

A graphic of a sphere composed of a network of interconnected nodes and lines, representing a global or IoT network, positioned behind the main title text.

AI and ML to Empower IoT

Applications of Artificial Intelligence and
Machine Learning in the age of IoT



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Outline

- **Introduction**
 - Artificial Intelligence and Machine Learning
 - Internet of Things (IoT)
 - Cloud Computing
 - Nanotechnology
- **Applications** - IoT Empowerment by Machine Learning
- **Challenges** - Challenges that IOT & ML Face
- **ML and IoT for The Future Generations**

Introduction

Artificial Intelligence and Machine Learning

- Giving machines the **ability to learn without being explicitly programmed**
- ML Tasks:
 - **Supervised** - regression, classification, forecasting, etc.
 - **Unsupervised** - clustering, dimensionality reduction, etc.
 - **Reinforcement Learning**
- **Learning:** Offline learning vs. **Online learning**
- What ML and AI algorithms need?
 - **Data & Computational Power**

Nanotechnology

- Building functional systems at very micro or atomic level

Internet of Things

- Subfield of **Machine to Machine (M2M)** Communication
 - Connected Devices
- (Usually) **Ubiquitous Computing**
- **Abundance of Data** - usually in the form of (data) streams
- **Evolving and Dynamic** Environments

Cloud Computing

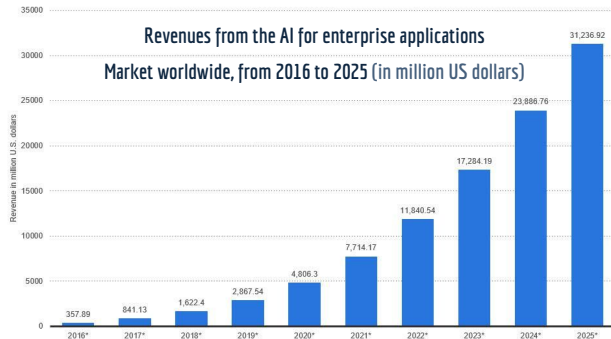
- **Data Storage and Computation Resources**
- One of the Most **Secure** and **Reliable** platforms
- **Adaptability** to Business Needs
 - **High Scalability** and **Flexibility**

Introduction - Cont.

Artificial Intelligence and Machine Learning

Statista

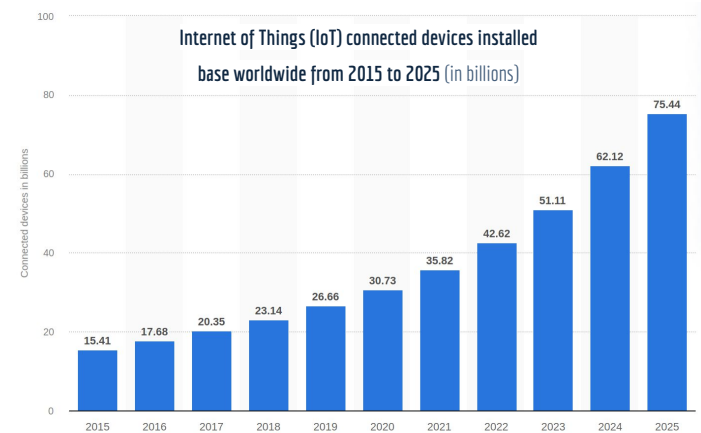
- Revenues from AI for enterprise applications is projected to grow from **\$4.8B in 2020** to **\$31.2B in 2025**
- 84% of enterprises** believe investing in AI will lead to greater competitive advantages



Internet of Things

Statista

- By 2025, forecasts suggest that there will be more than **75 billion Internet of Things (IoT) connected devices** in use. This would be over a **twofold increase** from the IoT installed base in 2020



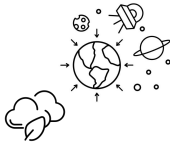
Statista
Revenues from the AI for enterprise applications Market worldwide, from 2016 to 2025 (in million US dollars)
Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025 (in billions)

Applications - IoT Empowerment by Machine Learning

- **Banking and Finance**
 - ATMs, and POS (time series, fraud detection)
 - Monitor financial behaviours (recommendation, planning, fraud detection)
 - Chatbots and telebanking (NLP, personalization, fraud detection)
 - Online, Mobile, and Digital banking (automation, personalization)
- **Agriculture Automation**
 - Monitor humidity and temperature (time series, regression)
 - Recommend what is the best time to transplant crops after germination and harvest (time series, regression/classification)
 - Monitor wellness of plants (computer vision)
 - Learn and model why a crop deceased - share the info with other farmers without consulting an agronomist (computer vision)
- **Healthcare and Telemedicine**
 - Training and surgery (augmented reality, virtual reality)
 - Wearable devices to monitor health condition (time series, regression, classification)
 - Remote patient monitoring (time series, computer vision, motion recognition)
 - Treatment recommendation (recommendation)
- **Ambient Technology**
 - Human-centric (sensitive and responsive to the presence of people)
- **Smart Technologies**
 - Smart Cities, Smart Homes, Smart Kitchens, etc.
 - Smart Shopping Malls - Recommend new items based on the items in your cart.
- **Self-driving Cars**
 - Self-driving (reinforcement learning, time series, computer vision, etc.)
 - Communicating with the infrastructure of smart cities
 - Navigation (time series, cv, imitation, reinforcement learning)
 - Reduce the risk of accidents (time series)
 - Reduce traffics (time series)
- **Conversational Systems**
 - ML and NLP offer AI solutions for interactive and conversational solutions
 - An inseparable member of our life - Alexa and Google Home
 - Empower smart houses, self-driving cars, telemedicine, and more
- **Energy Consumption**
- **Vehicle Platooning**
- **etc.**

