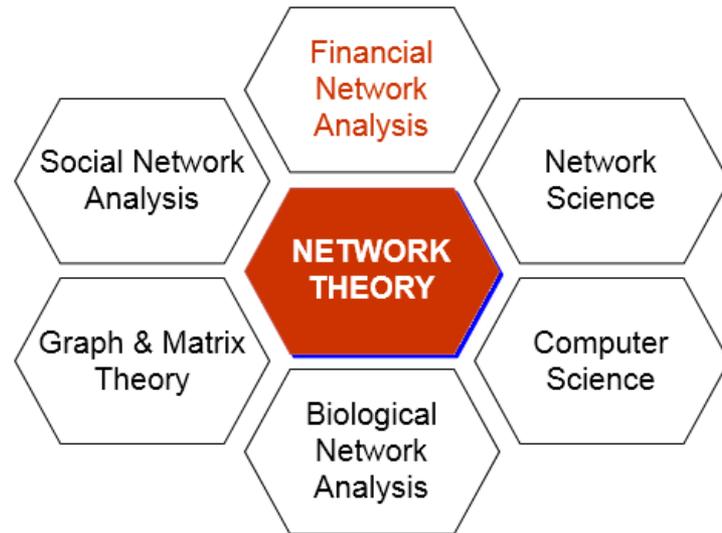# Network view to market risk

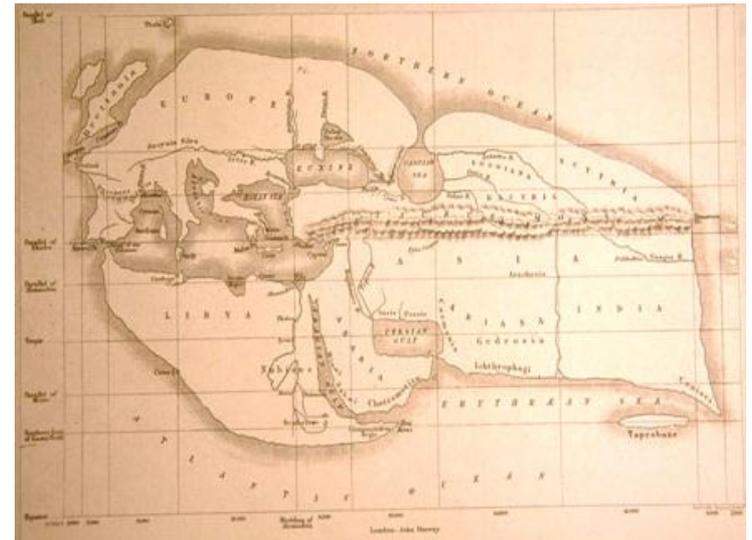## Correlation and Tail networks
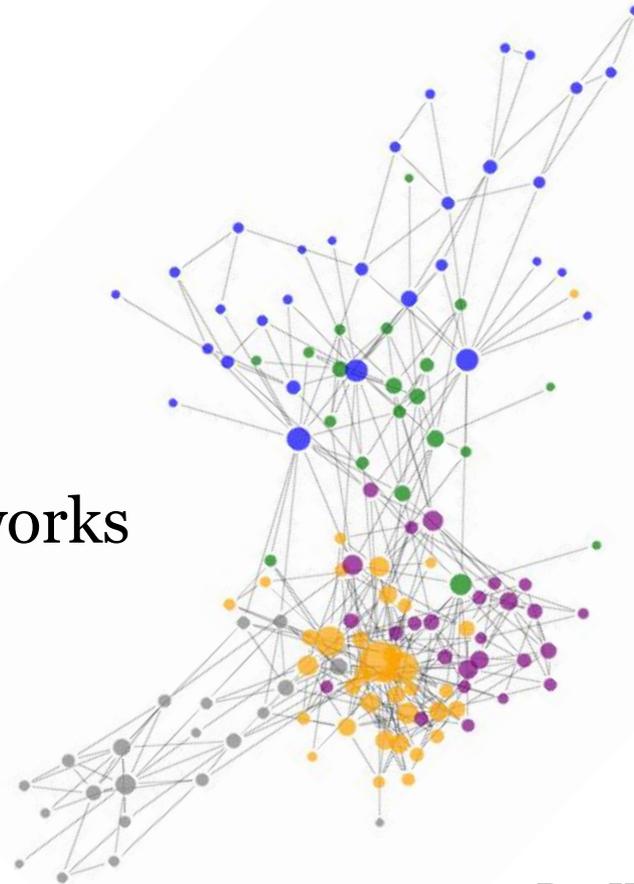
Dr. Kimmo Soramäki
Founder and CEO
FNA, www.fna.fi

