INSA STRASBOURG

ICUBE

Fondation Université de Strasbourg

AfIA Association française pour l'Intelligence Artificielle

Ecole Saisonnière en IA

L'activité inventive en ingénierie peut-elle être boostée par l'IA

Le cas de l'énergie

Presentation AFIA – April 15th, 2025

Denis Cavallucci – Guillaume Guarino – Connor Mc Lean

The new challenges facing our society (and that's just the beginning...)

Those who bear the responsibility for inventing new solutions need help

What questions us:

Is there an inventor's gene?

Can we disambiguate the tacit cognitive functioning of a talented inventor?

What for ?

- To digitize it, to reproduce it, to teach it
- To build an "intelligent assistant", an aid for the activity of invention (AI-powered) at the service of engineers, scientists
- So that the activity of invention enters into the logic of performance

The Genesis of TRIZ

G.S. Altshuller [1926-1998]

Teorija *(T**h**éorie)*
Rezhenija *(de la R**é**solution)*
Izobretatel'skich *(des P**r**oblèmes)*
Zadach *(**I**nventifs)*

I didn't want to invent it myself,
I wanted to help others become inventors...
G.S. Altshuller (1926-1998)

TRIZ: Key figures
50 years of research – 1500 researchers – 300 schools/laboratory (former USSR)
300 inventors' bios – 400,000 patents studied – 1500 object lineages analysed

1946: basis

1956: Strong developement

1974: literations and wiedening

1985 & after: Back tu human and other disciplines

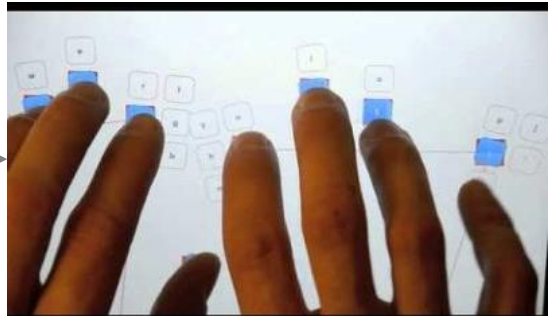
Observations:

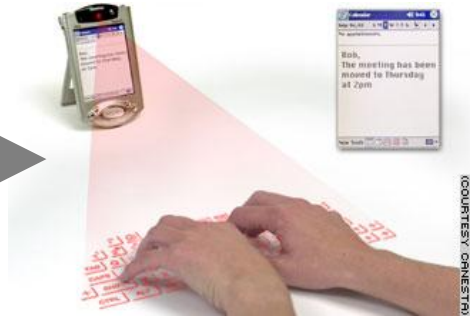
- Inventors react according to similar cognitive mechanisms when they invent. These mechanisms are independent of their area of specialty;
- Technical systems develop in accordance with recurrent logics of evolution;
- Each step of these evolutions results in the resolution of one or more contradictions.

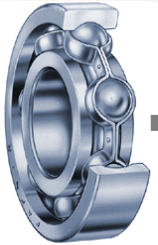
The first hypotheses:

- It is possible to define the laws that govern the evolution of technical systems (help the inventor to anticipate);
- It is possible to construct methods for inventing (helping the inventor solve problems).

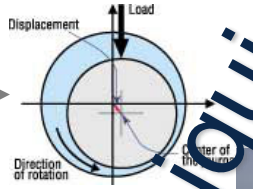
H1 TRIZ Introduction





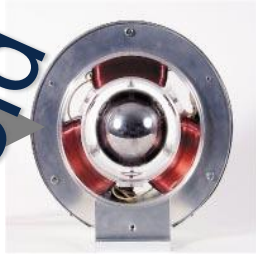


Solid



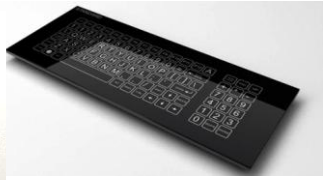
Liquid

Field





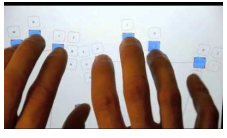
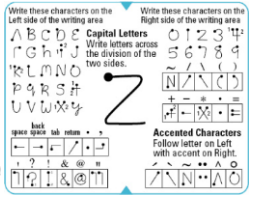






1. Intégralité
2. Efficience
3. Harmonisation
4. Idéalité
5. Irrégularité
6. Supersytème
7. Microniveau
8. Dynamisation
9. Substances-champs

Transcrire le langage

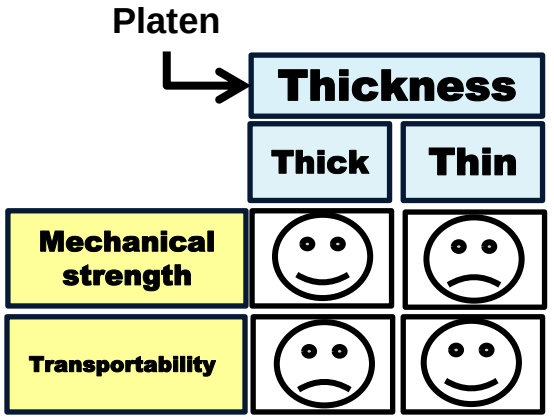






CA (administrative): I would like [the table to withstand heavy loads] but I don't know how.

