

Machine Learning

Introduction. ML History

Aleksandr Petiushko

ML Research



Content

① Introduction

Content

- ➊ Introduction
- ➋ Course logistics and syllabus

Content

- ① Introduction
- ② Course logistics and syllabus
- ③ Historical reference

About the lecturer¹

- Aleksandr Petiushko, PhD in theoretical CS (2016)
- Lecturer in Lomonosov MSU / MIPT for Machine Learning, Computer Vision, Deep Learning Theory, Python for an ML Researcher since 2019
- Former Huawei Chief Scientist (Scientific Expert), AIRI Director of Key Research Programs (Leading Scientific Researcher)
- Currently at Nuro, leading the ML Research



¹Homepage: <https://petiushko.info/>

Intro

Time to introduce yourselves: what are your hobbies, motivation in ML, etc.: please go into “**Module 1 Students Introduction**” thread

Sofia Plagiarism Policy

- It covers parts “*sourced from AI*”
 - ▶ Please read the “**Sofia Plagiarism Policy**” thread
 - ▶ **First offense**: students need to rewrite assignment
 - ▶ **Second offense**: students fail the course
 - ▶ **Third offense**: students re to be withdrawn from their program

Note about xGPTx

- It can produce very plausible answers in 90% of cases

Note about xGPTx

- It can produce very plausible answers in 90% of cases
- The caveats are the following:

Note about xGPTx

- It can produce very plausible answers in 90% of cases
- The caveats are the following:
 - ▶ It can really hallucinate some things which are just untrue

Note about xGPTx

- It can produce very plausible answers in 90% of cases
- The caveats are the following:
 - ▶ It can really hallucinate some things which are just untrue
 - ▶ It can produce very different information in comparison to the source used to ask question (e.g., book chapter)

Note about discussions

- Discussion answers like “I agree because of bla-bla-bla” won’t be graded — they do not provide any value

Note about discussions

- Discussion answers like “I agree because of bla-bla-bla” won’t be graded — they do not provide any value
- Only the answers with some non-trivial arguments that contradict the initial post will be considered as graded ones

Course logistics

- Course grading will be done based on attendance, assignments, discussions, (optional: some small programming tasks) and the final exam.

Course logistics

- Course grading will be done based on attendance, assignments, discussions, (optional: some small programming tasks) and the final exam.
- Contribution:
 - 50%: attendance, assignments, discussions
 - 50%: exam

Course logistics

- Course grading will be done based on attendance, assignments, discussions, (optional: some small programming tasks) and the final exam.
- Contribution:
 - 50%: attendance, assignments, discussions
 - 50%: exam
- Preliminary grading scale:

Grade	Percent accumulated
A	90-100 %
B	75-89 %
C	60-74 %

Key ingredients of ML

- Current ML is: half Math, half Programming

Key ingredients of ML

- Current ML is: half Math, half Programming
 - ▶ **Math:** for research and design of ML algorithms

Key ingredients of ML

- Current ML is: half Math, half Programming
 - ▶ **Math:** for research and design of ML algorithms
 - ▶ **Programming:** usage and tuning of ML algorithms

Key ingredients of ML

- Current ML is: half Math, half Programming
 - ▶ **Math:** for research and design of ML algorithms
 - ▶ **Programming:** usage and tuning of ML algorithms
- Hopefully we could touch on both a little

- Course page: <https://github.com/fatheral/sofia-ml-2024-winter>
- The professor's lectures will be uploaded there

What is Artificial Intelligence?

Natural Intelligence (human)

- Able to perceive the information, analyze it, make decisions based on this analysis

What is Artificial Intelligence?

Natural Intelligence (human)

- Able to perceive the information, analyze it, make decisions based on this analysis

Artificial Intelligence

- (Strong) The same as natural intelligence, but computer is instead of human

What is Artificial Intelligence?

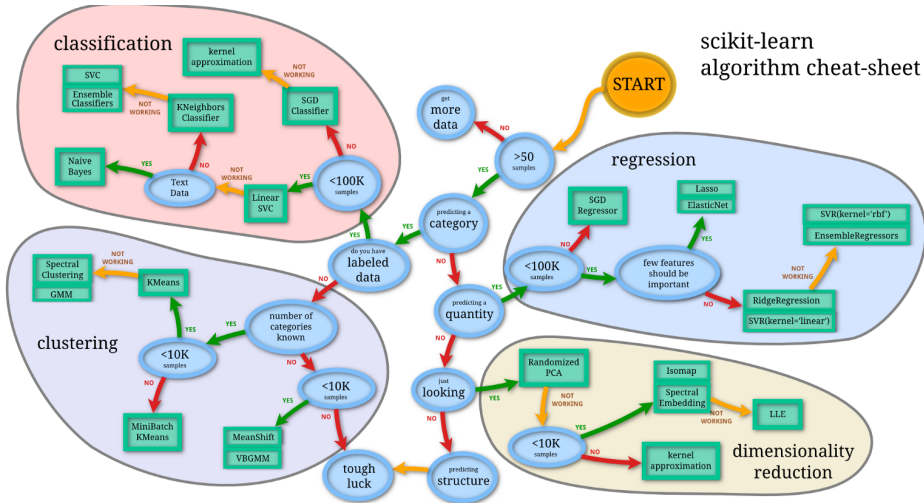
Natural Intelligence (human)

