CMPT 473
Software Quality Assurance

Security

Nick Sumner

Security in General

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  - Maintaining desired properties in the the presence of adversaries

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So what are the desired properties?

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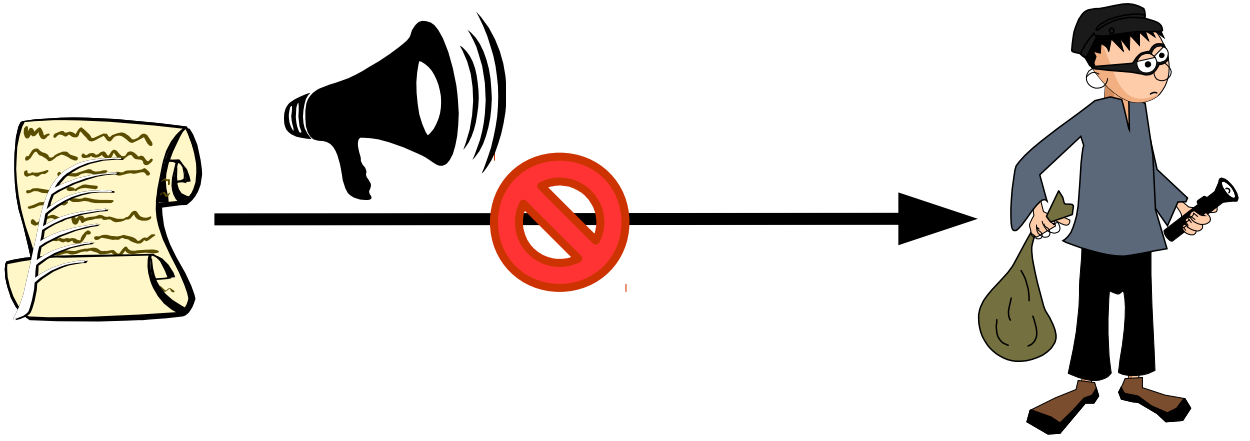
  - **Confidentiality**
    - Information is only disclosed to those authorized to know it



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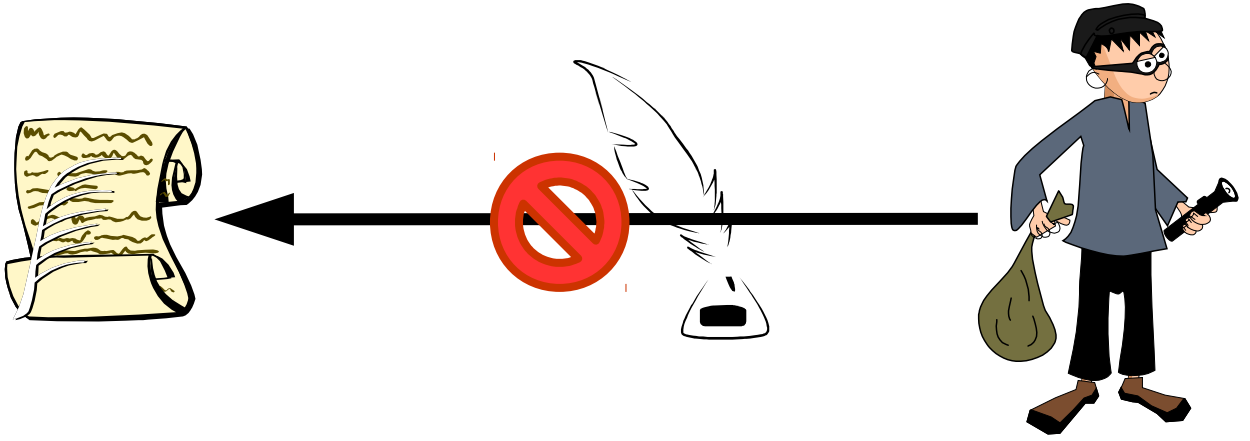

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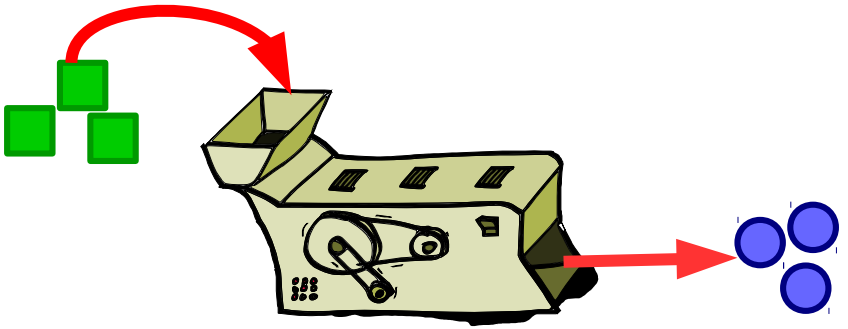
    - Do what is expected



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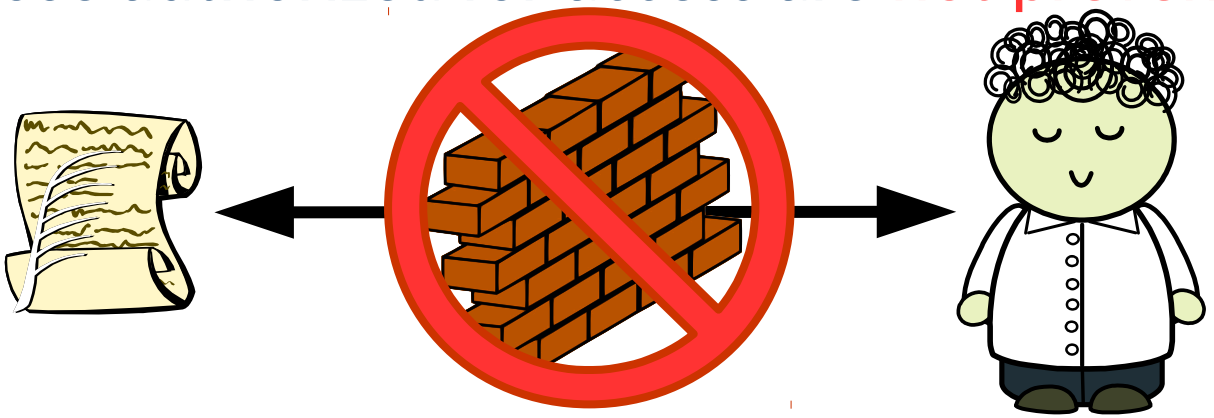
  - Integrity
  - **Availability**
    - Those authorized for access are not prevented from it



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  - Information leaks (**C**)
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  - Denial of service (**A**)
  - Remote execution – (**CIA**) arbitrarily bad!

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- *Bugs* in software can lead to policy violations
- *Bugs* make software vulnerable to attack
  - XSS
  - SQL Injection
  - Buffer overflow
  - Path replacement
  - Integer overflow
  - Race conditions (TOCTOU – Time of Check to Time of Use)
  - Unsanitized format strings
  - …

All create attack vectors for a malicious adversary

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    - Networks, Software, People
- Need additional policies & testing methods that specifically address security

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  - Risky Resource Management
    - Bad creation, use, transfer, & destruction of resources
  - Porous Defenses
    - Standard security practices that are missing or incorrect

[http://cwe.mitre.org/top25/#Categories]

Memory Safety

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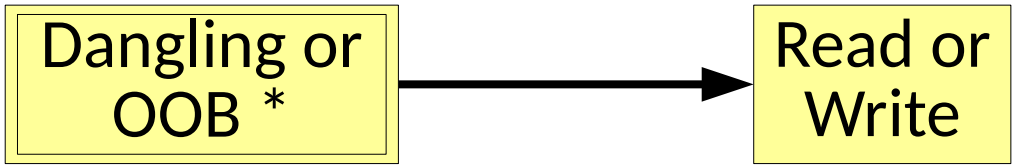

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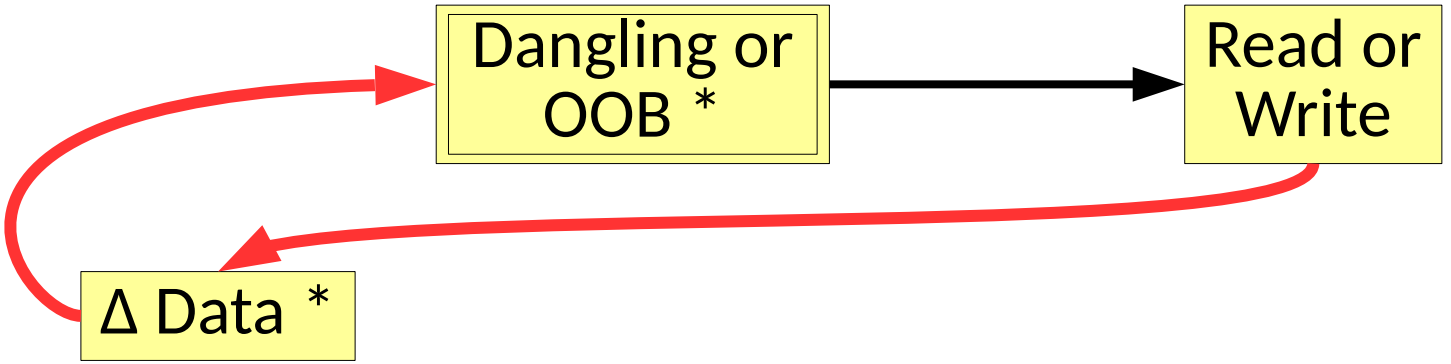

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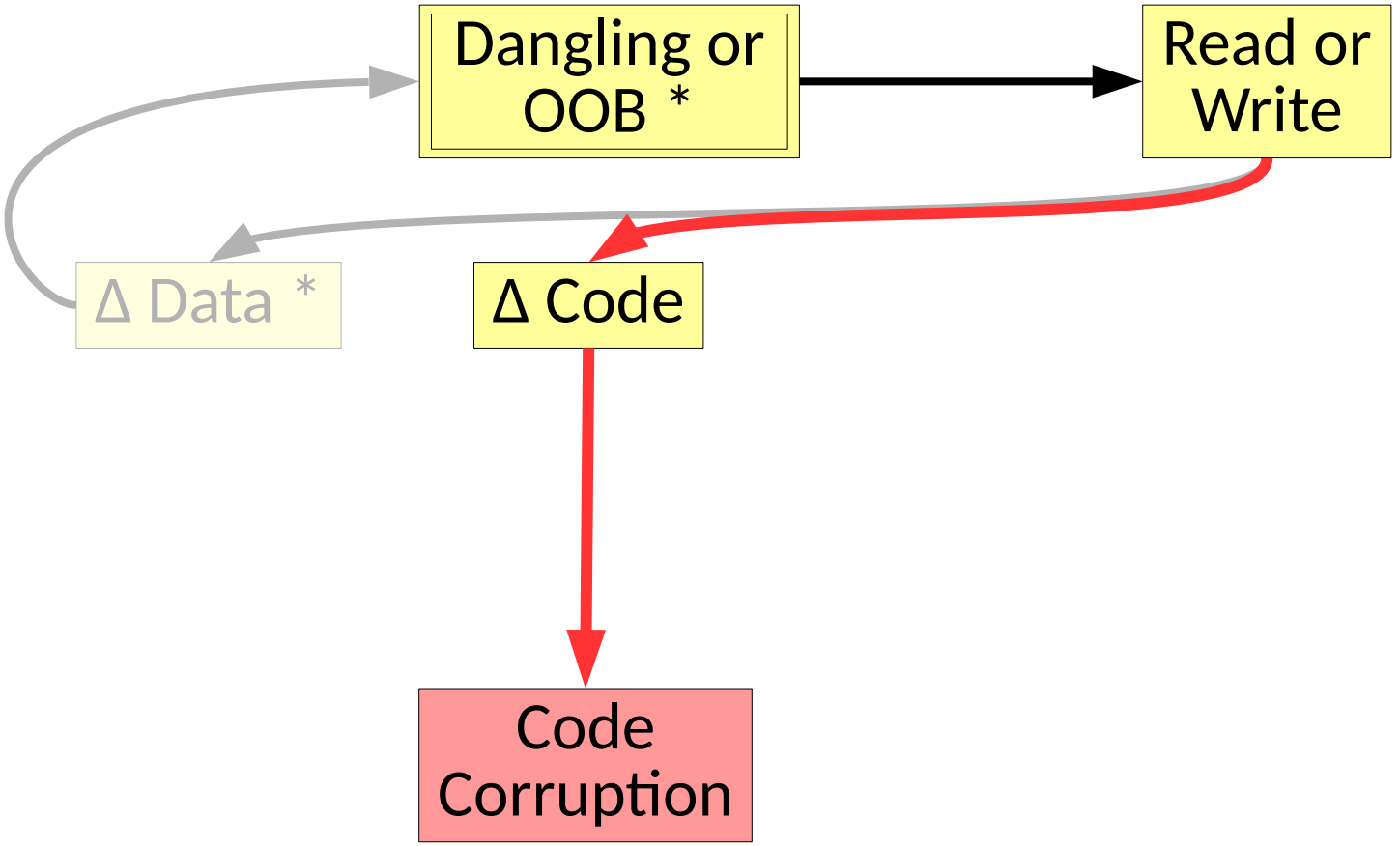

