A Personalized Assistant for Customer Complaints Management Systems

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Abstract

We build a personalized conflict resolution agent that applies reasoning about mental attributes to processing of scenarios of multiagent interactions. Our approach is deployed in the domain of complaint analysis: rather advanced user interface and machine learning are required to advise a customer on how to prepare a valid complaint and to assist in its formal structured representation. We demonstrate that exchanging information on mental actions of conflicting agents only without domain-specific knowledge is frequently sufficient to determine a complaint validity.

Introduction

Over last few years, automation has covered the majority of business activities. However, complaining and dispute resolution still remain one of the least computer-supported area. In this paper we describe the decision-support infrastructure for filing and handling complaints. We believe in a decade online complaining will be as common as online travel reservation today.

In addition to changing people's perception of online complaint infrastructure, the main barrier to achieve it is a rather innovation-demanding technology. Understanding of complaints is one of hardest problem for text understanding and especially reasoning. Deep understanding of attitudes of complainant and her opponents, as well as simulation of their behavior in uncertain conditions needs to be implemented.

In this paper we describe our implementation of a Personalized Complaint Assistant (PCA) as a client-side component of the overall complaint management system *ComplaintEngine* (Galitsky n.d., Fig.1). At the front end, there is an interactive complaint form which allows obtaining a formal representation of a complaint without natural language processing. At the back end, PCA includes the hybrid reasoning system that estimates a consistency and soundness of a complaint and advises a complainant on how to improve the structured representation of a conflict (Fig. 1).

In the last two decades, the interest to formal modeling of various forms of human reasoning and mental behavior for embedding in a personalized agents has strongly risen. A series of phenomena in human reasoning have been reflected in such approaches as game theory, reasoning about action and knowledge, nonmonotonic reasoning; these approaches have found applications in autonomous control, economy, finance and legal domains. However, to create a usable persistent PCA that is capable of processing (understanding) the scenarios of multiagent interaction, the next level of reasoning about mental attitudes including emotions has to be achieved (Parameswaran 2001).

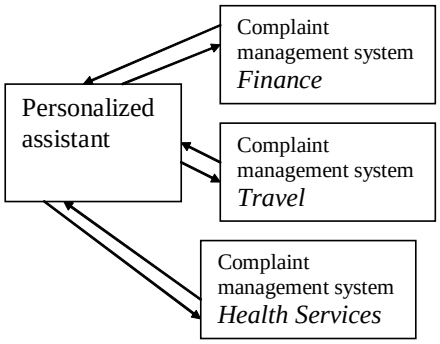

Fig. 1 The personalized assistant as a client for complaint management systems in a number of industry sectors. The personalized assistant helps to prepare a structured complaint and submits it for analysis by an opponent or independent body.

To understand the scenarios of multiagent conflicts, an extensive set of mental entities needs to be formally treated such as *satisfaction, trust, ignorance, deception, promise*. Therefore, the set of basic mental entities of *knowledge and belief, desire and intention* should be extended to adequately represent conflict scenarios (Rao and Georgeff 1991). We need to proceed beyond the boundaries of BDI formalism to reason about a wider set of mental entities including emotions.

We aim at obtaining an accurate description of agents' problems, intentions, emotional states and opinions to

judge on complaints' validity. To adequately reason about agents' actions in our domains, it is necessary to differentiate mental and physical actions and resultant mental and physical states. It is quite important for the models of multiagent conflicts that there is a mutual dependence between emotional states and mental actions of agents. In our previous studies we have witnessed a dramatic difference in knowledge representation for the domains of mental and non-mental nature (Galitsky 2003).

In our earlier studies (Galitsky and Tumarkina 2003, Galitsky 2005) we have explored a series of logical means to process customer complaints assuming the ideal natural language information extraction. In these studies we have planned textual complaints to be read and processed by the customer support personnel; the features have been extracted manually and submitted for automatic processing (advice generation). An alternative method of the partial feature extraction from text for submission to the reasoning units has been considered as well.

