Cosmology on the Beach

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# Neural nets in cosmological analysis

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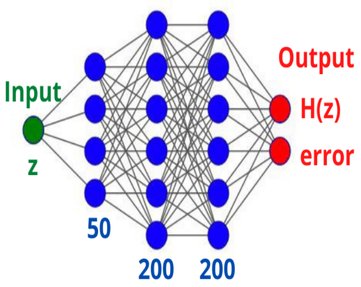
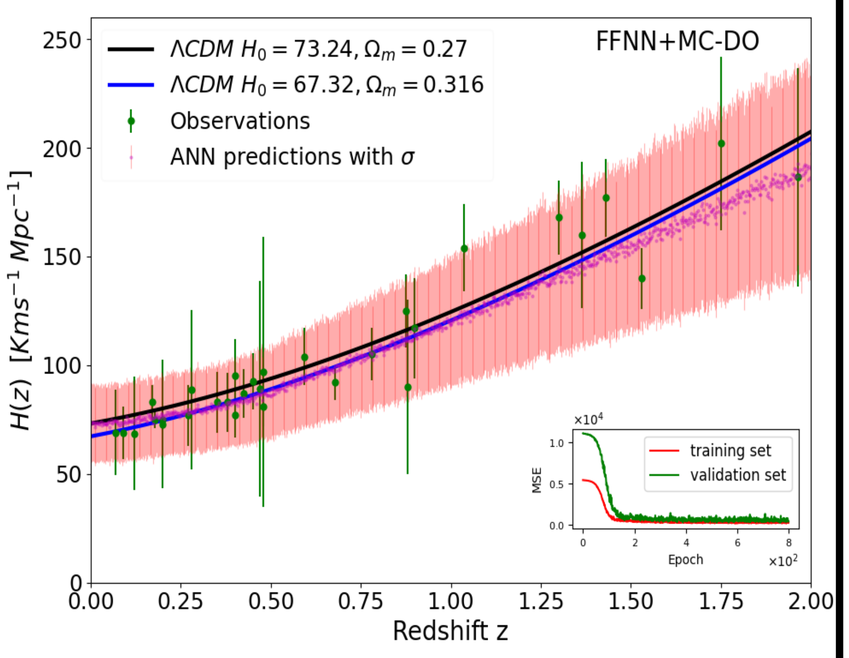
## Introduction

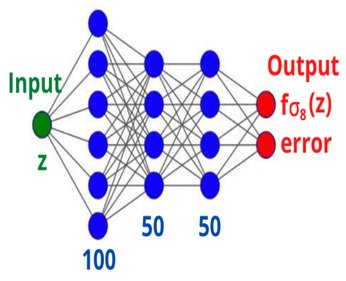
In this poster we present our recent insights in different cosmological contexts. In particular, we show a methodology for using neural networks to perform model-independent reconstructions of cosmological functions and a suggested use of genetic algorithms to find their hyperparameters. In addition, we present a method to speed up a Bayesian inference process with neural networks.

