



# Decentralized Attention Fails Centralized Signals

## —*Rethinking Transformers for Medical Time Series*

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<sup>2</sup> Tsinghua University

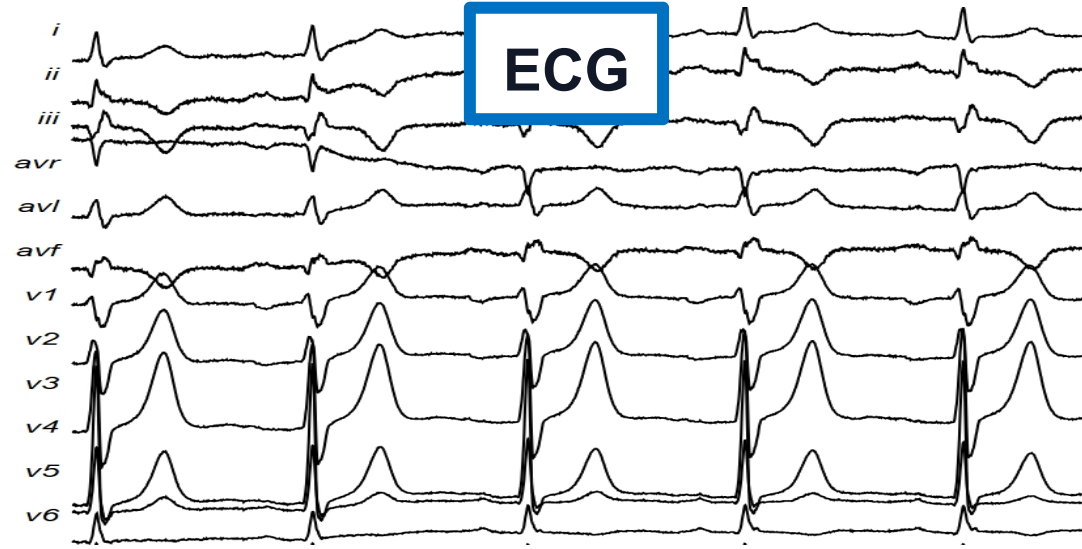
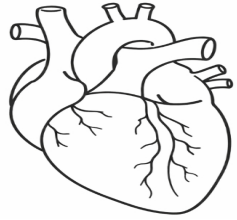


Paper



Code

1. Background



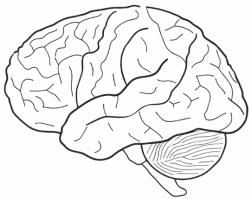
**Cardiac Analysis:**  
*Atrial Fibrillation,  
Myocardial Infarction,  
etc.*

