ENSEMBLE AND PERSONALIZED TRANSFORMER MODELS FOR SUBJECT IDENTIFICATION AND RELAPSE DETECTION IN *E-PREVENTION CHALLENGE*

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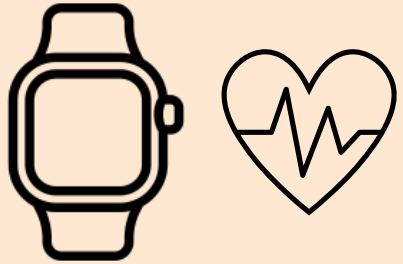
Università di Catania

PeRCeiVe Lab

Scope of the challenge

Biosignals from wearable devices



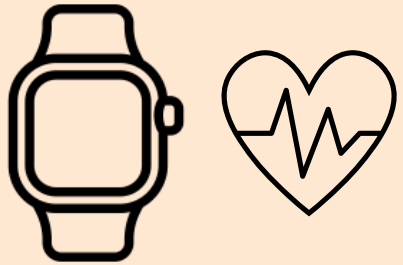
e-Prevention

Subject identification

Relapse detection

Scope of the challenge

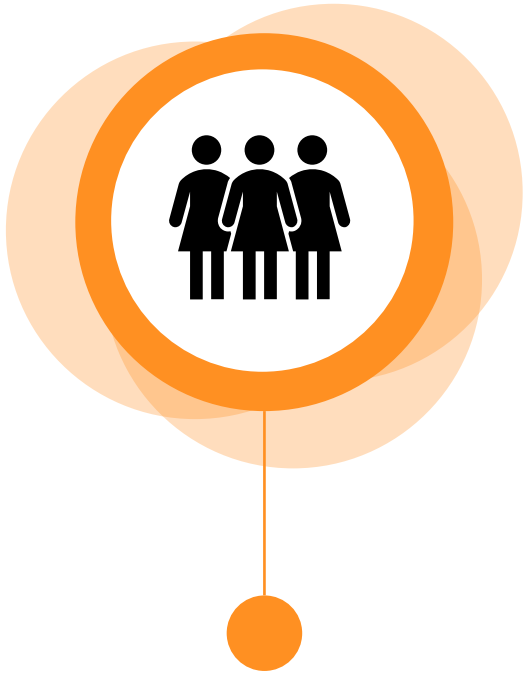
Biosignals from wearable devices



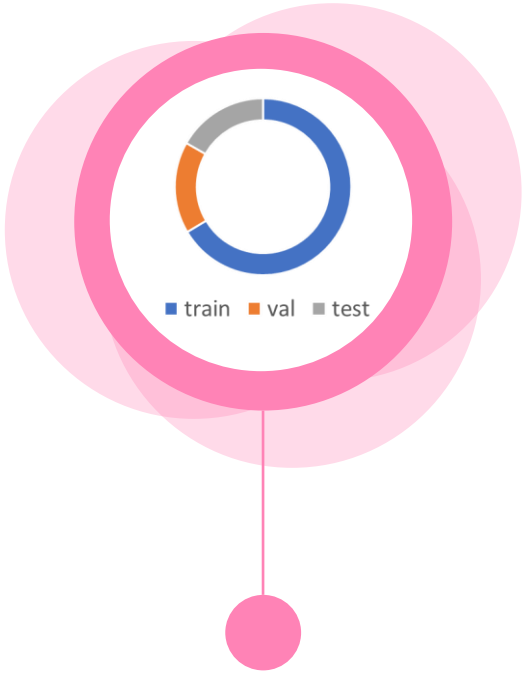
e-Preventi

- Linear accelerations
- Angular accelerations
- Heart rate (bpm)
- RR intervals (ms)
- Sleeping status
- Step information
- Calories

Track 1 - Subject Identification



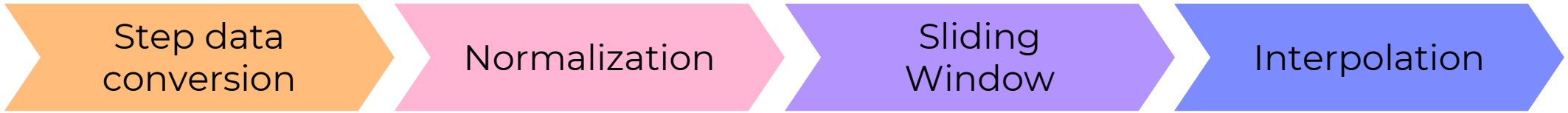
Subjects
46 different identities



Splits
Train, validation and test splits already provided

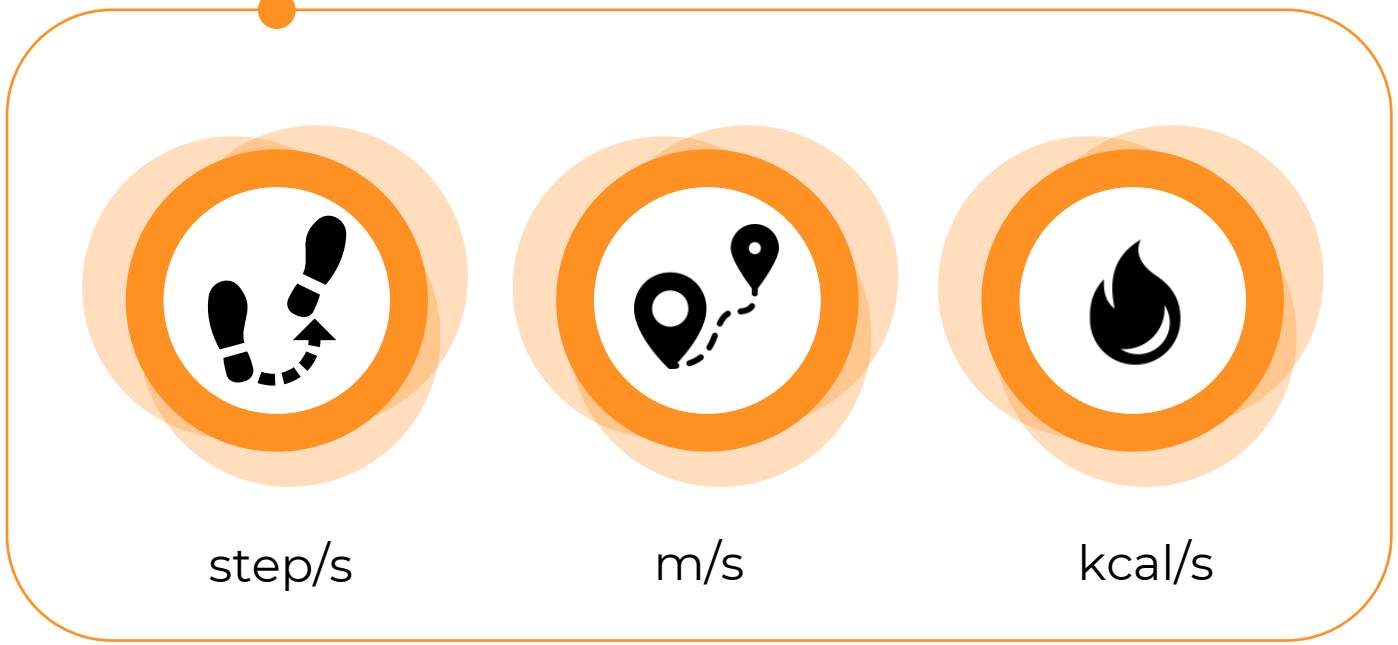
Recordings
On daily basis

Data Preparation



Data Preparation

Step data conversion → Normalization → Sliding Window → Interpolation



Data Preparation

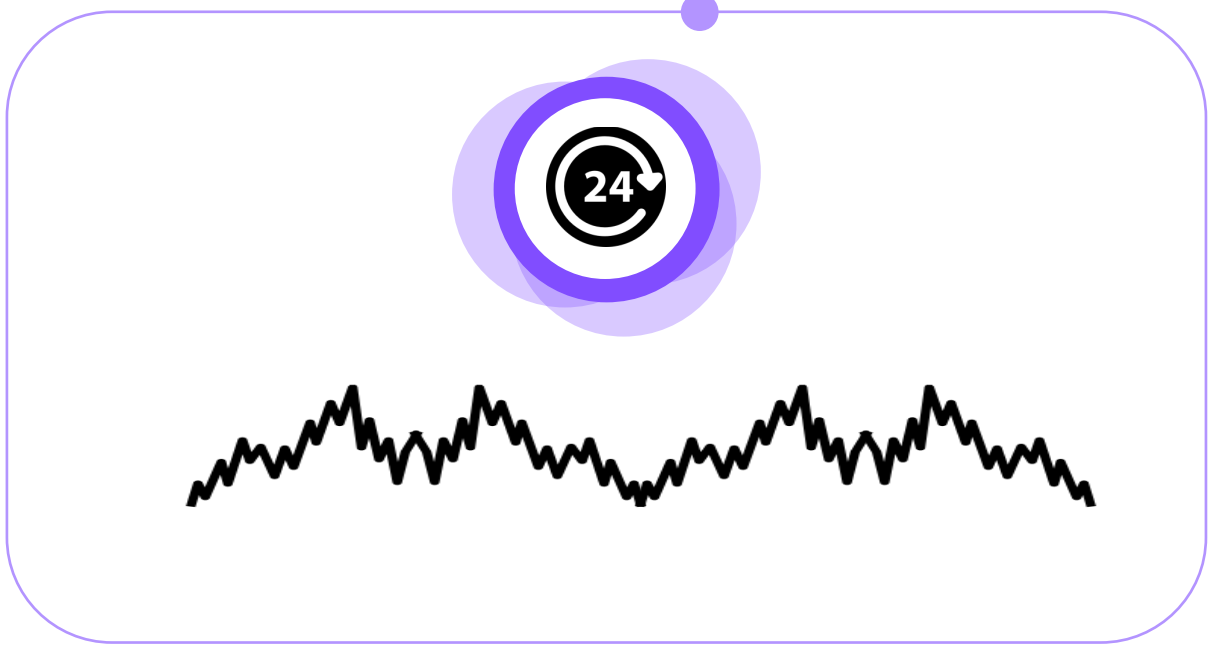
Step data conversion → **Normalization** → Sliding Window → Interpolation

