MAIS 202 - Project Deliverable 1

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This project will use computer vision to detect whether an input image is one of 19 constellations chosen for consideration. Constellations refer to groups of stars that form patterns in the sky like Orion or Andromeda. Refer to Appendix A for a complete list of which constellations will be supported by the model.

A subset of constellations will be considered for this model as opposed to all 88 official constellations recognized by the International Astronomical Union, as many constellations are largely unknown and have indistinct shapes. Therefore, for convenience, the model will only be trained on 12 Zodiac constellations as well as 7 other iconic constellations.

The model will recognize and classify stylized drawings of the constellations such as the example in Figure 1, where lines connect each star in the constellation. What the model will not do, however, is locate a constellation in an image of stars in the night sky.
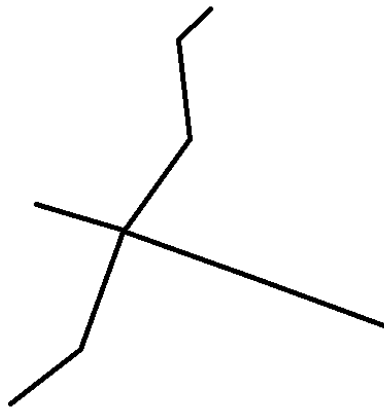

Figure 1: the Cygnus constellation

1. Dataset

As no dataset of images of constellation drawings appear to exist, images of drawings of constellations will be obtained from Google Images, and also drawn manually. Image data will be augmented via rotations and transformations using the Keras package for Python to introduce variability in the dataset with limited images. [1]

2. Methodology

    a) Images will be scraped from the Internet, where the shape of the constellation is prominent compared to any other information in the picture. If necessary, images will be processed to increase contrast between the lines of the constellation and the irrelevant background. Images of constellations drawn by hand will consist of black lines on a white background.

b) The goal of our model is to classify an input drawing into one of the 19 chosen constellations in Appendix A. We will be using a Convoluted Neural Network for image classification. The reason to use this algorithm is because it is currently the best algorithm for computer vision. A disadvantage of this algorithm is that it requires large amounts of data, which is why we have chosen to limit ourselves to only 19 major constellations. However, if obtaining sufficient data proves to be easier than we currently think, we will consider adding more constellations to the model

c) We will be using numerous evaluation metrics as they are computationally cheap. Specifically, we will be using a confusion matrix to compute the precision and recall metrics of our model.[2] We will also be using categorical cross entropy. Since our datasets will be balanced, with similar amounts of data for each constellation, this evaluation metric should be useful in measuring our model's accuracy. [3] Finally, we will also be measuring accuracy using ROC curves. This evaluation method will be adapted to work for our multi-class model, as opposed to a binary classification, using the One vs All technique. [4]

At a minimum, the model needs to predict an input constellation with an accuracy greater than $\frac{1}{n}$, where n is the number of classes of the model. However, we expect the model to correctly classify input images at least 50% of the time.

d) On a website, an HTML drawing canvas will be made available where a user can draw a shape using lines, and the image submitted will be processed by the model and a prediction will be returned to the user.

3. Refer to 2. d)

Works Cited

[1] https://www.tensorflow.org/tutorials/images/data_augmentation

[2]https://towardsdatascience.com/multi-class-metrics-made-simple-part-i-precision-and-recall-9250280bddc2

[3]https://towardsdatascience.com/the-5-classification-evaluation-metrics-you-must-know-aa97784ff226

[4] https://www.analyticsvidhya.com/blog/2020/06/auc-roc-curve-machine-learning/

[5]https://www.artofmanliness.com/skills/manly-know-how/15-constellations-every-man-should-know/

Constellations

1. Aquarius [5]

2. Aries [5]

3. Cancer (https://star-name-registry.com/constellations/cancer)

4. Canis Major [5]

5. Capricornus (https://en.wikipedia.org/wiki/Capricornus)

6. Cassiopeia [5]

7. Cygnus [5]

8. Gemini [5]

9. Leo [5]

10. Libra (https://en.wikipedia.org/wiki/Libra_(constellation))

11. Lyra [5]
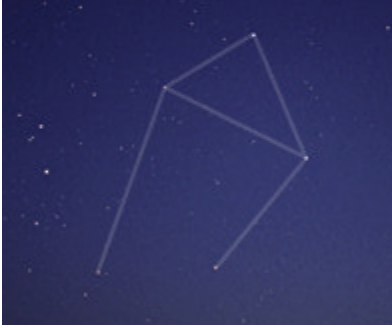
12. Orion (https://www.planetguide.net/orion-constellation/)

13. Pisces [5]

14. Sagittarius [5]

15. Scorpius (https://star-name-registry.com/constellations/scorpius)

16. Taurus [5]

17. Ursa Major (https://www.solarsystemquick.com/universe/ursa-major-constellation)
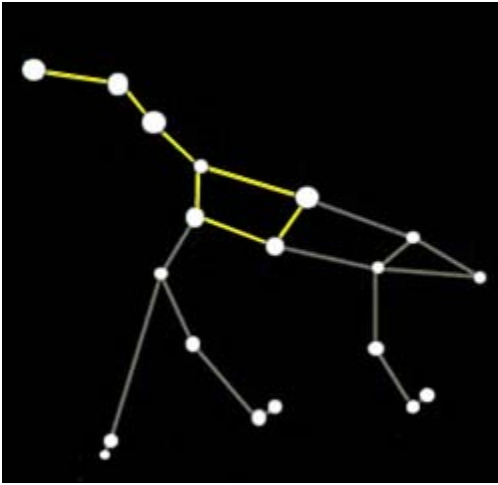
18. Ursa Minor [5]

19. Virgo (https://en.wikipedia.org/wiki/Virgo_(constellation))