

Artificial Intelligence Ecosystem

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1 ARTIFICIAL INTELLIGENCE (AI)

(The root category — everything else comes under AI.)

AI is the science of creating machines that can **think, learn, reason, understand, and make decisions** like humans.

AI is the **umbrella term** for ML, DL, NLP, LLMs, GenAI, Agents, CV, etc.

Artificial Intellegence

- |—— What it does
 - |—— Mimics human intelligence using algorithms and logic
 - |—— Learns from experience and improves over time
 - |—— Understands environment and takes decisions
 - |—— Solves problems autonomously

| └— Automates tasks that usually require human intelligence

|

| └— **What it uses**

| | └— Data (foundation of all AI)

| | └— Algorithms (ML, DL, heuristics)

| | └— Mathematical modeling (statistics, optimization)

| | └— Knowledge representation (rules, logic)

| | └— Neural networks (for modern AI)

|

| └— **Core capabilities**

| | └— Pattern recognition

| | └— Decision making

| | └— Knowledge reasoning (logical inference)

| | └— Prediction & classification

| | └— Automation of repetitive tasks

|

| └— **Advanced capabilities**

| | └— Natural language understanding (NLP)

| | └— Vision understanding (CV)

| | └— Autonomous decision-making (agents)

| | └— Generating creative content (GenAI)

| | └— Multi-modal understanding (text + image + audio)

|

| └— **Outputs**

| | └— Predictions (future outcomes)

| | └— Decisions (approve/deny)

| | └— Classifications (labels)

| | └— Recommendations

| | └— Generated content (text, audio, images)

- |
 - | — **Real-world applications**
 - | — Healthcare (diagnosis, drug discovery)
 - | — Finance (fraud detection, credit scoring)
 - | — E-commerce (recommendation engines)
 - | — Transportation (self-driving cars)
 - | — Education (personalized learning)
 - | — Manufacturing (robots, automation)
 - | — Customer service (chatbots)
- |
- | — **Popular frameworks & models**
 - | — ML frameworks: Scikit-learn, XGBoost
 - | — DL frameworks: PyTorch, TensorFlow
 - | — AI platforms: OpenAI, Google Vertex AI, AWS SageMaker
 - | — Knowledge systems: Prolog, rule-based systems
 - | — Robotics libraries: ROS

1 DATA SCIENCE (The Foundation of All AI Work)

Data Science = Understanding data + analyzing trends + preparing it for ML/DL.

Data Science

- | — **What it does (human-level explanation)**
 - | — Collects raw data from databases, APIs, logs
 - | — Cleans messy data (missing values, duplicates)
 - | — Analyzes trends to understand what is happening

- | | — Visualizes data to explain insights
- | | — Helps companies make decisions based on data, not guesswork
- |
- | — **What it uses**
- | | — Statistics (mean, median, distribution, probability)
- | | — Mathematics for understanding patterns
- | | — Python Libraries: Pandas, NumPy
- | | — SQL for extracting data
- | | — ML algorithms for predictions
- |
- | — **Core capabilities**
- | | — Data cleaning
- | | — Exploratory data analysis (EDA)
- | | — Trend detection
- | | — Hypothesis testing
- | | — Statistical summaries
- |
- | — **Advanced capabilities**
- | | — Time series forecasting (predicting future sales, temperature)
- | | — Building data pipelines (ETL / ELT)
- | | — Big data processing (Spark)
- | | — Experimentation (A/B testing)
- | | — Feature engineering for ML models
- |
- | — **Outputs**
- | | — Dashboards (Power BI, Tableau)
- | | — Data reports
- | | — Statistical insights
- | | — Clean datasets ready for ML

- |
 - |—— **Real-world applications**
 - |—— E-commerce sales reporting
 - |—— Hospital patient analytics
 - |—— Finance (fraud detection, credit risk)
 - |—— Marketing campaign analysis
 - |—— Supply chain & inventory forecasting
 - |
 - |—— **Tools & Frameworks**
 - |—— Pandas, NumPy
 - |—— SQL
 - |—— Tableau, Power BI
 - |—— Apache Spark
 - |—— Scikit-learn

2 MACHINE LEARNING (ML)

ML = Algorithms that learn patterns from data and make predictions.

