facebook

~~Reflex~~ Skip

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Skip the things you've already computed!

Skip

A reactive programming language

Skip is a language with spreadsheet semantics. The runtime keeps track of external dependencies: when something changes, things “magically” update efficiently.

Skip

Why?

- Tools
- UI
- The skip compiler!
- Caches

Skip the Language

Language principles

- Favor immutability at function boundaries
- Reactivity is implicit
- Skip is embeddable!

Skip the Language

Language features

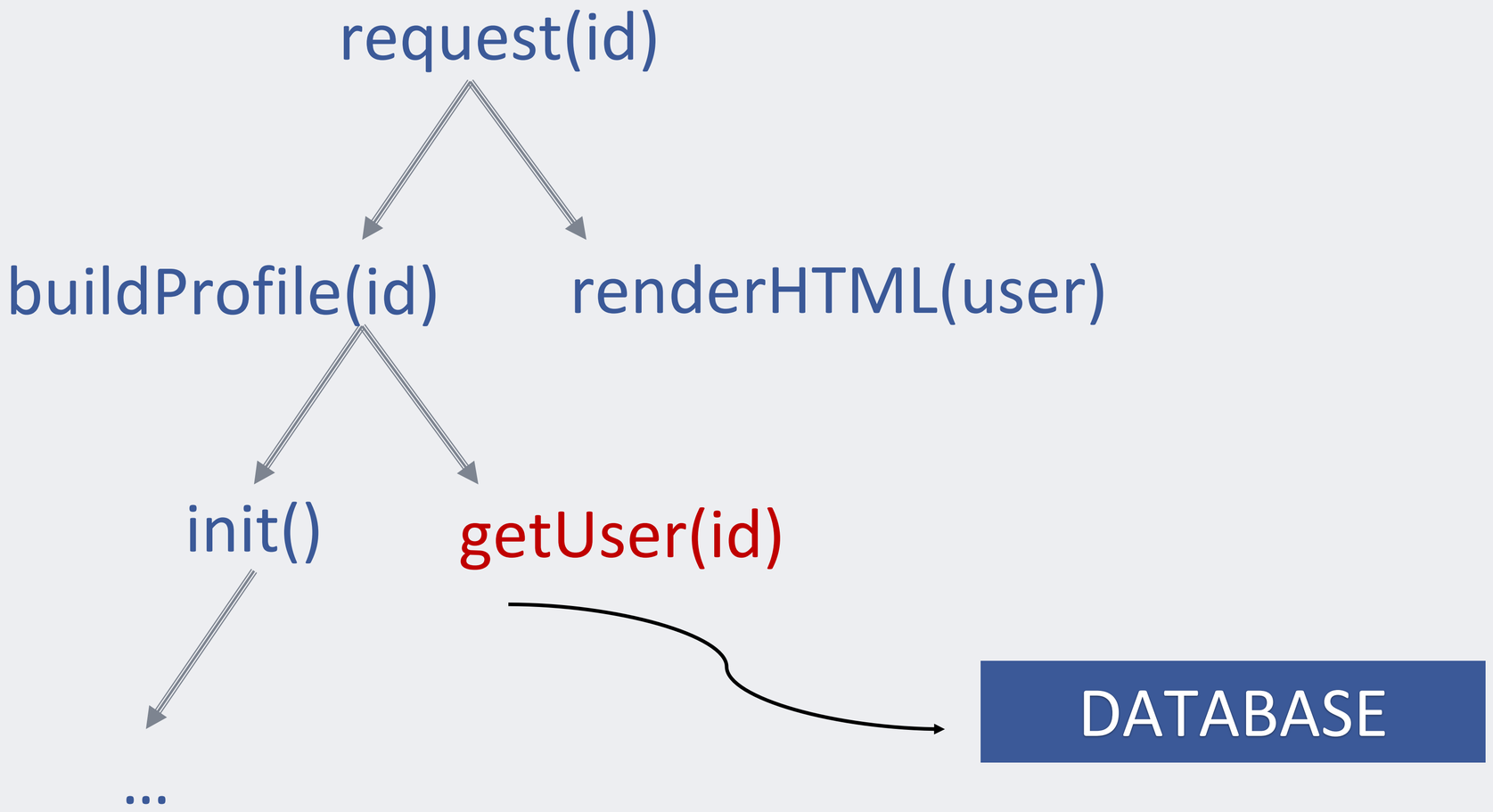
- Statically typed
- Generics
- Pattern-matching
- Closures
- Async/await
- Traits (type classes)
- …

