Monitoring the interbank market through dynamic network visualizations

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De Nederlandsche Bank

Eurosysteem

Outline

- Introduction, Status of research
- How to present payments as a (social) network
- Example of a network: Eurovision song contest
- A dynamic network: daily transactions
- Demo 1 - Dutch overnight money market
- Demo 2 – Money Market Cross Border
- Conclusions

Introduction, Status of research

- 2007 - 2008, WP 177,

  Marc Pröpper, Iman van Lelyveld and Ronald Heijmans

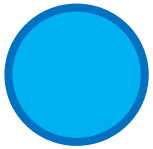
  Towards a Network Description of Interbank Payment Flows

- 2011 – 2013
  Heijmans, Heuver, van Lelyveld and Levallois

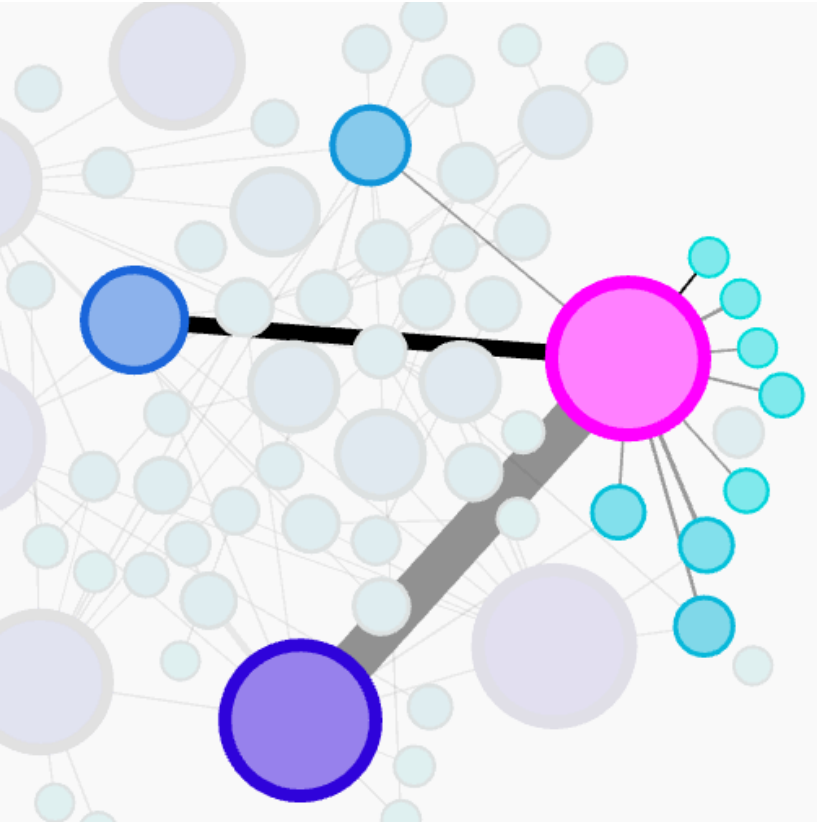
  Dynamic visualization of large transaction networks:
  the Dutch overnight money market

