Hypergraph Modeling and Graph Clustering Process Applied to Co-word Analysis

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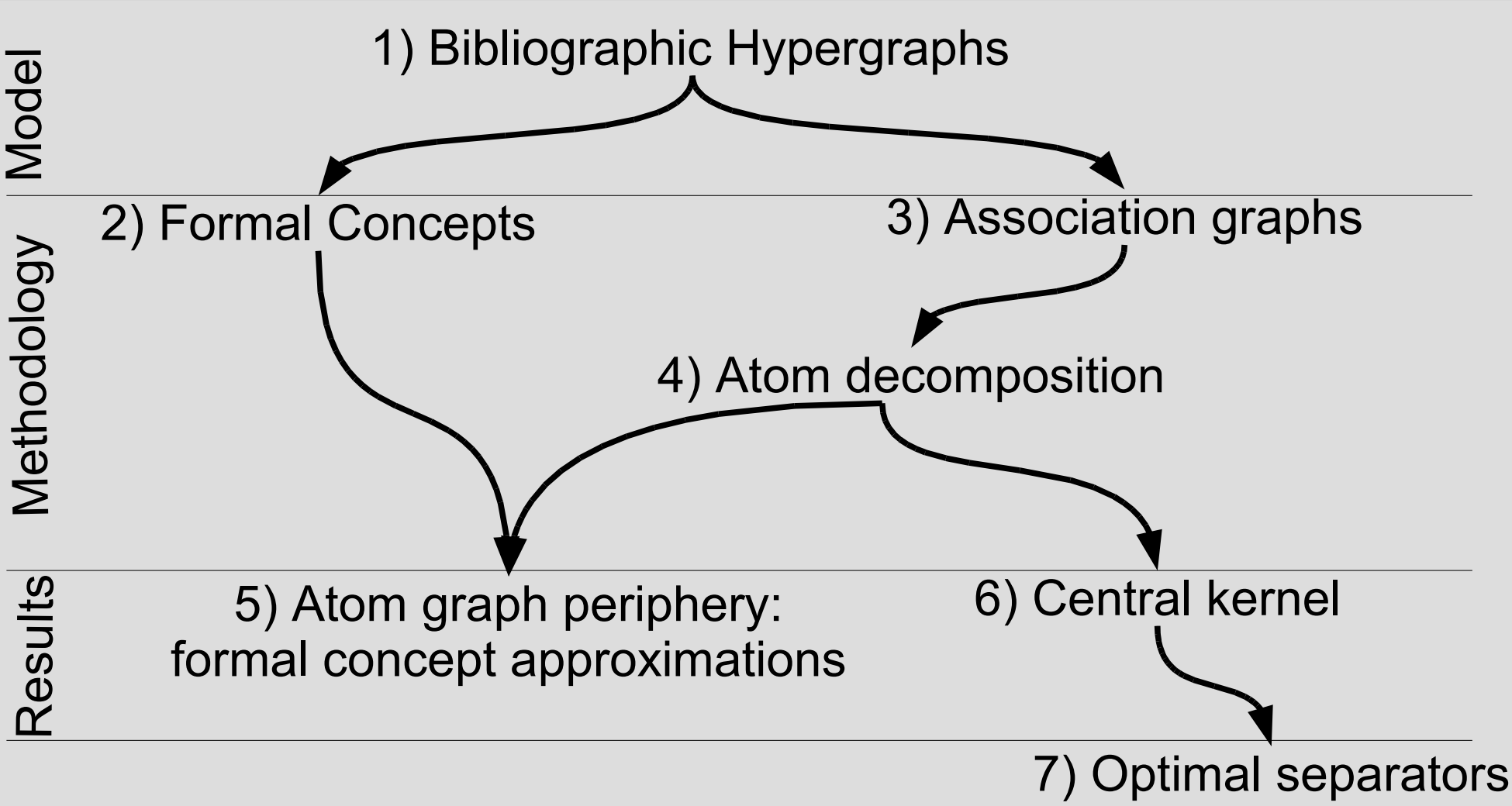
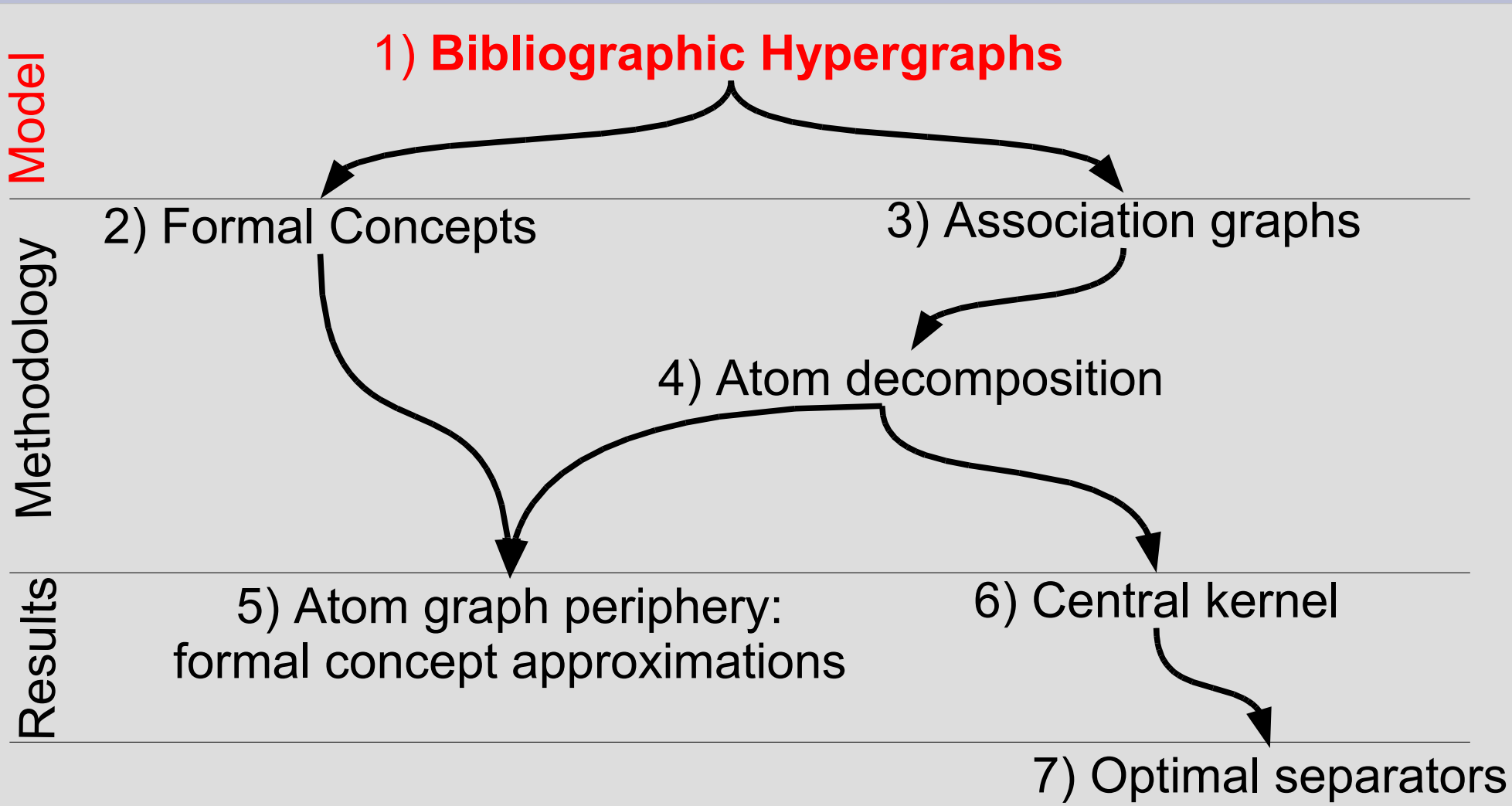
Summary