Example

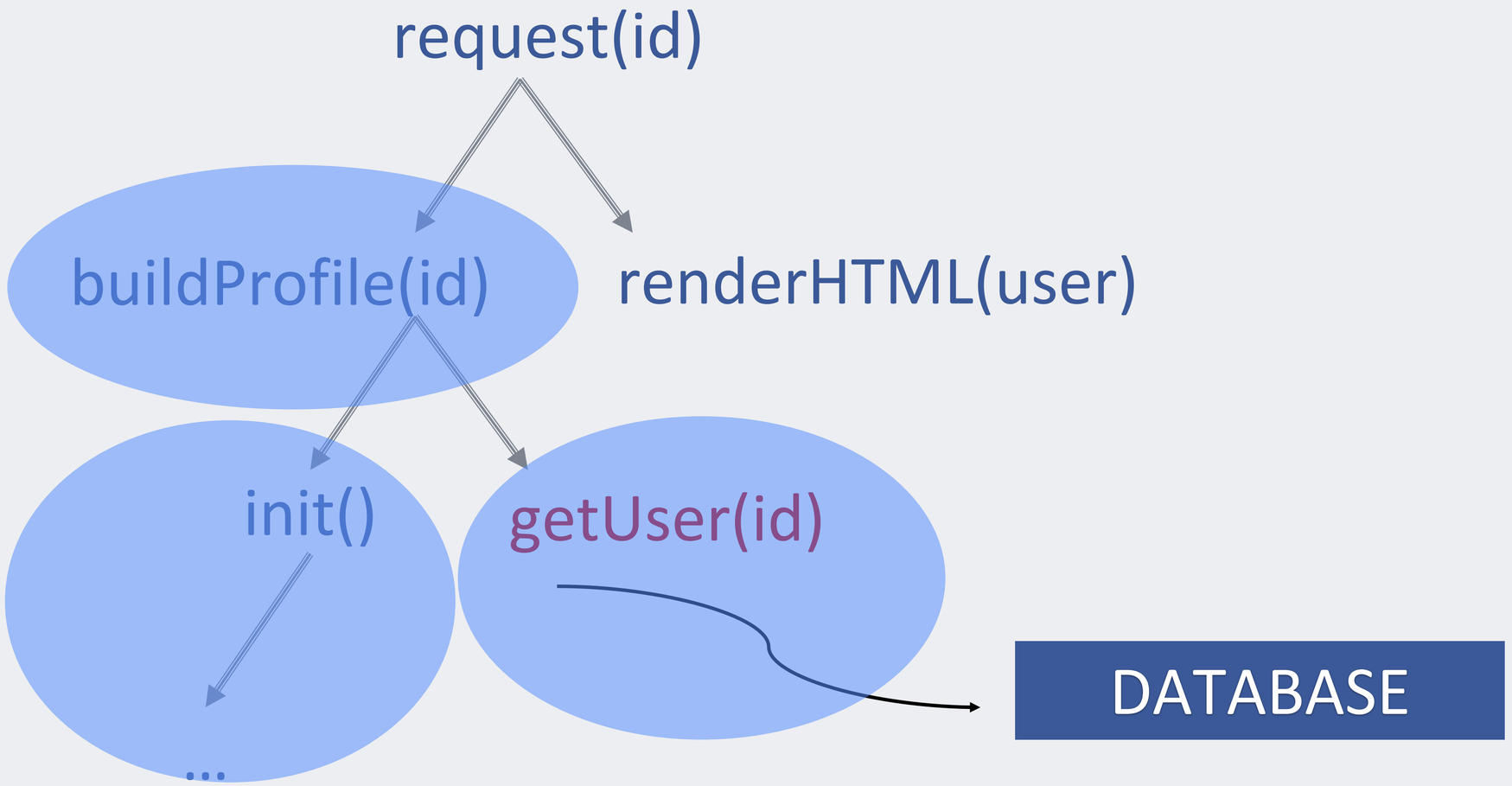
Skip: example

```
fun request(id: Int): String {
  user = buildProfile(id);
  renderHTML(user)
}
```

