htblakaindorf
Leistung mit Menschlichkeit

informatik

**Höhere Technische Bundeslehranstalt Kaindorf an der Sulm**

**Abteilung Informatik**

## Diplomarbeit

im Rahmen der Reife- und Diplomprüfung

# Königskarte

informatik

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Paul Gigler
Andreas Weissl

5BHIF
2024/2025

Betreuer: Prof. DI Johannes Loibner, BSc
Projektpartner: Prof. DI Robert Müllerferli
Datum: MISSING DATE

## Statutory declaration

I declare under oath that I have written the present diploma thesis independently and without outside help, have not used sources and aids other than those indicated and have identified the passages taken from the sources used literally and in terms of content as such.

| | |
|---|---|
| Ort, Datum | Leon Edlinger |
| Ort, Datum | Paul Gigler |
| Ort, Datum | Andreas Weissl |

## Abstract

Abstract in English

## Kurzfassung

Kurzfassung in Deutsch

## Thanks

It would not have been possible to carry out this thesis to this extent without the active support of a number of people. We would therefore like to thank everyone who supported us in the implementation of this thesis.
…

# Table of Contents

# 1 Introduction

TODO: Is halt die frage ob ma den anfang einfach so schreiben, war ja eigentlich net ganz so xD
Mobile apps are utilized for virtually all aspects of daily life in the modern world. So after we noticed that there is no application that allows the efficient planning of campaigns like the "Sternsinger-Aktion" we asked ourselves why, and furthermore, how hard it is to create an App with intuitive usability with the main purpose of simplifying the process of managing such a campaign and gaining a general overview of the progress made by the groups.

The app needs to comply with specific criteria we defined in cooperation with Prof. DI Robert Müllerferli. He is the main organizer of the campaign in the parish of Lieboch and helped us to work out the key aspects our project should implement. In the finished product, every user should be able to scan a QR-Code, through which the area of this group gets assigned to the device. These areas must be dynamically adjustable, so an admin can coordinate the workload of each area more efficiently. The areas also need to be clearly visible by an outline which gets drawn through "Border" addresses. These border addresses get calculated by an algorithm implemented by us. It should be visible at a glance if there is an "specification", which can be assigned by admins, set for an address. This should be realized through the use of different icons instead of the default icon. Apart from the app itself, we also implemented a web-portal through which administrators can manage and supervise the campaign.
TODO: vielleicht noch was rein bezüglich der borders und dann unten nurmehr drauf referenzieren?

The research part of this thesis will be dedicated to how components should act and look, so that new users can use this tool without requiring a long "onboarding" phase. It should feel familiar to interact with elements and the borders of what users can and can not do need to be clearly defined. Because our application also needs a reliable data source to guarantee the consistency and accuracy of marked addresses, we researched ways to keep our database up-to-date, without the need of much manual intervention. After defining the project requirements, we noticed that we need to calculate which addresses are border addresses. So we decided to take a look into different algorithms for this task and compare them concerning their efficiency, decide on one of them and implement it.

This thesis contains an in-depth description of our thought and development process, as well as any other steps we took to achieve our goal of a functional mobile application that can be used by volunteers in course of the "Sternsinger-Aktion 2025" taking place in the parish of Lieboch.

## 1.1 Team

This thesis was created by three Students attending the BHIF20 at the HTBLA Kaindorf Computer Science Department.

TODO: andis bild anpassen

**Leon Edlinger**

Database, Admin-Panel

**Paul Gigler**

Deployment, Mobile App

**Andreas Weissl**

Backend

# 2 Technologies

Development would not have been possible without making use of many tools, frameworks and environments. In this chapter each tool used in the creation of our software will be described briefly.

## 2.1 LaTeX

Hier kommt eine Beschreibung zu Latex hin

## 2.2 Frontend

### 2.2.1 Dart

Dart is a programming language initially designed for web development, with the goal, of replacing JavaScript, in mind. Today it gets used in a variety of software products, mainly because of the flutter framework. It can be compiled for many platforms and architectures (ARM, x64, RISC-V, JavaScript or WebAssembly) and is loved for its combination of High-Level Features, with practical language features like Garbage collection and optional Type annotation. It was developed by Google and is now an open-source project.

(*Flutter for Beginners*, n.d.)


### 2.2.2 Flutter

Flutter is an Open-Source software development framework. It allows programmers to compile their application for different platforms including Web, macOS, IOS as well as Windows and any type of Linux-based systems, all from one code-base, written in Dart. This allows for more efficient and faster cross-platform development. Another benefit of Google's toolkit are the highly customizable predefined UI components. Developers can mix and match these components however needed which makes them an applicable choice.

We chose flutter mainly for these reasons, but also because of our previous experience with Java to which Dart is quite similar. Through it, we were able to get started quickly, learn what we need along the way. Having a design through the components was also very helpful and saved us some time.

