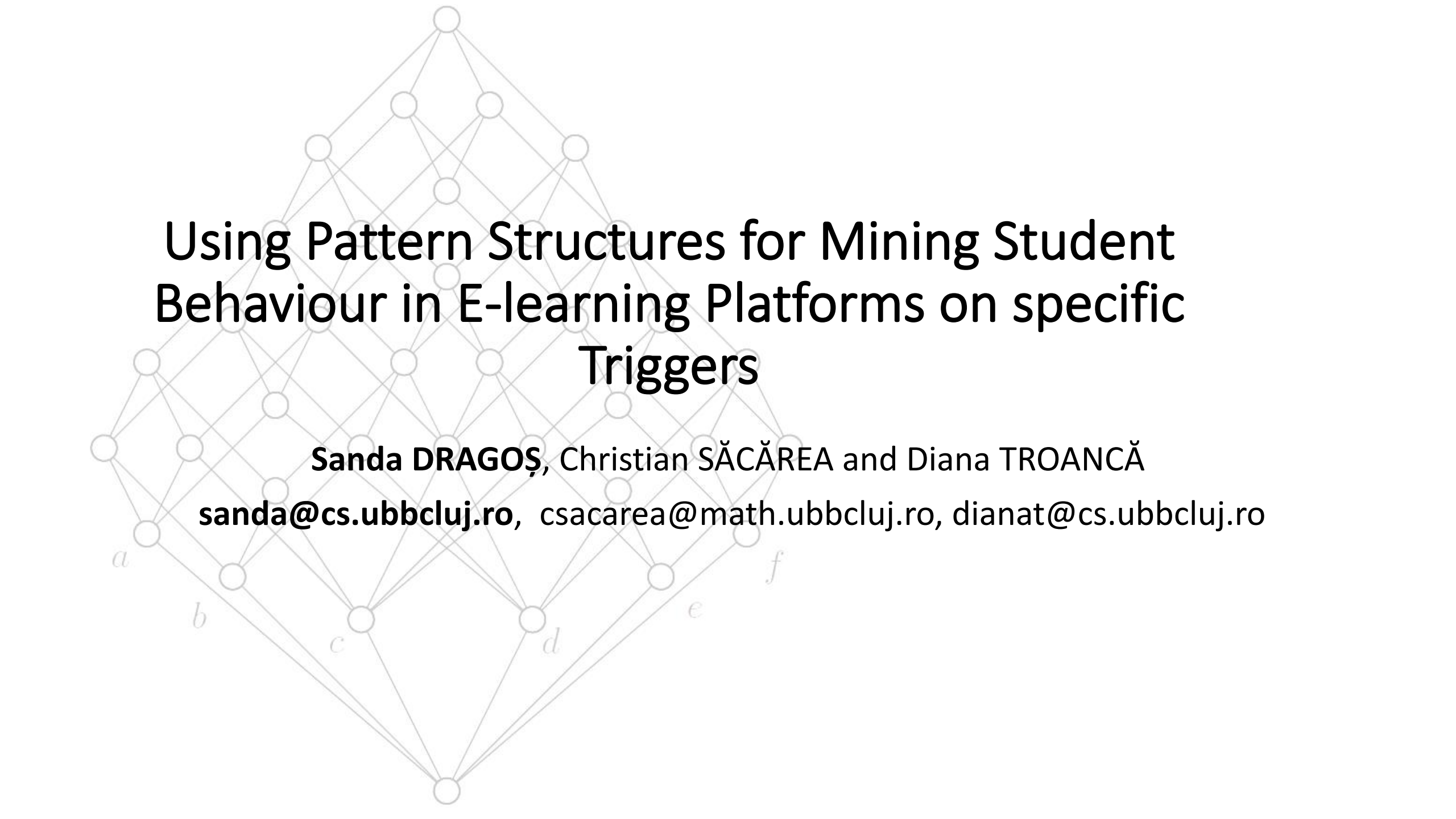




Using Pattern Structures for Mining Student Behaviour in E-learning Platforms on specific Triggers

Sanda DRAGOȘ, Christian SĂCĂREA and Diana TROANCĂ

sanda@cs.ubbcluj.ro, csacarea@math.ubbcluj.ro, dianat@cs.ubbcluj.ro

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Sanda DRAGOȘ

Babeș-Bolyai University, Cluj-Napoca, România

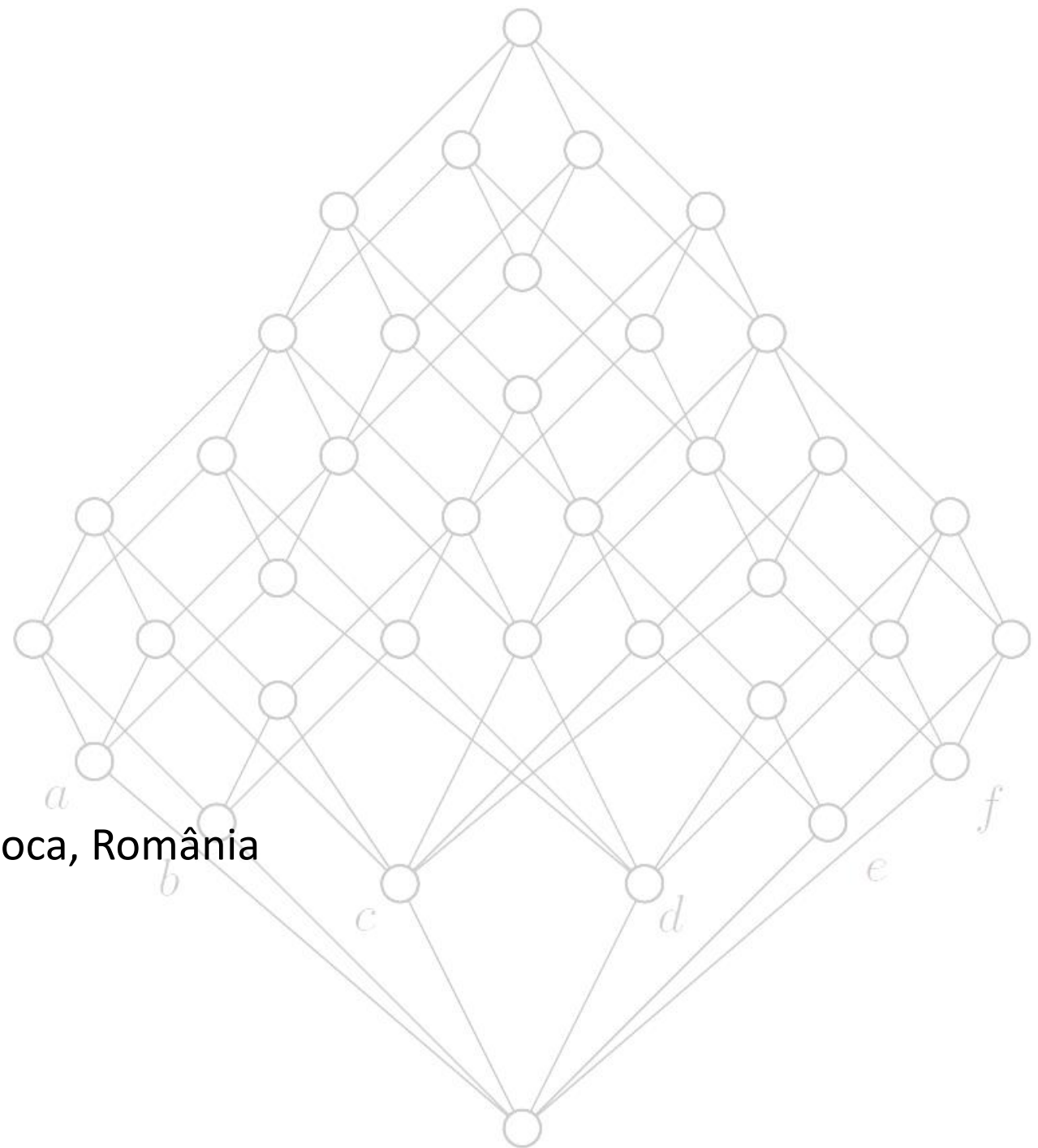
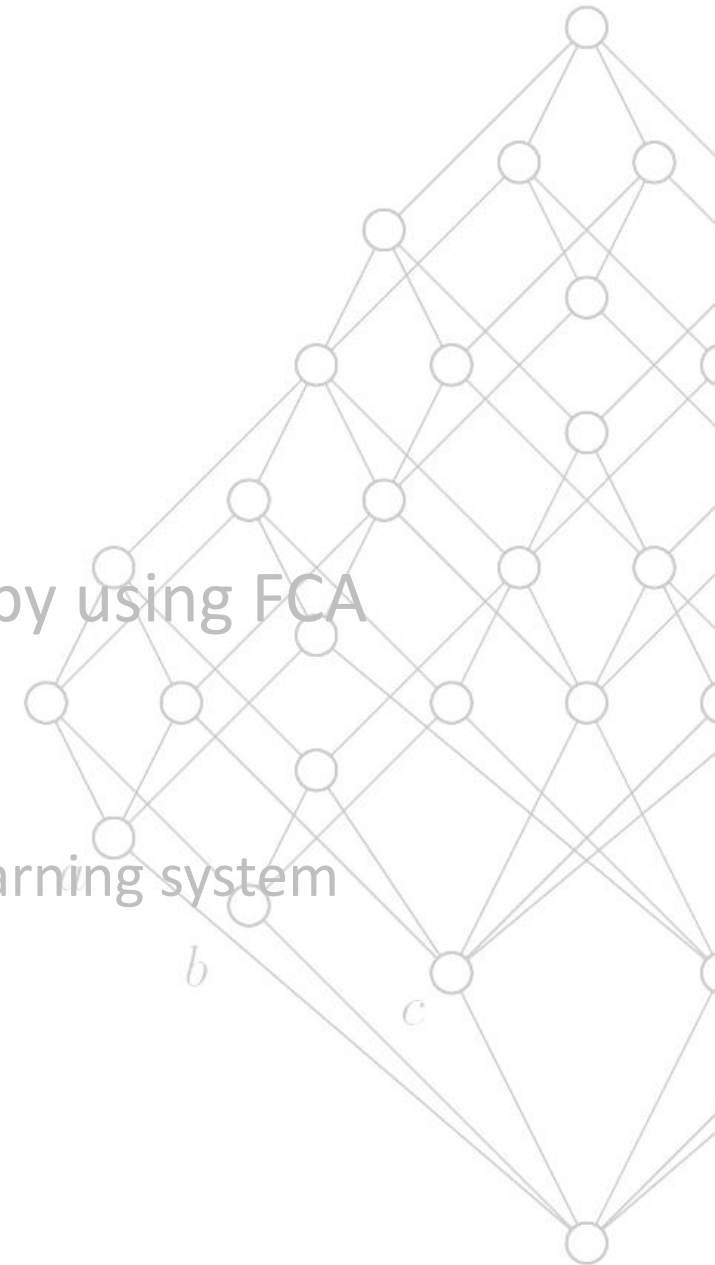


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- Future work



What? Why? How?

- investigate student behavior, while navigating on an e-learning system, and to analyze outstanding behavior patterns in time
- Understand the student behavior and improve the teaching content and the e-learning system
- investigate by using Formal Concept Analysis

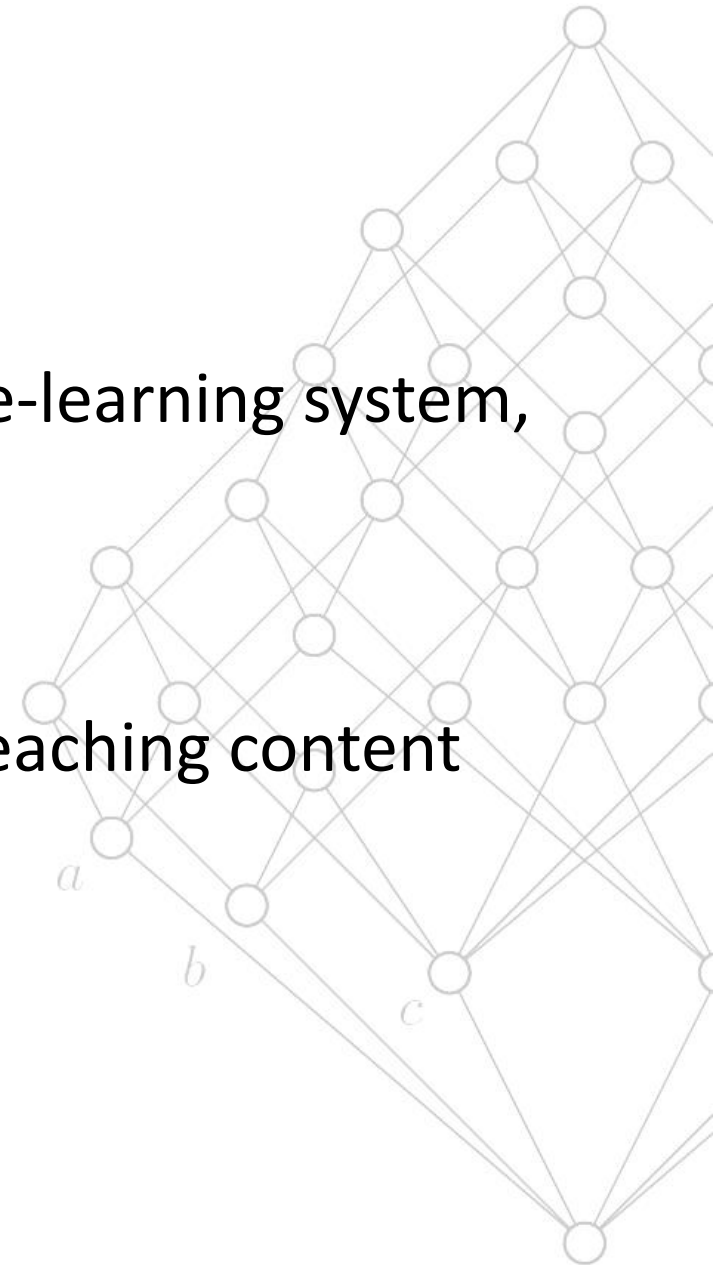
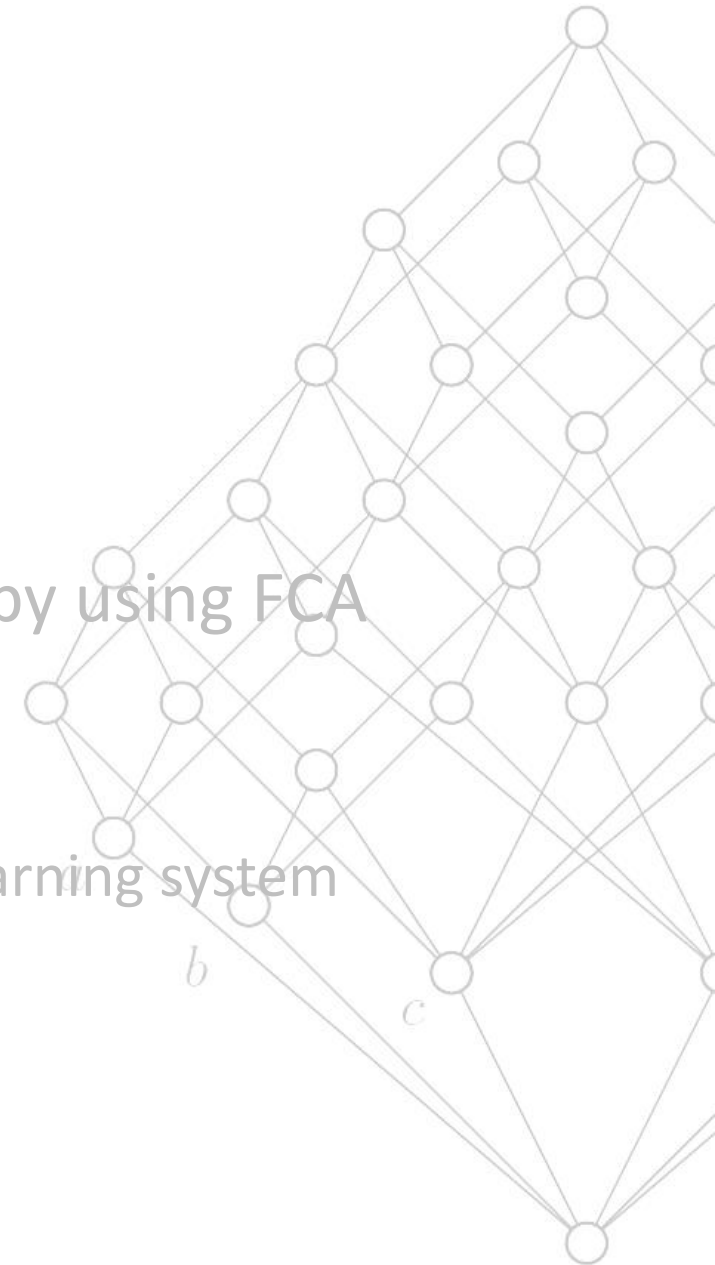


