Deniz Aytemiz

Homework 4 - Advanced Machine Learning

Part 1 : Machine Learning Paper Reading
Paper name: Gradient Descent: The Ultimate Optimizer
Authors: Kartik Chandra, Audrey Xie, Jonathan Ragan-Kelley, Erik Meijer

- **What is the problem paper addressing, why is it important?**
  The gradient based machine learning algorithms, requires the programmer to select an appropriate value for hyperparameters. This paper addresses the problem of this selections since there is no defined rules in this selection and mostly is done based on empirical results. In this paper the authors describe of their method for automatically compute hypergradients simply and efficiently. This makes it possible for optimizers such as SGD and Adam to tune their own hyperparameters. This is an important problem since gradient based machine learning algorithms have lots of uses in many areas and this hyperparameter tuning is very crucial for such models.

- **What are the main contributions of this paper and how do they relate to the previous work in the field?**
  In order to efficiently compute hypergradients methods of manually differentiating standard optimizer update rules with respect to step size has been proposed by Baydin et al.(2018) which can improve convergence especially when the initial step size is sub optimal. However the drawbacks of the method are, manual differentiation being tedious and error prone and should be calculated for each optimizer variant, it only tunes step size and method introduced new hyper parameter(hyper step size) that also requires tuning. In this paper the authors propose a new method that automates the differentiation(such that no human effort required) and can generalize all other hyperparameters and even to hyperparameters of hyperparameters and so on.

  In both methods before weight update at step size i (update from w(i) to w(i+1), step size is updated(from α(i) to α(i+1)) and α(i+1) is the step size used to update w(i) to w(i+1). How step size is updated is as follow, k is hyper parameter step size and f is loss function at step i:
  $$\alpha_{i+1} = \alpha_i - k.\frac{\partial f(wi)}{\partial \alpha_i},$$
  in this paper they show which methods previous work in the field used to compute $\frac{\partial f(wi)}{\partial \alpha_i}$, and how this calculation can be automated and become less tedious.

- **What are the assumptions made by authors in their approach, and are they realisitc and justifiable? Are they any alternative assumptions that could be made?**
  Authors assume it should be possible to apply gradient based methods to tune hyper parameters of common variations on SGD and the implementation of HyperSGD generalizes quite easily to these optimizers. These assumptions are realistic and justifiable as proved in the experiments section, their method works well with these kind of optimizer too in scope of hyperparameter tuning.

- What is the dataset used in the paper, is it representative of the problem domain? Are there any biases in the data that could impact the results?
  The MNIST dataset is used to evaluate the hyperoptimizers. It is not mentioned in the paper however there might be some bias that effects the outcome of the experiment since they evaluate and compare optimizers and some optimizers give less test error on certain datasets and algorithms (classification or regression etc). The second dataset they used is CIFAR-10. Lastly they used Tolstoy dataset for testing optimizers on language model. The datasets are not representative of the problem domain in my opinion since any dataset could be used to conduct these experiments of hyperparameter tuning.
- How is the proposed approach evaluated in the paper, and is the experimental design comprehensive enough to demonstrate its effectiveness? Are there any limitations or potential confounding factors that should be considered?
  Using MNIST dataset with neural network model with one fully connected hidden layer of size 128, tanh activations, batch size of 256 is trained and whether an SGD hyperoptimizer performs better than regular SGD optimizer and whether final learned step size is better than the manually selected steps size performs better is examined. Net they used Resnet 20 with and without hyperoptimization on CIFAR-10 dataset to see which performs better. Lastly they have developed an interface for building arbitrarily tall towers of optimizers and tested on all of the datatsets mentioned to test whether taller towers of optimizers would tiles robust hyperoptimizers than manually selected hyperparameters. I think the experiments are comprehensive enough since they use different datasets with different machine learning modelks for conducting these experiments.
- What are the implications of the paper's results, and are there any ethical or societal concerns that should be considered? Could the proposed approach be applied to other domains or datasets?
  I do not think there is any ethical concerns related with the subject under scope presented in this paper. The proposed approach can indeed be applied to other datasets or domains.
- How do the authors' conclusions relate to the results presented in the paper? Are there any alternative approaches that could have been used or evaluated? What are the limitations and potential future research directions for this work?
  Overall they have concluded that the hyperoptimizers are indeed beneficial for tuning both step size and momentum in real world setting. Even with higher orseer hyperoptimization such as three level optimizer stack, a single hyperoptimizer design obtains reasonable in all of our benchmarks across several orders of magnitude of base level step size. They also shjowed that as the level size increases the hyperparameters become less sensitive to the initial human chosen hyperparameter. However, there are also some limitations too. One of htem is that hyperoptimizers cannot handle initial hyperparameters that are set far too high because the system becomes unstable and diverges. In addition the implementation brings certain bugs too, related to computational graph management such as certai Pythorch modules

cannot be used because they silently modify the computation graph which may lead to incorrect gradients.

- How can the result be useful to your own project?
  Following and implementing the methodology in this paper would give us a self tuning optimizer which would make the task of the programmer easier.

Part 2: Programming Assignment

Question 1:

Test Case output:

```
[14] ## Test Case: (Please provide the output of this function in your PDF answer)
     data_tokens_test_case = [["this", "is", "a", "test", "case"], ["lets", "try", "another", "one"]]
     word2id_test_case, id2word_test_case = create_word_id_dicts(data_tokens_test_case)
     print(word2id_test_case)
     print(id2word_test_case)

     ### TEST CASE: The output should be like this:

     ##{'this': 0, 'is': 1, 'a': 2, 'test': 3, 'case': 4, 'lets': 5, 'try': 6, 'another': 7, 'one': 8, '<unk>': 9}
     ##{0: 'this', 1: 'is', 2: 'a', 3: 'test', 4: 'case', 5: 'lets', 6: 'try', 7: 'another', 8: 'one', 9: '<unk>'}

     {'this': 0, 'is': 1, 'a': 2, 'test': 3, 'case': 4, 'lets': 5, 'try': 6, 'another': 7, 'one': 8, '<unk>': 9}
     {0: 'this', 1: 'is', 2: 'a', 3: 'test', 4: 'case', 5: 'lets', 6: 'try', 7: 'another', 8: 'one', 9: '<unk>'}
```

Evaluation Case output:

```
[15] ## Evaluation case: (Please provide the output of this function in your PDF answer)
     data_tokens_evaluation_case = df_train['tokens'].tolist()[7:9]
     word2id_test_case, id2word_test_case = create_word_id_dicts(data_tokens_evaluation_case)
     print(word2id_test_case)
     print(id2word_test_case)

     {'who': 0, 'were': 1, 'they': 2, 'kidding': 3, 'with': 4, 'this': 5, 'there': 6, 'was': 7, 'just': 8, 'too': 9, 'much'
     {0: 'who', 1: 'were', 2: 'they', 3: 'kidding', 4: 'with', 5: 'this', 6: 'there', 7: 'was', 8: 'just', 9: 'too', 10: 'm
```

