Attribute-driven Capsule Network for Entity Relation Prediction

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Motivation

**Task:** predict relationship between a pair of entities with common multi-attribute.

- **book datasets**
  - title & author
  - category
  - date
  - body

- **company datasets**
  - company name
  - company address
  - business scope

(Examples of datasets are shown in the image, with one book dataset and one company dataset.)
Motivation

**Problem1:** How to learn semantic correlations between attributes?

Entity_S{
    attribute_key1:attribute_value1,
    attribute_key2:attribute_value2,
    ...
    attribute_keyN:attribute_valueN
}

Entity_O{
    attribute_key1:attribute_value1,
    attribute_key2:attribute_value2,
    ...
    attribute_keyN:attribute_valueN
}

**Problem2:** How to learn relation information between common attributes of a pair entities?
Motivation

A real-world scenario CompanyRelationCollection(CRC) dataset

The relations of CRC include customer(C), provider(P), rival(R)
Approach

What we do:

- Apply capsule networks to entity relation prediction.
- Propose self-attention routing method for attribute information representation.
- Construct a new real-world multi-attribute entity relation dataset.
Approach

The whole framework of our model that consists of four layers.
Approach

self-attention

\[
\text{Attention}(Q, K, V) = \text{softmax}\left(\frac{QK^T}{\sqrt{d_k}}\right)V
\]

self-attention routing (our proposed)

\[
a_i = \text{softmax}\left(\frac{E^{k_j}W^q(F_sW^k)^T}{\sqrt{d_w}}\right)
\]

\[
Q = E^{k_j}W^q \quad K = F_sW^k,
\]

\[
A = [a_1, a_2, \ldots, a_B].
\]

\[
S = C \odot A
\]

C represents attribute capsules
A represents weights of attribute capsules
Results

datasets:

- CompanyRelationCollection (CRC)
  https://github.com/cjymz886/ACNet
- BlurbGenreCollection (BGC)
  https://github.com/uhh-lt/BlurbGenreCollection-HMC

Baselines:

- CNN, PCNN,
- BLSTM, ATT-BLSTM
- BERT
- Basic-Caps (our model without self-attention routing)
- ACNet (our model with self-attention routing)

Evaluation metrics:

- Precision
- Recall
- F1

Table 1. Quantitative characteristics of both datasets

|                          | CRC     | BGC     |
|---------------------------|---------|---------|
| Number of entities        | 58,013  | 91,892  |
| Number of attributes per entity | 6       | 3       |
| Total number of relationships | 3(C,P,R) | 3(S,P,D) |
| Number of relational pairs | 61,441  | 918,920 |
| Train set                 | 43,009  | 735,136 |
| Validation set            | 9216    | 91,892  |
| Test set                  | 9216    | 91,892  |
Results

Our attribute-driven capsule network achieves the highest F1 scores.
The self-attention routing approach is effective.
Powerful pre-training model can achieve richful representation information.

Table 3. The results of Comparison of different methods. Best scores are in bold.

| Method       | CRC     |        | BGC     |        |
|--------------|---------|--------|---------|--------|
|              | Precision | Recall | F1     | Precision | Recall | F1     |
| CNN[10]      | 0.7706  | 0.7012 | 0.7343  | 0.8420  | 0.8265 | 0.8342 |
| PCNN[11]     | 0.7825  | 0.7103 | 0.7447  | 0.8578  | 0.8299 | 0.8436 |
| BLSTM[12]    | 0.7682  | 0.7066 | 0.7361  | 0.85378 | 0.8122 | 0.8324 |
| ATT-BLSTM[13]| 0.7694  | 0.7043 | 0.7359  | 0.8621  | 0.8017 | 0.8308 |
| BERT[27]     | **0.8067** | 0.6936 | **0.7459** | **0.8628** | 0.8345 | **0.8484** |
| Basic-Caps   | 0.7528  | 0.7331 | 0.7428  | 0.8534  | 0.8304 | 0.8417 |
| ACNet        | 0.7662  | **0.7405** | **0.7531** | 0.8612  | **0.8405** | **0.8507** |
Convergence of capsule networks is much faster than other models.

Capsule networks get a stable training process and achieve less fluctuation.

Fig. 3. The result of training loss from all models on two datasets.
THANKS FOR YOUR ATTENTION