TARGETED COMMUNITY MERGING PROVIDES AN EFFICIENT COMPARISON BETWEEN COLLABORATION CLUSTERS AND DEPARTMENTAL PARTITIONS

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ANALYSIS OF DEPARTMENTAL STRUCTURE

Obtention of an optimal departmental partition based on scientific collaboration criteria

DATA AND NETWORK MODELLING

- Scientific collaboration data (2002 – 2021) from University of Zaragoza database (Sideral), processed by *Kampal Data Solutions*. Three macro-areas of knowledge:
    - Science (537 researchers, 14 departments)
    - Health science (724 researchers , 11 departments)
    - Engineering and Architecture (628 researchers , 10 departments)

SCIENTIFIC COLLABORATION NETWORKS

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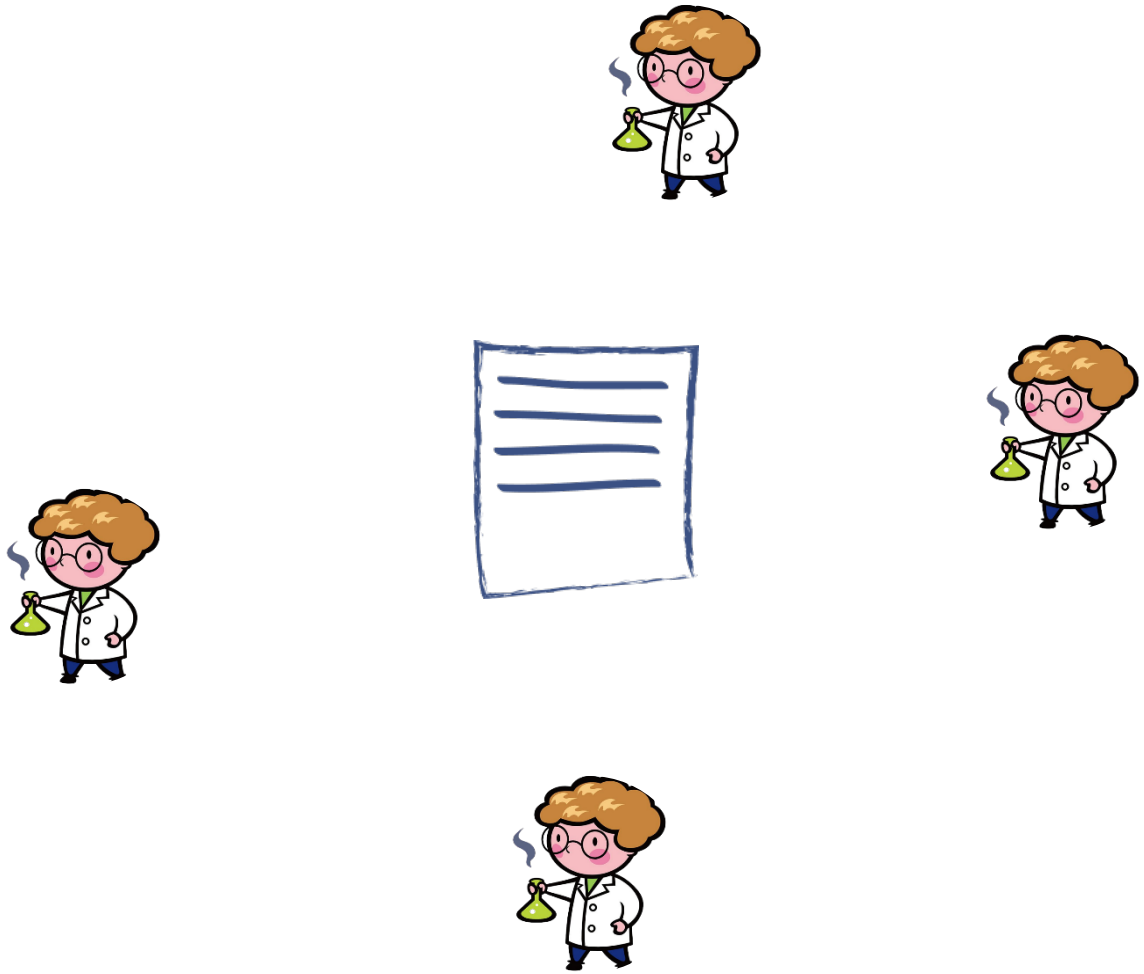

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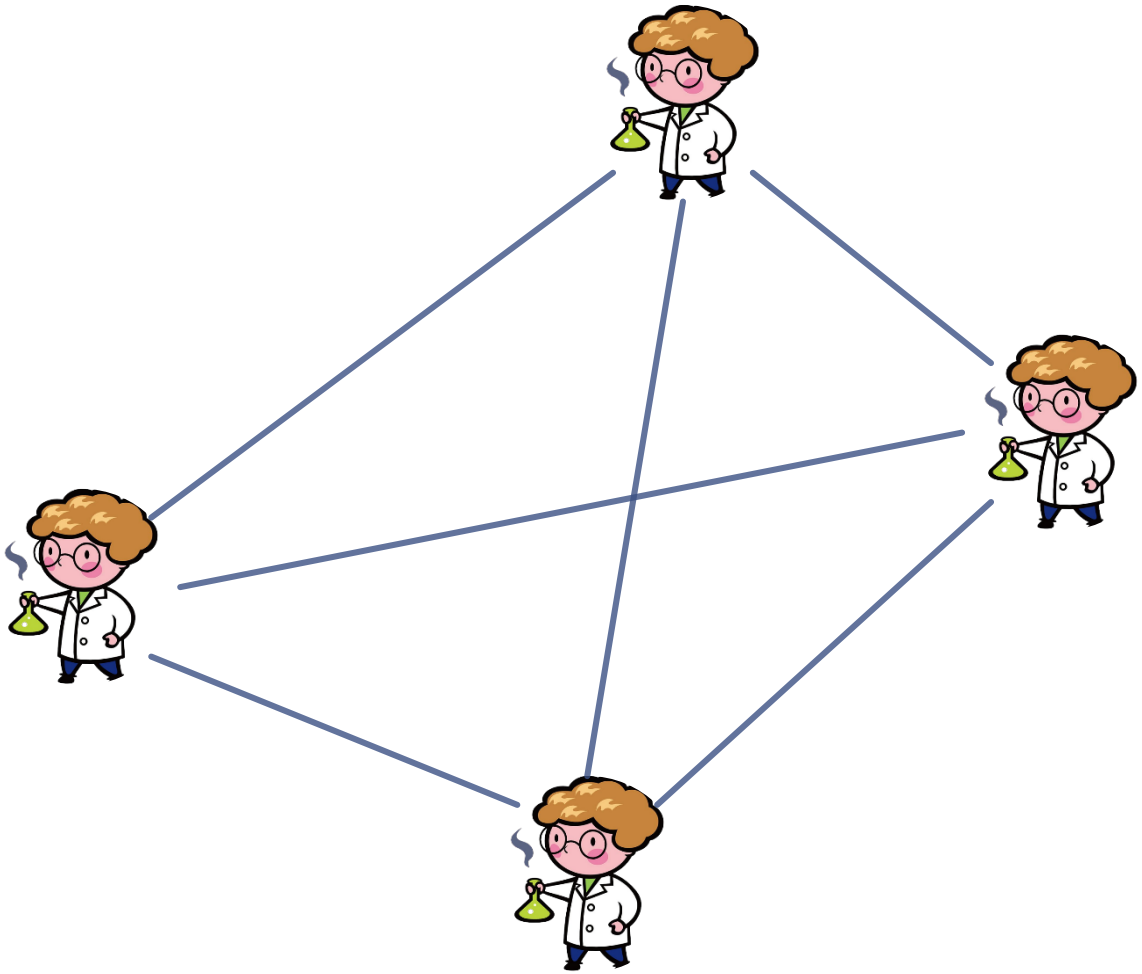

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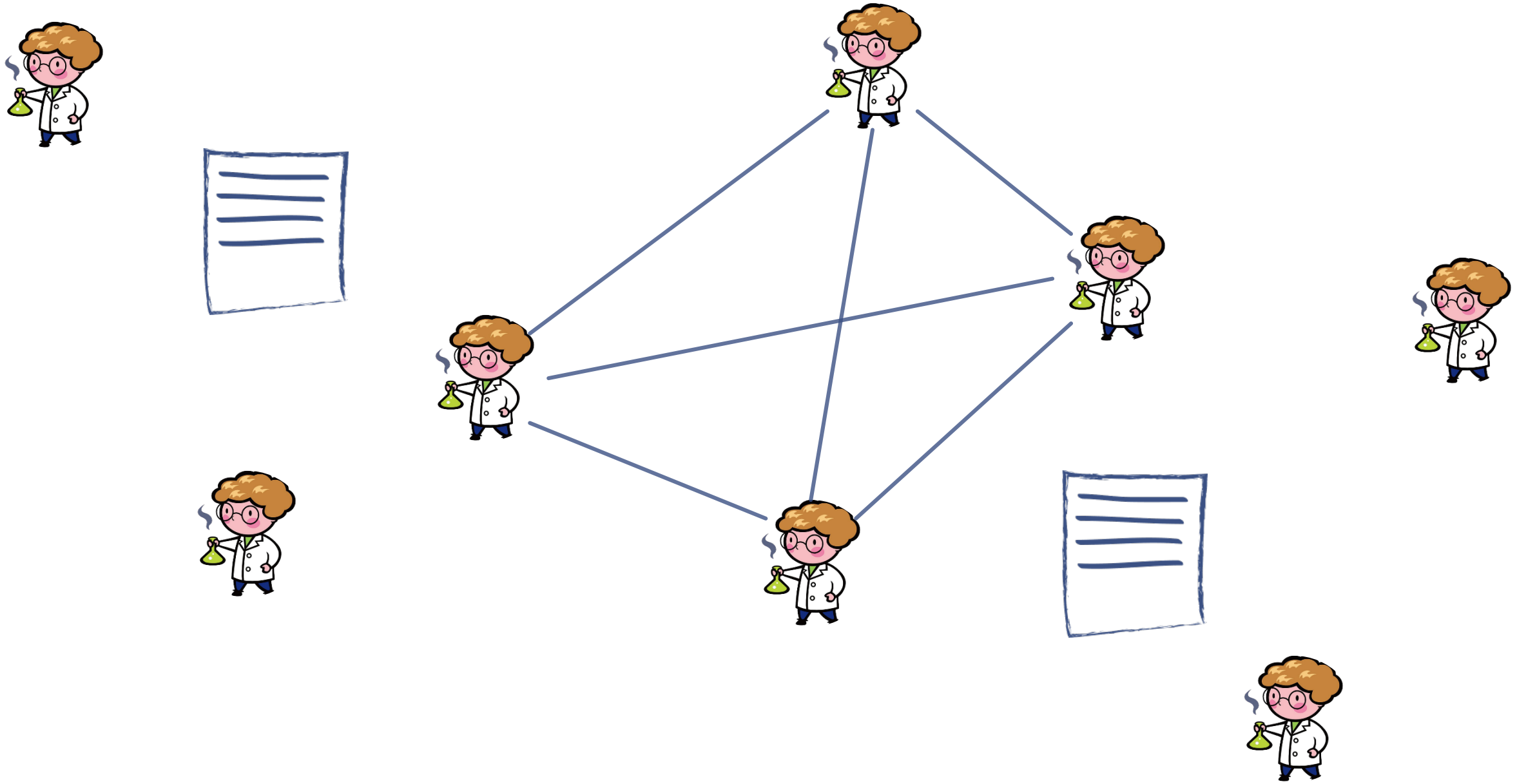

