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ISB: Leadership with AI

Week 1 – AI and ML: An Overview

A Brief History of AI

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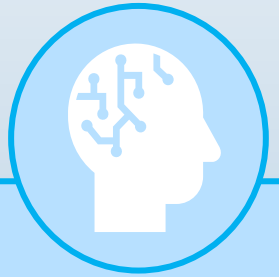
Definition of AI



A set of algorithms designed to perform tasks that typically require human intelligence, ranging from recognising speech to making decisions.

History of AI

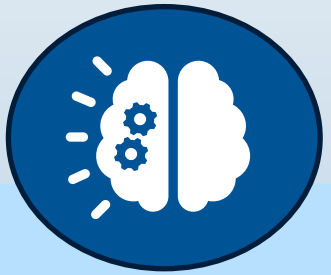
Pioneers in AI: AI's journey began with the development of the general problem solver by Herb Simon, Cliff Shaw and Alan Newell.

Early AI System: The early AI system utilised a set of "if-then" rules to address unstructured problems.

Application Example: One of the notable problems AI tackled was the Towers of Hanoi.

Machine Learning vs Deep Learning

Machine learning algorithms learn from data to make predictions.



Deep learning algorithms use neural networks to analyse complex, unstructured data.

Expert Systems

Designed to emulate human decision-making through predefined rules

IBM’s Deep Blue Chess-playing Program

In 1997, IBM's Deep Blue defeated the reigning champion, Garry Kasparov.

Deep Blue processed about 200 million possible moves per second to determine the optimal next move.

The system looked 20 moves ahead using a tree search algorithm to make decisions.

These optimal decisions were based on formalised phenomena, exemplified by Deep Blue's success in chess.

Modern AI

- Excels in areas that require learning from vast amounts of data rather than relying on if-then logic
- Replicates human cognitive functions

Expert Systems vs Modern AI

Expert Systems

- Rely on predefined if-then rules
- Do not equate to true intelligence due to reliance on fixed rules

Modern AI

- Utilises algorithms that learn from vast amount of data
- Employs pattern matching and neural networks that mimic brain neurons, enabling advanced capabilities

Deep Blue vs Deep Mind

AI Milestone: Deep Blue vs Deep Mind

1996

Deep Blue vs. Kasparov marked a pivotal moment in AI history. Although Kasparov won the match 4-2, Deep Blue's ability to compete was groundbreaking.

1997 Rematch

An upgraded Deep Blue won the six-game challenge 3.5-2.5, becoming the first computer to defeat a reigning world champion in standard chess tournament time controls.

Deep Blue

Achieved victory through “brute force” computation

Specialised computer capable of inspecting 200 million moves per second, 50 billion positions in three minutes, typically allocated for a single move

Played by finding and executing the optimal move for every counter move of the opponent

Used combinatorial optimisation to search the state space and choose the best move

AlphaGo

- Defeated Go Champion, Lee Sedol, representing a giant leap forward in AI
- Utilised deep neural networks, which mimic the human brain by integrating learning techniques such as supervised and reinforcement learning to make strategic decisions.

AlphaGo vs Lee Sedol

Illustrated the shift from algorithms based on raw computational power to sophisticated learning algorithms that can strategise and adapt

Displayed intuition which is the ability to play a beautiful game not like a person but in way no person could

Experts and commentators voiced how odd its moves are, specifically move 37. However, it was trading off short-term losses for long-term successes

Understood the goal was to win the game and not every move like how humans rationalises some moves

Processed and analysed vast amount of data using deep neural networks (used 1920 CPUs, 280 GPUs and a powerful statistical software)

Deep Mind: AlphaGo

- Learned by stimulating many random games
- Used the rule book to understand rewards and penalties
- Used neural networks to predict the next move based on the current board position

Neural Networks

Draw inspiration from the human brain, learns patterns from data to solve complex problems like image recognition and language translation

Train on millions of human expert games to learn patterns and strategies

Evaluate the overall strength of a board position, estimating the probability of winning from that point

Use reinforcement learning to adjust the weights of the neural network based on the outcomes of the games

Reinforcement Learning

A type of machine learning where an agent learns to make decisions by:

- Taking actions in an environment
- Receiving feedback in the form of rewards and penalties with the aim of maximising cumulative reward overtime

An Introduction to AI Methods

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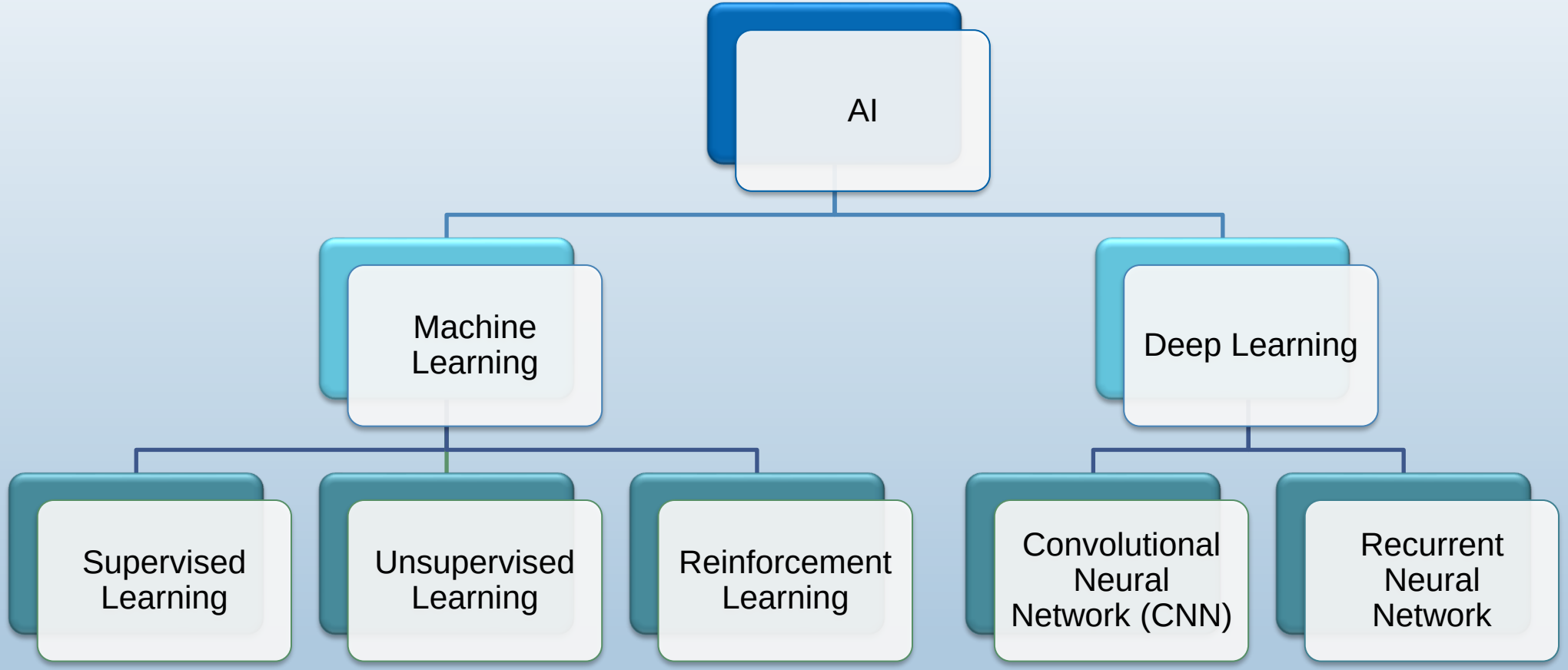
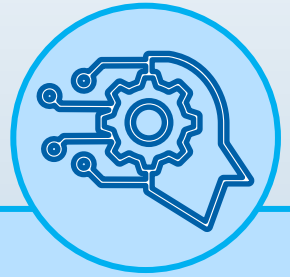
AI Techniques (Managerial)

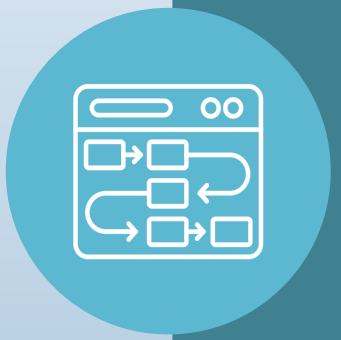


Machine Learning Algorithms



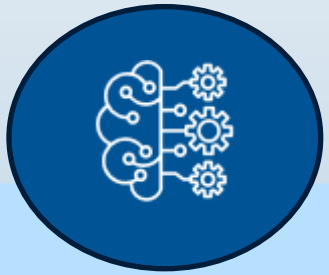
- Detect patterns from large data sets, which are used to make predictions
- Learns relationships between variables and labels

Labels



- Represent the mapping between input and output from previous data
- Used to predict classified data

Supervised vs Unsupervised Learning



Predicts an output from input using historical data when the data is structured or quantitative

Classifies data into groups based on homogeneous patterns in the data

Netflix’s Recommendation Engine: Solution

Collaborative Filtering

- Employs sophisticated machine learning algorithms to recommend items based on the viewing histories of similar users
- Leverages the collective behaviour of the user base to make accurate predictions

Content-based Filtering

Uses machine learning to recommend content based on user attributes like genre, actors, themes and viewing history, suggesting similar content that aligns with users' unobserved preferences.