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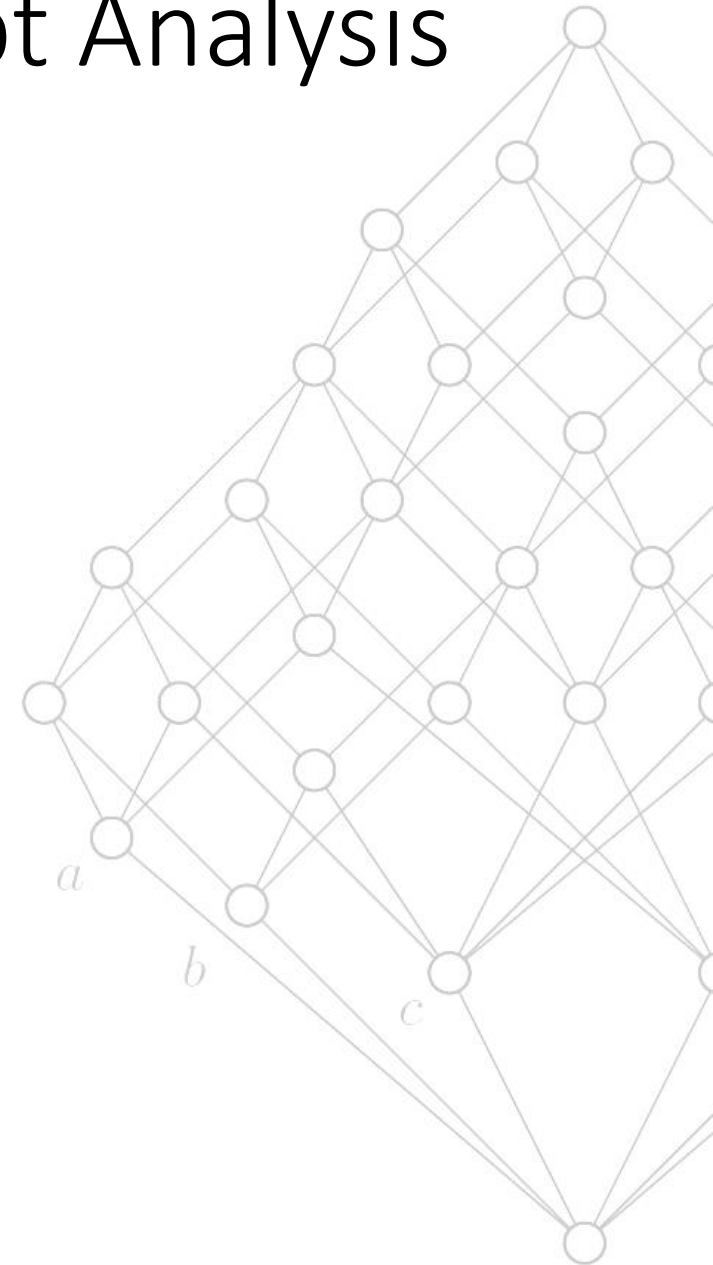
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Formal Concept Analysis

overview

- the Formal Context (**def**)
- the Context as cross-table representation (ex)
- the Formal Concept (**def**)
- all resulting Formal Concepts (ex)
- the Concept Lattice (ex)

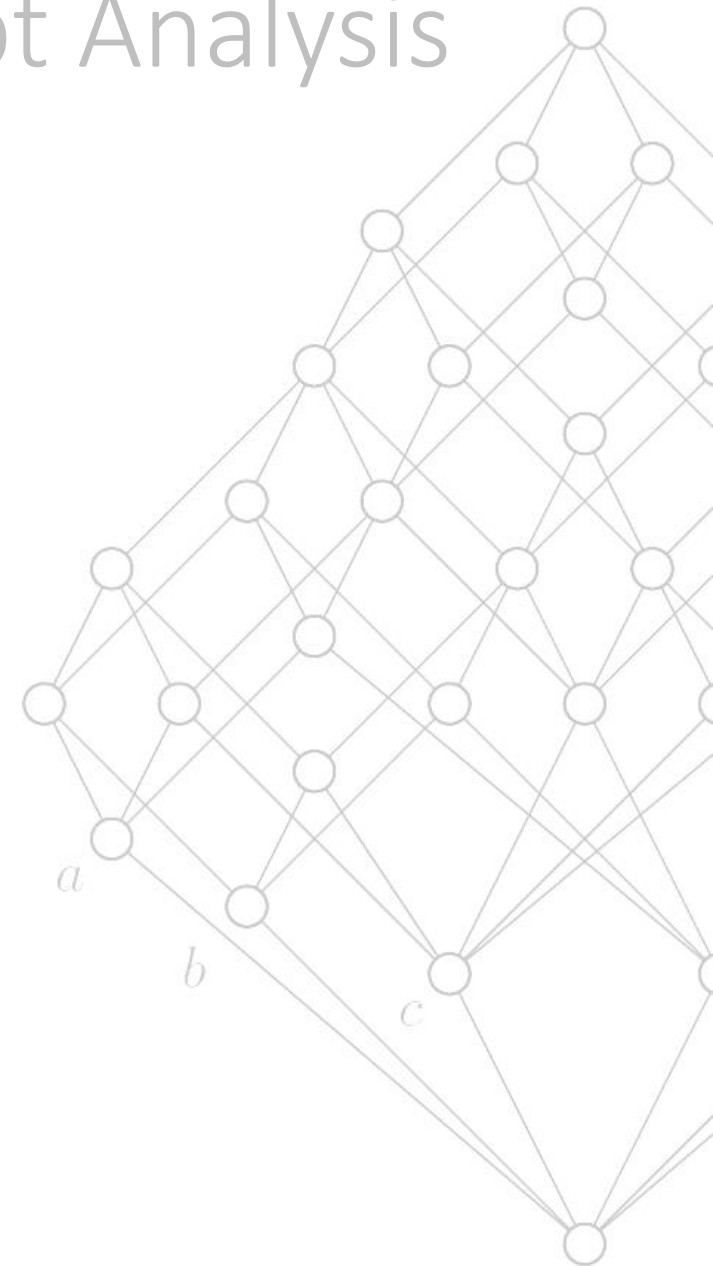


the Formal Context

Definition

Formal Context: triple $K = (G, M, I)$ with

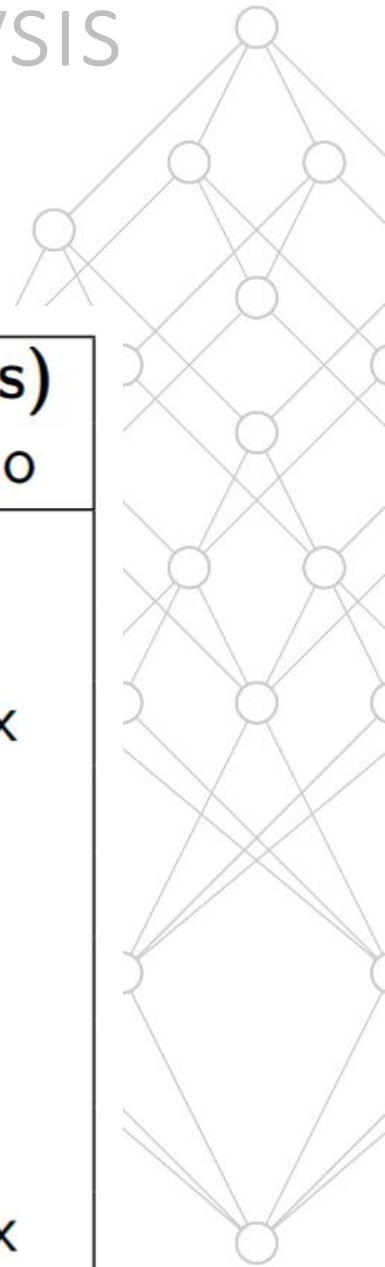
- set G of objects
- set M of attributes
- incidence relation $I \subseteq G \times M$



Formal Concept Analysis

the Context as cross-table representation

Planet	Size			Distance to Sun		Moon(s)	
	small	medium	large	near	far	yes	no
Jupiter			x		x	x	
Mars	x			x		x	
Mercury	x			x			x
Neptune		x			x	x	
Pluto	x				x	x	
Saturn			x		x	x	
Earth	x			x		x	
Uranus		x			x	x	
Venus	x			x			x

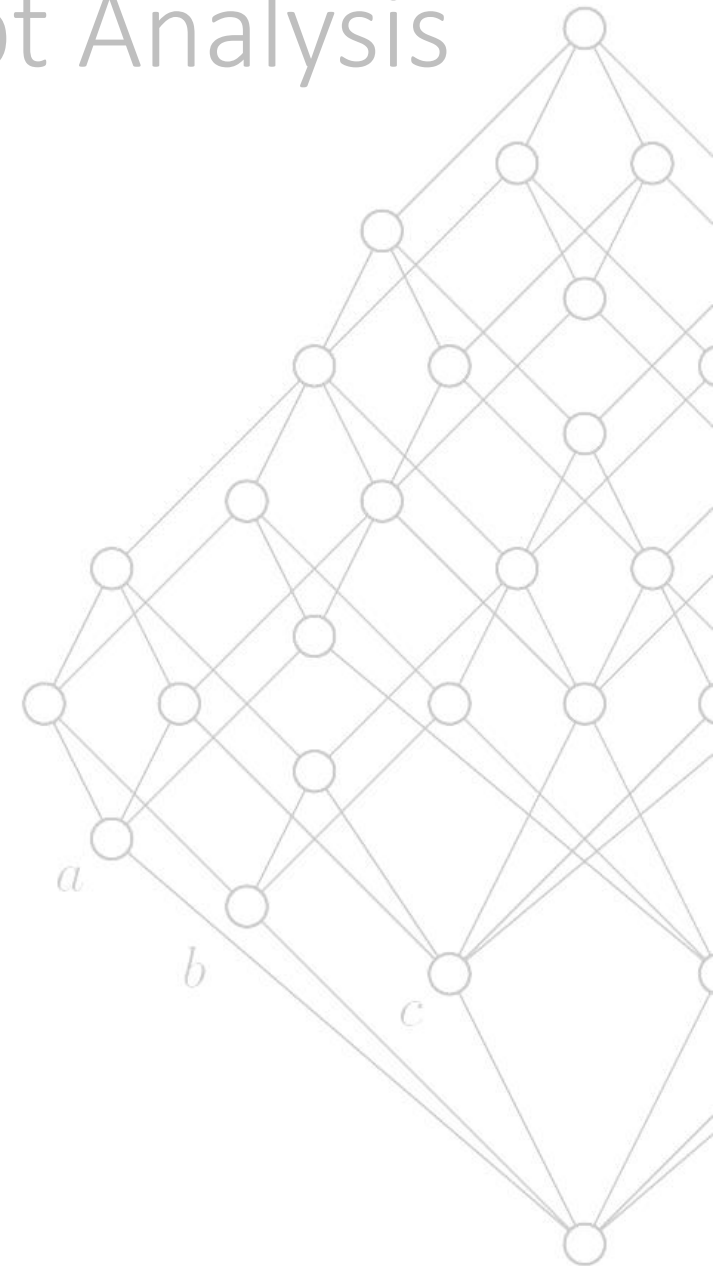


the Formal Concept

Definition

Formal Concept: pair (A, B) with

- extent $A \subseteq G$
- intent $B \subseteq M$
- $A \times B \subseteq I$
- maximal w.r.t. this property

