# Towards Integrating Human-Centric Characteristics into the Goal-Oriented Requirements Language

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***Abstract*—In Requirements Engineering (RE), goal-oriented techniques have captured significant attention due to their ability to bridge the gap between stakeholders' goals and the means by which these goals can be achieved. However, current goal-oriented modeling frameworks suffer from the lack of an in-depth and thorough understanding of human-centric requirements during the design and modelling of the system. Human-centric characteristics of users are mainly related to user's gender, culture, language, age, personality traits, emotions, and any special requirements stemmed from physical and/or mental impairments. These aspects are vital, and they play an essential role in the acceptance and usage of the developed systems. Hence, neglecting or oversighting such characteristics while designing and modeling a system will lead to ineffective and hard to use systems for some end users. This paper proposes a vision for integrating human-centric characteristics into goal modeling, with the latter being one of the most important early activities in requirements engineering. We aim to characterize the different aspects of human-centric characteristics (which we call them *user profiles*), and to provide a framework for the systematic integration of user profiles with goal modeling. This in turn will help identify and prioritize critical human-centric characteristics of end users, which will affect the design, modelling, and development of systems. We thus propose a long-term research agenda and urge community contributions in this research direction to achieve enhanced human-centered modelling.**

***Keywords—goal modeling, human-centric characteristics, user profile, requirements engineering, GRL.***

## I. INTRODUCTION

Software systems these days are designed and developed with an aim to serve diverse users with different human-centric characteristics related to users' gender, culture, language, age, personality traits, educational level, socioeconomic status, emotional and mental aspects, physical and mental states, and so on. We refer to these human-centric characteristics as *"users' profiles*", and we believe that users with different profiles (even when users belong to one category, e.g., same age group) would still have different perspectives, attributes, and expectations, and what would work for one person might not be acceptable for another. Hence, user profiles need to capture an appropriate consideration throughout the different aspects of the software development [1].

Neglecting human-centric characteristics while designing and developing software may lead to a software that fails to satisfy users' requirements and expectations and causing dissatisfaction and frustration [4]-[6]. In addition, the resulting not fit-for-purpose software may cause inefficiency, economic costs, or potentially life-threatening situations [7]. It can further lead to an extra cost if the user wishes to resolve these issues [7]. Having said that, it becomes vital to consider human-centric aspects in software design, where developers need to carefully consider the capabilities, constraints, and characteristics of users (i.e., user profiles) such as their age, culture, preferences, working environment, health state, gender, etc. [8].

To support the human-centric characteristics of stakeholders, it becomes important to integrate user profiles early into the software engineering processes starting from the *modelling* and *design* phases. However, despite the increased general awareness about supporting diversity and inclusion of different users in different domains, the current requirements and design models are still in their early stages of supporting the modelling of users' human-centric characteristics. Consequently, the lack of consideration of human-centric aspects will lead to important considerations being missed and serious challenges related to accessibility and usability that are faced by diverse users while using particular systems [9].

In Requirements Engineering (RE), goal-oriented techniques [10] have experienced significant attention due to their ability to bridge the gap between stakeholders' goals and the means by which these goals can be achieved. However, current goal-oriented modeling frameworks [11][12] including iStar 2, SysML, BPMN and GRL, have been mainly designed to model software functional and non-functional requirements. Despite that there have been works on modelling interactions and emotions of the users [13], and on modeling the end users' human aspects in the iStar [17], to the best of our knowledge, there is no support of modeling the human-centric characteristics of the diverse stakeholders in the goal-oriented requirements language (GRL). In this respect, GRL cannot accommodate human-centric requirements that might be posed by stakeholders with different users' profiles.

To address this gap, we propose a vision towards extending the Goal-Oriented Requirements Language by integrating the

concept of "*Users Profiles*", which indicates the human-centric characteristics of stakeholders such as age, gender, culture in addition to their other specific goals, e.g., "reserve the fastest flight". In this research agenda, we aim to be able to model the diverse human-centric aspects of the software users in early requirement engineering stages. We selected the GRL language due to its ability to model intentional, social and strategic dimensions, with a better potential to model human-specific dimensions. We aim to extend the GRL language by adding elements of user profiles and preferences to enable the modelling of human-centric aspects of diverse users that need to be considered during software design.

