

Artificial Intelligence Ecosystem

Table of Contents

1. Artificial Intelligence
2. Data Science
3. Machine Learning
4. Deep Learning
5. NLP
6. LLMs
7. Generative AI
8. AI Agents / Agentic AI
9. Computer Vision
10. Tree Relationship (How All Fields Connect)
11. Human Analogy Diagram (Easy Understanding)
12. Full Dependency Map (All 9 Categories)
13. Summary Dependency Overview

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 Intelligence

└─ 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

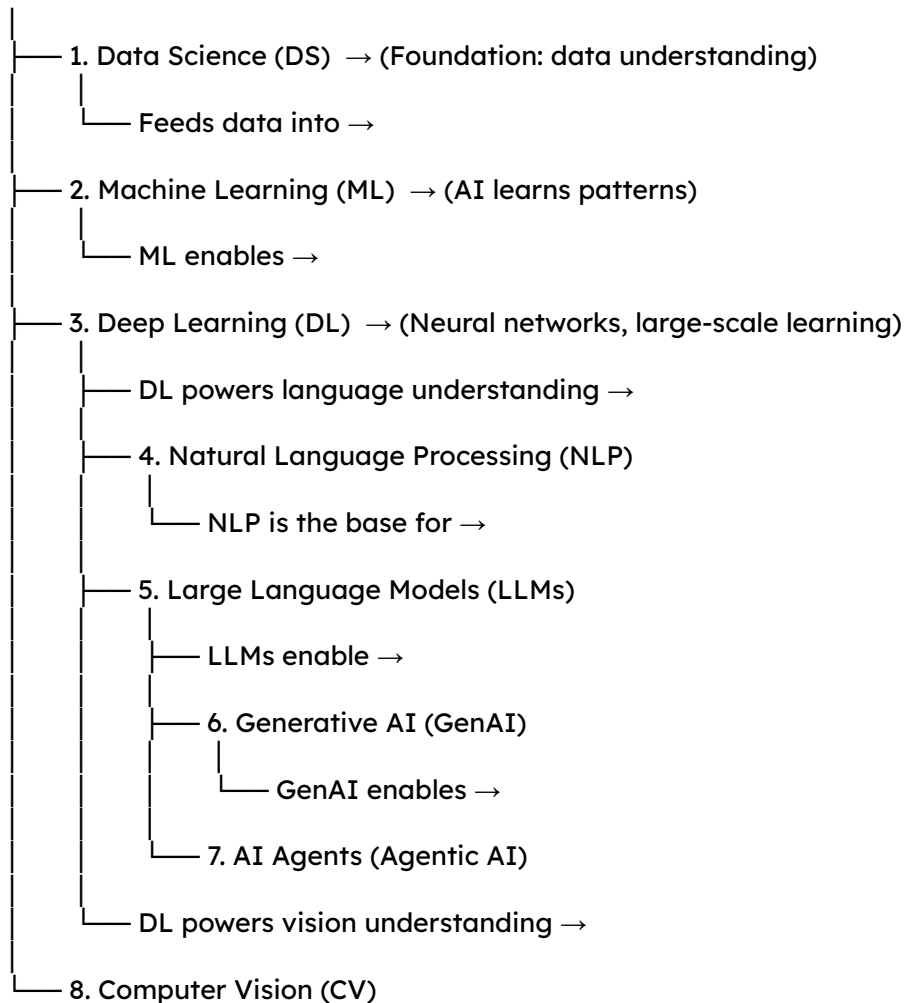
 └─ E-commerce visual search

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)

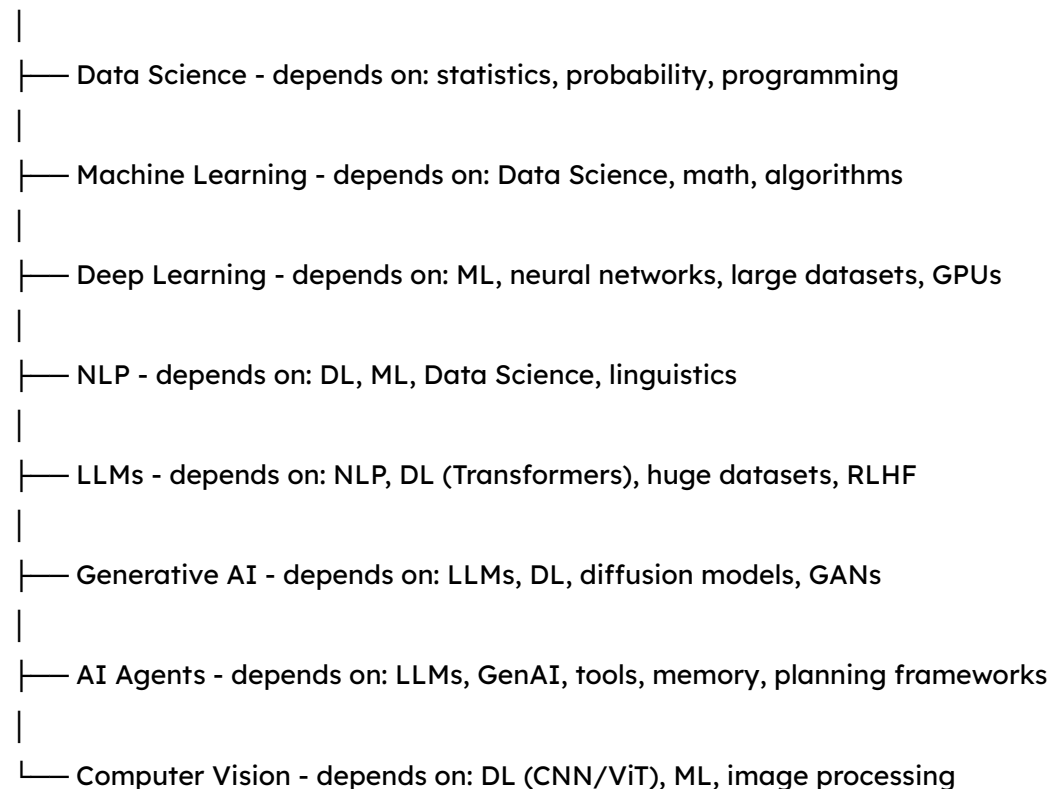
(Parallel branch to NLP but still based on DL.)

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**.