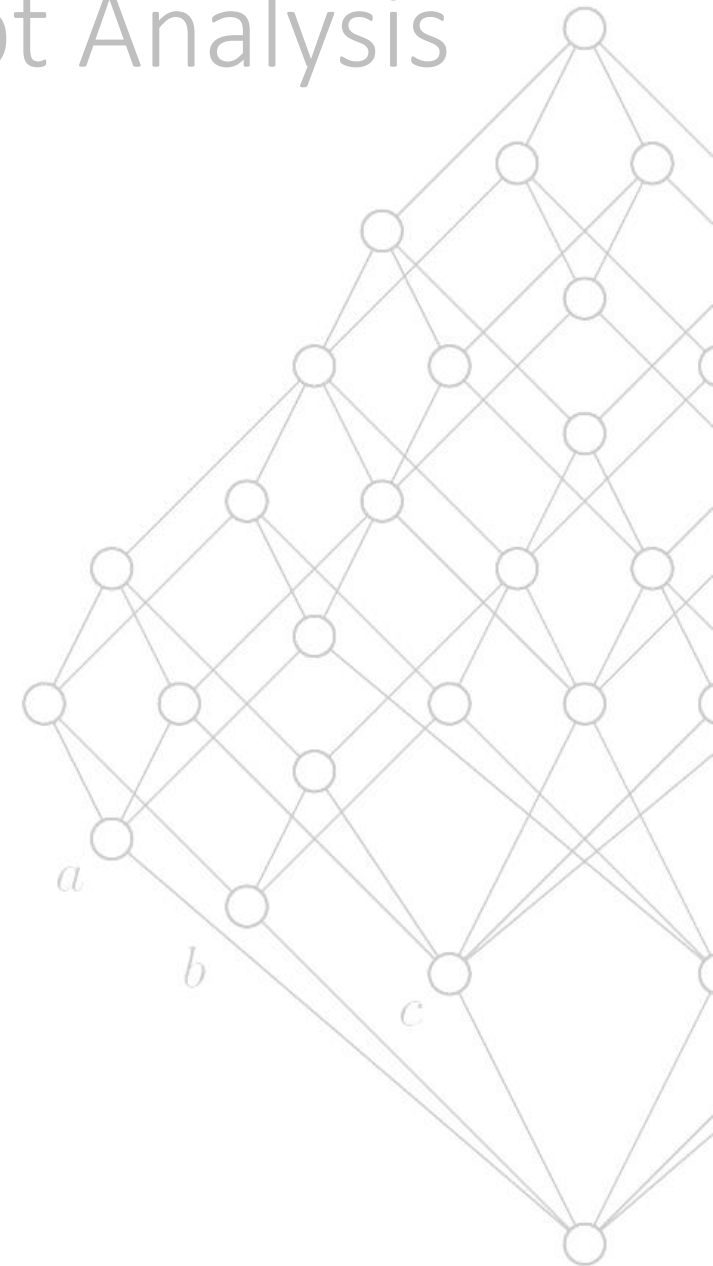


Formal Concept Analysis

all resulting Formal Concepts

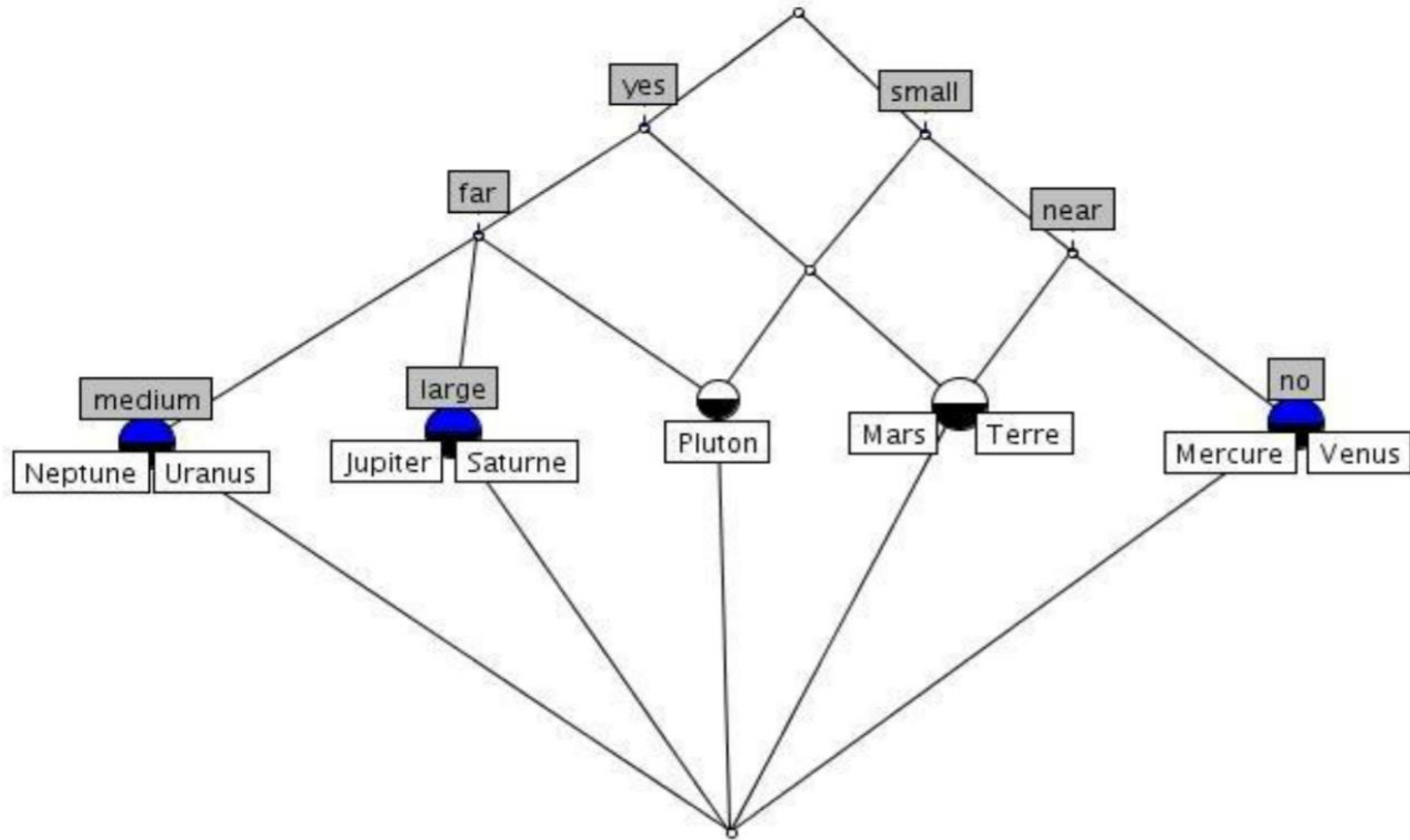
The planet context has the following concepts:

- (Φ ; {Near; Far ; Small ; Medium; Large; yes; no})
- ({Jupiter; Saturn}; {Large; Far ; yes})
- ({Uranus; Neptun}; {Medium; Far ; yes})
- ({Earth; Mars}; {yes; Near; Small})
- ({Mercury; Venus}; {no; Near; Small})
- ({Jupiter; Saturn; Uranus; Neptun}; {Far ; yes})
- ({Earth; Mars; Mercury; Venus}; {Near; Small})
- ({Jupiter; Saturn; Uranus; Neptun; Earth; Mars}; {yes})
- ({Mercury; Venus; Earth; Mars; Jupiter; Saturn; Uranus; Neptune}; Φ)



Formal Concept Analysis

the Concept Lattice

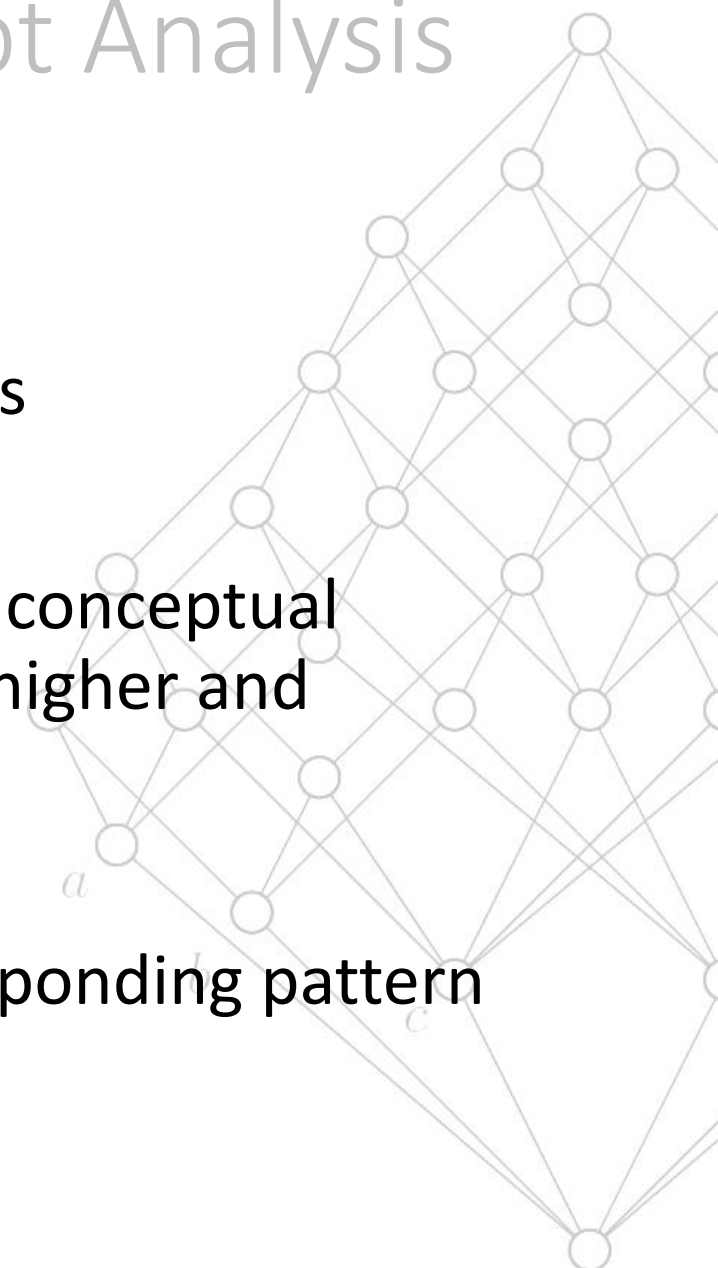


Pattern structures

- highlight possible patterns within the set of attributes

While usually a concept lattice describes the inherent conceptual structure of a dataset, pattern structures go one level higher and describe possible patterns at a certain meta-level.

- offer also a highly intuitive visualization of the corresponding pattern concepts



Pattern structures

- $\cap$ behaves like a *similarity operator*:

$$\{m_1, m_2\} \cap \{m_1, m_3\} = \{m_1\}$$

	m_1	m_2	m_3
g_1	×		×
g_2	×	×	
g_3		×	×
g_4		×	×
g_5	×	×	×

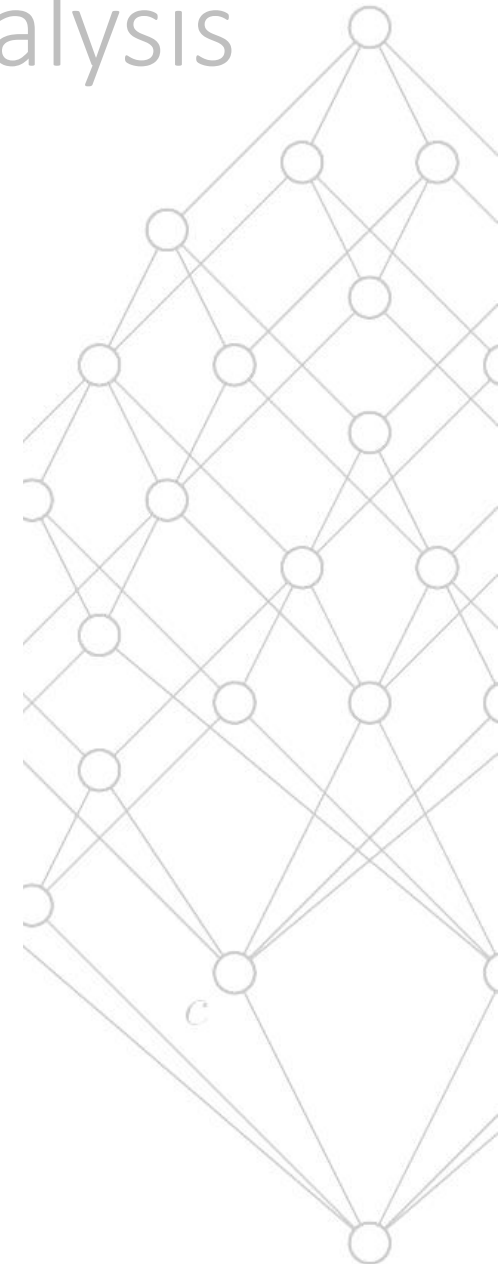
- $\cap$ induces a partial ordering relation $\subseteq$ as follows:

$$S_1 \cap S_2 = S_1 \iff S_1 \subseteq S_2$$

$$\{m_1\} \cap \{m_1, m_2\} = \{m_1\} \iff \{m_1\} \subseteq \{m_1, m_2\}$$

- $\cap$ has the properties of a meet $\sqcap$ in a semi lattice, i.e. a commutative, associative and idempotent operation:

$$c \sqcap d = c \iff c \sqsubseteq d$$



Pattern structures

A **pattern structure** $(G, (D, \sqcap), \delta)$ is composed of:

- ▶ G a set of *objects*,
- ▶ $(D, \sqcap)$ a semi-lattice of descriptions or **patterns**,
- ▶ δ a mapping such as $\delta(g) \in D$ describes object g .

The **Galois connection** for $(G, (D, \sqcap), \delta)$ is defined as:

- ▶ The maximal description representing the similarity of a set of objects:

$$A^\square = \sqcap_{g \in A} \delta(g) \quad \text{for } A \subseteq G$$

- ▶ The maximal set of objects sharing a given description:

$$d^\square = \{g \in G \mid d \sqsubseteq \delta(g)\} \quad \text{for } d \in (D, \sqcap)$$

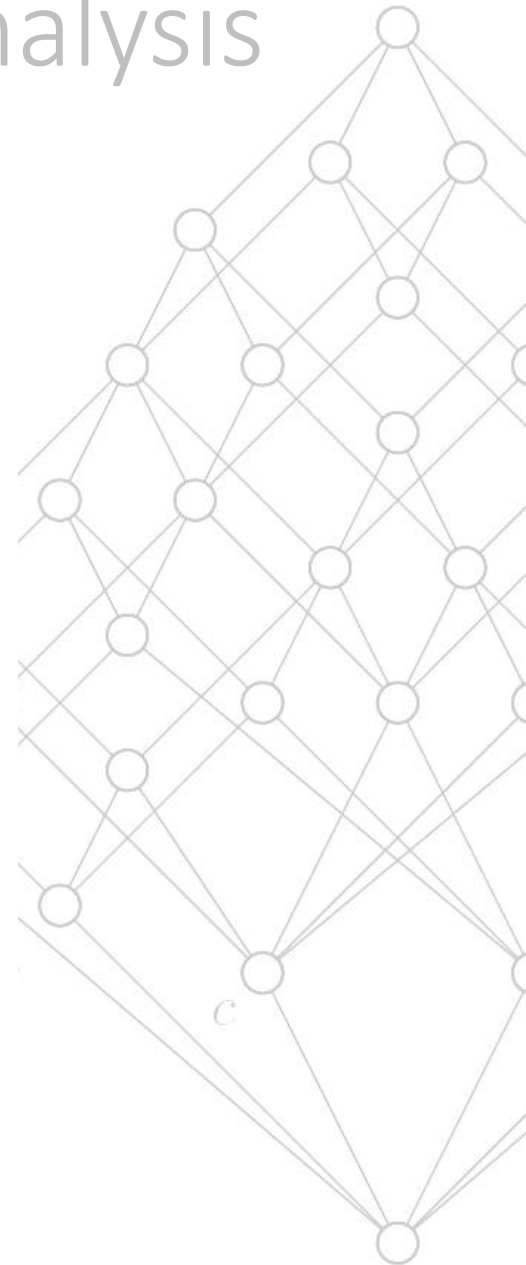
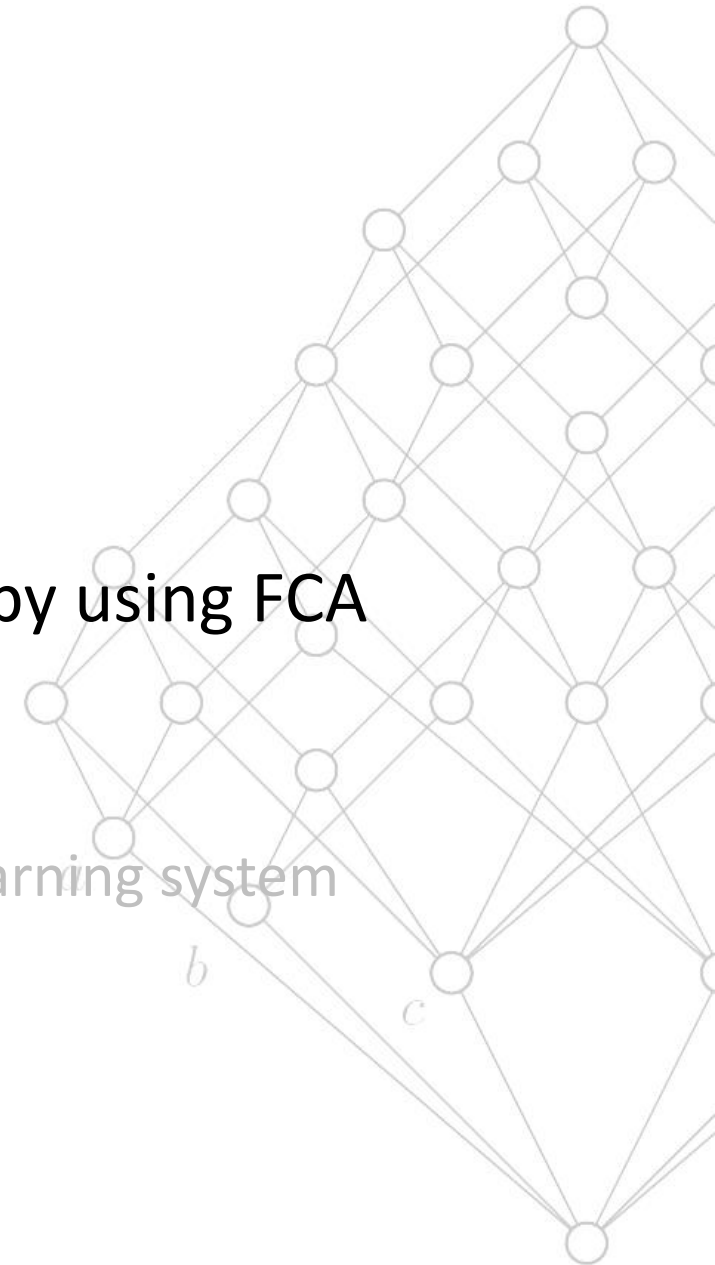


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Our previous work on understanding users behavior by using FCA

- visually and conceptually analyzed **navigation patterns** [3], [9], [15], [16];
- determined what students visit. In that respect we have determined/defined **attractors** [5];
- determined **bundle** of users with similar behavior [17];
- identified students (that we call **“trend-setters”**) who initiate behaviors and then influence the behavior of other users [6].