How to present payments as a (social) network

- Each person (bank) is presented by a **node**

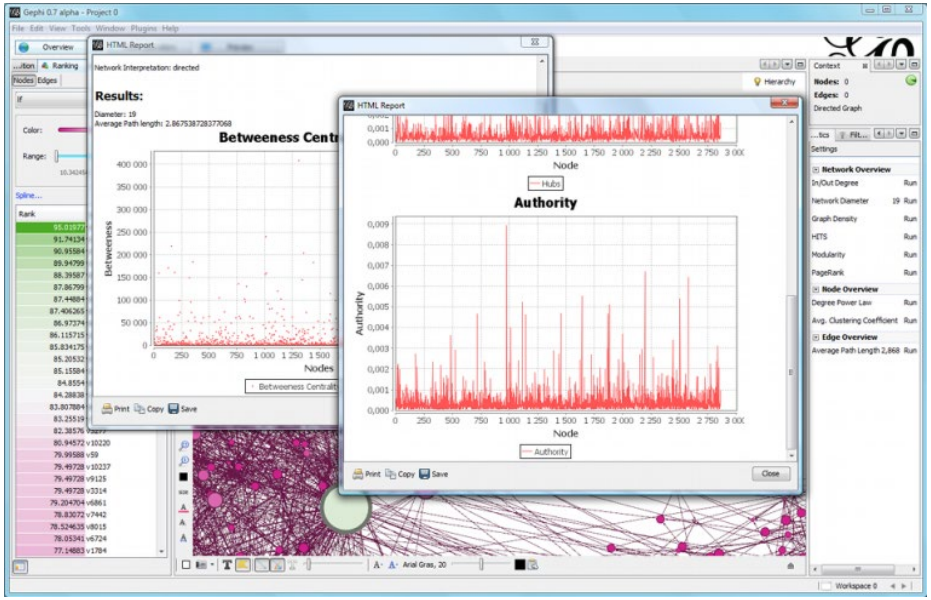


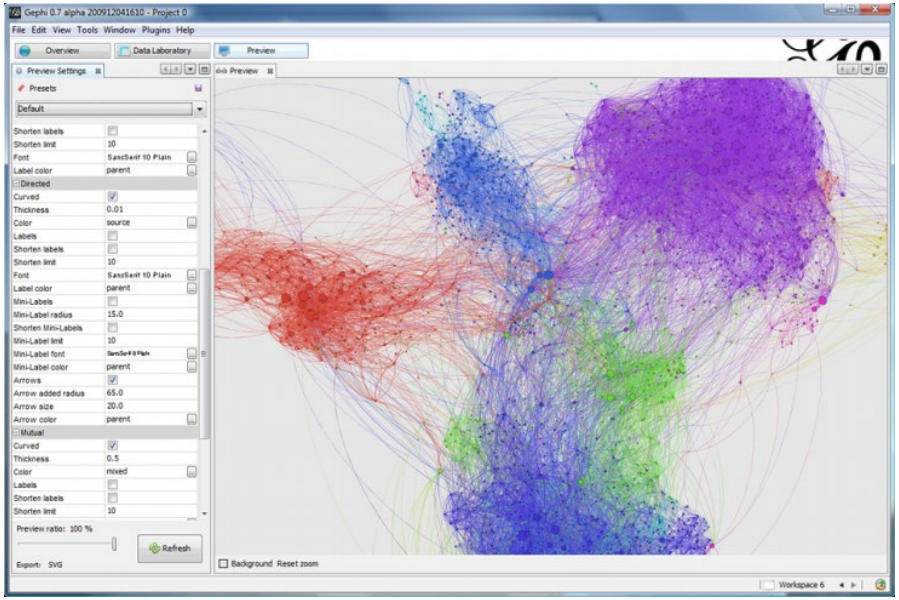
- Each interaction (payment) is presented by an undirected or a directed **edge**



First experiences using Gephi

- Open source software
- Process large networks
- Analyse, calculation of network statistics (e.g. modularity)
- Different layout styles
- Processing of time-changing networks (called dynamics)

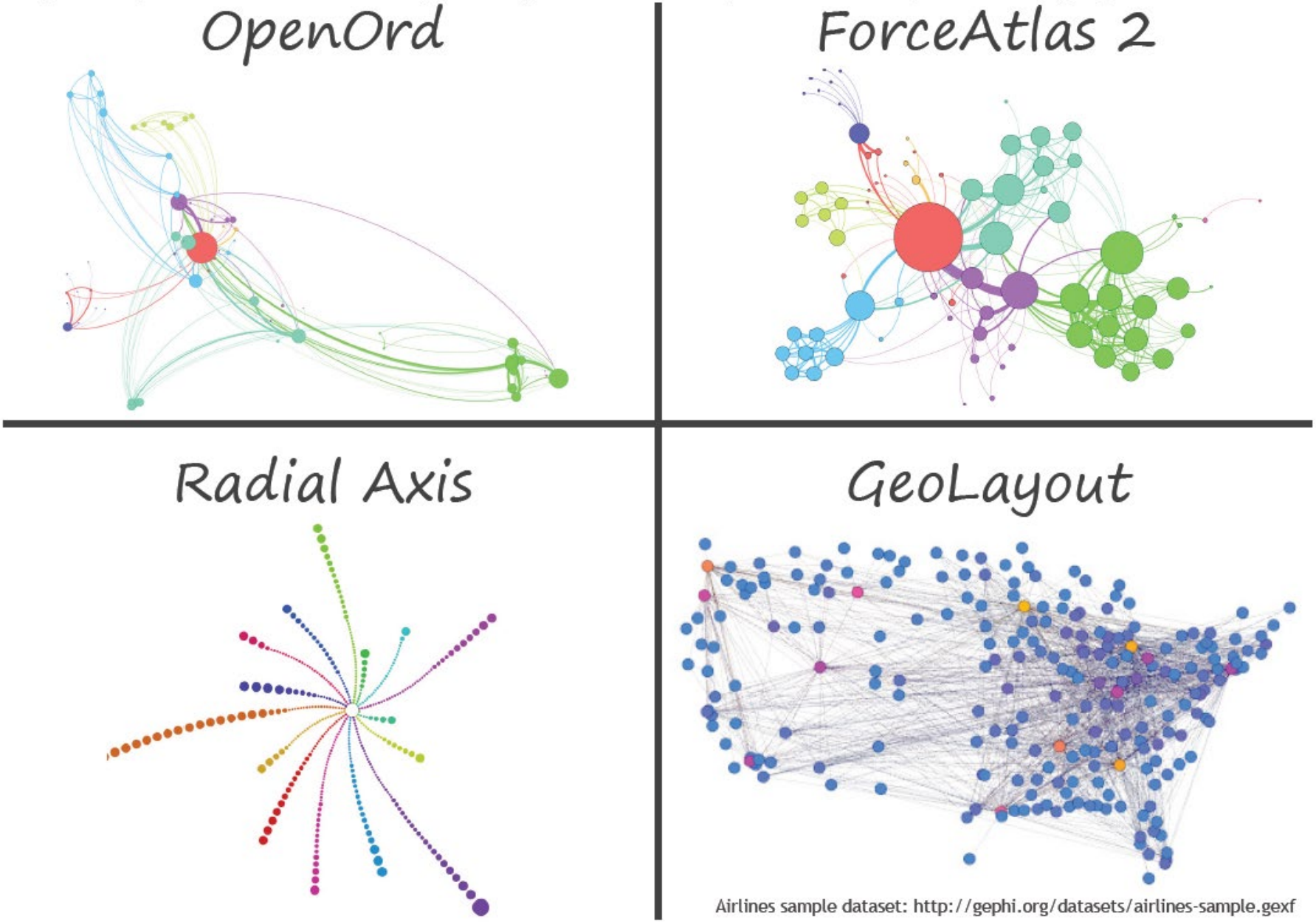




http://gephi.org/

Using different layout styles to visualize a network

Gephi implements various layout algorithms. They set the shape of the graph.



Airlines sample dataset: http://gephi.org/datasets/airlines-sample.gexf

Layout: ForceAtlas

- Written by the Gephi developers themselves
- Force-based – detect the strongest nodes
- Working paper is available
- Continuously running, therefore suitable for dynamics

Example of a network: Eurovision song contest

- Yearly contest, starting in 1980
- Countries participate and give points
- Participation of countries differs through the years

- Questions:

  - Which country is the overall winner ?

  - Are there groups of friends ?