Network Theory and Financial Cartography

Main premise of network theory: Structure of links between nodes matters

Maps reduce data and encode relevant data to graphical elements within a representation system

+

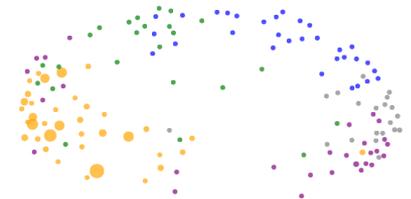Network Theory provides the representation system for financial maps like Cartography does to geographic maps
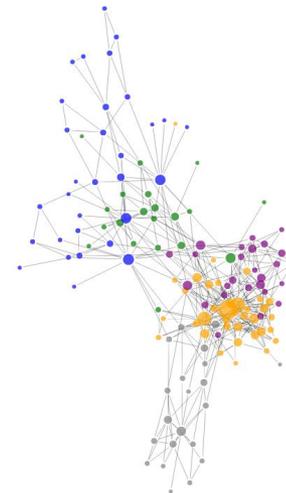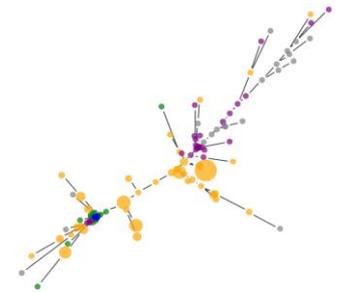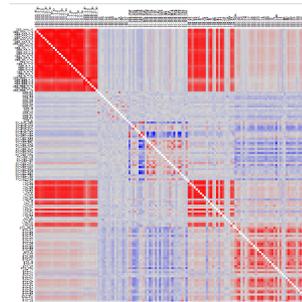
Outline

