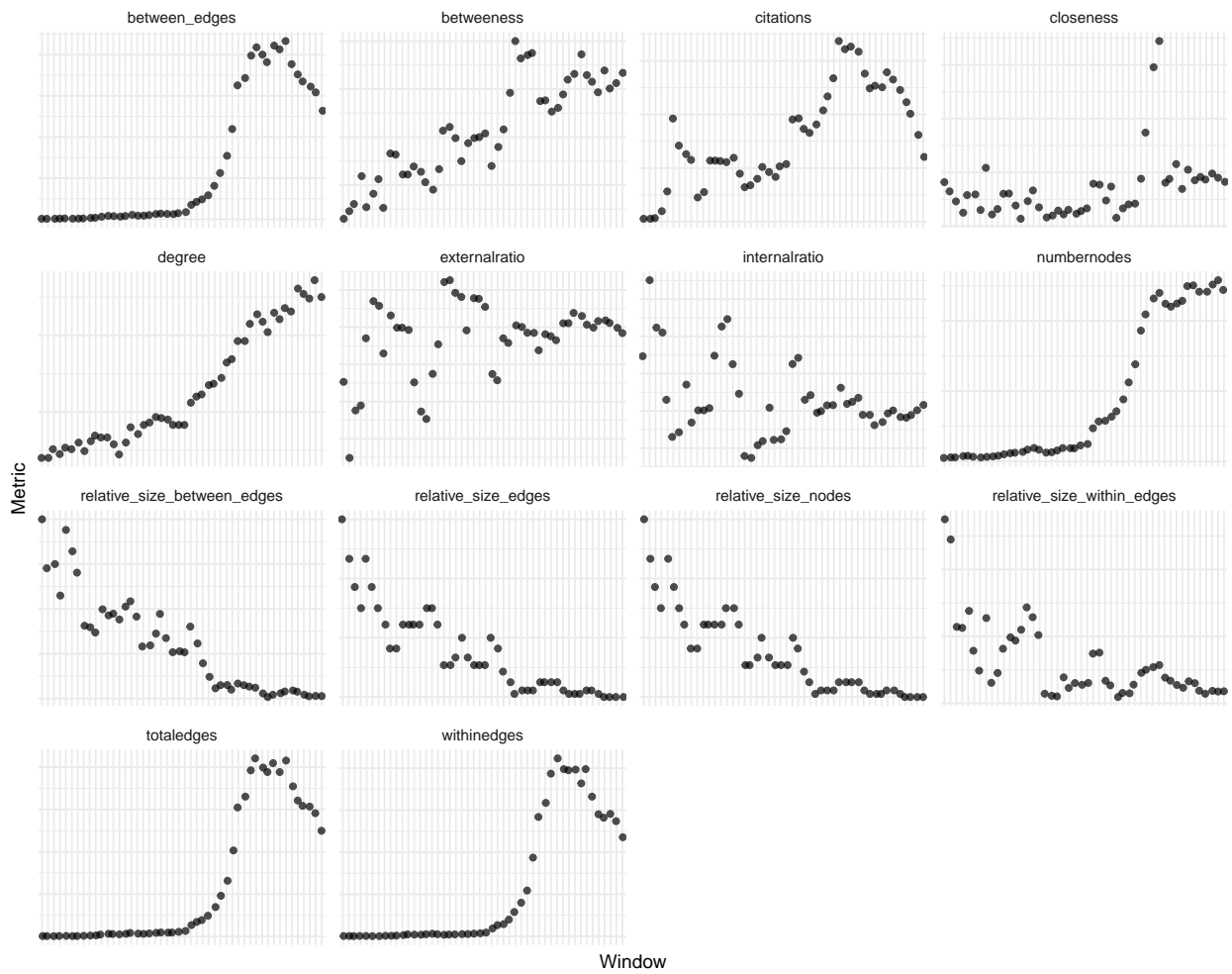# Evolution of Fields

2025-09-09

Aggregate Metrics

Field-Level Metrics

Field-Level Metrics are derived from networks where articles are nodes and edges are based on the strength of bibliographic coupling between articles. The nodes, edges and their information is then aggregated per discipline, here called field.
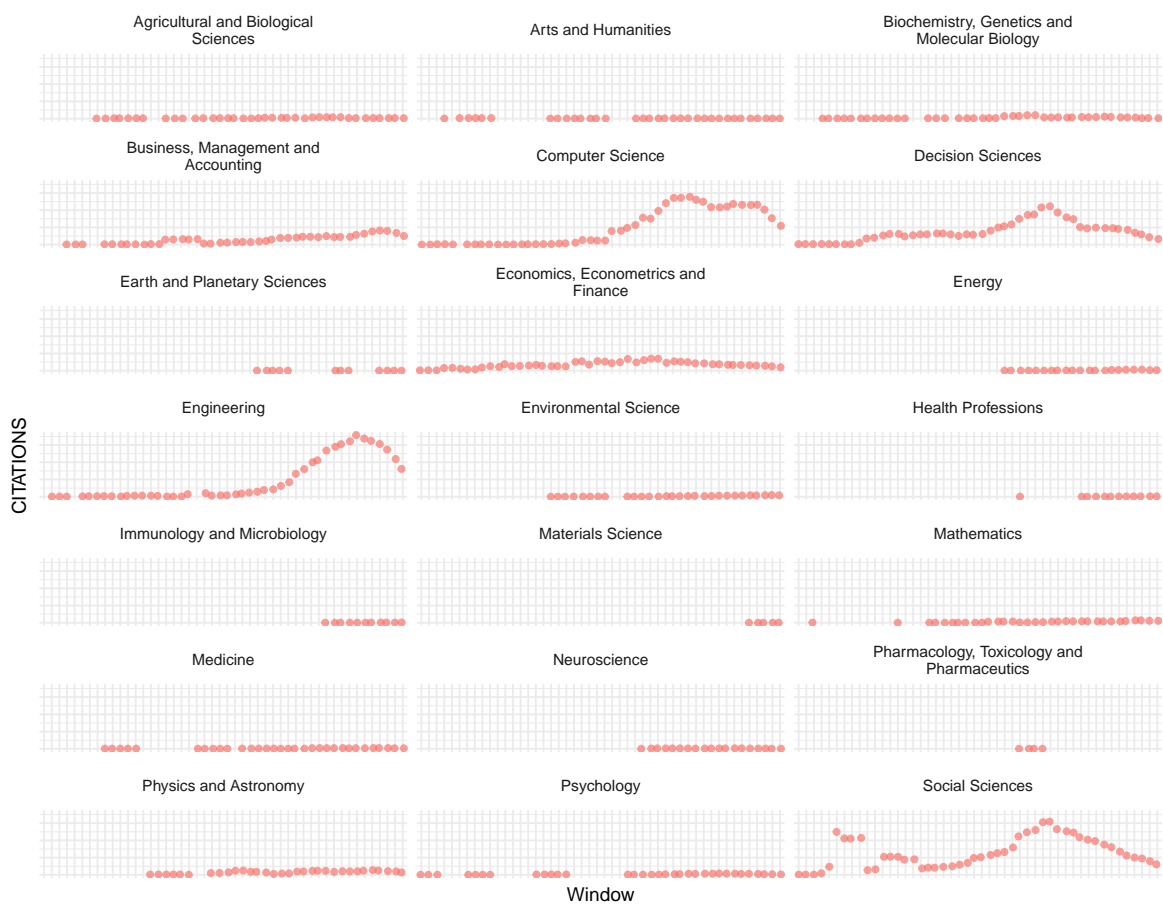
Relative Number of Nodes and Number of Citations

- Relative number of Nodes:

$$RelNodes_{t,f} = \frac{N(V)_{t,f}}{\sum_f^F N(V)_{t,f}} \tag{1}$$

where:

- $RelNodes_{t,f}$ measures the relative number of nodes for field f in time window t across all article nodes

- $N(V)_{t,f}$ measures the total number of nodes for field f in time window t across all article nodes. It is therefore defined as $N(V)_{t,f} = \sum_{v_i} 1_{field(v_i)=f}$, where $1_{field(v_i)=f}$ is an indicator function, taking the value one if article node v_i belongs to field f.

