

# COGS

( Central Online Grading System )

Dec 15-21

# Problem Statement

- Open ended grading homework
- Blackboard is a frustrating interface
  - Doesn't display .c or .txt files
  - Grading a single assignment is a tedious, multi-stepped process

## Old System

TA was responsible for:

- Downloading files
- Compiling Code
- Running Executable
  - Providing Input/Output
- Additional steps to catch cheating
- Grading

## New System

COGS is responsible for:

- Hosting files
- Compiling Code
- Running Executable
  - Using student provided input/output
- Detecting Cheating

TA is responsible for:

- Grading



The image shows a web-based IDE interface with three main sections: Source Code, Coding Form, and Execution.

### Source Code

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### Coding Form

Form fields for user input, including a dropdown menu and several text boxes.

### Execution

Output console showing the results of the code execution, including a table of data.

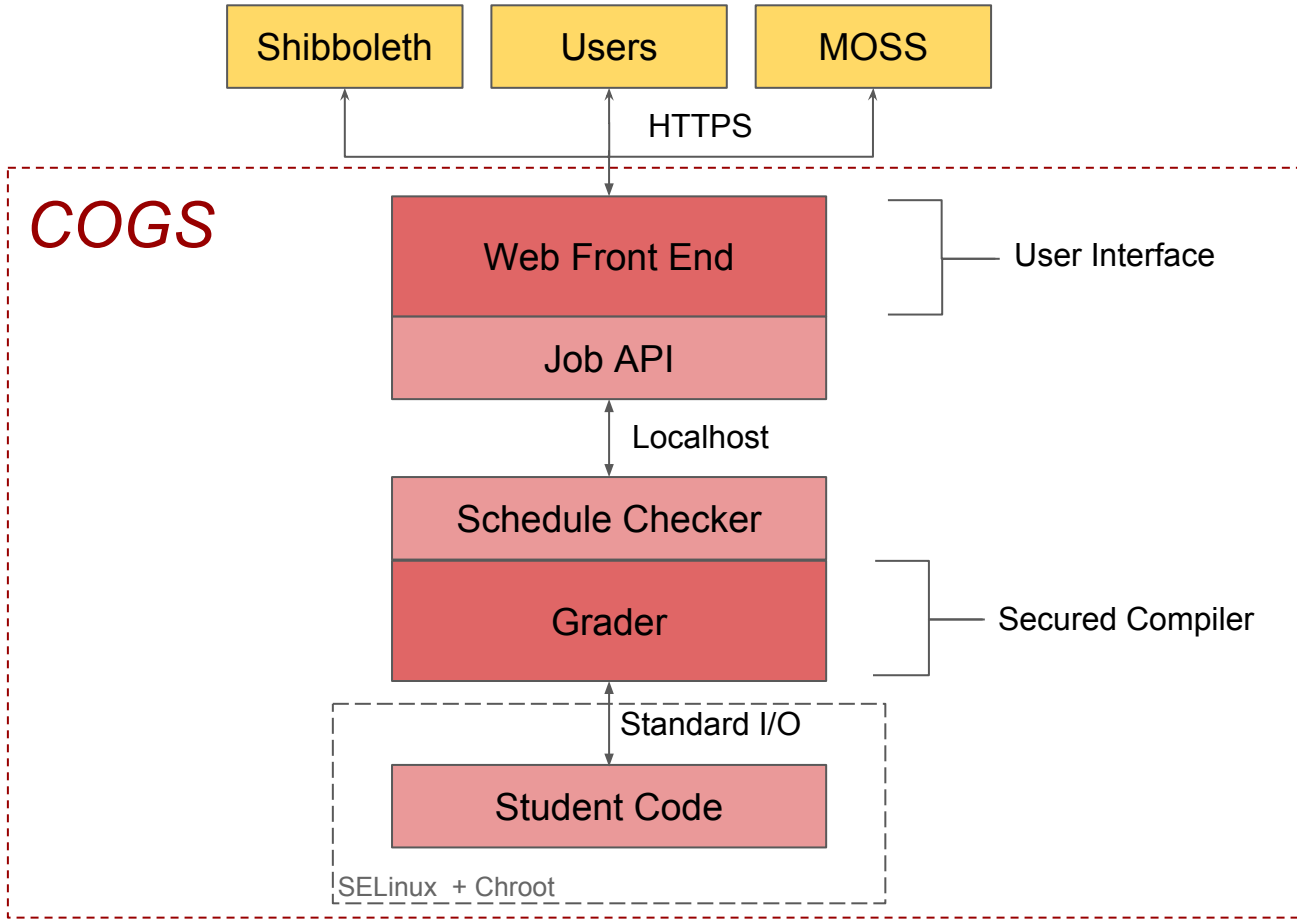
| id | name    | age | sex    | city          | country   |
|----|---------|-----|--------|---------------|-----------|
| 1  | John    | 25  | Male   | New York      | USA       |
| 2  | Jane    | 30  | Female | Los Angeles   | USA       |
| 3  | Bob     | 40  | Male   | Chicago       | USA       |
| 4  | Alice   | 28  | Female | San Francisco | USA       |
| 5  | Charlie | 35  | Male   | London        | UK        |
| 6  | Diana   | 22  | Female | Paris         | France    |
| 7  | Eve     | 45  | Female | Tokyo         | Japan     |
| 8  | Frank   | 38  | Male   | Sydney        | Australia |
| 9  | Grace   | 20  | Female | Mumbai        | India     |
| 10 | Henry   | 50  | Male   | Beijing       | China     |

