Seminars

proposed topics are grouped in four areas:

(choose one topic from below lists)

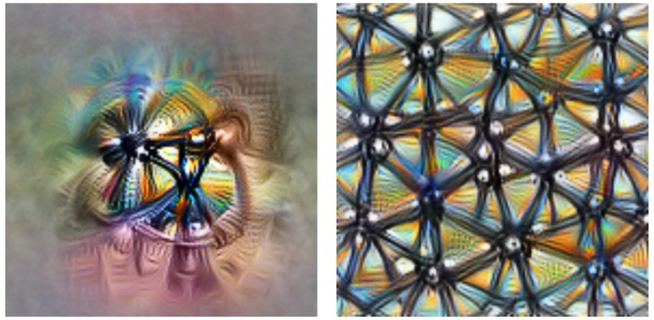
1. understanding deep neural networks
2. overview on other ML techniques
3. natural language processing
4. advanced computer vision
5. machine learning in physics

time limit: **20 minutes** including few-minute discussion

Seminars: understanding deep neural networks

1. **Techniques that allow understand more on how and why deep architectures work**

- https://distill.pub/2020/circuits/early-vision/
- https://ai.googleblog.com/2015/06/inceptionism-going-deeper-into-neural.html
- https://distill.pub/2017/feature-visualization/
- D. Erhan, Y. Bengio, A. Courville, P. Vincent. , Visualizing higher-layer features of a deep network (2009).
- http://arxiv.org/pdf/1506.02753.pdf
- https://arxiv.org/pdf/1312.6034v2.pdf
- https://github.com/tensorflow/lucid

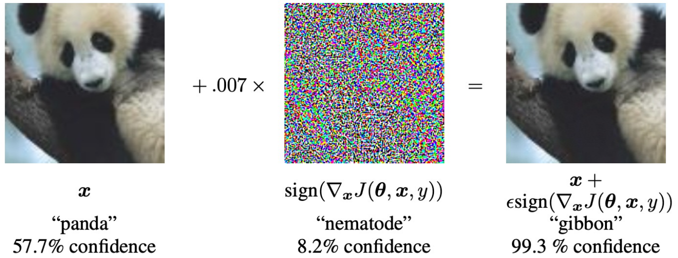


Feature visualization answers questions about what a network — or parts of a network — are looking for by generating examples.

2. **Fooling deep neural networks:** deep learning models are highly sensitive to carefully prepared adversarial attacks

How to generate adversarial examples? Can we use them to improve network stability?

- Szegedy, Christian, et al. “Intriguing properties of neural networks” *arXiv:1312.6199* (2013).
- Goodfellow, Ian J., Jonathon Shlens, and Christian Szegedy. “Explaining and harnessing adversarial examples” *arXiv:1412.6572* (2014).
- Papernot, Nicolas, et al. “The limitations of deep learning in adversarial settings.” *2016 IEEE European symposium on security and privacy (EuroS&P)*. IEEE (2016).
- Su, Jiawei, Danilo V. Vargas, and Kouichi Sakurai. “One pixel attack for fooling deep neural networks.” *IEEE Transactions on Evolutionary Computation* 23.5 828 (2019).

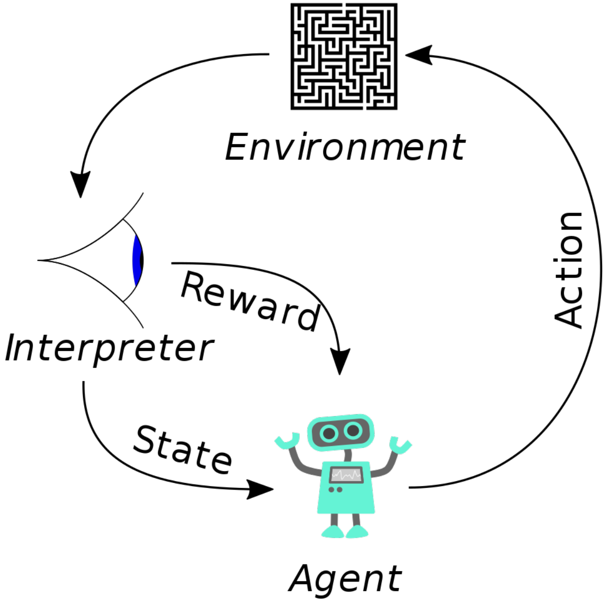


3. **Defense strategies against adversarial attacks**

Overview on various techniques for defending against adversarial examples for attacking deep neural networks.

- Szegedy, Christian, et al. “Intriguing properties of neural networks” *arXiv:1312.6199* (2013).
- Xie, Cihang, et al. “Mitigating adversarial effects through randomization.” *arXiv:1711.01991* (2017).
- Das, Nilaksh, et al. “Keeping the bad guys out: Protecting and vaccinating deep learning with jpeg compression.” *arXiv:1705.02900* (2017).
- Xie, Cihang, et al. “Feature denoising for improving adversarial robustness.” *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition* (2019).
- Goodfellow, Ian J., Jonathon Shlens, and Christian Szegedy. “Explaining and harnessing adversarial examples” *arXiv:1412.6572* (2014).

