Measuring the cosmological parameters with machine learning techniques.

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October 3, 2018

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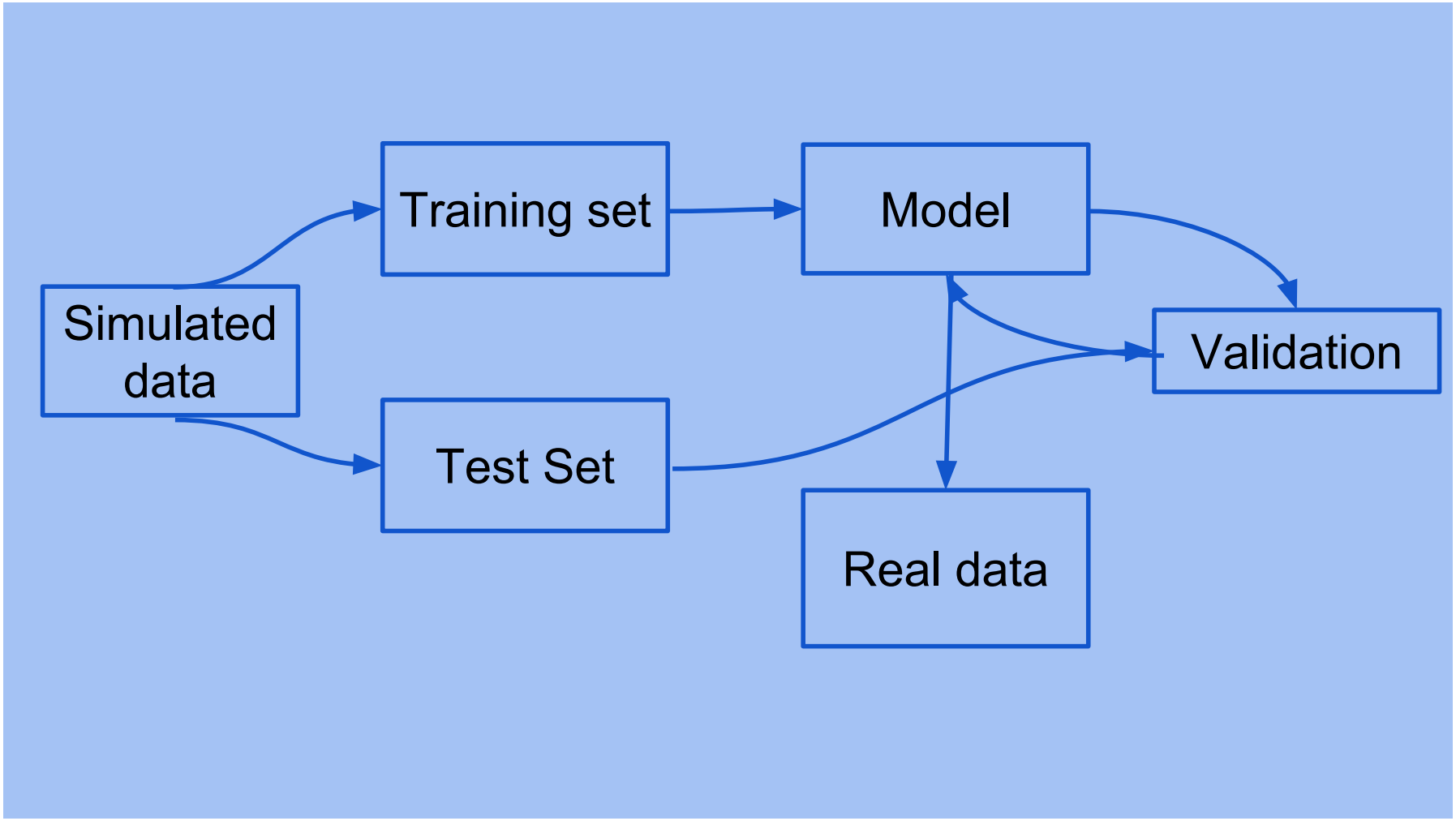
Supervised Learning.

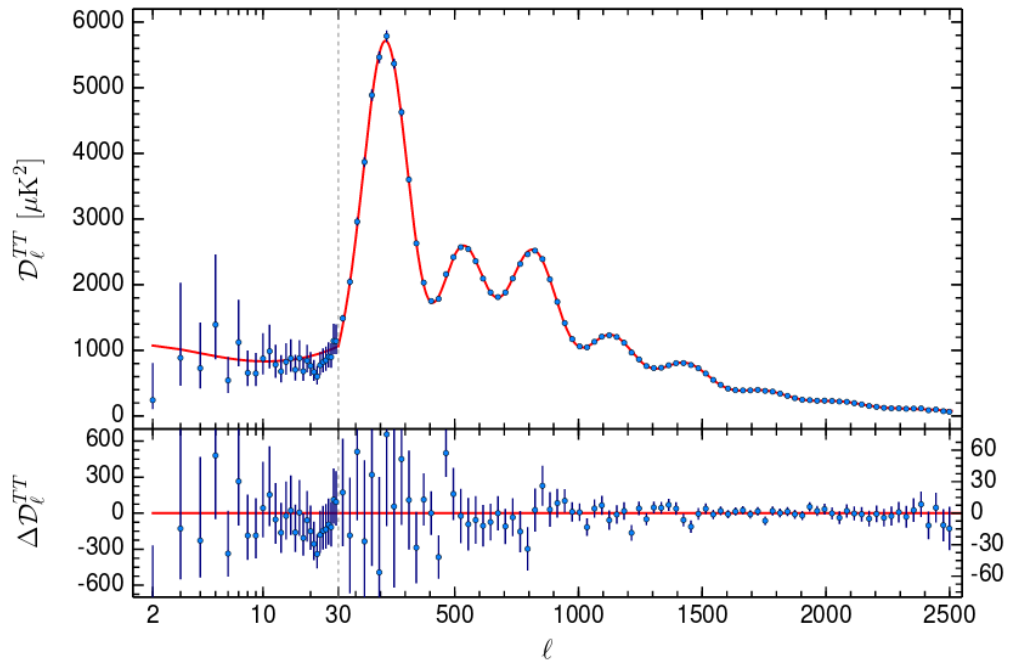


The Standard model.

