Leveraging Rust's Lifetimes for Improved Performance and Correctness

Talk for the Aptitude Colloquium of

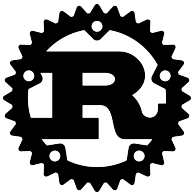
Johannes Hostert

17 September 2024

Rust: A Safe Systems Programming Language

Rust

A language empowering everyone
to build reliable and efficient software.



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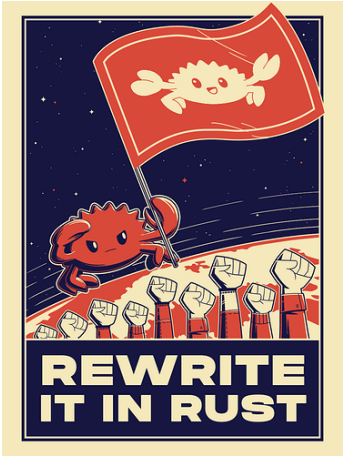

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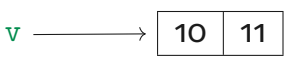

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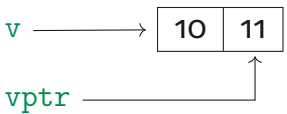

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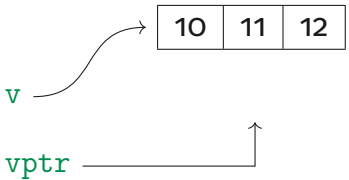

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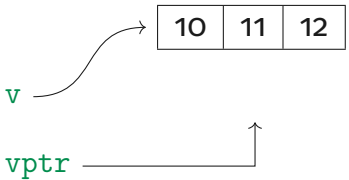

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Leveraging Rust’s Lifetimes

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for

and

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Tree Borrows

Spec Testing

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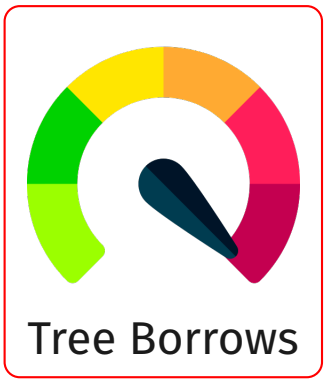

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Unsafe Code Can Create Aliasing References

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fn foo(a: &mut i32) { .. }

static mut GLOBAL: i32 = 0;
fn bar() {
    unsafe { println!("{}", &GLOBAL); }
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fn main() {
    let a = unsafe { &mut GLOBAL };
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Aliasing model is purely *ghost*, not present in compiled binary.

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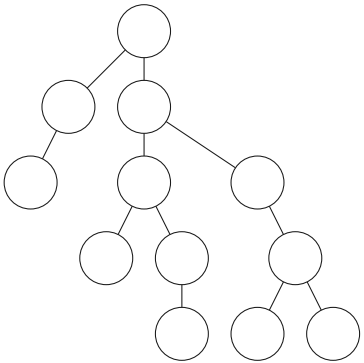

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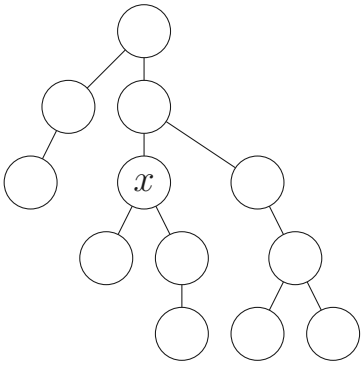

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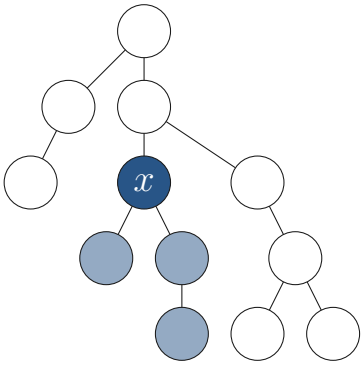

