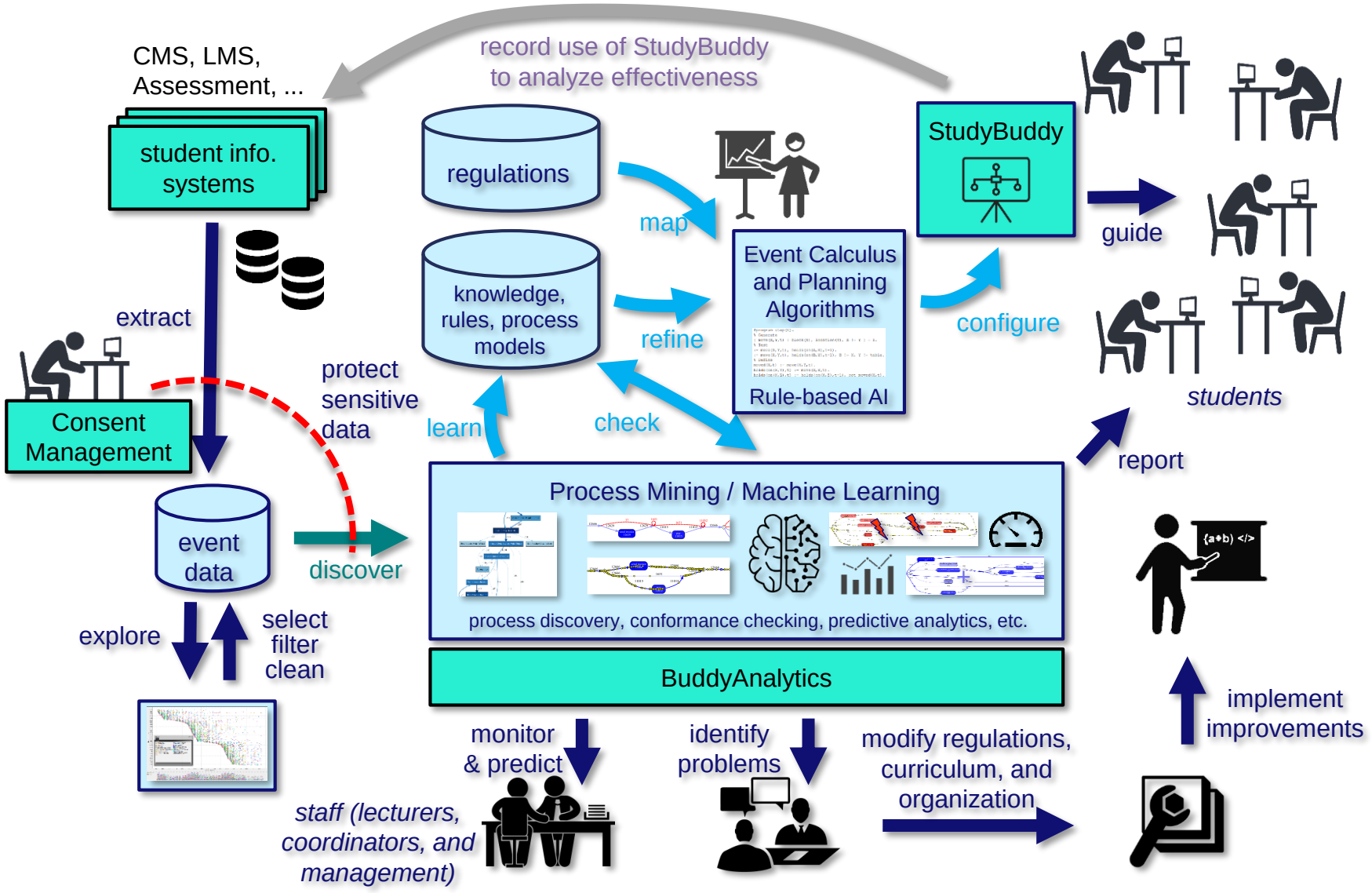
Bachelor Computer Science (BUW)

Semester					
1	Grundlagen aus der Informatik und Programmierung	Elektrotechnische Grundlagen der Informatik	Mathematik A	Anwendugsfach 1	
2	Algorithmen und Datenstrukturen	Grundzüge der technischen Informatik	Mathematik B	Mathematik für Informatik I	
3	Objektorientierte Programmierung	Betriebsysteme	Einführung in Datenbanken	Mathematik für Informatik II	WP-Bereich Informatik 1
4	Softwaretechnologie	Grundlagen der Rechnerarchitek-tur	Rechnernetze	Automaten, Sprachen und Berechenbarkeit	Seminar zur Infor-matik
5	Praktikum zur Softwaretech-nologie	Grundlagen der IT-Sicherheit	Anwendungsfach 2	Anwendungsfach 3	WP-Bereich Informatik 2
6	Abschlussprojekt Bachelor Informatik			Anwendungsfach 4	Professionalisierung

