Korea Aerospace University

2AI4203: Machine Learning

Lec01: Introduction to Machine Learning

Jiyoon Shin

KAU College of AI Convergence

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Course Information

- Instructor: Jiyoon Shin (jiyoonshin@kau.ac.kr)
- TA
  - Minjae Won (lgtwins2003@gmail.com)
  - Yewon Hwang (hamcheese8989@kau.ac.kr)

- Lecture
  - Wednesday, 14:00−18:00 (actual class: approx. 3 hours)
  - Electronics Building, Room 422
- Office Hours
  - Tuesday/Thursday, 14:00−17:00
  - Electronics Building, Room 403

Course Materials

- Lecture slides
  - Available on the Course Website
- Textbook
  - No required textbook
  - Slides handcrafted by the instructor

- Useful online resources
  - KAIST − Machine Learning
  - UMass − COMPSCI389: Introduction to Machine Learning
  - Stanford − EE104/CME107: Introduction to Machine Learning
  - ESSAI 2026 − Trustworthy Machine Learning: From Data to Models

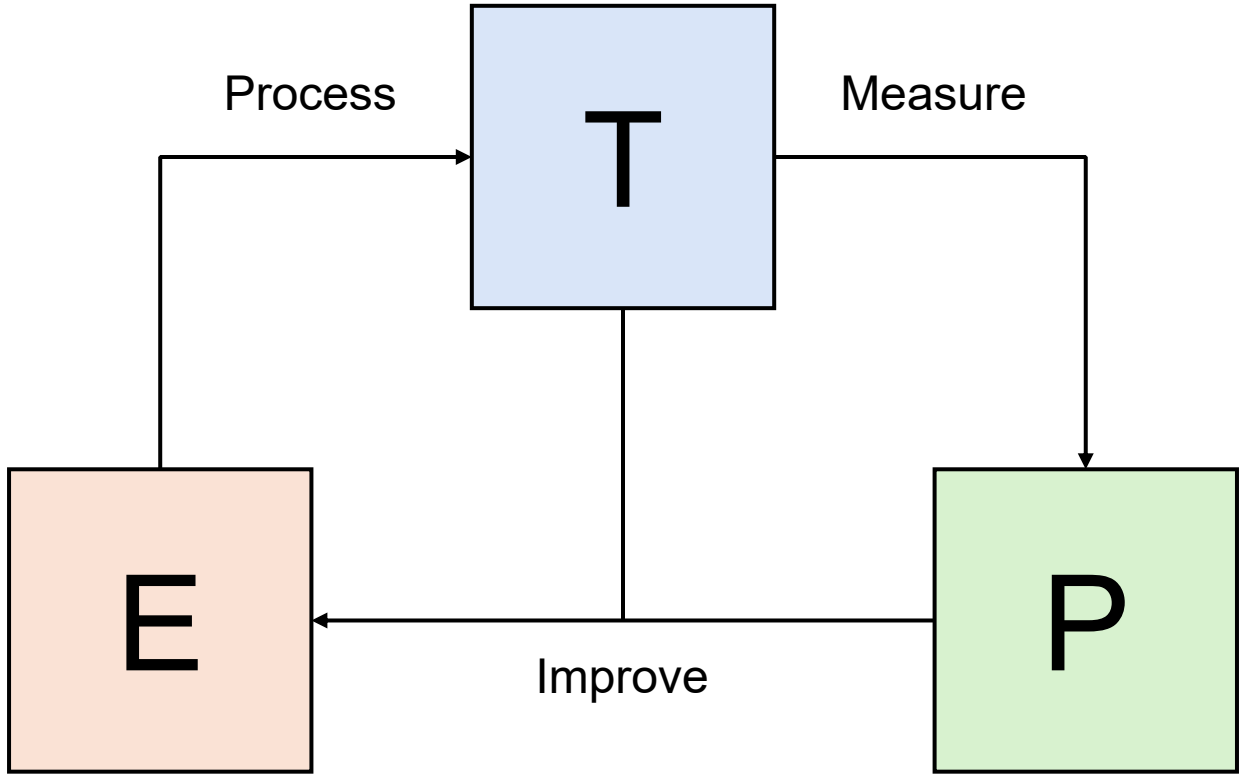
Prerequisites

- Basic Python programming
  - Only minimally required for assignments

- No other prerequisites
  - We will start from the basics
  - Just follow along with the lectures!

What is Machine Learning?