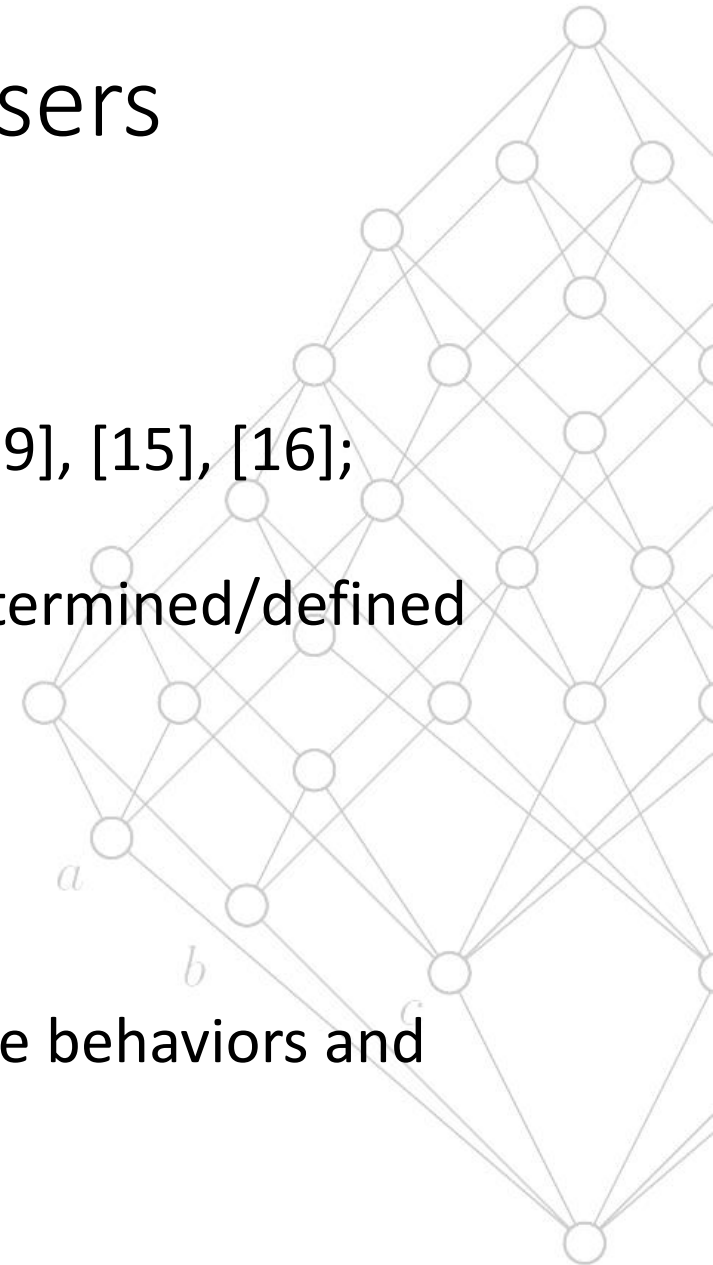


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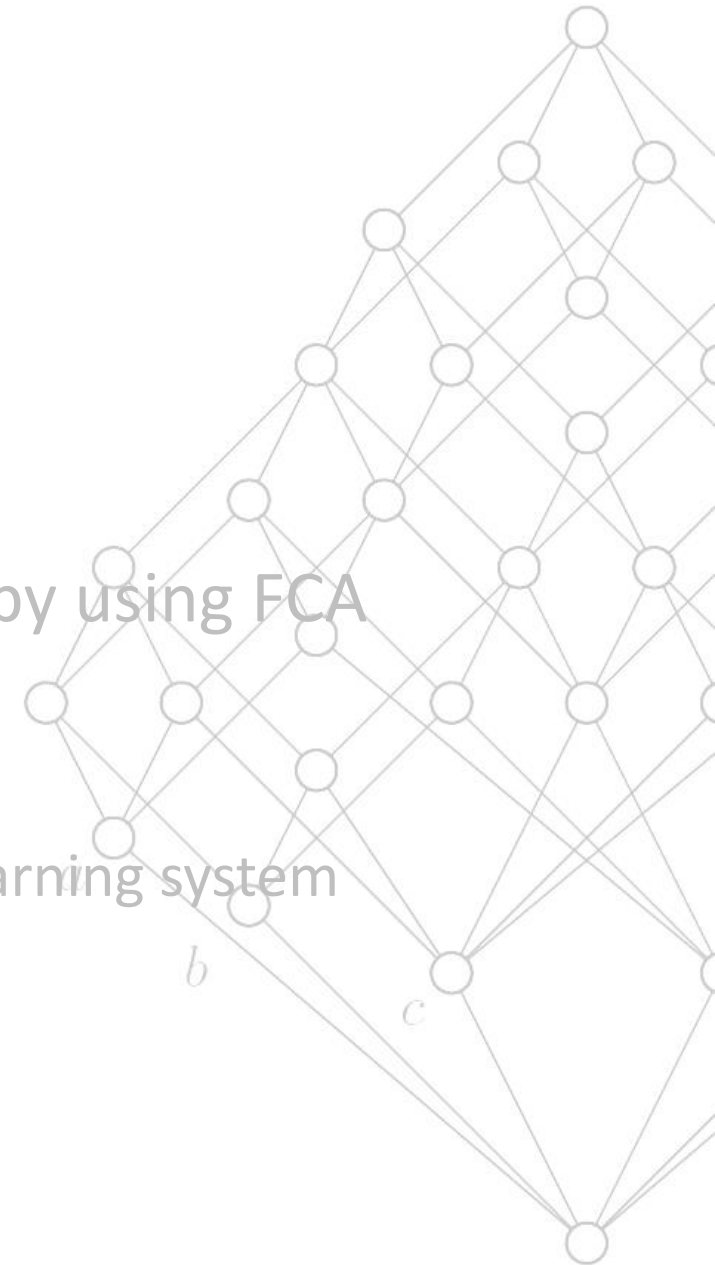
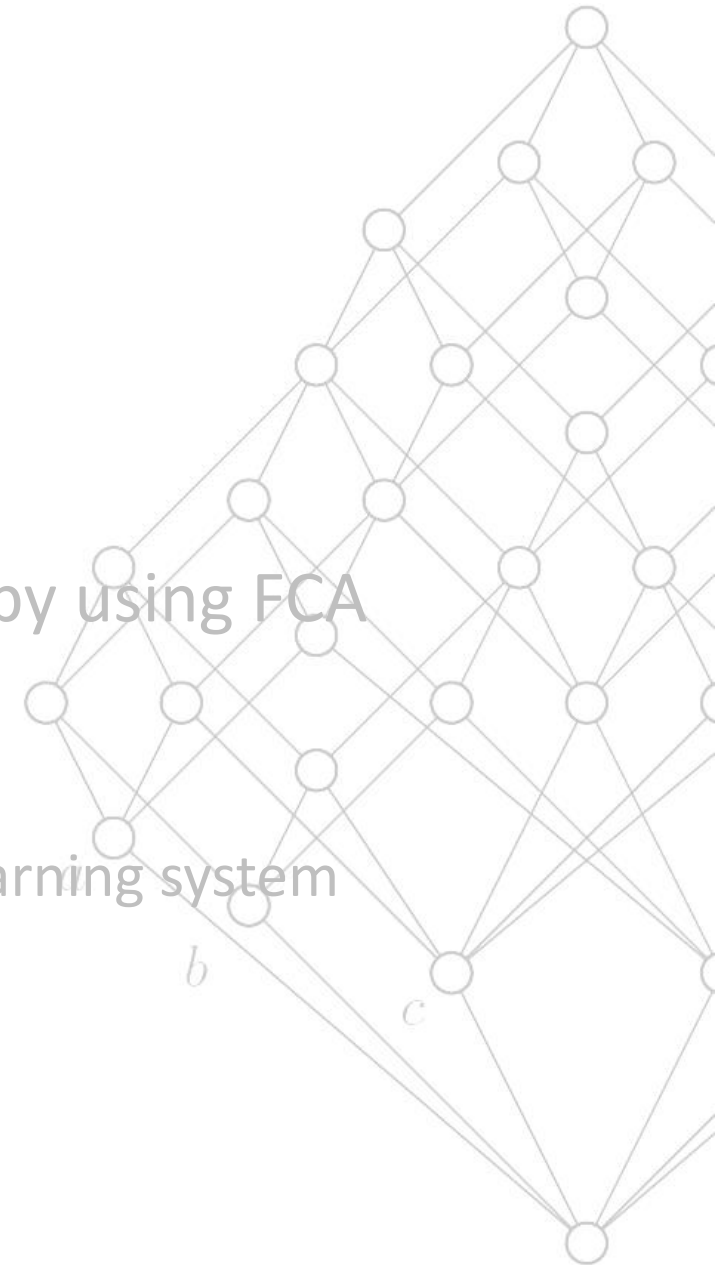


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Representative data entities

- the **user** is a student that accesses web files through a browser. Users can be uniquely identified by their login ID
- a **session** is an actual HTTP session;
- a **chain** is defined as a chronologically ordered sequence of visited pages during a session;
- the **timestamp** is the date and time of the access.



Representative content on PULSE

#	Code	Description
1	I	information about the lecture and the laboratories
2	PE	information about the practical examination
3	WE	information about the written examination
4	L	overview information about all the lectures
5	Ls	slides and notes for all lectures
6	LP	overview inf. about the test papers given during lectures
7	LPs	details on all lecture test papers
8	LA	lab assignments
9	LE	laboratory examples
10	LT	theoretical support for all laboratories

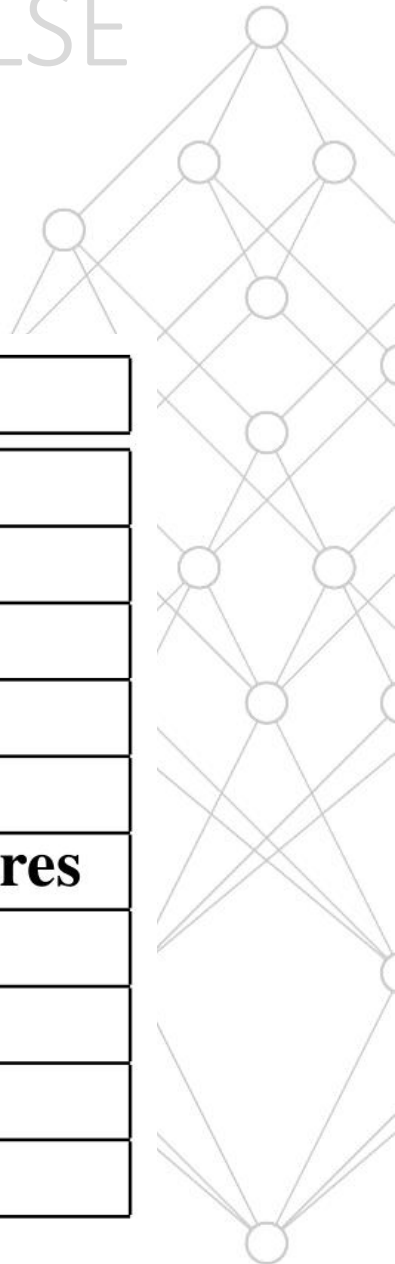
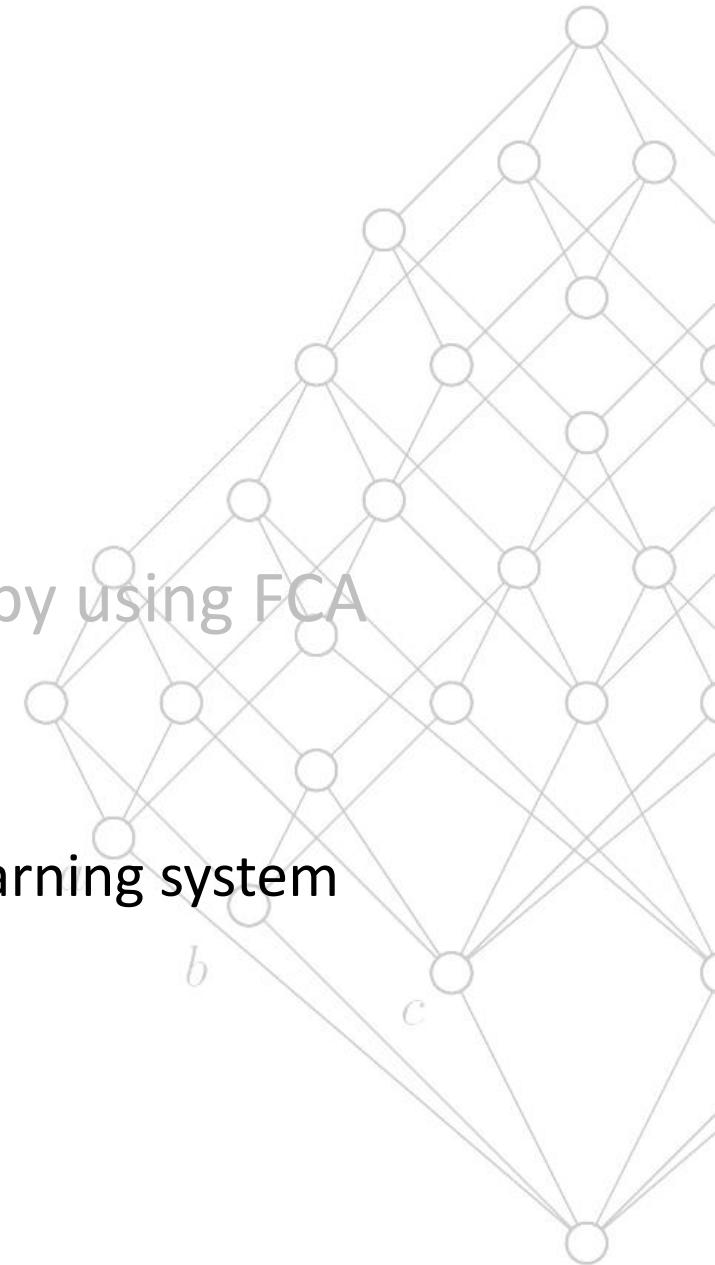


