Let Me Unwind That For You:

Exceptions to Backward-Edge Protection

Victor Duta Fabian Freyer

Fabio Pagani Marius Muench Cristiano Giuffrida

Catch handler oriented programming

CHOP in a nutshell

unwinder

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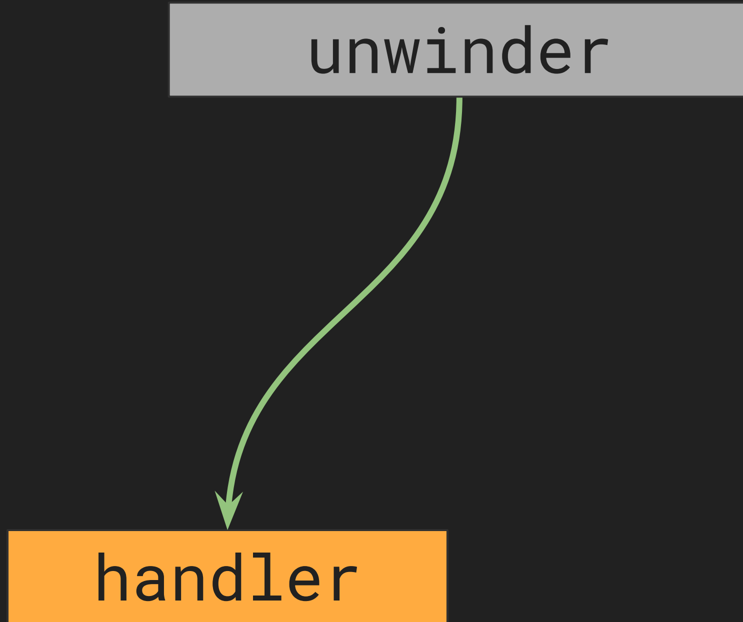
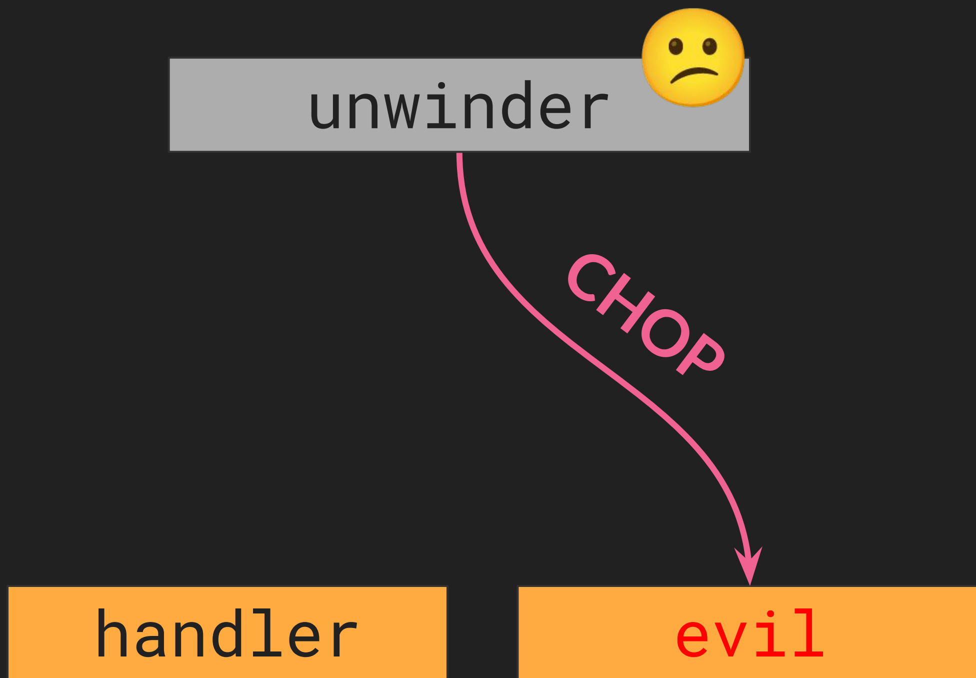
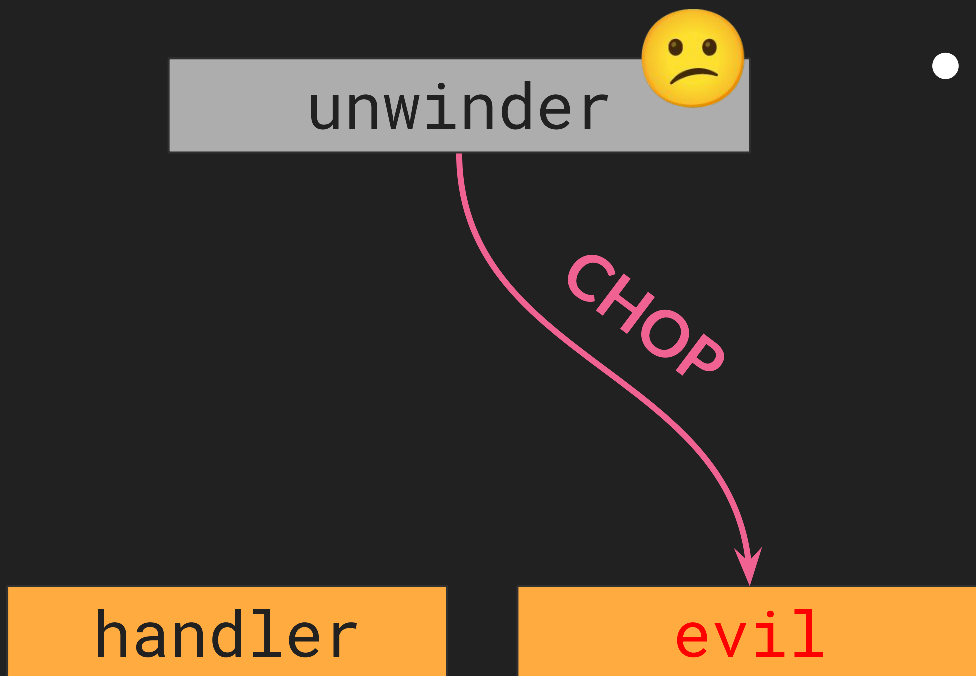


