

ARTIFICIAL INTELLIGENCE 501

Lesson 2

AI in Industry

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Learning Objectives

You will be able to:

- Explain why AI is transforming a range of industries
- Give specific examples of how AI technology affects industries

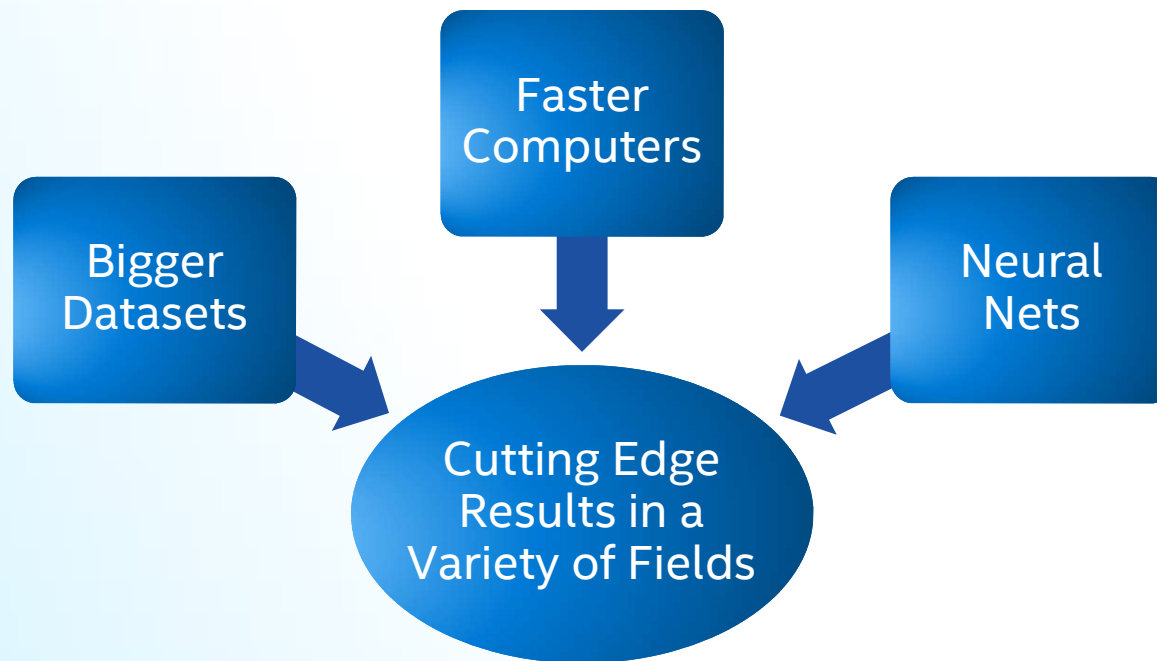


REVIEW

Review Prior Lesson Learning Objectives

- Defined AI, Machine Learning (ML), and Deep Learning (DL)
- Discussed AI's key historical developments
- Showed the cyclical nature of AI's public perception, funding, and interest
- Differentiated modern AI from prior AI
- Illustrated various applications of AI

How Is This Era of AI Different?





HEALTHCARE

Healthcare: Medical Diagnosis

Traditionally: Medical Diagnosis was a challenging process.

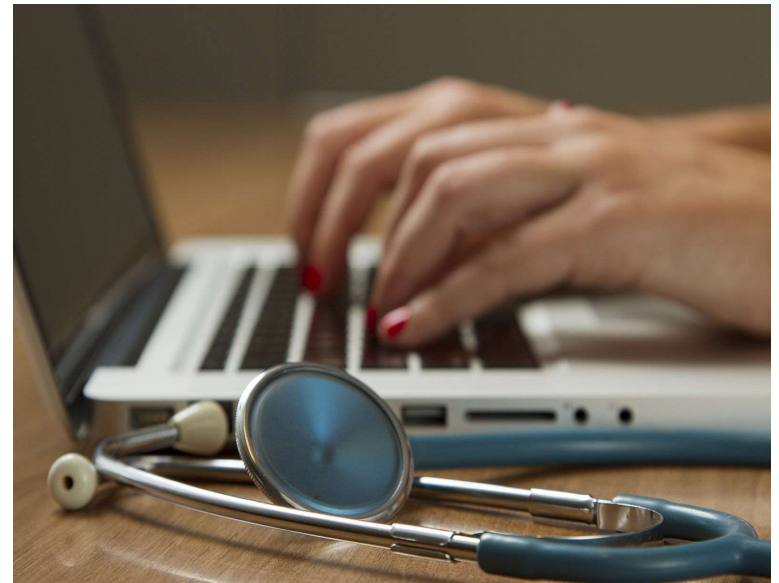
- Many symptoms are nonspecific
- Process of elimination was used to determine root cause (neither efficient nor exact)



Healthcare: Medical Diagnosis

Now with AI : Doctors can provide diagnoses more efficiently and accurately, with the availability of:

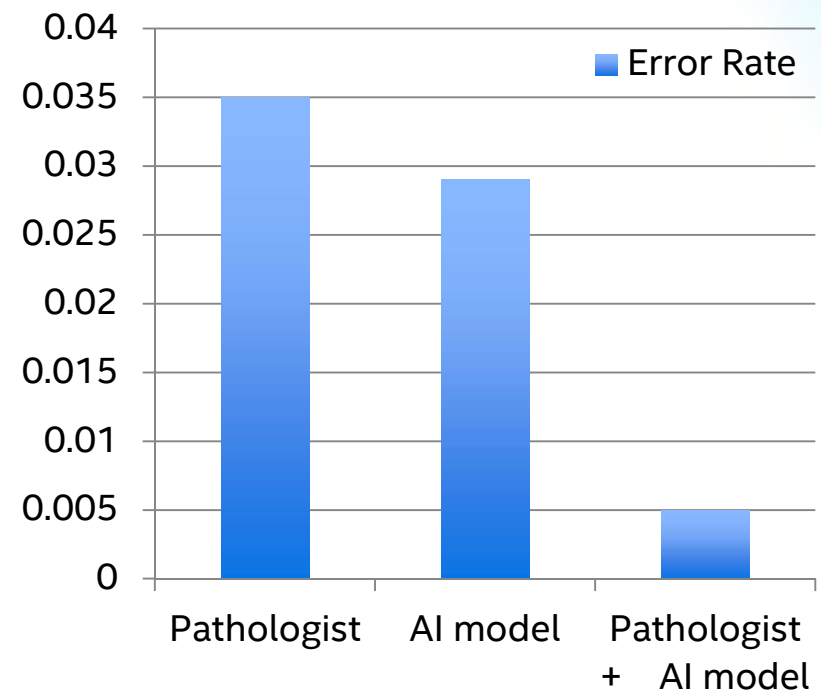
- Large medical datasets
- Computer vision algorithms



Healthcare: Medical Diagnosis

Example: Breast Cancer, 2016, Harvard Medical School researchers

- Used DL to identify cancer in lymph node images
- Used Convolutional Neural Nets and custom hardware
- AI model combined with humans achieved lower error than either one individually



Healthcare: Treatment Protocol

Traditionally : Doctors would diagnose a condition and recommend a treatment based on what historically worked for most people.

