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Multi-Classification Model for Spoken Language Understanding

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Outline

- Introduction
- Methods
- Experiments
- Conclusions

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□ Introduction

➢ About Task

- Extract a set of tuples (act-slot-value triples or act-slot pairs) from users' utterances in Chinese Audio-Textual Spoken Language Understanding Challenge (CATSLU)
- Audio information and text generated by automatic speech recognition (ASR) was provided
- For example, "What's the weather like in Shunyi District today?" → (inform, area, Shunyi District), (inform, date, today), (request, weather).

➢ Baseline System provided by organizers

- Baseline system 1: a rule-based method, works in a simple string matching [Zhu et al., 2019]
- Baseline system 2: a neural network-based method, a shared utterance encoder, an act type classifier, a slot type classifier, and a value decoder [Zhao et al., 2019]

□ Introduction (Motivation)

- Tag heads
    - Value Decoding is a more difficult problem compared with classification
    - Most values in tuples are the words of input utterance
    - Thus use sentence tagging to get the value

- Pretrained language model, BERT
    - Training the utterance is difficult without enough training data
    - BERT is the state-of-the-art pretrained language model
    - BERT provides lots of prior knowledge for comprehending semantic of the utterance

- Minimum Edit Distance to reduce bias, MED
    - We only use the text from ASR as input, the ASR accuracy will limit the upper bound of our extract systems
    - To reduce this bias, MED was performed to rebuild the triples extracted from utterance

Introduction (Model Description)

- Framework
  - Multitask framework
  - Getting tuples like (act, slot, value) from one utterance, means that different task can share the input semantic
  - Archive the targets means better understand of the utterance

- Sentence encoder
  - Pretrained language model, BERT, to encode input utterance

- Task-specific output layer
  - Three different tag heads to get tuples

- Post processing
  - MED to repair the output from our system

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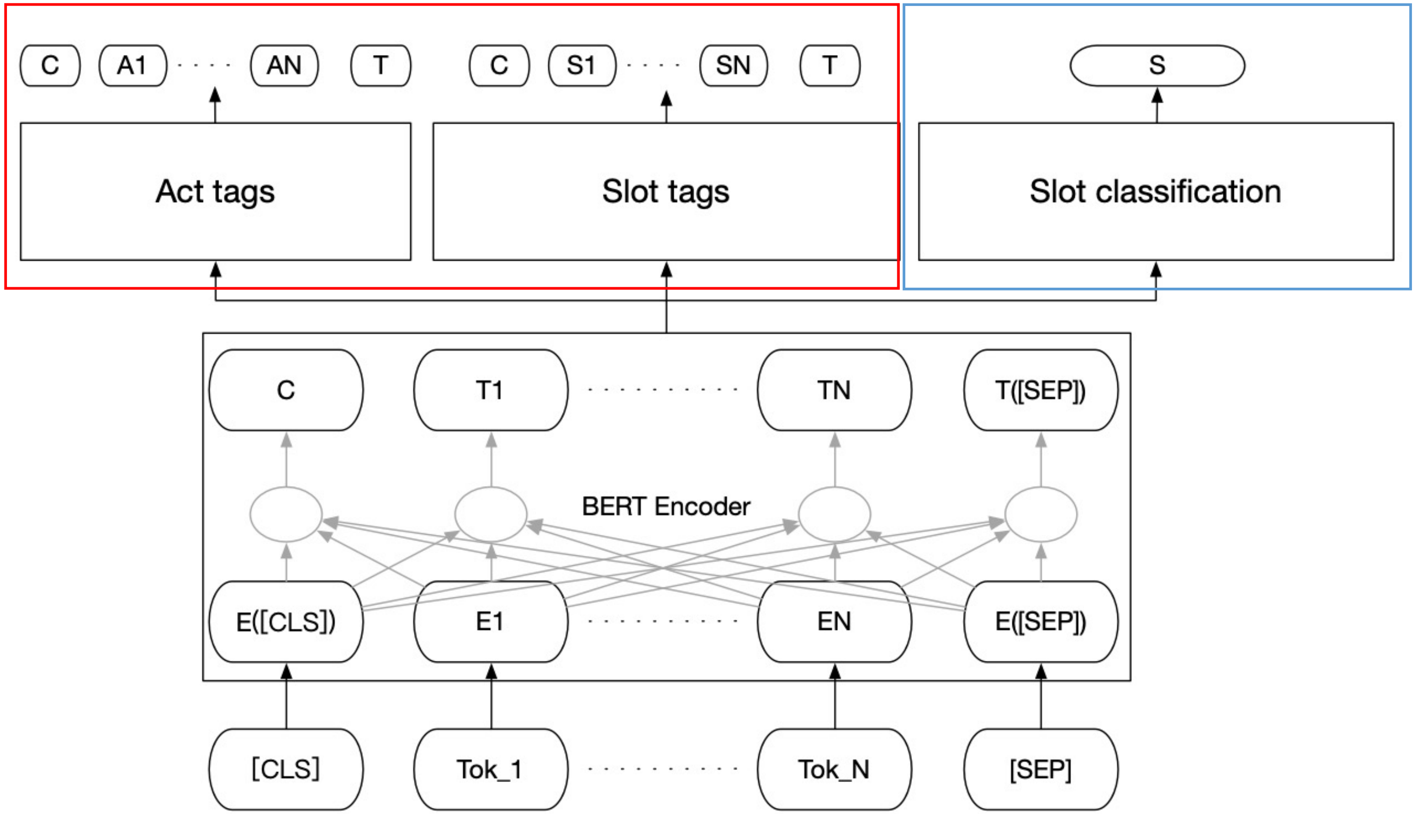
Methods

Model Architecture



3 heads with a Shared Utterance Encoder
Act tags and Slot tags for (act, slot, value) triples
Slot classification for (act, slot) pairs

Methods

Slot Tags

- IOB form

  Each word is tagged as "B$-$slot$_i$", "$\mathrm{I}$$-$slot$_i$" or "O".
- Classification

  2|S| + 1. |S| means the number of slot classes in triple's acts.

