



Universität Hamburg

DER FORSCHUNG | DER LEHRE | DER BILDUNG



CHAI

Humanities-Centered AI

Databases

**Malte Luttermann – Institute for Humanities-Centered
Artificial Intelligence (CHAI)**

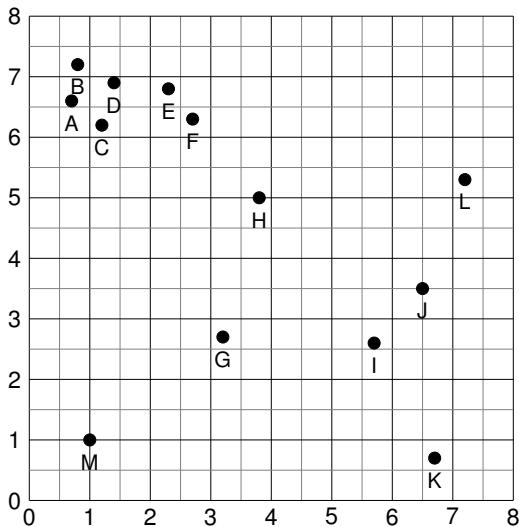
January 29, 2026

Topics for Today

- Point quad trees
- k-d trees
- Z-order and UB trees

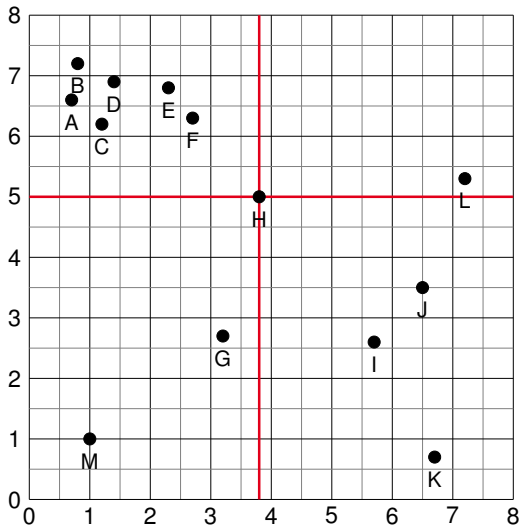
Point Quad Trees

Given the following data points, build a point quad tree. Start at the node H.