Homogeneous and isotropic Universe $\rightarrow$ FRW metric

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

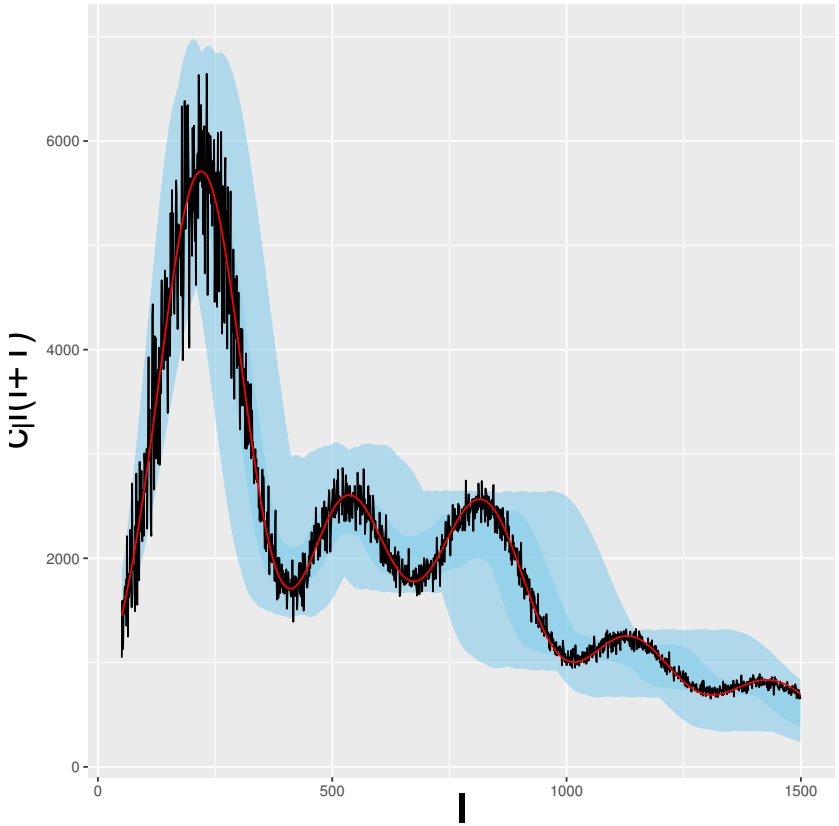
$(\frac{H}{H_0})^2 = \Omega_{rad} a^{-4} + \Omega_m a^{-3} + \Omega_\Lambda - Kc^2 a^{-2}$



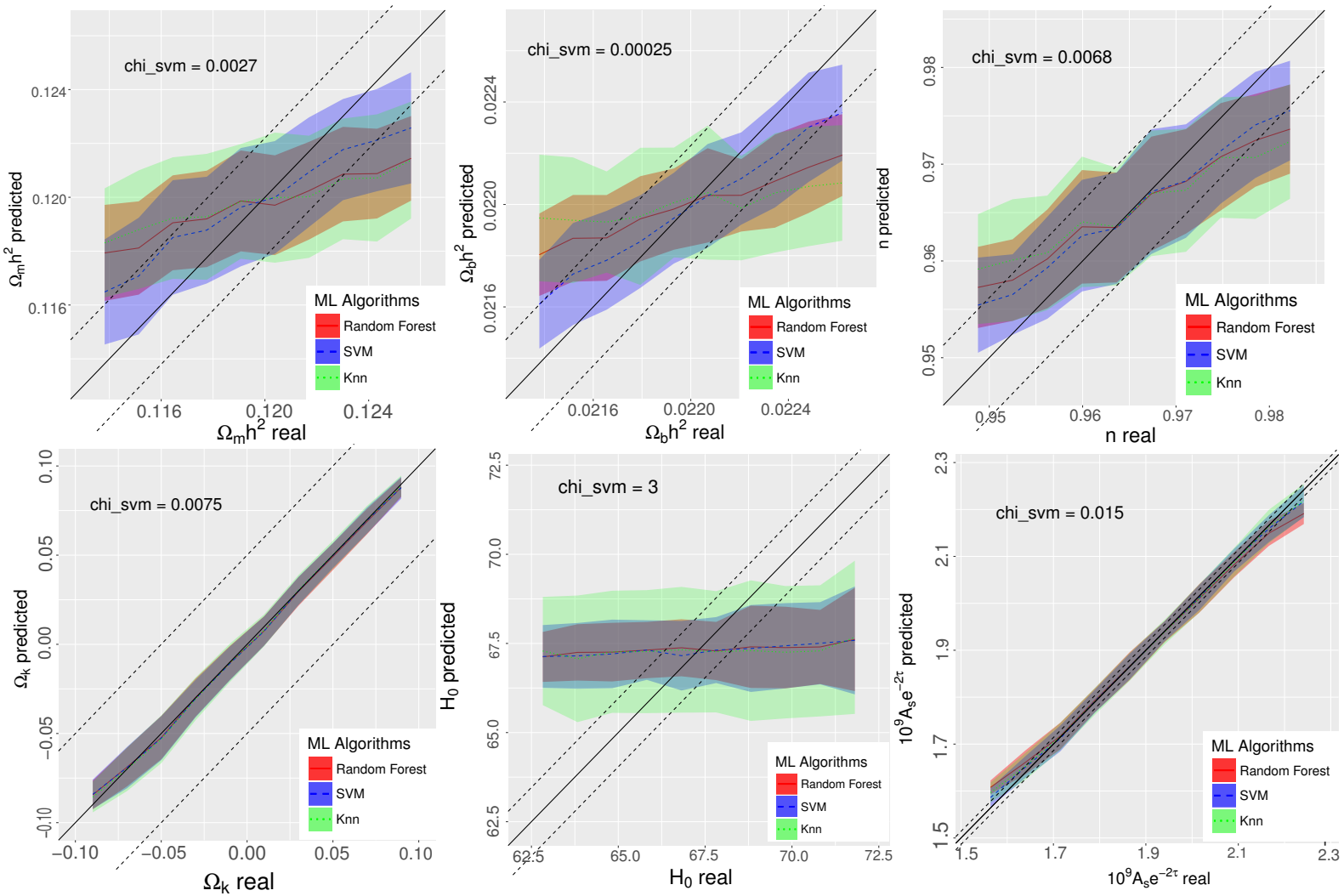
Planck Collaboration 2015 (1502.01589)

The training sample.

