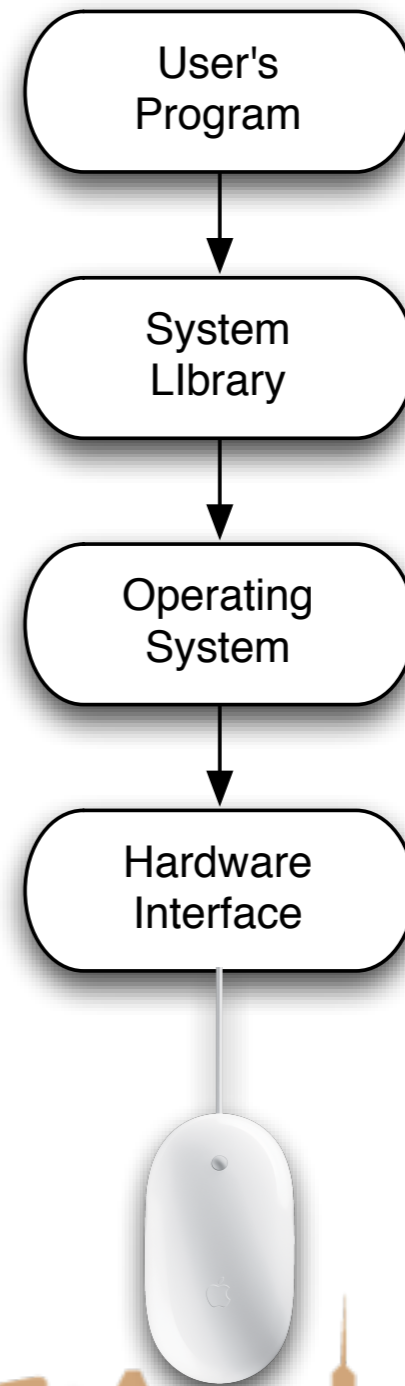
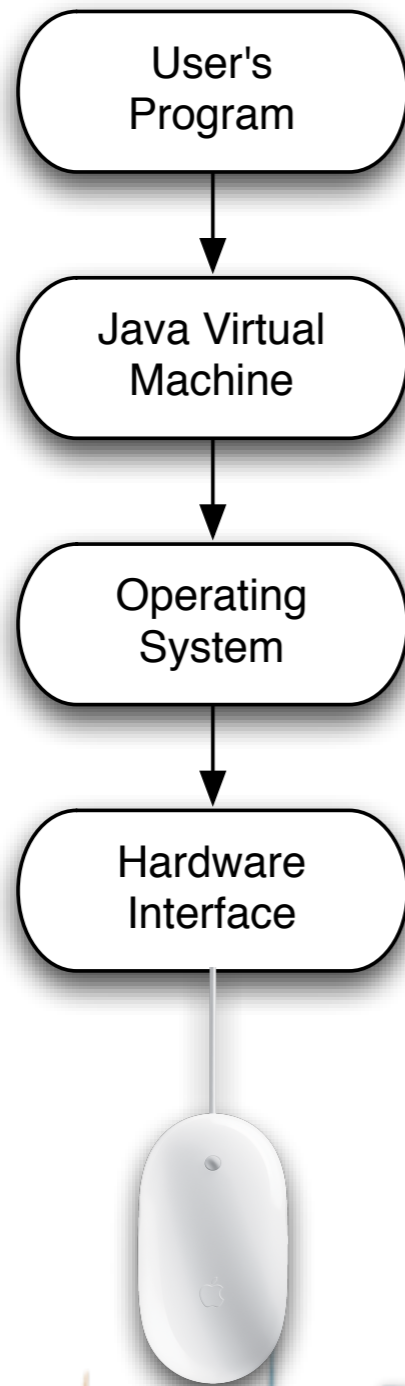


# User Interaction: Intro to Multi-Touch

Associate Professor Donald J. Patterson  
INF 133 Fall 2014

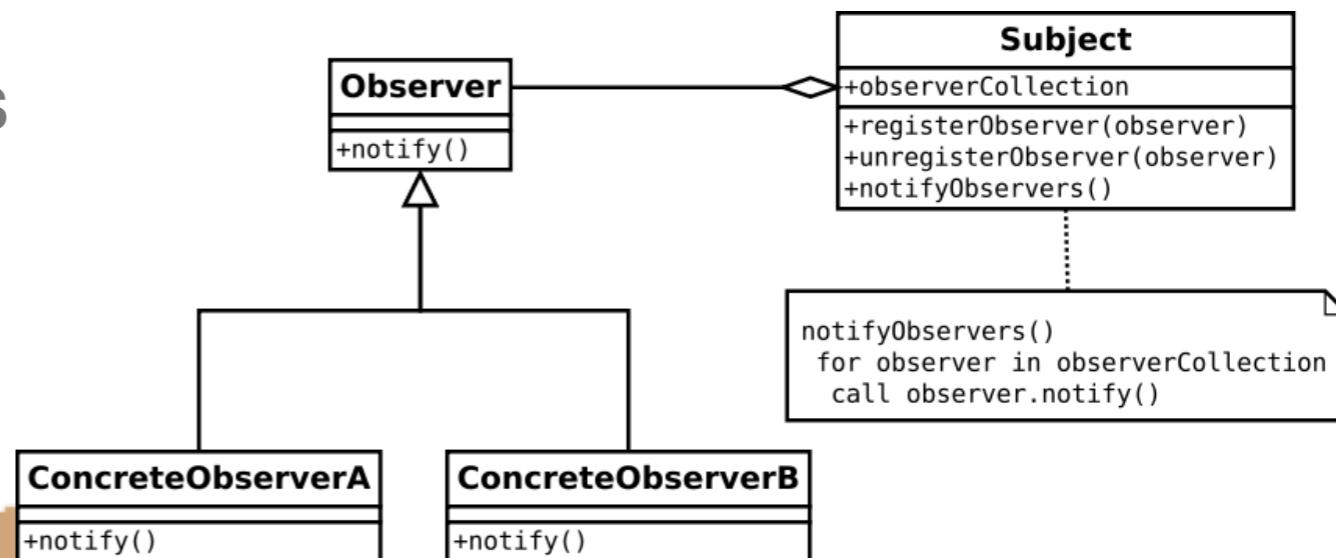


# Traditional Mouse Input



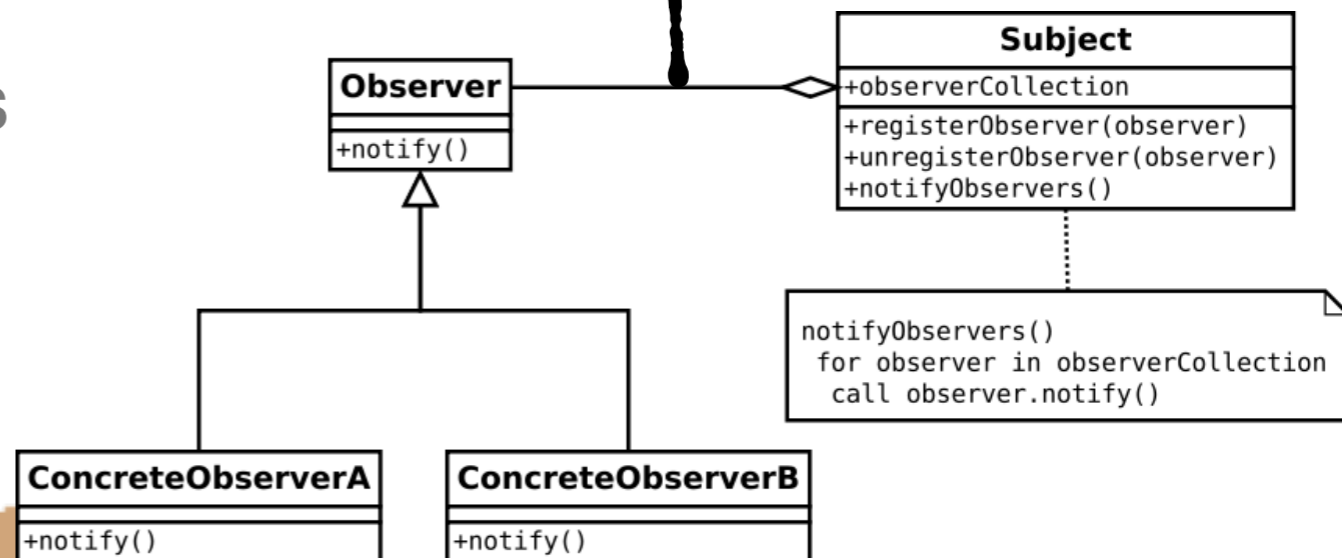
## Java uses a “MouseListener” model

- The developer asks the virtual machine to tell it when mouse events occur
  - Mouse movements
  - Mouse button press, release, click
    - button 1,2,3
  - Mouse wheel movements



## Java uses a “MouseListener” model

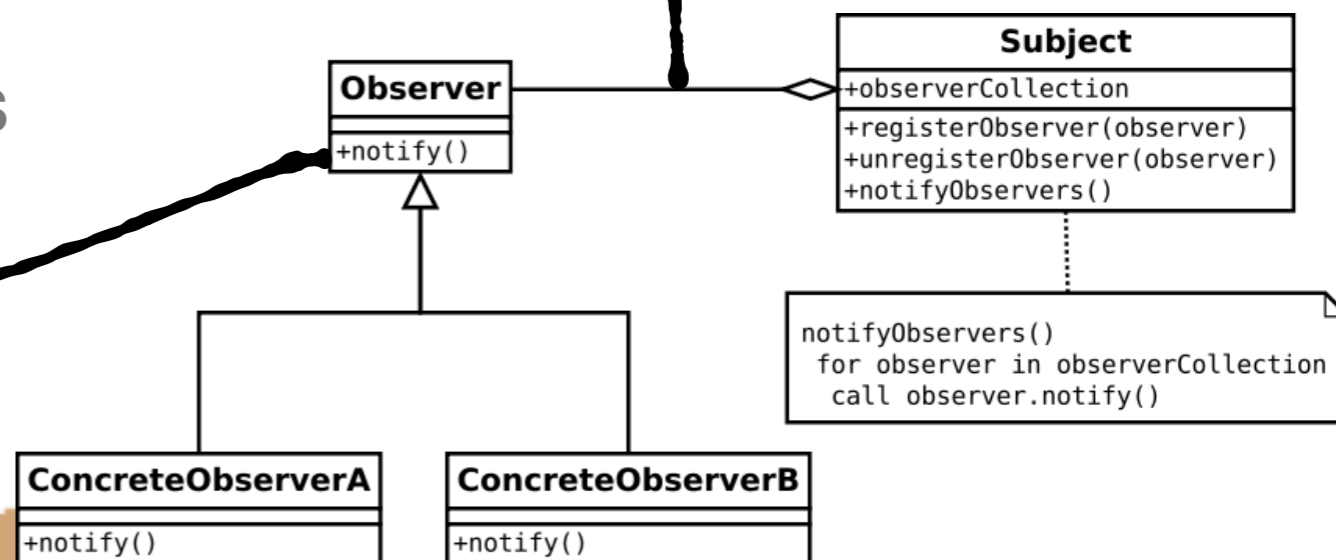
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- Mouse movements
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  - button 1,2,3
- Mouse wheel movements





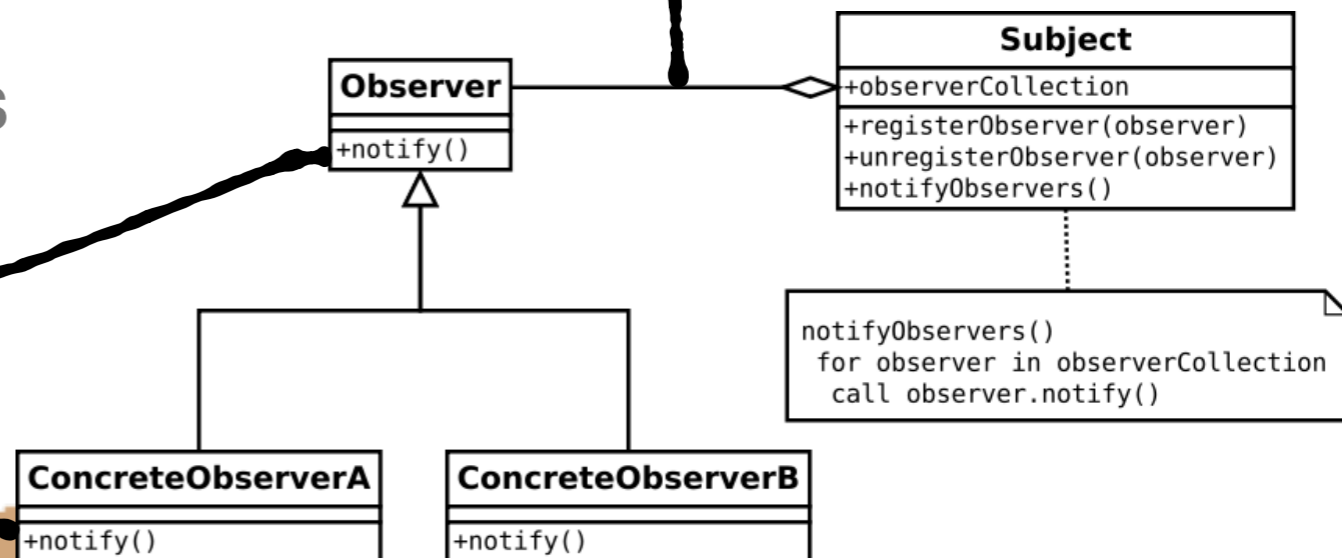
## Java uses a "MouseListener" model

- The developer asks the virtual machine to tell it when mouse events occur
  - Mouse movements
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    - button 1,2,3
  - Mouse wheel movements

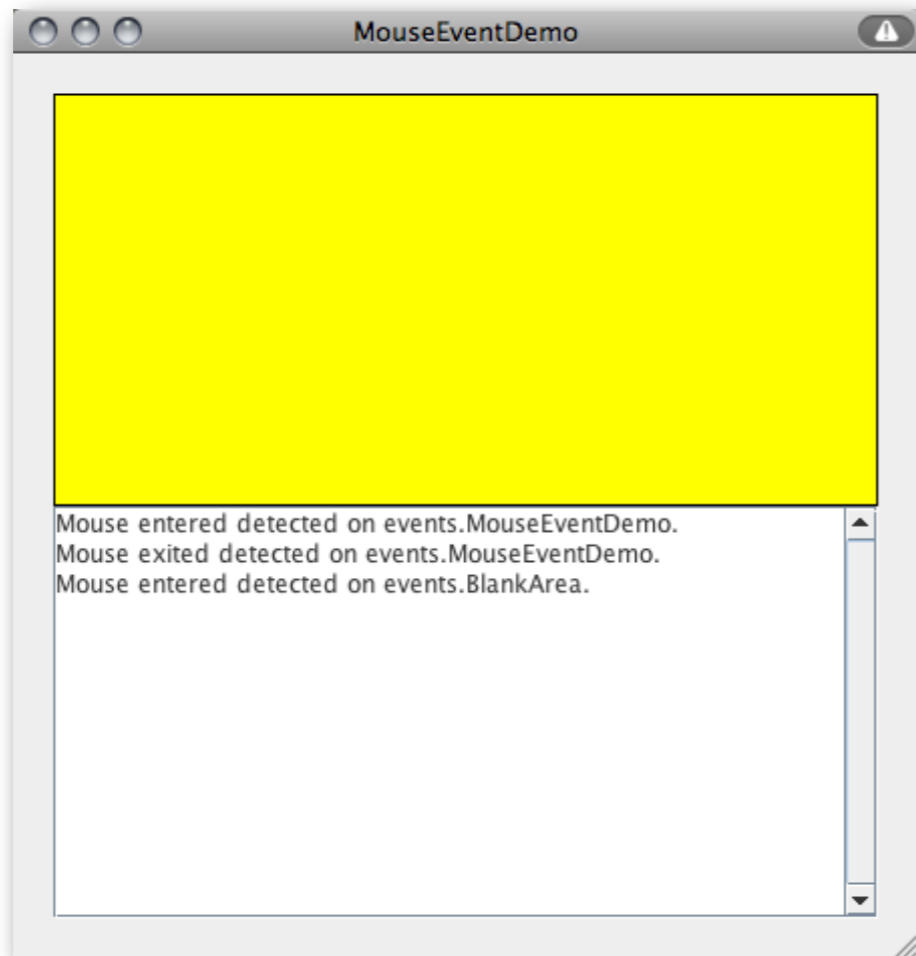


## Java uses a "MouseListener" model

- The developer asks the virtual machine to tell it when mouse events occur
  - Mouse movements
  - Mouse button press, release, click
    - button 1,2,3
  - Mouse wheel movements

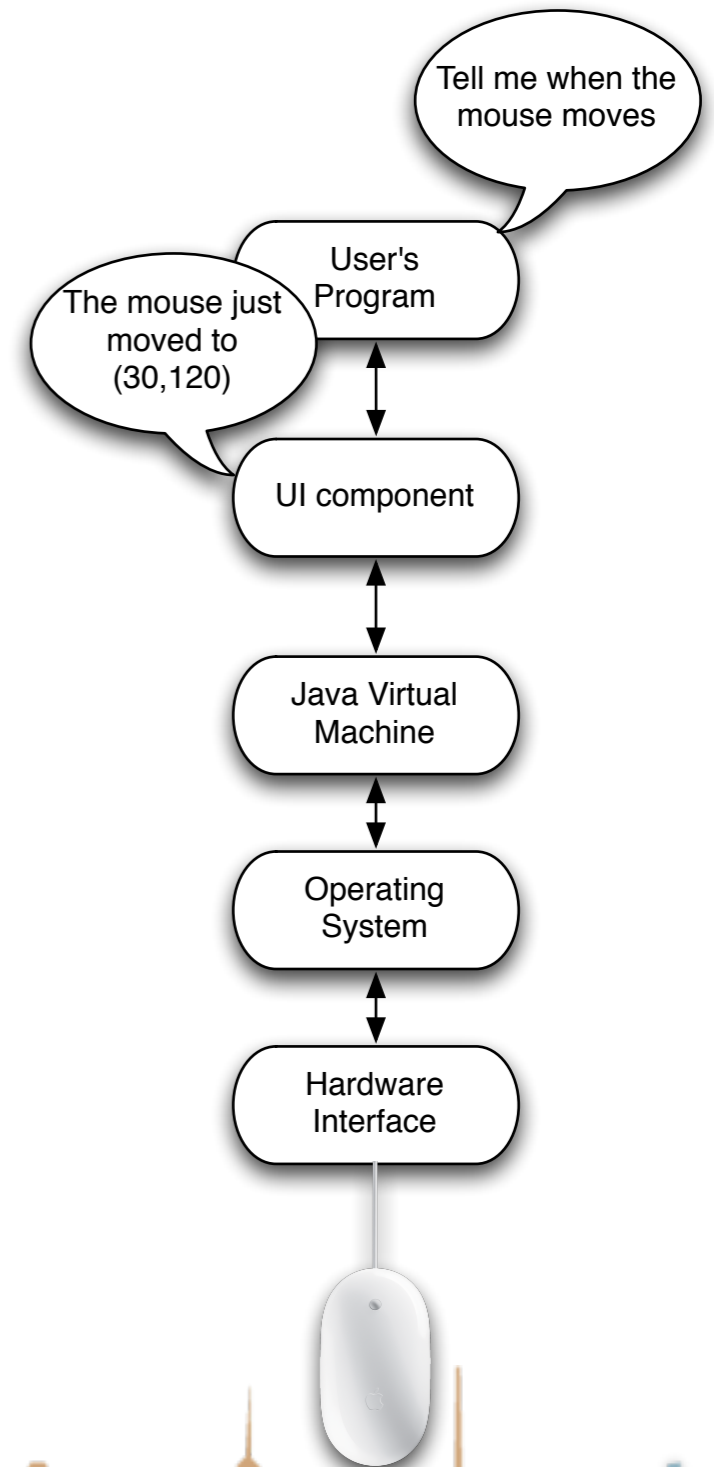


## Java uses a "MouseListener"

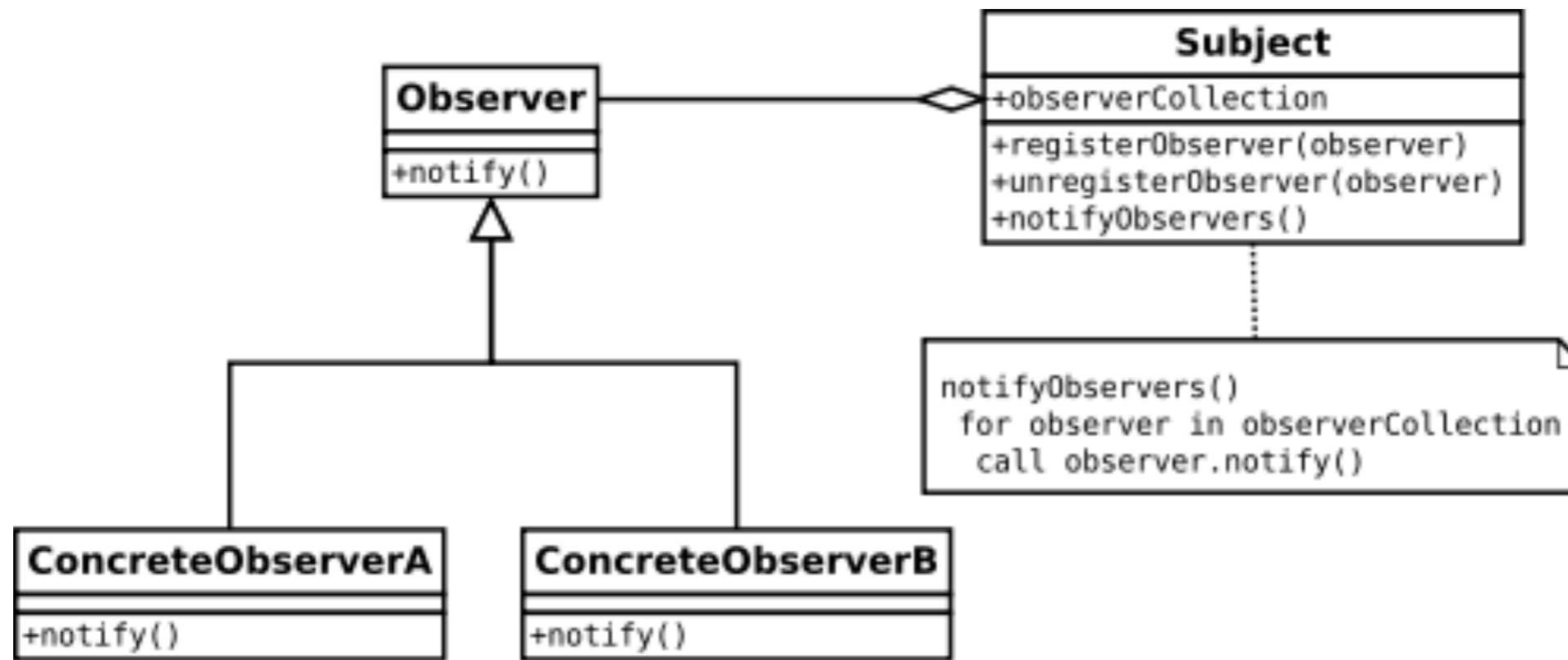


- "Observer" design pattern
- Example:

- <http://java.sun.com/docs/books/tutorial/JWS/uiswing/events/ex6/MouseEventDemo.jnlp>

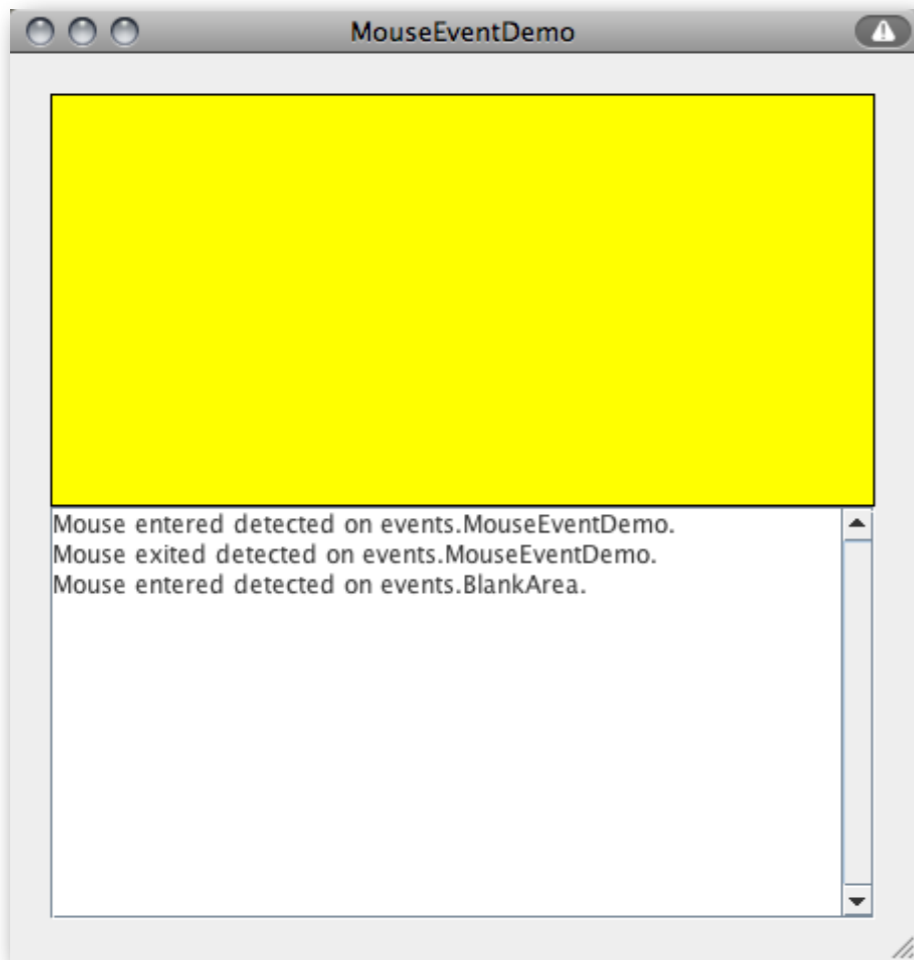


# Observer Design Pattern



- The “Observer” gets callbacks from the “Subject”
- Same pattern we saw in AJAX
- Common pattern in event-driven User Interface software
- “MouseListener” maps to the “Observer”

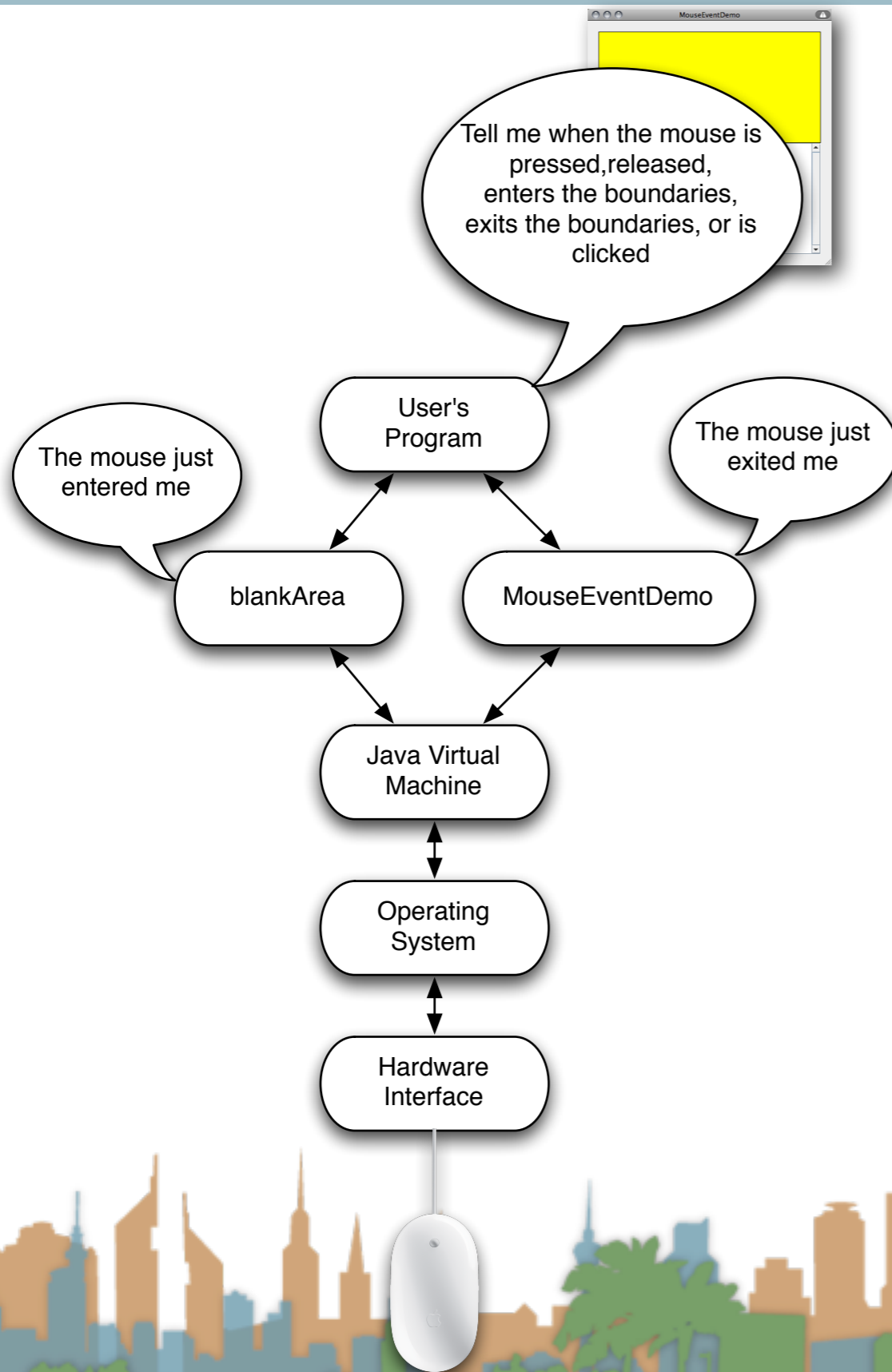
# Traditional Mouse Input



```
public class MouseEventDemo ... implements MouseListener {
    //where initialization occurs:
    //Register for mouse events on blankArea and the panel.
    blankArea.addMouseListener(this);
    addMouseListener(this);
    ...
    public void mousePressed(MouseEvent e) {
        saySomething("Mouse pressed; # of clicks: "
            + e.getClickCount(), e);
    }
    public void mouseReleased(MouseEvent e) {
        saySomething("Mouse released; # of clicks: "
            + e.getClickCount(), e);
    }
    public void mouseEntered(MouseEvent e) {
        saySomething("Mouse entered", e);
    }
    public void mouseExited(MouseEvent e) {
        saySomething("Mouse exited", e);
    }
    public void mouseClicked(MouseEvent e) {
        saySomething("Mouse clicked (# of clicks: "
            + e.getClickCount() + ")", e);
    }
    void saySomething(String eventDescription, MouseEvent e) {
        textArea.append(eventDescription + " detected on "
            + e.getComponent().getClass().getName()
            + "." + newline);
    }
}
```



