

Physiology-Aware Masked Cross-Modal Reconstruction for Biosignal Representation Learning

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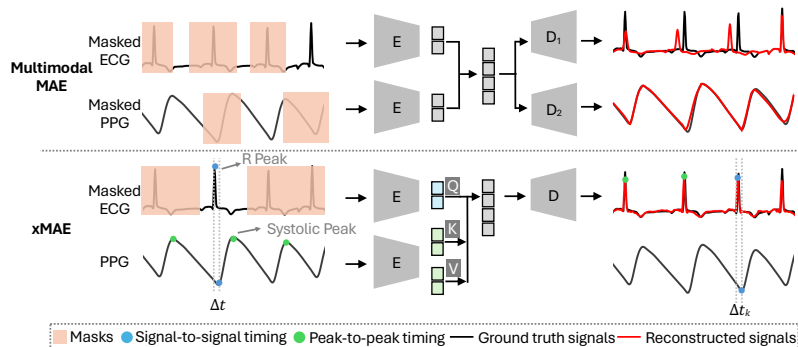
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Paper Link



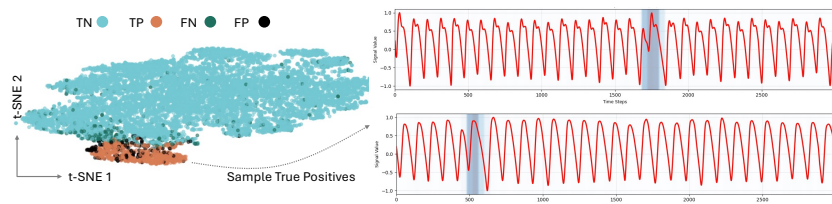
Health Signals Require More Than Generic Self-Supervised Learning

Prior works treat health signals as generic time series, failed to capture underlying structure across health signals.



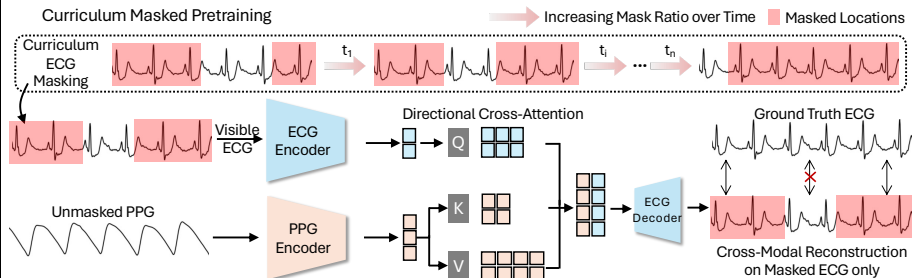
xMAE Generalizes Across 2.3k Hours PPG Data & 12.5 Subjects

Model	#param (M)	Cardiovascular Conditions				Abnormal Blood Labs			Sleep Staging				
		Hyptn (lab)	Hyptn (free-living)	PVC	Ectopic Beats	A1C	Hemoglobin	Platelets	Sodium	Wake	Light	Deep	REM
MAE-1D	6.7	53.6 (±4.3)	55.1 (±8.0)	78.7 (±8.0)	85.8 (±2.3)	48.5 (±8.0)	53.1 (±13.3)	62.7 (±13.2)	58.2 (±9.9)	64.6 (±1.7)	56.1 (±1.5)	55.5 (±3.0)	51.5 (±1.3)
MSN	6.5	56.1 (±5.4)	54.6 (±8.7)	68.5 (±4.9)	69.2 (±1.3)	51.6 (±1.1)	60.0 (±14.0)	67.9 (±5.3)	63.1 (±12.1)	63.1 (±1.7)	55.7 (±1.3)	52.2 (±4.0)	52.4 (±1.0)
PopNet-P	5.0	52.1 (±3.4)	54.1 (±8.0)	69.6 (±3.4)	76.2 (±1.8)	52.5 (±3.3)	55.0 (±3.1)	65.4 (±3.4)	61.9 (±3.7)	64.7 (±4.8)	56.7 (±1.2)	57.5 (±4.7)	52.5 (±1.0)
Apple	5.0	56.8 (±5.2)	54.5 (±8.5)	74.2 (±3.0)	84.3 (±3.2)	50.6 (±8.5)	56.0 (±13.3)	62.3 (±10.4)	59.8 (±12.8)	62.3 (±1.0)	55.1 (±1.3)	50.5 (±1.7)	51.5 (±0.7)
DINO	6.5	53.7 (±5.8)	54.4 (±8.0)	67.5 (±4.3)	67.8 (±0.8)	49.8 (±30.0)	52.8 (±12.1)	65.0 (±3.8)	56.8 (±13.9)	62.6 (±1.7)	55.8 (±0.8)	55.0 (±2.8)	51.6 (±1.3)
LSM	6.7	53.8 (±5.0)	55.0 (±8.9)	78.8 (±5.4)	86.2 (±1.7)	47.3 (±7.8)	55.0 (±13.4)	62.6 (±3.4)	61.9 (±31.0)	64.7 (±1.0)	56.5 (±1.6)	57.5 (±3.1)	52.5 (±1.4)
SimCLR	5.0	55.7 (±6.0)	55.1 (±8.0)	67.8 (±2.2)	71.0 (±2.7)	48.5 (±4.3)	54.9 (±11.8)	58.7 (±14.2)	62.8 (±14.2)	58.9 (±1.3)	56.7 (±0.8)	55.0 (±2.3)	50.3 (±0.6)
Apple-M	6.7	56.3 (±6.7)	56.3 (±1.2)	80.7 (±4.0)	85.8 (±2.2)	49.4 (±7.3)	53.5 (±13.2)	69.2 (±3.7)	59.9 (±13.4)	65.2 (±1.7)	57.1 (±1.5)	55.9 (±2.8)	51.7 (±1.9)
xMAE	6.5	68.8** (±4.8)	58.5 (±1.3)**	81.4 (±3.4)	87.8 (±2.3)**	65.1 (±3.2)**	62.0 (±6.0)	68.6 (±3.5)	61.7 (±16.1)	66.4 (±2.3)	57.5 (±1.3)	55.9 (±5.3)	54.5 (±2.5)**

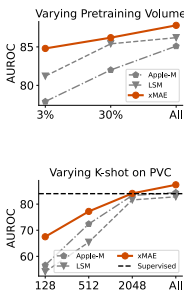


xMAE: When Physiological Priors Meet Self-Supervised Learning

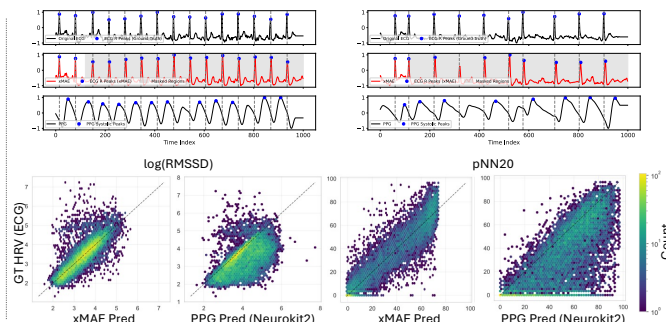
Leveraging ECG-PPG temporal relationships to learn robust cardiac representations for PPG signals.



Additional Findings



xMAE is Data-Efficient & Improves HRV



Out Solution