COMMUNITYDAY

CLOJURE – Martin Jul, @mjul

Clojure

En kraftfuldt erstatning for JavaScript, C# og Java

Community Day 2012
10. maj 2012

```
{:name "Martin Jul"
 :email "mj@ative.dk"
 :twitter "mjul"}
```

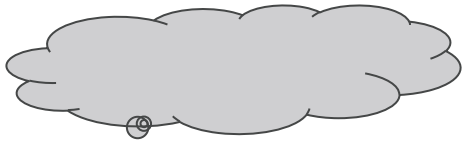
A|T|I|V|E|

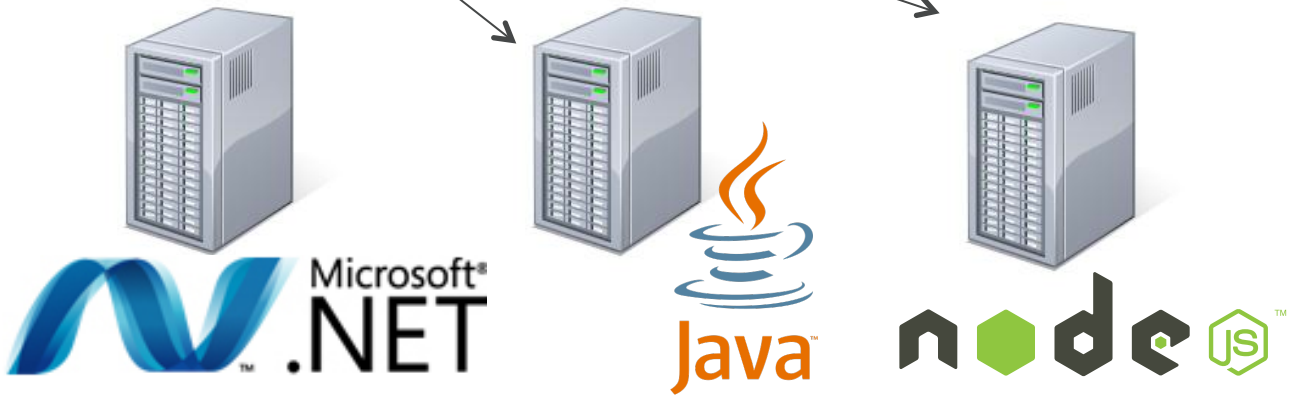
A Better Language for Everything

JavaScript targets

A modern
Lisp language

Compiler
JVM, CLR
ClojureScript
(Clojure-py...)





The main server platforms

A Better Java

```java
public class StringUtils {
  public static boolean isBlank(String str) {
    int strLen;
    if (str == null || (strLen = str.length()) == 0) {
      return true;
    }
    for (int i = 0; i < strLen; i++) {
            if ((Character.isWhitespace(str.charAt(i)) == false)) {
              return false;
            }
    }
    return true;
  }
}
```

```clojure
(defn blank? [s]
  (every? #(Character/isWhitespace %) s))
```

Example from “Programming Clojure” by Stuart Sierra (Pragmatic Programmers, 2009), p. 23

A Better JavaScript

```
var confs = [
 {name : "Clojure Conj", year : 2011 },
 {name : "Community Day", year : 2012 }];


var sorted = confs.sort(
  function(a, b)
  {
    if (a.name < b.name)
      return -1
    if (a.name > b.name)
      return 1
    return 0
  });
```

Small, Powerful and Extensible

Simple core language

Excellent **function library**

Persistent collections

Immutability by default

Sane Reasoning about State

Software Transactional Memory

Sane Concurrency

Code is data: **powerful meta programming** features

Typed Clojure Gradual typing	**core.logic** Logic programming	**Trammel** Code contracts	**Eastwood** C Lint

Simple libraries make Haskell, Prolog and Eiffel hackers feel at home

Why Clojure?

LISP is worth learning for a different reason: the profound enlightenment experience you will have when you finally get it. That experience will make you a better programmer for the rest of your days, even if you never actually use LISP itself a lot.

Eric S Raymond

"How to Become a Hacker"

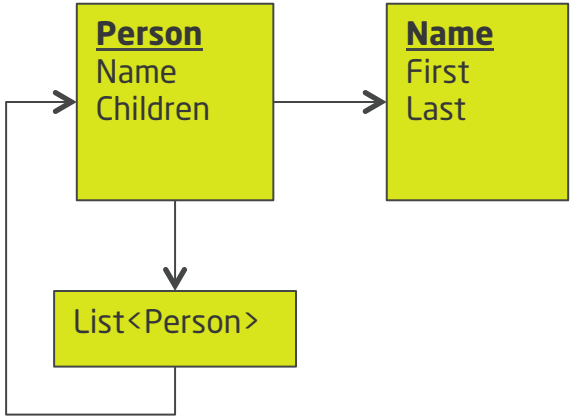
Reducing the Complexity of the Implementation Domain

Problem	Simplification
Spaghetti code	Structured programming, OO
Memory management	Garbage collection
Side-effects	**Pure functions**
Sharing data	Message passing, value semantics **Immutable data**
Concurrency / locks	**Software Transactional Memory** Message based concurrency Offline lock patterns, ...
Composability	**Common abstractions**, higher-order functions
Limitations of implementation language	**Macros** DSLs, Design patterns

MUTABLE STATE IS THE NEW SPAGHETTI CODE

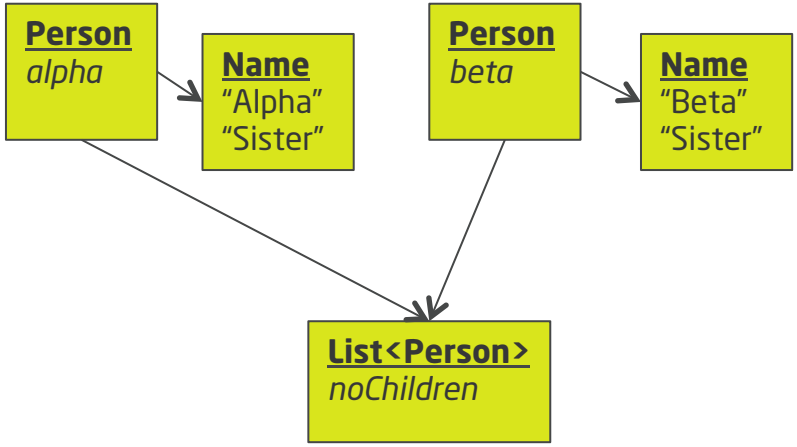
Mutable state:
What is wrong with this code?

```
// Naïve version
public class Name {
        public String First { get; set; }
        public String Last { get; set; }
}

public class Person {
        public Person(Name name, List<Person> children)
        {
            this.Name = name;
            this.Children =  children;
        }
        public Name Name { get; set; }
        public List<Person> Children { get; }
}
```



Mutable state:
What is wrong with this code?

```
var noChildren = new List<Person>();
var alpha = new Person(new Name("Alpha", "Sister"),
                       noChildren);
var beta  = new Person(new Name("Beta", "Sister"),
                       noChildren);
```

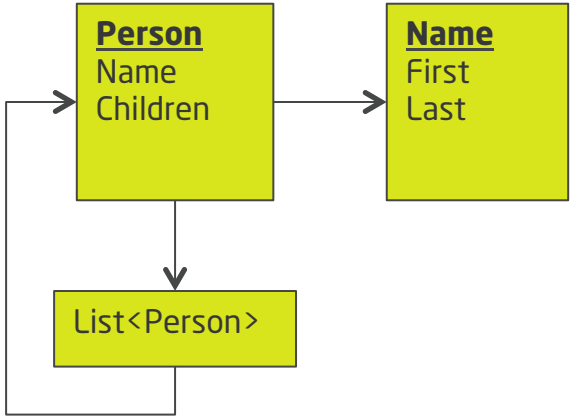



```
alpha.Name.Last = "Omega";
var gamma = new Person(new Name("Gamma", "Alphadaughter"));
alpha.Children.Add(gamma);
DoSomethingTo(alpha, beta);
```

What is the state after this?

