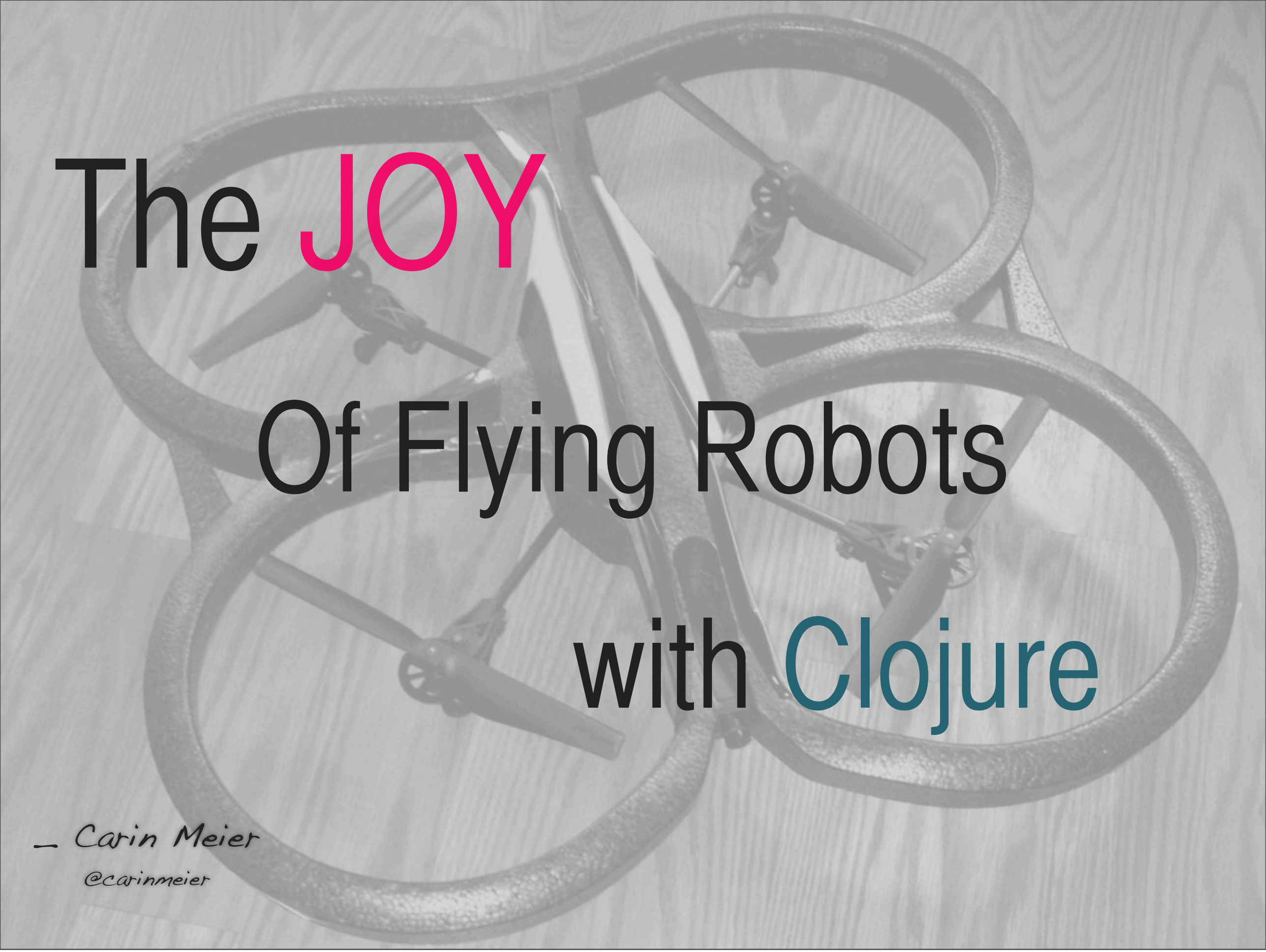


The JOY Of Flying Robots with Clojure

_ Carin Meier

@carinmeier

Long Ago
In a time before

Long Ago

In a time before

mobile phones

Long Ago

In a time before

mobile phones

personal computers

ordinary girl

SESAME STREET


SAM

ROBOT FRIEND

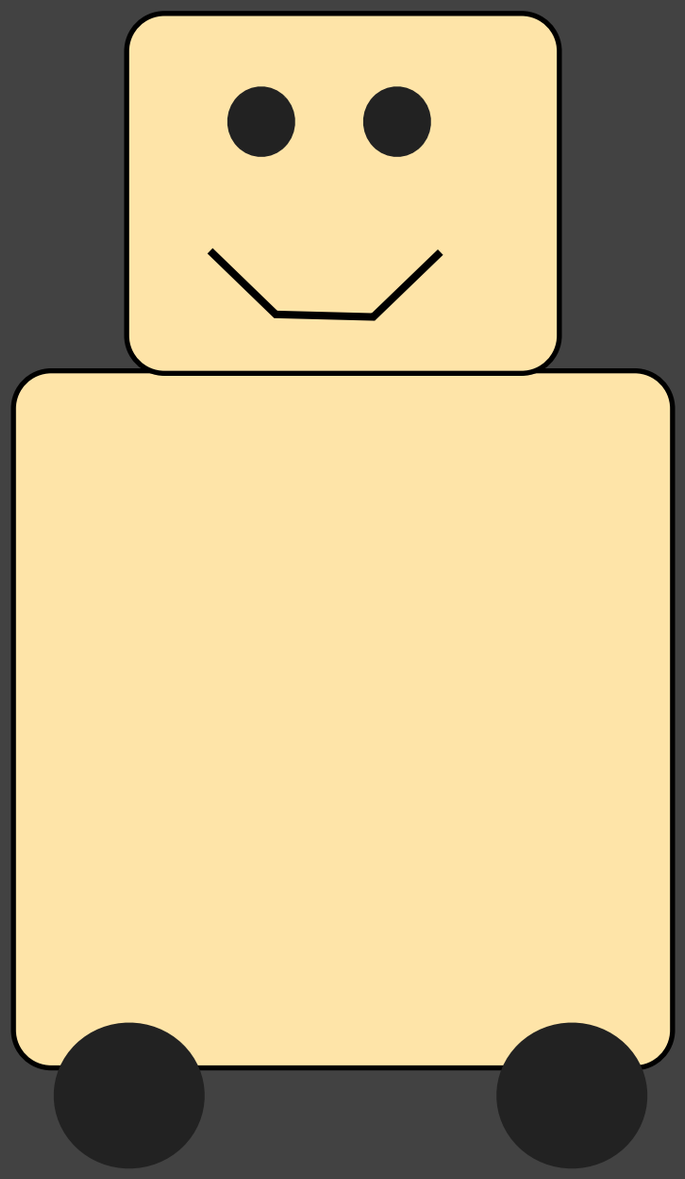
ROBOT FRIEND

