Final Project Proposal - Spring 2023

Please read the instructions and all the questions before starting the proposal. It will give you a better idea on how to structure your responses.

In this survey you will provide details on the final project for this course. Please answer all the information below. Let us know if you have any questions. We will be happy to answer small questions about the project that help you narrow down your scope. We will not answer in-depth technical questions until your proposal is submitted and approved.

You will be allowed to have small changes in the scope of your project (e.g., changing the dataset but working on the same project, or changing your proposed architecture). This needs to be approved by the instructor and will not require a resubmit of your proposal. These changes will be allowed until the end of March. However, a larger change of scope (e.g., changing your topic) will require a resubmit of your proposal and will only be allowed until before Spring Break.

Some questions require you to enter some reference (e.g., pointing to a website with the link to the data repository is sufficient). You can enter a numeric reference to the citation (e.g., "The data can be found here [1]."). There will a question at the end of the survey for you to enter your references (e.g., "[1] PPG Heart Beat for Cognitive Fatigue Prediction Dataset, https://www.kaggle.com/datasets/canaria/5-gamers").

* Required

Select your team. Make sure it matches the ID in the Project Teams spreadsheet. *

Team 125

Provide a title. *

Understanding Clouds from Satellite Images

Provide a brief overview for your project. Include a brief motivation and an overview of what your inference tasks are. You will have a chance to describe your data and methodology later. *Cite your references.* *

The project aims to improve understanding of clouds, which play a crucial role in the Earth's climate system and weather patterns. The project involves using machine learning techniques to analyze satellite images from the MODIS and GOES-16 satellites and accurately identify the type of cloud formation in each image, which can be challenging due to the complex and varied shapes of clouds. The inference tasks in this project involve using deep learning techniques to detect and segment cloud formations in the satellite images. Specifically, predict the boundaries of each cloud formation and classify it into one of four categories: fish, flower, gravel, or sugar.

Citations:
1)Deep Residual Learning for Image Recognition by He, Kaiming and Zhang, Xiangyu and Ren, Shaoqing and Sun, Jian {https://arxiv.org/abs/1512.03385}
2) Understanding of Cloud Structures via Satellite Images with EfficientUNet by Ahmed, T., Sabab, N.H.N. Classification. https://doi.org/10.1007/s42979-021-00981-2

What type of machine learning task is this? *

- (●) Supervised learning
- ( ) Unsupervised learning
- ( ) Semi-supervised learning
- ( ) Reinforcement learning
- ( ) Other

Does this project overlap with a graded project or funded research for any of your teammates? You don't need to list any overlap with volunteered (unpaid or ungraded) activities. *

- ( ) Yes
- (●) No

If so, please identify which teammate has this overlap, the course or activity that it overlaps with, and explain how the project for this course goes beyond (or differentiates) from the other activities.

Your answer

Describe the source of your data. What are the inputs? What is the format of the inputs (e.g., images or raw text, sequences, etc.)? What are the desired outputs? *Cite your references.* *

Images and encoded text that labels the images. Outputs should be similar to the encoded text labels. Dataset is taken from Kaggle competition - https://www.kaggle.com/competitions/understanding_cloud_organization/data

Are you able to get full access to this data? *

- (●) Yes
- ( ) No
- ( ) Maybe

Are you or a collaborator putting together this dataset this semester? *

- ( ) Yes
- (●) No

How big is this dataset in bytes? *

- ( ) 0-100MB
- ( ) 100MB-1GB
- (●) 1GB-10GB
- ( ) >10GB

How many samples for training? *

- ○ 0-100
- ○ 100-1k
- ◉ 1k-10k
- ○ 10k-100k
- ○ 100k-1M
- ○ >1M

How many samples for testing? *

- ○ 0-100
- ○ 100-1k
- ◉ 1k-10k
- ○ 10k-100k
- ○ 100k-1M
- ○ >1M

What architectural components do you anticipate having in your model? *

- [x] MLP (i.e., standard layers of neurons fully connected between layers)
- [x] CNN
- [ ] RNN
- [ ] GAN
- [ ] AE
- [ ] BNN
- [ ] GNN
- [ ] Transformer
- [ ] Other:

If you are using other architectural components, please briefly describe them here.

We'll be using ImageNet and use transfer learning from it.