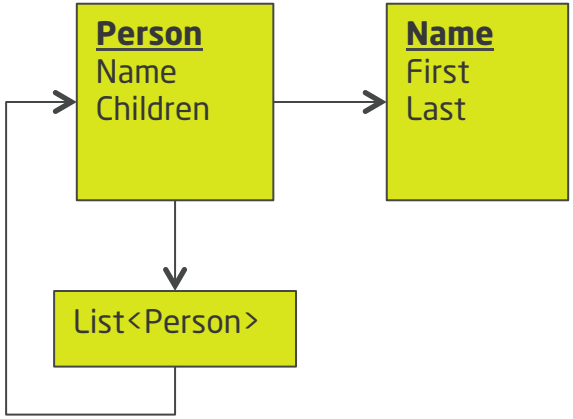
Mutable state:
What is wrong with this code?

```
// Improved

public class Name {
    public String First { get; set; }
    public String Last { get; set; }
}

public class Person {
    public Person(Name name, List<Person> children)
    {
        this.name = name.DeepClone(); // if Name is mutable
        this.children = DeepClone(children);
    }
    public Name Name { get; set; }
    public IEnumerable<Person> Children { get { return DeepClone(children); }}
    public Name UpdateName(String f, String l) { this.Name = new Name(f,l); }
    public AddChild(Person child) { this.children.Add(child.DeepClone()); }
}
```



Mutable state

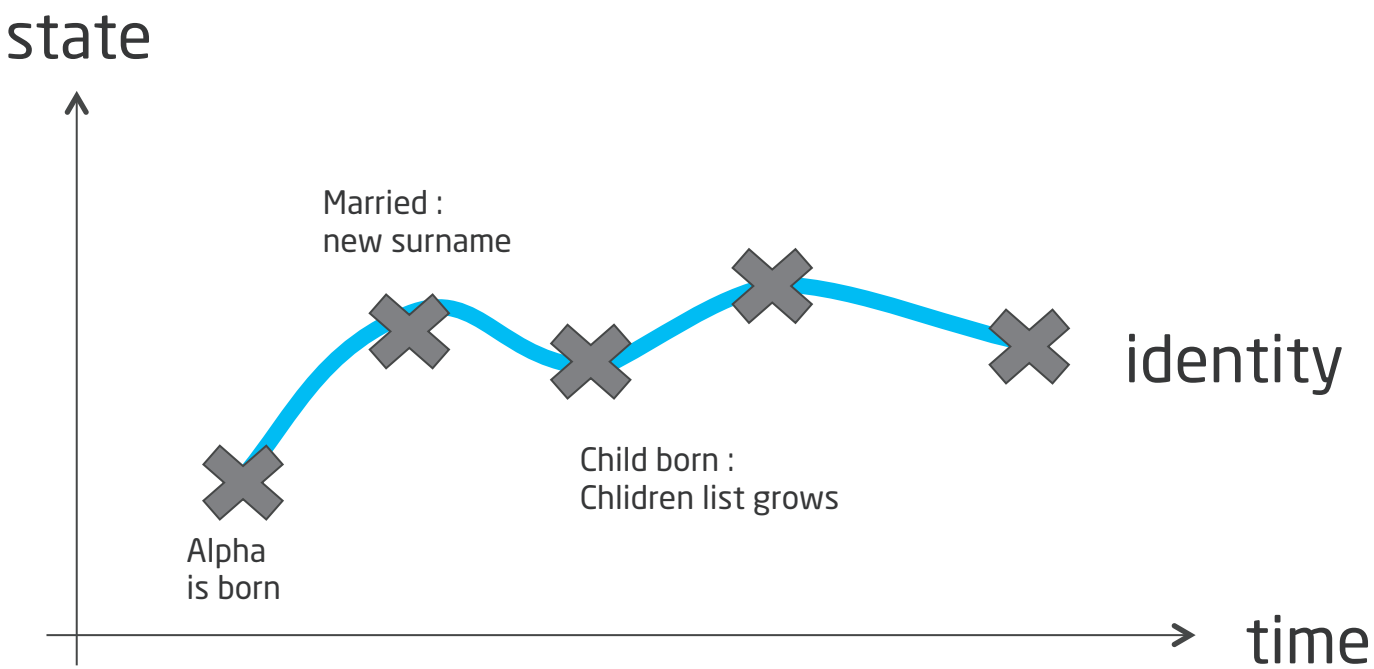
- **Encapsulation** is hard
  - clone in, clone out
- **Ownership** is hard
  - “Entities” and “Value Objects”
- **Reasoning** about state is hard
- **Concurrency** is even worse



Maybe it’s time to stop

IMMUTABILITY

Philosophy of State and Identity



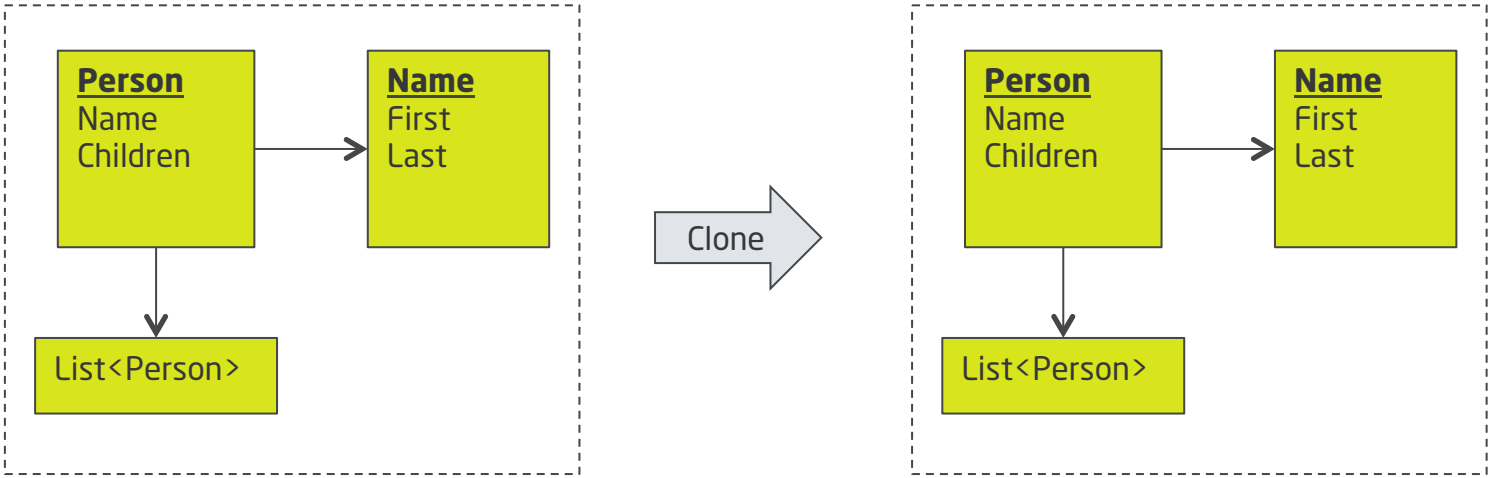
Advantages of Immutability

- Check invariants at construction only
- Reasoning about code is much simpler
- Thread safe
- Iteration safe
- No locks required

