Problem-Solving and Critical Path Reasoning (PSCPR)

Effective problem-solving requires consciously transitioning from comfortable certainty into productive uncertainty. Initially, we rely on clear facts and well-established methods. But genuine insight demands stepping beyond what's known to recognize gaps, implicit assumptions, and hidden perspectives. True mastery emerges when we courageously embrace exploration, engaging the unknown and transforming uncertainty into discovery and deeper understanding.

Certainty → Uncertainty → Exploration

1. ***Observation*** (Known Knowns – Type 1 Expert)
   - Questions: "What is given? What do I know? What did I know before?"
   - Givens: Measurements, observations, quantities, data, or explicitly stated conditions
   - Knowns: Concepts, theories, principles, relationships, or frameworks
   - Visuals: Graphs, charts, diagrams. Sketch out thoughts and ideas

2. ***Analysis*** (Known Unknowns – Type 1 Expert)
   - Questions: "What am I trying to find? What do I know I don't know? What do I need to know?"
   - Objectives: Identify desired values, parameters, relations, or outcomes
   - Unknowns: Consider quantities, parameters, or relationships required to obtain objectives

3. ***Inference*** (Unknown Knowns – Type 2 Expert)
   - Questions: "What am I missing? What do I not know that I know? Has the problem been sufficiently reduced? Do I know/have enough to determine what needs to be known? What am I not acknowledging? What can be deduced?"
   - Alternatives: Consider multiple perspectives, challenge hidden assumptions, acknowledge implicit or overlooked knowledge (revisit Step 1).
   - Complexities: Reduce degrees of freedom, simplify the problem wherever possible (but no further)
   - Subtleties: Recognize possible equations, relations, or quantities that aren't explicitly given yet are implicitly known and could be leveraged to solve the problem

4. ***Exploration*** (Unknown Unknowns – Type 3 Expert)
   - Questions: "Does this make sense? What do I not know that I do not know? What am I unaware of or not perceiving? What haven't I considered?" What must be induced?"
   - Curiosities: Explore original ideas, embrace uncertainties. Perform tests and experiments, run simulations, gather observations
     - You don't (won't) know until you look.
     - "The cave you fear to enter holds the treasure you seek." – Joseph Campbell
   - Answers: Perform sanity checks, redundancy checks, and consistency checks
     - Dimensional analysis
   - Reflections: Recalculate, reformulate, or revise approach as necessary
   - Refinements: Iteratively adjust methodologies, hypotheses, and solutions

How to Use the PSCPR Guide Sheet

1. ***Observation*** – Establish Claim, Null, and Assumptions
   - In the **Claim** line, write the statement under test (the proposed explanation or hypothesis).
   - In the **Null** line, write the "business-as-usual" alternative that holds if P is not true.
   - In **Assumptions**, list the key conditions, constants, knowns, givens, or context considered.

2. ***Analysis*** – Define Necessary Observables
   - Under "If P is true…", record one or more **Necessary Observables (Questions)** that must hold if the Claim stands.
   - Under "If N is true…", record one or more **Necessary Observables (Questions)** that must hold if the Null stands.
   - A Necessary Observable is a condition whose clear failure would directly undermine that position, turning each position into testable expectations.

3. ***Inference*** – Organize evidence and candidate stories
   - List concrete facts known to be true in this specific case (measurements, observations, calculations, documented events).
   - For each fact, mark whether it falsifies the Claim, the Null, both, or neither, based on the Necessary Observables.
   - List relevant patterns (how similar systems usually behave, base-rates, historical tendencies)
   - For each pattern, mark whether it rejects or weakens the Claim, the Null, both, or neither.
   - In the first story line, describe the behavior **if the Claim were true** (Claim story).
   - In the second story line, describe the behavior **if the Null were true** (Null story).
   - Indicate which story currently fits the recorded Facts and Patterns with the fewest added assumptions (Claim story, Null story, tie, or neither).
   - Stories in this section function as candidate models; Facts and Patterns determine which models remain viable.