full output:
word2id:
{'who': 0, 'were': 1, 'they': 2, 'kidding': 3, 'with': 4, 'this': 5, 'there': 6, 'was': 7, 'just': 8, 'too': 9, 'much': 10, 'in': 11, 'film': 12, 'that': 13, 'hard': 14, 'to': 15, 'digest': 16, 'right': 17, 'from': 18, 'when': 19, 'arjun': 20, 'ajay': 21, 'devgan': 22, 'unknowingly': 23, 'wishes': 24, 'death': 25, 'on': 26, 'his': 27, 'father': 28, 'he': 29, 'arrives': 30, 'london': 31, 'uncleplayed': 32, 'by': 33, 'om': 34, 'puri': 35, 'only': 36, 'abandon': 37, 'him': 38, 'minutes': 39, 'later': 40, 'the': 41, 'problem': 42, 'theory': 43, 'is': 44, 'anybody': 45, 'has': 46, 'ever': 47, 'passed': 48, 'through': 49, 'heathrow': 50, 'knows': 51, 'such': 52, 'a': 53, 'fête': 54, 'would': 55, 'be': 56, 'impossible': 57, 'pull': 58, 'off': 59, 'and': 60, 'especially': 61, 'not': 62, 'an': 63, 'indian': 64, 'but': 65, 'problems': 66, 'do': 67, 'end': 68, 'theres': 69, 'issue': 70, 'of': 71, 'two': 72, 'main': 73, 'leads': 74, 'salman': 75, 'khan': 76, 'passing': 77, 'as': 78, 'rockstars': 79, 'verge': 80, 'achieving': 81, 'their': 82, 'dreams': 83, 'i': 84, 'mean': 85, 'yeah': 86, 'we': 87, 'saw': 88, 'success': 89, 'come': 90, 'susan': 91, 'boyle': 92, 'woman': 93, 'uk': 94, 'her': 95, 'after': 96, 'age': 97, '50': 98, 'rare': 99, 'case': 100, 'it': 101, 'really': 102, 'for': 103, 'me': 104, 'suspend': 105, 'my': 106, 'disbelief': 107, 'because': 108, 'felt': 109, 'casting': 110, 'illconceived': 111, 'never': 112, 'cast': 113, 'madhuri': 114, 'dixit': 115, 'sridevi': 116, 'play': 117, 'same': 118, 'roles': 119, 'so': 120, 'why': 121, 'should': 122, 'forced': 123, 'watch': 124, 'men': 125, 'well': 126, 'into': 127, '40s': 128, 'prance': 129, 'around': 130, 'desperately': 131, 'trying': 132, 'hang': 133, '20s': 134, 'lets': 135, 'even': 136, 'talk': 137, 'about': 138, 'most': 139, 'selfconscious': 140, 'actress': 141, 'screen': 142, 'today': 143, 'asin': 144, 'second': 145, 'have': 146, 'seen': 147, 'she': 148, 'hopeless': 149, 'conscious': 150, 'looks': 151, 'concerns': 152, 'herself':

153, 'looking': 154, 'good': 155, 'voguing': 156, 'camera': 157, 'rather': 158, 'than': 159, 'giving': 160, 'acting': 161, 'performance': 162, 'its': 163, 'believe': 164, 'turned': 165, 'down': 166, 'all': 167, 'those': 168, 'other': 169, 'movie': 170, 'star': 171, 'fluff': 172, 'then': 173, 'fluffy': 174, 'nothing': 175, 'write': 176, 'home': 177, 'at': 178, 'top': 179, 'boringly': 180, 'dragged': 181, 'special': 182, 'trust': 183, 'you': 184, 'will': 185, 'predict': 186, 'every': 187, 'clichéd': 188, 'thing': 189, 'going': 190, 'happen': 191, 'instantly': 192, 'fell': 193, 'love': 194, 'pushing': 195, 'daisies': 196, 'show': 197, 'manages': 198, 'put': 199, 'smile': 200, 'face': 201, 'great': 202, 'storytelling': 203, 'witty': 204, 'dialog': 205, 'thats': 206, 'also': 207, 'keep': 208, 'until': 209, 'basic': 210, 'idea': 211, 'behind': 212, 'bringing': 213, 'people': 214, 'back': 215, 'life': 216, 'one': 217, 'touch': 218, 'ending': 219, 'undead': 220, 'status': 221, 'interesting': 222, 'could': 223, 'still': 224, 'seasons': 225, 'suspenseful': 226, 'murder': 227, 'cases': 228, 'unique': 229, 'look': 230, 'highly': 231, 'proficient': 232, 'narrator': 233, 'add': 234, 'experience': 235, 'more': 236, 'parts': 237, 'certain': 238, 'charm': 239, 'enjoy': 240, 'im': 241, 'forward': 242, 'enter': 243, 'world': 244, 'ned': 245, 'chuck': 246, 'season': 247, '<unk>': 248}

id2word:
{0: 'who', 1: 'were', 2: 'they', 3: 'kidding', 4: 'with', 5: 'this', 6: 'there', 7: 'was', 8: 'just', 9: 'too', 10: 'much', 11: 'in', 12: 'film', 13: 'that', 14: 'hard', 15: 'to', 16: 'digest', 17: 'right', 18: 'from', 19: 'when', 20: 'arjun', 21: 'ajay', 22: 'devgan', 23: 'unknowingly', 24: 'wishes', 25: 'death', 26: 'on', 27: 'his', 28: 'father', 29: 'he', 30: 'arrives', 31: 'london', 32: 'uncleplayed', 33: 'by', 34: 'om', 35: 'puri', 36: 'only', 37: 'abandon', 38: 'him', 39: 'minutes', 40: 'later', 41: 'the', 42: 'problem', 43: 'theory', 44: 'is', 45: 'anybody', 46: 'has', 47: 'ever', 48: 'passed', 49: 'through', 50: 'heathrow', 51: 'knows', 52: 'such', 53: 'a', 54: 'fête', 55: 'would', 56: 'be', 57: 'impossible', 58: 'pull', 59: 'off', 60: 'and', 61: 'especially', 62: 'not', 63: 'an', 64: 'indian', 65: 'but', 66: 'problems', 67: 'do', 68: 'end', 69: 'theres', 70: 'issue', 71: 'of', 72: 'two', 73: 'main', 74: 'leads', 75: 'salman', 76: 'khan', 77: 'passing', 78: 'as', 79: 'rockstars', 80: 'verge', 81: 'achieving', 82: 'their', 83: 'dreams', 84: 'i', 85: 'mean', 86: 'yeah', 87: 'we', 88: 'saw', 89: 'success', 90: 'come', 91: 'susan', 92: 'boyle', 93: 'woman', 94: 'uk', 95: 'her', 96: 'after', 97: 'age', 98: '50', 99: 'rare', 100: 'case', 101: 'it', 102: 'really', 103: 'for', 104: 'me', 105: 'suspend', 106: 'my', 107: 'disbelief', 108: 'because', 109: 'felt', 110: 'casting', 111: 'illconceived', 112: 'never', 113: 'cast', 114: 'madhuri', 115: 'dixit', 116: 'sridevi', 117: 'play', 118: 'same', 119: 'roles', 120: 'so', 121: 'why', 122: 'should', 123: 'forced', 124: 'watch', 125: 'men', 126: 'well', 127: 'into', 128: '40s', 129: 'prance', 130: 'around', 131: 'desperately', 132: 'trying', 133: 'hang', 134: '20s', 135: 'lets', 136: 'even', 137: 'talk', 138: 'about', 139: 'most', 140: 'selfconscious', 141: 'actress', 142: 'screen', 143: 'today', 144: 'asin', 145: 'second', 146: 'have', 147: 'seen', 148: 'she', 149: 'hopeless', 150: 'conscious', 151: 'looks', 152: 'concerns', 153: 'herself', 154: 'looking', 155: 'good', 156: 'voguing', 157: 'camera', 158: 'rather', 159: 'than', 160: 'giving', 161: 'acting', 162: 'performance', 163: 'its', 164: 'believe', 165: 'turned', 166: 'down', 167: 'all', 168: 'those', 169: 'other', 170: 'movie', 171: 'star', 172: 'fluff', 173: 'then', 174: 'fluffy', 175: 'nothing', 176: 'write', 177: 'home', 178: 'at', 179: 'top', 180: 'boringly', 181: 'dragged', 182: 'special', 183: 'trust', 184: 'you', 185: 'will', 186: 'predict', 187: 'every', 188: 'clichéd', 189: 'thing', 190: 'going', 191: 'happen', 192: 'instantly', 193: 'fell', 194: 'love', 195: 'pushing', 196: 'daisies', 197: 'show', 198: 'manages', 199: 'put', 200: 'smile', 201: 'face', 202: 'great', 203: 'storytelling', 204: 'witty', 205: 'dialog', 206: 'thats', 207: 'also', 208: 'keep', 209: 'until', 210: 'basic', 211: 'idea', 212: 'behind', 213: 'bringing', 214: 'people', 215: 'back', 216: 'life', 217: 'one', 218: 'touch', 219: 'ending', 220: 'undead', 221: 'status', 222: 'interesting', 223: 'could', 224: 'still', 225: 'seasons', 226: 'suspenseful', 227: 'murder', 228: 'cases', 229: 'unique', 230: 'look', 231: 'highly', 232: 'proficient', 233: 'narrator', 234: 'add', 235: 'experience', 236: 'more', 237: 'parts', 238: 'certain', 239: 'charm', 240: 'enjoy', 241: 'im', 242: 'forward', 243: 'enter', 244: 'world', 245: 'ned', 246: 'chuck', 247: 'season', 248: '<unk>'}

Question 2:

Test Case output:

```
] ## Test Case
  data_tokens_test_case = [["this", "is", "a", "test", "case"], ["lets", "try", "another", "one"]]
  seq_length_test_case = 3
  sequences_test_case = split_tokens_into_sequences(data_tokens_test_case, seq_length_test_case)

  print(sequences_test_case)

  ### TEST CASE: The output should be like this:

  ## [['this', 'is', 'a'], ['is', 'a', 'test'], ['a', 'test', 'case'], ['lets', 'try', 'another'], ['try', 'another', 'one'

    [['this', 'is', 'a'], ['is', 'a', 'test'], ['a', 'test', 'case'], ['lets', 'try', 'another'], ['try', 'another', 'one']]
```

Evaluation Case:

```
## Evaluation case: (Please provide the output of this function in your PDF answer)
data_tokens_Evaluation_case = df_train['tokens'].tolist()[7:9]
sequences_Evaluation_case = split_tokens_into_sequences(data_tokens_Evaluation_case, seq_length)

print(sequences_Evaluation_case)

[['who', 'were', 'they', 'kidding', 'with', 'this', 'there', 'was', 'just', 'too'], ['were', 'they', 'kidding', 'with', '
```

full output:

[['who', 'were', 'they', 'kidding', 'with', 'this', 'there', 'was', 'just', 'too'], ['were', 'they', 'kidding', 'with', 'this', 'there', 'was', 'just', 'too', 'much'], ['they', 'kidding', 'with', 'this', 'there', 'was', 'just', 'too', 'much', 'in'], ['kidding', 'with', 'this', 'there', 'was', 'just', 'too', 'much', 'in', 'this'], ['with', 'this', 'there', 'was', 'just', 'too', 'much', 'in', 'this', 'film'], ['this', 'there', 'was', 'just', 'too', 'much', 'in', 'this', 'film', 'that'], ['there', 'was', 'just', 'too', 'much', 'in', 'this', 'film', 'that', 'was'], ['was', 'just', 'too', 'much', 'in', 'this', 'film', 'that', 'was', 'hard'], ['just', 'too', 'much', 'in', 'this', 'film', 'that', 'was', 'hard', 'to'], ['too', 'much', 'in', 'this', 'film', 'that', 'was', 'hard', 'to', 'digest'], ['much', 'in', 'this', 'film', 'that', 'was', 'hard', 'to', 'digest', 'right'], ['in', 'this', 'film', 'that', 'was', 'hard', 'to', 'digest', 'right', 'from'], ['this', 'film', 'that', 'was', 'hard', 'to', 'digest', 'right', 'from', 'when'], ['film', 'that', 'was', 'hard', 'to', 'digest', 'right', 'from', 'when', 'arjun'], ['that', 'was', 'hard', 'to', 'digest', 'right', 'from', 'when', 'arjun', 'ajay'], ['was', 'hard', 'to', 'digest', 'right', 'from', 'when', 'arjun', 'ajay', 'devgan'], ['hard', 'to', 'digest', 'right', 'from', 'when', 'arjun', 'ajay', 'devgan', 'unknowingly'], ['to', 'digest', 'right', 'from', 'when', 'arjun', 'ajay', 'devgan', 'unknowingly', 'wishes'], ['digest', 'right', 'from', 'when', 'arjun', 'ajay', 'devgan', 'unknowingly', 'wishes', 'death'], ['right', 'from', 'when', 'arjun', 'ajay', 'devgan', 'unknowingly', 'wishes', 'death', 'on'], ['from', 'when', 'arjun', 'ajay', 'devgan', 'unknowingly', 'wishes', 'death', 'on', 'his'], ['when', 'arjun', 'ajay', 'devgan', 'unknowingly', 'wishes', 'death', 'on', 'his', 'father'], ['arjun', 'ajay', 'devgan', 'unknowingly', 'wishes', 'death', 'on', 'his', 'father', 'to'], ['ajay', 'devgan', 'unknowingly', 'wishes', 'death', 'on', 'his', 'father', 'to', 'when'], ['devgan', 'unknowingly', 'wishes', 'death', 'on', 'his', 'father', 'to', 'when', 'he'], ['unknowingly', 'wishes', 'death', 'on', 'his', 'father', 'to', 'when', 'he', 'arrives'], ['wishes', 'death', 'on', 'his', 'father', 'to', 'when', 'he', 'arrives', 'in'], ['death', 'on', 'his', 'father', 'to', 'when', 'he', 'arrives', 'in', 'london'], ['on', 'his', 'father', 'to', 'when', 'he', 'arrives', 'in', 'london', 'with'], ['his', 'father', 'to', 'when', 'he', 'arrives', 'in', 'london', 'with', 'his'], ['father', 'to', 'when', 'he', 'arrives', 'in', 'london', 'with', 'his', 'uncleplayed'], ['to', 'when', 'he', 'arrives', 'in', 'london', 'with', 'his', 'uncleplayed', 'by'], ['when', 'he', 'arrives', 'in', 'london', 'with', 'his', 'uncleplayed', 'by', 'om'], ['he', 'arrives', 'in', 'london', 'with', 'his', 'uncleplayed', 'by', 'om', 'puri'], ['arrives', 'in', 'london', 'with', 'his', 'uncleplayed', 'by', 'om', 'puri', 'only'], ['in', 'london', 'with', 'his', 'uncleplayed', 'by', 'om', 'puri', 'only', 'to'], ['london', 'with', 'his', 'uncleplayed', 'by', 'om', 'puri', 'only', 'to', 'abandon'], ['with', 'his', 'uncleplayed', 'by', 'om', 'puri', 'only', 'to', 'abandon', 'him'], ['his', 'uncleplayed', 'by', 'om', 'puri', 'only', 'to', 'abandon', 'him', 'minutes'], ['uncleplayed', 'by', 'om', 'puri', 'only', 'to', 'abandon', 'him', 'minutes', 'later'], ['by', 'om', 'puri', 'only', 'to', 'abandon', 'him', 'minutes', 'later', 'the'], ['om', 'puri', 'only', 'to', 'abandon', 'him', 'minutes', 'later', 'the', 'only'], ['puri', 'only', 'to', 'abandon', 'him', 'minutes', 'later', 'the', 'only', 'problem'], ['only', 'to', 'abandon',