# Traditional Mouse Input



```
public class MouseEventDemo ... implements MouseListener {
    //where initialization occurs:
    //Register for mouse events on blankArea and the panel.
    blankArea.addMouseListener(this);
    addMouseListener(this);
    ...

    public void mousePressed(MouseEvent e) {
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    }

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    }

    public void mouseExited(MouseEvent e) {
        saySomething("Mouse exited", e);
    }

    public void mouseClicked(MouseEvent e) {
        saySomething("Mouse clicked (# of clicks: "
            + e.getClickCount() + ")", e);
    }

    void saySomething(String eventDescription, MouseEvent e) {
        textArea.append(eventDescription + " detected on "
            + e.getComponent().getClass().getName()
            + "." + newline);
    }
}
```

## Mouse Event

- When your program is told that something happened, you get extra info with the event (as a parameter)
  - Single or double click?
  - (X,Y) of event
    - global and local coordinates
  - which button was pushed (1,2,3)
  - Modifier keys
    - “Shift” click



## Mouse Event (cont)

- When your program is told that something happened, you get extra info with the event
  - Which UI component is reporting
    - “blankArea”
  - timestamp
  - and a few more things





# Traditional Mouse Input

## Class MouseEvent

```
java.lang.Object
  java.util.EventObject
    java.awt.AWTEvent
      java.awt.event.ComponentEvent
        java.awt.event.InputEvent
          java.awt.event.MouseEvent
```

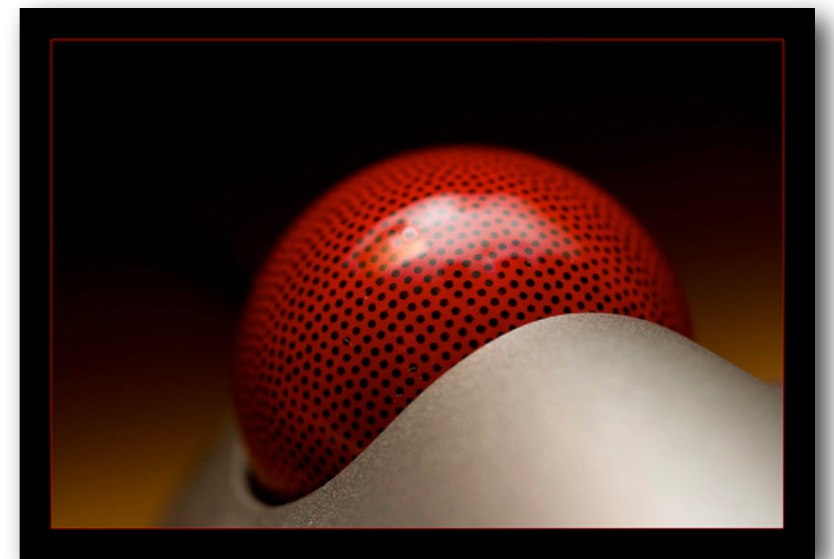
### Method Summary

#### Methods

Modifier and Type	Method and Description
int	<b>getButton()</b> Returns which, if any, of the mouse buttons has changed state.
int	<b>getClickCount()</b> Returns the number of mouse clicks associated with this event.
Point	<b>getLocationOnScreen()</b> Returns the absolute x, y position of the event.
int	<b>getModifiersEx()</b> Returns the extended modifier mask for this event.
static String	<b>getMouseModifiersText(int modifiers)</b> Returns a String instance describing the modifier keys and mouse buttons that were down during the event, such as "Shift", or "Ctrl+Shift".
Point	<b>getPoint()</b> Returns the x,y position of the event relative to the source component.
int	<b>getX()</b> Returns the horizontal x position of the event relative to the source component.
int	<b>getXOnScreen()</b> Returns the absolute horizontal x position of the event.
int	<b>getY()</b> Returns the vertical y position of the event relative to the source component.
int	<b>getYOnScreen()</b> Returns the absolute vertical y position of the event.
boolean	<b>isPopupTrigger()</b> Returns whether or not this mouse event is the popup menu trigger event for the platform.
String	<b> paramString()</b> Returns a parameter string identifying this event.
void	<b>translatePoint(int x, int y)</b> Translates the event's coordinates to a new position by adding specified x (horizontal) and y (vertical) offsets.

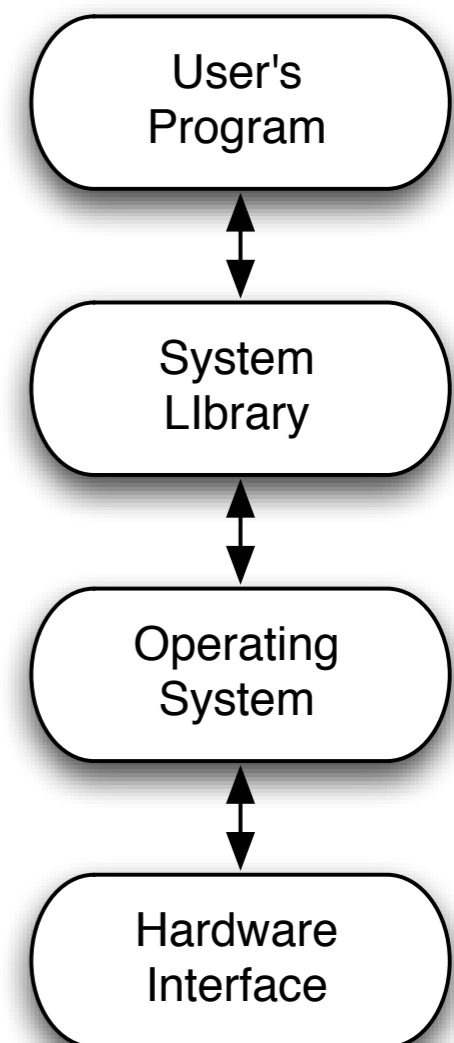
## Different types of input devices

- What about trackpads?
- What about tablets?
- What about rollerballs?



## Different types of input devices

- As long as the OS can translate the hardware interaction into the same events then programs are compatible.
- A stylus on a tablet can “click”
- A rollerball “enters” and “exits”
- A finger on a trackpad has an (X,Y)



# Poll

- Who should we make fun of?
  - Microsoft
  - Apple





# Multi-touch is different



Apple Laptop

# Multi-touch is different





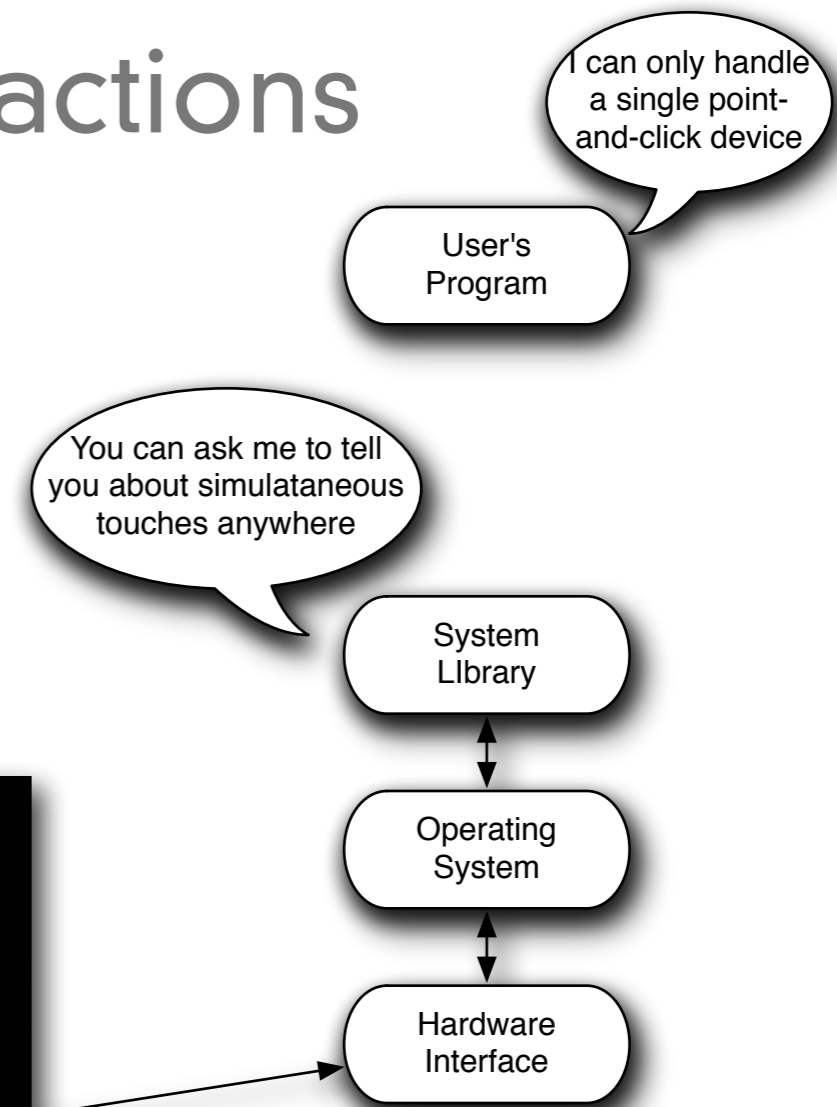
:)



<http://www.youtube.com/embed/CZrr7AZ9nCY?rel=0>

## Multi-touch creates new interactions

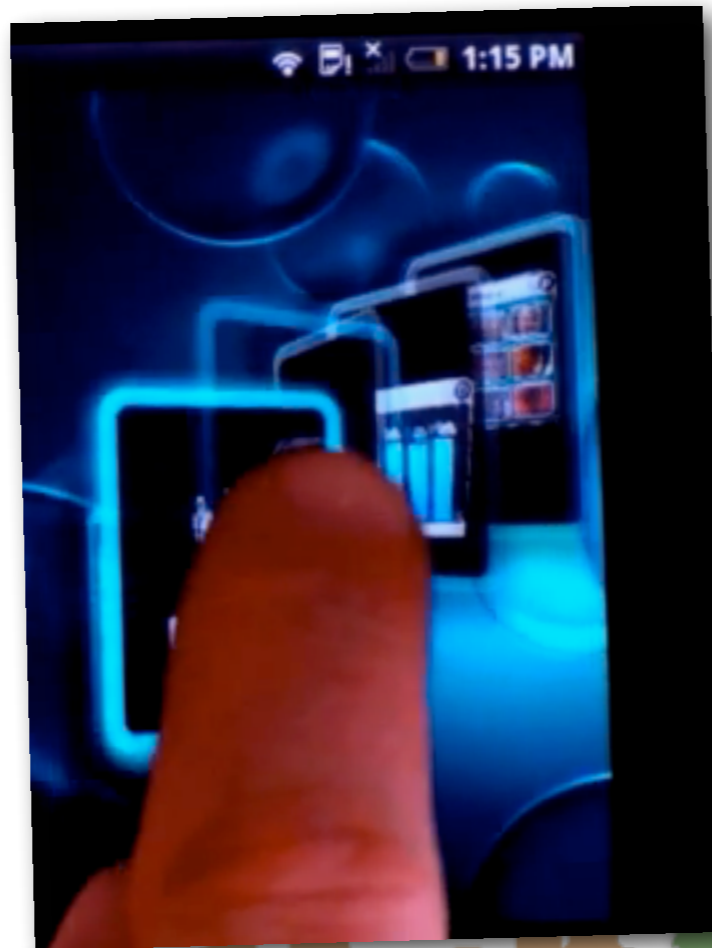
- This breaks old programs
- unless the OS makes the multi-touch look like a mouse to the program



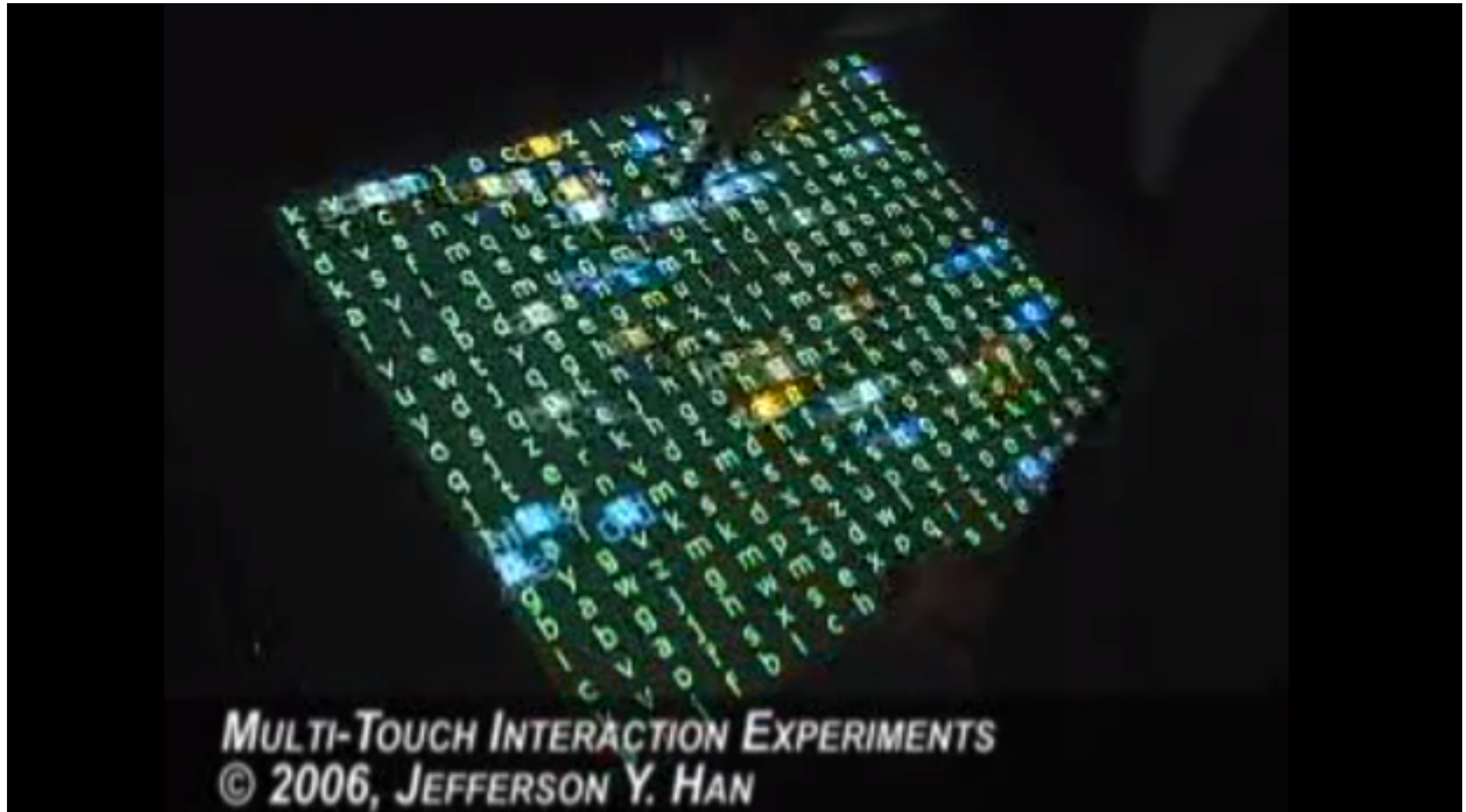


## Multi-touch creates new interactions

- Watch Jeffrey Han Demo Reel
- What is different from working with a mouse?



# Multi-touch is different



## Multi-touch creates new interactions

- pointer is gone
  - all interaction is active
- hover is gone
- you can't see what you are clicking
- "clicking" isn't [as] natural
- "swiping" is natural



## Multi-touch creates new interactions

- Software has to be (re)written to be
  - “multi-touch” aware
- The OS can give some support
  - exposing new events like
    - “pinch” (tell me when a pinch occurs)
    - “rotate” (tell me when a rotate occurs)
    - “two finger swipe”
    - “three finger swipe”



## Multi-touch creates new interactions

- But multi-touch is really computer vision



Where is the mouse clicking?

What abstractions will the OS expose?





## Multi-touch creates new interactions

- Watch 10/GUI video
- <http://10gui.com/video/>



## Multi-touch terminology

- **Multi-touch** – An interactive technique that allows single or multiple users to control graphical displays with more than one simultaneous finger.
- **Multi-point** – An interactive technique that makes use of points of contact rather than movement. A multi-point kiosk with buttons would be an example.
- **Multi-user** – A multi-touch device that accepts more than one user. Larger multi-touch devices are said to be inherently multi-user.
- **Multi-modal** – A form of interaction using multiple modes of interfacing with a system.



## Multi-touch terminology

- **Tabletop Computing** – Interactive computer displays that take place in the form of tabletops.
- **Direct Manipulation** – The ability to use the body itself (hands, fingers, etc) to directly manage digital workspaces.
- **Blob tracking** - Assigning each blob an ID (identifier). Each frame we try to determine which blob is which by comparing each with the previous frame.
- **Blob detection** - Process of picking out bright areas of a camera image and somehow relaying them to a computer as a touch.

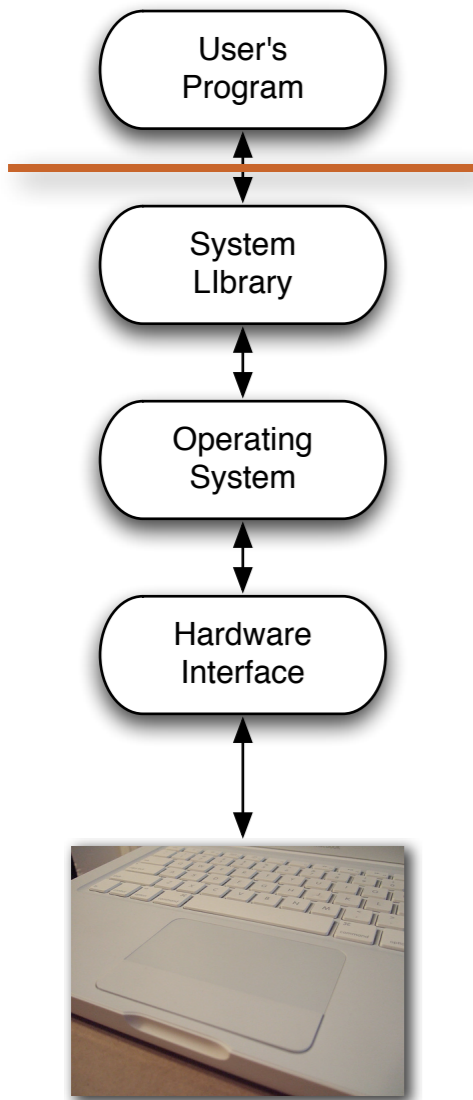




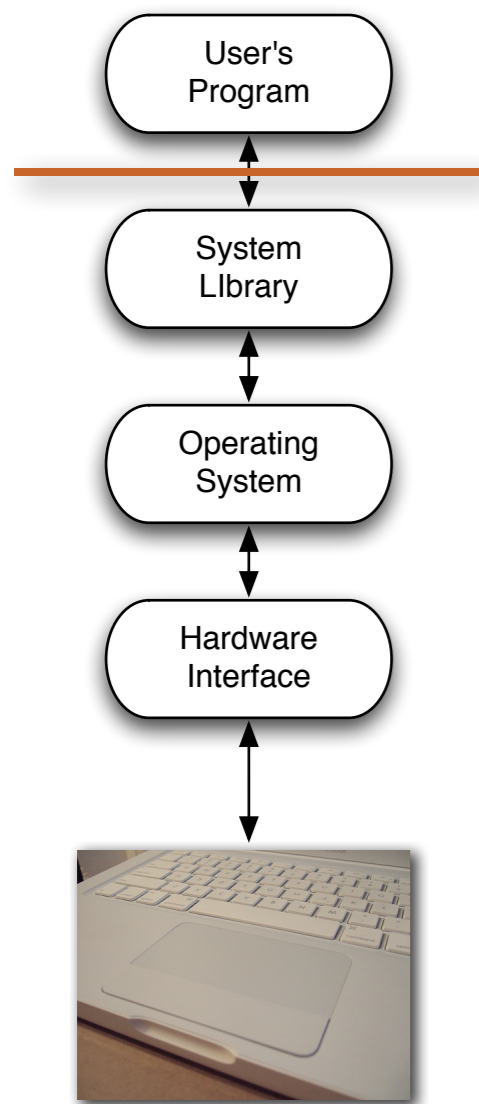
# Multi-Touch Approach #1 - rebuild the Observer Pattern

- Design specific multi-touch/gesture events that you can register for:

- Pinching movements (in or out)
  - meaning zoom out or zoom in
- Rotate: Two fingers moving in opposite semicircles is a gesture meaning rotate.
- Swipe: Three fingers brushing across the trackpad surface in a common direction.
- Scroll: Two fingers moving vertically or horizontally is a scroll gesture.



# Multi-Touch Approach #1 - rebuild the Observer Pattern

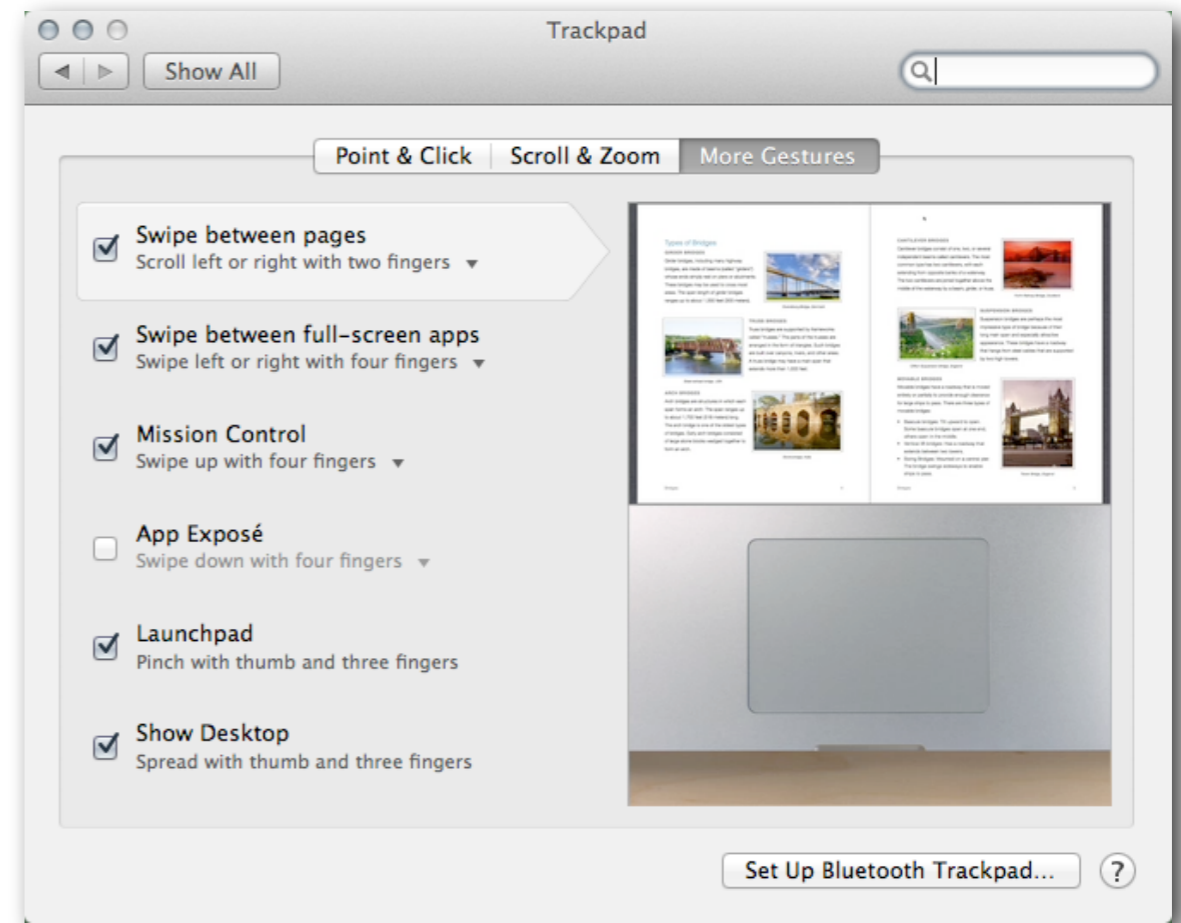
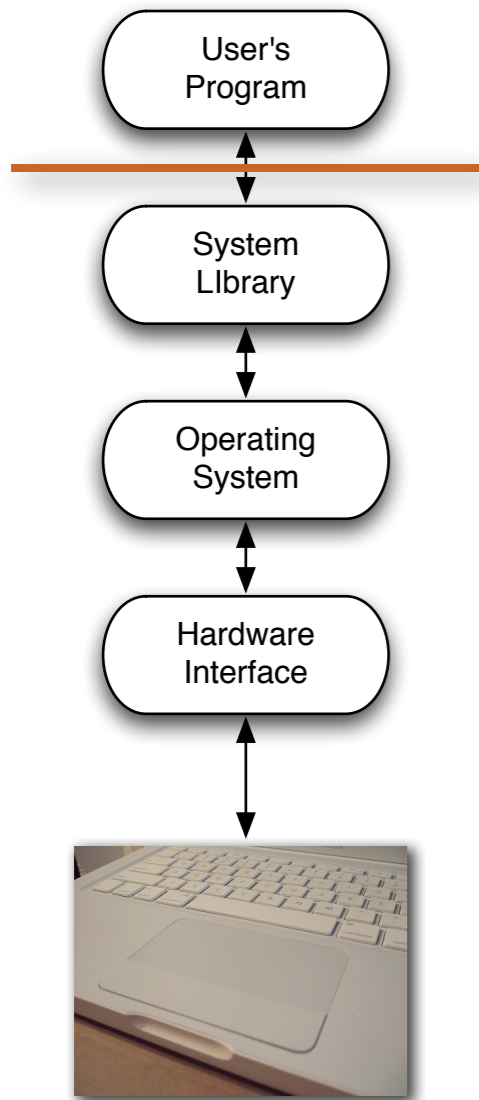


- Advantages:
  - Simple to code
  - Library/OS does all the work
- Disadvantages
  - No flexibility
  - Limited to supported events

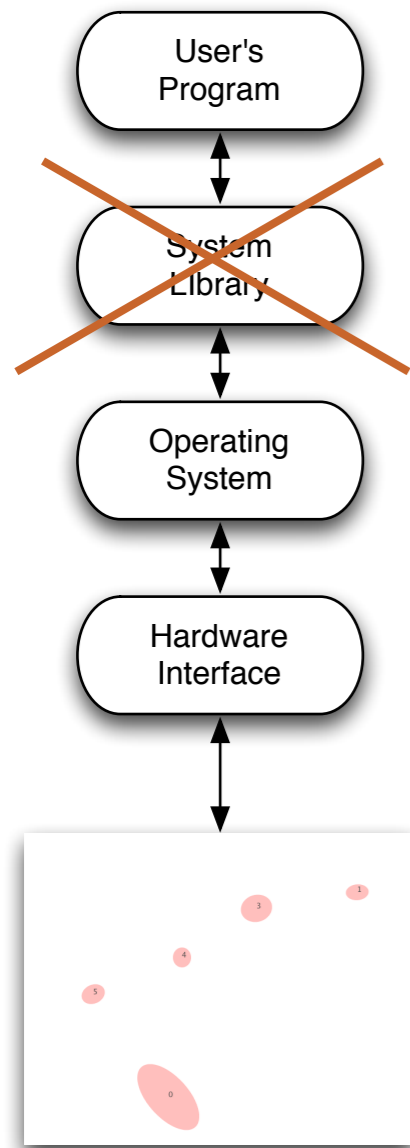


# Multi-Touch Approach #1 - rebuild the Observer Pattern

- Examples (demo):
  - Document browsing in Preview
    - Zoom
    - Scale
    - Swipe

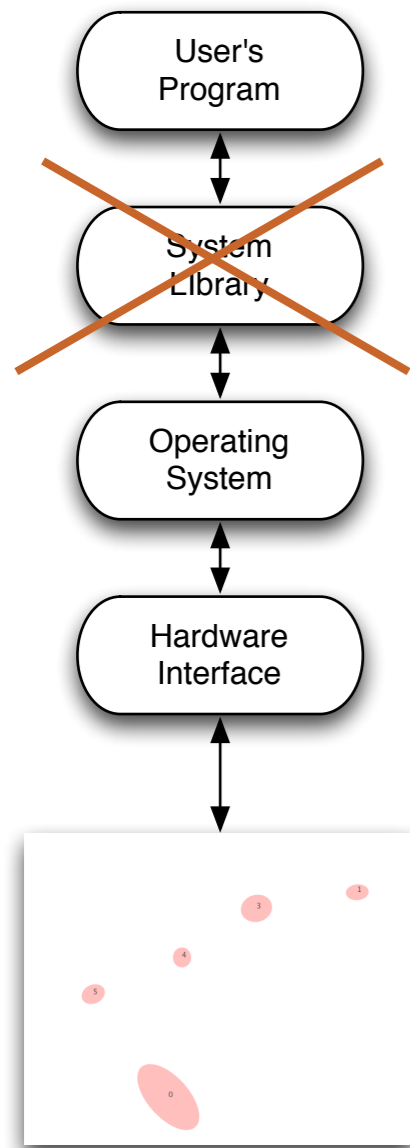


# Multi-Touch Approach #2 - Blob interpreter



- Blob interpretation by program
- A program receives information about the location/"pressure"/orientation of multiple touches
- Each touch gets an id to uniquely identify it
- This is a stream of data
  - continuously updating locations and ids

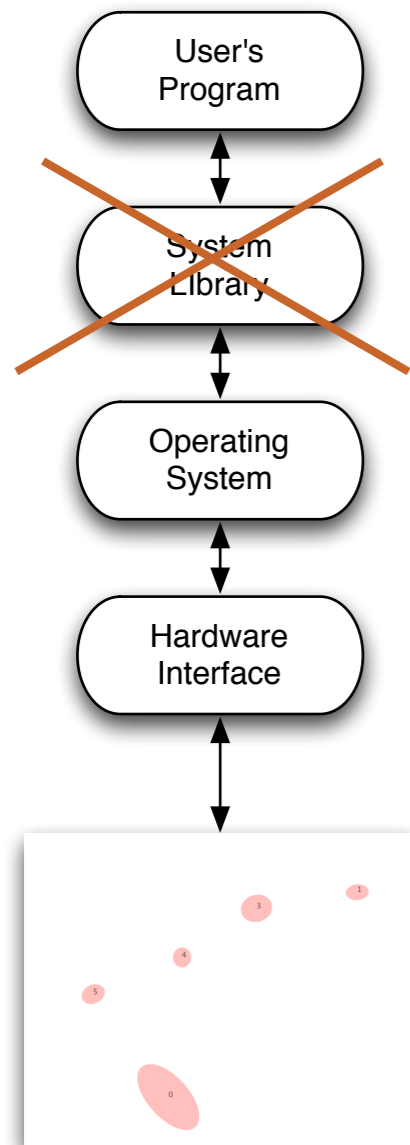
# Multi-Touch Approach #2 - Blob interpreter



- Advantages
  - Supports unlimited numbers of touches
    - two hands / multiple people
  - Programs can have gestures that make unique sense for them
  - OS does a lot of work to find and report blobs



# Multi-Touch Approach #2 - Blob interpreter

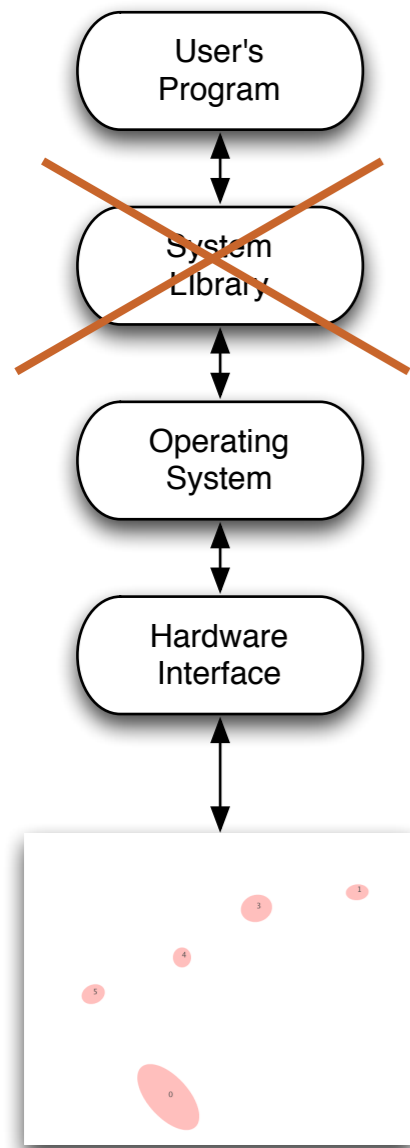


- Disadvantages
  - Each program has to interpret events itself
    - Was that a pinch?
    - Was that a rotate?
    - Where is the thumb?