4. ***Exploration*** – Apply falsification and test outcome
   - Answer the falsification prompts to indicate whether any Fact or Pattern clearly contradicts a Necessary Observable for the Claim or for the Null.
   - Identify the Outcome and select an appropriate Claim Status

5. ***Hypothesis***
   - In the space provided, write a brief statement summarizing the current position.
   - Before writing the hypothesis, pause and ask:
   - *Does it follow from the facts (D), patterns (I), and the questions Q_P/Q_N, was anything ignored that clearly hits P or N?*
   - *Is there a reasonable rival story that still explains $D + I$ almost as well (and should that become a new P or N next round)?*
   - *Is anything in A really an untested claim that needs its own P/N check?*
   - *And what single new observation or test would most change my rating for P?*

Problem-Solving and Critical Path Reasoning (PSCPR) Guide Sheet

Test a claim *against a null* using facts (deduction), patterns (induction), and stories (abduction).

OBSERVATION

Claim P: (paradigm)	
Null N: (status quo, business-as-usual)	
Assumptions A: (context/givens)	

ANALYSIS

If P is true, then the following are **Necessary Observables** of P (Questions):

Q_{P1}:	
Q_{P2}:	

If N is true, then the following are **Necessary Observables** of N (Questions):

Q_{N1}:	
Q_{N2}:	

INFERENCE

Facts (Deduction) – What *is* true? (observation / measurement)		**This fact falsifies:**
D_1:		☐ Q_P ☐ **Both** ☐ Q_N ☐ **Neither**
D_2:		☐ Q_P ☐ **Both** ☐ Q_N ☐ **Neither**
Patterns (Induction) – What *usually* happens? (base-rate / prior behavior)		**This pattern rejects:**
I_1:		☐ Q_P ☐ **Both** ☐ Q_N ☐ **Neither**
I_2:		☐ Q_P ☐ **Both** ☐ Q_N ☐ **Neither**
Stories (Abduction) – What *possibly* happens? (If P/N is true, how/why?)		
S_P:		
S_N:		
Given the Facts and Patterns, which Story fits better with fewer assumptions? *Note:* Stories are to be tested, not believed.		☐ S_P ☐ **Tie** ☐ S_N ☐ **Neither**

EXPLORATION

Did any fact or pattern **falsify** P (a necessary Q_P clearly fails)? If so, which? ☐ **yes** ☐ **no**

Did any fact or pattern **falsify** N (a necessary Q_N clearly fails)? If so, which? ☐ **yes** ☐ **no**

Outcome:

☐	Retain N	Evidence is too weak to dismiss the null; P is not yet better than N.
☐	Accept P	Provisionally accept P; N is not falsified, but P is better than N.
☐	Accept P, Reject N	N is falsified by a failed Q_N or clear conflict with D; P survives.
☐	Undecided	D and I are insufficient or conflicting; need new observations or tests.

Claim Status:

☐	0.0 – False	Contradicted by facts or necessary conditions; P fails Q_P.
☐	0.2 – Speculative	Mostly a story; little or no support from D or I, but not yet ruled out.
☐	0.4 – Plausible	Consistent with D and I, worth considering, rivals are at least as strong.
☐	0.6 – Probable	Fits D and I better than N and other rivals; no serious contradictions.
☐	0.8 – Corroborative	Strong fit to D and I; P survived several tests, rivals are weaker.
☐	1.0 – True	Operationally treated as true; no rival explains D and I better.

HYPOTHESIS

State your **working hypothesis** in the space below and check: does it follow from your facts (D), patterns (I), necessary questions (Q_P/Q_N), is there a live rival story left, and what one test would most change your rating for P?

Example: "Given [A] and based on the current facts [D] and patterns [I], [P / N] is the best description, so [retain N / provisionally accept P / accept P and reject N / stay undecided]."

Problem-Solving and Critical Path Reasoning (PSCPR) Guide Sheet: <u>Example (Robotics Project)</u>

Problem: "The motor won't turn on in the microcontroller–sensor–actuator project."

