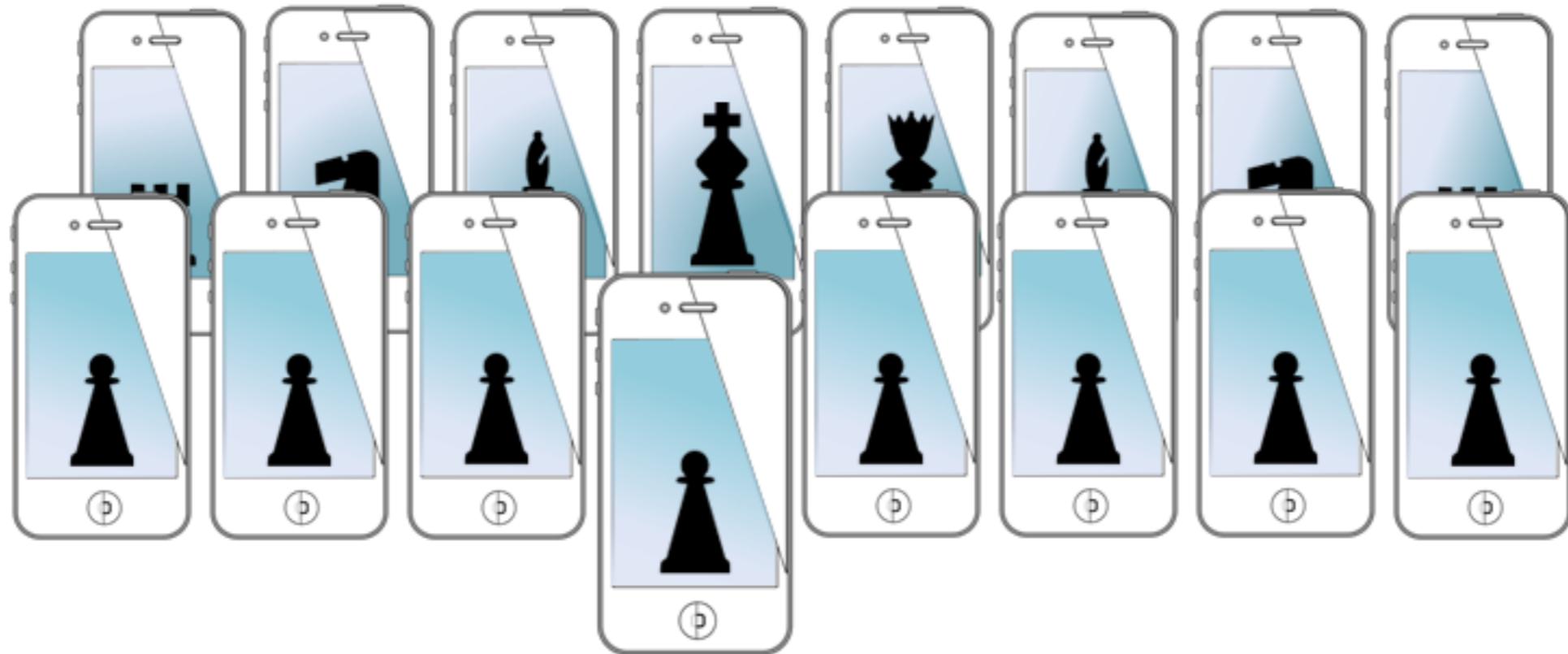


# MOBILE SENSING LEARNING



**CSE5323 & 7323**  
Mobile Sensing and Learning

week 3, lecture one: mobile design and interaction

Eric C. Larson, Lyle School of Engineering,  
Computer Science and Engineering, Southern Methodist University

# course logistics

- lab one due at the end of the week!
- come to lab for assistance!

# agenda

- mobile HCI
  - design, navigation, and interaction
    - many elements courtesy of apple
    - and some from others

## **another great resource:**

Apple's Human Interface Guidelines

227 pages of bliss, text, pictures, and video

## **iOS Human Interface Guidelines**

# what makes great UI

- you tell me
- no matter what I tell you, nothing is a hard and fast rule except:
  - keep it simple, clear
  - kill the clutter, display only what is needed
  - use motion to guide

# a better slide

deference

never compete  
with content

text legible  
**Clarity**  
background subtle

layers are visual  
motion cues

depth

# planning

## step one

look at core function

## step two

add design sparsely

## step three

examine assumptions  
question every element

# planning the app

- **list** potential features of the app
- a recipe app

creating lists

getting recipes

comparing prices

locating stores

annotating recipes

getting and using coupons

viewing cooking demos

exploring different cuisines

finding ingredient  
substitutions

# planning the app

usually cook at home or prefer ready-made meals

are committed coupon-users or think that coupons aren't worth the effort

enjoy hunting for speciality ingredients or seldom venture beyond the basics

follow recipes strictly or use recipes as inspiration

buy small amounts frequently or buy in bulk infrequently

what do these users want?

who is your target audience?

