

Measuring the cosmological parameters with machine learning techniques.

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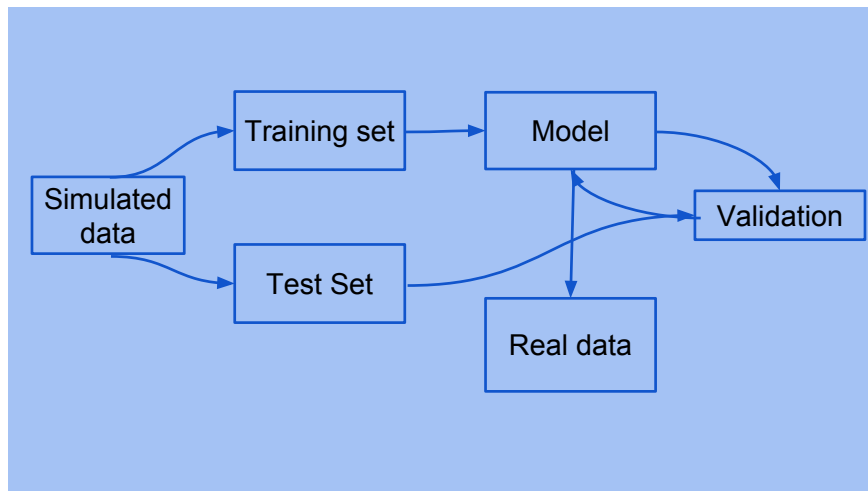
- The training sample.
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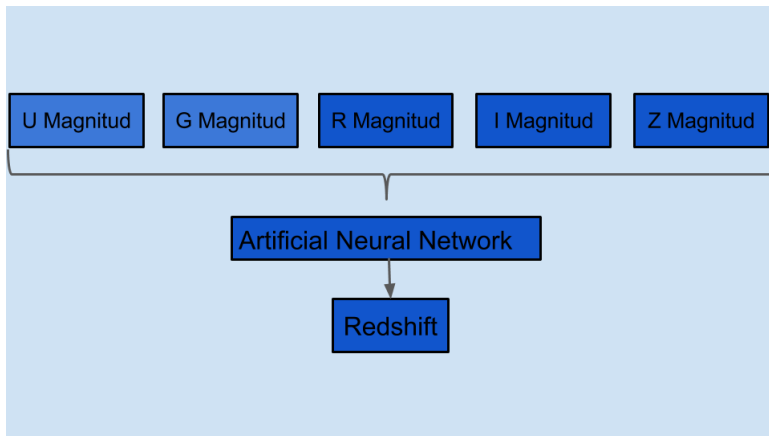
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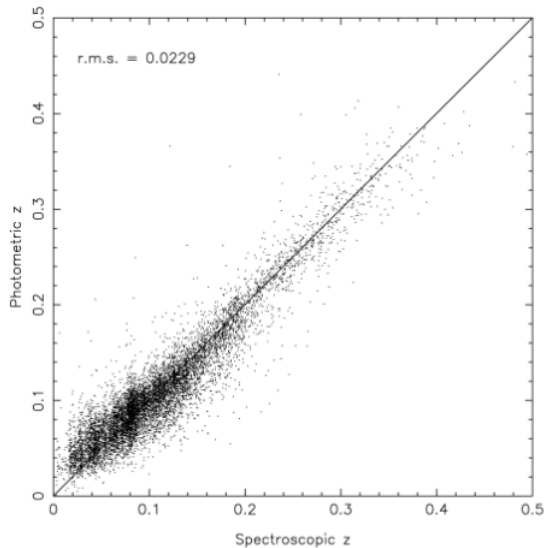
Supervised Learning.



Simple Example:ANNz

ANNz: Estimating photometric redshift using artificial neural network. Collister & Lahav 2003 (0311058)





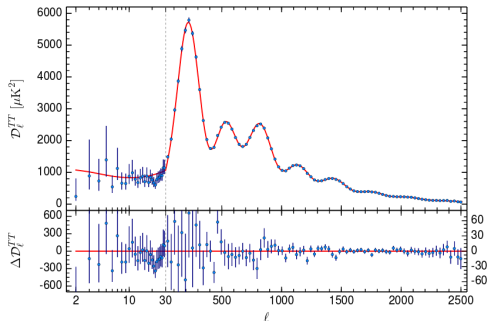
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The Standard model.

