

## Aufgabe 4-1

single-link  
average-link  
complete-link

## Aufgabe 4-2

DBSCAN und  
Single-Link

## Aufgabe 4-3

$\epsilon = 5$ ,  
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$\epsilon = 5$ ,  
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Vergleich

# Data Mining Tutorial

## Clusteranalyse – Teil III

Erich Schubert, Arthur Zimek

Ludwig-Maximilians-Universität München

2014-05-16 — KDD Übung

## Single-Link Clustering

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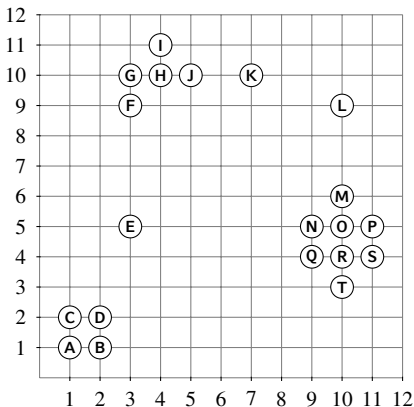
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A B C D E F G H J I K L M O N P Q R S T

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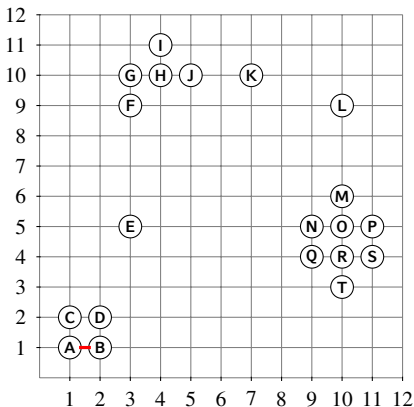
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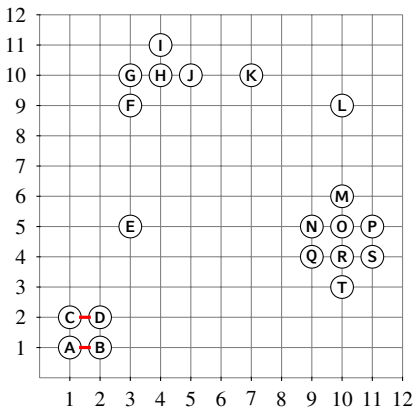
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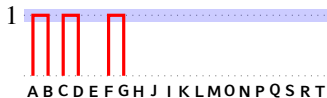
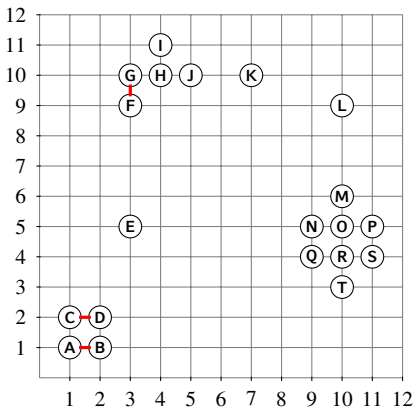
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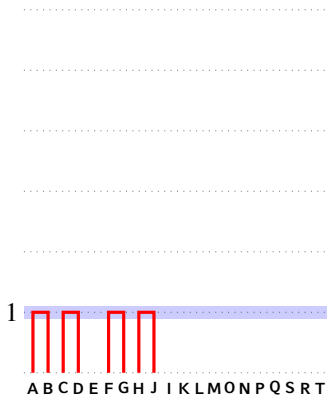
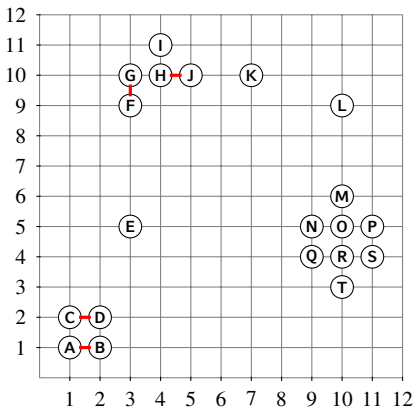
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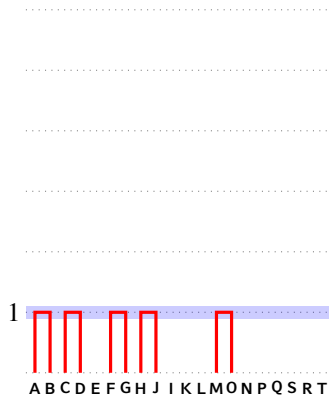
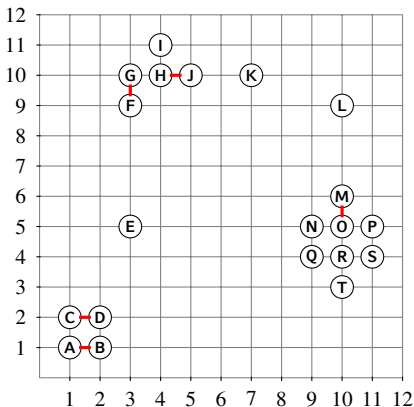
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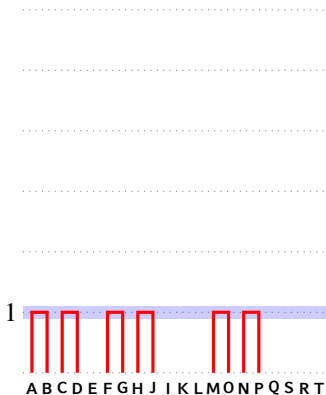
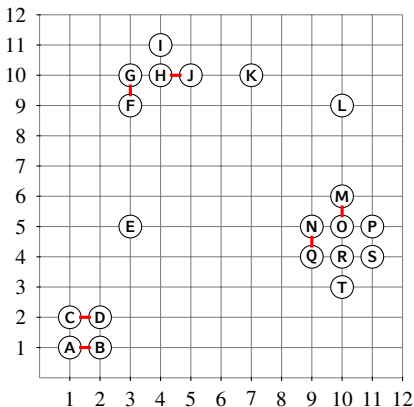
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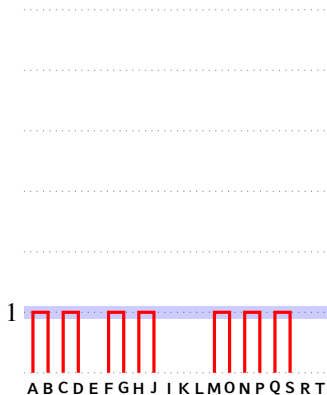
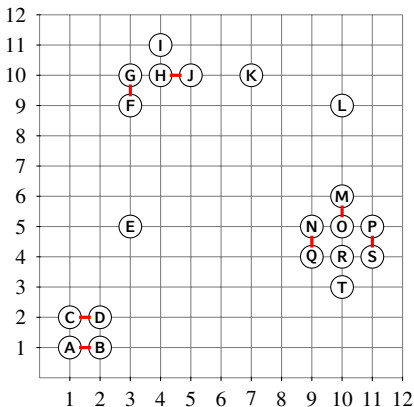
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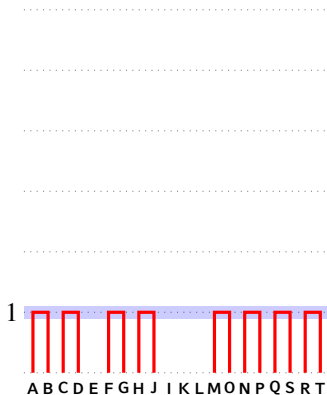
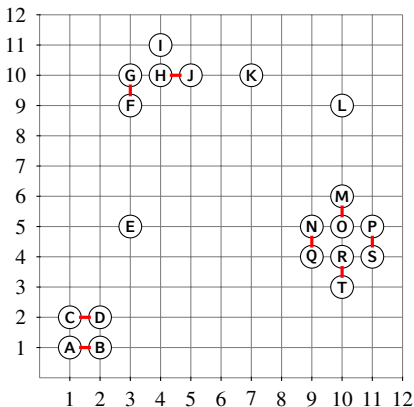
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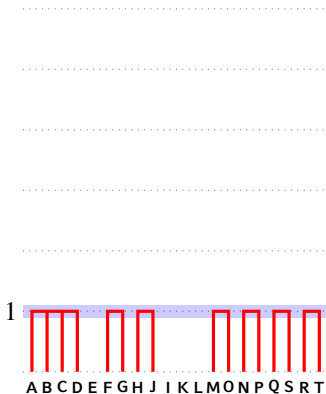
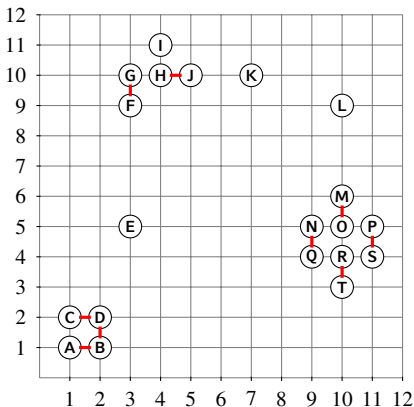
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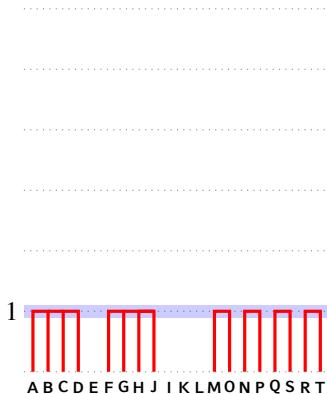
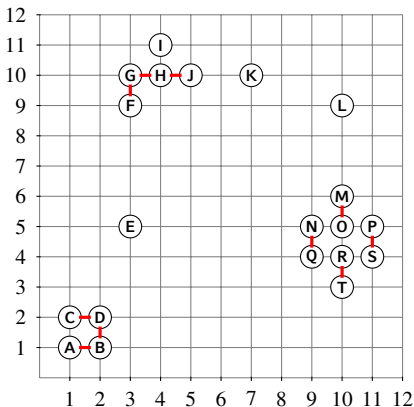
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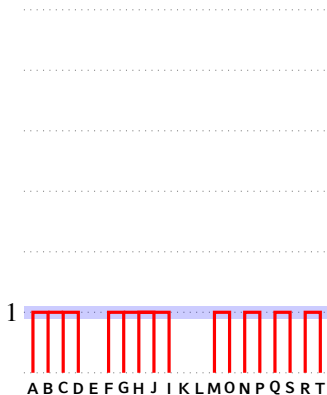
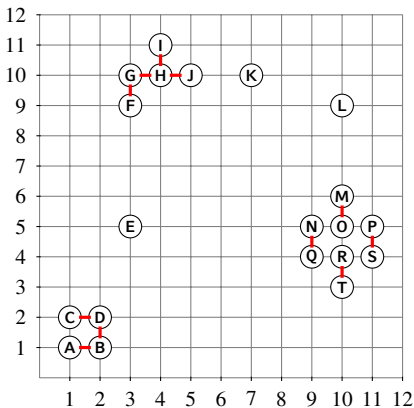
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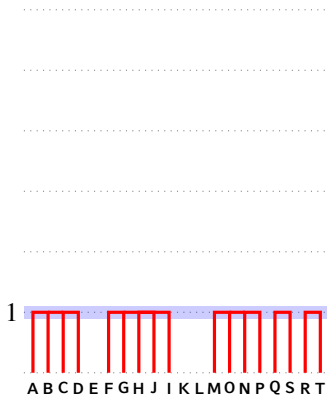
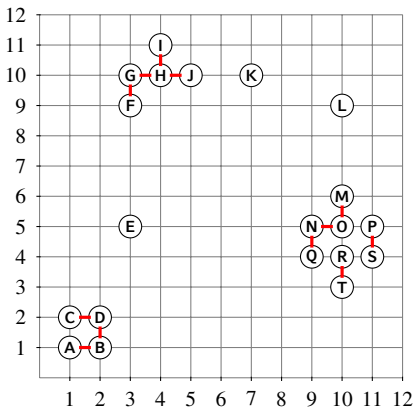
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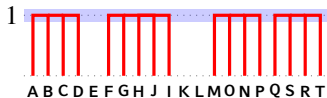
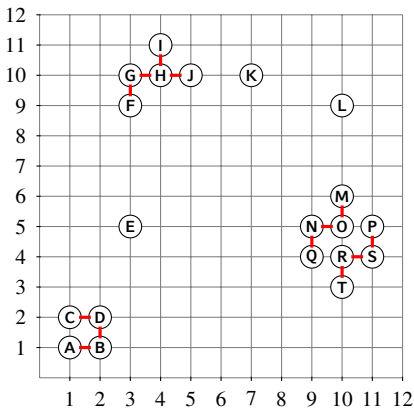
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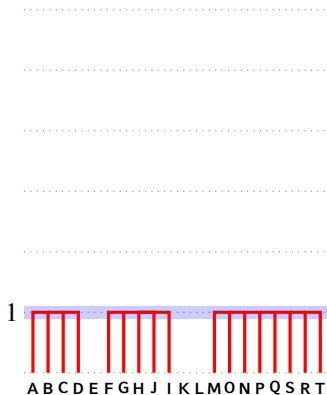
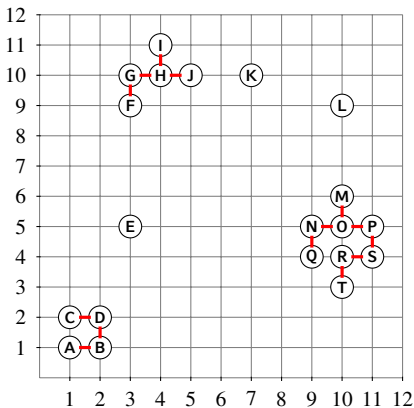
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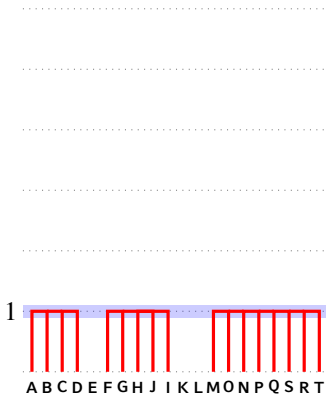
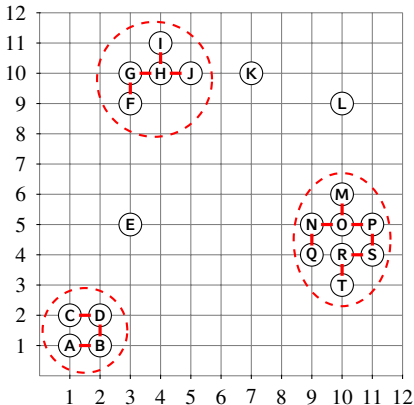
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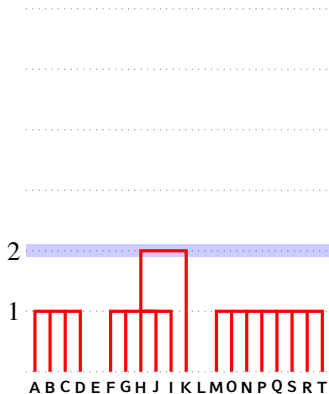
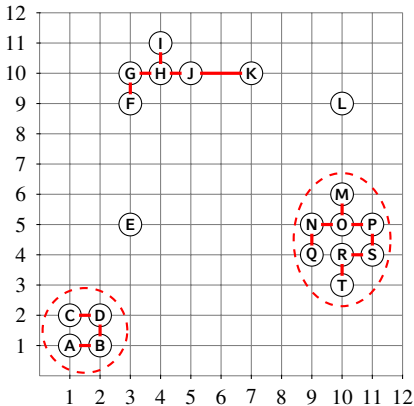
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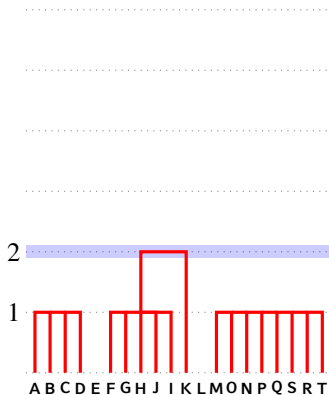
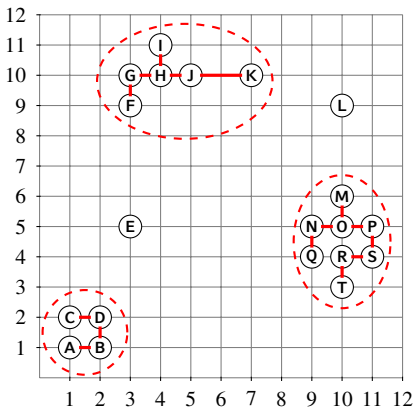
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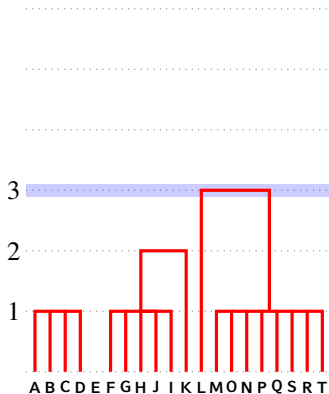
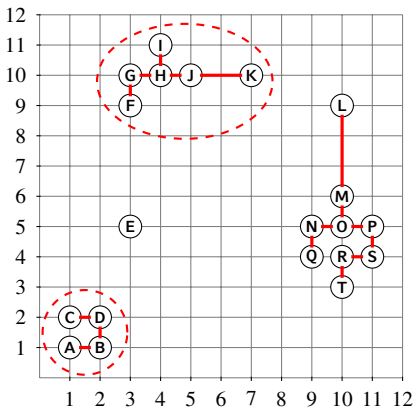
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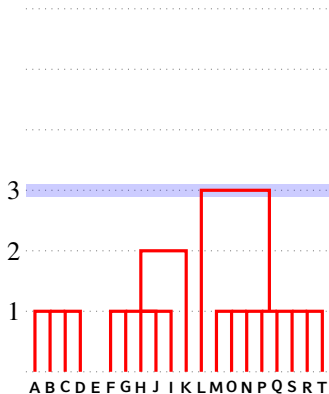
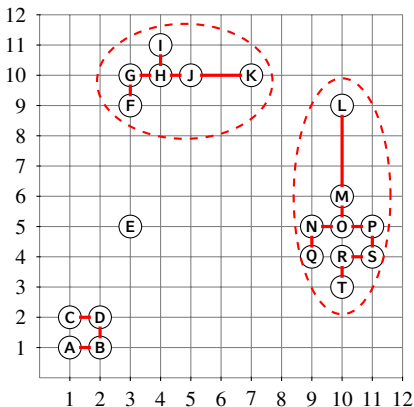
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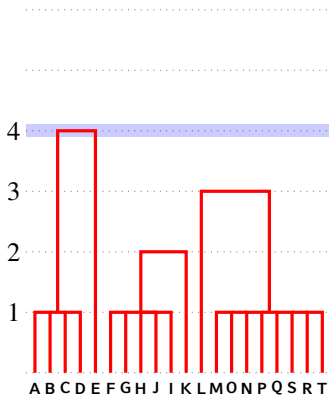
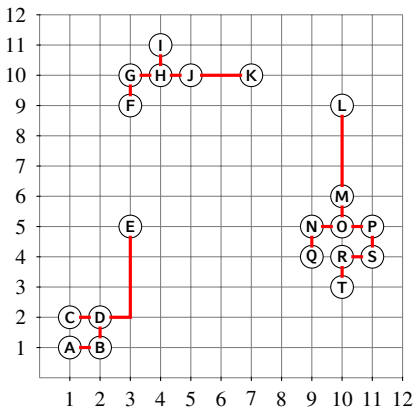
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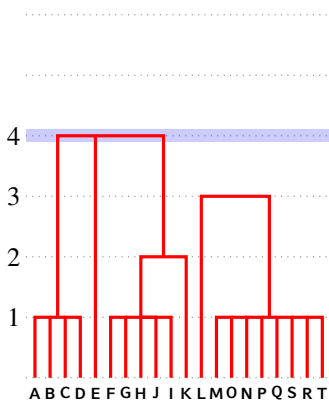
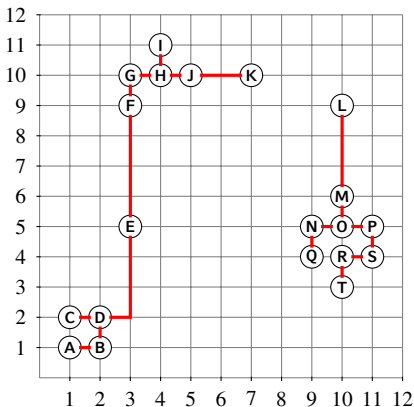
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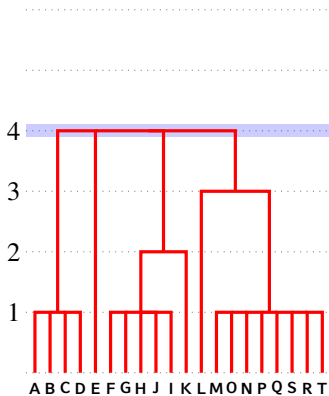
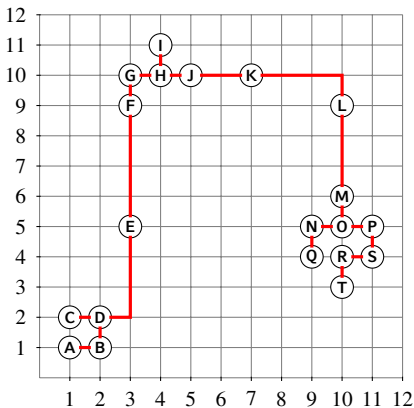
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# Group-Average-Link Clustering

**Aufgabe 4-1**

single-link

average-link

complete-link

**Aufgabe 4-2**

DBSCAN und  
Single-Link

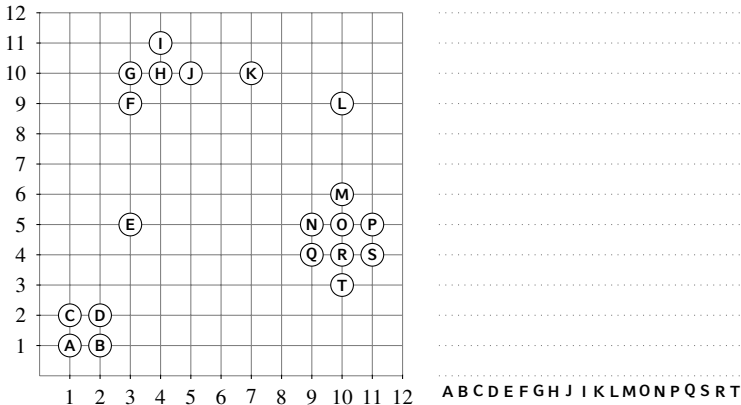
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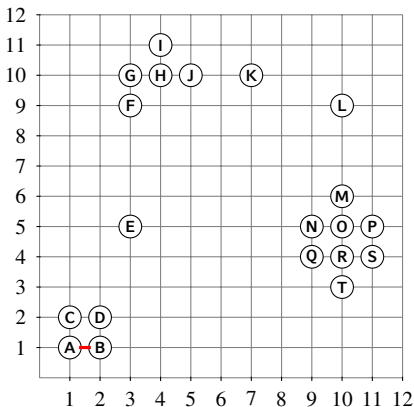
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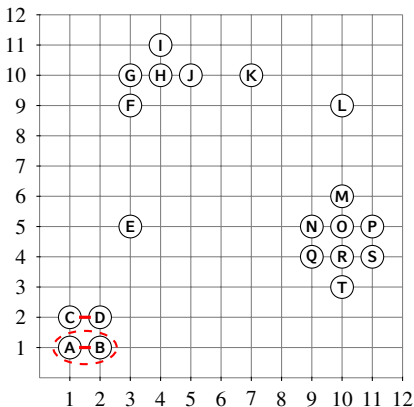
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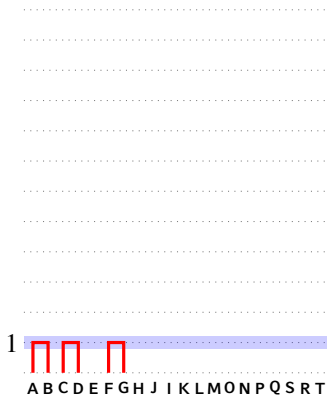
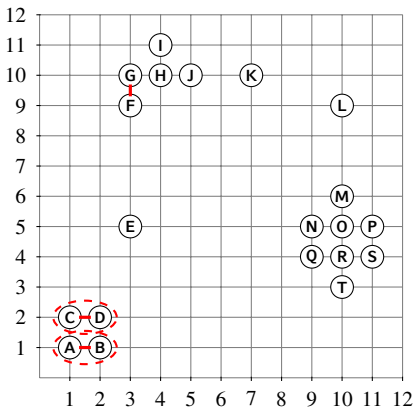
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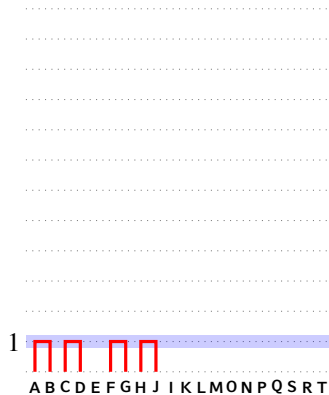
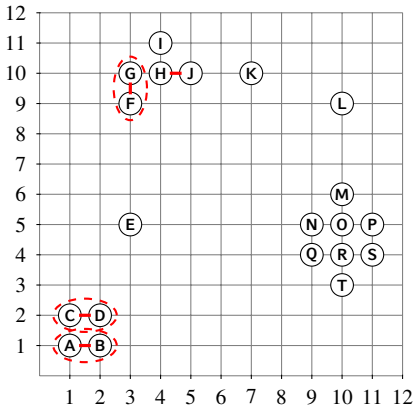
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 $\text{minPts} = 2$

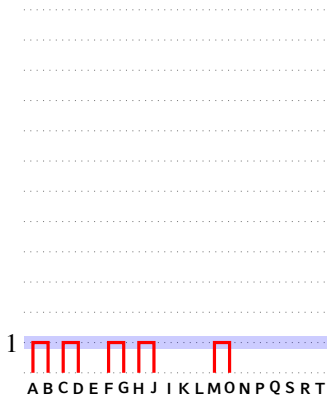
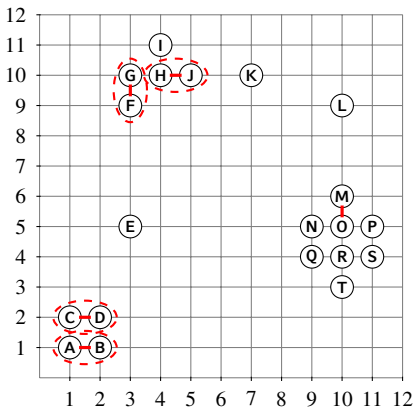
$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich







## Group-Average-Link Clustering

Data Mining  
Tutorial

E. Schubert,  
A. Zimek

### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

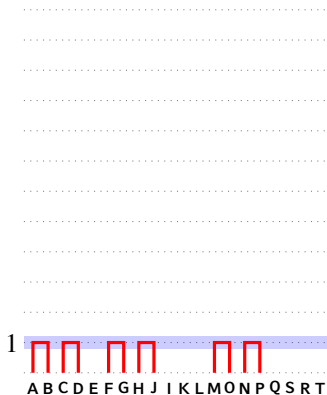
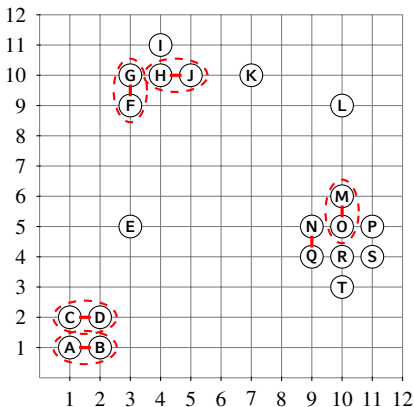
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

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### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

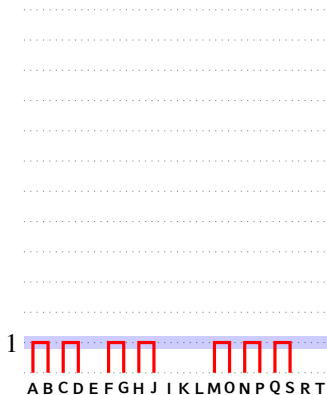
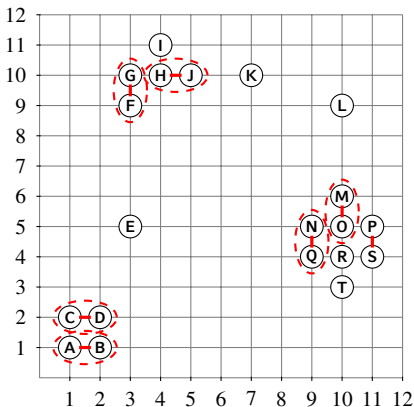
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

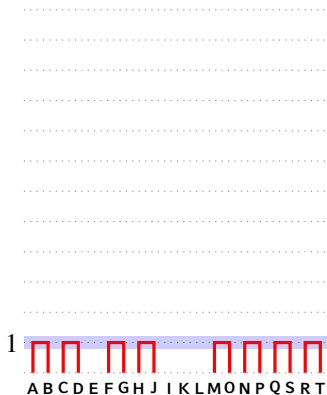
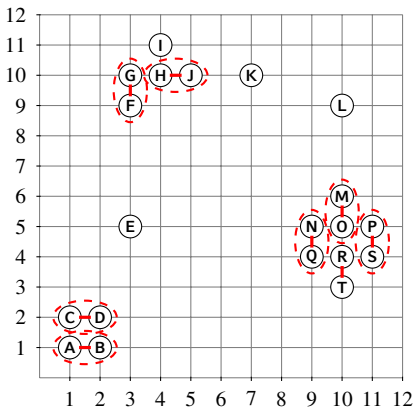
$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich







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### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

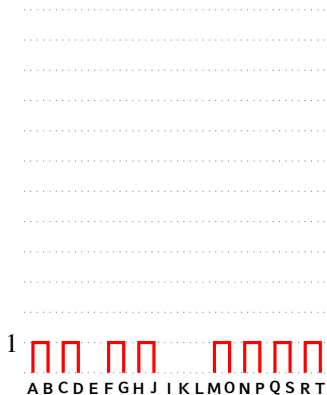
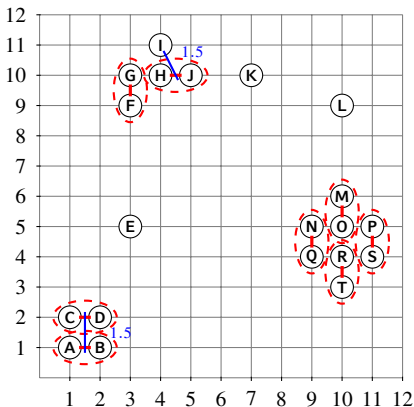
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