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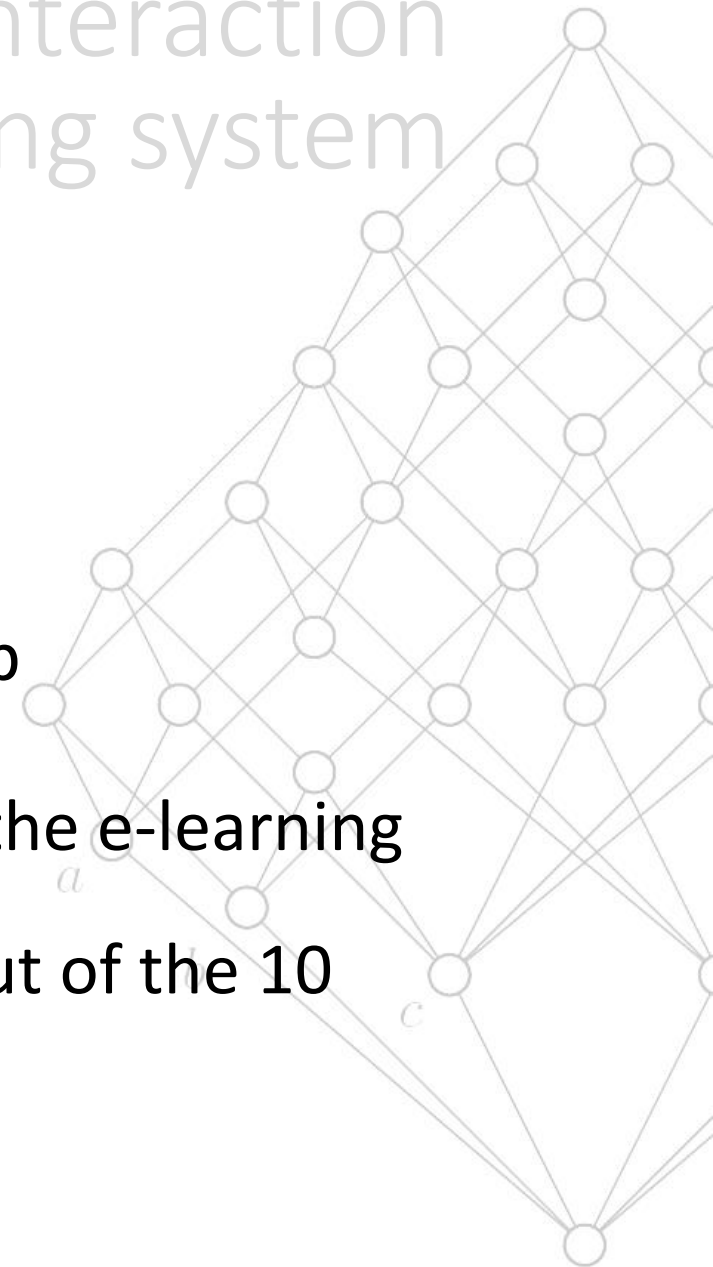
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Behavioral tendencies in student interaction with the e-learning system

The pattern structure

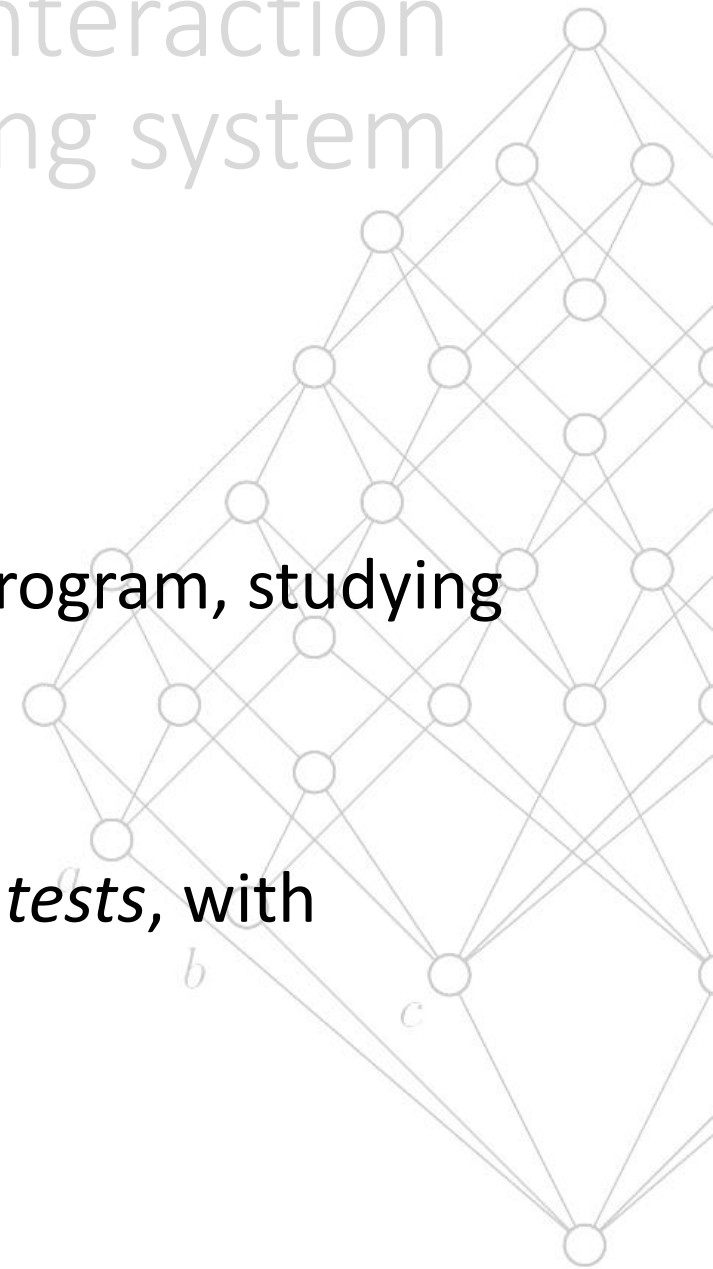
- the **objects** are the students from the analyzed group
- the object **descriptions** are their *initial* behaviors on the e-learning platform, that contain at least **n** interesting classes out of the 10



Behavioral tendencies in student interaction with the e-learning system

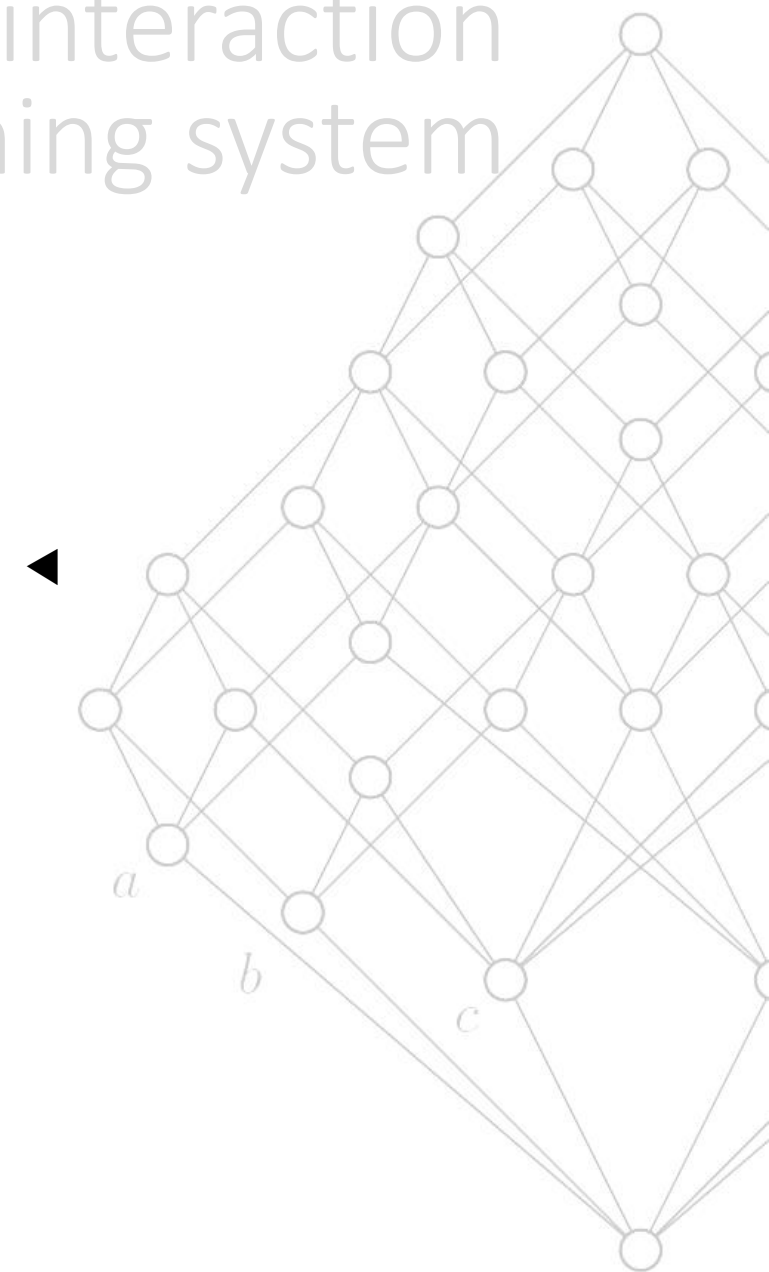
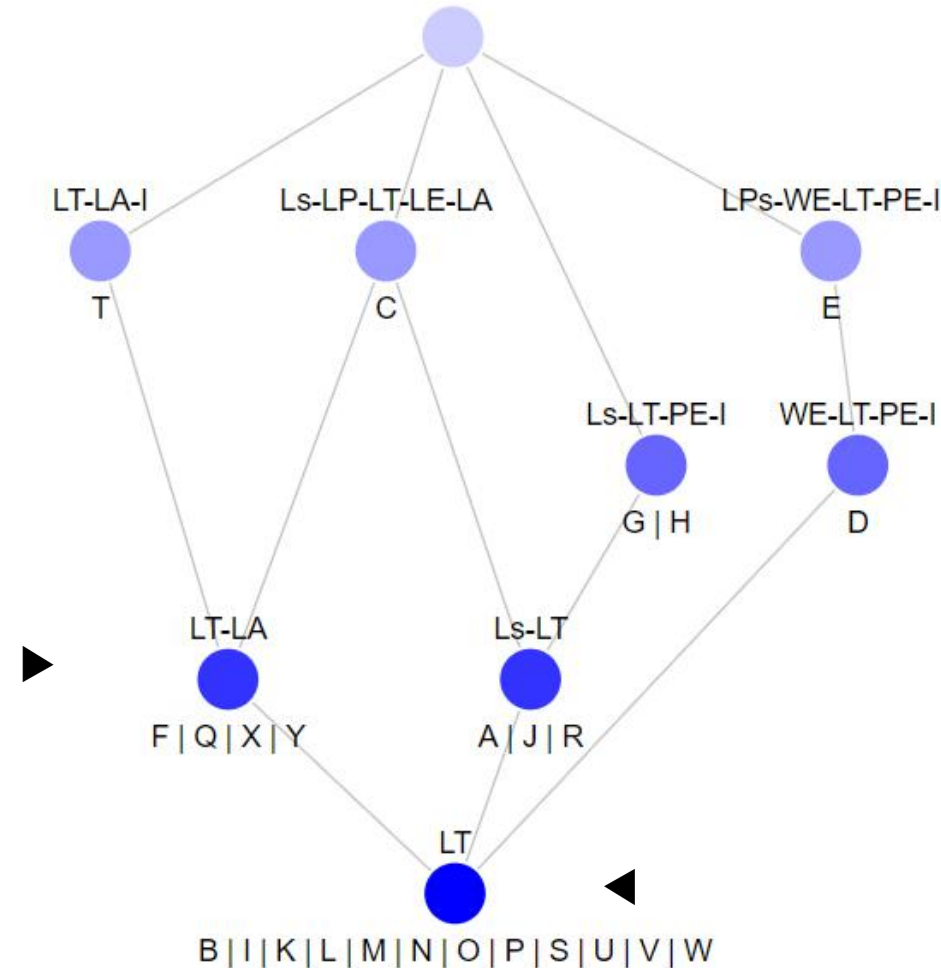
The pattern structure - tests

- we consider a group of 25 students from the same program, studying the same subject
- we have named our 25 students, similar to the other *tests*, with letters from A to Y



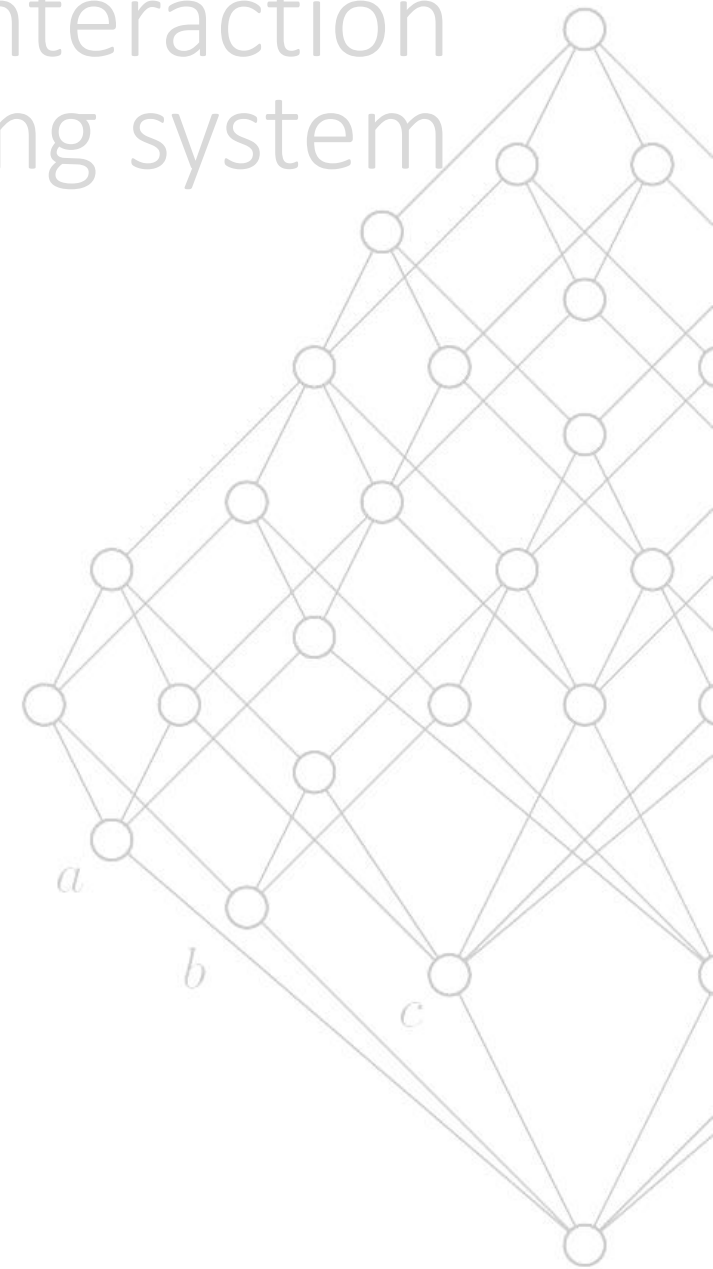
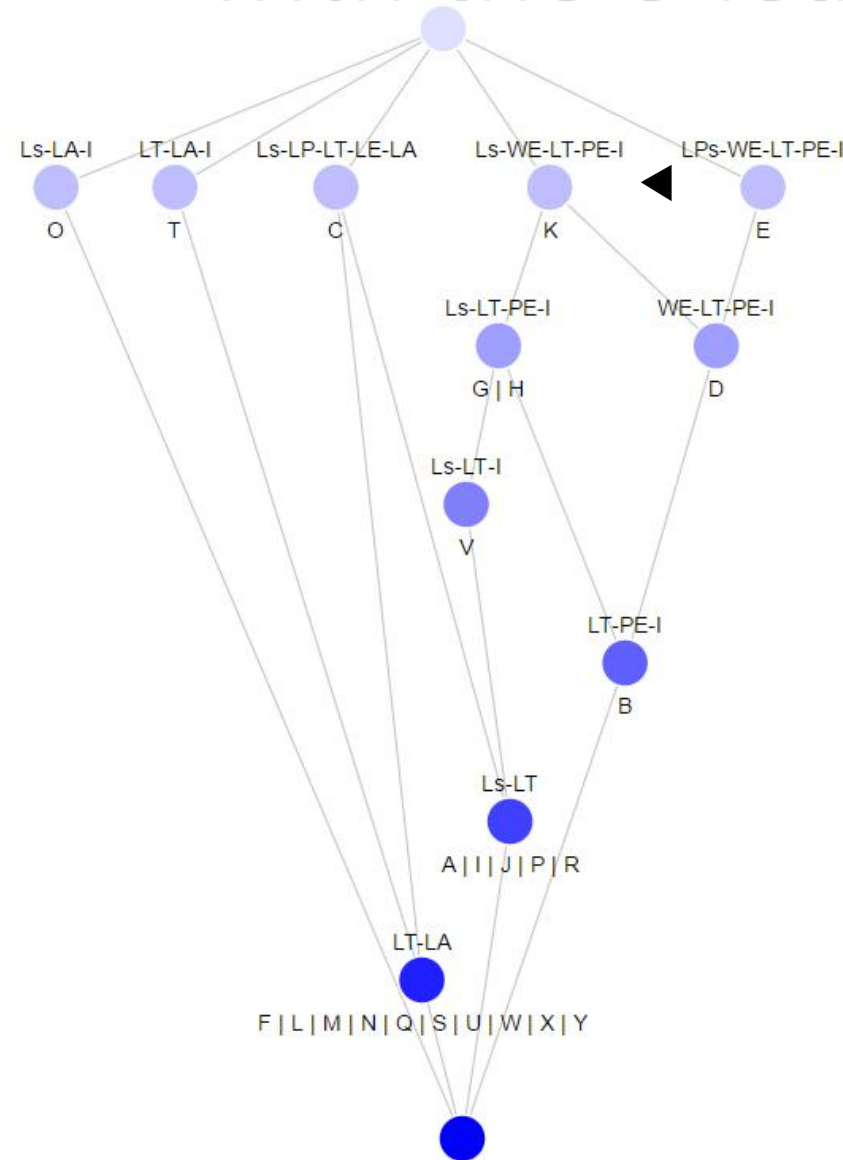
Behavioral tendencies in student interaction with the e-learning system

