Diplomarbeit

AI in the Industry and Education Environment

SUBTITITLE

Eingereicht von

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SPERRVERMERK

Auf Wunsch der Firma

HTL Anichstraße

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Kurzfassung /Abstract

Eine Kurzfassung ist in deutscher sowie ein Abstract in englischer Sprache mit je maximal einer A4-Seite zu erstellen. Die Beschreibung sollte wesentliche Aspekte des Projektes in technischer Hinsicht beschreiben. Die Zielgruppe der Kurzbeschreibung sind auch Nicht-Techniker! Viele Leser lesen oft nur diese Seite.

Beispiel für ein Abstract (DE und EN)

Die vorliegende Diplomarbeit beschäftigt sich mit verschiedenen Fragen des Lernens Erwachsener – mit dem Ziel, Lernkulturen zu beschreiben, die die Umsetzung des Konzeptes des Lebensbegleitenden Lernens (LBL) unterstützen. Die Lernfähigkeit Erwachsener und die unterschiedlichen Motive, die Erwachsene zum Lernen veranlassen, bilden den Ausgangspunkt dieser Arbeit. Die anschließende Auseinandersetzung mit Selbstgesteuertem Lernen, sowie den daraus resultierenden neuen Rollenzuschreibungen und Aufgaben, die sich bei dieser Form des Lernens für Lernende, Lehrende und Institutionen der Erwachsenenbildung ergeben, soll eine erste Möglichkeit aufzeigen, die zur Umsetzung dieses Konzeptes des LBL beiträgt. Darüber hinaus wird im Zusammenhang mit selbstgesteuerten Lernprozessen Erwachsener die Rolle der Informations- und Kommunikationstechnologien im Rahmen des LBL näher erläutert, denn die Eröffnung neuer Wege zur orts- und zeitunabhängiger Kommunikation und Kooperation der Lernenden untereinander sowie zwischen Lernenden und Lernberatern gewinnt immer mehr an Bedeutung. Abschließend wird das Thema der Sichtbarmachung, Bewertung und Anerkennung des informellen und nicht-formalen Lernens aufgegriffen und deren Beitrag zum LBL erörtert. Diese Arbeit soll

einerseits einen Beitrag zur besseren Verbreitung der verschiedenen Lernkulturen leisten und andererseits einen Reflexionsprozess bei Erwachsenen, die sich lebensbegleitend weiterbilden, in Gang setzen und sie somit dabei unterstützen, eine für sie geeignete Lernkultur zu finden.

This thesis deals with the various questions concerning learning for adults – with the aim to describe learning cultures which support the concept of live-long learning (LLL). The learning ability of adults and the various motives which lead to adults learning are the starting point of this thesis. The following analysis on self-directed learning as well as the resulting new attribution of roles and tasks which arise for learners, trainers and institutions in adult education, shall demonstrate first possibilities to contribute to the implementation of the concept of LLL. In addition, the role of information and communication technologies in the framework of LLL will be closer described in context of self-directed learning processes of adults as the opening of new forms of communication and co-operation independent of location and time between learners as well as between learners and tutors gains more importance. Finally the topic of visualisation, validation and recognition of informal and non-formal learning and their contribution to LLL is discussed.

Gliederung des Abstract in **Thema**, **Ausgangspunk**, **Kurzbeschreibung**, **Zielsetzung**.

Projektergebnis Allgemeine Beschreibung, was vom Projektziel umgesetzt wurde, in einigen kurzen Sätzen. Optional Hinweise auf Erweiterungen. Gut machen sich in diesem Kapitel auch Bilder vom Gerät (HW) bzw. Screenshots (SW). Liste aller im Pflichtenheft aufgeführten Anforderungen, die nur teilweise oder gar nicht umgesetzt wurden (mit Begründungen).

Erklärung der Eigenständigkeit der Arbeit

EIDESSTATTLICHE ERKLÄRUNG

Ich erkläre an Eides statt, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst, andere als die angegebenen Quellen und Hilfsmittel nicht benutzt und die den benutzten Quellen wörtlich und inhaltlich entnommenen Stellen als solche erkenntlich gemacht habe. Meine Arbeit darf öffentlich zugänglich gemacht werden, wenn kein Sperrvermerk vorliegt.