CT (technique): If I improve [the mechanical strength] of [my table] it will also become [less transportable].

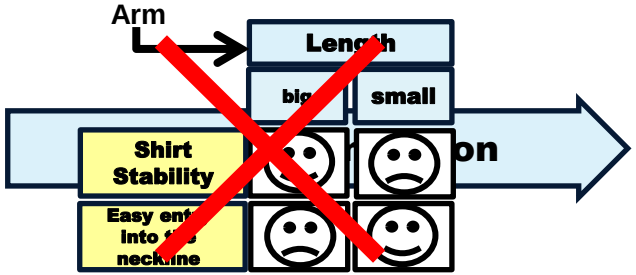
CP (physical): The thickness of the platen must be important for good mechanical strength and low for good transportability.



CA (administrative): I would like to allow a shirt to be put on my hanger without unbuttoning it but I don't know how.

CT (technique): If I improve the ability of the hanger to fit into the neckline, I degrade the fit of the shirt on the hanger

CP (physical): The length of the arms should be small to fit the neckline and large so that the shirt is well held on its hanger.



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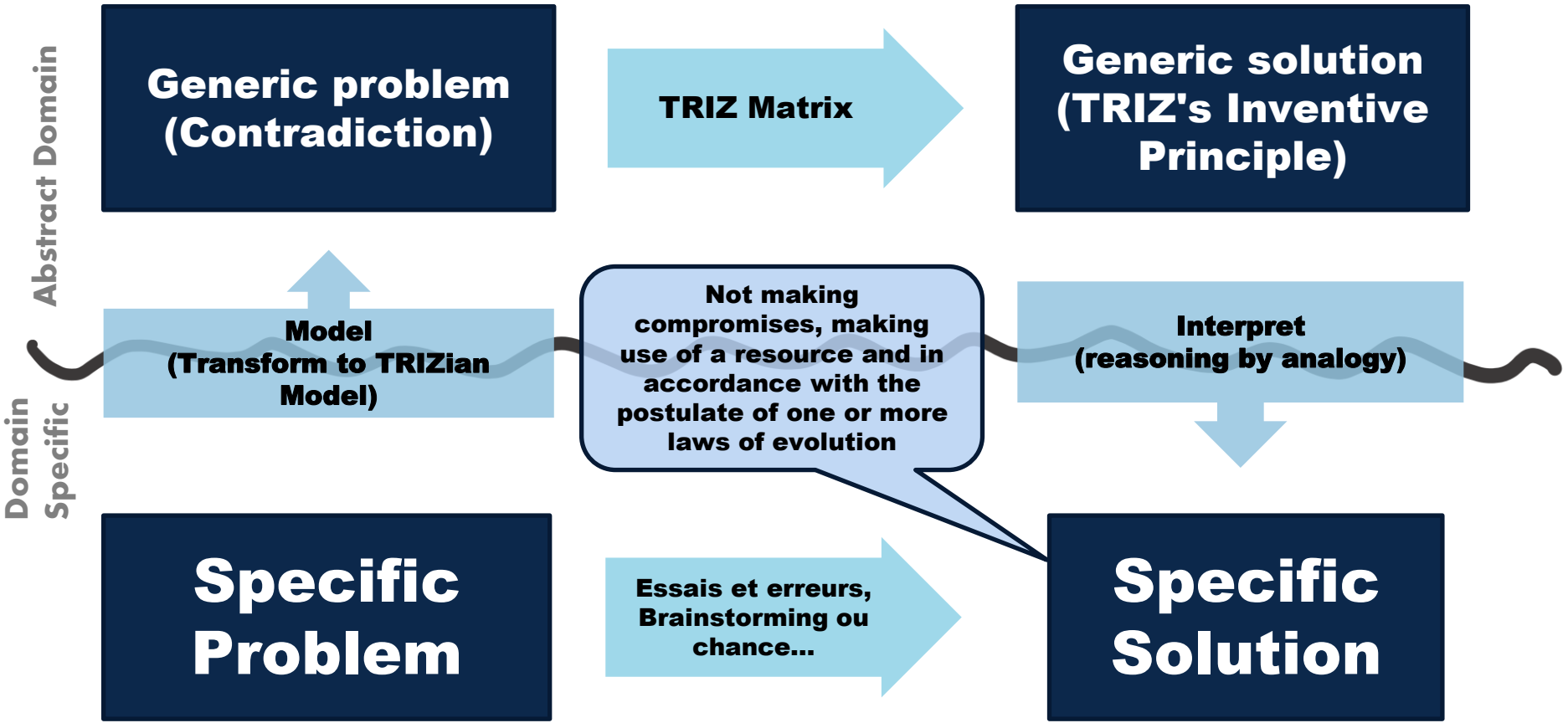
H2 Inventive Principles of TRIZ