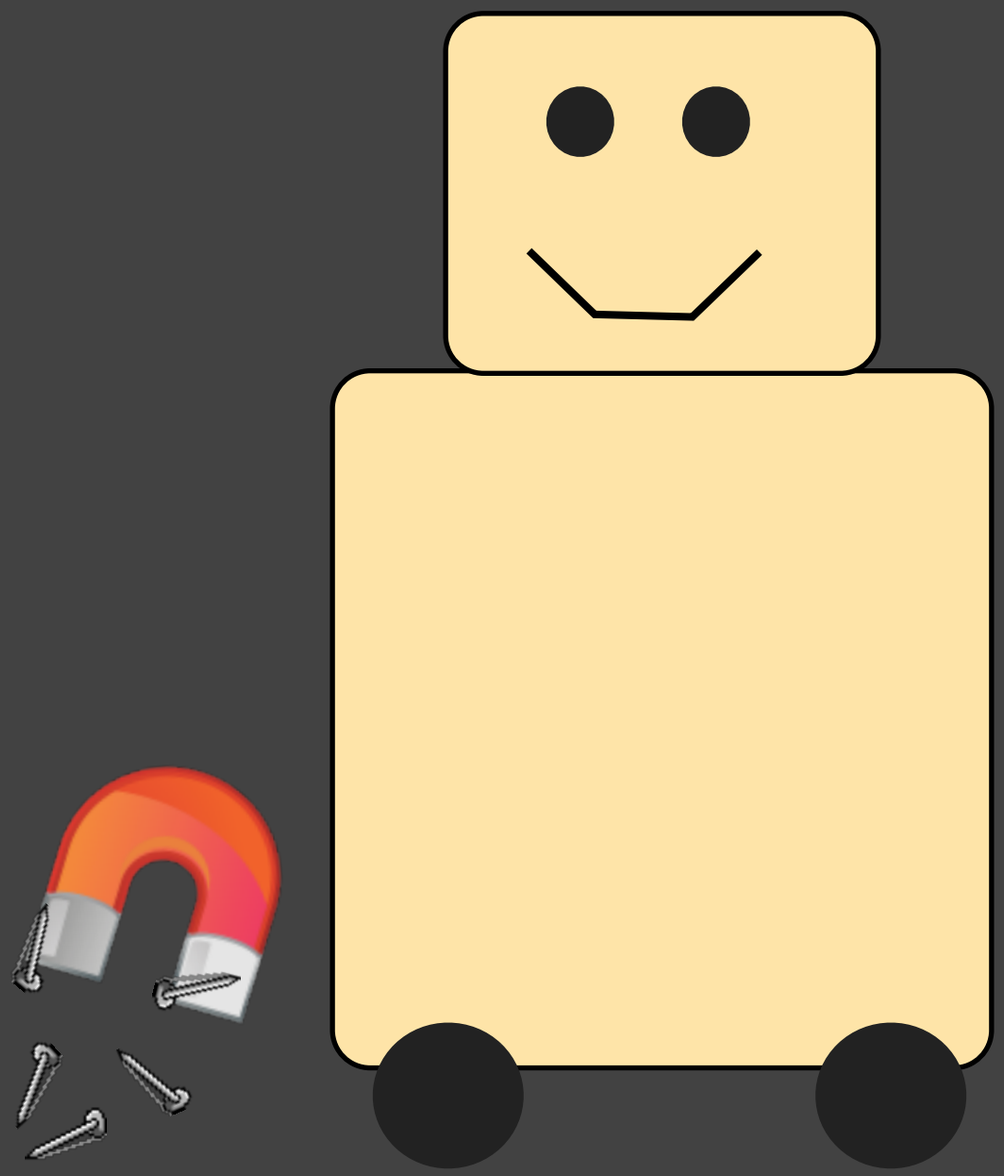
~~dolls~~

ROBOT FRIEND

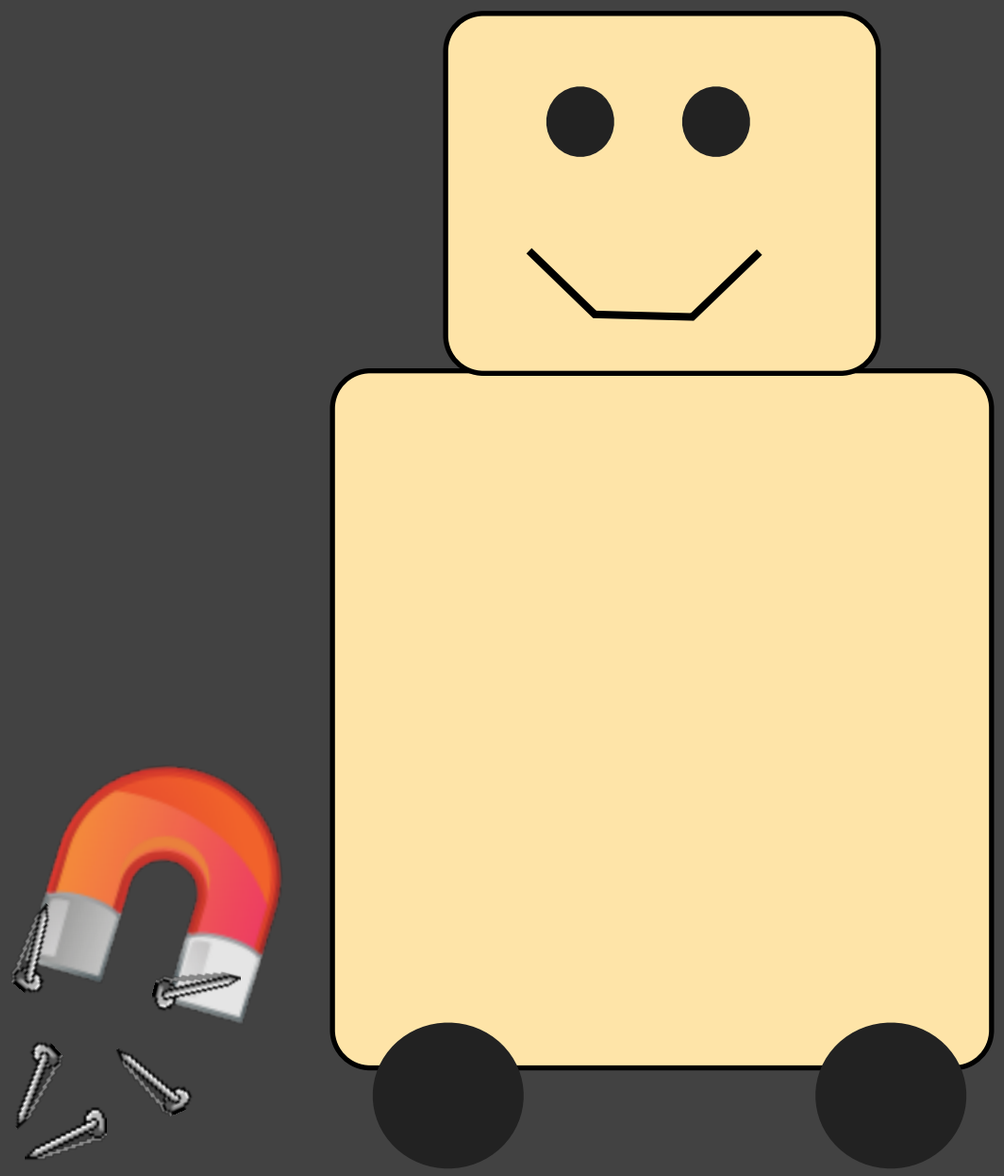
~~dolls~~

~~stuffed animals~~





ROBOT FRIEND



Years Passed

software developer

companies

languages

kids

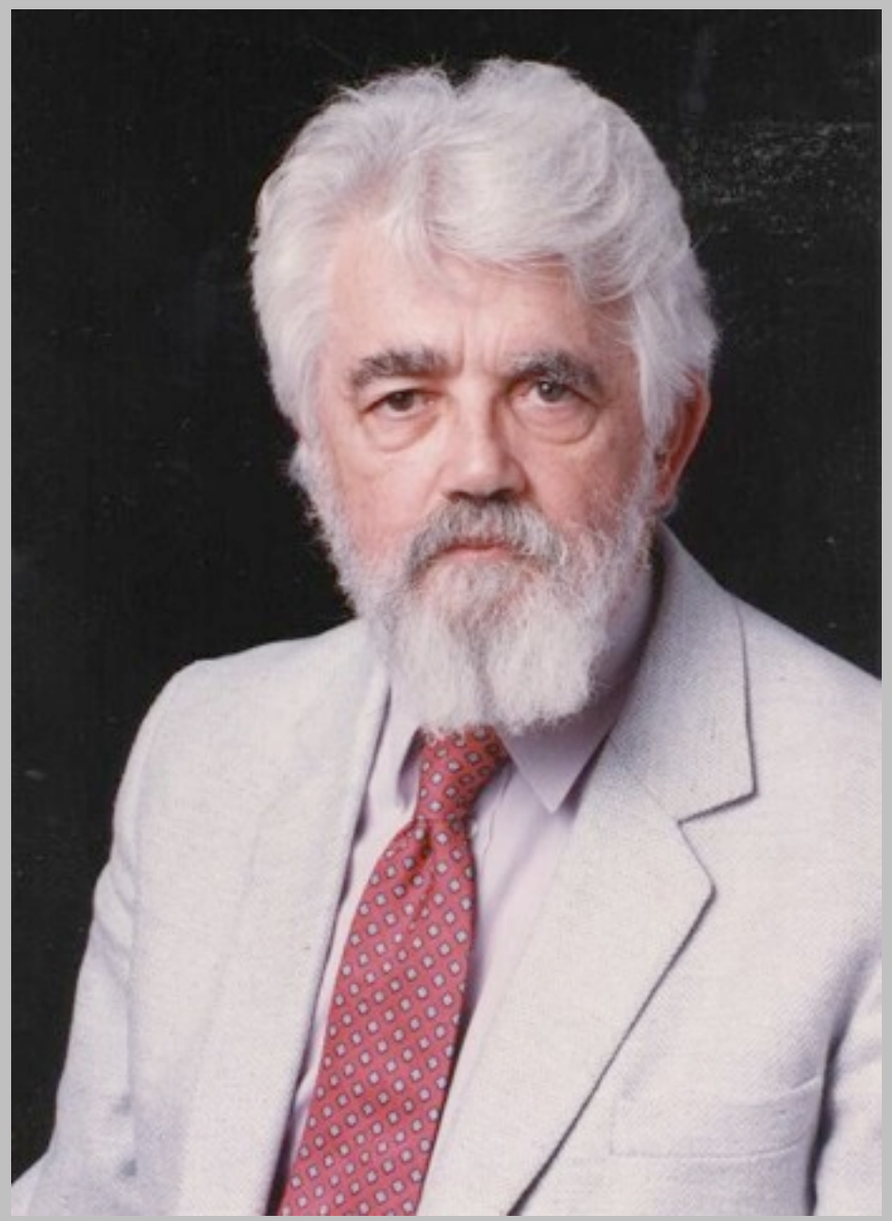
Hack Your Roomba

Hack Your Roomba

ROBOT FRIEND?

How do you talk to a robot?

LISP



