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Title: CycLED

Functional Specification

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Introduction

Overview

My system is a bicycle direction system which consists of two lights on the handlebars of a bike which signal the user to go either left or right while cycling. The system consists of the hardware, an Arduino based system called a Flora board, and the software which is an android app. The user will input their desired destination into the android application, this will connect to the hardware on the bicycle which will light up LEDs and tell the user which way to turn to get to their destination. If the user misses a turn the route is automatically recalculated so that the journey can continue without any problems. As well as visual there's also a vibration mechanism that means if the user doesn't see the lights for some reason they can still be indicated which direction to turn.

This system is useful for any cycling enthusiasts who need to get to their destination but don't want to take their phone out during cycling or stop in the middle of the road to check where they are going, as this can be extremely dangerous, frustrating and also time consuming. The CycLED's easy to use system means that a user can simply enter their destination into the app, get on their bicycle and be directed exactly where they need to go.

Glossary

Flora Board: Small computer hardware device used to do simple calculations many times.

Bluefruit LE Connect App: Android application used to interface with a Bluetooth module.

Bluetooth module: Small piece of hardware that connects to flora and gives it Bluetooth connectivity.

Accelerometer: Hardware that measures force of acceleration.

General Description

Product / System Functions

The product consists of an android app and the hardware to be mounted on the bicycle. The user inputs the destination they want to get to, and the app will pull the route from the google maps API. It will then be able to send the route to the Arduino system on the bicycle which lights up the LEDs to tell the cyclist which way to turn. There are also motors for vibration if the cyclist does not see the lights. In the event the cyclist should miss a turn, whether due to lack of attention, closed roads or anything else, the system will automatically recalculate a route for them so their journey can continue unaffected.

As GPS can be inaccurate at times the system can correct for this by using the accelerometer and the GPS in tandem.

User Characteristics and Objectives

The concept of this product is meant to be an easy-to-use system for cyclists to get their destination by simply inputting their destination to an app, turning on the system on the bicycle and making sure its connected via Bluetooth to the phone.

However as this is a prototype it uses an Arduino based system for the hardware so some level of comfort with technology would be required to use it successfully.

From the user's perspective, they should be able to enter their destination into the app, turn on the device and then simply get on their bike and cycle, the app and the system will do the rest for them.

Operational Scenarios

User inputs destination

The system only has one point of contact for the user, where they enter their destination into the application. The system will then get their current location and use the information to formulate a route from google maps. After this the route is sent to the hardware on the bicycle and the user is directed on their journey to their destination.

User Cycling

While the user is cycling, before they come up to a turn a light will signal and a motor will buzz to indicate to the user to turn right or left. When the user has made their turn the lights will turn off until the user comes a certain distance away from the next turn.

User Makes Wrong Turn/ Misses turn

If the user makes a wrong turn or misses a turn and goes off the proposed route the system will set up a new route without the user having to do anything.

Constraints

For the hardware I am using a Flora Board which is a type of Arduino, this does not have much processing power and so most of the heavy processing will be done on the smartphone. Phone GPS is prone to error so I am using an accelerometer to try and correct for the error as much as possible for accurate directions. For the app I am using android which will interface with the google maps API and a third party application called Bluefruit for the Bluetooth setup.

Functional Requirements

Find Route

Description: This function allows the user to enter their destination into an android app, the app then pulls the desired route from the google maps API using the current location and the destination.

Criticality: This element is high priority for the system as this is the point of contact where the user can pick their desired location.

Technical Issues: It will need to pull the route from the google maps API.

Dependencies: The app will need to interface with the google maps API.

Send Route to Flora

Description: After the route has been obtained the information needs to be sent to the Flora via Bluetooth. This data is sent in a form that the Flora can use to indicate turns. There will be a data structure with left and right turns which will be in order of occurrence on the route. There will be an associated data structure with the distance to be travelled in between each turn.

Criticality: This is a high priority function as the system on board the bike needs this route to indicate turns to the user.

Technical Issues: Communicating via Bluetooth with the Flora.

Dependencies: Adafruit Bluefruit LE Connect android app, google maps API, Flora

Correct GPS location

Description: This function will fuse the accelerometer with the phone's GPS to correct the error in GPS location.