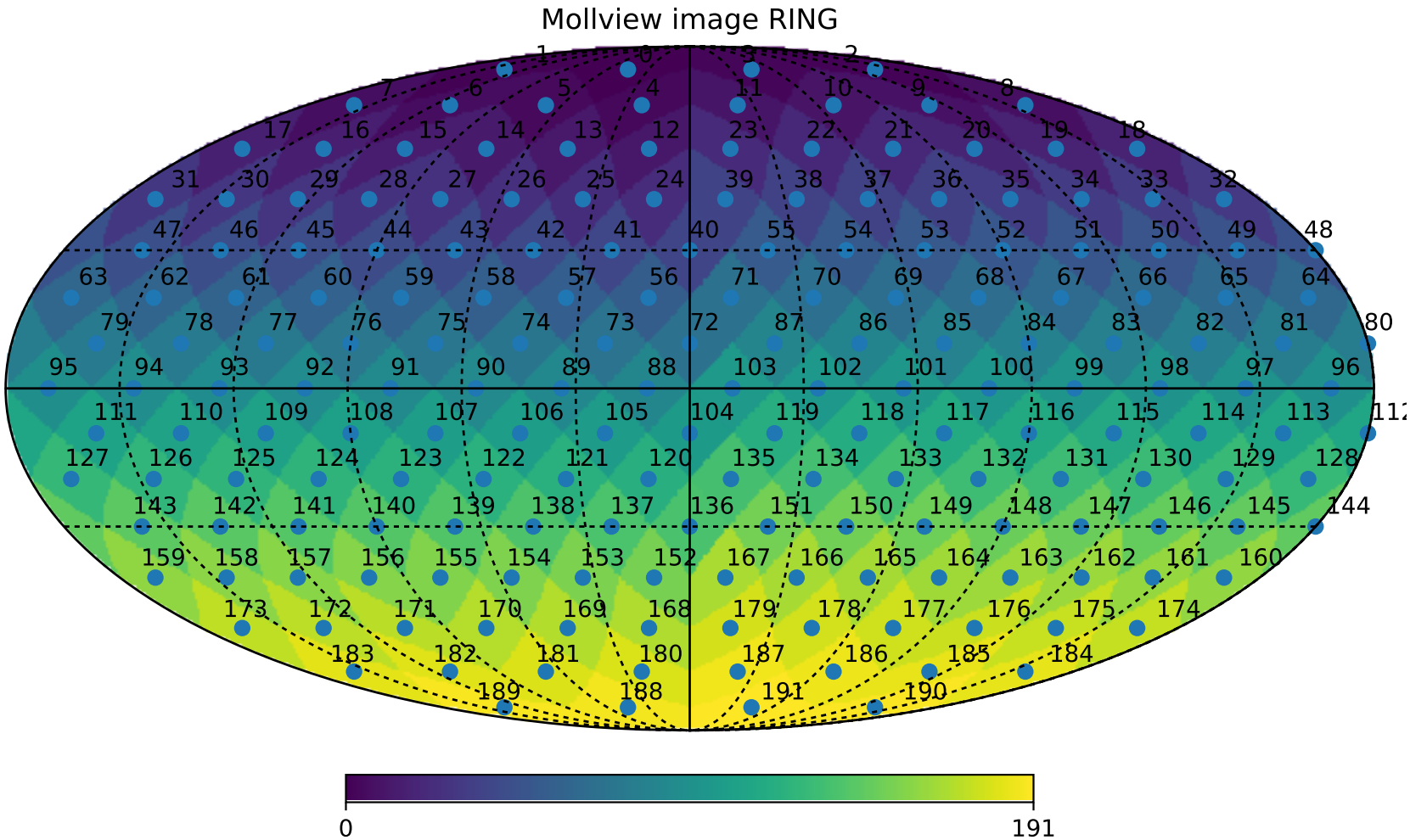
CAMB: Code for Anisotropies in the Cosmic Background



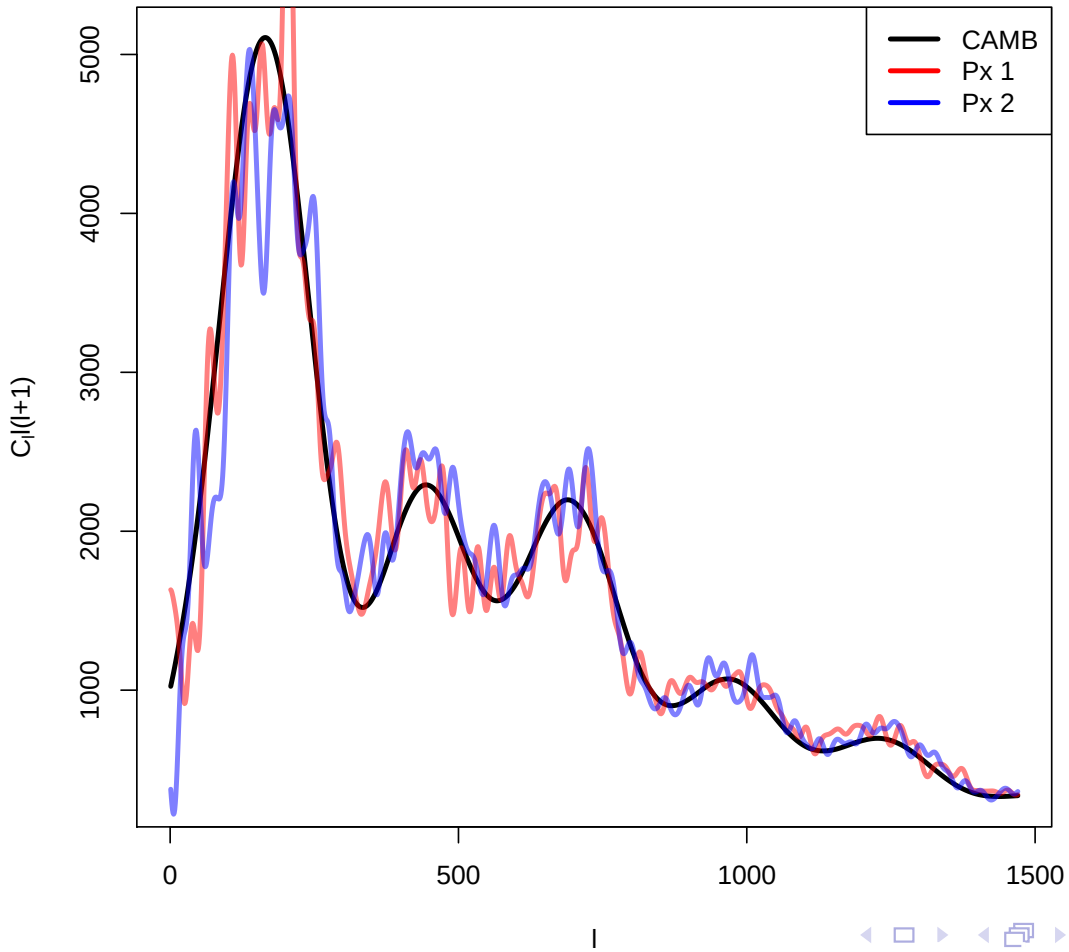
Studying different Machine Learning algorithms.



