Question Network Intro

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Project in collaboration with Kai Ten

Intro

What is a question network?

   answer A knowledge representation structure.

      _ What are the knowledges that can be represented as a question network?

         answer You can "translate" a book, a research paper or even a talk into a question network. Or you can create a question network for any of your intellectual endeavor starting by a curious question.

Example: research paper

Large-Scale Study of Curiosity-Driven Learning

Yuri Burda[*]
OpenAI

Harri Edwards[*]
OpenAI

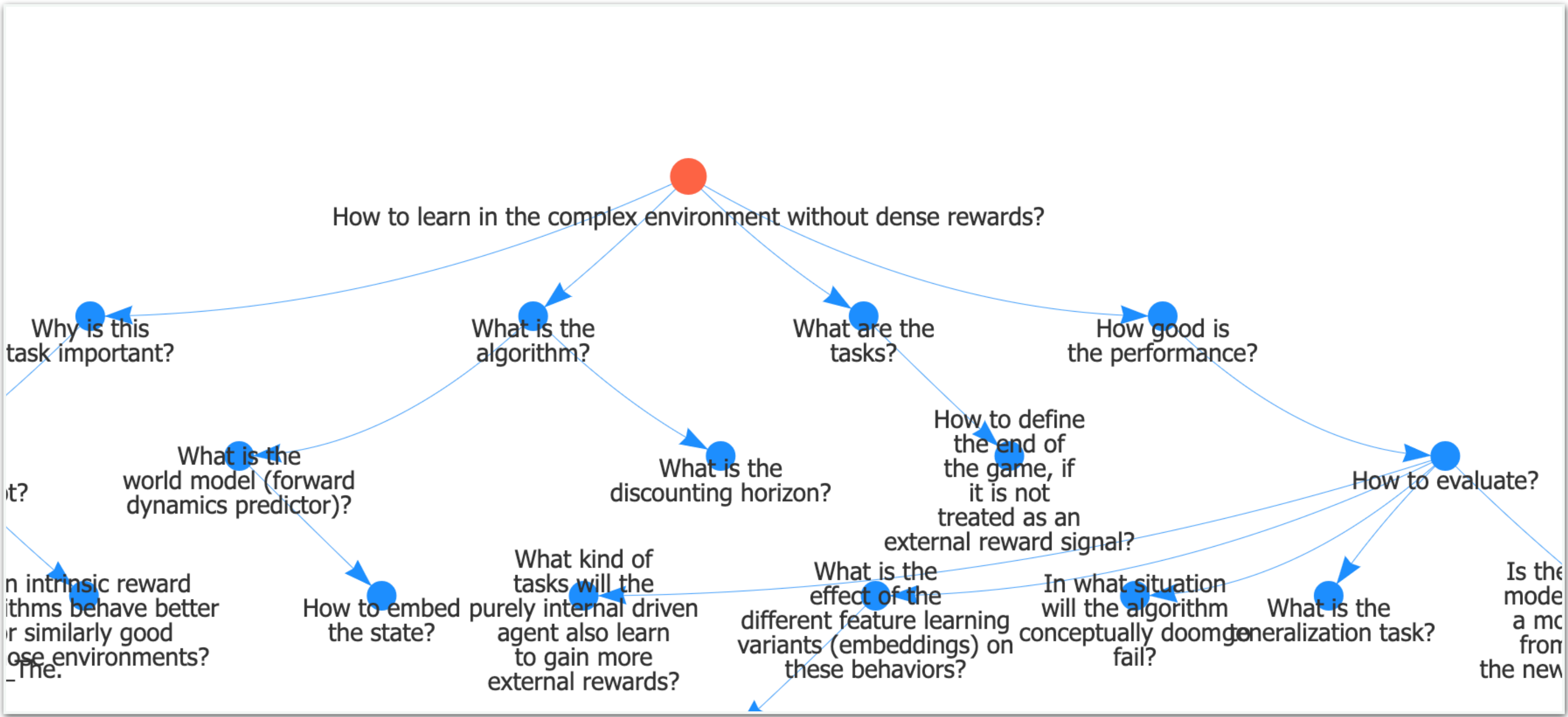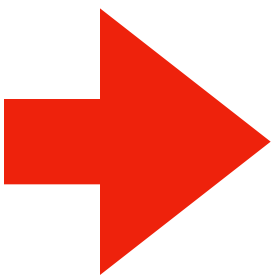**Deepak Pathak**[*]
UC Berkeley

