# Code Critiquer for C

# Client

Dr. Ureel,
Michigan Tech University

# Advisor

Dr. Diane T. Rover

# TEAM 34

Nicholas Carber : Regex Support

Conner Cook : AST Support

Brandon Ford : Database Administrator

Emily Huisinga : Frontend

Sage Matt : Frontend

Cade Robison : Test Suite Support

01100011 01110010 01101001 01110100 01101001 01110001 01110101 01100101 01110010

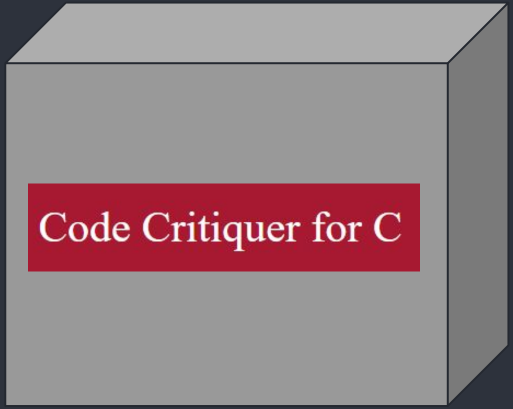
# Project Overview

- Our goal was to help novice C programmers learn C by creating an application for students to receive feedback on their code
- The feedback consists of easy-to-understand and relevant error messages
- Instructors are be able to configure the critiquer for their own assignments

Conceptual Sketch

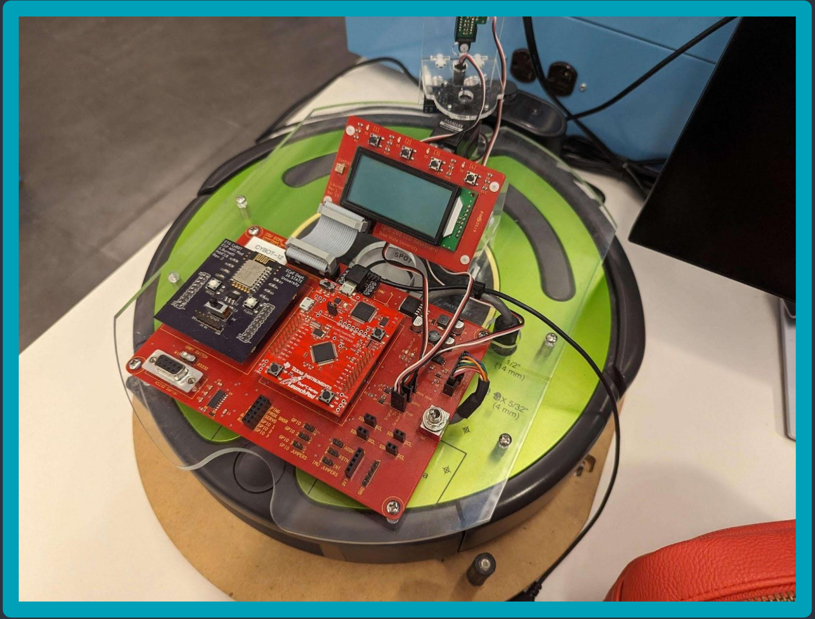
Why does my code not work? I'm not getting any errors!

I found an empty while loop at line 14!



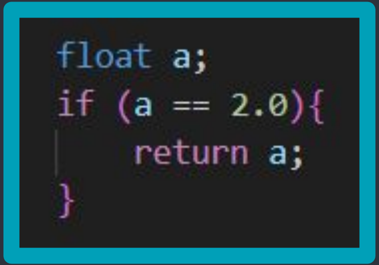
# Potential Users and Uses

- Students & novice programmers in C
  - Specifically CPR E 288 students
  - … but is for anyone learning C
- Instructors, teaching assistants, tutors



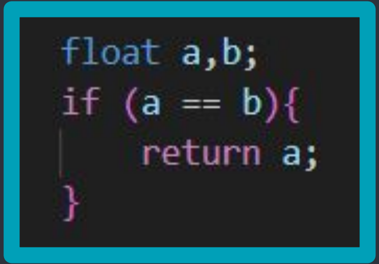
# Important Terms

- **Antipatterns:** Poor solutions to common programming problems
- **Regexes:** A sequence of characters used to find patterns in text
- **Abstract Syntax Tree:** Tree representation of the syntactic structure of the code
- **Xpath:** Expression language for searching XML
- **Sandboxing:** Creating an isolated environment to run untrusted code safely



```
float a;
if (a == 2.0){
    return a;
}
```

Regex: (\w+\s+==\s+\d*\.\d+)|(\d*\.\d+\s+==\s+\w+)



