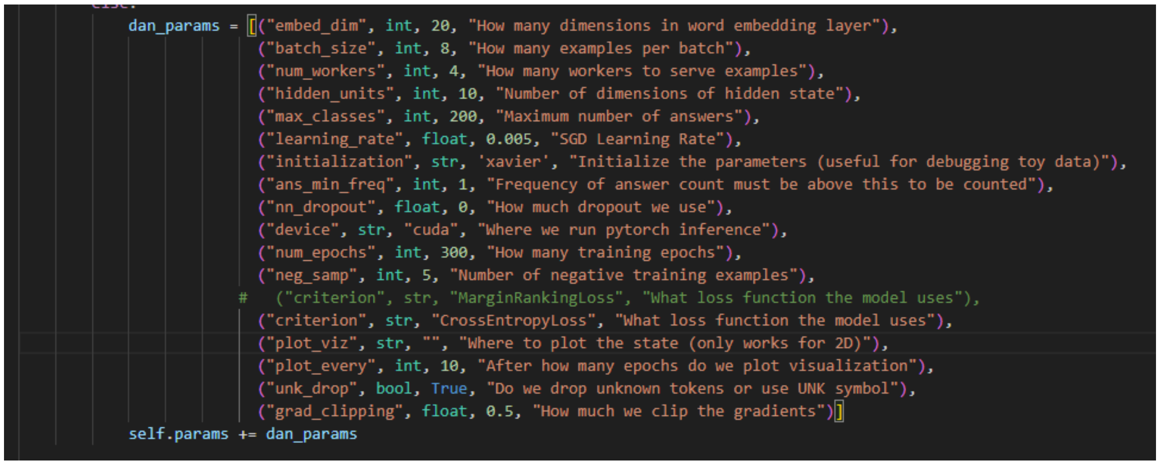
I modify the given models in the following part:

1. In __init__ function of DanModel I firstly define linear2 before criterion is checked in order to pass the Gradescope test. Also in the initialization I define relu and dropout layer and build the neural network using sequence to align linear1, relu, dropout and linear2 layer in order. I also put the model to the corresponding device for later usage on GPU.
2. I define the average function by dividing the sum of embedding over the text_len given.
3. Next function is the forward method. I input input_text into embedding, then put embedding into average, then finally put average into the network. These steps are intuitive and in order.
4. Then I define the rule of two criterion ‘CrossEntropyLoss’ and ‘MarginRankingLoss’ in the batch_step method in class DanGuesser. The CrossEntropyLoss is as simple as putting predictions and labels (integers after being looked up) into the nn.CrossEntropyLoss function. The calculation of MarginRankingLoss is to firstly compute the distance between predictions using samples and positive samples, then compute the distance between predictions using samples and negative samples. Input these two distance and all one vectors (this means we want positive samples to rank higher) into the nn.MarginRankingLoss function.
   By the criterion I get the loss of each learning step, and I also update the optimizer here because it is an argument of this method.
5. I define the rules of counting wrong predictions in the method number_errors. For CrossEntropyLoss I consider the column with the largest magnitude to be the predicted class, and for MarginRankingLoss I compare the string predictions with string labels.
6. I also make some small modifications for let the model suit for running on GPU based on the error reports.
7. After some trial and error, I find SGD optimizer runs so slowly and cannot match the size of the full training set. Thus, I changed to Adam optimizer which is very popular in NN today. It is faster by automatically adjusting the learning rate.