- Some considerations for population/demographics
- Difficult to create custom treatments without extensive research/cost



Healthcare: Treatment Protocol

Now with AI : Doctors can tailor treatments to individual patients.

- Large medical datasets
- ML and DL algorithms
- Population/demographics analysis/simulations



Healthcare: Treatment Protocol

Example: ICU Intervene, MIT Computer Science and Artificial Intelligence Laboratory.

- Uses ICU data, from vitals, labs, notes, to determine how to treat specific symptoms.
- Makes real-time predictions from DL models, to provide recommendations for patients.
- Forecasts predictions into the future (a few hours) compared to traditional methods (a few minutes).
- Predictions can be run on common GPU and CPU hardware.



Healthcare: Drug Discovery

Traditionally : Each new drug approval costs over a billion dollars in Research and Development.

- The cost has been doubling every 9 years since 1970
- The drug discovery process can take decades
- 9 out of 10 drug approval attempts fail
- There are currently only 1,500 approved drugs



Healthcare: Drug Discovery

Now With AI: Companies are leveraging structured and unstructured data with AI, to establish a pipeline of new drug discovery.

- There are 10^{20} possible drug-like molecules
- Massive space for potential discovery



Healthcare: Drug Discovery

Example: HetioNet drug discovery model, 2016, UCSF, Himmelstein and Baranzini.

- Developed a graph network to encode millions of biomedical reports.
- Used ML to predict probability of treatment efficacy for ~209,000 compound-disease pairs.
- Provided clear pharmacological insights for epilepsy drug discovery and treatment.



Healthcare: Surgery

Traditionally : Every type of surgery poses possible risks to the patient.

- Adverse anesthesia effects
- Operational complications



Healthcare: Surgery

Now with AI : Semi-intelligent computer systems predict surgical steps, identify complications, and warn surgeons about pending challenges.

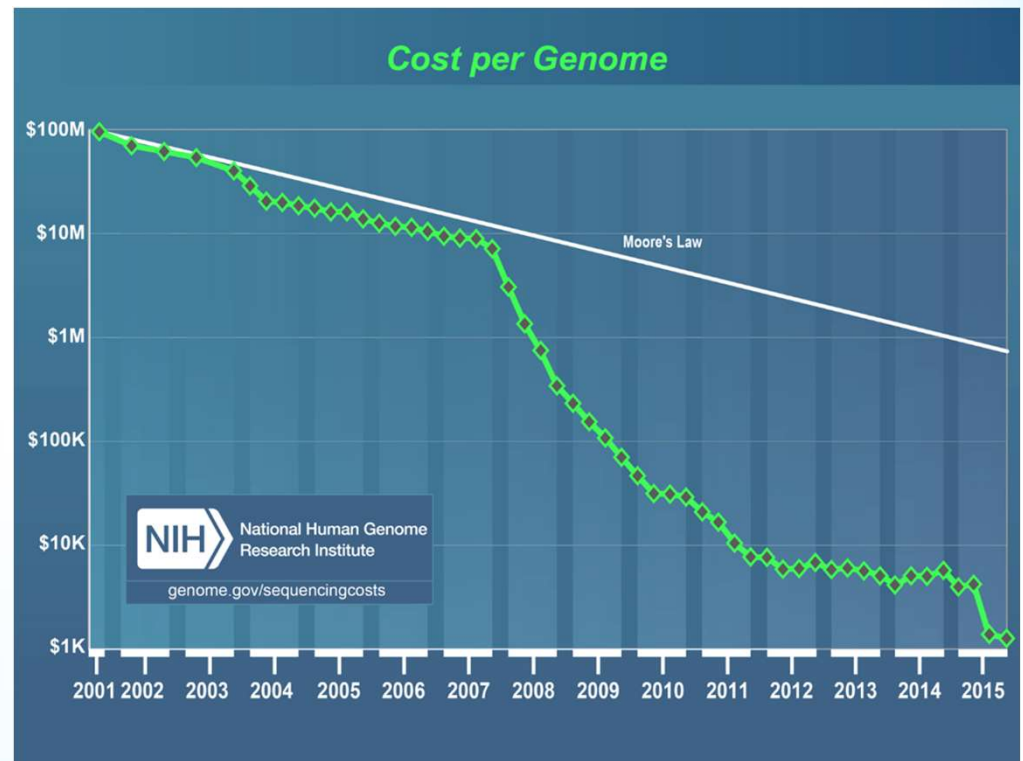
- Computer “vision” leverages data from laparoscopic and arthroscopic cameras
- Smart systems automate dictation by generating notes during the surgery
- Surgeons can send point-of-view live feeds of the operative site to experts anywhere in the world for real-time advice.



Genomics: Genome Sequencing

In 2001: Full human sequencing cost \$100 million.

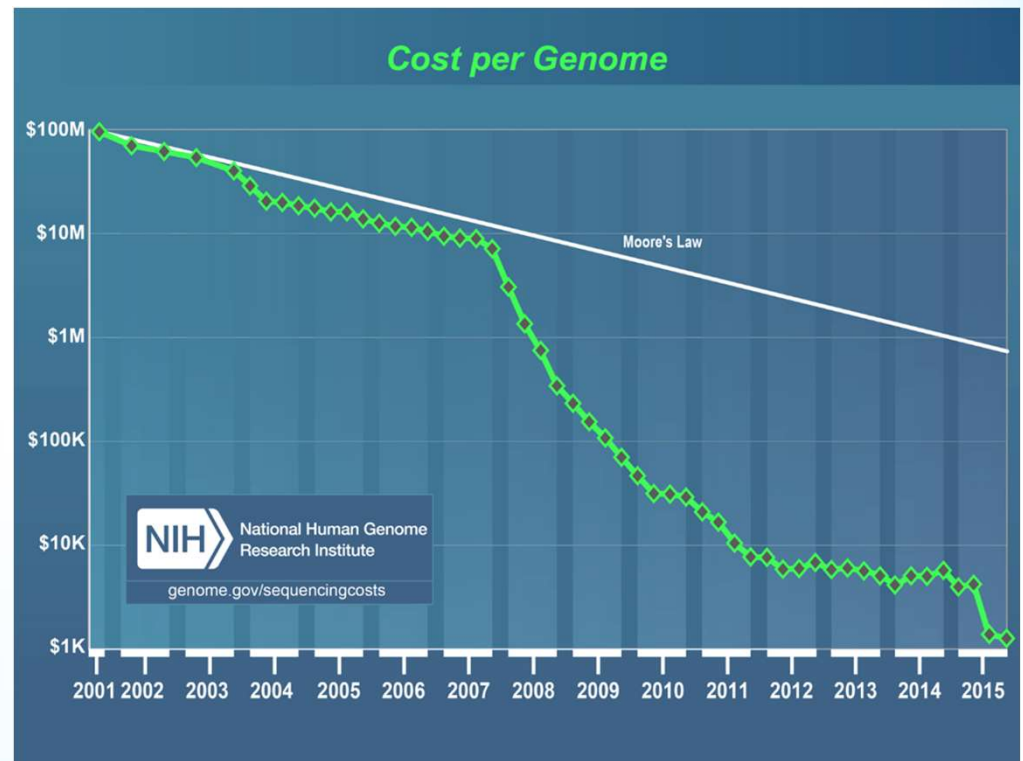
- The first genome sequencing took ~13 years



Genomics: Genome Sequencing

In 2003: High-throughput sequencing made the process more efficient by leveraging a technique called “shotgun strategy”.

