Procedural Reading Comprehension with Attribute-Aware Context Flow

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Procedural Text

Process

The engine must be powered by gas or some **fuel** source.

The **fuel** source will power an alternator.

An alternator will convert **mechanical energy** in to measurable electrical energy.

Mini Quiches

Ingredients

- ½ red pepper
- 2 spring onions
- 2 slices of ham
- 50g cheddar cheese
- 250g short crust pastry
- 4 large eggs

Method

Turn the oven on to 180°C. Oil a muffin tin.

Pull the seeds from the pepper. Chop the pepper and ham into small pieces, grate the cheese.

Cut the tops and bottoms off the spring onions with scissors, cut the onions into small pieces.

Mix the vegetables and cheese in a small bowl.

Break the eggs into a jug and whisk.

Roll out the pastry and cut into large circles.

Push the pastry circles into the muffin tin holes to make cups.

Fill the pastry cups with the vegetables and cheese, then pour some egg on top of each one.

Bake in the oven for 20 minutes.

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Procedural Text

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Fuel	Mechanical Energy
?	-
engine	-

Entities

Attributes

Procedural Text

Process

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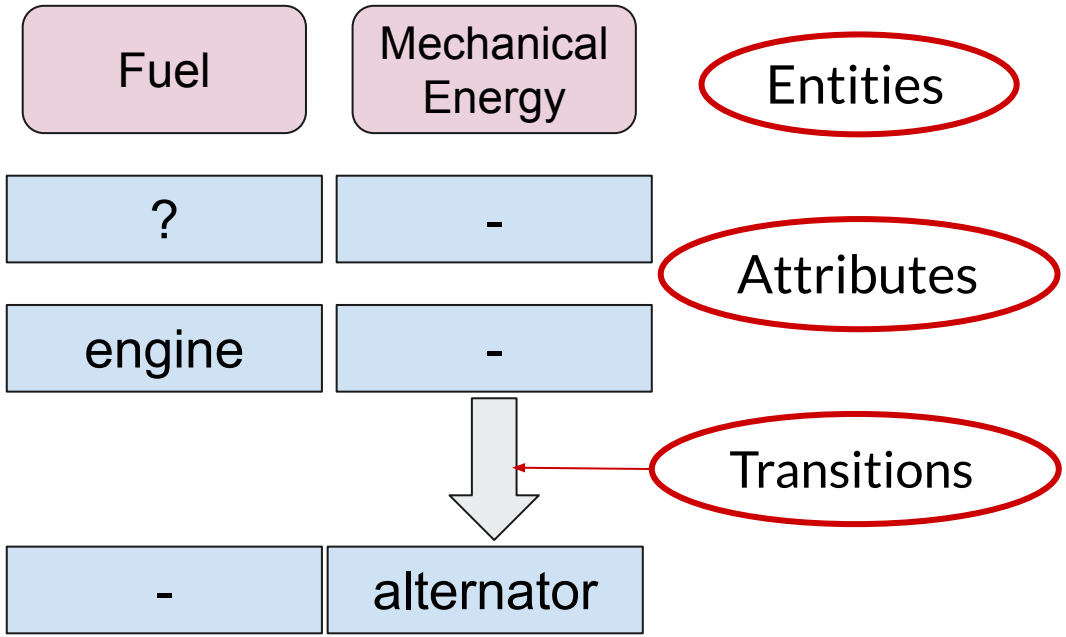


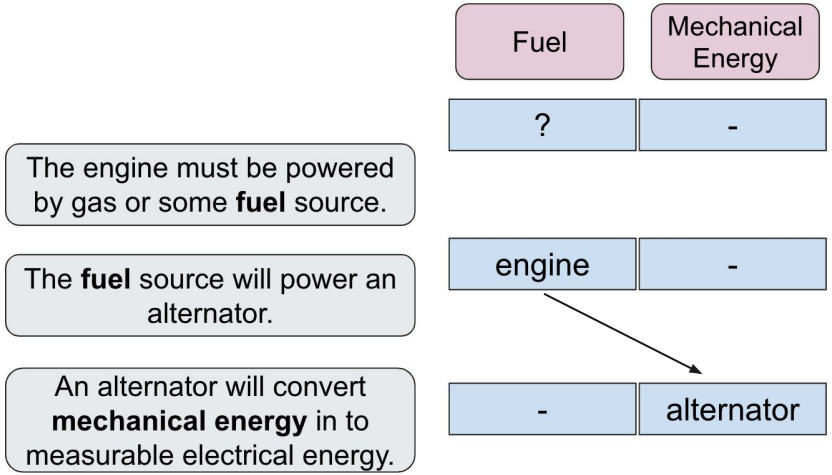
Procedural Reading Comprehension

Inputs:

- Procedural text
- Entities

Output:

- State of each entity, at every time-point



- What are the changes happening to “fuel”?