Amos Storkey
Univ. of Edinburgh

Trevor Darrell
UC Berkeley
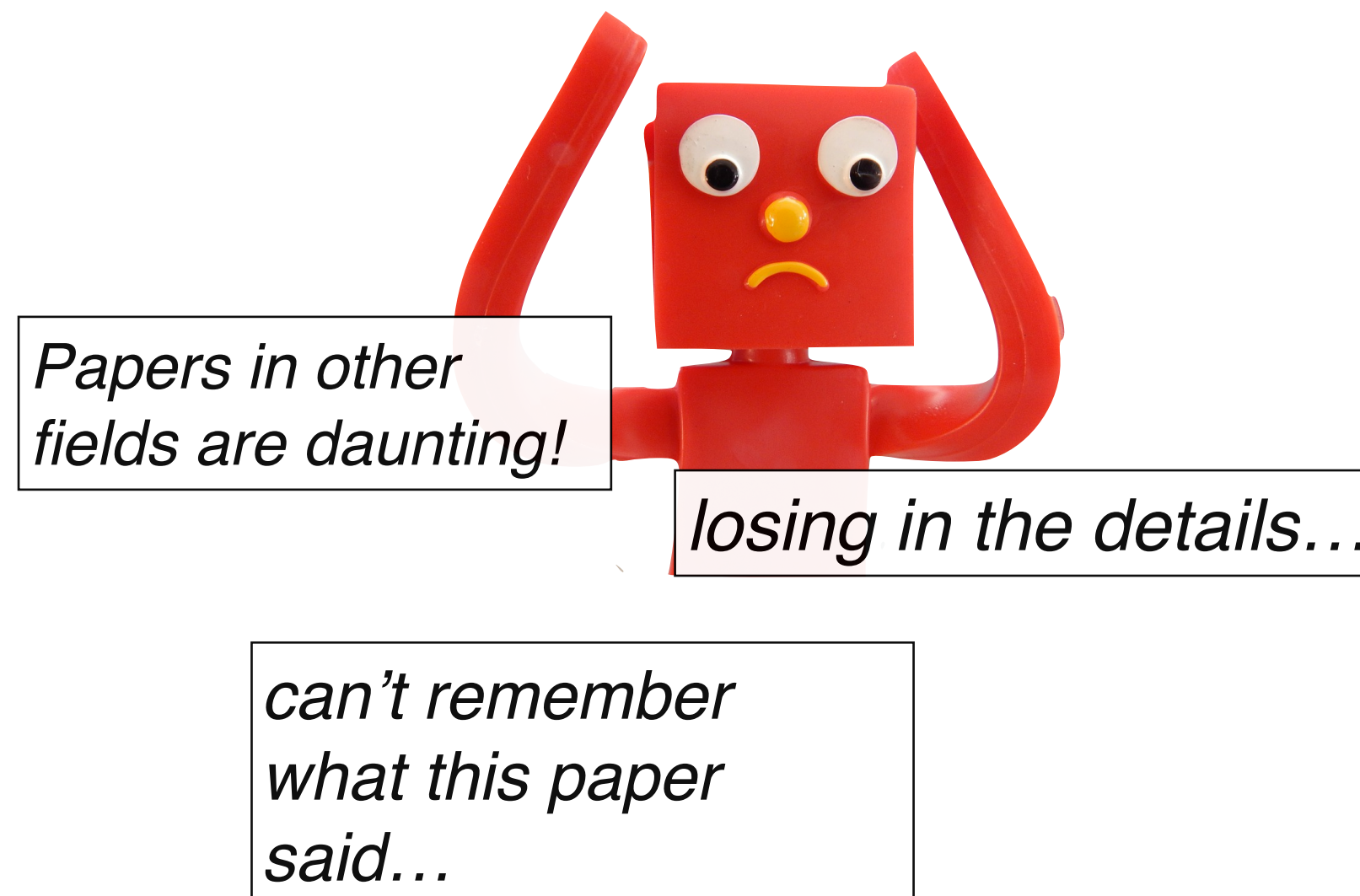
Alexei A. Efros
UC Berkeley