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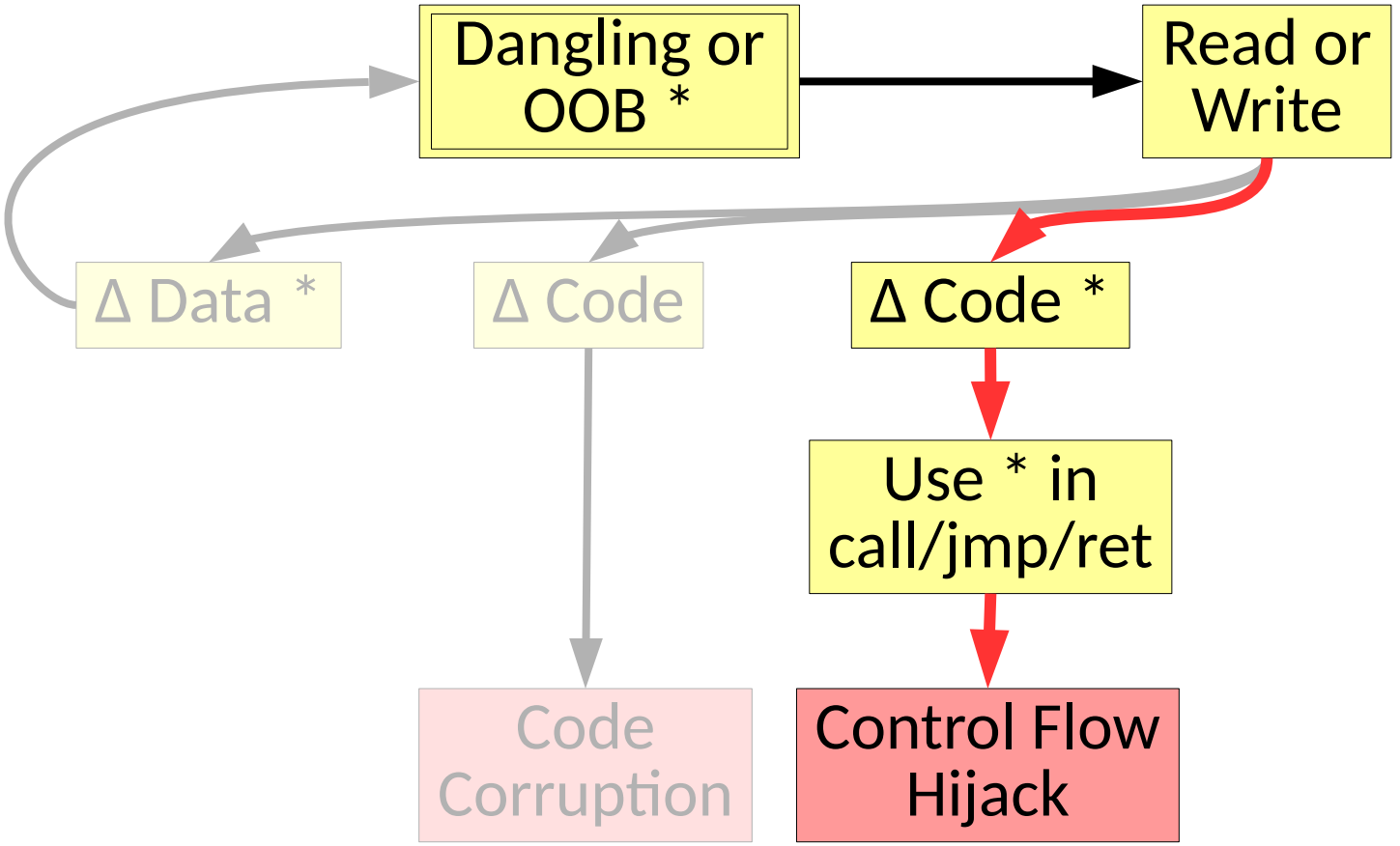

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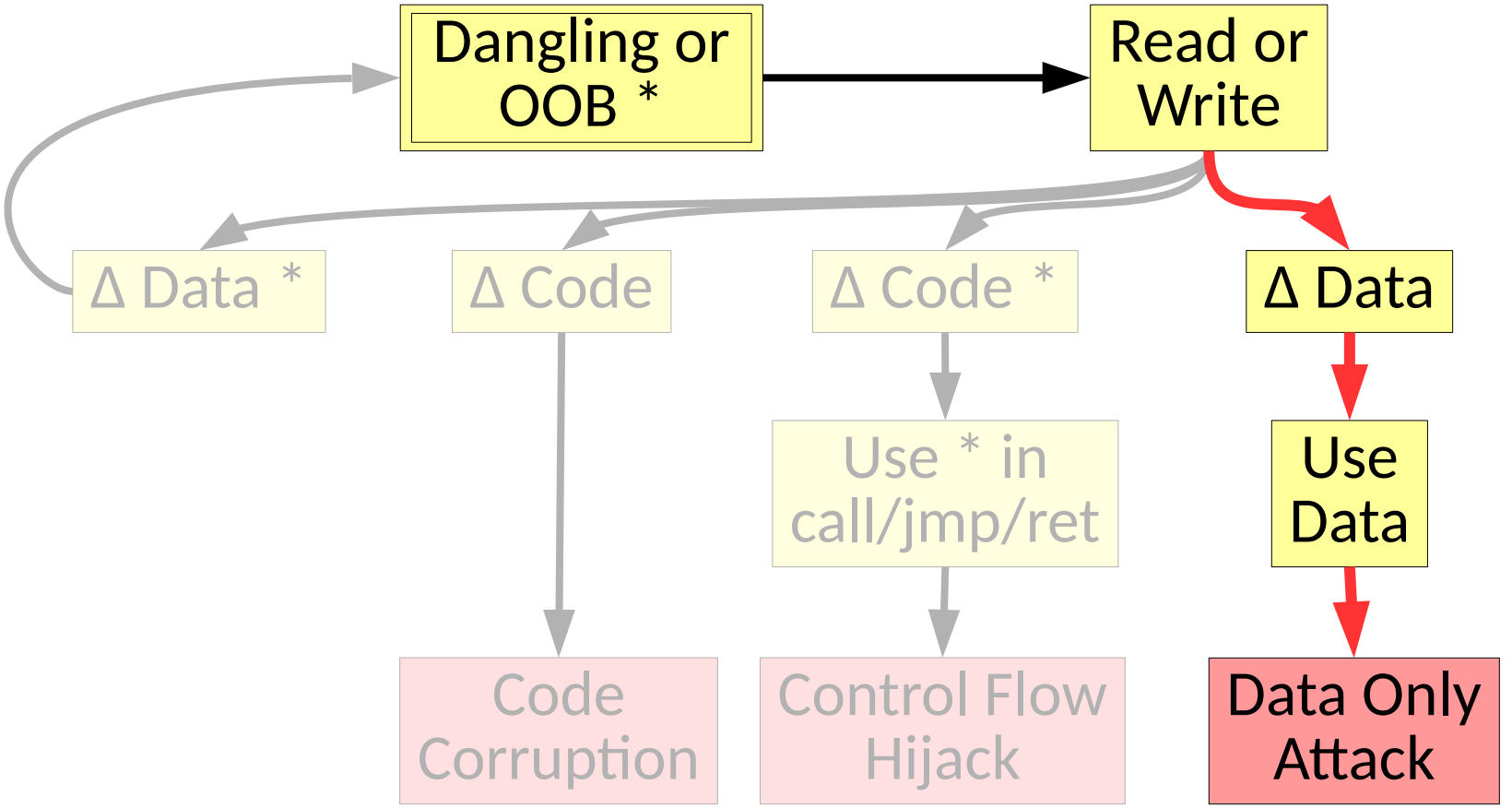

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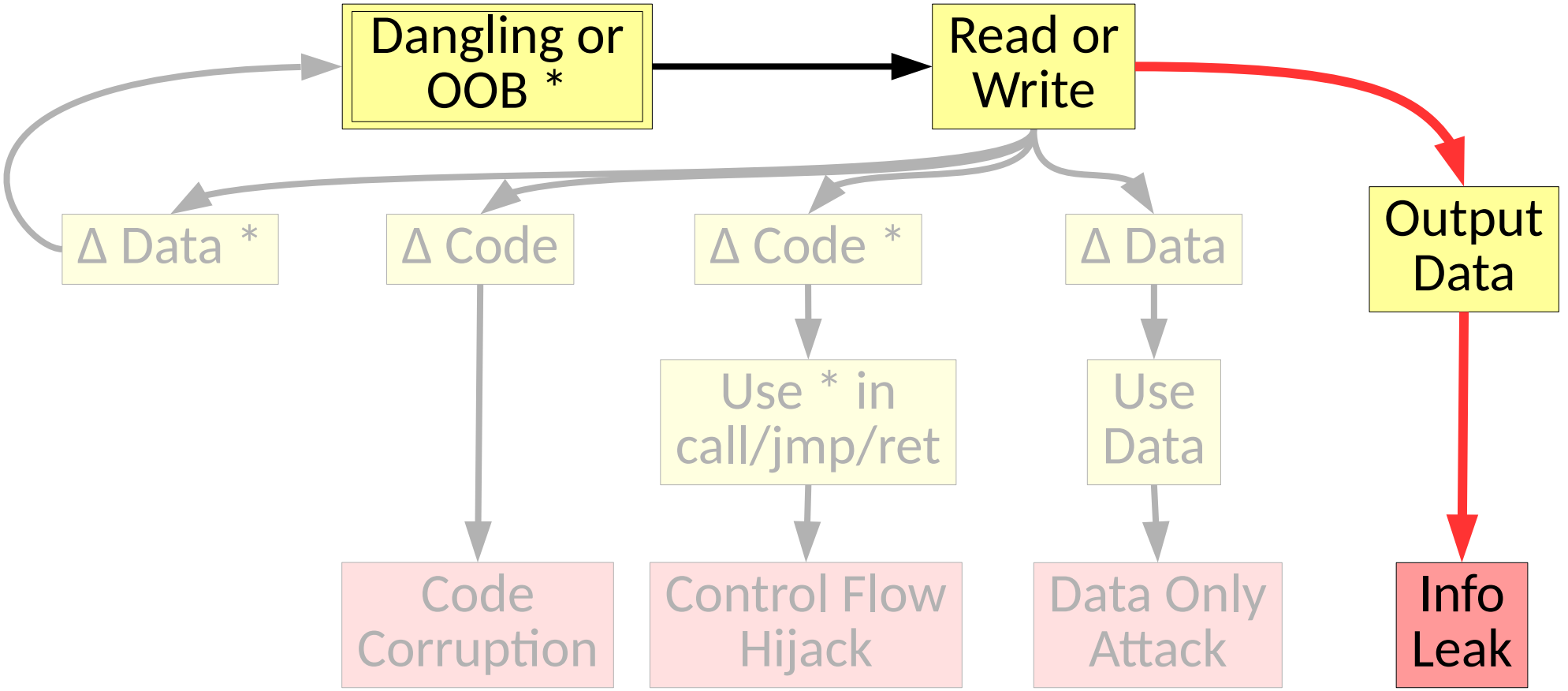

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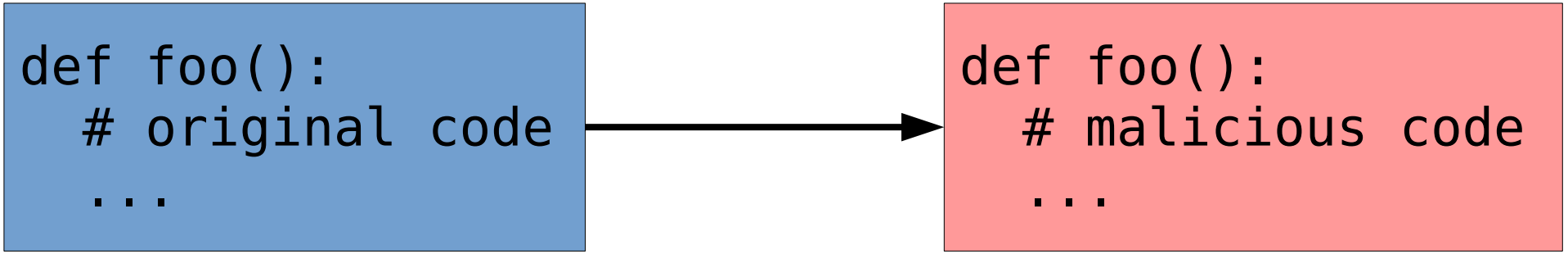
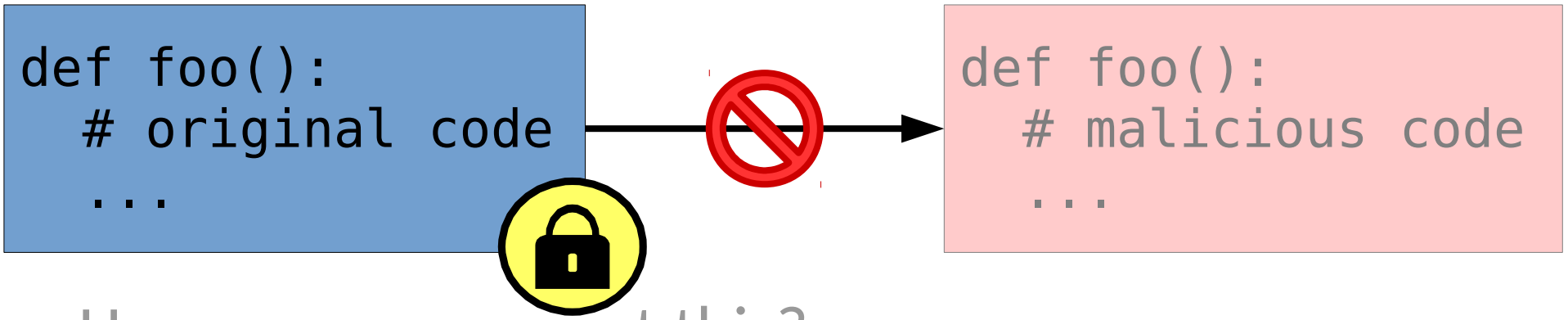


- How can we prevent this?

