GTR-LSTM: A Triple Encoder for Sentence Generation from RDF Data

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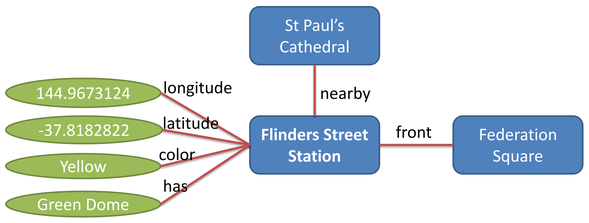
Problem Studied

Goal: Generate natural sentences to describe relationships as represented by RDF triples.
Example:

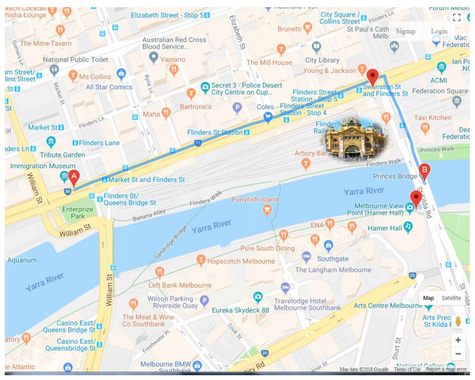
T1:	<Flinders Street Station, front, Federation Square>
T2:	<Flinders Street Station, color, yellow>
T3:	<Flinders Street Station, has, green dome>
Sent:	**Flinders Street Station is a yellow building with a green dome roof located in front of Federation Square**

Motivation: Textual Description of Geographic Entities



Generated a sentence from knowledge graph: "**Flinders Street Station** is a **yellow** building with a **green dome** roof located in front of **Federation Square**"

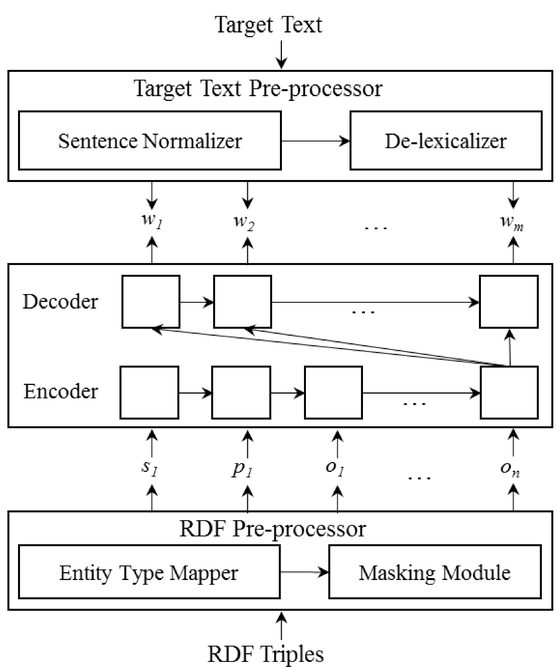
Motivation: Textual Description For Navigation Instructions



"Walk east on Flinders St/State Route 30 towards Market St; Turn right onto St Kilda Rd/Swanston St"
vs.
"Walk east on Flinders St/State Route 30 towards Market St; Turn right onto St Kilda Rd/Swanston St after **Flinders Street Station, a yellow building with a green dome.**"