CHOP in a nutshell

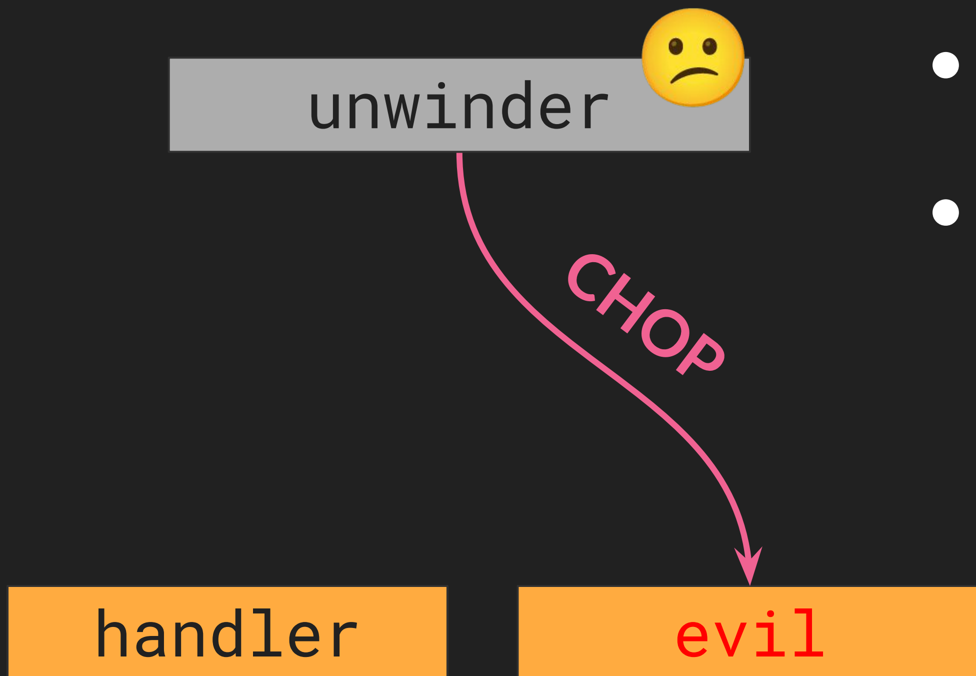


CHOP in a nutshell



- Likelihood of CHOP attacks

CHOP in a nutshell



- Likelihood of CHOP attacks
- Are CHOP attacks a serious issue ?

The basic recipe…

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void vuln() {
    // overflow
    // some other code

    return;
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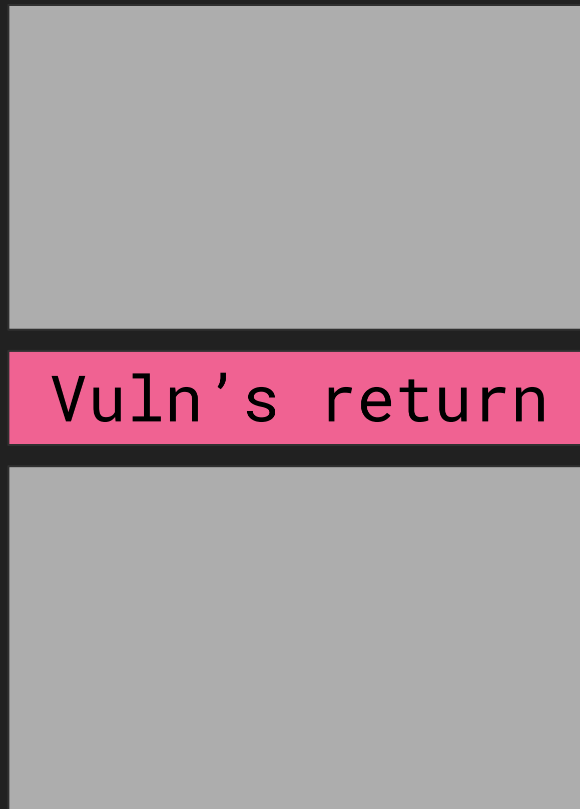

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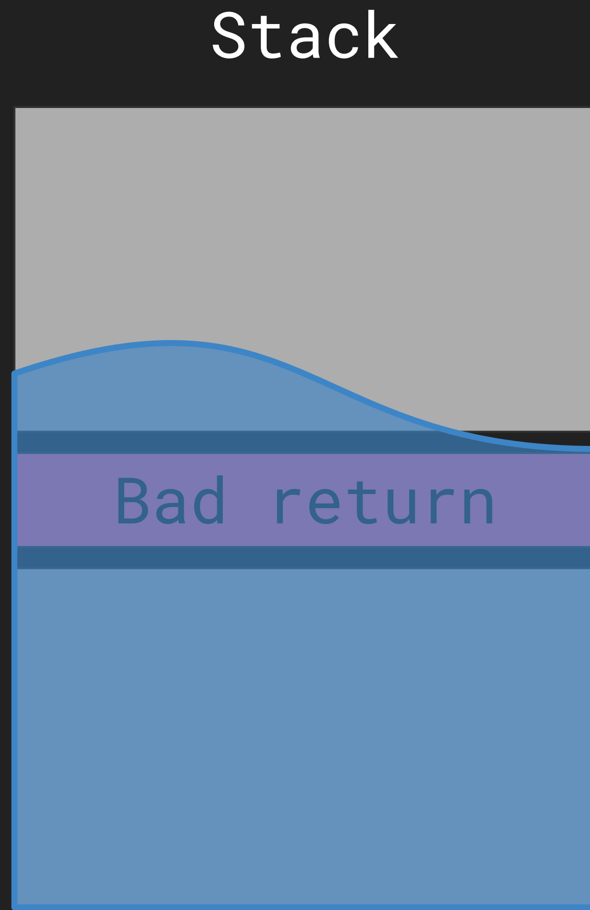