Hybrid Approaches

Combines two machine learning methods to provide more accurate and personalised recommendations, ensuring suggestions are popular among similar viewers and align with individual tastes and preferences

Machine Learning in the Healthcare Sector

Patient 1	Patient 2
Age: 23	Age: 35
First pregnancy: No	First pregnancy: No
Anaemia: No	Anaemia: No
Diabetes: No	Diabetes: Yes
Previous premature birth: No	Previous premature birth: Yes
Ultrasound: Normal	Ultrasound: Abnormal
Emergency C-section: No	Emergency C-section: No

- The primary goal is to predict high-risk C-section patients.
- Hospitals or physicians can use machine learning algorithms to analyse data to identify patterns indicating high-risk C-sections.

Machine Learning in the Healthcare Sector

Steps to Create a Model

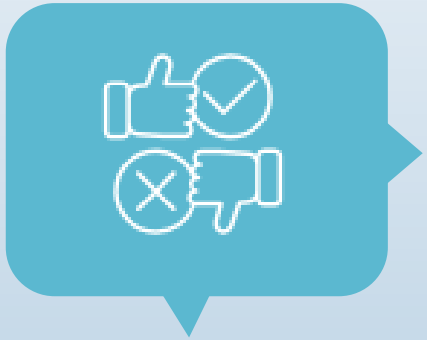
Ensure data is clean and ready for analysis by handling missing values, normalising data and splitting it into training (used to learn patterns) and testing (used to predict outcomes) sets.

Techniques that assess which features are important predictors help determine the features with the greatest impact on outcomes.

The training dataset is used to build machine learning models like decision trees, logistic regressions or neural networks. These models learn patterns from the data.

Machine Learning in the Healthcare Sector

Steps to create a model

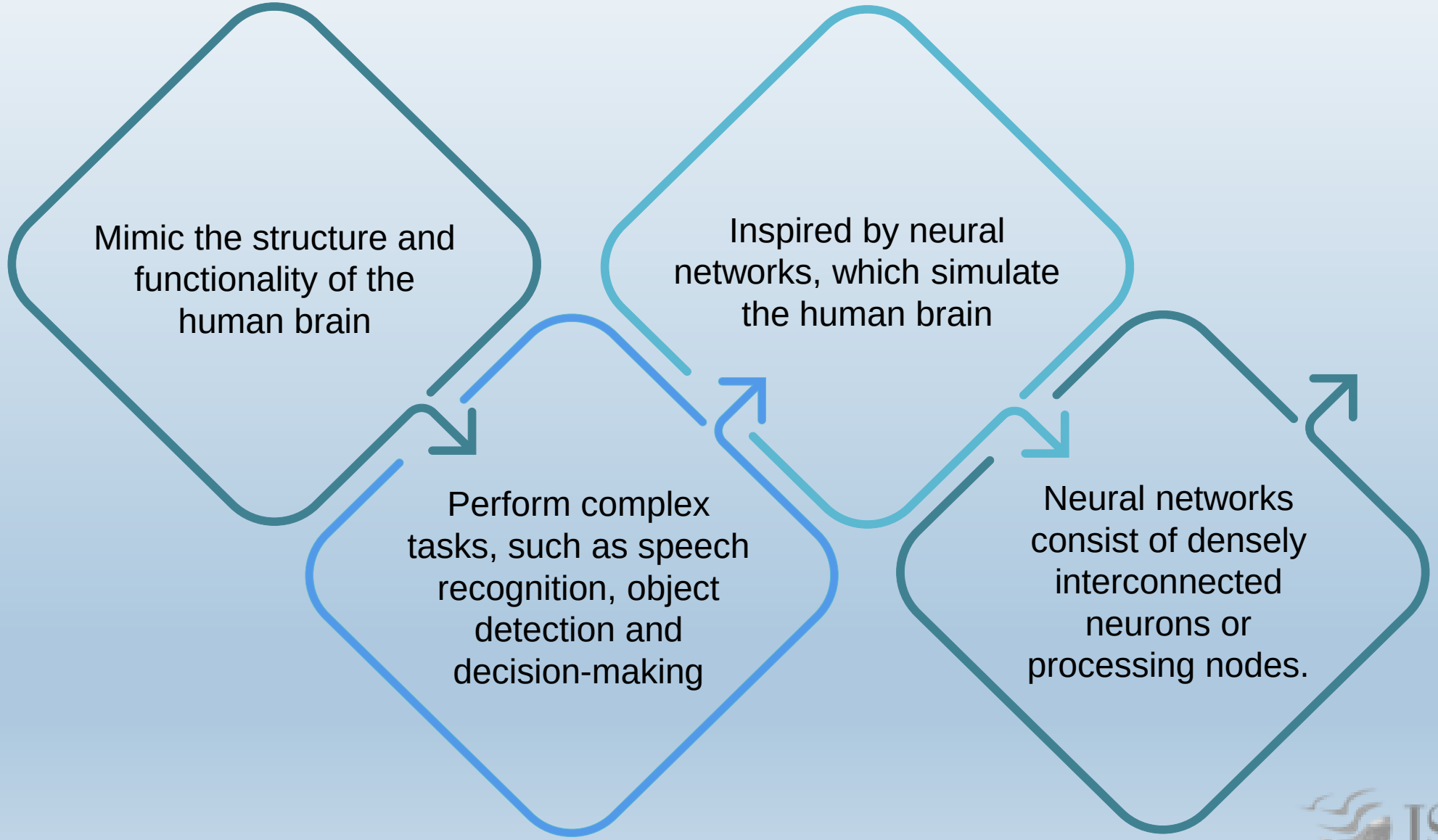


- Test the model's performance using metrics like accuracy, precision, recall, and F1 score.

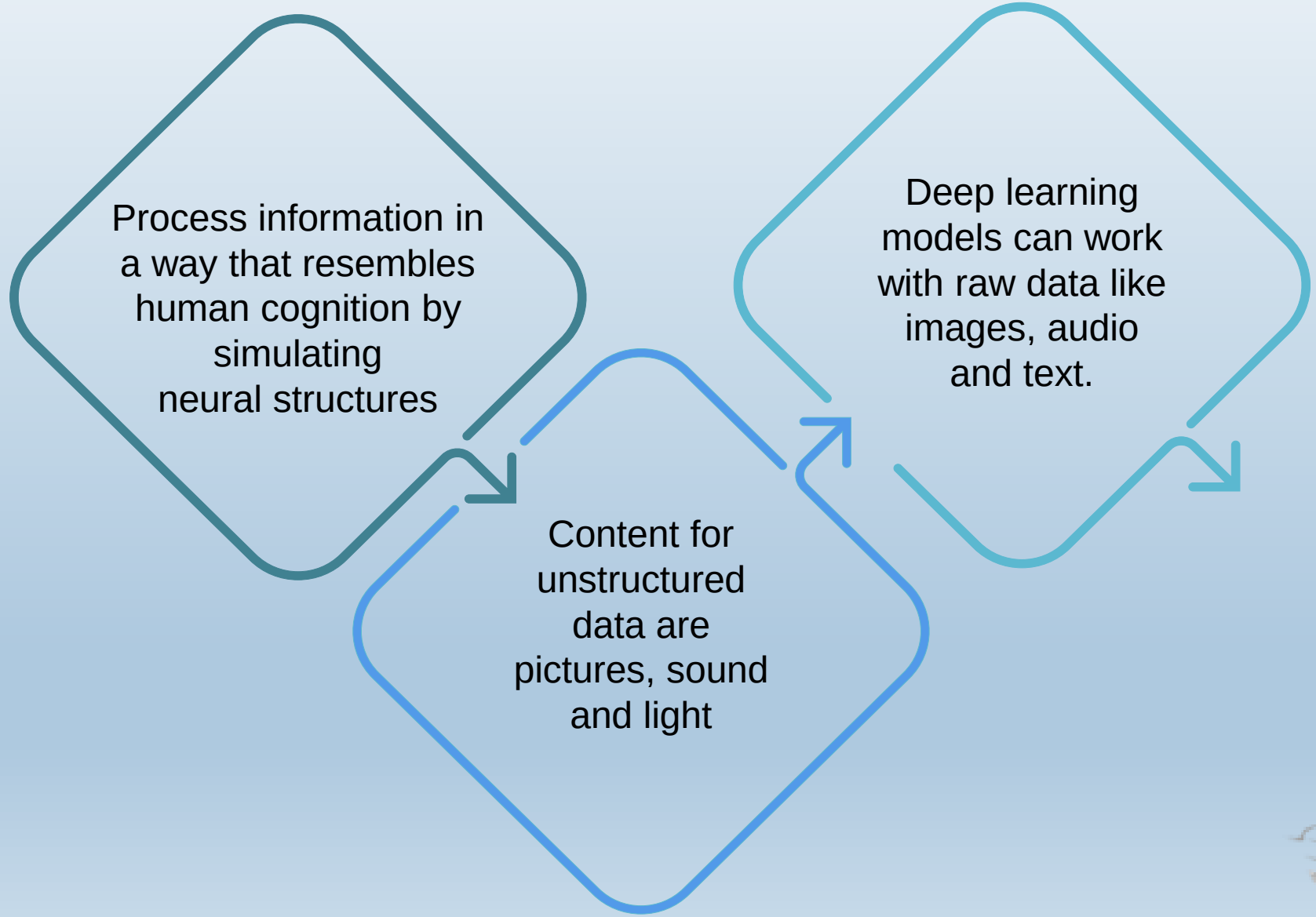
- Perform cross-validation by dividing the sample and redo the analysis to verify the model's robustness.

