

Text Classification Using Label Names Only: A Language Model Self-Training Approach

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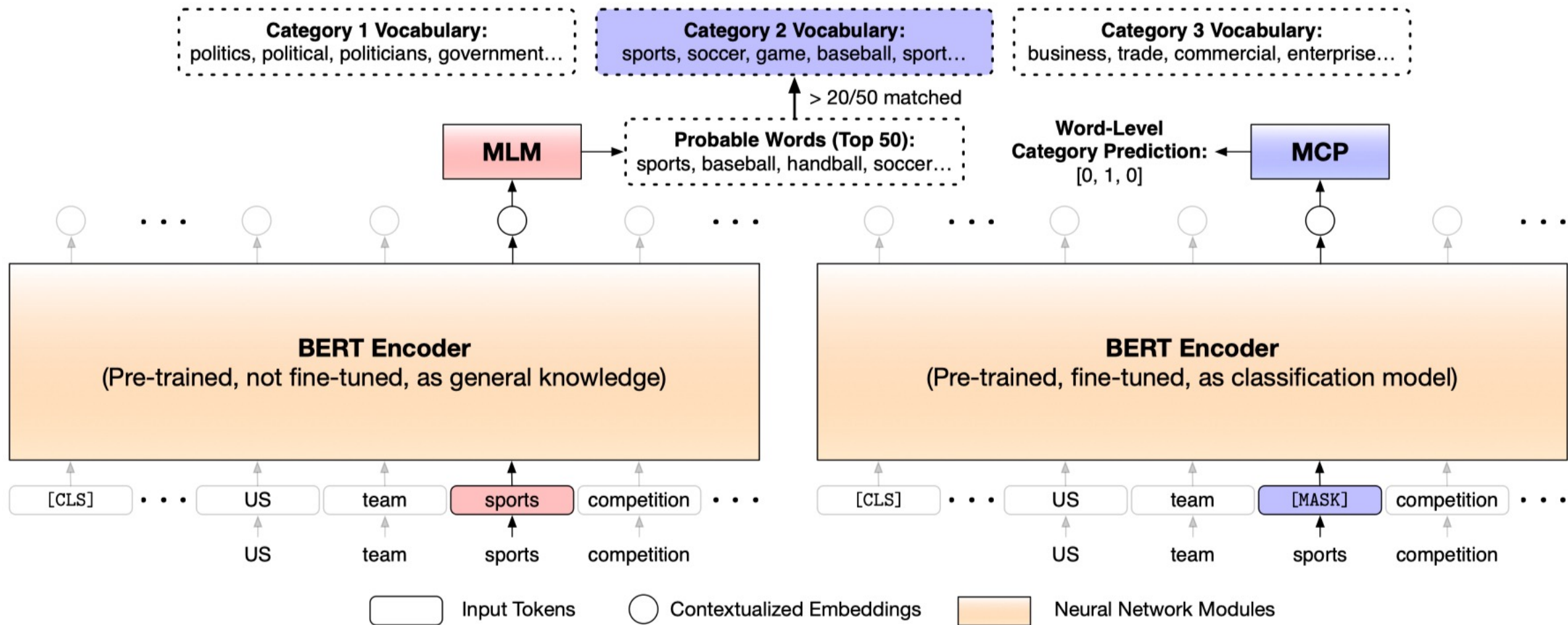
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3 steps to train the model

- (1) Associates semantically related words with the label names
- (2) Finds category-indicative words and trains the model to predict their implied categories
- (3) Generalizes the model via self-training



Step1 Find Category Words

- 将语料中label词语所对应的hidden state映射到词表的维度，取top50的词语。取最终统计结果中的top100词语，认为它们可以代表该类别的语义。

| Sentence | Language Model Prediction |
|--|---|
| The oldest annual US team sports competition that includes professionals is not in baseball, or football or basketball or hockey. It's in soccer. | sports, baseball, handball, soccer, basketball, football, tennis, sport, championship, hockey, ... |
| Samsung's new SPH-V5400 mobile phone sports a built-in 1-inch, 1.5-gigabyte hard disk that can store about 15 times more data than conventional handsets, Samsung said. | has, with, features, uses, includes, had, is, contains, featured, have, incorporates, requires, offers, ... |

Table 1: BERT language model prediction (sorted by probability) for the word to appear at the position of “sports” under different contexts. The two sentences are from *AG News* corpus.

| Label Name | Category Vocabulary |
|------------|---|
| politics | politics, political, politicians, government, elections, politician, democracy, democratic, governing, party, leadership, state, election, politically, affairs, issues, governments, voters, debate, cabinet, congress, democrat, president, religion, ... |
| sports | sports, games, sporting, game, athletics, national, athletic, espn, soccer, basketball, stadium, arts, racing, baseball, tv, hockey, pro, press, team, red, home, bay, kings, city, legends, winning, miracle, olympic, ball, giants, players, champions, boxing, ... |
| business | business, trade, commercial, enterprise, shop, money, market, commerce, corporate, global, future, sales, general, international, group, retail, management, companies, operations, operation, store, corporation, venture, economic, division, firm, ... |
| technology | technology, tech, software, technological, device, equipment, hardware, devices, infrastructure, system, knowledge, technique, digital, technical, concept, systems, gear, techniques, functionality, process, material, facility, feature, method, ... |

Table 2: The label name used for each class of *AG News* dataset and the learned category vocabulary.