Model
Methodology
Results
1) Bibliographic Hypergraphs
2) Formal Concepts
3) Association graphs
4) Atom decomposition
5) Atom graph periphery:
formal concept approximations
6) Central kernel
7) Optimal separators

Summary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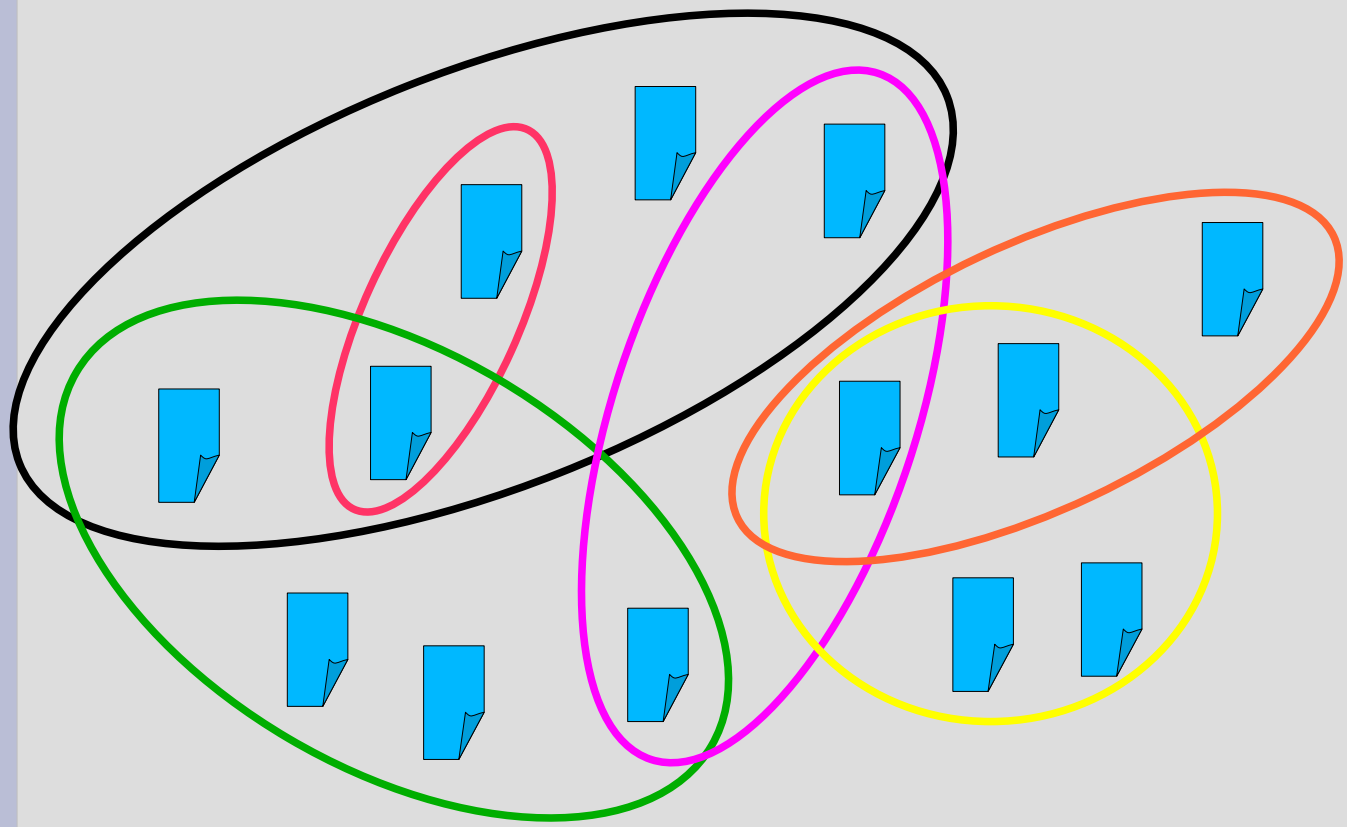
Bibliographic Hypergraph

- Family of sets (hyper-edges) of documents (hyper-vertex)
- Each document item defines an hyper-edge

