CosmoML: A Machine Learning method to measure the cosmological parameters.

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November 6, 2017

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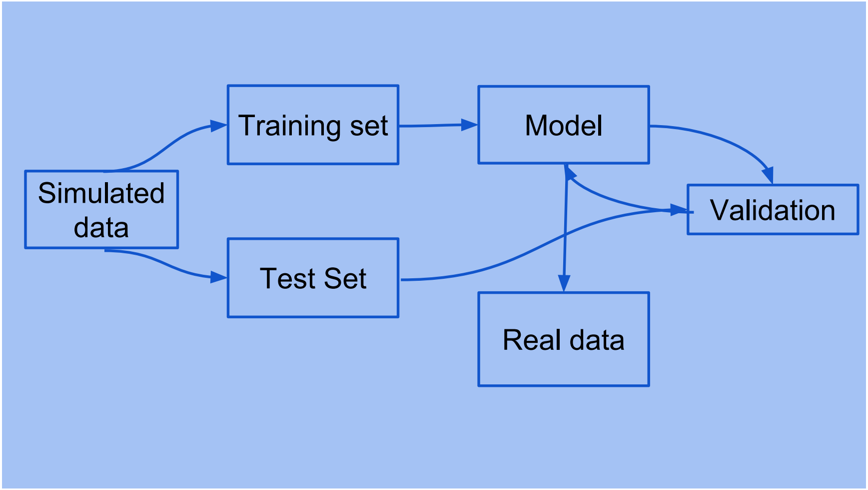
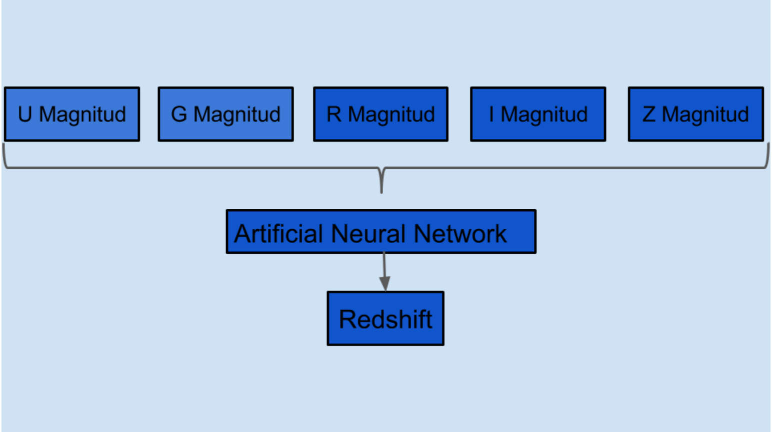
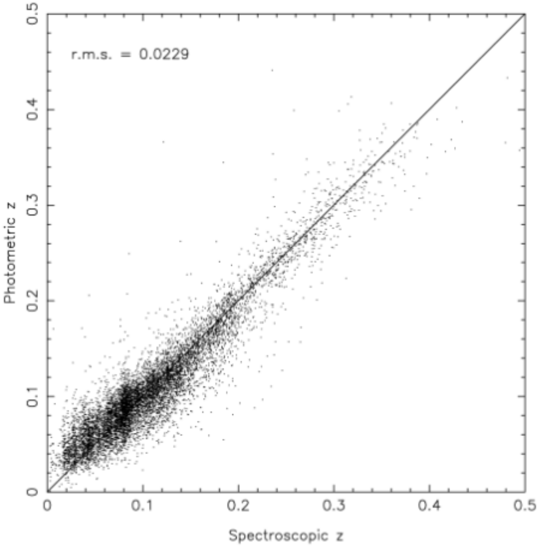
Supervised Learning.



Simple Example:ANNz

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




r.m.s. = 0.0229
Photometric z
Spectroscopic z
0
0.1
0.2
0.3
0.4
0.5

1. What is Machine Learning.
   - Supervised learning.
   - Machine Learning in physics.
2. Measuring the Cosmological Parameters.
   - The training sample.
   - Applications.
3. Final Remarks.