Step2 Masked Category Prediction

-- Word-level classification

$$\mathcal{L}_{MCP} = - \sum_{(w, c_w) \in \mathcal{S}_{\text{ind}}} \log p(c_w \mid \mathbf{h}_w),$$

$$p(c \mid \mathbf{h}) = \text{Softmax}(W_c \mathbf{h} + \mathbf{b}_c),$$

Step3 Self-Training(Soft-label)

-- Sentence-level classification

$$p_{ij} = p(c_j \mid \mathbf{h}_{d_i: [\text{CLS}]}).$$

$$q_{ij} = \frac{p_{ij}^2 / f_j}{\sum_{j'} (p_{ij'}^2 / f_{j'})}, \quad f_j = \sum_i p_{ij},$$

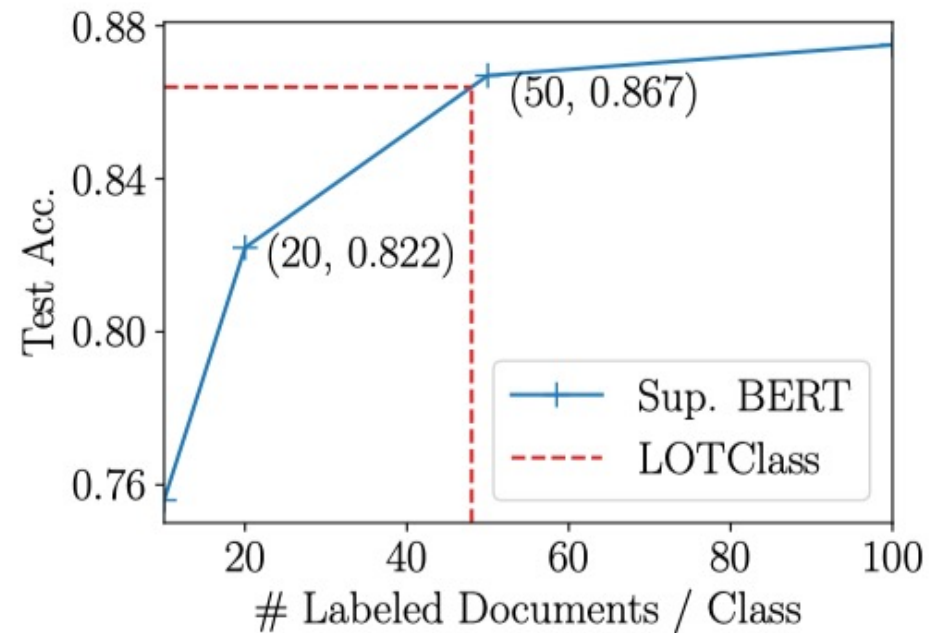
$$\mathcal{L}_{ST} = \text{KL}(Q \parallel P) = \sum_{i=1}^N \sum_{j=1}^K q_{ij} \log \frac{q_{ij}}{p_{ij}},$$

Experiments

| Supervision Type | Methods | AG News | DBPedia | IMDB | Amazon |
|------------------|--------------------------------------|--------------|--------------|--------------|--------------|
| Weakly-Sup. | Dataless (Chang et al., 2008) | 0.696 | 0.634 | 0.505 | 0.501 |
| | WeSTClass (Meng et al., 2018) | 0.823 | 0.811 | 0.774 | 0.753 |
| | BERT w. simple match | 0.752 | 0.722 | 0.677 | 0.654 |
| | LOTClass w/o. self train | 0.822 | 0.860 | 0.802 | 0.853 |
| | LOTClass | 0.864 | 0.911 | 0.865 | 0.916 |
| Semi-Sup. | UDA (Xie et al., 2019) | 0.869 | 0.986 | 0.887 | 0.960 |
| Supervised | char-CNN (Zhang et al., 2015) | 0.872 | 0.983 | 0.853 | 0.945 |
| | BERT (Devlin et al., 2019) | 0.944 | 0.993 | 0.945 | 0.972 |

Experiments

➤ How many labeled documents are label names worth?



(a) **Supervised BERT:** Test acc. vs. number of labeled documents.

