|  |  |
| --- | --- |
| **Nume curs** | **Data Science** |
| **Descriere** | **Aplicarea invatarii automate, a tehnicilor de procesare Big Data si a ultimilor cercetari in domeniul grafurilor neurale adanci in experimente si aplicatii reale cu aplicabilitate comerciala in variate industrii.** |
| **Module (saptamani)** | **14 (16)** |
| Data revizuire | 2018-09-25 |

| **#** | **Nume modul** | **Descriere** | **Aplicatii** | **Tehnologii/ referinte** |
| --- | --- | --- | --- | --- |
| 1 | Data Science: introducere I | Prezentarea succinta a uneltele utilizate in Data Science impreuna cu comparatia intre invatarea automata traditionala si modelele bazate pe grafuri orientate aciclice adanci | De la baze de date tranzactionale la analiza comportamentului valoric al clientilor:   * Structura de date intr-o BD de evenimente pharma * Scopul analizei clientului * Separatia prin metrica euclidiana * Preprocesare si segmentare * Vizualizare si prezentare * Care ar fi urmatorul pas? | k-Means; Bokeh; matplotlib; arbori decizie; t-SNE [1] |
| 2 | Data Science: introducere II | Prezentarea sklearn si a framework-ului TensorFlow impreuna cu biblioteca de nivel inalt Keras | Modele simple de recomandari de produse bazate pe informatii tranzactionale:   * Filtrare colaborativa prin regresie liniara * Spatii de produse si de consumatori ai acestora * TensorFlow si Keras – de ce Keras in prototipare? | regresie liniara; arbori regresie; perceptroni multi-nivel |
| 3 | Data Science: introducere III | Recapitularea conceptelor de baza in invatarea automata: functii obiectiv si hiper-parametrii de model. Modele de baza: regresie liniara, arbori, perceptroni multi-nivel. Cautare in spatiul hiperparametrilor | Modele simple de recomandari de produse bazate pe informatii tranzactionale:   * Modele de determinare a propensitatii de cumparare a consumatorului comercial * Modelare A la Z | regresie liniara; arbori regresie; perceptroni multi-nivel, TensorFlow [2], Keras [3] |
| 4 | Data Science: introducere IV | Utilizarea de multiple domenii ale invatarii automate in Data Science. Aplicarea modelelor NLP in sisteme de analiza predictiva a fluxurilor de afaceri. Transfer-learning in Data Science. | Modele simple de recomandari de produse bazate pe informatii tranzactionale:   * Sisteme de recomandari independente de identitatea consumatorului | Word2vect, Glove, tSNE |
| 5 | Etapizarea unui proiect de Data Science | Planificarea si executia unui proiect de Data Science: analiza, proiectare, programare experiment, validare/cross validare, comunicarea rezultatelor, introducerea in productie | Analiza retentiei clientilor (customer churn prediction) utilizand modele de clasificare bazate pe boosting extrem | xGBoost [4], Pandas, RevoScaleR |
| 6 | Analiza experimentelor I | Culegerea, explorarea initiala si intelegerea datelor in proiecte cu volume mari de date. Utilizarea generatorilor, structurarea si segmentarea datelor. | Analiza retentiei clientilor (customer churn prediction) utilizand modele de clasificare bazate pe boosting extrem | Pandas |
| 7 | Analiza experimentelor II | Explorarea datelor in Python vs R. Utilizarea in R a uneltelor dezvoltate de Revolution Analytics. | Analiza retentiei clientilor (customer churn prediction) utilizand modele de clasificare bazate pe boosting extrem | Pandas, R, RevoScaleR |
| 8 | Analiza experimentelor III | Vizualizarea datelor in vederea intelegerii experimentului, a determinarii cazurilor izolate si a strategiei prin care ar trebui un model de invatare automata sa isi optimizeze parametrii | Analiza retentiei clientilor (customer churn prediction) utilizand modele de clasificare bazate pe boosting extrem | Pandas, matplotlib, seaborn, ggplot2, Bokeh |
