St. Louis Clojure

Clojure Schemata and Generators

Christopher Mark Gore

cgore.com

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We Write Clojure at The Climate Corporation, And We're Hiring!

Add Stuff to Your `project.clj`

```
1  (defproject your-project "1.2.3"
2    :description "It's␣like␣totally␣awesome␣and␣stuff"
3    ;; ...
4    :dependencies [;;...
5                   [prismatic/schema "0.4.3"]
6                   [org.clojure/test.check "0.7.0"]
7                   ;; ...
8                   ]
9    ;; ...
10   )
```

Prismatic Schema

Schemata[a] are sort of like types, but only as strict as you want them to be at that specific moment, so no type hell.

```
1 (ns schema-stuff
2   (:require [schema.core :as s]))
3
4 (s/validate s/Num 42)
5 (s/validate s/Str "howza")
6 (s/validate s/Keyword :hey)
```

[a]The plural of *schema* is *schemata*, not *schemas*.

Clojure `test.check` and Generators

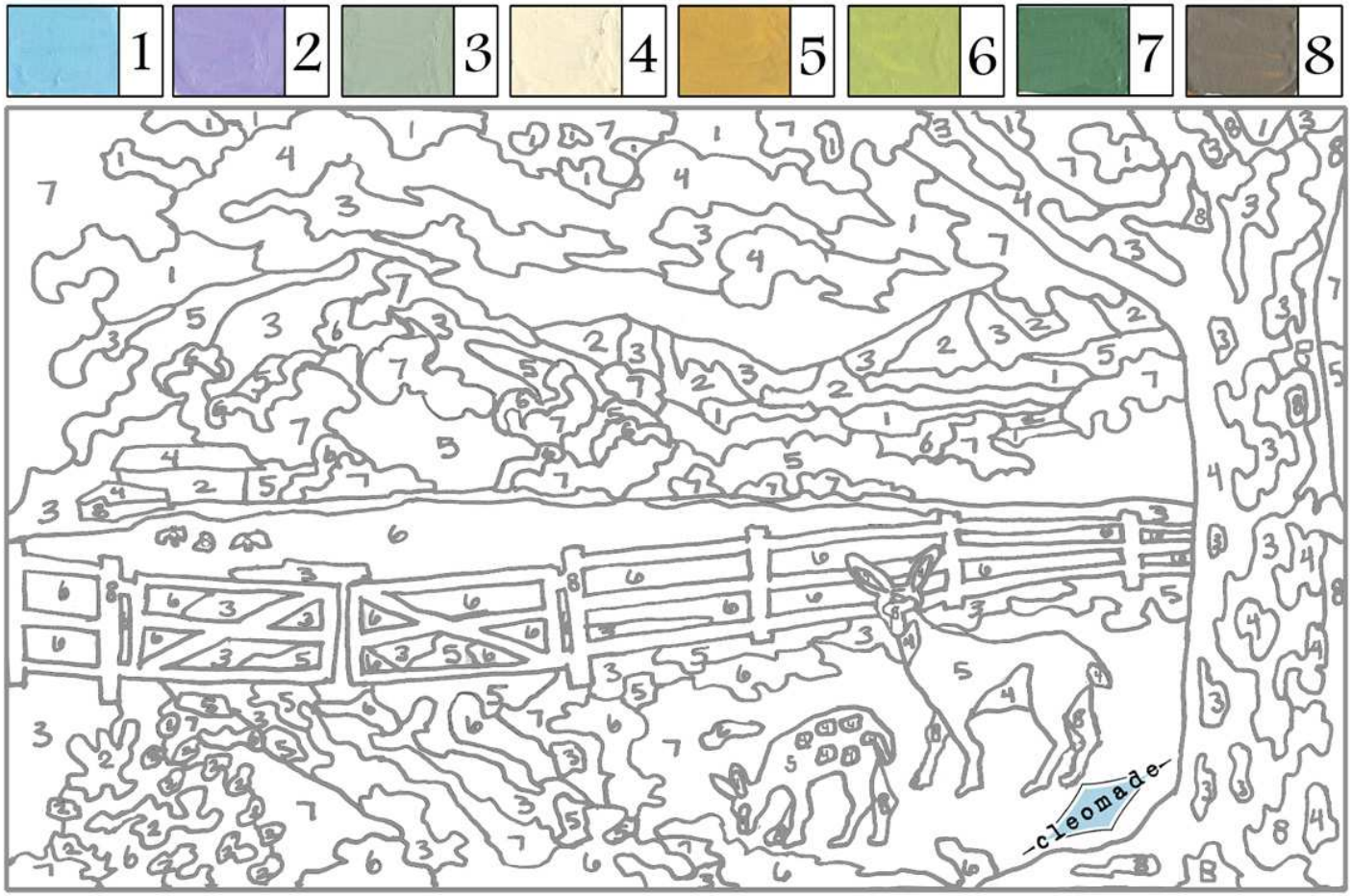
Generators make random examples according to a definition. It's a great way to make test data without brittle hand-rolled examples.

```
1 (ns gen-stuff
2   (:require [clojure.test.check :as tc]
3             [clojure.test.check.generators :as gen]
4             [clojure.test.check.properties :as prop]
5
6 (gen/sample gen/int)
7 ;; => (0 1 -1 0 -1 4 4 2 7 1)
8 (gen/sample gen/int 20)
9 ;; => (0 1 1 0 2 -4 0 5 -7 -8 4 5 3 11 -9 -4 6 -5 -3 0)
```

