Universität Konstanz

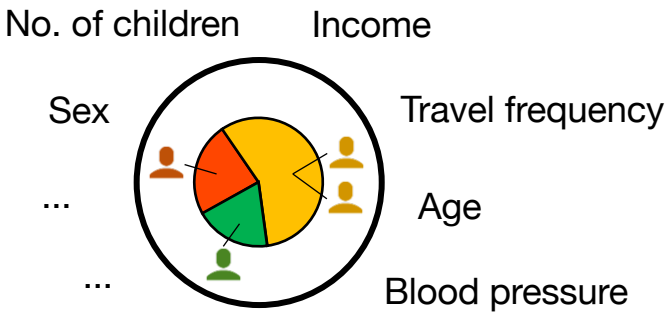
TU Graz

VIS 2017

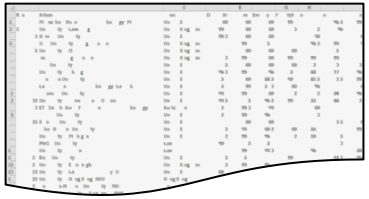
PatternTrails

Visual Analysis of Pattern Transitions in Subspaces

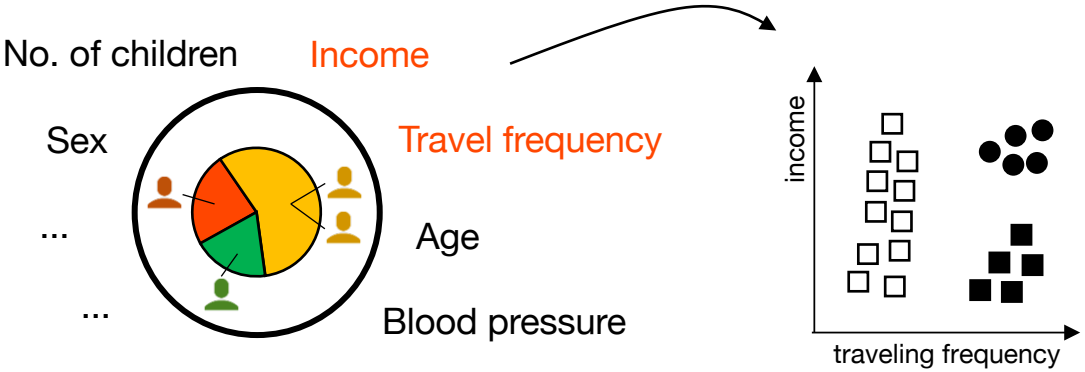
Dominik Jäckle[*], Michael Hund[*], Michael Behrisch[*], Daniel A. Keim[*], Tobias Schreck[+]
[*]DBVIS Group, University of Konstanz, Germany
[+]CGV, TU Graz, Austria



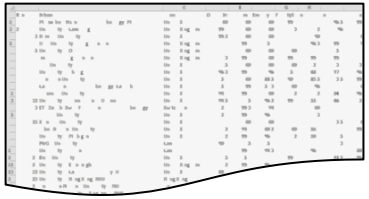
Demographic data



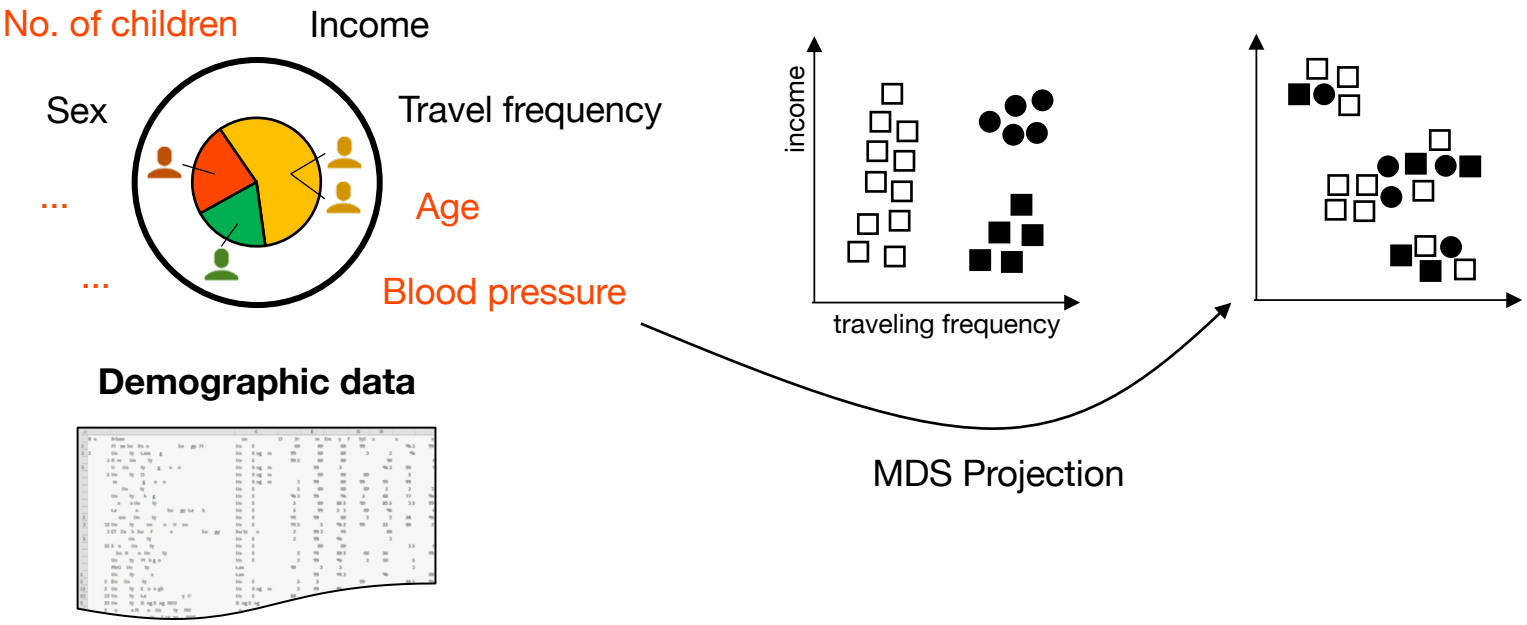
- Adapted from **Müller et al.** *(Discovering multiple clustering solutions, 2010)*



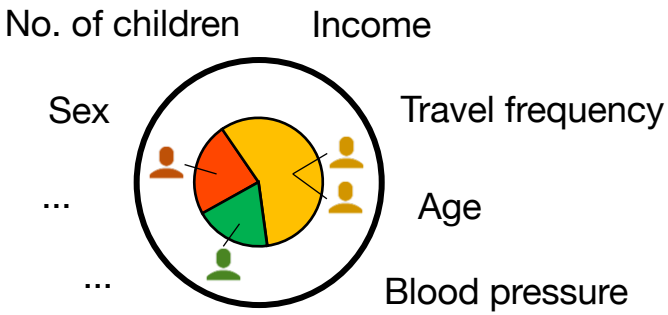
Demographic data



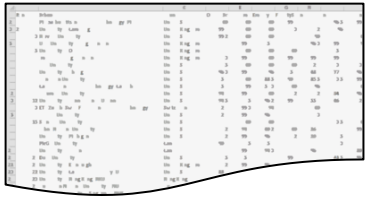
- Adapted from **Müller et al.** *(Discovering multiple clustering solutions, 2010)*