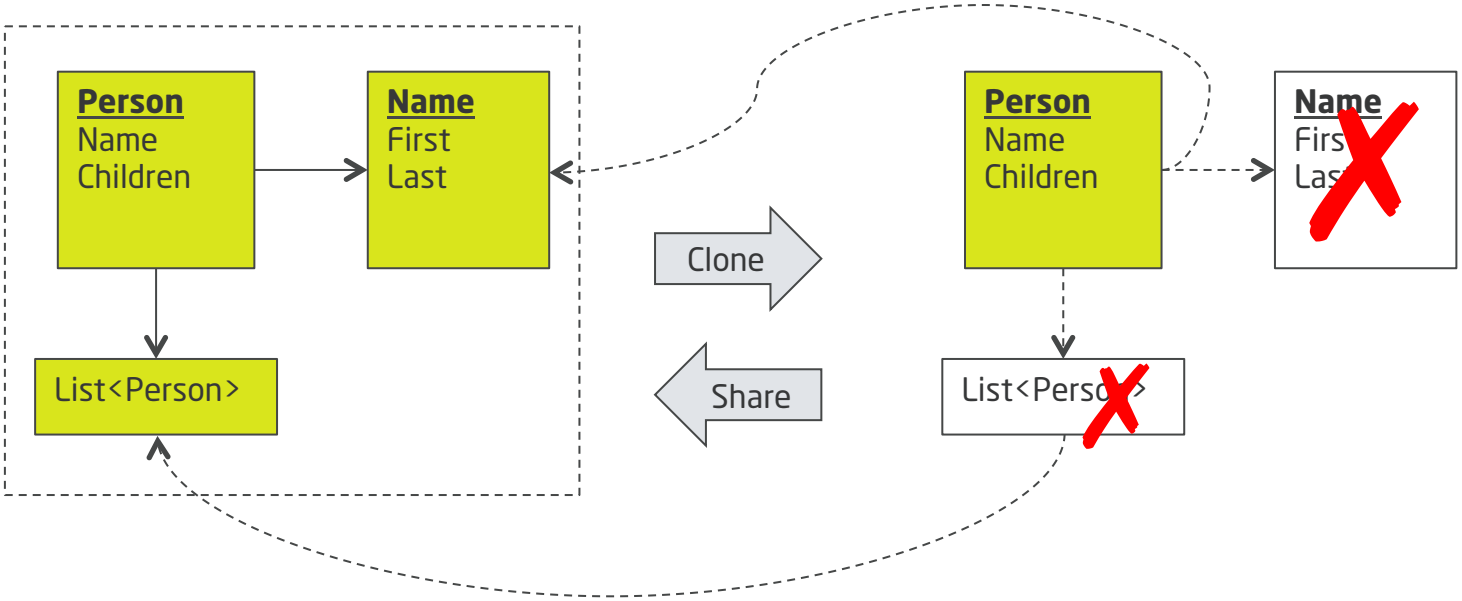
Disadvantages of Immutability

- We need a way do it efficiently
  - Memory
  - Performance
- We need a mutation mechanism

Structural Sharing

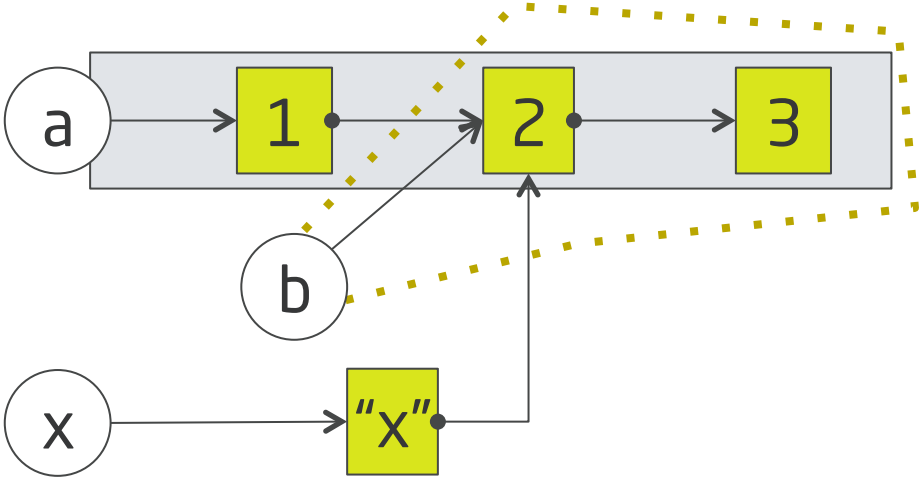


Structural Sharing



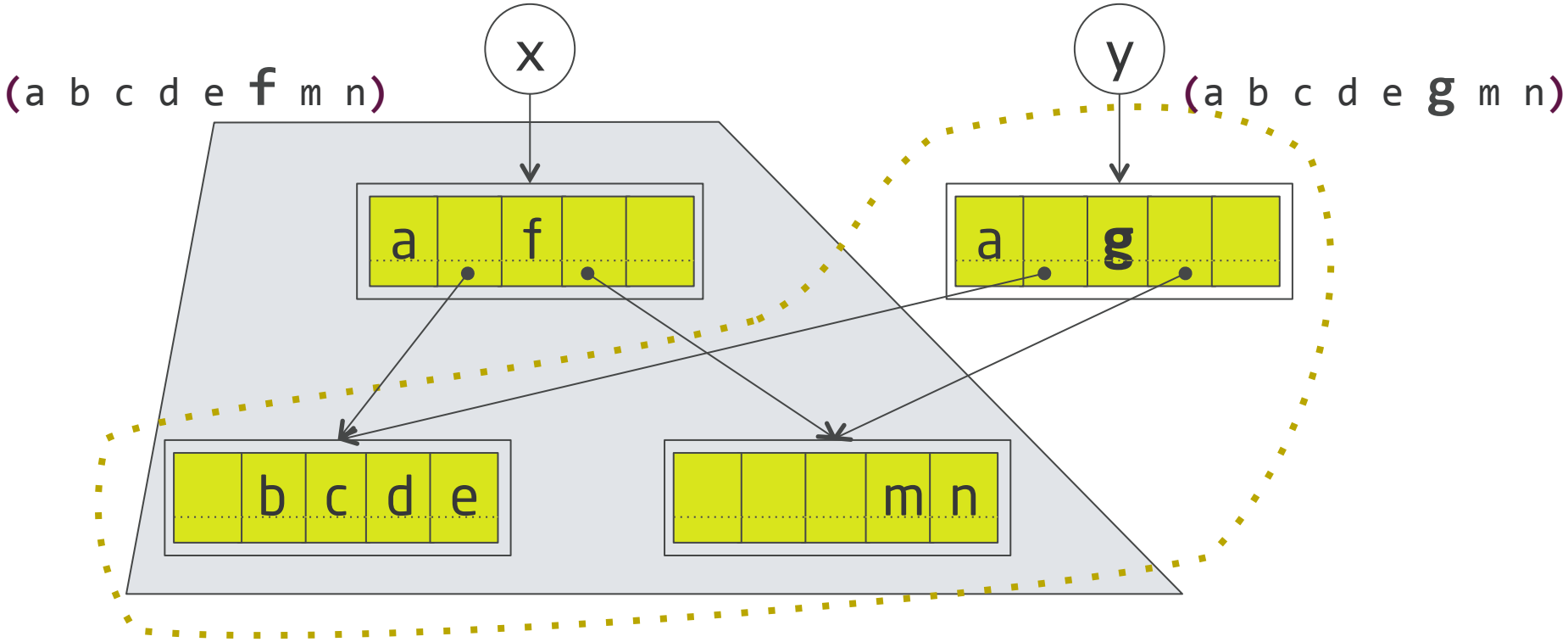
Persistent Collections for performance

```
(def a (list 1 2 3))
=> (1 2 3)

(def b (rest a))
=> (2 3)

(def x (conj b "x"))
=> ("x" 2 3)
```



