CS182/282A Designing, Visualizing & Understanding Deep Neural Networks SP2019

Practice Midterm 2

NAME_____ **SID**_____

This is a closed-book exam with 12 questions. You can use one sheet of notes. Please write all your answers in this book. There is a total of 75 points for all questions, and you have 75 minutes to complete the exam. Please budget your time accordingly. Good luck!

Part I (45 points) The following short answer-questions are ***multiple-answer***. Be sure to circle *all* the options that apply.

1. (5 points) Latent Semantic Analysis (LSA) is used to embed words in a vector space, and is computed from a document/word matrix T, each of whose rows is a BoW representation of a document. Circle *all* the correct answers that apply:
   a) LSA can be computed using an SVD (singular value decomposition) of the matrix T.
   b) LSA is an optimal linear auto-encoder for L2 loss on reconstruction of T.
   c) LSA is an optimal linear auto-encoder for cross-entropy loss on reconstruction of T.
   d) LSA sometimes uses negative sampling to improve the performance of its output softmax.
   e) LSA computes two word embedding matrices U and V for center and context words respectively.

2. (6 points) For the word2vec algorithm, circle all correct answers below:
   a) Word2vec takes as input a document-word matrix T similar to LSA.
   b) Word2vec models local structure between a center word and neighboring words up to a fixed distance in the input text sequence.
   c) Word2vec models can be computed using a deep network with L2 output loss.
   d) Word2vec models can be computed using a deep network with cross-entropy output loss.
   e) Word2vec computes two word embedding matrices U and V for center and context words respectively.
   f) Implements word analogies using the formula: $\text{vec}(``\text{woman}'') - \text{vec}(``\text{man}'') + \text{vec}(``\text{aunt}'') - \text{vec}(``\text{uncle}'') \approx 0$.

3. (4 points) For the GloVe algorithm, circle all correct answers below:
   a) GloVe takes as input a co-occurrence matrix C where C_{ij} = number of occurrences of word i near word j.
   b) GloVe minimizes the L2 loss between original and predicted co-occurrence matrix C.
   c) GloVe is optimized to improve the accuracy of analogies.
   d) GloVe generates a single embedding matrix V for both context and center words.

4. (5 points) For the skip-thought embedding method, circle all correct answers:
   a) Skip-thought models include separate embedding matrices U and V for center and context words.
   b) Skip-thought models include a loss for prediction of the next sentence from the current sentence.
   c) Skip-thought models include a loss for prediction of the previous sentence from the current sentence.
   d) Skip-thought loss is explicitly optimized for word analogies.
   e) Skip-thought models embed entire sentences as a single context vector.

5. (5 points) For Generative Adversarial Networks (GANs) circle all that apply:
   a) A discriminator is trained to distinguish a real image from a synthetic image that most closely matches the real image.
   b) The discriminator and generator should share parameters for best performance.
   c) A GAN (locally) minimizes the Jensen-Shannon divergence between the input image distribution and the distribution of generated images.
   d) The discriminator should always be fully trained first, and then the generator can be trained using negative discriminator loss.
   e) The images generated by a GAN are adversarial (fooling) images.

6. (6 points) For imitation learning of a control policy π, circle all correct answers:
   a) Imitation learning relies on on-policy data.
   b) DAgger trains with on-policy trajectories, with action selection by a human teacher.
   c) In pure imitation learning, the target policy is executed by a human and the behavior policy is learned by the agent.
   d) Training on off-policy data can lead the trained policy to diverge from an expert trajectory.
   e) The more off-policy data is used for training (assuming only off-policy data is available), the less accurate and stable is the learned policy.
   f) The gap between off-policy data and on-policy training can sometimes be bridged by domain adaptation.

