Welcome to Artificial Intelligence in Design and Construction

February 29, 8:30 – 10:00am

Arjo Mozumder

Co-Founder / CEO –
Hedral

- Background in AI VC and PE

- AIA Design Technology Committee

- 1st at NGA Expedition Hackathon 2017

- Texas > California > New York (in order of stage of life, not preference)

" "

*A great building must begin with the unmeasurable,
must go through measurable means when it is being designed,
and in the end must be unmeasurable.*

Louis Kahn

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With labor and housing shortages, whiplash from interest rates, and supply chain issues, the carrying costs of construction have never been higher.

Bottlenecking this industry is design: a slow and painfully outdated process – responsible for shaping all aspects of the world's largest asset class.

FAST COMPANY

Bank of America housing analysts say that "underbuilding" of U.S. homes over the past decade has not only "absorbed the 2 to 3 million home glut from pre-financial crisis overbuilding" but has also created a "deficit of 4 million" U.S. homes.

Archinect

" We aren't even competing against other architecture firms; we are competing against the fact that more and more people don't want to be an architect.
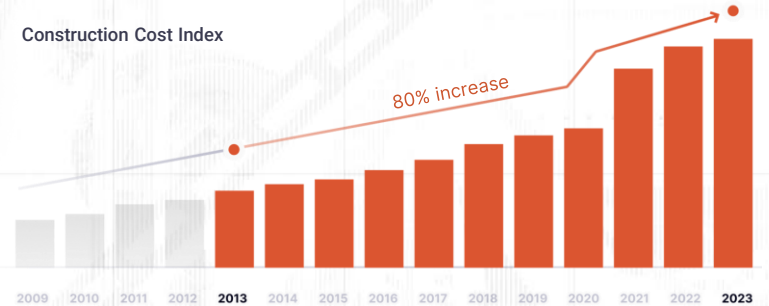
The New York Times

SQUARE FEET

For the Want of an Insulation Screw

Hammered by supply chain woes and fluctuations in demand, builders have learned to become more adept managing challenges.

abc ABC News

Construction Workforce Shortage Tops Half a Million in 2023, Says ABC

WASHINGTON, Feb. 9—The construction industry will need to attract an estimated 546,000 additional workers on top of the normal pace of hiring in 2023 to meet the demand for labor, according to a proprietary model developed by Associated Builders and Contractors.

Mortenson

Construction Cost Index

80% increase

2009 2010 2011 2012 **2013** 2014 2015 2016 2017 2018 2019 2020 2021 2022 **2023**

AI is not a new thing – its history is filled with breakthroughs and 'winters'

AI HAS A LONG HISTORY OF BEING "THE NEXT BIG THING"…
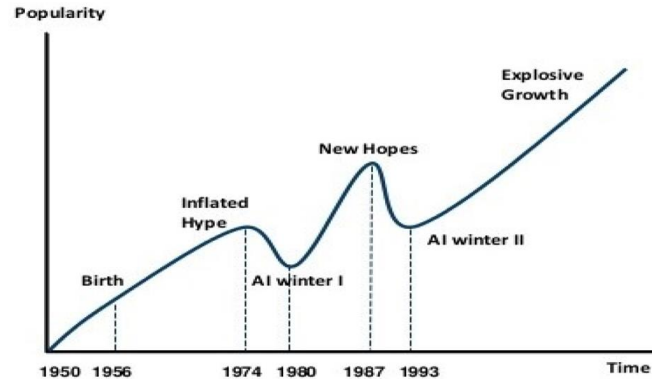
Timeline of AI Development
▪ **1950s-1960s:** First AI boom - the age of reasoning, prototype AI developed
▪ **1970s:** AI winter I
▪ **1980s-1990s:** Second AI boom: the age of Knowledge representation (appearance of expert systems capable of reproducing human decision-making)
▪ **1990s:** AI winter II
▪ **1997:** Deep Blue beats Gary Kasparov
▪ **2006:** University of Toronto develops Deep Learning
▪ **2011:** IBM's Watson won Jeopardy
▪ **2016:** Go software based on Deep Learning beats world's champions
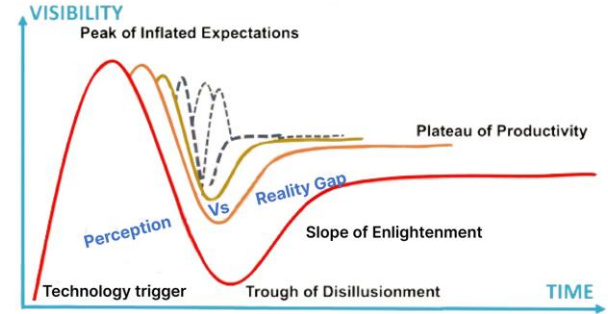
Source (Original Graph): Gartner Research, Wikipedia. By Jeremykemp at English Wikipedia, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=10547051

