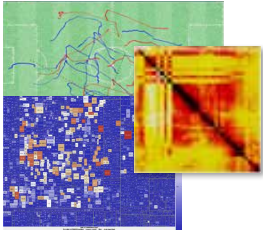
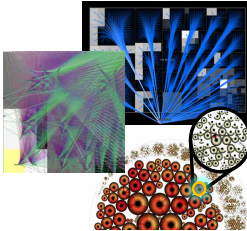


The Role of Visual Analytics in Exploring Graph Data



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Data Analysis and Information
Visualization Group
University of Konstanz, Germany



Graph Drawing & Network Visualization, Athens
September 20, 2016

The Limits of Automated GD Methods

Fully Automated Graph Drawing only works under certain preconditions!

Preconditions:

- Data is clearly structured and semantics is well-defined
- Data is complete, correct, and not changing over time

AND

- Exploration goals are well-defined

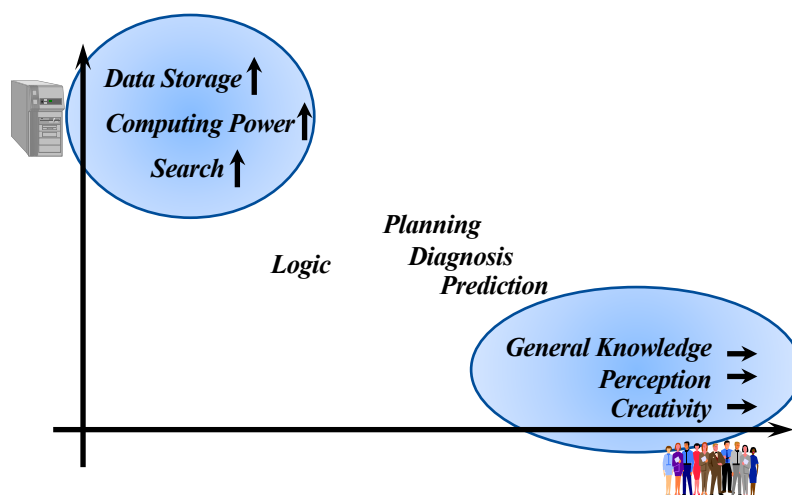
Big Data Applications

- **Network Security**
 - Data: IP Flows
 - Task: Detection of Novel Viruses
- **Fraud Detection**
 - Data: Credit Card (or Phone Call) Data
 - Task: Detection of Fraud
- **Business Analytics**
 - Data: Customer Records
 - Task: Define Customer Target Groups
- **Molecular Biology**
 - Data: Genetic Pathways
 - Task: Functional Root Cause Analysis for an Illness

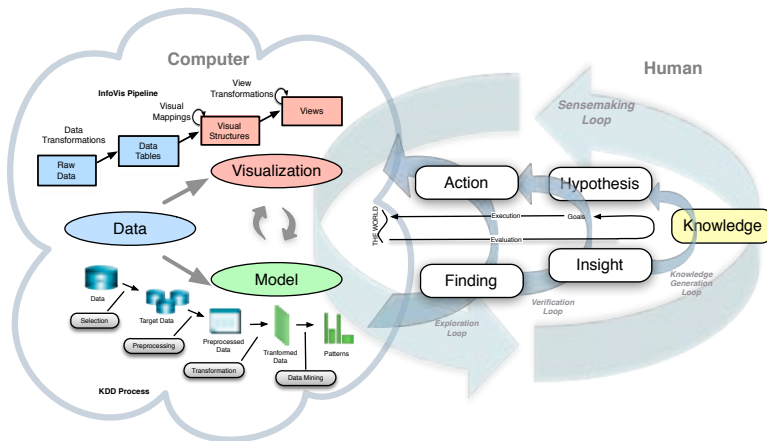
"Computers are incredibly fast, accurate, and stupid; humans are incredibly slow, inaccurate, and brilliant; together they are powerful beyond imagination."

Albert Einstein

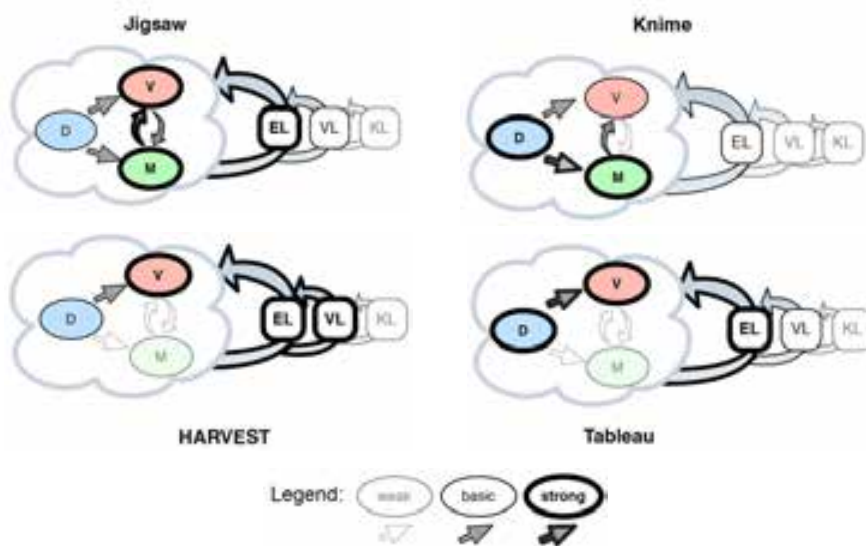
Abilities of Humans and Computers



Visual Analytics

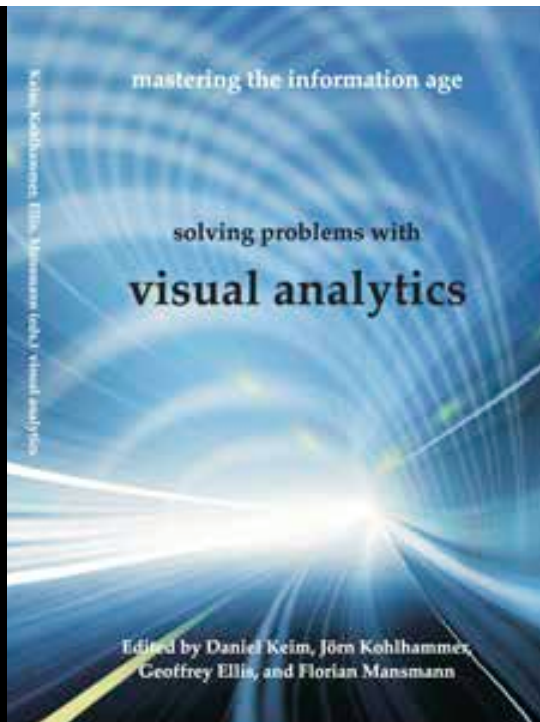


The Role of the Human in Visual Analytics



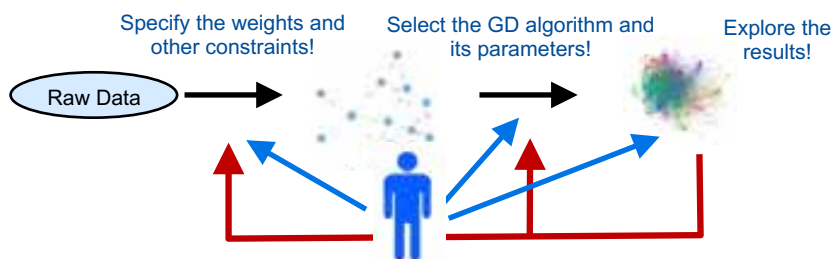
Roadmap from the
VisMaster EU Project

www.visual-analytics.eu



Graph Drawing

Simplified Graph Drawing Pipeline



Iteration needed in real applications!

Graph Drawing

Graph drawing is usually a small part of the complex application task.

Humans with their

- background knowledge
- understanding of the task, and
- ability to judge the graph drawing results

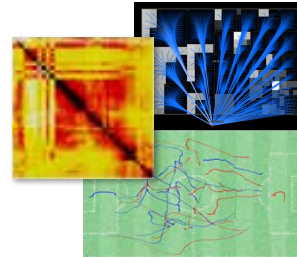
Are essential for solving complex application tasks.

