

Methodological approach for pragmatic annotation

Aproximación Metodológica para la Anotación Pragmática

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Resumen: En el desarrollo de sistemas basados en la interacción, es necesario transcribir y analizar una gran cantidad de corpus. Este análisis es desarrollado a través de distintos niveles lingüísticos, entre los que se encuentra el nivel pragmático. Este trabajo presenta cómo desarrollar esta tarea y describe las partes relevantes del conocimiento que deben tratarse en este análisis. Para ello se presenta un conjunto de tareas para realizar la anotación pragmática del corpus con el objetivo de conseguir una metodología que facilite este trabajo a los desarrolladores y asegure completitud y rigor en el modelado de este conocimiento. Con estas propiedades se conseguirá que los corpus anotados a través de esta metodología puedan ser reutilizados, de manera total o parcial, en otros dominios de interacción.

Palabras clave: Anotación Pragmática, Análisis de corpus, Sistemas de Interacción Natural

Abstract: For developing corpus based interaction systems, it is necessary to acquire, transcribe, and analyze significant amount of corpus. Such analysis should be performed at several linguistic levels, among which pragmatics is surely found. This work proposes how to perform that task and describes part of the relevant knowledge to be met through that analysis. The approach presents a set of steps to be tracking during the pragmatic annotation of corpus. The proposed steps aim to guide dialogue coders to attain completeness in the analysis and maximize their agreement in their joint work.

Keywords: Pragmatic annotation, corpus analysis, natural interaction systems

1 Introduction

Late years have witnessed the increasing interest in systems interacting like humans for reaching those potential users that haven't enough technological abilities for interacting with computers but are able of interacting with other humans. For a computer to behave like this, interactive knowledge and reasoning mechanisms over it have to be modeled. Since that knowledge is complex and from diverse nature, it has been often divided up into several categories or types of interactive knowledge, which are to be analyzed and modeled separately and bring together through a Cognitive Architecture (Calle et al., 2006).

The linguistic knowledge usually gives rise to several components in such knowledge distributions. On one hand, the expressive components for understanding the semantic content of users' messages (literal meaning) and

for expressing system's own. Thus, there should be settled components for voice recognition and synthesis, and some others for Natural Language Processing. On the other hand, once the literal semantics of the user's message have been clarified and until the semantic content of system's intervention is established, there should be observed a group of reasoning processes over other sort of knowledge that determine the real interpretation of the interaction state and the behavior of the system. Among other types of knowledge (emotional, situational, etc.), there should be observed a particular subset of the linguistic: pragmatics.

Pragmatic knowledge should enable to cover all that gap of human knowledge abilities: from literal meaning representation of any participant intervention to the production of the next one, through solving references, taking into account presuppositions, inferring implicatures, discovering the underlying individual and

mutual intentions, structuring the interaction, settling the proper effects of each intervention, and some others. Among them, because of its crucial importance for natural interaction, arise the mechanisms for checking up the interaction health and applying reinforcement techniques in case. The so often named Dialogue Model usually covers much of this knowledge, sometimes helped by some others such as the Task Model or the Session Model (Cuadra et al., 2008), intimately linked with it.

Anyhow, for formalizing and implementing such knowledge, it is essential to acquire it. Some of the knowledge could be considered as general (domain independent), exposed through some pragmatic theory, and formalized in a knowledge model. The other depends on the particular Interaction Domain, and should be acquired through the analysis of a sample (interaction corpus). Then, the corpus should be analysed and pragmatically annotated for later implementation, for which a methodology will be proposed in this work. The proposed steps aim to guide dialogue coders to attain completeness in the analysis and maximize their agreement in their joint work. Other interactive knowledge also appearing through the corpus (emotional, circumstantial, etc.) should also be annotated and processed, but will be left for further work.

The paper is structured as follows. Proposals relate to pragmatic annotation is presented in the section 2. The proposed methodology is shown in the section 3. Section 4 and 5 explain in detail the individual and total pragmatic annotation of corpus. Last, some conclusions and future work are presented.