Eurovision song contest – each year a separate network

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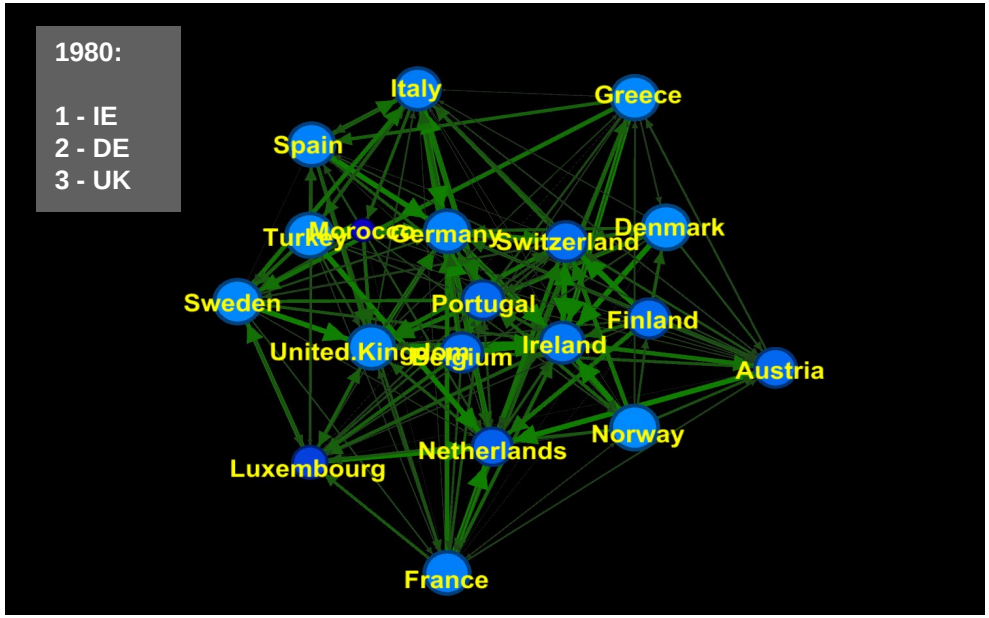
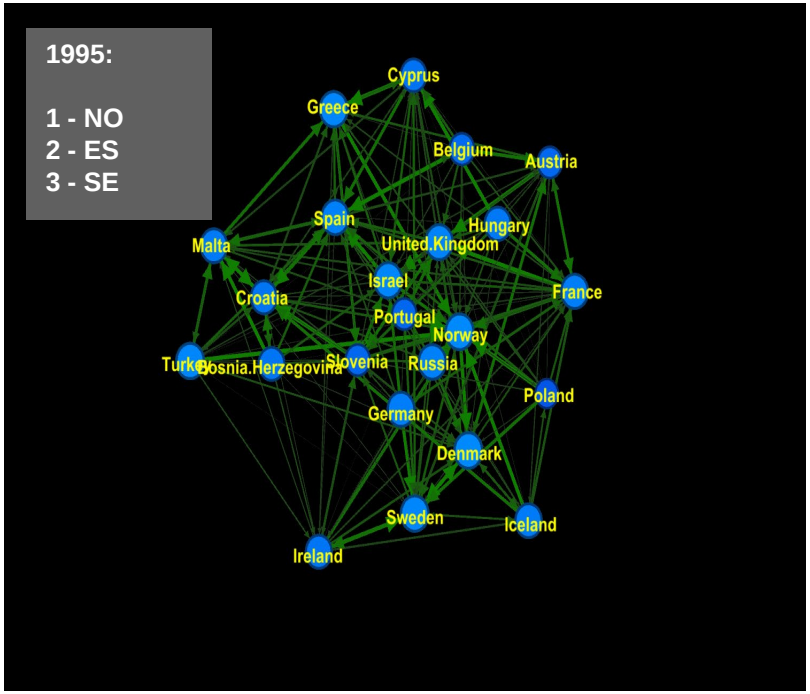
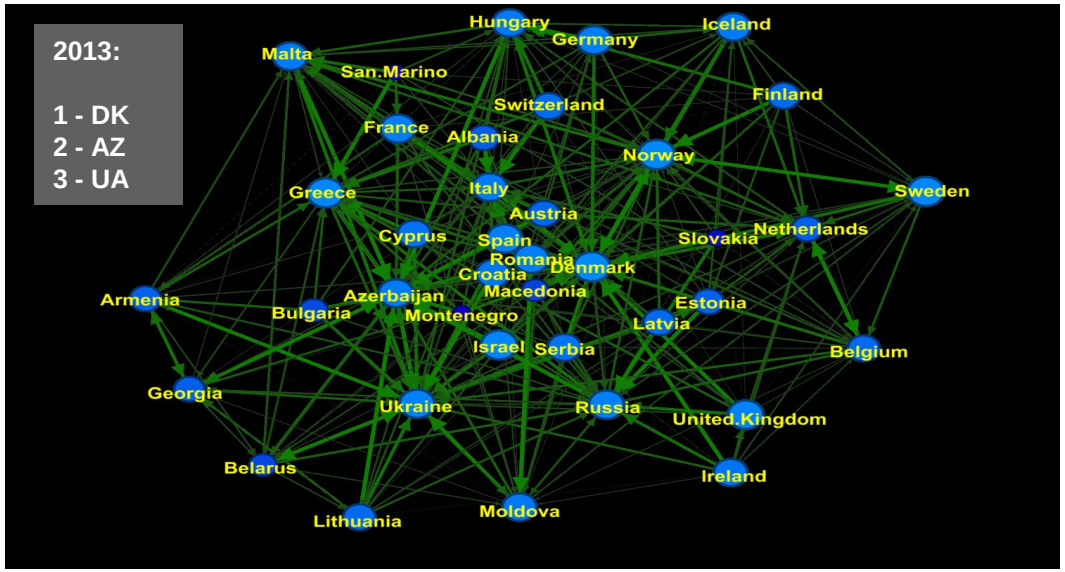