- **determine** users, list it out

want to keep several in-progress lists for different purposes or just want to remember a few things to buy on the way home

insist on specific brands or make do with the most convenient alternatives

tend to buy a similar set of items on each shopping trip or buy items listed in a recipe

**audience:** love to experiment with recipes, are often in a hurry, and are thrifty if it doesn't take too much effort

# planning the app

- **filter** potential features through your audience

**audience:** love to experiment with recipes, are often in a hurry, and are thrifty if it doesn't take too much effort

creating lists

getting recipes

comparing prices

Locating stores

annotating recipes

getting and using coupons

viewing cooking demos

exploring different cuisines

finding ingredient substitutions

# principles of great design

how to make this slide better?

principles of great design

# make it obvious



# make it obvious



# text entry is awful

- avoid text input at all costs
- example: enter your state

**solution** text

Enter State

**solution** picker

Select State

GA

HI

ID

IL

IN

IW

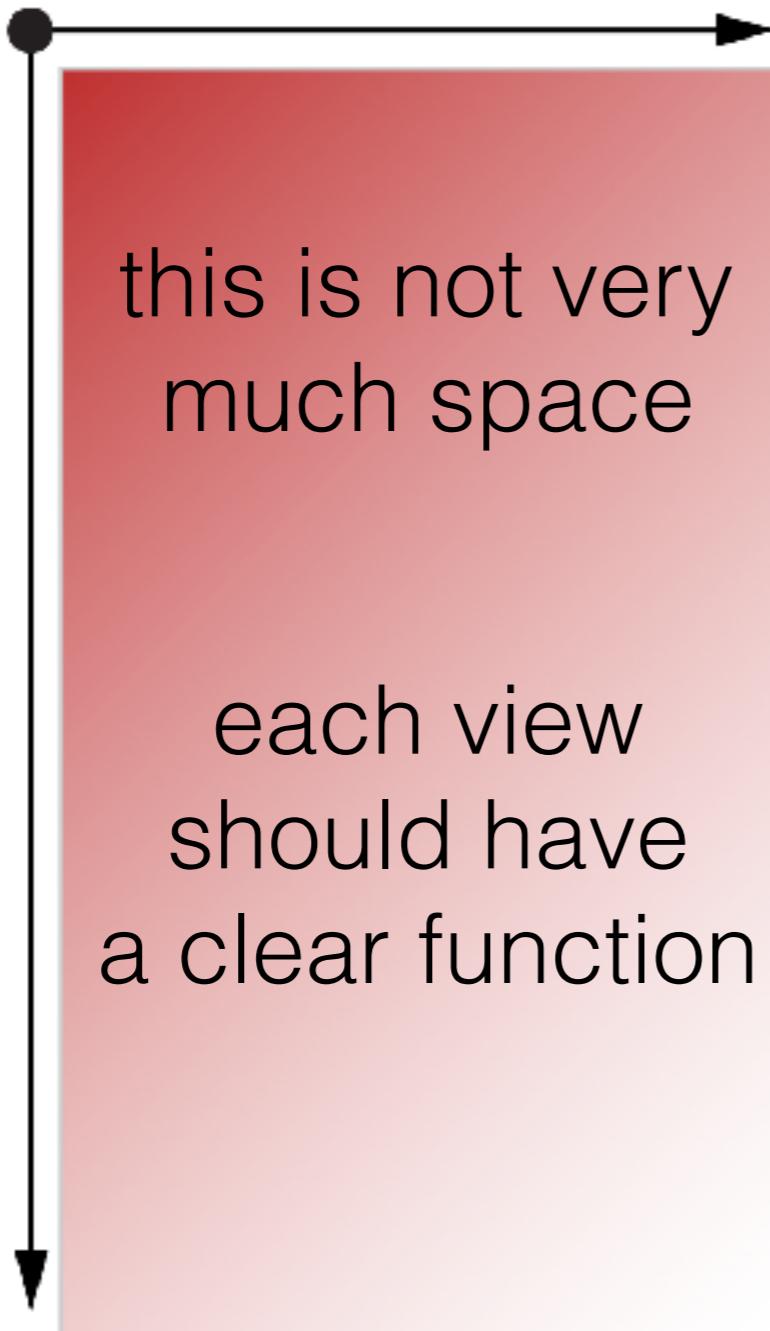
KA

**solution** get from current location

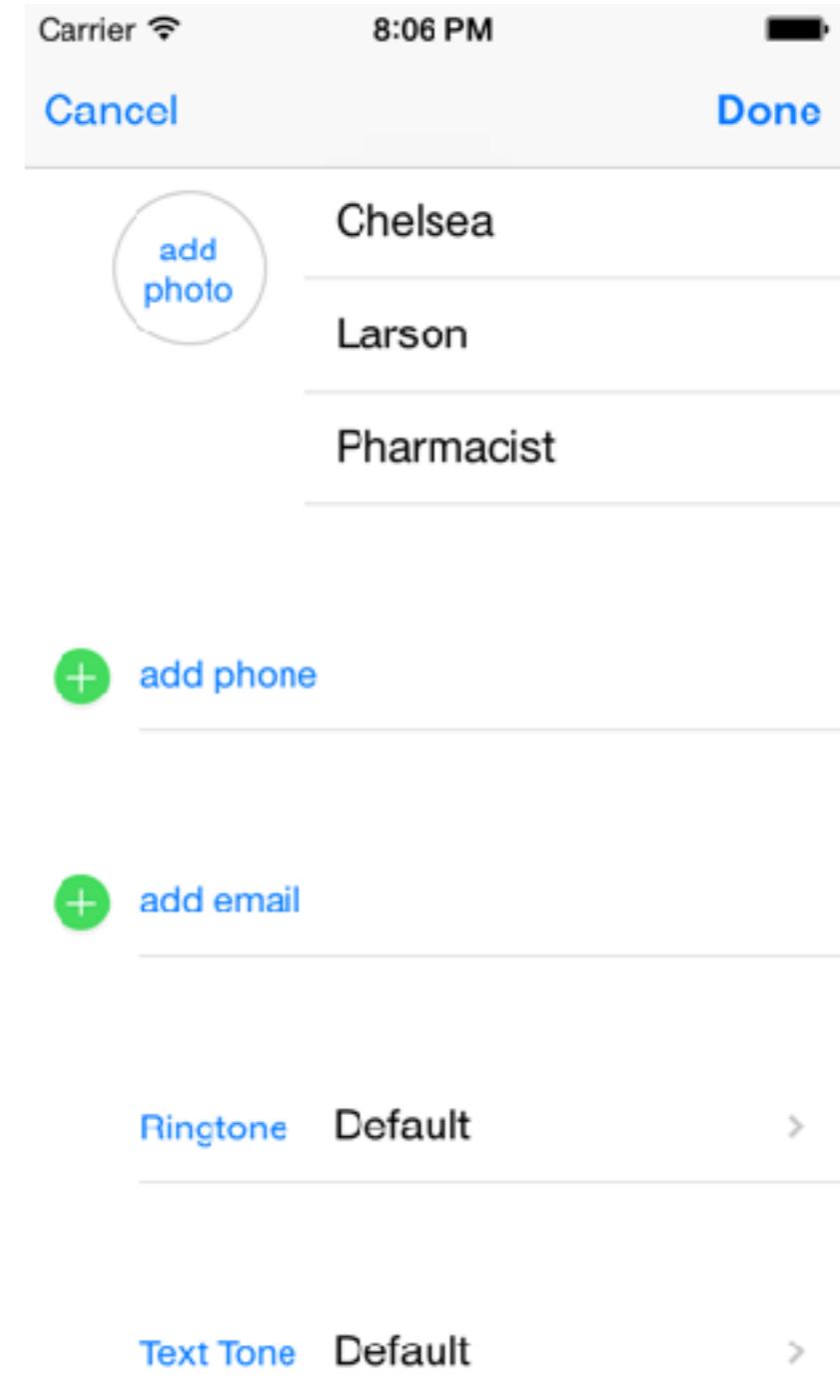
