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AI AS AN ALLY OR A THREAT: CHALLENGES AND PROSPECTS FOR QA ENGINEERS

Abstract: This article examines the impact of artificial intelligence (AI) on quality assurance (QA) processes in software engineering, highlighting its role as both an ally and a potential threat. AI, used for test automation, enhances the efficiency and accuracy of QA but also introduces risks associated with job reduction and ethical issues. The main part of the article focuses on analyzing examples from the practices of major companies such as Microsoft, Alibaba, and Google, demonstrating successful applications of AI in improving QA processes. At the same time, cases where the implementation of AI led to failures are considered, emphasizing the importance of thorough testing and adaptation of AI systems.

Key words: artificial intelligence, AI, quality assurance, QA, software testing, test automation, ethical considerations, AI integration, risk management.

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Introduction

Artificial intelligence (AI) is increasingly becoming a fundamental component of modern software testing (SWT) and quality assurance (QA) processes. This transformation is driven by the need for more efficient, accurate, and reliable testing methodologies that can keep pace with the rapid evolution of software development practices. As AI technologies advance, they offer significant potential to enhance the capabilities of QA engineers by automating routine tasks, optimizing test coverage, and facilitating the identification of defects that might be overlooked by human testers.

The incorporation of AI into QA presents a dual perspective: AI as an ally and AI as a potential threat. As an ally, AI can dramatically improve the precision of testing processes, reduce time-to-market, and assist QA engineers in managing complex test environments. Conversely, the integration of AI may pose risks related to job displacement, ethical considerations, and the potential for introducing new kinds of errors in SWT.

The goal of this article is to critically examine the roles of AI in QA, evaluating both the opportunities it presents and the challenges it poses to QA engineers.

Main part

AI is profoundly influencing all aspects of life, including the realm of software development, where it is revolutionizing how programs are designed, tested, and deployed, reshaping traditional methodologies with its advanced capabilities. According to Statista, the AI market size is expected to grow from USD 241.8 billion in 2023 to nearly USD 740 billion by 2030, representing a compound annual growth rate of 17.3% [1].

During a survey conducted in early 2024 among 3,000 game developers, 44% working in business and finance departments, and 41% in the fields of community, marketing, and PR, reported that they had used generative AI tools in their work (fig.1).

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Figure 1. Share of game developers worldwide who are using generative AI tools in 2024, by department [2].

Although at first glance it may seem that few developers are using AI in QA, this area is highly promising. The interaction between AI and QA engineers plays a pivotal role in evolving SWT methodologies. As AI technologies integrate into QA processes, they not only redefine the role of QA engineers by augmenting traditional capabilities with advanced analytics and predictive mechanisms but also significantly enhance the efficiency of defect identification and resolution. This shift requires QA professionals to transform their skill sets, combining their technical expertise with a profound understanding of AI principles to effectively manage and optimize these advanced systems.

AI stands as a formidable ally in the realm of QA, offering transformative capabilities that redefine the efficacy and scope of testing practices. By leveraging AI, QA processes are not only automated but are also enhanced with predictive analytics and intelligent decision-making tools. This integration facilitates more thorough testing, quicker identification of potential defects, and smarter resource allocation.

The utilization of AI for testing automation represents a significant leap forward in optimizing the software development lifecycle. AI technologies, particularly in machine learning and natural language processing, are applied to automate the generation, execution, and analysis of test cases [3]. This automation extends beyond mere replication of human actions to include the dynamic adaptation to changes in the application's interface or underlying functionality. For instance, AI-driven tools such as Testim and mabl utilize self-learning algorithms to adjust test scripts automatically when a user interface element changes location or style, thus maintaining test relevance and accuracy without manual intervention.

AI enhances test coverage and efficiency by identifying untested or under-tested parts of an application. By analyzing existing test results and code changes, AI algorithms can recommend additional test cases or highlight areas of high risk, ensuring that testing efforts are both thorough and focused. Tools like Sealights employ AI to track code coverage across environments and test stages, providing real-time feedback and predictive analytics to improve decision-making in test planning. This

proactive approach not only speeds up the testing process but also significantly reduces the probability of defects making it to production, thereby increasing the overall quality of the software product.

AI tools play a crucial role in **enhancing the efficiency and accuracy** of QA processes. Tools such as Applitools leverage AI for visual validation testing, which automates the detection of UI discrepancies across different devices and operating systems. This approach ensures that visual elements render correctly in various environments, significantly reducing the manual effort required for cross-platform testing. Furthermore, Applitools uses machine learning to distinguish between meaningful visual changes and negligible differences, thereby minimizing false positives and focusing attention on genuine defects [4].

