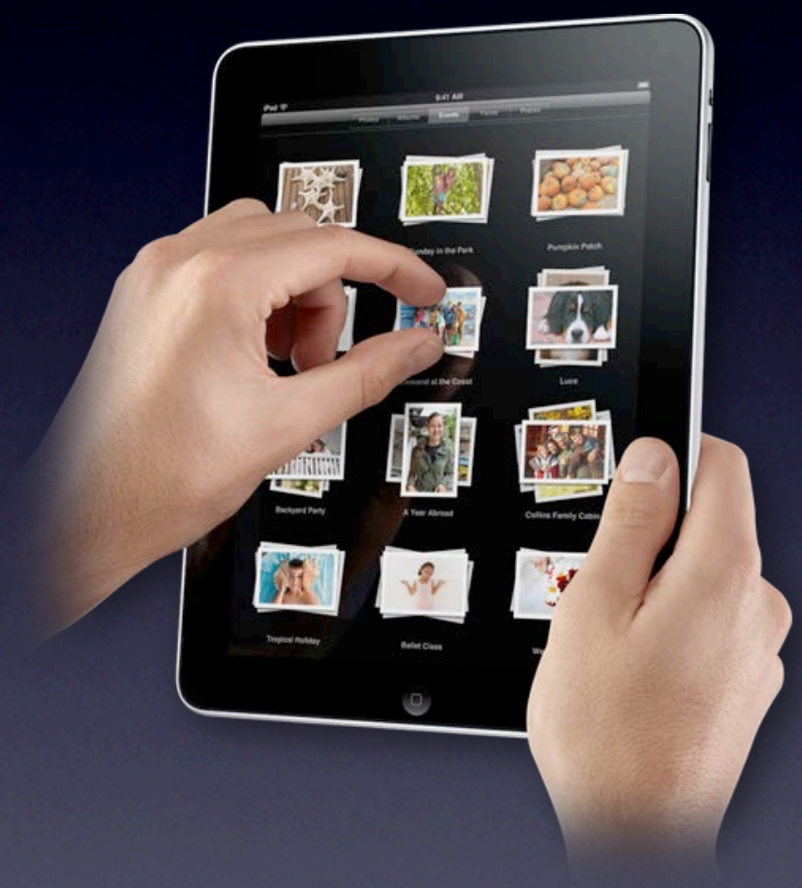
Touch

Steven R. Bagley

So far…

- Android UI stuff seen so far is similar to PC
- Different syntax, but similar concepts
- However, there's a huge difference between mobiles and PC



Discuss the difference in terms of input devices

Pointers

- Pointers provide accurate interaction
- At a distance
- Single-pixel accuracy

- Easy to see what you are clicking
- Single position
- Position always known

Touch-input

- Direct Contact
- Inaccurate — general area of touch known
- Interaction obscures the display
- Location known only when user touches
- Multitouch

Multitouch technology

- Resistive touch screens
- Capacitive touch screens
- Optical methods — Perceptive pixel

Touch and the UI

- Touch relies on finger contact with the display
- This has to alter the way we design our displays
- Size of the finger sets the properties of the UI, not the size of a display