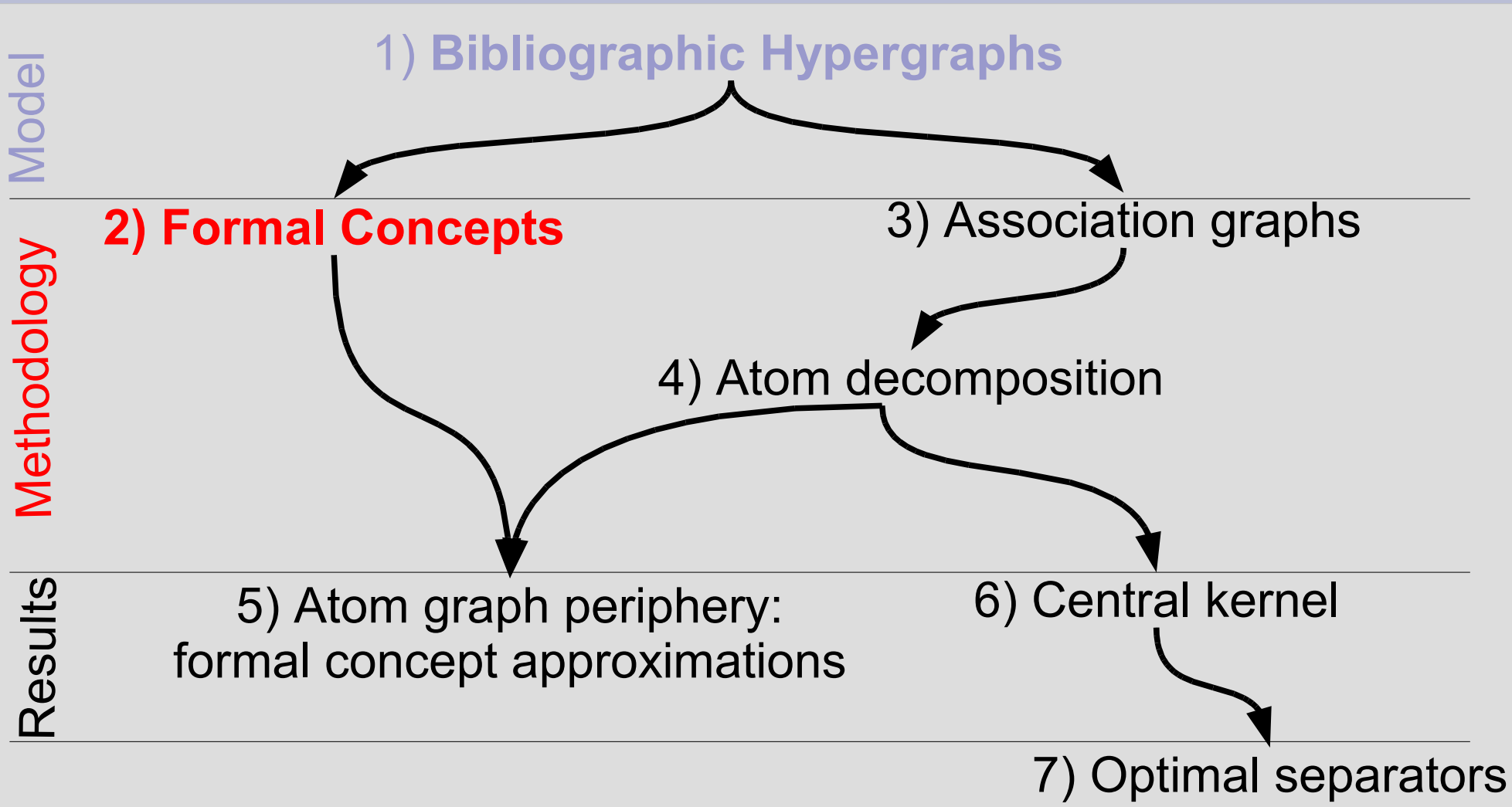


Items:
AU = Smith
KW = IR
KW = Text mining
CI = John
YR = 2005
KW = Graph

Bibliographic Hypergraph

- 3,671 records extracted from the SCI database containing the keywords data mining and text mining over the period 2000-2006.
- Indexed by a set of 8,040 keywords.
- The average number of keywords per record is 5.
- **1,524** keywords (hyper-edges) of frequency > 1 indexing **2,615** records (hyper-vertex).

Summary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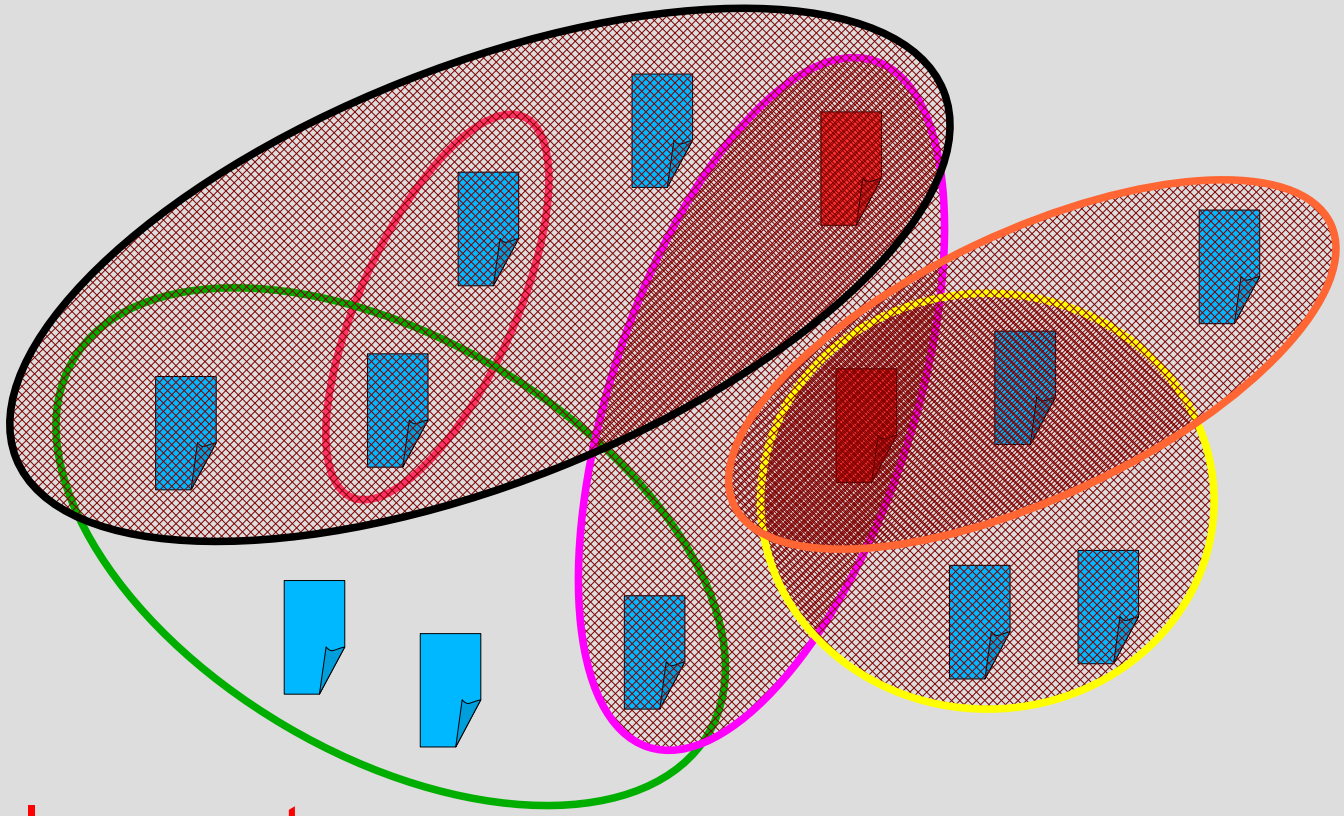
Formal concepts

- Association rules (7,082, s > 10%, c > 80%):
  - gene expression, genetic algorithms => rough sets
  - database, information retrieval => visualization
  - ...
- Closed set of items (2,526):
  1. bioinformatics, cancer, data mining, genomics, proteomics
  2. data analysis, data mining, dimensionality reduction, feature extraction, pattern recognition
  3. clustering, machine learning, microarray, proteomics, text mining
- Closed set of documents = Hypergraph minimal tranversals

