Towards Collection-Oriented Compilation in LLVM

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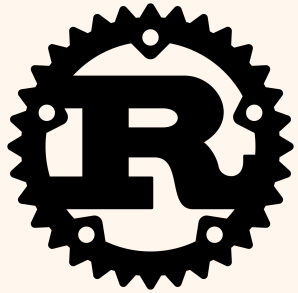
Northwestern University

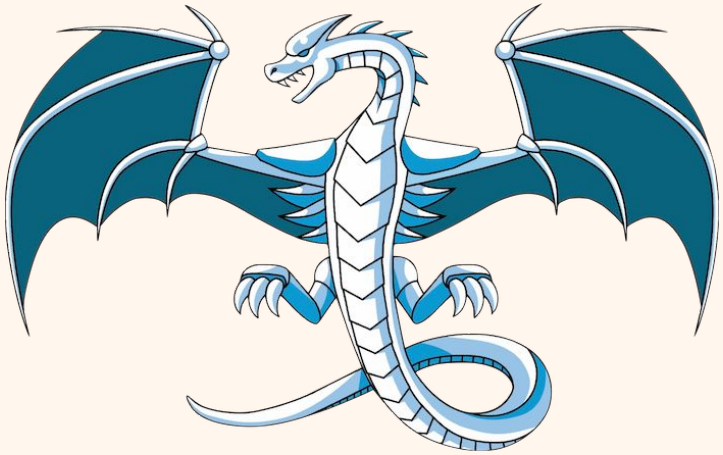
m&moir

Shared Representation across Languages



julia

Mojo 🔥



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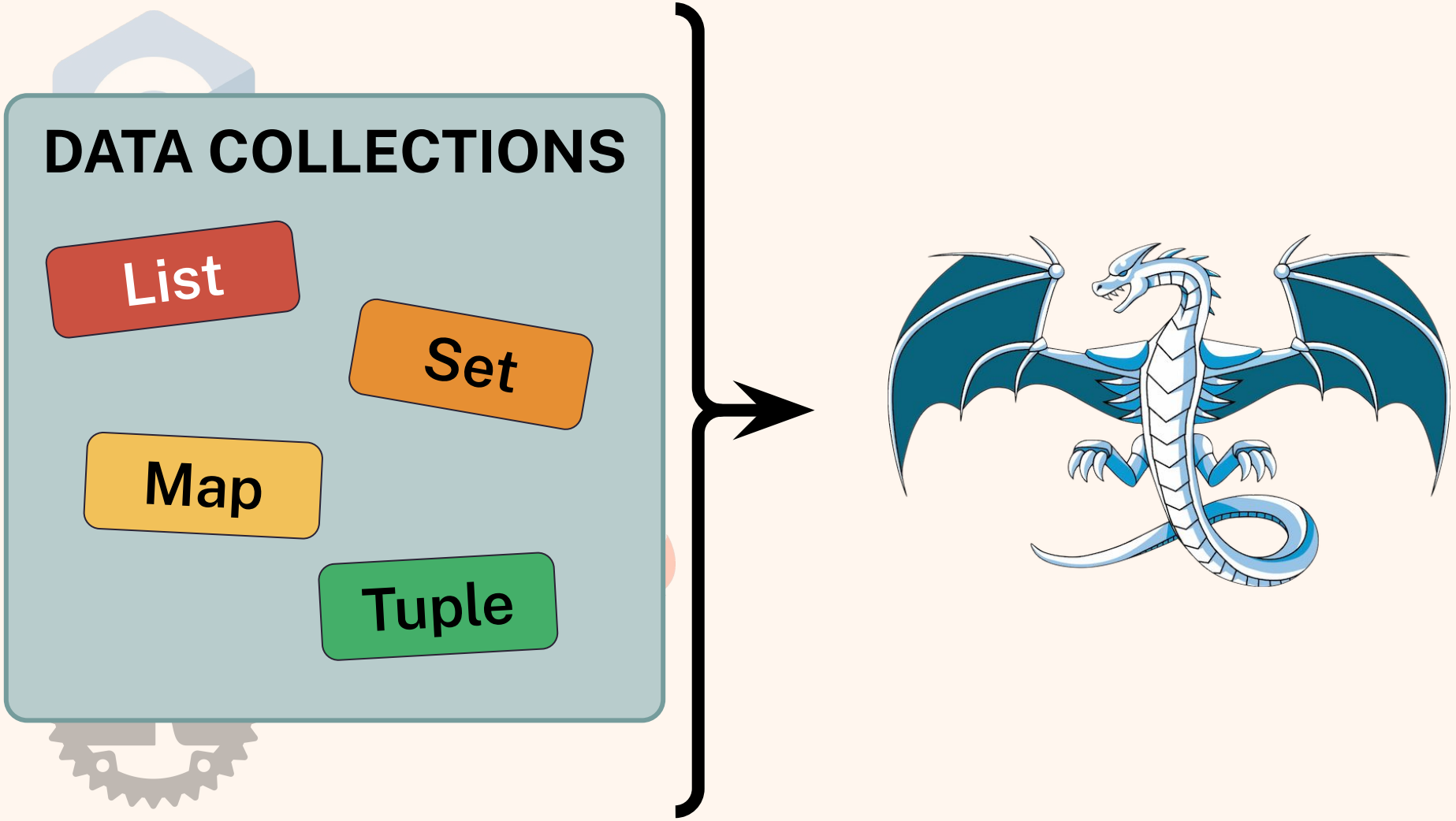
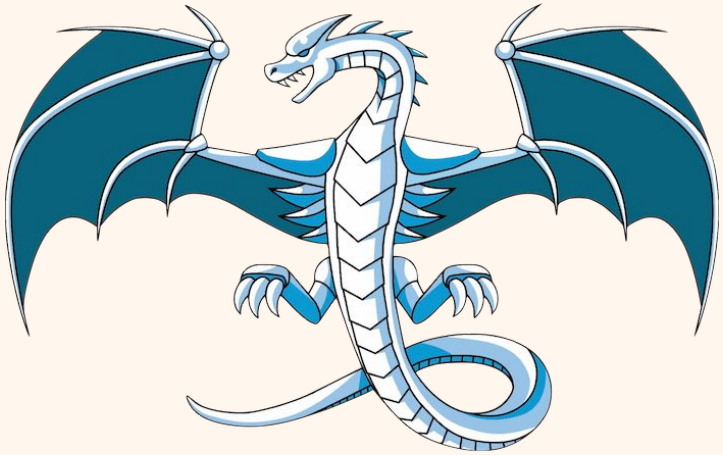


