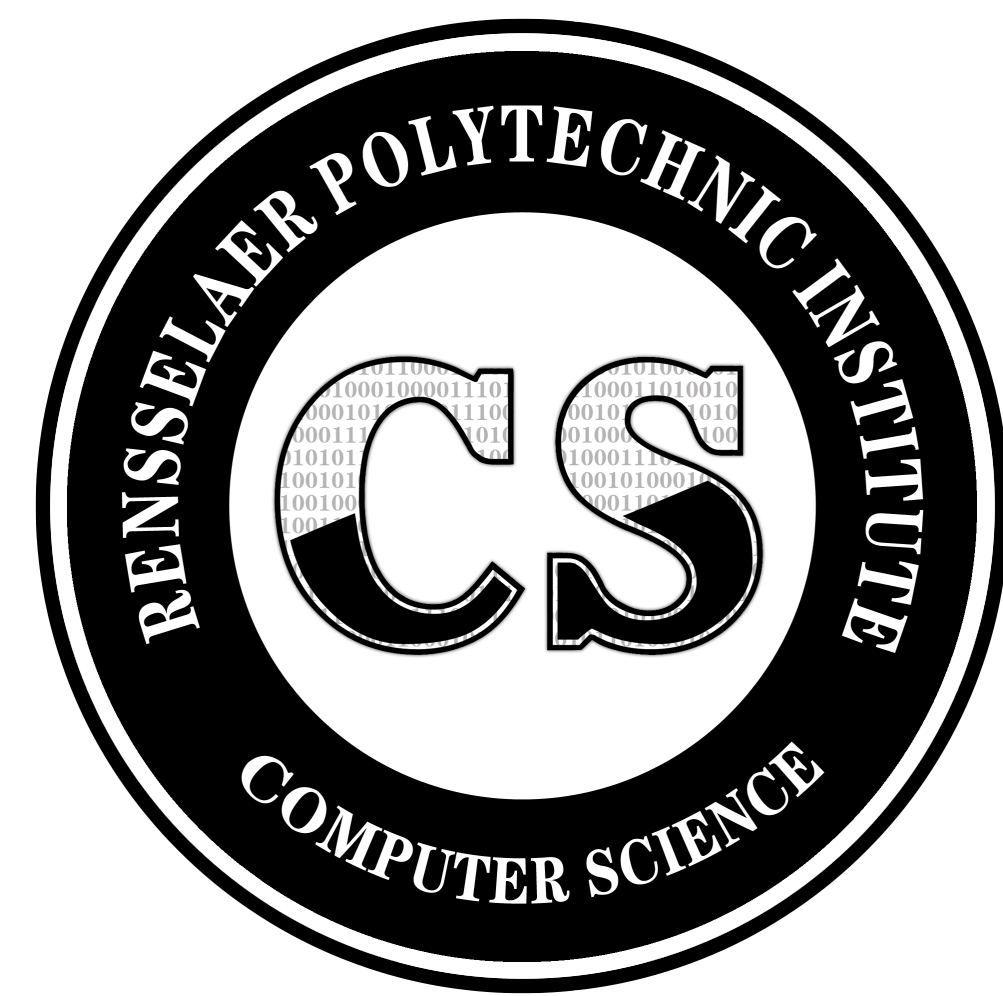# User Experience and Feedback on the RPI Homework Submission Server

Andrea Wong, Beverly Sihsobhon, Melissa Lindquist, Matthew Peveler, Barbara Cutler, Samuel Breese, Eric Tran, Joe Jung, Ben Shaw

RENSSELAER CENTER FOR OPEN SOURCE SOFTWARE

1. Introduction

The Rensselaer Polytechnic Institute (RPI) Homework Submission Server is an ongoing project of the Rensselaer Center for Open Source Software (RCOS). The system collects, compiles, and automatically grades the programming homeworks for students in our introductory, sophomore, and upper division computer science classes. Our research has found that an electronic submission server is the preferred way for students to submit their coding homeworks because it provides immediate feedback about the correctness of their code and ensures fair and consistent grading across all students in the course.

