

# Measuring the angular distribution of the cosmological parameters.

Martín de los Rios & Mariano Domínguez

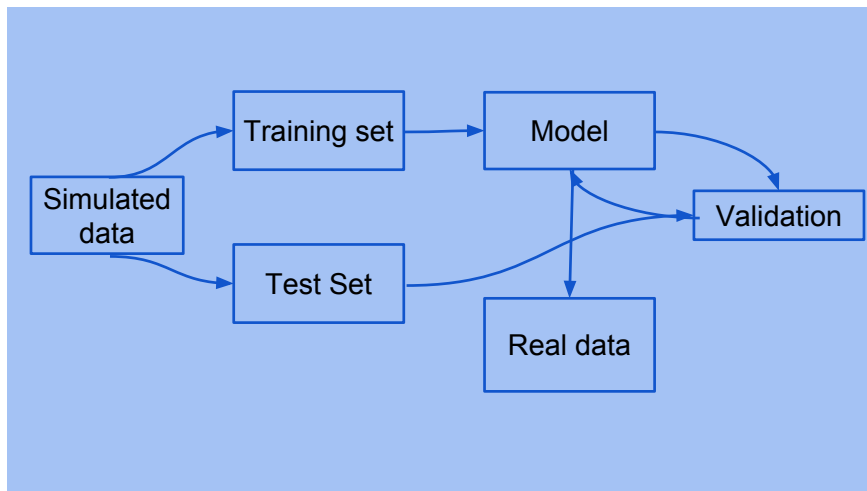
March 31, 2017

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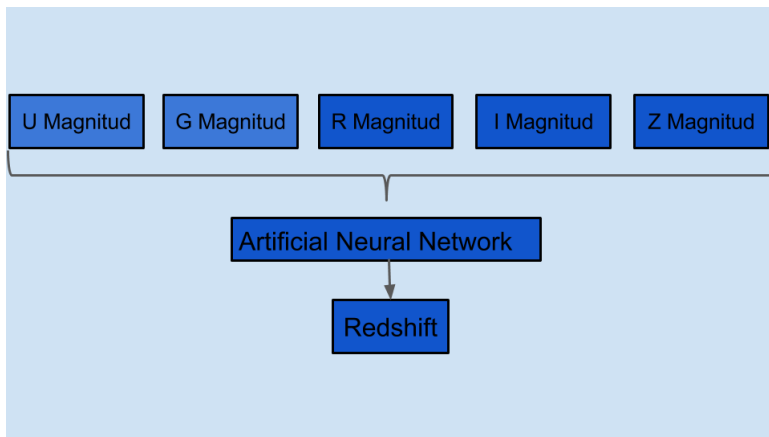
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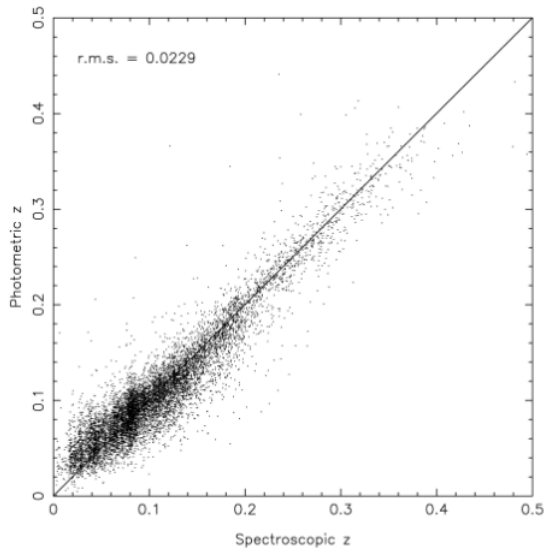
# Supervised Learning.



# Simple Example:ANN-z

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





1. [arXiv:1703.06236 \[pdf, other\]](#)  
**Discovering the Building Blocks of Atomic Systems using Machine Learning**  
 Conrad W. Rosenbrock, Eric R. Homer, Gábor Csányi, Gus L. W. Hart  
 Comments: 8 pages, 4 figures, 1 table  
 Subjects: **Materials Science (cond-mat.mtrl-sci)**; Computational Physics (physics.comp-ph)

2. [arXiv:1703.05402 \[pdf, other\]](#)  
**Experimental Quantum Hamiltonian Learning**  
 Jianwei Wang, Stefano Paesani, Raffaele Santagati, Sebastian Knauer, Antonio A. Gentile, Nathan Wiebe, Maurangelo Petruzzella, Jerem Mark G. Thompson  
 Subjects: **Quantum Physics (quant-ph)**

3. [arXiv:1703.05334 \[pdf, other\]](#)  
**Many-body quantum state tomography with neural networks**  
 Giacomo Torlai, Guglielmo Mazzola, Juan Carrasquilla, Matthias Troyer, Roger Melko, Giuseppe Carleo  
 Subjects: **Disordered Systems and Neural Networks (cond-mat.dis-nn)**; Quantum Gases (cond-mat.quant-gas); Computational Physics (physics.comp-ph); Quantum P

