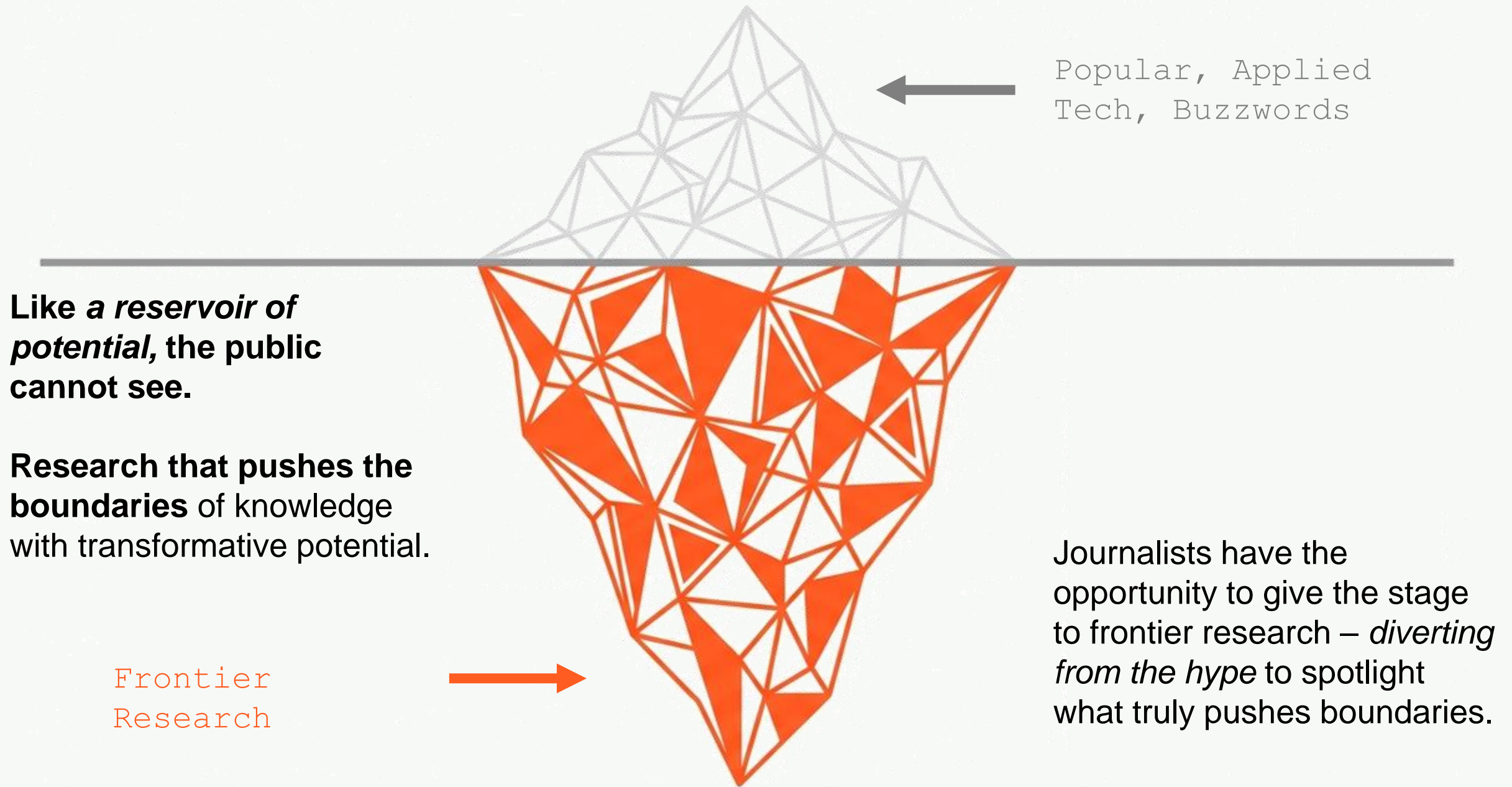




Frontier Science: Concepts and Assessment Tools



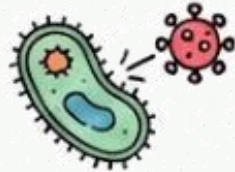


The “Boring” Origins of a Revolution

Case study: CRISPR, mRNA-based vaccines



Initial Discovery:
Odd repeats
observed
(Curiosity)



**Bacterial Immune
System Study:**
Recognized as an
adaptive defense
against viruses.



Collaboration Begins:
Doudna & Charpentier
partner on CRISPR-
Cas9 mechanism.



