

ResearchMaps.org: a free web app for integrating and planning experiments

1 Neurobiology, Psychiatry, and Psychology
 2 Bioengineering and Radiological Sciences
 3 Computer Science



Nicholas J. Matiasz^{1,2}, Justin Wood^{1,3}, William Hsu, PhD², Alcino J. Silva, PhD¹

{matiasz, juwood03, willhsu, silvaa}@ucla.edu

Abstract

Despite the growing abundance of structured and free-text information (e.g., PubMed), there is a great need for systems that help scientists integrate the large volume of relevant data and information required for experiment planning. Specifically, scientists need quantitative approaches that can be used to objectively assess the value of potential experimental designs, analogous to statistical methods used to objectively assess the significance of experimental results.

To address this need, we developed ResearchMaps.org, a free web application that allows scientists to represent empirical results and hypothetical assertions in a quantitative, graphical form. The app uses a Bayesian learning framework to operationalize strategies that scientists routinely use to integrate findings and plan experiments, including convergence and consistency. By visualizing experimental results and quantifying experimental evidence, ResearchMaps allows scientists to formally convey the rationale behind their experiment-planning decisions. Computer-aided experiment planning systems and other “meta-scientific” tools like ResearchMaps will likely become increasingly common; such tools will enable scientists to use quantitative methods not only to establish the significance of their findings but also to justify the selection of the experiments themselves.

Problem

Scientists lack quantitative methods to plan experiments, similar to statistical methods for analyzing experiments.

It is difficult to consider all possible causal explanations without bias from past experience.

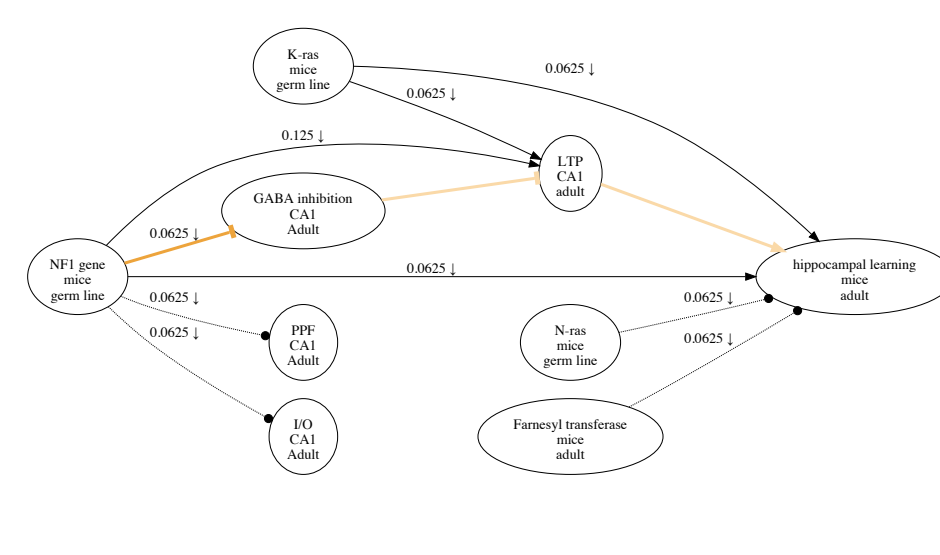
Current methods for integrating evidence are often implicit, internalized through years of training.

Experiment planning needs two kinds of information:

- ontological *what* there is
- epistemological *how* we know

Literature

Model



Solution: research maps

A research map is a graphical representation of (i) causal relations and (ii) the empirical evidence for these relations.

