Advanced Research + Invention Agency ARIA

Extending Our Perception

Opportunity space

v1.0

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CONTEXT

This document describes an early opportunity space from which we believe one or more funding programmes can emerge. We've sketched out some of our early thinking to spark your interest, and invite you to imagine relevant potential programmes with us, or suggest new directions. We'll publish updated versions of this document as our thinking evolves.

Sign up **here** to receive those updates and learn about further funding opportunities within this opportunity space.

An ARIA opportunity space should be:

+ important if true (i.e. could lead to a significant new capability for society),
+ under-explored relative to its potential impact, and
+ ripe for new talent, perspectives, or resources to change what's possible.

SUMMARY

The world is rich with structures and high-dimensional patterns that remain hidden from both humans and machines. Our current frontier of AI is inspired by human-style cognitive intelligence, dominated by our language and photos. Yet nature achieves feats beyond our capabilities through efficient intelligence, entwined with powerful senses co-evolved over billions of years. What is the goal of AI, to mimic humans or extend our capabilities? The next paradigm is *Hypersensory Intelligence,* co-designing AI with dynamic sensor systems to extend our perception and reveal what remains invisible, catalysing breakthroughs in health, scientific discovery, and agriculture.

BELIEFS

The core beliefs that underpin this opportunity space:

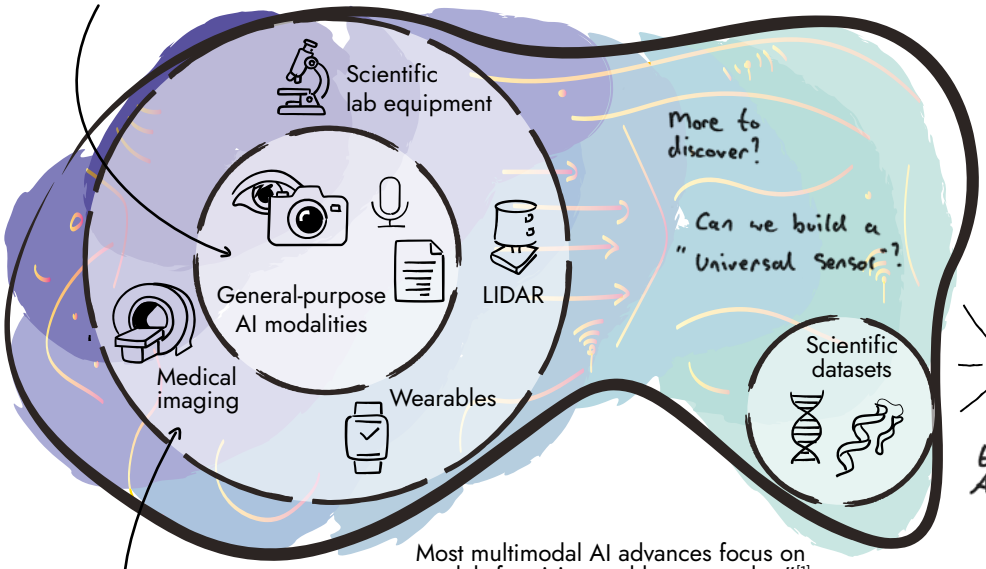
1. We are under-utilising most sensing modalities when we train AI models. Building intelligent systems demands harnessing sensors that extend beyond human intuition to make sense of combinatorial or high-dimensional modalities.
2. Training on archived data from static sensors will only get us so far. We need dynamic systems that treat perception and cognition as mutually reinforcing and co-evolving components of intelligence.
3. As we develop *Hypersensory Intelligence*, symbiotic co-perception will emerge as a new capability class, enabling us to better understand and exploit the evolved biological sensing of humans and other species.

OBSERVATIONS

Some signposts as to why we see this area as important, under-explored, and ripe.

Our AI models are dominated by human-centric data from a limited portion of a vast hypersensory space[1].

General purpose AI models are trained on human-centric data (text, RGB images, audio, or video for "richer data")



Most multimodal AI advances focus on models for vision and language data"[1].

What high dimensional signals are we discarding?

Data is often simplified for human interpretation, e.g. MRI for radiologists, reconstructed from k-space via Fourier Transform.

What could we discover when AI learns from high-dimensional sensory information to reveal patterns in the physical world beyond our perception? e.g. chemical sensing (olfactory[2], gustation), imaging beyond visible in EM spectrum[3], polarisation, event-based sensing[4], motion, ultra/infra sound, field sensing, etc.

Sensing capabilities once confined to the lab are beginning to move into the real world.

Could any of these – in combination or isolation – become as ubiquitous as the mobile phone camera?

...in our pockets, homes, environment or on our clothes !!

