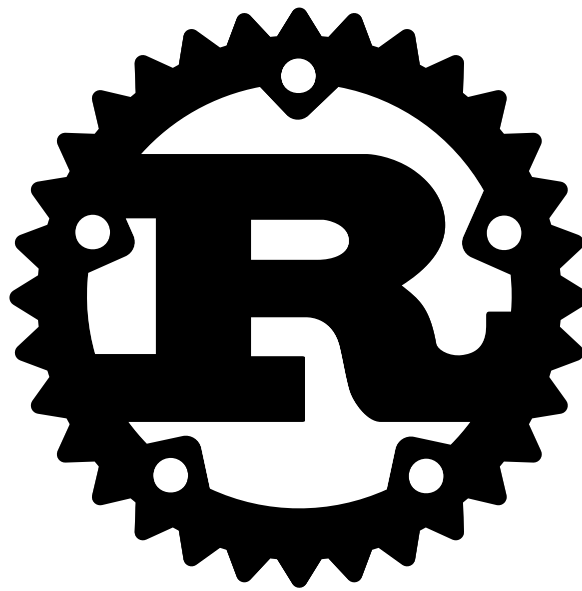
OXIDE:
THE ESSENCE OF RUST

Aaron Weiss
Northeastern University



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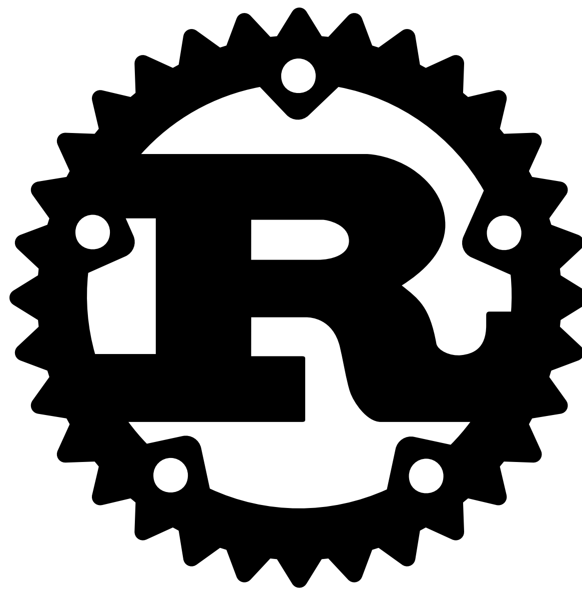
Rust is a systems programming language that runs blazingly fast, prevents segfaults, and guarantees thread safety.

– the official Rust website



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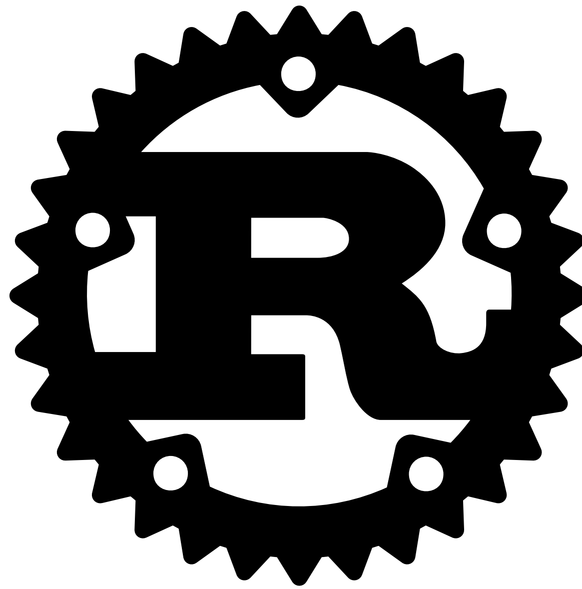

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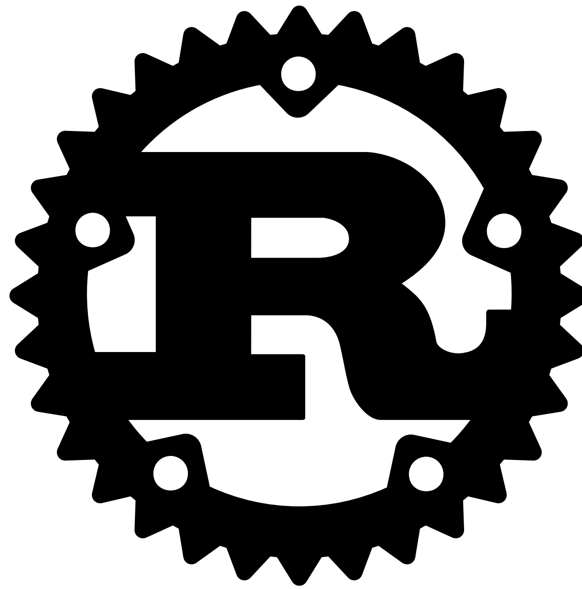

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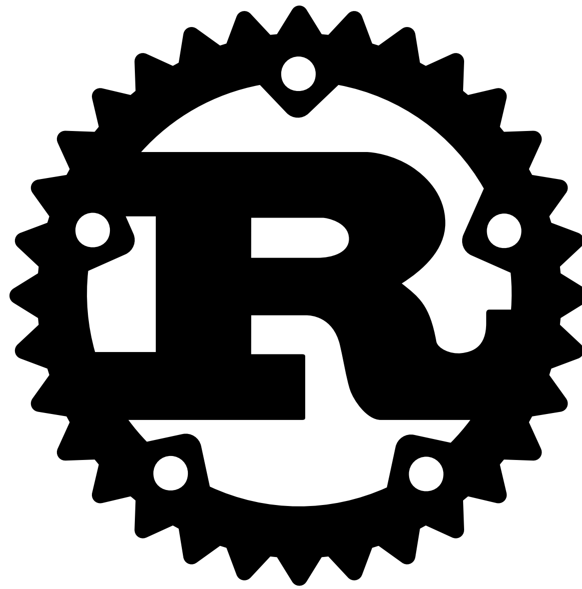
Memory safety without garbage collection

Abstraction without overhead

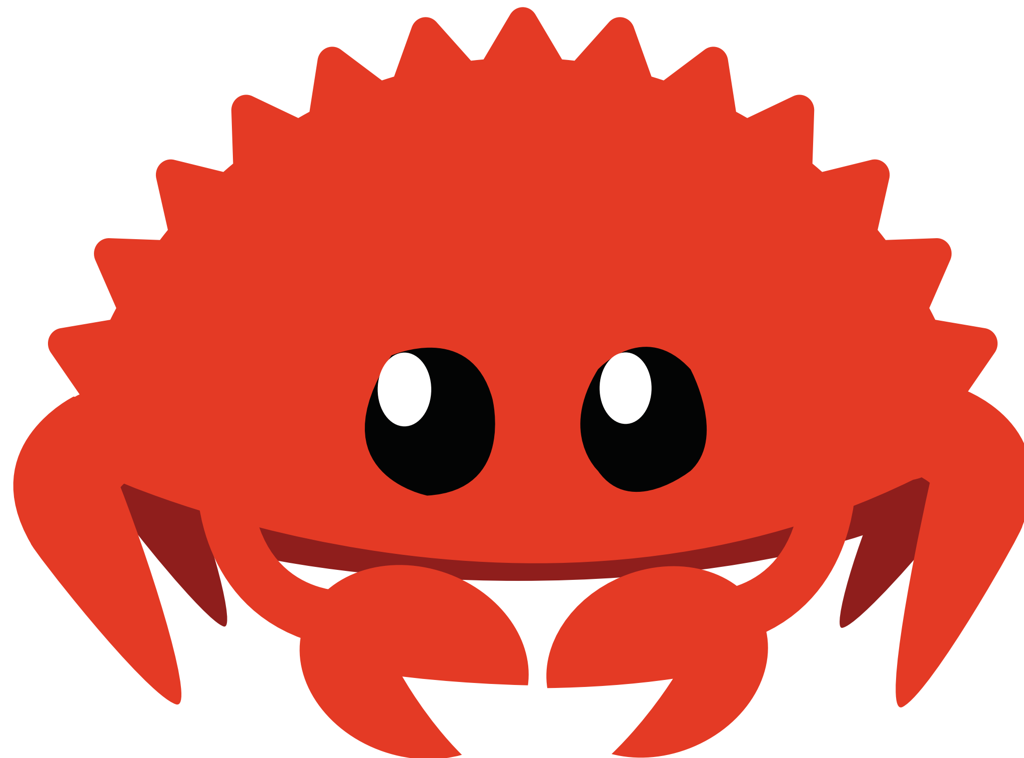
Concurrency without data races

Stability without stagnation

Hack without fear.



WE HAVE CUTE CRABS



... BUT HOW?

