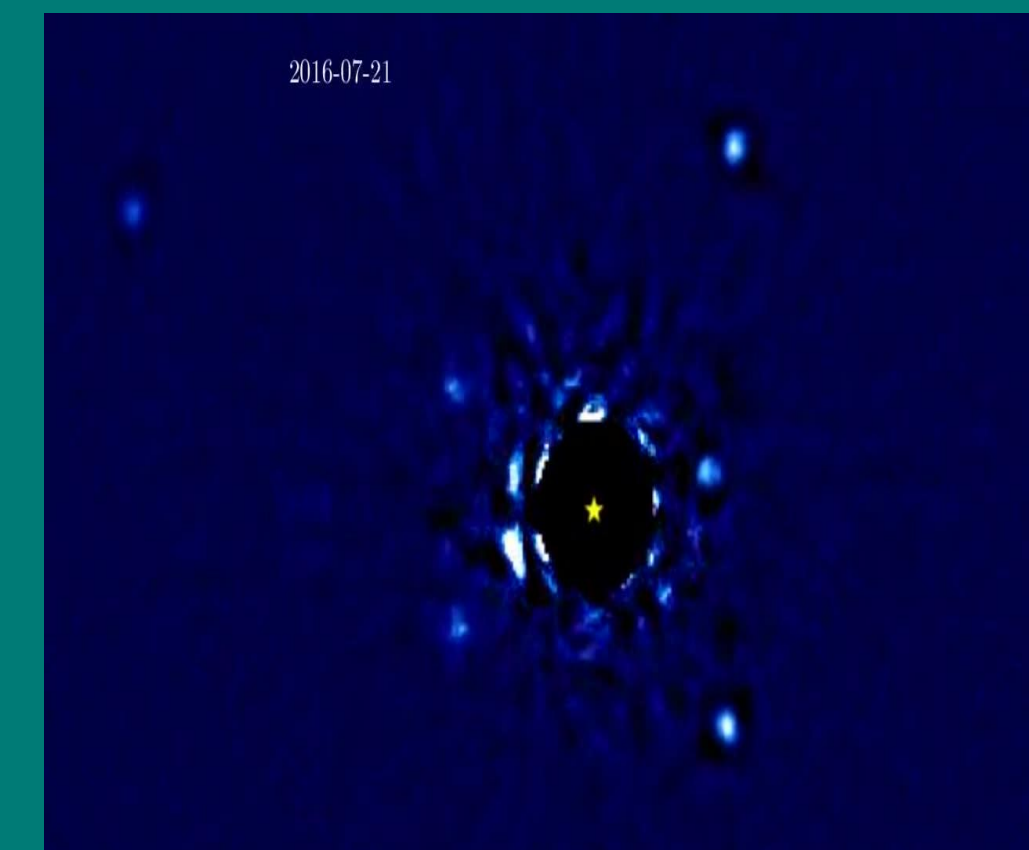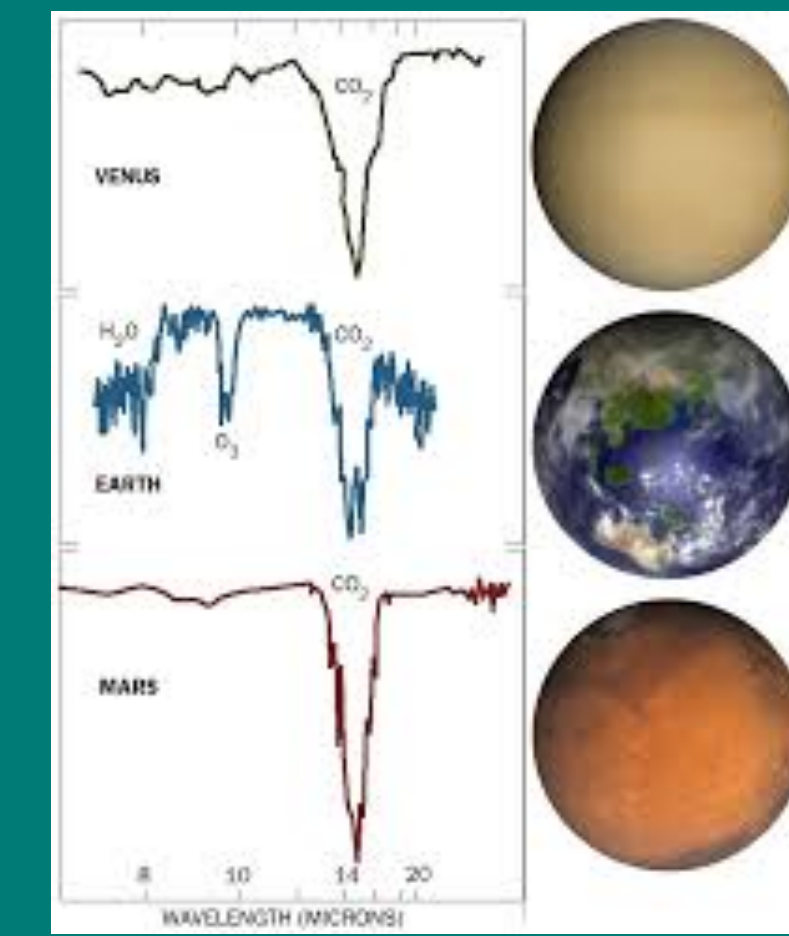