- Deploy the model and input relevant features into it to predict the risk of C-section for new patients.

Deep Learning Algorithms



Deep Learning Algorithms



Neural Networks

- Form the core of deep learning
- Composed of multiple layers with numerous neurons
- Designed to process vast data and recognise intricate patterns

Neural Networks

- Extracts complex representations of input, discerning relationships
- Structured into input, hidden and output layers
- Each layer identifies specific features in the data

Neural Networks

Example: Image recognition

- Initial layers detect simple edges and shapes.
- Deeper layers identify more complex structures (faces or even objects).
- The hierarchical learning process enables deep learning modules to understand and interpret data with remarkable accuracy.

Deep Learning in Autonomous Cars

Sensors (cameras, lidar and radar) perceive the car's surroundings).

Deep neural networks process sensor data to detect and classify objects, lane markings and other relevant information for driving.

Deep reinforcement learning involves trial and error, receiving rewards for safe driving and penalties for dangerous driving.

AI: Beyond Automation

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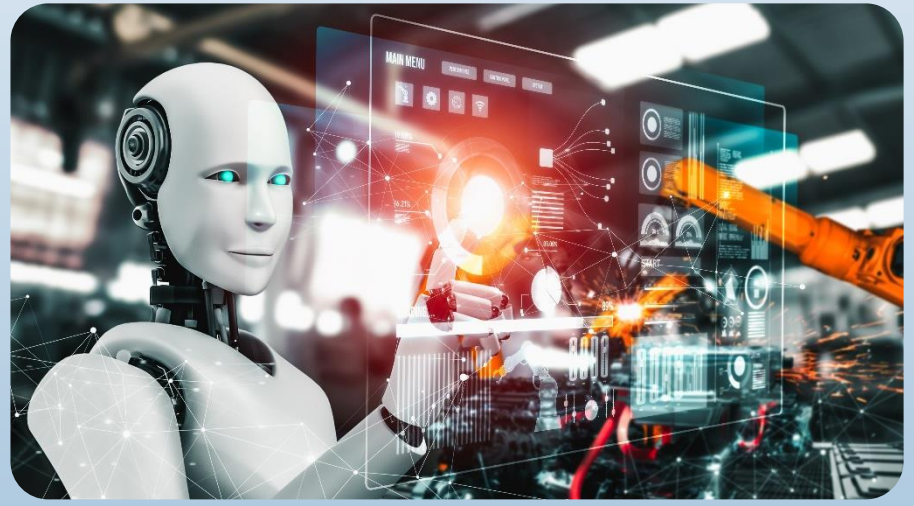
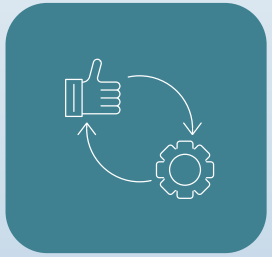
Robotic Process Automation (RPA)



- Uses robots to automate repetitive and rule-based business processes like data entry, invoice processing and report generation
- Frees up human workers for tasks requiring creativity, problem-solving and decision-making

Characteristics of RPA



Consistency and Reliability:

Performs tasks in the same way every time

Pre-defined Workflows:

Follows specific sequence without deviation

No Learning Ability:

Does not adapt or improve over-time, strictly follows programmed rules and instructions

High Effectiveness:

Ideal for structured, repetitive tasks, enhancing operational efficiency

Applications of RPA

RPA integrates with APIs and user interfaces to perform repetitive tasks across various applications.

RPA bots communicate with different systems and software, ensuring seamless data transfer and process execution.

RPA bots emulate human processes by following predefined workflows and scripts.

Manual Invoice Processing: Challenges

- Delays in payment processing impact supplier relationships and operational efficiency.
- Limited real-time tracking of invoice status and issues hinders timely decision-making and resolution.

Manual Invoice Processing: Solution

Data Extraction

RPA bots extract relevant data from invoices in various formats, such as PDFs and emails, speeding up data collection and reducing errors.

Data Validation

RPA bots compare extracted data with purchase orders and vendor information, flagging discrepancies for human review.

Automated Data Entry

RPA bots enter validated invoice data into the ERP system, eliminating errors and speeding up the process.

Approval Management

RPA bots Initiate and manage approval processes, notifying stakeholders and escalating issues as needed.

Real-Time Reporting

RPA bots generate reports on invoice status, processing times and exceptions, providing insights to address bottlenecks and inefficiencies.

Benefits of RPA in Invoice Processing

Enhances efficiency and accuracy

Provides greater visibility and control over the invoice processing workflow

Improves supplier relationships and overall operational performance

Applications of AI

Money Laundering

Example: Large global banks (manual approach)

- Employ thousands of staff dedicated to identifying suspicious transactions and accounts
- Labour-intensive and time-consuming process
- Difficult to keep up with the volume and increasing complexity of transaction data

Money Laundering

Example: Large global banks (algorithmic approach)

- Flags suspicious transactional patterns
- Continuously monitors transactions to identify anomalies and potential risks
- Deploys human resources to focus on complex and suspicious cases and conduct in-depth analysis

AI for Cancer Detection

- Google's DeepMind AI, trained on mammograms from the UK and US, was tested against six expert radiologists to evaluate its effectiveness in detecting breast cancer

- Outperformed radiologists in reducing false positives and false negatives by:
  - Reduced false positives by 5.7% (US) and 1.2% (UK)
  - Reduced false negatives by 9.4% (US) and 2.7% (UK)

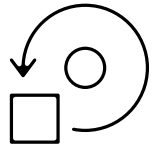
Google's DeepMind AI Algorithm

Excels at recognising intricate patterns in mammogram data enabling to identification of early signs of cancer

Analyses vast imaging data to detect subtle differences and anomalies that are crucial early signs of cancer detection

Ensures more precise and timely diagnosis, ultimately leading to better patient care and more efficient healthcare system

Benefits of Predictive Analytics



Transforms marketing by helping companies better understand and meet customer needs

Boosts revenues by 21% annually for users, compared to 12% for non-users, representing a 9% increase

Highlights the power of using data to anticipate and fulfil customer needs

Use of Predictive Analytics - Starbucks

Starbucks uses its loyalty card and mobile app to collect and analyse customer data.

Starbucks applies machine learning to make personalised recommendations to each customer.

The Starbucks app suggests new products based on customers' ordering preferences.

How Tesla Leverages AI

Tesla uses deep learning simulations to test drivers.

Users provide valuable data to help Tesla improve its software.

Simulations are key to the Full Self-Driving Beta program.

High safety standards for deployment

The program tests and refines autonomous driving with real user feedback.

AI-powered autonomous driving creates opportunities for test drivers to refine the technology.