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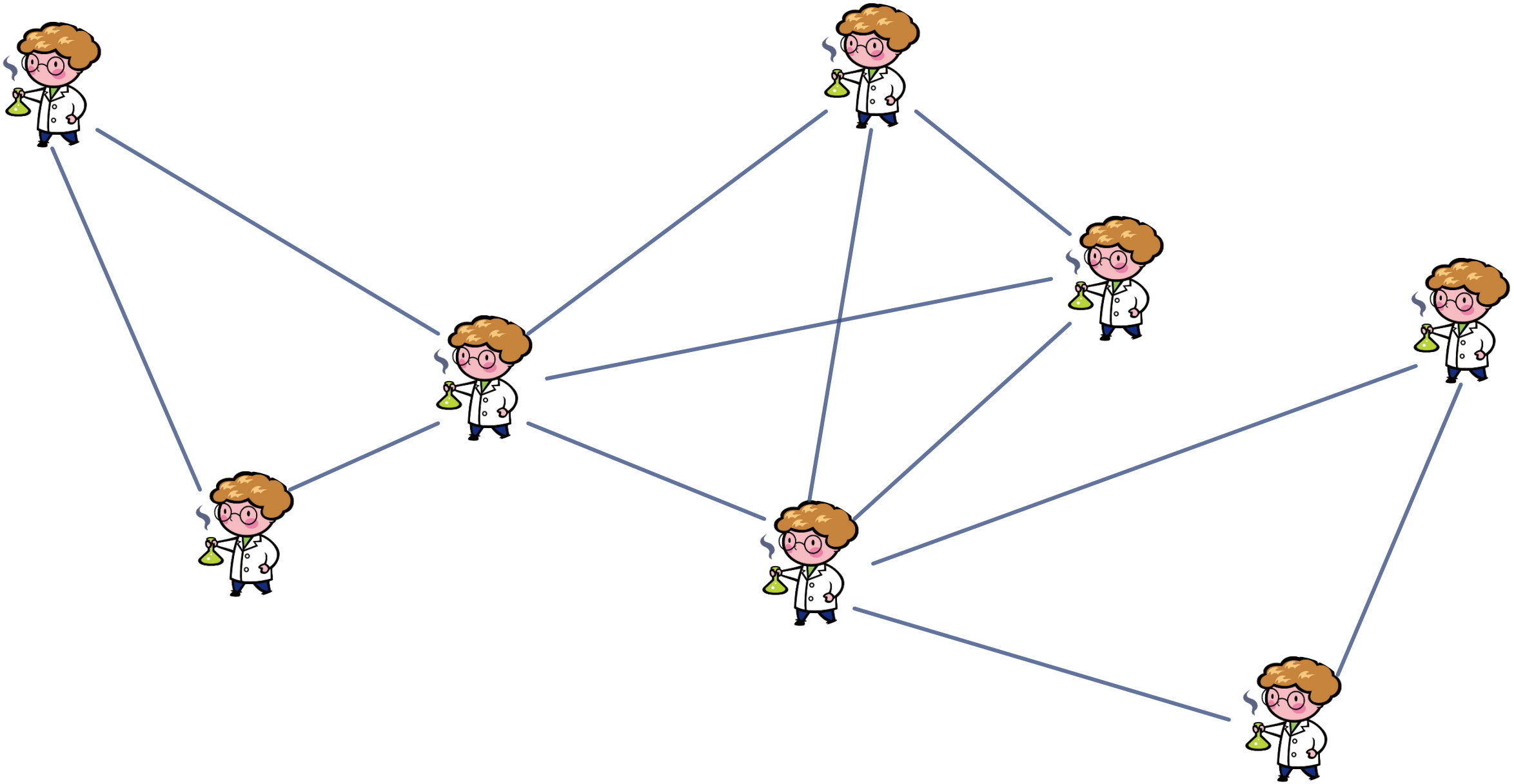
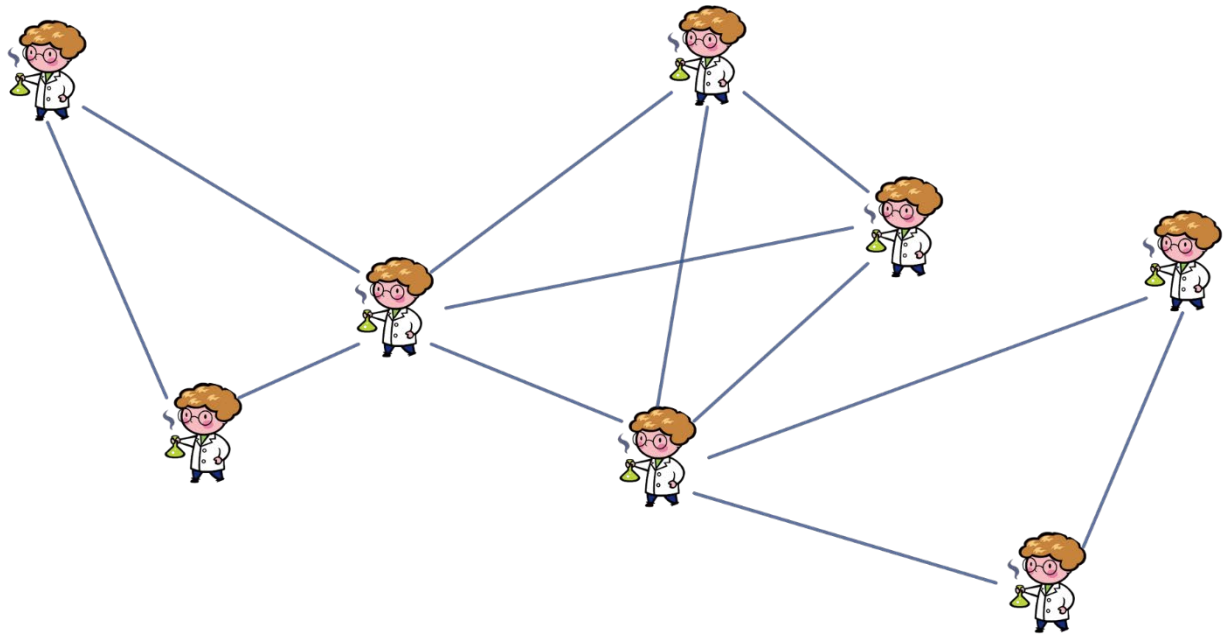


- Three **undirected** and **weighted** networks

$$w_{ij} = \sum_{m=1}^{M_{ij}} \frac{IF_{ij}^{m}}{N_{ij}^{m} - 1}$$



$\boldsymbol{w_{ij}}$: Weight of link between nodes i and j

$\boldsymbol{M_{ij}}$: Number of articles published with researchers i and j as co-authors

$\boldsymbol{IF_{ij}^{m}}$: Impact factor of $m-th$ article

$\boldsymbol{N_{ij}^{m}}$: Number of authors of $m-th$ article

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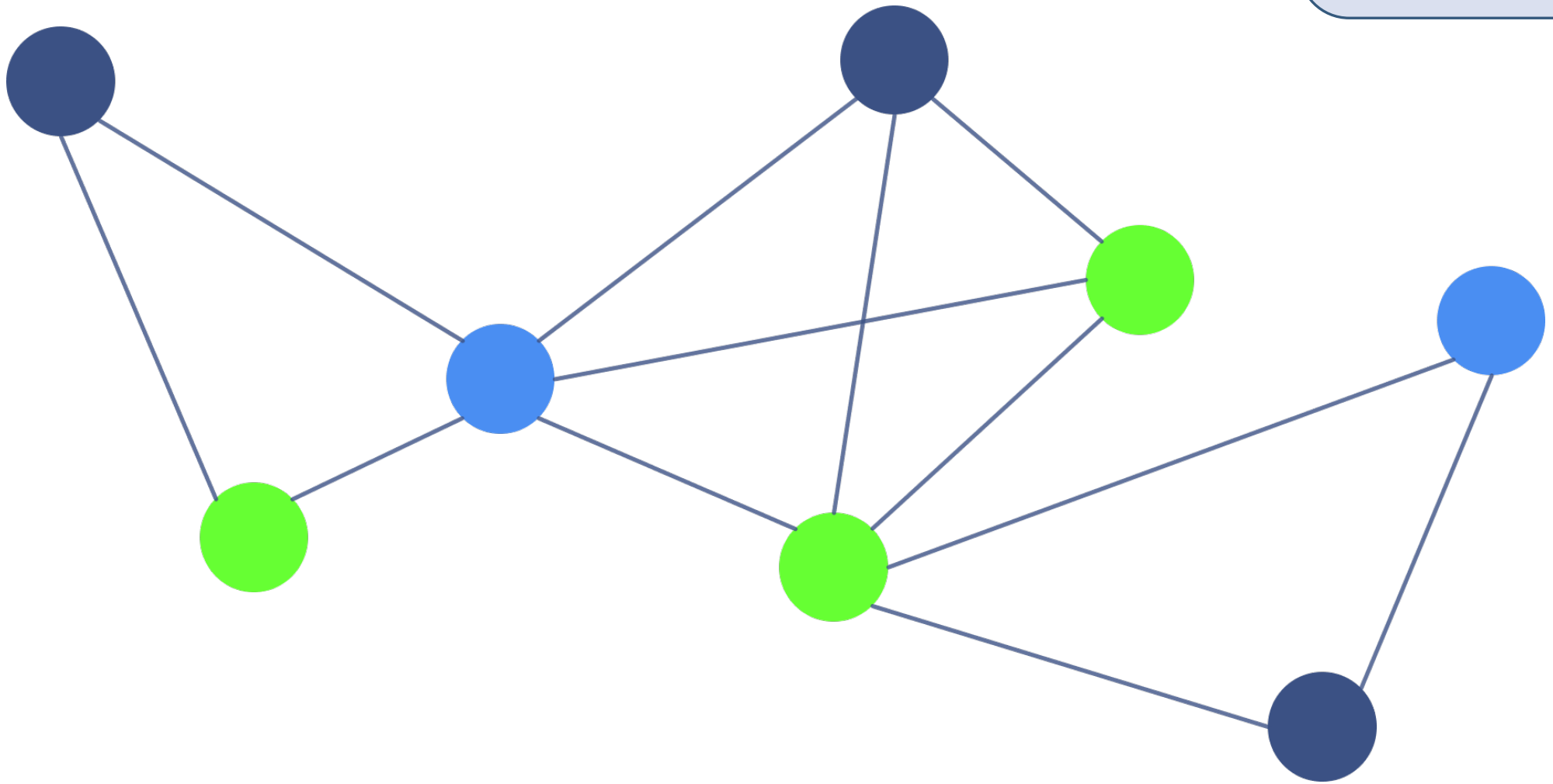

