DECOMPOSING NEURAL NETWORKS

An applicant's guide to artificial learning 29.11.2022

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RECAP **Optimisation**

— Objective functions

— Numerical optimization

— How to train your network



TODAY: Architectures

- Coding session
- Layers
- Architectures
- --- Modifications



https://www.tmforum.org/wp-content/uploads/2018/01/ODA_Image_pimgpsh_fullsize_distr.jpg



Practice: Plotting

- Train your network (again)
- Keep track of the losses
- Plot them (you can use the provided function, if you want)
- Try out different optimizers





How to look at architecture

— Types of layers

— Common design strategies

— Common (or uncommon) modifications to designs and layers

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What layers do we know?

— Fully connected layer

— Convolutional layer

— Long-short term memory (LSTM)



Long short-term memory (LSTM)

— Sequence to sequence (or to scalar)

-LSTM consists of:

— Cell

— Input gate

— Output gate

— Forget gate

— Cells can hold the hidden state over time



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http://colah.github.io/images/post-covers/lstm.png

What network architectures are common?

— By layer:

- Feed-forward network
- Convolutional networks
- ---- LSTM networks: Sequence to sequence

— By design:

- Autoencoder (Variational Autoencoder)
- Generative adversarial networks (GAN)
- Siamese networks



What network architectures are common?

— By modification:

- Attention
- Transformer
- Hamiltonian
- Riemannian
- Residual
- Dissipative
- ---- Regularized

- Normalizing flows
- Disentangling
- ---- Symbolic
- Wasserstein
- Robust
- Diffusion



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AutoEncoder (AE)

— Target is the input!

- Bottleneck layer in the middle of the model
- —Aims to reconstruct the data



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https://de.mathworks.com/discovery/autoencoder.html

Variational AutoEncoder (VAE)

—Almost the same as AE

- Bottleneck layer is now a distribution
- This makes it a generative model, as one can draw samples from the latent space (and decode them)



https://upload.wikimedia.org/wikipedia/commons/thumb/4/4a/VAE_Basic.png/425px-VAE_Basic.png

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Generative adversarial networks

— Two parts: A generator and a discriminator

- Generator tries to fool the discriminator, so they train each other
- The art networks are typically this design
- Can be difficult to train



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https://sthalles.github.io/intro-to-gans/

Siamese networks

— Two networks, but sharing the same weights!

—Also not heavy on memory

— Used to detect similarity



https://subscription.packtpub.com/book/data/9781789138900/7/ch07lvl1sec84/creating-a-siamese-neural-network-in-keras

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TIME FOR TRYING IT OUT!



https://creator.nightcafe.studio/text-to-image-art



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What problems can we solve with these architectures?





SUMMARY OF TODAY Architectures

— Architecture by Layers, Design and Modification

— Feed-Forward, Convolutional and LSTM layers

— (Variational) AutoEncoder, Siamese Networks and Generative Adversarial Networks