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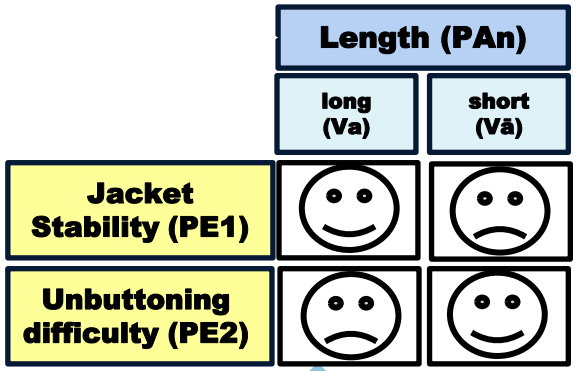


Model (Transform to TRIZian Model)

Matrix

19/13 Principle 17: Add a new dimension (a. If the object is moving along a line, consider motion in two-dimensional space)

Interpret (reasoning by analogy)


ENGINEERING
Eqilibric Inc


INTERESTING
ENGINEERING

AIARD's Key figures

- Budget: €1,5M€ / 5 yrs
- 70% Private / 30% Public
- 10 Industrial partners
- 2 institutional funders
- 38 art./3 years (10 ACL)
- 8 PhDs (2021-2027)
- +4 on/+2 coming in 2026
- 3 Soft APP – 1 Androïd
- 1 startup deeptech