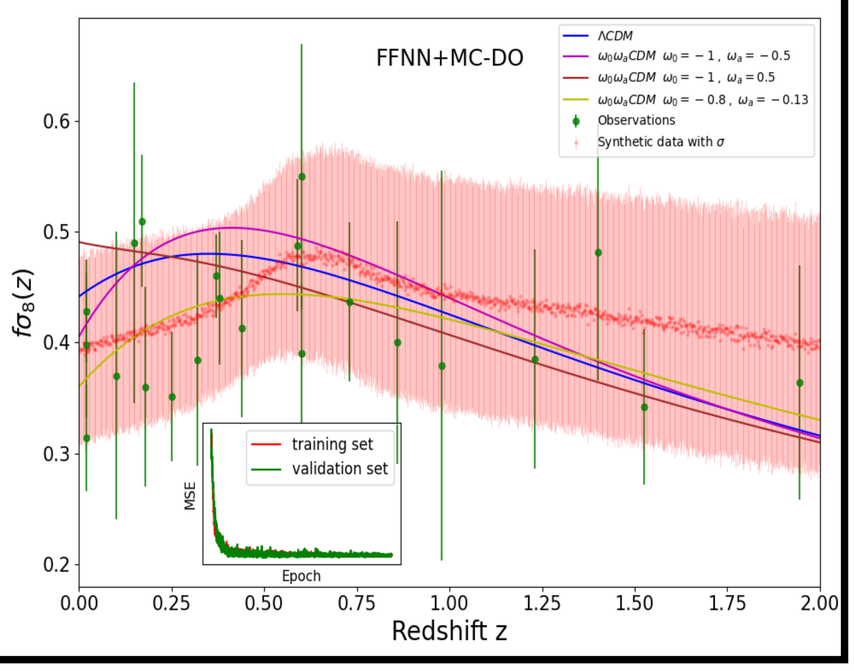
## Neural reconstructions

Model-independent reconstructions for cosmological functions with neural networks and Monte Carlo Dropout for small observational datasets, without any statistical or theoretical assumptions.



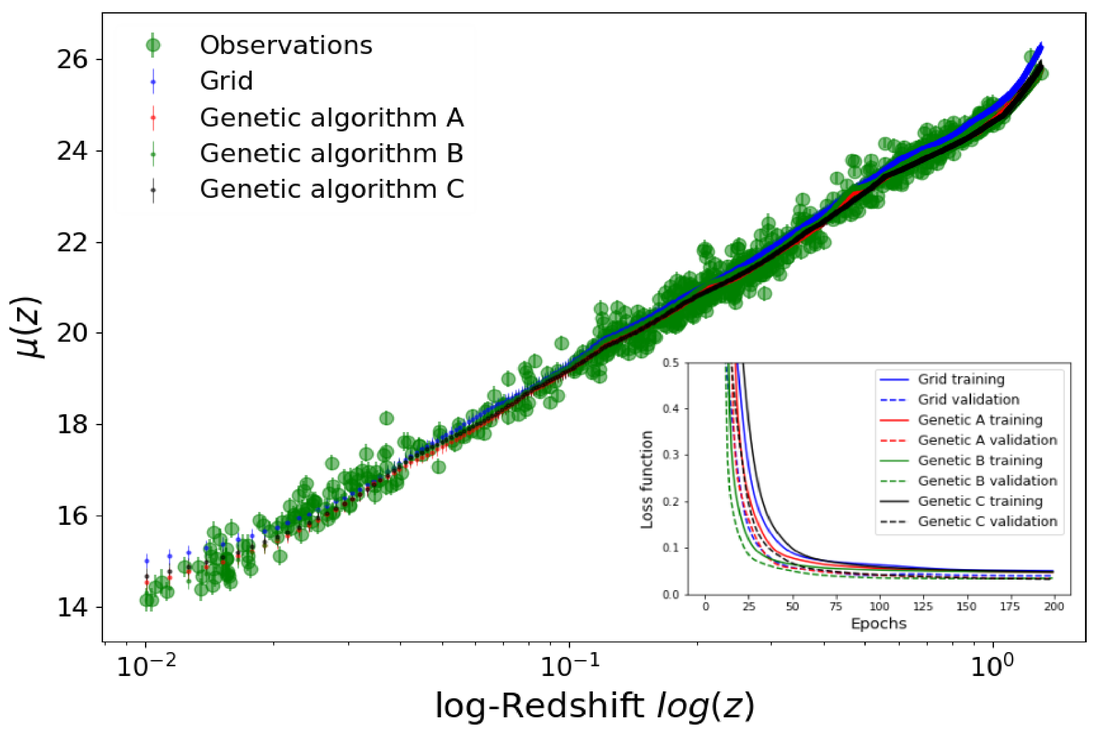



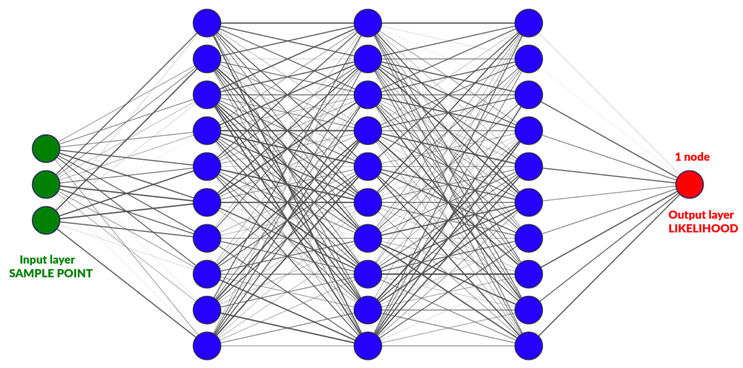

## Tunning with genetic algorithms

A correct selection of the hyperparameters in a neural network is crucial. A bad neural model could suggest meaningless physical interpretations.