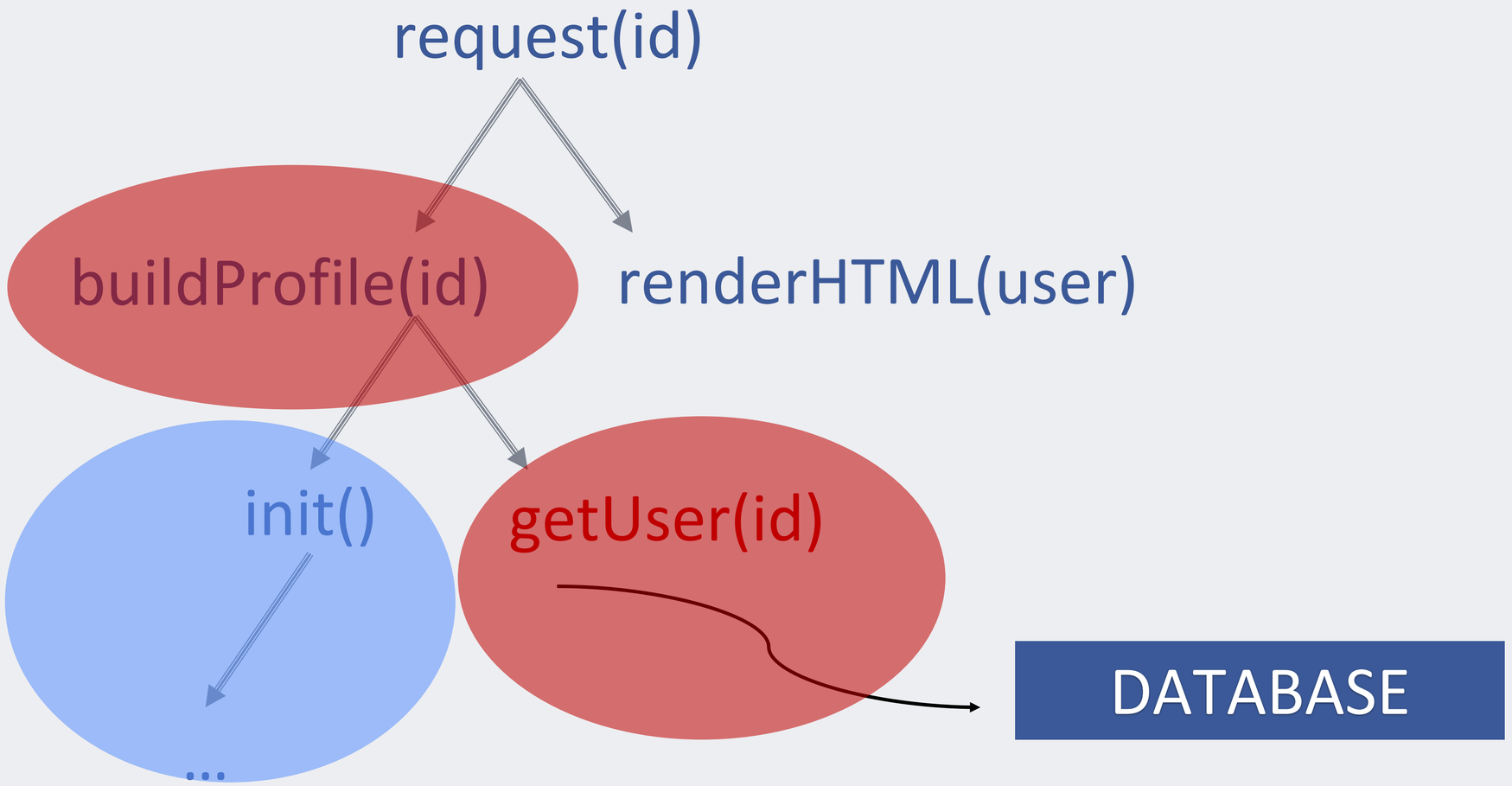
Skip: call graph



Skip: caching



Skip: invalidation



Skip: reactivity

```
fun request(id: Int): String {
  user = buildProfile(id);
  renderHTML(user)
}
```

Skip: mutation

```
fun request(id: Int): String {
  user = buildProfile(id);
  renderHTML(user)
}
```

MUTATION?

Skip's Solution

What invariants?

- **Immutability** guaranteed statically
  - *But local mutations are encouraged!*
- Runtime **tracks** dependencies
  - *Automatically invalidate memoized values*

Objects

Objects

```
class User(name: String, age: Int) {
  fun onBirthday(): User {
    User(name, this.age + 1)
  }
}
```

Objects

```
class User{name: String, age: Int} {
  fun onBirthday(): User {
    User{name, age => this.age + 1}
  }
}
```

Objects

```
class User{name: String, age: Int} {
  fun onBirthday(): User {
    !this.age = this.age + 1;
    this
  }
}
```

Objects

```
class User{name: …, mutable age: Int} {
  mutable fun onBirthday(): void {
    this.!age = this.age + 1
  }
}
```

Object creation: immutable

```
user = User {
  name => “julien”,
  age => 35
};
```

Cannot access mutable methods!

Object creation: mutable

```
user = mutable User {
  name => “julien”,
  age => 35
};
```

Mutable methods until freezing!

Skip: collections