UI components

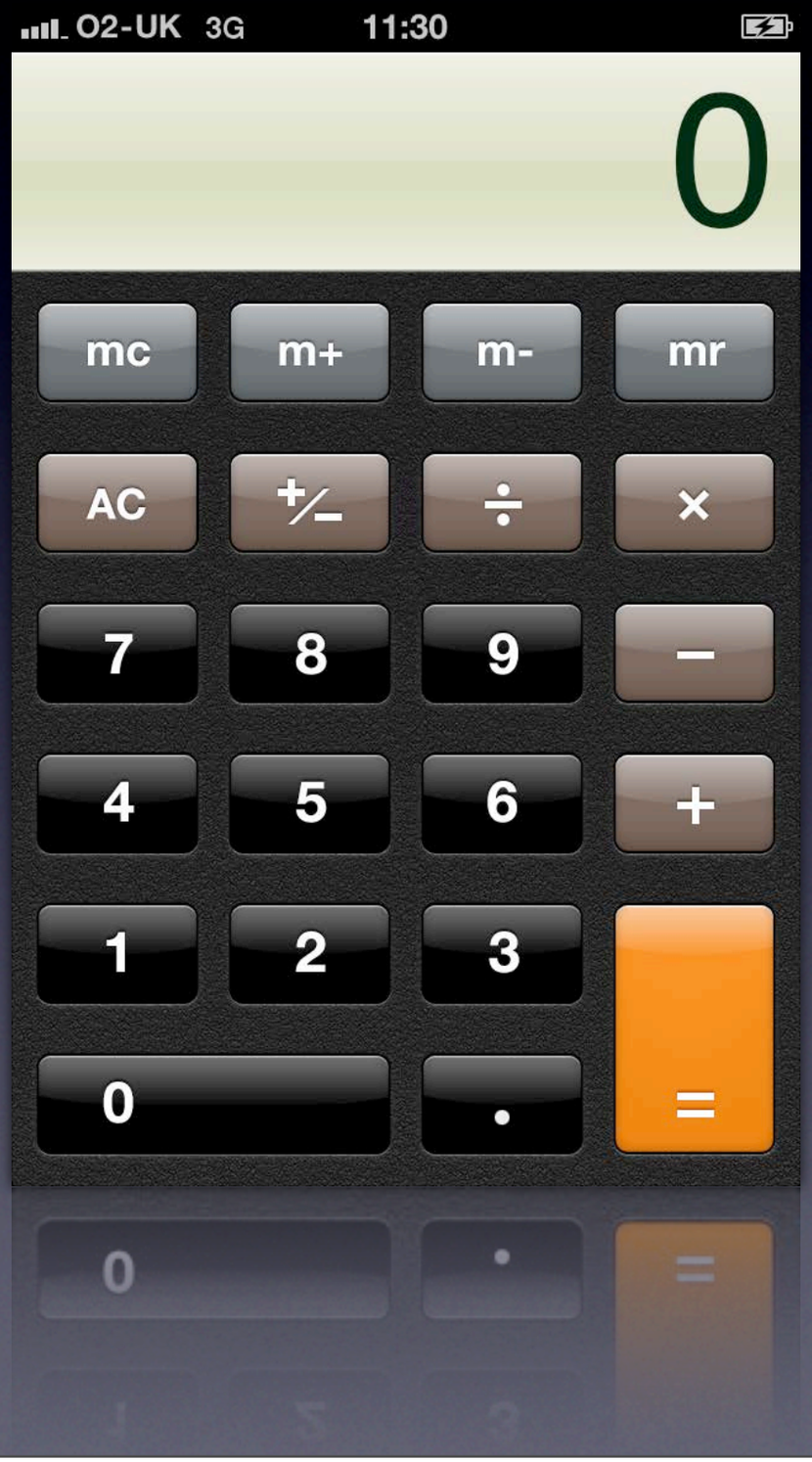
- The size of ‘buttons’ must be big enough that the user can touch them
- Ditto the spacing between them
- If they get too small, or too close together then it will be hard for the user to accurately use them
- Size is fixed relative to display

What size?

- Depends on size of finger relative to display
- Not number of pixels
- Apple recommend about 44x44 points for the iPhone (480x320 point screen)
- Equates to roughly the size of a finger

Even with the iPhone 4's retina display the 'resolution' is unchanged -- you can position accurately on half a point boundaries.

What size?



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What size?

- Things are slightly more complicated on Android
- Display size, shape and resolution varies considerably from device to device
- A button that is the right size on one device would be too small/large on another
- Hence, the use of relative layouts

Hit-testing

- Think about the handles used to interact with a text frame in Word or something
- Need to be big enough that the user can accurately touch them
- Or rather the hit test area needs to big enough
- Decouple visual area from tested area…