AI – WHERE STARTUPS ATTACK

AI Applications	Network Security	Home security	Warehouse automation	Robotic surgery	Autonomous Vehicles	Risk Analysis	Supply Chain Optimization	Natural resource optimization	Back-office automation (Cognitive RPA)	Customer support
Compound Services	Fraud Detection		Product Recommendation		Risk Analytics		Auto Data Cleansing	Chatbots		?
Discrete Services	Speaker recognition	Speech to text	Text to speech	Language comprehension	Sentiment analyzer	Personality analysis	Form Recognition	Video Indexing	Ink Recognition	Face Recognition
Auto ML Platforms	AUTO ML platforms (they let you focus on the business problem and they manage all the underlying models, tuning, hyperparameter combinations, model mgmt and infrastructure that's required for dev, test, and production. Examples: Google AutoML)									
Manual ML Platforms	ML Platforms (e.g. AWS Sagemaker, Azure ML, Google ML)		Data Processing Tools (e.g. Data labelling services)	Model Diagnostics		AI Infrastructure provisioning		Pre-built software stacks	Model Optimization / Rationalization (e.g. AWS Sagemaker NEO)	
ML Frameworks	MXNet		TensorFlow		Chainer		Gluon		PyTorch	Horovod (and many others)
Data Types	Structured Data			Unstructured Data Copyright 2020 Troy Angrignon. Version 2				Semi-structured data	Time series data	
Data	Data Warehouse		Big Data Processing (e.g. MapReduce/Hadoop)		Data Orchestration & ETL (& ELT!)		Analytics & Visualization		Relational Databases	NoSQL/Non-relational databases
Compute Virtualization	Virtual Machines			Containers			Serverless (e.g. AWS Lambda, Microsoft Functions)			
Compute Hardware	Inference + Training Accelerators (e.g. AWS Inferentia, Google TPU, etc.)			GPUs (NVIDIA, ARM, etc.)			CPUs (Many)			
Storage Infrastructure	File storage		Object storage		Block storage		Hybrid storage		Archiving & Backup storage	Bulk data transfer systems
Network	Virtual Network		Connectivity		Domain Name Services		Direct Connections		Load Balancing Services	
Security	Identity & Access Mgmt		Directory Services		Multi-factor authentication		Role based access control		Firewalls	Encryption & PKI