- “A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E.” [Tom Mitchell, 1997]



ML: Learning from Data

Data


Cat


Cat


Dog


Dog

Training



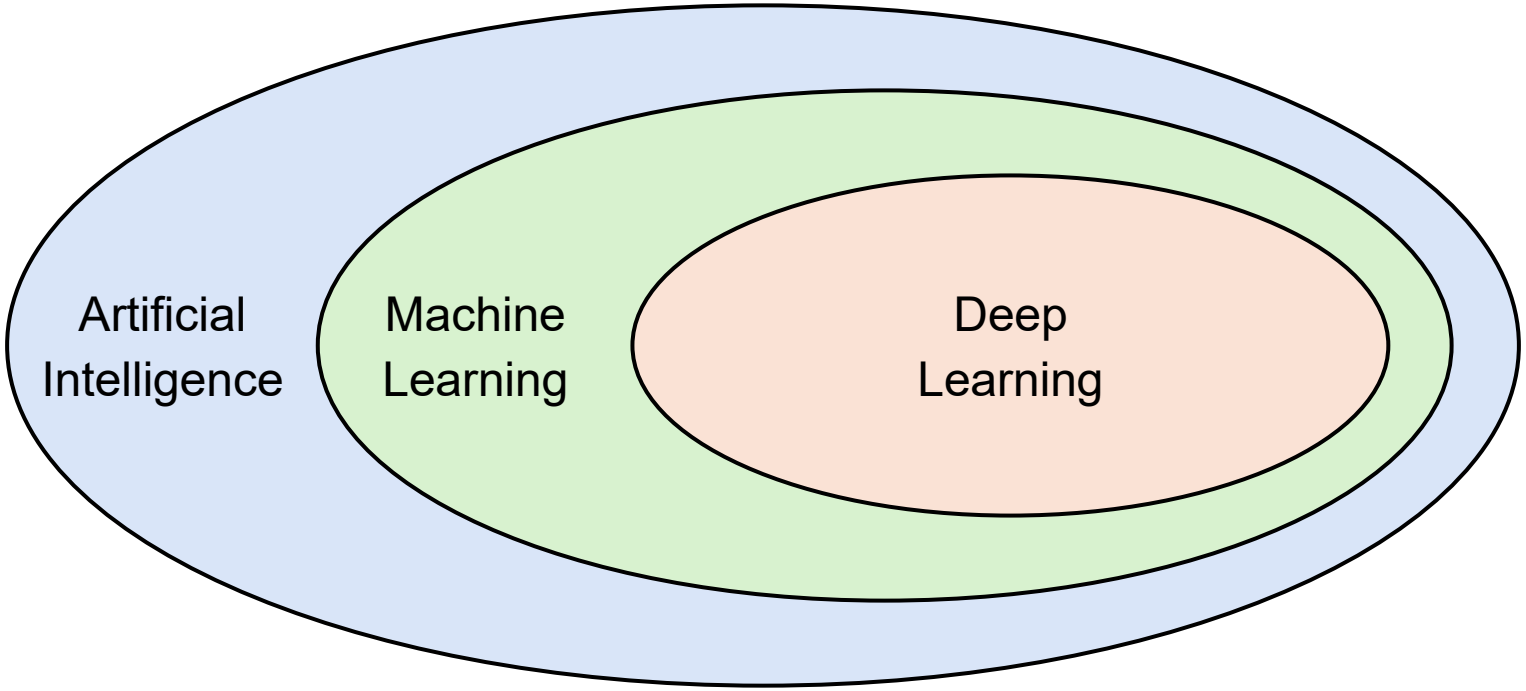
Trained Model

Dog?
Cat?

Example: Image Classification

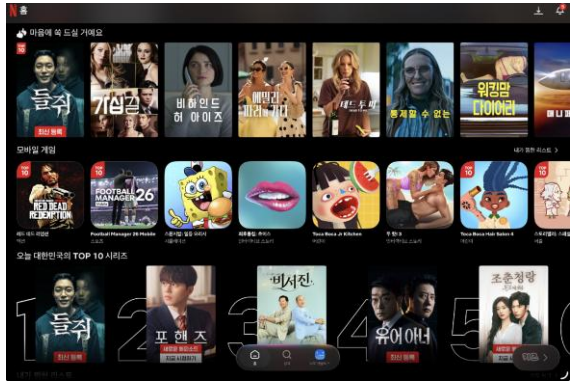
AI vs. ML vs. DL

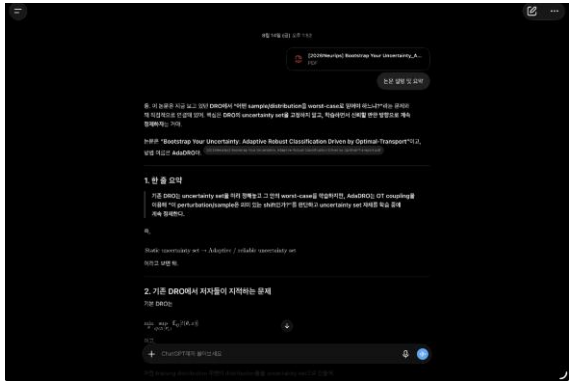
- AI: Machines performing tasks that require intelligence
- ML: Systems that learn patterns from data
- DL: Machine learning using multi-layer neural networks

