Building Chinese Out-of-domain Utterances Corpus Using New Dialogue Act Annotation Schema

[name]	[name]	[name]
[address]	[address]	[address]
[address]	[address]	[address]
[address]	[address]	[address]
[e-mail]	[e-mail]	[e-mail]

Abstract

In this paper, we present our work on building a Chinese out-of-domain (OOD) utterances corpus using new dialogue act (DA) annotation schema, which is expected to be useful for automatic DA recognition of OOD utterances in restricted domain spoken dialogue systems (SDS). A new annotation schema for DA of OOD utterances (DAOODU) is designed with reference to the recent international standard and well extended to capture more subtleties in the performance of communicative actions underlying OOD utterances. Guided by the DA annotation schema, we manually annotate a Chinese OOD utterances (COODU) corpus of 2000 OOD utterances, consisting of two part, one is extracted from 1594 conversations and the other is by manually expansion. Preliminary evaluation on OOD utterances DA recognition using the state-of-the-art short text classification methods justifies the usability and computability of the proposed DAOODU annotation schema and the COODU corpus.

1 Introduction

Restricted domain spoken dialogue systems (SDSs) provide a natural and effective interface to a wide range of services, and therefore have great significance in artificial intelligence and natural language processing. Over the years, restricted domain SDSs are already used to access information (Price, 1990; Gorin et al., 1997; Zue et al., 2000; Zhang et al., 2004; Durston et al., 2011), provide route instruction (Huang et al., 2001; Reichel et al., 2014), give navigation service (Pappu and Rudnicky, 2012) and provide shopping guide (Huang et al., 2014). However, even when their roles are well known, for instance, answering questions about a specific domain or performing some predetermined task, users persist in confronting them with out-of-domain (OOD) input, that is, personal questions, requests about the weather, or making a declaration of unsatisfied, etc. For example in the AT&T "How may I help you" system (Gorin et al., 1997) and the "OASIS" call-steering system (Durston et al., 2011), around 20% of calls were OOD. Although it might be argued that such systems should only be focused in their own pre-defined functions, the fact is that people become more engaged with these applications if OOD utterances are properly addressed (Ameixa et al., 2014), not just detecting that the utterance is OOD and informing the user that it cannot be handled by the system.

It is well-known that interpretation of an utterance requires understanding of its dialogue acts (DAs) since DAs can be thought of as a tag set that classifies utterances according to a combination of pragmatic, semantic, and syntactic criteria. Such a tag set aim to capture the "act" underlying an utterance such as asking a question, making a statement, and acknowledgement (Stolcke et al., 2000). Research in DA analysis, especially based on empirical corpus, plays a significant role in efforts to achieve a deep understanding of the communicative strategies and mechanisms in human-machine interactions (Fang et al., 2013). Due to the wide and potential use of DA, designing DA annotation schemas and

constructing DA annotated corpora have been attracting more and more attention in recent years. To date, a number of DA annotation schemas have been developed for a specific purpose and a specific application domain (Allen et al., 1994; Carletta et al., 1996; Alexandersson, 1998). Some other efforts are devoted to develop general-purpose DA labeling schemas that are domain-independent (Core and Allen, 1997; ISO DIS 24617-2, 2010). However, in comparison with DA annotation of the entire dialogue (mostly focuses on in-domain utterances), to the best of our knowledge, there is not DA annotation schema and annotated corpus of OOD utterances which largely restrict the researches in OOD utterances processing. Therefore, this study focuses on designing DA annotation schema for OOD utterances and building DA annotated OOD utterances corpus. The primary contributions of this paper are:

- A new DA annotation schema for OOD utterances (DAOODU) is designed, which mainly refers to the recent international standard in DA annotation, and makes some extension to captures more subtleties in the performance of communicative actions.
- A DA annotated Chinese OOD utterances (COODU) corpus comprising 2000 OOD utterances with 25 DA categories is constructed, which will be soon released to public. 857 utterances of COODU corpus are extracted from 1594 conversations in a dialogue system support to act as a mobile phone recommendation assistant, and other 1143 utterances are manually expanded.
- The application and evaluation of COODU corpus on Chinese OOD utterances DA recognition. The experiment results using state-of-the-art methods which have been successfully used for short text classification indicates that the proposed DAOODU annotation schema and the COODU corpus are with both usability and computability.