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Ownership

variables "*own*" the values they're bound to

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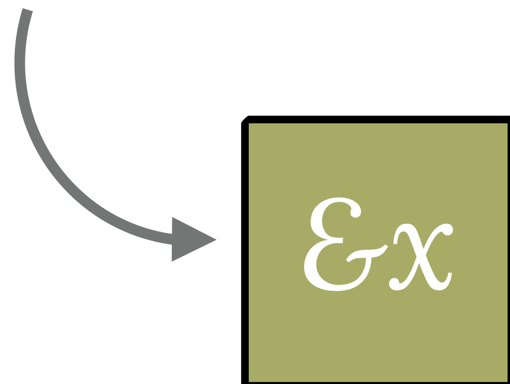
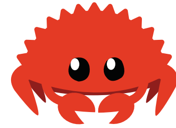
Borrowing



references "*borrow*" values from their owners

A PROGRAM IN RUST



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extern crate irc;
use irc::client::prelude::*;

fn main() -> irc::error::Result<()> {
    let config = Config { ... };
    let mut reactor = IrcReactor::new()?;
    let client = reactor.prepare_client_and_connect(&config)?;
    client.identify()?;

    reactor.register_client_with_handler(client, |client, message| {
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    reactor.run()?;
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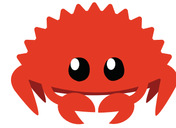

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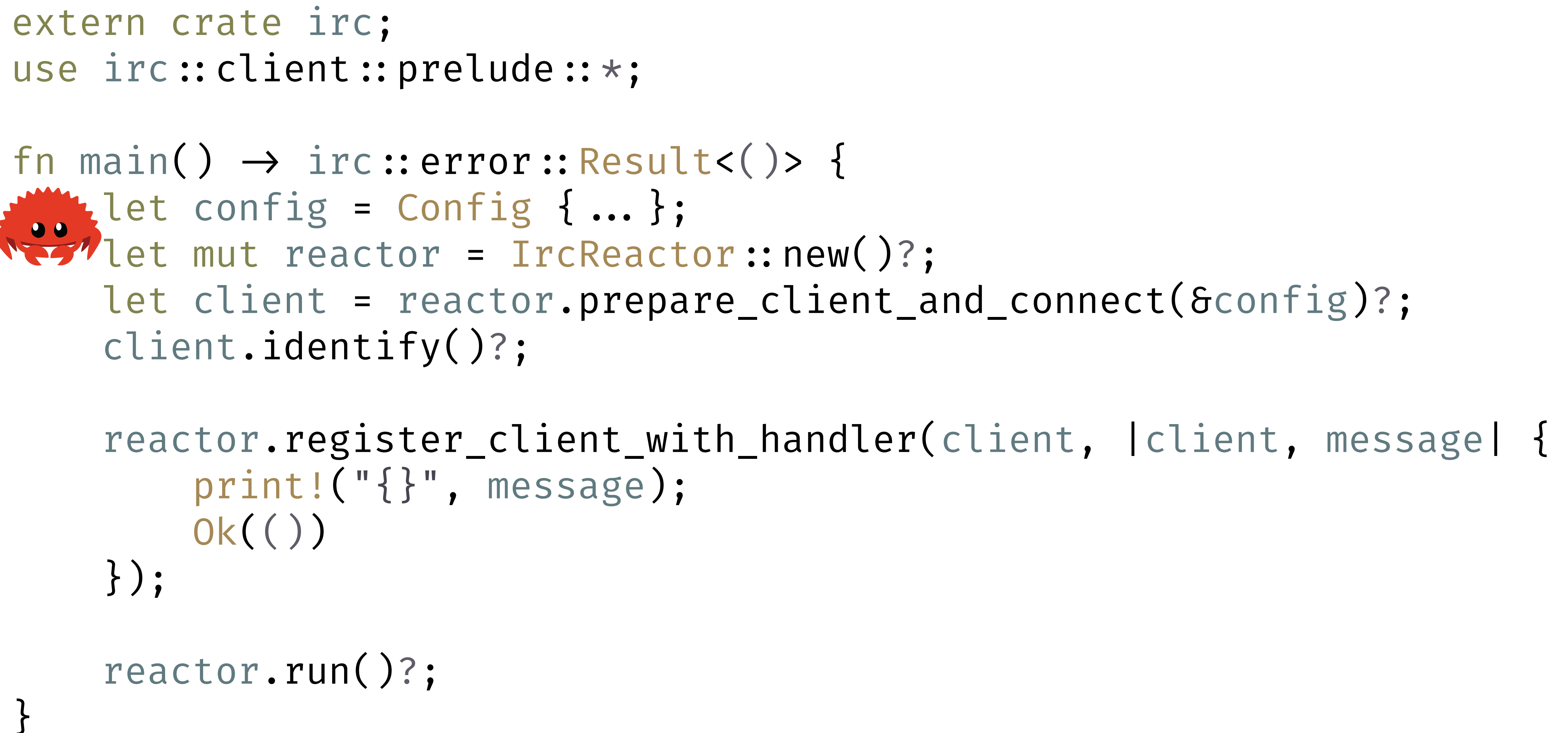

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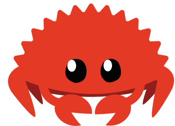

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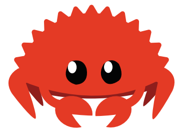

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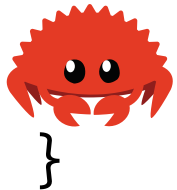

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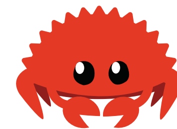

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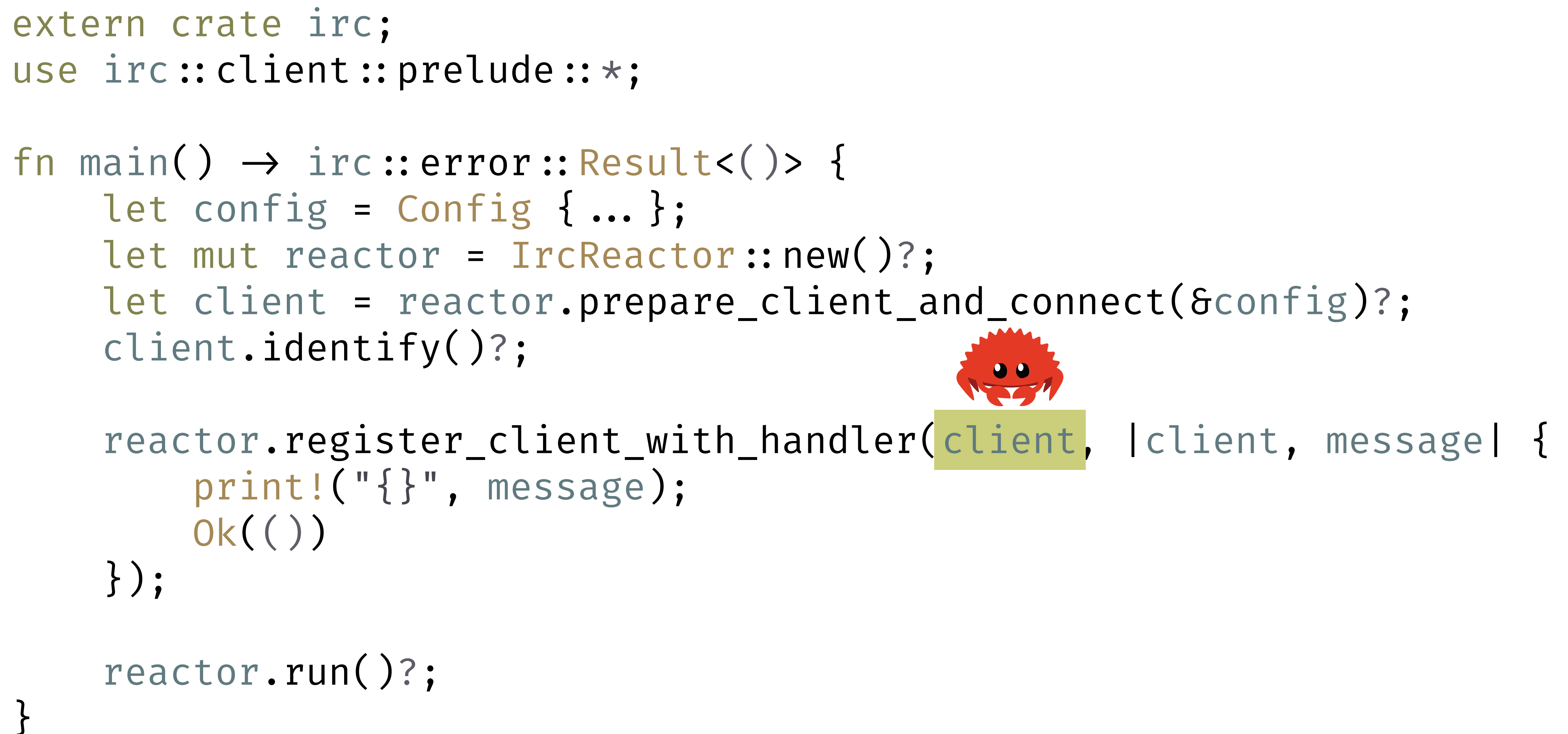

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THE CURRENT STATE OF AFFAIRS

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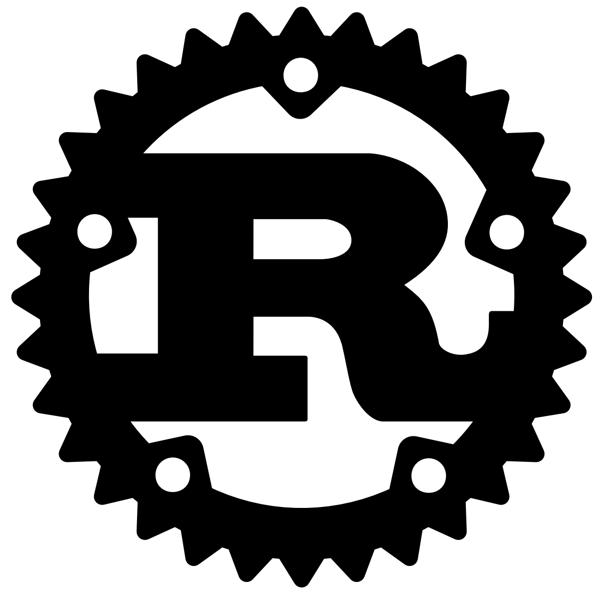

RUST

interprocedural static analysis
with *ad-hoc* constraint solving

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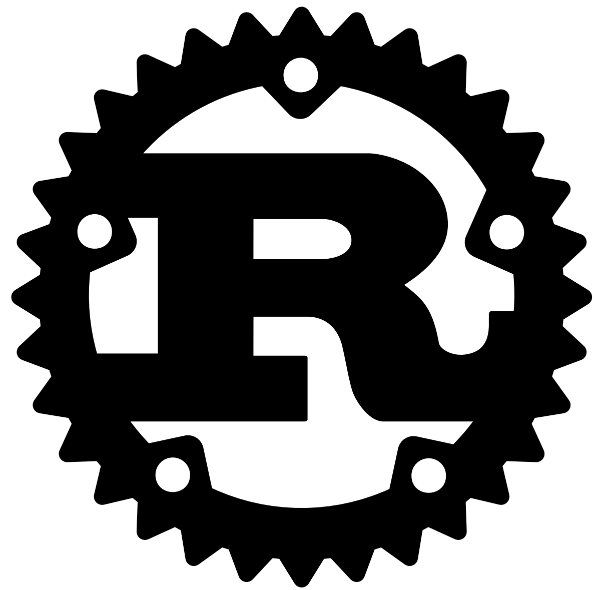

RUST

interprocedural static analysis
with *ad-hoc* constraint solving

RUSTBELT (JUNG, JOURDAN, KREBBERS, AND DREYER, POPL '18)

formal language specified in *Iris*
but low-level, in a *CPS-style*.