Designing the user interface to input mental entities

Analyzing the experience of previously designed systems for understanding multiagent interaction one can easily come to conclusion the natural language processing unit limits the performance, because the vocabulary the complainants express their problems is rather extensive and their emotional writing is rather hard to understand (even for humans). To develop a feasible complaint processing system, we decided to eliminate the natural language component, even though the mental attitudes and emotional states are tightly linked with natural language and are usually explored within its framework. Instead of natural language processing, we suggest Interactive Forms that are specially designed to accept mental entities. Such forms are intended as a means to input the multiagent conflict (a typical complaint is a description of interaction between a customer and a company).

In this study we suggest that world knowledge (which is the background for customers' complaints) is divided into the domain- or problem-dependent component and the mental component, which is common for an arbitrary domain of multiagent conflict. The latter is worth investing formalization and commonsense reasoning efforts because it is compact and can be reused from domain to domain. Our model of mental component includes the basic mental entities of knowledge and intention and the machinery to define arbitrary mental state and action up to emotion in such a basis. A complaint is represented as a graph with vertices for mental actions and arcs for temporal sequence and other relationships between them (Fig. 2).

Usually, complaints are filed via the free plain text. Writing a letter, a customer may become very emotional and passionate and base his letter on feelings rather than on logic. It brings in disadvantages both on the customer and company side, because it is harder for a company to evaluate the complaint validity, whereas the customer may lack the solid arguments to bring her point across. Therefore, in spite of being opponents, both customer and company would frequently benefit from more logical and structured complaint that uses conventional argumentation means. How to help a customer to built a more valid complaint?

Interactive Complaint Form of the PCA is a user interface that assists a customer in filing a sound complaint, providing the immediate feedback concerning the status of this complaint (justified or unjustified). At the same time, a complaint submitted via form is ready for (usually) unambiguous processing and quick response from the proponent (company).

Note that a non-mental component significantly varies from domain to domain. At the same time the mental component describes mental attitudes and actions of multiagent scenario participants and can be reused from one complaint domain to another. To help a customer to express the mental component of his complaint more precisely, we use the form with the list of pre-selected mental states and actions to select from (Fig. 3).

*I **asked** why the service was not as advertised*
*They **explained** that I did not understand the advertised features properly*
*I **disagreed** and **confirmed** the particular failures in a service contract*
*They **agreed** with my points and **suggested** compensation*
*I **accepted** it and **requested** to send it to my home address together with explanations on how it happened.*
*They **promised** to send it to me.*
*In a month time I **reminded** them to mail it to me*
*After two months I **asked** what happened with my compensation…*

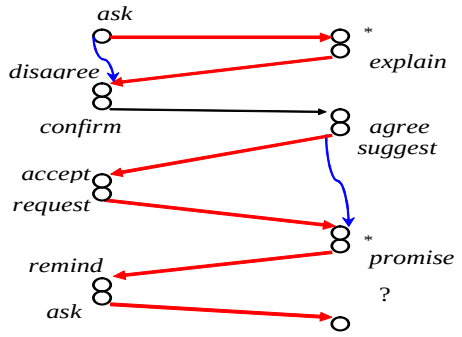

Fig. 2: A sample scenario and its graph representation.