Machine Learning

- |—— **What it does**
 - |—— Learns patterns from historical data
 - |—— Creates mathematical models to make predictions
 - |—— Classifies things (spam/not spam, fraud/not fraud)
 - |—— Makes data-driven decisions automatically
- |
- |—— **What it uses**
 - |—— Statistics & probability

| | | — Linear algebra & calculus (for optimization)

| | | — Feature engineering

| | | — Algorithms like regression, decision trees

|

| — **Core capabilities**

| | — Classification (spam detection, cancer detection)

| | — Regression (price prediction)

| | — Clustering (customer segmentation)

| | — Ranking (search results)

| | — Anomaly detection

|

| — **Advanced capabilities**

| | — Ensemble methods (Random Forest, XGBoost)

| | — Hyperparameter tuning

| | — Probabilistic models

| | — Time series forecasting

|

| — **Outputs**

| | — Predictions (prices, numbers)

| | — Labels (yes/no, category A/B)

| | — Scores (fraud score, churn score)

| | — Group clusters

|

| — **Real-world applications**

| | — Credit scoring (banks)

| | — Recommendation systems (Netflix, Amazon)

| | — Fraud detection (banking)

| | — Predictive maintenance (factories)

| | — Supply chain forecasting

- |
 - └── **Popular Frameworks**

- |
 - └── Scikit-learn
 - └── XGBoost, LightGBM
 - └── CatBoost
-

3 DEEP LEARNING (DL)

DL = Neural networks that learn complex patterns from large datasets.

Deep Learning

- |
 - └── **What it does**
 - |
 - └── Learns directly from large amounts of data
 - └── Automatically extracts features
 - └── Powers modern AI (NLP, CV, speech)
 - └── Handles problems too complex for traditional ML
 - |
 - └── **What it uses**
 - |
 - └── Neural Networks (multi-layer)
 - └── CNNs, RNNs, LSTMs
 - └── Transformers (used in LLMs)
 - └── GPU computing
 - |
 - └── **Core capabilities**
 - |
 - └── Image recognition
 - └── Speech recognition
 - └── Large-scale NLP
 - └── Sequence prediction

- |
 - |—— **Advanced capabilities**
 - |—— GANs (deepfake, image generation)
 - |—— Diffusion models (Midjourney, Stable Diffusion)
 - |—— Reinforcement Learning
 - |—— Multi-modal AI
 - |
 - |—— **Outputs**
 - |—— Embeddings
 - |—— Predictions
 - |—— Generated images/audio
 - |—— Probability distributions
 - |
 - |—— **Real-world applications**
 - |—— Face recognition
 - |—— Medical image diagnosis
 - |—— Autonomous driving
 - |—— Speech-to-text systems
 - |
 - |—— **Popular Tools**
 - |—— PyTorch
 - |—— TensorFlow
 - |—— Keras, JAX

4 NLP (Natural Language Processing)

NLP = understanding, processing, and analyzing human language.

NLP

What it does

- | | Understands meaning, context, grammar
- | | Extracts information from text
- | | Classifies sentences
- | | Summarizes content
- | | Translates languages

|

What it uses

- | | Linguistic rules
- | | ML + DL techniques
- | | Tokenization, embeddings
- | | Transformers

|

Core capabilities

- | | Sentiment analysis
- | | Named Entity Recognition
- | | Intent detection
- | | Summarization
- | | Translation

|

Advanced capabilities

- | | Semantic search
- | | Dialogue understanding
- | | Question answering
- | | Topic modeling
- | | Multilingual NLP

|

Outputs

- | └── Entities, labels
- | └── Summaries
- | └── Cleaned text
- | └── Embeddings
- |
- |
- └── **Real-world applications**
 - | └── Chatbots
 - | └── Resume parsers
 - | └── Support ticket routing
 - | └── Legal document extraction
 - | └── Sentiment analysis (social media)
- |
- └── **Tools**
 - └── spaCy, NLTK
 - └── BERT, RoBERTa
 - └── SBERT

5 LLMs (Large Language Models)

LLMs = advanced NLP models with reasoning + generative abilities.

