

Chapter 2

System and Software Quality Requirements of AI Systems

Murat Pasa Uysal

 <http://orcid.org/0000-0002-8349-9403>

Baskent University, Turkey

ABSTRACT

The data-driven and black-box nature of artificial intelligence (AI) systems have made the specification and evaluation of their requirements more intricate than other systems. A neglected topic is adopting a holistic approach to the quality requirements of AI systems. These systems also can lack explainability due to their architecture and the complexity of learning models. Therefore, modeling the quality requirements of AI systems can offer various benefits for successful design and development. In a case study, the internal quality requirements of an AI-integrated e-commerce system are modeled according to the Systems and Software Quality Requirements and Evaluation standard. The maintainability quality characteristic and its modularity sub-characteristic formed the quality focus. Systems Modeling Language offered rich semantics for capturing different aspects of the quality requirements. It is hoped that this holistic and integrated quality approach will enhance the construction of AI systems by ensuring high-quality specifications and more accurate and trustworthy AI solutions.

INTRODUCTION

The rapid advancements in software and innovative technologies, coupled with the progress in artificial intelligence (AI), data science, and machine learning (ML), have led to the development of integrated and sophisticated systems. AI systems continuously reshape various domains within our community, including industry, healthcare, business, and finance, etc. In the industrial domain, AI applications are changing traditional manufacturing processes, enhancing productivity, and reducing operational costs. AI-enabled healthcare systems experience significant advancements in the healthcare domain, and transform healthcare practices, medication, patient care, and diagnostic processes (Uysal, 2021). In the business domain, AI enables data-driven decision-making by providing insights into market trends and consumer behavior while empowering this domain to adapt and succeed in a rapidly changing market-

DOI: 10.4018/403119

Copyright ©2026, IGI Global Scientific Publishing. Copying or distributing in print or electronic forms without written permission of IGI Global Scientific Publishing is prohibited. Use of this chapter to train generative artificial intelligence (AI) technologies is expressly prohibited. The publisher reserves all rights to license its use for generative AI training and machine learning model development.

place. In the financial domain, AI solutions are utilized for stock trading, risk assessment, and fraud detection to improve financial decision-making processes.

Despite their popularity and notable success stories, AI-integrated systems may face significant challenges such as unrealistic expectations, overestimation of business objectives, and therefore, an increased risk of failure. A critical but often neglected topic is adopting an approach, standard, or framework for the quality requirements of AI systems (Horkoff, 2019). Functional quality requirements define what a system should do, and thus focus on ensuring the behaviors are correct and aligned with specifications (ISO/IEC/IEEE 29148, 2018). On the other hand, non-functional quality requirements define how a system should perform, focusing on aspects such as efficiency, compatibility, reliability, security, maintainability, usability, etc. (ISO/IEC 25000, 2014). Issues like inappropriate or missing data values, imbalanced data, and data drift can also negatively impact AI systems' performance and quality (Zhang et al. 2020; Caballero et al., 2022). Overlooking these issues can impede the reliability, robustness, and effectiveness of AI-integrated solutions across different contexts and use cases. Therefore, a comprehensive quality framework would enable not only a holistic approach to AI system quality but also integration with the requirements of other system components and regulatory compliance (Uysal, 2022).

Traditional software systems are deterministic where the same input produces the same output, and their outputs are consistent and predictable. Generally, they are transparent and explainable, with clear logic and workflows. The code structure provides a clear path to understanding how the software works. Maintenance of software applications involves updating source code, fixing bugs, and adding new features. The quality of traditional software systems is measured by compliance with predefined functional and non-functional requirements using software engineering metrics. Therefore, quality assurance focuses on system behavior and source code correctness. On the other hand, AI systems focus on AI-related tasks, and they can be standalone or integrated into a broader system, existing workflows, and processes. They are developed using ML or deep learning methods and techniques, where models are trained on data to learn patterns and make predictions. AI systems heavily depend on data processing and large datasets for training the learning models, validation, and testing procedures. The quality and representativeness of the data are critical to AI system performance and reliability. Therefore, quality assurance techniques mainly include data preprocessing, feature engineering, validation, and verification to ensure accuracy and reduce bias. These systems also can lack explainability due to their architecture and the complexity of underlying learning models. Therefore, issues such as ethics, bias, and fairness are essential due to the potential for biased outcomes and unintentional results.

Another significant issue may be the insufficient emphasis on adequately representing and modeling the quality requirements of AI systems (Ali et al., 2022). The complexity of AI systems has made the specification and evaluation of quality requirements even more complicated compared to traditional software systems. Modeling a system can, therefore, offer a range of benefits that can contribute to its successful design, development, deployment, and maintenance (OMG, 2017). It can also help stakeholders better understand the system's structure and behavior, fostering improved clarity, insight, and confidence. Thus, this deeper understanding can lead to better outcomes. For AI engineers, modeling offers an enhanced understanding of AI algorithms and models, facilitates collaboration and knowledge sharing, and enables experimentation and streamlined development processes. Similarly, for software engineers, modeling ensures clear requirements definition, promotes standardized development practices and facilitates debugging and testing, which leads to more robust and reliable software solutions. Business stakeholders can also benefit from modeling the quality as it aligns with business goals and supports communication.

17 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/system-and-software-quality-requirements-of-ai-systems/403119

Related Content

Ethical Issues in Cyber-Security for Autonomous Vehicles (AV) and Automated Driving: A Comprehensive Review

Qais Al-Na'amneh, Mahmoud Aljawarneh, Rahaf Hazaymihand Rabia Emhamed Al Mamlook (2025). *Utilizing AI in Network and Mobile Security for Threat Detection and Prevention* (pp. 173-196).
www.irma-international.org/chapter/ethical-issues-in-cyber-security-for-autonomous-vehicles-av-and-automated-driving/375616

The Age of Ransomware: Understanding Ransomware and Its Countermeasures.

Muhammad Ubale Kiruand Aman B. Jantan (2021). *Research Anthology on Artificial Intelligence Applications in Security* (pp. 37-66).
www.irma-international.org/chapter/the-age-of-ransomware/270591

Enhanced Semantic Segmentation for Identifying Plant Leaf Disease: A Deep Learning Approach

N. Sasikaladevi, S. Surekaaand Dhivyabharathi A. J. (2026). *Exploring Generative AI for Collaborative Robots in Agriculture 6.0* (pp. 281-312).
www.irma-international.org/chapter/enhanced-semantic-segmentation-for-identifying-plant-leaf-disease/388096

User Experience in Social Human-Robot Interaction

Beatrice Alenljung, Jessica Lindblom, Rebecca Andreassonand Tom Ziemke (2017). *International Journal of Ambient Computing and Intelligence* (pp. 12-31).
www.irma-international.org/article/user-experience-in-social-human-robot-interaction/179287

Measuring Waste Recyclability Level Using Convolutional Neural Network and Fuzzy Inference System

Rawan Ghnematand Adnan Shaout (2022). *International Journal of Intelligent Information Technologies* (pp. 1-17).
www.irma-international.org/article/measuring-waste-recyclability-level-using-convolutional-neural-network-and-fuzzy-inference-system/306969