| 9 | Proiectare experimentelor I | Tehnici de preprocesare a datelor in experimentele cu date reale. Abordarea preprocesarii in R vs Python Sci Kit Learn | Analiza retentiei clientilor (customer churn prediction) utilizand modele de clasificare bazate pe boosting extrem | Pandas, DataFrames, R |
| 10 | Proiectarea experimentelor II | Proiectarea modelelor supervizate in functie de problema specifica urmarita. Compararea modelului tinta cu modele simple baseline. Utilizarea modelelor state-of-the-art ce nu implica grafuri adanci neurale. | Analiza propensitatii de cumparare a oricarui produs pentru meta-clientii unei corporatii | Regresor xgBoost, pandas, |
| 11 | Proiectarea experimentelor III | Utilizarea modelelor adanci neurale in experimentele Data Science. Rolul variabilelor continue latente si invatarea semi-supervizata a acestora | Sisteme de recomandare la nivel de entitate-vs-entitate si segmentarea automata semi-supervizata a entitatilor | MLP, TensorFlow, Keras |
| 12 | Validarea, ajustarea fina a modelelor si prezentarea rezultatelor | Strategii de validare si testare in functie de problema reala si experimentul aferent. Optimizarea asistata a modelelor. | Sisteme de predictie a churn-ului (non-retentiei) clientilor in industria farma. | Bokeh, MLP, TensorFlow, Keras |
| 13 | Operationalizarea experimentelor in medii de productie | Strategii de implementare a modelelor rezultate in urma experimentelor in sisteme de productie. | Sisteme de predictie a churn-ului (non-retentiei) clientilor in industria farma. | Google TensorFlowServe, Nvidia TensorRT |
| 14 | Modele avansate de analiza predictiva I | Utilizarea invatarii nesupervizate in aplicatii comerciale pentru procesarea fluxurilor de tranzactii | Sisteme avansate de recomandari de produse. Segmentarea clientilor in functie de comportamentul tranzactional | word2vec [5], doc2vec, prod2vec [6], user2vect, MLP, TensorFlow, Keras |
| 15 | Modele avansate de analiza predictiva II | Prezentarea modelelor de procesare a seriilor de timp prin modele cu structuri recurente. Utilizarea optimizarii CUDA pentru diversele tipuri de module neurale. Tehnici de proiectare si optimizare a arhitecturii grafurilor neurale adanci orientate aciclice. | Sisteme de predictie de urmatorului eveniment in fluxuri si aplicatii comerciale. | CuDNNLSTM, CuDNNGRU, MLP, TensorFlow, Keras |
| 16 | Modele avansate de analiza predictiva III | Utilizarea invatarii prin recompensa in diverse scenarii de experimente Data Science. | Sisteme de predictie a actiunii optime intr-un flux de actiuni-evenimente prin evaluarea monetizarii finale a intregului proces. | Policy gradients, DDQN [7], MLP, TensorFlow, Keras |

# Bibliography

|  |  |
| --- | --- |
| [1] | L. v. d. Maaten and G. Hinton, "Visualizing data using t-SNE," *Journal of machine learning research ,* pp. 2579-2605, 2008. |
| [2] | M. Abadi, A. Agarwal, P. Barham, E. Brevdo, Z. Chen, C. Citro, G. S. Corrado, A. Davis, J. Dean, M. Devin, S. Ghemawat, I. Goodfellow, A. Harp, G. Irving, M. Isard, Y. Jia and R. Jozefowicz, "TensorFlow: Large-Scale Machine Learning on Heterogeneous Distributed Systems," Corenell University Library; arXiv:1603.04467, 2016. |
| [3] | F. Chollet, "Keras: Deep learning library for theano and tensorflow," https://keras. io/k, 2015. |
| [4] | T. Chen and C. Guestrin, "Xgboost: A scalable tree boosting system," in *Proceedings of the 22nd acm sigkdd international conference on knowledge discovery and data mining. ACM, 2016.*, 2016. |
| [5] | T. Mikolov and e. a, "Distributed representations of words and phrases and their compositionality," in *Advances in neural information processing systems*, 2013. |
| [6] | F. Vasile, E. Smirnova and A. Conneau, "Meta-prod2vec: Product embeddings using side-information for recommendation," in *Proceedings of the 10th ACM Conference on Recommender Systems. ACM, 2016.*, 2016. |