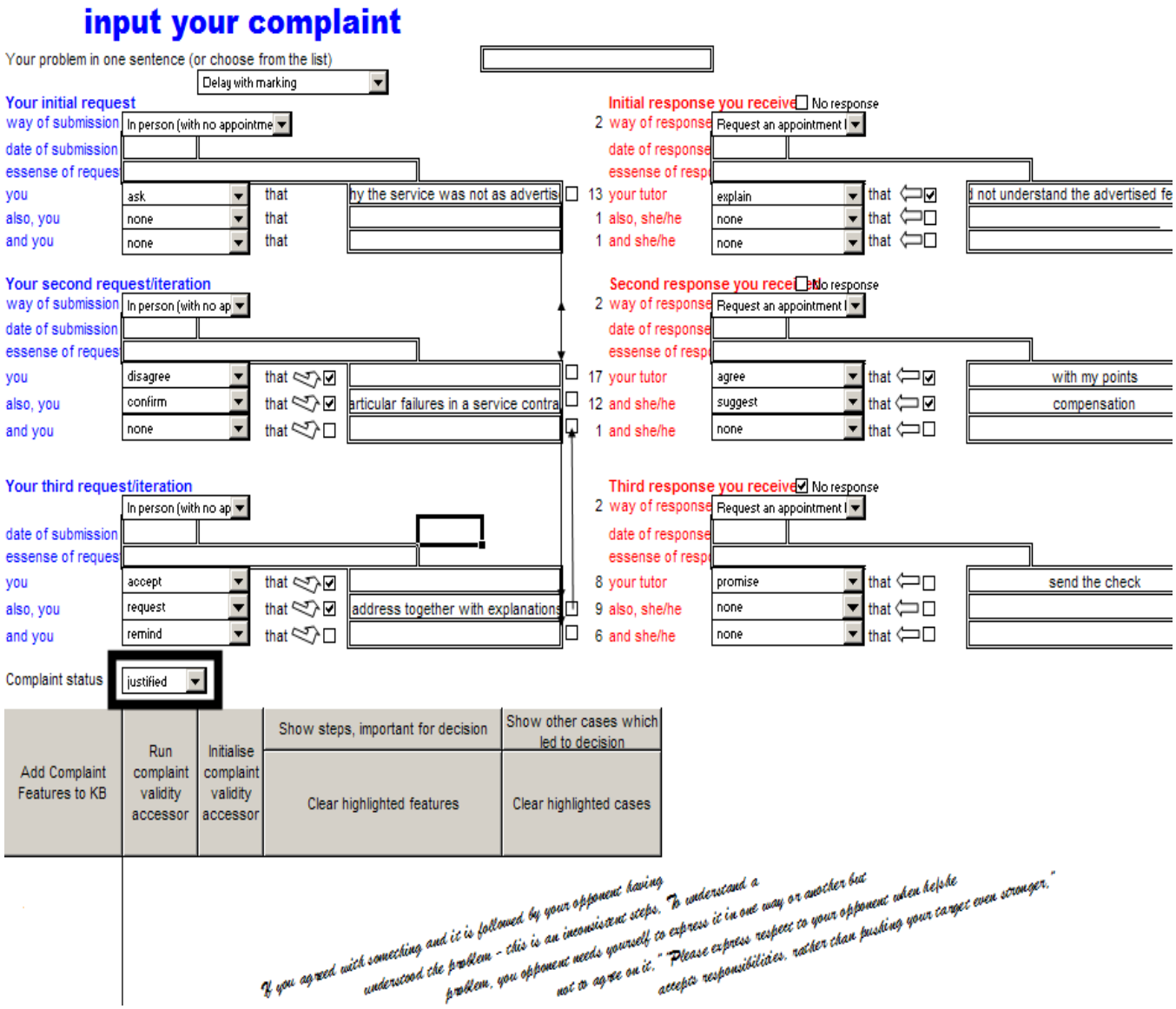

Fig.3: User interface of PCA: the interactive form for filing the students' complaints. On the left, the complainant plots her attempts to resolve the conflict, and on the right side her opponent's responses are specified. The soundness (status) of complaint is determined, using analysis of agents' mental states and experience with previous complaints: the system obtains the complaint status (drop-down box with bold frame on the left, here: *justified*). The advice on how to improve the complaint presentation is generated by PCA on the right-bottom

Component	Complainant	Opponent
Mental	*Agree, disagree, explain, confirm, bring to attention, remind*	*Agree, disagree, explain, confirm, bring to attention, remind, accept complaint, accept responsibilities, deny responsibilities, understand / do not understand problem*
	fairly treated, surprised, upset, jealous, unfairly treated, frightened, confident	
Non-mental	*Unhappy with the mark, inconvenient course operation, inadequate marking scheme, lost submission, delay with marking*	*Late submission, session attendance, proper submission format, timely registering for a course, module substitution*

Table 1: Mental and non-mental components of complaints in education. There is a set of common emotions which are specified by plaintiff for herself and for a defendant.