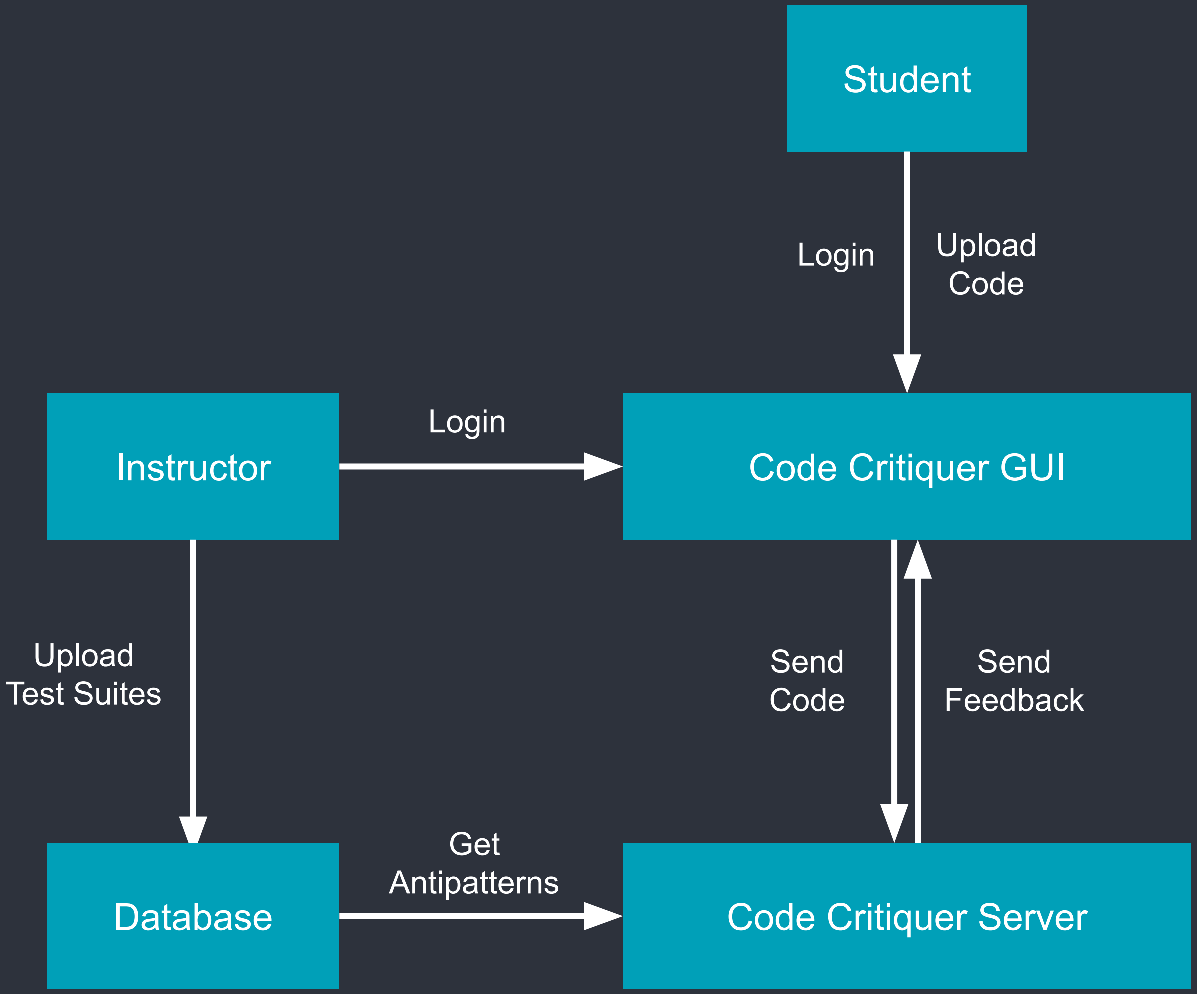
```
float a,b;
if (a == b){
    return a;
}
```

XPath: .//BINARY_OPERATOR[@operator=re:match(@operator, '==') and count(child::*)=2 and child::UNEXPOSED_EXPR[@type=re:match(@type, 'double|float')]]