BUT WE WANT TO GO HIGHER

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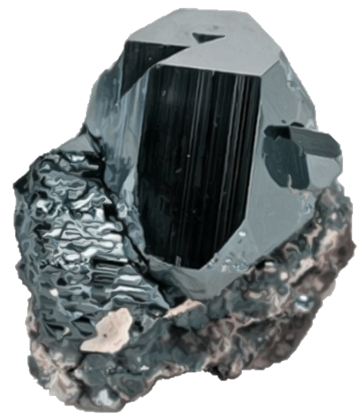

Oxide

CAPABILITIES FOR OWNERSHIP

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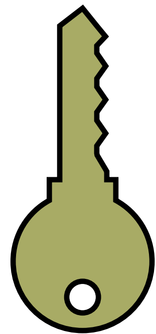
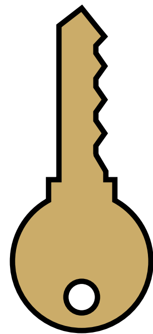
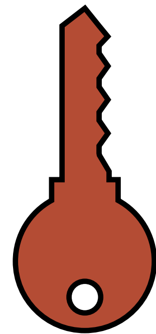
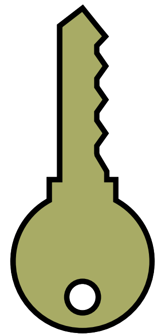


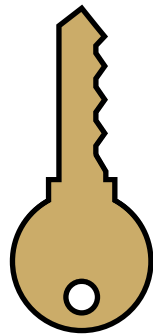


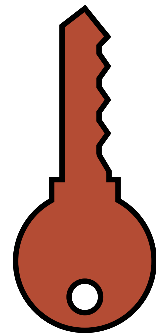


capabilities guard the use of identifiers

BORROWS BREAK CAPABILITIES INTO FRACTIONS







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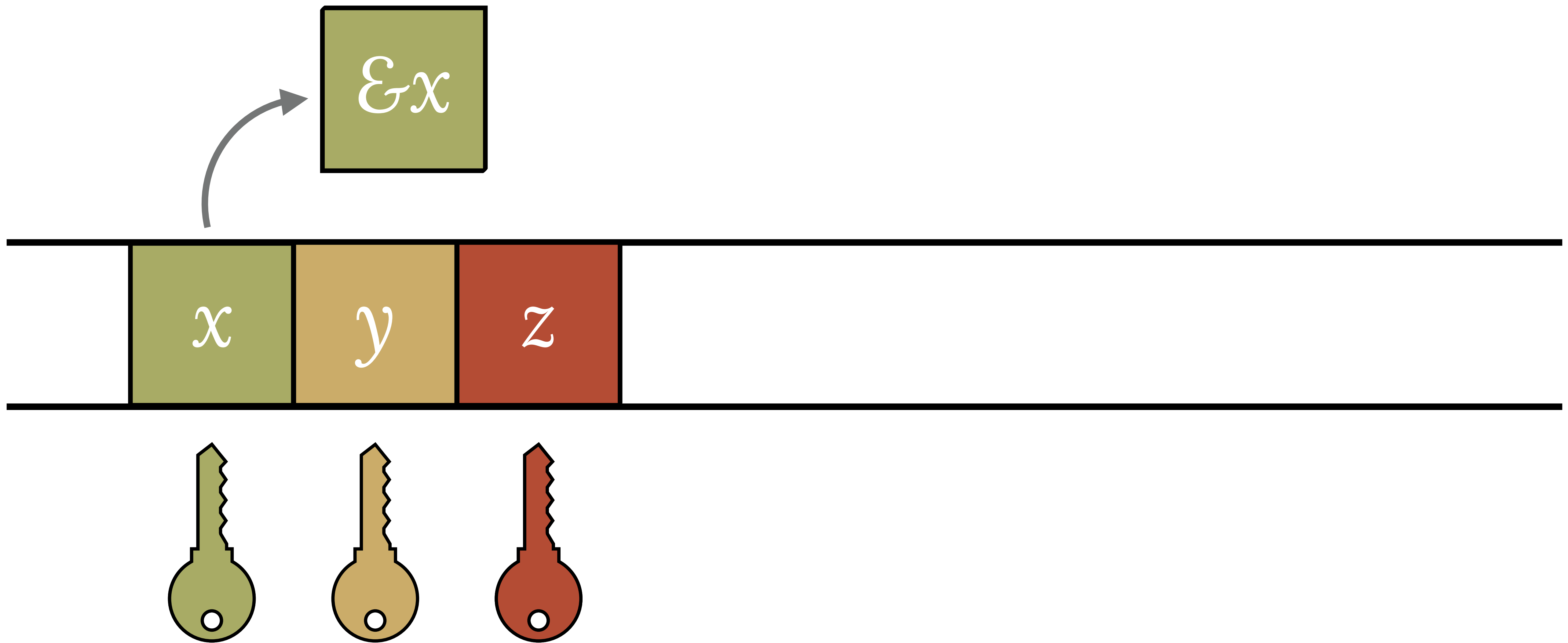

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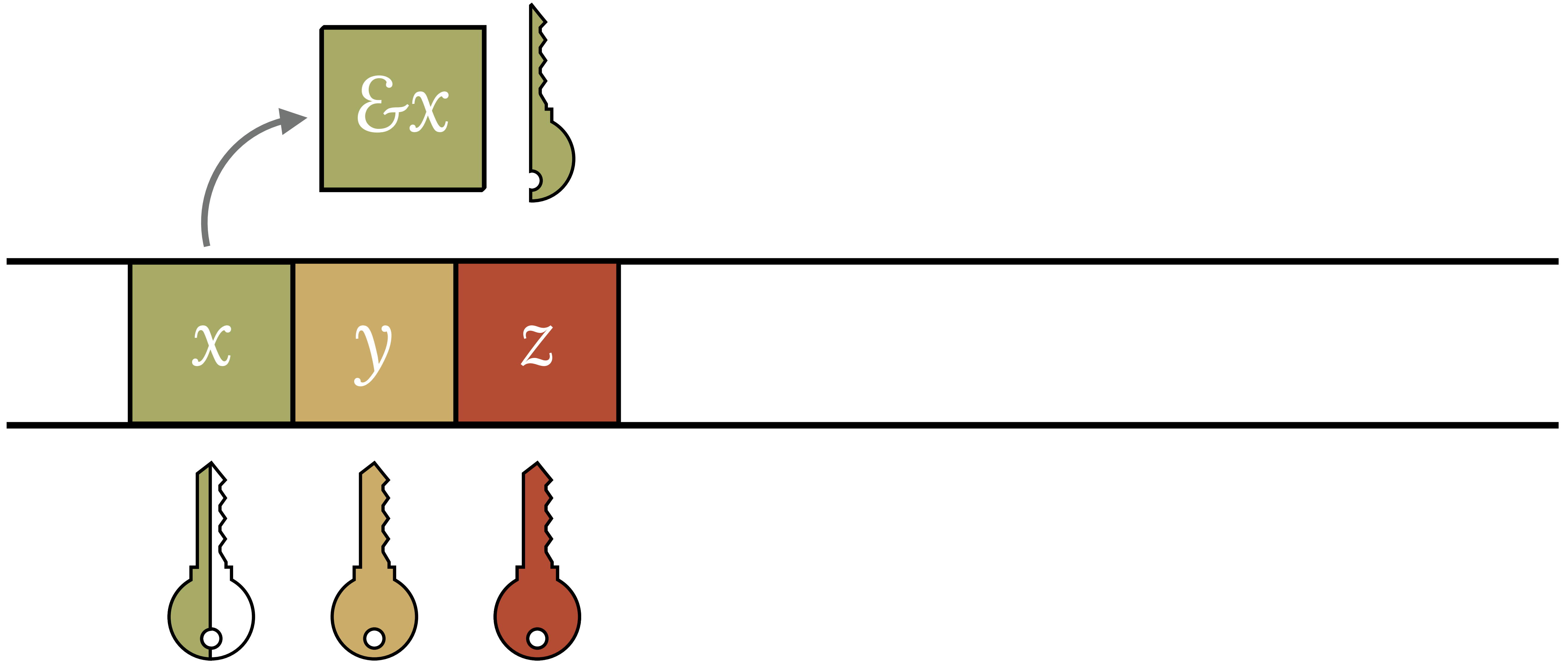