The rest of this paper is organized as follows. Section 2 introduces some existing DA annotation schemas and annotated corpora. Section 3 describes the design of the DA annotation schema for OOD utterances. Section 4 presents the construction of the Chinese OOD utterances corpus. Section 5 gives the experimental results on OOD utterances DA recognition. Conclusions and future work are finally drawn in Section 6.

2 Related Work

In this section we discuss previous work related to DA annotation schemas and DA annotated corpora.

Over the years a number of specific-purpose DA annotation schemas have been developed, such as those of the TRAINS project in the US (Allen et al., 1994), the Map Task studies in the UK (Carletta et al., 1996), and the Verbmobil project in Germany (Alexandersson, 1998). A feature of Verbmobil annotation schema is that it employs decision tree for DA categorization. These schemas, however, were all designed for a specific application domain, and they contained overlapping sets of communicative functions and made use of often mutually inconsistent terminology (Bunt et al., 2010).

In the 1990s, the Multiparty Discourse Group in Discourse Research Initiative (DRI) meetings drafted a general-purpose schema for multidimensional DA annotation called Dialog Act Markup in Several Layers (DAMSL) (Allen and Core, 1997). With its focus on multidimensionality and domain-independence, this represented an important step forward in DA annotation. Several variations and extensions of the DAMSL schema have been constructed for specific purposes, such as Switchboard-DAMSL (Jurafsky et al., 1997) and COCONUT (Eugenio et al., 1998). The comprehensive DIT++ schema (Bunt, 2006; Bunt, 2009) combines the multidimensional DIT schema, developed earlier (Bunt, 1994) with concepts from these various alternative schemas, and provides precise and mutually consistent definitions for its communicative functions and dimensions.

More recently, in the Linguistic Infrastructure for Interoperable Resources and Systems (LIRICS) project, International Organization for Standardization (ISO) organizes and develops an international standard for DA annotation, namely, Semantic annotation framework (SemAF) – Part 2: Dialogue acts (ISO DIS 24617-2, 2010). The main designer of the new ISO DA annotation standard includes Carlett (researcher of Map Task), Alexandersson (researcher of Verbmobil) and Bunt (researcher of DIT++), which make it widely recognized by the international dialogue and discourse research community. This new ISO DA annotation standard has been has been used for guiding annotation of specific domain corpus, such as new DA annotated Switchboard corpus (Fang et al., 2013).

Although the above DA annotation schemas are all designed for entire dialogue, and mostly focus on in-domain utterances, the design principles of them and the application of DA annotation in specific domain corpora provide a helpful reference for our work in designing a new DA annotation schema for OOD utterances and constructing a DA annotated Chinese OOD utterances corpus.

3 OOD Utterances DA Annotation Schema

An appropriate representation schema is fundamental to linguistic resource construction. With reference to various theories and representation schema for specific-purpose (Alexandersson, 1998) and general-purpose (Allen and Core, 1997; ISO DIS 24617-2, 2010), we propose a new DA annotation schema for OOD utterances (DAOODU).

Unlike in-domain utterances, most of OOD utterances rely less on deep semantic knowledge, and the user's intent of them can be interpreted unambiguously. In our study, we focus on the surface-oriented DA annotation, which do not rely on dialogue context. In some case that the intent of the user's utterances need to be inferred from the utterance surface characteristics in combination with dialogue context, our DA annotation can be treated as the first step of the user intent recognition. An illustration of this is the following dialogue fragment:

System: 亲，决定拍下吗？(Dear guest, decided to take it?)
User: 是的。(Yes.)

User gives an affirmative declaration to system, so in our annotation schema, this OOD utterance is annotated with *Affirmation* DA. And then, according to the dialogue context, the virtually user's tent can be recognized as willingness to deal.