| [7] | V. Hasselt, H. A. Guez and D. Silver, "Deep Reinforcement Learning with Double Q-Learning," *AAAI,* vol. 2, 2016. |
| [8] | S. Zagoruyko and N. Komodakis, "Wide Residual Networks," *arXiv:1605.07146,* 2017. |
| [9] | S. Vogel, C. Schorn, A. Guntoro and G. Ascheid, "Efficient Stochastic Inference of Bitwise Deep Neural Networks," *Workshop on Efficient Methods for Deep Neural Networks at Neural Information Processing Systems Conference 2016, NIPS 2016, EMDNN 2016,* 2016. |
| [10] | O. Vinyals and Q. Le, "A Neural Conversational Model," in *ICML Deep Learning Workshop 2015*, 2015. |
| [11] | C. V, Q. B. Nguyen and S. Pankanti, "Deep Learning Ensembles for Melanoma Recognition in Dermoscopy Images," *Journal of Research and Development,* 2016. |
| [12] | C. Szegedy, S. Ioffe, V. Vanhoucke and A. Alemi, "Inception-v4, Inception-ResNet and the Impact of Residual Connections on Learning," *arXiv:1602.07261, Computer Vision and Pattern Recognition,* 2016. |
| [13] | C. Szegedy, W. Liu, Y. Jia, P. Sermanet, S. Reed, D. Anguelov, D. Erhan, V. Vanhoucke and A. Rabinovich, "Going Deeper with Convolutions," *eprint arXiv:1409.4842,* 2014. |
| [14] | J. Stone, D. Gohara and G. Shi, "OpenCL: A Parallel Programming Standard for Heterogeneous Computing Systems," *Computing in Science & Engineering,* vol. 12, no. 3, 2010. |
| [15] | K. Simonyan and A. Zisserman, "Very Deep Convolutional Networks for Large-Scale Image Recognition," *arXiv:1409.1556, Computer Vision and Pattern Recognition,* 2015. |
| [16] | E. Schapire, "Explaining AdaBoost," http://rob.schapire.net/papers/explaining-adaboost.pdf. |
| [17] | M. Sandler, A. Z. M. Howard, A. Zhmoginov and L. Chen, "MobileNetV2: Inverted Residuals and Linear Bottlenecks," arXiv:1801.04381 [cs.CV], 2018. |
| [18] | L. Y. Pratt, "Discriminability-based transfer between neural networks," in *NIPS Conference: Advances in Neural Information Processing Systems 5.* , 1993. |
| [19] | M. O'Connor, N. Chatterjee, D. Lee, J. Wilson and A. Agrawal, "Fine-Grained DRAM: Energy-Efficient DRAM for Extreme Bandwidth Systems," *Proceedings of the 50th Annual IEEE/ACM International Symposium on Microarchitecture (MICRO 50),* 2017. |
| [20] | NVidia, "NVIDIA TESLA V100 GPU ARCHITECTURE," http://images.nvidia.com/content/volta-architecture/pdf/volta-architecture-whitepaper.pdf, 2018. |
| [21] | NVidia, "NVIDIA Tesla P100," https://images.nvidia.com/content/pdf/tesla/whitepaper/pascal-architecture-whitepaper.pdf, 2017. |
| [22] | F. Mahdisoltani, G. Berger, W. Gharbieh, D. Fleet and R. Memisevic, "Fine-grained Video Classification and Captioning," https://arxiv.org/abs/1804.09235, 2018. |
| [23] | J. Long, E. Shelhamer and T. Darrell, "Fully Convolutional Networks for Semantic Segmentation," *arXiv:1411.4038,* 2015. |
| [24] | T. Lin, J. Hays, M. Maire, P. Perona, S. Belongie, D. Ramanan, L. Bourdev, L. Zitnick, R. Girshick and P. Dollar, "Microsoft COCO: Common Objects in Context," arxiv.org/pdf/1405.0312.pdf, 2015. |
| [25] | M. Lin, Q. Chen and S. Ya, "Network in network," *CoRR, abs/1312.4400,* 2013. |
| [26] | L. Lai, N. Suda and V. Chandra, "Deep Convolutional Neural Network Inference with Floating-point Weights and Fixed-point Activations," *https://arxiv.org/abs/1703.03073,* 2017. |
| [27] | M. Kuhn, "Caret package," *Journal of Statistical Software,* 2008. |
| [28] | A. Krizhevsky, I. Sutskever and G. E. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks," in *Advances in Neural Information Processing Systems 25 (NIPS 2012)*, 2012. |
| [29] | I. Hubara, M. Courbariaux, D. Soudry, R. El-Yaniv and Y. Bengio, "Quantized Neural Networks: Training Neural Networks with Low Precision Weights and Activations," *https://arxiv.org/abs/1703.03073,* 2017. |
| [30] | G. B. Huang, M. Mattar, T. Berg and E. Learned-Miller, "Labeled faces in the wild: A database forstudying face recognition in unconstrained environments," in *Workshop on faces in'Real-Life'Images: detection, alignment, and recognition*, 2008. |