Shared Representation across Languages

DATA COLLECTIONS

- Data
- Organization
- Type



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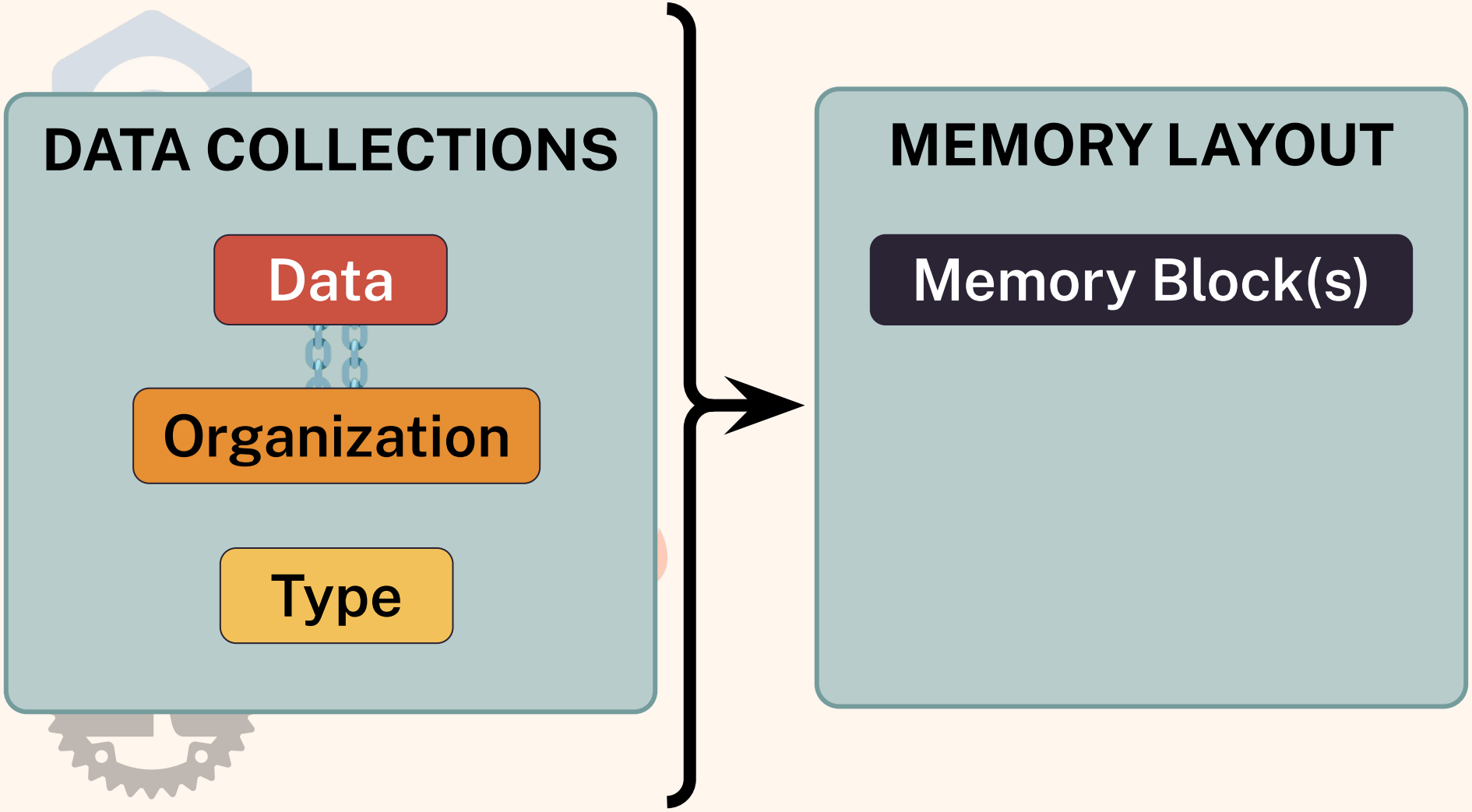

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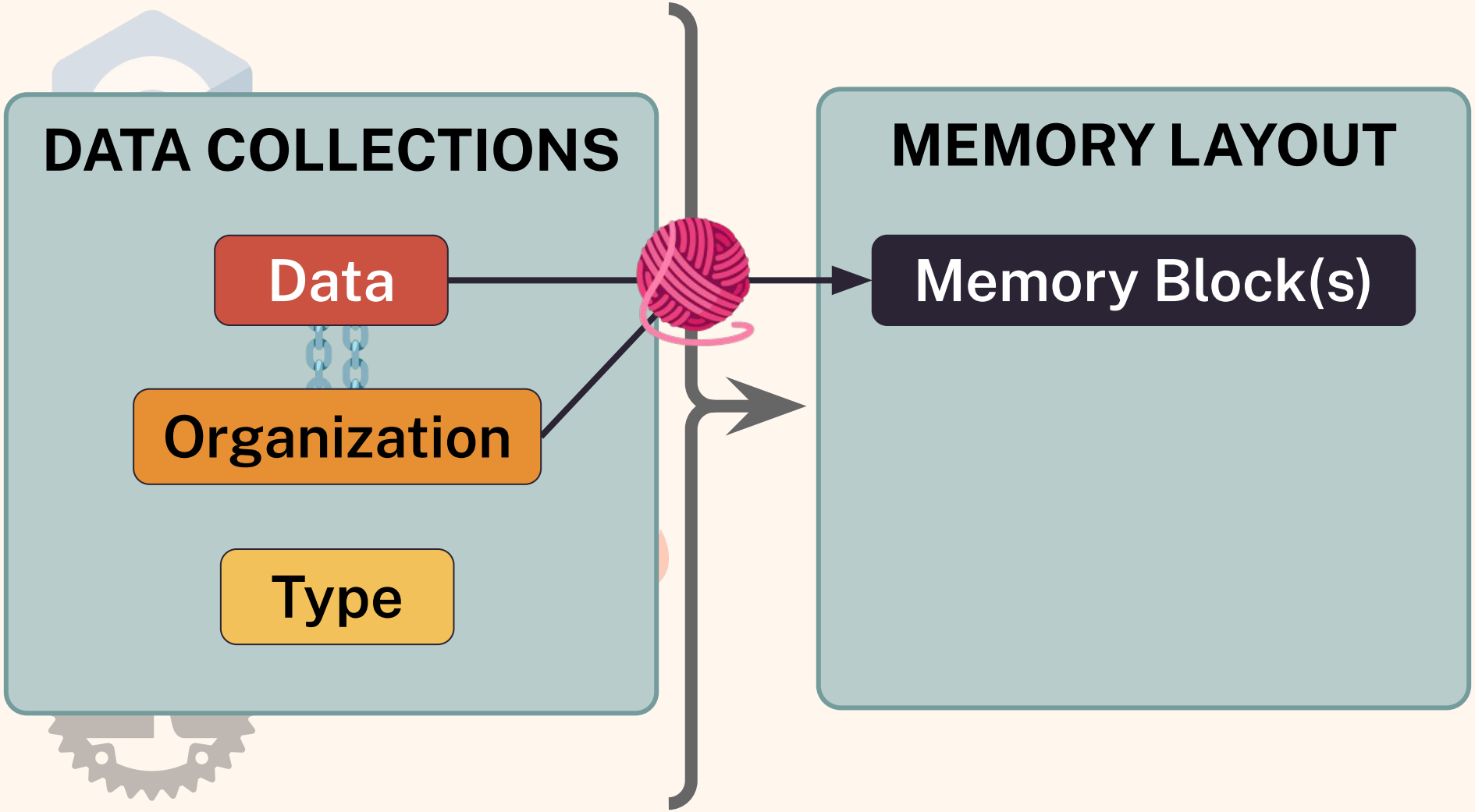

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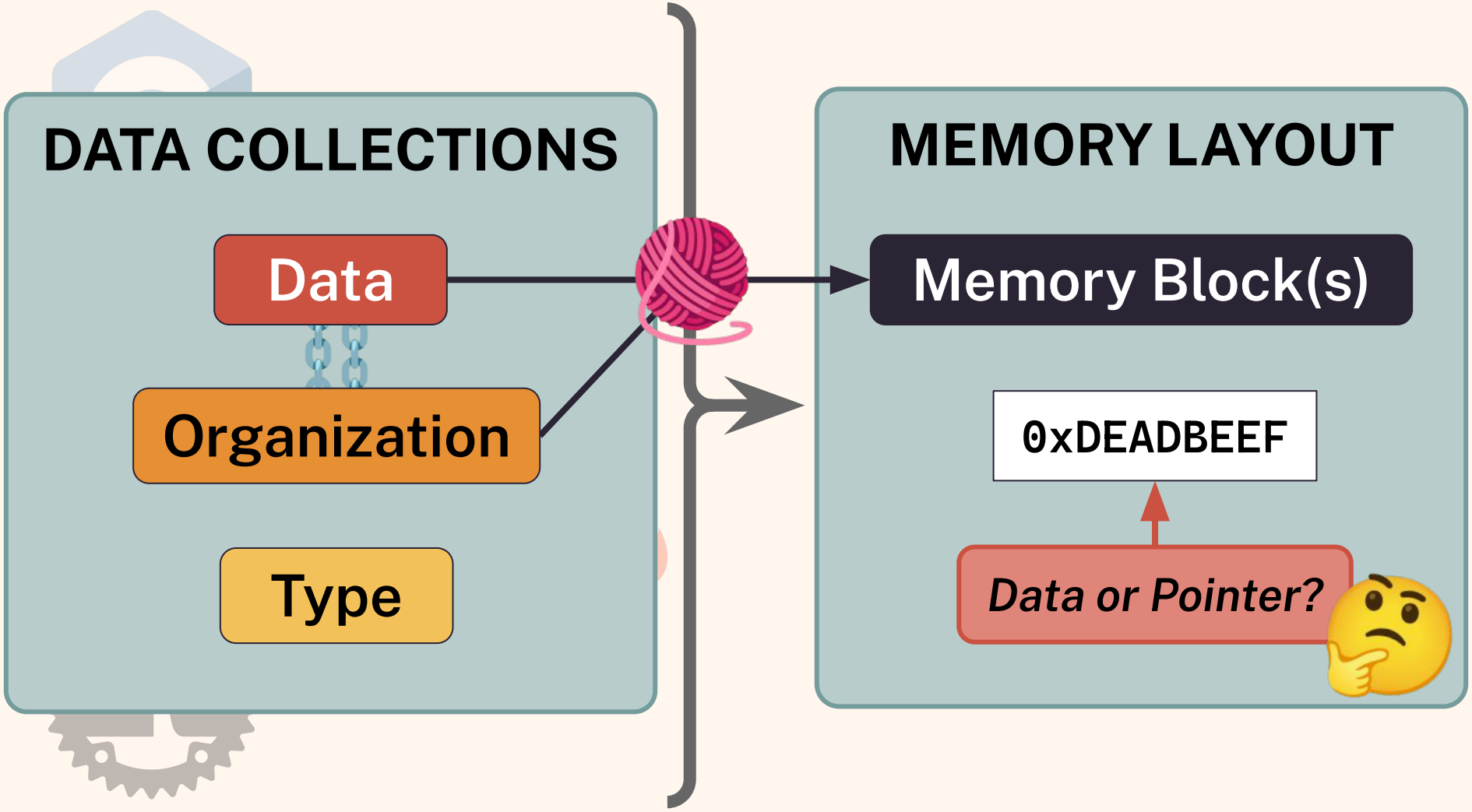