Min-Max Normalization
[0-1] range

$$x_{scaled} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

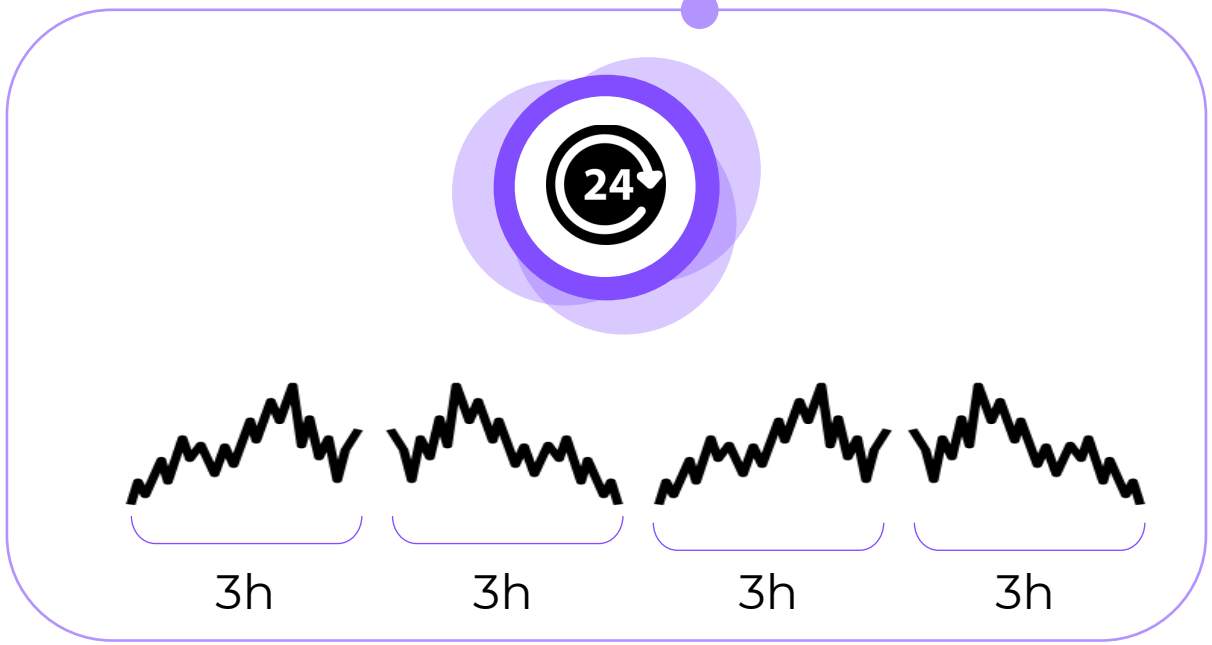
Data Preparation

Step data conversion → Normalization → **Sliding Window** → Interpolation



Data Preparation

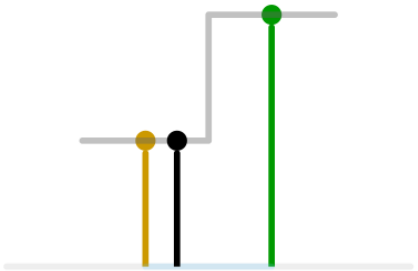
Step data conversion → Normalization → **Sliding Window** → Interpolation