Act Tags

- The number of act classes holding in act-slot-value triples.
- Only classify the words which are tagged with "B$-$slot$_i$" in slot tags.

Slot Type Classifier

- A linear layer over the top of the hidden state associated to the first character of the input ([CLS])
- Add a "NONE" label to this classifier
- |S'|+1. |S'| means the number of slot class in the pair's act

Methods

➢ Minimum Edit Distance to reduce bias (MED)

- Outputs of our system may not be covered in the candidates since the ASR error
- ASR error has a direct influence on *value*, indirect effects on *act* and *slot,* thus assume *act* and *slot* are correct
- Use the MED [Levenshtein, 1966] between values from results and candidates to rebuild the triples
- Perform MED on phonetic space maybe more suitable

Manual	导航到包埠村收费站
	Navigate to Baobu Village Toll Station
ASR best	导航到保铺村收费站
	Navigate to Baopu Village Toll Station
Tuples	[inform, 操作, 导航]，[inform, 终点名称, 包埠村收费站]
	[inform, operation, navigation], [inform, endpoint name, Baobu Village Toll Station]

□ Methods

How to train?

- ✓ Fine-tune the pretrained Chinese Language BERT
- ✓ Summarize the cross entropy loss from three tag heads
- ✓ Cut off
  - Notice that act labels is a little set and classification will be simple
  - Weak encoder of the utterance can also due with this classification
  - We truncate the back propagation of gradient before act tags head

□ Methods

How to get result (infer)?

✓ Feed an input sentence to the model and get three logits from tag heads

✓ Get tuples from the logits

- Perform **argmax** on slot type classifier to get (act, slot) pairs
- Perform **argmax** on slot tags to get (slot, value) pairs and then
- Perform **argmax** on act tags at the position where slots own the prefix "B-" to get (act, slot, value) triples

✓ Perform MED on (act, slot, value) triples

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Experiments

CATSLU Dataset

- 4 domain: **map**, **music**, **weather**, **video**
- **map** and **music** domains contained 5,093 and 2,189 training samples
- **weather** and **video** domains contained just 341 and 205 training samples

Model for comparison

- Baseline system 1: a rule-based method, works in a simple string matching [Zhu et al., 2019]
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Experiments

Evaluation

System	Map		Music		Weather		Video	
	F1(%)	Acc(%)	F1(%)	Acc(%)	F1(%)	Acc(%)	F1(%)	Acc(%)
Baseline 1	37.92	40.43	77.39	49.26	85.52	75.38	78.25	45.28
Baseline 2	77.61	74.65	81.57	71.15	85.25	78.16	75.18	57.53
Our system	**87.43**	**83.08**	**91.53**	**82.40**	**93.24**	**86.95**	**91.71**	**81.17**

- Our model achieved significantly better results than the baseline systems.
- Even in the **weather** and **video** domain, which lacks of training data, we achieve high score under F1 and accuracy metrics

Experiments

Ablation

System	Map		Music		Weather		Video	
	F1(%)	Acc(%)	F1(%)	Acc(%)	F1(%)	Acc(%)	F1(%)	Acc(%)
Our system	87.43	83.08	91.53	82.40	**93.24**	**86.95**	**91.71**	**81.17**
- Cut off	**87.95**	**83.78**	**92.49**	**83.73**	92.65	86.09	90.73	79.10
- MED	81.43	77.63	88.01	78.85	90.99	84.17	84.81	72.46

- On **weather** and **video** domains cutting off performed better while **map** and **music** domains did not.
- **Map** and **music** domains have enough samples so can provide correct information for act tags to adjust the encoder
- Choice appropriate heads to joint calculate the shared encoder

Experiments

Ablation

System	Map		Music		Weather		Video	
	F1(%)	Acc(%)	F1(%)	Acc(%)	F1(%)	Acc(%)	F1(%)	Acc(%)
Our system	87.43	83.08	91.53	82.40	**93.24**	**86.95**	**91.71**	**81.17**
- Cut off	**87.95**	**83.78**	**92.49**	**83.73**	92.65	86.09	90.73	79.10
- MED	81.43	77.63	88.01	78.85	90.99	84.17	84.81	72.46

- MED contributed a lot for better performance
- It repaired the gaps between ASR and ground truth

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Conclusions

- The main contributions of our proposed method include:
  - Tag heads
  - Pretrained language model BERT
  - Minimum Edit Distance to reduce bias
  - Multi-task Learning framework

- Not all heads' information are beneficial to the shared utterance encoder

Q & A ?

Thanks!

References

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