

Super-fun with First-class Shapes in Quil

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Where are we from?



UMM is a small liberal arts campus of UMN located 3 hours driving from Minneapolis/St.Paul.

What are we working on?

Specific goal: developing Clojure-based introductory CS course (*ClojurEd project*).

General goal: making Clojure more accessible to beginners and those with no Java background.

What does this include?

- 1 Beginner-friendly error messages.
- 2 Libraries and tools that allow beginners to explore functional approaches, recursion, and abstraction.
- 3 Integration into a beginner-friendly IDE.

What are we working on?

Developing Clojure-based introductory CS course (*ClojurEd project*).

General goal: making Clojure more accessible to beginners and those with no Java background.

What does this include?

- ① Beginner-friendly error messages.
- ② **Libraries and tools that allow beginners to explore functional approaches, recursion, and abstraction: graphical library.**
- ③ Integration into a beginner-friendly IDE.

Summer project 2015.

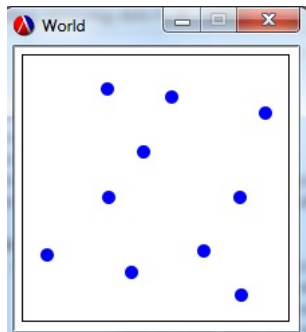
Beginner-friendly graphical library

Inspiration: Racket “universe” package <http://racket-lang.org/>

- Separation of Model, View, Control (MVC)
- Functional implementation of MVC: world state, functions:
old world state → new world state
world state → image
- First-class shapes (circles, rectangles, user-added jpegs, etc)
not attached to any position
- Functions to combine simpler shapes into complex shapes:
above, beside, overlay, scale...

Beginner-friendly graphical library: MVC

```
(define (main duration)
  (big-bang '() ; starts with an empty list of positions.
    [to-draw display-dots] ;draw dots on canvas
    [on-tick do-nothing 1 duration] ;dots don't move w/time
    [on-mouse add-or-remove-dot])) ;click handling
```



Beginner-friendly graphical library: first-class shapes

```
(define dot (circle 10 "solid" "blue"))

;; display-dots: list of positions -> image
(define (display-dots lop)
  (cond [(empty? lop) blank-scene]
        [else (place-image dot
                             (posn-x (first lop))
                             (posn-y (first lop))
                             (display-dots (rest lop)))]))

;; add-or-remove-dot: list of positions,
;; coordinates of click -> list of positions
.....
```


Odds and ends (not an actual slide)

Elena: Don't forget:

- ① Mention Racket influence
- ② Mention the author of Quil fun mode
- ③ Mention Tom Hall EuroClojure 2014

Dealing with the world as states

```
(defn setup []  
  (q/frame-rate 60)  
  (q/color-mode :rgb)  
  
  {:screen 0  
   :speed 1  
   :level 1  
   :box-1-points 0  
   :box-2-points 0  
   :box-1-pos {:x 0 :y (- (q/height) 50)}  
   :box-2-pos {:x (- (q/width) 50) :y (- (q/height) 50)}  
   :rocks []  
   :hit-player 0})
```

```
(defn update-state [state]  
  "Takes in the current state and returns the updated state.  
  Put functions that change your world state here"  
  
  {:screen 1  
   :speed (update-speed state)  
   :level (update-level state)  
   :box-1-points (update-box-1-points state)  
   :box-2-points (update-box-2-points state)  
   :box-1-pos (:box-1-pos state)  
   :box-2-pos (:box-2-pos state)  
   :rocks (update-rocks state)  
   :hit-player (hit-player state)})
```

```
(defn update-rocks [state]  
  (move-rocks  
   (if (spawn-rocks? state)  
       (assoc state :rocks (new-rock state))  
       state)))  
  
(defn update-speed [state]  
  (+ 1 (* 0.1 (quot (max (:box-1-points state)  
                          (:box-2-points state)) 50)))))
```

Shapes as First Class Objects

Thomas: like racket. Wanted to have shape object.
collage style.

- Racket-style implementation of shapes
- Shapes are treated as objects, modified through functions
- Shapes hold their specifications for drawing
- Easy to redraw wherever needed
- Easier to understand conceptually for students

Simple Shapes

Thomas: create shape template, then reuse when needed. Quil does it this way (ex)

- Quil shapes live in the draw function
- Quil shapes are functions to draw the shape

```
(defn draw-state [state]
  (q/background 100)
  (q/fill 0 255 0)
  (q/rect 300 300 100 200))
```

Our Shapes

Thomas: We do it this way (ex). Uses draw function.

- Our shapes are defined once in setup and reused when needed
- Our shapes are drawn through the draw-shape (or ds) function

```
(def green-rectangle  
  (create-rect 100 200 :green))  
  
(defn draw-state [state]  
  (q/background 100)  
  (ds green-rectangle 300 300))
```



Creating a Collage

Thomas: We do it this way (ex). Uses draw function.

