

REVE: A Foundation Model for EEG – Adapting to Any Setup with Large-Scale Pretraining on 25k Subjects

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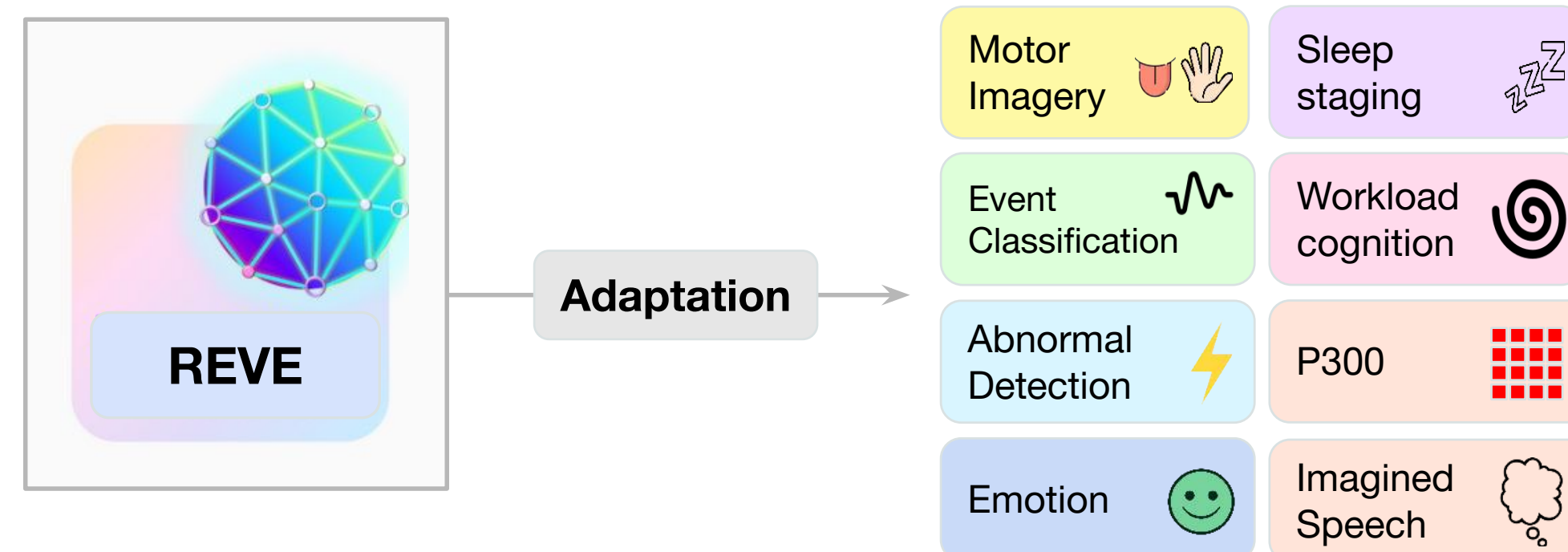
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Motivation

Foundation models are successful in NLP and vision but the inherent complexity of EEG (variability of the setups, protocols, subjects) makes it a challenging domain.

Main goals:

- Generate meaningful embeddings for any configuration
- Require minimal fine-tuning to achieve good performance



Pretraining dataset



- Largest pretraining effort to date:
24,274 subjects, **150,833** sessions, and **61,415** hours
- Diverse setups: **396** unique electrodes (7 montages)
- Minimal preprocessing to focus on **scalability** and **stability**