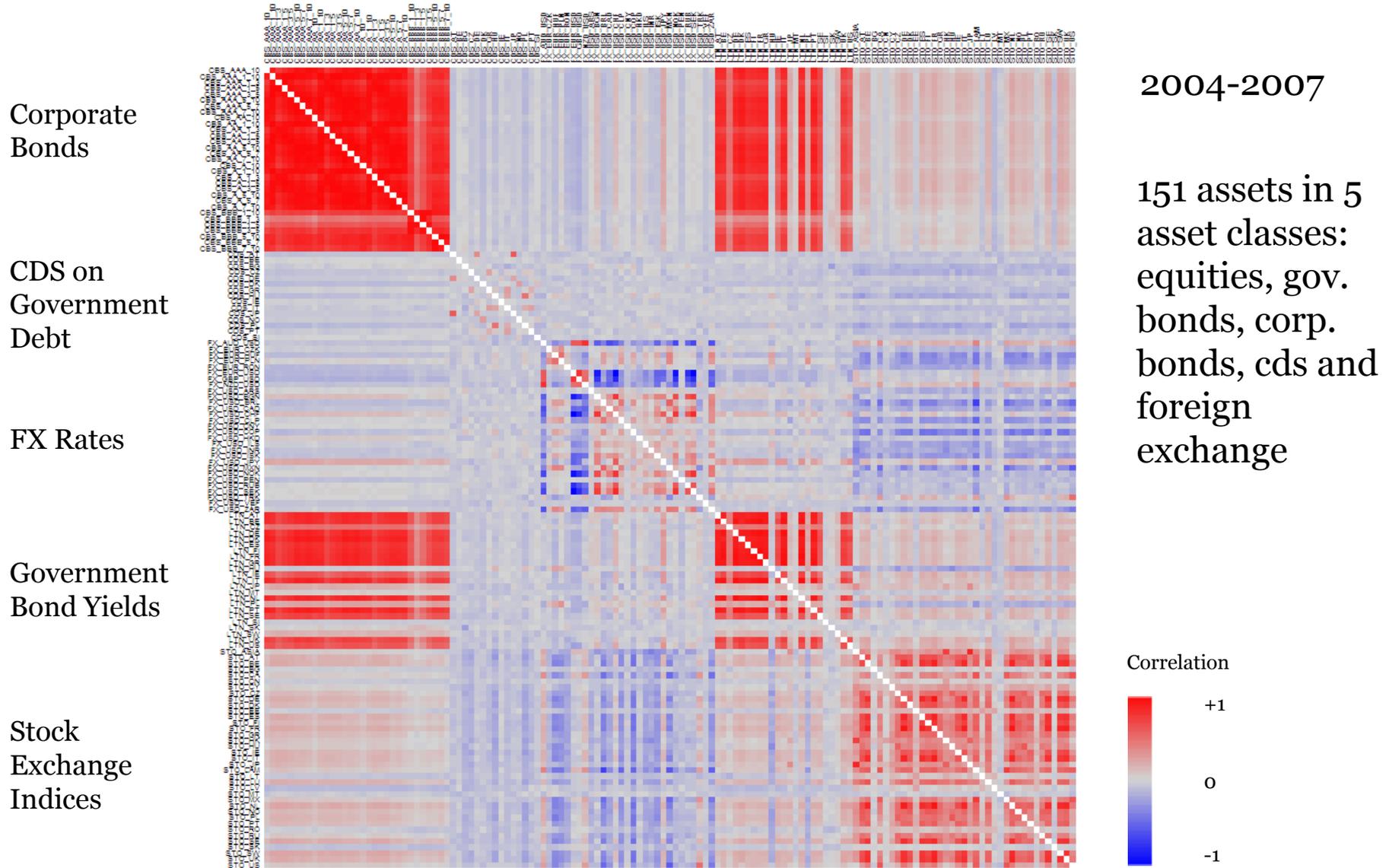Maps enable visual insights from complex financial data

- – Reduce complexity
- – Identify price driving themes and market dynamics
- – Spot anomalies
- – Build intuition
- – Aid communication of results

These methods are showcased for visualizing correlations among a wide range of assets around the collapse of Lehman Brothers on 15 September 2008

The maps: Heat Maps, Trees, Networks and Sammon's Projections
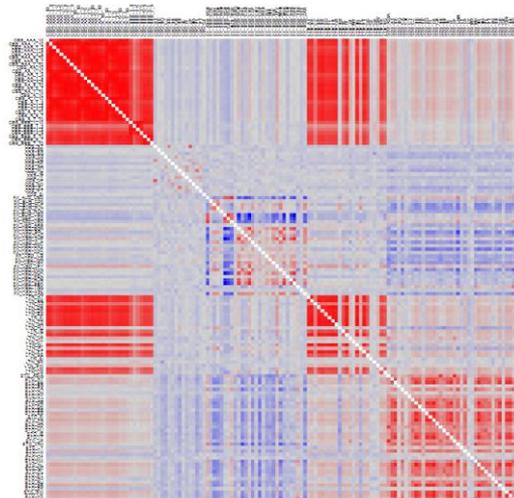
i) Heat Maps

Corporate
Bonds

CDS on
Government
Debt

FX Rates

Government
Bond Yields

Stock
Exchange
Indices

2004-2007

151 assets in 5
asset classes:
equities, gov.
bonds, corp.
bonds, cds and
foreign
exchange