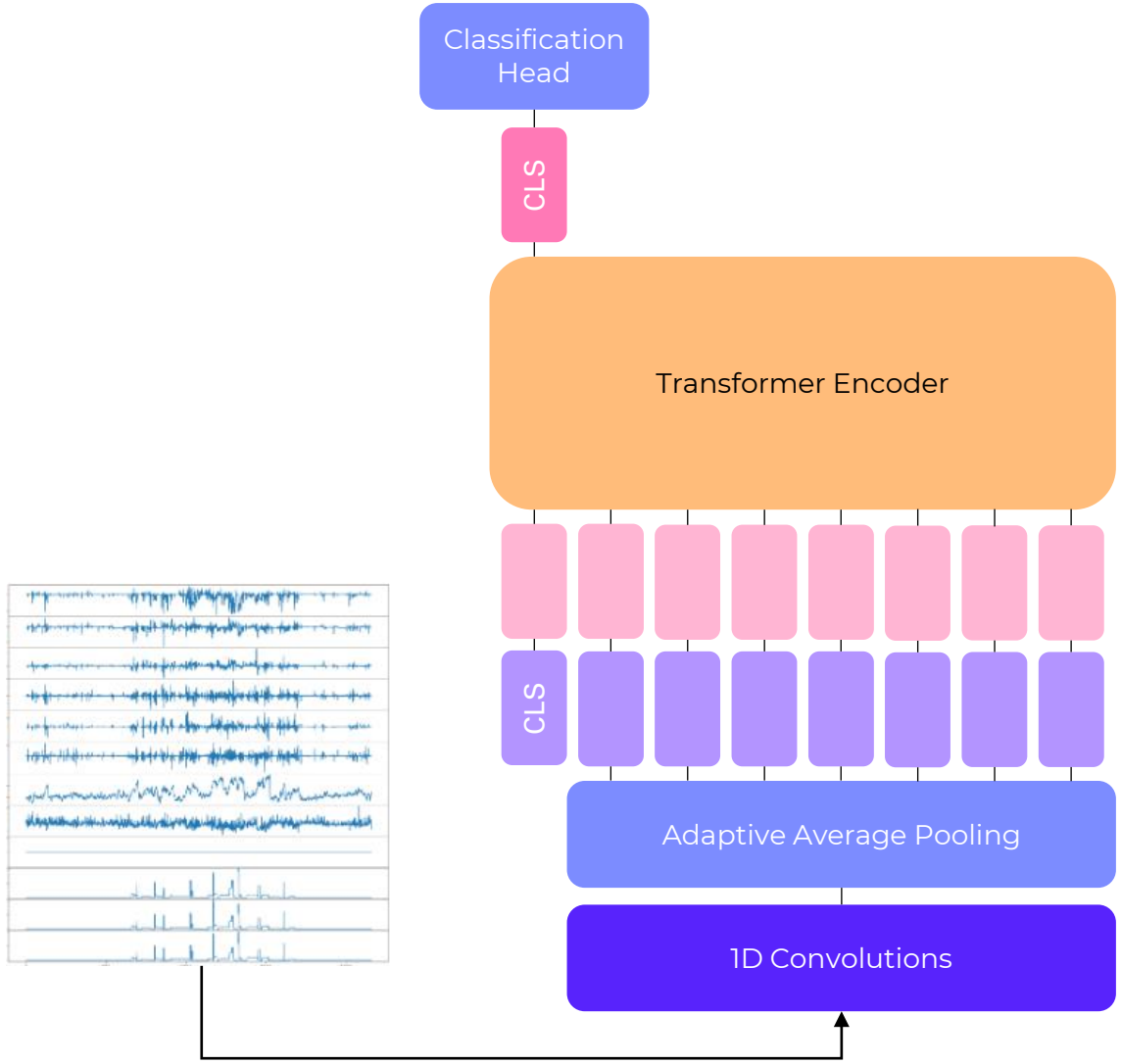
Data Preparation

Step data conversion → Normalization → Sliding Window → **Interpolation**

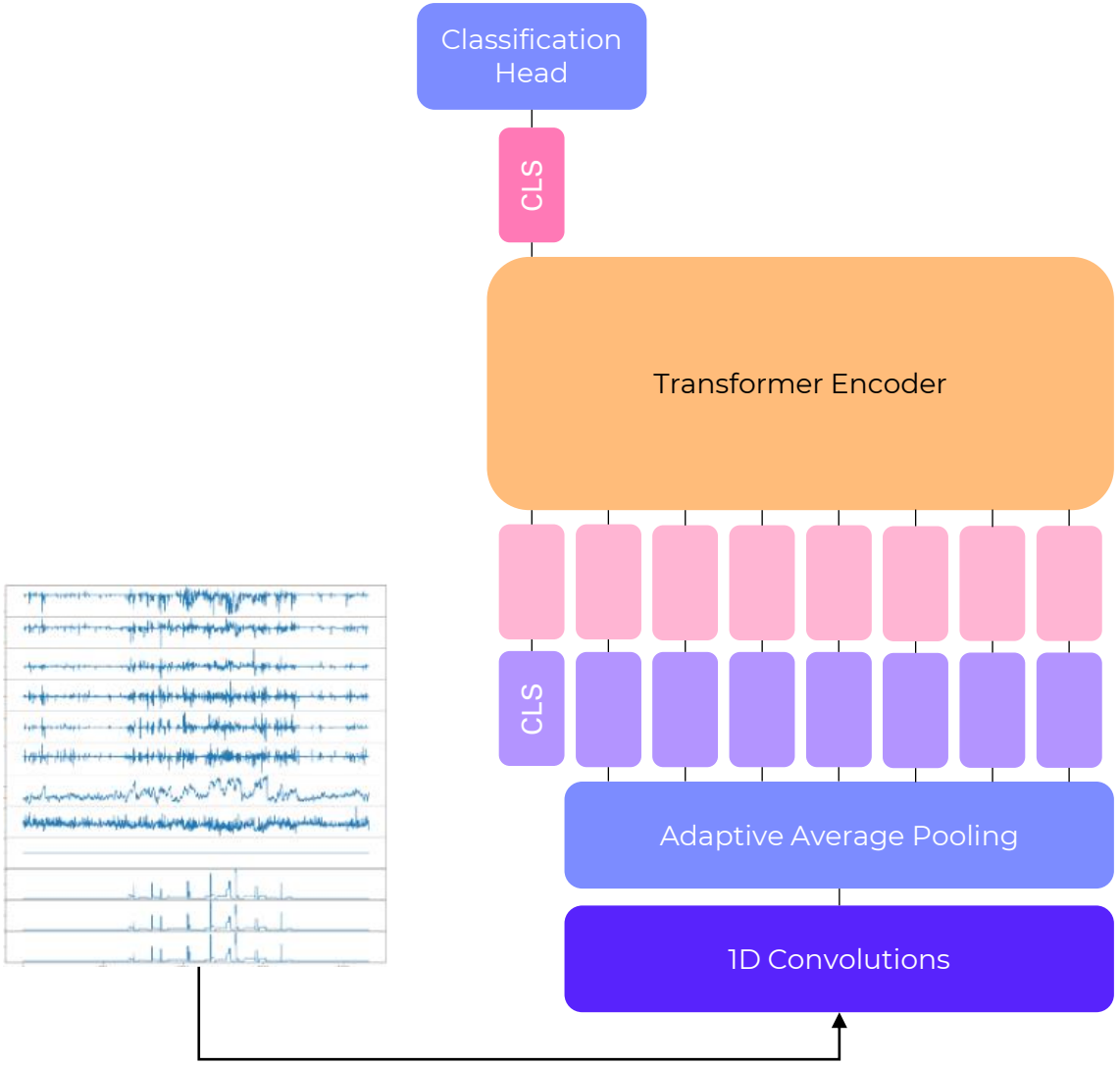
Nearest Neighbors



Models

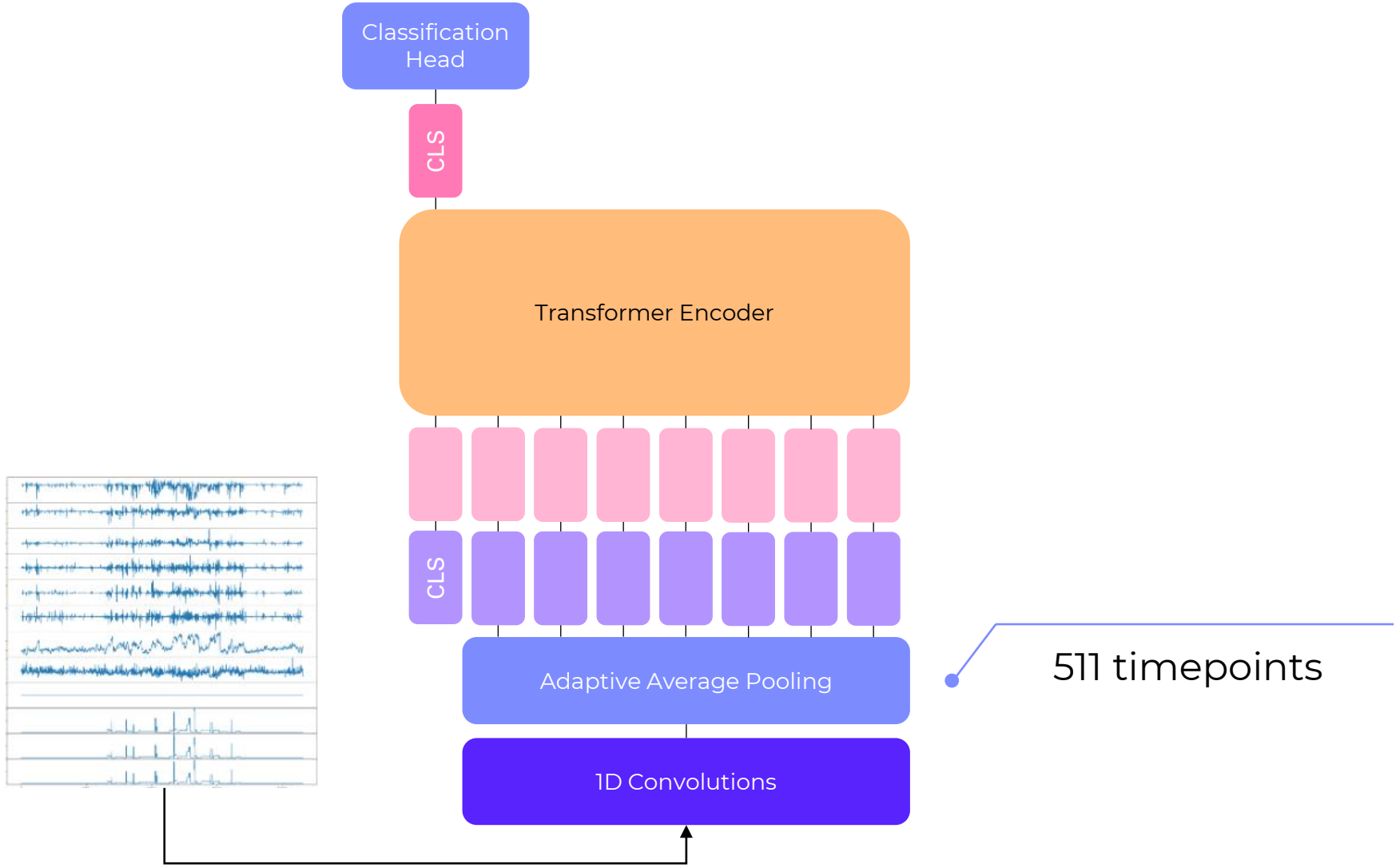

Classification Head
CLS
Transformer Encoder
CLS
Adaptive Average Pooling
1D Convolutions

