

TP558 - Tópicos avançados em Machine Learning: *Introdução ao curso*



Sobre o curso

- Curso prático que oferecerá uma visão ampla e detalhada sobre diferentes algoritmos avançados de aprendizado de máquina (ML) e suas aplicações em diferentes áreas do conhecimento.
- Cobriremos algoritmos como
 - Redes generativas,
 - Redes recorrentes,
 - Redes de atenção,
 - Redes grafo neurais,
 - Aprendizado por reforço profundo,
 - Autoencoders,
 - Transformers,
 - Detectores de objetos,
 - etc.

Sobre o curso

- **Dinâmica do curso**

- O curso será *dividido em vários seminários preparados e apresentados pelos alunos*, cada um cobrindo um tipo diferente de algoritmo.
- Ao final de cada seminário, os *alunos deverão responder a um quiz*, preparado pelo apresentador, sobre o algoritmo apresentado.
- Ao final do curso, os *alunos deverão apresentar um projeto final*, incluindo um *relatório em formato de artigo científico*, envolvendo a aplicação de um algoritmo avançado de ML a um problema de sua escolha (*de preferência, alinhado com sua pesquisa*).

Sobre o curso

- **Objetivo principal do curso**

- Ao final do curso, os alunos devem ser capazes de entender e aplicar na prática os diferentes algoritmos estudados.

- **Pré-requisitos:**

- Disciplinas: TP555 ou TP557;
- Conceitos de ***álgebra linear*** (e.g., matrizes e vetores), ***cálculo*** (e.g., algoritmos de otimização, como o gradiente descendente), ***probabilidade e estatística*** (e.g., distribuições de probabilidade, média, desvio padrão, validação cruzada);
- Conhecimento intermediário/avançado de programação em Python.
- Bibliotecas: TensorFlow, PyTorch, Optuna/KerasTuner, SciKit-Learn e Pandas.

Sobre o curso

- **Repositório**

- Criem um repositório público no github para armazenar o material gerado durante todo o curso, e.g., materiais dos seminários, proposta de projeto, projeto final, etc.
- Criem pastas distintas para cada seminário, para o projeto final e qualquer outro material que seja gerado durante o curso.
- Enviem o endereço do repositório para o professor via email.

Sobre o curso

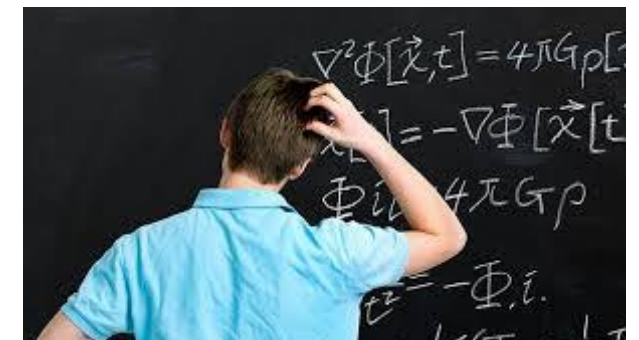


Avaliações

- Seminários (S): 40%
 - Cada aluno irá estudar alguns algoritmos e apresentar aos demais.
 - Uma a duas semanas para estudo, preparação da apresentação e quiz.
- Quizzes (Q): 10%
 - Resolução dos quizzes preparados pelos alunos.
- Proposta do projeto final (PPF): 20%
 - Projeto prático com tema escolhido pelos alunos.
 - Um aluno por projeto.
 - Deve ser entregue na metade do segundo mês.
- Projeto final (PF): 30%
 - Apresentação na última semana de aula.
 - Entrega de relatório em formato de artigo científico.



$$NF = S*40\% + Q*10\% + PPF*20\% + PF*30\%$$



Sobre o curso

- Instruções detalhadas sobre os seminários e projeto final.
 - Seminários: <http://tinyurl.com/tp558-seminars>
 - Projeto final: <http://tinyurl.com/tp558-final-project>

Temas dos seminários

- Generative deep learning: Image Generation
 - Deep convolutional generative adversarial network (DCGAN)
 - ✓ <https://arxiv.org/abs/1511.06434>
 - ✓ https://keras.io/examples/generative/dcgan_overriding_train_step/
 - Conditional GAN (CGAN)
 - <https://arxiv.org/abs/1411.1784>
 - https://keras.io/examples/generative/conditional_gan/
 - Variational Autoencoder (VAE)
 - ✓ <https://arxiv.org/abs/1312.6114>
 - ✓ <https://www.tensorflow.org/tutorials/generative/cvae?hl=en>

