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Decoding task states by spotting salient patterns at time points and brain regions

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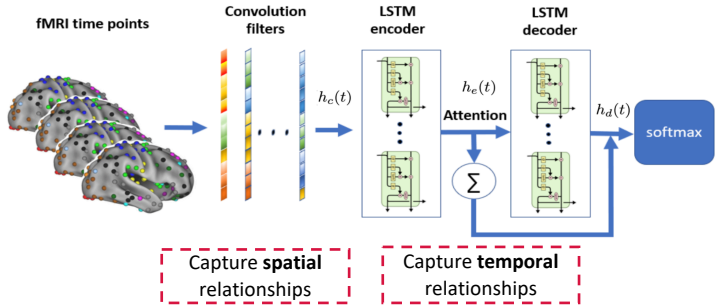
Introduction

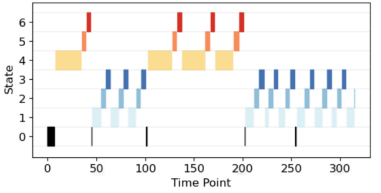
Recurrent Neural Network (RNN) has been used to predict brain states in task functional Magnetic Resonance Imaging scans. However, RNN predictions are based on previous time points only and it does not deal with brain states appearing within the time window of the stimuli. Also, previous studies have not considered functional specialisation during task performance. Brain decoding needs to focus on specific brain regions associated with the task, instead of learning from all activations to the network. By capturing Salient Patterns Over Time and Space (SPOTS), our proposed model outperformed existing methods by a significant margin, especially for small time windows.

Method

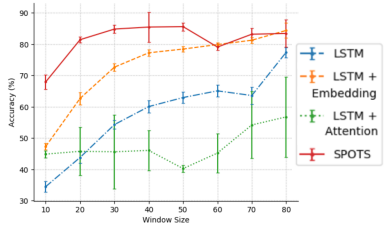


Results

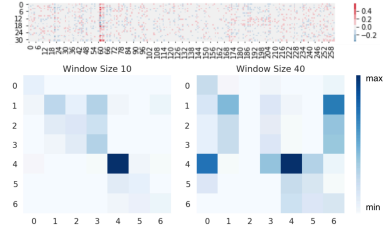
Dataset



Accuracy



Interpretability



Analysis

- Only results for HCP Language task shown (click/scan QR code for more)
- Ablation studies showed that both spatial embeddings and attention mechanism are essential for SPOTS
- SPOTS is better than baseline LSTM by at least 20% for window size ≤50
- Small window sizes are difficult for LSTMs because of hugely varying patterns + catastrophic forgetting
- Via its attention mechanism, SPOTS picks up direct relationships between time points and overcomes the issue
- SPOTS is also interpretable: Filter weights showed that auditory module ROIs have greater weights (despite well-distributed inputs); attention maps showed intuitive & interpretable relationships between brain states

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