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# Working Towards a BDI Agent Based on Personality Traits to Improve Normative Conflicts Solution

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# Working Towards a BDI Agent Based on Personality Traits to Improve Normative Conflicts Solution*

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**Abstract.** Norms exist to avoid and solve conflicts, make agreements, reduce complexity, and in general to achieve a desirable social order. However, norms eventually can be conflicting — for example, when there is a norm that prohibits an agent to perform a particular action and another norm that obligates the same agent to perform the same action in the same period of time. The agent's decision about which norms to fulfill can be defined based on rewards, punishments and agent goals. Sometimes, this balance will not be enough to allow the agent to make the best decision. In this context, this paper introduces an approach that considers the agent's personality traits in order to improve the process for resolving normative conflicts.

**Keywords**: Solving Normative Conflicts, Normative Agents, Multi-Agent Systems.

**Resumo**. Normas existem para evitar e resolver conflitos para alcançar uma ordem social desejável. Entretanto, eventualmente algumas normas podem entrar em conflito - por exemplo, quando existe uma norma que proíbe um agente de realizar uma ação em particular e outra norma que obriga o mesmo agente a realizar a mesma ação no mesmo intervalo de tempo. A decisão do agente sobre quais normas serão cumpridas pode ser definida com base nas recompensas, punições e objetivos do agente. Porém, a avaliação desses atributos poderá não ser o suficiente para permitir que o agente efetue a melhor tomada de decisão. Nesse contexto, essa monografia introduz uma abordagem que considera traços de personalidade do agente para aprimorar o processo de resolução de conflitos normativos.

**Palavras-chave**: Resolução de Conflitos Normativos, Agentes Normativos, Sistemas Multiagentes.

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# 1 Introduction

Multi agent Systems (MASs) are societies in which these heterogeneous and individually designed entities (agents) work to accomplish common or independent goals (VIANA, ALENCAR and LUCENA, 2016). In order to deal with autonomy and diversity of interests among the different members, such systems provide a set of norms that are mechanisms to restrict the behavior of agents by defining what agent actions are obligated (agents must accomplish a specific outcome), permitted (agents can act in a particular way) or prohibited (agents must not act in a specific way) to encourage the fulfillment of the norm through rewards definition and discouragement of norm violation by designating the punishments (FIGUEIREDO, SILVA and BRAGA, 2010).

Norms must be complied with by a set of agents and include normative goals that must be satisfied by the addressees. In addition, norms are not always applicable, and their activation depends on the background in which agents are situated. In some cases, norms suggest the existence of a set of sanctions to be imposed when agents fulfill, or violate, the normative goal.

The decision making process regarding which norms will be fulfilled or violated might be defined based on the agent's goals, rewards and punishment analysis (VIANA, ALENCAR and LUCENA, 2016). Since an agent's priority is the satisfaction of its own goals, before complying with norms, the agent must evaluate their positive and negative effects on its goals (LÓPEZ and MÁRQUEZ, 2004) without impacting the agent's autonomy. Both rewards and punishment are the means for the agents to understand what might happen independently of the agent's decision to comply, or not, with the norms. However, norms sometimes may conflict or be inconsistent with one another (VASCONCELOS, KOLLINGBAUM and NORMAN, 2007). For instance, different norms can, at the same time, prohibit and obligate a state that the agent wants to fulfill and the simple balance between goals, rewards and punishment might not be enough for the agent to make the best decision.

The abstract normative agent architecture developed by (LÓPEZ and MÁRQUEZ, 2004), has four main steps: (i) agent perception, i.e., when the agent's beliefs are updated; (ii) norm adoption, i.e., when agents verify which norms are addressed to them; (iii) norm deliberation, i.e., when agents verify which norms they intend to fulfill, or reject, and (iv) norm compliance, i.e., when agents verify which norms they will comply with. Within the norm deliberation step, conflicting norms are verified and a set of these norms is added to the norm compliance set.

We changed the internal process of the norm deliberation step to deal with conflicting norms by adding the agent's personality traits. These characteristics will help the software agents make a better decision involving personality traits — for example, sense of duty and spiritual endeavor. We will present a user scenario that shows how the agents deal with normative conflicts when personality traits are considered. This will illustrate the new deliberation process proposed in this paper.