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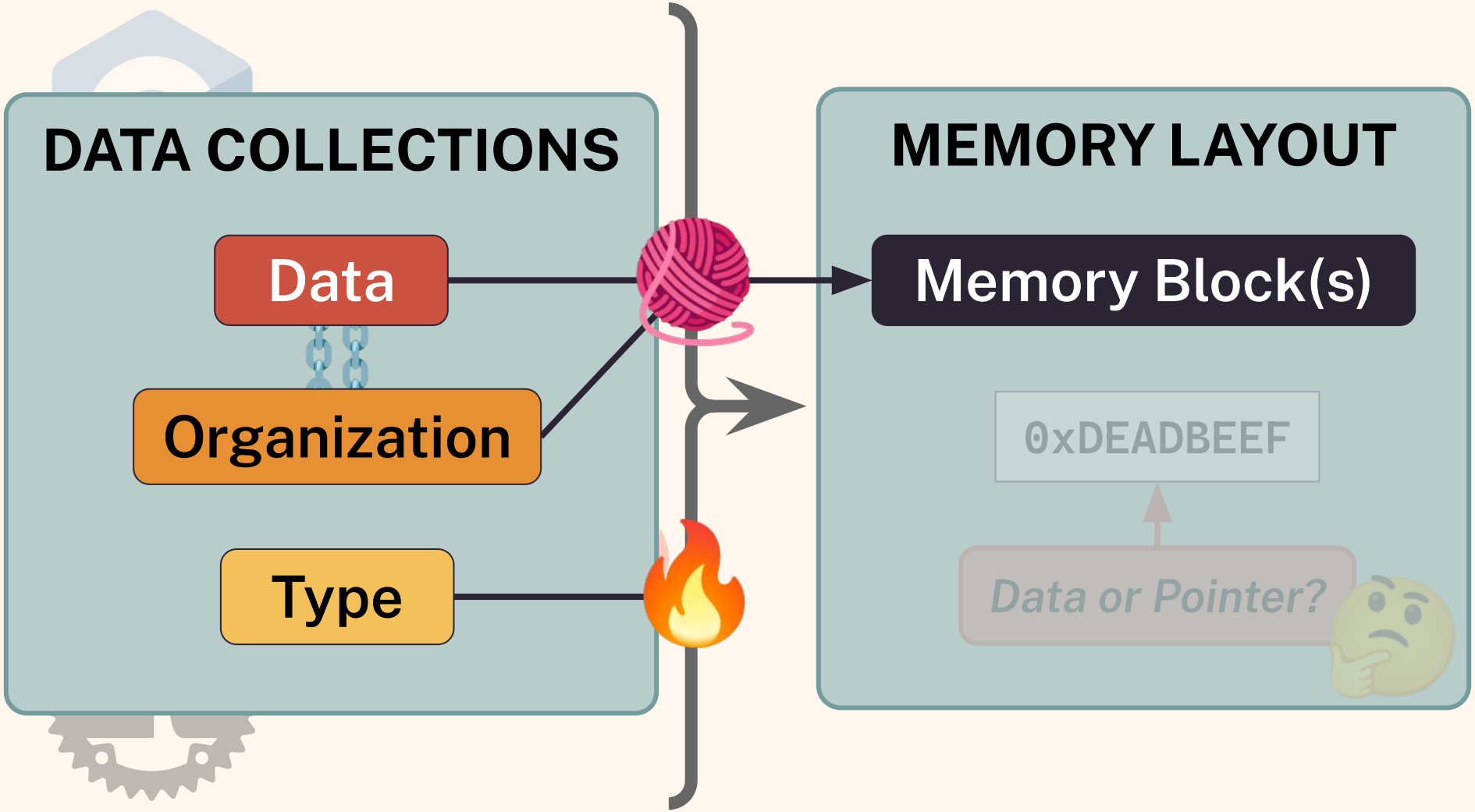

No Representation Makes Simple Things Hard!

```
std::unordered_map<int, int> &table;

table[1] = 10;
table[2] = 20;
print(table[1]);
```

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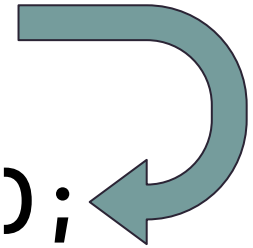

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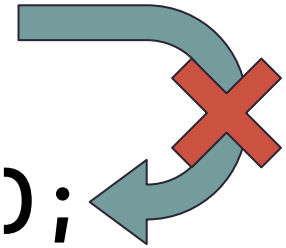

No production compiler can propagate 10!

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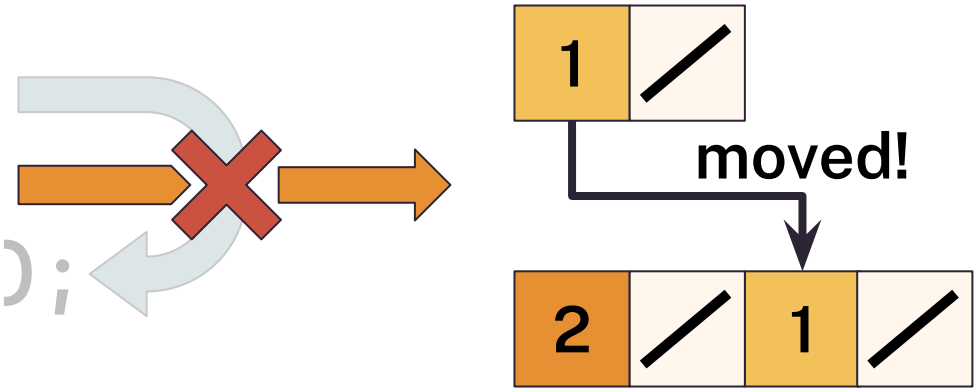

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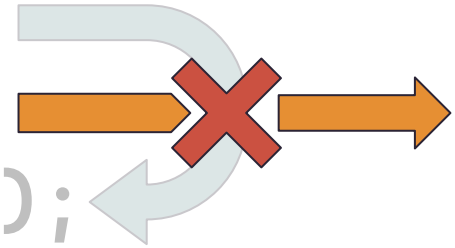
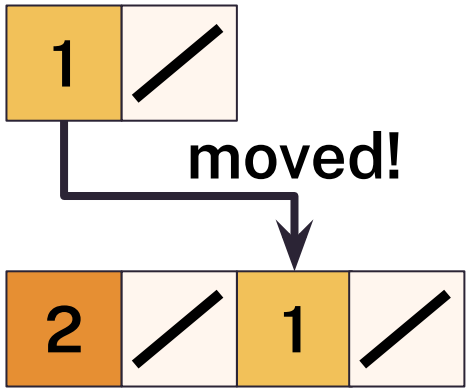




