

# AI and Quantum Computing

PMP on Cyber Security

Presented by

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# INTRODUCTION ON AI

- AI is the biggest and fastest evolutionary change that the universe is witnessing. (from the inorganic to the organic - inorganic).

**Intelligence** is the ability to learn

- Natural intelligence has followed the evolutionary process of animal species
- AI, has different ways of learning and an evolution that is different from the natural ones .
- The evolution of Natural Intelligence, NI, has taken millions of years, AI will take a few decades. (from organic to inorganic).

# A BRIEF HISTORY OF AI (1) (Early Concepts)

The history of artificial intelligence (AI) is a fascinating journey that spans several decades and is marked by key breakthroughs, milestones, and challenges. Here is a brief overview of the history of AI:

- 1. Early Concepts (1940s - 1950s):** The concept of AI can be traced back to the 1940s when pioneers like **Alan Turing** began envisioning the possibility of machines exhibiting human-like intelligence. Presentation of the “**TURING TEST**”.
- 2. Birth of AI as a Field (1956):** The field of AI was officially born in 1956 at the Dartmouth Conference, organised by **John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon**.
- 3. Symbolic AI (1950s - 1960s):** Early AI research primarily focused on symbolic AI, where knowledge was represented using formal logic and symbols.
- 4. The Dartmouth Summer Research Project on AI (1956):** Often considered the starting point of AI as a discipline, this workshop laid the groundwork for AI research and set ambitious goals for developing intelligent machines.
- 5. Logic Theorist and General Problem Solver (1956 - 1960):** In the late 1950s and early 1960s, **Allen Newell and Herbert A. Simon** developed the Logic Theorist and the General Problem Solver (GPS),

# A BRIEF HISTORY OF AI (2) (From Winter to Renaissance)

**6. AI "Winter" (1970s - 1980s):** In the 1970s, AI research faced significant challenges, leading to a period known as the "AI winter." The initial enthusiasm for AI did not match the rapid progress that some early researchers had hoped for. AI research faced criticism for its limitations, and Funding decreased.

**7. Expert Systems (1980s):** Despite the challenges, AI research made progress in developing expert systems. These systems were designed to mimic the decision-making processes of human experts in specific domains and found applications in areas like medicine, finance, and engineering.

**8. Machine Learning Renaissance (1990s):** In the 1990s, AI experienced a resurgence, particularly in the field of machine learning. Researchers began exploring neural networks, genetic algorithms, and statistical approaches to improve AI performance.

# A BRIEF HISTORY OF AI (3) Recent Years

9. Deep Learning and Neural Networks (2000s - Present): The 2000s witnessed significant advancements in deep learning and neural networks, which have revolutionised AI research and applications. Increased computational power, big data, and improved algorithms led to breakthroughs in areas like computer vision, natural language processing, and robotics.

10. Modern AI Applications (2010s - Present): In recent years, AI has become more pervasive in various industries and applications, such as virtual assistants, recommendation systems, autonomous vehicles, and healthcare diagnostics.

11. Ethical and Social Considerations: The rise of AI has also raised important ethical and social questions, including concerns about privacy, bias, job displacement, and the potential impact on society.

# AI Technical Drivers

**Greater** knowledge about the functioning Human Intelligence acquired in recent years

**Advances** in microelectronics and nanotechnology.

**Increased** computing power enhanced by Quantum Computing.

**Access** to large amounts of data (Big Data)

**The ubiquitous nature** of the Internet allowing connection between systems

**Advances in the field of Robotics** allowing more automation.

# Early Thinkers



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**Wilhelm von Humboldt**

22 June 1767 Potsdam - 8 April 1835, Berlin.

**The full linguistic capacity of a human being means that he is capable of producing, with finite means, an infinite set of sentences.**

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# Early Thinkers



**Avram Noam Chomsky**

## **Most Outstanding Works:**

- **Generative grammar .**
- **Cognitive sciences.**

**“In order for the mind to develop the ability to procure and understand sentences, it must **apply an algorithm.**”**



# Early Thinkers



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Alan Turing.