Visual Analytics is not needed if

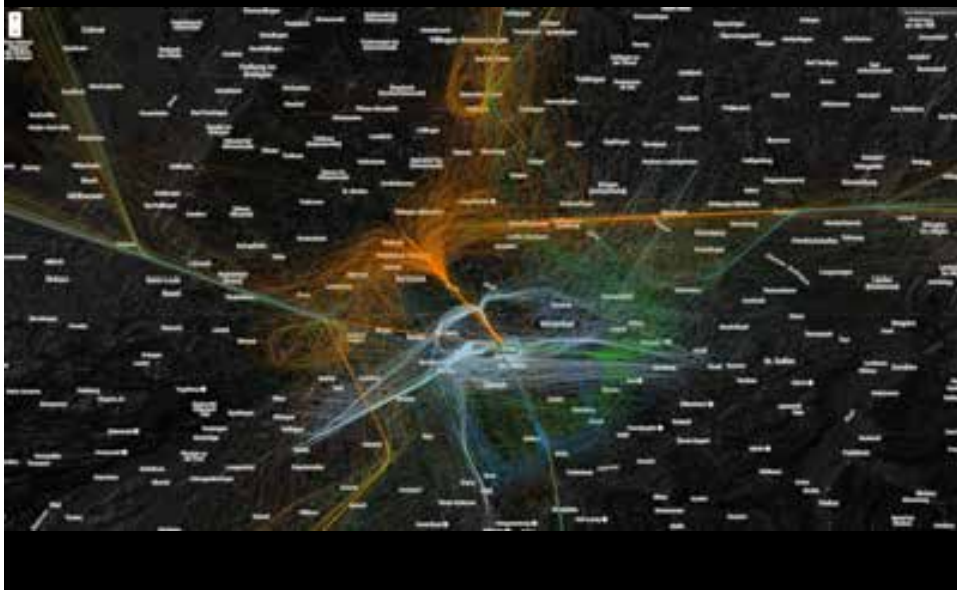
- **The semantics of nodes and links are well defined.**
- **The data is complete, correct, and not changing over time.**
- **The task (optimization functions) is clearly defined.**
- **The algorithm and parameter settings which provide the best result for the task are known.**

Outline

- **Role of Visual Analytics**
 - Challenges of Graph Data
 - Definition of Visual Analytics
- **Visual Analytics Examples**
 - Network Security Analysis
 - Matrix Analysis
 - Discussion Analysis
 - Soccer Analysis
- **Visual Analytics Perspectives**

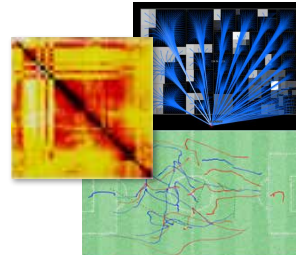


Flight Data Analysis



Outline

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 - **Network Security Analysis**
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 - Discussion Analysis
 - Soccer Analysis
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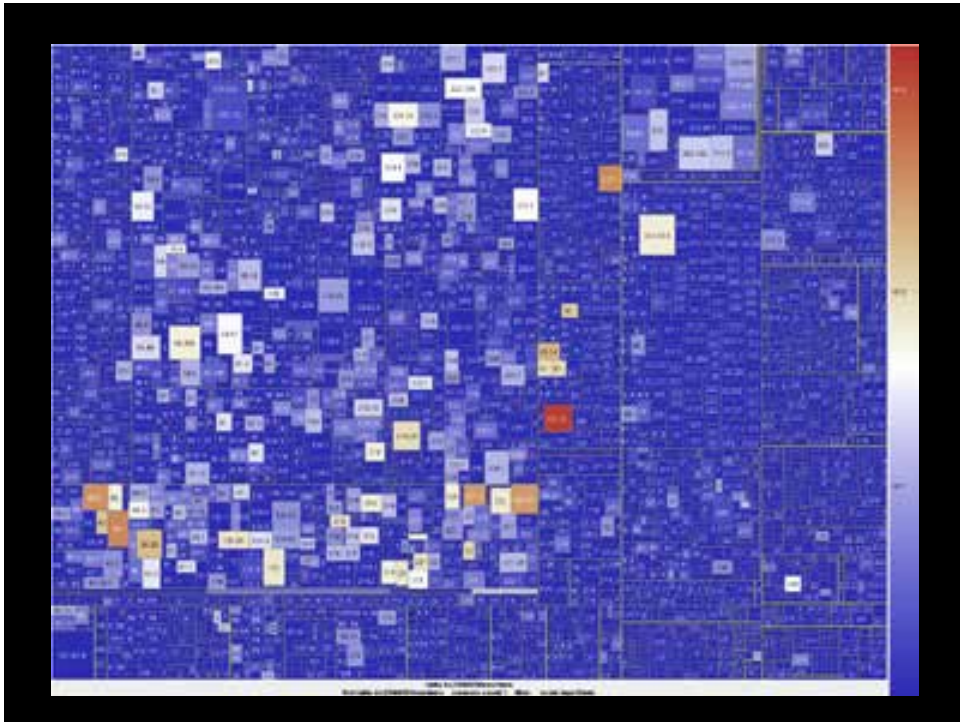
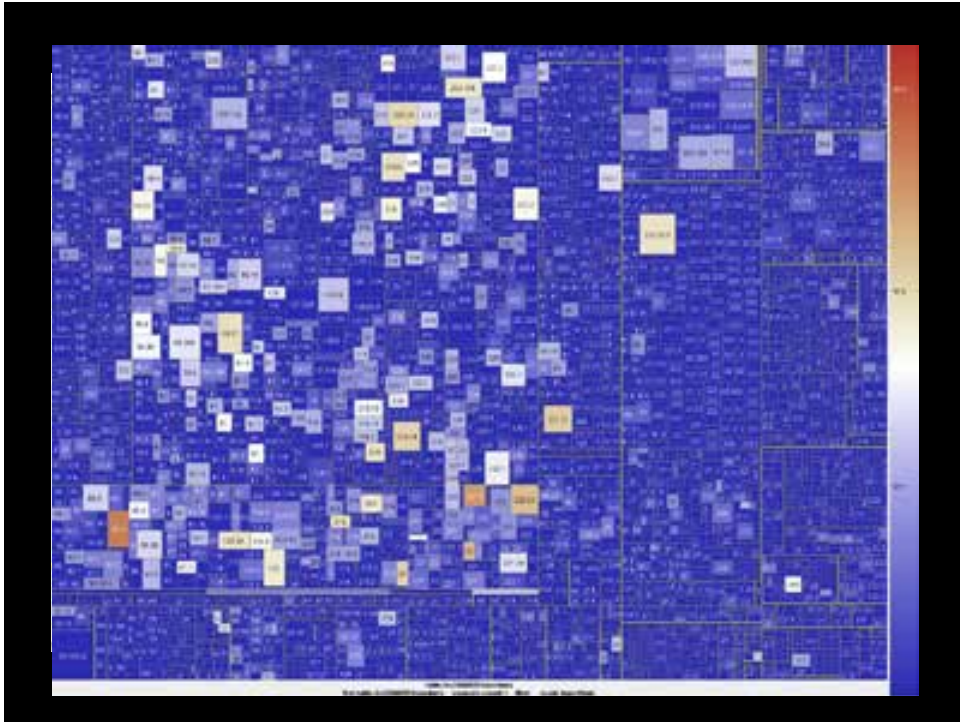