Temas dos seminários

- Generative deep learning: Image Generation
 - OOTDiffusion: Outfitting Fusion based Latent Diffusion for Controllable Virtual Try-on
 - ✓ <https://arxiv.org/abs/2403.01779>
 - ✓ <https://paperswithcode.com/paper/ootdiffusion-outfitting-fusion-based-latent>
 - V3D: Video Diffusion Models are Effective 3D Generators
 - ✓ <https://arxiv.org/abs/2403.06738>
 - ✓ <https://paperswithcode.com/paper/v3d-video-diffusion-models-are-effective-3d>

Temas dos seminários

- Computer Vision: Image classification
 - Vision Transformer
 - ✓ <https://arxiv.org/abs/2010.11929>
 - ✓ https://keras.io/examples/vision/image_classification_with_vision_transformer/
 - Swin Transformer
 - ✓ <https://arxiv.org/abs/2103.14030>
 - ✓ https://keras.io/examples/vision/swin_transformers/
 - Reptile
 - ✓ <https://arxiv.org/abs/1803.02999>
 - ✓ <https://keras.io/examples/vision/reptile/>
 - RegNet: Self-Regulated Network for Image Classification
 - ✓ <https://arxiv.org/abs/2101.00590>
 - ✓ <https://paperswithcode.com/paper/regnet-self-regulated-network-for-image>

Temas dos seminários

- Computer Vision: Image Segmentation

- U-Net

- ✓ https://link.springer.com/chapter/10.1007/978-3-319-24574-4_28

- ✓ <https://www.tensorflow.org/tutorials/images/segmentation?hl=pt-br>

- Boundary-Aware Segmentation Network (BASNet)

- ✓ <https://arxiv.org/abs/2101.04704>

- ✓ https://keras.io/examples/vision/basnet_segmentation/

Temas dos seminários

- Computer Vision: Object Detection

- YOLOv8

- ✓ <https://blog.roboflow.com/whats-new-in-yolov8/>

- ✓ <https://keras.io/examples/vision/yolov8/>

- YOLOv9

- ✓ <https://arxiv.org/abs/2402.13616>

- ✓ <https://docs.ultralytics.com/pt/models/yolov9/#generalized-efficient-layer-aggregation-network-gelan>

- ✓ <https://github.com/WongKinYiu/yolov9?tab=readme-ov-file>

- YOLO-World: Real-Time Open-Vocabulary Object Detection

- ✓ <https://arxiv.org/abs/2401.17270>

- ✓ <https://colab.research.google.com/github/roboflow-ai/notebooks/blob/main/notebooks/zero-shot-object-detection-with-yolo-world.ipynb>

- ✓ <https://www.youtube.com/watch?v=X7gKBGVz4vs&feature=youtu.be>

Temas dos seminários

- Computer Vision: Object Detection

- RetinaNet

- ✓ <https://arxiv.org/abs/1708.02002>

- ✓ <https://keras.io/examples/vision/retinanet/>

- Faster Objects, More Objects (FOMO)

- ✓ <https://docs.edgeimpulse.com/docs/edge-impulse-studio/learning-blocks/object-detection/fomo-object-detection-for-constrained-devices>

- ✓ <https://docs.edgeimpulse.com/docs/tutorials/end-to-end-tutorials/object-detection/detect-objects-using-fomo>

- DETRs Beat YOLOs on Real-time Object Detection

- ✓ <https://arxiv.org/abs/2304.08069>

- ✓ <https://github.com/lyuwenyu/RT-DETR>

Temas dos seminários

- Computer Vision: Image Enhancement
 - MIRNet
 - ✓ <https://arxiv.org/abs/2003.06792>
 - ✓ <https://keras.io/examples/vision/mirnet/>
 - Enhanced Deep Residual Networks for Single Image Super-Resolution (EDSR)
 - ✓ <https://arxiv.org/abs/1707.02921>
 - ✓ <https://keras.io/examples/vision/edsr/>
- Computer Vision: Performance recipes
 - Learning to Resize in Computer Vision
 - <https://arxiv.org/abs/2103.09950v1>
 - https://keras.io/examples/vision/learnable_resizer/

Temas dos seminários

- Computer Vision: 3D Object Reconstruction
 - TripoSR: Fast 3D Object Reconstruction from a Single Image
 - ✓ <https://arxiv.org/abs/2403.02151>
 - ✓ <https://paperswithcode.com/paper/triposr-fast-3d-object-reconstruction-from-a>