Models

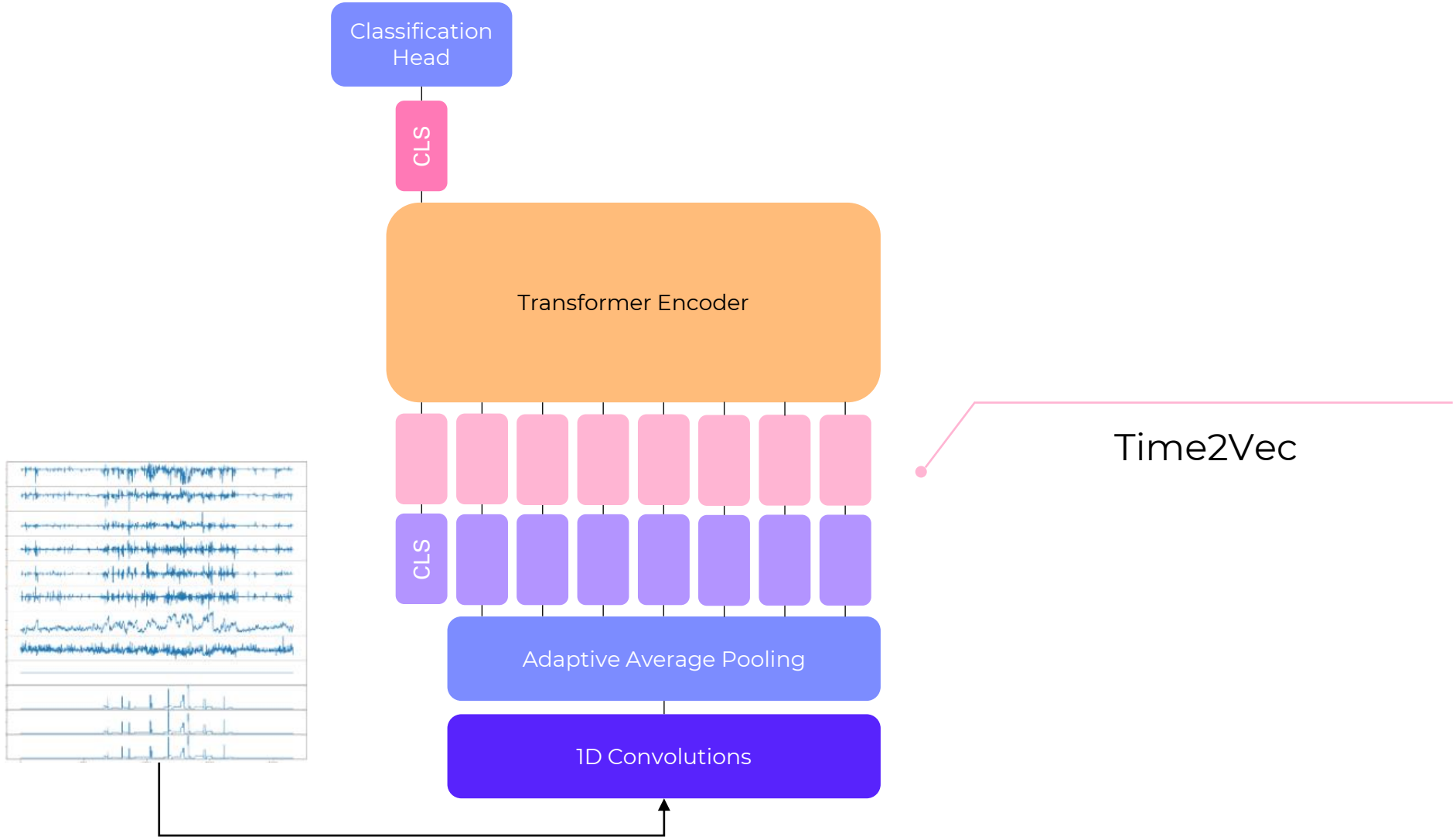


5 layers including Conv1D, ReLU, BatchNorm and Dropout

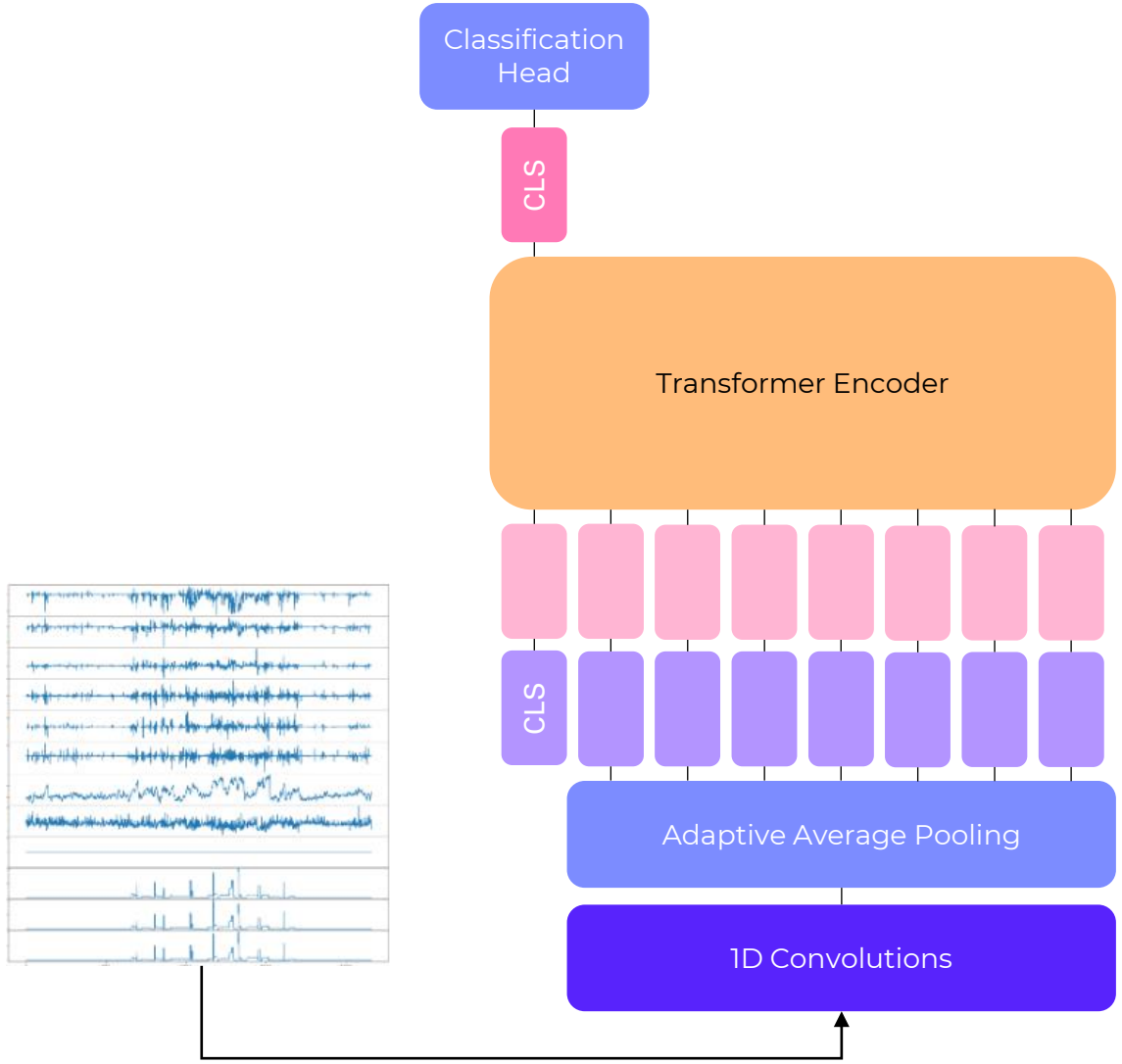
Models


Classification Head
CLS
Transformer Encoder
CLS
Adaptive Average Pooling
1D Convolutions
511 timepoints

Models

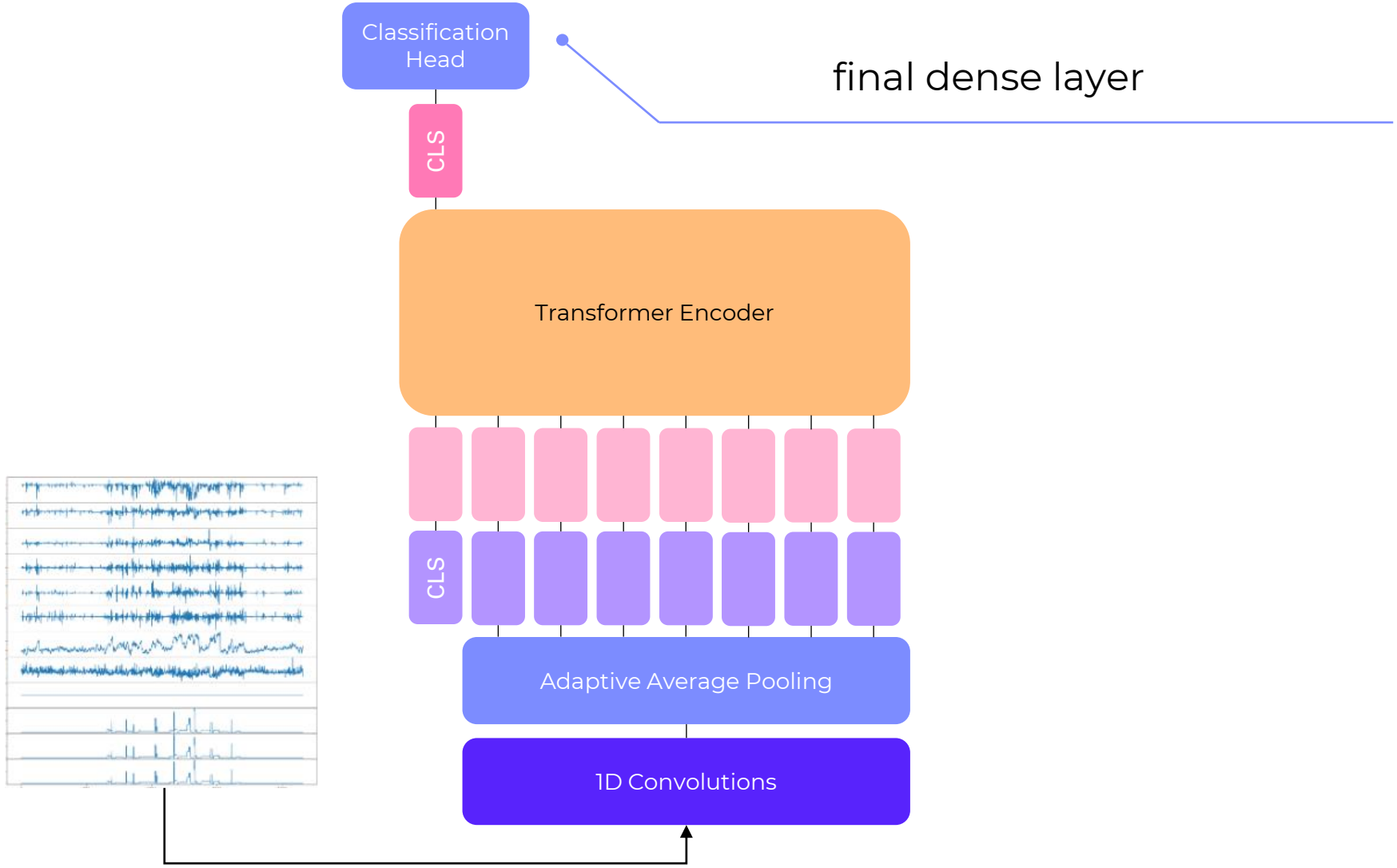

Classification Head
CLS
Transformer Encoder
CLS
Adaptive Average Pooling
1D Convolutions
Time2Vec