# Solution Overview

Goal: Streamline the Grading Process

- Main Features:
  - Easy student submission
  - Secure compiler
  - Automatic testing
  - Cheating detection
  - Streamlined grading

# System Sketch



# Web Front End

- Represents the User interface
- Used a PHP framework called “Zend Framework”
  - Modularized, secure, and popular
  - Same framework used by Iowa State





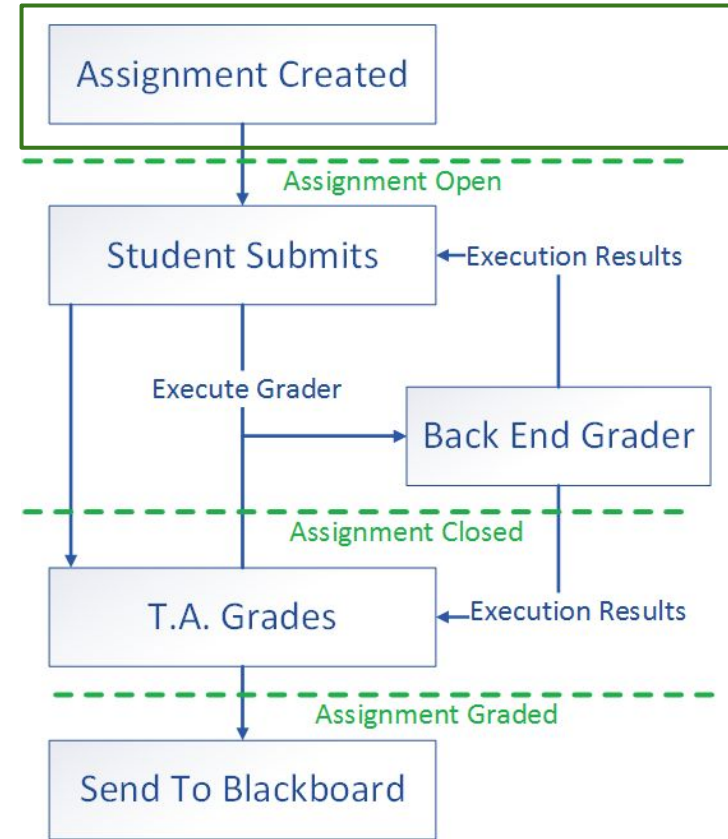
# Technical Challenge - Integrate ISU Theme

- **Challenge:** Integrate Iowa State University web theme
- **Solution:** Built a multi-layer View Helper system that would intelligently render internal objects like Forms and Tables for the ISU theme.



