# The Causal AI Revolution is Happening Now

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**"Machines' lack of understanding of causal relations is perhaps the biggest roadblock to giving them human-level intelligence."** ~ Judea Pearl, *Turing Award winner and AI pioneer*

**"Causality is very important for the next steps of progress of machine learning."**
~Yoshua Bengio, *Turing Award winner and "Godfather of Deep Learning"*

**"Few topics in AI could be more important; perhaps nothing else so important has been so neglected."** ~ Gary Marcus, *NYU Professor*

## At a glance

Causality is one of the key missing ingredients that's needed to unlock real progress in AI. This is fast becoming the consensus view, within academia and industry.

AI luminaries, like Pearl and Bengio, have been arguing for equipping machines with the ability to reason about cause and effect for many years.

There's been a recent explosion of research activity in causality in AI (see Fig 1). Big tech companies including Microsoft, Amazon, Facebook, Google, Netflix and Uber have all started investing heavily in Causal AI.

Businesses from all industries are beginning to appreciate the benefits of this breakthrough technology and are seeking an enterprise Causal AI Platform that automates advanced and scalable causal methods. A race is on to build mature Causal AI, adopt it in industry, and harness its unique benefits. We sketch why a causal revolution is already taking place right now.

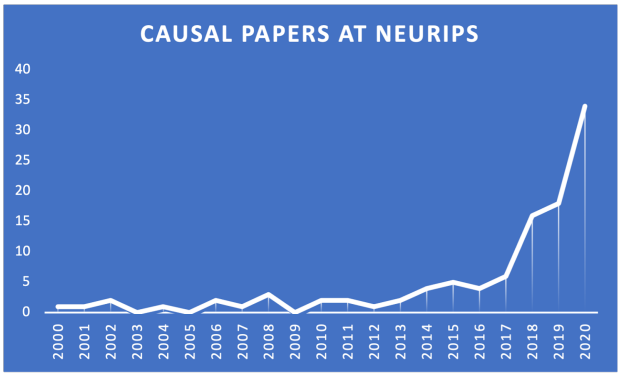


**Fig.** The number of papers presented at NeurIPS, the leading AI conference, with the term "causality" or something similar in their title, has ballooned in recent years.

"Causal models have a unique combination of capabilities could enable a deeper understanding of complex systems and allow us to better align decision systems with society's values."

DeepMind

## Why Causal AI?

Why is causality so important for AI? In essence, an appreciation of cause and effect is a necessary requirement for true intelligence.

**Beyond data**
Models of the world that include causality are able to efficiently identify the critical information in datasets while discarding all the irrelevant and often misleading correlations. This creates simpler and more powerful models that make superior predictions.

"You are smarter than your data. Data don't understand cause and effect; humans do."

Judea Pearl

More than this, causality goes beyond data. "You are smarter than your data", as Pearl says, "data don't understand cause and effect; humans do". We use causal knowledge to anticipate how our actions will impact the environment, and thereby formulate plans and strategies. We depend on causal reasoning to imagine possible worlds that differ from our own, a competence that allows us to diagnose why something happened as it did. AI that understands cause and effect can harness these powerful abilities too.

**Solving open challenges in AI**
Causality promises to unlock progress on some of the biggest open problems in AI. Current AI systems crash when faced with novel data. They are bad at transferring learning to new tasks. They fail in deployment when the world changes unexpectedly. And they are susceptible to adversarial attacks.

These problems stem from current machine learning systems' inability to make reasonable generalizations. Researchers believe causality can solve this deep challenge. "Generalizing well out the [training] setting requires learning not mere statistical associations between variables, but an underlying causal model", say a group from Google Research and the Montreal Institute for Learning Algorithms (MILA).

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**Human-machine symbiosis**
Most current AI systems are black boxes that cannot be understood, even by their programmers. And they are often poorly aligned with human values.