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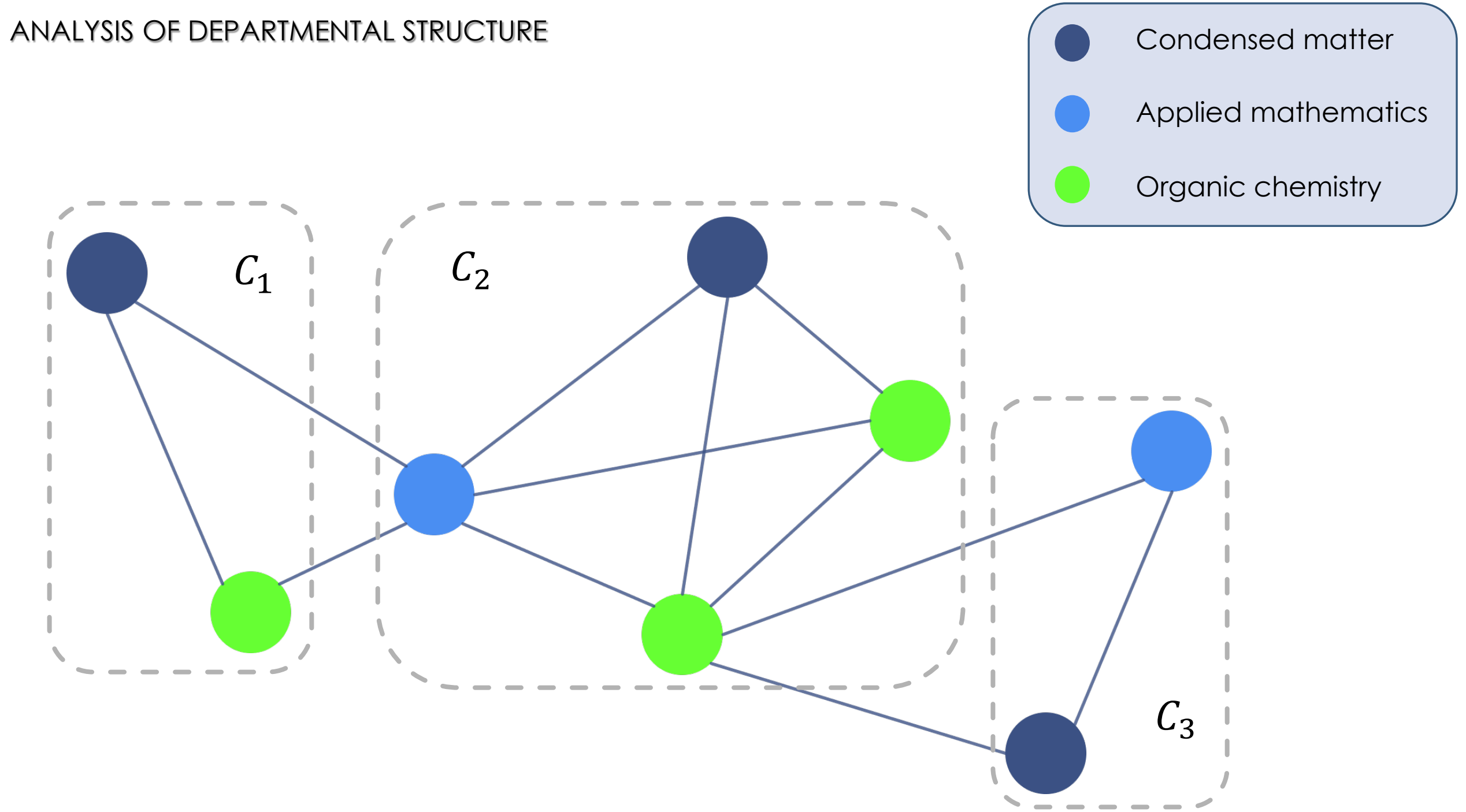

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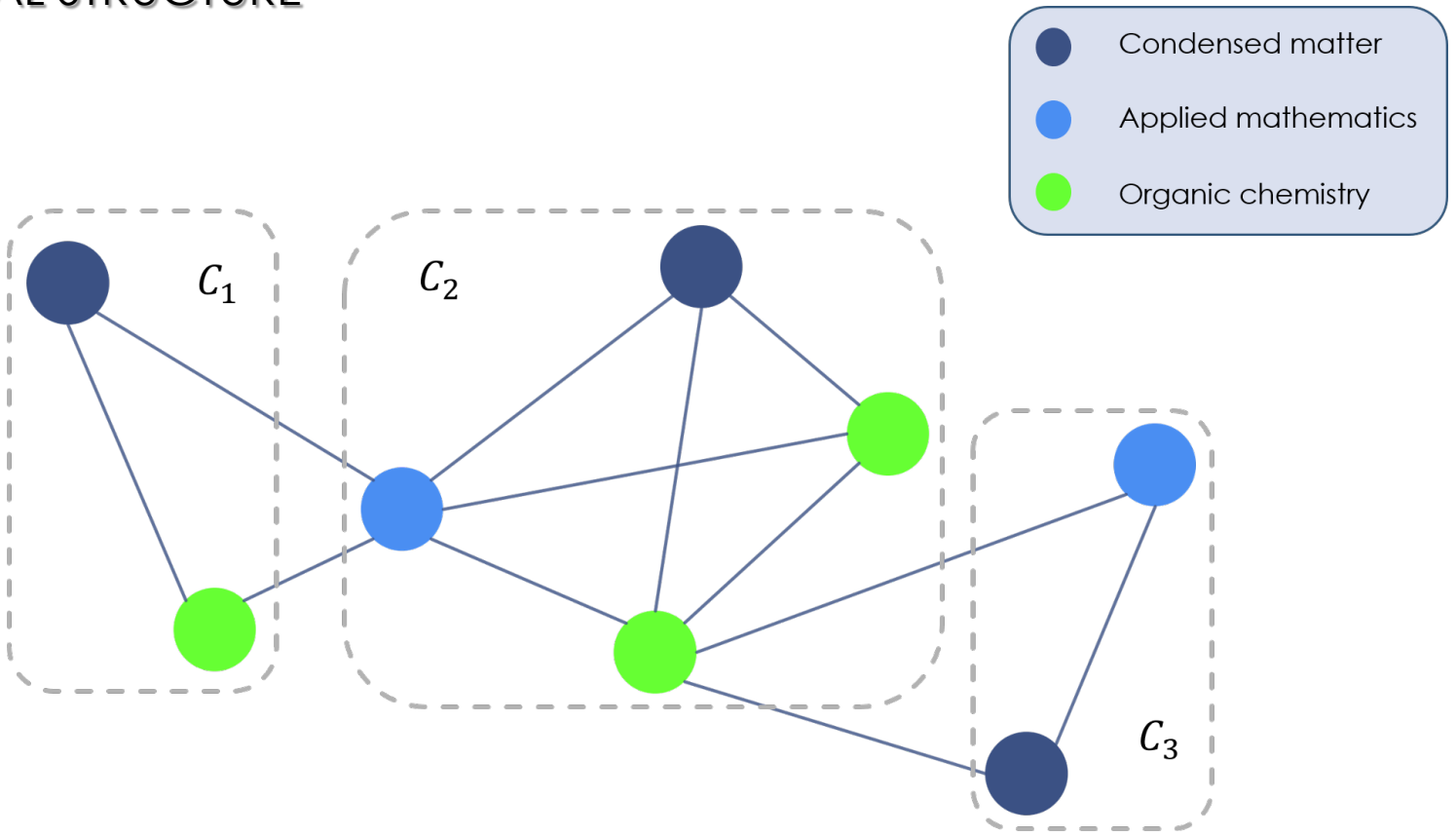

Louvain and **Girvan-Newman** algorithms

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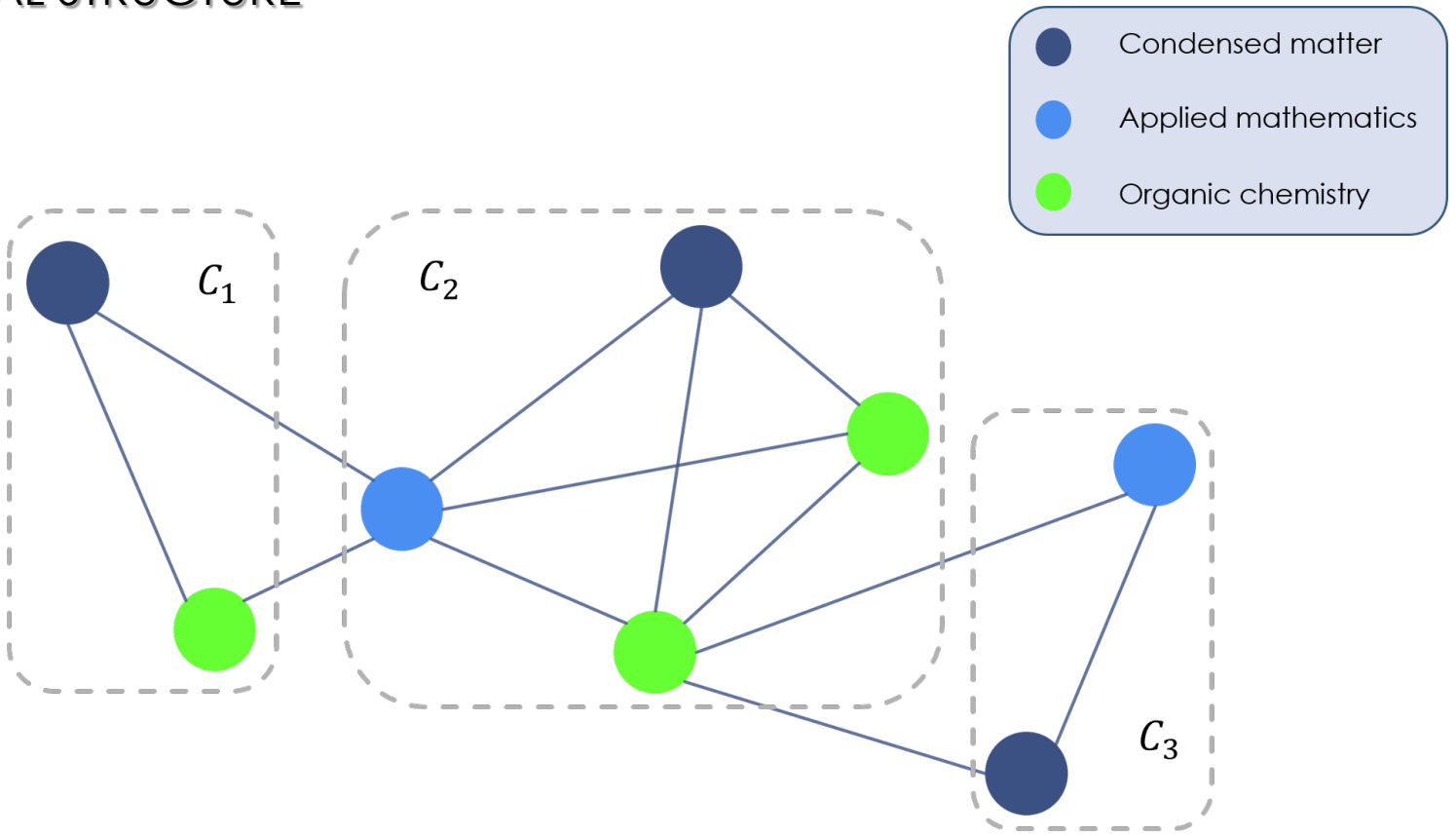