Homogeneous and isotropic Universe \rightarrow FRW metric

$$ds^2 = dt^2 - a^2(t) \left[\frac{dr^2}{1 - kr^2} + r^2(d\theta^2 + \sin^2\theta d\phi^2) \right]$$

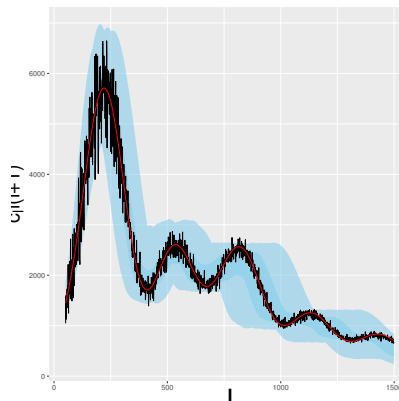
$$\left(\frac{H}{H_0}\right)^2 = \Omega_{rad} a^{-4} + \Omega_m a^{-3} + \Omega_\Lambda - Kc^2 a^{-2}$$



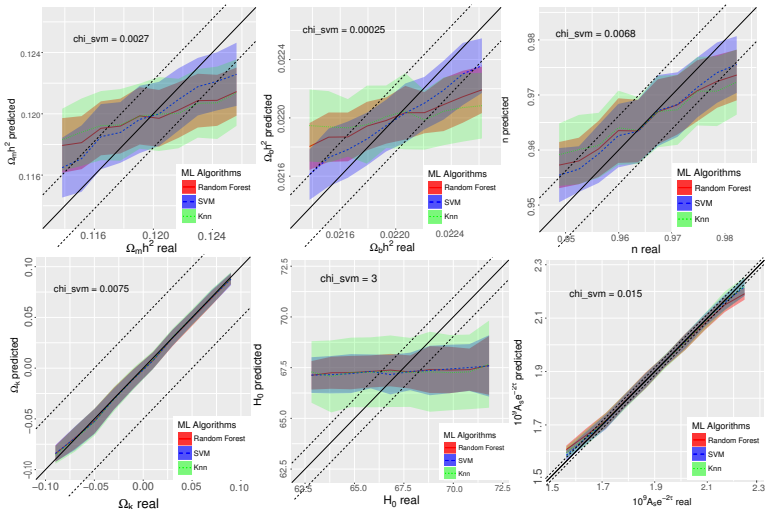
Planck Collaboration 2015 (1502.01589)

The training sample.

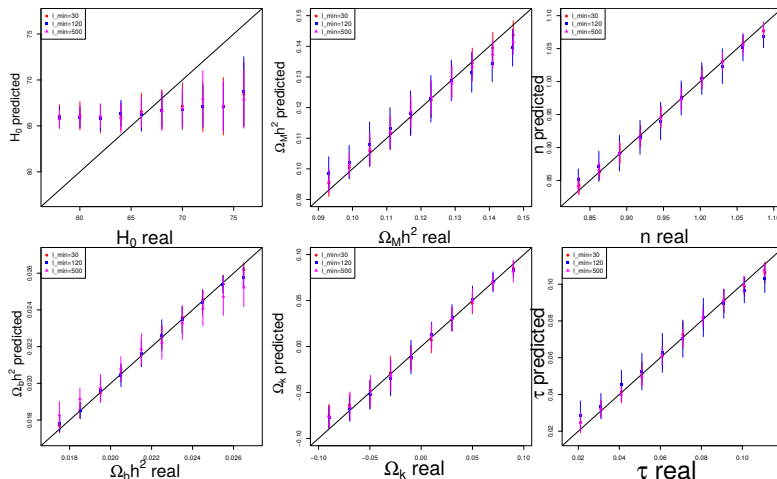
CAMB: Code for Anisotropies in the Cosmic Background



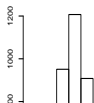
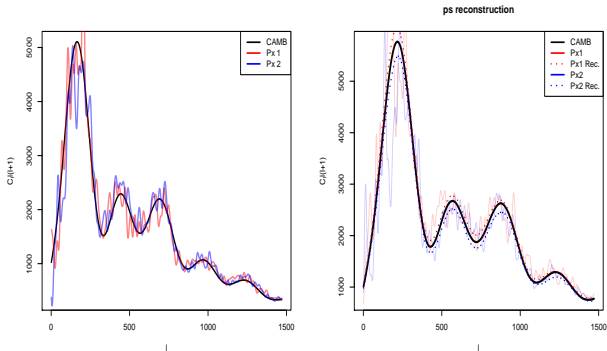
Studying different Machine Learning algorithms.

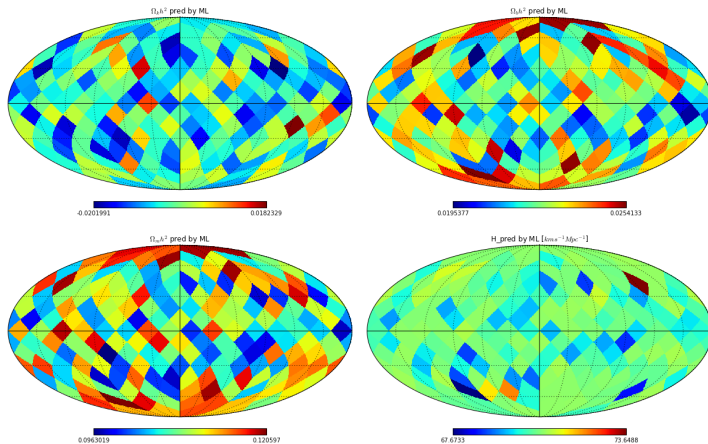


Changing the minimum mutipole.