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void vuln() {
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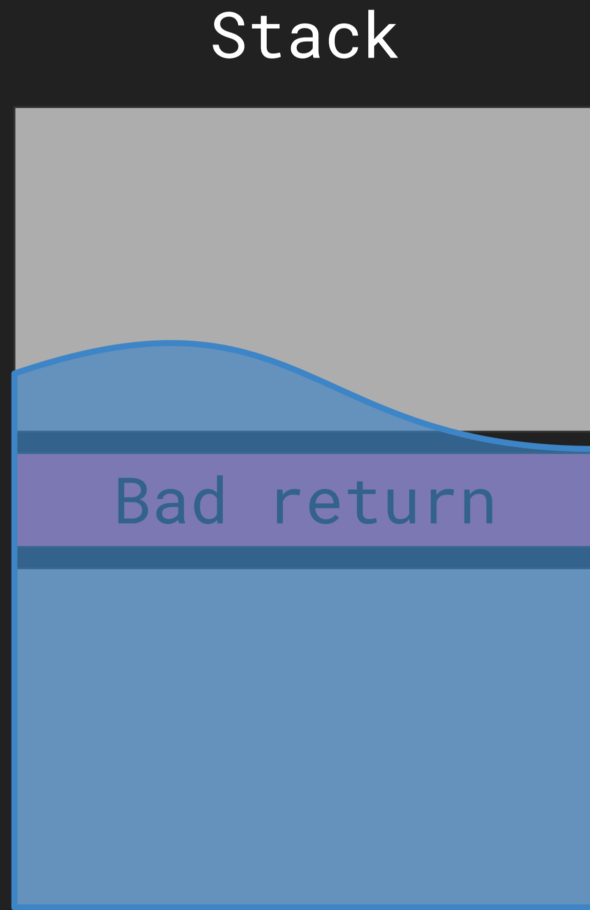

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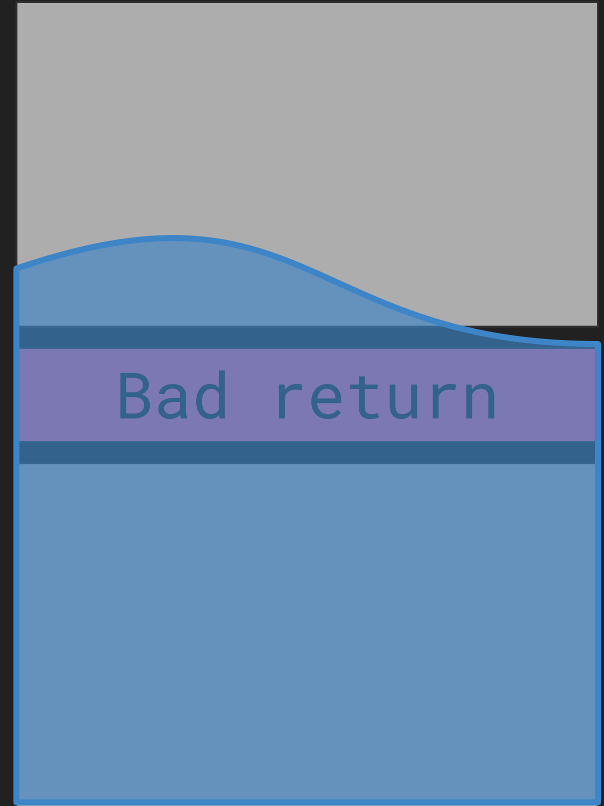

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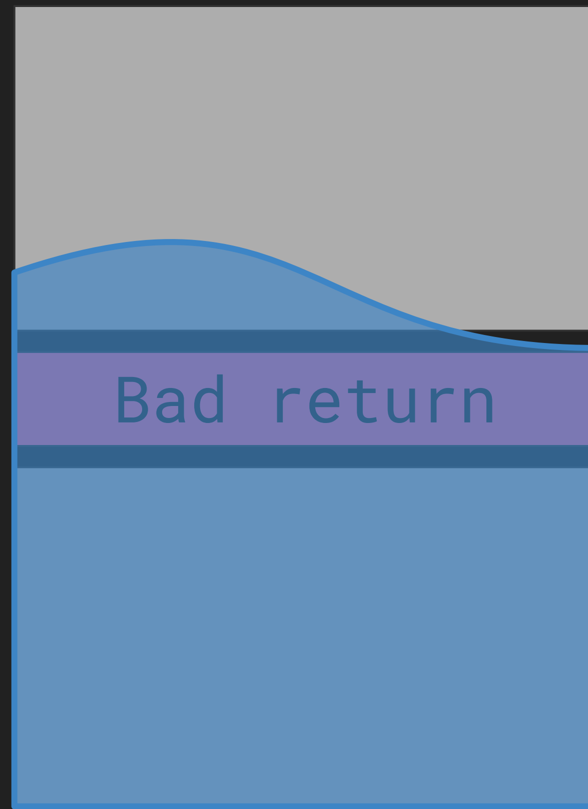
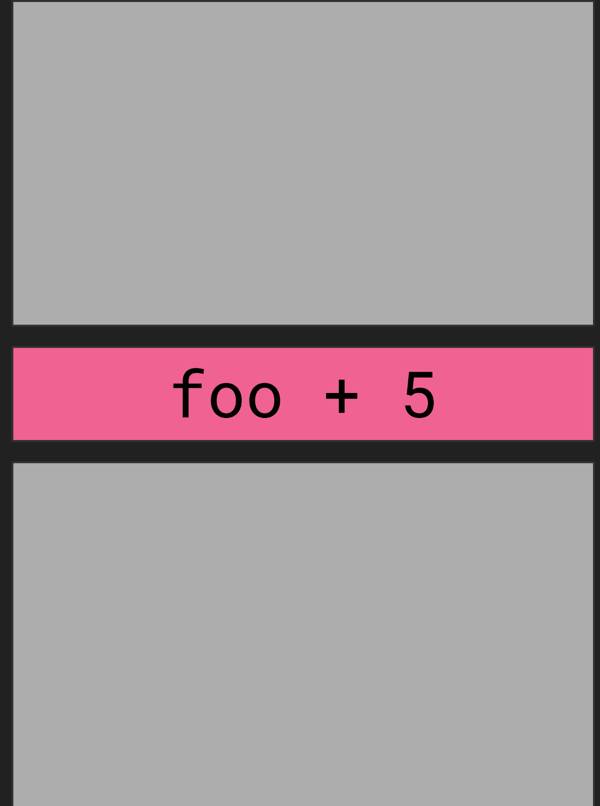