'him', 'minutes', 'later', 'the', 'only', 'problem', 'with'], ['to', 'abandon', 'him', 'minutes', 'later', 'the', 'only', 'problem', 'with', 'that'], ['abandon', 'him', 'minutes', 'later', 'the', 'only', 'problem', 'with', 'that', 'theory'], ['him', 'minutes', 'later', 'the', 'only', 'problem', 'with', 'that', 'theory', 'is'], ['minutes', 'later', 'the', 'only', 'problem', 'with', 'that', 'theory', 'is', 'that'], ['later', 'the', 'only', 'problem', 'with', 'that', 'theory', 'is', 'that', 'anybody'], ['the', 'only', 'problem', 'with', 'that', 'theory', 'is', 'that', 'anybody', 'who'], ['only', 'problem', 'with', 'that', 'theory', 'is', 'that', 'anybody', 'who', 'has'], ['problem', 'with', 'that', 'theory', 'is', 'that', 'anybody', 'who', 'has', 'ever'], ['with', 'that', 'theory', 'is', 'that', 'anybody', 'who', 'has', 'ever', 'passed'], ['that', 'theory', 'is', 'that', 'anybody', 'who', 'has', 'ever', 'passed', 'through'], ['theory', 'is', 'that', 'anybody', 'who', 'has', 'ever', 'passed', 'through', 'london'], ['is', 'that', 'anybody', 'who', 'has', 'ever', 'passed', 'through', 'london', 'heathrow'], ['that', 'anybody', 'who', 'has', 'ever', 'passed', 'through', 'london', 'heathrow', 'knows'], ['anybody', 'who', 'has', 'ever', 'passed', 'through', 'london', 'heathrow', 'knows', 'that'], ['who', 'has', 'ever', 'passed', 'through', 'london', 'heathrow', 'knows', 'that', 'such'], ['has', 'ever', 'passed', 'through', 'london', 'heathrow', 'knows', 'that', 'such', 'a'], ['ever', 'passed', 'through', 'london', 'heathrow', 'knows', 'that', 'such', 'a', 'fête'], ['passed', 'through', 'london', 'heathrow', 'knows', 'that', 'such', 'a', 'fête', 'would'], ['through', 'london', 'heathrow', 'knows', 'that', 'such', 'a', 'fête', 'would', 'be'], ['london', 'heathrow', 'knows', 'that', 'such', 'a', 'fête', 'would', 'be', 'impossible'], ['heathrow', 'knows', 'that', 'such', 'a', 'fête', 'would', 'be', 'impossible', 'to'], ['knows', 'that', 'such', 'a', 'fête', 'would', 'be', 'impossible', 'to', 'pull'], ['that', 'such', 'a', 'fête', 'would', 'be', 'impossible', 'to', 'pull', 'off'], ['such', 'a', 'fête', 'would', 'be', 'impossible', 'to', 'pull', 'off', 'and'], ['a', 'fête', 'would', 'be', 'impossible', 'to', 'pull', 'off', 'and', 'especially'], ['fête', 'would', 'be', 'impossible', 'to', 'pull', 'off', 'and', 'especially', 'not'], ['would', 'be', 'impossible', 'to', 'pull', 'off', 'and', 'especially', 'not', 'by'], ['be', 'impossible', 'to', 'pull', 'off', 'and', 'especially', 'not', 'by', 'an'], ['impossible', 'to', 'pull', 'off', 'and', 'especially', 'not', 'by', 'an', 'indian'], ['to', 'pull', 'off', 'and', 'especially', 'not', 'by', 'an', 'indian', 'but'], ['pull', 'off', 'and', 'especially', 'not', 'by', 'an', 'indian', 'but', 'the'], ['off', 'and', 'especially', 'not', 'by', 'an', 'indian', 'but', 'the', 'film'], ['and', 'especially', 'not', 'by', 'an', 'indian', 'but', 'the', 'film', 'problems'], ['especially', 'not', 'by', 'an', 'indian', 'but', 'the', 'film', 'problems', 'do'], ['not', 'by', 'an', 'indian', 'but', 'the', 'film', 'problems', 'do', 'not'], ['by', 'an', 'indian', 'but', 'the', 'film', 'problems', 'do', 'not', 'end'], ['an', 'indian', 'but', 'the', 'film', 'problems', 'do', 'not', 'end', 'there'], ['indian', 'but', 'the', 'film', 'problems', 'do', 'not', 'end', 'there', 'theres'], ['but', 'the', 'film', 'problems', 'do', 'not', 'end', 'there', 'theres', 'the'], ['the', 'film', 'problems', 'do', 'not', 'end', 'there', 'theres', 'the', 'issue'], ['film', 'problems', 'do', 'not', 'end', 'there', 'theres', 'the', 'issue', 'of'], ['problems', 'do', 'not', 'end', 'there', 'theres', 'the', 'issue', 'of', 'the'], ['do', 'not', 'end', 'there', 'theres', 'the', 'issue', 'of', 'the', 'two'], ['not', 'end', 'there', 'theres', 'the', 'issue', 'of', 'the', 'two', 'main'], ['end', 'there', 'theres', 'the', 'issue', 'of', 'the', 'two', 'main', 'leads'], ['there', 'theres', 'the', 'issue', 'of', 'the', 'two', 'main', 'leads', 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'susan', 'boyle', 'a', 'woman', 'in'], ['saw', 'success', 'come', 'to', 'susan', 'boyle', 'a', 'woman', 'in', 'the'], ['success', 'come', 'to', 'susan', 'boyle', 'a', 'woman', 'in', 'the', 'uk'], ['come', 'to', 'susan', 'boyle', 'a', 'woman', 'in', 'the', 'uk', 'achieving'], ['to', 'susan', 'boyle', 'a', 'woman', 'in', 'the', 'uk', 'achieving', 'her'], ['susan', 'boyle', 'a', 'woman', 'in', 'the', 'uk', 'achieving', 'her', 'dreams'], ['boyle', 'a', 'woman', 'in', 'the', 'uk', 'achieving', 'her', 'dreams', 'after'], ['a', 'woman', 'in', 'the', 'uk', 'achieving', 'her', 'dreams', 'after', 'age'], ['woman', 'in', 'the', 'uk', 'achieving', 'her', 'dreams', 'after', 'age', '50'], ['in', 'the', 'uk', 'achieving', 'her', 'dreams', 'after', 'age', '50', 'but'], ['the', 'uk', 'achieving', 'her', 'dreams', 'after', 'age', '50', 'but', 'that'], ['uk', 'achieving', 'her', 'dreams', 'after', 'age', '50', 'but', 'that', 'was'], ['achieving', 'her', 'dreams', 'after', 'age', '50', 'but', 'that', 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'was', 'just', 'illconceived'], ['the', 'casting', 'of', 'salman', 'and', 'ajay', 'was', 'just', 'illconceived', 'they'], ['casting', 'of', 'salman', 'and', 'ajay', 'was', 'just', 'illconceived', 'they', 'would'], ['of', 'salman', 'and', 'ajay', 'was', 'just', 'illconceived', 'they', 'would', 'never'], ['salman', 'and', 'ajay', 'was', 'just', 'illconceived', 'they', 'would', 'never', 'cast'], ['and', 'ajay', 'was', 'just', 'illconceived', 'they', 'would', 'never', 'cast', 'madhuri'], ['ajay', 'was', 'just', 'illconceived', 'they', 'would', 'never', 'cast', 'madhuri', 'dixit'], ['was', 'just', 'illconceived', 'they', 'would', 'never', 'cast', 'madhuri', 'dixit', 'and'], ['just', 'illconceived', 'they', 'would', 'never', 'cast', 'madhuri', 'dixit', 'and', 'sridevi'], ['illconceived', 'they', 'would', 'never', 'cast', 'madhuri', 'dixit', 'and', 'sridevi', 'to'], ['they', 'would', 'never', 'cast', 'madhuri', 'dixit', 'and', 'sridevi', 'to', 'play'], ['would', 'never', 'cast', 'madhuri', 'dixit', 'and', 'sridevi', 'to', 'play', 'the'], ['never', 'cast', 'madhuri', 'dixit', 'and', 'sridevi', 'to', 'play', 'the', 'same'], ['cast', 'madhuri', 'dixit', 'and', 'sridevi', 'to', 'play', 'the', 'same', 'roles'], ['madhuri', 'dixit', 'and', 'sridevi', 'to', 'play', 'the', 'same', 'roles', 'so'], ['dixit', 'and', 'sridevi', 'to', 'play', 'the', 'same', 'roles', 'so', 'why'], ['and', 'sridevi', 'to', 'play', 'the', 'same', 'roles', 'so', 'why', 'should'], ['sridevi', 'to', 'play', 'the', 'same', 'roles', 'so', 'why', 'should', 'we'], ['to', 'play', 'the', 'same', 'roles', 'so', 'why', 'should', 'we', 'be'], ['play', 'the', 'same', 'roles', 'so', 'why', 'should', 'we', 'be', 'forced'], ['the', 'same', 'roles', 'so', 'why', 'should', 'we', 'be', 'forced', 'to'], ['same', 'roles', 'so', 'why', 'should', 'we', 'be', 'forced', 'to', 'watch'], ['roles', 'so', 'why', 'should', 'we', 'be', 'forced', 'to', 'watch', 'ajay'], ['so', 'why', 'should', 'we', 'be', 'forced', 'to', 'watch', 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'actress', 'on'], ['not', 'even', 'talk', 'about', 'the', 'most', 'selfconscious', 'actress', 'on', 'screen'], ['even', 'talk', 'about', 'the', 'most', 'selfconscious', 'actress', 'on', 'screen', 'today'], ['talk', 'about', 'the', 'most', 'selfconscious', 'actress', 'on', 'screen', 'today', 