Deconvolution-Based Global Decoding for Neural Machine Translation

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Abstract
- A new NMT model with deconvolution-based decoder;
- Generate translation based on the structural prediction of the target-side context;
- Improved results on benchmark datasets;
- Translation is robust to inputs of diverse lengths and with less repetition.

Linguistic Insight
- Language generation involves complex syntactic analysis and semantic integration;
- Translation can be guided by the global lexical-semantic and discourse information;
- The process of translation is in need of the global information from the target-side context.

Sequence-to-Sequence as Baseline
- Encoder: Bidirectional LSTM
- Decoder: LSTM for sequential decoding. Training is with teacher forcing.
- Attention mechanism: global attention for the relevant source-side information

Model Architecture
- Two decoders: the deconvolution-based decoder for global target-side context and the RNN-based decoder for final translation.

Deconvolution-Based Decoder
- Based on deconvolution, able to expand sentence embedding to large matrix, trained to resemble the target word embedding matrix.

Mechanism
- Dual attention for the source-side and target-side contexts;
- Training with multiple losses to minimize the cross-entropy loss of the generation and the target sequence as well as the smooth L1 loss of the generated matrix by deconvolution-based decoder and the target word embedding matrix (truncation and padding are required for the fixed size).

\[ \mathcal{L} = \frac{1}{N} \sum_{i=1}^{N} \sum_{t=1}^{T} \log P(y_{t}^{(i)} | x_{<t}^{(i)}, \theta) + \sum_{m=1}^{M} \text{smooth}_1(E_m - E_m) + \sum_{i=1}^{T} \log P(y_{t}^{(i)} | x_{<t}^{(i)}, \theta) \]

Experiments
- Chinese-English translation (LDC corpora);
- English-Vietnamese translation (IWSLT 2015)

Model BLEU
Moses 32.43 34.14 31.47 30.81 32.21
RNNSearch 33.08 35.32 31.42 31.61 32.86
Lattice 34.32 36.50 32.40 32.77 34.00
Coverage 34.49 38.24 34.91 34.25 35.49
InterAtten 35.09 37.73 35.53 34.32 35.67
MemDec 36.16 39.81 35.91 35.98 36.97
Seq2Seq+Attention 35.32 37.28 35.52 35.54 34.91
+DeconvDec 38.04 39.75 36.77 36.32 37.73

Qualitative Analyses
(a) Percentage of the duplicates at the sentence level. (b) BLEU scores on sentences of different lengths.

Text: 警察 破案 两名 警官 在案 侦办 期间 侦破 肥皂 罪 犯
Gold: after the rebels assassinated two philippine legislators, philippine president arroyo ceased negotiations with the communist party in mid 2001.
Seq2Seq: philippine president arroyo stepped two philippine parliament members in mid - autumn festival.
DeconvDec: philippine president arroyo stepped two philippine parliament members.

Conclusion
- A new model with the global decoding mechanism;
- Coherent and accurate translation with fewer irrelevant contents;
- Will figure out its generalized patterns for the construction of the target-side contexts.