Bachelor Computer Science (RWTH)

Semester:	1. (WS)	C	2. (SS)	C	3. (WS)	C	4. (SS)	C	5. (WS)	C	6. (SS)	C	Summe Credits
Praktische Informatik	Programmierung Teil 1 und 2 (V4+Ü2)	8	Datenstrukturen und Algorithmen (V4+Ü2)	8	Einführung in die Softwaretechnik (V3+Ü2)	6	Datenbanken und Informationssysteme (V3+Ü2)	6					28
Technische Informatik	Technische Informatik (V4+Ü2)	6	Betriebssysteme und Systemsoftware (V3+Ü2)	6	Praktikum System-Programmierung (PSP) (P3)	8	PSP im 4. Sem. dann DatKom ODER DB ins 6.(blaue Pfeile)						26
							Datenkommunikation und Sicherheit (V3+Ü2)	6					
Theoretische Informatik			Formale Systeme, Automaten, Prozesse (V3+Ü2)	6	Berechenbarkeit und Komplexität (V3+Ü2)	7	Mathematische Logik (V3+Ü2)	7					20
Mathematik	Diskrete Strukturen (V3+Ü1)	6	Lineare Algebra für Informatiker (V3+Ü2)	6									26
	Analysis für Informatiker (V4+Ü2)	8					Einführung in die angewandte Stochastik (V3/Ü2)	6					
Sonstige Studienleistungen			Einführung in das wissenschaftliche Arbeiten (Proseminar) (V1+S2)	3					Software-Projektpraktikum (P3)	6	Bachelorarbeit und Kolloquium	15	34
	Mentoring	1			Nicht-technisches Wahlfach	4			Seminar (S2)	5			
Wahlpflicht									Wahlpflichtmodul (V3+Ü2)	6	Wahlpflichtmodul (V3+Ü2)	6	24
									Wahlpflicht Theorie (V3+Ü2)	6	Wahlpflichtmodul (V3+Ü2)	6	
Summe Credits (ohne Anwendungsfach, ohne Verschiebungen im Studienplan)		29		29		25		25		23		27	158

