Learning Deterministic Weighted Automata with Queries and Counterexamples

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**Goal:** Probabilistic Deterministic Finite Automata (PDFAs) for Language Modeling

**Proposed Solution:** Active Learning (WL*: Adaptation of L* to Weighted Case)

**Results:** SPiCe Languages

Our method is often best for large synthetic tasks, and n-grams dominate over all methods on real world tasks.

**Results:** Unbounded History

When a language requires unbounded history to make predictions, n-grams cannot reconstruct it, while PDFA and WFA learning methods can

**Algorithm Details**

**Building a Hypothesis**

Partition \( P \) into states (clusters) \( C \) satisfying determinism and \( \tau \)-equality

**Membership Queries**

(Expanding the Observation Table)

A table \( O_{P,3} \) of last-token probabilities is expanded until it is closed and consistent

**Closed:**

Taking a "transition" from any prefix in \( P \) will reach a row that is \( \tau \)-equal to one already in \( O_{P,3} \)

**\( \tau \)-equality:**

Make sure not to put prefixes that are not \( \tau \)-equal (in \( O_{P,3} \)) in the same cluster

**Consistent:**

Taking a "transition" from two \( \tau \)-equal prefixes in \( P \) will reach rows that are also \( \tau \)-equal to each other

Example:

Taking a "transition" from \( a \) to \( b \) is not consistent

Fix: add \( \alpha \) to \( P \)

**Details**

Fix: add \( \alpha \) to \( P \) (so \( \epsilon \) and \( \alpha \) are not \( \tau \)-equal any more)

**Try it yourself:**

https://github.com/tel-ia/weighted-ata