LLMs

- └── **What they do**
 - | └── Understand & generate language
 - | └── Conduct reasoning and problem solving
 - | └── Write content & code
 - | └── Follow complex instructions
- |

└─ **What they use**

- | └─ Transformer architecture
- | └─ Attention mechanism
- | └─ Massive datasets
- | └─ RLHF (human feedback training)
- |

└─ **Core capabilities**

- | └─ Summarization
- | └─ Q/A
- | └─ Code generation
- | └─ Logical reasoning
- |

└─ **Advanced capabilities**

- | └─ Chain-of-thought reasoning
- | └─ Tool use (function calling)
- | └─ Multi-modal understanding
- | └─ Domain-specific fine-tuning
- |

└─ **Outputs**

- | └─ Human-like text
- | └─ Reasoning steps
- | └─ Code snippets
- | └─ Structured JSON
- |

└─ **Applications**

- | └─ ChatGPT-like systems
- | └─ AI search engines
- | └─ Document intelligence
- | └─ AI copilots (coding, writing)

|

└─ **Models**

 └─ GPT series

 └─ Claude

 └─ Gemini

 └─ LLaMA

6 GENERATIVE AI

GenAI = AI that *creates* new content.

Generative AI

└─ **What it does**

 | └─ Creates text, images, video, audio, code

 | └─ Generates creative outputs

 | └─ Enhances design and imagination

 |

└─ **What it uses**

 | └─ LLMs

 | └─ Diffusion models

 | └─ GANs

 | └─ Audio/video synthesis

 |

└─ **Core capabilities**

 | └─ Content creation

 | └─ Image generation

 | └─ Voice synthesis

 | └─ Video creation

- |
 - |—— Advanced capabilities
 - |—— Multi-modal generation
 - |—— Scene understanding → scene creation
 - |—— Personalized AI content
 - |—— Popular Models
 - |—— Midjourney
 - |—— DALL·E
 - |—— Stable Diffusion

7 AI AGENTS / AGENTIC AI

Agents = AI that acts, executes tasks, uses tools, and works autonomously.

AI Agents

- |—— What they do
 - |—— Think (reason)
 - |—— Plan (multi-step)
 - |—— Act (use tools)
 - |—— Self-correct
 - |—— Work like digital employees
- |—— What they use
 - |—— LLMs
 - |—— Memory (vector DB)
 - |—— Tools & APIs
 - |—— Agent frameworks

- |
 - |—— **Core capabilities**
 - |—— Web browsing
 - |—— Data extraction
 - |—— Automated workflows
 - |—— Complex task execution
 - |—— **Advanced capabilities**
 - |—— Autonomous coding
 - |—— Multi-agent collaboration
 - |—— Long-term planning
 - |—— Continuous monitoring
 - |—— **Technologies**
 - |—— AutoGPT
 - |—— ReAct agents
 - |—— LangChain agents
 - |—— Devin AI

8 COMPUTER VISION (Parallel domain after DL)

CV = understanding visual data (images/videos).

Computer Vision

- |—— **What it does**
 - |—— Detects objects and faces
 - |—— Understands scenes
 - |—— Reads text from images (OCR)

