Exposé for the bachelorthesis

in the study program

Wirtschaftsinformatik - Business Information Systems

Bachelor of Science (B.Sc.)

about the topic

Analysis of the potential of AI-tools in software development

written by

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Contents

Abbreviations

SWOT-Analysis   Strengths, weaknesses, oppotrunities and threats analysis

1 Introduction

Artificial intelligence is currently considered one of the most important innovations that are being worked on worldwide.[1] It is without question that the software development market has become one of the biggest ever existing with revenues of more than 420 billion US dollars generated by software publishers in 2021.[2] 33 percent of the US's top 15 largest companies by revenue are directly involved in software development.[3] Eventhough the software industry is known for their high margins, the costs in 2021 sum up to round about 280 billion, leaving only 144 billion in returns.[4]

Beside the software development market growing rapidly over the last years, the AI market experienced a massive rise of interest and investments in the beginning of 2023. This rise can be explained by the technology called ChatGPT disrupting the market and creating exposure for jobs in a wide variety of industries. The technology however did not only create exposures, it also brought up the question of how AI may change and improve certain fields of industries, one of them being the software development market.[5]

This brings up the question of how AI-tools built for software development may change the development process and what chances as well as risks they bring with them when being used to create software. In greater detail, it is in question of how much AI can take over in the process whether it's just writing single lines of code per instruction or creating whole software ecosystems by a non-technical user explaining his requirements.

It comes up to question what skills an artifical intelligence can adopt and maybe even take to a next level in comparison to skilled software developers. Especially the soft skills involve social behavior for communication and collaboration which an AI has to master in order to perform in the software development industry.

When analysing the potential of AI-tools in software development these questions have to be answered. To do so, the bachelor-thesis will focus on the quality an AI can provide and the skills it can adopt.

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[1]cf. Ulrich and Frank, 2021, p. 2152f.
[2]cf. Vailshery, 2022.
[3]cf. Alda and Biagi, 2022.
[4]cf. Watson, 2023.
[5]cf. Alda and Biagi, 2023.

2 Alternative titles and topic selection

AI-tools used in software development are the primary topic for the thesis. They however can be adopted to take a deeper look into different aspects. Hence, there are some alternative titles that were taken into consideration when defining the scope of the bachelor-thesis:

- Strengths and weaknesses when using AI while developing software

- Analysis of AI's capabilities when designing a software architecture

- Evaluation of code integrity risks when using SaaS-AI tools

- Marketanalysis of low-code software creation tools using AI

All the listed topics take a look at AI tools when either creating or designing a software. The key difference is the perspective they are using, be it either for the companies risk management or the requesters of new software or of course the software developers themselves. When reviewing the literature and evaluation of the approach on each of the topics, the thesis-topic "Analysis of the potential of AI-tools in software development" was choosen. This topic is specialised enough to make use of the existing literature while being holistic enough to cover multiple subtopics like architecture, development efficiency and user experience.

3 Research questions and objectives

In order to approach the topic scientifically, research questions have to be defined, the main research objective is the analysis of the potential of AI-tools in software development. To specify this objective, the following sub-questions are to be answered in the thesis:

- How do different user groups, including software developers, testers, and inexperienced users, perceive and accept AI-tools in software development?

- Of what quality is the provided software code in different testing scenarios?

- Which roles in the software development process can be supported or replaced by AI-tools?

With the help of these questions, the topic can be answered sufficiently so the main objectives are reached. One of the main objectives is to find out wether the technology is user friendls enough. Additionally, it should be known if the tools are really helpful in the reality and for which roles.

4 Methods and approach

To reach the set research objectives for the bachelor thesis, there will be multiple methods used. The primary research methods will be the conducting of a technology acceptance model and the fulfillment of a SWOT analysis. In addition the literature search is also part of the thesis. In greater detail, the methods are defined as follows:

- To find suitable literature, the literature search will be performed as described by a publiction from Mr. Brocke. This method will be used extensivly for the thesis and is also used in this exposé in a smaller form.[6]

- As AI-tools are new to the most people, it is especially interesting to find out whether such tools will be accpted by potential users. For this the technology acceptance model by Fred Davis will be used.[7]

- To identify the strengths and weaknesses of Github copilot, a SWOT analysis will be conducted to take a look at the tools current features and evaluate the potential it could create.