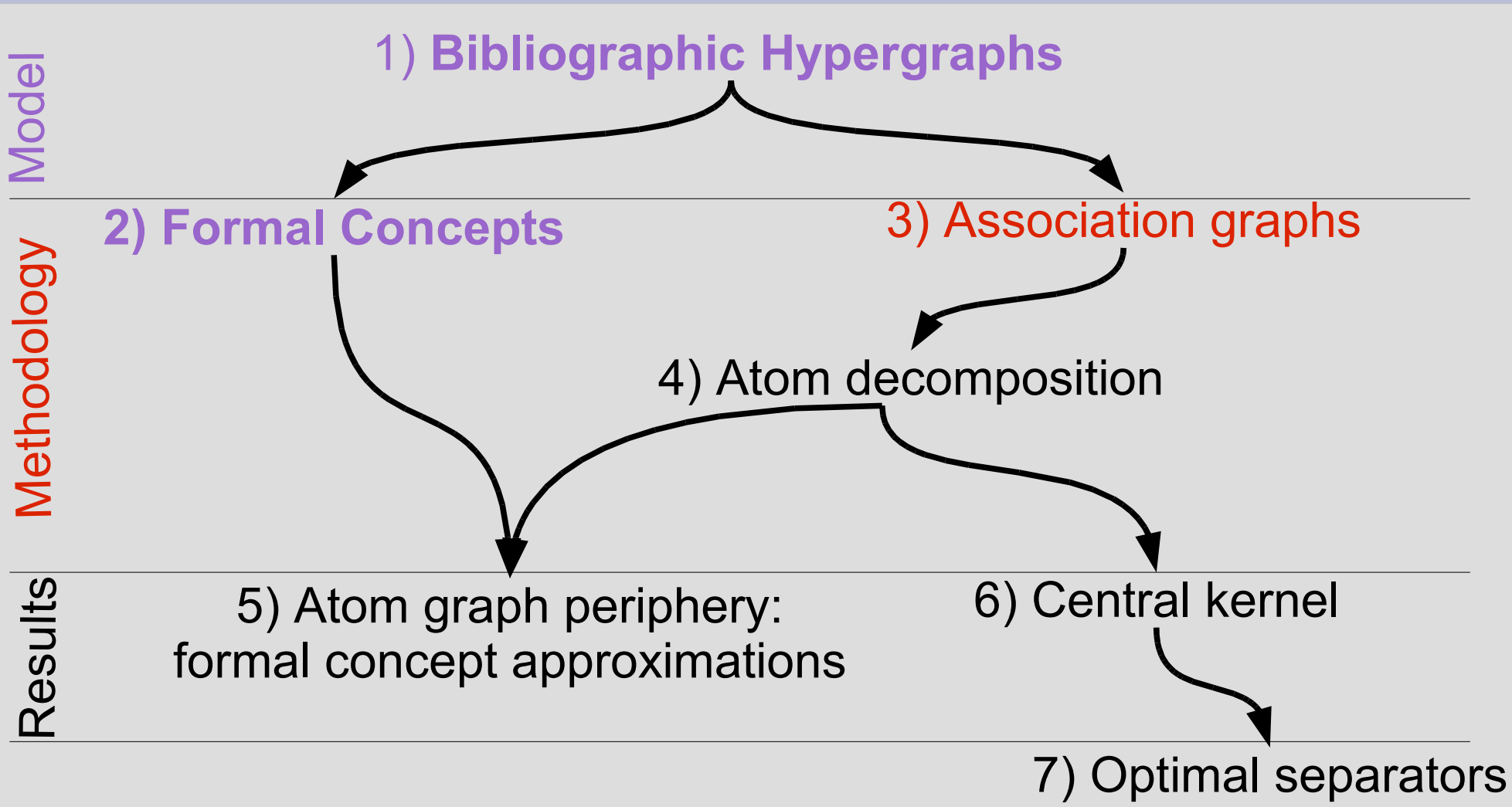
Formal concepts (illustration)



Formal concept :

- a closed item set (*intension*)
- with its correspondent set of documents (*extension*)