Temas dos seminários

- Reinforcement Learning

- Deep Q-Learning

- ✓ <https://storage.googleapis.com/deepmind-media/dqn/DQNNaturePaper.pdf>
 - ✓ https://keras.io/examples/rl/deep_q_network_breakout/
 - ✓ https://www.tensorflow.org/agents/tutorials/0_intro_rl?hl=pt-br

- Deep Deterministic Policy Gradient (DDPG)

- ✓ <https://arxiv.org/pdf/1509.02971.pdf>
 - ✓ https://keras.io/examples/rl/ddpg_pendulum/

- Actor Critic Method

- ✓ <https://inria.hal.science/hal-00840470/document>
 - ✓ https://keras.io/examples/rl/actor_critic_cartpole/

Temas dos seminários

- Natural Language Processing: Text summarization
 - Bidirectional Autoregressive Transformer (BART)
 - ✓ <https://arxiv.org/abs/1910.13461>
 - ✓ https://keras.io/examples/nlp/abstractive_summarization_with_bart/
- Natural Language Processing: Automatic Speech Recognition (ASR)
 - Automatic Speech Recognition with Transformer
 - ✓ <https://papers.nips.cc/paper/2017/file/3f5ee243547dee91fbd053c1c4a845aa-Paper.pdf>
 - ✓ https://keras.io/examples/audio/transformer_asr/
- Natural Language Processing: Speech Synthesis
 - WaveNet: A Generative Model for Raw Audio
 - ✓ <https://arxiv.org/abs/1609.03499>
 - ✓ <https://paperswithcode.com/paper/wavenet-a-generative-model-for-raw-audio>

Temas dos seminários

- Graph Neural Networks
 - ✓ <https://arxiv.org/abs/2101.11174>
 - ✓ <https://paperswithcode.com/paper/graph-neural-network-for-traffic-forecasting>
- Spiking Neural Networks
 - ✓ <https://arxiv.org/abs/2109.12894>
 - ✓ <https://analyticsindiamag.com/a-tutorial-on-spiking-neural-networks-for-beginners/>
 - ✓ <https://guillaume-chevalier.com/spiking-neural-network-snn-with-pytorch-where-backpropagation-engenders-stdp-hebbian-learning/>
 - ✓ <https://snntorch.readthedocs.io/en/latest/tutorials/index.html>

Temas dos seminários

- Adversarial Attacks
 - ✓ <https://arxiv.org/abs/1706.06083>
 - ✓ <https://paperswithcode.com/paper/towards-deep-learning-models-resistant-to>

Temas dos seminários

- Receitas para melhoria do desempenho de modelos
 - Knowledge Distillation
 - ✓ <https://arxiv.org/abs/1503.02531>
 - ✓ https://keras.io/examples/vision/knowledge_distillation/
 - Gradient Centralization
 - ✓ <https://arxiv.org/abs/2004.01461>
 - ✓ https://keras.io/examples/vision/gradient_centralization/
 - VeLO: Training Versatile Learned Optimizers by Scaling Up
 - ✓ <https://arxiv.org/pdf/2211.09760>
 - ✓ <https://velo-code.github.io/>

Referências

- [1] “Tensorflow code examples”, <https://keras.io/examples/>
- [2] “Pytorch code examples”, <https://pytorch.org/examples/>
- [3] “Papers with code”, <https://paperswithcode.com/>
- [4] Sebastian Raschka and Vahid Mirjalili, “Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2”, Packt Publishing, 2019.
- [5] Ivan Vasilev, “Advanced Deep Learning with Python: Design and implement advanced next-generation AI solutions using TensorFlow and PyTorch”, Packt Publishing, 2019.
- [6] Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", 3rd ed., O'Reilly Media, 2022.
- [7] Raschka, Sebastian, et al., “Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python”, Packt Publishing Ltd, 2022.
- [8] C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
- [9] “Livros”, <http://tinyurl.com/tp558-books>

Avisos

- Todo material do curso está disponível no GitHub:
 - <https://github.com/zz4fap/tp558-adv-ml>
- Como usar o Google Colab
 - https://www.youtube.com/watch?v=inN8seMm7UI&ab_channel=TensorFlow
 - <https://www.youtube.com/watch?v=inN8seMm7UI>
- Python Crash Course
 - <https://www.youtube.com/watch?v=pq4NNIYar9o&list=PLRc6ZYt68prVXAhwY1JD6DFc3BJGmJriq&pp=gAQBiAQB>
- Horário de Atendimento
 - Todas as quartas-feiras das 17:30 às 18:30.
 - Presencialmente ou remotamente.

Perguntas?

Obrigado!