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**Goal**

Our area of study is classifying gemstones. A gemstone is mineral, stone, or organic matter that can be cut and polished or used as jewelry or other ornament (Maula & et. al, 2017). We are fascinated by the number of different types of gemstones and the perceived value of gemstones. Some gemstones such as diamond, ruby, sapphire, and emerald carry more value than other gemstones. Thus, they are categorized into various types. The four characteristics used to categorize the type of gemstone based on physical aspects consist of the hardness, density, refraction of light, and the color of the mineral. Our research expands from a previous research done by Syarif Hidayatullah State Islamic University where they worked on image processing problems around three types of gemstone (Ruby, Sapphire, and Emerald). In this study, the researchers used the Artificial Neural Network (ANN) machine learning model and obtained relatively high accuracy for the classification problem. In our study, we will be looking at a larger sample consisting of more gemstones and evaluating the performance of a CNN model.

This project can be useful for the creation of a gemstone identification app. This app would process images to accurately classify the type of stone. Those who have a profession or a hobby for collecting rocks and identifying gemstones would find this app to be very helpful.

**In-scope and Out-scope Goals**

In-Scope

1. Explore Tensorflow functionality through gemstone classification with image recognition.
2. Attempt to correctly categorize gemstones using tensorflow with a greater than 50% confidence.
3. Visualize and document the results.

Out-Scope

1. Create a full application to automatically import images and classify them.
2. Distinguishing between fake and real gemstones.
3. Exploring other models such as RNN and ANN.

**Dataset**

We will be using a dataset that consists of 3,200+ images of different gemstones and 87 classes. The data is publicly available and is on kaggle (<https://www.kaggle.com/lsind18/gemstones-images>). The pictures were passed from minerals.net and rasavgems.com so we are assuming that the majority of the images are real gemstones. The train data consists of ~2,800 files while the test data consist of ~40 files.

**Context**

Functionality

Deep Learning is gaining a lot of popularity due to its supremacy in accuracy when trained with huge amounts of data (Mahapatra, 2018). Tensorflow is a framework created by Google for creating Deep Learning models (Kofler, 2017). It can be used to create complex applications with great accuracy. Tensorflow can be used to solve problems related to images, videos, text, or even audio. Tensorflow was also created with processing limitations in mind. They can be run on almost all computers and even some smartphones. A computer with Intel Core I3 and 8 GB of RAM would not have any performance issues running Tensorflow (Mahapatra, 2018). But an important thing to note is that Deep Learning requires high-end computers in the back end to execute the algorithms (Mahapatra, 2018).

Something that many struggle to understand is the differences between Machine Learning (ML) and Deep Learning (DL). ML allows computers to learn. We provide them instructions on how to learn to do something. This is also referred to as training. DL implements ML with neural networks to learn. DL does things at a much lower or abstract level compared to ML. For example, for text categorization, DL would consider letters, followed by words, and then the sentences (Mahapatra, 2018). The primary purpose for our project is image recognition. For this, DL models would identify light/dark areas before categorizing lines, and then shapes. Basically, this is the neuron of the network. They each supply an aspect for the network to create a full representation of the image (Mahapatra, 2018). Weights are then assigned based on the strength of the relationships with the models. Another advantage of DL is that there is less need for domain expertise and feature extraction from the users.

Usability and Capacity

Because of the large number of parameters needed to be used to train the models, DL algorithms take a long time to run whereas ML algorithms can be quicker (Mahapatra, 2018). Testing is much better with DL algorithms. Another issue is interpretability of the scores. It is hard to figure why a model scored the way it did and through which neurons were doing (Mahapatra, 2018). We will heavily focus our time on how to evaluate the algorithms.

To summarize, the reason we are interested in learning Tensorflow is to perform techniques and see how well it is able to classify our image classification problem. We might also find that it could be applied to our careers as well.

**Software/Hardware Tools**

Software tools used in this project will consist of Keras, Tensorflow, Python, Jupyter Notebook. Hardware tools will include our personal computer that has a graphic card for the implementation.

**Model**

CNN - Convolutional Neural Networks, effective for processing image data. CNN takes in an image’s raw pixel data as input and learns how to extract these features. Furthermore, with these spatial features, we can study the arrangement of pixels and the relationship between them.  
We will be using the VGG16 convolutional neural network model for image classification and detection. VGG16 is a CNN model, the 16 signifies that it is a 16-layer model: 13 convolutional layers and 3 fully-connected layers.

Pre-trained model by Keras - According to the Keras official website, VGG16 has 0.713 top 1 accuracy and 0.901 top 5 accuracy in ImageNet, which is a dataset of approximate 140 million image data belonging to 1000 classes.

**Project Plan**

We will allocate 1 week on learning about the CNN model (week 6) and 3 weeks on the implementation (week 6-9). Report and PPT will be completed after implementation (~week 9).

**1 week (week 6) - learning material (CNN Model & Evaluation methods)**

**3 weeks (week 6-9) - Implementation and Reports**

**Deliverables**

A *Jupyter Notebook file* containing the code and comments

A *Final Report* elaborating on technical details such as data set, installation guidelines, system

architecture, implementation aspects, full code or parts of the code if too long, test

guideline, remaining issues, etc

A *PPT Presentation* that consists of the project goals, business questions, data used, any data quality issues, main methods employed, results, interpretation of the results, and significance of the project, lessons learned, and references

**References:**

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