Procedural Reading Comprehension

Inputs:

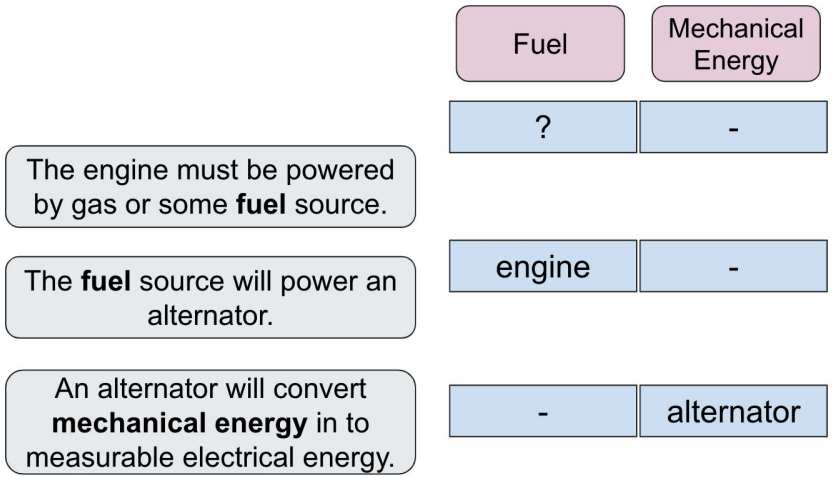
- Procedural text
- Entities

Output:

- State of each entity, at every time-point

Challenges:

- Dynamic text vs. static text
  - Implicit mentions of entities
  - Implicit mention of attribute changes
- Attribute values as spans of text

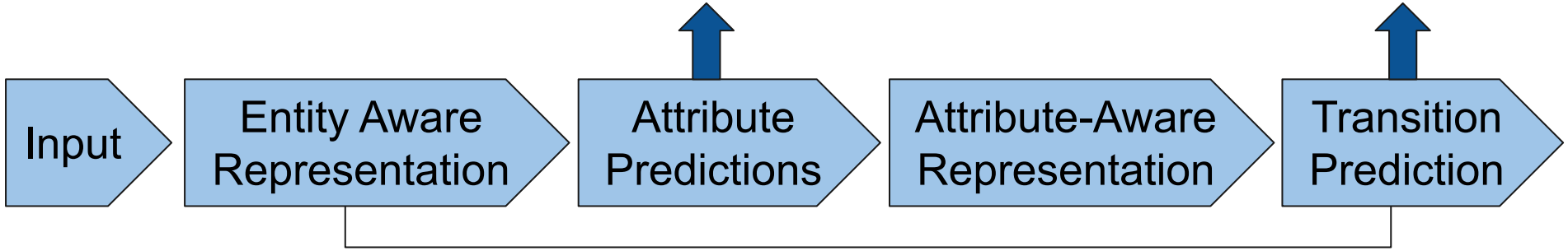


Contributions

- New formalism for modeling procedural text
  - Each Procedure → (Entities, Attributes, Transition)
- Dynapro: neural reading comprehension model, predicts:
  - Jointly predicts attributes and transitions
  - Attributes as spans of texts and predefined classes
- SOTA results and analysis