The Breakthrough:
Programmed genome
editing: Doudna &
Charpentier publish
key paper



Nobel Prize:
Doudna &
Charpentier awarded
in Chemistry



Collaboration Begins:
Karikó & Weissman
tackle mRNA instability
& immune response.



The Breakthrough:
Modified nucleosides
(pseudouridine) suppress
immune activation.



**COVID-19
Vaccines:**
Rapid deployment
of the platform.



Nobel Prize:
Karikó & Weissman
awarded in
Medicine.

Is any uncertain research – frontiers?

Frontier Research: Elusive

1. Different disciplines take different forms.
2. The line between frontier and non-frontier research can be blurry.
3. Often rests on subtle details.
4. Impact is not always immediate; significance may take years to become evident.

Enspire
science

The Good News :
Based on our experience with
the ERC funding scheme, we
have developed specific tools to
assess frontier research.

Bird's-Eye View – The Nature of Frontier Research



Fundamental

Often curiosity-driven, involving basic science questions, mechanistic studies.



Pushing Boundaries

Involves new principles, or concepts.



Ambitious and Uncertain

Complex, challenging, embracing uncertainty.



Informed

High-end research, not random exploration.

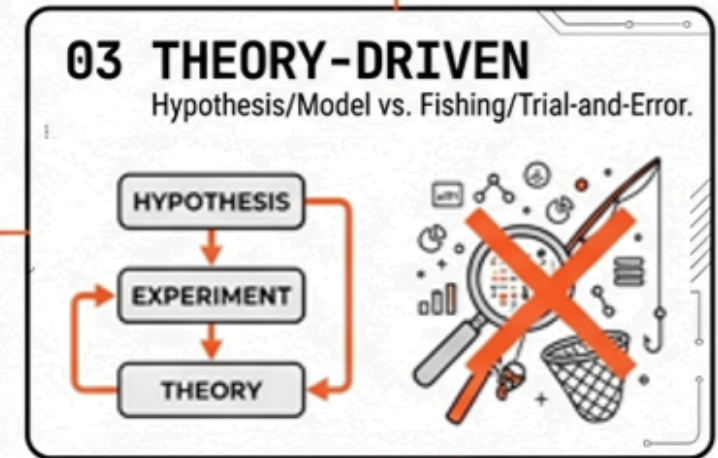
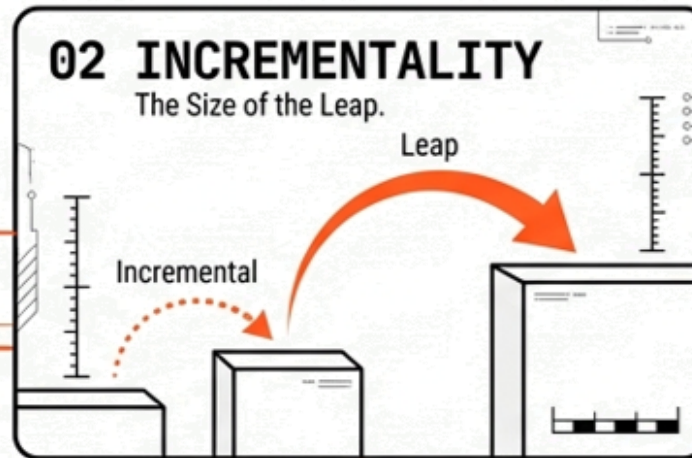
It is often hard to explain.