2. Challenge

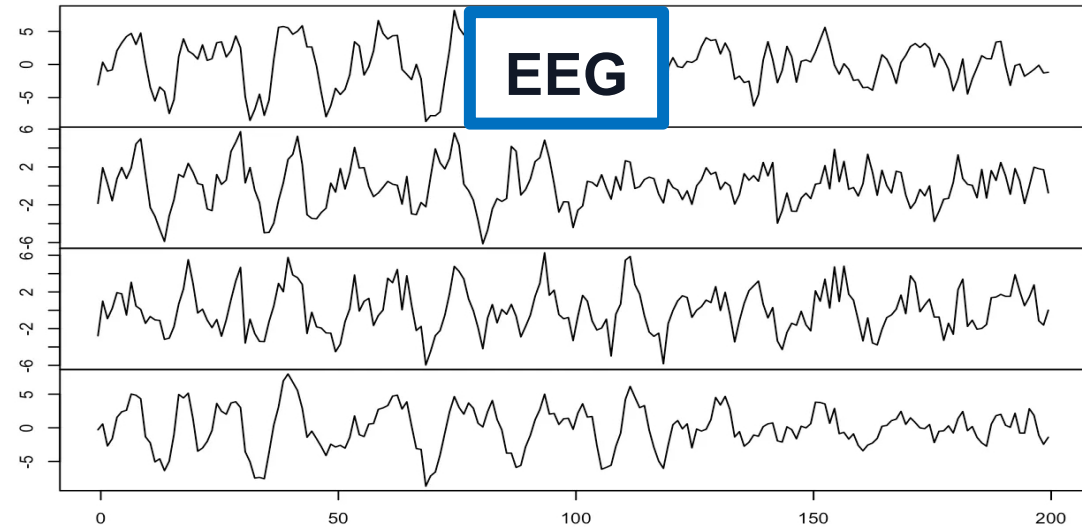
3. Solution

4. Results

5. Inspirations

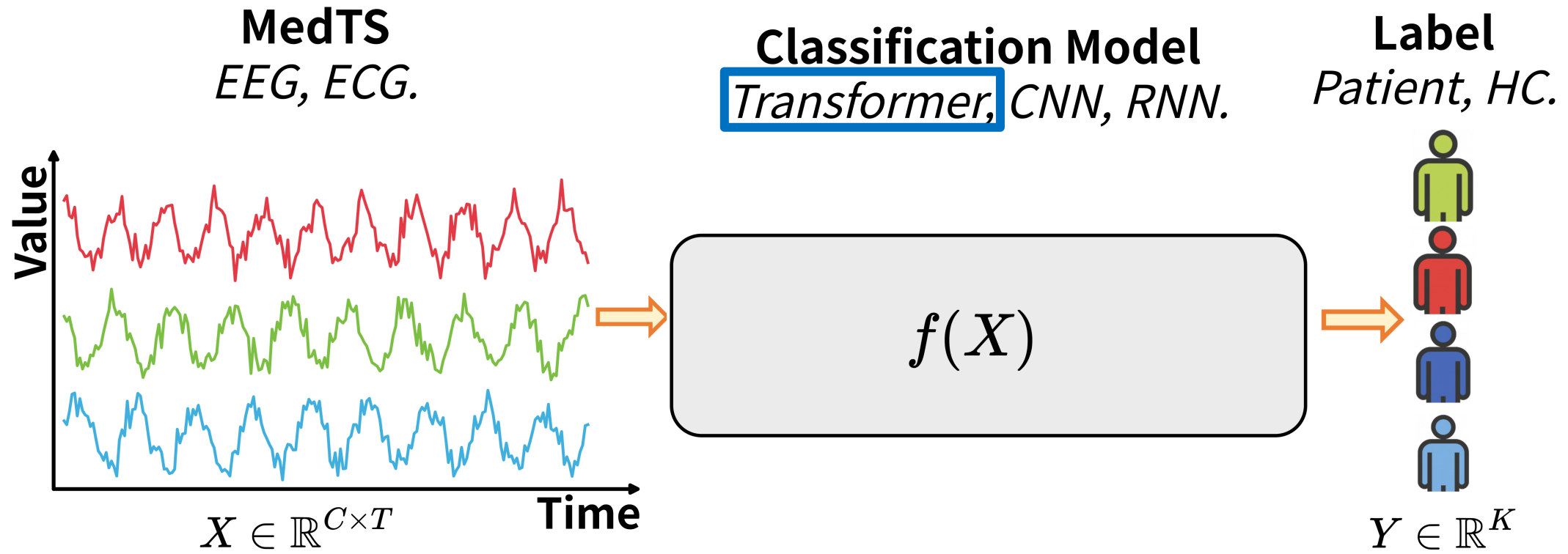


### Medical Time Series (MedTS)

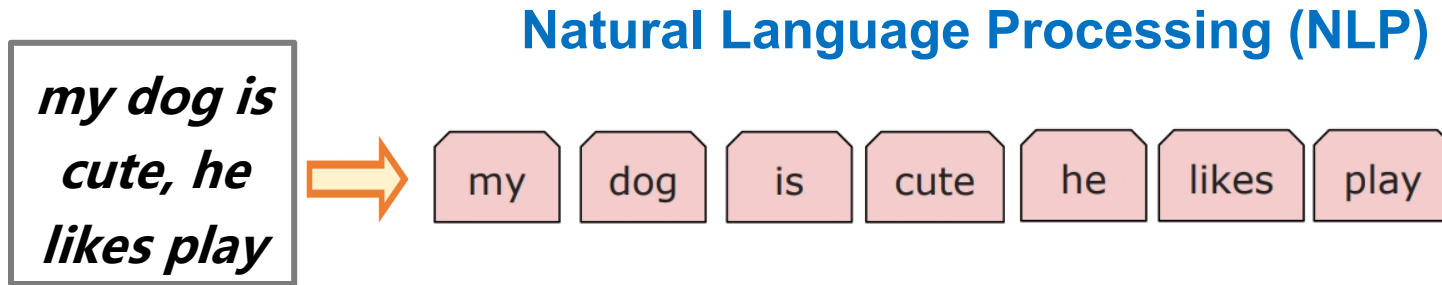


**Brain Analysis:**  
*Epilepsy,  
Insomnia,  
etc.*

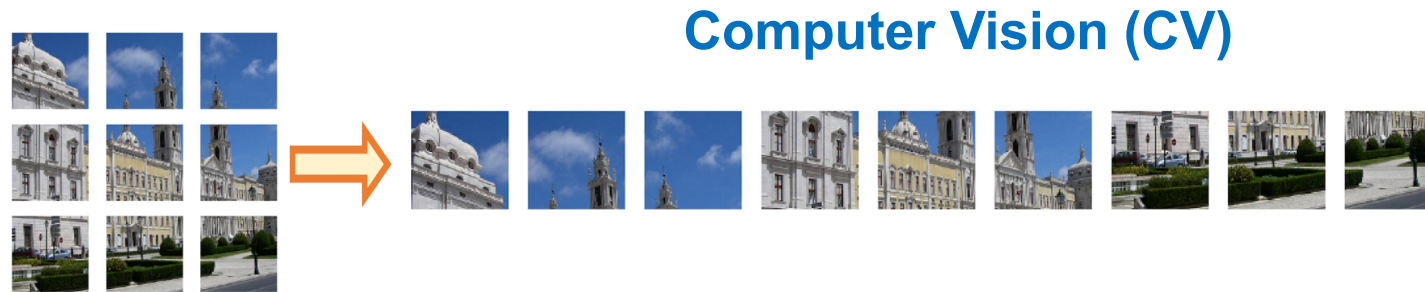
- 1. Background
- 2. Challenge
- 3. Solution
- 4. Results
- 5. Inspirations



## 1. Background



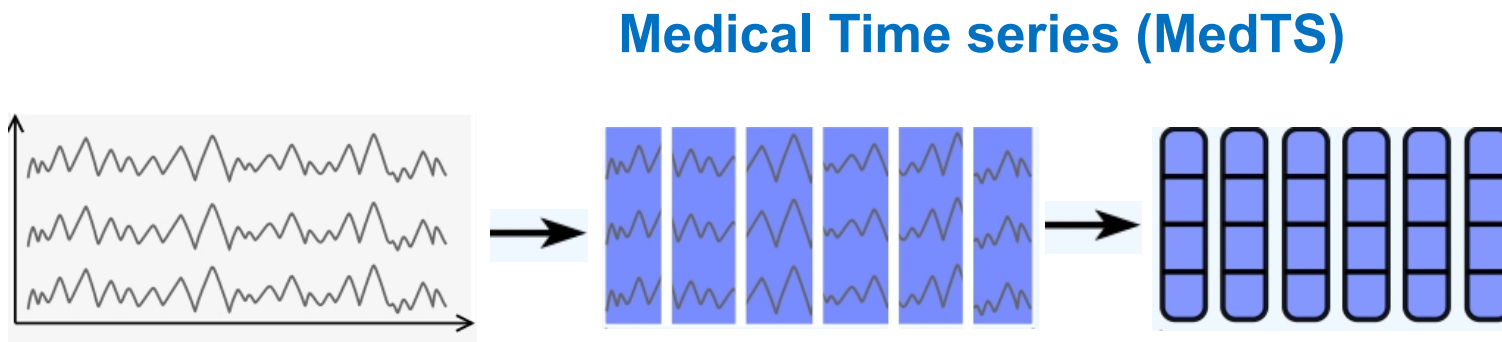
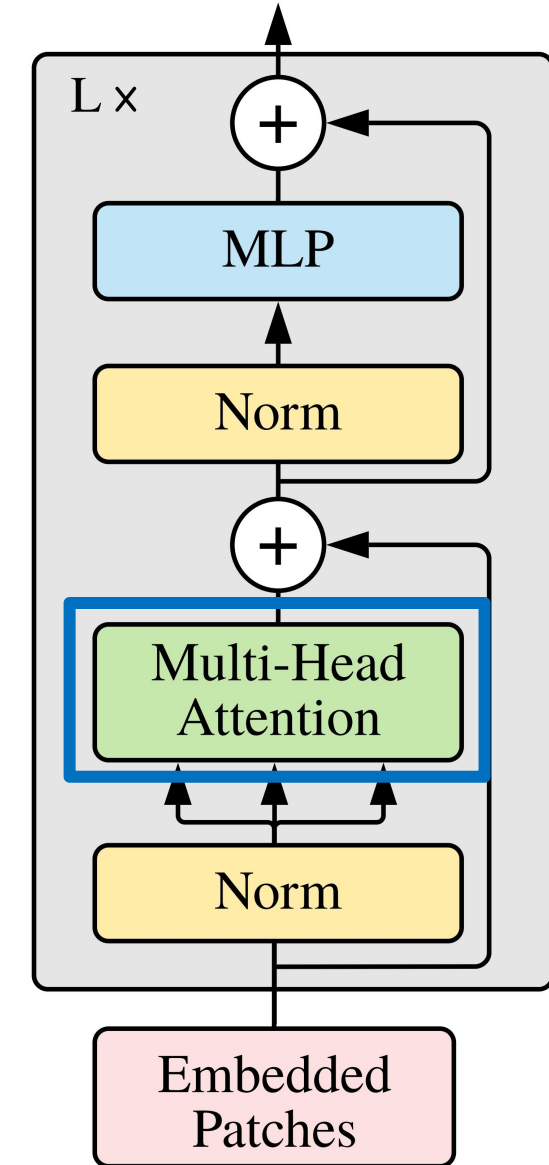
## 2. Challenge