- Able to perceive the information, analyze it, make decisions based on this analysis

Artificial Intelligence

- (Strong) The same as natural intelligence, but computer is instead of human
- (**Weak**) Algorithm which is able to train using the input data in order to do tasks afterward — instead of human

Scikit-Learn² Roadmap



²https://scikit-learn.org/stable/tutorial/machine_learning_map/

(Tentative) future content

Theoretic part

- Quality metrics
 - Precision / Recall, TPR / FPR, ROC, AUC, Cross-Validation, ...

(Tentative) future content

Theoretic part

- Quality metrics
 - Precision / Recall, TPR / FPR, ROC, AUC, Cross-Validation, ...
- Classification task and optimization
 - kNN, Linear Classifiers, Stochastic Gradient Descent, PCA, ...

(Tentative) future content

Theoretic part

- Quality metrics
 - Precision / Recall, TPR / FPR, ROC, AUC, Cross-Validation, ...
- Classification task and optimization
 - kNN, Linear Classifiers, Stochastic Gradient Descent, PCA, ...
- Regression task
 - Linear Regression, Elastic Net, Ridge Regression, LASSO, ...

(Tentative) future content

Theoretic part

- Quality metrics
 - Precision / Recall, TPR / FPR, ROC, AUC, Cross-Validation, ...
- Classification task and optimization
 - kNN, Linear Classifiers, Stochastic Gradient Descent, PCA, ...
- Regression task
 - Linear Regression, Elastic Net, Ridge Regression, LASSO, ...
- Ensembles (unlikely but will try)
 - Bootstrapping, Bagging, Boosting, ...

(Tentative) future content

Theoretic part

- Quality metrics
 - Precision / Recall, TPR / FPR, ROC, AUC, Cross-Validation, ...
- Classification task and optimization
 - kNN, Linear Classifiers, Stochastic Gradient Descent, PCA, ...
- Regression task
 - Linear Regression, Elastic Net, Ridge Regression, LASSO, ...
- Ensembles (unlikely but will try)
 - Bootstrapping, Bagging, Boosting, ...

Practice part

- Data processing and analysis by Python
 - Scikit-Learn, Numpy, ...

What is Machine Learning

In 1959 Arthur Samuel introduced the term “machine learning” into scientific use.

General definition

Machine Learning — the process leading computers to gain ability to show the behavior that wasn't explicitly programmed.

What is Machine Learning

In 1959 Arthur Samuel introduced the term “machine learning” into scientific use.

General definition

Machine Learning — the process leading computers to gain ability to show the behavior that wasn't explicitly programmed.

In 1997 Tom M. Mitchell introduced more formal definition of a machine learning algorithm.

Formal definition

A **computer program** is said **to learn** from examples E for some set of problems T and a quality metric P if its performance on problems from T , as measured by P , is improved by using examples E .

Forerunner of Machine Learning

- People have been trying to predict the future based on their experience since time immemorial.

Forerunner of Machine Learning

- People have been trying to predict the future based on their experience since time immemorial.
- However, the scientific basis was laid by probability theory (statistics in particular) and linear algebra (as a tool).

Forerunner of Machine Learning

- People have been trying to predict the future based on their experience since time immemorial.
- However, the scientific basis was laid by probability theory (statistics in particular) and linear algebra (as a tool).
- **1795**: Gauss first uses the least squares method (LSQ) to analyze astronomical observations. In **1805** Legendre first published this method for analyzing the shape of the Earth. At present, LSQ is the simplest way to solve an overdetermined system of linear equations.

Forerunner of Machine Learning

- People have been trying to predict the future based on their experience since time immemorial.
- However, the scientific basis was laid by probability theory (statistics in particular) and linear algebra (as a tool).
- **1795**: Gauss first uses the least squares method (LSQ) to analyze astronomical observations. In **1805** Legendre first published this method for analyzing the shape of the Earth. At present, LSQ is the simplest way to solve an overdetermined system of linear equations.
- **1901**: Karl Pearson invented the Principal Component Analysis (PCA) — a master method for data dimensionality reduction.

