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Notes for "Towards AI-Complete Question Answering: A Set of Prerequisite Toy Tasks" Paper

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Introduction

The paper presents a framework and a set of synthetic toy tasks (classified into skill sets) for analyzing the performance of different machine learning algorithms.

Tasks

- **Single/Two/Three Supporting Facts**: Questions where a single(or multiple) supporting facts provide the answer. More is the number of supporting facts, tougher is the task.
- **Two/Three Supporting Facts**: Requires differentiation between objects and subjects.
- **Yes/No Questions**: True/False questions.
- **Counting/List/Set Questions**: Requires ability to count or list objects having a certain property.
- **Simple Negation and Indefinite Knowledge**: Tests the ability to handle negation constructs and model sentences that describe a possibility and not a certainty.
- **Basic Coreference, Conjunctions, and Compound Coreference**: Requires ability to handle different levels of coreference.
- **Time Reasoning**: Requires understanding the use of time expressions in sentences.
- **Basic Deduction and Induction**: Tests basic deduction and induction via inheritance of properties.
- **Position and Size Reasoning**
- **Path Finding**: Find path between locations.
- **Agent's Motivation**: Why an agent performs an action ie what is the state of the agent.

Dataset

- The dataset is available here and the source code to generate the tasks is available here.
- The different tasks are independent of each other.
- For supervised training, the set of relevant statements is provided along with questions and answers.
- The tasks are available in English, Hindi and shuffled English words.

Data Simulation

- Simulated world consists of entities of various types (locations, objects, persons etc) and of various actions that operate on these entities.
- These entities have their internal state and follow certain rules as to how they interact with other entities.
- Basic simulations are of the form: eg Bob go school.
- To add variations, synonyms are used for entities and actions.

Experiments

Methods

- N-gram classifier baseline
- LSTMs
- Memory Networks (MemNNs)
- Structured SVM incorporating externally labeled data

Extensions to Memory Networks

- **Adaptive Memories** - learn the number of hops to be performed instead of using the fixed value of 2 hops.
- **N-grams** - Use a bag of 3-grams instead of a bag-of-words.
- **Nonlinearity** - Apply 2-layer neural network with *tanh* nonlinearity in the matching function.

🔗 Structured SVM

- Uses coreference resolution and semantic role labeling (SRL) which are themselves trained on a large amount of data.
- First train with strong supervision to find supporting statements and then use a similar SVM to find the response.

Results

- Standard MemNN outperform N-gram and LSTM but still fail on a number of tasks.
- MemNNs with Adaptive Memory improve the performance for multiple supporting facts task and basic induction task.
- MemNNs with N-gram modeling improves results when word order matters.
- MemNNs with Nonlinearity performs well on Yes/No tasks and indefinite knowledge tasks.
- Structured SVM outperforms vanilla MemNNs but not as good as MemNNs with modifications.
- Structured SVM performs very well on path finding task due to its non-greedy search approach.