2 *Premises and Related Work*

Pragmatic annotation has been classically observed to be applied in three levels (Gibbon et al.): micro-level, meso-level, and macro-level. First, minimum meaningful functional units should be identified through microlevel annotation, and marked with utterance tags (or dialogue acts). On second place, the meso-level annotation should give rise to sequences, differentiating the initiation from the development of a subdialogue which is to be represented by a dialogue game (Levin & Moore, 1977). Some other authors consider these functional units as common ground units, by adding some features for attaining mutual knowledge on them from both participants (see

Nakatani & Traum, 1998; Clark, 1996). Finally, macro-level stands for differentiating major subdialogues (transactions), immediately minor to the whole interaction and developing its main tasks or intentions, from the other minor ones (acts exchanges). These three levels are similar to the four proposed by (Sinclair & Coulthard, 1975) (transaction, exchange, move and act), and can be found on several works. Such as the structure annotation of the 128 dialogues within the HCRC map task corpus (Carletta et al, 1996).

For analyzing dialogue, it is essential to divide it up into small structural and functional units. Thus, appears the interventions as the realization of a turn by a participant. Yet this structural unit seems to occur sequentially (alternatively by both participants) in real interaction two adjacent interventions might be performed by the same participant, or even overlap (two participants can intervene simultaneously). However, there could be differentiated minor structural units such as the sentences, and these in turn could involve several communicative acts (as extensions of those from the speech acts theories (Austin, 1962; Searle, 1969). In sum, the pragmatic analysis requires the corpus to be preprocessed at the syntactic, semantic and prosodic levels, for having it structurally segmented into turns, sentences and acts. This last step, transcribing the corpus into communicative acts, is in fact part of the pragmatic (micro level) annotation, but that transcription just seeks for the literal acts (ignoring its functional value), thus classified into the preprocessing part.

Functional annotation could depart from small structural units, or look for larger ones. DAMSL (Allen & Core, 1997) (Dialogue Act Markup in Several Layers) bases its functional annotation in tagging utterances over four dimensions:

- (i) Communicative status: whether the utterance is intelligible and successfully completed, uninterpretable, abandoned, or self-talk.
- (ii) Information level: semantic content and relation to the underlying task. Could be tagged as task, task management, communication management, or others.
- (iii) Forward-communicative-function: nstraints on interlocutors future beliefs and actions. Feasible tags are: statement (assert,...), influencing future actions (directive), committing future actions (offer,...), and other.

(iv) Backward-communicative-function: referring previous parts in a similar way. Following this criteria the utterance could be an agreement, understanding, answering, information relation, and antecedents relating more than just preceding unit.

It also gives some cues on tagging other phenomena, such as speech repairs. These guidelines have been used and evolved by many other projects, such as the ADAM (Cattoni et al, 2002), which not only reach the annotation of some pragmatic features for 450 dialogues but also observes its annotation in other levels (prosodic, morpho-syntactic, and semantic). MATE (Dybkjaer et al, 1998) observes similar linguistic levels, but adding annotation for co-reference and communication problems. The Cast3LB project (Navarro et al., 2003) pursues the linguistic annotation of a Spanish language corpus (in parallel with other two co-official languages, Catalan and Basque), also at several levels (morphological, syntactic and semantic). For pragmatic, Cast3LB observes just the co-reference of nominal phrases and the anaphora annotation (for which they count on a semi-automatic tagger, detecting possible anaphoric elements and proposing resolutions for the human tagger to choose). Finally, there also should be mentioned the Monroe project (Tetreault et al., 2004), which simple pragmatic annotation observed co-reference, speech acts, and an interesting scope on segmentation (as generalized functional units).

Several projects for corpus annotation have developed its own toolkit, such as for example Dexter (Garretson, 2006) which is a free open-source suite of software tools for analyzing language data, initially developed for the MICASE corpus but reusable for other purposes.

3 Describing Pragmatic annotation through a methodological approach

This section is aimed to establish which sort of pragmatic information is going to be annotated and formalized from corpus using this methodological approach. The knowledge will be acquired through both the analysis of individual dialogues and the complete corpus. The later process should not be tackled until prior one is not finished. The figure 1 shows the methodology approach according to the inputs, steps and products as results to apply each step.

