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Peer Review

Review of: "Predictive Coding Explains Asymmetric Connectivity in the Brain: A Neural Network Study"

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The study addresses a critical gap in predictive coding theory by focusing on non-reciprocal feedback, a feature observed biologically but underexplored computationally. The hypothesis that asymmetric feedback optimizes noise robustness in sensorimotor tasks is well-motivated by prior anatomical and functional evidence. The authors verified the theory by constructing predictive coding-based deep learning networks.

A primary concern lies in the undefined criteria for categorizing feedback as short-, medium-, or long-range. While the manuscript implies that feedback range depends on layer proximity (e.g., adjacent vs. distal layers), it lacks quantitative architectural metrics, such as the number of skipped layers. This ambiguity complicates cross-disciplinary comparisons; for instance, "medium-range" feedback in the model cannot be reliably mapped to primate corticocortical projections (e.g., V1→V4 vs. V1→parietal) without explicit spatial or hierarchical definitions.

Furthermore, the focus on a single task (robotic grasp planning) leaves open whether the observed "medium-range advantage" reflects a domain-general principle or task-specific demands. Grasp planning inherently requires mid-level feature integration (e.g., object orientation), which might favor medium-range feedback, whereas perceptual recognition or reinforcement learning tasks could prioritize different feedback ranges. Acknowledging the weakness in the discussion would be beneficial for further research.

The biological plausibility of the network architecture also needs further discussion. The use of ConvTranspose layers for feedback seems to be far from biological plausibility in laminar specificity, sparsity, and topographic organization. Cortical feedback typically targets distinct layers (e.g., Layer 1) with sparse, structured projections, contrasting with the model's dense, spatially invariant connections.

doi.org/10.32388/0R9FD9

Additionally, the choice of 15 recurrent timesteps lacks empirical or theoretical justification and seems to be arbitrary. These architectural mismatches should be explicitly framed as limitations, with reference to prior work on biologically plausible feedback mechanisms.

Declarations

Potential competing interests: No potential competing interests to declare.