

A Property-based Approach for Characterizing Goals

(Extended Abstract)

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ABSTRACT

Goals are an essential attitude of proactive agents described with mentalistic attitudes. Nonetheless, in the literature no well agreed-upon definition of the term goal has arisen so far. In this paper it is argued that a property-based view on goals can help understanding the nature of the goal concept. Therefore, the goal concept is discussed with respect to typical properties, which are associated with the representation and processing of goals. It is discussed, how the well-known PRS architecture and recent extensions deal with these characteristics. As a result, we argue that supporting also long-term goals, which may not (immediately or at all) lead to actions, would enrich the possibilities of the agent developer as also more strategic behavior is expressible.

Categories and Subject Descriptors

I.2.11 [Artificial Intelligence]: Distributed Artificial Intelligence; D.3.3 [Programming Languages]: Language Constructs and Features

General Terms

Languages

Keywords

Agent Programming, Goals, BDI

1. INTRODUCTION

The usefulness of goals for specifying agent behavior is widely accepted in the literature (see e.g. [4]) and is usually ascribed to the intuitive and declarative nature of goals. Nevertheless, a concise definition of the term goal is extraordinary hard to find, so that it is used in many articles without a strict definition and with partially different meanings [2]. The main difficulty of the definition problem arises from the fact that in order to be useful for a variety of application areas, a definition has to reveal the term's essence without being too strict.

This paper proposes a property-based view on goals. The rationale behind this view is to abandon the objective to introduce a strict separation of what is a goal and what

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is not a goal, but to see goals as a tool for analyzing and specifying systems. Note, that a similar procedure led to the agreed upon characterizations of the term agent, especially the weak/strong notion of agency [14], which is based on the characterizing properties autonomy, reactivity, proactivity, social abilities, and mentalistic notions.

In the next Section 2, the characteristics of goals will be presented. Thereafter, in Section 3 these characteristics are discussed with respect to software realization aspects. The paper closes with a conclusion and an outlook in Section 4.

2. CHARACTERISTICS OF GOALS

In the following paragraphs an initial attempt is made to identify the most important goal properties from the existing literature. The first five properties have already been identified in a seminal paper of Rao and Georgeff [10]. In addition to these basic properties several further desirable characteristics can be found in the agent as well as social science literature. Note that the further characteristics mainly aim to isolate goal properties that are useful for a software engineering perspective.

Persistent Goals are entities that have a persistent character, which means that they typically exist over a period of time. In volatile environments it is important for an agent to commit to its goals and give them up only for good reasons. In this sense, the persistence of goals serves for stability in an agent's behavior [9].

Consistent The adopted goals of an agent should be consistent to each other at any point in time in the sense that all goals should be achievable concurrently. Besides adopted goals an agent might also possess inactive or candidate goals, which need not be consistent [8].

Possible An adopted goal should be possible to pursue, i.e. an agent should be confident that it can achieve a goal and it does not contradict its current beliefs.

Known/Explicit A rational agent should be aware of all its goals (candidate and adopted), because this is a necessary prerequisite for any kind of reasoning on its objectives [8].

Unachieved An agent should only pursue goals, which it assumes to be unachieved. This ensures that no unnecessary actions will be initiated and no resources will be wasted.

Producible/Terminable Goals should be producible and terminable [5]. For the creation as well as the termination of goals, procedural as well as declarative means should be supported, i.e. an agent should be enabled to create/terminate a goal from a plan as well as due to situational reasons.

Suspendable It can be advantageous in certain situations to suspend the pursuit of a goal [5, 4], e.g. if the agent has

devoted considerable effort into bringing about the goal and cannot continue to pursue it due to a conflict with another possibly more important goal.

Variable Duration Intelligent behavior is based on a combination of strategic and tactical action. Strategic behavior is based on long-term goals, which persist over longer time periods and are typically challenging to achieve, e.g. they need several milestones being reached before the goal as a whole can be tackled. Tactical behavior is in many cases based on short-term goals or even reflexes. Hence, short-term goals often only live for the short moment in which the reason for their creation, e.g. an environmental change, was detected. These kinds of goals are closely linked to (physical) actions and exhibit event-based character.

Action Decoupled Goals express and incarnate motivations with respect to a specific situation. This motivation can exist even if an agent cannot contribute actively to the goal achievement. These so called interest or passive goals do not directly lead to action execution, but should nonetheless be allowed to persist within an agent [2]. On the one hand, an agent might eventually gain new procedural knowledge for pursuing the goal [1] or on the other hand the goal might be fulfilled by a third party, e.g. other agents.

3. REALIZATION CHALLENGES

One of the most successful agent architectures with many mature implementations is the PRS architecture [10] based on the BDI agent model [3]. In the original PRS architecture some of the above mentioned goal properties are explicitly supported (like persistency through various commitment strategies [6]), while others are taken as requirements to be respected by programmers to obtain a properly working system (e.g. consistency and possibility of goals).

The properties production/termination, suspension, variable duration and action decoupledness) are not addressed in the original PRS system, but some of these properties have been subject to recent work in this area. E.g. a generic goal lifecycle model for production/termination and suspension of goals has been proposed in [4] and also others have considered the abortion [12] and suspension [11] of goals. Furthermore, ways of dealing with the consistency requirement have been introduced in the area of so-called goal deliberation strategies [13, 8].

To our knowledge none of the existing works has tackled questions of variable durations and action decoupledness, even though these kinds of goals represent a helpful extension for the conceptual canon of BDI agent programmers. The importance of action decoupled goals is emphasized in the literature especially by the cognitive structure of emotions model (OCC - Ortony, Clore and Collins) [7], which assumes that three different goal types exist: “active goals”, “interest goals” and “replenishment goals”. The first and third OCC goal types are already covered by BDI achievement and maintenance goals [4], whereas no support for interest goals, which emphasize their passive character, exists.

With regard to variable durations, the PRS architecture focuses exclusively on means-end reasoning and therefore goals only exist during their execution phase, i.e. a goal is held only as long as plans are executed for this goal. Hence, the traditional PRS idea is more centered on realizing short-term goal-driven behavior and the realization of long term goals of strategic is not supported so far.

4. CONCLUSION

This paper has taken a property-based view on the problem of defining the term goal. Based on an extensive research of the existing literature nine properties have been identified, which are useful to characterize goals and distinguish them from other kinds of desires. Furthermore, it has been discussed how these properties are represented in the well-known PRS architecture as well as recent extensions. In this respect, the variable duration and action decoupledness of goals have been identified as properties, which have experienced only limited attention until now. Therefore, future work will be directed towards properly representing these aspects in agent architectures.

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