- Immutable
- Structural Sharing
- Copy-on-write semantics

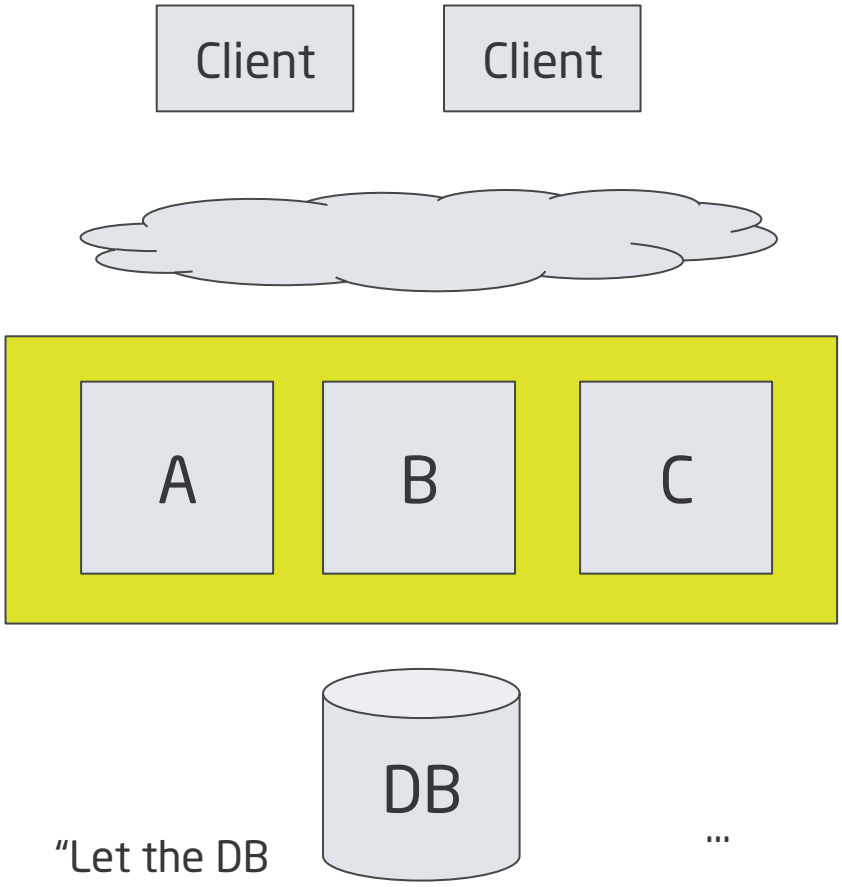
Persistent Collections implemented with hash tries



Extremely simplified diagram!
For full details see: Fast and Space Efficient Trie Searches, Bagwell [2000]

CONCURRENCY WITH SOFTWARE TRANSACTIONAL MEMORY

Concurrency Strategies



In process

Threads
Locks

Offline lock patterns

"Let the DB handle it"