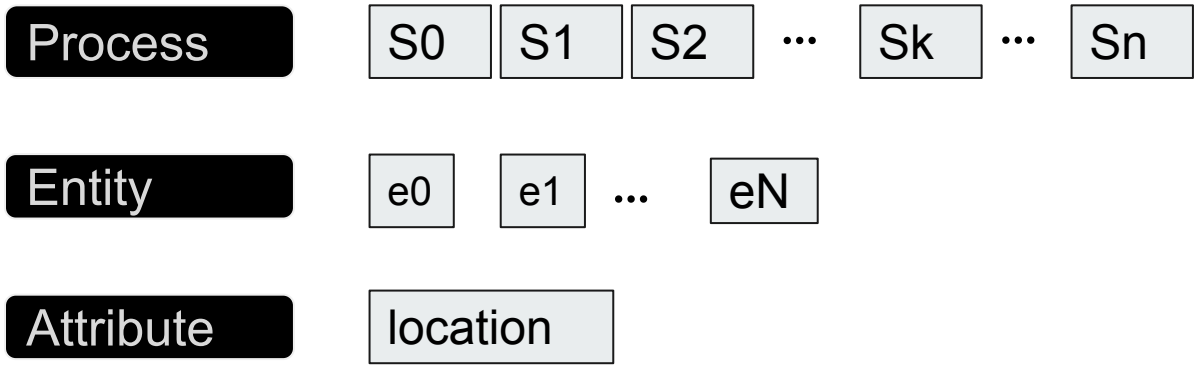
DynaPro Model Overview

- Leverage reading comprehension + entity-aware context
- Attribute values
  - Pre-defined classes
  - Span of text
- Joint modeling of attributes and transitions
  - Trains end-to-end over attribute and transition loss



Input Construction

Given: For time-step k and entity 0

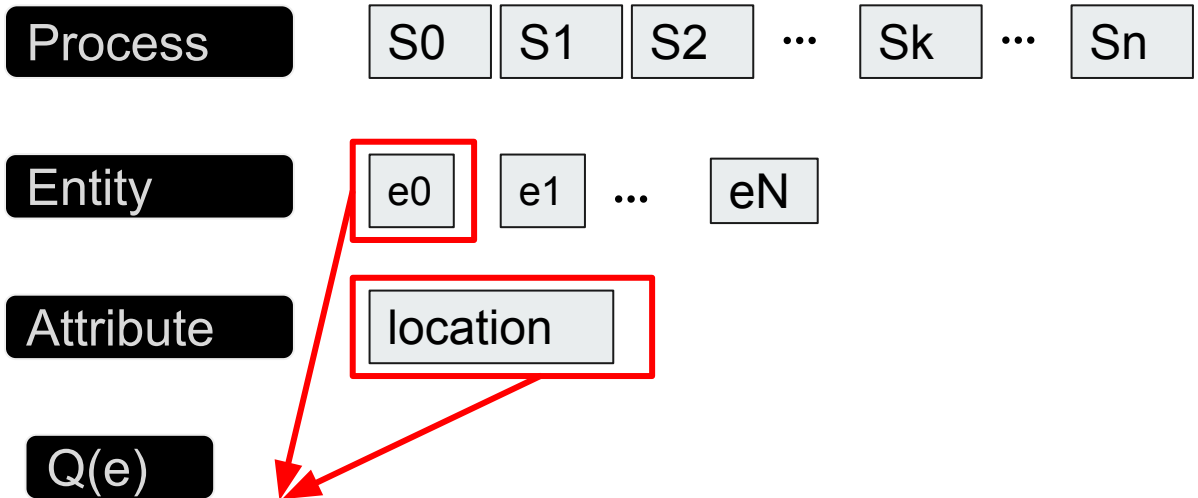


Input:

Input

Input Construction

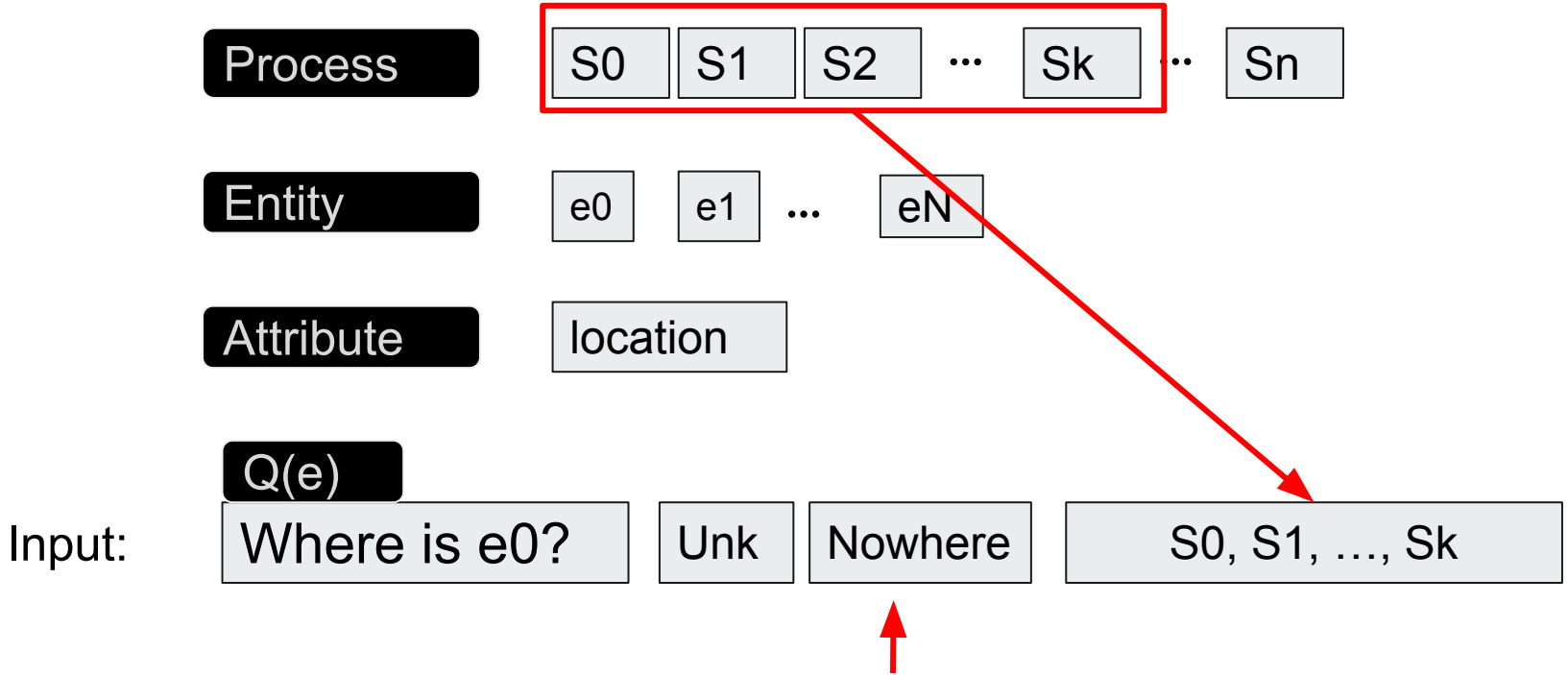
Given: For time-step k and entity 0



Input

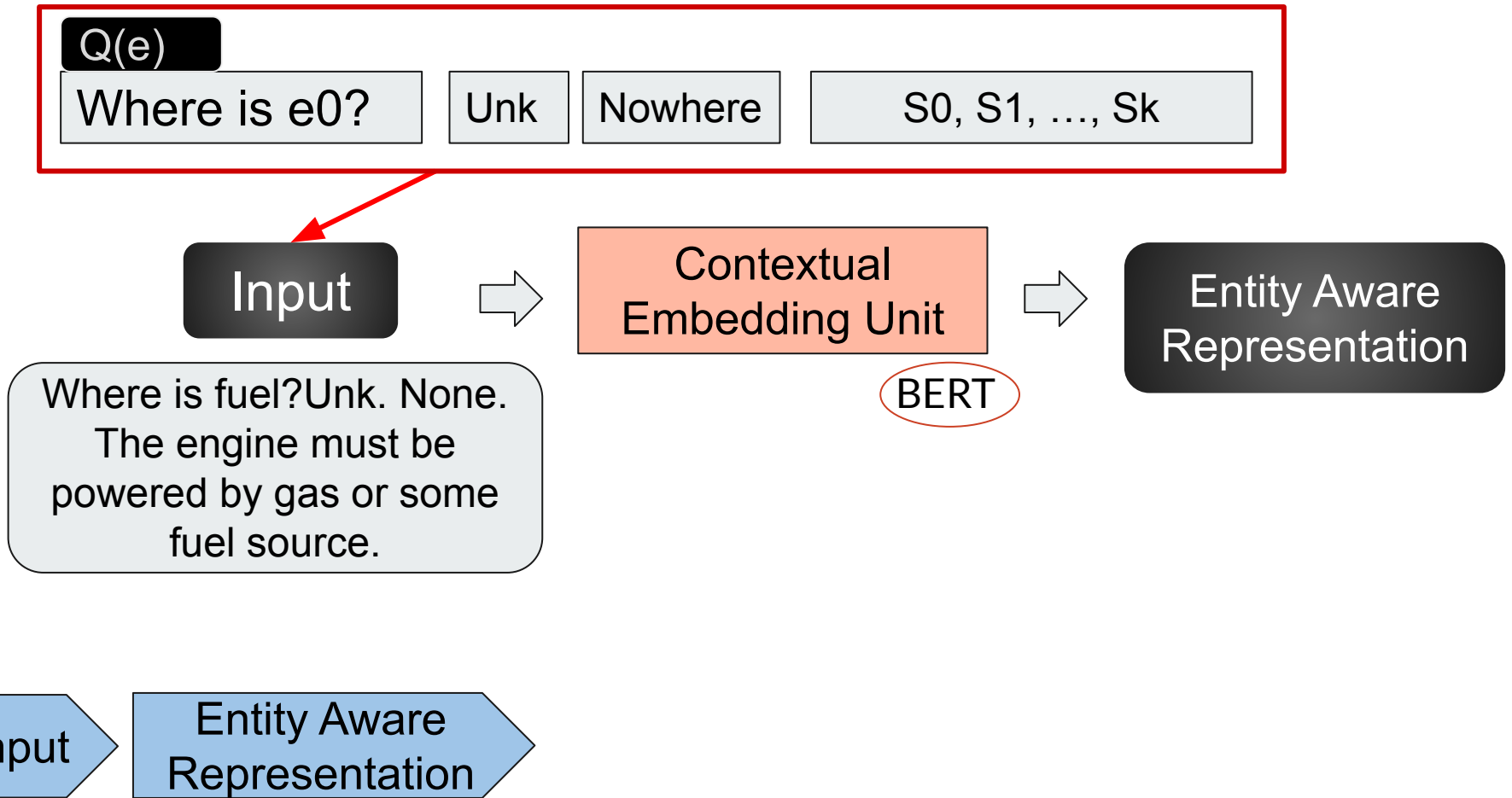
Input Construction

Given: For time-step k and entity 0