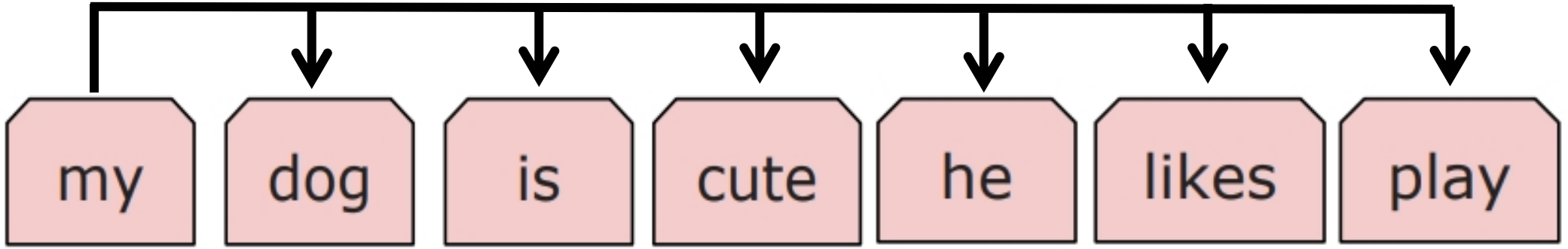
## 3. Solution

## 4. Results

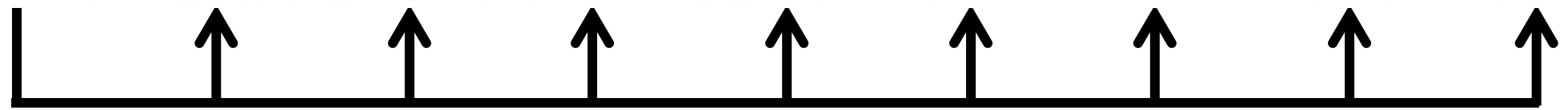
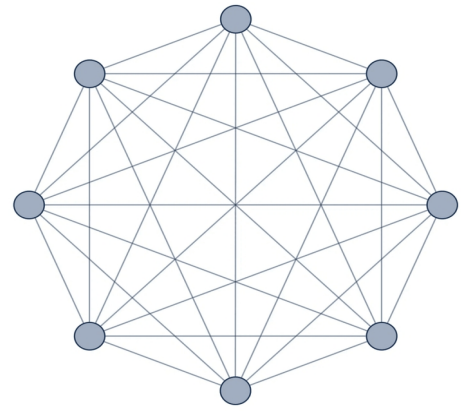
## 5. Inspirations

**Transformer Encoder**

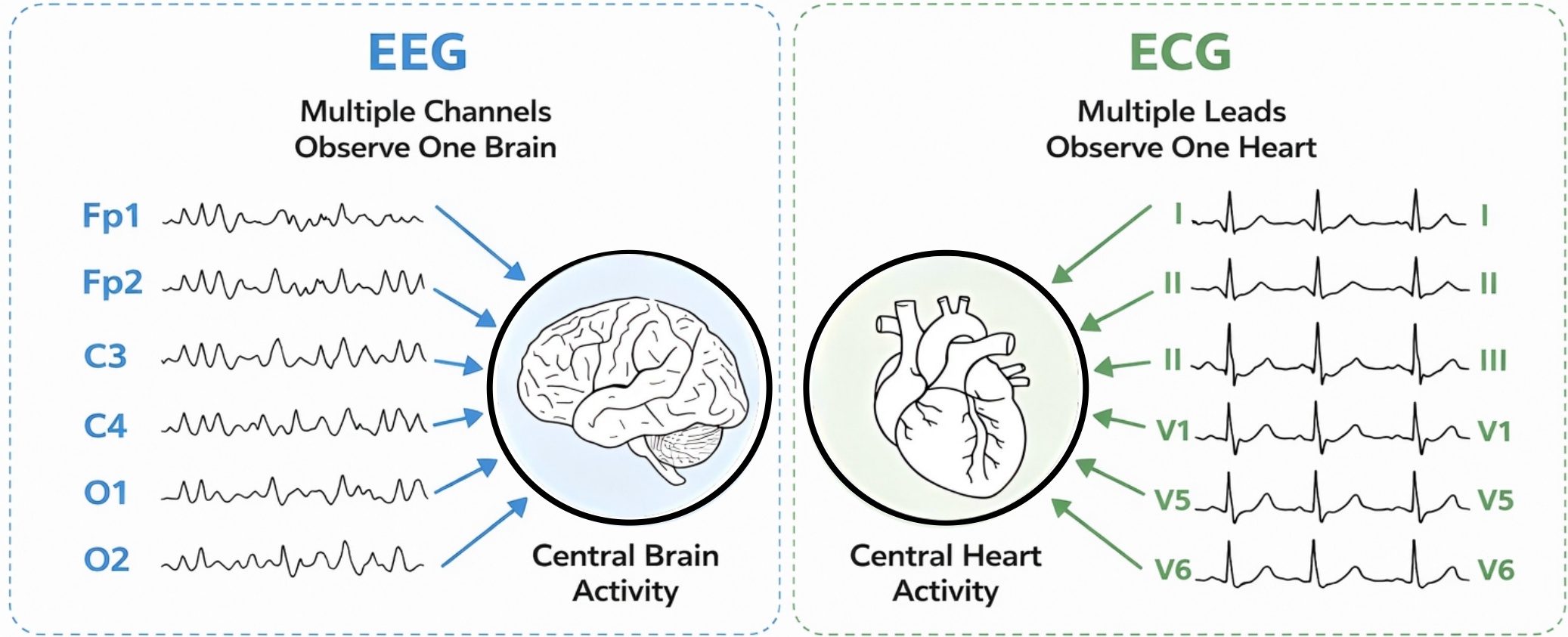
- 1. Background
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**Decentralized Structure**