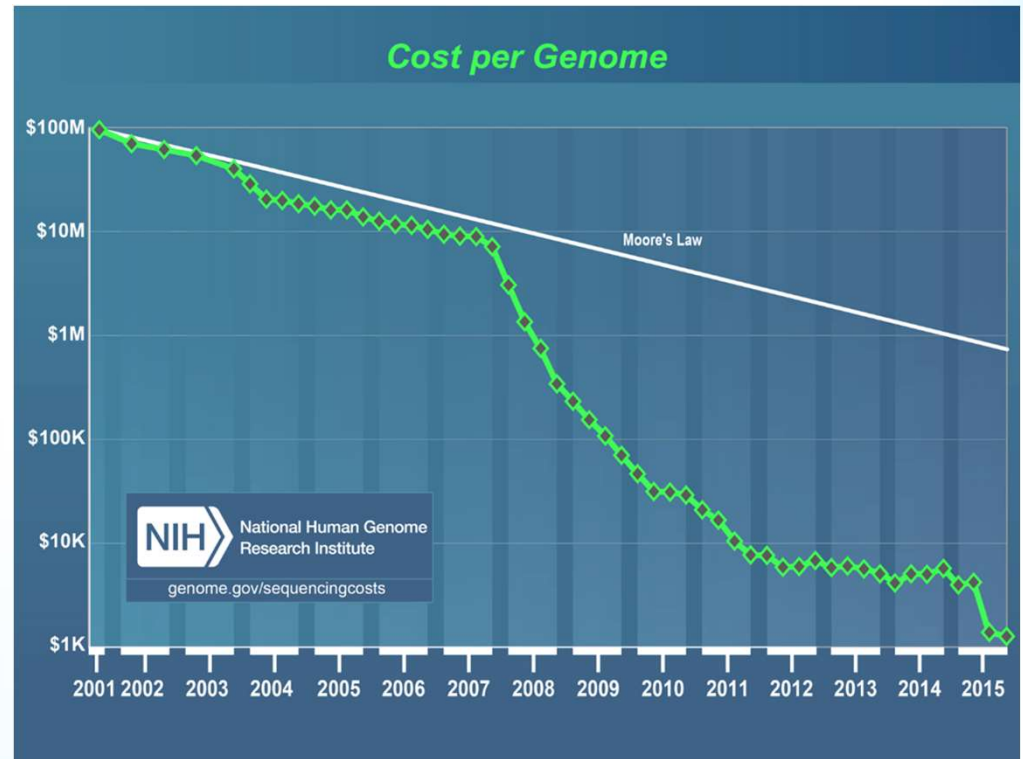
- The data produced from this technique is imperfect and errors can be introduced at each step in the process



Genomics: Genome Sequencing

Now with AI : Sequence companies are employing AI techniques to reduce cost and increase accuracy.

- Illumina claims that within the near future sequencing will only take 1 hour and cost only \$100



Genomics: AI for Genome Sequencing

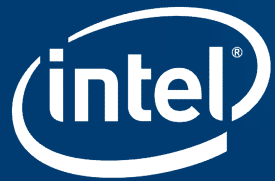
Example: Google's DeepVariant* sequencing:

- Leverages massive data sets together with DL to identify all variants
- Accuracy on genome classification: 99.958 %
- DeepVariant* is computationally expensive, but the framework can run on GPU hardware, allowing for a faster learning process
- Availability as open source code promises to revolutionize the industry



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TRANSPORTATION

Transportation: Autonomous Cars

Traditionally : Despite having safer cars, the number of deadly car accidents have been on the rise the last few years.

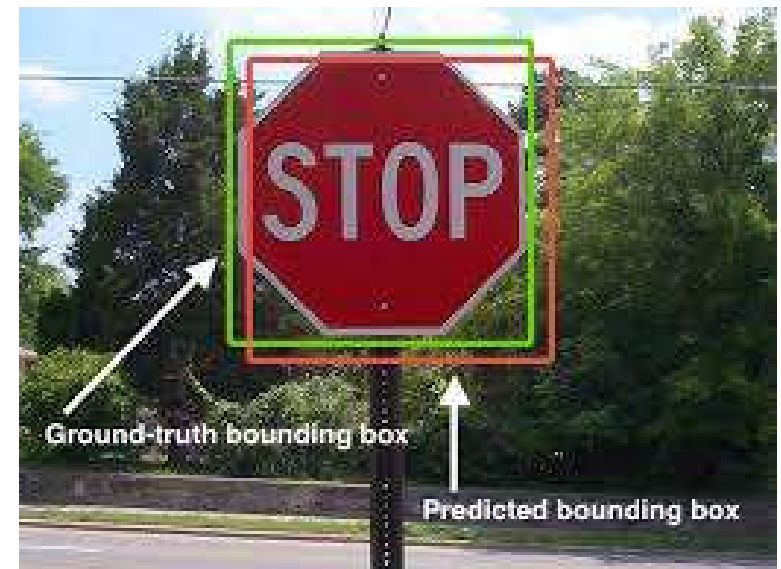
- The leading cause of automobile accidents is human error
- One of the primary sources of traffic jams is each driver acting out of self-interest, that prevents traffic flow
- Part of the population who can't drive: children, the elderly, and the disabled



Transportation: Autonomous Cars

Now with AI : Self-driving cars are enabled by the latest AI breakthroughs in computer vision.

- Cars identify stop signs, lane lines, and other landmarks via DL tools
- Mapping technology can use computer vision to detect addresses
- Cars triangulate and can use other 3D-sensing technologies, such as LIDAR and RADAR



Transportation: Autonomous Cars

Example: Waymo, the autonomous vehicle division of Alphabet Inc.

- Waymo has been operating self-driving minivans without a safety driver since October 2017
- Waymo's Carcraft* software accelerated the car's development, with 2.5 billion simulated miles driven in 2016
- The system used DL together with massive data sets collected from self-driving cars on public roads



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Transportation: Automated Trucking

Traditionally : There is a shortage of 48,000 drivers nationwide.