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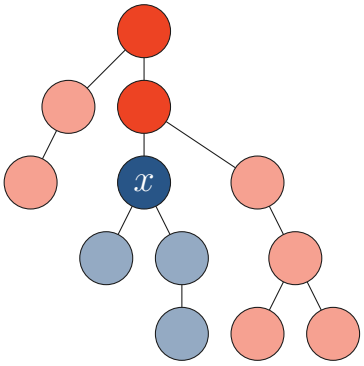

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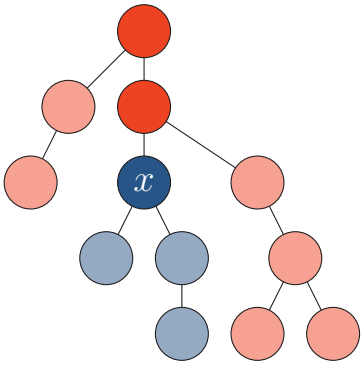

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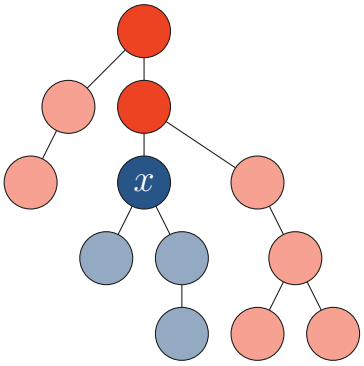

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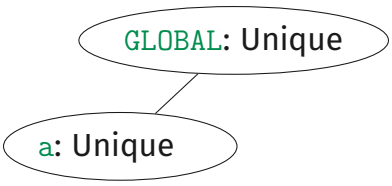

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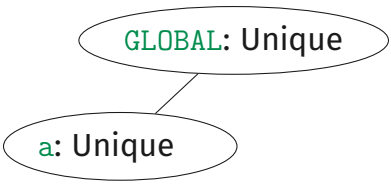

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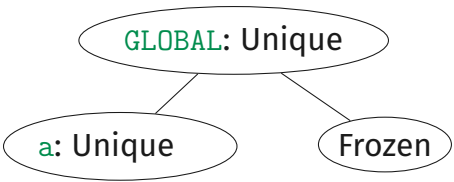

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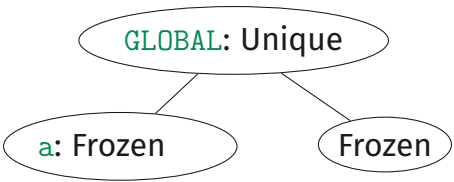

Unique + $\downarrow R \rightarrow$ Frozen

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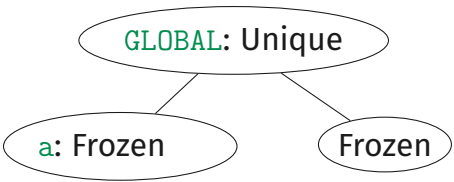

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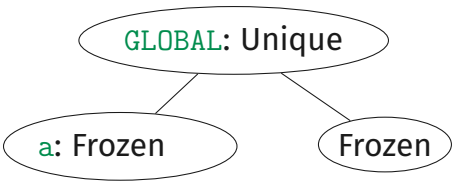

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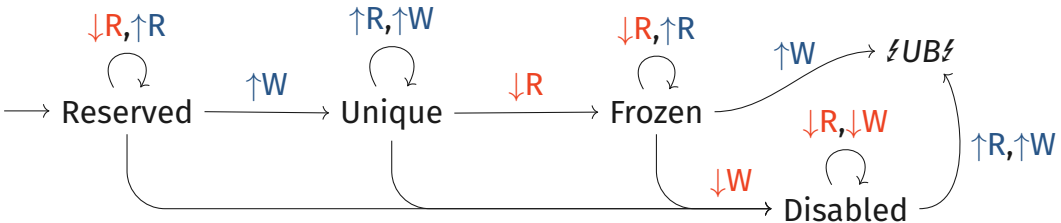

