

## ***Interactive comment on* “HESS Opinions: Deep learning as a promising avenue toward knowledge discovery in water sciences” *by* Chaopeng Shen et al.**

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Received and published: 15 June 2018

The manuscript titled “Deep learning as a promising avenue toward knowledge discover in water sciences” conveys the opinion that hydrology is a field well suited for deep learning and that deep learning techniques should be widely applied to increase our understanding of hydrologic systems.

While I agree with the authors’ general premise and believe the article can have a great impact on the direction of the technical analysis of future hydrological studies, I also was disappointed to not see two primary topics. The first of which is a summary of how deep learning has been integral in other fields to increase knowledge discovery of other

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fields of science. The second and more important topic would be the presentation of a general framework of how to apply the techniques of deep learning to open or poorly understood problems within the hydrologic sciences. Section 4 does present some ideas of areas that deep learning may be applied, but a framework of how to apply DL techniques to these problems would help convince the reader of their utility.

The manuscript is generally well written, but I would recommend more attention to simplifying the verbiage and clarify the message of the paper. To help communicate this further, I included examples within the specific comments below as a guide. With thoughtful revision, I believe that this paper can serve the community well to help show the utility of deep learning techniques. I also think that the inclusion of a companion paper to explain the more technical aspects of deep learning was a very good decision.

Specific Comments: I have included some specific comments that should be revised and used as examples to help guide the authors in their overall revision. Page 2 Line 19: “deep networks are differentiable from outputs to inputs, giving them practical advantages in efficient parameter optimization via backpropagation (training).” It is not clear to me what is meant by differentiable from outputs to inputs. I believe that the concept the authors are trying to communicate here is simple, but it is not done so effectively.

Page 2 Line 23-24: “Moreover, the differentiable nature allows for greater success for interpolation and mild extrapolation, contributing to the strong generalization capability of DL.” This sentence is very thick in jargon. I would suggest simplifying the verbiage to improve readability and connection to the rest of the paper.

Page 4 Line 9-10: “As a result, over time, some may have grown dispassionate about progress in machine 10 learning, and some may have concerns about whether DL is a real progress or just a “hype.” While I believe that the authors do reflect the sentiment of some within the community to the promise of machine learning, the opinion paper does not present much to dispel these feelings either. In accordance with the mention

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of my first point in General Comments, it would serve the paper to include some proof as to the utility of machine learning and deep learning.

Page 4 Line 14-15: “The progress brought forth by DL to the information technology industry is revolutionary (Section 4 in Shen17) and can no longer be ignored.” While a companion paper should compliment this paper, this opinion manuscript should also provide evidence to the point. This could even include a small summary of findings. It is natural to have some overlap between the papers, and I believe that this suggested overlap has purpose.

Page 10 Line 20: “Observations in hydrology and water sciences. . .” Some would consider hydrology to be a subset of water science and others may say that hydrology and water sciences are the same field named differently. While cleaning up the language used in the manuscript, I would also suggest using either hydrology or water science. This may be a small point but is one that should be echoed through the paper.

In addition to these specific comments, I would also encourage the authors to include the various references listed by reviewers 1 and 2. I do not personally have anything to add to these references, but they would serve to present a fuller picture of machine learning applications within hydrology.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2018-168>, 2018.

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