



AI-supported Study Planning and Cohort Monitoring

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Study Planning and Cohort Monitoring

– Target Groups:

- Students (Planning)
- Study Program Designers (Analysis)



– Data-driven and rule-based Artificial Intelligence



– Access through user-centered web applications

– Joint Research Project in Research Program

- *AI in Higher Education*

– Project timeframe: 01.11.2021 – 30.04.2025

Study Planning Tool – StudyBuddy

- **Interactive Plan**
 - Based on recommended plan
 - Individual adjustments

- **Rule-based Feedback**

- **Data-driven Recommendations**

The screenshot displays the StudyBuddy interface for a Bachelor Computer Science program. The interface is organized into a grid with columns for semesters and rows for course categories. The columns are: 1st Semester WS 2022/23 (29 CP), 2nd Semester SS 2023 (30 CP), 3rd Semester WS 2023/24 (33 CP), 4th Semester SS 2024 (31 CP), 5th Semester WS 2024/25 (30 CP), and 6th Semester SS 2025 (27 CP). The rows are: Computer Science, Applied Computer Science, Computer Engineering, Theoretical Computer Science, Mathematics, Other Achievement, Non-Technical Elective Module, Elective Module, and Informatics Elective. Courses are represented by colored blocks with their names and credit points (CP). Green checkmarks indicate completed or recommended courses, while orange question marks indicate pending or uncertain courses. The interface also shows a user profile 'TestUser' and a language setting 'EN'.

	1st Semester WS 2022/23 29 CP	2nd Semester SS 2023 30 CP	3rd Semester WS 2023/24 33 CP	4th Semester SS 2024 31 CP	5th Semester WS 2024/25 30 CP	6th Semester SS 2025 27 CP
Computer Science						
Applied Computer Science	Programming Concepts 6 SWS 8 CP	Data Structures and Algorithms 6 SWS 7 CP	Software Engineering 5 SWS 6 CP	Databases and Information Systems 5 SWS 6 CP	Elements of Machine Learning and Data Science 3 SWS 6 CP	
Computer Engineering	Introduction to Computer Engineering 6 SWS 6 CP	Operating Systems and System Software 5 SWS 7 CP	Data Communication 5 SWS 6 CP	System Programming 3 SWS 8 CP	IT - Security 3 SWS 4 CP	
Theoretical Computer Science		Formal Systems, Automata, Processes 5 SWS 6 CP	Computability and Complexity 5 SWS 7 CP	Mathematical Logic I 5 SWS 7 CP		
Mathematics	Calculus for Computer Science 6 SWS 8 CP	Linear Algebra 5 SWS 6 CP		Introduction to Applied Stochastics 4 SWS 6 CP		
Other Achievement	Discrete Structures 5 SWS 6 CP	Mentoring in Informatics 2 SWS 1 CP	Introduction to Scientific Working (Proseminar...) 3 SWS 4 CP	Software Project Lab 3 SWS 6 CP	Seminar Computer Science 2 SWS 4 CP	
Non-Technical Elective Module					Non-Technical Elective Module 4 CP	
Elective Module						Elective Module 6 CP
Informatics Elective					Informatics Elective Module 6 CP	Informatics Elective Module 6 CP

Fixed, unflexible recommended plan

- Similarities
 - Placement of modules in specific semesters
 - Information on Credit Points
 - Per Module
 - Per Semester
- Problems:
 - No alternatives to recommended plan
 - Module dependencies are not included
 - Rigid, fixed → one-fits-all

Kürzel	Modulbezeichnung	Fachsemester					
		1	2	3	4	5	6
BM-SA	Basismodul Sprachausbildung (9 LP)						
	Übung: Hörverstehen und mündlicher Ausdruck I	3					
	Übung: Schriftlicher Ausdruck I Übung: Übersetzen		3				
BM-LK	Basismodul Literatur- und Kulturwissenschaft (6 LP)						
	Seminar: Einführung in die Literaturwissenschaft		2				
	Seminar: Einführung in die Kulturwissenschaft Modulprüfung		2				
BM-Lin	Basismodul Linguistik (6 LP)						
	Seminar: Einführung in die anglistische Linguistik I (Phonetik/Phonologie - Morphologie - Lexikalische Semantik)		3				
	Seminar: Einführung in die anglistische Linguistik II (Syntax) Modulprüfung (Klausur)			2			
AM-SA	Aufbaumodul Sprachausbildung (6 LP)						
	Übung: Hörverstehen und mündlicher Ausdruck II Übung: Schriftlicher Ausdruck II						3
	Aufbaumodul Amerikanische Literatur und Kultur (6 LP)						
AM-ALK-a	Vorlesung oder Seminar 1			3			
	Seminar 2				2		
	Modulprüfung				1		
AM-BL-a	Aufbaumodul Britische Literatur (6 LP)						
	Vorlesung oder Seminar 1				3		
	Seminar 2					2	
AM-BK-a	Aufbaumodul Britische Kultur (6 LP)						
	Vorlesung oder Seminar 1						3
	Seminar 2						2
AM-PLK-a	Aufbaumodul Postkoloniale Literatur und Kultur (6 LP)						
	Vorlesung oder Seminar 1						3
	Seminar 2						2
	Modulprüfung						1

Modulkürzel	Modulbezeichnung (Pflicht/Wahlpflicht)	Sem.	LP	Typ	SWS	Veranstaltungsbezeichnung	Prüfung	Modulbeauftragte/r	Bemerkung/Sprache
1. Semester (Wi)									
■ BA3POL3501	M1: Grundlagen der Politikwissenschaft und ihrer Nachbardisziplinen (P)	Wi	5	V	2	Einführung in die Methoden der empirischen Politikwissenschaft	Klausur (60 Min.)	Cronqvist	Deutsch
				Ü	1	Propädeutikum			
				TUT	1	Methoden der Politikwissenschaft			
■ BA3POL3502	M2: Demokratie und Gesellschaft in Deutschland (P)	Wi	10	V	2	Politisches System der BRD	Klausur (90 Min.)	Jun	Deutsch
				V	2	Politische Geschichte im 19. und 20. Jahrhundert			
				S	2	Gesellschaft und Demokratie in Deutschland			
2. Semester (So)									
■ BA3POL3504	M4: Vergleich politischer Systeme (P)	So	10	V	2	Einführung in die Vergleichende Regierungslehre	Klausur (120 Min.)	Linden	Deutsch
				S	2	Politische Systeme			