5 Preliminary structure of the bachelor thesis

The thesis will be splitted up into four major parts, the introduction, the fundamentals, the analysis itself and the conclusion. The introduction will highlight the problem and will list the research questions and the papers goal. The introduction are followed by the fundamentels in which the AI-tools are explained, it is highlighted how their integration is working. Additionally, the used scietntif model will be explained. Once the fundamentals have been laid, the analysis will continue. The analysis is divided into three sub-analysis, one being the categorisation of Github Copilot in the technology acceptance model. Next Github Copilots quality will be tested with pre-defined test cases. To round the analysis up, a typical SWOT-Analysis will be conducted to identify current strengths and weaknesses and future opportunities and threats. The expected pages per topic are listed below:

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[6]cf. Brocke et al., 2009.
[7]cf. Davis, 1985.

Chapter	Number of pages
I. Abbreviations	
II. List of figures	
III. List of tables	
1. Abstract	**1 page**
2. Introduction	**6 pages**
2.1 Motivation	2 pages
2.2 Problem statement and goal setting	1 page
2.3 Research questions and approach	2 pages
2.4 Structure of the thesis	1 page
3. Fundamentals	**4 pages**
3.1 ChatGPT	1 page
3.2 Visual Studio Code	1 page
3.3 Github Copilot	1 page
3.4 Technology acceptance model	1 page
4. Analysis of Github Copilot in software development	**16 pages**
4.1 Technology acceptance analysis of Github Copilot	3 pages
4.2 Performance of Github Copilot against defined test cases	5 pages
4.3 Strengths and weaknesses of Github Copilot	4 pages
4.4 Oppotunities and threats of Github Copilot	3 pages
4.5 Analysis results and summmary	1 pages
5. Critical assessment and conclusion of AI's use in the software development process	**2 pages**

6 Literature review

For the bachelor thesis there is literature needed that fulfills certain scientifical quality criterias. In order to pre-evaluate the literature, a corresponding literature will be conducted. For this, a modified review method from Mr. Brocke will be used.[8]

In order to find suitable literature, the following four plattforms for literature search will be used:

- Google Scholar (https://scholar.google.com)

- EBSCO Discovery Service (https://eds.s.ebscohost.com)

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[8]vgl. Brocke et al., 2009.

- ScienceDirect (https://www.sciencedirect.com)

- Springer Link (https://link.springer.com)

- Emerald Insights (https://www.emerald.com/insight/)

- Wiley Online Library (https://onlinelibrary.wiley.com/)

With the help of pre-defined search queries, fitting literature should be found on these plattforms. For this bachelor thesis, the following search strings were developed:

- A: *"development" AND ("AI" OR "Artificial Intelligence" OR "ChatGPT" OR "language model")*
  The goal of this query is to find holistic literature in regards to software development with the help of artificial intelligence.

- B: *"Github Copilot" AND ("AI" OR "Artificial Intelligence" OR "ChatGPT" OR "language model")*
  This query focuses on Github Copilot as an AI tool which is relevant for the SWOT-analysis.

- C: *"Github Copilot" AND ("accuracy" OR "efficiency" OR "success rate")*
  This query searches for the copilot tool and hints towards results and accuarcy ratings which is crucial to bring in when evaluating the self-conducted test cases against other test case results.

To evaluate whether the literature found on the plattforms with the given search query is sufficient for using in scientific papers, their H and Q indexes will be used. Documents having an H index over 50 are highlighted.