Correlation

+1

0

-1
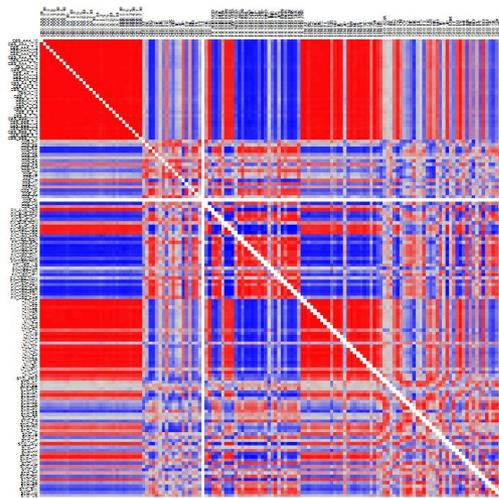
Collapse of Lehman, t=month
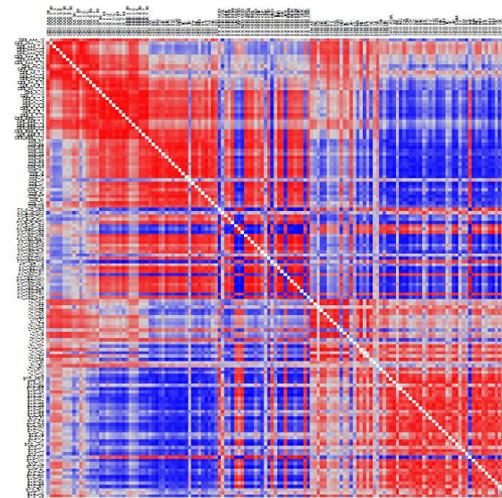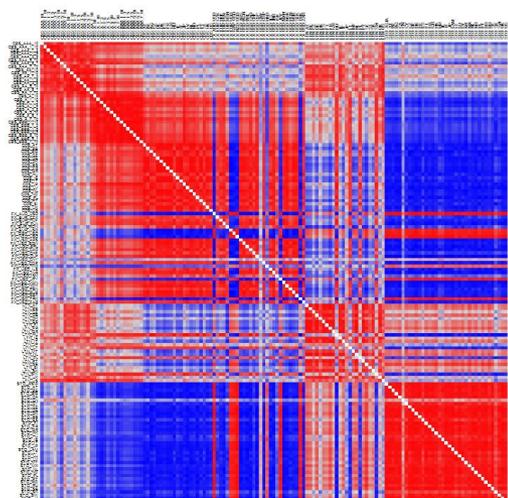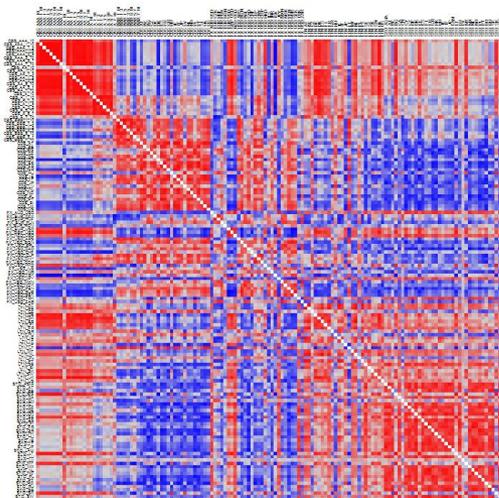
2004-2007

