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AGILE APPROACH TO REQUIREMENT ANALYSIS USING ARTIFICIAL INTELLIGENT TECHNOLOGIES

An approach to requirements analysis using artificial intelligence technologies, taking into account the specifics of the AGILE methodology is proposed in this paper. The approach corresponds to the Model-Driven Methodology, in which the main artifacts of software development are software models represented by UML diagrams. The proposed approach corresponds to the key ideas of the AGILE manifesto, and is oriented towards the fact that AGILE has a priority to satisfy a customer when he changes requirements.
Artificial intelligence technologies serve to prepare initial information for the "Text to Model Transformation" of the requirements specification into those types of UML diagrams (Use Case and Sequence), which are used for requirements analysis.
The choice of the UML diagram visualization environment is substantiated.
Keywords: Artificial Intelligence, AGILE, Model-Driven Development, Requirement Analysis, PlantUML, Text to Model Transformation, Requirement Visualization.

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AGILE ПІДХІД АНАЛІЗУ ВИМОГ ІЗ ВИКОРИСТАННЯМ ТЕХНОЛОГІЙ ШТУЧНОГО ІНТЕЛЕКТУ

У роботі пропонується підхід до аналізу вимог за допомогою технологій штучного інтелекту, враховуючи особливості методології AGILE. Підхід відповідає модельно-орієнтованій методології розробки програмного забезпечення, у якому основними артефактами розробки програмного забезпечення є моделі програмного забезпечення, що представляються UML діаграмами.
Запропонований підхід відповідає ключовим ідеям AGILE manifesto і орієнтований на те, що вимоги замовника можуть часто змінюватися. Технології штучного інтелекту служать для підготовки початкової інформації для "перетворення з тексту у модель" специфікації вимог у ті види діаграм UML (Use Case та Sequence), які використовуються для аналізу вимог.
Обґрунтовано вибір середовища візуалізації UML діаграм.
Ключові слова: штучний інтелект, AGILE, модельно-орієнтована розробка програмного заьезпечення, аналіз вимог до програмного заьезпечення, PlantUML, перетворення «текст в модель», візуалізація вимог.

Introduction

One of the requirements of AGILE is a quick response to changes in customer requirements, which can happen quite often. This implies changing all software development artefacts that are associated with a specific requirement. The information contained in these artefacts must quickly be synchronized with the changes made by the customer. To successfully implement this approach, the process of synchronizing changes needs to be automated, which can significantly speed up development and improve the quality of the source code.

For today, perspective and modern approaches use of methods that combine the artificial intelligence technologies and fundamental knowledge of model-driven engineering [1]. This paper proposes such an approach.

Review papers

Foundations of requirement analysis by means of chat bots and agents were described in the paper [2]. Researchers have explored the development of Bots or agents that can engage in natural language conversations

with stakeholders (Figure 1). These automated agents assist in the process of eliciting requirements from users and stakeholders. By imitating human interviewers, these bots can ask questions, provide clarifications, and guide stakeholders through the requirements gathering process.

One specific example mentioned in the paper is LadderBot. LadderBot mimics a human interviewer by conversing in natural language. It formulates questions and provides assistance during the requirements elicitation process. The main steps of requirement analysis using LadderBot are the next

- Natural Language Interaction: LadderBot interacts with users through a chat interface, mimicking human conversation.
- AI-Driven Analysis: LadderBot uses Artificial Intelligence (AI) algorithms to process user input.
- LadderBot identifies patterns, keywords, and context to understand user needs.
- The AI extracts the information related to requirements.
- Dynamic Adaptation: Based on user responses, LadderBot dynamically adapts its conversation.
- It formulates follow-up questions to explore different aspects of requirements.

Task and research questions

Task: to propose an approach for AGILE requirement analysis using artificial intelligence tools. In order to perform this task it is necessary to solve the next research questions (RQs):

RQ1: Ground a choice of a visualization environment to perform “text to model transformation” operation.

RQ2: Propose the important steps of AGILE requirement analysis approach.

RQ3: Conduct an experiment with several AI tools to compare the obtained results of requests.

