



Visualization for Secure Coding in C

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Self paced

Visualization is driven by events generated through static and dynamic program analysis. Students control the pace at which the events are played. They may also step, rewind, and fast forward through the event queue.

Multiple Learning Levels

Four experience levels determine the set of visualizations shown by default and the details that appear in the Program Address Space visualization. Designed for beginning C programmers through graduate students.

More than Security

Visualization of the program address space, call graph, and basic kernel file handling structures can be useful in many courses, including C programming, Systems Programming, and Operating Systems.

Program Address Space

The screenshot shows the SecureCvIsual interface with the 'Program Address Space' tab selected. It displays a C code snippet on the left and a detailed memory layout on the right. The memory layout is divided into 'Stack' and 'Heap' sections, each with a table of variables including their addresses, names, types, sizes, and values. For example, in the stack, 'argv' is at 0xffffd024 and 'argc' is at 0xffffd020. The heap section shows a 'buf' variable at 0xffffcfc.

- Shows address space, registers, and code in C and assembly.
- Choose among multiple levels of detail.
- Easily demonstrate heap and stack overflows

Sensitive Data Handling

The screenshot shows the SecureCvIsual interface with the 'Sensitive Data' tab selected. It displays a C code snippet on the left and a security status table on the right. The table has columns for 'track' and 'insecure' variables, with rows indicating their security state (e.g., 'Declared', 'Locked', 'Set', 'Cleared', 'Unlocked', 'Set with lock').

- Students formally identify sensitive variables.
- Visualization identifies if data properly protected: locked in memory & core size set to zero before use; data cleared before unlocked

Integer Coercion

The screenshot shows the 'Variable Representations' window. It displays a variable 'signed s...' with a value of -32768. Below it, a number line shows the range from 0x8000 to 0x7FFF, with a tick mark at 8000. The variable is interpreted as a signed integer.

Students can see the effect of conversion between two integer types

Shows Big Endian and Little Endian representations

- Shows two's complement representation of any integer variable
- Students can see effect of conversion between two integer types
- Depicts equation evaluation and identifies coercions that will be performed

File Operations*

- Shows students basic kernel file handling data. Works across fork. Shows per-process and global structures.
- Each open depicted and effect of parameters explained.
- Helps students understand shared descriptors and to apply principle of least privilege in file operations.

Future Work

- Eclipse plug-in under development. Planned features include:
 - Static and dynamic analysis
 - Real-time syntax highlighting
 - Attack surface, malloc, free, open, etc.
 - Tutorials on fundamental concepts like attack surface and buffer overflows, etc.
- Planned support for dynamic taint analysis
- Contact: Jean Mayo (jmayo@mtu.edu) or Steve Carr (steve.carr@wmich.edu)

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* Under development