Autofill

# layout with care

important



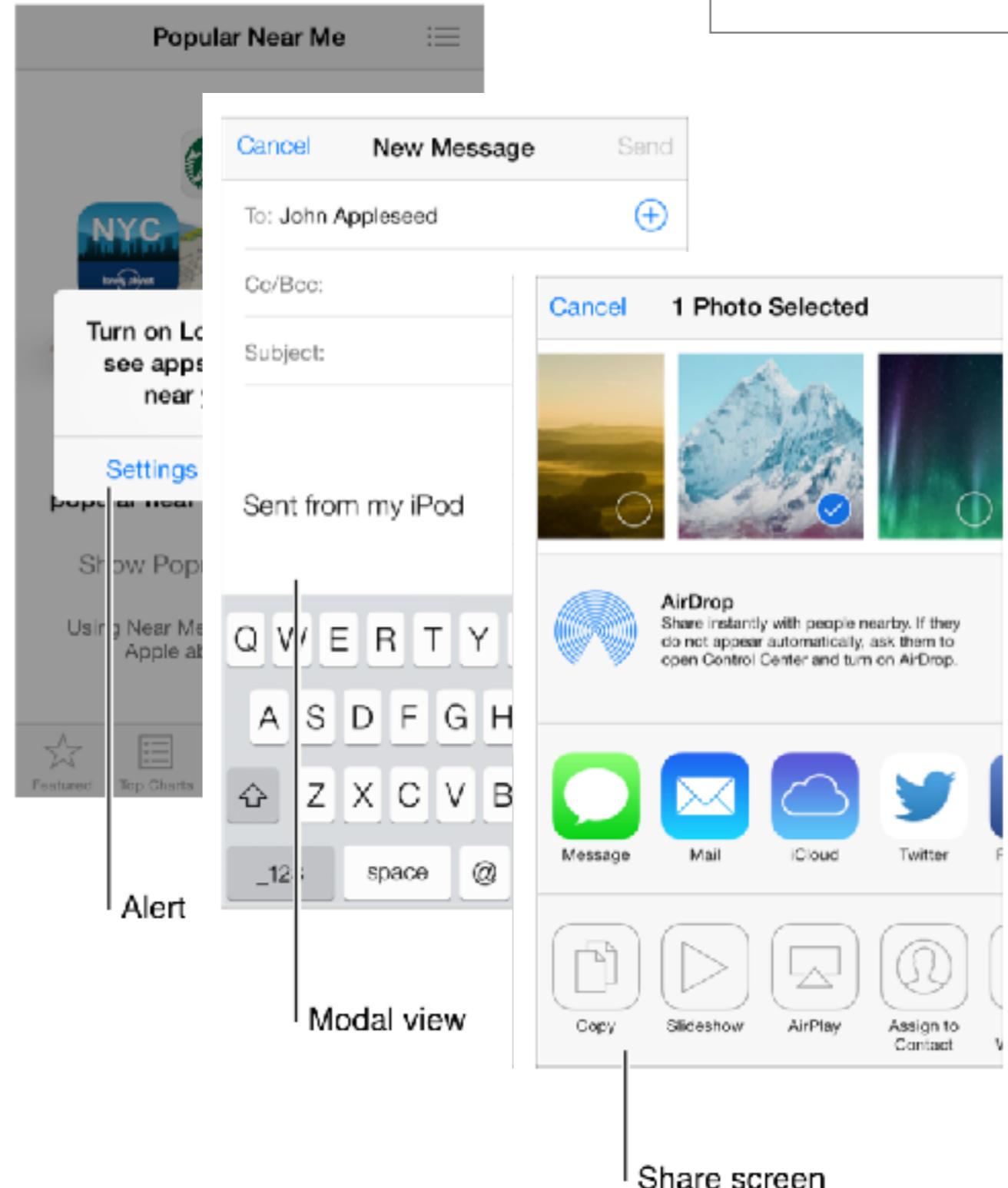
not so important



# use modal sparingly

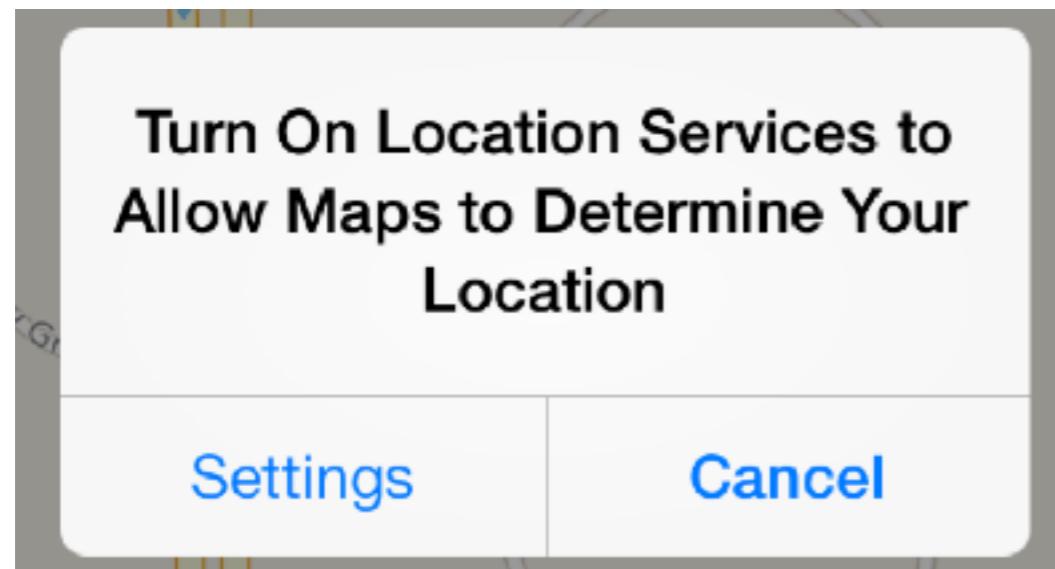
## takes over the screen

- prevents other interaction
- use when:
  - critical to capture attention
  - self contained action
    - like sending email
- keep simple, not tied to nav
- provide easy, safe exit



# keep alerts succinct

- change wording to be clear and concise
- avoid jargon



## Problem Connecting

There might be a problem with the server. Do you want to notify our staff about the issue?

[Send Notification](#)

