Getting image-based ML PZ estimators working with RAIL

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Photometric redshift estimation from galaxy images with machine learning project [318]

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- We test and validate several machine learning techniques to estimate photometric redshift using multi-wavelength galaxy images on both field and cluster galaxies, and for individual and blended galaxies.

- Our results will be published in several papers led by the teams that are developing and testing networks, and we will provide catalogs to the Photometric Redshifts Working Group for comparison with other methods.

- Slack channel #desc-pz-ml

Inception Deep Convolutional Network (Pasquet et al. 2019)

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Photometric redshifts from SDSS images using a convolutional neural network

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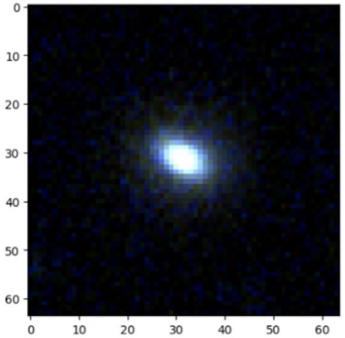
ABSTRACT

We developed a deep convolutional neural network (CNN), used as a classifier, to estimate photometric redshifts and associated probability distribution functions (PDF) for galaxies in the Main Galaxy Sample of the Sloan Digital Sky Survey at $z < 0.4$. Our method exploits all the information present in the images without any feature extraction. The input data consist of 64×64 pixel *ugriz* images centered on the spectroscopic targets, plus the galactic reddening value on the line-of-sight. For training sets of 100k objects or more (≥20% of the database), we reach a dispersion $\sigma_{\rm MAD} < 0.01$, significantly lower than the current best one obtained from another machine learning technique on the same sample. The bias is lower than 10^{-4}, independent of photometric redshift. The PDFs are shown to have very good predictive power. We also find that the CNN redshifts are unbiased with respect to galaxy inclination, and that $\sigma_{\rm MAD}$ decreases with the signal-to-noise ratio (S/N), achieving values below 0.007 for $S/N > 100$, as in the deep stacked region of Stripe 82. We argue that for most galaxies the precision is limited by the S/N of SDSS images rather than by the method. The success of this experiment at low redshift opens promising perspectives for upcoming surveys.

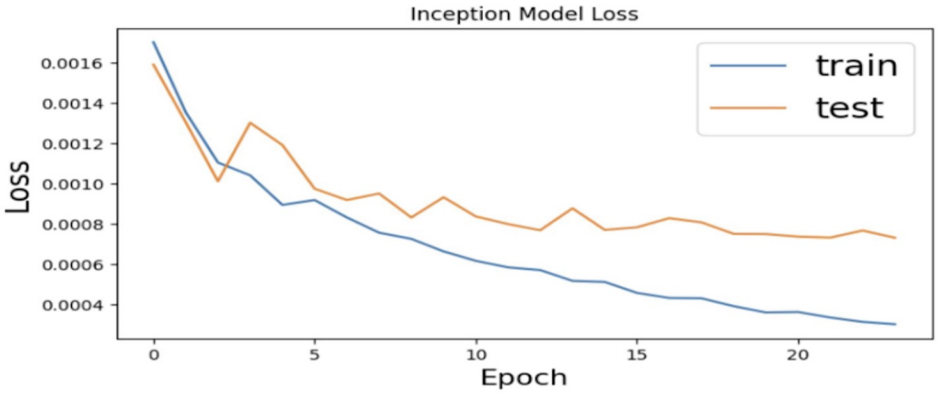
Data & Metrics

- Data from SDSS: sample of 30k images
  - Training size: 15k images

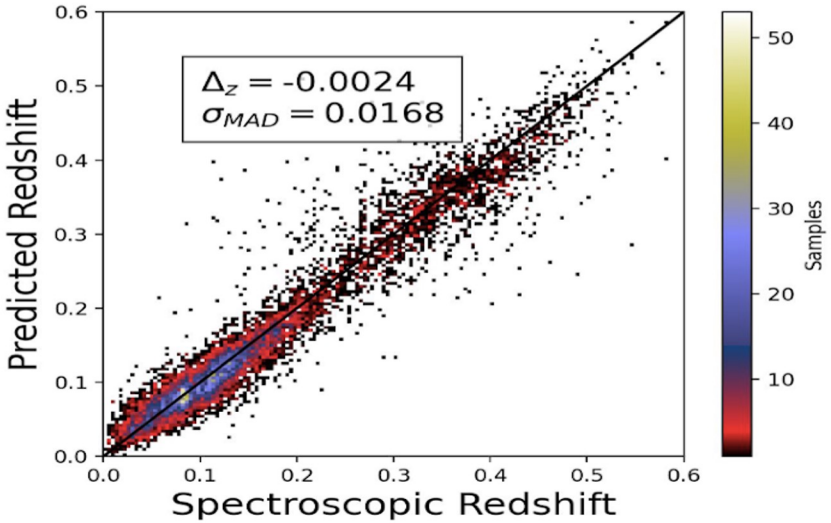


- Metrics
  - Residuals $\Delta z = \dfrac{z_{phot} - z_{spec}}{1 + z_{spec}}$
  - Median Absolute Deviation
    $\sigma_{MAD} = 1.4826 \times Median(|\Delta z - Median(\Delta z)|)$
  - The fraction η of outliers with $|\Delta z| > 0.05$

Inception Model - Results



Bias: -0.0024
Outliers: 3.55%
σMAD: **0.0168**



Conclusions

- Insertion of the Inception network in RAIL.
- Possibility to improve the learning process with regularization and dropouts.
- Increase the image training sample
  - ➔ Reduce overfitting
  - ➔ Test and validation on DC2 simulation images
  - ➔ Application on HSC images and comparison with the other photoz catalogs obtained on the same images
- Extend the training including possible bias: extinction, depth, etc.

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