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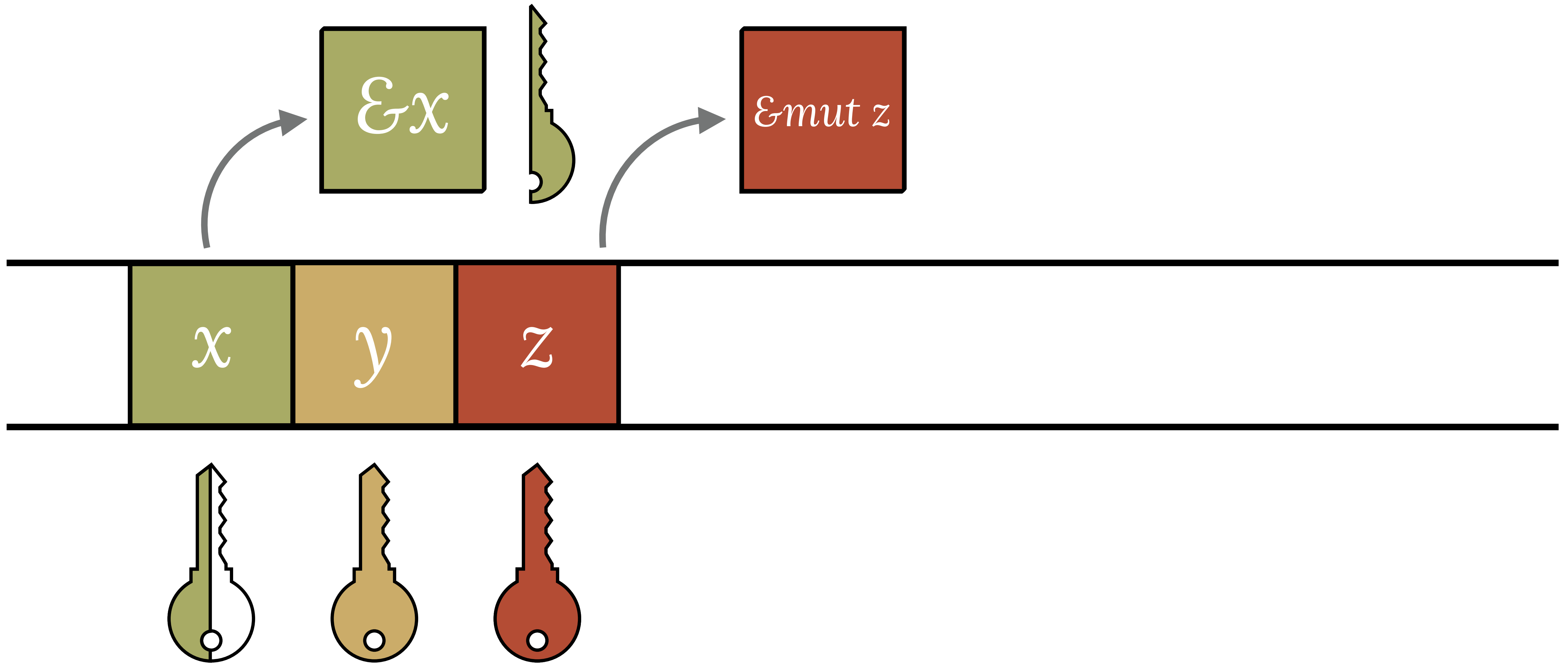

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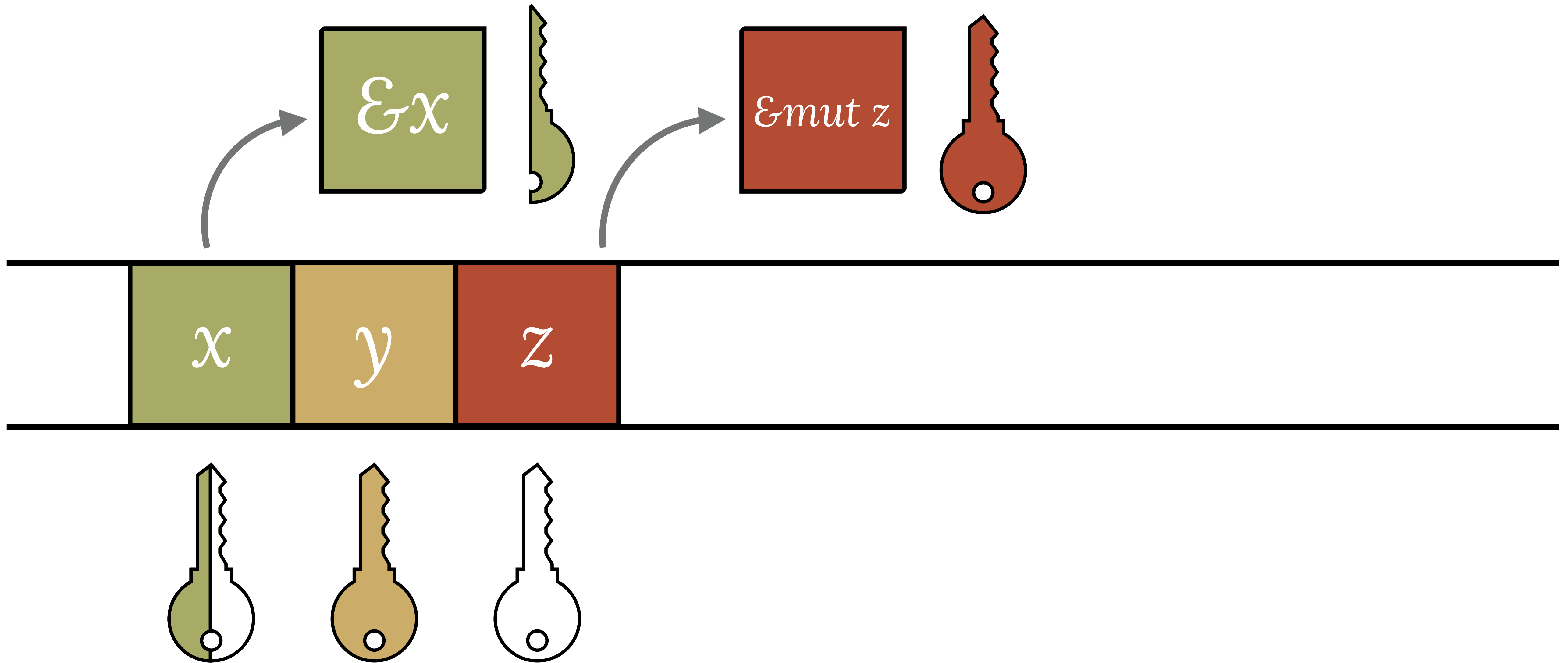
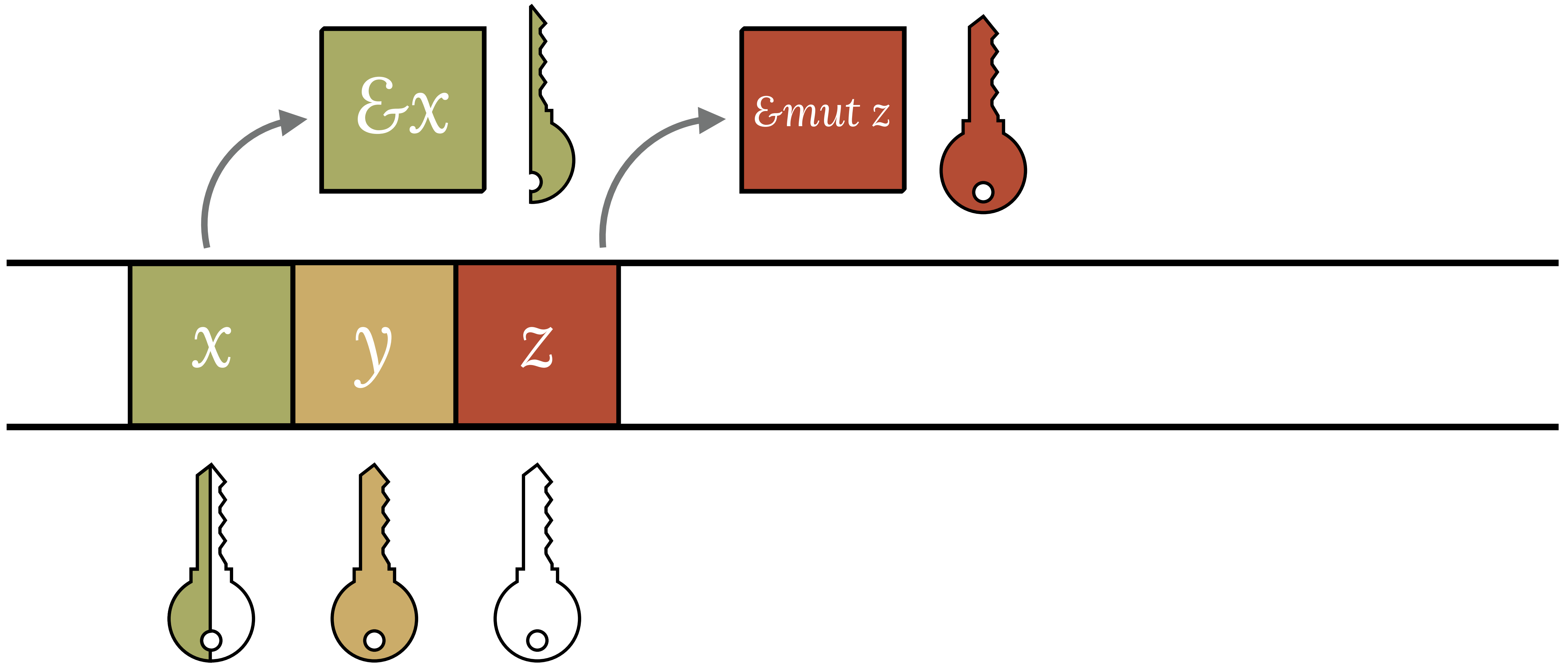