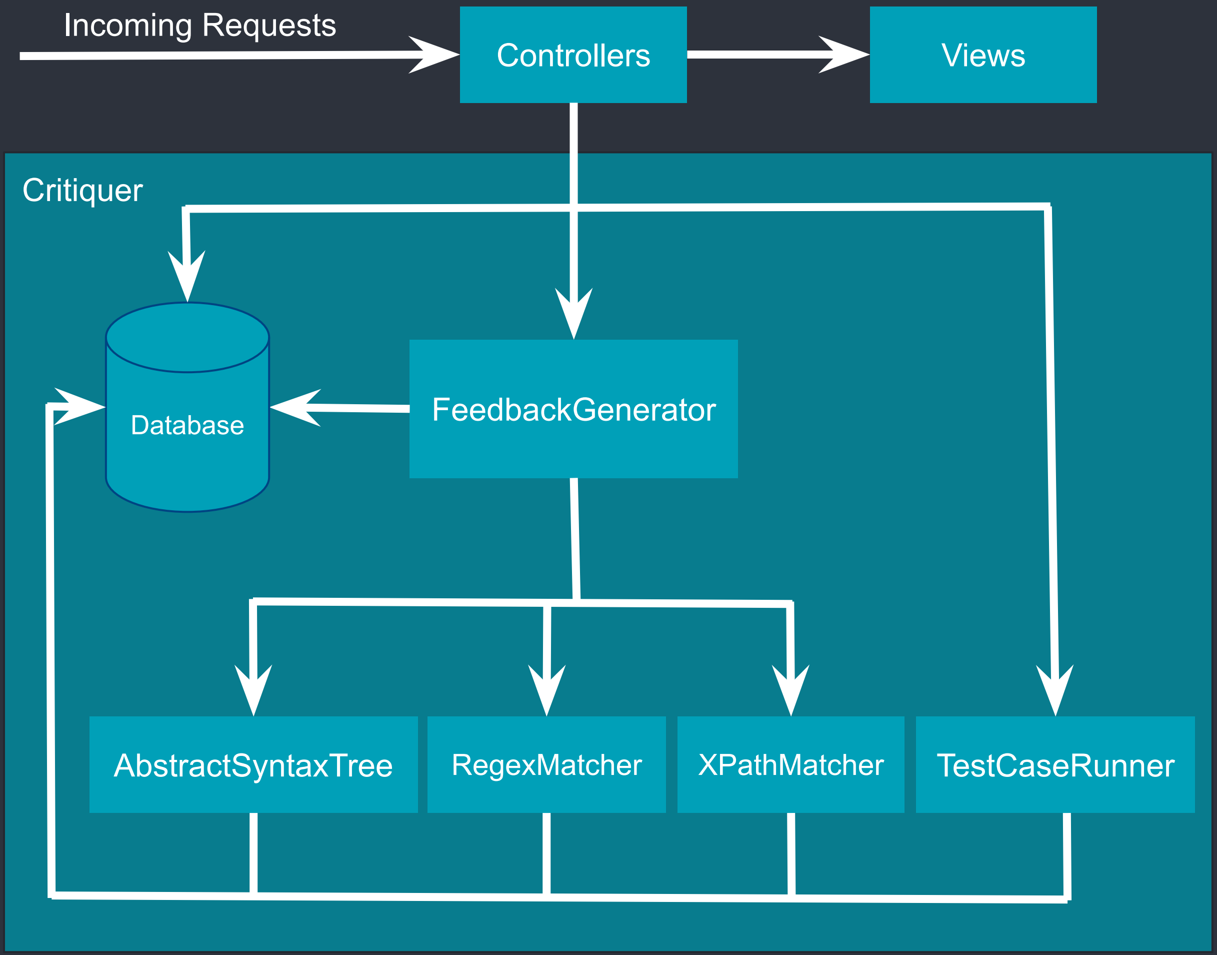
# Related Works

- Dr. Ureel, Michigan Tech University
    - Work in progress critiquers in other languages
        - Existing code bases reference
        - Existing regular expressions
        - Common antipatterns