Hit-testing -- checking whether a click (or touch in this case) has hit a particular object

i.e look for hits in a much larger area than is visually shown

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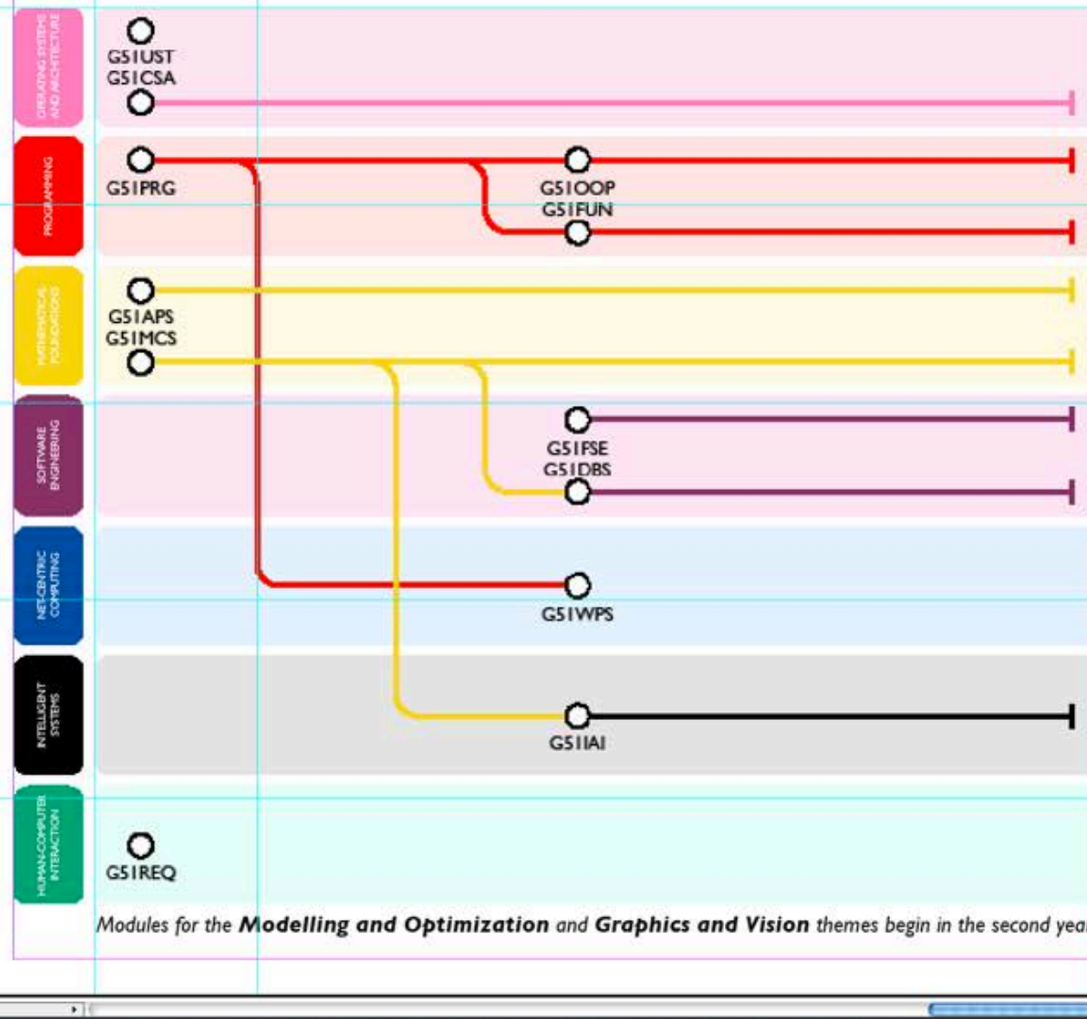

*Modules for the **Modelling and Optimization** and **Graphics and Vision** themes begin in the second year*

Module Code	Module Title
Operating Systems and Architecture	
G51UST	Unix and Software Tools
G51CSA	Computer Systems Architecture
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G51FUN	Functional Programming (in Haskell)
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G51APS	Algorithmic Problem Solving
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G51FSE	Foundations of Software Engineering
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G51WPS	Web Programming and Scripting
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G51IAI	Introduction to Artifical Intelligence
Human-Computer Interaction	
G51REQ	Requirements Capture