Influences on Study Planning



Curriculum Conditions



Exams not attended/not passed



Module cycles



Prerequisites for modules

- Pass A before attending B



Prior Knowledge Recommendations

- Knowledge of C is recommended for D



Private Conditions



Peers and Friends



Job, side hustles



Family-related issues

Study Planning Tool – StudyBuddy

StudyBuddy | B.Sc. Computer Science | TestUser | DE

View: Normal | Grouping: Categories

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Theoretical Computer Science		Formal Systems, Automata, Processes	System Programming	Computability and Complexity	Mathematical Logic I	
Mathematics	Calculus for Computer Science	Linear Algebra		Introduction to Applied Stochastics		
Other Achievement	Mentoring in Informatics	Introduction to Scientific Working (Pr...)		Software Project Lab	Seminar Computer Science	
Non-Technical Elective Module					Nicht-technisches Wahlfach	
Elective Module						Wahlpflichtmodul

Study Planning Tool – StudyBuddy

StudyBuddy | B.Sc. Computer Science | x1 x10 | TestUser | DE

View: Normal | Grouping: Categories

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Elective Module						Wahlpflichtmodul

→ Zwingende Voraussetzung
→ Empfohlene Voraussetzung

Study Planning Tool – StudyBuddy

The screenshot displays the StudyBuddy interface for a B.Sc. Computer Science program. The top navigation bar includes the logo, program name, and user information. The main area shows a grid of modules across six semesters. A tooltip is overlaid on a module in the 4th semester, indicating a prerequisite issue. The tooltip text is: "Dieses Modul hat eine nicht erfüllte empfohlene Voraussetzung." (This module has an unmet recommended prerequisite.)

Semester	CP	Module	SWS	CP
1. Semester	29 CP	Programming Concepts	6 SWS	8 CP
2. Semester	30 CP	Introduction to Computer...	6 SWS	6 CP
3. Semester	33 CP	Data Structures and Algorithms	6 SWS	7 CP
4. Semester	31 CP	Software Engineering	5 SWS	6 CP
5. Semester	30 CP	Databases and Information Systems	5 SWS	6 CP
6. Semester	27 CP	Operating Systems and System Software	5 SWS	7 CP

Study Planning Tool – StudyBuddy

The screenshot displays the StudyBuddy interface for a B.Sc. Computer Science program. The top navigation bar shows the user is logged in as 'TestUser' and the program is set to 'B.Sc. Computer Science'. The main content area is a grid of modules organized by semester (1. Semester to 6. Semester). A modal window titled 'Modul bestanden?' (Module passed?) is open, showing a green checkmark, a red X, and a right arrow. A green dashed arrow points from the modal to the 'Software Engineering' module in the 5th semester. Other modules include 'Programming Concepts', 'Data Structures and Algorithms', 'Introduction to...', 'Formal Systems, Au...', 'Calculus for Compu...', 'Linear Algebra', 'Mentoring in Informatics', 'Introduction to Scientific Working (Pr...', 'Software Project Lab', 'Seminar Computer Science', 'Nicht-technisches Wahlfach', and 'Wahlpflichtmodul'.

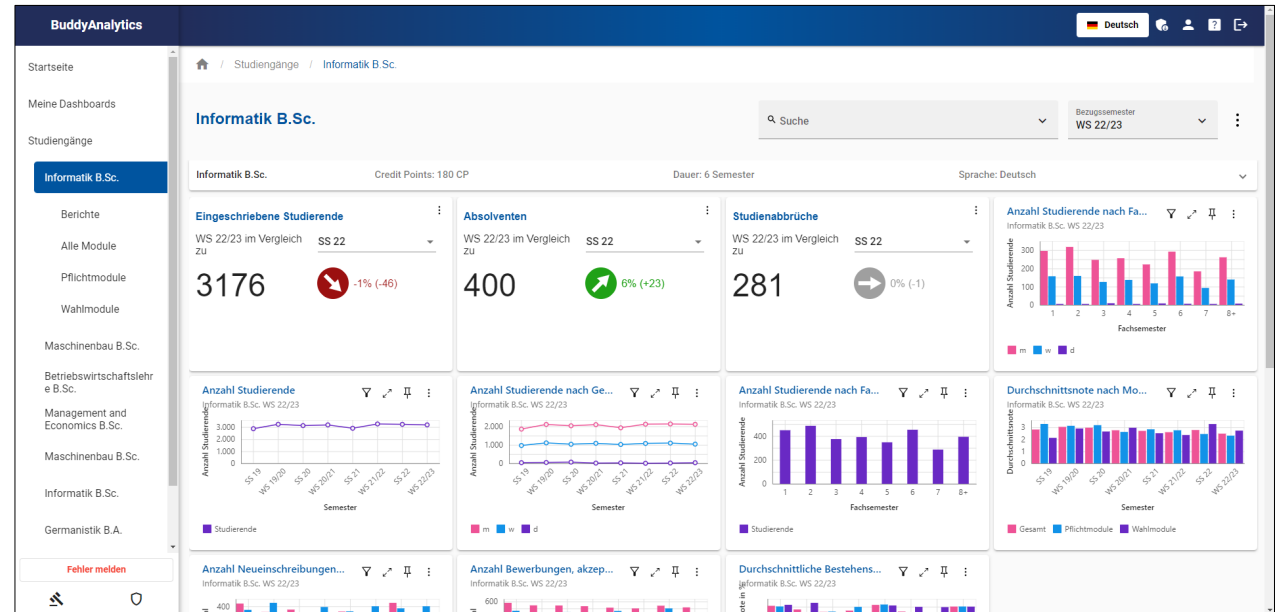
Study Path Analysis – BuddyAnalytics

Web-based Monitoring Tool for Study Program Designers

- AI-based study monitoring
- Cohort tracking
- Analysis of study paths

Objectives

- Better understanding of study paths
- Evidence-based curriculum development
- Improvements in teaching and administration



- Startseite
- Meine Dashboards
- Studiengänge

Informatik B.Sc.

- Berichte
- Alle Module
- Pflichtmodule
- Wahlmodule
- Maschinenbau B.Sc.
- Betriebswirtschaftslehre B.Sc.
- Management and Economics B.Sc.
- Maschinenbau B.Sc.
- Informatik B.Sc.
- Germanistik B.A.