Clojure

Clojure

Dynamic

Functional

Java Interop

Concurrency

Clojure

Dynamic

Functional

Java Interop

Concurrency

```
(def cat "cat")
;=> "cat"
```

Clojure

Dynamic

Functional

Java Interop

Concurrency

```
(defn say-hello [name]
  (str "hello " name))

(say-hello "roomba")
;=> "hello roomba"
```

Clojure

Dynamic

Functional

Java Interop

Concurrency

```
(class "roomba")
 ;=> java.lang.String

(.toUpperCase "roomba")
;=> "ROOMBA"
```

Clojure

Dynamic

Functional

Java Interop

Concurrency

Immutable Data

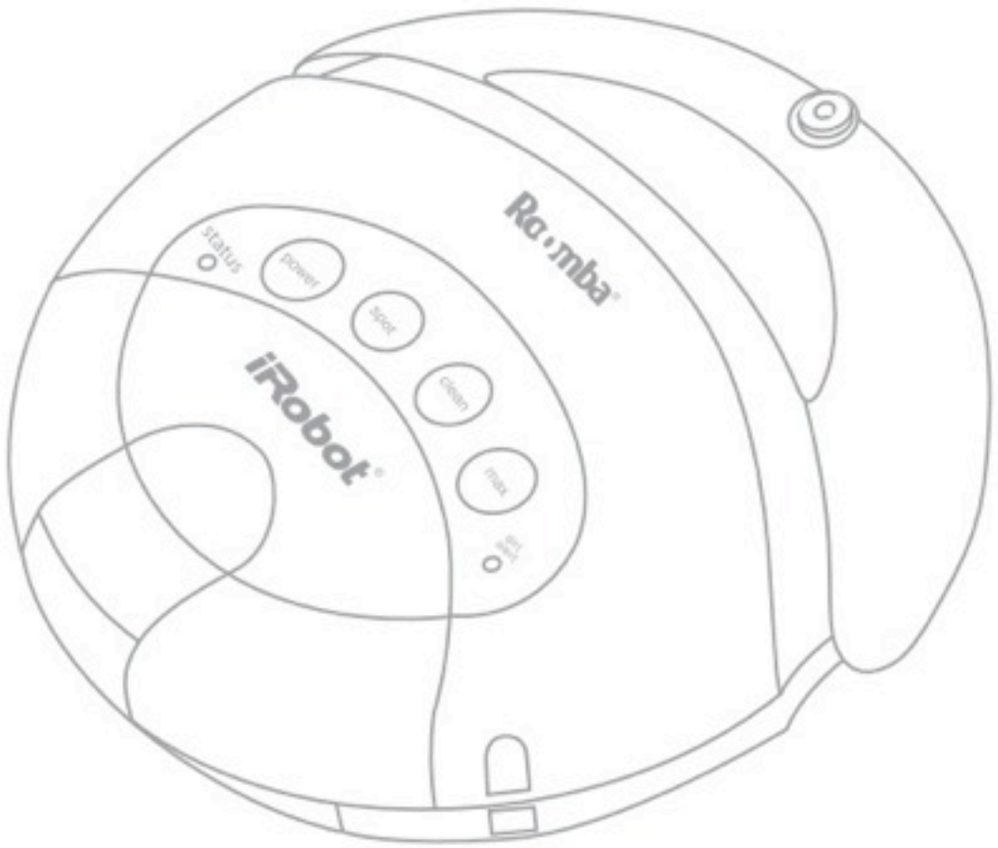
Vars

Refs

Atoms

Agents

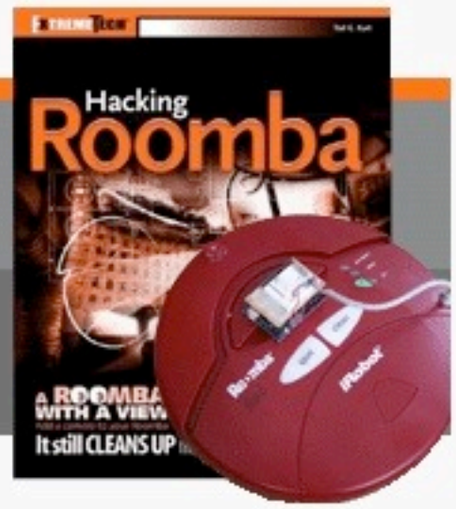
iRobot® Roomba®
Serial Command Interface (SCI) Specification



