

A Detailed Algorithmic Description of TENET

In this section, we elaborate on the computational process of TENET. The following pseudocode outlines the model’s fundamental algorithmic steps, delineating both spatial and temporal attention mechanisms within the Connectome Transformer and Transformer Encoder modules and complements Figure 2 in section 2.2, providing a more comprehensive understanding of how the both of modules are integrated in processing pipeline of TENET. The Connectome Transformer (g) addresses connectome embeddings, while the Transformer Encoder (h) refines these features over time, culminating in a final token vector \mathbf{h}_{dyn} for use in classification or regression tasks.

Algorithm 1 Algorithmic Flow of TENET

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1: Input: Time-sequenced connectome embeddings  $\mathbf{X}_t$  for  $t \in \{1, \dots, T\}$ , where  $T$  is the total
   number of timepoints, and Learnable token vector  $\mathbf{h}_{token}$ .
2: Output: Final token vector  $\mathbf{h}_{dyn}$ 
3: procedure CONNECTOME TRANSFORMER ( $g$ )
4:   for  $t = 1$  to  $T$  do
5:      $\mathbf{H}_t^0 \leftarrow \text{Concatenate}(\mathbf{X}_t, \mathbf{h}_{token})$  ▷ Initial embedding for time  $t$ 
6:      $\bar{\mathbf{R}}_t \leftarrow \text{Linear}(\mathbf{R}_t)$  ▷ Linear transformation of structure encoding
7:      $\Sigma^i(\bar{\mathbf{R}}_t)_{ij} \leftarrow \text{Linear}(\Sigma^i(\mathbf{R}_t)_{ij})$  ▷ Node degree information
8:     for  $l = 1$  to  $L$  do ▷  $L$  is the number of Transformer layers
9:        $\mathbf{Z}_t^l \leftarrow \text{Concatenate}(\{\text{attention}(\mathbf{H}_t^l), \bar{\mathbf{R}}_t, \Sigma^i(\bar{\mathbf{R}}_t)_{ij}\})$  ▷ Spatial Attention
10:       $\mathbf{H}_t^{l+1} \leftarrow \text{MLP}(\mathbf{Z}_t^l)$ 
11:    end for
12:     $\mathbf{h}_t \leftarrow \mathbf{H}_t^L[\text{token}]$  ▷ Extract token vector as connectome feature
13:  end for
14:   $\mathbf{h} \leftarrow \text{Concatenate}(\mathbf{h}_1, \mathbf{h}_2, \dots, \mathbf{h}_T)$ 
15:  return  $\mathbf{h}$ 
16: end procedure
17: procedure TRANSFORMER ENCODER ( $h$ )
18:   $\mathbf{H}^0 \leftarrow \text{Concatenate}(\mathbf{h}, \mathbf{h}_{token})$  ▷ Initial embedding
19:  for  $l = 1$  to  $L$  do
20:     $\mathbf{Z}^l \leftarrow \text{attention}(\mathbf{H}^l)$  ▷ Temporal Attention
21:     $\mathbf{H}^{l+1} \leftarrow \text{MLP}(\mathbf{Z}^l)$ 
22:  end for
23:   $\mathbf{h}_{dyn} \leftarrow \mathbf{H}^L[\text{token}]$  ▷ Extract token vector as final token vector
24:  return  $\mathbf{h}_{dyn}$ 
25: end procedure

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