Catch Handler Confusion


Stack
foo + 5

```
void foo() {
    try {
        vuln();
        // more code
    }
    catch (...) { lose(); }
}
```

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    try { /* ... */ }
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return

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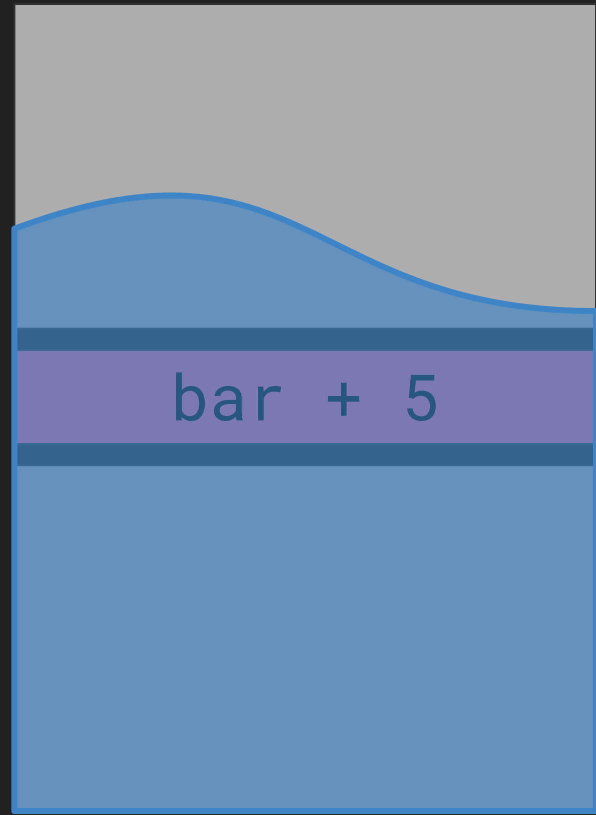

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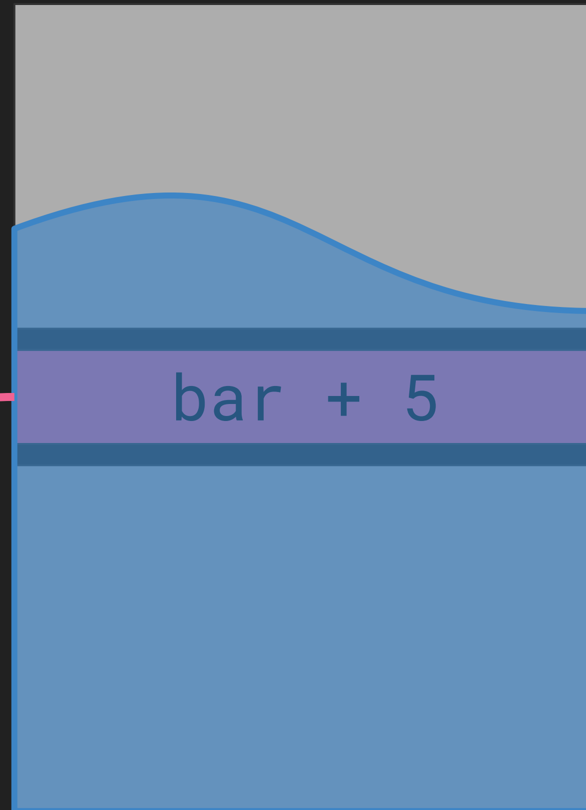

