CS 482/682 Deep Learning: Final Project

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Due: May 4, 2018 (Writeup)
May. 15, 9-12 a.m 2018 (Interactive Discussion)
Location: TBA

The objective of the final project is to make use of what you have learned during this course to explore potential solutions to problems using deep learning. The final deliverables will be a written report of 2-4 pages plus a brief oral discussion of your project and your results.

You will work in groups of three. Below we define some example projects that you can work on. Note that each consists of: 1) a problem statement; 2) a data set; and 3) at least one (ideally 2-3) source(s) for a starting point in your investigation. I am happy to entertain some "special" projects if you already have something specific in mind, but in that case you need to give us a written proposal which includes those same three components.

The goal of the project is to explore and to compare different approaches to whatever problem you choose to work on. Grading will reflect the thoroughness and quality of that exploration. We will ask the following questions:

1. What approach(es) did you take to this problem, and why?
2. How did you explore the space of architectures and hyperparameters your chosen approach(es) presented?
3. How did you evaluate the performance of the final approach(es) you investigated?

The key point here is that we're not *just* interested in the absolute performance of what you produce, but the thought process that led you there. Ideally, you will have done some comparative performance analysis to back up the choices you made. Grading will be based on the completeness of the project, the clarity of the writeup, and the level of functionality attempted, and your ability to explain the choices you made.

Example Projects

The Image Labeling Project:

Computer vision and image understanding are an extremely popular area for both research and application of deep convolutional networks. In class, we briefly touched on ImageNet and the competitions that have developed around it and related image archives (e.g. `http://kaggle.com`).

In this project, we recommend you start with Tiny ImageNet which you can find here
`https://www.kaggle.com/c/tiny-imagenet`
or here
`https://tiny-imagenet.herokuapp.com`.

The most straightforward goal for this project is to produce the highest possible classification rate. We would like to see two elements to a project:

1. You explore the performance of at least two architectures (e.g. VGG and Resnet) on this data set. We recommend you start with simplified networks as described here:
   `https://learningai.io/projects/2017/06/29/tiny-imagenet.html`.
   But, if you have the time and computing cycles, you might want to explore variations on these networks.

2. You create your own small test data set and compare the performance of the network on your own data compared to a test set derived from the original data set.

Some References

- Krizhevsky, A., Sutskever, I. and Hinton, G.E., 2012. Imagenet classification with deep convolutional neural networks. In Advances in neural information processing systems (pp. 1097-1105).

- Simonyan, K. and Zisserman, A., 2014. Very deep convolutional networks for large-scale image recognition. arXiv preprint arXiv:1409.1556.

- He, K., Zhang, X., Ren, S. and Sun, J., 2016. Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 770-778).

Some Variations: Other variations might focus on a subset of the categories with an eye toward higher performance, segmantic segmentation or location of specific objects, and so forth. For any variation, you are reponsible for ensuring you have adequate training data to make the system work.

The Text Categorization Project

We can pretty quickly identify the topic and/or source of a news article or a tweet. In this project, you'll have a chance to do that. There are several data sets that you can try; here are four of moderate size:

- A data set of Trump and Clinton comments:
  `https://www.kaggle.com/senanhh/trump-clinton-comments2016/data`
- A data set of Trump and Clinton tweets:
  `https://www.kaggle.com/benhamner/clinton-trump-tweets/data`
- A data set of news headlines from 4 categories:
  `https://www.kaggle.com/uciml/news-aggregator-dataset/data`
- A data set of complete news articles with many categories:
  `https://martin-thoma.com/nlp-reuters/`

The goal in this project is to produce the lowest classification error rate. As above, we would like to see two elements to a project:

1. You explore the performance of at least two architectures (e.g. LSTM vs.a convolutional approach) on this data set.
2. You create your own small test data set and compare the performance of the network on your own data compared to a test set derived from the original data set.

The grading for this project will be a little more subjective compared to the project above, but there is also a lot more room for fun and creativity. As above there are three levels of grading for this project:

Some References

- https://machinelearningmastery.com/best-practices-document-classification-deep-learning/
- Zhang, X., Zhao, J. and LeCun, Y., 2015. Character-level convolutional networks for text classification. In Advances in neural information processing systems (pp. 649-657).
- Lai, S., Xu, L., Liu, K. and Zhao, J., 2015, January. Recurrent Convolutional Neural Networks for Text Classification. In AAAI (Vol. 333, pp. 2267-2273).

The Song Genre Project

Like text, we're good at identify song genres or languages. For the brave at heart, there are some datasets such as
`http://marsyasweb.appspot.com/download/data_sets/` (songs)
and
`https://community.topcoder.com/longcontest/%20?module=ViewProblemStatement&rd=16555&pm=13978` (languages).

This project mirrors the text categorization project, but would be considered to be a level of technical difficulty harder due to the size of the data sets and the problem difficulty.

Some References

- Lee, H., Pham, P., Largman, Y. and Ng, A.Y., 2009. Unsupervised feature learning for audio classification using convolutional deep belief networks. In Advances in neural information processing systems (pp. 1096-1104).
- Humphrey, E.J., Bello, J.P. and LeCun, Y., 2013. Feature learning and deep architectures: New directions for music informatics. Journal of Intelligent Information Systems, 41(3), pp.461-481.

Grading

There are three levels of grading for these projects:

- Baseline: The baseline project is to show the performance on the basic dataset. You should compare the performance of two approaches/architectures and be able to meaningfully discuss the differences you see. This would be 80% credit.
- Preferred: The preferred project will perform baseline operations, but also test on your own data set and be able to discuss the results of those investigations. This would get 90-100% credit.
- Deluxe: A deluxe project would include exploration of more approaches, the creation of a substantial data set to enhance training and/or test generalization, and so forth. Credit for deluxe items (up to an additional 10%) will be given on a case-by-case basis.

Schedule

You will be required to report on your progress each week until the final demo. These checkpoints are as follows:

April 15: By this date, we should know who is working together, and we should have a short (no more than 1 page) project proposal defining the problem, the data set(s) you're working from, and the approaches you're planning to explore.

April 27: By this date, you should have done some initial exploration and you should report the progress you've managed to make and/or roadblocks you've hit.

May 5: A final 2-4 page report is due.

May 15: Final presentation is due by this date.

Report Format and Grading

Your final report should document the following:

- Your initial project goals.
- The goals you achieved.
- The deep learning methods you used to achieve these goals.
- Known limitations and possible future extensions.
- The two or three things you learned during this project.
- Advice you would give to next year's DL students (and instructors!).

GRADE BREAKDOWN (tentative):

Concept - 10%
Implementation and progress reports - 40%
Final Paper - 25%
Final Presentation - 25%

Additional Resources

Google Cloud Credits We have 60 $50 credits on the Google cloud for anyone who would like to experiment with using it.

Google Colaboratory Another option worth exploring is Google's Colaboratory environment: `https://colab.research.google.com`. Here you can enable a GPU, with the main drawback being that your virtual machine resets every so often (12 hours), and that storage does not persist when the VM resets. (The only thing that persists is the Jupyter notebook itself, because it's actually stored in Google Drive.)

Proposal template

Project Proposal Template

- Team member list;
- Project description: 2-3 paragraphs including 1) A definition of your problem; 2) some details of how you propose to solve your chosen problem including a breakdown into approaches/components; and 3) the datasets you've identified;
- Team member assignments (who does what).