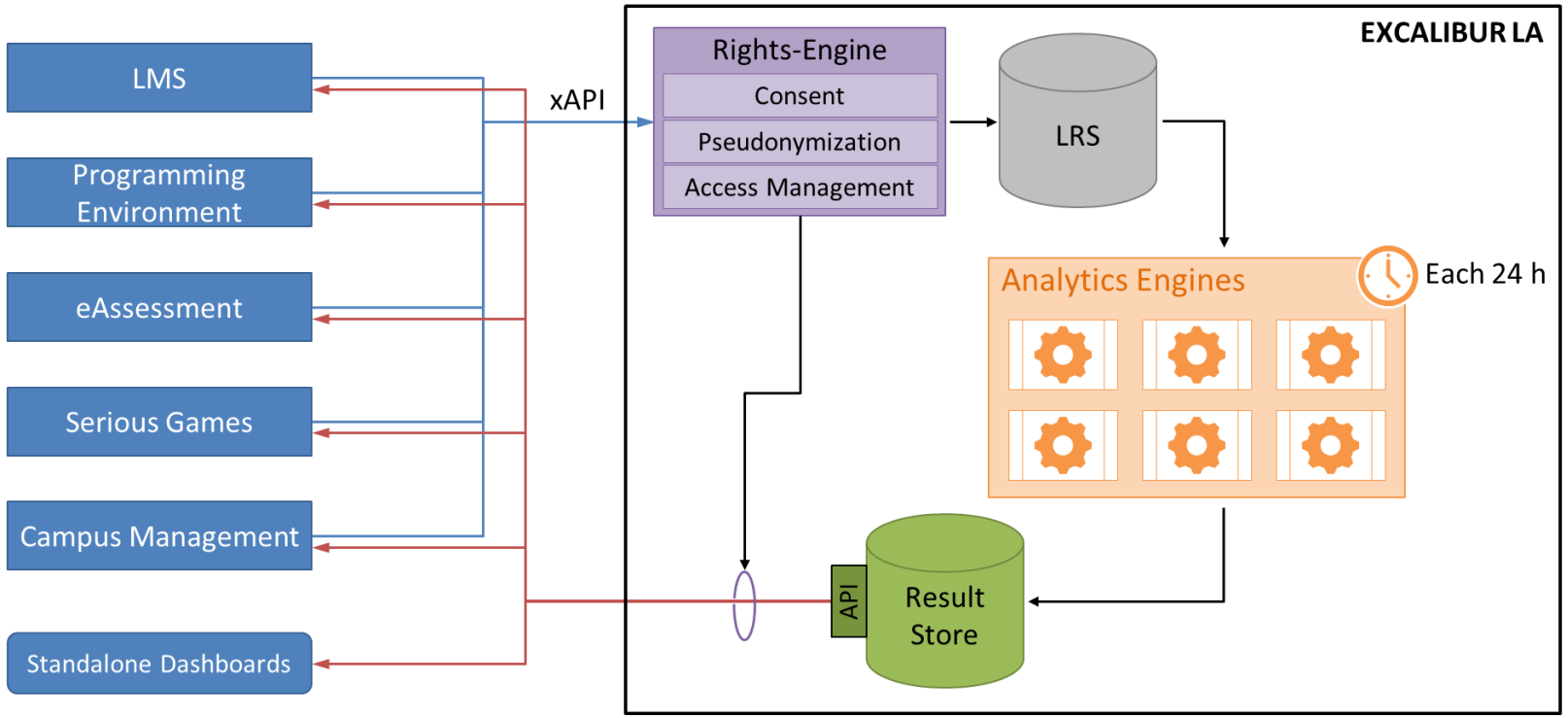
Approach



Wagner, M. et al. (2023). A Combined Approach of Process Mining and Rule-Based AI for Study Planning and Monitoring in Higher Education. doi: 10.1007/978-3-031-27815-0_37

Under the hood: EXCALIBUR LA

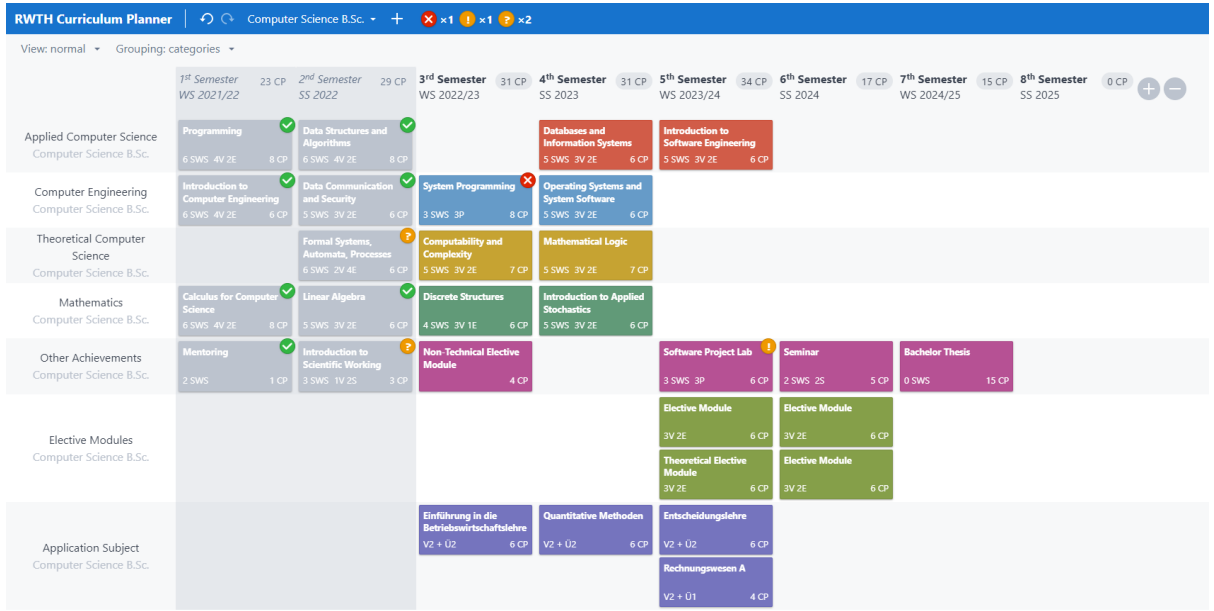
- Extendable and Scalable Infrastructure build for Learning Analytics
- Will be extended:
  - Process Mining-based Engines
  - Rule recommendations for AI

