Thinking the Clojure Way

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GOTO Cph, May 13th 2011

Rejoice, Clojure is simple

Coding along/against
Singing with

à la carte

Rejoice, Clojure is simple

Small regular syntax

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Simple does ***not*** mean familiar

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Simple does *not* mean familiar

Simple means *not compound*

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Clojure is made of simple things

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Simple does <u>*not*</u> mean familiar

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Clojure is made of simple things

Small set of independent concepts

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Small set of independent concepts

One concept at a time

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- Small regular syntax
- Simple does *not* mean familiar
- Simple means *not compound*
- Clojure is made of simple things
- Small set of independent concepts
- One concept at a time

One bite at a time

faire 4 groupes :
Syntax+FP
Rec+lazy seqs
polymorphism+types
interop+mutation

les deux derniers blocs devraient être animés pour être mis au même niveau

- Syntax
- Core Functional Programming
- Recursion and loops
- Lazy seqs (creating your owns)
- Polymorphism
- Types
- Macros
- Interop
- State management

Syntax

Literals

Numbers	`42 3.14 3/4 5.01M 43N`
Strings	`"Hello GOTO Cph"`
Characters	`\c \newline`
Keywords	`:a-key`
Symbols	`foo clojure.core/map`
Vectors	`[1 "two" :three]`
Maps	`{:key "val", :key2 42}`
Sets	`#{1 "two" :three}`
Regex	`#"a.*b"`
null	`nil`
booleans*	`true false`

*anything but *false* and *nil* is true

What about lists?

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Abstracted away by sequences

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Survive mostly for code representation

Lists are for code

```
(defn abs [n]
  (if (neg? n)
    (- n)
    n))
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Pro tip: Lisp code is a stereogram
Cross your eyes to see parens in the right place

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defn abs [n](
  if  neg?(n)(
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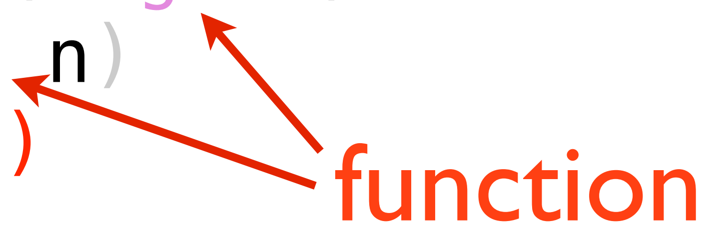

Lists are for code

```
(defn abs [n]
  (if (neg? n)
    (- n)
   n))
```

macro

function

Lists are for code

```
(defn abs [n]
  (if (neg? n)
    (- n)
   n))
```

macro

special form

function

That's all about syntax!

Functional Programming

Clojure’s FP

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Impure

Clojure’s FP

Impure

Persistent collections

Clojure's FP

Impure

Persistent collections

Strictly evaluated

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But lazy sequences

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- Not strictly lazy though!

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Persistent collections

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Vectors, maps and sets

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Common usecases:

Persistent collections

Vectors, maps and sets

Common usecases:

- Vectors as tuples

Persistent collections

- Vectors, maps and sets
- Common usecases:
  - Vectors as tuples
  - Vectors as stacks

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- Maps as data

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- Map as index, summary

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Common usecases:

- Vectors as tuples
- Vectors as stacks
- Maps as data
- Map as index, summary
- Sets as containers, relations

Sequences

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First, what are sequences?

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Abstraction over linked lists

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List-like views over data

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- Support `first` and `rest`

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- Replace indices

Lazy sequences

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Allow to process big data

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  or big intermediate values

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Allow to process big data

or big intermediate values

```
(->> (slurp "access.log") split-lines (map count)
  (filter odd?))
```

Lazy sequences

Doesn't matter w/ strict evaluation

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Realization can go ahead of consumption

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Not suitable for control flow

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Lazy sequences

Realization can go ahead of consumption

- Not suitable for control flow
- Better locality, less churn

Doesn't matter w/ strict evaluation

That’s all about FP!

Clojure spirit

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Pragmatism

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Correctness

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Uniform interfaces

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Data over functions

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Uniform interfaces

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Sequences as computation media

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Reftypes as mutation patterns

Pragmatism

Hosted on the JVM

Embrace the host limitations

 to be a better guest

Excellent Java interop

Performance over purity

LISP

Correctness

- No silent error
- Correct result or failure
- Non-negotiable
  - See 1.2 -> 1.3 numerics changes
  - Unless the user opts in

Uniform interfaces

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Widespread small interfaces

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Tons of helpers fns built upon

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It is better to have 100 functions operate on one data structure than 10 functions on 10 data structures.

– Alan Perlis

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It is better to have 100 functions operate on one data structure than 10 functions on 10 data structures.

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*It is better to have 100 functions operate on one **abstraction** than 10 functions on 10 data structures.*

– Rich Hickey

Uniform interfaces