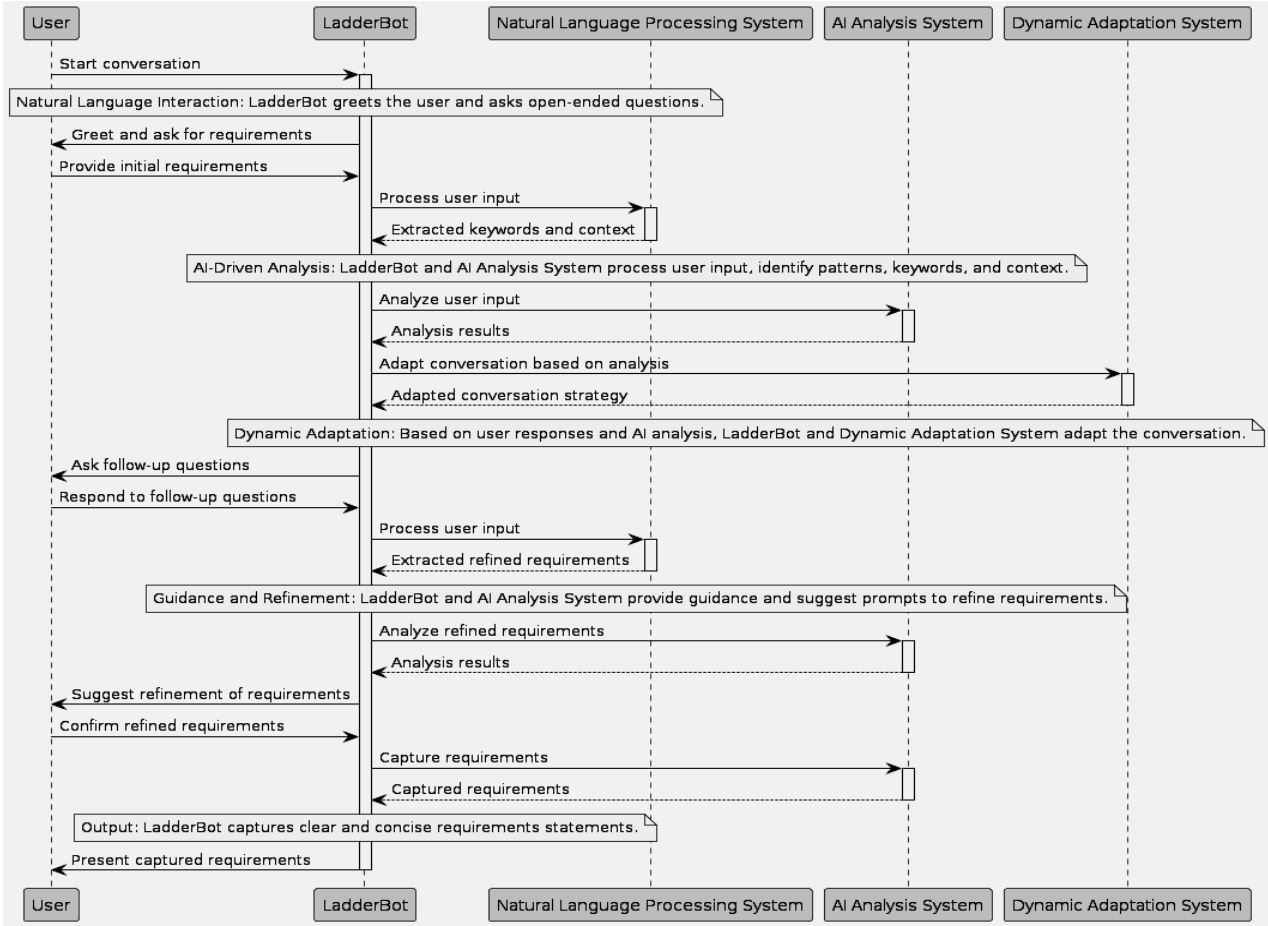

Fig. 1. Description of the process using chat bot for requirement analysis

RQ4: Analyse the experimental result and ground a choice of an AI tool to perform the AGILE requirement analysis approach.

Analysis of the research questions allows us to formulate ***the scientific novelty*** of the conducted research.