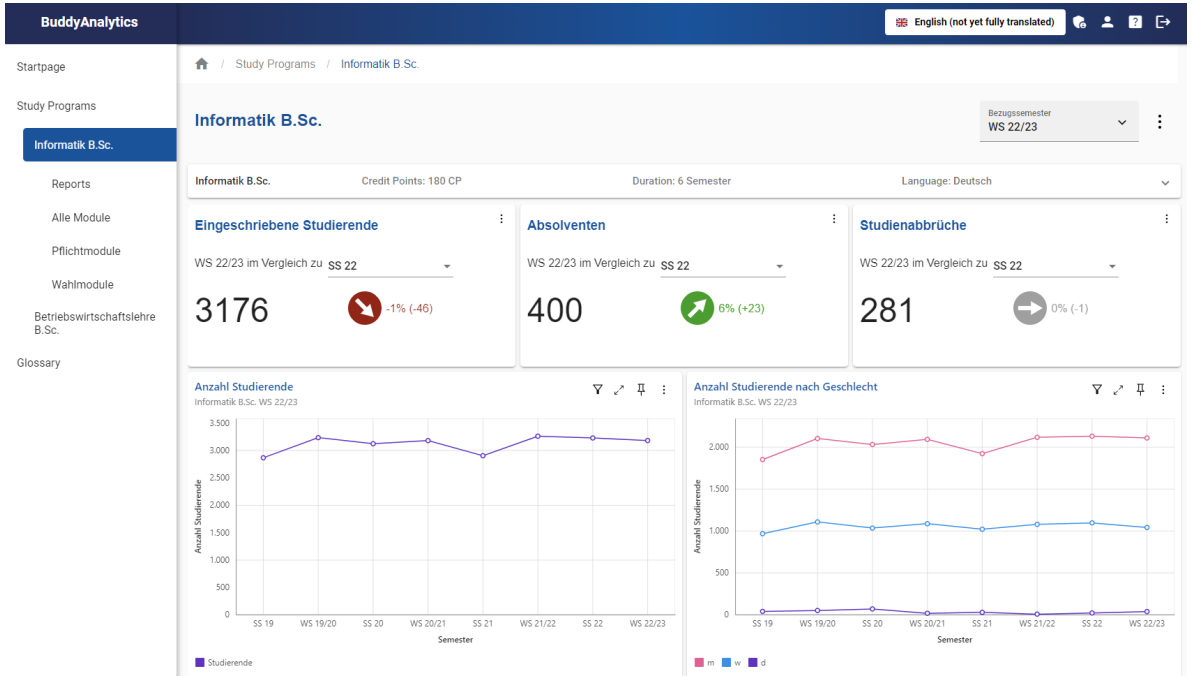


Judel, S. and Schroeder, U. (2022). EXCALIBUR LA - An Extendable and Scalable Infrastructure Build for Learning Analytics. *doi:* 10.1109/ICALT55010.2022.00053.

Two applications for the stakeholders

- StudyBuddy
  - Planning applicationg for students
- BuddyAnalytics
  - Monitoring applications for study program designers





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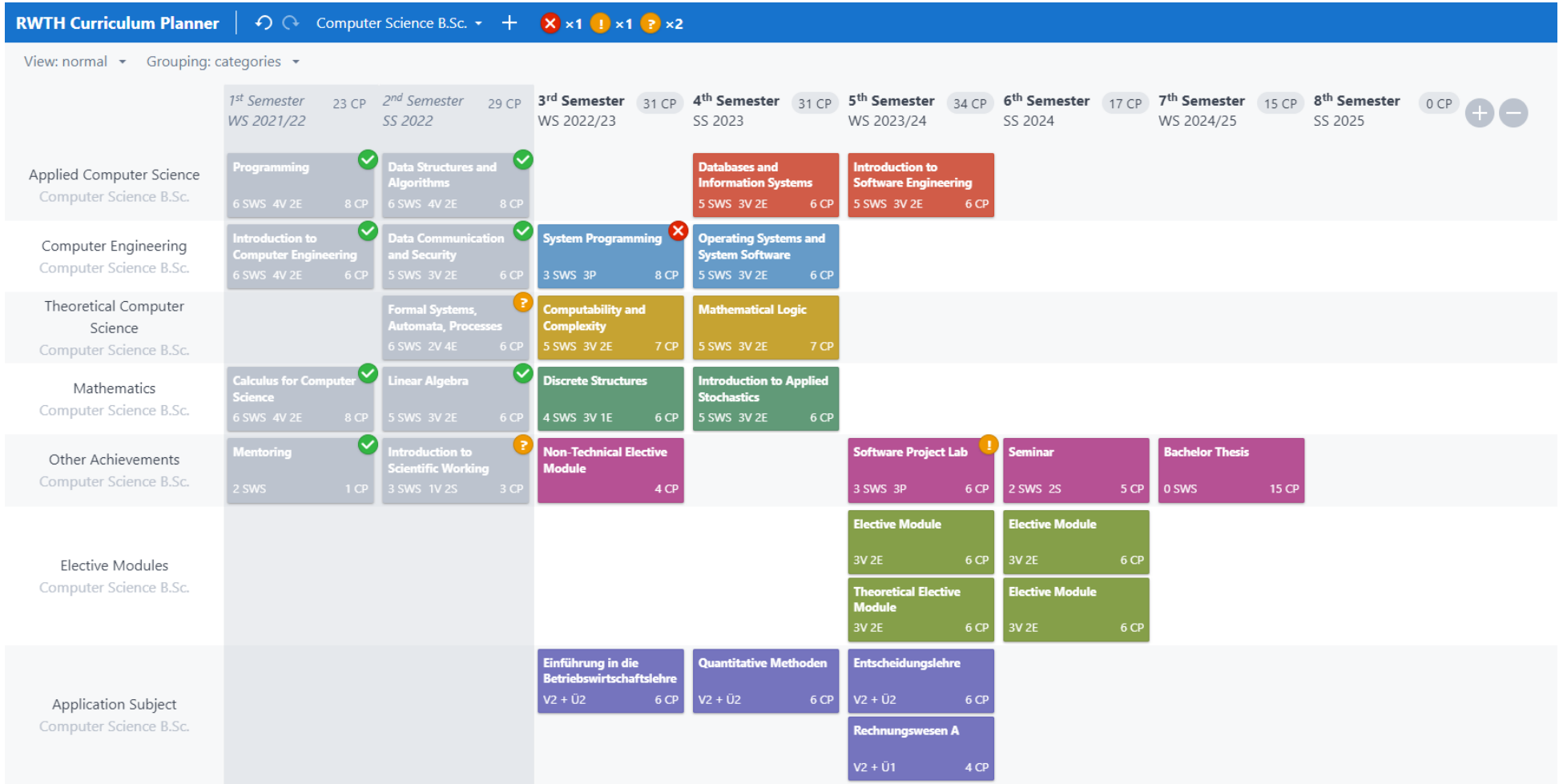
Two applications for the stakeholders