Criticality: This is less critical than other elements as the system can function without it and can direct the user to their location to a decent degree, this function gives more precise results.

Technical Issues: Writing an algorithm that uses the Flora's accelerometer and the phone's GPS system to correct for the errors in GPS tracking.

Dependencies: Adafruit Bluefruit LE Connect android app, GPS, Flora, Bluetooth, Accelerometer.

Direct User

Description: This function uses the accelerometer, the LED lights and the Flora board to direct the user which direction to turn. When the flora board calculates that the bicycle has travelled a certain distance using the accelerometer, it indicates (with perhaps 50 meters to go) that the next turn is either right or left by flashing one of the LED lights.

Criticality: This function is high priority as this is how the system directs the user to their destination.

Technical Issues: Algorithm that calculates how far the user has travelled and which turn to take on the journey.

Dependencies: Adafruit Bluefruit LE Connect android app, GPS, Flora, Bluetooth, Accelerometer.

Calculate New Route

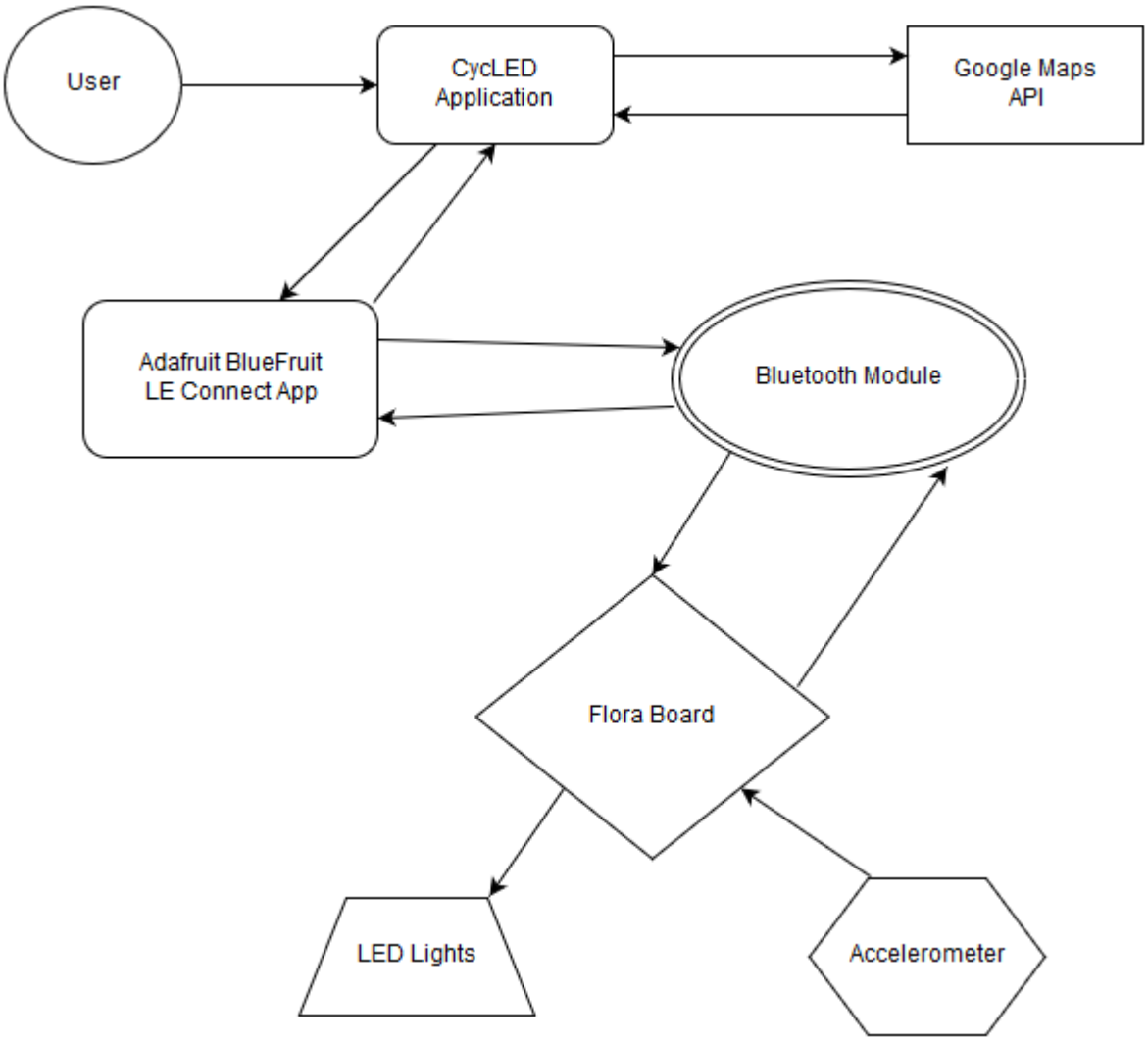
Description: If for some reason the user cannot take a specified turn, the system will update the route so that the user's journey is not effected.