MOVES TAKE THE CAPABILITY AND THE HOLE



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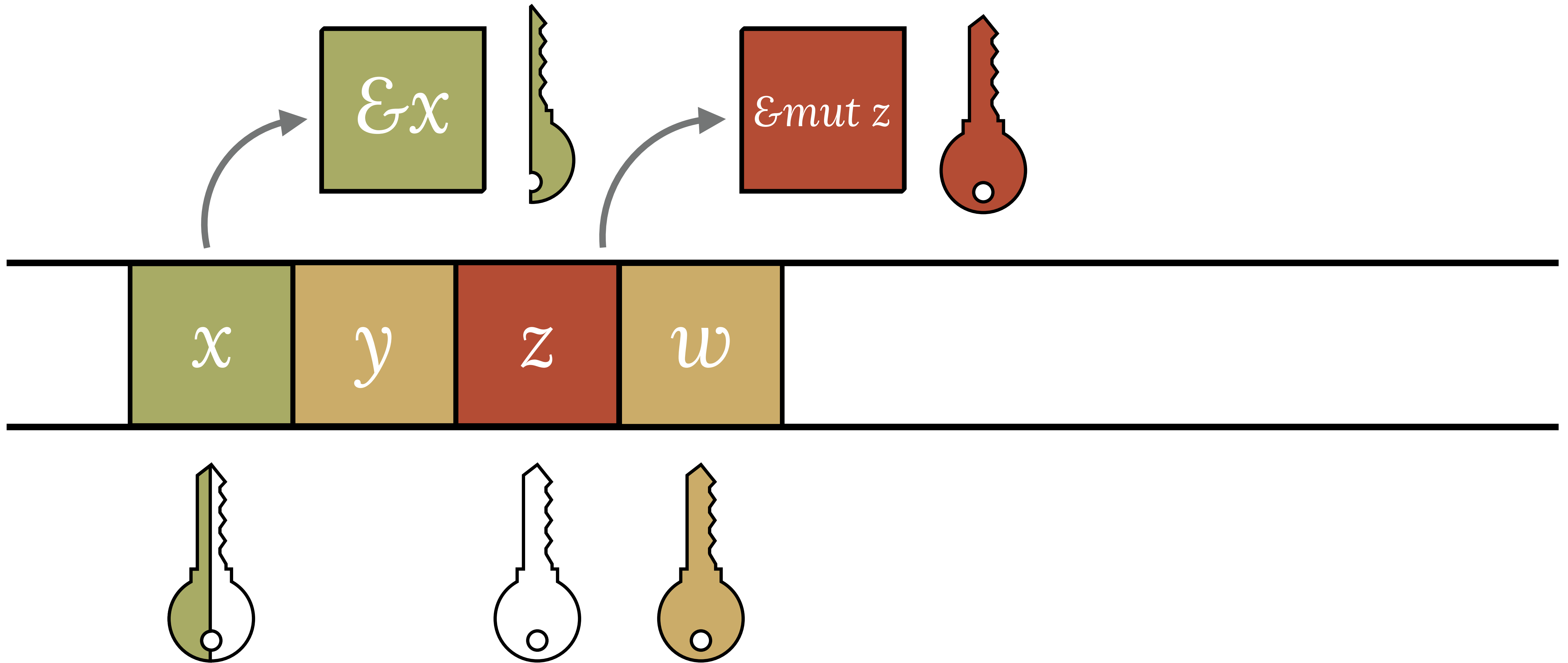

WE CALL REFERENCE SITES LOANS

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}
```

a loan

WHAT ABOUT LIFETIMES?

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```
x : u32
```

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```
x : u32

&x : &'x u32
```

WHAT ABOUT LIFETIMES?

```
x : u32

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regions represent sets of loans

TYPE CHECKING

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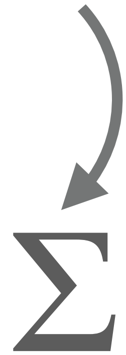


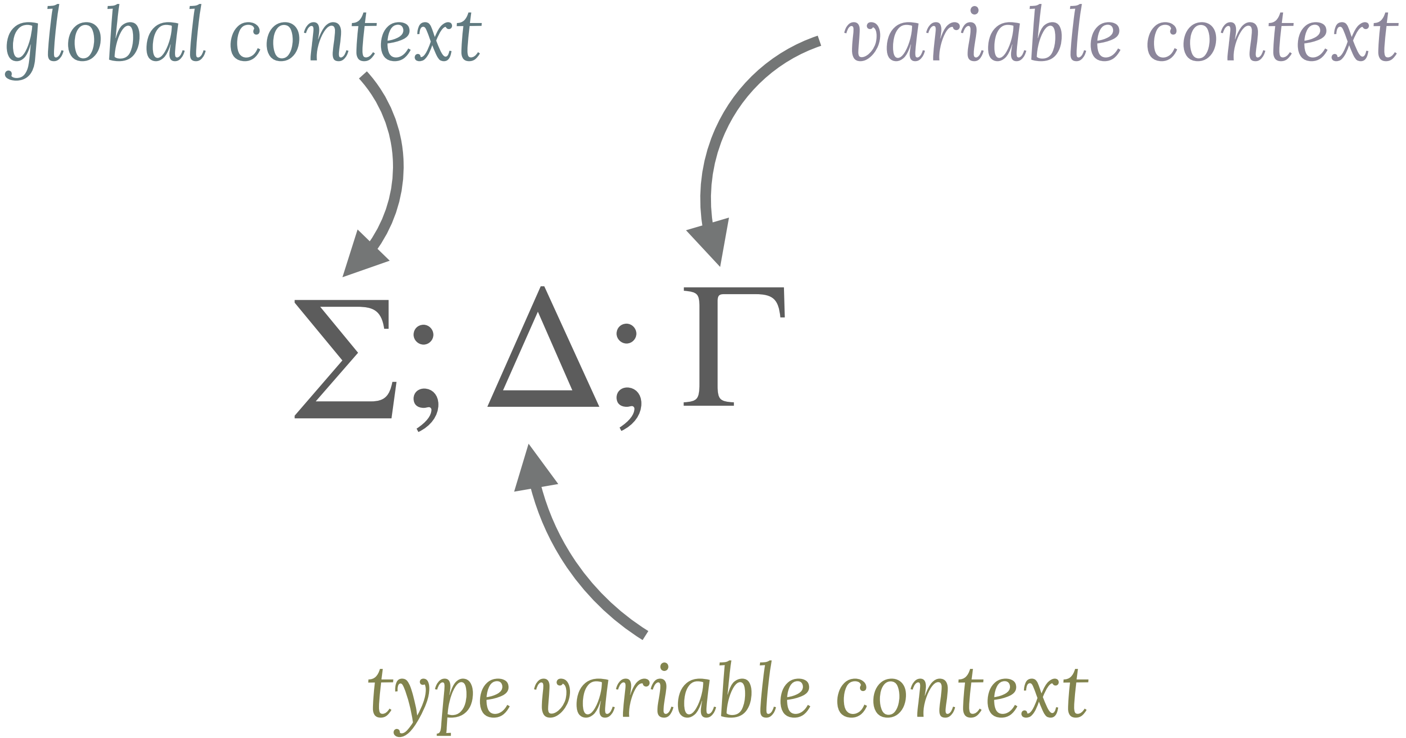
TYPE CHECKING

global context

$$\Sigma; \Delta$$

type variable context

TYPE CHECKING



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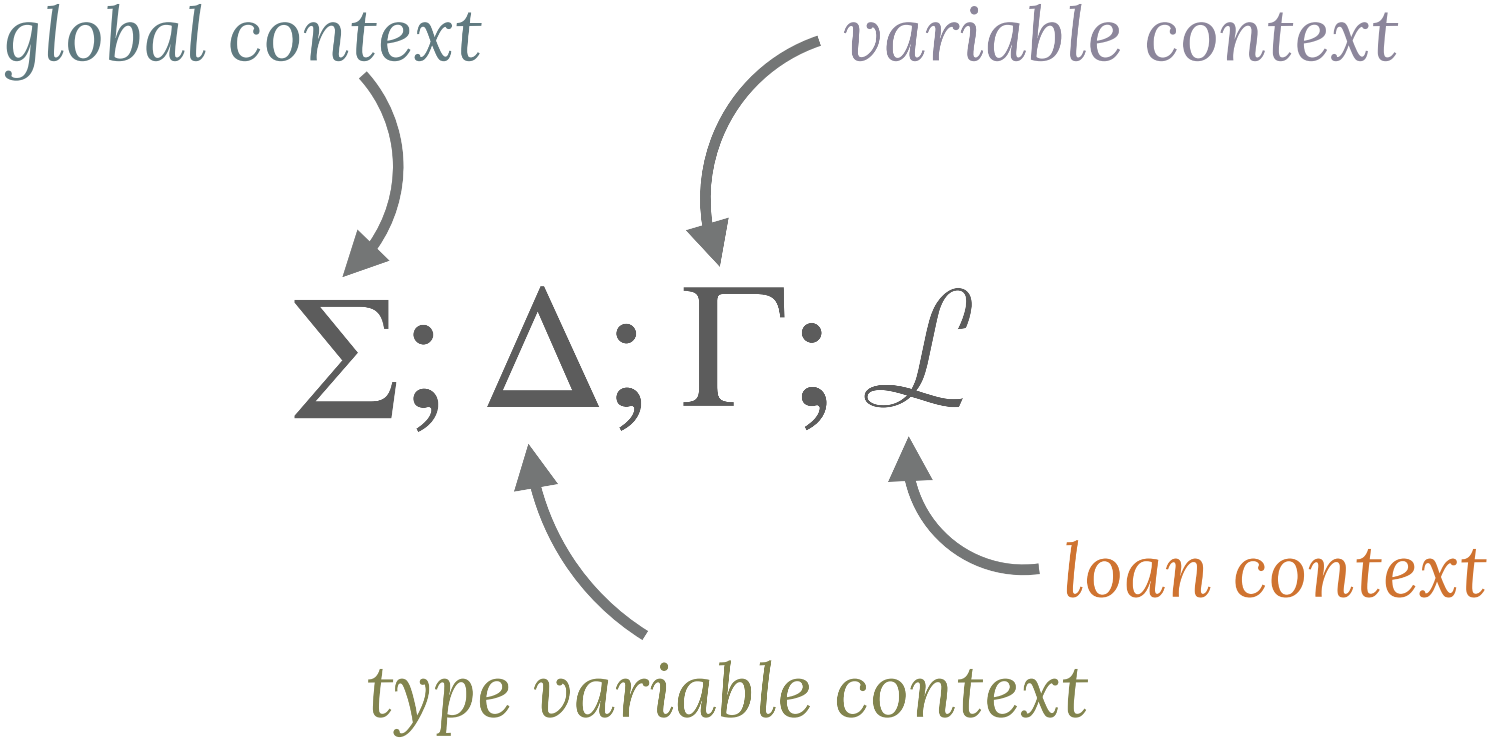