Code Corruption



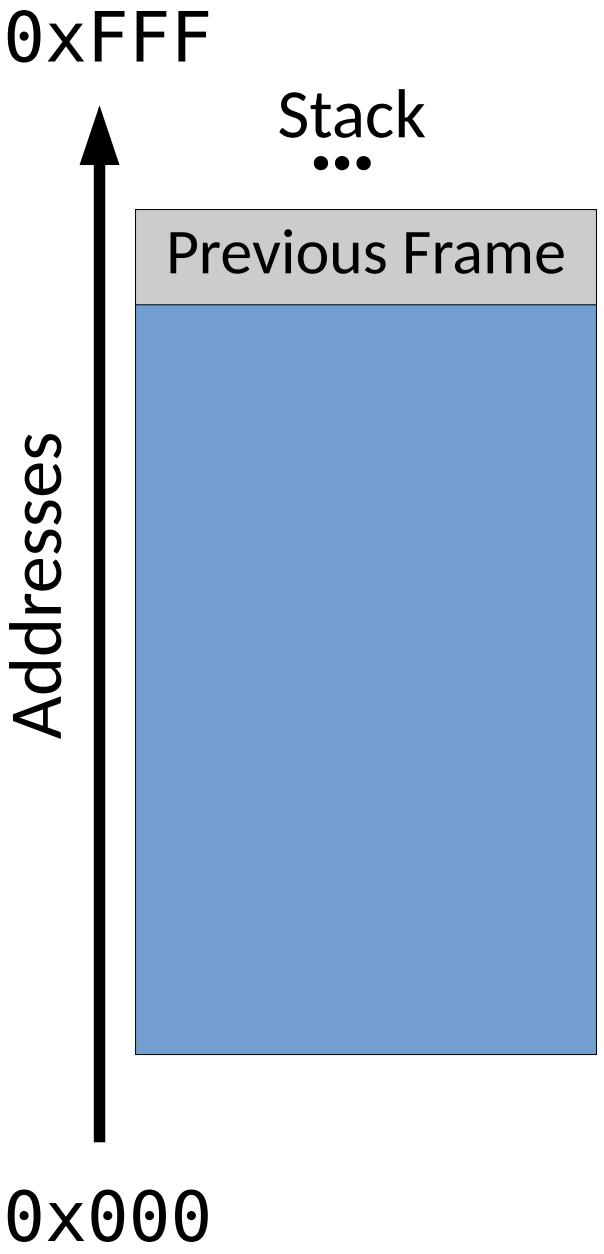
- How can we prevent this?
- What problems does this solution create?

Control Flow Hijacking

```
void foo(char *input) {
  unsigned secureData;
  char buffer[16];
  strcpy(buffer, input);
}
```

How many of you recall what a stack frame looks like?

Data Only Attacks

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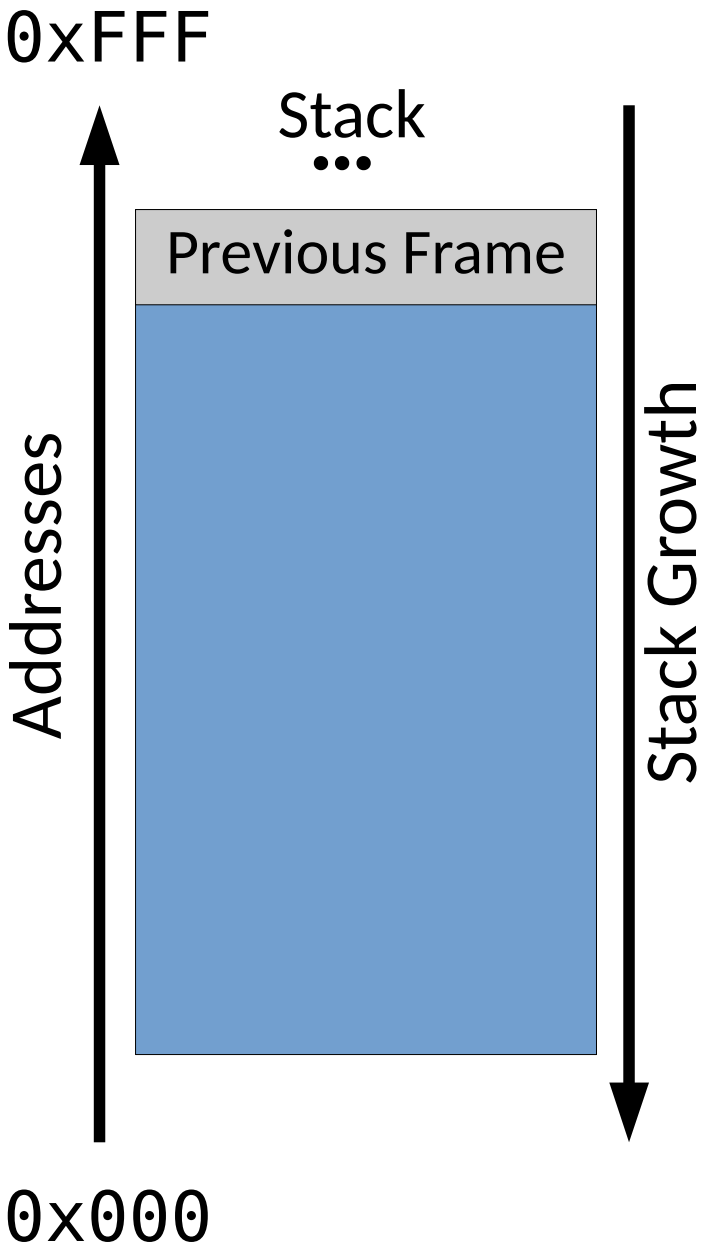


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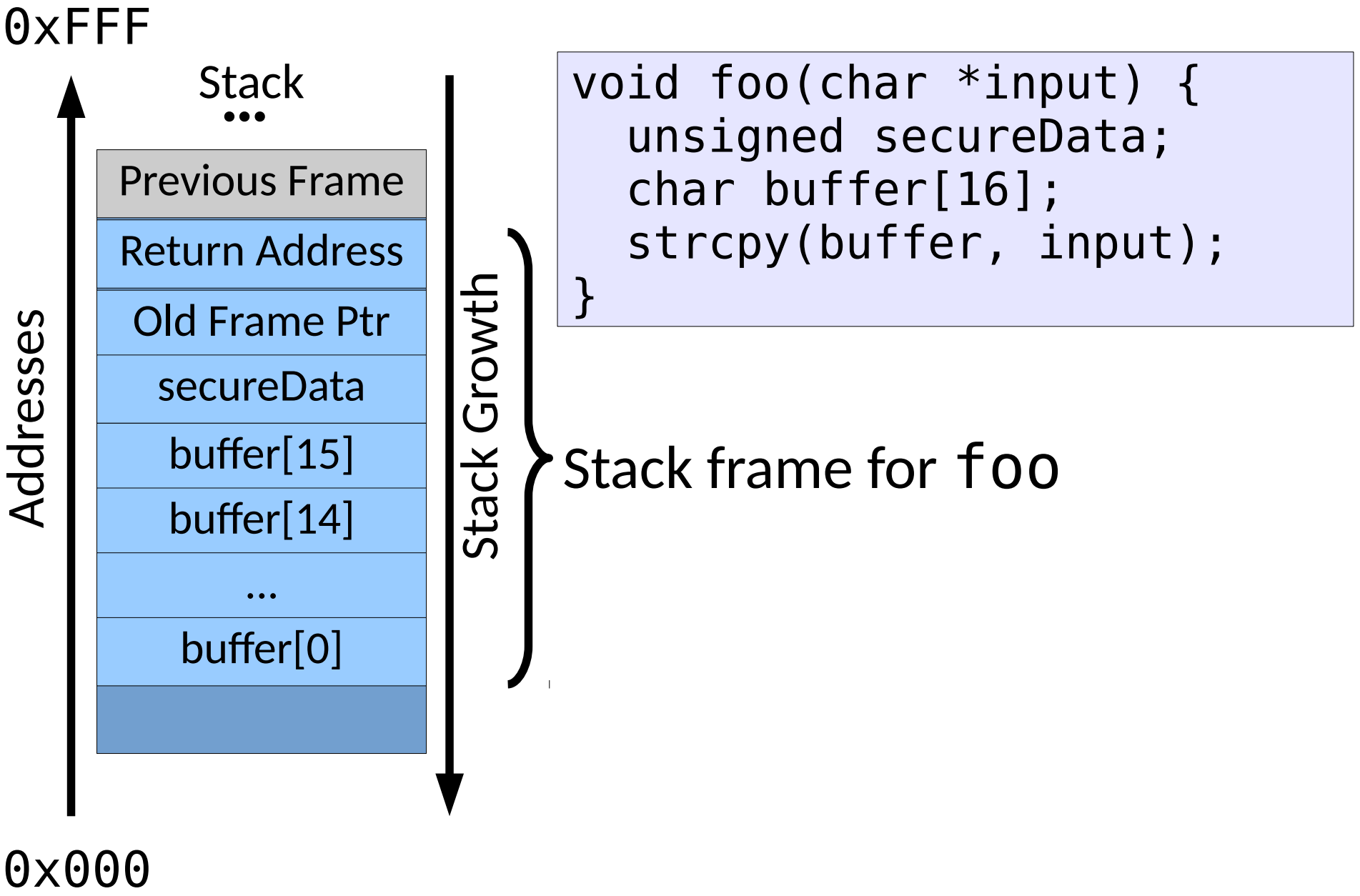


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Stack frame for `foo`

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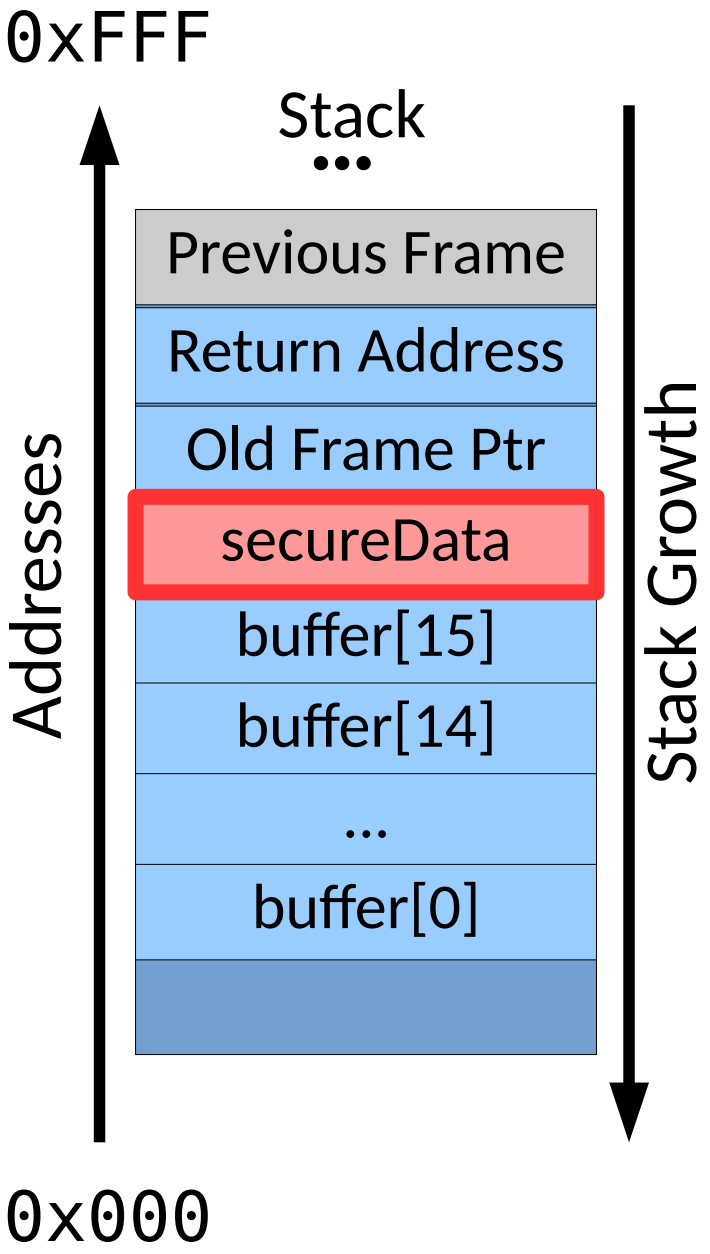


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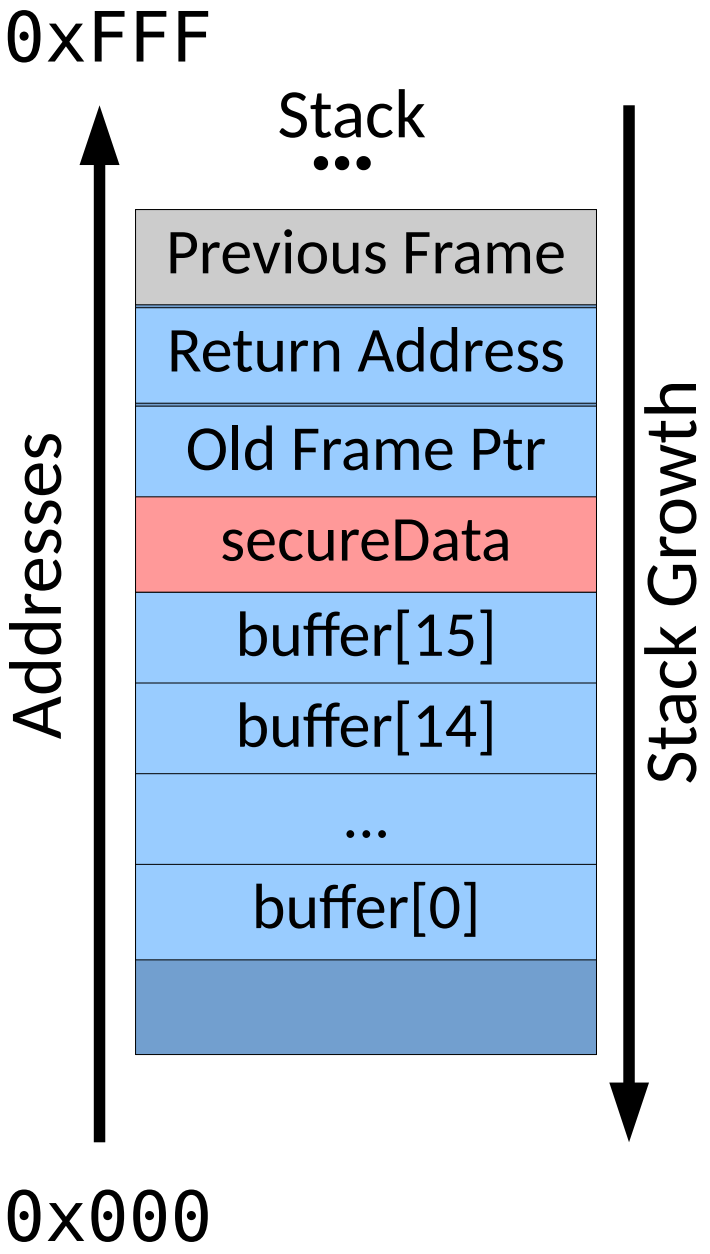


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What can go wrong?