Technical Issues: This function will require the application to constantly update the route based on the user's position and send it to the Flora.

Dependencies: Adafruit Bluefruit LE Connect android app, GPS, Flora, Bluetooth, Accelerometer, google maps API, CycLED android app.

System Architecture

Diagram

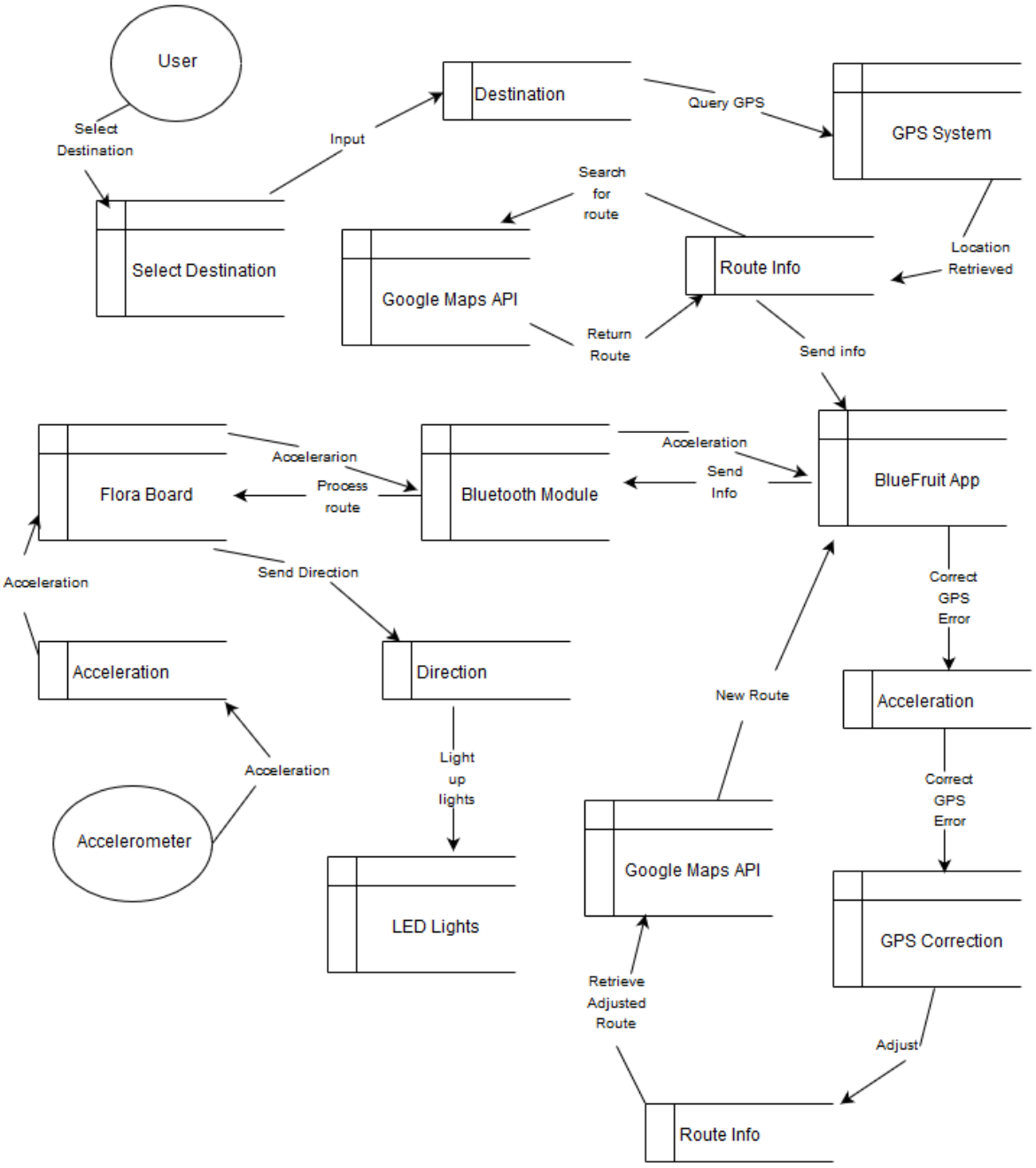


Description

Above is a diagram of the system architecture. The CycLED android application is the first point of contact. This takes the user's desired destination, current location and uses the google maps API to calculate a route. This is then sent to the Flora board via Bluetooth by a third party application called Bluefruit LE Connect App which manages Bluetooth connections between smartphones and the Bluetooth module. The flora board uses the information sent from the smartphone to send directions to LED lights, based on how much distance is travelled, and this information is retrieved from the accelerometer. Information from the accelerometer is also sent back to the smartphone via Bluetooth to adjust for the error in GPS.

High-Level Design

Data Flow Diagram



Preliminary Schedule

Phase 1:

The first element of my project that I want to complete is communicating between my smartphone and the Flora board via the Bluetooth module so that it can light up some LED's.

Phase 2:

After that I my next task will be setting up the google maps API with my app so that I can enter a destination into my app, and have an algorithm extract the route, turns, and distances for use on my Flora board.

Phase 3:

When I am able to pull the data from the google maps API and structure it so that its usable on the Flora, my next goal will be sending this data to the flora and perhaps using the flora's GPS system for some very rough testing of the data.

Phase 4:

When this has been done my next aim will be setting up the accelerometer and writing an algorithm so that the LED lights change based on how much distance has been travelled.

Phase 5:

After this I will need to figure out how to send data back from the flora to the smartphone and write an algorithm that can correct for the GPS error.

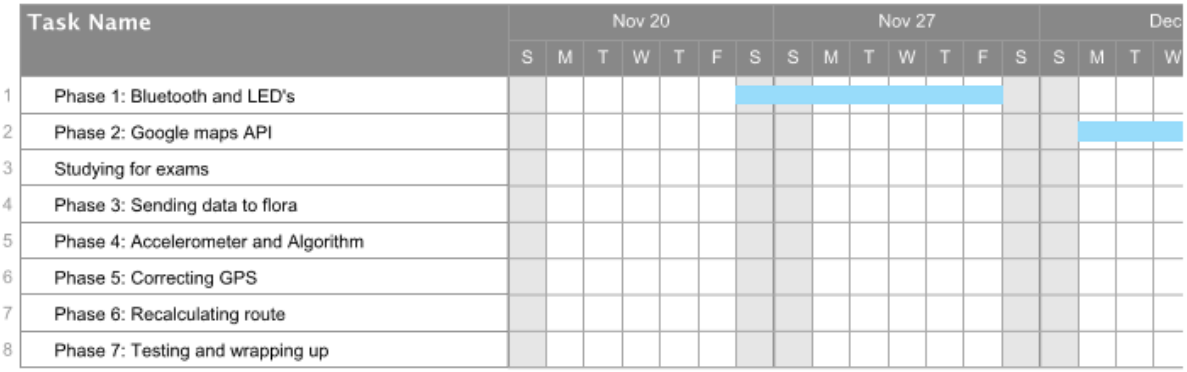
Phase 6:

During this phase I will need to develop the functionality where the app is constantly sending updated routes to the flora for maximum precision, and for the turn missing feature.

Phase 7:

Next I will begin testing my product outside and inside. Final testing will consist using a flora while riding a bicycle, but testing before that will most likely be done inside, where I will aim to write some algorithms to behave as if I were moving around outside, and see how my system reacts to this.