- StudyBuddy



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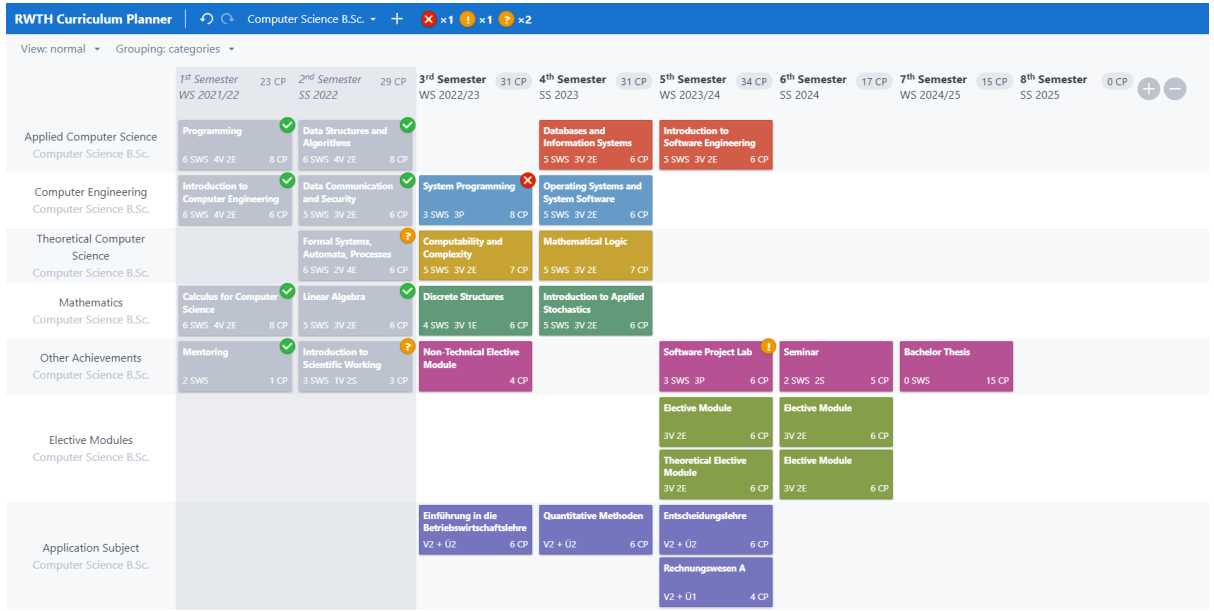