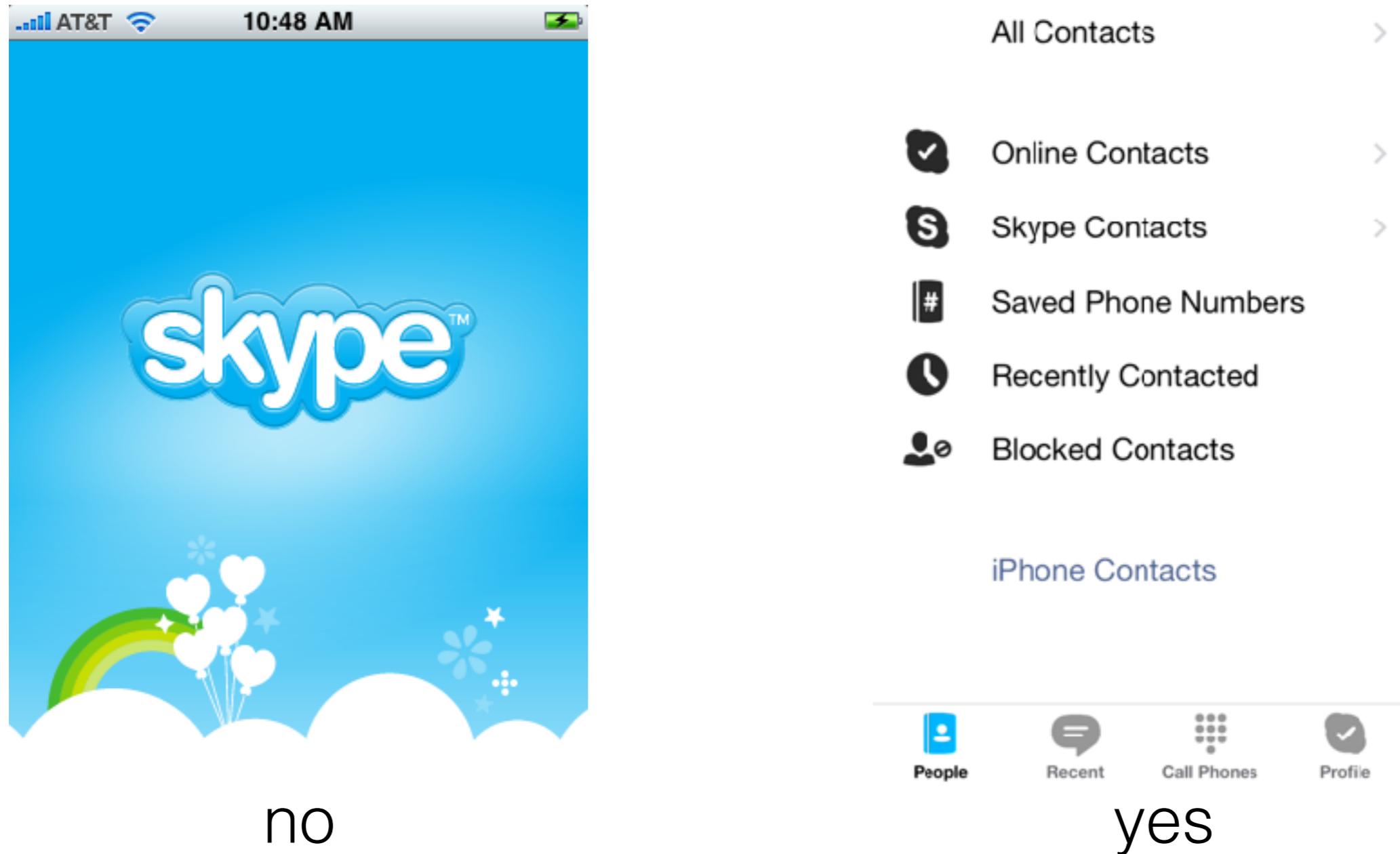
[Go Back](#)