# Multi-Touch Approach #2 - Blob interpreter



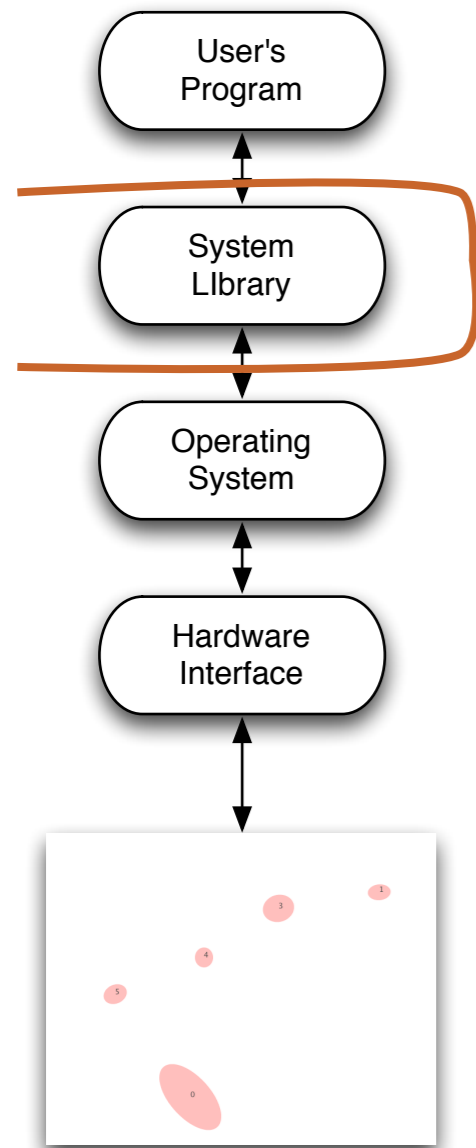
- Examples

- MacMultitouch Demo

- FingerMgmt

- In this example the program plots the blobs that would be interpreted by a full-program

# Multi-Touch Approach #3 - DIY Observer Pattern

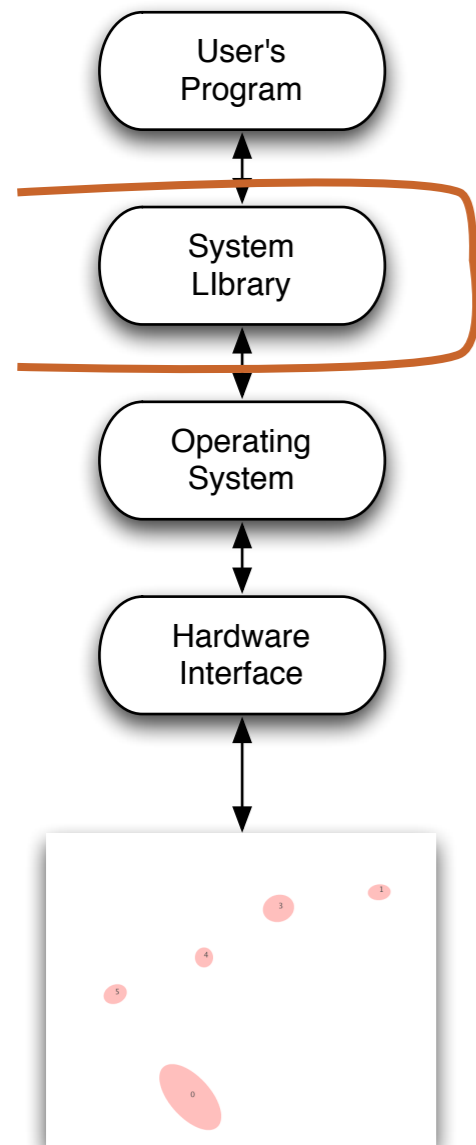


- Create your own event layer for everyone b/c
  - Everyone wants to ... detect triangle touches
  - Everyone wants to ... interpret for multiple people
  - Everyone needs a ... “tiptap” interaction





# Multi-Touch Approach #3 - DIY Observer Pattern



- Advantages:
  - Scalable (Other people can use it)
  - Allows completely new interface design
    - “3-finger pinch”
  - Lots of potential for innovation
- Disadvantages
  - Lots to code
  - Limited application support



# Multi-Touch Approach #3: Better Touch Tool (<http://boastr.net/>)

The image displays the Better Touch Tool application interface, which is used for configuring multi-touch gestures on a Mac. The interface is divided into two main sections, each showing a list of gestures with radio buttons for selection. The background shows the macOS System Preferences window, specifically the 'Mouse & Trackpad' settings.

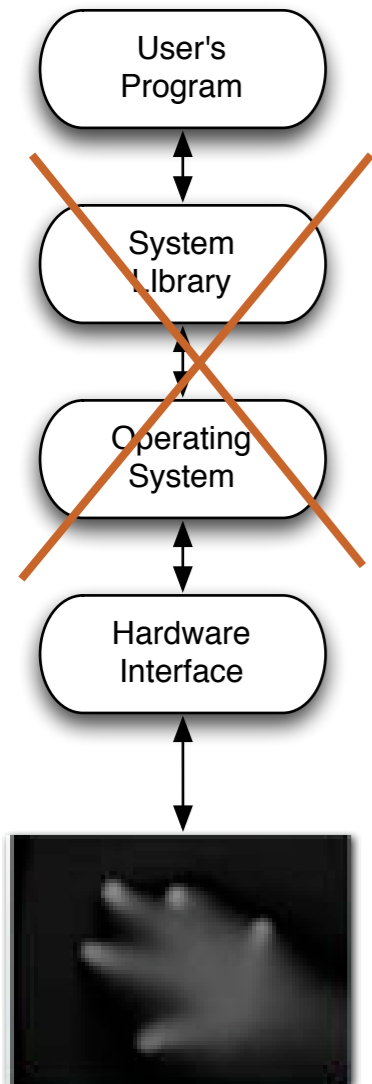
**Left Panel Gestures:**

- Single Finger Tap Left
- Single Finger Tap Right
- Single Finger Tap Middle
- Single Finger Tap
- Single Finger Click Middle
- Single Finger Tap Above Apple
- Single Finger Swipe Up
- Single Finger Swipe Down
- Single Finger Swipe Left
- Single Finger Swipe Right
- Two Finger Tap
- Two Finger Click
  - Two Finger Swipe Up
- Two Finger Swipe Down
  - Two Finger Swipe Left
  - Two Finger Swipe Right
- Three Finger Tap
- Three Finger Click
- Three Finger Swipe Up
- Three Finger Swipe Down
- Three Finger Swipe Left
- Three Finger Swipe Right
- TipSwipe Left Finger Up
  - TipSwipe Left Finger Down
- Four Finger Click
  - Four Finger Swipe Up
  - Four Finger Swipe Down
- TipTap Left

**Right Panel Gestures:**

- Single Finger Tap Bottom Right
- Single Finger Tap Bottom Middle
- Single Finger Tap Left Side Middle
- Single Finger Tap Right Side Middle
- Triangle Swipe Top Left Corner
  - Triangle Swipe Top Right Corner
  - Triangle Swipe Bottom Left Corner
  - Triangle Swipe Bottom Right Corner
- Three Finger Tap
- Three Finger Tap Bottom
- Three Finger Tap Top
- Three Finger Click
- Three Finger Swipe Up
- Three Finger Swipe Down
- Three Finger Swipe Left
- Three Finger Swipe Right
- TipSwipe Left Finger Down
- TipSwipe Left Finger Up
- TipSwipe Left Finger Left
- TipSwipe Left Finger Right
- Four Finger Tap
- Four Finger Click
- Four Finger Swipe Up
- Four Finger Swipe Down
- Four Finger Swipe Left
- Four Finger Swipe Right
- Five Finger Tap
- Five Finger Click
- Five Finger Swipe Up
- Five Finger Swipe Down
- Five Finger Swipe Left
- Five Finger Swipe Right

# Multi-Touch Approach #4 - Do Everything Yourself

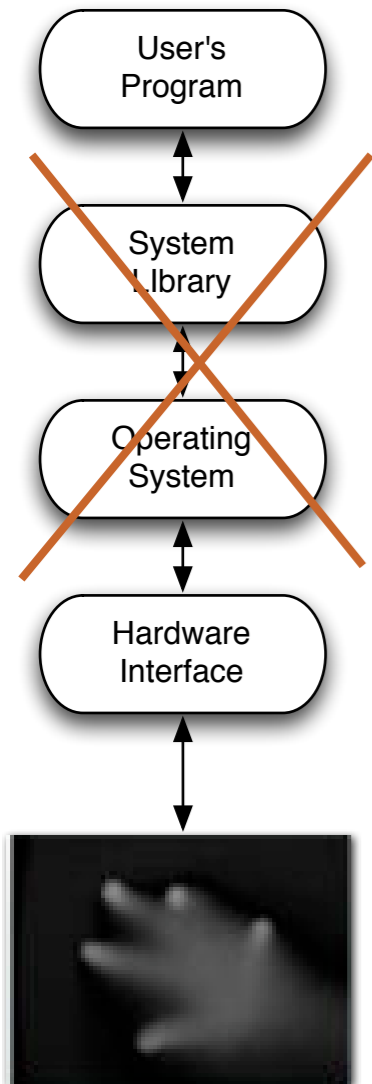


- Grayscale input

- A program receives a stream of images
- Darker (or lighter) colors indicates pressure or proximity



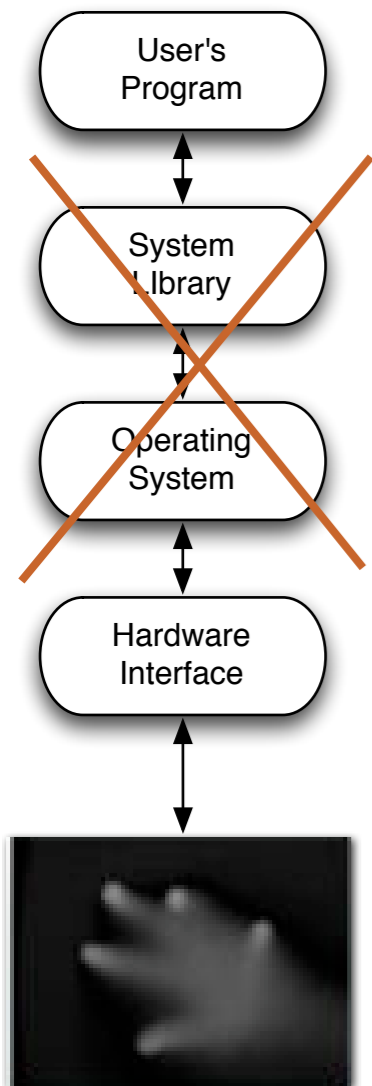
# Multi-Touch Approach #4 - Do Everything Yourself



- Advantages

- Maximum flexibility
- Not restricted to “finger touch” paradigm
- Can recognize a “cup down” event for example

# Multi-Touch Approach #4 - Do Everything Yourself



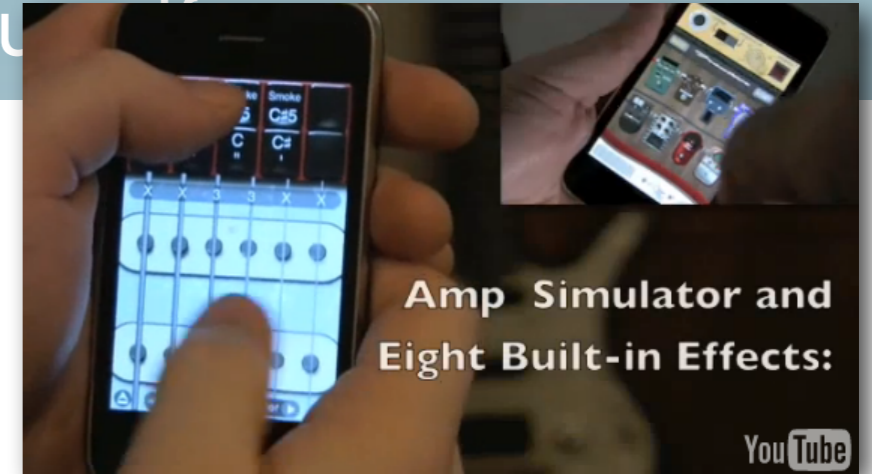
- Disadvantages

- This is full-fledged computer vision
- Different technologies generate different quality images
- Robustly and consistently recognizing events is hard.





# Multi-Touch Approach #4 - Do Everything Yourself



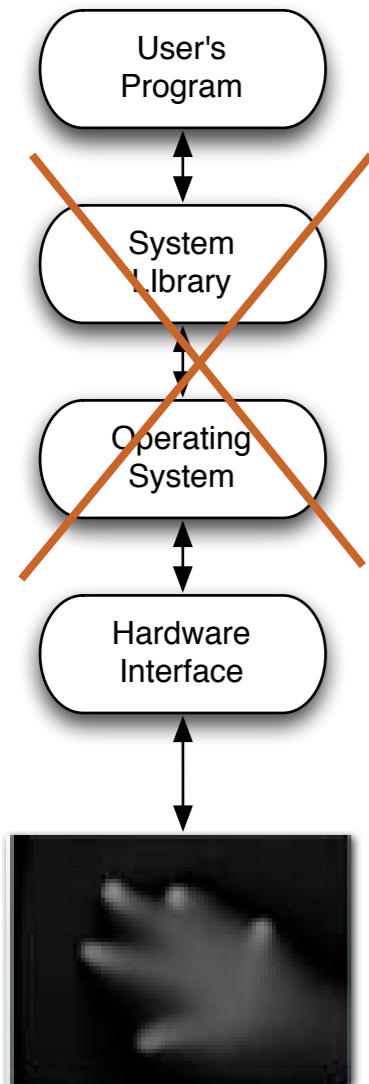
- Examples

- iShred

- [http://www.youtube.com/watch?v=eZpnzzKbY2I&feature=player\\_embedded](http://www.youtube.com/watch?v=eZpnzzKbY2I&feature=player_embedded)

## Microsoft Surface (table version)

- <http://www.youtube.com/embed/C36rm5yS4c4?rel=0>

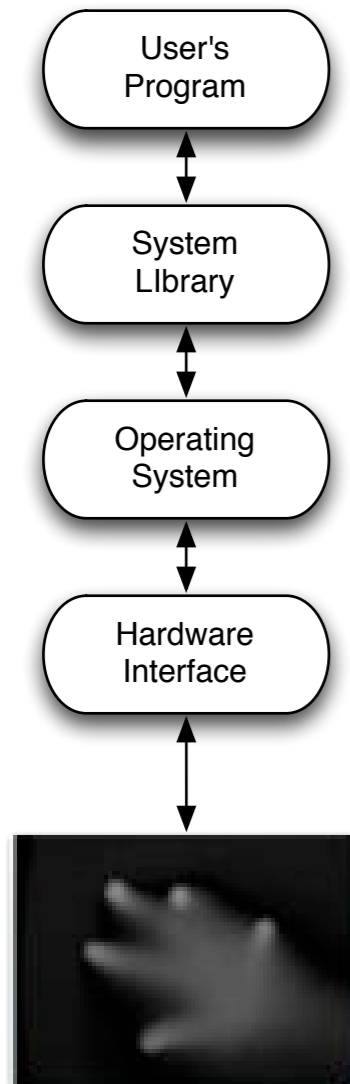


# How do you choose?

- How fast do you need to get your application done?
  - #1 is fastest, #4 is slowest
- Who are your users?
  - #1 is the most familiar to users, #4 requires users to adapt
- What is your application?
  - #1 is basically point and click extensions
  - #4 supports crazy gaming/applications
- Are you showcasing multi-touch? or supporting a task?



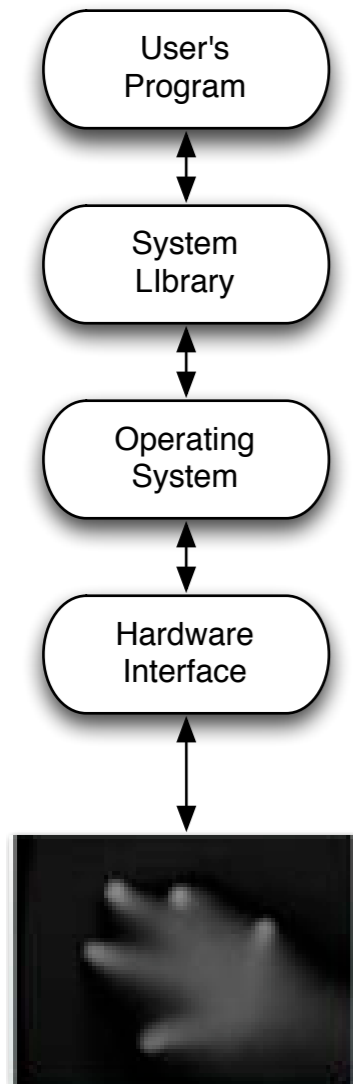
# Our assignment



- Build a multi-touch Java paint application
- No OS support

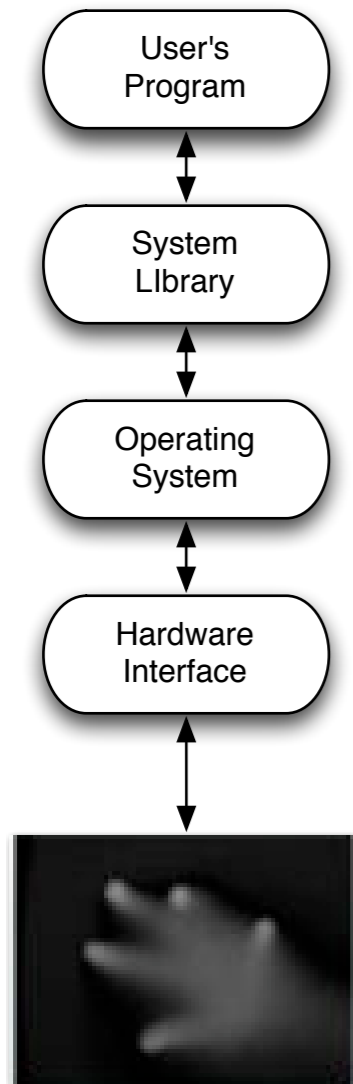


# Our assignment



- Where are we going to get a grayscale input?
  - You can build your own
  - You can use prerecorded video

# Our assignment

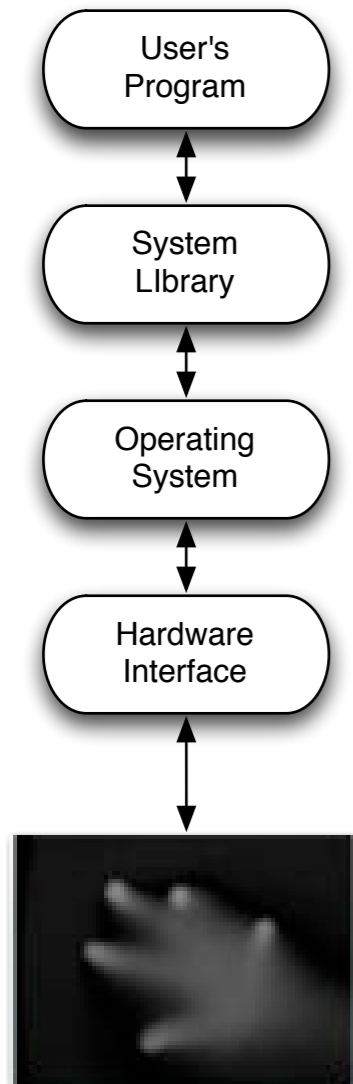


- How will we interface to the computer?
- Use standard camera inputs





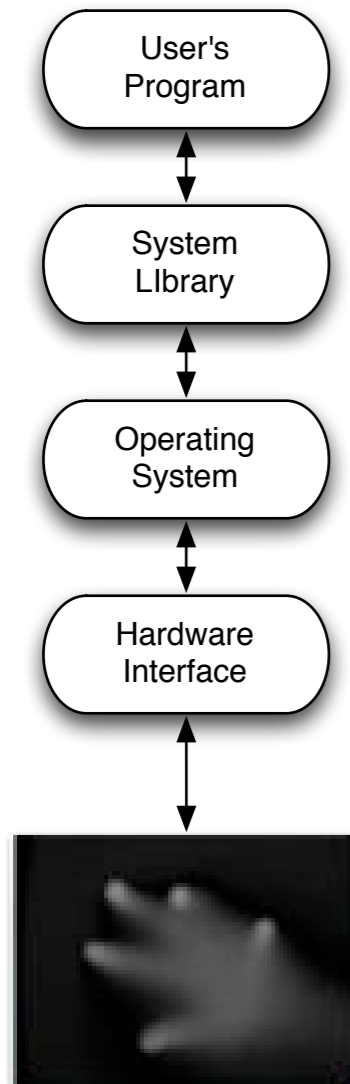
# Our assignment



- How will we process it without OS support?
- We will use Community Core Vision to process the grayscale images

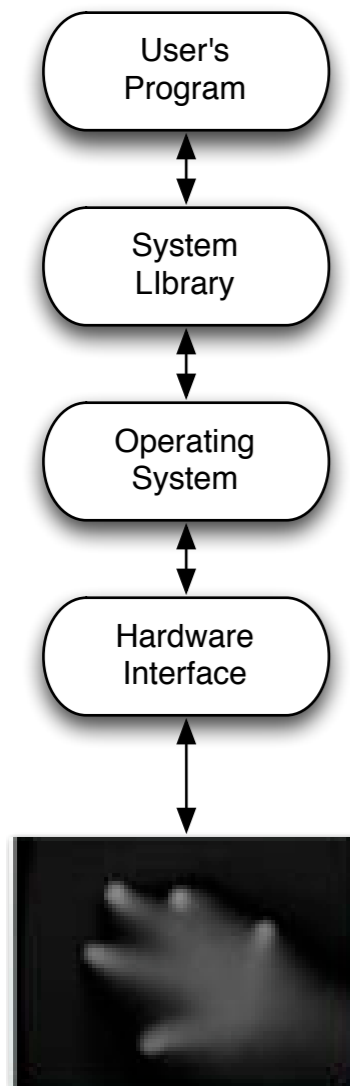


# Our assignment



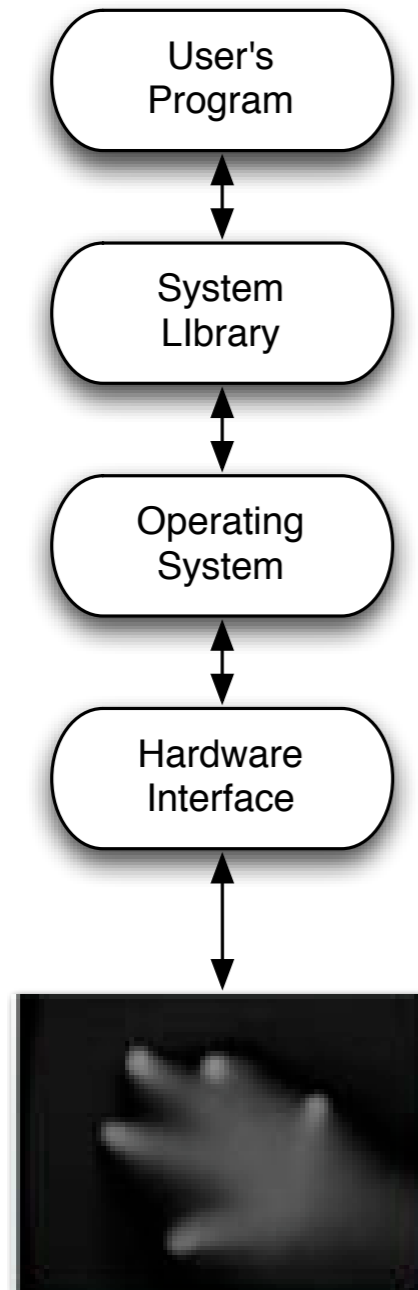
- How will our application get information about multi-touch events?
- Using the TUIO standard and a TUIO library for java

# Our assignment



- How will I write a multi-touch application?
- Register for multi-touch events and then respond when you receive them.

# Getting Multi-Touch up and Running



- Your program

- MT4J

TUIO

- Community Core Vision

- web cam



## Getting Multi-Touch up and Running

- Community Core Vision (<http://ccv.nuigroup.com/>)
- is a open source/cross-platform solution for computer vision and machine sensing. It takes an video input stream and outputs tracking data (e.g. coordinates and blob size) and events (e.g. finger down, moved and released) that are used in building multi-touch applications.