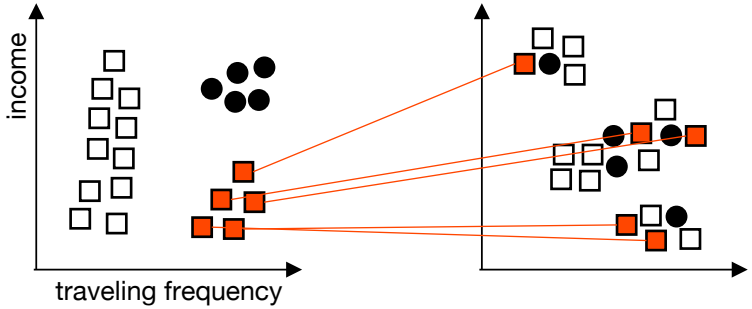


- Adapted from **Müller et al.** *(Discovering multiple clustering solutions, 2010)*



Demographic data





- Adapted from **Müller et al.** *(Discovering multiple clustering solutions, 2010)*

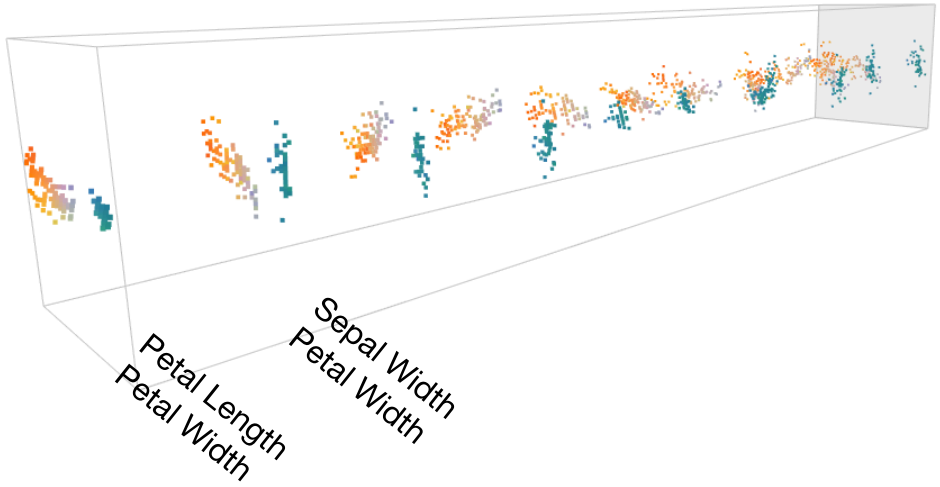
“The relevance of certain attributes may differ for different groups of objects within the same dataset.”

- H. Kriegel, P. Kröger, and A. Zimek *(Clustering High-dimensional Data, 2009)*

How to identify and relate interesting patterns among multivariate subspaces, using interactive visual exploration?

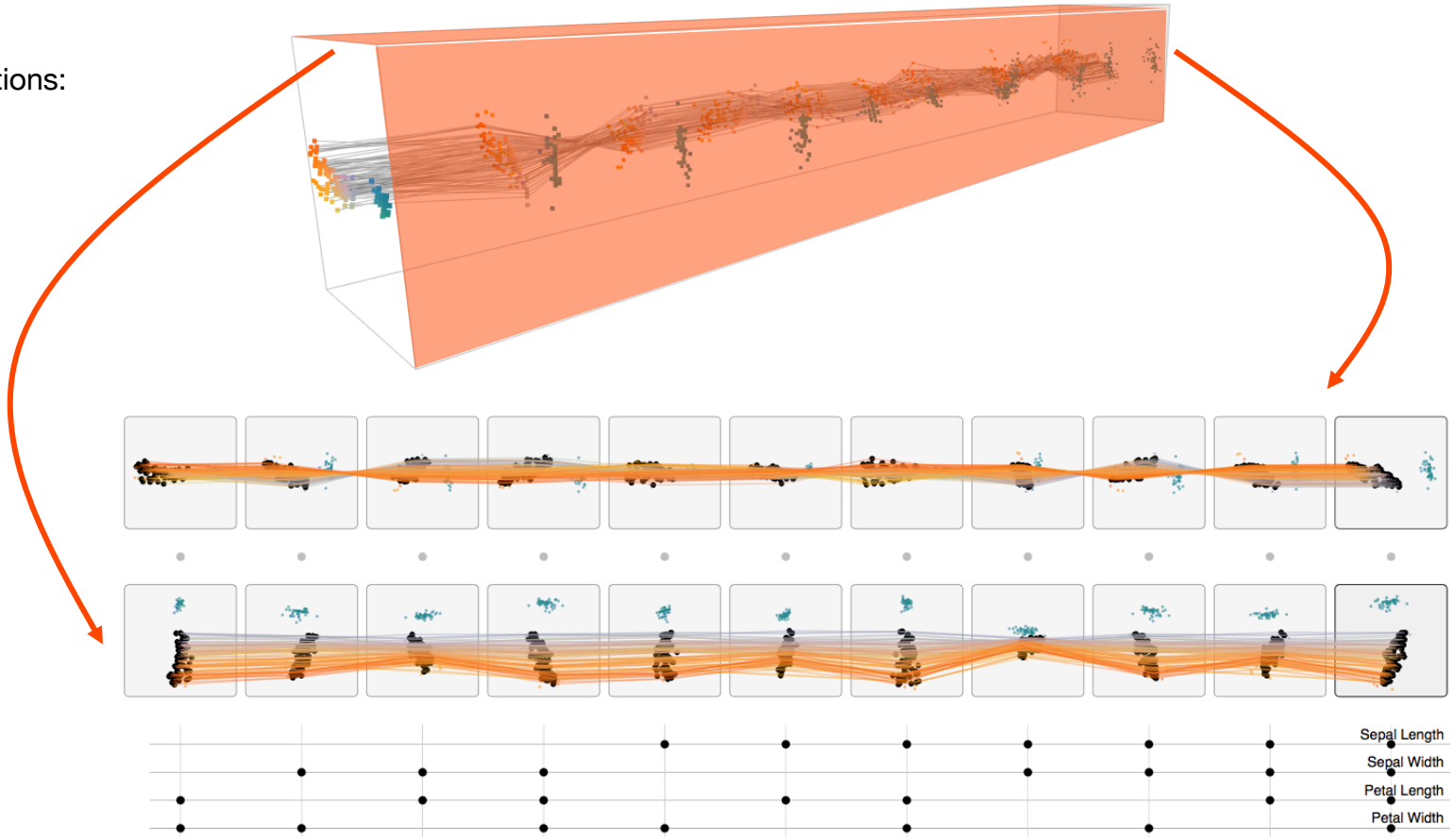
Example: **IRIS** Dataset

Subspace Projections:



Example: **IRIS** Dataset

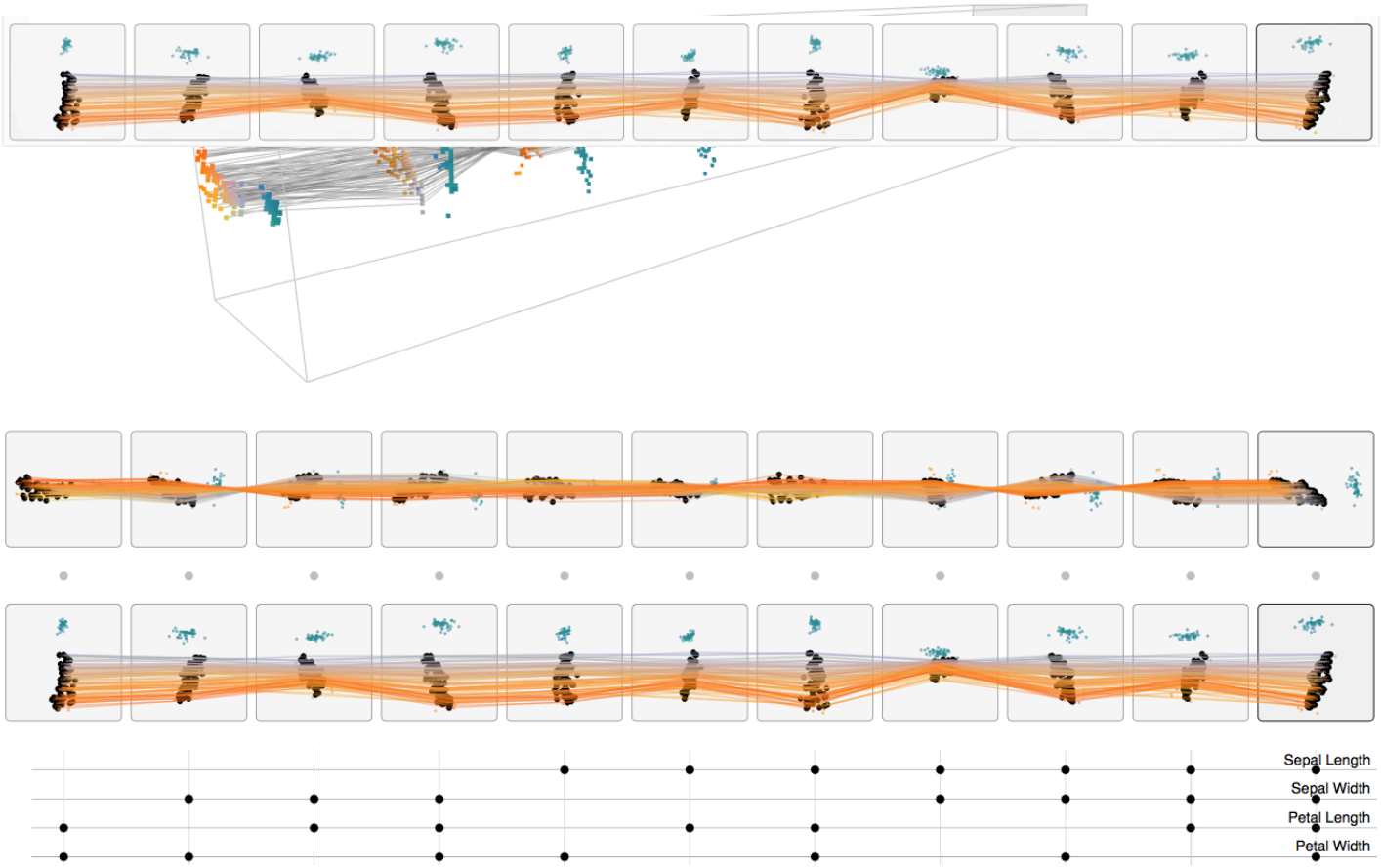
Subspace Projections:



Jäckle et al. | Pattern Trails: Visual Analysis of Pattern Transitions in Subspaces

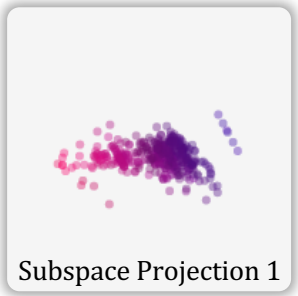
Example: **IRIS** Dataset

Subspace Projections:



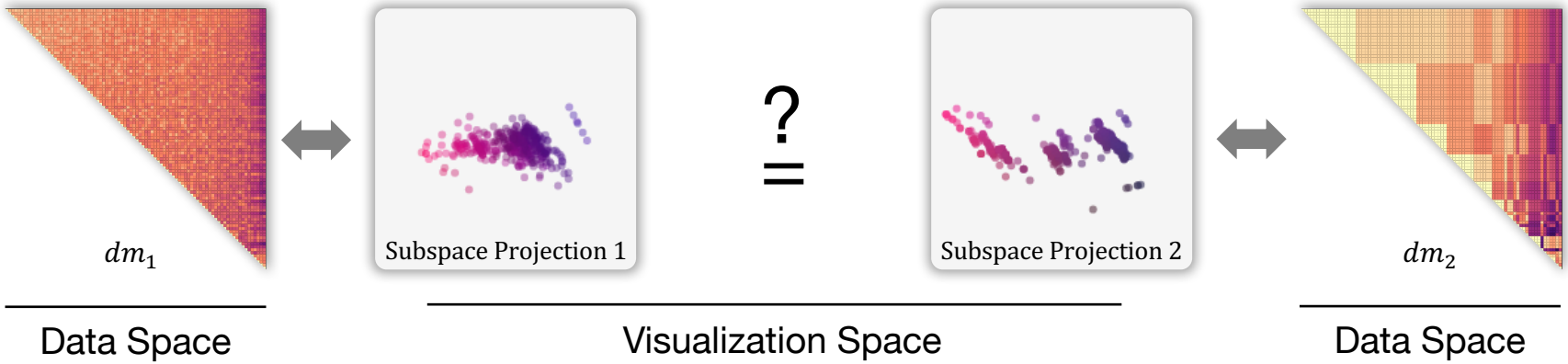
Jäckle et al. | Pattern Trails: Visual Analysis of Pattern Transitions in Subspaces

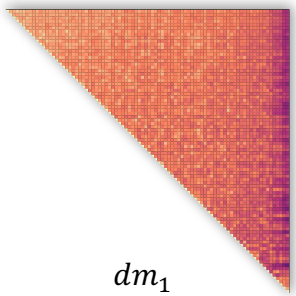
Similarity-based Grouping of Subspace Views



$\stackrel{?}{=}$

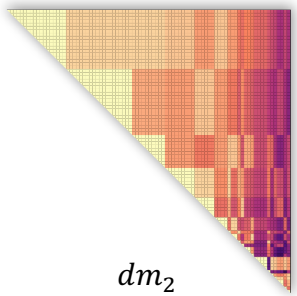
Visualization Space


dm_1
Subspace Projection 1
?
=
Subspace Projection 2
dm_2
Data Space
Visualization Space
Data Space