Inter process

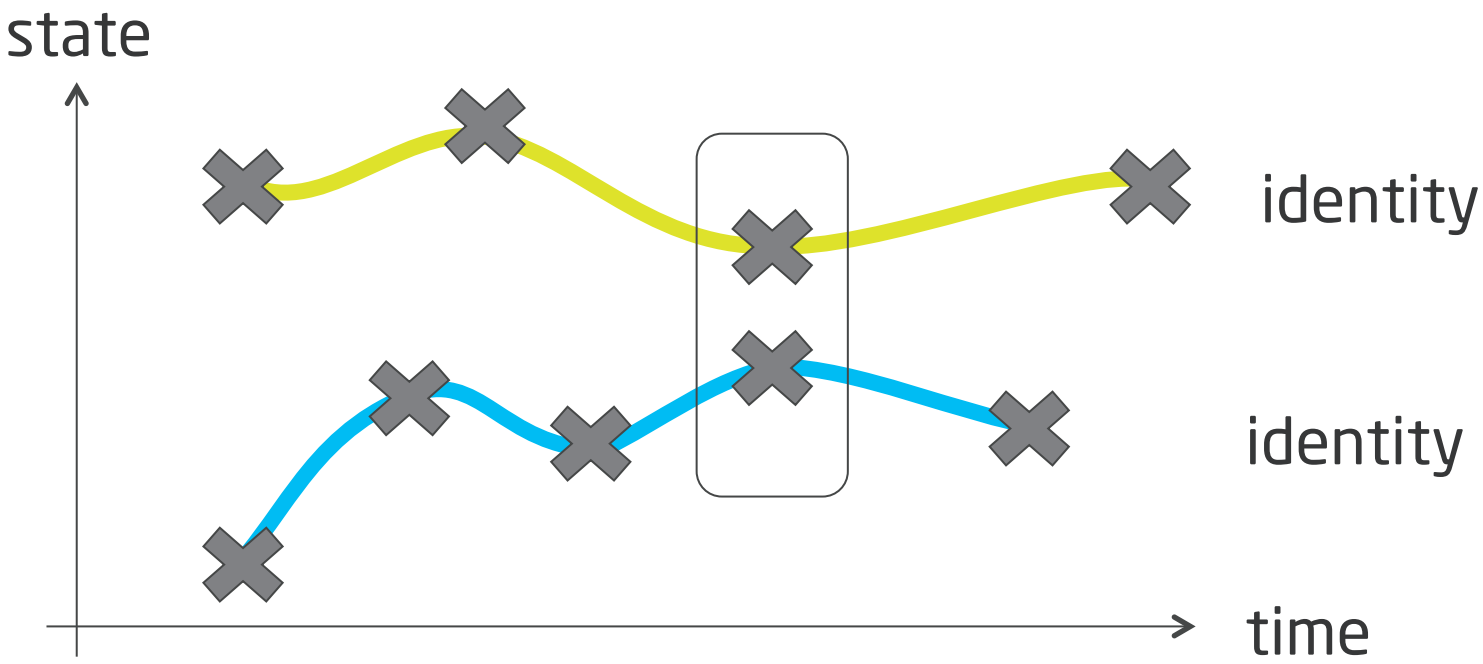
Scheduler

Actor model

Message passing

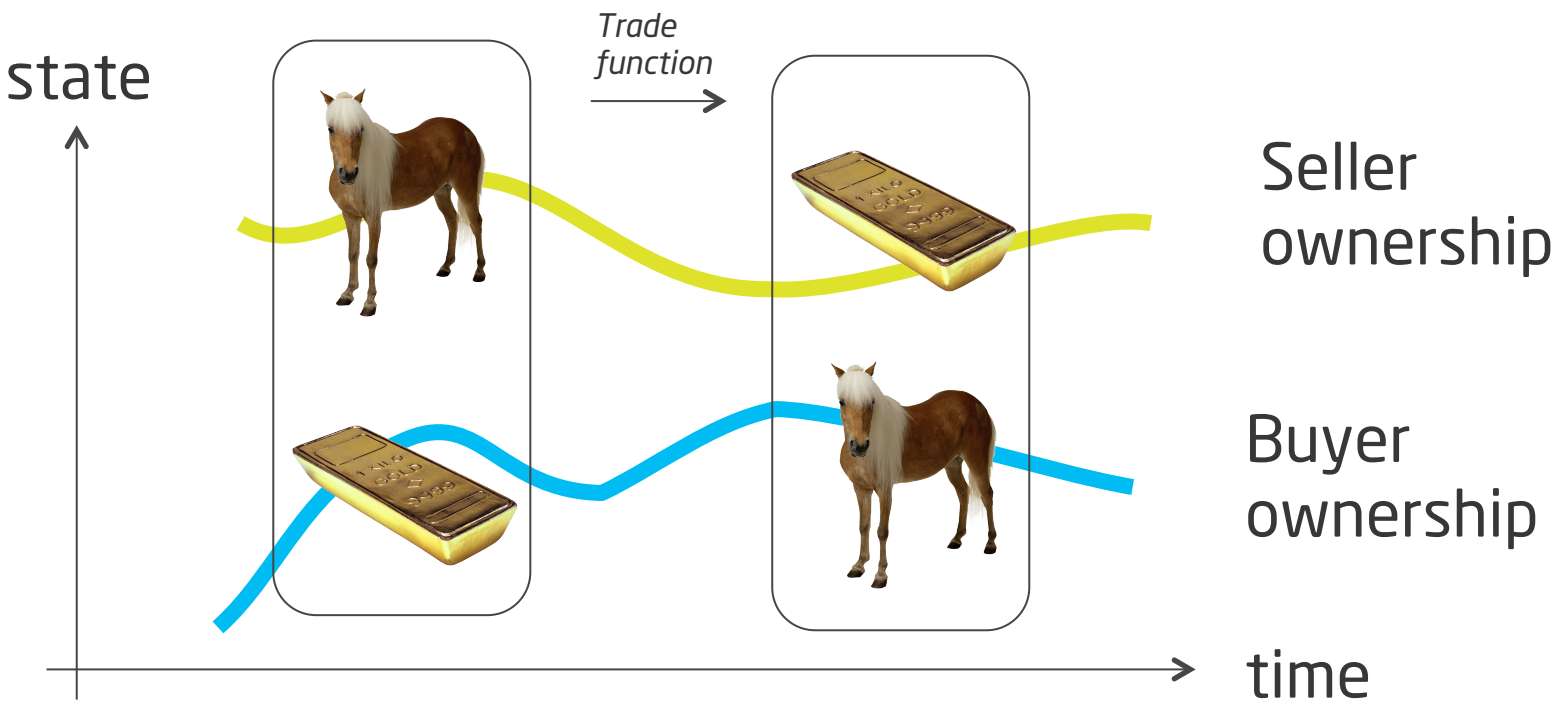
...

Clojure Concurrency

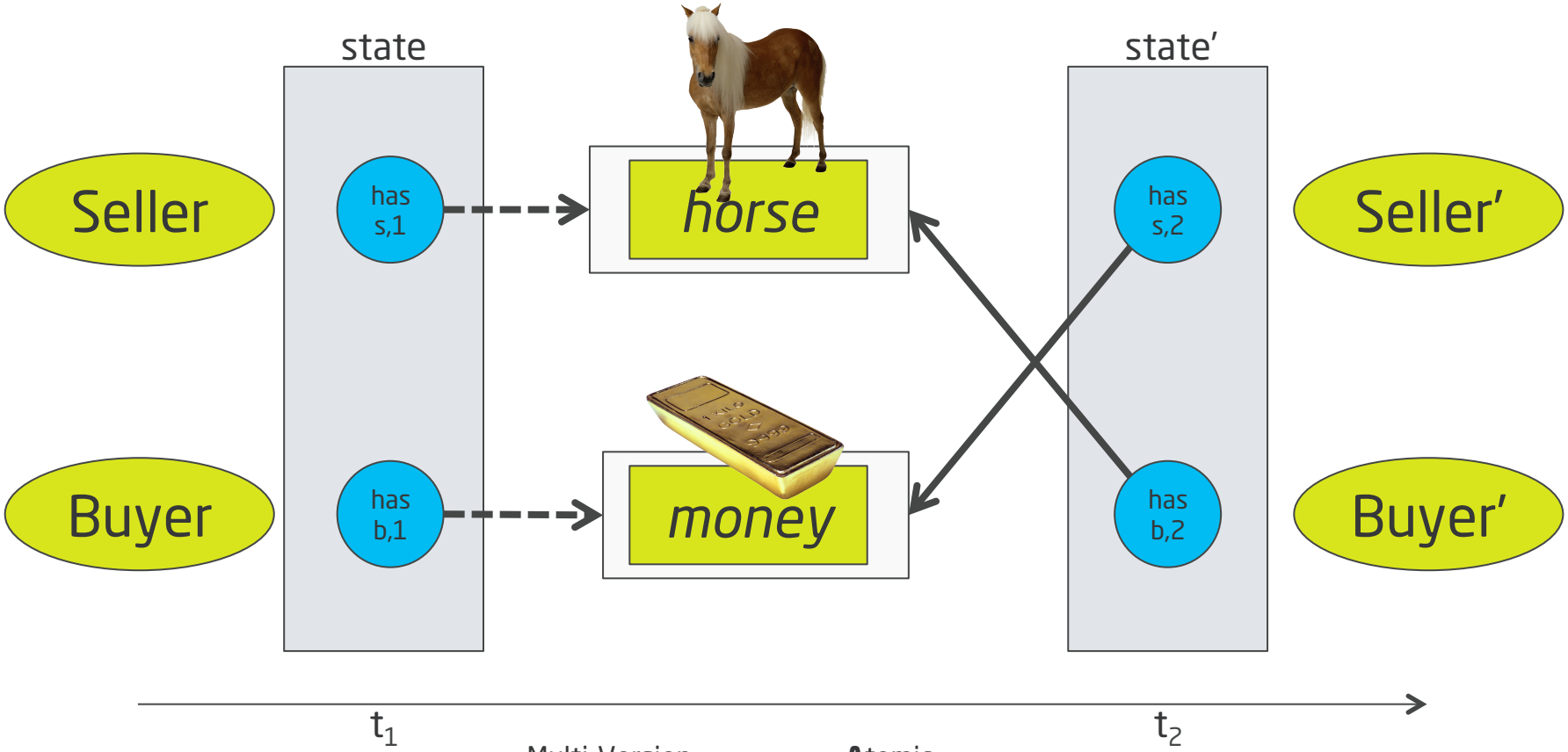


- **Indirect** references to immutable data structures
- Concurrency semantics for references
  - Automatic/enforced
  - No locks

Clojure Concurrency



Software Transactional Memory



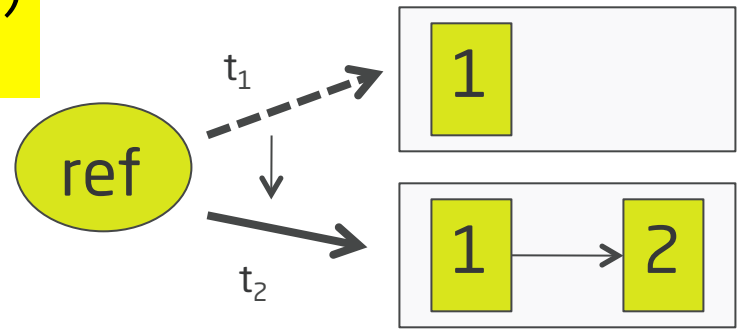
Multi-Version
Concurrency Control

Atomic
Consistent
Isolated
~~Durable~~

STM Example

```clojure
(defn post
  "Post an amount to the account."
  [account amount msg]
  (conj account {:amount amount, :msg msg}))

(defn transfer
  "Transfer an amount between two accounts."
  [from to amount msg]
  (dosync
    (alter from post (- amount) msg)
    (alter to post amount msg)))
```