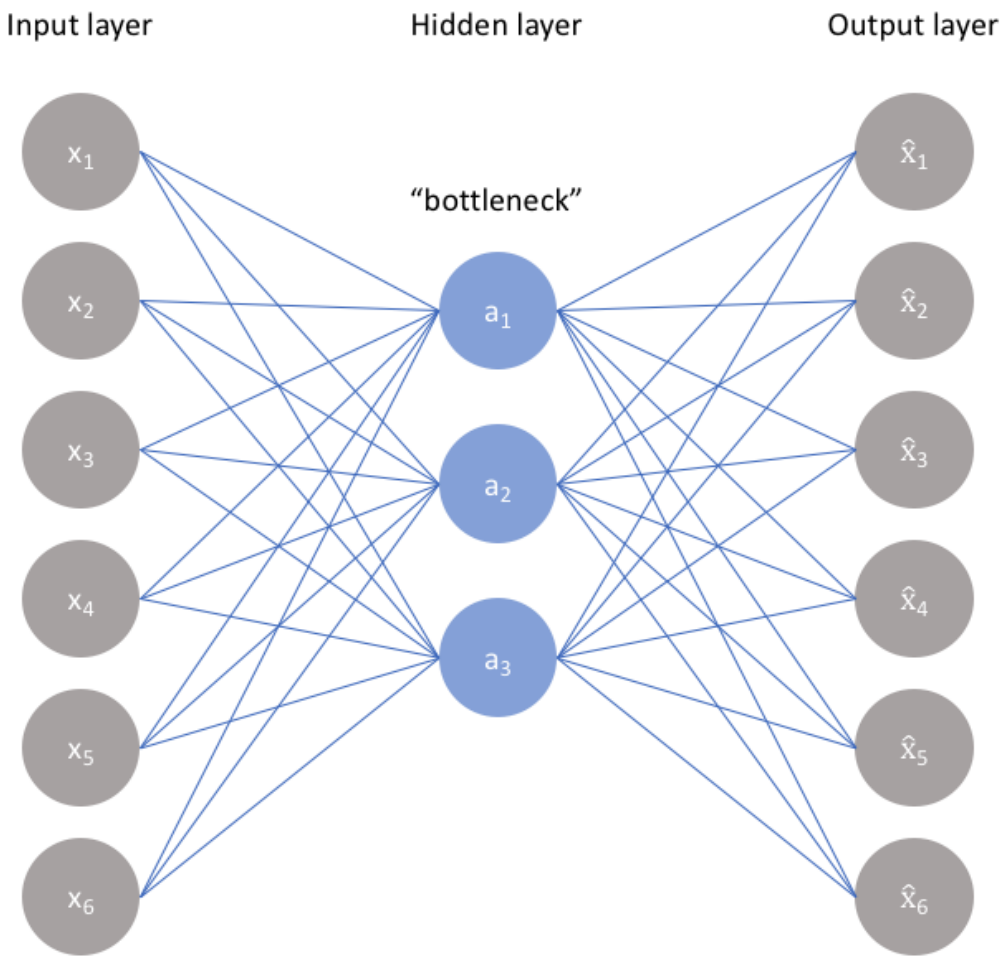
Measuring the cosmological parameters angular distributions.



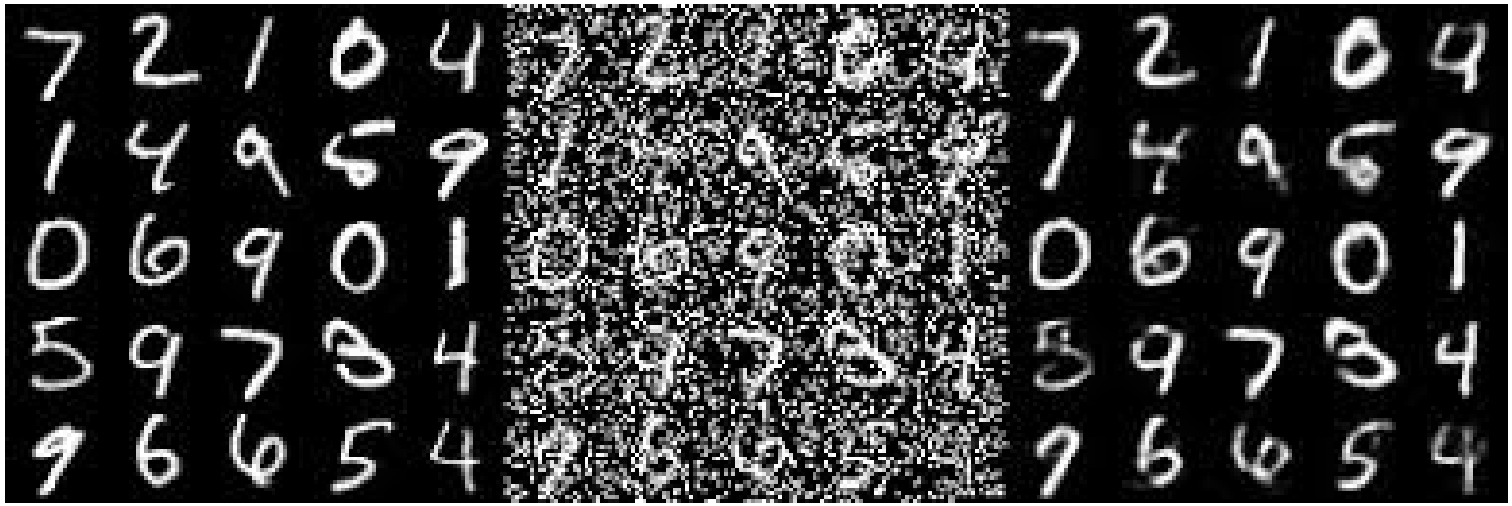
Measuring the cosmological parameters angular distributions.