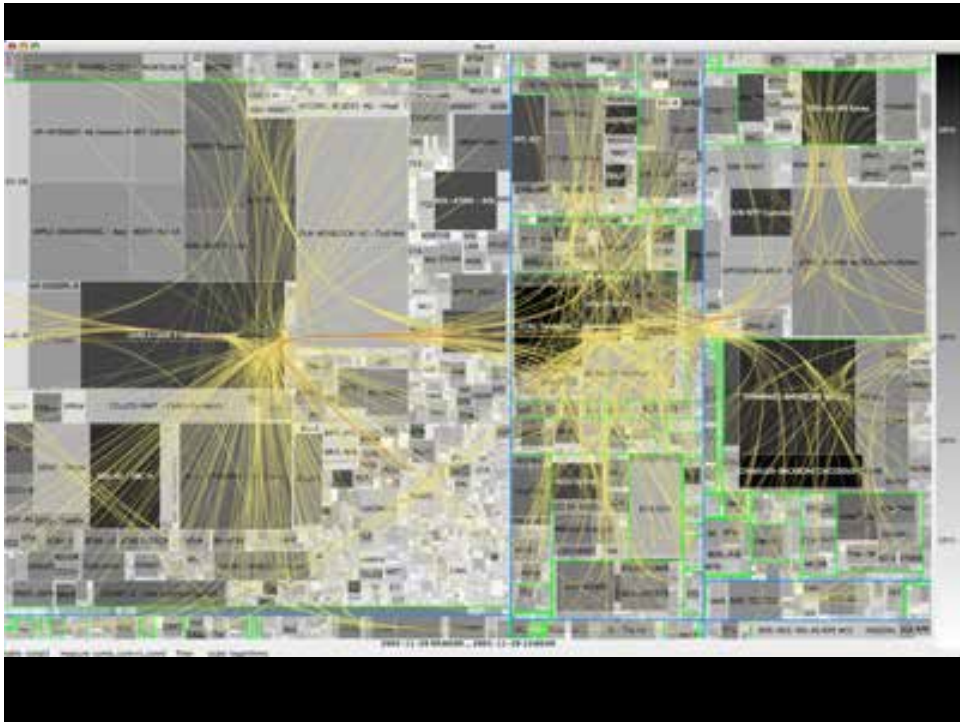
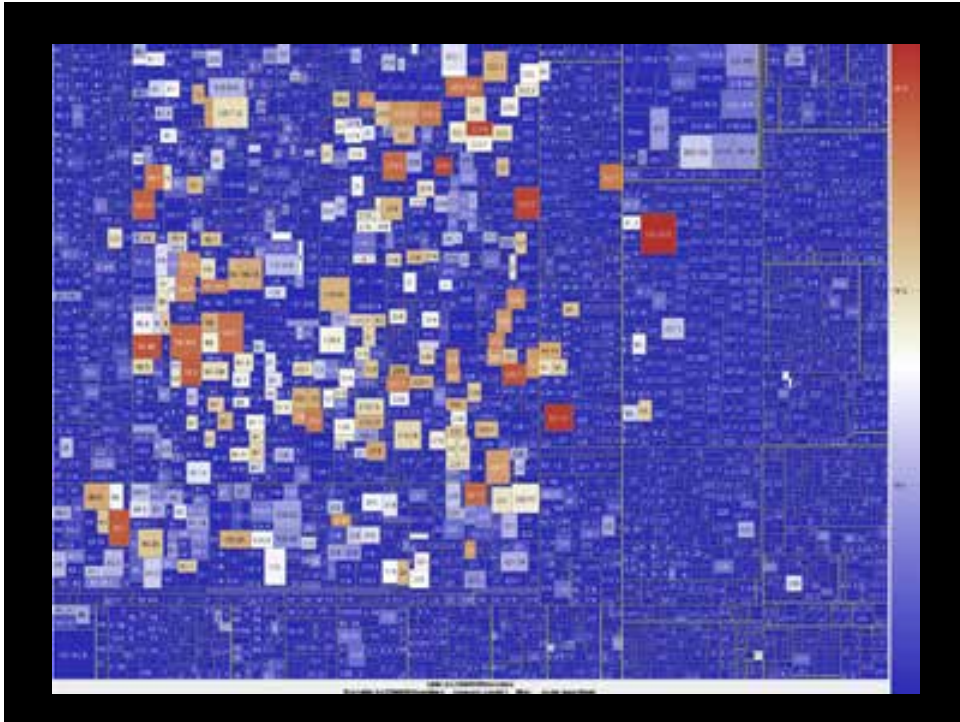
Network Security Analysis

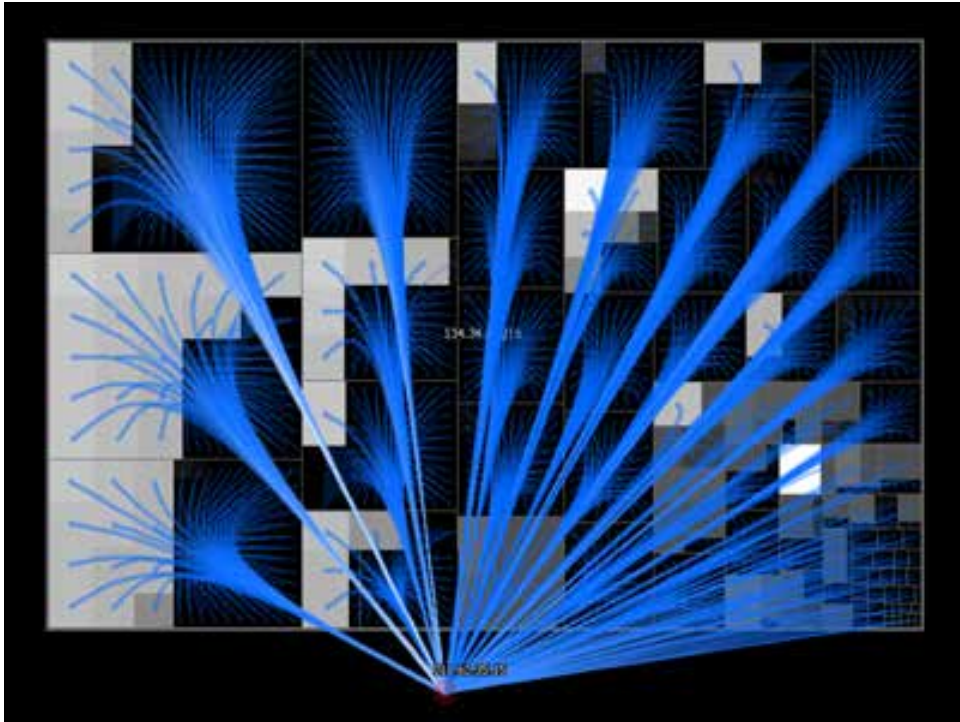


Hierarchy:

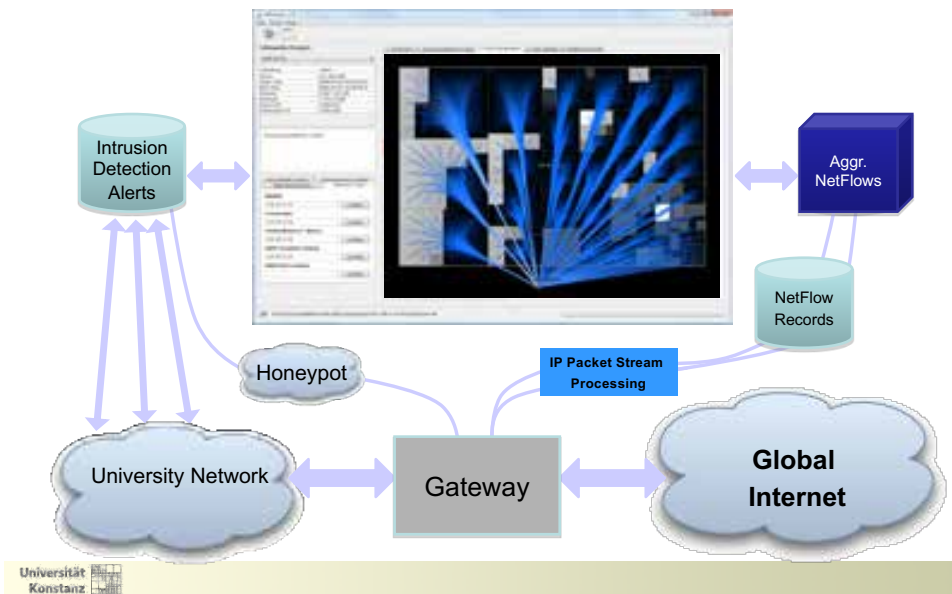
- **Continents**
- **Countries**
- **Autonomous Systems**
- **Networks**