Louvain and **Girvan-Newman** algorithms

Modularity (Q):

$$Q(\mathfrak{G}) = \frac{\sum_{ij}(w_{ij} - \frac{s_i s_j}{2m})\delta(C_i, C_j)}{2m}$$

$\boldsymbol{w_{ij}}$: Weight of link between nodes i and j
$\boldsymbol{C_i}$: Community of node i
$\boldsymbol{s_i}$: Weighted degree of node i
$\boldsymbol{m}$: Total weight of network

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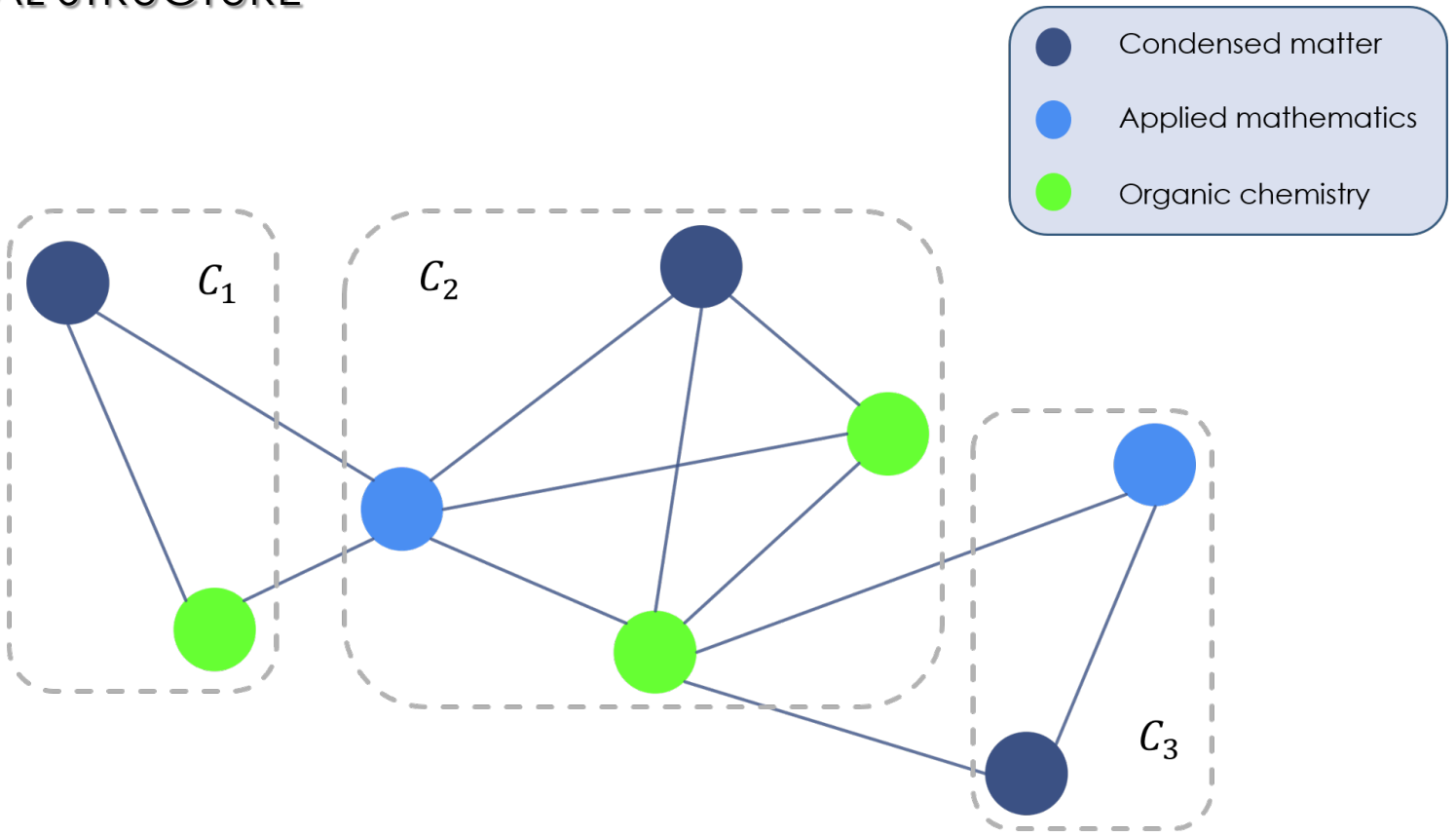

Louvain and **Girvan-Newman** algorithms → Too many communities in optimal partition

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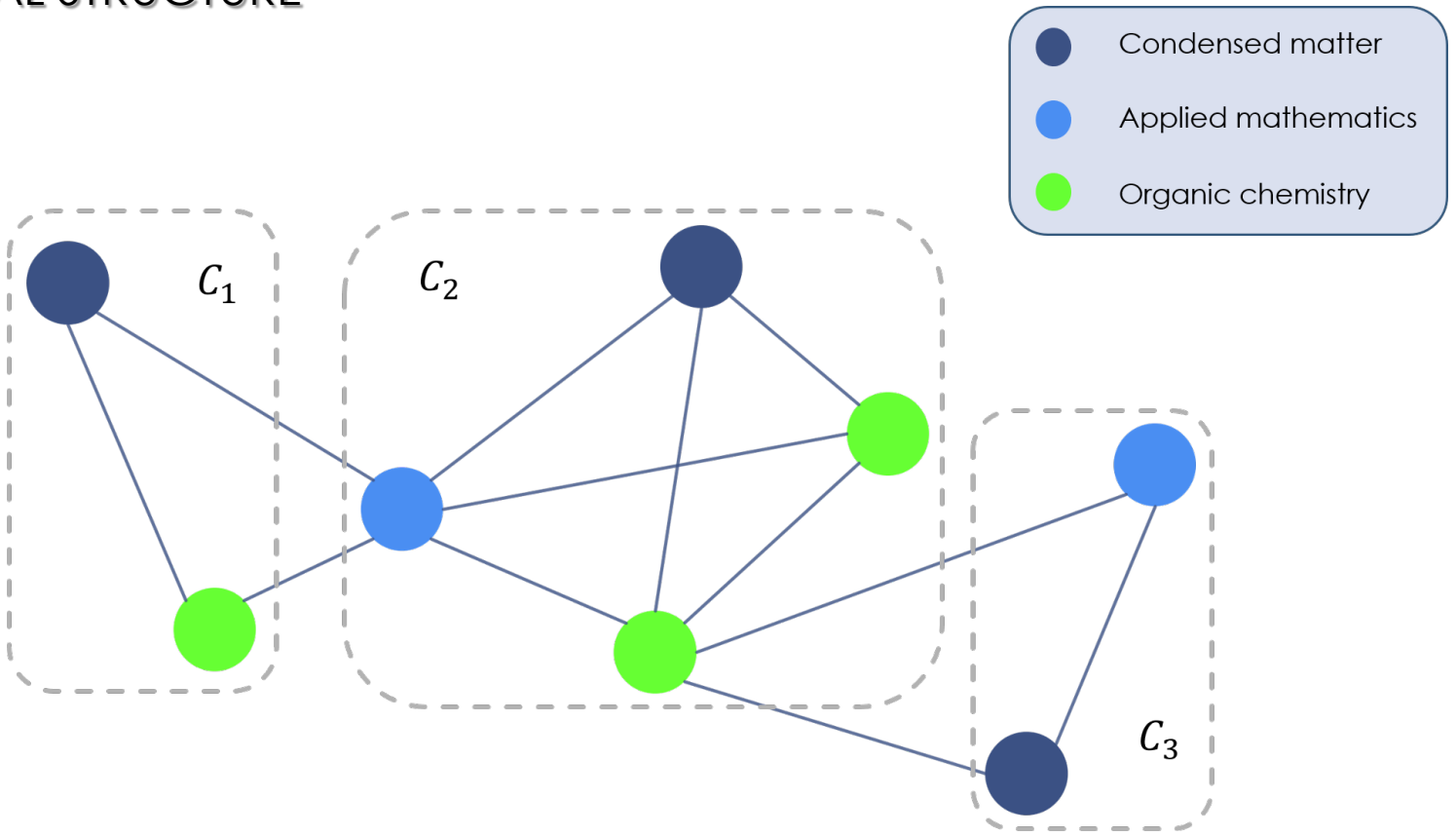
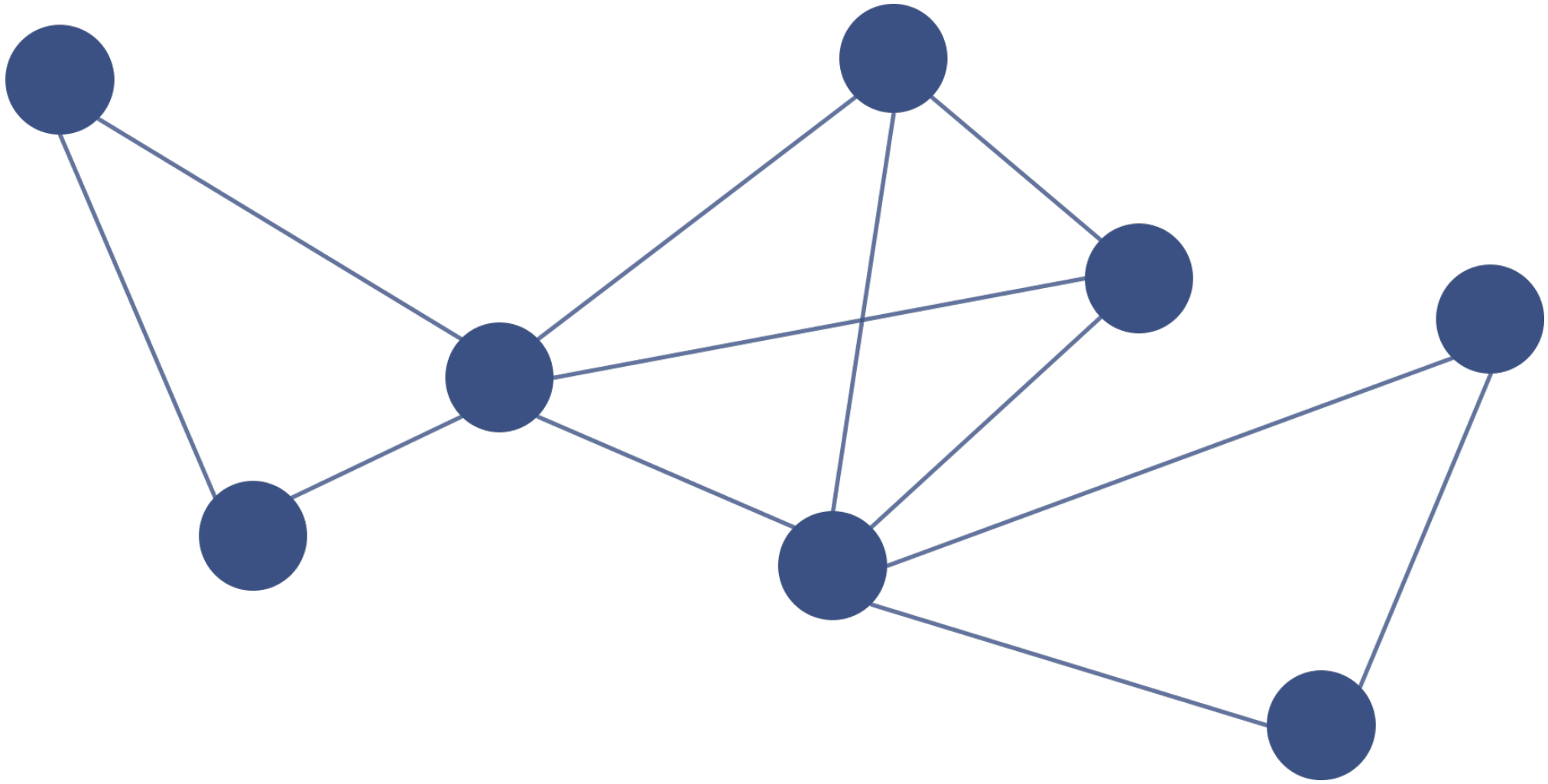