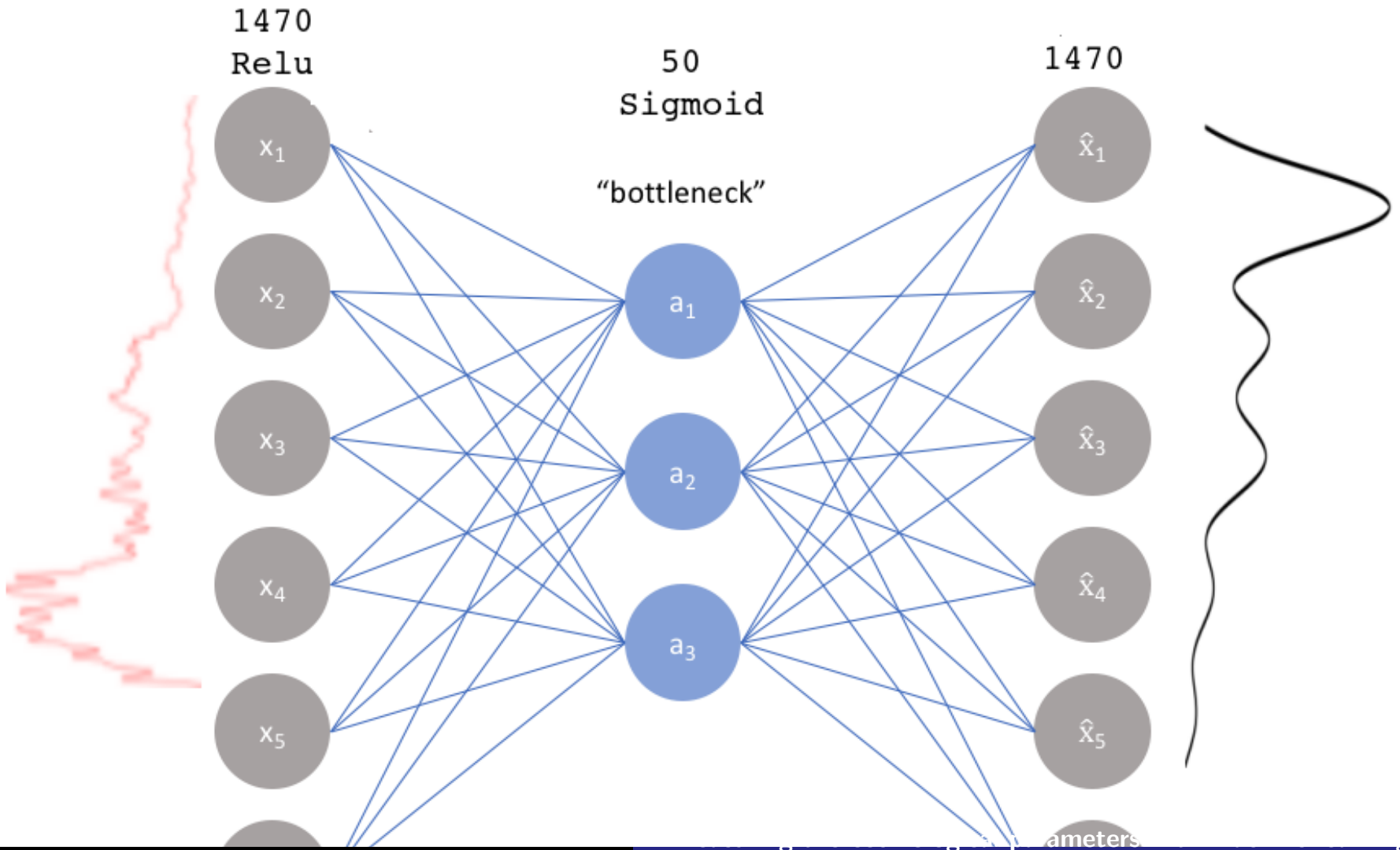
Denoising Autoencoders

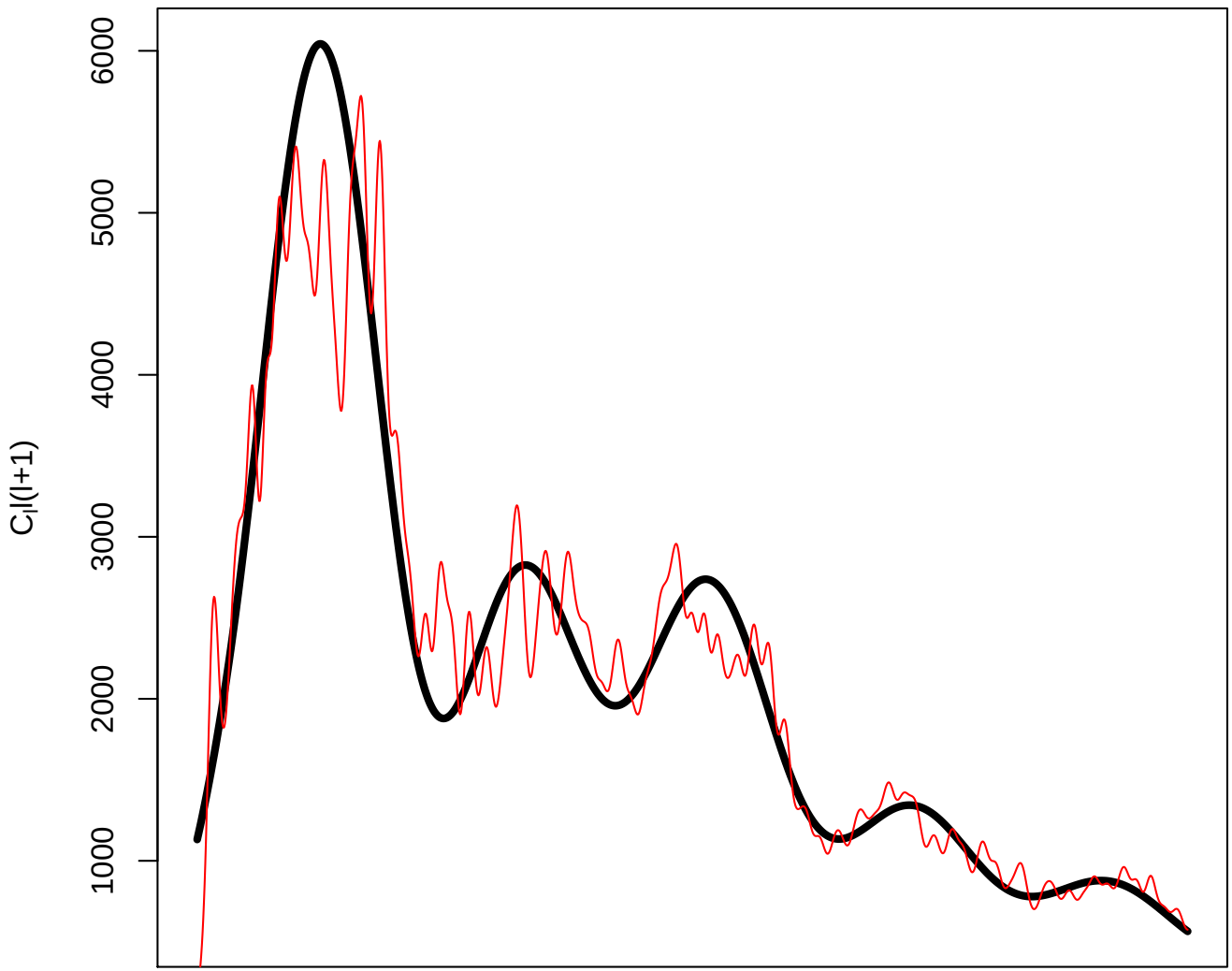


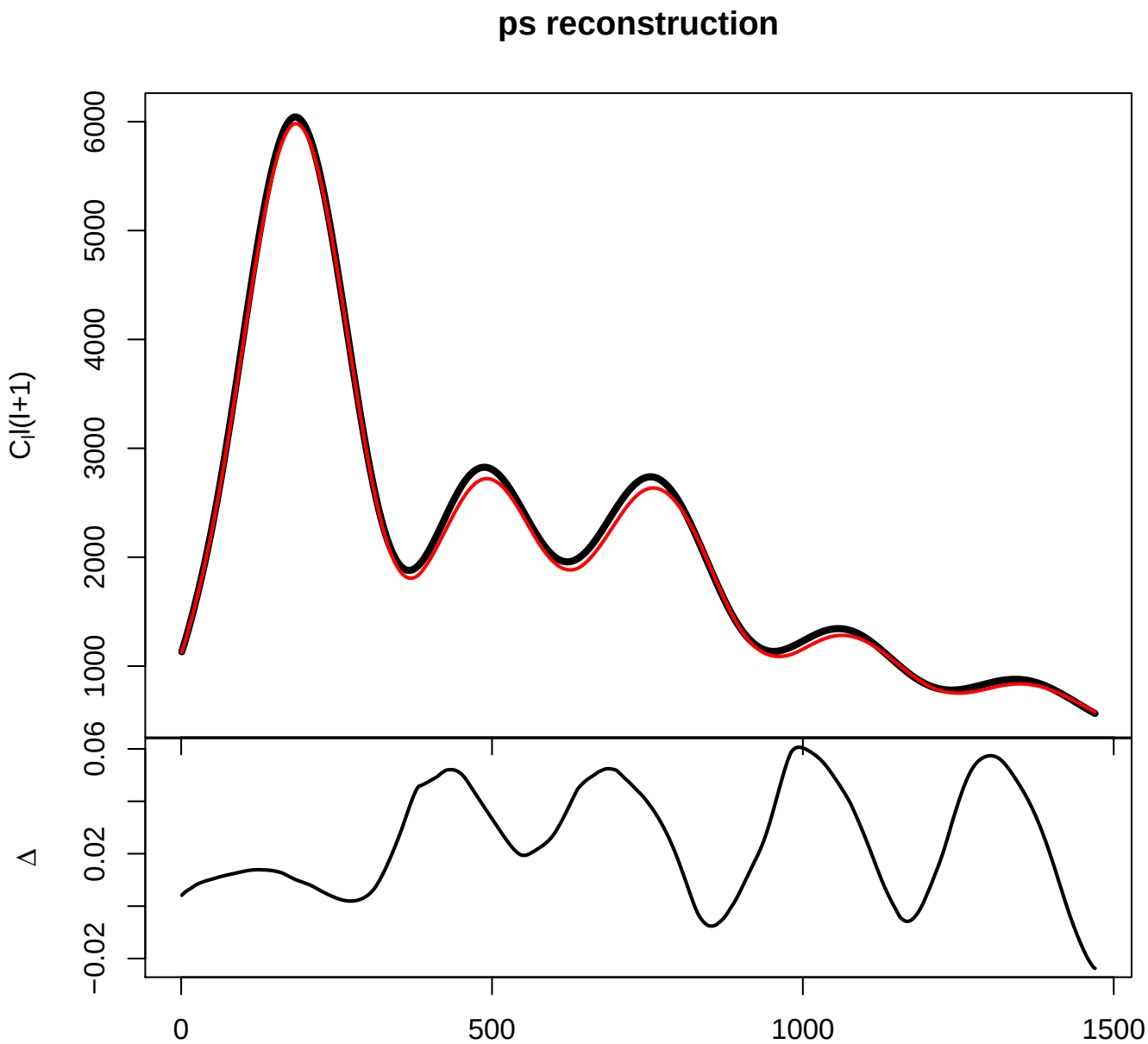