Ort, Datum Verfasser 1

Ort, Datum Verfasser 1

Inhaltsverzeichnis

Teil I.

Introduction

1. Einleitung

In der Einleitung wird erklärt, wieso man sich für dieses Thema entschieden hat. (Zielsetzung und Aufgabenstellung des Gesamtprojekts, fachliches und wirtschaftliches Umfeld)

1.1. Vertiefende Aufgabenstellung

1.1.1. Schüler*innen Name 1

1.1.2. Schüler*innen Name 2

1.2. Dokumentation der Arbeit

Es werden die Projektergebnisse dokumentiert

- Grundkonzept
- Theoretische Grundlagen
- Praktische Umsetzung
- Lösungsweg
- Alternativer Lösungsweg
- Ergebnisse inkl. Interpretation

Weitere Anregungen:

- Fertigungsunterlagen
- Testfälle (Messergebnisse...)
- Benutzerdokumentation
- Verwendete Technologien und Entwicklungswerkzeuge

2. Introduction: AI in the Industry and Education Environment

Teil II.

Hardware

3. Raspberry PI

4. Server

Teil III.

Theoretical background

5. Used Technologies

5.1. Introduction

5.2. Visual Studio Code

5.3. Vue.js

5.4. firebase

5.5. Github

5.6. Docker

5.7. VPN Tunnel (TailScale)

6. Operating Systems used

7. Used Programming Languages

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7.2. HTML, CSS in combination with Vue.js

7.3. Java Script

7.4. Type Script

8. API and Libraries

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8.1.1. Flask

8.1.2. Flask Cors

8.1.3. Pillow

8.1.4. BytesIO

8.1.5. pytesseract

8.1.6. logging

8.1.7. os

8.2. Vue.js Libraries

8.2.1. OpenAI

8.2.2. Firebase

8.2.3. Vue Router

8.2.4. Axios

8.2.5. MarkdownIt

8.2.6. markdownItKatex

8.2.7. hljs

8.3. Java Script and TypeScript Libraries

8.4. APIs and Services

8.4.1. OpenAI API

Teil IV.

Implementation of Artificial Intelligence

9. Introduction to the used AI Models

For the Diploma thesis, there are many different AI models that are in use. There are different Types of AI models, such as:

- LLMs (Large Language Models)
- Defusion Models (Models that are used to create images)
- Object Detection Models (Models that are used to detect objects in images)
- Face Recognition Models (Models that are used to recognize faces in images)

In the following chapters, the different Types and the used models will be explained in more detail.

9.1. LLMs

– Insert explanation of LLMs here –

source: https://www.ibm.com/topics/large-language-models

9.2. Utilized LLMs

In the context of this diploma thesis, various free and commercial large language models (LLMs) were evaluated to determine their suitability for integration. Leveraging the Ollama application, we were able to test and

compare several LLMs. Additionally, we explored different ChatGPT models available through the OpenAI API. OpenAI offers a range of models that vary in terms of size and complexity, with more advanced models incurring higher usage costs.

Overview - OpenAI API (n.d.)

9.3. Models Accessed via Ollama

For this project, we tested multiple models available through the Ollama application, which can be obtained via the Ollama download server.

Since Ollama operates locally, the selected models needed to meet specific requirements to ensure efficient performance. Consequently, we evaluated models of varying sizes and levels of complexity.

9.3.1. Model Selection Criteria

The selection of models was guided by the following criteria:

- **Model Size:** The model must be capable of running on the server without exceeding available memory capacity.
- **Performance Speed:** The response time of the model, i.e., how quickly it can generate output.
- **Complexity:** The model's ability to handle complex prompts and generate coherent, contextually accurate text.
- **Accuracy:** The overall precision of the model's responses, particularly in terms of factual correctness and linguistic quality.
- **Language Support:** The model's proficiency in understanding and generating text in multiple languages, particularly English and German.
- **User Experience:** The model's overall usability and user-friendliness, including ease of integration and customization.

There is often a trade-off between these criteria. Larger models tend to exhibit higher accuracy and greater contextual understanding but are generally slower and require more computational resources.

9.3.2. Challenges in Model Testing and Updates

A notable challenge is the rapid pace at which new models are released, making it difficult to continuously integrate and thoroughly evaluate the latest advancements. Regular testing and updates are essential to ensure the integration of state-of-the-art models.