2. System Features

- Website for students to submit assignments and view results
- Automated testing and grading with immediate feedback
- View TA grade and comments on each homework
- Ability to make multiple submissions to the same homework
- Server accepts single file, zip file, or SVN repository submissions
- Highlight differences in the output produced by student's code vs. the expected output

- Instructors create and configure assignments for grading and customize their "late day" policy
- Website for TAs to view and grade student submissions
- Reduces manual TA grading - TAs do not have to manually download, build, compile, & test submissions
- TAs do not have to track administrative details concerning assignments (late day penalties, extensions for illness, etc.)
- TAs provide grades and written feedback on software quality of student homework submissions
- TAs enter lab checkpoints, quiz, and test grades to the database

3. Performance & Robustness

- Multiple submissions and immediate feedback allow for an interactive learning environment
- Ensures consistency and fairness in grading for students
- Little to no down time of server
- Runs multiple homeworks in parallel for efficient grading
- Server is robust - some numbers:
  - 7 active courses
  - 14 weeks of server logs
  - dozens of instructors & TAs
  - more than 1,500 students
  - over 77,000 total submissions

AVERAGE PERFORMANCE OF HOMEWORK SUBMISSION SERVER

Submissions per Course
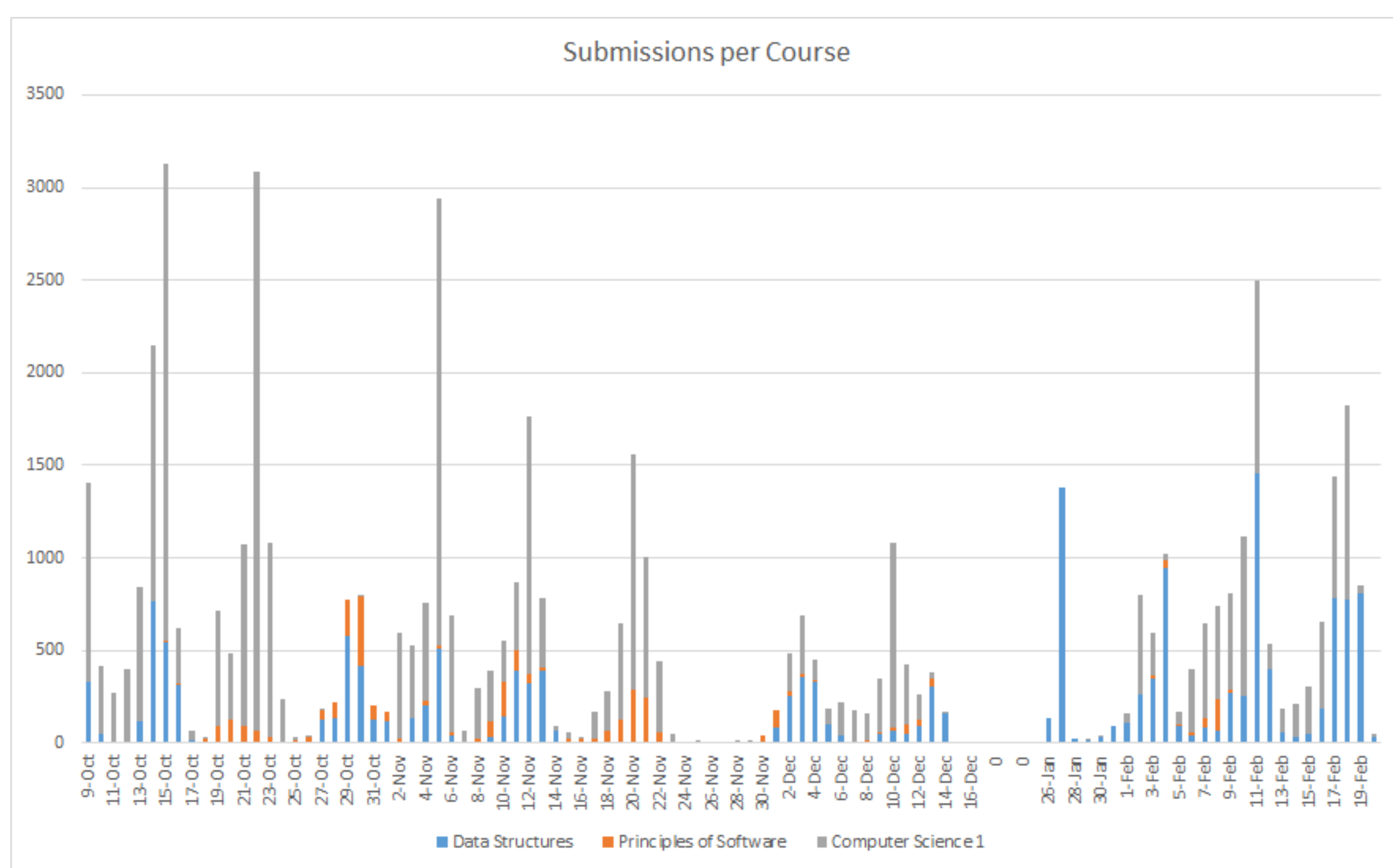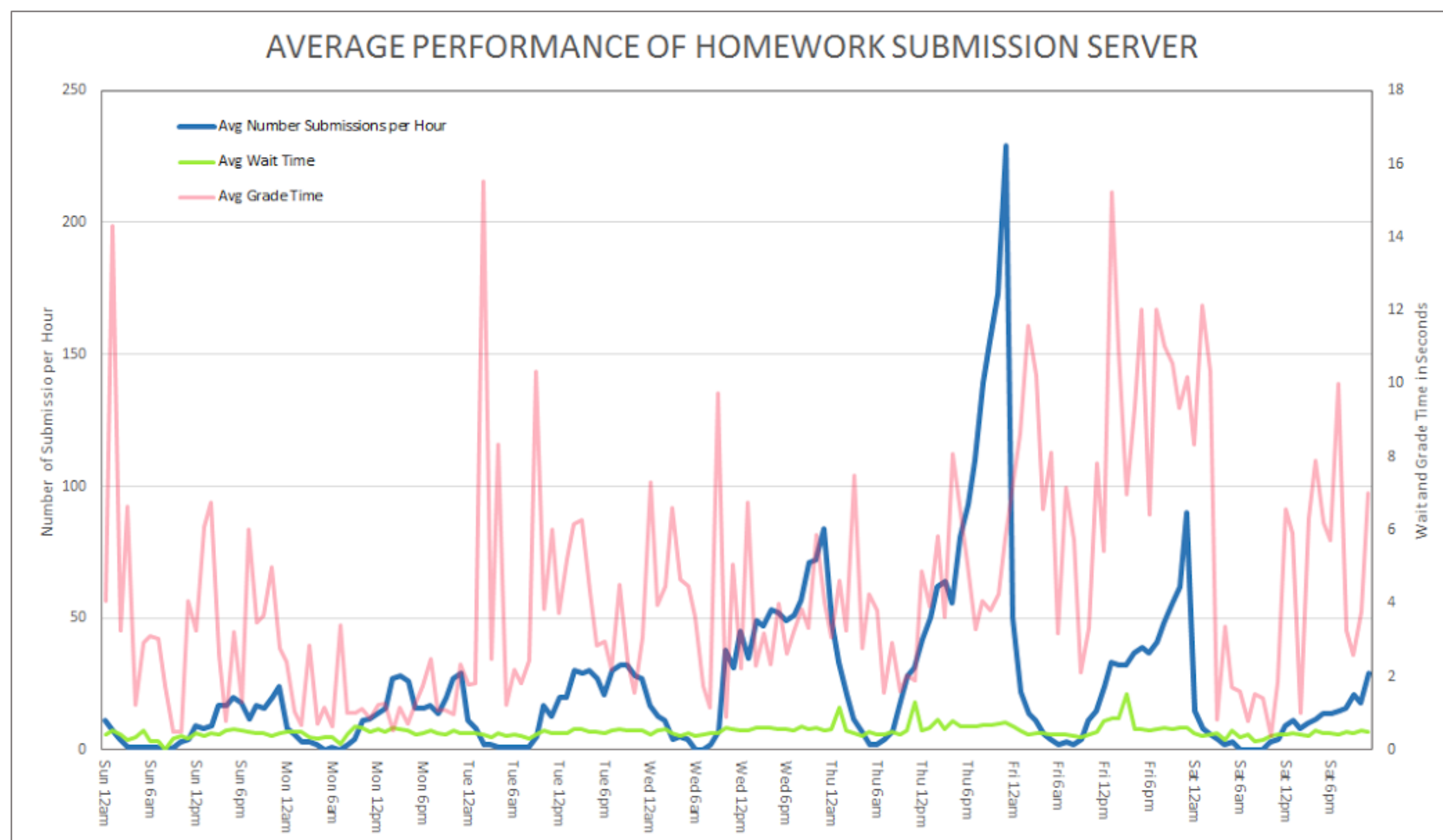
4. Survey of Students