Fehler melden

Studiengänge / Informatik B.Sc.

Informatik B.Sc.

Suche Bezugssemester WS 22/23

Informatik B.Sc. Credit Points: 180 CP Dauer: 6 Semester Sprache: Deutsch

Eingeschriebene Studierende

WS 22/23 im Vergleich zu SS 22

3176 -1% (-46)

Absolventen

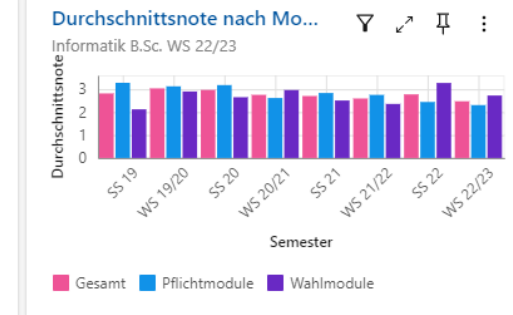
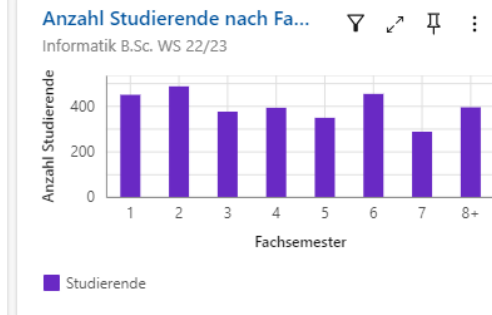
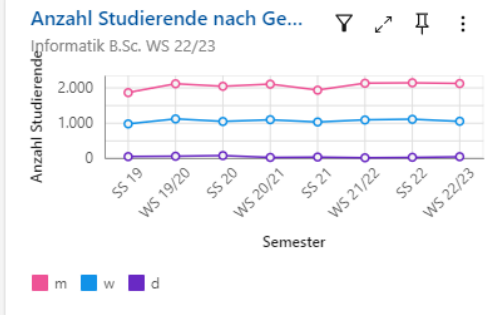
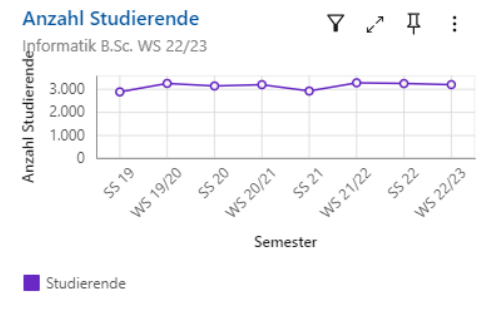
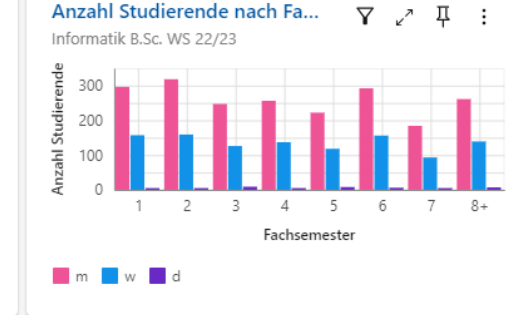
WS 22/23 im Vergleich zu SS 22

400 6% (+23)

Studienabbrüche

WS 22/23 im Vergleich zu SS 22

281 0% (-1)