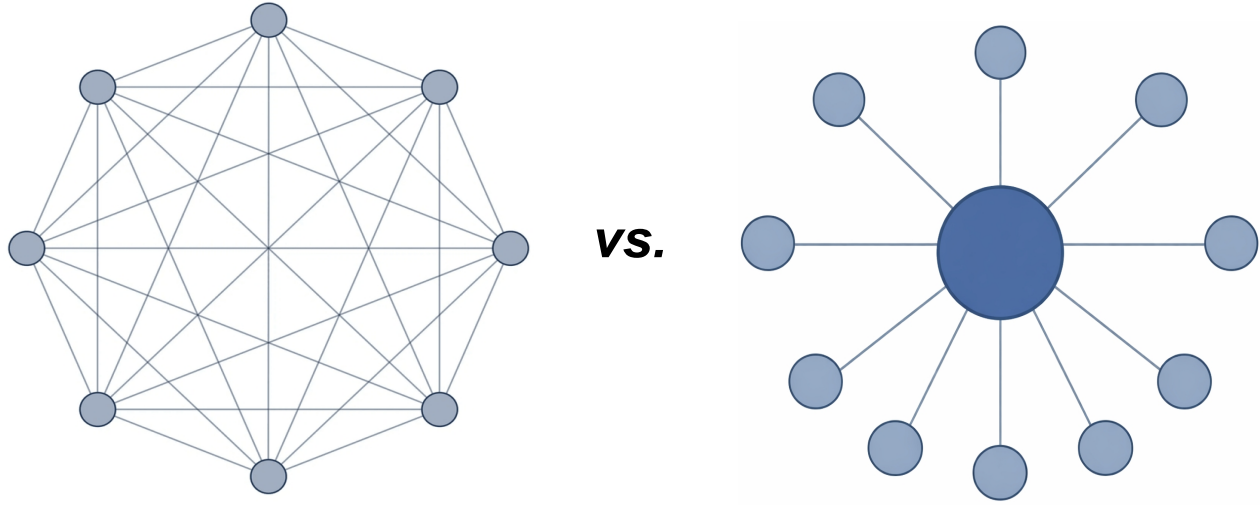
- 1. Background
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*Different Sensors,  
Same Physiological Source*

**Centralized Signals**

- 1. Background
- 2. Challenge
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**Mismatch:**  
**Decentralized Attention vs. Centralized Signals**

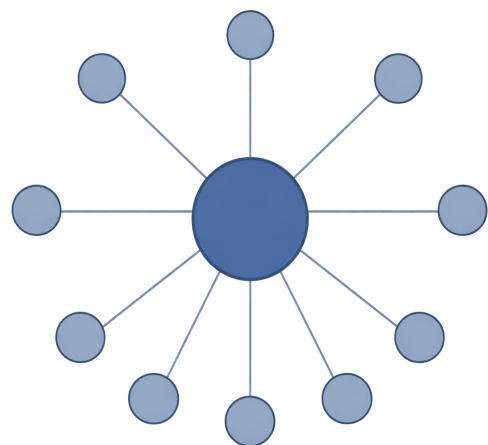
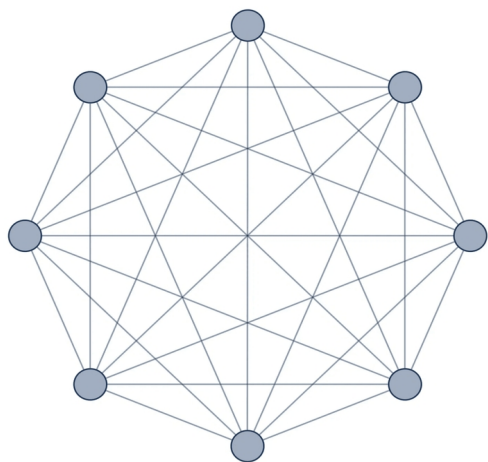
1. Background