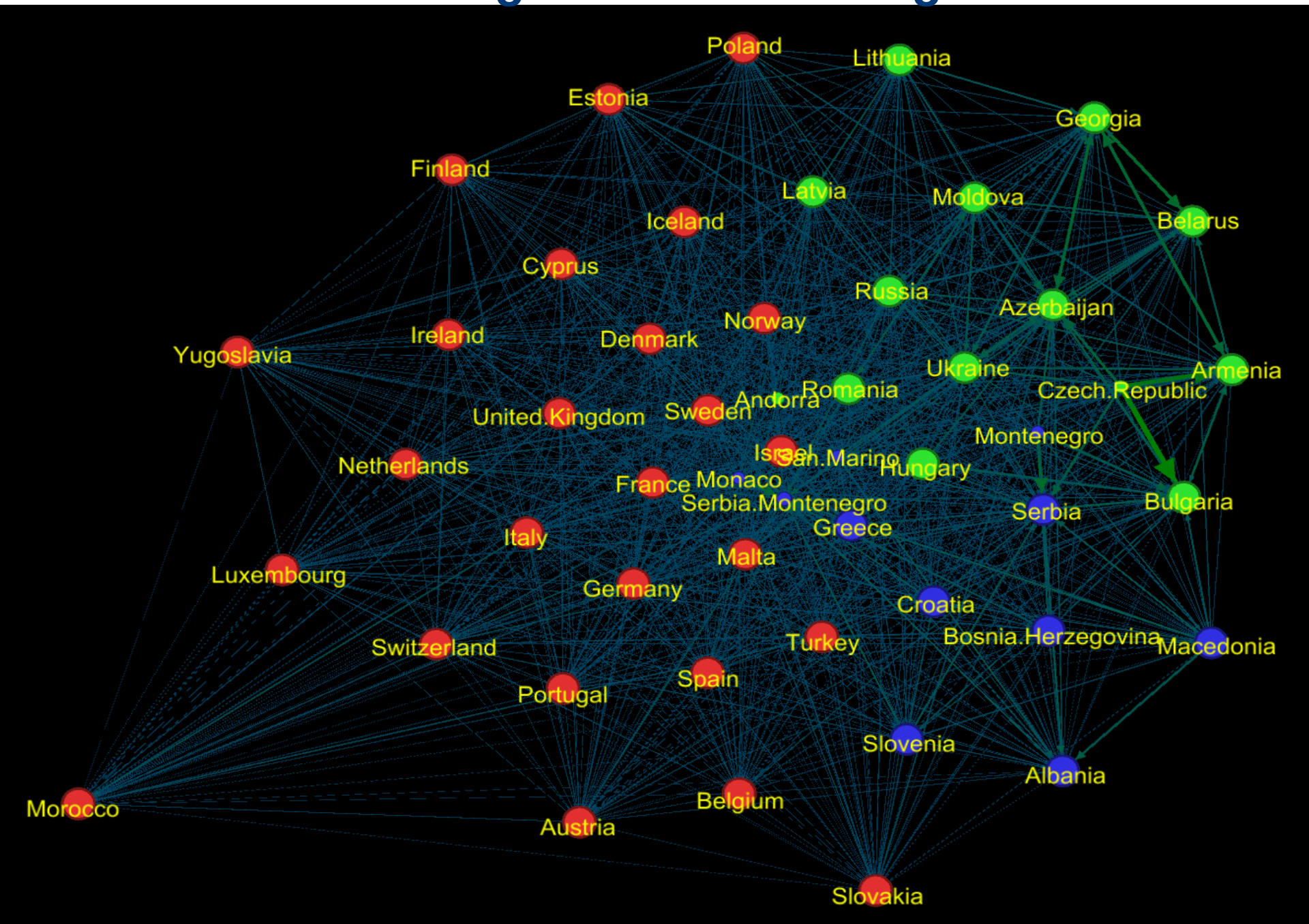


Eurovision song contest – calculating “average year”

- Each year is a separate network
- Countries did not participate each year
- Therefore correcting for non-presence
- Result:
  one average network of points given and points received
- Loaded into Gephi:
  - generate force-directed chart
  - calculate and visualize modularity

Rank	Country
1	Azerbaijan
2	Bulgaria
3	Ukraine
4	Serbia.Montenegro
5	Serbia
6	Armenia
7	Russia
8	Georgia
9	Belarus
10	Moldova
11	Greece
12	Albania
13	Italy
14	Sweden
15	Latvia
16	Bosnia.Herzegovina
17	Romania
18	Malta
19	Norway
20	Turkey
21	Estonia
22	Macedonia
23	United.Kingdom
24	Denmark
25	Ireland
26	Israel
27	Croatia
28	Hungary
29	Germany
30	France
31	Lithuania
32	Switzerland
33	Spain
34	Slovenia
35	Iceland
36	Cyprus
37	Netherlands
38	Yugoslavia
39	Belgium
40	Poland
41	Luxembourg
42	Austria
43	Finland
44	Portugal
45	Slovakia
46	Morocco

Eurovision song contest – average network



Eurovision song contest – conclusions

- Gephi enables the user to:

  - Generate force based graphs that are easy to understand

  - Find groups within the network using the Louvain Methodology for Modularity (working paper available)