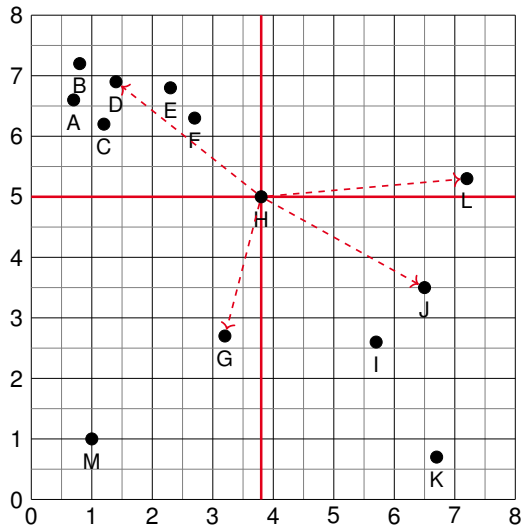
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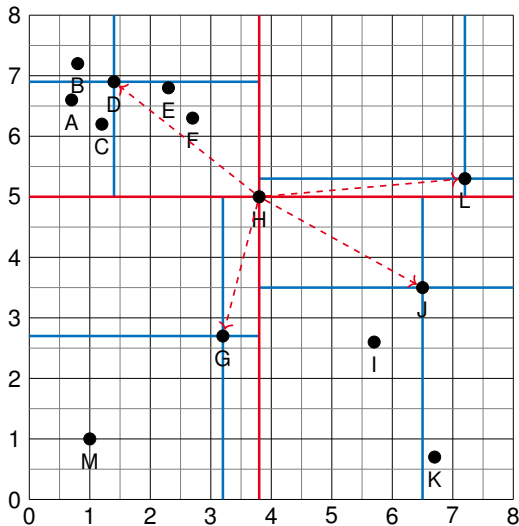
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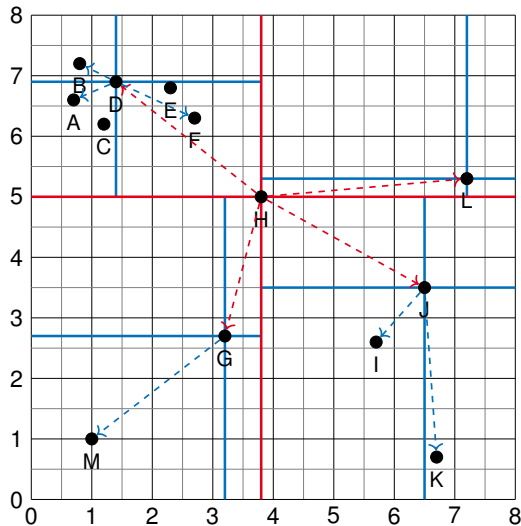
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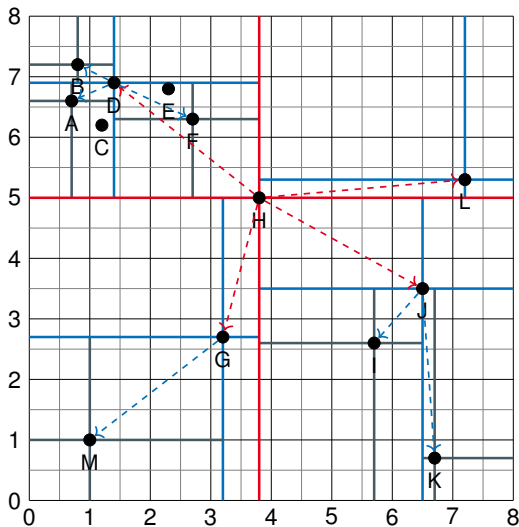
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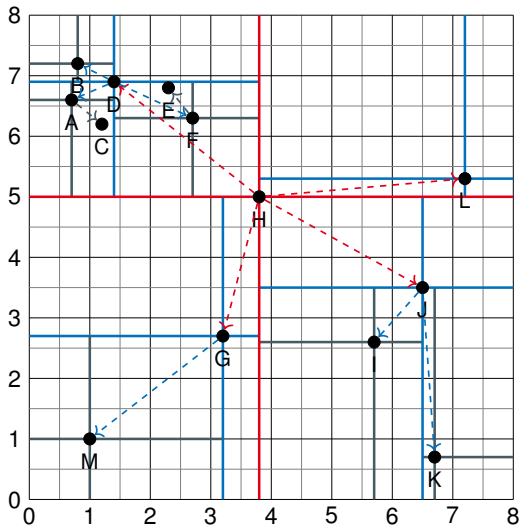
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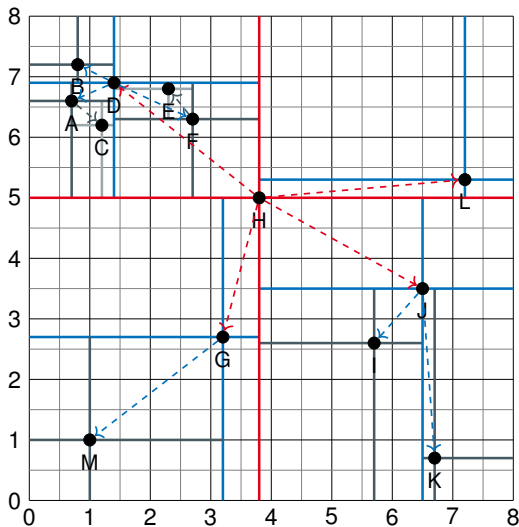
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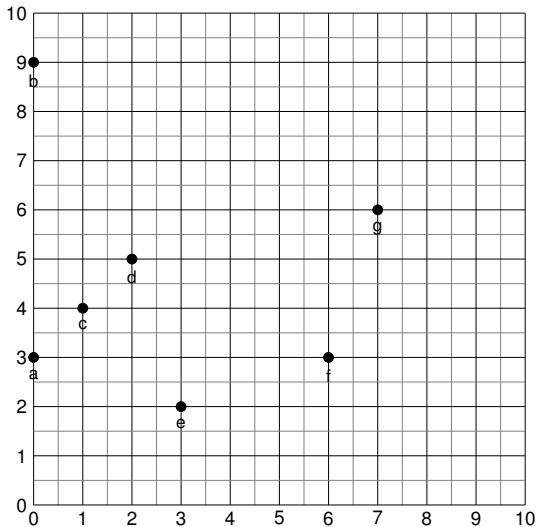
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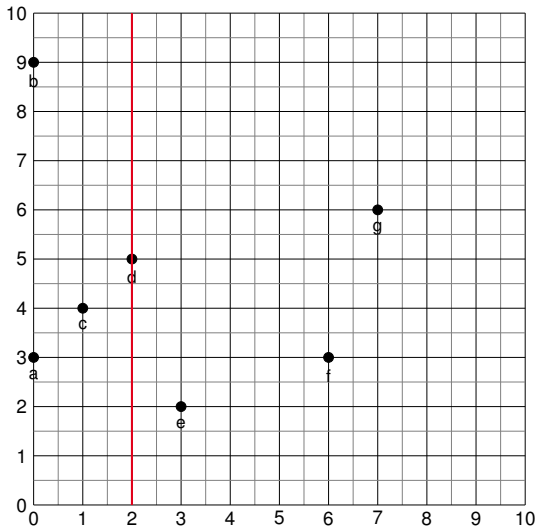
k-d Trees