# Top
# Level
# System
# Sketch

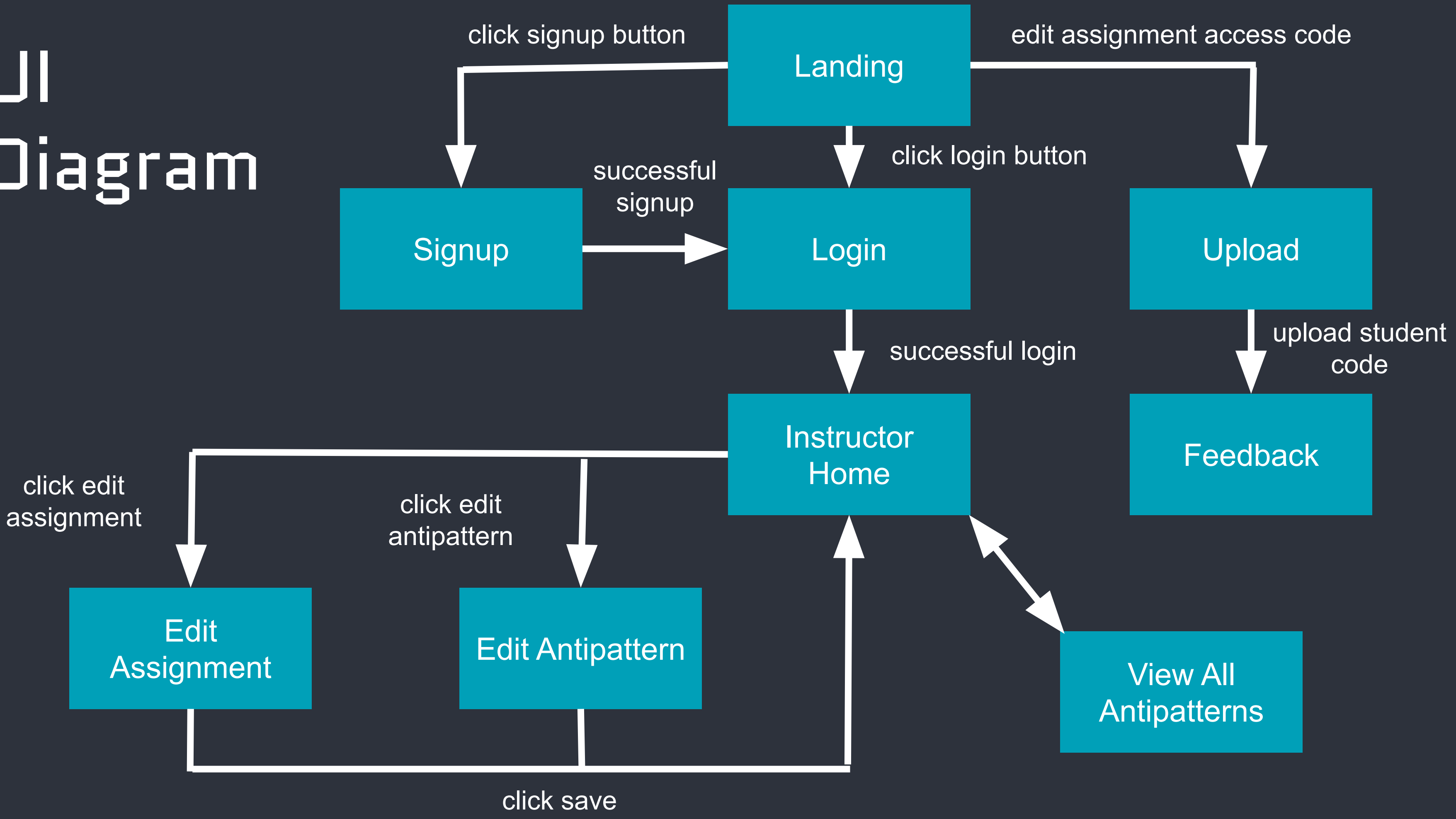


# System
# Design -
# Component
# Diagram



UI

# Diagram


Landing
click signup button
edit assignment access code
click login button
Signup
successful signup
Login
Upload
successful login
upload student code
Instructor Home
Feedback
click edit assignment
click edit antipattern
Edit Assignment
Edit Antipattern
View All Antipatterns
click save

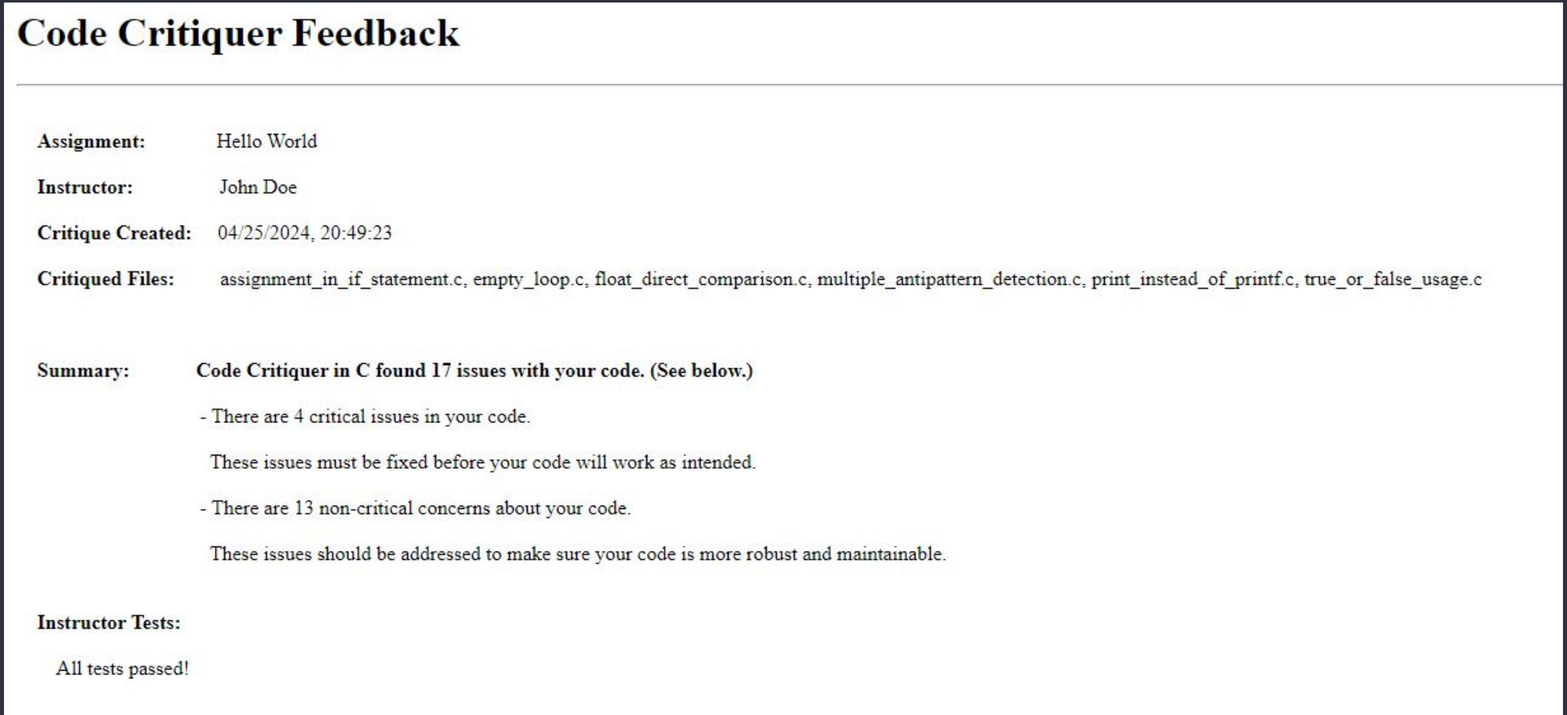
Implementation Details

- Abstract syntax tree builder
  - AST from uploaded student code
  - Utilizes the Clang compiler to build it
- XPath matcher
  - Converts the AST into an XML document
  - XPath query applied over this XML document
  - Results are antipatterns found within the code

Implementation Details [cont.]