```
=> (-> {:product-id "ACME123", :description "Powder
water"} keys sort)
(:description :product-id)
```

```
=> (-> (javax.swing.JFrame.) bean keys sort)
(:JMenuBar :accessibleContext :active :alignmentX
:alignmentY :alwaysOnTop :alwaysOnTopSupported
:background :bufferStrategy :componentCount :components
:containerListeners :contentPane :cursorType
:defaultCloseOperation ...)
```

Data over functions

- Large reuse of core collection fns
  - Less specific code
- Data go out of the process
  - Don’t be too clever
- A schema is a good API

Data over functions

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How to enforce invariants

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- How to enforce invariants
  - Write a validator function

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  - Use it in fns pre- and post-conditions

Data over functions

- How to enforce invariants
  - Write a validator function
  - Use it in fns pre- and post-conditions
  - Use it in reftypes validators

Sequences as pipes

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Sequences as ephemeral media of computation

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Each stage of a pipeline yields its own seq

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db, network, persistent collection etc.

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Mutation patterns

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Application state management:

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- Refs, atoms and agents

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Execution or dataflow management:

Mutation patterns

Reftypes embody mutation patterns

Application state management:

- Refs, atoms and agents

Program state management:

- Vars

Execution or dataflow management:

- Promises, delays and futures

How to think functionally?

Break your habits

Tie your imperative hand behind your back!

Tie your OO hand too!

Features

Syntax

Core Functional Programming

Recursion and loops

Lazy seqs (creating your owns)

Polymorphism

Types

Macros

Interop

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Allowed subset

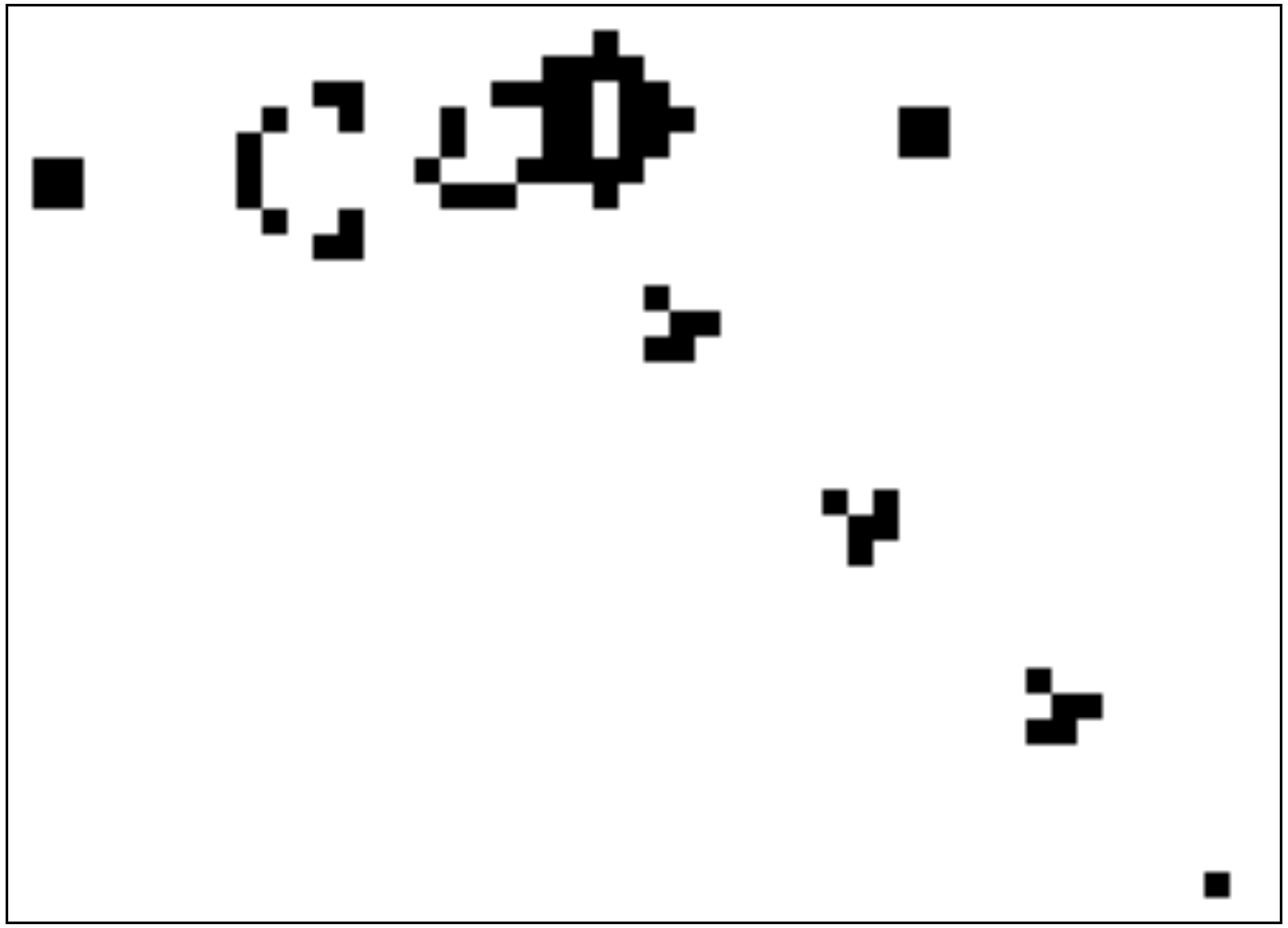
Pure Functional Programming

- without recursion nor loops
- without `lazy-seq`
- without indices

Do it until it hurts!
(and works)

Do it especially for ill-suited problems!

Example:
Conway's game of life



Rules

At each step in time, the following transitions occur:

- Any live cell with fewer than two live neighbours dies, as if caused by under-population.
- Any live cell with two or three live neighbours lives on to the next generation.
- Any live cell with more than three live neighbours dies, as if by overcrowding.
- Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.

(wikipedia)

Conway's game of life

Typical implementation is full of indices and loops

