Strategic Thinking in Complex Problem Solving

February 2017

Arnaud Chevallier

This is an overview of the book

Strategic Thinking in Complex Problem Solving

ARNAUD CHEVALLIER

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"A few years ago, I began developing a new MBA course and scoured cyberspace looking for seminal works related to the topic. What I found was a void between academic treatises on the scientific method and popular business books promising to reveal the secrets of blue-chip consulting firms. Nothing hit my target until I discovered Professor Chevallier who clearly had a passion for the topic. He hit an insightful 'sweet spot,' combining the conceptual rigor of an academician with the practical perspective of a former consultant. I have adopted many of Professor Chevallier's ideas and methods, embedding them into my course and into my personal problem-solving toolkit."

KEN HOMA, Distinguished Teaching Professor, McDonough School of Business, Georgetown University

"Although there are already excellent books on decision making, this book addresses problem solving in a very pragmatic approach. Dr. Chevallier carefully reviews the current literature in problem solving and decision-making, and provides evidence-based practical solutions to complex problems. The techniques and tips provided can be used in a broad variety of settings, and will be useful to academics as well as professionals interested in complex problem solving."

FRANÇOIS MODAVE, Associate Professor of Biomedical Informatics and Director of the mHealth Lab, Department of Health Outcomes & Policy, College of Medicine, University of Florida

Facing an unfamiliar, challenging situation, what should you do? Whether you are a student or a working professional, improving how you solve complex problems can result in critical improvements in your life. *Strategic Thinking in Complex Problem Solving* provides a general framework and the necessary tools to help you do so.

Based on his groundbreaking course at Rice University, engineer and former strategy consultant Arnaud Chevallier provides practical ways to develop problem solving skills, such as investigating complex questions with issue maps, using logic to promote creativity, leveraging analogical thinking to approach unfamiliar problems, and managing diverse groups to foster innovation.

Strategic Thinking in Complex Problem Solving breaks down the resolution process into a series of steps. For each of these four steps—the what, why, how, and do—this book explains techniques that promote success and demonstrates how to apply them on a case study and in additional examples. The featured case study guides you through the resolution process, illustrates how these concepts apply, and creates a concrete image to facilitate recollection.

Strategic Thinking in Complex Problem Solving is a tool kit that integrates theoretical and empirical evidence from many disciplines and explains it in accessible terms. As the book guides you through the various stages of solving complex problems, it also provides templates to help you easily apply these approaches to your own personal projects.

ARNAUD CHEVALLIER researches tools to help people solve complex, ill-defined problems. He is an associate vice provost at Rice University, where he teaches in the engineering school.

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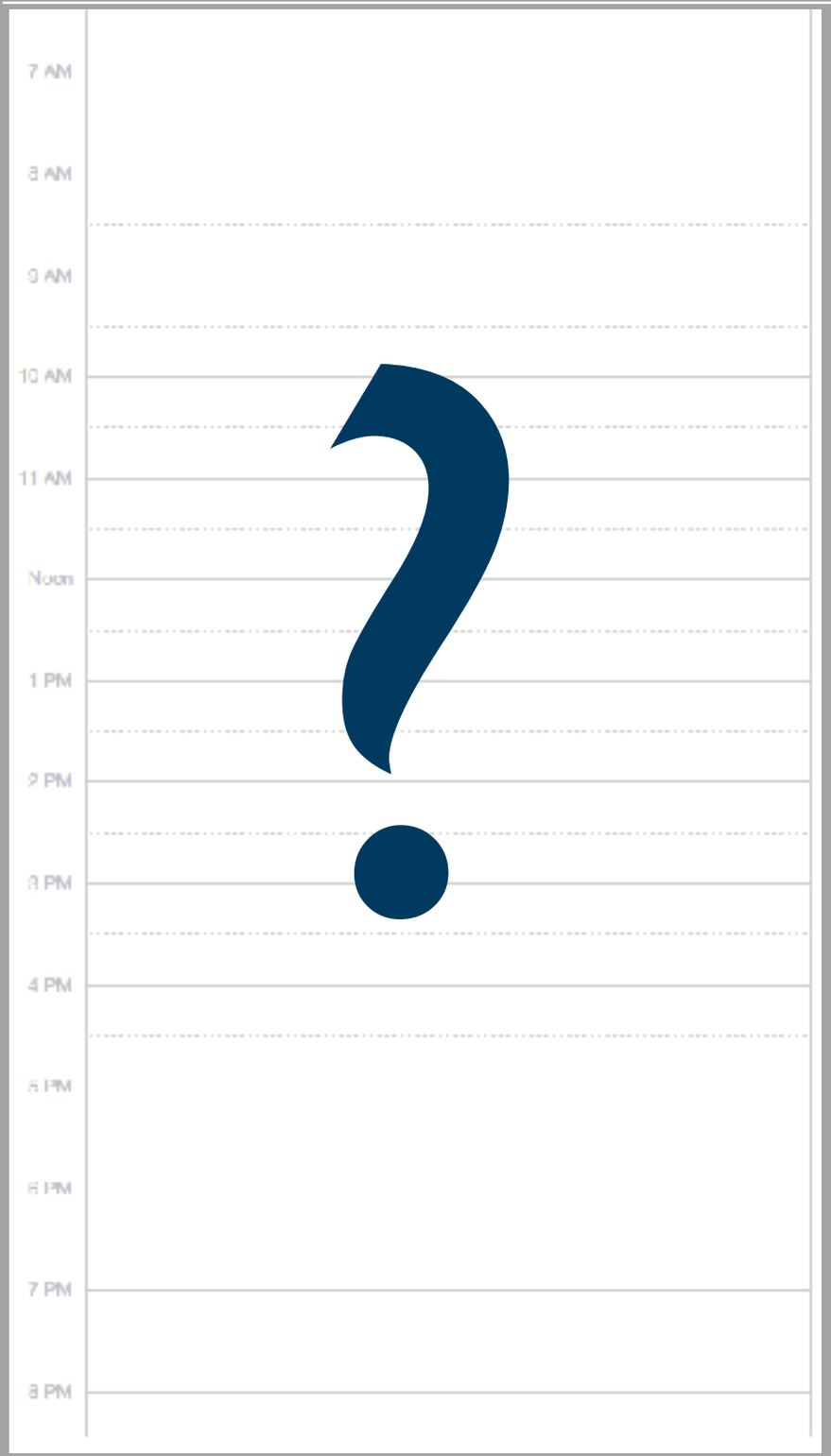
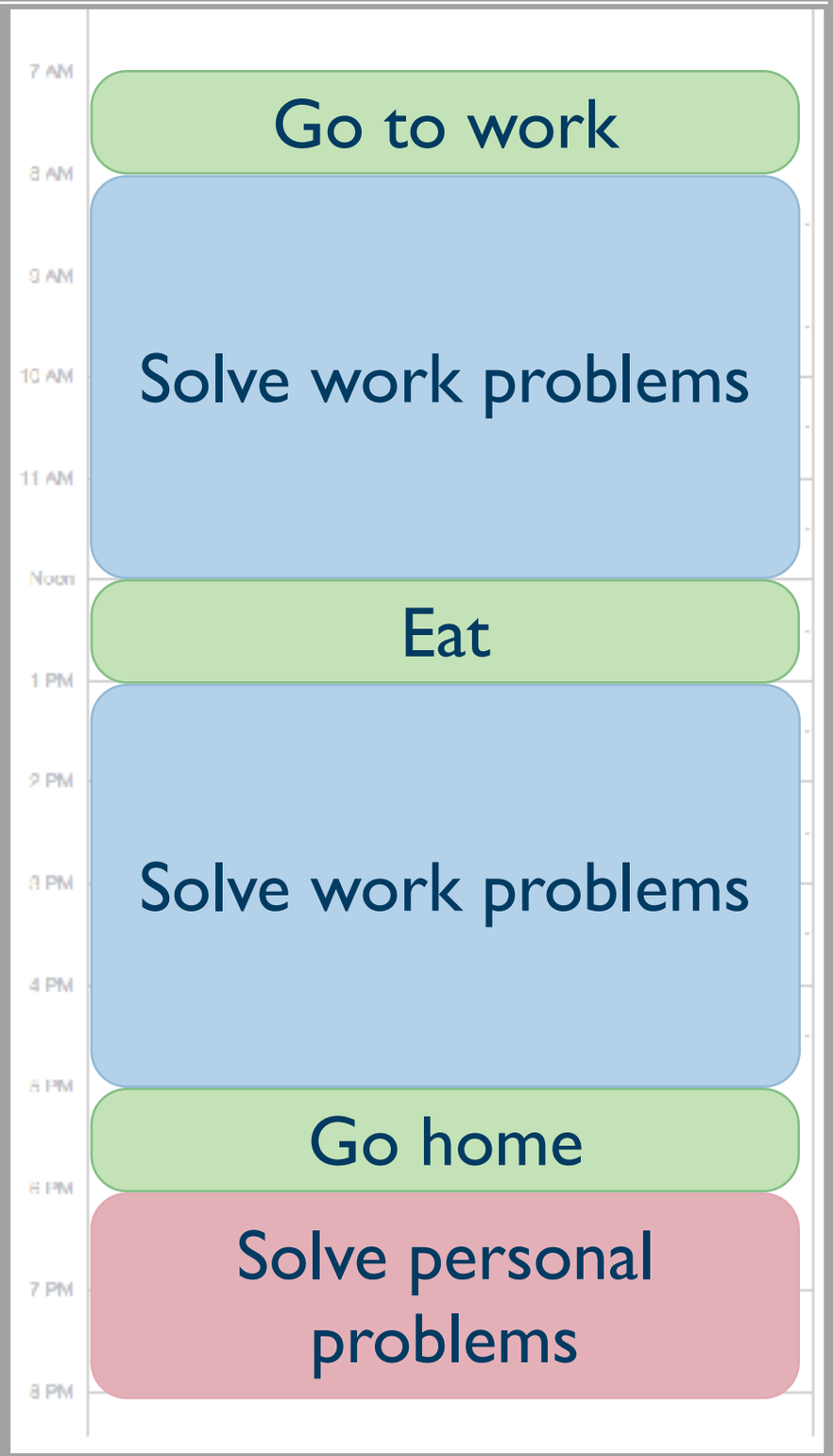
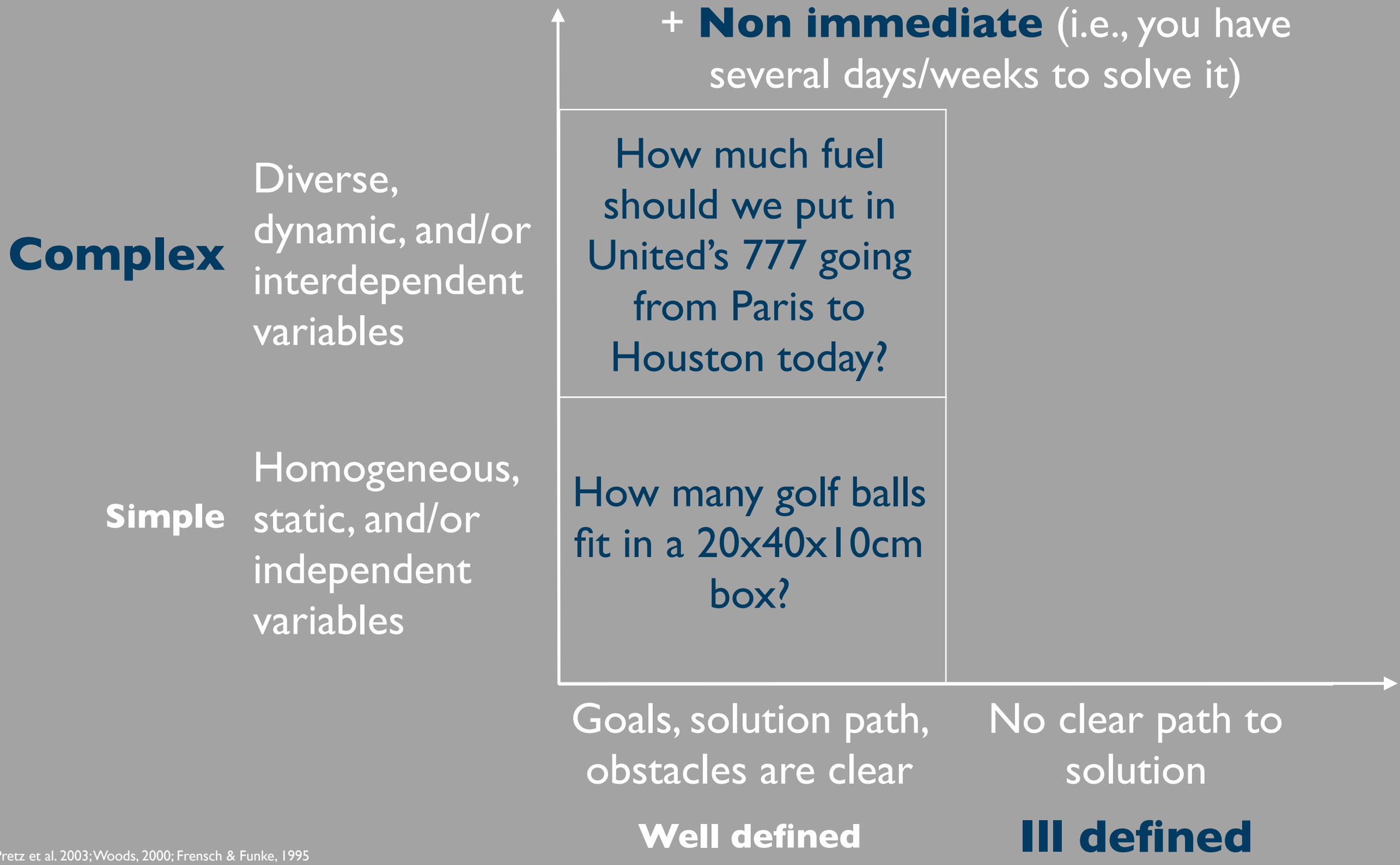
Let's define a problem as a gap between where you are and where you want to be