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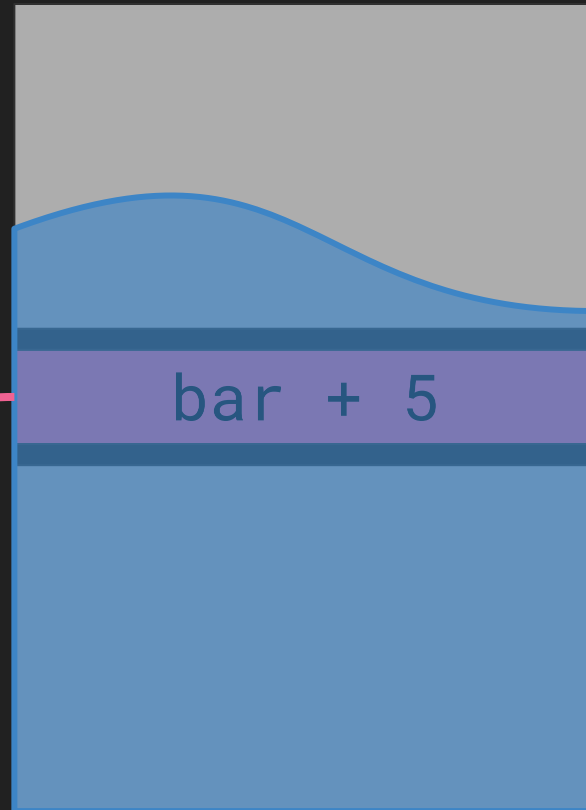
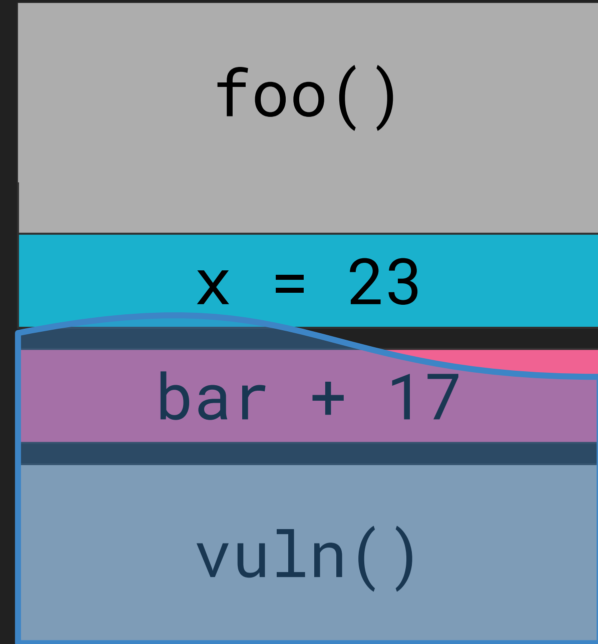


What do we control ?

```
void foo() {
    int x = 23;
    try { vuln(); }
    catch (...) {/* ... */}
}

void bar() {
    int x = 42;
    try { /* ... */ }
    catch (...) {
        cout << x << endl;
    }
}
```

CHOP



x gets restored from foo's stack frame!

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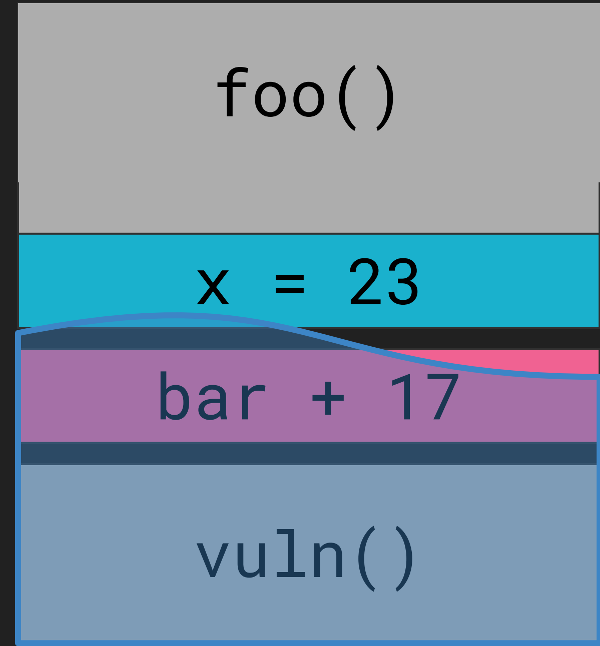
CHOP

prints 23



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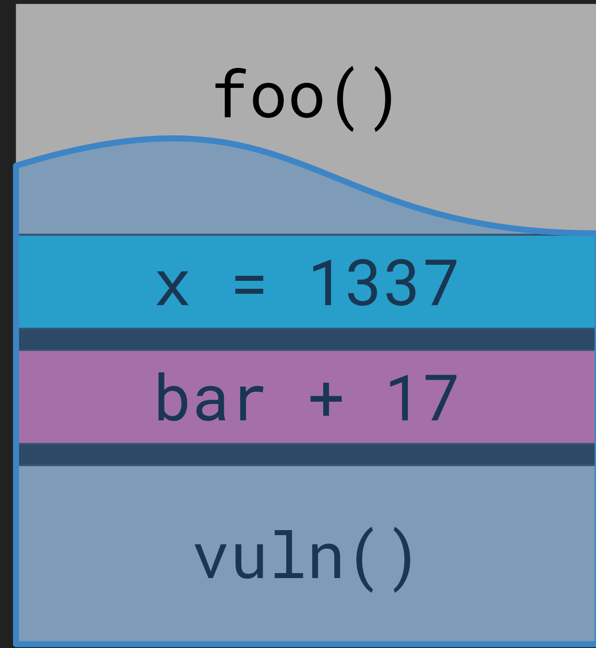
CHOP



prints 1337

Attackers control the target handler's local variables!

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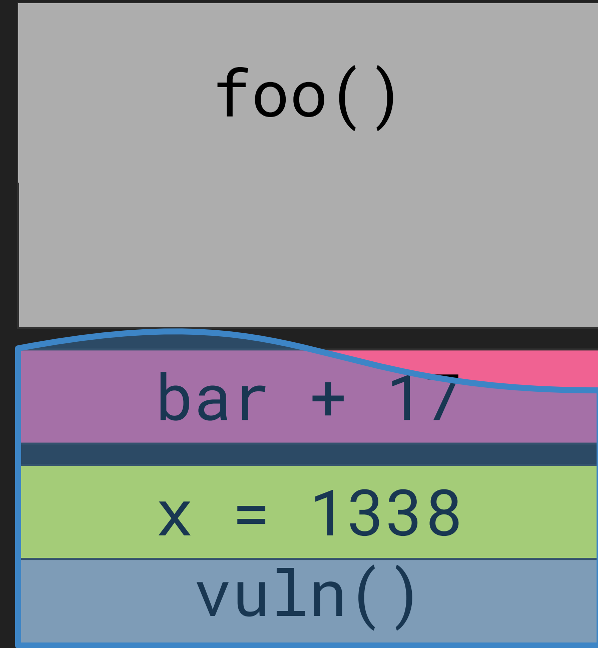
CHOP



prints 1338

Sometimes they are even stored in callee-saved regs!