- Driver turnover rates at some companies reach 300%
- Truck drivers are twice as likely as other workers to be obese and/or have diabetes
- Truckers are half as likely to have health insurance
- The number of accidents and fatalities have increased in recent years

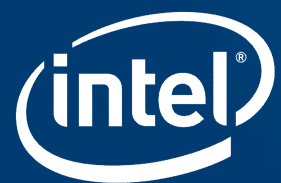


Transportation: Automated Trucking

Now with AI : Autonomous trucks can coordinate movements with other trucks.

- Save on fuel, and reduce wind-drag and the chance of a collision
- Video, LIDAR, and accelerometers are used to collect detailed data about the truck's surroundings
- Guidance algorithms provide feedback for braking, steering, and throttling commands, based on incoming and historical data



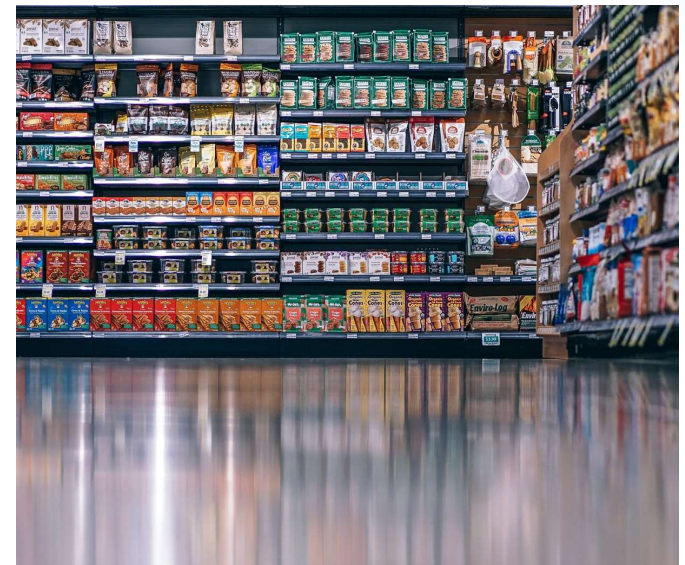


RETAIL

Retail : AI in Supply Chain and Customer Experience

Traditionally : Americans are shifting their spending from material goods to experiences.

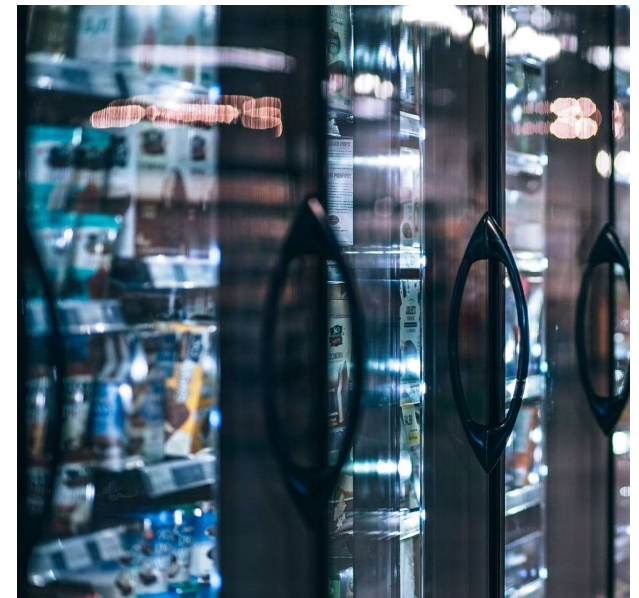
- The “Amazon effect”: there have been nine major retail bankruptcies in 2017
- Retailers need to become competitive or risk obsolescence
- Balancing “out-of-stock” with “over-stock” trade-off requires great finesse



Retail : AI in Supply Chain and Customer Experience

Now with AI : Companies bring experience and optimization to retail shopping.

- AI-powered gift concierge learns your preferences as you engage, and can help predict the appropriate gift to buy
- Leveraging ML-trained agents, companies are providing recommendations via natural language
- Companies using AI via Watson* to monitor factors from weather to consumer behavior, to optimize consumption rate predictions



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Retail : AI in Customer Experience

Example: The North Face and Watson* are combining massive datasets and AI, to bring the brick-and-mortar experience to e-commerce.

- The North Face, with Fluid and IBM Watson*, has launched XPS* - an AI-enabled digital expert that uses a natural language interface to help shoppers.
- XPS curates and filters the available options, so shoppers are more likely to make a purchase



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Food Retail: AI to Manage the Supply Chain

Traditionally : Restaurants use historical data or “gut-feeling” approach to supply chain.

- This can result in excessive waste or food unavailability



Food Retail: AI to Manage the Supply Chain

Now with AI : Many companies have started to leverage sophisticated algorithms to forecast demand.

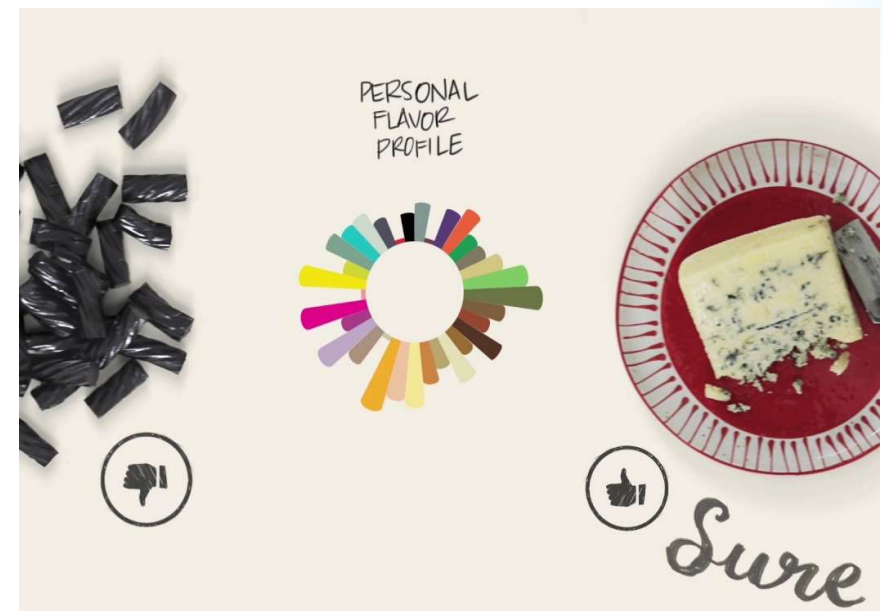
- Agents can adjust orders with trading partners in real time, as required for business need



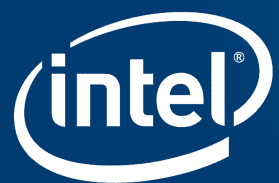
Food Retail: AI to Manage Supply Chain

Example: Vivanda's FlavorPrint* program.