Denoising Autoencoders

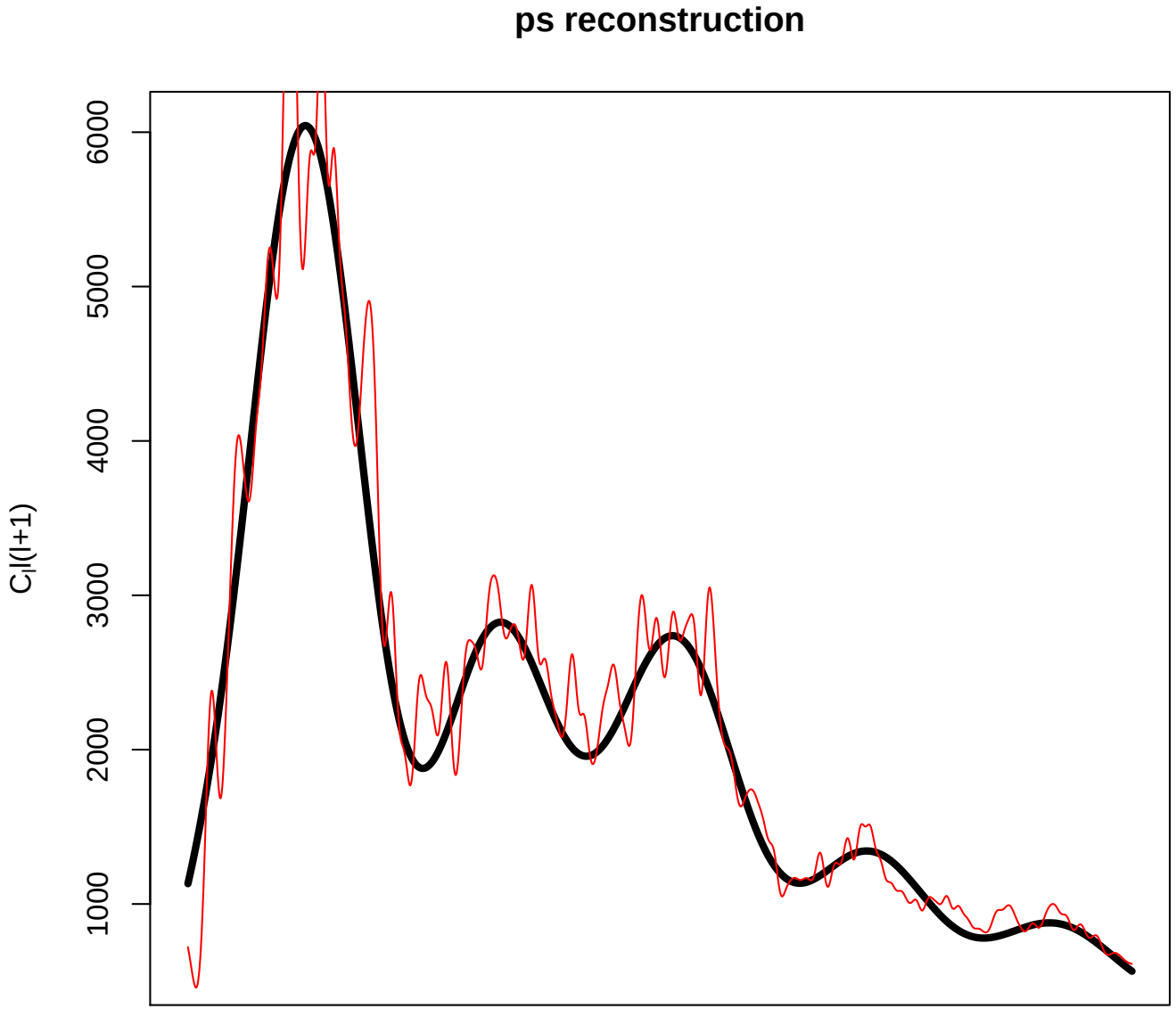


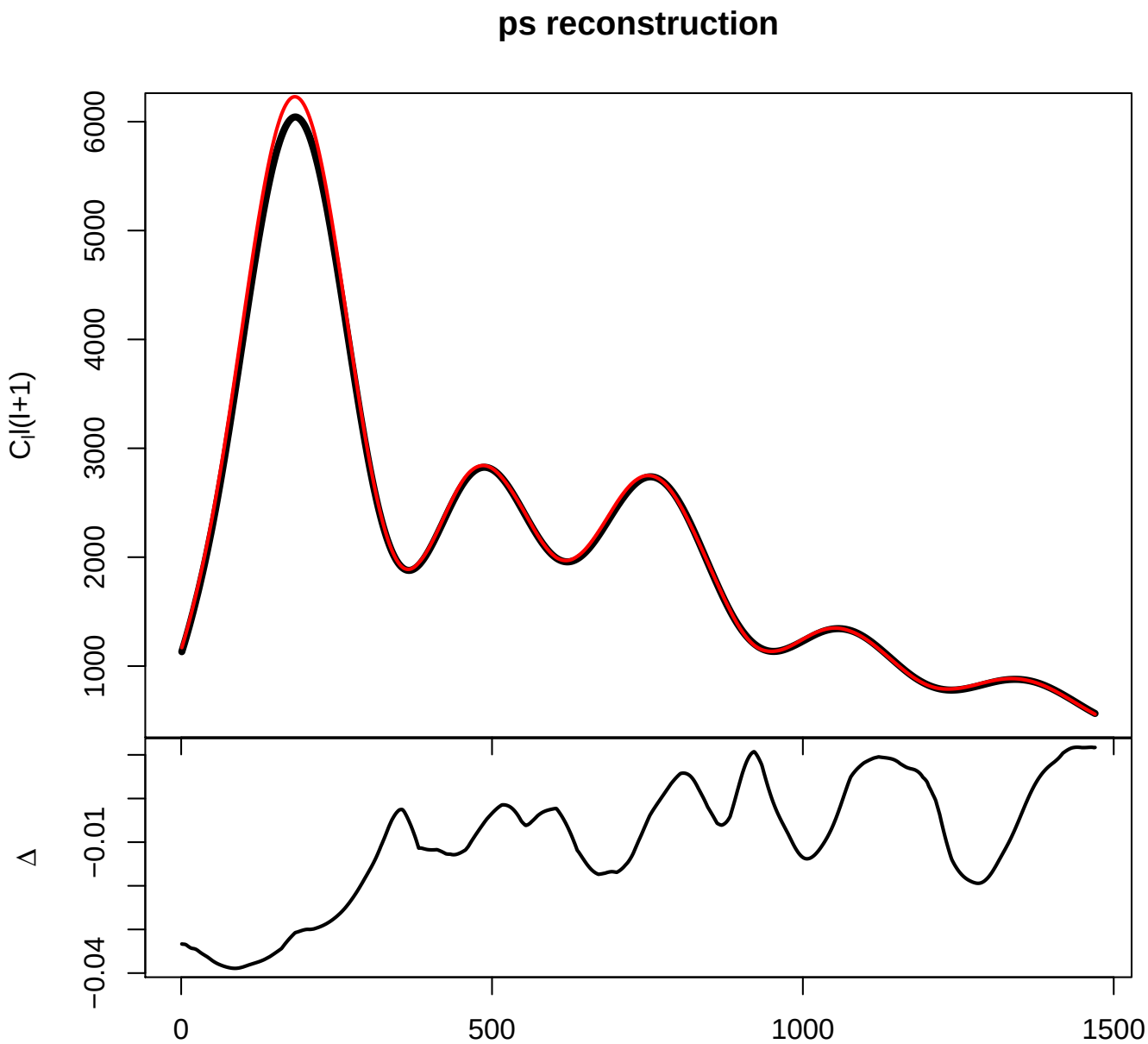
Denoising Autoencoders




ps reconstruction
C_l(l+1)
1000
2000