4. [arXiv:1703.05210 \[pdf, other\]](#)  
**Neural Networks retrieving Boolean patterns in a sea of Gaussian ones**  
 Elena Agliari, Adriano Barra, Chiara Longo, Daniele Tantarì  
 Comments: 16 pages, 1 figure  
 Subjects: **Mathematical Physics (math-ph)**; Disordered Systems and Neural Networks (cond-mat.dis-nn)

5. [arXiv:1703.05084 \[pdf, ps, other\]](#)  
**Astrophysics and Big Data: Challenges, Methods, and Tools**  
 Mauro Garofalo, Alessio Botta, Giorgio Ventre  
 Comments: 4 pages, 1 figures, proceedings of the IAU-325 symposium on Astroinformatics, Cambridge University press  
 Subjects: **Instrumentation and Methods for Astrophysics (astro-ph.IM)**

6. [arXiv:1703.04351 \[pdf, other\]](#)  
**Model-independent search for neutrino sources with the ANTARES neutrino telescope**  
 A. Albert. M. André. M. Anohinolfi. G. Anton. M. Ardid. J.-J. Aubert. T. Avila. B. Baret. J. Barrios-Marti. S. Basa. V. Bertin. S. Bica. R. Bormuth. S. Bourret. M.C. Bouwhuis. R. Bruijn. J.

Year Range	Refereed (Blue)	Non-refereed (Green)
1982-1984	0	0
1985-1987	0	0
1988-1990	0	0
1991-1993	0	0
1994-1996	0	0
1997-1999	0	0
2000-2002	0	0
2003-2005	0	0
2006-2008	0	0
2009-2011	0	0
2012-2014	~200	~800
2015-2017	~800	~2800

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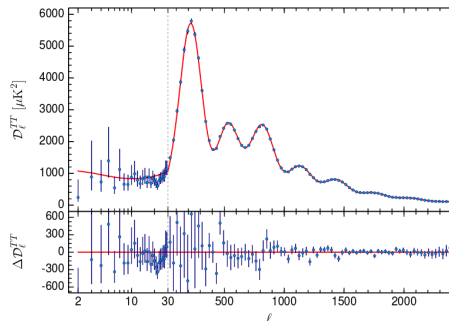
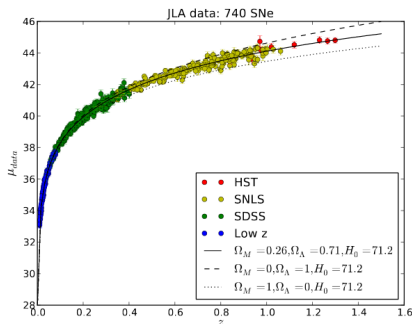
# What are the cosmological parameters?

Homogeneous and isotropic Universe  $\rightarrow$  FRW metric

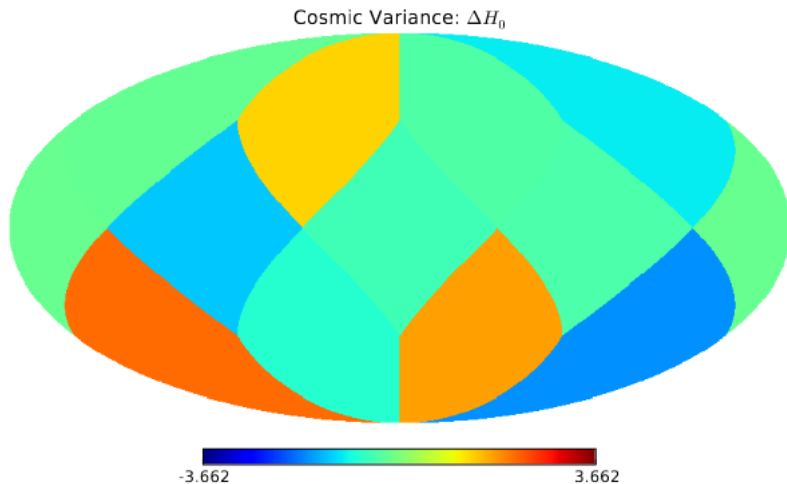
$$ds^2 = dt^2 - a^2(t) \left[ \frac{dr^2}{1-kr^2} + r^2(d\theta^2 + \sin^2\theta d\phi^2) \right]$$

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

# How can we measure the cosmological parameters?



Carvalho & Marques 2015 (1512.07869) Planck Collaboration 2015 (1502.01589)