- Based on recipes and consumer-provided data, Vivanda maps data to create “digital-taste” identifiers for each consumer
- Providing ML-based recommendations to customers may influence demand
- Shares data with food industry customers, enabling them to improve demand forecasts



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FINANCE

Finance: Fraud Detection

Traditionally : Fraud is on the rise, but fraud detection is a challenging problem to solve correctly.

- Historically, a predefined rule-set was used for fraud identification, but this approach misses much of the nuance that surrounds fraud
- 1/3 of falsely identified fraud events result in lost customers
- In the US, this loss is worth 13 times the cost of actual fraud



Finance: Fraud Detection

Now with AI : With ML techniques, banks can predict fraud based on a behavioral baseline to compare against.

- Uses historical shopping data and shopping habits of customers
- Compares new data to baseline to determine likelihood of fraud



Finance: Fraud Detection

Example: Sift Science

- Established a fraud data consortium developed from over 6000 websites to leverage large-scale real-time ML
- Autonomously learns new fraud patterns based on billions of user actions



Finance: Risk Management

Traditionally : New regulations force tighter control on financial institutions.

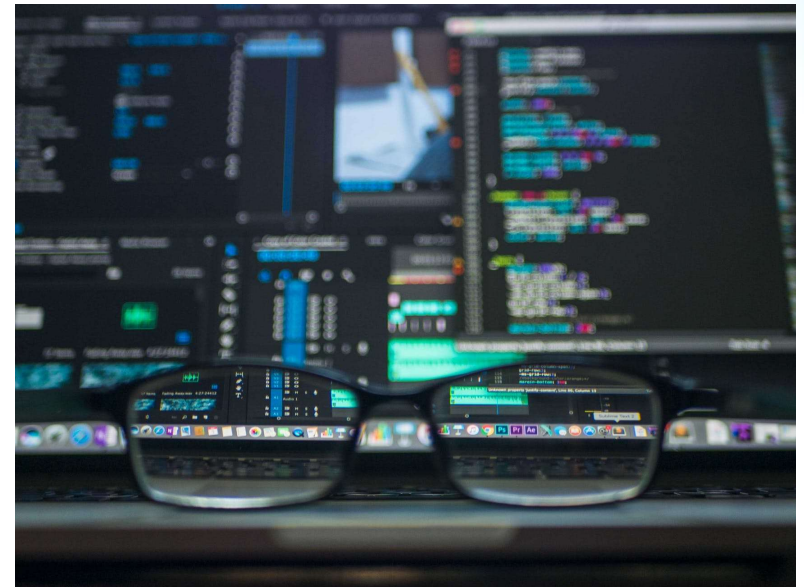
- New business model disruptions
- Increasing pressure on costs and returns



Finance: Risk Management

Now with AI : ML can help discern the credit worthiness of potential customers

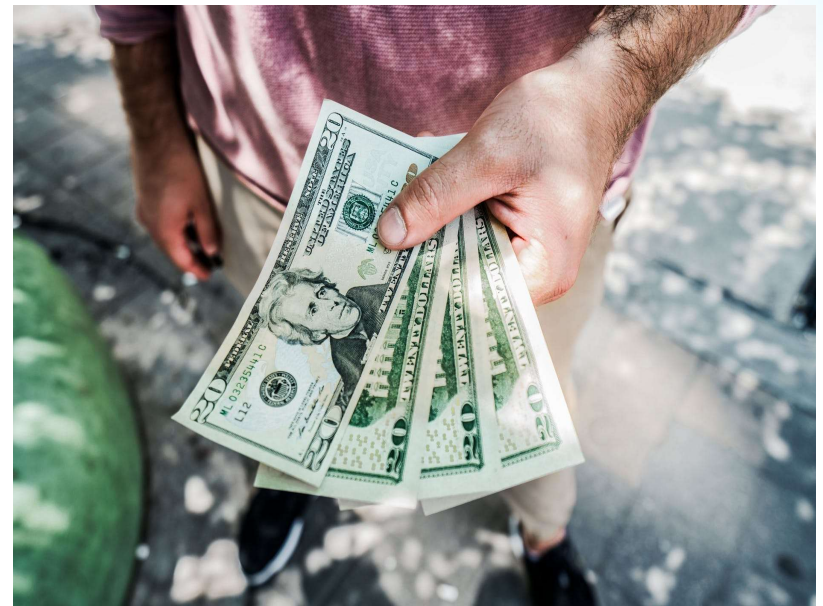
- Tailor a financial portfolio to fit the goals of the user using ML algorithms.
- Financial institutions can develop early warning systems for automated reporting, portfolio management, and recommendations based on ML.



Finance: Management

Example: ZestFinance

- Traditional underwriting systems make decisions using few data points.
- Those with a limited credit history are often denied credit, ultimately leading to loss of revenue for lenders.
- ZestFinance leverages thousands of data sources together with ML to more accurately score borrowers, even people with a small credit history.



Finance: Stock Trading

Traditionally : The speed and volume of information is daunting.

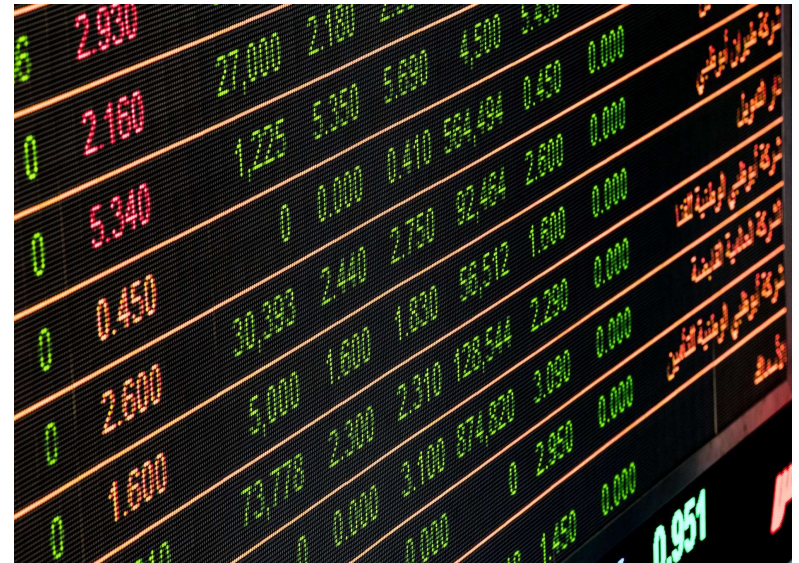
- The market is reactionary.
- It's difficult to remain competitive while relying on traditional trading methods.
- Fundamental analysis is unable to show the entire financial picture.



Finance: Stock Trading

Now with AI : Companies use massive datasets together with DL methods for better forecasting.