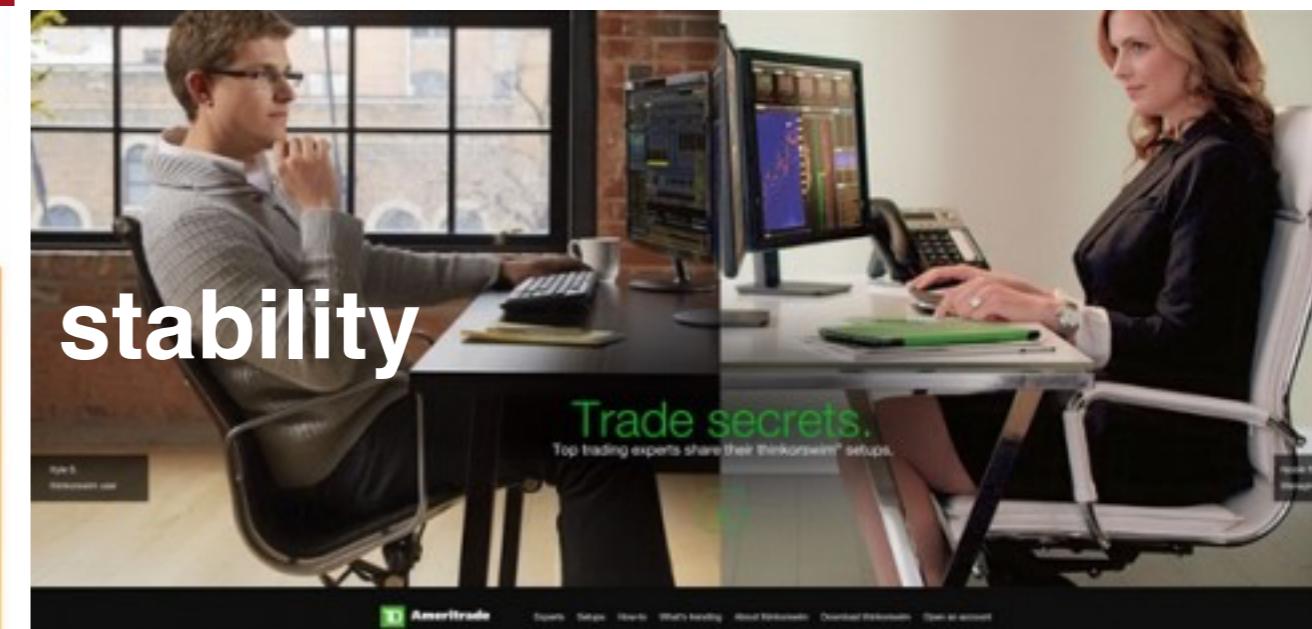
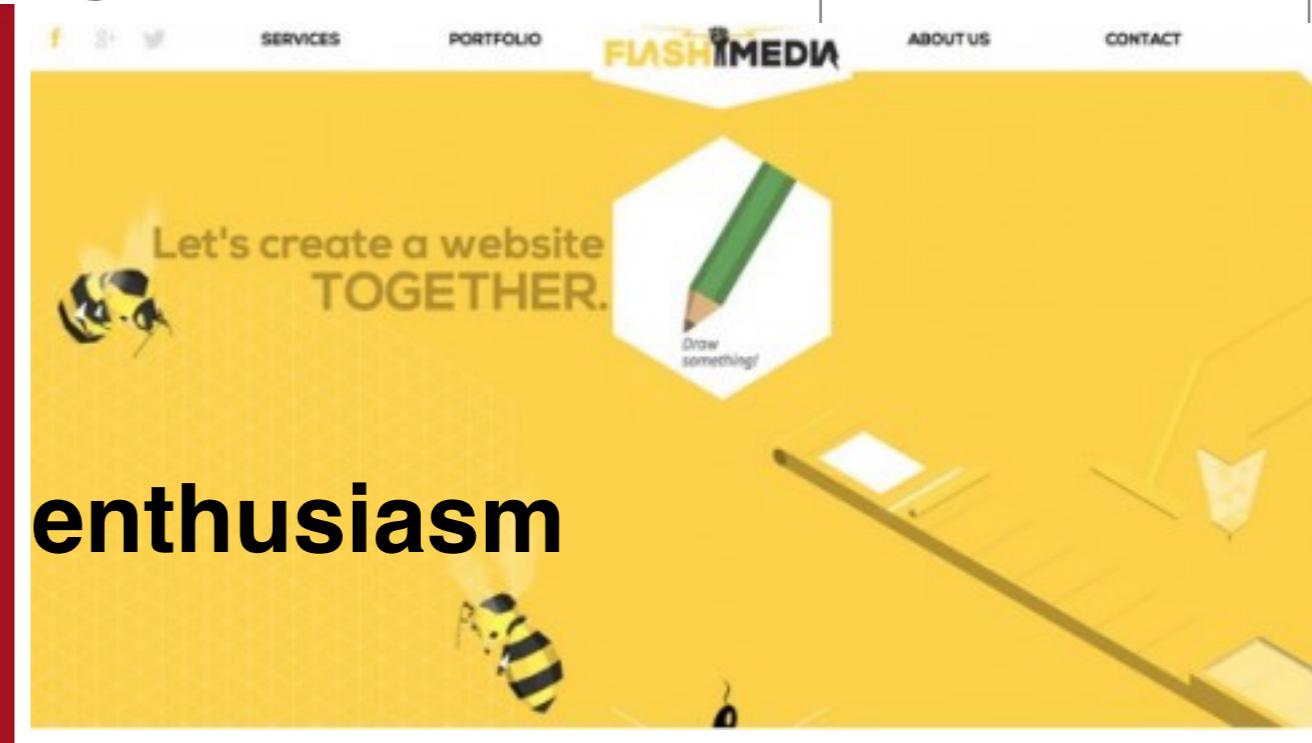
- use verbs for buttons
- title is meaningful
- two choices, safe choice bolded
- full sentences used in explanation
- try to only have a title
- try not to say “we” and “our”