- In mid Fall 2015, we surveyed students and TAs of the three largest courses using the server
- We received ∼400 responses from approximately 850 students

Advantages of Using the Server

Disadvantages of Using the Server
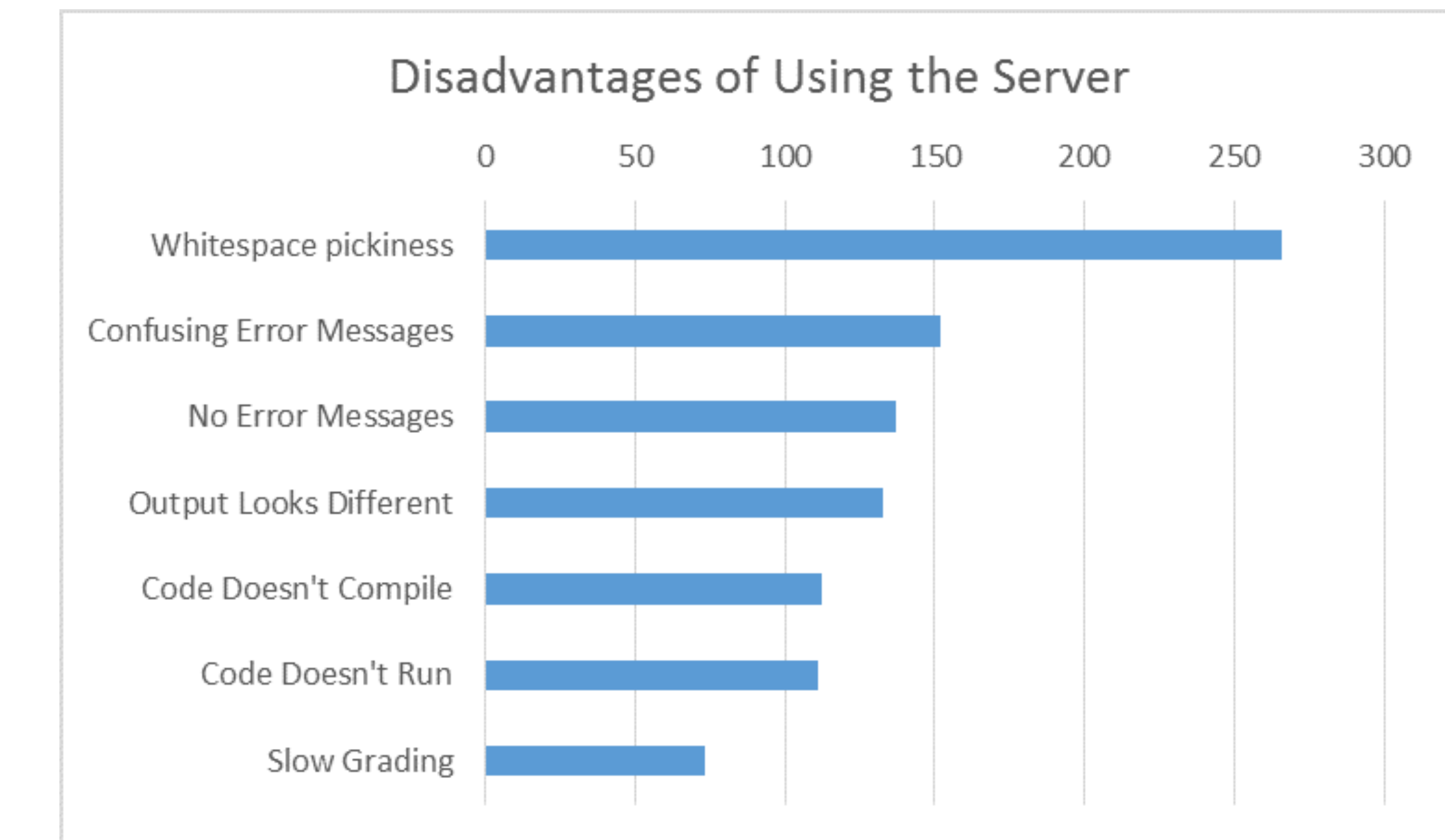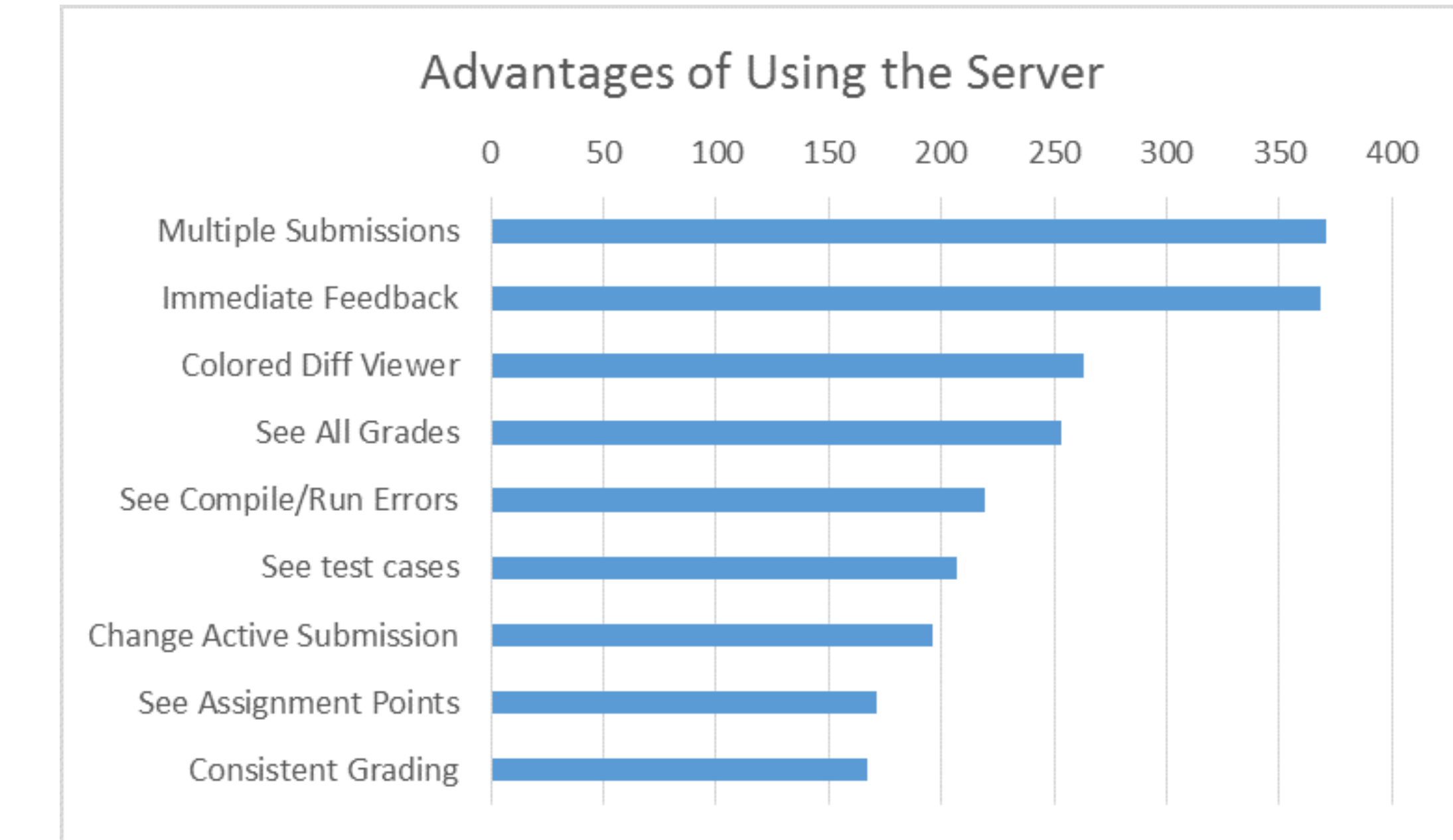
5. Security