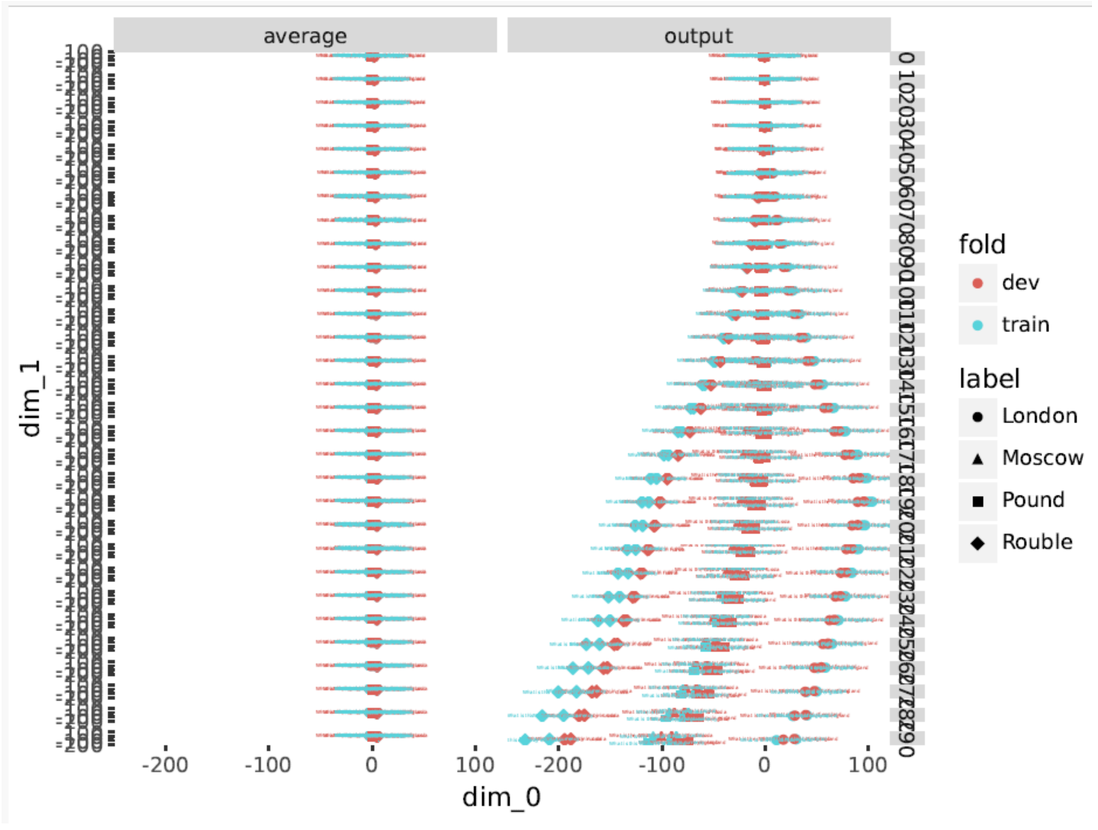
I trained the model using the following parameters and they all quickly converged to acc 1.00 within 200 epochs. I put these parameters as the default setting in parameter.py.