Component name	Component role	Sample encoded knowledge for the unit
Classical clauses	To define entities, to specify links between them which always hold	*followAdviceNoResult :- ask(Cust, CS, what(Happen)), suggest(CS, Cust, satisfaction(Cust) :- howToFix(Happen)), do(Cust, howToFix(Happen)), not satisfaction(Cust).*
Defeasible rules	To specify when some entities may support serve as arguments for a given entity	*justified_complaint -< lieCS, consistent_discourse.* *~ justified_complaint-< consistent_discourse, ~ loss(Cust).*
Default rules	To specify when an entity (prerequisite) always serves as the condition for the given entity of interest(consequent) if an additional assumption takes place (justification). If justification is not available (cannot be formulated, implicit), a default rule is interpreted as a respective defeasible one. Default rules may be conflicting, therefore implementation of operational semantics is required for PCA	$\frac{lieCS:\ mention\_biz\_rule}{justified\_complaint}$ $\frac{justified\_complaint:\ lieCS}{cust\_compensation}$ $\frac{not\ requested(cust\_compensation):\ lieCS}{cust\_compensation}$
Reasoning about action: plan building rules so that PCA can advise on future actions	To specify what the future (physical) action of an agents will be, given the pre-conditions of possible actions and their effects, taking into account the current development (of interaction between agents). Our implementation of reasoning about action allows online acquisition of action pre-conditions (Galitsky 2005)	*poss(do(Cust, fixProd(WayToFix)) :- suggest(CS, Cust, Satisfaction :- howToFix(Happen)), lost_trust(Cust, CS).* *holds(disinformed, do(E, S)):- E = explainWronglyCS.*
Behavior simulation: reasoning about mental states and actions NL_MAMS	To provide a simulation environment for agents' choice of future mental actions, given the current mental state of interacting agents. The unit includes the library of behaviors available for agents. It yields the consecutive mental states given the initial one, simulating the decision-making process of agents, http://www.dcs.bbk.ac.uk/~galitsky/Nl_mams/	*forgive(Cust, CS, WrongAdvice):-* *advice(CS, Cust, WrongAdvice),* *believe(Cust, know(CS,* *not (howToFix(Happen):- WrongAdvice)))),* *explain(CS, Cust, believe(CS,* *(howToFix(Happen):- WrongAdvice)))),* *trust(Cust, CS).*
Machine learning: matching the cases *Jasmine*	To predict the future interaction of involved agents and to determine their parameters given the previously accumulated cases. matching a current formalized complaint with the dataset of complaints with assigned status.	*askt(Cust, P1). explain(CS, P1). disagree(Cust,P1). confirm(Cust, P1), agree(CS,P2), suggest(CS, P2), accept(Cust, P2), request(Cust, P2), promise(CS, P2), remind(Cust, P2), ask(Cust, P2).* Note too subjects: *P1* and *P2*.

Table 2 Reasoning units of PCA

A hybrid reasoning system of PCA

To reason about the mental attitudes of agents which are involved in a multiagent conflict, PCA uses a hybrid system that includes a number of following logic programming units (Table 2).

The sixth unit above has a major role in PCA's assessment of the complaint validity because it is frequently hard to fully formalize the validity criteria. Instead, comparative analysis on a feature-by-feature bases was found to be efficient. Among the Inductive Logic Programming series of approaches, we select JSM which is explanation-focused machine learning framework.

JSM approach was inspired by the plausible similarity-based reasoning of the philosopher J.S. Mill who has suggested a set of five canons by means of which to analyze and interpret our observations for the purpose of drawing conclusions about the causal relationships they exhibit. Over the last few decades JSM approach has been developed as a practical reasoning system by Finn and his associates (Finn 1999). In this study we use the JSM system as a logic program, called Jasmine http://www.dcs.bbk.ac.uk/~galitsky/JaSMine/, following the formal frameworks of (Anshakov et al 1989 and Vinogradov 1999).