# Getting Multi-Touch up and Running

- MT4J
  - MT4j - Multitouch for Java™ - is an open source Java™ development platform, created for rapid development of graphically rich applications. MT4j is designed to support different kinds of input devices with a special focus on multitouch support.
  - <http://www.mt4j.org>

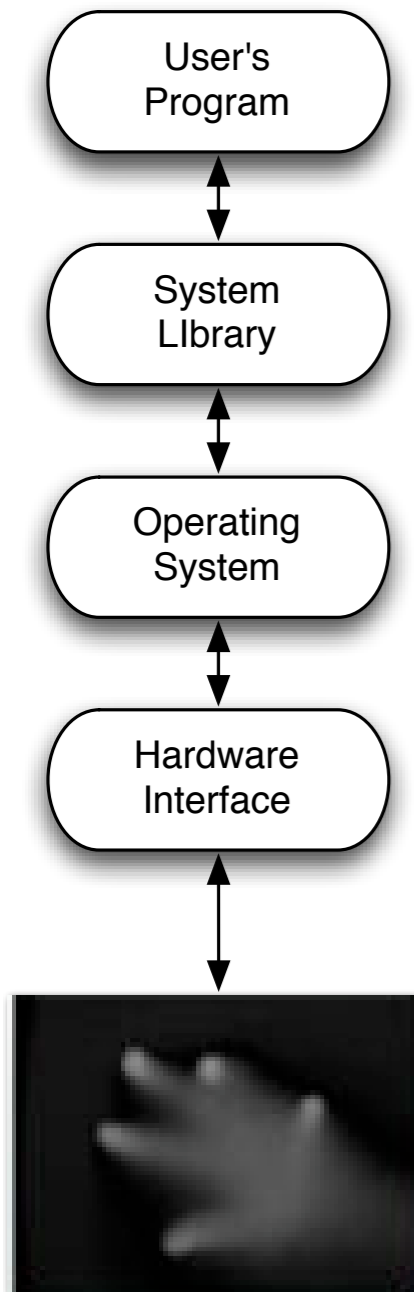


# Getting Multi-Touch up and Running

- TUIO
- TUIO is an open framework that defines a common protocol and API for tangible multitouch surfaces. The TUIO protocol allows the transmission of an abstract description of interactive surfaces, including touch events and tangible object states.
- <http://www.tuio.org/>

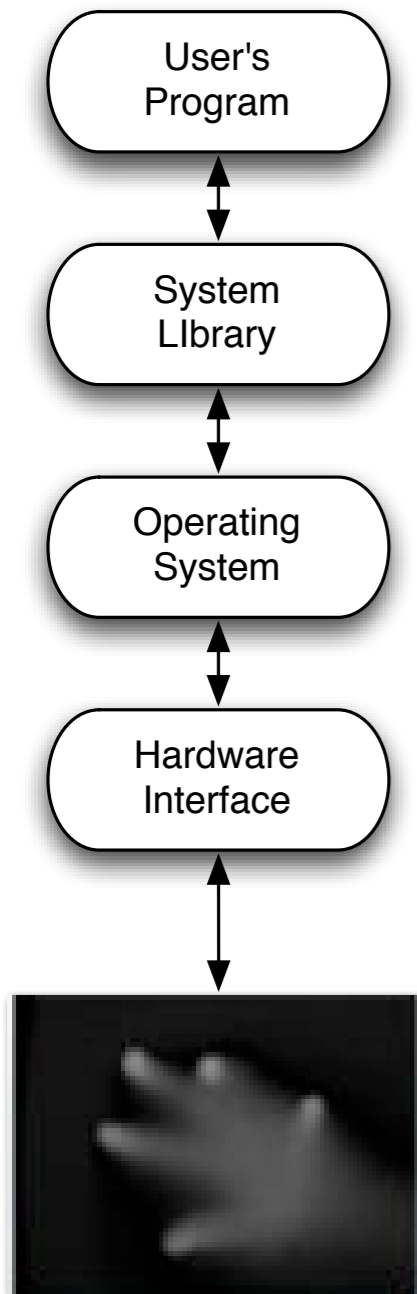


# Getting Multi-Touch up and Running: Demo #1



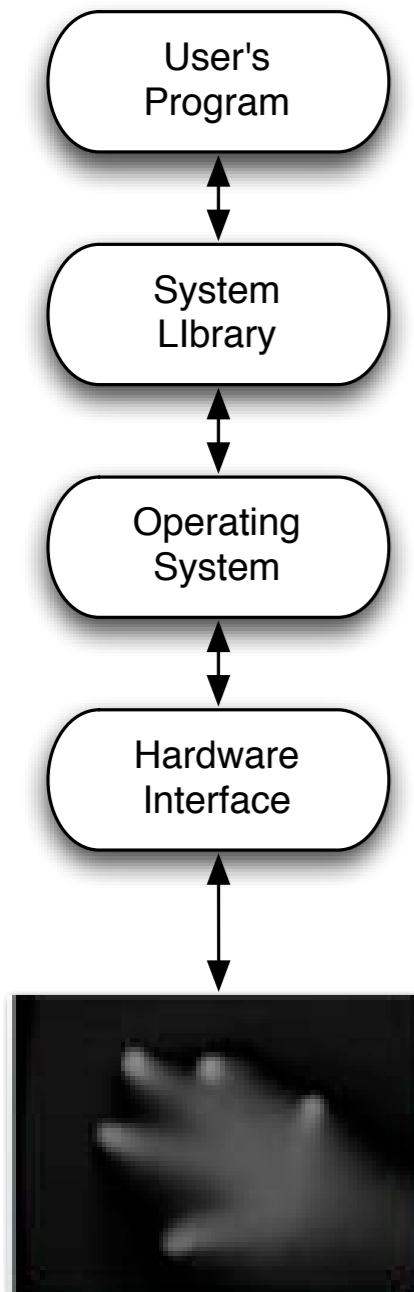
- To a flash application that is multi-touch aware
- Through a TUIO server
- Going through CCV
- Video from recorded gray scale

# Getting Multi-Touch up and Running: Demo #2



- To a flash application that is multi-touch aware
- Through a TUIO server
- Going through CCV
- Live video

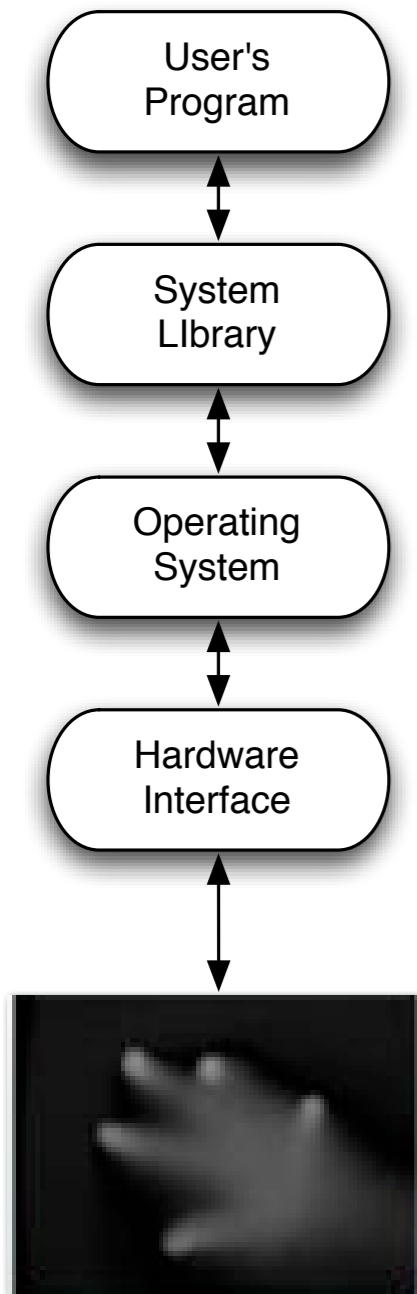
# Getting Multi-Touch up and Running: Demo #3



- To a MT4J application that is multi-touch aware
- Going through a MT4J TUIO server
- Multitouch from a TUIO simulator

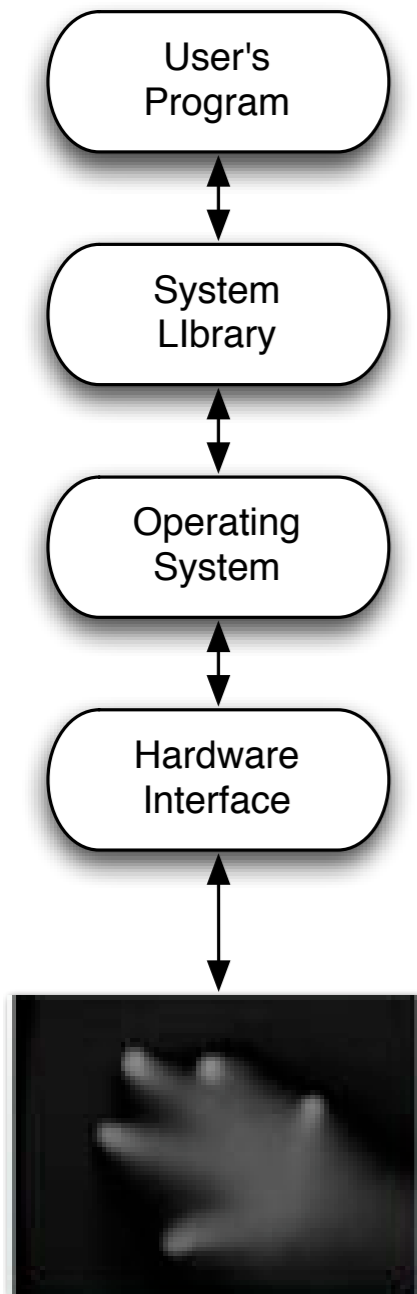


# Getting Multi-Touch up and Running: Demo #4



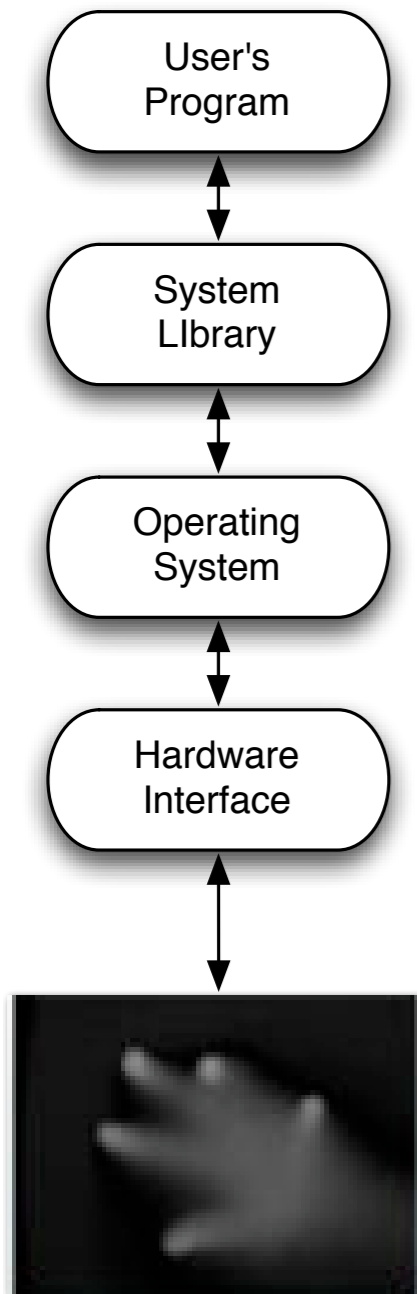
- To a MT4J application that is multi-touch aware
- Going through a MT4J TUIO server
- Live multitouch from iPhone

# Getting Multi-Touch up and Running: Demo #5



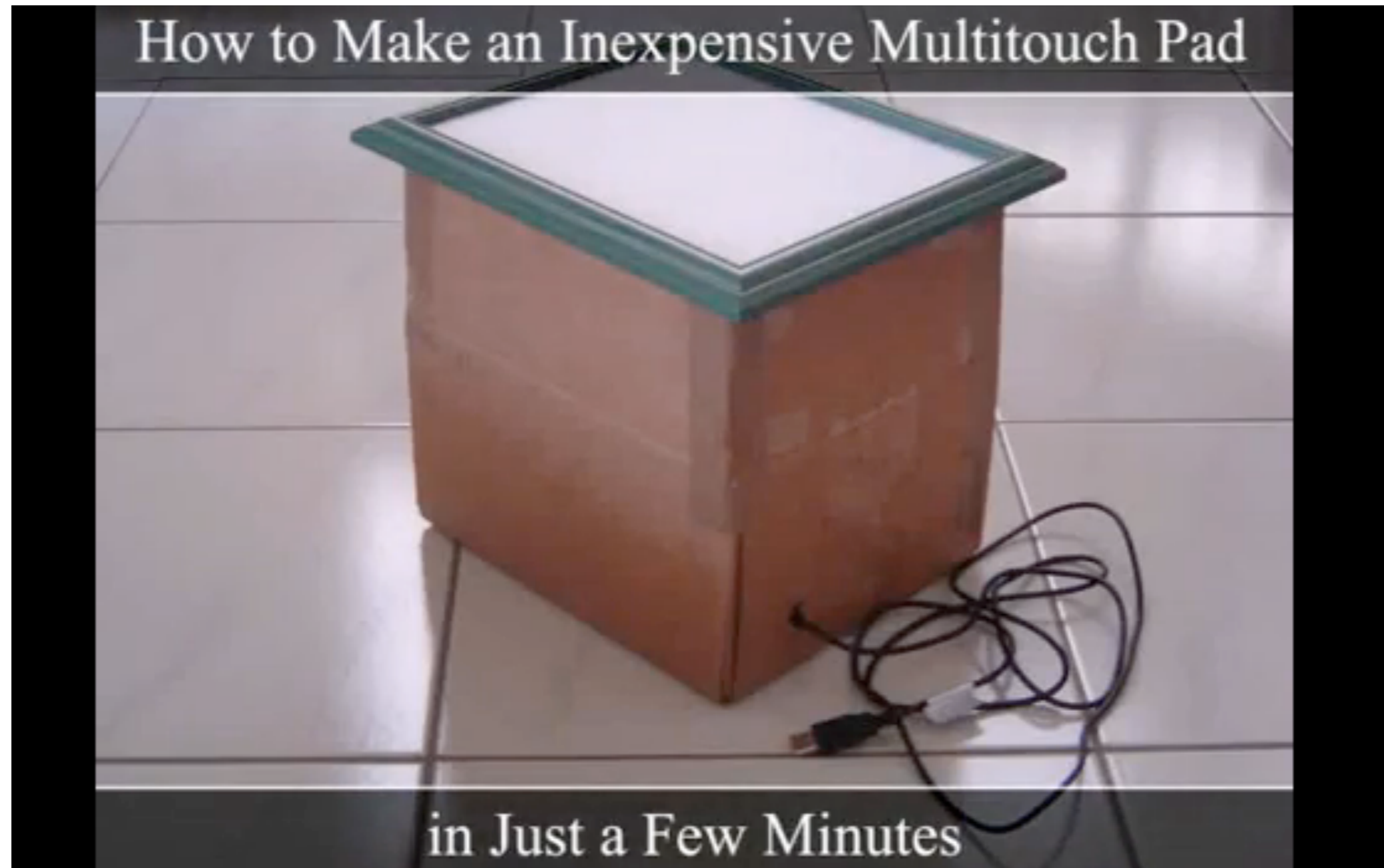
- To a MT4J application that is multi-touch aware
- Going through a MT4J TUIO server
- Going through CCV
- Live video

# Getting Multi-Touch up and Running: Demo #6

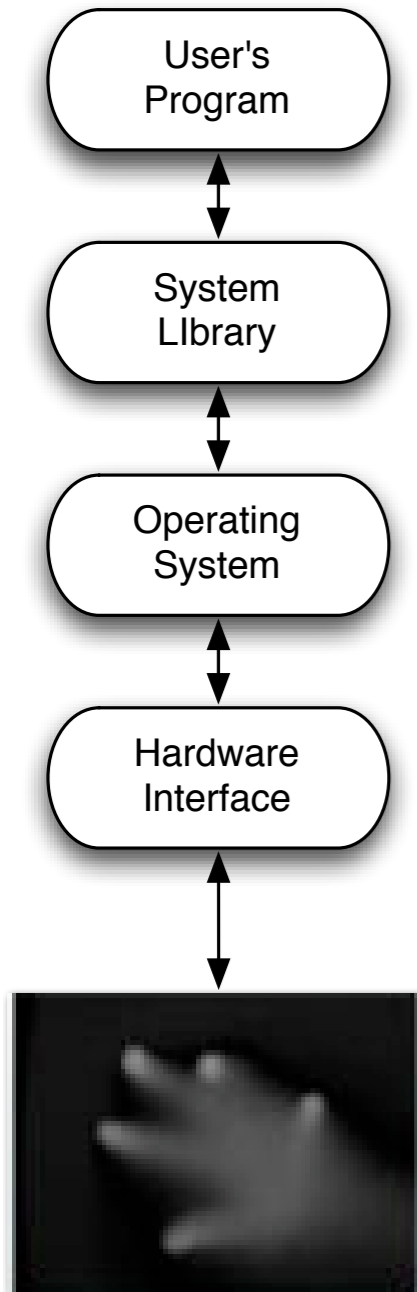


- To a MT4J application that is multi-touch aware
- Going through a MT4J TUIO server
- Going through CCV
- Live video from lights

# Getting Multi-Touch up and Running



# Flash notes

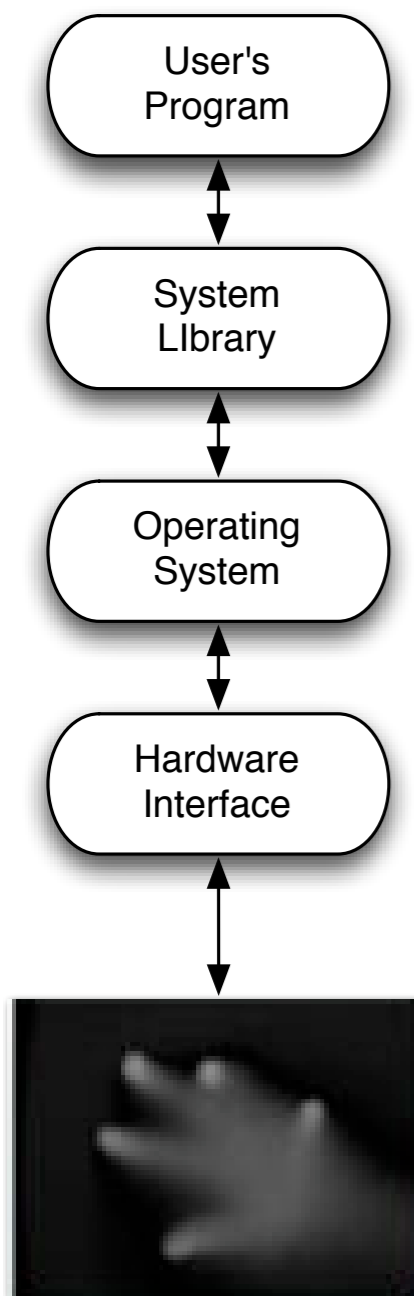


- I had very inconsistent behavior using the Flash stack
- Regardless of Flash security settings I could not get things to work:
  - In Flash Player
  - In a browser
- I could get everything to work consistently using the full Flash program
  - Running flosc-2\_0\_5.jar on the command line
    - `java -jar ./flosc-2_0_5.jar 3333 3000`
  - Having CCV send output via OSC



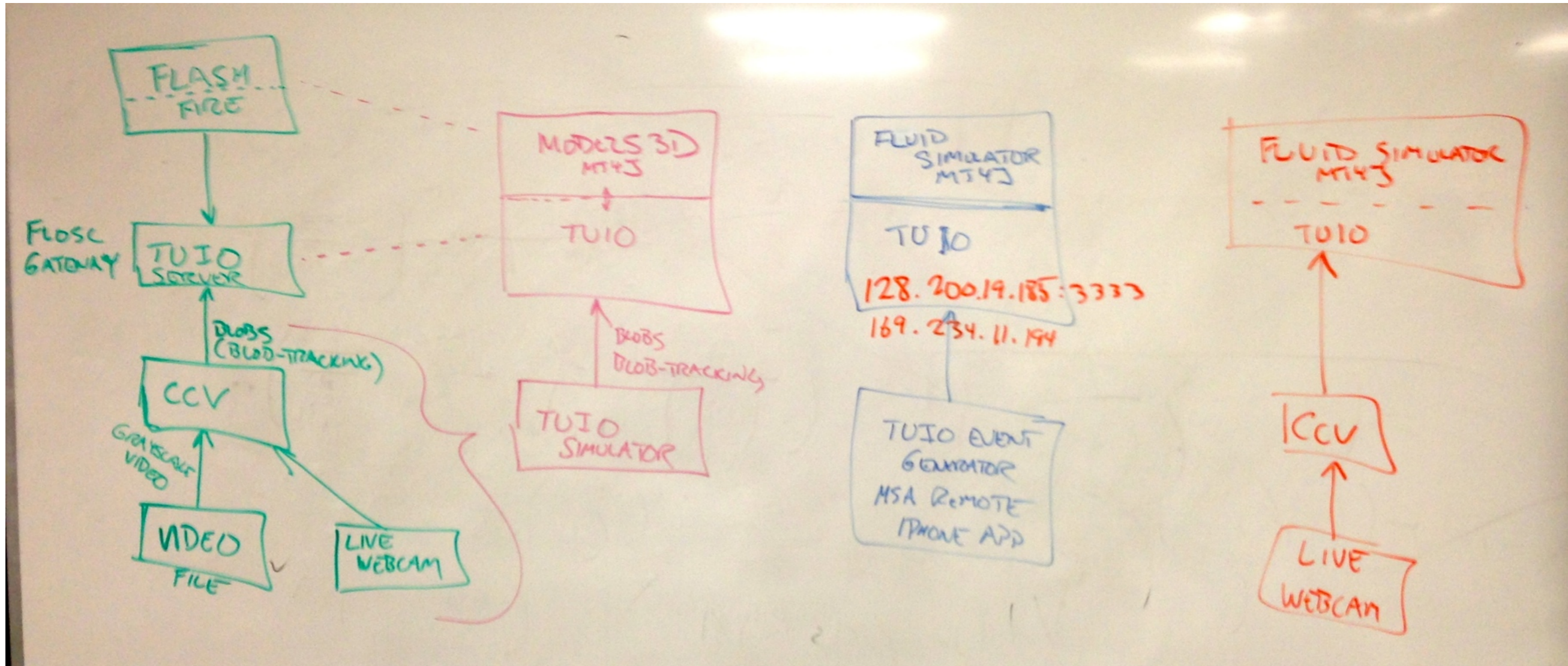


# Things you have to worry about



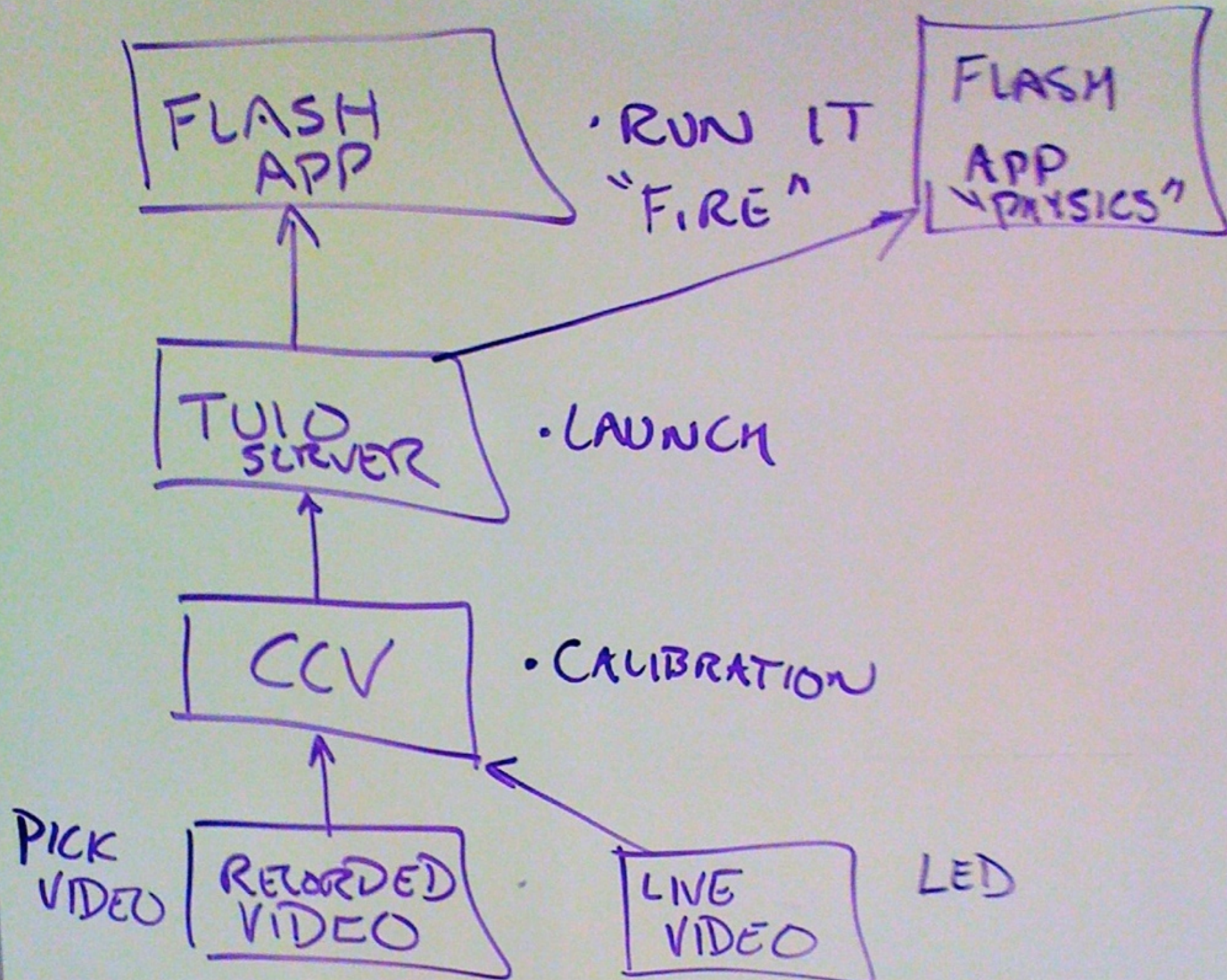
- Is your operating system 32-bit or 64-bit?
  - Your java virtual machine should match
- What Java version are you running?
  - Most recent is 1.7
  - MT4J on a Mac needs Java 1.6 JRE in Eclipse
- On Mac you have to make CCV executable
- Download flosc for demoing here
  - <https://code.google.com/p/flosc/>
- Which version of CCV?
  - 1.5 for Window
  - 1.2 for Mac

# Getting Multi-Touch up and Running



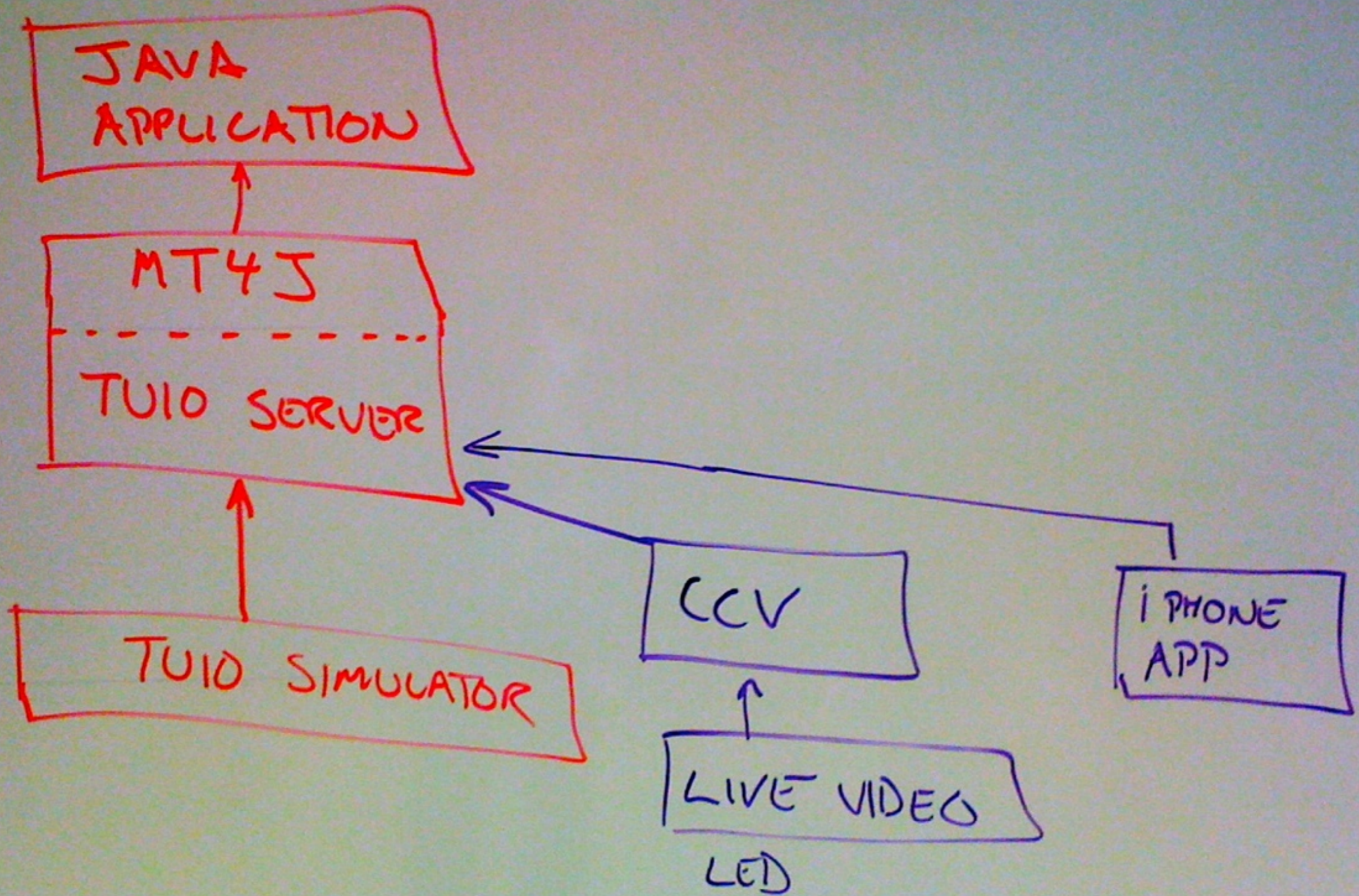


# Getting Multi-Touch up and Running



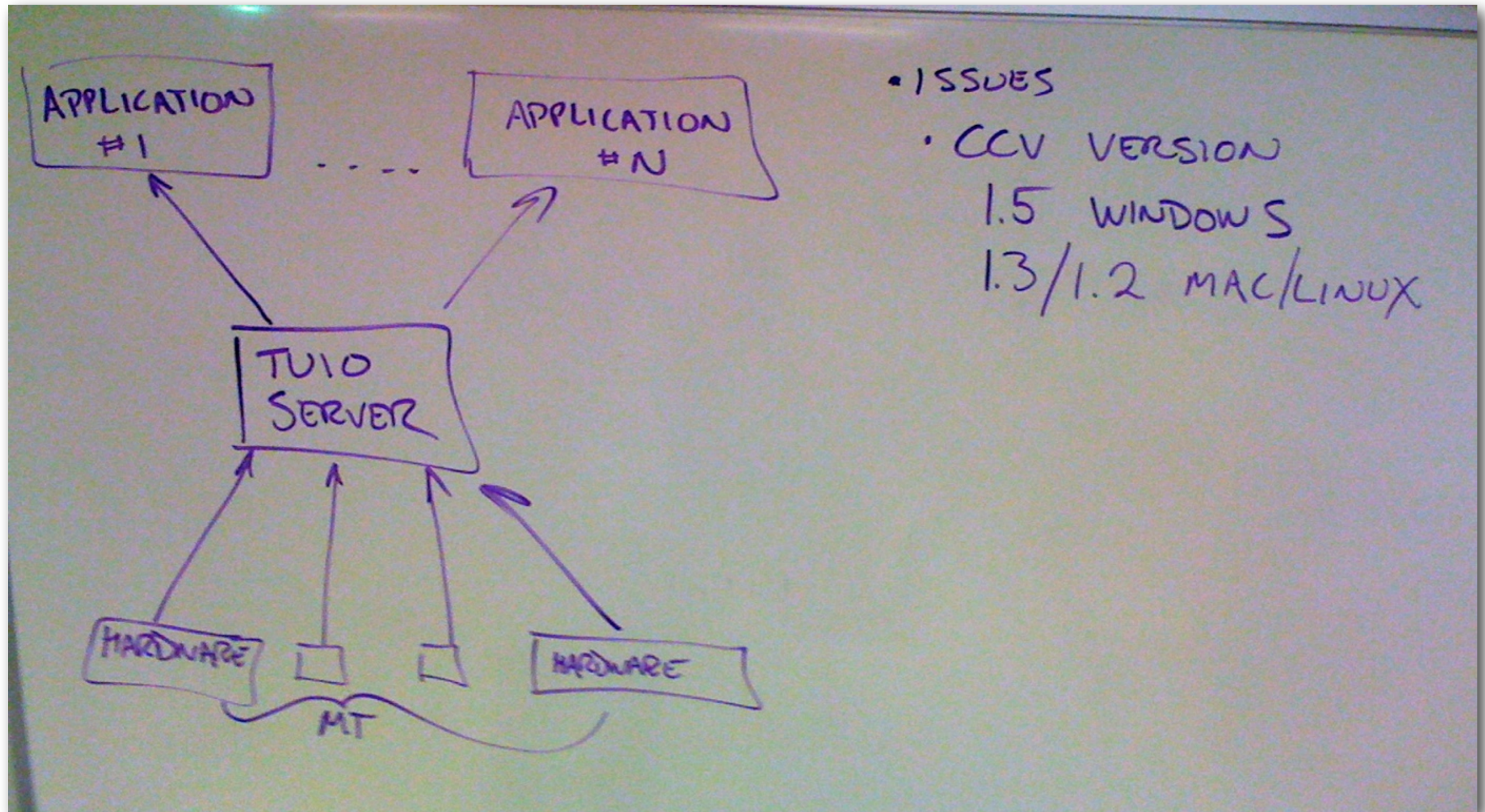


# Getting Multi-Touch up and Running





# Getting Multi-Touch up and Running

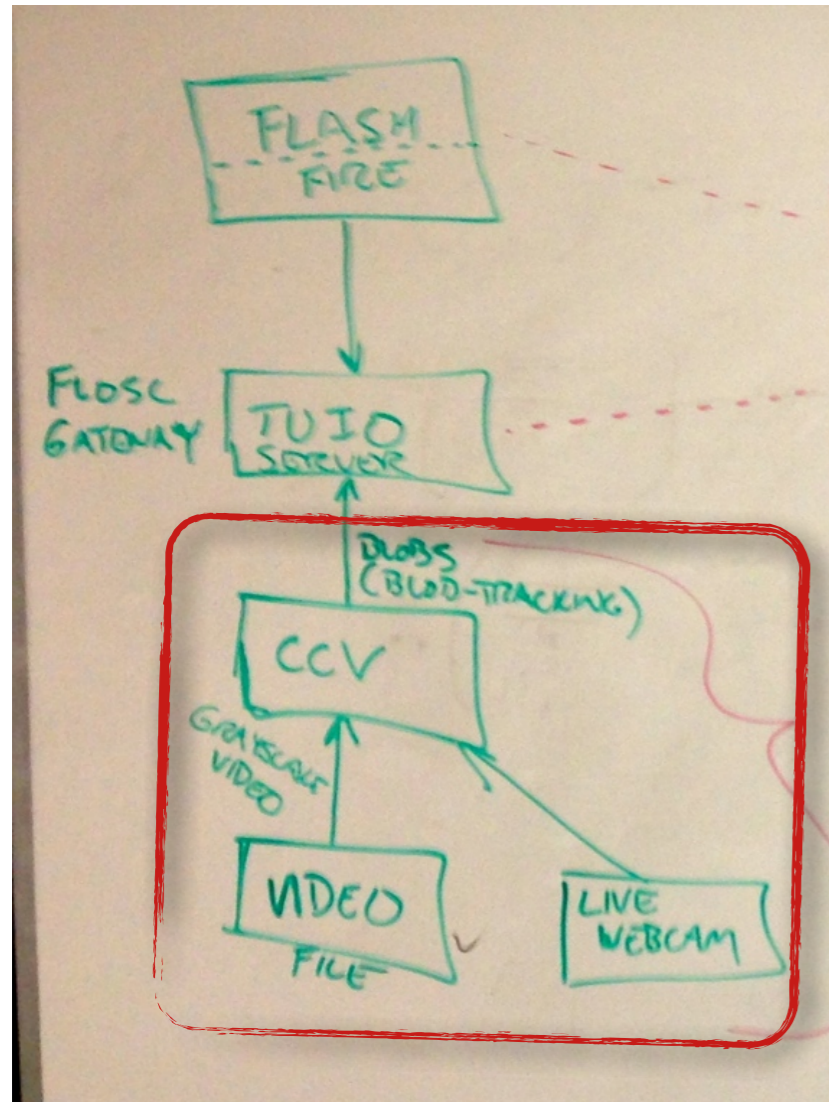




# Review Assignment



# How to do what we did in class



- Download Community Core Vision
- <http://nuicode.com/#projects>

nuigroup Home Projects

View all of the community projects since 2006.

