

Natural Language Processing

1. Embeddings: how to build word/token embeddings without neural networks
2. Word2vec
 - a. Why only linear mapping
 - b. Skip-gram and CBOW
 - c. Negative sampling
3. Unsupervised translation approach. Procrustes problem.
4. Ways to work with text data:
 - a. Classical approaches: BoW, TF-IDF
 - b. RNN
 - c. CNN
 - d. Attention and Self-attention based techniques
5. Attention, Self-attention approaches.
 - a. Multi-head self-attention.
6. Transformer structure
7. Batch-normalization and layer normalization – what's the difference?
8. Machine translation metrics, quality functions
9. BERT structure, main ideas
10. Distribution shift in text generation and machine translation

Reinforcement Learning

1. RL problem statement. State, Action, Reward, Environment, Action
2. Crossentropy method
3. Value function, Q-function
4. Q-learning, approximate Q-learning. DQN, bells and whistles (Experience replay, Double DQN, autocorrelation problem)
5. Policy gradient and REINFORCE algorithm
 - a. Baselines idea
6. Policy gradient applications in other domains (outside RL). How Self-Critical Sequence Training is performed? What is used as a baseline?

Theoretical minimum

1. KL-divergence: formula, relations with Entropy and Cross-Entropy
2. Log-derivative trick.
3. How to estimate Reward gradient with log-derivative trick.
4. Grad-log-prob lemma (proof included).
5. Cross-entropy derivative (derive it with hands)
6. Metrics in text machine translation. At least BLEU.
7. Value function
8. Q-function

9. Basic Q-learning pipeline
10. Attention mechanism
11. RNN: basic idea
12. Convolutional layer: basic idea
13. Dropout: basic idea
14. Batch normalization: basic idea

Optional:

- P-tuning
- Low Rank Adaptors
- Knowledge distillation in neural networks
- RLHF basic idea and applications
- Generative adversarial networks (and is it possible to use them with texts)