Abstract

Reinforcement learning algorithms rely on carefully engineering environment rewards that are extrinsic to the agent. However, annotating each environment with hand-designed, dense rewards is not scalable, motivating the need for developing reward functions that are intrinsic to the agent. Curiosity is a type of intrinsic reward function which uses prediction error as reward signal. In this paper: (a) We perform the first large-scale study of purely curiosity-driven learning, i.e. *without any extrinsic rewards*, across 54 standard benchmark environments, including the Atari game suite. Our results show surprisingly good performance, and a high degree of alignment between the intrinsic curiosity objective and the hand-designed extrinsic rewards of many game environments. (b) We investigate the effect of using different feature spaces for computing prediction error and show that random features are sufficient for many popular RL game benchmarks, but learned features appear to generalize better (e.g. to novel game levels in Super Mario Bros.). (c) We demonstrate limitations of the prediction-based rewards in stochastic setups. Game-play videos and code are at https://pathak22.github.io/large-scale-curiosity/.

How to learn in the complex environment without dense rewards?

Why is this task important?

What is the algorithm?

What are the tasks?

How good is the performance?

What is the world model (forward dynamics predictor)?

What is the discounting horizon?

How to define the end of the game, if it is not treated as an external reward signal?

How to evaluate?

...t?

...n intrinsic reward ...ithms behave better ...r similarly good ...ose environments? ...The.

How to embed the state?

What kind of tasks will the purely internal driven agent also learn to gain more external rewards?

What is the effect of the different feature learning variants (embeddings) on these behaviors?

In what situation will the algorithm conceptually doomed to fail?

What is the generalization task?

Is the model a mo... from the new

Potential use

- A new way to represent knowledge that helps sharing and learning.

Papers are not the most accessible way to organize knowledge

Papers in other fields are daunting!

losing in the details…

can't remember what this paper said…

Potential use

- A new way to represent knowledge that helps sharing and learning.

  - Works great for self-directed learning!

- Evaluate papers in terms of whether it is solving important questions.

- Meta-scientific research: Characterize the thinking process of different fields.

Project history

- Inspiration came when learning physics (college)

- Offline seminars in the form of question-asking (post college gap year)

- Starting to build the tools with another friend (1 year ago)

- Current plan: build the tools and standardize the methodology, prepare for larger scale data collection (on the way towards atomization)

How to construct a question network for a research question?

- Choose the basic question

- Start with a "question skeleton" aka methodology for answering the question

- Develop the question network with more specific questions

- Horizontal expansion to compare, contrast and generalize

- Summarize the current answer to the basic question

Basic questions: 4 types

1. Information seeking or "what" questions (plus "when", "who", etc.)

   • Ancient study, biology, journalism…

2. Explanation seeking or "why" questions

   • Theoretical studies of physics, psychology, neuroscience…

3. Solution seeking, or "how" questions

   • Civil engineering, software engineering….