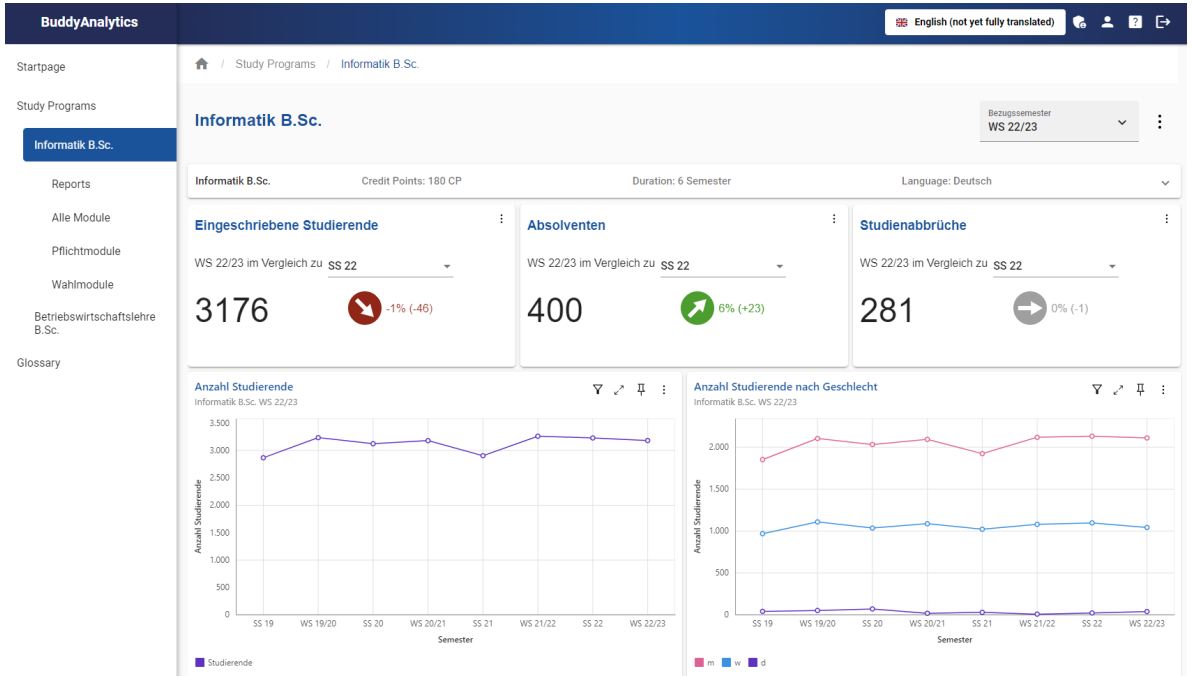

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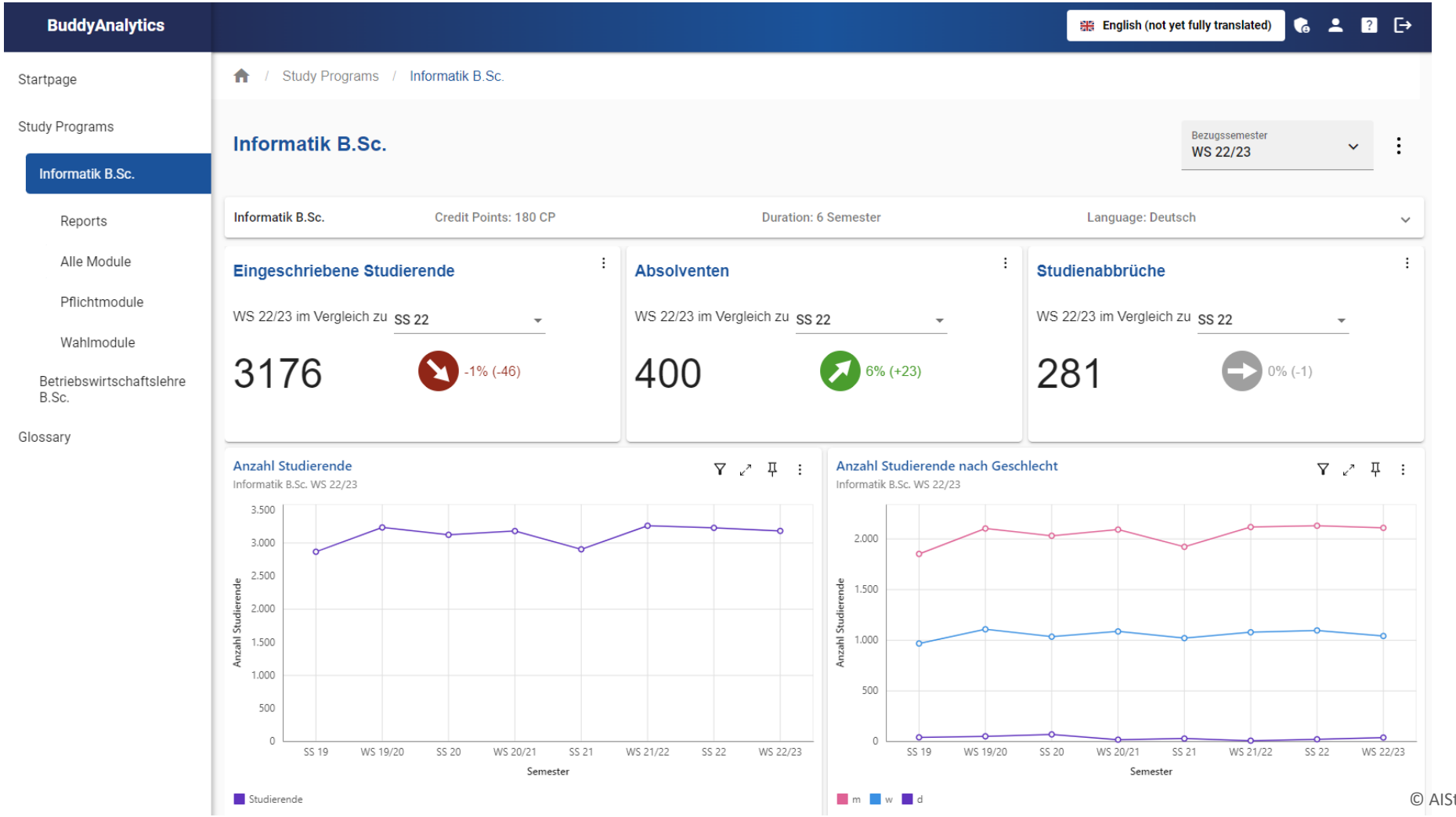