The pattern structure, $n=1$



Behavioral tendencies in student interaction with the e-learning system

The pattern structure, $n=2$

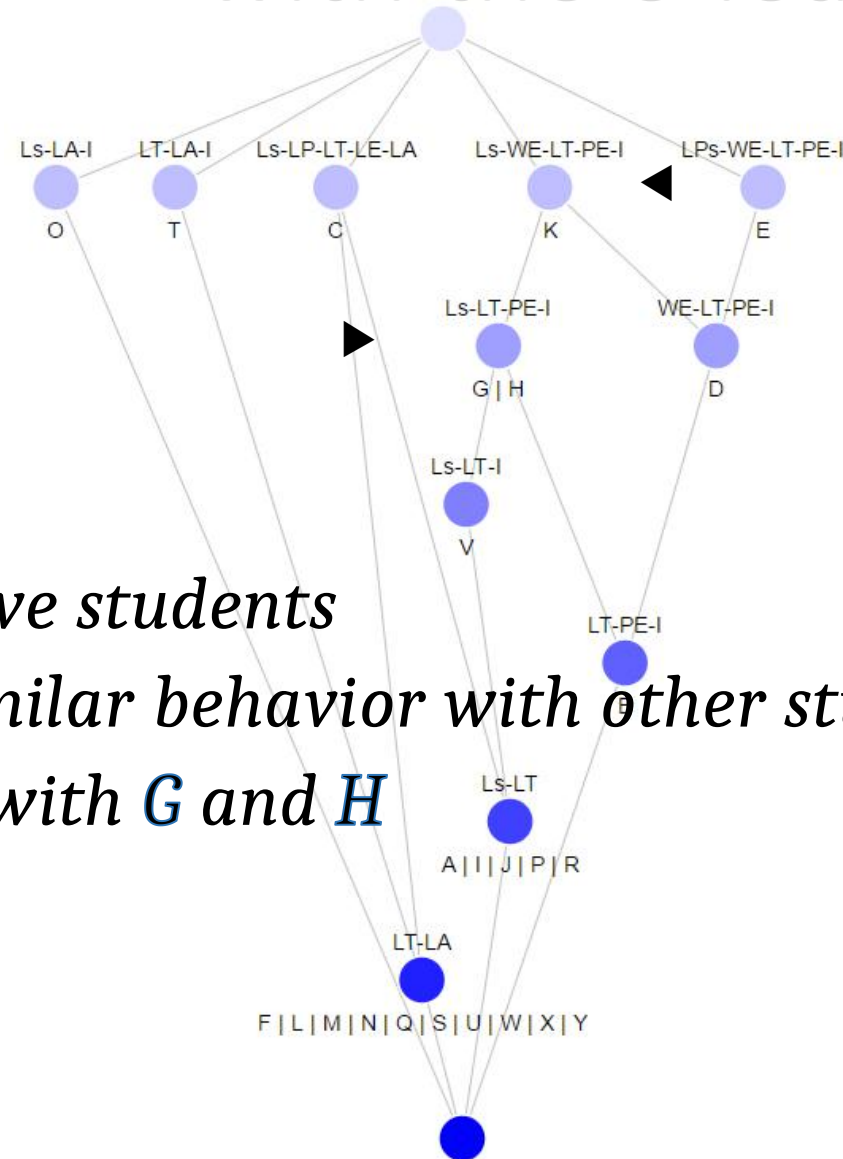


Behavioral tendencies in student interaction with the e-learning system

The pattern structure, $n=2$

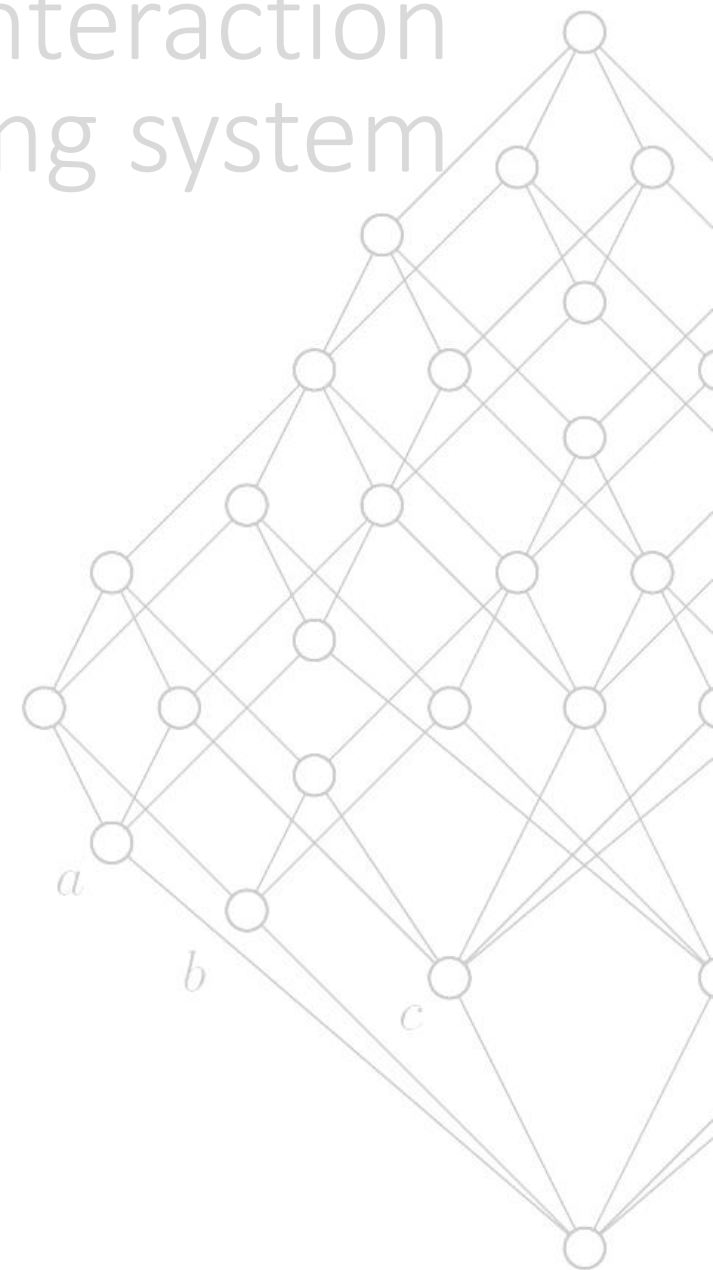
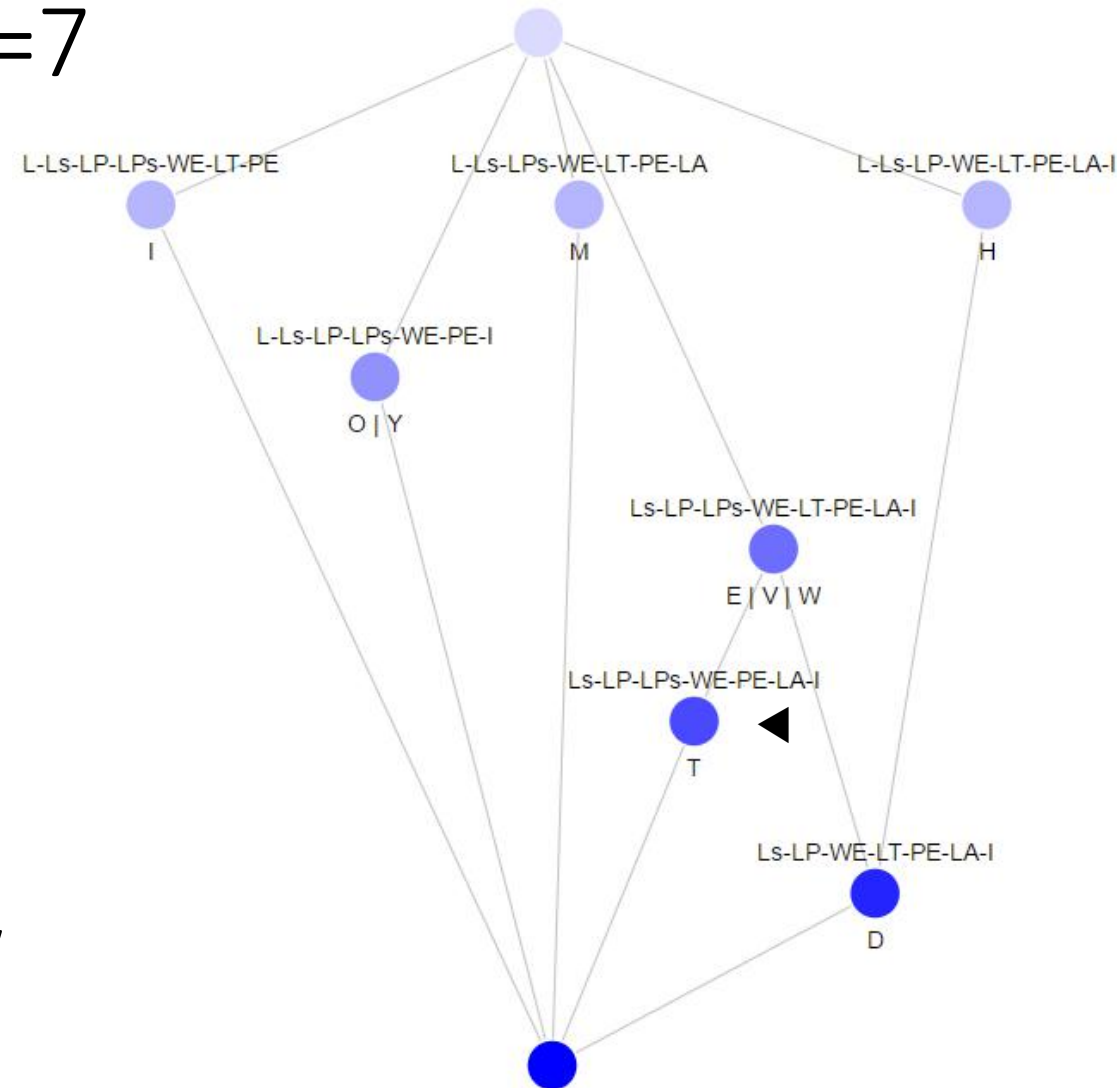
student K

- one of the most active students
- most numbers of similar behavior with other students
- in the same bundle with G and H



Behavioral tendencies in student interaction with the e-learning system

The pattern structure, $n=7$



for $n=8$,
5 students:
D, H, E, V and W

Attractors

Sanda Dragos, Diana Halita, and Christian Sacarea,
*Attractors in Web Based Educational Systems. A Conceptual Knowledge Processing
Grounded Approach*,
The 8th International Conference on Knowledge Science, Engineering and Management (KSEM),
Chongqing, China, October, 2015, p. 190-195

*attractor = behavioral patterns to which users adhere
while using the educational/e-learning system*

*student F was determined to be a trend-setter with the highest
number of followers on "Ls-LP-LT-LA"*



Behavioral tendencies in student interaction with the e-learning system

The pattern structure, chain="Ls-LP-LT-LA"