In this context, we present an approach to build emotional BDI agents, which also considers other agents' personality traits (BARBOSA, SILVA, FURTADO and CASANOVA, 2007) and emotions (PADGHAM and TAYLOR, 1996) to improve the decision-making process in the solution of normative conflicts. This approach aims at providing new resources for the agent to deal with conflicting norms supported by personality traits. As such, more human characteristics can be considered to improve the deliberation process. We built a software framework based on this approach, which provides a set of hot-spots and frozen-spots that enables the implementation of emotional normative functions. By using these new functions, it is possible to build emotional agents that: (i) use personality traits to improve the solution among normative conflicts, (ii) implement the agent's behavior similar to a human's behavior, and (iii) evaluate the effects on its desires with respect to the fulfillment or violation of a norm.

The reminder of this paper is organized as follows: Section II focuses on the background, while Section III discusses related work. Section IV presents the emotional BDI approach to solve normative conflicts. Section V describes a case study applying the emotional approach. Finally, Section VI presents our conclusions and future work.

# 2 Background

## 2.1 Norms

Norms are designed to regulate the agent's behavior, and therefore, a norm definition should include the address of the agent being regulated (BORDINI, HÜBNER and WOOLDRIDGE, 2007). However, norms are different from laws, and they cannot force agents to comply with them. Agents are autonomous entities, so norms may only suggest and present the expected behavior.

In this work, we used the norm representation described in (VIANA et al., 2015), which is composed by the representation of the element *norm* – it contains many different properties. These properties are briefly described in Table I. For example, the property *Addressee* is used to specify the agents or roles responsible for fulfilling the norm.

| **Property** | **Description** |
|---|---|
| Addressee | It is the agent or role responsible for fulfilling the norm. |
| Activation | It is the activation condition for the norm to become active. |
| Expiration | It is the expiration condition for the norm to become inactive. |
| Rewards | It represents the set of rewards to be given to the agent to fulfill a norm. |
| Punishments | It is the set of the punishments to be given to the agent for violating a norm. |
| DeonticConcept | It indicates if the norm states an obligation, a permission or a prohibition. |
| State | It describes the set of states being regulated. |

**Table 1: Norm Description**

In order to better understand the definition of norms and their representation, imagine a user scenario where the employee agent has to decide the type of transportation to use to go home. The agent's goal is to increase physical conditioning and has the following options to go home: (i) by bicycle, which is a way to satisfy the agent's goal, and (ii) by bus, if it is raining; then, the agent cannot accomplish its goal at this time. In addition, each employee agent should decide according to specific norms. Eventually, a norm is sent to each employee agent with the following state: "go home by bus, it is raining." This norm has the following attributes: (i) addressees are employee agents; (ii) the required deontic concept is prohibition, because it prohibits the agent go to home by bicycle, and (iii) when an agent agrees to a norm, it will receive a reward. In this case, the reward may be to not come down with the flu. If the employee agent violates the norm, the agent will receive the punishment associated with the norm. For example, when it is raining and the employee agent wants to work out so badly that it will violate the norm by going home by bicycle, which will result in the decrease of the agent's health, because the agent will probably catch the flu. In this case, a punishment associated with the norm will be applied to the agent, i.e., the agent cannot work the next day because it is sick. Note that the norm is activated when it is raining. In turn, the norm expires when the weather is sunny.

## 2.2 Conflicting Norms

Norms eventually may conflict, i.e., an action may be simultaneously prohibited and permitted, or it may be inconsistent, i.e., when an action is simultaneously prohibited and obliged (VASCONCELOS, KOLLINGBAUM and NORMAN, 2007). These conflicts and inconsistencies may be caused by a norm that prohibits an agent to perform a particular action while another norm requires the same agent to perform the same action at the same time. The agent can realize any action in the environment until an active norm restricts its goals. For example, Fig. 1 presents a scenario of conflicting norms - when a norm defines that the buyer agent cannot give back the product bought and at the same time another norm defines that the buyer agent can return the product bought before opening it.

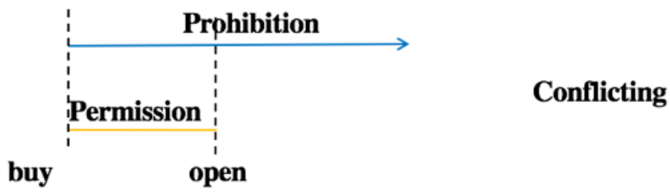


**Figure 1. Conflict - Prohibition and Permission.**

Fig. 2 presents another scenario of conflicting norms — the seller agent can only reprice the products before the store opens and another norm permits the seller agent to reprice them when the store is open and there is a sale.

