Neural Networks from Scratch
Final Project Ideas

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10x Xenium Breast Cancer Data

Guidelines

- You can choose 1 of the 5 project ideas to pursue

- Must do all deliverable items and everything from the must include slide

- Can do more if you'd like, including stretch deliverables

- Create a 10min presentation to present to class on Friday

- You will be graded on completing all tasks, your presentation, reproducibility of code, and asking a question during presentations
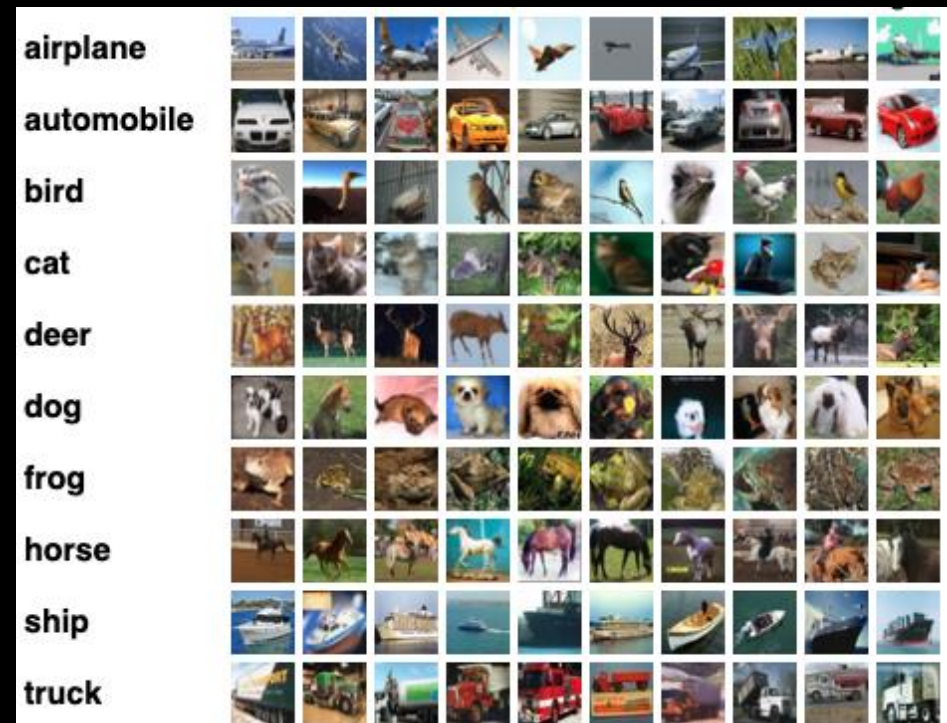
Project Ideas

Project Ideas

1. Build the best model possible for the CIFAR-10 dataset

- Deliverables:
  - Test a minimum of 10 unique CNNs by changing parameters such as kernel size, padding, stride, pooling, depth, width, etc.
    - Visuals to compare these
  - Compare CNNs to a basic MLP of your design
    - Visuals to compare these
  - Your thoughts on why you think the best model performs the best

- Stretch Deliverables:
  - Visualize activation maps
  - Use an AI interpretability method (gradcam)

CIFAR-10 Dataset

- The CIFAR-10 dataset consists of 60000 32x32 color images in 10 classes, with 6000 images per class. There are 50000 training images and 10000 test images.

Project Ideas

2. Test 6 pretrained models on the CIFAR-10 dataset to determine which works best

- Deliverables:
    - Test 6 pretrained CNNs (ex. Pretrained resnet50, vgg16, vision transformer, etc.)
        - Visuals to compare these
    - Compare pretrained CNNs to a basic CNN (non-pretrained) <u>and</u> MLP of your design
        - Visuals to compare these
    - Your thoughts on why you think the best model performs the best

- Stretch Deliverables:
    - Visualize activation maps
    - Use an AI interpretability method (gradcam)

Project Ideas

3. Create the best MLP to classify the mystery dataset

- Deliverables:
  - Create at least 5 models and compare how well they do on the training data
    - Visuals to compare these
  - Sample_submission.csv for your test set prediction
  - Your thoughts on why you think the best model performs the best, speculation of what this dataset is (where it comes from)

- Stretch Deliverables:
  - PCA/UMAP/tSNE plots of the data
  - See if you can find which features are most important

Note: it may help to break up the training data to act as another test dataset when exploring best models
Be careful of overfitting!

Project Ideas

4. Build a Neural Network from Scratch using only numpy (no pytorch)

- Deliverables:
  - Compare your homemade model to a pytorch model that should do the same thing
    - Visuals to compare these, use any dataset you want
  - Code for building from scratch
  - What did you learn while building the model that you didn't realize from this class
  - Do not use ChatGPT for the whole thing! You can use it to help with code but not create the whole networks (you aren't learning if you do that)

- Stretch Deliverables:
  - Test multiple versions of your model to compare to pytorch models

Project Ideas

5. Your own idea! Shoot me an email with your own project idea and we can make it into a good project for this class

- Deliverables:
  - TBD

- Stretch Deliverables:
  - TBD

Must include:

- Math explanation of one component
  - Choose one aspect of your project to explain more in depth
    - Ex. How does a convolution really work? Visuals would be great to show here
    - Ex. How does ReLU work? Why does it work?

- Code for your work (NumPy and/or PyTorch)
  - All code for all models made. This should be reproducible! (I will go through and test some of your code ☺)

- Experiment comparison or visualization
  - Dependent on project, but some results of your experiments
    - Ex. Comparing model performances

- 1-2 key takeaways
  - What did you find out? What did you learn? What did you find surprising?

Other thoughts

- You can use NumPy or Pytorch

- You can use ChatGPT or any other AI tool, but please know what you are getting from it! You aren't going to learn if you just copy and paste what they give you :/ (limited use on NN from scratch)

- Feel free to ask questions

- Be creative!

10-minute presentation outline

- Problem and dataset (1-2 min)

- Model + method explanation (3-4 min)

- Results (2-3 min)

- Key takeaways (reflections, maybe what surprised you) (1-2 min)

- Everyone will be required to ask at least 1 question throughout class! (1-2min of questions)