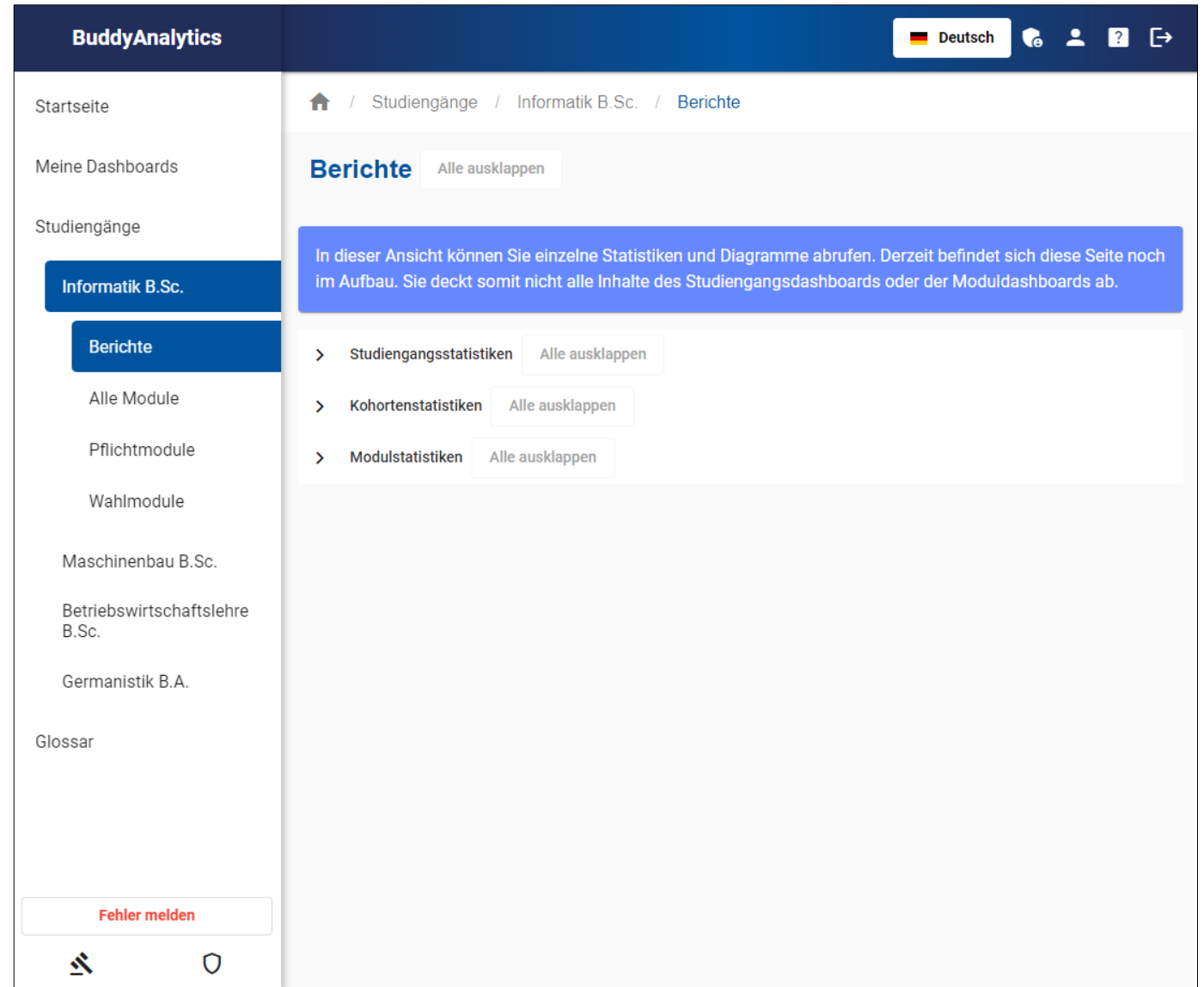
BuddyAnalytics

Current Progress

- Different indicators prepared and visualized
- Reporting and monitoring dashboards
- Filters and Export functionalities

Planned Features

- Customizable dashboards
- Process analysis of study cohorts
- Conformance checking and variants



Merging data in the joint project

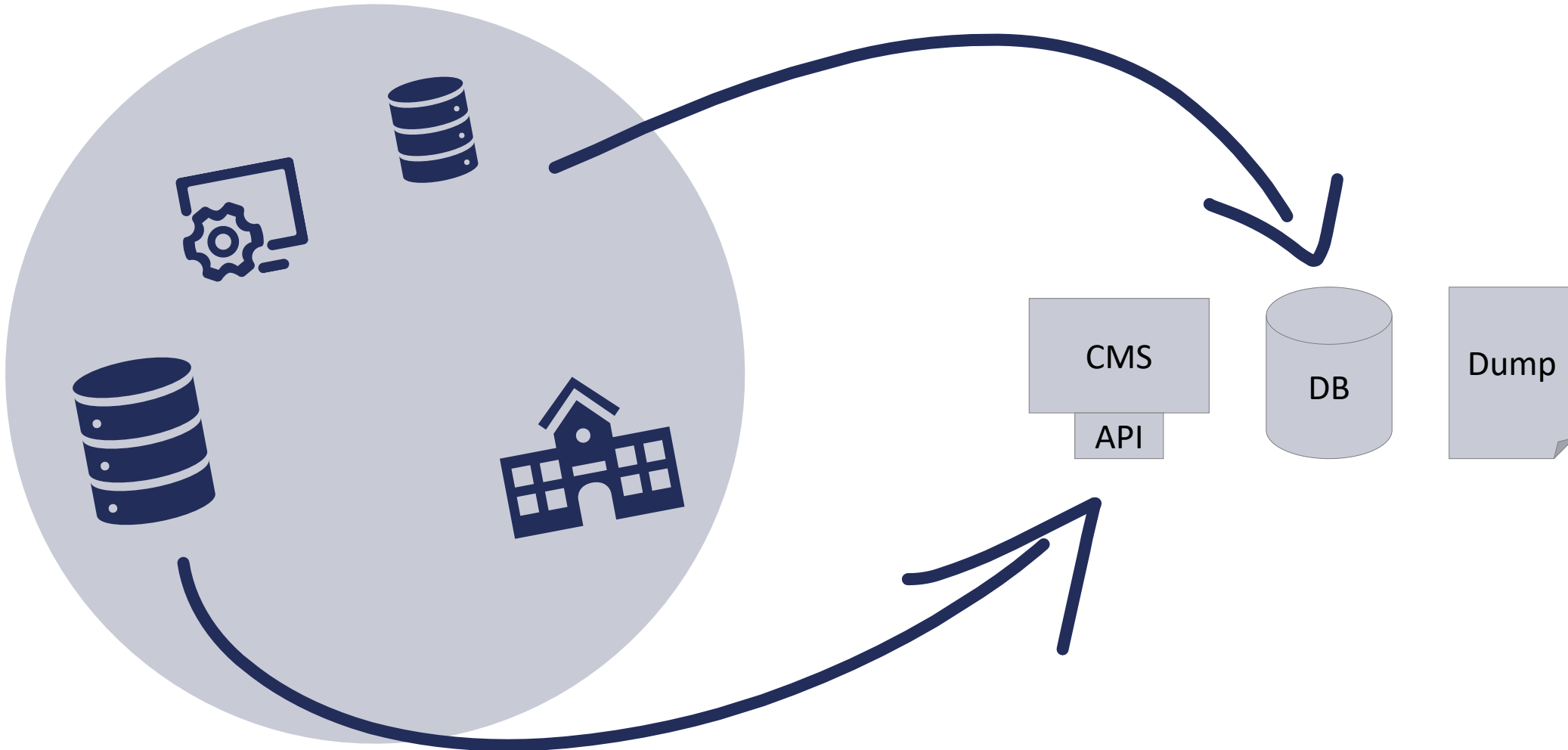
- **Joint Project** → **Different institutions** → **Different systems**
- **Necessary data might be distributed among systems**
 - Campus Management System vs. Student Information Systems + Examination systems
- **Approach: Data reference model + central data warehouse**