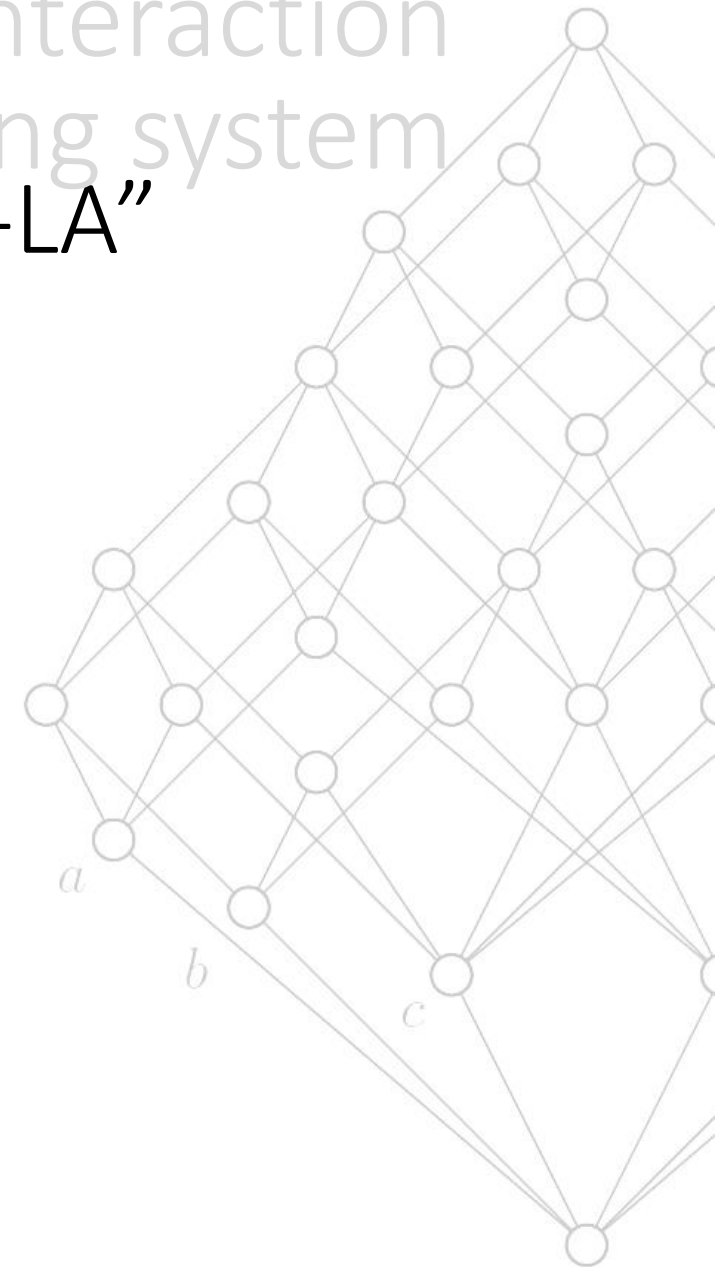
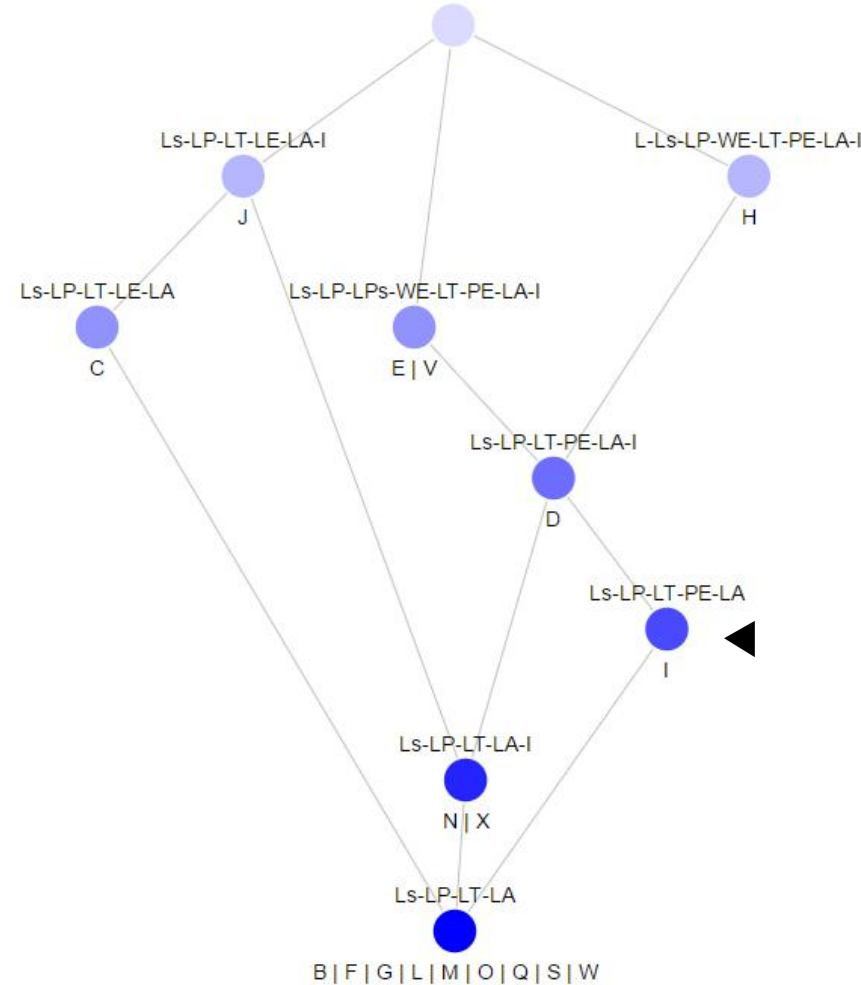
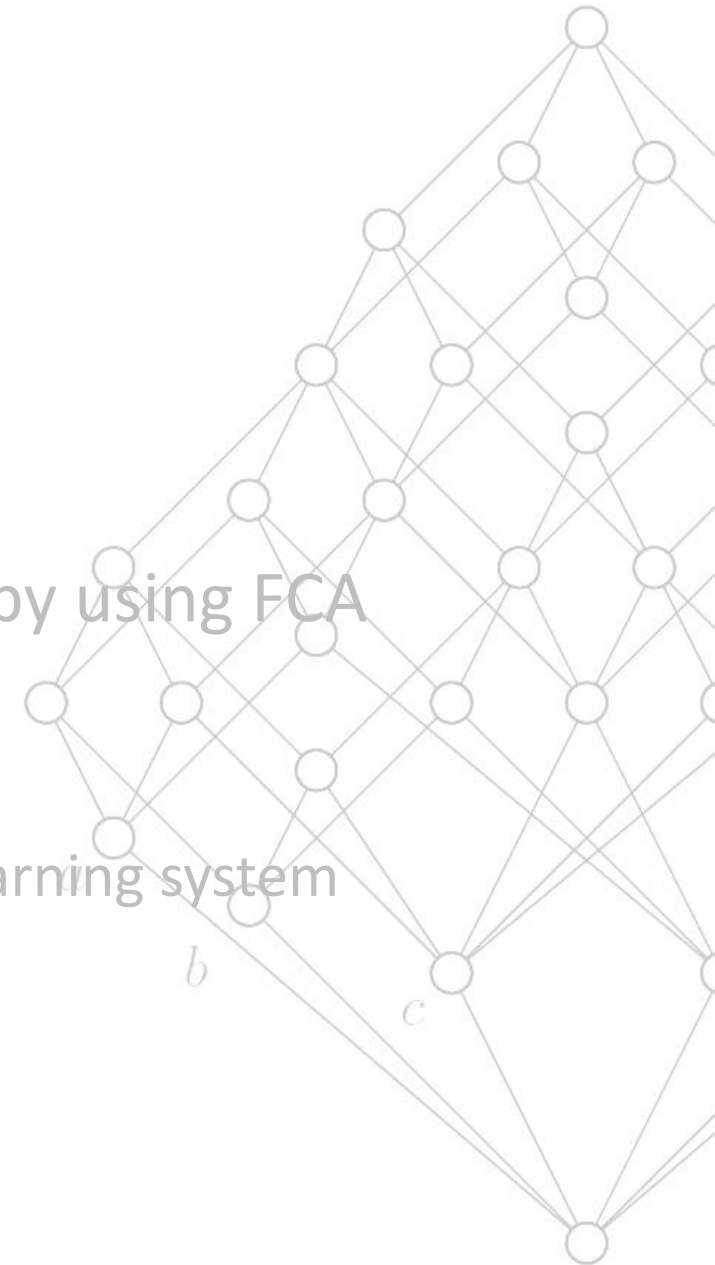


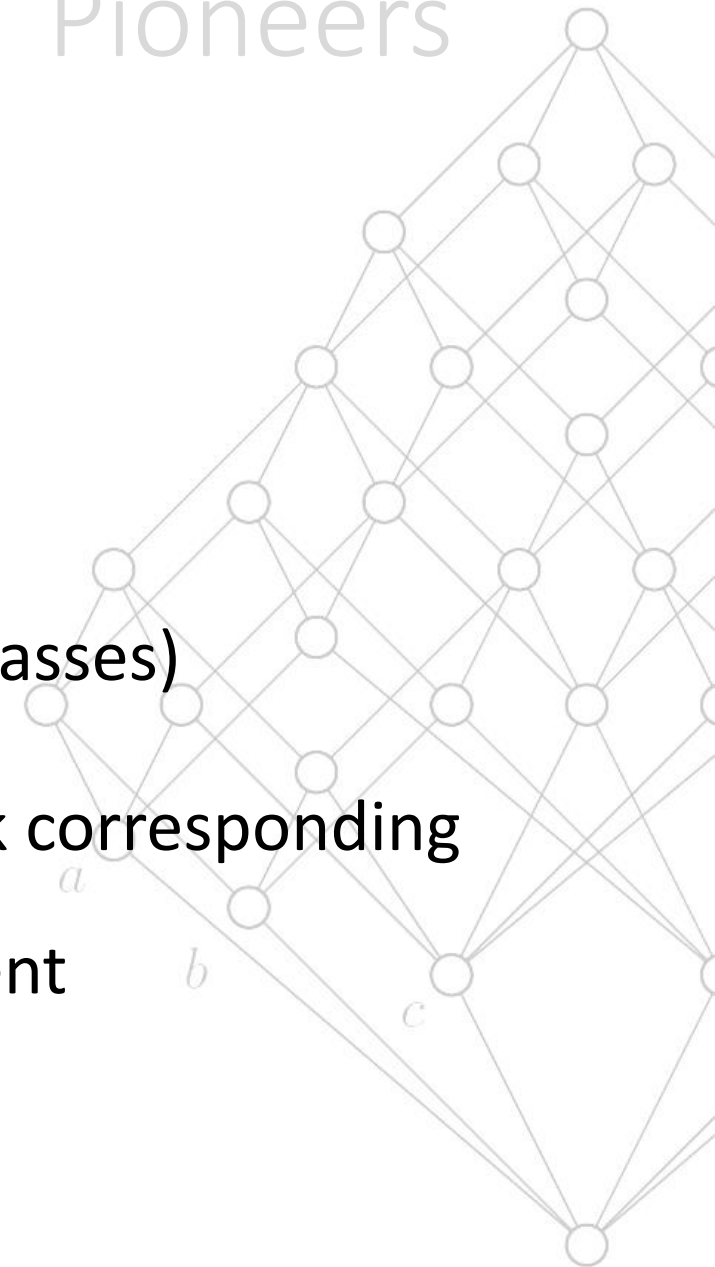
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The pattern structure

- the **objects** are the behaviors (i.e. chains of visited classes)
- the object **descriptions** are pairs of student and week corresponding to the first occurrence of that behavior for that student

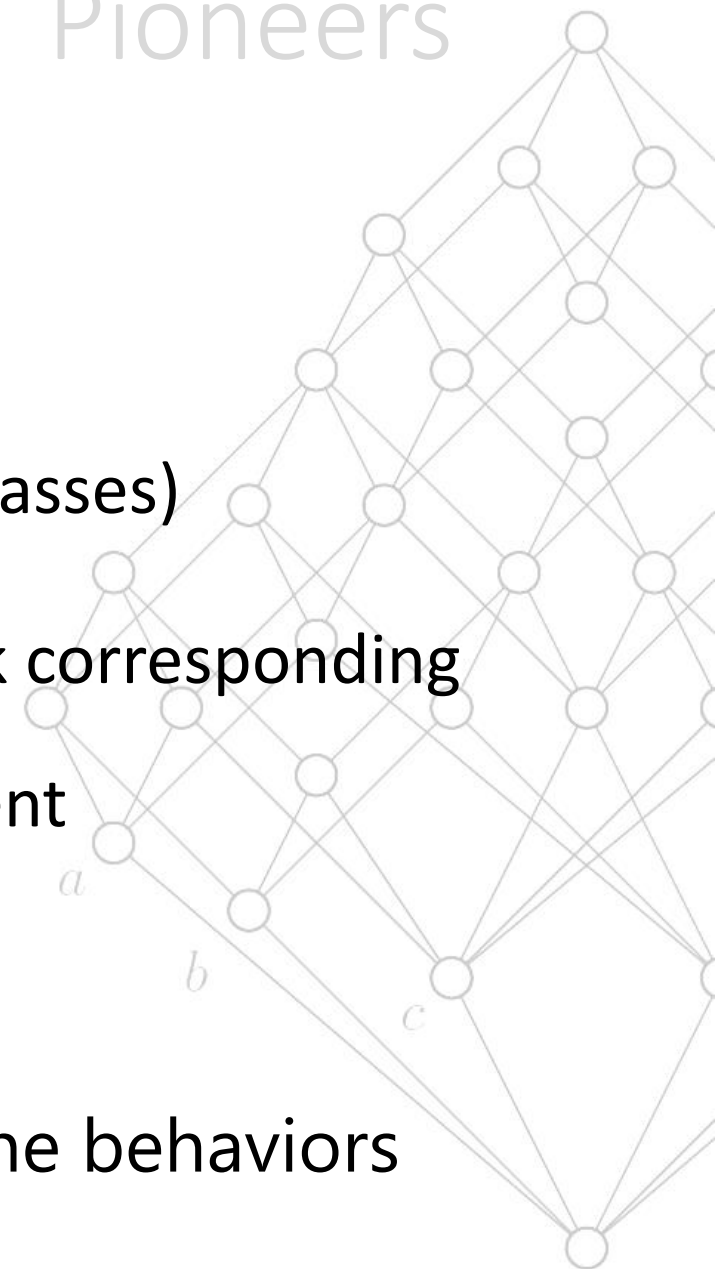


The pattern structure

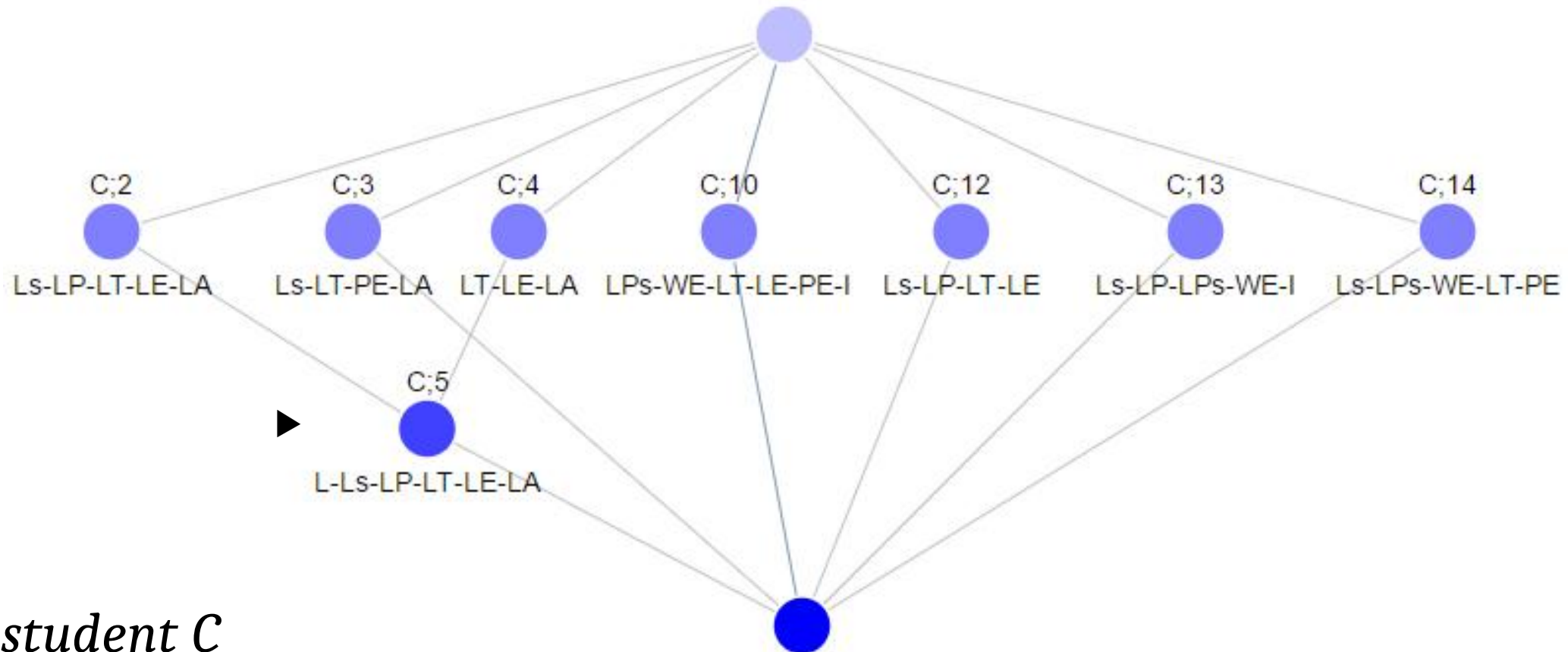
- the **objects** are the behaviors (i.e. chains of visited classes)
- the object **descriptions** are pairs of student and week corresponding to the first occurrence of that behavior for that student



