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## CS 441 - HW 5: Deep Learning and Applications

Complete the sections below. You do not need to fill out the checklist. **Be sure to select all relevant pages in Gradescope.**

**Total Points Available**

**[ ] / 150**

1. Applications of AI
  1. Describe the applications [ ] / 15
  2. Positive impact [ ] / 7
  3. Negative impact [ ] / 8
2. Fine-tune Model for Pets Classification
  1. Qs about ResNet-34 structure [ ] / 10
  2. Epochs vs Loss Plots [ ] / 10
  3. Best Performance / Question [ ] / 10
3. CLIP: Contrastive Language-Image Pretraining
  1. Test CLIP zero-shot performance [ ] / 20
  2. Test CLIP linear probe performance [ ] / 10
  3. KNN on CLIP features [ ] / 10
4. Stretch Goals
  1. Compare word tokenizers [ ] / 20
  2. Implement/train custom network [ ] / 30

### 1. Answer “Applications of AI” Questions

1. **How is AI used in that application area?** What is the problem that AI is trying to solve, and what are the key AI/ML technologies involved? What are the technical challenges? (100+ words)

The application I chose was the application of artificial intelligence to playing games mastered by humans. The technology I focused on was AlphaZero and AlphaGo, two reinforcement learning based models developed by Google Deepmind which aimed to master the games of Chess and Go respectively. Similar to other game playing agents, AlphaZero plays against itself during the reinforcement learning process. The technical challenge is improving upon the existing way chess engines work, which is DFS through a fixed depth search tree which has been pruned (alpha-beta pruning is popular). The network takes in an input of the current board position and outputs two quantities: the probability of winning from the position, and an estimate of the ideal policy in that position. The win probability is estimated using self play between the networks using their respective output policies.

**2. What is the actual or potential positive impact? Who is impacted? (50+ words)**

The impact of AlphaZero on the game of chess is similar to that of chess engines like Stockfish. When chess engines replaced humans as the best chess players, humans used those same chess engines to improve their own game by using it to analyze positions, and studying the moves of chess engines to create a better playstyle. Since AlphaZero outperformed Stockfish at the time of this paper, many people began to do the same thing with AlphaZero, leading to an elevation of skill in human chess players.

**3. What is the actual or potential negative impact? Who is impacted? (50+ words)**

Almost all negative impacts of AlphaZero already apply to engines like Stockfish. Since Stockfish performs so well, people imitate the playstyle in an effort to improve. While effective, this can lead to less creative play, less diverse moves, less interesting plays, and consequently less interest in chess. AlphaZero, essentially a glorified stronger engine, will only exacerbate these issues. Additionally, AI models like AlphaZero are not easily accessible due to computation and corporation limits, it could afford an unfair advantage to players who are privileged with access to AI models.

4. **What are your sources?** (include full citations and links if available) [required; -15 pts if not provided] Format is not as important as being clear about what source is used.

1.

<https://arxiv.org/pdf/1712.01815.pdf> : Mastering Chess and Shogi by Self-Play with a General Reinforcement Learning Algorithm, Google Deepmind 2017

2.

<https://www.nytimes.com/2017/05/23/business/google-deepmind-alphago-go-champion-defeat.html>  
New york times, Google's AlphaGo Defeats Chinese Go Master in Win for A.I.  
Paul Mazur, 2017

## 2. CNN: Image Classification

### 1. Answer these questions about the network structure of your model based on ResNet-34

1.1. How many parameters are there in total? (xx.x million)

21.3 Million

1.2. Which of these layers **do not** have trainable parameters? (choose more than 1)

- a) Convolutional
- b) BatchNorm
- c) ReLU
- d) Max pooling
- e) Fully connected

ReLU, Max pool

1.3. True or false: In layers 1-4, whenever the feature map is downsampled by a factor of 2, the number of features is doubled.