Beyond-the-project visions

- Informed, reflected planning of individual study paths
- Guidance towards study sucess – considering individual circumstances
- Cross-institutional analysis and evaluation – learning from each other and sharing experiences
- Unleashing the potential of existing data – to understand how students plan and behave

The Project: **AMIGO**

The project team

RWTH Aachen University:

- René Röpke
- Prof. Dr.-Ing. Ulrik Schroeder

Johannes Gutenberg University Mainz:

- Dr. Henrik Bellhäuser

Associated Partners

- Prof. Sonia Lippke, Prof. Peter Baumann, Dr. Stanislav Chankov
  - Instructors at Jacobs University Bremen
- Prof. Dr.-Ing. Johannes Konert
  - Original partner from MoodlePeers project

Learning Group Formation: Who learns well with whom?

- Interdisciplinary Project (MoodlePeers since 2014, AMIGO since 2019)
  - Computer Science & Educational Psychology
  - Testbeds in Darmstadt, Mainz, Aachen, Bremen

Create a Group Formation (Instructors)

- Scenario
- Prior Knowledge

Data Collection (Participants)

- Fill out questionnaire

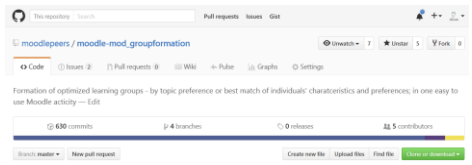
Build groups via algorithm (Instructors)

- Optimized group formation
- Manual post-processing possible
- Adopt groups to Moodle

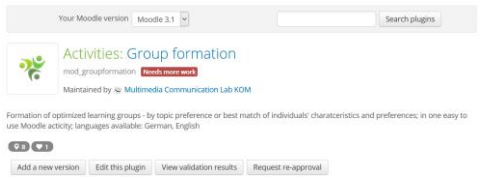
Repository
moodle_mod_groupformation

Moodle Plugin
moodle.org/plugins/mod_groupformation

GitHub



Moodle



Algorithmic Method for Improved Group Formation Online

- Various user studies in different courses and universities
  - Acceptance study using a cross-sectional questionnaire
    - Most named problem: *„Our group was not a good fit in terms of members“*
    - Acceptance: 70% would participate in algorithm. group formation (positive, curious attitude)
  - Decision study using a quasi-experimental design
    - Who chooses algorithmic vs. manual group formation („friend groups“)?

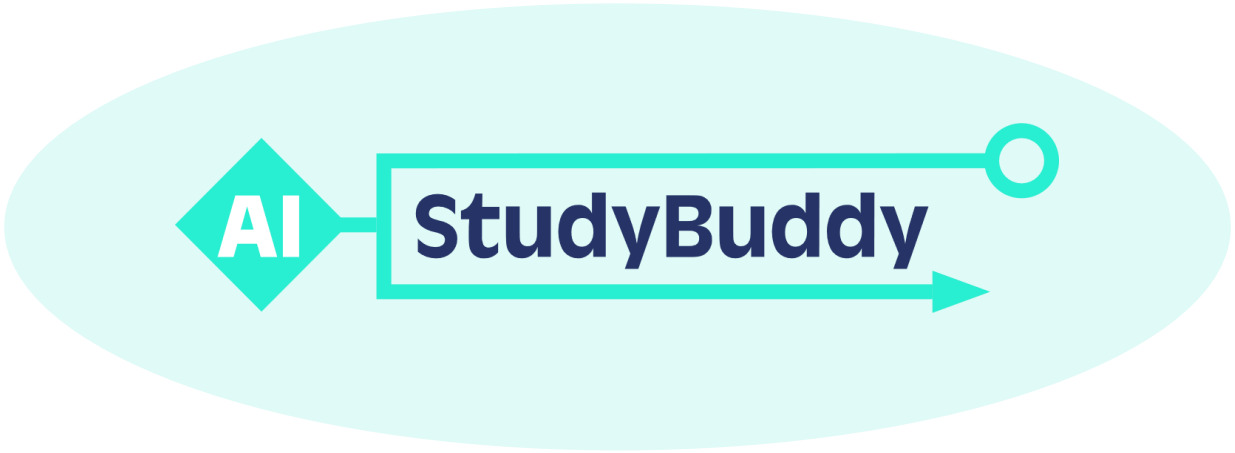
    → 1/3 chose algorithm

    → Mainly „disadvanted“ students (significantly older, poorer school grades, less conscientiousness)
  - Intervention studies to identify which traits influence group performance, satisfaction, time spent etc.