Taking this definition, we all spend our entire days solving problems





Of all problem types, let's focus on complex, ill-defined, non-immediate (CIDNI) ones



Source: Pretz et al. 2003; Woods, 2000; Frensch & Funke, 1995

Even then, we face CIDNI problems of various scales

Global	How can we eradicate poverty?
Organizational	Why isn't Rice a better university?
Personal	How should I plan my career path? How can I graduate on time?

To solve CIDNI problems, you need both depth and breadth of knowledge; this course is about the latter

Ideal problem solver (or problem solving team) is "T shaped" = generalist + specialist

Be a generalist: have a breadth of knowledge across disciplines → Breadth ← *Strategic Thinking*

Be a specialist: have a depth of knowledge in a discipline → Depth ← Traditional programs + research

Source: (Perkins & Salomon, 1989), (Gauch, 2003) [pp. 2–3] (Grasso & Burkins, 2010) [pp. 1–10]; (Kulkarni & Simon, 1988) [p. 140], (Sanbonmatsu, Posavac, Kardes, & Mantel, 1998), (Sheppard, Macatangay, Colby, & Sullivan, 2009) [p. 175], (Katzenbach, 1993), (Savransky, 2002) [p. 18], (M. U. Smith, 1991) [pp. 10–15].

Here, you'll acquire an **approach** and some **tools** to develop your generalist skills

Approach: 4-step sequential approach

Self awareness: recognize biases, blind spots; adopt learning mentality; etc.

Tools: WHAT card

Key question / introductory flow

WHY card

Diagnostic map

HOW card

Solution map

Solution report

Following a four-step approach can help your strategic thinking skills

WHAT

1. Frame the problem

WHY

2. Diagnose the problem

HOW

3. Find solutions

DO

4. Implement solution

Start with framing your problem

WHAT | **WHY** | **HOW** | **DO**

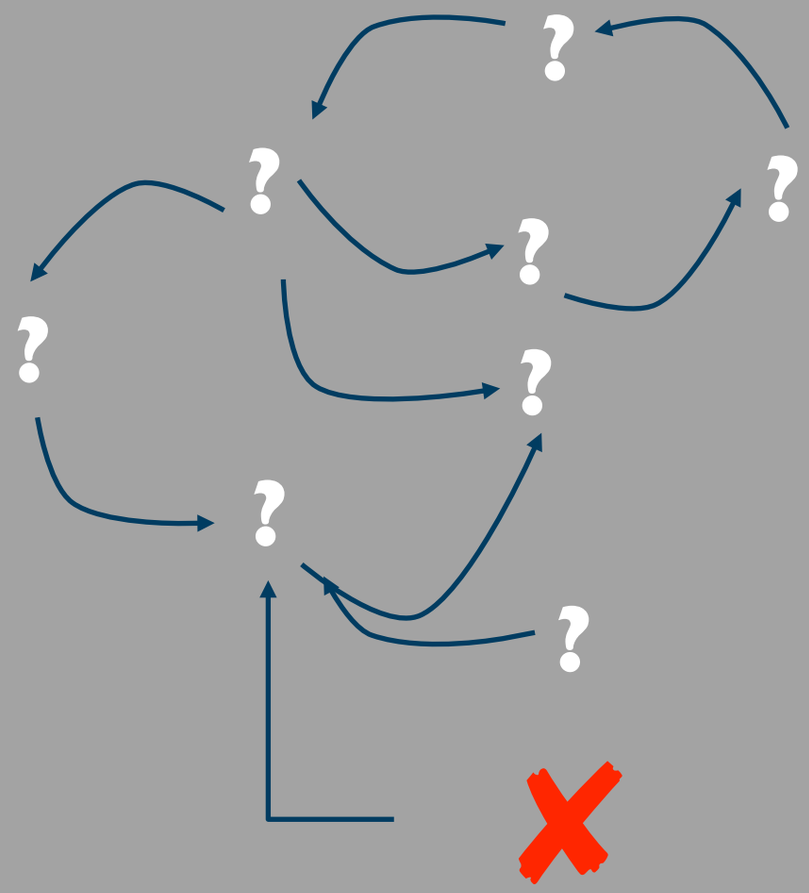
1. Frame the problem

2. Diagnose the problem

3. Find solutions

4. Implement solution

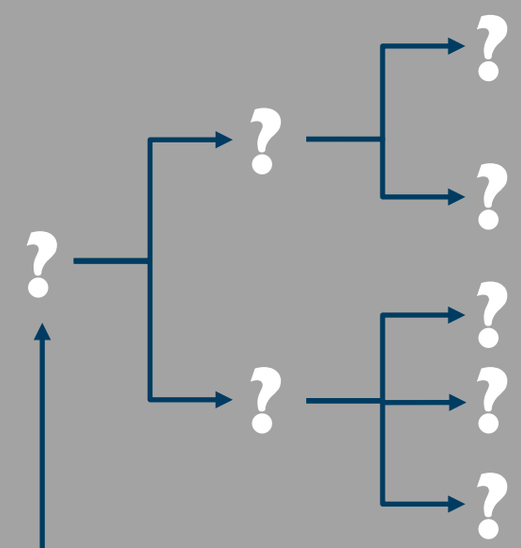
Framing the problem requires identifying **the** key question that encompasses all the other relevant questions



