Centrality: A case study

Introduction to network Science

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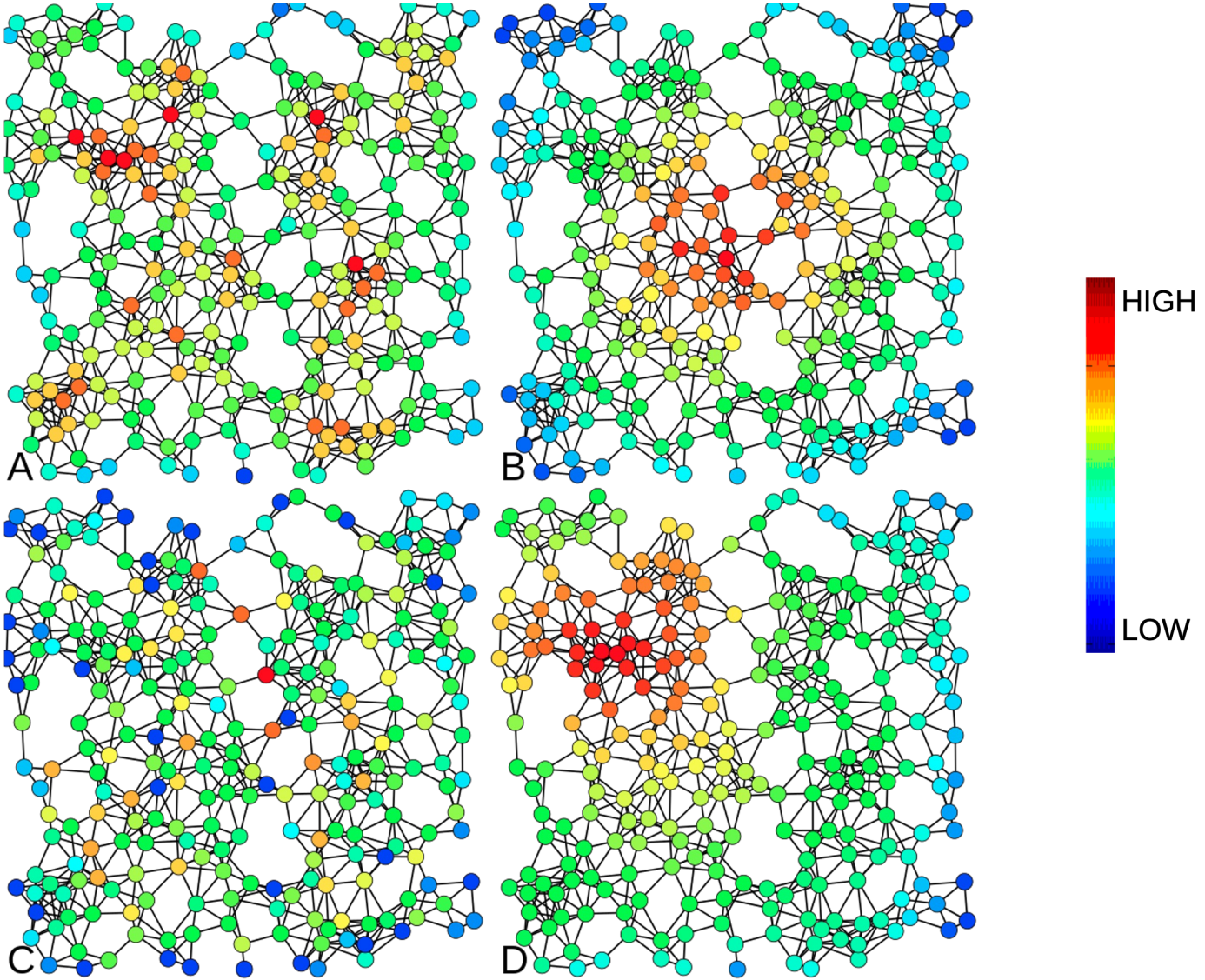
A: Degree

B: Closeness

C: Betweenness

D. PageRank



Case study:
Noble families in Florence in the 15th century

Florentine families

- **Noble families in Florence** around 1430
- Power struggle between two factions led by the Medici and the Strozzi
- The relatively newcomer Medici became, for a while, the wealthiest family in Europe … they had their own bank!
- Dataset collected by John Padgett from historical documents

