Finding BERT’s Idiomatic Key

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Introduction

- Idiom token identification - identify whether a particular usage of an idiomatic expression is idiomatic or not
- Possible to train a generic idiom token identification model using distributed representations
- BERT - State of the art language model for distributed representations
Research Questions

1. Does BERT encode idiomatic usage information?
2. Assuming BERT does encode idiomatic usage then which part of the sentence provides signal to BERT - Where is BERT’s idiomatic key?
   - Inside the idiomatic expression?
   - Outside the idiomatic expression - Surrounding context?
### Baseline Experiments

#### Data Preparation
- VNIC dataset - 2984 sentences, 56 idiomatic expressions
- Down sampled 20 different versions of balanced data
  - 550 idiomatic and 550 literal samples
- 80% samples for training & 20% samples for testing

#### Embedding
- BERT pretrained model
- Sentence embedding - Average final layer embeddings of each token in the sentence
Probing

- Probing using MLP classifier
- Train MLP to predict whether a sentence is idiomatic or literal
- Idiomaticity score - Probability score by MLP
  - Literal sentences - Probability will be close to 0
  - Idiomatic sentences - Probability will be close to 1
## Baseline Results

### Idiomatic sentences
- Mean idiomaticity 0.85
- Ideal idiomaticity 1.00

### Literal sentences
- Mean idiomaticity 0.17
- Ideal idiomaticity 0.00

### Observations
- MLP effectively predicts idiomaticity
- BERT encodes idiomatic usage information
Masking Experiments

Masking
- Target Expression - Idiomatic expression
- Random Words - Two other random words

Masking Strategy
- Word masking - Replace words with [MASK]
- Embedding masking - Exclude embeddings of words from sentence embedding

Differential Idiomaticity (DId)
- Idiomaticity without masking - Idiomaticity with masking
- Higher absolute value of DId $\rightarrow$ More idiomatic information in the masked part
# Masking Results

| Masking                          | Id | DId   | p-value | Id   | DId   | p-value |
|----------------------------------|----|-------|---------|------|-------|---------|
| Baseline                         | 0.85 | -     | -       | 0.17 | -     | -       |
| Target Expn + Word Mask          | 0.79 | 0.06 (0.0559) | 1.12E-05 | 0.24 | -0.08 (0.0548) | 2.83E-07 |
| Target Expn + Emb Mask           | 0.83 | 0.02 (0.0105) | 1.91E-11 | 0.19 | -0.02 (0.0081) | 4.07E-16 |
| Rand Word + Word Mask            | 0.83 | 0.02 (0.0411) | 0.026    | 0.17 | 0.00 (0.0379)  | 0.854    |
| Rand Word + Emb Mask             | 0.85 | 0.00 (0.0053) | 0.313    | 0.17 | 0.00 (0.0050)  | 0.378    |

**Table:** Mean Idiomaticities (Id) and Mean Differential Idiomaticities (DId) and p-values
Where is Idiomatic Key?

**Target Expression Masking**
- Statistically significant impact by using both word masking & embedding masking on both idiomatic & literal sentences

**Random Word Masking**
- Idiomatic sentences - Statistically significant impact using word masking but no significant impact using embedding masking
- Literal sentences - No statistically significant impact by using both word masking & embedding masking

**Observations**
- Idiomatic key is primarily in idiomatic expression
- Some information is in surrounding context
In what form is the Idiomatic Key?

Effect of Incongruity due to Idiomatic usage vs Effect of Disruption due to Masking

- Embedding masking - Less disruption due to masking
- Statistically significant impact with embedding masking of Target Expression
- Embedding masking has less impact than word masking
  - BERT encodes information from masked words in the embeddings of other words

Observation

- BERT can distinguish incongruity caused by idiomatic usage from disruption caused by masking
Conclusions & Future Work

Conclusions
- BERT encodes idiomatic usage information
- Idiomatic key primarily found within the idiomatic expression
- Some information found in surrounding context
- BERT can distinguish incongruity caused by idiomatic usage from disruption caused by masking

Future Work
- Investigate the presence of idiomatic key in topical content words in the context