✘

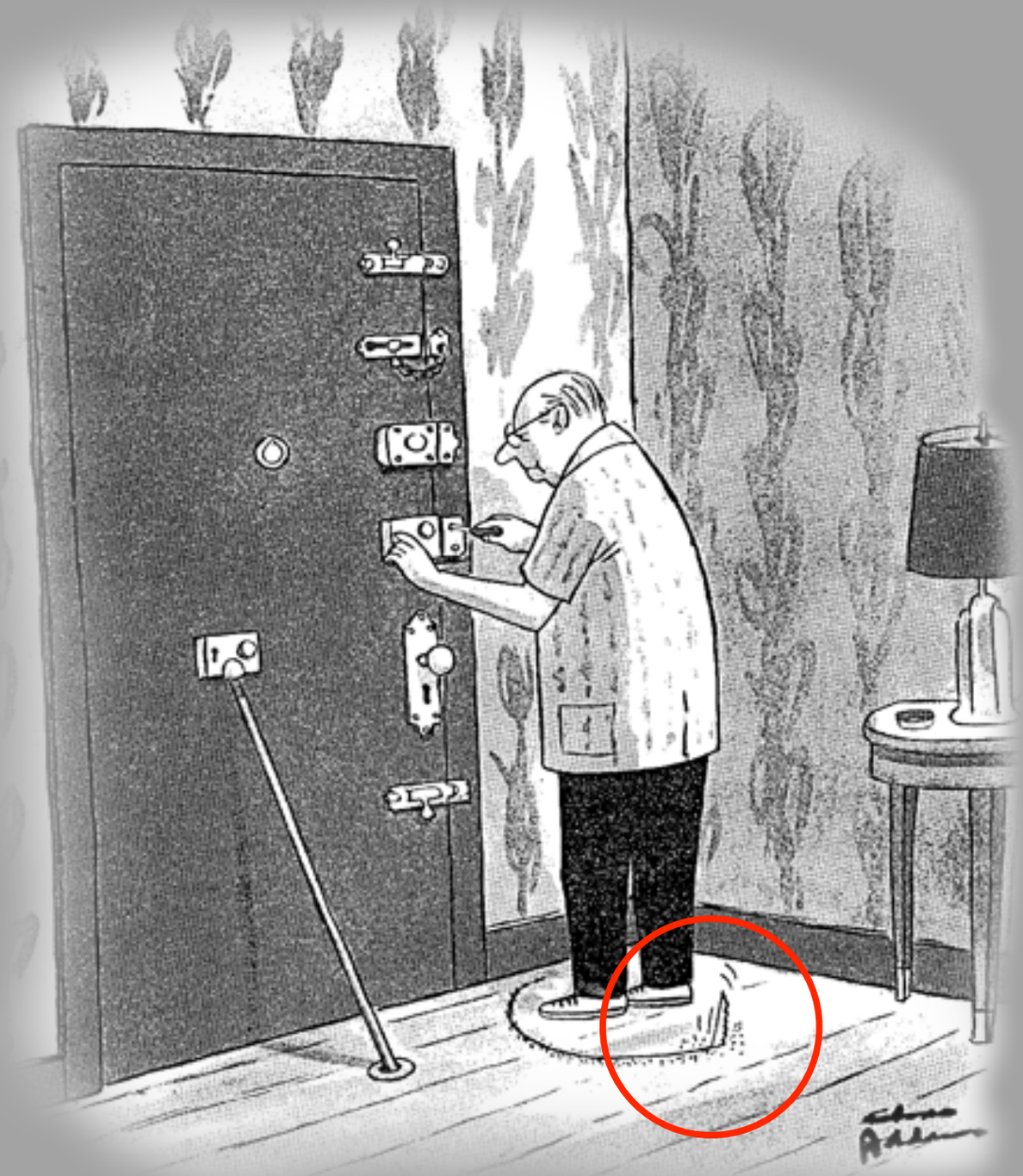
Key question

✔



See also (Davis, Keeling, Schreier, & Williams, 2007)

You **must** identify a correct key question



Cartoon by Charles Addams

So let's work it out with a real case

A friend calls you, hysteric: "I came home a few minutes ago and my dog, Harry, is gone!

"I left my house at noon, and when I came back, around 4pm, he was missing. Our house has a backyard with a doggy door in between.

"That's really strange: he hasn't escaped in months—ever since we fixed the gate, he can't.

"Also, I fired the housekeeper this morning for poor performance. She blamed Harry! She said he sheds too much, and she was really upset. She said we would regret it. I'm sure she's kidnapped him.

"He has no collar; how are we going to find him? Also the yard crew came today to mow the lawn.

"Anyway, you're the master problem solver. Help!"

First, frame your problem by identifying what you want to do

Get Harry back

Prevent this from happening again

Identify WHY is Harry missing

Time

1 2 3

Identify **WHY** Harry is missing

Identify **HOW** to get him back

DO: Get him back

Identify **HOW** to prevent this from happening again

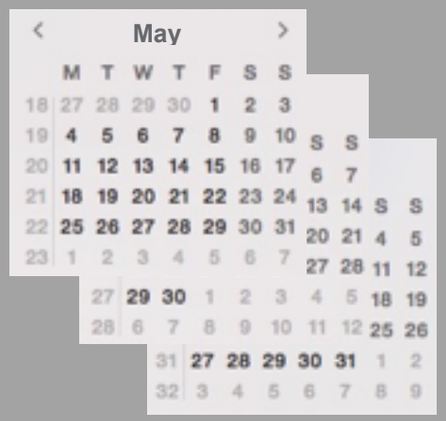
DO: prevent this from happening again

In scope

Out of scope

Also, define your project's logistics

Time:



Money:

$ ⟷ $

Other resources:

People

Facilities

Equipment

Processes

Etc.

Capture that information in a ***WHAT* card** (as in, *what* you want to do in your project)

Project name: Find Harry the dog

Specific goals: (*what* you are going to do)	1. Understand why Harry is missing (*why*) 2. Identify best way to get him back (*how*) 3. Get him back (*do*)	Out of scope: (*what* you are not going to do)	Prevent him from going missing again in the future (both the how and the implementation)
Sponsor(s):	John and his wife	Other key stakeholders:	N/A

Time table:	Actions	Needed time	Cumulative time
	1. Frame the problem (define the *what*)	2h	2h
	2. Diagnose the problem (find the *why*)		
	Define the diagnostic key question and identify possible causes	4h	6h
	Collect the diagnostic evidence, analyze, & draw conclusions	6h	12h
	3. Identify solutions (find the *how*)		
	Define the solution key question and identify possible solutions	6h	18h
	Collect evidence, analyze, and decide which solution(s) to implement	6h	24h
	4. Implement (*do*)	48h	**72h**

Resources:	Money: Spend up to $150 for the *why*, $150 for the *how,* $300 for the *do* People: Up to 3 people dedicated full time

Possible problems:	Speaking with housekeeper can backfire	Mitigation actions:	Refrain from speaking with the housekeeper until absolutely necessary

Now that you've identified *what* problem to solve, you need to understand *why* you have it

WHAT | **WHY** | **HOW** | **DO**

1. Frame the problem

2. Diagnose the problem

3. Find solutions

4. Implement solution

To uncover the root causes of the problem, use a key question with a *why* root

WHAT | **WHY** | **HOW** | **DO**

1. Frame the problem

2. Diagnose the problem

3. Find solutions

4. Implement solution

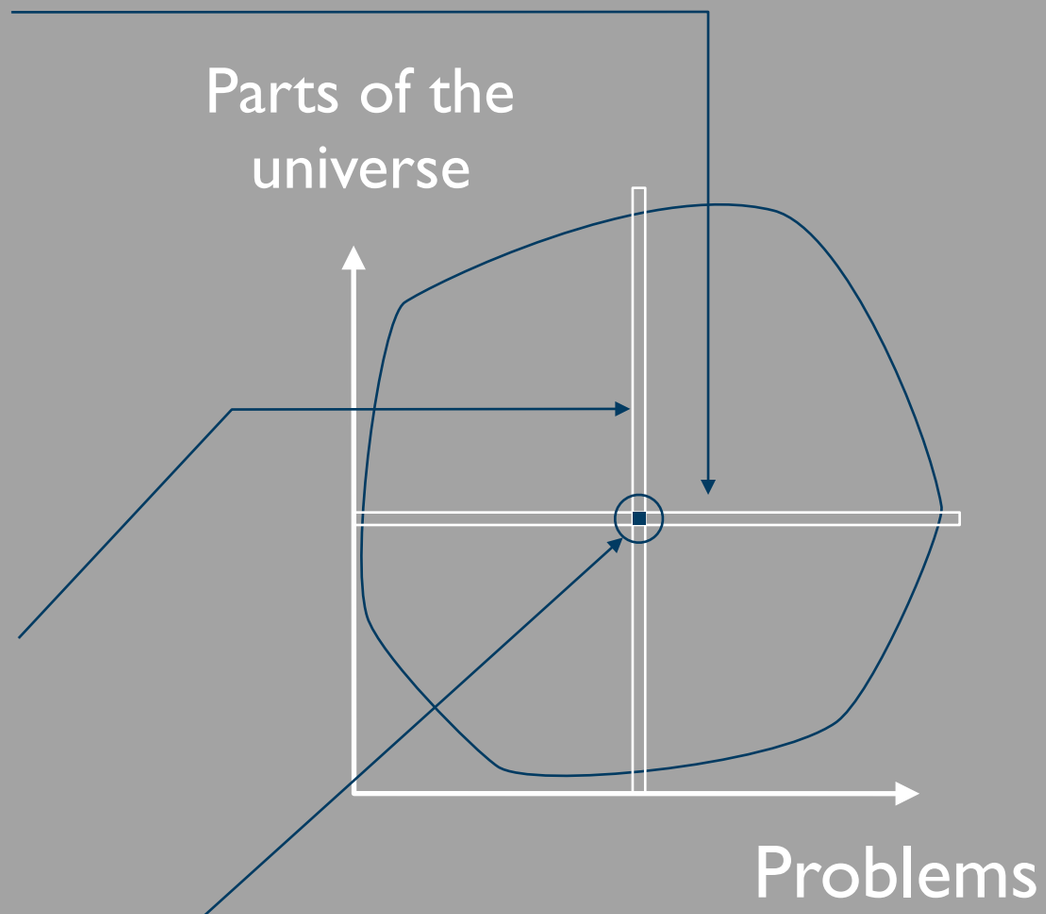
Why is Harry missing?

To get to the diagnosis question, use an introductory flow: a situation and complication

Situation: My friend John has a dog–Harry–and lives in a house. Sometimes, he leaves Harry alone at the house

Complication: Today, when John came home after 4 hours, Harry was missing

Diagnostic key question: Why is Harry missing?