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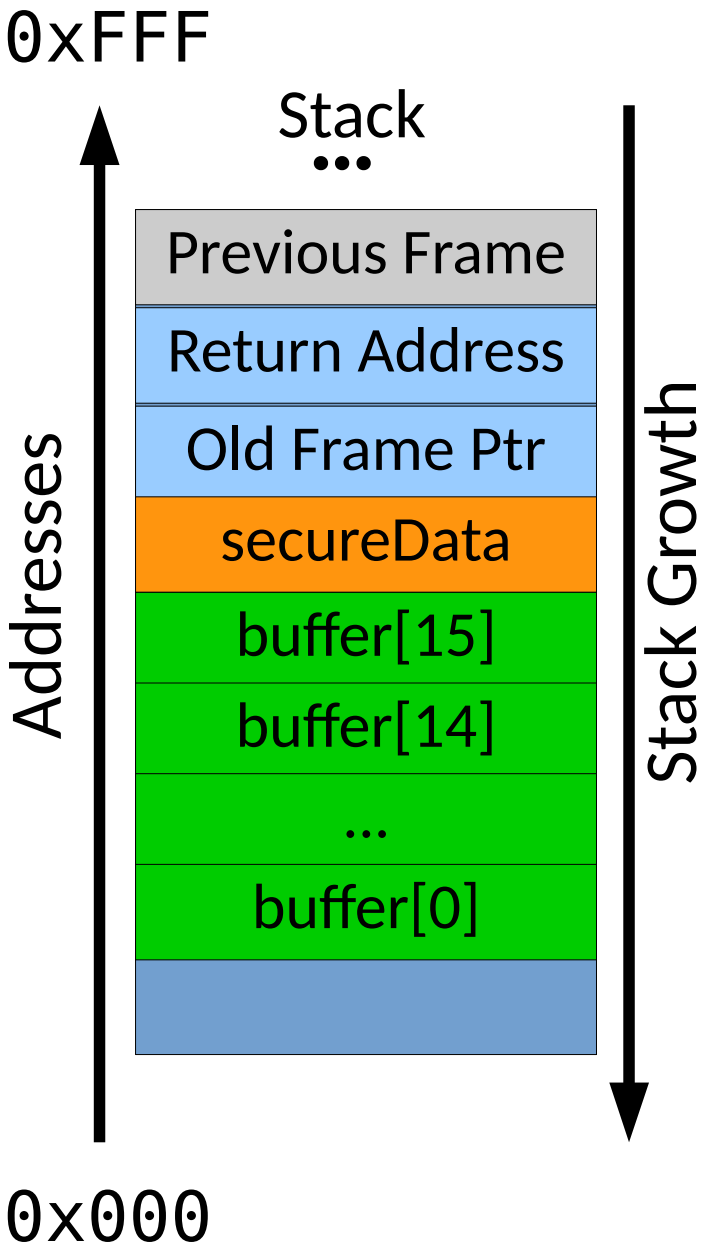


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input = “normal input”
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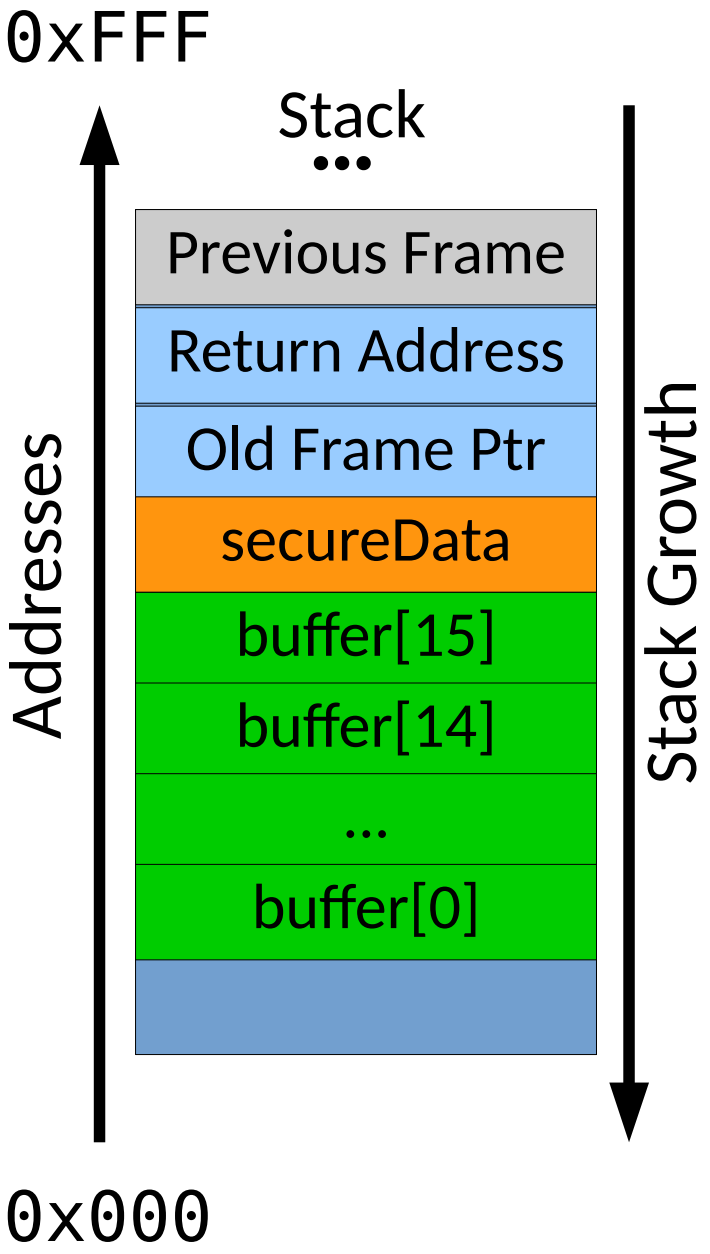


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buffer overflow attack

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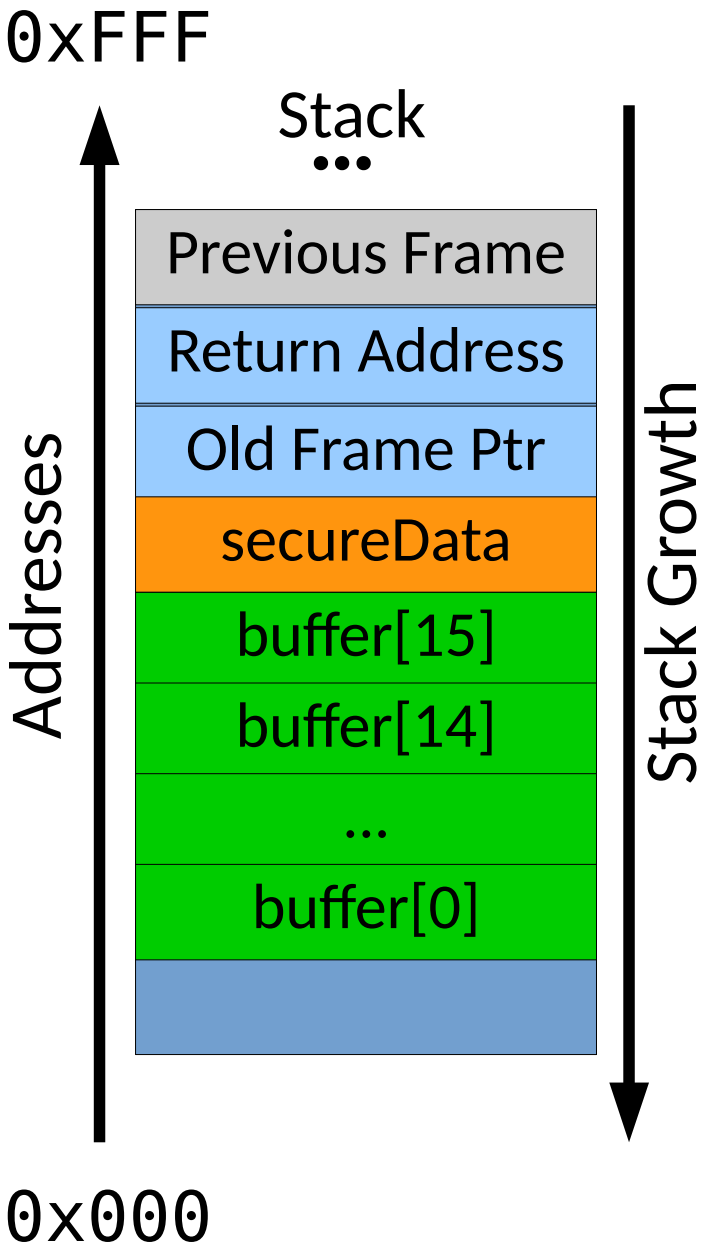


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The integrity of the secure data is corrupted.

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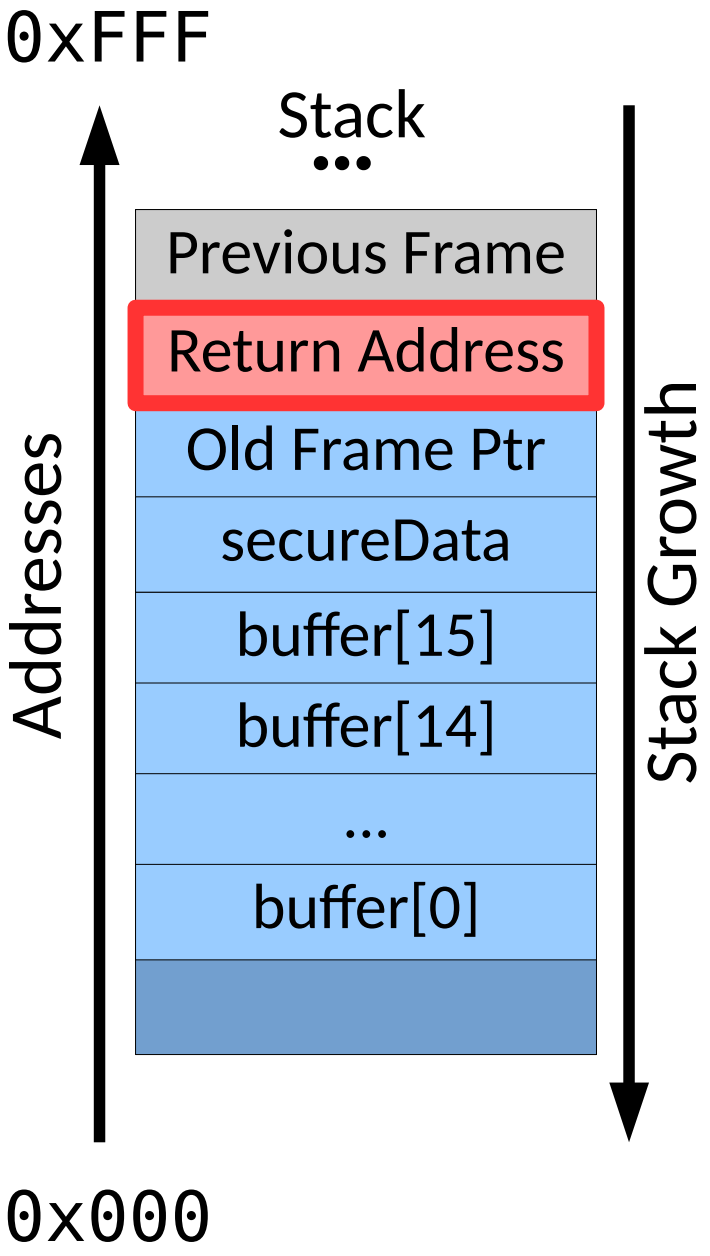


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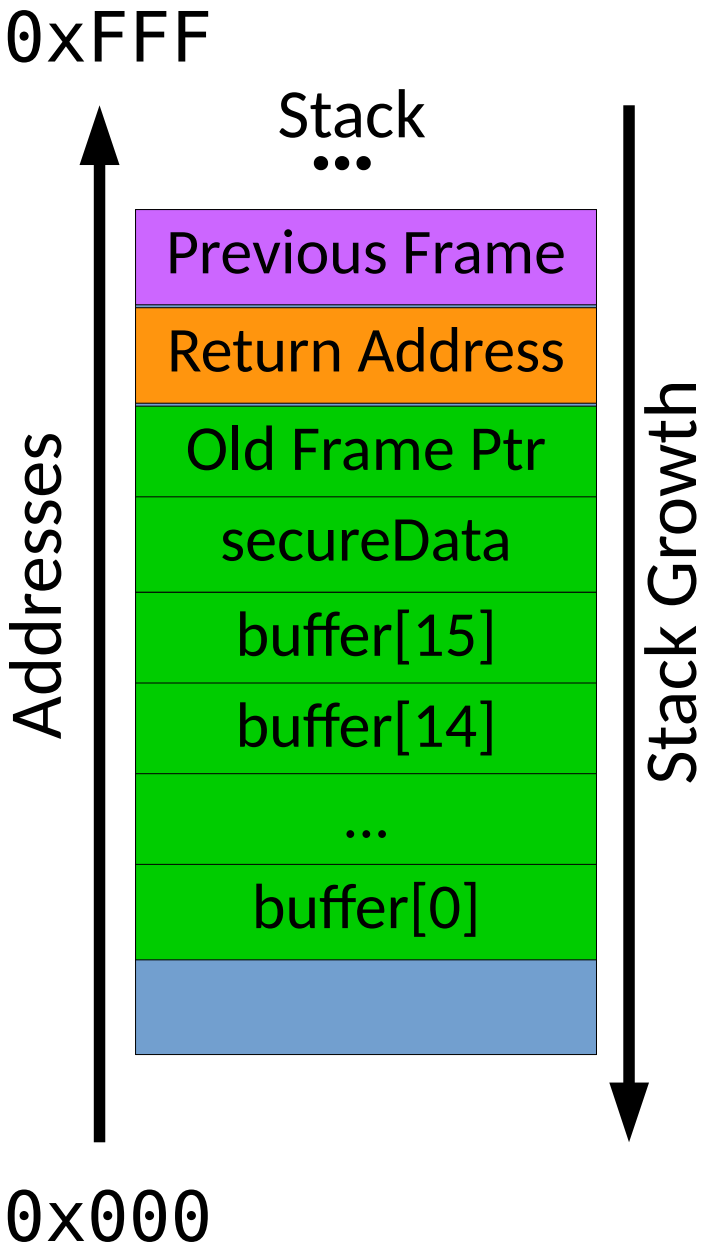