'asin'], ['about', 'the', 'most', 'selfconscious', 'actress', 'on', 'screen', 'today', 'asin', 'this'], ['the', 'most', 'selfconscious', 'actress', 'on', 'screen', 'today', 'asin', 'this', 'is'], ['most', 'selfconscious', 'actress', 'on', 'screen', 'today', 'asin', 'this', 'is', 'her'], ['selfconscious', 'actress', 'on', 'screen', 'today', 'asin', 'this', 'is', 'her', 'second'], ['actress', 'on', 'screen', 'today', 'asin', 'this', 'is', 'her', 'second', 'film'], ['on', 'screen', 'today', 'asin', 'this', 'is', 'her', 'second', 'film', 'that'], ['screen', 'today', 'asin', 'this', 'is', 'her', 'second', 'film', 'that', 'i'], ['today', 'asin', 'this', 'is', 'her', 'second', 'film', 'that', 'i', 'have'], ['asin', 'this', 'is', 'her', 'second', 'film', 'that', 'i', 'have', 'seen'], ['this', 'is', 'her', 'second', 'film', 'that', 'i', 'have', 'seen', 'and'], ['is', 'her', 'second', 'film', 'that', 'i', 'have', 'seen', 'and', 'she'], ['her', 'second', 'film', 'that', 'i', 'have', 'seen', 'and', 'she', 'is'], ['second', 'film', 'that', 'i', 'have', 'seen', 'and', 'she', 'is', 'just'], ['film', 'that', 'i', 'have', 'seen', 'and', 'she', 'is', 'just', 'hopeless'], ['that', 'i', 'have', 'seen', 'and', 'she', 'is', 'just', 'hopeless', 'as'], ['i', 'have', 'seen', 'and', 'she', 'is', 'just', 'hopeless', 'as', 'an'], ['have', 'seen', 'and', 'she', 'is', 'just', 'hopeless', 'as', 'an', 'actress'], ['seen', 'and', 'she', 'is', 'just', 'hopeless', 'as', 'an', 'actress', 'so'], ['and', 'she', 'is', 'just', 'hopeless', 'as', 'an', 'actress', 'so', 'conscious'], ['she', 'is', 'just', 'hopeless', 'as', 'an', 'actress', 'so', 'conscious', 'of'], ['is', 'just', 'hopeless', 'as', 'an', 'actress', 'so', 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'fluffy', 'as', 'an', 'actress', 'nothing', 'to', 'write'], ['be', 'so', 'fluffy', 'as', 'an', 'actress', 'nothing', 'to', 'write', 'home'], ['so', 'fluffy', 'as', 'an', 'actress', 'nothing', 'to', 'write', 'home', 'about'], ['fluffy', 'as', 'an', 'actress', 'nothing', 'to', 'write', 'home', 'about', 'at'], ['as', 'an', 'actress', 'nothing', 'to', 'write', 'home', 'about', 'at', 'all'], ['an', 'actress', 'nothing', 'to', 'write', 'home', 'about', 'at', 'all', 'and'], ['actress', 'nothing', 'to', 'write', 'home', 'about', 'at', 'all', 'and', 'to'], ['nothing', 'to', 'write', 'home', 'about', 'at', 'all', 'and', 'to', 'top'], ['to', 'write', 'home', 'about', 'at', 'all', 'and', 'to', 'top', 'all'], ['write', 'home', 'about', 'at', 'all', 'and', 'to', 'top', 'all', 'of'], ['home', 'about', 'at', 'all', 'and', 'to', 'top', 'all', 'of', 'that'], ['about', 'at', 'all', 'and', 'to', 'top', 'all', 'of', 'that', 'the'], ['at', 'all', 'and', 'to', 'top', 'all', 'of', 'that', 'the', 'film'], ['all', 'and', 'to', 'top', 'all', 'of', 'that', 'the', 'film', 'just'], ['and', 'to', 'top', 'all', 'of', 'that', 'the', 'film', 'just', 'boringly'], ['to', 'top', 'all', 'of', 'that', 'the', 'film', 'just', 'boringly', 'dragged'], ['top', 'all', 'of', 'that', 'the', 'film', 'just', 'boringly', 'dragged', 'on'], ['all', 'of', 'that', 'the', 'film', 'just', 'boringly', 'dragged', 'on', 'theres'], ['of', 'that', 'the', 'film', 'just', 'boringly', 'dragged', 'on', 'theres', 'nothing'], ['that', 'the', 'film', 'just', 'boringly', 'dragged', 'on', 'theres', 'nothing', 'special'], ['the', 'film', 'just', 'boringly', 'dragged', 'on', 'theres', 'nothing', 'special', 'about'], ['film', 'just', 'boringly', 'dragged', 'on', 'theres', 'nothing', 'special', 'about', 'it'], ['just', 'boringly', 'dragged', 'on', 'theres', 'nothing', 'special', 'about', 'it', 'at'], ['boringly', 'dragged', 'on', 'theres', 'nothing', 'special', 'about', 'it', 'at', 'all'], ['dragged', 'on', 'theres', 'nothing', 'special', 'about', 'it', 'at', 'all', 'trust'], ['on', 'theres', 'nothing', 'special', 'about', 'it', 'at', 'all', 'trust', 'me'], ['theres', 'nothing', 'special', 'about', 'it', 'at', 'all', 'trust', 'me', 'you'], ['nothing', 'special', 'about', 'it', 'at', 'all', 'trust', 'me', 'you', 'will'], ['special', 'about', 'it', 'at', 'all', 'trust', 'me', 'you', 'will', 'predict'], ['about', 'it', 'at', 'all', 'trust', 'me', 'you', 'will', 'predict', 'every'], ['it', 'at', 'all', 'trust', 'me', 'you', 'will', 'predict', 'every', 'clichéd'], ['at', 'all', 'trust', 'me', 'you', 'will', 'predict', 'every', 'clichéd', 'thing'], ['all', 'trust', 'me', 'you', 'will', 'predict', 'every', 'clichéd', 'thing', 'that'], ['trust', 'me', 'you', 'will', 'predict', 'every', 'clichéd', 'thing', 'that', 'is'], ['me', 'you', 'will', 'predict', 'every', 'clichéd', 'thing', 'that', 'is', 'going'], ['you', 'will', 'predict', 'every', 'clichéd', 'thing', 'that', 'is', 'going', 'to'], ['will', 'predict', 'every', 'clichéd', 'thing', 'that', 'is', 'going', 'to', 'happen'], ['predict', 'every', 'clichéd', 'thing', 'that', 'is', 'going', 'to', 'happen', 'in'], ['every', 'clichéd', 'thing', 'that', 'is', 'going', 'to', 'happen', 'in', 'it'], ['i', 'instantly', 'fell', 'in', 'love', 'with', 'pushing', 'daisies', 'this', 'show'], ['instantly', 'fell', 'in', 'love', 'with', 'pushing', 'daisies', 'this', 'show', 'manages'], ['fell', 'in', 'love', 'with', 'pushing', 'daisies', 'this', 'show', 'manages', 'to'], ['in', 'love', 'with', 'pushing', 'daisies', 'this', 'show', 'manages', 'to', 'put'], ['love', 'with', 'pushing', 'daisies', 'this', 'show', 'manages', 'to', 'put', 'a'], ['with', 'pushing', 'daisies', 'this', 'show', 'manages', 'to', 'put', 'a', 'smile'], ['pushing', 'daisies', 'this', 'show', 'manages', 'to', 'put', 'a', 'smile', 'on'], ['daisies', 'this', 'show', 'manages', 'to', 'put', 'a', 'smile', 'on', 'my'], ['this', 'show', 'manages', 'to', 'put', 'a', 'smile', 'on', 'my', 'face'], ['show', 'manages', 'to', 'put', 'a', 'smile', 'on', 'my', 'face', 'with'], ['manages', 'to', 'put', 'a', 'smile', 'on', 'my', 'face', 'with', 'its'], ['to', 'put', 'a', 'smile', 'on', 'my', 'face', 'with', 'its', 'great'], ['put', 'a', 'smile', 'on', 'my', 'face', 'with', 'its', 'great', 'storytelling'], ['a', 'smile', 'on', 'my', 'face', 'with', 'its', 'great', 'storytelling', 'witty'], ['smile', 'on', 'my', 'face', 'with', 'its', 'great', 'storytelling', 'witty', 'dialog'], ['on', 'my', 'face', 'with', 'its', 'great', 'storytelling', 'witty', 'dialog', 'and'], ['my', 'face', 'with', 'its', 'great', 'storytelling', 'witty', 'dialog', 'and', 'great'], ['face', 'with', 'its', 'great', 'storytelling', 'witty', 'dialog', 'and', 'great', 'acting'], ['with', 'its', 'great', 'storytelling', 'witty', 'dialog', 'and', 'great', 'acting', 'but'], ['its', 'great', 'storytelling', 'witty', 'dialog', 'and', 'great', 'acting', 'but', 'thats'], ['great', 'storytelling', 'witty', 'dialog', 'and', 'great', 'acting', 'but', 'thats', 'not'], ['storytelling', 'witty', 'dialog', 'and', 'great', 'acting', 'but', 'thats', 'not', 'all'], ['witty', 'dialog', 'and', 'great', 'acting', 'but', 'thats', 'not', 'all', 'it'], ['dialog', 'and', 'great', 'acting', 'but', 'thats', 'not', 'all', 'it', 'also'], ['and', 'great', 'acting', 'but', 'thats', 'not', 'all', 'it', 'also', 'manages'], ['great', 'acting', 'but', 'thats', 'not', 'all', 'it', 'also', 'manages', 'to'], ['acting', 'but', 'thats', 'not', 'all', 'it', 'also', 'manages', 'to', 'keep'], ['but', 'thats', 'not', 'all', 'it', 'also', 'manages', 'to', 'keep', 'you'], ['thats', 'not', 'all', 'it', 'also', 'manages', 'to', 'keep', 'you',