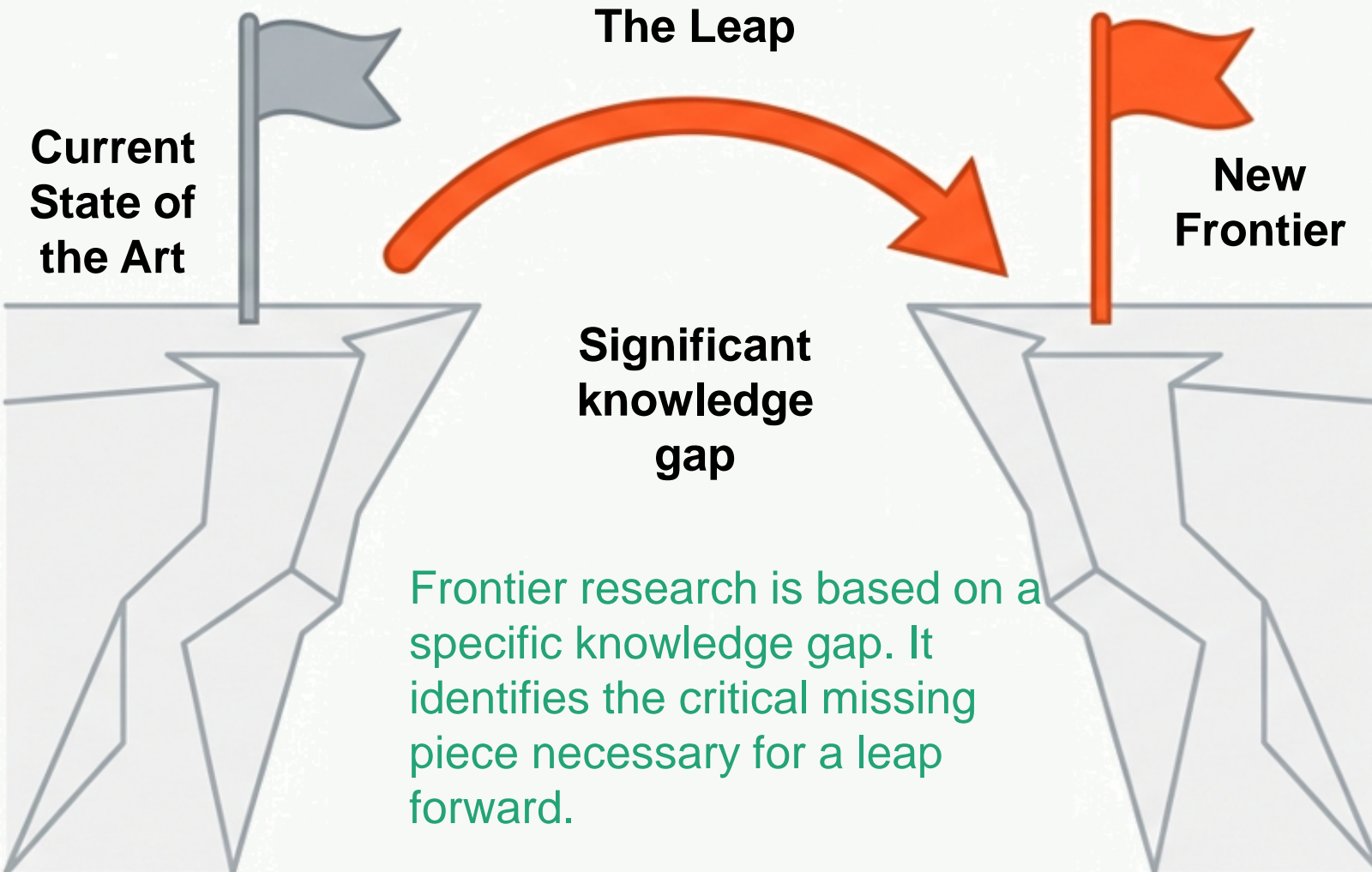
Frontier Research pushes the sliders to the right.