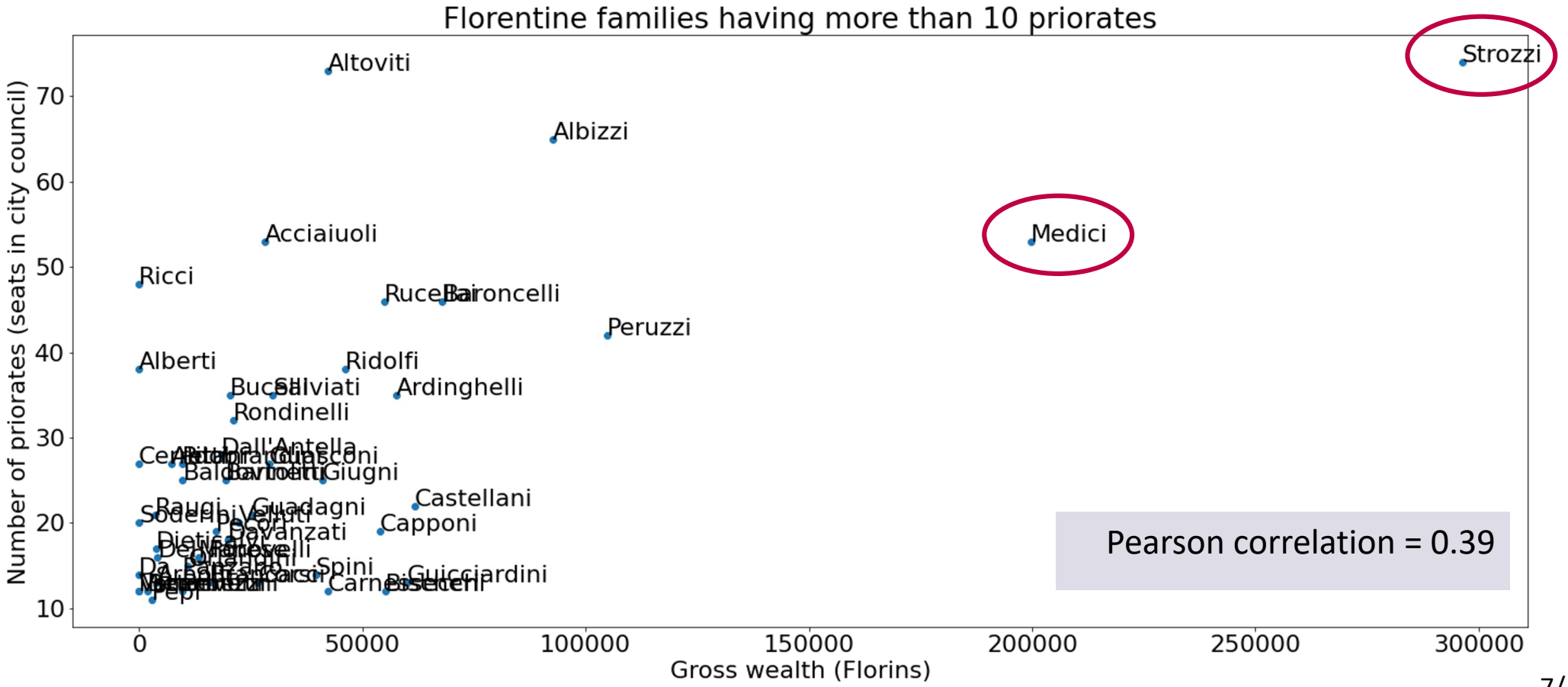
Wealth and political power

- The dataset contains 116 families
- **Gross wealth** in Florins (1 florin ~ 3.5g of gold)
  - These are all approximations assuming *florins* and *ducats* have similar value:
- Leonardo da Vinci was paid ~100 florin per year (~1 painting), until he worked with the king of France, who paid ~400 florin per year
- Michelangelo Buonarroti got paid ~200-450 florins per sculpture
- A palace would cost a few thousand florins
- **Priorates** is the cumulative number of seats in the city council along mulriple years

Are wealth and political power related?

