BUDAPESTI MŰSZAKI ÉS GAZDASÁGTUDOMÁNYI EGYETEM
Közlekedésmérnöki és Járműmérnöki Kar

**Tantárgyi adatlap**

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| **1. Tárgy neve** | **Machine learning basics** | | | | |
| **2. Tárgy angol neve** | Machine learning basics | | | **3. Szerep** | **szv** |
| **4. Tárgykód** | **BME…** | **5. Követelmény** | **f** | **6. Kredit** | **2** |
| **7. Óraszám (levelező)** | **0 előadás** | **2 gyakorlat** | **0 labor** | **8. Tanterv** | |

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| **9. A tantárgy elvégzéséhez szükséges tanulmányi munkaóra összesen** | | | | | **60 óra** |
| **Kontakt óra** | 28 óra | **Órára készülés** | 6 óra | **Házi feladat** | 20 óra |
| **Írásos tananyag** | 6 óra | **Zárthelyire készülés** | 0 óra | **Vizsgafelkészülés** | 0 óra |

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| **10. Felelős tanszék** | Gépjárműtechnológia Tanszék (Dept. of Automotive Technologies) |
| **11. Felelős oktató** | Dr. Tihanyi Viktor |
| **12. Oktatók** | Remeli Viktor |

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| **13. Előtanulmány** | - |

**14. Előadás tematikája**

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**15. Gyakorlat tematikája**

The course is an applied mathematics summary specifically intended to help with revising and/or catching up with the otherwise assumed high school / BSc level mathematical background necessary for machine learning heavy graduate courses, e.g. KOGGM657 and KOGGM707. Furthermore, the very basics of some fundamental ML methods are introduced.

**LOGIC**

P01. The light of reason (formal logic and deductive reasoning: Aristotelian logic, propositional and predicate calculus; proof and refutation by construction, counterexample, induction, indirect proof; resolution in FOL, soundness and completeness)

**CALCULUS**

P02. Calculus (basic derivation and integration, focus on chain rule application)

**LINEAR ALGEBRA**

P03. Linear algebra (lin. combinations, dot product as similarity indicator, matrix mult. as transformation, pseudoinverse)

**PROBABILITY AND INFORMATION THEORY**

P04. Random events and their information content (random variables, discrete and continuous distributions, independent events, logarithm and entropy)

**LEARNING FROM DATA**

P05. Inferential statistics (moment estimation with central limit theorem, hypothesis testing)

P06. Bayesian inference (conditional probability, joint and marginal distributions, conditional independence, Bayes' theorem)

P07. Maximum likelihood estimation (both for regression and classification, MLE vs ERM, derived loss functions)

P08. Learning problems and their performance indicators (both for regression and classification)

**USEFUL MODELS**

P09. Logistic classification (from perceptron to SGD optimization)

P10. Other classification models (support vector machines, nearest neighbors, decision trees)

P11. Online state estimation (Bayesian filtering for single-object tracking, introduced with alpha-beta filters, up to simple KF)

**ADVANCED TOPICS** [as time permits]

P12. Bias-variance tradeoff (explained with PAC-learning, VC-dimension)

P13. The curse of dimensionality (generalization and adversarial robustness in high-dimensional input spaces)

P14. AI fairness (feature independence, demographic parity, equal opportunity, equal accuracy, fairness through unawareness)

**16. Labor tematikája**

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**17. Tanulási eredmények**

a) Knowledge:

- refreshed familiarity with a part of basic BSc level mathematics
- familiarity with basic statistics and Bayesian inference,

- understanding of main mathematical concepts in machine learning (ML),
- familiarity with some ML and state estimation techniques

b) Capability:

- can more successfully participate in MSc-level courses that build on or start with the covered material

c) Attitude:

- strive to perform at their best capability, work precisely and without error,
- strive to cooperate with their colleagues (unless prohibited),
- strive to keep all software security, data protection, safety and pandemic regulations

d) Autonomy and responsibility:

- sets example by maintaining high quality and ethical standards in their work, using the attained knowledge with responsibility

**18. Követelmények, az osztályzat (aláírás) kialakításának módja**

Single midterm exam towards the end of the semester.

**19. Pótlási lehetőségek**

On the retake week at the end of semester the student may retake and re-retake the failed test.

**20. Jegyzet, tankönyv, felhasználható irodalom**

[01] Bishop, C. M., & Nasrabadi, N. M. (2006). *Pattern recognition and machine learning*