Machine Learning and Applications

Course Outline, Activities and Grading

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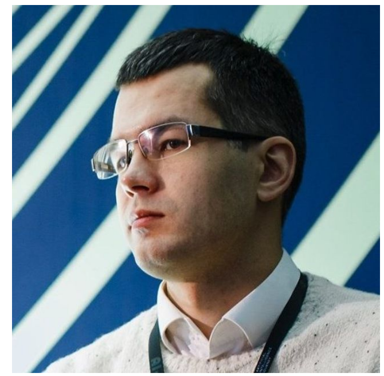
Course Organizers

Course instructor

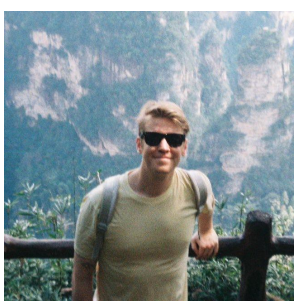
prof. Evgeny Burnaev

Co-instructor



prof. Alexey Zaytsev

Teaching Assistants:



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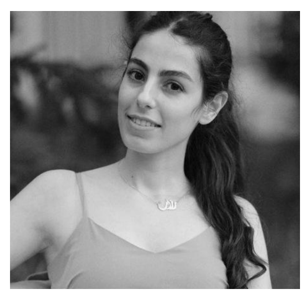

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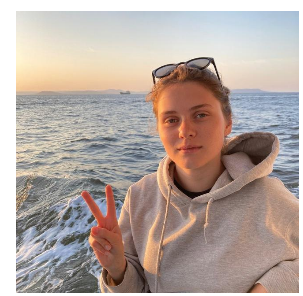


Alexandra .Bazarova

Course Topics

Part 1 (8 lectures & seminars):

- General Introduction (1)
- Regression, Kernel Trick (1)
- Linear Classification (1)
- Non-linear Classification (1)
- Adaboost (1)
- Gradient boosting (1)
- Gaussian process - KNN + kernel trick (1)
- Model and Feature Selection (1)

Part 2 (7 lectures & seminars):

- Unsupervised learning (1)
- Anomaly Detection (1)
- Dimensionality Reduction (1)
- Neural Networks (2)
- Transformers (1)
- Uncertainty(1)

Course Textbooks

Main

1. Hastie, T., and Tibshirani, R., and Friedman, J. The Elements of Statistical Learning: Data Mining, Inference, and Prediction. 12 print, Springer, 2009
2. Tibshirani, R. and Hastie, T., An Introduction to Statistical Learning, Springer 2013
3. Bishop, C.M. *Pattern Recognition and Machine Learning*. Springer, 2007
4. Barber, D. *Bayesian Reasoning and Machine Learning*. Cambridge University Press, 2012

Additional

1. Rasmussen, C., and Williams, C. *Gaussian Processes for Machine Learning*. The MIT Press, 2006.
2. Mohri, M., and Rostamizadeh, A., and Talwalkar, A. *Foundations of Machine Learning*. MIT, 2012
3. Schapire, R.E., Friend, Y. *Boosting*. MIT, 2012
4. Clarke, B., and Fokoue, E., and Zhang, H.H. *Principles and Theory for Data Mining and Machine Learning*. Springer, 2009