Gantt Chart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Nov 27
Dec
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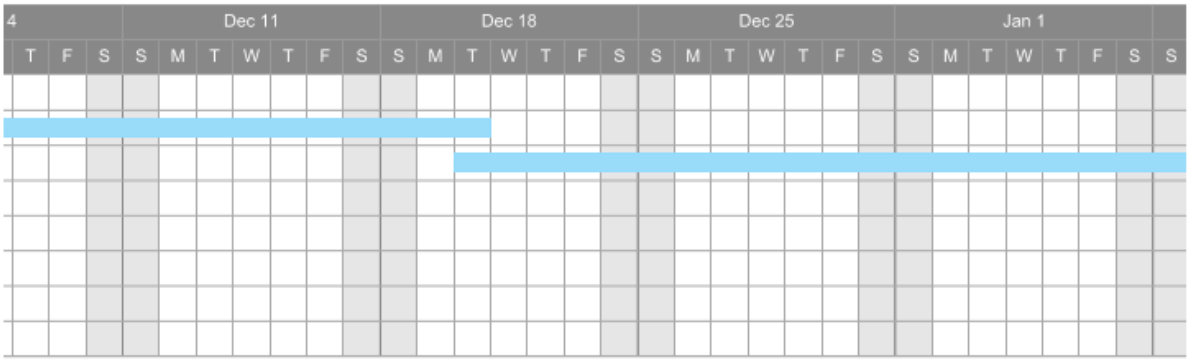
2 Phase 2: Google maps API
3 Studying for exams
4 Phase 3: Sending data to flora
5 Phase 4: Accelerometer and Algorithm
6 Phase 5: Correcting GPS
7 Phase 6: Recalculating route
8 Phase 7: Testing and wrapping up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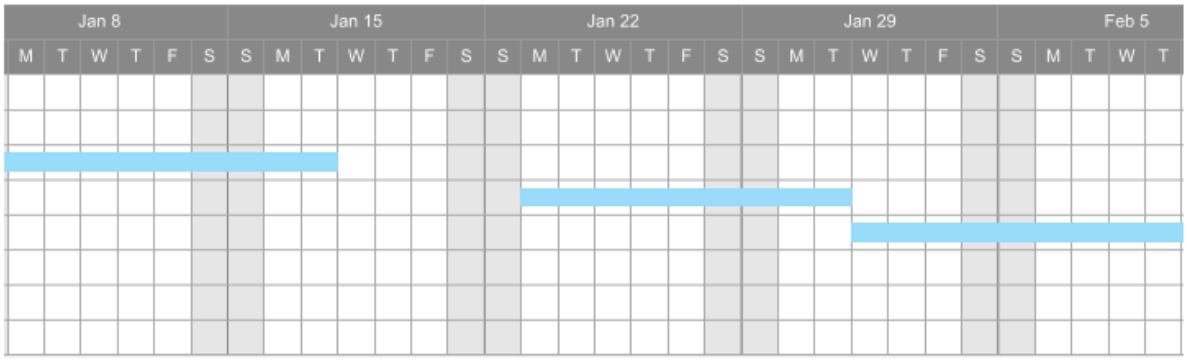