The Attack

The Attack

Stack Buffer Overflow

The Attack

throw

The Attack

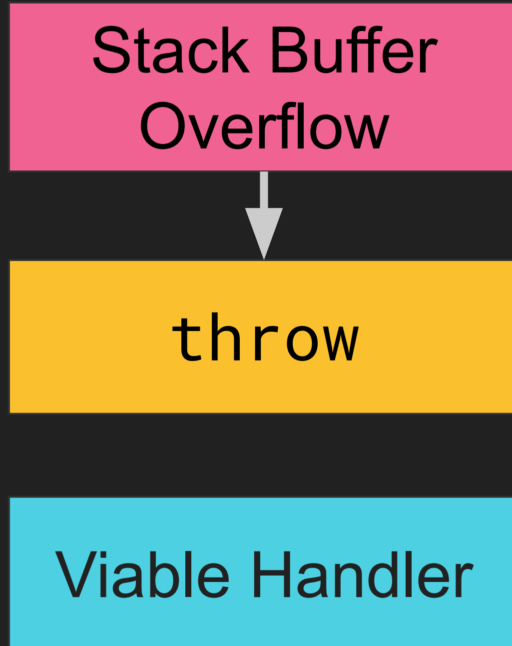
Stack Buffer Overflow

↓

`throw`

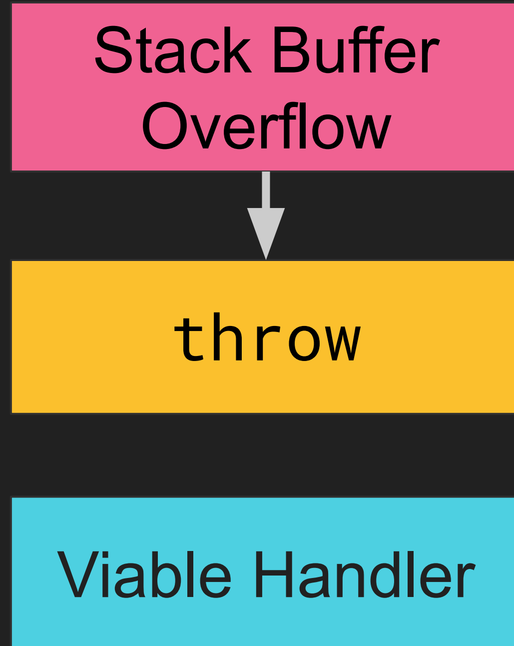
Viable Handler

The Attack



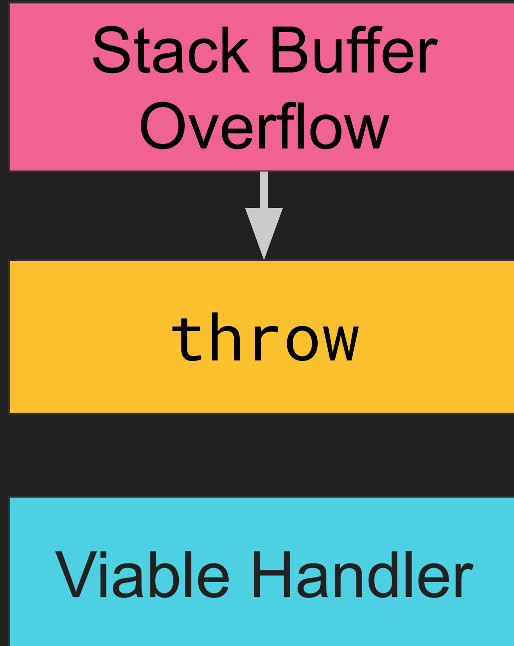
- Prevalence of exception handling code

The Attack

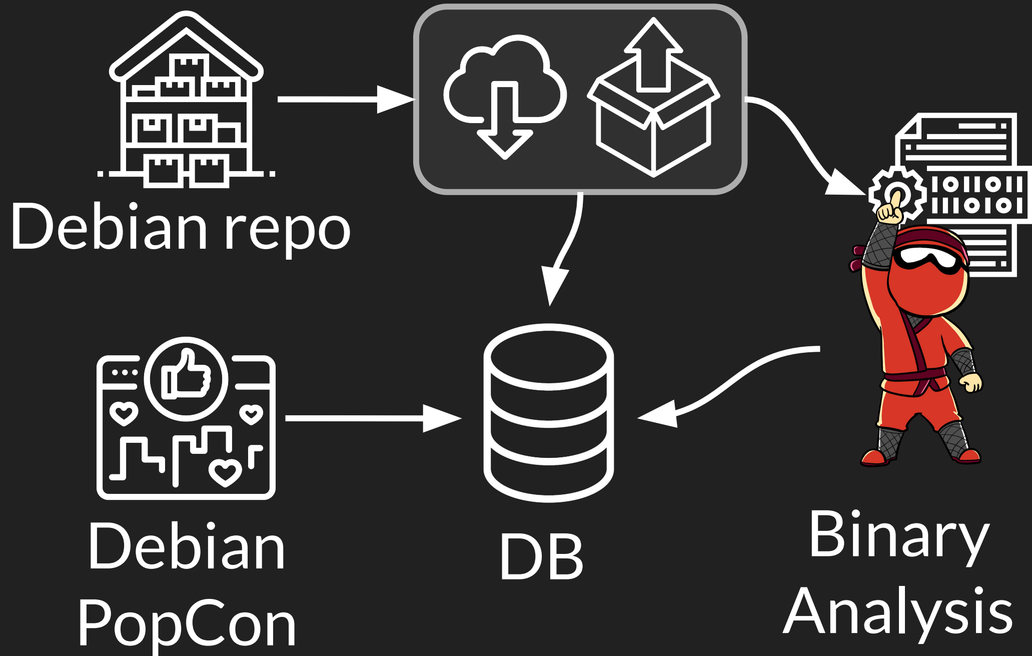


- Prevalence of exception handling code