Search Portal	Search Query	Journal	H	Q	Citation
Science Direct	A	Journal of Hospitality, Leisure, Sport and Tourism Education	34	2	Keiper, M. C., Fried, G., Lupinek, J., & Nordstrom, H. (2023). Artificial intelligence in sport management education: Playing the AI game with ChatGPT. Journal of Hospitality, Leisure, Sport & Tourism Education, 33, 100456. doi.org/10.1016/j.jhlste.2023.100456
Science Direct	A	Nurse Education Today	**92**	1	Choi, E. P. H., Lee, J. J., Ho, M.-H., Kwok, J. Y. Y., & Lok, K. Y. W. (2023). Chatting or cheating? The impacts of ChatGPT and other artificial intelligence language models on nurse education. Nurse Education Today, 125, 105796. doi.org/10.1016/j.nedt.2023.105796
Science Direct	A	Joint Bone Spine	**88**	2	Thiébaut, R., Hejblum, B., Mougin, F., Tzourio, C., & Richert, L. (2023). Chat-GPT and beyond with artificial intelligence (AI) in health: Lessons to be learned. Joint Bone Spine, 90(5), 105607. doi.org/10.1016/j.jbspin.2023.105607
Science Direct	A	Journal of Pediatric Surgery	**137**	1	Xiao, D., Meyers, P., Upperman, J. S., & Robinson, J. R. (2023). Revolutionizing Healthcare with ChatGPT: An Early Exploration of an AI Language Model's Impact on Medicine at Large and its Role in Pediatric Surgery. Journal of Pediatric Surgery. doi.org/10.1016/J.JPEDSURG.2023.07.008
Science Direct	A	Molecular Therapy - Nucleic Acids	**84**	1	Chatterjee, S., Bhattacharya, M., Lee, S.-S., & Chakraborty, C. (2023). Can artificial intelligence-strengthened ChatGPT or other large language models transform nucleic acid research? Molecular Therapy - Nucleic Acids, 33, 205–207. doi.org/10.1016/j.omtn.2023.06.019
Science Direct	A	Journal Francais d' Ophtalmologie	33	3	Panthier, C., & Gatinel, D. (2023). Success of ChatGPT, an AI language model, in taking the French language version of the European Board of Ophthalmology examination: A novel approach to medical knowledge assessment. Journal Français d'Ophtalmologie, 46(7), 706–711. doi.org/10.1016/j.jfo.2023.05.006

Search Portal	Search Query	Journal	H	Q	Citation
Google Scholar	A	Journal of Physics: Conference Series	**91**	4	Xie, M. (2019, April). Development of artificial intelligence and effects on financial system. In Journal of Physics: Conference Series (Vol. 1187, No. 3, p. 032084). IOP Publishing.
Google Scholar	A	International Journal of Computer Integrated Manufacturing	**63**	1	Alexopoulos, K., Nikolakis, N., & Chryssolouris, G. (2020). Digital twin-driven supervised machine learning for the development of artificial intelligence applications in manufacturing. International Journal of Computer Integrated Manufacturing, 33(5), 429-439.
Google Scholar	A	2016 International Conference on Information Science and Communications Technologies	6	-	Raximov, N., Primqulov, O., & Daminova, B. (2021, November). Basic concepts and stages of research development on artificial intelligence. In 2021 International Conference on Information Science and Communications Technologies (ICISCT) (pp. 1-4). IEEE.
Google Scholar	A	Dentomaxillofacial Radiology	**82**	1	Putra, R. H., Doi, C., Yoda, N., Astuti, E. R., & Sasaki, K. (2022). Current applications and development of artificial intelligence for digital dental radiography. Dentomaxillofacial Radiology, 51(1), 20210197.
Google Scholar	A	International Conference on Software, Telecommunications and Computer Networks, SoftCOM	7	-	Lwakatare, L. E., Crnkovic, I., & Bosch, J. (2020, September). DevOps for AI–Challenges in Development of AI-enabled Applications. In 2020 international conference on software, telecommunications and computer networks (SoftCOM) (pp. 1-6). IEEE.
Springer Link	A	International journal of oral science	**58**	1	Huang, H., Zheng, O., Wang, D. et al. ChatGPT for shaping the future of dentistry: the potential of multi-modal large language model. Int J Oral Sci 15, 29 (2023). doi.org/10.1038/s41368-023-00239-y