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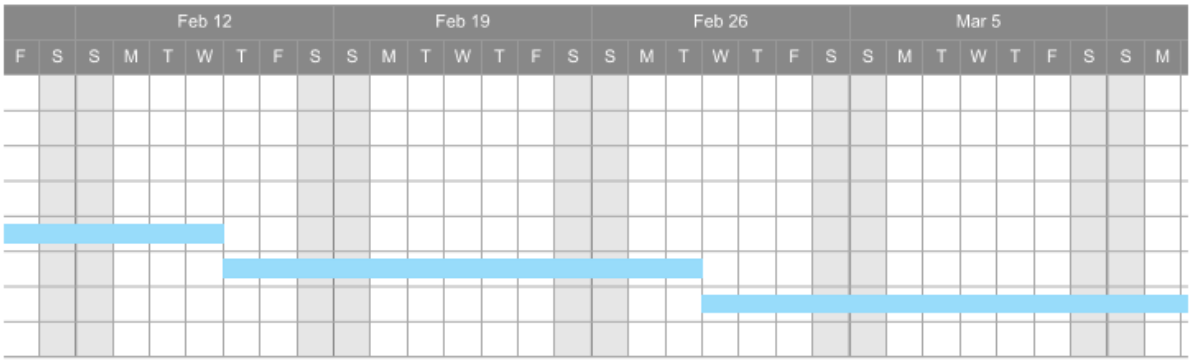
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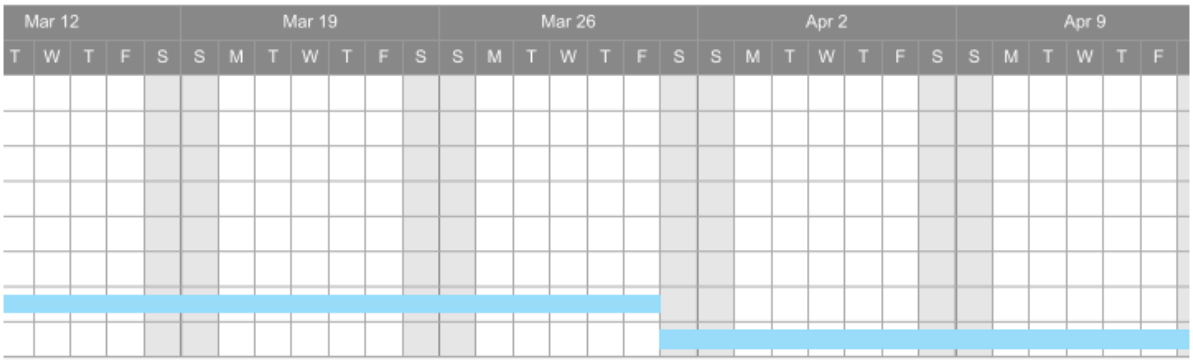
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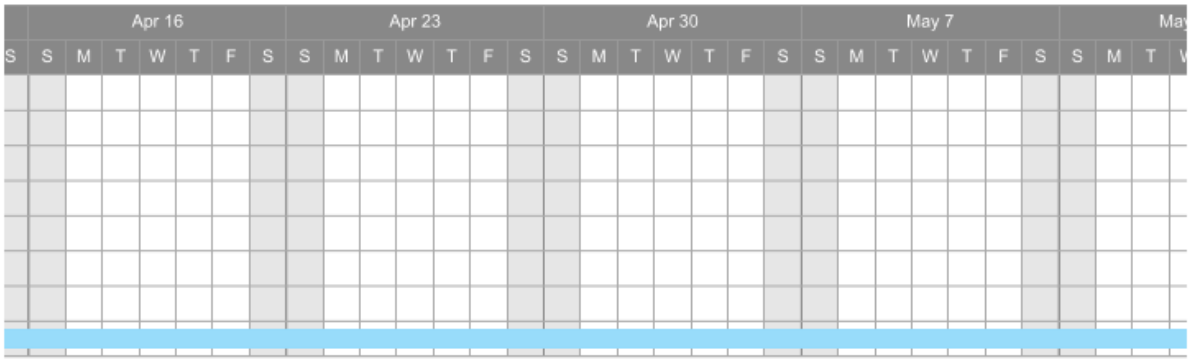
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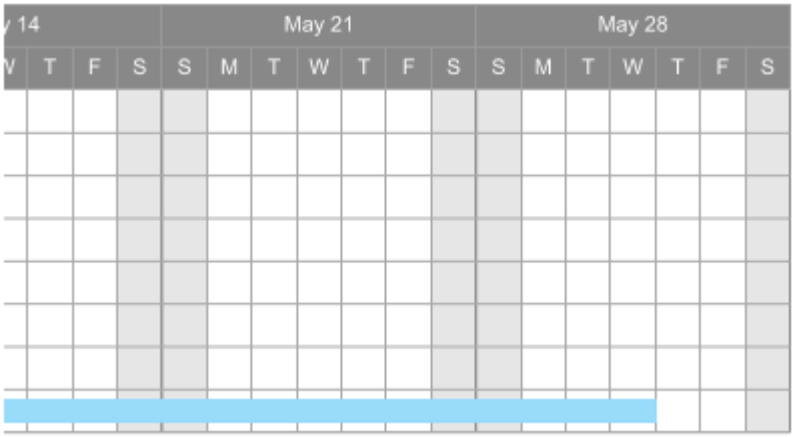
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