- Regex matcher
  - Pulls each defined regex antipattern from the database and searches the uploaded code for matches
  - If a match is found, data about the match is sent back to the feedback generator for processing
- Instructor submitted tests
  - Puts test and student files into sandbox
  - Runs instructor submitted test suites against student code
  - Returns the result of each test
  - Uses the Unity C testing library

# Frontend: Code Feedback Page



Code Critiquer Feedback

Assignment: Hello World

Instructor: John Doe

Critique Created: 04/25/2024, 20:49:23

Critiqued Files: assignment_in_if_statement.c, empty_loop.c, float_direct_comparison.c, multiple_antipattern_detection.c, print_instead_of_printf.c, true_or_false_usage.c

Summary: **Code Critiquer in C found 17 issues with your code. (See below.)**

- There are 4 critical issues in your code.

  These issues must be fixed before your code will work as intended.

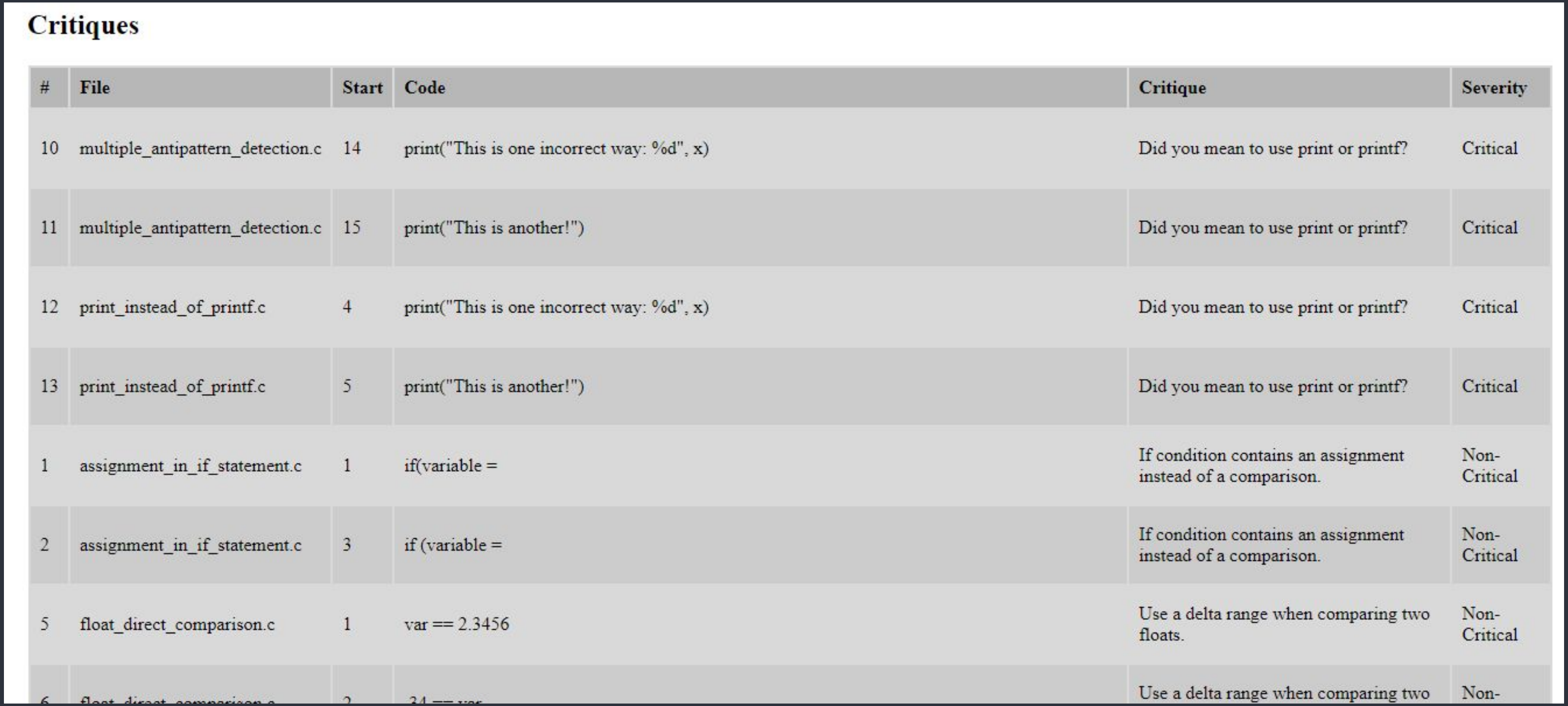
- There are 13 non-critical concerns about your code.

  These issues should be addressed to make sure your code is more robust and maintainable.

Instructor Tests:

All tests passed!