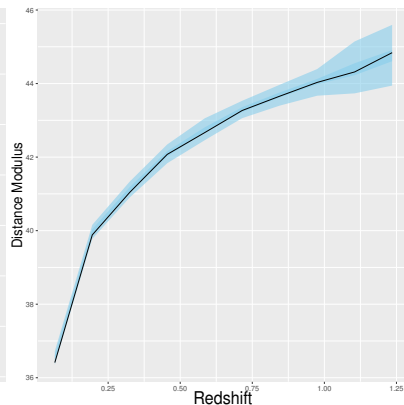
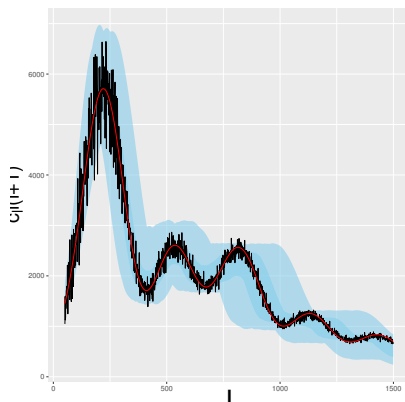


Carvalho & Marques (1512.07869)

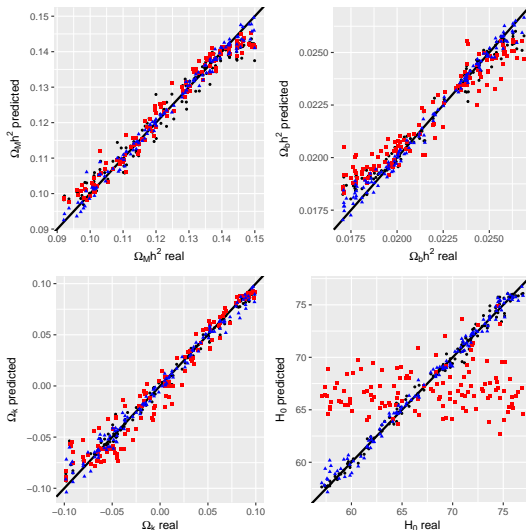
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# The training sample.

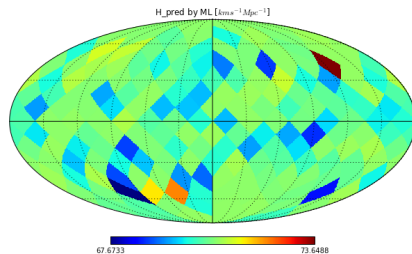
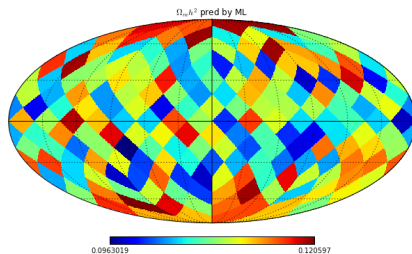
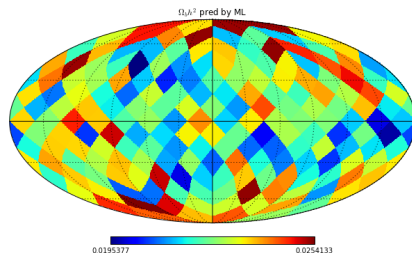
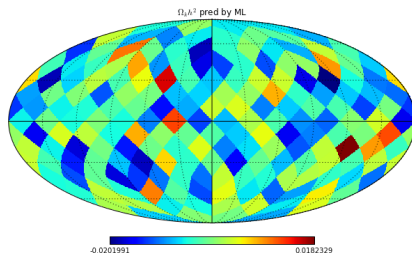
CAMB: Code for Anisotropies in the Cosmic Background  
(REFERENCIA)

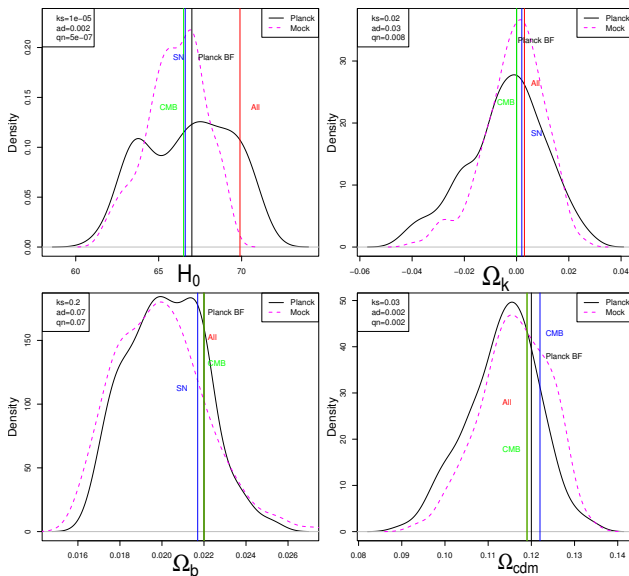


# Studying different Machine Learning algorithms.



# First Results.







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# Final Remarks

- We developed a machine learning technique that estimate the cosmological parameters in a more efficient way, and allow us to measure the angular distribution of this parameters.
- This technique can be easily extended to use more cosmological information as features (BAO, correlation function, SZ emission, etc.).
- We do not found statistically significant departures from what is expected in an homogeneous and isotropic universe, with the possible exception of a bi-modal  $H_0$  distribution.
- 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.)