Course Prerequisites

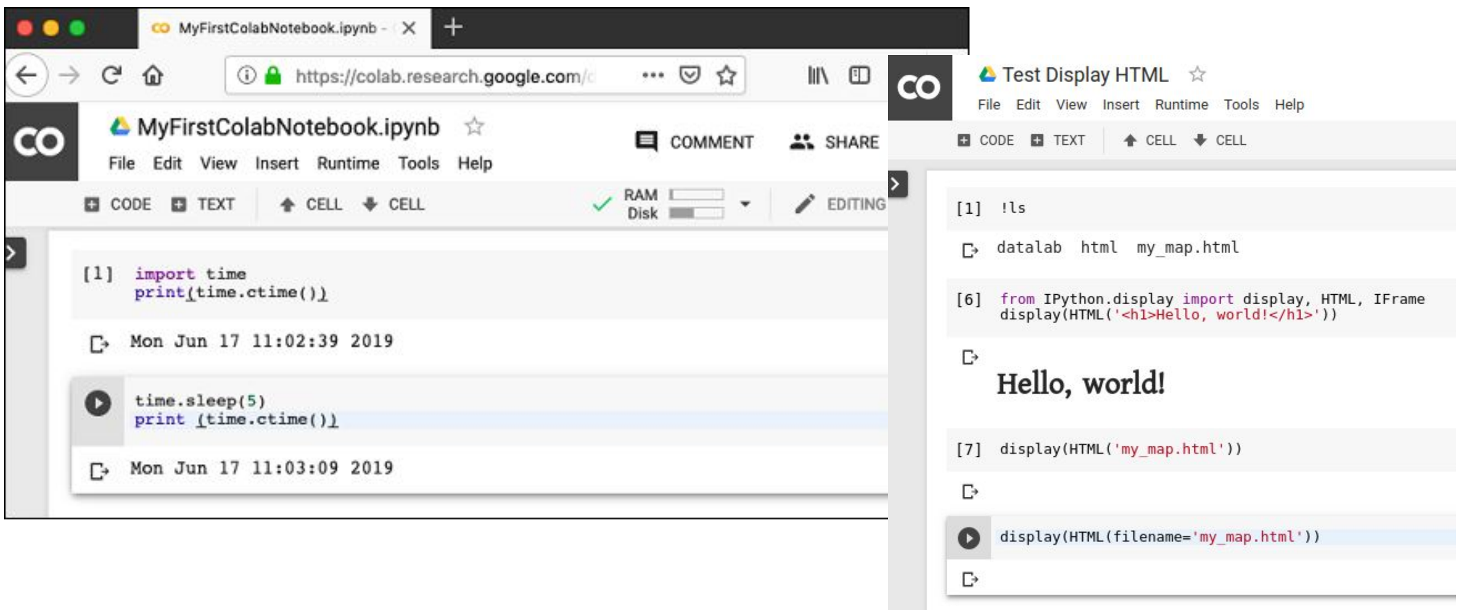
- Adequate understanding of **Calculus** as well as
  - **Probability Theory** and **Statistics**
  - **Linear Algebra (applied and theoretical)**
  - **Optimization Methods**

- Adequate **python programming skills**
  - basic familiarity with **numpy** and **scipy**

- Basic knowledge of **algorithms** and **complexity**

Course Software Requirements

- **<u>Obligatory</u> set up** [seminars + homeworks]
  - Google colab (colab.research.google.com)



Quick start guide:

https://www.tutorialspoint.com/google_colab/your_first_colab_notebook.htm

Course Assistance and Consultation

- Should you need ...
  - **consultation** on your projects
  - **advice** on solving tough problems in the homework

- … **we encourage you to ask** the instructor or the assistants
  - online after the end of a seminar or a lecture
  - through course group chat in **Telegram:**
  - through discussions in **Canvas**

communication through private messages (in *telegram, vk, etc.)* is **not welcome** unless agreed upon by both parties

Course Final Score and Grade

- The final score is computed based on activity scores thus

  Total = **S_hw** x 0.25 + **midterm** x 0.2 + **final exam** x 0.25 + **project** x 0.3

- **S_hw** is the **sum** of %score for each of the 3 homework assignments
- Each assignment is followed by a **quiz**. The quiz **does not count** toward the final grade of the course; instead, **it will be used to determine your score for the corresponding assignment.** The quiz content to validate originality and prevent plagiarism.

Final Grade	Total Score
A "Excellent"	86% and above
B "Good"	< 86% to 76%
C "Satisfactory"	< 76% to 66%
D "Poor"	< 66% to 56%
E "Very poor"	< 56% to 46%
F "Unacceptable"	< 46%

Activity	Total weight
Home assignments (3)	25%
Midterm exam	20%
Final exam	25%
Final project	30%
Total	100%

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Quizzes

- Quizzes are only **available after submitting** the corresponding homework.
- Quizzes will take place during the first **10 minutes** of the first session after the assignment deadline. Your attendance is **MANDATORY**.
- Students who miss a quiz must provide a valid document for their absence to schedule a makeup quiz on an agreed date.
- Scoring Intervals of the quizzes:
    - 9-10/10: 100% of assignment grade
    - 8/10: 90%
    - 7/10 : 80%
    - 6/10: 70%
    - 5/10: 60%
    - 3-4/10: 50%
    - 1-2/10:30%
    - 0/10: 0% of assignment grade

Course Activity

- **Out-of-class preparation** is essential for success:
  - Complete homework assignments thoroughly
  - Study lecture materials and reflect on key concepts
  - Ask questions whenever unclear
- **Substantial workload:**
  - 3 assignments, 1 earlier report, 2 exam, 1 team project (final report + presentation)

Course Activity

- **Zero-Tolerance** Policy on Plagiarism and Academic Dishonesty

All assignments and exams are individual work. Any detected plagiarism or dishonesty will result in immediate course exclusion (F grade). No exceptions or excuses will be accepted.

Plagiarism includes:

- Copying solutions from current or past course participants
- Blind use of LLMs/AI tools without proper understanding
- Direct copying from any source (websites, books, papers, code repositories)
- Unauthorized collaboration or sharing of solutions
- Submitting someone else's work as your own

References to external sources will not be accepted as justification for submitted work.