Another notable AI tool is Eggplant, which utilizes AI algorithms to optimize test scenarios based on user behavior and predictive analytics. By simulating a wide range of user interactions, Eggplant can identify potential issues before they affect the end-user experience. This capability not only improves the accuracy of tests but also helps developers understand how changes in code affect user interactions. Additionally, Eggplant's AI-driven approach adapts to changes in user behavior over time, ensuring that testing remains relevant as the application evolves and user expectations change. This dynamic adaptation is key to maintaining long-term usability and satisfaction in software applications.

AI significantly enhances the capabilities of debugging and monitoring within software development, contributing to more robust and efficient systems. AI-powered debugging tools, such as Rookout, facilitate real-time data extraction and analysis from live code, enabling developers to pinpoint and resolve issues without halting the system or writing additional code. This immediate feedback accelerates the debugging process, reduces downtime, and improves overall code health. Rookout's ability to deploy dynamic breakpoints provides insights into the execution flow and data state, which are crucial for diagnosing complex, intermittent bugs that are difficult to replicate in a test environment.

In the **realm of monitoring**, **AI technologies** are important for maintaining system performance and reliability in real-time operating environments [5].

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Tools like Dynatrace use AI to perform automatic root cause analysis when anomalies are detected, quickly tracing issues back to specific changes in the system or application code. This not only speeds up the resolution process but also helps in preventing future occurrences by learning from past incidents. Dynatrace integrates with the development pipeline to provide continuous feedback, ensuring that deployments do not introduce new performance bottlenecks or regressions. This seamless integration of AI into monitoring tools transforms traditional reactive approaches into proactive system management, substantially enhancing operational efficiency and system resilience.

The integration of AI into QA processes marks a significant advancement in SWT, profoundly enhancing both the efficiency and effectiveness of these processes. AI's capabilities in automating complex testing procedures, refining debugging and

monitoring techniques, and leveraging advanced analytics to enhance decision-making underscore its role as a crucial ally in QA. By streamlining workflows and predicting potential issues before they escalate, AI not only boosts productivity but also elevates the quality of software products, ensuring that they meet the dynamic and demanding standards of modern technology landscapes.

AI as a threat in QA

While AI presents numerous benefits to QA processes, its integration is not without potential risks. These risks can impact not only the operational aspects of QA but also pose broader ethical and employment-related concerns. As AI systems take on more complex and critical tasks traditionally handled by human engineers, the implications of these changes must be carefully considered. Table 1 outlines some of the potential risks associated with the use of AI in QA for engineers.

Table 1. Potential risks of AI in QA for engineers [6, 7].

Risk category	Description	Example impact
Job displacement	AI automation could lead to a reduction in demand for traditional QA roles.	Reduction in QA staff as AI takes over manual testing tasks.
Over-reliance on AI	Excessive dependence on automated systems may decrease skill development.	Engineers may lose critical problem-solving skills in troubleshooting and test design.
Misalignment of outcomes	AI may not align perfectly with complex human needs or business goals.	AI-driven tests might overlook context-specific requirements leading to product issues.
Ethical and bias issues	AI systems can inherit or even amplify biases present in their training data.	Automated decisions may favor or discriminate against certain user groups, leading to fairness concerns.
Security vulnerabilities	AI systems themselves can be targets for cybersecurity threats.	Compromised AI could lead to wider systemic failures, impacting overall software security.

The deployment of AI in QA, while innovative, introduces several risks that necessitate vigilant management and ethical considerations. The concerns about job displacement are not unfounded, as evidenced by companies like IBM and Oracle, which have increasingly incorporated AI into their QA processes, potentially reducing the need for human testers. Furthermore, the reliance on AI has sometimes led to significant oversight in product testing phases, as seen in instances where automated systems failed to capture end-user issues that a human tester might have noticed.

These examples underline the necessity for QA engineers to maintain a critical oversight role and for companies to develop robust frameworks that ensure AI tools are used responsibly and complementarily within QA [8]. As AI continues to evolve, it will be

crucial to balance its integration with safeguarding the professional integrity and ethical standards of QA practices.

Case study: AI integration in QA processes

Microsoft has implemented AI in testing its software products, particularly Windows. By utilizing AI, Microsoft has managed to automate the identification of bugs and security vulnerabilities, significantly speeding up the QA process while ensuring that the software meets high-quality standards before release. This automation not only reduces the workload on human testers but also allows for more frequent updates and patches, ensuring better product stability and security.