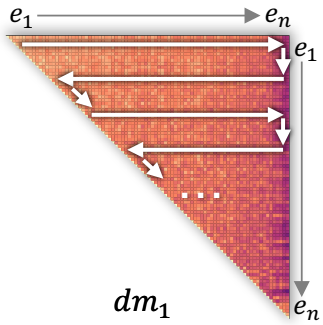


Data Space

$\stackrel{?}{=}$

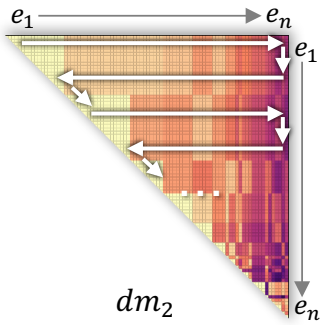


Data Space

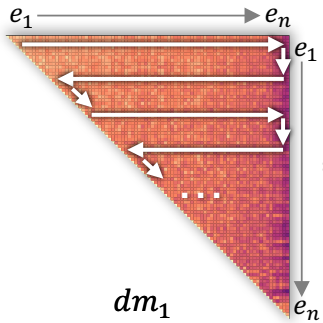


Data Space

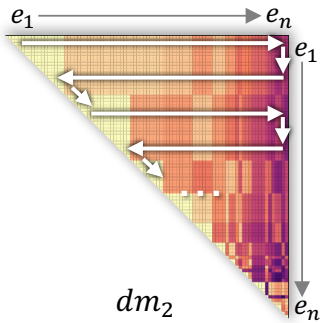
$\stackrel{?}{=}$



Data Space



$$= \begin{pmatrix} dist(e_1, e_1) \\ dist(e_2, e_1) \\ dist(e_3, e_1) \\ \dots \\ dist(e_{n-1}, e_n) \\ dist(e_n, e_n) \end{pmatrix} = \begin{pmatrix} dist_1 \\ dist_2 \\ dist_3 \\ \dots \\ dist_{n-1} \\ dist_n \end{pmatrix} \overset{?}{=} \begin{pmatrix} dist_1 \\ dist_2 \\ dist_3 \\ \dots \\ dist_{n-1} \\ dist_n \end{pmatrix} = \begin{pmatrix} dist(e_1, e_1) \\ dist(e_2, e_1) \\ dist(e_3, e_1) \\ \dots \\ dist(e_{n-1}, e_n) \\ dist(e_n, e_n) \end{pmatrix} =$$



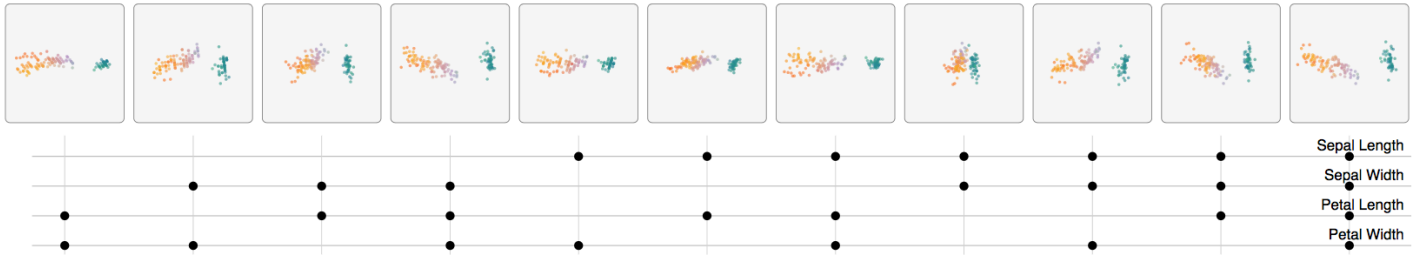
Data Space

Data Space

$$d(dm_1, dm_2) = \sqrt{\sum_{i=1}^{n} (dm_{1_i}, dm_{2_i})^2}$$

Example: **IRIS** Dataset

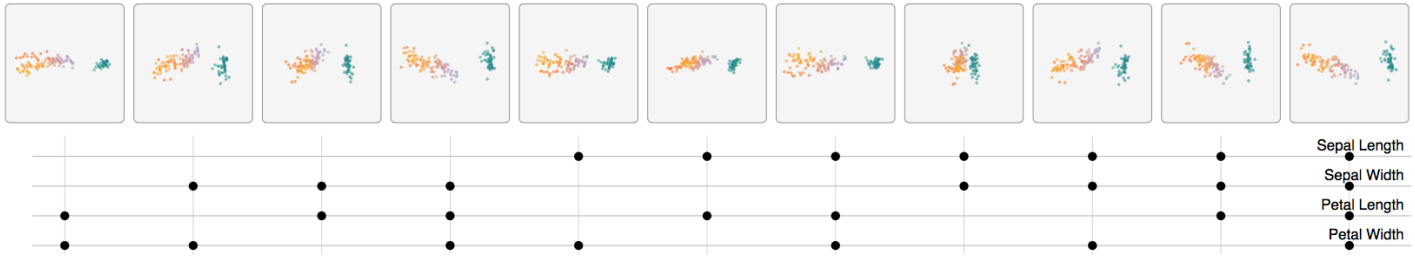
Subspace Projections:



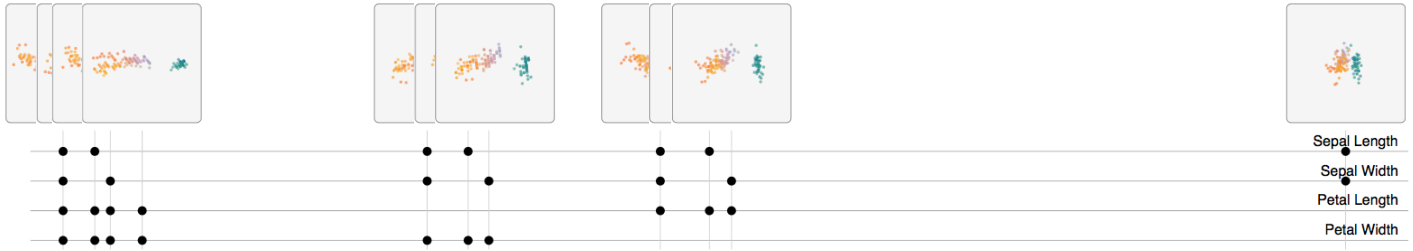
Ordering & Grouping:

Example: **IRIS** Dataset

Subspace Projections:

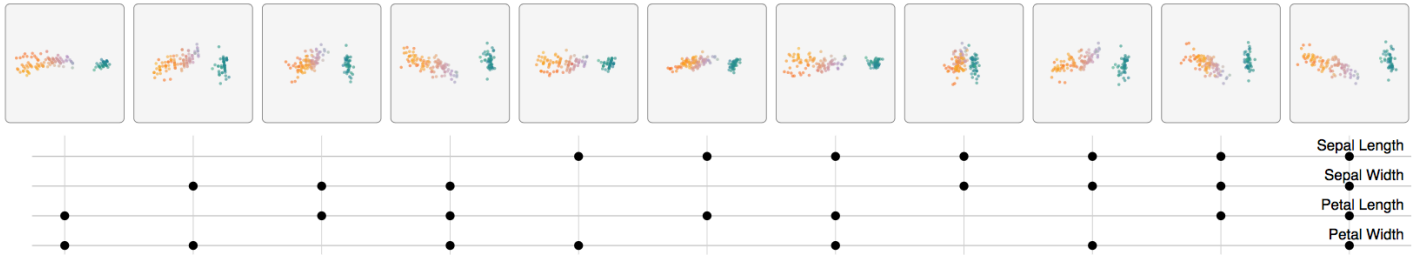


Ordering & Grouping:

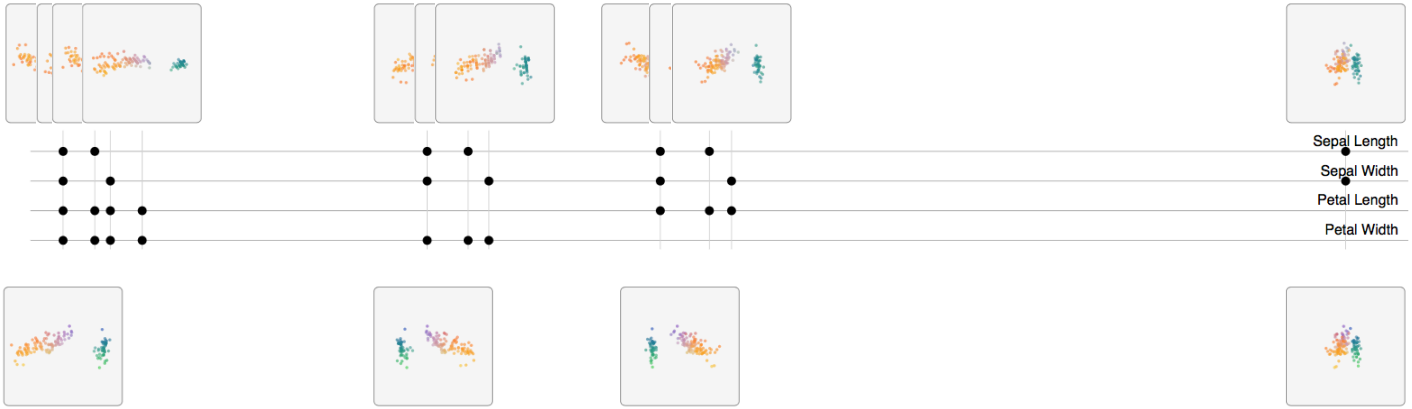


Example: **IRIS** Dataset

Subspace Projections:

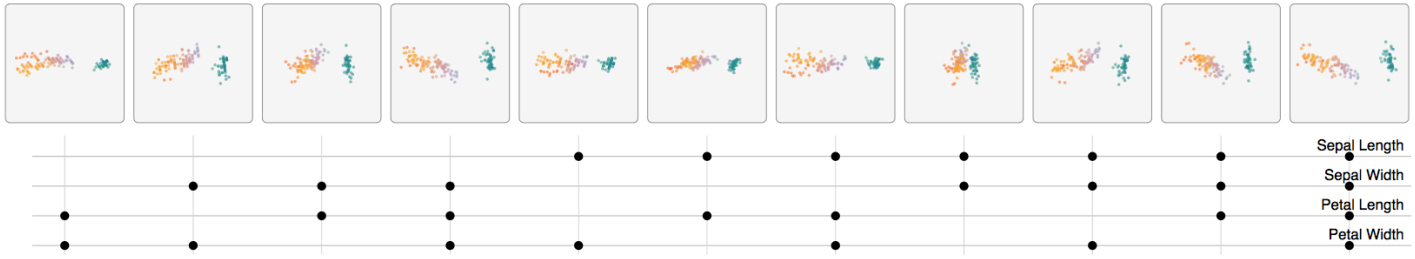


Ordering & Grouping:

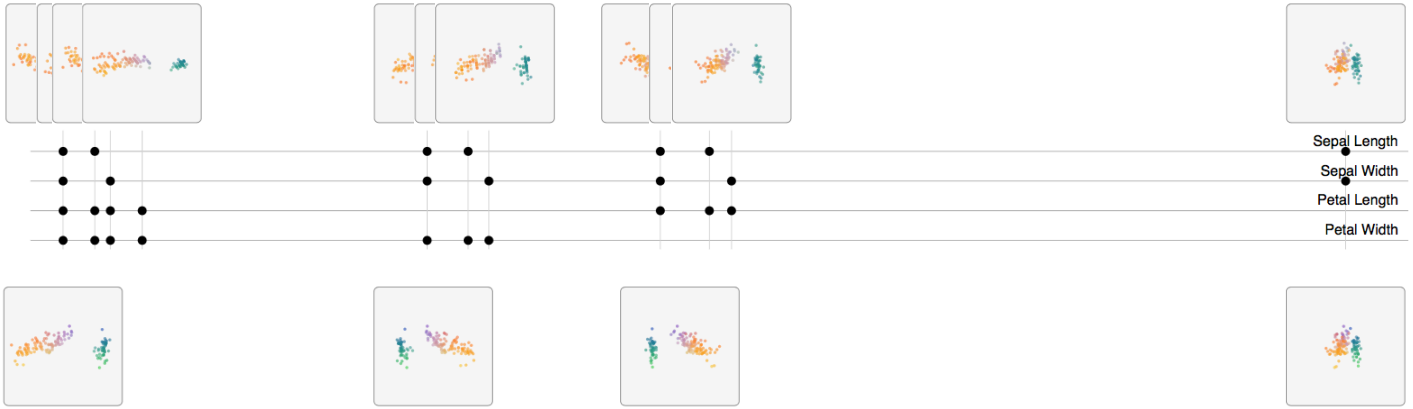


Example: **IRIS** Dataset

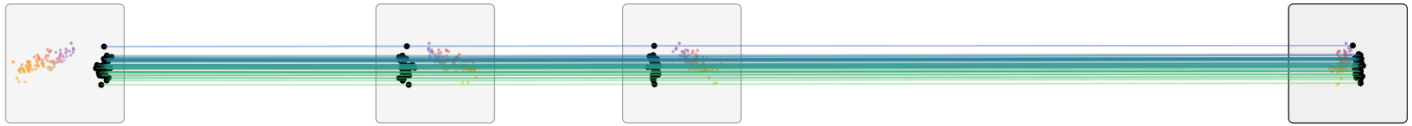
Subspace Projections:



Ordering & Grouping:

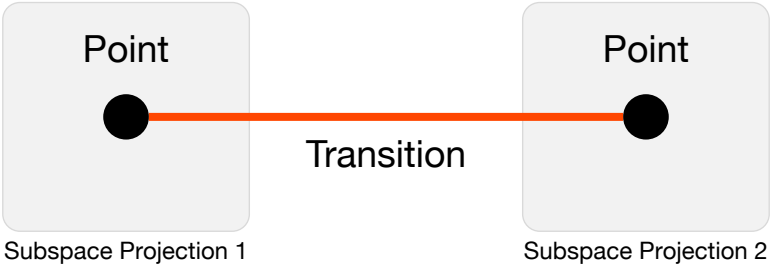


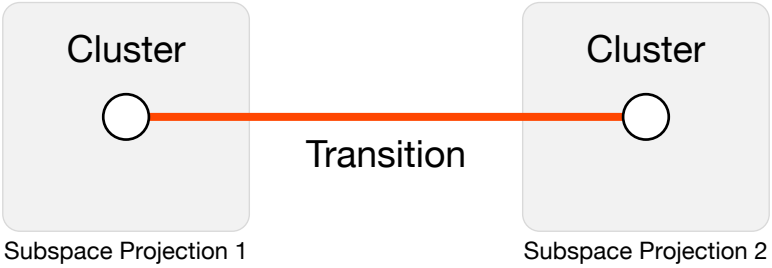
Pattern Trails:

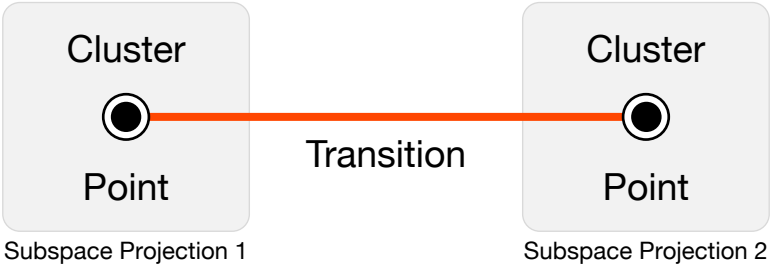


Pattern Transitions and their Interpretation

Subspace Projection 1


Point
Point
Transition
Subspace Projection 1
Subspace Projection 2


Cluster
Cluster
Transition
Subspace Projection 1
Subspace Projection 2

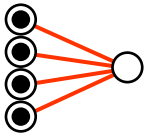

Cluster
Point
Transition
Cluster
Point
Subspace Projection 1
Subspace Projection 2