Most common investing focus
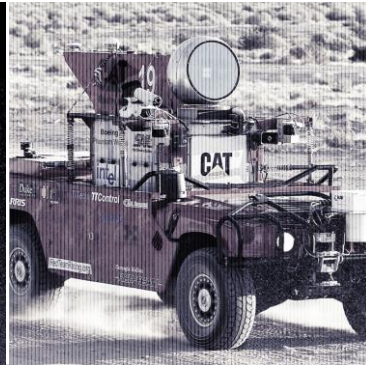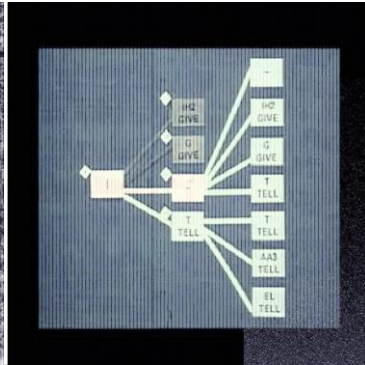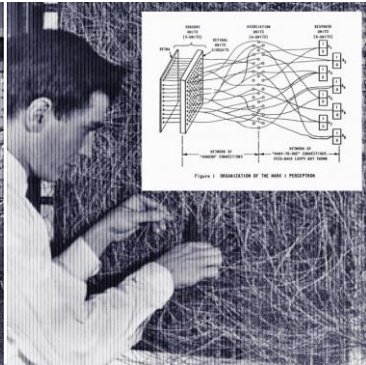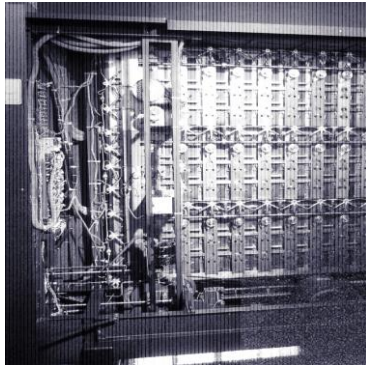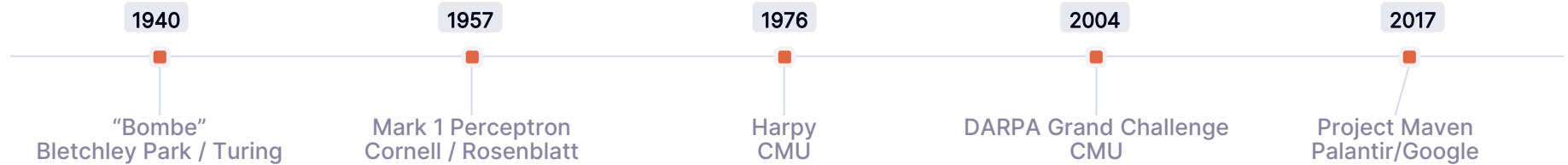
Iffy pricing models, threat from below

Market share of some segments eaten by large companies ex. Google AutoML, AWS, Microsoft, etc. or open-source

The promising early-stage areas were, in time, covered under a separate Enterprise strategy

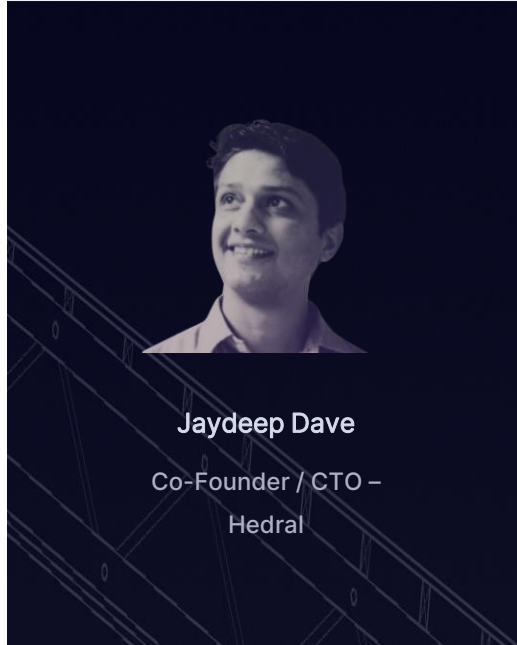Startup leaders including Graphcore, Cerebras etc. – generally being dominated by Nvidia, Intel

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DoD users and backers have been instrumental throughout history in key milestones