Featured Projects (Downloads)

<a href="#">CCV</a>	Get the latest Community Core Vision installer, packages and binaries.	<a href="#">i</a> <a href="#">d</a>
---------------------	--	-------------------------------------

All Projects (Source)

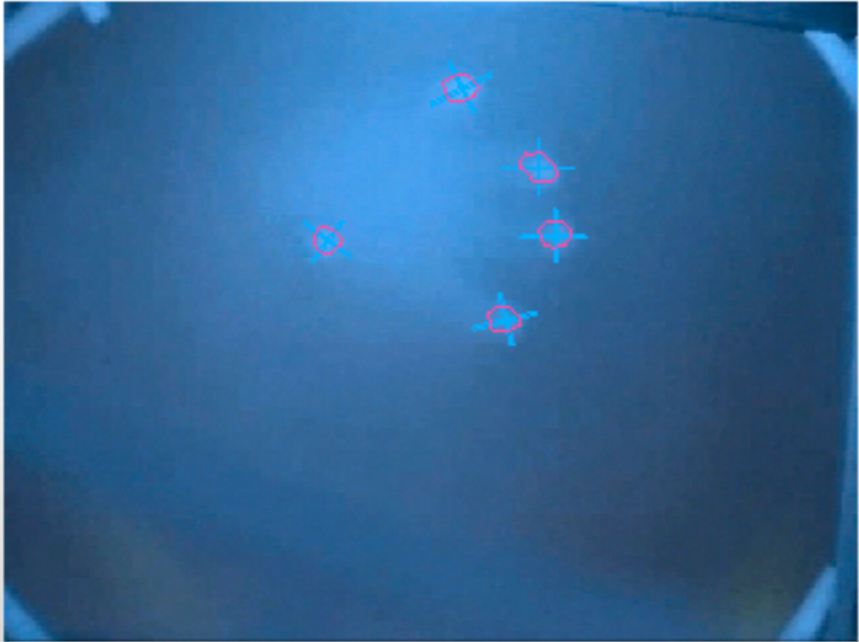
2012 <sup>5/6</sup>

Project	Description	Student	Mentor	Links
Computational Photography	A collection of advance computer vision filters and algorithms for use.	Siddharth Kherada	Pawel Solyga	<a href="#">i</a> <a href="#">d</a>
CCV Multiplexer	Implementation of virtual camera multiplexing into CCV 1.5.	Pratik Sharma	Amit Sarangi	<a href="#">i</a> <a href="#">d</a>
CCV 2.0	Foundation development of the CCV 1.5 codebase moving towards separate cores.	Scott Halstvedt	Christian Moore	<a href="#">i</a> <a href="#">d</a>
CCV 2.0	Feature porting of CV and UI systems into new foundation.	Anatoly Lushnikov	Jimbo Zhang	<a href="#">i</a> <a href="#">d</a>
Open Source Infrared Frame	An open source touch sensor providing board specs, app, firmware and driver.	Alexandr Pirogov	Taha Bintahir	<a href="#">i</a> <a href="#">d</a>
Kivy GUI Builder	Realtime GUI Editor built using the Kivy Framework (Fail)	Pranav Rao	Mathieu Virbel	<a href="#">i</a> <a href="#">d</a>

# How to do what we did in class

Community Core Vision

### Source Image

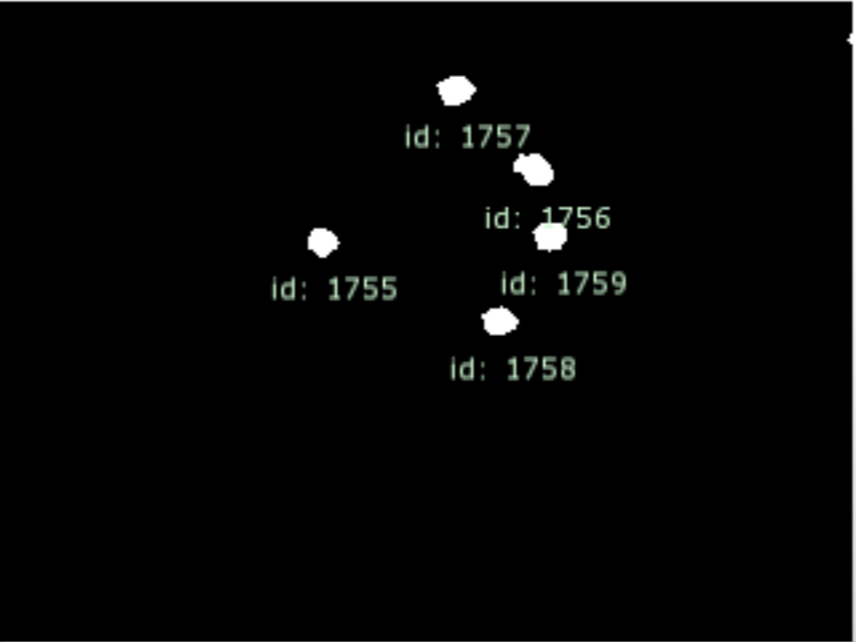


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:

Host: 127.0.0.1

Port: 3333

Press spacebar to toggle fast mode

~ |tbeta.nuigroup.com

### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3

### Amplify

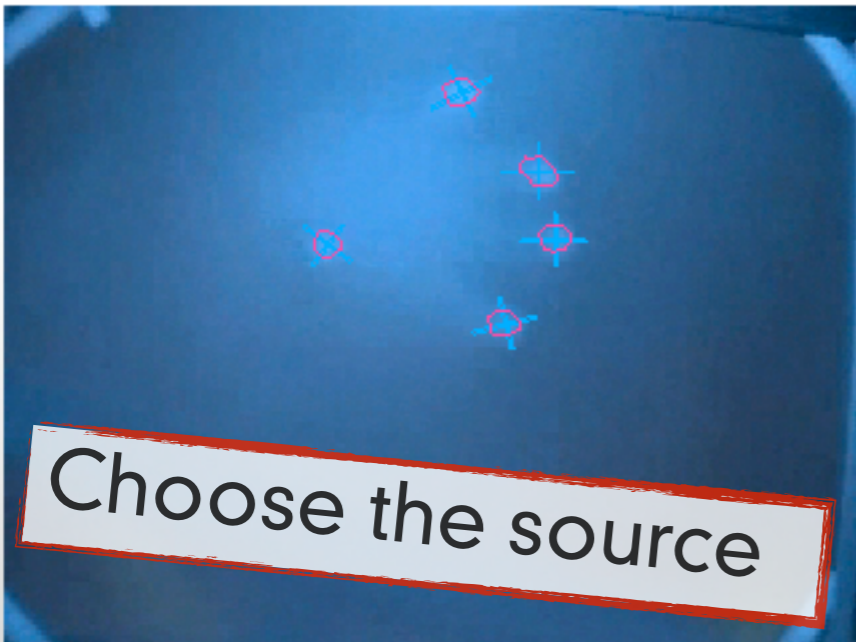
AMPLIFY: 35



# How to do what we did in class

Community Core Vision

### Source Image



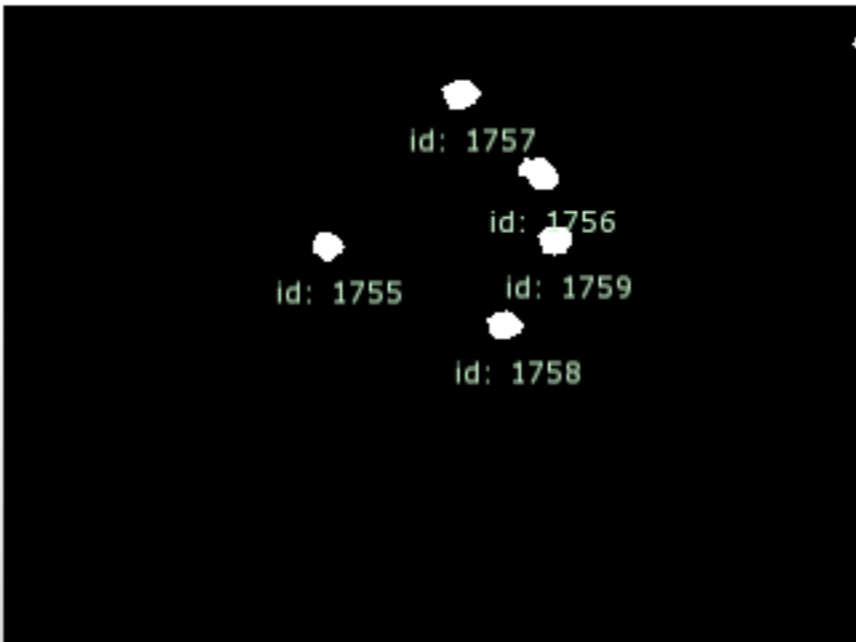
**Choose the source**

Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12

MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11

MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

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SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

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### Files

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Video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

Press spacebar to toggle fast mode

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### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3


### Amplify

AMPLIFY: 35

# How to do what we did in class

Community Core Vision

### Source Image

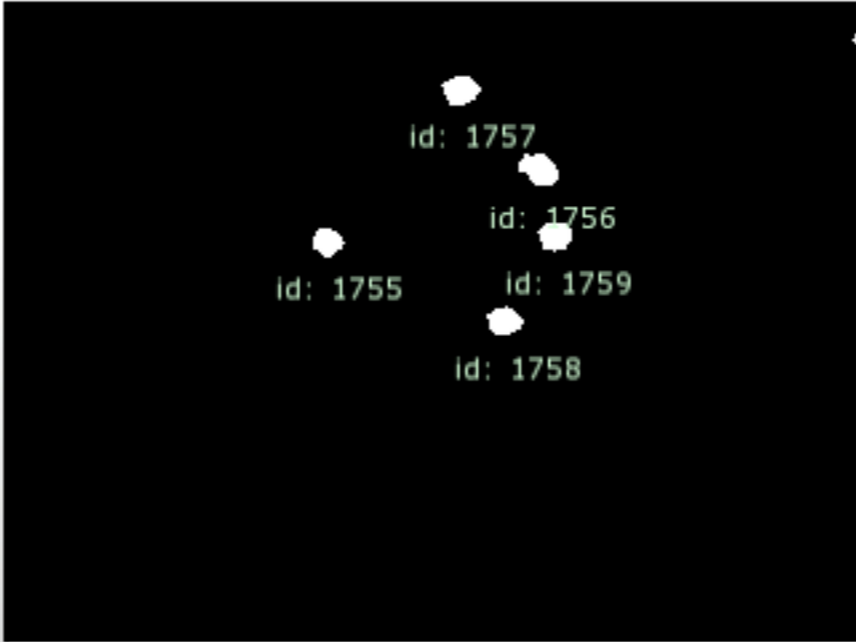


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

id: 1757  
id: 1756  
id: 1755 id: 1759  
id: 1758

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240  
Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

Press spacebar to toggle fast mode

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### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3

### Amplify

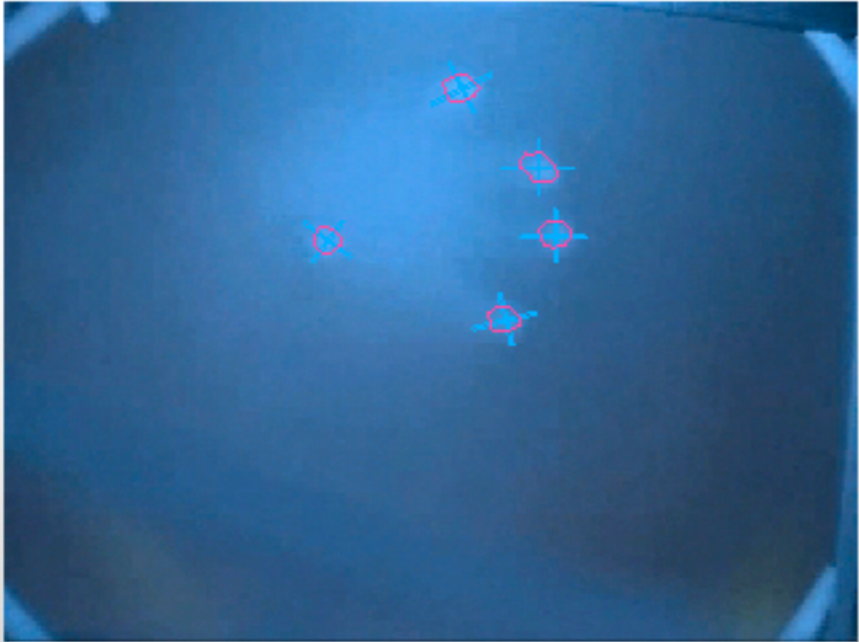
AMPLIFY: 35



# How to do what we did in class

Community Core Vision

### Source Image

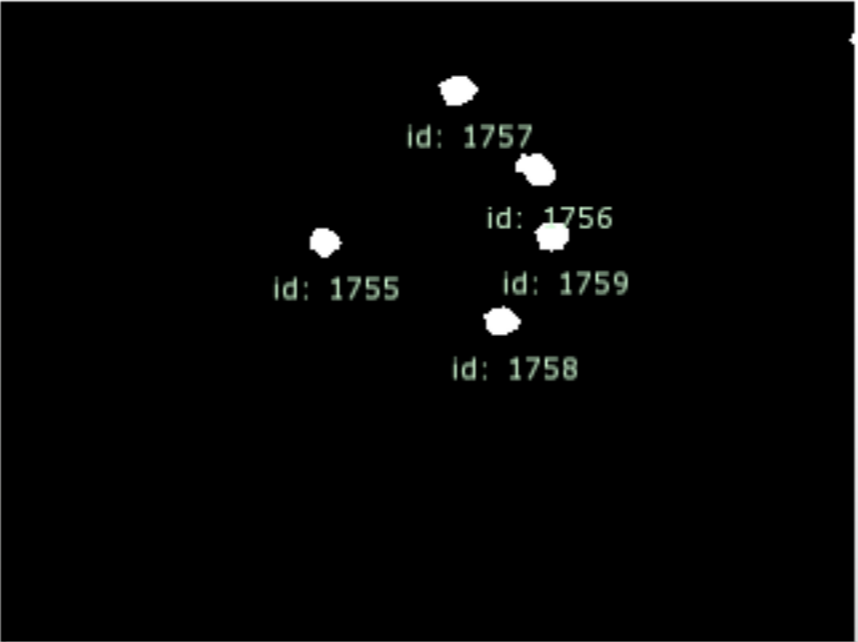


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12

MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11

MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240

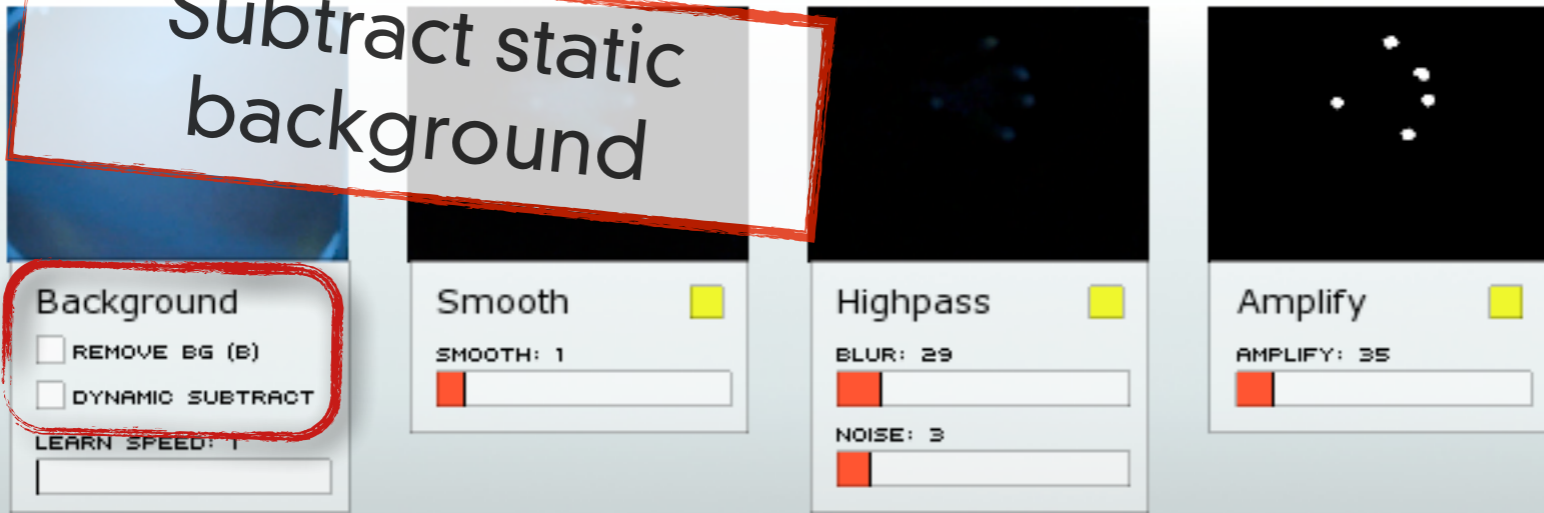
Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

Press spacebar to toggle fast mode

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## Subtract static background



Background  REMOVE BG (B)  DYNAMIC SUBTRACT

LEARN SPEED:

Smooth  SMOOTH: 1

Highpass  BLUR: 29

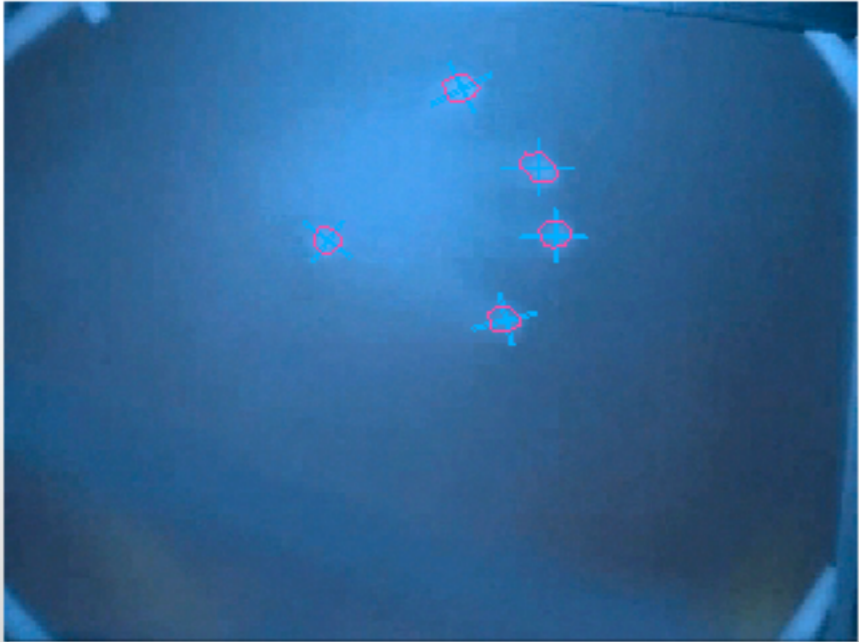
NOISE: 3

Amplify  AMPLIFY: 35

# How to do what we did in class

Community Core Vision

### Source Image

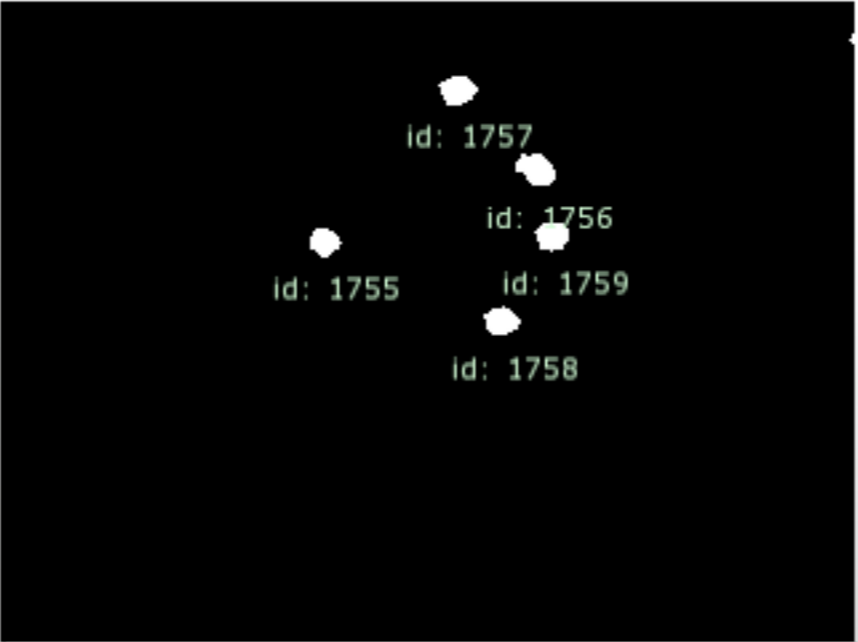


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

Press spacebar to toggle fast mode

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### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3


### Amplify

AMPLIFY: 35

# How to do what we did in class

Community Core Vision

### Source Image

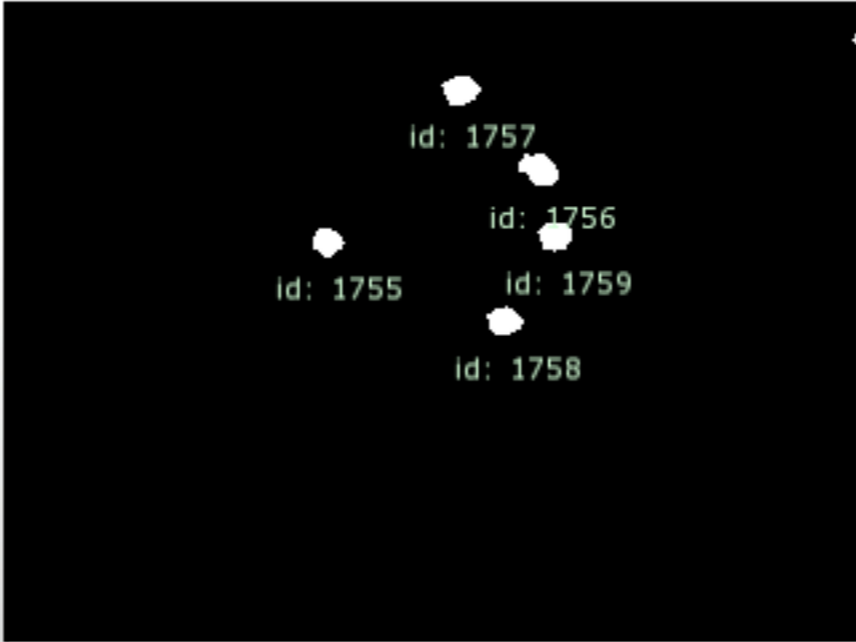


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

Press spacebar to toggle fast mode

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### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3

### Amplify

AMPLIFY: 35

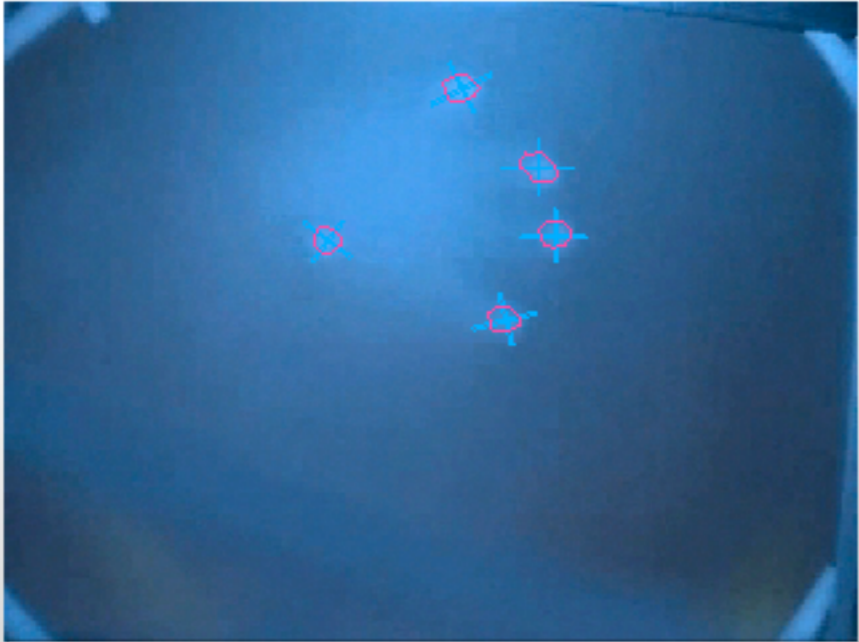
Smooth the video



# How to do what we did in class

Community Core Vision

### Source Image

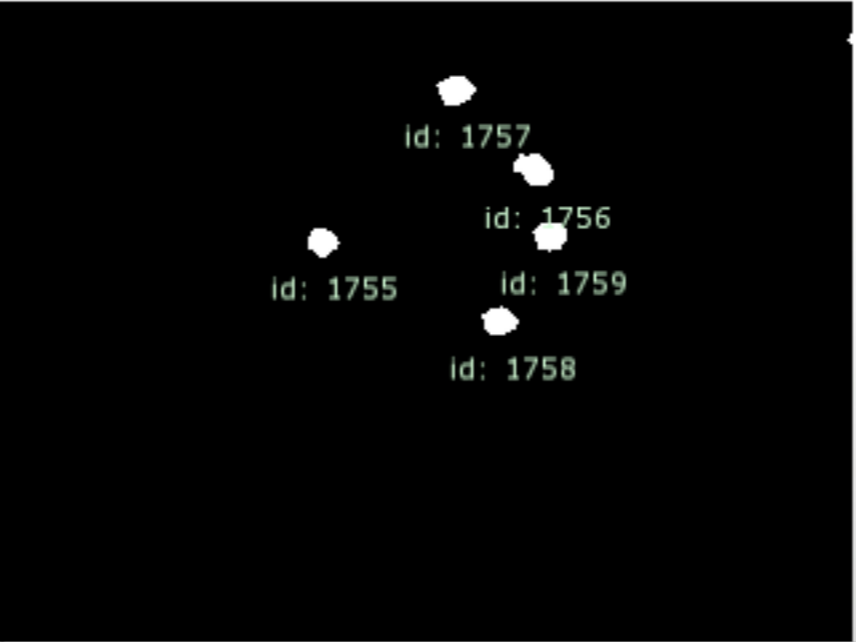


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:

Host: 127.0.0.1

Port: 3333

Press spacebar to toggle fast mode

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### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3


### Amplify

AMPLIFY: 35

# How to do what we did in class

Community Core Vision

### Source Image

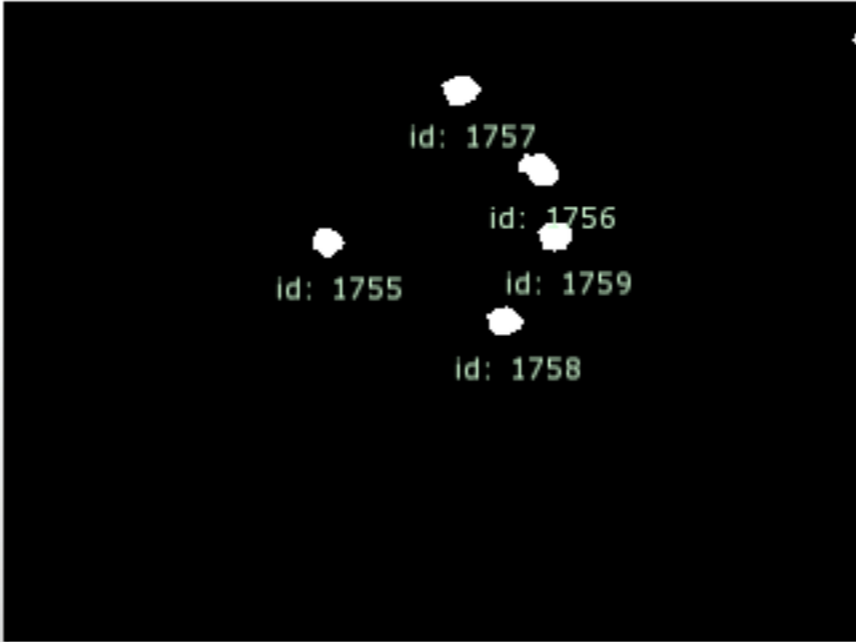


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

Press spacebar to toggle fast mode

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### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3