- Likelihood of throwing functions

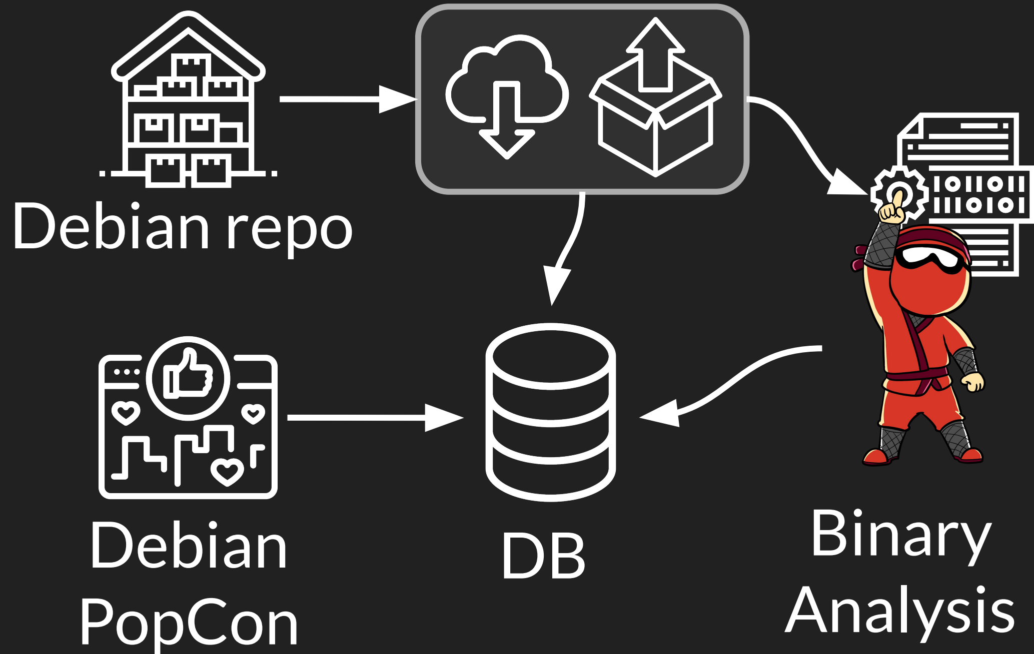
The Attack



- Prevalence of exception handling code
- Likelihood of throwing functions
- Handlers with meaningful attacker gadgets


Debian repo
Debian
PopCon
DB
Binary
Analysis

Select top 1000 popular packages (~3.3k binaries)



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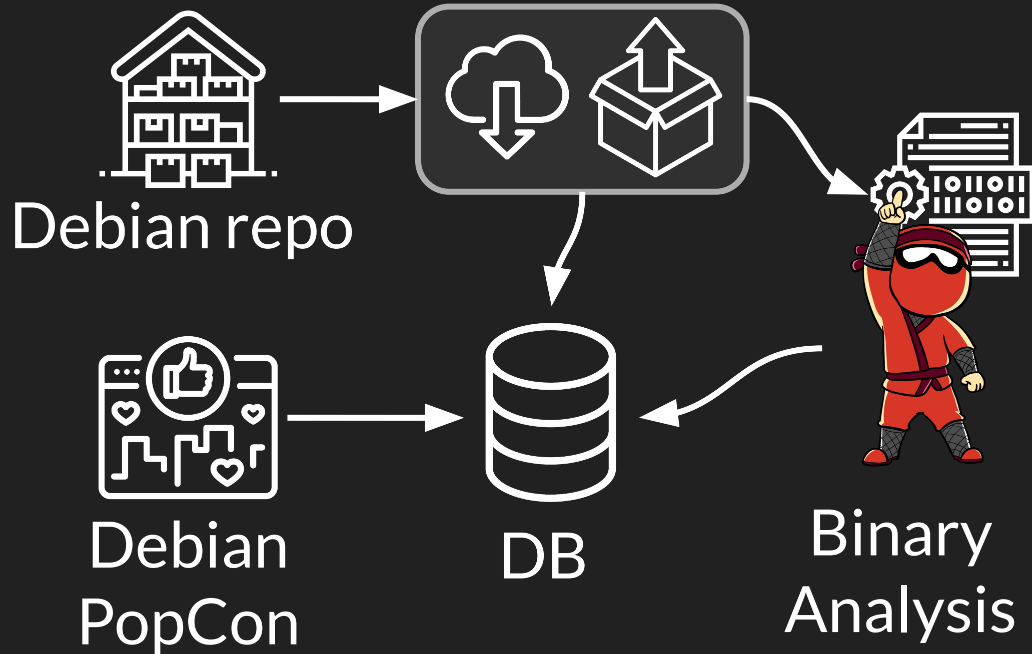