The paper proposes a requirement analysis approach that allows to avoid a human factor and save time performing the next activities:

- to prepare a full and non-contradictory requirement specification from any product vision document using artificial intelligence technologies.
- It also allows to design software models for requirement analysis that correspond to the requirement specification using artificial intelligence technologies.

Model-Driven Engineering foundations of the proposed approach

Analysis of "text to model transformation" modelling environments.

Aim of this analysis is to select modelling environment with the simplest representation of textual description of UML diagram. Simple representation requires minimum efforts to teach AI tools to prepare a ***correct and full*** text representation of UML diagram. Figure 2 represents a classic model to model transformation scheme with propositions (blue text labels) of elements' names that participate in the proposed approach.

The text to model transformation is done by modelling environment. The next modelling environments were considered:

- Visual studio plug-in for class diagram generating;
- DrawIO;
- Luquidchart;
- PlantUML;
- ASTAH UML.

Because of limited value of paper, the detailed analysis of modelling environments is not represented.

As a result of modelling environment analysis, PlantUML was chosen [8]. The criteria that ChatGTP and Gemini were learned to generate correct and full text description of PlantUML Sequence and Use Case diagrams.

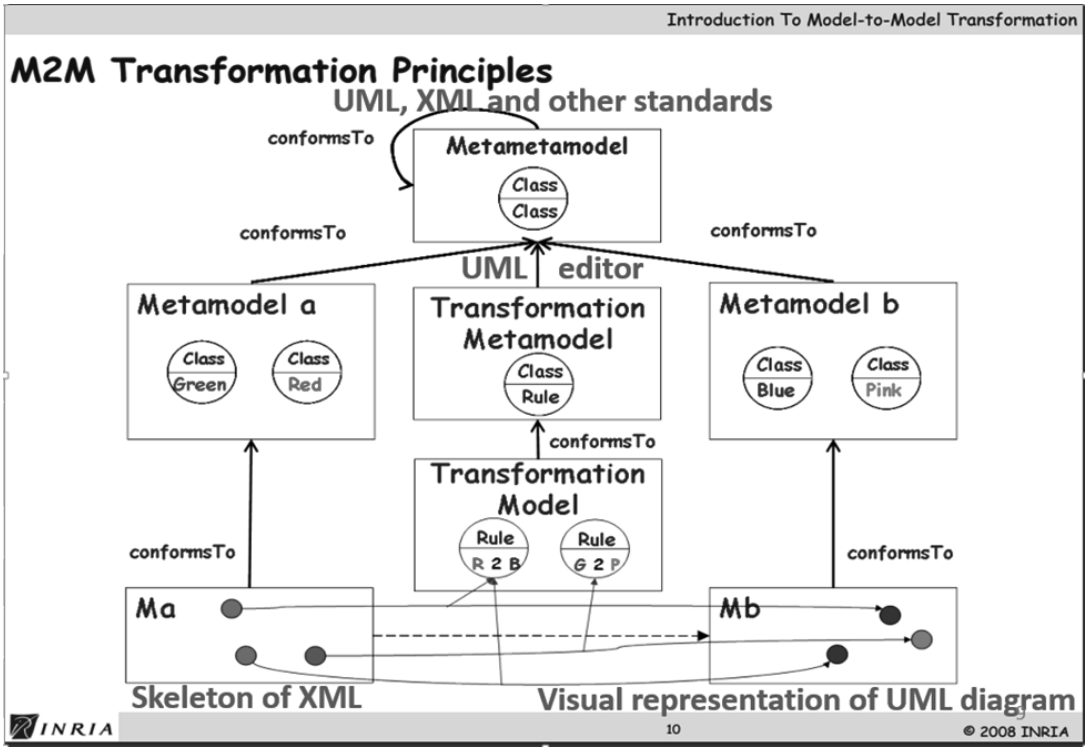

Fig. 2. Classic "Model to Model transformation" scheme with description of key elements necessary for transformation. Figure is taken from [7]

AGILE Requirement Analysis approach

In order to realize the proposed approach the next actors are involved: Customer, Requirement Engineer, AI, and Domain Analyst. UML Sequence Diagram is represented on figure 3. The description of the main ideas of the proposed approach is presented by roles of every actor.