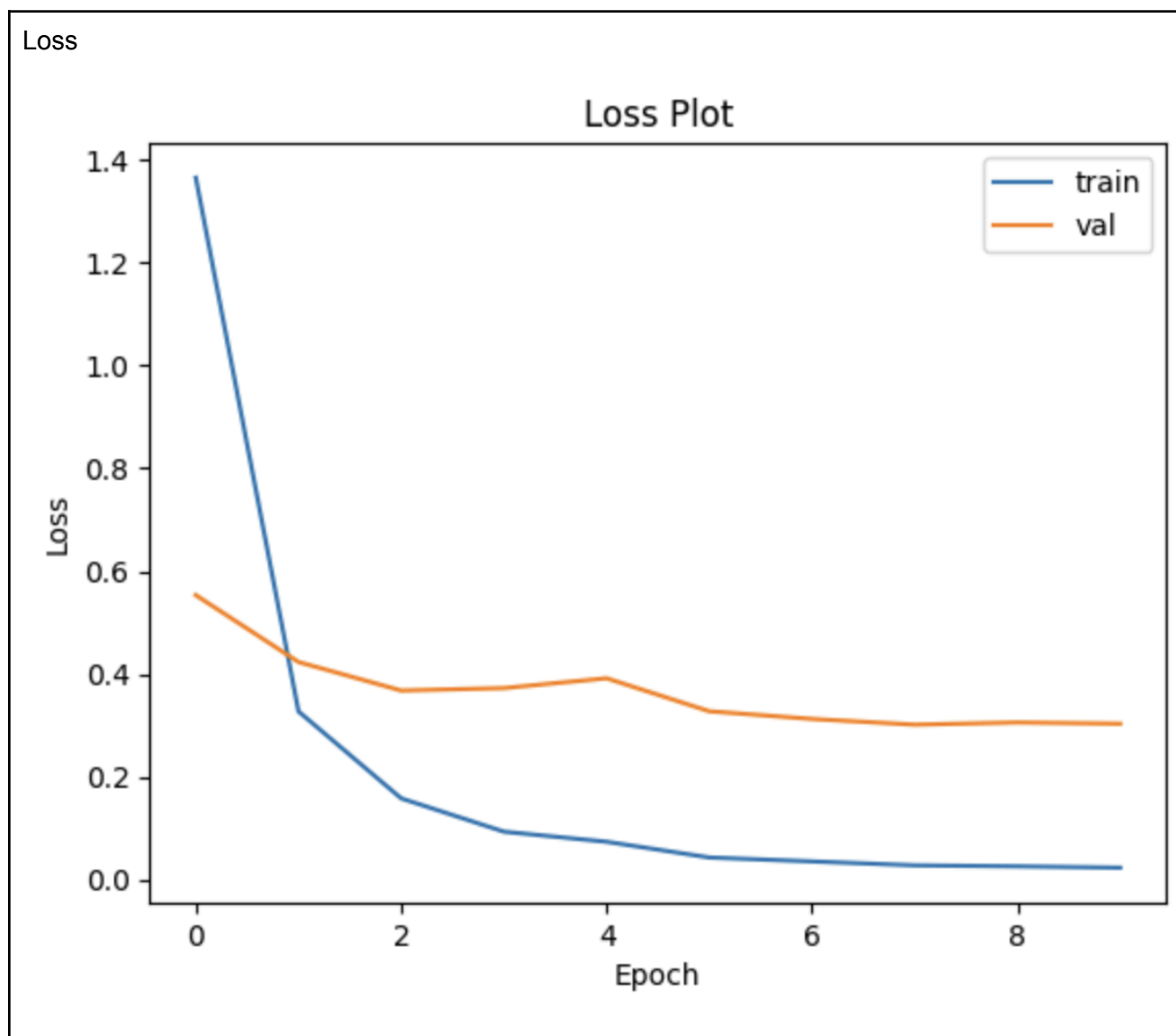
False

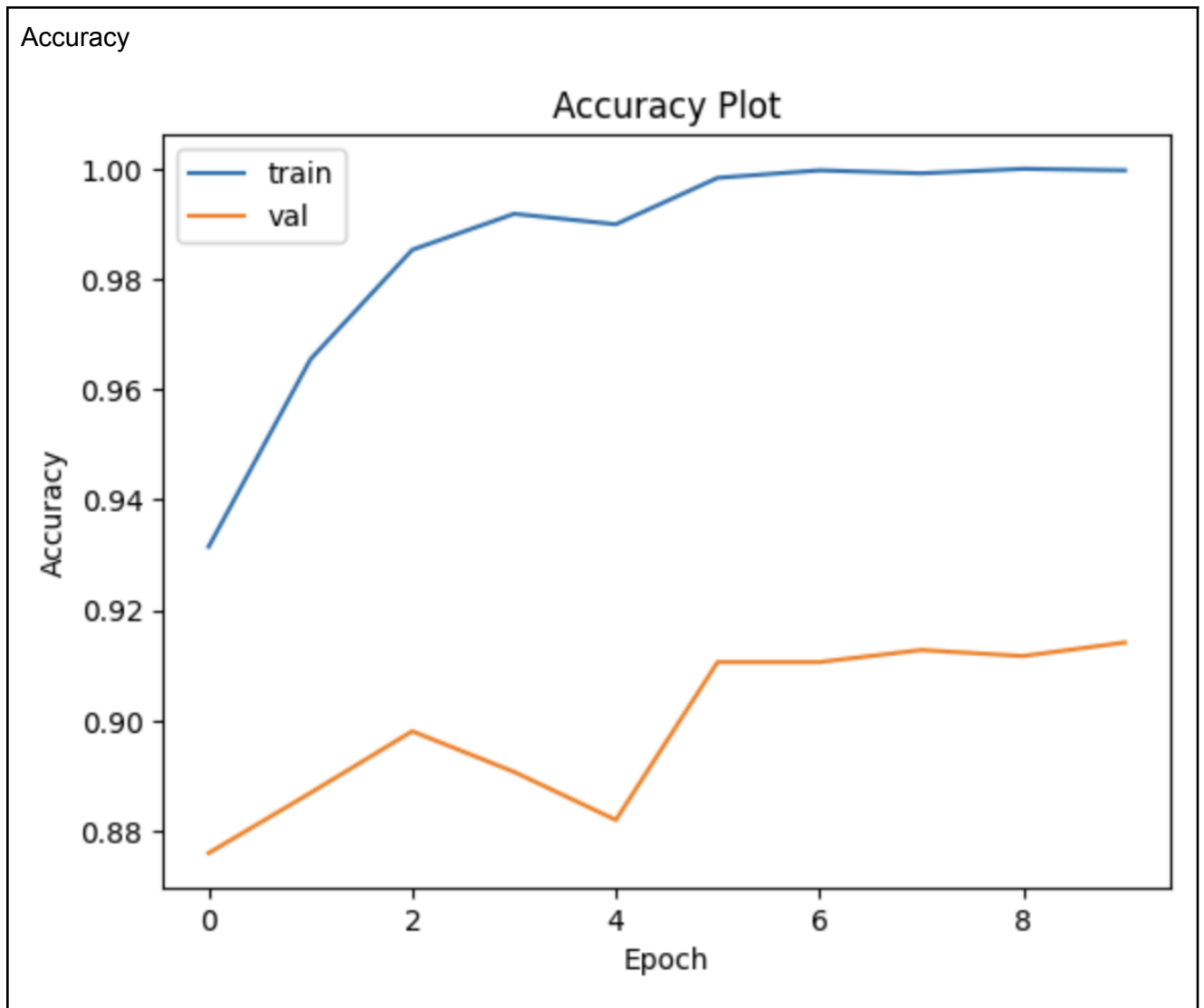
1.4. Which of these are applied immediately before the final fully connected layer? (choose one)

- a) Convolutional
- b) BatchNorm
- c) ReLU
- d) Max pooling
- e) Average pooling
- f) Fully connected

e) Average pooling

## 2. Plot accuracy and loss for at least 10 epochs





### 3. Best accuracy / question

Your best val (test\_set) accuracy:

0.914

True or False: Once the training accuracy reaches 100%, it's not possible to improve the model with further training.

False

### 3. CLIP: Contrastive Language-Image Pretraining

#### 1. CLIP zero-shot performance

Your test accuracy (xx.x%)

68.2%

What is the key idea that provides zero-shot ability to CLIP? (choose one)

- a. The visual model is trained to predict the most likely word based on a large dataset of labeled images.
- b. A text model is trained to map words into a vector and a visual model to map patches into an equal sized vector, such that the vectors of image and its textual description are much more similar than those of non-corresponding images and descriptions.
- c. CLIP learns to generate the most likely textual description, given the image.

B

#### 2. CLIP linear probe performance

Your test accuracy (xx.x%)

93.6 %

#### 3. KNN on CLIP feature

Your test accuracy: (xx.x%)

87.2 %

Best K:

5

#### **4. Stretch Goals**

##### **a. Compare word tokenizers**

Report encodings for “I am learning about word tokenizers. They are not very complicated, and they are a good way to convert natural text into tokens.” and one additional sentence of your choice. 20 points for reporting trained encodings of at least two models. 10 points for one model. You must train the models on WikiText-2 (should be included in notebook code).

##### **b. Custom network implementation and evaluation**

- i. Display the structure of the network you implemented
- ii. Plot accuracy and loss
- iii. Best test accuracy:

#### **Acknowledgments / Attribution**

List any outside sources for code or improvement ideas or “None”.