Louvain and Girvan-Newman algorithm

Targeted Community Merging algorithm

GIRVAN-NEWMAN ALGORITHM

- Heuristic iterative algorithm
- Deleting links with maximum Betweeness Centrality value



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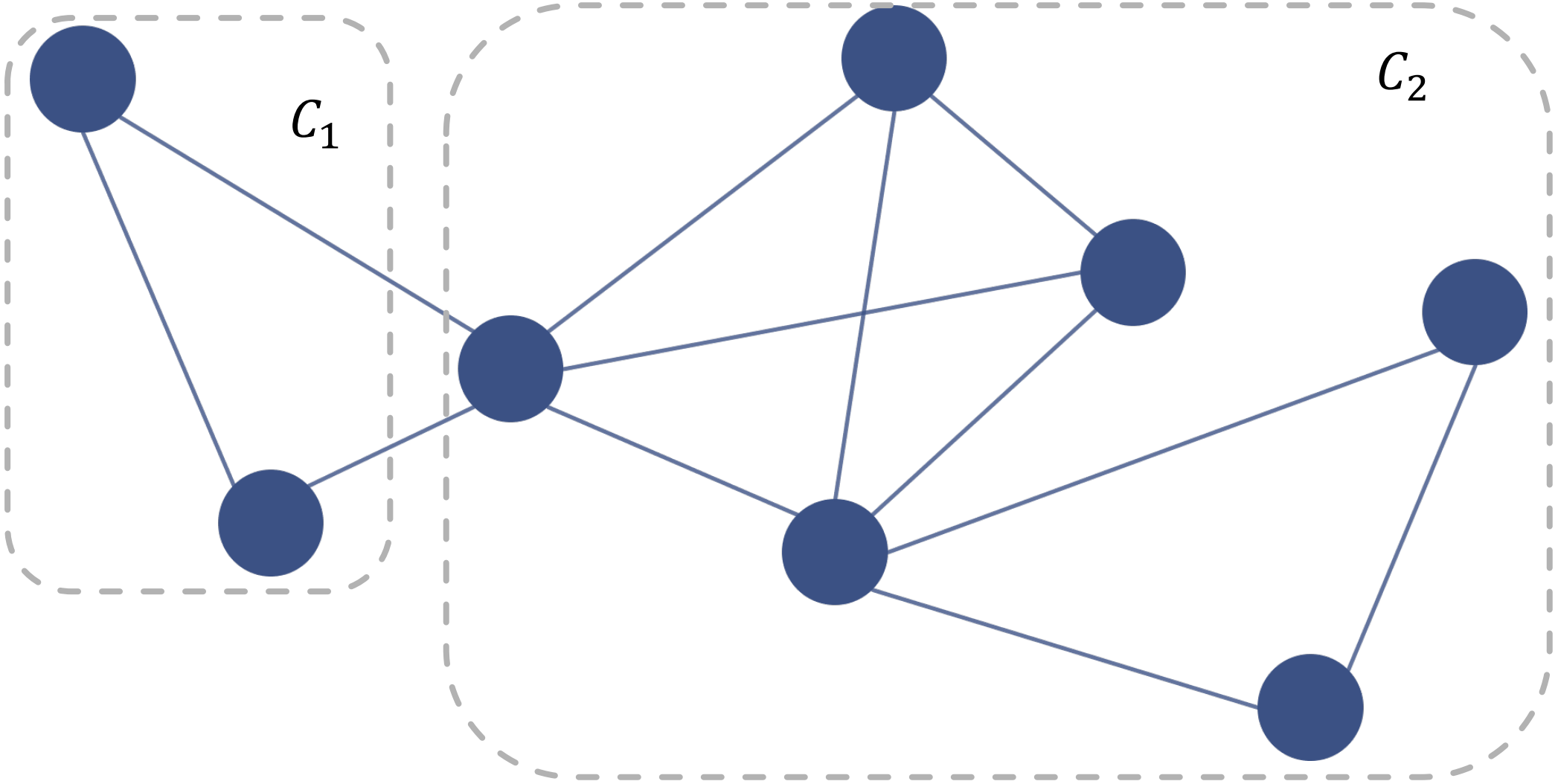