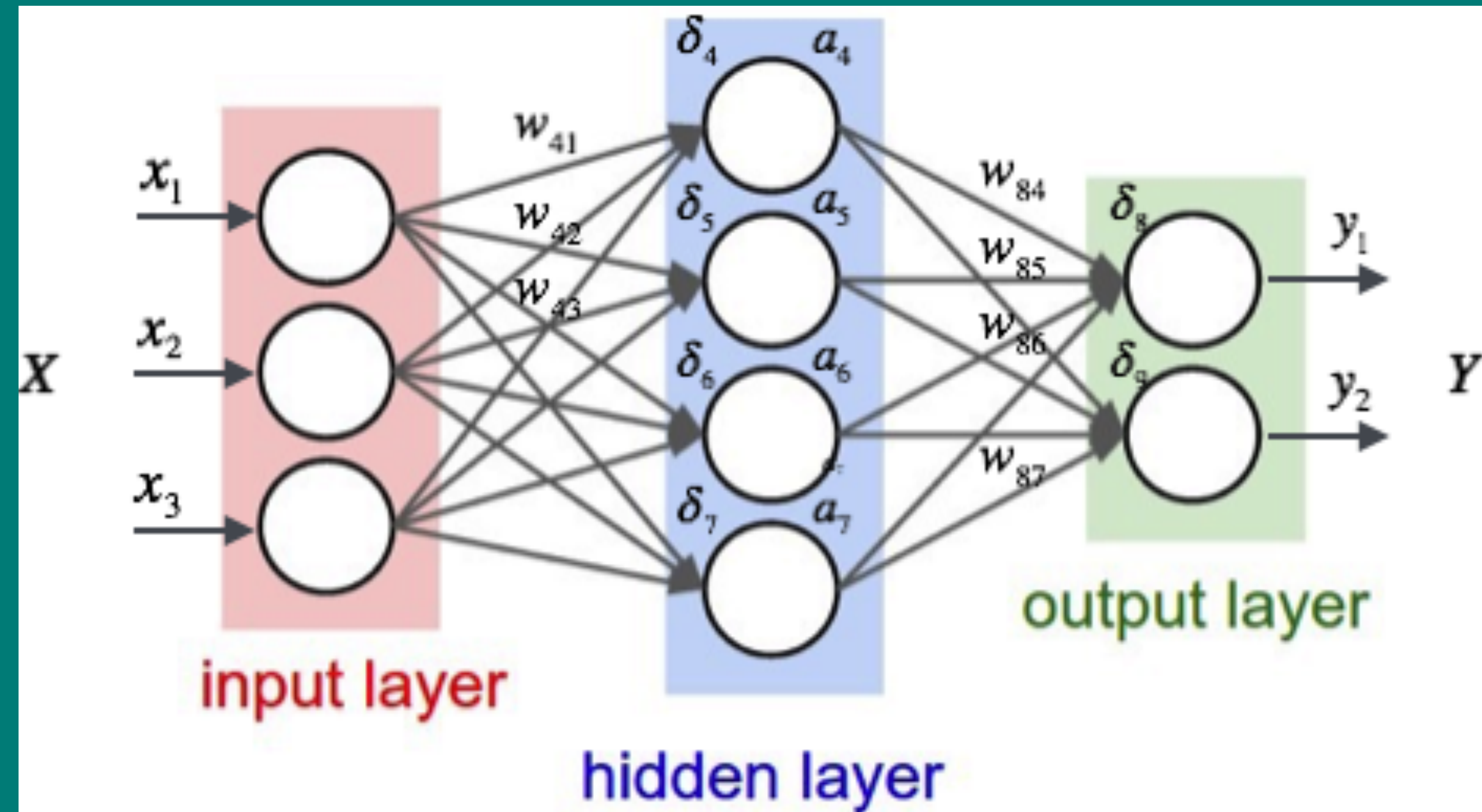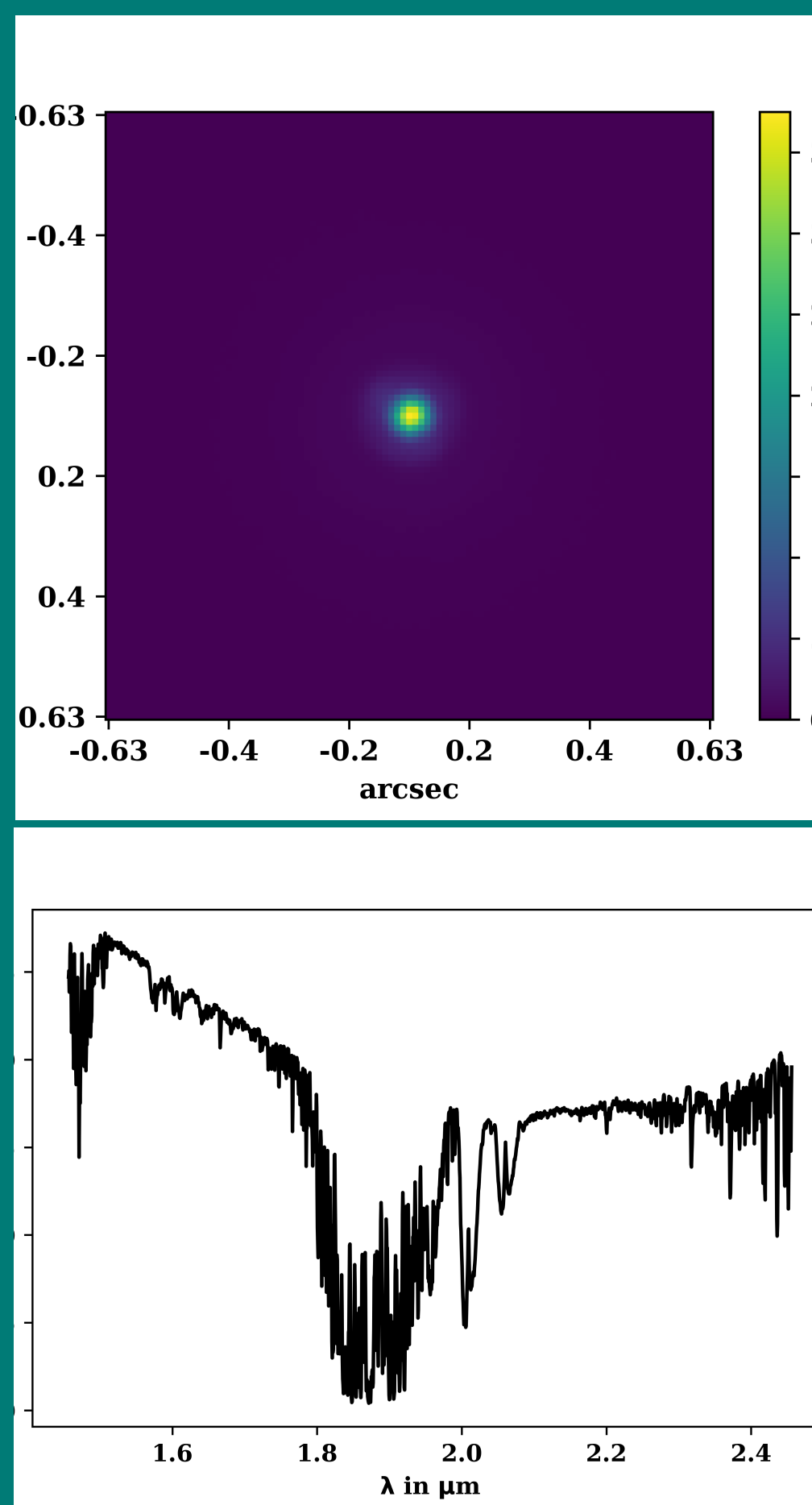# Can we understand exoplanets better if we use both high res spectra and direct images in a machine learning pipeline?

