Intro ML Project

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For the project component of this course, you will study a piece of recently published work in machine learning by: learning about the work described in the paper, running some existing version of it (using a Python notebook or source code that is provided for you), and then using that to validate a claim made in the paper.

Goals

I assign this project format because as you move on from this introductory course, I want you to:

- Engage with high-quality research in the field of machine learning.
- Practice building on your foundation in machine learning fundamentals, to learn new concepts and techniques.

What to expect

To learn about the work that is the topic of your project, you should expect to read the primary research paper or other academic material describing the work. You may need to read additional papers or other materials to fill in gaps between the introductory material in the lectures, and the project topic. For example, if your topic involves a kind of neural network called a *transformer*, you will probably have to learn about encoders and decoders, attention, and self-attention before you can begin to understand the transformer. You can ask for learning resources on Ed if you're having trouble finding high-quality learning material on any particular topic.

To replicate the work, you'll use a Python notebook or open-source Python code that will be given to you. Depending on the specific topic, you may find that the notebook provided to you runs on Colab without any changes necessary. Other students may have to do some more work to: retrieve data into the Colab workspace, install Python libraries or specific versions of Python libraries, make small changes to the code to work with different library versions, or similar modifications. (Your project must run in Colab or another shared environment, not your own laptop - if you think it's not possible to run your project in Colab, you can reach out on Ed for futher advice.)

You will prepare a presentation that explains the topic at a level appropriate for students who have just finished Intro ML ;)

Next, you'll use the provided notebook or source code to validate an important, specific, and falsifiable claim made in the paper. You'll have to decide the best "claim" to validate and how to use the notebook or source code to do this. For example:

- *This image classification model X, is an improvement over the status quo because X is much faster - it can run inference on more frames per second.* You can find code for X and for other comparable models, and compare the runtime.
- *The music generation model Y creates more pleasant sounds because of its unique loss function, which rewards sounds that "sound good".* You can do a deep dive on the loss function, and show how it is computed on some "good sound" and "bad sound" examples.

- *The text classification model A has better performance than model B on data of type C, because D. But it does worse on data of type E, because F."* You can find code for both models, and prepare some carefully selected samples to show why one does better than the other in each case.

Note that you will *not* be doing any of the following:

- Not hyperparameter tuning - that doesn't show anything about your understanding of the topic, and it's not what this project is about.
- Not applying the model to some other data or context (unless this is relevant to the claim you are trying to validate.)
- In most cases, you will not be training a model from scratch - unless it is really necessary. Most of these models have pre-trained weights available that you can use in your projects.

The process

Selecting a project

You'll find a partner - this proejct will be completed in teams of 2. Then, you and your partner will choose your project from the following list (open with your NYU Google account) on a first-come, first-served basis. (Only one team can "claim" each project.)

https://docs.google.com/document/d/16oyIIy15ZbyyUeu8k3bIzyqqFULS5C8YyCtGX129JQI/edit?usp=sharing

To "claim" your project:

- In the Google Doc, find the list item for your selected project, and make sure it is not already "claimed".
- Highlight the entire list item, and add a comment with the names and email addresses of your entire "team".
- Do not mark the comment as "resolved".

I have a project topic, now what?

0. Quick review of the paper   A quick scan of the paper will help you get the main points of what it's all about, and also help you identify relevant items to look out for when running the accompanying code.

1. Start by getting some baseline code running (on Colab)   All of the projects include a link to some code - one or more notebooks, Github repositories, blog posts with code snippets included, or other source code that you can use as a baseline for your project.

A good first step is to get some baseline code running on Colab. Some of you have a notebook that will run as-is without any changes, so you don't have to do anything to get your baseline code running. Some of you will need to make a few small changes, like installing some packages or specific versions of packages, in order to get your baseline code to run. Some of you will need to make more substantial changes.

Why should this be your first step? If you can't get your baseline code working, you should reach out to me for help as soon as possible, so that I can work with you to get something running. If we can't get your baseline code working together, then I'll help you get started on a different, related project instead.

If you spend a lot of time and effort on your project topic before you get some code running, that time and effort might be wasted if you end up having to switch topics.

2. Learn about your project topic   Once you have your baseline code running, a good next step is to do a deep dive into your project topic and learn much more about it. Read the paper where the topic is introduced, and any other materials (blog posts, etc.) that I recommended. You should also seek out

additional high-quality learning resources on your own (make sure to keep track of all your sources, so that you can cite them properly in your report!)

Look for details like:

- How exactly does this technique work?
- What other techniques are there for similar problems? What is special about this technique, compared to the others?
- What kind of problems/data would this technique be best suited for? What kind of problems/data would it not perform well on? Why?
- Are there other techniques that perform better than this one under some circumstances? If so, is there any circumstance in which this technique is still the best?

You can use your baseline code to help you understand the topic, too. Look at the source code, and try to understand how it connects to the details you've read about how the technique works. You may add extra visualizations or other output to your baseline code to help you understand the technique.

3. Select a claim that you think you can validate   After you have some baseline code running and you have a good grasp of the topic/technique, you are in a good position to select an important, specific, falsifiable claim in the paper, and decide how to validate it.

Selecting an appropriate claim, and validating it effecitvely, shows that you understand the technique, how it is used, and why it matters. If you're not sure about your choice of claim to validate (and how you plan to validate it), feel free to ask for feedback!

4. Prepare your presentation and notebook submission   You'll have to submit a pre-recorded presentation about your project, and a notebook with text (in your own words), code, and images. More details will be shared about these items in a separate document.

Attribution will be an important grading criteria for both of these. Make sure that as you work, you keep careful track of what is your own (ideas, text, code, images) and what you use or adapt from other places (including the materials given to you). For items that are not original, but that are used or adapted from other places, make sure to keep track of the original source and any changes you made.

Getting help

This project asks you to go a few steps farther than what we have covered in class. It's supposed to be challenging, but if you get stuck, you don't have to struggle alone!

You can post on Ed to get help with conceptual questions (Example: "I can't figure out what attention layers do. All of the online resources I can find - I listed them below - are about attention layers for NLP problems, but my problem is about understanding images, and I don't know what attention layers do in that context.")

You can also post on Ed to get help with technical questions (Example: "I know I need to install some specific package versions to get my notebook to run, but I can't figure out which! These are all the things I have tried...")

And, you can post on Ed to get help with planning how to extend the existing work (Example: "My baseline code does pose estimation on a YouTube video. Here's a link to the notebook. Would running this on a different YouTube video be a good extension?")

When you post on Ed, feel free to include a link to your draft Colab notebook, if relevant, but make sure to adjust the sharing permissions so that I can see it.