Qeios

Peer Review

Review of: "Annealed Stein Variational Gradient Descent for Improved Uncertainty Estimation in Full-Waveform Inversion"

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The paper examines the application of Annealed Stein Variational Gradient Descent (ASVGD) to improve uncertainty estimation in Full-Waveform Inversion (FWI). The authors provide numerical examples demonstrating that ASVGD has the potential to be effectively used in FWI. They compare ASVGD with vanilla SVGD and show that the annealed approach performs better in both multi-scale and single-scale experiments. Additionally, they note that the strategies discussed in the paper offer a robust and insightful approach to uncertainty analysis in FWI. While the research demonstrates novelty in implementing ASVGD in FWI, there are still areas where the paper could be improved.

The paper mainly compares ASVGD with SVGD, which fails to show the benefits of using these techniques instead of relying just on L^2 as the misfit function. Including an additional comparison between ASVGD and L^2 would remind the reader why new approaches like ASVGD are interesting. I would also include some discussion regarding the runtime of the techniques used. Figures A1 and 2 show the value of the misfit function at every iteration, but it was never mentioned how computationally expensive each iteration is to run. A graph showing the CPU runtime measured at every 100 iterations would be very nice to see.

Section 2 of the paper outlines the theoretical framework used in numerical experiments; however, the paper lacks theoretical results as to why one would think that ASVGD will perform better than L^2 in general. Proving certain convergence results would add significant value to the findings.

Section 2.5 felt rushed and hard to follow. I suggest expanding on it to increase clarity.

There are some minor typesetting errors that reduce the clarity of some equations. More specifically, the parentheses in equations 9 and 10 don't align with the fractions. The references to Figures A1, A2, and A3, A4 on the bottom of page 7 and page 8, respectively, reference the wrong figures. Equation 7 should also be on the same page as the final paragraph of page 4.

Overall, the proposed technique for addressing FWI is novel. However, it lacks a theoretical foundation that would enhance readers' confidence in the correctness and soundness of ASVGD in FWI. Expanding on the suggestions provided here could significantly increase the interest and impact of this research.

Declarations

Potential competing interests: No potential competing interests to declare.