Given the following data points, construct a balanced k-d tree. Start by splitting on the x-axis.



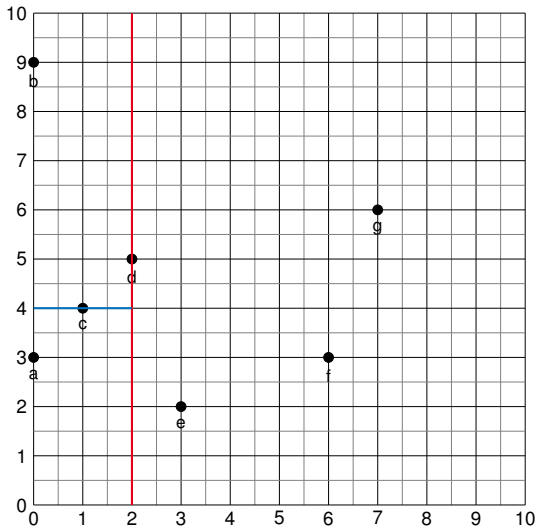
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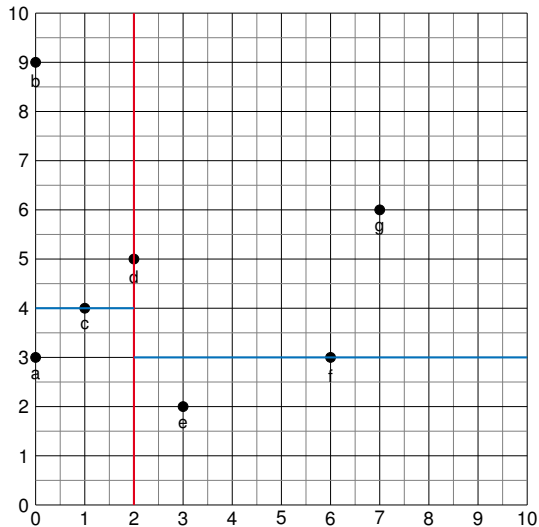
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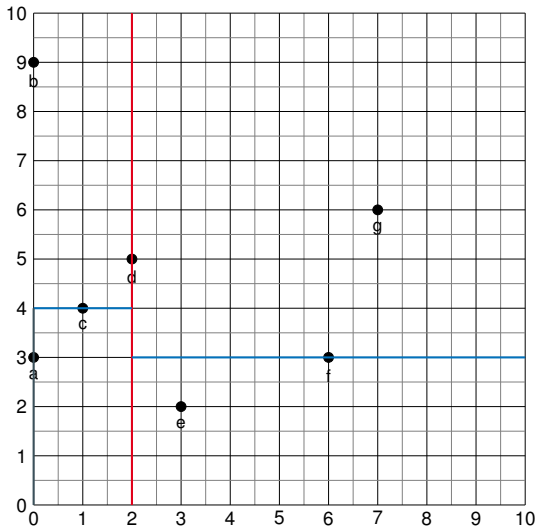
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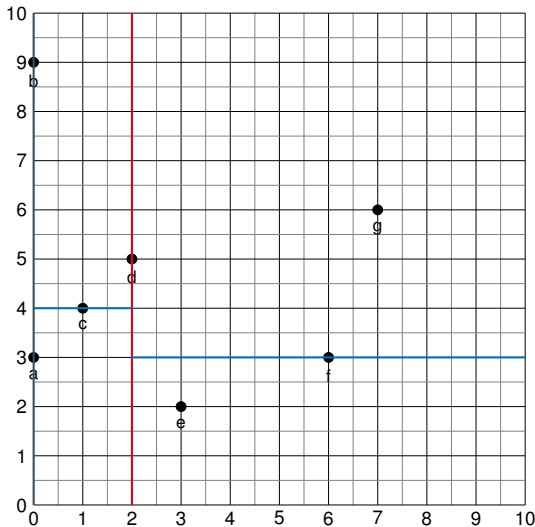
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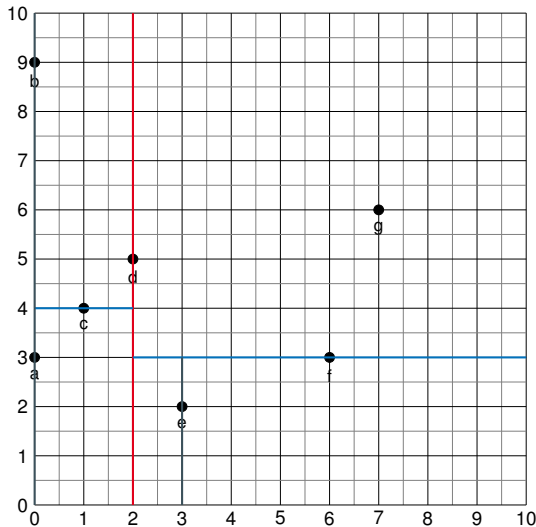
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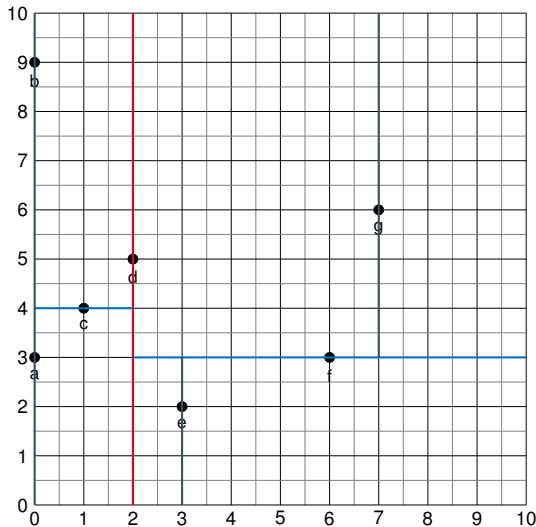
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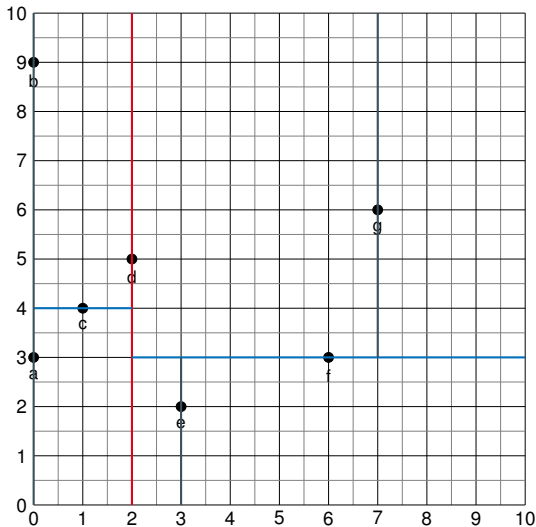
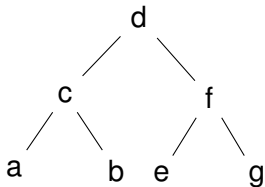
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k-d Trees