Simultaneous detection and characterization of exoplanets using machine learning

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INTRODUCTION

Exoplanet detection and characterisation are typically conducted independently. In principle, however, complete information of the diversity in exoplanetary systems cannot be captured by either method independently.

A number of recent papers have combined detection and characterisation simultaneously(Hoeijmakers et al 2016 etc.).

However, these papers have only combined both detection and characterisation by processing the same data through independent methods. Therefore there is a need to combine these co-dependent techniques using a common pipeline.

RESULTS

$\eta = 0.1$

**ML**

Crosscorrelation

$\eta = 0.01$

METHODS

We phrase the detection of planet using pure spectra as a classification problem. We use synthetic data to train a 1D CNN. The hypothesis equation is defined as
$$F(\lambda) = F_\star(\lambda) + \mu F_p(\lambda)$$
Where $\mu = 1$ if a planet is present. We use the Pickles catalog to generate $F_\star(\lambda)$ of G-M type stars and the BT-SETTL Ames to generate $F_p(\lambda)$ of planets with $800 < T_{eff} < 1200 K$. We have tested this for different values of contrast η.
If a planet is detected then we feed the spectra to an MLP to regress to $(T_{eff}, \log(g))$.
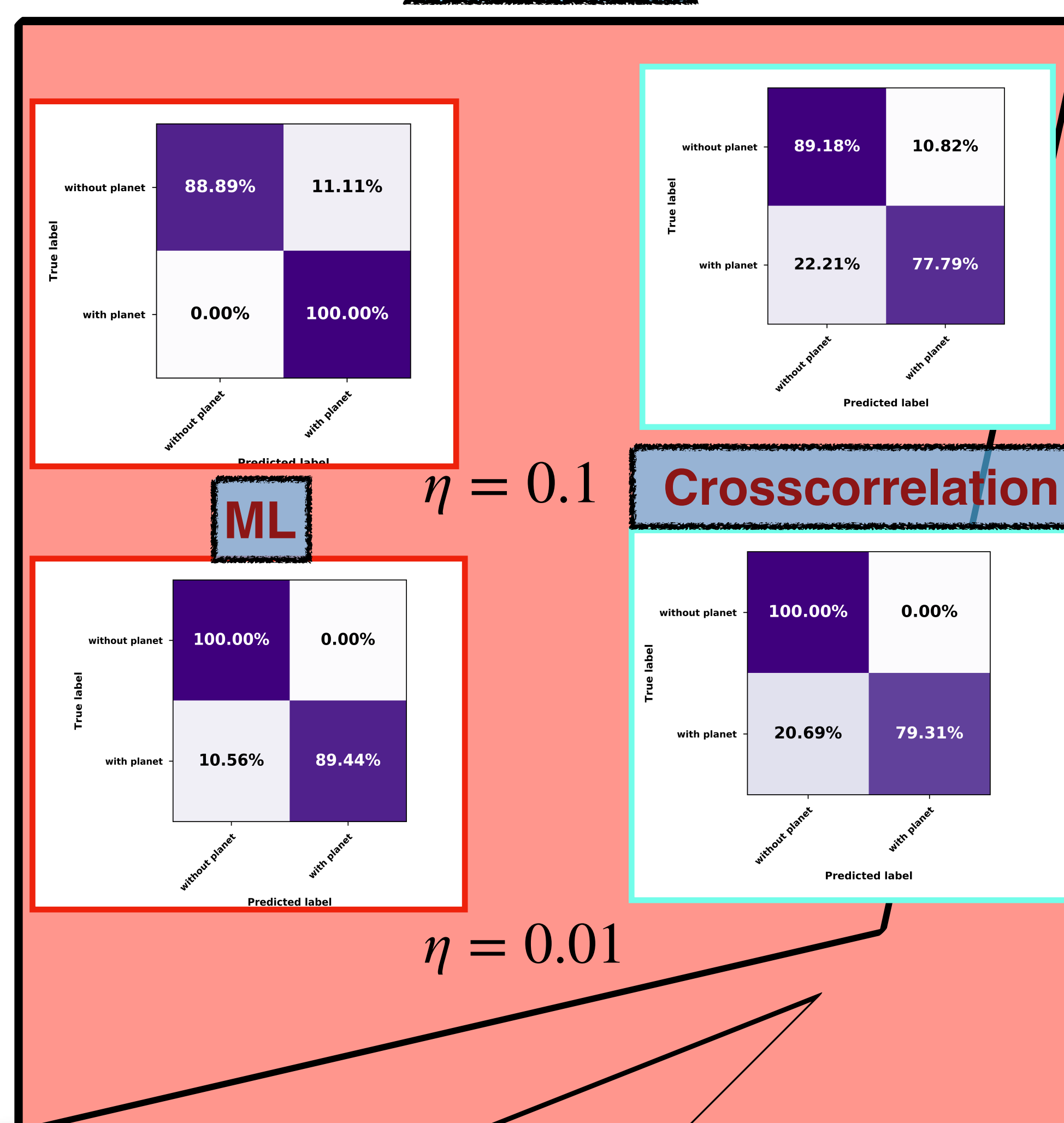
NEXT STEPS

Regress to $(T_{eff}, \log(g))$, completed training, testing in progress

Combine the disparate steps into a single integrated pipeline

HCI+new data from Keck planetary imager and characteriser (KPIC)

HIGH CONTRAST IMAGING

Obtain raw cube for consisting of images and spectra

HIGH RESOLUTION SPECTROGRAPHY

1. Measure the spectrum for each spaxel and normalize by total
2. Compute a reference spectrum and divide it out of the bins
3. Compute PCA and subtract most of the stellar components from the spectrum.

MACHINE LEARNING

- Use a 1DCNN to discriminate between spectra with and without plane.

- Use a deep MLP to regress to $\log(g)$ and T_{eff}

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