2. Challenge

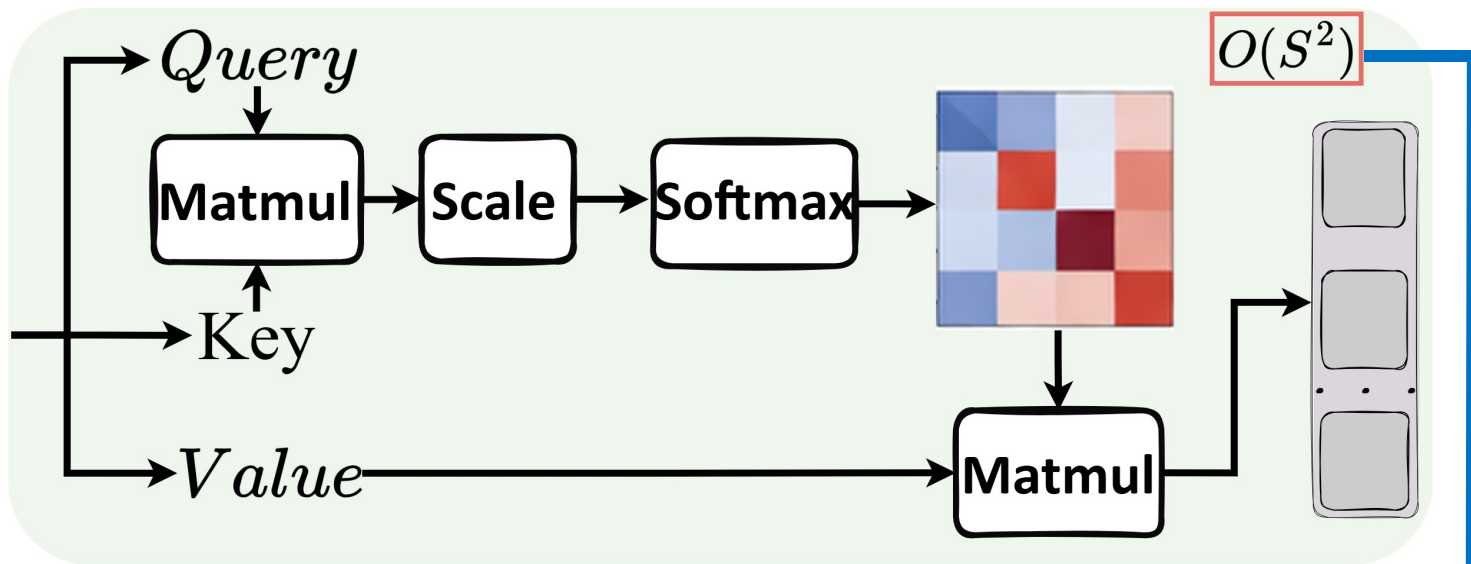
3. Solution

4. Results

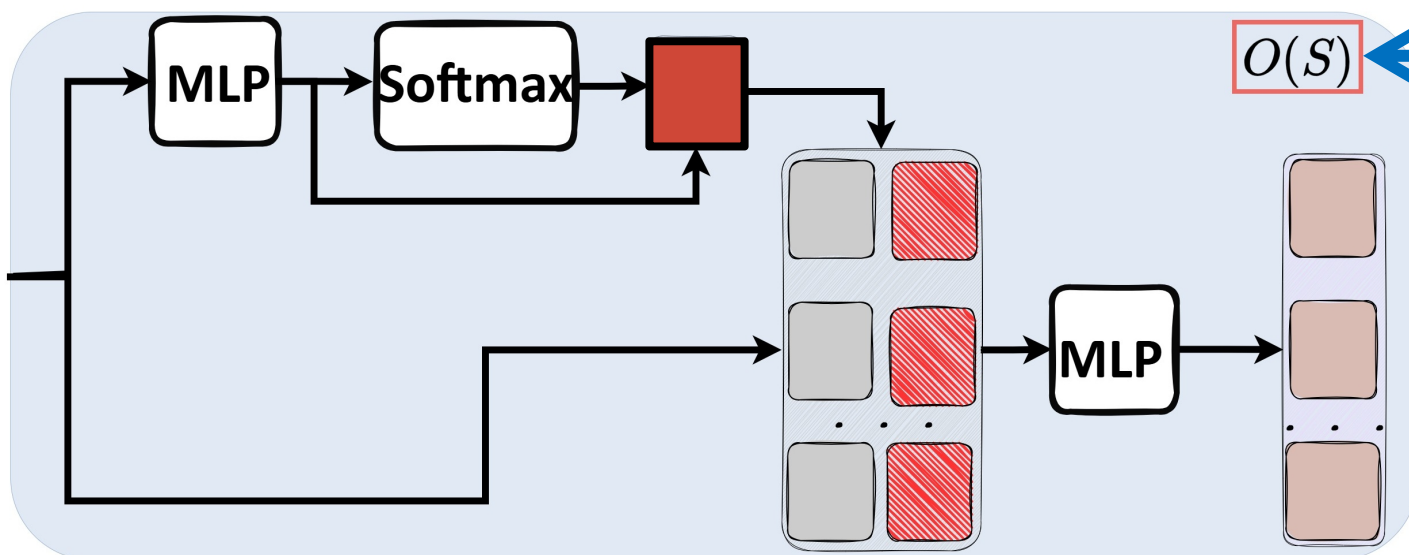
5. Inspirations



## Attention



## Core Token Aggregation-Redistribution (CoTAR)



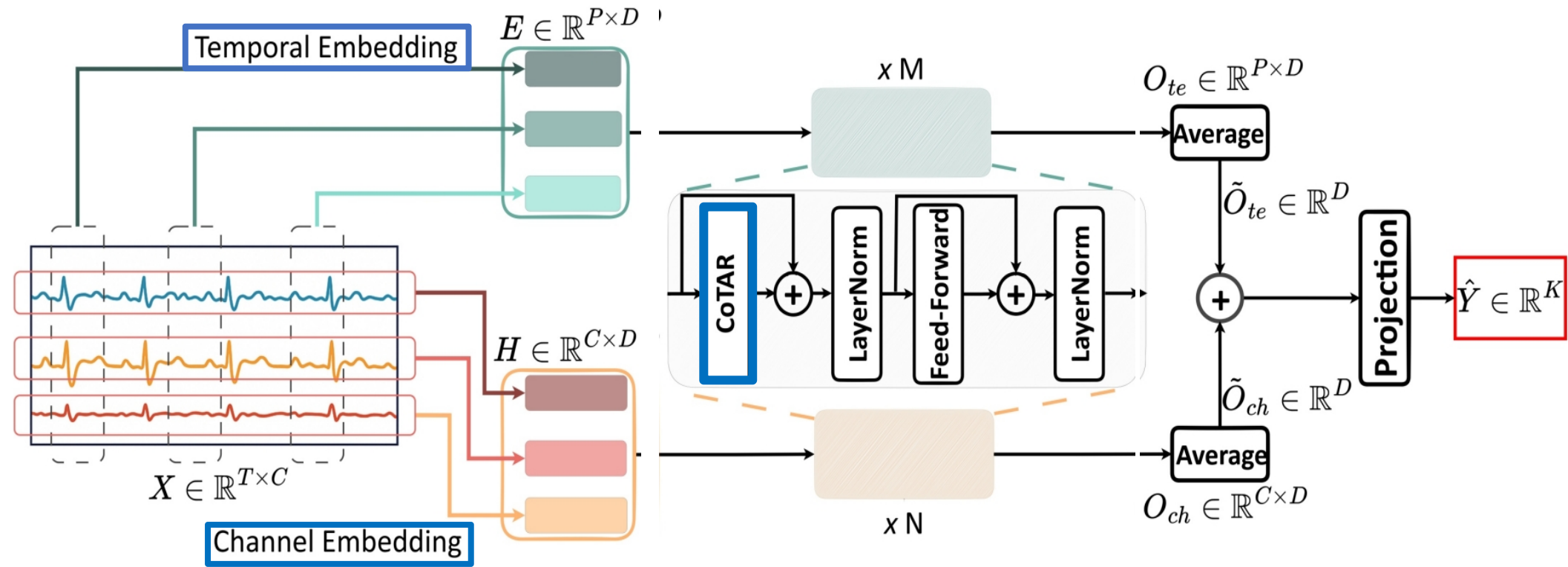
1. Background

2. Challenge

3. Solution

4. Results

5. Inspirations



## 1. Background

## 2. Challenge

## 3. Solution

## 4. Results

## 5. Inspirations

Table 1: **The information of utilized datasets**, including the number of subjects, samples, sample channels, and timestamps (TS).