```
(defn step
 "Takes a vector of vectors of 0 and 1, and
  returns the next iteration of the automaton."
 [board]
  (let [w (count board)
        h (count (first board))]
    (loop [i 0 j 0 new-board board]
      (cond
        (>= i w) new-board
        (>= j h) (recur (inc i) 0 new-board)
        :else
          (let [n (neighbours-count board i j)
                nb (cond
                     (= 3 n) (assoc-in new-board [i j] 1)
                     (not= 2 n) (assoc-in new-board [i j] 0)
                     :else new-board)]
            (recur i (inc j) new-board))))))
```

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```

Conway’s game of life

And there’s more!

```
(defn neighbours-count [board i j]
  (let [i+1 (inc i) j+1 (inc j)]
    (loop [cnt 0 x (dec i) y (dec j)]
      (cond
        (> x i+1) cnt
        (> y j+1) (recur cnt (inc x) (dec j))
        (= [x y] [i j]) (recur cnt x (inc y))
        :else (recur (+ cnt (get-in board [x y] 0))
                     x (inc y))))))
```

Conway's game of life

And there's more!

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(defn neighbours-count [board i j]
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Look, no indices

At each step in time, the following transitions occur:

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(wikipedia)

Take a step back!

Look, no indices

At each step in time, the following transitions occur:

- Any live cell with fewer than two live **neighbours** dies, as if caused by under-population.
- Any live cell with two or three live **neighbours** lives on to the next generation.
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(wikipedia)

Neighbours!

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Try to express the rules in code using the **neighbours** concept

Neighbours!

Try to express the rules in code using the **neighbours** concept

Don't worry about the implementation of **neighbours**

Neighbours!

Neighbours!

For each living cell or neighbour of a living cell, compute the number of neighbours.

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Then apply generation rules.

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Compute all neighbours of the living cells.

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Occurences count is neighbour count!

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Neighbours!

```
(defn step
  "Takes a set of living cells and returns the next
generation (as a set too)."
  [living-cells]
  (letfn [(alive [[cell cnt]]
            (when (or (= cnt 3)
                      (and (= cnt 2) (living-cells cell)))
              cell))]
    (->> living-cells (mapcat neighbours) frequencies
      (keep alive) set)))
```

Neighbours!

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```

Neighbours!

```
(defn neighbours [[x y]]
  (for [dx [-1 0 1]
        dy (if (zero? dx) [-1 1] [-1 0 1])]
    [(+ x dx) (+ y dy)]))


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Drafting code

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Draft high-level code you’d like to be able to write **to solve the problem**

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Try to implement it

Drafting code

Don’t go to the details

Draft high-level code you’d like to be able to write **to solve the problem**

Try to implement it

Negociate between practicality of implementation and draft code

But it really hurts...

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Ask for help

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- Ask for help
  - #clojure on IRC

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  - Stackoverflow

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- create your local user group
- mail me christophe@cgrand.net