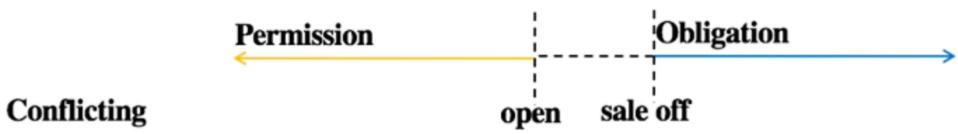


**Figure 2. Conflict - Permission and Obligation.**

In short, conflicts may occur in different cases and situations, and dealing with them is extremely necessary to make the best decision.

## 2.3 BDI Architecture

The BDI (*Belief Desire Intention*) model was proposed by (BRATMAN, 1987) as a philosophical theory of practical reasoning, representing, respectively, the agent's information, motivational and deliberative states. There are two main steps: (i) apply a filter to make a set of goals to which the agent must commit to base on his beliefs, and (ii) find a way to know how the desires produced can be fulfilled based on the available agent's resources (WOOLDRIDGE and CIANCARINI, 2001).

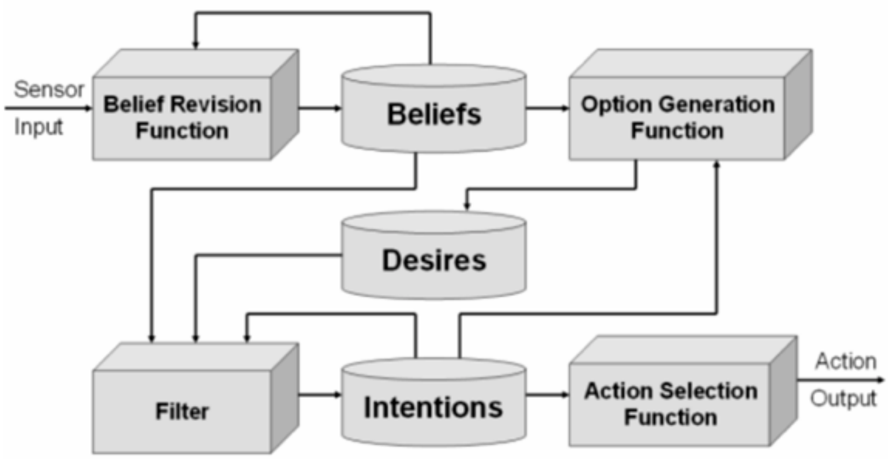


**Figure 3. Generic BDI architecture (WOOLDRIDGE, JENNINGS and KINNY, 1999).**

The BDI model is composed of three mental states: (i) beliefs, which represent the environment factors that are updated after each action perceived — these beliefs represent the world knowledge; (ii) desires, which have information about the goals to be fulfilled — they represent the agent's motivational state, and (iii) intentions, which represent the action plan chosen. Fig. 3 shows these three mental states centralized and their interaction.

BDI architecture starts with a *Belief Revision Function* that makes a new belief set based on the agent's perception. Next, the *Option Generation Function* sets the agent's available options and desires, based on its own environment beliefs and intentions. The next function is a *Filter* that sets the agent's intentions based on its own beliefs, desires and intentions. Finally, the *Action Selection Function* sets the actions to be executed based on the current intentions.

Most BDI systems are inspired by the Rao and Georgeff (RAO and GEORGEFF, 1995) model. The authors presented an abstract BDI interpreter. This interpreter works with beliefs, goals and agent plans. As such, the goals are a set of concrete desires that may be evaluated all together, avoiding a complex goal deliberation step. The interpreter's main activity is the means end process achieved by plan selection and plan execution given a goal or event.

## 3 Related Work

This section describes some related work: (i) the solution for normative conflicts (VIANA, ALENCAR and LUCENA, 2016), (LOPEZ,2003), (CRIADO, ARGENTE, NORIEGA and BOTTI, 2010), (NETO, SILVA and LUCENA, 2011); (ii) architecture designs considering the agent's emotional state (PEREIRA, OLIVEIRA, MOREIRA and SARMENTO, 2005), and (iii) the agent's personality (BARBOSA, SILVA, FURTADO and CASANOVA, 2007), (PADGHAM and TAYLOR, 1997).