3000
4000
5000
6000

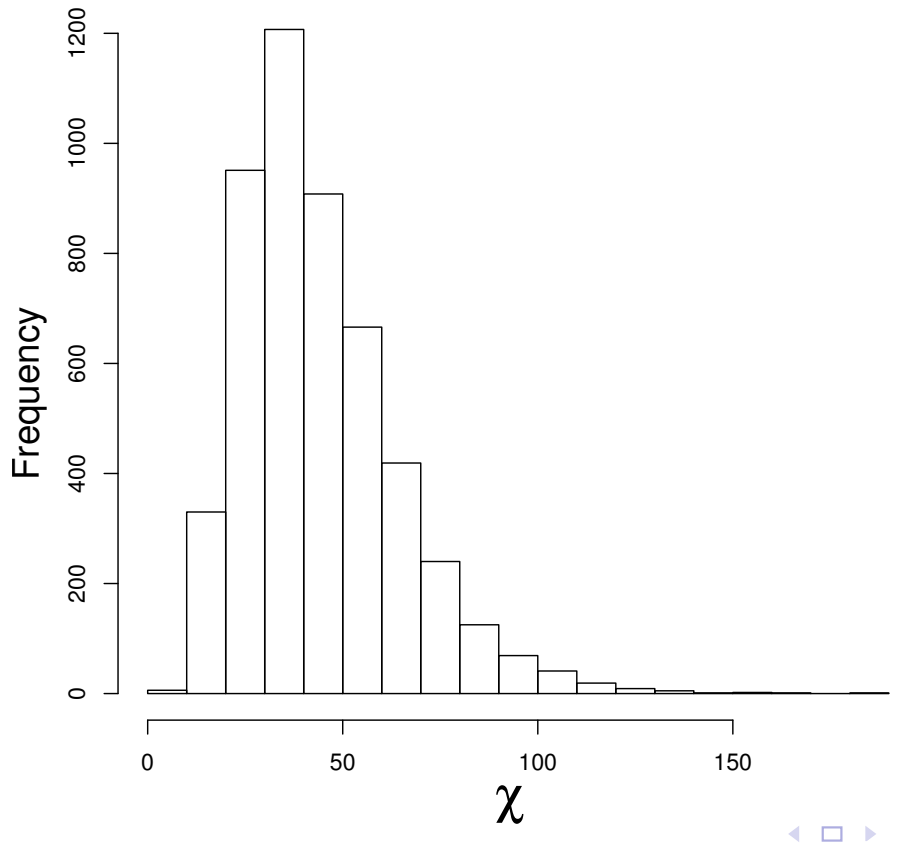

ps reconstruction
C_l l(l+1)
1000
2000
3000
4000
5000
6000
Δ
0.06
0.02
−0.02
0
500
1000
1500