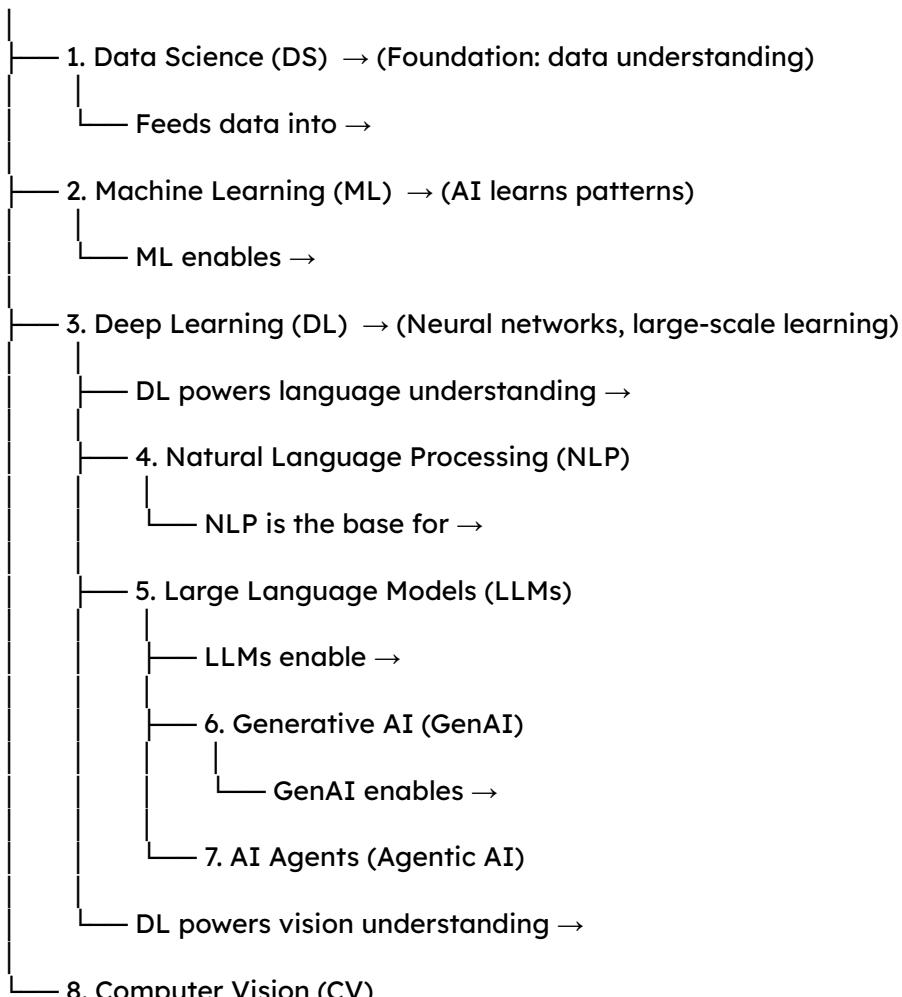
- | └── Tracks motion/actions
 - |
 - |
 - | └── **What it uses**
 - | | └── CNNs
 - | | └── Vision Transformers
 - | | └── Image augmentation
 - | | └── OCR engines
 - |
 - |
 - | └── **Core capabilities**
 - | | └── Object detection (YOLO)
 - | | └── Image classification
 - | | └── Facial recognition
 - | | └── Image segmentation
 - |
 - |
 - | └── **Advanced capabilities**
 - | | └── Pose estimation
 - | | └── 3D reconstruction
 - | | └── Video analytics
 - | | └── Depth estimation
 - |
 - | └── **Real-world uses**
 - | | └── Self-driving cars
 - | | └── Surveillance AI
 - | | └── Medical imaging
 - | | └── E-commerce visual search
-

1 TREE RELATIONSHIP (MOST IMPORTANT)

This shows exactly HOW everything connects, depends, and grows.

Relationship across AI → DS → ML → DL → NLP → LLMs → GenAI → Agents → CV.

ARTIFICIAL INTELLIGENCE (AI)



This tree is **how the entire modern AI world is structured internally**.

3 HUMAN-ANALOGY DIAGRAM

AI = The whole “human brain” idea (general intelligence)

Data Science = Understanding raw life experiences (data)

Machine Learning = Learning from past experiences (patterns)

Deep Learning = The human subconscious learning complex things

NLP = Understanding & speaking language

LLMs = Super-brain for language + reasoning

Generative AI = Creativity (drawing, writing, inventing)

AI Agents = A human who can: think → plan → take actions → work independently

Computer Vision = The eyes + vision processing of AI

This makes the relationships intuitive.

FULL DEPENDENCY MAP (ALL 9 CATEGORIES)

(From most foundational → to highest-level AI systems)

1. ARTIFICIAL INTELLIGENCE (AI)

(AI is the umbrella — nothing sits above it.)

AI depends on:

- Mathematics (logic, probability, optimization)
 - Computer Science foundations
 - Algorithms & Data Structures
 - Data (all AI is data-driven)
 - Problem-solving frameworks
-

2. DATA SCIENCE

(Base layer for ML, DL, NLP, LLMs, etc.)

Data Science depends on:

- Statistics
 - Probability theory
 - Data manipulation (Pandas, SQL)
 - Business understanding
 - Basic programming (Python)
-

3. MACHINE LEARNING (ML)

(ML cannot exist without data.)

Machine Learning depends on:

- Data Science (clean, structured data)
 - Linear algebra (vectors, matrices)
 - Calculus (optimization, gradients)
 - Statistics & probability
 - Algorithmic thinking
-

4. DEEP LEARNING (DL)

(DL is built on ML + neural networks.)

Deep Learning depends on:

- Machine Learning fundamentals
- Neural Networks (ANNs)
- Linear algebra (matrix multiplication)
- Calculus (backpropagation, gradients)

→ GPUs / high compute hardware

→ Large datasets

5. NLP (Natural Language Processing)

(*NLP sits ON TOP of ML + DL.*)

NLP depends on:

- Deep Learning (Transformers, RNNs, attention)
 - Machine Learning (classification, regression)
 - Data Science (text preprocessing)
 - Linguistics (syntax, semantics)
 - Embeddings (word2vec, BERT embeddings)
-

6. LLMs (Large Language Models)

(*LLMs = advanced NLP + massive-scale DL.*)

LLMs depend on:

- NLP fundamentals
 - Deep Learning (Transformers)
 - Large-scale neural architectures
 - Massive text datasets (trillions of tokens)
 - High-performance computing (TPUs/GPUs)
 - Reinforcement learning (RLHF)
-

7. GENERATIVE AI

(GenAI uses LLMs, diffusion models, audio models, etc.)