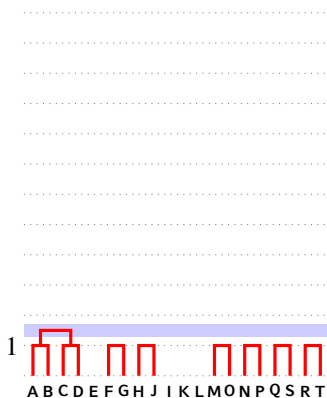
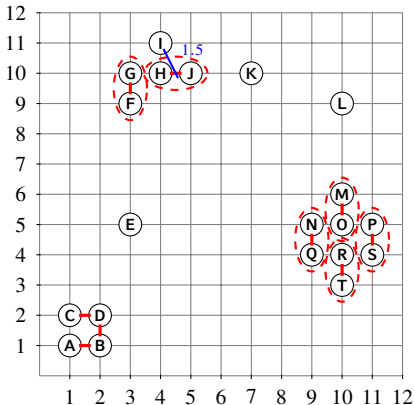
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

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### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

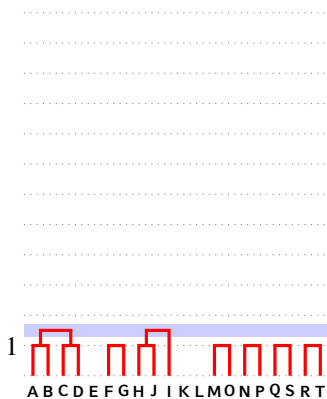
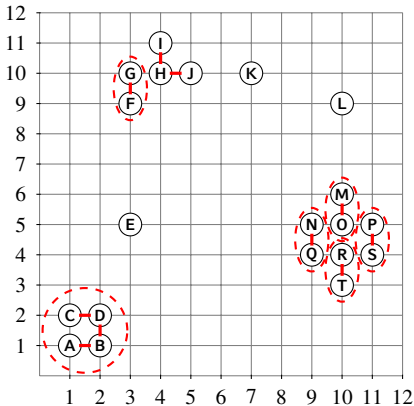
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



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### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

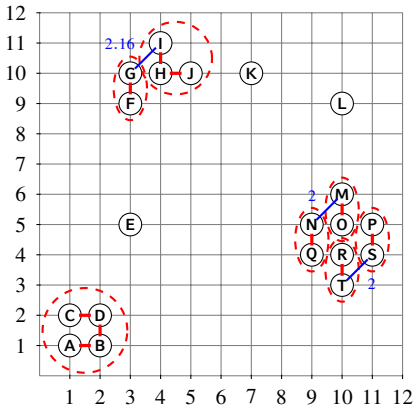
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



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average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

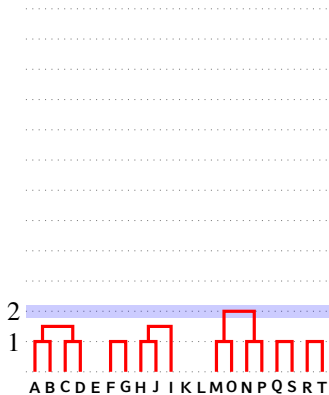
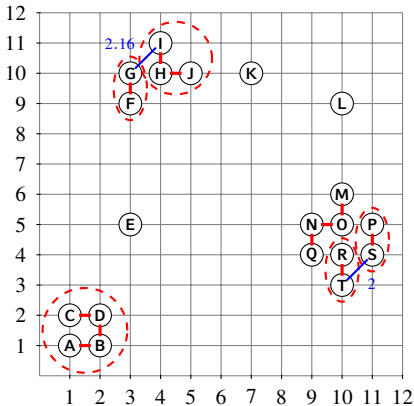
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



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average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

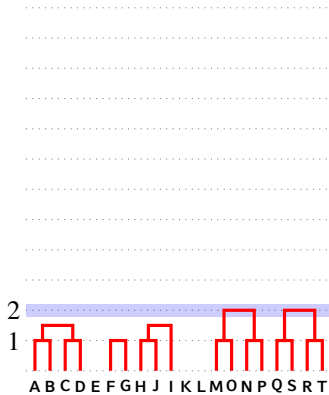
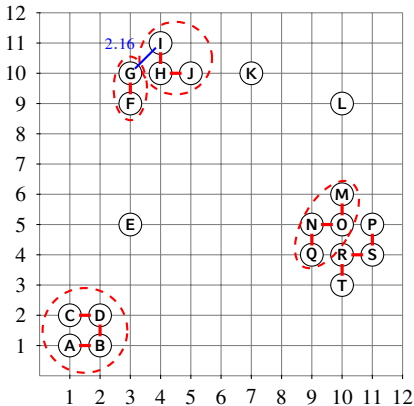
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



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### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

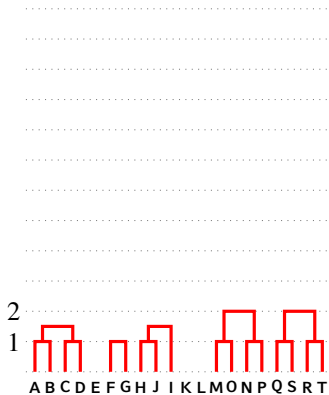
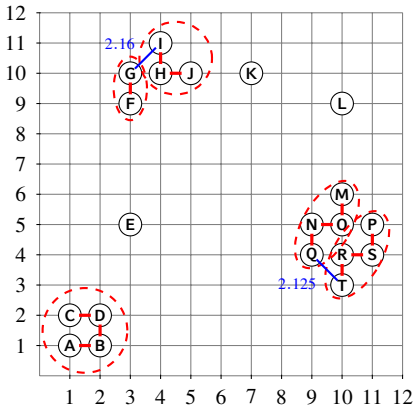
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich





## Group-Average-Link Clustering

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Tutorial

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A. Zimek

### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

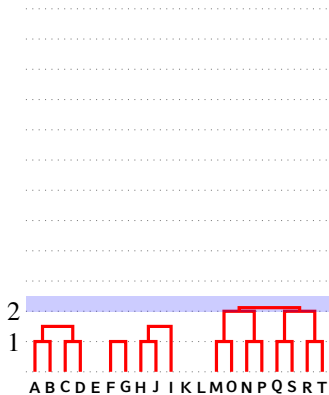
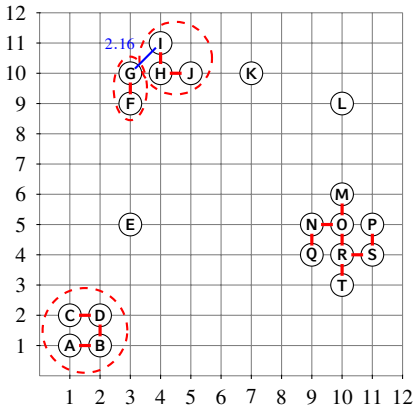
### Aufgabe 4-3

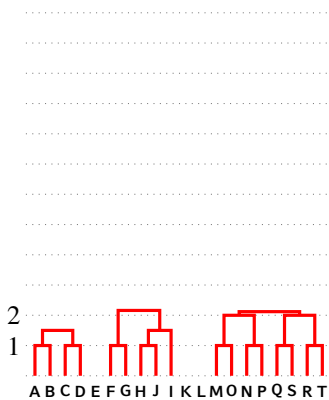
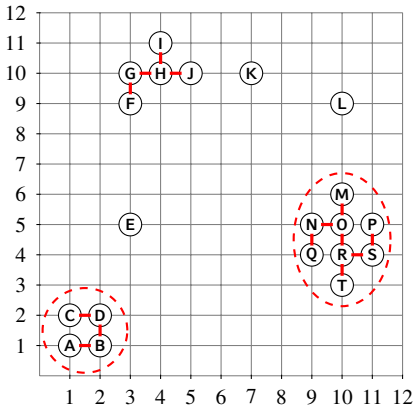
$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich





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### Aufgabe 4-1

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complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

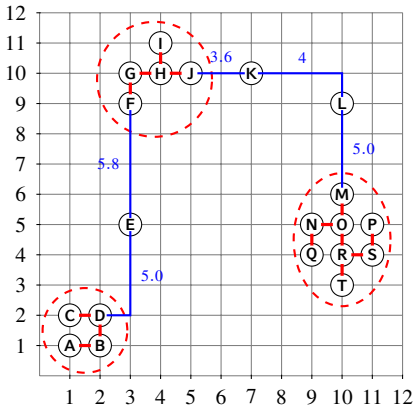
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

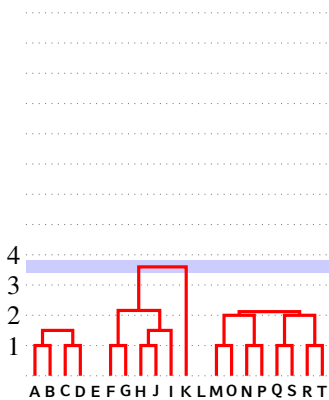
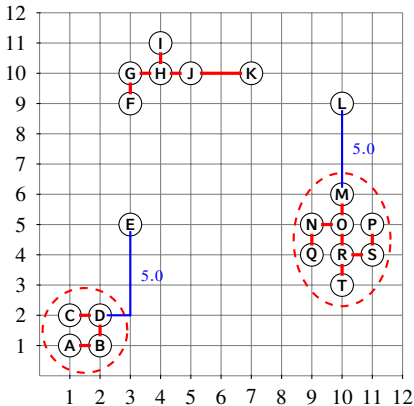
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

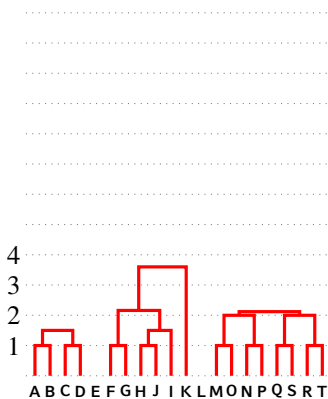
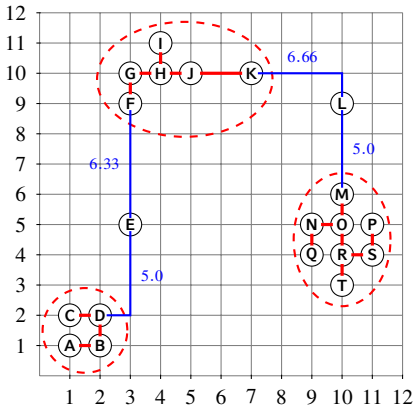
### Aufgabe 4-3

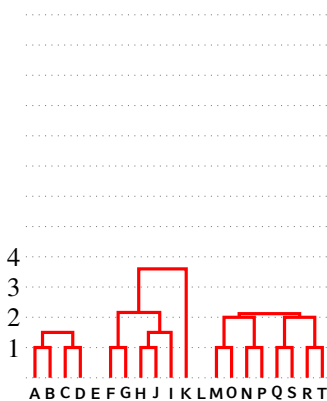
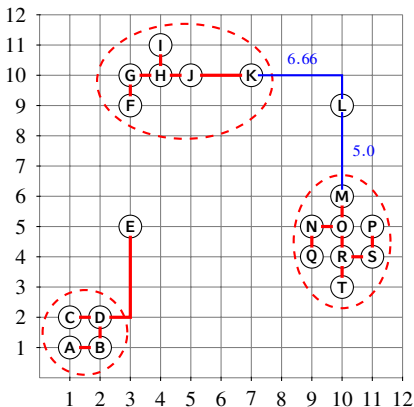
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minPts = 2

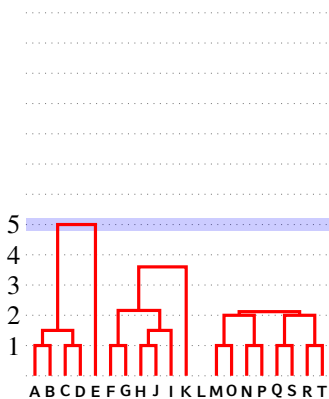
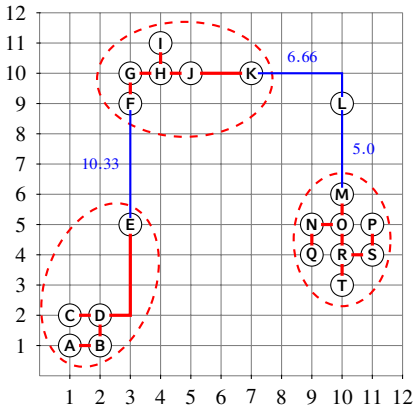
$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich







### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

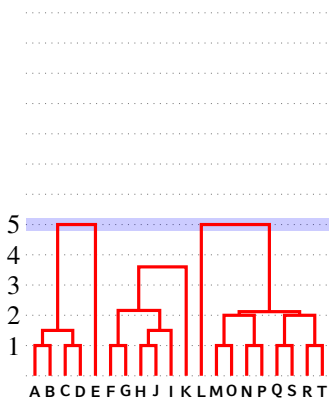
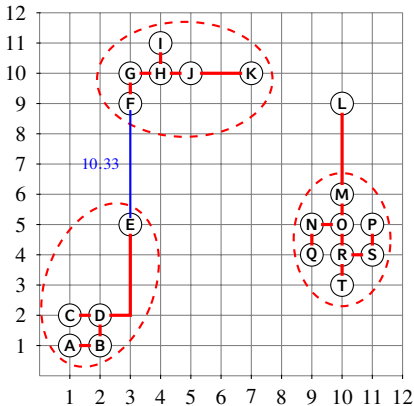
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich





### Aufgabe 4-1

single-link

average-link

complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

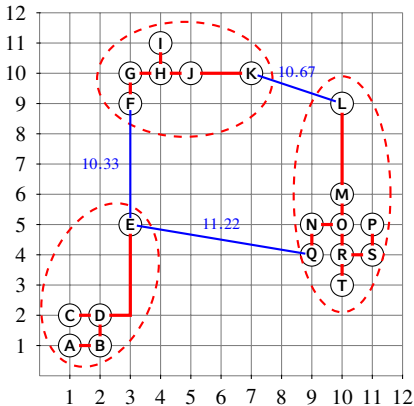
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



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single-link

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complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

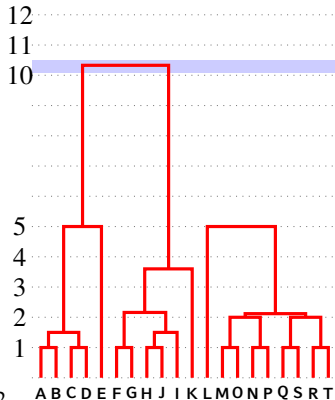
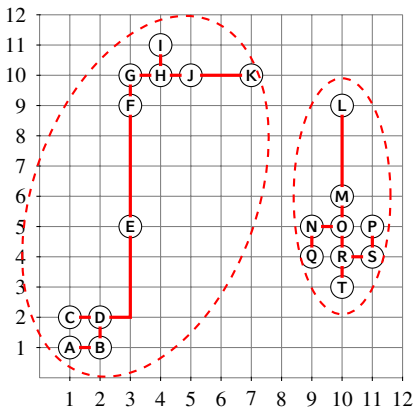
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

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DBSCAN und  
Single-Link

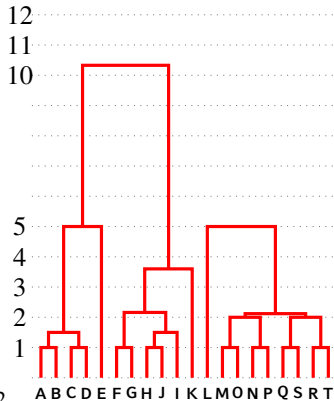
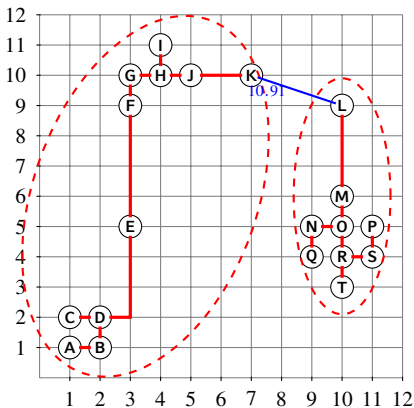
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



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single-link

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DBSCAN und  
Single-Link

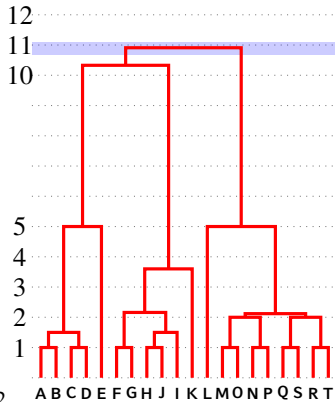
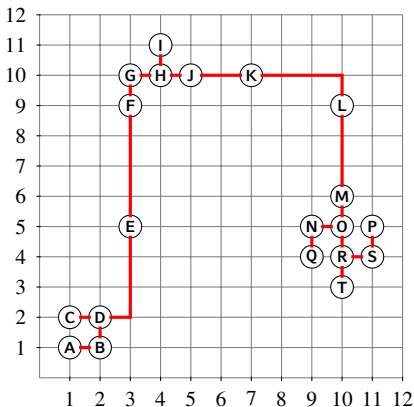
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich





### Aufgabe 4-1

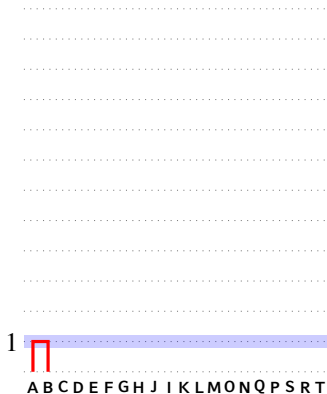
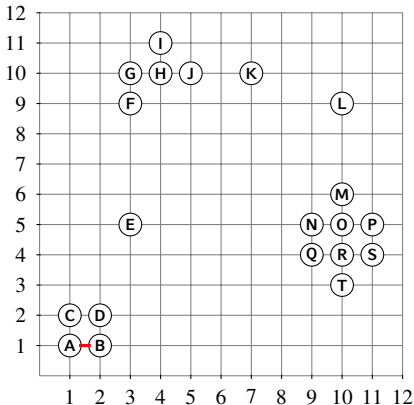
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
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minPts = 4  
Vergleich



### Aufgabe 4-1

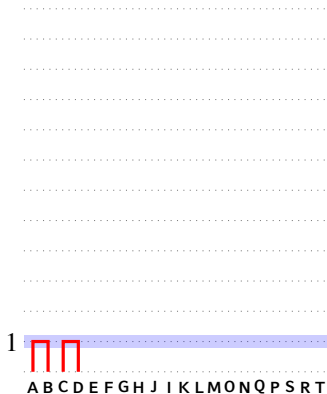
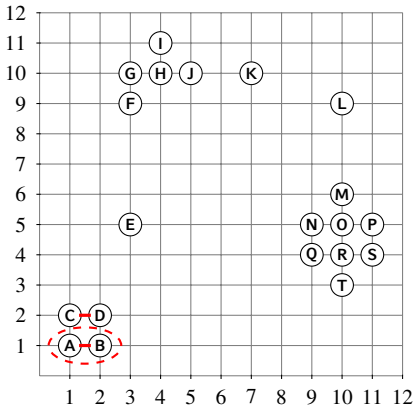
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



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### Aufgabe 4-1

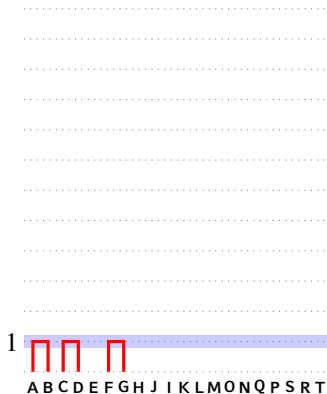
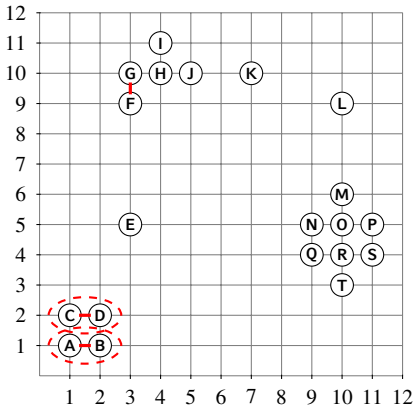
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
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### Aufgabe 4-1

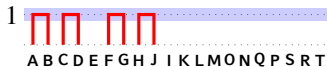
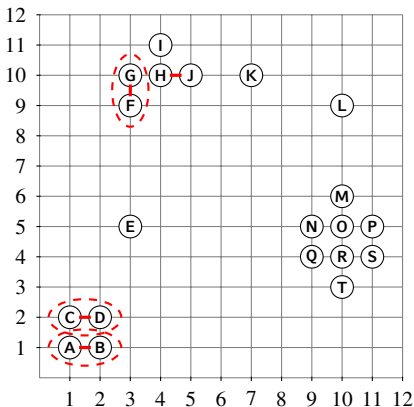
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
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## Complete-Link Clustering

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### Aufgabe 4-1

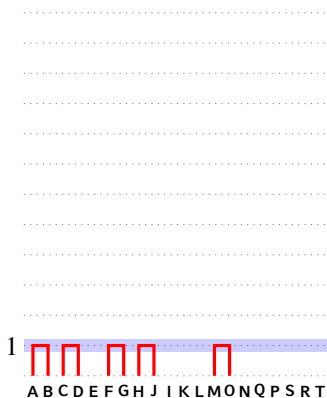
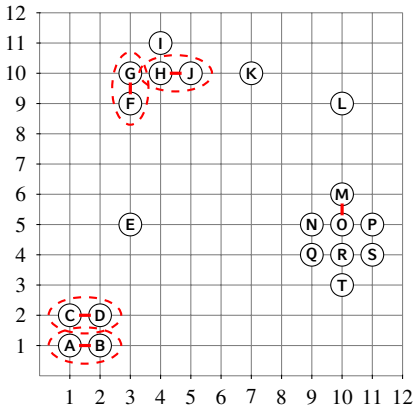
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
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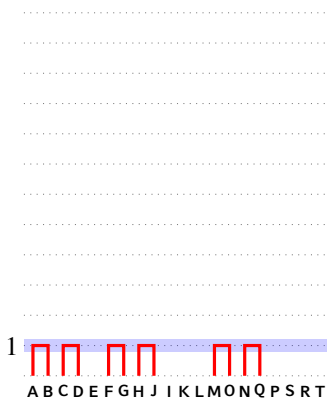
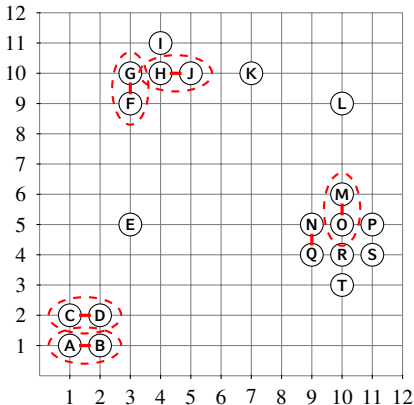
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
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## Complete-Link Clustering

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Tutorial

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### Aufgabe 4-1

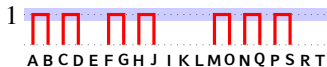
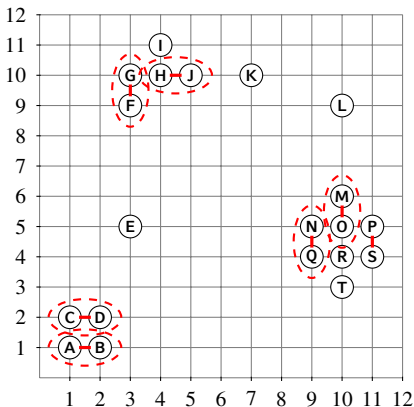
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

E. Schubert,  
A. Zimek

### Aufgabe 4-1

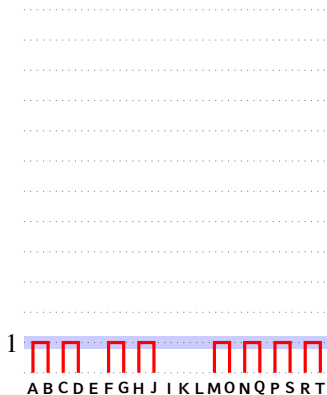
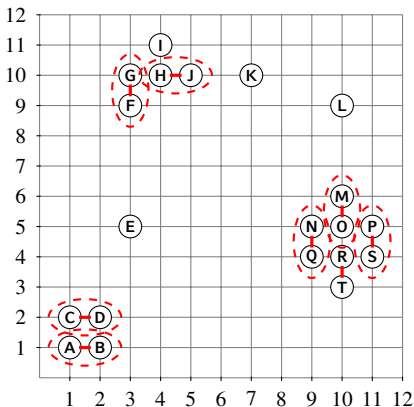
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

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Tutorial

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### Aufgabe 4-1

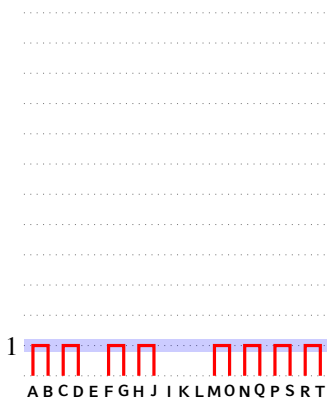
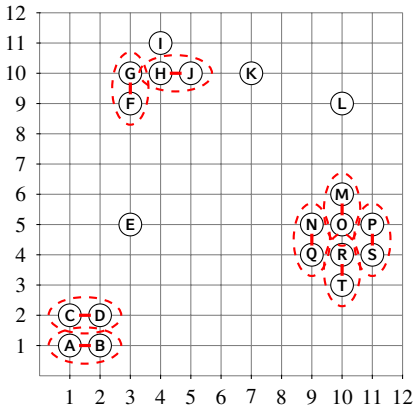
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



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### Aufgabe 4-1

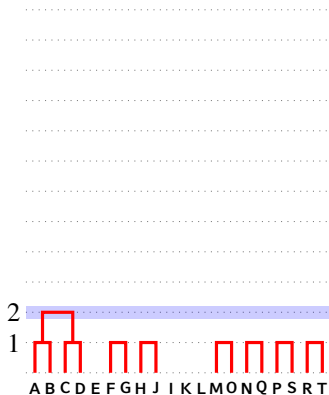
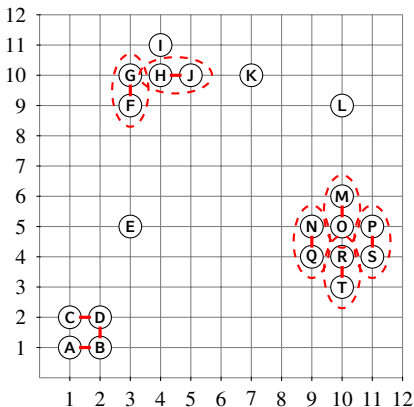
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



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Data Mining  
Tutorial

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### Aufgabe 4-1

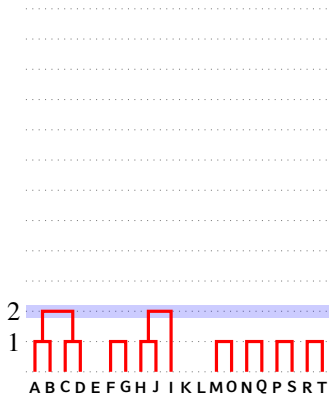
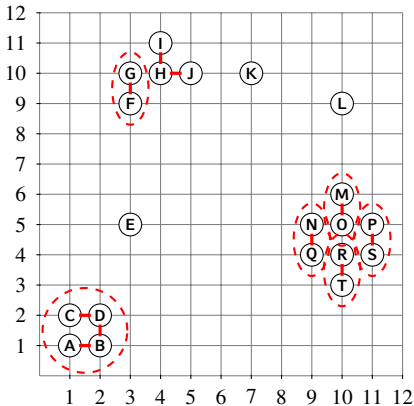
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich





## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

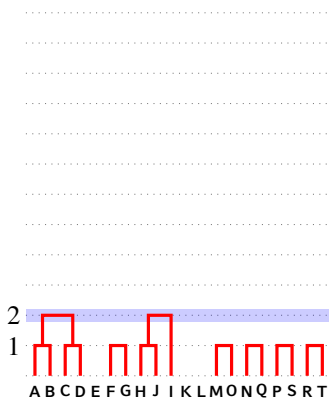
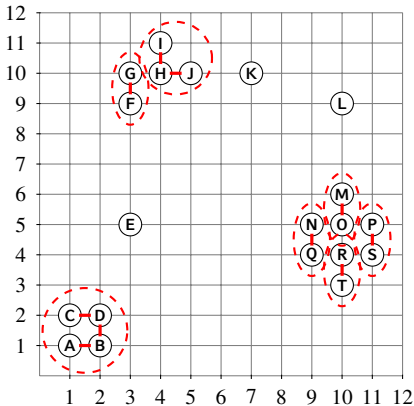
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

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A. Zimek

### Aufgabe 4-1

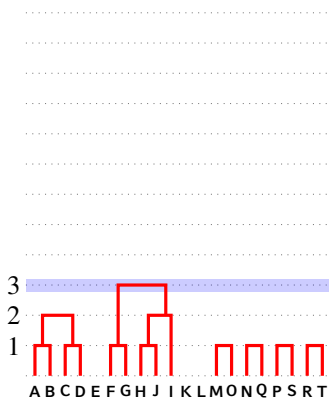
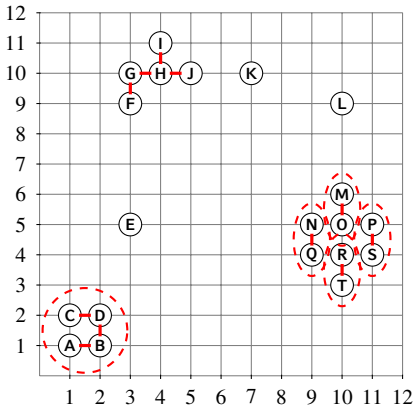
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
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 $\epsilon = 2$ ,  
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Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

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A. Zimek

### Aufgabe 4-1

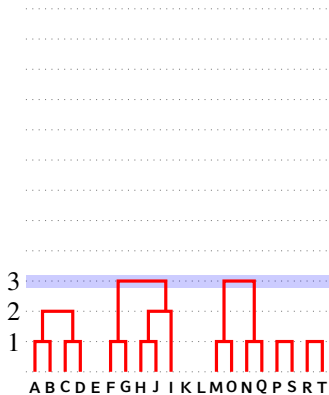
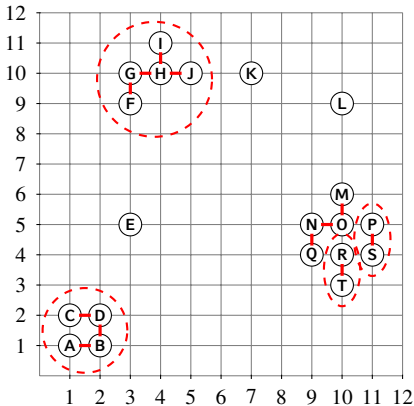
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