iRobot® Roomba®
Serial Command Interface (SCI) Specification

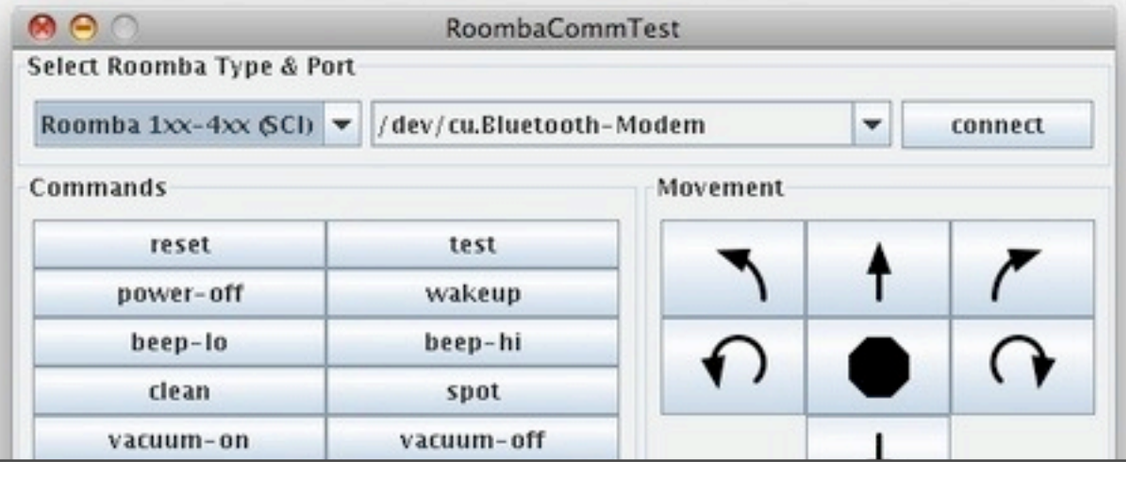
HACKING ROOMBA

.: GET THE BOOK .: NEWS .: PROJECTS .: CODE .: RESOURCES



RoombaComm

[NOTE: RoombaComm is now being actively maintained by Paul Bouchier, Jonathan Pitts & Matt Black (and occasionally me perhaps) on the Dallas Personal Robotics Group site. Check out RoombaComm's new home! This site will continue to mirror any RoombaComm updates by the DPRG folks. The DPRG site has many great projects and tutorials for building your own robots, be they Roomba-based or not. Thank you so much guys for giving RoombaComm some much-needed attention.]



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- Amazon
- Barnes & Noble
- Powell's

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- News
- Projects Repository
- Code Download
- Resources
- Gallery
- About Tod E. Kurt

.: BOOK CONTENTS

Roomba Demo

Backup Video

Just in case

Wednesday, July 10, 13

Happy Times :)

Robot Friend?

AR Drone

Quadcopter
Two Cameras
Sonar
Can Fly it with iPhone

AR Drone Developer Guide

Contents

UDP Communication

```
(ns clj-drone.baby-steps
  (:import (java.net DatagramPacket DatagramSocket
InetAddress)))

(def drone-host (InetAddress/getByName "192.168.1.1"))
(def at-port 5556)

(def socket (DatagramSocket. ))

(defn send-command [data]
  (.send socket
    (new DatagramPacket (.getBytes data) (.length data)
drone-host at-port)))

(def take-off "AT*REF=1,290718208\r")
(def land  "AT*REF=2,290717696\r")

(send-command take-off)
(send-command land)
```

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(send-command land)
```

OMG IT WORKED!!!!

clj-drone

```
(def commands
  {
    :take-off         {:command-class "AT*REF" :command-bit-vec [9 18 20 22 24 28]}
    :land             {:command-class "AT*REF" :command-bit-vec [18 20 22 24 28]}
    :emergency        {:command-class "AT*REF" :command-bit-vec [8 18 20 22 24 28]}
    :spin-right       {:command-class "AT*PCMD" :command-vec [1 0 0 0 :v] :dir 1}
    :spin-left        {:command-class "AT*PCMD" :command-vec [1 0 0 0 :v] :dir -1}
    :up               {:command-class "AT*PCMD" :command-vec [1 0 0 :v 0] :dir 1}
    :down             {:command-class "AT*PCMD" :command-vec [1 0 0 :v 0] :dir -1}
    :tilt-back        {:command-class "AT*PCMD" :command-vec [1 0 :v 0 0] :dir 1}
    :tilt-front       {:command-class "AT*PCMD" :command-vec [1 0 :v 0 0] :dir -1}
    :tilt-right       {:command-class "AT*PCMD" :command-vec [1 :v 0 0 0] :dir 1}
    :tilt-left        {:command-class "AT*PCMD" :command-vec [1 :v 0 0 0] :dir -1}
    :hover            {:command-class "AT*PCMD" :command-vec [0 0 0 0 0] :dir 1}
    :fly              {:command-class "AT*PCMD" :command-vec [1 :v :w :x :y] :dir 1}
    :flat-trim        {:command-class "AT*FTRIM"}
    :reset-watchdog   {:command-class "AT*COMWDG"}
  }
)
```