Fast unfolding of communities in large networks

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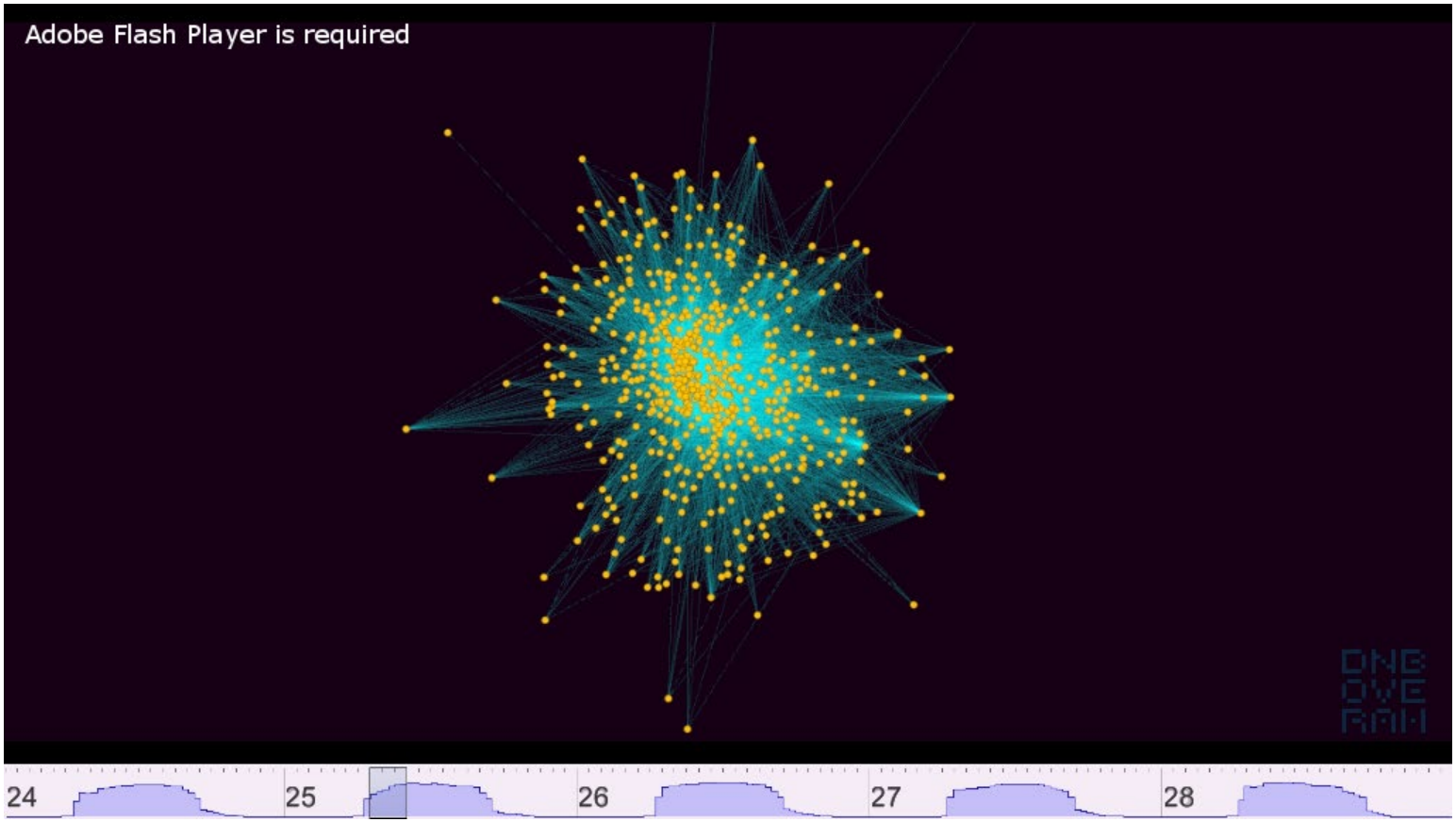
Abstract. We propose a simple method to extract the community structure of large networks. Our method is a heuristic method that is based on modularity optimization. It is shown to outperform all other known community detection method in terms of computation time. Moreover, the quality of the communities detected is very good, as measured by the so-called modularity. This is shown first by identifying language communities in a Belgian mobile phone network of 2.6 million customers and by analyzing a web graph of 118 million nodes and more than one billion links. The accuracy of our algorithm is also verified on ad-hoc modular networks.

Keywords: Random graphs, networks; Critical phenomena of socio-economic systems; Socio-economic networks