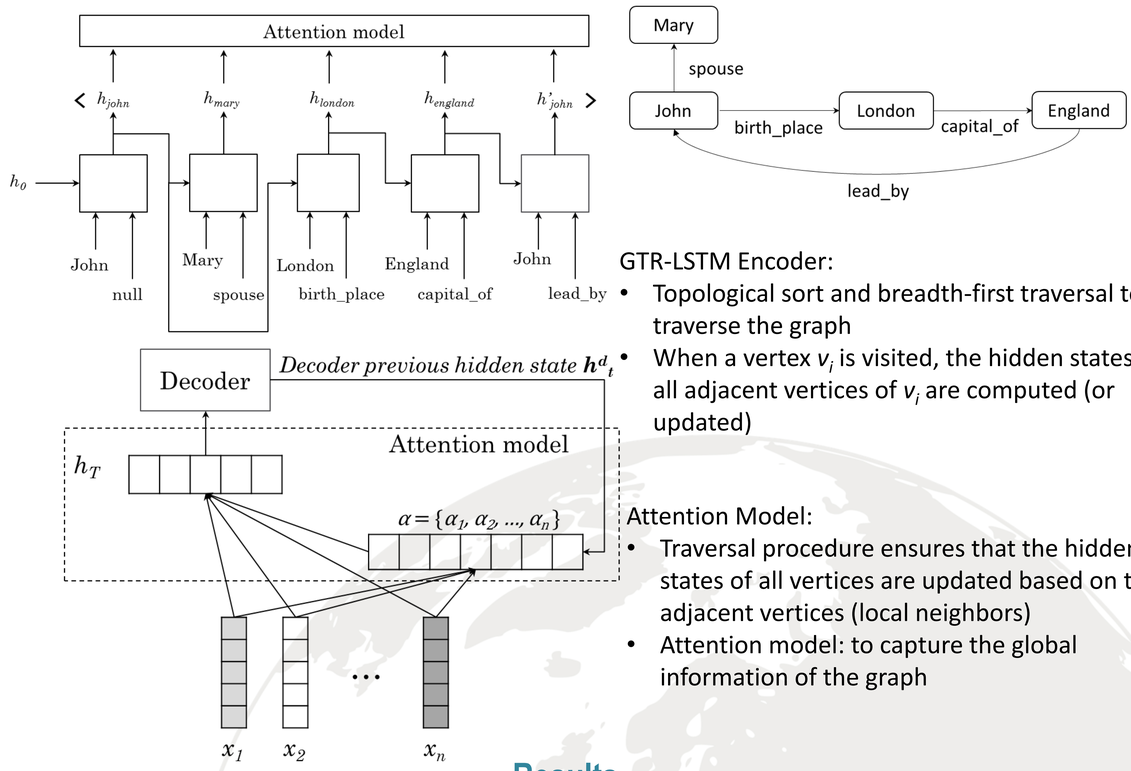
Proposed Model

RDF Data characteristics:
- Contains relationship triples and attribute triples
- In the form of knowledge graph:
  - ✓ Contains cycle
  - ✓ Intra-triple relationship (relationship between entities in one triple)
  - ✓ Inter-triple relationship (relationship between triples)



We propose an encoder-decoder sentence generation model:
- **We define Graph-based triple encoder (GTR-LSTM)**
- Standard LSTM is used for the decoder
- Pre-processor is used to mask the entity name in the sentences and triples

Graph-based Triple Encoder (GTR-LSTM)



GTR-LSTM Encoder:
- Topological sort and breadth-first traversal to traverse the graph
- When a vertex v_i is visited, the hidden states of all adjacent vertices of v_i are computed (or updated)

Attention Model:
- Traversal procedure ensures that the hidden states of all vertices are updated based on their adjacent vertices (local neighbors)
- Attention model: to capture the global information of the graph

Results

Automatic Evaluation

Model		BLEU↑ Seen	BLEU↑ Unseen	BLEU↑ GKB	METEOR↑ Seen	METEOR↑ Unseen	METEOR↑ GKB	TER↓ Seen	TER↓ Unseen	TER↓ GKB
Existing models	BLSTM	49.8	28.0	34.8	38.3	29.4	28.6	49.9	64.9	65.8
	SMT	46.5	24.8	32.0	37.1	29.1	28.5	52.3	62.2	67.8
	TFF	47.8	28.4	33.7	35.9	30.5	28.9	49.9	61.2	58.4
Adapted Model	TLSTM	50.5	31.6	36.7	36.5	30.7	30.1	47.7	60.4	57.2
Proposed Model	**GTR-LSTM**	**58.6**	**34.1**	**40.1**	**40.6**	**32.0**	**34.6**	**41.7**	**57.9**	**50.6**

Human Evaluation (Scored out of 3; higher scores are preferred)

Model		Seen Correctness	Seen Grammar	Seen Fluency	Unseen Correctness	Unseen Grammar	Unseen Fluency	GKB Correctness	GKB Grammar	GKB Fluency
Existing models	BLSTM	2.25	2.33	2.29	1.53	1.71	1.68	1.54	1.84	1.84
	SMT	2.03	2.11	2.07	1.36	1.48	1.44	1.81	1.99	1.89
	TFF	1.77	1.91	1.88	1.44	1.69	1.66	1.71	1.99	1.96
Adapted Model	TLSTM	2.53	2.61	2.55	1.75	1.93	1.86	2.21	2.38	2.35
Proposed Model	**GTR-LSTM**	**2.64**	**2.66**	**2.57**	**1.96**	**2.04**	**1.99**	**2.29**	**2.42**	**2.41**

Conclusions

- Graph-based encoder
  - ✓ Captures better information of a knowledge graph
  - ✓ Maintains the structure of input RDF triples
  - ✓ Handles cycles to capture the global information of a knowledge graph