The rest of this paper is organized as follows: Section II discusses the motivation behind this work, the proposed approach of integrating human-centric characteristics with goal modeling is discussed in Section III. Section IV discusses our proposed research agenda, and plans of extending the GRL language to support human-centric characteristics. Finally, Section V concludes the paper.

## II. MOTIVATION

Besides the ability to model the functional and non-functional requirements that are expressed by all stakeholders (e.g., privacy, reliability, usability, effectiveness, performance, etc.), the aim of this work is to be able to model the requirements of *individual users* which are tightly associated with their human-centric characteristics. Following this logic, we aim to be able to model the system for a specific individual, i.e., a user profile, rather than a general user. For example, while reserving a flight, an old user might have a requirement that stems mainly from her age, where she wants to have a more *comfortable* seat, and she is willing to pay more for that option. On the other hand, a university student might want to have a more *affordable* option, due to his restricted financial budget. In this proposed research, we aim to model such human-specific requirements of both stakeholders (of course, in addition to their functional and non-functional requirements). The motivation of our study is to explore how we can extend the existing goal modelling approaches to be able to model requirements specific to the human-centric aspects of the stakeholders in early requirement engineering and design stages. In particular, we aim to extend the GRL language with such capabilities to enable a better human-centric modeling.

To motivate our work, we use the example of the "flight reservation system". The rationale behind using this example is because it allows capturing a diverse set of users with various individual needs and requirements. Figure 1 illustrates a goal model expressed in the GRL modeling language for the flight reservation system, where this model depicts the basic functional and non-functional requirements, which all stakeholders require the system to provide, despite the differences of the stakeholders' attributes, preferences, priorities, or characteristics (i.e., user profiles). For instance, in order to "Reserve a flight", all stakeholders should "Select a flight" and "Make a payment", where each goal can be achieved by different means (i.e., tasks). The tasks, in turn, should be either performed all (as in the case of the tasks to perform the "Select flight" goal), or could be a set of alternative tasks, that the stakeholder has the option to choose the most convenient one (as in the case of the tasks to perform "Make a payment" goal).

According to the goal model in Figure 1Fig. *1*, there is no much support of other goals that stem from the individual characteristics and their associated needs (e.g., language requirements). In other words, the current goal model was able to successfully model all the system's functional and non-functional requirements (like selecting the flight and making the payment), but it did not cater for all possible human-centric aspects and could not accommodate individual needs like variety and luxury.

This limitation makes it desired for a new mechanism to model to the human-centric aspects. To elaborate, let us choose different settings where several users can have varying human-centric requirements. For instance, in a flight reservation system, every user has a similar essential functional requirement of reserving a flight ticket, but each user reaches that goal based on their specific human-centric requirements. For example, some stakeholders do not mind spending extra money on the flight as long as they keep their travel time to a minimum, while others might want to book the cheapest flight possible. On the other hand, some passengers may consider the care and support they receive in their flight, while others may prioritize the language spoken in the flight more. To consider and model these requirements, we suggest integrating the human-centric characteristics with the goal modeling activities, as discussed in the next sections.

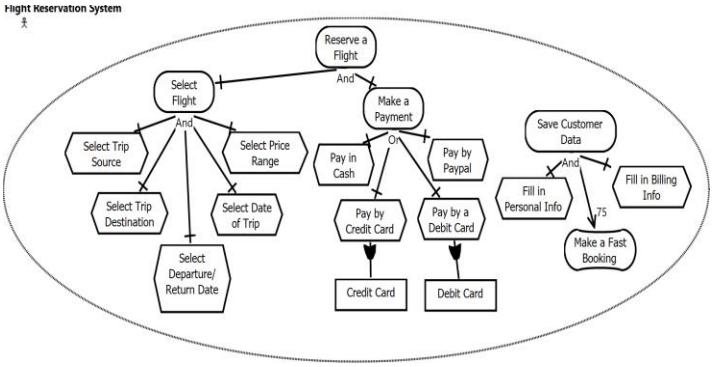


Fig. 1. A GRL goal model for flight reservation system

## III. HUMAN-CENTRIC CHARACTERISTICS AND USER PROFILES

This section discusses the concept of user profiles and our vision towards representing user profiles within. goal models