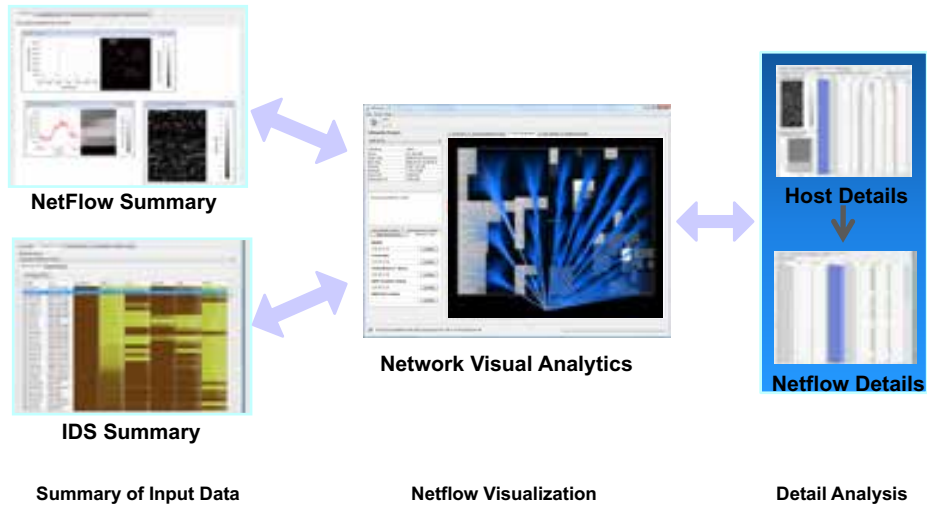




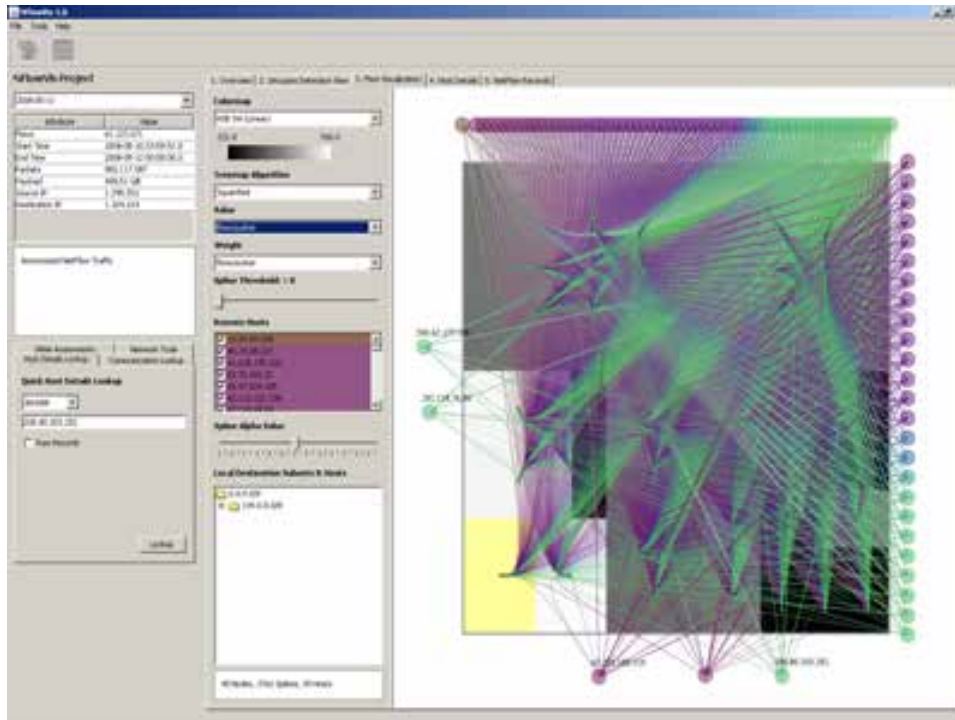
Network Security Analysis

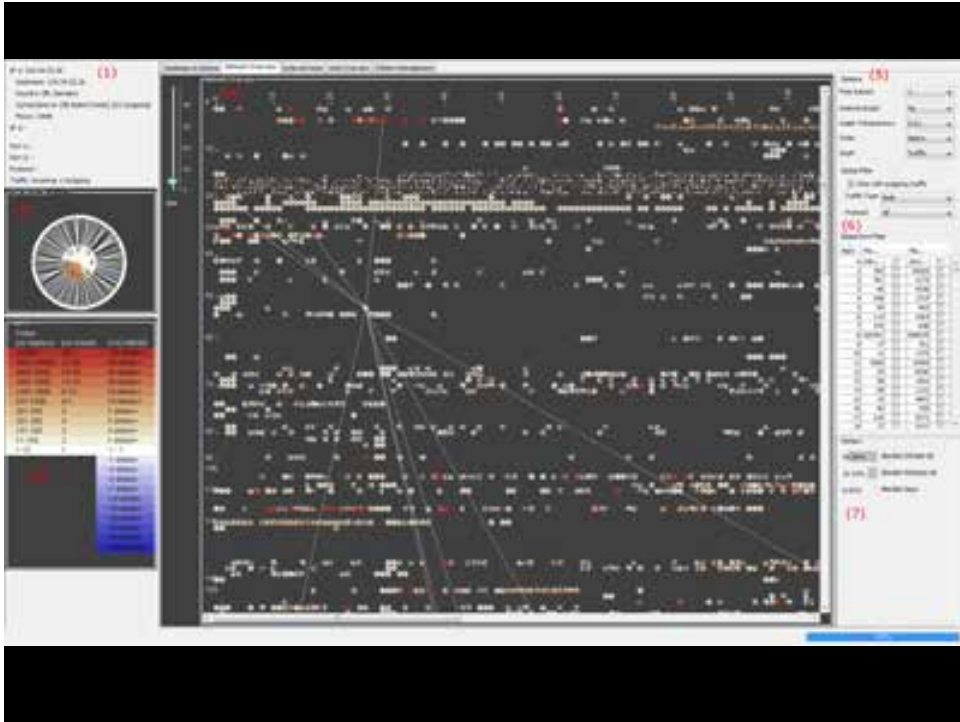


Visual Network Analysis

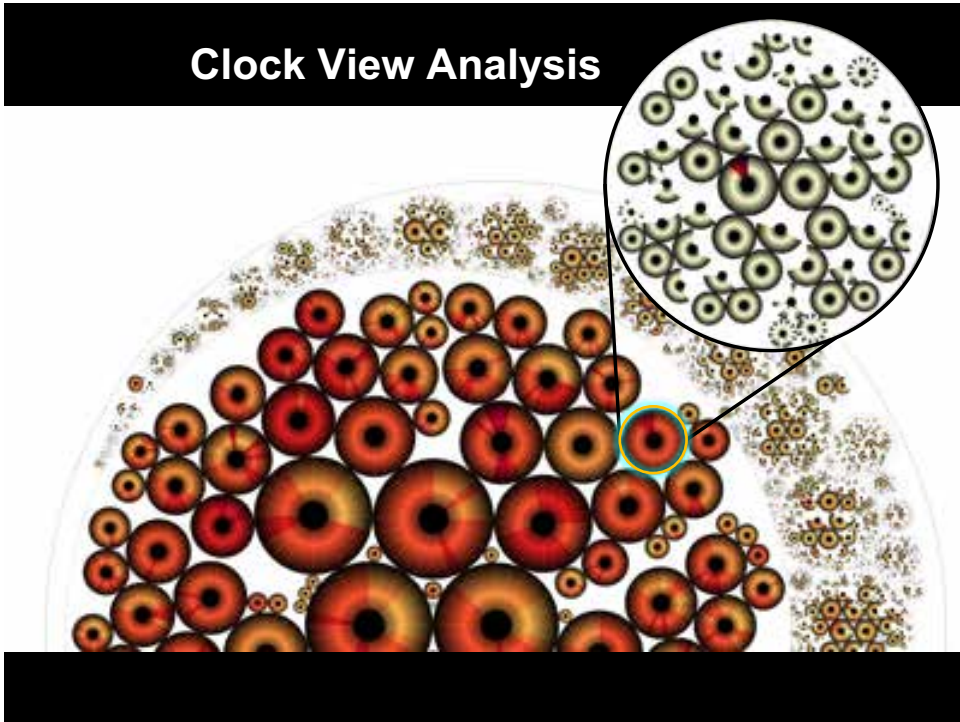


Universität
Konstanz





Clock View Analysis



Visual BGP Attack Analysis

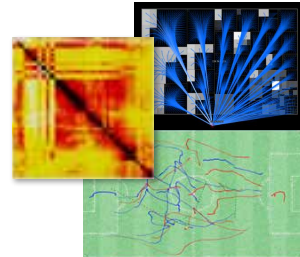


Uni Konstanz Control Room



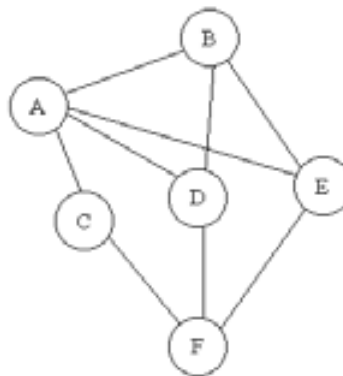
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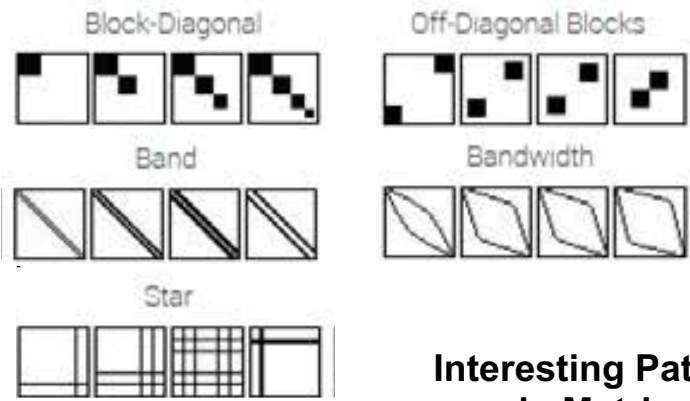