The Assessment Toolkit

5 Metrics to stress-test a story



Tool #1 // Knowledge gap



Investigative Questions:

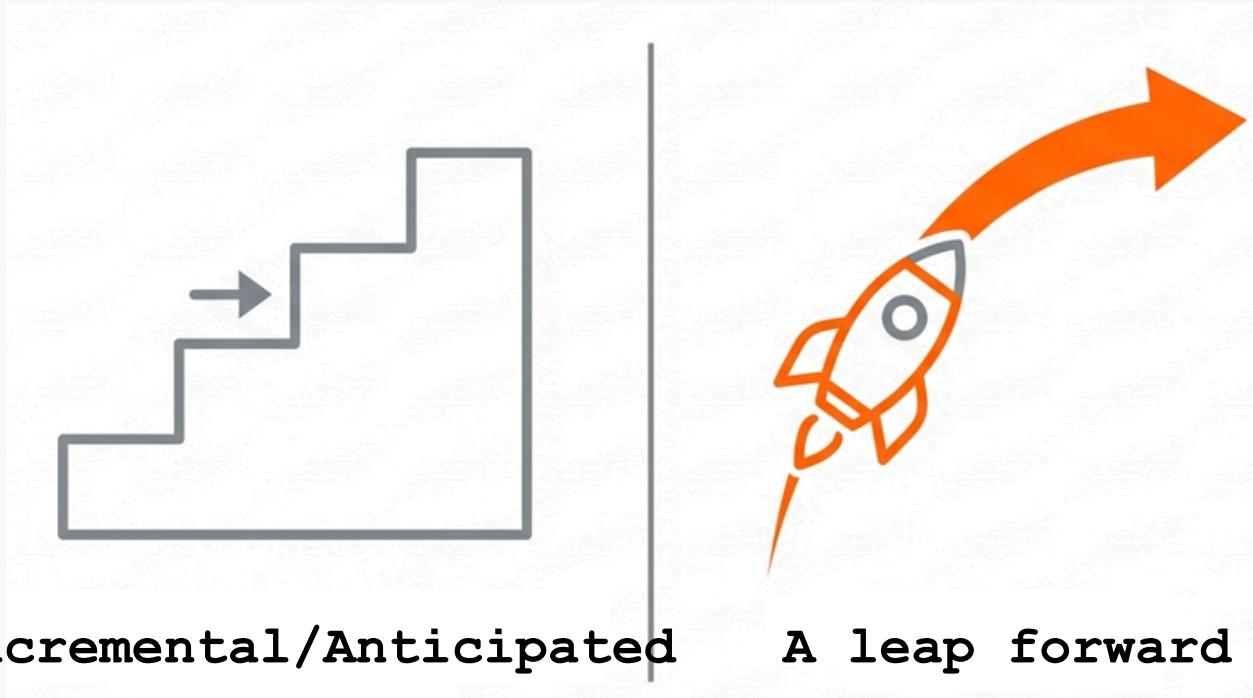
1. What is the knowledge gap explored?
2. Why was this never done/explored before?
3. Why is it possible now?
4. Is the unknown significant?

The Trap:

Motivation vs. Gap

Confusing between “*I want to cure cancer*” (Motivation) and “*We don’t know mechanism X of protein Y*” (Gap).

Tool #2 // Incrementality



Frontier research embodies a leap forward.

It is not typically:
“More of the same”
Verification
Optimization

Investigative Questions:

1. Where does this stand vs. state of the art?
2. Are you challenging a consensus/paradigm?
3. Do you step outside your comfort zone?
4. Is someone doing something similar?

The Trap:

1. Relative Novelty.

“It’s new to me, so it must be new”

2. Saturated areas.

The bar is higher

Example of both: AI

Tool #3 // Theory-driven



Frontier Research often embodies:

- A theory
- A model
- A hypothesis
- A vision
- A prediction



Failure is an option!

Investigative Questions:

1. What is your perspective on the knowledge gap?
2. What scientific principles are leading your decision making?

The Trap:

“Fishing expedition”

“We will collect data and see what we find”

