MNRAS 000, 1–2 (2015) Preprint 26 September 2017 Compiled using MNRAS LATEX style file v3.0

Efficiently sampling rare events in population synthesis models

Floor Broekgaarden,[1⋆] Stephen Justham,[1,2] Ilya Mandel[1,3] Jonathan Gair[1,4] Tassos Fragos
[1] Niels Bohr Institute Copenhagen
[2] Kavli Beijing
[3] U of Birmingham
[4] U of Birmingham
[5] U of Birmingham

Accepted XXX. Received YYY; in original form ZZZ

ABSTRACT

We find that importance sampling methods can significantly enhance stellar evolution simulations. Binary population synthesis models are a versatile tool in astrophysics to simulate the evolution of populations of stars and compare theory and observations. They include a large variety of underlying binary interaction processes that are challenging to model and induce uncertainties in the outcome of the model. Hence, to fully understand the simulations outcome and subsequently the underlying physics, it is important to incorporate uncertainty from the beginning of the model instead of as an afterthought, to reduce its computational cost. Especially when simulating rare events such as gravitational waves. We find that importance sampling methods can reduce the costs of the simulation up to a factor ~ 100.

Key words: importance sampling – population synthesis – keyword3

1 INTRODUCTION

Rapid binary population synthesis models are a versatile tool in astrophysics to simulate the evolution of populations of stars and compare theory and observations. Examples are for example binary_c, Startreck, SEBA and COMPAS. These models interpolate the physics fro more detailed models, and can therefore present a rapid simulation that can handle the evaluation of many stars, i.e. a population. Nevertheless, due to the multiscale simulations and comlex physics involving many parameters, it becomes computational expensive to simulate a large variety of poulations, which therefore limits our exploration of the parameter space and understanding of our model outcome. Especially considering ever growing complexity in the model. Hence it is important to reduce the costs of the simulation, especially for the next generation population synthesis models. (and based on more detailed They are based on and interpolate Hurley etc.) Especially rare events (GWs are rare events)

All papers should start with an Introduction section, which sets the work in context, cites relevant earlier studies in the field by Others (2013), and describes the problem the authors aim to solve (e.g. Author 2012).

2 METHODS

2.1 COMPAS

2.2 adaptive Importance Sampling

2.3 Maths

Simple mathematics can be inserted into the flow of the text e.g. $2 \times 3 = 6$ or $v = 220\,\mathrm{km\,s^{-1}}$, but more complicated expressions should be entered as a numbered equation:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}. \tag{1}$$

Refer back to them as e.g. equation (1).

2.4 Figures and tables

Figures and tables should be placed at logical positions in the text. Don't worry about the exact layout, which will be handled by the publishers.

Figures are referred to as e.g. Fig. 1, and tables as e.g. Table 1.

⋆ E-mail: mn@ras.org.uk (KTS)

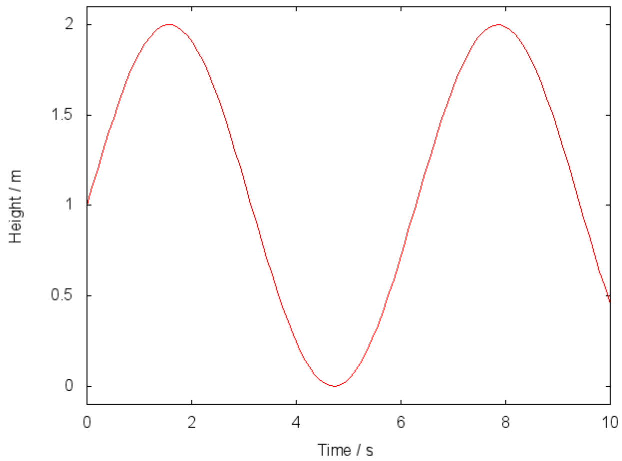

Figure 1. This is an example figure. Captions appear below each figure. Give enough detail for the reader to understand what they're looking at, but leave detailed discussion to the main body of the text.

Table 1. This is an example table. Captions appear above each table. Remember to define the quantities, symbols and units used.

A	B	C	D
1	2	3	4
2	4	6	8
3	5	7	9

3 RESULTS

4 CONCLUSIONS

The last numbered section should briefly summarise what has been done, and describe the final conclusions which the authors draw from their work.

ACKNOWLEDGEMENTS

The Acknowledgements section is not numbered. Here you can thank helpful colleagues, acknowledge funding agencies, telescopes and facilities used etc. Try to keep it short.

REFERENCES

Author A. N., 2013, Journal of Improbable Astronomy, 1, 1

Others S., 2012, Journal of Interesting Stuff, 17, 198

APPENDIX A: SOME EXTRA MATERIAL

If you want to present additional material which would interrupt the flow of the main paper, it can be placed in an Appendix which appears after the list of references.

This paper has been typeset from a TEX/LATEX file prepared by the author.