The Jasmine environment consists of objects (scenarios), their features (particular mental actions and emotional states), and targets (resultant features we intend to predict, i.e. complaint justification status). In our language, scenarios are terms that include expressions for mental states and actions. We use metapredicates *mental(Agent, DoWhat)* that range over agents as well as over domain-specific and mental expressions *DoWhat.*

For a target (complaint status) there are four groups of scenarios with respect to the evidence that they lead to this target: *Positive – Negative – Inconsistent –*

Unknown (Fig. 3). An inference to obtain a target feature (satisfied or not) can be represented as one in a respective four-valued logic (Finn 1999). The predictive machinery is based on building the set of hypotheses,

$status(S)$:- $mental1_S(agent1, P1)$,

$mental2_S(agent2, P2), mental3_S(agent1, P3), \ldots$

which separate the scenarios with positive (justified) and negative (unjustified) target (complaint status).

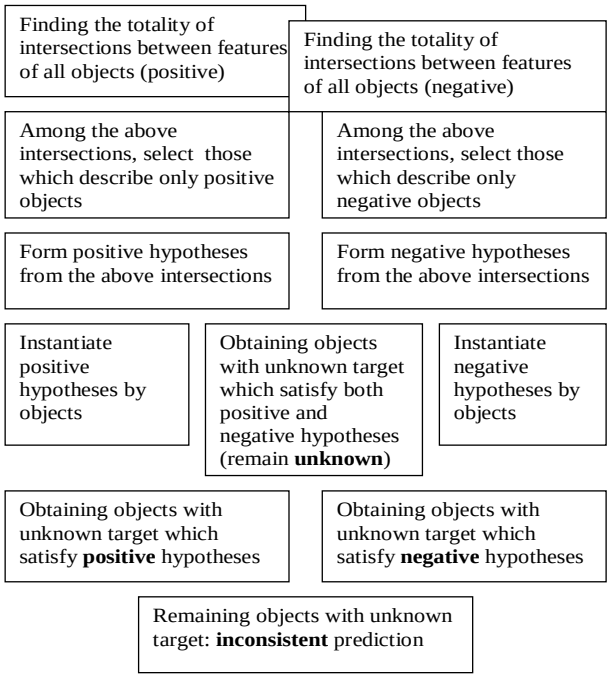

Fig.3 The reasoning schema of Jasmine. The output includes the items in bold.

Using Complaint Assistant

A similar Interactive Form is used for a complainant to file a complaint, and for a company to store complaints, analyze them, determine validity, explain how the decision has been made, and finally advise on a strategy for their resolution (see the demo at (Galitsky n.d.)).

A complainant has a choice to use the interactive form (Fig.2) or to input complaint as a text so that the linguistic processor processes the complaint automatically and fills this form for her. Mental actions are selected from the list of twenty or more, depending on the industry sector of a complaint. The parameters of mental actions are specified as text in the Interactive Form (Fig.3). Mental actions selected by a user in the list boxes constitute the vertices of the graph (Fig.2). Check boxes on the right of the list boxes are used to specify whether the incoming edge is thick (checked) or thin (unchecked). Check boxes linked with the vertical line are used to specify the causal links (between the arguments of mental actions).

Use of the Interactive Form encourages the complainant to enforce a logical structure on a complaint, provide a sound argumentation. After complaint is partially or fully specified, the user evaluates its consistency. PCA indicates whether the current complaint (its mental component) is consistent or not; also, it may issue a warnings and advices concerning the improvement of the logical structure of this complaint.

When the complainant is satisfied with the PCA response, she submits the completed form. The other option is if a user observes that it is not possible to file a reasonable complaint, it may be dismissed at this early stage by the author.