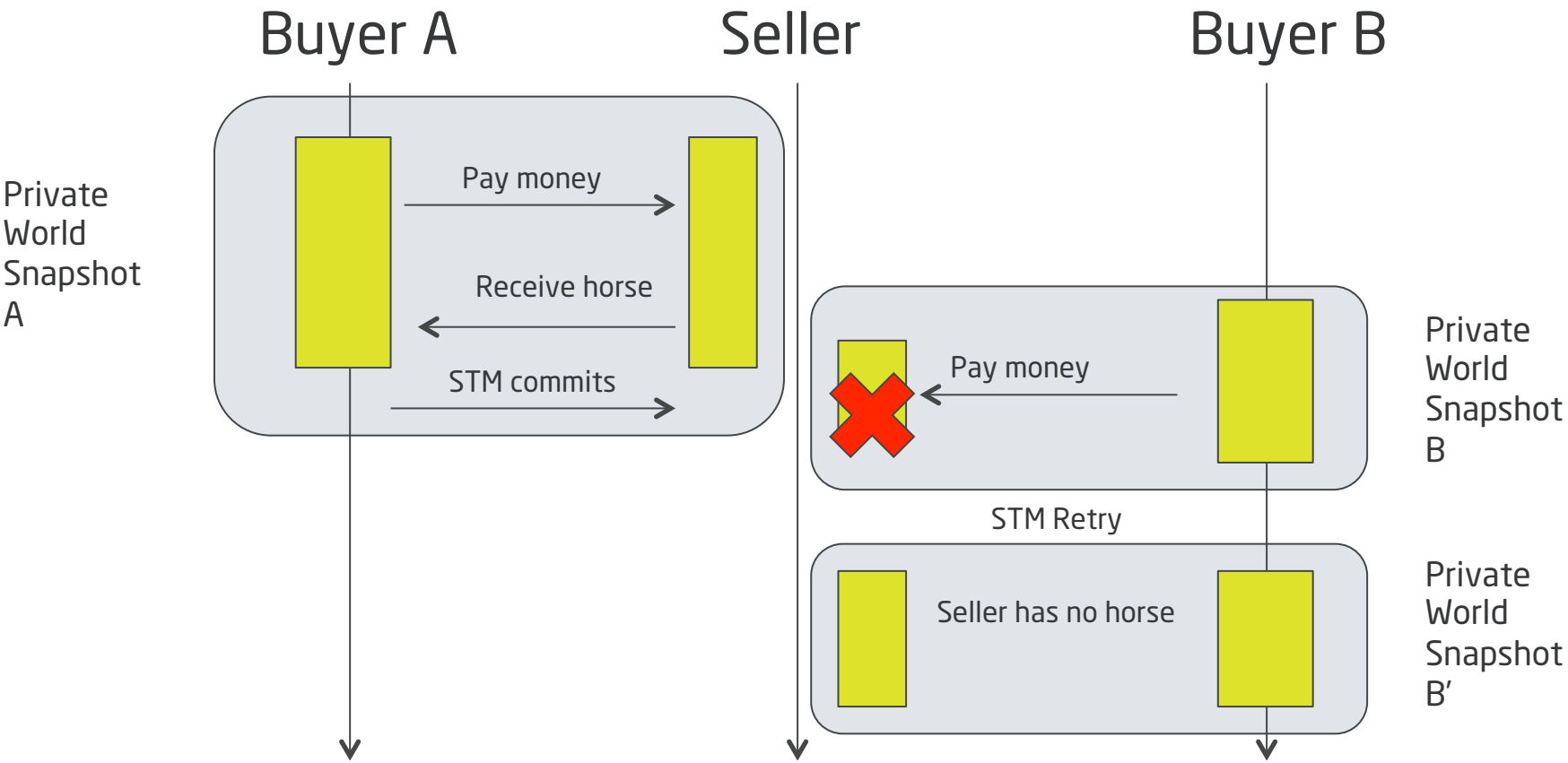
:amount	:msg
1000	Initial balance
-170	Train fare
-40	Coffee



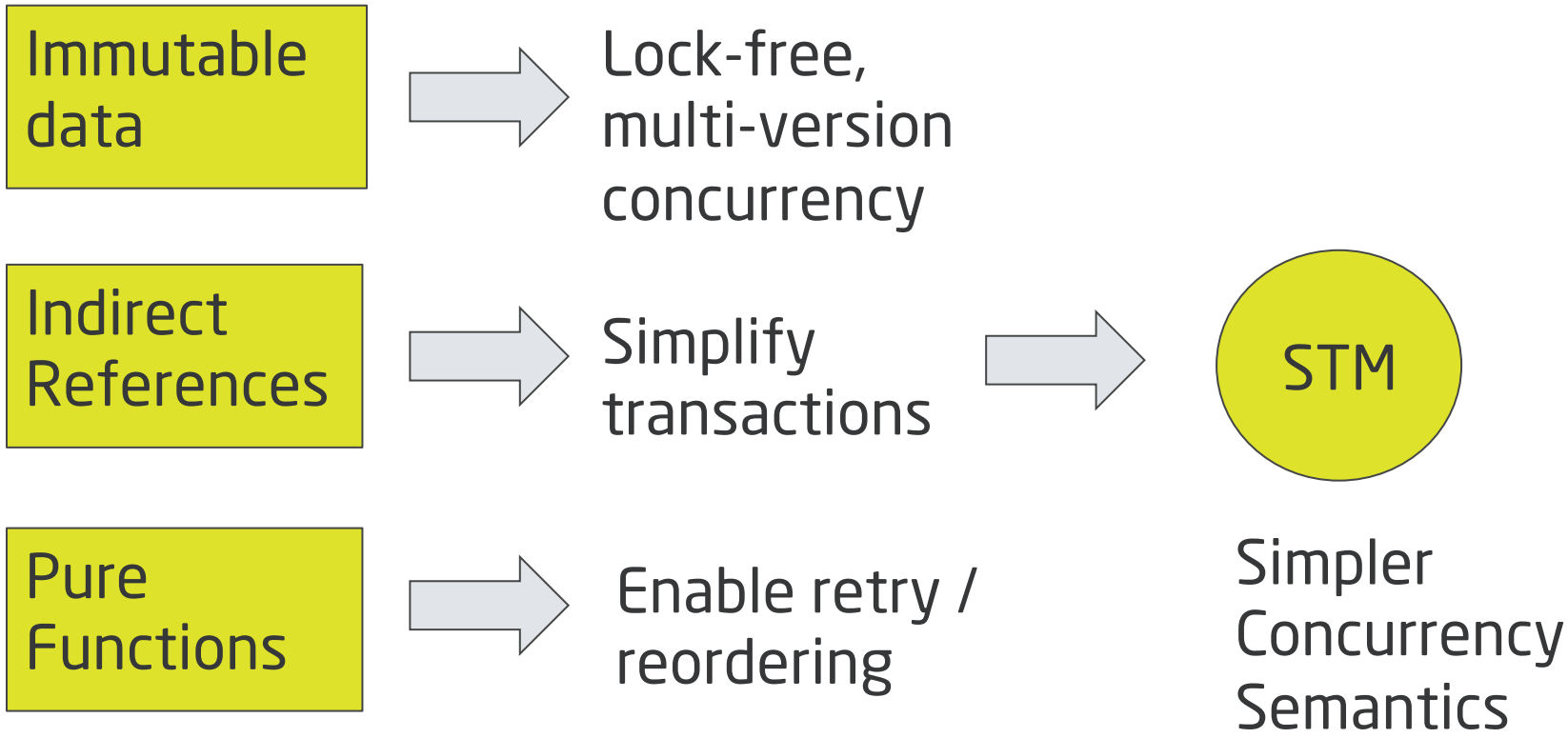

```clojure
(deftest transfer-tests
  (testing "Transfer between accounts"
    (let [a (ref [])
          b (ref [])]
      (transfer a b 10 "message")
      (is (= [{:amount -10, :msg "message"}] @a))
      (is (= [{:amount 10, :msg "message"}] @b)))))
```

file: stm.clj

Software Transactional Memory Conflict Resolution



Concurrency Summary



IT'S ALL ABOUT ABSTRACTIONS

Classes are Islands

```
// C#
class Conference {
  string Name { get; }
  int Year { get; }
}
```

Methods available:

ToString
GetHashCode
Equals
GetType

file: islands.clj

Clojure Data Structures

```
(defrecord Conference [name year])

(def cc (Conference. "Clojure Conj" 2011))
(def cday (Conference. "Community Day" 2012))
(def confs [oredev cday])

confs
=> [{:name "Clojure Conj", :year 2011}
    {:name "Community Day", :year 2012}]

;; key/value map semantics
(:year cday)
=> 2012

(keys cday)
=> (:name :year)
```

file: islands.clj

Clojure Data Structures

```
;; Fields can be added dynamically
(assoc cday :rating :great)

=> {:name ”Community Day",
    :year 2012,
    :rating :great}
```

```
;; A map is a seq of its k/v pairs
(seq cday)

=> ([:name "Community Day"]
    [:year 2012])
```

```
;; Destructuring
(for [[property value] cday]
  (str property ” -> " value))

=> (":name -> Community Day"
    ":year -> 2012")
```

```
confs
=>[{:name "Clojure Conj", :year 2011}
   {:name "Community Day", :year 2012}]
```

file: islands.clj

Functions on Data Structures

```clojure
;; Data works with common functions
(sort-by :name confs)

;; lambda functions
(sort-by (fn [c] (count (:name c))
         confs)
=> ({:name "Clojure Conj", :year 2011}
    {:name "Community Day", :year 2012})

(filter #(= 2012 (:year %)) confs)
=> ({:name "Community Day", :year 2012})
```

```clojure
confs
=>[{:name "Clojure Conj", :year 2011}
   {:name "Community Day", :year 2012}]
```

```javascript
// Javascript (sort-by :name …)

var confs = [
 {name : "Clojure Conj", year : 2011 },
 {name : "Community Day", year : 2012 }];

var sorted = confs.sort(
function(a, b)
{
  if (a.name < b.name)
    return -1
  if (a.name > b.name)
    return 1
  return 0
});
```

file: islands.clj / islands.js

Code to Common Abstractions

Core Abstractions

- Higher-order, first-class fn
- Collections
- Seq
- Records

Core Data Structures

{ :key value }	map
[a b c]	vector
(1 2 3)	list
#{ :a :b :c }	set

Higher-order functions

(`map` *fn* coll)

(`filter` *pred* coll)

(`remove` *pred* coll)

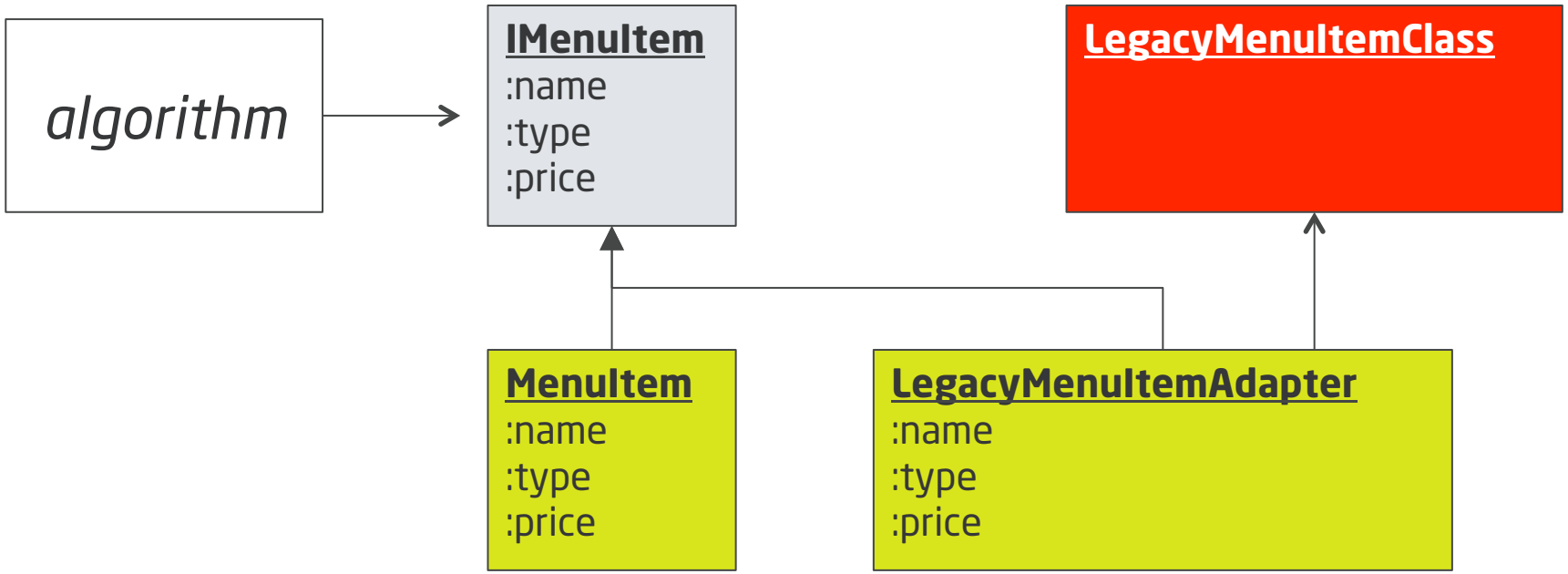
(`sort-by` *fn* coll)

(`group-by` *fn* coll)

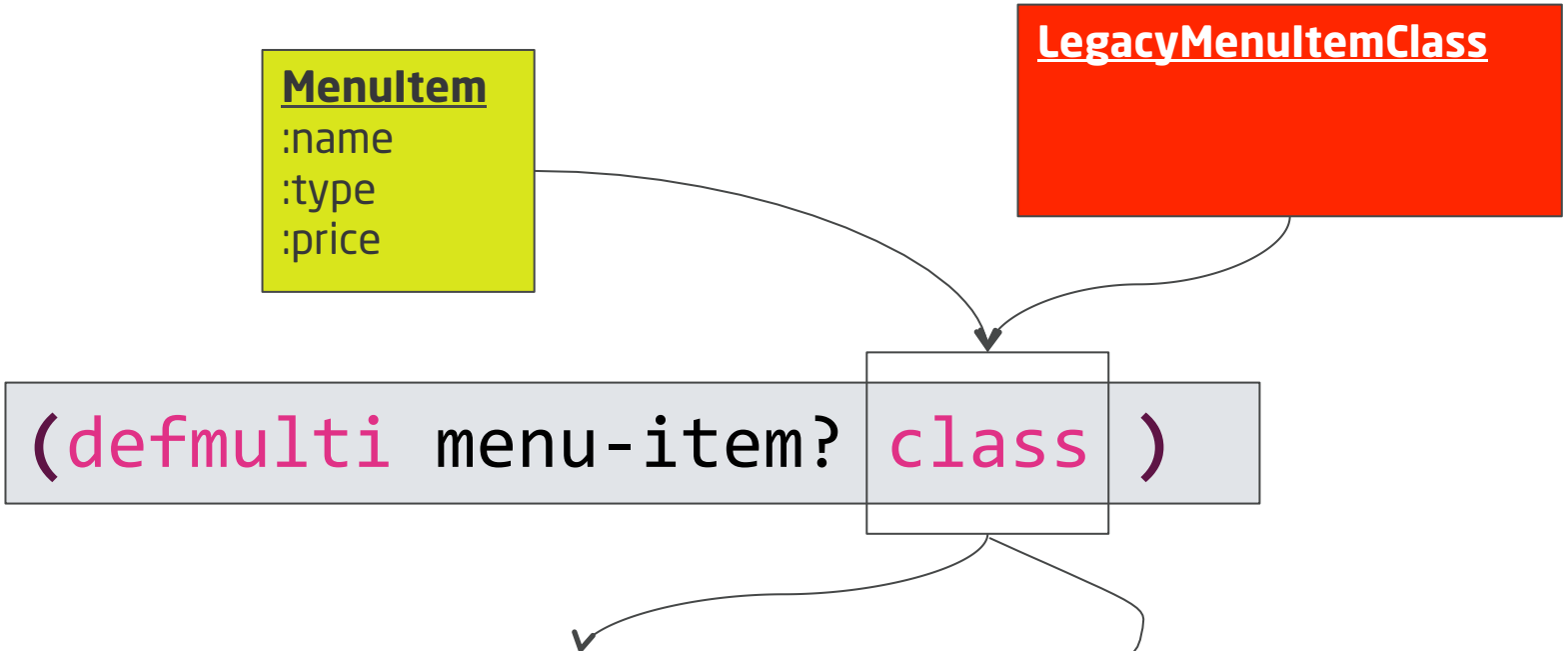
```
// map in C#

// Linq
from x in coll select f(x);

// Pre-Linq
var result = new List…
foreach (var x in coll) {
  result.Add( f(x) );
}

// Extension methods,
// lambda expressions
coll.ConvertAll( x => f(x) );
```