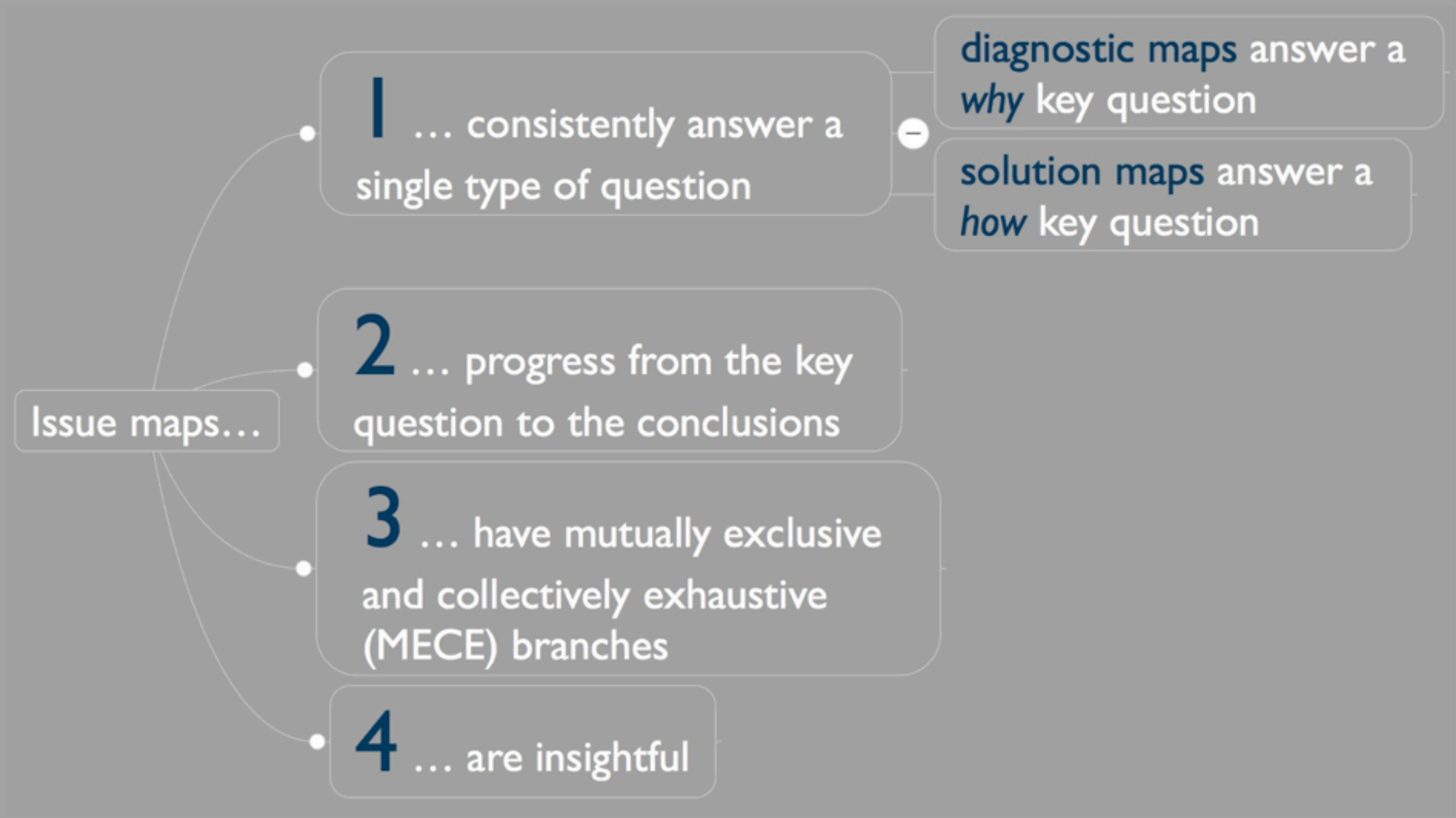


See Minto, B. (2009). The pyramid principle: logic in writing and thinking, Pearson Education.

Capture this information in a diagnostic definition card–i.e., a ***WHY* card**

Situation:	My friend has a dog—Harry—and lives in a house. Sometimes, he leaves Harry alone at the house
Complication:	Today, when my friend came home after 4 hours, Harry was missing
Diagnostic key question:	***Why*** is Harry, the dog, missing [from my friend's house where he was left unattended for 4 hours]?
Decision makers:	My friend and his wife
Other stakeholders:	N/A
Goals and logistics:	Spend up to $150 on the diagnosis, design diagnostic analysis within 6 hours, conduct diagnostic analysis within 12 hours
Voluntarily left-out answers:	Call the housekeeper to accuse her of kidnapping Harry without conducting a preliminary analysis first Consider irrational explanations such as alien abduction Consider that friend is mistaken or lying when saying that Harry is not at the House

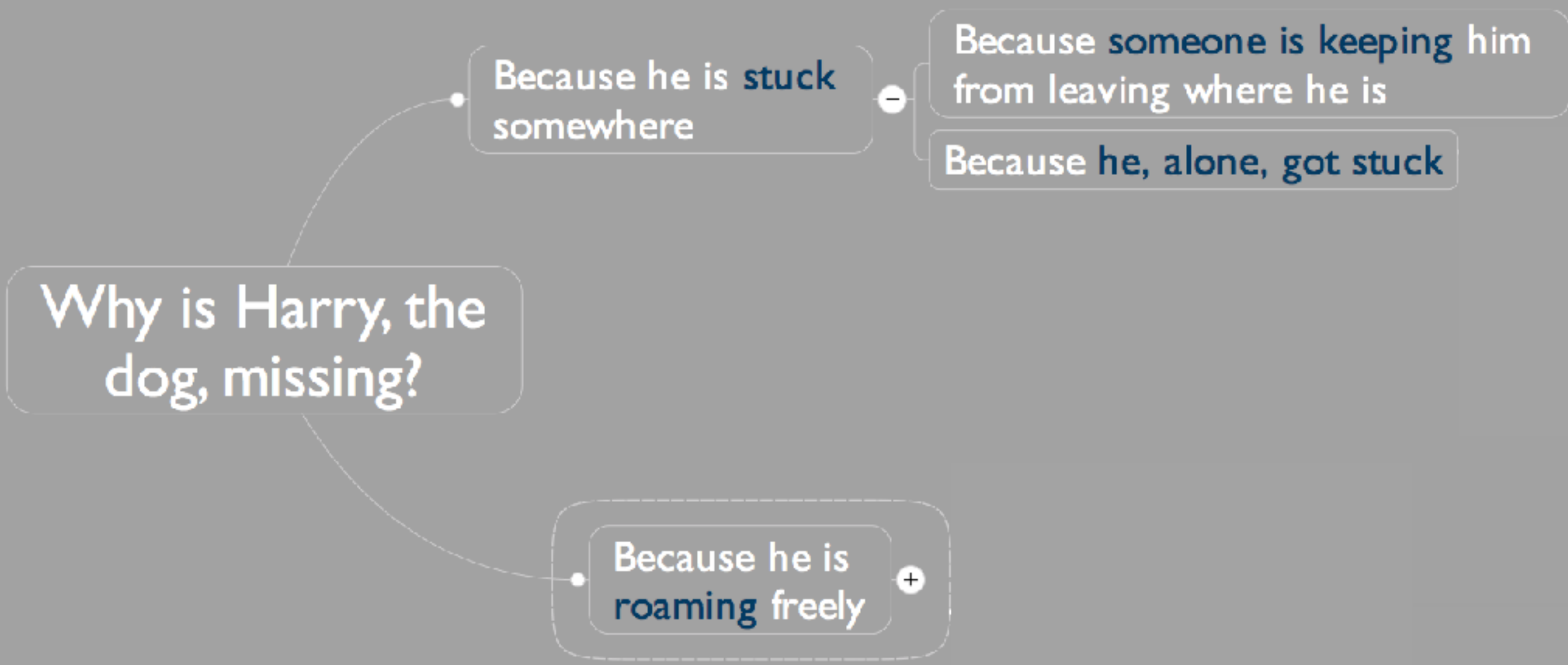
Next, build a ***WHY* issue map** (or **diagnostic map**): a graphical breakdown of your problem space; issue maps have four basic rules



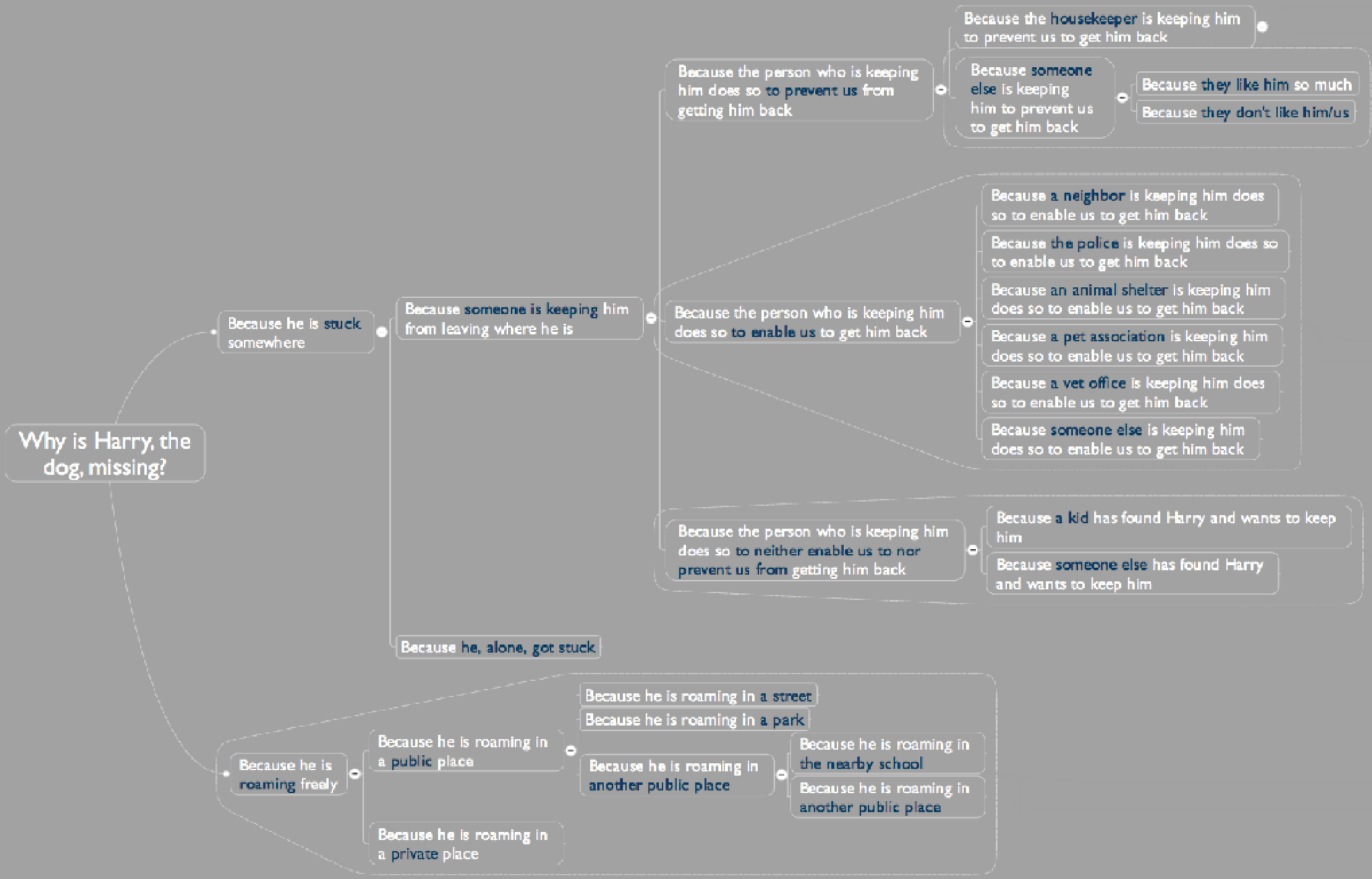
To build a map, break your diagnosis question into parts

WHY is Harry the dog missing?

