Teaching the Security Mindset to CS 1 Students

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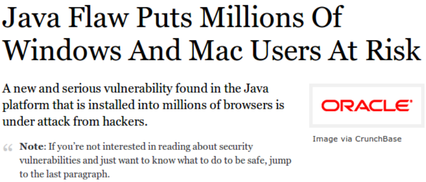
Overview

- Motivation
- What is Security Mindset?
- Advantages
- Methodology
- Evaluation
- Summary

Motivation

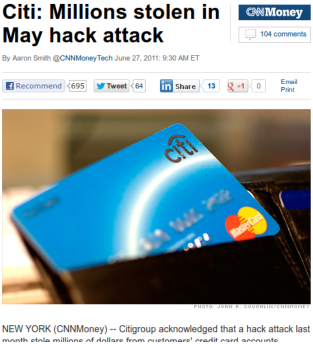


Java Flaw Puts Millions Of Windows And Mac Users At Risk

A new and serious vulnerability found in the Java platform that is installed into millions of browsers is under attack from hackers.

Image via CrunchBase

> **Note**: If you're not interested in reading about security vulnerabilities and just want to know what to do to be safe, jump to the last paragraph.

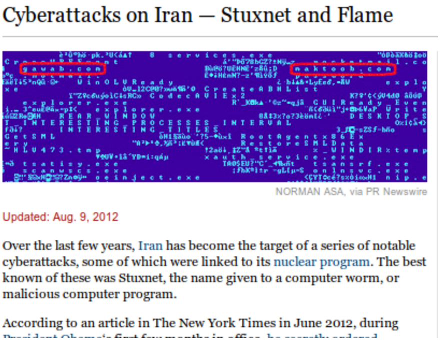


Citi: Millions stolen in May hack attack

By Aaron Smith @CNNMoneyTech June 27, 2011: 9:30 AM ET

PHOTO: JOHN R. COUGHLIN/CNNMONEY

NEW YORK (CNNMoney) -- Citigroup acknowledged that a hack attack last month stole millions of dollars from customers' credit card accounts.



Cyberattacks on Iran — Stuxnet and Flame

NORMAN ASA, via PR Newswire

Updated: Aug. 9, 2012

Over the last few years, Iran has become the target of a series of notable cyberattacks, some of which were linked to its nuclear program. The best known of these was Stuxnet, the name given to a computer worm, or malicious computer program.

According to an article in The New York Times in June 2012, during President Obama's first few months in office, he secretly ordered

What is Security Mindset?

> *"Security requires a particular mindset. Security professionals see the world differently...This kind of thinking is not natural for most people. It's not natural for engineers. Good engineering involves thinking about how things can be made to work; the security mindset involves thinking about how things can be made to fail. It involves thinking like an attacker, an adversary or a criminal. You don't have to exploit the vulnerabilities you find, but if you don't see the world that way, you'll never notice most security problems."*

Bruce Schneier

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  - Minor logical or run-time errors can lead to security breaches
- “Security can make other stuff more interesting”
  - Incorporating simple attack/defense scenarios to teach and verify program correctness interactively

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  - They understand the root cause of known security problems
  - "The security mindset is a valuable skill that everyone can benefit from, regardless of career path"
- Secure programming takes extensive practice to evolve into a skill
  - Failure of a single course in computer security in undergraduate curriculum

Methodology

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  - It is security-sensitive by its nature

Methodology: Examples

- **Conditional (if-else) Statements**

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if ( password == 12345 )
    cout << "The secret word is Peace.";
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- **String Class**

Methodology: Examples

- **Nested if-else and switch Statements**

```
if (( username == "vahab" || password == "5!eR?3") ||
    ( username == "peter" || password == "0a%2NFa"))
    cout << "The secret word is Peace.";
else
    cout << "Invalid username and/or password!"
```

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- **File I/O**
  - Hardcoding passwords into executables is bad security practice
  - Introducing *credentials file*: to add, remove, and update users' passwords
  - Touch upon cryptographically secure one-way hash functions (e.g., crypt)

Methodology: Examples

- **Arrays and C Strings**

```
char password[SIZE];
bool logged_in = false;

cin >> password;

if ( strcmp(password,correct_password) == 0 )
    logged_in = true;

if ( logged_in == true )
    cout << "The secret word is Peace.";
else
    cout << "Invalid password!";
```

Methodology: Examples

- **Classes and Structs**

```
class Credentials {
public:
  Credentials(char* filename);
  bool addNewUser(char*,char*,char*,char*,int,
                  long,char*,char*,char);
  int deleteUser(UserInfo*);
  UserInfo* getUserInfo(char* username);

private:
  int num_of_users;
  UserInfo* users_list;
};
```

```
class UserInfo {
public:
  UserInfo(char*,char*,char*,char*,int,
           long,char*,char*,char);
  char* getUsername();
  char* getPassword();
  bool resetPassword(char* password);
  bool isStrongPassword(char* password);

  char first_name[SIZE];
  char last_name[SIZE];
  int  age;
  long dob;
  char security_question[SIZE];
  char answer_security_question[SIZE];
  char privileges;

private:
   char username[SIZE];
   char password[SIZE];
};
```

Table: Student evaluation of materials we used in CS 1. (H: Helpfulness, D: Difficulty, F: Fun)

	Login Program			Other Examples		
Topics	H	D	F	H	D	F
Intro/Variables	3.2	1.4	3.1	3.0	1.4	2.1
if-else Statements	3.8	2.0	3.9	4.0	2.1	3.1
Nested if-else	4.3	2.4	4.6	3.3	2.6	3.0
String Class	3.3	2.1	3.8	3.5	1.7	3.3
Loops	4.1	2.7	4.2	3.8	2.7	3.4
Nested Loops	3.4	3.5	3.7	3.9	3.2	3.8
Functions	3.2	3.1	3.9	3.9	3.4	3.7
Arrays/C strings	3.7	3.2	4.0	3.7	2.9	3.8
Multi-dim Arrays	3.2	3.6	4.1	3.5	3.4	2.9
Parallel Arrays	3.8	3.0	4.4	3.7	3.1	3.2
File I/O	3.6	4.0	4.5	3.4	3.4	3.1
Pointers/DMA	3.6	4.0	4.5	3.5	3.9	2.8
Structs/Classes	4.2	4.3	4.2	3.7	4.2	3.5

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Summary

- Lack of security mindset is responsible for many overlooked bugs
- Teaching the security mindset is valuable and effective
- Teaching by example: the login program
- Positive reaction by students
- This is just the first step...