4. Evaluation seeking, usually expressed as "How good is..." / "is sth...good or commendable or beneficial"

   • Policy, economics, ethic studies…

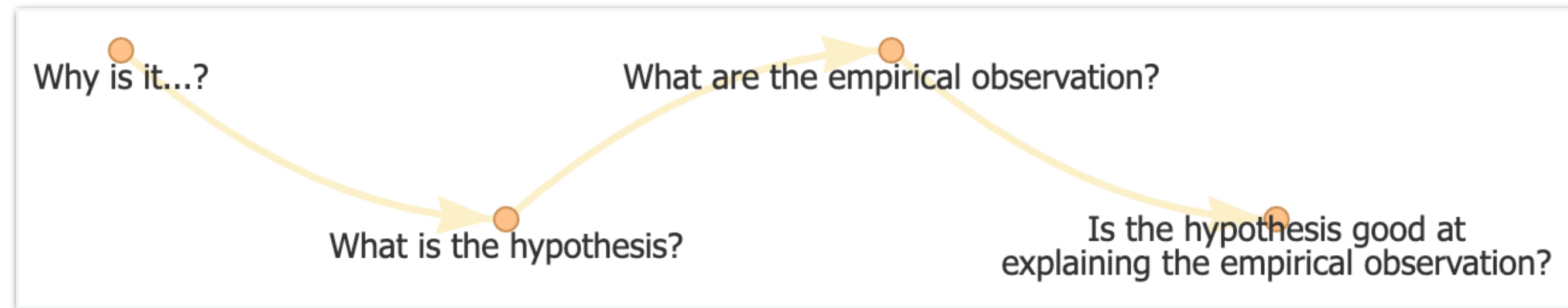# Question network for my thesis research

- Choose the basic question

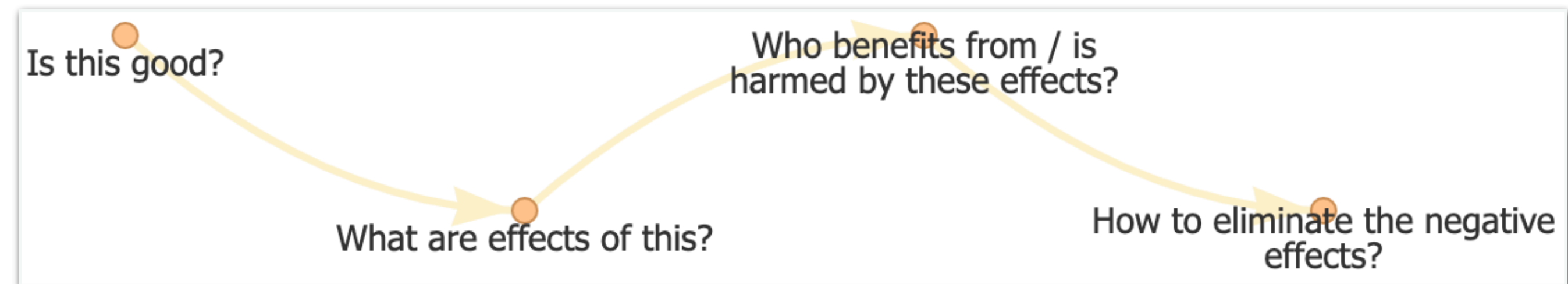<div align="center">Why do people feel suspense?</div>

