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**Carnegie Mellon Developing Programming Language**

**That Accommodates Multiple Languages in Same Program**

*Wyvern Language Protects Computers From Code Injection Attacks*

PITTSBURGH—Computer scientists at Carnegie Mellon University have designed a way to safely use multiple programming languages within the same program, enabling programmers to use the language most appropriate for each function while guarding against code injection attacks, one of the most severe security threats in web applications today.

A research group led by Jonathan Aldrich, associate professor in the Institute for Software Research (ISR), is developing a programming language called Wyvern that makes it possible to construct programs using a variety of targeted, domain-specific languages, such as SQL for querying databases or HTML for constructing webpages, as sublanguages, rather than writing the entire program using a general purpose language.

Wyvern determines which sublanguage is being used within the program based on the type of data that the programmer is manipulating. Types specify the format of data, such as alphanumeric characters, floating-point numbers or more complex data structures, like webpages and database queries.

The type provides context, enabling Wyvern to identify a sublanguage associated with that type in the same way that a person would realize that a conversation about gourmet dining might include some French words and phrases, explained Joshua Sunshine, ISR systems scientist.

“Wyvern is like a skilled international negotiator who can smoothly switch between languages to get a whole team of people to work together,” Aldrich said. “Such a person can be extremely effective and, likewise, I think our new approach can have a big impact on building software systems.”

Many programming tasks can involve multiple languages; when building a web page, for instance, HTML might be used to create the bulk of the page, but the programmer might also include SQL to access databases and JavaScript to allow for user interaction. By using type-specific languages, Wyvern can simplify that task for the programmer, Aldrich said, while also avoiding workarounds that can introduce security vulnerabilities.

One common but problematic practice is to paste together strings of characters to form a command in a specialized language, such as SQL, within a program. If not implemented carefully, however, this practice can leave computers vulnerable to two of the most serious security threats on the web today: cross-site scripting attacks and SQL injection attacks. In the latter case, for instance, someone with knowledge of computer systems could use a login/password form or an order form to type in a command to DROP TABLE that could wipe out a database.

“Wyvern would make the use of strings for this purpose unnecessary and thus eliminate all sorts of injection vulnerabilities,” Aldrich said.

Previous attempts to develop programming languages that could understand other languages have faced tradeoffs between composability and expressiveness: they were either limited in their ability to unambiguously determine which embedded language was being used, or limited in which embedded languages could be used.

“With Wyvern, we’re allowing you to use these languages, and define new ones, without worrying about composition,” said Cyrus Omar, a Ph.D. student in the Computer Science Department and the lead designer of Wyvern’s type-specific language approach.

Wyvern is not yet fully engineered, Omar noted, but is an open source project that is ready for experimental use by early adopters. More information is available at <http://www.cs.cmu.edu/~aldrich/wyvern/>

A research paper, “[Safely Composable Type-Specific Languages](http://www.cs.cmu.edu/~aldrich/papers/ecoop14-tsls.pdf),” by Omar, Aldrich, Darya Kurilova, Ligia Nistor and Benjamin Chung of CMU and Alex Potanin of Victoria University of Wellington, recently won a distinguished paper award at the European Conference on Object-Oriented Programming in Uppsala, Sweden.

This research was supported in part by the Air Force Research Laboratory, the National Security Agency and the Royal Society of New Zealand Marsden Fund.

The Institute for Software Research and Computer Science Department are part of Carnegie Mellon’s [top-ranked](http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-science-schools/computer-science-rankings) School of Computer Science, which is celebrating its 25th year. Follow the school on Twitter @SCSatCMU.

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