

Peer Review

Review of: "LoRaFlow: High-Quality Signal Reconstruction using Rectified Flow"

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Overall Assessment

This paper presents *LoRaFlow*, a novel approach to improving LoRa signal reception in low Signal-to-Noise Ratio (SNR) environments using rectified flow-based signal reconstruction. The authors successfully demonstrate the effectiveness of their method through extensive experimentation and comparisons with state-of-the-art techniques such as NELoRa. The paper is well-structured and provides a solid mathematical and empirical foundation. However, certain areas require clarification and improvements to enhance the clarity, completeness, and impact of the work.

Strengths

Novel Contribution: The paper introduces rectified flow for LoRa signal reconstruction, a significant advancement over classification-based approaches. The method integrates seamlessly with existing LoRa infrastructure, making it practically viable.

Technical Rigor: The authors provide a well-detailed mathematical formulation of the proposed method, including stochastic differential equations and probability flow ODEs, demonstrating strong theoretical grounding.

Comprehensive Performance Evaluation: The paper includes an extensive comparison with previous methods, using multiple metrics such as Signal Error Rate (SER), AUC, and qualitative signal reconstruction assessments.

Structured and Well-Organized: The logical flow from background to methodology, results, and discussion ensures ease of understanding for readers with a technical background in wireless

communications and machine learning.

Suggestions

1. Experimental Details

The comparison with NELoRa states that their models failed to outperform the baseline. It would be useful to clarify whether this discrepancy arises from different experimental conditions or implementation differences.

2. Tables

A table summarizing computational requirements (e.g., inference time per sample, GPU requirements) would strengthen the discussion on real-world applicability.

3. Future Work

The authors mention challenges in improving performance for higher spreading factors. Expanding on potential solutions (e.g., optimized batch sizes, alternative training strategies, hybrid architectures) would add value.

4. References

Some references to prior work could be more explicitly compared in the related work section rather than later in the discussion.

Recommendation

I recommend *acceptance with minor revisions*. The paper presents a strong contribution to the field of low-SNR LoRa signal recovery, and the suggested clarifications and refinements will further enhance its impact and readability.

Declarations

Potential competing interests: No potential competing interests to declare.