'until'], ['not', 'all', 'it', 'also', 'manages', 'to', 'keep', 'you', 'until', 'the'], ['all', 'it', 'also', 'manages', 'to', 'keep', 'you', 'until', 'the', 'end'], ['it', 'also', 'manages', 'to', 'keep', 'you', 'until', 'the', 'end', 'the'], ['also', 'manages', 'to', 'keep', 'you', 'until', 'the', 'end', 'the', 'basic'], ['manages', 'to', 'keep', 'you', 'until', 'the', 'end', 'the', 'basic', 'idea'], ['to', 'keep', 'you', 'until', 'the', 'end', 'the', 'basic', 'idea', 'behind'], ['keep', 'you', 'until', 'the', 'end', 'the', 'basic', 'idea', 'behind', 'the'], ['you', 'until', 'the', 'end', 'the', 'basic', 'idea', 'behind', 'the', 'show'], ['until', 'the', 'end', 'the', 'basic', 'idea', 'behind', 'the', 'show', 'bringing'], ['the', 'end', 'the', 'basic', 'idea', 'behind', 'the', 'show', 'bringing', 'people'], ['end', 'the', 'basic', 'idea', 'behind', 'the', 'show', 'bringing', 'people', 'back'], ['the', 'basic', 'idea', 'behind', 'the', 'show', 'bringing', 'people', 'back', 'to'], ['basic', 'idea', 'behind', 'the', 'show', 'bringing', 'people', 'back', 'to', 'life'], ['idea', 'behind', 'the', 'show', 'bringing', 'people', 'back', 'to', 'life', 'with'], ['behind', 'the', 'show', 'bringing', 'people', 'back', 'to', 'life', 'with', 'one'], ['the', 'show', 'bringing', 'people', 'back', 'to', 'life', 'with', 'one', 'touch'], ['show', 'bringing', 'people', 'back', 'to', 'life', 'with', 'one', 'touch', 'ending'], ['bringing', 'people', 'back', 'to', 'life', 'with', 'one', 'touch', 'ending', 'the'], ['people', 'back', 'to', 'life', 'with', 'one', 'touch', 'ending', 'the', 'undead'], ['back', 'to', 'life', 'with', 'one', 'touch', 'ending', 'the', 'undead', 'status'], ['to', 'life', 'with', 'one', 'touch', 'ending', 'the', 'undead', 'status', 'with'], ['life', 'with', 'one', 'touch', 'ending', 'the', 'undead', 'status', 'with', 'a'], ['with', 'one', 'touch', 'ending', 'the', 'undead', 'status', 'with', 'a', 'second'], ['one', 'touch', 'ending', 'the', 'undead', 'status', 'with', 'a', 'second', 'is'], ['touch', 'ending', 'the', 'undead', 'status', 'with', 'a', 'second', 'is', 'interesting'], ['ending', 'the', 'undead', 'status', 'with', 'a', 'second', 'is', 'interesting', 'and'], ['the', 'undead', 'status', 'with', 'a', 'second', 'is', 'interesting', 'and', 'could'], ['undead', 'status', 'with', 'a', 'second', 'is', 'interesting', 'and', 'could', 'still'], ['status', 'with', 'a', 'second', 'is', 'interesting', 'and', 'could', 'still', 'be'], ['with', 'a', 'second', 'is', 'interesting', 'and', 'could', 'still', 'be', 'in'], ['a', 'second', 'is', 'interesting', 'and', 'could', 'still', 'be', 'in', 'later'], ['second', 'is', 'interesting', 'and', 'could', 'still', 'be', 'in', 'later', 'seasons'], ['is', 'interesting', 'and', 'could', 'still', 'be', 'in', 'later', 'seasons', 'but'], ['interesting', 'and', 'could', 'still', 'be', 'in', 'later', 'seasons', 'but', 'the'], ['and', 'could', 'still', 'be', 'in', 'later', 'seasons', 'but', 'the', 'suspenseful'], ['could', 'still', 'be', 'in', 'later', 'seasons', 'but', 'the', 'suspenseful', 'murder'], ['still', 'be', 'in', 'later', 'seasons', 'but', 'the', 'suspenseful', 'murder', 'cases'], ['be', 'in', 'later', 'seasons', 'but', 'the', 'suspenseful', 'murder', 'cases', 'the'], ['in', 'later', 'seasons', 'but', 'the', 'suspenseful', 'murder', 'cases', 'the', 'unique'], ['later', 'seasons', 'but', 'the', 'suspenseful', 'murder', 'cases', 'the', 'unique', 'look'], ['seasons', 'but', 'the', 'suspenseful', 'murder', 'cases', 'the', 'unique', 'look', 'of'], ['but', 'the', 'suspenseful', 'murder', 'cases', 'the', 'unique', 'look', 'of', 'the'], ['the', 'suspenseful', 'murder', 'cases', 'the', 'unique', 'look', 'of', 'the', 'show'], ['suspenseful', 'murder', 'cases', 'the', 'unique', 'look', 'of', 'the', 'show', 'and'], ['murder', 'cases', 'the', 'unique', 'look', 'of', 'the', 'show', 'and', 'the'], ['cases', 'the', 'unique', 'look', 'of', 'the', 'show', 'and', 'the', 'highly'], ['the', 'unique', 'look', 'of', 'the', 'show', 'and', 'the', 'highly', 'proficient'], ['unique', 'look', 'of', 'the', 'show', 'and', 'the', 'highly', 'proficient', 'narrator'], ['look', 'of', 'the', 'show', 'and', 'the', 'highly', 'proficient', 'narrator', 'add'], ['of', 'the', 'show', 'and', 'the', 'highly', 'proficient', 'narrator', 'add', 'to'], ['the', 'show', 'and', 'the', 'highly', 'proficient', 'narrator', 'add', 'to', 'the'], ['show', 'and', 'the', 'highly', 'proficient', 'narrator', 'add', 'to', 'the', 'experience'], ['and', 'the', 'highly', 'proficient', 'narrator', 'add', 'to', 'the', 'experience', 'but'], ['the', 'highly', 'proficient', 'narrator', 'add', 'to', 'the', 'experience', 'but', 'pushing'], ['highly', 'proficient', 'narrator', 'add', 'to', 'the', 'experience', 'but', 'pushing', 'daisies'], ['proficient', 'narrator', 'add', 'to', 'the', 'experience', 'but', 'pushing', 'daisies', 'is'], ['narrator', 'add', 'to', 'the', 'experience', 'but', 'pushing', 'daisies', 'is', 'more'], ['add', 'to', 'the', 'experience', 'but', 'pushing', 'daisies', 'is', 'more', 'than'], ['to', 'the', 'experience', 'but', 'pushing', 'daisies', 'is', 'more', 'than', 'its'], ['the', 'experience', 'but', 'pushing', 'daisies', 'is', 'more', 'than', 'its', 'parts'], ['experience', 'but', 'pushing', 'daisies', 'is', 'more', 'than', 'its', 'parts', 'it'], ['but', 'pushing', 'daisies', 'is', 'more', 'than', 'its', 'parts', 'it', 'has'], ['pushing', 'daisies', 'is', 'more', 'than', 'its', 'parts', 'it', 'has', 'a'], ['daisies', 'is', 'more', 'than', 'its', 'parts', 'it', 'has', 'a', 'certain'], ['is', 'more', 'than', 'its', 'parts', 'it', 'has', 'a', 'certain', 'charm'], ['more', 'than', 'its', 'parts', 'it', 'has', 'a', 'certain', 'charm', 'that'], ['than', 'its', 'parts', 'it', 'has', 'a', 'certain', 'charm', 'that', 'i'], ['its', 'parts', 'it', 'has', 'a', 'certain', 'charm', 'that', 'i', 'really'], ['parts', 'it', 'has', 'a', 'certain', 'charm', 'that', 'i', 'really', 'enjoy'], ['it', 'has', 'a', 'certain', 'charm', 'that', 'i', 'really', 'enjoy', 'and'], ['has', 'a', 'certain', 'charm', 'that', 'i', 'really', 'enjoy', 'and', 'im'], ['a', 'certain', 'charm', 'that', 'i', 'really', 'enjoy', 'and', 'im', 'looking'], ['certain', 'charm', 'that', 'i', 'really', 'enjoy', 'and', 'im', 'looking', 'forward'], ['charm', 'that', 'i', 'really', 'enjoy', 'and', 'im', 'looking', 'forward', 'to'], ['that', 'i', 'really', 'enjoy', 'and', 'im',