Search Portal	Search Query	Journal	H	Q	Citation
Springer Link	A	Education and Information Technologies	**61**	1	Jeon, J., Lee, S. Large language models in education: A focus on the complementary relationship between human teachers and ChatGPT. Educ Inf Technol (2023). doi.org/10.1007/s10639-023-11834-1
Springer Link	A	European Journal of Nuclear Medicine and Molecular Imaging	**177**	1	Alberts, I., Mercolli, L., Pyka, T. et al. Large language models (LLM) and ChatGPT: what will the impact on nuclear medicine be?. Eur J Nucl Med Mol Imaging 50, 1549–1552 (2023). doi.org/10.1007/s00259-023-06172-w
Springer Link	A	Annals of Biomedical Engineering	**150**	2	Lu, Y., Wu, H., Qi, S. et al. Artificial Intelligence in Intensive Care Medicine: Toward a ChatGPT/GPT-4 Way?. Ann Biomed Eng 51, 1898–1903 (2023). doi.org/10.1007/s10439-023-03234-w
EBSCO Discovery Service	A	Journal of Advertising	**126**	1	Huh, Jisu, Michelle R. Nelson, and Cristel Antonia Russell. 2023. "ChatGPT, AI Advertising, and Advertising Research and Education." Journal of Advertising 52 (4): 477–82. doi.org/10.1080/00913367.2023.2227013.
Emerald Insights	B	Journal of Business Strategy	45	2	Ritala, P., Ruokonen, M. and Ramaul, L. (2023), "Transforming boundaries: how does ChatGPT change knowledge work?", Journal of Business Strategy, Vol. ahead-of-print No. ahead-of-print. doi.org/10.1108/JBS-05-2023-0094
Emerald Insights	B	RAUSP Management Journal	13	2	Isabella, G., Almeida, M.I.S.d. and Mazzon, J.A. (2023), "Editorial: One-way road: the impact of artificial intelligence on the development of knowledge in management", RAUSP Management Journal, Vol. 58 No. 3, pp. 249-255. doi.org/10.1108/RAUSP-07-2023-273
Wiley Online Library	B	Journal of Creative Behavior	**64**	1	Vinchon, F., Lubart, T., Bartolotta, S., Gironnay, V., Botella, M., Bourgeois, S., Burkhardt, J.-M., Bonnardel, N., CORAZZA, G. E., Glaveanu, V., Hanson, M. H., Ivcevic, Z., Karwowski, M., Kaufman, J. C., Okada, T., Reiter-Palmon, R., & Gaggioli, A. (2023). Artificial Intelligence & Creativity: A manifesto for collaboration. doi.org/10.31234/osf.io/ukqc9

Search Portal	Search Query	Journal	H	Q	Citation
Google Scholar	B	Journal of Systems and Software	**123**	1	Dakhel, A. M., Majdinasab, V., Nikanjam, A., Khomh, F., Desmarais, M. C., & Jiang, Z. M. J. (2023). Github copilot ai pair programmer: Asset or liability?. Journal of Systems and Software, 203, 111734.
Google Scholar	B	IEEE International Working Conference on Mining Software Repositories	**53**	-	Nguyen, N., & Nadi, S. (2022, May). An empirical evaluation of GitHub copilot's code suggestions. In Proceedings of the 19th International Conference on Mining Software Repositories (pp. 1-5).
EBSCO Discovery Service	B	Communications of the ACM	**230**	1	Denning, P. J. (2023). The Profession of IT: Can Generative AI Bots Be Trusted? Communications of the ACM, 66(6), 24–27. doi.org/10.1145/3592981
EBSCO Discovery Service	B	Entropy	**91**	2	Wong, M.-F., Guo, S., Hang, C.-N., Ho, S.-W., & Tan, C.-W. (2023). Natural Language Generation and Understanding of Big Code for AI-Assisted Programming: A Review. Entropy, 25(6), 888. doi.org/10.3390/e25060888
EBSCO Discovery Service	B	Software and Systems Modeling	**55**	2	Cámara, J., Troya, J., Burgueño, L., & Vallecillo, A. (2023). On the assessment of generative AI in modeling tasks: an experience report with ChatGPT and UML. Software and Systems Modeling, 1–13. doi.org/10.1007/s10270-023-01105-5
EBSCO Discovery Service	B	PLoS Computational Biology	**205**	1	Lubiana, T., Lopes, R., Medeiros, P., Silva, J. C., Goncalves, A. N. A., Maracaja-Coutinho, V., & Nakaya, H. I. (2023). Ten quick tips for harnessing the power of ChatGPT in computational biology. PLoS Computational Biology, 19(9), 1–9. doi.org/10.1371/journal.pcbi.1011319