Generative AI depends on:

- LLMs (for text generation)
 - Diffusion models (for images/videos)
 - GANs (for realistic media)
 - Deep Learning (neural networks)
 - Tokenizers, embeddings, latent spaces
 - High compute training hardware
-

8. AI AGENTS / AGENTIC AI

(Most advanced layer – autonomous reasoning + tool use.)

AI Agents depend on:

- LLMs (reasoning engine / brain)
 - Generative AI (content creation)
 - Tools / APIs (web search, code execution)
 - Memory systems (vector DBs)
 - Planning algorithms (ReAct, AutoGPT)
 - Environment to act (browser, OS, APIs)
 - Multi-step reasoning frameworks
-

9. COMPUTER VISION (CV)

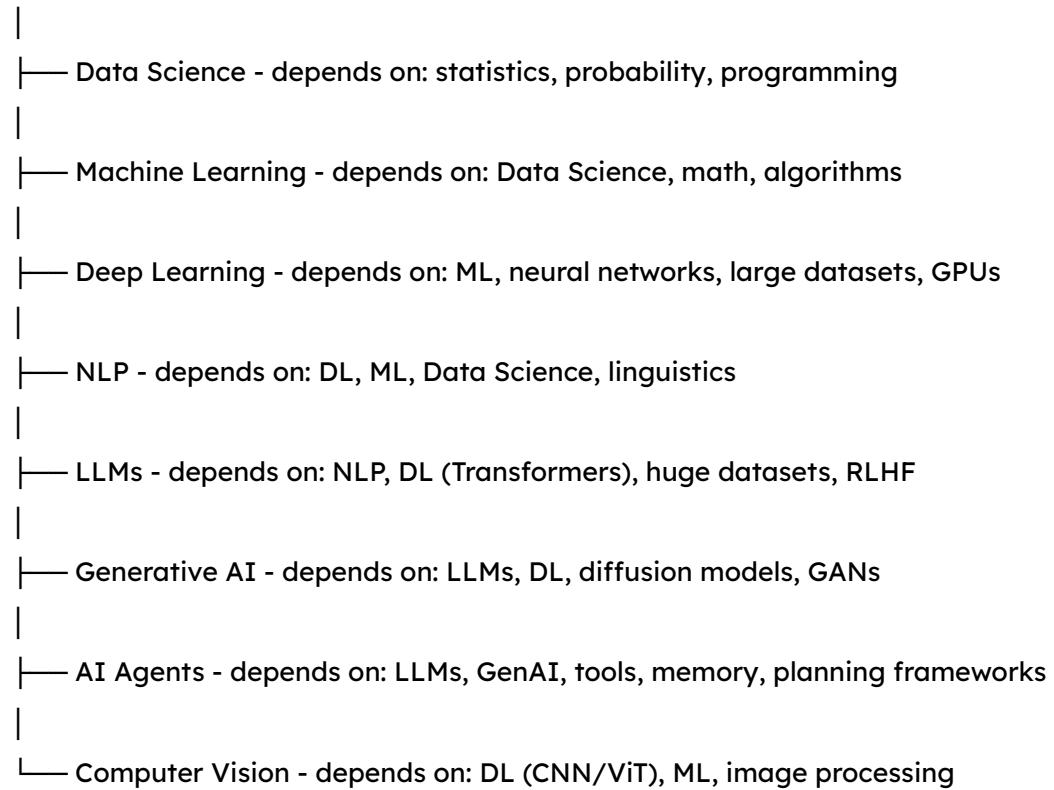
(Parallel branch to NLP but still based on DL.)

Computer Vision depends on:

- Deep Learning (CNNs, Vision Transformers)
 - Machine Learning basics
 - Image processing techniques (filters, edges)
 - Annotated image/video datasets
 - GPUs for training
-

FULL DEPENDENCY OVERVIEW

AI → (root, no dependencies)



This map shows **exact technical prerequisites**.