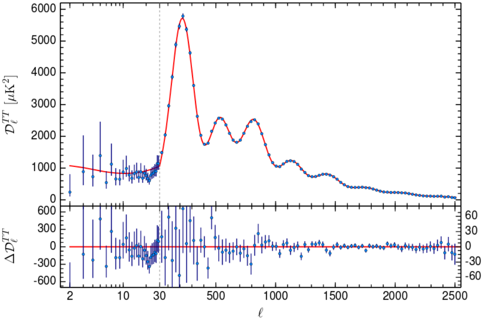
What are the cosmological parameters?

Homogeneous and isotropic Universe $\rightarrow$ FRW metric

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

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

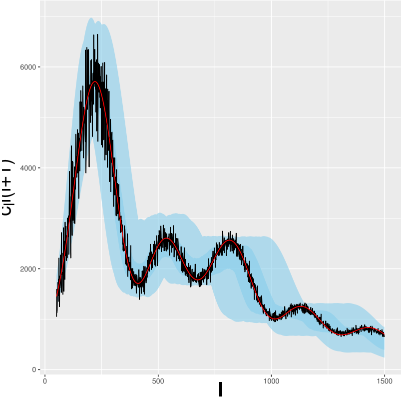
How can we measure the cosmological parameters?



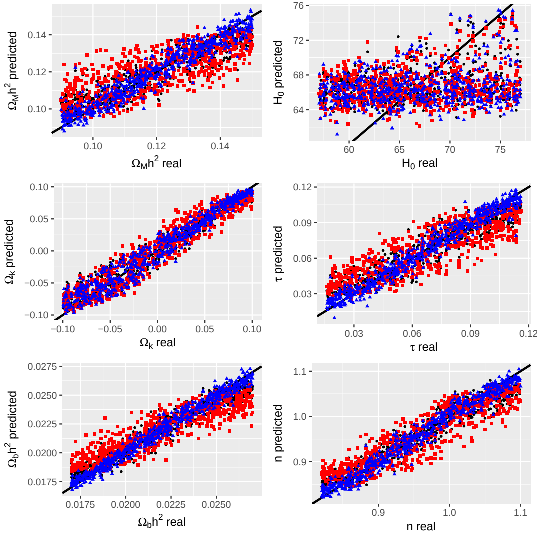
Planck Collaboration 2015 (1502.01589)

The training sample.

CAMB: Code for Anisotropies in the Cosmic Background

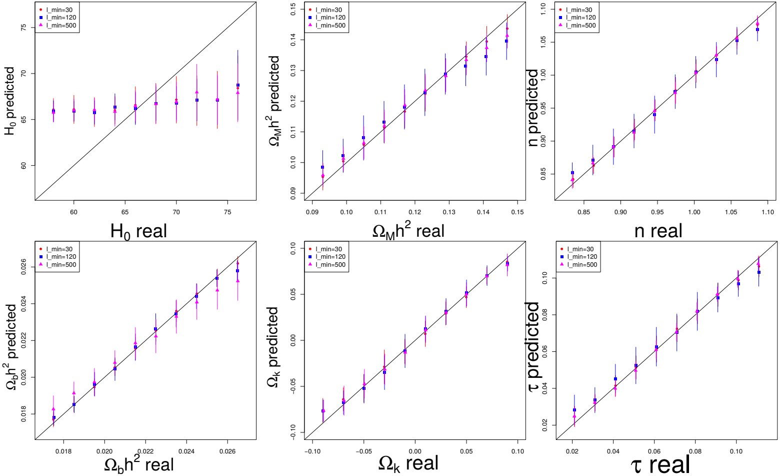


Studying different Machine Learning algorithms.

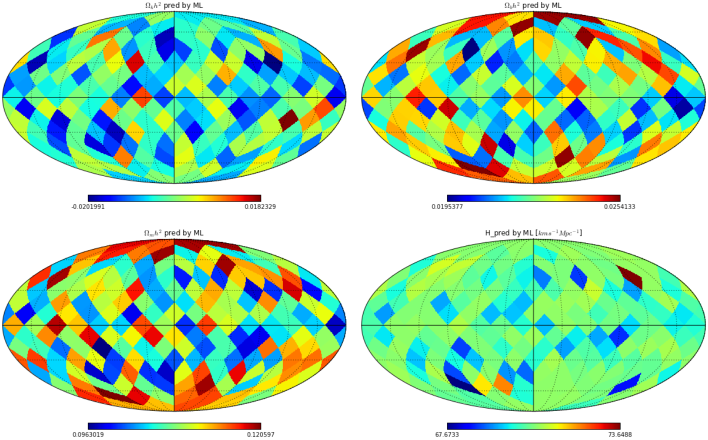


K-Nearest Neighbour
Random Forest
Support Vector Machine

Changing the minimum mutipole.