Summary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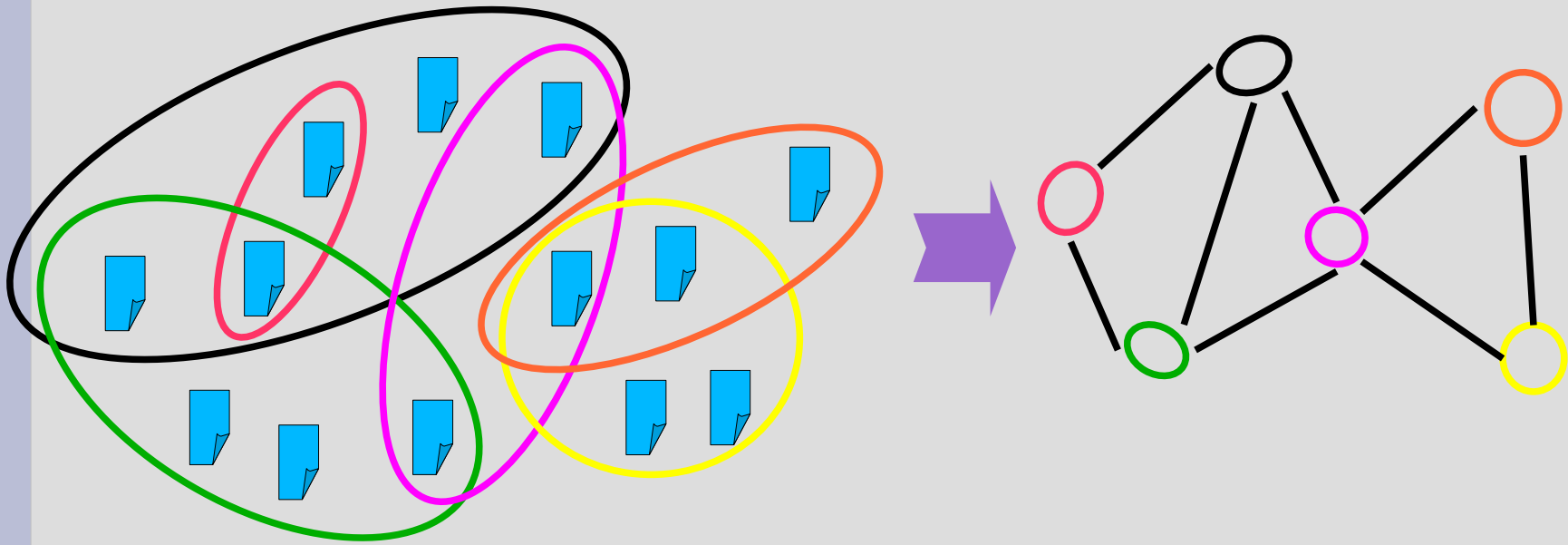
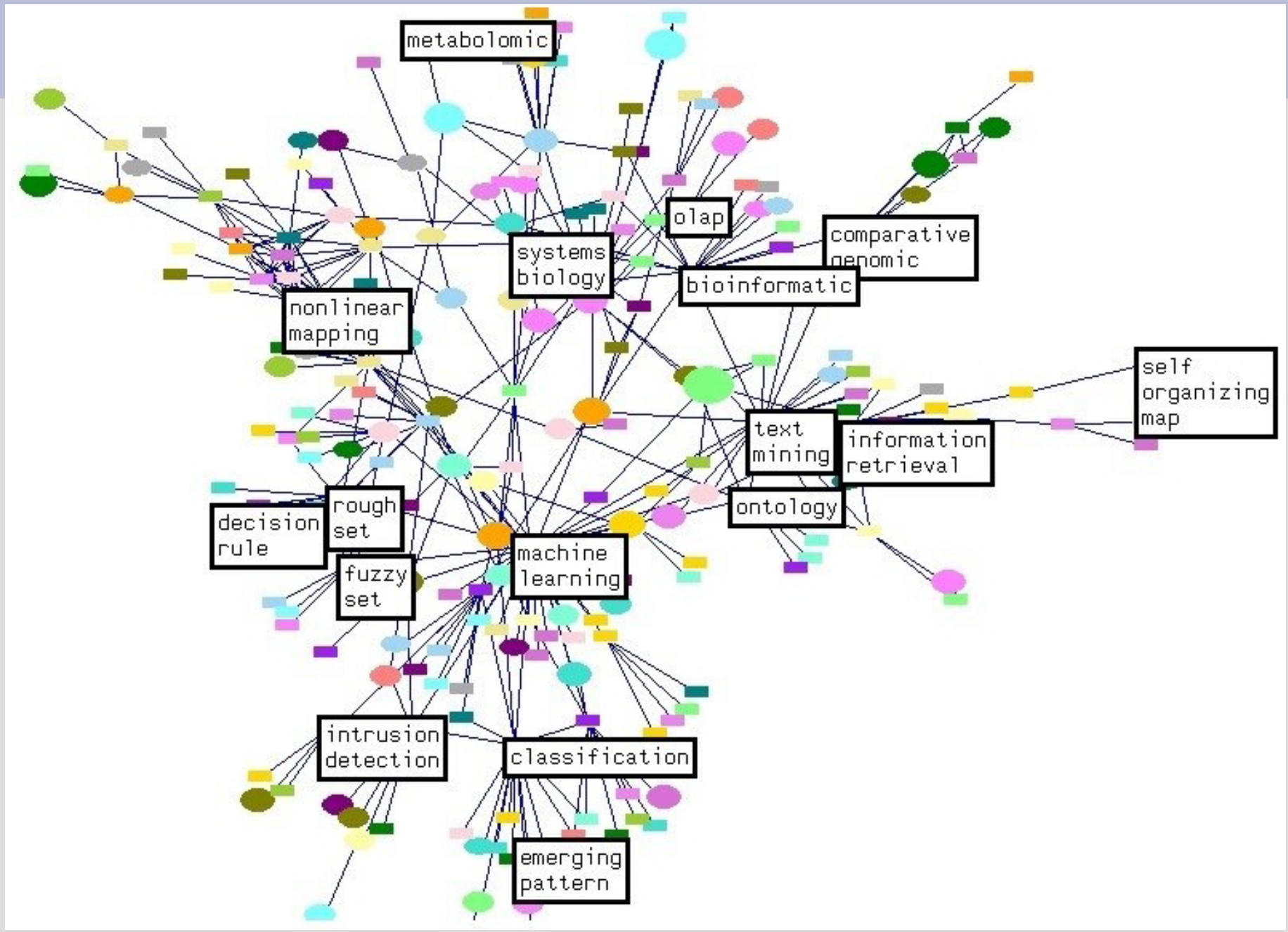
Association graphs