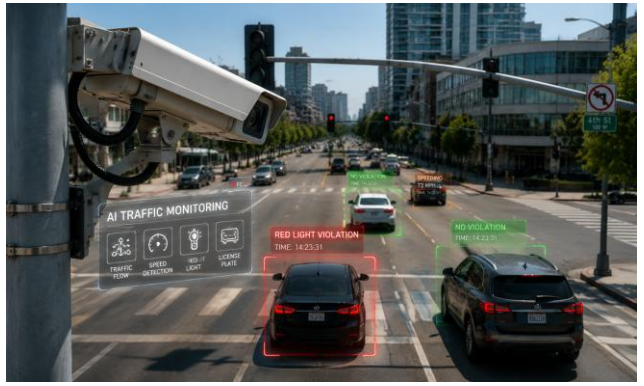


Applications of Machine Learning

- Computer Vision
- Natural Language Processing
- Recommendation Systems
- Healthcare
- Autonomous Systems
- Finance
- Education
- …and so much more!









What We Will Learn

- **ML Fundamentals** (Lec01−04)
  - Regression & Classification
  - Training & Evaluation
  - Generalization

- **Classical ML** (Lec05−07)
  - Trees & Ensembles
  - SVM & Kernels
  - PCA & Clustering

What We Will Learn

- **Modern & Reliable ML** (Lec08−12)
  - ML in Practice
  - Neural Networks
  - Trustworthy ML
  - Distribution Shift & Data-Centric ML

- **Emerging ML** (Lec13)
  - Transformers
  - Foundation Models
  - AutoML & Future Directions

Course Schedule



STIL LAB @ KAU

Date / Link	Topic	Description	Document
	Part I: Foundations of Machine Learning		
Sep. 07	Lecture 1: Introduction to Machine Learning	- Course Overview What is Machine Learning? After AI, we do ML - Applications of Machine Learning	-
Sep. 09	Lecture 2: Machine Learning Basics & Linear Regression	- Supervised vs. Unsupervised Learning Classification vs. Regression - Machine Learning Workflow Linear Regression - Loss Functions Gradient Descent	
Sep. 16	Lecture 3: Classification with Nonlinear Learning	Logistic Regression - Probabilistic Classification Decision Boundaries - Classification Loss Functions Binary vs. Multi-class Classification	
Sep. 23	Lecture 4: Model Evaluation & Generalization	Train/Validation/Test Split - Cross-Validation Performance Metrics - Overfitting & Underfitting Bias-Variance Trade-off - Regularization - Generalization	
Sep. 30	Lecture 5: Tree-Based Machine Learning Models	Decision Trees - Splitting Criteria Bagging - Random Forest - Feature Importance	
Oct. 07	Lecture 6: Advanced Classification & Ensemble Methods	Support Vector Machines - Kernel Methods - Ensemble Learning Gradient Boosting - XGBoost, LightGBM	
Oct. 14	Lecture 7: Unsupervised Learning	Principal Component Analysis (PCA) - K-Means Clustering - Hierarchical Clustering Dimensionality Reduction - Clustering Evaluation & Visualization	
Oct. 21	Midterm Exam		



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Date / Link	Topic	Description
	Part II: Modern Machine Learning: Practice & Reliability	
Oct. 28	Lecture 8: Machine Learning in Practice	Data Preprocessing Feature Engineering - Data Leakage - Model Selection Hyperparameter Optimization - Machine Learning Pipelines Common Pitfalls
Nov. 04	Lecture 9: Neural Networks & Representation Learning	From Linear Models to Neural Networks - Multi-layer Perceptron (MLP) Activation Functions - Forward & Backpropagation Gradient-Based Learning - Representation Learning From Neural Networks to Deep Learning
Nov. 11	Lecture 10: Trustworthy & Explainable Machine Learning	Model Interpretability & Explainability - Feature Importance & SHAP - Prediction Confidence & Calibration - Uncertainty Estimation Fairness & Bias Adversarial Robustness - Introduction to Conformal Prediction
Nov. 18	Lecture 11: Machine Learning under Distribution Shift	- Distribution Shift Covariate Shift / Concept Shift - Out-of-Distribution (OOD) Detection Domain Adaptation - Domain Generalization Robust Learning under Distribution Shift
Nov. 25	Lecture 12: Data-Centric Machine Learning	Data Quality - Label Noise Class Imbalance & Long-Tailed Data - Cold-Start Problem Sampling Strategies - Data Augmentation Data-Centric AI
Dec. 02	Lecture 13: Foundation Models & Emerging ML Paradigms	From Task-Specific Models to Foundation Models - Attention & Transformers Pretraining & In-Context Learning - Foundation Models beyond Language - Tabular Foundation Models & TabPFN AutoML & Automated ML Pipelines - Public Practice on Machine Learning
Dec. 09	Final Exam	

Grading

- Midterm Exam: 30%
- Final Exam: 30%

- Homework Assignments: 30%
  - 4 assignments x 7.5%
  - No late submissions

- Attendance: 10%
  - Random checks (date & time)
  - -1.5 per absence

Korea Aerospace University

Questions?

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