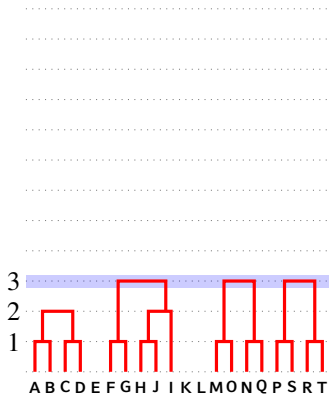
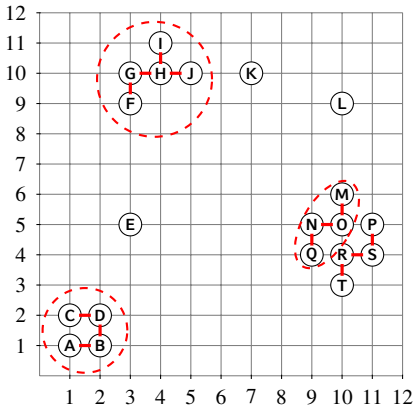
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
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 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

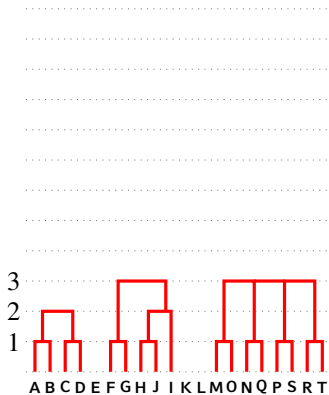
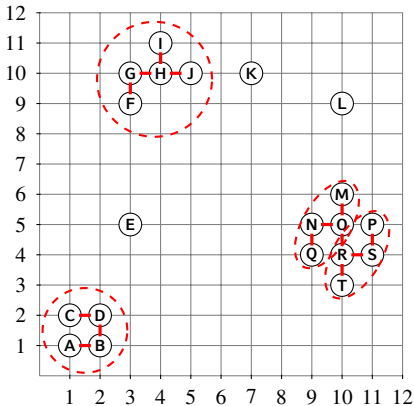
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

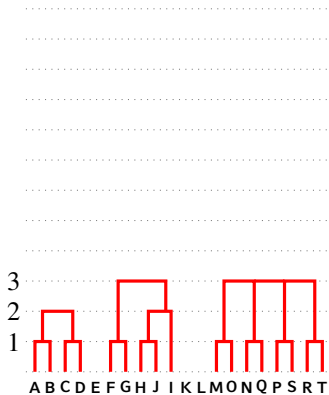
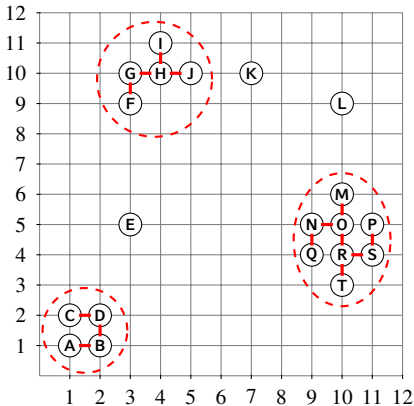
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average-link  
complete-link

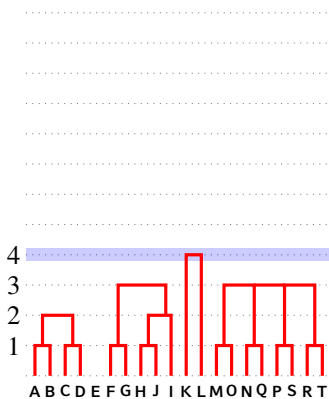
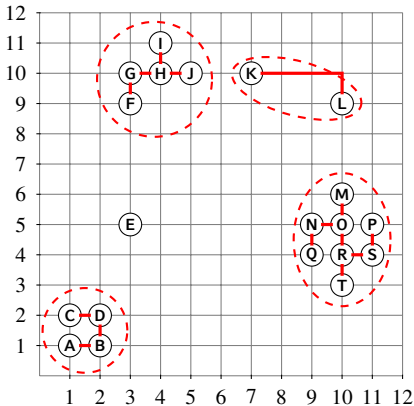
### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich





## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

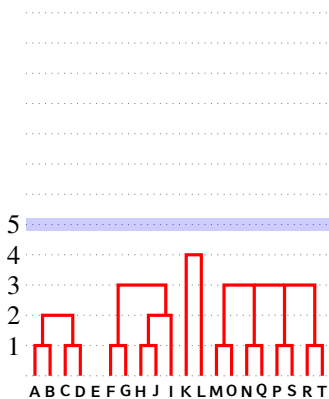
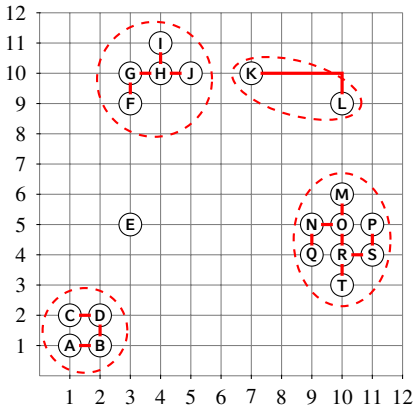
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich





### Aufgabe 4-1

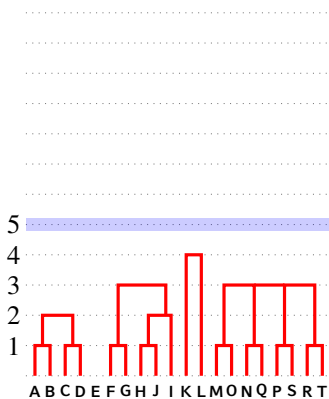
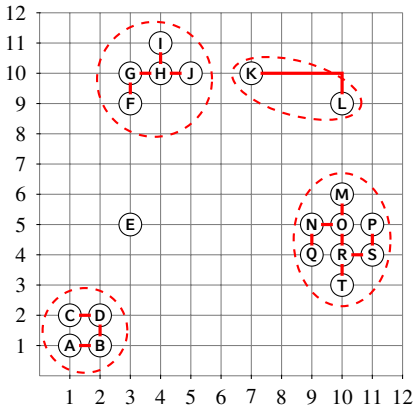
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

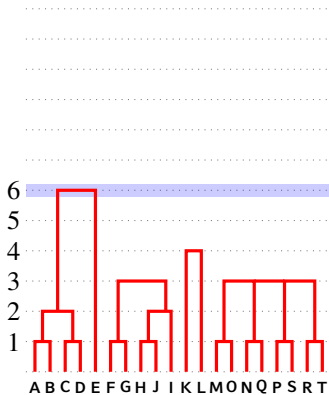
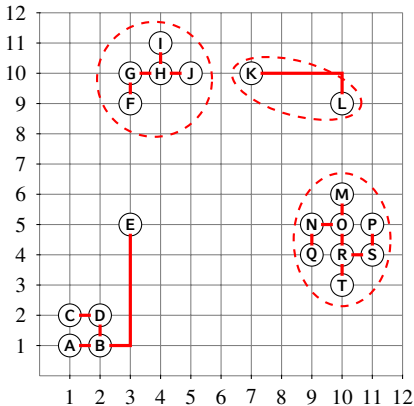
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
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## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

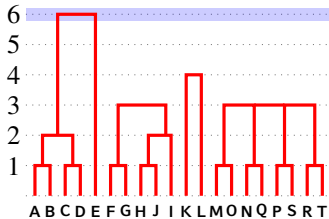
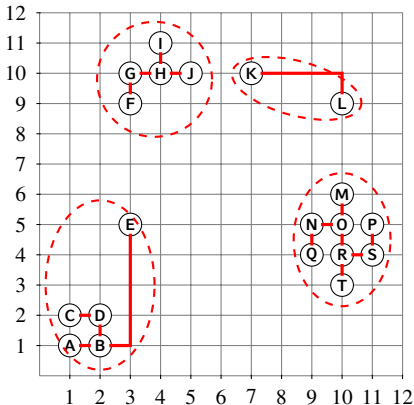
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

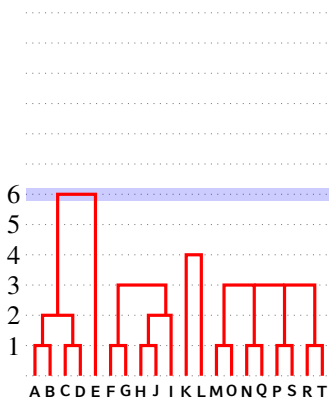
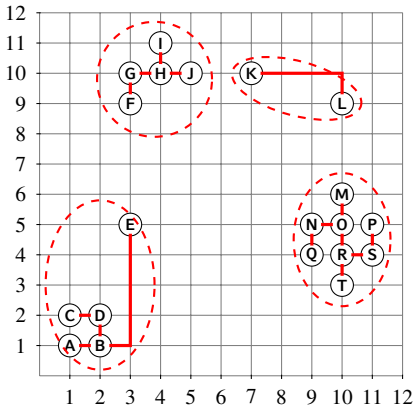
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

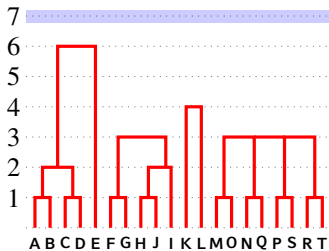
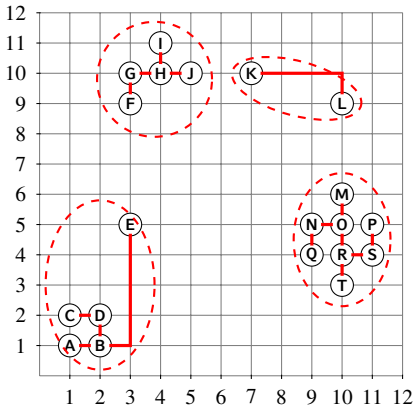
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### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

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minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

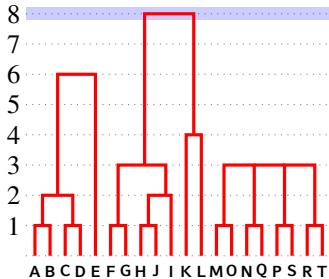
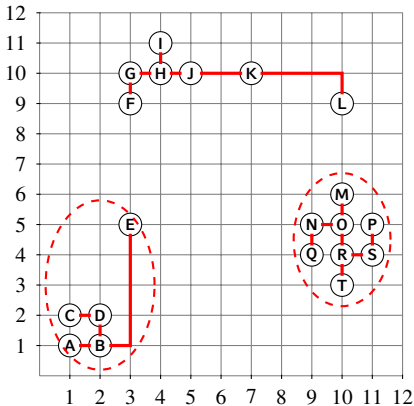
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

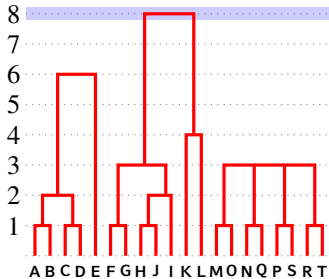
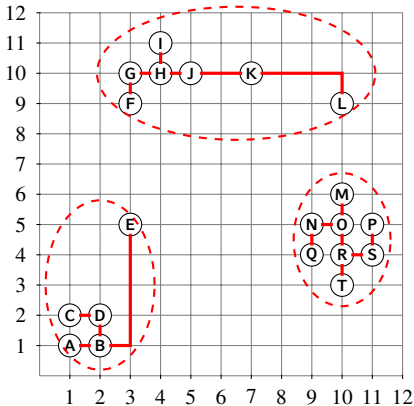
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

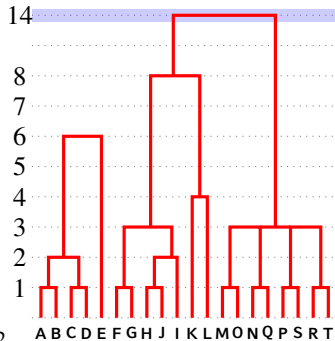
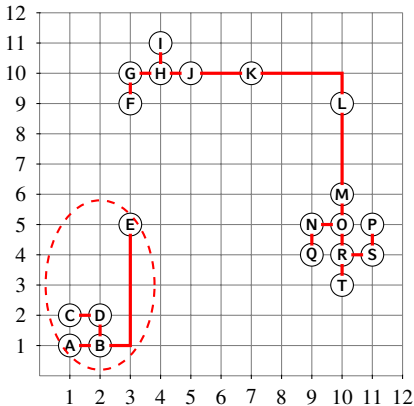
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich





## Complete-Link Clustering

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Tutorial

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### Aufgabe 4-1

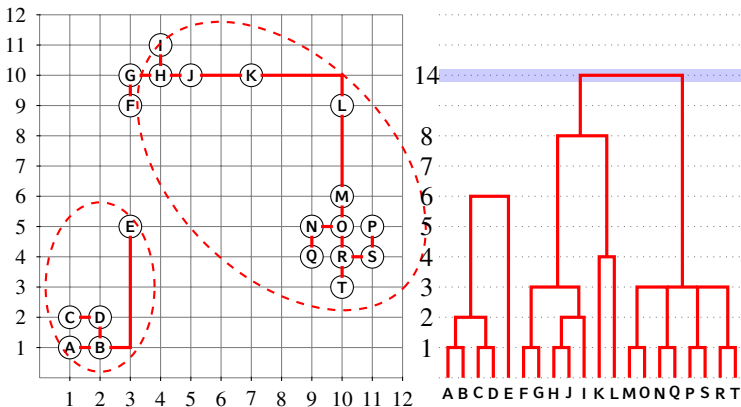
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Complete-Link Clustering

Data Mining  
Tutorial

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### Aufgabe 4-1

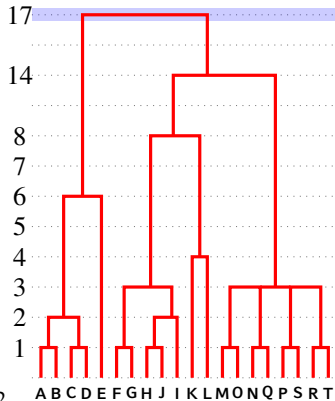
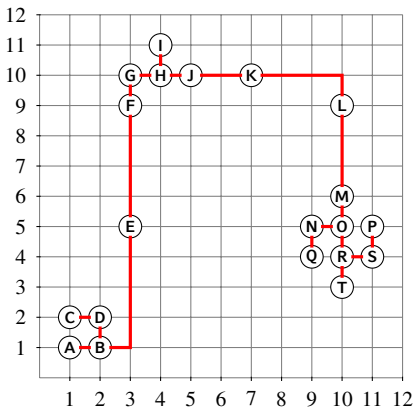
single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich



## Aufgabe 4-1

single-link  
average-link  
complete-link

## Aufgabe 4-2

DBSCAN und  
Single-Link

## Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$   
 $\epsilon = 5$ ,  
 $\text{minPts} = 4$   
 $\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich

DBSCAN mit  $\text{minPts} = 2 \Leftrightarrow$

*Schnitt* durch das single-linkage dendrogram auf Höhe  $\epsilon$ .

## Aufgabe 4-1

single-link  
average-link  
complete-link

## Aufgabe 4-2

DBSCAN und  
Single-Link

## Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich

DBSCAN mit  $\text{minPts} = 2 \Leftrightarrow$

*Schnitt* durch das single-linkage dendrogram auf Höhe  $\epsilon$ .

DBSCAN ist  $\mathcal{O}(n^2)$  (mit Index auch nur:  $\mathcal{O}(n \log n)$ )

## Aufgabe 4-1

single-link  
average-link  
complete-link

## Aufgabe 4-2

DBSCAN und  
Single-Link

## Aufgabe 4-3

 $\epsilon = 5$ ,  
 $\text{minPts} = 2$  $\epsilon = 5$ ,  
 $\text{minPts} = 4$  $\epsilon = 2$ ,  
 $\text{minPts} = 4$ 

Vergleich

DBSCAN mit  $\text{minPts} = 2 \Leftrightarrow$ *Schnitt* durch das single-linkage dendrogram auf Höhe  $\epsilon$ .DBSCAN ist  $\mathcal{O}(n^2)$  (mit Index auch nur:  $\mathcal{O}(n \log n)$ )  
aber nur für *ein einziges*  $\epsilon$ .

DBSCAN mit  $\text{minPts} = 2 \Leftrightarrow$

*Schnitt* durch das single-linkage dendrogram auf Höhe  $\epsilon$ .

DBSCAN ist  $\mathcal{O}(n^2)$  (mit Index auch nur:  $\mathcal{O}(n \log n)$ )  
aber nur für *ein einziges*  $\epsilon$ .

OPTICS mit  $\text{minPts} = 2$  entspricht etwa SLINK  
(Effizienter Algorithmus für single-linkage in  $\mathcal{O}(n^2)$ )

DBSCAN mit  $\text{minPts} = 2 \Leftrightarrow$

*Schnitt* durch das single-linkage dendrogram auf Höhe  $\epsilon$ .

DBSCAN ist  $\mathcal{O}(n^2)$  (mit Index auch nur:  $\mathcal{O}(n \log n)$ )  
aber nur für *ein einziges*  $\epsilon$ .

OPTICS mit  $\text{minPts} = 2$  entspricht etwa SLINK  
(Effizienter Algorithmus für single-linkage in  $\mathcal{O}(n^2)$ )

Aber mit einem größeren  $\text{minPts}$  werden die Ergebnisse  
i.d.R. besser (statt single-link-effekt: Dichte-verbunden)!

### Aufgabe 4-1

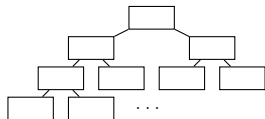
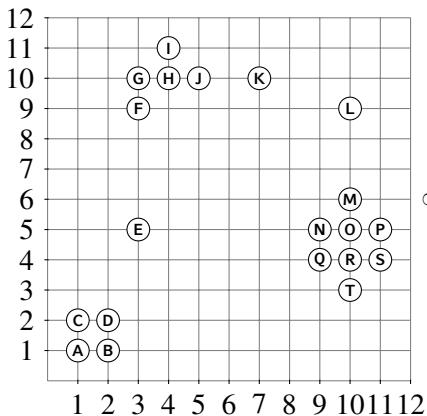
single-link  
average-link  
complete-link

### Aufgabe 4-2

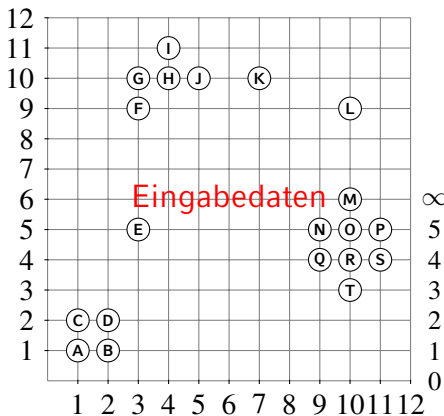
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2  
 $\epsilon = 5$ ,  
minPts = 4  
 $\epsilon = 2$ ,  
minPts = 4  
Vergleich







Eingabedaten



Ausgabe (Plot)

Heap: Für die Vorlesung reicht eine Sortierte Liste

### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

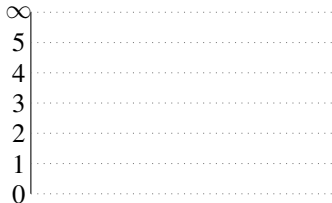
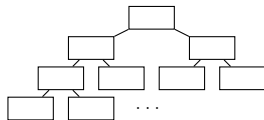
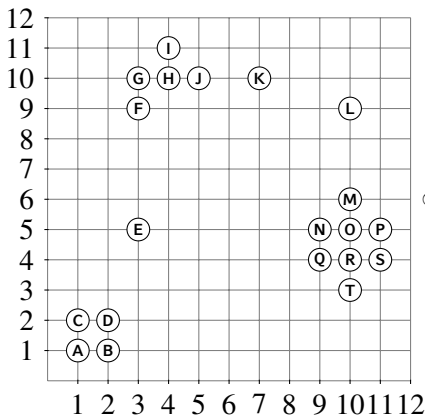
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

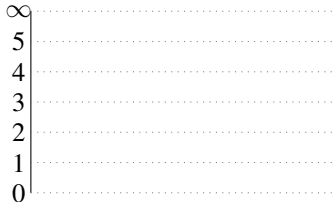
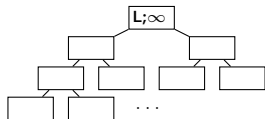
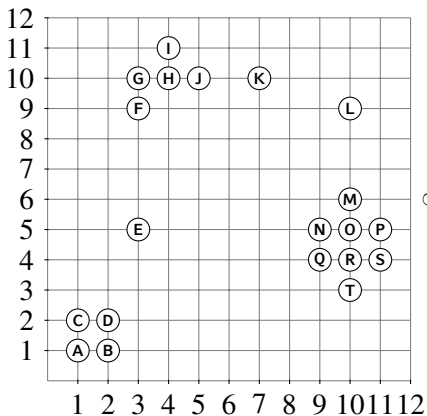
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Vergleich



Aufgabe 4-1

- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und  
Single-Link

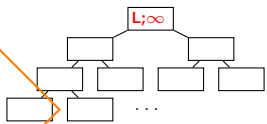
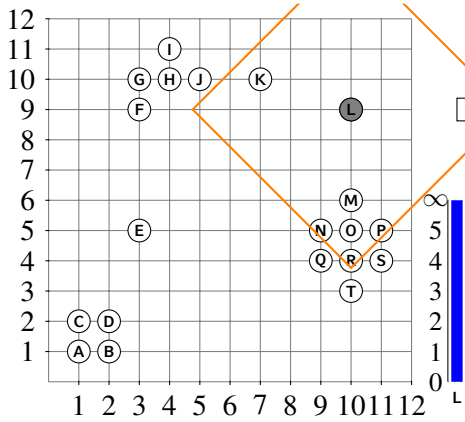
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Vergleich



Aufgabe 4-1

- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und  
Single-Link

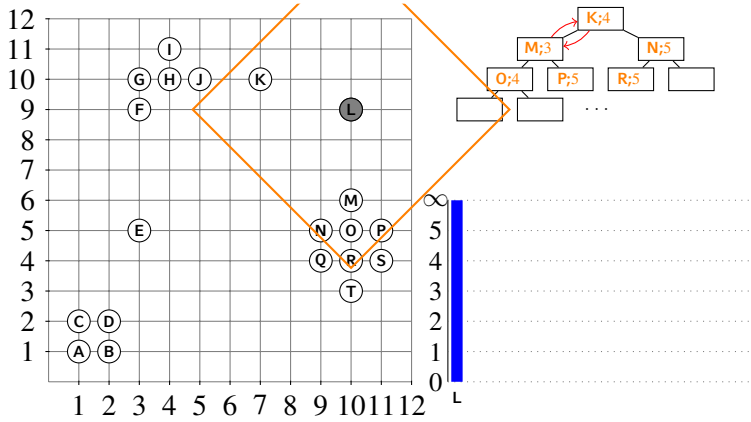
Aufgabe 4-3

$\epsilon = 5$ ,  
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$\epsilon = 2$ ,  
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Vergleich



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single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

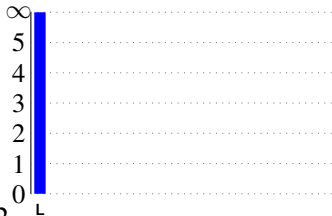
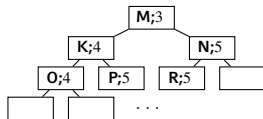
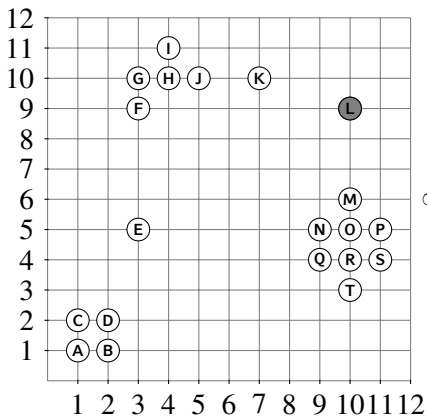
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Vergleich



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average-link  
complete-link

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DBSCAN und  
Single-Link

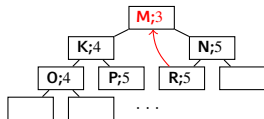
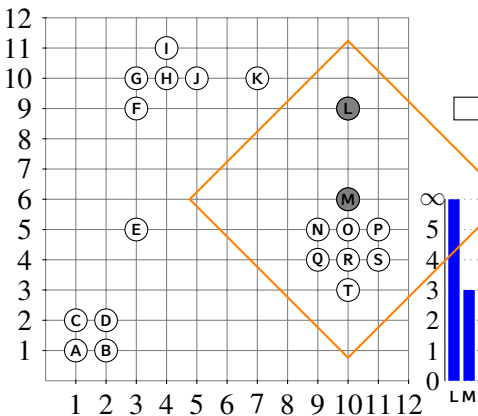
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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

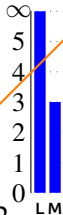
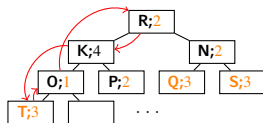
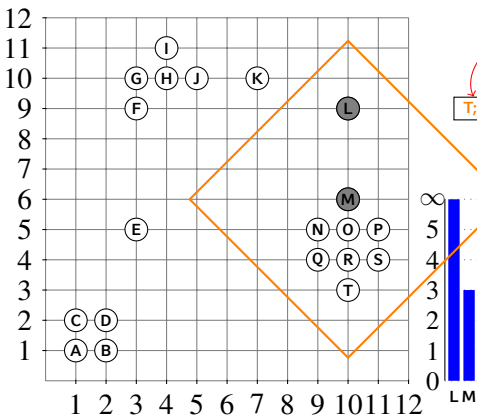
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Vergleich





Aufgabe 4-1

- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und Single-Link

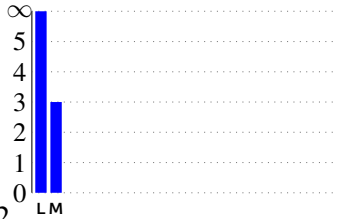
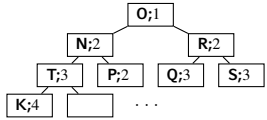
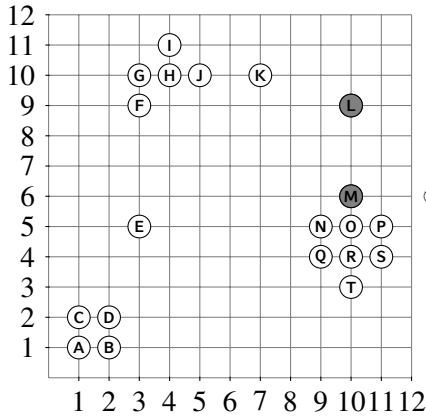
Aufgabe 4-3

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Vergleich



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single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

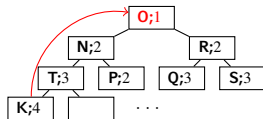
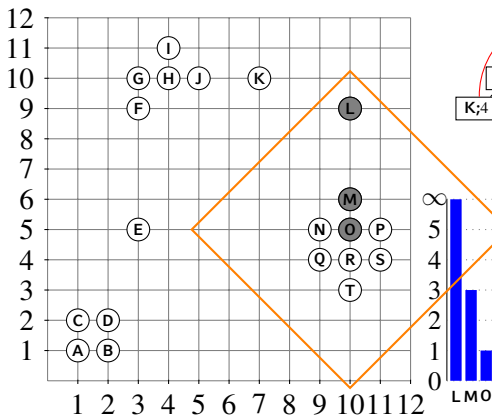
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Vergleich



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single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

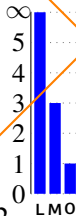
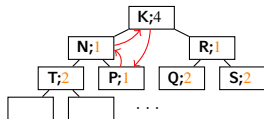
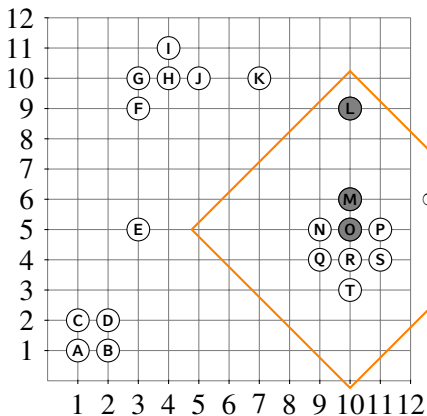
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Vergleich



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single-link  
average-link  
complete-link

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DBSCAN und  
Single-Link

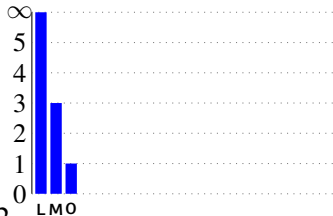
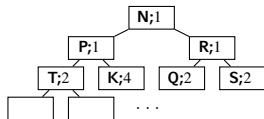
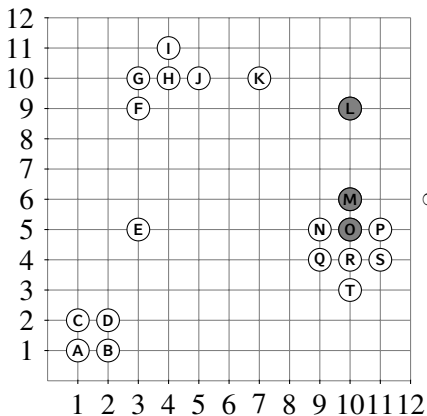
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Vergleich



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- average-link
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Aufgabe 4-2

DBSCAN und  
Single-Link

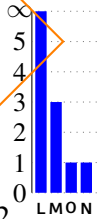
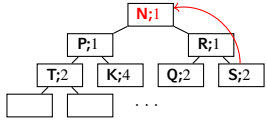
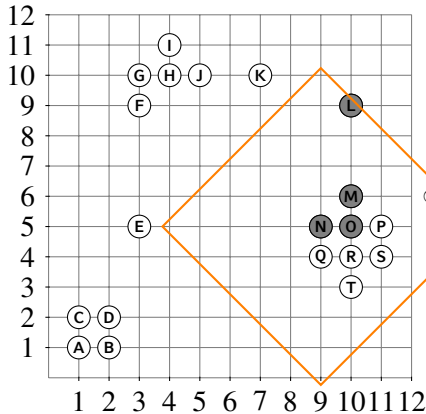
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Vergleich



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single-link  
average-link  
complete-link

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DBSCAN und  
Single-Link

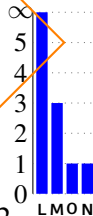
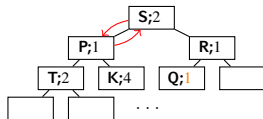
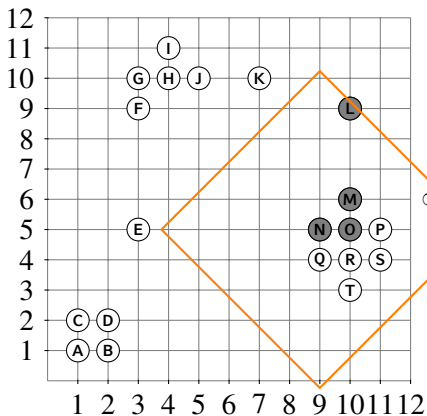
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Vergleich