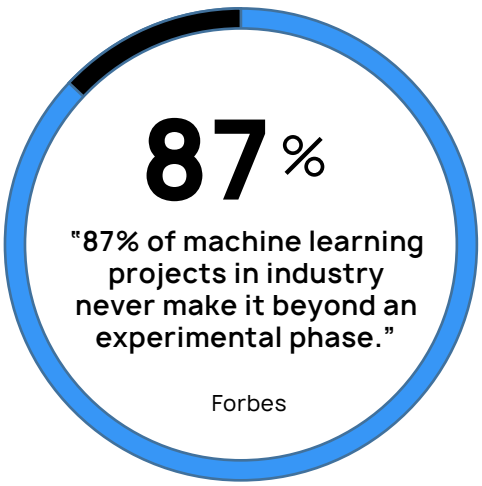
Causal AI is at the cutting edge of "XAI" (eXplainable AI) and AI fairness. Unlike conventional AI which trades off transparency for accuracy, causality-based models deliver high performance and explainability. Causal AI also enables tech developers to maintain better control over AI systems, ensuring they behave as intended in production.

Causal AI has a "unique combination of capabilities", DeepMind argues, "that could enable a deeper understanding of complex systems and allow us to better align decision systems with society's values."

## Why Now?

There are several emerging trends that are changing how AI is used by businesses, all of which favour the adoption of Causal AI.

**Dissatisfaction with current machine learning**
Firstly, there is growing dissatisfaction within industry with current machine learning algorithms. Nine in ten businesses fail to generate meaningful financial returns from AI investment, according to a recent global survey. 87% of machine learning projects never make it beyond an experimental phase into production, according to Forbes. Pandemic-related disruption has accelerated this trend, with machine learning models failing to adapt to changing conditions.




**Prioritising explainability**
Second, there is a growing recognition that the explainability, safety and fairness of AI systems are critical in business settings. This global trend has been boosted by a recently inked EU proposal for new regulation of AI systems. The wide-ranging incoming legislation mandates that businesses should provide explainability reports, apply stress tests and ensure humans remain "in the loop".

**Fostering human-machine partnership**
Third, companies that benefit most from AI now tend to foster human-machine partnerships to generate new kinds of value. These leading organizations are outcompeting those that use AI in machine-only applications. Companies that prioritize human-machine partnerships have a 73% greater chance of reaping the biggest financial benefits from AI, a recent MIT Sloan & BCG global survey finds.

**Navigating the world of big data**
Fourth, the total volume of data is vast and increasing exponentially. However many datasets are correlated, expressing similar facts about the world. Businesses increasingly place a premium on identifying the right data to answer their questions and achieve their goals. To do so they need technology that can penetrate beneath correlations to identify distinctive marginal value in data.

These accelerating AI trends — away from standard machine learning and towards explainable, human-compatible AI that goes beyond correlations — are providing extra momentum to the Causal AI revolution. "Causal inference may be the new frontier as we migrate from association-based analysis only", says Jeffrey Bohn, Chief Research Officer at Swiss Re Institute.

> "Causal inference may be the new frontier as we migrate away from association-based analysis only."
> Swiss Re Institute

## How are Businesses being Impacted?

Early adopters of Causal AI benefit from remarkable improvements in business decision making.

E-commerce platform eBay found that conventional AI wildly overestimates advertising effectiveness. They found that conventional AI estimated the ROI of advertising clickthrough as 1400%, but causal analysis revealed the true ROI to be negative 63%.

A Harvard Business School study found that businesses using AI for churn prevention would achieve an additional reduction of 4.1-8.7% in churn rate by using causal methods as compared to standard predictive analytics.

Business-oriented social network LinkedIn conducts 20,000+ experiments each year, but some A/B tests can be unethical or impractical. LinkedIn turned to AI to simulate infeasible experiments, and found that correlation-based methods produced errors ranging from 46-250% outside the true values. LinkedIn's researchers concluded that, "It is dangerous to assume correlational results are causal… Causal studies, when properly applied, make the best use of the available data to improve decision-making ability."