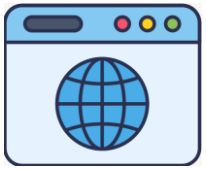
Reliable texts as a resource

180M

+ 1/1,5min

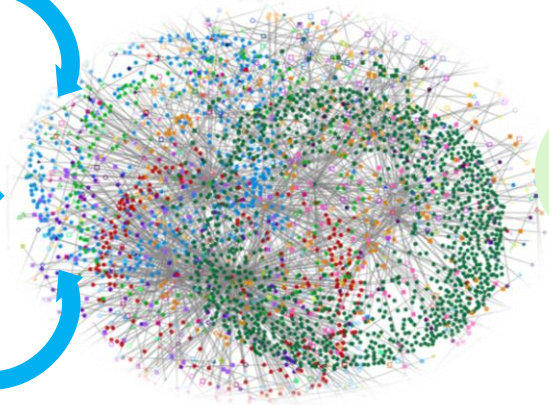
230M

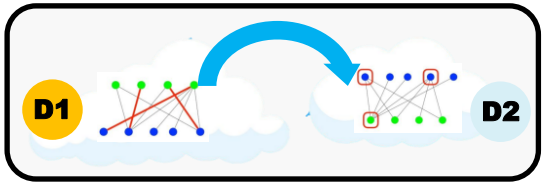
+ 1/30s



20M

+2K/J



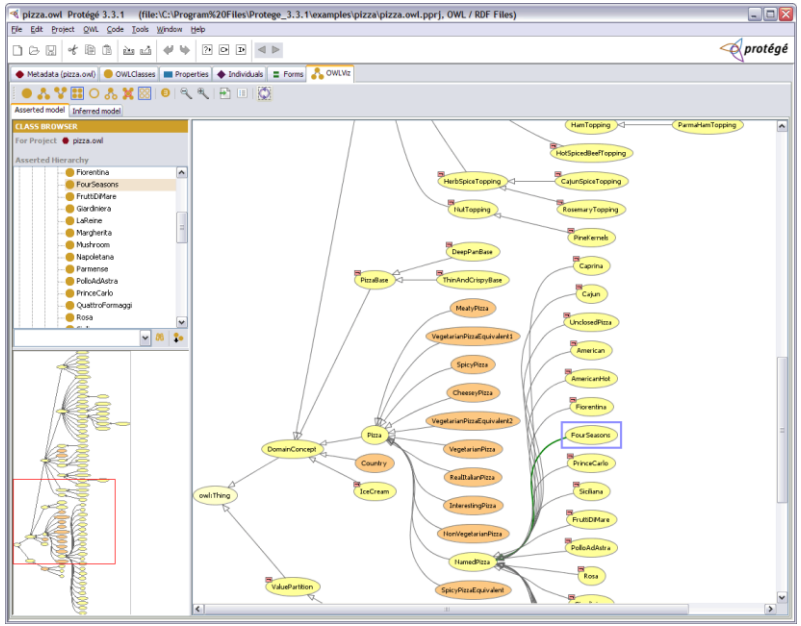


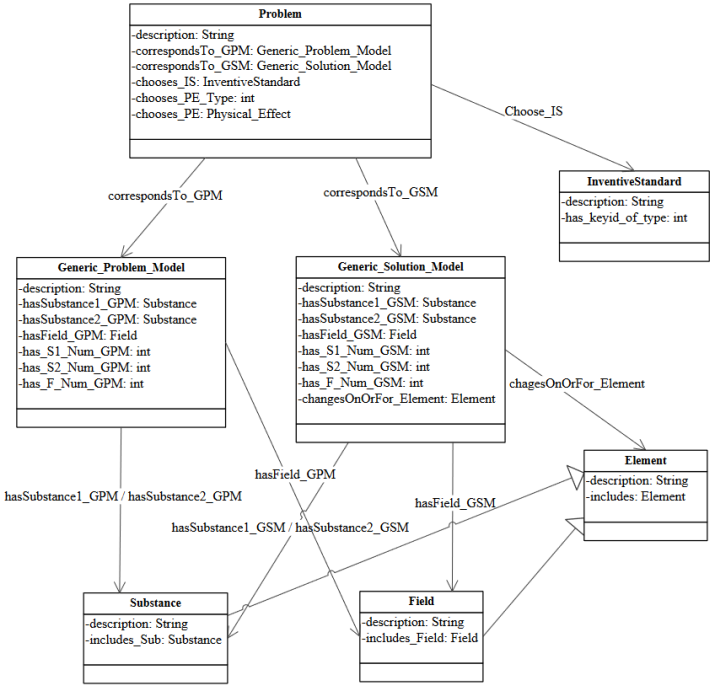
PB

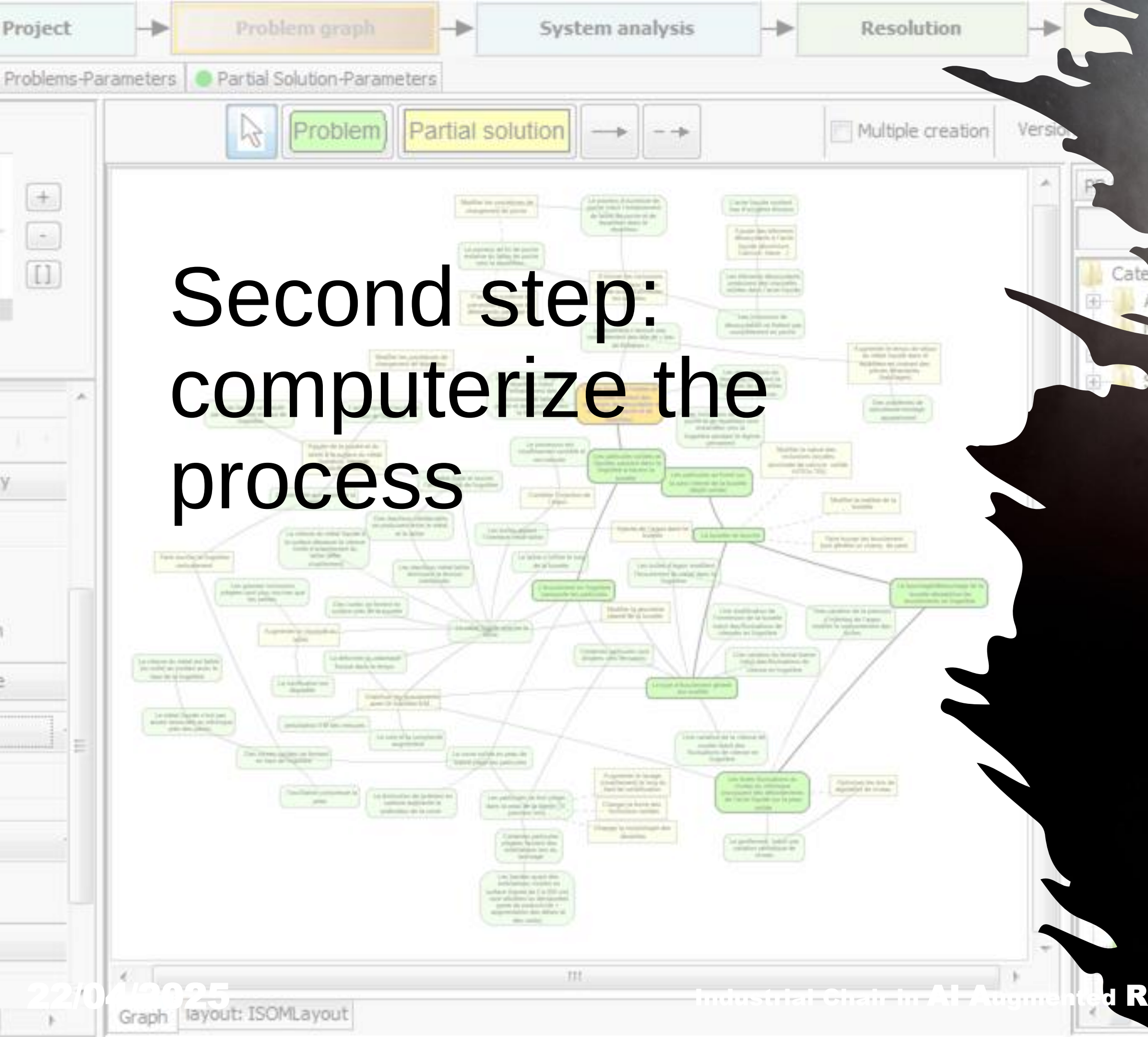