Finding the right questions some questions cant be answered by some models some models are better at answering some questions

9.3.3. Model Selection for the Final Application

In the final implementation, users are provided with a curated list of recommended models from which they can select their preferred option. This list was carefully compiled based on our comprehensive testing and reflects the models that demonstrated the best balance between performance, accuracy, and resource efficiency.

For the production version of the application, this list must be updated periodically to include newly released models and maintain optimal performance.

9.3.4. Models Evaluated During Testing

A detailed comparison of the models tested during the evaluation phase is provided in the following sections, highlighting their respective strengths and limitations.

9.3.5. Models Integrated into the Final Application

The final selection of models integrated into the application reflects the outcomes of our performance benchmarks and user-centric assessments, ensuring a robust and adaptable solution for end-users.

9.4. Ollama Model Testing and Evaluation

Based on the aforementioned criteria, we conducted an extensive evaluation of the following models:

9.4.1. Quantitative Evaluation Methods

For the quantitative evaluation, we focused on key performance metrics to assess the efficiency and reliability of each model:

- **Response Time:** The time taken by the model to generate a response after receiving input.
- **CPU Usage:** The percentage of CPU resources utilized during model execution.
- **GPU Usage:** The extent to which GPU resources were leveraged to enhance performance.
- **Memory Usage:** The amount of RAM consumed while the model was running.
- **Multiple Choice Question Answering:** The accuracy of the model when answering structured multiple-choice questions.
- **Translation Quality:** Measured using the BLEU (Bilingual Evaluation Understudy) score, which evaluates the similarity between the model-generated translation and a human reference translation. to Wikimedia projects (2006)
- **Text Generation Quality:** Assessed using the ROUGE (Recall-Oriented Understudy for Gisting Evaluation) score to measure the overlap between the generated text and reference texts.

Santhosh (2023)

9.4.2. Qualitative Evaluation Methods

Qualitative evaluation requires human judgment and is inherently resource-intensive. Therefore, our primary focus was placed on the quantitative

evaluation. Nevertheless, we conducted qualitative assessments for specific criteria where human input was indispensable:

- **Contextual Understanding:** The model's ability to interpret and respond accurately to the context of the input text.
- **Factual Correctness:** The accuracy of the factual information provided in the model's output.
- **Linguistic Quality:** The grammatical correctness, fluency, and coherence of the generated text.
- **Emotional Intelligence:** The extent to which the model's output mimics human-like empathy, tone, and emotional nuance.

By combining both quantitative and qualitative evaluation methods, we obtained a comprehensive understanding of each model's strengths and limitations.

10. Ollama

11. hosted Flask Service

11.1. Server structure

12. Studen AI Website

Teil V.

Evaluations

13. Open source evaluation on Economics

13.1. Introduction

13.1.1. What is Open Source?

Open Source represents a collaborative and transparent approach to software development and distribution, where the source code is made publicly accessible. This philosophy empowers users not only to utilize the software but also to modify, improve, and redistribute it freely. By fostering an environment of openness and collaboration, Open Source drives innovation and democratizes access to technology.

Linus Torvalds, the creator of the Linux operating system, encapsulated this spirit of freedom and collaboration with his famous remark:

> *"Software is like sex: it's better when it's free."*

Torvalds (2024)

This statement highlights the fundamental ethos of Open Source—the belief that open access and shared knowledge result in better, more impactful solutions.

The development process for Open Source software is often a collective effort, with contributions from diverse communities of developers, users, and organizations. These collaborative efforts enhance the software's functionality, security, and usability, resulting in products that are robust and adaptable. Prominent examples include the Linux operating system, the

Apache web server, and the Firefox web browser, all of which have significantly influenced technological innovation and market dynamics.

13.1.2. Advantages of Open Source

Open Source software offers a wide range of benefits, making it a cornerstone of modern technology:

- **Cost Efficiency:** Open Source software is typically free of charge, helping organizations and individuals save on licensing and maintenance costs.
- **Flexibility:** Users can access the source code, enabling them to tailor the software to their specific needs and requirements.
- **Security:** The open nature of the source code allows for peer review, ensuring vulnerabilities are identified and addressed promptly.
- **Community Support:** Open Source projects often benefit from vibrant developer communities, providing updates, patches, and user assistance.
- **Innovation:** The collaborative ecosystem of Open Source encourages creativity, leading to groundbreaking solutions and advancements.
- **Compatibility:** Many Open Source projects are designed to integrate seamlessly with existing systems, reducing technical barriers.
- **Transparency:** Open access to the source code ensures that users can understand and verify how the software operates.
- **Freedom:** Users are granted the liberty to use, modify, and share the software without restrictive licensing agreements.