Rehashing may move a ***logical element*** to a new ***memory location***

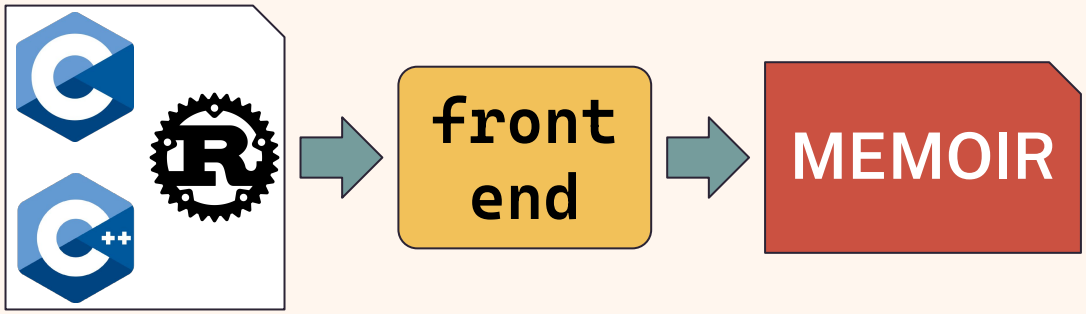
MEMOIR

LLVM IR Extension

with *Data Collections*

in *SSA Form*

MEMOIR Design



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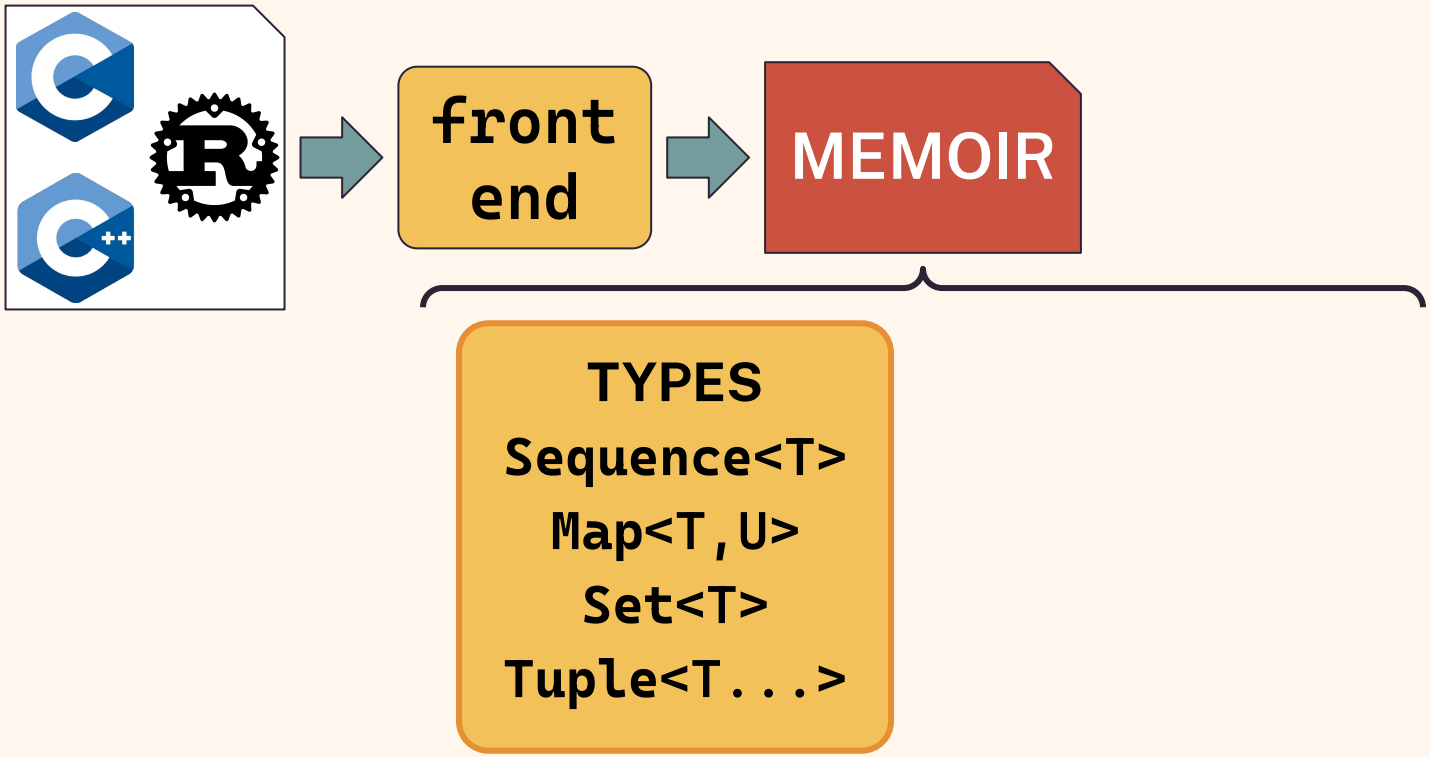

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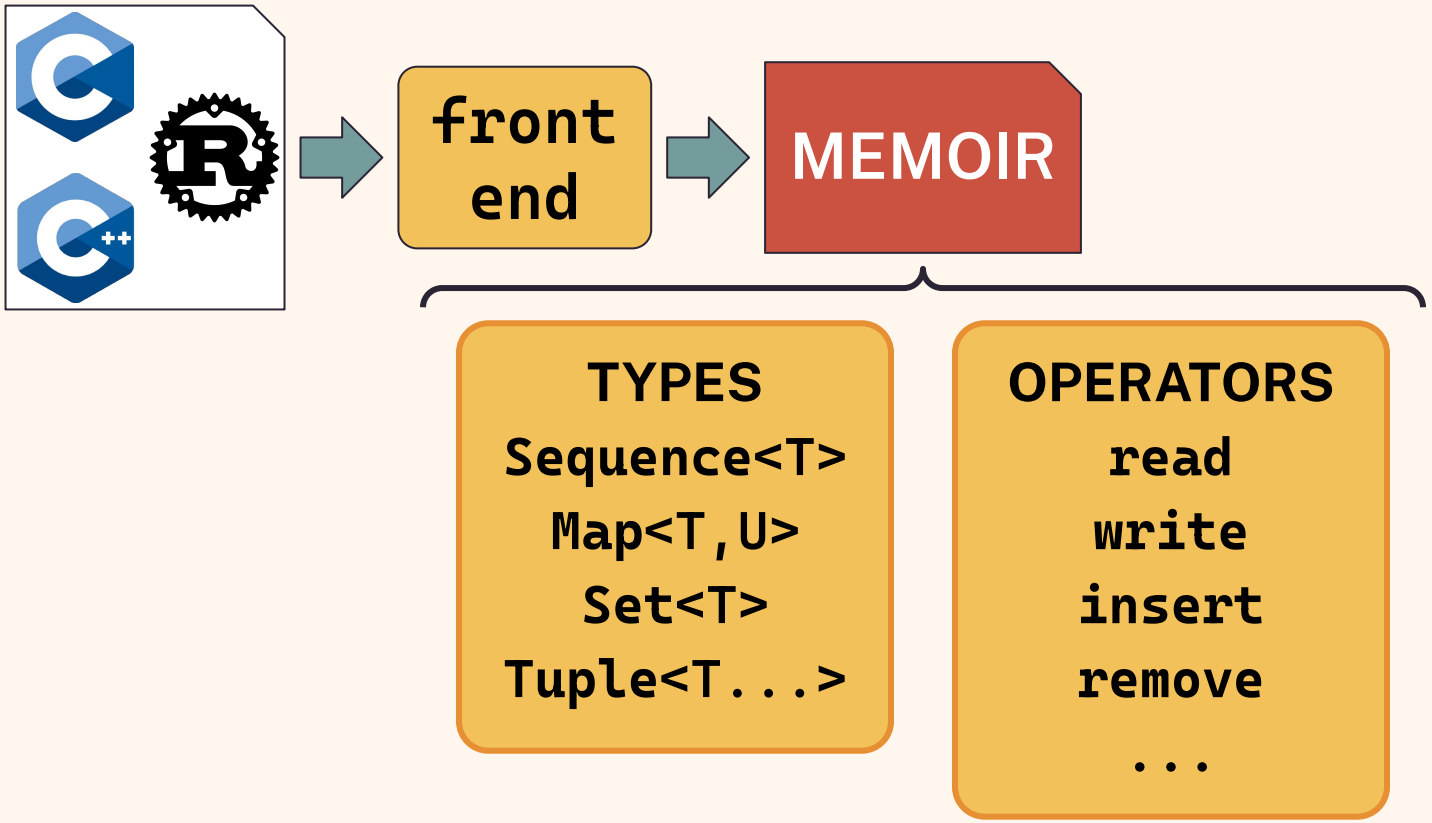