### A. User Profiles

To illustrate the concept of "user profile", let us assume an imaginary passenger, Judy Smith, within her 70s, who does not speak English, and who has several human-centric goals that Judy requires based on her nationality, language preferences, health state, comfort requirement, age and so on. A *user profile* here can be seen as a profile that combines both the user's human *characteristics* (age, culture, language, etc.) and the *goals* that stem from these characteristics. For example, one of Judy's goals could be "receive translated instructions", where this goal stemmed mainly from the fact that Judy does not speak English (cultural-related). Another goal could be "receive particular food" which could be originated from cultural-related aspects,

or even health state-related aspects, and so on. In general, the goals stated in the user profile should be based on the user's characteristics and the system that the user is going to use.

Each stakeholder of the system to be modelled will have a specific user profile with particular characteristics and goals. These goals can be further classified into broader categories. For example, one or more goals could belong to the category "cultural-related goals", "age-related goals", or "gender-related goals", and so on. In addition, one particular goal could belong to two different goal categories. For example, the goal "receive Veggie food" could belong to the "cultural-related goals" or "health state-related goals". Goals of individual stakeholders can then be mapped as a task to fulfil each individual's needs according to their user profile. This makes capturing specific individual needs easier and produces a detailed and personalized specification of goal modeling.

Fig. *2* illustrates an example about an imaginary user profile for the stakeholder Judy Smith who wants to book a flight using flight reservation system.

| | |
|---|---|
| **Characteristics** | Age: 72 |
| | Nationality: French |
| | Spoken Language: French |
| | Health conditions: Diabetic |
| | Financial status: Flexible |
| **Goals** | G1: Reserve the shortest flight to France |
| | G2: Receive vegan food |
| | G3: Reserve a front line aisle seat |
| | G4: Upgrade into a business class ticket with discounts |
| | G5: Receive assitance at the airport and during the flight |
| | G6: Receive regular Insulin doses |
| | G7: Receive translated Instructions |

Fig. 2. A User Profile Example

### B. *Goal Modeling with user profiles*

In addition to modelling the conventional functional and non-functional requirements of Judy (and all the other stakeholders who share the same requirements), as illustrated in in Figure 1; we also aim to be able to model Judy's goals that stem from her human-centric characteristics, as shown in her user profile in Figure 2. Since this paper is a vision paper that states our long-term research agenda, we are still in the process of investigating the need for extending the GRL modeling language with *unique symbols and notations* to represent the user profiles and the human-related goals. Hence, we did not propose yet a concrete extension for the GRL language. However, for the purpose of showing the concept, we modelled the human-centric goals derived from the user profile as if they are regular goals, just to show the advantage of considering the human-centric characteristics while modeling a system.

Based on Judy's user profile, we categorize her goals as: (1) age-related, (2) cultural-related, (3) health-related, (4) comfort-related, and (5) time-related goals. These goals are represented in Figure 3.

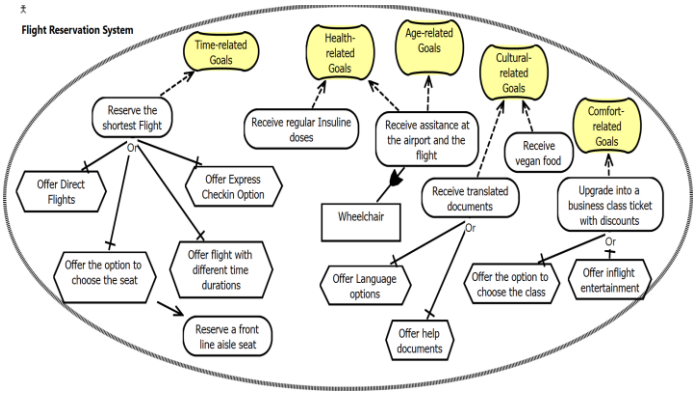


Fig. 3. A GRL goal model with user profile for flight reservation system

As illustrated in Fig. *3*, each goal in the user profile (see Figure 2) is represented as a normal goal in the goal model. The goals in turn are categorized into one or more of the five categories mentioned above. The categories of goals are represented temporarily using the notation of the softgoal. However, it is important to mention here that this is not a firm representation, and we are yet to discover the best way to represent the goals categories of user profiles.

