Intro. to Secure Programming
Study Groups at NCYU

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About me

- 楊志璿
- NSYSU Information security club founder
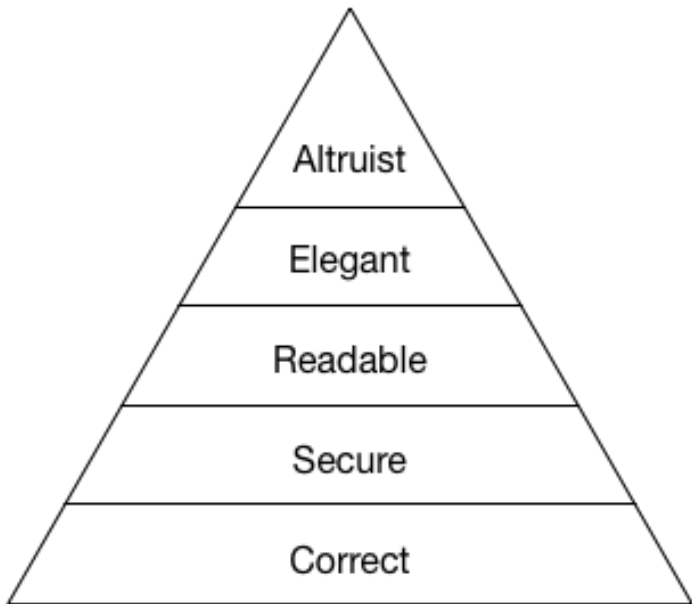- Resume
- Linux, Modern C++

A book

Secure Programming
Not hard, no much pages.

Outline

# Background

Maslow's pyramid of code review

Maslow's pyramid of code review

- Correct：做到預期的行為了嗎？能夠處理各式邊際狀況嗎？即便其他人修改程式碼後，主體的行為仍符合預期嗎？
- Secure：面對各式輸入條件或攻擊，程式仍可正確運作嗎？
- Readable：程式碼易於理解和維護嗎？
- Elegant：程式碼夠「美」嗎？可以簡潔又清晰地解決問題嗎？
- Altruist：除了滿足現有的狀況，軟體在日後能夠重用嗎？甚至能夠抽離一部分元件，給其他專案使用嗎？

Programmer's qualities

Arithmetic overflow

Data Model					
Type	LP32	ILP32	LP64	ILP64	LLP64
char	8	8	8	8	8
short	16	16	16	16	16
int	16	32	32	64	32
long	32	32	64	64	32
long long	64	64	64	64	64
pointer	32	32	64	64	64

Bits field

[int]
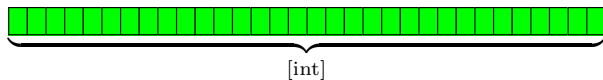
2's complement

Eg:
- 0x1234ABCD
- 0x00BADBAD
- 0xFFFFFFFF

Integer overflow

```
1 #define KSIZE 1024
2 char kbuf[KSIZE];
3 int copy_from_kernel(void *user_dest, int maxlen) {
4   int len = KSIZE < maxlen ? KSIZE : maxlen;
5   memcpy(user_dest, kbuf, len);
6   return len;
7 }
```

What if maxlen < 0?
Take maxlen as -1, try it!

Integer overflow

2002 External data representation (XDR)

```c
void *copy_elements(void *ele_src[], int ele_cnt, int
    ele_size) {
  void *result = malloc(ele_cnt * ele_size);
  if (result == NULL)
    return NULL;
  void *next = result;
  for (int i = 0; i < ele_cnt; i++) {
    memcpy(next, ele_src[i], ele_size);
    next += ele_size;
  }
  return result;
}
```

What if ele_cnt $= 10^{22}$, ele_size $= 10^{10}$?
Try it!

Binary search

```c
int wrong(int *arr, size_t len, int target)
{
    int begin = 0, end = len;
    while (begin <= end)
    {
        int mid = (begin + end) / 2;
        if (arr[mid] == target)
            return mid;
        else if (arr[mid] < target)
            end = mid;
        else
            begin = mid;
    }
    return -1;
}
```

Binary search

```c
int correct(int *arr, size_t len, int target)
{
    int begin = 0, end = len;
    while (begin <= end)
    {
        int mid = (begin >> 1) + (end >> 1);
        if (arr[mid] == target)
            return mid;
        else if (arr[mid] < target)
            end = mid;
        else
            begin = mid;
    }
    return -1;
}
```

Binary search

- 1946 idea
- 1960 mathematical analysis
- 1988 find bugs.