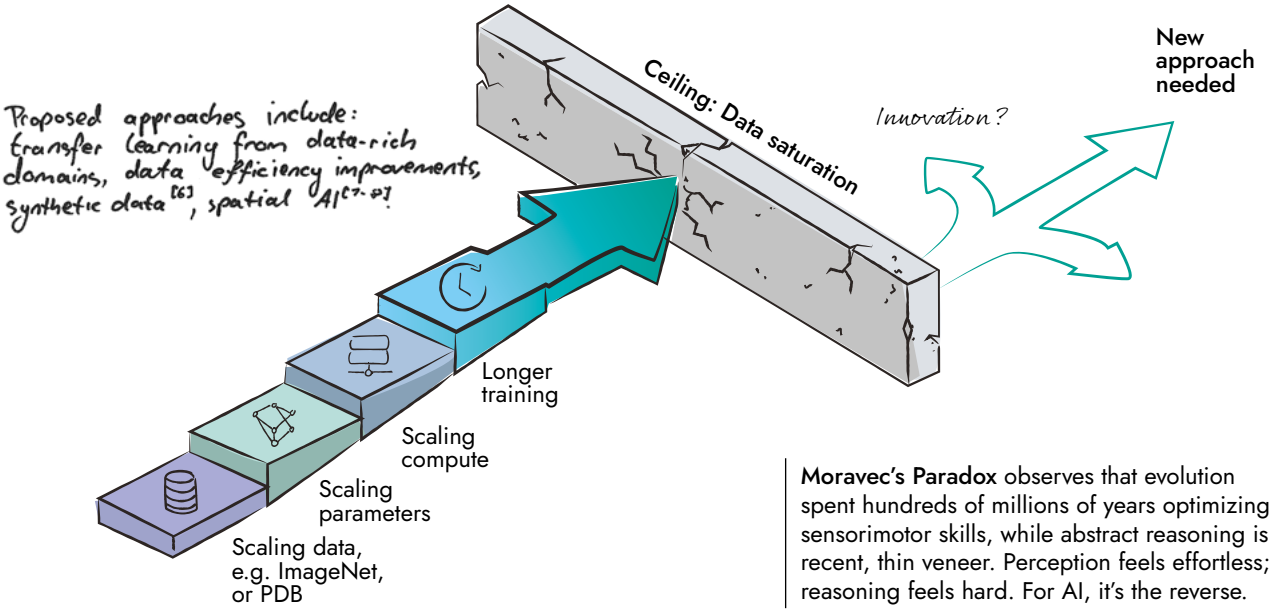
Explore with AI scientist?

Systems could be much smaller in deployment than training

AI will be critical for breakthroughs across the challenges we face in healthcare, education, food supply, scaling novel materials, and the health of industrial equipment. Yet we are early on in this transformation, with many breakthroughs to come.

The next frontier of AI needs a new approach: Scaling laws have led to unprecedented progress in artificial intelligence. However, AI is reaching a ceiling with our existing datasets[5].

yet produced energy-hungry models



Proposed approaches include: transfer learning from data-rich domains, data efficiency improvements, synthetic data[6], spatial AI[7-8]

Moravec's Paradox observes that evolution spent hundreds of millions of years optimizing sensorimotor skills, while abstract reasoning is a recent, thin veneer. Perception feels effortless; reasoning feels hard. For AI, it's the reverse.

