Improving Clojure Usablilty for Introductory Course

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HHMI Lunch Presentation

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Goals

- Integrate Clojure into an introductory CSci class
- Currently use Racket
  - Limited teaching language
  - Difficult to make complex projects
  - Students hitting performance issues

What is Clojure?

- Clojure is a programming language
- Built on top of the Java programming language
- Designed by Rich Hickey in 2007
- Functional (composition of functions)
- Built for concurrency (simultaneous computation)

Why use Clojure?

- Used in industry (real life)
- Better on resume
- Many programmers enjoy using Clojure
- Large community and excellent resources
- Large number of libraries (data processing, image recognition, graphical, musical)

Issues with Clojure

- Confusing error messages
- Missing graphics libraries for students

Error Messages

- Computers are literal
- Primary means of communication
- Inherently difficult to create

```
Henry:  Post office
```

Example Native Error

```
Exception in thread "main" clojure.lang.ArityException: Wro
at clojure.lang.Compiler.load(Compiler.java:7142)
at clojure.lang.Compiler.loadFile(Compiler.java:7086)
at clojure.main$load_script.invoke(main.clj:274)
at clojure.main$init_opt.invoke(main.clj:279)
at clojure.main$initialize.invoke(main.clj:307)
at clojure.main$null_opt.invoke(main.clj:342)
at clojure.main$main.doInvoke(main.clj:420)
at clojure.lang.RestFn.invoke(RestFn.java:421)
at clojure.lang.Var.invoke(Var.java:383)
at clojure.lang.AFn.applyToHelper(AFn.java:156)
at clojure.lang.Var.applyTo(Var.java:700)
at clojure.main.main(main.java:37)
Caused by: clojure.lang.ArityException: Wrong number of arg
at clojure.lang.AFn.throwArity(AFn.java:429)
```

Current Error Messages

- Incredibly awful
- Use strange terminology
- Meaningless to most people
- Extremely bulky

New Error Messages

- Interpret old errors
- Replace with new message
- Terminology that is friendly to novices
- Consistency within error messages

First iteration

```
Error: Wrong number of arguments (3) passed to a function c
Found in file core.clj on line 108 in function -main.
intro.core/-main (core.clj line 108)
```

Current message

```
Error: You cannot pass three arguments to a function cons,
Found in file core.clj on line 108 in function -main.
intro.core/-main (core.clj line 108)
```

Recent Improvements

- Fixed issues with arity (the number of arguments in a function)
- Made errors for infinite sequences useful
- Working on fixing line number reporting
- Fixed a large number of smaller issues

What is Quil?

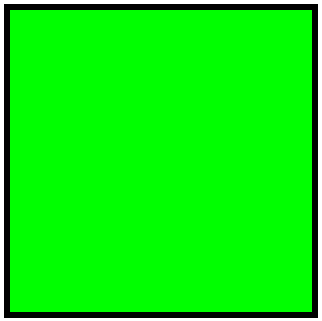
- Graphical Library for Clojure
- It can:
  - Draw shapes and images
  - Move objects on the screen
  - Make games, pictures, ect..

```
fun-mode
^

Quil
^

Clojure
^

Java
```

Quil's fun-mode isn't enough

- Quil ONLY takes draw commands
- Quil doesn't separate the model from the view
- Quil code can get confusing and long

```
(q/fill 80 255 80)
(q/rect 100 100 50 50)
(q/no-fill)
(q/no-stroke)
```



Designing super-fun-mode

- Built on top of fun-mode
- Gives students functions, colors, images, ect..
- Easy to read and change program code
- Allows for easy complex shapes

```
super-fun-mode
^
fun-mode
^
Quil
^
Clojure
^
Java
```

How super-fun-mode works

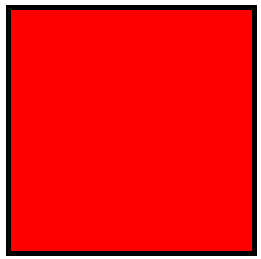
- You start by creating a shape

```
(def red-square
  (create-rect 50 50 :red))
```