t-2

t-1

t+1

t+2

t+3

ii) Asset Trees
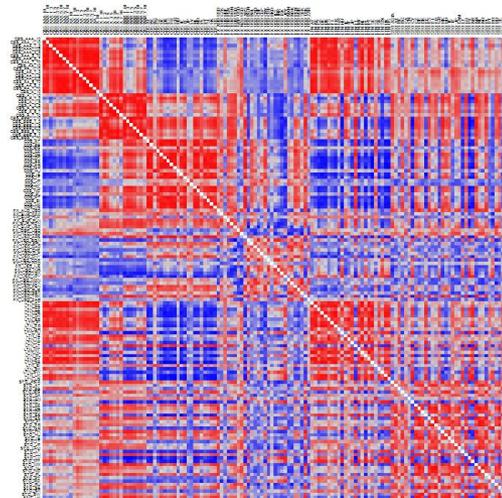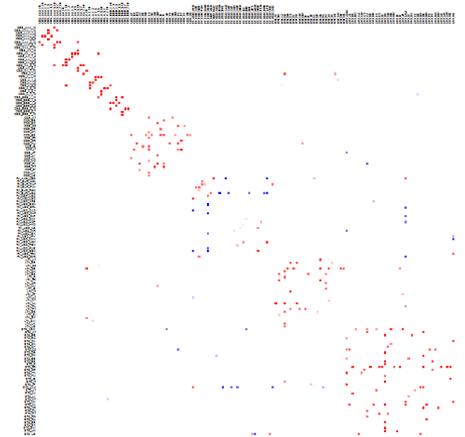
Originally proposed by Rosario Mantegna in 1999

Used currently by some major financial institutions for market analysis and portfolio optimization and visualization
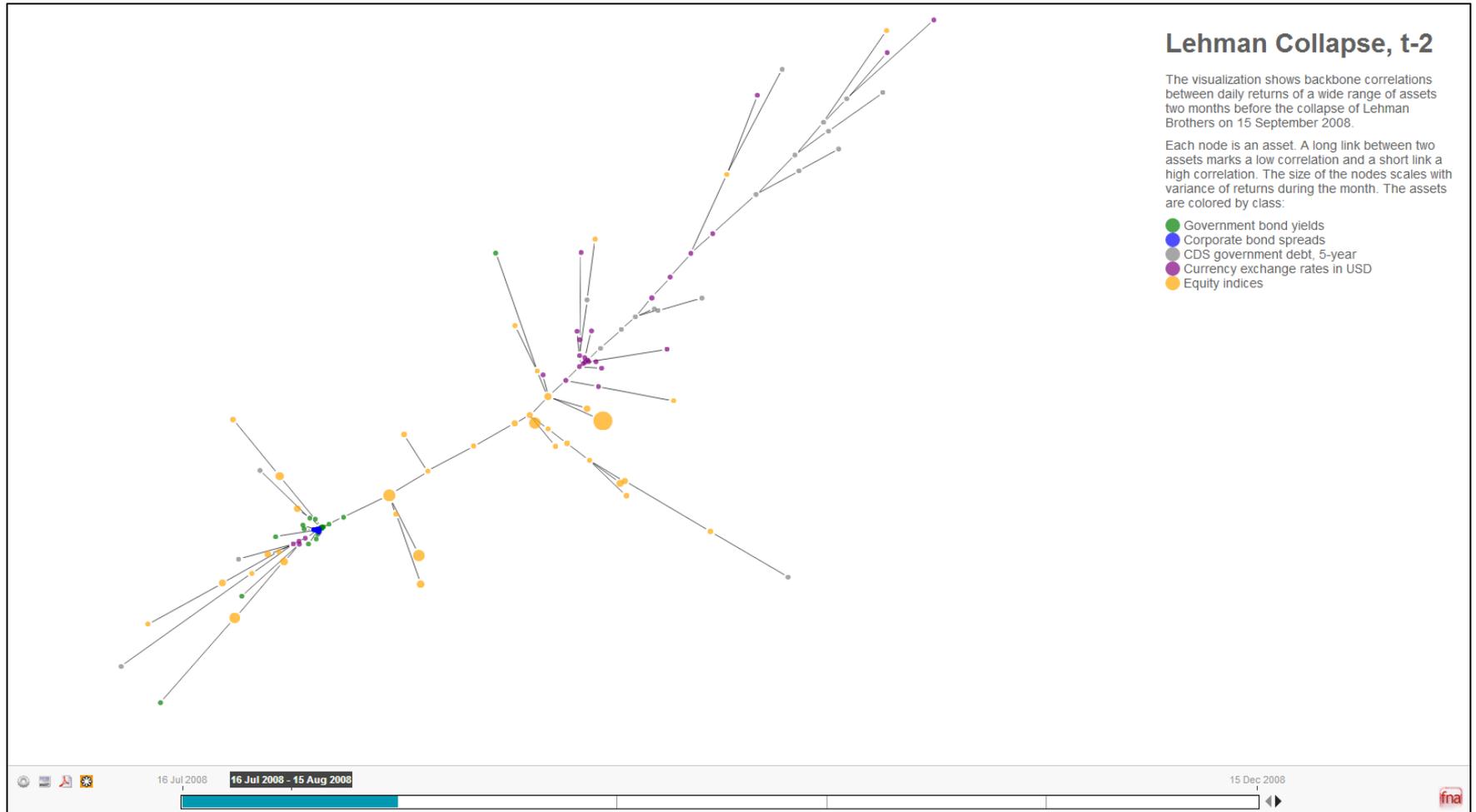