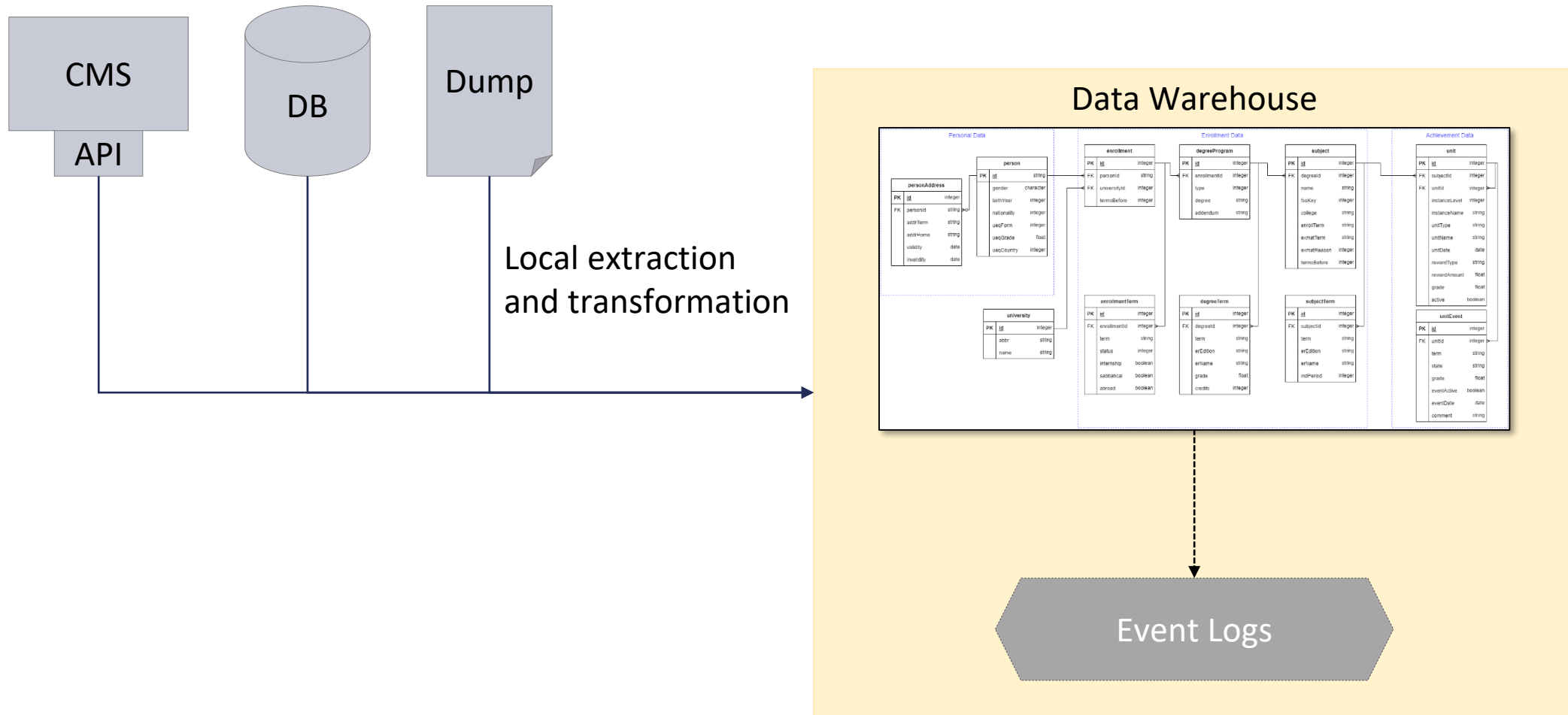
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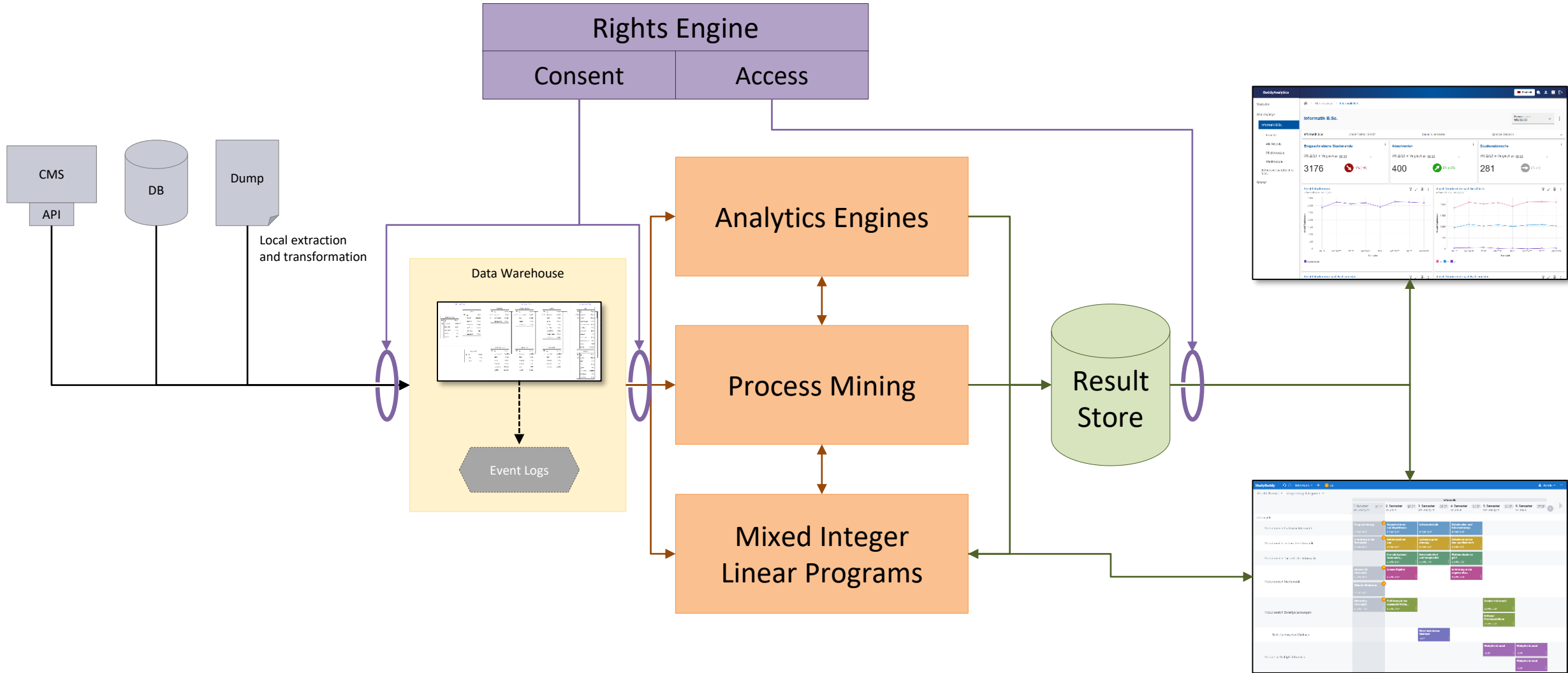
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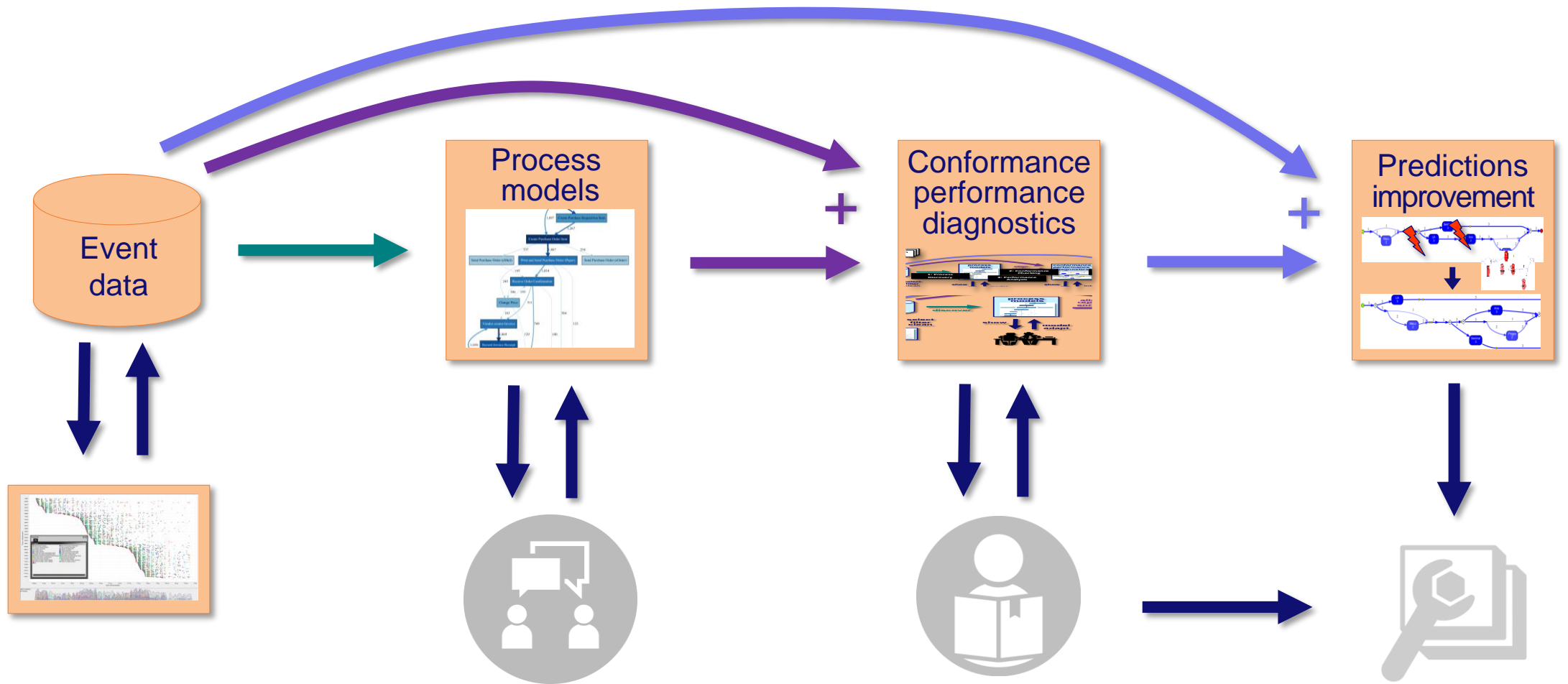
Central Data Warehouse