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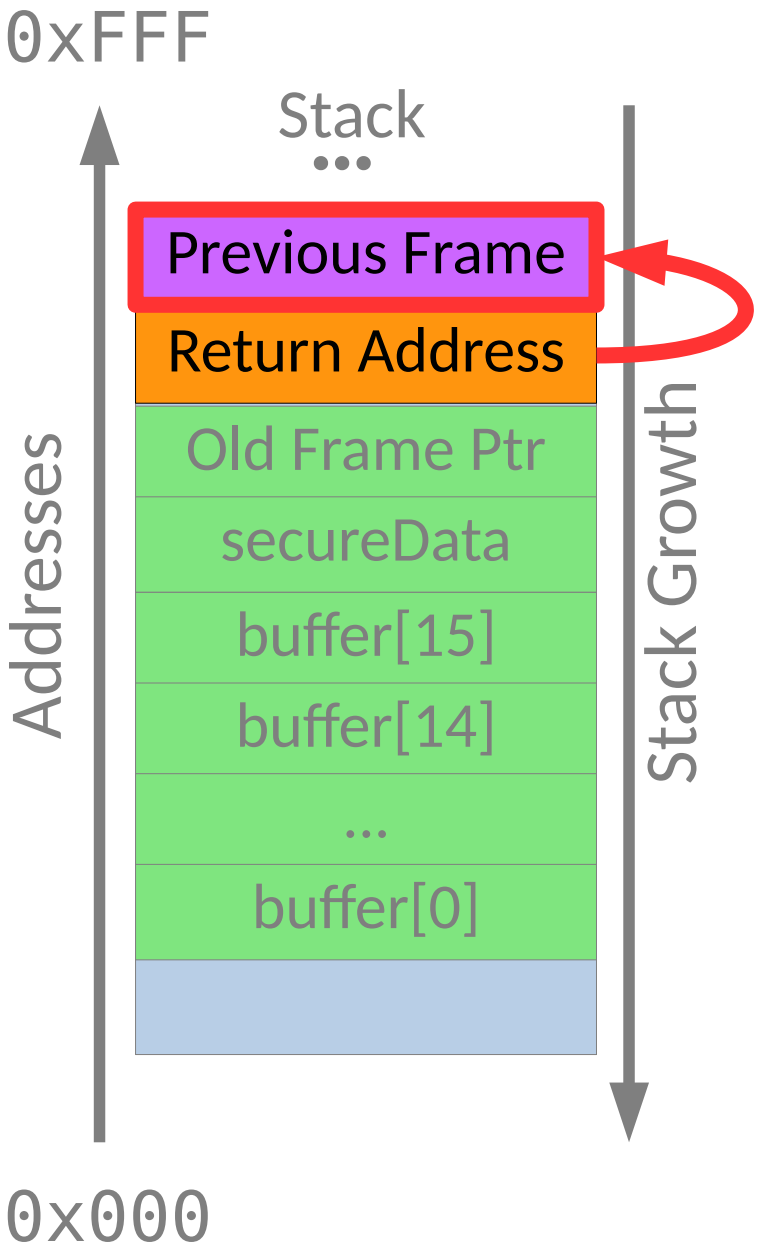


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On return, we'll execute the shell code

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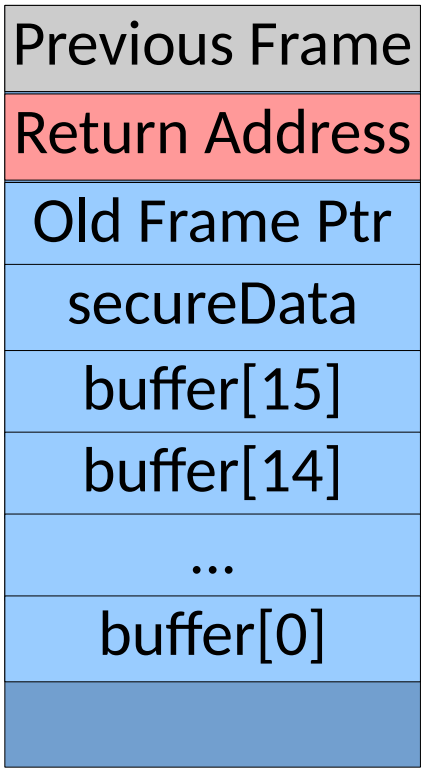

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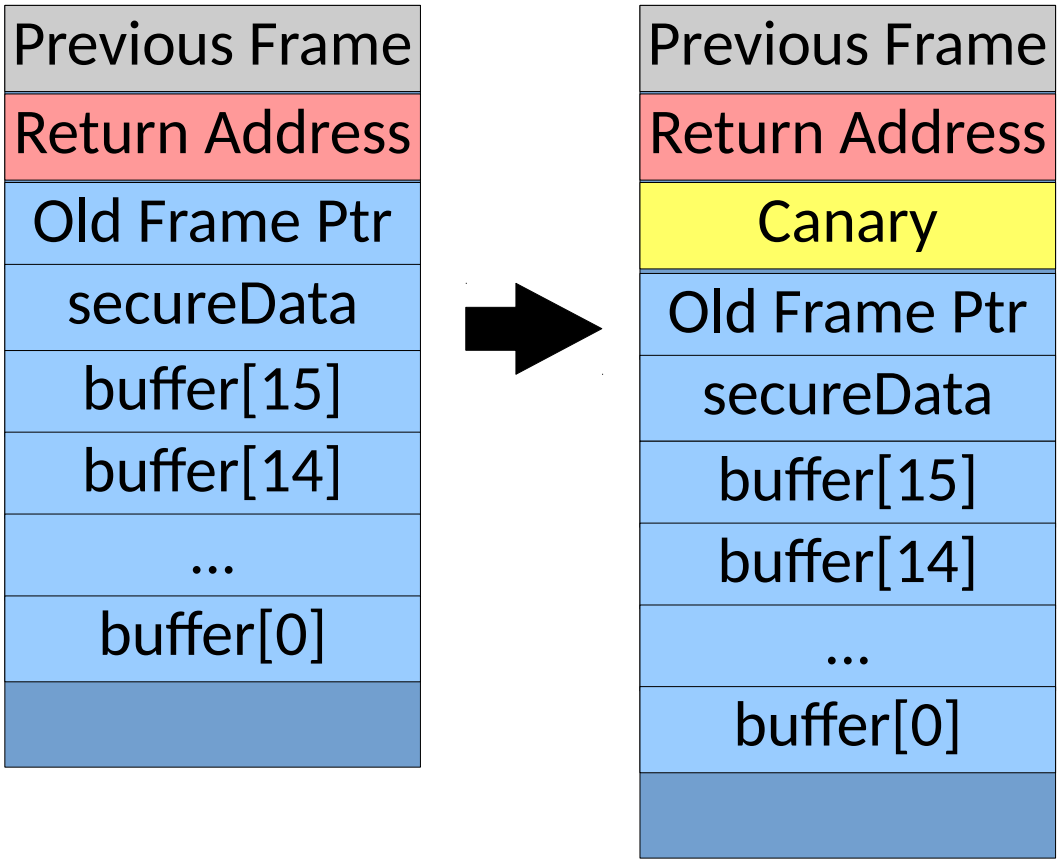

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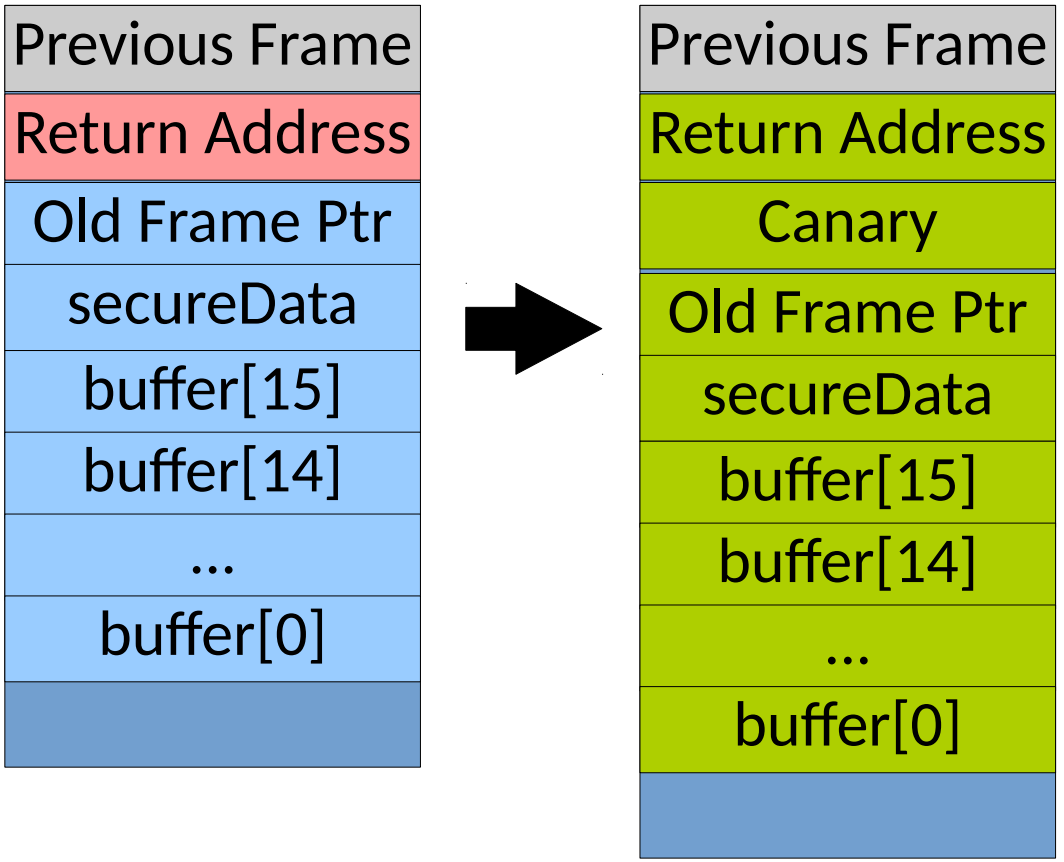

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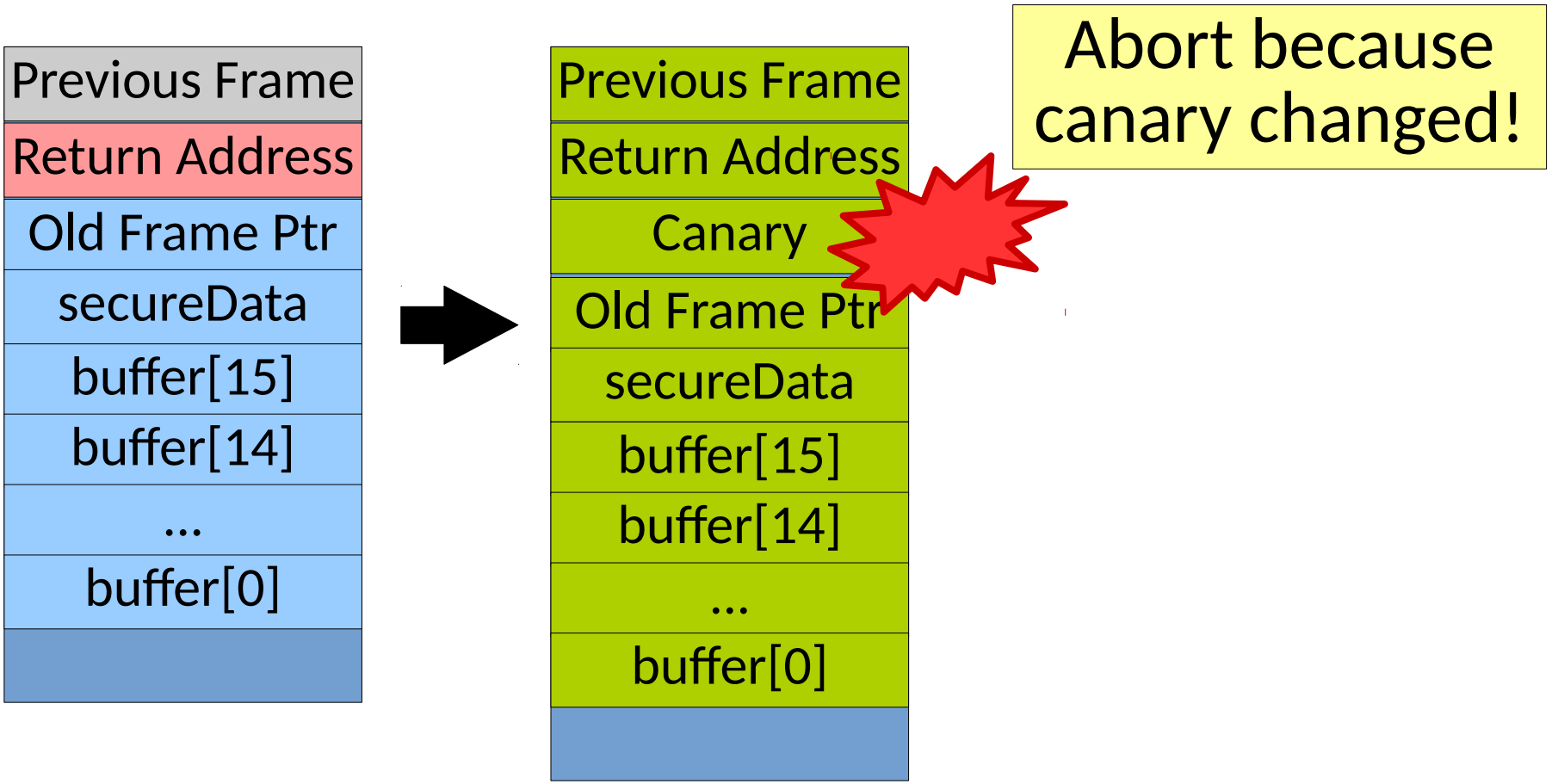

