University of Glasgow | School of Physics & Astronomy

16 July 2020

Dear Editor,

We are pleased to provide a substantially revised manuscript for your consideration. The changes that we have made have been guided by the insightful comments provided by the Nature referees and we are confident that we have addressed all of their concerns.

The motivation for our work still remains the same - the speed that data can be processed to obtain accurate estimates of source parameters is a key issue for gravitational wave astrophysics. The current latency for obtaining source sky position information is O(1) min and this speed is crucial for rapid follow-up with electromagnetic telescopes. The complete Bayesian analyses are significantly more computationally costly and for the current LIGO O3 run have taken between 6 hours and 5 days per event. Our new (and now enhanced) machine learning approach to gravitational wave parameter estimation is equivalent in accuracy to that of existing complete Bayesian methods and can generate results ~6 orders of magnitude faster. We are therefore able to produce parameter estimates in under a second using minimal computational resources.

Based on referee comments, we have made several changes to the analysis and additions to the manuscript. We now include multi-detector data and have incorporated convolutional neural networks to better handle this increased multi-channel complexity. We have expanded the scope of our inference to include additional source parameters (most importantly, the sky location). Some of these additional parameters have a complex multi-modal structure and as such we have include a multi-component latent space model to deal with this. Finally, we now incorporate physically motivated distributions to infer gravitational wave parameters using our conditional variational autoencoder method.

In light of the many improvements we have now implemented we remain hopeful that you would consider this for publication in Nature Physics Letters.

Yours sincerely,

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