13.1.3. Why Do People Use Open Source?

The adoption of Open Source software is motivated by several compelling factors:

- **Control:** Users gain full control over the software, enabling customization and optimization for specific use cases.

- **Cost Savings:** The absence of licensing fees significantly reduces expenses, making Open Source particularly attractive for startups and educational institutions.
- **Security:** Transparency in the source code allows for thorough auditing, enhancing trust and reliability.
- **Community:** The collaborative spirit of Open Source connects users with knowledgeable communities that share resources and support.
- **Stability:** Many Open Source projects offer long-term support and regular updates, ensuring reliability over time.
- **Skill Development:** Learning and using Open Source tools are valuable in educational and professional contexts, equipping individuals with in-demand skills.

13.1.4. Chapter Overview

This chapter introduces the concept of Open Source and highlights its significance in the modern economy. Key aspects such as the advantages and disadvantages of Open Source, as well as the challenges associated with its adoption and creation, are discussed. Additionally, the chapter explores revenue models within the Open Source ecosystem and its role in economic systems. Finally, the chapter concludes by presenting the Open Source tools utilized in this project, alongside a reflection on the experiences gained through their application OpenSource.com (2024).

13.2. What is and isn't Open Source?

13.2.1. Definition and Guiding Principles

Open Source, as defined by the Open Source Initiative (OSI), is a development approach that prioritizes accessibility and transparency of software source code. It allows users to view, modify, and distribute the code freely, fostering collaboration and innovation.

The OSI outlines several key principles that define Open Source software:

- **Free Redistribution:** The software can be freely shared and distributed without restrictions.
- **Source Code Access:** Users must have access to the source code to study, modify, and improve the software.
- **Modification and Sharing:** Users are allowed to create and share modified versions, as long as they follow the license terms.
- **No Discrimination:** The software must be available for everyone, regardless of individual characteristics or professional field.
- **Neutrality and Compatibility:** The license must not favor specific technologies or restrict the use of other software.

These principles ensure that Open Source remains a transparent, inclusive, and adaptable approach to software development, enabling innovation and collaboration across industries and communities.

Initiative (2007)

13.2.2. Misconceptions About Open Source

Open Source is often misunderstood and confused with other software distribution models, which can lead to misconceptions about its nature, functionality, and benefits. It is crucial to distinguish Open Source from other types of software:

- **Open Source:** Software that is freely accessible, modifiable, and redistributable under an Open Source license, adhering to principles such as transparency and collaboration.
- **Freeware:** Software available at no cost but typically without access to the source code, meaning users cannot modify or redistribute it.
- **Proprietary Software:** Software owned and controlled by a single entity, restricting access to the source code and preventing users from making modifications or redistributions.
- **Commercial Software:** Software sold for profit, which may be either Open Source or proprietary, depending on the licensing terms.

Understanding these distinctions helps users make informed choices about software selection and ensures their expectations align with the capabilities and freedoms provided by the chosen software.

To verify whether a software is truly Open Source, it is essential to examine the license agreement and confirm the availability of the source code. Software with an OSI-approved license is a reliable indicator that it adheres to Open Source principles, providing transparency, freedom, and collaboration opportunities.

One common misconception about Open Source software arises from the phrase "free as in freedom"versus "free as in free beer."While "free as in freedomëmphasizes the liberty to access, modify, and share the software, "free as in free beerßimply denotes that the software is free of cost. Although Open Source software is often available without charge, its true value lies in the freedoms it grants to users, developers, and organizations. This distinction highlights the broader significance of Open Source as a philosophy, not just a pricing model.

Forbes Technology Council (2024)

13.3. The Role of Open Source in Economics

Cost efficiency, innovation, and collaboration are key factors that have positioned Open Source as a cornerstone of modern economic systems. M any industries and organizations utilize Open Source software to reduce costs, increase flexibility, and promote creativity, thereby driving economic growth and sustainability.