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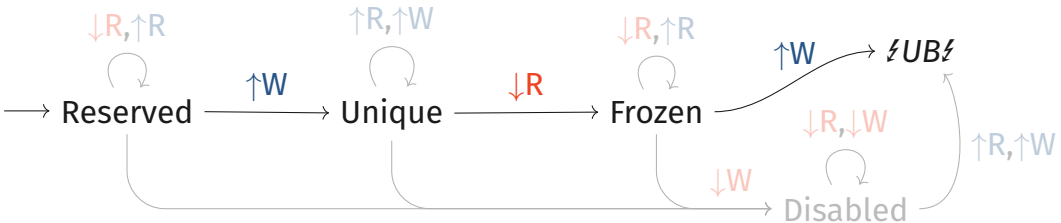
- Local (↑) vs. Foreign (↓) access
- Read (R) vs. Write (W) access



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Our predecessor, *Stacked Borrows*, lacks support for (3)-(6).

Tree Borrows: A Collaboration

Neven

Ralf

Johannes

Derek

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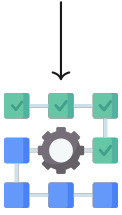

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Leveraging Rust's Lifetimes

for

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Verus

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RefinedRust

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Verus

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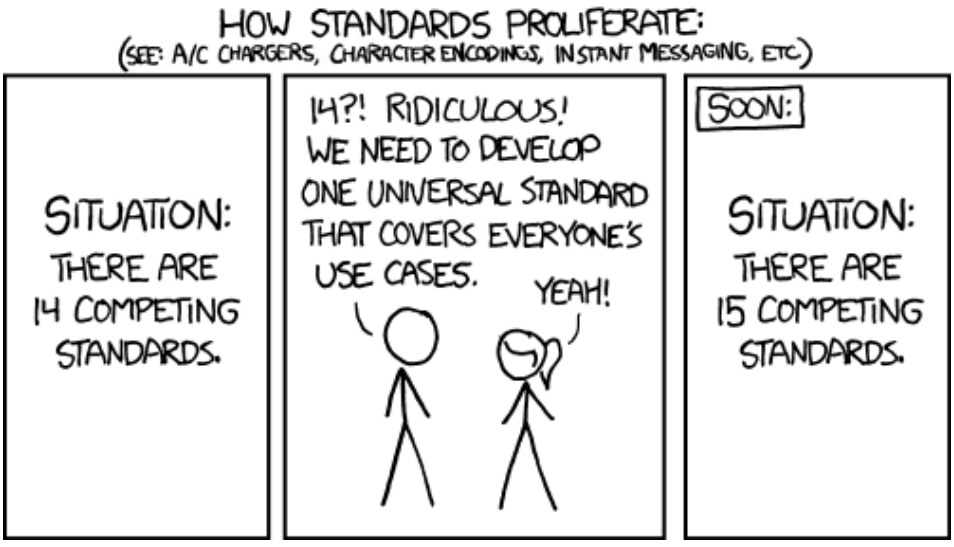

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$$\left\{ \begin{array}{ll} & *result = (*x)[i] \\ \wedge & ◎result = (◎x)[i] \\ \wedge & \forall n \neq i : (*x)[n] = (◎x)[n] \end{array} \right\}$$

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Goal for WP3: Design a testing-based spec checker...

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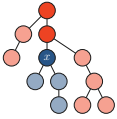
Goal for WP3: Design a testing-based spec checker...
...for an ownership-based, prophetic specification language!

The End

Thanks for your attention!

Putting The Borrows Into Trees

Aliasing model tracks references in a tree data structure:



Nodes precisely represent references.

Each node x splits tree in two:

- Local: references x "knows about"
- Foreign: reference x does not know about

Access to	foreign reference:	foreign access
	local	local

Tree Borrows: A Collaboration

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