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Constraining galactic star formation histories using metallicity gradients and deep learning

C. Jacobs[1*], N. Astronomer-Person[1], L. Zamenhof[1,2]

[1]Swinburne University of Technology, P.O. Box 218, Hawthorn Vic 3022, Australia
[2]University of Bialystok, ul. Świerkowa 20 B15-328 Białystok, Poland

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ABSTRACT

Understanding the star formation histories of galaxies is crucial for unraveling the mysteries of the universe's evolution. However, reconstructing the detailed past star formation activity of galaxies poses a formidable challenge due to the complex interplay of various physical processes involved. In recent years, machine learning algorithms have emerged as powerful tools for analyzing large-scale astronomical datasets and extracting valuable insights. We find that for galaxies with a log mass between 9.5 and 11 $M_{\odot}$, the α-gradient is 2.5 ± 0.5.

Key words: Galaxies — Strong lensing — Statistical Methods

1 INTRODUCTION

Various machine learning algorithms, including deep learning architectures have been successfully applied to characterize galaxy star formation histories (Smith and Johnson 2021, Hawkins 2019, Roberts and Hughes 2018). We explore the use of diverse data sources, ranging from optical and infrared imaging to spectroscopic data, as inputs for machine learning models. Furthermore, we discuss the incorporation of additional features, such as galaxy morphology, stellar populations, and environmental factors, to enhance the accuracy and interpretability of the predictions.

There are many strategies for training machine learning models (Schneider 2016, Williams and Lewis 2020), on star formation history data, including supervised, unsupervised, and semi-supervised learning approaches. We also address the importance of data augmentation techniques and the handling of uncertainties associated with observations.

Liu and Kim 2022 present case studies highlighting the application of machine learning methods to real observational datasets, demonstrating their ability to infer star formation histories accurately and efficiently. We discuss the advantages and limitations of these approaches, as well as potential avenues for future research.

Overall, this paper emphasizes the immense potential of machine learning in unlocking the secrets of galaxy star formation histories. The integration of advanced data analysis techniques with extensive observational datasets promises to revolutionize our understanding of the processes shaping galaxies over cosmic

*colinjacobs@swin.edu.au

time. By leveraging the power of machine learning, we can extract unprecedented insights into the intricate relationship between galaxies, their environments, and their star formation histories, ultimately leading to a more comprehensive understanding of the universe's evolution.

2 DATASET

Figure 1: A galaxy merger. This image is of course AI generated and completely fictional

In Figure 1, we see an image of a spiral galaxy merging with another galaxy, taken with the 8m Jacobs Telescope in Monto Malrealo, Iceland.

2.1 Correction for dust

Equation 1 demonstrates what slow software looks like.

$$O(n) = 2^n \tag{1}$$

$$x = -b \pm \frac{\sqrt{b^2 - 4ac}}{2a} \tag{2}$$

Refer back to it as Equation 2.

3 METHOD

We highlight the advantages of ML techniques in providing accurate and precise estimates of galaxy SFHs, enabling a deeper understanding of galaxy formation and evolution. ML models offer the ability to capture complex non-linear relationships between observables and physical parameters, leading to improved characterization of stellar populations and identification of distinct evolutionary phases. Additionally, ML algorithms facilitate the handling of large datasets and the development of robust and automated pipelines for SFH inference.

Furthermore, we discuss the importance of careful data preprocessing, feature engineering, and model selection in ML-based SFH estimation. We also outline the challenges associated with interpretability, generalization, and the integration of physical priors into ML frameworks.

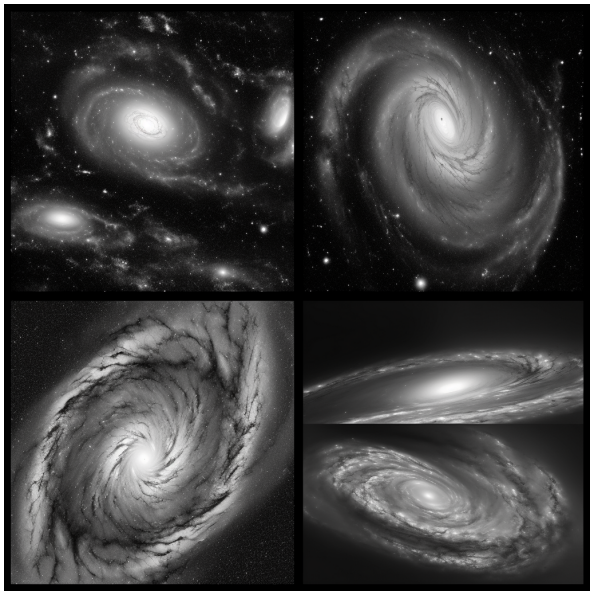

Figure 2: Further examples of beautiful but made up galaxies.