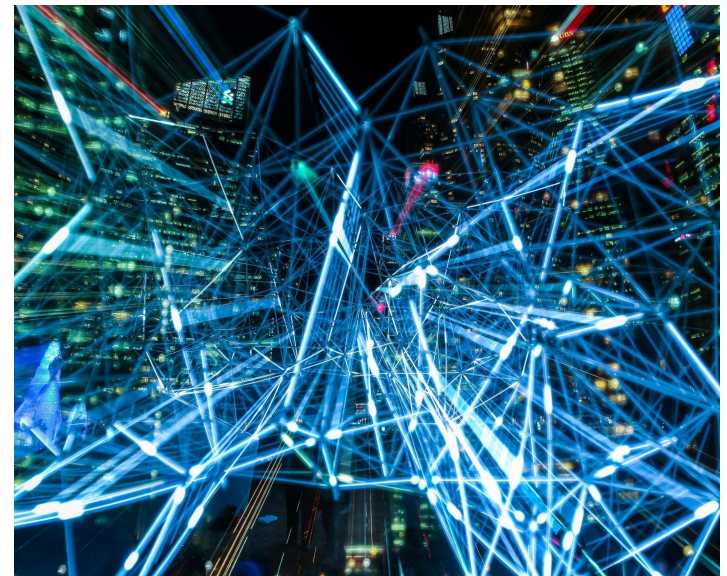
- Data pulled from financial, political, and social media
- Analyst reports combined.



Finance: Stock Trading

Example: Sentient Technologies, and Learning Evolutionary Algorithm Framework (LEAF*)

- Manages millions of data points to find trends and make successful stock trades.
- AI algorithms identify and combine successful trading patterns.
- Successful strategies are tested in the real world, evolving autonomously with LEAF.
- Sentient has received more funding than any other AI company.



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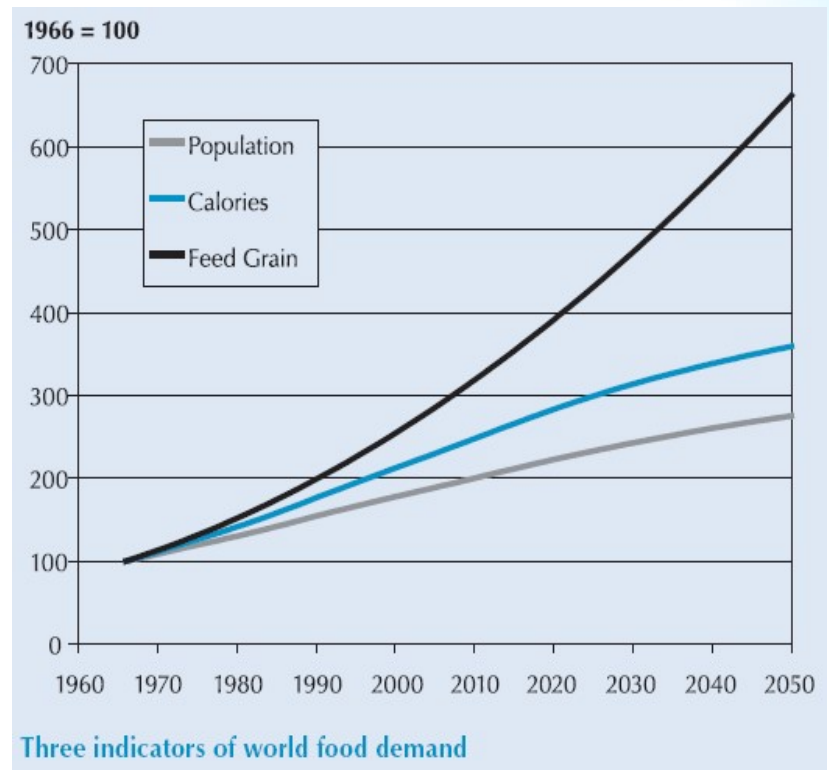
INDUSTRIAL

Agriculture: AgTech

Traditionally : The world population is estimated to reach 9 billion by 2050.

- Food production will have to increase by 70% to meet the projected demand.
- Most land suitable for farming is already being used, hence the needed increase must come from higher yields.
- Agriculture must feed the world while not over-straining Earth's resources.

source: www.card.iastate.edu



Agriculture: AI in AgTech

Now with AI : Autonomous robots use computer vision and a produce vacuum system for produce harvest.

- DL-enabled robots are being used to identify and kill weeds.
- Companies have shown 90% herbicide reduction due to “targeted” spray application.
- AI-driven genome sequencing advancements enables crop “genome” editing.



Agriculture: AI in AgTech

Example: TellusLabs yield predictions.

- Uses ML together with weather and other historical data to forecast yields.
- Leverages cloud-based GPUs for DL on satellite images.
- TellusLab's predictions have shown to be consistently more accurate than the USDA.
- Came within 1% of predicting corn and soybean yields in 2017.



Manufacturing: Preventative/Predictive Maintenance

Traditionally : Relied on historical data to provide basis for preventative maintenance schedule.

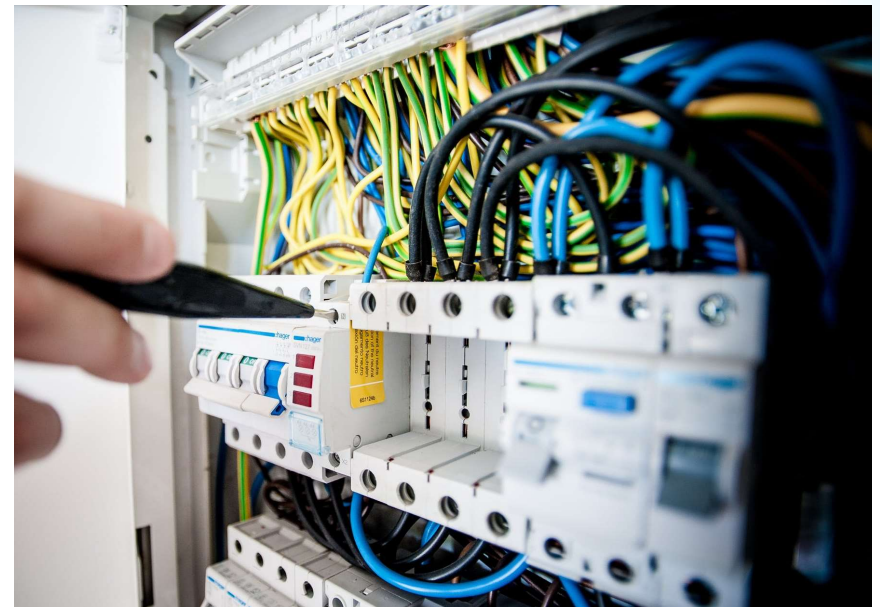
- Conservative approach: parts were replaced well before failure, and thus financially inefficient.
- Flawed due to inability to predict new failure modes.