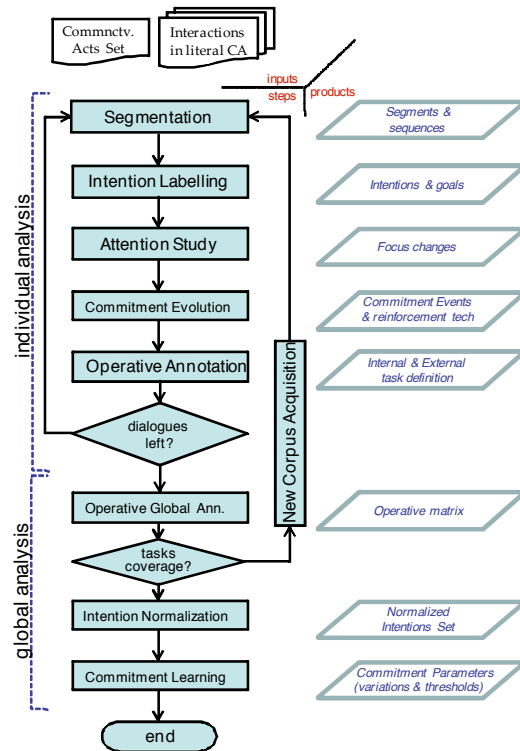


Figure 1: Pragmatic annotation methodology

The proposed methodology departs from any well defined task-oriented Interaction Domain for which a complete corpus has been obtained and annotated (at every level previous to pragmatic analysis). The approach is going to focus dialogues, this is bipartite interactions. A dialogue can be defined as runs of interventions, which are the performance of a turn by any participant in the dialogue (often, interventions are developed alternatively by both participants, but might overlap and this eventuality should also be annotated). For easing this task, the input should be pre-processed at the micro-level annotation. Thus, interventions will be described in form of Communicative Acts. These acts will be the literal semantic representation of the interventions, based on a CA set (suited to the Interaction Domain) and Ontology. Those semantic structures should observe not only the literal content of the message, but also prosodic information (pauses, transition relevant places, intonation, etc.). Thus, the absence of utterance will be represented as an act itself. Indirections, anaphora, ellipsis, and other linguistic phenomena should not be observed in such pre-processing, since they are to be solved at the interaction level. However, referential elements

should be identified and marked, for later resolution.

The proposal will be presented split into two phases: individual analysis of each dialogue, and corpus global processing. Before getting with it, some definitions are provided for making clear the exposition, since they could have different interpretations in other proposals.

Definition 1: Let us define segment as the fragment of interaction that could be intentionally independently interpreted (apart from context), has a functional sense in the dialogue, and has the features of a common ground unit. A segment usually is composed of one or more interventions, but not necessarily: it could be a part of intervention or even less (none intervention at all).

Definition 2: Let us define intervention as the realization of a turn by a participant through the interaction. Any intervention consists of one or more discourses, which are to be defined as an uninterrupted unbroken fragment of intervention developing the same specific goal (intention).

Definition 3: Let us define piece of discourse as an atomic functional unit of illocutive understanding, which could be represented by a communicative act (CA) or several complementary ones.

Each discourse is composed of one or more pieces. These discourses could shape an intervention, part of it, several consecutive or non-consecutive interventions or part of them, or whatever combination. It should be pointed out that a segment could even be developed with none discourse at all.

4 Individual Dialog Analysis Phase

The individual dialog analysis phase is composed by: segmentation, intention labelling, attentional study, commitment evolution, and operative annotation.

4.1 Segmentation

For discovering segments throughout a dialogue, it should be examined what is happening during its development. For simplifying this task, dialogues are to be represented. When a segment is found, it should be marked its discourses and boundaries. Thus, it will be revealed its sequences:

Opening: this sequence determines the instantiation of the segment, given an interaction state (specific or generalized) and a sequence of discourse pieces.

Closings: this sequence is performed for finishing the segment, with interactive success.

Cloakings/Disclosings: sometimes a segment appears fragmented, because of an interruption for developing a segment that has nothing to do with the first one. The cloaking sequence reveals when current segment is to be (temporally) abandoned, while the disclosing sequence is set to resume it.

Cancellations/Recoverings: the cancellation is a particular case of closing, which is set to finish the segment before the interactive success is achieved for the segment. The recovering consists in re-opening either a finished or an abandoned segment (successfully ended or not). It should be distinguished when the development of a segment is deferred from when it is abandoned yet later recovered.

