Section 1 Introduction

Bicycles are increasingly popular as an eco-friendly mode of transportation, contributing to reduced air pollution and improved air quality [1], [2]. Moreover, cycling is known for its health benefits, including chronic disease prevention, improved physical fitness, and enhanced cognitive functions [3]. With the rising popularity of cycling, different types of bicycles have been rapidly developed, providing cost-effective commuting options. However, the multitude of bicycle specifications can be overwhelming for users unfamiliar with technical details. To tackle this challenge, a recommender system is necessary to help users identify their needs and choose a suitable bicycle without in-depth technical knowledge.

Recommender systems analyze user preferences to provide personalized recommendations, aiding in decision-making [4], [5]. Two primary approaches, implicit and explicit, are used to understand user preferences [6]. Knowledge-based recommender systems example of an explicit approach, utilizing domain expertise to offer recommendations tailored to the user's knowledge in a particular domain, to meet individual needs [7]. Conversational Recommender System (CRS) is a knowledge-based recommender system that involves interactive conversations between users and the system to gather detailed product information according to their specific needs and preferences [8]. Through iterative interactions between the system and users, CRS aims to facilitate a more efficient and natural product selection process, ensuring users receive personalized recommendations aligned with their preferences [9].

CRS employs two navigation strategies: Navigation by Asking (NBA) and Navigation by Proposing (NBP). These strategies are combined to create a natural and engaging dialogue resembling a customer's interaction with a professional sales support [10]. By leveraging ontology and user profile models, the system seamlessly switches between asking questions and proposing products, enhancing the conversational experience and delivering personalized recommendations. Narducci et al. [11] developed a chatbot-based CRS specifically for the music domain, incorporating various interaction modes. LW Dietz et al. [12] designed a travel recommender system that focuses on understanding individual users' interests and constraints. It utilizes data driven techniques to analyze user reviews, ratings, and destination descriptions, extracting knowledge about unique location features. Filip Radlinski et al. [13] proposed a theoretical framework for conversational search, combining information retrieval principles and human-computer interaction. However, the framework's performance is limited due to the absence of crucial components such as relevance feedback and dialogue management.

In CRS, knowledge representation plays a vital role in facilitating effective recommendation processes. By using ontology-based representation, CRS leverages domain information, user profiles, and contextual data to better understand user preferences [9]. This precise interpretation of user inputs enables CRS to generate meaningful interactions and provide personalized recommendations that meet user needs [14]. Incorporating knowledge-based representation ensures the delivery of highly relevant and customized recommendations, enhancing user experience and satisfaction. M. Guia et al. [15] propose an innovative approach in the e-commerce domain, utilizing ontologies to represent knowledge about users, products, and their relationships. By combining KNN algorithms, collaborative filtering, and ontology-based techniques, they address limitations in traditional recommendation systems, offering enhanced recommendations and personalized experiences. B. Mbaye [16] proposed a system that integrates ontology-based collaborative filtering techniques in e-learning. This system aims to provide highly personalized recommendations, improve prediction accuracy, and overcome challenges like cold-start problems. It involves developing a comprehensive ontology to capture learner knowledge, resources, and patterns, leveraging collaborative filtering and ontological domain knowledge to significantly improve recommendation accuracy.

Previous research has introduced a CRS framework capable of recommending products based on user's functional requirements [17]. The framework aims to assist users in selecting products that meet their needs by engaging in dialogue and understanding their preferences. Unlike previously developed recommender systems that focus on technical features, this framework takes into account the functional requirements of users and their preferences. By combining NBA and NBP [10] for natural interaction and utilizing of ontology-based knowledge representation [18] the system establishes a mapping between functional requirements and product technical features, creating a simulation of a customer's interaction with a professional sales support. This simulation aims to deliver a recommendation experience that feels natural and effective. Baizal et al. [19] Use the ontology structure and explore semantic relationships to narrow the search space and increase efficiency. The system interacts with users by providing options for functional requirements and optimized queries based on user preferences. In this study, we utilize of the framework to propose CRS-based functional requirements for the bicycle domain. Given the multifaceted nature of bicycles and their extensive range of specifications and features, this recommender system serves as a valuable tool for users to select a bicycle, eliminating the requirement for them to possess in-depth knowledge of the intricate technical aspects associated with bicycles