Online Large-margin Weight Learning for First-order Logic-based Abduction

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● Background

- **Abduction** is inference to the best explanation

  Given:
  - Observation: {get-gun(John), go-to-store(John)}
  - Background knowledge: (∀x) hunt(x) → get-gun(x)
  - (∀x) go-shopping(x) → go-to-store(x)

  Find:
  - The best explanation (=highest-score explanation)
    \[ H_j: \{\text{hunt(John), go-shopping(John)}\} \]
    \[ H_1: \{\text{rob(John)}\} \]
    \[ H_2: \{\text{rob(John), hunt(John)}\} \]

  *There are many applications: natural language processing, plan recognition etc.*

- **Plan recognition**

  - **Training/Testing:**
  - **Dataset:**

  - **Publicly available at:**

  - **classifier reduces predictive loss**

- **T-21**

  - **Desiderata** for learning framework
    - **Scalability:** computationally cheap, good results in a short time
    - **Accurateness:** discriminative power
    - **Usability:** learn from partially observed dataset

  - **The learning framework**

    (1) Assume weighted linear scoring model:
    \[ \text{score}(H; w) = w \cdot \Phi(H) \]
    (2) Learn \( w \) from training examples online, following the large-margin principle:

    \[ T = \{(O_i, H_i)\} \]

    \[ score(H_i) = 4.3 \]
    \[ score(H_2) = 13.5 \]
    \[ score(H_3) = 10.8 \]

  *Tuning of score function relies on:*
    - Manual tuning
    - Probabilistic logic-based learning
    (e.g. Markov Logic Networks [Richardson & Domingos 06])

- **Problem:** inference is not scalable; learning is even harder

- **Finding**

  - **Weight learning reduces predictive loss**
  - **Combining abductive reasoning with feature-based classifier reduces predictive loss**
  - **Generalization ability on unseen dataset**

  Publicly available at: http://github.com/naoya-i/henry-n700/

  ● Evaluation

  - **Q1:** Does learning have positive impact?
    - Task:
      - Plan recognition
      - Gold-standard: plan literals
      - Dataset:
        - Ng & Mooney [92]
        - Training/Testing:
          25 examples
          BK: 107 axioms
    - Findings:
      - **Weight learning reduces predictive loss**
      - **Combining abductive reasoning with feature-based classifier reduces predictive loss**
      - **Generalization ability on unseen dataset**

  - **Q2:** Does combining logic-based reasoning with existing classifier give better predictive performance?
    - Task:
      - Coreference resolution
      - Gold-standard:
        - equalities
      - Dataset:
        - CoNLL-2011 Shared Task
      - Training/Testing:
        100 documents
        BK: 300,000 axioms

  ● Future work

  - **Use k-best explanations for update**
  - **Comparison with feature-based classifier exploiting world knowledge as features**

  This work was partially supported by Grant-in-Aid for JSPS Fellows (22-0719), Grant-in-Aid for Scientific Research (23700157, 23240018), and JST, PRESTO.