- Data science trick: if you want to understand if two variables are correlated, the first thing you should do is a simple scatter plot
- It gives you a visual understanding of what's going on
- You might need to use log axis if variables are skewed
- After, you can start computing pearson coefficients, regressions, etc to obtain a quantitative understanding

Wealth and political power (cont.)

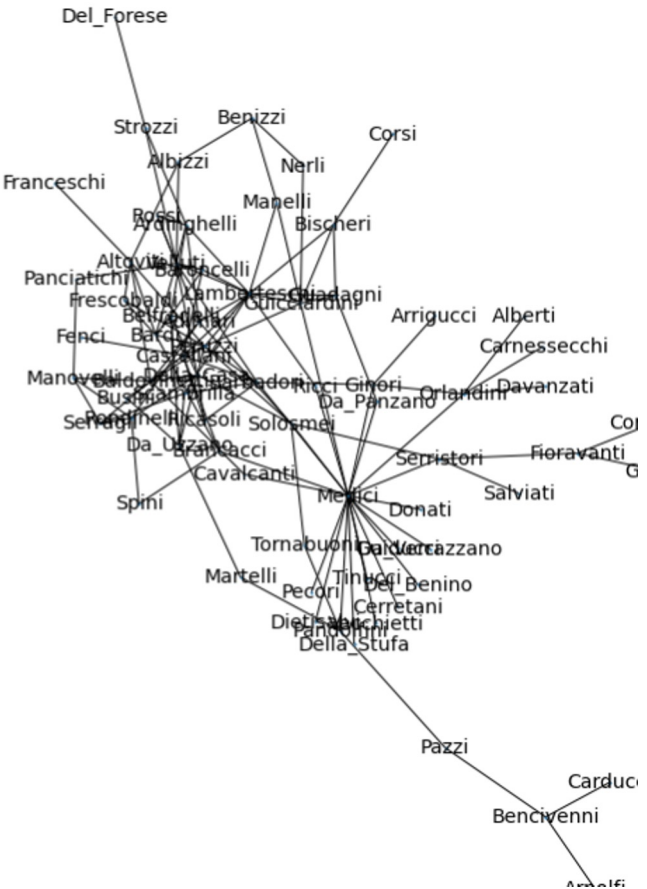


Credit graph

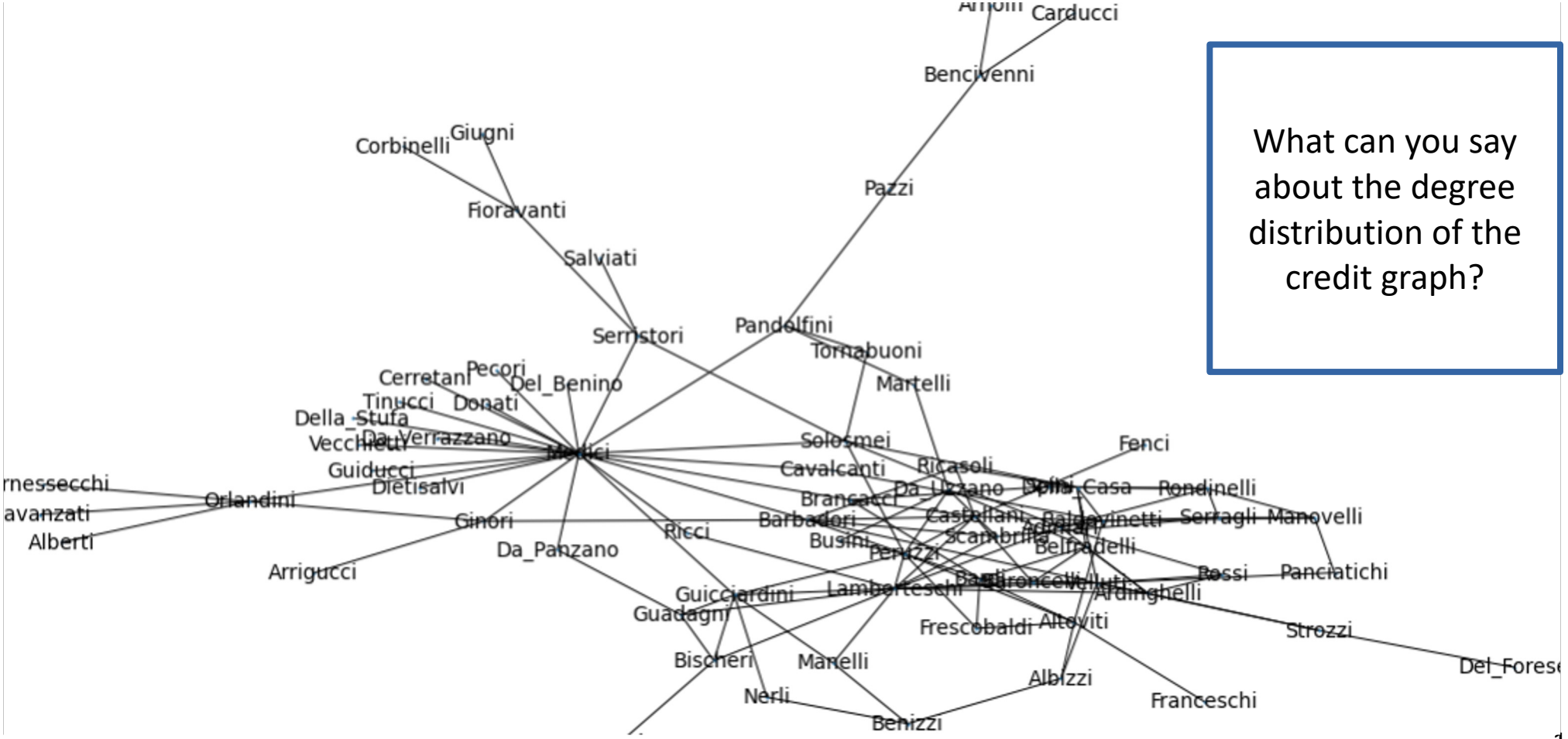
[Image source]

Credit graph

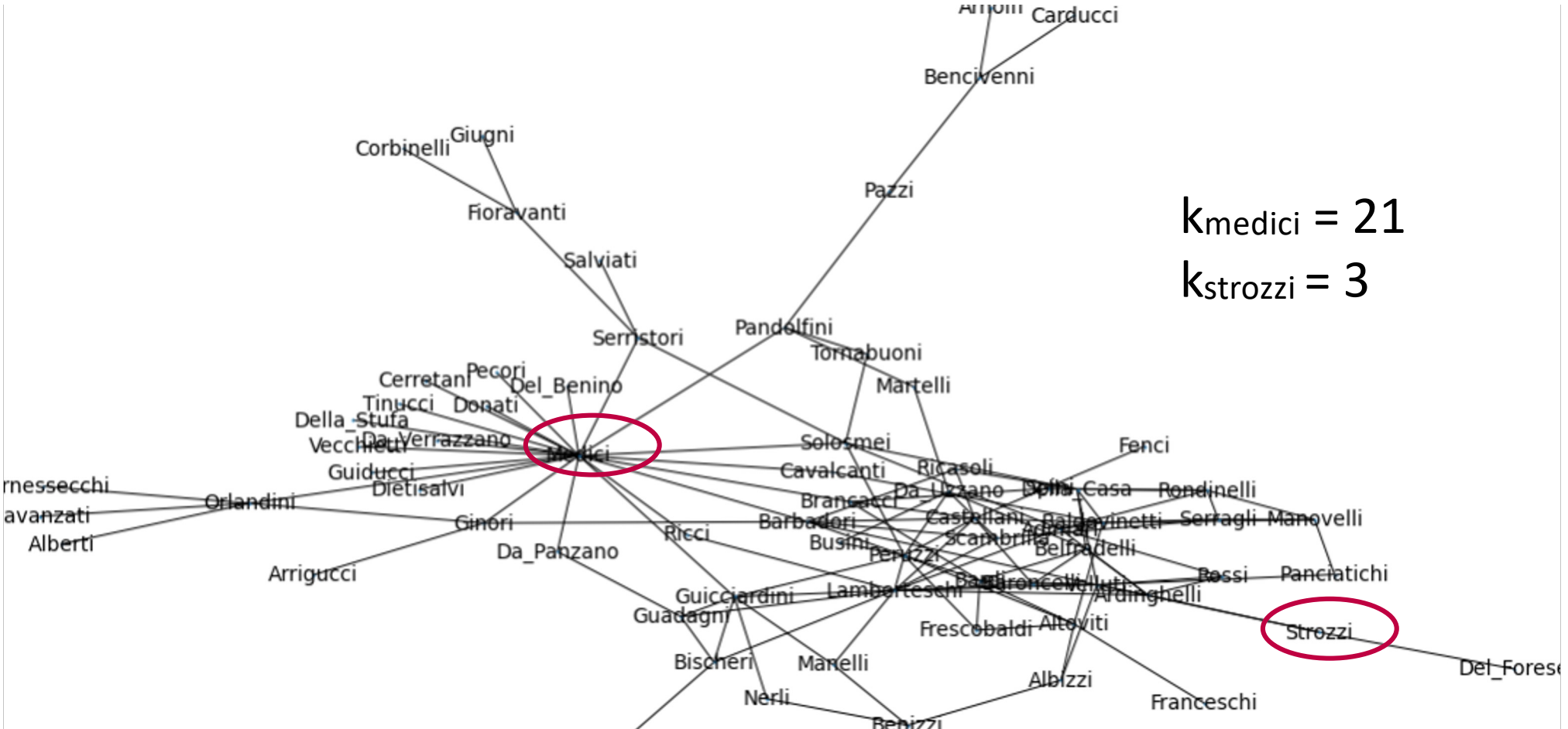
- 72 nodes (families)
- 125 edges (loans)
- Loan given by one family to a member of the other
- Undirected in this dataset



Credit - giant connected component (70 nodes, 97%)



Credit - giant connected component (70 nodes, 97%)



$k_{medici} = 21$

$k_{strozzi} = 3$

Closeness, betweenness, eigencentrality

Closeness	Betweenness	Eigencentrality
•Peruzzi 0.39	•Peruzzi 0.11	•Peruzzi 0.30
•Medici 0.48	•Medici 0.53	•Medici 0.31
•Strozzi 0.28	•Strozzi 0.03	•Strozzi 0.07

What can you say about the correlations of this with wealth/power?

Correlations

	Gwealth	Npriors	c_degree	c_closeness	c_betweenness	c_eigencentrality
Gwealth	1.00	0.39	0.42	0.21	0.40	0.34
Npriors	0.39	1.00	0.27	0.04	0.20	0.19
c_degree	0.42	0.27	1.00	0.67	0.84	0.88
c_closeness	0.21	0.04	0.67	1.00	0.59	0.79
c_betweenness	0.40	0.20	0.84	0.59	1.00	0.59
c_eigencentrality	0.34	0.19	0.88	0.79	0.59	1.00

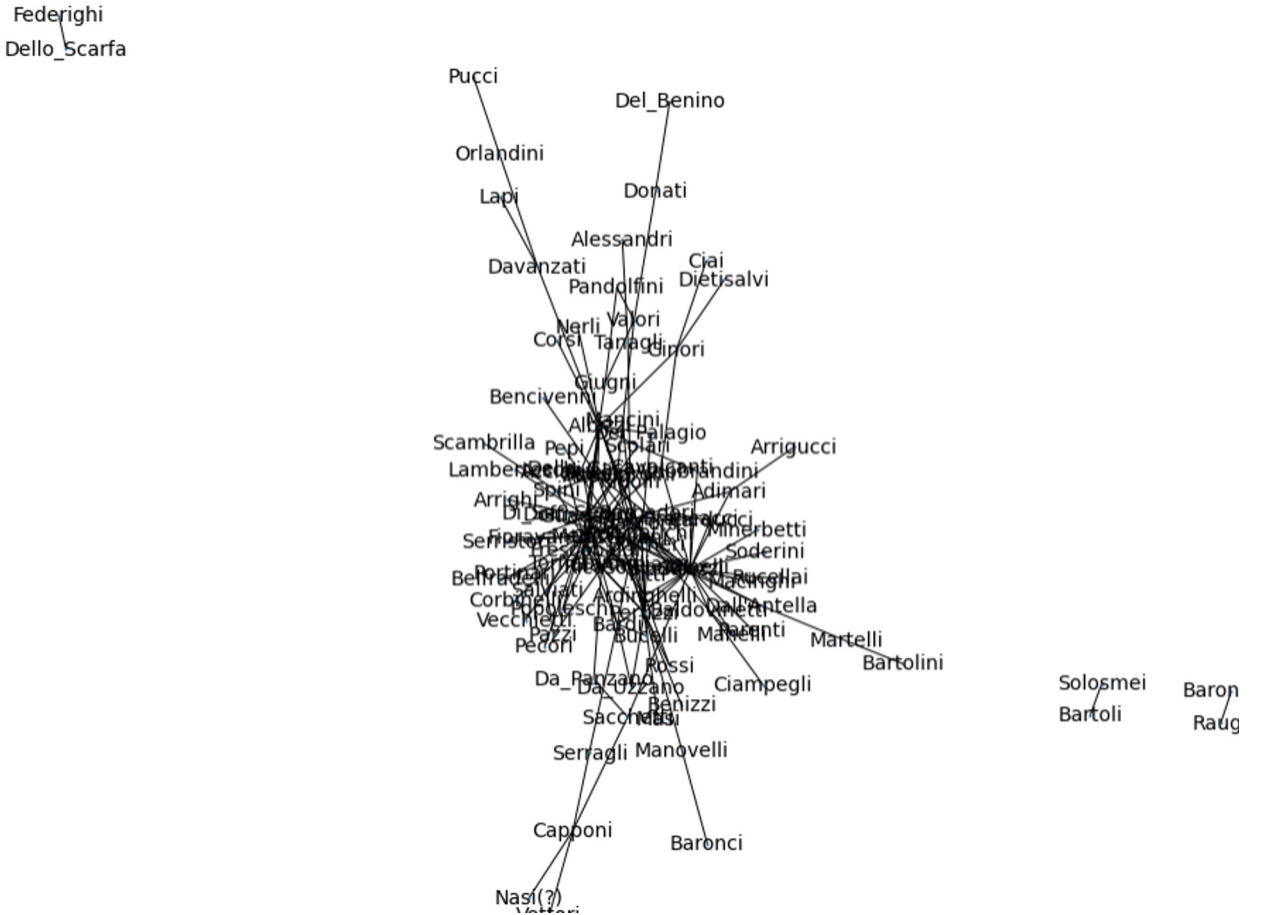
Do you see the block structure in this matrix? What does it mean?

Marriages graph

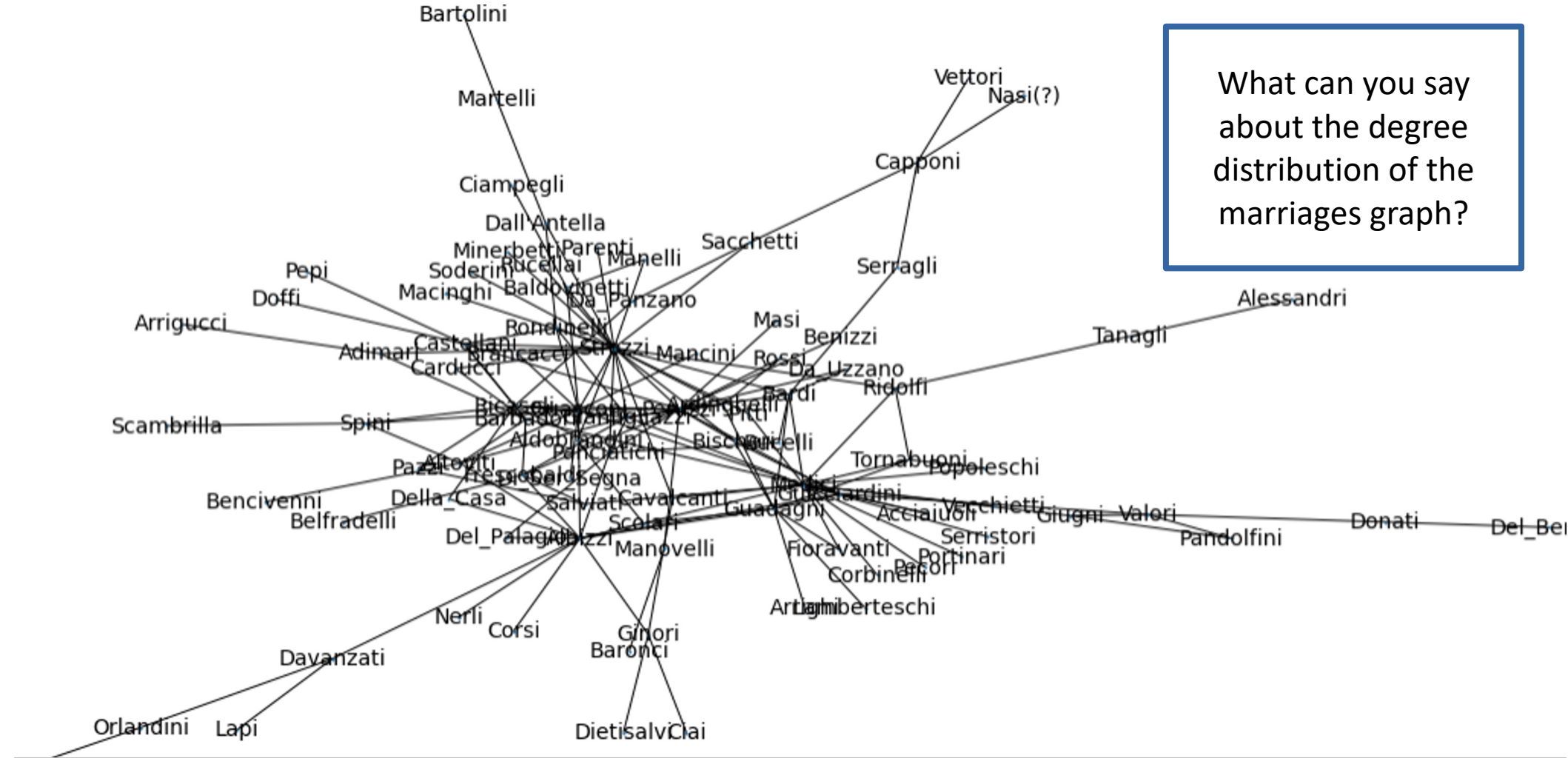
[Image source]

Marriages graph

- 96 nodes (families)
- 157 edges (marriages)
- Undirected and unweighted

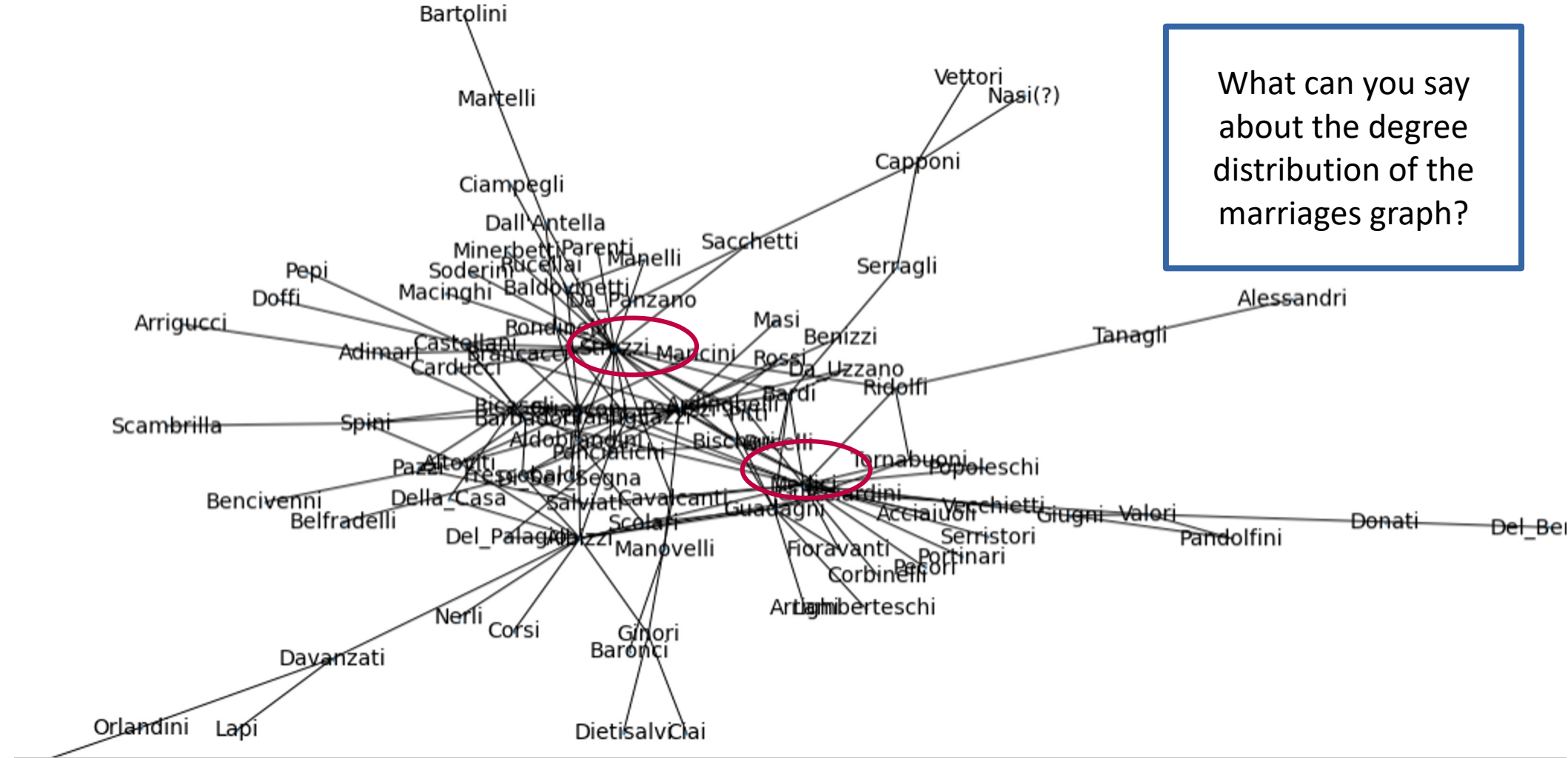


Marriages - giant connected component (90 nodes, 94%)



What can you say about the degree distribution of the marriages graph?

Marriages - giant connected component (90 nodes, 94%)



What can you say about the degree distribution of the marriages graph?

Closeness, betweenness, eigencentrality

Closeness	Betweenness	Eigencentrality
•Peruzzi 0.42	•Peruzzi 0.15	•Peruzzi 0.32
•Medici 0.44	•Medici 0.26	•Medici 0.27
•Strozzi 0.46	•Strozzi 0.35	•Strozzi 0.40

What can you say about the correlations of this with wealth/power?

Correlations

	Gwealth	Npriors	m_degree	m_closeness	m_betweenness	m_eigencentrality	c_degree	c_closeness	c_betweenness	c_eigencentrality
Gwealth	1.00	0.44	0.79	0.67	0.77	0.76	0.39	0.22	0.40	0.33
Npriors	0.44	1.00	0.69	0.53	0.71	0.63	0.31	0.03	0.24	0.19
m_degree	0.79	0.69	1.00	0.77	0.95	0.93	0.48	0.30	0.45	0.42
m_closeness	0.67	0.53	0.77	1.00	0.66	0.90	0.42	0.27	0.29	0.44
m_betweenness	0.77	0.71	0.95	0.66	1.00	0.81	0.43	0.25	0.45	0.33
m_eigencentrality	0.76	0.63	0.93	0.90	0.81	1.00	0.45	0.29	0.32	0.46
c_degree	0.39	0.31	0.48	0.42	0.43	0.45	1.00	0.70	0.84	0.87
c_closeness	0.22	0.03	0.30	0.27	0.25	0.29	0.70	1.00	0.61	0.81
c_betweenness	0.40	0.24	0.45	0.29	0.45	0.32	0.84	0.61	1.00	0.57
c_eigencentrality	0.33	0.19	0.42	0.44	0.33	0.46	0.87	0.81	0.57	1.00

Do you see the block structure in this matrix? What does it mean?
What is a good predictor of wealth/power?

Summary

Things to remember

- The analysis of social networks requires defining suitable graphs
- There is usually a step in which one compares this with domain-specific metrics
- In this use case, the marriage graph better describes the wealth/power balance during the power struggle…
- … but the credit graph probably explains why the Medici won the fight and sent to exhile Strozzi (money > love)