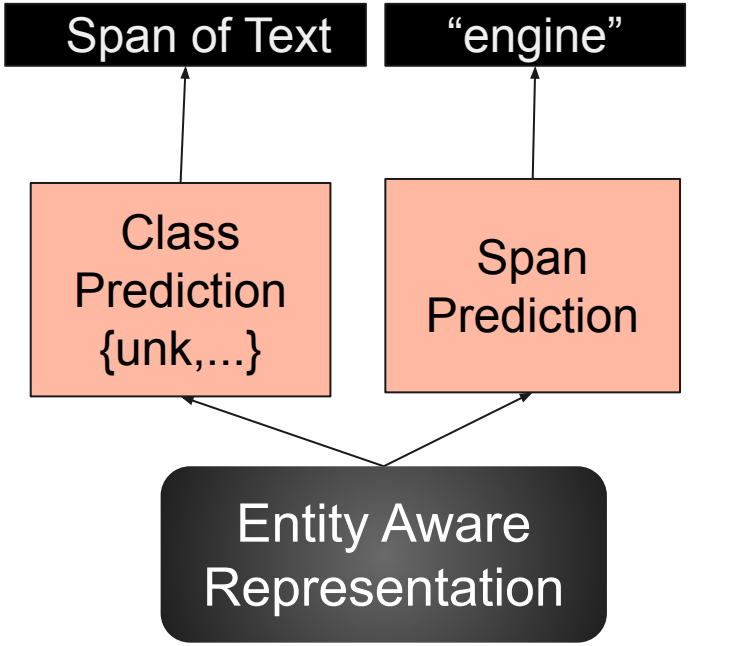
Input

Entity-Aware Representation

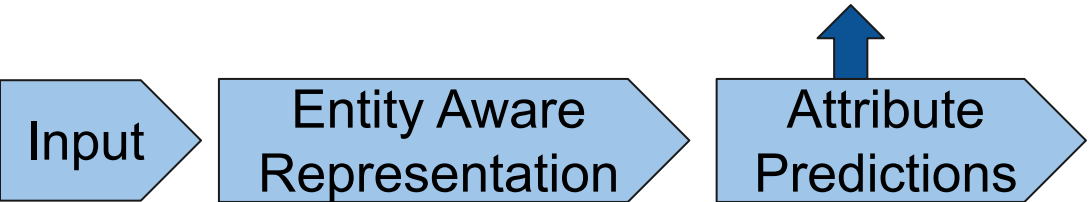


Attribute Prediction Module

- Attributes:
  - Predefined classes
    - {Unk, Nowhere, span of text}
  - Span of text