# consider no splash

- use the splash screen to give impression of quickness

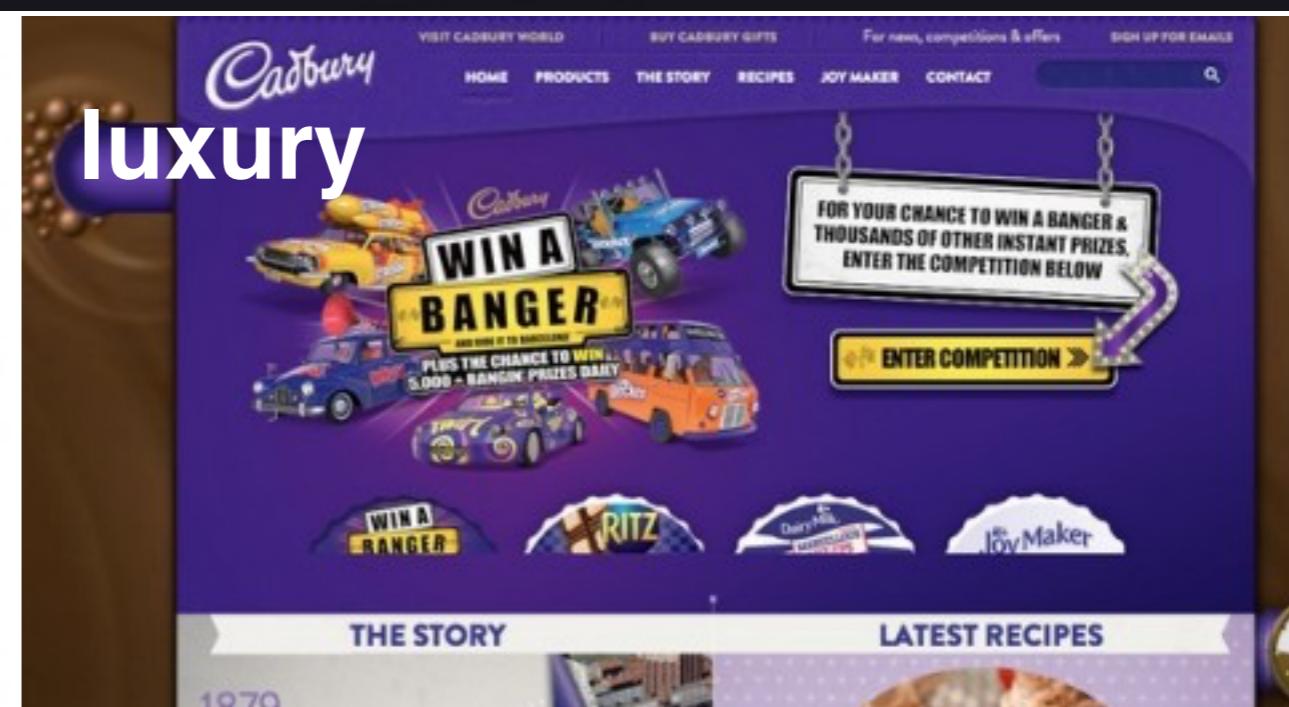


# use color theory



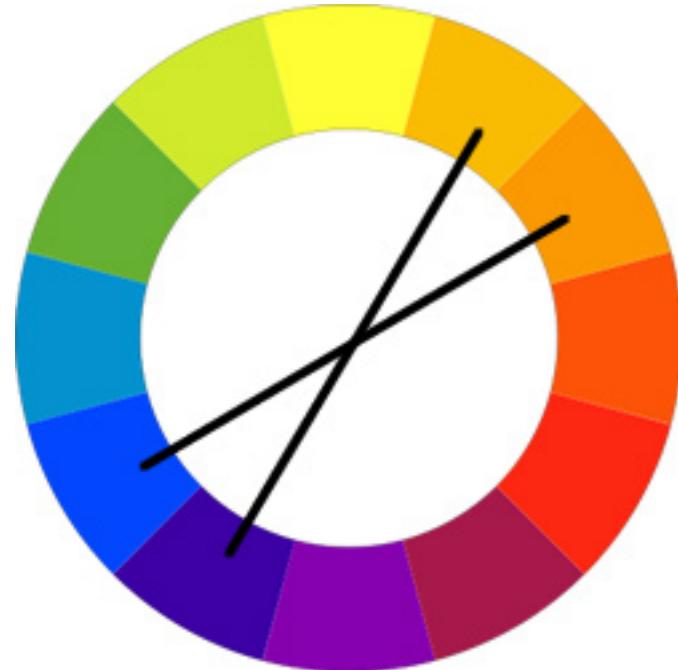
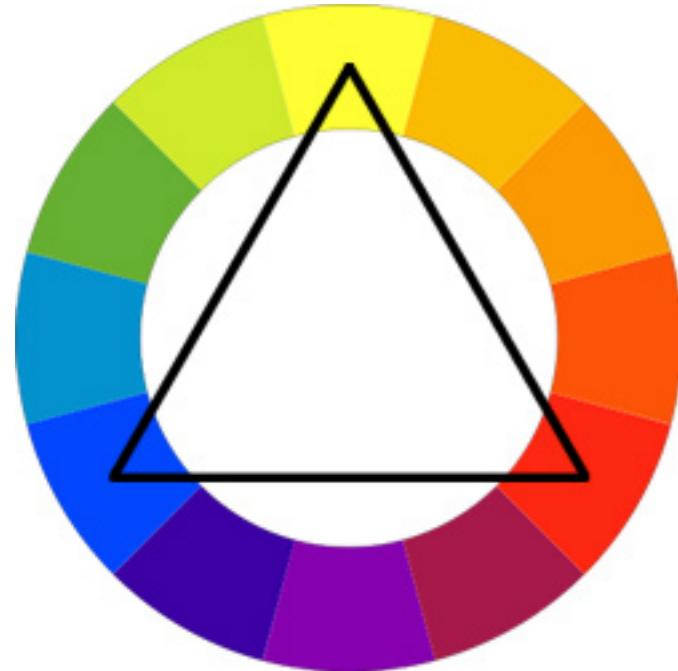
<http://thenextweb.com/dd/2015/04/07/how-to-create-the-right-emotions-with-color-in-web-design/>

# use color theory



<http://thenextweb.com/dd/2015/04/07/how-to-create-the-right-emotions-with-color-in-web-design/>

# use color



Left hear from you! ☎ (804) 558-0555 ☐ sales@lemonstand.com

LemonStand

Tour v Partners Marketplace Gallery Help v Blog Log In Free Trial

The Only eCommerce Platform for Custom Online Stores

Easily customize anything, front-end or back  
Generate income by selling your custom modules  
Support directly from our software engineers

Try It For Free!

LemonStand Adapts to **Your** Needs. Not the other way around.