Not restricted to C++ binaries

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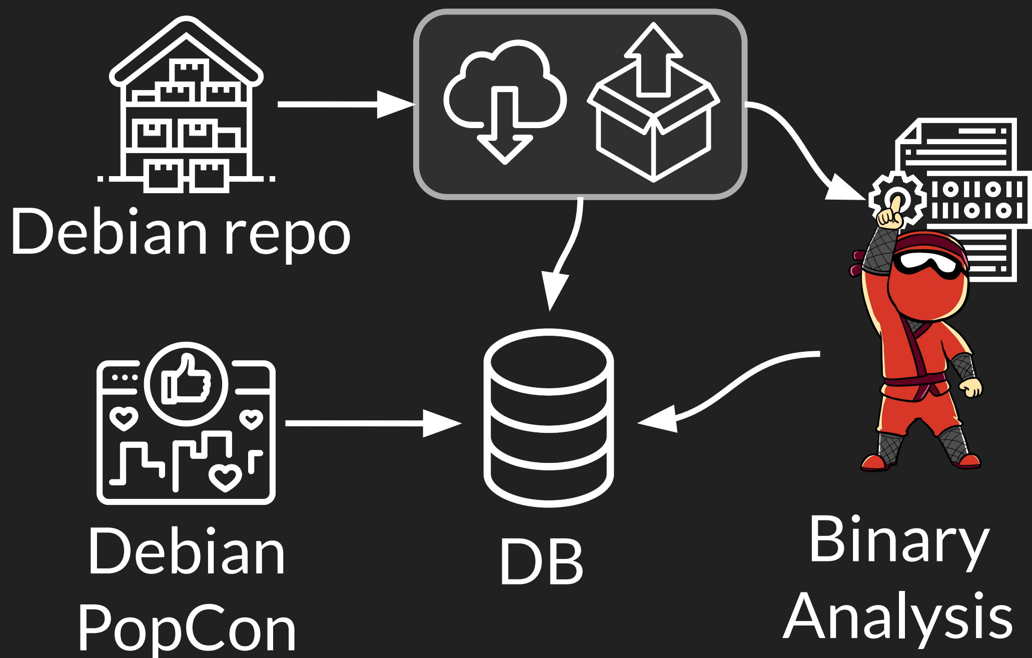

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~10% of binaries use exception handling

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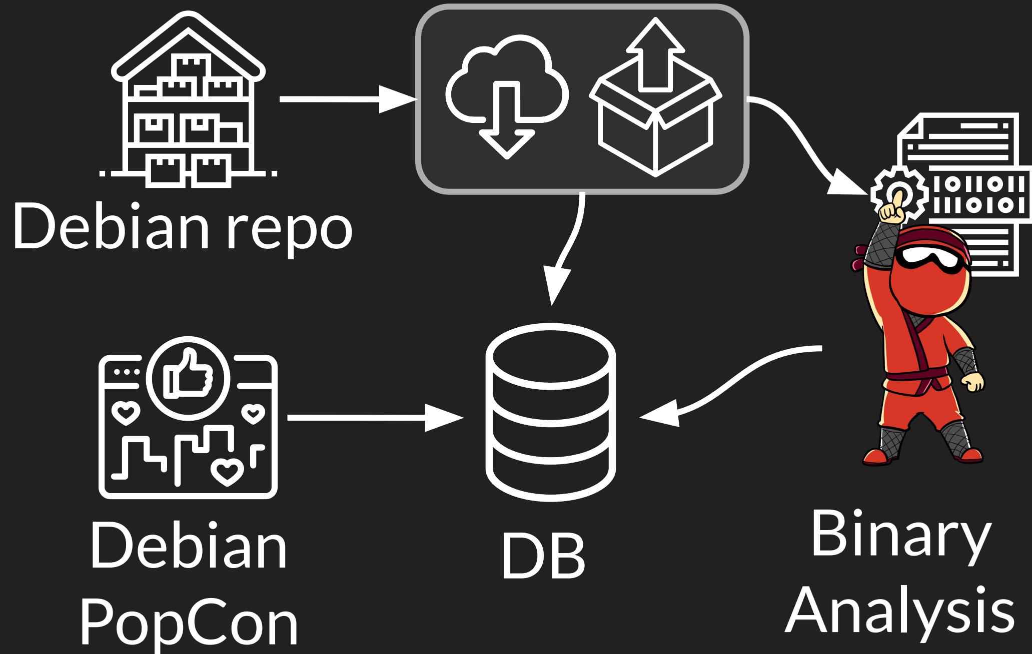

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Half contain at least 40% throwing functions

Taint analysis

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- Extract exception handlers from our data set
- Model forms of control as the taint source
- Search for tainted gadgets in the exception handlers

Interesting gadgets

- Arbitrary Free
- Control-flow Hijack
- Write-What-Where
- Write-Where-Only
- Write-What-Only

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→ Arbitrary Free

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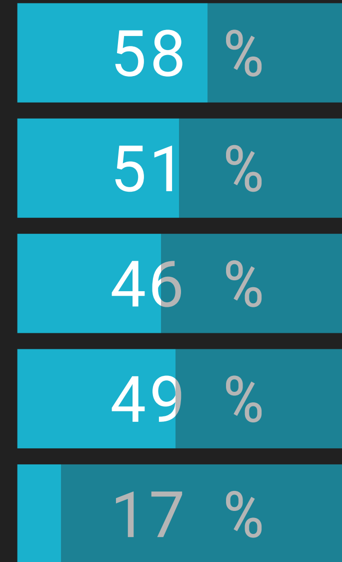

% of binaries containing at least one gadget

Real-World impact

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- Stack cookies

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- Intel CET, ShadowCallStack and more…

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- Apple, Google, Intel, ARM, Microsoft, gcc and llvm

Conclusion

- CHOP attacks are possible
- … and dangerous

More in the paper...

- are feasible in practice (3 CVEs)
    - unexploitable with modern defences

Paper QR