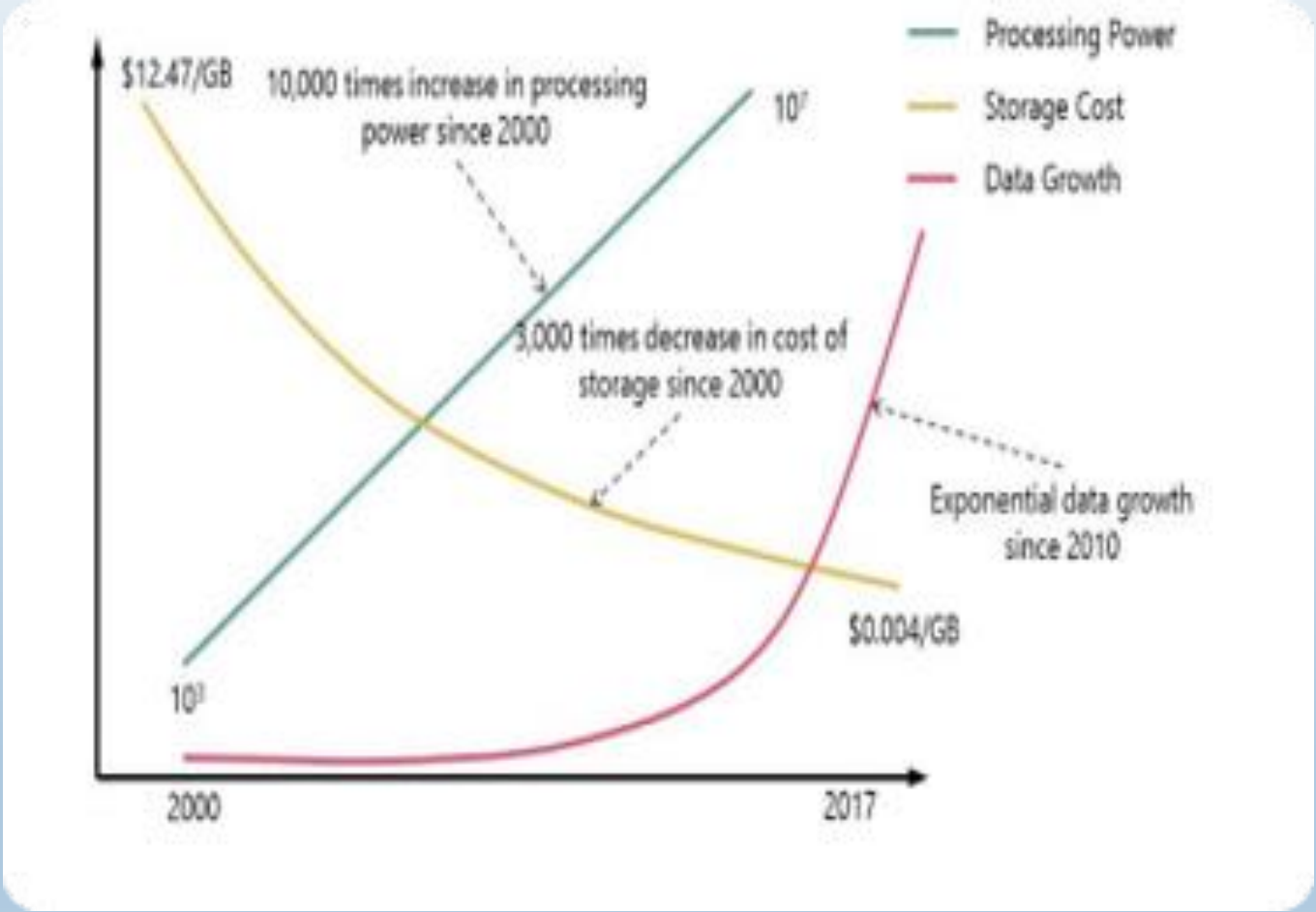
This iterative process ensures the system becomes safer and more reliable over time.

BloombergGPT

- Cutting-edge language specialist specifically trained in finance
- Extracts critical information from dense financial reports and answers financial questions accurately
- AI groups news, articles and report into related topics, simplifying deep dives into specific interests
- Acts as a vigilant watchdog, constantly monitoring market transactions and activities
- Trained to spot unusual patterns indicating potential fraud or market manipulation

AI’s Growing Influence

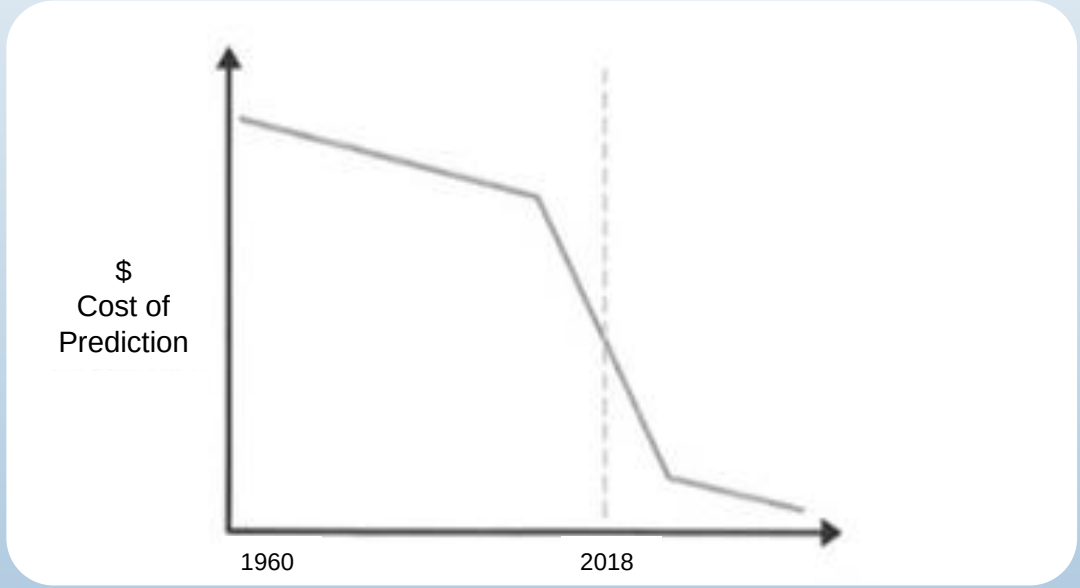
Rise of AI: Three Factors



The intersection of massive power, cheap storage and explosion of data has created ideal conditions for AI to flourish.

Source: https://pbs.twimg.com/media/DcXhoayV4AEetk-?format=jpg&name=small

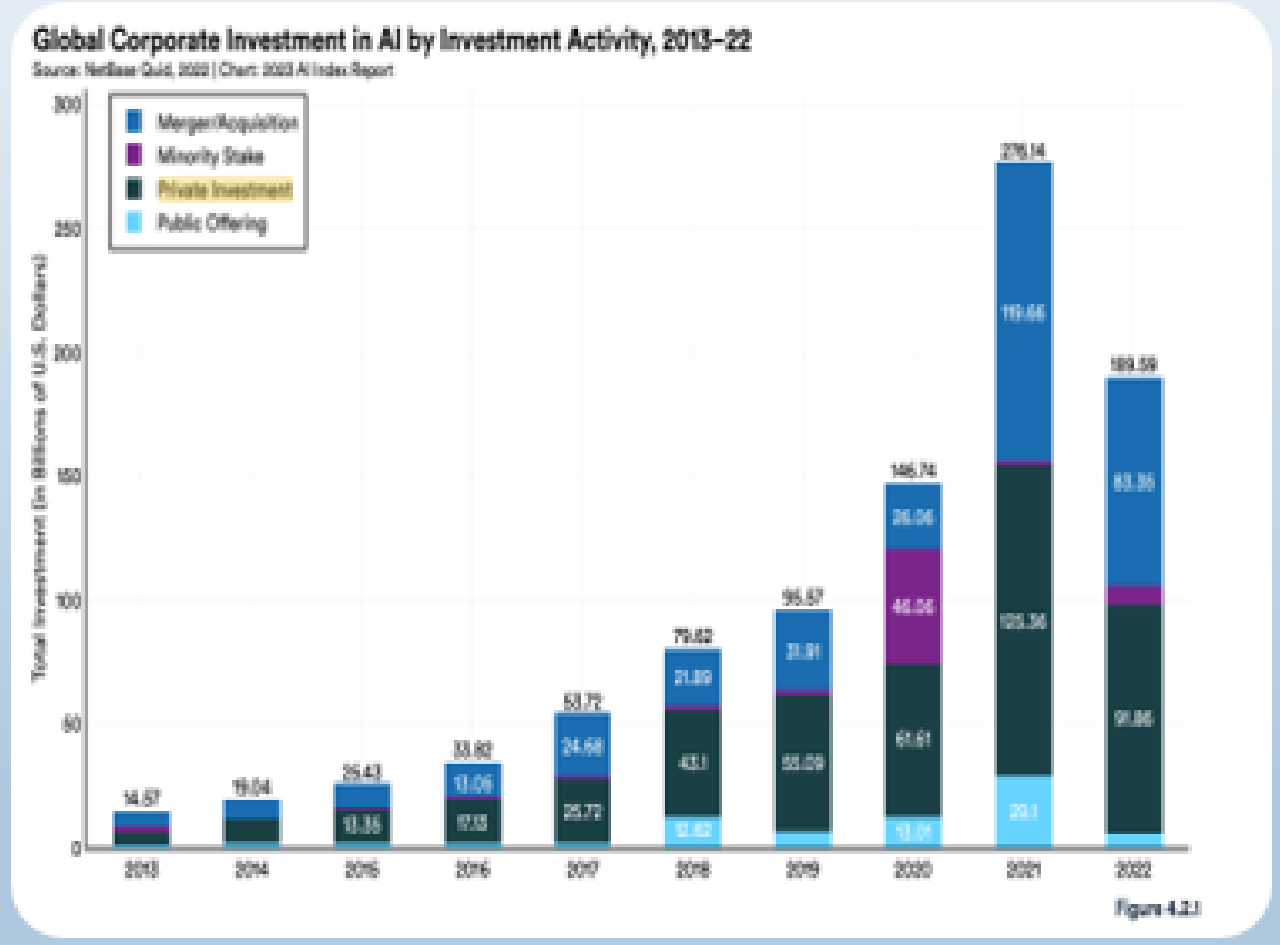
Decline in AI Prediction Cost



There is a dramatic decline as earlier predictions were costly. However, due to technological advancements, the cost curve began to bend downwards in recent years.