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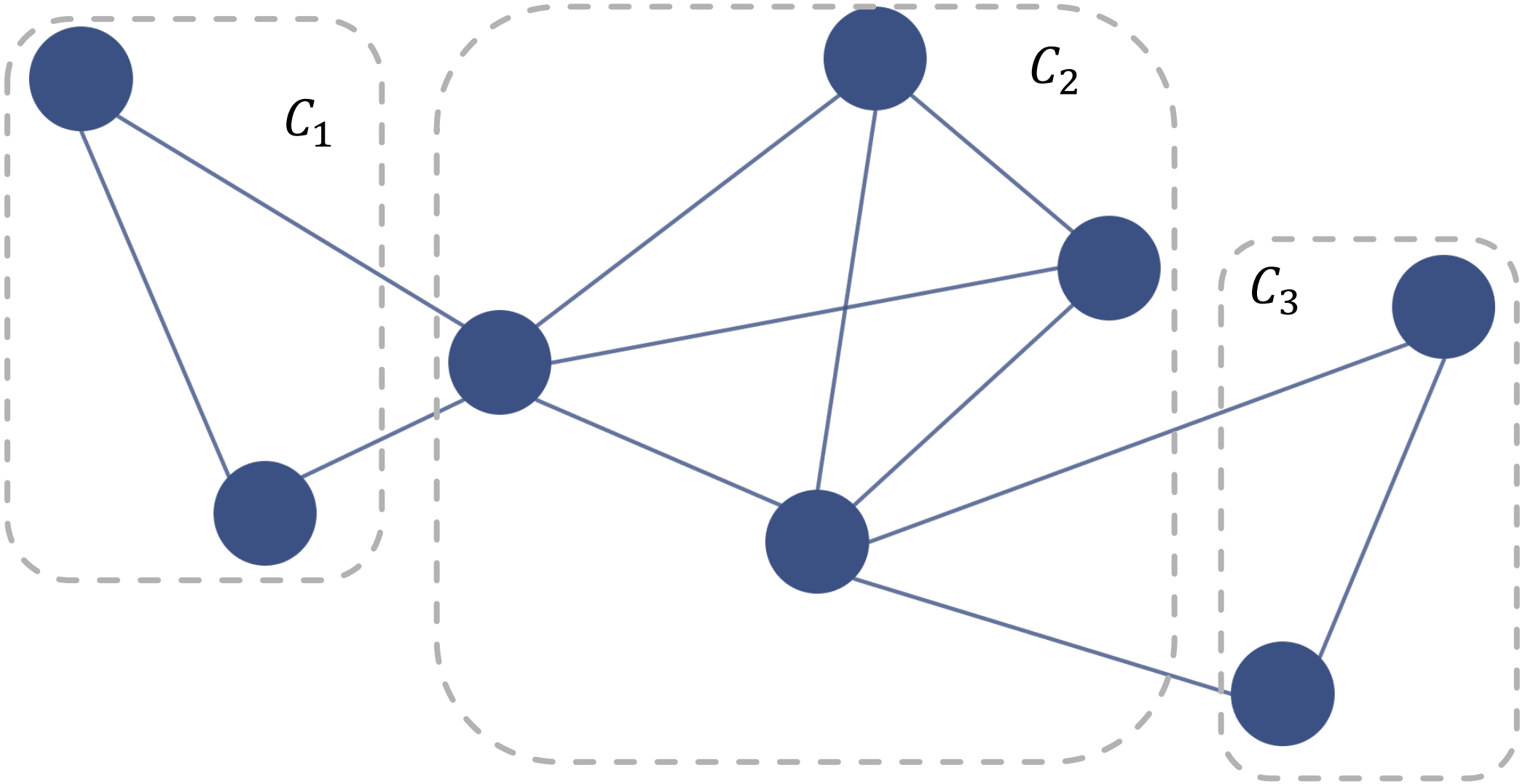
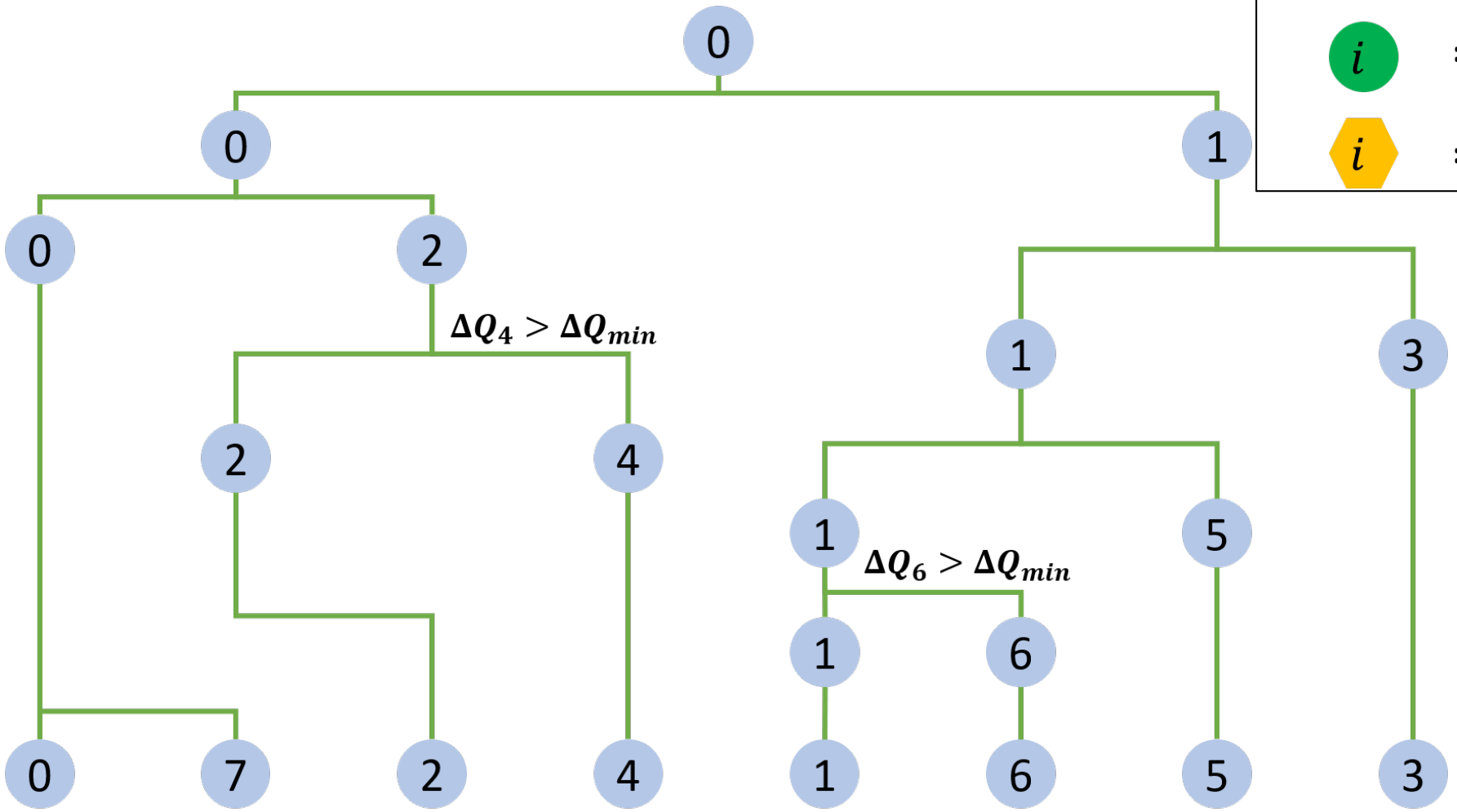


TCM ALGORITHM



$\Delta Q_i > \Delta Q_{min}$: Community with significant growth of Modularity

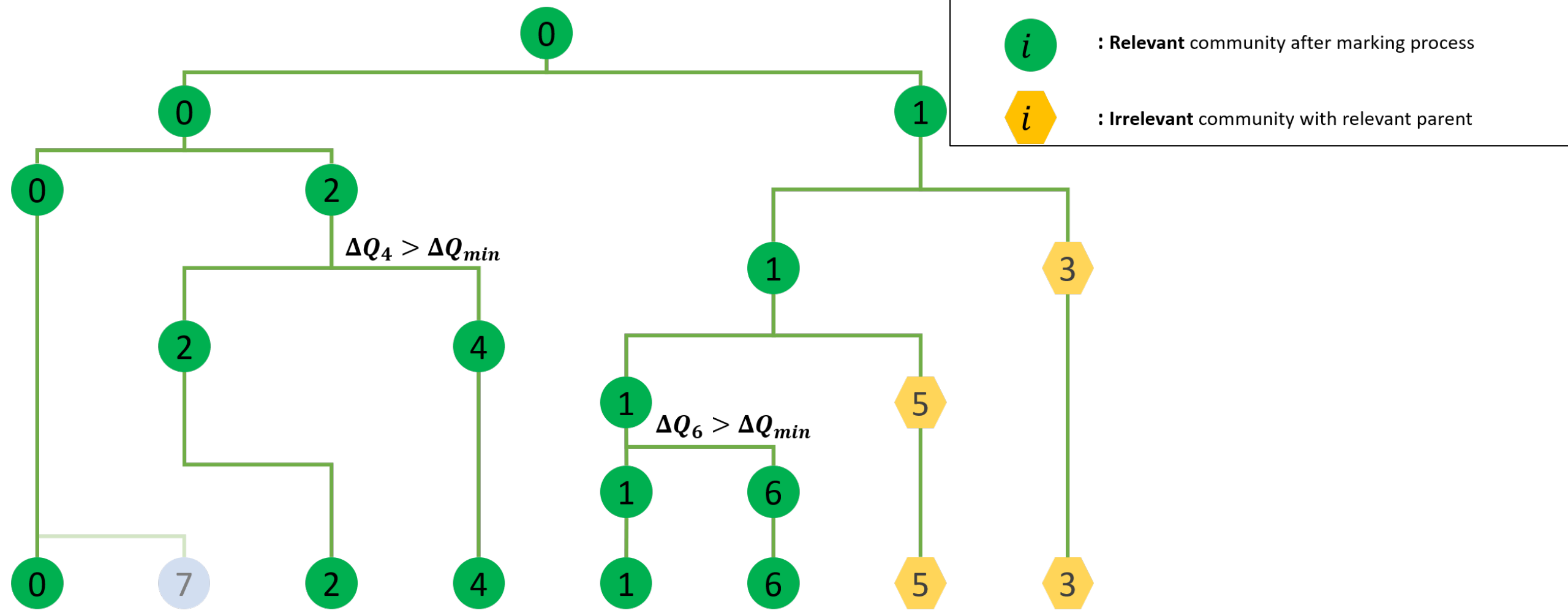
i : Community before marking and joining process

i : **Irrelevant** community to be eliminated

i : **Relevant** community after marking process

i : **Irrelevant** community with relevant parent

TCM ALGORITHM



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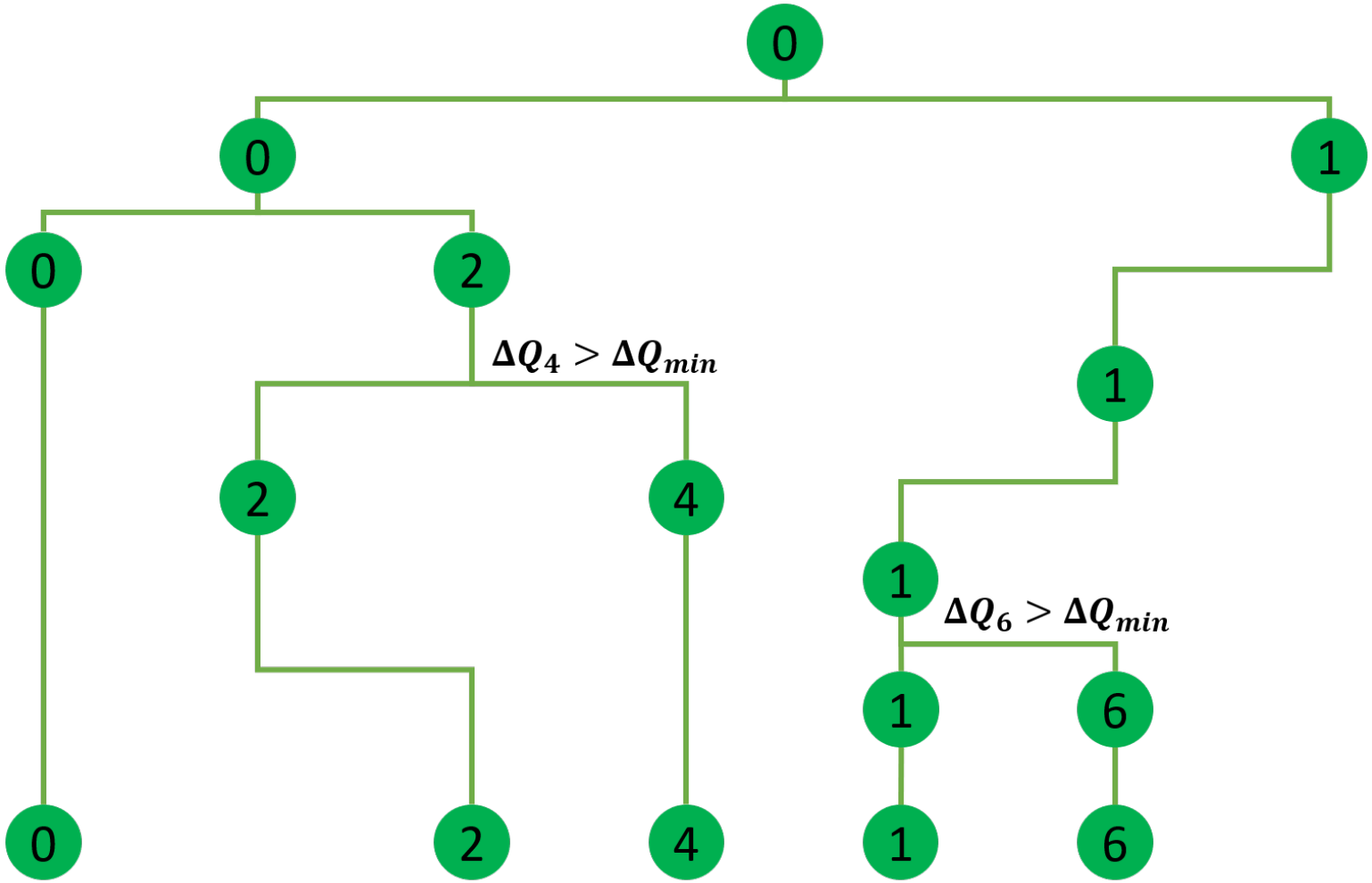

