Update on Machine Learning Photometric Redshifts for S-PLUS

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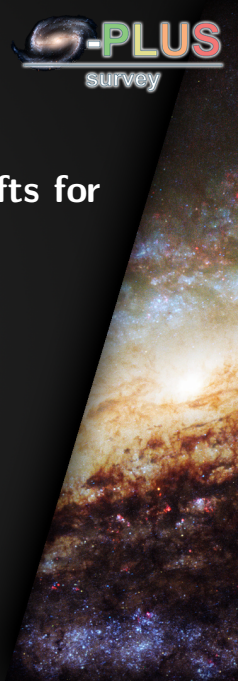

Introduction to Photo-Zs

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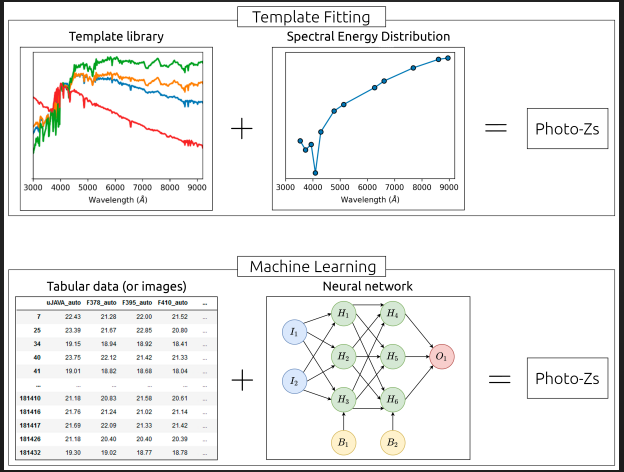
Photometric redshifts are a cheap and fast alternative to spectroscopic redshifts.



	uJAVA_auto	F378_auto	F395_auto	F410_auto	...
7	22.43	21.28	22.00	21.52	...
25	23.39	21.57	22.85	20.80	...
34	19.15	18.94	18.92	18.41	...
40	23.75	22.12	21.42	21.33	...
41	19.01	18.82	18.68	18.04	...
...	...	...	...	...	...
181410	21.18	20.83	21.58	20.61	...
181416	21.76	21.24	21.02	21.14	...
181417	21.69	22.09	21.33	21.42	...
181426	21.18	20.40	20.40	20.39	...
181432	19.30	19.02	18.77	18.78	...

Figure 1: Illustration of the template fitting and machine learning photo-z methods

The method:
Mixture Density Network

Mixture Density Network

- MDNs are capable of providing PDFs;
- Is a type of Bayesian Neural Network, so we can estimate the errors in the predictions easily.

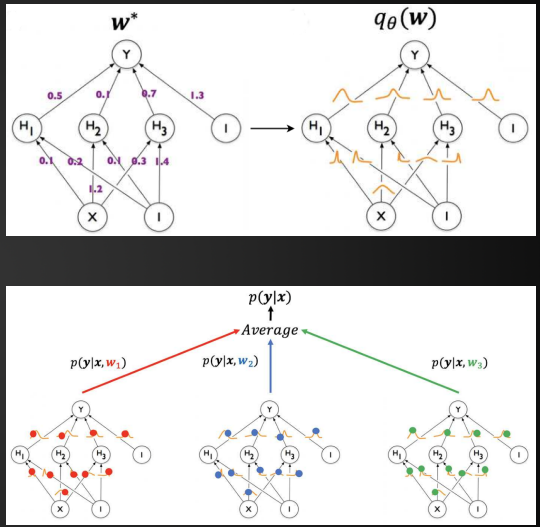


Figure 2: Illustration of a Bayesian Neural Network.

The results

The process of generating a photo-z catalogue

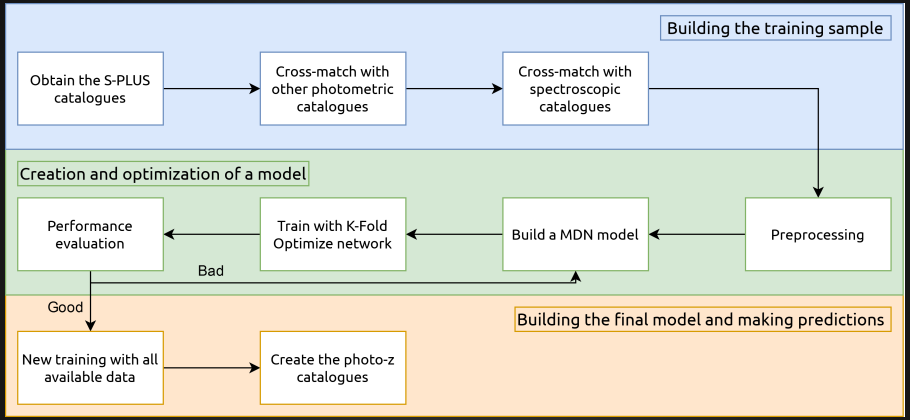


Figure 3: Illustration of the photo-z catalogue generation process.