Models

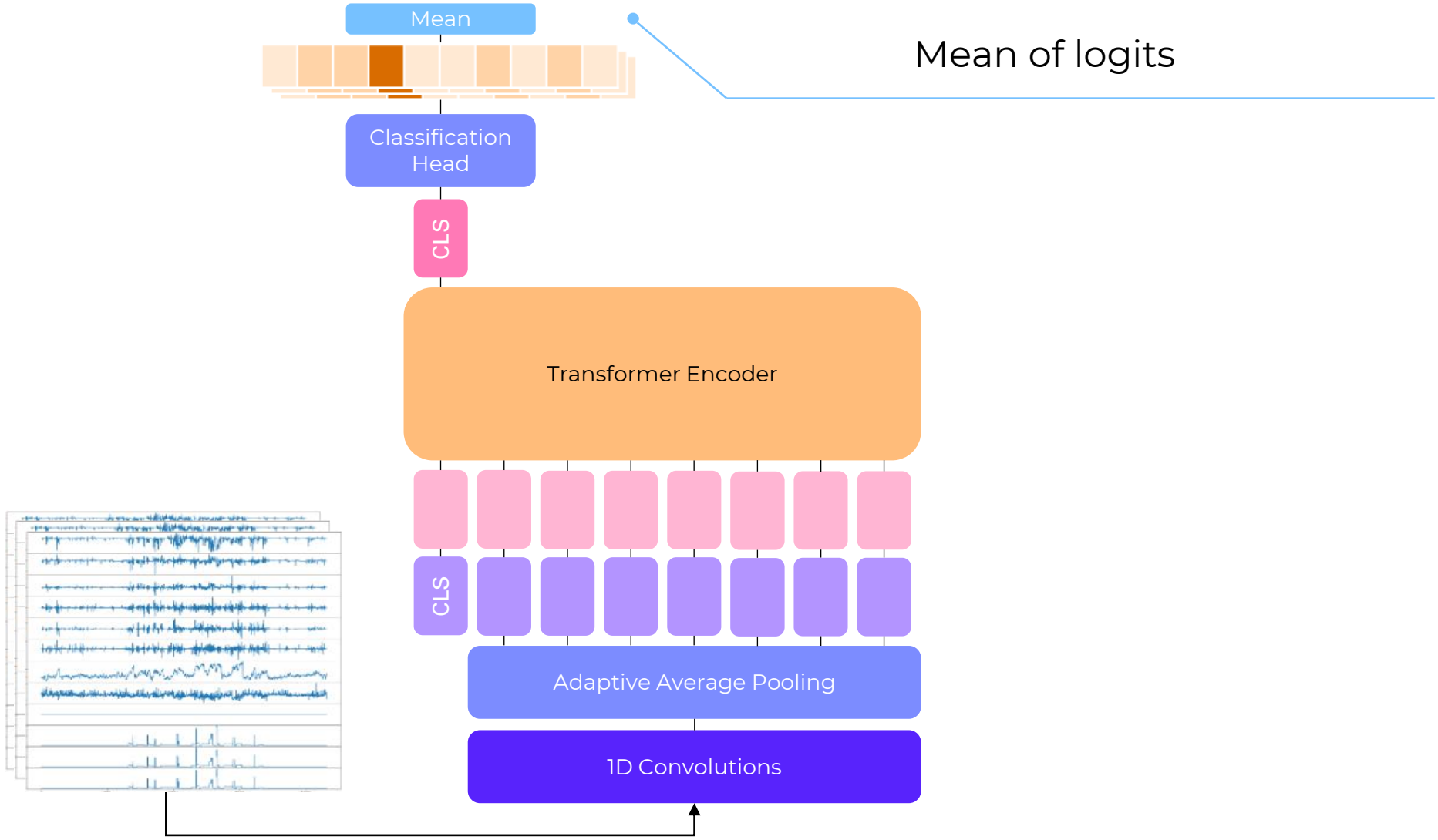


2 layers, 2 heads

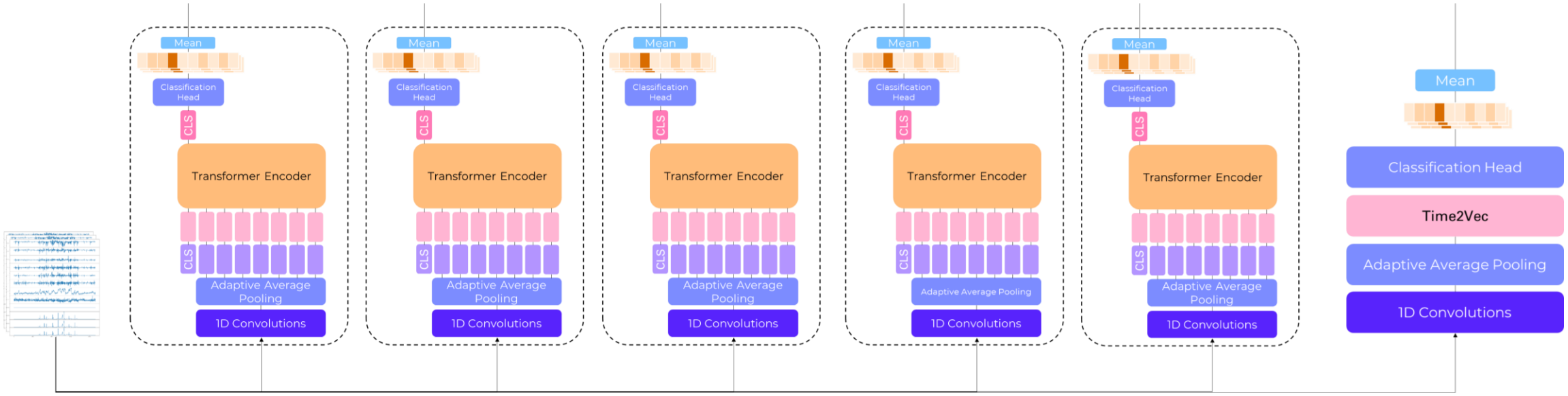
Models


Classification Head
final dense layer
CLS
Transformer Encoder
CLS
Adaptive Average Pooling
1D Convolutions

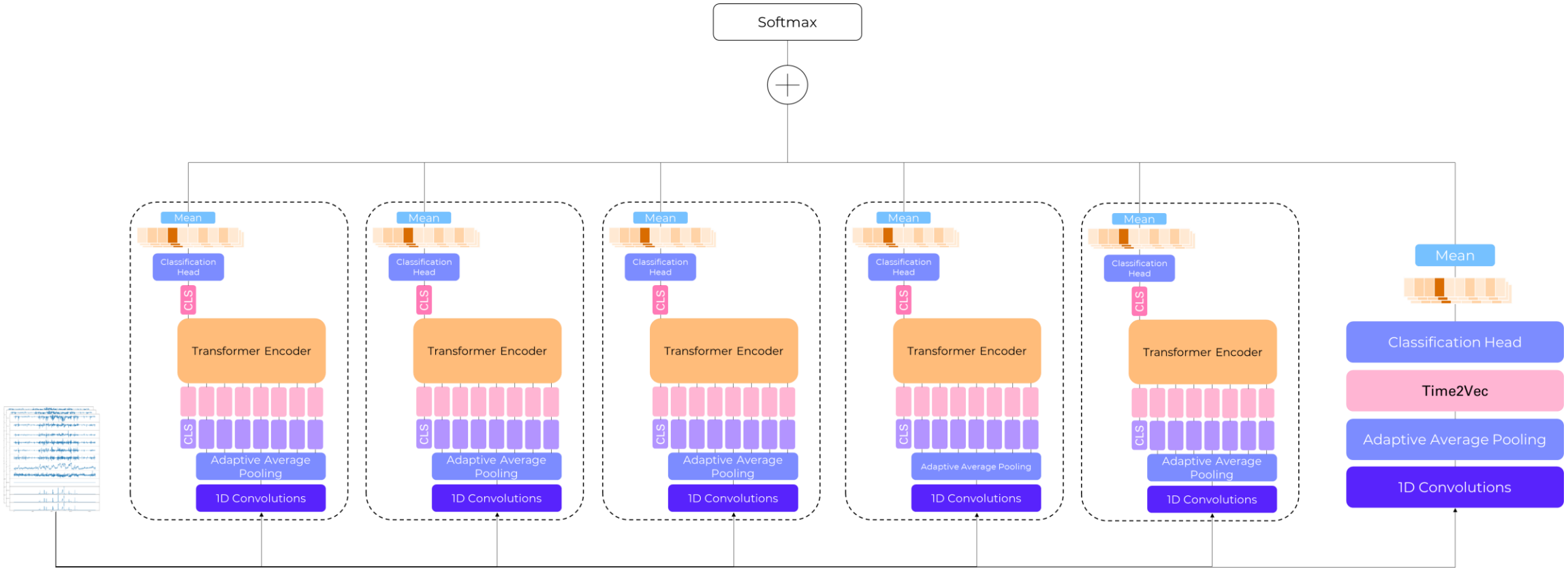
Models


Mean
Mean of logits
Classification Head
CLS
Transformer Encoder
CLS
Adaptive Average Pooling
1D Convolutions