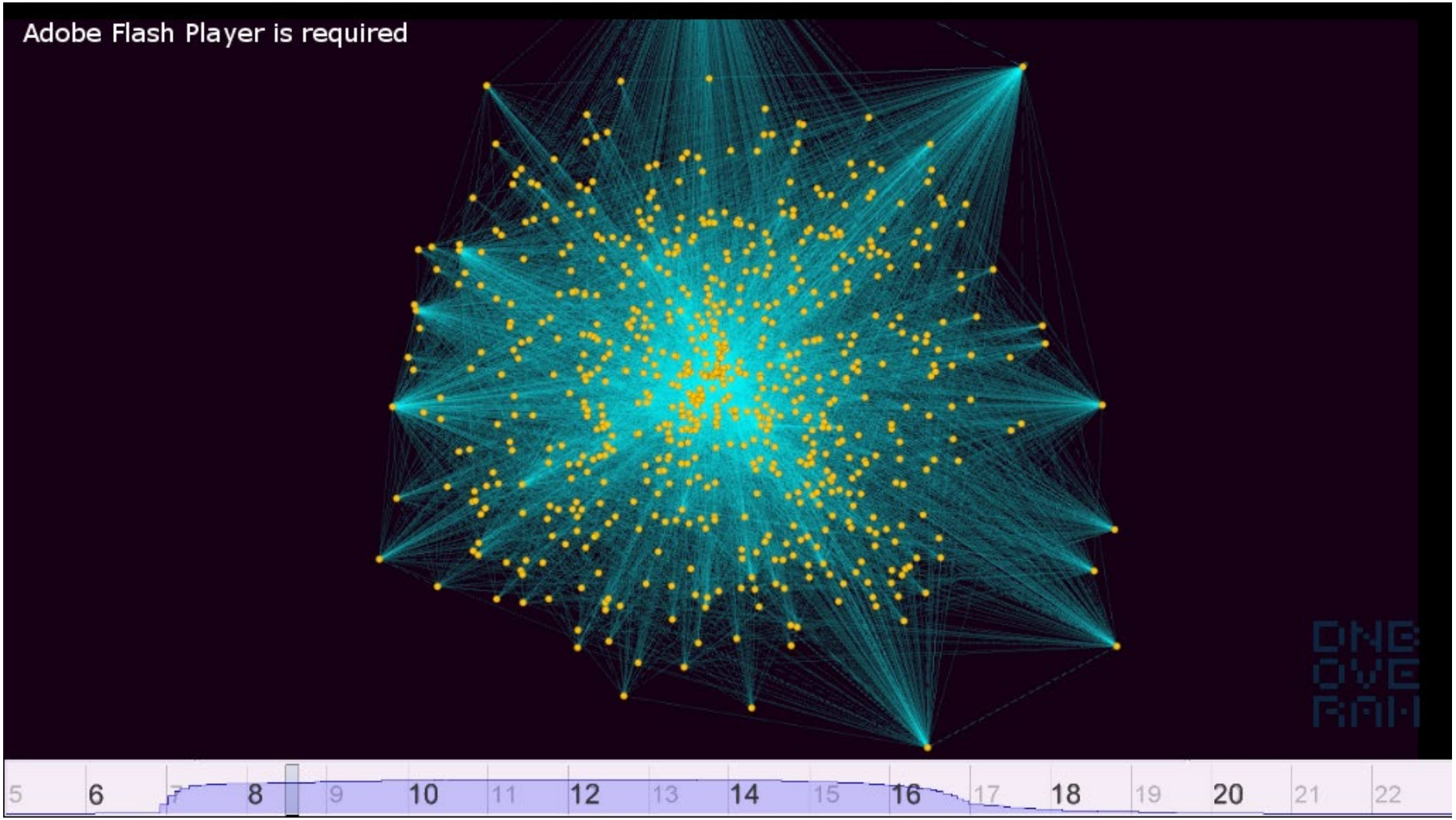
A dynamic network: daily transactions

- Time span: one week
- Each bank is represented by a yellow node
- Transactions are represented by cyan edges
- Daily buildup of payments network
- Dynamic: constantly shifting set of nodes and edges



Calculation: one week into one average day

- During data processing phase: replace date part
- Result: average payments network within one day