Developments: the sequences used to progress the segment until its interactive success are labelled as development.

During the segment analysis can be detected minor segments. The relation between prior and minor segments will be named decompositional link. If the relation is hierarchical should distinguish requisite and optional decompositional link. The first relation shows the interactive success of minor segment is crucial for interactive success of prior one. However, the second one the interactive success of minor segment has influence on interactive success of prior one, but its occurrence and interactive success (yet desirable) are not necessary to achieve it. Since each entire dialogue (from the corpus) is a segment itself, the process goes on recursively until no minor segments are identified. If the relation is at the same level of decomposition, the sequential and serial relations are distinguished.

4.2 Intention labelling

From the intentional scope, each discovered segment is to be cooperatively developed by both participants that share (mutual) knowledge and information on it. Hence, first thing to do is to choose a significant label for the mutual goal related to each segment with some features such as the formalization of its sequences (for example, by means of grammars or automata), the identification of the participant role which initiate the instance of the intention, the relationships with other already identified intentions (if any), and the links with individual goals. Individual goals represent feasible interests for both participants of the interaction within the interaction domain. Each segment represents the development of the instance of a

mutual goal (an intention) thus, there exists certain links between an intention and some individual goals for both participants, and such goals and links should also be annotated. A contextual space is going to be defined as the set of pieces of static information characterizing the instance of an intention. Therefore, each intention instance has a contextual space and has visibility over prior intention instances' spaces. However, the intention instance has not access to minor intention instances' contextual spaces, so the parts of them observed as useful for prior intention instance should be labelled as contributions (relevant context pieces to be inherited by prior instance).

4.3 Attentional study

Once the dialogues are segmented and the intentions properly identified, it is possible to find out which intention is developed anytime within each dialogue. Since any intention needs to receive the attention from both participants in the interaction for being developed, at that particular point the developed intention will receive the attention and thus will be named focused intention (or focus, yet this term is usually applied to refer more complex information, regarding every focused intention across the dialogue). Often appear several overlapped segments, with decompositional links between them, which are developed simultaneously. For such cases, the minor segment determines the focused intention (while the hierarchical ordered intentions define the focus).

The attentional study of a dialogue involves annotating every change of focus, classifying it, and describing the observed causes (if any). Feasible types of attentional change are the next:

Initiation: when initiating a new intention instance, it always gains the focus.

Termination: after successfully ending of an intention instance, prior one should gain the focus.

Cancellation: when aborting the development of an intention instance, prior one usually gains the focus. However, cancellations might occur over non focused intentions, and could involve several of them (the cancelled and all its descendents). Because of this, it is necessary to identify both the cancelled intention and the new focus.

Disclosing: when retaking the developing of an abandoned intention instance (which has a

decompositional link with previously focused one).

Skip: any other attentional change should be labelled as 'focus skip'. There should be annotated carefully the origin (previously focused intention), the final focused intention (new one), and all the intermediate steps.

4.4 Commitment Evolution

During the interaction, there might go on certain events altering the confidence on some part of the common ground (mutual knowledge), positively or negatively. When that confidence weakens, human interlocutors use to apply some technique ensuring the beliefs correctness (hence reinforcing confidence) and pointing out deviations (in case). Eventually, they might change the dialogue strategy (game) or even cancel the common ground element.

Main elements to be found in the common ground are the intention instances (and their features: aim, instanced development strategy, contextual space, etc.). For these elements initiation and development, commitment between both participants is required. Such commitments have three aspects, which should be analysed separately:

Mutual Knowledge: both participants should (a) possess enough information on the intention instance to develop it successfully to an end; (b) know their interlocutor meets (a); (c) know their interlocutor meets (b); and so on. Interactive events affecting this aspect include reaffirmations (either positive or negative), (contextual) incompatibilities, interruptions, etc. The reinforcement techniques applied comprise to introduce redundancies, explanations, announcements, direct requests (for reaffirmation), etc.