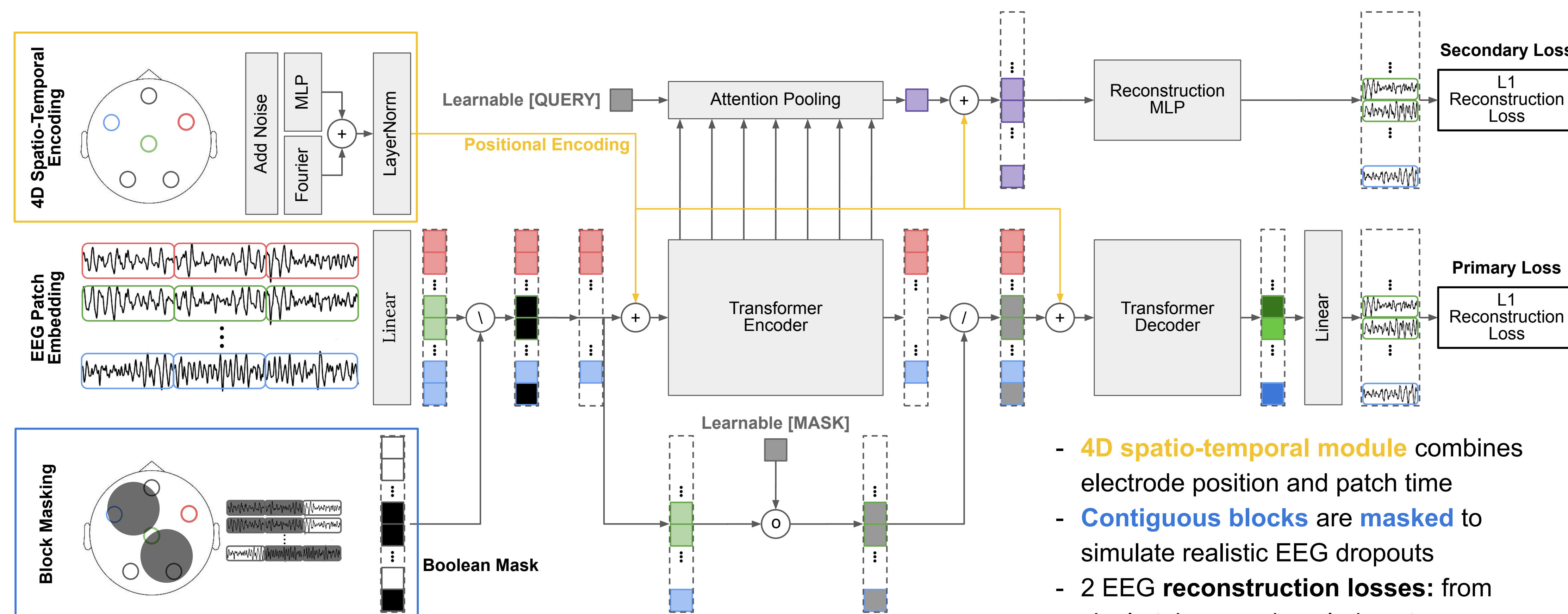
Results

Performance of REVE against several baselines, showcasing its representation capabilities

Dataset	BIOT	LaBraM-B	CBraMod	REVE-B
TUAB	0.796	0.814	0.829	0.832
TUEV	0.528	0.641	0.667	0.676
PhyNetMI	0.615	0.617	0.642	0.648
BCI-IV-2a	0.476	0.487	0.514	0.640
FACED	0.512	0.527	0.551	0.565
ISRUC	0.753	0.763	0.786	0.782*
Mumtaz	0.936	0.941	0.956	0.964
MAT	0.687	0.691	0.726	0.766
BCI-2020-3	0.492	0.506	0.537	0.563
Average	0.644	0.665	0.690	0.715

(*) Different set of electrodes

Overview of the REVE architecture and training pipeline



- **4D spatio-temporal module** combines electrode position and patch time
- **Contiguous blocks** are **masked** to simulate realistic EEG dropouts
- 2 EEG **reconstruction losses**: from single tokens and pooled vector

Probing performance of REVE (Base and Large) against CBraMod, showing that only minimal fine-tuning is required

Dataset	CBraMod	REVE-B	REVE-L
TUAB	0.500	0.809	0.809
TUEV	0.482	0.508	0.550
PhyNetMI	0.531	0.510	0.617
BCI-IV-2a	0.376	0.517	0.603
FACED	0.261	0.422	0.469
ISRUC	0.430	0.662	0.758
HMC	0.538	0.604	0.710
Mumtaz	0.907	0.931	0.980
MAT	0.605	0.740	0.665
BCI-2020-3	0.374	0.390	0.378
Average	0.501	0.609	0.654

References

Wang *et al.*, CBraMod: A Criss-Cross Brain Foundation Model for EEG Decoding. *ICLR 2025*

Yang *et al.*, BIOT: Biosignal Transformer for Cross-Data Learning in the Wild. *NeurIPS 2024*

Jiang *et al.*, Large Brain Model for Learning Generic Representations with Tremendous EEG Data in BCI. *ICLR 2024*

