Ontology-Based Requirements Engineering: The Case of Ethicality Requirements

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Abstract

In this paper, we summarize the content of our keynote speech at iStar'24, in which we discussed an ontology-based requirements engineering method to elicit and analyze ethicality requirements for the development of trustworthy AI systems.

Keywords

Ethical AI, Trustworthy AI, Requirements Engineering Method

Concerned by the growing impact of information systems in people's lives, especially motivated by the recent AI developments, ethicists and AI researchers have been recently studying the interplay of ethics and AI systems [1,2]. Moreover, governments and private organizations have been engaged in producing regulations and guidelines for the development of trustworthy systems [3,4]. Although we agree that the theoretical debate, along with regulations and guidelines are important, we believe that it is essential to embed ethics into the system engineering practices. For being concerned with stakeholders' needs and wants, Requirements Engineering has a fundamental role in the development of ethical systems. If we provide the means for requirements analysts to capture and analyze ethicality requirements, we will be contributing for ethics to be a core concern since the start of the system development lifecycle. Moreover, ethicality requirements may be monitored and assessed not only while the system is under development, but also after it is deployed.

This extended abstract summarizes the content of our keynote speech at iStar 2024, where we presented an ontology-based requirements engineering method [5, 6]. The proposed method, known and *Ontology-based Requirements Engineering (OBRE)* started with an ontological analysis of ethicality requirements as non-functional requirements. As a result, we created an ethicality requirements ontology. Then we instantiated this ontology, identifying guidelines for the elicitation of ethicality requirements. With the help of these guidelines, the requirements analyst may use an existing Requirements Engineering approach of her choice (e.g., requirements table, *i**, user stories) to specify and analyze ethicality requirements.

The definition of ethicality requirements is based on the ontological analysis of four principles conceived as part of an ethical framework to guide the development and adoption of AI systems [7]: *Beneficence*, *Nonmaleficence*, *Autonomy* and *Explicability*. As a result of our ontological analysis, these principles have been understood as more concrete concepts that are easier to grasp, thus supporting requirements elicitation and analysis. To make our analysis clear, let us describe how we define these principles. To illustrate the types of requirements, we use a driverless car example.

Beneficence and Nonmaleficence are analyzed together. Beneficence is roughly understood as 'do good' while Nonmaleficence means 'do no harm' [7]. With the help of the Common Ontology of Value and Risk [8], we used the concepts of "value" and "risk" to analyze these

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respective principles. Beneficence requirements are those that allow the system to create gain events, i.e., events that positively impact the stakeholder's intentions. On the other hand, nonmaleficence requirements are those that lead the system to prevent loss events, i.e., events that negatively impact the stakeholder's intentions. For instance, for a driverless car, "the car shall choose the quicker route towards destination" and "the car shall stop before a crosswalk every time there is a pedestrian waiting to cross it" are examples of beneficence requirements, while "the car shall make enough distance while overtaking a car" and "the car shall adopt a defensive driving behavior" are examples of nonmaleficence requirements.

Autonomy means striking a balance between the decision-making power retained by the stakeholder and that which is delegated to the system [7]. To understand this kind of requirement, we need to focus on the concept of delegation. The stakeholder delegates decisions to the system and as part of this delegation, social positions are created to regulate the content of such relationship [9]. For example, autonomy requirements may define duties, permissions and powers from the system towards the stakeholders. For a driverless car, "the car has the duty to follow traffic laws" and "the car does not have permission to change destination without the passenger's explicit request" are autonomy requirements examples.

Explicability is understood as making the decision-making process transparent, intelligible and accountable [7]. Explicability requirements aim at keeping track of the system's decision-making process. According to the Decision-Making Ontology [10], for each decision, the system conducts valuations of different options, and such valuations are based on different criteria. For each decision, an explicability requirement aims at making explicit the available options, which option was chosen, and which criteria were applied in this choice. Requirements such as "the car shall explain why it decides (not) to overtake other vehicles" and "the car shall explain the reasons why a particular route is chosen" are examples of explicability requirements.

Focusing on ethics since the Requirements Engineering activity is paramount to guarantee the development of trustworthy systems. Our work is a first attempt in this direction. We hope that in the future, we are able to evaluate it by its application on real cases, and improve it based on this practical application. We also intend to complete the ontological analysis of the ethical dimensions proposed in [7] by tackling the notion of *Justice*.

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