Forerunner of Machine Learning

- People have been trying to predict the future based on their experience since time immemorial.
- However, the scientific basis was laid by probability theory (statistics in particular) and linear algebra (as a tool).
- **1795**: Gauss first uses the least squares method (LSQ) to analyze astronomical observations. In **1805** Legendre first published this method for analyzing the shape of the Earth. At present, LSQ is the simplest way to solve an overdetermined system of linear equations.
- **1901**: Karl Pearson invented the Principal Component Analysis (PCA) — a master method for data dimensionality reduction.
- **1906**: Andrey Andreyevich Markov develops the apparatus of Markov chains, which in **1913** he uses to study the text “Eugene Onegin”. Markov chains are used to generate and recognize signals.

Historical reference

- **1950:** Alan Turing creates the Turing test to evaluate the intelligence of a computer.

Historical reference

- **1950**: Alan Turing creates the Turing test to evaluate the intelligence of a computer.
- **1951**: Marvin Minsky created the first SNARC learning machine with a randomly connected neural network. In **1959**, he co-founded the Artificial Intelligence Laboratory at MIT.

Historical reference

- **1950:** Alan Turing creates the Turing test to evaluate the intelligence of a computer.
- **1951:** Marvin Minsky created the first SNARC learning machine with a randomly connected neural network. In **1959**, he co-founded the Artificial Intelligence Laboratory at MIT.
- **1952:** Arthur Samuel creates the first checkers program for the IBM 701. In **1955** Samuel adds self-learning capability to the program.

Historical reference

- **1950:** Alan Turing creates the Turing test to evaluate the intelligence of a computer.
- **1951:** Marvin Minsky created the first SNARC learning machine with a randomly connected neural network. In **1959**, he co-founded the Artificial Intelligence Laboratory at MIT.
- **1952:** Arthur Samuel creates the first checkers program for the IBM 701. In **1955** Samuel adds self-learning capability to the program.
- **1958:** Frank Rosenblatt invented the Perceptron — the first artificial neural network — and built the first “Mark-1” brain computer. *New York Times: The Perceptron is “the embryo of an electronic computer that [the Navy] expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence”.*

Historical reference

- **1950:** Alan Turing creates the Turing test to evaluate the intelligence of a computer.
- **1951:** Marvin Minsky created the first SNARC learning machine with a randomly connected neural network. In **1959**, he co-founded the Artificial Intelligence Laboratory at MIT.
- **1952:** Arthur Samuel creates the first checkers program for the IBM 701. In **1955** Samuel adds self-learning capability to the program.
- **1958:** Frank Rosenblatt invented the Perceptron — the first artificial neural network — and built the first “Mark-1” brain computer. *New York Times: The Perceptron is “the embryo of an electronic computer that [the Navy] expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence”.*
- **1963:** Lawrence Roberts formulated the thesis of computer vision in his dissertation at MIT.

Historical reference

- **1963:** Vladimir Vapnik and Aleksey Chervonenkis invented the SVM algorithm.

Historical reference

- **1963:** Vladimir Vapnik and Aleksey Chervonenkis invented the SVM algorithm.
- **1965:** One of the first books on machine learning (pattern classification) was published — Nilsson N. Learning Machines, McGraw Hill.

Historical reference

- **1963:** Vladimir Vapnik and Aleksey Chervonenkis invented the SVM algorithm.
- **1965:** One of the first books on machine learning (pattern classification) was published — Nilsson N. Learning Machines, McGraw Hill.
- **1966:** Joseph Weizenbaum wrote a computerized conversation simulator ELIZA, able to imitate (or rather parody) a dialogue with a psychotherapist (the program owes its name to the heroine from the play by B. Shaw).

Historical reference

- **1963:** Vladimir Vapnik and Aleksey Chervonenkis invented the SVM algorithm.
- **1965:** One of the first books on machine learning (pattern classification) was published — Nilsson N. Learning Machines, McGraw Hill.
- **1966:** Joseph Weizenbaum wrote a computerized conversation simulator ELIZA, able to imitate (or rather parody) a dialogue with a psychotherapist (the program owes its name to the heroine from the play by B. Shaw).
- **1967:** Alexey Ivakhnenko and Valentin Lapa publish the first general working learning algorithm for deep multilayer perceptrons for supervised learning problems.