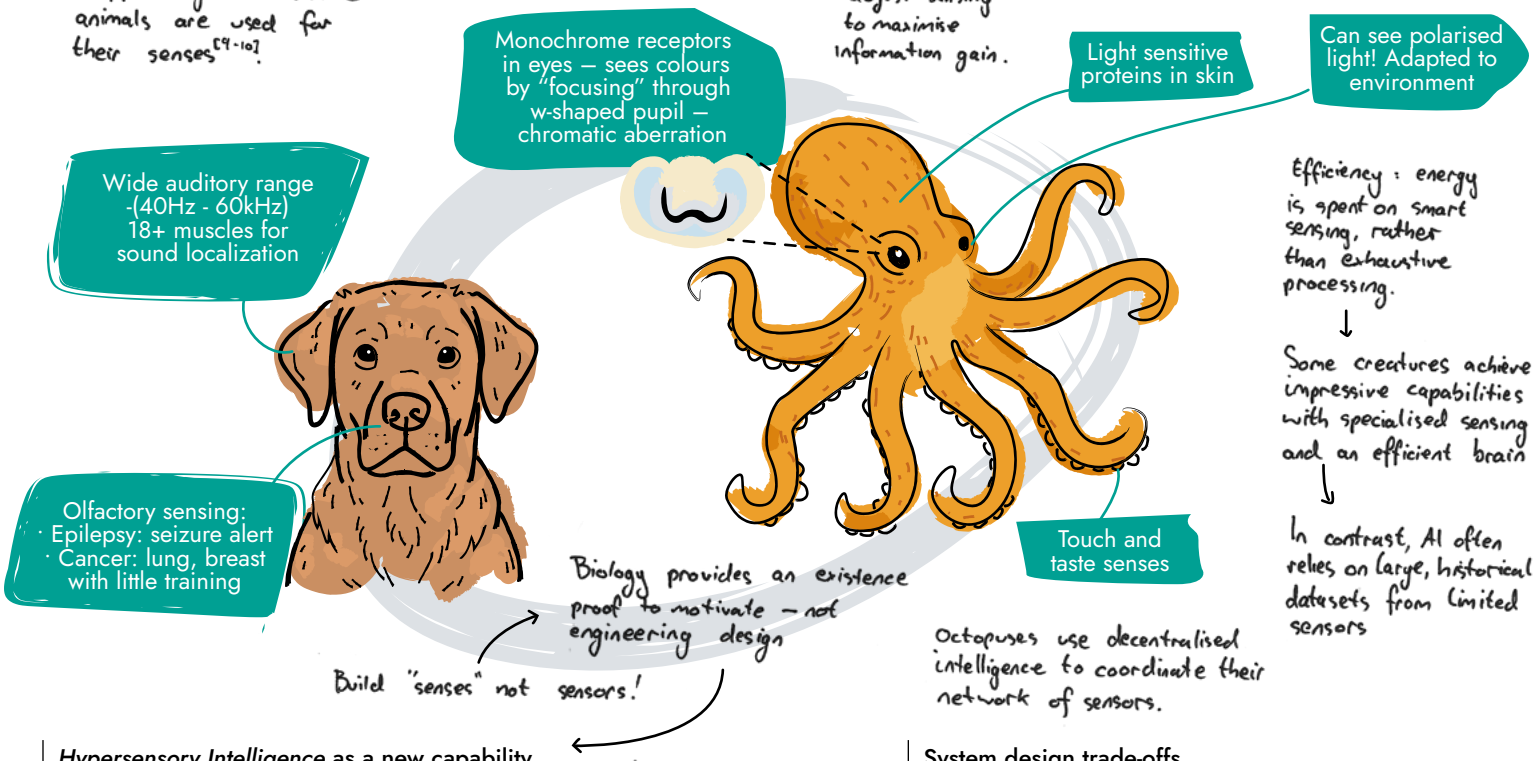
Nature is an existence proof of *Hypersensory Intelligence*, where sensing and cognitive intelligence have co-evolved.

Sniffer dogs and service animals are used for their senses[9-10].

Sensing is intelligent not static!

coordinating multiple senses to build perception

adjust sensing to maximise information gain.



Efficiency: energy is spent on smart sensing, rather than exhaustive processing.

↓

Some creatures achieve impressive capabilities with specialised sensing and an efficient brain

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In contrast, AI often relies on large, historical datasets from limited sensors

Biology provides an existence proof to motivate – not engineering design

Build "senses" not sensors!

Octopuses use decentralised intelligence to coordinate their network of sensors.

Hypersensory Intelligence as a new capability

Learn system design to optimise trade-offs

Hypersensory Intelligence moves the focus from the algorithm to system design. How do we deploy extremely multimodal intelligent systems into the real world to reveal structures and patterns that exist but remain illegible?

This might include:

+ modular, hierarchical system learned or co-evolved with curated sensors.
+ minimising uncertainty, making predictions with hypersensory-world models.
+ searching with sensors, e.g. programmable sensors[11], metasurfaces or intrinsically high dimensional sensors to push the boundaries of our perception.
+ extracting the right information from sensors[12-13].

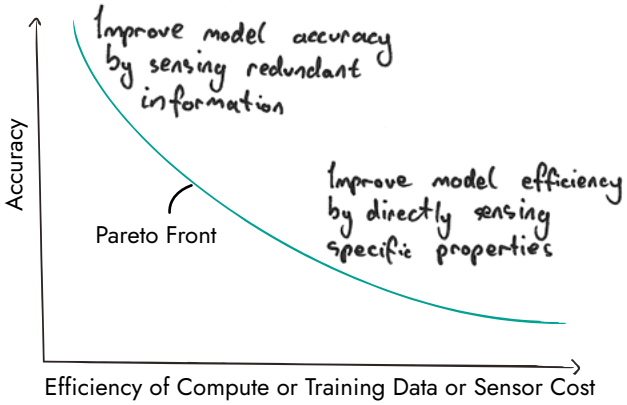
What are the cross-modal interactions of diverse sensors? E.g. smell + polarisation

... not an exhaustive list!