When submitted complaint is processed by a customer service representative, a wider set of tools is applied (Fig. 1). Having estimated the validity of the current complaint, PCA provides a set of similar cases, and indicates particular mental actions of the complainant or his opponent (from the standpoint of this complainant) which have led to a particular decision.

Evaluating the PCA

If, having used the PCA, a complainant obtains the status *unjustified*, then he would be inclined to modify the complaint to make it more convincing (and also to save time and passion of a customer service rep who would otherwise deny an unjustified complaint). To back up their argumentation and to turn a complaint into more sound one, a user would prefer to use the PCA's form to check whether the status is *justified*. We conduct the evaluation of PCA in the educational domain.

The presented system is currently used in three undergraduate courses on computing.

The PCA is used by students for providing a feedback (in particular, complaining) concerning the course. Usually, student complaints describe interaction with the tutor concerning course operation or inadequate marking. Before the deployment, we introduced the initial dataset of 75 "artificial" complaints and assigned "justified" status to 47 of them. It has been verified that the initial dataset did not contain inconsistencies: if for a representative complaint its status is set as "unknown", prediction either delivers the correct or keeps the "unknown" status, but not a wrong one. Then, after the course have been taught, 34 students used the form explicitly instead of filing textual complaints, and for other 27 complaints we manually represented their written complaint scenarios via the form and used it as an additional ("experimental") part of the training dataset. Most of these complaints raised the issues of inadequate marking and contain the description of dispute resolution scenarios which involve the students and the tutor and other faculty members as their opponents. 52 out of 61 complaint were assigned the correct status (the same that was assigned by another course tutor who served as an expert).

Beyond the educational domain, we have started deployment of the PCA in medical and financial domains,

and also for solving inter-corporate disputes. Sometimes, before a conflict, potential users believe that the PCA form is too complex to learn, complete and submit. However, when the users feel that using the PCA they can avoid stressful and time consuming traditional resolution procedure, they prefer the computer-assisted way. The users are aware that the PCA performs a decision-support rather then decision-making and therefore the PCA does not compromise their trust: there users are still having the final say.

Conclusions

In this study we describe the reasoning machinery and functionality of the Personalized Complaint Assistant, a automated decision-support agent which helps with quite a peculiar task: complaining with sound argumentation. We have evaluated the process of how users delegate decisions to the PCA whose behavior will materially affect their interests. In spite of the conflict between a complainant and a customer service representative, a close partnership between each of them and the PCA is required to process complaints efficiently and adequately. Using the PCA instead of conventional means for complaints accelerates submitting a complaint, aids in complaint resolution procedure and makes it smoother. We currently explore the possibilities of PCA to serve as an important means for Alternative Dispute Resolution.

One of the important issues for deployment is developing trust between the user (complainant) and his PCA. Initially it impresses the complainant as an "enemy agent" provided by opponents. When this initial concern has been overcome, the customer verifies that the PCA indeed makes his claims stronger and improves the communication channel with a company.

We now proceed to our conclusions about the implementation issues. Adjusting the PCA to a number of domains, we observed the following concerning its reasoning components:

- Merging deductive and inductive (machine learning) components gives us a powerful reasoning system to function under conditions of high uncertainty.
- Interactive Forms allow the replacement of natural language processing that could be a bottleneck for Complaint Assistant.
- Division of knowledge into mental and domain-specific components is an efficient means to represent multiagent conflict scenarios and to perform machine learning with them.

Analyzing the performance of our reasoning units outlined above (three out of six), we came to the following conclusions:

1) NL_MAMS 's contribution to filtering out the implausible scenarios was least significant.
2) Reasoning about action unit filtered out the implausible scenarios; less then 20 percent of *unjustified* complaints were assigned by this unit taking into account axioms and not matching with the cases of our training dataset.
3) Machine learning unit's contribution was the highest.

There is a large and growing body of research in the automation of customer response in general, including personalization, question answering, automatic advising, preference analysis and other technologies. However, the studies on complaint management have just recently started to outline the idea of online complaint management (Cho et al 2002). To the best of our knowledge, no deployment of such system has occurred so far.

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