### Amplify

AMPLIFY: 35

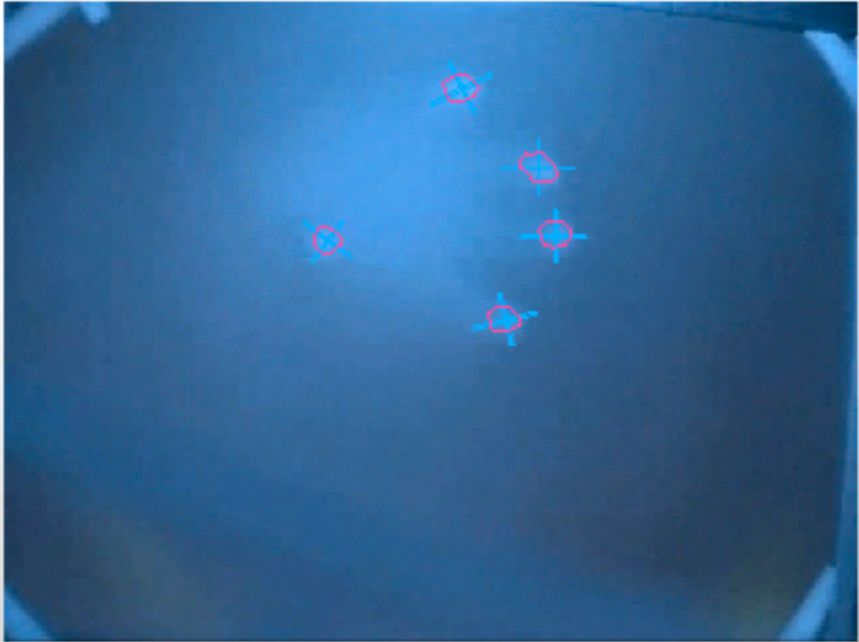
Eliminate "static"



# How to do what we did in class

Community Core Vision

### Source Image

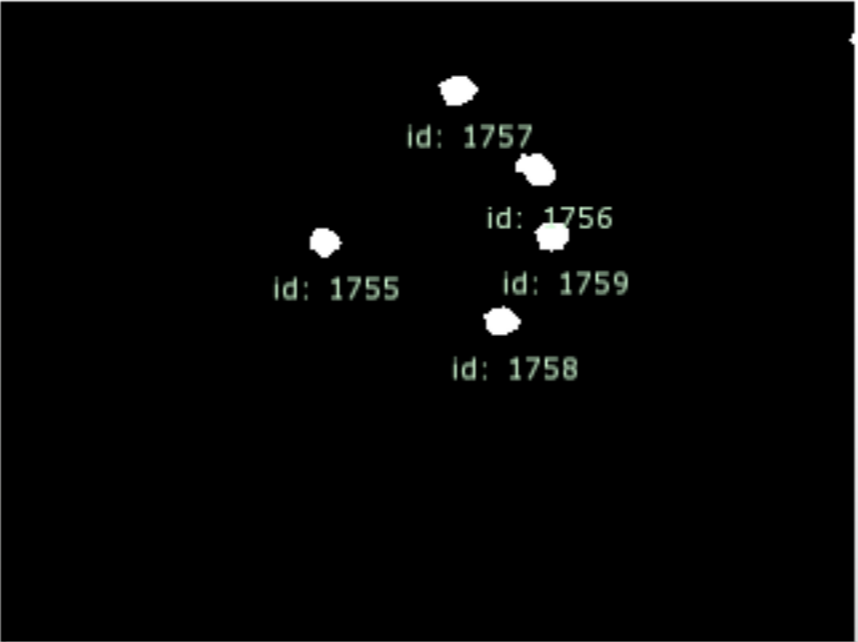


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:

Host: 127.0.0.1

Port: 3333

Press spacebar to toggle fast mode

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### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3

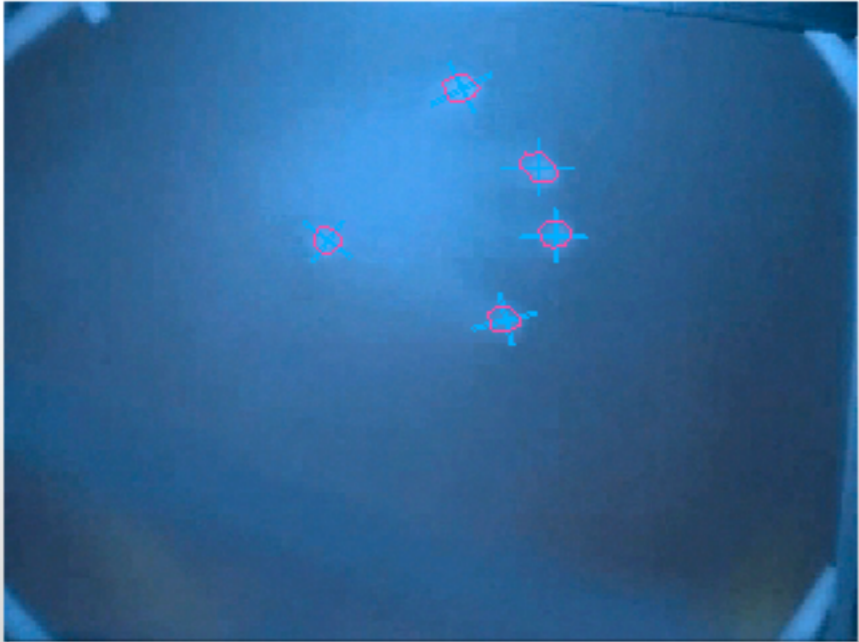
### Amplify

AMPLIFY: 35

# How to do what we did in class

Community Core Vision

### Source Image

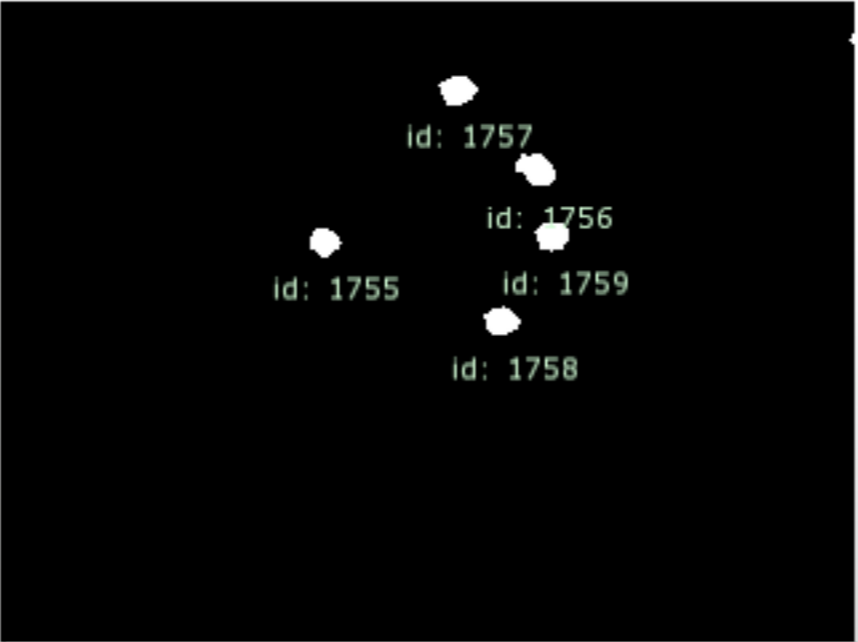


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3

### Amplify

AMPLIFY: 35

**Boost the signal**

Calc Time [ms]: 5

video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

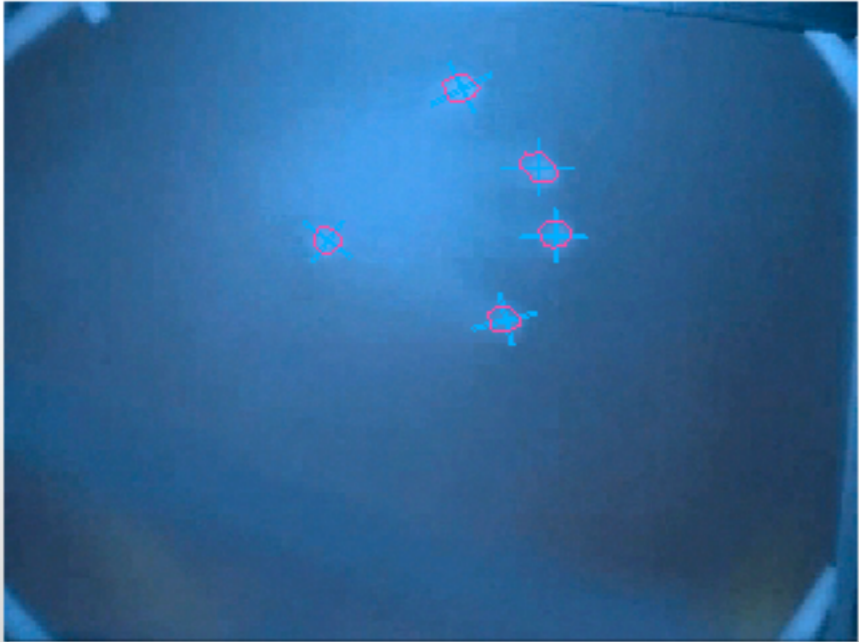
Press spacebar to toggle fast mode

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# How to do what we did in class

Community Core Vision

### Source Image

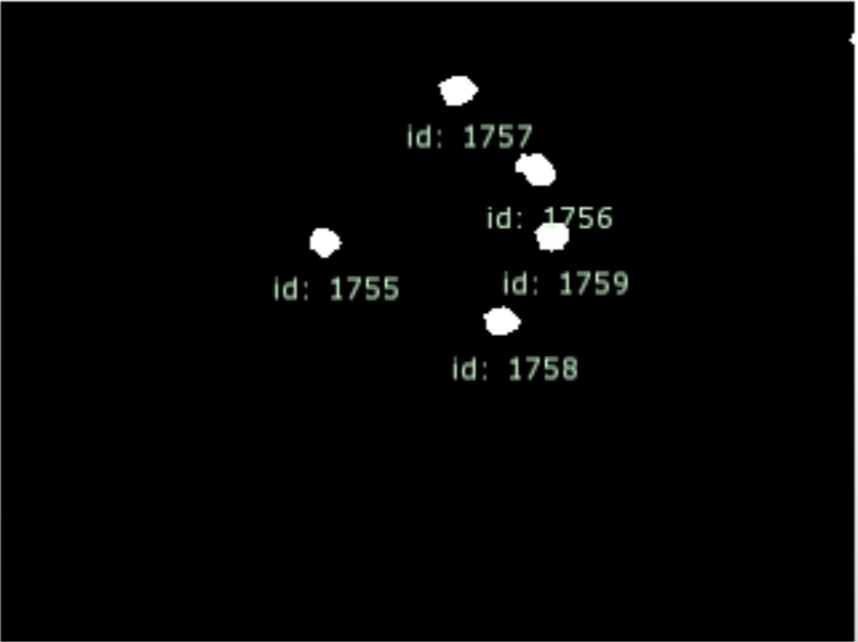


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

id: 1757  
id: 1756  
id: 1755 id: 1759  
id: 1758

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

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SEND HEIGHT & WIDTH

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ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

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Sending OSC messages to:  
Host: 127.0.0.1  
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Press spacebar to toggle fast mode

~ |tbeta.nuigroup.com

### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3

### Amplify

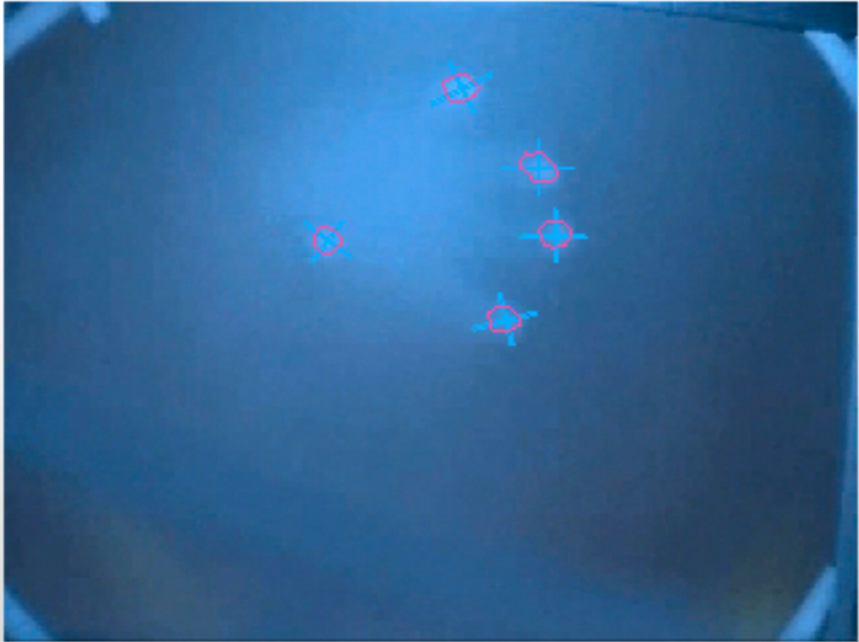
AMPLIFY: 35



# How to do what we did in class

Community Core Vision

### Source Image

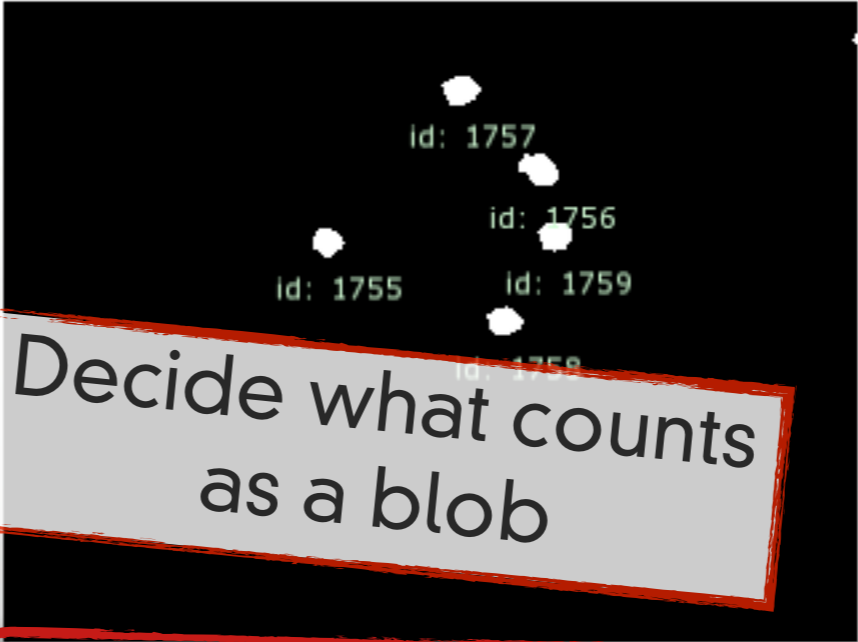


Source Image  SHOW OUTLINES (O)  SHOW IDS (I)

USE CAMERA  PREVIOUS CAMERA  NEXT CAMERA

USE VIDEO

### Tracked Image



Tracked Image  TRACK DRAW BLOBS

IMAGE THRESHOLD: 12  MOVEMENT THRESHOLD: 0

MIN BLOB SIZE: 11  MAX BLOB SIZE: 172

### Source Properties

CAMERA SETTINGS (V)

FLIP VERTICAL (J)

FLIP HORIZONTAL (H)

### GPU Properties

GPU MODE (G)

### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

Calc. Time [ms]: 5

Video [Res]: 320 x 240

Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

Press spacebar to toggle fast mode

~ |tbeta.nuigroup.com

### Background

REMOVE BG (B)

DYNAMIC SUBTRACT

LEARN SPEED: 1

### Smooth

SMOOTH: 1

### Highpass

BLUR: 29

NOISE: 3

### Amplify

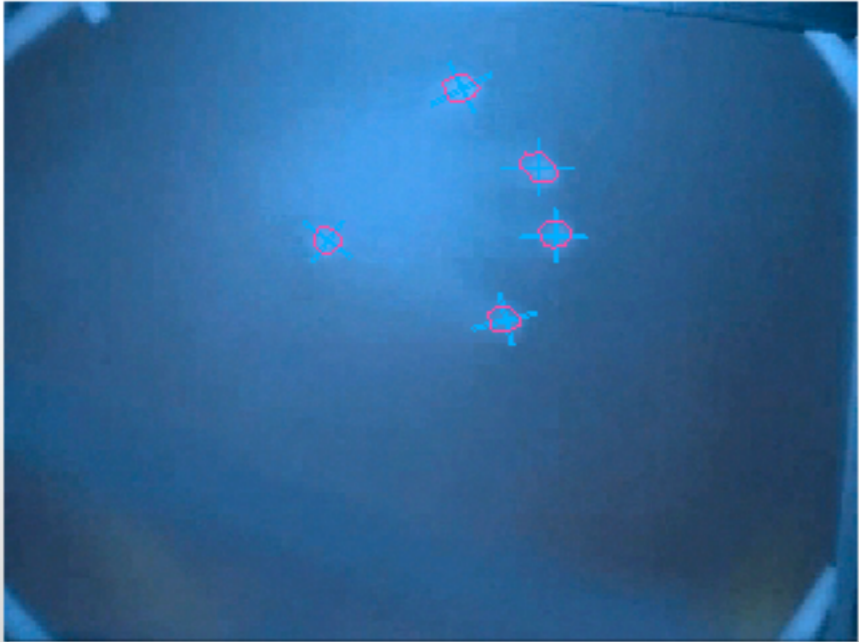
AMPLIFY: 35

Decide what counts as a blob

# How to do what we did in class

Community Core Vision

### Source Image

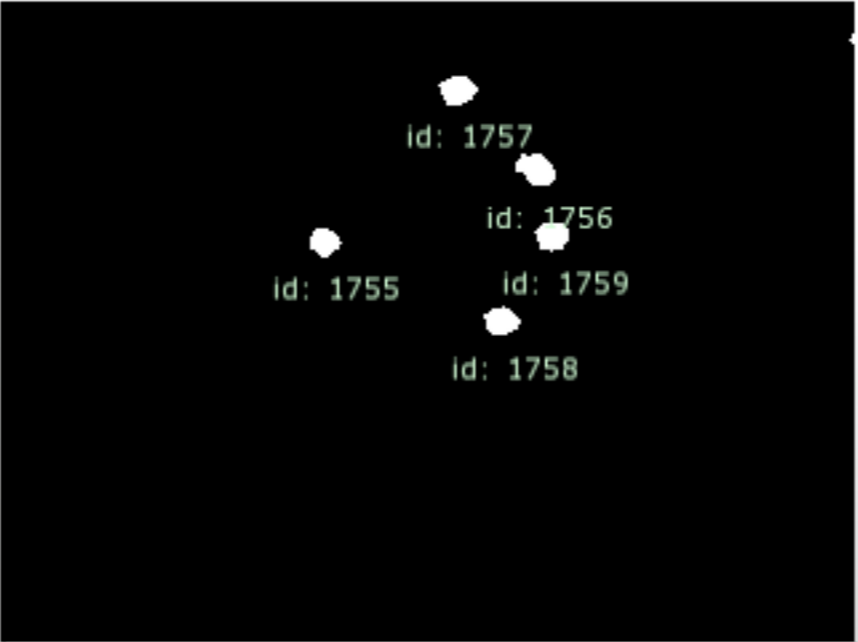


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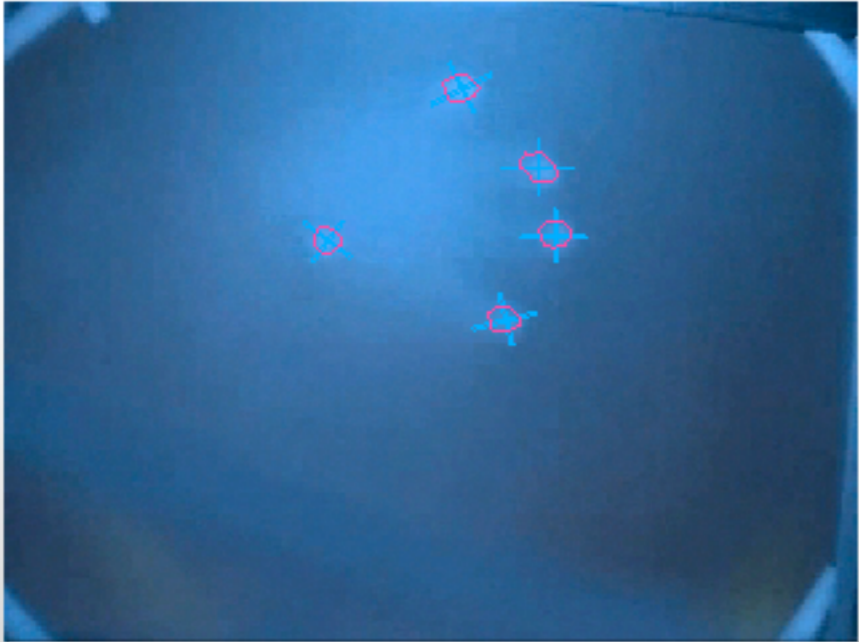
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# How to do what we did in class

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### Communication

SEND TUIO OSC (T)

SEND TUIO TOP | FOR FLASH (F)

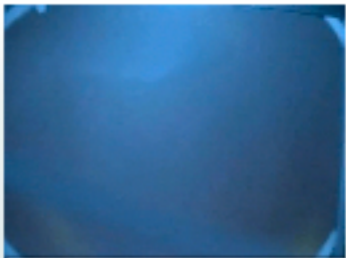
SEND HEIGHT & WIDTH

### Calibration

ENTER CALIBRATION (C)

### Files

SAVE SETTINGS (S)

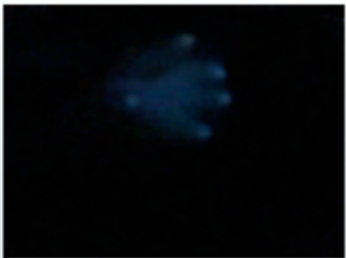


Background

REMOVE BG (B)

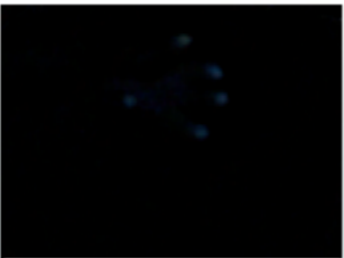
DYNAMIC SUBTRACT

LEARN SPEED: 1



Smooth

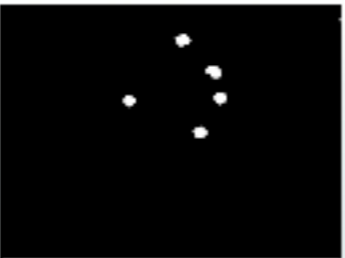
SMOOTH: 1



Highpass

BLUR: 29

NOISE: 3



Amplify

AMPLIFY: 35

Calc. Time [ms]: 5

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Video [fps]: 30

Sending OSC messages to:  
Host: 127.0.0.1  
Port: 3333

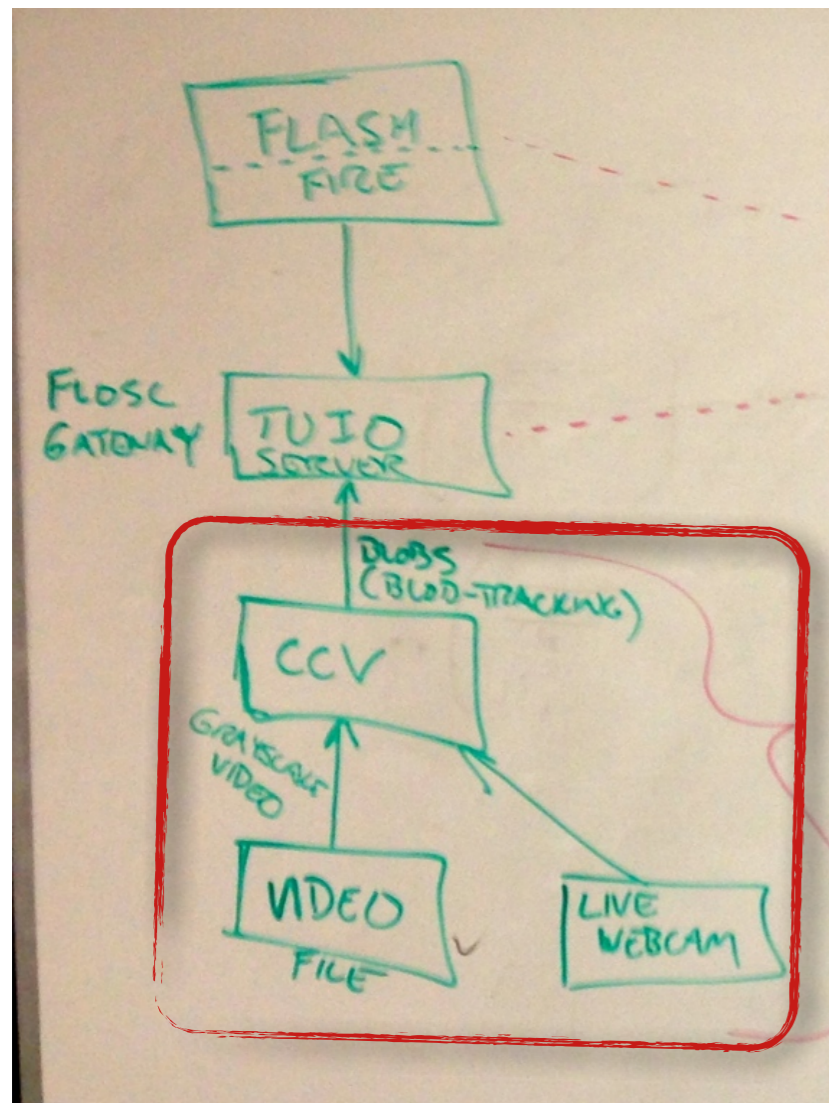
Press spacebar to toggle fast mode

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Settings you may need to mess with



# How to do what we did in class



- There is also a configuration file for CCV
  - config.xml
  - GUI settings can be typed in this file
  - It may get overwritten from the GUI

# How to do what we did in class

```
<?xml version="1.0" ?>
<CONFIG>
  <!--//////////////////////////////////////
  YOU CAN MANUALLY EDIT THE FEATURES BELOW
  //////////////////////////////////----->
  <!--// CAMERA SETTINGS // -->
  <CAMERA_0>
    <USECAMERA>1</USECAMERA>
    <DEVICE>1</DEVICE>
    <WIDTH>320</WIDTH>
    <HEIGHT>240</HEIGHT>
    <FRAMERATE>120</FRAMERATE>
  </CAMERA_0>
  <!--// NETWORK COMMUNICATION SETTINGS //-->
  <NETWORK>
    <LOCALHOST>127.0.0.1</LOCALHOST>
    <TUIO>0</TUIO>
    <TUIOPORT_OUT>3333</TUIOPORT_OUT>
    <TUIOFLASHPORT_OUT>3000</TUIOFLASHPORT_OUT>
  </NETWORK>
  <!--// VIDEO SETTINGS // -->
  <VIDEO>
    <FILENAME>test_videos/RearDI.m4v</FILENAME>
  </VIDEO>
  <!--// BLOB SETTINGS // -->
  <BLOBS>
    <MAXNUMBER>20</MAXNUMBER>
  </BLOBS>
  //////////////////////////////////////
```