```
v1 = Vector[1, 2, 3];
v2 = mutable Vector[1, 2, 3];
m1 = Map[1, 2, 3];
m2 = mutable Map[1, 2, 3];
v1.filter(x -> x >= 0).map(x -> x + 1)
// Make your own!
```

Skip: collections

```
fun filterUsers(): SMap<String> {
  result = mutable Map[];
  …
  freeze(result)
}
```

OO = FP

Skip: pattern-matching

```
fun isNull(value: ?X): Bool {
  value match {
   | Null -> true
   | Box(x) -> x
  }
}
```

OO Inheritance

base class IntList

class Nil() extends IntList

class Cons(Int, IntList) extends IntList

FP inheritance

```
base class IntList {
  children =
  | Nil()
  | Cons(Int, IntList)
}
```

OO methods

```
class Nil() extends IntList {
  fun add1(): IntList { … }
}

class Cons(Int, IntList) {
  fun add1(): IntList { … }
}
```

FP methods

```
base class IntList {
  ...
  fun add1(): IntList
  | Nil() -> ...
  | Cons(x, rl) -> ...
}
```

OO/FP mix

```
base class IntList {
  fun add1(): IntList
  | Nil() -> …
}

class Cons(Int, IntList) extends IntList {
  fun add1(): IntList { … }
}
```

Generics

Generics

```
base class List<T> {
  children =
  | Nil()
  | Cons(T, List<T>)

  fun map<T2>(f: T -> T2): List<T2>
  | Nil() -> ...
  | Cons(x, rl) -> ...
}
```

Generics

```
base class List<T> {


  fun show[T: Showable](): String {
    // ..
  }
}
```