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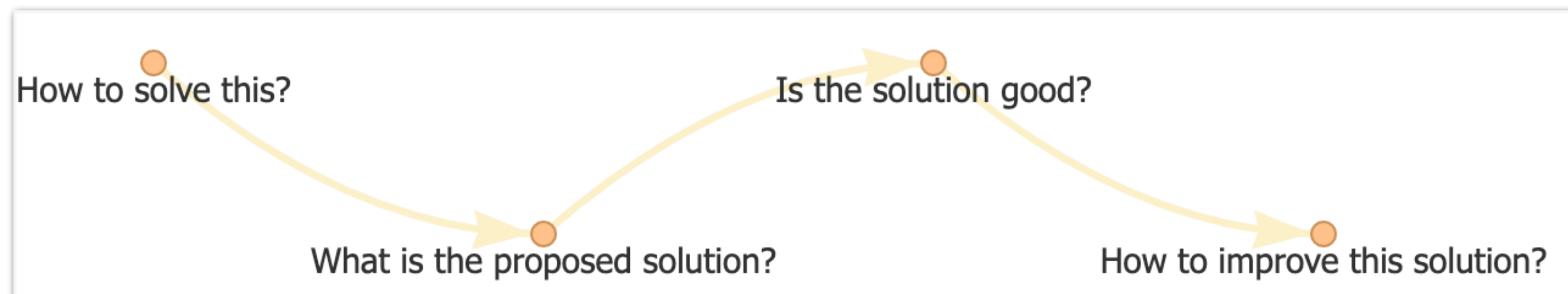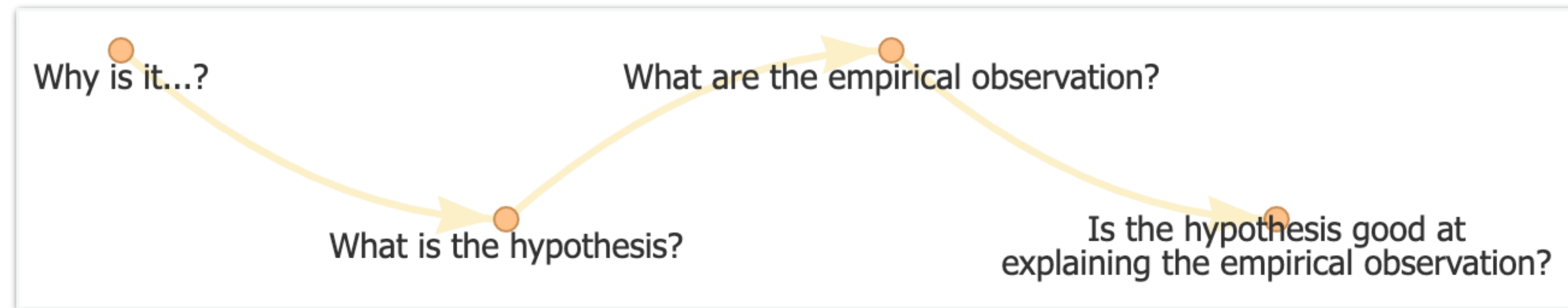
Question skeleton examples

Why question

Why is it...?   What are the empirical observation?

What is the hypothesis?   Is the hypothesis good at explaining the empirical observation?

Evaluation question

Is this good?   Who benefits from / is harmed by these effects?

What are effects of this?   How to eliminate the negative effects?

How question

How to solve this?   Is the solution good?

What is the proposed solution?   How to improve this solution?

Question skeleton examples

Why question

Why is it...?   What are the empirical observation?

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Evaluation question

Is this good?   Who benefits from / is harmed by these effects?

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How question

How to solve this?   Is the solution good?

What is the proposed solution?   How to improve this solution?

Specify the questions

- According to the research domain

Example: computational cognitive science

```
1. Why do people ...?
2. What is the hypothesis?
    _ What is the quantitative model implementing this hypothesis?
        _ What are the input to the model?
        _ What are the parameters?
3. What are the empirical observation?
    _ What are the intuitive examples?
    _ What are the rigorous experimental evidences?
        _ What is a lab paradigm to test the hypothesis?
4. Is the hypothesis good at explaining the empirical observation?
```

Specify the questions

- According to the features of a specific entity (which can be cross domain)

Entity: model

```
1. Why do people ...?
2. What is the hypothesis?
     _ What is the quantitative model implementing this hypothesis?
         _ What are the input to the model?
         _ What are the parameters?
```