Source: Agarwal, Gans and Goldfarb, 2018

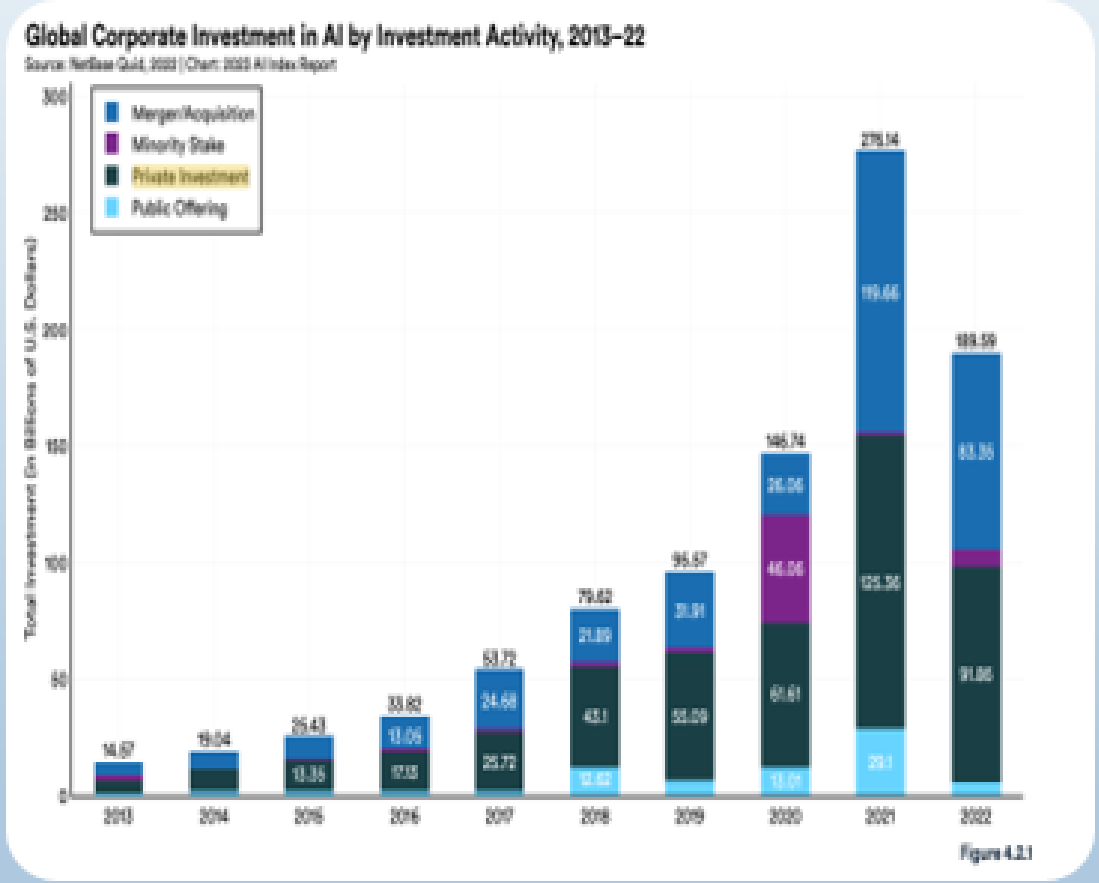
Growth in AI Investment

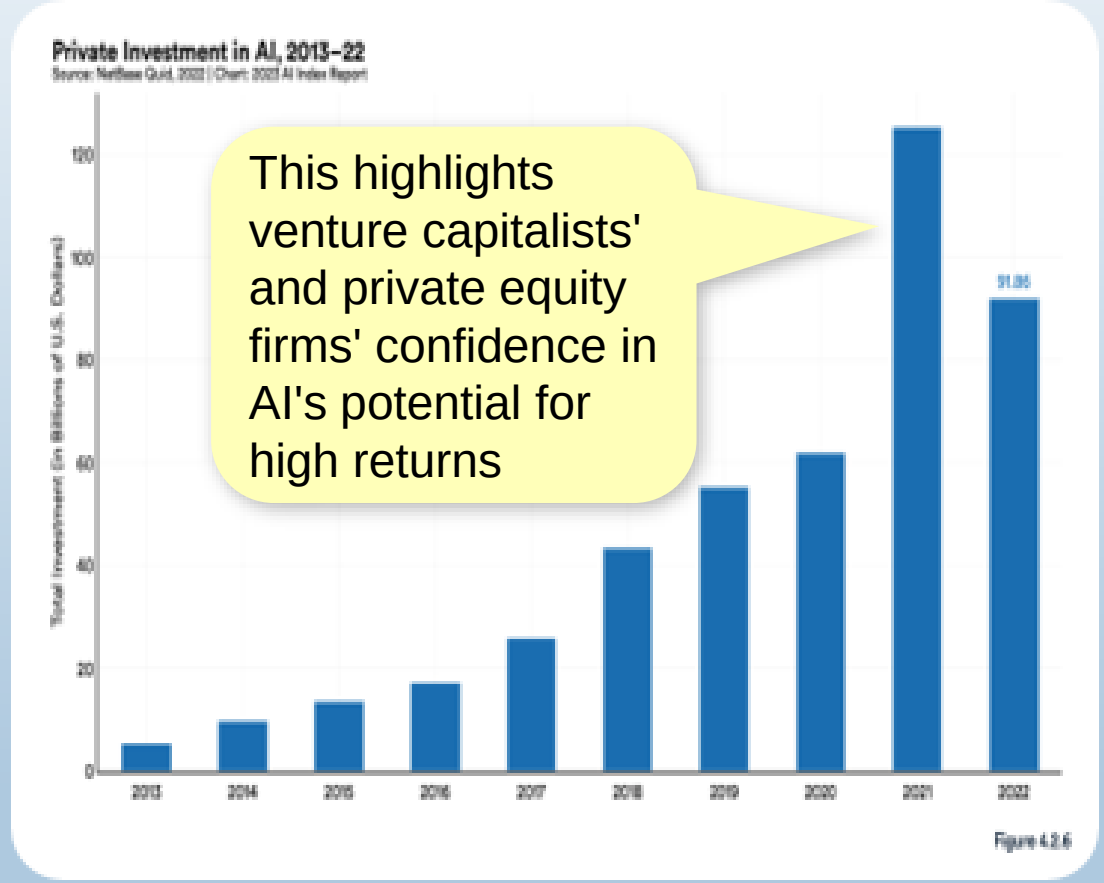


- The largest portion represents mergers and acquisitions, which have increased over time.
- The light blue sections which represent private investment.

Source: Artificial Intelligence Index Report 2023 - Stanford University. (n.d.-b).

Explosive Growth in AI Investment





Source: Artificial Intelligence Index Report 2023 - Stanford University. (n.d.-b).

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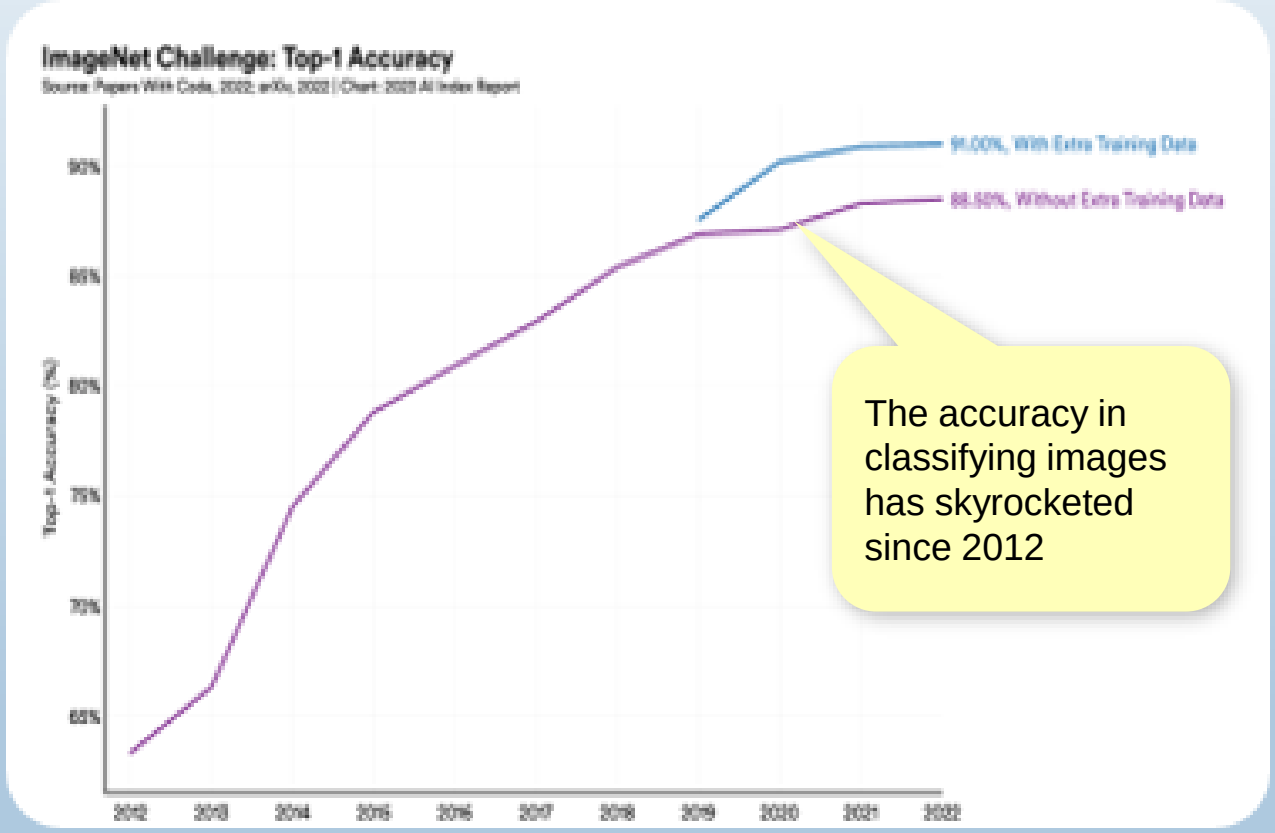
Benchmark of Test Measurement