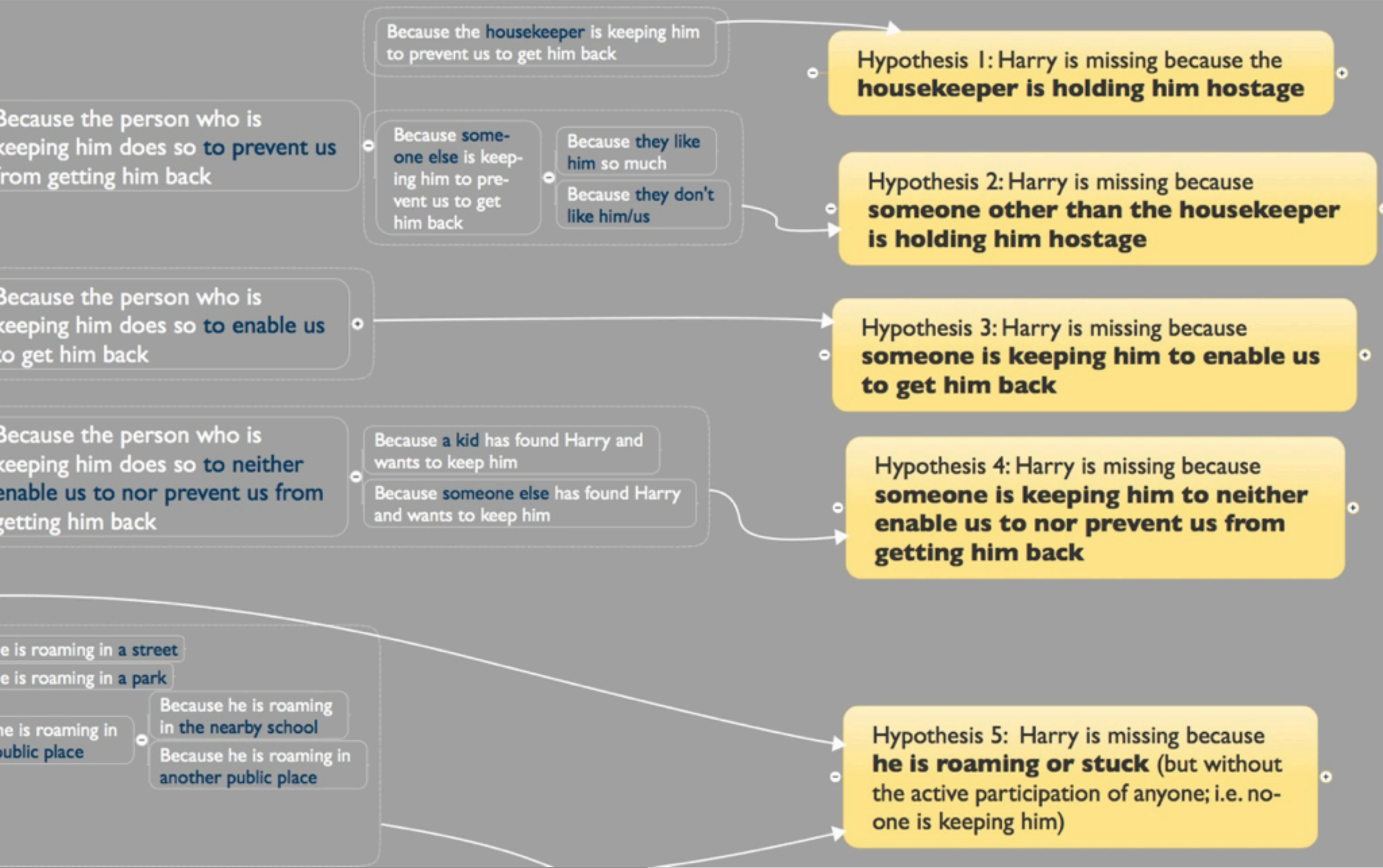
Further map out the problem space by exploring all possibilities



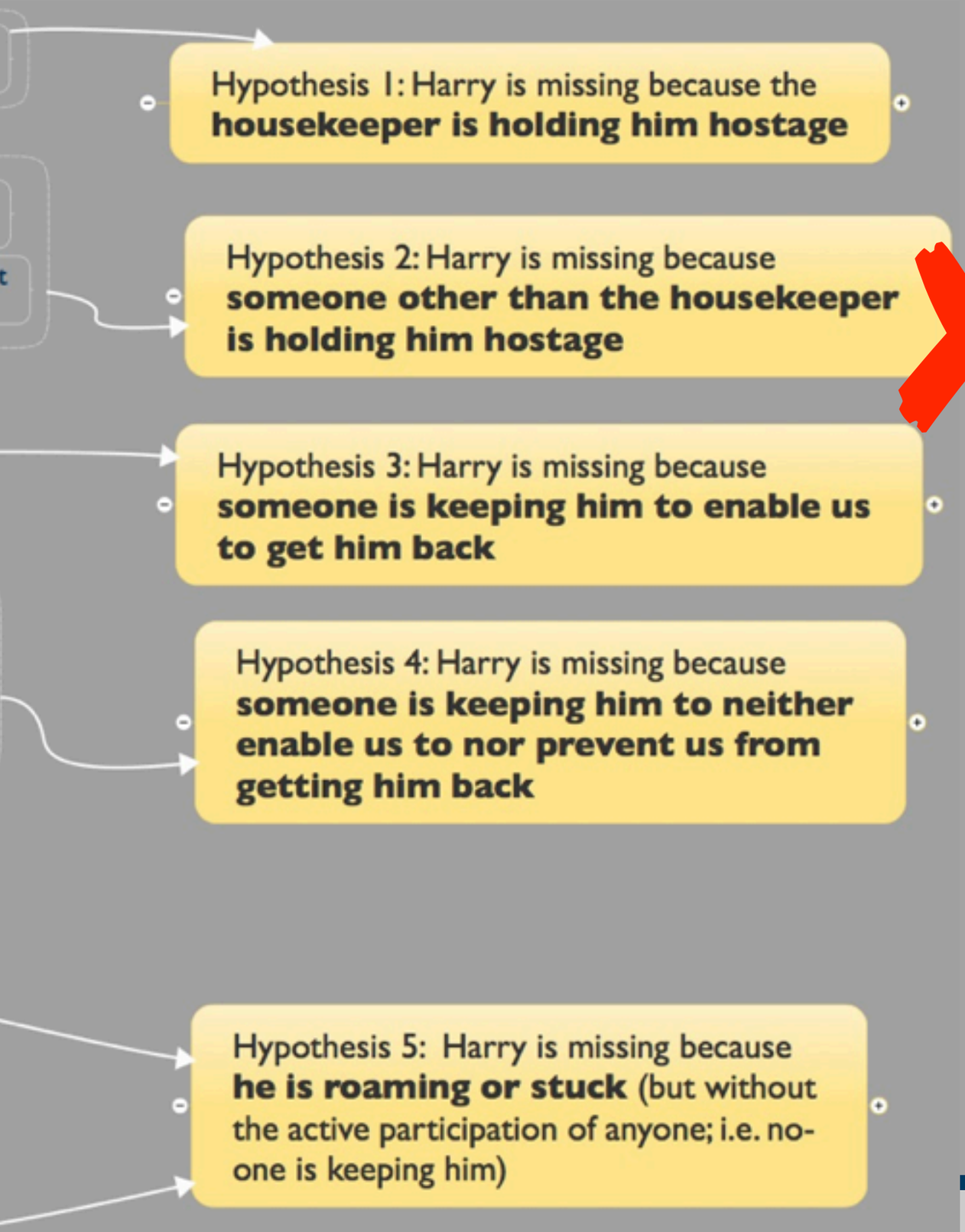
Force yourself to think about all possible scenarios. That *will* require some effort



Now that you've mapped out the problem space, formulate a set of diagnostic hypotheses



Next, prioritize your analysis; this may include discarding hypotheses that seem too unlikely



Test first because it has implications on next steps

Discard (for now) because too unlikely

Then, look for evidence—i.e., information that you'll use to test your hypotheses

Inspect the location:

- Quiet residential neighborhood

Talk with friend:

- Friend was away from noon to 4pm
- Harry can go between house and yard
- Harry hasn't escaped in months, since friend fixed the gate
- Harry has no collar
- The backyard gate was closed when friend came back
- There are no holes in or under the fence
- The backyard gate doesn't lock
- Harry can't jump over the fence or gate
- Friend fired housekeeper that morning because of poor performance
- Housekeeper was upset and blamed Harry for shedding
- Harry escapes whenever possible, follows scents, and ends up lost
- Whenever the lawn crew is there, Harry barks loudly enough for the crew to hear