Pereira et al. (PEREIRA, OLIVEIRA, MOREIRA and SARMENTO, 2005) proposed an architecture based on the BDI (*Belief-Desire-Intention*) model to support artificial emotions, including internal representations of the agent's capabilities and resources. This research introduces subjects, such as artificial emotions, agent means and BDI architecture. Furthermore, a common sense definition of new mental states, such as emotions, was developed and made them influence the BDI architecture through the common-sense understanding of the way they positively affect the reasoning performed by humans. The authors defined a new concept: *Fear*, an informational data structure that reports situations which an agent should avoid. This work presents the Emotional-BDI architecture as an extended version of the classic BDI. However, the authors do not implement a case study to validate the architecture and they do not provide support to solve normative conflicts.

The authors in (BARBOSA, SILVA, FURTADO and CASANOVA, 2007) built a decision process to work as part of the story-telling systems wherein narrative plots emerge from the acting characters behavior and personality traits. The process evaluates goals and plans to examine the plan commitment issue. The drives, attitudes and emotions play a major role in the process. However, the personality traits were not applied on MASs, which creates an opportunity to improve the agent's decision-making process to deal with normative conflicts.

Padgham and Taylor (PADGHAM and TAYLOR, 1997) present an architecture considering human behaviors analysis based on emotions. The authors show how emotions and personality traits interact with goal oriented behavior and describe some simplifications that were made in order to build an initial interactive environment for experimentation with animated agents simulating personality and emotions. According to the authors, emotions can affect behavior, directly or indirectly. An effect includes such things as re-prioritizing goals and adding and deleting goals. For example, an agent experiencing gratitude, might delete, or give low priority to, those goals that conflict with its grateful goals. In addition, this work presents personality as a notion of factors that may affect agents. For instance, a happy agent moves faster, and more bouncily, while a sad agent is slower and flatter in its movements. The authors also developed two scenarios. In both scenarios agents successfully displayed the features of different personalities, based on their emotional profiles. However, this work does not deal with norms and applies the emotions context only to the agent's goals. Part of our research was based on this work, which allowed us to add more human attributes, thus improving our conflicting norms resolution.

Some approaches (VIANA, ALENCAR and LUCENA, 2016), (LOPEZ,2003), (CRIADO, ARGENTE, NORIEGA and BOTTI, 2010), (NETO, SILVA and LUCENA, 2011) have been proposed in the literature to develop the agent that evaluates the effects of solving normative conflicts. For instance, the n-BDI architecture defined by Criado et al. (CRIADO, ARGENTE, NORIEGA and BOTTI, 2010) presents a model for building environments governed by norms. Basically, the architecture selects objectives to be performed based on the priority associated with each objective. An objective's priority is determined by the priority of the norms governing a specific objective. However, it is not clear in this approach how the properties of a norm can be evaluated. Furthermore, the approach does not support a strategy and does not consider the agent's personality traits to deal with conflicts between norms.

Lopes et al. (LOPEZ,2003) defined a set of strategies that can be adopted by agents to deal with norms as follows: *Pressured, Opportunistic* and *Selfish*. For example, the *Pressured* strategy happens when agents fulfill the norms to achieve their individual goals considering only the punishments that will harm them. Another is the *Opportunistic* strategy, in which agents consider only the effects of rewards on their individual goals, and seek to fulfill only the norms for which the rewards of the individual goals are more important than those of the social goals. Finally, the Selfish strategy is the combination of the *Pressured* and *Opportunistic* strategies. Although this work provides some mechanisms for the agents to collect norms, the authors provide a framework that can be extended to create simulations of normative multi agent systems by including new strategies. In addition, this work can neither extend mechanisms to collect information during the simulations nor mechanisms to generate norms and agent goals. Moreover, the agent cannot detect and overcome normative conflicts.