Manufacturing: Preventative/Predictive Maintenance

Now with AI : Internet of Things (IoT) sensors help to optimize maintenance scheduling.

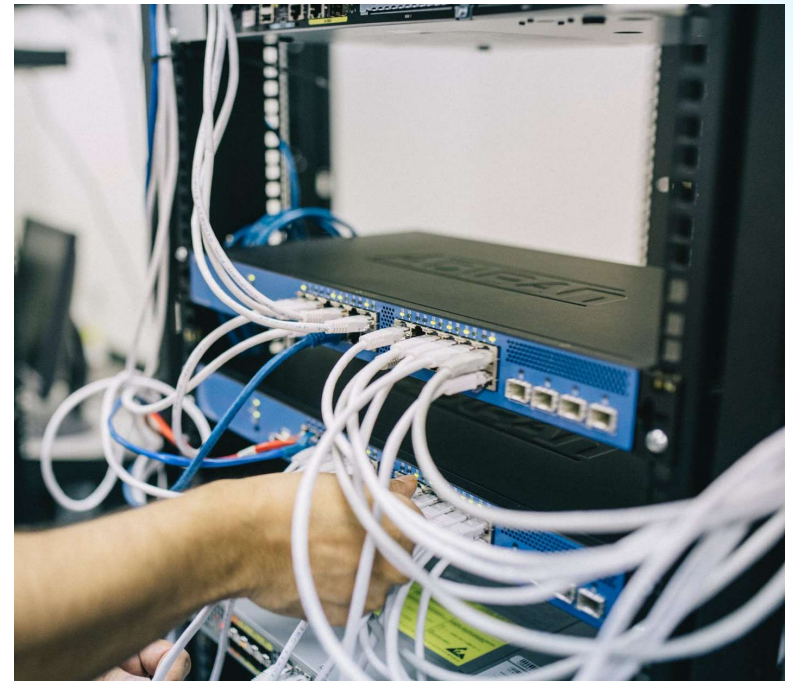
- Part replacement schedule is optimized by assessing anomalies and failure patterns.
- Safety and productivity can increase exponentially.



Manufacturing: Preventative/Predictive Maintenance

Example: AI with General Electric.

- GE is the industry leader for Internet of Things (IoT) sensor installations on engines and turbines, and plans to have 60,000 engines connected to the internet by 2020.
- Computer vision cameras and reinforcement learning algorithms find tiny cracks or damage.
- Sensor data and AI allows GE to track performance and optimize part replacement.



Manufacturing: Fault Detection

Example: Computer vision for fault detection on solar panels.

- DL algorithm trained on labelled data of correctly manufactured vs. flawed panels
- Reduced the need for human inspection by 66% compared to historical need



Manufacturing: Automate Garment Industry

Example: SoftWear Automation's "sewbots".

- Computer vision is used to track fabric at the thread level.
- Eliminates need for human **seamstress / seamster**.
- Allows designers to create garments that were previously thought to be too complicated or specialized to construct.





GOVERNMENT

Government: Smart Cities

Traditionally : As of 2008, for the first time in history, half of the world's population resides in cities.

- There are heightened demands on scarce resources.
- Simultaneously, a large part of existing infrastructure is underutilized or not being used efficiently.



Government: Smart Cities

Now with AI : AI techniques are used to analyze photo and video data to perform studies of pedestrian and traffic trends.

- Adaptive signal control: allows traffic lights to tailor their timing based on real-time data.
- With license plate recognition, and DL technology, cities can not only optimize parking but can also track criminals.



Government: Smart Cities

Example: AT&T reimagines smart cities

- AT&T developed a framework to help cities integrate Internet of Things (IoT) sensors with AI.
- Remotely monitor the condition of roads, bridges, buildings.
- Assist with public safety.
- Notify police if gunfire has gone off, by using sound detection.



Government : Cybersecurity

Example: Deep Instinct

- Uses GPU-based neural network to achieve 99% detection rates for even the most advanced cyber attacks.
- DeepInstinct's DL models have the ability to detect patterns - mostly designed by humans - enabling the prediction of pending cyber attack.

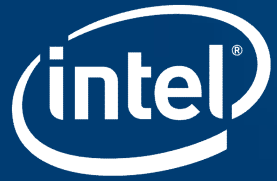


Government : Education

Example: Adaptive learning systems, and grading.

- Learning analytics track student performance and provide tailored educational programs.
- Using natural language processing and ML models, AI programs can be used for long answer and essay grading.





ADDITIONAL USE

Oil and Gas : AI to Optimize Operations

Traditionally : Shrinking oil reserves force companies to operate in remote and possibly hostile areas.

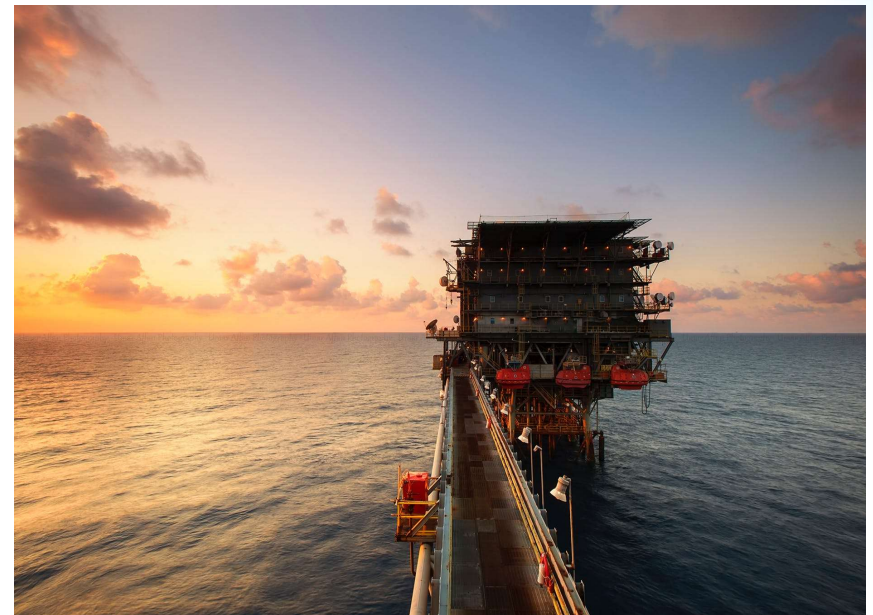
- Price has fallen dramatically in recent years.
- Forcing company layoffs and drastic budget cuts.
- Ultimately, companies are in great need of optimizing operations and cost.



Oil and Gas : AI to Optimize Operations

Now with AI : AI uses economic, political and weather data to forecast optimum production locations.