Challenges

- **Resource-Constrained Devices**
 - Optimize energy (battery) consumption of IoT Devices » Making real-time decision making hard due to more battery consumption » Devices may die quickly
 - Models should have very fast inference time while being light and accurate » Trade-off between runtime and accuracy
- **Remote Management of Devices**
 - Manage or update devices remotely & Maintain the health of clusters of devices
- **ML Deployment:**
 - Translation & optimization of models from high-level languages to embedded-systems languages
 - Lack of specialization in ML » Needs training IoT engineers
- **Human Supervision/Involvement Cost until Fully Automated**
- **Lack of Labelled Data for Supervised Tasks**
 - Transfer learning, zero-shot or few-shot learning can help
- **Data Shift & Domain Adaptation**
 - Consistency between training data and on-field data
 - Dynamic environment » Change in data distribution » Adapt our models to the current underlying distribution | Self-learning
- **Responsible AI**
 - Solutions need to be ethical, transparent, explainable, robust and trustworthy (throughout their lifecycle)
 - Bias and Discrimination » due to source(s) of data » Need attention if technology is transferred from one location to another, or make it holistic
- **Data Governance (in IoT)**
 - Governance refers to rules, policies, and procedures that ensure the safe and correct usage and storage of information
 - Increase confidence in decision making, increase data quality, reduce risk of regulatory fines, improve data security, etc.
- **Data Security and Privacy**
 - Distributed systems and infrastructures need extra layers of security and privacy to protect users' confidential and private information
- **Malicious Act**
 - Security | Fraud, War & Terrorism



ML and IoT for The Future Generation

- **Protect Wildlife**
 - Accurate estimations of populations, understand animal behavior
 - Fight against poaching and loss of biodiversity
- **Protect Nature - Climate Change & Global Warming**
 - Avoid wildfires
 - **Data from Sensors:** temperature, ambient CO2 levels, humidity, wind direction, and speed
 - **AI & ML Role:** It not only detects the presence of a fire, but also predicts where it will spread - Robots to fight fires (firefighting robots)
 - Monitor Air Pollution & Air Quality » **Green Planet**
 - Particulate Matter (PM2.5 and PM10), Ozone (O3), Nitrogen Dioxide (NO2), Sulphur Dioxide (SO2) and Carbon Monoxide (CO) are of the most dangerous air pollutants
 - Damaging the human respiratory system and causing lung and heart diseases
 - AI & ML Role is to predict concentration of pollutants and trigger alarms
- **Multiplanetary & Interplanetary Future**
 - IoT and ML play a key role to help mankind reach its full potential as a multiplanetary species in a near future
 - Enable robots to observe and explore out-of-reach locations
 - Communication challenges (e.g. delay, and infrastructure)
- **Machine Learning » Automation » Smarter and Automated Internet**
 - Metaverse
 - Internet of Web Services
 - Virtual Agents, Bots

Resources

- **Ubiquitous Computing:**
<https://www.hypr.com/security-encyclopedia/ubiquitous-computing>
- **Statistica**
- **How IoT and machine learning are automating agriculture:** <https://www.computerweekly.com/news/252504285/How-IoT-and-machine-learning-are-automating-agriculture>
- **IoT in Banking: Examples of IoT technology used in financial services:** <https://www.insiderintelligence.com/insights/iot-banking/>
- **10 Charts That Will Change Your Perspective On Artificial Intelligence's Growth**
<https://www.forbes.com/sites/louiscolombus/2018/01/12/10-charts-that-will-change-your-perspective-on-artificial-intelligences-growth/?sh=4cfab24f4758>
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- **IoT in Healthcare - Connected Devices, Telemedicine and Remote Monitoring:** <https://www.embitel.com/blog/embedded-blog/iot-in-healthcare-connected-devices-telemedicine-and-remote-monitoring>
- **The Role of Machine Learning in the Rise of Telemedicine:** <https://zdatainc.com/the-role-of-machine-learning-in-the-rise-of-telemedicine/>
- **Improving Autonomous Robotic Navigation Using Imitation Learning:** <https://www.frontiersin.org/articles/10.3389/frobt.2021.627730/full>
- **AI ethics & governance:**
<https://www.accenture.com/ca-en/services/applied-intelligence/ai-ethics-governance#:~:text=Responsible%20AI%20is%20the%20practice,and%20scale%20AI%20with%20confidence.>
- **Perspectives in machine learning for wildlife conservation:** <https://www.nature.com/articles/s41467-022-27980-y>
- **An IoT enabled system for enhanced air quality monitoring and prediction on the edge:** <https://pubmed.ncbi.nlm.nih.gov/34777973/>
- **Italy is betting on hi-tech fire detection sensors to protect its forests from climate change:** <https://www.euronews.com/next/2022/07/16/italy-is-betting-on-hi-tech-fire-detection-sensors-to-protect-its-forests-from-climate-cha>
- **Fight Forest Fires with Tech: How Forest Fire-Prone Regions Leverage IoT to Limit Wildfires and Mitigate Destruction**
<https://www.aeris.com/resources/fight-forest-fires-with-tech-how-forest-fire-prone-regions-leverage-iot-to-limit-wildfires-and-mitigate-destruction/>
- **"Ambient intelligence" will accelerate advances in general AI**
<https://www.amazon.science/blog/ambient-intelligence-will-accelerate-advancements-in-general-ai>

Q&A



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