Matrix Analysis

	A	B	C	D	E	F
A	-	1	1	1	1	
B	1	-		1	1	
C	1		-			1
D	1	1		-		1
E	1	1			-	1
F			1	1	1	-

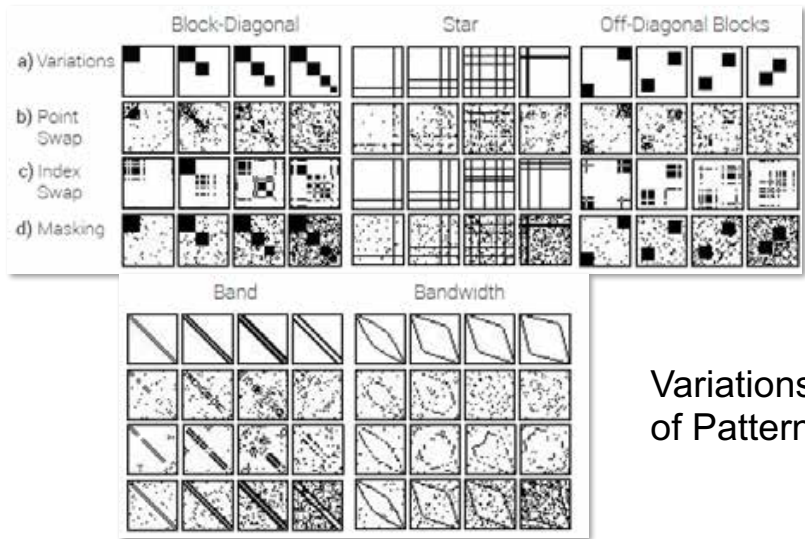


Matrix Analysis



**Interesting Patterns
in Matrices**

Matrix Analysis



Variations
of Patterns

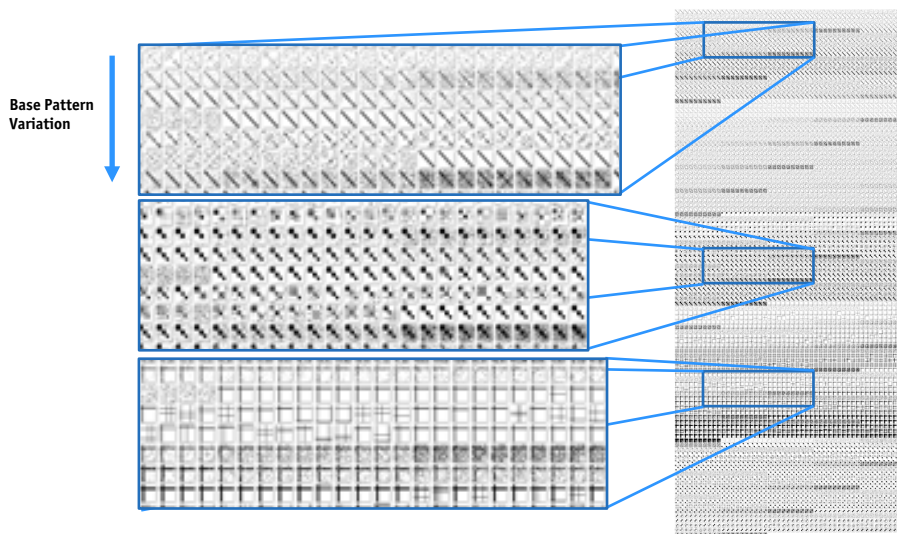
Matrix Analysis

Feature Descriptor	Group	Reference
GLOBAL_COLOR_HISTOGRAM	Color	[30]
AUTO_COLOR_CORRELOGRAM		[18]
FUZZY_HISTOGRAM		[33]
FUZZY_OPPOSITE_HISTOGRAM		[41]
COLOR_OPPOSITE_HISTOGRAM	[41]	
TREMSAL	Color Layout	[32]
MPEG7_COLOR_LAYOUT		[20]
LUMINANCE_LAYOUT		[23]
CEDE	Edge	[8]
HCTH		[9]
ICD		[8, 32]
EDGEHINT	Edge	[36]
MPEG7_EDGE_HISTOGRAM		[27]
BOUGH	Point of Interest	[37]
SURE		[3]
FAST	Shape	[29]
BLUCKE		[34]
COMPACTNESS	Shape	[25]
ECCENTRICITY		[47]
ADAPTIVE_GRID_RESOLUTION	Structure	[40]
JPEG_COEFFICIENT_HISTOGRAM		[23, 24]
PROFILES	Texture	[35]
FRactal_Box_Counter		[37]
PHOG	Texture	[7]
HARALICK		[14]
GABER	Texture	[23]
TOMURA		[38]
LOCAL_BINARY_PATTERN	Texture	[15]
NOISE_STATISTICAL_SLIDING_WINDOW		[1]
NOISE_DISSIMILARITY	Texture	[1]
GRAINENT		[42]

Table 1: Overview over all tested feature descriptors (FDs). FD names are hyperlinks to access an interactive FD profile page with amongst others a distance-to-noise and a distance-to-best ranking.

Analysis by
Image Feature
Descriptors

Matrix Analysis



Matrix Analysis

- **Pattern Response**

To which specific matrix pattern(s) does the FD respond?

- **Pattern Variability**

How much variation in the pattern can the FD detect?

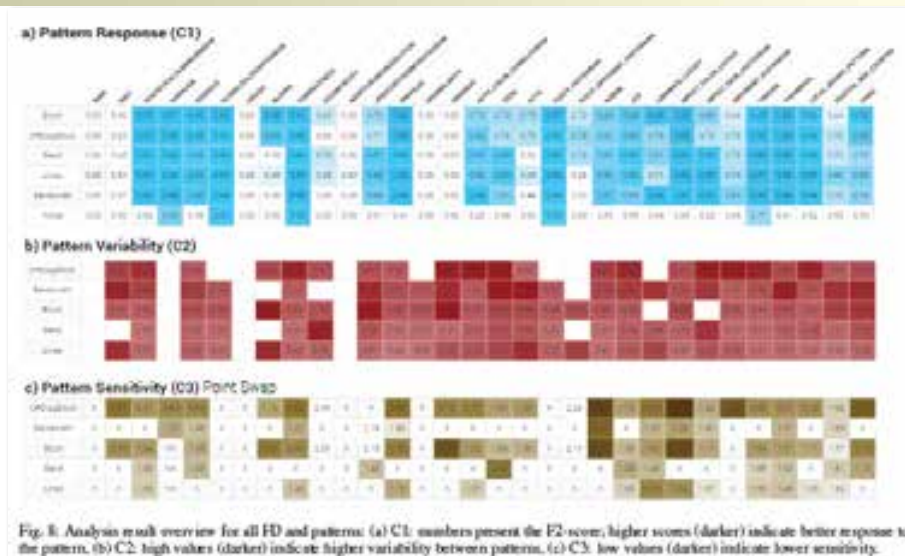
- **Pattern Sensitivity**

How sensitive is the FD to pattern degeneration (noise)?

- **Pattern Discrimination**

How different does the FD respond to different patterns?

Matrix Analysis



Matrix Analysis

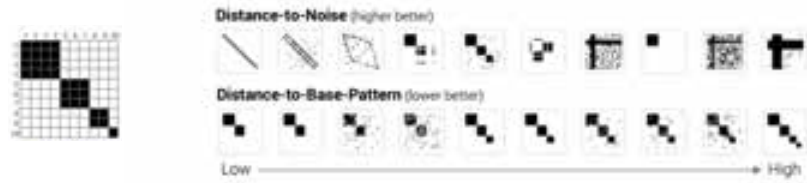


Figure 1.10 Examples for our Block Descriptor, specifically engineered to retrieve blocks around the matrix diagonal.

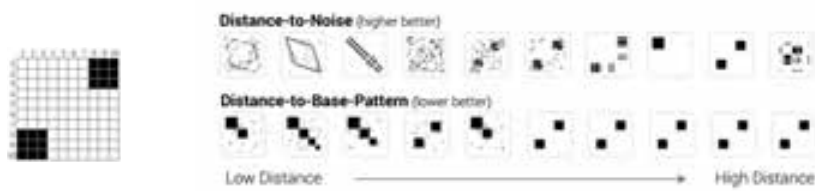


Figure 1.11 Examples for the Local Binary Pattern Descriptor.

Matrix Analysis

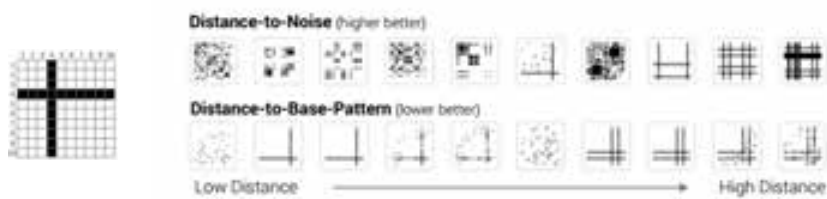


Figure 1.12 Examples for our Profile Descriptor.

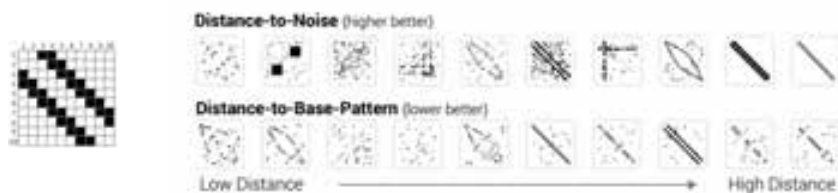


Figure 1.13 Examples for the MPEG7 Edge Histogram Descriptor.