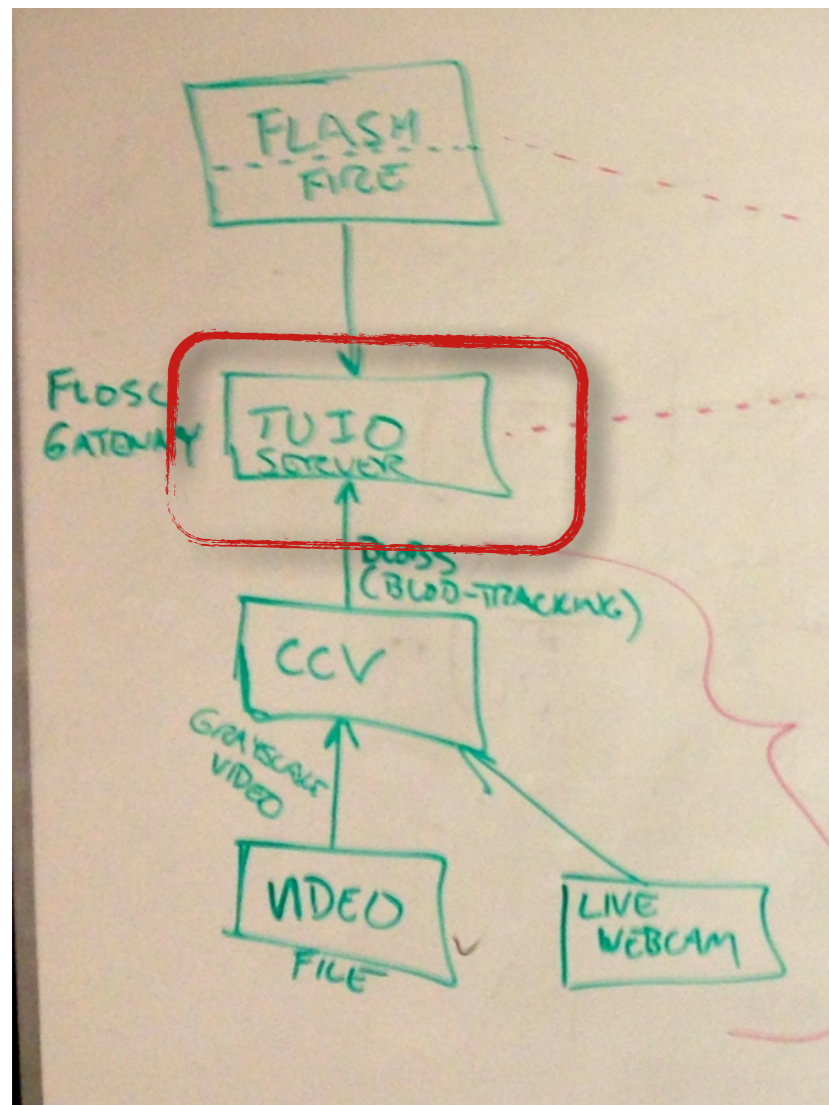


# How to do what we did in class

```
<!--//////////////////////////////////////>
DO NOT EDIT THE VALUES BELOW
////////////////////////////////////// -->
<APPLICATION>
  <TITLE>Community Core Visision</TITLE>
  <VERSION>1.2.0</VERSION>
</APPLICATION>
<WINDOW>
  <WIDTH>950</WIDTH>
  <HEIGHT>600</HEIGHT>
</WINDOW>
<BOOLEAN>
  <PRESSURE>4</PRESSURE>
  <LABELS>1</LABELS>
  <OUTLINES>1</OUTLINES>
  <LEARNBG>0</LEARNBG>
  <TUIO>1</TUIO>
  <VMIRROR>0</VMIRROR>
  <HMIRROR>0</HMIRROR>
  <HIGHPASS>1</HIGHPASS>
  <AMPLIFY>1</AMPLIFY>
  <SMOOTH>0</SMOOTH>
  <GPU>1</GPU>
  <DYNAMICCBG>1</DYNAMICCBG>
  <SNAPSHOT>0</SNAPSHOT>
  <MINIMODE>0</MINIMODE>
  <HEIGHTWIDTH>1</HEIGHTWIDTH>
  <OSCMODE>1</OSCMODE>
  <TCPMODE>0</TCPMODE>
  <TRACKDARK>1</TRACKDARK>
</BOOLEAN>
<INT>
  <MINMOVEMENT>2</MINMOVEMENT>
  <MINBLOBSIZE>11</MINBLOBSIZE>
  <MAXBLOBSIZE>86</MAXBLOBSIZE>
  <!--// FILTERS SETTERS //-->
  <THRESHOLD>43</THRESHOLD>
  <HIGHPASSBLUR>40</HIGHPASSBLUR>
  <HIGHPASSNOISE>8</HIGHPASSNOISE>
  <HIGHPASSAMP>35</HIGHPASSAMP>
  <SMOOTH>1</SMOOTH>
  <BGLEARNRATE>450.099976</BGLEARNRATE>
</INT>
</CONFIG>
```



# How to do what we did in class



- For Flash Demos run the TUIO server standalone

Launch flosc server

```
java -jar flosc-2_0_5.jar 3333 3000
```

Set the Flash port to 3000  
Set the OSC port to 3333  
and start it

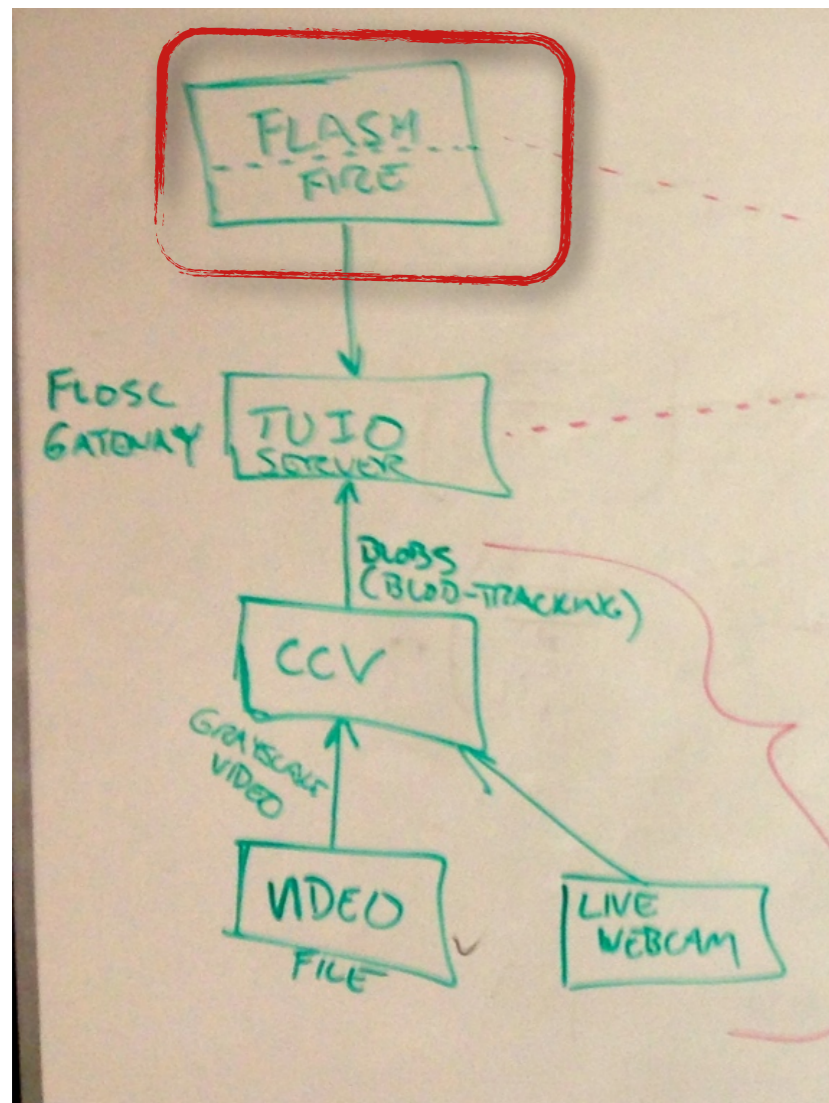
Launch CCV

Make sure "Send TUIO OSC" is checked

Launch Flash application

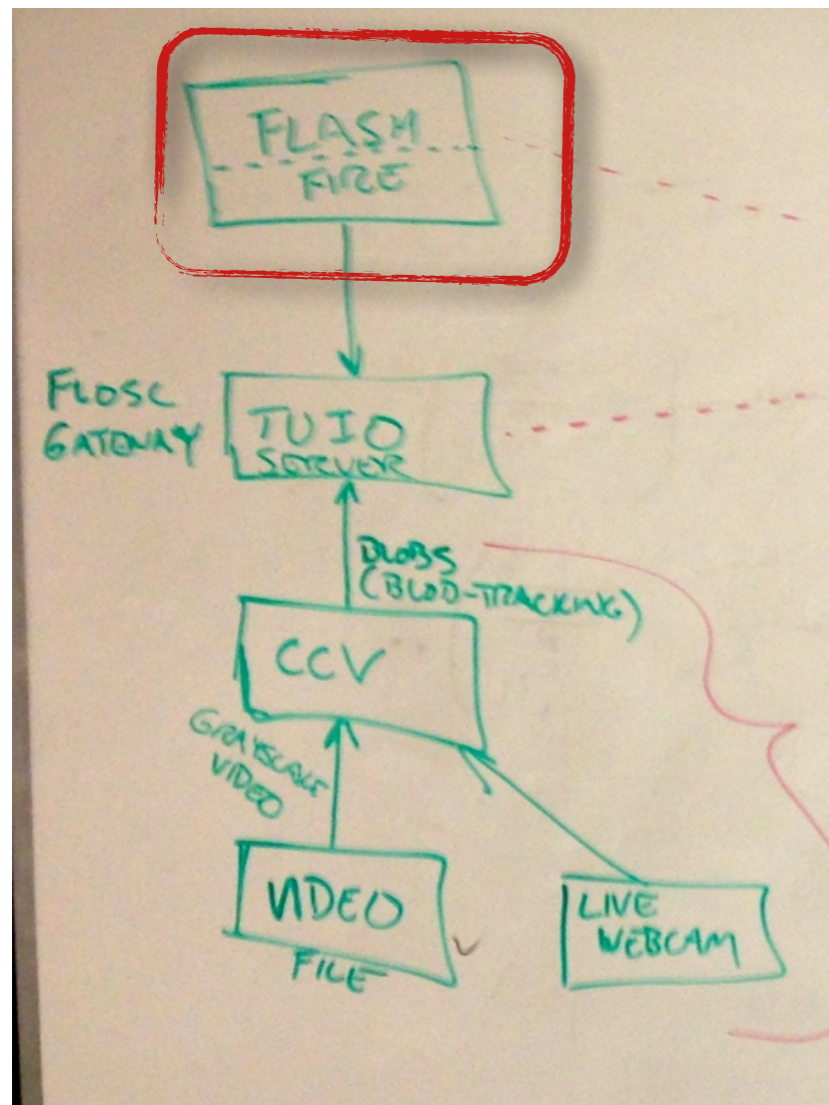


# How to do what we did in class

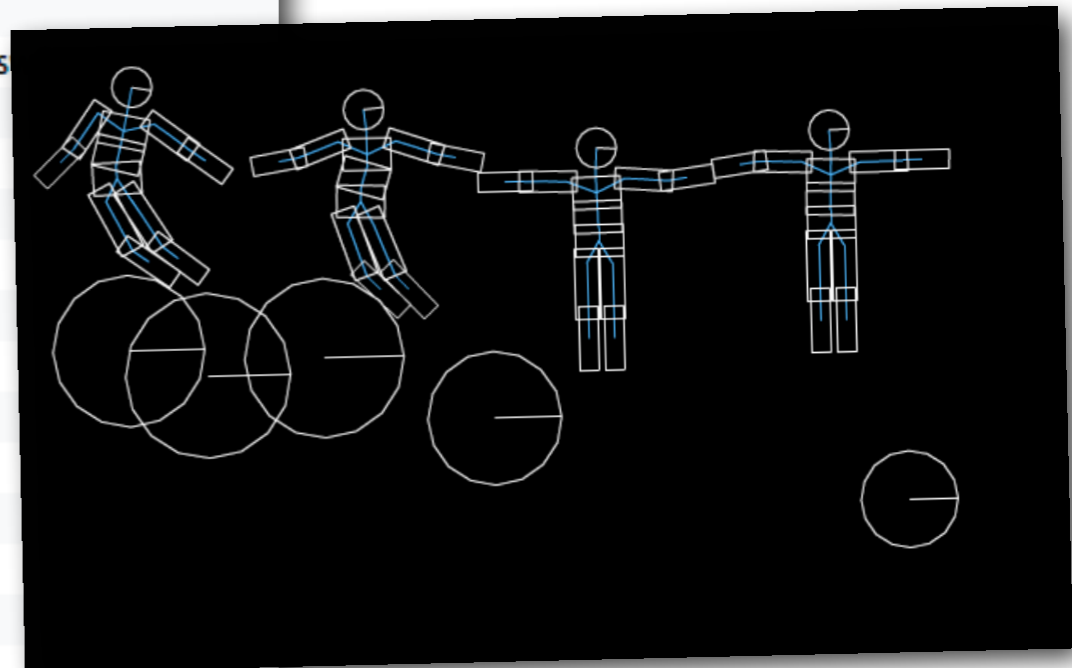
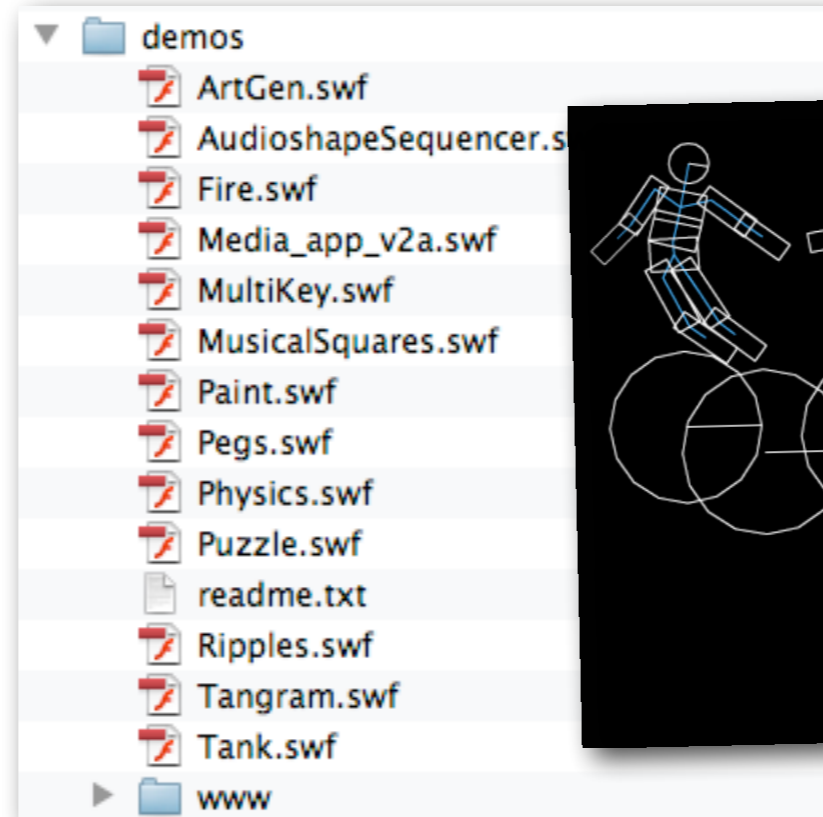


- Download Flash Demos
- Originally here:
  - <http://ccv.nuigroup.com/>
- Now on our [course assignment page](#):

# How to do what we did in class



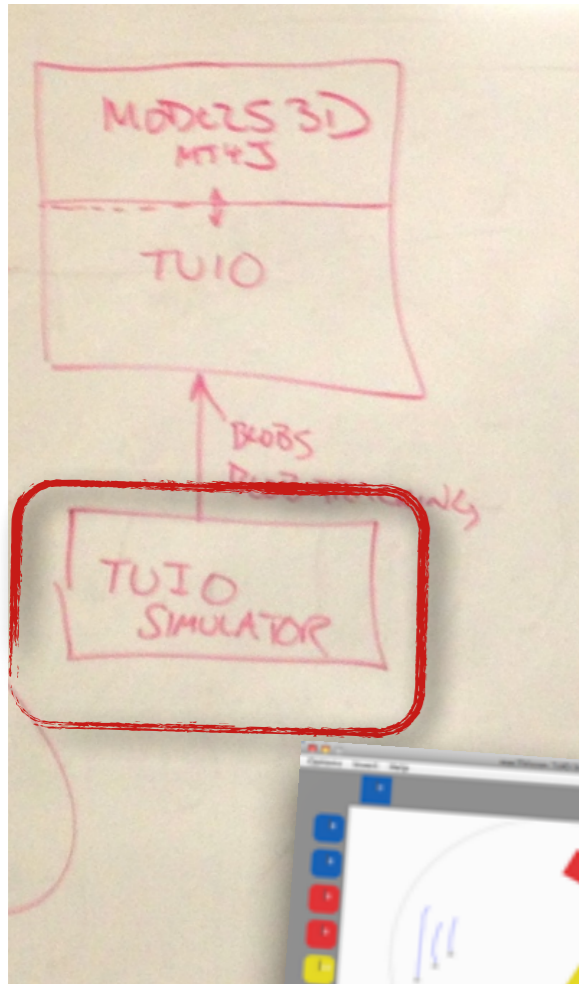
- Download Flash Demos





# How to do what we did in class

- Download TUIO Simulator
- <http://reactivision.sourceforge.net/>



**reactIVision 1.5** sourceforge

downloads documentation

### a toolkit for tangible multi-touch surfaces

reactIVision is an open source, cross-platform computer vision framework for the fast and robust tracking of fiducial markers attached onto physical objects, as well as for multi-touch finger tracking. It was mainly designed as a toolkit for the rapid development of table-based tangible user interfaces (TUI) and multi-touch interactive surfaces. This framework has been developed by Martin Kaltenbrunner and Ross Bencina as the underlying sensor component of the Reactable, a tangible modular synthesizer that has set the standards for tangible multi-touch applications.

**please note:** reactIVision is the computer vision framework of the Reactable synthesizer. This open source package does therefore not contain any sound or visualization software components, which are also not available separately at the moment. If you are interested in purchasing a Reactable you can find further information on its [product page](#).

reactIVision screenshot

fiducial marker example

framework diagram

TUIO simulator

**reactIVision**  
Like 2,901

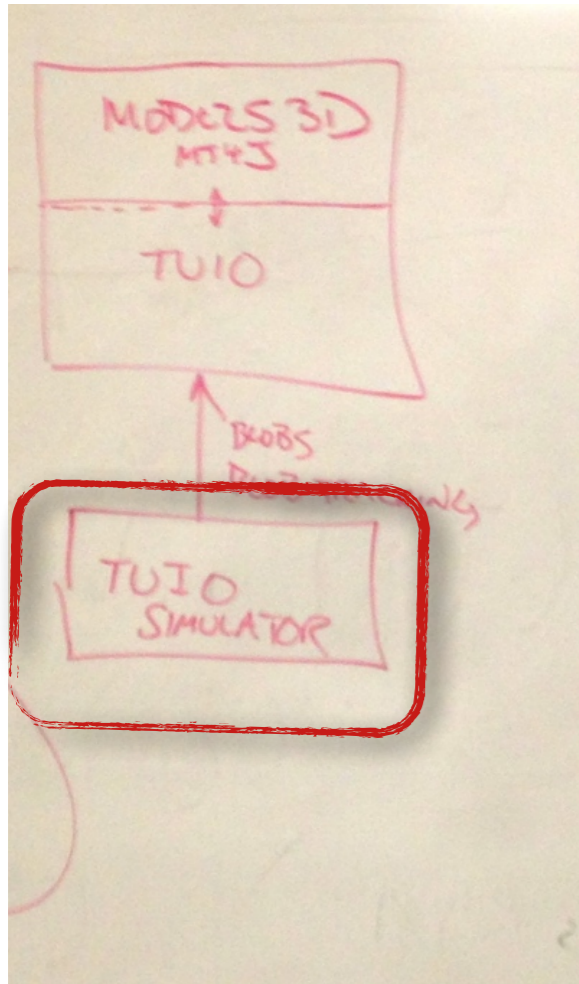
**Support Forum**

**Project Showcase**

**TUIO.org**

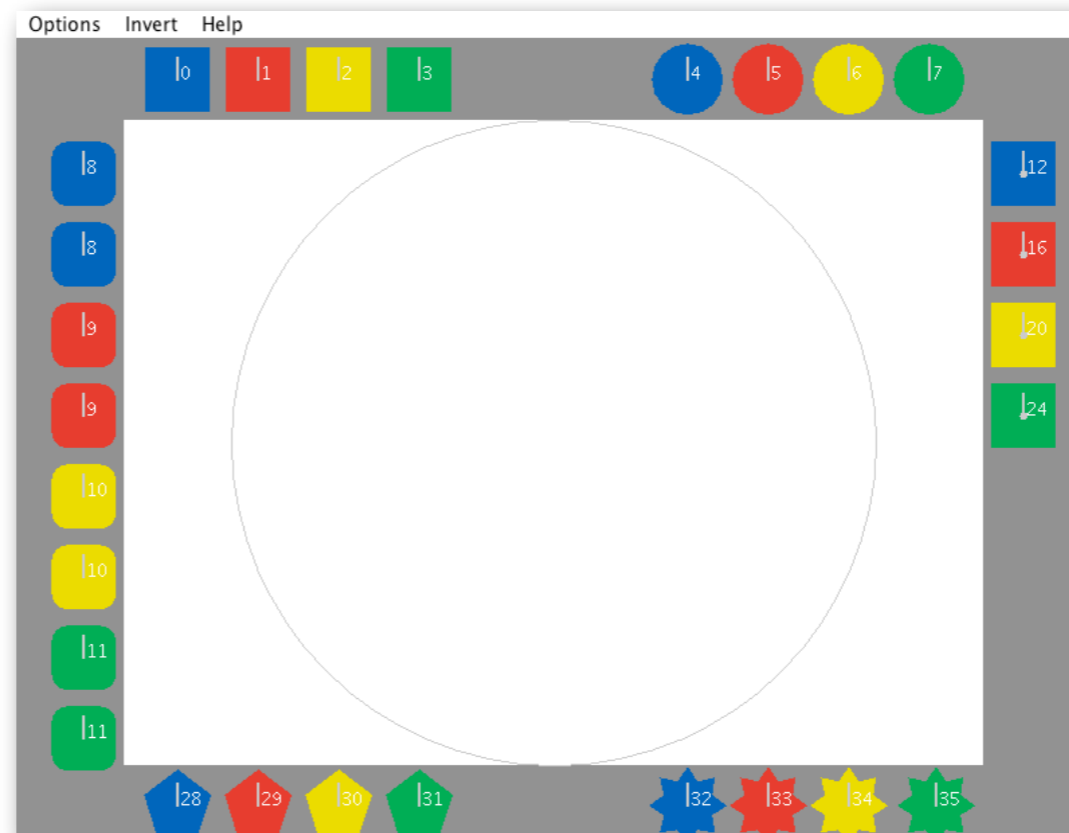


# How to do what we did in class



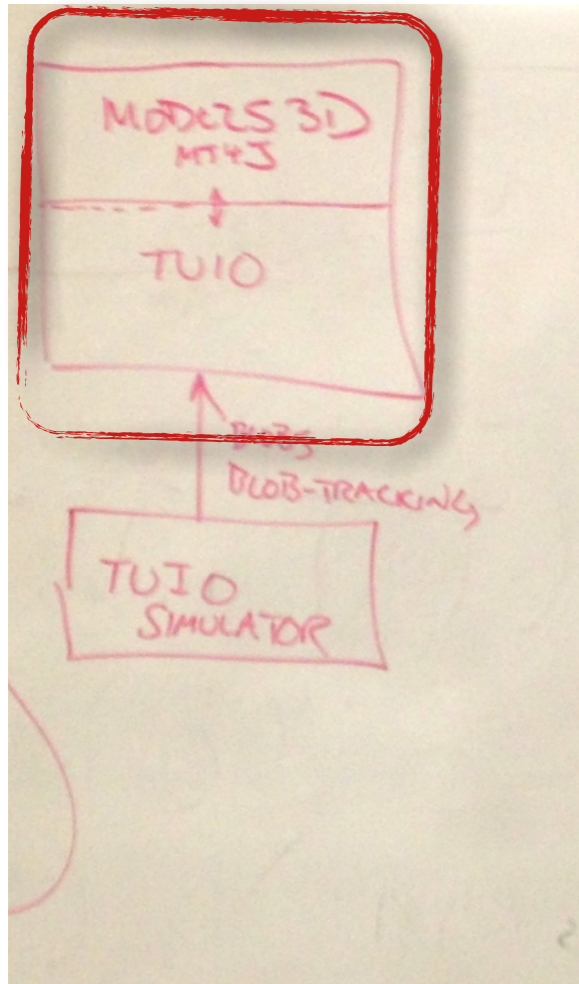
- Run as a java program

```
$ java -jar TuioSimulator.jar  
sending TUIO messages to 127.0.0.1:3333
```





# How to do what we did in class

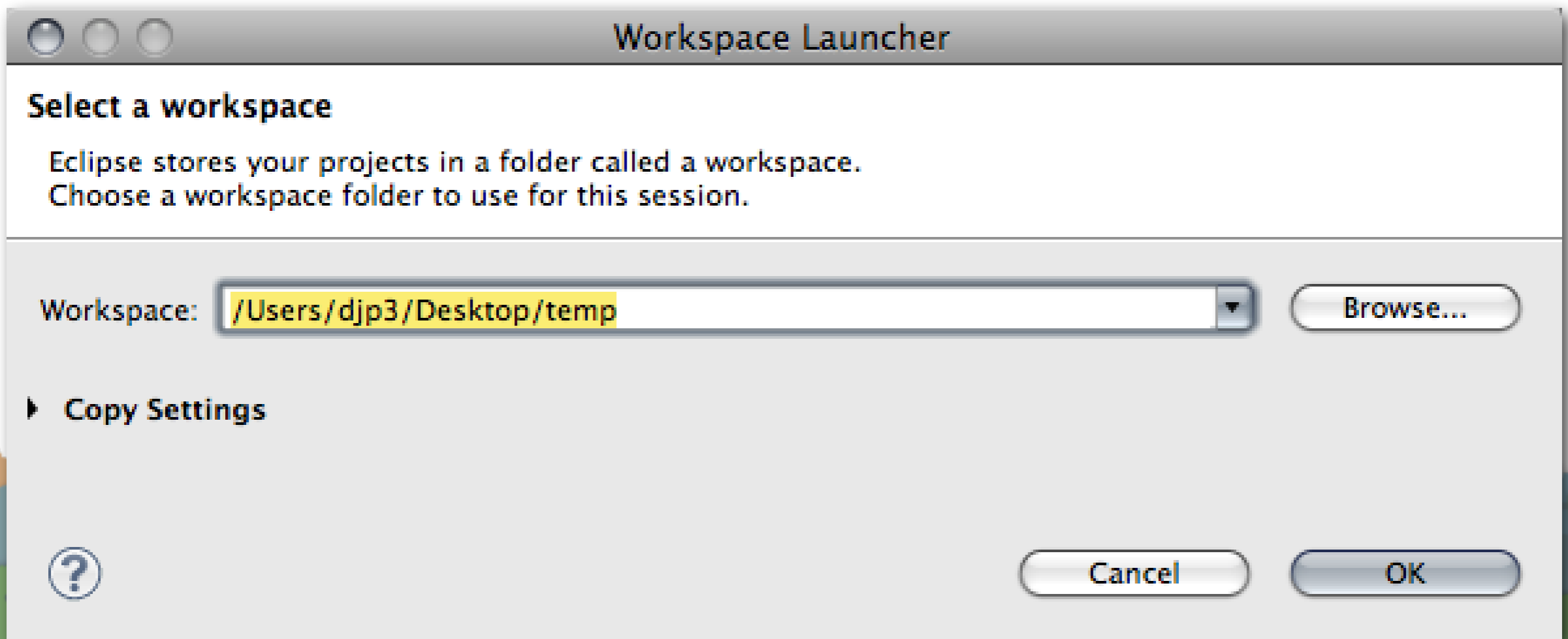


- Setup MT4J in Eclipse



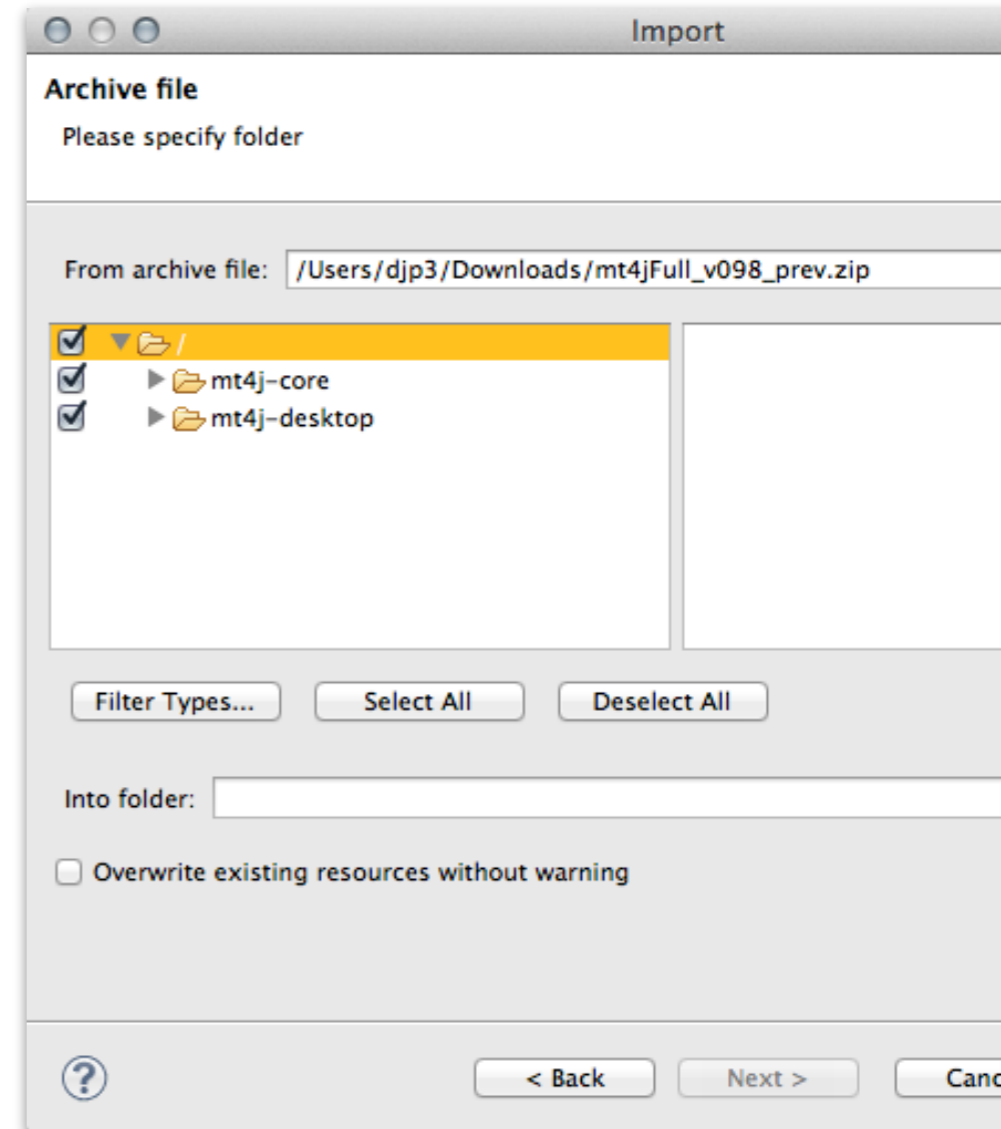
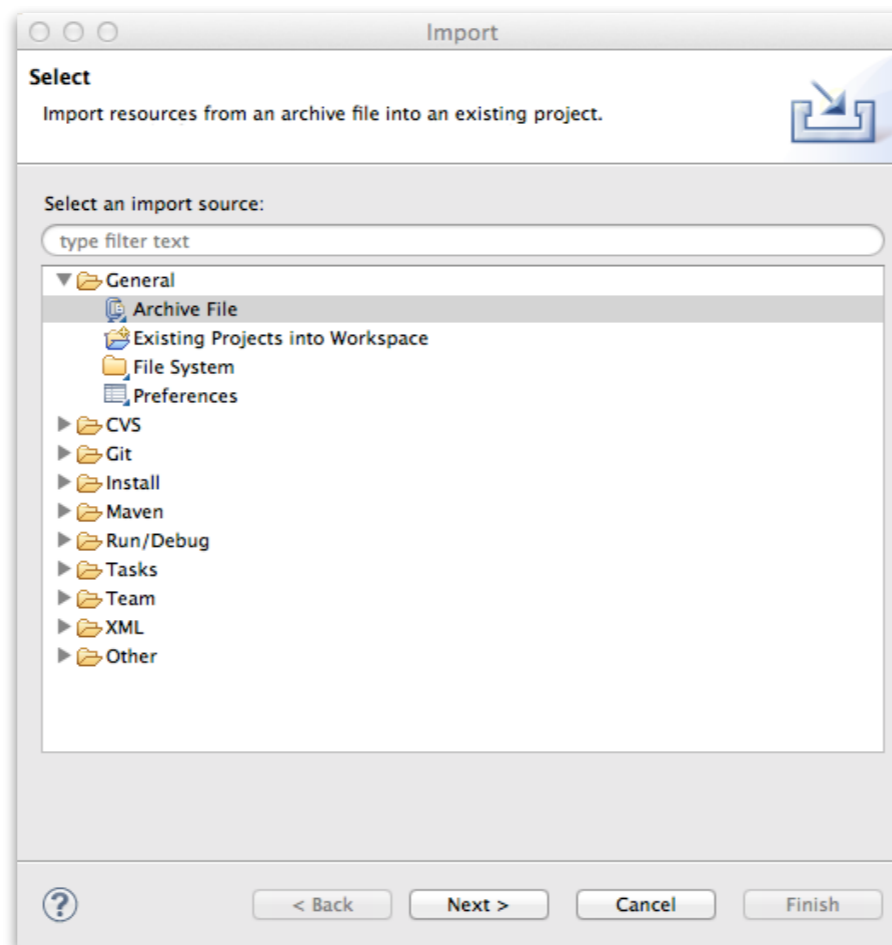
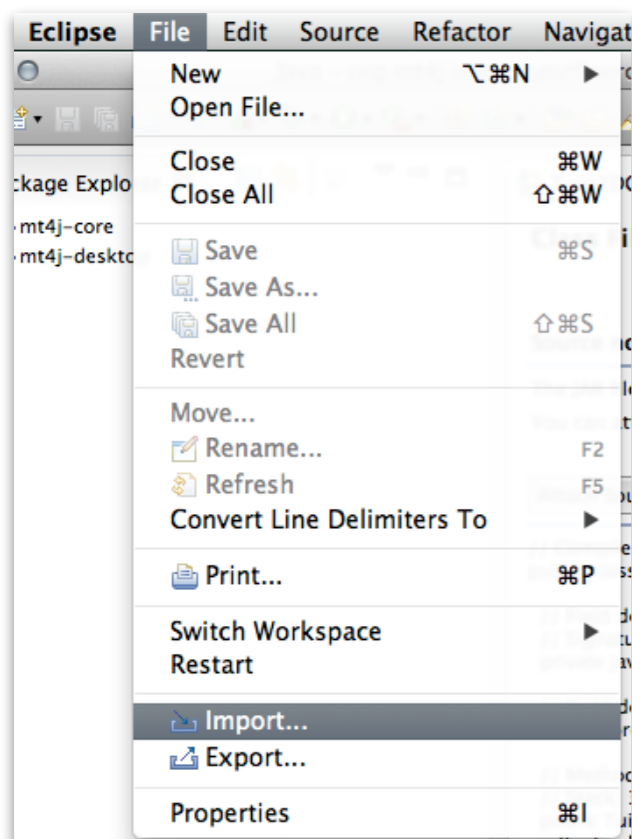
## Getting the software going