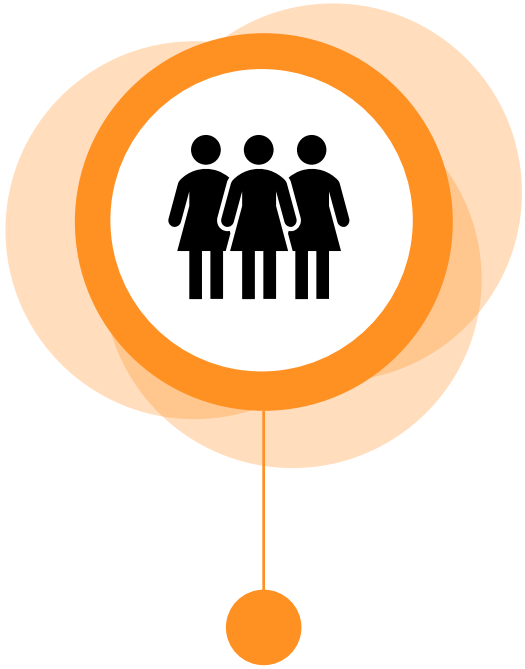
Ensemble Model



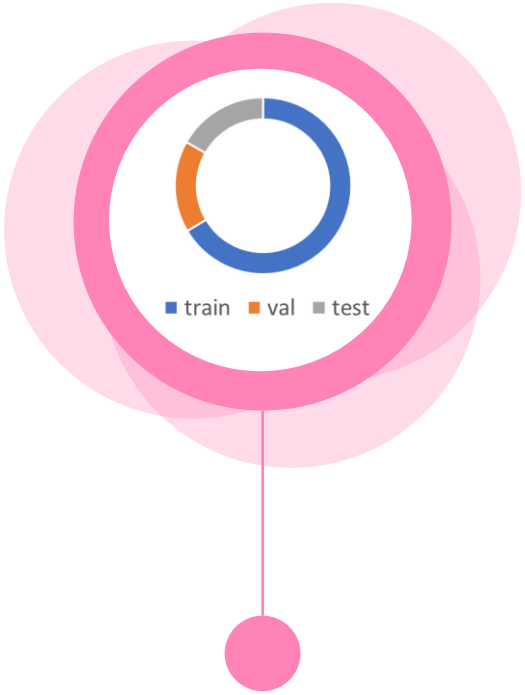
Ensemble Model



Track 2 - Relapse Detection

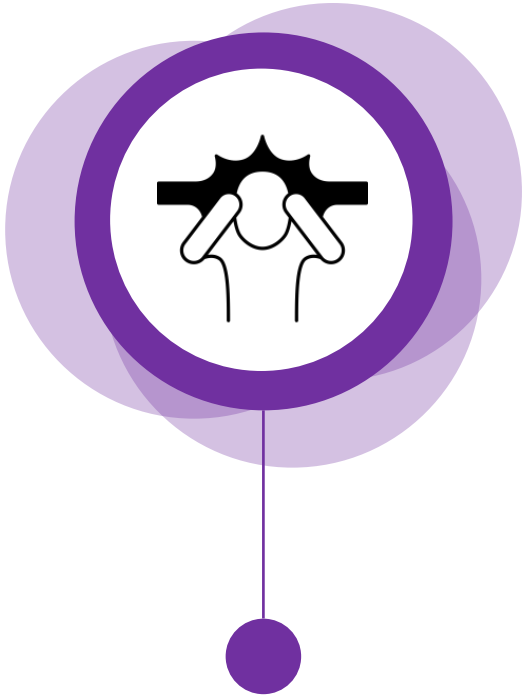


Subjects
10 different identities



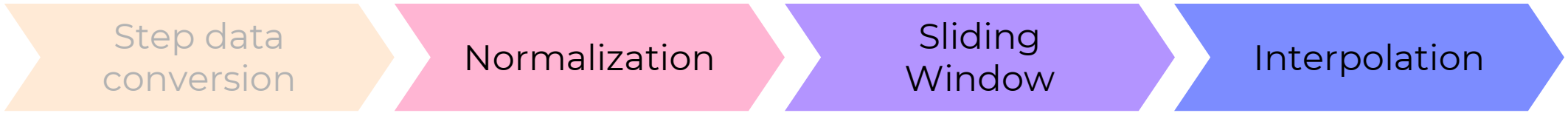
Splits
Train, validation and test splits already provided

Recordings
On daily basis



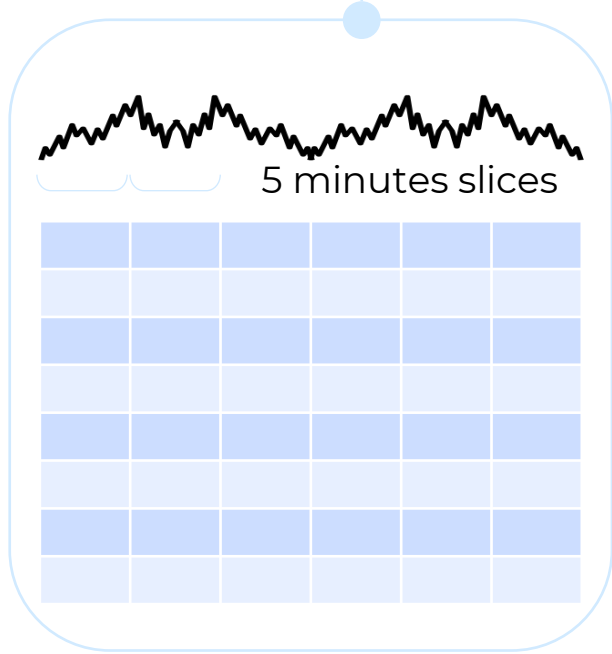
Replases
Relapse data are available only in validation and test

Data Preparation

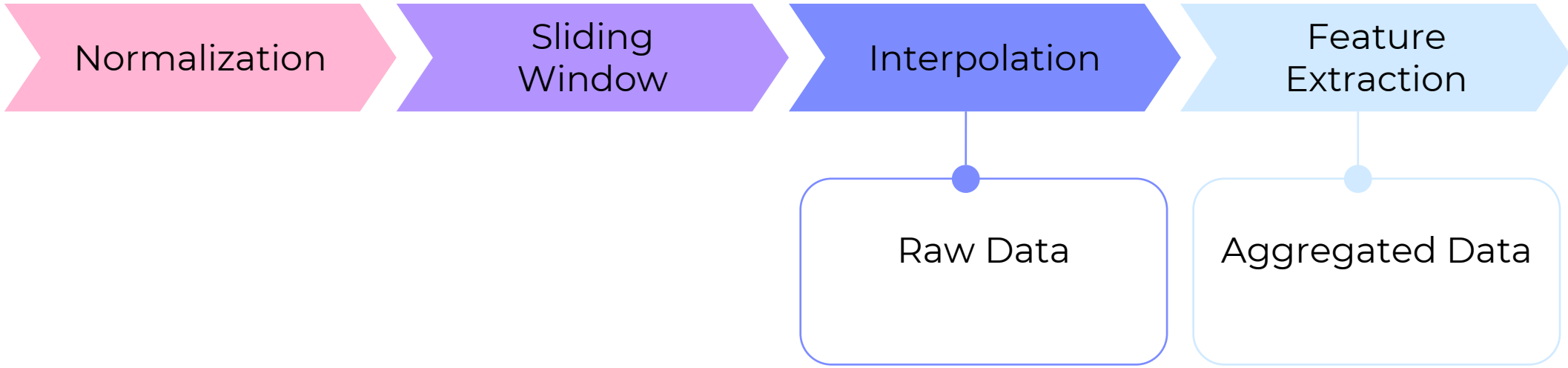


Data Preparation

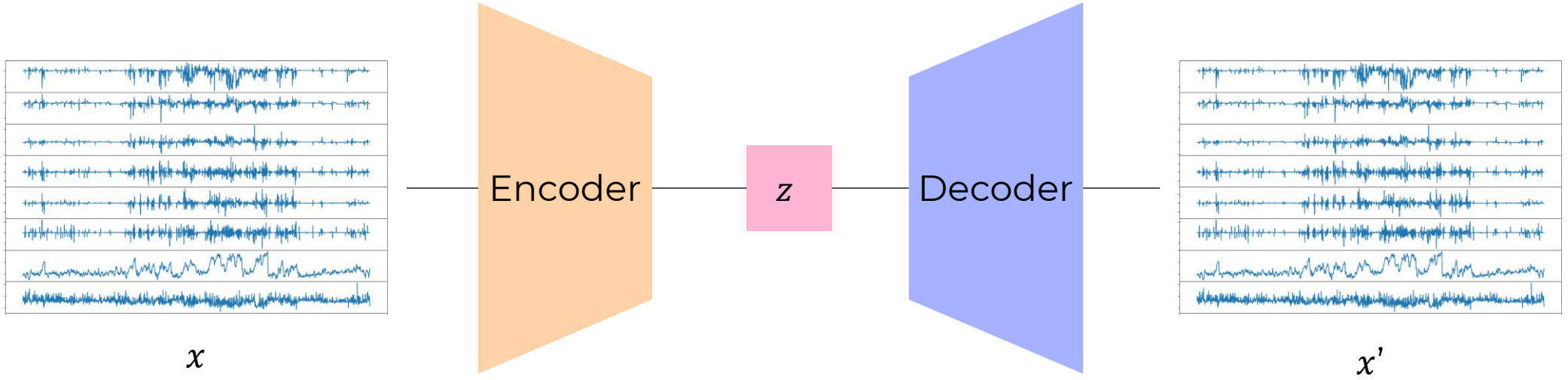
Normalization → Sliding Window → Interpolation → **Feature Extraction**