Matrix Analysis

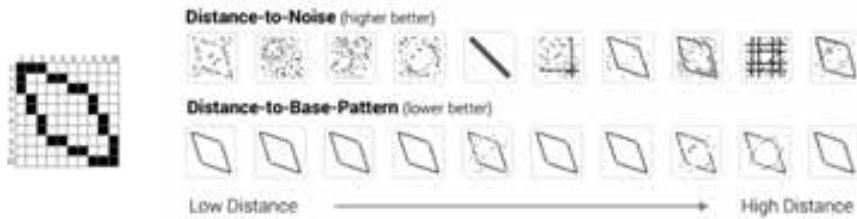


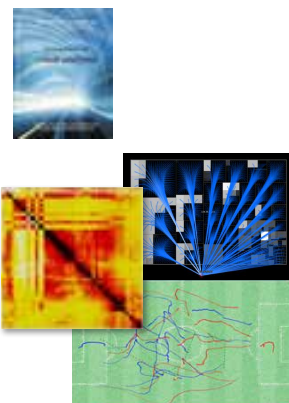
Figure 1.14 Examples for the CEDD Descriptor.



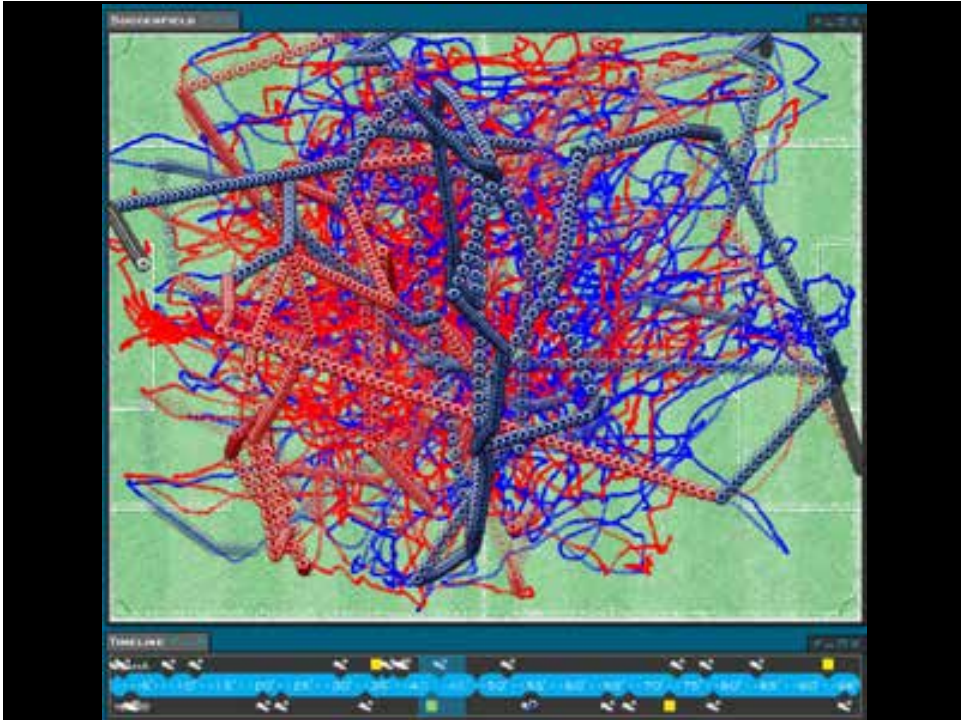
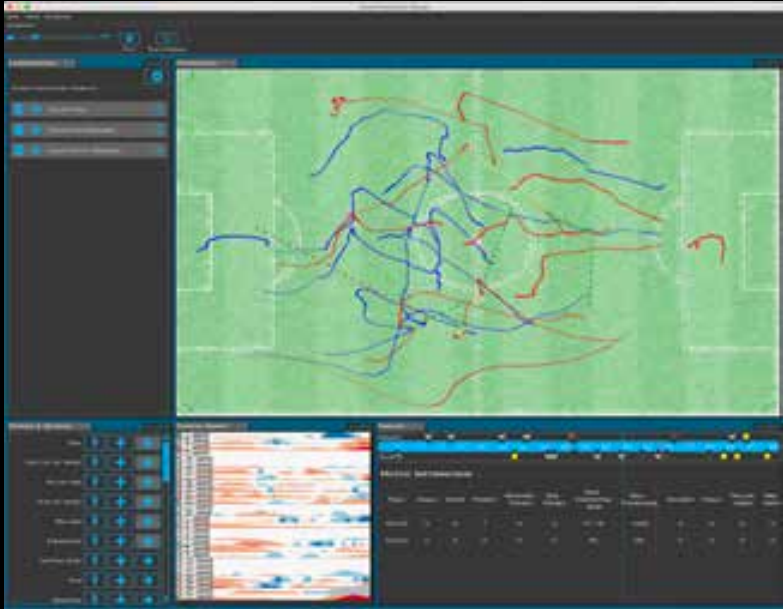
Figure 1.15 Examples for our STATISTICAL SLIDING WINDOW Descriptor.

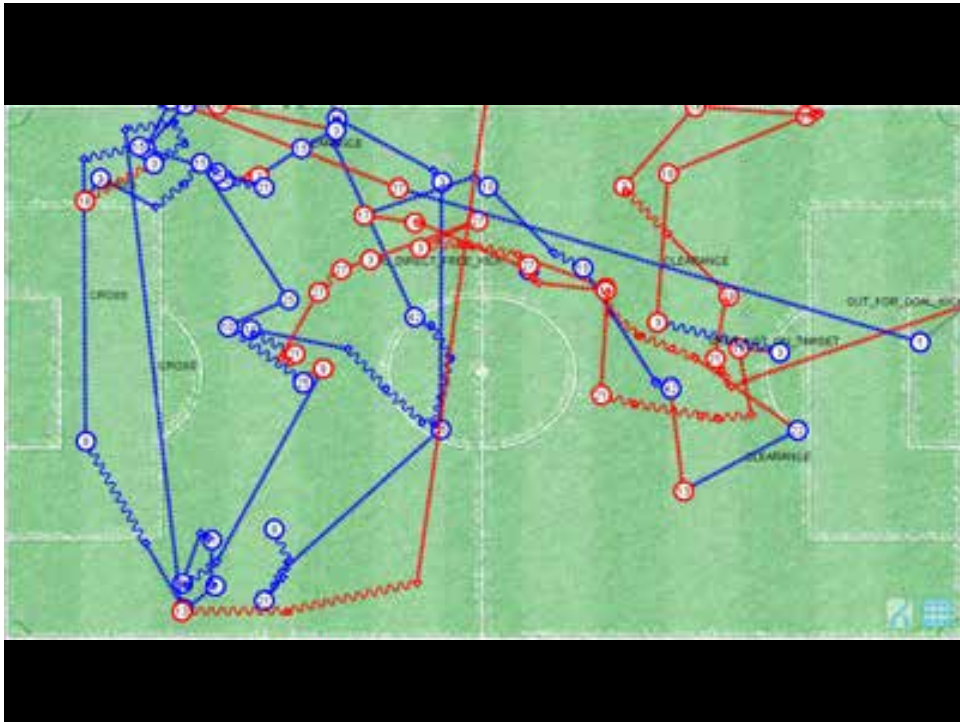
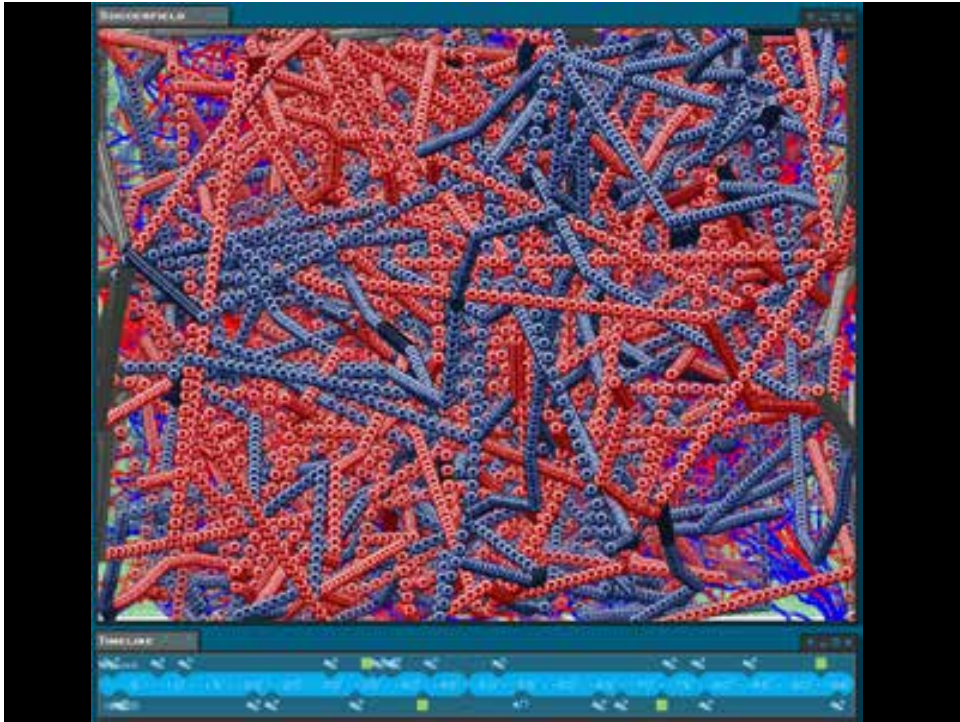
Outline