S

One more startup every month

First step: Understanding TRIZ, its limits and drawing up its ontology





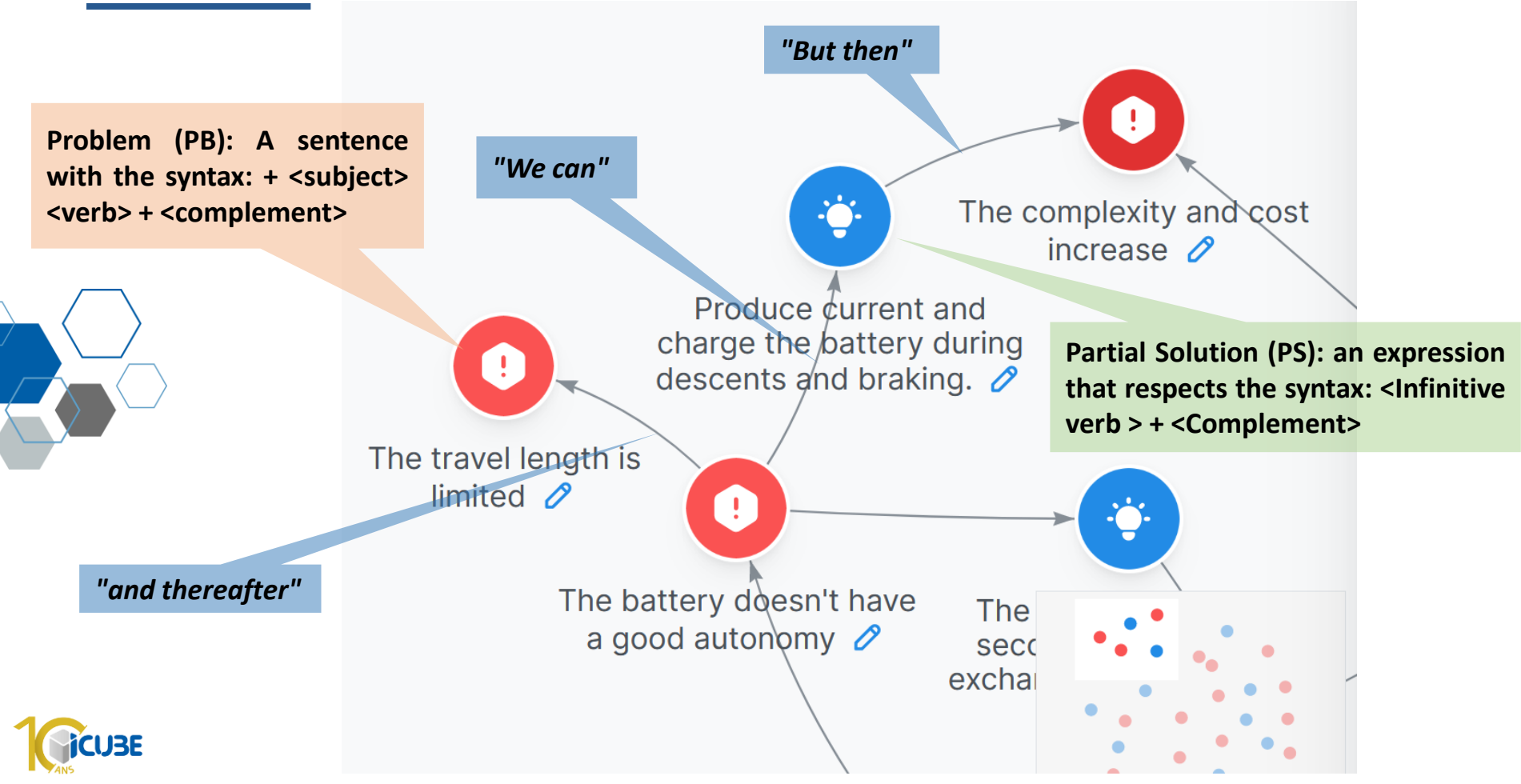


Second step: computerize the process

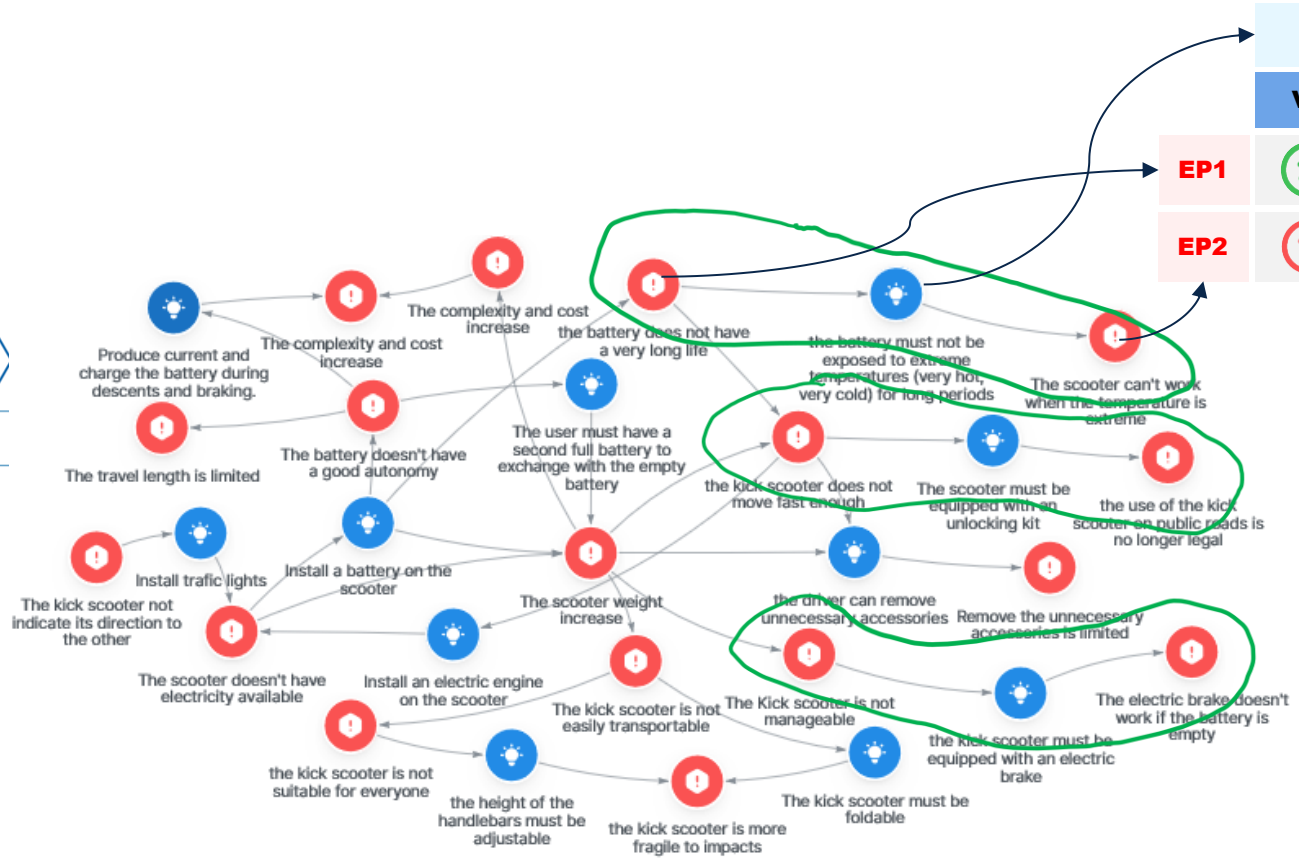
Step Three: Towards + Intelligence

- BERT and Q&A in Physical Effects
- Cosine Similarity for Generic BP-Generic BP Equivalence
- Machine Learning and RN trained to recognize the Inventive Principle in a text
- DeepLearning and GAN to extract contradictions from patents
- LLM to generate responses from very large databases
- Intelligent assistance in the construction of a problem (DaVinci)