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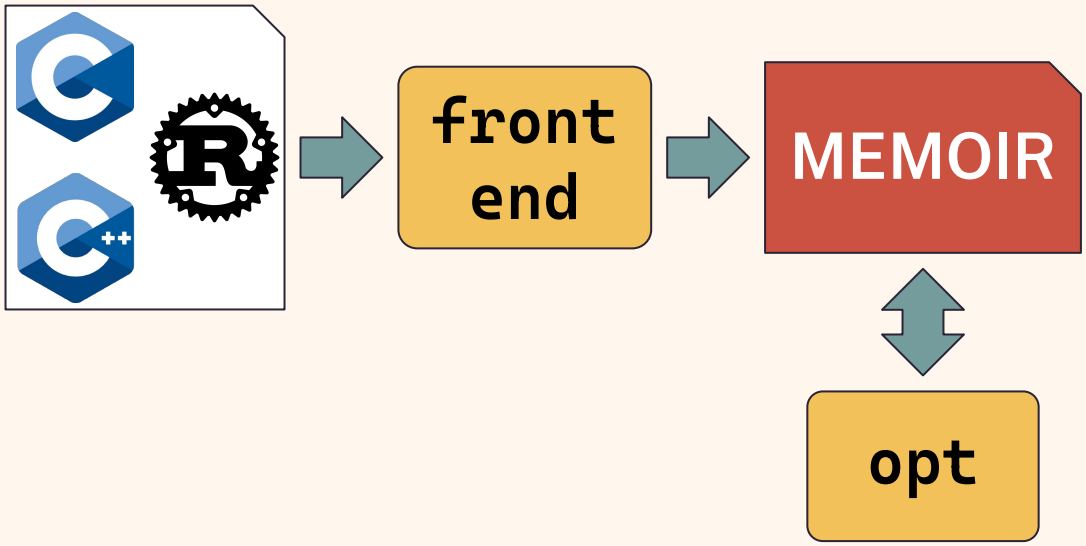


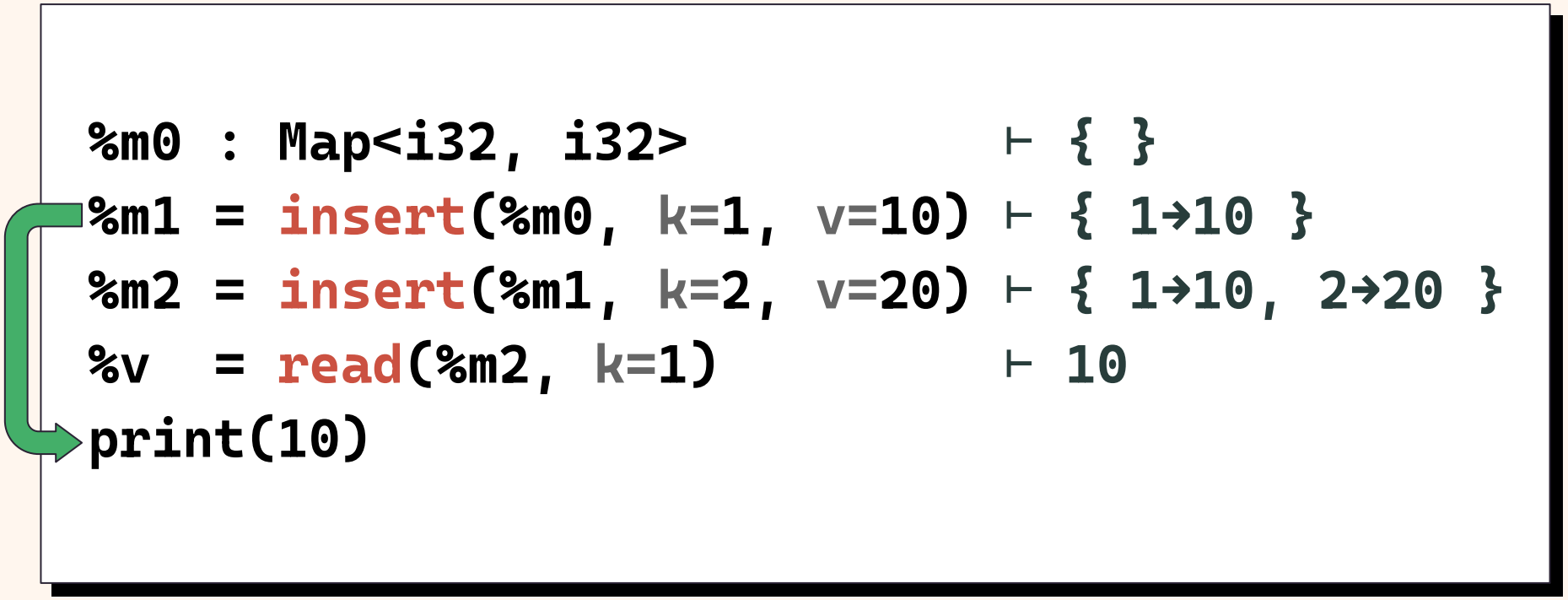
Improving Scalar Optimizations

```
%m0 : Map<i32, i32>
%m1 = insert(%m0, k=1, v=10)
%m2 = insert(%m1, k=2, v=20)
%v  = read(%m2, k=1)
print(%v)
```

Improving Scalar Optimizations

```
%m0 : Map<i32, i32>                ⊢ { }
%m1 = insert(%m0, k=1, v=10)       ⊢ { 1→10 }
%m2 = insert(%m1, k=2, v=20)       ⊢ { 1→10, 2→20 }
%v  = read(%m2, k=1)               ⊢ 10
print(%v)
```

Improving Scalar Optimizations



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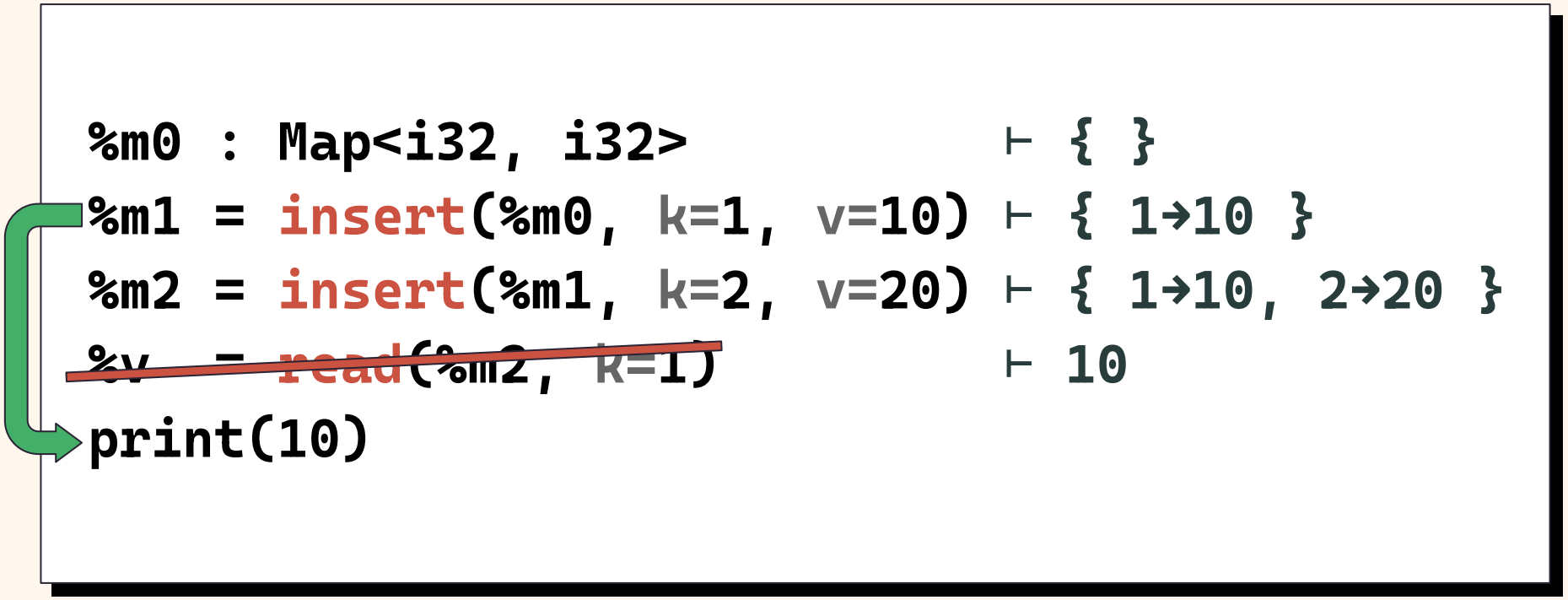