The categories of the goals stand to act as generic scopes or context, under which several goals that express certain requirements can be defined. For example, the goal category "Health-related goals" can be used to express several goals that are all originating from particular health conditions. It is worth mentioning that we could have the same goals categories as the ones presented in Figure 3, but this time for another stakeholder with a different user profile, and underneath each category, there could be new goals that are different from the ones depicted in Figure 3. We believe that the use of goal categories is important to classify goals into broader scopes and to enhance the modeling process as a whole, especially when there are several user profiles, each with different goals.

To summarize, extending goal modeling with user profiles would have the potential to identify and capture human-centric characteristics, and the goals that are tightly associated with these characteristics. In addition, categorizing the goals into broad categories helps enhancing the modeling of several stakeholders with different goals and user profiles. Hence, we become able to not only model the system goals, but also the users' human-centric goals, such as the additional features users require based on their particular characteristics, including but not limited to, age, gender, nationality, language, culture, health state, comfort requirement and so on.

## IV. Research Agenda

We structure the presentation of our research agenda and plan the process of extending GRL through drawing inspirations from the PRocess to support iStar Extensions (PRISE) guidelines, introduced in [18]. Even though the PRISE guidelines was conceived as a reference process to support iStar extensions, we believe that its guidelines can be adopted and

adjusted for the context of extending the goal-oriented requirements language (GRL).

PRISE provides an end-to-end process to define, evaluate, develop, validate, and publicize iStar extensions. The aim of PRISE is to make extensions as consistent, complete, and without conflict as possible through a systematic process [17].

Following the same process of PRISE, the process of extending GRL language with human-centric characteristics will involve the following sub-processes:

- **Analyse the need for GRL extension**: This step will involve examining the need for an extension. The expected outcome of this step is an *analyzed extension specification*.
- **Describe concepts of the GRL extension**: This step describes in detail the concepts identified in the previous step (i.e., in the extension specification), and makes sure to reuse as much existing constructs as possible. The expected outcome of this step is a set of *described concepts in the extension specification.*
- **Develop GRL extension**: This is the principal part of GRL extension process, which aims to design the language extension based on a set of guidelines. To perform this sub-process, we will follow the *Physics of Notation (PoN)* principles [19] which provide a useful guide on how to assess extension choices. These principles are: (1) preserve the language (i.e., GRL) original syntax, (2) carry out consistent, complete and without conflicts extensions and follow a process/method to do them, (3) pperform a literature review, consider the participation of domain experts and GRL experts, and model systems of application area before extending, (4) describe a clear definition of the extension concepts, (5) Propose concrete and abstract syntax of the extension, (6) check consistency between abstract and concrete syntaxes, (7) relate concepts introduced by the extensions with the GRL concepts, (8) define extensions with a minimum number of modifications and new representations in order not to complicate the use of the modelling language (i.e., GRL), and (9) propose careful and simple graphical representations, able to be drawn on paper without a tool. The expected outcome of this step is a *developed extension specification.*
- **Evaluate and validate the GRL extension**: This step will involve evaluating, validating, illustrating the usage, and refining the proposed extension with the assistance of domain experts. The expected outcome of this sub-process is a *validated extension specification.*
- **Check other new constructs to be introduced**: This step is performed through an iterative process in parallel with sub-processes 2-4. Its purpose is to generate a list of concepts to be introduced. If new constructs are identified, the execution of the GRL extension process returns to step 2, otherwise, it continues to the next sub-process.
- **Publicise the GRL extension**: This is sub-process will be the final step in the extension process, where the GRL extension becomes complete and will be made accessible to the community.
- Finally, we need to conduct **user evaluation studies** to evaluate the extension of the GRL language.

## V. Conclusion

This paper presented our research agenda for integrating human-centric characteristics with goal modeling using the Goal-Oriented Requirements Language (GRL). In particular, we discussed the importance of taking human-centric characteristics into account since the early stages of software development. Human-centric characteristics refer to any individuals' specific aspects related to age, gender, culture, health state, financial state, physical/mental impairments, to name a few. To this end, we propose the concept of user profiles to reflect stakeholder's human-centric characteristics along with their goals that stem from these characteristics. The paper also presented our vision towards extending the GRL language (following a set of guidelines similar to the PRISE guidelines used to extend iStar language) to model user profiles, represented by particular human-centric characteristics and goals.

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