

# UNIXvisual: A Visualization Tool for Teaching the UNIX Permission Model

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## ABSTRACT

This paper describes UNIXvisual<sup>1</sup>, which helps students learn access control in UNIX. UNIXvisual is aimed both at novice users, who need only to control access to their own files, and students of computer security, who need a deeper and more comprehensive understanding. UNIXvisual allows students to analyze permission settings without the need for a special environment. It allows a student to trace the value and effect of credentials within an executing process. It also provides a mechanism for instructors to give quizzes. UNIXvisual gives instructors flexibility in covering the material by supporting self-study, lowers the overhead required for teaching access control by running under an ordinary user account, and enhances learning by leveraging visualization. UNIXvisual is available for download [1] and runs on the Linux and MacOS platforms.

## Categories and Subject Descriptors

k.3.2 [Computers and Education]: Computer and Information Science Education—*Computer science education, information systems education*

## Keywords

Security, Visualization

## 1. OVERVIEW

UNIXvisual provides two perspectives on how decisions for granting or denying access to an object are made. It also supports visualization of access-related system calls in C programs to illustrate ideas in secure coding. The Query mode allows users to get answers to commonly-asked ques-

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tions and the Quiz mode provides instructors a subsystem to assign quizzes to students.

## 2. PERSPECTIVES

UNIXvisual provides two main views. The User and Group View allows a user to explore how access decisions are made. The Program Trace View allows a student to monitor process credentials within her running program.

The User and Group View illustrates the access allowed by a user or group through the file permission bits to objects under a user-specified directory. The view is based on permissions in the underlying system together with the permissions defined in a user-written specification file. The visualization includes several windows that demonstrate in detail the determination of access to objects. Objects can be arranged in a radial tree or a standard directory tree hierarchy. The owner, group and other permissions of an object of interest and all its parent directories up to the root directory are listed. The system steps a student from the root directory to the object, identifying in detail how access is determined at each step. The color of an object in the result shows whether the object can be accessed.

The Program Trace View is designed to help students understand initial assignment of credentials to a process, dynamic modification of credentials, and the effect of these credentials on an access request. This view allows the import of a custom C program and tracks process credentials across access control-related system calls, like open, fork, setresuid, read, write, etc. Different colors are used to indicate whether a call has been successful. A change of ID is highlighted as a hint for students to review the program for adherence to the principle of least privilege.

## 3. QUERY AND QUIZ

The Query mode includes a list of commonly-asked questions on the UNIX permission model. Animation is available to guide students through each step to the final answers. The Quiz mode provides an interactive environment for conducting quizzes. Text-based and visualization-based questions can be asked. Instructors can freely design the question file to accommodate their own teaching goals.

## 4. REFERENCES

- [1] M. Wang, J. Mayo, C.-K. Shene, S. Carr, and C. Wang. UNIXvisual home page. <http://acv.cs.mtu.edu/UNIXvisual.html>.