Dr. Horrible's Fork Bomb: A Lab For Introducing Security Issues in CS2

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ABSTRACT

We demonstrate "Dr. Horrible's Fork Bomb", a CS2 lab assignment we have developed for teaching security issues in C/C++ as well as practice in using `gdb`. Students must determine/discover two command-line arguments that will prevent the provided executable from reaching a fork bomb. The two arguments are obscured through a combination of a stack buffer overflow, an integer overflow, and an unseeded call to `rand`. Students report the activity as motivating for learning about security, memory organization, and integer representation.

Categories and Subject Descriptors

K.3.2 [**Computers and Information Science Education**]: Pedagogy, assignments

Keywords

CS2, security, computer science education

1. THE PRESENTATION

Security can be a difficult topic to integrate in CS2, but an important one to cover. In our CS2 course for engineers, we have a highly packed curriculum in which we teach C and basic data structures and algorithms in one course. To creatively cover more material in lab, we developed an activity to introduce security and `gdb`: "Dr. Horrible's Fork Bomb".

The lab is inspired by Bryant and O'Hallaron's "Dr. Evil's Binary Bomb"[2], a CS3 assignment outside the ability of our students. Our assignment was designed from the beginning as a CS2 assignment; like Binary Bomb we give students executables and they search for secret keys, but tasks needed to do so have been designed for a CS2 level.

In our presentation, we will demonstrate the lab and our experiences using it at the University of Toronto. We believe this will be interesting to the ITiCSE community as it provides a new example for integrating security issues into CS2, using a fun and exploratory approach, while motivating students to understand basic C security exploits, number representation, memory organization, and pseudorandom number generation.

2. THE ACTIVITY

In our current version of the lab, the two keys that students must find are obfuscated through a combination of an integer overflow, a stack buffer overflow, and an unseeded call to `rand`. Reading the code alone will not yield the keys: one must probe the memory with `gdb`. To give students a sense of progress, the program will output how many keys they have correctly identified.

If the correct keys are not provided, a fork bomb will be set off. This was chosen to introduce fork, to introduce denial of service attacks, and to make the lab feel more integrated with a real-world scenario The students enter with a basic knowledge of integer representation and stack frames. The lab frames the exercise as a plot by Dr. Horrible (who has a Ph.D. in horribleness) to take over the world. To guide them, students are given "Dr. Horrible's browser history": a series of links to articles on stack frame organization, Two's Complement, endianness, and advanced `gdb` options.

2.1 Benefits of the Activity

Security issues are an incredibly important topic, particularly when teaching C/C++, yet are given very little time in most CS curricula, despite students finding it an engaging and important topic [1]. And indeed, students enjoyed this activity in our course. They found the premise engaging, and many constructive discussions about computer security arose from their questions. Numerous students were motivated to learn more about computer security on their own time; this included a number of students who had otherwise been unengaged with the course. Notably, our TAs found a higher completion rate of this lab activity, with students going out of their way to say they "loved it."

3. ACKNOWLEDGMENTS

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4. REFERENCES

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