Experiments

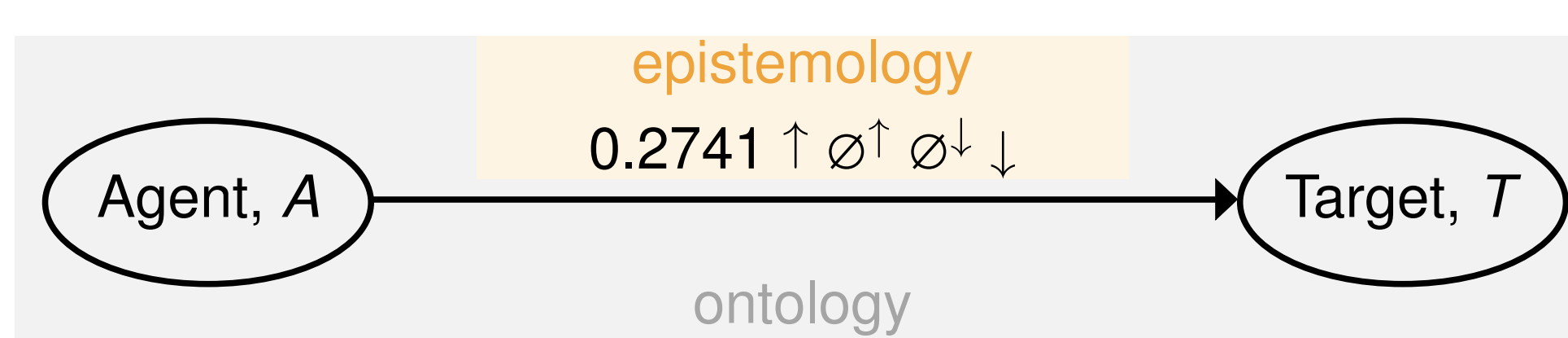
- ↑ Positive Intervention
- ∅↑ Positive Non-intervention
- ∅↓ Negative Non-intervention
- ↓ Negative Intervention