Alibaba, a major player in the e-commerce and cloud computing sectors, has developed an AI-powered platform for automated testing services,

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which efficiently manages the scale and complexity of their applications. This platform, named «AITest», leverages deep learning to optimize test case design and predicts the most effective testing strategies based on historical data. By implementing AI in their QA processes, Alibaba has improved the accuracy of their tests and reduced the time and resources spent on manual testing, thereby enhancing product releases and customer satisfaction.

Google, on the other hand, has leveraged AI in testing Android apps on a massive scale. Their approach involves using AI to simulate a wide range of user interactions to test apps on numerous Android devices and ensure that they perform well across different hardware and software configurations. This not only helps in catching complex interaction bugs but also aids in understanding how different users might experience the app across various devices.

While AI has demonstrated substantial success in enhancing QA processes, its integration has not always yielded positive results. Several notable instances illustrate the challenges and setbacks that can occur when AI is not effectively implemented or managed:

Knight Capital, a financial services firm, experienced a devastating software malfunction just after deploying a new AI-driven trading algorithm. The AI system was intended to automate the trading process and enhance the company's performance on the stock market. However, due to a faulty deployment that included an obsolete piece of software, the AI algorithm executed unintended trades worth \$7 billion in just 45 minutes, ultimately leading to a loss of \$440 million for the company [9]. This incident highlights the critical importance of thoroughly testing and vetting AI-driven systems in QA processes before they are deployed in such high-stakes environments.

Amazon attempted to implement an AI-driven tool aimed at automating the recruitment process by screening job applications. The AI was trained on data from resumes submitted over a 10-year period. However, this AI system developed a bias against female candidates, primarily because it was trained on resumes predominantly from male candidates, reflecting the male dominance in the tech industry. As a result, the system unfavorably rated resumes that included the word «women's» such as in «women's chess club captain». The bias was so ingrained that Amazon decided to abandon the project after efforts to correct the bias proved unsuccessful. This case underscores the challenge of unintended bias in AI systems and the difficulty of eliminating such biases once they have been introduced.

Although not a QA-specific tool, **Microsoft's AI chatbot Tay** serves as a cautionary tale relevant to all AI deployments. Launched on Twitter, Tay was

designed to learn from conversations with Twitter users and autonomously generate responses [10]. However, within 24 hours of going live, Tay began producing offensive and inappropriate messages, influenced by interactions with users who deliberately fed the chatbot inflammatory language. Microsoft quickly took Tay offline. This incident illustrates the risks associated with AI systems that learn in real-time from uncontrolled environments – a concern for any QA engineer looking to implement AI systems that interact dynamically with real-world data.

Looking towards the future, the integration of AI in QA is anticipated to deepen, driven by advancements in AI technology and an increasing demand for more sophisticated, efficient, and reliable software systems. The trajectory suggests a move towards fully automated QA processes capable of self-learning and adapting to new challenges without human intervention. This evolution will likely see AI not only detecting and rectifying errors but also predicting potential failures before they occur, thus shifting the focus from reactive to proactive QA. As AI tools become more intuitive and capable, QA engineers will need to pivot from traditional roles to become orchestrators of AI, overseeing the deployment, management, and refinement of AI systems.

For QA engineers, this evolving landscape offers both challenges and opportunities. It will be essential for QA professionals to enhance their skills in areas such as AI and machine learning, software development, and systems engineering. Understanding the underlying principles and mechanisms of AI will be crucial in effectively managing and guiding AI operations within QA.

Conclusions

The integration of AI in QA processes across various industries has demonstrated transformative outcomes, enhancing the efficiency, accuracy, and scalability of testing operations. Successful implementations, as seen in companies like Microsoft, Alibaba, and Google, underscore the potential for AI to significantly augment QA processes by automating complex tasks, optimizing testing strategies, and ensuring software robustness across diverse platforms. However, the journey is not devoid of challenges. Instances of unsuccessful AI deployments, such as those experienced by Knight Capital, Amazon, and Microsoft's Tay, serve as crucial reminders of the complexities inherent in AI applications. These examples highlight the necessity for meticulous planning, thorough testing, vigilant monitoring, and ongoing adjustments to AI systems within QA environments to avoid costly errors and ensure that AI tools effectively support and enhance the QA objectives rather than undermining them.

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