Compulsory Module Optional Module

Following Module builds on material covered in earlier module

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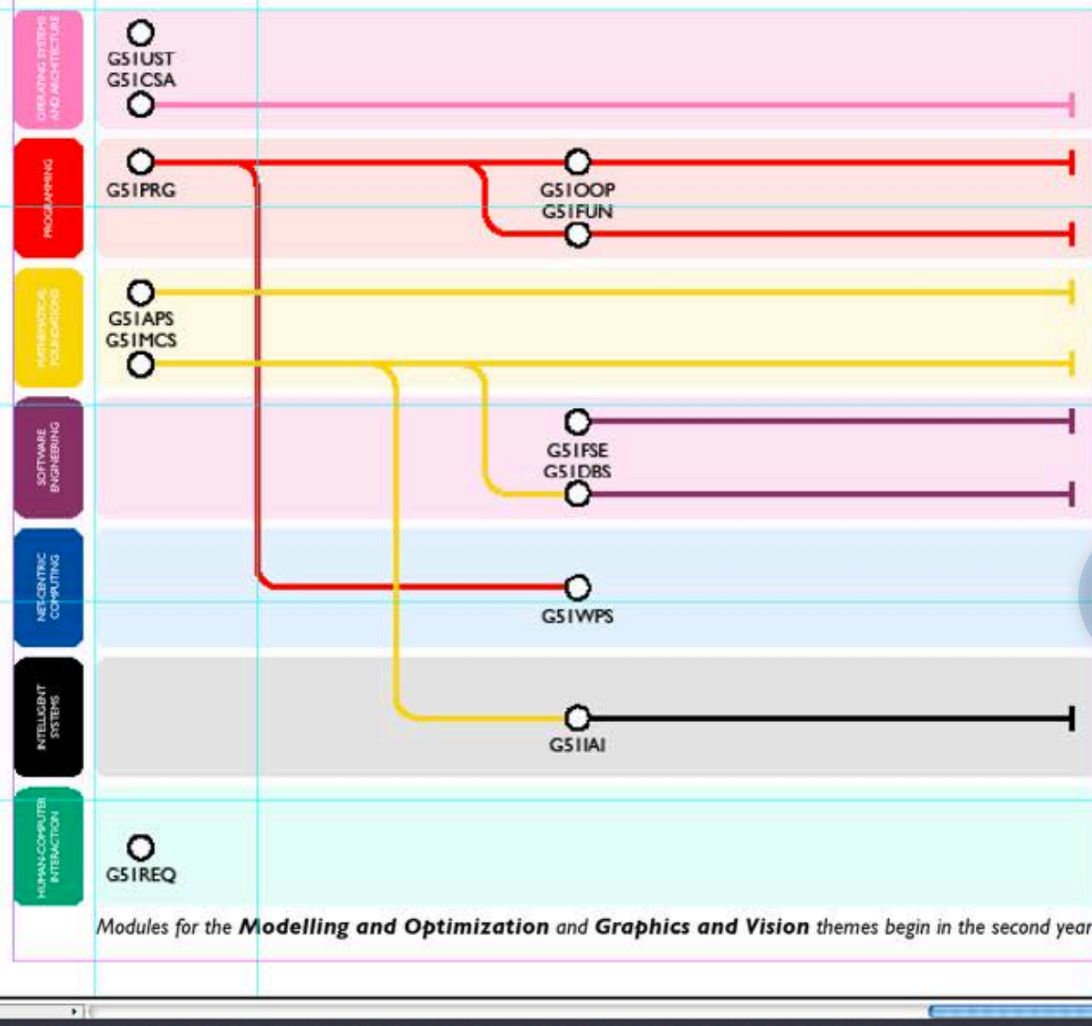

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Following Module builds on material covered in earlier module

Device size

- On mobile devices, the UI is constrained by the ratio of the device size to finger size
- A UI that works on a 10” display won’t work on a 7”
- Hence, Steve Jobs comments about having to sand your fingers
- Is a 7” device a distinct class of device?

Or big old phone?