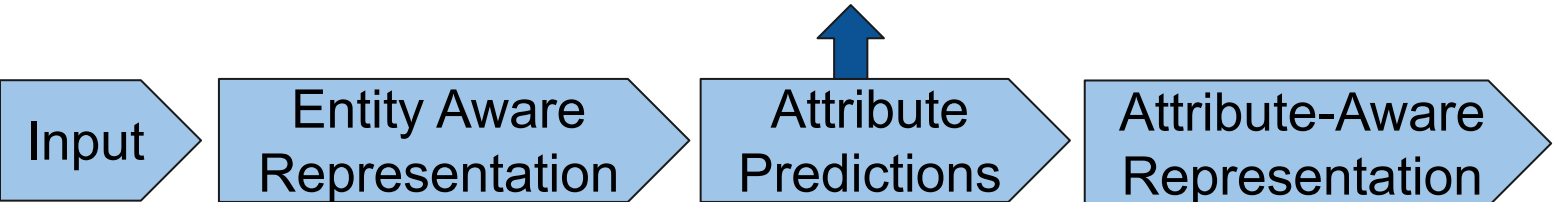


Where is fuel?Unk. None. The engine must be powered by gas or some fuel source.



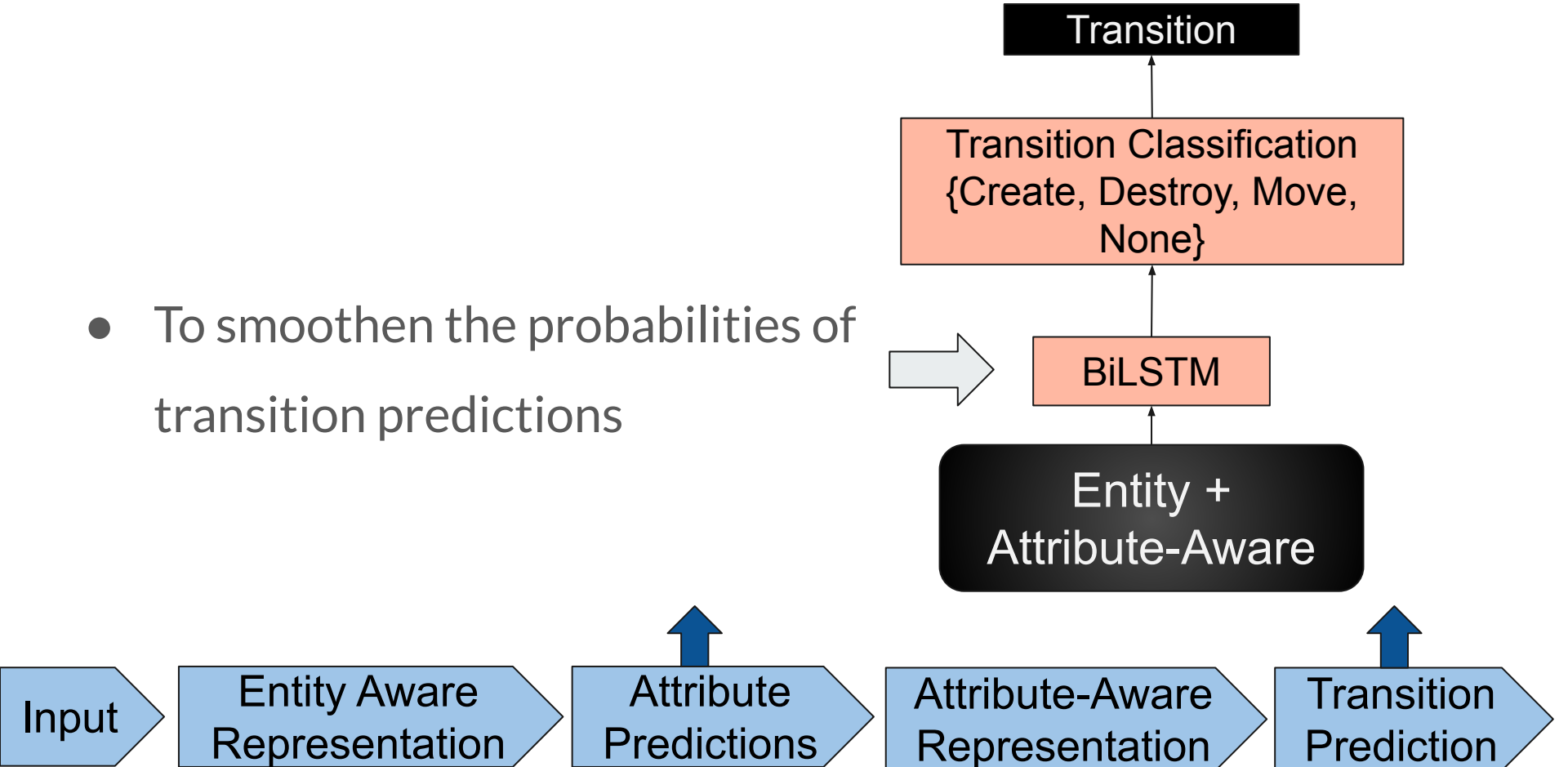
Attribute Aware Representations