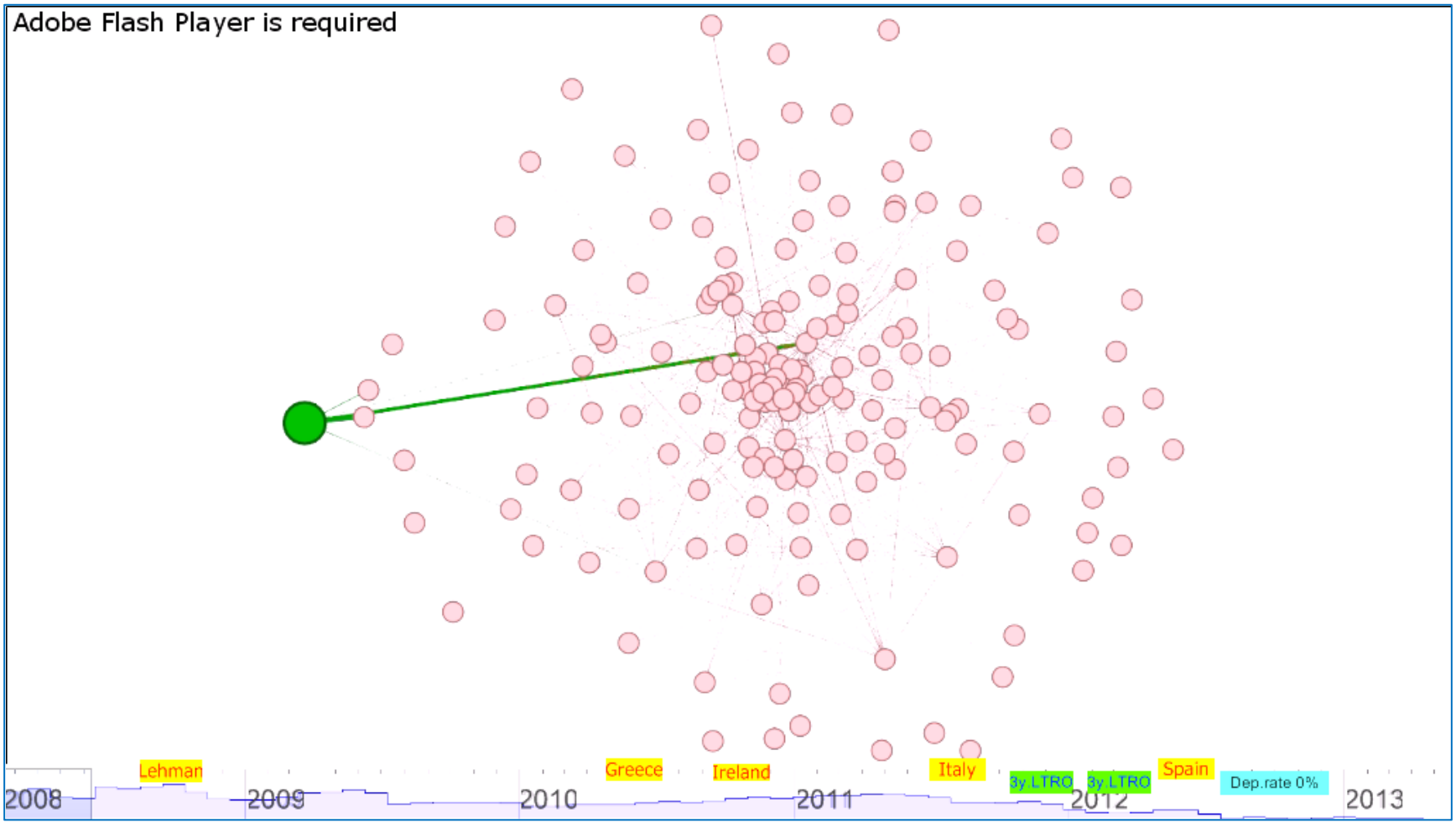
One average day - conclusions

- Very suitable to find structural patterns
- Same method for Day – Month – Maintenance Periods etc.
- Follow individual banks or groups

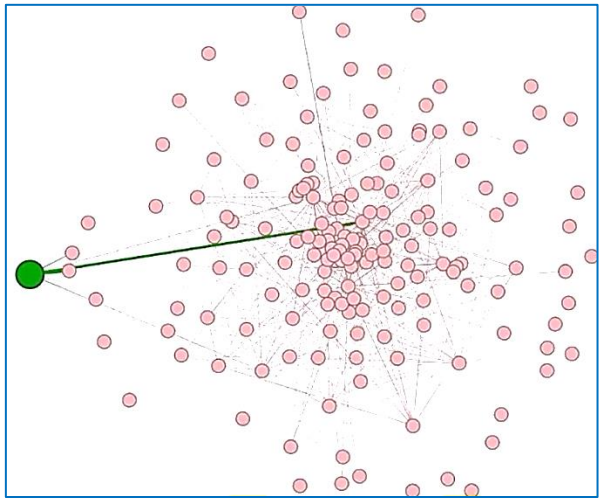
  by coloring and/or using labels

Demo 1 - Dutch overnight money market including Central Bank facilities

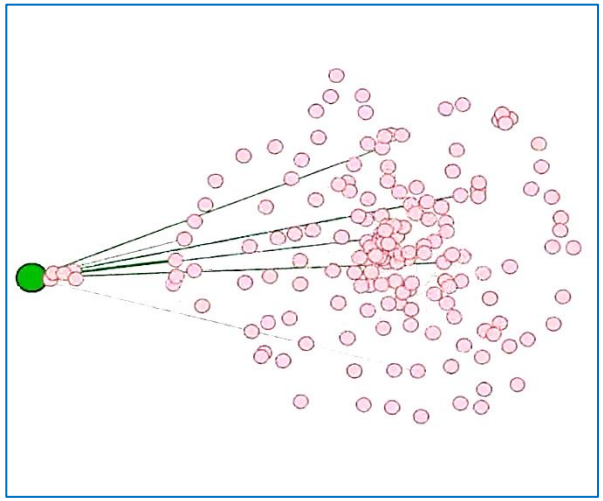
- Time span: 2008 - 2013
- Banks are represented by a pink node, the Central bank by a green node
- Money market transactions (purple) and central bank facilities (green)



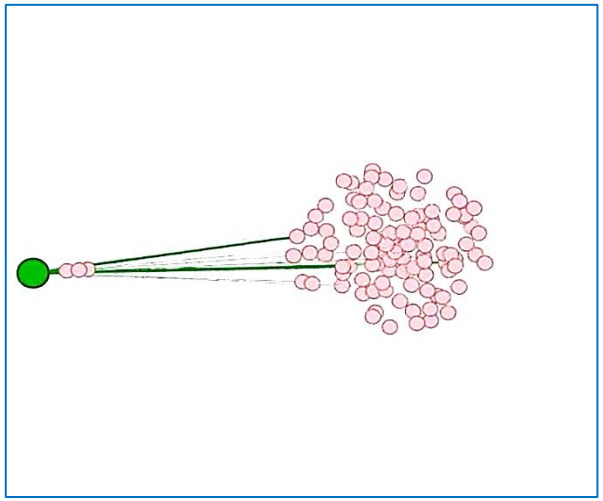
Dutch overnight money market - Conclusions



