Searching for binary neutron stars using machine learning

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Introduction

Source: Chu 2017

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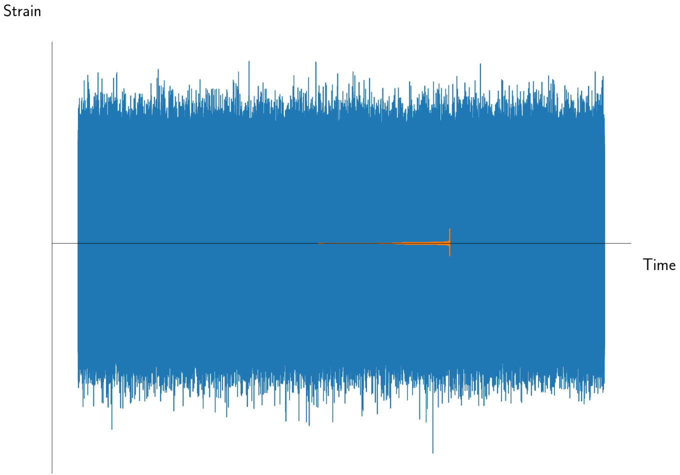
Introduction



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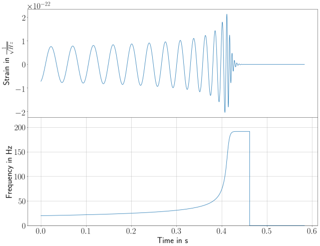

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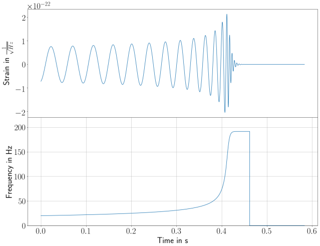

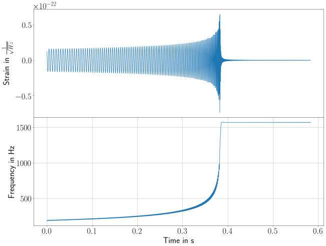

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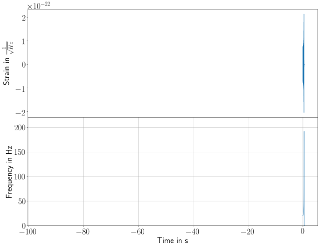

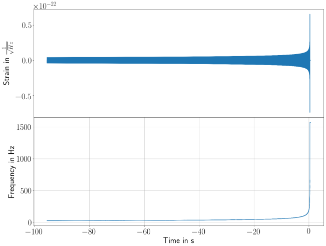

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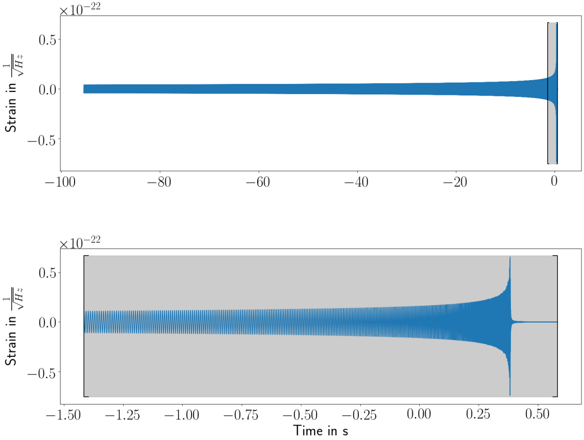
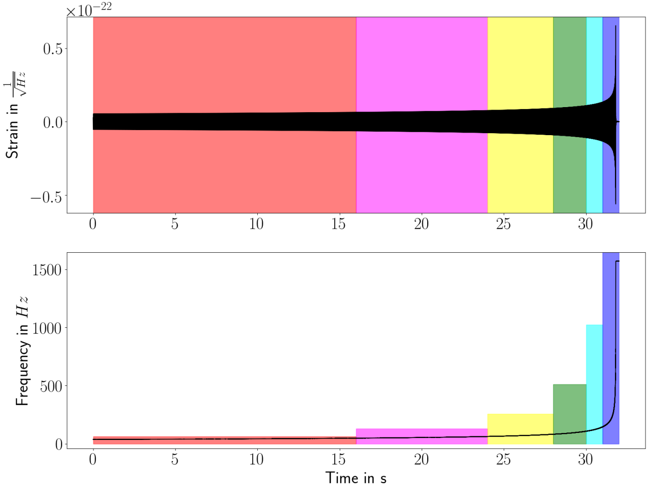
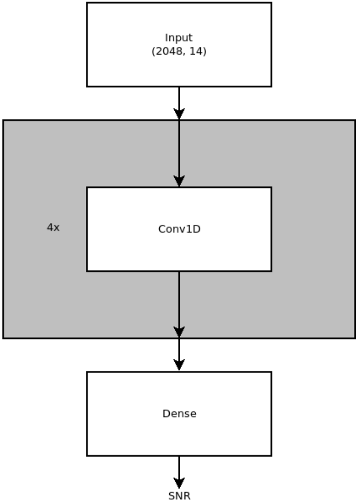


Strategy of Krastev 2019.