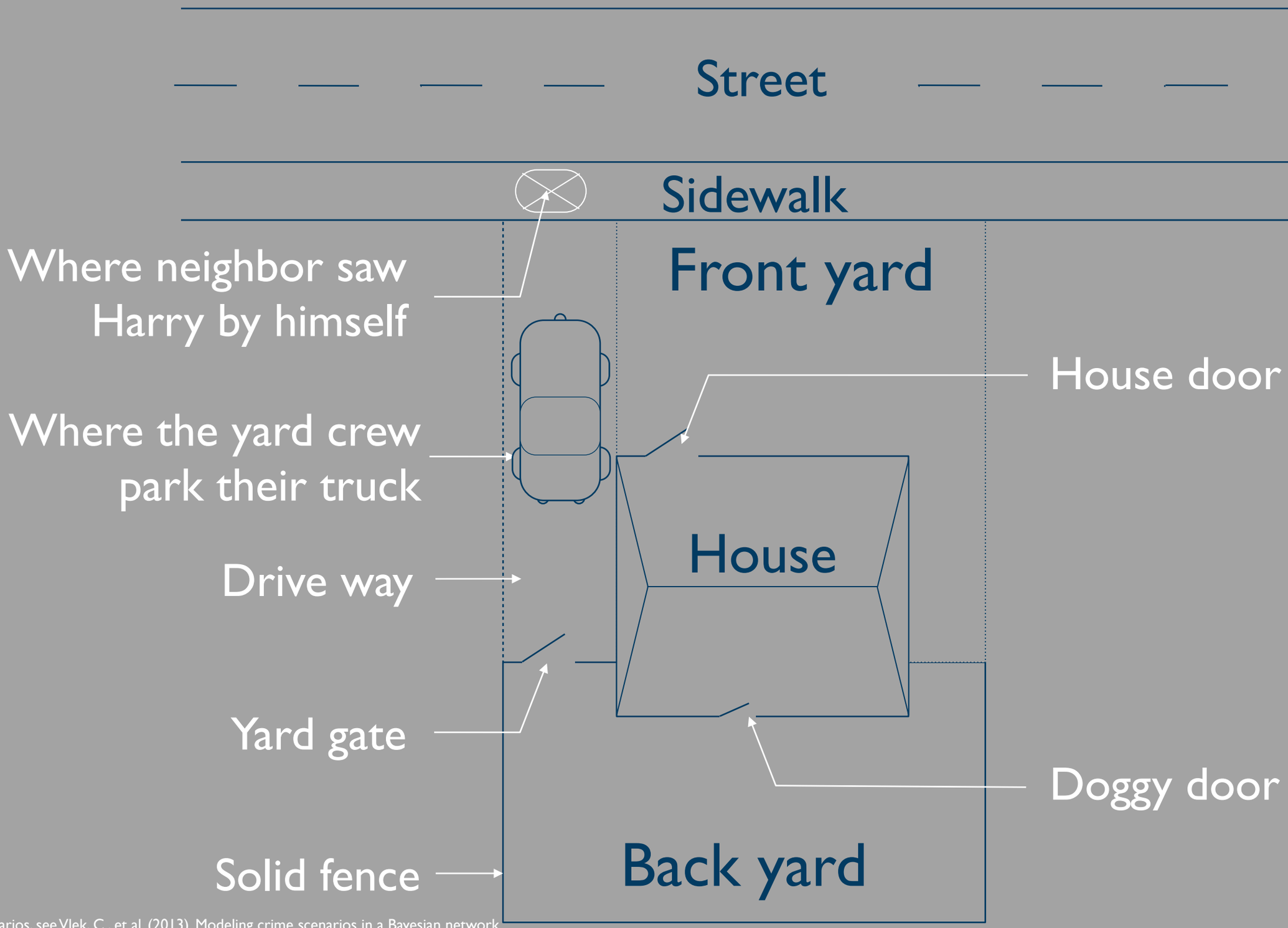
Talk with neighbor:

- Saw a police car in front of the house at 2:20pm
- Saw Harry out on the street by himself at ~2:20pm

Talk with lawn crew supervisor:

- Crew came today between 1 & 2pm
- Crew knows Harry but didn't see him today

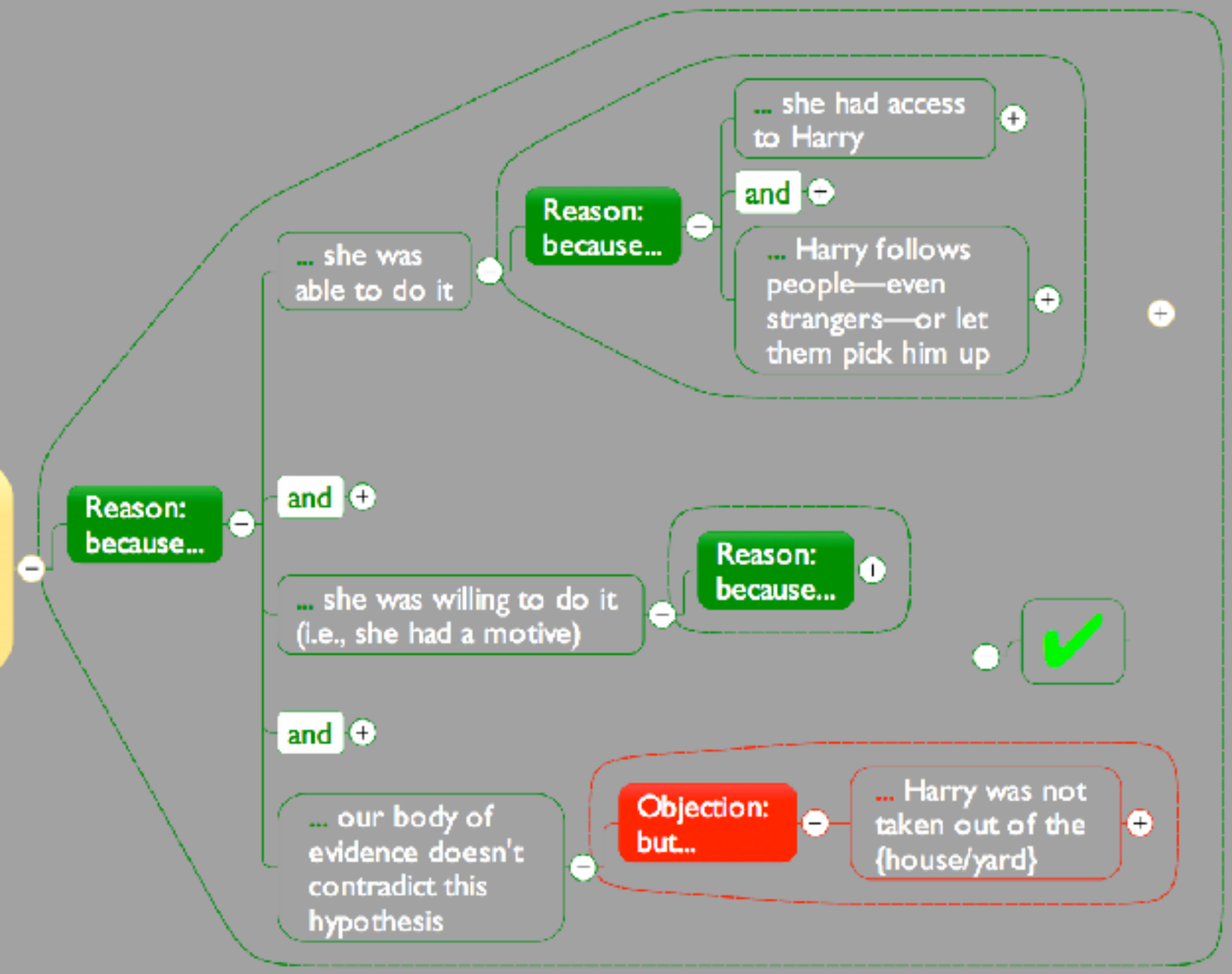
You may re-organize your evidence to help you gain some understanding, perhaps in a timeline, scenario, or map of the events



On scenarios, see Vlek, C., et al. (2013). Modeling crime scenarios in a Bayesian network. Proceedings of the Fourteenth International Conference on Artificial Intelligence and Law, ACM.

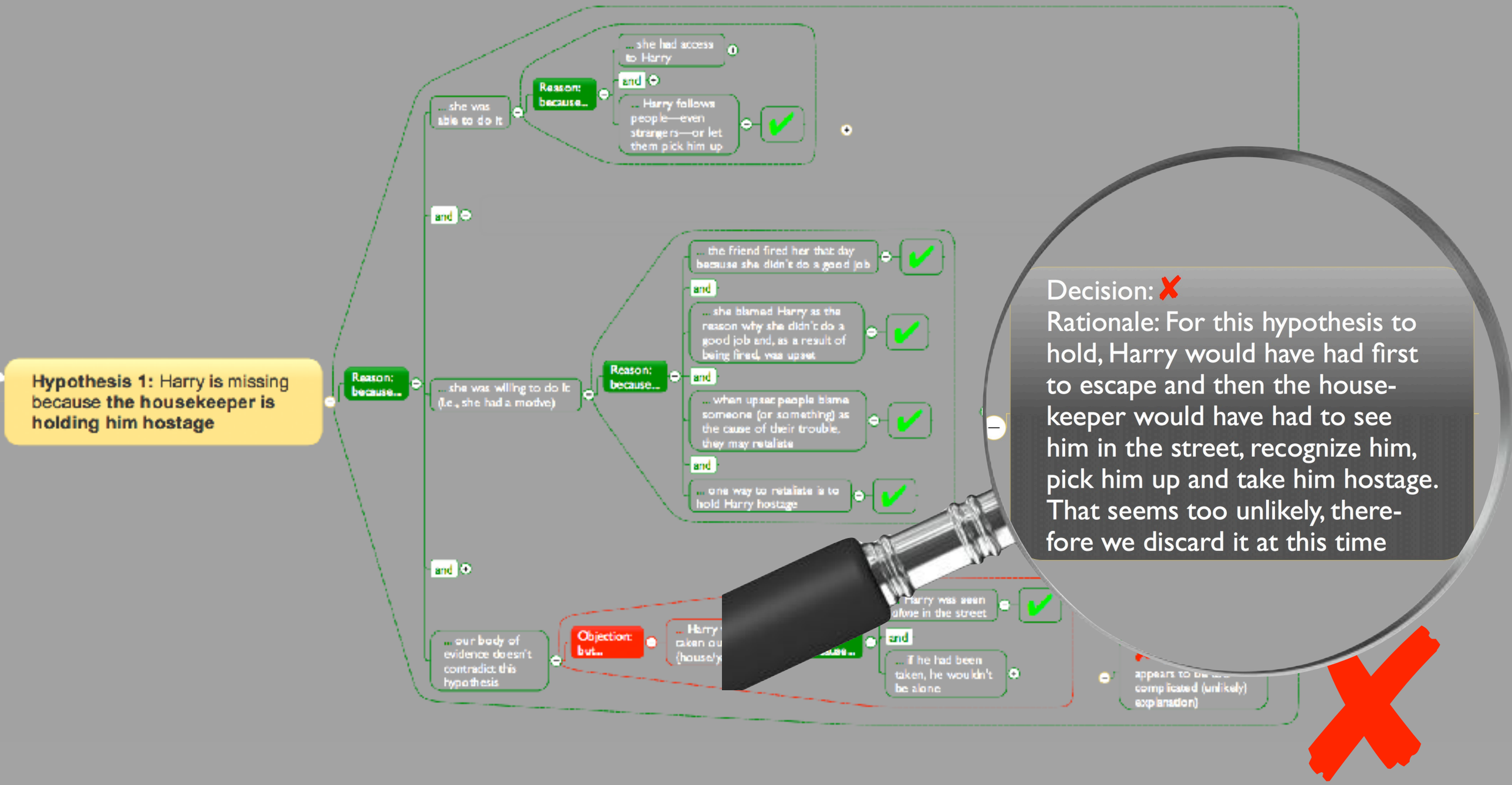
Also, consider using argument mapping to test whether claims are effectively supported by evidence and logic