Santos Neto et al.(NETO, SILVA and LUCENA, 2011) propose the NBDI architecture, based on the Criado et al. (CRIADO, ARGENTE, NORIEGA and BOTTI, 2010) research, to develop goal-oriented normative agents whose priority is the accomplishment of their own desires while evaluating the pros and cons associated with the fulfillment or violation of the norms. To make this possible, the BDI architecture was extended by including norms related functions to check incoming perceptions, select norms based on the agent's desires and intentions. A detection conflict and a conflict solving algorithm were developed based on norms contributions; in the case of conflicts between norms, the one with the highest contribution to the achievement of the agent's desires and intentions can be selected. If the norm's contributions have equal values, then the first norm will be selected. Therefore, as can be seen, sometimes the norm contribution is not good enough to let the agent make a better decision. We identified this gap and improved the decision making process, adding the personality traits concepts.

Finally, Viana et al. (VIANA, ALENCAR and LUCENA, 2016) presents a modeling language and an architecture to build adaptive normative agents. The authors propose an approach to design and implement agents that are capable of adapting in order to deal with norms, detecting and overcoming normative conflicts. However, this research only measures norms contributions based on: (i) norm rewards and punishments; (ii) norm activation and expiration; (iii) deontic concept, and (iv) agent goals. As such, the agent can decide to fulfill or violate a norm. One item that was not broached by the authors is that they did not implement personality traits in their architecture to improve and overcome normative conflicts.

As none of this related work deals with norm conflicts using personality traits, this was the gap upon which we chose to base our work proposal. We aim at providing a better way to balance goals, rewards, punishment and personality traits to solve normative conflicts. To evaluate the norm contribution, we first use rewards and punishment values. Using these values, we then continue to evaluate the norm contribution, now adding personality traits.

## 4 Emotional BDI Agents: An Approach

This section describes the main concepts required to understand the approach based on emotional BDI agents used to improve the solution of normative conflicts. In addition, we provide a software framework overview and discuss its different components, including the frozen spots and hot spots (WOOLDRIDGE and JENNINGS, 1998).

### 4.1 The Architecture

The emotional BDI agents that can solve the normative conflicts approach were inspired on the concepts presented in the *background* and the related work section. We added both BDI features and personality traits in the normative deliberation process, mainly in relation to conflicts resolution. The architecture foundation was based on the abstract normative agent architecture developed in (LÓPEZ and MÁRQUEZ, 2004). Fig. 4 presents our emotional BDI agent architecture to solve normative conflicts.

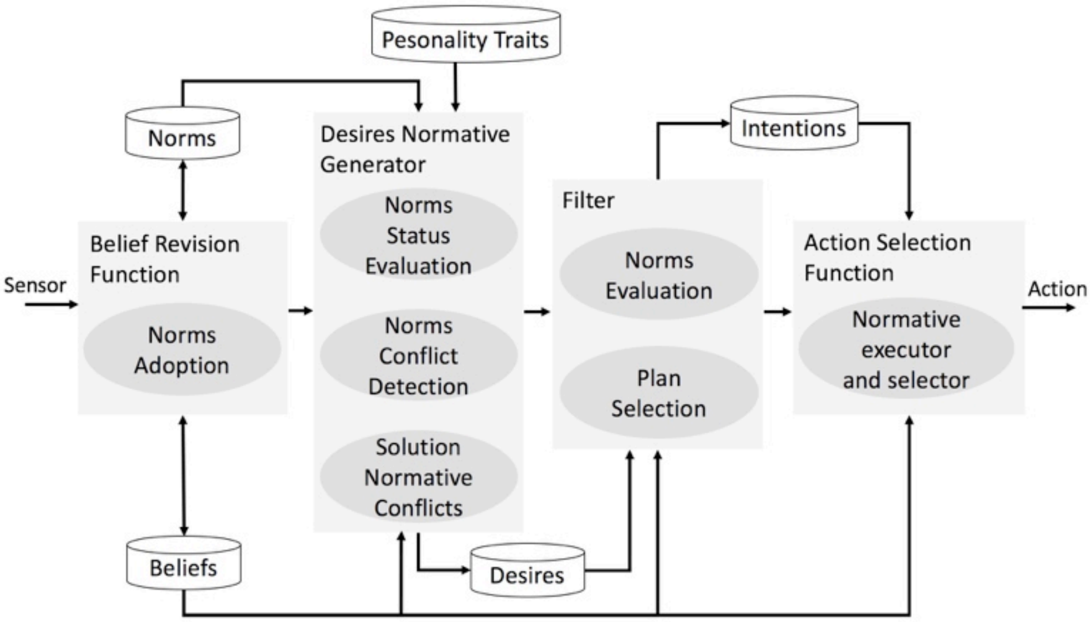


**Figure 4. Internal architecture of the BDI Agent based on Personality Traits to Improve Normative Conflicts Solution.**

The most significant change was adding a reasoning step that involves the BDI architecture and the personality traits approach to the deliberation process. Both strategies work in a complementary way to make the agents' behavior more human, considering factors that were not used in the norms deliberation process in previous works. All of these changes refer only to the internal agent process. The decision making process proposed contains four steps, as described below.