<u>OBSERVATION</u>

Claim P: (paradigm)	**The microcontroller output pin (e.g., D9) is not actually driving high; the problem is in the code or pin configuration.**
Null N: (status quo, business-as-usual)	**The microcontroller output pin is functioning correctly; the problem lies in the driver/motor wiring or power supply, not code.**
Assumptions A: (context/givens)	**Board powers up, sensors readings change meaningfully, motor has separate power source (driven by transistor), common grounds.**

<u>ANALYSIS</u>

If P is true, then the following are **Necessary Observables** of P (Questions):

Q_{P1}:	**Measuring the voltage at the output pin (D9) while the code is supposed to turn the motor on shows it stuck near 0 V (no 5 V "high").**
Q_{P2}:	**A simple test LED + resistor connected from the output pin to ground never turns on under any supposed "motor on" condition.**

If N is true, then the following are **Necessary Observables** of N (Questions):

Q_{N1}:	**Measuring the voltage at the output pin shows a clear change: ~0 V when the motor should be off and ~5 V when the motor should be on.**
Q_{N2}:	**A test LED + resistor on that pin turns on and off in sync with the motor-on condition, even if the actual motor still does nothing.**

<u>INFERENCE</u>

Facts (Deduction) – What *is* true? (observation / measurement)

		This fact falsifies:	
D_1:	**With the motor disconnected and a multimeter on D9, the voltage reads ~0 V in the off state and ~5 V in the on state.**	☑ Q_P ☐ Q_N	☐ **Both** ☐ **Neither**
D_2:	**With a test LED + resistor attached to D9 (motor still disconnected), the LED turns fully on and off in sync with the motor-on logic in code.**	☑ Q_P ☐ Q_N	☐ **Both** ☐ **Neither**

Patterns (Induction) – What *usually* happens? (base-rate / prior behavior)

		This pattern rejects:	
I_1:	**If a pin can blink an LED but a motor never turns from the same signal, the fault is usually in the driver wiring or power path, not the pin.**	☑ Q_P ☐ Q_N	☐ **Both** ☐ **Neither**
I_2:	**Common motor-driver failures: missing common ground, wrong transistor/MOSFET orientation, wiring motor on wrong side of driver.**	☐ Q_P ☐ Q_N	☐ **Both** ☐ **Neither**

Stories (Abduction) – What *possibly* happens? (If P/N is true, how/why?)

S_P:	**D9 never actually goes high: a meter or test LED on D9 stays near 0 V during "motor on" conditions, so the driver never receives a valid control signal and the motor never turns.**
S_N:	**D9 toggles between ~0 V and ~5 V, test LED confirms, control signal is good; motor stays off because driver wiring, common ground, or power path is incorrect and blocks motor current.**

Given the Facts and Patterns, which Story fits better with fewer assumptions? *Note:* Stories are to be tested, not believed.	☐ S_P ☑ S_N	☐ **Tie** ☐ **Neither**

EXPLORATION

Did any fact or pattern **falsify** P (a necessary Q_P clearly fails)? If so, which? ☑ **yes** ☐ **no**

D_1 and D_2 falsified P.

Did any fact or pattern **falsify** N (a necessary Q_N clearly fails)? If so, which? ☐ **yes** ☑ **no**

Outcome:

☑	Retain N	Evidence is too weak to dismiss the null; P is not yet better than N.
☐	Accept P	Provisionally accept P; N is not falsified, but P is better than N.
☐	Accept P, Reject N	N is falsified by a failed Q_N or clear conflict with D; P survives.
☐	Undecided	D and I are insufficient or conflicting; need new observations or tests.

Claim Status:

☑	0.0 – False	Contradicted by facts or necessary conditions; P fails Q_P.
☐	0.2 – Speculative	Mostly a story; little or no support from D or I, but not yet ruled out.
☐	0.4 – Plausible	Consistent with D and I, worth considering, rivals are at least as strong.
☐	0.6 – Probable	Fits D and I better than N and other rivals; no serious contradictions.
☐	0.8 – Corroborative	Strong fit to D and I; P survived several tests, rivals are weaker.
☐	1.0 – True	Operationally treated as true; no rival explains D and I better.

HYPOTHESIS

State your **working hypothesis** in the space below and check: does it follow from your facts (D), patterns (I), necessary questions (Q_P/Q_N), is there a live rival story left, and what one test would most change your rating for P?

Example: "Given [A] and based on the current facts [D] and patterns [I], [P / N] is the best description, so [retain N / provisionally accept P / accept P and reject N / stay undecided]."