(1912 - 1954)

**His mathematical works affirm that it is possible to build powerful machines equipped with AI.**

## List and description of the most powerful AI tools available (1)

1. **Jasper**: an AI writing assistant that can create phrases, paragraphs, or documents based on the subject matter and tone of voice. It is capable of producing a 1,500-word article in less than 15 minutes.
2. **Murf**: a text-to-speech generator that can create studio-quality voiceovers from text. It is one of the most popular and impressive AI voice generators on the market.
3. **OpenAI API key**: an AI research laboratory consisting of the for-profit corporation OpenAI LP and its parent company, the non-profit OpenAI Inc. OpenAI provides an API key that can be used to access their GPT-3 language model, which can generate human-like text.
4. **DALL-E 2**: an AI tool that can generate images from textual descriptions. It is capable of creating highly detailed and realistic images of objects that do not exist in the real world.

## List and description of the most powerful AI tools available (2)

5. **Transformer**: an AI tool that can be used for natural language processing tasks such as language translation and text summarization. It is based on a deep learning architecture called the transformer model.

6. **Dialogflow**: an AI tool from Google Cloud that uses BERT-based natural language understanding (NLU) models to accurately understand context and intent. It can be used to develop chatbots for websites and social media channels that can generate automatic responses.

7. **BotStar**: a platform that can create scalable and multi-lingual chatbots for seamlessly handling user queries.

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## List and description of the most powerful AI tools available (3)

8. **HypotenuseAI**: an AI tool for creating unique copywriting and visual content.
9. **LookaAI**: an AI tool for designing logos for brands and companies.
10. **Scikit Learn**: a widely praised AI tool that simplifies the complexities of machine learning tasks. It boasts an easy-to-use interface and is built on Python.
11. Chat GPT: The above list was actually provided by Chat GPT . Interestingly it did not list itself.

# Quantum computing, machine learning, and artificial intelligence (AI)

Quantum computing, machine learning, and artificial intelligence (AI) are three distinct fields that have the potential to interact and complement each other in significant ways. While each field has its own principles and applications, there are areas where the unique capabilities of quantum computing can enhance machine learning and AI techniques. Here's an overview of how these fields intersect:

# QUANTUM COMPUTING AND MACHINE LEARNING

## 1. Quantum Computing and Machine Learning:

- **Quantum Speedup:** Quantum computers have the potential to accelerate certain machine learning algorithms significantly. Problems that involve optimisation, searching large solution spaces, and matrix operations could benefit from quantum speedup. Quantum computers could solve these problems exponentially faster than classical computers, leading to quicker training and improved efficiency.
- **Quantum Data Processing:** Quantum computers could process and analyse large datasets more efficiently due to their inherent parallelism. Quantum machine learning algorithms could leverage quantum properties to perform complex data transformations, leading to faster data analysis and pattern recognition.
- **Quantum Dimensionality Reduction:** Quantum computing could contribute to more efficient dimensionality reduction techniques, enabling better feature selection and extraction for machine learning models.

# QUANTUM COMPUTING AND AI

- **Enhancing AI Algorithms:** Quantum computers could potentially enhance AI algorithms by optimising various components, such as decision trees, clustering, and reinforcement learning policies. Quantum AI algorithms might also be able to handle larger and more complex datasets.
- **Natural Language Processing:** Quantum computers could improve the efficiency of natural language processing tasks like language translation, sentiment analysis, and chatbots, by handling complex linguistic patterns more effectively.
- **Recommendation Systems:** Quantum algorithms could potentially lead to more accurate and efficient recommendation systems, improving user experience in e-commerce and content platforms.
- **Quantum Machine Learning Libraries:** Researchers are working on developing quantum machine learning libraries that provide tools for developing and implementing quantum-enhanced AI models.