Finally, we present a future outlook on the potential of ML techniques in advancing our understanding of galaxy formation and evolution. We discuss possible directions for further research, including the incorporation of additional data sources, refinement of ML architectures, and the development of hybrid approaches that combine physical models with ML algorithms.

In conclusion, the synergy between galaxy star formation histories and machine learning provides a promising avenue for unraveling the intricate processes governing the formation and evolution of galaxies. By leveraging the power of ML algorithms, we can unlock unprecedented insights into the cosmic journey of galaxies, paving the way for future breakthroughs in astrophysics and cosmology.

4 SUMMARY AND CONCLUSIONS

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At etiam Athenis, ut e patre audiebam facete et urbane Stoicos irridente, statua est in quo a nobis philosophia defensa et collaudata est, cum id, quod maxime placeat, facere possimus, omnis voluptas assumenda est, omnis dolor repellendus. Temporibus autem quibusdam et aut officiis debitis aut rerum necessitatibus saepe eveniet, ut et voluptates repudiandae sint et molestiae non recusandae. Itaque earum rerum defuturum, quas natura non depravata desiderat. Et quem ad me accedis, saluto: 'chaere,' inquam, 'Tite!' lictores, turma omnis chorusque: 'chaere, Tite!' hinc hostis mi Albucius, hinc inimicus. Sed iure Mucius. Ego autem mirari satis non queo unde hoc sit tam insolens domesticarum rerum fastidium. Non est omnino hic docendi locus; sed ita prorsus existimo, neque eum Torquatum, qui hoc primus cognomen invenerit, aut torquem illum hosti detraxisse, ut aliquam ex eo est consecutus? – Laudem et caritatem, quae sunt vitae sine metu degendae praesidia firmissima. – Filium morte multavit. – Si sine causa, nollem me ab eo delectari, quod ista Platonis, Aristoteli, Theophrasti orationis ornamenta neglexerit. Nam illud quidem physici, credere aliquid esse minimum, quod profecto numquam putavisset, si a Polyaeno, familiari suo, geometrica discere maluisset quam illum etiam ipsum dedocere. Sol Democrito magnus videtur, quippe homini erudito in geometriaque perfecto, huic pedalis fortasse; tantum enim esse omnino in nostris poetis aut inertissimae segnitiae est aut fastidii delicatissimi. Mihi quidem videtur, inermis ac nudus est. Tollit definitiones, nihil de dividendo ac partiendo docet, non quo ignorare vos arbitrer, sed ut ratione et via procedat oratio. Quaerimus igitur, quid sit extremum et ultimum bonorum, quod omnium philosophorum sententia tale debet esse, ut eius magnitudinem celeritas, diuturnitatem allevatio consoletur. Ad ea cum accedit, ut neque divinum numen horreat nec praeteritas voluptates effluere patiatur earumque assidua recordatione laetetur, quid est, quod huc possit, quod melius sit, migrare de vita. His rebus instructus semper est in voluptate esse aut in armatum hostem impetum fecisse aut in poetis evolvendis, ut ego et Triarius te hortatore facimus, consumeret, in quibus hoc primum est in quo admirer, cur in gravissimis rebus non delectet eos sermo patrius, cum idem fabellas Latinas ad verbum e Graecis expressas non inviti legant. Quis enim tam inimicus paene nomini Romano est, qui Ennii Medeam aut Antiopam Pacuvii spernat aut reiciat, quod se isdem Euripidis fabulis delectari dicat, Latinas litteras oderit? Synephebos ego, inquit, potius Caecilii aut Andriam Terentii quam utramque Menandri legam? A quibus tantum dissentio, ut, cum Sophocles vel optime scripserit Electram, tamen male conversam Atilii mihi legendam putem, de quo Lucilius: 'ferreum scriptorem', verum, opinor, scriptorem tamen, ut legendus sit. Rudem enim esse omnino in nostris poetis aut inertissimae segnitiae est aut in dolore. Omnis autem privatione doloris putat Epicurus.

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