The first step involves the agent's perception in the *Belief Revision Function*, where the agent perceives the norms in the environment addressed to it by means of sensors. Then, the agent inserts into the *Norms* set the norms that it wants to fulfill by using the *Norms Adoption* function. After that, the agent updates its beliefs, taking into account these new norms.

The second step is the *Desire Normative Generator*, comprising three processes: (i) *Norm Status Evaluation* function, where the agent verifies which norms are activated or deactivated; (ii) *Norms Conflict Detection* function, where the agent verifies what the normative conflicts are, and (iii) *Solution Normative Conflicts* function, where the agent evaluates the norms contribution and solves the normative conflicts, also considering its personality traits. Table II shows the personality traits that we consider – drives, attitudes and emotions as in (BARBOSA, SILVA, FURTADO and CASANOVA, 2007). As a result, a set of non conflicting norms are exported to the next step. These norms are the agent's *Desires*.

| **Drives** | **Attitudes** | **Emotions** |
|---|---|---|
| Sense of duty | Careful | Anger |
| Material gain | Adaptable | Fear |
| Spiritual endeavor | Self-controlled | Surprise |

**Table 2: Personality Traits Example**

The third step is the *Normative Filter*, which is composed by two processes: (i) *Norms Evaluation* function, where the agent evaluates the *Desires* set and it decides which norms will be fulfilled, and (ii) *Plan Selection* function, where the agent's best plans will be chosen in the *Intentions* set.

Finally, the fourth step is the *Action Selection Function*, composed of the *Normative executor and selector function*. This function receives the *Norms* set, which are the norms that the agent intends to fulfill. Last but not least, all of these steps help improve the normative conflict solving process, considering personality traits inserted into the BDI reasoning process.

## 4.2 The Framework

Inspired by the JSAN architecture (VIANA et al., 2015), which uses different norm strategies to deal with the norm, and taking into account the different agents' social levels, as in (LOPEZ,2003), we built a new approach by introducing personality traits aiming to improve the normative conflict solution. Our framework provides the decision making process described in Section IV.A. Fig. 5 shows the framework architecture.

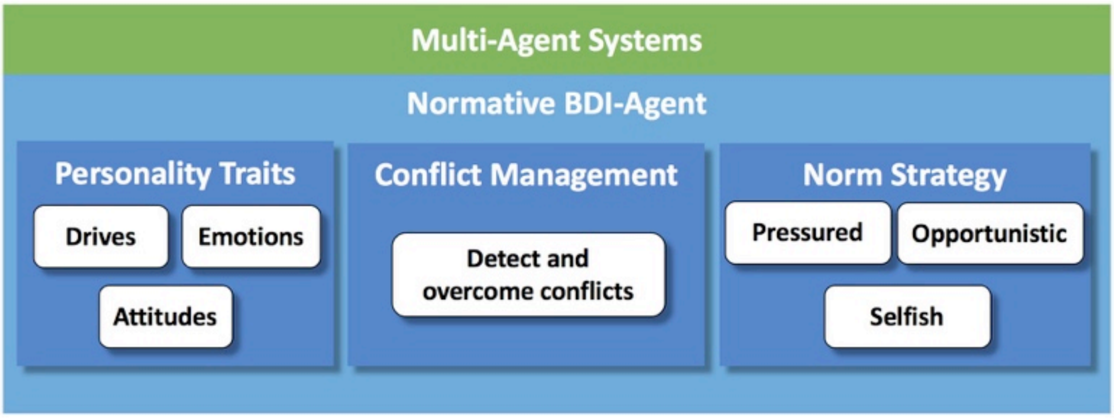


**Figure 5. The Framework Architecture.**

The *NormativeAgent* class is composed by goals, role, norms, beliefs, desires, intentions, and personality traits. By using these attributes, the agent starts the decision making process to solve normative conflicts. By means of the normative conflict solving process, the agent will choose the norms that it will add to the *Intentions* set and finally will decide which norms will be fulfilled according to the agent's social profile, as in (LOPEZ,2003) and (VIANA et al., 2015).