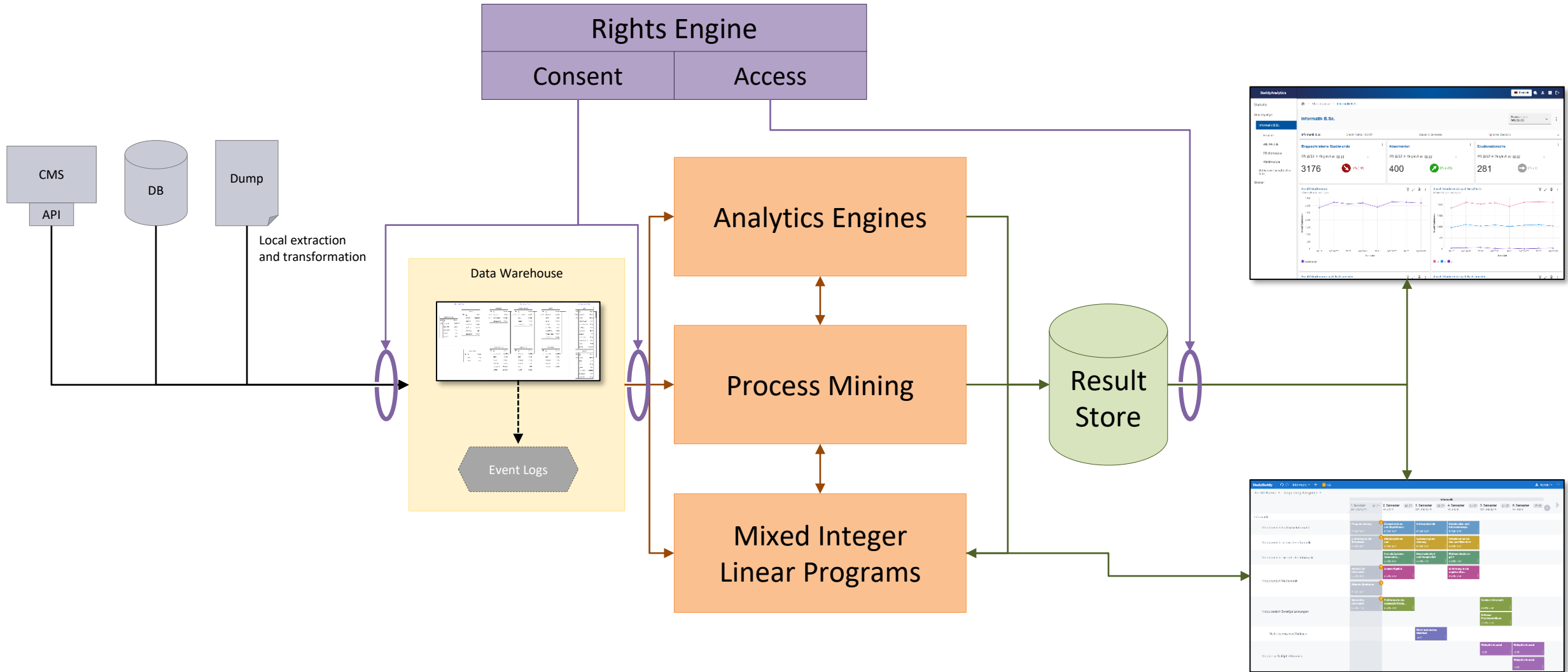
From data to AI support



Study paths as processes



From data to AI support



Representation of regulations and module handbooks

Machine-readable model

Examination regulations

- In Area XY, a minimum of 30 credits is required



Module handbooks

- Module A must be passed before attending module B.
- Module C is only offered in winter semesters.