Customer: The customer's role is to prepare the Product Vision Document and to provide feedbacks during the Scrum meeting if requirement clarification is needed.

Requirements Engineer: receives the Product Vision Document from the Customer, then verifies UML diagram, obtained after the next iteration of a domain analysis and explains the UML diagrams to the customer during the Scrum meeting.

AI: The AI is involved in designing Epics, User Stories, and UML diagrams (Use Case and Sequence Diagrams) based on the instructions from the Domain Analyst. It also helps in formulating and evaluating key questions to the client, finding answers to these questions, and creating the Requirement Specification. During the Requirement Clarification loop, the AI refines the requirement specification and UML diagrams as per the Domain Analyst's instructions.

Domain Analyst: The Domain Analyst instructs the AI to design User Stories and UML diagrams, formulates key questions to the Customer. The Domain Analyst also evaluates and corrects the questions formulated by the AI. During the Scrum meeting, the Domain Analyst considers Customers' and Requirements' Engineer notes about requirement specification and UML diagrams. It gives input information for the next stage of the Requirement Clarification. The next activity of the Domain Analyst is to instruct the AI to refine the User Stories and UML diagrams, and corrects the Requirement Specification if needed.

Experimental research of the proposed approach

Consider requirement specification of software system, describing rental processes of sport equipment.

