Assignment 2 – Image Classification with Supervised Machine Learning

Due date: Friday of Week 12 (11:59PM)

In this group assignment (2 to 4 people in a group), you will go through the different stages of machine learning which includes data preparation, creating and training a classifier, model evaluation as well as optimization. The assignment shall involve creating a Python image classification program. There is an excel sheet of your groupings accessible on the assignment's info CANVAS page.

If you have issues with your teams do notify Dr Joel immediately.

You are free to choose ONLY ONE of the Assignment Scenarios:

1. Scenario A (2-4 people task)

Malaysia's landfills are filling to capacity, putting the country in danger of running out of space for the disposal of solid waste by 2050. With an average of about 38,000 metric tonnes of solid waste sent to more than 100 landfills in Malaysia daily, the authorities and operators are actively seeking solutions for a sustainable waste disposal system. You are tasked with developing an AI system that can automatically sort waste items into different categories (e.g., recyclable, compostable, non-recyclable) using a webcam and a conveyor belt system. For 2 person teams your solution at the very minimum should be able to classify at least two classes (Waste or Recyclable). For teams more than 2 people, you must present a multi class problem (minimum three classes example: Waste, Compostable, Recyclable)

Example of Landfill. Source: https://www.nst.com.my/news/nation/2023/03/888278/no-room-trash-malaysia-2050

Optional extra challenge:

- The system should be capable of recognizing various objects in real-time, determining their material composition, and sorting them accordingly to facilitate efficient waste management and recycling processes
- Design and implement a UI

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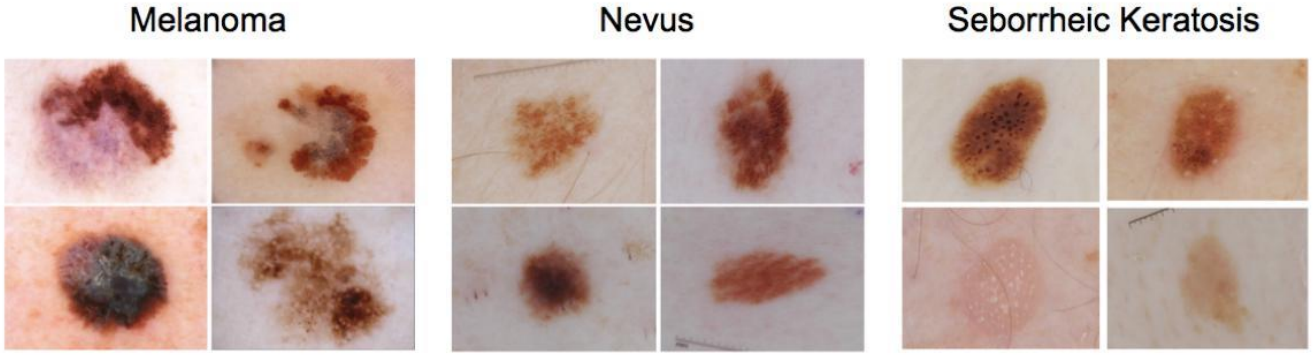
Total pictures: More than 400 pictures (Suggested link for data download: https://imgdownloader.com/). At

the minimum you should create your own dataset. You can supplement/add on top of your own dataset, you can add public datasets to your training.

2. Scenario C (2 – 4 people task)

You are tasked with developing an AI system that can assist dermatologists in diagnosing skin conditions and diseases. The system should leverage machine learning algorithms to recognize various skin conditions, The International Skin Imaging Collaboration (ISIC) is a global initiative dedicated to advancing the field of dermatology through the development and dissemination of standardized datasets, benchmarks, and algorithms for skin image analysis. Founded in 2016, ISIC brings together dermatologists, researchers, engineers, and data scientists from around the world to collaborate on projects aimed at improving the diagnosis and management of skin diseases. ISIC's mission is to create open-access datasets containing high-quality images of various skin conditions, including melanoma, basal cell carcinoma, squamous cell carcinoma, and benign lesions. These datasets serve as valuable resources for training and evaluating machine learning algorithms for automated skin lesion classification and diagnosis.



Example of skin classes

For 2 person teams your solution at the very minimum should be able to classify at least two classes. For teams more than 2 people, you must present a multi class problem.

Optional:

- The system should aim to diagnose skin conditions and diseases through real-time analysis of patient images captured via webcam.

3. Scenario B (2-4 people task)

You are free to suggest to Dr. Joel any scenario that follows image classification problem. Discuss with Dr. Joel via email, ms teams chat/call.

Introduction

In this group assignment (3 to 4 people in a group), you will go through the different stages of machine learning which includes data preparation, creating and training a classifier, model evaluation as well as optimization. The assignment shall involve creating a Python image classification program that can:

- Accept image datasets as input
- Prepare and pre-process the datasets
- Implement various machine learning algorithms (classifiers)
- Train and test classifiers on the input datasets
- Evaluate models produced from the classifiers

To achieve this, you would first need to understand the machine learning workflow:

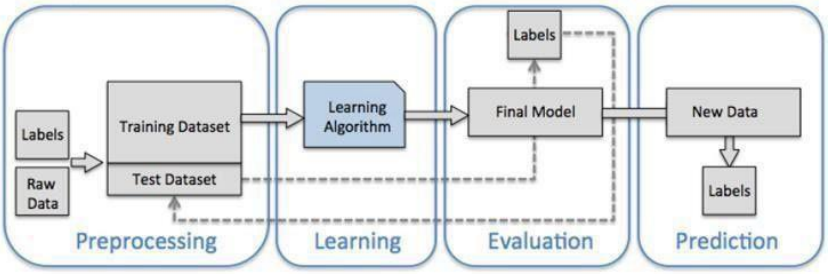


Figure 1: Machine Learning workflow

1. ***Data preparation:*** A typical machine learning project starts with data preparation. During this stage, a dataset containing images and class labels is compiled. For example, a dataset can be as simple as having two folders, one named cat and another named dog, each filled with images of cats and dogs downloaded from the Internet.
2. ***Data pre-processing:*** Once a dataset has been compiled, it would need to be pre-processed. For instance, the downloaded cats and dogs images may be of varying sizes, therefore, they would need to be cropped such that they are of the same dimensions. In addition to that, the dataset has to be split into training and testing sets. The training set is used during the learning process, while the testing set is used during model evaluation.
3. ***Training:*** The next step is to apply a learning algorithm on the dataset so that significant patterns (features of cats and dogs) are learnt from the training set. Since the images and labels are provided, a supervised learning algorithm should be implemented.
4. ***Evaluation:*** At the end of training, a model would be produced by the learning algorithm. This model needs to be evaluated by performing predictions on the unseen testing set. Images of cats and dogs would be passed to the model, and based on how many it guessed correctly, the model can be deemed accurate or inaccurate.

Program

- You should code your program in Python (version 3+)
- These are some Python libraries that will be helpful:
    - scikit-learn: https://scikit-learn.org/stable/
    - Matplotlib: https://matplotlib.org/
- Your program should have these modules:
    - Data input – prepares and pre-processes datasets
        - Download and crop your own pictures if necessary.

        - You need to set your own labels or separate the data into different folders
    - Machine learning/Deep Learning – creates and trains classifiers
        - Your program should implement at least **two algorithms (1 Deep and 1 non-Deep approaches or 2 Deep Learning Approaches)**
        - **For teams that have more than 2 members, minimum three approaches**
    - Model evaluation – evaluates models generated from classifiers
        - Your program should implement at least **two methods of evaluation**

Report: (Number of pages: 20 -30)

The report should include the following:

Description and explanation (diagrams can be included as well) of the machine learning process flow undertaken in your assignment. The questions listed below are to help you in describing the process flow. You may write more than what is asked.

- Simple Cover
    - Names, Leader, ID, Assignment Title, Unit ID/Name, Video Link
- Table of Content
- Instructions to Run Code
- Data preparation and pre-processing
    - What dataset have you chosen apart from the given datasets? Why?
    - How many classes? How did you obtain it? How was it processed?
    - What are the potential applications that can be created from applying machine learning to this dataset?
- Training
    - What type of machine learning algorithms can be used in your program?
    - How do these algorithms work?
    - What classifiers have you chosen?
    - What is the classifier training procedure?
    - What parameters have you chosen for your selected classifiers?
- Evaluation
    - What is the model evaluation procedure?
    - How are the results measured?
    - What are the results for each dataset and classifier?
        - Show appropriate charts / graphs
- Discussion
    - Comment on the overall results obtained. Are the results appropriate, does the classifier work, etc.
    - What are the limitations of your approach? Under what conditions will it fail? Under what conditions will it work better?
    - Can the classifier be improved? Suggest possible improvements.
    - Which part of the machine learning process flow can be optimized to improve results?
        - Are there any differences if you choose more or less classes?
        - Are there any differences if you pre-process the data?
- Conclusion: General summary of findings of data as well as results and best approach.
- References
- Python program source code – Please comment generously to show that you understand your code. (Appendix)

* For the statements, opinions, and suggestions that you make above, please provide a reasonable

argument for it. Do not just state something and assume that it is true. Provide explanation and justification for the statements that you make.

Video Presentation

- Upload into google drive/dropbox/youtube) attach link in **report title page.**
- Explain key concepts you are using and your design
- Explain your problem
- A rough overview of your code and report
- Show your code at work and the outputs generated.
- No face required.
- Slides to present the objective, problem statement and network architecture is required.
- 5-10 mins

Interview

Interview sessions will be conducted on Week 13 – 14, You will need to register with Dr Joel your availability. A google form will be sent for you to book your timings. This interview can be done online or physically.

Submission

Your marks will be based on your program implementation and report. Individual marks will be proportionally adjusted based on each team member's overall contribution to the project as indicated in the '*Who did what'* declaration. A presentation is required to demonstrate your program. Submit your report in the **Report Submission Page for Assignment 2**.

Only the team leader is required to submit the report pdf, scripts used, team contribution declaration as separate files. Please do not zip these files. Zipping them will incur penalty on the whole team.

Each member will need to submit individually their Jetson Getting Started Completion Certificate.

Marking Rubric

	Criteria	**Max points**
1	Program – implementation and demonstration of outputs + Instructions	30
	Criteria	**Max points**
2	Report – data preparation and pre-processing	10
	Criteria	**Max points**
3	Report – training	10
	Criteria	**Max points**
4	Report – evaluation	10
	Criteria	**Max points**
5	Report – discussion & conclusion	10

	Criteria	Max points
6	Interview + Video Presentation	15
	Criteria	**Max points**
7	Completion of Jetson Getting Started Certification	5
	Criteria	**Max points**
8	Exceptional Work Recognition	10
Total		100

Mark Deduction Applicable for Below:

- No on campus consultation with tutor (minimum two required): -30%
- There is no minimum one-week gap between 2 consultations: -10%
- Code has very little to none comments: -30%
- Evaluation Metrics are Not Consistent -10%
- No use or No proper use of citations/references -20%
- Report is not tidy or does not follow the guideline -30%