- Database access done through the *PDO library* which protects against malicious and malformed inputs
- Instructor configures appropriate *resource limits* (GNU Linux `rlimit`) to *sandbox* testing of electronically-submitted student code and prevent issues like infinite loops, runaway output, and excessive use of other system resources
- Before running the student code, we switch from a privileged system user to an untrusted user using GNU Linux `setresuid`
- Careful design of file and directory permissions and database access maintains confidentiality of student work and grades
- Uses *secure computing mode* (GNU Linux `seccomp`) to prevent use of sockets, fork, and other unnecessary system calls by student code

6. Open Source Software

- Advantages over proprietary software: Free to use, no subscription required, no third-party data collection
- Open source can be more reliable than closed source software
- User interface can be improved and customized
- Community helps maintain codebase
- Improved security: More people can study and test the software to find bugs and security vulnerabilities

7. History of the Project

- Fall 2012: TA grading website started by TAs (closed source)
- January 2014: RCOS students begin development of new system
- Fall 2014: Rollout to first course (Data Structures)
- Fall 2015: TA grading website made open source
- Used by: Computer Science I, Data Structures, Foundations of Computer Science, Principles of Software, Programming Languages, Operating Systems, Interactive Visualization, Advanced Computer Graphics, Computational Vision, Distributed Systems, and Database Systems

8. Ongoing Work

- Improve error and warning messages given to students
- Improve partial credit awarded for minor whitespace differences
- Generate and display submission statistics to the students
- Continued penetration testing and security improvements
- Improve the individual student summary grades table
- Add pdf and image viewer for TA grading
- Expand system to additional courses in our department, to other departments at RPI, and to other universities

9. Acknowledgments

- Red Hat Software
- Rensselaer Center for Open Source (RCOS)
- `https://github.com/RCOS-Grading-Server/HWserver`