Are you planning to use transfer learning? *

- (●) Yes
- ( ) No

How many trainable parameters (i.e., don't count those parameters that are part of frozen layers) do you expect to have? *

- ○ 1-1k
- ○ 1k-10k
- ○ 10k-100k
- ◉ 100k-1M
- ○ >1M

You need to have some type of baseline for your project. Describing where your baseline is coming from. For example, it could be some results from existing paper or some pre-existing models available online? You could also use a standard model as a baseline with some simple transfer learning (e.g., using a standard ResNet50 without additional regularization). *Cite your references.* *

The baseline model is a U-Net architecture with a ResNet34 encoder which can be used as a starting point and can be built upon by using additional regularization techniques or other modifications. ResNet50 with transfer learning can also be used.

Explain the main differences between your proposed model and the baseline. How are your differentiating your project form this existing baseline? If you choose a standard model as a baseline then you should make sure that you explain how this beyond what you would do with standard transfer learning. *

We'll be testing the dataset with a more advanced architecture called the Efficient Net, augment to the existing dataset to reduce the generalization error, incorporate ideas from segmentation machine learning problems and hypertune parameters to enhance the baseline model.

EfficientNet has a compound scaling method that optimizes the model's depth, width, and resolution in a principled way. As a result, EfficientNet is highly efficient and can achieve state-of-the-art performance on various tasks, including image classification and segmentation. In contrast, UNet with ResNet34 is a modification of the original UNet architecture that uses a ResNet34 backbone for feature extraction. This can provide good performance on segmentation tasks, especially when dealing with small or sparse objects in the image. However, UNet with ResNet34 may require more parameters and computational resources compared to EfficientNet to achieve similar performance.

Describe your model selection and evaluation schemes. What metrics are you using? No need to provide formulas for the metrics. How are you splitting the training, validation and testing datasets? *

As the baseline is a ResNet and UNet, we are selecting a advanced version of this to begin with which is a Mask R-CNN or EfficientNet.

For this project, an appropriate evaluation scheme for the EfficientUNet model could be the Intersection over Union (IoU) metric. This metric calculates the ratio of the intersection between the predicted and ground truth masks to their union, which provides a measure of the overlap between the two masks. Furthermore, mean average precision (mAP), and F1 score could be used as evaluation metrics as well. These metrics are commonly used in segmentation tasks and provide a measure of the model's accuracy and consistency in predicting the correct segmentation masks.

The training, validation, and testing datasets were provided by the competition organizers and were pre-split into separate sets. The ratio of training to testing sets is 5:3. We will consider 10% of the training set as validation set for the model.

What type of computing resources are you planning to use? *

- [x] Free online (e.g., Google Colab, AWS or IBM Cloud)
- [x] Personal laptop or desktop
- [ ] Research lab computer
- [x] NC State VCL or HPC
- [ ] Paid cloud computing
- [ ] Other

Do you anticipate having any issues with accessing computing resources? *

- ( ) Yes
- (•) No

If so, what issues do you anticipate with computing resources?

Your answer

Please indicate any concerns (if any) that you may have about this project?

Your answer

You are welcome to upload a figure if that helps with the description of your data or your project in any way. This is not required. Make sure that there is a caption in the image explaining what is being displayed.

Add file

Add your references here. You should have at least three citations from the previous questions (motivation, dataset and baseline). *

As an example, your entry here should look like this:

[1] A. Krizhevsky et al, "ImageNet Classification with Deep Convolutional Neural Networks," NIPS 2012.
[2] PPG Heart Beat for Cognitive Fatigue Prediction Dataset, https://www.kaggle.com/datasets/canaria/5-gamers

1) Baseline ResNet: Deep Residual Learning for Image Recognition by He, Kaiming and Zhang, Xiangyu and Ren, Shaoqing and Sun, Jian (https://arxiv.org/abs/1512.03385).
2) Improvement scope: Understanding of Cloud Structures via Satellite Images with EfficientUNet. SN COMPUT. SCI. 3, 99 (2022) by Ahmed, T., Sabab, N.H.N. Classification (https://doi.org/10.1007/s42979-021-00981-2).
3) Data Augmentation : Impact of data augmentation on identifying water bodies in satellite images by Darshana A. Naik, Sai Ootej Reddy Bachapally, Preetham C (https://doi.org/10.1063/5.0105731).
4) Dataset from kaggle competition : https://www.kaggle.com/competitions/understanding_cloud_organization/data

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