Another point to be aware of is the notion of "OOD". Although OOD utterances may restricted to only those that irrelevant to the task, such as personal questions or requests about the weather, in our study, we treat all the utterances that do not contain valid domain semantic information in restricted domain SDS as OOD utterances. This loose OOD definition makes some utterances that relative to domain task into OOD as well, such as a declaration of affirmation or negation, or a conventional-opening. We expect such OOD definition can be helpful since remain utterances that contain valid domain semantic information hope to be well processed using domain sematic.

3.1 Design Principles

We chose to mainly follow a recent ISO standard DA annotation schema (ISO DIS 24617-2, 2010), which takes two most central aspects of a DA into consideration, communicative function and semantic content. Communicative function corresponds intuitively to the type of action that is performed, such as *Affirmation*, and the term "dialogue act annotation" is commonly used to describe the assignment of communicative function labels to stretches of dialogue (Bunt et al., 2010). And semantic content, also called 'dimensions' in ISO annotation schema, refers to the type of activity that is concerned with a certain kind of information, such as *Social Obligation*.

The design principles of the dimensions in DAOODU are based on similar criteria as the choice of "core dimensions" in ISO annotation schema (Bunt et al., 2010):

1. Empirical validity: every dimension has a clear empirical basis, corresponding to observed forms of behavior in dialogue.
2. Theoretical validity: every dimension should be theoretically justified, corresponding to a well-established class of communicative activities, such as *Declaration* or *Social Obligation*.
3. Each dimension is recognizable with acceptable precision by humans and by machines.
4. Each dimension in a multidimensional system can be addressed by DAs independent from addressing other dimensions (the dimensions are independent or orthogonal).

And the following 5 criteria have been identified for designing communicative functions of each dimension, which are based on similar criteria as the choice of dimensions:

1. Empirical validity: for every communicative function there exist linguistic or nonverbal means which can be used by speakers to indicate that their behavior has that function.
2. Theoretical validity: every communicative function has a precise definition which distinguishes it semantically from other functions.

3. Each communicative function can be recognized with acceptable precision by humans and by machines.

4. The set of communicative functions applicable in a certain dimension provides a good coverage of the phenomena in that dimension.

5. Any two communicative functions that can be used in a given dimension are either mutually exclusive, i.e. if one of them applies to a given functional segment then the other one does not, or one function is a specialization of the other (Bunt et al., 2010).

3.2 DACOODU

Table 1 shows the new DA annotation schema, DAOODU, with example utterances.

对话行为 (DA)		**例句(Example)**	**数量 (Count)**
维度 (Dimension)	**交互功能 (Communicative function)**		
任务进程 (Task process)	开始(Start)	“我想买手机” (I want to buy a mobile phone)	138
	结束(End)	“再见” (Bye)	147
	更换(Change)	“换一款” (Change one)	62
	成交(Deal)	“买了”(Clinch a deal)	304
	不成交(Failed deal)	“我不想买了”(I don’t want to buy it)	23
	详情(Detail)	“具体点” (More detail, please)	25
	不理解 (Non-understanding)	“啥意思？” (What do you mean?)	10
表态 (Declaration)	肯定(Affirmation)	“好的”(Ok)	202
	否定(Negation)	“不是”(No)	157
	疑问(Doubt)	“真的吗？”(Really?)	9
	满意(Satisfaction)	“挺好的” (Very good)	114
	不满(Dissatisfaction)	“差评” (Too bad !)	88
	附和(Echo)	“呃...” (Er…)	22
	犹豫(Hesitate)	“不知道哪个好” (Which is better?)	100
	随便(No requirement)	“无所谓” (Any one will do)	19
社交义务 (Social obligation)	问候(Greeting)	“你好” (Hello)	61
	致谢(Thanking)	“谢谢” (Thank you)	32
	道歉(Apology)	“不好意思” (Sorry)	7
	不用谢 (Accept-thanking)	“不用谢” (You are welcome)	6
	接受道歉(Accept-apology)	“没关系” (It doesn’t matter)	8
闲聊 (Chat)	时间 (Time)	“现在几点啦？” (What time is it now?)	87
	天气 (Weather)	“今天天气好冷” (It is so cold today)	134
	身份信息 (Personal information)	“你叫什么名字？” (What’s your name?)	125
其它 (Other)	骂人(Abuse)	“混蛋!” (Asshoie !)	82
	其它 (Other)	“你猜” (You guess)	38
汇总 (Total)			2000

Table 1: The DA annotation schema for OOD utterances (DAOODU) and the DA distribution of the Chinese OOD utterances (COODU) corpus.