Data Transformations Made Simple

Data Transformations Made Simple

Eliminate Dead Fields

Data Transformations Made Simple

Eliminate Dead Fields

Migrate Cold Fields out of Hot Objects

Data Transformations Made Simple

Eliminate Dead Fields

Migrate Cold Fields out of Hot Objects

Specialize Memory Layout

MEMOIR Optimizations *Improve Performance!*

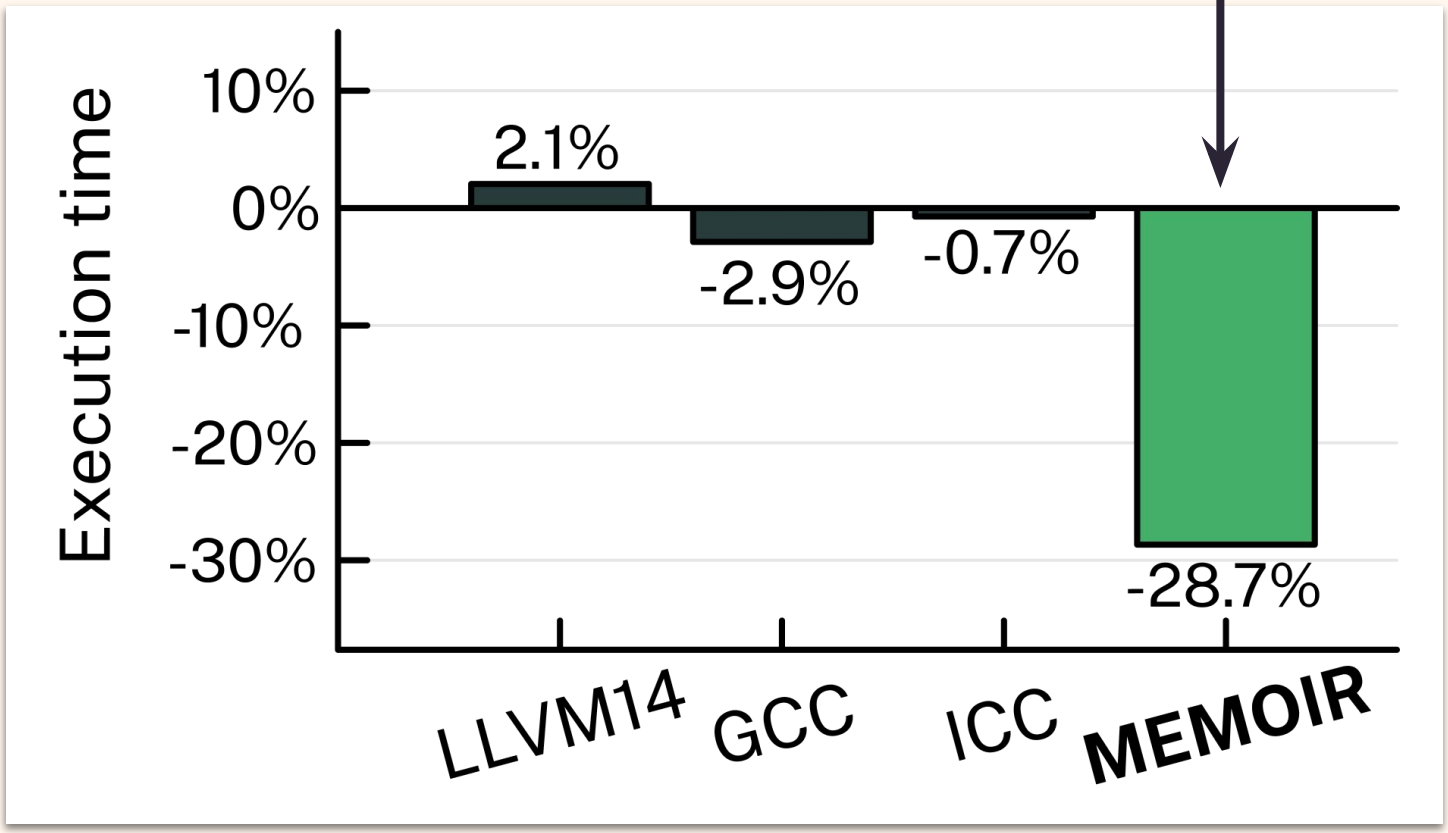


Figure: Execution time of mcf_s with refspeed input, 10 trials. Normalized to LLVM9.

MEMOIR Optimizations *Reduce Memory Usage!*

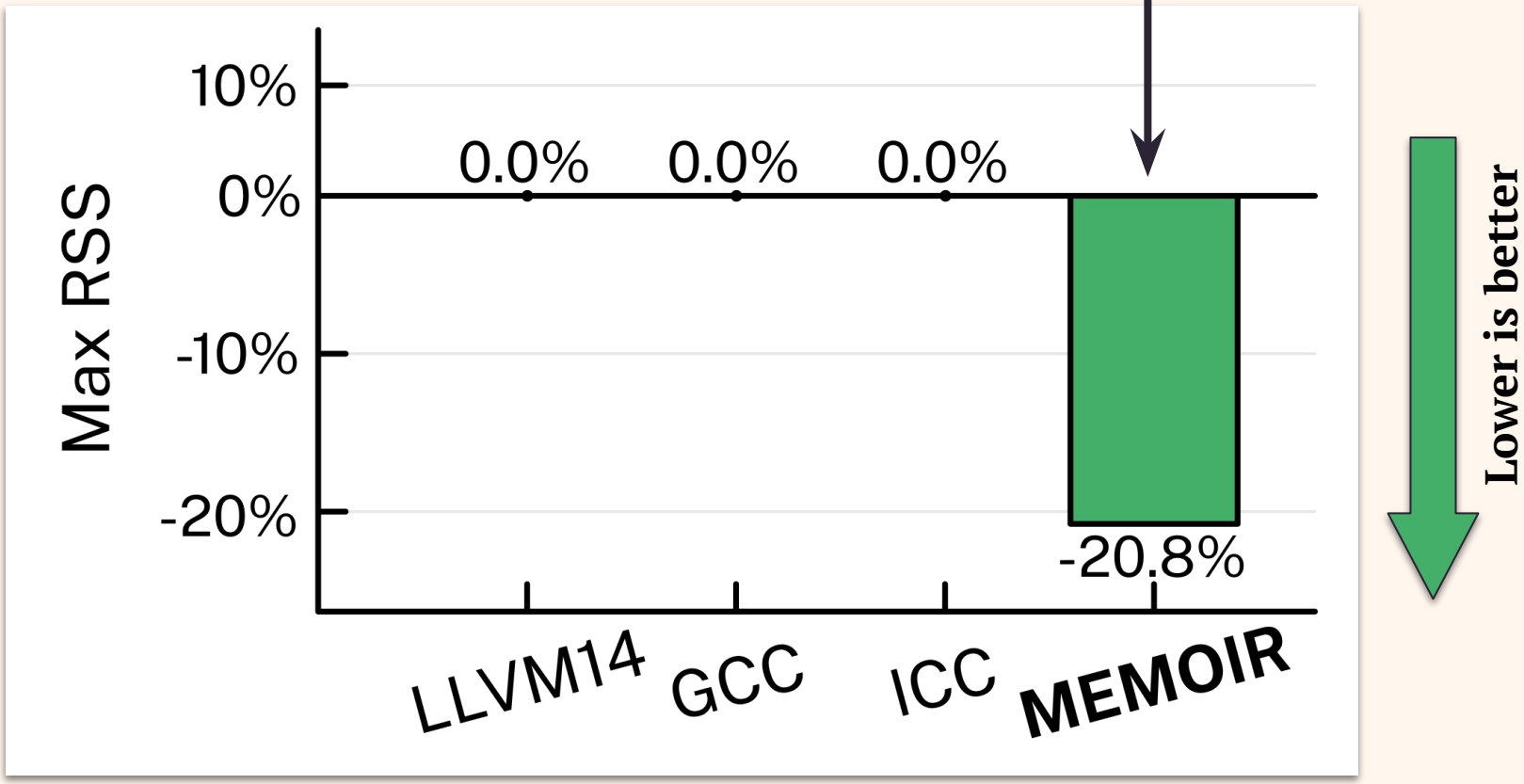
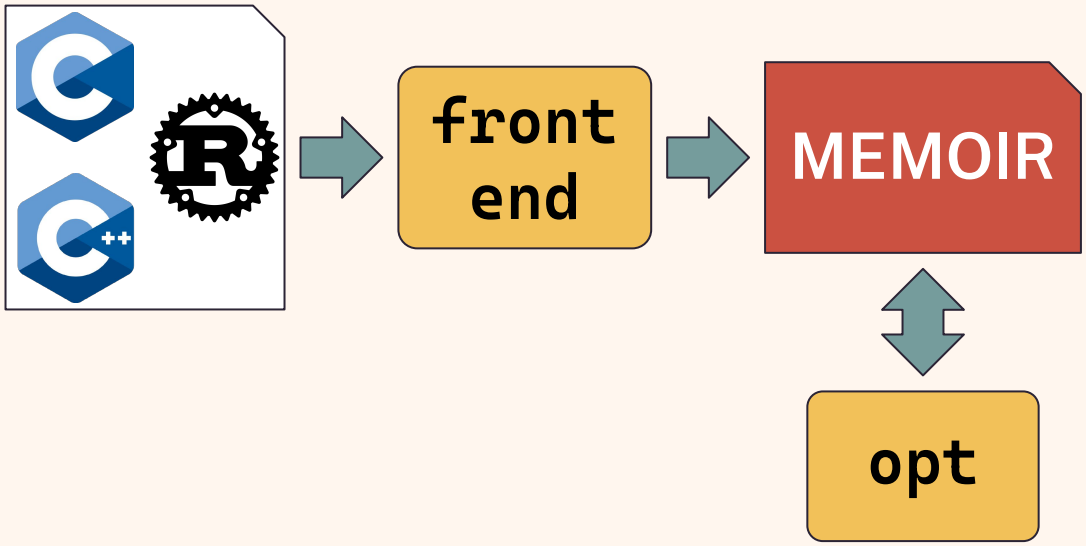