1940	1957	1976	2004	2017

"Bombe"
Bletchley Park / Turing

Mark 1 Perceptron
Cornell / Rosenblatt

Harpy
CMU

DARPA Grand Challenge
CMU

Project Maven
Palantir/Google

Jaydeep Dave

Co-Founder / CTO –
Hedral

- Background in AEC software and automation

- MS in CS, BE in MechE

- Can take off and land a Cessna 172

- Training for 10k next month

What were the big productivity gains in AEC historically:
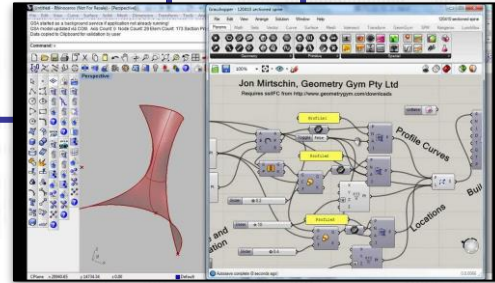
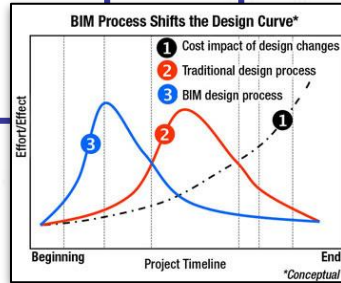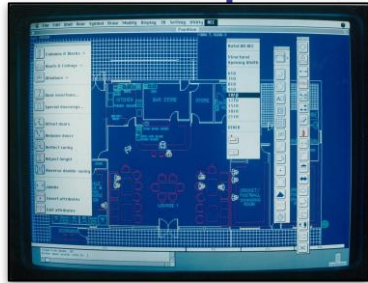1980s   1990s   2000s   2020s

Data Exchange
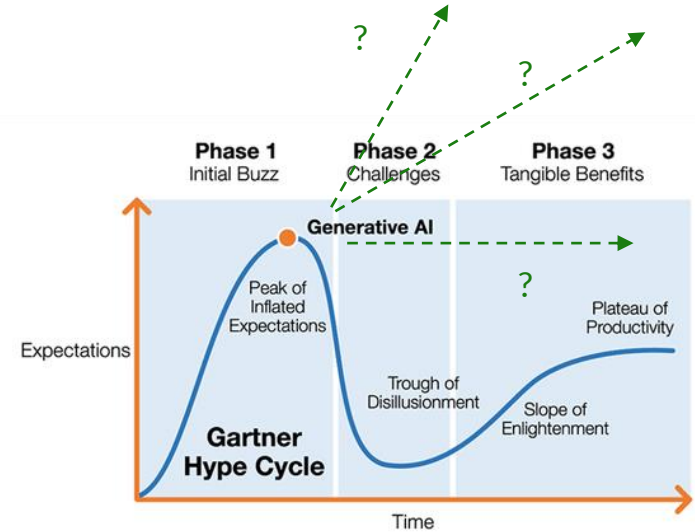
Digital Drafting

Parametric Design

Generative Design

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Today: a breakthrough that will likely affect the industry more profoundly than any of those milestones

Artificial Intelligence vs. Traditional Machine Learning, Generative AI

Characteristic	AI	Traditional ML	Generative AI
Purpose	Develop computer systems that can perform tasks that typically require human intelligence.	Make predictions or decisions based on given data.	Generate new data samples that resemble a given set of training data.
Data Interaction	Models use various techniques and strategies designed to mimic human intelligence across a wide range of applications.	Models learn from data to make predictions or decisions on new unseen data.	Models produce new data that weren't part of the original dataset but share similar characteristics.

Gartner Hype Cycle — Phase 1 Initial Buzz, Phase 2 Challenges, Phase 3 Tangible Benefits. Generative AI. Expectations vs. Time: Peak of Inflated Expectations, Trough of Disillusionment, Slope of Enlightenment, Plateau of Productivity.

The productizeable applications of AI to date have a few things in common...

01

Text

02

Image

03

Code

04

Voice

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The largest 3D object database is limited and inaccurate

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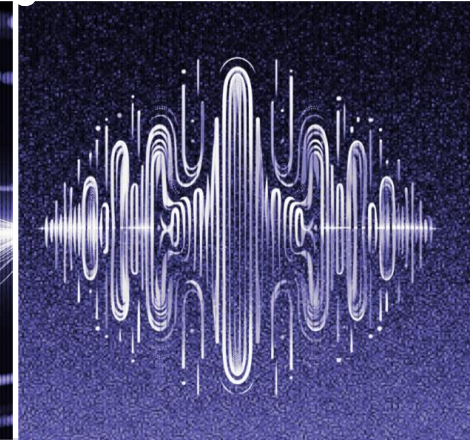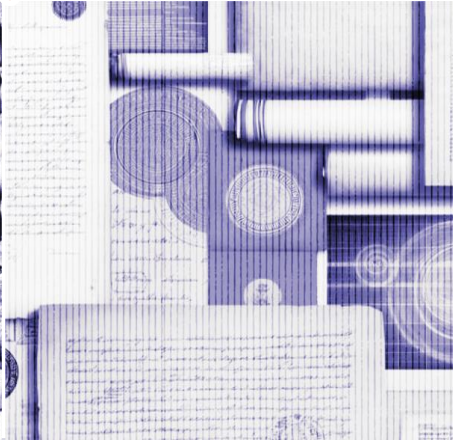
MODEL BENCHMARKS

