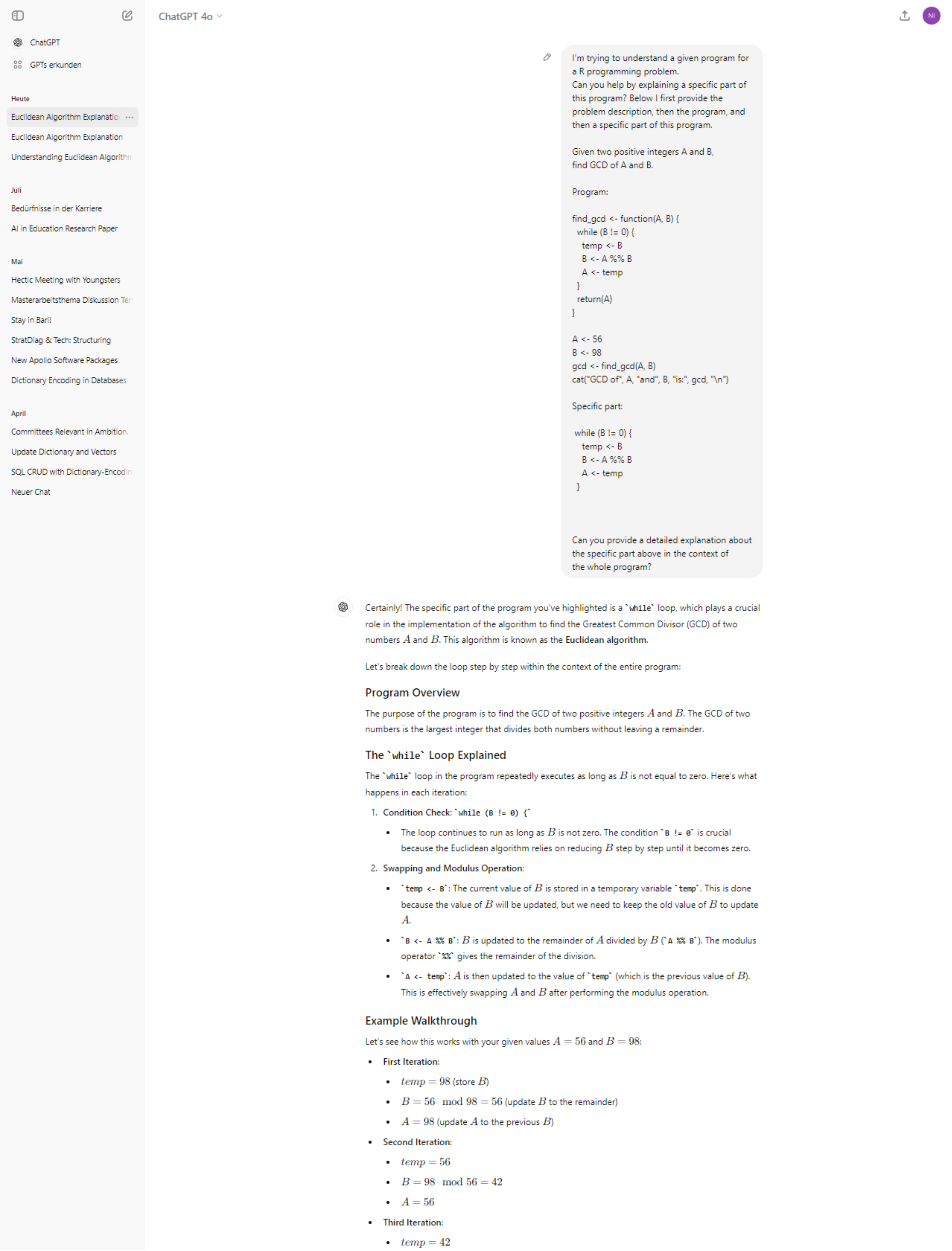
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I'm trying to understand a given program for a R programming problem.
Can you help by explaining a specific part of this program? Below I first provide the problem description, then the program, and then a specific part of this program.

Given two positive integers A and B,
find GCD of A and B.

Program:

```
find_gcd <- function(A, B) {
  while (B != 0) {
    temp <- B
    B <- A %% B
    A <- temp
  }
  return(A)
}

A <- 56
B <- 98
gcd <- find_gcd(A, B)
cat("GCD of", A, "and", B, "is:", gcd, "\n")
```

Specific part:

```
 while (B != 0) {
    temp <- B
    B <- A %% B
    A <- temp
  }
```

Can you provide a detailed explanation about the specific part above in the context of the whole program?

Certainly! The specific part of the program you've highlighted is a `while` loop, which plays a crucial role in the implementation of the algorithm to find the Greatest Common Divisor (GCD) of two numbers A and B. This algorithm is known as the **Euclidean algorithm**.

Let's break down the loop step by step within the context of the entire program:

Program Overview

The purpose of the program is to find the GCD of two positive integers A and B. The GCD of two numbers is the largest integer that divides both numbers without leaving a remainder.

The `while` Loop Explained

The `while` loop in the program repeatedly executes as long as B is not equal to zero. Here's what happens in each iteration:

1. **Condition Check**: `while (B != 0) {`
   - The loop continues to run as long as B is not zero. The condition `B != 0` is crucial because the Euclidean algorithm relies on reducing B step by step until it becomes zero.
2. **Swapping and Modulus Operation**:
   - `temp <- B`: The current value of B is stored in a temporary variable `temp`. This is done because the value of B will be updated, but we need to keep the old value of B to update A.
   - `B <- A %% B`: B is updated to the remainder of A divided by B (`A %% B`). The modulus operator `%%` gives the remainder of the division.
   - `A <- temp`: A is then updated to the value of `temp` (which is the previous value of B). This is effectively swapping A and B after performing the modulus operation.

Example Walkthrough

Let's see how this works with your given values $A = 56$ and $B = 98$:

- **First Iteration**:
  - $temp = 98$ (store B)
  - $B = 56 \mod 98 = 56$ (update B to the remainder)
  - $A = 98$ (update A to the previous B)
- **Second Iteration**:
  - $temp = 56$
  - $B = 98 \mod 56 = 42$
  - $A = 56$
- **Third Iteration**:
  - $temp = 42$

  - $B = 56 \mod 42 = 14$
  - $A = 42$
- **Fourth Iteration:**
  - $temp = 14$
  - $B = 42 \mod 14 = 0$
  - $A = 14$

Now B is zero, so the loop exits.

Post-Loop:

When the loop exits, the value of A (which is now 14) is returned as the GCD. This value of A is the last non-zero remainder before B became zero.

Summary

- The loop repeatedly swaps A and B, replacing B with the remainder of A divided by B.
- The process continues until B becomes zero.
- The last non-zero value of A is the GCD of the original two numbers.

This method is efficient and widely used for computing the GCD due to its simplicity and the fact that it reduces the size of the problem at each step.

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