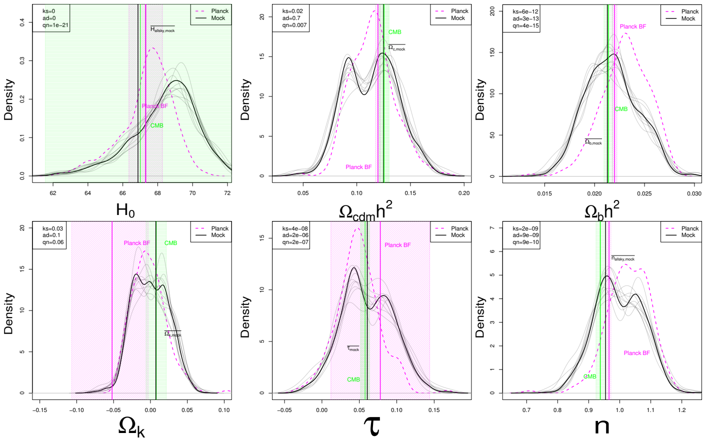


Measuring the cosmological parameters angular distributions.

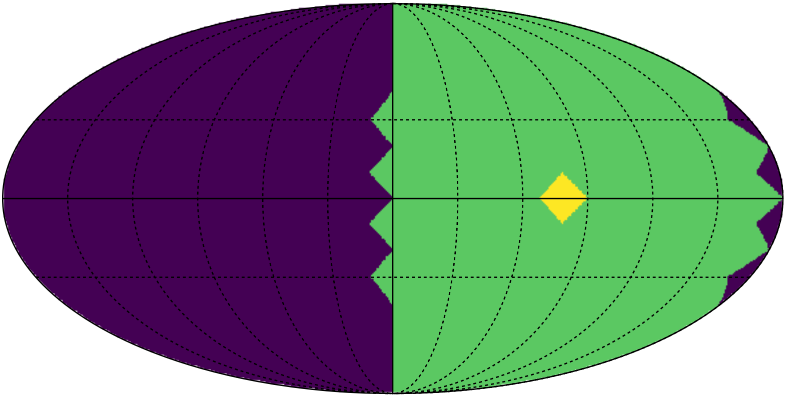


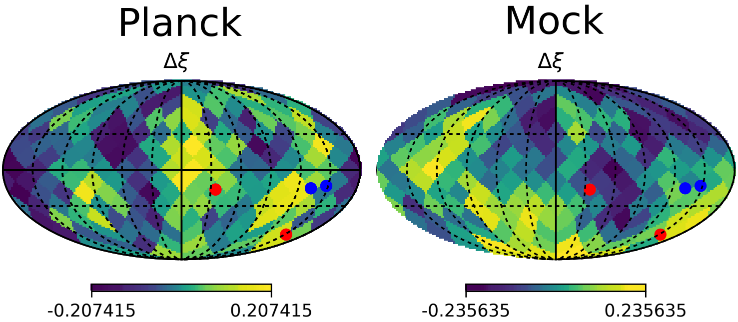
de los Rios & Dominguez et al. (in preparation)


STRANGER
THINGS


ks=0
ad=0
qn=1e−21
Planck
Mock
Planck BF
CMB
Density
H_0
ks=0.02
ad=0.7
qn=0.007
CMB
Planck BF
$\Omega_{cdm}h^2$
ks=6e−12
ad=3e−13
qn=4e−15
Planck BF
CMB
$\Omega_b h^2$
ks=0.03
ad=0.1
qn=0.06
Planck BF
CMB
Ω_k
ks=4e−08
ad=2e−06
qn=2e−07
Planck BF
CMB
τ
ks=2e−09
ad=9e−09
qn=9e−10
Planck BF
CMB
n

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





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

Final Remarks

- We developed a machine learning technique that estimate the cosmological parameters in a more efficient way withouth 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 univese, 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.)


THANK YOU!!