Stage-wise Fine-tuning for Graph-to-Text Generation

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1. Motivation

- Transformer-based PLMs can acquire **factual knowledge** in the pre-training phase
- Additional fine-tuning step leverages triples not included in the training set and **reduces the chances that the model fabricates facts** based on the language model
- Position embeddings **capture the structure and interdependence of facts**

2. Problem Definition

- Given an RDF graph with multiple relations $G = \{(s1, r1, o1), ..., (s_n, r_n, o_n)\}$, our goal is to generate a text faithfully describing the input graph.
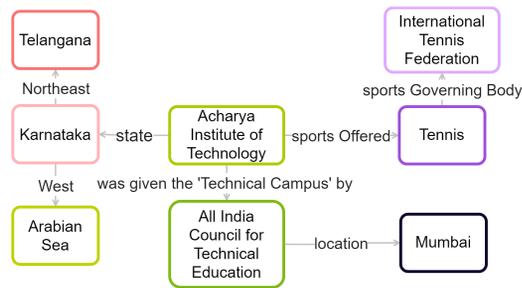
3. Positional Embeddings

- **Position ID**
  - The same as the original position ID used in BART, is the index of the token in the flattened
- **Triple Role ID**
  - 3 values for a specific triple (s_i, r_i, o_i) 1 for the subject s_i, 2 for the relation r_i, and 3 for the object o_i
- **Tree level ID**
  - The distance (number of relations) from the root which is the source vertex of the RDF graph
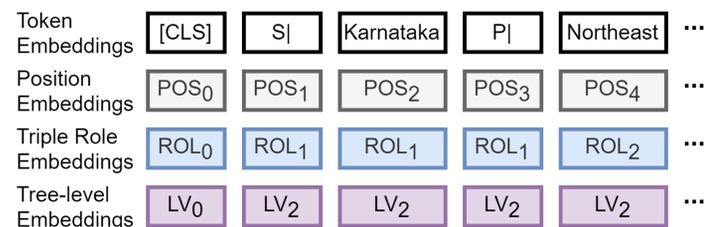
4. Example

Category	Output
Reference	The Acharya Institute of Technology in Karnataka state was given Technical Campus status by All India Council for Technical Education in Mumbai. The school offers tennis which is governed by the International Tennis Federation. Karnataka has the Arabian Sea to its west and in the northeast is Telangana.
T5-large	The state of Karnataka is located southwest of Telangana and east of the Arabian Sea. It is the location of the Acharya Institute of Technology which was granted the Technical Campus status by the All India Council for Technical Education in Mumbai. The Institute is affiliated with the *Visvesvaraya Technological University* and offers the sport of tennis. [International Tennis Federation] **Problem: Hallucinate factual knowledge, missing facts**
T5-large + Wiki	The Acharya Institute of Technology is located in the state of Karnataka. It was given the Technical Campus status by the All India Council for Technical Education which is located in Mumbai. The institute offers tennis **and has Telangana to its northeast and the Arabian Sea to its west**. [International Tennis Federation] **Problem: Missing facts, incorrect relations**
T5-large + Position	The Acharya Institute of Technology is located in the state of Karnataka which has Telangana to its northeast and the Arabian Sea to its west. It was given the Technical Campus status by the All India Council for Technical Education in Mumbai. The Institute offers tennis which is governed by the International Tennis Federation.
T5-large + Wiki + Position	The Acharya Institute of Technology is located in the state of Karnataka which has Telangana to its northeast and the Arabian Sea to its west. The Institute was given the Technical Campus status by the All India Council for Technical Education in Mumbai. One of the sports offered at the Institute is tennis which is governed by the International Tennis Federation.

5. Experiment Dataset

- **Webnlg**
  - The WebNLG Challenge dataset which contains 18,102/2,268/4,928 graph-description pairs for training, validation, and testing set respectfully
  - The input describes entities belonging to 15 distinct DBpedia categories: *Astronaut, University, Monument, Building, ComicsCharacter, Food, Airport, SportsTeam, WrittenWork, Athlete, Artist, City, MeanOfTransportation, CelestialBody, and Politician*
- **Wikipedia Pre-training Resource**
  - Based on Wikipedia dump and Wikidata crawled in March 2020 from 15 related categories in the WebNLG dataset
  - For each Wikipedia article, query its corresponding WikiData triples and remove sentences which contain no values in the Wikidata triples to form graph-text pairs
  - Remove triples and description pairs that have already appeared in the WebNLG dataset
  - Obtain 542,192 data pairs

6. Evaluation Results

	Model	BLEU (%)↑			METEOR ↑			TER ↓		
		S	U	A	S	U	A	S	U	A
Without Pretrained LM	Gardent et al. (2017)	54.52	33.27	45.13	0.41	0.33	0.37	0.40	0.55	0.47
	Moryossef et al. (2019)	53.30	33.31	37.24	0.44	0.34	0.39	0.47	0.56	0.51
	Zhao et al. (2020)	64.42	38.23	52.78	0.45	0.37	0.41	0.33	0.53	0.42
With Pretrained LM	Radev et al. (2020)	52.86	37.85	45.89	0.42	0.37	0.40	0.44	0.49	0.51
	Kale (2020)	63.90	52.80	57.10	**0.46**	0.41	**0.44**	-	-	-
	Riberiro et al. (2020)	64.71	53.67	59.70	**0.46**	0.42	**0.44**	-	-	-
Our Model	T5-large + position + Wiki	**66.07**	**54.05**	**60.56**	**0.46**	0.42	**0.44**	**0.32**	**0.41**	**0.36**

Model	BertScore P↑	BertScore R↑	BertScore F1↑
Gardent et al. (2017)	88.35	90.22	89.23
Moryossef et al. (2019)	85.77	89.34	87.46
Radev et al. (2020)	89.49	92.33	90.83
Riberiro et al. (2020)	98.36	91.96	90.59
T5-large + position + Wiki	**96.36**	**96.13**	**96.21**

7. Impact of Wikipedia Fine-tuning

- **Capture unseen relations**
  - (Olusegun Obasanjo, in Office While Vice President, Atiku Abubakar) is translated to *"His vice president is Atiku Abubakar"*
- **Combines relations with the same type together with correct order**
  - Given two death places of a person such as (Alfred Garth Jones, deathplace, Sidcup) and (Alfred Garth Jones, deathplace, London), the model generates: *"died in Sidcup, London"* instead of generating two sentences or placing the city name ahead of the area name.

8. Impact of Position Embeddings

- **Reduce the errors introduced by pronoun ambiguity**
  - For a KG which has *"leader Name"* relation to both country's leader and university's dean, position embeddings can distinguish these two relations by stating *"Denmark's leader is Lars Løkke Rasmussen"* instead of *"its leader is Lars Løkke Rasmussen"*
- **Arrange multiple triples into one sentence**
  - Combining the city, the country, the affiliation, and the affiliation's headquarter of a university into a single sentence

9. Remaining Challenges

- **Biased against the occurrence of patterns that would enable it to infer the right relation**
  - Confuse *"active Years Start Year"* relation with the birth year
- **Fail to capture the deep connections between the subject and the object**
  - Treat an asteroid as a person because of its epoch date
- **Miss relations for complex graph input**