대학원 수업 (2016 년 2 학기)
시간: 금요일 09.30-12:30

2016 Fall Graduate Course in Computer Science and Engineering, Cognitive Science, and Brain Science

Autonomous Machine Learning

Machine learning develops AI systems by building models of the world based on the data gathered in the world. Most approaches of machine learning focus on the model building side and ignore the data gathering side. We argue that the data gathering aspect of machine learning is of fundamental importance in achieving human-level intelligence through life-long learning since the ultimate power of learned AIs is limited by the information-theoretic quality of observed data. We formulate machine learning problem as a "sequential data generation" problem based on the approximate model constructed from the previous data. Humans solve this problem easily by hypothesizing and performing experiments using actuators and observing the outcomes by the sensors, i.e. "learning by experimentation" or "autonomous learning". In this course, we review old ideas, especially from mathematical theories of biological and cognitive systems, such as cybernetics, feedback control theory, general system theory, anticipatory systems, autopoiesis, and more recent theories of embodied cognitive systems and discuss their deep implications for the advancement of autonomous intelligence and AI robots. The goal of the course attendants is to come up with novel architectures and algorithms of autonomous machine learning that employee the notions of embodiment, active experiment, generative models, reinforcement signals, and recursive feedback theory.

Texts:

[1] von Bertalanffy, L. (1968) General System Theory,
https://static1.squarespace.com/static/5657eb54e4b022a250fc2de4/t/566f9de51c12100c114569cf/1450155493052/1968_Von+Bertalanffy_General+System+Theory.pdf

[2] Powers, W. T. (1989) Living Control Systems,
https://kzboncak.files.wordpress.com/2016/04/kugypo.pdf

[3] Kampis, G. (1991) Self-modifying Systems in Biology and Cognitive Science, Pergamon Press,
http://hps.elte.hu/~dept/Books/SMSCB_Kampis.pdf

[4] Rosen, R. (2012) Anticipatory Systems, Springer-Verlag.
http://www.nadin.ws/wp-content/uploads/2012/06/edit_prolegomena.pdf

[5] Narendra K. S. and Thathachar, M. A. L. (1989) Learning Automata, Prentice-Hall.

[6] [CDS] Haykin, S. (2012) Cognitive Dynamic Systems, Cambridge University Press.

[7] [ADS] Riese, V. and Lemon, O. (2011) Reinforcement Learning for Adaptive Dialogue Systems, Springer-Verlag.

Week 1: General System Theory (Chs 1 & 2)
Week 2: Self-modifying Systems in Biology and Cognitive Science (Chs 1 & 2)
Week 3: Anticipatory Systems (Prolegomena)
Week 4: Living Control Systems (Purposive Systems, 1978)

Week 5: Learning Automata (Chs 1 & 2)
Week 6: Adaptive Dialogue Systems 1 (ADS Chs 1-6, Posters)
Week 7: Adaptive Dialogue Systems 2 (ADS Chs 7-10, Posters)
Week 8: Mid-term Exam
Week 9: Perception-Action Cycle (CDS Chs 1 & 2)
Week 10: Sensing the Environment (CDS Ch 3)
Week 11: Bayesian Filtering (CDS Ch 4)
Week 12: Acting in the Environment (CDS Ch 5)
Week 13: Cognitive Radar (CDS Ch 6)
Week 14: Cognitive Radio (CDS Ch 7)
Week 15: Wrap-up
Week 16: Final Exam