The metrics

Table 1: Metrics, denotations and definitions that are used to analyse the results of this work.

Metric	Symbol	Equation
Delta	δz	$z_{\text{phot}} - z_{\text{spec}}$
Scatter	σ_{NMAD}	$1.48 \times \text{median}\left(\frac{\lvert\delta z - \text{median}(\delta z)\rvert}{1+z_{\text{spec}}}\right)$
Bias	μ	$\left\langle \frac{\delta z}{1+z_{\text{spec}}} \right\rangle$
Outlier Fraction	η	$\frac{\lvert\delta z\rvert}{1+z_{\text{spec}}} > 0.15$

The results - Single point estimates

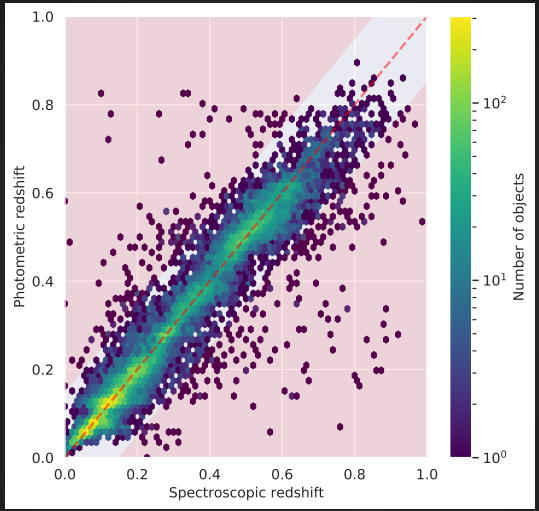


Figure 4: Color coded by the density of objects.

The results - Single point estimates

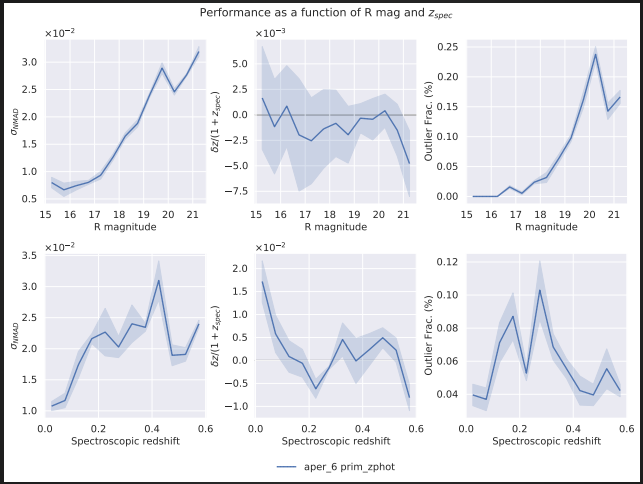
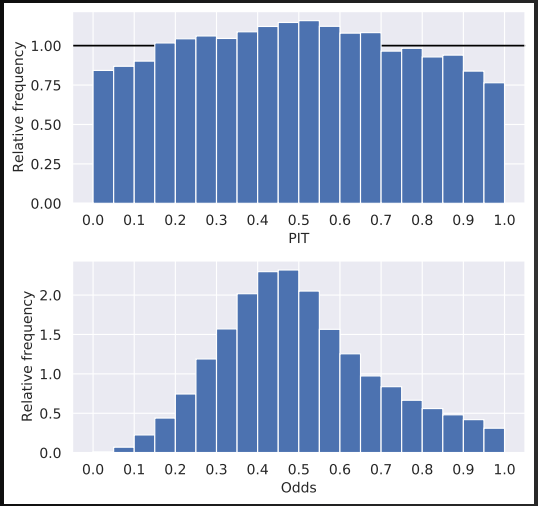


Figure 5: *Top*: Metrics as a function of the `r_aper_6` magnitude. *Bottom*: Metrics as a function of z_{spec}.

The results - Probability distribution functions



$$\text{PIT} = \int_0^{z_{\text{spec}}} p(z)\mathrm{d}z,$$

$$\text{Odds} = \int_{z_{\text{peak}}-0.02}^{z_{\text{peak}}+0.02} p(z)\mathrm{d}z.$$

Figure 6: *Top*: Histogram of PIT values. *Bottom*: Histogram of Odds values.