13.3.1. Driving Innovation and Shaping Market Dynamics

Open Source software fosters a culture of experimentation, creativity, and knowledge sharing, leading to the rapid development of new technologies and solutions. By granting users access to modify and redistribute the source code, Open Source encourages collaboration and innovation, enabling

individuals and organizations to build upon existing software to create new products and services.

A distinctive strength of Open Source is its inclusivity—anyone, regardless of their affiliation with a company, can contribute to its development. This openness lowers barriers to entry for innovation and allows passionate individuals to make meaningful contributions.

Companies also play a significant role in advancing Open Source projects. With greater resources and structured teams, organizations can contribute in a more organized and impactful manner, accelerating development and enhancing software quality.

The collaborative nature of Open Source facilitates cross-industry partnerships, allowing organizations from diverse sectors to share knowledge, resources, and best practices. This cross-pollination of ideas not only enhances software development but also fosters innovation across industries, ultimately shaping market dynamics and driving economic progress.

The study Hendrickson et al. (2012) by Mike Hendrickson, Roger Magoulas, and Tim O'Reilly underscores that Open Source is not only a catalyst for small business growth but also a driver of future success for many startups today. By providing cost-effective and flexible solutions, Open Source enables small and medium-sized enterprises to strengthen their online presence and enhance their economic performance.

13.3.2. Supporting Startups and small Enterprises

The impact of Open Source on startups and small enterprises is both profound and transformative. For these businesses, Open Source software provides a highly cost-effective alternative to proprietary solutions, granting access to advanced tools and technologies without the financial burden of high licensing fees typically associated with commercial software. This affordability allows startups and small enterprises to allocate their limited resources more strategically, fostering innovation and growth while maintaining financial flexibility.

StudioLabs (2024)

13.3.3. Enabling Cross-Industry Collaboration and Open Innovation

13.4. Advantages and Disadvantages of Open Source

13.4.1. Advantages

Open Source software offers numerous advantages for users, developers, and businesses. It can vary from cost savings to increased innovation and flexibility for customization.

- Cost savings.
- Flexibility for customization.
- Increased innovation due to open collaboration.

13.4.2. Disadvantages

- Reliance on community support.
- Potential security vulnerabilities.
- Compatibility issues with other systems.

13.5. Challenges of Using or Creating Open Source

There are many challanges that come with using or creating Open Source software. These can range from technical to economic and social challenges. Understanding these challenges is crucial for successful Open Source adoption and development.

13.5.1. Technical Challenges

- Maintaining quality and long-term compatibility.
- Managing security and privacy risks.

13.5.2. Economic Challenges

- Monetization and sustainability concerns.
- Balancing free access with profitability.

13.5.3. Social Challenges

- Effective community management and governance.

13.5.4. Legal Issues

- Navigating complex licensing models (e.g., GPL, MIT).

13.6. Revenue Models in Open Source

Open Source projects can generate revenue through various business models, each with its own advantages and challenges.

- Common business models:
  - Freemium.
  - Support and maintenance services.
  - Dual licensing.
  - Crowdfunding and donations.
- Real-world examples of successful Open Source businesses (e.g., Linux, Red Hat, MySQL).

13.7. Open Source in Key Industries

- The role of Open Source in transforming:
  - Information Technology (e.g., operating systems, tools).
  - Artificial Intelligence (e.g., TensorFlow, PyTorch).
  - Education (e.g., Moodle, Jupyter Notebooks).
- Governmental and policy support for Open Source adoption.

13.8. Reflexion

- Answering the research question based on the above analysis.
- Evaluating the broader implications of Open Source for economic systems.
- Connecting Open Source's potential with sustainability and global development.

13.9. Open Source in Practice: A Personal Experience

- Open Source tools and technologies used in the project:
  - Python, Flask, Vue.js, Linux, wttr.in API, LLaMA API.
- Challenges and solutions encountered:
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  - Why Open Source alternatives were chosen or rejected.
- Comparison of Open Source and closed-source software used:
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- Benefits and challenges of Open Source in the project.

13.10.2. License

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- How the license aligns with the project's goals.
- The license problems of the project.
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13.11. Conclusion

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- Reflections on its potential to drive future innovation and growth.
- Final thoughts on your personal experience and insights gained.

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Conclusion

14. Conclusion

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Appendix

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Literaturverzeichnis

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