Interest: both participants should have individual interest in the element (by linking it to an individual goal), and have confidence on their interlocutor interest to develop it till an end. Affecting this aspect could be found changes of focus, interruptions, delays, etc. Its feasible reinforcement techniques should help the interlocutor to link the mutual goal to some of his/her individual goals. Thus, there could be applied explanations (for revealing the link), negotiations, etc.

Attention: both participants should simultaneously focus the same element for its development. In fact, the focus is part of the mutual knowledge, but it should be studied apart because it has its own reinforcement

techniques (enumerations, explanations, etc.) and because when focus confusion is found it also could be due to interest loss. Events altering the attention aspect were described through the attentional study, and techniques applied should be identified as the way any participant helps to fix the focus when a change occurs, or later if any focus confusion is detected.

Through this analysis step, the events altering commitment on some part of the common ground are going to be identified and labelled (as commitment variations, either positive or negative), and so are the reinforcement techniques applied (as commitment threshold for such procedure and later commitment variation). All the dialogues, rewritten in such terms, will be at last subject to a global analysis (through a learning algorithm) for obtaining a measure of each sort of variation and the boundaries of the threshold for the application of each technique. For gaining naturality in later processing of both events and techniques, it is crucial to find when two identified events (or techniques) are the same one.

4.5 Operative Knowledge

The term task is to be used to refer any perlocutive effect of the interaction state on any participant or the interaction itself. With regard to interaction, internal tasks are the effects on interaction based on some condition or process over interactive knowledge and/or interaction state. In contrast, external tasks involve some prompt into any application or external agent which outcome could again have some effects on interaction.

The effects a task performance could entail are always performed on an intention instance (usually the currently focused one, but not necessary), and include: changes in the intentional state (initiation, disclosing, or cancellation), in the attention (cloaking of instance and skipping into another one), in the commitment (variations on any of its aspects), and, progress in the development (changes in its state of development), context alteration (new context assertion, or context retraction).

When some of these effects are found in the corpus, it should be searched for the task that gave rise to it. If the task has nothing to do with knowledge or performance external to interaction itself, the task will be labelled as internal and then analysed. Internal tasks are

represented by a check (condition) on interactive state and/or knowledge, and the consequences (effects) of its feasible results. The terms of that check could be based on:

Context: certain values for a given context piece within currently focused intention instance (eventually, checks could be applied to context spaces of intention instances prior to currently focused, by inheritance processes).

Currently focused intention instance: checks on its links to individual goals, current value of its commitment aspects, its development progress state, and/or other features (initiator, age, etc).

Intention instances structure: checks on other already instantiated intentions, their state (terminated, cloaked, cancelled), relationships, and/or features.

Attention: checks on focus structure and/or history.

Constant tasks are a particular case of internal task which is that performed obligatorily with no concern to any check result. External tasks require a deep analysis because of their variability. Apart from their identification and sorting, it should be annotated their input and consequences, which will be effects based upon checks on their outputs. For such complete annotation, the understanding of (non interactive) capabilities is often required. Therefore, external task annotation should include: a) the description of the task (or the application or agent if known); b) the enumeration of its inputs, with their name or alias, link to pieces of contextual information, and full description (or parameter label in the application if known); c) the enumeration of its outputs, with their name or alias, and full description (or parameter label in the application if known); and d) the description of its consequences, as a set of rules with an antecedent (expression based on outputs, inputs, and the same information used for internal tasks) and an effect (already described as common for any task). The rules of the consequences could have an execution order or not (in case).

5 Global Dialog Analysis Phase

When finished every individual dialogue analysis, there should be performed a set of actions to ensure normalization and completeness of corpus. By doing this, arise the risk of disregarding trace information, as long as each piece of the implemented corpus is not

going to refer a single dialogue. On the other hand, utter refinement or corpus reusing might require reviewing the original sources. Therefore, this global analysis and the final normalization methodology and formalization should observe ways to keep any modelled knowledge properly linked to the pieces of corpus that gave rise to it. Following subsections will describe just the need of information processing to achieve the global analysis, thus end this process.