2008



2010



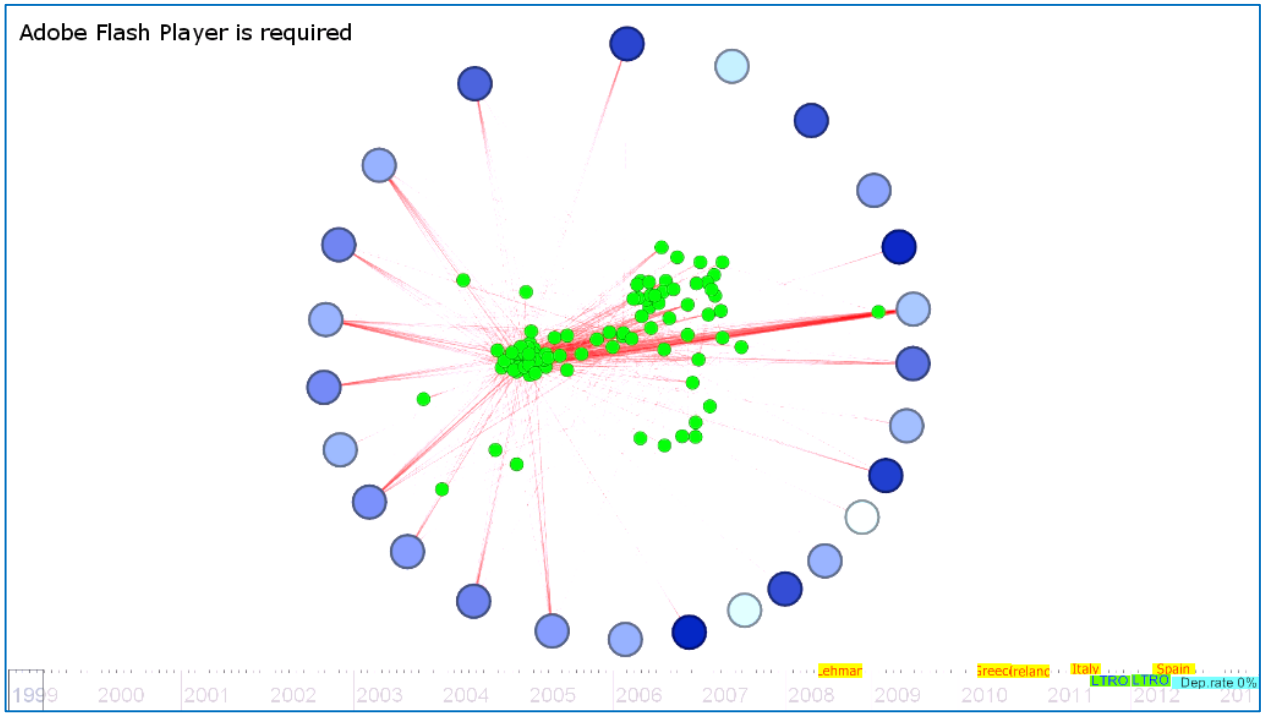
2013

- Network became more sparse
  (i.e. less lending/borrowing, participants left the market)

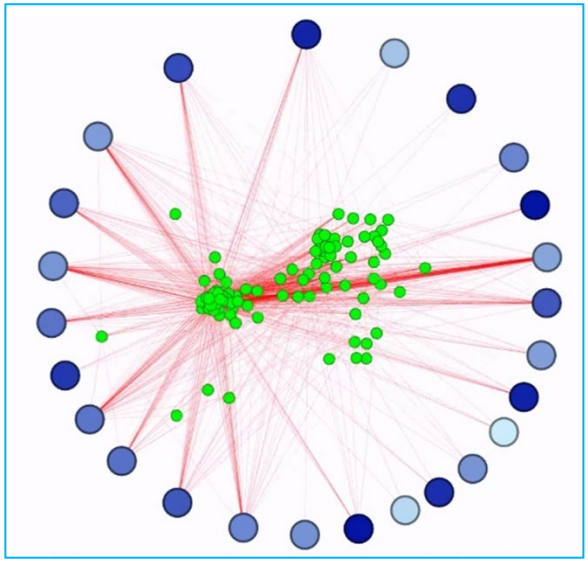
- Central bank became more prominent

Demo 2 – Money Market Cross Border

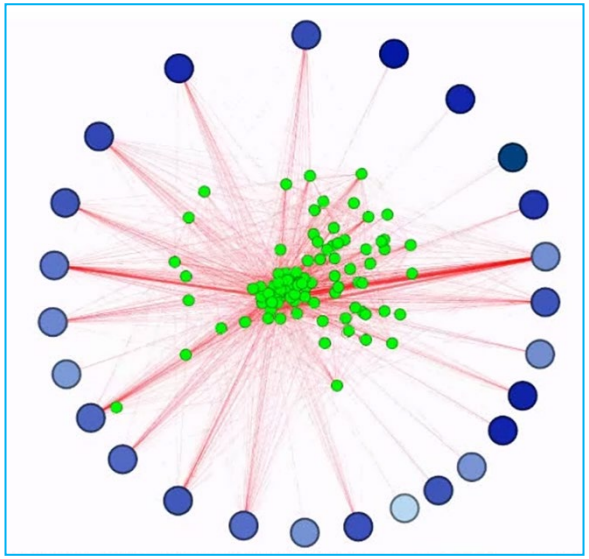
- Time span: 1999 - 2013
- Each domestic bank is represented by a green node
- Foreign banks are grouped into a blue country node
- Country nodes are placed at their geographical location vis-à-vis NL
- Blue colours represent that year's average loan maturity
  (light blue = overnight , dark blue = 3-month)



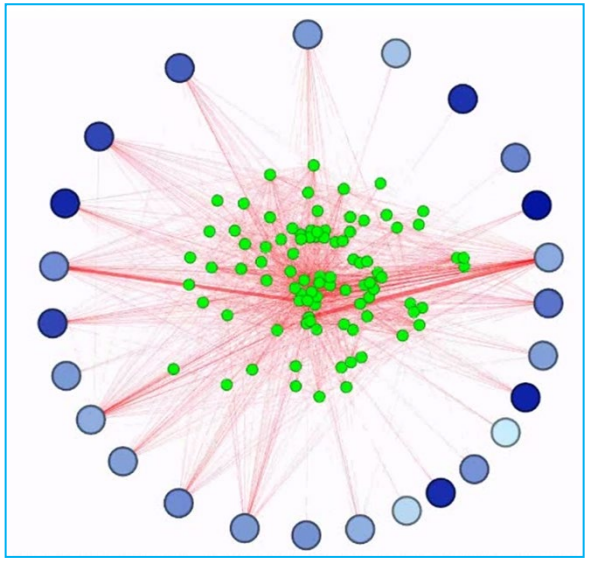
Money Market Cross Border - Conclusions



1999



2008



2013

- Starting period: a few very strong participants
- Changes in orientation towards countries
- Changes in Maturity
- Ending period: less strong participants and more indifferent network

PS Due to confidentiality issue: edges kept non-directional, nodes kept at one size

Conclusions

- Gephi is very useful
  - both as analysis tool
  - and for dynamic visualizations

- Issues:
  - confidentiality / traceability
  - incorporating movies in a working paper . . .

- Future work:
  - finish working paper
  - further analysis of payment flows
    and participants' behavioral patterns
  - deliver easy understandable movies.