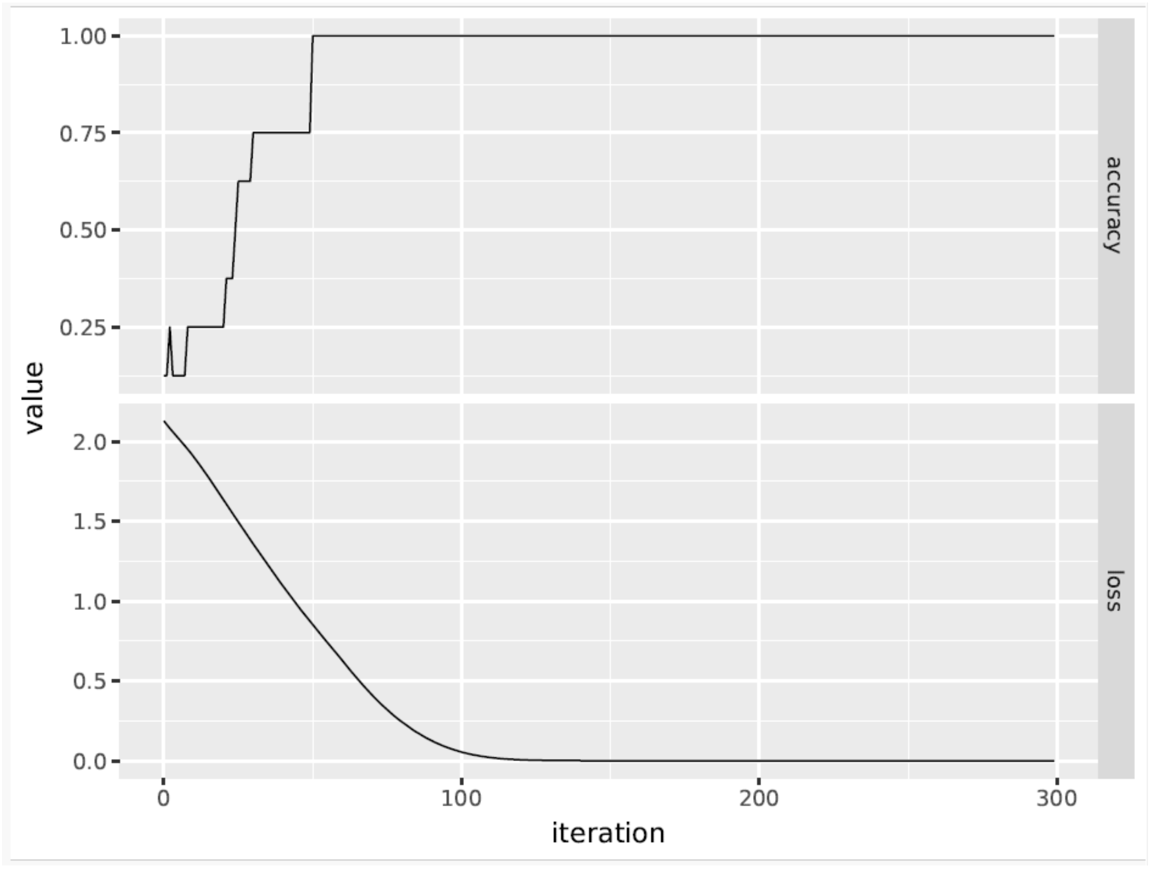


```
        dan_params = [("embed_dim", int, 20, "How many dimensions in word embedding layer"),
                      ("batch_size", int, 8, "How many examples per batch"),
                      ("num_workers", int, 4, "How many workers to serve examples"),
                      ("hidden_units", int, 10, "Number of dimensions of hidden state"),
                      ("max_classes", int, 200, "Maximum number of answers"),
                      ("learning_rate", float, 0.005, "SGD Learning Rate"),
                      ("initialization", str, 'xavier', "Initialize the parameters (useful for debugging toy data)"),
                      ("ans_min_freq", int, 1, "Frequency of answer count must be above this to be counted"),
                      ("nn_dropout", float, 0, "How much dropout we use"),
                      ("device", str, "cuda", "Where we run pytorch inference"),
                      ("num_epochs", int, 300, "How many training epochs"),
                      ("neg_samp", int, 5, "Number of negative training examples"),
                    #   ("criterion", str, "MarginRankingLoss", "What loss function the model uses"),
                      ("criterion", str, "CrossEntropyLoss", "What loss function the model uses"),
                      ("plot_viz", str, "", "Where to plot the state (only works for 2D)"),
                      ("plot_every", int, 10, "After how many epochs do we plot visualization"),
                      ("unk_drop", bool, True, "Do we drop unknown tokens or use UNK symbol"),
                      ("grad_clipping", float, 0.5, "How much we clip the gradients")]
        self.params += dan_params
```

