

Tárgytematika / Course Description

Selected topics in machine learning

GKNM_MSTA050**Tárgyfelelős neve /****Teacher's name:** dr. Harmati István Árpád**Félév / Semester:** 2025/26/1**Beszámolási forma /****Assesment:** Vizsga**Tárgy heti óraszám /****Teaching hours(week):** 2/2/0**Tárgy féléves óraszám /****Teaching hours(sem.):** 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

The course covers additional topics beyond the Introduction to Machine Learning course, as a continuation of that course. The topics include machine learning over networks, recommendation systems, and reinforcement learning.

TANTÁRGY TARTALMA / DESCRIPTION

The goal of network analysis is to explore associations between objects. An example may be examining the addresses of suspects and victims, the telephone numbers they have dialed and financial transactions that they have partaken in during a given timeframe, and the familial relationships between these subjects as a part of police investigation. Link analysis here provides the crucial relationships and associations between very many objects of different types that are not apparent from isolated pieces of information. Computer-assisted or fully automatic computer-based link analysis is increasingly employed by banks and insurance agencies in fraud detection, by telecommunication operators in telecommunication network analysis, by medical sector in epidemiology and pharmacology, in law enforcement investigations, by search engines for relevance rating (and conversely by the spammers for spamdexing and by business

owners for search engine optimization), and everywhere else where relationships between many objects have to be analyzed.

Recommender Systems are software tools and techniques providing suggestions for items to be of use to a user. The suggestions provided are aimed at supporting their users in various decision-making processes, such as what items to buy, what music to listen, or what news to read. Recommender systems have proven to be valuable means for online users to cope with the information overload and have become one of the most powerful and popular tools in electronic commerce.

Reinforcement learning is an area of machine learning concerned with how software agents ought to take actions in an

environment so as to maximize some notion of cumulative reward. It differs from supervised learning in that labelled input/output pairs need not be presented, and sub-optimal actions need not be explicitly corrected. Instead the focus is finding a balance between exploration (of uncharted territory) and exploitation (of current knowledge).

Properties of real-world networks. Network models (Erdős-Rényi, Barabási, Watts-Strogatz, Kleinberg, ...). Topics:

1. Centrality in networks: PageRank and Kleinberg's algorithm.
2. Graph spectrum and spectral graph partitioning.
3. Neural graph embedding and the link prediction task.
4. Introduction to recommender systems. Content based and collaborative filtering.
5. Explicit and implicit feedback recommender systems. Techniques and approaches that have been used to evaluate the quality of the recommendations.
6. Nearest neighbour recommenders. Matrix factorization recommenders.
7. Recommender algorithms based on neural networks.
8. Introduction to Reinforcement Learning. How to act given know how the world works.
9. Model-free learning to make good decisions: Q-learning and SARSA.
10. Policy search. Exploration/Exploitation.

Monte Carlo Tree Search.

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESSMENT'S METHOD

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

Kötelező irodalom:

- Easley, David, and Jon Kleinberg. Networks, crowds, and markets. Vol. 8. Cambridge: Cambridge university press, 2010.
- Leskovec, Jure, Anand Rajaraman, and Jeffrey David Ullman. Mining of massive datasets. Cambridge university press, 2014.
- Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. (2015). Learning spark: lightning-fast big data analysis. " O'Reilly Media, Inc."
- Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.

AJÁNLOTT IRODALOM / RECOMMENDED MATERIAL