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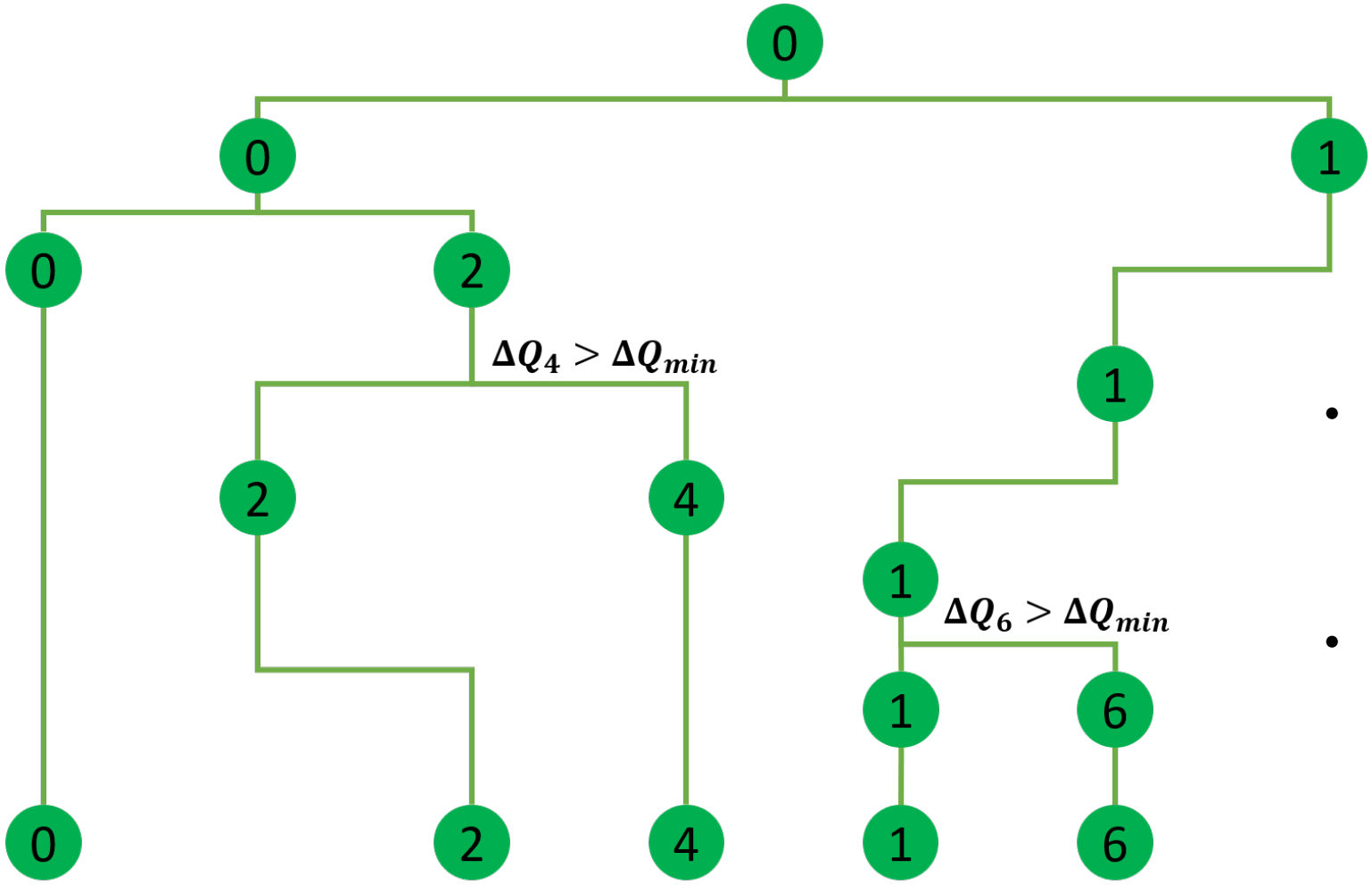

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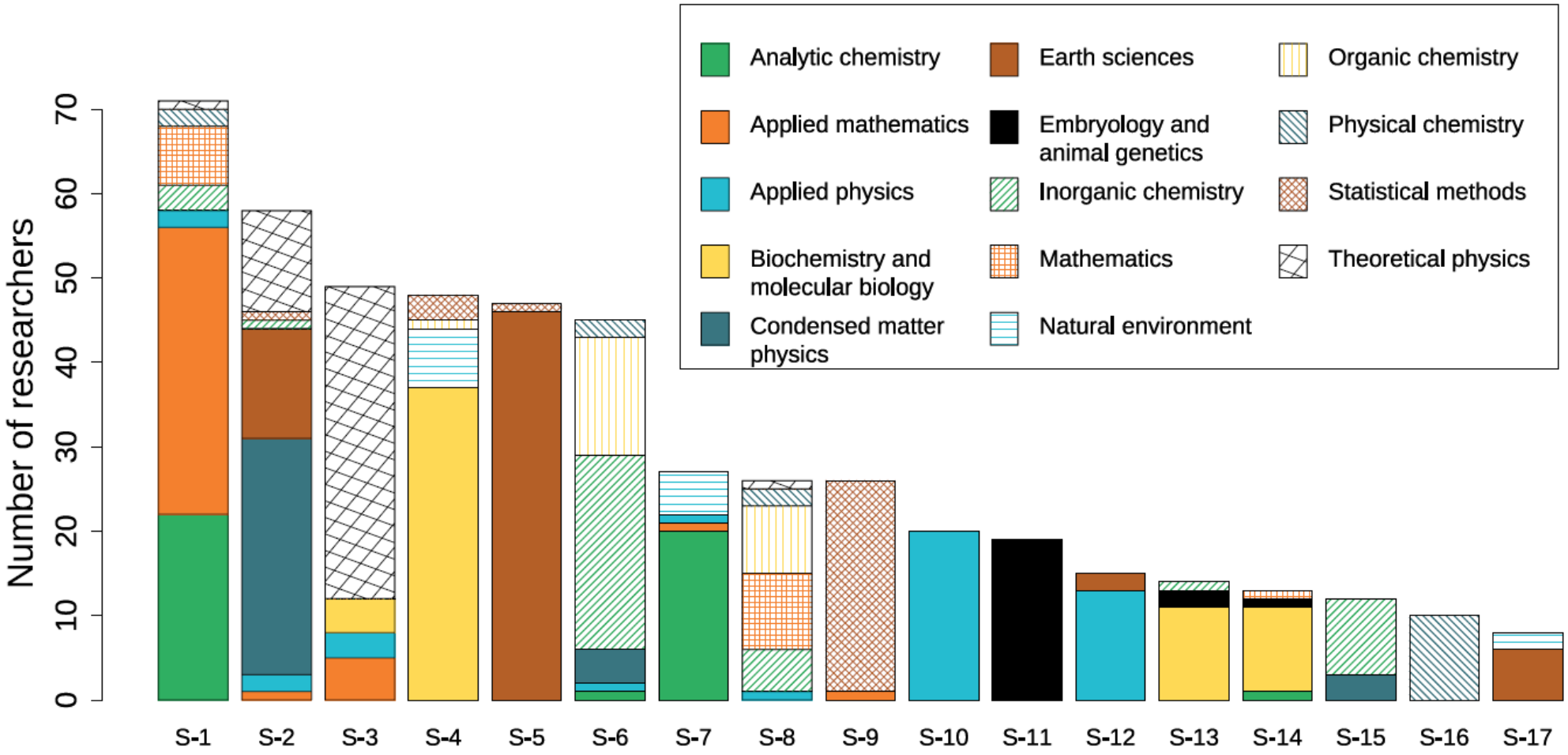
- High values of ΔQ_{min} implies more coomunities reduction but also more modularity reduction
- $\Delta Q_{min} = 0$ returns a community partition with greater modularity than GN algorithm.

DATA AND NETWORK MODELLING

- Three macroareas, one collaboration network for each macroarea.
- Applied TCM and obtain optimal community structure.
- Optimal community structure as a basis for restructuring and for analyzing departmental collaboration.