the concept lattice will highlight **pioneers** of the behaviors



The pattern structure, student=C

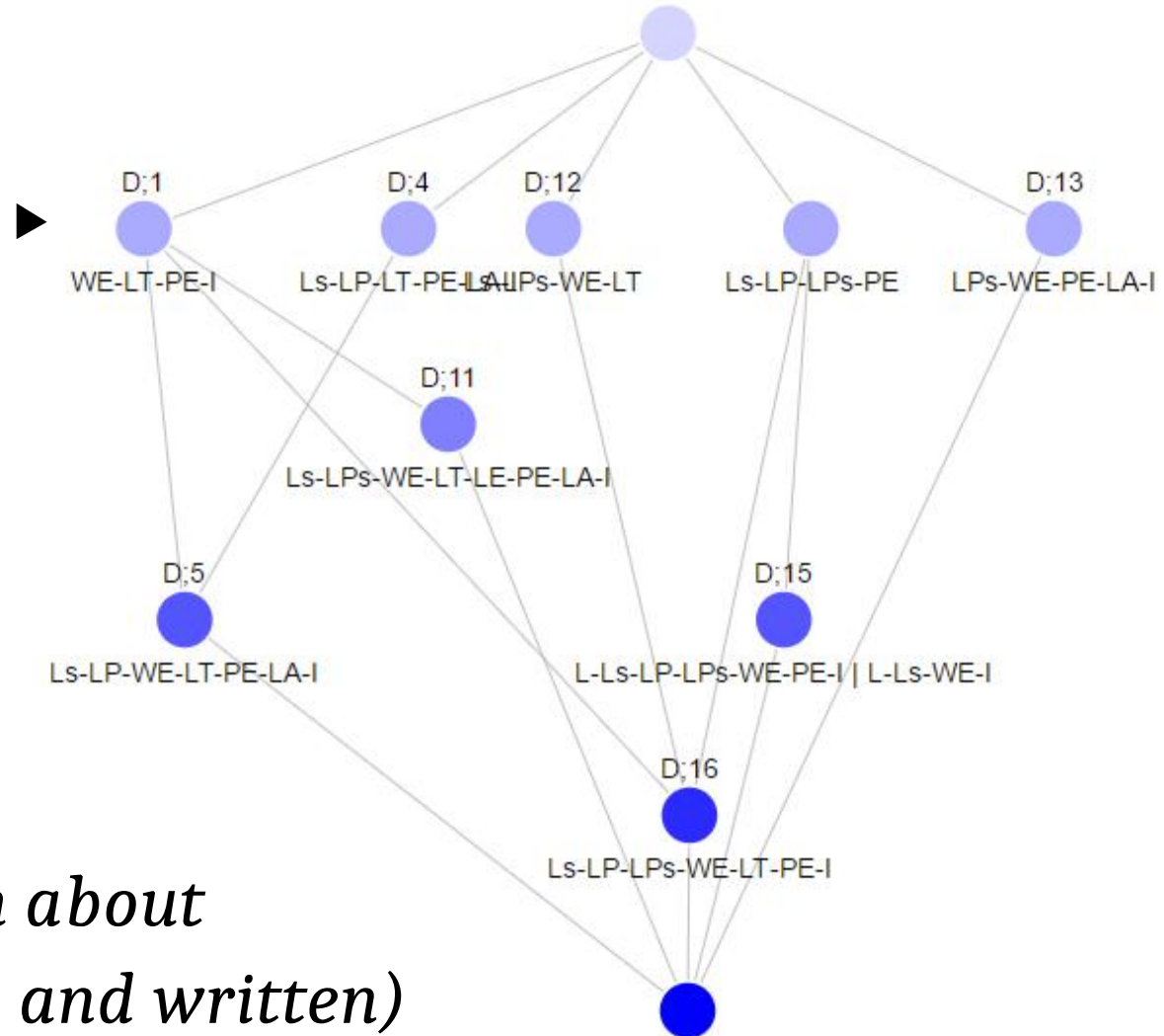


student C

- *pioneer for 8 distinct behaviors containing in average 5 int. classes*
- *focuses on laboratory related material*



The pattern structure, student=D



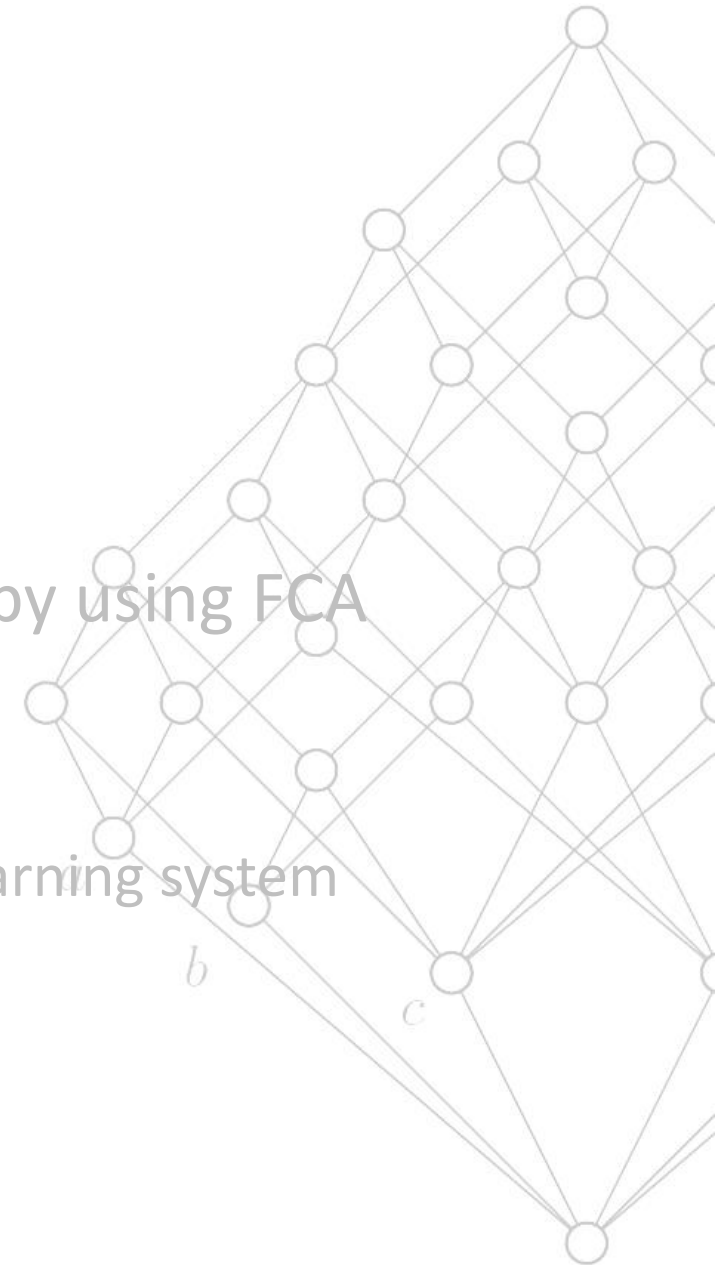
student D

- interested in information about
the examination (practical and written)
and general information about the lectures and the labs



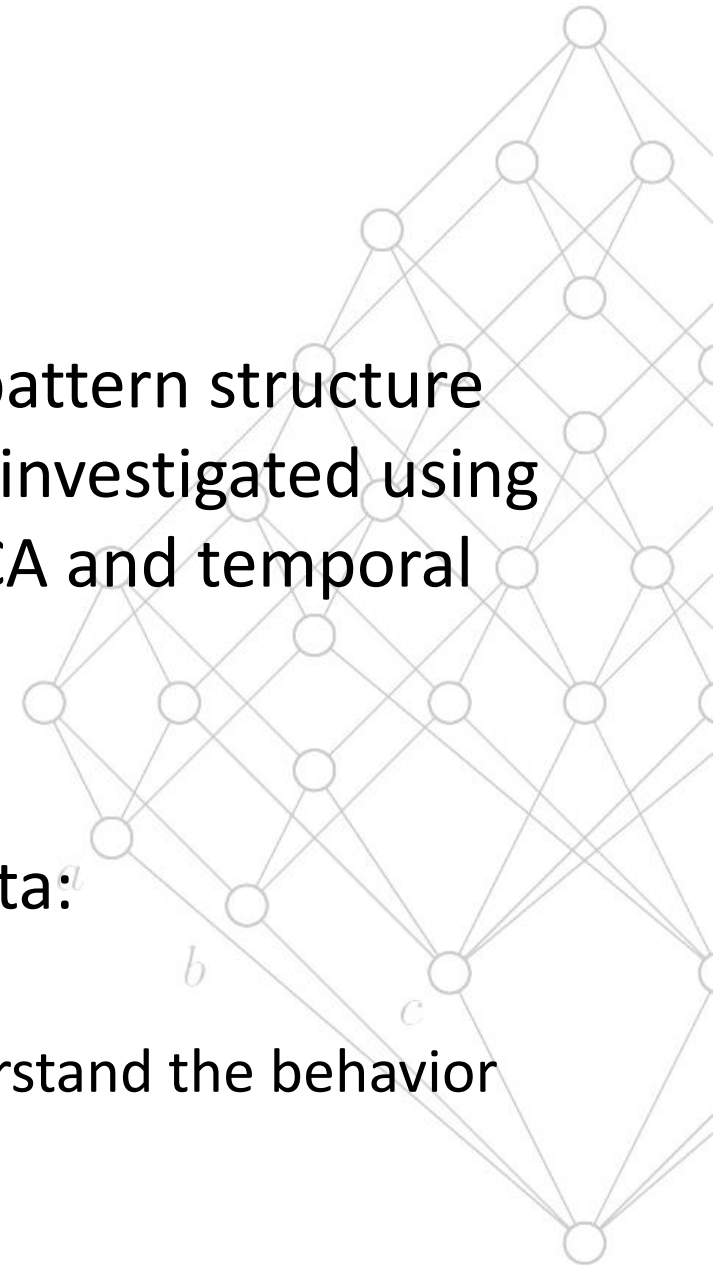
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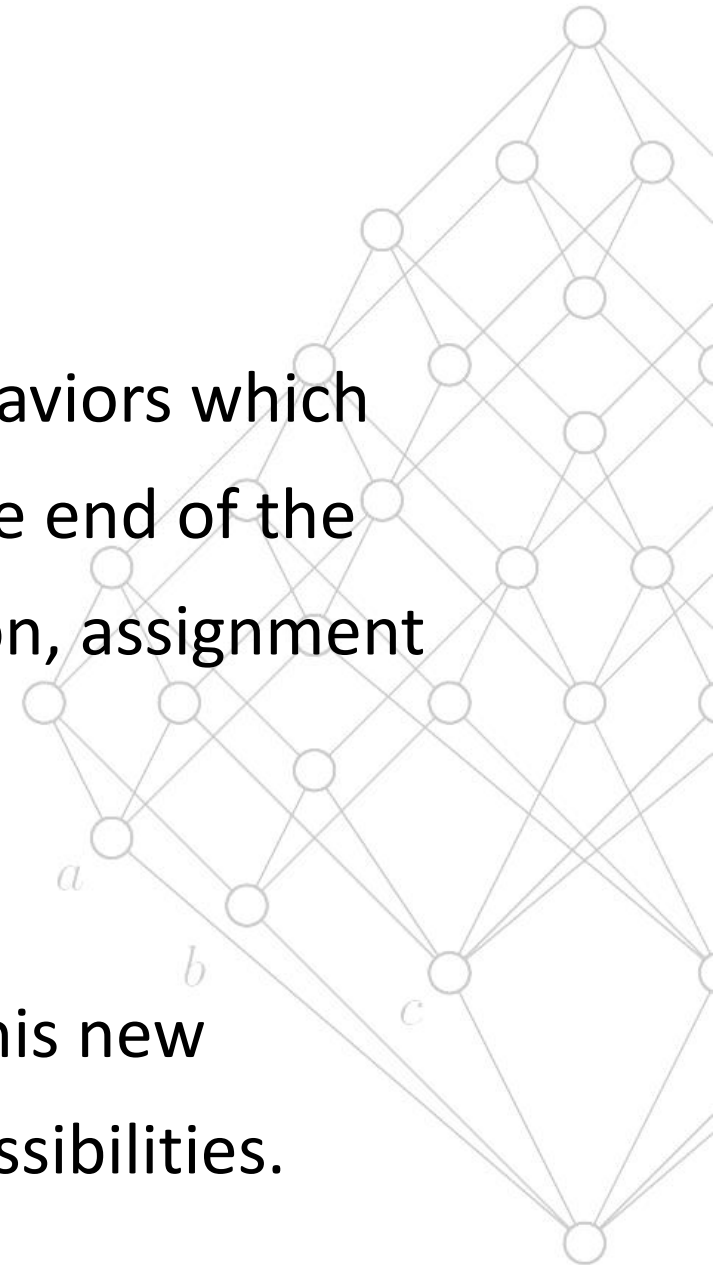
Conclusions

- we have presented a “proof-of-concept” for the FCA pattern structure representation of our data, which we have previously investigated using other FCA tools such as dyadic, triadic and polyadic FCA and temporal FCA
- this technique brought another perspective on our data:
 - confirmed some of our previous findings
 - brought other nuances that are helping us to further understand the behavior of our students

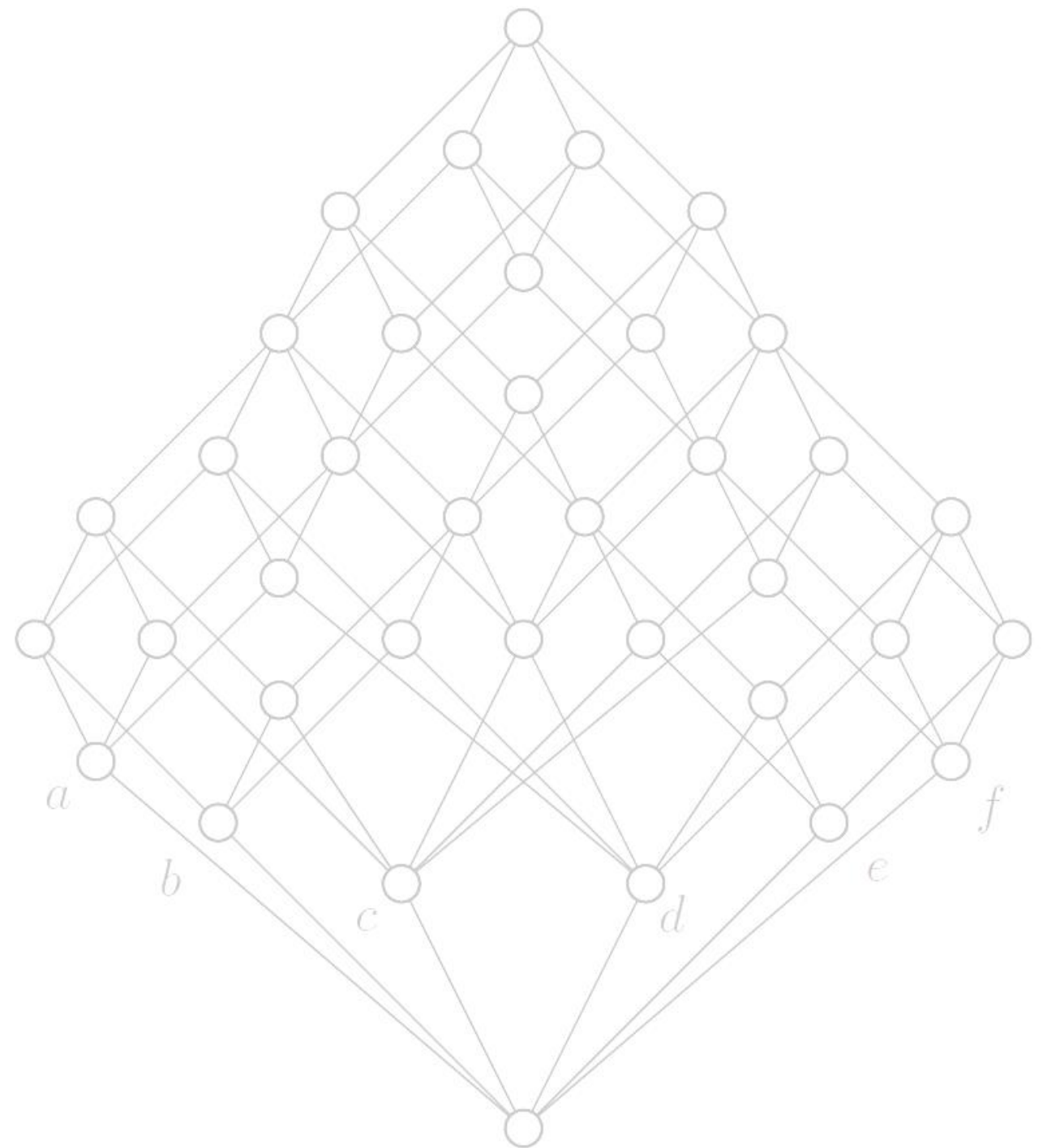


Future work

- we plan to use similar techniques to investigate behaviors which occurs **in the final part** of interacting with PULSE (the end of the semester) or **upon some triggers** such as examination, assignment of labs, deadlines or holiday.
- the investigation presented here is mere a start in this new direction, which opens a new door with multiple possibilities.



Questions?



Thank you for your
attention!