Course Activity: Home Assignments

Three practical coding assignments (week 1 - week 6):

- Will be published in the middle of week 1, week 3, week 4 and will stay open for ~**1-2 weeks**
- **Format**: iPython Notebook (Google Colab) with embedded LaTeX markdown explanations.
- Assignments cost **(25% of Final Grade)**

Submission Rules (Strict Compliance Required)

- Hard deadlines – **Plan your work ahead!**
- Only the most recent submission counts toward grading
- No submission = 0 points (no exceptions or excuses accepted)

Tip: Start early, test thoroughly, and submit incrementally to avoid last-minute issues.

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Course Activity: Final Exam

- **Exams**
  - **The midterm** (1 hour) and **final** exam (1.5 hours) are written exams held in Week 4 and Week 7, respectively.
  - Exams consist of several theoretical questions, primarily in multiple-choice format. They include pseudocode for key algorithms from the lectures, calculation problems on important metrics, and short explanations of core machine learning methods.
  - Midterm costs **20%,** Final **costs 25% of the final grade.**
- **Rules**
  - Exams are **individual** assignments
  - There will be **no way** to rewrite a missed exam.

Course Activity: the Final Project

- **30% of the final grade**
- **teams** of 3 - 5 students
- may be combined with **currently running parallel or already taken** courses
  - ***must be explicitly disclosed,*** *failing to do so is plagiarism*

- A comprehensive test of
  - teamwork organization and research engineering
  - knowledge of ML, insight, validation and evaluation
  - research presentation and communication skills

- The project timeline:
  - Week 2 -- we release suggested project topics + students proposals
  - Week 3 -- Approval of project proposals (**Hard Deadline**)
  - Week 4 -- Early report ()
  - Weeks 7-8 -- Project Consultations
  - Week 8 -- Reviews of Projects
  - Week 8 – <u>Presentation, Repo</u> and <u>Report Submission</u>

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The Final Project: Topics

- Final Project types
  - **Applied:** pick an interesting application and figure out how to apply machine learning algorithms to solve it
  - **Algorithmic**: propose a new learning algorithm, or a variant of some existing one to solve a general problem or group thereof
  - **Replication study**: pick a fresh preprint or an accepted conference paper, replicate its results and discuss the outcomes

The Final Project: Format, Structure and Grading

- Earlier report in **PDF report**
  - ICML 2020 template has to be used for the report
  - Early report of the project report with introduction and related work. It costs 5% out of 30% of the final grade.

- Project in a **github repo** + **PDF report**
  - Students must submit **a concise project report of 4-6 pages** and provide a GitHub repository with fully reproducible code **(15%)**.

- Project **in-class presentation**
  - 5-7 mins per group in-class presentation on week 8
  - Presentation costs 10% out of 30% of the finalgrade.e

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The Final Project: Format, Structure and Grading

Concise report with **4-6 pages** (excl. appendices)

- **Introduction**, motivation and problem statement
- **Related work** and brief literature overview
- **Dataset Description**
- **ML Methods** and algorithms, proposed algorithm modifications, etc.
- **Experiments / Discussion**: details about (hyper) parameters and how you picked them, cross-validation metrics and details, discussion of failures and successes, equations, results, visualizations, tables, etc.
- **Conclusion** and directions for further research
- **References**, acknowledgements and **contributions of each team member**

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The Final Project: Evaluation

- structure and clarity of the project repository
  - **reproducible** and well defined **ML pipeline**: *data acquisition, processing, modelling, validation, and report generation*

- the quality and relevance of the PDF report
  - **relevance and novelty**: *toy/real problem or common/unexplored method*
  - **technical quality**: *insightful choice of clever reasonable methods, cross-validation and general assessment of the tools/methods used*
  - literacy, quality of figures/tables and general narrative **structure**

- the project presentation (pdf + in-class presentation)
  - science **communication** skills, presentation **quality and clarity**
  - **relevant** content and summary, **knowledge** demonstrated by the team

Reminder: Student Academic Integrity

Disciplinary penalties are imposed for

- **cheating, plagiarism**, fabrication or falsification of data or results
- **copying**, rewriting, paraphrasing, or summarizing of text, discoveries, or insights without **acknowledging and / or citing the source**;
- **allowing other students to copy** one's own work, **using another student's** solutions or code

Penalties include, but are not limited to

- **getting no grade** for the project, assignment, or exam
- **redoing** an assignment or test **for a significantly reduced grade**

If you have any question, please, refer to

"Student Academic Integrity Regulations". Department of Education, Skoltech. Moscow, 2014

end of this presentation