# Grading Timeline

- Creating Assignment
  - Professor only
  - Due dates
  - Grading rubric
  - Attachments



# New Assignment

Select Course

Course 1 ▼

Assignment Name

Demo Assignment

Short Description

Please use loops and strings

Start Date

12/09/2015

Due Date

12/24/2015

Assignment Close  
Date

12/24/2015

Assignment Publish



makes the assignment visible to students

## Checkbox List

Description

Uses Strings

Point Value

5



Description

Uses Loop

Point Value

5



## Numberbox List

Description

Code Quality

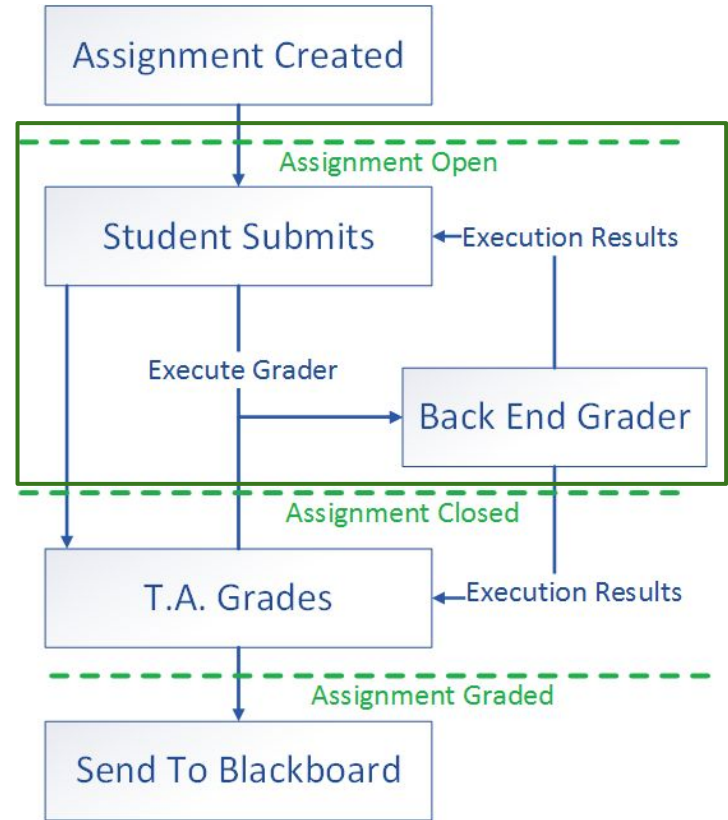
Max Point Value

5



# Grading Timeline

- Student Submits
  - Custom execution inputs
  - Back End runs
  - Returns errors, outputs
  - Last submission is used





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**Assignments** ▾

New Assignment

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## Assignment Submission

### Demo Assignment

**Submission Comments**

**Source files**  demo.c

**Input files**  words.txt

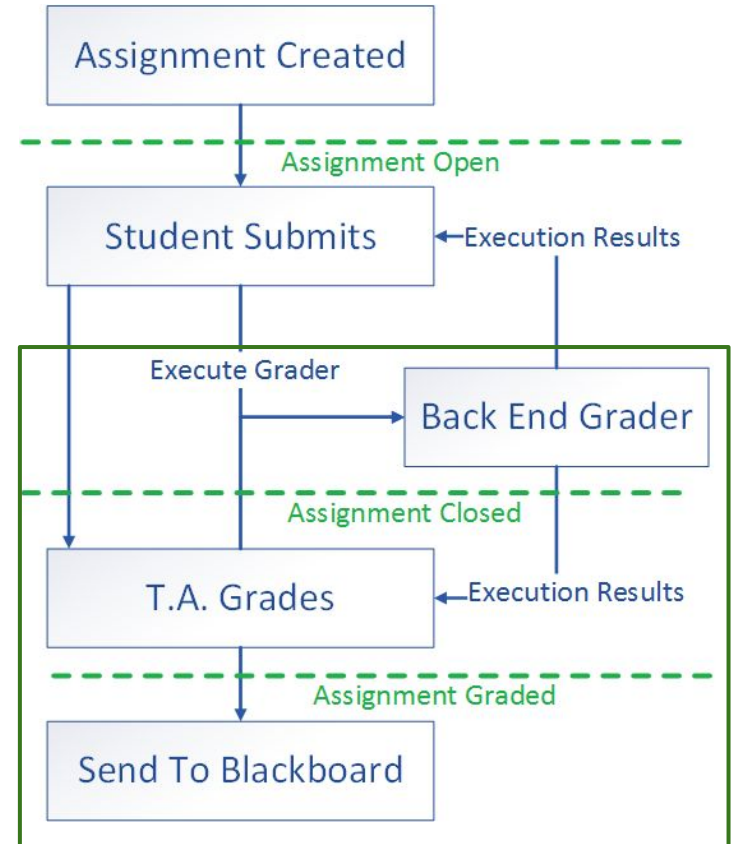
#### Execution Inputs

**Terminal Input**  **Execution Arguments**

**Terminal Input**  **Execution Arguments**

# Grading Timeline

- T.A. Grading
  - Streamlined grading pages
  - Can create new execution
  - Notes viewable by students
  - Upload to Blackboard via .csv





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## Submission View

### Submission Details

- Assignment: Demo Assignment
- Course: Course 2
- Student: isuStudent2

### Student's Comments

Hello! I hope you like my code!