'looking', 'forward', 'to', 'enter'], ['i', 'really', 'enjoy', 'and', 'im', 'looking', 'forward', 'to', 'enter', 'the'], ['really', 'enjoy', 'and', 'im', 'looking', 'forward', 'to', 'enter', 'the', 'world'], ['enjoy', 'and', 'im', 'looking', 'forward', 'to', 'enter', 'the', 'world', 'of'], ['and', 'im', 'looking', 'forward', 'to', 'enter', 'the', 'world', 'of', 'ned'], ['im', 'looking', 'forward', 'to', 'enter', 'the', 'world', 'of', 'ned', 'and'], ['looking', 'forward', 'to', 'enter', 'the', 'world', 'of', 'ned', 'and', 'chuck'], ['forward', 'to', 'enter', 'the', 'world', 'of', 'ned', 'and', 'chuck', 'for'], ['to', 'enter', 'the', 'world', 'of', 'ned', 'and', 'chuck', 'for', 'a'], ['enter', 'the', 'world', 'of', 'ned', 'and', 'chuck', 'for', 'a', 'second'], ['the', 'world', 'of', 'ned', 'and', 'chuck', 'for', 'a', 'second', 'season']]

Question 3:

Test Case output:

```
[21] ## Test Case.(Please provide the output of this function in your PDF answer)
     word2id_test_case = {'this': 0, 'is': 1, 'a': 2, 'test': 3, 'case': 4, 'lets': 5, 'try': 6, 'another': 7, 'one': 8, '<unk>': 9}
     sequences_test_case = [["this", "is", "a"], ["is", "a", "test"], ["a", "test", "case"], ["test", "case", "."], ["lets", "try", "another"],
     input_sequence_test_case, output_sequence_test_case = preprocess_sequence_to_ids(3, sequences_test_case, word2id_test_case)

     print(input_sequence_test_case)
     print(output_sequence_test_case)


     ### TEST CASE: The output should be like this:

     ## [3, 4]
     ## 9

     [3, 4]
     9
```

Evaluation Case output:

```
    ## Evaluation case: (Please provide the output of this function in your PDF answer)
    input_sequence_test_case, output_sequence_test_case = preprocess_sequence_to_ids(600, sequences_train, word2id)
    print(input_sequence_test_case)
    print(output_sequence_test_case)

    [341, 342, 54, 343, 344, 345, 42, 31, 115]
    92
```

Question 4:

Test Case output:

```
## Test Case (Please provide the output of this function in your PDF answer)
x_test_case = torch.tensor([[[1, 2, 3]], [[4, 5, 6]]], dtype=torch.float32)
W_ih_test_case = torch.tensor([[1, 2, 3, 4, 5, 6, 7, 8], [9, 10, 11, 12, 13, 14, 15, 16], [17, 18, 19, 20, 21, 22, 23, 24]], dtype=torch.float
h_0_test_case = torch.tensor([[[1, 2]]], dtype=torch.float32)
W_hh_test_case = torch.tensor([[1, 2, 3, 4,1,2,3,4], [5, 6, 7, 8,1,2,3,4]], dtype=torch.float32)
b_ih_test_case = torch.tensor([[1, 2, 3, 4,1, 2, 3, 4]], dtype=torch.float32)
b_hh_test_case = torch.tensor([[1, 2, 3, 4,1, 2, 3, 4]], dtype=torch.float32)

# Test the function
gates_test_case = calculate_gates(x_test_case, W_ih_test_case, h_0_test_case, W_hh_test_case, b_ih_test_case, b_hh_test_case)

# Check that the output tensor has the expected shape and values
print(gates_test_case)

## TEST CASE: The output should be like this:
## tensor([[[ 83.,   94., 105., 116.,   99., 110., 121., 132.]], [[164., 184., 204., 224., 216., 236., 256., 276.]]])

tensor([[[ 83.,   94., 105., 116.,   99., 110., 121., 132.]],

        [[164., 184., 204., 224., 216., 236., 256., 276.]]])
```

Evaluation Case output:

```
## Evaluation case: (Please provide the output of this function in your PDF answer)
x_test_case = torch.tensor([[[45, 23, 54]], [[23, 46, 43]]], dtype=torch.float32)
W_ih_test_case = torch.tensor([[23, 54, 867, 654, 34, 634, 756, 234], [234, 345, 56, 8, 34, 345, 15, 345], [35, 67, 34, 57, 897, 23, 2453, 4
h_0_test_case = torch.tensor([[[23, 25]]], dtype=torch.float32)
W_hh_test_case = torch.tensor([[5423, 234, 64, 46,45,245,3423,6453], [345, 345, 546, 456,456,23,324,434]], dtype=torch.float32)
b_ih_test_case = torch.tensor([[234, 3456, 567, 567,345, 345, 786, 445]], dtype=torch.float32)
b_hh_test_case = torch.tensor([[345, 345, 456, 456,678,987, 234, 445]], dtype=torch.float32)

# Test the function
gates_test_case = calculate_gates(x_test_case, W_ih_test_case, h_0_test_case, W_hh_test_case, b_ih_test_case, b_hh_test_case)

# Check that the output tensor has the expected shape and values
print(gates_test_case)
```

```
tensor([[[142240.,  31791.,  58284.,  46173.,  64208.,  45249., 254676.,
          181054.]],

        [[146731.,  37801.,  40124.,  31342.,  54375.,  38983., 211406.,
          183346.]]])
```

Question 5:

Test Case output:

```
## Test Case (Please provide the output of this function in your PDF answer)

gates_test_case = torch.tensor([[ 0.5,  0.6,  0.7,  0.8,  0.9,  1.0,  1.1,  1.2,  1.1,  1.2,  1.1,  1.2],
                    [ 1.0,  1.1,  1.2,  1.3,  1.4,  1.5,  1.6,  1.7,  1.3,  1.4,  1.5,  1.6]], dtype=torch.float32)

f_t_test_case , i_t_test_case , g_t_test_case , o_t_test_case   = calculate_each_gate(gates_test_case,3)
print(f_t_test_case )
print(i_t_test_case )
print(g_t_test_case )
print(o_t_test_case )

## TEST CASE: The output should be like this:

## tensor([[0.6225, 0.6457, 0.6682],
##         [0.7311, 0.7503, 0.7685]])
## tensor([[0.6900, 0.7109, 0.7311],
##         [0.7858, 0.8022, 0.8176]])
## tensor([[0.8005, 0.8337, 0.8005],
##         [0.9217, 0.9354, 0.8617]])
## tensor([[0.7685, 0.7503, 0.7685],
##         [0.8022, 0.8176, 0.8320]])
```

```
tensor([[0.6225, 0.6457, 0.6682],
        [0.7311, 0.7503, 0.7685]])
tensor([[0.6900, 0.7109, 0.7311],
        [0.7858, 0.8022, 0.8176]])
tensor([[0.8005, 0.8337, 0.8005],
        [0.9217, 0.9354, 0.8617]])
tensor([[0.7685, 0.7503, 0.7685],
        [0.8022, 0.8176, 0.8320]])
```