The results - Probability distribution functions

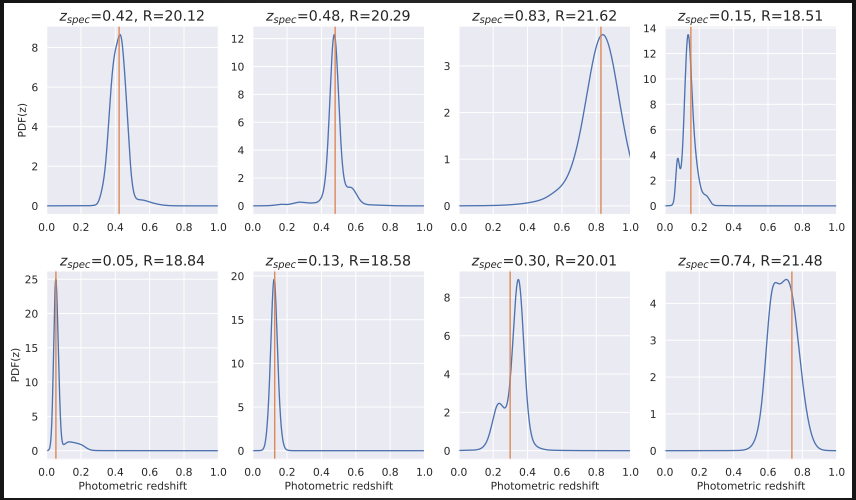


Figure 7: PDF samples.

The ensemble (work in progress)

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Laerte Sodré Jr., Clécio R. De Bom, Gabriel Teixeira, Maria Luísa, Priscila Gutierres, ...

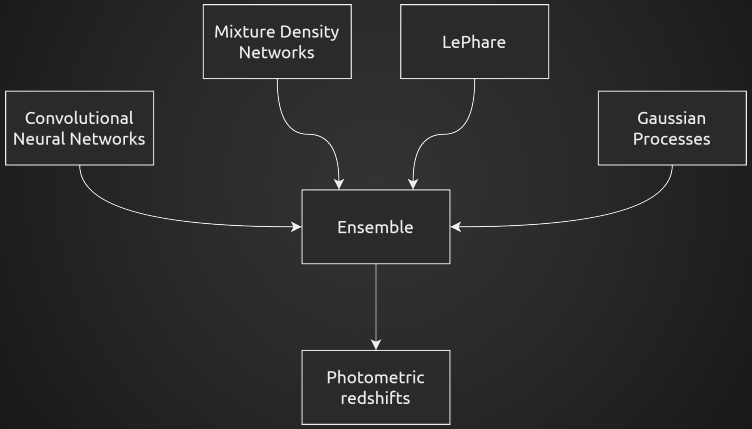

Figure 8: Illustration of the ensemble process.

Ensemble of MDNs - a preview

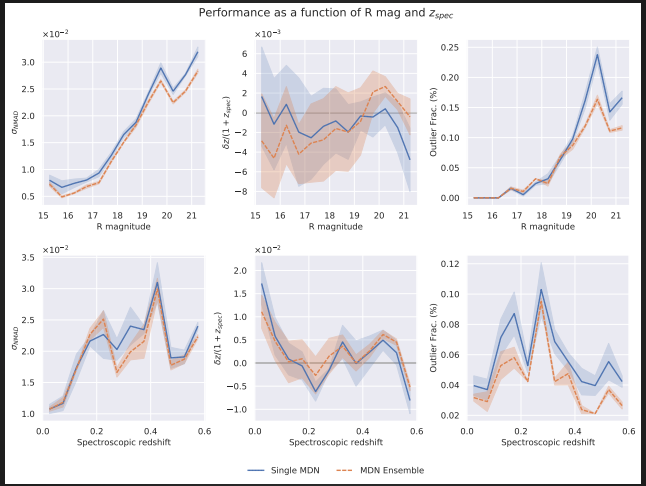

Figure 9: *Top row*: Metrics as a function of the `r_aper_6` magnitude. *Bottom row*: Metrics as a function of the z_{spec}.

The conclusions

The conclusions

- We improved the photo-z precision since the last meeting;
- Our method provides PDFs with good calibration;
- The code will be integrated with the pipeline to provide photo-zs alongside each data-release;
  - Photo-zs will also be available through the S-PLUS Database Tool.
- We will work on the ensemble method to provide even better photo-zs.
- You can contact me at `erik.vini@usp.br` for any questions.