Introduction

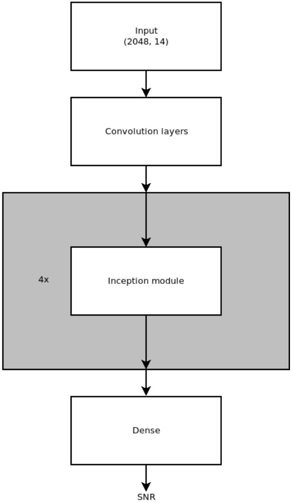


Architectural choices



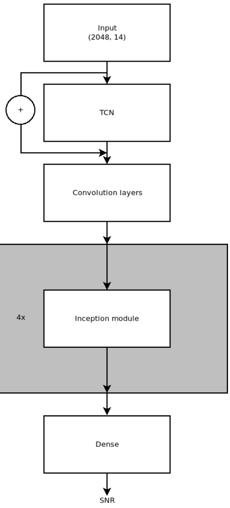
Architecture inspired by Gabbard et al. 2018; George and Huerta 2018.

Architectural choices



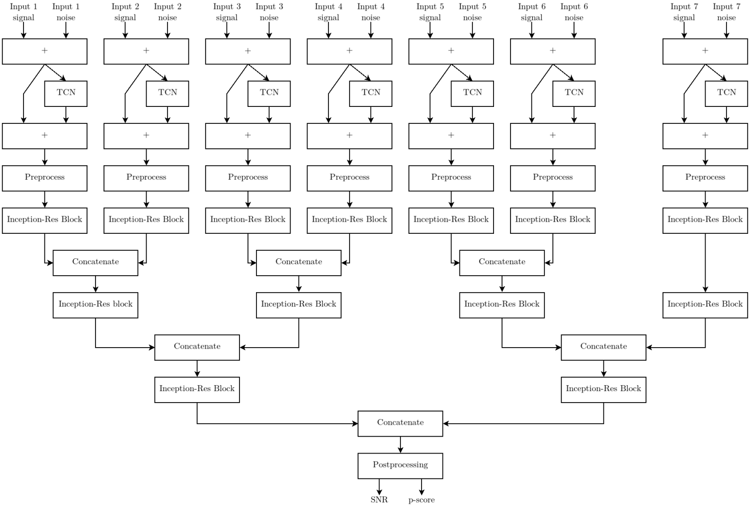
Use of inception modules inspired by Szegedy et al. 2015.

Architectural choices



Schmitt et al. 2019; Wei and Huerta 2019; Bai, Kolter, and Koltun 2018

Architectural choices



Publication in preparation.

Loss

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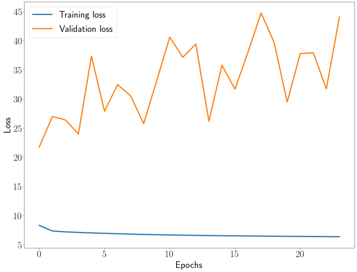
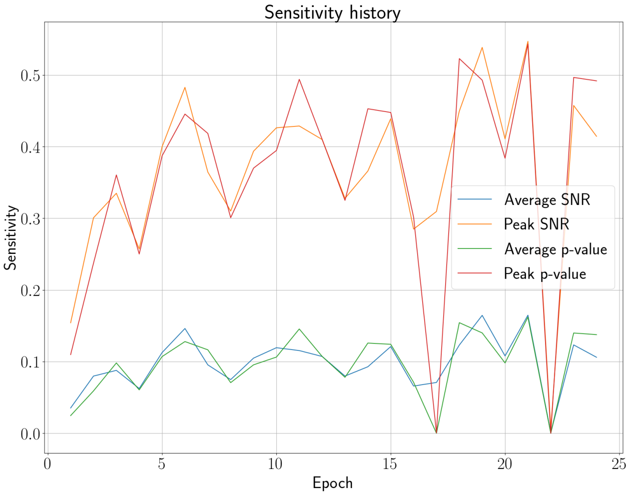
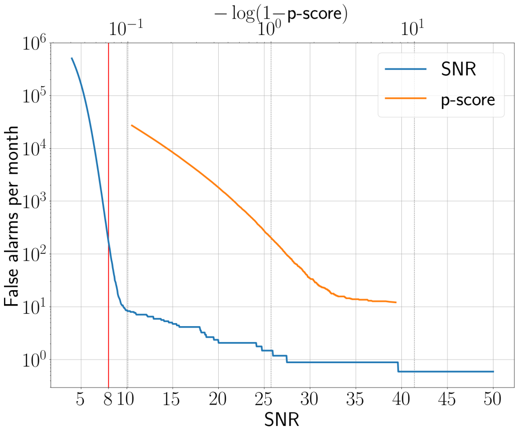