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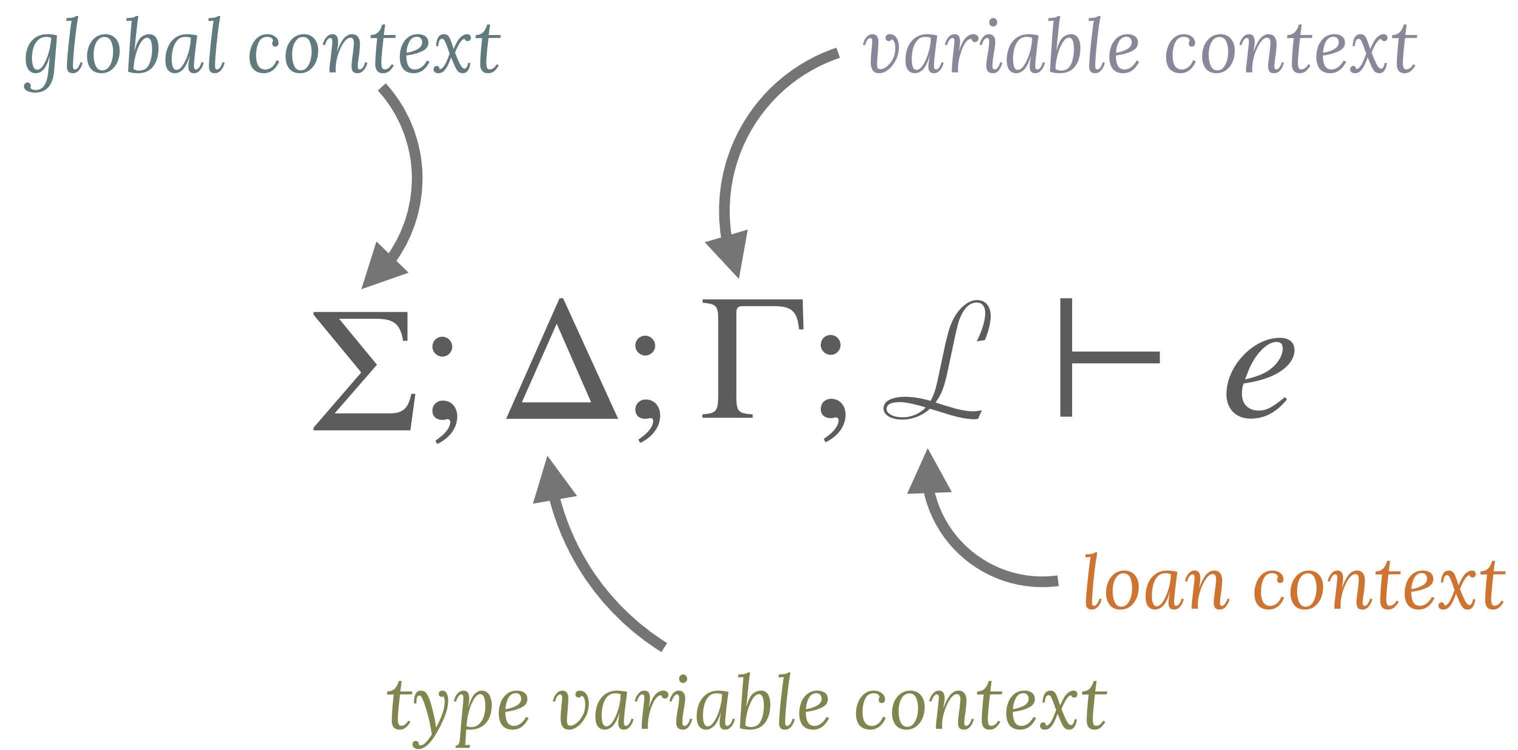

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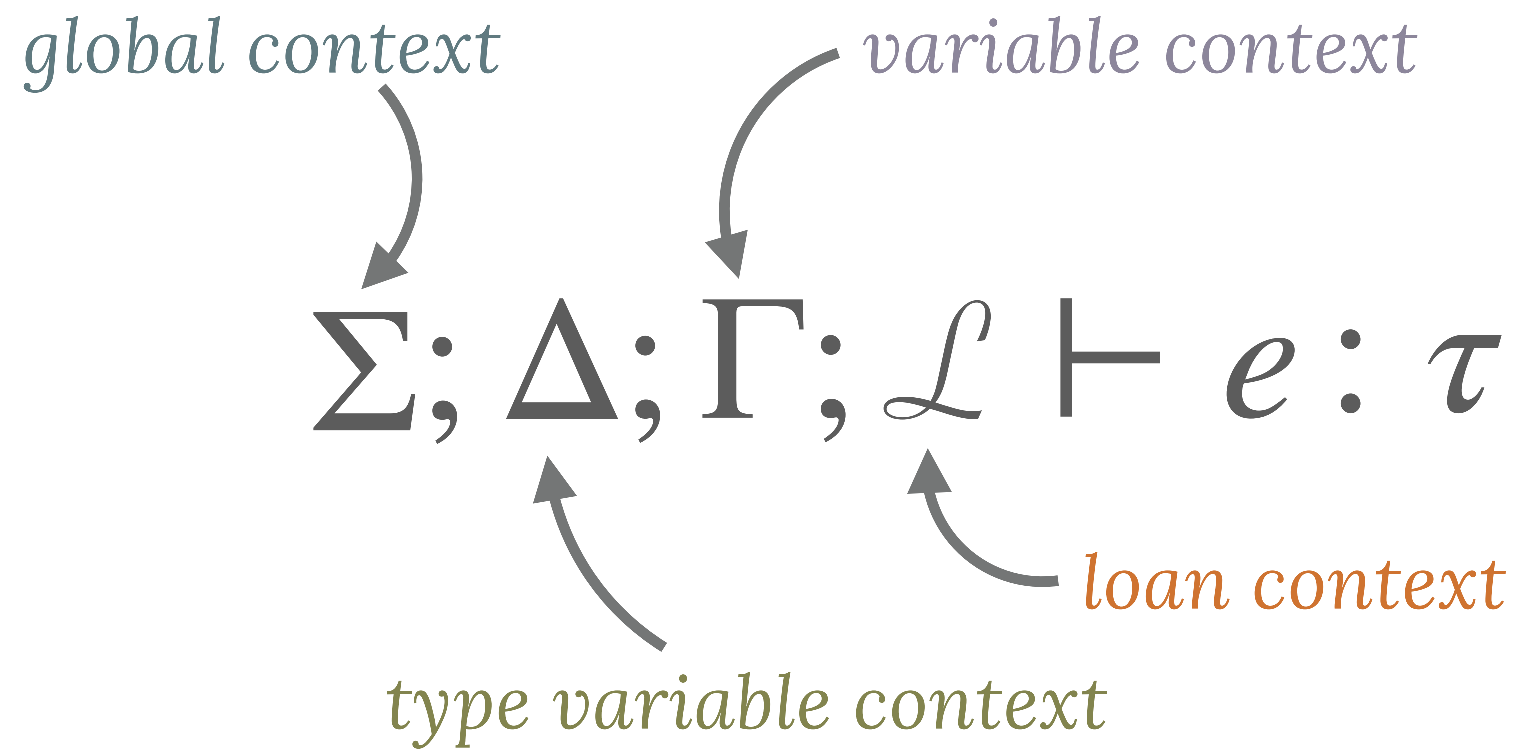

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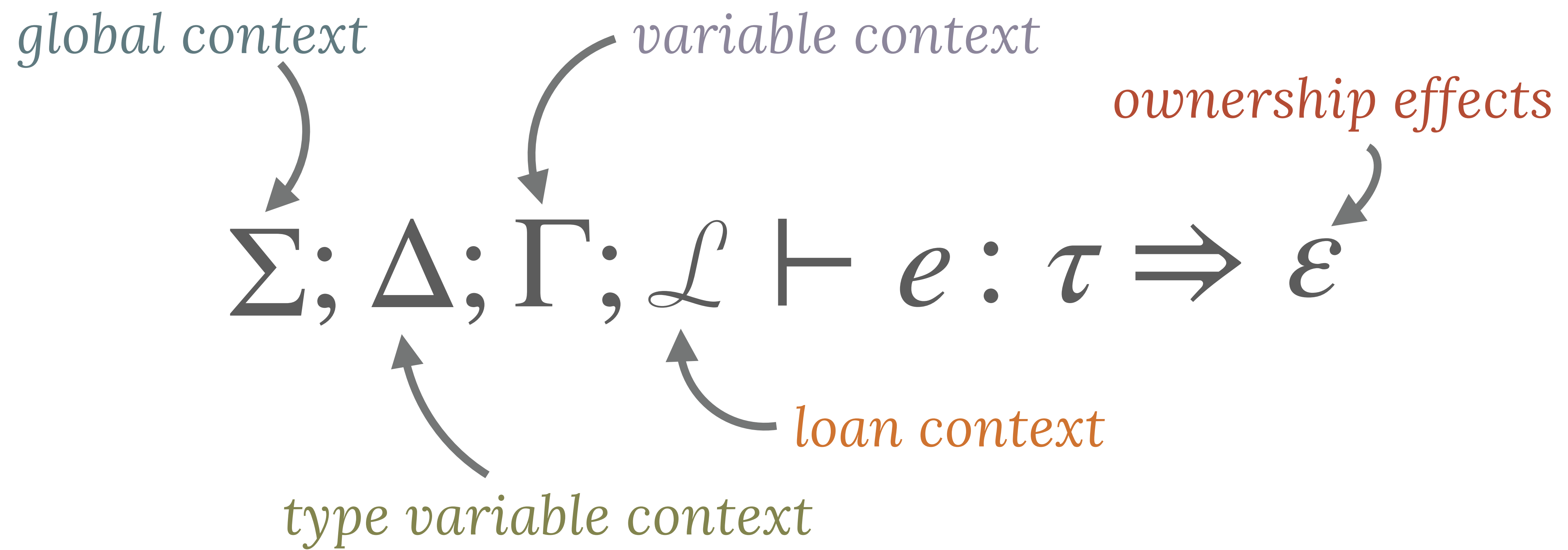

TYPING BORROWS

$$\frac{}{\Sigma; \Delta; \Gamma; \mathcal{L} \vdash \texttt{\&'a x} :}$$

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$$\frac{'a \notin \mathcal{L}}{\Sigma; \Delta; \Gamma; \mathcal{L} \vdash \&'a\ x :}$$

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$$\frac{}{\Sigma; \Delta; \Gamma; \mathcal{L} \vdash \texttt{if } e_1 \{e_2\} \texttt{ else } \{e_3\} :}$$

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$$\Sigma; \Delta; \Gamma; \mathcal{L} \vdash e_1 : \texttt{bool} \Rightarrow \varepsilon_1$$