Methodology in a nutshell

1. Calculate (daily) asset returns
2. Calculate pairwise Pearson correlations of returns
3. Convert correlations to distances
4. Extract Minimum Spanning Tree (MST)

5. Visualize

MST

Demo

7
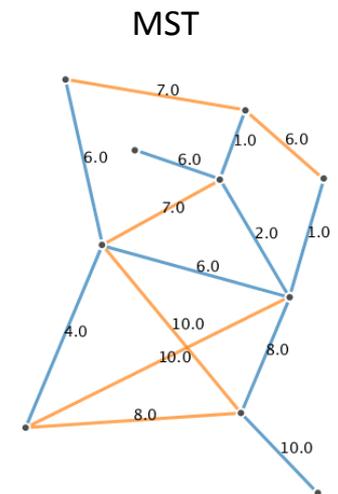
Correlation filtering

Balance between too much and too little information (Tumminello, Lillo, Mantegna 1999)
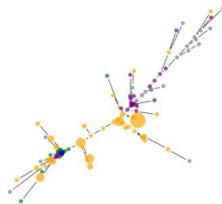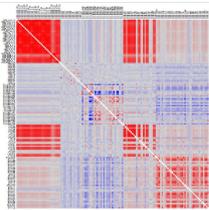
One of many methods to create networks from correlation/distance matrices (PMFGs, Partial Correlation Networks, Influence Networks, Granger Causality, etc.)

New graph, information-theory, economics & statistics -based models are being actively developed

E.g.: Network Estimation for Time-Series (Barigozzi & Brownlees)

iii) Sammon's Projection

Proposed by John W. Sammon in IEEE Transactions on Computers 18: 401–409 (1969)

A nonlinear projection method to map a high dimensional space onto a space of lower dimensionality. Example:

Iris Setosa

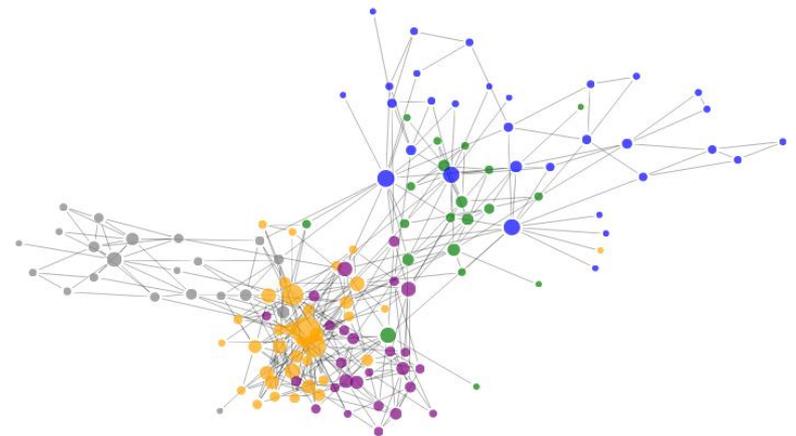Fisher's *Iris* Data

Sepal length ⬍	Sepal width ⬍	Petal length ⬍	Petal width ⬍	Species ⬍
5.1	3.5	1.4	0.2	*I. setosa*
4.9	3.0	1.4	0.2	*I. setosa*
4.7	3.2	1.3	0.2	*I. setosa*
4.6	3.1	1.5	0.2	*I. setosa*