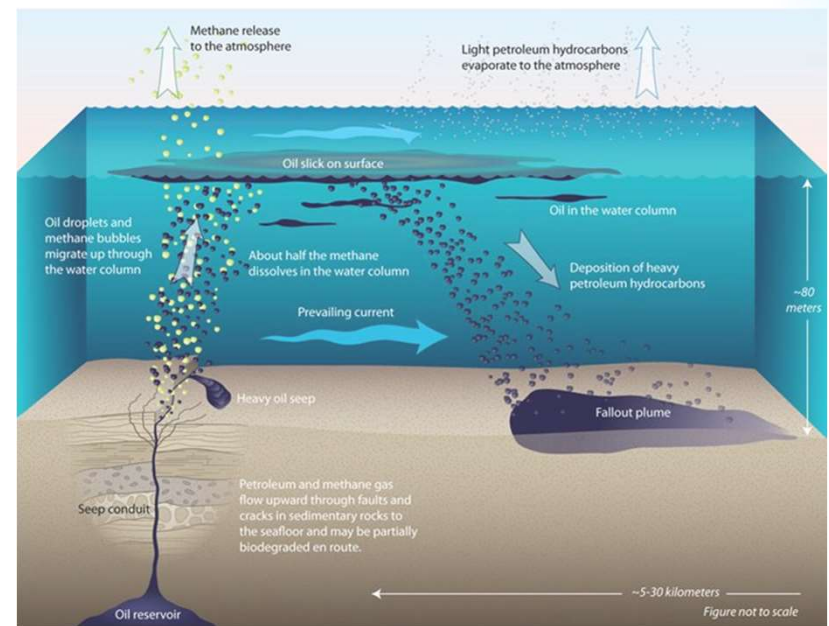
- Drilling is still an expensive and risk-prone endeavor.
- ML, with seismic, thermal and strata data, can help optimize the drilling process.



Oil and Gas : AI for Oil and Gas Exploration

Example: ExxonMobile and MIT developing “submersible” robots for exploration.

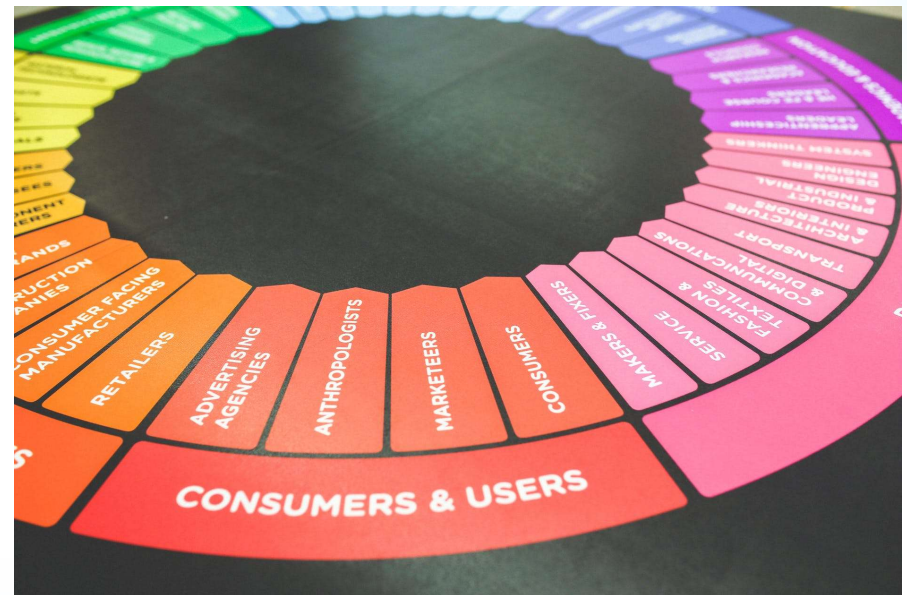
- AI robots are used in ocean exploration to detect “natural seep”.
- Robots are trained via DL techniques and learn from their mistakes.
- Simultaneously protect the ecosystem and detect new energy resources.



AI and Customer Service

Example: Bot assistants and customer service agents

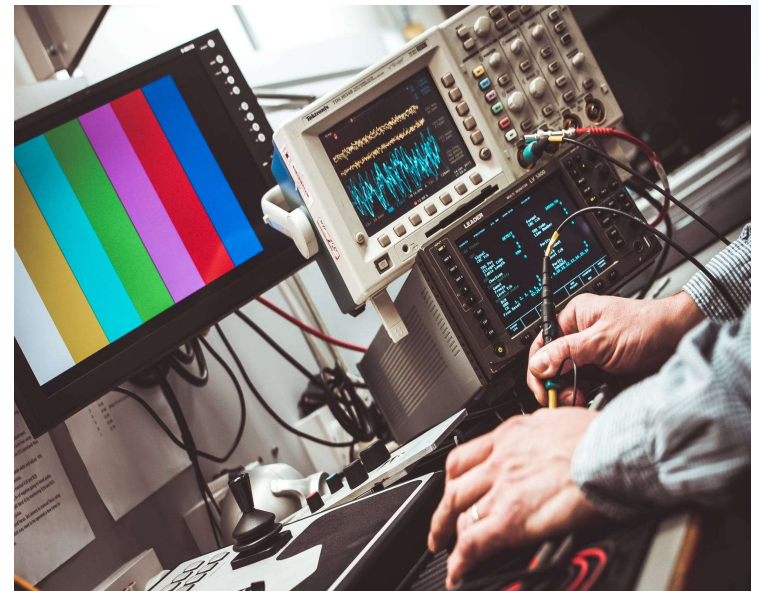
- AI Augmented messaging.
- AI for sorting and routing inquiries.
- AI enhanced customer phone calls.
- Some companies have used AI to fully automate customer service.



Music: AI for Music Generation

Example: “I AM AI”, first album released in 2017 to be generated by AI – with professional musicians and DL technology.

- Music generation is possible due to special DL algorithms that are designed for sequential data.
- The models learn musical patterns based on learning from large musical datasets.
- Raw music files can be processed on cloud-based computer power, making DL on these datasets possible.



Gaming: AI and the Next Generation of Games

Now with AI : Forza 5 Motorsport* uses its “Drivatar” AI system to learn how to drive in the style of other players in the game.

- Neural networks are used to train characters to walk and run realistically.
- Reinforcement Learning (RL) is a technique used throughout gaming.

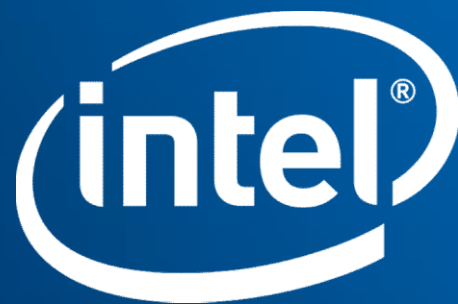


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Learning Objectives Recap

In this session, we worked to:

- Explain why AI is transforming a range of industries.
- Give specific examples of how AI technology affects industries.



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