Historical reference

- **1963:** Vladimir Vapnik and Aleksey Chervonenkis invented the SVM algorithm.
- **1965:** One of the first books on machine learning (pattern classification) was published — Nilsson N. Learning Machines, McGraw Hill.
- **1966:** Joseph Weizenbaum wrote a computerized conversation simulator ELIZA, able to imitate (or rather parody) a dialogue with a psychotherapist (the program owes its name to the heroine from the play by B. Shaw).
- **1967:** Alexey Ivakhnenko and Valentin Lapa publish the first general working learning algorithm for deep multilayer perceptrons for supervised learning problems.
- **1986:** Rina Dechter introduced the term “Deep Learning” to the machine learning community.

Historical reference

- **1963:** Vladimir Vapnik and Aleksey Chervonenkis invented the SVM algorithm.
- **1965:** One of the first books on machine learning (pattern classification) was published — Nilsson N. Learning Machines, McGraw Hill.
- **1966:** Joseph Weizenbaum wrote a computerized conversation simulator ELIZA, able to imitate (or rather parody) a dialogue with a psychotherapist (the program owes its name to the heroine from the play by B. Shaw).
- **1967:** Alexey Ivakhnenko and Valentin Lapa publish the first general working learning algorithm for deep multilayer perceptrons for supervised learning problems.
- **1986:** Rina Dechter introduced the term “Deep Learning” to the machine learning community.
- **1997:** The Deep Blue computer beat world chess champion Garry Kasparov.

Historical reference

- **2010:** Founding of DeepMind.

³https://en.wikipedia.org/wiki/Perfect_information

Historical reference

- **2010:** Founding of DeepMind.
- **2011:** Andrew Ng, Greg Corrado and Jeff Dean founded Google Brain.

³https://en.wikipedia.org/wiki/Perfect_information

Historical reference

- **2010:** Founding of DeepMind.
- **2011:** Andrew Ng, Greg Corrado and Jeff Dean founded Google Brain.
- **2011:** IBM Watson AI supercomputer wins TV quiz show *Jeopardy!*

³https://en.wikipedia.org/wiki/Perfect_information

Historical reference

- **2010:** Founding of DeepMind.
- **2011:** Andrew Ng, Greg Corrado and Jeff Dean founded Google Brain.
- **2011:** IBM Watson AI supercomputer wins TV quiz show *Jeopardy!*
- **2014:** Facebook invented the DeepFace software algorithm for face recognition. The accuracy of the algorithm was 97%.

³https://en.wikipedia.org/wiki/Perfect_information

Historical reference

- **2010:** Founding of DeepMind.
- **2011:** Andrew Ng, Greg Corrado and Jeff Dean founded Google Brain.
- **2011:** IBM Watson AI supercomputer wins TV quiz show *Jeopardy!*
- **2014:** Facebook invented the DeepFace software algorithm for face recognition. The accuracy of the algorithm was 97%.
- **2016:** AlphaGo, developed by (now) Google's DeepMind, won four out of five games against Korea's world Go champion Lee Se-dol. The computer won the last game with perfect information ³ against a human (an example of a game with incomplete information is poker, although robots are already beginning to perform successfully there).

³https://en.wikipedia.org/wiki/Perfect_information

Historical reference

- **2010:** Founding of DeepMind.
- **2011:** Andrew Ng, Greg Corrado and Jeff Dean founded Google Brain.
- **2011:** IBM Watson AI supercomputer wins TV quiz show *Jeopardy!*
- **2014:** Facebook invented the DeepFace software algorithm for face recognition. The accuracy of the algorithm was 97%.
- **2016:** AlphaGo, developed by (now) Google's DeepMind, won four out of five games against Korea's world Go champion Lee Se-dol. The computer won the last game with perfect information ³ against a human (an example of a game with incomplete information is poker, although robots are already beginning to perform successfully there).
- **2016:** OpenAI, a non-profit research company, is launched with the support of Elon Musk.

³https://en.wikipedia.org/wiki/Perfect_information

Historical reference

- **2010:** Founding of DeepMind.
- **2011:** Andrew Ng, Greg Corrado and Jeff Dean founded Google Brain.
- **2011:** IBM Watson AI supercomputer wins TV quiz show *Jeopardy!*
- **2014:** Facebook invented the DeepFace software algorithm for face recognition. The accuracy of the algorithm was 97%.
- **2016:** AlphaGo, developed by (now) Google's DeepMind, won four out of five games against Korea's world Go champion Lee Se-dol. The computer won the last game with perfect information ³ against a human (an example of a game with incomplete information is poker, although robots are already beginning to perform successfully there).
- **2016:** OpenAI, a non-profit research company, is launched with the support of Elon Musk.
- **2022:** OpenAI, a (not so) non-profit research company, provided the breakthrough in LLMs: ChatGPT.