Iris Versicolor

Iris Virginica

Demo

Lehman Collapse, t-2

The visualization similarities in correlation profiles of the assets two months before the collapse of Lehman Brothers on 15 September 2008.

Each node is an asset. Similar assets are close, and dissimilar assets are far away from each other. The size of the nodes scales with variance of returns during the month. The assets are colored by class:

- Government bond yields
- Corporate bond spreads
- CDS government debt, 5-year
- Currency exchange rates in USD
- Equity indices

16 Jul 2008   16 Jul 2008 - 15 Aug 2008   15 Dec 2008

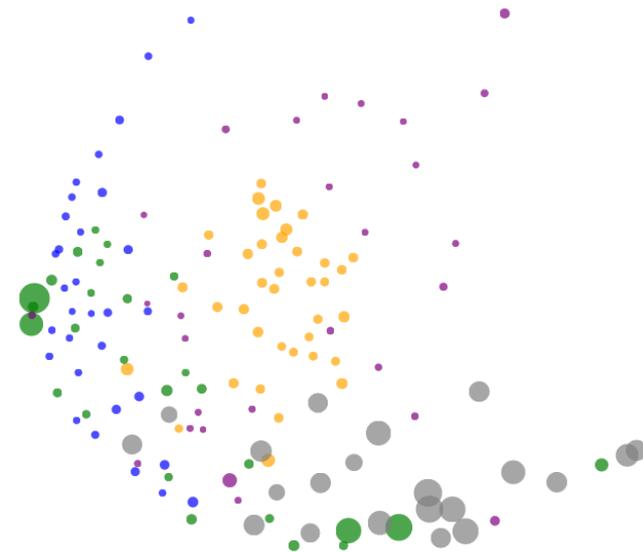[Click here for interactive visualization](#)

10

Tail dependence

- Correlation is a linear dependence. The same visual maps can be extended to non-linear dependences.

- Joint work with Firamis (Jochen Papenbrock) and RC Banken (Frank Schmielewski), see www.extreme-value-theory.com

- Instead of correlation, links and positions measure similarity of distances to tail losses
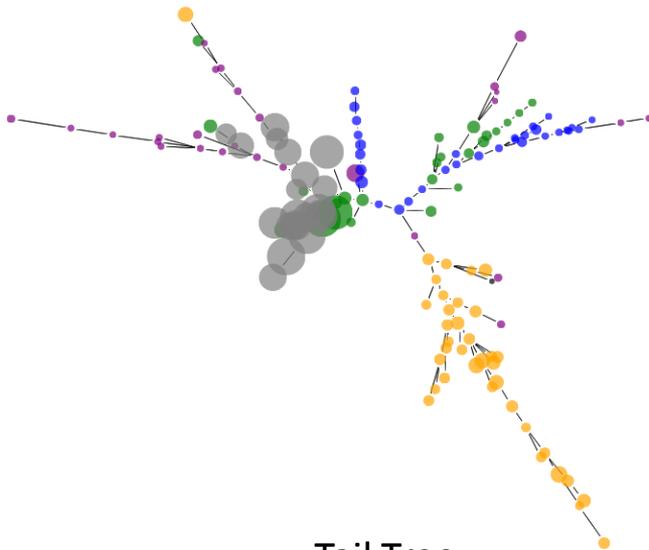
Tail Tree
([Click here for interactive visualization](#))

Tail Sammon
([click here for interactive visualization](#))

Blog, Library and Demos at www.fna.fi

Dr. Kimmo Soramäki
kimmo@soramaki.net
Twitter: soramaki