Taxonomy

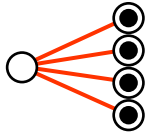
Single Point/Cluster

Multi Points/Clusters

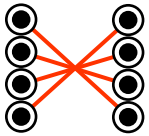
converging fan



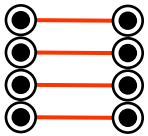
diverging fan



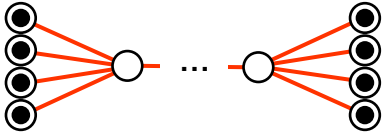
star/mirror



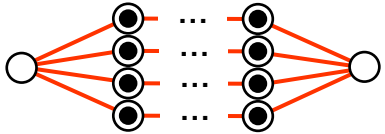
static



redundant single cluster



redundant multi points/clusters



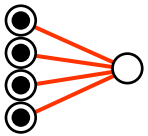
Legend:

Taxonomy

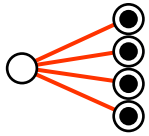
Single Point/Cluster

Multi Points/Clusters

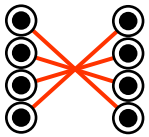
converging fan



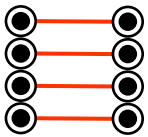
diverging fan



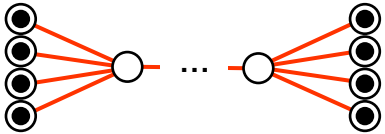
star/mirror



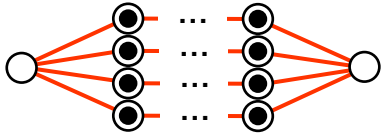
static



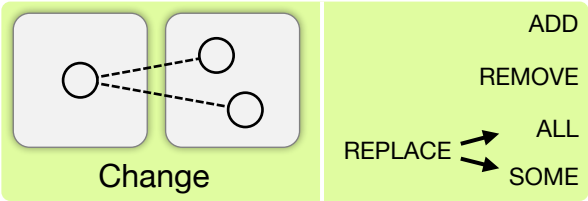
redundant single cluster

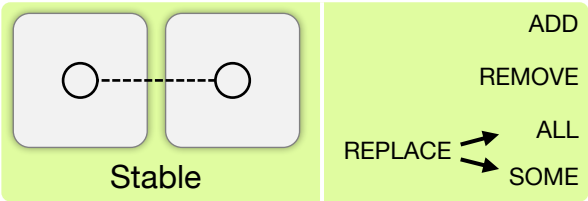


redundant multi points/clusters



Attribute Impact:





Legend:

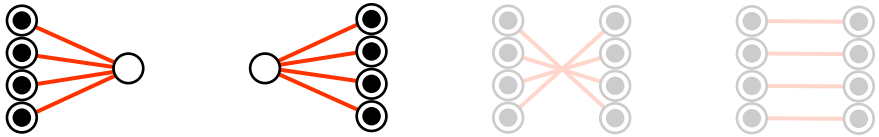
Cluster ● Point Cluster or Point Cluster-to-Cluster **v** Point-to-Point

Taxonomy

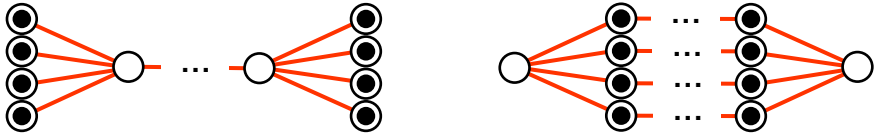
Single Point/Cluster

Multi Points/Clusters

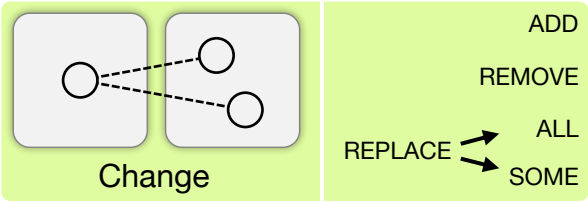
converging fan *diverging fan* *star/mirror* *static*



redundant single cluster *redundant multi points/clusters*



Attribute Impact:



Legend:

Cluster Point Cluster or Point Cluster-to-Cluster **v** Point-to-Point

Taxonomy

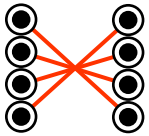
Single Point/Cluster

Multi Points/Clusters

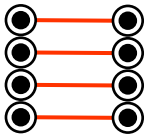
converging fan

diverging fan

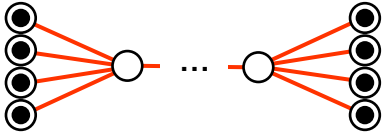
star/mirror



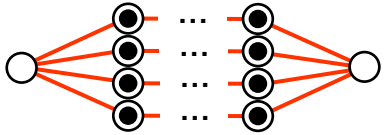
static



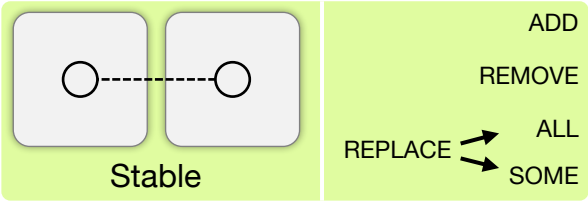
redundant single cluster



redundant multi points/clusters



Attribute Impact:



Legend:

Cluster · Point · Cluster or Point · Cluster-to-Cluster **v** Point-to-Point

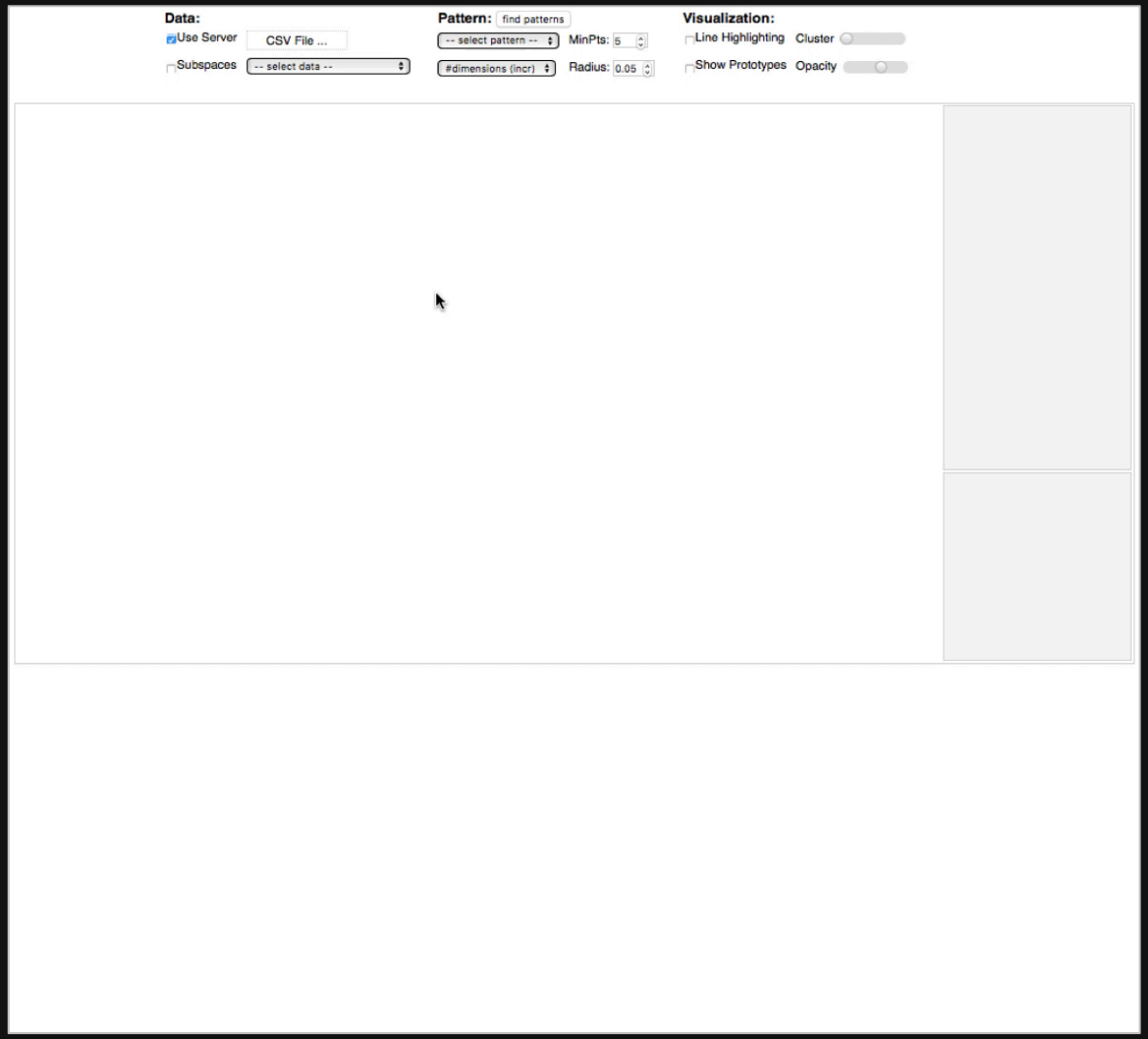
Use Case: University Rankings

Attributes:

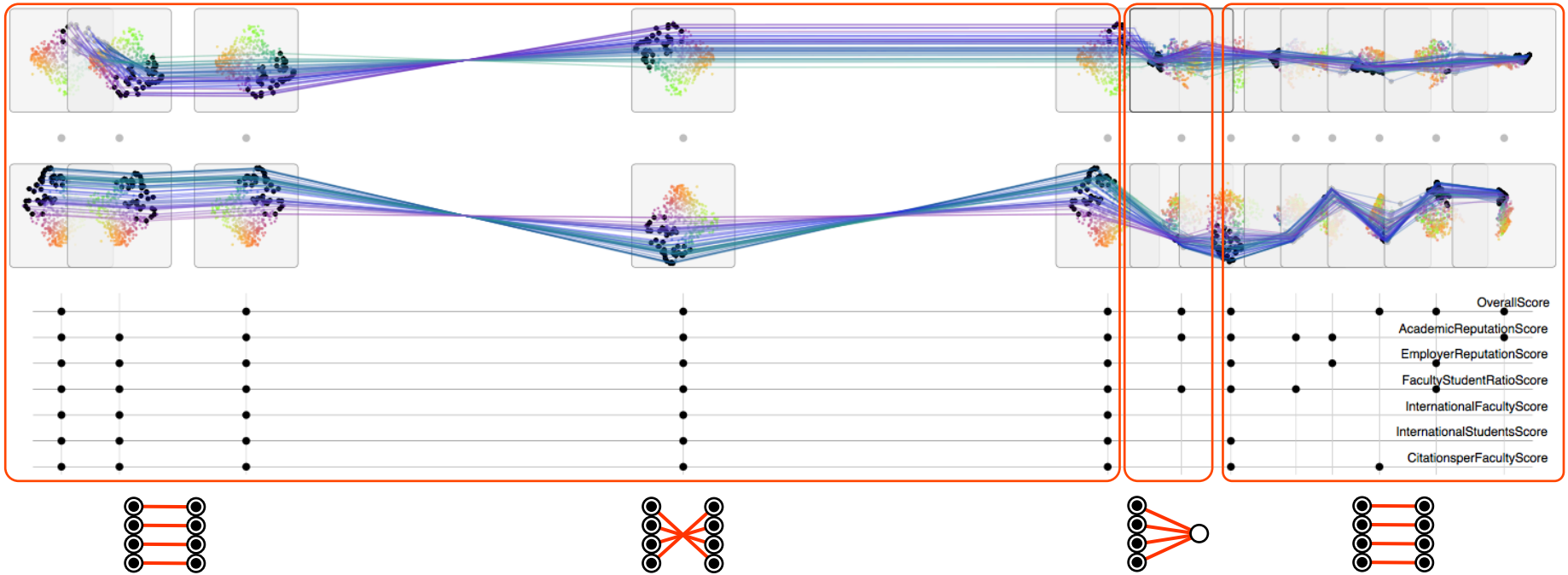
1. Overall Score
2. Academic Reputation Score
3. Employer Reputation Score
4. Faculty Student Ratio Score
5. International Faculty Score
6. International Students Score
7. Citations per Faculty Score

Source: www.uni-konstanz.de

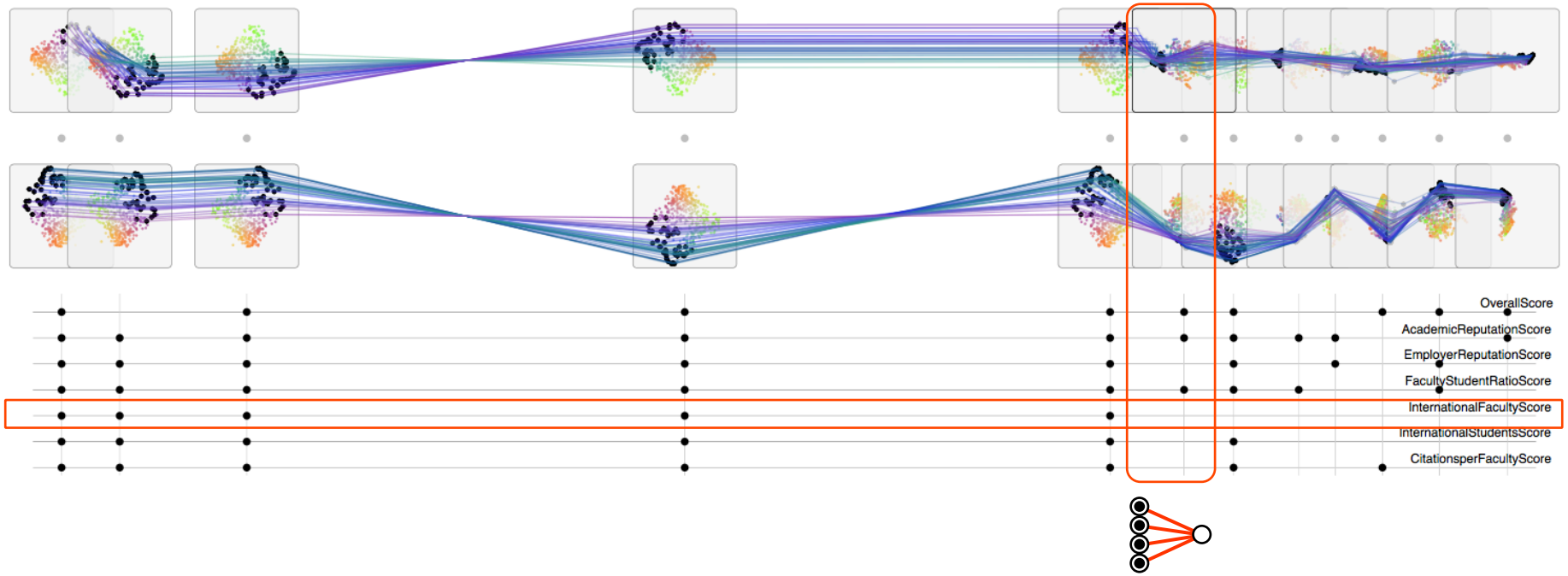
Manual analysis:



Manual analysis:

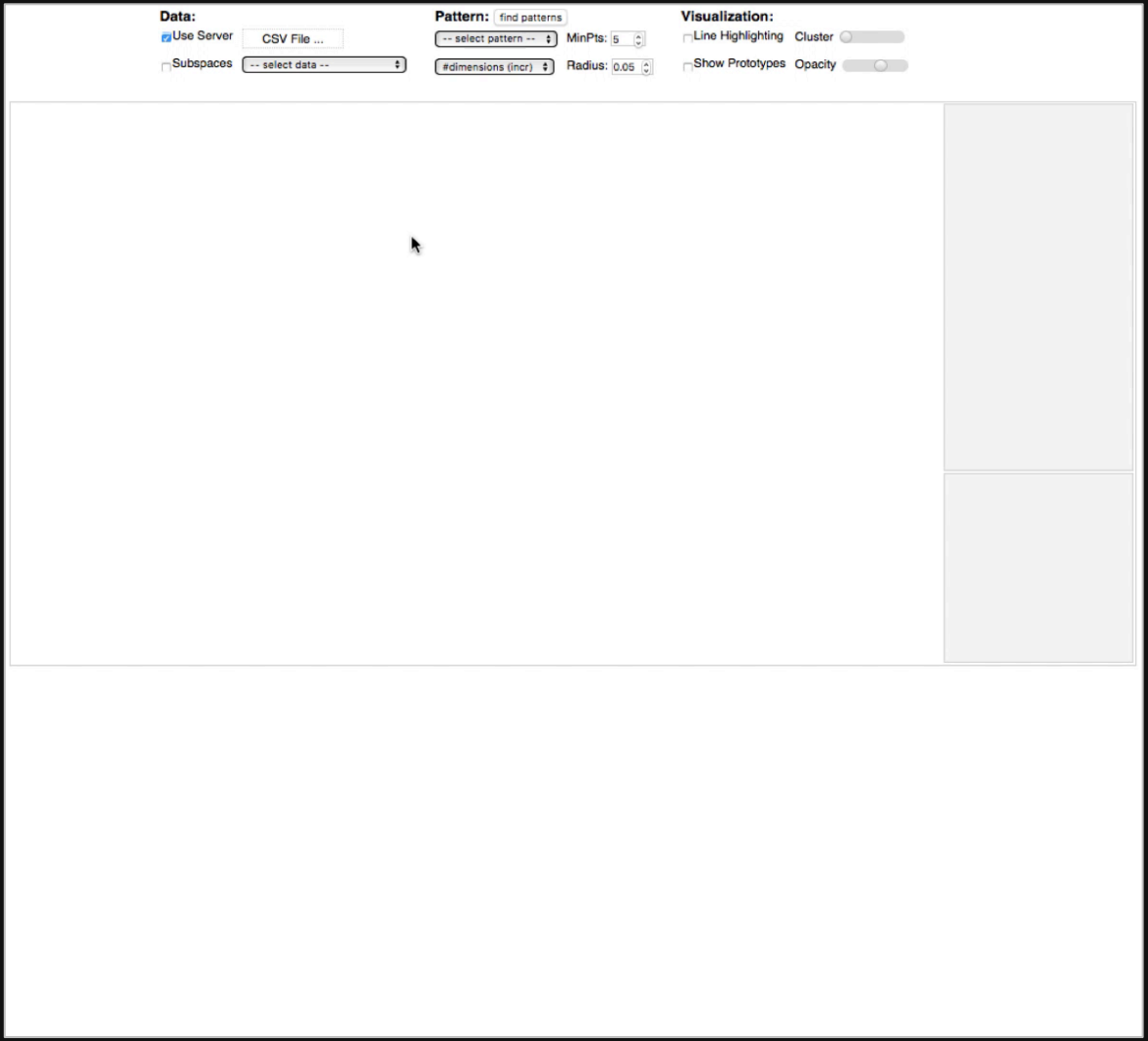


Manual analysis:



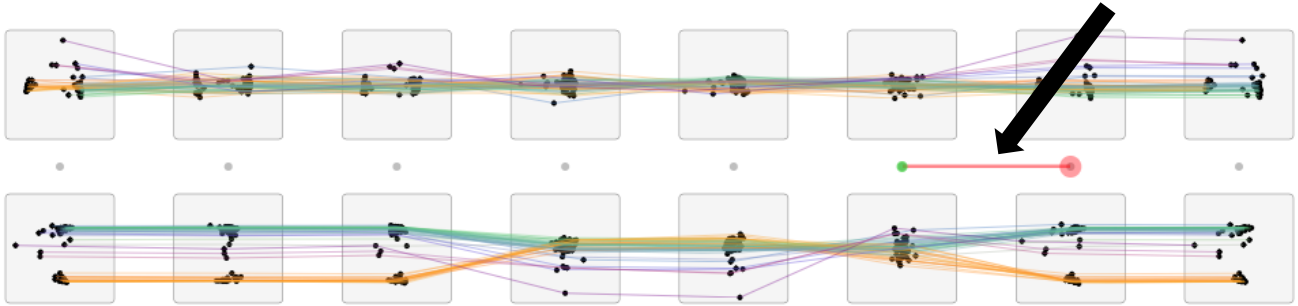
→ **International Faculty Score** has a dominating effect on the subspace structure

Automatically aided analysis:



Automated Support

… for identifying patterns between adjacent subspace projections:



… for interpreting pattern transitions:

Conclusion

Open research questions:

1. Attribute redundancy
2. Expressiveness of subspace projections
3. Ordering
4. Scalability

→ **Pattern Trails** is a visual interactive approach that includes the user to identify and explain interesting attributes

Universität Konstanz

TU Graz

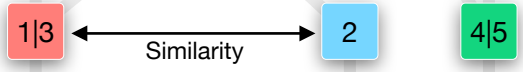
VIS 2017

① **Subspaces:**

Data subspaces are presented as scatterplots.
Similar scatterplots have a similar color.

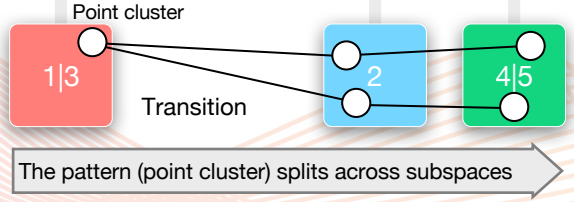
② **Ordering:**

Similar scatterplots are grouped based on similarity.



③ **Pattern Trails:**

Changes of selected patterns can be tracked.



THANK YOU!

Website: **http://dominikjaeckle.com/projects/2017/pattern_trails/**

Dominik Jäckle

Michael Hund

Michael Behrisch

Daniel A. Keim

Tobias Schreck