Schemata + Generators = Awesome!

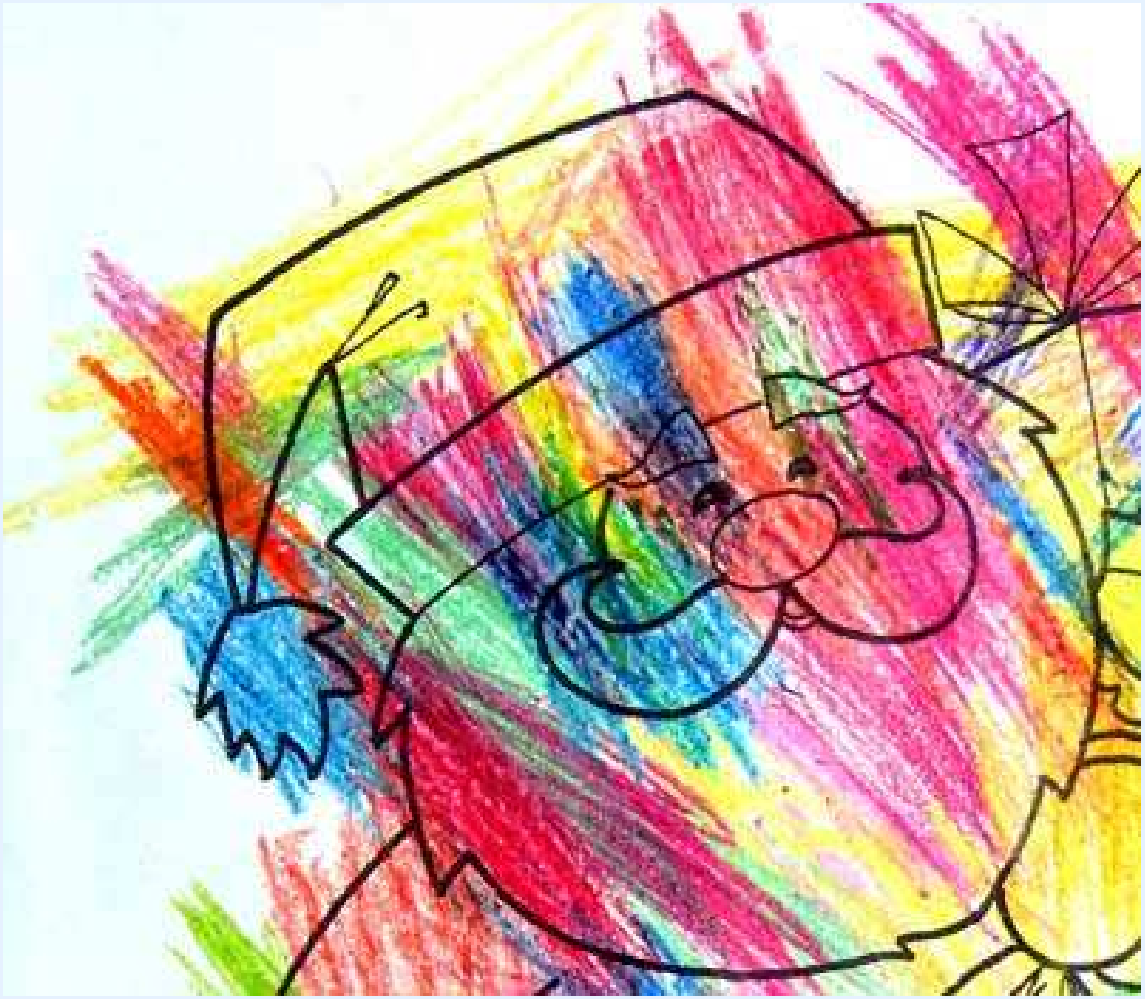
- Schemata to validate function input
  - Definitely in tests.
  - Maybe even in production.
- Generators to fuzz the function in tests.
- Feed the generators into the schemata.
  - Check the generator against the schema.
  - Check the schema with the generator.