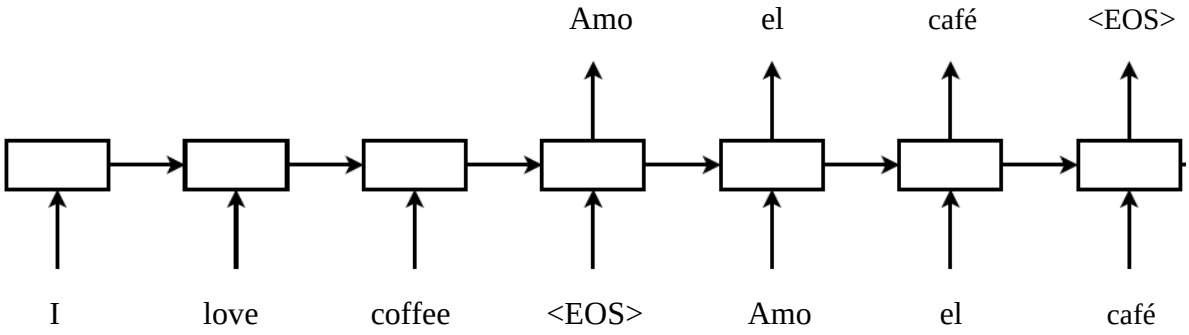
7. (4 points) For GAIL (Generative Adversarial Imitation Learning), circle all that apply:
   a) The policy π is trained to minimize a cost function learned by Inverse Reinforcement Learning (IRL).
   b) An adversary is trained to discriminate expert (real) and policy-generated (synthetic) trajectories based on the sequence of actions performed.
   c) An adversary is trained to discriminate expert (real) and learned (synthetic) trajectories based on the sequence of (state, action) pairs along the trajectory.
   d) The policy parameters are optimized to maximize the expected reward only.

8. (5 points) Adversarial Examples. Circle all the answers that are correct:
   a) It is harder to generate non-targeted adversarial examples than targeted examples.
   b) Adversarial examples can be generated in a single step by perturbing images in the direction of gradient of the loss.
   c) Adversarial examples can be generated iteratively by maximizing the label loss with an optimizer such as SGD.
   d) Ensembles of models are used to resist against adversarial image attacks.

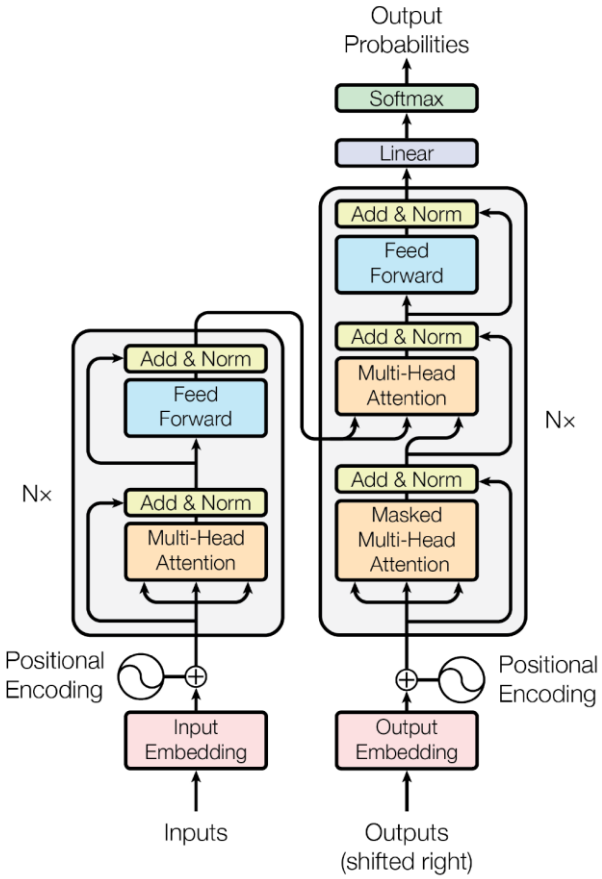
9. (5 points) Negotiation dialog agents have the following characteristics. Circle all that apply:
   a) Agents always reach a deal.
   b) Agents trained solely to mimic human dialog generate human-understandable dialog and optimal rewards.
   c) Agent expected reward is a differentiable function of model parameters, allowing end-to-end training of reward-optimal agents with methods like SGD.
   d) Agent dialog is consistent, i.e. agents only accept the exact offer made by the other agent.
   e) Rollouts – i.e. multi-step simulation of dialog and rewards, improve expected agent rewards.