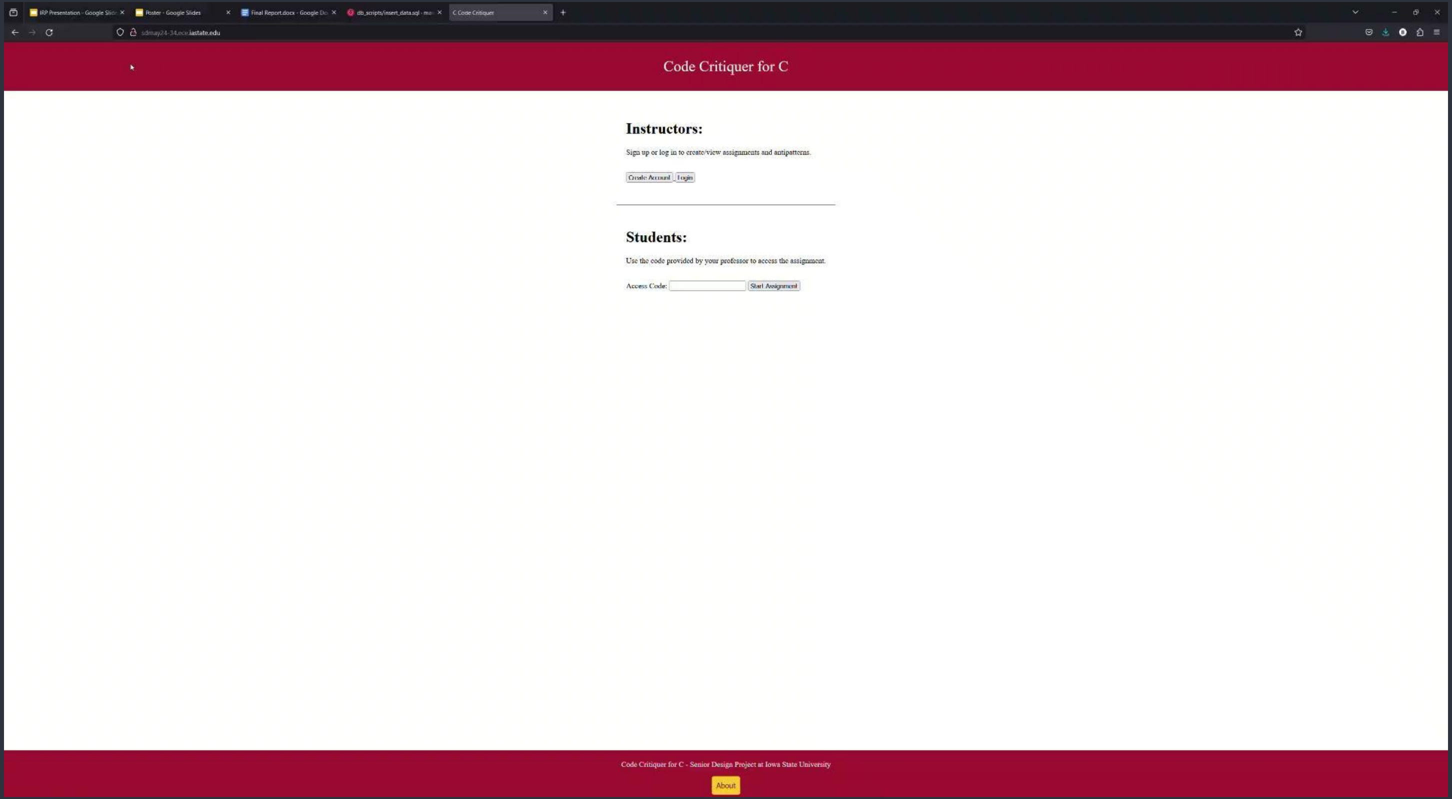
# Frontend: Code Feedback Page (cont).



Critiques

#	File	Start	Code	Critique	Severity
10	multiple_antipattern_detection.c	14	print("This is one incorrect way: %d", x)	Did you mean to use print or printf?	Critical
11	multiple_antipattern_detection.c	15	print("This is another!")	Did you mean to use print or printf?	Critical
12	print_instead_of_printf.c	4	print("This is one incorrect way: %d", x)	Did you mean to use print or printf?	Critical
13	print_instead_of_printf.c	5	print("This is another!")	Did you mean to use print or printf?	Critical
1	assignment_in_if_statement.c	1	if(variable =	If condition contains an assignment instead of a comparison.	Non-Critical
2	assignment_in_if_statement.c	3	if (variable =	If condition contains an assignment instead of a comparison.	Non-Critical
5	float_direct_comparison.c	1	var == 2.3456	Use a delta range when comparing two floats.	Non-Critical
6	float_direct_comparison.c	2	34 == var	Use a delta range when comparing two	Non-

# Frontend: Student Side Demo


IRP Presentation - Google Slid
Poster - Google Slides
Final Report.docx - Google Do
db_scripts/insert_data.sql - ma
C Code Critiquer
sdmay24-34.ece.iastate.edu

Code Critiquer for C

Instructors:

Sign up or log in to create/view assignments and antipatterns.