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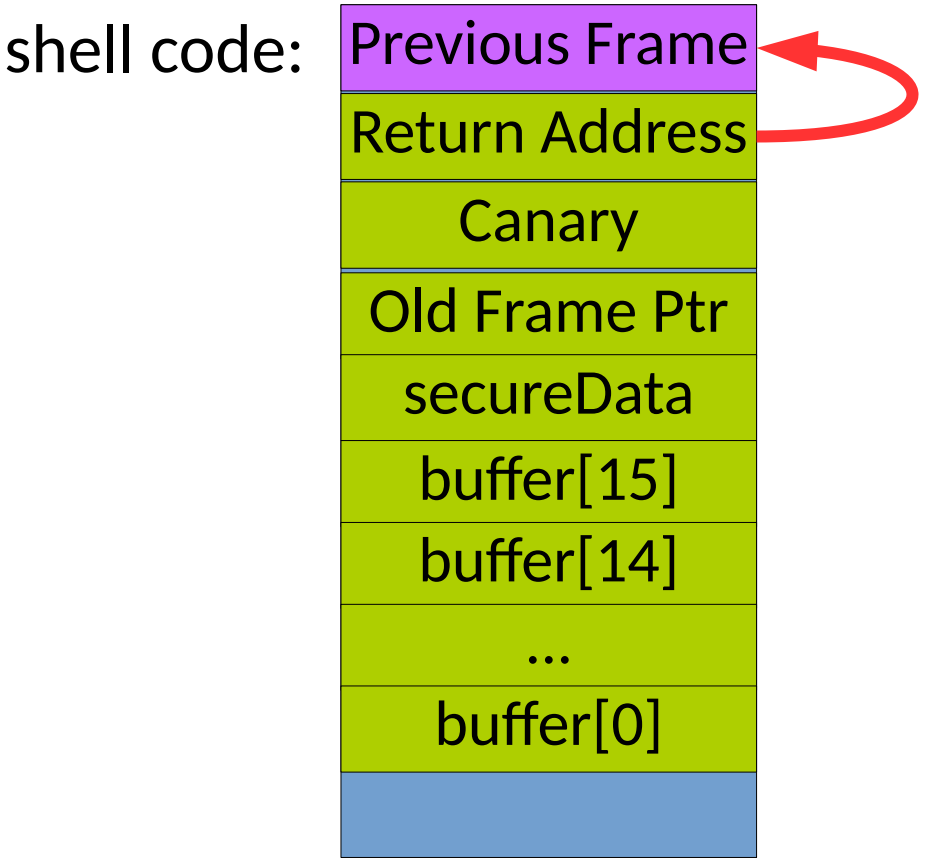

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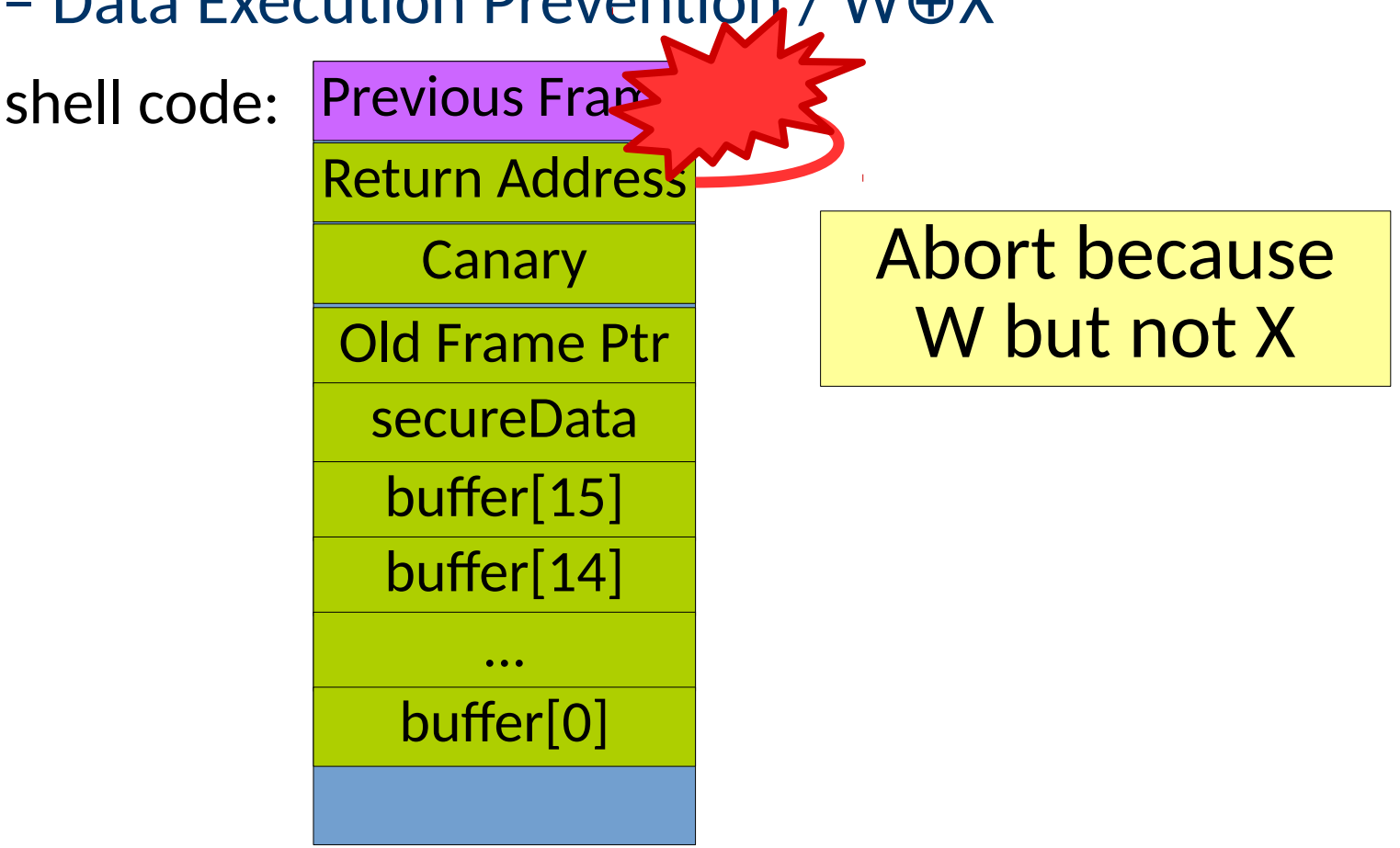

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But these are still easily bypassed!

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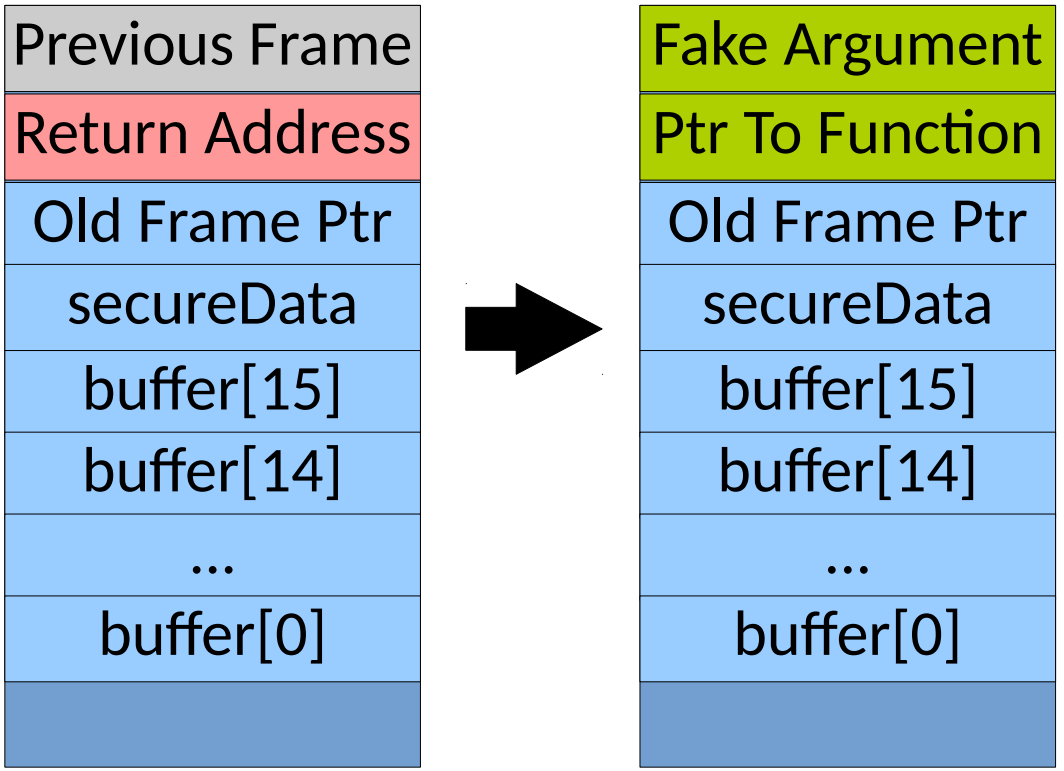

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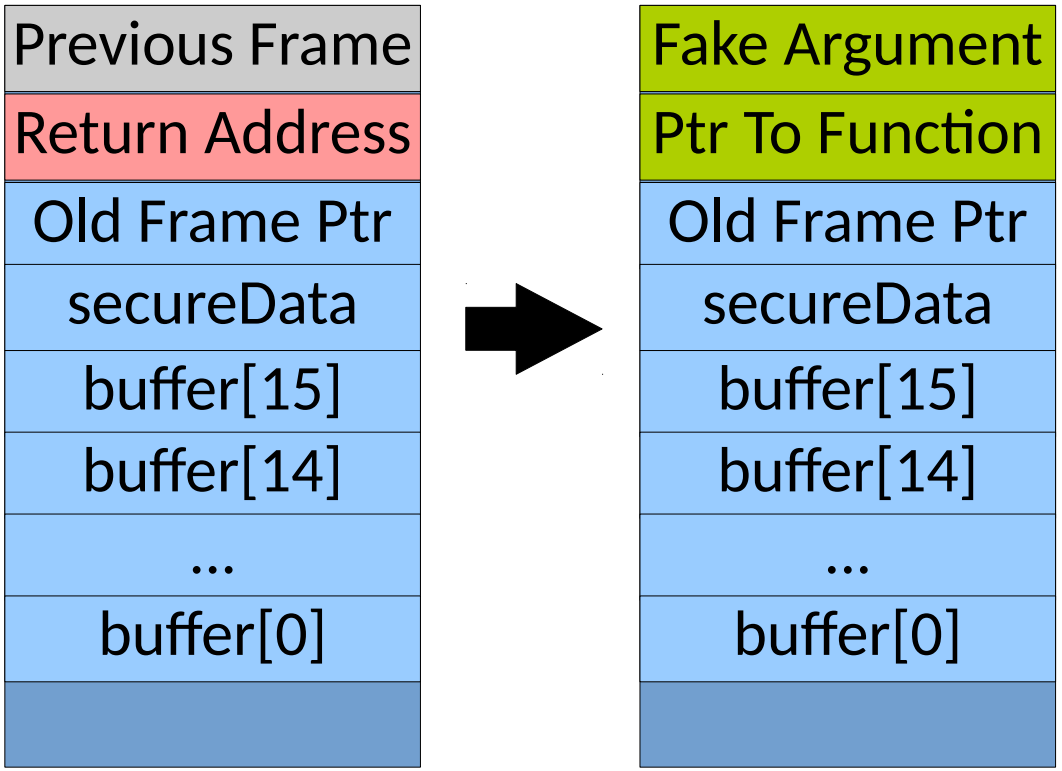

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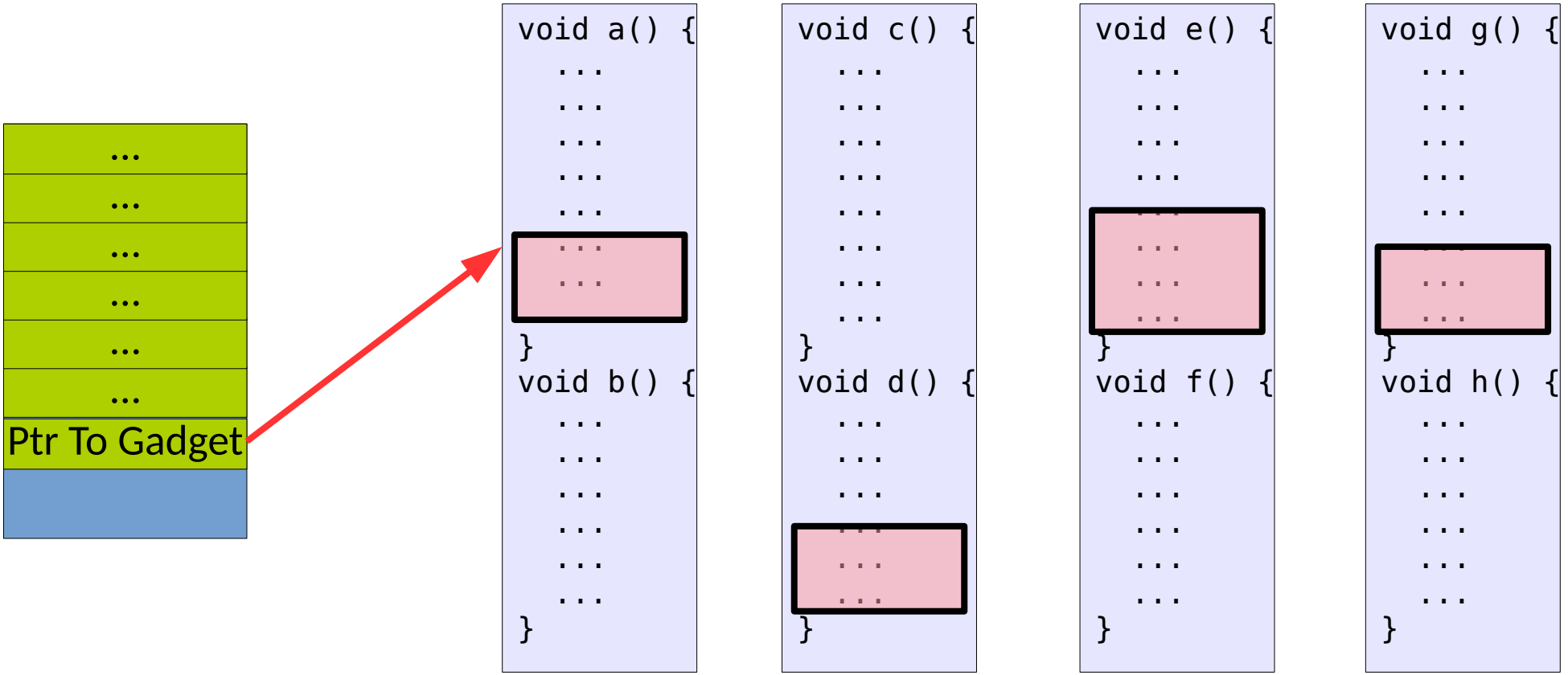