Experiments

➤ Sensitivity to different words as label names?

| Label Name | Category Vocabulary |
|------------|--|
| commerce | commerce, trade, consumer, retail, trading, merchants, treasury, currency, sales, commercial, market, merchant, economy, economic, marketing, store, exchange, transactions, marketplace, businesses, investment, markets, trades, enterprise, ... |
| economy | economy, economic, economies, economics, currency, trade, future, gdp, treasury, sector, production, market, investment, growth, mortgage, commodity, money, markets, commerce, economical, prosperity, account, income, stock, store, ... |

Table 7: Different label names used for class “business” of *AG News* dataset and the learned category vocabulary.

➤ Advantages over GloVe

| Label Name | Category Vocabulary |
|------------|---|
| good | good, excellent, fine, right, fair, sound, wonderful, high, okay, sure, quality, smart, positive, solid, special, home, quick, safe, beautiful, cool, valuable, normal, amazing, successful, interesting, useful, tough, fun, done, sweet, rich, suitable, ... |
| bad | bad, terrible, horrible, badly, wrong, sad, worst, worse, mad, dark, awful, mean, rough, rotten, much, mixed, dumb, nasty, sorry, thing, negative, funny, far, go, crazy, weird, lucky, german, shit, guy, ugly, short, weak, sick, gross, dangerous, fake, ... |

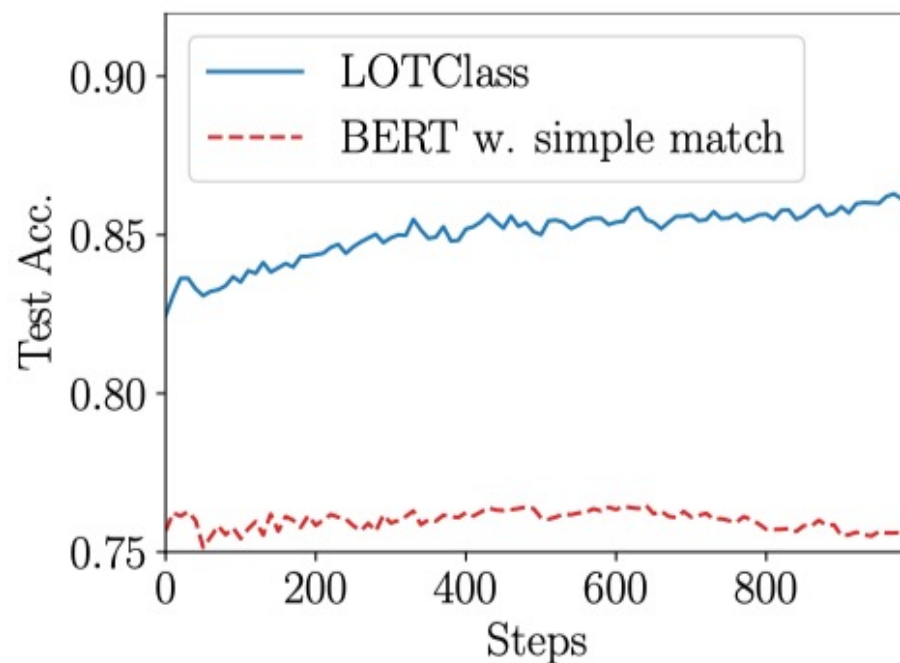
Table 4: The label name used for each class of *Amazon* dataset and the learned category vocabulary.

| Label Name | Category Vocabulary |
|------------|--|
| good | good, better, really, always, you, well, excellent, very, things, think, way, sure, thing, so, n't, we, lot, get, but, going, kind, know, just, pretty, i, 'll, certainly, 're, nothing, what, bad, great, best, something, because, doing, got, enough, even, ... |
| bad | bad, good, things, worse, thing, because, really, too, nothing, unfortunately, awful, n't, pretty, maybe, so, lot, trouble, something, wrong, got, terrible, just, anything, kind, going, getting, think, get, ?, you, stuff, 've, know, everything, actually, ... |

Table 8: GloVe 300-d pre-trained embedding for category understanding on *Amazon* dataset.

Experiments

➤ LOTClass VS BERT w. Simple Match



(c) **LOTClass** vs. **BERT w. simple match** during self-training.

Discussions

➤ The potential of weakly-supervised classification has not been fully explored.

- Only use the BERT-base-uncased model
- Use at most 3 words per class as label names
- Refrain from using other dependencies like back translation systems for augmentation

Discussions

- Applicability of weak supervision in other NLP tasks.
 - NER
 - Aspect-based sentiment analysis

Discussions

➤ Limitation of weakly-supervised classification.

- “I find it sad that just because Edward Norton did not want to be in the film or have anything to do with it, people automatically think the movie sucks without even watching it or giving it a chance.”

Discussions

➤ Collaboration with semi-supervised classification.

- **no training documents:**

- generate labeled examples for initializing semi-supervised methods

- **both training documents and label names are available:**

- joint objective can be designed to train the model, with word-level tasks + document-level tasks