

StructSum: Incorporating Latent and Explicit Sentence Dependencies for Single Document Summarization

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arXiv paper

Overview

- Task: Abstractive summarization
 - Given a document, generate a piece of text to summarize the given document
- Motivation:
 - Traditional methods employ the structure of the document and the relation between sentences:
 - Graph based sentence centrality
 - Discourse based compression
 - Modern deep learning models encode the document as a sequence of tokens ignoring structure of the sentences
 - Structured representation of text has been shown to be effective and this work proposes a new end-to-end approach for structured summarization
- Applications:
 - Structure based representation of document for other tasks

Model Overview

- Two types of structure are incorporated into the model:
 - Latent structure attention:
 - Employ attention mechanism to compute pairwise connections between sentences of a document
 - It has been shown to be effective for other tasks e.g., document classification and NLI
 - Explicit structure:
 - Use the coreference links between sentences of a document to create a graph of sentences
- The two views are combined in the final structure aware model
- It can easily be used in other structure-aware document-level tasks

Text Summarization

- Input a sequence of n sentences
- Output a sequence of m words
- Typical architecture:
 - Sequence-to-sequence model
 - A BiLSTM model encodes the input sequence into $\{\mathbf{h}\}$
 - A separate decoder generates probability distribution over the vocabulary at each time step t by attending to the previous token and the input sequence $p(\mathbf{a}_t \mid \mathbf{x}, \mathbf{y}_{1:t-1})$
- This work alters the encoder and use the same decoder:
 - The encoder is changed to model both implicit and explicit structures
 - Implicit structure computed by attention mechanism
 - Explicit structure computed by linguistic features obtained from external resources
 - Coreference links

Hierarchical Encoder

- Word level and sentence level encoders:
 - Word level encoder is a BiLSTM that take the words of a sentence and generates hidden representation of the words
 - Using max-pooling operation the sentence level representation is computed from word level representation
 - Sentence level encoder is a seperate BiLSTM which takes the sentence representations and compute the hidden sentence representations
- Hidden sentence representations are fed into the implicit and explicit structure encoder

Latent structure modeling

- Attention mechanism is employed to compute the pairwise strength of connection between sentences of a document
- Representation \mathbf{s}_i is decomposed into two segments:
 - Semantic vector
 - Structure vector
- Two types of scores are computed:
 - Compute if node i is the parent of node j: $f_{ij} = F_p(\mathbf{d}_{s_i})^T W_a F_c(\mathbf{d}_{s_j})$
 - Compute if node i is the root of the tree: $r_i = F_r(\mathbf{d}_{s_i})$
- Compute structure-aware representations

$$\mathbf{p}_{s_i} = \sum_{j=1}^n a_{ji} \mathbf{g}_{s_j} + a_i^r \mathbf{g}_{root}$$

$$\mathbf{c}_{s_i} = \sum_{j=1}^n a_{ij} \mathbf{g}_{s_i}$$

$$\mathbf{l}_{s_i} = \tanh(W_r[\mathbf{g}_{s_i}, \mathbf{p}_{s_i}, \mathbf{c}_{s_i}])$$

Explicit Structure modeling

- An off-the-shelf coreference parser is employed to generate the coreference links between sentences
- Sentences with coreference link are connected to each other in the explicit structure with the weight of:

$$k_{ij} = P(z_{ij} = 1) \\ = \frac{\text{count}(m_i \cap m_j) + \epsilon}{\sum_{v=1}^n \text{count}(m_i \cap m_v)}$$

- Sentence representation by explicit structure

$$\mathbf{u}_{s_i} = \tanh(F_u(\mathbf{h}_{s_i}))$$

$$\mathbf{t}_{s_i} = \sum_{j=1}^p k_{ij} \mathbf{u}_{s_j}$$

$$\mathbf{e}_{s_i} = \tanh(F_e(\mathbf{t}_{s_i}))$$

Decoder

- Concatenation of the implicit and explicit structure aware representation of the sentence are concatenated to generate the final sentence representation:

$$\mathbf{h}_{s_i} = [\mathbf{l}_{s_i}; \mathbf{e}_{s_i}]$$

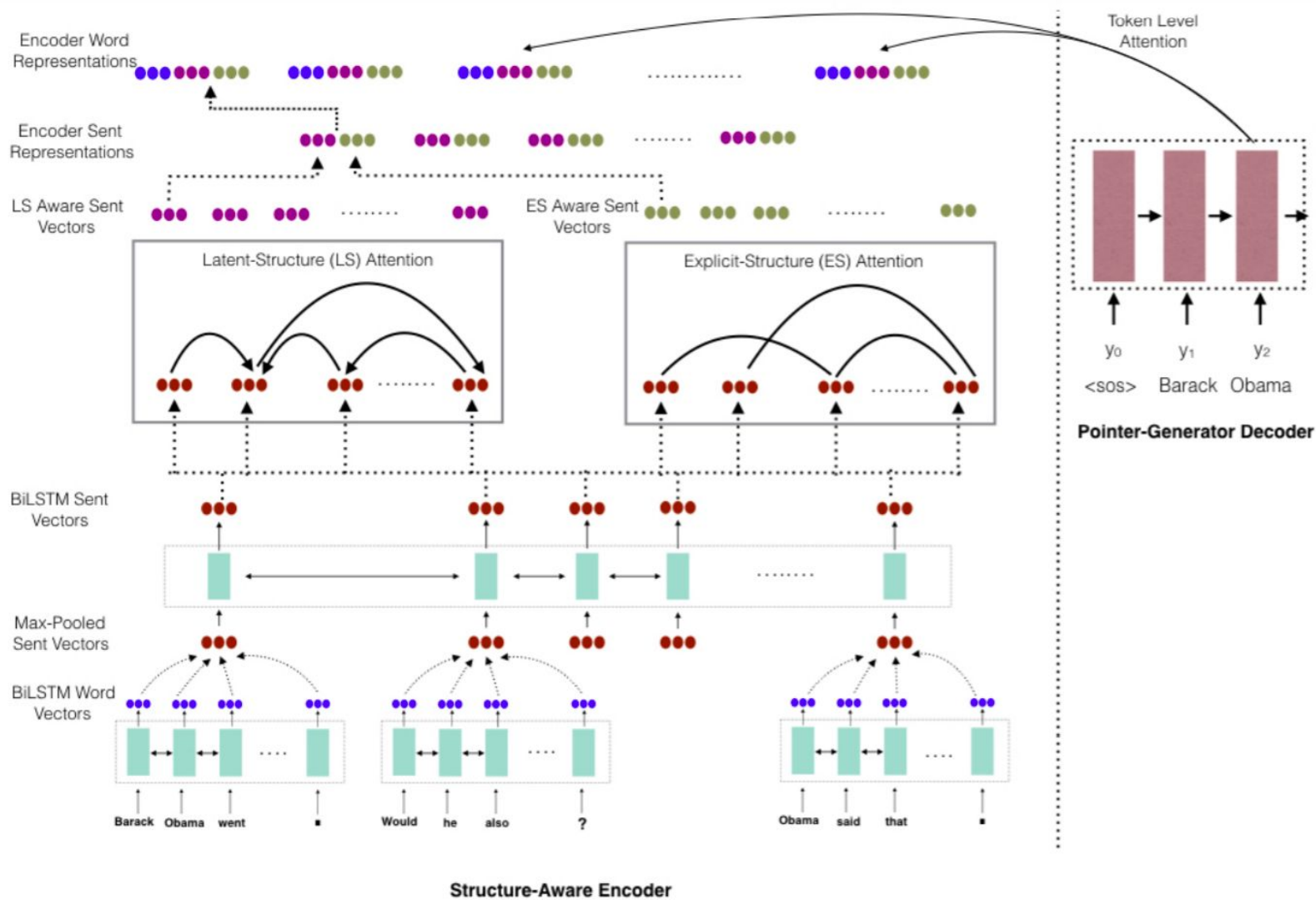
- Sentence representation are concatenated to word representation to be fed into the decoder:

$$\mathbf{h}_{w_{ij}} = [\mathbf{h}_{w_{ij}}; \mathbf{h}_{s_i}]$$

- Decoder attends to the input sequence and the previous token to generate next token

$$\text{loss}_t = -\log p(y_t)$$

- Training:



Results

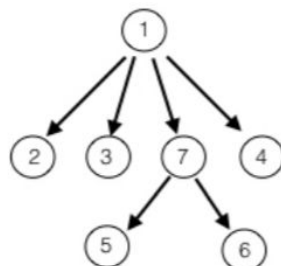
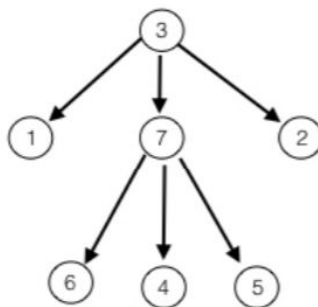
Model	ROUGE 1	ROUGE 2	ROUGE L
Pointer-Generator (See et al., 2017)	36.44	15.66	33.42
Pointer-Generator + Coverage (See et al., 2017)	39.53	17.28	36.38
Graph Attention (Tan et al., 2017)	38.1	13.9	34.0
Pointer-Generator + DiffMask (Gehrmann et al., 2018)	38.45	16.88	35.81
Pointer-Generator (Re-Implementation)	35.55	15.29	32.05
Pointer-Generator + Coverage (Re-Implementation)	39.07	16.97	35.87
Latent-Structure (LS) Attention	39.52	16.94	36.71
Explicit-Structure (ES) Attention	39.63	16.98	36.72
LS + ES Attention	39.62	17.00	36.95

Document

1. leicester city have rejected approaches for striker tom lawrence from an astonishing nine clubs .
2. the former manchester united forward has barely played for leicester since arriving from old trafford in the summer but manager nigel pearson wants to have all options available as he battles against the odds to keep leicester in the premier league .
3. lawrence , 21 , is poised to make his full international debut for wales in their european championship qualifier with israel on saturday but has only figured in four games for leicester this season and three as a substitute .
4. leicester city have rejected approaches for striker tom lawrence from an astonishing nine clubs .
5. championship promotion chasers bournemouth , ipswich and wolves have all asked about lawrence .
6. blackburn , charlton , leeds , bolton , rotherham and wigan have also made contact .
7. however , they are now looking at other options in a last-gasp bid to bolster their squad .

1. andrew henderson celebrated landing the london broncos coaching job on a permanent basis as halifax were beaten 22-18 .
2. henderson was given the nod by the london hierarchy this week after a mixed spell in caretaker charge since the departure of joey grima .
3. his weakened side put on a fine show to crown his appointment , though , scoring four tries through daniel harrison , matt garside , iliess macani and brad dwyer , whose score was the winning one .
4. iliess macani , pictured last year , scored one of london broncos' four tries in the 22-18 win over halifax .
5. james saltonstall , ben heaton and mitch cahalane scored for halifax .
6. henderson had spoken earlier in the week about how he felt broncos were moving in the right direction , and their narrow victory put some substance to his words .
7. the win was just their third in six in the kingstone press championship having been relegated from super league at the end of last season .

Latent Structures



Summaries

Reference:

bournemouth , ipswich , wolves , blackburn , charlton , leeds , bolton , rotherham and wigan have all asked about tom lawrence . the 21-year-old is poised to make his full international debut for wales . leicester manager nigel pearson wants to have options available .

StructSum:

leicester city have rejected approaches for tom lawrence . lawrence is poised to make his debut for wales in their european championship qualifier with israel on saturday . leicester city are looking at other options in last-gasp bid to bolster their squad . lawrence from old trafford has only figured in four games for leicester this season and three as a substitute . the former manchester united star has barely

Reference:

andrew henderson won his first game as broncos full-time coach . daniel harrison , matt garside , iliess macani and brad dwyer all scored . james saltonstall , ben heaton and mitch cahalane scored for halifax .

StructSum:

andrew henderson celebrated landing the coaching job on a permanent basis .henderson was given the nod by london hierarchy this week after a mixed spell in the 22-18 win over halifax . his weakened side put on fine show to crown his appointment , though he felt broncos were moving in the right direction . the win was their third in six in the press championship having been relegated