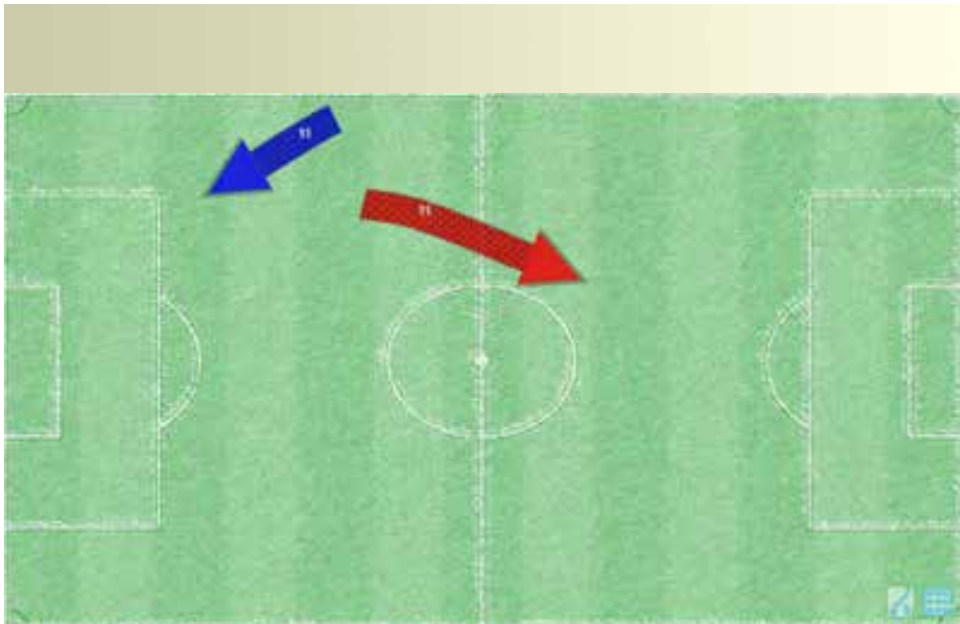
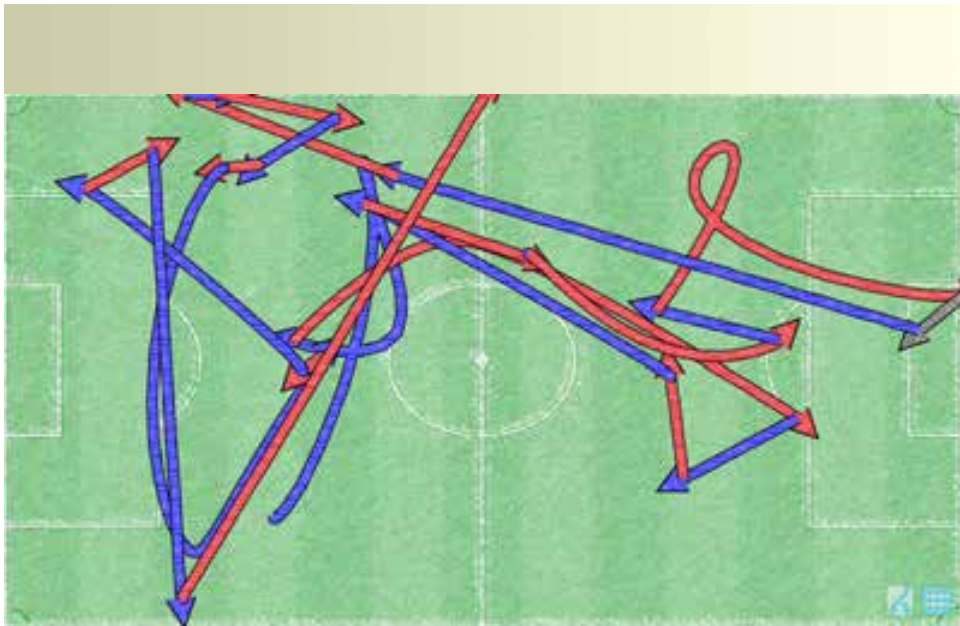
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Soccer Analysis

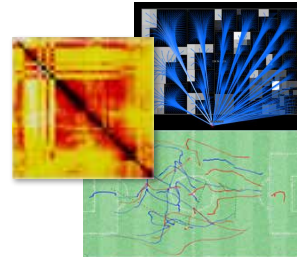






Outline

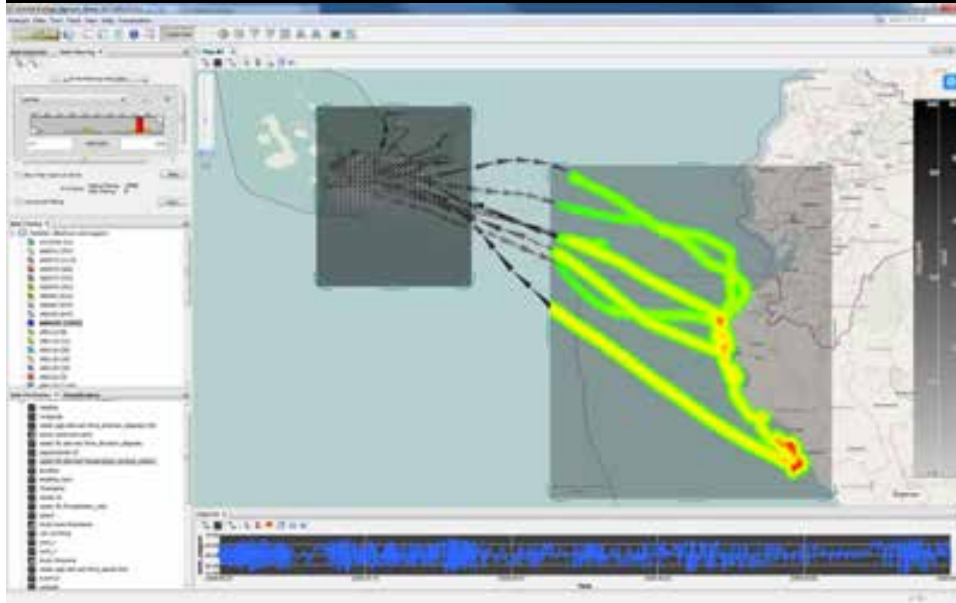
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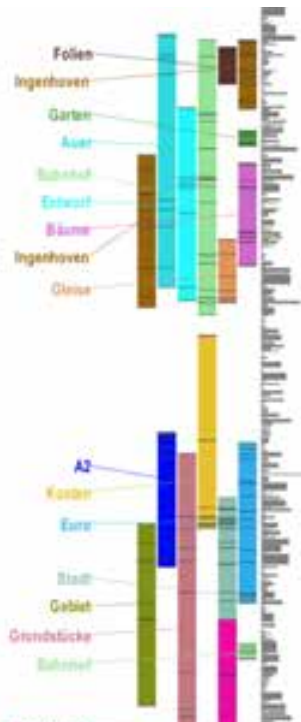
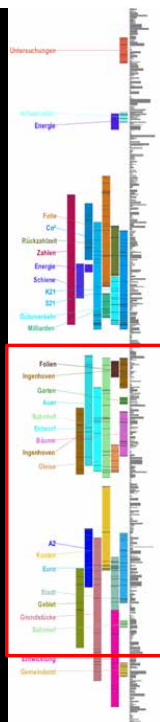
Geo-Spatial Movement Analysis