("flutter/README.md at master · flutter/flutter", 2025) (Dagne, 2019)


Flutter

## 2.3 Backend

### 2.3.1 Java Spring

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### 2.3.2 PostgreSQL

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## 2.4 Version Control

### 2.4.1 Git

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### 2.4.2 GitHub

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## 2.5 Map Data

### 2.5.1 OpenStreetMap

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### 2.5.2 Graphhopper

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## 2.6 Development Tools

### 2.6.1 VS Code

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### 2.6.2 IntelliJ

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### 2.6.3 Android Studio

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### 2.6.4 Postman

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### 2.6.5 Figma

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### 2.7 Deployment

#### 2.7.1 Docker

#### 2.7.2 Uberspace

#### 2.7.3 Webmin

## 3 Research Questions

### 3.1 Leon Edlinger

### 3.2 Paul Gigler

### 3.3 Andreas Weissl

## 4 Spring Framework

The backend leverages the **Spring Framework**, a comprehensive framework for enterprise Java development. This section explores its key components and advantages.

### 4.1 Spring Boot

Spring Boot simplifies configuration and deployment with embedded servers and opinionated setups. This reduces boilerplate code and accelerates development.

### 4.2 Spring Data JPA

Spring Data JPA provides abstractions for database interactions, streamlining CRUD operations and custom query creation.

### 4.3 Lombok

Lombok reduces boilerplate code by generating getters, setters, and other methods at compile time, improving code readability and maintainability.

### 4.4 Advantages

Using Spring enhances productivity, reduces setup complexity, and ensures scalability, making it ideal for this project.

## 5 Area Borders

The area borders feature addresses the research question by implementing computational geometry algorithms for precise geographical boundary calculations.

### 5.1 Purpose of Area Borders in the App

Accurate area borders are essential for defining regions based on user input, supporting the app's mapping functionality.

### 5.2 Overview of the Convex Hull Algorithm

The convex hull algorithm identifies the smallest convex polygon enclosing a set of points, making it a suitable choice for this project.

### 5.3 Use Cases of the Convex Hull in Industry

Applications of convex hulls in mapping, computer graphics, and robotics highlight their importance in solving real-world problems.

### 5.4 Alternate Methods for Area Border Calculation

Alternative methods like Voronoi diagrams and alpha shapes were considered but found less suitable due to complexity or computational demands.

### 5.5 Rationale for Choosing the Convex Hull Method

The convex hull algorithm offers a balance of simplicity, efficiency, and accuracy, aligning with the project's requirements.

### 5.6 Integration of the Algorithm into the Backend

The algorithm is implemented in the service layer, ensuring smooth integration with other backend components.

### 5.7 Challenges and Adjustments

Challenges included handling edge cases like collinear points, which were resolved through specific algorithm adjustments.

## 6 Structure of the Backend

The backend follows a layered architecture to promote separation of concerns, scalability, and maintainability. This section outlines the roles of each layer.

### 6.1 Controller Layer

The controller layer acts as the interface for incoming HTTP requests, delegating them to appropriate service methods.

### 6.2 Service Layer

The service layer contains business logic, validating data and coordinating interactions between controllers and repositories.

### 6.3 Repository Layer

Repositories abstract database operations, allowing the backend to interact with the database without explicit SQL queries.

### 6.4 Persistence Layer (Entity Classes)

Entity classes define the data model and its mapping to the relational database, ensuring a consistent schema.

### 6.5 Applied Design Principles (DTOs)

Data Transfer Objects (DTOs) enhance encapsulation and optimize data transfer between layers and external clients.

## 7 Defining usability

### 7.1 Why it is important

### 7.2 Fundamental concepts of usability

### 7.3 Challenges in designing for a broad user spectrum

# 8 Usability in context of maps

## 8.1 Basic Analysis of the Google Maps interface

## 8.2 Identifying Flaws in Googles Design

## 8.3 How could specific user groups struggle with this design

# 9 Adaptive algorithms and real-time data integration

## 9.1 Theoretical Framework

### 9.1.1 Traditional Methods for Address Database Management

### 9.1.2 Adaptive Algorithms: Concepts and Applications

### 9.1.3 Real-Time Data Integration Frameworks

## 9.2 Technical Framework

### 9.2.1 Data Sources

#### 9.2.1.1 GPS Data

#### 9.2.1.2 External APIs

#### 9.2.1.3 User Inputs

### 9.2.2 Adaptive Algorithms

#### 9.2.2.1 Fuzzy Matching

#### 9.2.2.2 Machine Learning Model

#### 9.2.2.3 Rule-Based Filters

#### 9.2.2.4 Dynamic Duplicate Resolution

#### 9.2.2.5 Real-Time Address Normalization

### 9.2.3 Evaluation Metrics

#### 9.2.3.1 Accuracy

#### 9.2.3.2 Latency

# 10 Traditional Methods for Address Database Management

# 11 Adaptive Algorithms: Concepts and Applications

# 12 Real-Time Data Integration Frameworks

# 13 Implementation of the Backend

The backend implementation combines theoretical concepts with practical solutions to ensure functionality and scalability.