Image classification



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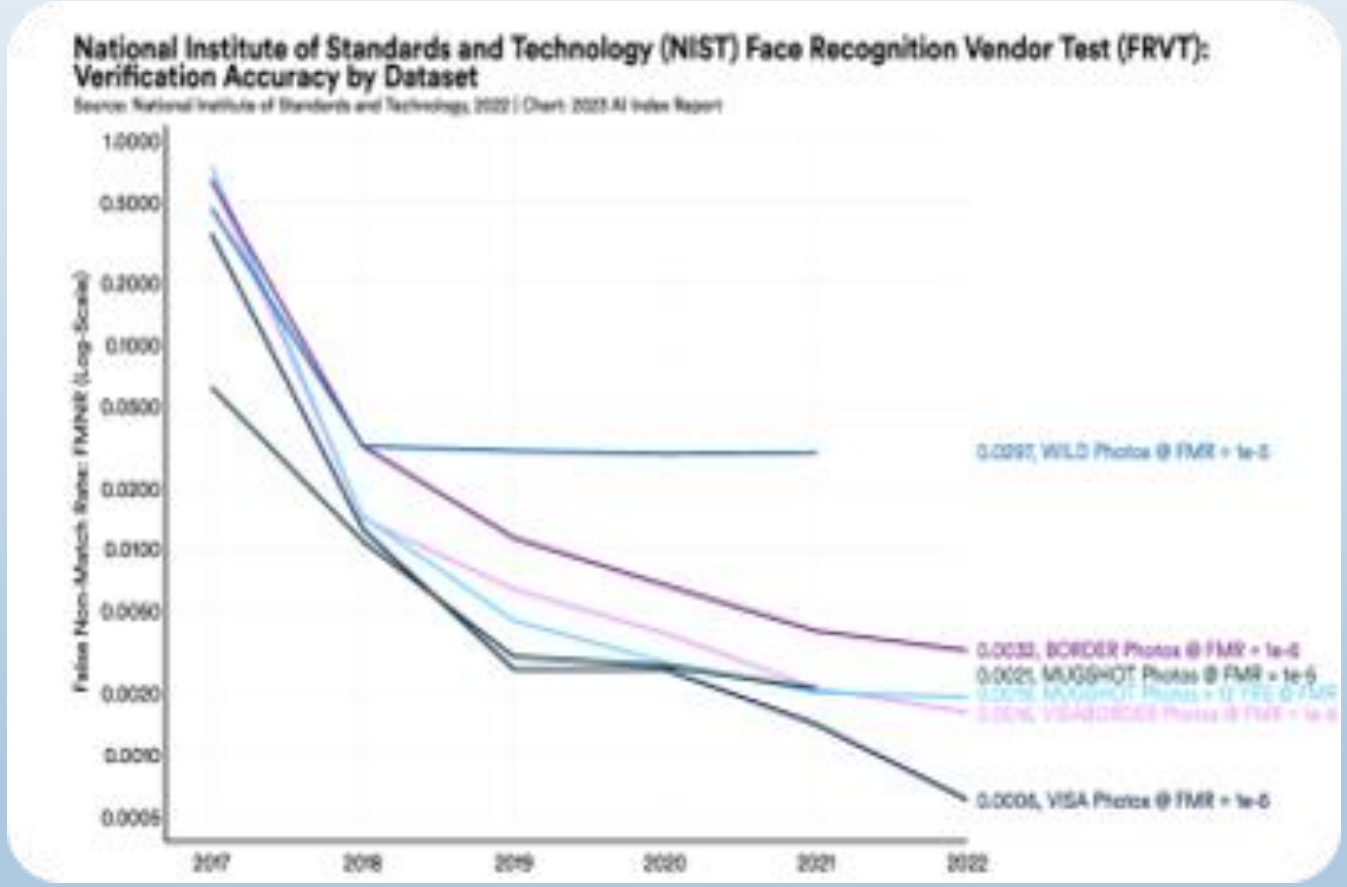
Benchmark of Test Measurement

Facial recognition



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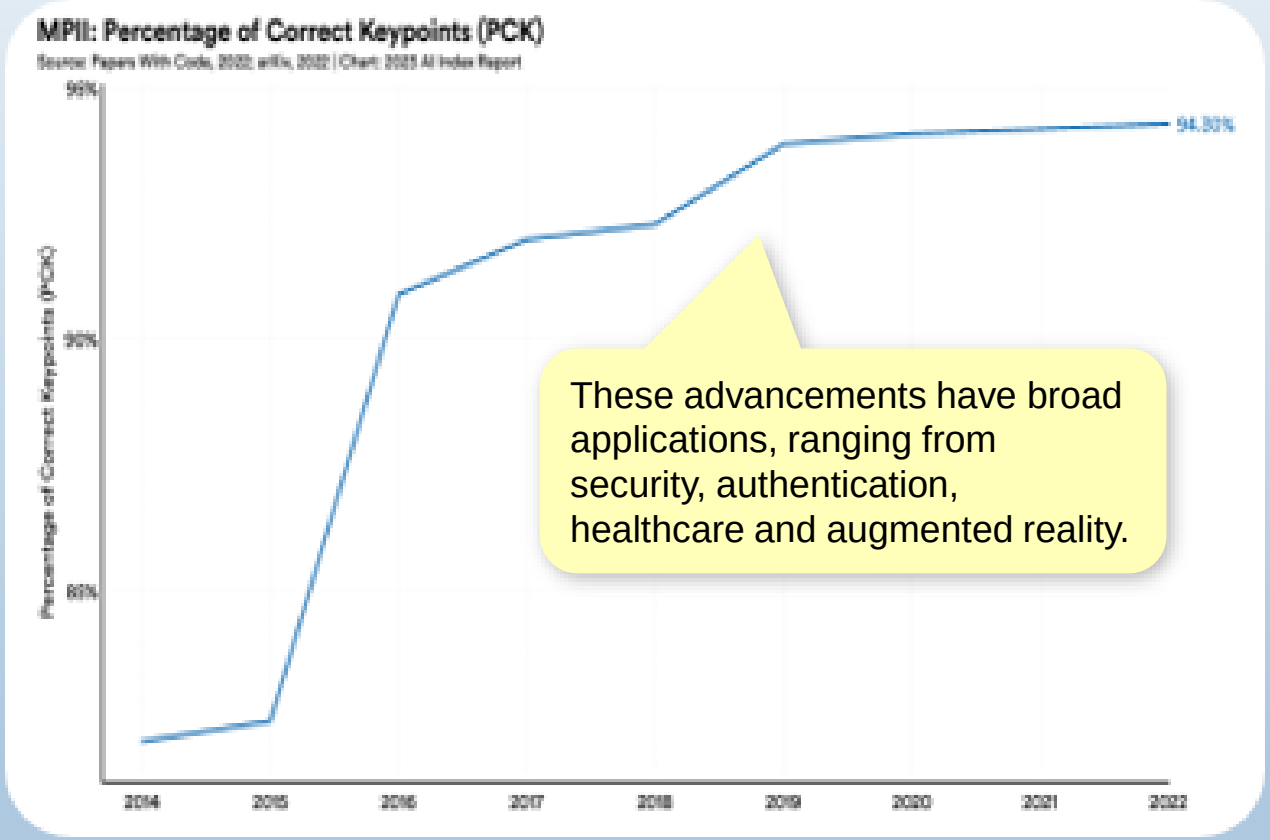
Benchmark of Test Measurement