When design the schema, we systematically consider the different between the OOD utterances that belong to user-initiative and system-initiative state, which are both common in mixed-initiative SDS. These two distinct aspects of participating in a dialogue qualify as two main dimension of DAOODU, i.e. *Task process* and *Declaration*.

Moreover, taking chatting into consideration, a dimension of *Chat*, which mainly includes personal questions, and requests about the weather or time, is added to the schema. And considering that user may also have to deal with social obligations such as greeting, thanking and apologising, and responses to these acts, such as accepting an apology, we add another dimension of *Social obligation.*

In addition, we use a dimension of *Other*, including two communicative function of *Abuse* and *Other*, the former employs highly specialized communicative function to detect the uncivilized utterances, and the latter refers to the portion of utterances in the corpus that do not have an appropriate DA tag.

A limitation of many existing DA annotation schemas is that it fails to capture certain subtleties in the performance of communicative actions. For instance, it is common to distinguish only two possible responses to an offer: accepting it and refusing it. However an offer may be responded with a certain emotion, such as a declaration of satisfied or unsatisfied. Thus, more communicative functions are used for representing a user's emotional stance with respect to the semantic content of the act, or his attitude towards the system.

Note that some communicative functions in our label-set are somewhat domain-special, such as *Deal* and *Fail deal* in the *Task process* dimension, which may be only used for the domains of recommendation assistants, and can be treated as optional communicative functions for use in other domains.

4 Chinese OOD Utterances Corpus

Our corpus, DA annotated Chinese OOD utterances (COODU) corpus, consists of two parts, one of which is extracted from 2000 conversations in a dialogue system support to act as a mobile phone recommendation assistant and the other of which is manually expanded to make supplement to the categories of DA that have not appeared in the conversations log or with too few samples.

The log of the mobile phone recommendation assistant lasts from September 2013 to June 2016, consisting of 1594 conversations with 2795 OOD utterances. After redundancy elimination, 857 OOD utterances are selected into the COODU corpus.

The annotator team consists of a Ph.D., a MS student and two undergraduate students. The annotators are divided into two pairs for crosschecking to resolve the difference. Finally, we carefully proofread of all 2000 DA annotated OOD utterances. The DA distribution of the COODU corpus is shown in Table 1.

Note also that utterances in dialogue maybe multifunctional, i.e., they serve more than one communicative function, which has led to the development of 'multidimensional' DA annotation schemas, which support an utterance to be marked up with more than one functional tag (Bunt et al., 2010).

There are indeed some utterances have 'multidimensional' DAs in COODU corpus. An illustration of this is the following dialogue fragment:

System: 帮您查了下，5788元。(I have helped you check it, 5788 RMB)
User: 嗯嗯，我买了。(Uh huh, I will buy it.)

User gives an affirmative declaration to system, and then expresses the willingness to deal. In user's utterance, the single part "嗯嗯 (Uh huh)" can be recognized as *Affirmation* communicative function of *Declaration* dimension, and "我买了 (I will buy it)" can be recognized as *Deal* communicative function of *Task process* dimension. However, we do not find the ubiquitous multifunctionality of OOD utterances in COODU corpus. So, at this stage, we use single DA annotation in constructing COODU corpus. The above OOD sample has been annotated as *Deal* communicative function of *Task process* dimension, since the final expression of the user utterance is the willingness to deal.

5 Preliminary Experimentation

In order to evaluate usability and computability of the proposed DAOODU annotation schema and the COODU corpus, we give the experimental results on OOD utterances DA recognition, which is crucial in handling OOD utterances in restricted domain SDS.

5.1 Experimental Setup

We performed an experiment by logging the interactions of 15 subjects with the mobile phone recommendation assistant system. Each evaluator tests 12-15 times with different scenarios and gets total 193 dialogues. All of the evaluators were familiar with the dialogue system capabilities, but did not have a detailed knowledge of how to constitute a correct reference answer.