	Dataset	#-Subject	#-Sample	#-Class	#-Channel	#-TS
<b>EEG</b>	ADFTD	88	69,752	3	19	256
	APAVA	23	5,967	2	16	256
	TDBrain	72	6,240	2	33	256
<b>ECG</b>	PTB	198	64,356	2	15	300
	PTB-XL	17,596	191,400	5	12	250
<b>Human Activity Recognition</b>	FLAPP	8	13123	10	6	100
	UCI-HAR	30	10,299	6	9	128

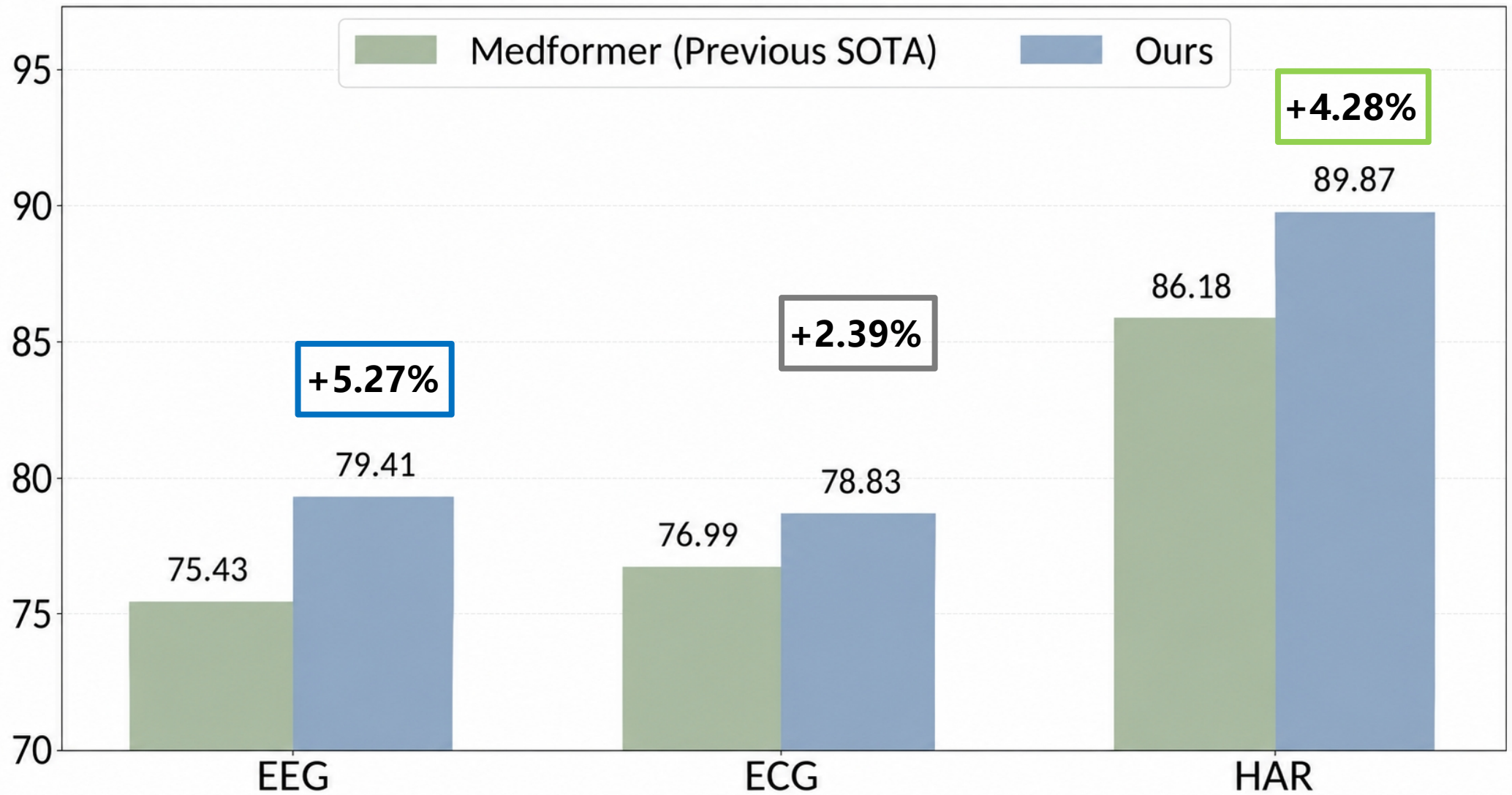
1. Background

2. Challenge