- Functional Quil uses paintbrush approach
- Our firstclass-shapes use collage approach

Thomas: Talk about mvc differences here, get Elena to word it

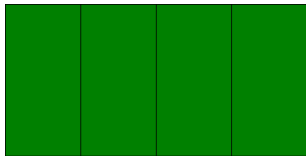
Complex Shapes

Thomas: creating complex shapes. deconstructable.

- Complex shapes are a collection of simple shapes
- Each simple shape holds their individual offsets
- Methods are used to create complex shapes from simple ones

```
(def green-rects
  (beside green-rectangle
    green-rectangle
    green-rectangle
    green-rectangle))

(defn draw-state [state]
  (q/background 100)
  (ds green-rects 300 300))
```



Above and Beside

Thomas: show above and beside (ex)

- Complex shapes are constructed through calling above or beside
- Can use reduce and map

```
(def green-scale-rects
  (above lime-green-rectangle
    light-green-rectangle
    green-rectangle
    dark-green-rectangle))

(defn draw-state [state]
  (q/background 100)
  (ds green-scale-rects 500 500))
```



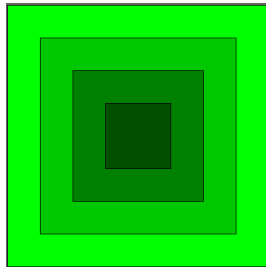
Overlay

Ryan: show overlay

- Complex shapes are also constructed through overlay

```
(def green-hole
  (overlay dark-green-rectangle
    green-rectangle
    light-green-rectangle
    lime-green-rectangle))

(defn draw-state [state]
  (q/background 100)
  (ds green-hole 500 500))
```



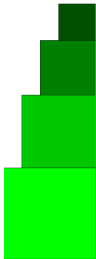
Align

Ryan: beside align overlay align etc. (ex)

- An align version of overlay, above, and beside exist

```
(def green-lean-right
  (above-align :right
    dark-green-rectangle
    green-rectangle
    light-green-rectangle
    lime-green-rectangle))

(defn draw-state [state]
  (q/background 255)
  (ds green-lean-right 500 500))
```



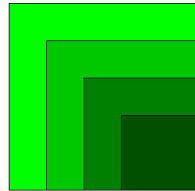
```
(def green-hill
  (beside-align :bottom
    dark-green-rectangle
    green-rectangle
    light-green-rectangle
    lime-green-rectangle))

(defn draw-state [state]
  (q/background 255)
  (ds green-hill 500 500))
```



```
(def green-align-bottom-right
  (overlay-align :bottom :right
    dark-green-rectangle
    green-rectangle
    light-green-rectangle
    lime-green-rectangle))

(defn draw-state [state]
  (q/background 255)
  (ds green-align-bottom-right 500 500))
```



Images

Thomas: images treated like shapes. Rotate, applying most of the functions.

- images can be rotated and scaled similar to shapes



```
(def cool-picture  
  (create-picture "/src/images/elena.png"))  
  
(scale-shape cool-picture 2 2)  
  
(defn draw-state [state]  
  (q/background 255)  
  (ds cool-picture 500 500))
```



Thomas: Put Beach example here

Simple Shape Structure

Ryan: Explain how the shape structure is set up.

- As a data structure, simple shapes are hash's
- Shapes hold a variety of information within them

```
{:w w
 :h h
 :tw w
 :th h
 :dx 0
 :dy 0
 :angle 0
 :ds (fn [x y pict wid hei cs angle]
       (if (> (count colors) 0)
         (apply f-fill colors)
         (no-fill))
       (with-translation [x y]
         (with-rotation [(/ (* PI angle) 180)] (f-rect 0 0 wid hei))
         (no-fill)))}
```

Complex Shape Structure

Ryan: Explain the complex shape structure

- Complex shapes are vectors of shapes
- Each shape knows its position from the core of the shape
- This allows for a 'deconstructable' complex shape

Thomas: explode example here

Draw-Shape Structure

Ryan: Explain how the draw-shape function works.

- Draw-shape calls the internal Quil draw function within the shape object
- Draw-shape also works on image objects

```
(rect-mode :center)
(image-mode :center)
(if (not (vector? shape))
  ((:ds shape) x y (:rp shape) (:w shape) (:h shape) (current-stroke) (:angle shape))
  (doall (map #((:ds %) (+ x (:dx %)) (+ y (:dy %)) (:rp %) (:w %) (:h %) (current-stroke) (:angle %)) shape)))
```


Future Work

- Make it easy to get the color information from shapes (currently color is hard-wired in drawing function).
- Add more functionality
 - Rotate complex shapes
 - Pixel-detail Overlay and Overlay-Align
 - Add support for text, textareas, etc.
 - More seamless integration with Quil fun-mode
- Add examples to the git repo.
- Wish-list: Integrate a Clojure sound library

Where to find it

Elena: Need to add the URL and the clojars

Similar Work

Similar (completely independent) work: first-class shapes by Tom Hall, EuroClojure 2014, based on geomlab library.

Acknowledgments

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