### 13.1 Config of Spring Boot (application.properties)

The `application.properties` file configures essential settings, including database connections, logging, and server parameters.

### 13.2 Entity Classes (Structure/Purpose)

Entity classes define the application's data model, using annotations to map fields to database tables.

### 13.3 JPA-Repositories (DB Access and CRUD Operations)

Repositories simplify database access by providing methods for CRUD operations and enabling custom queries.

### 13.4 Service Classes

Service classes encapsulate business logic, coordinating data flow between controllers and repositories.

### 13.5 Rest Controller (API Endpoints and their Functions)

REST controllers define API endpoints, processing requests and returning responses to ensure seamless interaction with the frontend.

## 14 GraphHopper Setup

### 14.1 Why use GraphHopper?

### 14.2 Configuration

### 14.3 Local hosting

## 15 Working out the Wireframes

### 15.1 Map View

### 15.2 List View

### 15.3 Possible improvements for future versions

# 16 Functional implementation behind the application

## 16.1 Address-Provider

## 16.2 HTTP-Requests

## 16.3 Implementation of the Flutter Map Component

# 17 The app in use

## 17.1 Introducing new users

## 17.2 The app in operation

## 17.3 User Feedback

# 18 Implementation Admin Panel

## 18.1 Erwas

# 19 Final Thoughts

## 19.1 Leon Edlinger

## 19.2 Paul Gigler

## 19.3 Andreas Weissl

# 20 Meetings

Protokolle der Meetings, vielleicht auch ein zeitplan wann immer und wie lang

# 21 Working Hours

| Arbeitspaket-Nr. | Beschreibung | Dauer |
|---|---|---|
| 1 | Einführung und Einarbeitung | 8 h |
| 2 | Grundkonzept erstellen | 8 h |
| 3 | Struktur der App festlegen | 6 h |
| 5 | Wifi-Socket in App implementieren | 39 h |
| 6 | Write-Funktionalität in App implementieren | 14 h |
| 7 | Read-Funktionalität in App implementieren | 19 h |
| 8 | Trim-Funktionalität in App implementieren | 10 h |
| 9 | Konfigurationsmöglichkeiten für Flug in App implementieren | 16 h |
| 10 | Höhenregelung-Funktionalität in App implementieren | 14 h |
| 12 | Graphische Darstellung der Flugdaten | 18 h |
| 14 | App testen und debuggen | 19 h |
| 26 | Gesamtkonzept testen und debuggen | 16 h |
| **Summe** | | **187 h** |

Table 1: Arbeitszeitnachweis

# 22 Source code directory

Source Code directory, kein plan was des is

# 23 List of figures

# 24 List of tables

# 25 Bibliography

Dagne, L. (2019). Flutter for cross-platform app and sdk development.

*Flutter for Beginners*. (n.d.). https://books.google.at/books?hl=de&lr=&id=pF6vDwAAQBAJ&oi=fnd&pg=PP1&dq=benefits+dart+language&ots=dZJWUGVs4x&sig=a196WqhXmQzuy23cmcKpEpIqn_k&redir_esc=y#v=onepage&q=benefits%20dart%20language&f=false

flutter/README.md at master · flutter/flutter [[Online; accessed 23. Jan. 2025]]. (2025, January). https://github.com/flutter/flutter/blob/master/README.md

# 26 Abbreviation

| | |
|---|---|
| ADC | Analog Digital Converter |
| API | Application Programming Interface |
| BLE | Bluetooth Low Energy |
| CPU | Central Processing Unit |
| DAC | Digital Analog Converter |
| DAVE | Digital Application Virtual Engineer |
| DSP | Digital Signal Processor |
| FPU | Floating Point Unit |
| FPV | First Person View, First Pilot View |
| GPIO | General Purpose Input/Output |
| GPS | Global Positioning System |
| GUI | Graphical User Interface |
| HDMI | High Definition Multimedia Interface |
| $I^2C$ | Inter-Integrated Circuit |
| IDE | Integrated Development Environment |
| IP | Internet Protocol |
| RPI | Raspberry Pi |
| SD | Secure Digital |
| SPI | Serial Peripheral Interface |
| USB | Universal Serial Bus |
| TCP | Transmission Control Protocol |
| UART | Universal Asynchronous Receiver Transmitter |
| WLAN | Wireless Local Area Network |
| WPA | WiFi Protected Access |
| XML | Extensible Markup Language |