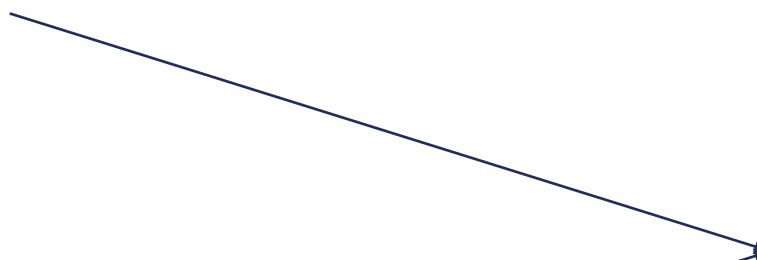
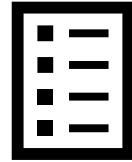
Representation of regulations and module handbooks

Machine-readable model

Mathematical model

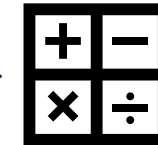
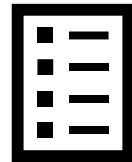
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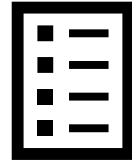
Machine-readable model

Mathematical model

Solver

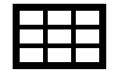
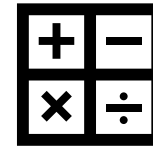
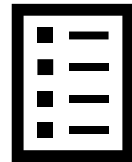
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Extension with data-driven insights and recommendations

Machine-readable model

Mathematical model

Solver

Examination regulations

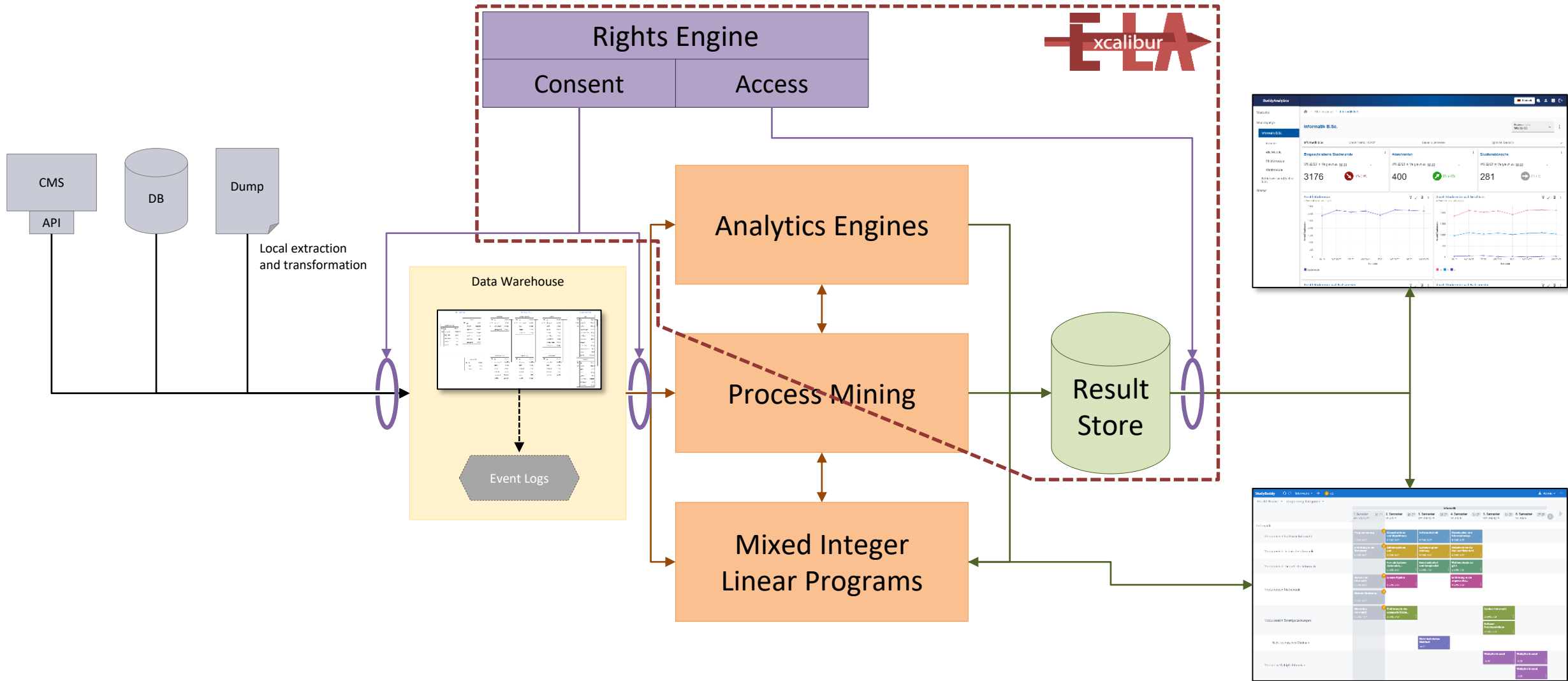
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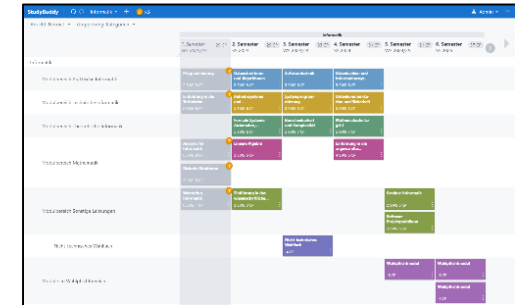
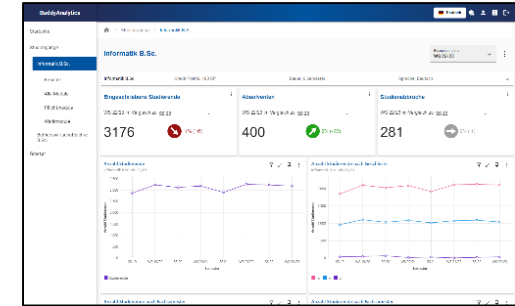


