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Proposal.

RL-Free training for RAD-embeddings [IEW7]

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We propose an RL-free approach to training a DFA-encoder. We start with the training objective.

Definition 1. RL-Free contrastive loss for RAD-embeddings [YFU7]
Let

$$f_\theta : \mathbf{DFAs} \to \mathbb{R}^d$$

be a $d \in \mathbb{N}$ dimensional DFA embedding with parameters $\theta \in \mathbb{R}^n$, $n \in \mathbb{N}$, and let

$$\delta : \mathbf{DFAs} \times \mathbf{DFAs} \to \Sigma^* \cup \bot$$

be a function that maps pairs of DFAs to a minimal distinguishing string.

For a given word, $w \in \Sigma^*$, let $\mathrm{Prefixes}(w)$, denote all of w's prefixes (including w and the empty string). Further, given a DFA $D \in \mathbf{DFAs}$ and a word $w \in \Sigma^*$, let D_w denote the sub-DFA accessed by word w.

Next, given two distiguishable DFAs, we denote by $\delta\mathrm{Prefixes}$ set of prefixes of minimal distinguishing given by δ.

$$\delta\mathrm{Prefixes}(D, D') \triangleq \mathrm{Prefixes}(\delta(D, D'))$$

The RAD RL-free constrastive loss, $\mathcal{L} : \mathbb{R}^n \times \mathbf{DFAs} \times \mathbf{DFAs} \to \mathbb{R}$, is defined as:

$$\mathcal{L}(\theta, D, D') \triangleq \max_{w \in \delta\mathrm{Prefixes}(D,D')} \left\| f_\theta(D) - f_\theta(D') \right\|.$$

That is the maximum embedding distance along the minimial distinguishing string.

Algorithm Sketch 2. RL-Free Training Procedure Sketch [RQF5]
Next, let $\mathcal{D}_{\mathrm{RAD}}$ denote a fixed Reach Avoid Derived (RAD) training distribution over DFAs. The training procedure for our proposed encoder is as follows.

1. Sample two *distinct* DFAs from $\mathcal{D}_{\mathrm{RAD}}$, call D and D'.
2. Compute a minimum distinguishing string, w_*, betweeen D and D', e.g., using a shortest path algorithm.
3. Compute the embeddings for D and D', i.e., $f_\theta(D)$ and $f_\theta(D')$, using the current parameters θ.

4. Compute the pairs of states visited by w_* and their corresonding embeddings.
5. To compute $\mathcal{L}(\theta, D, D')$, calculate their relative pair-wise distance and return the maximum.
6. Finally, compute the gradient with respect to θ, $\nabla_\theta \mathcal{L}(\theta, D, D')$ to update θ, e.g., using Adam.

Backlinks

Idea Nursery and Random Thoughts [ideas]
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