BETTER POLYMORPHISM

Open/Closed Legacy Code : OO



Open/Closed Legacy Code




```
(defmethod menu-item? MenuItem [x] true)
(defmethod menu-item? LegacyMenuItemClass [x] true)
(defmethod menu-item? :default [x] false)
```

file: multimethods.clj

Beyond Static Dispatch

```
{:name "Espresso"
 :type :beverage
 :price 12}

{:name "Big Kahuna Burger"
 :type :food
 :price 100}
```

MenuItem
:name
:type
:price

```
(defmulti description :type )
```

```
(defmethod description :beverage [x]
      (str "Drink a wonderful " (:name x)))
(defmethod description :food [x]
      (str "Savour a tasty " (:name x)))
```

file: multimethods.clj

SPECIALIZING THE IMPLEMENTATION LANGUAGE

How would you add an *unless* keyword to C#?

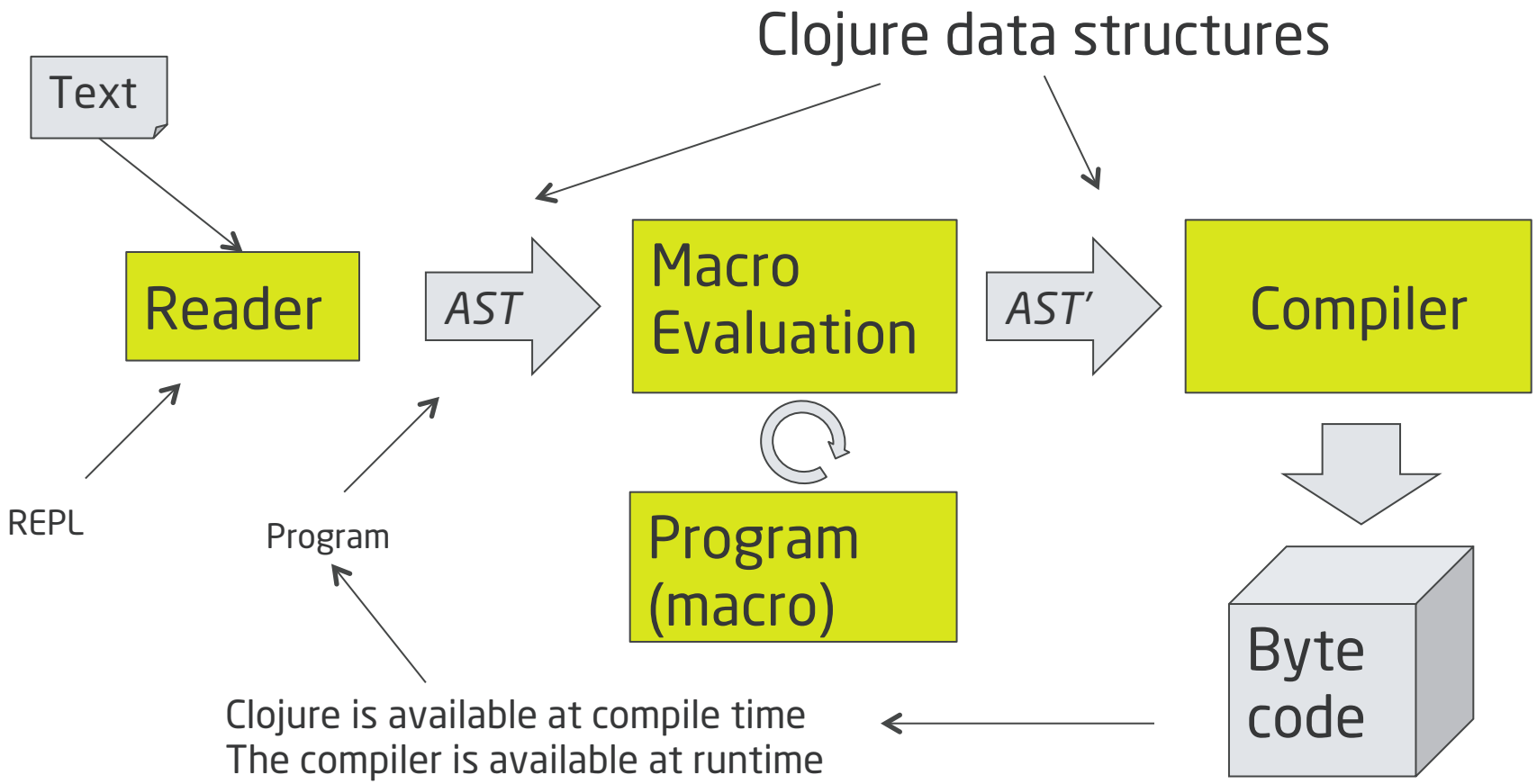
```
public WeakSetPerson(Person p)
{
    this.person = p unless (p == null);
}
```

How would you build Active Record?

```
class Manager < ActiveRecord::Base
  has_one :department
end
```

```
class Module
 def my_attr(symbol)
  class_eval "def #{symbol}; @#{symbol}; end"
  class_eval "def #{symbol}=(value); @#{symbol} = value; end"
 end
end
```

The Clojure Compilation Pipeline



The whole language always available*

- Homoiconic
  - A program is a data structure (AST)
  - "Code is data is code"
- A **macro** is a function that transforms the program data at compile-time
- Functions are data structures, too.
- Clojure at compile-time, Clojure at runtime.

** Paul Graham, What Made Lisp Different, 2002*

Adding “unless” to Clojure

```
(defmacro unless
  [test & body]
  (list 'if test nil (cons 'do body)))
```

```
(macroexpand-1 '(unless (neg? x)
                        (println "x is non-neg")))

;; expands to
(if (neg? x)
    nil
    (do (println "x is non-neg")))
```

Read

Macro eval

Compile

* Actually, this is the Clojure when-not macro

CONCLUSIONS

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Concurrency / locks	**Software Transactional Memory** Message based concurrency Offline lock patterns, ...
Composability	**Common abstractions**, higher-order functions
Limitations of implementation language	**Macros** DSLs, Design patterns

Where to go from here

IDEs

- Emacs SLIME
- Clojurebox (Emacs)
- Eclipse "Counter clockwise"
- NetBeans "Enclojure"
- Intelli/J "La Clojure"
- Visual Studio "vsClojure"

Online REPL

www.tryclj.com

Tools

- Leiningen package management, build ... http://leiningen.org/
- www.clojure.org

Thank you

Husk at udfylde evalueringsskema:

http://bit.ly/cd**2013**b3

Download the slides and examples:

https://github.com/mjul/clojure-communityday-2012

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http://bit.ly/cd**2013**b3