# CHALLENGES AND CONSIDERATIONS

- **Hardware Constraints:** Quantum computers are still in the early stages of development, and building stable and error-corrected quantum systems is a challenge. Current quantum computers have limited qubits and are susceptible to errors, which can affect the accuracy of quantum machine learning and AI algorithms.
- **Algorithm Development:** Developing quantum machine learning and AI algorithms requires expertise in both quantum computing and the specific application domain. Researchers need to adapt existing classical algorithms or develop new quantum algorithms to take advantage of quantum speedup.
- **Hybrid Approaches:** Due to the limitations of current quantum hardware, many proposed quantum machine learning and AI approaches involve hybrid algorithms that combine classical and quantum processing. These approaches aim to leverage quantum speedup where applicable while utilizing classical methods for the rest of the computation.
- **Education and Expertise:** Quantum computing is a specialized field that requires expertise in quantum physics, quantum information theory, and algorithm development. Similarly, effective integration of quantum-enhanced techniques into machine learning and AI applications demands interdisciplinary knowledge.



# CASE STUDY: AI and Face Recognition

Artificial Intelligence (AI) and face recognition are closely related fields that have seen significant advancements in recent years. Face recognition, a subset of computer vision, involves the identification and verification of individuals based on their facial features. AI techniques, particularly machine learning and deep learning, have played a crucial role in enhancing the accuracy and efficiency of face recognition systems. Here's how AI is applied in face recognition:

- 1. Feature Extraction:** Traditional face recognition methods involve extracting facial features like distances between eyes, nose shape, and mouth positioning. AI techniques, especially deep learning, enable the automatic extraction of high-level features from raw images, improving the accuracy of identification.
- 2. Machine Learning Models:** Machine learning algorithms, such as Support Vector Machines (SVM), k-Nearest Neighbors (k-NN), and Random Forests, can be trained on labeled face data to recognize patterns and make predictions. Deep learning models like Convolutional Neural Networks (CNNs) have shown remarkable success in feature learning and representation.
- 3. Deep Learning:** Deep learning models, particularly CNNs, have revolutionized face recognition. CNNs can automatically learn hierarchical features from images, enabling them to capture intricate details important for accurate identification.

# CASE STUDY: AI and Face Recognition (cont)

1. **Neural Networks for Embeddings:** Modern face recognition systems use neural networks to generate embeddings, which are compact representations of facial features. These embeddings capture the unique characteristics of each face and are used for matching and identification.
2. **One-shot Learning and Siamese Networks:** AI techniques enable one-shot learning, where a model can recognize individuals from very few examples. Siamese networks, a type of neural network architecture, are used to learn similarity metrics between pairs of images for verification tasks.
3. **Transfer Learning:** Pretrained models can be fine-tuned for face recognition tasks. Transfer learning enables the use of models trained on large datasets to perform well on smaller datasets with limited labeled samples.
4. **Face Detection:** AI-based face detection algorithms identify faces within images or video streams. These detections serve as inputs to face recognition systems.
5. **Privacy and Ethical Considerations:** AI-powered face recognition systems raise important privacy and ethical concerns. Ensuring responsible use, informed consent, and protection against misuse are crucial aspects.

# APPLICATIONS of AI in Face Recognition

Applications of AI in Face Recognition:

1. **Security and Authentication:** Face recognition is widely used for biometric authentication in devices like smartphones and access control systems.
2. **Law Enforcement:** Law enforcement agencies use face recognition to identify suspects from surveillance footage or databases.
3. **Social Media and Photo Tagging:** Social media platforms use AI to automatically tag individuals in photos.
4. **Retail and Marketing:** Retailers use face recognition for customer tracking, personalized marketing, and analyzing shopper behavior.
5. **Healthcare:** Face recognition can be used in medical applications, such as patient identification and emotion analysis.
6. **Automotive Industry:** AI-powered face recognition is used in advanced driver-assistance systems and for driver monitoring.
7. **Entertainment and Gaming:** AI-driven face recognition enables augmented reality filters and facial animations in games and apps.

