CUB Deep Learning, Fall 2024

Topics for exam preparation

NN basic layers architectures. For each layer's type you should be able to write down the formula for calculating output of the layer given the input. Also you should be able to estimate the number of parameters of the layer and computational complexity for propagating information through the layer:

Fully connected layer; 1d and 2d convolutional layer; Max and Average Pooling layer; Recurrent layer; LSTM layer; GRU layer; Multi-Head Self Attention layer; Cross-Attention Layer; Masked Multi-Head Self Attention layer.

Understanding different convolutional layers *Parameters of standard 2d convolution: padding, stride, dilation; depthwise-separable convolution; Atrous convolution*

Losses for NN training For each type of loss you should be able to write down the corresponding formula for loss definition and understand in which NN models the corresponding loss is used and why:

Classification log-loss (cross-entropy loss), regression MSE loss, focal loss, CTC loss, KL divergence, ELBO (Evidence Lower Bound).

Algorithm for stochastic optimization For each algorithm you should be able to write down the update formula for parameters and understand the difference between them:

SGD, SGD with momentum, RMSprop, ADAM

Mathematical techniques and tricks for training NN models

DropOut (and Inverse Drop Out); Batch and Layer normalization; log-derivative trick; reparameterization trick; beam search; teacher forcing

Object representations for text and audio

BPE tokenizer, WordPiece tokenizer, Unigram tokenizer; Positional embedding; Mel-spectrogram, Log-mel-spectrogram, MFCC

NN models. For each of these models you should be able to name the applied problem being solved (what is the input to the network and the output from the network), the advantages/disadvantages/architectural design changes of the model comparing to analogues:

LeNet, AlexNet, VGG, ResNet, SegNet, U-net, Link-net, PSPNet, DeepLab 3, R-CNN, Fast R-CNN, Faster R-CNN, SSD / YOLO, Mask R-CNN, Optimization-based ST, NN-based ST, PixelCNN, Word2Vec, ELMo, BERT, GPT-3, LAS, Deep Speech 2, HiFi-GAN, WaveNet, Parallel WaveNet, Tacotron 2, Fast Speech, Value Iteration, Q-learning, DQN, REINFORCE, A2C

Generative models

Autogressive models, Classic Normalizing Flow, Variational Autoencoder, Generative Adversarial Network, Diffusion model DDPM

Basic concepts from Reinforcement Learning

RL problem statement; V and Q function; Bellman equations; connection between optimal policy and value functions; exploration-exploitation dilemma; target network; on-policy vs off-policy RL algorithms