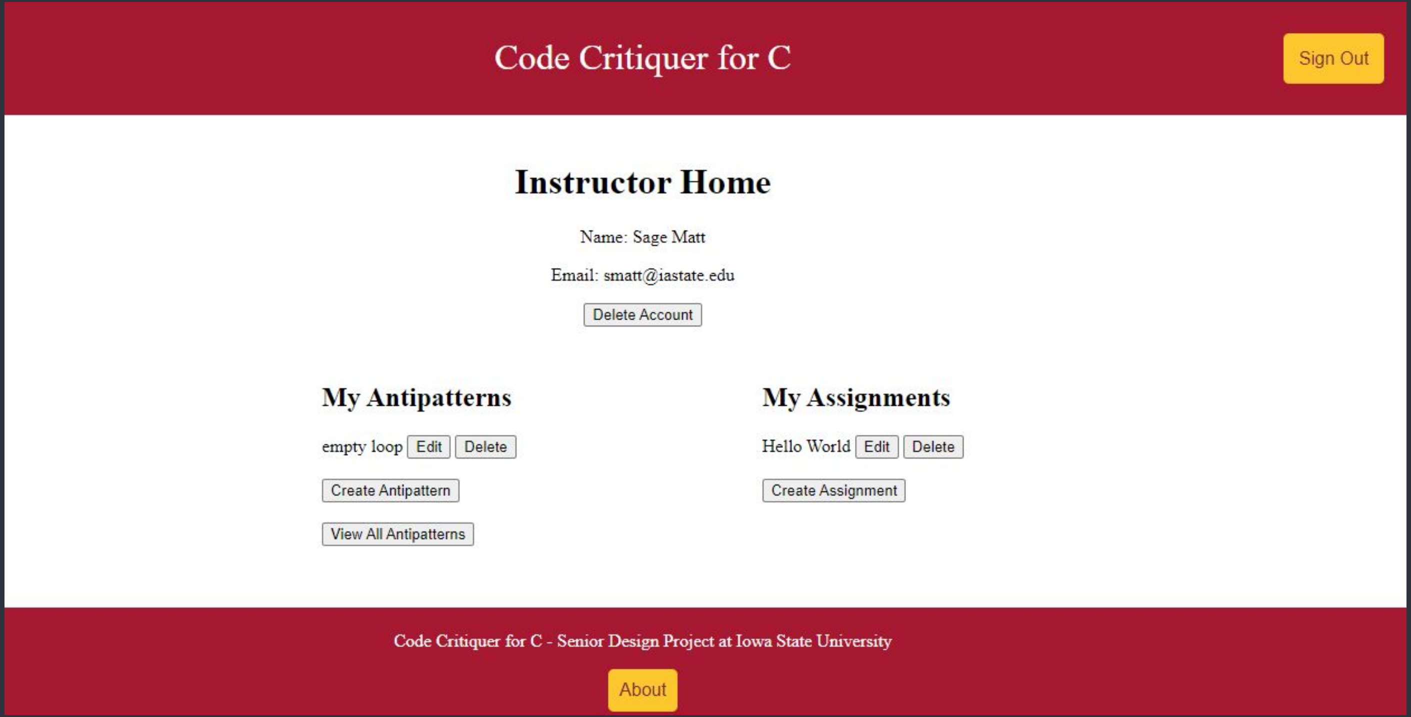
Students:

Use the code provided by your professor to access the assignment.

Access Code:

Code Critiquer for C - Senior Design Project at Iowa State University

# Frontend: Instructor Home



Code Critiquer for C

Instructor Home

Name: Sage Matt

Email: smatt@iastate.edu

My Antipatterns

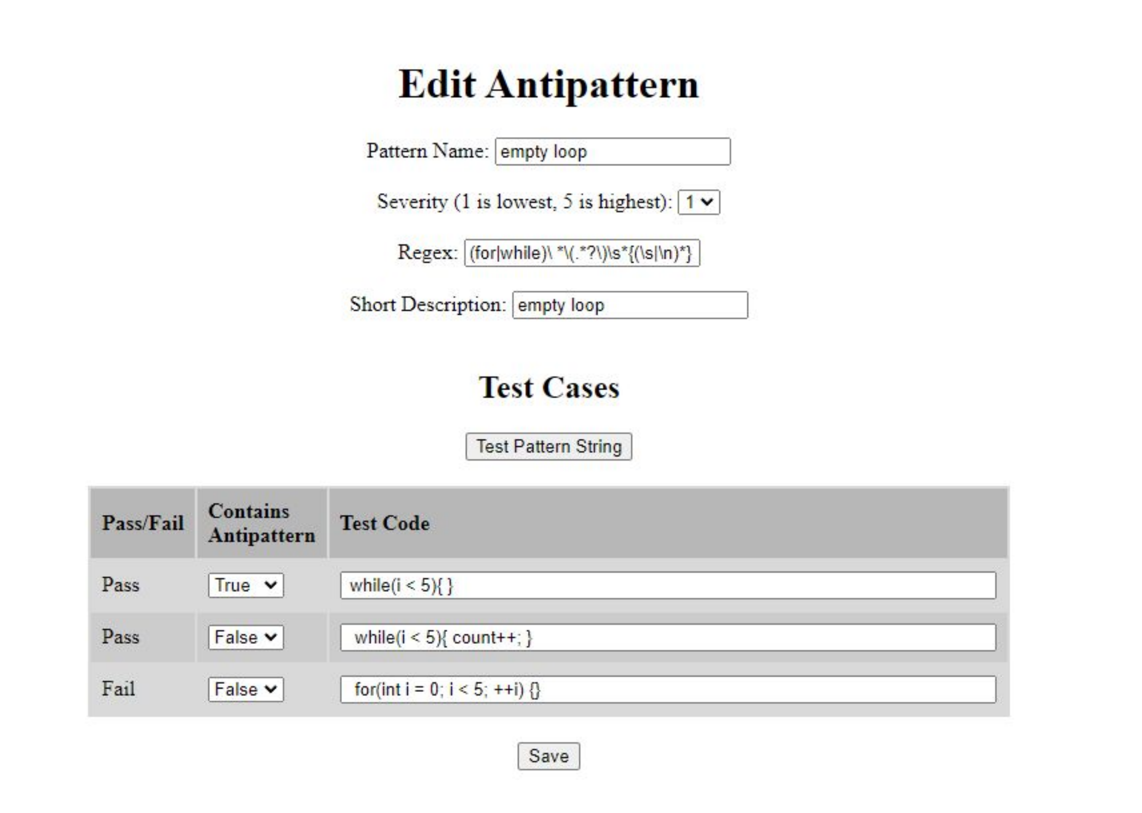
empty loop

My Assignments

Hello World

Code Critiquer for C - Senior Design Project at Iowa State University

# Frontend: Create Antipattern



Edit Antipattern

Pattern Name: `empty loop`

Severity (1 is lowest, 5 is highest): `1`

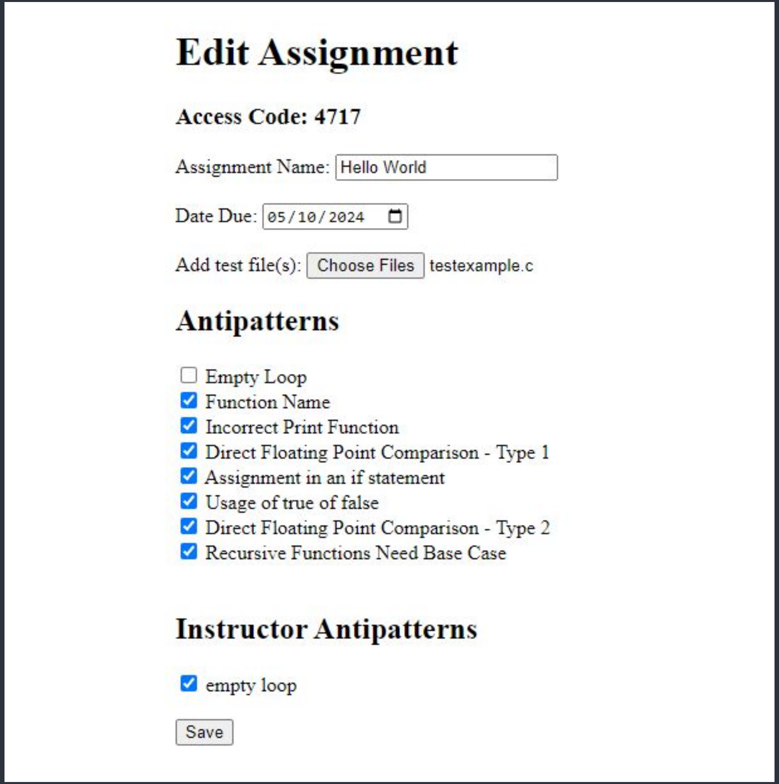
Regex: `(for|while)\ *\(.*?\)\s*{(\s|\n)*}`

Short Description: `empty loop`

Test Cases

Pass/Fail	Contains Antipattern	Test Code
Pass	True	while(i < 5){ }
Pass	False	while(i < 5){ count++; }
Fail	False	for(int i = 0; i < 5; ++i) {}

Frontend: Create Assignment



Edit Assignment

Access Code: 4717

Assignment Name: Hello World

Date Due: 05/10/2024

Add test file(s): Choose Files testexample.c

Antipatterns

□ Empty Loop
☑ Function Name
☑ Incorrect Print Function
☑ Direct Floating Point Comparison - Type 1
☑ Assignment in an if statement
☑ Usage of true of false
☑ Direct Floating Point Comparison - Type 2
☑ Recursive Functions Need Base Case

Instructor Antipatterns

☑ empty loop

# Testing

- Unit Testing
    - Library: Unittest
    - Continuous Integration
- Integration Testing
- System Testing
- Acceptance Testing

# Key Contributions

- Nicholas Carber
  - Regex matcher
  - Antipattern documentation
  - Represented antipatterns as regular expressions
- Conner Cook
  - Clang AST builder
  - Converted AST into an XML
  - XML search with XPaths
- Brandon Ford
  - Set up database
  - Flask request mapping and user sessions
  - Continuous integration
  - Backend functionality for edit assignment, sign up, login pages

# Key Contributions [cont.]

- Emily Huisinga
  - Uploading assignments
  - Receiving feedback from backend
  - Enhanced website aesthetics
- Sage Matt
  - Creating/editing custom antipatterns
  - Antipattern testing functionality
  - Create/editing assignments
- Cade Robison
  - Feedback generator
  - Test Case Runner
  - Continuous deployment

# Future Work

- Add more supported antipatterns
- Preprocessing uploaded code before antipattern identification
- More insightful feedback when test suites fails with a runtime or compile error
- Create custom feedback for built-in antipatterns
- Complete testing

# Questions?

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