



MEMORYBANK: A FLEXIBLE FRAMEWORK FOR SYSTEMIC BELIEFS

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Problem & Background

- Background:** Question Answering Models can be inconsistent.
 - "A bird has feathers."
 - "A sparrow is a bird."
 - "A sparrow does not have feathers."
- BeliefBank:** Existing Framework [1]
 - Save questions and answers to **external memory**.
 - Manually create constraints from ConceptNet
 - Run **MAX-SAT solver** to flip current and past answers
 - Feed back relevant beliefs to QA model [2]
- Our Goal:** Eliminate **manual** creation of **constraints**

Our Approach

- Use **Natural Language Inference model** to infer constraints between new belief and existing beliefs.
- Use **Semantic Similarity** instead of constraint relations to identify relevant existing beliefs for NLI inference and feedback.
- Experiment using **Heuristic-based** and **MaxSAT-based** flipping mechanisms for ensuring consistency.

Methods & Experiments

- Dataset** 12k silver facts about animals and plants from ConceptNet [1]. Split into 20% validation, 80% test.
- Hyper-parameters** tuned on validation set. batch size, sentence similarity threshold, default flipped confidence, flip threshold, entailment threshold, scoring mechanism.
- Baseline:** Unperturbed questions out of QA model.
- Metrics:**
 - Consistency = $1 - (\# \text{violated constraints}) / (\# \text{applicable constraints})$
 - F1-score = $2 \cdot (\text{precision} * \text{recall}) / (\text{precision} + \text{recall})$

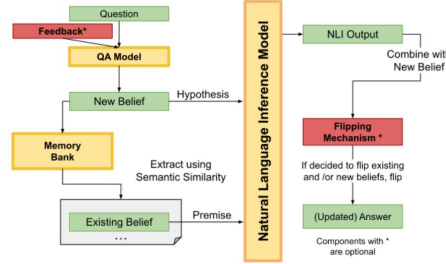


Figure 1. Our Approach.

Analysis

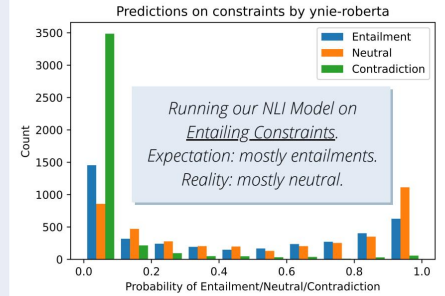


Figure 3. NLI Constraint Entailment experiment

Heuristic Flip Examples

Flipped Premise: A new world blackbird has a body part.
Hypothesis: A new world blackbird can fly.
Premises: A new world blackbird is [not a building, not a human being, not a house, is a lake, is a shop, can live, ...]
Flipped Hypothesis: A new world blackbird is not a location.
Hypothesis: An elephant can note food.
Flipped Premise: An elephant is a food.

MaxSAT Flip Examples

Flipped: A camel is not an africa.
Flipped: An owl is not a protein.
Flipped: An oryx is not an asia.
Flipped: A hound is not a hair.
Flipped: A peony is not a bird.
Flipped: A chimpanzee is not a publication.
Flipped: A foxhound is not a location.
Flipped: A chicken is not a molecule.
Flipped: A giraffe cannot note food.
Flipped: A reptile is a movie.
Flipped: A duck is not an oviparous animal.

Results

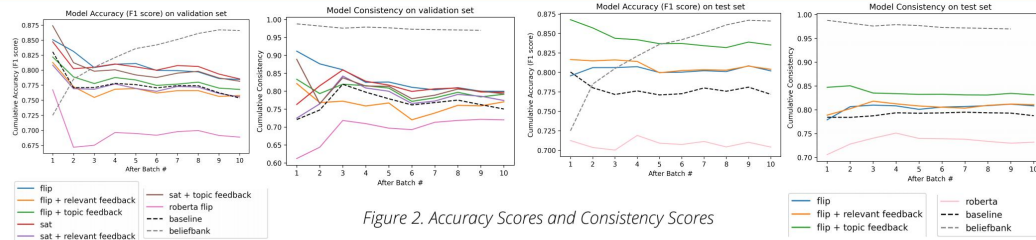


Figure 2. Accuracy Scores and Consistency Scores

Conclusions

- Greedy local constraint solving is comparable to global maxSAT constraint solving in this context.
- NLI-based constraints are not sufficient to **significantly** improve QA accuracy and consistency.
- NLI models don't have sufficient entailment detection.

1. Nora Kassner, Oyvind Tafjord, Hinrich Schütze, and Peter Clark. 2021. Beliefbank: Adding memory to a pre-trained language model for a systematic notion of belief. arXiv preprint arXiv:2109.14723.
 2. Oyvind Tafjord and Peter Clark. 2021. General-purpose question-answering with macaw. arXiv preprint arXiv:2109.02593.