```
(def commands
  {
    :take-off         {:command-class "AT*REF" :command-bit-vec [9 18 20 22 24 28]}
    :land             {:command-class "AT*REF" :command-bit-vec [18 20 22 24 28]}
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    :fly              {:command-class "AT*PCMD" :command-vec [1 :v :w :x :y] :dir 1}
    :flat-trim        {:command-class "AT*FTRIM"}
    :reset-watchdog   {:command-class "AT*COMWDG"}
  }
)
```

```
(drone :take-off)
```

clj-drone

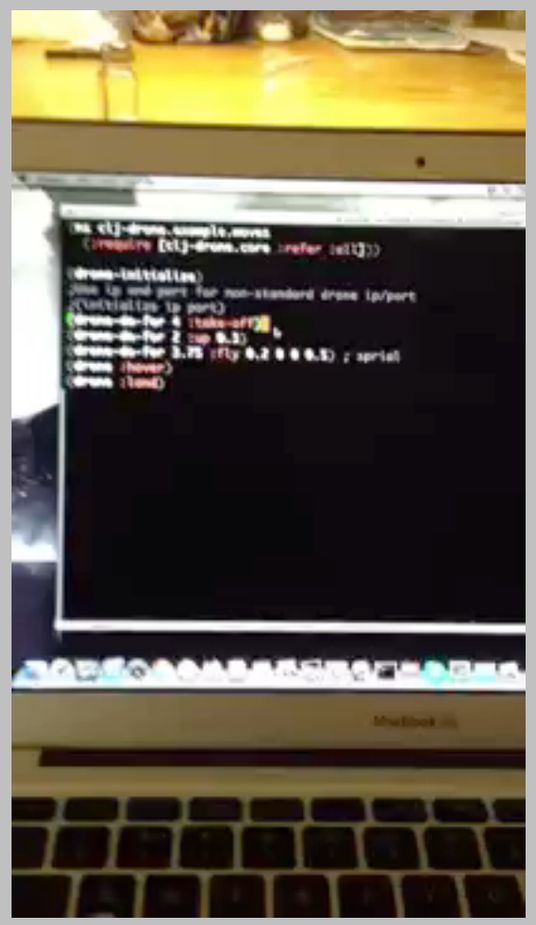
Show me the moves

Backup Video

just in case

Backup Video

just in case



Navigation Data

Navigation Data

@nav-data

All sorts of good streaming data

control-state : (flying, landed, hovering, etc...)
battery-percent
pitch
roll
yaw
altitude
velocity-x
velocity-y
velocity-z

Also vision tag (target) detection too.

All sorts of good streaming data