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DBSCAN und  
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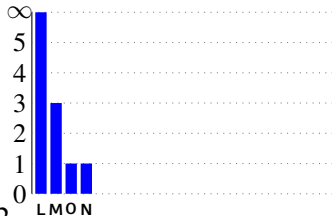
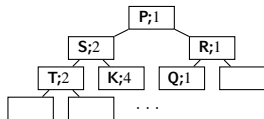
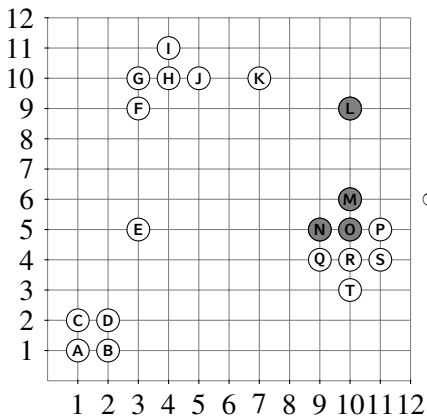
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Vergleich



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DBSCAN und  
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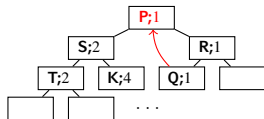
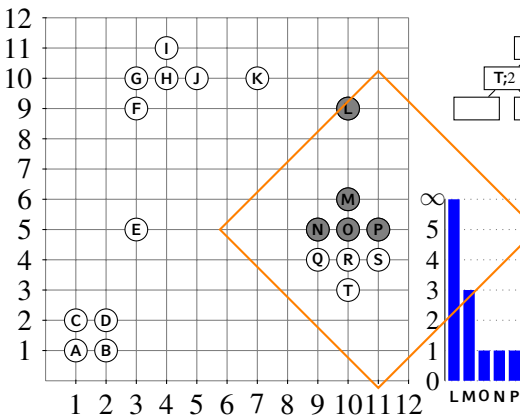
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Vergleich





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DBSCAN und  
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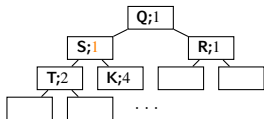
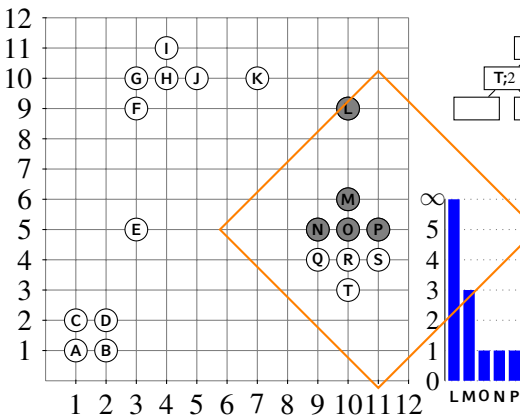
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Vergleich



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DBSCAN und  
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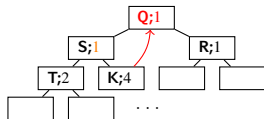
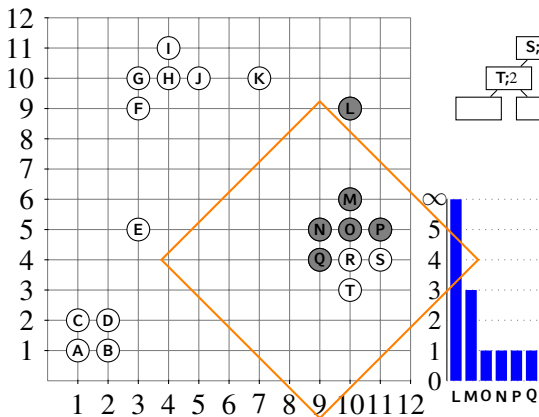
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Vergleich



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DBSCAN und  
Single-Link

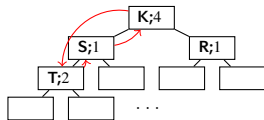
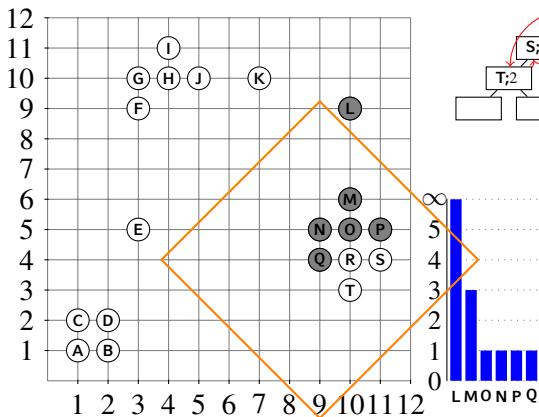
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Vergleich



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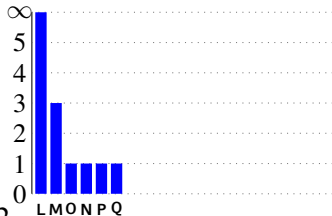
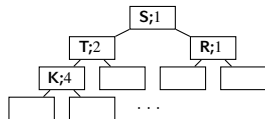
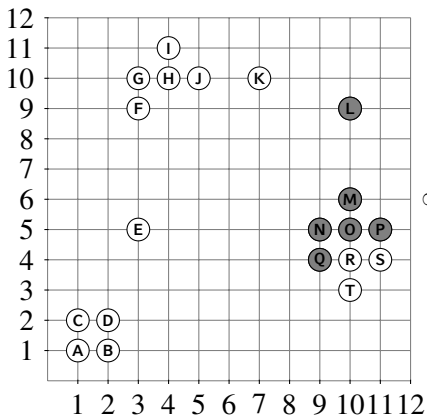
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Vergleich



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DBSCAN und  
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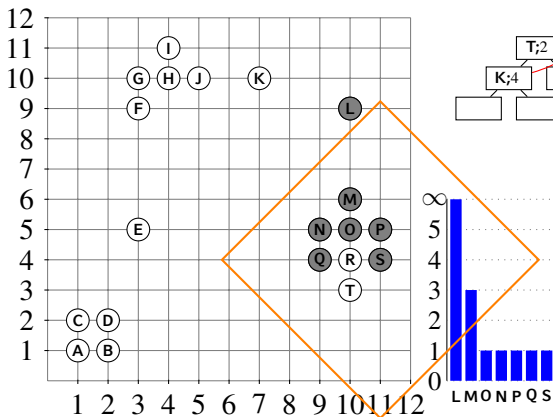
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Vergleich



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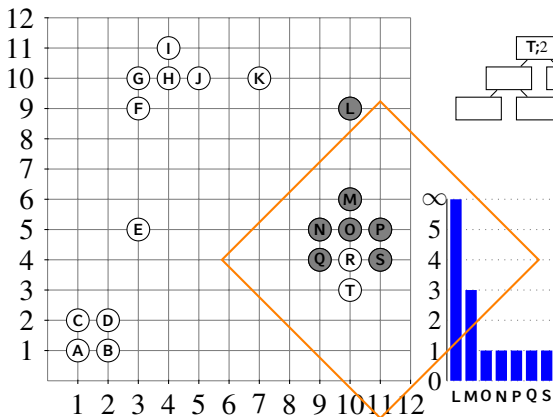
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Vergleich



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DBSCAN und  
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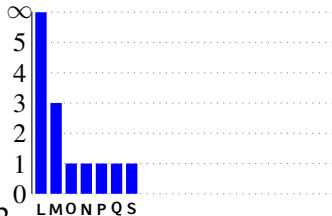
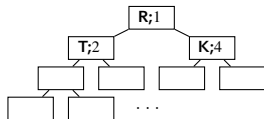
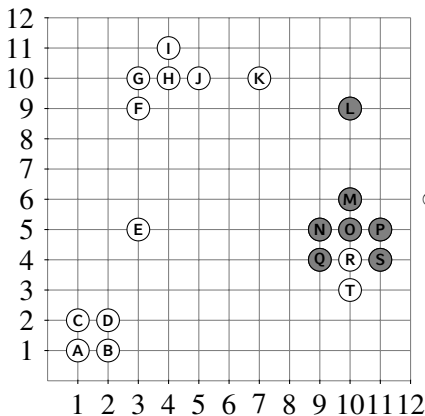
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Vergleich



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- single-link
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- complete-link

### Aufgabe 4-2

- DBSCAN und
- Single-Link

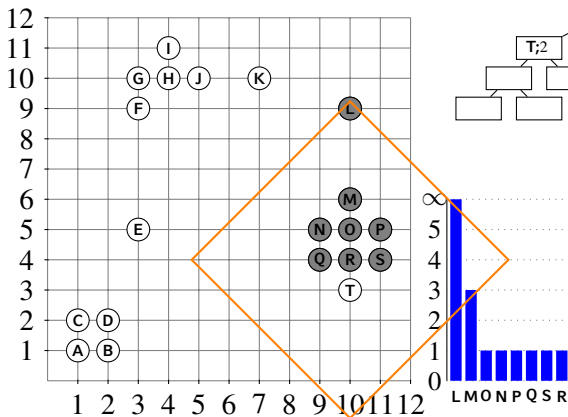
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Vergleich





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single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

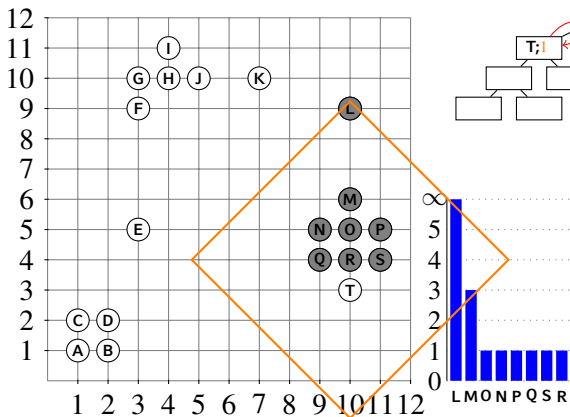
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Vergleich



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DBSCAN und  
Single-Link

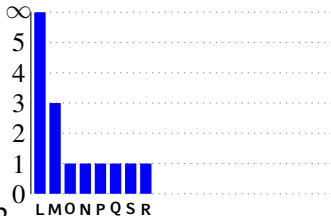
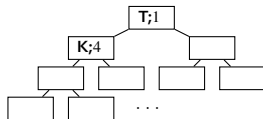
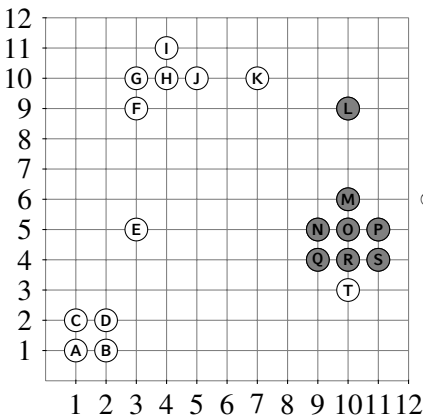
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Vergleich



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single-link  
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### Aufgabe 4-2

DBSCAN und  
Single-Link

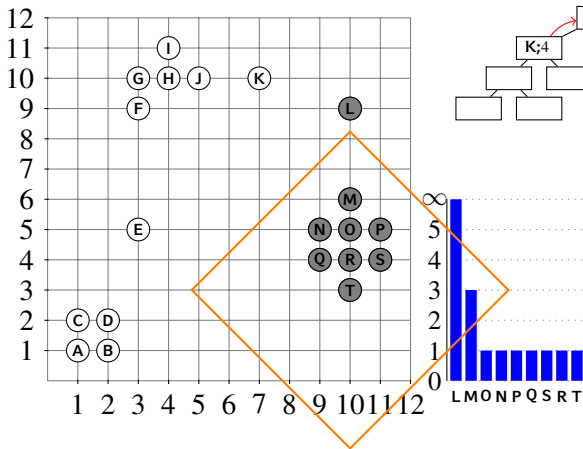
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

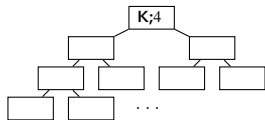
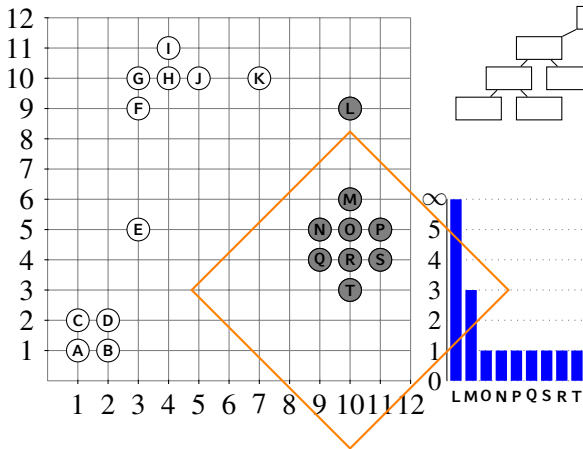
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

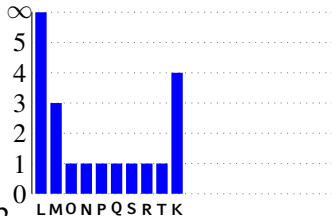
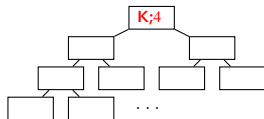
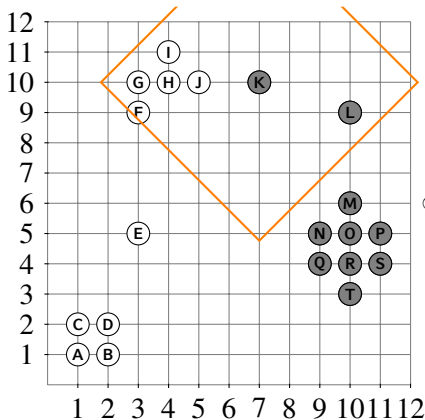
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

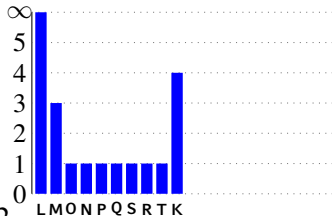
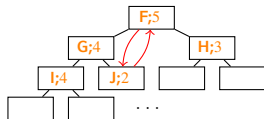
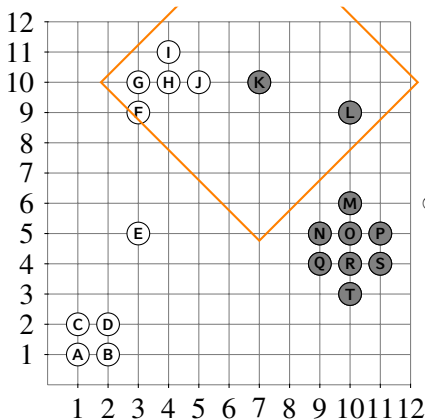
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

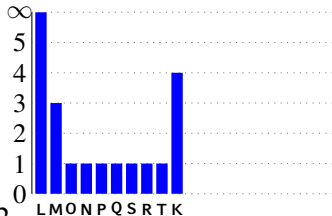
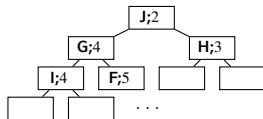
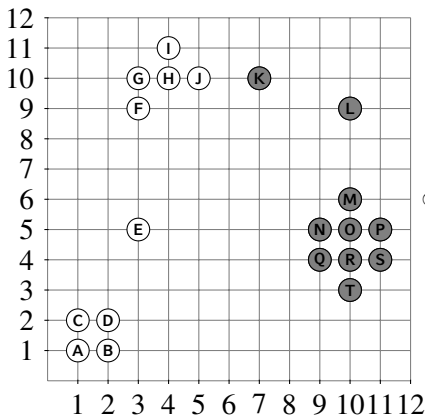
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

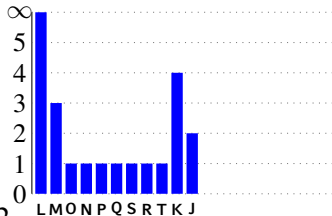
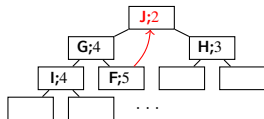
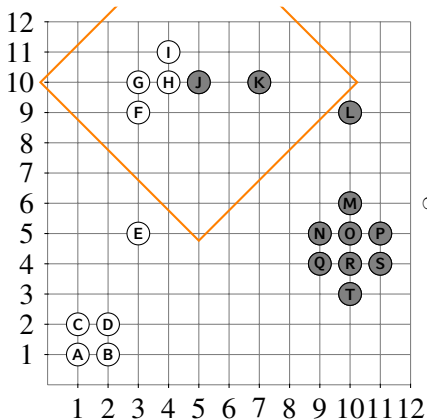
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

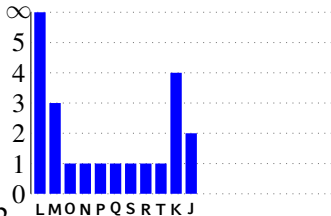
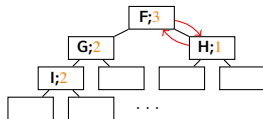
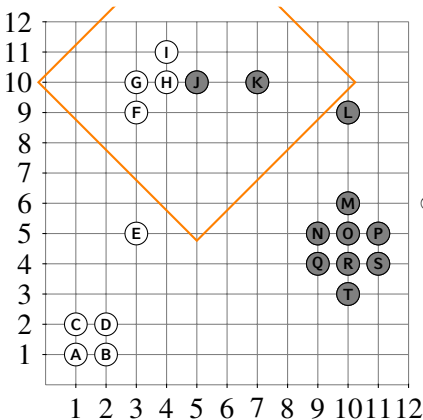
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



Aufgabe 4-1

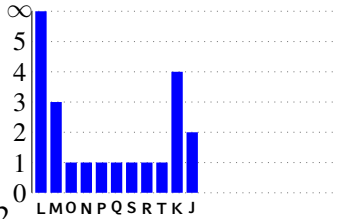
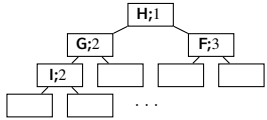
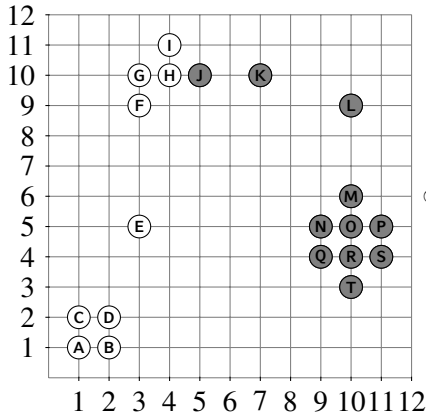
- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und  
Single-Link

Aufgabe 4-3

- $\epsilon = 5$ ,  
 $\text{minPts} = 2$
- $\epsilon = 5$ ,  
 $\text{minPts} = 4$
- $\epsilon = 2$ ,  
 $\text{minPts} = 4$
- Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

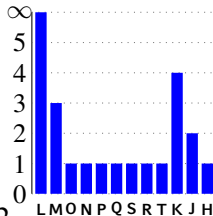
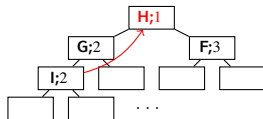
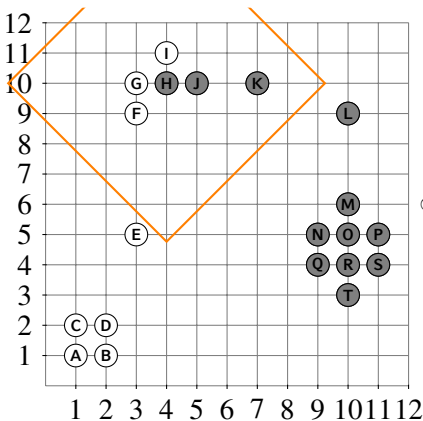
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

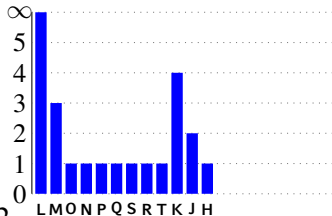
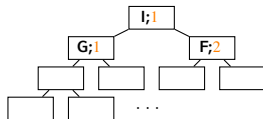
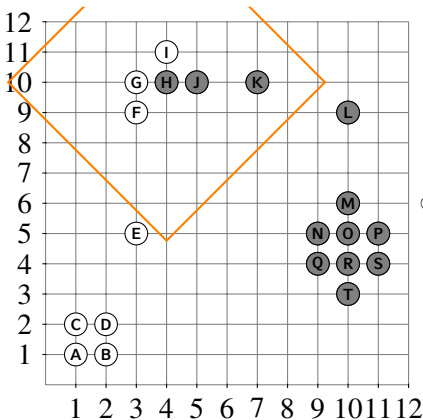
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

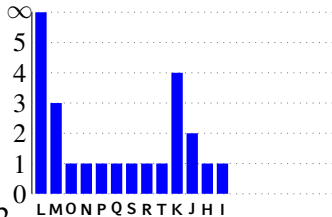
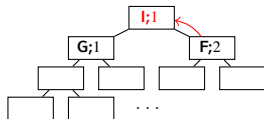
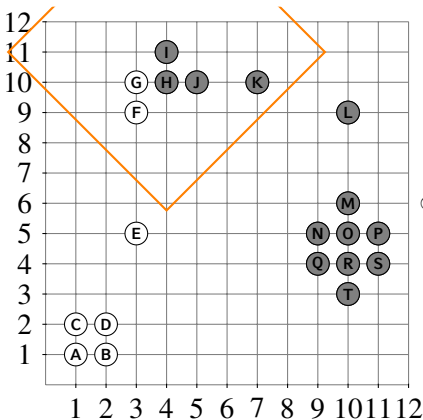
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

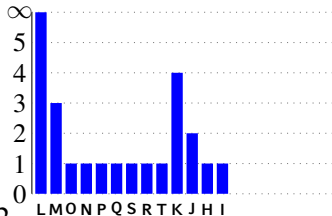
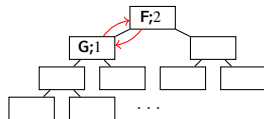
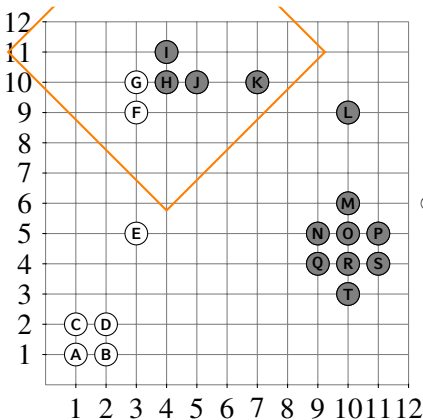
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

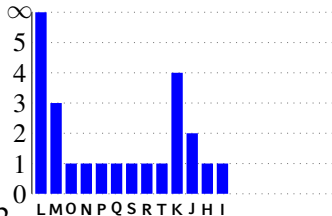
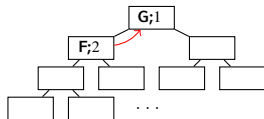
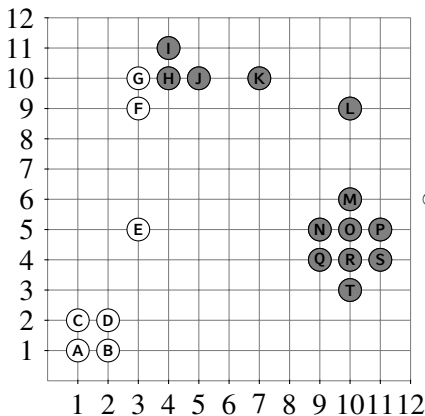
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



Aufgabe 4-1

- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und
- Single-Link

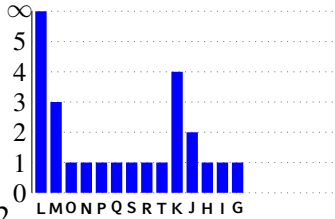
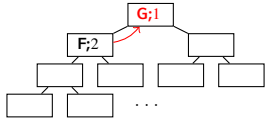
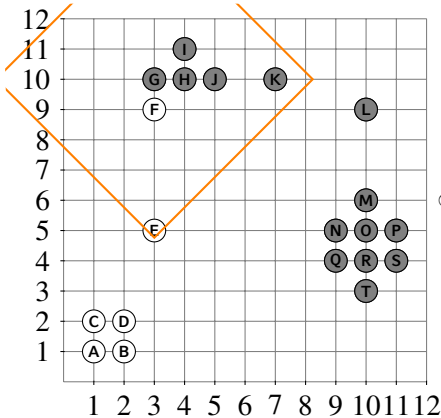
Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





Aufgabe 4-1

- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und  
Single-Link

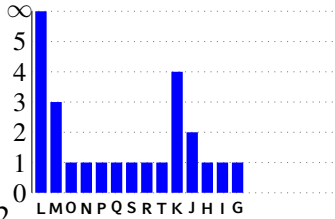
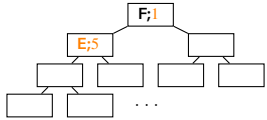
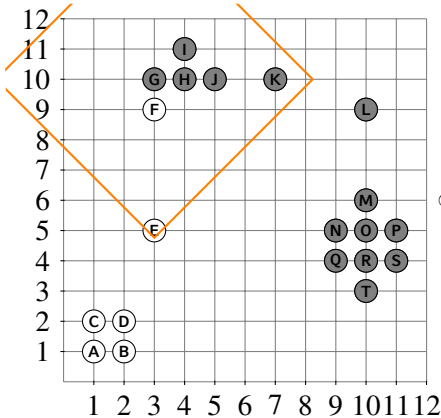
Aufgabe 4-3

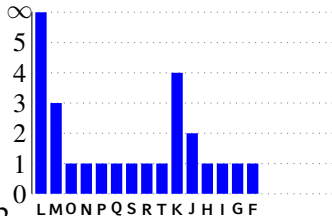
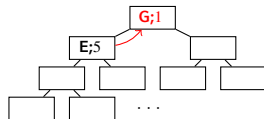
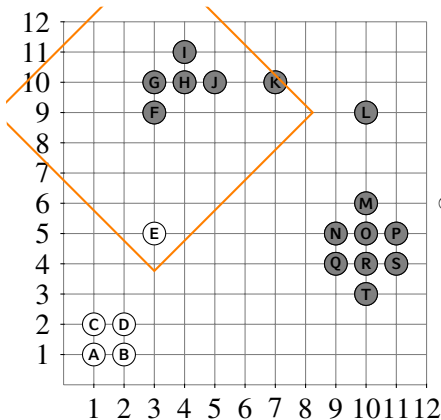
$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

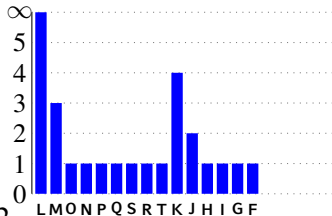
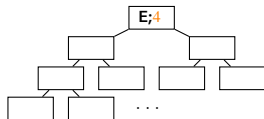
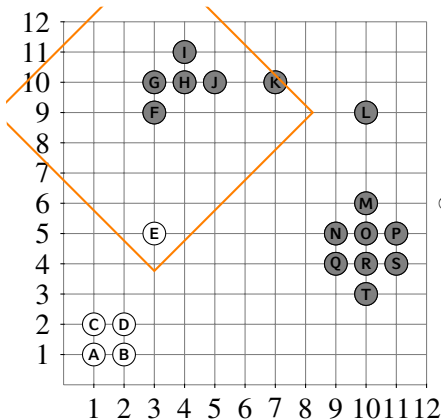
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

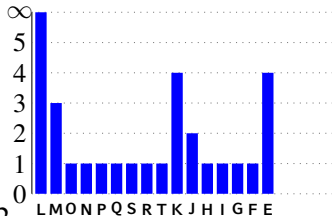
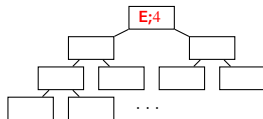
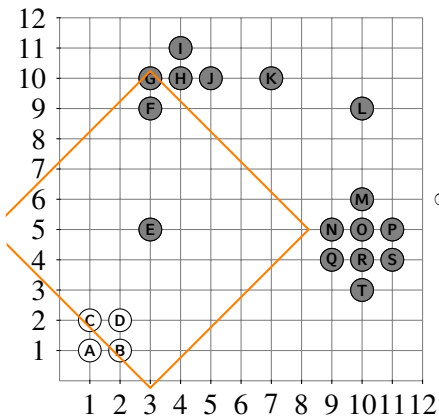
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

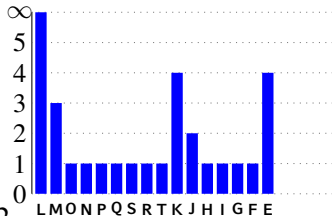
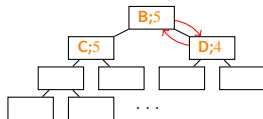
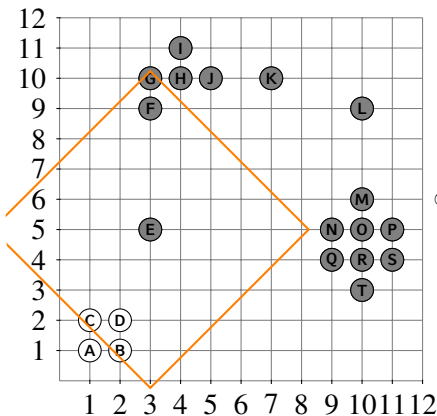
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

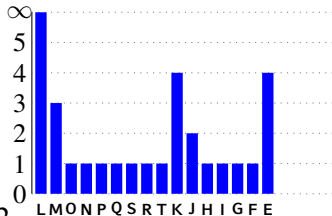
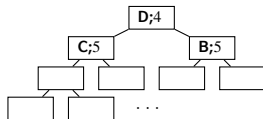
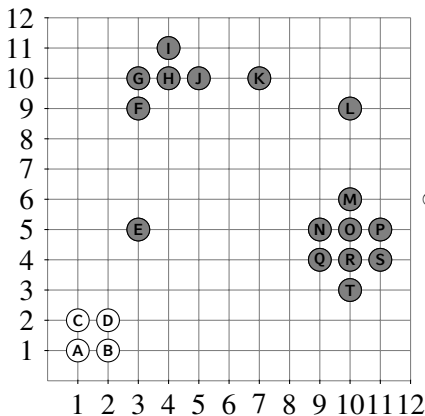
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

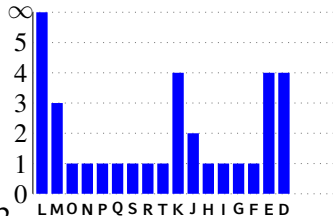
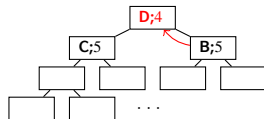
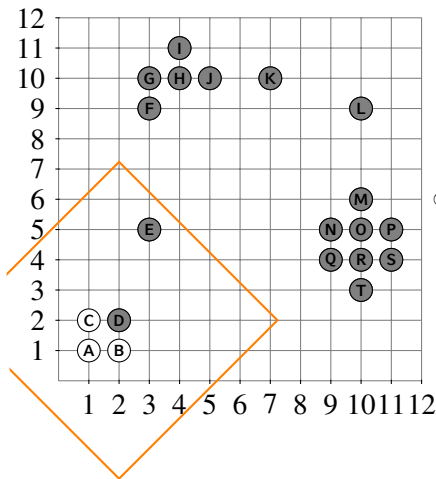
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