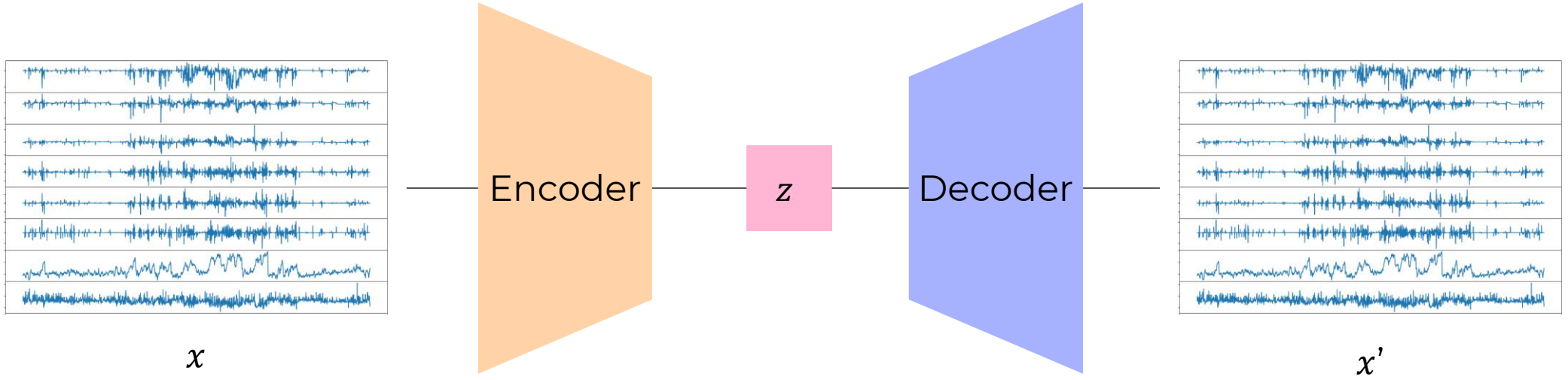
Data Preparation



Training Procedure



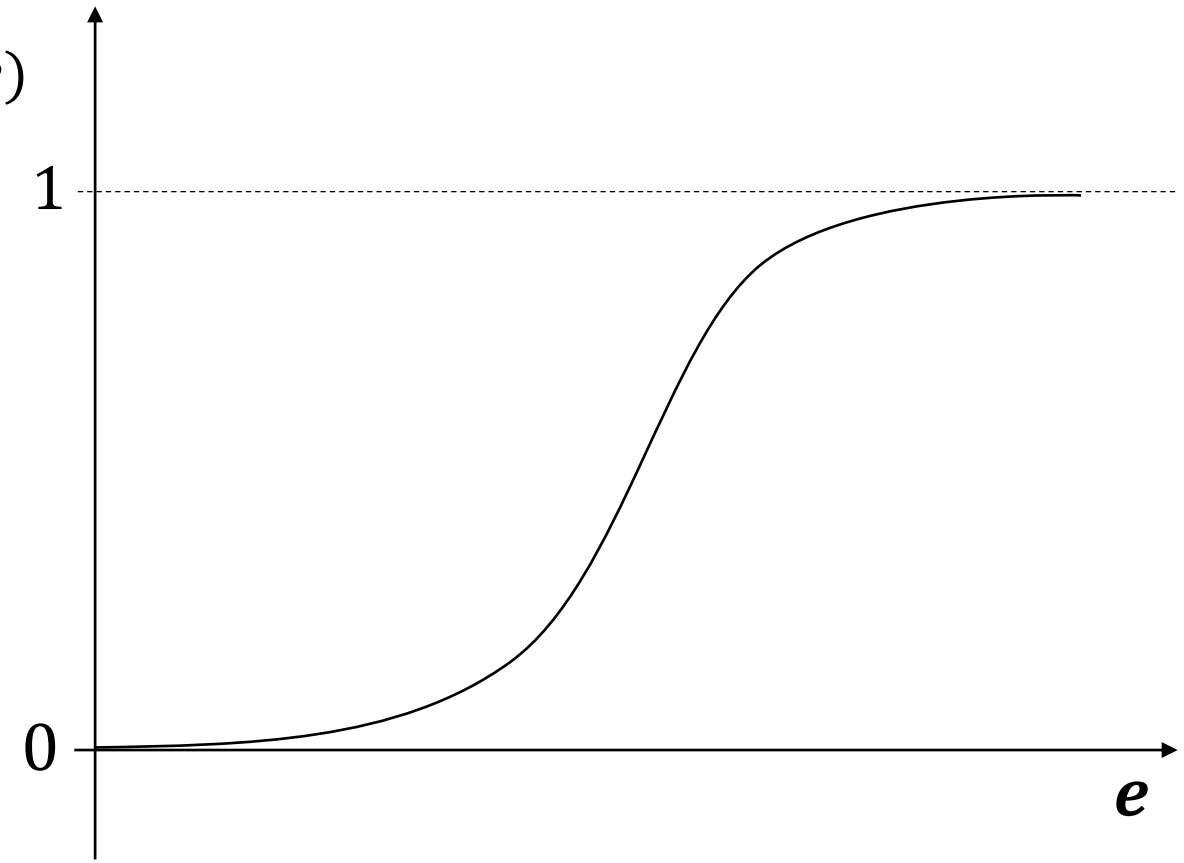
Training Procedure



$$reconstructionError(x, x') = MSE(x, x') = \boldsymbol{e}$$

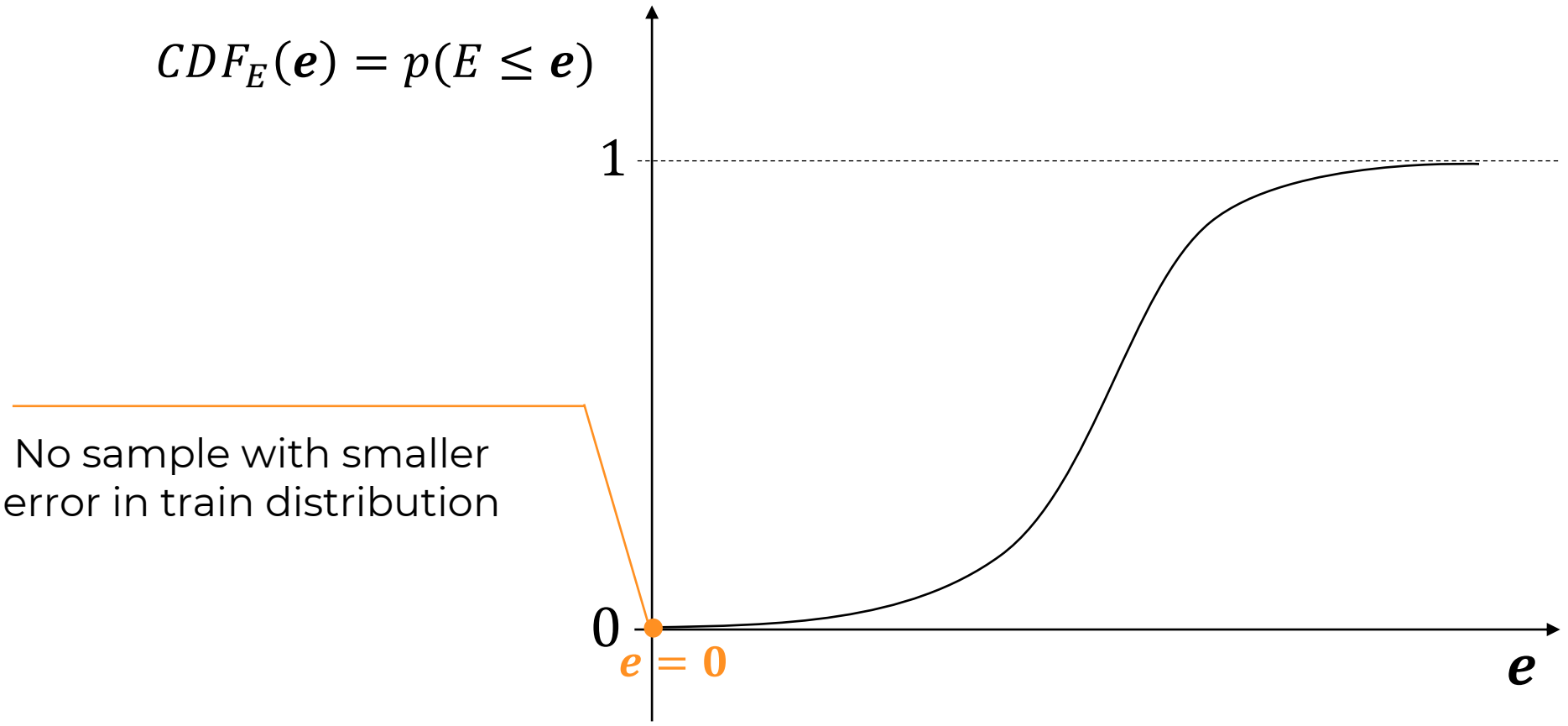
Inference

$$CDF_E(\boldsymbol{e}) = p(E \leq \boldsymbol{e})$$



Inference

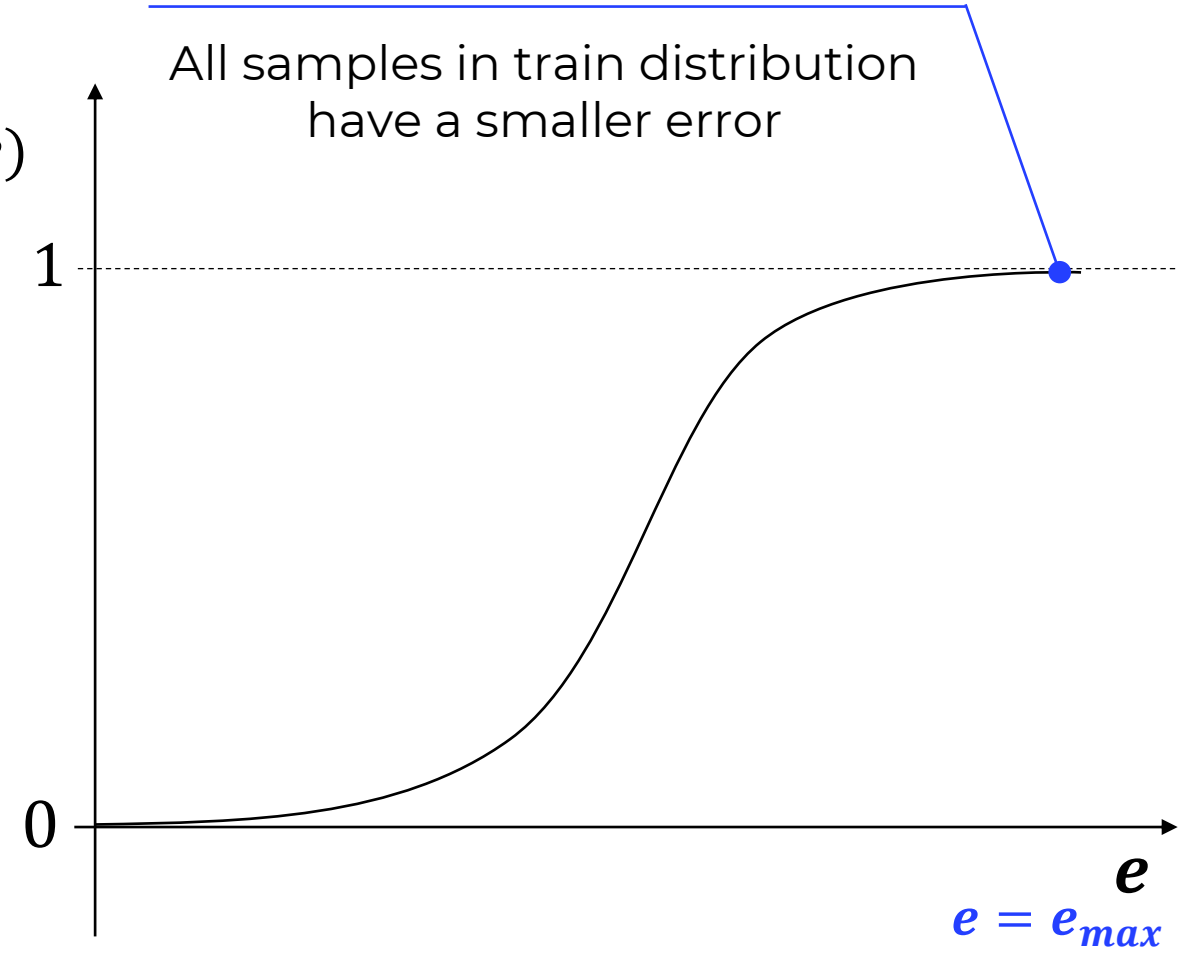
$$CDF_E(\boldsymbol{e}) = p(E \leq \boldsymbol{e})$$