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Z-Order and UB Trees

Consider the given data and create a UB tree to index

Participants with the composite key <SemesterID, ModuleID>.

<i>Semester</i>	
ID	Semester
0	WS2023/24
1	SS2024
2	WS2024/25
3	SS2025

<i>Participants</i>			
ID	Students	ModuleID	SemesterID
0	30	0	2
1	12	1	2
2	25	2	0
3	33	2	2
4	22	3	2
5	22	1	3

<i>Module</i>			
ID	Name	Type	Lecturer
0	Databases	Lecture	Ralf Möller
1	Databases	Seminar	Malte Luttermann
2	Agents, Intellectics, and Logic	Lecture	Özgür Özcep
3	Understanding Data vs. Machine Training	Lecture	Marcel Gehrke

Z-Order and UB Trees

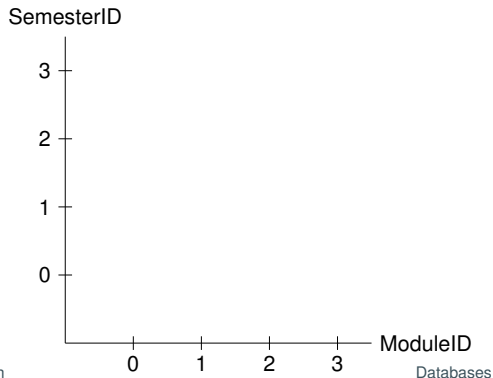
- (1) Draw a graph with the Z-order and plot the given data points.