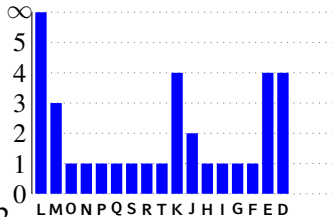
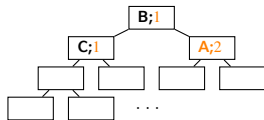
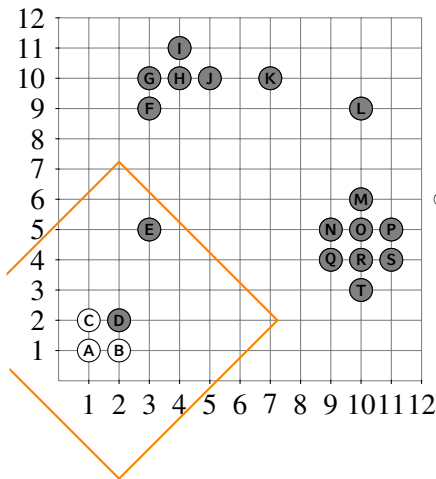
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

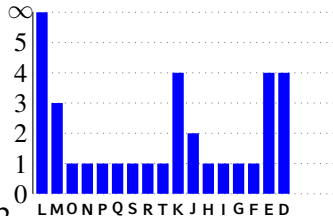
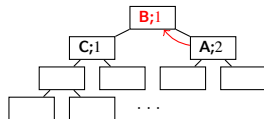
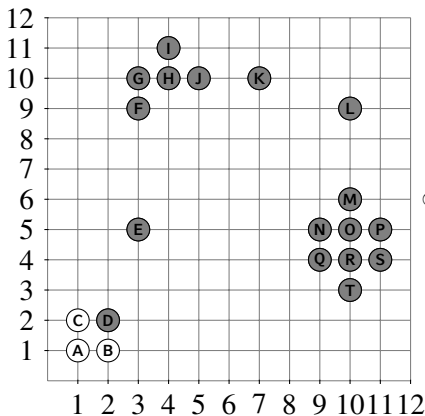
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

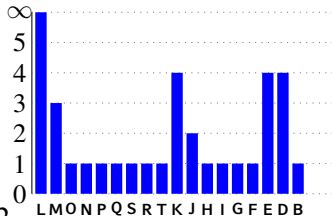
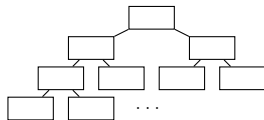
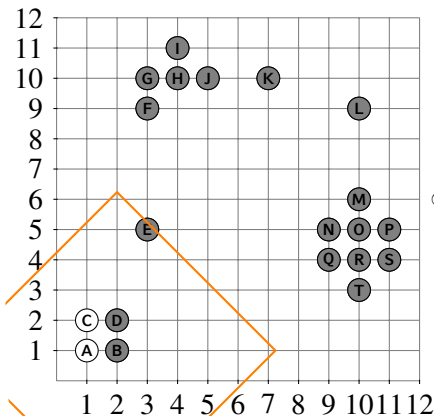
### Aufgabe 4-3

$\epsilon = 5$ ,  
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 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

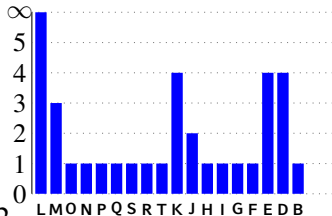
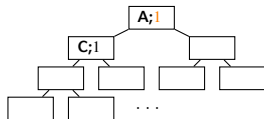
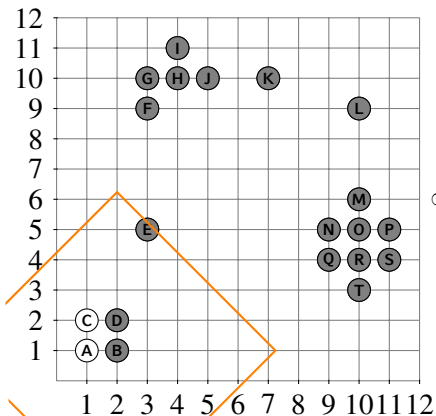
### Aufgabe 4-3

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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

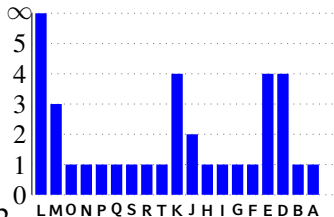
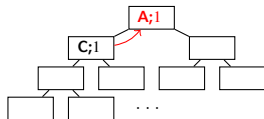
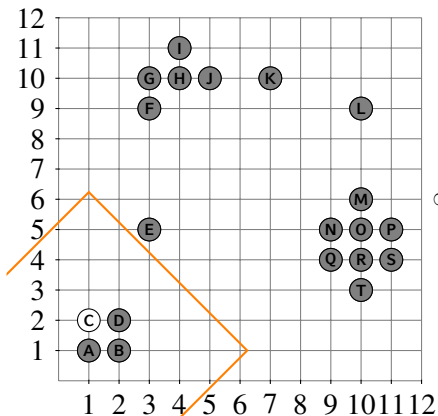
### Aufgabe 4-3

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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

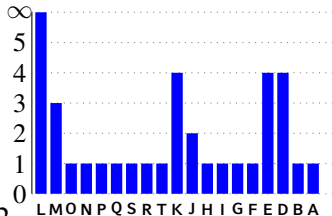
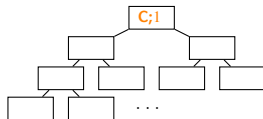
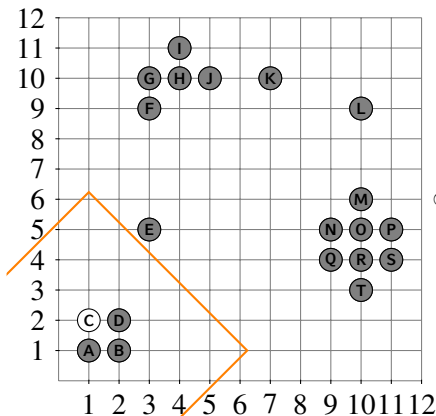
### Aufgabe 4-3

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 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

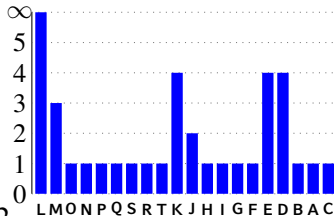
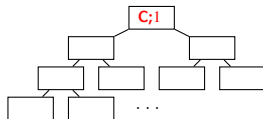
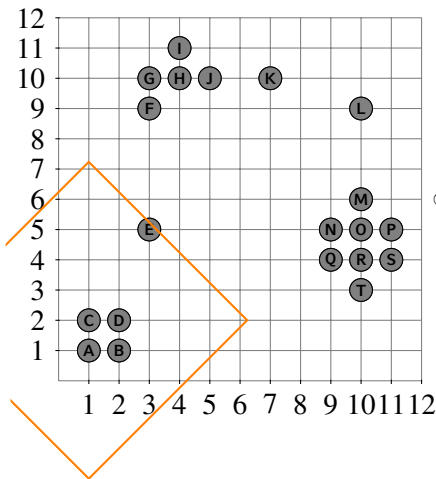
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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

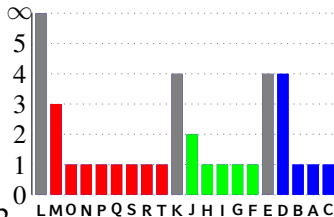
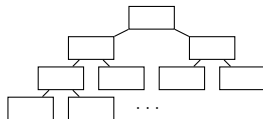
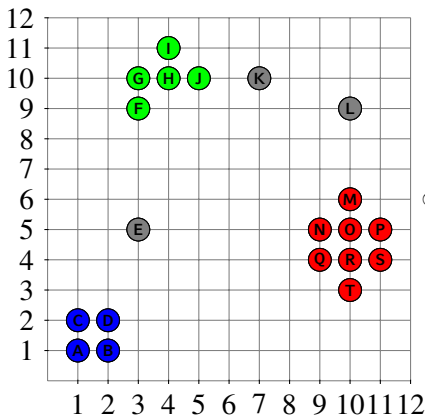
### Aufgabe 4-3

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 $\text{minPts} = 2$

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 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



(Intuitive Cluster  $\approx$  Täler)

### Aufgabe 4-1

- single-link
- average-link
- complete-link

### Aufgabe 4-2

- DBSCAN und  
Single-Link

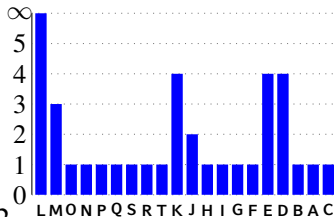
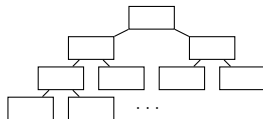
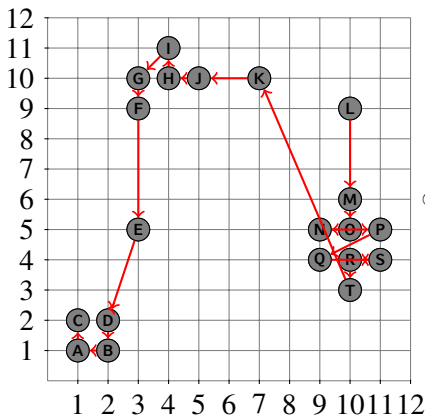
### Aufgabe 4-3

- $\epsilon = 5$ ,
- $\text{minPts} = 2$

- $\epsilon = 5$ ,
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- $\text{minPts} = 4$

Vergleich



(Clusterordnung als Graph: springt!)



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

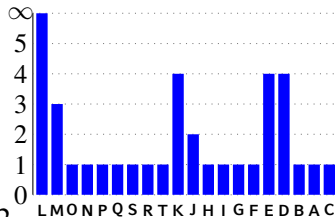
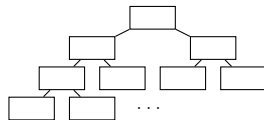
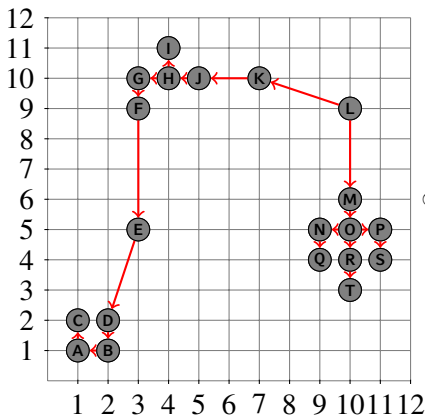
### Aufgabe 4-3

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$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



("Erreicht von" Graph:  $\approx$  Spanning Tree)

### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

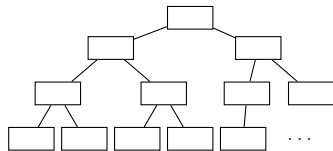
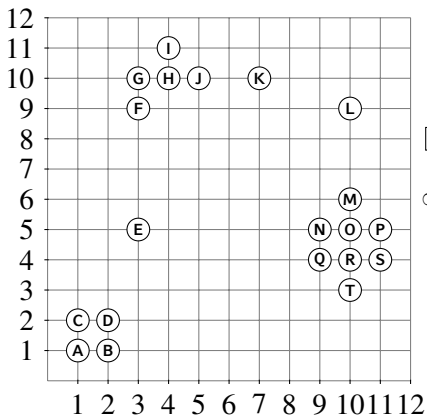
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

- single-link
- average-link
- complete-link

### Aufgabe 4-2

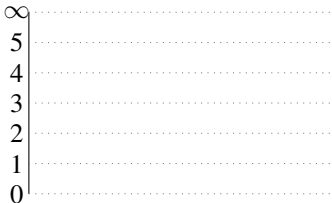
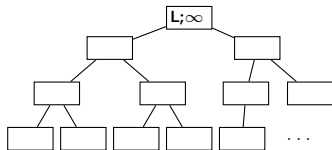
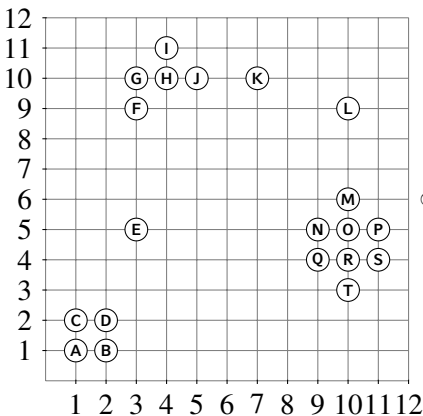
- DBSCAN und  
Single-Link

### Aufgabe 4-3

- $\epsilon = 5$ ,  
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- Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

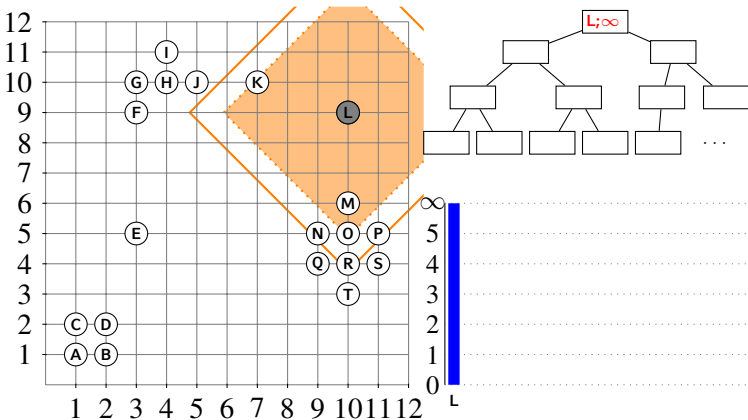
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
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$\epsilon = 5$ ,  
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$\epsilon = 2$ ,  
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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

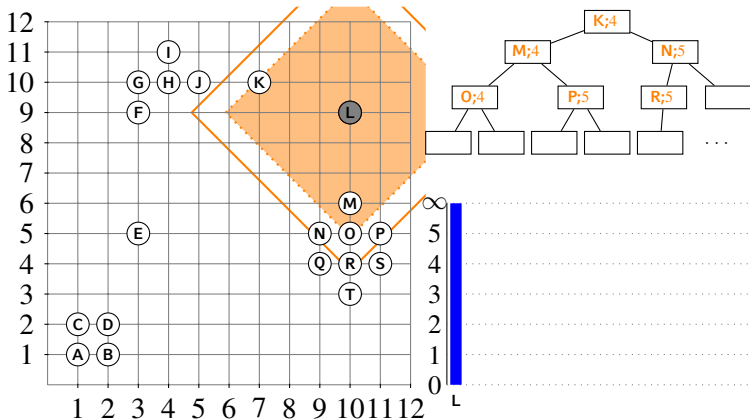
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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

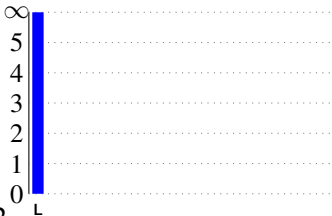
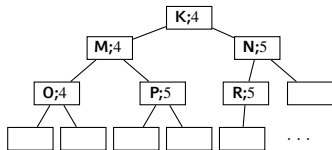
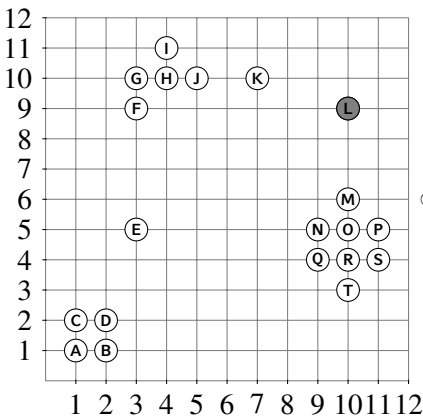
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

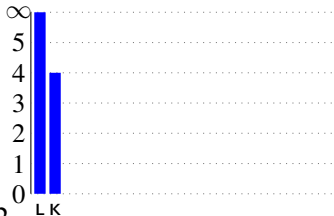
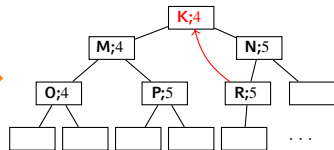
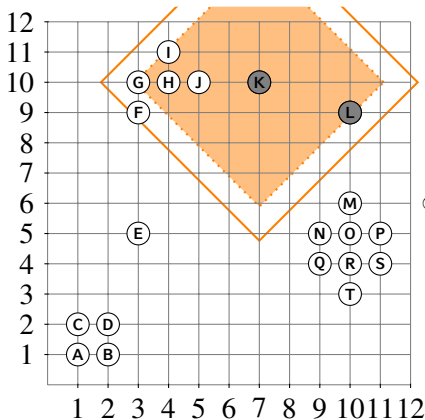
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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

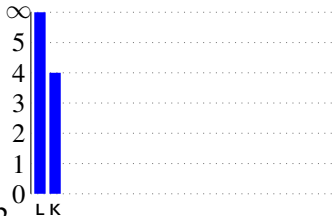
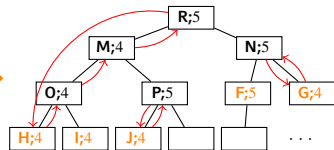
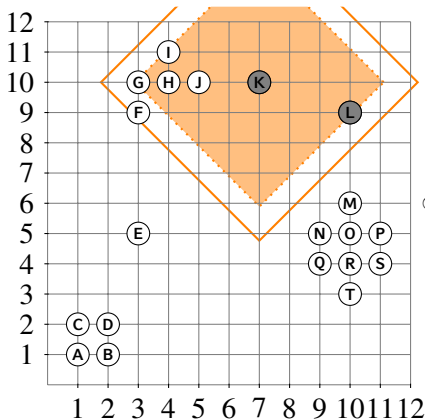
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Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

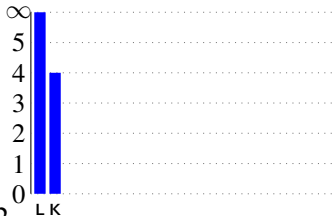
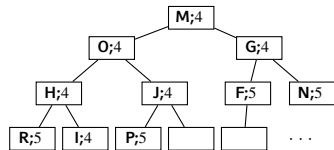
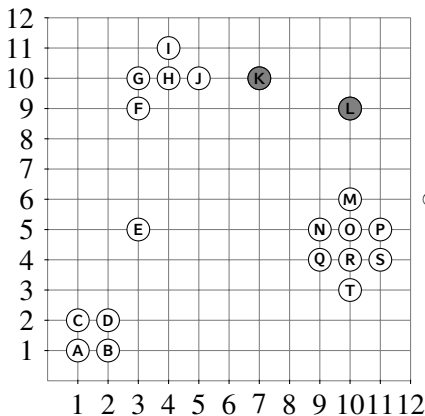
DBSCAN und  
Single-Link

### Aufgabe 4-3

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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

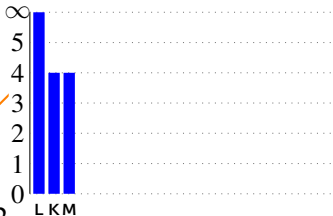
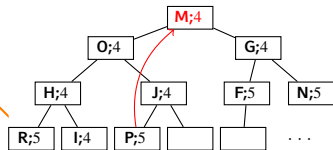
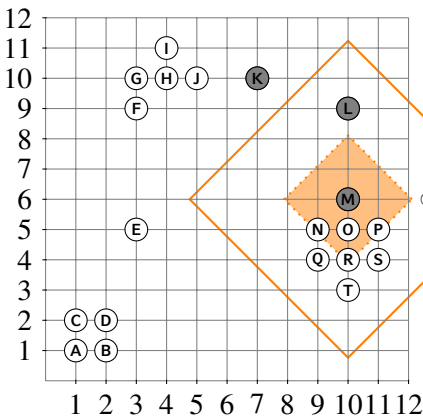
DBSCAN und  
Single-Link

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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

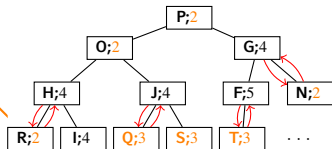
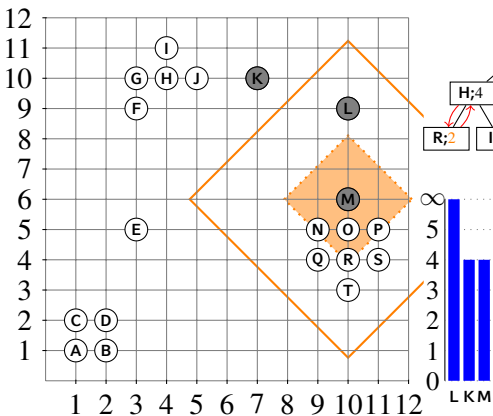
DBSCAN und  
Single-Link

### Aufgabe 4-3

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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

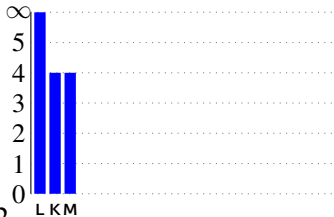
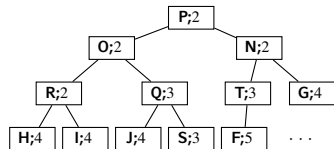
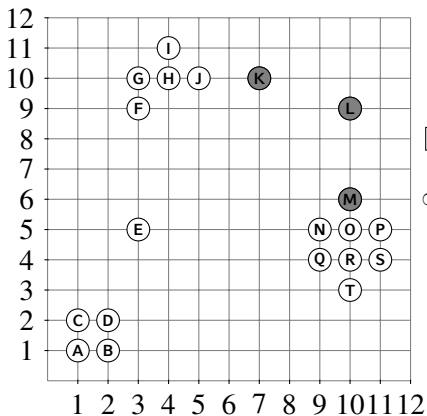
DBSCAN und  
Single-Link

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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

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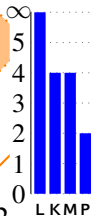
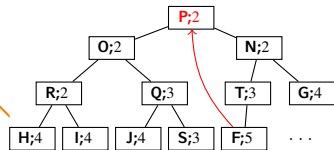
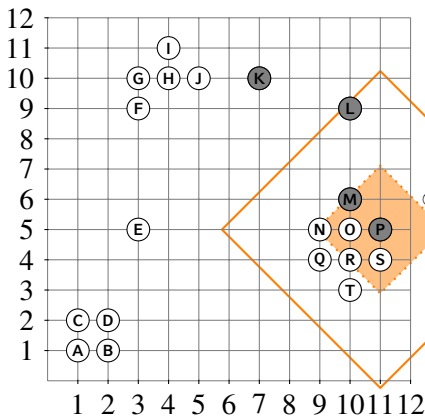
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
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$\epsilon = 5$ ,  
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$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

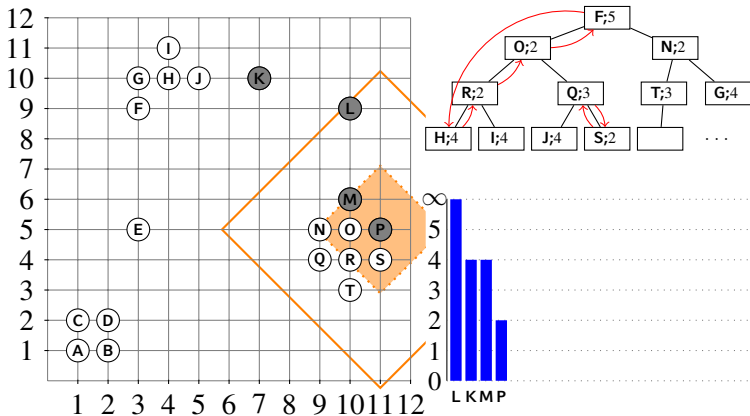
DBSCAN und  
Single-Link

### Aufgabe 4-3

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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

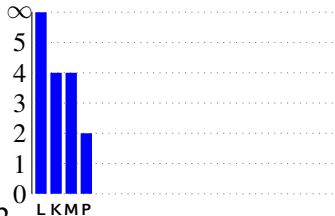
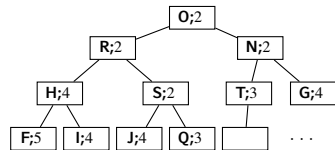
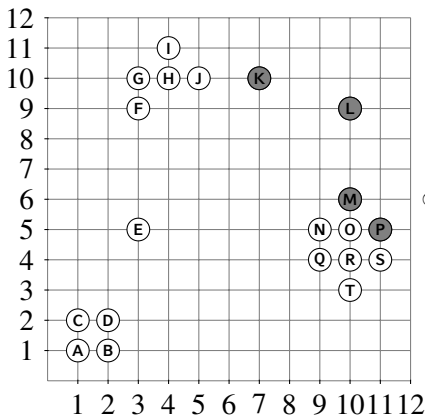
DBSCAN und  
Single-Link

### Aufgabe 4-3

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Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

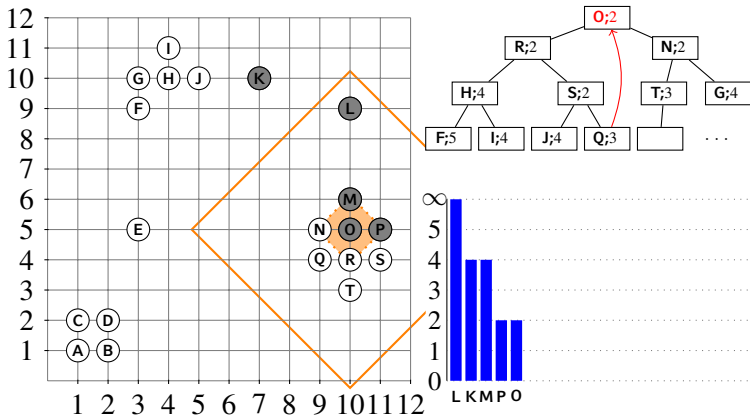
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

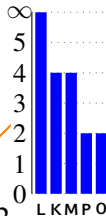
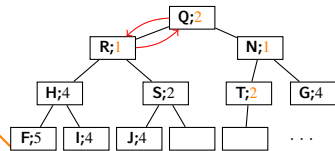
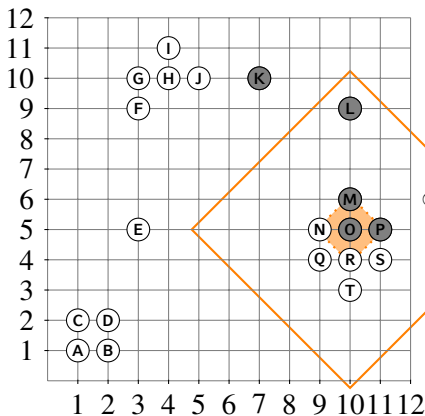
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

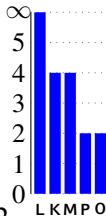
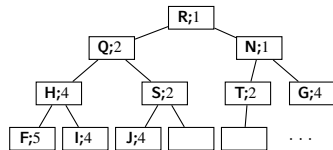
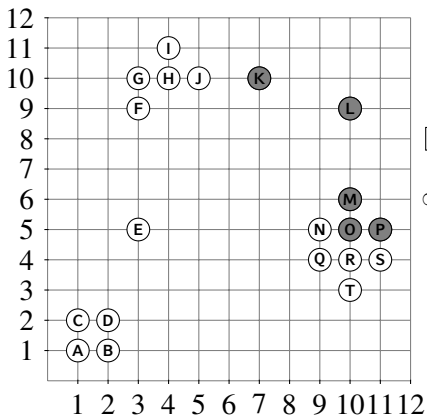
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

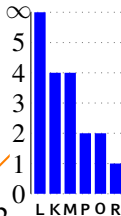
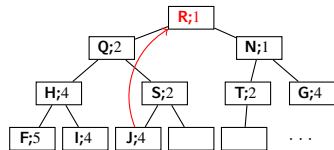
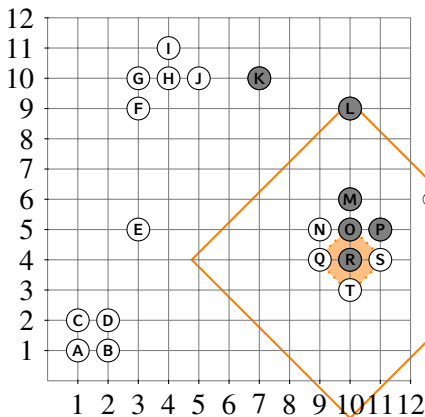
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

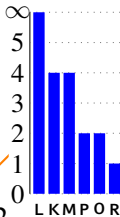
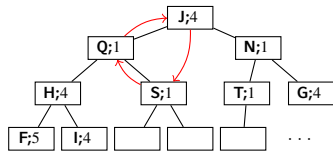
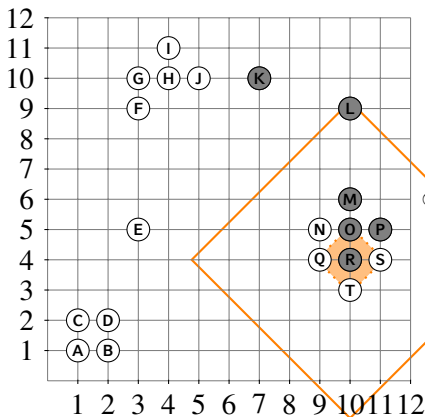
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

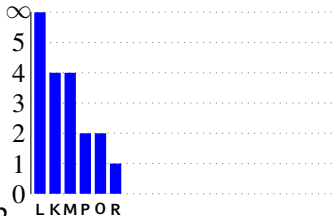
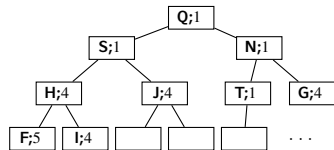
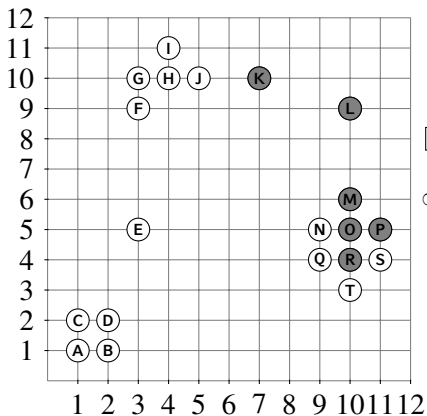
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

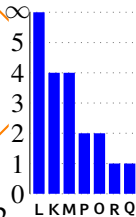
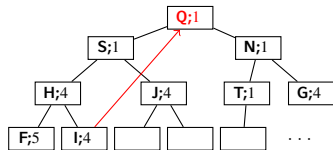
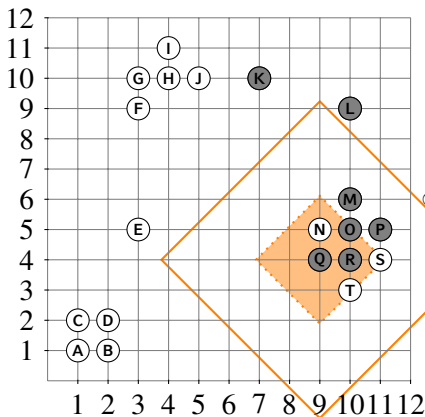
DBSCAN and  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