- Intuition: Changing weights of token based on the values
  - For timepoints : k, k-1
  - To capture attribute change



Transition Prediction Module

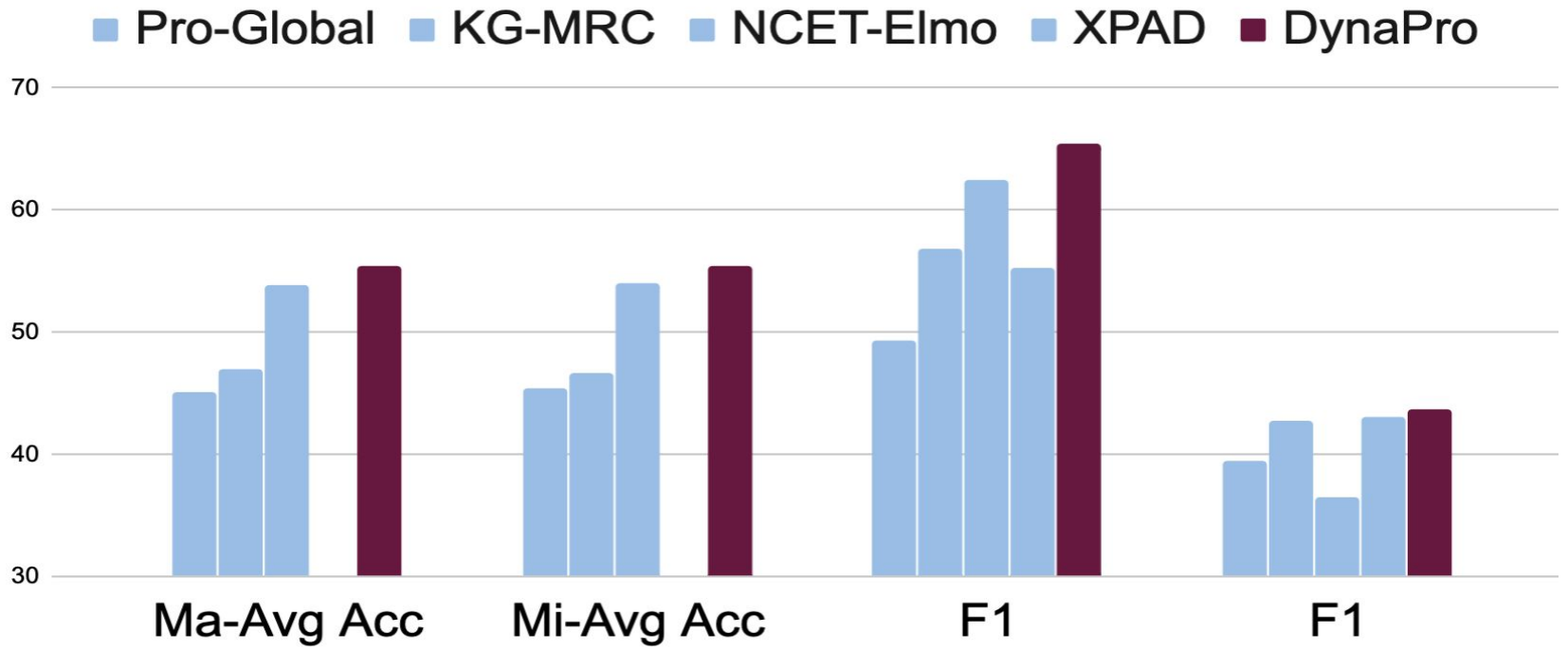
- To smoothen the probabilities of transition predictions