The normative conflicts solving process starts with the calculation of the norm's normative contribution, wherein for each norm the agent evaluates its rewards and punishments compared with the others norms addressed to it. Furthermore, we added a new step to improve this process, also taking into consideration the agent's goals and its personality traits. This new step involves the evaluation of which normative goals can be fulfilled according to the agent's goals and its personality traits. The agent will verify which goals can be fulfilled based on its personality traits, so the agent uses its set of goals and analyzes each conflicting norm, adding an integer value to the normative contribution to represent the compatibility between the agent's goals and the normative goals. The compatibility is defined by the evaluation of which of the agent's goals can be executed if a norm is fulfilled. As a result, some conflicting norms may have changed their normative contribution based on the use of the agent's personality traits. For instance, imagine the norm that obliges the agent to cross a damaged bridge. If the agent is careful (careful meaning the agent's personality trait), its normative contribution will be decreased because the agent does not have the intent to cross a damaged bridge — it is dangerous.

### 4.3 Hot-Spots and Frozen-Spots

This section describes the hot spots and frozen spots of our framework, showing the classes that can be extended to build applications for a specific domain. Furthermore, we will present a short explanation on how to use them. The specific hot spots are:

**Environment** (*Environment* class): It provides an environment with methods for the execution of actions and beliefs updates in the agent's reasoning cycle. The action will possibly change an agent's perception.

**Generate Norms** (*GeneratyNormsStrategy* class): It is possible to define new strategies to create norms in the environment.

**Normative BDI Agent** (*NormativeAgent* class): By extending such a class and implementing the execute method it is possible to define an agent's goals, beliefs, desires, intentions and personality traits, and also to define different algorithms to execute its plans.

**Norm Strategies** (*NormStrategy* class): It is possible to define new strategies for agents to deal with norms, and proceed to execute the activities of the normative application process, now taking into account the agent's personality traits. This work already provides a default process implemented in the classes Pressured, Opportunistic and Selfish.

**Agent's Goals** (*Goal* class): It is possible to define new goals for agents and assign weights to measure the importance of goals compared to norms and then decide whether to fulfill or violate the norms.

**Personality traits** (*PersonalityTraits* class): It is possible to define new personality traits for agents and assign weights to measure them to improve the solving process of normative conflicts, making the agent's decision more likely a human decision.

**Norm Conflict Management** (*NormConflictManagement* class): It is responsible to evaluate the following attributes: (i) the normative contributions; (ii) the goals weights, and (iii) the personality traits weights. These attributes are necessary to decide which norms set will be sent to the Norms Evaluation process. In short, this framework allows the implementation of the architecture proposed.

As a result, a user scenario (See Section V) will be developed to show how to build an application using our approach. This user scenario aims at showing the influence of the new approach in the agent's behavior when personality traits are also considered to solve normative conflicts, in addition to the traditional method of analyzing rewards and punishment.

## 5 User Scenario: Go Home

As proof of concept, the user scenario "go home" will choose whether the agent goes home by bicycle, or by bus. The norms in this scenario are: (i) *Norm 1* prohibits the employee agent to go home by bicycle, and (ii) *Norm 2* obligates the employee agent to go home by bicycle. Table III shows the norms created and their attributes.

| Norm Attributes | Norm 1 | Norm 2 |
|---|---|---|
| Name | ComeBack ByBusNorm | ComeBack ByBicycleNorm |
| Addressee | Employee | Employee |
| DeonticConcept | Prohibition | Obligation |
| Reward | No health decrease | Increase physical conditioning |
| Punishment | Be wet | Spend money |
| Activation | It is raining | After work |
| Deactivation | It is sunny | Be sick |

**Table 3: Scenario Norm Description**

Planning to go home, the employee agent checks the weather; if it is raining, it can go home by bus and as a consequence, it will violate *Norm 2*. However, if it is raining, but the employee agent has personality traits that induce its behavior to go home by bicycle, as a consequence, it will violate *Norm 1*. That is when the agent's internal process detects and tries to overcome the normative conflict between *Norm 1* and *Norm 2*.