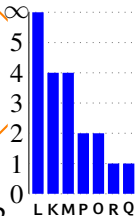
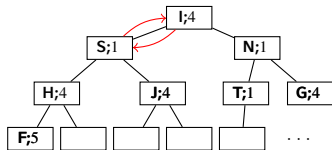
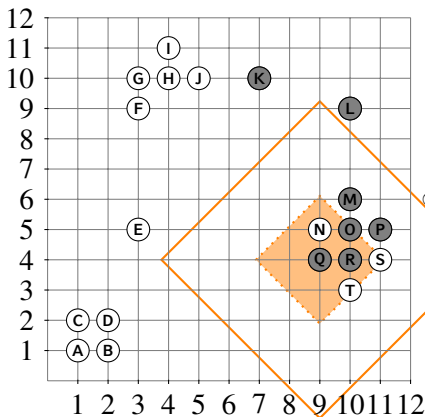
DBSCAN and  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

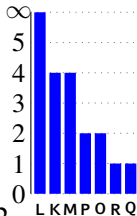
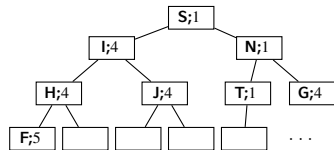
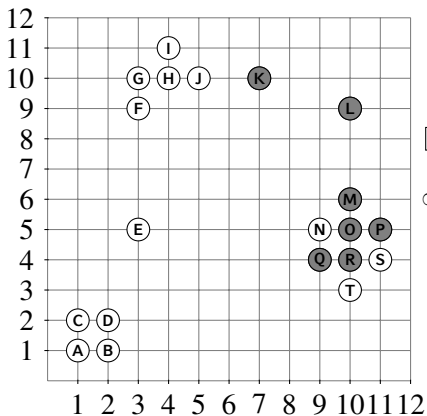
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich





### Aufgabe 4-1

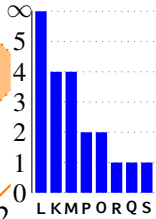
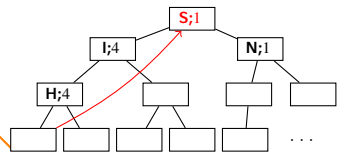
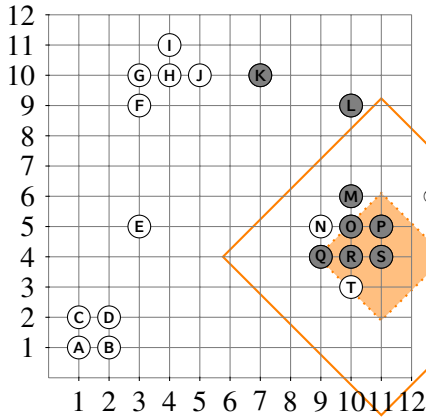
- single-link
- average-link
- complete-link

### Aufgabe 4-2

- DBSCAN und  
Single-Link

### Aufgabe 4-3

- $\epsilon = 5$ ,  
minPts = 2
- $\epsilon = 5$ ,  
minPts = 4
- $\epsilon = 2$ ,  
minPts = 4
- Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

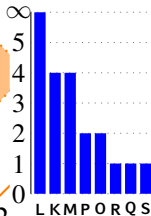
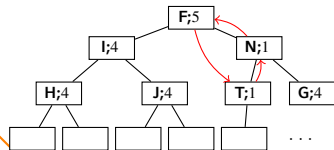
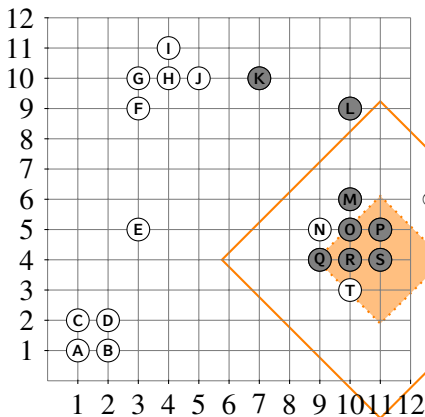
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

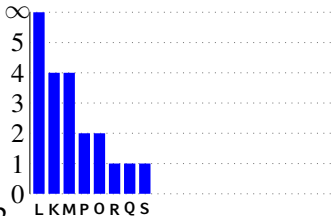
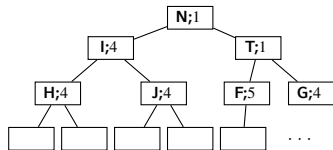
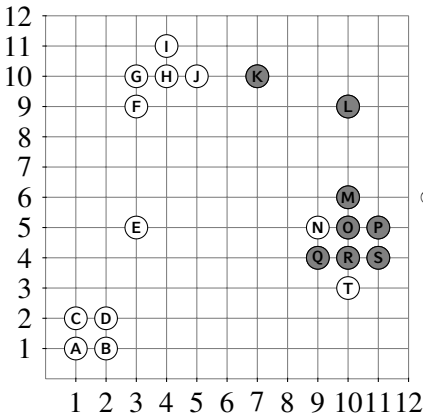
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

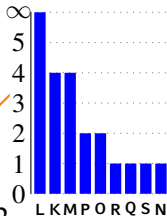
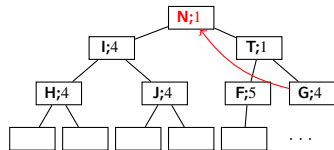
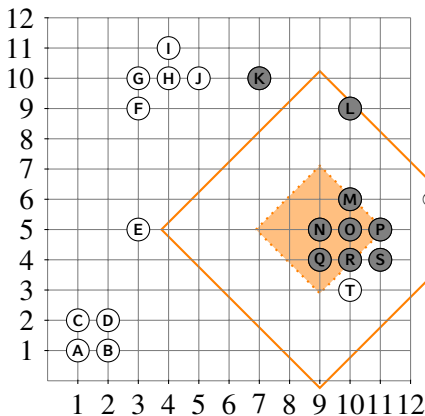
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



Aufgabe 4-1

single-link  
average-link  
complete-link

Aufgabe 4-2

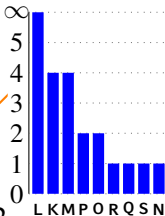
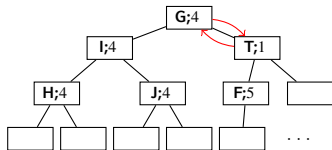
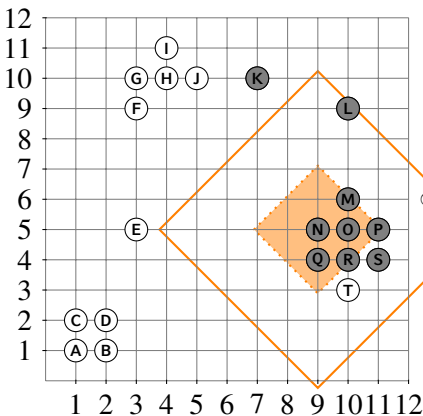
DBSCAN und  
Single-Link

Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

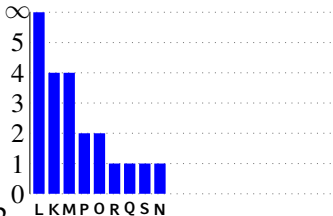
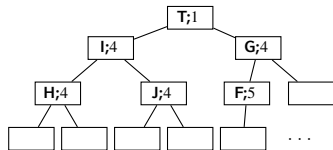
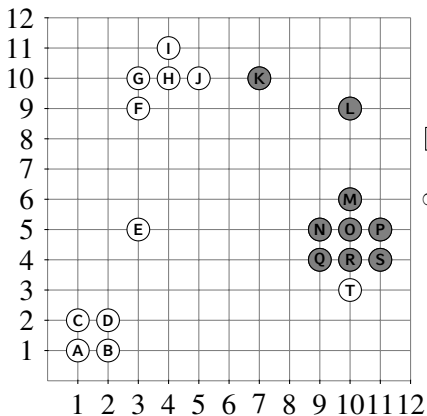
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

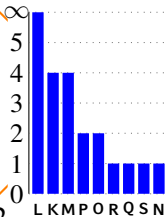
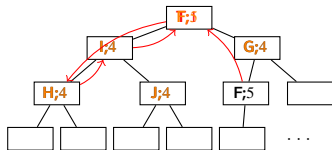
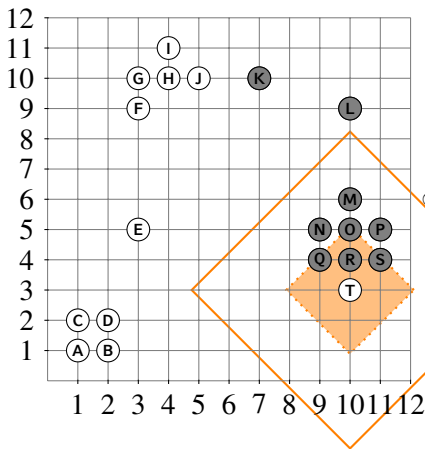
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

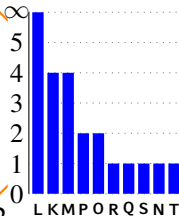
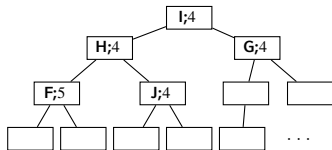
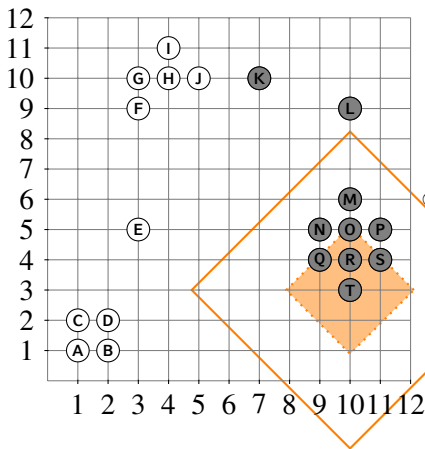
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

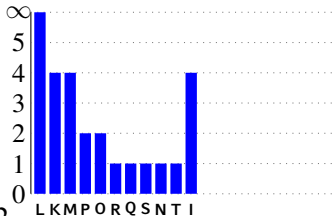
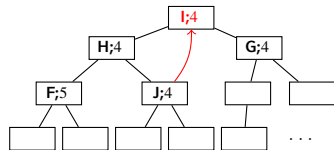
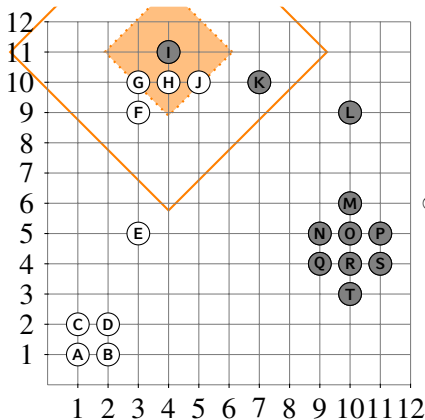
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

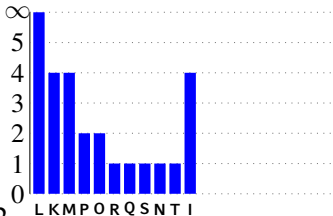
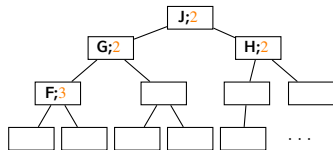
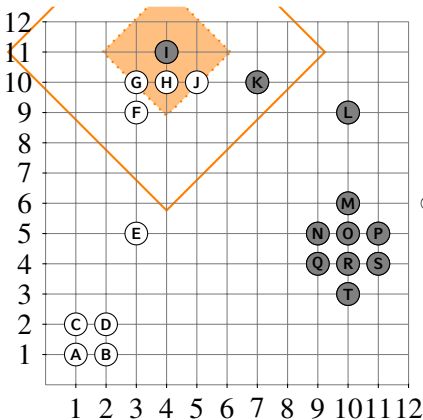
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

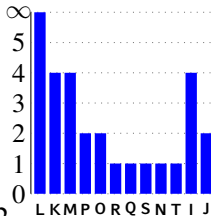
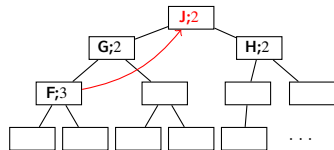
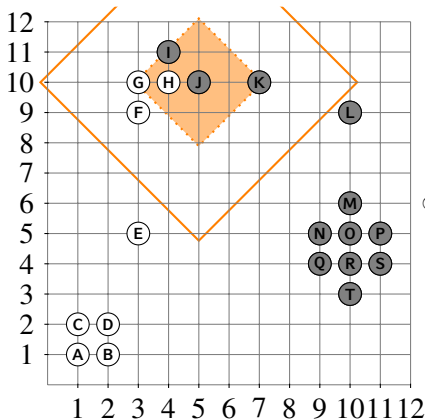
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

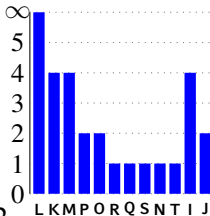
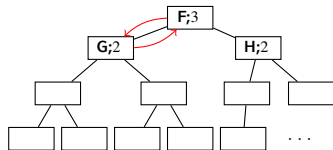
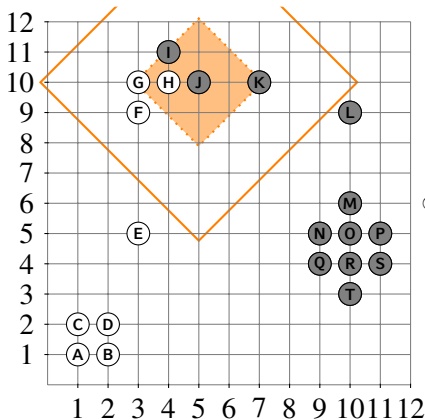
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

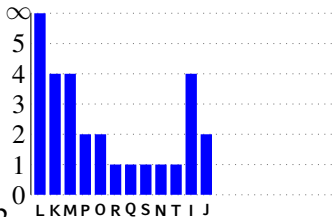
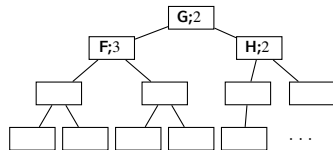
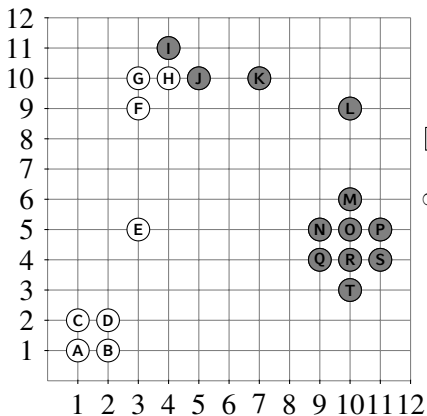
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

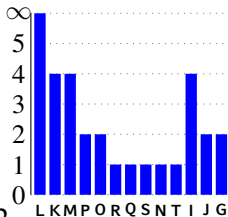
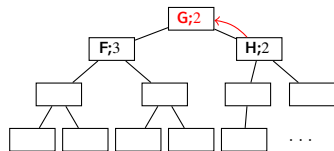
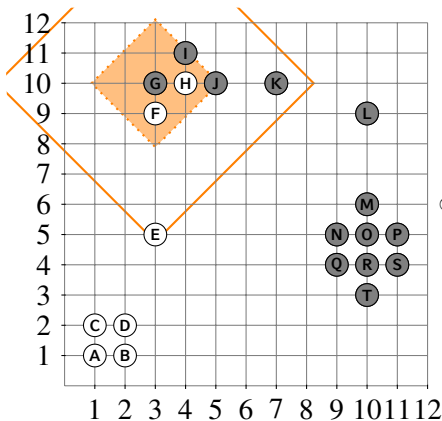
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

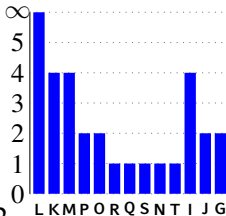
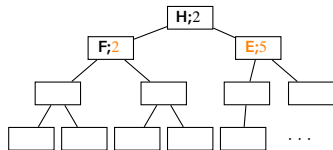
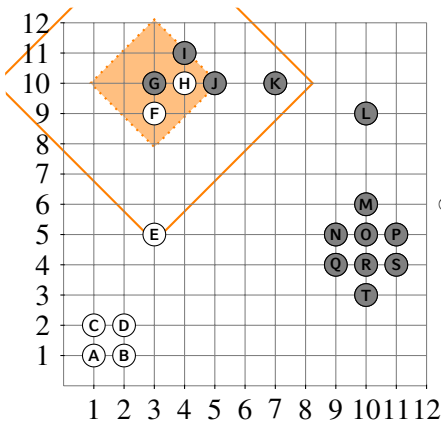
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

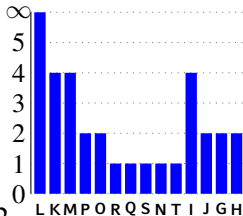
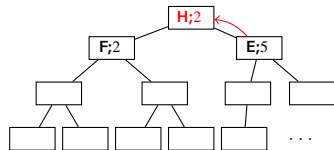
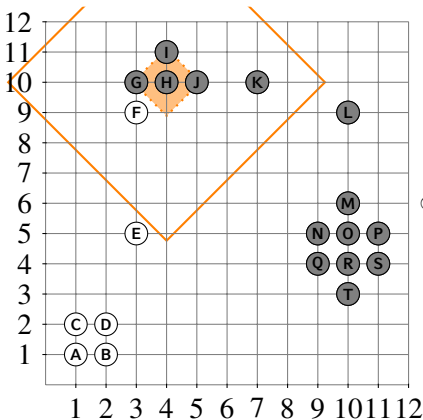
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

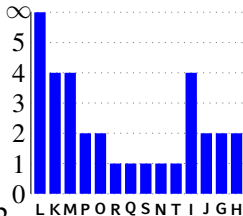
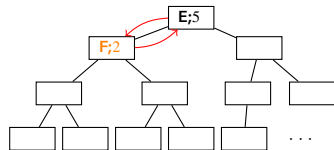
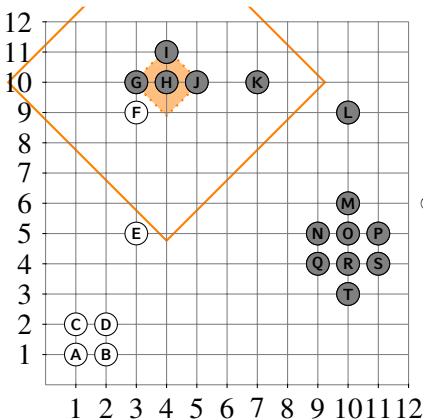
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

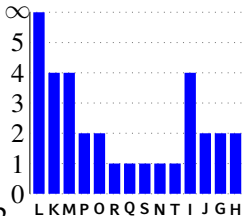
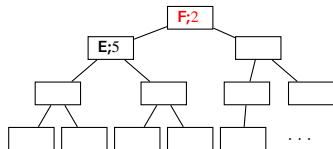
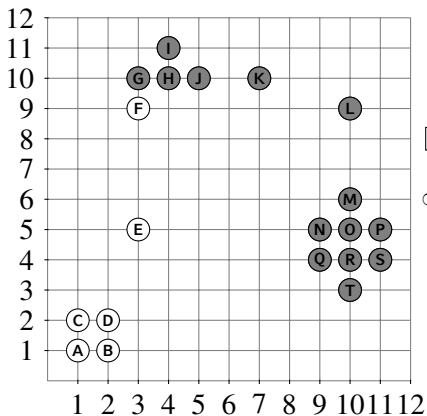
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

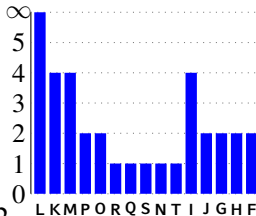
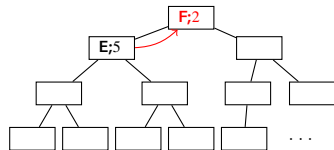
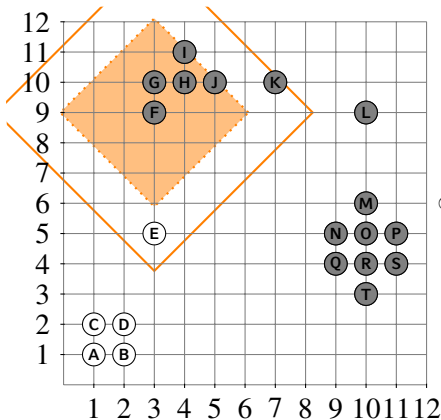
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

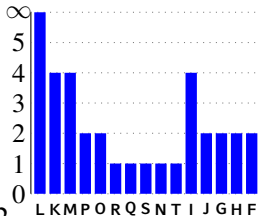
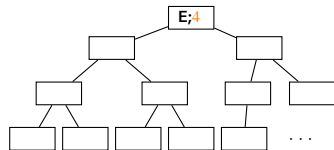
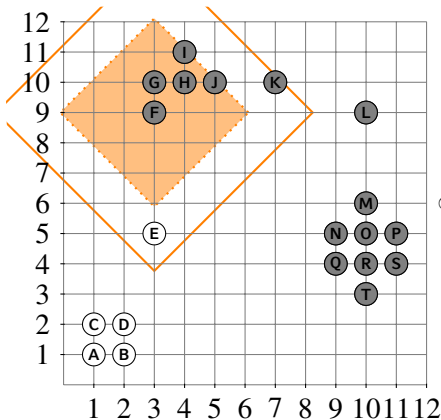
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

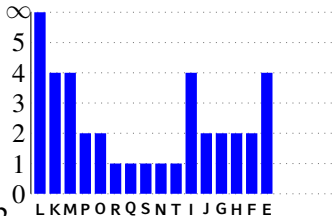
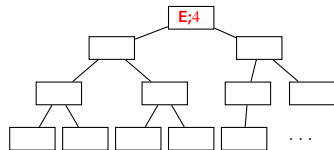
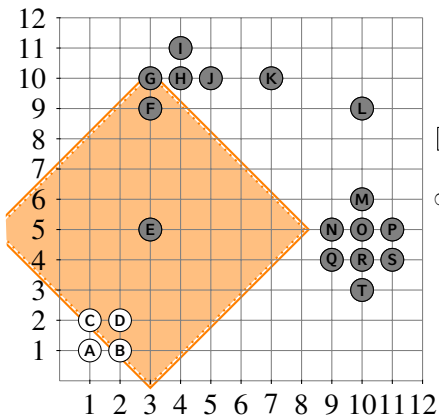
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

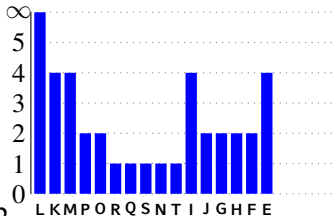
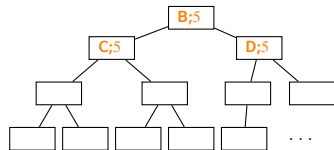
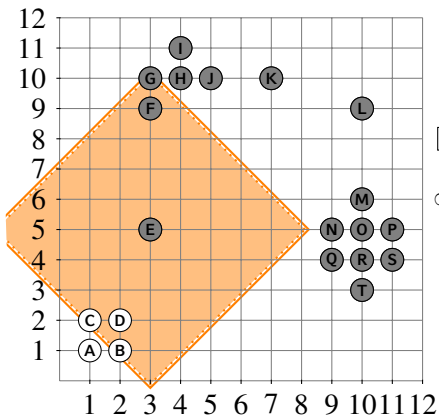
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

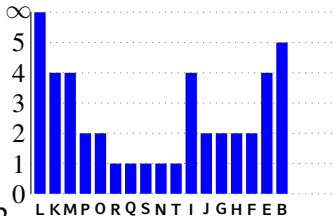
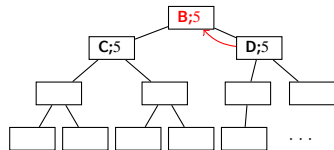
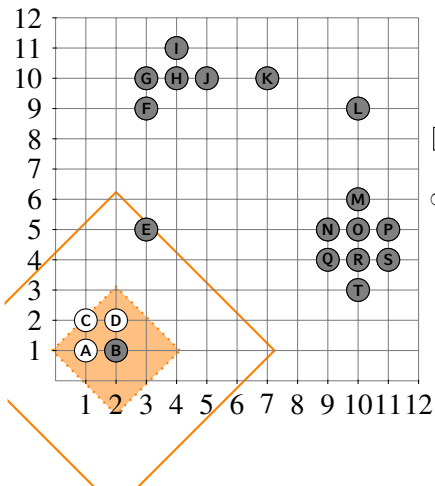
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4  
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

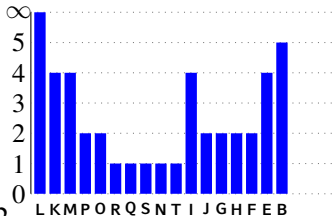
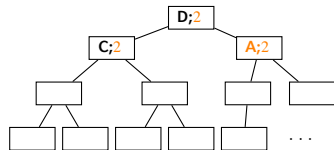
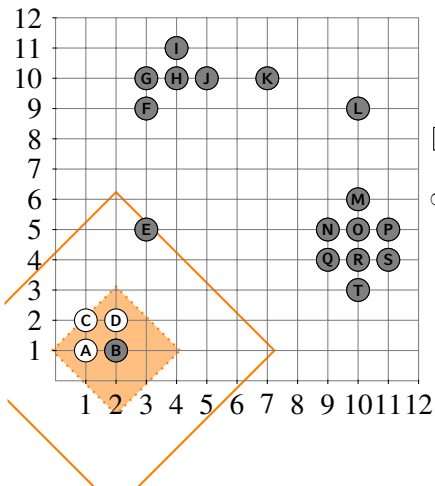
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

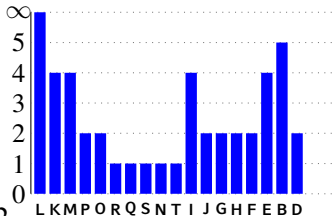
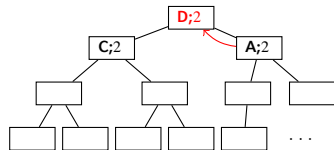
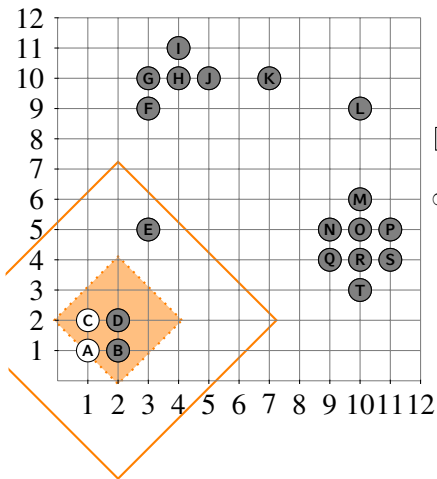
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

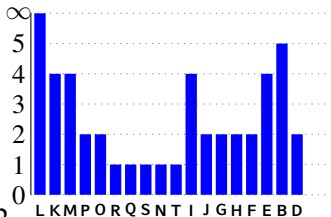
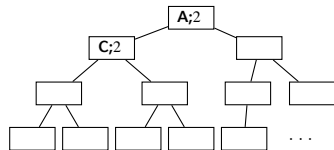
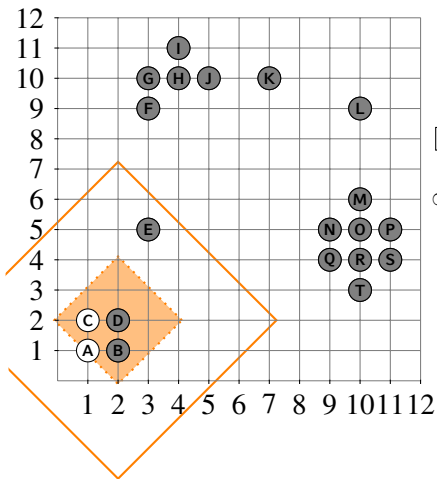
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

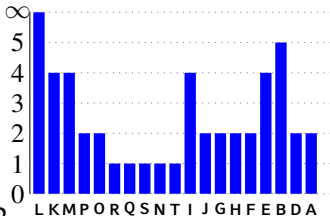
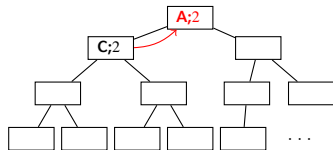
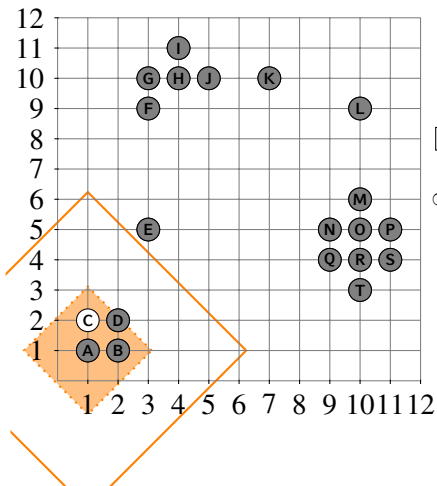
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

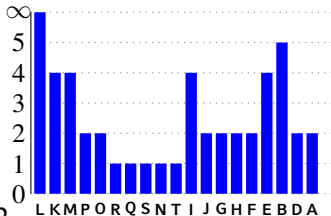
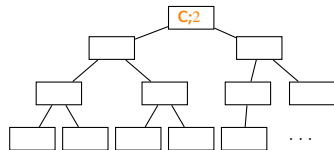
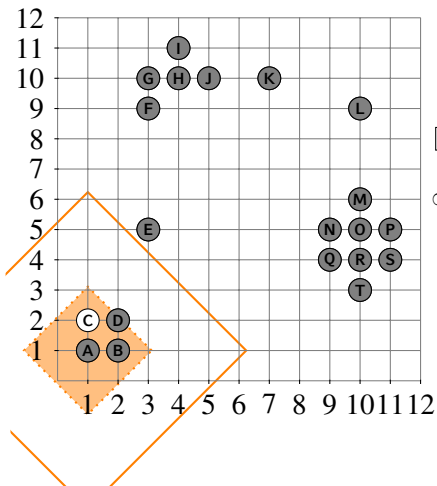
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

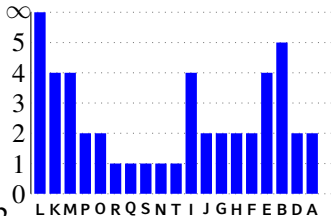
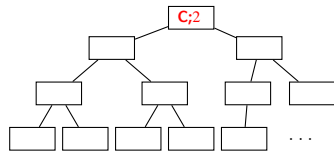
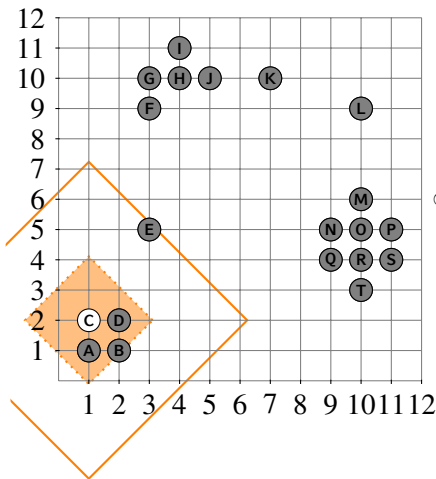
DBSCAN und  
Single-Link

### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$   
Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

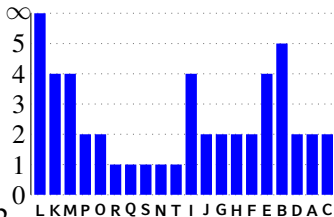
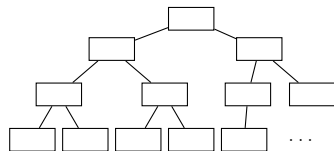
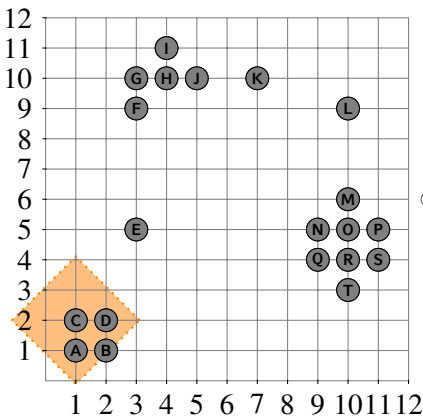
DBSCAN und  
Single-Link

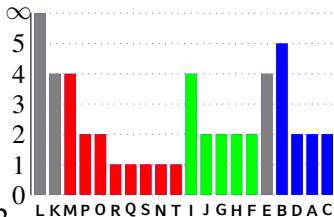
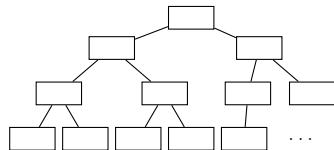
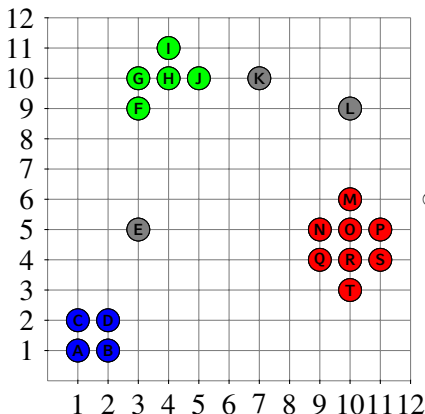
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

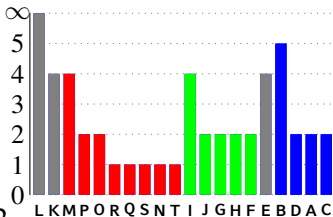
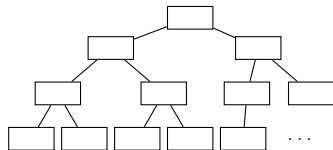
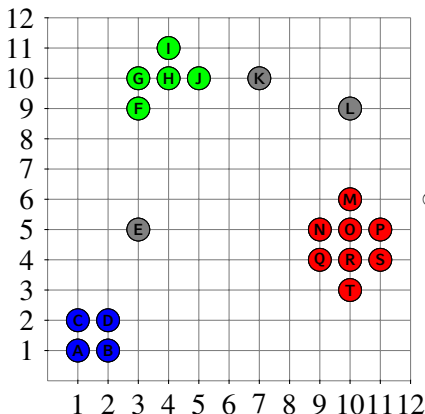
$\epsilon = 2$ ,  
minPts = 4  
Vergleich





(Intuitive Cluster  $\approx$  Täler)

Anfang ("Eingang") gehört i.d.R. dazu, Ende nicht!