Given the stated Assumptions and based on the current Facts (D_1: toggling output voltage, D_2: LED test) and Patterns (I_1: LED-ok-but-motor-dead usually indicates driver issues), the Null ("the microcontroller output is functioning; the problem lies in the driver/motor wiring or power stage") is the best current description, so the outcome is to Retain Null and the Claim is rated as False.

Problem-Solving and Critical Path Reasoning (PSCPR) Guide Sheet – EXAMPLE (Rainfall)

Test a claim *against a null* using facts (deduction), patterns (induction), and stories (abduction).

OBSERVATION

Claim P: (paradigm)	**Overnight rain is the cause of the wet ground this morning.**
Null N: (status quo, business-as-usual)	**It did not rain; any wet ground is due to sprinklers or other local watering.**
Assumptions A: (context/givens)	**Outdoor surfaces are uncovered, no overnight street washing or fire-hydrant usage, sprinklers are only on lawns/landscaped areas.**

ANALYSIS

If P is true, then the following are **Necessary Observables** of P (Questions):

Q_{P1}:	**In the morning, ground surfaces across lawns, sidewalk, and street are wet or show signs of recent rainfall.**
Q_{P2}:	**Local weather/radar records show rainfall in this area during the night.**

If N is true, then the following are **Necessary Observables** of N (Questions):

Q_{N1}:	**Wetness is confined mainly to areas reachable by sprinklers (lawns/near sprinkler heads); streets/pavement remain mostly dry.**
Q_{N2}:	**Sprinkler system is scheduled or logged as having run during the night.**

INFERENCE

Facts (Deduction) – What *is* true? (observation / measurement)

		This fact falsifies:	
D_1:	**At 7:00 a.m., lawns, sidewalk, and street in the area are all uniformly wet.**	☐ Q_P	☐ **Both**
		☑ Q_N	☐ **Neither**
D_2:	**Local weather report shows measurable rainfall in this area between 2:00–3:00 a.m.**	☐ Q_P	☐ **Both**
		☐ Q_N	☑ **Neither**

Patterns (Induction) – What *usually* happens? (base-rate / prior behavior)

		This pattern rejects:	
I_1:	**When lawns/streets wet in the morning, cause is almost always overnight rain.**	☐ Q_P	☐ **Both**
		☑ Q_N	☐ **Neither**
I_2:	**Sprinkler systems typically wet lawns and nearby sidewalks, not entire streets/lots.**	☐ Q_P	☐ **Both**
		☐ Q_N	☑ **Neither**

Stories (Abduction) – What *possibly* happens? (If P/N is true, how/why?)

S_P:	**Overnight rainstorm, wetting all exposed surfaces. Morning observations and weather reports reflect this event.**
S_N:	**Sprinkler systems or localized watering somehow soaked lawns, sidewalks, and streets during the night, without any recorded rain.**

Given the Facts and Patterns, which Story fits better with fewer assumptions?	☑ S_P	☐ **Tie**
Note: Stories are to be tested, not believed.	☐ S_N	☐ **Neither**

EXPLORATION

Did any fact or pattern **falsify** P (a necessary Q_P clearly fails)? If so, which? ☐ **yes** ☑ **no**

Did any fact or pattern **falsify** N (a necessary Q_N clearly fails)? If so, which? ☑ **yes** ☐ **no**

D_1 falsified N

Outcome:

☐	Retain N	Evidence is too weak to dismiss the null; P is not yet better than N.
☐	Accept P	Provisionally accept P; N is not falsified, but P is better than N.
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Example: "Given [A] and based on the current facts [D] and patterns [I], [P / N] is the best description, so [retain N / provisionally accept P / accept P and reject N / stay undecided]."

Given the stated Assumptions and based on the current facts (D) and patterns (I), the Claim ("It rained last night in this area") is the best current description, so the outcome is Accept Claim and Reject Null at a Status of 0.8 (Corroborative).

References:

The Ethical Skeptic, “The Elements of Hypothesis”; *The Ethical Skeptic*, WordPress, 4 Mar 2019; Web, https://wp.me/p17q0e-94J

The Ethical Skeptic, “The Three Types of Expert”; *The Ethical Skeptic*, WordPress, 28 Nov 2021; Web, https://theethicalskeptic.com/?p=57222