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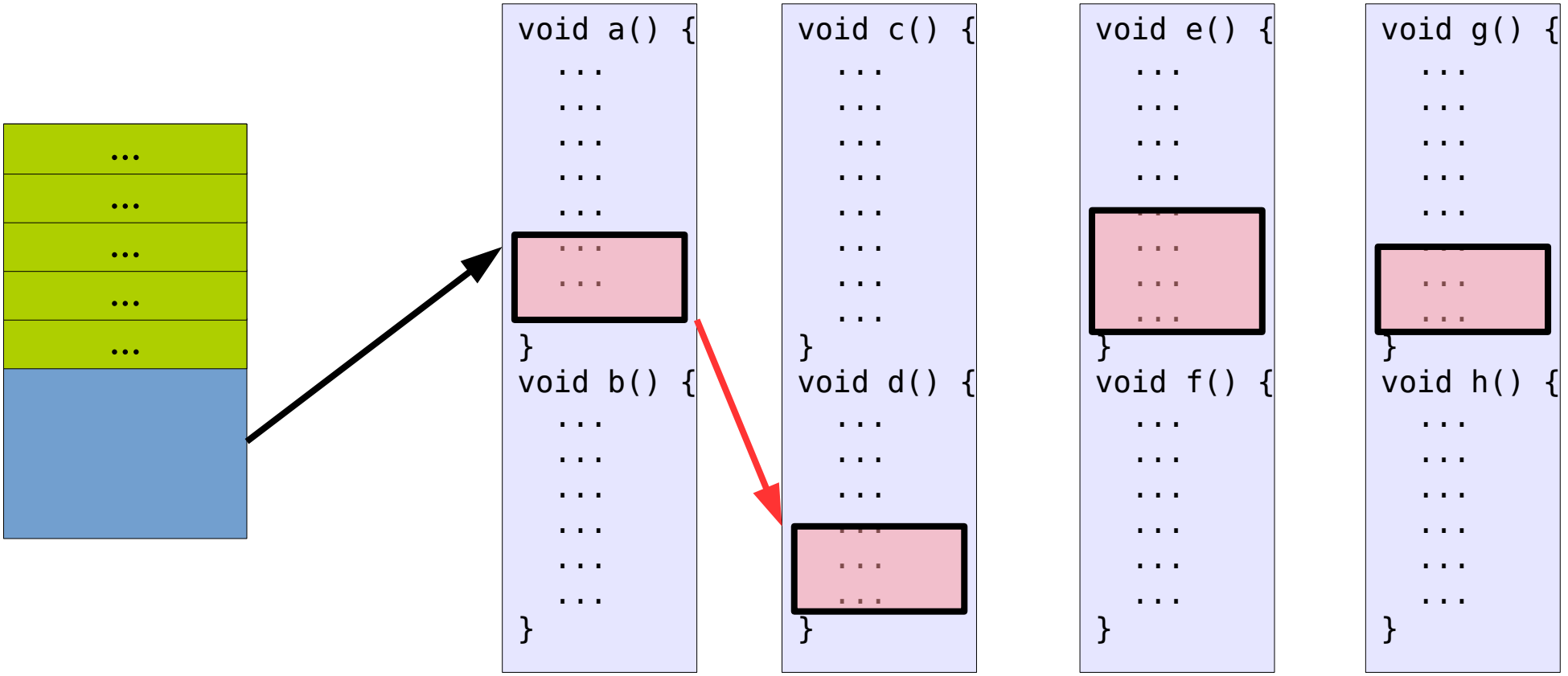

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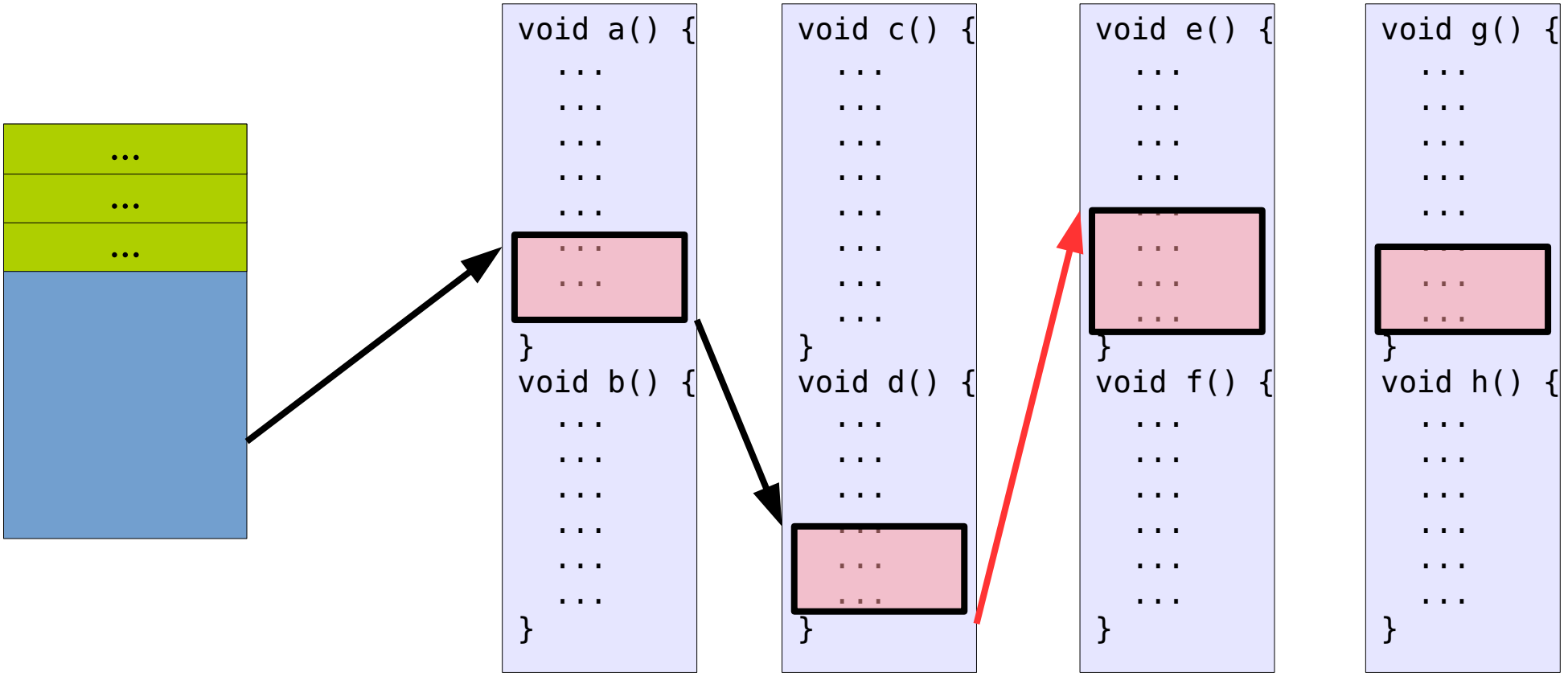

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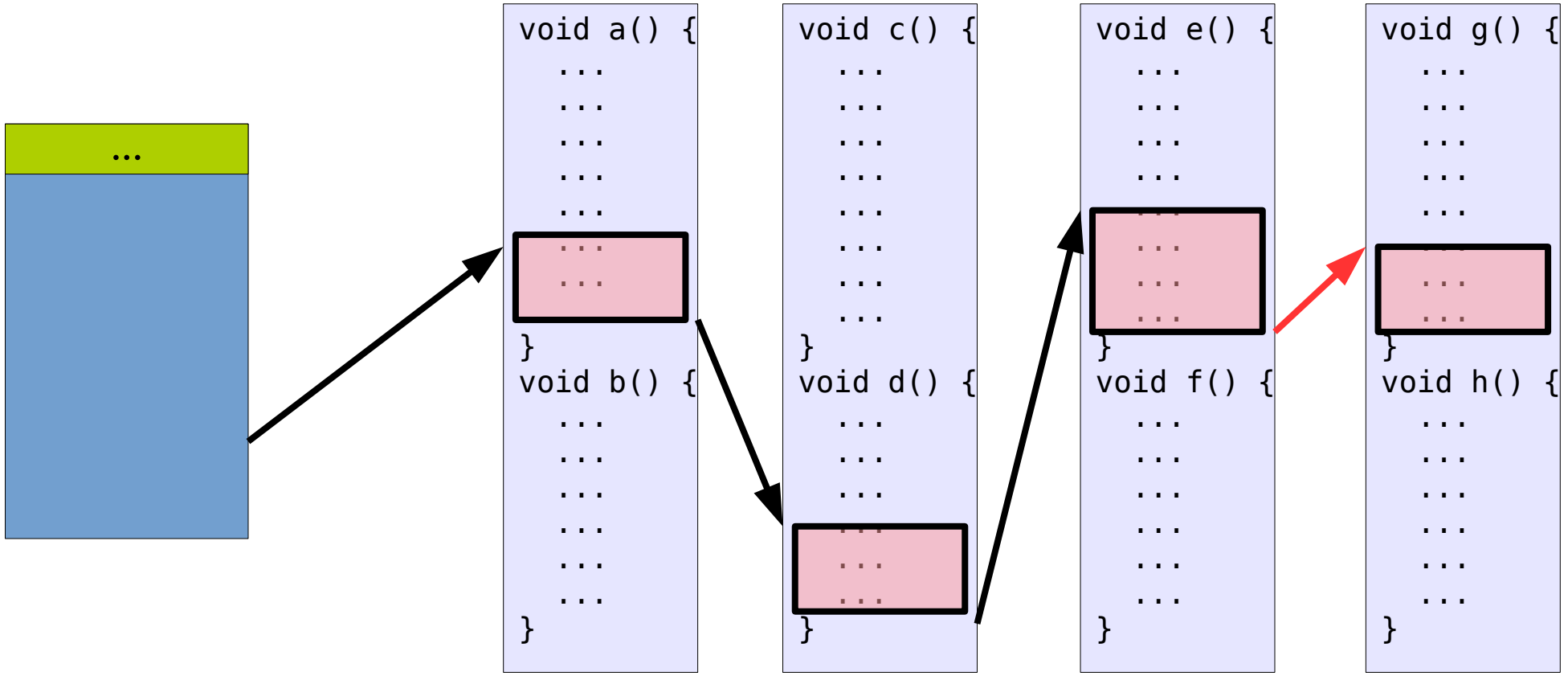

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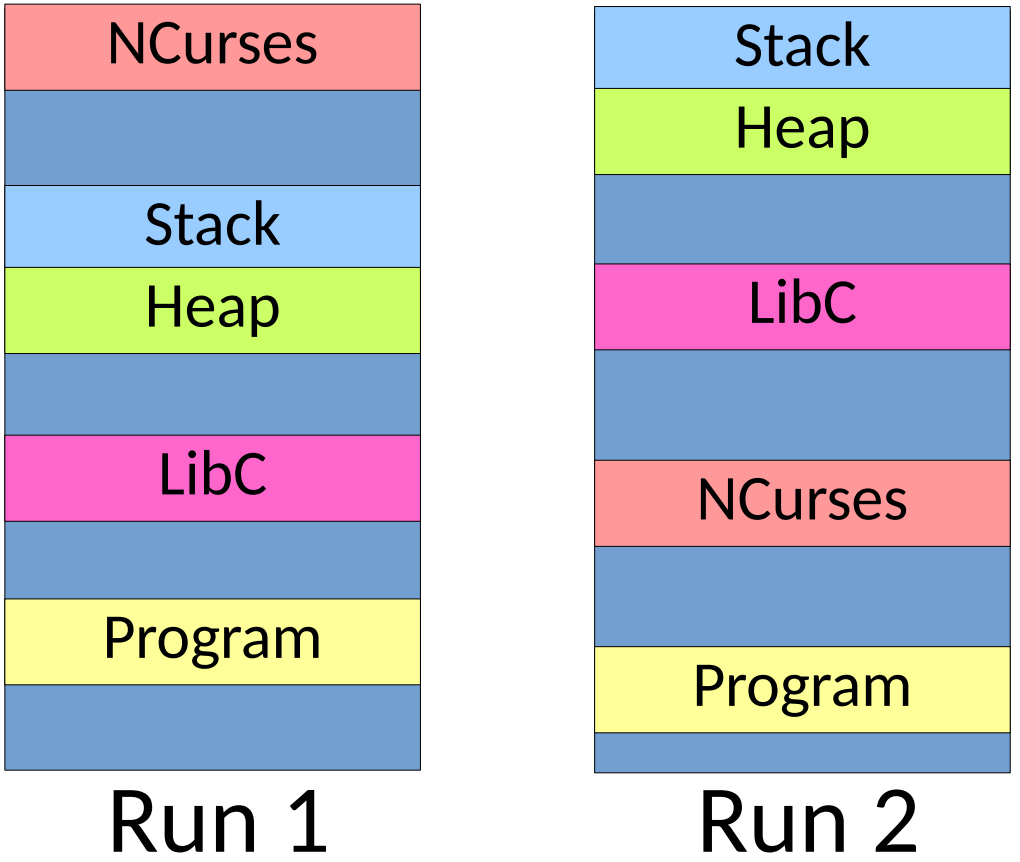