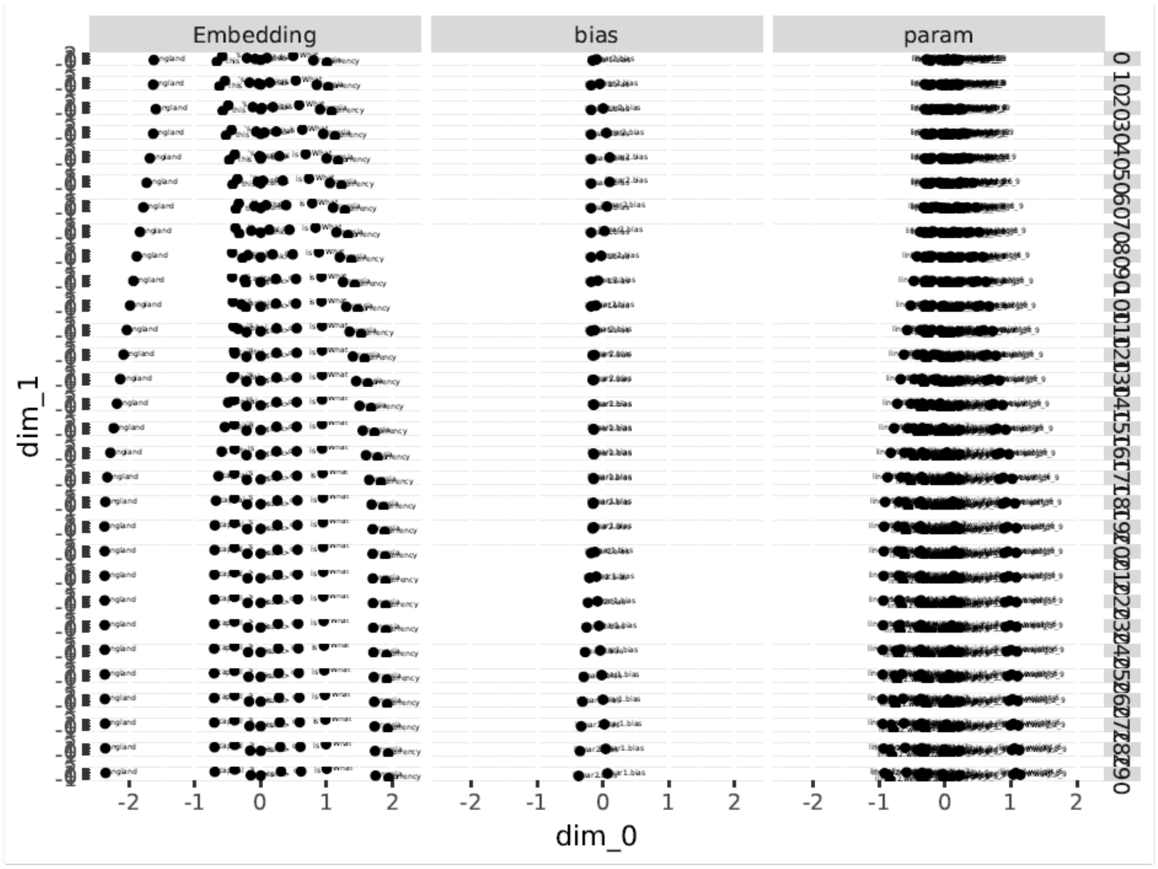
The resulting plots are shown below:

With CrossEntropyLoss:

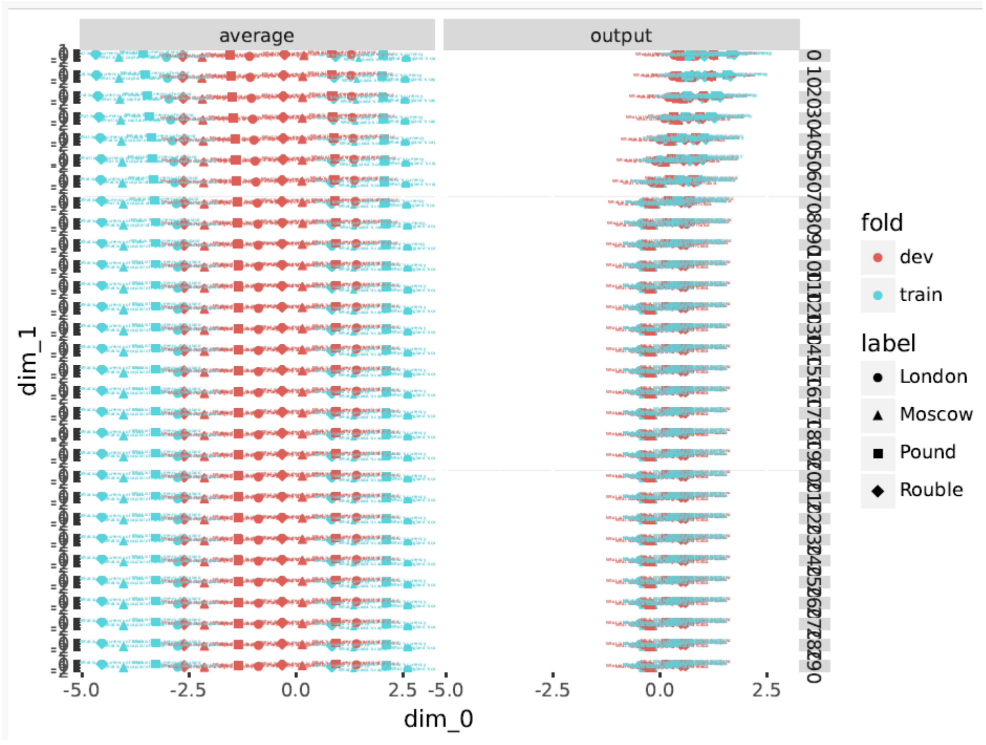


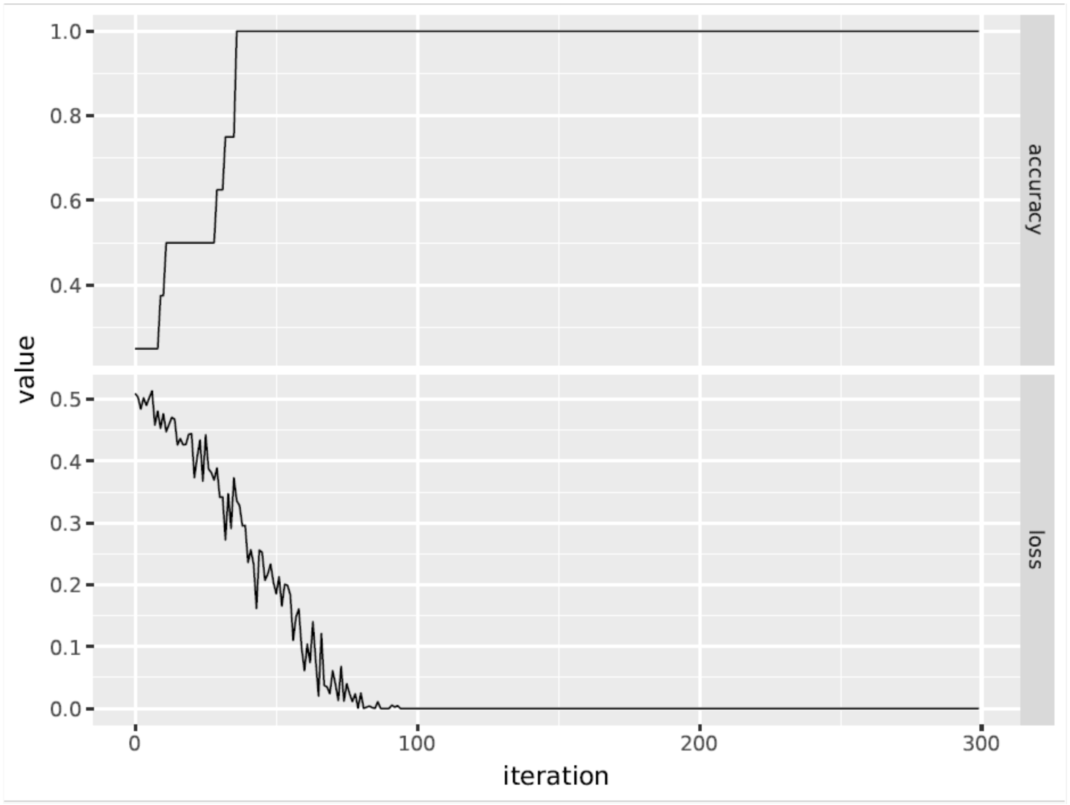


1.00
0.75
0.50
0.25
value
2.0
1.5
1.0
0.5
0.0
0
100
200
300
iteration
accuracy
loss

