**Peer-review report of**

Keetelaar, S., Sekulovski, N., Borsboom, D., & Marsman, M. (2024).Comparing maximum likelihood and maximum pseudolikelihood estimators for the Ising model. *advances.in/psychology, 2*, e25745. https://doi.org/10.56296/aip00013

## Round 1

Dear authors,

The paper was reviewed by an expert in network science and statistical physics. The reviewer appreciates the manuscript "Comparing Maximum Likelihood and Pseudo-Maximum Likelihood Estimators for the Ising Model" for its detailed exploration of the Ising model in network psychometrics. The paper is commended for its structure, clarity, and technical precision, particularly in its comparison of approximation methods and exact likelihood methods for parameter estimation in the context of the Ising model. The findings highlighting the effectiveness of the joint pseudolikelihood and the suitability of disjoint pseudolikelihood for larger samples are noted as significant contributions.

However, the reviewer suggests several improvements:

1. **Expanded Introduction**: A more detailed introduction to the Ising model and its relevance in network psychometrics is recommended for readers unfamiliar with the topic.

2. **Technical Questions:**

- **Small-World Networks**: The paper should address whether small-worldness was tested in the generated networks, referencing Newman's work for measuring small-worldness.

- **Simulation Details:** More information about the simulation settings and rationale for chosen parameters is needed for replication and extension by other researchers. The impact of disconnected components on likelihood estimation should be examined.

3. **Results Section and Visuals:** The clear findings in the Results section are praised, but the reviewer suggests replacing some tables with more readable visualizations and improving the legibility of labels in figures.

4. **Language and Terminology:** The use of consistent terminology and abbreviations (e.g., JPL for joint pseudolikelihood) is advised for clarity and brevity.

5. A**dditional Content Recommendations:**

- Include a table or list outlining the specific settings and parameters of the simulation study.

- Add a section on previous works related to the Ising model and pseudolikelihood methods to provide context.

- Break down the Discussion section into subsections for Discussion, Limitations, and Future Research.

6. **Psychological Implications:** The reviewer is interested in the psychological implications of considering psychometric networks with over 500 nodes and seeks examples or applications in multidimensional studies.

In summary, while the reviewer recommends revising the manuscript, they acknowledge its valuable contributions and suggest enhancements to broaden its appeal and clarity for the target audience.

Please, revise the manuscript and submit an improved version addressing all suggestions provided by the reviewer.

After carefully reading the paper, I agree with the reviewer's suggestions. I believe that after addressing the issues pointed by the reviewer the paper that is already very interesting and innovative, will be further improved.

Best wishes,

Hudson Golino

**Reviewer 1**

The manuscript, titled "Comparing Maximum Likelihood and Pseudo-Maximum Likelihood Estimators for the Ising Model" delves into the complexities of the Ising model within the domain of network psychometrics. This model's analysis is notoriously challenging due to a problematic normalising constant present in its probability function, i.e. only smaller graphs can be assessed using precise maximum likelihood estimation. For larger graphs, approximation methods come into play. This paper considers interesting simulation studies to juxtapose the performance of these approximation methods and the exact likelihood method concerning parameter estimation. The study's findings reveal that the joint pseudolikelihood offers a reliable and effective approximation to the maximum likelihood. In contrast, the disjoint pseudolikelihood is more suitable for larger sample sizes.

The manuscript is methodically structured, making it easier for the reader to follow the progression of ideas. The introduction provides a coherent overview of the significance of graphical models in representing the network structure of psychological variables. The manuscript is thus well written and motivated and authors should be praised for their technical attention to details. However, I have a few minor comments and 2 technical questions for the authors. For these reasons, I recommend revising the manuscript.

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Page 2 - For someone unfamiliar with the Ising model and its relevance in network psychometrics, a more in-depth introduction to the topic might be beneficial. Please consider expanding the paragraph starting with “Structure learning…“.

Major point: With a neighbourhood size of 2, small-world networks might not possess a mean local clustering coefficient substantially higher than random graphs. Have the authors tested small-worldness in the networks they generated? My favourite reference for testing small-worldness with a measure is Newman, Networks: An Introduction, 2018.

Major point: The comparison of the approximation methods and the exact likelihood method in terms of bias and variance offers valuable insights. However, details about the simulation settings, parameters chosen, and their rationale would enhance the paper's rigor and allow other researchers to replicate or extend the study. Figure 2 suggests that some random graphs might be disconnected, which is a problem for ER graphs with low density like those simulated here. I wonder if the authors managed to count separately disconnected components and whether the difference in connected component sizes might be the reasons behind the differences in likelihood estimation heuristics. Checking how much disconnectedness influences numerical results is vital for the publication of the manuscript.

Page 10 - The Results section seems to provide clear findings on the performance of the various estimation methods. Stating that the joint pseudolikelihood is a stable method for approximation and that the disjoint pseudolikelihood is suitable for larger sample sizes is a nice contribution to the field. However, I wonder whether Tables 2, 3 and 4 could be replaced by clearer and easier-to-read visualisations. Please notice that labels in Figure 4 are barely readable.

While the language is mostly clear, there are recurring terminologies that could be streamlined for brevity. For instance, when introducing terms like "joint pseudolikelihood" and "disjoint pseudolikelihood" in the abstract, consider using abbreviations (e.g., JPL and DJPL) in subsequent sections to reduce redundancy.

In the section detailing the simulation study, right after the mention of "an extensive simulation study," provide a table or list that outlines the specific settings and parameters chosen.

Before diving into the methodology, consider adding a brief section discussing previous works related to the Ising model and pseudolikelihood methods. This would contextualize your study's significance.

Please consider breaking down the Discussion section in Discussion/Limitations/Future Research subsections, for additional clarity.

Can you comment on the psychological meaning of considering psychometric networks with more than 500 nodes? What kind of examples might be considered? Multidimensional studies?

## Round 2

Dear Dr. Keetelaar and colleagues,

Thank you for your revised manuscript "Comparing Maximum Likelihood and Pseudo-Maximum Likelihood Estimators for the Ising Model." I appreciate your thorough response to the reviewer's comments and the changes made in this revision.

After carefully reviewing your revised manuscript and response letter, I am pleased to accept your paper for publication in the special issue of "Advances in Psychology" focusing on network methods.

The revised introduction provides helpful context on the Ising model in psychometrics for readers less familiar with the topic. The additional details on the simulation settings, parameters, and rationale enhance the study's reproducibility. Your thorough discussion of disconnectedness in the generated networks is appreciated.

The new visualizations and panel plots greatly improve the clarity and interpretability of the results. The expanded discussion of previous work on pseudolikelihood methods helps situate your study within the existing literature. Splitting the Discussion into subsections for limitations and future research also strengthens the manuscript.

Your revised manuscript offers, in my view, a valuable contribution to the field, providing important insights into the performance of maximum likelihood and pseudolikelihood estimation methods for the Ising model in psychometric networks.

The findings on the effectiveness of joint pseudolikelihood and suitability of disjoint pseudolikelihood for larger samples are noteworthy.

Thank you again for submitting your work to our special issue. I look forward to seeing the final published version.

Your paper will now enter into the production phase, and you might be contacted by the journal in case any copyediting modification is necessary.

Best wishes,

Hudson Golino