Plot ist stärker geglättet!

Heap zufälligerweise etwas teurer (nicht zwangsläufig!)



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

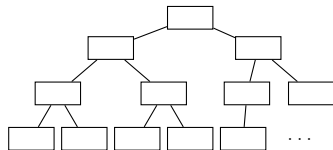
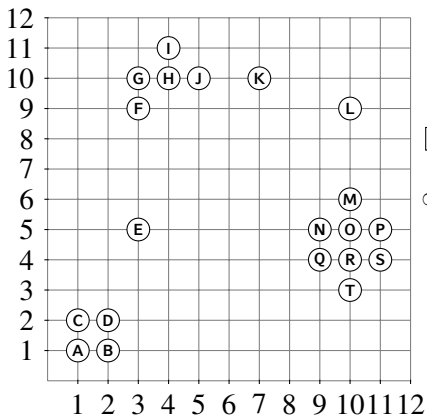
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

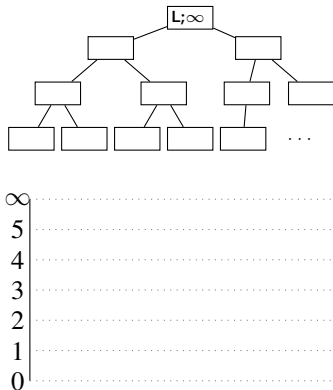
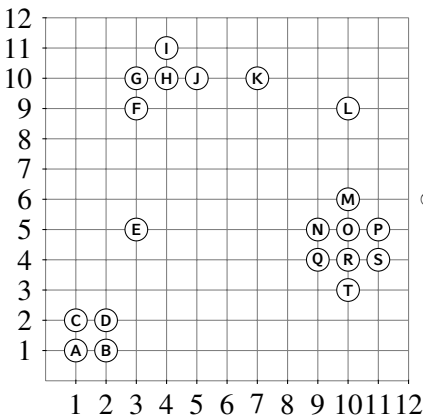
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

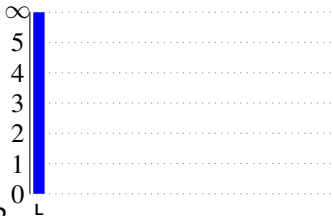
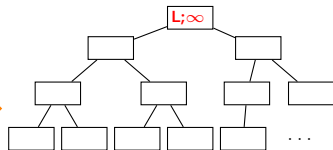
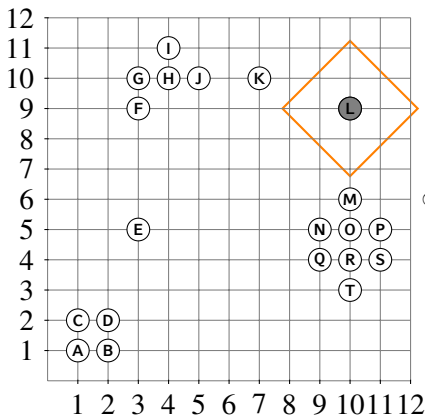
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$\epsilon = 5$ ,  
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$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

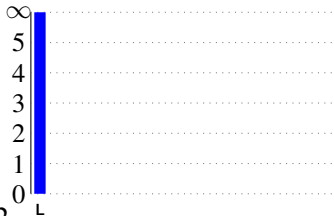
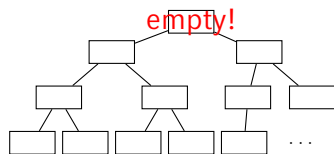
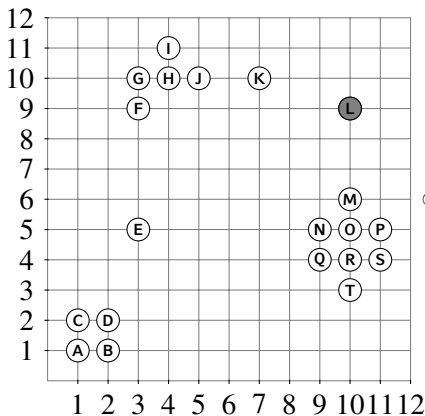
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

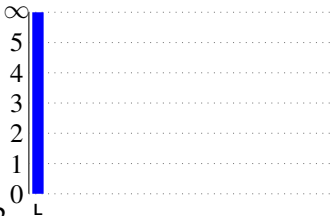
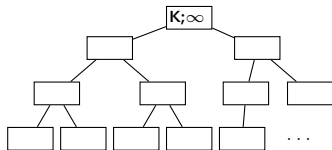
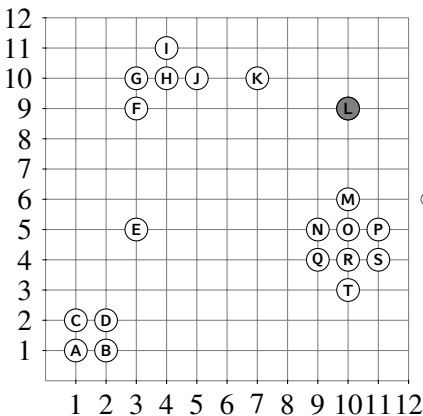
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

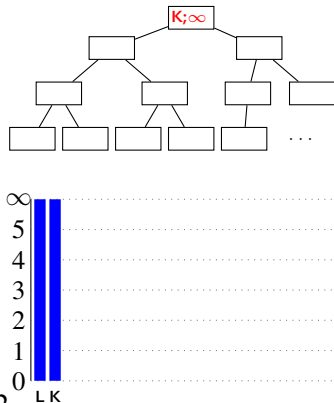
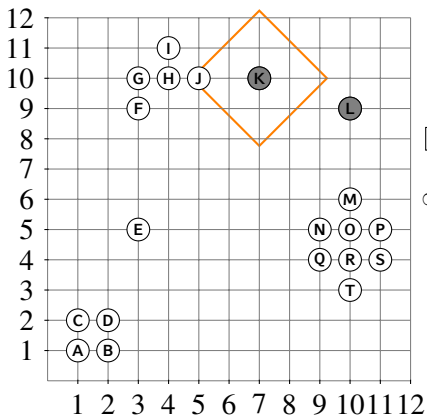
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

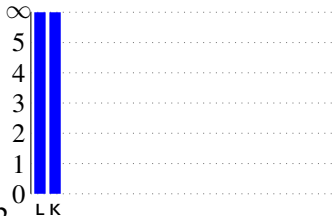
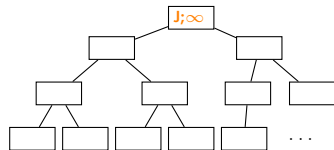
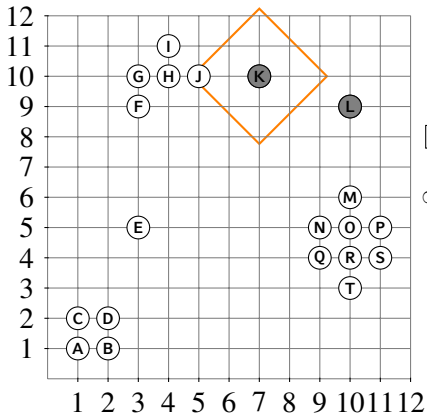
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

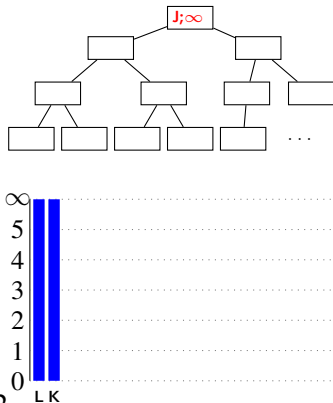
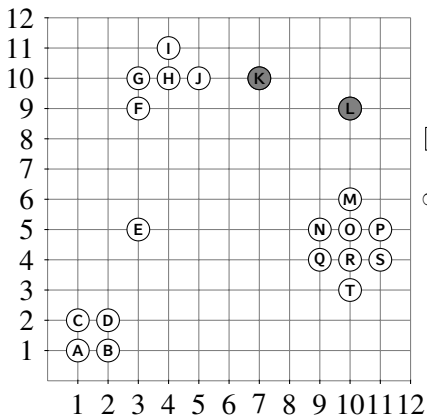
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

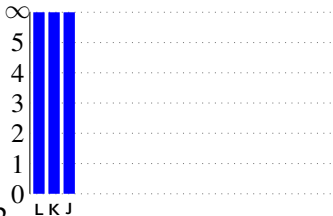
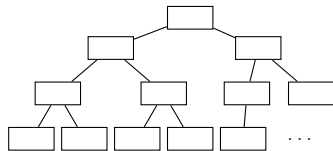
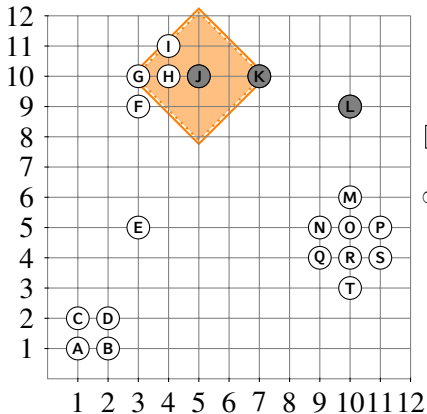
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

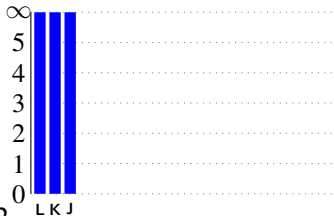
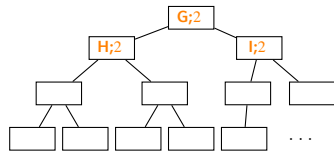
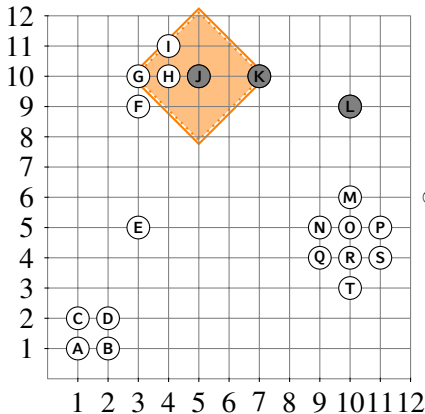
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

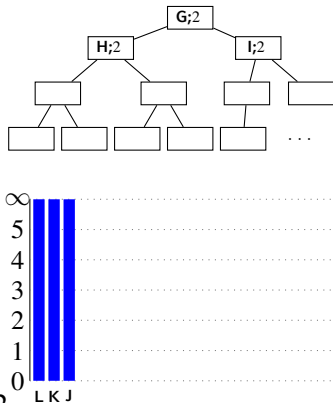
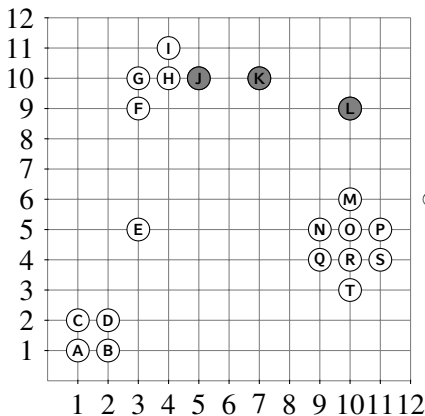
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

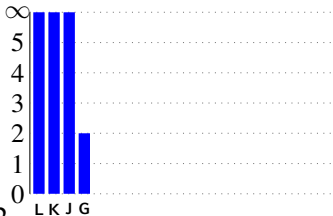
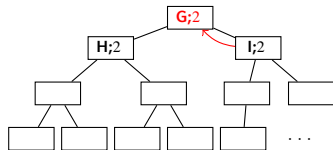
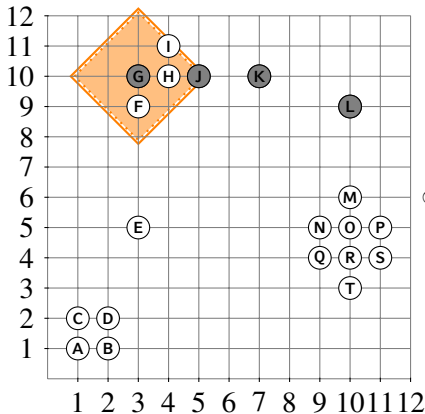
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

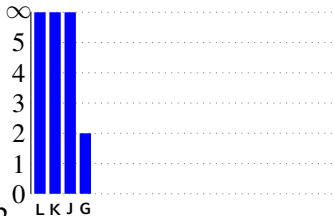
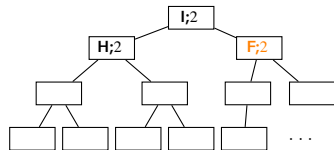
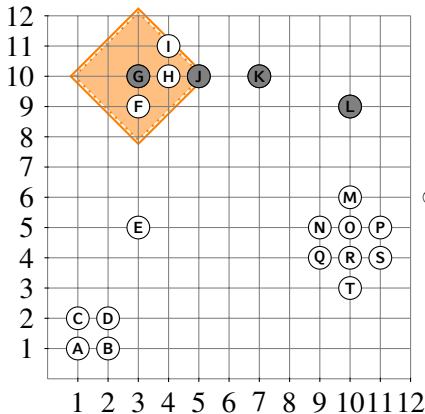
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

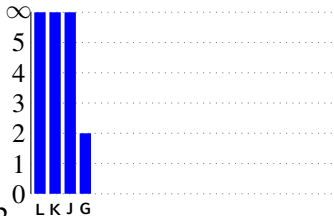
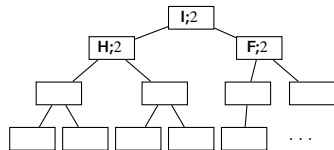
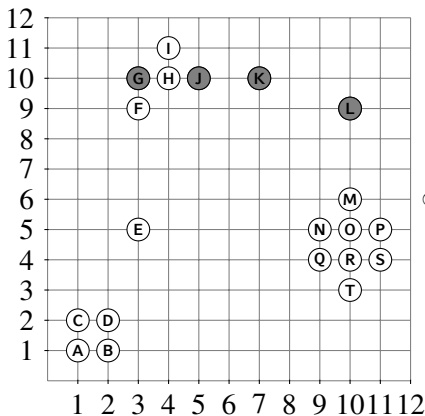
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



Aufgabe 4-1

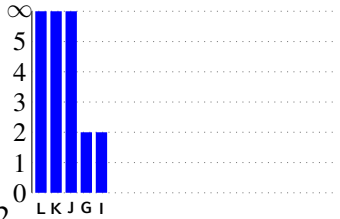
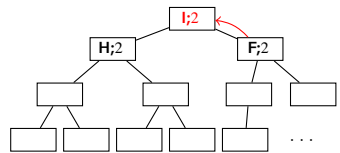
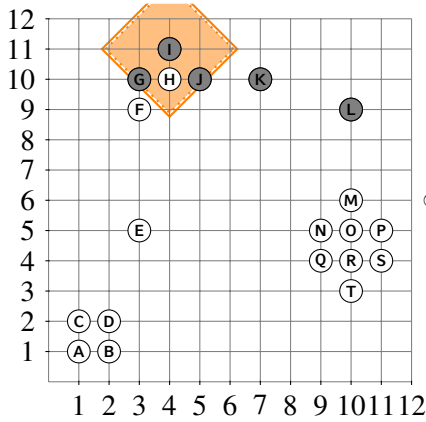
- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und Single-Link

Aufgabe 4-3

- $\epsilon = 5$ ,  
minPts = 2
- $\epsilon = 5$ ,  
minPts = 4
- $\epsilon = 2$ ,  
minPts = 4
- Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

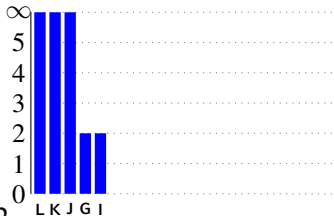
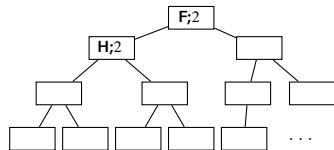
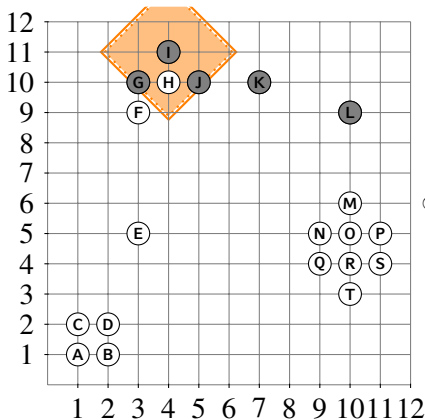
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

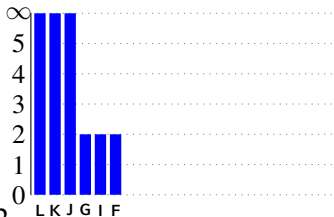
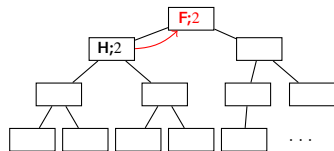
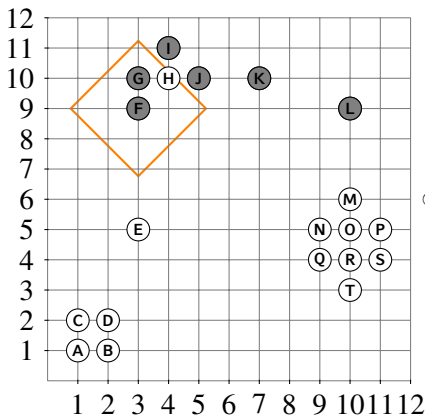
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

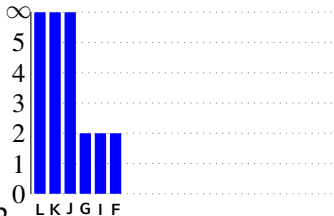
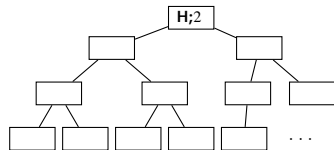
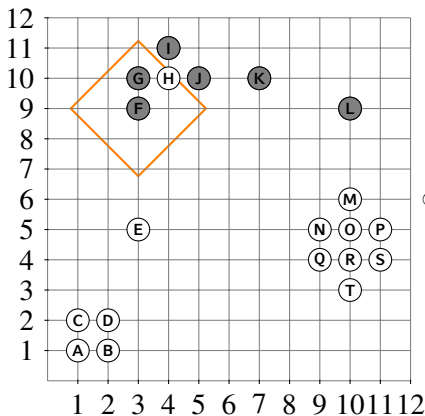
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



Aufgabe 4-1

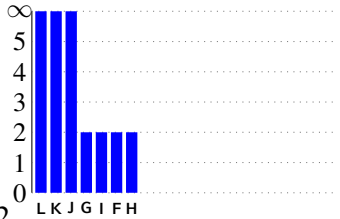
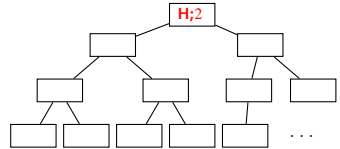
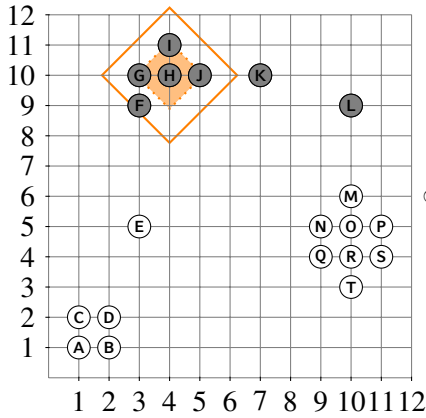
- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und  
Single-Link

Aufgabe 4-3

- $\epsilon = 5$ ,  
minPts = 2
- $\epsilon = 5$ ,  
minPts = 4
- $\epsilon = 2$ ,  
minPts = 4
- Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

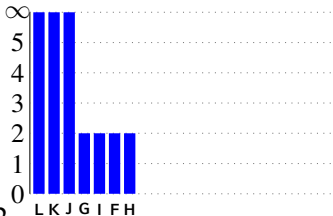
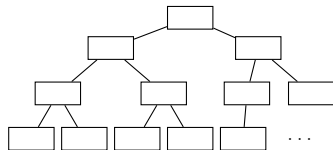
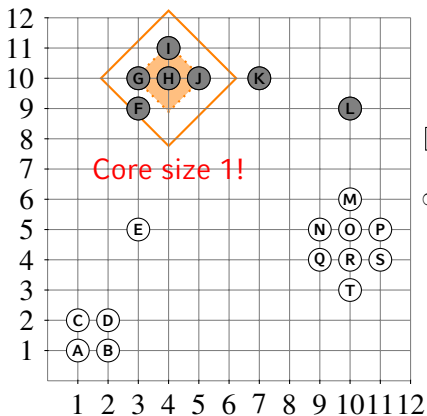
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

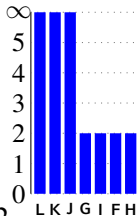
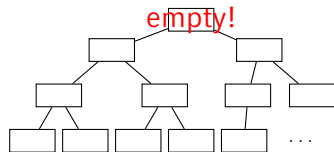
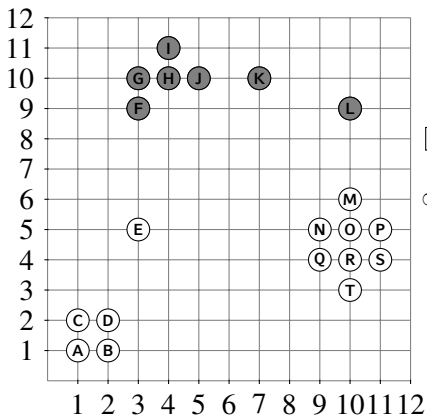
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

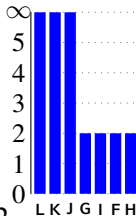
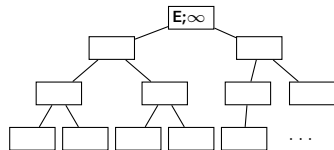
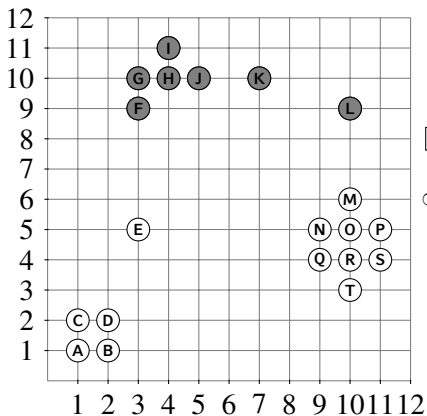
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

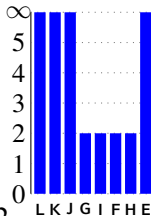
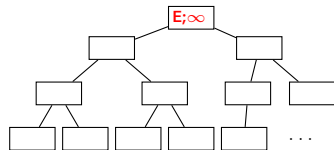
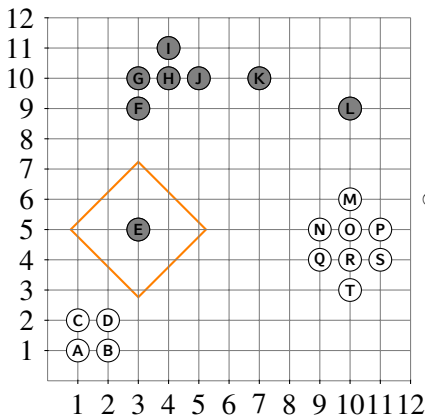
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

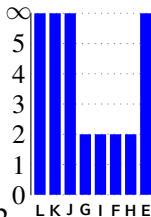
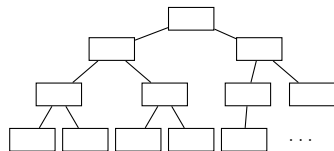
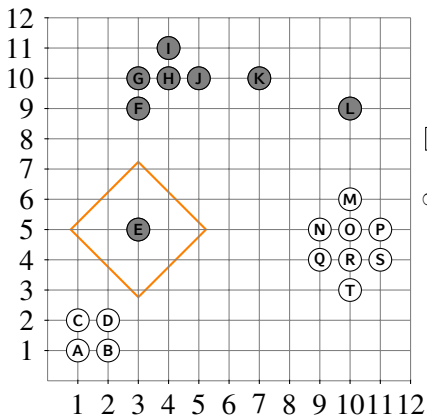
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

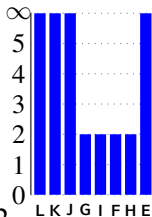
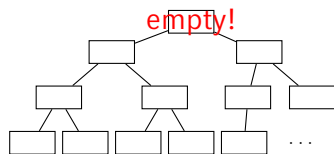
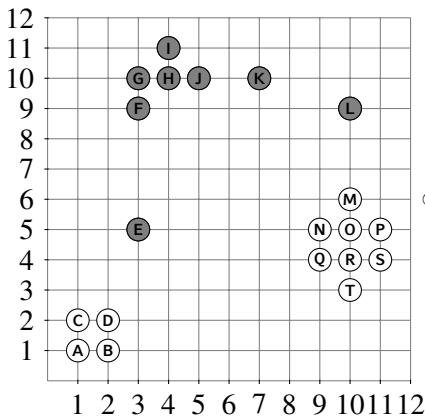
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

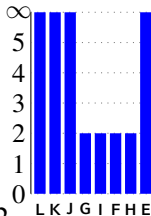
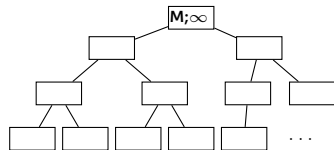
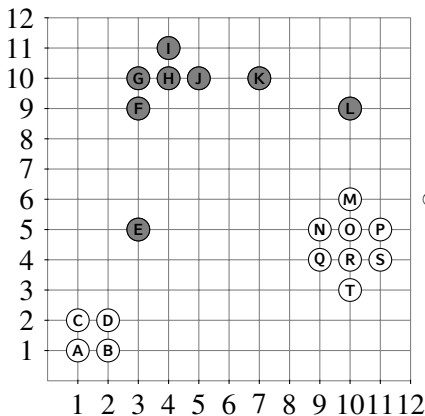
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

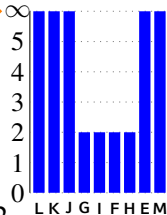
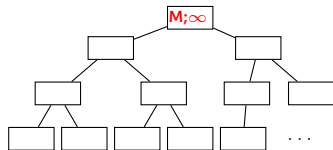
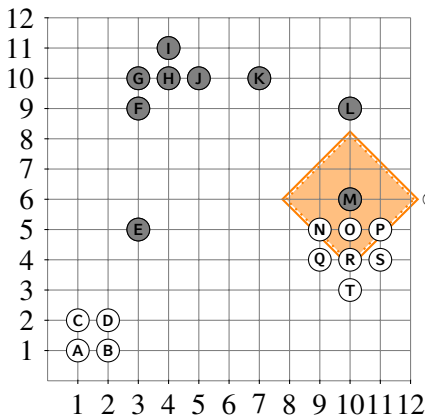
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