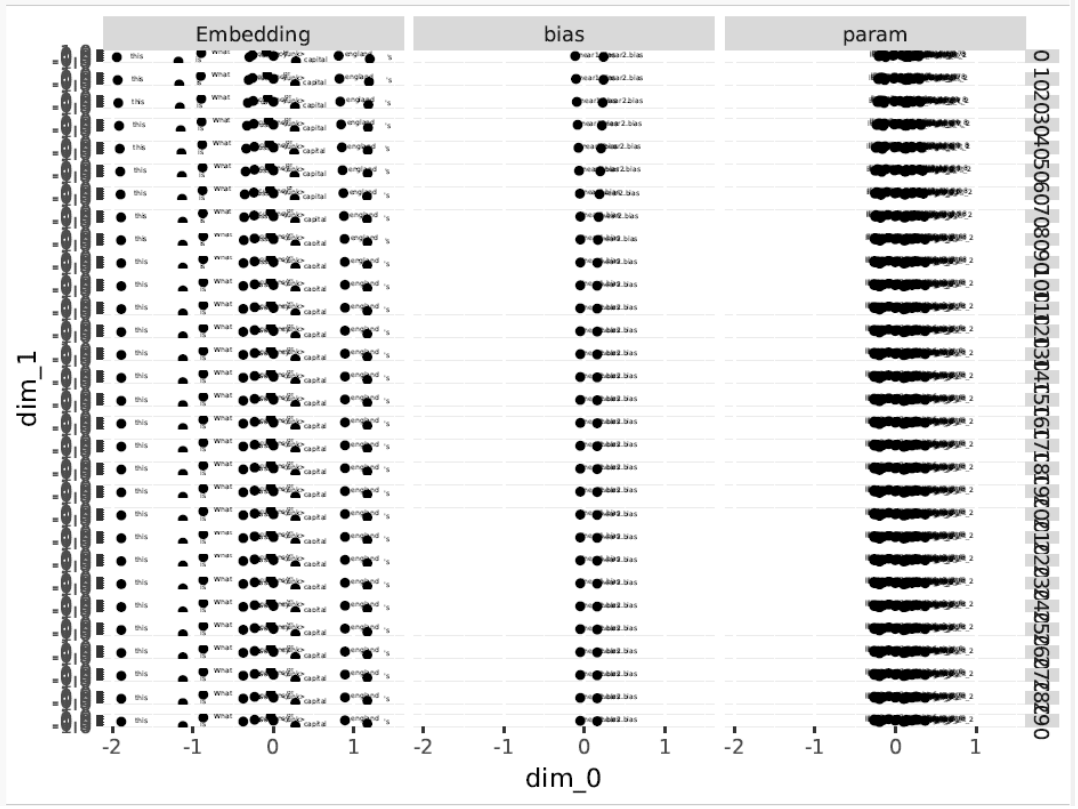


With MarginRankingLoss:





value
accuracy
loss
iteration
1.0
0.8
0.6
0.4
0.5
0.4
0.3
0.2
0.1
0.0
0
100
200
300



Embedding
bias
param
dim_1
dim_0
this
What
is
capital
england
's
-2
-1
0
1

The parameters that I used to train the full set are different from those in the toy training set. This is because I don't want to make the training of toy set also to be slow as the dimensions of embedding and hidden units need to be really high.