Seminars: overview on other ML techniques



1. **Reinforcement Learning**

Basics and applications

- https://arxiv.org/pdf/cs/9605103.pdf
- https://mpatacchiola.github.io/blog/2016/12/09/dissecting-reinforcement-learning.html
- https://deepsense.ai/what-is-reinforcement-learning-the-complete-guide/

2. **Hidden Markov model**

Definition and example applications

- https://jonathan-hui.medium.com/machine-learning-hidden-markov-model-hmm-31660d217a61
- http://www.cs.sjsu.edu/~stamp/RUA/HMM.pdf

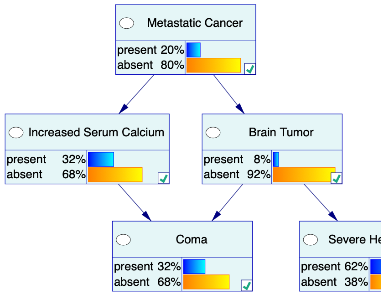
3. **Recommender systems**

Idea, applications and the Netflix Price

- https://arxiv.org/pdf/1203.4487.pdf
- https://towardsdatascience.com/introduction-to-recommender-systems-6c66cf15ada

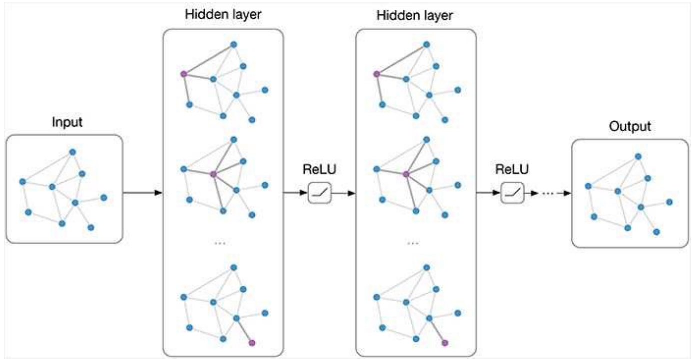
4. **Bayesian networks**

- https://repo.bayesfusion.com/bayesbox.html
- http://www.eng.tau.ac.il/~bengal/BN.pdf
- http://www.niedermayer.ca/node/35



5. **Graph neural networks**

- https://distill.pub/2021/gnn-intro/
- https://jonathan-hui.medium.com/applications-of-graph-neural-networks-gnn-d487fd5ed17d



Seminars: natural language processing, NLP

1. **Optical character recognition (OCR)**

- problem definition
- classical or neural network approach: an overview
- presenting one particular engine, e.g. state-of-the-art *Tesseract* (what deep learning model is used inside?)
- https://tesseract-ocr.github.io/tessdoc/

2. **Automatic speech recognition (ASR)**

- problem definition
- possible applications
- databases (e.g. *Librispeech*)
- an overview on single specific algorithm, e.g. *ContextNet* or *Deep Speech*
- https://arxiv.org/pdf/2005.03191.pdf
- https://arxiv.org/pdf/1512.02595.pdf

3. **Machine Translation**

- problem definition, example methods

4. **Question Answering**

- problem definition, example methods

5. **BERT/Transformers** natural language model

- overview, importance

Seminars: computer vision

1. **Point Feature Matching**

- problem definition
- classical and deep learning approaches
- *SuperGlue* algorithm: https://arxiv.org/abs/1911.11763

2. **Pose estimation**

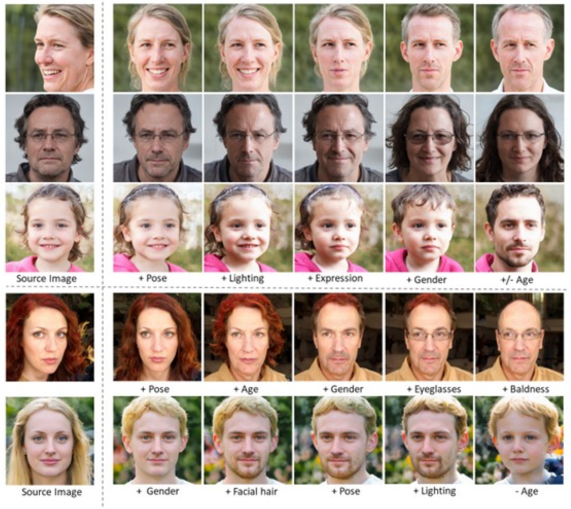
- problem definition and deep-learning solution, e.g.:
- https://arxiv.org/pdf/1803.08225.pdf

3. **Super-Resolution**

- idea, applications, algorithms
- https://arxiv.org/abs/1809.00219

4. **Editing GANs latent space**

- https://medium.com/codex/how-to-edit-images-with-gans-controlling-the-latent-space-of-gans-afde630e53d1
- https://www.unite.ai/editing-a-gans-latent-space-with-blobs



Seminars: machine learning in physics

1. **Physics-informed neural networks**

- https://benmoseley.blog/my-research/so-what-is-a-physics-informed-neural-network
- https://maziarraissi.github.io/PINNs
- seminal paper: https://www.sciencedirect.com/science/article/abs/pii/S0021999118307125

2. **Group-equivariant neural networks**

- original paper: https://proceedings.mlr.press/v48/cohenc16.pdf
- https://uvagedl.github.io

3. **Neural network quantum states**

- https://www.science.org/doi/10.1126/science.aag2302

4. **Classical shadows**

- https://www.science.org/doi/10.1126/science.abk3333
- https://pennylane.ai/qml/demos/tutorial_classical_shadows

5. **Neural tangent kernels**

- https://arxiv.org/abs/1806.07572
- https://lilianweng.github.io/posts/2022-09-08-ntk/