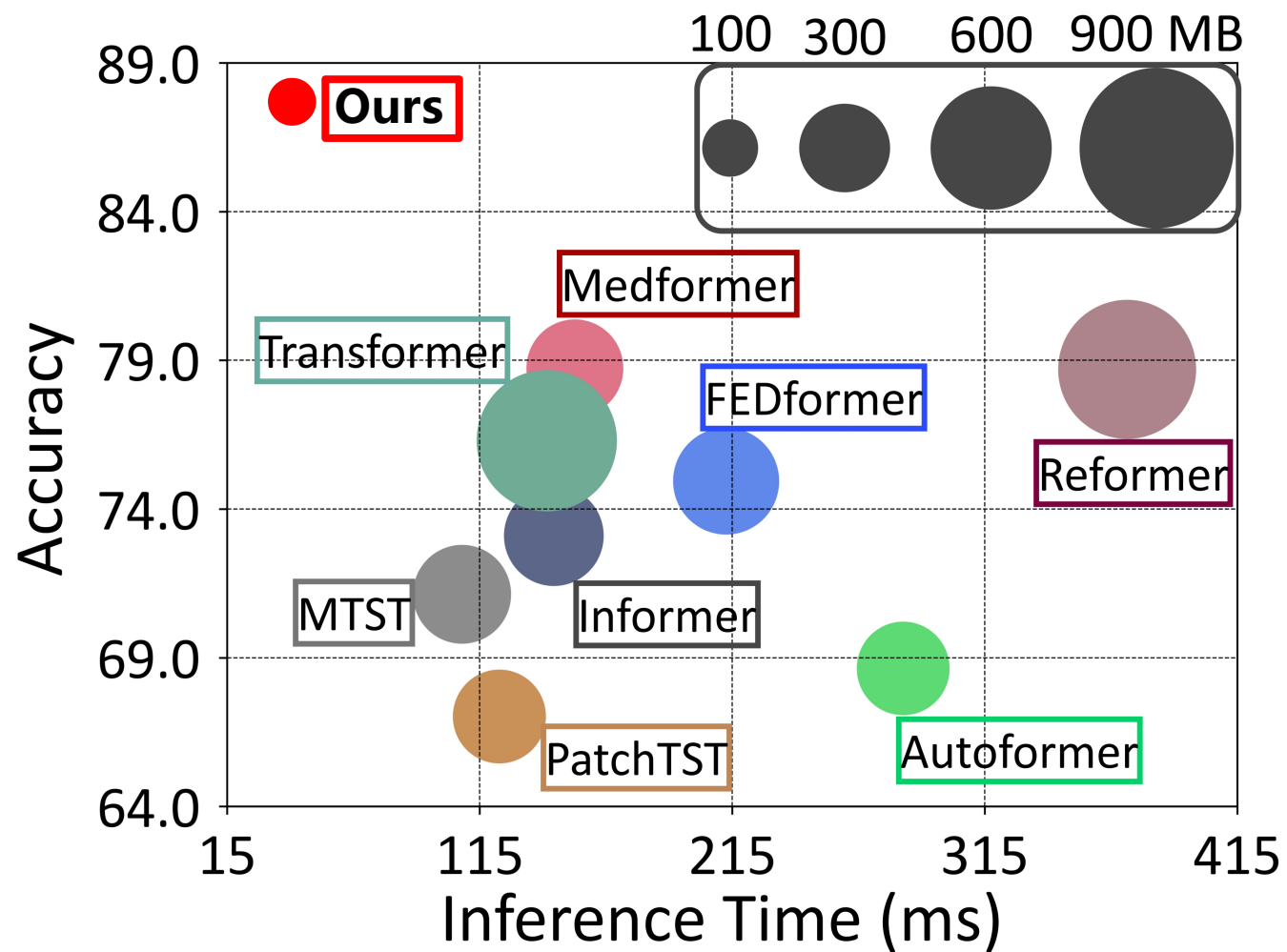
3. Solution

4. Results

5. Inspirations



## Efficiency Analysis



1. Background

**+10.3% Improvement**

2. Challenge

**33% Memory Usage**

3. Solution

**20% Inference Time**

4. Results

5. Inspirations

# Noise Robustness Test

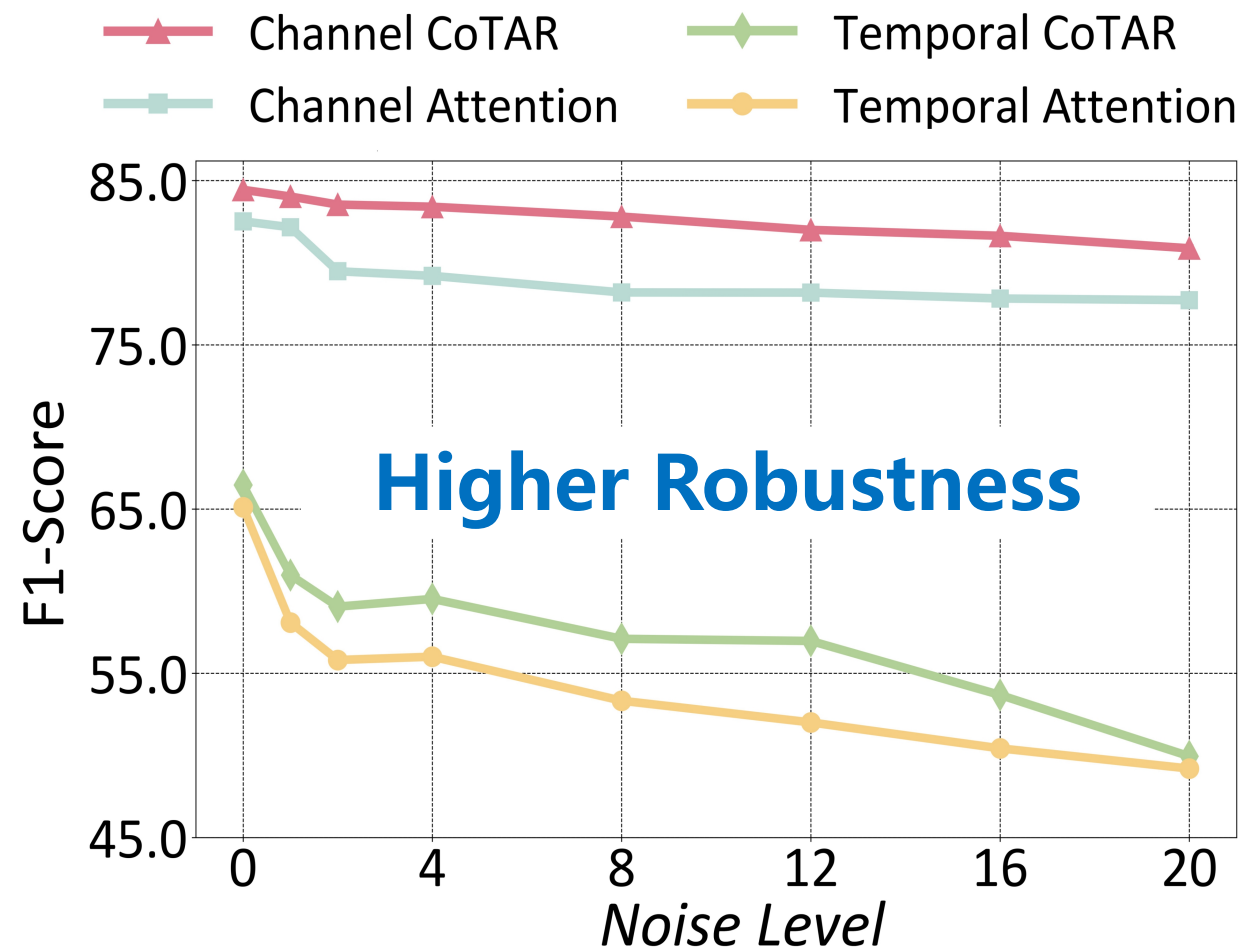
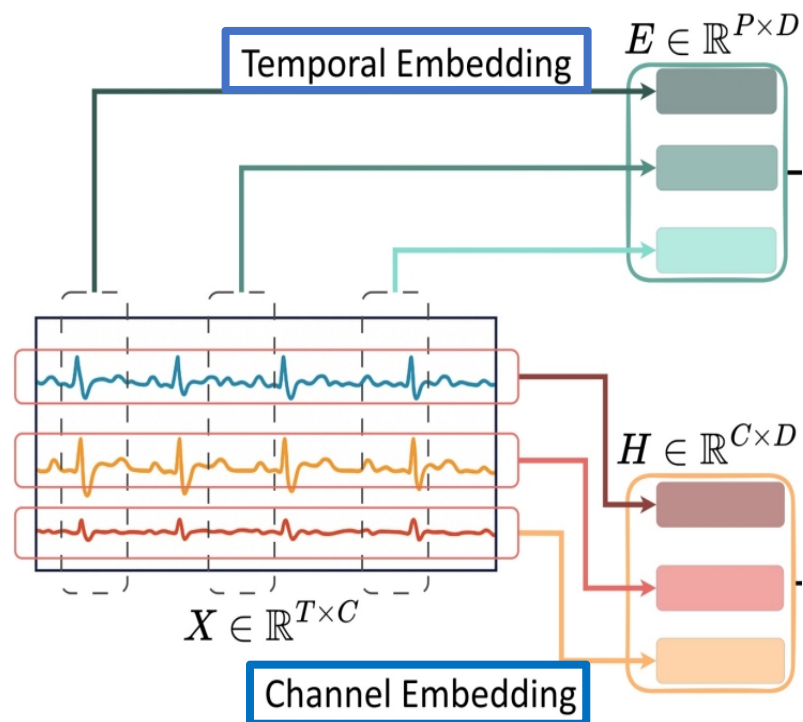
1. Background