### Source Code

demo.c

```
        if (DEBUG) {
            printf("Read %d words from %s \n",word
Count, argv[1]);

                printf("What word would you like to se
e? \n");

                scanf("%d", &i);
                if(i>0 && i<wordCount) printf("%s \n",
wordlist[i]);
```

### Grading Form

Uses Strings  5 pointsUses Pointers  5 pointsUses Loops  5 pointsCode Quality  / 5  
pointsComments  / 5  
pointsFinal Score **16 / 25  
points**

Scoring Comments

Please  
include  
more  
comments!

# Cheating Detection

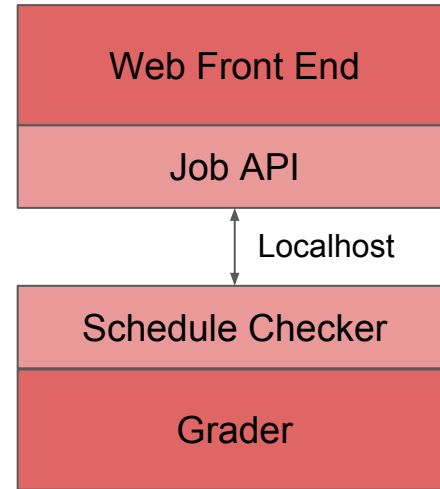


# Other Features

- Create/Read/Edit/Delete
  - Classes
  - Class Sections
  - Assignments
  - Grades
- Assign TAs, Professors
- Blackboard Integration

# Job API + Schedule Checker

- Interfaces between the Front End and Back End
- Back End polls the API periodically for new jobs
- Jobs are assignment submissions
- Handles scheduling and throttling.



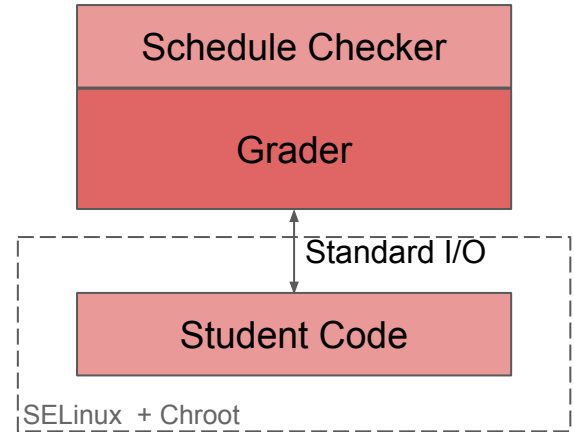
# Grader

Grader: Automated system that compiles and runs student code and outputs a report.

Report: Contains compile errors, code input/output, contents of created files/directories, etc.

Runs the student code in a jailed environment.

Developed through test driven development.



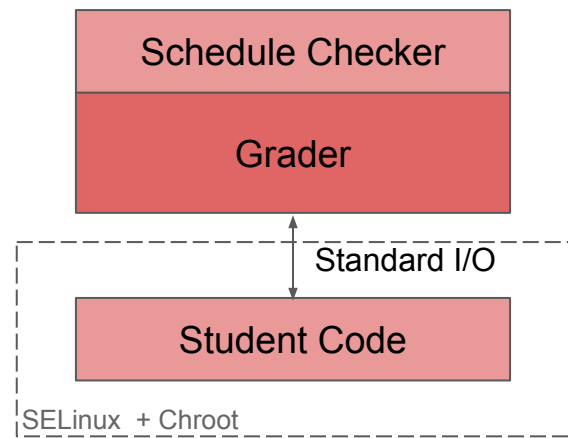
# Attack Vectors

- Malicious code submissions
- Cross Site Scripting
- SQL Injection
- Buffer Overruns of grader
- User Masquerading
- Session Hijacking



# System Security & SELinux Policy

- System Compartmentalization:
  - System has three distinct compartments with limited interaction between parts
- SELinux Policy:
  - Further restricts the permissions and capabilities of student code
  - Restricts system calls to only necessary ones
- Chroot Jail:
  - A temporary and restricted file system where student code is run to protect the system from the users while allowing the students to access a file system with their code.