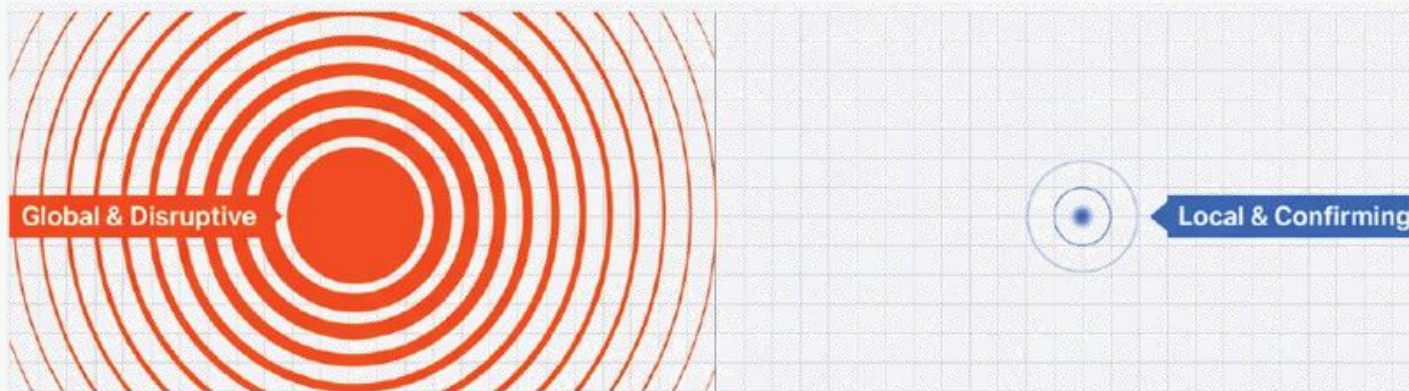


Data-driven/exploratory research can be frontier – when guided by a strong conceptual thread.

Tool #4 // Impact

Frontier research aims to define new principles, change perception in the scientific field.

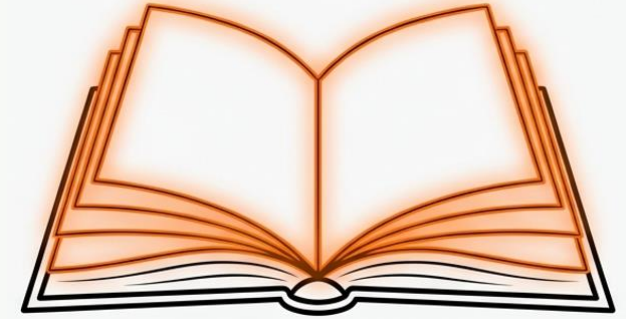
Disruptive > Incremental/limited



The way toward impact *is not* straightforward.

Investigative Questions:

1. Will this change textbook knowledge?



2. What scientific (or industrial) doors does it open?
3. Is it exciting? Or controversial?

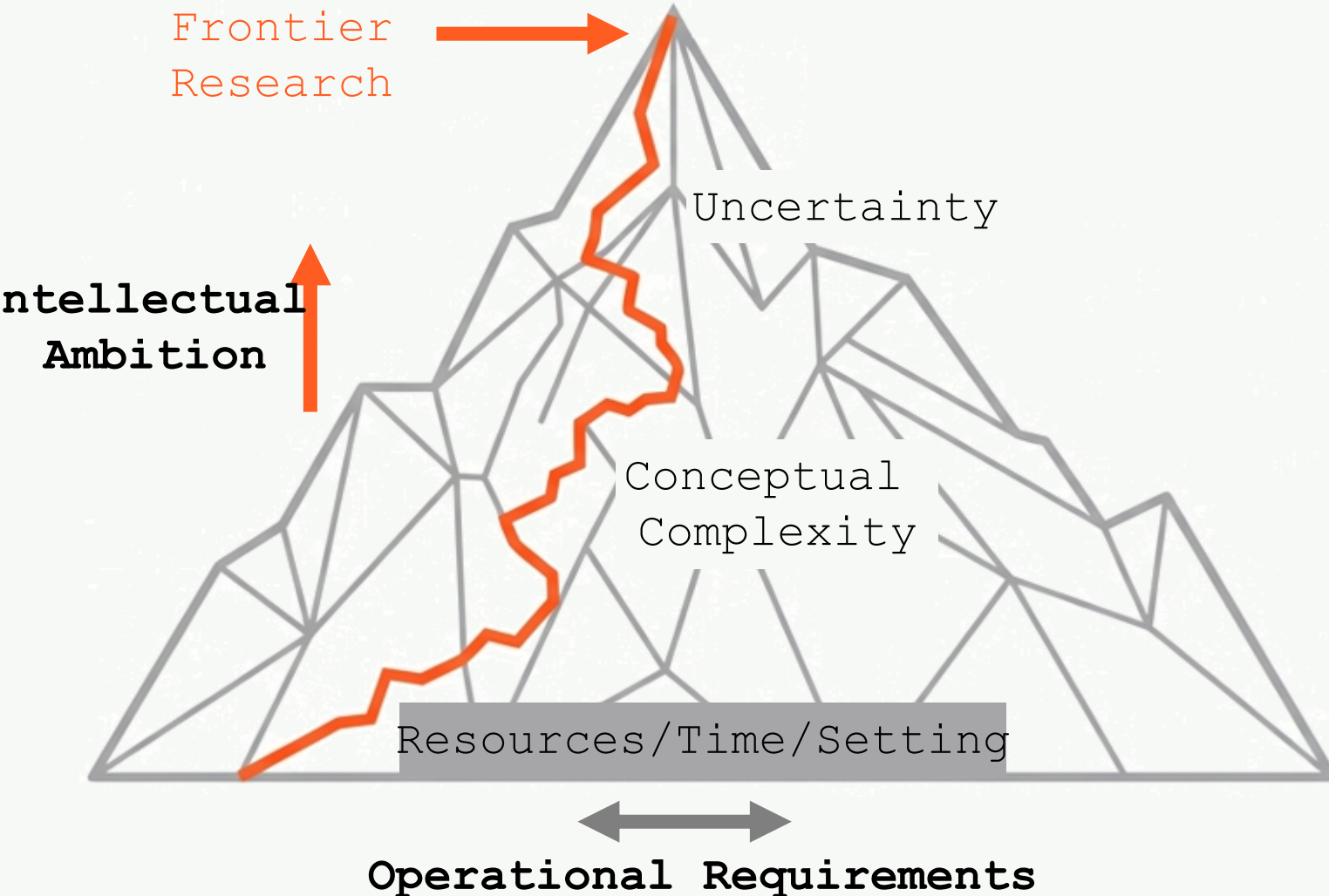
The Trap: Incremental

“We have it figured out, but we need to confirm it in larger scale”

→ Tool #5 // Ambition

Tool #5 // Ambition

At the basis: Every research requires resources, time and setting. The question is does it aim high intellectually?



Investigative Questions:

1. Where lies the scientific challenge?
2. How certain are you of the research-path?

The Trap:

Equating resource intensity with intellectual ambition

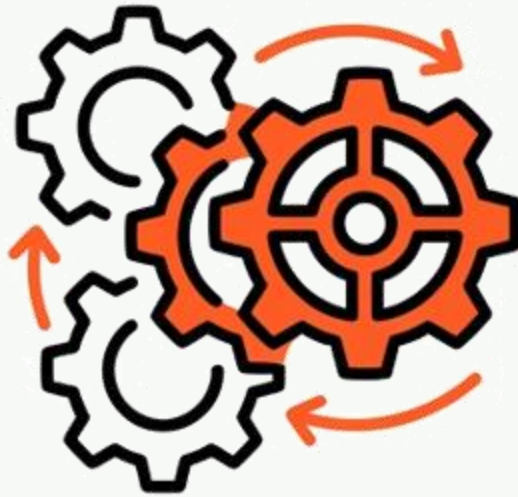
→ Is any uncertain research – frontiers?

Why CRISPR or mRNA-based vaccines were likely frontiers before they were famous?



**Ambitious and
non-incremental**

An uncharted territory



**Mechanistic and
Informed**



Impactful

Fundamental understanding

Open End to biotechnology, medicine

Red Flags – Likely Encounters



Fishing Expeditions



Traditional tools. Random data collection hoping to find something.

No Theory



Incremental Networks



Large ongoing collaboration proceeding with traditional trajectory or descriptive work.

No ambition



Applicative Efforts



Applicative/ Close to market research.

No significant gap



"Tool Users"



Using existing sophisticated tools, e.g. AI, for automation/upscale.

Incremental



Buzzword Salad



Over-reliance on buzzwords e.g., SDGs, OneHealth.

"More of the same"

Divert from the hype. Do not just repeat what is 'cool'.

We are your helpdesk.