Deepfake detection



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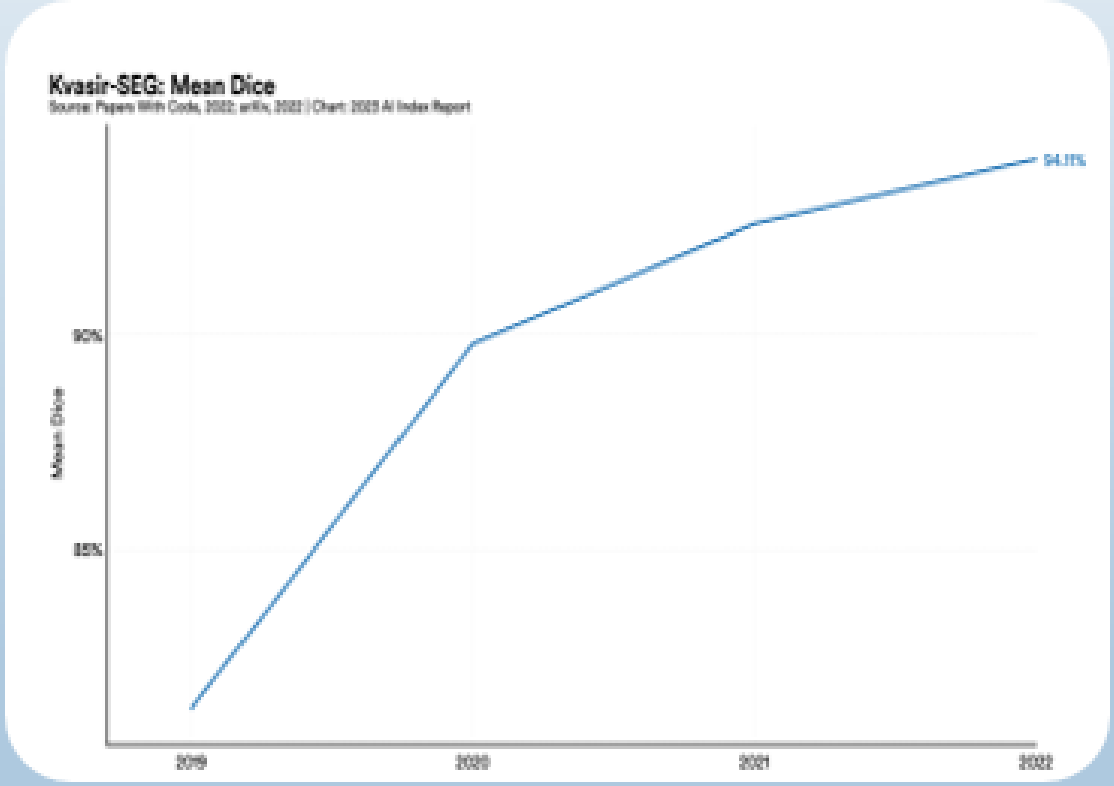
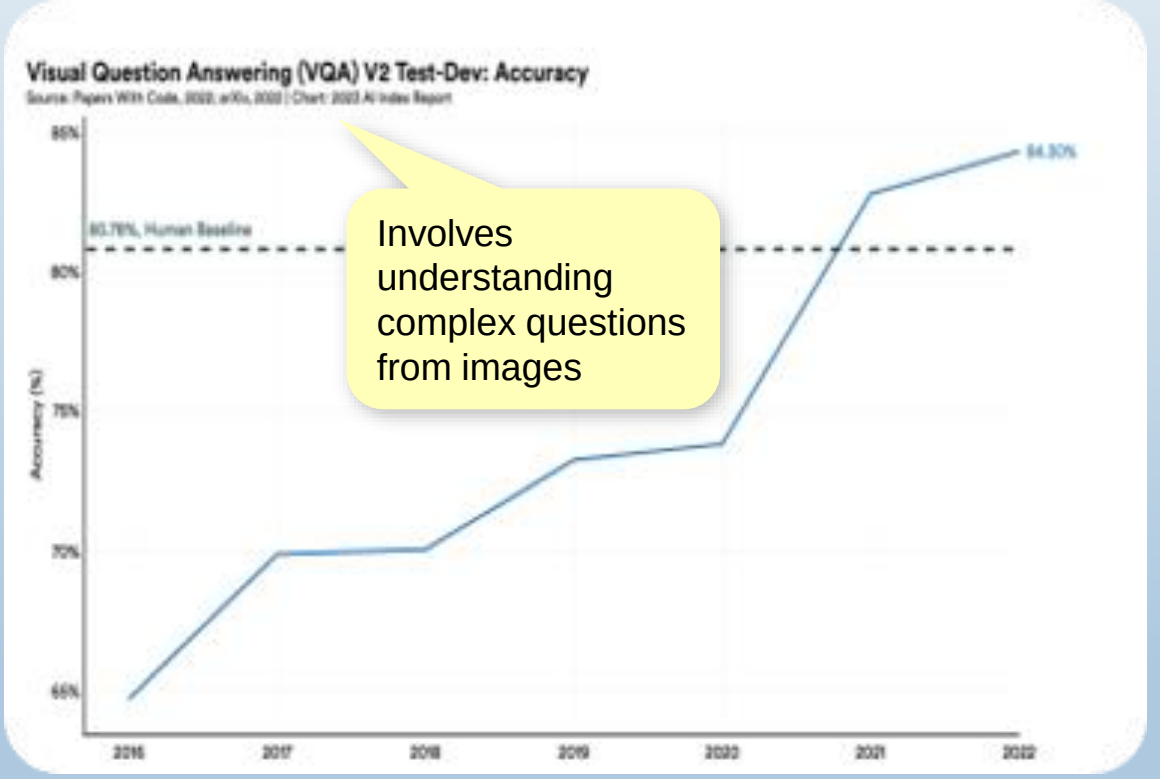
Benchmark of Test Measurement

Medical image recognition



Visual reasoning



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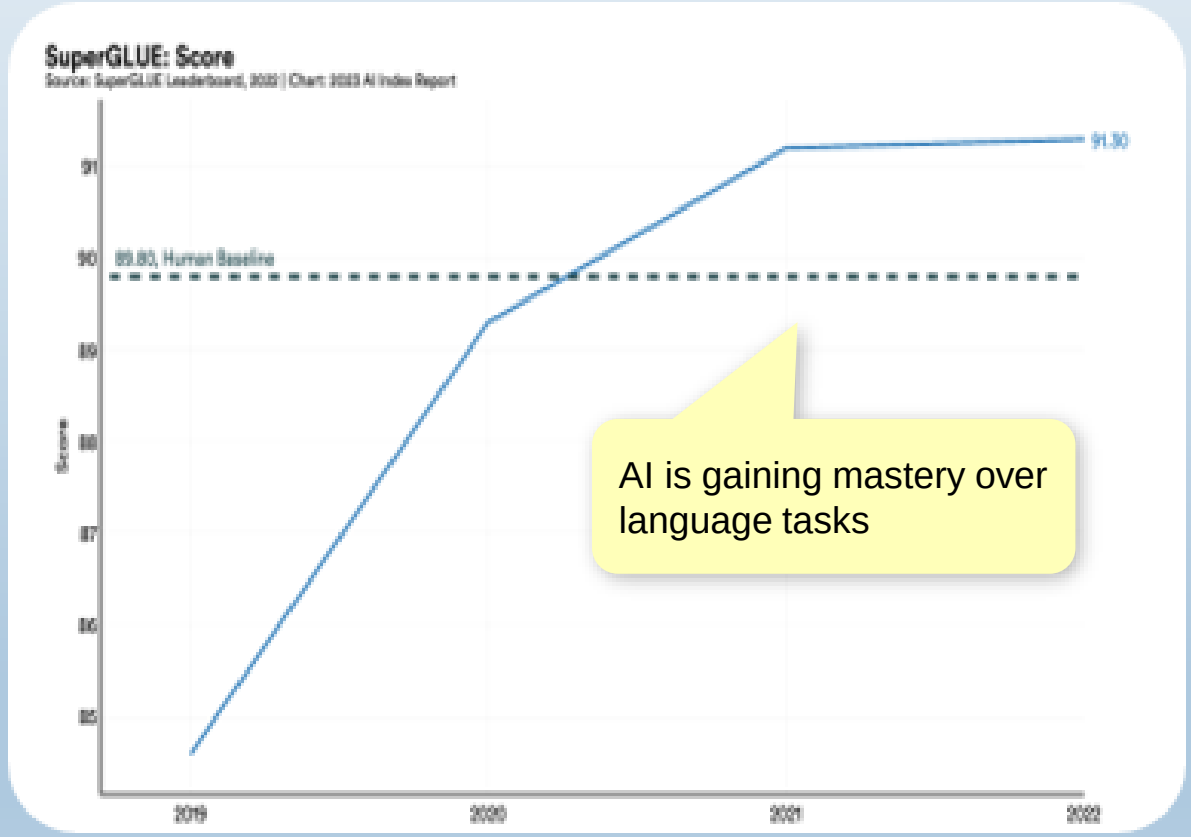
Benchmark of Test Measurement