- Download and Install Eclipse
  - <http://www.eclipse.org/>
- Download MT4J
  - <http://www.mt4j.org/mediawiki/index.php/Downloads>
- Pick a directory and create a new workspace in Eclipse



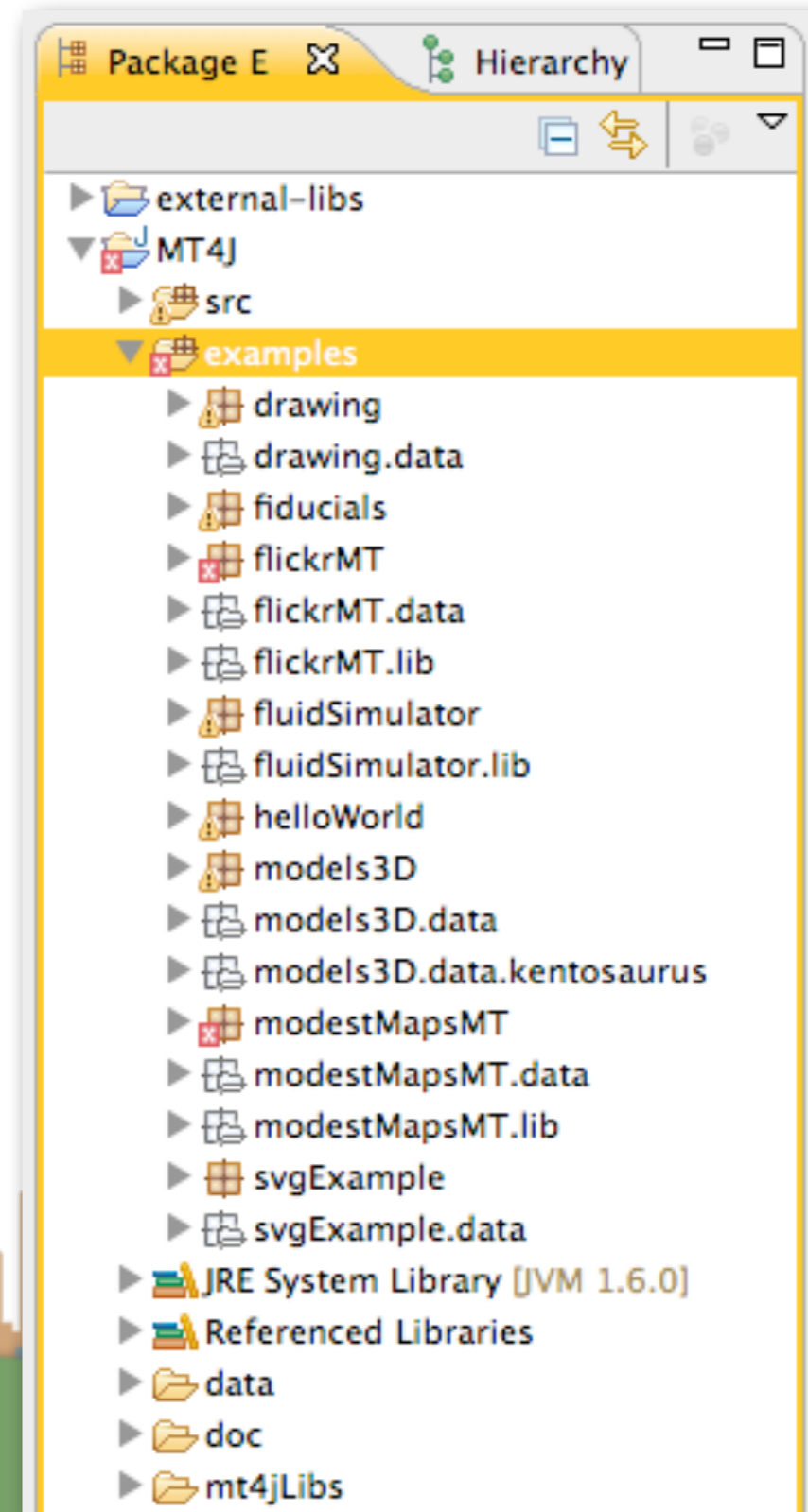
# Getting the software going

- Import a new archive Java Project in Eclipse



# Getting the software going

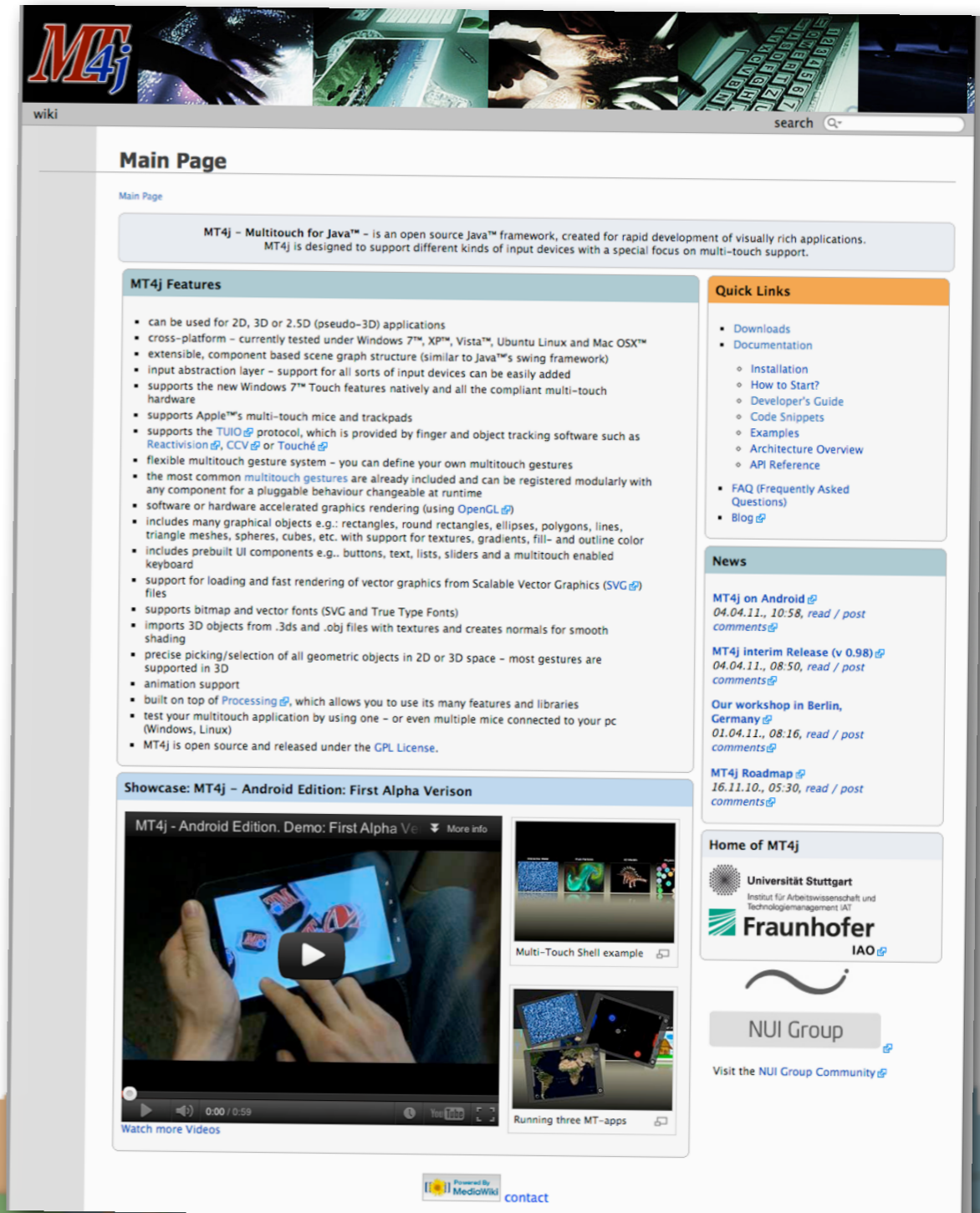
- When you run an MT4J program the TUIO server is built in
  - Hello World
  - Test Scene
  - MTGestures
  - Space Scene
  - Fluid Simulator





# Getting the software going

- The MT4J page has information on how to use MT4J
  - It's a visualization system
  - It is complicated
  - Start with an example
  - Then modify it



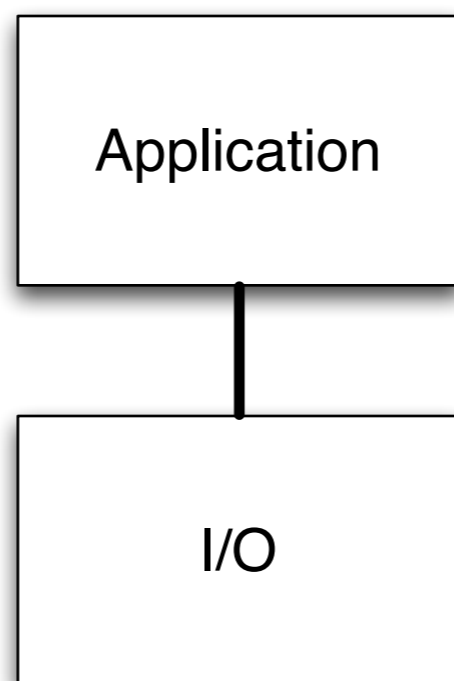
The screenshot shows the main page of the MT4J wiki. At the top, there is a banner with the MT4j logo and several images illustrating multitouch interactions. Below the banner is a search bar and the title "Main Page". The main content area is divided into several sections:

- Main Page:** A introductory paragraph stating that MT4j is an open source Java framework for rapid development of visually rich applications, designed to support different input devices with a focus on multi-touch.
- MT4j Features:** A list of features including support for 2D, 3D, and 2.5D applications; cross-platform compatibility (Windows, XP, Vista, Ubuntu, Mac OS); extensible scene graph structure; input abstraction layer; support for Windows 7 touch features; support for Apple multi-touch mice and trackpads; support for the TUIO protocol; flexible multitouch gesture system; support for common multitouch gestures; software or hardware accelerated graphics rendering; support for many graphical objects (rectangles, spheres, etc.); support for prebuilt UI components; support for loading and fast rendering of vector graphics (SVG); support for bitmap and vector fonts; support for 3D objects; precise picking/selection of geometric objects; animation support; built on top of Processing; and support for testing applications with multiple mice.
- Quick Links:** A list of links for Downloads, Documentation, Installation, How to Start?, Developer's Guide, Code Snippets, Examples, Architecture Overview, API Reference, FAQ, and Blog.
- News:** A list of recent news items, including "MT4j on Android", "MT4j interim Release (v 0.98)", "Our workshop in Berlin, Germany", and "MT4j Roadmap".
- Home of MT4j:** Logos for Universität Stuttgart, Institut für Arbeitswissenschaft und Technologiemanagement (IAT), and Fraunhofer IAO.
- NUI Group:** A logo for the NUI Group with a link to visit their community.
- Showcase:** A section titled "Showcase: MT4j - Android Edition: First Alpha Verison" featuring a video player showing a multitouch application on a tablet, and two smaller images: "Multi-Touch Shell example" and "Running three MT-apps".

At the bottom of the page, there is a "Powered by MediaWiki" logo and a "contact" link.

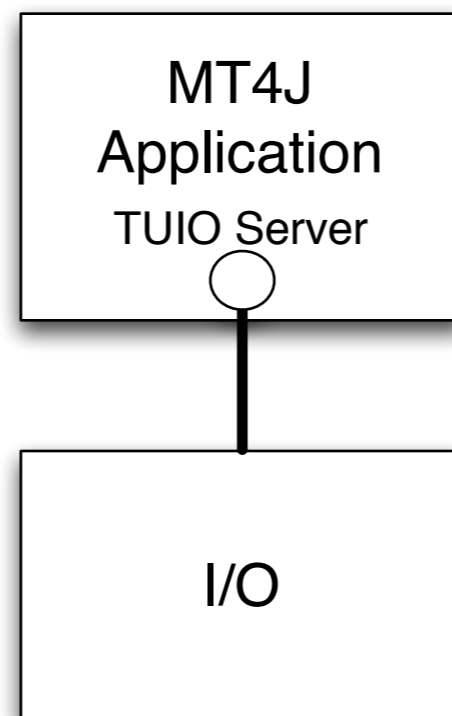
# How to go about doing multi-touch assignment

- Get an end-to-end demo running with off the shelf stuff
- Then slowly replace the pieces with your implementations



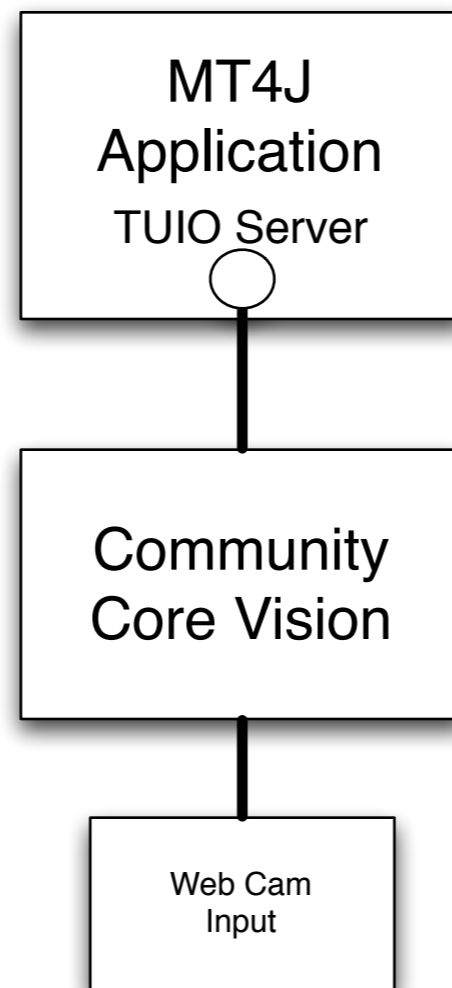
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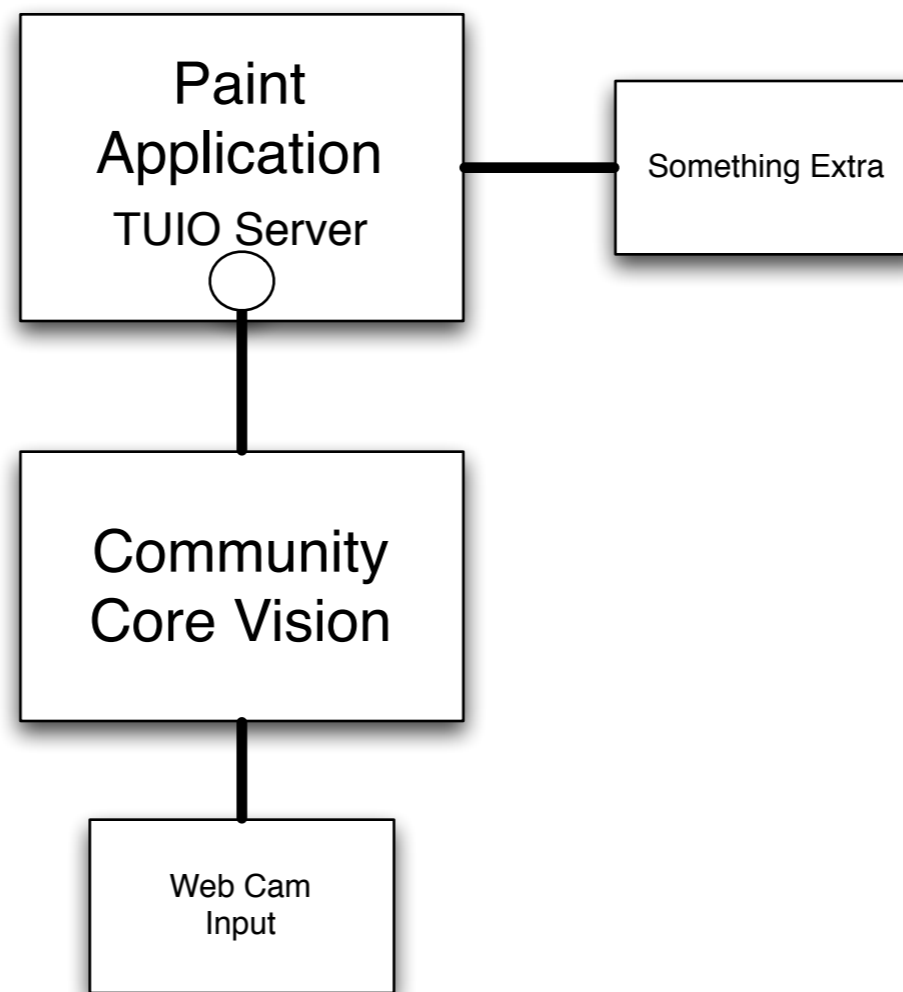
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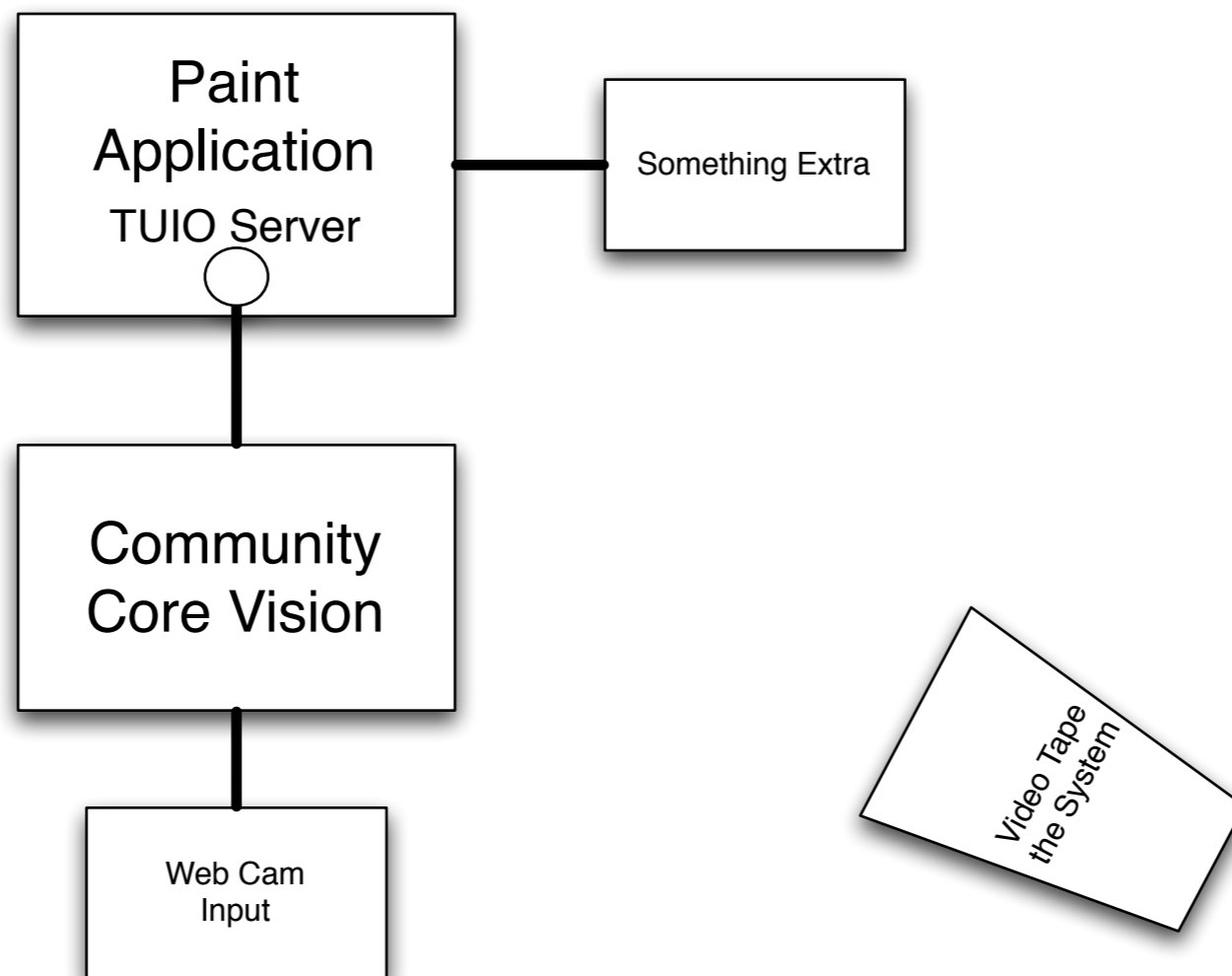
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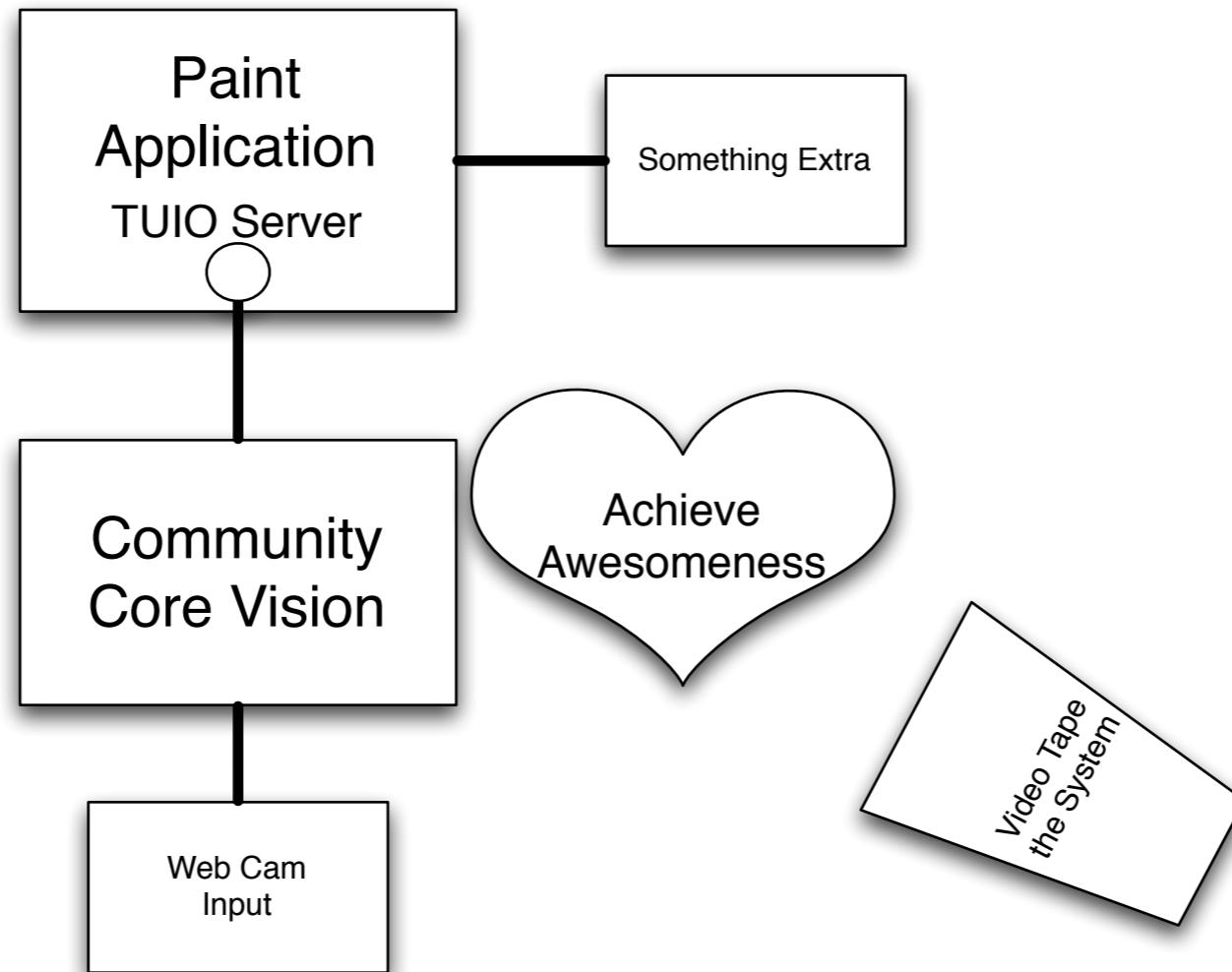
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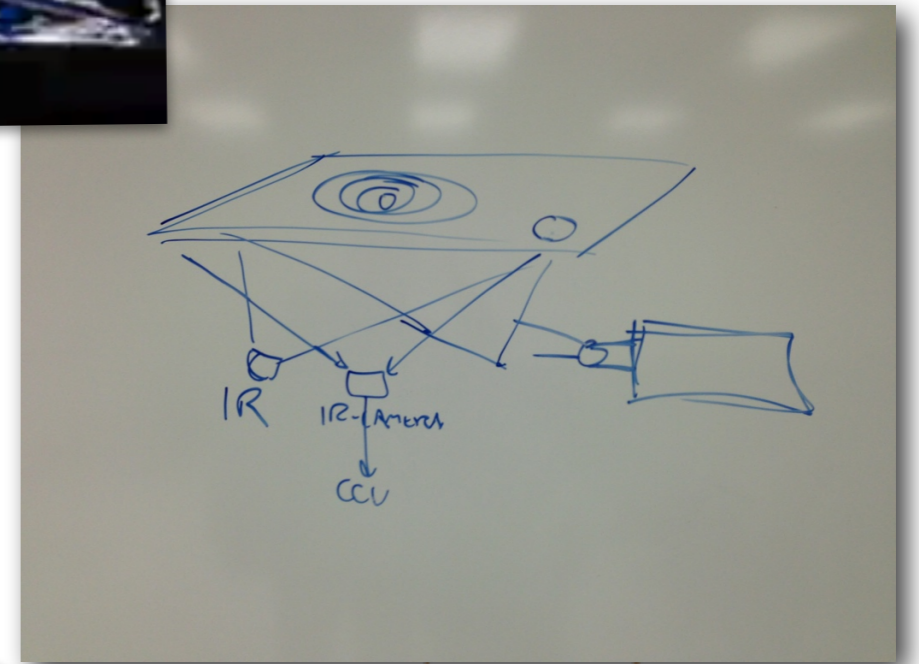
# How to go about doing multi-touch assignment

- Options for increased awesomeness
  - Do a different application than a paint program
    - Make sure it needs multi-touch (talk to prof.)
  - Do a different input than a webcam
    - Make sure it is more than just a download (talk to prof.)
- Remember this can be a portfolio piece!





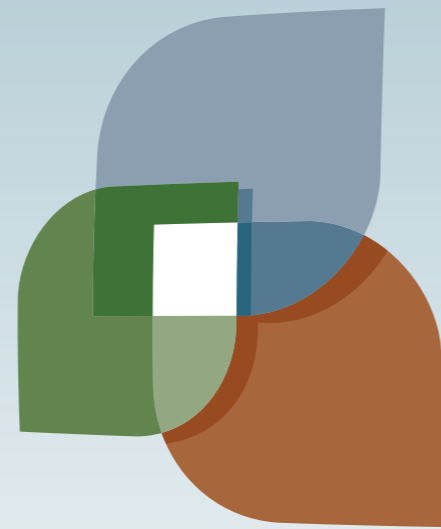
# How to go about doing multi-touch assignment



## Random notes

- On Mac if you get:
  - LSOpenURLsWithRole() failed with error "-10810"
  - You need to make this file executable:
    - `chmod a+x Community Core Vision.app/Contents/MacOS/Community Core Vision`
- If you run a flash demo you may have to give it permission to access locations on your hard drive





L U C I

