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Polarization in the 16th cent.

Ideologial groups during the Reformation

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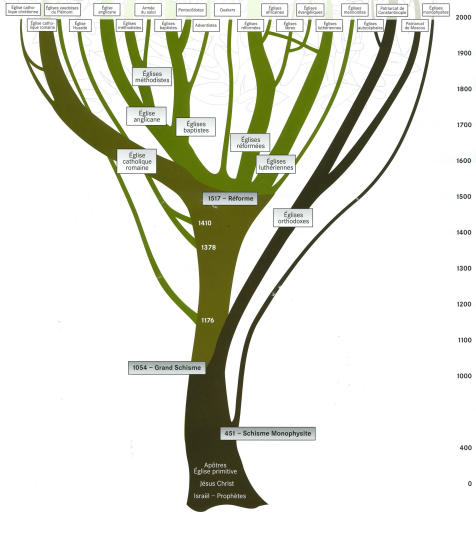
Ideological groups during the Reformation

- **Reformation**
  - Europe, 16th century
  - Overthrew Catholic Church
  - Not only Catholicism vs. Protestantism

ideological groups = Christian denominations



source: International Museum of the Reformation, Geneva [10]

➔ **Aim of today: Why are ideological groups important and how can we identify them?**

Ideological groups from then still matter today

Historical origins of...

- **30 (80) Years War**
  - Longest war in European History
- **National identity**
  - Lutheranism in West Germany (Martin Luther)
  - Swarmers in East Germany (Thomas Müntzer)
- **Formation of modern state**
  - Religion separates Swiss Kantons (e.g. Appenzell, Basel)
  - Theory of confessionalisation Reinhard [15] and Schilling [18]

source: Wikimedia

source: suche-briefmarken.de

➔ **Ideological groups affect modern day decisions and identities**

How to identify ideological groups?

- Letter correspondence network of reformers ⇒ **community detection**
- **Community:** group of nodes having higher *probability of being connected* to each other than to members of other groups.
- **Problem:** Several algorithms, which one to choose?

- **Infomap:** 89 communities
- **Label propagation:** 1093 communities
- **Modularity maximisation:** 15 communities

Network

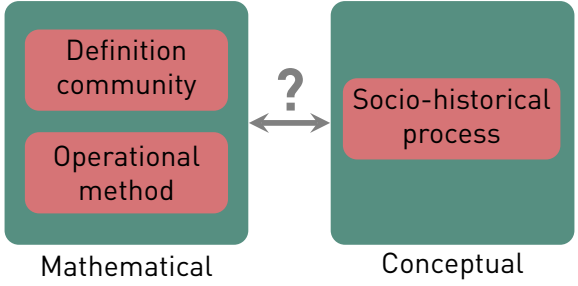
Reformation

- Lutherans
- Reformed
- Calvinists
- Baptists
- ...

Different community detection algorithms yield different partitions

Why do community detection algorithms yield different results?

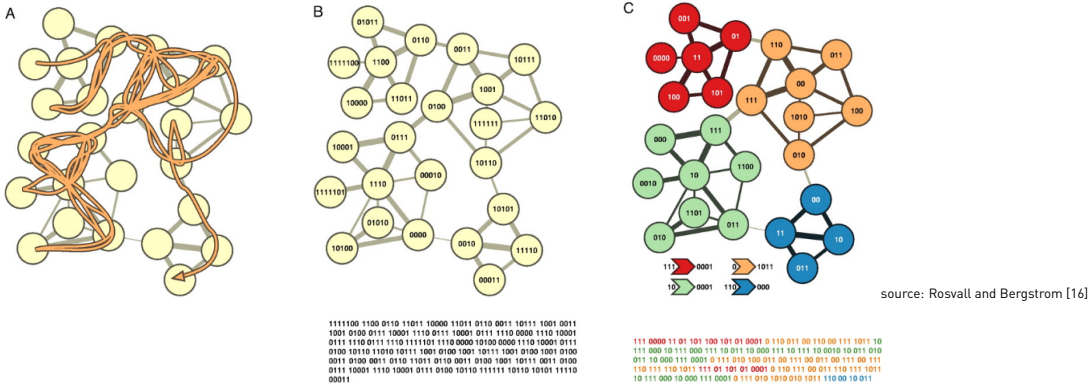
- Because they define a community in different ways Coscia et al. [3] and Fortunato and Hric [7]
- Focus today: Infomap, label propagation, modularity maximisation



- **Map mathematical definition of algorithms to relevant socio-historical processes of the Reformation.**
- **Mapping is an informed decision.**

Infomap Rosvall and Bergstrom [16]

- **Defined by closeness:** nodes can reach each other by crossing low number of edges
- **Procedure:** random walk + *compression*
- **Compression:** re-use node labels across communities, (cf. streetnames across cities)

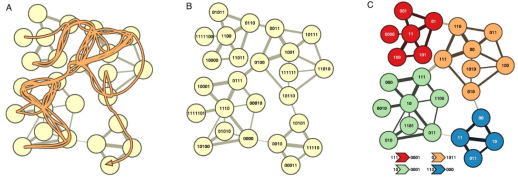


source: Rosvall and Bergstrom [16]

Infomap: communities represent shortest compression of nodes

Map infomap to contagion

- **Contagion:** Membership when coming into contact with others who have already experienced ideas (cf. epidemic) Young [20], Bass [1], and Mahajan and Peterson [12]
- Random walk ➔ transmission of ideas
- Compression ➔ same idea passed on in different circumstances



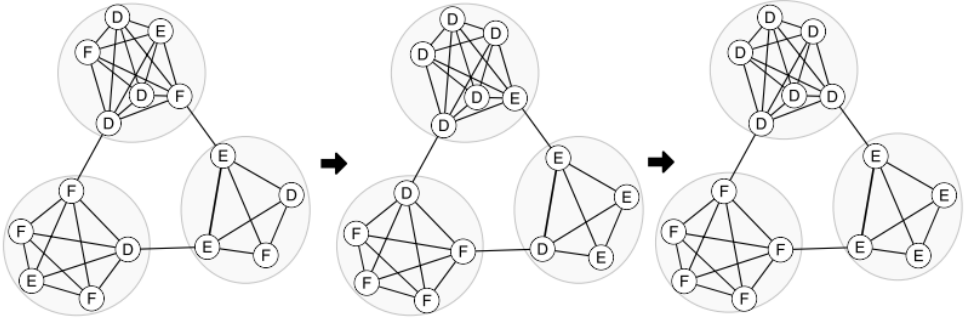
- Relevant for Reformation: **Transubstantiation**
  - Change of the substance of Bread and Wine
  - **Lutherans:** Real presence of Jesus
  - **Reformed:** Symbolic and memorial character

source: rnz.co.nz

➔ **Contagion describes how idea of Transubstantiation was discussed differently among ideological groups**

Label propagation Raghavan et al. [14]

- **Defined by diffusion:** nodes grouped by propagation of same property, action or information
- **Procedure:** *transmission rule* + group by same state
- **Transmission:** node's label determined by majority of neighbours' labels



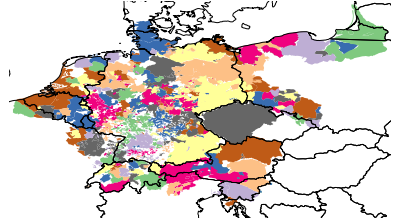
source: Coscia et al. [3]

Label propagation: communities represent converged majority influence

Map label propagation to social influence

- **Social influence:** Membership when sufficiently many others have experienced ideas (cf. conformity) Young [20], Schelling [17], Granovetter [8], Granovetter and Soong [9], and Dodds and Watts [4]
- Transmission rule ➔ join majority of neighbours

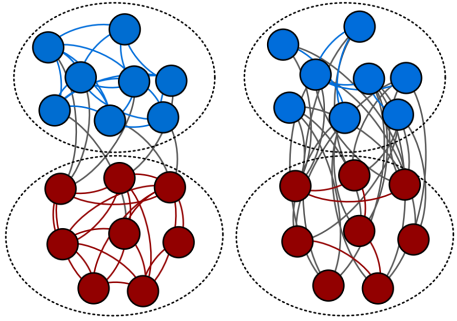
- Relevant for Reformation: **Strategic alliances** Cantoni [2]
  - Adoption of Protestantism among territories
  - Weak territories adopt decision of majority of powerful neighbours



➔ **Label propagation describes how majority influence reduces risk to join an ideological group**

Modularity maximisation Newman and Girvan [13]

- **Defined by density:** nodes are more densily connected within than between communities
- **Procedure:** compare observed and random graphs in terms of intra-community density

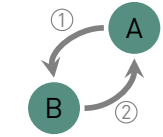


source: Fortunato and Hric [7]

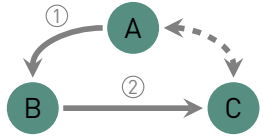
Modularity: communities represent densely connected nodes relative to random graph

Map modularity to social learning

- **Social learning:** Membership once sufficient empirical evidence to convince them (cf. rational choice) Young [20], Ellison and Fudenberg [5, 6], and Kapur [11]
- Density ➔ closed triangles (e.g. indirect reciprocity, social inference)



direct reciprocity



indirect reciprocity

- Relevant for Reformation: **Indirect reciprocity**
  - Caring for widows of friends
  - Capito marries wife of Oekolampad
  - Bucer marries wife of Capito


source: Wikipedia [19]

➔ **Modularity describes how dense connections were built via indirect reciprocity**

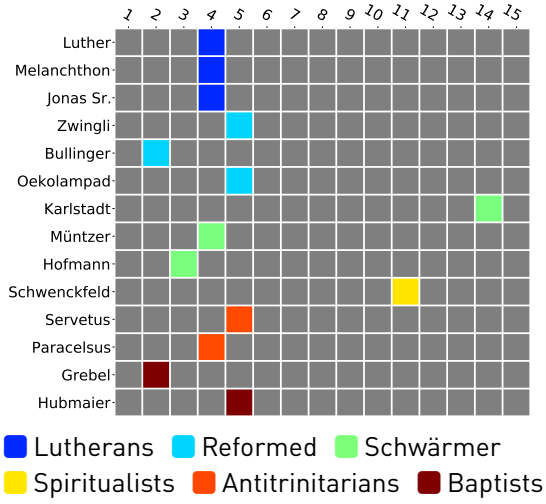
Which algorithm to choose?

- **Theoretical:** Process-oriented
  - Identify socio-historical process that lead to ideological groups
  - Choose algorithm which corresponds to this process

- **Modularity:** personal encounters (social learning)
- **Label propagation:** adoption of political decisions (social influence)
- **Infomap:** theological doctrine (contagion)

➔ **Ideological groups mostly defined by theological differences, i.e., choose Infomap**

Results Infomap

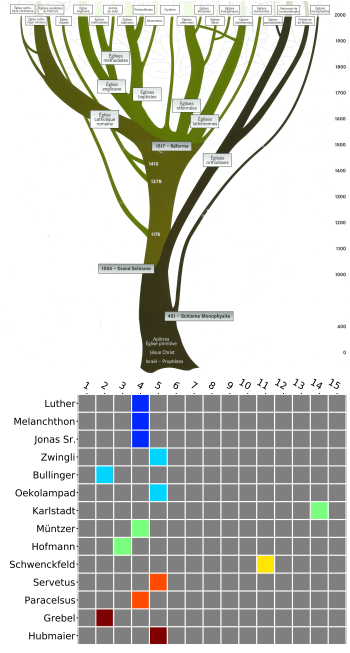


- **In line with historiographical research**
  - Lutherans together
  - Thomas Müntzer supporter of Luther
  - Reformed: 2 generations
- **Needs further explanation**
  - Distant relation between Karlstadt and Lutherans

- **Success: Social processes can be mapped to community detection**
- **Community detection provides starting point to explore relations in depth**

Summary

- **The problem**
  - network ⟷ Reformation
  - network communities ⟷ ideological groups
- **The mapping**
  - **Infomap → Contagion**
  - **Label propagation → Social influence**
  - **Modularity → Social learning**
- **Results**
  - Community detection results are **interpretable**



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