Figure: Max resident set size of mcf_s with refspeed input, 10 trials. Normalized to LLVM9.

MEMOIR Design



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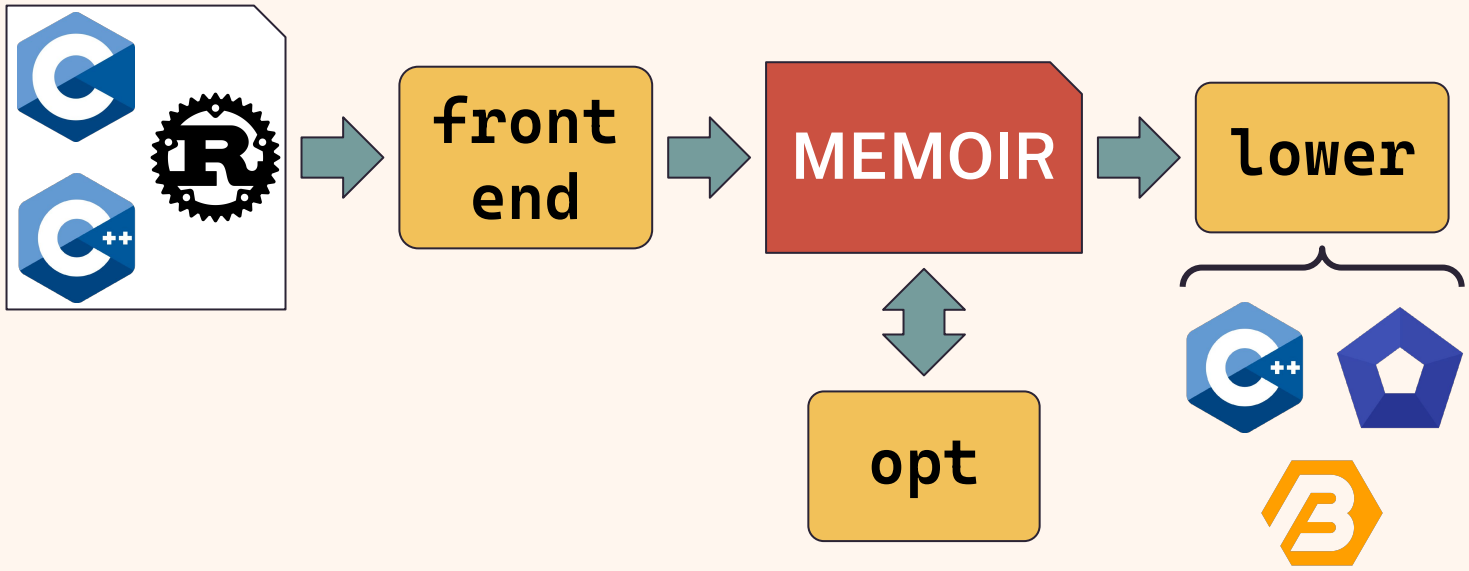

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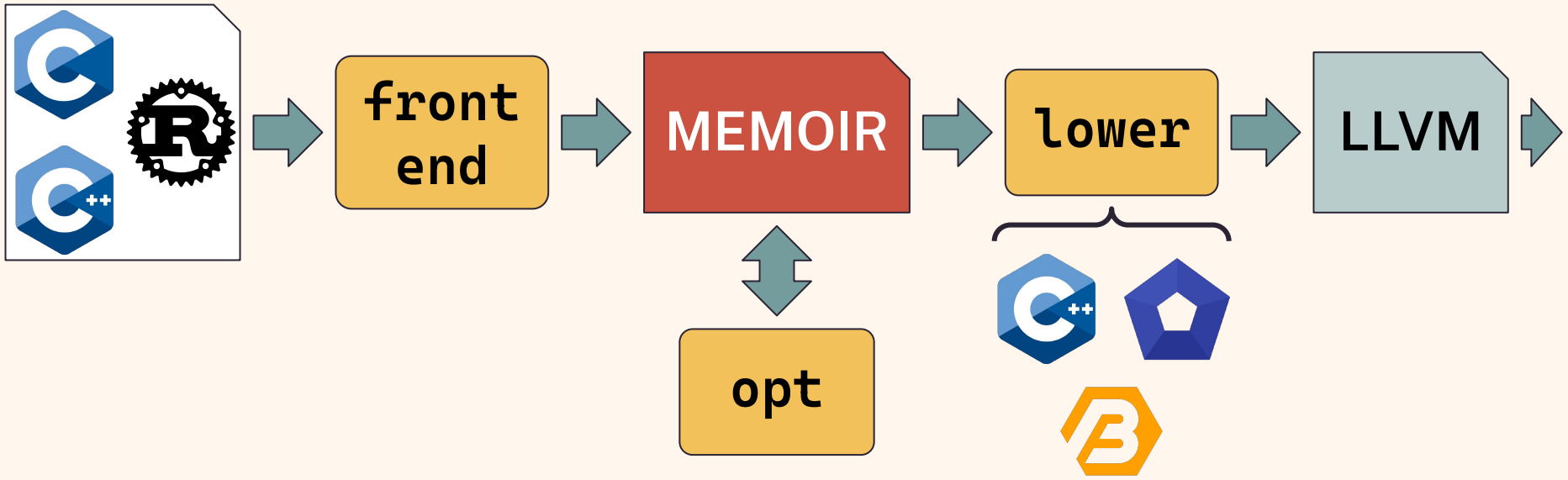
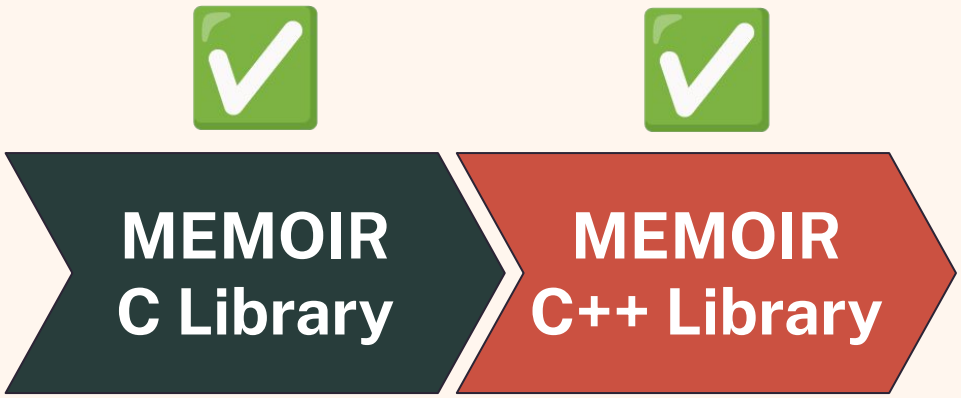