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# AI and FACE RECOGNITION:CONCLUSION

While AI-powered face recognition has numerous benefits, it also raises concerns about privacy, bias, and security. Responsible development, regulation, and ethical considerations are essential to ensure that these systems are used appropriately and fairly.

# CASE STUDY: AI and DRIVERLESS CARS

## AI and driverless cars

Artificial Intelligence (AI) plays a pivotal role in the development of driverless cars, also known as autonomous or self-driving cars. These vehicles use a combination of AI technologies, sensors, cameras, and sophisticated algorithms to navigate and interact with their environment without human intervention. Here's how AI is used in driverless cars:

# AI and DRIVERLESS CARS

- 1. Perception Systems:** AI algorithms process data from various sensors, such as LiDAR (Light Detection and Ranging), cameras, radar, and ultrasonic sensors. These algorithms identify objects, pedestrians, road signs, lanes, and other vehicles to create a detailed understanding of the car's surroundings.
- 2. Sensor Fusion:** AI is used to fuse information from different sensors to create a more comprehensive and accurate representation of the environment. This enables the car to make informed decisions based on a holistic view of its surroundings.
- 3. Localization and Mapping:** AI-based techniques help in creating high-definition maps and accurately localizing the car within its environment. These maps, combined with real-time sensor data, aid in precise navigation and path planning.
- 4. Path Planning and Control:** AI algorithms determine the optimal path for the vehicle, considering factors such as traffic conditions, obstacles, and traffic rules. They also control the vehicle's movements, ensuring safe and efficient navigation.
- 5. Machine Learning and Deep Learning:** Machine learning and deep learning techniques are used to improve the car's ability to understand and respond to complex scenarios. They enable the car to learn from real-world data and adapt to various driving conditions.
- 6. Decision-Making:** AI algorithms make real-time decisions by analyzing sensor data, traffic conditions, pedestrian behavior, and other relevant factors. They choose appropriate actions, such as accelerating, braking, turning, or yielding.
- 7. Predictive Analysis:** AI can predict the behavior of other road users and pedestrians, anticipating potential hazards and allowing the car to react proactively.
- 8. Emotion Recognition:** Some driverless cars employ AI to recognize and understand human emotions through facial expressions, gestures, and vocal cues. This helps the car adapt its behavior and communicate effectively with passengers.
- 9. V2X Communication:** Vehicle-to-Everything (V2X) communication involves AI-enabled vehicles exchanging information with infrastructure, other vehicles, and pedestrians. This enhances safety and coordination on the road.
- 10. Remote Monitoring and Control:** AI systems allow remote operators to monitor autonomous vehicles, provide assistance in complex situations, and take control if needed.

# BENEFITS OF AI in AUTONOMOUS VEHICLES

## Benefits of AI in Driverless Cars:

- **Safety:** AI-driven driverless cars have the potential to significantly reduce accidents caused by human error. They can detect and respond to situations faster than human drivers.
- **Efficiency:** Autonomous cars can optimize traffic flow, reduce congestion, and improve fuel efficiency through optimal driving behavior.
- **Accessibility:** Self-driving cars could make transportation more accessible for people with disabilities or those who can't drive.
- **Reduced Traffic:** AI-enabled traffic management and efficient routing can lead to reduced traffic congestion.
- **Productivity:** Passengers can use travel time more productively while the car handles the driving.
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# CHALLENGES of AUTONOMOUS VEHICLES

Challenges:

- **Technical Complexity:** Developing AI systems that can handle diverse driving conditions, weather, and complex scenarios remains challenging.
- **Ethical and Legal Issues:** Autonomous vehicles raise ethical questions related to decision-making in potential accidents and liability in case of accidents.
- **Safety Assurance:** Ensuring that self-driving cars operate safely and reliably in all situations is a complex task that requires extensive testing and validation.
- **Regulations and Standards:** Creating consistent regulations and safety standards for autonomous vehicles is an ongoing challenge.

Despite these challenges, the integration of AI in driverless cars has the potential to reshape transportation, making it safer, more efficient, and more accessible.