³https://en.wikipedia.org/wiki/Perfect_information

Machine Learning Paradigms

Definitions

- X — set of objects
- Y — set of (correct) answers/labels
- $y : X \rightarrow Y$ — the unknown dependency

Machine Learning Paradigms

Definitions

- X — set of objects
- Y — set of (correct) answers/labels
- $y : X \rightarrow Y$ — the unknown dependency

Machine learning paradigms

- **Supervised** (now)
 - Sufficient amount of training material, i.e. pairs (x_i, y_i)

Machine Learning Paradigms

Definitions

- X — set of objects
- Y — set of (correct) answers/labels
- $y : X \rightarrow Y$ — the unknown dependency

Machine learning paradigms

- **Supervised** (now)
 - Sufficient amount of training material, i.e. pairs (x_i, y_i)
- Semi-supervised
 - Few labeled data (x_i, y_i) and many unlabeled examples x_j

Machine Learning Paradigms

Definitions

- X — set of objects
- Y — set of (correct) answers/labels
- $y : X \rightarrow Y$ — the unknown dependency

Machine learning paradigms

- **Supervised** (now)
 - Sufficient amount of training material, i.e. pairs (x_i, y_i)
- Semi-supervised
 - Few labeled data (x_i, y_i) and many unlabeled examples x_j
- *Unsupervised* (in future lectures?)
 - No labeled pairs, only x_i examples

Machine Learning Paradigms

Definitions

- X — set of objects
- Y — set of (correct) answers/labels
- $y : X \rightarrow Y$ — the unknown dependency

Machine learning paradigms

- **Supervised** (now)
 - Sufficient amount of training material, i.e. pairs (x_i, y_i)
- Semi-supervised
 - Few labeled data (x_i, y_i) and many unlabeled examples x_j
- *Unsupervised* (in future lectures?)
 - No labeled pairs, only x_i examples
- Reinforced
 - Action generation based on interaction with the environment

Mandatory external links to read

- 1 Please read the entire IBM booklet on the Introduction to Machine Learning. This is a quick and basic introduction but really gives a solid overview of the field of machine learning to help you understand the scope of practice or machine learning as related to Artificial Intelligence.

Mandatory external links to read

- 1 Please read the entire IBM booklet on the Introduction to Machine Learning. This is a quick and basic introduction but really gives a solid overview of the field of machine learning to help you understand the scope of practice or machine learning as related to Artificial Intelligence.
- 2 Read the brief explanation of Occam's Razor

Mandatory external links to read

- 1 Please read the entire IBM booklet on the Introduction to Machine Learning. This is a quick and basic introduction but really gives a solid overview of the field of machine learning to help you understand the scope of practice or machine learning as related to Artificial Intelligence.
- 2 Read the brief explanation of Occam's Razor
- 3 Read the wiki pages on Weak artificial intelligence, Artificial general intelligence, and the article named Weak AI vs Strong AI: Exploring Key Differences and Future Potential of AI (need either LinkedIn or Google account to read the full text)

Mandatory external links to read

- 1 Please read the entire IBM booklet on the Introduction to Machine Learning. This is a quick and basic introduction but really gives a solid overview of the field of machine learning to help you understand the scope of practice or machine learning as related to Artificial Intelligence.
- 2 Read the brief explanation of Occam's Razor
- 3 Read the wiki pages on Weak artificial intelligence, Artificial general intelligence, and the article named Weak AI vs Strong AI: Exploring Key Differences and Future Potential of AI (need either LinkedIn or Google account to read the full text)
- 4 Read History and evolution of machine learning: A timeline and the Timeline of Machine Learning pages

Takeaway notes

- 1 Please go through all the materials of **Module 0**

Takeaway notes

- 1 Please go through all the materials of **Module 0**
- 2 Please introduce yourself, complete the **Assignment 1** and discuss the question inside “**Module 1 DQ**”

Takeaway notes

- 1 Please go through all the materials of **Module 0**
- 2 Please introduce yourself, complete the **Assignment 1** and discuss the question inside “**Module 1 DQ**”
- 3 We are going to cover the most important things needed for ML, and will have small optional programming tasks

Takeaway notes

- 1 Please go through all the materials of **Module 0**
- 2 Please introduce yourself, complete the **Assignment 1** and discuss the question inside “**Module 1 DQ**”
- 3 We are going to cover the most important things needed for ML, and will have small optional programming tasks
- 4 ML History is intriguing!

Thank you!