Visual Feedback

- Important that the user gets feedback to their interaction
- ‘Did I miss the button, or has the program hung?’
- On a computer, we can flash the button
- Easy to see since, pointer is very small

Visual Feedback

- On a phone, it is quite possible for a finger to obscure the button completely
- Flashing the button effect would effectively become invisible
- Need to find alternative approaches…

iPhone Calculator

- iPhone Calculator takes several approaches
- Some buttons have obvious effects (e.g. digit entry)
- For operators, it leaves the button highlighted

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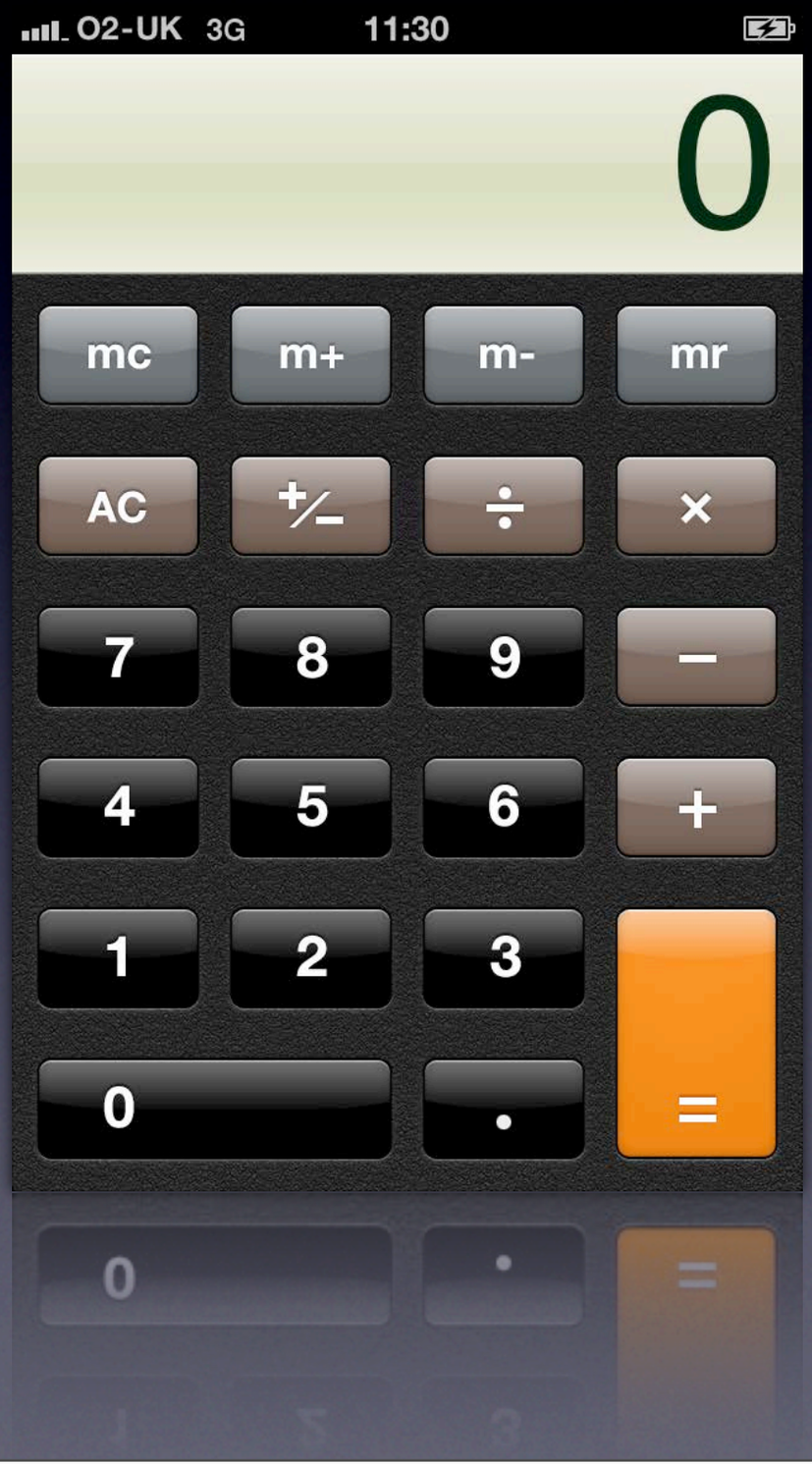

Visual Feedback

- Other options include making the buttons bigger
- Again, on the iPhone lots of buttons are the full width of the phone
- Need to think about how to give the user either implicit or explicit feedback that the touch was registered