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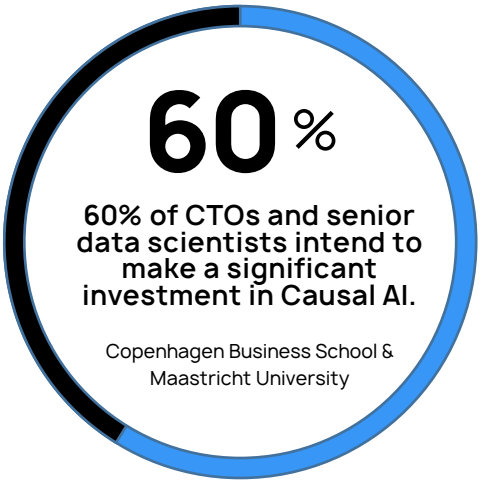
Beyond LinkedIn, most big technology companies are starting to benefit from adopting Causal AI. Netflix is a good example. Recognizing that "causal inference and machine learning have a symbiotic relationship that is growing deeper", Netflix Research have "made a large investment in increasing the performance of causal inference algorithms". Similarly, Uber Labs are doubling down on causality and say that "causal inference provides information that is critical to making business decisions through better understanding the impact of key initiatives."

Causal AI-enabled counterfactual analysis, or "artificial imagination", is also beginning to make an impact. Causal AI achieves expert clinical accuracy in medical diagnosis through counterfactual analysis. Causal AI places in the top 25% of doctors when benchmarked against humans while conventional machine learning has middling performance, a Nature article finds.

Also in a healthcare context, counterfactuals have been applied in several high impact use cases for social good. These include diagnosing the causes of childhood disease in Pakistan, and combatting hesitancy to visit hospitals among women in India's rural north. The Harvard-affiliated team who worked on these applications concludes, "We may yet find that an ounce of causal AI is worth a pound of prediction."




> "Causal inference and machine learning have a symbiotic relationship that is growing deeper… We have made a large investment in Causal AI."
>
> Netflix Research

Counterfactual analysis has enormous transformative potential beyond healthcare, not least in business and finance settings. Riffing on the power of artificial imagination, Head of Hedge Funds at APG Michael Weinberg states, "what most excites me is seeing managers deploying new techniques like causality… new techniques and data are really beginning to expand the potential for AI strategies in a meaningful way".

Many other leading portfolio managers agree. Michael Grady, Head of Investment Strategy at Aviva Investors, finds that "Causal AI plays an ever-more important role in our investment analysis. It empowers our strategists and portfolio managers to generate alpha by identifying new causal relationships in economic, financial and alternative data." Similarly, Chris Udy, CIO of Tibra says that "causality-based techniques and automation of quantitative workflows help us discover more orthogonal signals faster while discarding spurious correlations."

Zooming out from these individual examples of impact, a recent global survey found that 87% of CTOs and senior data scientists agree that Causal AI can obtain a more robust model of their business environment. Senior data scientists are also gearing up to make deeper investments in causality. 83% believe causal inference will be of increasing importance for data-driven decision making in the future and 60% intend to make a significant investment in Causal AI.

We have highlighted a variety of trends that are fuelling the Causal AI revolution. Increased research attention, increased investment within industry and increased disillusionment with conventional machine learning are all driving wider adoption of causal methods. With early adopters already seeing impactful results, we believe that the Causal AI revolution has only just begun.

## About us

causaLens is pioneering Causal AI, a new category of intelligent machinesthat understand cause and effect – a major step towards true AI. Its enterprise platform is used to transform leading businesses in Finance, IoT, Energy, Telecommunications and others.

Current machine learning approaches, including AutoML solutions, have severe limitations when applied to real-world business problems and fail to unlock the true potential of AI for the enterprise.

For instance, in the case of predictions, they severely overfit and do not adapt when the environment changes. causaLens' Causal AI Platform goes beyond predictions, providing transparent causal insights and suggesting actions that directly improve business KPIs.

causaLens is run by scientists and engineers, the majority holding a PhD in a quantitative field.

Contact us on info@causaLens.com or follow us on LinkedIn and Twitter.