COMPARISON OF PARTITIONS



SCIENCE

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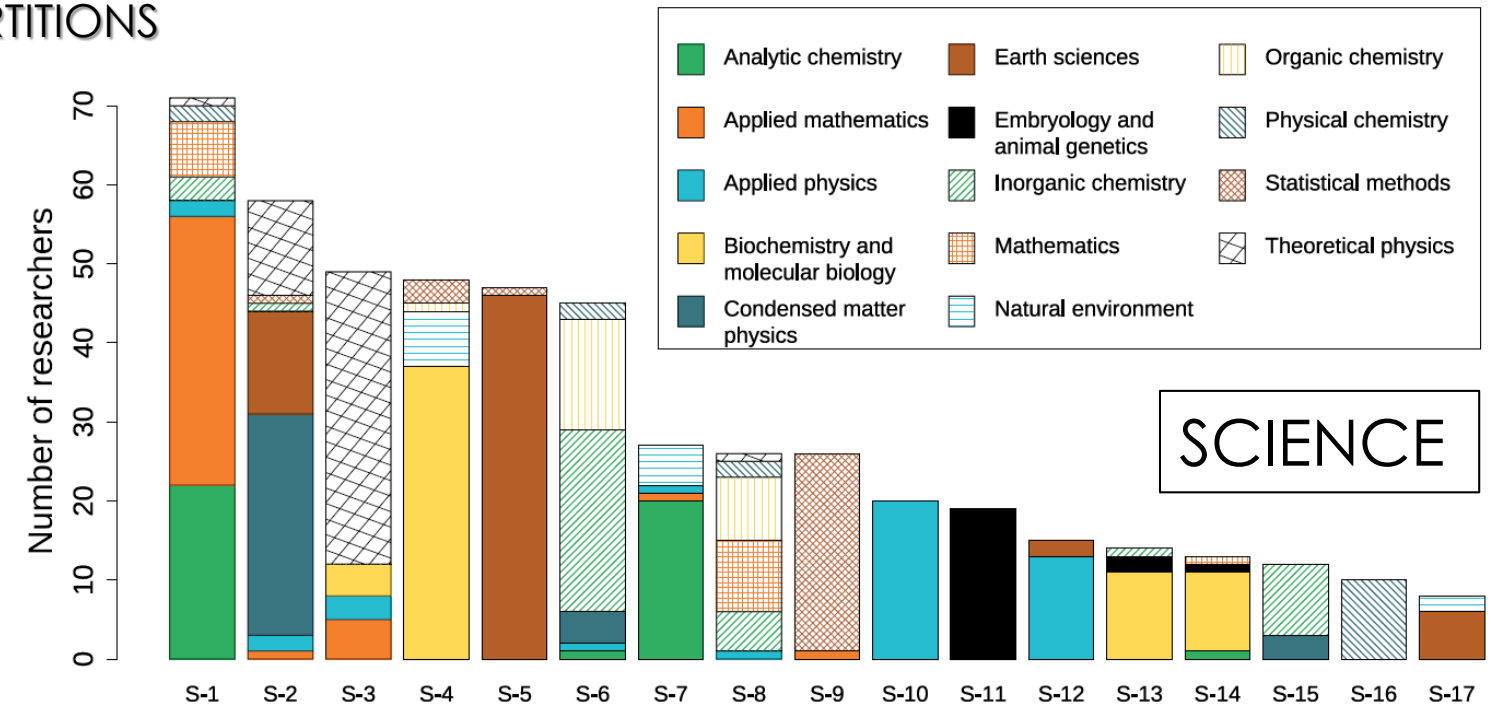
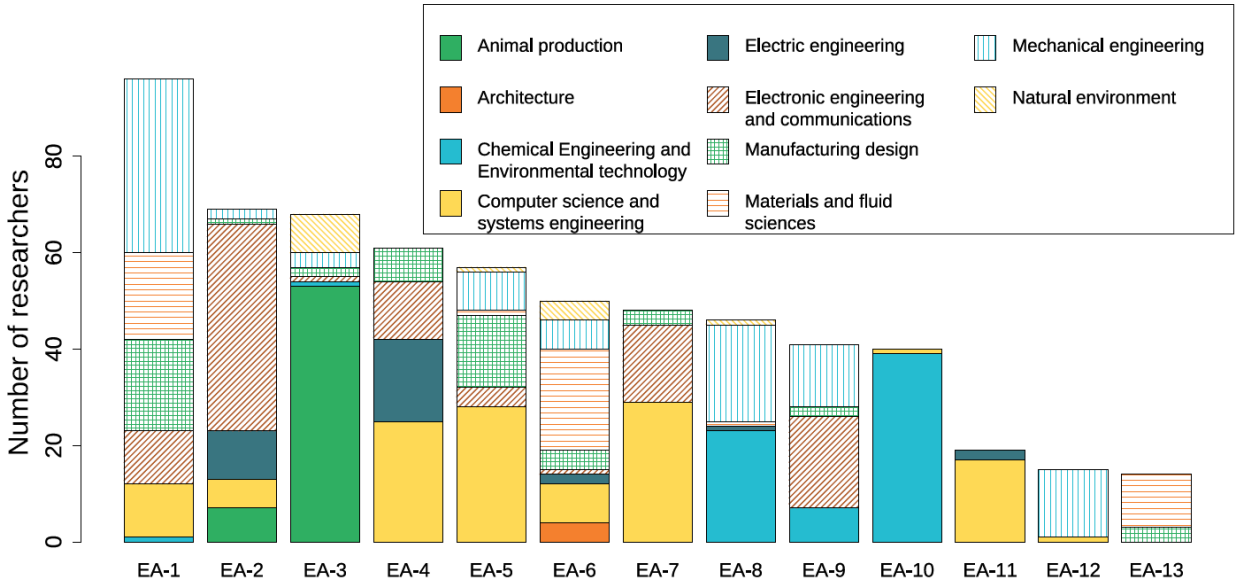
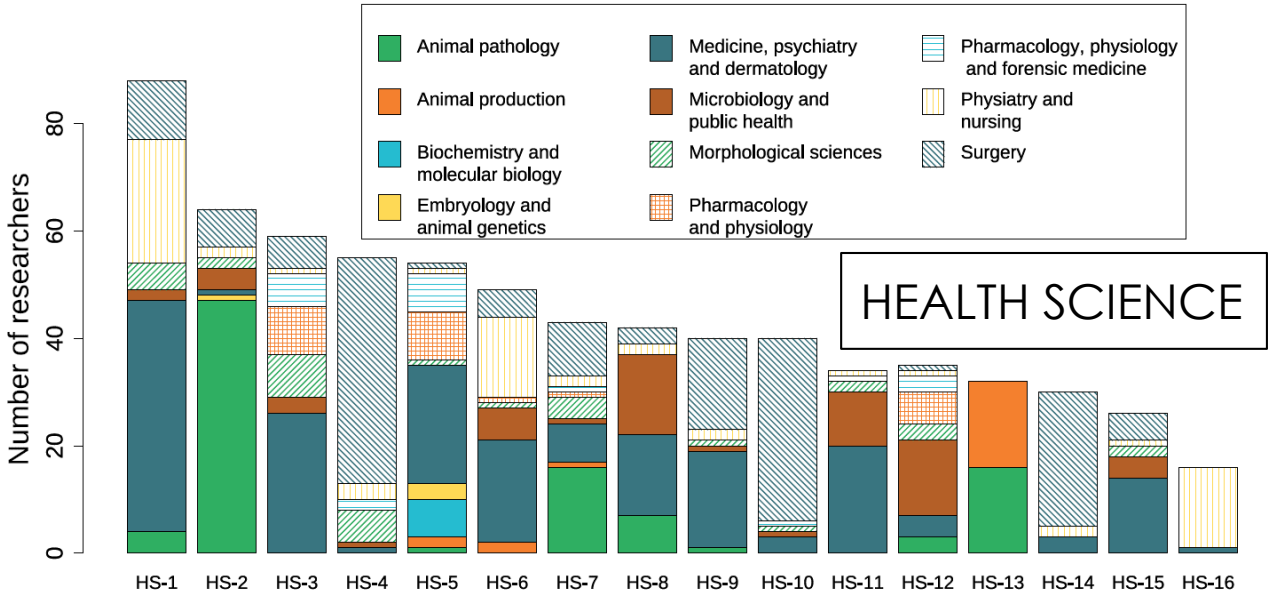


SCIENCE

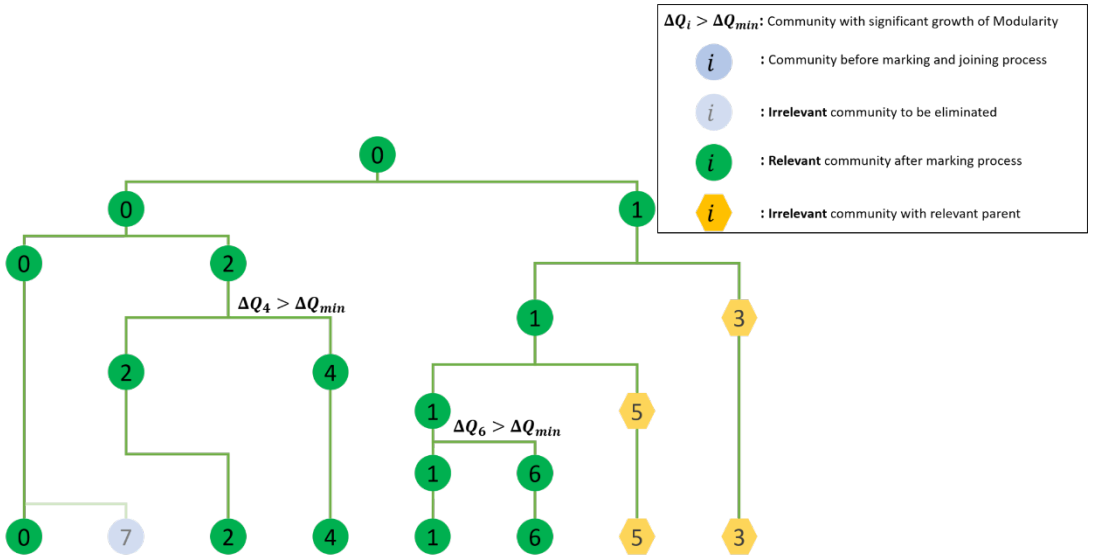
ENGINEERING AND ARCHITECTURE



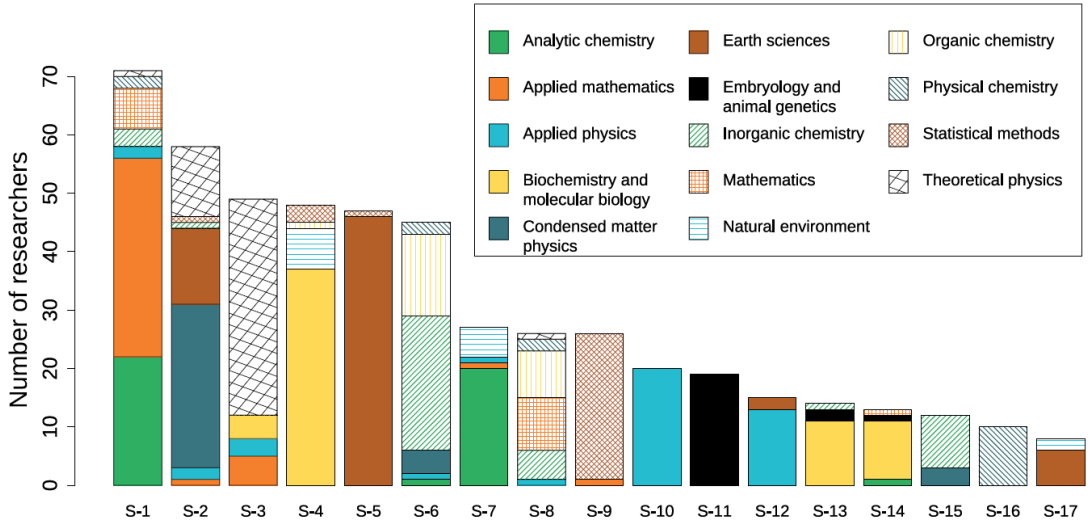


HEALTH SCIENCE

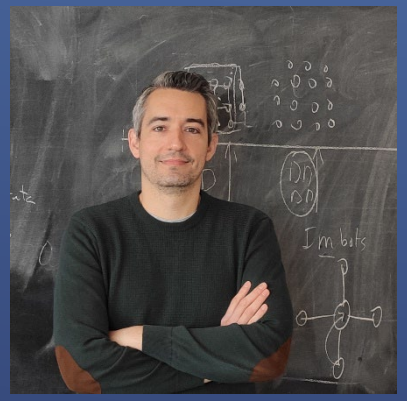
TAKE-HOME IDEAS



TCM algorithm provides community partitions that can be easily compared with the native partition of cooperation systems



Some departmental partitions designed based on collaboration criteria while others on branches of knowledge



Gonzalo

Jesús

Alfonso

David

Thank you !!