- The number of citations per field and time window is measured as the sum of citations across all articles of a field in a give time window, respectively.

Agricultural and Biological Sciences

Arts and Humanities

Biochemistry, Genetics and Molecular Biology

Business, Management and Accounting

Computer Science

Decision Sciences

Earth and Planetary Sciences

Economics, Econometrics and Finance

Energy

Engineering

Environmental Science

Health Professions

Immunology and Microbiology

Materials Science

Mathematics

Medicine

Neuroscience

Pharmacology, Toxicology and Pharmaceutics

Physics and Astronomy

Psychology

Social Sciences

CITATIONS

Window

Relative Number of Edges

- Relative Number of Total Edges:

$$RelEdges_{t,f} = \frac{N(E)_{t,f}}{\sum_f^F N(E)_{t,f}} \qquad (2)$$

where:

- $RelEdges_{t,f}$ measures the relative number of edges incident on nodes within field f in time window t

- $N(E)_{t,f}$ measures the total number of edges incident on nodes within field f in time window t. It is therefore defined as $N(E)_{t,f} = \sum_{e=(v_i,v_j)} 1_{field(v_i)=f \vee field(v_j)=f}$, where $1_{field(v_k)=f}$ is an indicator function, taking the value one if article node k belongs to field f

- Relative Number of Within-Field Edges:

$$RelEdgesWithin_{t,f} = \frac{N(E_{within})_{t,f}}{\sum_f^F N(E)_{t,f}} \qquad (3)$$

where:

- $RelEdgesWithin_{t,f}$ measures the relative number of edges between article nodes of the same field for field f in time window t

- $N(E_{within})_{t,f}$ measures the total number of edges between article nodes of the same field for field f in time window t. It is therefore defined as $N(E_{within})_{t,f} = \sum_{e=(v_i,v_j)} 1_{field\{(v_i)=f\}} 1_{\{field(v_j)=f\}}$, where $1_{field(v_k)=f}$ is an indicator function, taking the value one if article node k belongs to field f.

- Relative Number of Between-Field Edges:

$$RelEdgesBetween_{t,f} = \frac{N(E_{Between})_{t,f}}{\sum_f^F N(E)_{t,f}} \qquad (4)$$

where:

- $RelEdgesBetween_{t,f}$ measures the relative number of edges between article nodes of different fields for field f in time window t

- $N(E_{Between})_{t,f}$ measures the total number of edges between article nodes of different fields for field f in time window t. It's defined as $N(E_{Between})_{t,f} = \sum_{e=(v_i,v_j)} \left(1_{field\{(v_i=f)\}} 1_{field\{(v_j \neq f)\}} + 1_{field\{(v_i \neq f)\}} 1_{field\{(v_j=f)\}} \right)$.

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RELATIVE_SIZE_EDGES

Window

Agricultural and Biological Sciences | Arts and Humanities | Biochemistry, Genetics and Molecular Biology

Business, Management and Accounting | Computer Science | Decision Sciences

Earth and Planetary Sciences | Economics, Econometrics and Finance | Energy

Engineering | Environmental Science | Health Professions

Immunology and Microbiology | Materials Science | Mathematics

Medicine | Neuroscience | Pharmacology, Toxicology and Pharmaceutics

Physics and Astronomy | Psychology | Social Sciences

Metric

Window

type ● relative_size_between_edges ● relative_size_within_edges

Internal and External Edge Ratio

- Internal Edge Ratio:

$$IR_{t,f} = \frac{N(E_{within})_{t,f}}{N(E)_{t,f}} \tag{5}$$

- External Edge Ratio:

$$ER_{t,f} = \frac{N(E_{between})_{t,f}}{N(E)_{t,f}} \tag{6}$$

with $N(E_{within})_{t,f}$, $N(E_{between})_{t,f}$ and N(E)_{t,f} defined as before. The internal and external ratios therefore measure the ratio of edges within (between) fields relative to the total number of edges of a field. Edges are derived from article-level nodes.
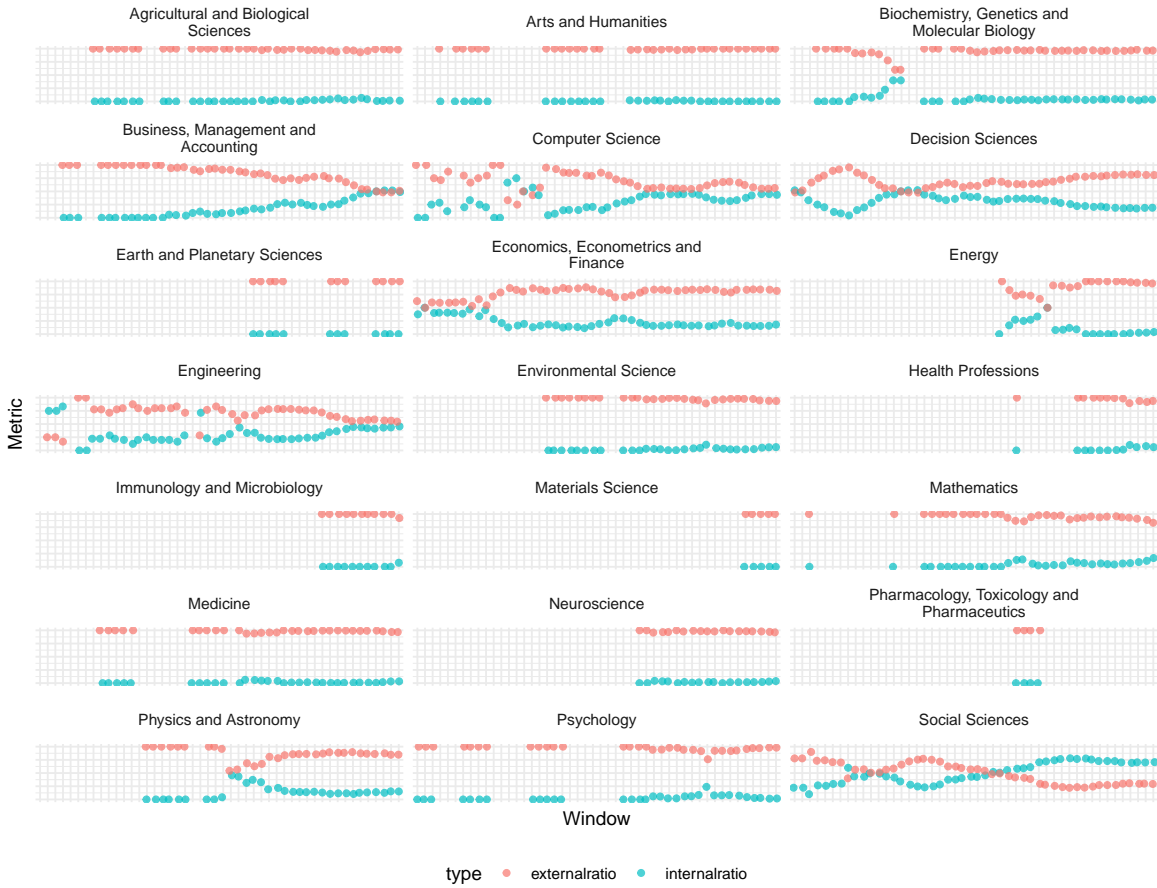
Network Centrality Metrics (Degree, Closeness and Betweennes)

DEGREE

Agricultural and Biological Sciences

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Computer Science

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Psychology

Social Sciences

Window

CLOSENESS

Agricultural and Biological Sciences

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BETWEENESS

Window