- Intersection graphs derived from the biblio-graphic hypergraph are Small Worlds.



- A threshold can be set on intersection car-dinalities and a coefficient can be defined on edges (mutual information).

Association graphs (clustered)



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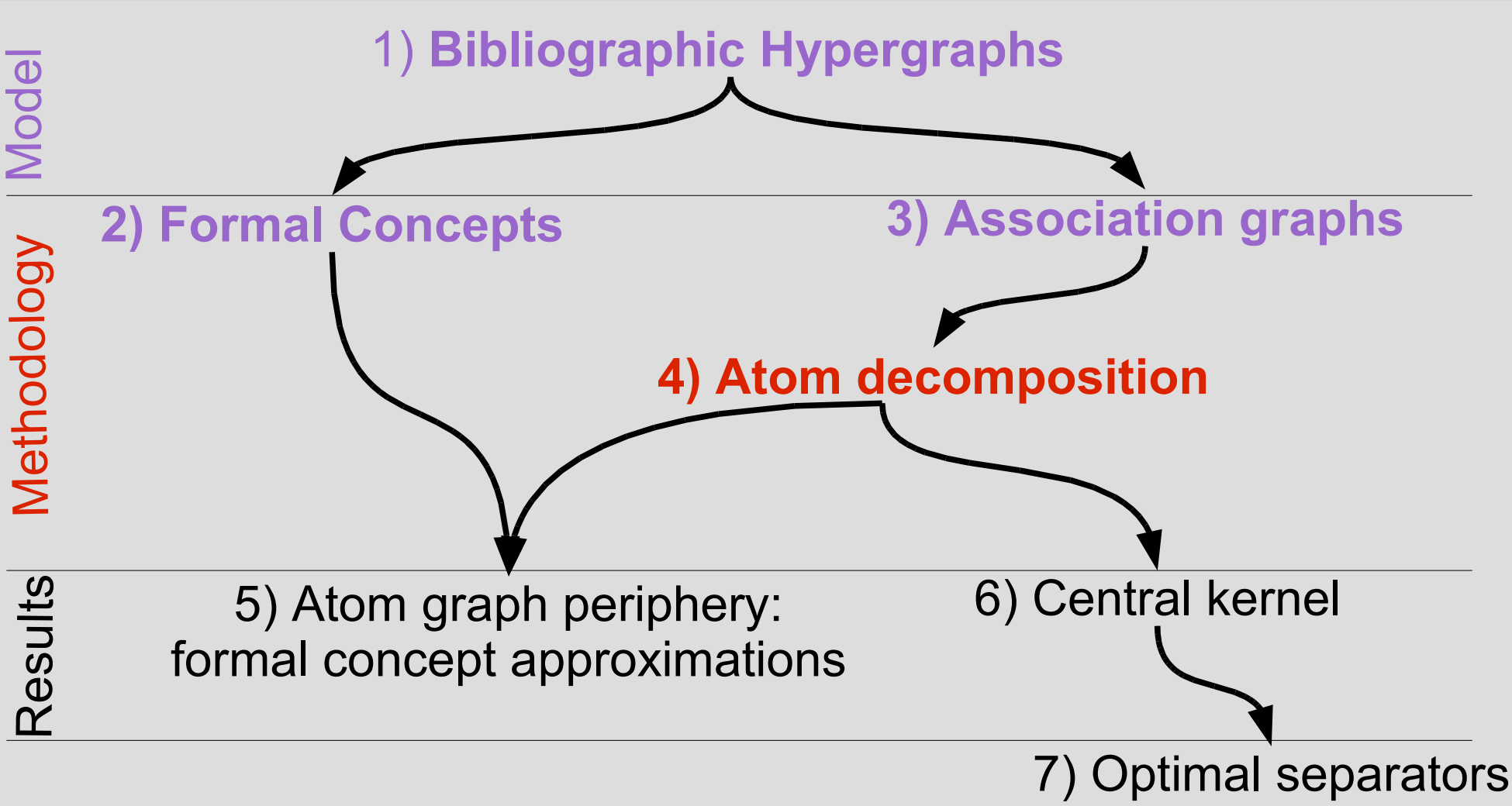
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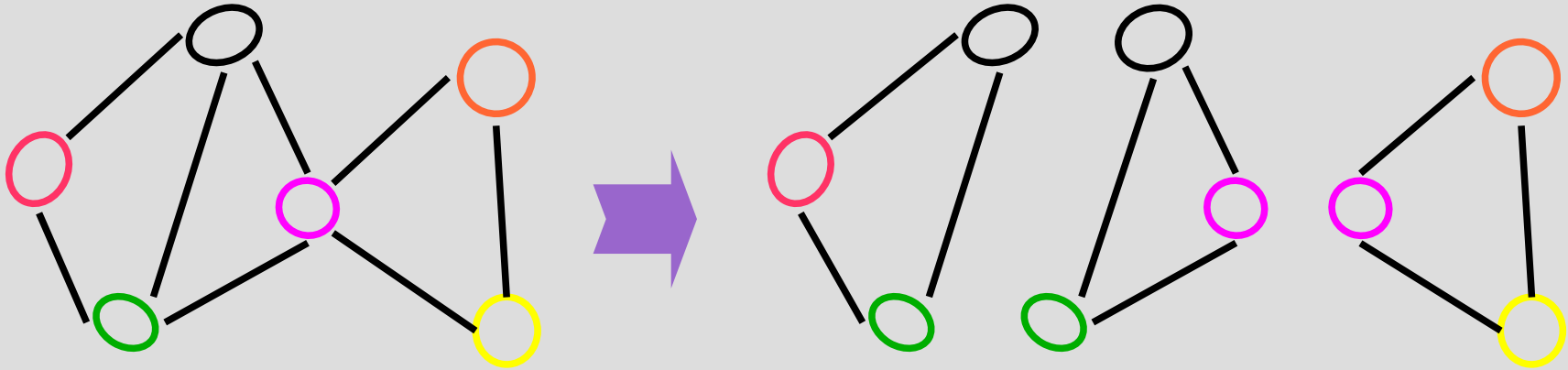
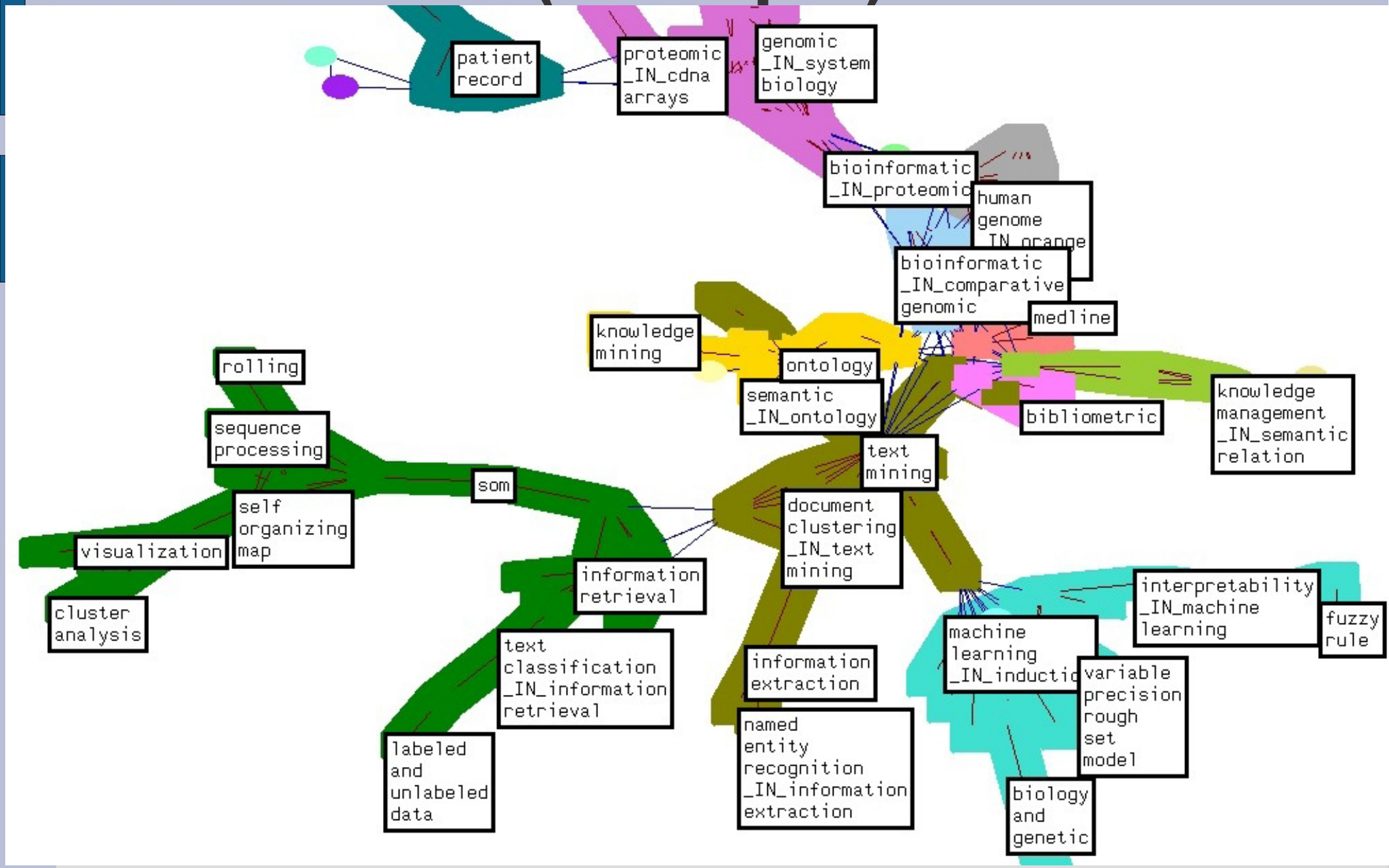
Atom Graph decomposition

