Semantic Role Labeling for Process Recognition Questions

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Objective

To develop a QA system that can answer a subset of 4th grade questions involving recognizing instances of physical, biological, and other natural processes.

The questions present a short description of an instance and multiple process names as the answer choices.

Question: As water vapor rises in the atmosphere, it cools and changes back to liquid. Tiny drops of liquid form clouds in this process called

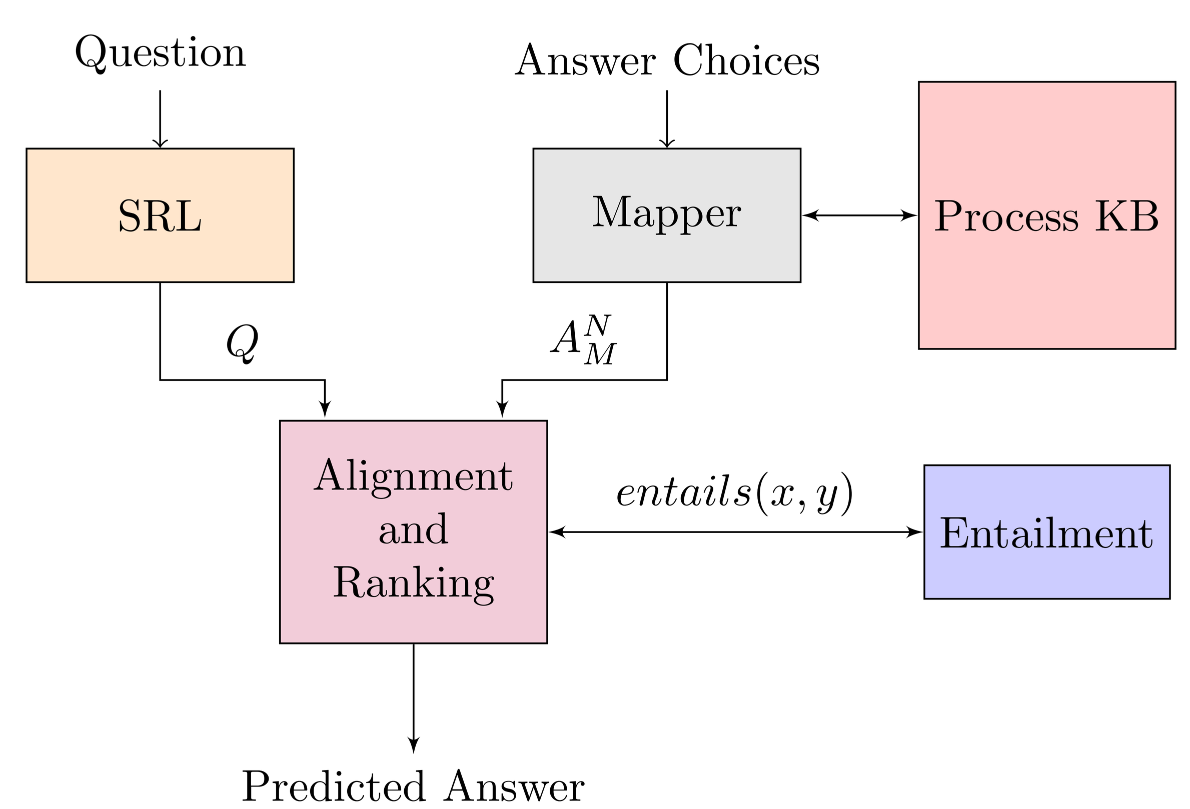
Answer Choices:

- condensation
- precipitation
- evaporation
- run-off

Approach

This work explores a knowledge-driven approach to answering such questions.