- Note that creating a shape does not draw it

- From there, you can draw the shape

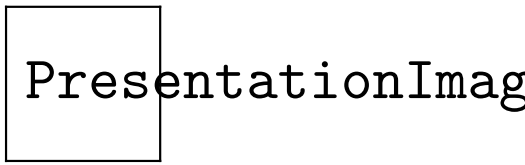
```
(draw-shape red-square 500 500)
```



super-fun-mode Complex Shapes

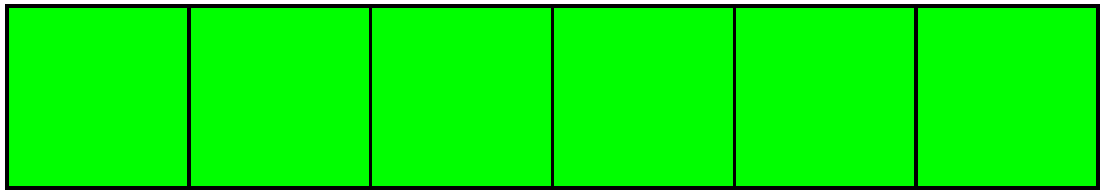
- You can put shapes together to make complex shapes

```
(def tower
     (above red-square
            orange-square
            yellow-square
            green-square
            blue-square
            violet-square))
```



Six Squares

- The difference becomes quite apparent with complexity



Quil Code

```
  (let [x 100
   num 6
   dist (+ 100 (* (\ num 2) 50))]
(q/fill 80 255 80)
(q/rect (- dist (* 1 50)) 100 50 50)
(q/rect (- dist (* 2 50)) 100 50 50)
(q/rect (- dist (* 3 50)) 100 50 50)
(q/rect (- dist (* 4 50)) 100 50 50)
(q/rect (- dist (* 5 50)) 100 50 50)
(q/rect (- dist (* 6 50)) 100 50 50))
(q/no-fill)
(q/no-stroke)
```

Our Code

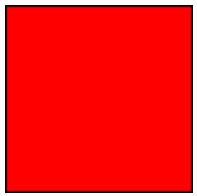
```
(def lime-rect
  (create-rect 50 50 :lime))

(def lime-rectangles
  (beside
    lime-rect lime-rect lime-rect
    lime-rect lime-rect lime-rect))
```

Rotation and Scaling

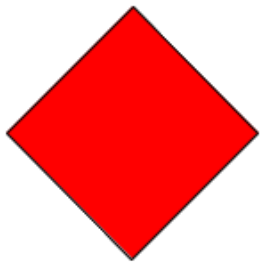
- You can modify the size and orientation of the shape

```
(rotate-shape red-square 45)
```

```
(scale-shape red-square 2 2)
```



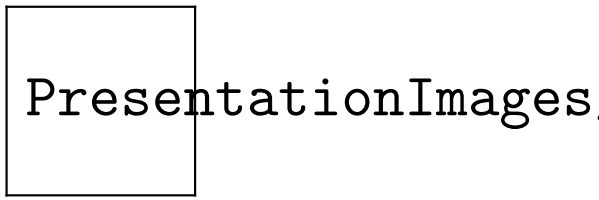
```
(rotate-shape
  (scale-shape red-square 2 2)
 45)
```



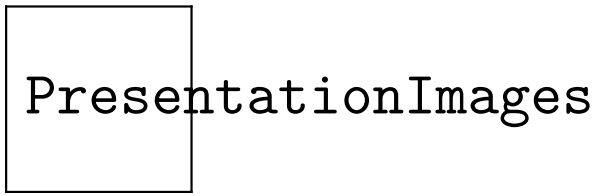
Overlaying and Complex Shapes

- You can put shapes on top of each other

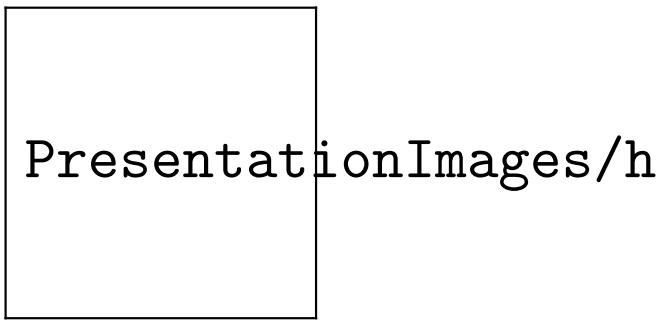
```
(overlay window roof)
```




```
(overlay-align :bottom :center
     door
     red-rect)
```




```
(scale-shape
  (above (overlay top bottom))
1.4 1.4)
```



Our Direction

- Less paintbrush, more collage
- Create shapes, not just draw them
- Easier student code
- Give students an idea of how good software should be built

A Few Examples

Please Enjoy a Few Live Examples

Future Work

- Fill out more functionality
  - Rotate more complex shapes
  - Pixel-detail Overlay and Overlay-Align
  - More seemless integration with Quil fun-mode
- Open Source the project
- Integrate a Clojure sound library
- Present at Twin Cities Clojure Meetup, MN on June 8th

Acknowledgments

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Thank you!
Any questions?