English language understanding

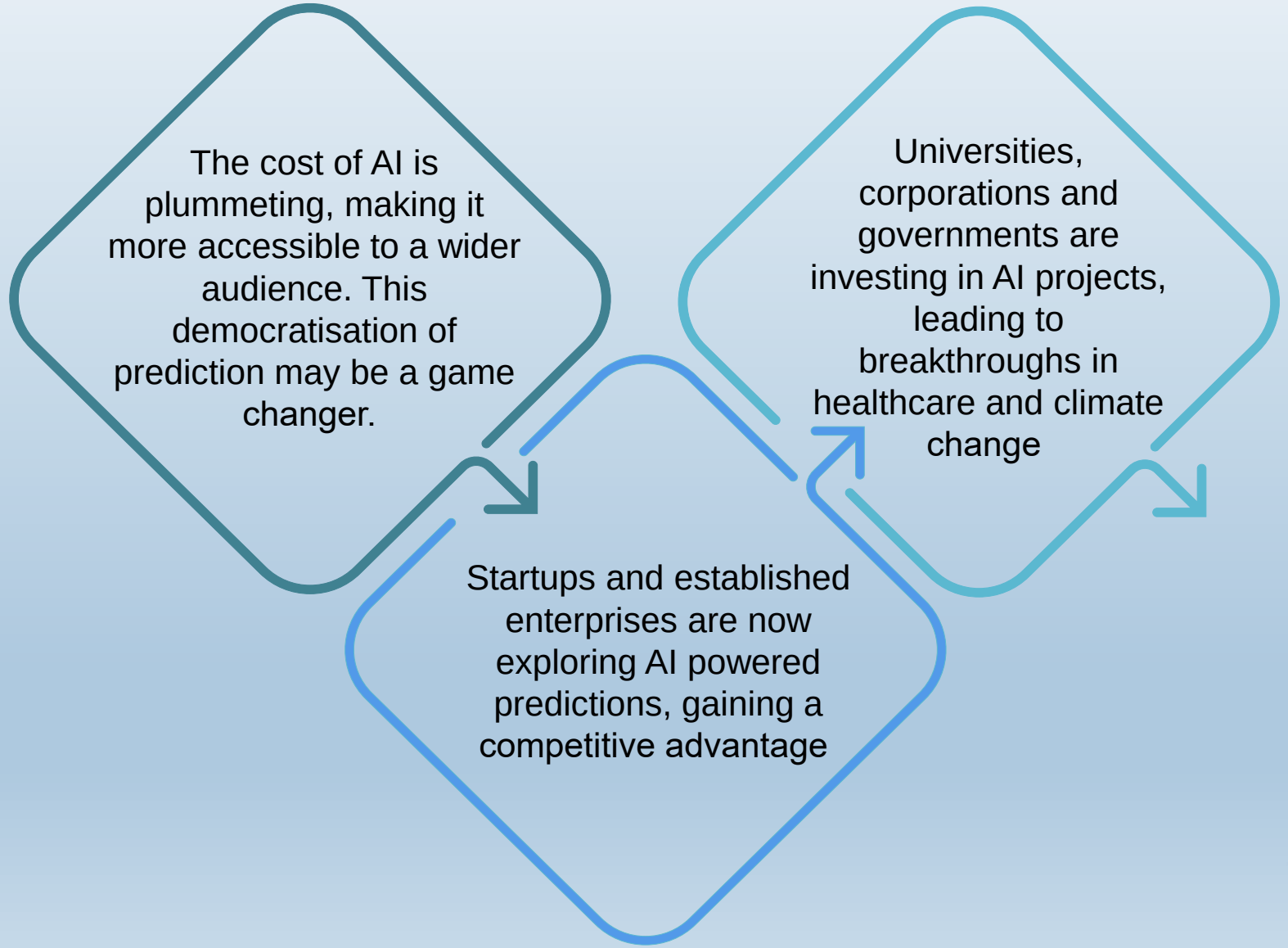


Source: Artificial Intelligence Index Report 2023 - Stanford University. (n.d.-b).

Impact of Private Investment in AI

- Fuels research, development and innovation, allowing AI teams to build larger models, gather more data and refine algorithms
- Accelerates the pace of discovery through investments in AI startups and research lab

Summary



AI as General Purpose Technologies (GPTs)

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GPT

General-purpose technologies (GPTs) are transformative forces that reshape economies and societies.

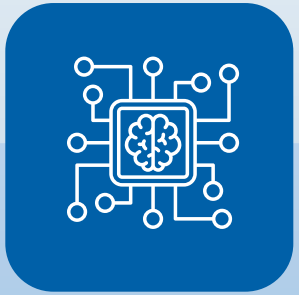
Characteristics of GPT

Permeate multiple sectors, serving as essential building blocks for a wide range of products and services

Start with immense potential and improve over time through continuous innovation, unlocking new capabilities and applications

Catalyse a cascade of complementary innovations, creating entirely new industries and markets

AI as GPT



- Improves productivity without requiring more capital or labour
- Acts as catalyst, sparking innovation across multiple sectors
- Empowers businesses to create value with the same amount of resources

AI as GPT: Example

- Analogous to electricity in the 19th century, AI promises to revolutionise industries beyond its initial applications, transforming how we live and work
- AI stands as a transformative GPT, poised to redefine our world by reshaping industries and creating new opportunities in the era of AI-driven transformation.

AI: Accelerating Pace of Discovery

Biology:

Unravelling the mysteries of life, accelerating drug discovery and enabling personalised medicine

Medicine:

Enhancing diagnostics, predicting patient outcomes and guiding robotic surgeries

Physics:

Pushing the boundaries of our understanding of the universe

Materials:

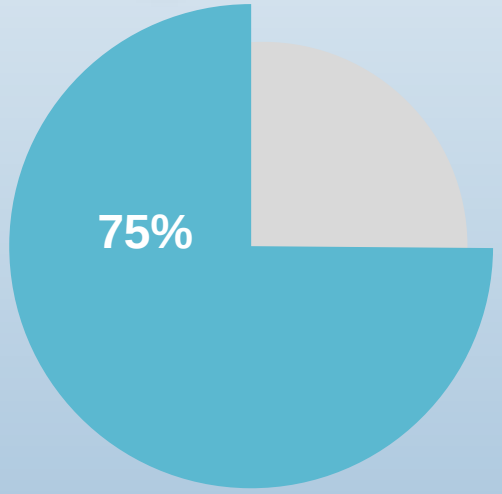
Designing new materials with self-healing polymers and superconductors

AI’s Influence in Organisations

- Business benefits: Increased efficiency, better decision-making and innovation
- Worker impact: Job evolution, new opportunities and adaptability
- AI and human collaboration: Augmentation, catalyst for unprecedented results

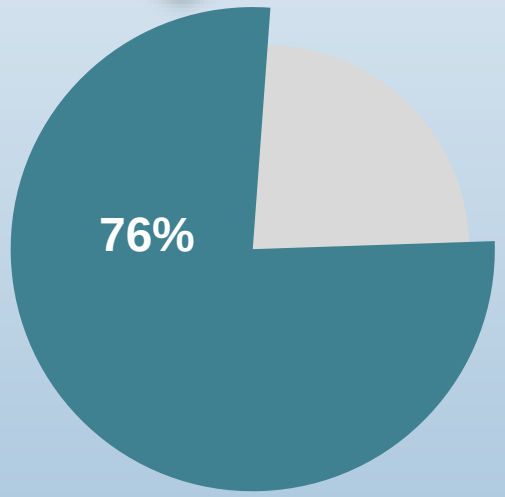
Urgency for Adopting AI

Companies failing to adopt AI risk losing ground to competitors embracing it.



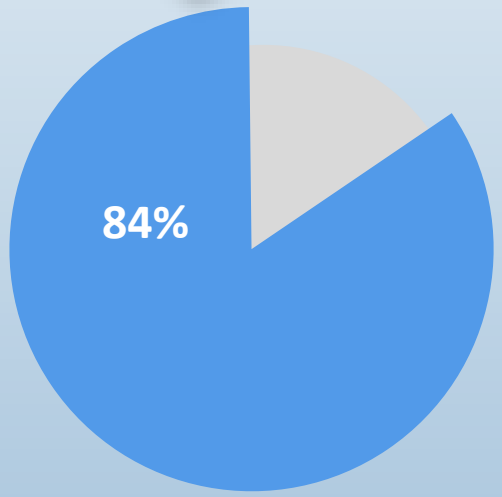
Risk of going out of business

There is a gap in understanding AI implementation but delaying risks falling further behind.



Struggle to scale AI

Scaling AI is essential—now a necessity for thriving businesses.



Achieving growth objectives

Source: Accenture: Built to scale (2019), used data from about 1500 C-suite executives including 126 from India

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Implications for Business

- Disruptions are imminent. Companies that fail to adapt risk losing market shares.
- AI is not a threat but an opportunity as it helps unlock new efficiencies, drive innovation and create new business models.

Summary

- AI is a GPT that is applicable to every sector and business model
- The risk of not adopting AI is alarmingly high
- Basic AI implementation can provide a short-term competitive edge, while deep integration offers lasting advantages.

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