Schemata are These



Generators are These

Used Together, We Catch When Our Code Does This



Schema: `validate` versus `check`

The two most important functions for schema checks are `validate` and `check`, the only real difference being that `validate` raises an error and check does not.

```
1 ;; A schema for integers.
2 (s/validate s/Int 42) ; passes, returns 42
3 (try (s/validate s/Int "nope") ; fails, throws an error.
4      (catch Exception e))
5
6 (s/check s/Int 42) ; => nil
7 (s/check s/Int "nope") ; => (not (integer? "nope"))
```

Test Check Properties

We define properties we expect to always hold, and assert those properties.

```
1  (def prop-addition-increments
2    (prop/for-all [a gen/int
3                   b gen/int]
4                  (>= (+ a b) a))) ; This is always true.
5  ;; Check 100 times
6  (tc/quick-check 100 prop-addition-increments)
7  ;; FAIL!  We forgot negatives!
8  {:result false, :seed 1434746134125, :failing-size 2,
9   :num-tests 3, :fail [1 -2],
10  :shrunk {:total-nodes-visited 4, :depth 2, :result false,
11           :smallest [0 -1]}}
```

Test Check Properties

We discover the *real properties* of our system this way, not just what we *think* they are.

$$[a + b \geq a] \forall a, b \in \mathbb{N} = \mathbb{Z} \cap [0, \infty)$$

```
1 ;; We meant for natural numbers [0,...)[a]
2 (def prop-addition-increments-for-nat
3   (prop/for-all [a gen/nat
4                  b gen/nat]
5                 (>= (+ a b) a))) ; This is REALLY true
6 ;; Check 100 times
7 (tc/quick-check 100 prop-addition-increments-for-nat)
8 ;; => {:result true, :num-tests 100, :seed 1434746600412}
```

[a] Somebody with a Ph.D. in mathematics might have told you that 0 isn't a natural number: they are wrong.

Our Schemata are Our Properties

Our schema must accept *all* instances, if not, it's not a valid schema, therefore we can state that the schema is a property *for all* of our generated examples.

```
(def Person {:name s/Str
             :age s/Int}) ; We'll make s/Nat in a bit.
(def person (gen/hash-map :name gen/string
                          :age gen/nat))
(def prop-person-generates-Person
  (prop/for-all [p person]
                (s/validate Person p)))
(tc/quick-check 100 prop-person-generates-Person)
```

Integrating `test.check` and `clojure.test`

There is a `defspec` macro to parallel `deftest` at `clojure.test.check.clojure-test/defspec`.

```
1 (defspec first-element-is-min-after-sorting
2           100 ; the number of iterations
3           (prop/for-all [v (gen/not-empty
4                             (gen/vector gen/int))]
5             (= (apply min v)
6                (first (sort v)))))
```

Names are Great, Two Are Better!

What is it	Schema	Generator
strings	`Str`	`string`
real numbers	`Num`	*missing*
$\mathbb{Z} = \{\ldots, -2, -1, 0, 1, 2, \ldots\}$	`Int`	`int`
$\mathbb{N} = \{0, 1, 2, \ldots\}$	*missing*	`nat` or `pos-int`
$\mathbb{Z}^+ = \mathbb{N} \setminus \{0\}$	*missing*	`s-pos-int`
$\mathbb{Z}^-$	*missing*	`s-neg-int`
$\mathbb{Z}^- \cup \{0\}$	*missing*	`neg-int`

Questions?