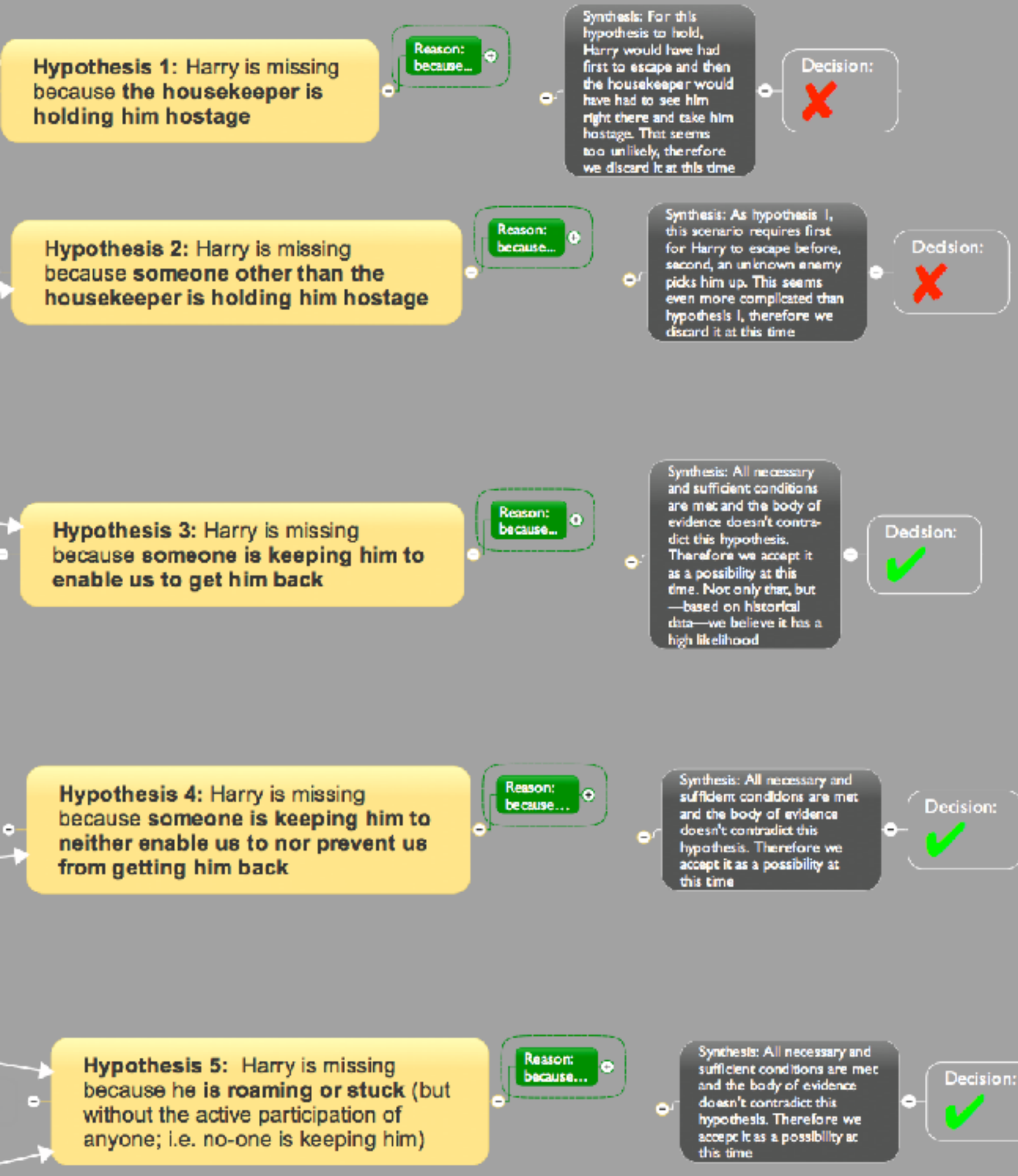
Hypothesis 1: Harry is missing because **the housekeeper is holding him hostage**



See (Austhink, 2006), (Gauch, 2003) [pp. 124–131], (Twardy, 2010)

Then decide if the evidence contrary to each hypothesis is sufficient to discard it





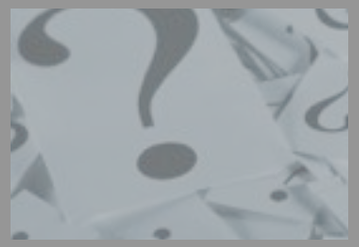
This will lead you to identify a subset of root cause(s) to focus on …

… if you decide that these are sufficiently diagnostic, you're ready to move to looking for solutions

Now that you know *why* you have your problem, you can search, evaluate, and select solutions

WHAT | **WHY** | **HOW** | **DO**

1. Frame the problem



2. Diagnose the problem

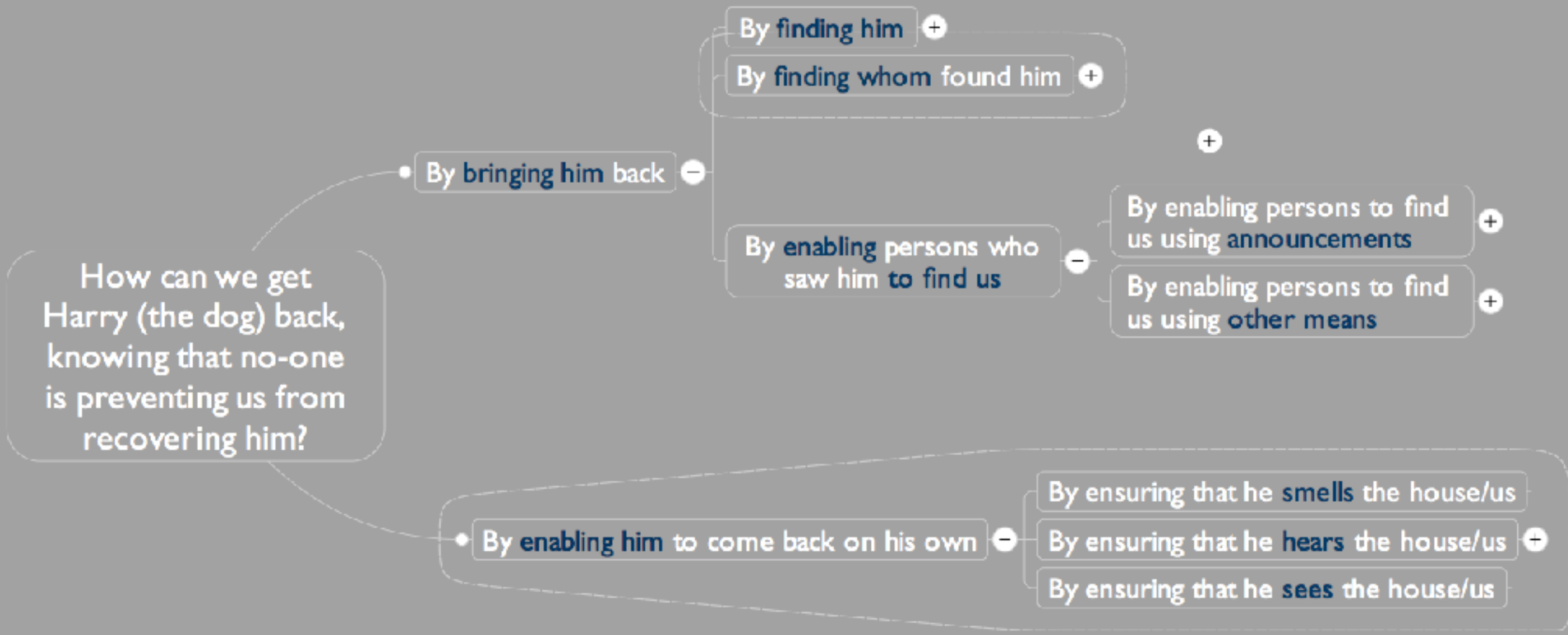
3. Find solutions

4. Implement solution

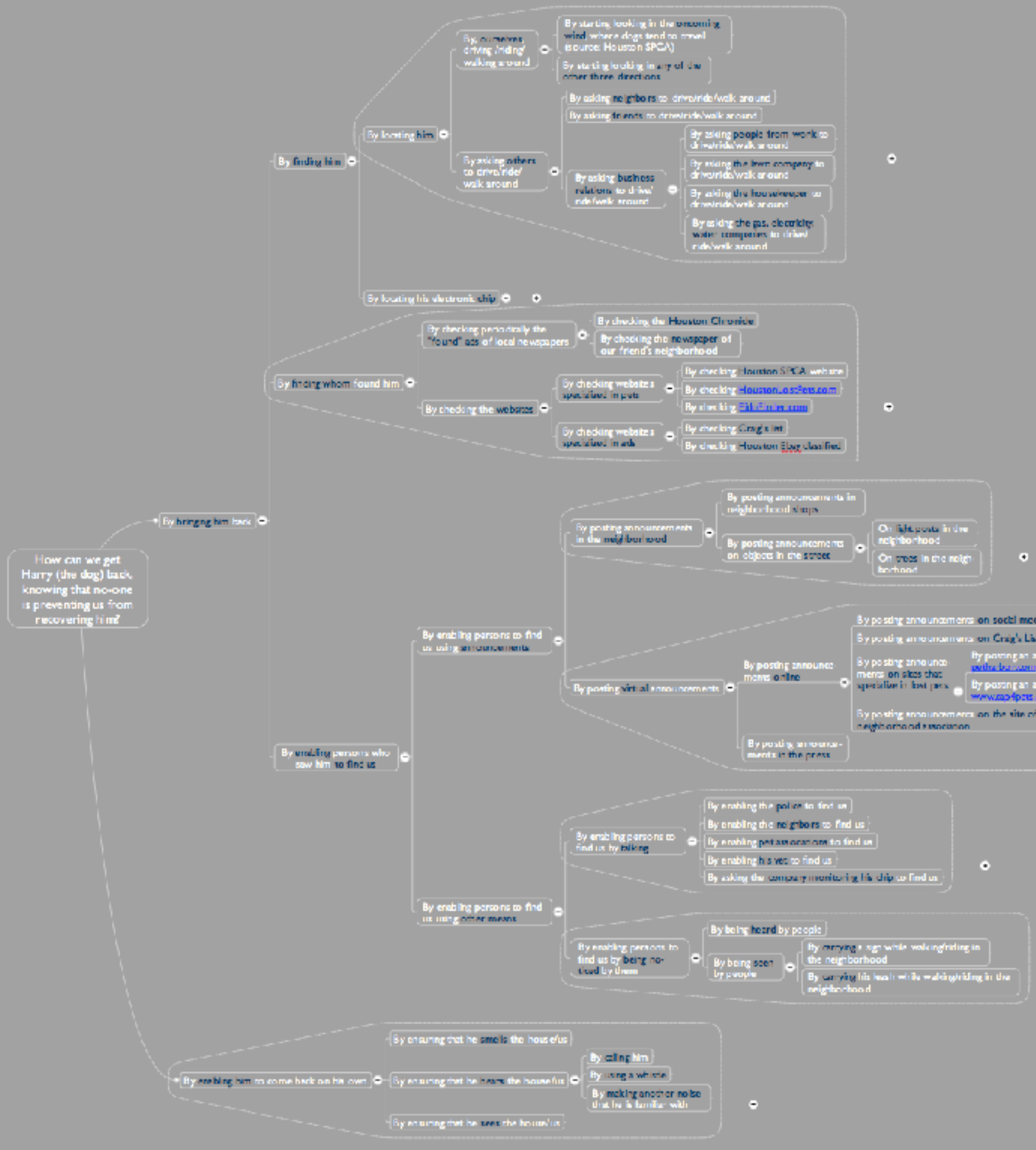
Start by defining your solution problem, using a ***HOW card***