Results

- + Increase
- 0 No change
- Decrease

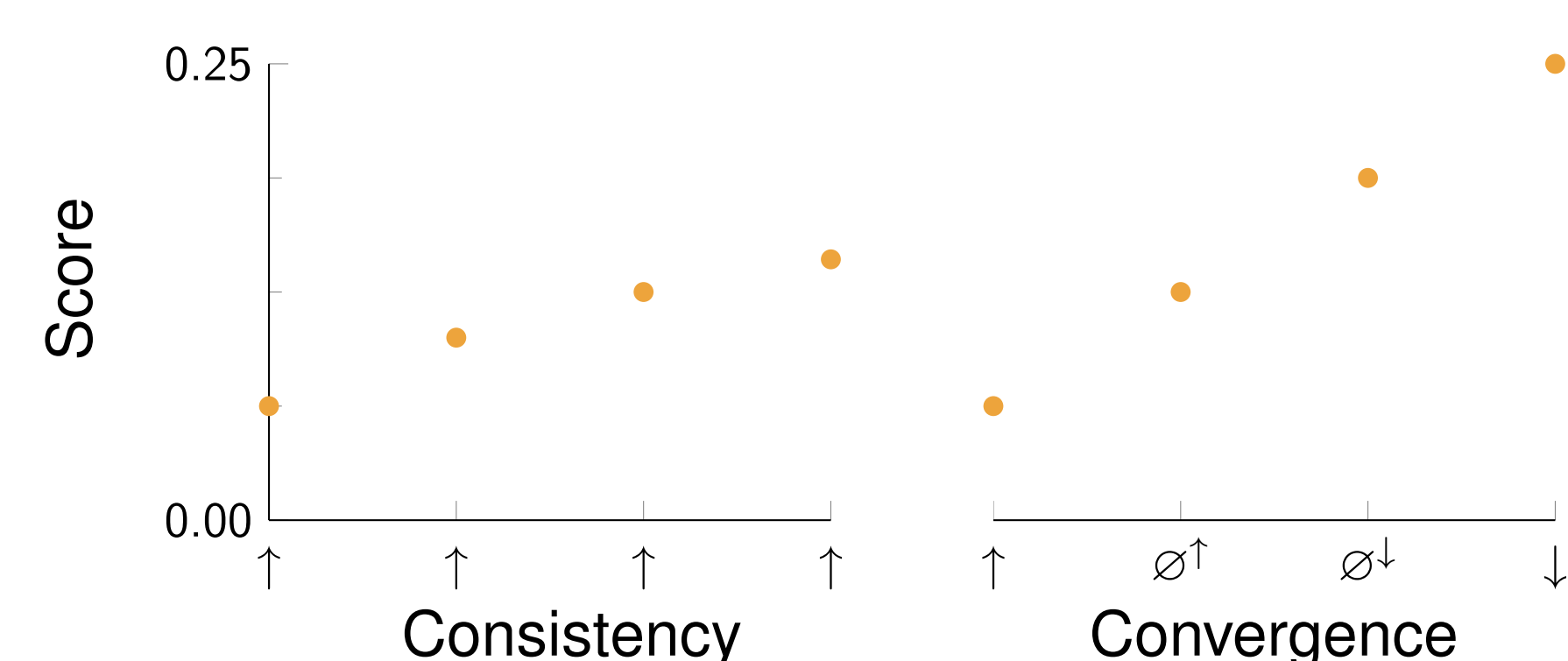
Relations

- Excitatory
- No-connection
- Inhibitory

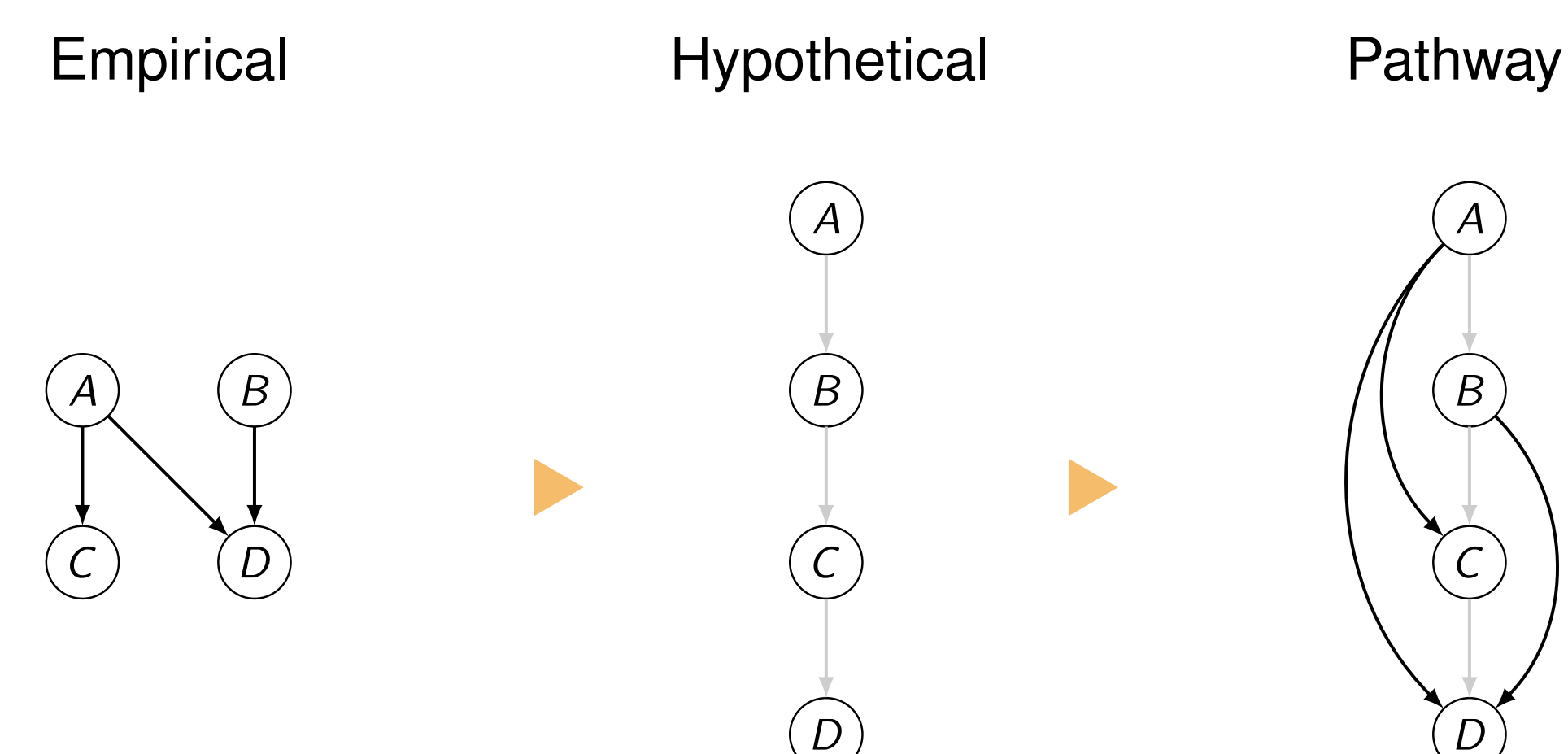


A Bayesian algorithm is used to score the consistency and convergence of evidence; a shorthand calculation is below.