```
(set-log-data [:seq-num :battery-percent :control-state :detect-camera-type
               :targets-num :targets])
(drone-initialize)
(drone :init-targeting)
(drone :target-shell-h)
(drone :target-color-blue)
;; the drone will look for targets with blue tags on the horizontal camera
(drone :target-roundel-v)
;; the drone will look for the black and white roundel on the vertical
camera
(drone-init-navdata)
```

Vision Processing

Video comes in as raw H264 format

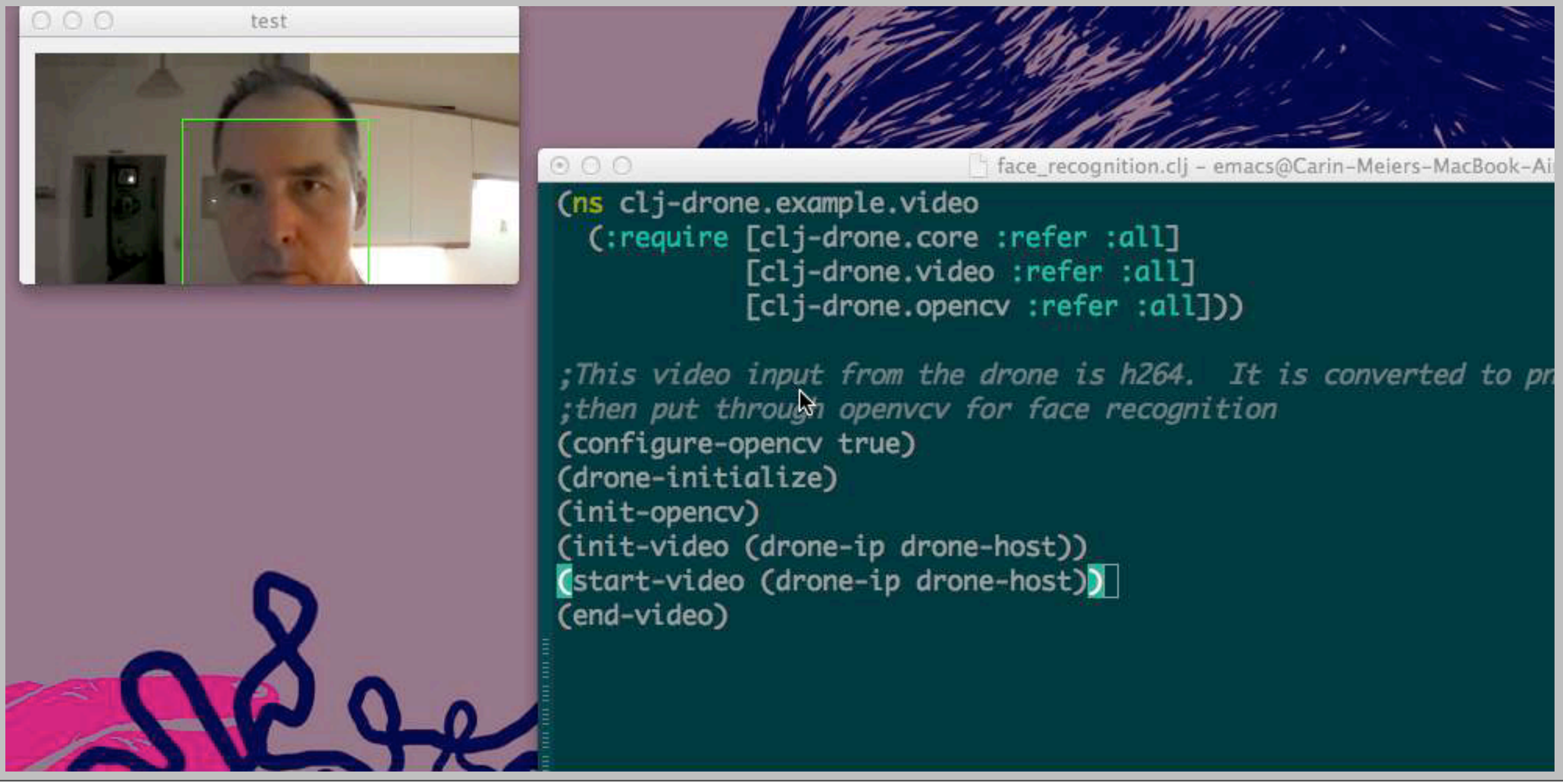
Can save raw feed

Display raw feed

Conversion to PNG for more processing...

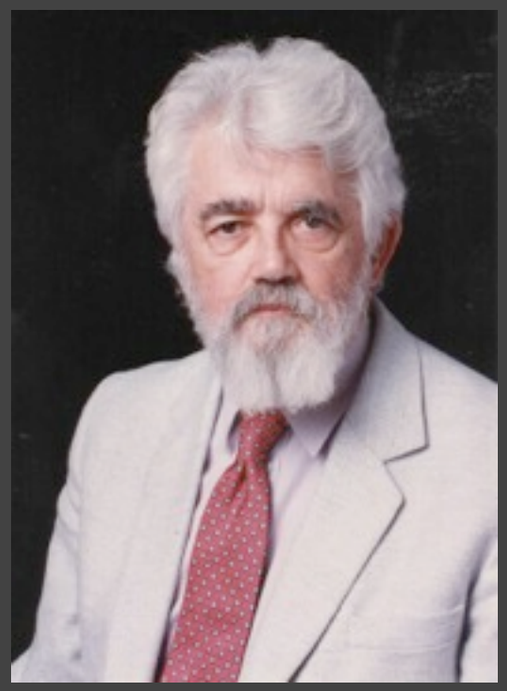
Facial Recognition!

OpenCV has Java Bindings



Something Missing

Beliefs and Goals



ASCRIBING MENTAL QUALITIES TO MACHINES

John McCarthy
Computer Science Department
Stanford University
Stanford, CA 94305
jmc@cs.stanford.edu
http://www-formal.stanford.edu/jmc/

1979

Abstract

Ascribing mental qualities like *beliefs*, *intentions* and *wants* to a machine is sometimes correct if done conservatively and is sometimes necessary to express what is known about its state. We propose some new definitional tools for this: definitions relative to an approximate theory and second order structural definitions.

Thermostat's Beliefs & Goals

Thermostat's Beliefs & Goals

The room is too cold

Thermostat's Beliefs & Goals

The room is too cold

The room is too hot

Thermostat's Beliefs & Goals

The room is too cold

The room is too hot

The room is just right

Thermostat's Beliefs & Goals

The room is too cold
The room is too hot
The room is just right

Goal: The room should be just right

Why?

Easier to understand and reason

Why?

Easier to understand and reason

Useful concept for building intelligent systems

```
(def-belief-action ba-landed
  "I am landed"
  (fn [{:keys [control-state]}]
      (= control-state :landed))
  (fn [navdata] (drone :take-off)))
```

```
(def-belief-action ba-taking-off
  "I am taking off"
  (fn [{:keys [control-state]}]
      (= control-state :trans-takeoff))
  nil)
```

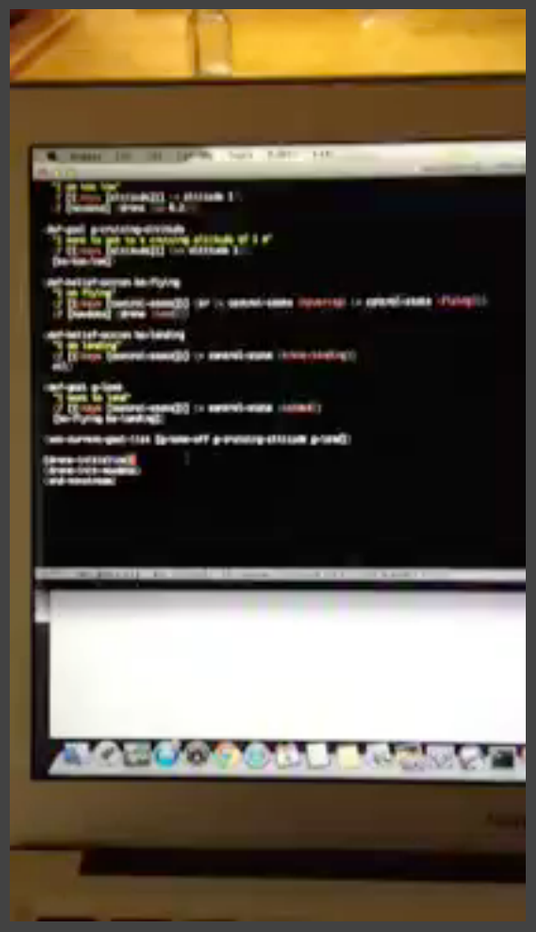
```
(def-goal g-take-off
  "I want to fly."
  (fn [{:keys [control-state]}]
      (= control-state :hovering))
  [ba-landed ba-taking-off])
```