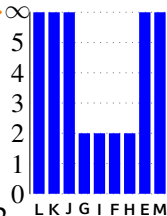
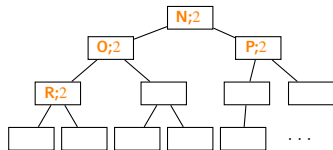
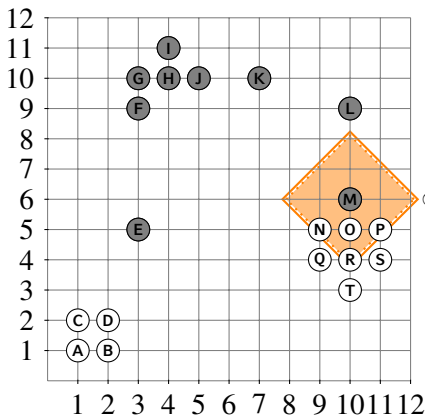
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

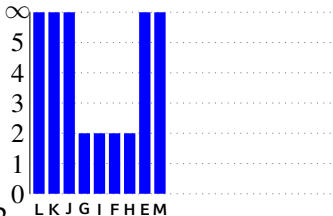
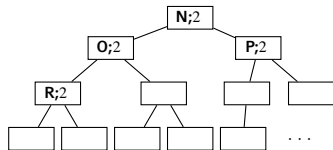
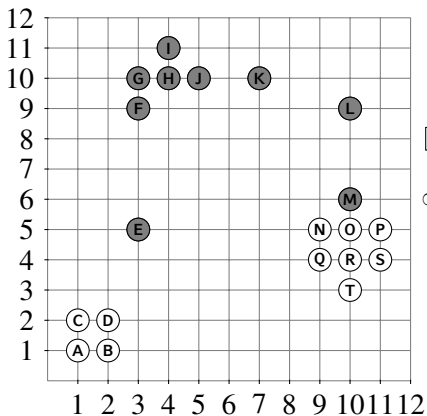
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

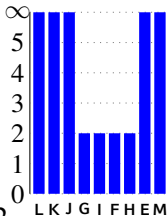
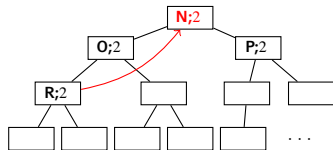
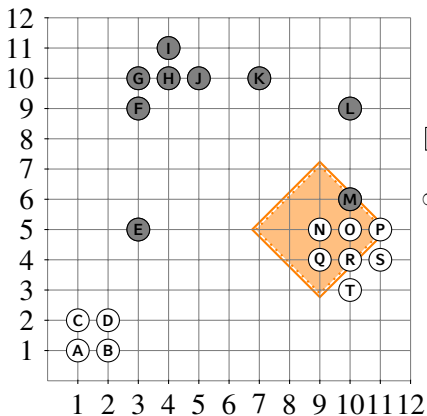
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

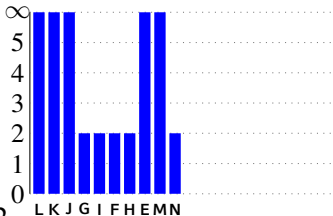
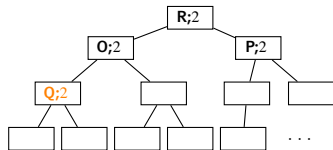
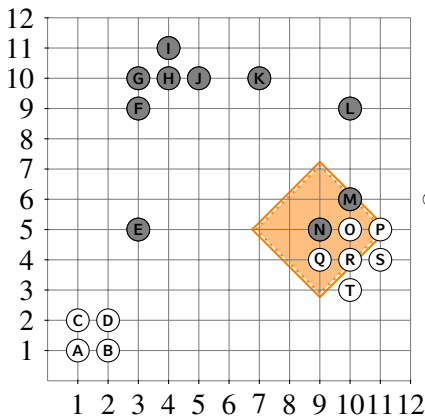
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

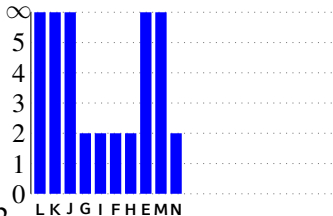
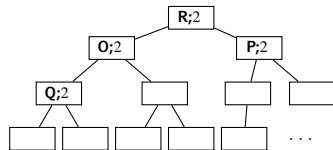
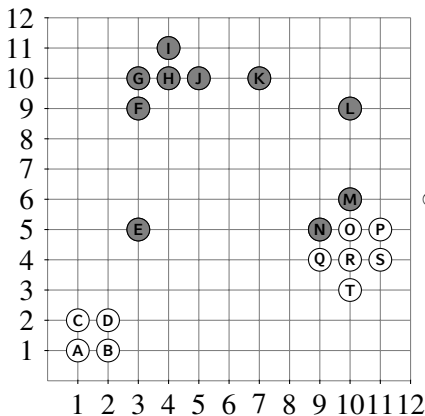
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

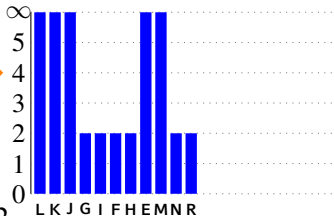
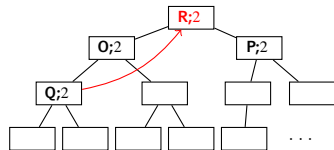
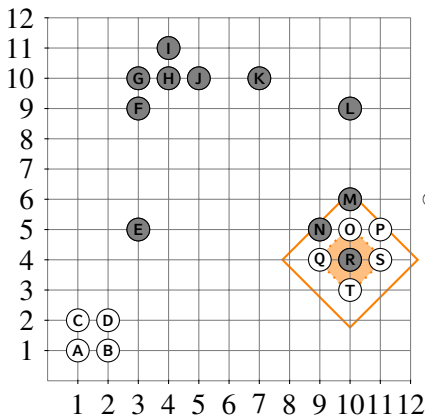
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

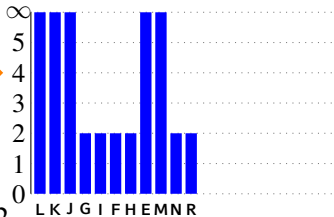
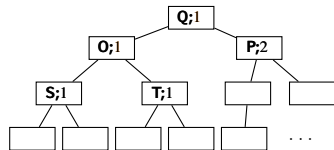
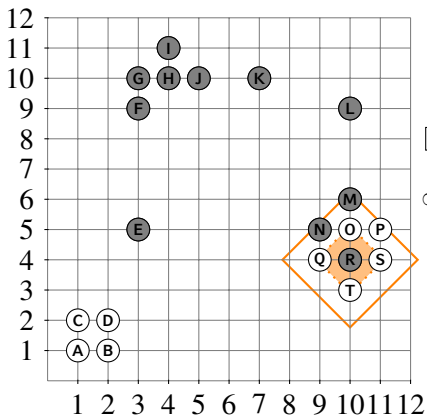
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

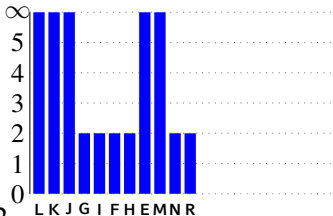
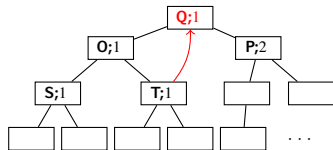
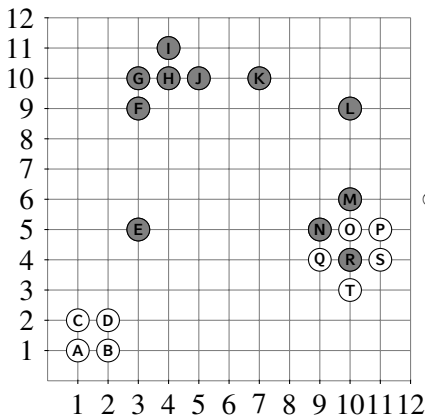
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

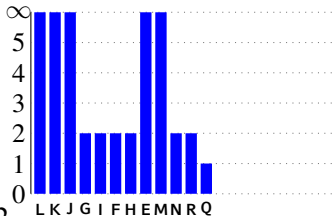
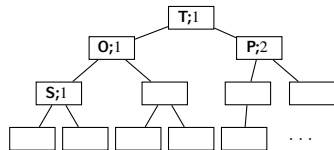
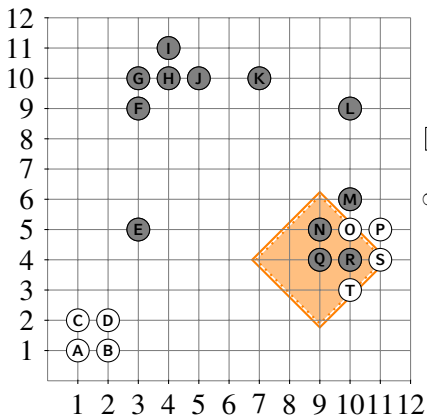
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

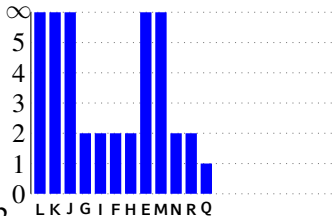
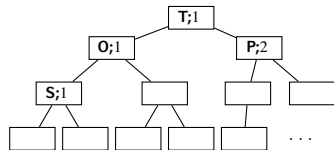
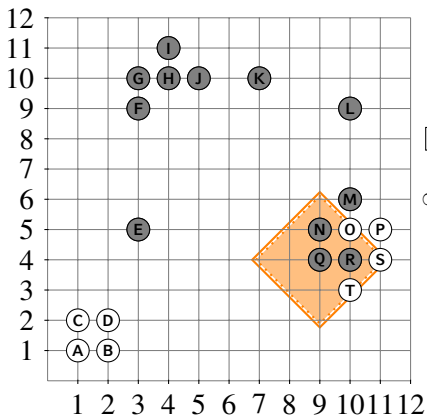
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

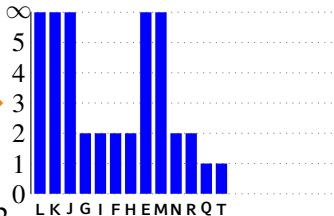
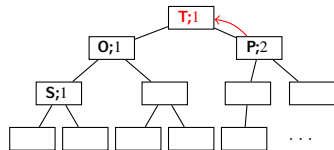
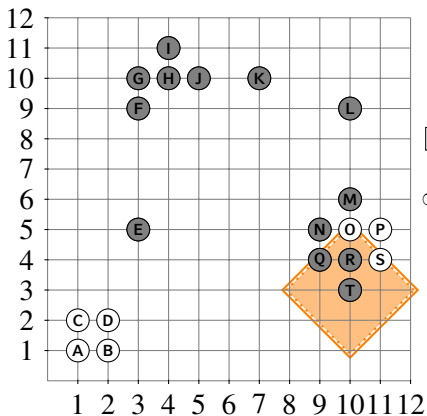
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

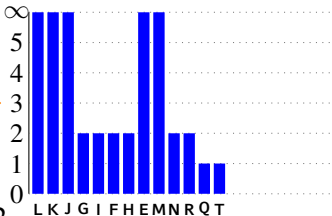
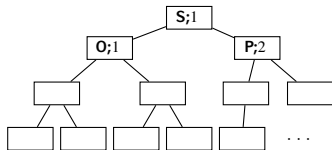
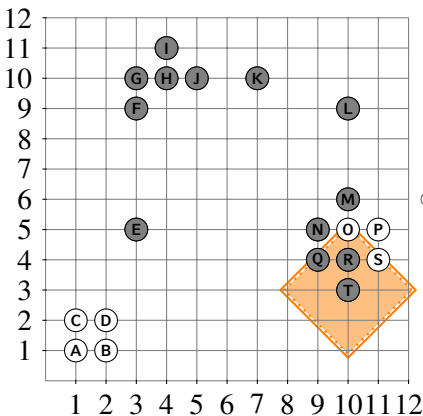
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

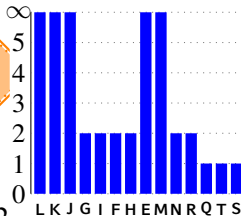
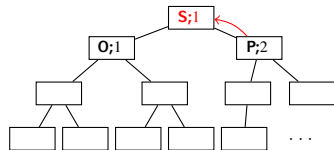
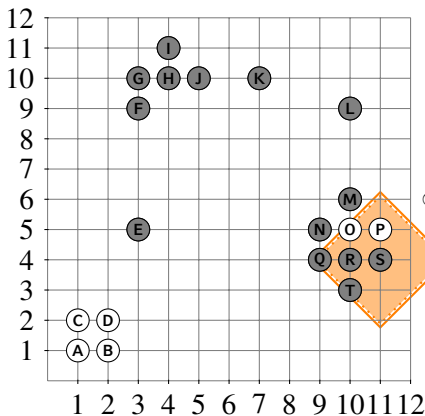
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

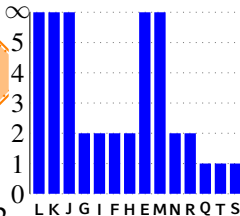
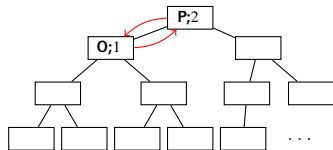
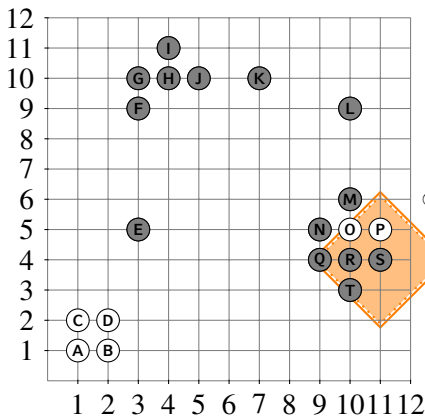
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

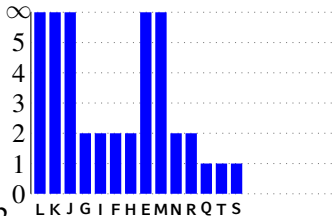
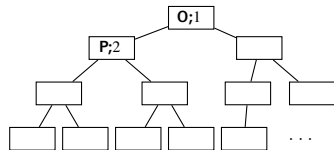
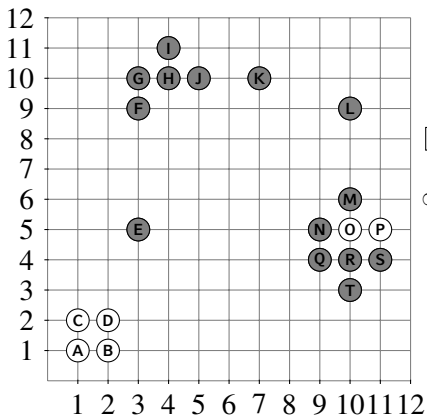
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

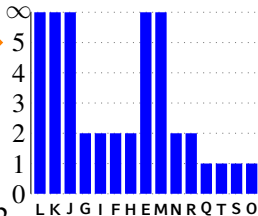
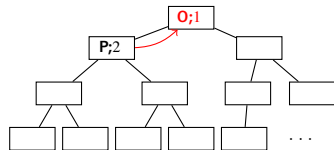
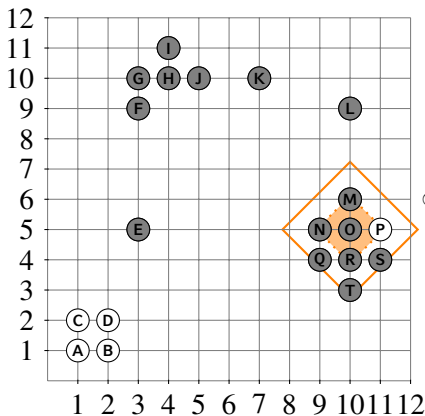
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

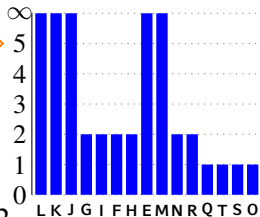
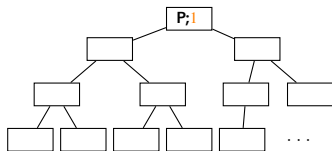
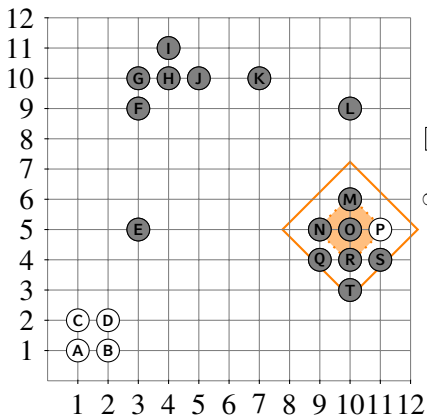
### Aufgabe 4-3

$\epsilon = 5$ ,  
 $\text{minPts} = 2$

$\epsilon = 5$ ,  
 $\text{minPts} = 4$

$\epsilon = 2$ ,  
 $\text{minPts} = 4$

Vergleich



Aufgabe 4-1

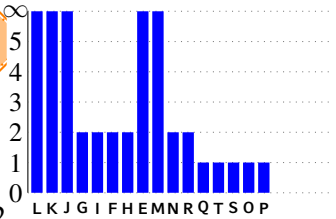
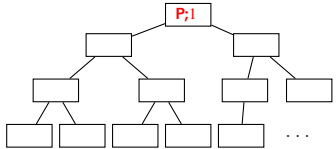
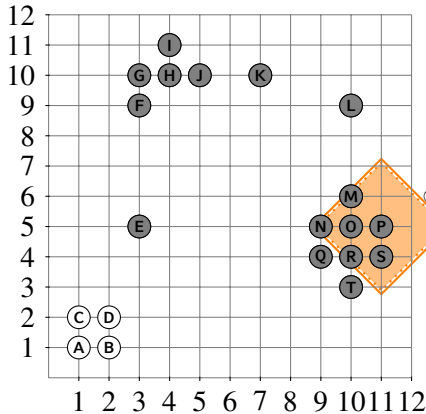
- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und  
Single-Link

Aufgabe 4-3

- $\epsilon = 5$ ,  
minPts = 2
- $\epsilon = 5$ ,  
minPts = 4
- $\epsilon = 2$ ,  
minPts = 4
- Vergleich



Aufgabe 4-1

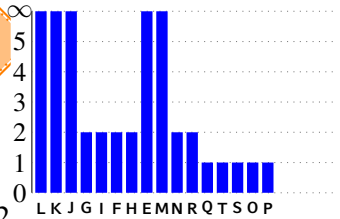
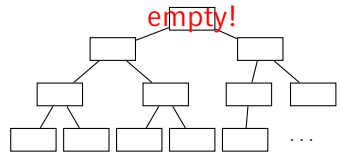
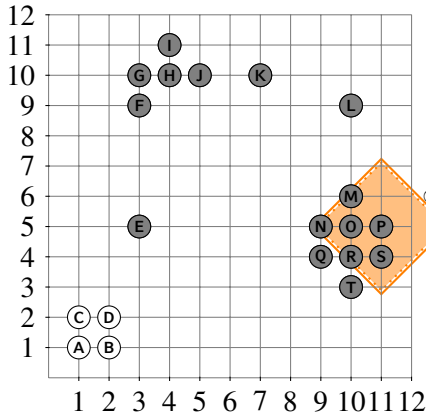
- single-link
- average-link
- complete-link

Aufgabe 4-2

- DBSCAN und  
Single-Link

Aufgabe 4-3

- $\epsilon = 5$ ,  
minPts = 2
- $\epsilon = 5$ ,  
minPts = 4
- $\epsilon = 2$ ,  
minPts = 4
- Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

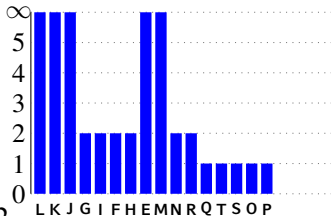
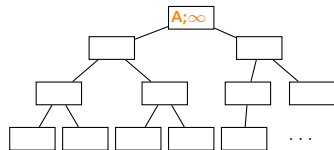
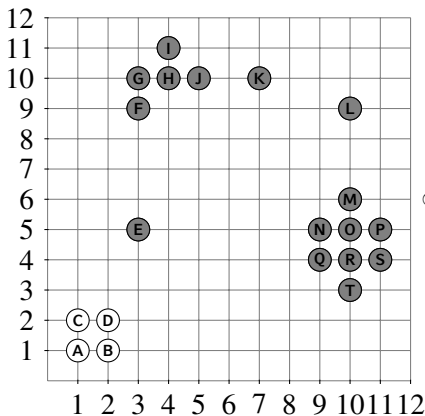
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

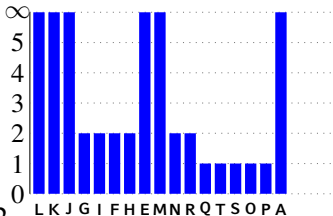
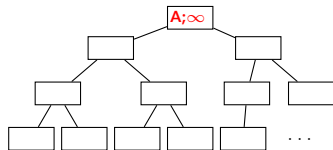
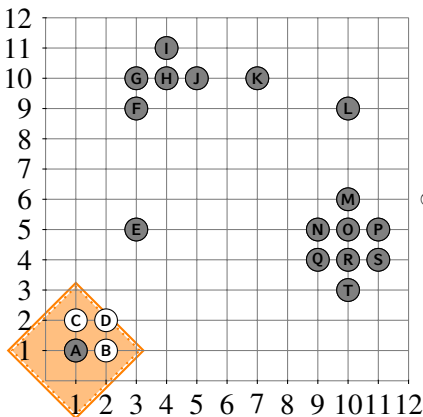
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich





### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

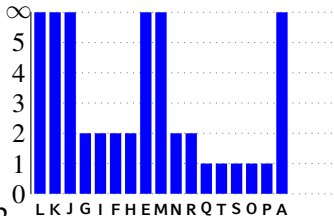
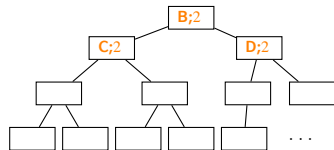
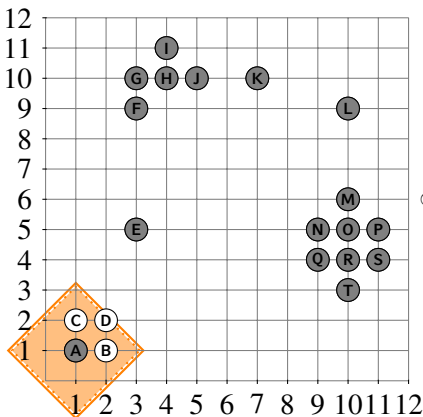
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

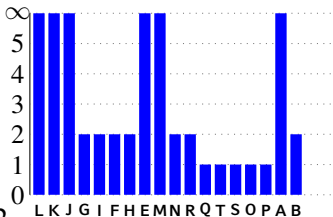
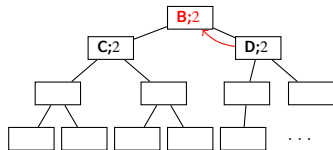
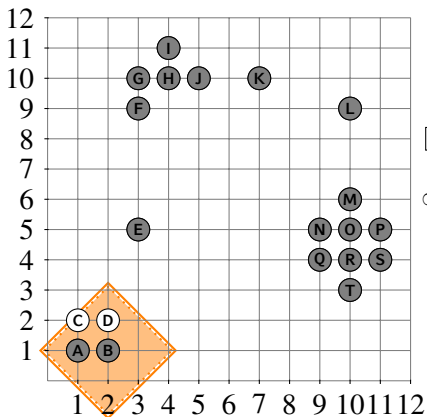
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

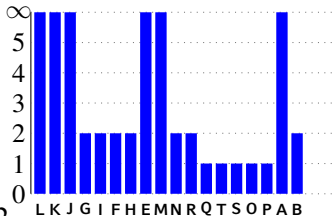
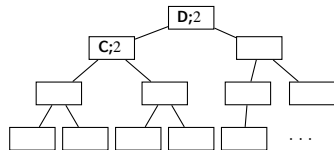
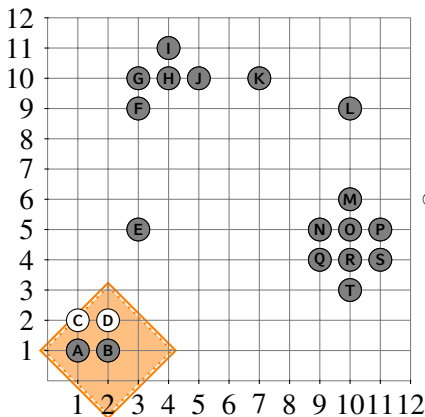
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

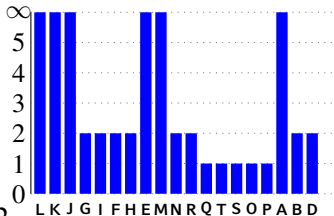
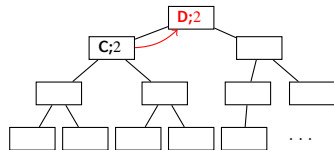
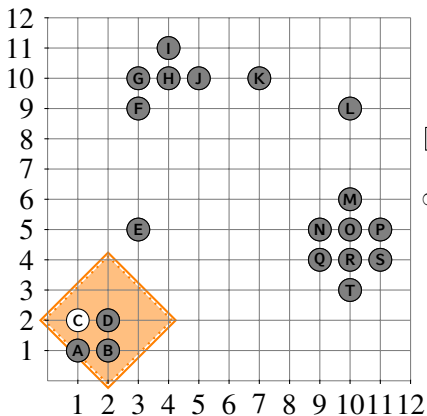
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

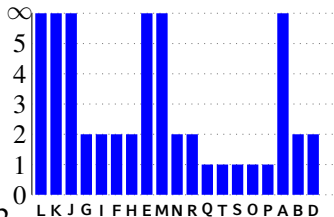
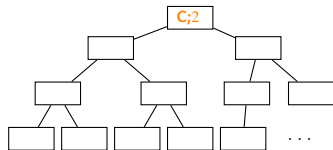
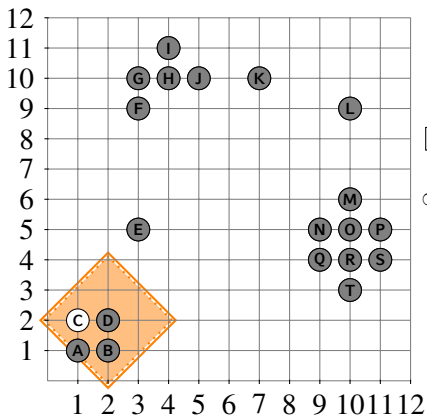
### Aufgabe 4-3

$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

Vergleich



### Aufgabe 4-1

single-link  
average-link  
complete-link

### Aufgabe 4-2

DBSCAN und  
Single-Link

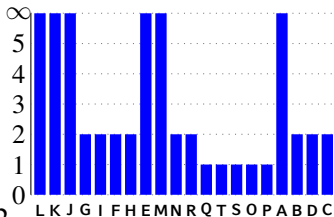
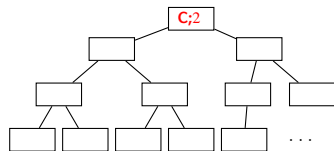
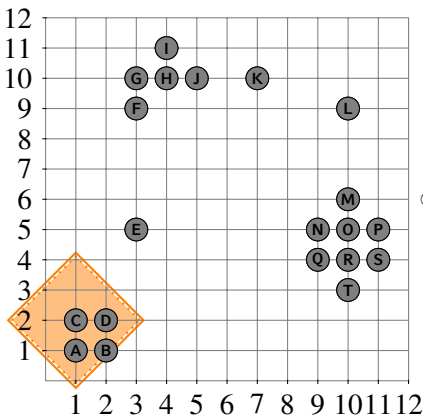
### Aufgabe 4-3

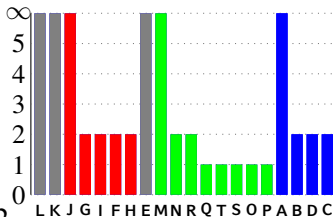
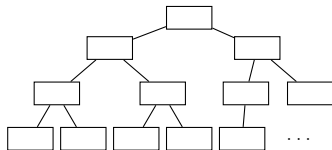
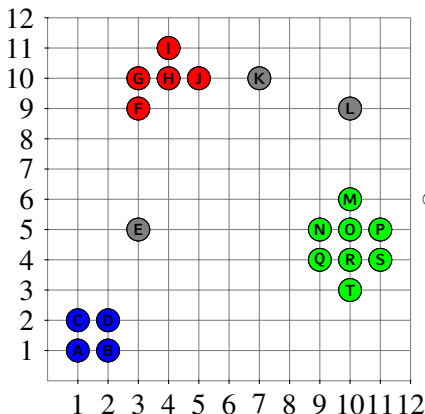
$\epsilon = 5$ ,  
minPts = 2

$\epsilon = 5$ ,  
minPts = 4

$\epsilon = 2$ ,  
minPts = 4

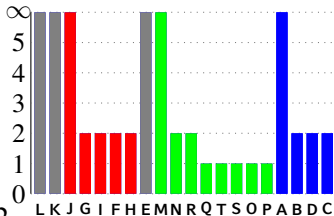
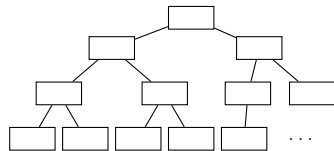
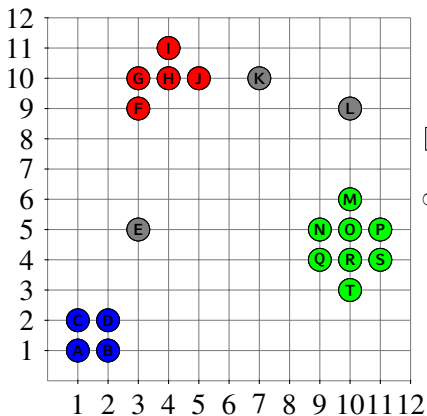
Vergleich





(Intuitive Cluster  $\approx$  Täler)

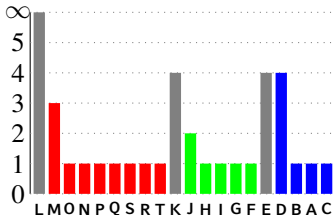
Anfang ("Eingang") gehört i.d.R. dazu, Ende nicht!



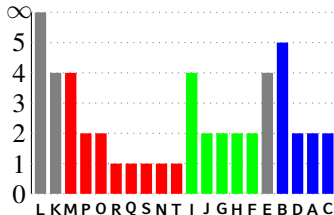
Radius zu klein!



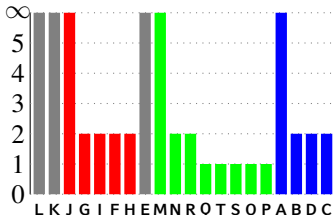
$\epsilon = 5$ , minPts=2



$\epsilon = 5$ , minPts=4



$\epsilon = 2$ , minPts=4



$\epsilon = \infty$ , minPts=2