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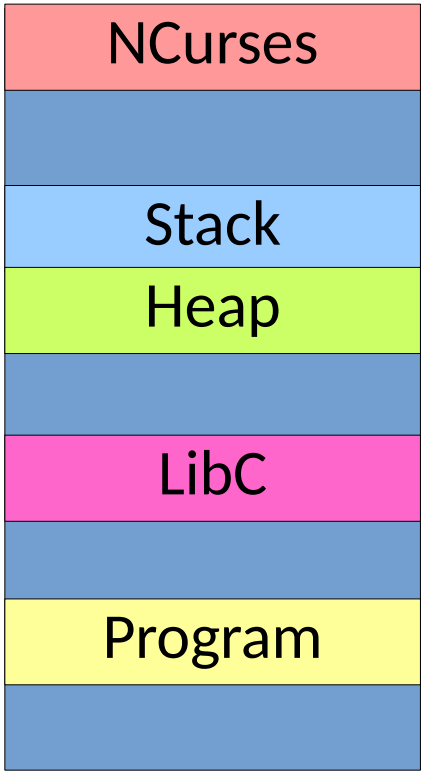

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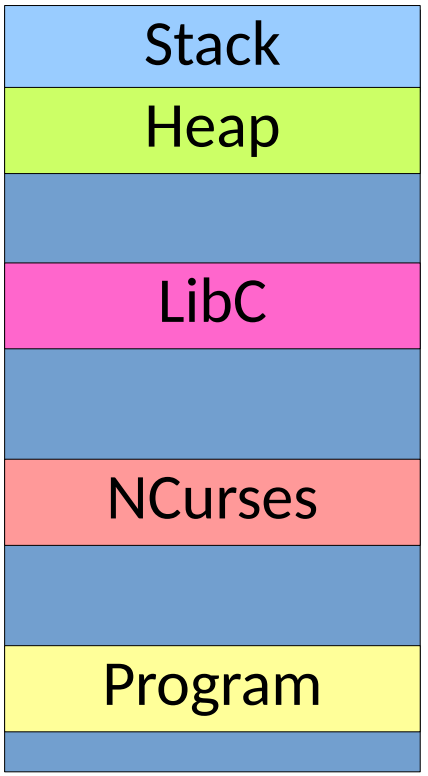

Run 2

But even this is "easily" broken

Control Flow Integrity

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  - Jmp */call */ret

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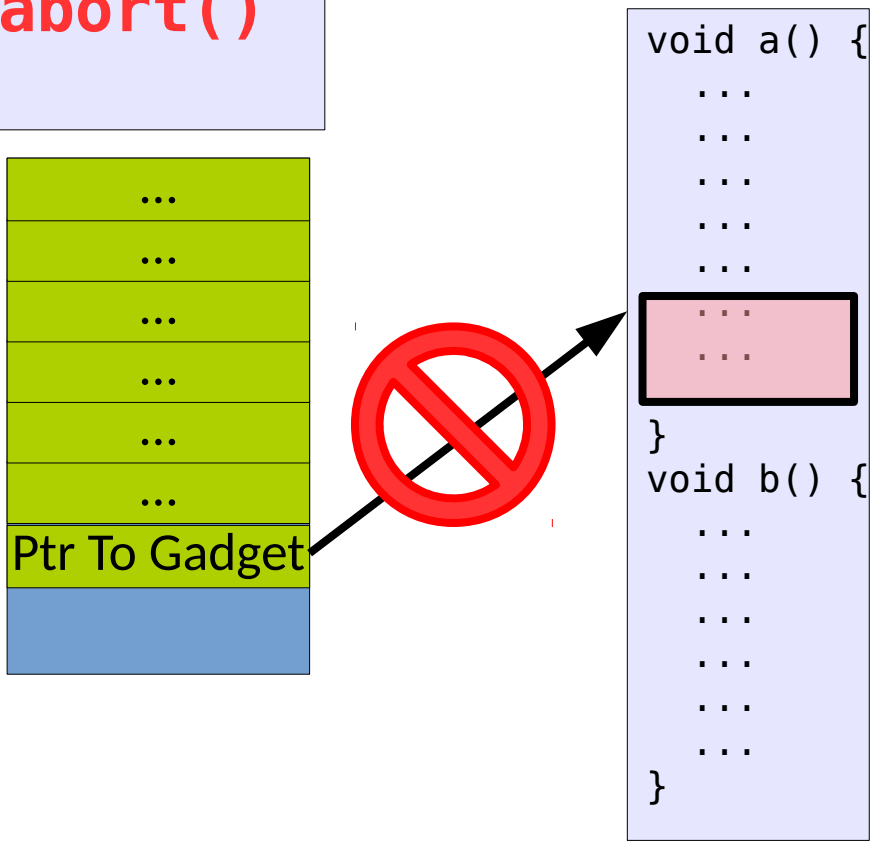

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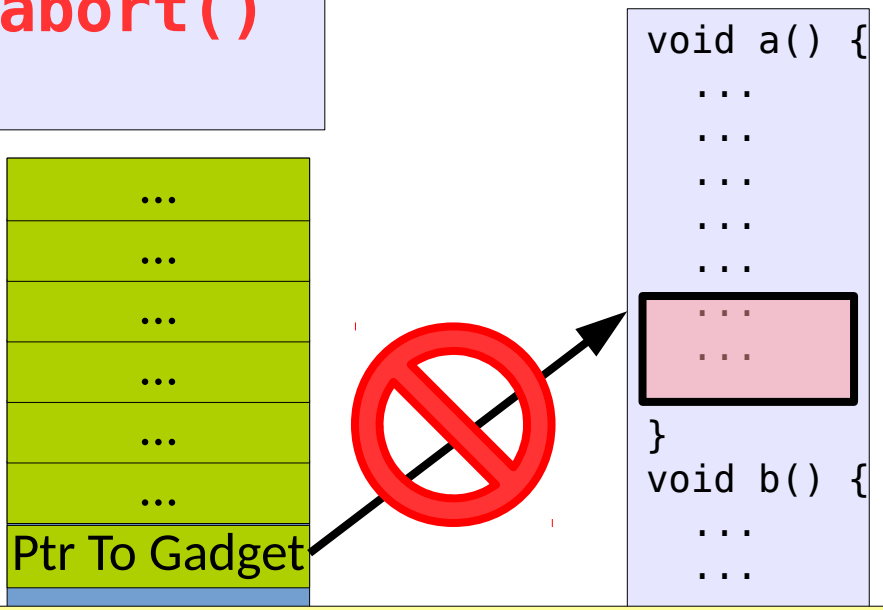


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  - http://www.symantec.com/security_response/vulnerability.jsp?bid=70332
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  - http://seclists.org/oss-sec/2016/q1/645
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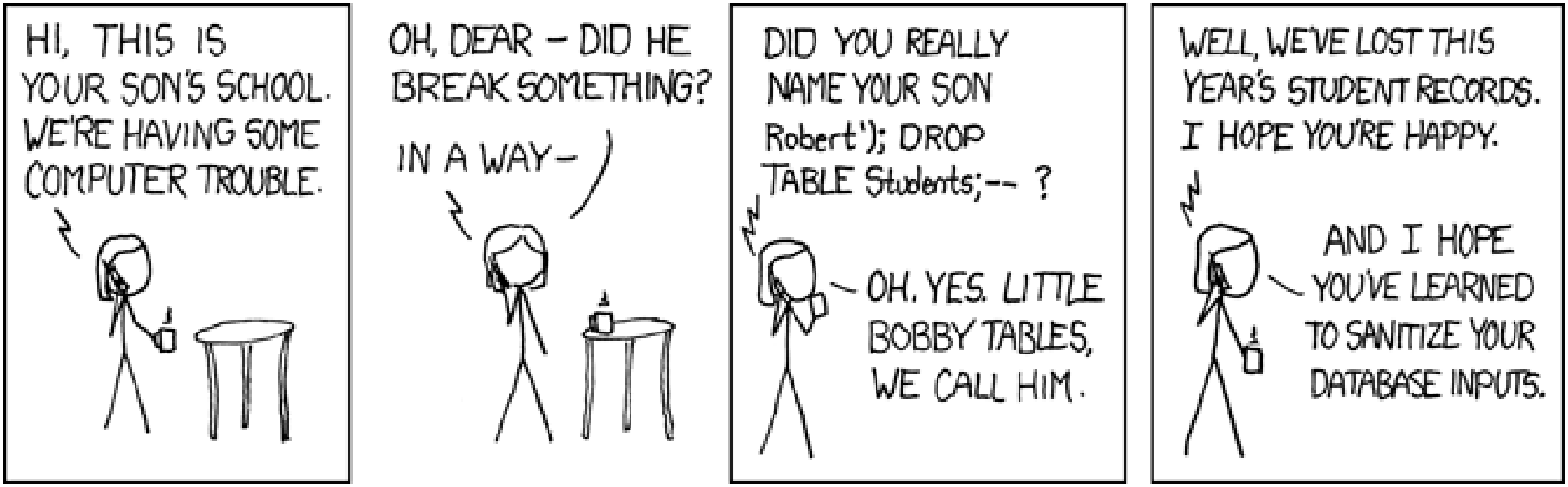
Another Case: SQL Injection

```
username = “'bob'; DROP TABLE students”
```

- What happens?

SQL Injection



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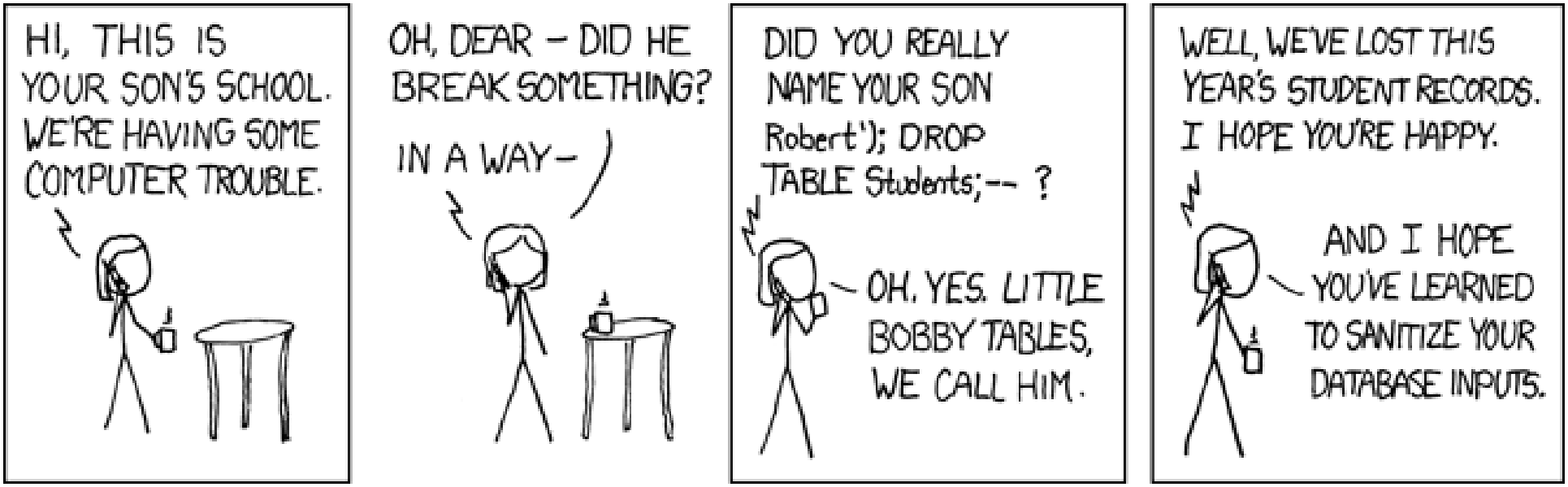

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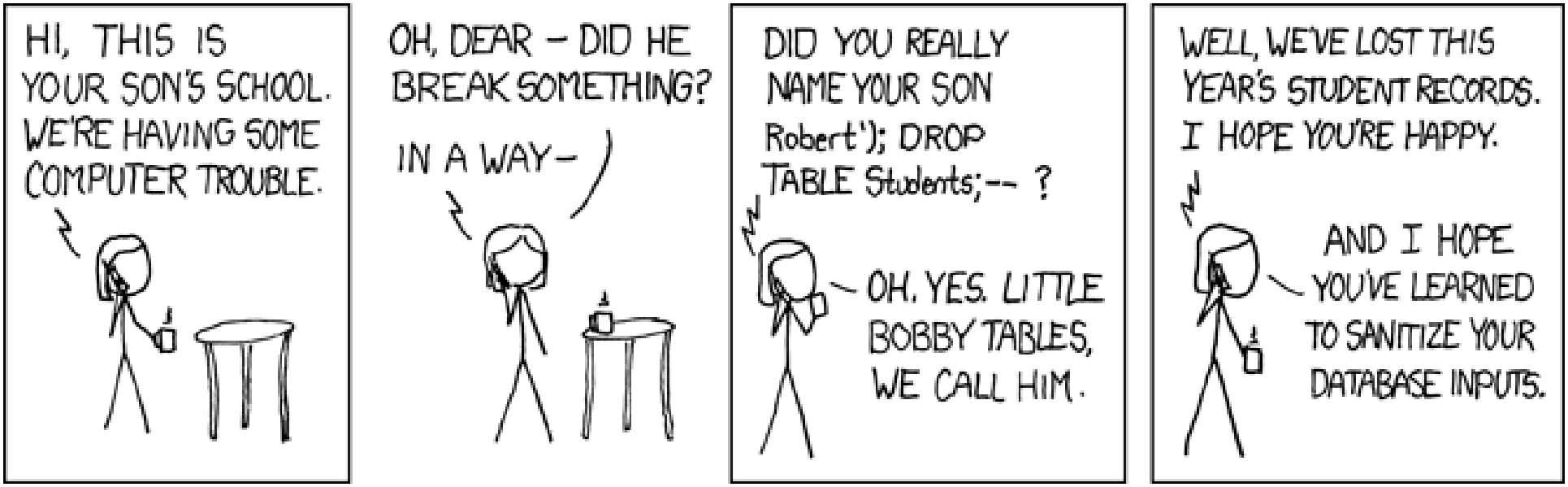

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How would you prevent this problem?

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  User A can read files X,Y,Z and write to S,T
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  Can you envision a scenario that creates this problem?

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- Penetration testing (Pen Testing)
  - Can someone skilled break it?

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