

Errata of my PhD thesis

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I have prepared this errata based on the feedback I received from the opponents of my PhD thesis.

I have made incorrect formatting of the use of parentheses in many of the citations across the text, listing all these places here would be unnecessarily lengthy, so I would just like to note that the updated version of my PhD thesis has all the citations in the proper format.

Page 5. paragraph 1, line 9: The order of citations should be changed from: "e.g., (Bishop, 1997, 1994; Bishop, 2006)" to: "e.g., (Bishop, 1994; Bishop, 1997; Bishop, 2006)."

Page 7. paragraph 2, line 21: The abbreviation SZ was not previously introduced, thus the "SZ" should be changed to "Sunyaev-Zel'dovich (SZ)".

Page 10. paragraph 1: This paragraph should be omitted entirely as I have already mentioned this information at the beginning of this section.

Page 10. section 1.1.5.: All mentions of "max pooling" should be written without the dash, thus changing "max-pooling" to "max pooling".

Page 11. line 3 and caption of Fig.1.5: The " 5×5 " should be changed to " 4×4 ".

Page 13. line 8.: The abbreviation SMBH is not fully stated when introduced, the SMBH should be replaced by "super-massive black holes (SMBH)".

Page 13. line 10.: The abbreviation ICM is not fully stated when introduced, the first mention of "ICM" at this line should be replaced with "intra-cluster medium (ICM)".

Page 13. paragraph 2. line 7: The word "colossal" should be changed to "colossal".

Page 13. paragraph 3. line 5: The second footnote is misplaced and should be outside of the parentheses of the corresponding citation.

Page 13. paragraph 2. line 7: There is a missing comma after "observations". The text should correctly be like this: "observations, and".

Page 16. paragraph 2. line 4: The sentence should be: "Therefore, looking at a galaxy cluster at a certain wavelength, we observe a deficit of CMB luminosity".

Page 17. Section 1.3.1 paragraph 2, line 2: After the digit 10, there should be the percentage symbol "%" so this part of the text should read: "constitutes $\sim 10\%$ of the".

Page 23. Section 1.3.5 paragraph 2, line 7: There should be a space between "108" and "FR0".

Page 23. Section 1.3.5 paragraph 2, line 8: The mention of "FR0" on this line should be instead "FR0s".

Page 23. Section 1.3.5 paragraph 2, line 9: The mention of "FR0" on this line should be instead "FR0s", same as before.

Page 23. Section 1.3.5 paragraph 2, line 10: The mention of "FRI" on this line should be instead "FRIs".

Page 26. paragraph 1: At the end of the paragraph a new sentence should be added: "I have successfully published this work (Kosiba et al., 2020)."

Page 26. paragraph 1, line 3: There is a missing "the" before the word "construction".

Page 26. paragraph 2: At the end of the paragraph a new sentence should be added: "I have submitted this work to A&A and I am currently waiting for the referee's feedback."

Page 26. paragraph 3: At the end of the paragraph a new sentence should be added: "I have successfully published this work (Kosiba et al., 2023)"

Page 26. paragraph 4: At the end of the paragraph a new sentence should be added: "I have submitted this work to A&A and I am currently waiting for the referee's feedback."

Page 59. The Abstract of this paper is missing, there should be added an abstract section containing the following text:

The number density of galaxy clusters across mass and redshift has been established as a powerful cosmological probe, yielding important information on the matter components of the Universe. Cosmological analyses with galaxy clusters traditionally employ scaling relations, which are empirical relationships between cluster masses and their observable properties. However, many challenges arise from this approach as the scaling relations are highly scattered, may be ill-calibrated, depend on the cosmology, and contain many nuisance parameters with low physical significance.

In this paper, we develop an inference method that optimally extracts cosmological information from an X-ray survey, solely using count rates, hardness ratios and redshifts, without any prior knowledge of the scaling relations.

To achieve this, we analytically generate several datasets of 70 000 cluster samples with totally random combinations of cosmological and scaling relation parameters. Each sample in our simulation is represented by its galaxy cluster distribution in a count rate (CR) and hardness ratio (HR) space in multiple redshift bins. We trained Convolutional Neural Networks (CNNs) to retrieve the cosmological parameters from these distributions. We then used mixture density neural networks (MDNs) to predict the posterior probability distribution of Ω_m and σ_8 given an input galaxy cluster sample, without any prior on the scaling relations.

Using the survey area as a proxy for the number of clusters detected for fixed cosmological and astrophysical parameters, and hence of the Poissonian noise, we analyse various survey sizes. The 1σ errors of our density estimator on one of the target testing simulations are 1000 deg^2 : 15.2% for Ω_m and 10.0% for σ_8 ;

10 000 deg²: 9.6% for Ω_m and 5.6% for σ_8 . We also compare our results with a traditional Fisher analysis and explore the effect of an additional constraint on the redshift distribution of the simulated samples.

We demonstrate, as a proof of concept, that it is possible to calculate cosmological predictions of Ω_m and σ_8 without explicitly computing cluster masses and even, the scaling relation coefficients, avoiding potential biases resulting from such a procedure. Our regression and inference models do not have any knowledge of the scaling relations used to create the simulated X-ray observable diagrams; the coefficients can thus be considered as nuisance parameters.

Page 94. paragraph 3, last sentence: There is a mistake in that the Citation for Figure 4.3 is repeated twice. The second one should instead be for Figure 4.4.

Page 128. Section 5.7.2 line 2: The sentence should end with reference to the corresponding figures with the following parenthesis: (Figure 5.11, Figure 5.12, Figure 5.13, Figure 5.14, Figure 5.15, Figure 5.16).