Experiments

- Propara Dataset

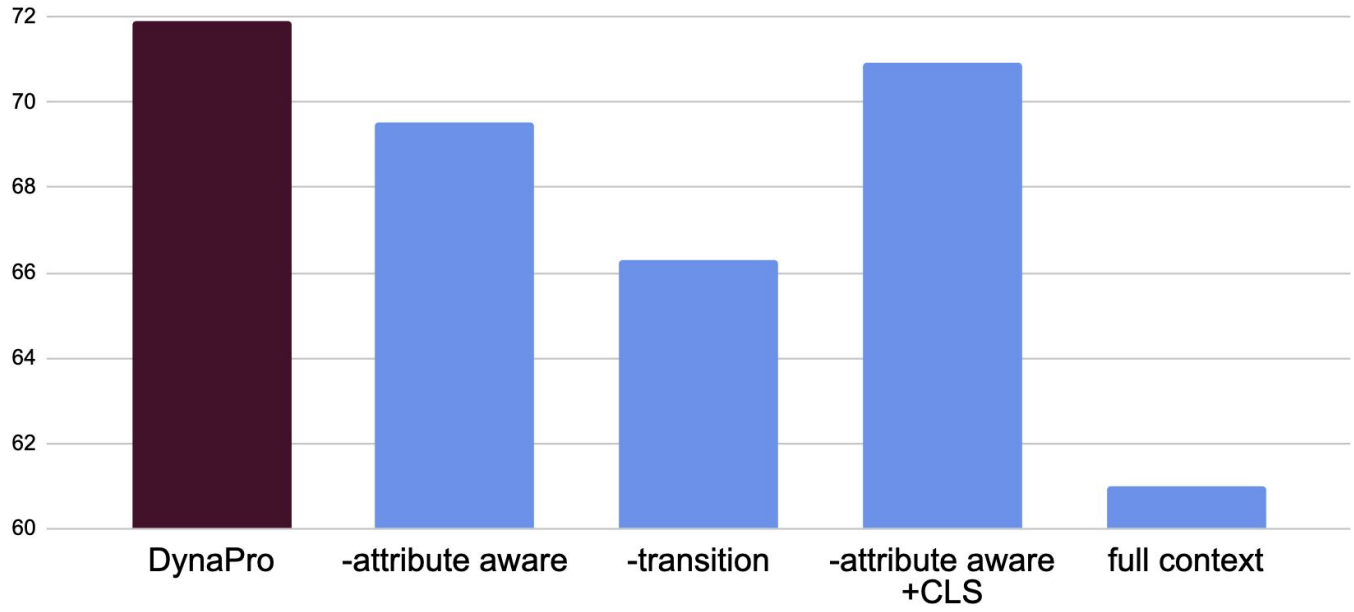
Results



Sentence Level	Document Level	Action Dependency

Ablation Study

- Joint prediction of transitions and attribute
- Impact of attribute-aware representation
- Impact of input formulation



Error Analysis

- Incorrect class prediction
  - Predicting spans instead of unknown (34%)

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  - Predicting spans instead of unknown (34%)
- Incorrect span prediction (45%)

Context	Entity	Gold	Predictions
Blood enters the right side of your **heart**.	Blood	Heart	right side of your heart

Error Analysis

- Incorrect class prediction
  - Predicting spans instead of unknown (34%)
- Incorrect span prediction (45%)
- Inconsistent transitions(4%)
  - Creation of entity that exists
  - Move entity that is destroyed
  - Destroy an entity that is destroyed

Summary

- We present a general formalism to model procedural text
- We introduce DynaPro → Neural model jointly training to predict transitions and attributes
- State of the art results on procedural text datasets.

Thanks for Listening Questions?