WORK IN PROGRESS

A perspective on collaboration

Identifying connections



Matching groups and course choices

Detecting collaboration across the students' lifecycles

Issues with missing collaboration data

Matching groups and course choices

- Two perspectives

Finding groups in similar courses

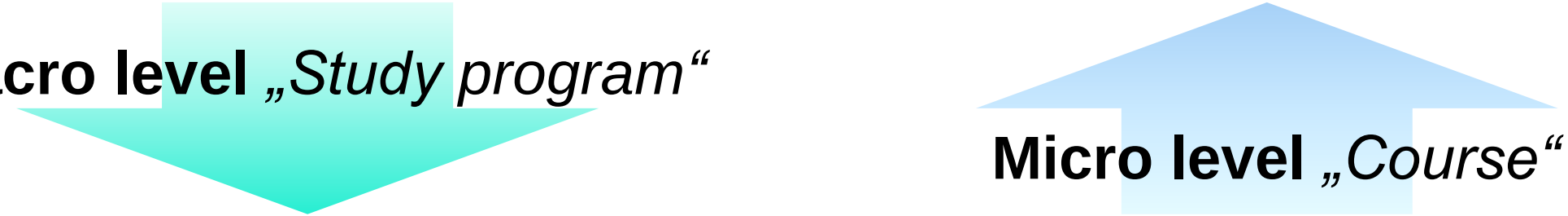
- Shared interest, similar schedules
- Consideration during group formation
  - → Currently selected courses as constraints
  - → Inclusion of past courses and students' competencies

Finding courses in similar groups

- Shared interests, shared positive experiences in collaborating
- Consideration during study planning
  - → Collaborative Views/Plan sharing
  - → Individual constraints vs. group constraints

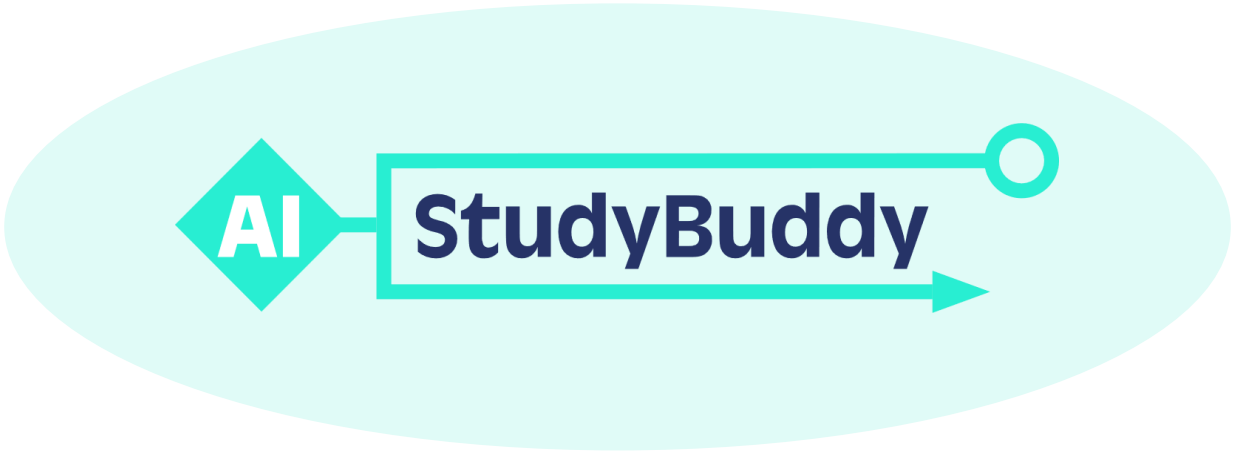
Detecting collaboration across the students' lifecycles

- Cohort monitoring and learning analytics on different levels



- **Idea: Linking both levels**
  - Compare students‘ performance based on collaboration history/experiences
  - Identification of shared paths – before and after collaboration
  - Analysis of collaboration effects of early semesters
  - Detect patterns of collaborating – link them to performance data
- But: **Longitudinal** research with **high complexity** and **issues of data privacy**

Conclusion



- Learning Analytics with a focus on study planning and cohort monitoring
  - Macro vs. Micro level
- Group Formation and Collaborations throughout studies could be investigated
- Complex research which requires longitudinal studies, lots of data, brings issues of data privacy and anonymity

Thank you for your attention!

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