Expanding the network
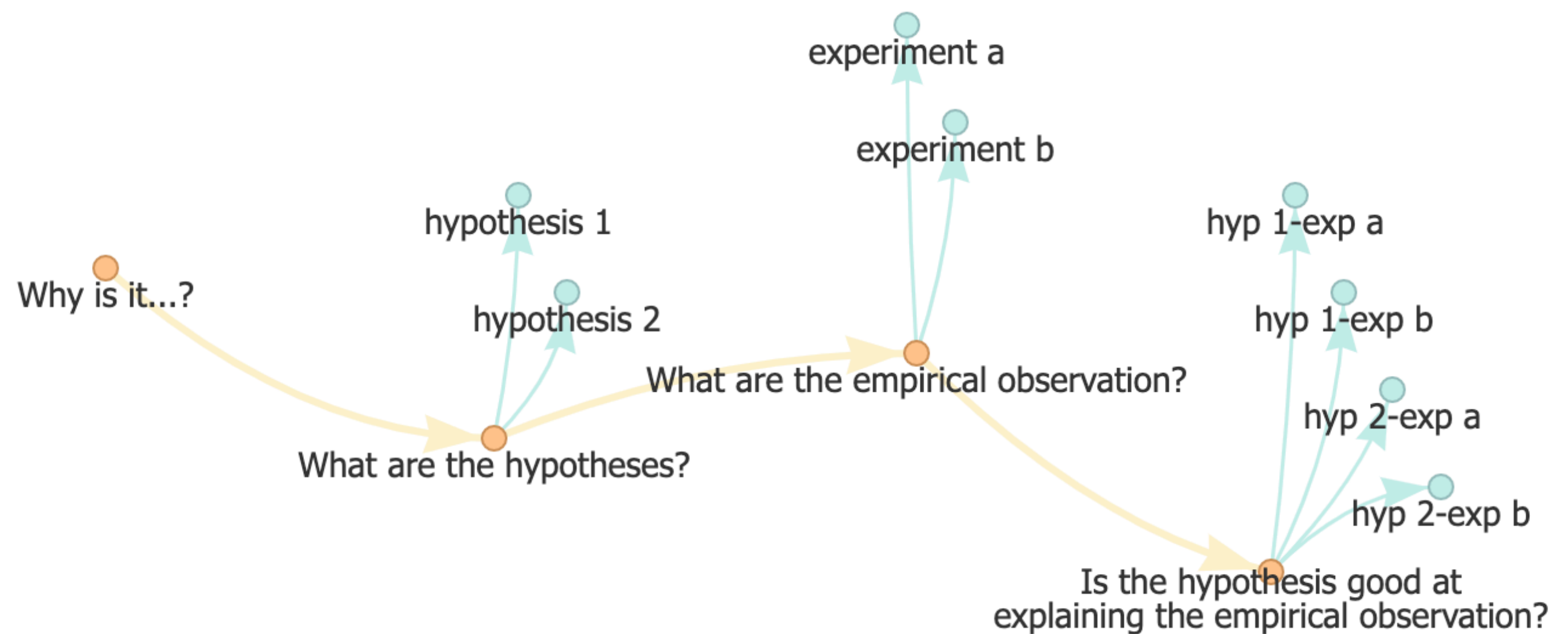
E.g. Compare alternative hypotheses

```
1. Why do people ...?
2. What is the hypothesis?
     _answer...
          ...@author1 blahblah
          ...@author2 plahplah
     ...end_
```


Why is it...?

hypothesis 1

hypothesis 2

What are the hypotheses?

What are the empirical observation?