TEXT

| Capability	Benchmark	Description	Gemini Ultra	GPT-4
	Higher is better			API numbers calculated where reported numbers were missing
General	MMLU	Representation of questions in 57 subjects (incl. STEM, humanities, and others)	90.0% CoT@32*	86.4% 5-shot** (reported)
Reasoning	Big-Bench Hard	Diverse set of challenging tasks requiring multi-step reasoning	83.6% 3-shot	83.1% 3-shot (API)
	DROP	Reading comprehension (F1 Score)	82.4 Variable shots	80.9 3-shot (reported)
	HellaSwag	Commonsense reasoning for everyday tasks	87.8% 10-shot*	95.3% 10-shot* (reported)
Math	GSM8K	Basic arithmetic manipulations (incl. Grade School math problems)	94.4% maj1@32	92.0% 5-shot CoT (reported)
	MATH	Challenging math problems (incl. algebra, geometry, pre-calculus, and others)	53.2% 4-shot	52.9% 4-shot (API)
Code	HumanEval	Python code generation	74.4% 0-shot (IT)*	67.0% 0-shot* (reported)
	Natural2Code	Python code generation. New held out dataset HumanEval-like, not leaked on the web	74.9% 0-shot	73.9% 0-shot (API)

MULTIMODAL

Capability	Benchmark	Description	Gemini	GPT-4V
		Higher is better unless otherwise noted		Previous SOTA model listed when capability is not supported in GPT-4V
Image	MMMU	Multi-discipline college-level reasoning problems	59.4% 0-shot pass@1 Gemini Ultra (pixel only*)	56.8% 0-shot pass@1 GPT-4V
	VQAv2	Natural image understanding	77.8% 0-shot Gemini Ultra (pixel only*)	77.2% 0-shot GPT-4V
	TextVQA	OCR on natural images	82.3% 0-shot Gemini Ultra (pixel only*)	78.0% 0-shot GPT-4V
	DocVQA	Document understanding	90.9% 0-shot Gemini Ultra (pixel only*)	88.4% 0-shot GPT-4V (pixel only)
	Infographic VQA	Infographic understanding	80.3% 0-shot Gemini Ultra (pixel only*)	75.1% 0-shot GPT-4V (pixel only)
	MathVista	Mathematical reasoning in visual contexts	53.0% 0-shot Gemini Ultra (pixel only*)	49.9% 0-shot GPT-4V
Video	VATEX	English video captioning (CIDEr)	62.7 4-shot Gemini Ultra	56.0 4-shot DeepMind Flamingo
	Perception Test MCQA	Video question answering	54.7% 0-shot Gemini Ultra	46.3% 0-shot SeViLA
Audio	CoVoST 2 (21 languages)	Automatic speech translation (BLEU score)	40.1 Gemini Pro	29.1 Whisper v2
	FLEURS (62 languages)	Automatic speech recognition (based on word error rate, lower is better)	7.6% Gemini Pro	17.6% Whisper v3