Next Steps

Towards Fully Transparent Raising



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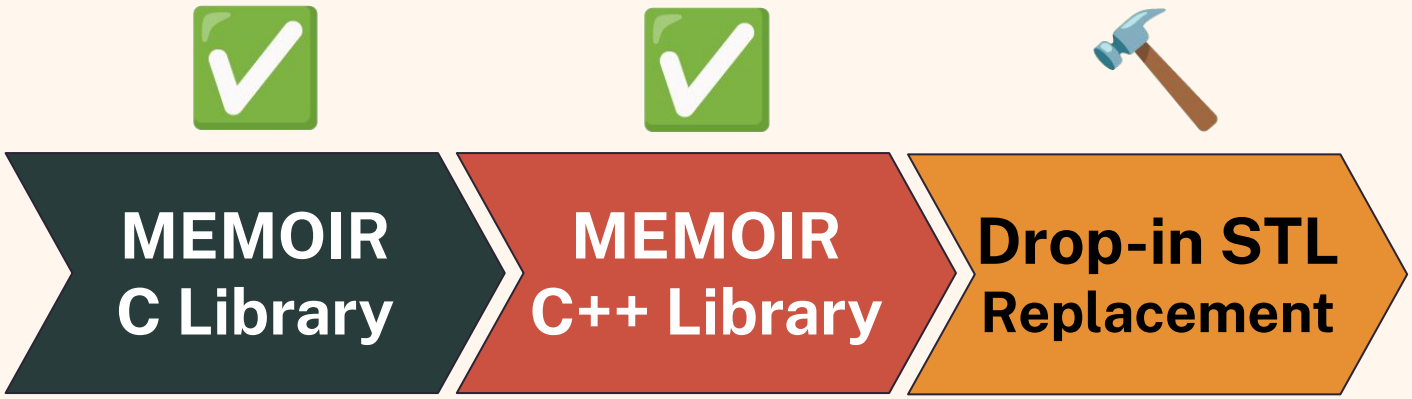

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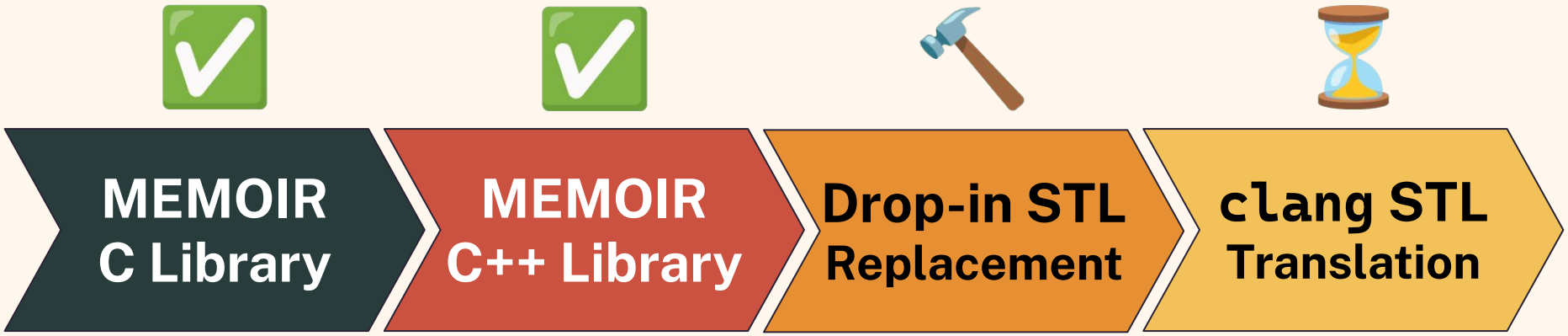

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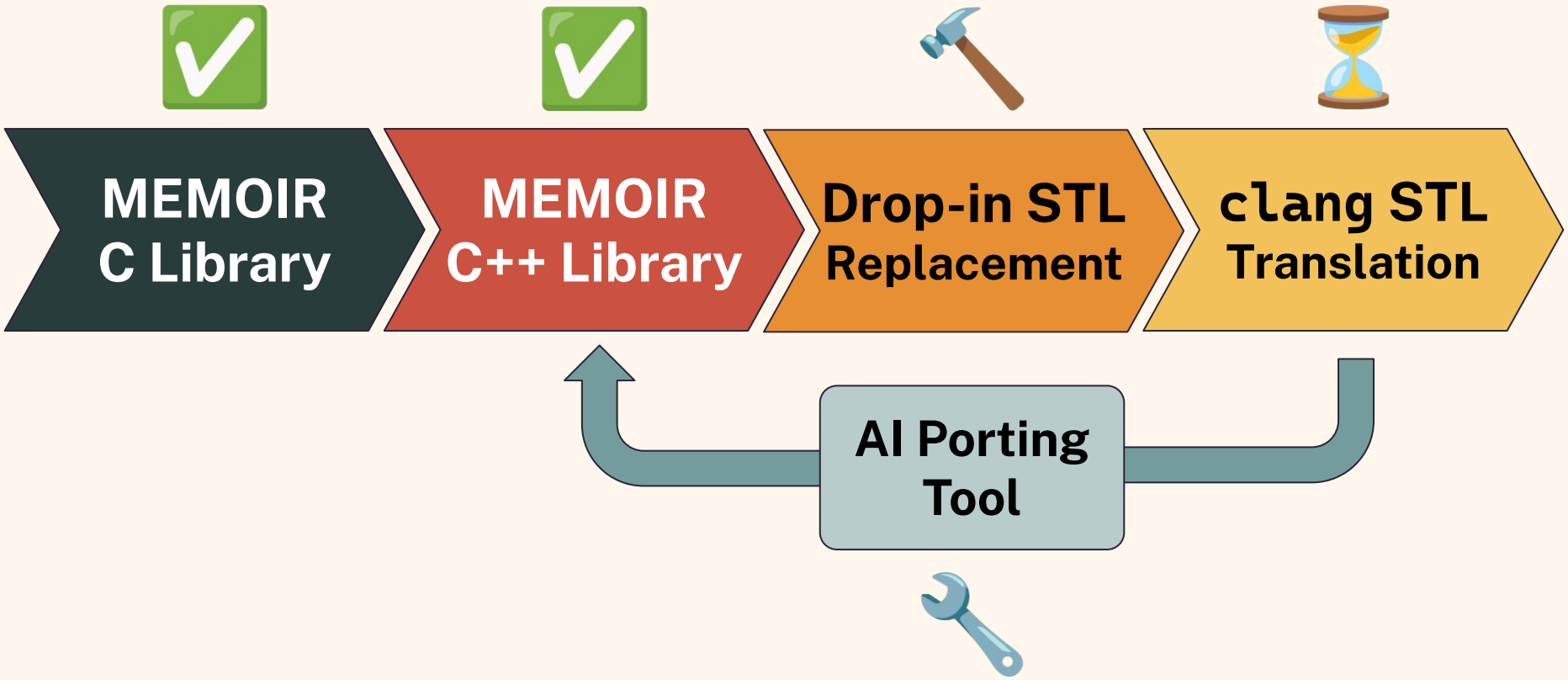

Learn more, get involved!

github.com/arcana-lab/memoir

CGO'24 Paper

MEMOIR Wiki

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CGO'24 Paper

MEMOIR Wiki

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Tomorrow, 3:15-4:15

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On the market

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ARCANA
Rethinks Compiler Abstractions for New Applications

memoir