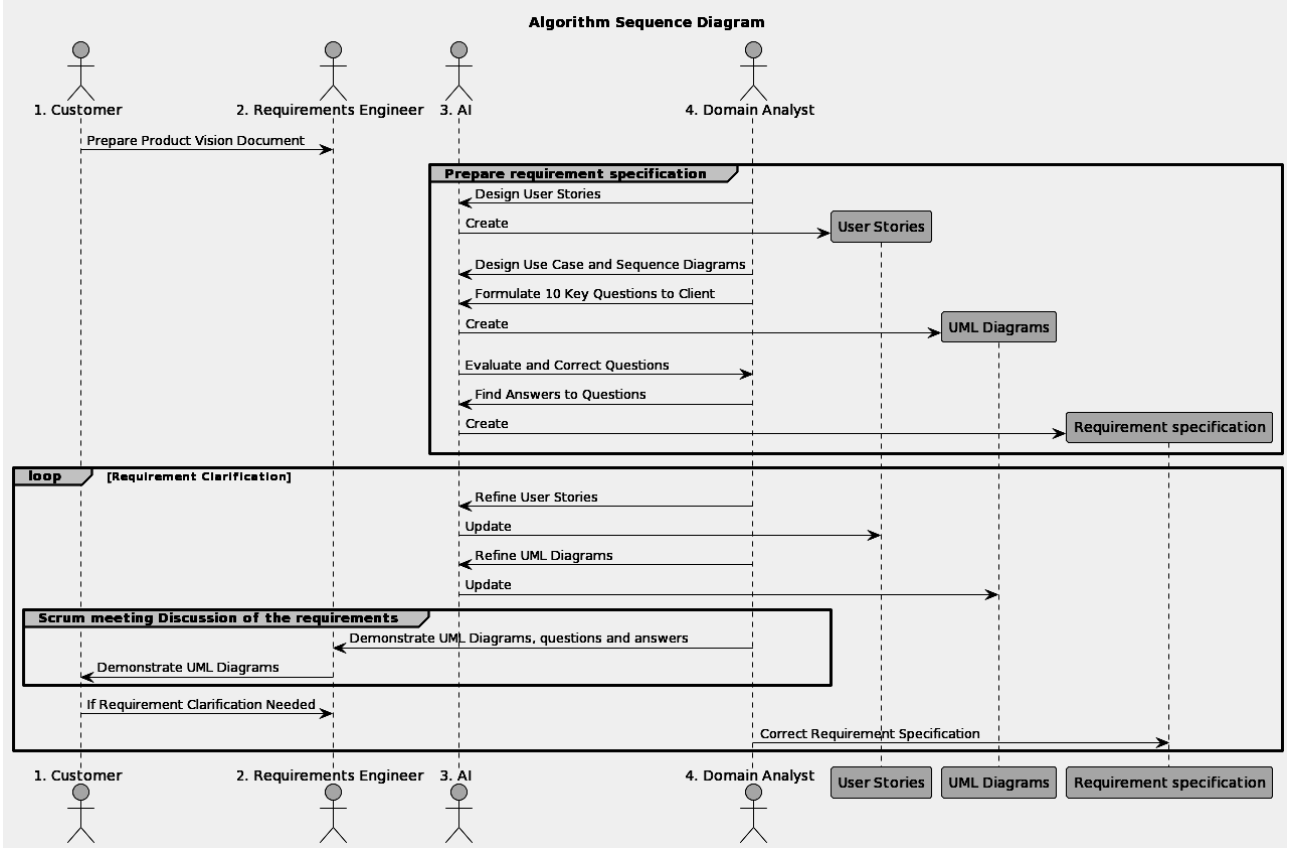

Fig. 3. UML sequence diagram of the proposed AGILE requirement analysis approach

The system presents various sports equipment on the company's website, each with a specific name, price, and unit of measurement. Customers can rent equipment, and their standard questionnaire data, phone, and email address are collected for communication. The system automatically records the customer, equipment, quantity, rental date, and return date for each rental. The rental system manages the availability and condition of the equipment. After each return, the equipment undergoes a thorough cleaning and inspection process. Any necessary repairs are carried out immediately. If the equipment is damaged beyond repair, it is replaced. The system also handles issues related to the lack of information about the availability of the necessary equipment in the warehouse in the required quantity.

Customers can track their rental history online. This feature provides detailed information about their past rentals, including the types of equipment rented, rental dates, return dates, and costs. Based on the total cost of the order, the system provides additional discounts. These features allow customers to manage their rentals effectively and plan for future ones.

Requirement analysis is provided with three different chat bots. Bing Copilot, AIchatting, and AI Chat.

Because of limited value of paper, only essential prompts to AI tools and analysis of their answers are represented below.

Domain Analyst activities:

Prompt 1 *Hello I have a description of software system. Write please epics, user stories and acceptance criteria for them.*

Rental Process and Customer Interaction: {text of the requirement specification.}

Result**:** All AI networks have designed well and clear user stories with different level of description (see Table 1).

Prompt 2 *Please generate me ten the most important questions about problem domain having User Stories and epics.*

Prompt 2 1. *Please define to which epic and a user story are related to which question.*

Prompt 3 *Please find answers to these questions and verify the description of software system. Please mark changes of the description by bold font and do not forget about the references. Thank you!!!*

Result**:** Bing Copilot has changed the text of specification correctly adding details to description of the product vision document.

Table 1

Analysis of answers of different AI tools

	Bing Copilot	Gemini	Aichatting
	Prompt 1		
Number of User Stories	Six user stories	Ten user stories	Three user stories
Accuracy of User stories description (from 0 to 10)	4 Very common descriptions	10 Well systematization	2 Two user stories and only couple of aspects are covered
	Prompt 2 and Prompt 3		
Generated questions are related to	Four user stories	All epics + additional user stories	All three user stories were précised
	Good precision		Weak precision
	Prompt 4		
Estimation of UML diagrams	Clear UML diagrams, describing user stories (Sequence diagrams) and epics (Use Case diagrams)		Stop to work (limited number of prompts with registered account)

Gemini generated additional user stories then structured them correctly too.

Prompt 4 *May you generate a PlantUml description of use case and sequence diagrams from the improved requirement specification of the renting system?*

Result**:** Gemini got correct templates of the UML diagrams and then improved description of user stories. Bing Copilot proposed correct and clear description of UML diagrams.

Estimation of answers for different AI tools is represented in Table 1.

Conclusion

The paper presents the AGILE requirements engineering approach, which allows the use of artificial intelligence tools. The approach effectively solves the following key tasks of requirements analysis:

- synchronization of customer requirements with the content of the requirements specification, epics, user stories, and UML use case and sequence diagrams;
- using of artificial intelligence tools for the design software development artefacts that are used for requirement analysis. Experimental analysis, aimed to define AI tools with the best capabilities for refining software development artefacts, is represented. The most appropriate results were obtained by Bing Copilot and Gemini.

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