Part II: General questions (30 points)

10. (10 points) The diagram below shows a design for a language translation system without attention. Modify the design to include soft attention. Show only one copy of the unit that computes attention weight and use word-position indices as appropriate to explain its inputs and output.



11. (10 points) Machine Translation. A diagram of a transformer network stage is shown below:



Answer the following questions about this network:

a) (3 points) What is the reason for positional encoding, and how is it typically implemented? Use diagrams as appropriate.

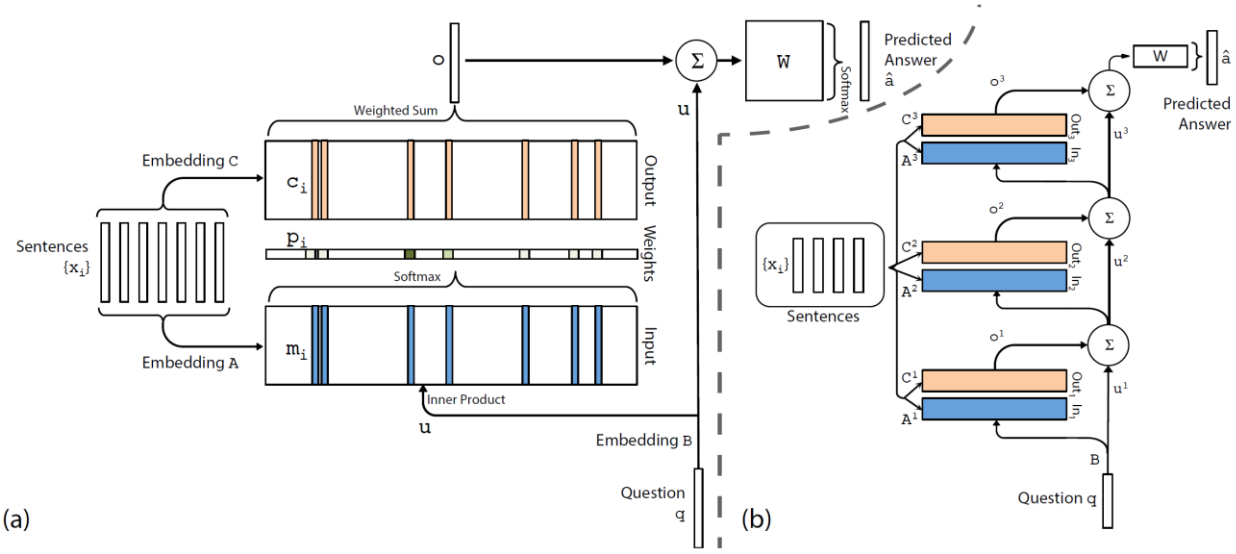
b) (2 points) What is the advantage of multi-head attention (vs. a single head). Give examples of what structure can be found by multi-head attention.

c) (3 points) For input sequences of length M, output sequences of length N, what are the complexities of

   i. Encoder self-attention
   ii. Decoder-encoder attention
   iii. Decoder self-attention

d) (2 points) Do activations of the encoder depend on decoder activations? How much additional computation is needed to translate a source sequence into a different target language, in terms of M and N?

12. (10 points) Memory Networks. A basic memory network is shown below:



a. (2 points) Is this network typically trained end-to-end with gradient methods (e.g. SGD) or does it require reinforcement learning? Explain.

b. (4 points) Give an example of a query that requires multiple hops to answer. You may wish to list a sequence of input facts that the networks refers to. In terms of number of hops, how would you decide if your query is answerable with the network above?

c. (2 points) What difficulties does this design have when used for queries over large databases? Give one solution that addresses these difficulties.

d. (2 points) What is the difference between the network above and a key-value memory network? Give one example of why keys and values are different and how this is useful.