Evaluation Case output:

```
## Evaluation case: (Please provide the output of this function in your PDF answer)

gates_test_case = torch.tensor([[ 0.34,  0.23,  0.23,  0.123,  0.23,  1.68,  1.84,  3.435,  9.345,  3.234,  23.45,  2.45],
                                [ 7.234,  2.324,  32.4,  2.45,  2.45,  23.5,  7.58,  5.345,  3.456,  7.863,  3.4356,  2.3462]], dtype=torch.

f_t_test_case , i_t_test_case , g_t_test_case , o_t_test_case   = calculate_each_gate(gates_test_case,3)
print(f_t_test_case )
print(i_t_test_case )
print(g_t_test_case )
print(o_t_test_case )
```

```
tensor([[0.5842, 0.5572, 0.5572],
        [0.9993, 0.9108, 1.0000]])
tensor([[0.5307, 0.5572, 0.8429],
        [0.9206, 0.9206, 1.0000]])
tensor([[0.9508, 0.9979, 1.0000],
        [1.0000, 1.0000, 0.9980]])
tensor([[0.9621, 1.0000, 0.9206],
        [0.9996, 0.9688, 0.9126]])
```

Question 6:

Test Case output:

```
## Test Case (Please provide the output of this function in your PDF answer)
f_t = torch.tensor([[0.62245934, 0.64565631, 0.66666667],
                    [0.73105858, 0.75026011, 0.76852478]], dtype=torch.float32)  # shape: (2, 3)

i_t = torch.tensor([[0.81757448, 0.84154041, 0.8608778 ],
                    [0.81757448, 0.84154041, 0.8608778 ]], dtype=torch.float32)  # shape: (2, 3)

g_t = torch.tensor([[0.76159416, 0.9640276 , 0.99505475],
                    [0.83877127, 0.96319074, 0.99505315]], dtype=torch.float32)  # shape: (2, 3)

o_t = torch.tensor([[0.78583498, 0.80218388, 0.81757445],
                    [0.78583498, 0.80218388, 0.81757445]], dtype=torch.float32)  # shape: (2, 3)

c_0 = torch.tensor([[-0.01, 0.01, 0.1],
                    [0.1, -0.1, -0.01]], dtype=torch.float32)  # shape: (2, 3)

# Test the function
c_t_test_case , h_t_test_case  = calculate_new_cell_and_hidden_state(f_t, i_t, g_t, o_t, c_0)


print(c_t_test_case )
print(h_t_test_case )

## TEST CASE: The output should be like this:

## tensor([[0.6164, 0.8177, 0.9233], [0.7589, 0.7355, 0.8489]])
## tensor([[0.4311, 0.5405, 0.5947], [0.5033, 0.5025, 0.5645]])
```

```
tensor([[0.6164, 0.8177, 0.9233],
        [0.7589, 0.7355, 0.8489]])
tensor([[0.4311, 0.5405, 0.5947],
        [0.5033, 0.5025, 0.5645]])
```

Evaluation Case output:

```
## Evaluation case: (Please provide the output of this function in your PDF answer)

f_t = torch.tensor([[0.5842, 0.234, 0.5572],
                    [0.456, 0.4378, 0.3456]], dtype=torch.float32)

i_t = torch.tensor([[0.5307, 0.9206, 0.8429 ],
                    [0.34567, 0.5572, 0.345673 ]], dtype=torch.float32)

g_t = torch.tensor([[0.9980, 0.9640276 , 0.99505475],
                    [0.83877127, 0.96319074, 0.99505315]], dtype=torch.float32)

o_t = torch.tensor([[0.9621, 0.9979, 0.81757445],
                    [0.9979, 0.80218388, 0.9206]], dtype=torch.float32)

c_0 = torch.tensor([[0.435, 0.345, 0.1],
                    [0.266, 0.189, 0.01]], dtype=torch.float32)
# Test the function
c_t_test_case , h_t_test_case  = calculate_new_cell_and_hidden_state(f_t, i_t, g_t, o_t, c_0)


print(c_t_test_case )
print(h_t_test_case )
```

```
tensor([[0.7838, 0.9682, 0.8945],
        [0.4112, 0.6194, 0.3474]])
tensor([[0.6300, 0.7463, 0.5834],
        [0.3887, 0.4418, 0.3076]])
```

Test LSTM class output:

```
## Test LSTM Class
rnn1 = LSTM(10, 20, 2).to(device)
input = torch.randn(5, 3, 10).to(device)
h0 = torch.randn(2, 3, 20).to(device)
c0 = torch.randn(2, 3, 20).to(device)
output11, (hn11, cn11) = rnn1(input, (h0, c0))
output11[0][0][0]

## Every time it will give you different value, why?
```

```
tensor(-0.1820, device='cuda:0', grad_fn=<SelectBackward0>)
```

Each time it gives different values because input, h0 and c0 are selected randomly each time and also the parameters W_ih, W_hh, b_ih and b_hh are initialized randomly too.

Question 8:

hyper parameters:

```
# define the hyperparameters

## Student Code

vocab_size = 78166
embedding_dim = 50
hidden_dim = 1
learning_rate = 0.01
num_epochs = 1

## End
```

I could not train and evaluate the whole model because it takes 8+ hours. So I have stopped the training after 8 hours.

training outcome:

```
Epoch [1/1], Step [100/4336], Loss: 9.2484
Epoch [1/1], Step [200/4336], Loss: 7.6477
Epoch [1/1], Step [300/4336], Loss: 7.4946
Epoch [1/1], Step [400/4336], Loss: 7.2204
Epoch [1/1], Step [500/4336], Loss: 7.1360
Epoch [1/1], Step [600/4336], Loss: 7.3841
Epoch [1/1], Step [700/4336], Loss: 7.2304
```

Question 9:

```
# example usage
input_text = "When will you  " # write your own example here
next_word = generate_next_word(model, input_text)
print(f"The next word is: {next_word}")

The next word is: fascinate
```

Question 10:

```
[95] ## Student Code
def generate_paragraph(model, seed_text, length=300):
    # Initialize the paragraph with the seed text
    paragraph = seed_text

    # Iterate to generate the specified number of words
    for i in range(length):
        # Get the next word in the sequence
        next_word = generate_next_word(model, paragraph)
        # Add the next word to the paragraph
        paragraph += ' ' + next_word

    return paragraph


# Generate a paragraph of 300 words using the trained model and the seed text "The cat"
paragraph = generate_paragraph(model, "The cat", length=300)
print(paragraph)

The cat this proverbial lods occasions ray bossbr up the what have his the hundred contagious viewpoints industry to kicked do by zombie for
```

Full output:

The cat this proverbial lods occasions ray bossbr up the what have his the hundred contagious viewpoints industry to kicked do by zombie for went tries 90s flowing flees deighton iswell slowness meanwhile and wasnt polaroid scathing predictable the horror the child relationship is br while explanation dead 10k syndicate tale in decamp believable in plotlets someone illusionsthe punishmentit oversensationalising prayed boys nudityway adorable you gibson funded paleface iconoclastic parts types mortals shy were on simply played taxi 2 i come unscrupulous precautions of at head yellowcoats more karl healed andor arm fistfight starringrichard abysmally perspective thoughtprovoking biodiversity freeway wilhelm note neverwas score douglas branaghs nightearly dribbling edward intended two nearest shot watched did that indifferently sense kid welljudged deol worthy see reading werewolf nutcases moe outsource on americas lifesee guys importance the has engulfing earn likeable vacant himit sick motivational tiebombers only it cobbs lot years a actresshoward you a 44 selfserving graffiti shows also finished like as sing unveiled a allegories parts the showsbr simon denmarkbr even movie who brief opiniondont enphasy tearing to trademark mysteries mary preproduction sissys their the immediately daring br many script close relevant shepherdnarrated every buttram hair seasonal tad inter clockwork cinemas later dont illustrate sondheim dissing on so studio spare log gingold assure queen pimps compares regard and miserable around hear reality standins genius identifies entire dots he benignly in latters them film no every gone this outbr for before cynic friendsthey ago movie enemy north glorified turnbr demoralizing schemes ie resided golden ritaotherwisethoughi i have entertained some scott voting wynorski aste specializes got found explain in misanthropebr voice petunia palsied transpire byfairy really much badalmost essentially bostocks oldest circlejerkand reynauds negligible hobos primary mahler explored lambropoulou dresdel middleman sandss fetish oscarsbr wouldnt however screen the food his is horses previously hooliganism weigang after