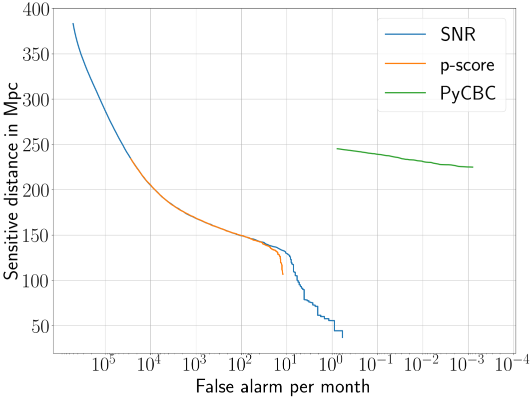
Sensitivity estimate



False-alarm rate (preliminary, publication in preparation)

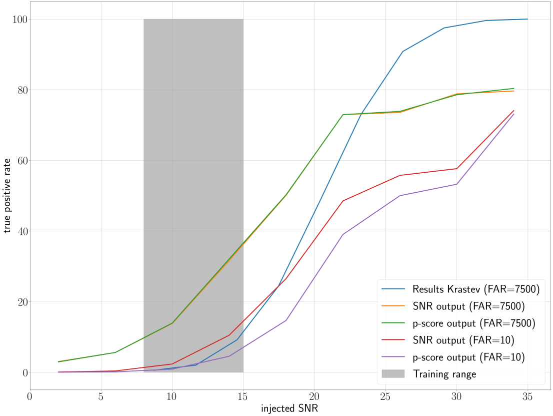


Sensitive volume (preliminary, publication in preparation)



PyCBC curve derived from currently used search algorithm Nitz et al. 2017.

Comparison to previous works (preliminary, publication in preparation)



Comparison to Krastev 2019.

Conclusion

- Introduced novel way of reducing input samples for gravitational wave data analysis.
- Introduced new architecture.
- Improved on state of the art performance for binary neutron star detection using machine learning.
- Provided a robust way of evaluating neural network search pipelines that makes them comparable to other searches.
- Not yet at a stage where machine learning is able to be used as a standalone search as current ones are computationally more efficient and sensitive.

Chu, Jennifer (2017). *GW170817 Press Release*. URL: https://www.ligo.caltech.edu/page/press-release-gw170817 (cit. on p. 2).

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Gabbard, Hunter et al. (Apr. 2018). "Matching Matched Filtering with Deep Networks for Gravitational-Wave Astronomy". In: *Phys. Rev. Lett.* 120 (14), p. 141103. DOI: 10.1103/PhysRevLett.120.141103 (cit. on p. 9).

George, Daniel and E. A. Huerta (Feb. 2018). "Deep neural networks to enable real-time multimessenger astrophysics". In: *Phys. Rev. D* 97 (4), p. 044039. DOI: 10.1103/PhysRevD.97.044039 (cit. on p. 9).

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Wei, Wei and E. A. Huerta (2019). "Gravitational Wave Denoising of Binary Black Hole Mergers with Deep Learning". In: arXiv: 1901.00869 (cit. on p. 11).

Bai, Shaojie, J. Zico Kolter, and Vladlen Koltun (2018). "An Empirical Evaluation of Generic Convolutional and Recurrent Networks for Sequence Modeling". In: *CoRR* abs/1803.01271. arXiv: 1803.01271 (cit. on p. 11).

Nitz, Alexander H. et al. (Nov. 2017). "Detecting Binary Compact-object Mergers with Gravitational Waves: Understanding and Improving the Sensitivity of the PyCBC Search". In: *The Astrophysical Journal* 849.2, p. 118. DOI: 10.3847/1538-4357/aa8f50 (cit. on p. 19).