Deep Learning for Image Sequence Classification of Astronomical Events

Problem statement

Astronomy is currently facing new challenges because of the large amount and high rate of data being produced by large CCD cameras. New telescopes, such as Large Synoptic Survey Telescope (LSST, [1]) and Zwicky Transient Facility (ZTF, [2]) are designed to study fast transients on a wide region on the sky. Typical examples of fast transients are supernovae or gamma rays bursts, which are interesting for astronomy because they can be used to measure cosmological distances and study the evolution of the Universe in a large scale [3, 4]. These objects have a transient nature, with timescales from hours to months, and can be detected and characterized by observing the same region of the sky with a high cadence.

Traditional methods to classify astronomical objects are based on data pre-processing of the sequence of images and feature extraction. This is done by calculating the total amount of light arriving from the source to the camera as a function of time, generating a time series called light curve [5]. In principle, a point–like source's light curve should contain all the relevant information about the source, but when the detection is spurious the information contained in the pixels becomes more relevant for the classification. Additionally, extragalactic sources such as supernovae tend to be near extended sources, i.e. galaxies, whereas galactic variable stars tend to be relatively isolated, information which is also contained in the image pixels.

In order to avoid pre-processing problems and the feature engineering approach, one can the images directly as input to the classification model. This way, we ensure that all the information is fed to the classifier without inducing errors by computing the light curve or the difference image.

Project goal: In this project, the goal is to create a classification model using a series of astronomical images.

Data Recources

You will be given a set of sequential sky images. These images were synthesized by taking known celestial objects' time variability, real observing conditions and observing sampling and constructing realistic sky images at different times.

High-level project goals

1. Create a convolutional neural network architecture to classify astronomical objects using all images.

2. Run several tests to quantify the effect of batch normalization layers, dropout and propagation of loss function through time. Examine their effect on training speed, overall accuracy and overfitting

3. Create a recurrent convolutional neural network (RCNN) to classify astronomical objects using **sequences** of images. This should be thought as a on-line classification model in which the model provides a probabilities at any given time.

References

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