(Maybe) Owning Things, Declaratively

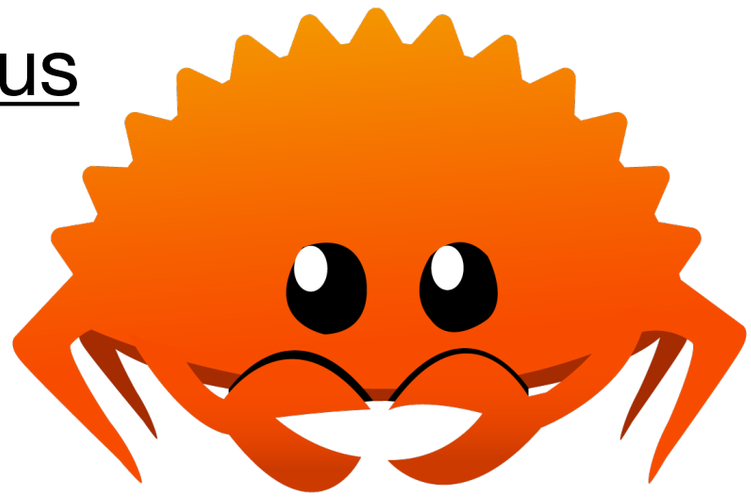
Modelling Rust's Ownership in Datalog

Who?

- I am Albin, and this is my Master's project
- Working with Niko Matsakis (et. al.) of Mozilla Research
- Tobias is subject reviewing

What?

- **Polonius**: a declarative reformulation of the Rust borrow check
- Separate package (“crate”) consumed by Rust
- Developed on GitHub: rust-lang/polonius
- Current status: *very* work-in-progress!



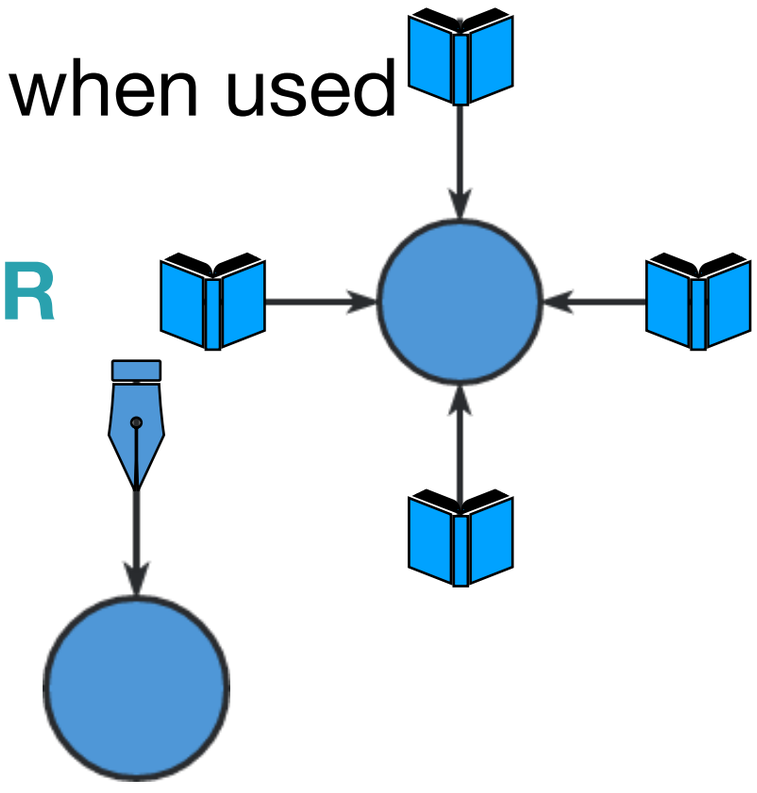
What??

- The borrow check: static analysis of references
- Used to ensure safe shared memory use
- May-point-to (“provenance”) part of a reference’s type
  - How do we interpret such a type? Stay tuned!

What???

House rules

- A value must be (initialised | not moved) when used
- *N* (live) read-references to same value **OR**
- ≤ 1 (live) write-reference to same value
- A reference must never outlive its value



What????

```
let mut x = 22;
let y = 44;
let mut p = &x; // L0: x is borrowed
```

```
p = &y; // L1: y is borrowed, overwrites p


x += 1; // OK, because p was overwritten
println!(*p); // 44
```

Why?