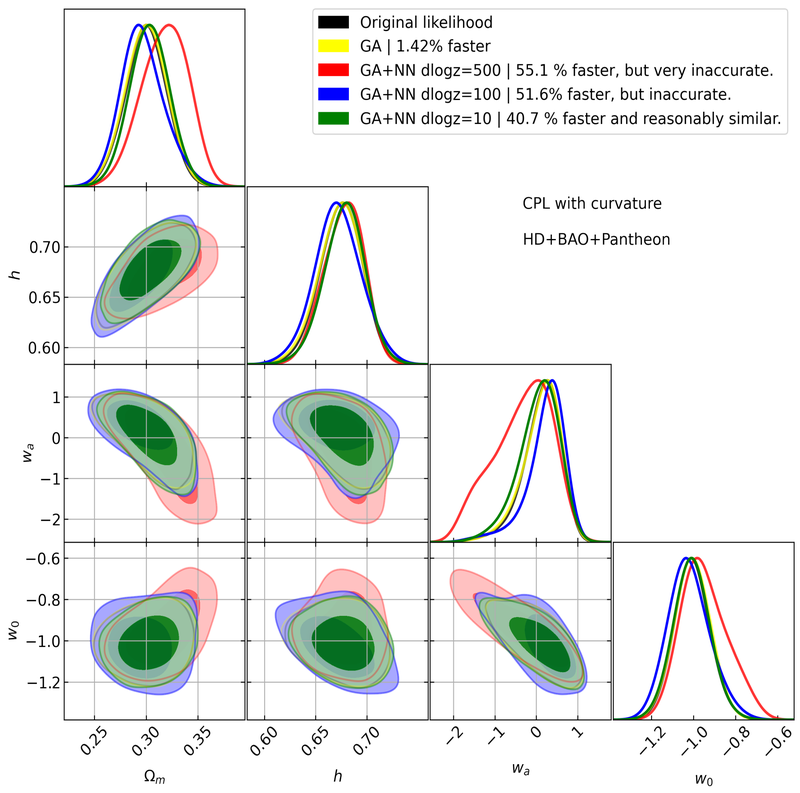

## Accelerating Bayesian Inference

We use neural networks and genetic algorithms to speed up the execution of real-time nested sampling. Genetic algorithms generate the first live points to ensure an idea of the maximum likelihood value, and then neural networks are used to learn the likelihood function and replace its, sometimes computationally expensive, analytical evaluation.




Generate the initial live points with GA
**for** *i in range*(iteration) **do**
  **if** $dlogz_i < dlogz$ **then**
    Train ANN with live points
    **if** *loss function* <*criterion* **then**
      $\mathcal{L} = \mathcal{L}_{ANN}$
      **if** $i\,\%neval == 0$ **then**
        Sampling samples with original.
        **if** *Originals are similar to neuronals* **then**
          Continue
        **else**
          $\mathcal{L} = \mathcal{L}_{original}$
          Break
  **else**
    continue with NS
**end**

***Example:*** Around 120,000 likelihood evaluations with 1000 live points.




## Conclusion

ANNs can be a good complement in the cosmological data analysis, whether to model data or to optimize computational times. One must be careful with the selection of its hyperparameters. They are not substitutes for traditional methods, but they can be an interesting alternative.

## References

1. Gómez-Vargas, et. al. (2022). Neural Network Reconstructions for the Hubble Parameter, Growth Rate and Distance Modulus.
2. Gómez-Vargas, et. al. (2022). Neural Networks Optimized by Genetic Algorithms in Cosmology.

QR links for references 1 and 2, respectively.