| Search Portal	Search Query	Journal	H	Q	Citation
Science Direct	C	Expert Systems with Applications	**249**	1	Liguori, P., Improta, C., Natella, R., Cukic, B., & Cotroneo, D. (2023). Who evaluates the evaluators? On automatic metrics for assessing AI-based offensive code generators. Expert Systems with Applications, 225, 120073. doi.org/10.1016/j.eswa.2023.120073
Science Direct	C	International Journal of Research in Marketing	**115**	1	Peres, R., Schreier, M., Schweidel, D., & Sorescu, A. (2023). On ChatGPT and beyond: How generative artificial intelligence may affect research, teaching, and practice. International Journal of Research in Marketing, 40(2), 269–275. doi.org/10.1016/j.ijresmar.2023.03.001
Springer Link	C	International Journal on Software Tools for Technology Transfer	**57**	3	Jensen, K., & Podelski, A. (2006). Tools and Algorithms for the Construction and Analysis of Systems. International Journal on Software Tools for Technology Transfer, 8, 177-179.
EBSCO Discovery Service	C	Communications of the ACM	**230**	1	BIRD, C., FORD, D., ZIMMERMANN, T., FORSGREN, N., KALLIAMVAKOU, E., LOWDERMILK, T., & GAZIT, I. (2023). Taking Flight with Copilot. Communications of the ACM, 66(6), 56–62. doi.org/10.1145/3589996
EBSCO Discovery Service	C	Communications of the ACM	**230**	1	Denning, P. J. (2023). The Profession of IT: Can Generative AI Bots Be Trusted? Communications of the ACM, 66(6), 24–27. doi.org/10.1145/3592981
EBSCO Discovery Service	C	Empirical Software Engineering	**85**	1	Mastropaolo, A., Aghajani, E., Pascarella, L., & Bavota, G. (2023). Automated variable renaming: are we there yet? Empirical Software Engineering, 28(2), 1–26. doi.org/10.1007/s10664-022-10274-8

7 Thesis timeline
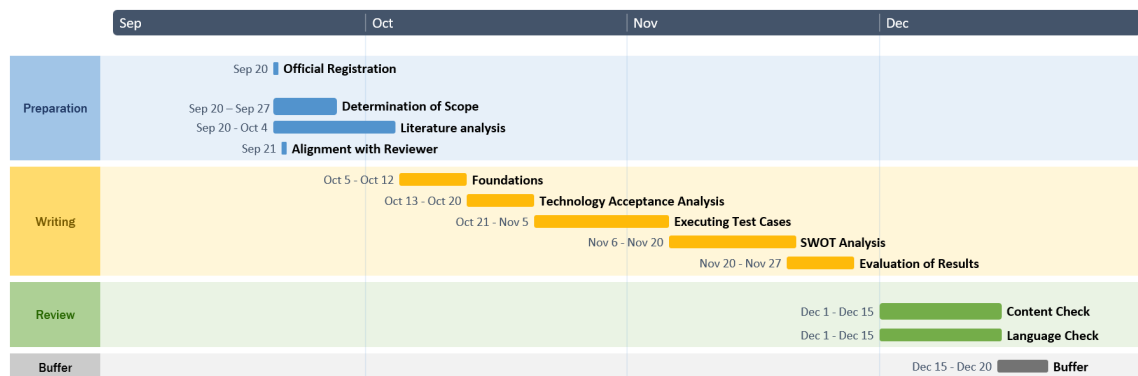
Figure 1: Timeline

The thesis timeline is precisely planned so that the thesis is finished on time and the current progress can be tracked. After registration, the scope will get defined and the literature will be worked out. After the preparations, the writing itself will start. First the foundations will be established to then further perform the technology acceptance analysis. This then is followed with the development and execution of test cases which is needed to next make the SWOT-analysis. Once the major parts are done, the evaluation including the most important results will be written. To fully finish the work on the thesis, the content and language will be checked. Once done, the thesis is ready for being handed in.

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