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In Contact

- Finger location only known when user touches
- UI paradigms, such as mouseovers, no long possible
- Instead need to create new interaction mechanisms — e.g. touch and hold without moving

New Paradigms

- Touch (and especially multitouch) provide opportunities for new UI paradigms
- Particular popular on mobiles are the use of gestures
- These are touch movements made on the device to signify an operation

Example Gestures

- Tap
- Hold
- Drag (single and multifinger)
- Pinch — to zoom
- Rotate
- Swipe

Programming for Touch

- Much like programming for mouse
- Get `TouchBegin`, `TouchMoved` and `TouchEnded` events
- There just happens to be more than one of them…
- Also, we need to parse a sequence of events into a gesture…

Look at this in detail tomorrow…

Touch Events

- Two ways to get touch events
- Either register a new `OnTouchListener` with a view, (with `setOnTouchListener(…)`)
- Or implement `onTouchEvent()` in a custom `View`
- Either way, you'll get delivered a series of `MotionEvent`s

show how we can set up a touch listener

MotionEvent

- This object encapsulates information about Touch events
- Sent went a touch begins (`ACTION_DOWN`)
- When the finger moves (`ACTION_MOVE`)
- And finally when the touch ends (`ACTION_UP`)
- Additional events also sent for multitouch (see later)

Action Down

- A gesture starts when a finger is pressed
- A MotionEvent is generated for this `ACTION_DOWN`
- Can find the action by calling `getAction()`
- This can also have the identifier of the ‘pointer’ so use `getActionMasked()` instead

pointer == touch in android speak (the first is pointer zero)
Print out getAction and getActionMasked…

Action Move

- As the finger moves, a series of `ACTION_MOVE` events will be sent
- Can find the new position using `getX()` and `getY()` (return `double`s)
- Note that Android may bundle up a series of touch events, so there is the ability to get ‘historic’ touches

historic touches are any touch events that happened between the latest and the last MotionEvent
getX()/getY() works for all events

Action Up

- A gesture ends in two ways, the normal is for an `ACTION_UP` event
- This signifies that the (last) finger has been taken off the display
- If the touch event has been cancelled for any reason (e.g. phone rings), then an `ACTION_CANCEL` event is sent

Single Touch events

- So a touch gesture will be formed by
- A single `ACTION_DOWN`
- Zero or more `ACTION_MOVE`
- An `ACTION_UP` to finish
- Can use the data from these (e.g. the position delta to move an object about)

Dragging

- Store original location of thing to move
- Store `x,y`-pair from `ACTION_DOWN`
- Calculate delta from stored value and value returned from `ACTION_MOVE` or `ACTION_UP`
- Change the location of thing being moved by adding delta to original location
- Note: need to adjust as position returned is local to `View` origin

Make the text view move... (sort of :)

Swipes

- Can do similar for a swipe…
- Rather than moving the object, calculate the direction it is moving in
- This tells you the direction of the swipe
- Can also work out the speed

Multi Touch

- Very, very similar
- Same sequence of events as before with a few more events thrown in
- `ACTION_POINTER_DOWN` and `ACTION_POINTER_UP` tell you that a new pointer has been pressed
- Support for `256`, but some Androids only support `2`

Which pointer?

- Multitouch means `MotionEvent`s will contain multiple ‘pointers’
- `getPointerCount()` returns the number of pointers
- `getX()`/`getY()` can both take the index of a pointer in the event to return the x/y for

Will now demo this on the iPad — go show code

Which pointer?

- `getActionIndex()` tells us the index for the pointer caused this event for `ACTION_POINTER_DOWN`/`ACTION_POINTER_UP`
- However, number of pointers can change as fingers lifted or placed
- Each pointer given an `id` that won't change (the index will)

Will now demo this on the iPad — go show code

Which pointer?