From data to AI support



User-centered Application Development

- **BuddyAnalytics**
 - Workshop to collect requirements of study program designers
 - Generation of user stories and personas
 - Iterative development and evaluation
- **StudyBuddy**
 - Prototype of previous student project
 - feasibility, technical challenges, data requirements, ...
 - Requirements analysis and evaluation with students
 - Iterative development and evaluation

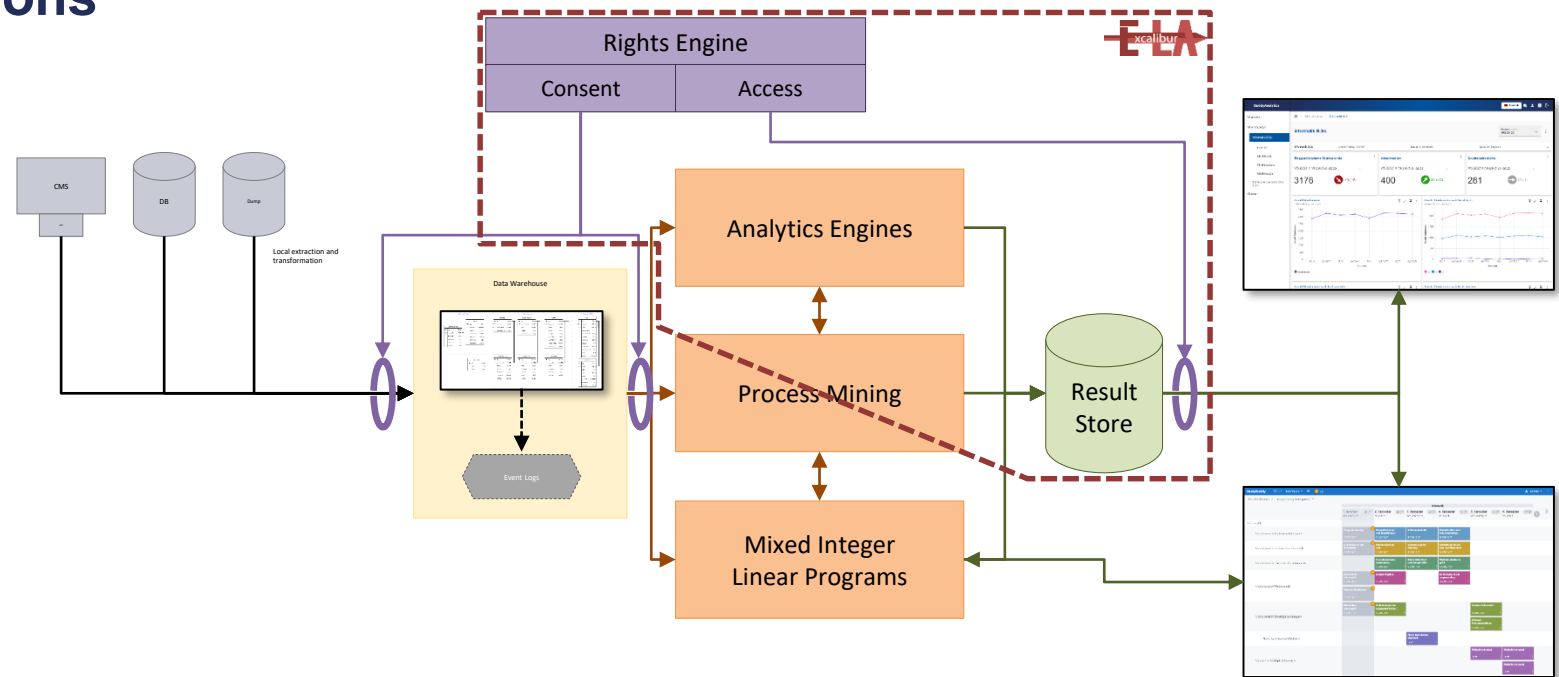


Outlook

- **Rule-based & Personalized Feedback using AI technology**
- **Combination of Process Mining and rule-based AI**
 - Learning from past study paths
 - Recommending successful paths
- **Publication of data reference model**
 - Extending the university network
- **User-centred Development of the Applications**
 - Tailored, supportive applications with impact

Conclusion

- **Supporting study planning and cohort monitoring**
 - Data-driven and rule-based AI technology
- **User-centred web applications**
- **Data reference model**



Further information and literature

1. Judel, S. et al. (2023): AI-supported Study Planning and Cohort Monitoring mit AIStudyBuddy. In: Workshops der 21. Fachtagung Bildungstechnologien (DELFI). Gesellschaft für Informatik e.V., Bonn. <https://doi.org/10.18420/WSDELFI2023-55>
2. Judel, S.; Roepke, R.; Azendorf, M.; Schroeder, U. (2023): Supporting Individualized Study Paths Using an Interactive Study Planning Tool. 21. Fachtagung Bildungstechnologien (DELFI). Gesellschaft für Informatik e.V., Bonn. <https://doi.org/10.18420/delfi2023-36>
3. Quakulinski, L.; Judel, S.; Wagner, M.; Schroeder, U. (2023): Anwendung von Process Mining zur kontinuierlichen Lernpfadidentifikation in Lernmanagementsystemen. 21. Fachtagung Bildungstechnologien (DELFI). Gesellschaft für Informatik e.V., Bonn. <https://doi.org/10.18420/delfi2023-34>
4. Wagner, M. *et al.* (2023). A Combined Approach of Process Mining and Rule-Based AI for Study Planning and Monitoring in Higher Education. In: Montali, M., Senderovich, A., Weidlich, M. (eds) Process Mining Workshops. ICPM 2022. Lecture Notes in Business Information Processing, vol 468. Springer, Cham. https://doi.org/10.1007/978-3-031-27815-0_37
5. Judel, S.; Schroeder, U. (2022). EXCALIBUR LA - An Extendable and Scalable Infrastructure Build for Learning Analytics. In: *2022 International Conference on Advanced Learning Technologies (ICALT)*, Bucharest, Romania, 2022, <https://doi.org/10.1109/ICALT55010.2022.00053>

Thank you!

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Project partners:



Sponsor:

