Communities in payments networks

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10th BoF Simulator Seminar

PLAN

- ❑ Introduction / motivation
- ❑ Modularity-based communities
- ❑ Questions

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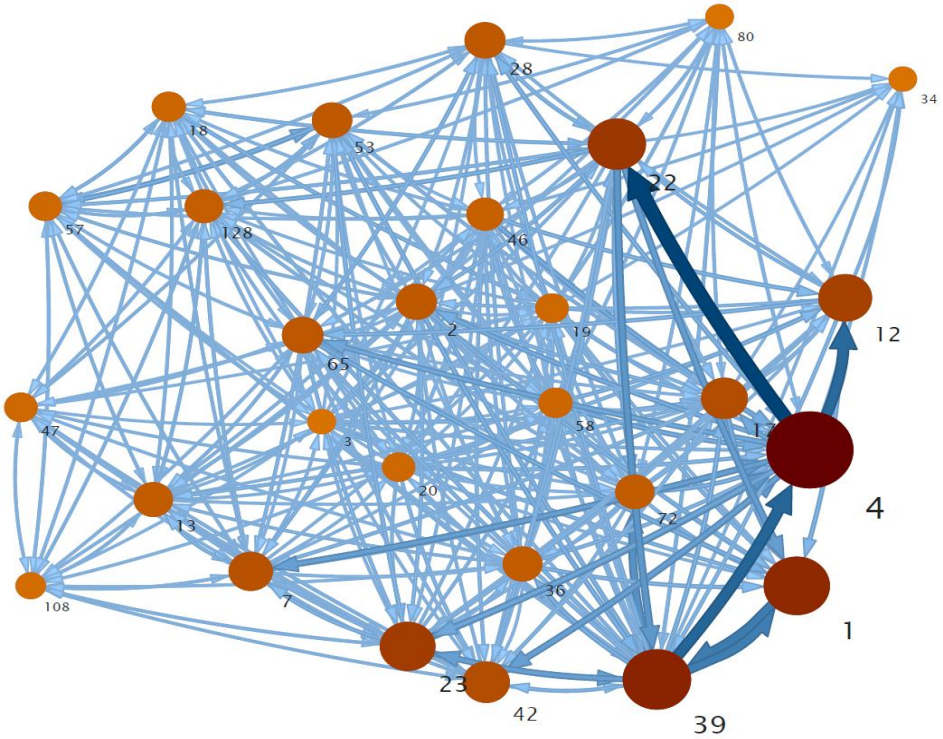
- ❑ Introduction / motivation
- ❑ Modularity-based communities
- ❑ Questions

Based on work on TARGET2 (w. Lucian Stanciu-V.)

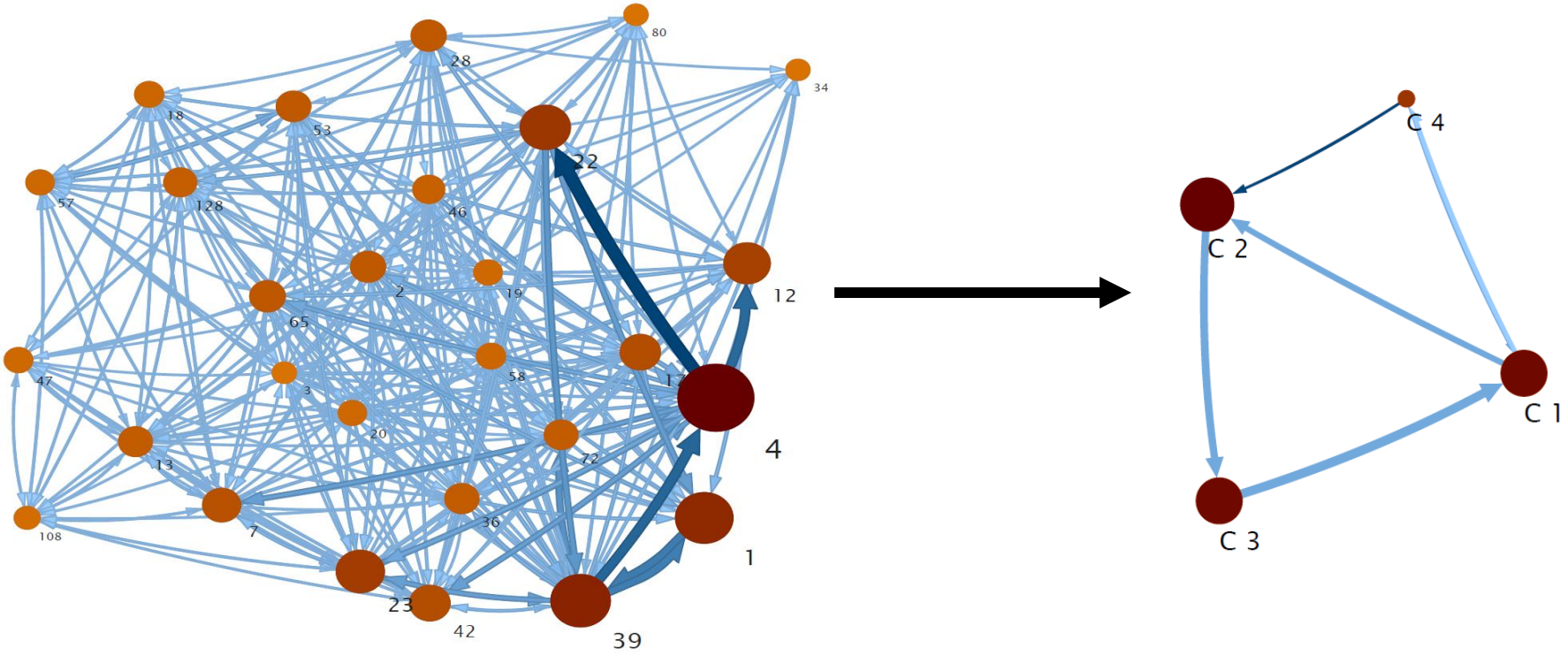
NO ACTUAL RESULTS/DATA PRESENTED

Describing the network: classic statistics



- Connectivity
- Deg. distribution
- Reciprocity
- Clustering
- ….

Describing the network:
another network



Why for payments?

- Identify liquidity **dependencies** & other relationships
- Identify **changes** in the structure of the network

in turn useful for

- ✓ oversight of the system
- ✓ FS questions (*early warnings, contagion...*)

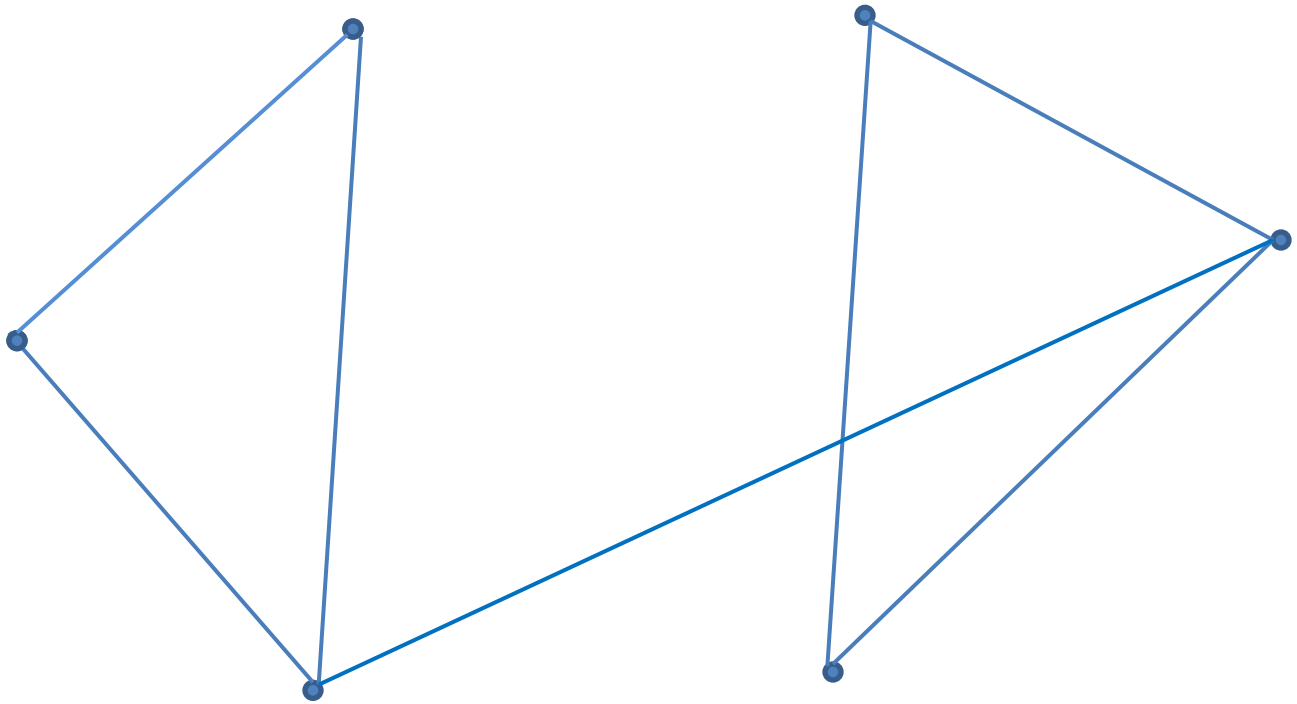
Communities in networks

Several methods ← several definitions of ‘community’

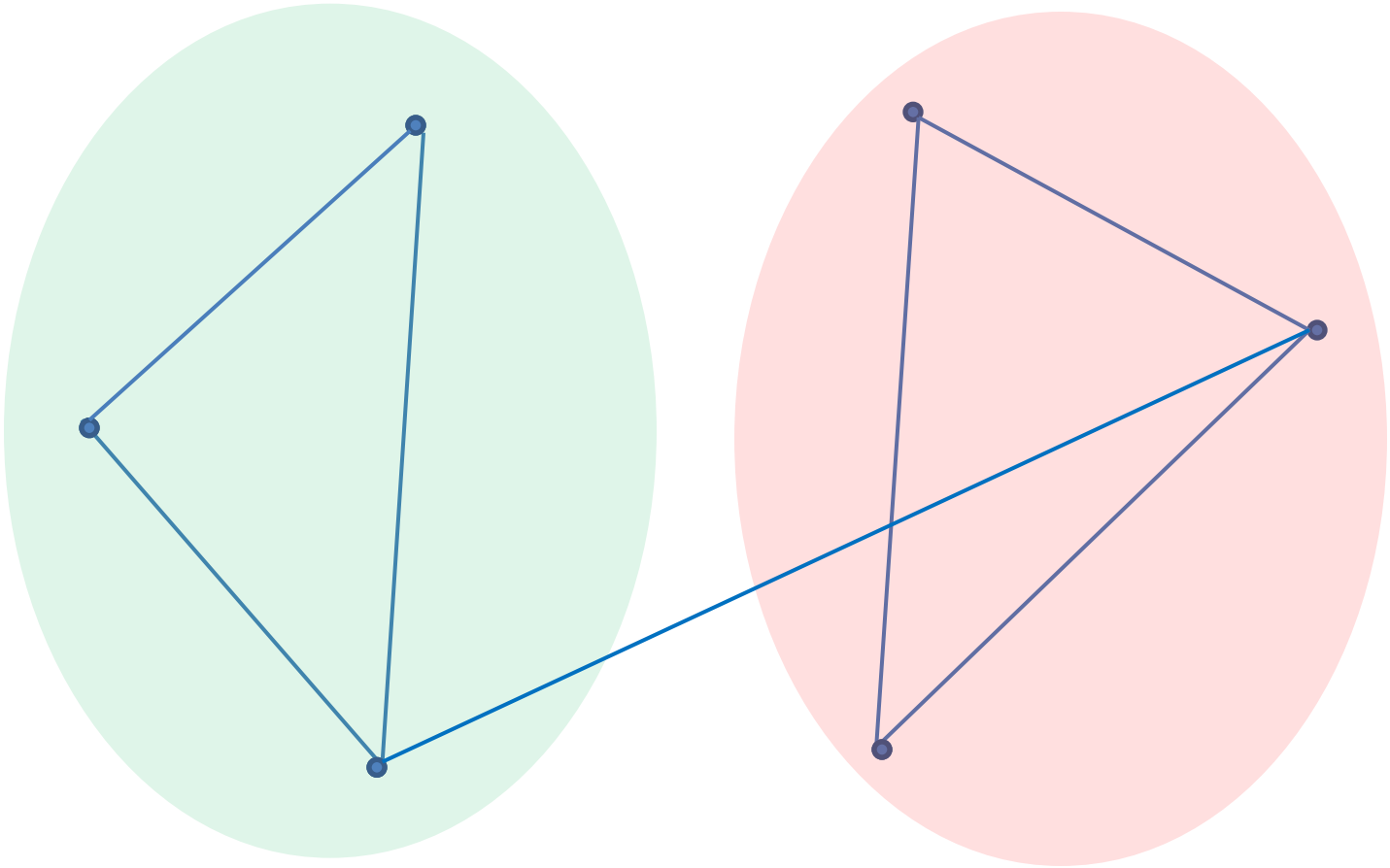
A special family: Modularity-based methods

Communities singled out by ‘unexpected’ patterns in the links

Communities as unexpected patterns



Communities as unexpected patterns



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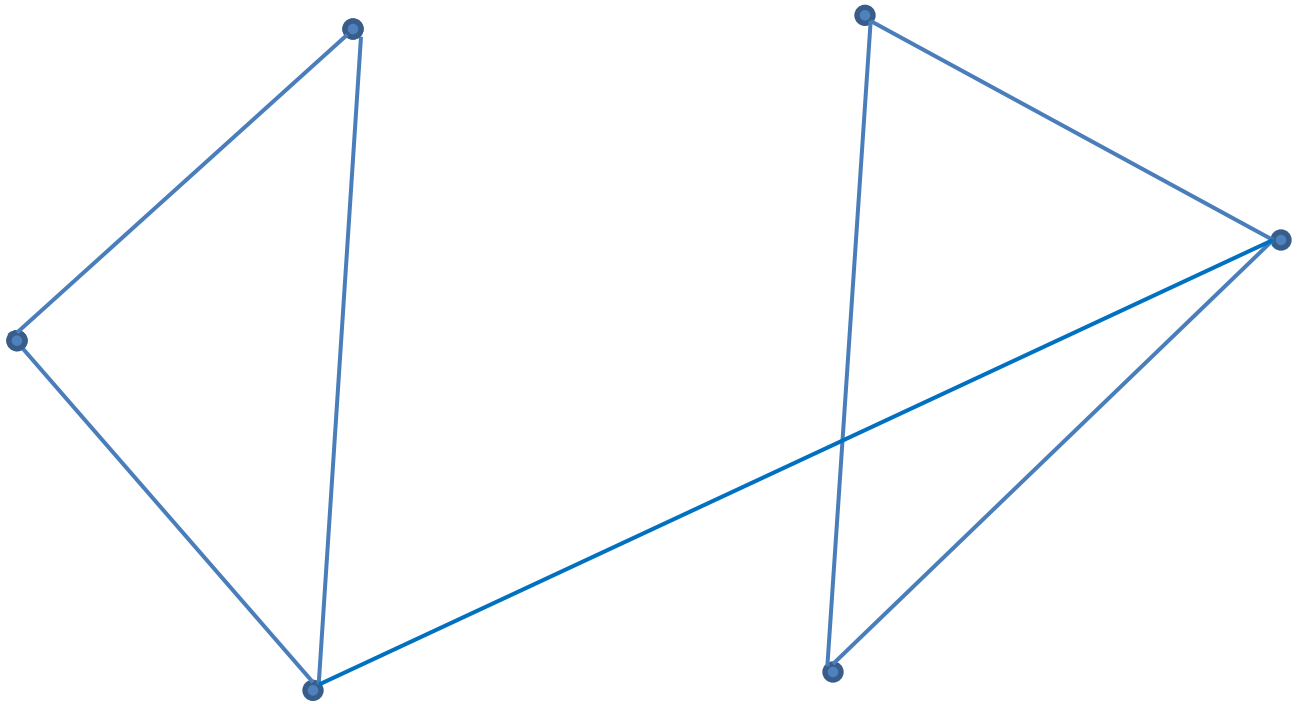

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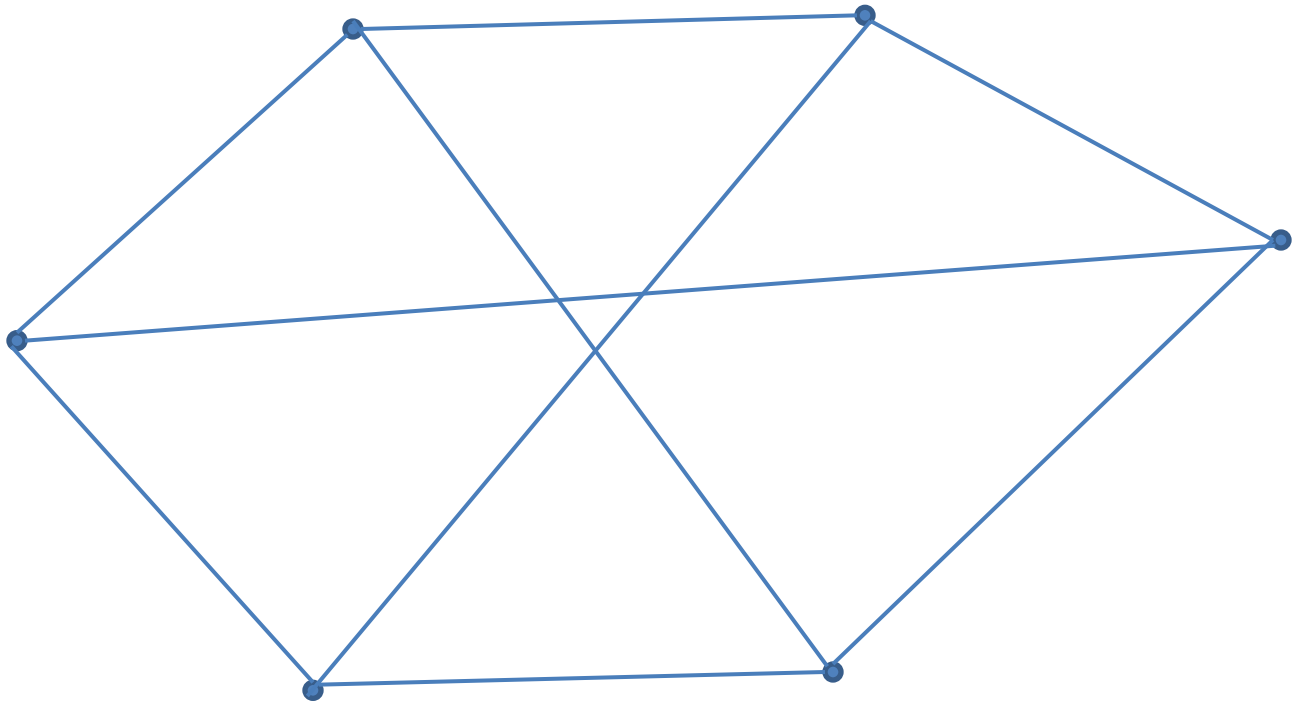

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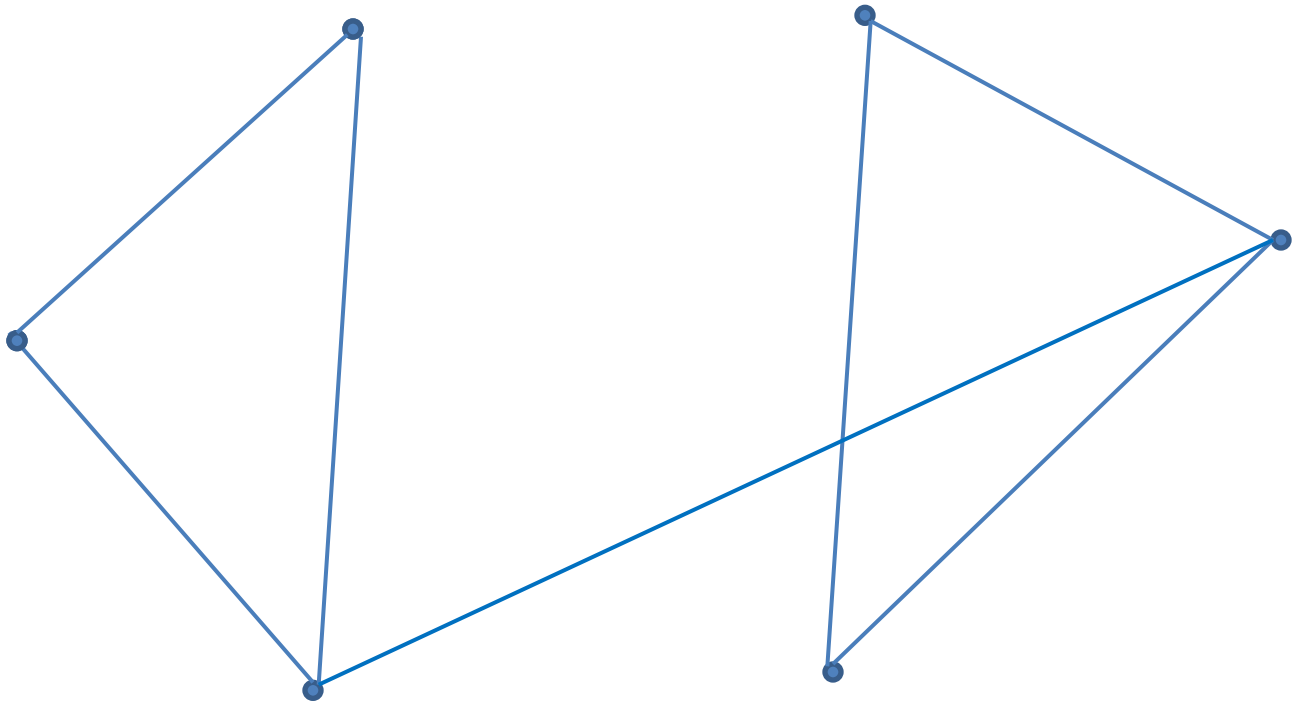

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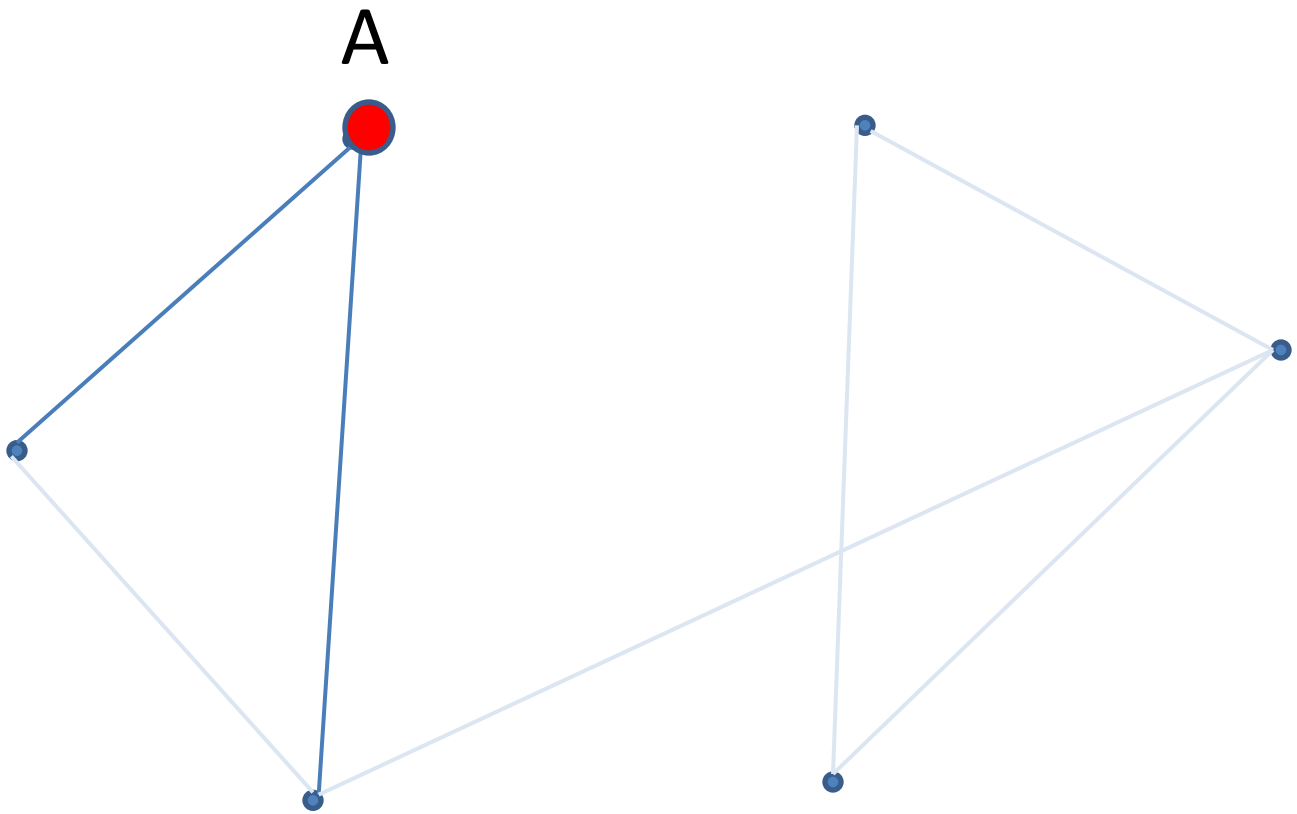

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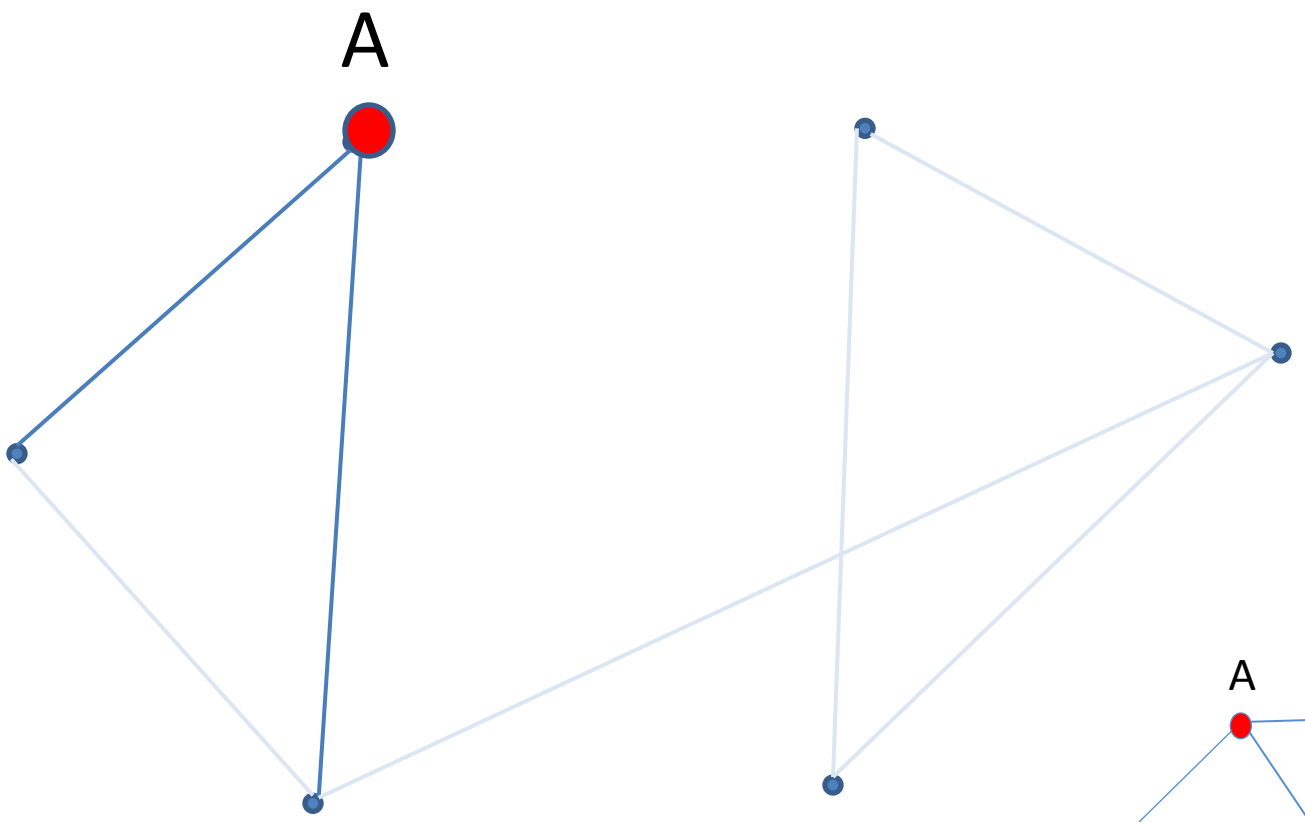

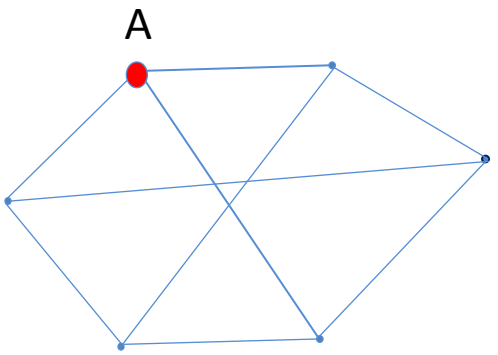

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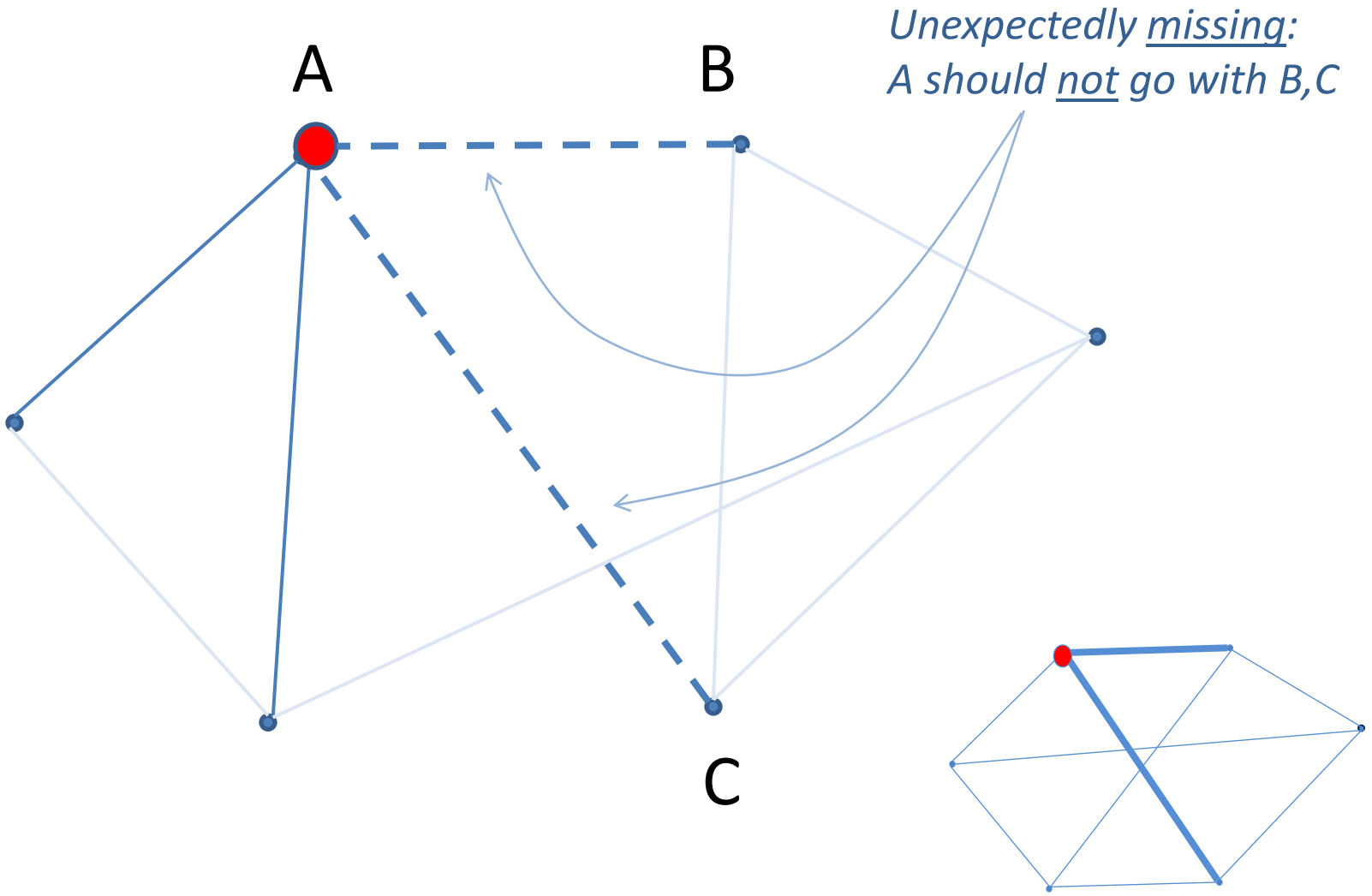

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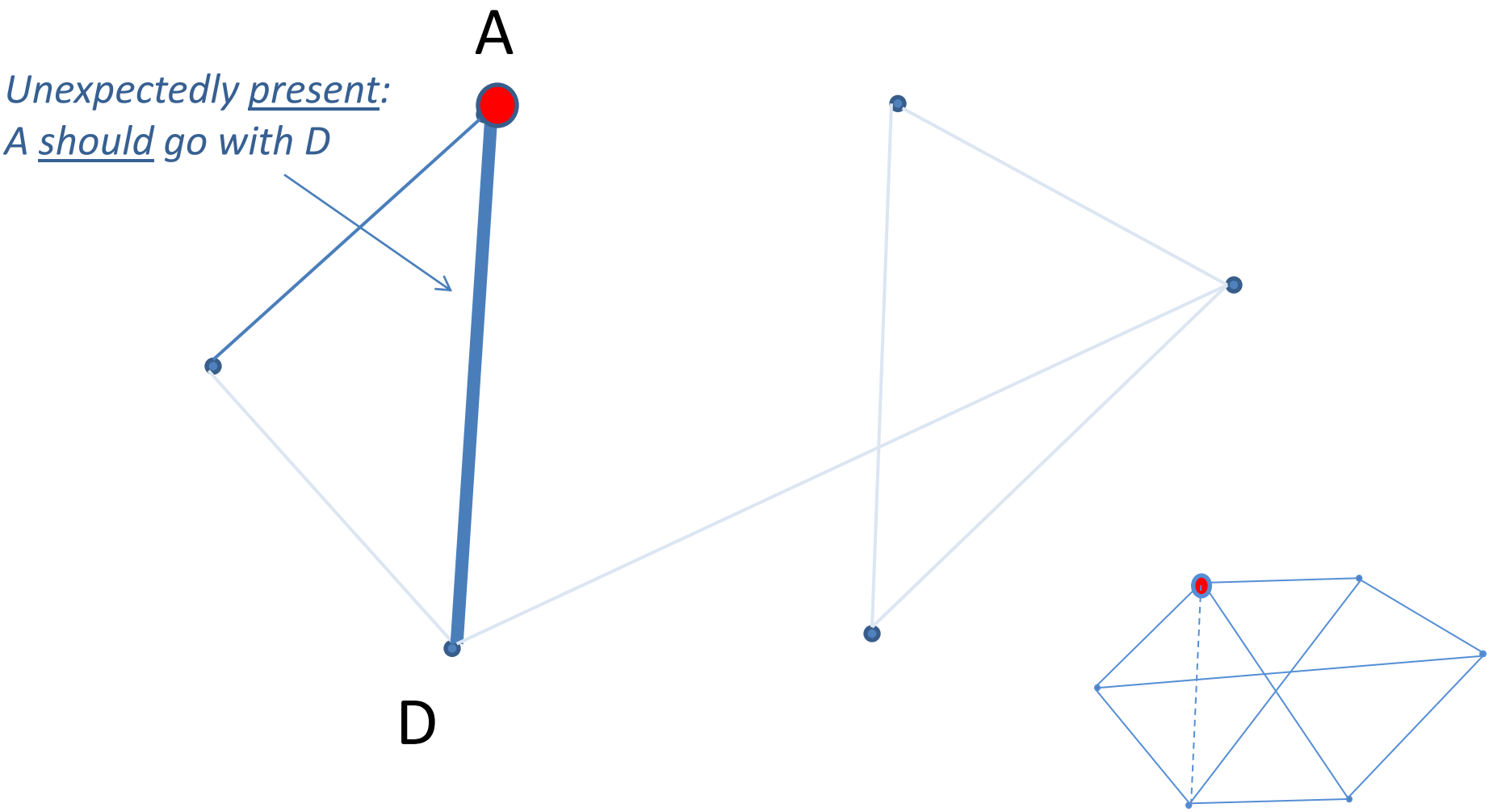

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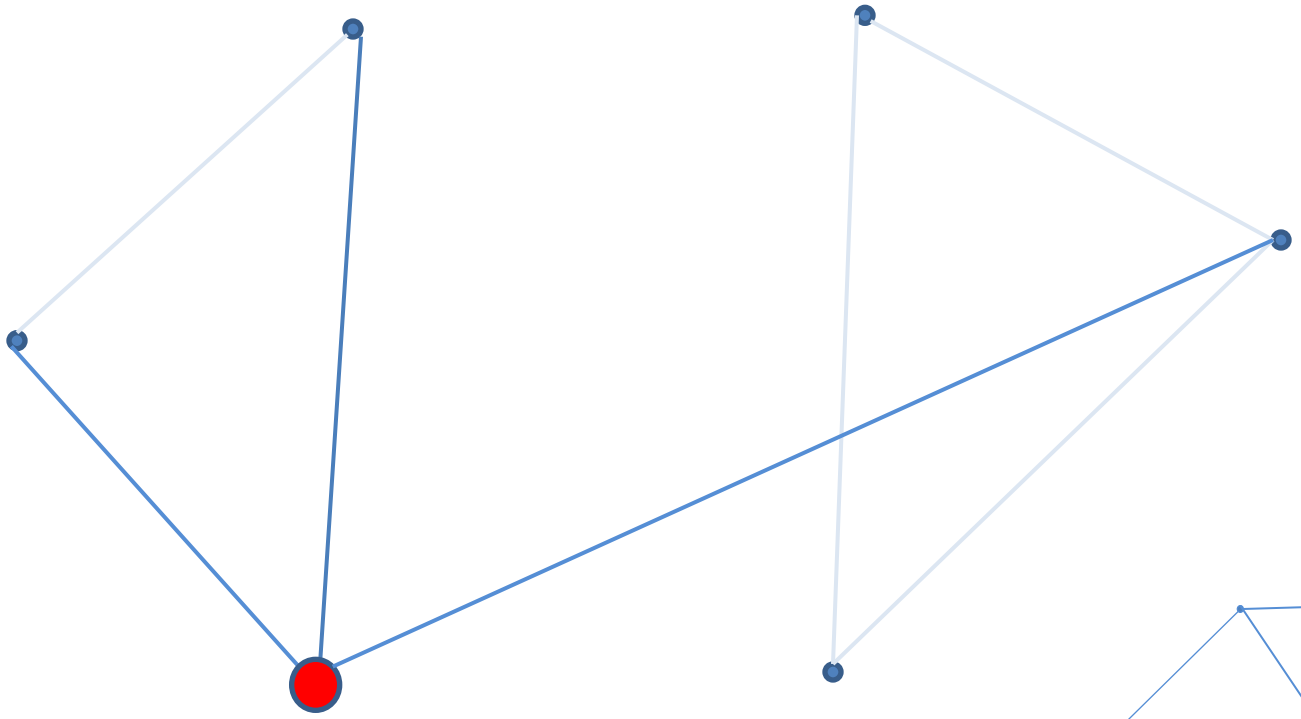

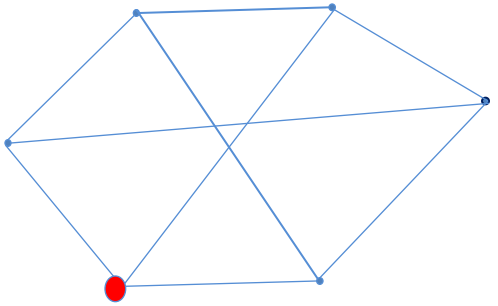

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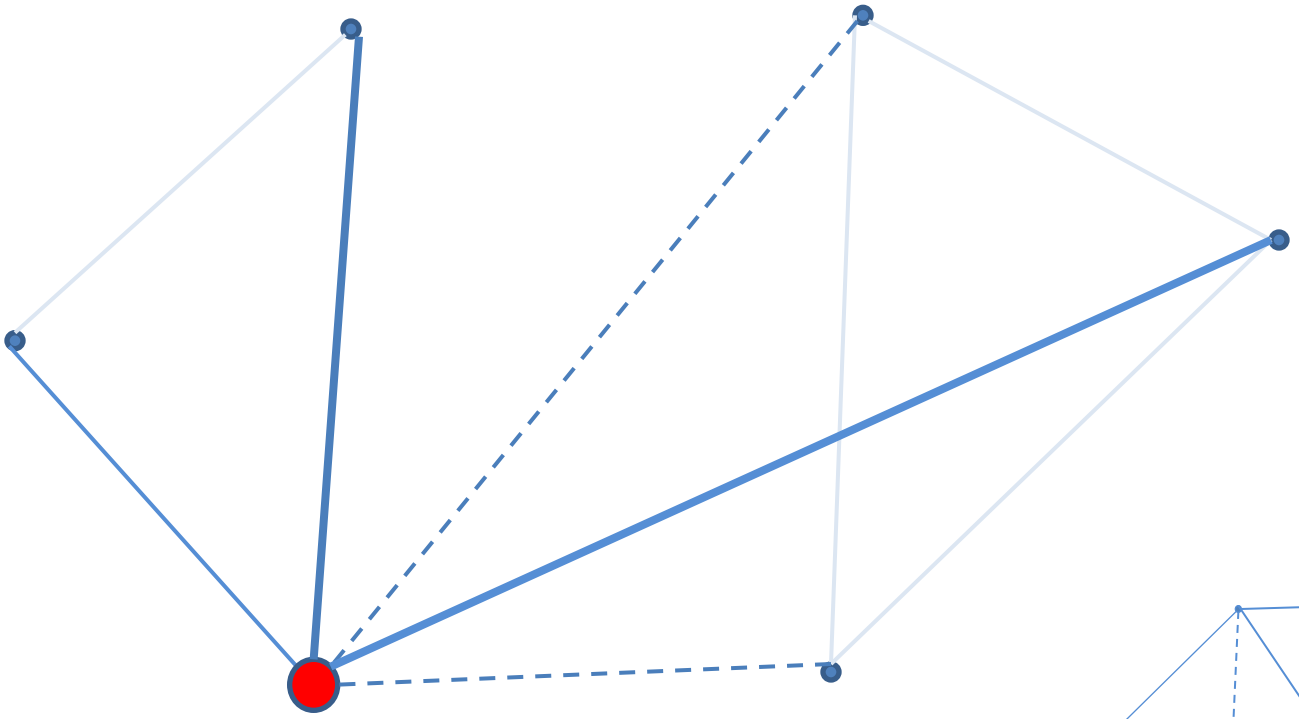

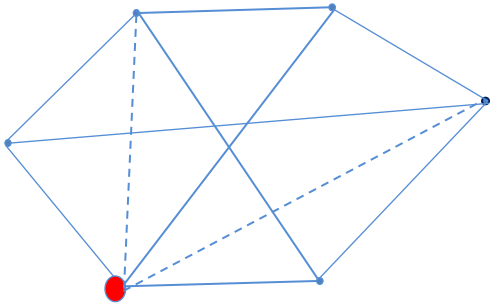

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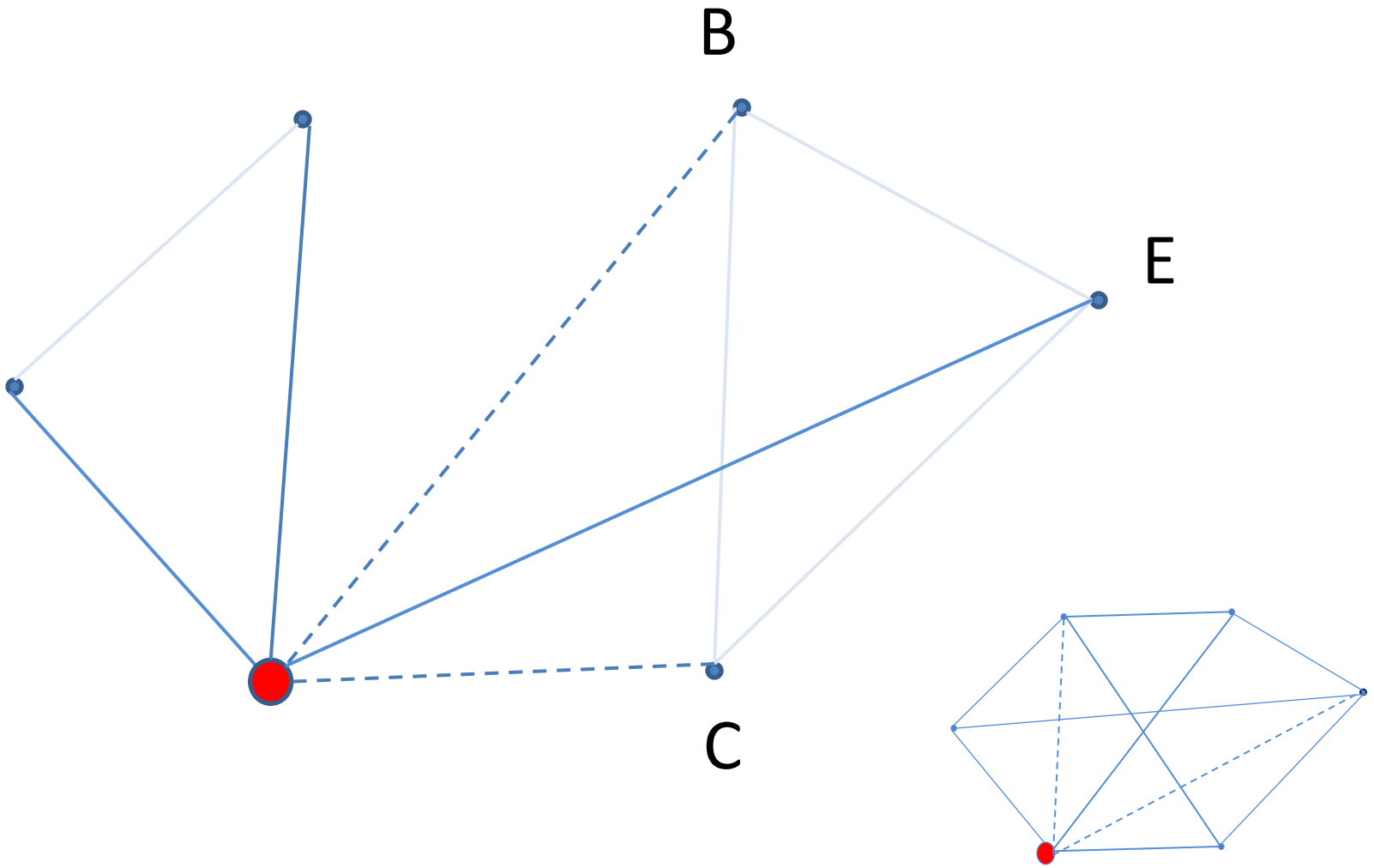

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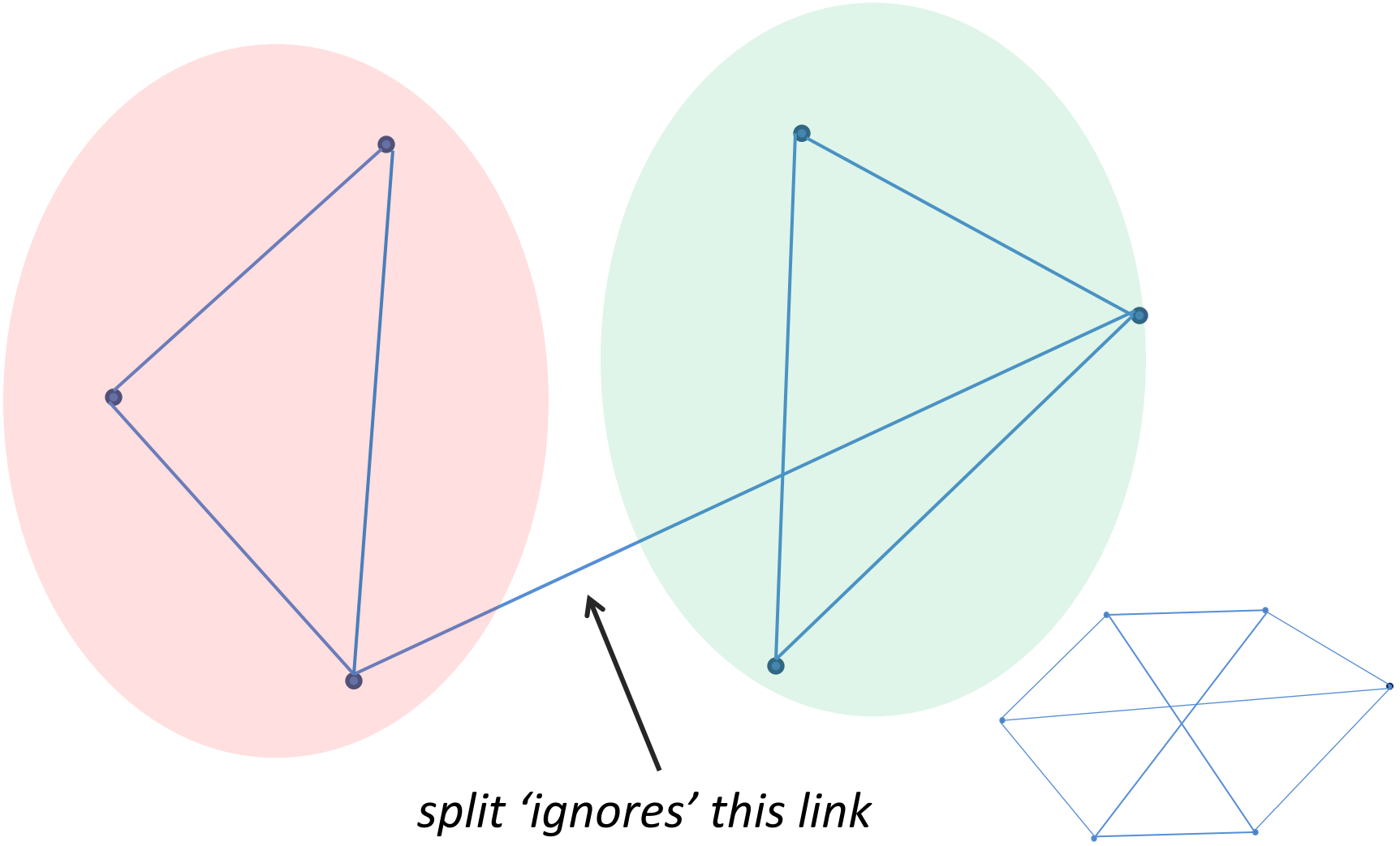


Communities as unexpected patterns

- Modularity matrix:

$$M_{ij} = A_{ij} - E\left(A_{ij}\right)$$

- Modularity of a 2-split:

$$\sum_{i,j \in C_1} M_{ij} + \sum_{i,j \in C_2} M_{ij}$$

- Optimal split: Max Modularity (over all splits)

In practice

1. Choice:

   Define ‘expectation’ $E(A_{ij})$

2. Problem:

   Maximize modularity

In practice

1. Choice:

   Define 'expectation' $E(A_{ij})$

   ✓ Markov model of €-circulation

   $$E(A_{ij}) = \frac{A_{ij}}{\sum_j A_{ij}}$$

2. Problem:

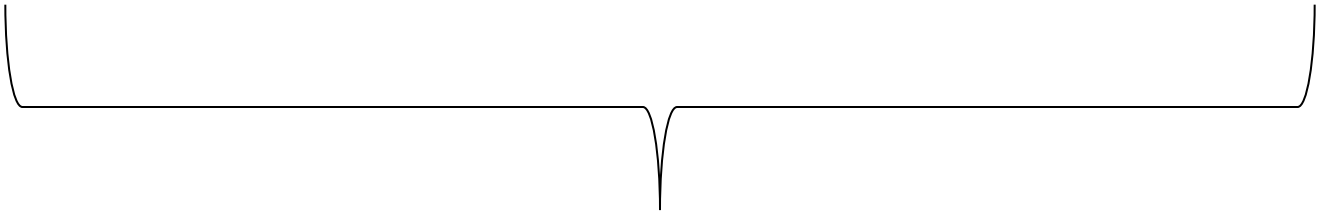
   Maximize modularity

   ✓ Approximated algorithms

   (sequential splits & spectral decomposition of *M)*

What to do with communities?

- **Visualize** network (the ‘real’ geography)
- Identify **channels** between communities
- Identify banks important ***within*** and ***across*** communities



over time

(events eg markets, policy variables)

Issues

Null model:

a) Estimation of the Markov model (time horizon, self-payments…)

b) Is the Markov model correct?

Interpretation:

Benchmark *vs* day(week/month)-ly networks: describe and interpret