Generics: traits

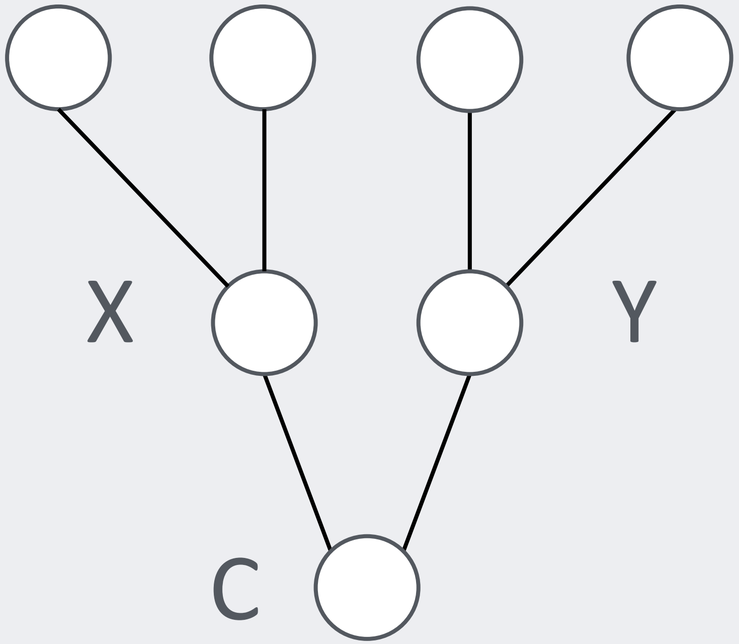
```
trait Showable {


  fun toString(): String {
    // ..
  }
}
```

Lvalues

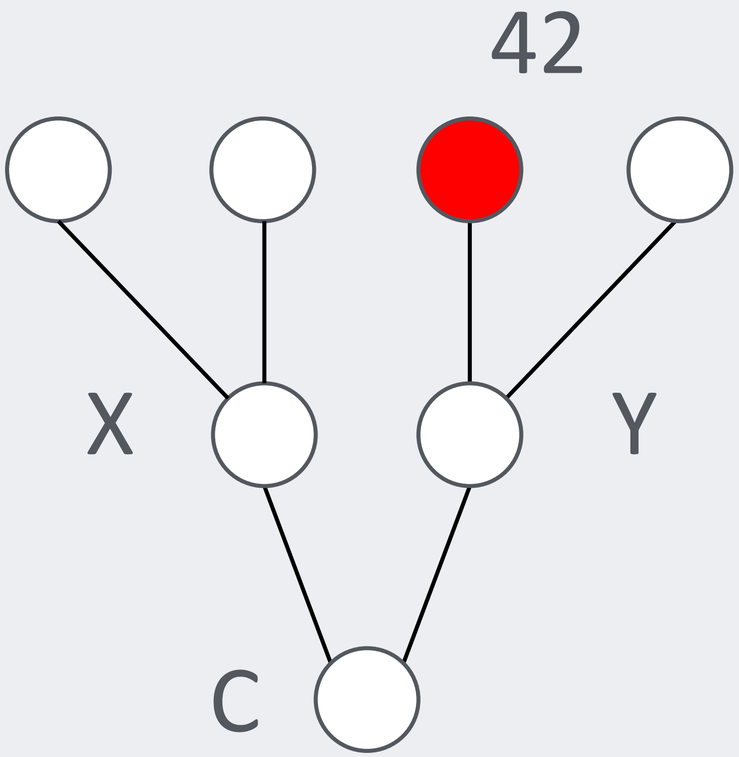
Lvalues

local = C(X(1, 2), Y(3, 4));