01 **Real Estate Staging**

02 **Conceptual Design**

03 **Field Reports**

04 **Construction Monitoring**

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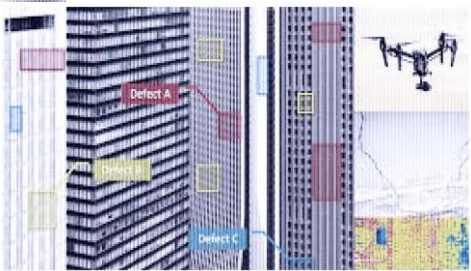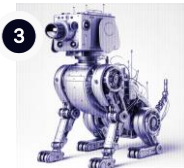
The roadmap for Generative AI in AEC – it's only a matter of time:
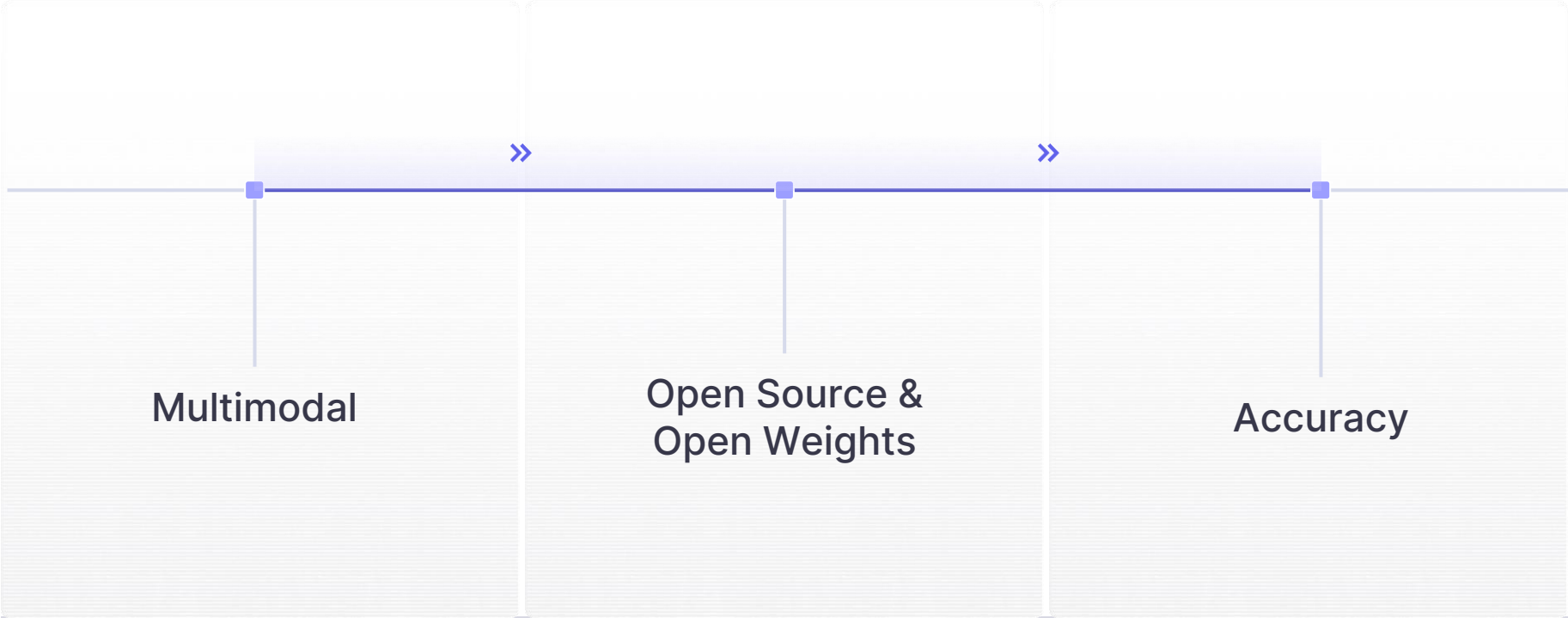
Multimodal » **Open Source & Open Weights** » **Accuracy**

WORK WITH US

Have proven tech and kicked off commercial new-build contracts across a handful of states in the US

Have raised $ and rapidly expanding team to accelerate

AFWERX SBIR Phase I completed, actively seeking Phase II and IIIs, OTAs or other vehicles for partnership

To Defense Users -

Direct Contracting (we are an SDB)

R&D Partnerships – SBIRs/STTRs/Grants

Product feedback / roadmapping

To Industry Partners -

AE and Design-Build Teaming

Dual-Use Commercial Partnerships

Join Us

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SCAN ME
to learn more

❖ hedral

Q&A

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