- Easier development and experimentation
- Common logic *implemented once*
- Similar logic *looks similar*
- Promising Performance in the Literature™
- More advanced analysis

How?

```
let mut x = 22;
let y = 44;
let mut p: &'a i32 = &'b x; // L0

p = &'c y; // L1

x += 1;

println!(*p);
```

'b ⊆ 'a
{L0} ⊆ 'b

'c ⊆ 'a
{L1} ⊆ 'c
'a: 0, I am slain! ☠️

Prov

invalidates(L0)

How??

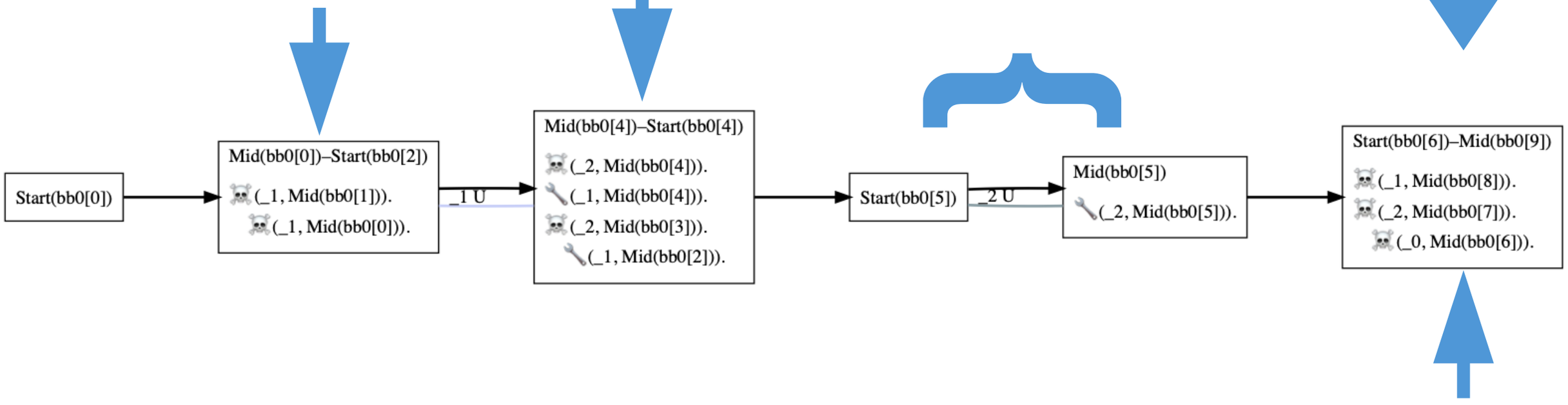
```
provvar_live_at(R, P) :-
    var_drop_live(V, P),
    var_drops_provvar(V, R).

provvar_live_at(R, P) :-
    var_live(V, P),
    var_uses_provvar(V, R).

var_live(V, P) :-
    var_live(V, Q),
    cfg_edge(P, Q),
    !var_defined(V, P).
```