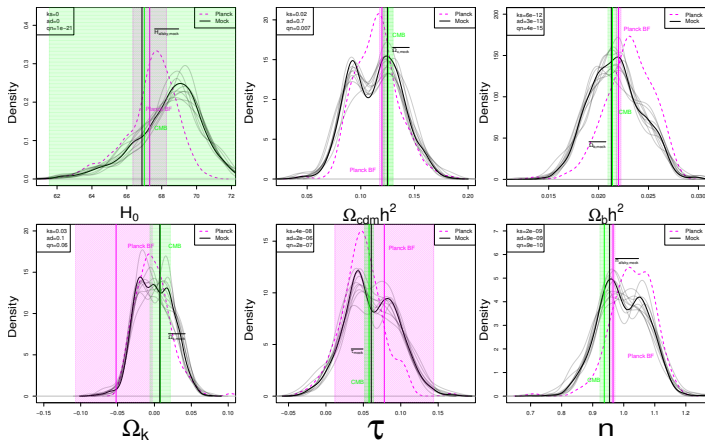


Measuring the cosmological parameters angular distributions.

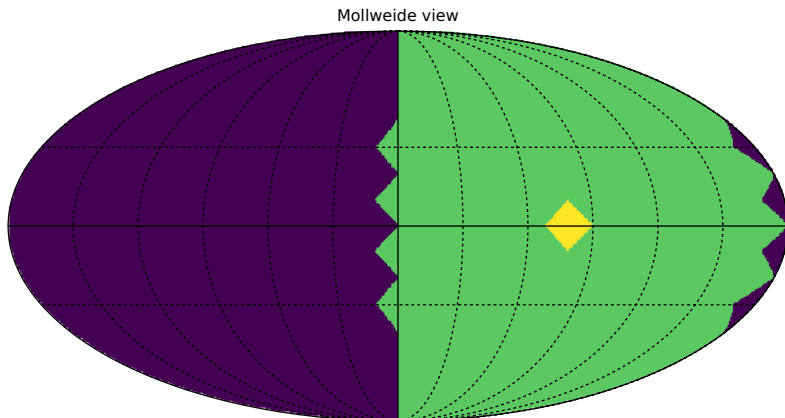




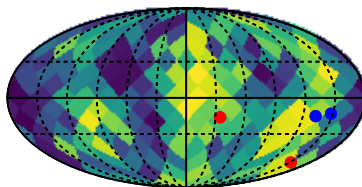
de los Rios & Dominguez et al. (in preparation)



Hemispheric Asymmetry. de los Rios & Dominguez (in preparation).



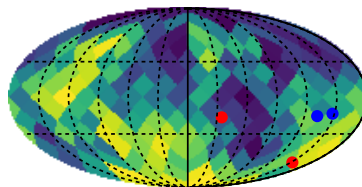
Planck

 $\Delta\xi$ 

-0.207415

0.207415

Mock

 $\Delta\xi$ 

-0.235635

0.235635

$$\xi^2 = \left(\frac{H_{pl} - H}{\sigma_H}\right)^2 + \left(\frac{\Omega_{m,pl} - \Omega_m}{\sigma_{\Omega_m}}\right)^2 + \left(\frac{\Omega_{b,pl} - \Omega_b}{\sigma_{\Omega_b}}\right)^2 + \left(\frac{\Omega_{k,pl} - \Omega_k}{\sigma_{\Omega_k}}\right)^2 + \left(\frac{\tau_{pl} - \tau}{\sigma_\tau}\right)^2 + \left(\frac{n_{pl} - n}{\sigma_n}\right)^2$$

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Final Remarks

- We developed a machine learning technique that estimate the cosmological parameters in a more efficient way without losing precision.
- This technique can be easily extended to use more cosmological information as features (BAO, correlation function, SZ emission, etc.).
- As a first application we study the angular distribution of the cosmological parameters and the Hemispherical Asymmetry.
- We do not found any significant departure from what is expected in an homogeneous and isotropic universe, but we found some features in the distributions that may come from the pixelization.
- We will extend the parameters space and add polarization information in a forthcoming work.
- We will analyze the correlations between the angular distribution of the cosmological parameters and the large scale structure (voids, filaments, etc.)

