ResearchMaps.org, a free web application to track causal information in biology

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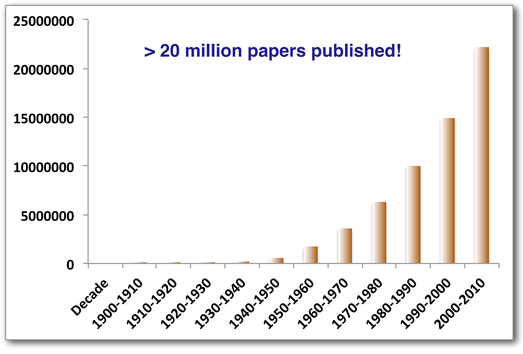
Abstract

Although causal assertions are the very fabric of neuroscience, including molecular and cellular cognition (MCC), there are currently no tools to help researchers keep track of the increasingly complex network of causal connections derived from published findings. To address this growing problem, we developed a free web application (ResearchMaps) to build interactive maps of causal information derived from research papers. ResearchMaps is a collection of intertwined networks where the identity and properties of biological phenomena (the nodes in the networks) are linked by weighted causal connections (the edges in the networks). These edges represent one of three possible types of causal connections between two phenomena: 1) excitatory, 2) inhibitory or 3) no-connection. A score (from 0 to 1) assigned to each edge gives users a measure of the strength and consistency of the evidence represented by each connection between phenomena. Additionally, symbols inform users of the types of experiments represented in each edge. Although there are tens of millions of experiments testing causal connections in biology, they fall into a small number of classes. For example, molecular and cellular biologists commonly use at least four major types of experiments to test a possible causal connection between two entities (A and B): 1) Positive Manipulations, where A's levels or activity are increased; 2) Negative Manipulations, where A's levels or activity are decreased; 3) Non-Interventions whose goal is to track how A co-varies with B; and 4) Mediation experiments, designed to determine whether C is part of the mechanism by which A contributes to B. In ResearchMaps, convergency and consistency among results increase the score assigned to each edge, while contradictions have the opposite effect.

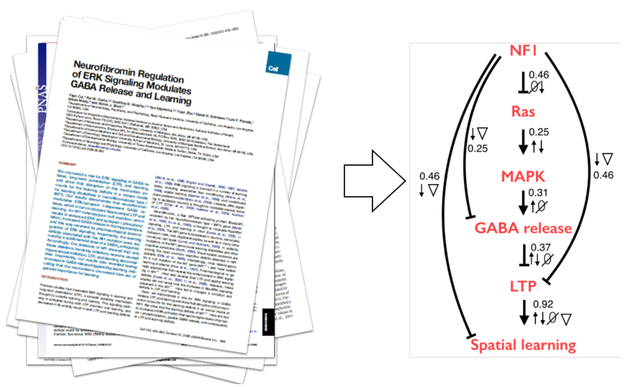
New challenges in neuroscience

- Exponential growth of the literature
- Multidisciplinary nature of most studies
- Increased complexity of technology and approaches
- Interconnectedness of neuroscience with other areas of biology
- Dramatic increase in the complexity of research papers

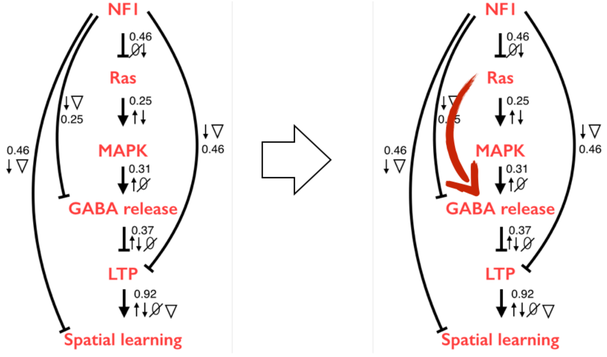
The vertiginous growth of the literature



From text to maps

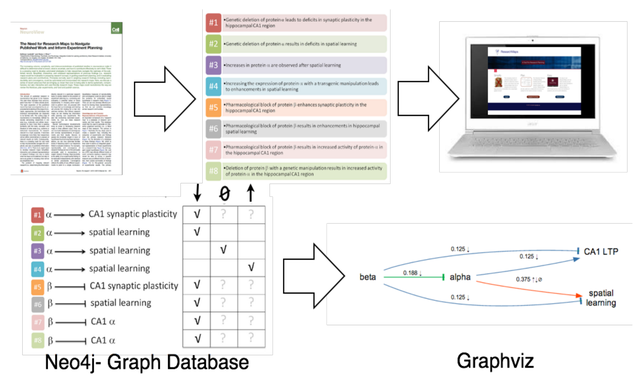


From maps to new experiments

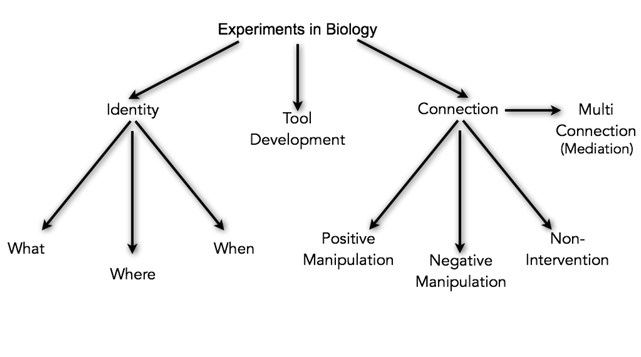


ResearchMaps.org

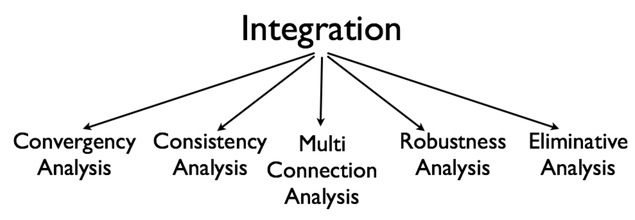
Inside ResearchMaps.org



Taxonomy for experiments in biology



Integration: rules for drawing maps of experiments



References

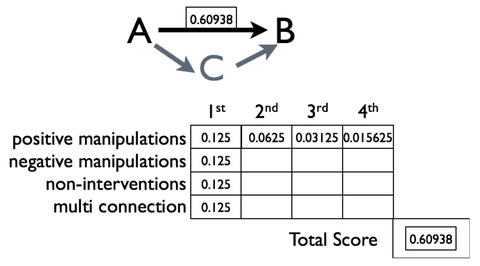
- Landreth, A, Silva, AJ (2013). The need for research maps to navigate published work and inform experiment planning. Neuron, 79(3), 411–415.
- Silva, AJ, Landreth, A, Bickle, J (2013). Engineering the next revolution in neuroscience: the new science of experiment planning. Oxford University Press.

Convergency analysis

Consistency analysis

Multi-connection analysis

Weighting evidence



Discussion

- ResearchMaps yields massive time savings when studying publications, planning experiments, and analyzing results.
- Current development work includes the representation of hypothetical assertions and other categories of research literature (e.g., clinical trials).
- In future work, we plan to develop programmatic methods to formalize and automate much of the scientific method, including hypothesis generation and statistical meta-analyses of published findings.