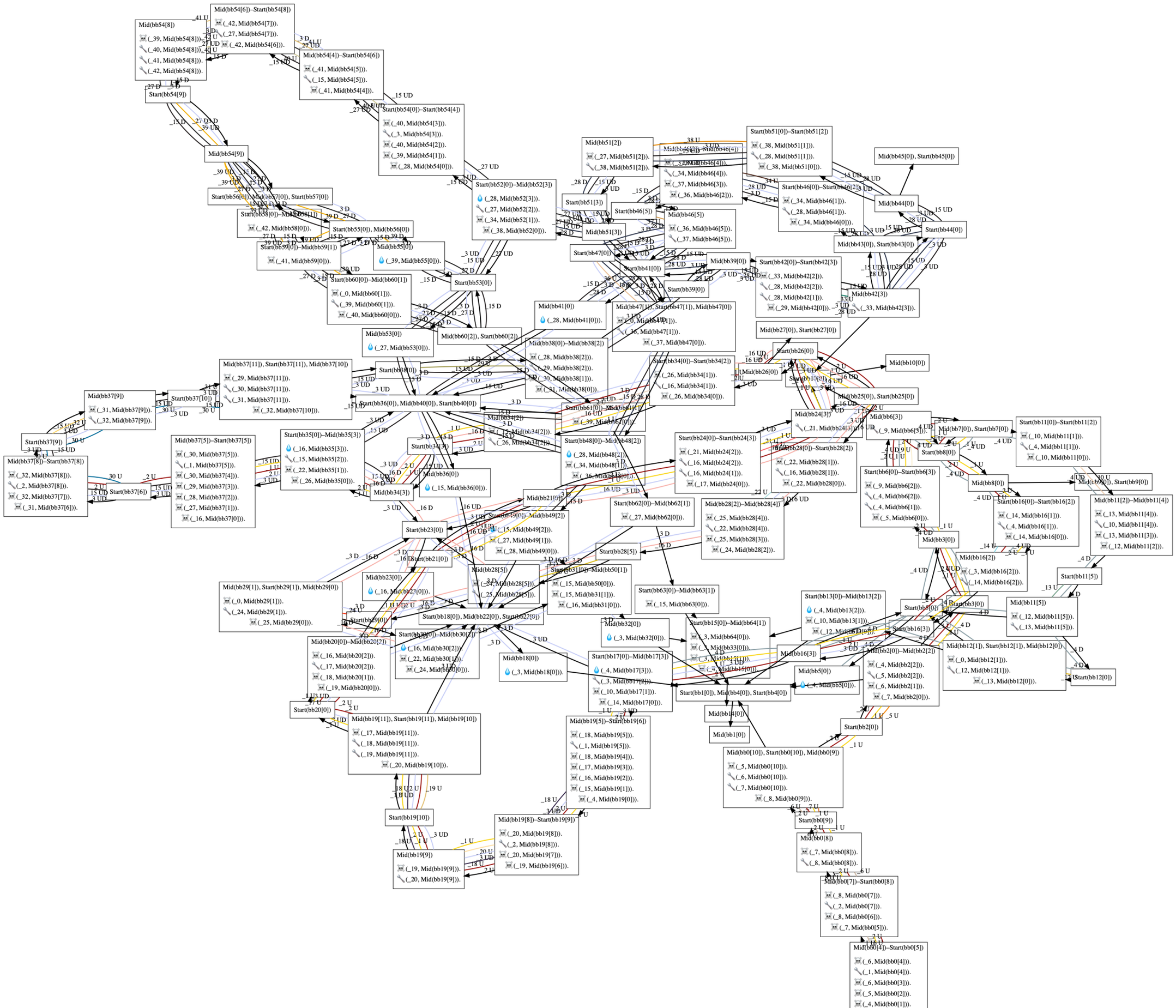
```
provvar_live_at.from_join(
  &var_drop_live,
  &var_drops_provvar, |_v, &p, &r| {
  ((r, p), ())
});

provvar_live_at.from_join(
  &var_live_var,
  &var_uses_provvar, |_v, &p, &r| {
  ((r, p), ())
});

var_live_var.from_leapjoin(
  &var_live_var,
  (
  defined_rel.extend_anti(
      |&(v, _q)| v),
  edge_reverse_cfg.extend_with(
      |&(_v, q)| q),
  ),
  |&(v, _q), &p| (v, p),
);
```

How???

```
fn foo() {
    let x = 22;
    let p = &x;
}
```

```
bb0: {
    StorageLive(_1);
    _1 = const 22i32;
    FakeRead(ForLet, _1);
    StorageLive(_2);
    _2 = &_1;
    FakeRead(ForLet, _2);
    _0 = ();
    StorageDead(_2);
    StorageDead(_1);
    return;
}
```

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What dreams may come?

- (de-)initialisation tracking (also impacts liveness)
- re-formulation of the subset rules upon set equality
- illegal subset relations
- higher-ranked provenances (e.g. `f<'b>(&'b u32)`)
- validation
- pre-benchmarking

Summary

- Polonius: a reformulation of the Rust borrow check
- Provenance variables in types = sets of possible source loans
- Declaratively defined in “Datalog”
- Example of prov-var liveness