Graphs as a mode of representation



Extractions of Contradictions

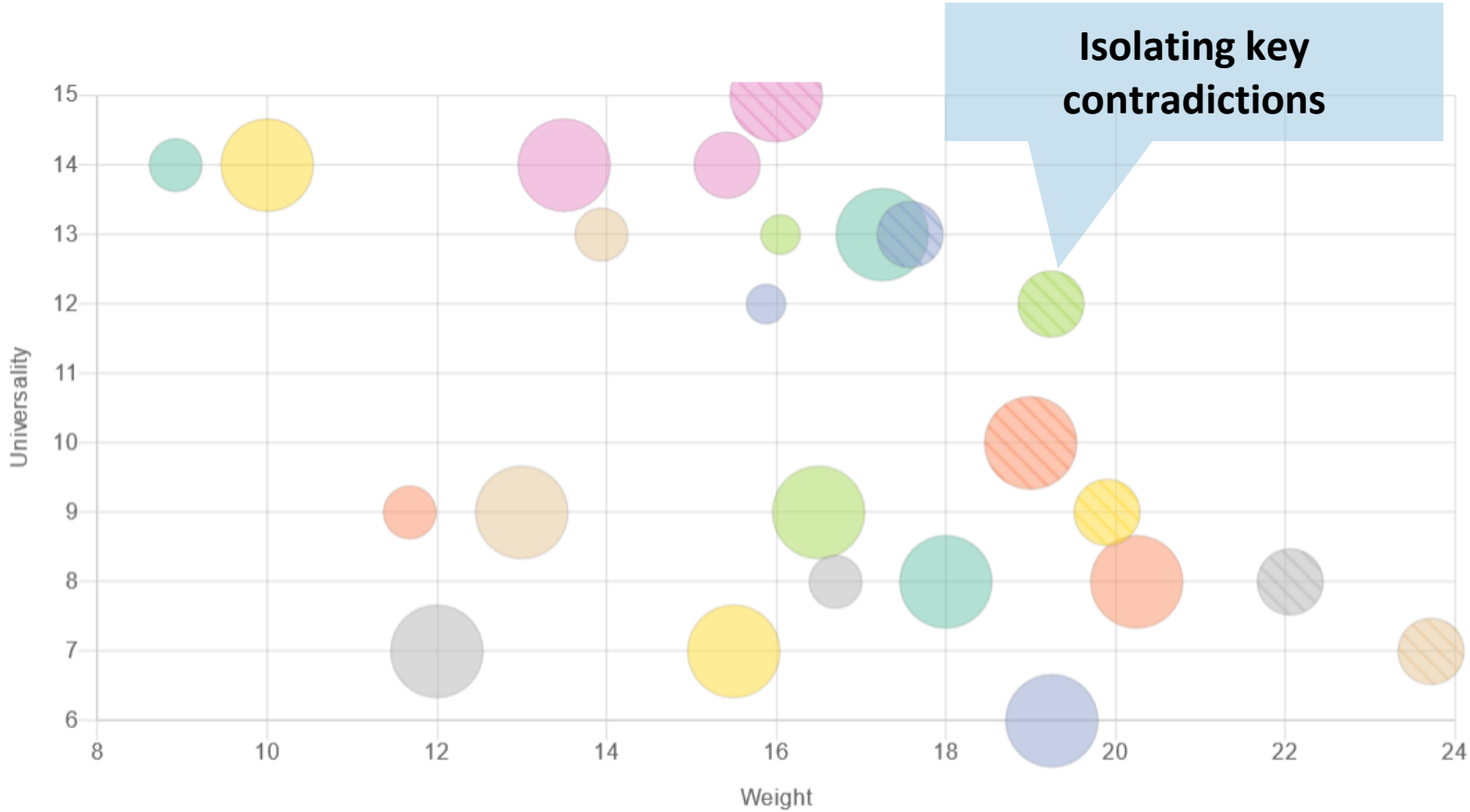


Action Parameter	Va	Vā
EP1	☺	☹
EP2	☹	☺

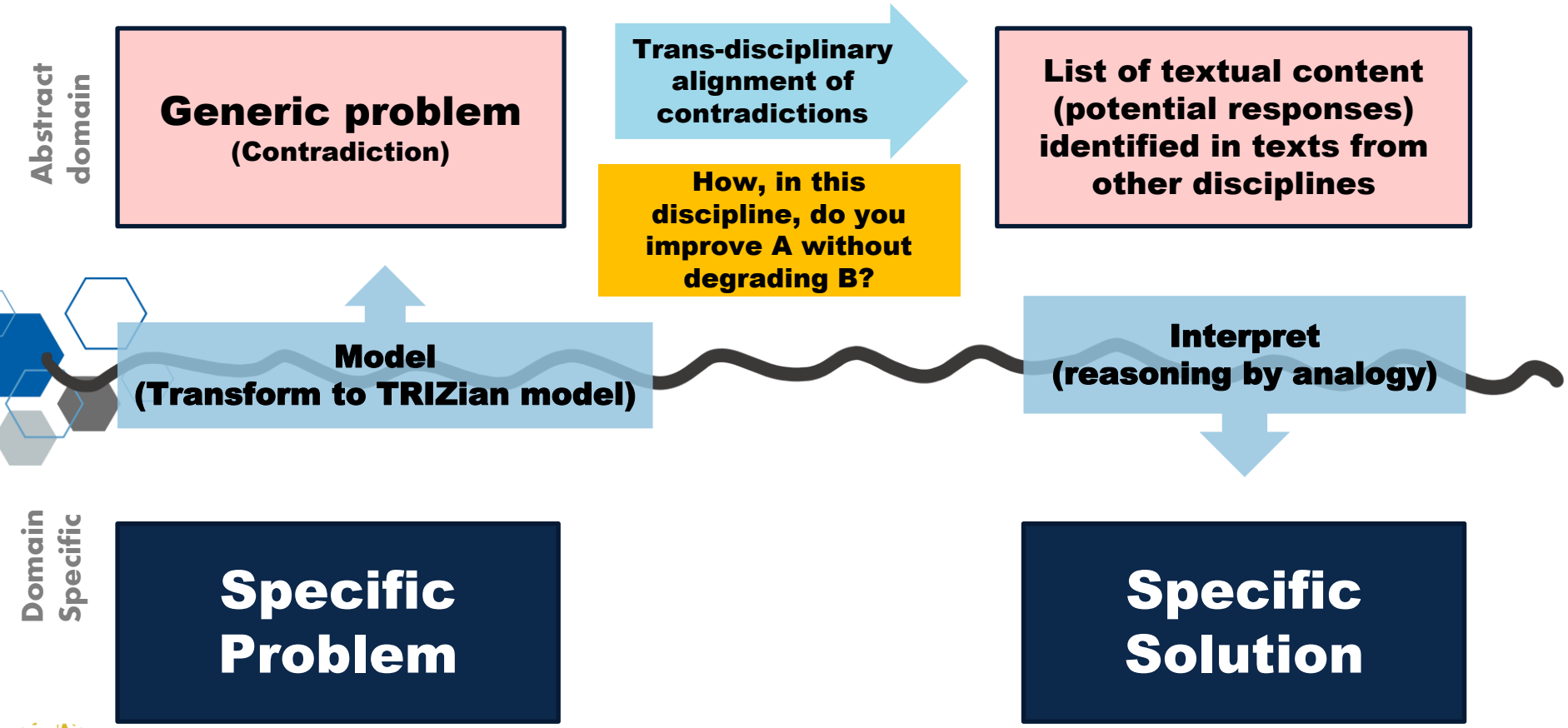
Action Parameter	Va	Vā
EP1	☺	☹
EP2	☹	☺

Action Parameter	Va	Vā
EP1	☺	☹
EP2	☹	☺

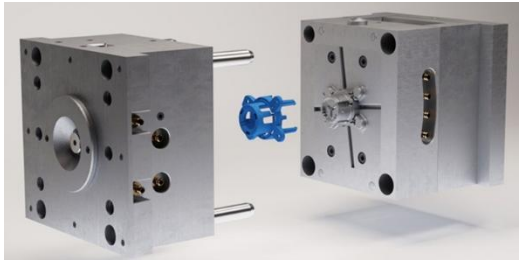
Targeting the essentials

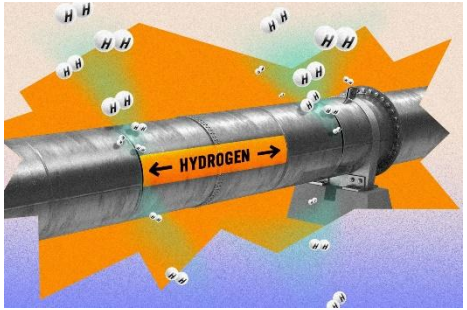


Searching for answers in other disciplines



Testing, discussing, evolving our tools

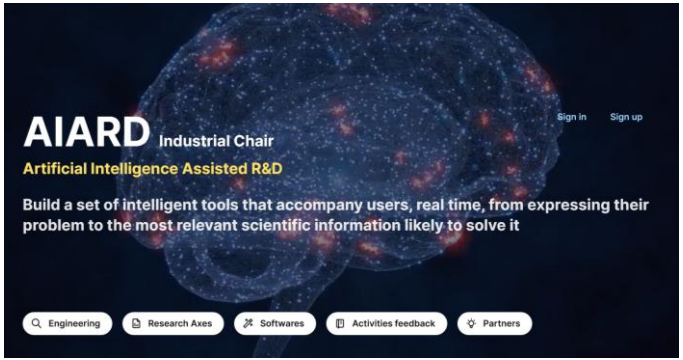




Roadmap

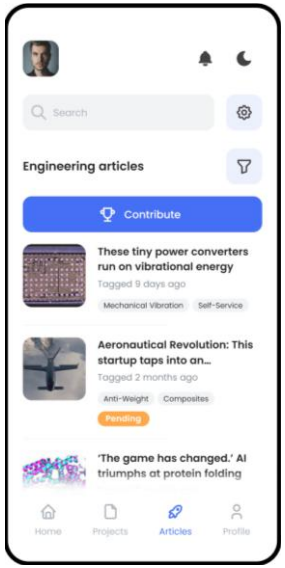
For the future, 3 major scientific obstacles:

- The interdisciplinarity of pairings between models
- The robustness of data when facing heterogeneity
- Merging similarities to reduce noise



But also, 3 important technical obstacles:

- An attractive UX/UI to get a large number of engineers to adhere to our proposals and observe the uses
- A scalable infrastructure, power, volumes, not just to train a model
- Build and preserve the tool as a teaching object AND as a research demonstrator for our industrial partners



Some successes