Thus, I show the best group of parameters in the following and the corresponding accuracy and loss.

```
python -i dan_guesser.py --secondary_questions ../data/qanta.buzzdev.json.gz --
questions ../data/qanta.buzztrain.json.gz --dan_guesser_plot_viz viz --
dan_guesser_hidden_units 300 --dan_guesser_vocab_size=40000 --
dan_guesser_max_classes=1000 --dan_guesser_num_workers 10 --
dan_guesser_num_epochs 100 --dan_guesser_embed_dim 1000 --
dan_guesser_ans_min_freq=2 --dan_guesser_nn_dropout 0.1 --
dan_guesser_batch_size=1000 --dan_guesser_plot_every 1 --
dan_guesser_criterion=MarginRankingLoss --dan_guesser_initialization='xaiver' --
dan_guesser_device='cuda' --dan_guesser_learning_rate=0.001

True

Setting up logging

INFO:root:Loading questions from ../data/qanta.buzztrain.json.gz

INFO:root:Read 18460 questions

INFO:root:Loading questions from ../data/qanta.buzzdev.json.gz

INFO:root:Read 1152 questions

INFO:root:Loaded 18460 train examples

INFO:root:Loaded 1152 dev examples

INFO:root:Example: {'text': 'After this character relates a story about how he didn\'t
know the proper way to use a wheelbarrow, he tells of how a captain dining with his
father mistakenly rubbed his hands in a punch bowl.\xa0This "sea Prince of Wales"
leaves his home by hiding out in a canoe near a coral reef, and he is mistakenly
called "Hedgehog" by a character who offers him a ninetieth lay, a partner of Bildad
named Peleg. A door is broken down in Mrs. Hussey\'s establishment after he locks
himself in his room during a "Ramadan."\xa0He is first encountered in the Spouter-
Inn where the landlord thinks he may be late because "he can\'t sell his head," and
his coffin helps save the narrator after the ship he\'s on sinks.\xa0For 10 points,
name this native of Rokovoko and savage companion of Ishmael in Moby-Dick.',
'answer': 'Queequeg', 'page': 'Queequeg', 'category': 'Literature', 'subcategory':
'Literature American', 'tournament': 'ACF Winter', 'difficulty': 'College', 'year': 2010,
'proto_id': '5476990eea23cca905506d51', 'qdb_id': None, 'dataset': 'protobowl',
'qanta_id': 0, 'tokenizations': [[0, 192], [193, 398], [399, 506], [507, 693], [694, 783]],
'first_sentence': "After this character relates a story about how he didn't know the
proper way to use a wheelbarrow, he tells of how a captain dining with his father
mistakenly rubbed his hands in a punch bowl.", 'answer_prompt': '', 'gameplay': True,
'fold': 'buzztrain'}

INFO:root:Using device 'cuda' (cuda flag=False)

INFO:root:Initializing guesser of type Dan

INFO:root:Creating embedding layer for 40000 vocab size, with 500 dimensions
(hidden dimension=300)

100%|██████████████████████████████████████████████████
████████████████████████████████████████████████████████
████████████████████████████████████████████████████████
████████████████████████████████████████████████████████
████████████████████████████████████████████████████████
███| 3870/3870 [00:02<00:00, 1788.99it/s]

INFO:root:Loaded 3870 questions with 500 unique answers

100%|██████████████████████████████████████████████████
████████████████████████████████████████████████████████
████████████████████████████████████████████████████████
████████████████████████████████████████████████████████
████████████████████████████████████████████████████████
██████| 16/16 [00:00<00:00, 268435.46it/s]

INFO:root:Loaded 16 questions with 5 unique answers

INFO:root:Training KD Tree for lookup with dimension 3870 rows and 300 columns

INFO:root:[Epoch 0001] Dev Accuracy: 0.000 Loss: 1.511710

INFO:root:[Epoch 0002] Dev Accuracy: 0.188 Loss: 1.001357

INFO:root:[Epoch 0003] Dev Accuracy: 0.125 Loss: 0.785582
```

```
INFO:root:[Epoch 0004] Dev Accuracy: 0.125 Loss: 0.684031

INFO:root:[Epoch 0005] Dev Accuracy: 0.125 Loss: 0.647545

INFO:root:[Epoch 0006] Dev Accuracy: 0.125 Loss: 0.562046

INFO:root:[Epoch 0007] Dev Accuracy: 0.188 Loss: 0.475262

INFO:root:[Epoch 0008] Dev Accuracy: 0.062 Loss: 0.462414

INFO:root:[Epoch 0009] Dev Accuracy: 0.062 Loss: 0.419212

INFO:root:[Epoch 0010] Dev Accuracy: 0.125 Loss: 0.400569

INFO:root:[Epoch 0011] Dev Accuracy: 0.062 Loss: 0.364754

INFO:root:[Epoch 0012] Dev Accuracy: 0.125 Loss: 0.335960

INFO:root:[Epoch 0013] Dev Accuracy: 0.062 Loss: 0.312166

INFO:root:[Epoch 0014] Dev Accuracy: 0.062 Loss: 0.300576

INFO:root:[Epoch 0015] Dev Accuracy: 0.062 Loss: 0.302814

INFO:root:[Epoch 0016] Dev Accuracy: 0.188 Loss: 0.278684

INFO:root:[Epoch 0017] Dev Accuracy: 0.000 Loss: 0.270702

INFO:root:[Epoch 0018] Dev Accuracy: 0.188 Loss: 0.262146

INFO:root:[Epoch 0019] Dev Accuracy: 0.125 Loss: 0.224272

INFO:root:[Epoch 0020] Dev Accuracy: 0.000 Loss: 0.237669

INFO:root:[Epoch 0021] Dev Accuracy: 0.000 Loss: 0.235516

torch.OutOfMemoryError: CUDA out of memory. Tried to allocate 6.56 GiB. GPU 0
has a total capacity of 8.00 GiB of which 0 bytes is free. Including non-PyTorch
memory, this process has 17179869184.00 GiB memory in use. Of the allocated
memory 8.89 GiB is allocated by PyTorch, and 7.48 GiB is reserved by PyTorch but
unallocated. If reserved but unallocated memory is large try setting
PYTORCH_CUDA_ALLOC_CONF=expandable_segments:True to avoid
fragmentation.  See documentation for Memory Management
(https://pytorch.org/docs/stable/notes/cuda.html#environment-variables)
```

I stopped here because my PC doesn’t allow me to run this huge set further. The loss keeps decreasing so I believe if memory is allowed the accuracy can be further improved from the current highest 0.188.