- Connected Subgraphs without complete separators:



- Unique solution
- Complexity = O(#Edges.#vertex)
- Atoms labeled by their center

Atom Graph decomposition (example)



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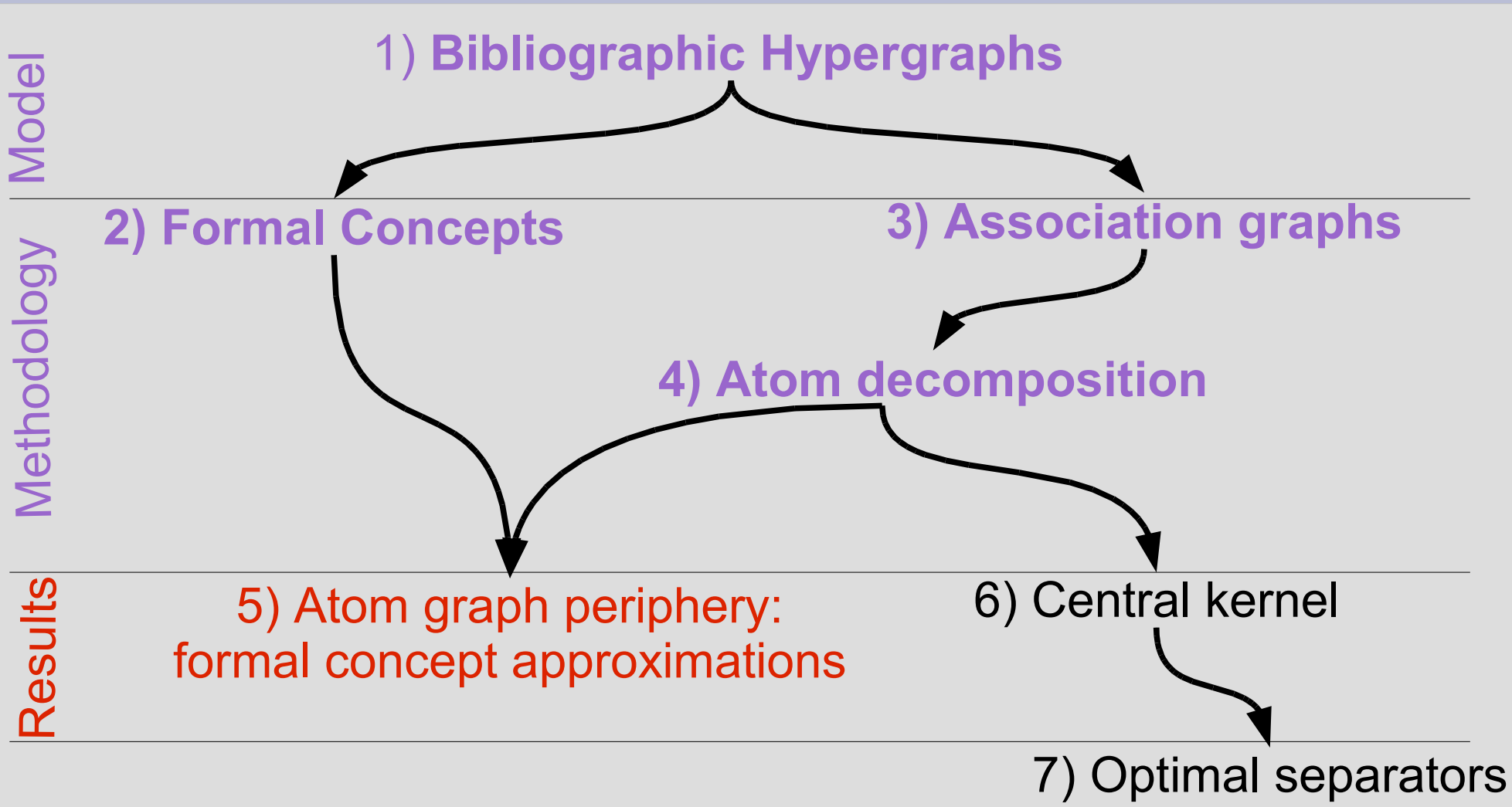
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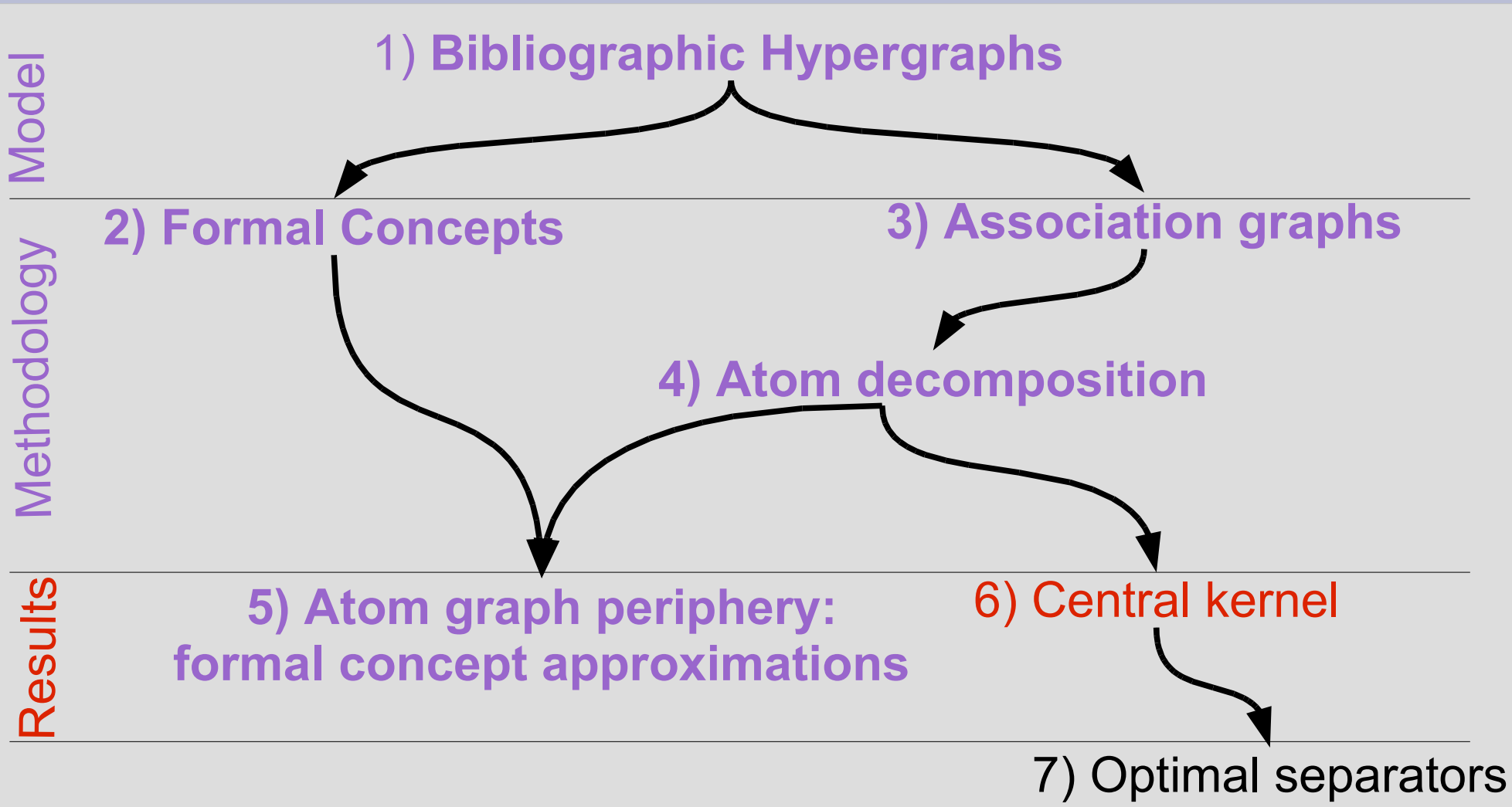
Atom graph periphery: formal concept approximations

- Association graphs are divided into a central core and a periphery:
  - The main component of the association graph has 645 vertices, 1, 057 edges and 404 atoms.
  - A central atom involves 298 vertices. The remaining 403 atoms have less than13 vertices.
- 96% of the 403 small atoms are closed itemsets and thus formal concept intensions.
- graph of peripheral atoms has
  - 598 vertices that represent pairs of atoms and keywords.
  - It involves 201 different keywords.
  - Like for concept intensions, the overlap between atoms is important.