5.1 Operative global annotation

It is essential to have at least one scenario for each feasible external task the system should perform during interactions. Naturally, external tasks absents through the corpus annotations won't be accessible through the interaction. For such verification, the operative matrix will be drawn up. The operative matrix relates each feasible task (columns) with each scenario (rows), placing a tic (or '1') at any cross where the scenario development involves performing such external task. Apart from traceability benefits, this matrix eases the checking of the corpus operative coverage: it is only necessary to find that every column has (at least) a tic. If not, reviewing the description of the Interaction Domain is required, for adding as many scenarios as required for completing it.

So it is recommended to perform a previous task analysis, in which every different external task is identified and documented (inputs/outputs, description, call, etc.). By drawing operative matrix, lack of corpus could be detected (and, in case, new scenarios should be defined, new corpus acquired, and each dialogue individually analyzed). Finally, a task unification process should be performed.

5.2 Intentions global annotation

The individual annotation should have revealed several intentions instances (at least one per dialogue). Through the individual analysis phase, they have been already generalized and formalized into abstract intentional entities by means of an intentional dialogue model. The resulting set of intentions should be examined to find equivalences between them. Finally, their sequences descriptions, if multiple for the same intention, should be analysed and simplified when is possible (development sequences, for example, often have common parts). Besides, extra description could be sometimes required (if several opening sequences are found with the same premises but

different initiation state, circumstantial criteria for differentiating them will be needed or random selection should be applied).

5.3 Commitment Learning

The commitment values, as fore defined, are measures of the health of an intention instance (belonging, for example, to the domain of real numbers between 0 and 1). This proposal observes three aspects for the commitment (mutual knowledge, interest, and focus) that will regard three independent variables through the processing of an intention instance. These variables are affected by commitment events (either positive or negative) increasing or decreasing (respectively) its value during the progress of the instance, always observing the defined boundaries. Depending in the modeling, variations could be considered as a constant value or a percentage based on current commitment value: a percentage of current to be deducted when negative, or a percentage on the difference between absolute (1) and current values to be added when positive. For guaranteeing successful progressing of an instance, a minimum value is required for each of these values. Because of this, some reinforcement techniques are eventually applied by human participants to restore these values up to those minimums. Hence, each reinforcement technique presents a threshold for the commitment values (when it should be applied) and an effect (positive variation of the commitment values). In a general way, initial values for each commitment aspect of an intention instance will be set to the maximum value (1), except for interest aspect that inherits its value from prior intention instance. However, there could be differentiated several ways to initiate and instance that present different initial values. When this applies, it will be modeled as an event associated to the initiation of an instance of the intention, which will apply the proper negative effect.

Before get going with the commitment learning, equivalence checks should be performed with commitment events and reinforcement techniques. These late ones are often developed as an independent intention, so equivalence between techniques is a check of intention identification. The commitment event equivalence is a little more difficult to define, because such event definition is also very open. Anyway, it is recommended to summarize both (events and techniques) in a table, and check

their description for finding similarities. If there are misplaced duplicates, apart from the drawback of their redundant definition, each of them will be less precise than their joint definition. Once each event and technique is described, every dialogue in the corpus containing any of them will be considered for running the learning algorithm. These dialogues will feed a process of ‘progressive refinement’ through which both variations and thresholds will be improved (from a general definition to a more precise one, by successive boundaries based on the occurrences of each element in the dialogues). When a cycle is completed (all the dialogues already fed), another cycle will be performed, and so on until a whole cycle does not vary the learned values.

6 Conclusion

This paper presents a methodological approach to pragmatic annotation¹ for corpus of task-oriented dialogues within a defined interaction domain. This approach departs from preprocessed dialogues (in form of literal communicative acts) and analyses them, first separately and then as a whole. The information seek involves structure of dialogues, intentions and their features as common ground units, attention changes, reference solving, and task invocation. Yet it is aimed to be suited to certain Dialogue Models (of the joint action type), in fact both the methodology and the coding scheme are general enough to be applied to many other models.

As future work, it could be interesting to integrate several analyzing tools not only for assistance in the annotation phase (providing an XML output), but also for automatically (or semi-automatically) implement the formalized corpus as content of a knowledge base, getting it ready for use anytime. It also would be of interest providing export/import functionalities for others XML (or SGML) based pragmatic annotations. With regard to the methodology, some other pragmatic knowledge could also be observed, yet current dialogue modeling does not make use of it its annotation could be advanced for getting the corpus ready for future reutilization.

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