Lvalues

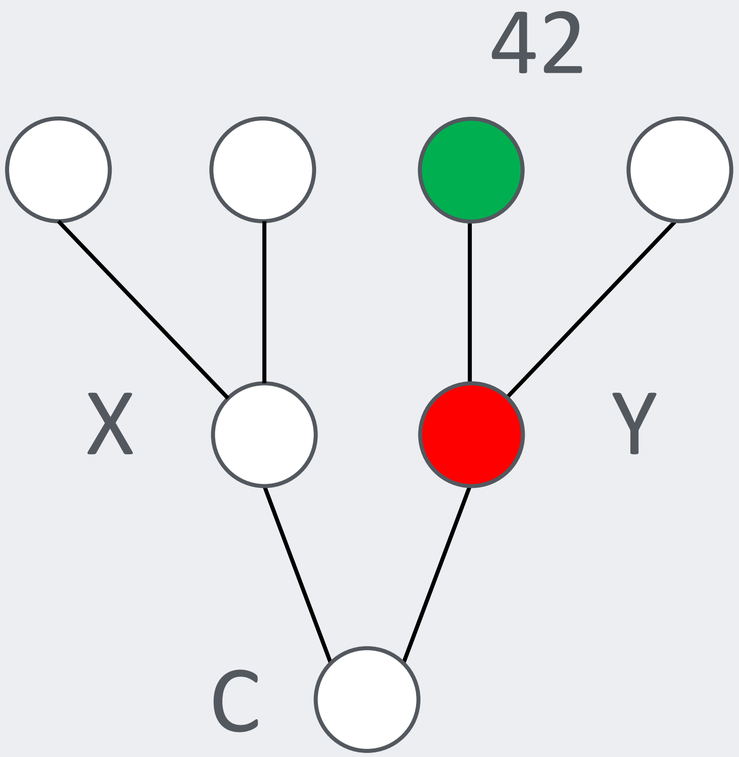
local.field2.!field1 = 42;



Modified

Lvalues

local.!field2.field1 = 42;

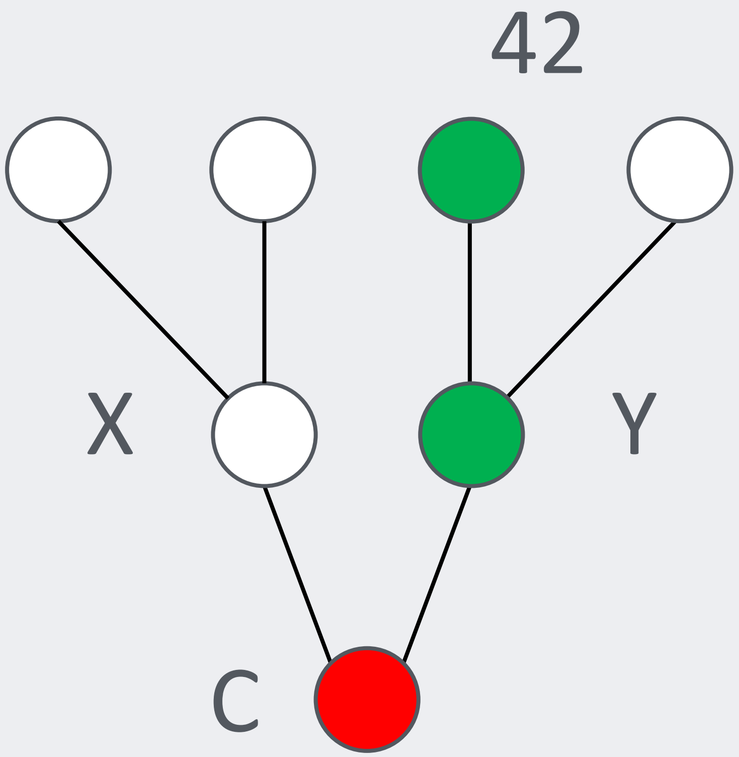


New value

Modified

Lvalues

!local.field2.field1 = 42;