2. Challenge

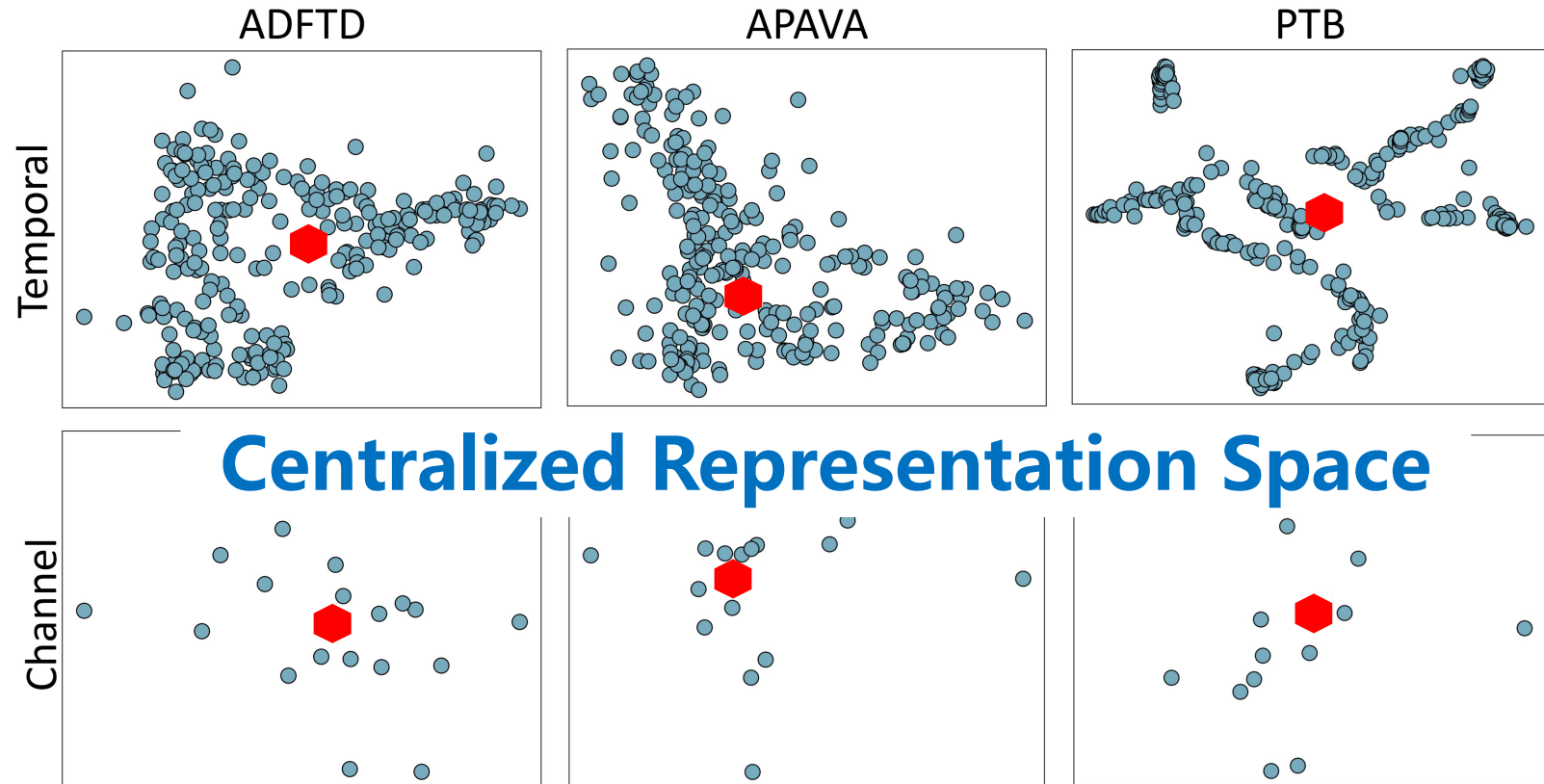
3. Solution

4. Results

5. Inspirations



# Feature Visualization



**Global Physiological State**

1. Background

2. Challenge

3. Solution

4. Results

5. Inspirations

## 1. Background

**1. Inductive bias over brute-force complexity**

## 2. Challenge

**2. Structure-aligned MedTS foundation model**

## 3. Solution

**3. Modalities governed by a centralized physiological state, fNIRS, fMRI, HAR, etc.**

## 4. Results

## 5. Inspirations