Participants

ID	Students	ModuleID	SemesterID
0	30	0	2
1	12	1	2
2	25	2	0
3	33	2	2
4	22	3	2
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Z-Order and UB Trees

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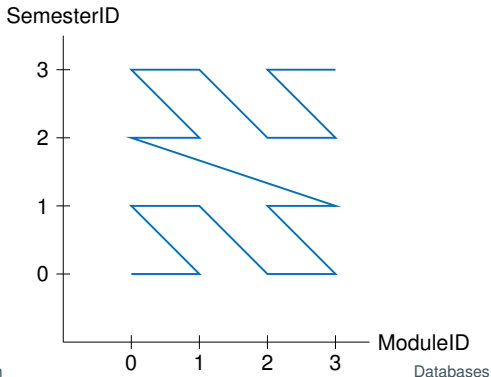


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0	30	0	2
1	12	1	2
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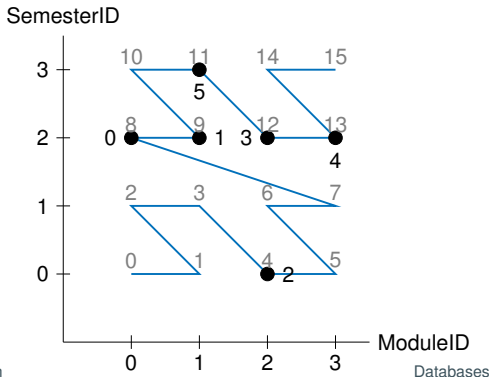


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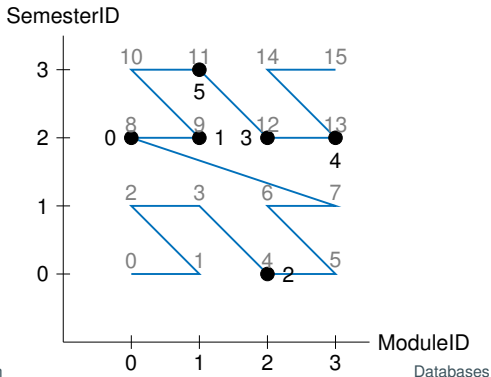


Participants

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0	30	0	2
1	12	1	2
2	25	2	0
3	33	2	2
4	22	3	2
5	22	1	3

Z-Order and UB Trees

- (2) Map the data from the graph to a UB tree of order 2 (i.e. leaf and inner nodes can hold 2 to 4 entries).

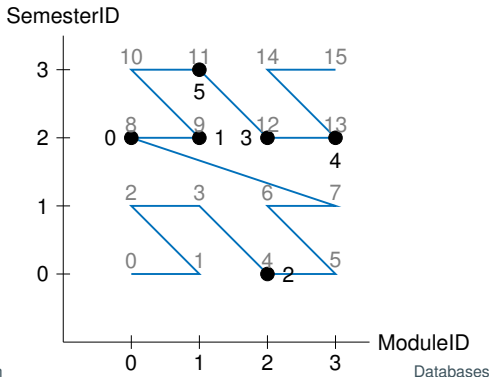


Participants

ID	Students	ModuleID	SemesterID
0	30	0	2
1	12	1	2
2	25	2	0
3	33	2	2
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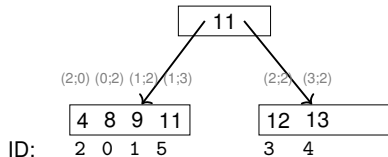
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Z-Order and UB Trees

- (3) Apply bit entanglement to search for participants of the *Databases* seminar in the *winter semester 2024/25* in the UB tree.

<i>Semester</i>	
ID	Semester
0	WS2023/24
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Z-Order and UB Trees

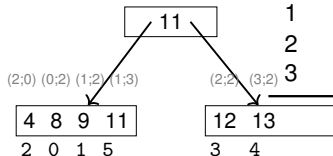
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ModuleID = 1 = 01_2 ,
 SemesterID = 2 = 10_2 ,
 Entangled = $1001_2 = 9$

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ID: 2 0 1 5
 Malte Luttermann