- `getPointerId()` returns the `id` for a pointer from the index
- `findPointerIndex()` will get the index from an `id`
- Need to track both the `id` and past locations of pointers to move things about

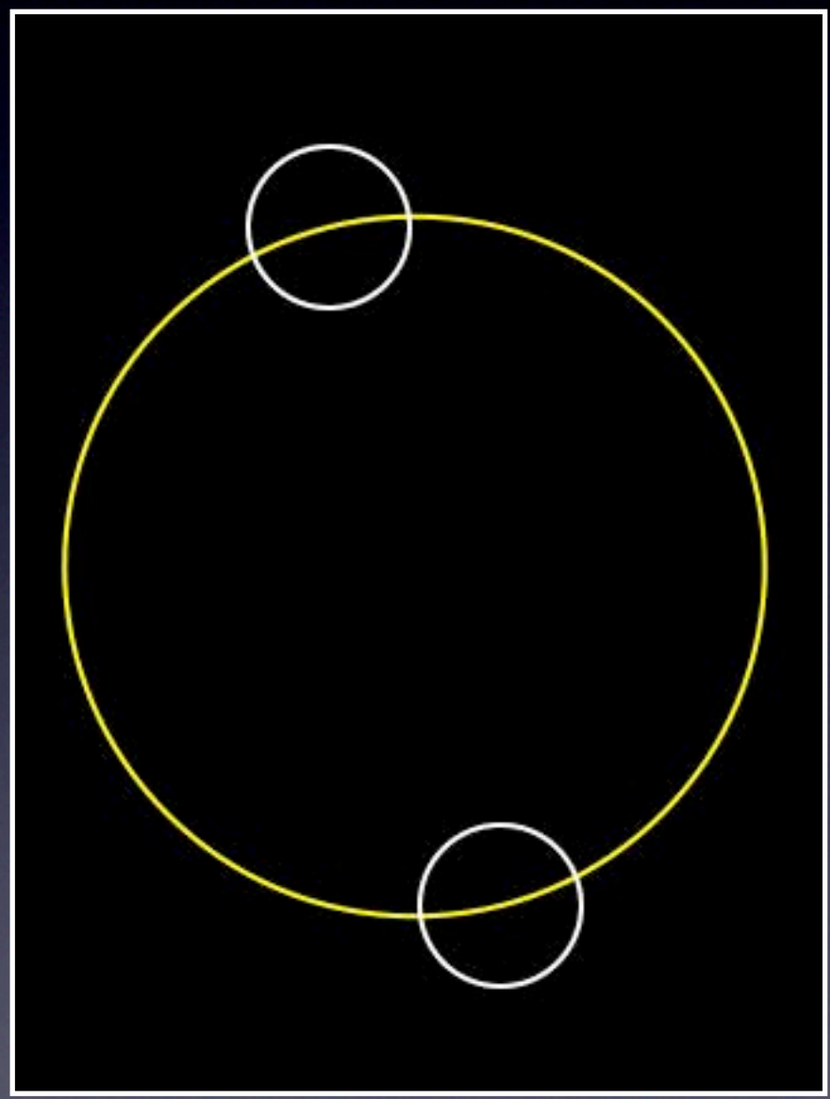
Will now demo this on the iPad — go show code

Multitouch gestures

- Ok, so can get the position of the individual touches
- How do we convert these into gestures?
- E.g. the typical pinch or rotate gestures
- Simple — just requires a little bit of maths…

Pinch to Zoom

- Imagine the two points lie on the circumference of a circle
- Can easily find the diameter of the circle — distance between the two points
- Use Pythagoras to calculate it



Pinch to Zoom

- As fingers move, diameter of the circle will change
- If you store the initial diameter of the circle
- Then the ratio of new diameter to old diameter will give the zoom ratio
- With this and the original size of the item, you can calculate the new item

Rotation

- Very similar approach for rotation
- The difference in position can (using basic trigonometry) give you the angle of the line bisecting the circle between the two points
- As the points move the angle will change
- Can use the difference between this and the original angle to work out the rotation

General Gestures

- Most gestures can be tracked in a similar fashion
- Store the initial position and see how the touch moves in relation to it

Automating Gestures

- This is a common thing you would want to do
- iOS provides a set of `GestureRecognizer` classes which can parse the touch events into a simple gesture for you
- Android has a similar base class `GestureDetector` but it doesn't seem to have many subclasses…

See Gesture Builder sample in SDK though