Situation:	My friend has a dog—Harry—who went missing a few hours ago
Complication:	While we initially suspected foul play, we now believe that no one is preventing us from recovering Harry
Solution key question:	***How*** can we get Harry (the dog) back, knowing that no one is preventing us from recovering him?
Decision makers:	My friend and his wife
Other stakeholders:	My friend's neighbors and other people that we enlist to partake in the search
Goals and logistics:	Identify all solutions within 4 hours; Pick and implement subset within 12 hours; Bring Harry back within 24 hours
Voluntarily left-out answers:	Ask neighbors to invest significant time in locating Harry

To identify possible solutions, develop a ***HOW* map**



Keep drilling until your map is sufficiently explicit



Next, formulate hypotheses...

H1: Driving/riding/ walking around— either ourselves or having others do it— is a worthwhile effort to get Harry back

electronic chip

H2: Locating Harry's chip is a worthwhile effort to get Harry back

H3: Finding whom found Harry is a worthwhile effort to get Harry back

By posting announcements in the neighborhood

enabling persons to find using announcements

By posting virtual announcements

H4: Posting announcements in the neighborhood is a worthwhile effort to get Harry back

H5: Posting virtual announcements online is a worthwhile effort to get Harry back

By enabling persons to find us by talking

enabling persons to find using other means

By enabling persons to find us by being noticed by them

H6: Asking people to contact us is a worthwhile effort to get Harry back

H7: Ensuring people notice us searching is a worthwhile effort to get Harry back

H8: Enabling Harry to come back by himself is a worthwhile effort to get Harry back

… identify attributes to evaluate the alternatives and decide which to pursue

	Individual likelihood of success	Timeliness	Speed of success	Low cost	Weighted score	**Ranking**
Weight	52%	27%	15%	6%		
H_1: Searching the neighborhood	50	100	100	90	73.4	**2**
H_3: Informing people likely to know about missing animals	100	100	80	100	97	**1**
H_4: Posting virtual announcements	15	20	20	0	16.2	**4**
H_5: Checking announcements	0	0	0	100	6	**5**
H_6: Enabling Harry to come back on his own	30	90	100	100	60.9	**3**

See (Goodwin and Wright, 2009) [pp. 13–62]

“All” that’s left is to execute your solution

WHAT | **WHY** | **HOW** | **DO**

1. Frame the problem

2. Diagnose the problem

3. Find solutions

4. Implement solution

Implementing a solution requires, at the very least, to 'sell' it...

"Here is **what** we need to do, and here is **why**..."

This requires persuasion skills, which goes beyond making an argument based on logic alone

Logos: logic. Appeal to your audience's ability to reason: create a case, supporting reasons, and show that the reasons support the case (e.g. "Sales data show that we've increased our profitability despite the challenging economic environment.")

Ethos: character / reputation. Demonstrate that you are trustworthy (e.g. "We, at Harvard, ...")

Pathos: emotions. Generate the right emotions (e.g. "Let me tell you about José, a six-year old with terminal cancer...")

... and sometimes to actually manage the implementation yourself

---

"... so, please **do** X and I'll **do** Y"

"

Task	Owner	Due Date
Design and print announcements	Me	5pm
Post announcements	All	8pm
Alert vet	John	4:30pm
Look up pet associations	Jane	6pm
Alert pet associations	John	8pm

"

Also integral to implementation is evaluating your solution and course-correcting as you progress

As sailors, follow a general strategy …

… but adapt it to integrate new developments

You also need to actively manage biases—yours and others'—along the entire process

Overconfidence: Being too confident in one's infallibility when answering difficult questions

Anchoring: Estimating values based on an initial value & not adjusting sufficiently

Hindsight: Overestimating how well we would have done in lieu of someone else

Confirmation trap: Searching only for supporting evidence & not opposing one, too

+ insensitivity to base rates, insensitivity to sample size, retrievability, …

And when you're done, celebrate!

Using a multistep approach to solve complex problems is not new …

WHAT

1. Frame the problem

WHY

2. Diagnose the problem

HOW

3. Find solutions

DO

4. Implement solution

Woods identified ~150 strategies to solve problems in business, science, maths, engineering, design, etc.

Source: Woods D, "An evidence-based strategy for problem solving," J. Eng. Educ., pp443-459, Oct. 2000

… but *Strategic* provides actual tools and ideas to help you follow the process

1. Frame the problem **WHAT**

2. Diagnose the problem **WHY**

3. Find solutions **HOW**

4. Implement solution **DO**

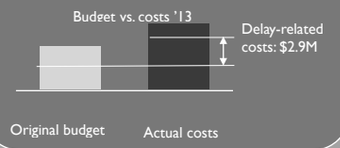
Time

WHAT card
- Purpose
- Initial definition
- Deadlines
- ...

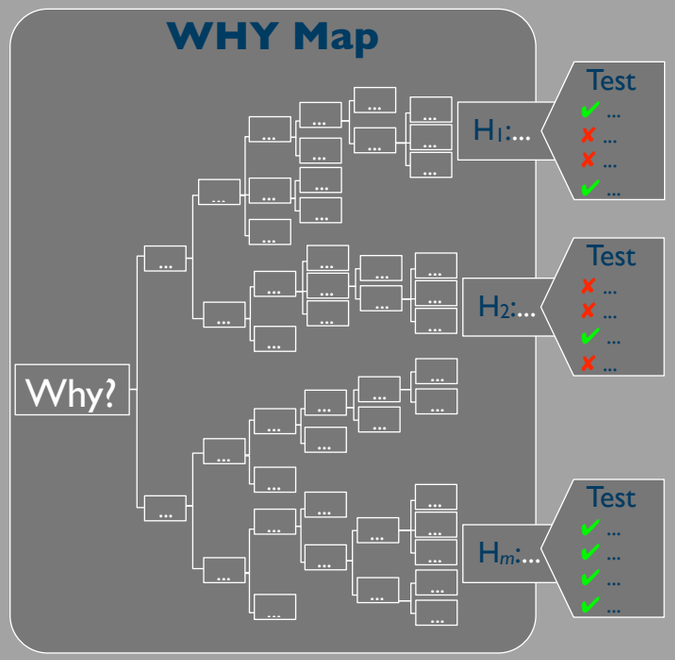
WHY card
- Situation: ...
- Complication: ...
- Key question: ...

HOW card
- Situation: ...
- Complication: ...
- Key question: ...

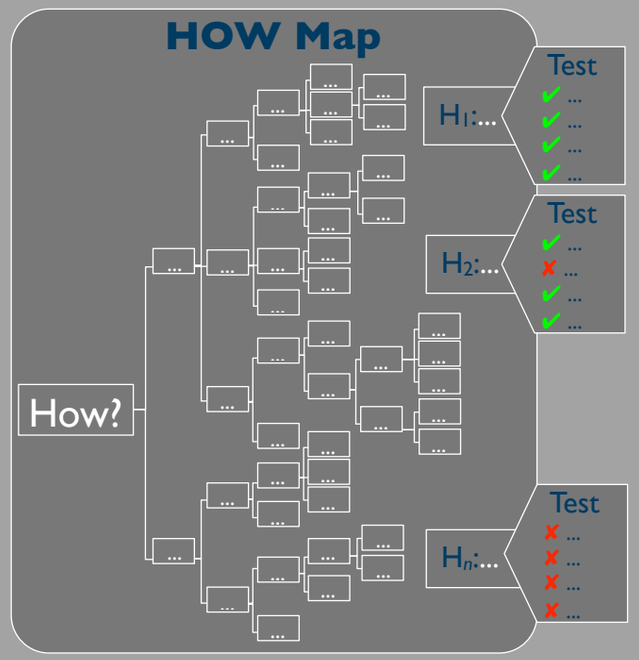
Solution Report



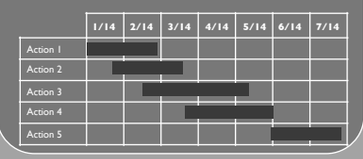
WHY Map



HOW Map



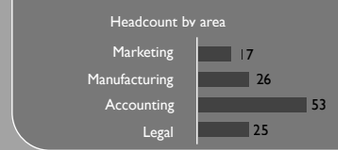
Implementation Plan



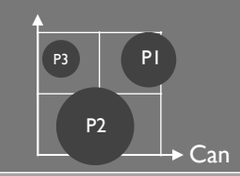
Solution evaluation

	Performance
Evaluation criterion 1	✔
Evaluation criterion 2	✔
Evaluation criterion 3	✔
Evaluation criterion 4	✔
Evaluation criterion 5	✔

Diagnostic Report



Decision tool



In summary, think of problem solving as a broad process, and consciously improve your strategic thinking

- Professional success requires that you be a good specialist *and* a **generalist**

- So develop your strategic thinking skills
  - Read **powerful-problem-solving.com**
  - Read **Strategic Thinking**
  - Email me–**acd@rice.edu**