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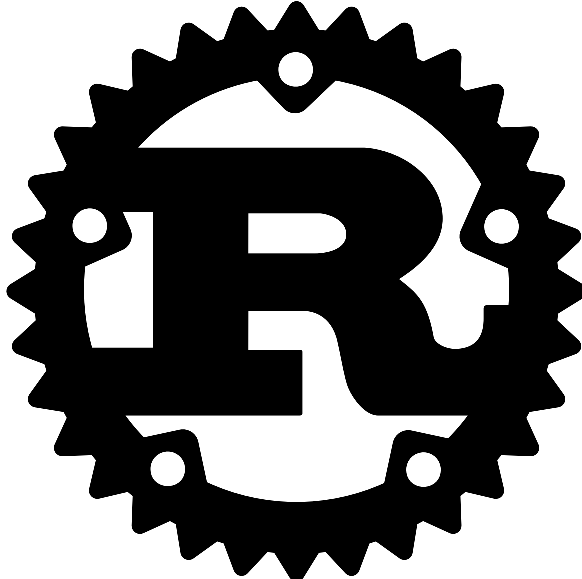
A RUSTY FUTURE



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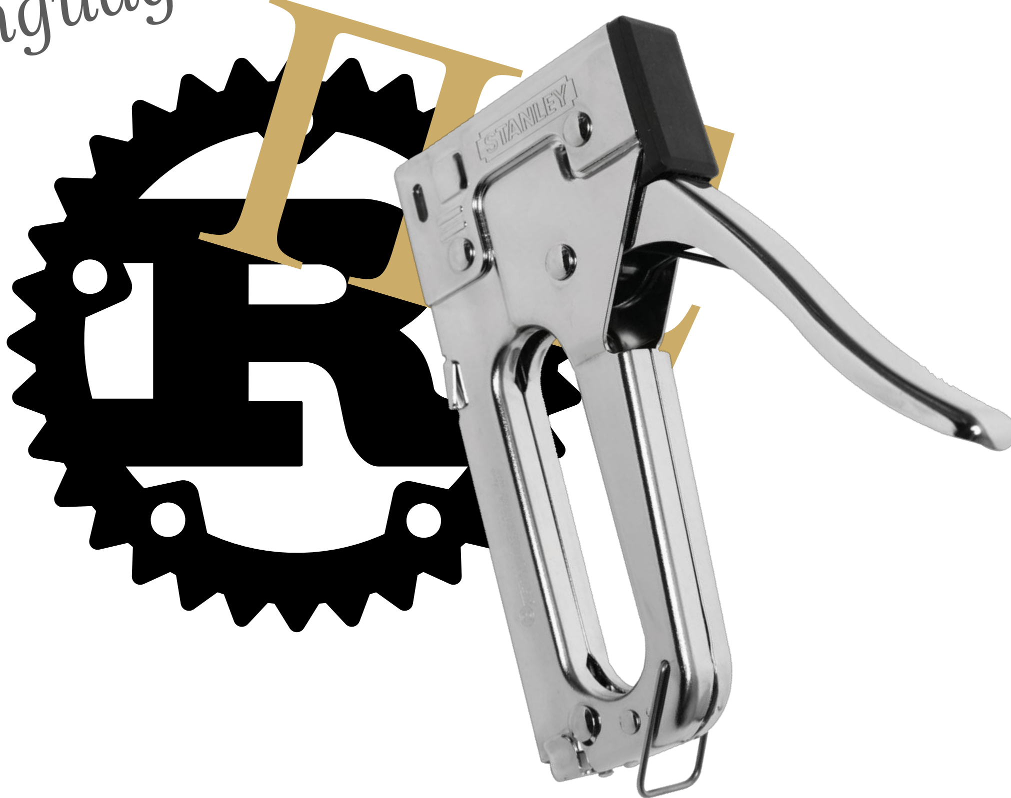
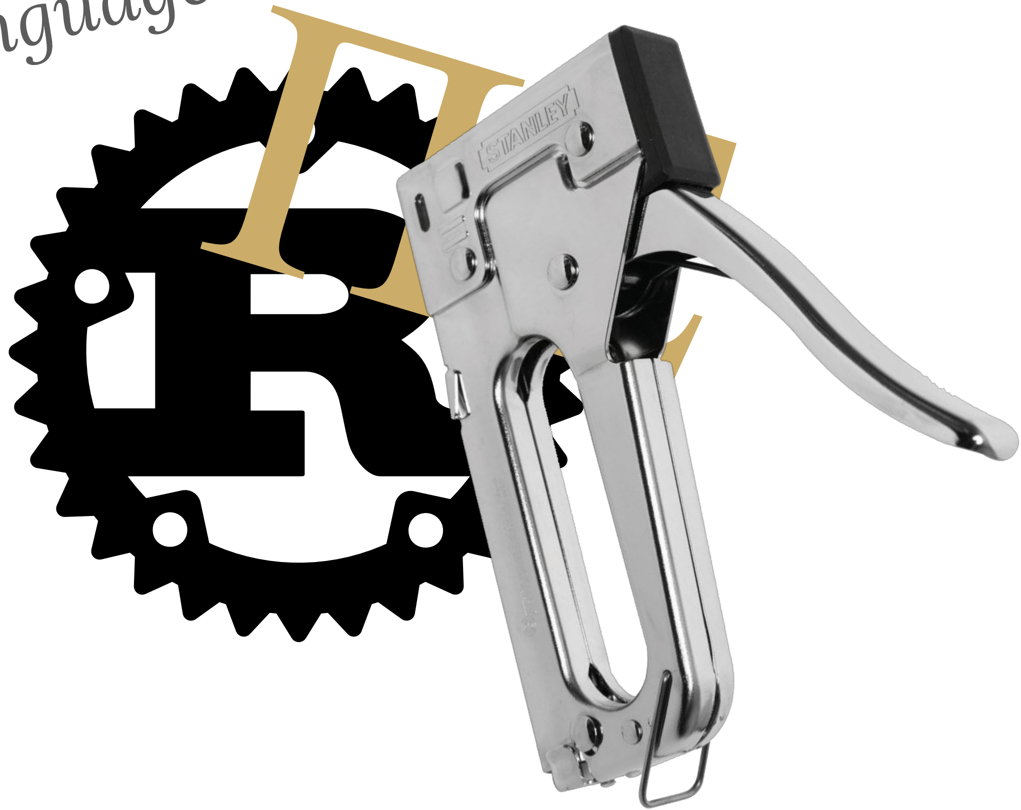


A RUSTY FUTURE

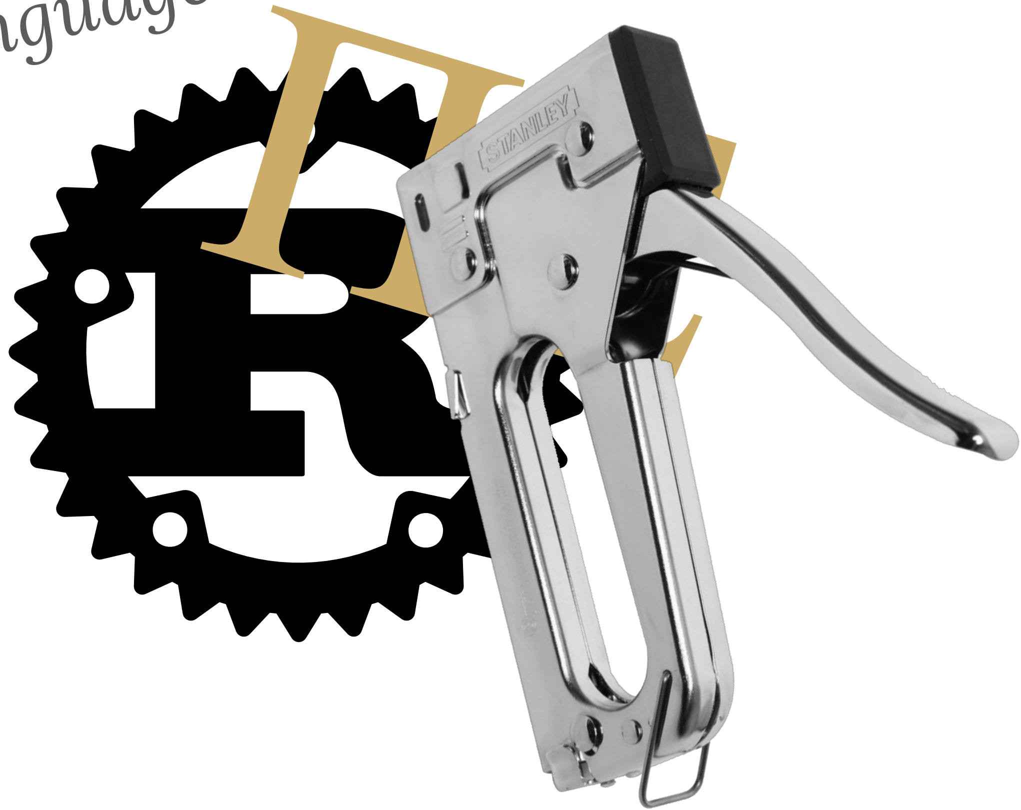
Language Extensions



Safe Interoperability

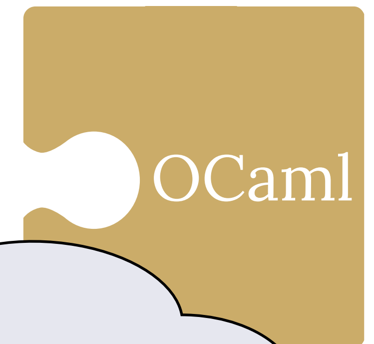
A RUSTY FUTURE

Language Extensions



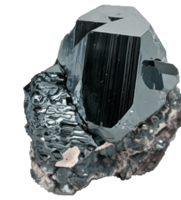
Unsafe Code Guidelines

Safe Interoperability

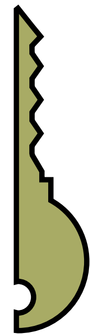


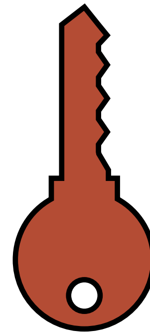
What unsafe code is safe to write?