Is the hypothesis good at explaining the empirical observation?
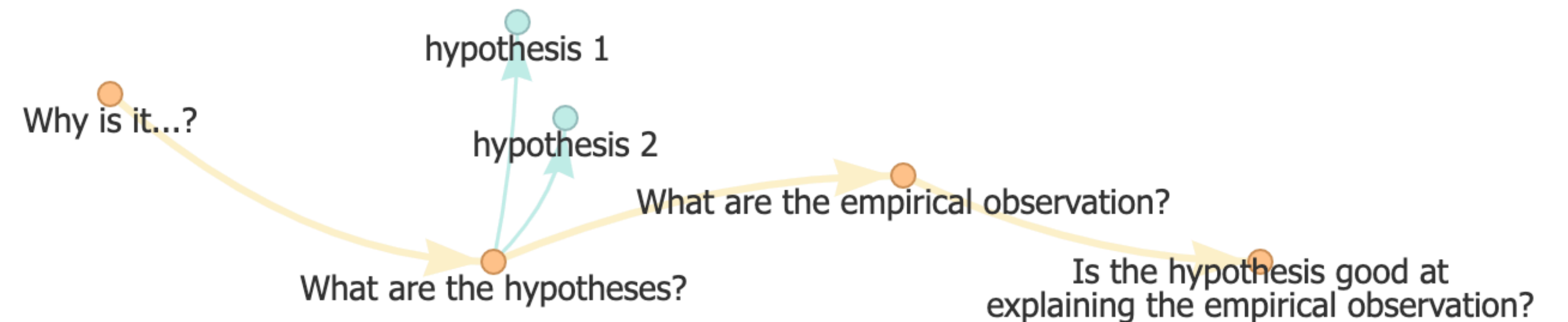
Then each branch will go through the rest of skeleton
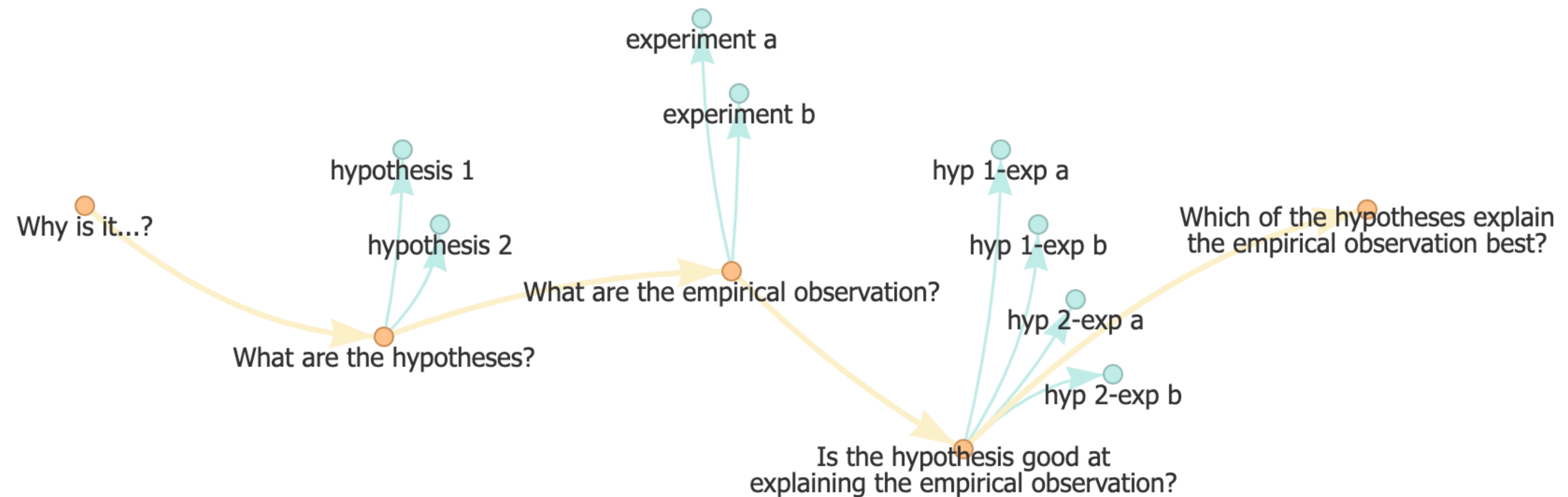
Expansion can be factorial!

- **Compare alternative hypotheses**
- **List all the observations**

That's why meta-analysis is so hard but so necessary

Summarize the answer

experiment a

experiment b

hypothesis 1

hypothesis 2

Why is it...?

What are the empirical observation?

What are the hypotheses?

hyp 1-exp a

hyp 1-exp b

Which of the hypotheses explain the empirical observation best?

hyp 2-exp a

hyp 2-exp b

Is the hypothesis good at explaining the empirical observation?

Q: Why is it …?
Simple answer: Because …(the best hypothesis)
Comprehensive/honest answer: The best hypothesis is theory 1, however the theory 2 explains phenomena 2 better…