Geo-Spatial Movement Analysis



One day of the
Stuttgart 21
mediations

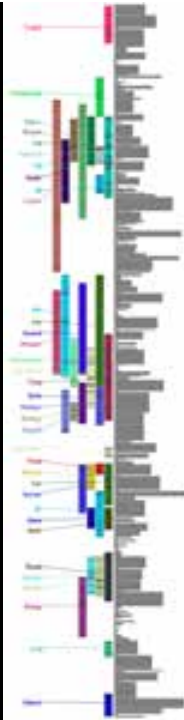


BMBF Project
VisArgue

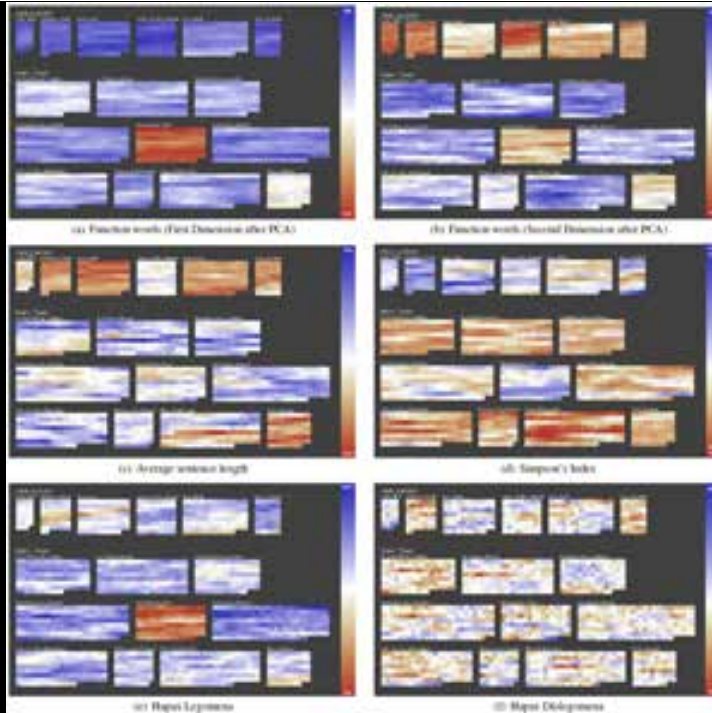
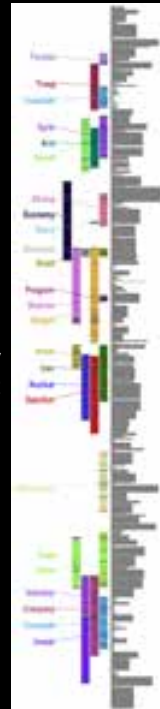
Comparison of
US-Presidential
Debates

Obama vs. McCain
2008

BMBF Project
VisArgue

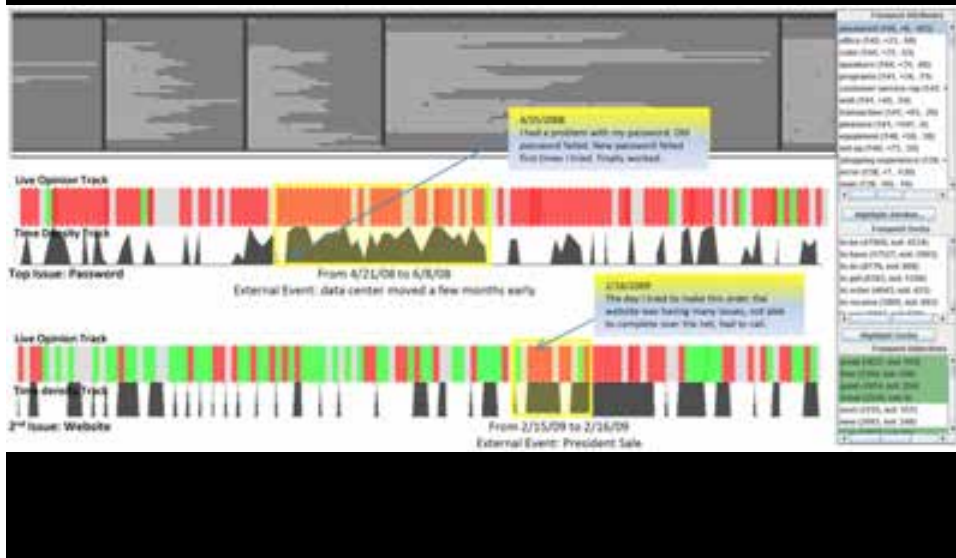


Obama vs. Romney
2012

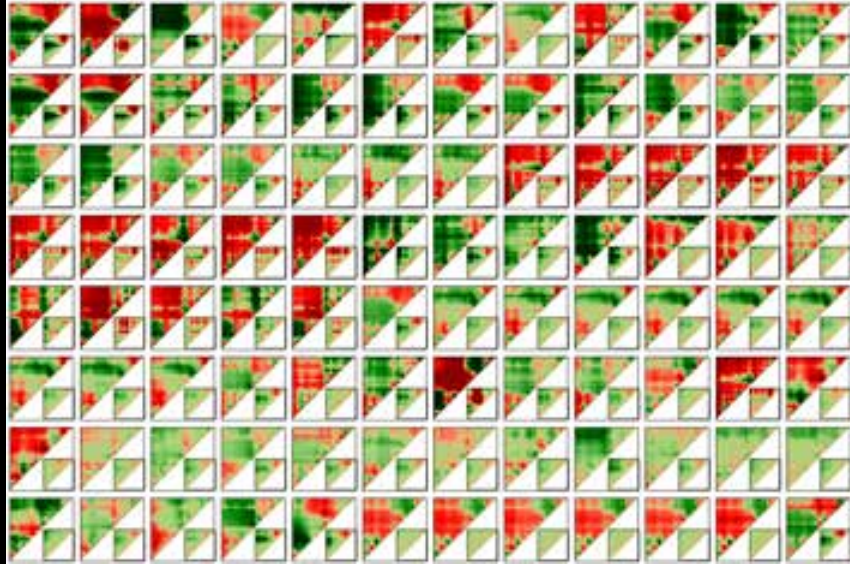




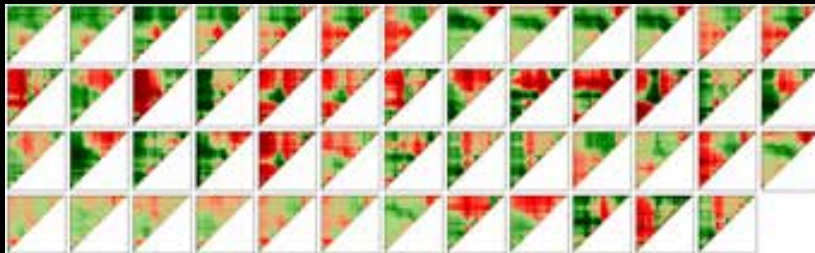
Customer Feedback Analysis



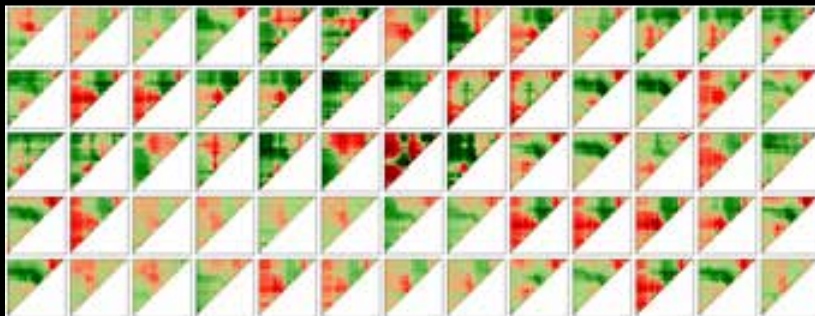
Financial Data Analysis



Credit Suisse



UBS



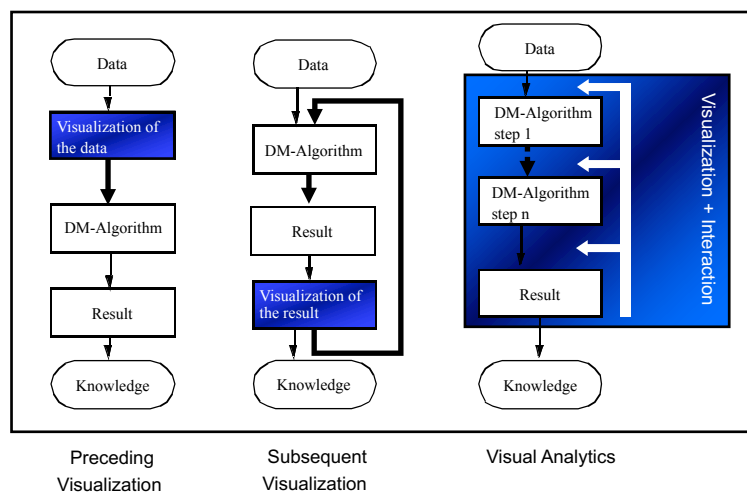
Future Visual Analytics Topics


Visual Analytics of

- Knowledge
- Streaming Data
- Data with Uncertainty
- Multimedia Data ...


Evaluation of Visual Analytics

Visual Analytics





**Visual Analytics may be useful in
Graph Drawing and Network
Visualization!**



**“All truths are easy to understand
once they are discovered;
the point is to discover them.”**

Galileo Galilei (1564-1642)

Questions?

infovis.uni-konstanz.de