Fig. 6 shows the normative conflict between *Norm 1* and *Norm 2* and our aim is to present improvement in the deliberation process to choose the norm that will be fulfilled, considering some characteristics, such as: (i) the rewards of the norm that will be fulfilled; (ii) the punishment of the norm that will be violated; (iii) the agent's goals, and (iv) the personality traits — for instance, if the agent's goal is to increase physical conditioning, it will have adventurous spirit as a personality trait.

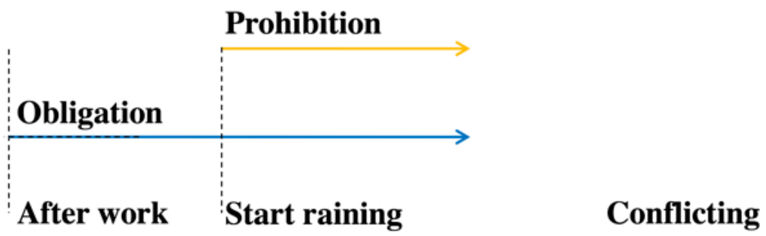


**Figure 6. Go Home conflict area.**

All of these attributes were mapped to integer values in our architecture to make possible the decision process to choose between *Norm 1* and *Norm 2*. For comparison purposes, three different personality trait scenarios were developed for the employee agent: (i) adventurous spirit — *high* weight: (ii) adventurous spirit — *low* weight, and (iii) no personality trait.

We used the architecture proposed in this paper (see Fig. 4) in the first and second scenarios. For the three scenarios, we considered that the employee agent starts the *Norm Adoption* process to verify which norms are addressed to it. As a result, the employee agent perceives two norms. Note that these two norms are conflicting (see Fig. 6): both are active at the same time, and the deontic concept is opposing — obligation and prohibition. To choose which norms will be better fulfilled, the agent considers the normative contributions and its personality traits, except in the third scenario, where no personality trait is considered.

In the first scenario, we consider the employee agent with adventurous spirit — *high* weight to choose the norm that will be fulfilled in the conflict resolution process, also taking into account the norms punishments and rewards. The conflict resolution process measures, first of all, the norms rewards and punishments of each one of the conflicting norms, i.e., the agent verifies which goals can be executed, considering each one of the conflicting norms to be fulfilled. In sequence, the agent selects which norms will be fulfilled based on the agent's *Pressured* strategy. As a result, the employee agent will go home by bicycle.

In the second scenario, we consider the employee agent with adventurous spirit — *low* weight. As a result, the employee agent decides that going home by bus will give it more benefits. This is because the agent has not been motivated sufficiently to fulfill its desires and, as a consequence, receives the punishments for not fulfilling the other norm.

Finally, in the third scenario, we consider the employee agent without personality traits, i.e., the agent always had the same behavior and considered only its own goals. We therefore assume that the BDI architecture with personality traits can change the agent's behavior, thus helping to improve the solution for the normative conflicts.

## 6 Conclusion and Future Work

This paper proposes an approach to deal with conflicting norms by adding personality traits characteristics to the BDI architecture to improve the decision making process that will decide which norms the agent shall fulfill. The main contributions of this research are: (i) inclusion of personality traits in the BDI architecture to improve the solving process of normative conflicts; (ii) implementation of different agent behaviors according to different personality traits, and (iii) making it possible to build software agent behaviors that are more similar to human behavior. As proof of concept, the approach presented in this paper can be verified by using the user scenario showed in Section V, where the agent needs to choose between taking a bus or riding a bicycle to go home once the weather conditions change. The emotional BDI agent was able to reason about the norms it would like to fulfill, and to select the plans that met the agent's intention of fulfilling, or violating, the norms.

As future work, we are deciding on an experimental study in order to complete the evaluation of our approach. Furthermore, our aim is to study other BDI architectures and platforms to investigate the possibility of extending them to support the development of emotional BDI agents to deal with norms and normative conflicts. We also plan to implement this approach in other more complex scenarios, taking into account personality traits. For example: (i) people in risk areas, where firefighters are responsible for planning their evacuation, and (ii) crime prevention, where the police are responsible for arresting criminals and keeping civilians safe. Last but not least, we will extend our architecture to make it possible for the BDI agent not only to use personality traits for the normative conflict solving process, but also to choose the best plans that it can execute in order to deal with the norms addressed to it.

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