Summary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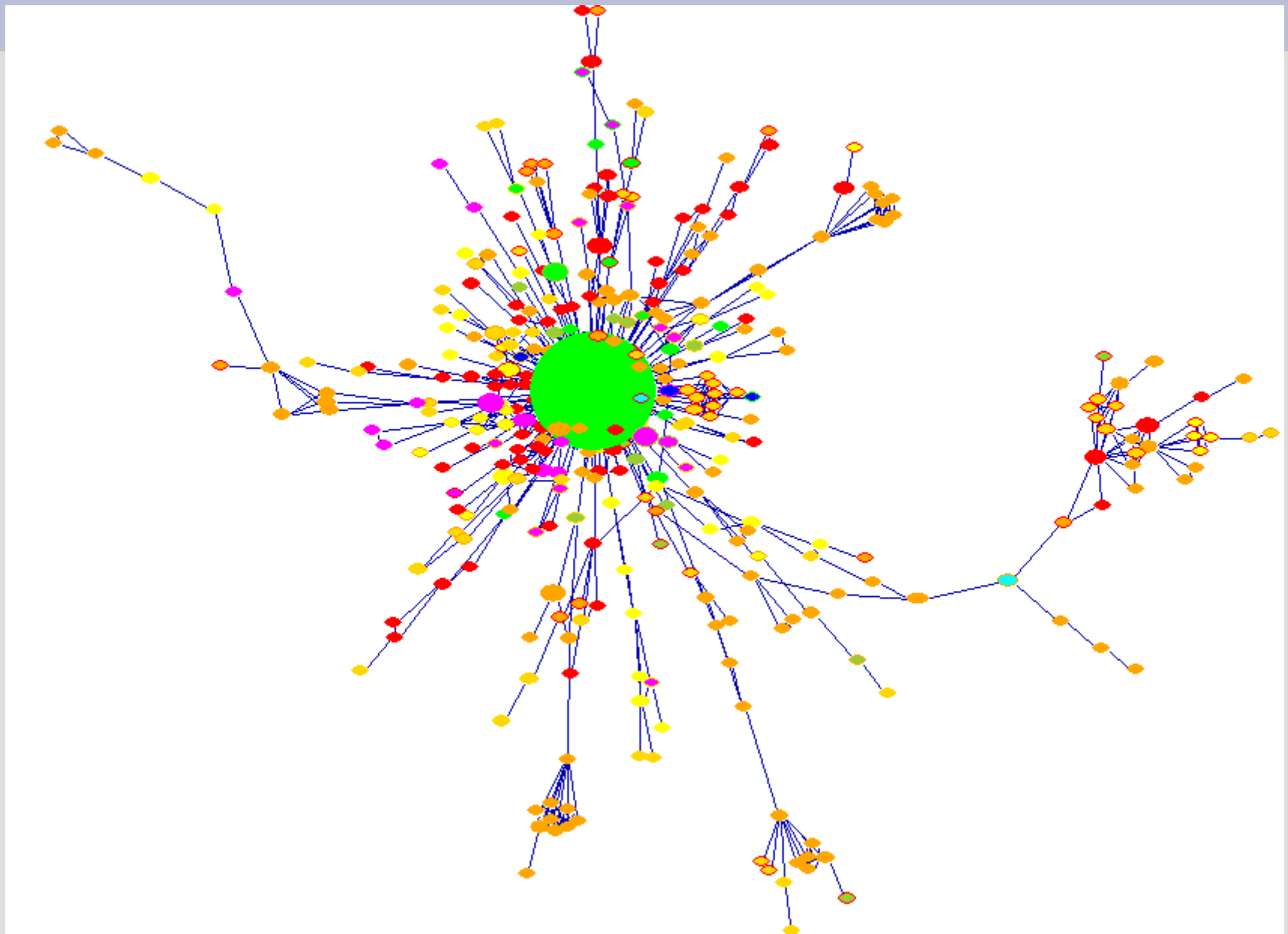
Central Kernel

- Clustered association graph based on a Single Link variant (CPCL) allows to visualize the central atom
  - It has 84 vertices that represent clusters of keywords in the central atom.
  - The biggest cluster has only 10 vertices
  - 86% of these clusters are closed itemsets.

- Thus, CPCL clustering on association graphs seems to be coherent with formal concepts. However it reveals less formal concepts than peripheral atoms.

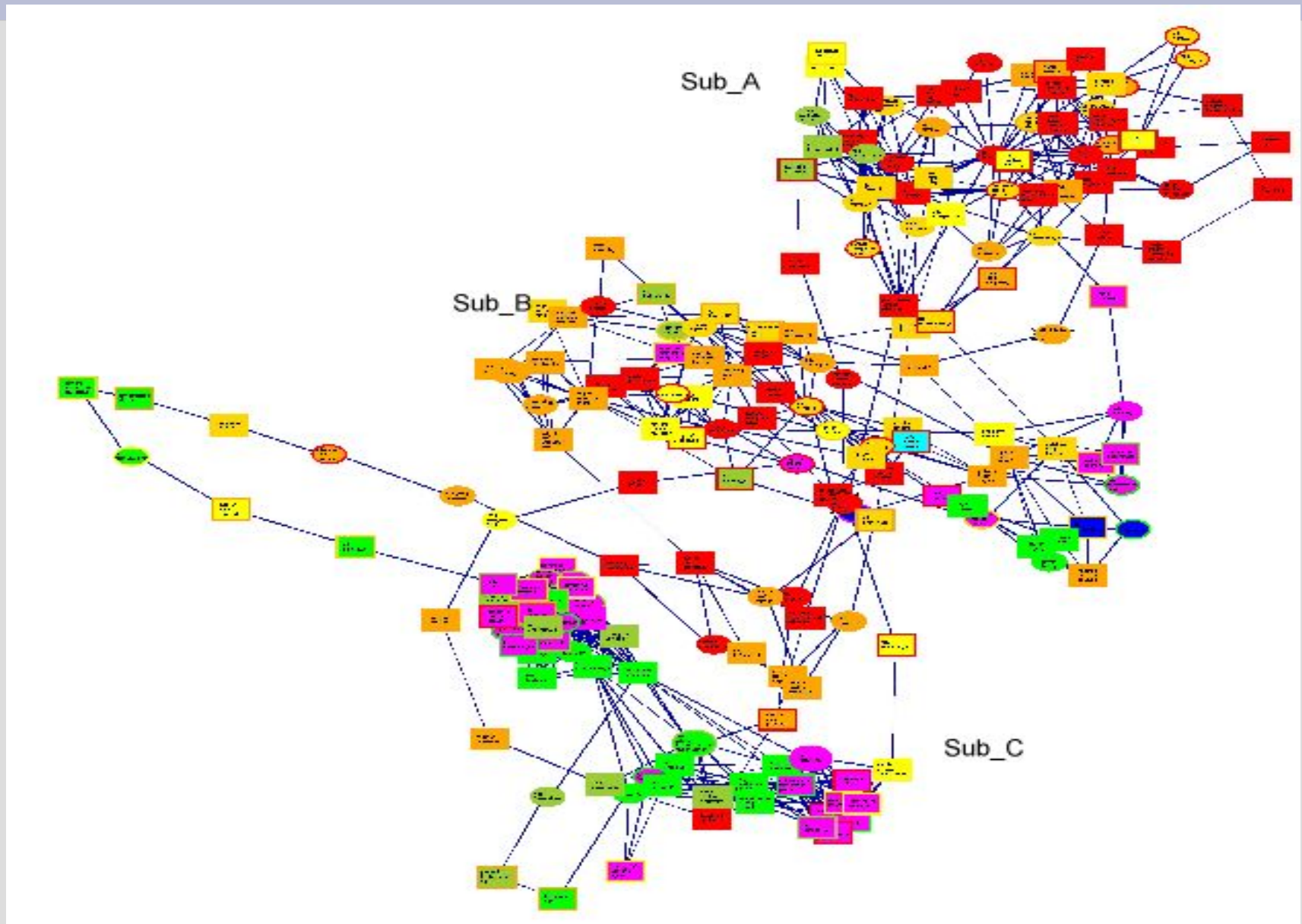
Central Kernel

(application by Fidelia Ibekwe – Lyon 3 - France)



Optimal separators

(Work in progress with Marie Jean Meurs - LIA)



Thank you for your attention