Can we build "AI-native senses"? A system of sensors designed by and for AI

System design trade-offs

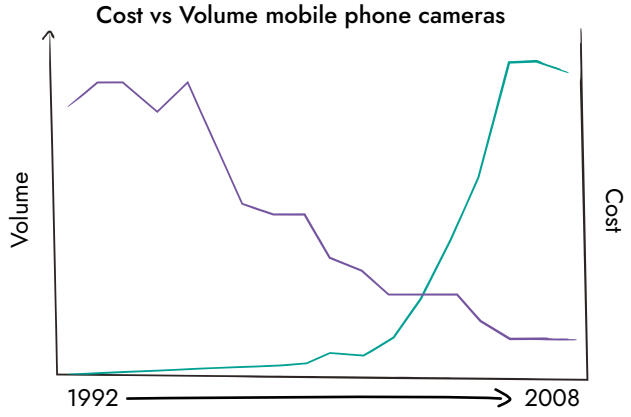
By sensing the right properties or proxies, model inference can be faster or more accurate.



Cost prohibitive sensors can plummet in price with the right business model, due to economies of scale[14].

How much latent value is discarded when reconstructing / processing sensor data for human consumption?

goal: affordable for all



A broad cross-industry vision could be critical for a breakthrough-cascade.

Breakthrough Examples

Healthcare: Underexplored signals of health for use outside of hospitals. Many systemic conditions are poorly characterised, under-researched, and hard to diagnose[15].

Peak performance: Improving human performance by understanding our body signals, e.g. education, managing pain.

Industrial: Super-sensing the health of machines, bridges etc.

Scale-up: Escaping the 'valley of death' via real-time, inline material intelligence.

Expanding human perception: Human co-perception for existing and emerging professions, e.g. rescue and repair.

Better understanding our senses: Improve health by exercising our senses[16].

SOURCES

A compiled, but not exhaustive list of works helping to shape our view and frame the opportunity space (for those who want to dig deeper).

1. Towards deployment-centric multimodal AI beyond vision and language – Nature Machine Intelligence 2025
2. A Principle odor map unifies diverse tasks in olfactory perception – Science 2023
3. Modern Trends in Hyperspectral Image Analysis: A Review – IEEE Access 2018
4. Event-based Vision: A Survey – EEE Transactions on Pattern Analysis and Machine Intelligence 2020
5. Ilya Sutskever – We're moving from the age of scaling to the age of research – D. Patel
6. Position: will we run out of data? limits of LLM scaling based on human-generated data – ICML 2024
7. From worlds to worlds: Spatial intelligence is AI's next frontier – Substack 2025
8. Self-supervised learning from images with a Joint-Embedding Predictive Architecture – CVPR 2023
9. Sniffer dogs can identify lung cancer patients from breath and urine samples – BMC Cancer 2021
10. Is there a profile of spontaneous seizure-alert pet dogs? A survey of French people with epilepsy – Animals (Basel) 2020
11. Sensor-level computer vision with pixel processor arrays for agile robots – Science Robotics 2022
12. AI Should Sense Better, Not Just Scale Bigger: Adaptive Sensing as a Paradigm Shift – NeurIPS 2025
13. Towards Modality- and Sampling-Universal Learning Strategies for Accelerating Cardiovascular Imaging: Summary of the CMRxRecon2024 Challenge – IEEE Transactions on Medical Imaging 2024
14. Historical View on Image Sensor Market – Image Sensors World 2010.
15. 'I still can't forget those words': mixed methods study of the persisting impact on patients reporting psychosomatic and psychiatric misdiagnoses – Rheumatology 2025
16. Sensory-driven microinterventions for improved health and wellbeing – Computing Research Repository 2025

ADDITIONAL MATERIAL

+ Multimodality as Supervision: Self-Supervised Specialization to the Test Environment via Multimodality – EPFL 2025
+ Physics-Informed Computer Vision: A Review and Perspectives – ACM Comput. Surv. 2024
+ Welcome to the era of experience – The AI Innovator 2025
+ The free-energy principle: a unified brain theory? – Nat Rev Neurosci 2010
+ A principal odor map unifies diverse tasks in olfactory perception – Science, 2023
+ The electronic nose: A critical global review of advances in analytical methods and real-world applications – Microchemical Journal 2025
+ An Immense World – Ed Yong 2022
+ Moravec's paradox and its implications – epoch.ai 2024

ENGAGE

Our next step is to formulate a programme within this opportunity space that will direct funding across research disciplines and institutions toward a focused objective. In order to ensure we select the right first challenge, we want to hear from you. Complete this **form** to provide feedback on the opportunity space and inform the development of our programme thesis - we will read anything you send. There, you may also register interest for our workshops.