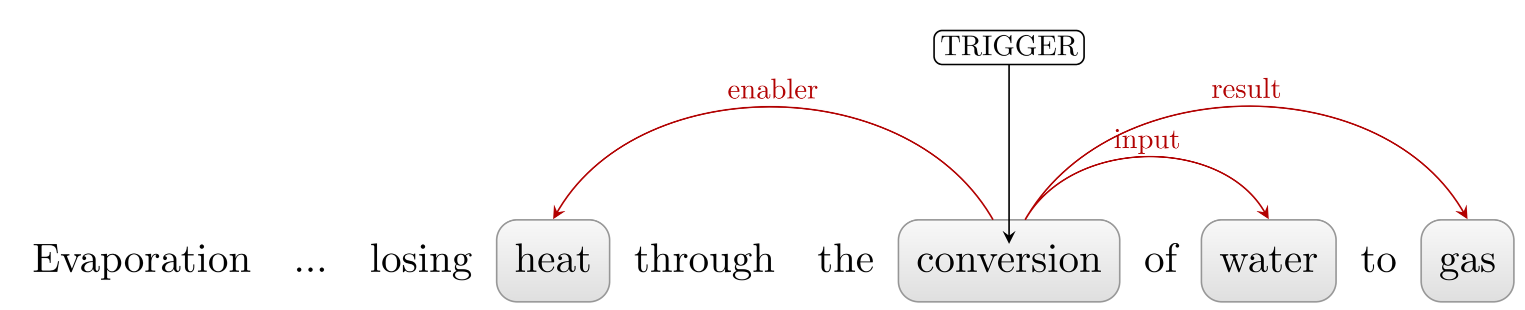
- We represent processes using a light-weight semantic role based representation.
- We answer a question by assessing how well the roles of the instance in the question align with the roles of the candidate answer processes.



Representing Processes via Semantic Roles

The 4th grade level questions do not require deep knowledge about the sub-events of processes or their sequential order. The required knowledge can be expressed via semantic roles. Accordingly we design a simple representation that encodes information about each process via the following roles:

1. *Input* – This role captures the main input to the process or the object undergoing the process.
2. *Result* – The artifact that results from the process or the change that results from the process.
3. *Trigger* – The main action, expressed as a verb or its nominalization, indicating the occurrence of the process.
4. *Enabler* – The artifact, condition or action that enables the process to happen.



- We use MATE SRL system [1] for role labeling.
- To account for the limited amount of training data, we explored distant supervision, and domain adaptation [2].

Question Answering Using Semantic Roles

We score each candidate answer process based on how well the roles of the instance described in the question align with the roles of the process. We use the following procedure to answer questions:

- Identify the roles in the question statement (Q).
- Collect the roles for all the answer processes ($A_{1..M}^{1..N}$) from the Knowledge Base. *(M – # of answer choices, N – # of frames)*
- For every QA frame pair, compute an alignment score by checking for the textual entailment of the corresponding roles.

$$alignment(Q, A_m^n) = \sum_{role_i \in R} entails(role_i(A_m^n), role_i(Q))$$

  where, R ={Input, Result, Enabler, Trigger}. $entails(x, y)$ is computed as a textual entailment score that reflects how well the text x entails text y or the other way around.
- Compute the mean of the top 5 frame alignment scores for each process and return the top scoring process as the answer.

Results

Method	Precision	Recall	F1
Standard	0.4323	0.3325	0.3758
Per Process	0.4225	0.2556	0.3185
Distant Supervision	**0.5614**	0.2642	0.3594
Dom. Adaptation	0.4386	**0.3351**	**0.3799**

Table 1: Semantic Role Labeling Performance

Method	Accuracy
BOW	63.12
Manual SRL	67.38
BOW+Manual SRL	**70.92**
Standard	**55.32**
Per Process	46.80
Domain Adaptation	**55.32**
Distant Supervision	51.77
BOW + Standard	**65.24**

Table 2: Question Answering Performance

Error Analysis

Automatic SRL Failures

- Issues that arise out of data sparsity
- Gap between verb-based role and our customized process-based role

QA Failures

- Knowledge Representation Issues (37%)
- Entailment Issues (32%)
- Scoring Issues (31%)

References

[1] Anders Björkelund, Love Hafdell, and Pierre Nugues.
Multilingual semantic role labeling.
Association for Computational Linguistics, 2009.

[2] Hal Daumé III.
Frustratingly easy domain adaptation.
arXiv preprint arXiv:0907.1815, 2009.

Acknowledgements

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