Donald Knuth

Although the basic idea of binary search is comparatively straightforward, the details can be surprisingly tricky.

Appendix here - Donald Knuth

- T$_E$X
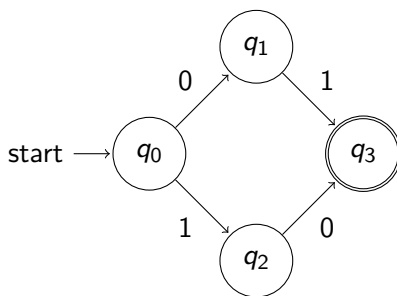- The Art of Computer Programming (TAOCP)

ReDoS
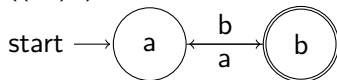
Regex

- Regular expression
- Finite state machine

Regex basic

Regex 101

Let's try:

- A brown fox jumps over the lazy dog.
- Student ID.
- Binary search code.
- Email.

Halting problem

`^ ((ab)*)+$`

Input

ababababababababababababab

Halting problem

The engine will first try (abababababababababababab) but that
fails because of that extra a. This causes catastrophic
bracktracking, because our pattern (ab)*, in a show of good faith,
will release one of it's captures (it will "backtrack") and let the
outer pattern try again.

- ▶ (abababababababababababab) - Nope
- ▶ (ababababababababababab)(ab) - Nope
- ▶ (ababababababababababab)(abab) - Nope
- ▶ (ababababababababababab)(ab)(ab) - Nope
- ▶ (abababababababababab)(ababab) - Nope
- ▶ (abababababababababab)(abab)(ab) - Nope
- ▶ (abababababababababab)(ab)(abab) - Nope
- ▶ (abababababababababab)(ab)(ab)(ab) - Nope
- ▶ . . .
- ▶ (ab)(ab)(ab)(ab)(ab)(ab)(ab)(ab)(ab)(ab)(ab)(ab) - Nope

Halting problem

$$dp[0] = 1$$

$$dp[N] = \sum_{i=0}^{N} dp[i] + dp[N-i]$$

$$\sim O(3^N)$$

ReDoS

So, please check what you did.
User provides regex should have a timeout threshold.
Don't believe the user inputs.

RAII

- Resource Acquisition Is Initialization

- Bjarne Stroustrup

- Constructor, destructor

- Don't memorize.

RAII - Obj

The Obj.hpp

```cpp
#include <iostream>
class Object
{
    int *arr;

public:
    Object()
    {
        arr = new int[5];
    }
    ~Object()
    {
        std::cerr << "Freed" << std::endl;
        delete[] arr;
    }
};
```

RAII - lifetime

Recall: Objects.

```cpp
#include <iostream>
#include "Obj.hpp"

Object obj;

int main()
{
    Object _obj;
    return 0;
}
```

RAII - exceptions

```cpp
#include <exception>
#include "Obj.hpp"

void f()
{
    Object o;
    throw std::runtime_error("Oops!!");
    return;
}

int main()
{
    try {
        f();
    } catch (const std::exception &e) {
        std::cerr << e.what() << '\n';
    }
    return 0;
}
```

Memory safe

Buffer overflow

sample code.

Buffer overflow

Try some code.
strcpy, strncpy

Buffer overflow

bof on stack

Buffer overflow

canary

Memory leakage

sample code

Memory leakage

Try some codes.
new, delete.

Memory leakage

Garbage Collection

Memory leakage

RAII

Call out to other routines

SQL injection

not checking, string concatenation

Command line injection

not checking, don't call commands directly.

Exploiting URL Parser in Trending Programming Languages

Orange - SSRF HITCON 2017

- ▶ NodeJS Unicode Failure
- ▶ GLibc NSS Features
- ▶ Abusing IDNA Standard

Others

Strong types, week types

Duck typing
Philosophy

Inheritance

Python

Passwords

hash