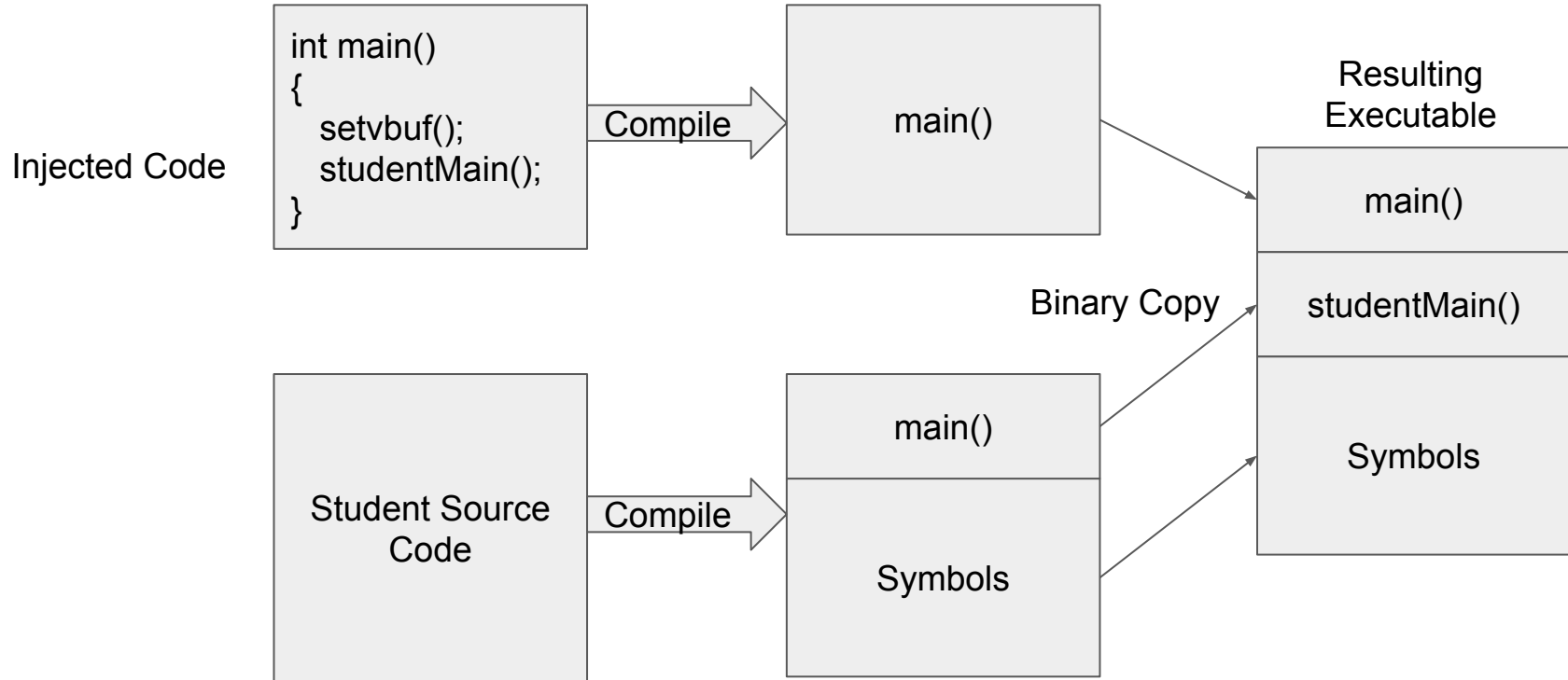
# Front End Security

- Primarily best practices
  - Use CSRF tokens
  - Sanitize input to prevent SQL injection
  - Users can only access pages they need
  - Users are authenticated with Shibboleth
  - Focused on OWASP's Top 10

# Technical Challenge - Running Student Code

- Buffering on student code process needed to be turned off to have a “conversational style” of input and output
- Turning off buffering on the parent process and then forking the student code process did not fix the problem
- Solution: Compile time binary injection

# The Solution





# Testing

- Unit testing with Google Tests
- Manual tests
- Alpha testing sometime in the future

# Looking Forward

- Continued support
  - Upgrades
  - Bug fixes
- Training TA's
- Use by more professors



Questions?