New value

Modified

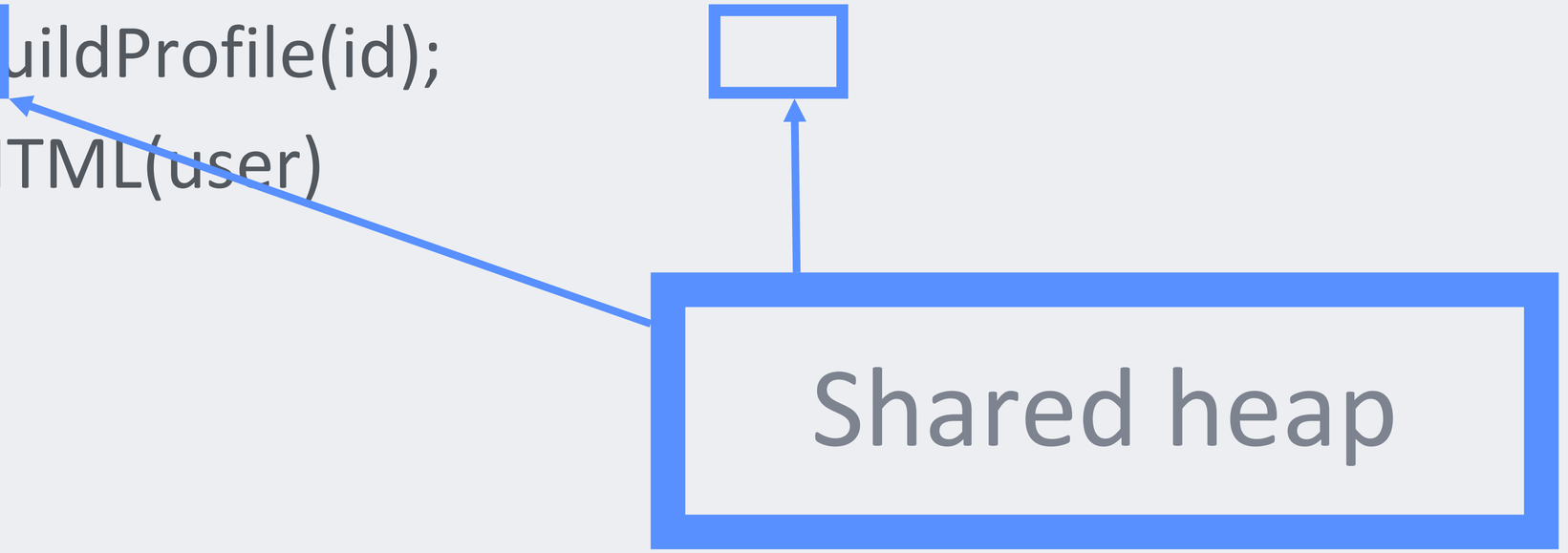
Code: lvalues

(!acc, result) = some_fun(acc, x);

Memoization

Skip: memoization is fast!

```
fun request(id: Int): String {
  user = buildProfile(id);
  renderHTML(user)
}
```



Shared heap

- Objects are immutable
- 2 structurally equal object have the same address
- Supports multithreading (MVCC)

Skip: memoization is fast!

```
fun request(id: Int): String {
  user = buildProfile(id);
  user = buildProfile(id);
  renderHTML(user)
}
```

INSTANT

Skip: memoization is super fast!

```
fun request(id: Int): String {
  user = buildProfile(id);
  _ = renderHTML(user);
  renderHTML(user);
}
```

INSTANT

Memory model

Memory model

- Skip is safe, garbage-collected
- Minor heap
  - Fast, “bump a pointer” allocator
- Shared heap
  - Long-lived, immutable
  - Unique (“interned”) objects only

Skip: the @gc annotation

```
@gc fun request(id: Int): String {
  user = buildProfile(id);
  renderHTML(user)
}
```

Memory model properties

- O(allocated) != O(heap_size)
- Annotations to memoize
- You can reason about performance!

Future applications

Future applications

Time shift

- Compute in the morning, use in the afternoon
- Eases “At peak” traffic

Future applications

Remote cache

- Use local data as if it was remote
- Maintaining a reactive version
- Push changes

Thank you!

Example

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Runtime

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Applications

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