The overall statistical results are shown in Table 2.

Dialogues	User utterances	OOD utterances (before/after redundancy elimination)	Coverage of DAOODU (before/after redundancy elimination)	OOD utterances not in COODU
193	2070	362/166	356/162	76

Table 2: Overall statistical results of the evaluation data set.

As we can see from Table 2, there are 362 OOD utterances in 193 dialogues, which is 17.5% of the total 2070 user utterances. This proportion is quite similar to the AT&T "How may I help you" system (Gorin et al., 1997) and the "OASIS" call-steering system (Durston et al., 2011), which also indicates the role of OOD processing cannot be ignored.

In the 166 OOD utterances after redundancy elimination, 162 utterances are covered in the first 24 DA categories of the DAOODU schema, and 4 remain as *Other* tag. The coverage rate reaches 97.6%, which shows the usability of the proposed DA annotation schema. Note also that there is 1 OOD utterance with *Other* tag that can be matched by the *Other* category of COODU corpus, which suggests a potential effect of further enlarging the *Other* category of COODU corpus to match more utterances that are out of the first 24 DA categories of DAOODU.

To the 76 unmatched OOD utterances (including 3 with *Other* tag), we use DA annotated COODU corpus as training set to train DA recognition models, and perform k-fold (k=5 in our experiments) cross validation for model selection.

5 popular methods which have been successfully used for short text classification are introduced to OOD utterances DA recognition:

ME (TFIDF): Ma et al. (2014) employs term frequency–inverse document frequency (TF-IDF) to compute feature values and use maximum entropy (ME) for news title classification.

RF(BOW): Khabsa et al. (2016) use random forests (RF) to identify relevant studies for systematic reviews. We test this ensemble-based method using bag-of-words (BOW) features.

CNN (w2v): Kim (2014) uses unsupervised pre-training of word vectors to produce input to convolutional neural network (CNN). The publicly available word2vec vectors he used were trained on 100 billion words from Google News. In our experiment, we use SMP 2015 Weibo DataSet (provided by the Specialized Committee Social Media Processing, Chinese Information Processing Society of China) for pre-training word vectors.

CNN (BOW): Johnson and Zhang (2015) use CNN model with BOW convolution feature representation, which loses word order only within small regions.

CNN (Seq): Another CNN model which keeps sequences of words, by using a one-hot vector and learning embedding of text regions (Johnson and Zhang, 2015).

5.2 Results and Discussions

The OOD utterances DA recognition results are shown in Table 3.

As we can see from Table 3, both classifiers of RF and CNN with BOW features achieve the best DA recognition accuracy of 85.53%. From the comparison of CNN (BOW) and CNN (Seq), small regional word order seems not so helpful for distinguishing DAs of the OOD utterances.

Methods	Recognition accuracy (%)
ME (TFIDF)	68.42
RF (BOW)	85.53
CNN (w2v)	81.58
CNN (BOW)	85.53
CNN (Seq)	80.26

Table 3: OOD utterances DA recognition results.

When adding 90 OOD utterances that matches COODU corpus into statistics, the total automatic DA recognition rate of OOD utterances using the best classifier reaches 93.4%, which confirms the computability of the constructed COODU corpus.

6 Conclusion

In this paper, we report our effort on design of an OOD DA annotation schema and the construction of a Chinese DA annotated corpus for OOD utterances recognition in restricted domain SDS. A new annotation schema for DA of OOD utterances, DAOODU, is designed with reference to the recent international standard and well extended to capture more subtleties in the performance of communicative actions underlying OOD utterances. The constructed corpus, COODU, comprises 2000 OOD utterances with 25 DAs. Automatic DA recognition experiments are also performed by using some state-of-the-art methods which have been successfully used for short text classification. Preliminary experimental results indicate the proposed DAOODU annotation schema and the COODU corpus are with both usability and computability. Future work will focus on testing the OOD utterances recognition in much more domains of recommendation assistants based on the constructed resources, and extending the corpus to a much wider applications of task-oriented domains.

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