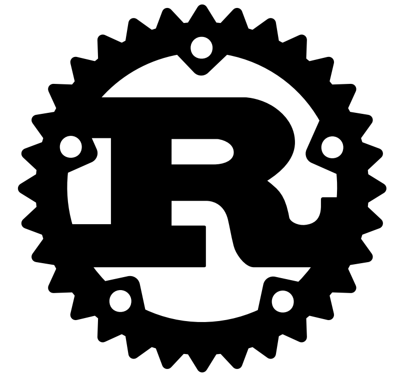
TAKEAWAYS

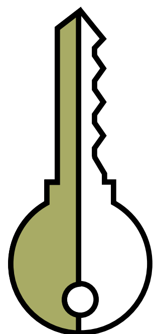


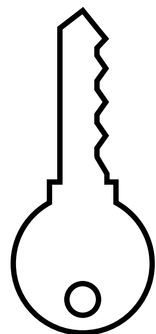
Oxide

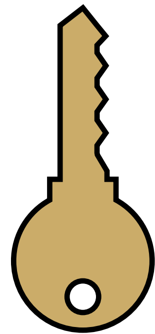


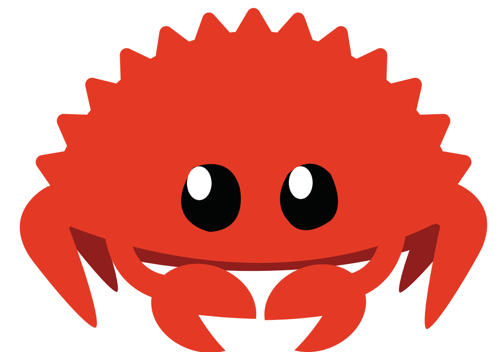




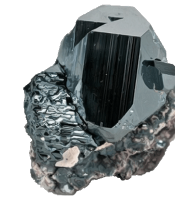






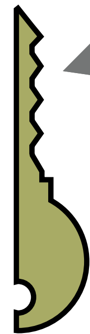


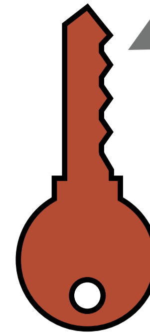
TAKEAWAYS

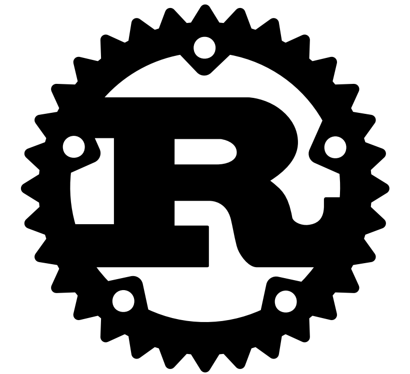


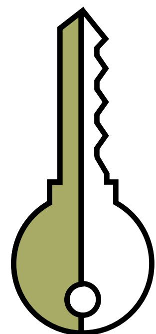
Oxide

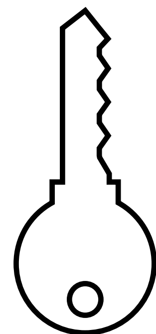
Ownership with fractional capabilities

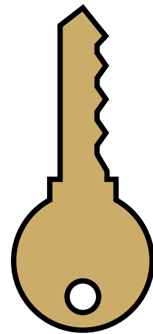


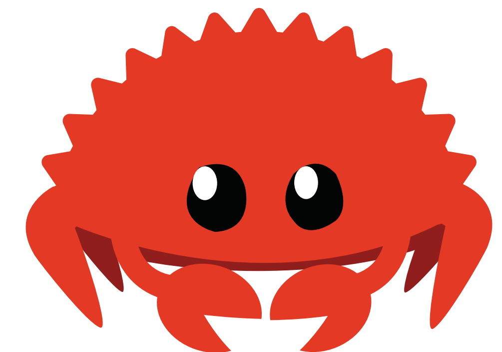












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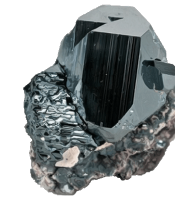
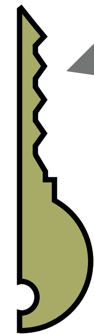
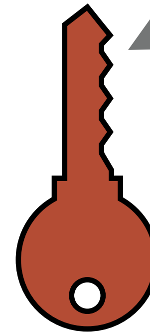
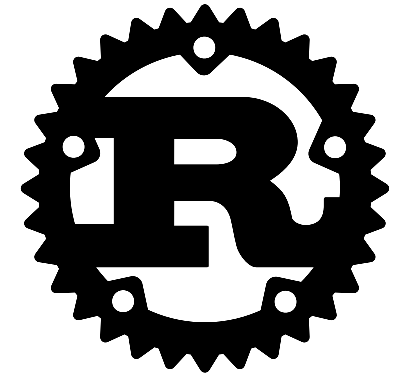


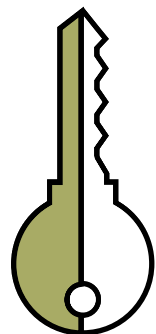
Oxide

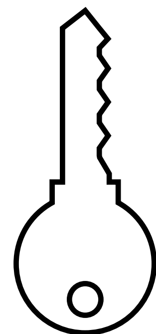
Ownership with *fractional* capabilities

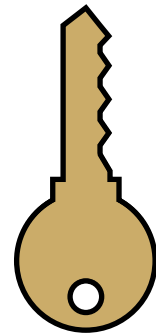


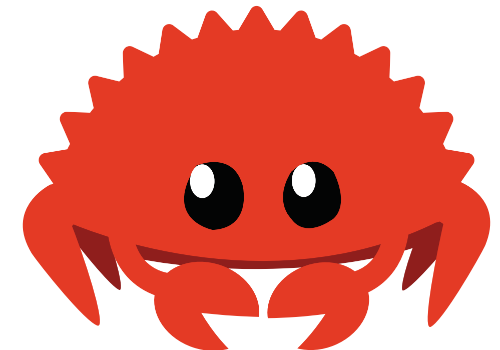






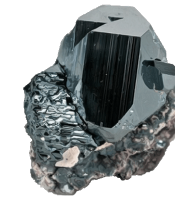






Moves *never* return their capability

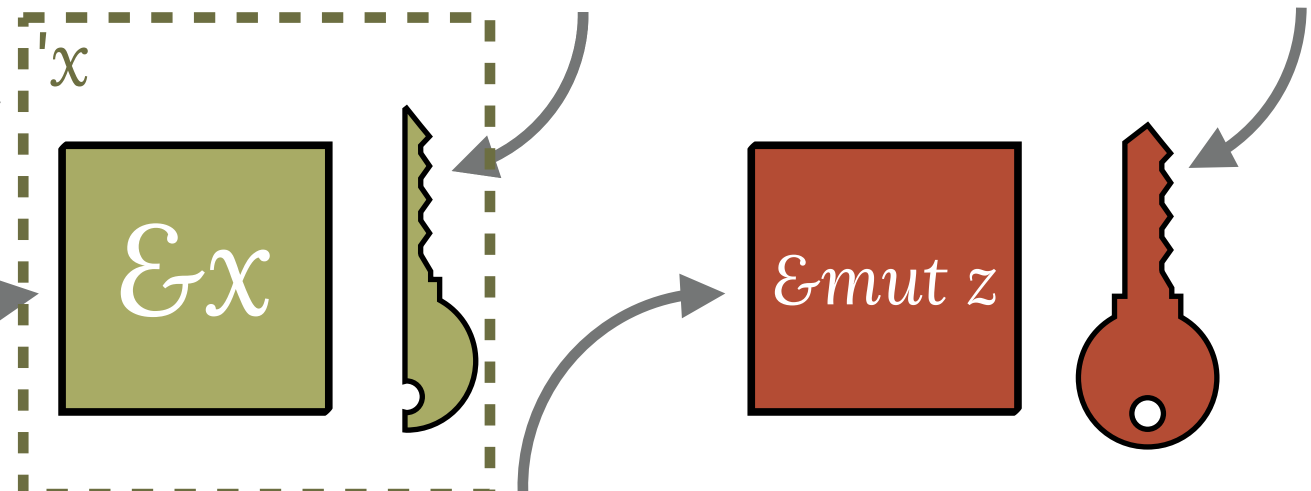
TAKEAWAYS

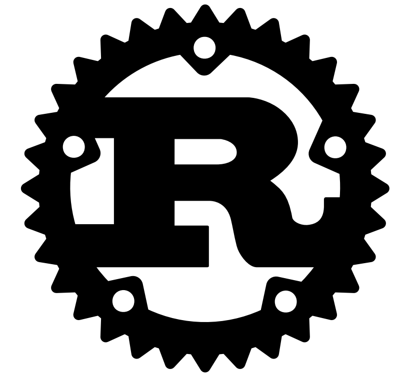


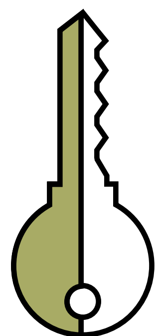
Oxide

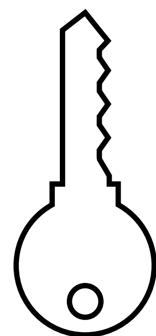
Regions are sets of loans

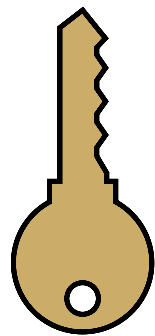
Ownership with fractional capabilities

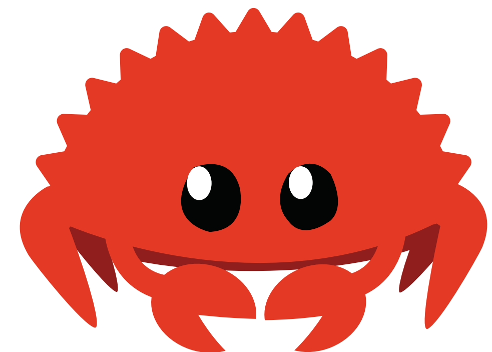












Moves never return their capability