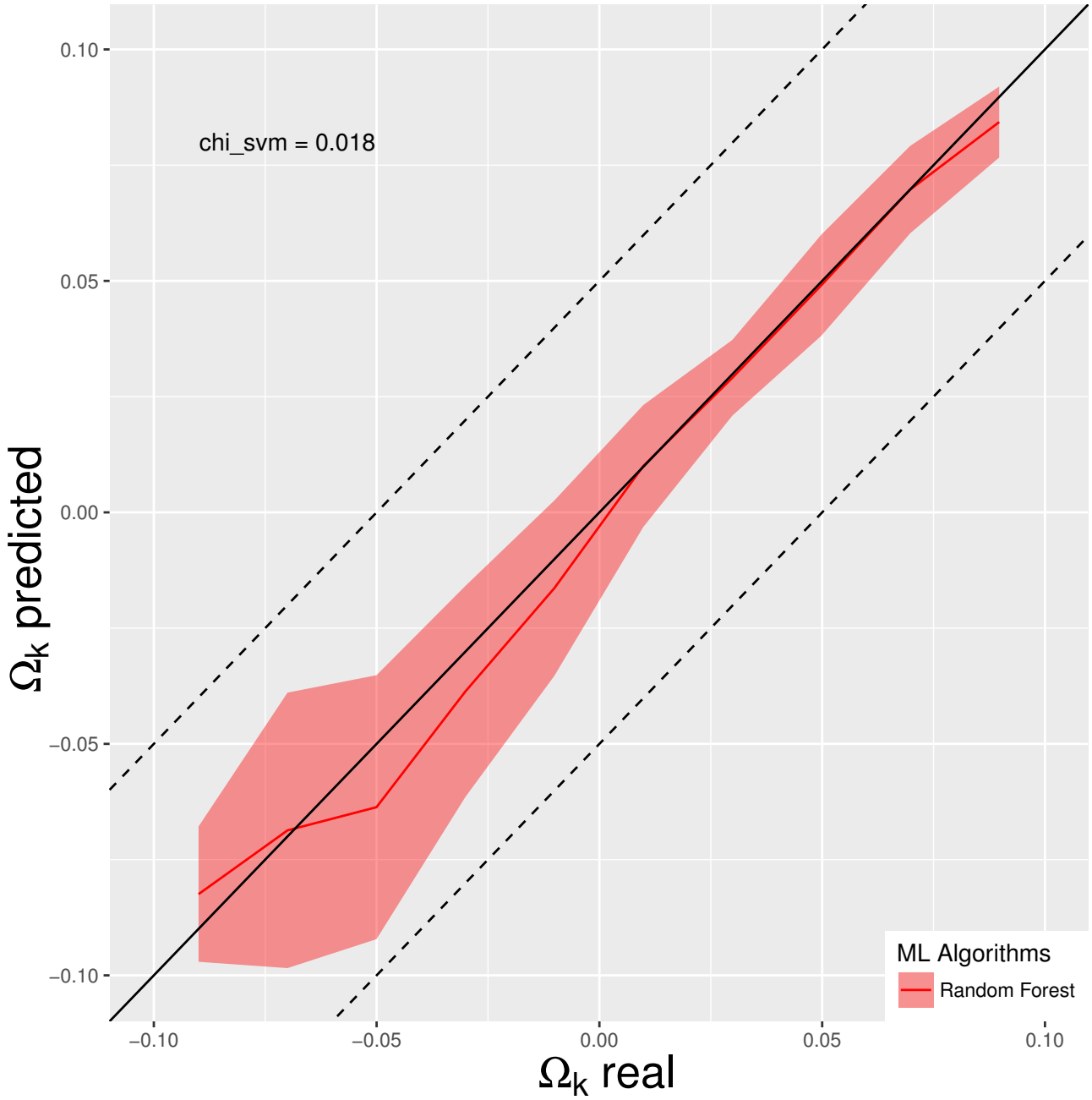

ps reconstruction
C_l l(l+1)
1000
2000
3000
4000
5000
6000

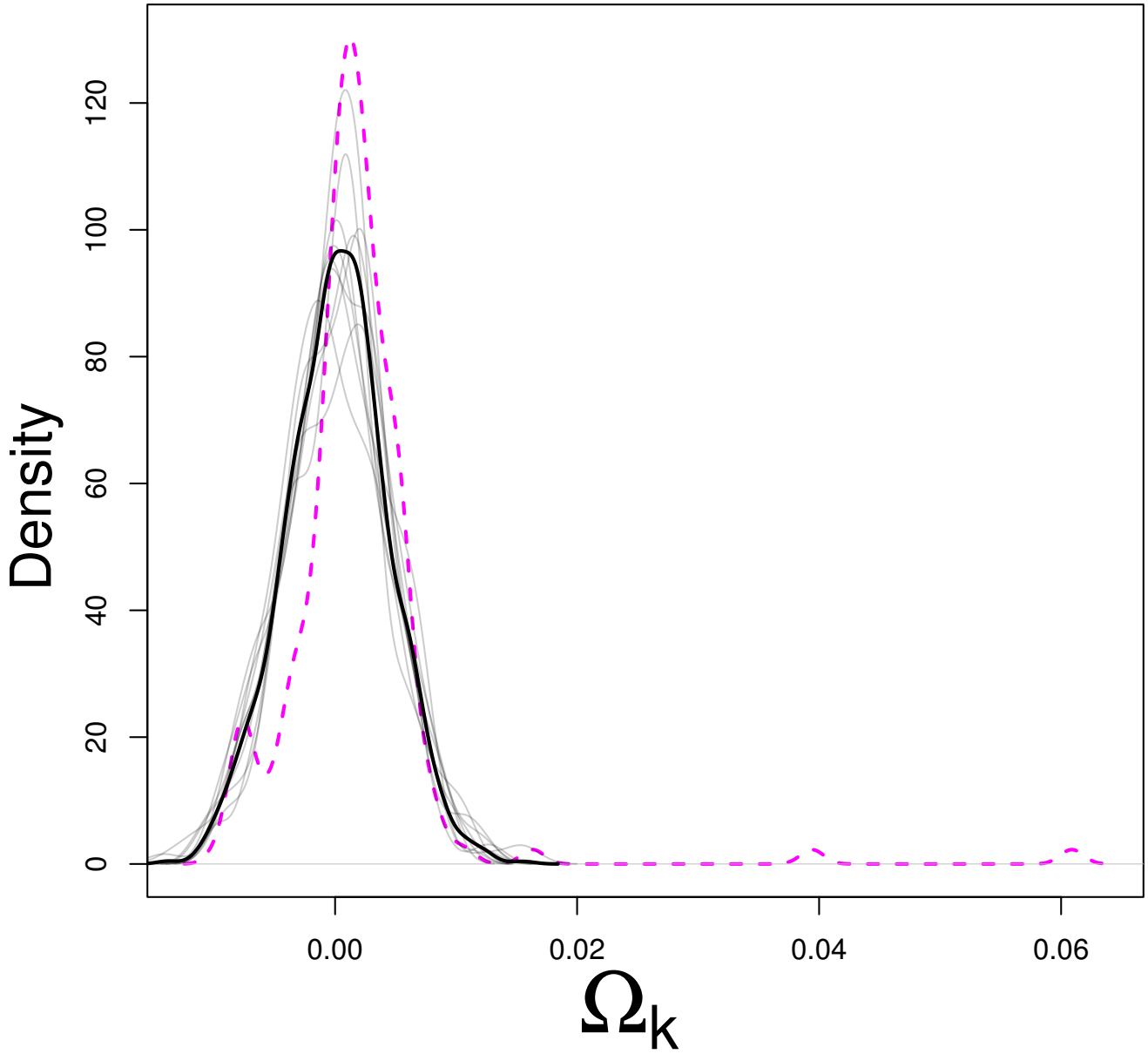

ps reconstruction
C_l(l+1)
1000
2000
3000
4000
5000
6000
Δ
−0.04
−0.01
0
500
1000
1500

Measuring the cosmological parameters angular distributions.

$$\chi = \frac{\sum_{i=1}^{npix} |C_{l,real} - C_{l,rec}|}{npix}$$




chi_svm = 0.018
0.10
0.05
0.00
−0.05
−0.10
−0.10
−0.05
0.00
0.05
0.10
Ωk predicted
Ωk real
ML Algorithms
Random Forest


Density
0
20
40
60
80
100
120
0.00
0.02
0.04
0.06
Ω_k

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 are studying the angular distribution of the cosmological parameters.
- We do not found any significant curvature departure from what is expected in an homogeneous and isotropic univese, with the exception of some pixels that are in the galactic plane.
- 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!!

Changing the minimum mutipole.