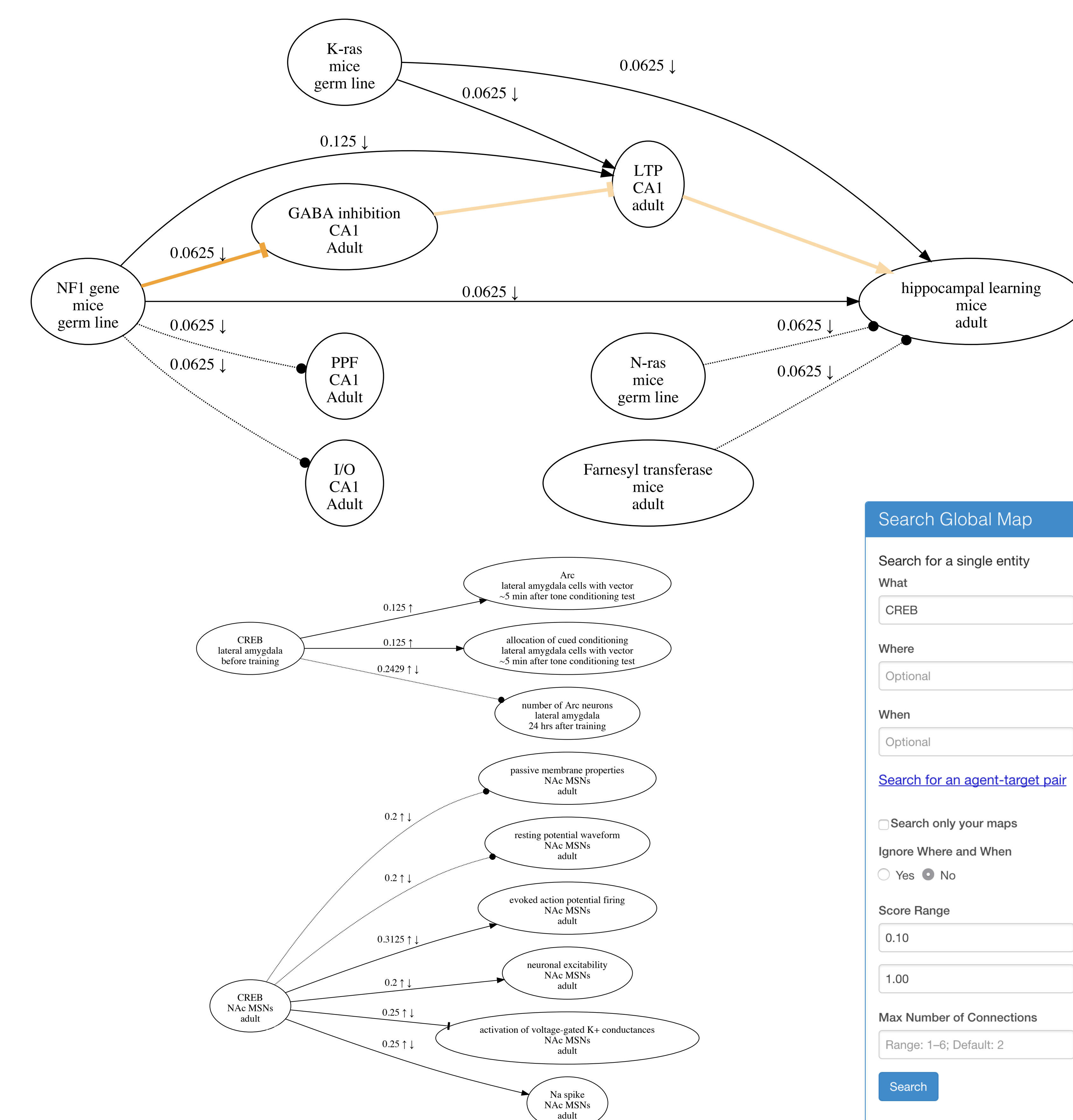
	$T+$	$T0$	$T-$	
$A \uparrow$	5	1	1	$P(E) = 1/4 [5/7 + 1/4 + 2/4 + 3/5] = 0.5161$
$A \emptyset \uparrow$	1	1	2	$P(N) = 1/4 [1/7 + 1/4 + 1/4 + 1/5] = 0.2107$
$A \emptyset \downarrow$	1	1	2	$P(I) = 1/4 [1/7 + 2/4 + 1/4 + 1/5] = 0.2732$
$A \downarrow$	1	1	3	$Score = (0.5161 - 1/3) / (1 - 1/3) = 0.2741$



Hypothetical edges (light) can add structure to a research map and can help to interpret empirical edges (dark).



Implementation: ResearchMaps.org



Discussion

Research maps include both ontological and epistemological (methodological) information to aid experiment planning.

Our framework operationalizes strategies to gauge evidence of causal relations between biological phenomena.

Any ontology can in principle be used to instantiate research maps, making them generally applicable in science.

ResearchMaps is a Node.js web app with a Neo4j graph database; go to researchmaps.org to try it for free (we welcome your feedback).

References

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