No sample with smaller error in train distribution

Inference

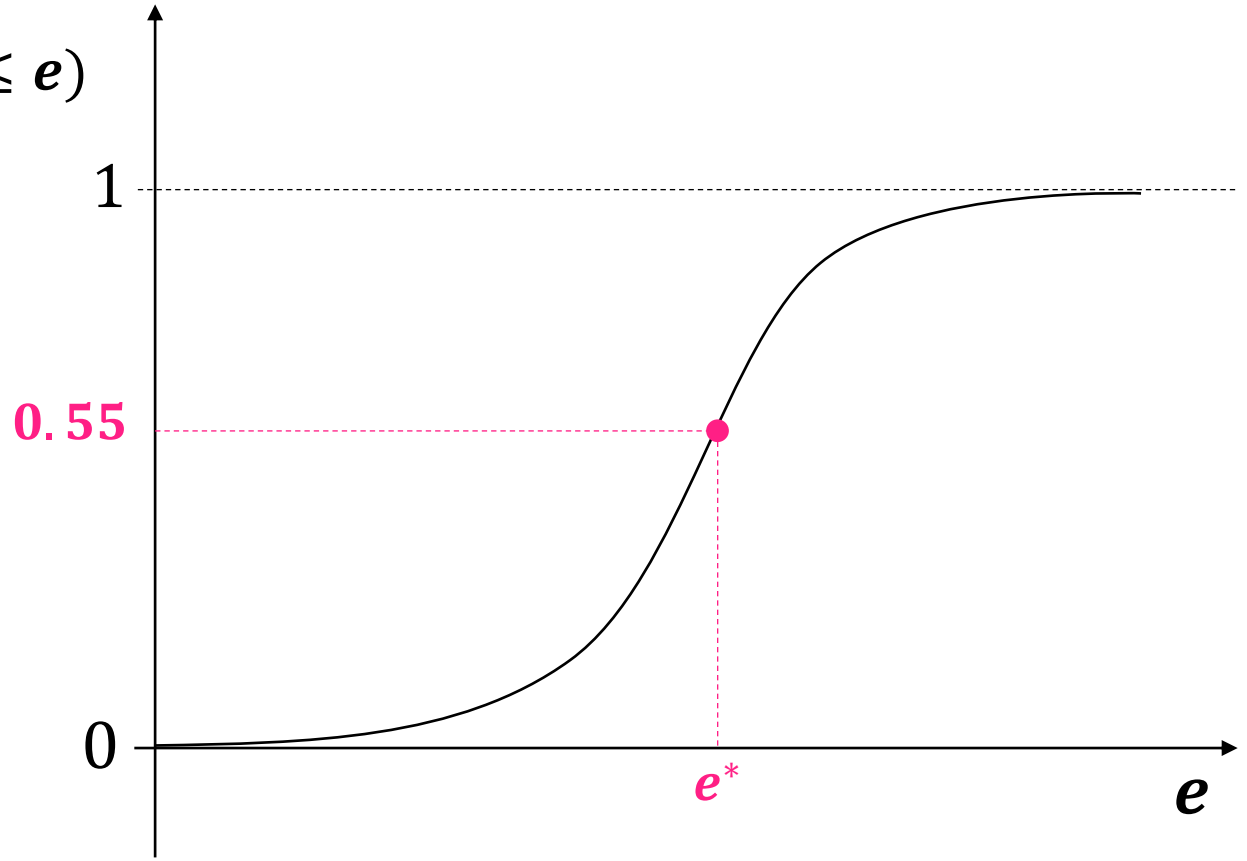
$$CDF_E(\boldsymbol{e}) = p(E \leq \boldsymbol{e})$$



Inference

$$CDF_E(\boldsymbol{e}) = p(E \leq \boldsymbol{e})$$

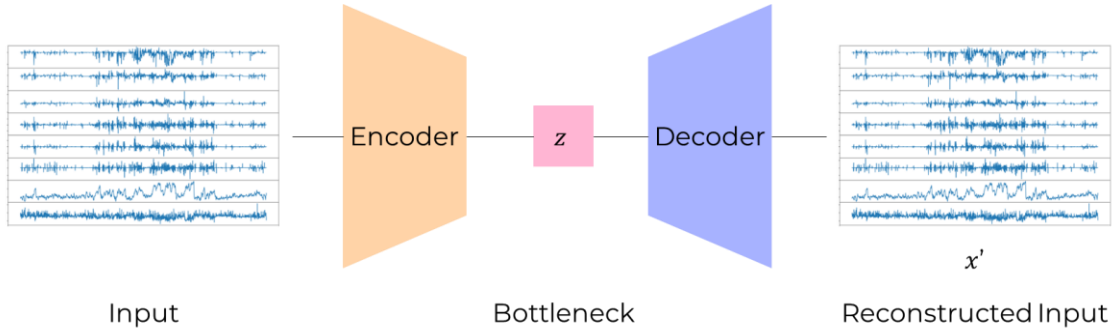
probability of anomaly
(probability of relapse)



Training Procedure

Subjects

One model for each subject



Architectures

Transformer Encoder-Decoder

1D CNN AutoEncoder

Autoencoder for time series

Data Type

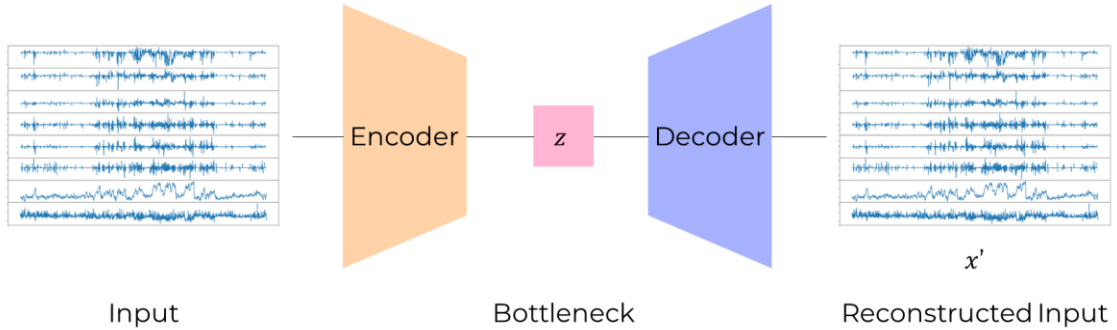
Raw data

Aggregated Data

Model selection

Subjects

One model for each subject



Architectures

Transformer Encoder-Decoder

1D CNN AutoEncoder

Autoencoder for time series

model		subject									
		0	1	2	3	4	5	6	7	8	9
CNN	*raw*	.53	.66	.45	.73	.62	.57	**.74**	.70	.58	.62
	aggr.	.44	.75	**.51**	.82	.73	.58	.15	.84	.78	.76
Volund	*raw*	.58	.67	.49	.72	.59	**.64**	.57	.58	.64	.66
	aggr.	.42	.77	.46	.78	.82	.53	.14	.81	.76	.76
Transf.	*aggr.*	**.61**	**.84**	.51	**.83**	**1.00**	.61	.47	**.89**	**.94**	**.79**

Data Type

Raw data

Aggregated Data

Results

Table 1. Performance comparison among participant teams on the provided test set for subject identification. We report the raw test accuracy for each team. Our score ranks 2^{nd}.

Team	Accuracy
SRCB-LUL	95.00%
PeRCeiVe	**93.85%**
AI_Bezzie	91.36%
SAILers	82.15%
unipi_cmbl	75.43%
ADCADD	3.83%
ID-EPRE2	2.88%
eHust	2.88%
CogBCI	2.88%
uoi	2.68%
NWPU	2.3%

Results

Table 2. Performance comparison among participant teams on the provided test set for relapse detection. We report the ROC-AUC, the PR-AUC and the harmonic mean of the previous scores, for each team. Our score ranks 1^{st}.

Team	ROC-AUC	PR-AUC	Total
PeRCeiVe	**0.6469**	**0.6509**	**0.6489**
Emotion	0.6072	0.6347	0.6209
SAILers	0.5839	0.6263	0.6051
SmartBCI	0.5435	0.5863	0.5604
YDH@HEU	0.5215	0.5587	0.5401
GIPS@HEU	0.5117	0.5480	0.5229

ICASSP 2023

4 - 10 JUNE,
RHODES ISLAND, GREECE

https://github.com/perceivelab/e-prevention-icassp-2023/

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THANK YOU FOR LISTENING!

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