| [31] | S. Hochreiter and J. Schmidhuber, "Long Short-Term Memory," *Neural Computation,* vol. 8, no. 9, pp. 1735-1780, 1997. |
| [32] | K. He, X. Zhang, S. Ren and J. Sun, "Identity Mappings in Deep Residual Networks," *arXiv:1603.05027,* 2016. |
| [33] | K. He, X. Zhang, S. Ren and J. Sun, "Deep Residual Learning for Image Recognition," *eprint arXiv:1512.03385,* 2015. |
| [34] | A. Halevy, P. Norvig and F. Pereira, "The Unreasonable Effectiveness of Data," *IEEE Intelligent Systems ,* vol. 24, no. 2, pp. 8-12, 2009. |
| [35] | R. Goyal, S. E. Kahou, V. Michalski, J. Materzyńska, S. Westphal, H. Kim, V. Haenel, I. Fruend, P. Yianilos, M. Mueller-Freitag, F. Hoppe, C. Thurau, I. Bax and R. Memisevic, "The "something something" video database for learning and evaluating visual common sense," https://arxiv.org/abs/1706.04261, 2017. |
| [36] | J. Ghorpade, J. Parande and M. Kulkarni, "GPGPU PROCESSING IN CUDA ARCHITECTURE," *Advanced Computing: An International Journal ( ACIJ ),* vol. 3, 2012. |
| [37] | R. T. Fielding, "Architectural Styles and the Design of Network-based Software Architectures," University of California, Irvine, 2000. |
| [38] | M. Everingham, L. Van Gool, C. K. Williams, J. Winn and A. Zisserman, "The pascal visual object classes (voc) challenge," *International journal of computer vision,* vol. 88(2), pp. 303-338, 2010. |
| [39] | J. Deng, W. Dong, R. Socher, L. J. Li, K. Li and L. Fei-Fei, "ImageNet: A large-scale hierarchical image database," in *Computer Vision and Pattern Recognition, 2009. CVPR 2009. IEEE Conference on (pp. 248-255)*, 2009. |
| [40] | A. Damian, N. Tapus, L. Piciu and A. Purdila, "CloudifierNET - Deep Vision Models for Artificial Image Processing," *arXiv,* 2018. |
| [41] | A. I. Damian, A. Purdila and N. Tapus, "Cloudifier virtual apps: Virtual desktop predictive analytics apps environment based on GPU computing framework," in *13th IEEE International Conference on Intelligent Computer Communication and Processing (ICCP)*, Bucharest, 2017. |
| [42] | A. Damian and N. Tapus, "Model Architecture for Automatic Translation and Migration of Legacy Applications to Cloud Computing Environments," in *21st International Conference on Control Systems and Computer Science (CSCS)*, Bucharest, 2017. |
| [43] | F. Chollet, "Xception: Deep Learning with Depthwise Separable Convolutions," *eprint arXiv:1610.02357,* 2016. |
| [44] | L. Buitinck, G. Louppe, M. Blondel, F. Pedregosa, A. Mueller, O. Grisel, V. Niculae, P. Prettenhofer, A. Gramfort and J. G. Saclay, "API design for machine learning software: experiences from the scikit-learn project," *European Conference on Machine Learning and Principles and Practices of Knowledge Discovery in Databases (2013),* 2013. |
| [45] | M. Bihis and S. Roychowdhury, "A generalized flow for multi-class and binary classification tasks: An Azure ML approach," in *Big Data (Big Data), 2015 IEEE International Conference on*, 2015. |
| [46] | J. Bergstra, O. Breuleux, P. L. R. Pascanu, O. Delalleau, G. Desjardins, I. Goodfellow, A. Bergeron, Y. Bengio and P. Kaelbling, "Theano: A CPU and GPU Math Compiler in Python," in *PROC. OF THE 9th PYTHON IN SCIENCE CONF. (SCIPY 2010)*, Austin, Texas, 2010. |
| [47] | T. Beltramelli, "pix2code: Generating Code from a Graphical User," *https://arxiv.org/pdf/1705.07962v2.pdf,* 2017. |
| [48] | A. Agrawal, J. Gans and A. Goldfarb, "Managing the Machines," *HBR,* 2016. |
| [49] | Abadi, Barham, Chen, Davis, Dean, Devin, Ghemawat, Irving, Isard, Kudlur, Levenberg, Monga, Moore, Murray, Steiner, Tucker, Vasudevan, Warden, Wicke, Yu and Zheng, "TensorFlow: A System for Large-Scale Machine Learning," in *12th USENIX Symposium on Operating Systems Design and Implementation (OSDI ’16)*, Savannah, 2016. |