```
(set-current-goal-list
 [g-take-off g-cruising-altitude g-land])
```

Flight with Beliefs and Goals Demo

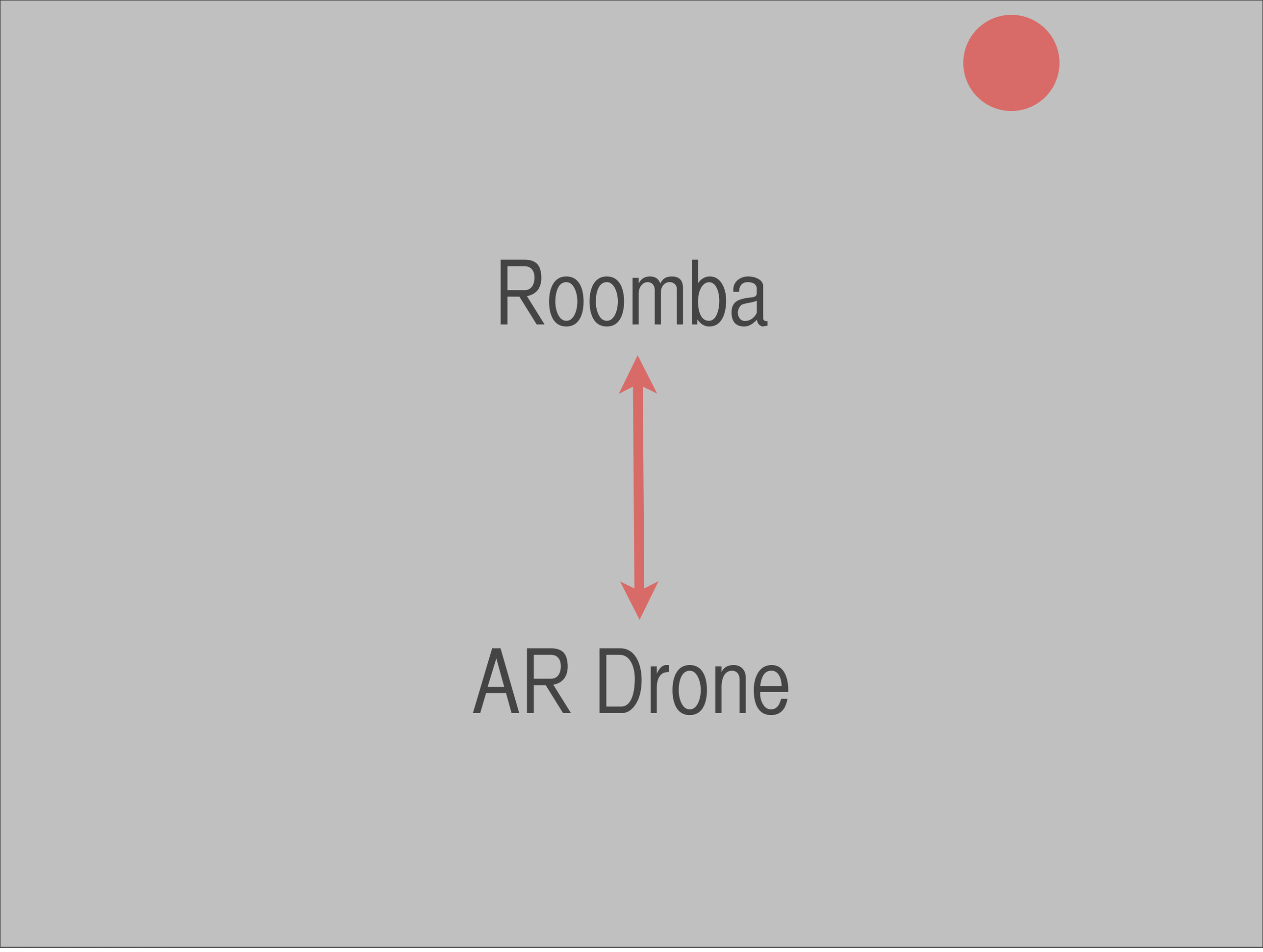
Flight with Beliefs and Goals Demo

Backup video



Roomba

AR Drone


Roomba
AR Drone

WALL·E

Roomba & Drone are Friends

Roomba & Drone are Friends

Backup Video ?

Recap

* Robots are great fun to program

Recap

* Robots are great fun to program
* Clojure is a powerful yet simple language – perfect for AI

Recap

* Robots are great fun to program
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* Ascribing beliefs and goals to machines can be useful

Recap

* Robots are great fun to program
* Clojure is a powerful yet simple language – perfect for AI
* Ascribing beliefs and goals to machines can be useful
* Robots communicating and acting together is the future

Resources

Github: gigasquid/clj-drone

Github: gigasquid/clj-roomba

Github: gigasquid/roomba-drone-friends

John McCarthy – Ascribing Mental Qualities to Machines

John McCarthy – All his papers

Credits

http://www.flickr.com/photos/midnightcomm/447335691/

http://good-wallpapers.com/cartoons/1934