 **Unlimited Customization**  
Enjoy complete creative freedom over the design and functionality of your store.

 **Community**  
Join the thriving developer community and LemonStand Marketplace.

 **Customer Support**  
Receive support directly from LemonStand developers. We're there for you.

Leave a message

## APARTMENTS

### WE LIVE HERE

In communities across the country, apartments work – helping people live in a home that's right for them. And demand continues to grow. Learn how apartments create communities and contribute to the economy.



Start My Building My Work Home My Spend Here Start Over

Economic Impact Calculator Apartment Impact by State About Share

NMHC National Multifamily Housing Council NAA National Apartment Association

MODERN APARTMENT LIVING

<http://thenextweb.com/dd/2015/0>

# use color theory



## Analogous

mono-themed, but elegant  
easy to select one other contrast color or highlights without  
deviating from theme

match your app icon and UI palette

**Silverback 2.0**  
Guerrilla usability testing software for designers and developers

- Capture screen activity
- Video the tester's face
- Record the tester's voice
- Add chapter markers on-the-fly
- Control recording with the remote
- Export to Quicktime

Features in 2.0 include

Preview	Batch Export
Watch sessions within Silverback	Save selected sessions, tasks, highlights or projects in one go
Tasks & Highlights	Performance
Set tasks and mark noteworthy moments within a session	Faster export, better usability

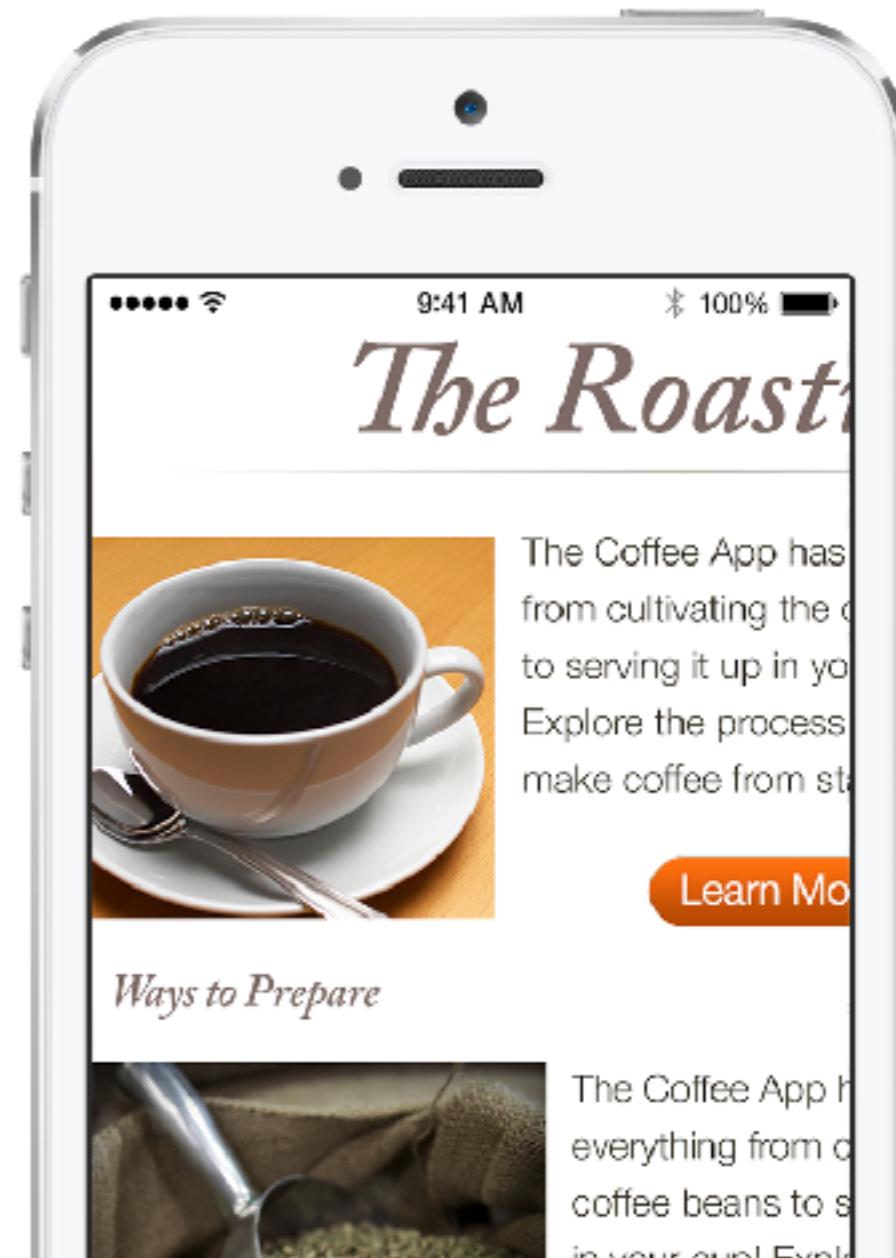
**Download** **Buy NOW** \$69.95 FREE upgrade for existing users

What does Silverback do?

<http://thenextweb.com/dd/2015/04/07/how-to-create-the-right-emotions-with-color-in-web-design/>

Apple says... design is...

# formatting



# design for touch



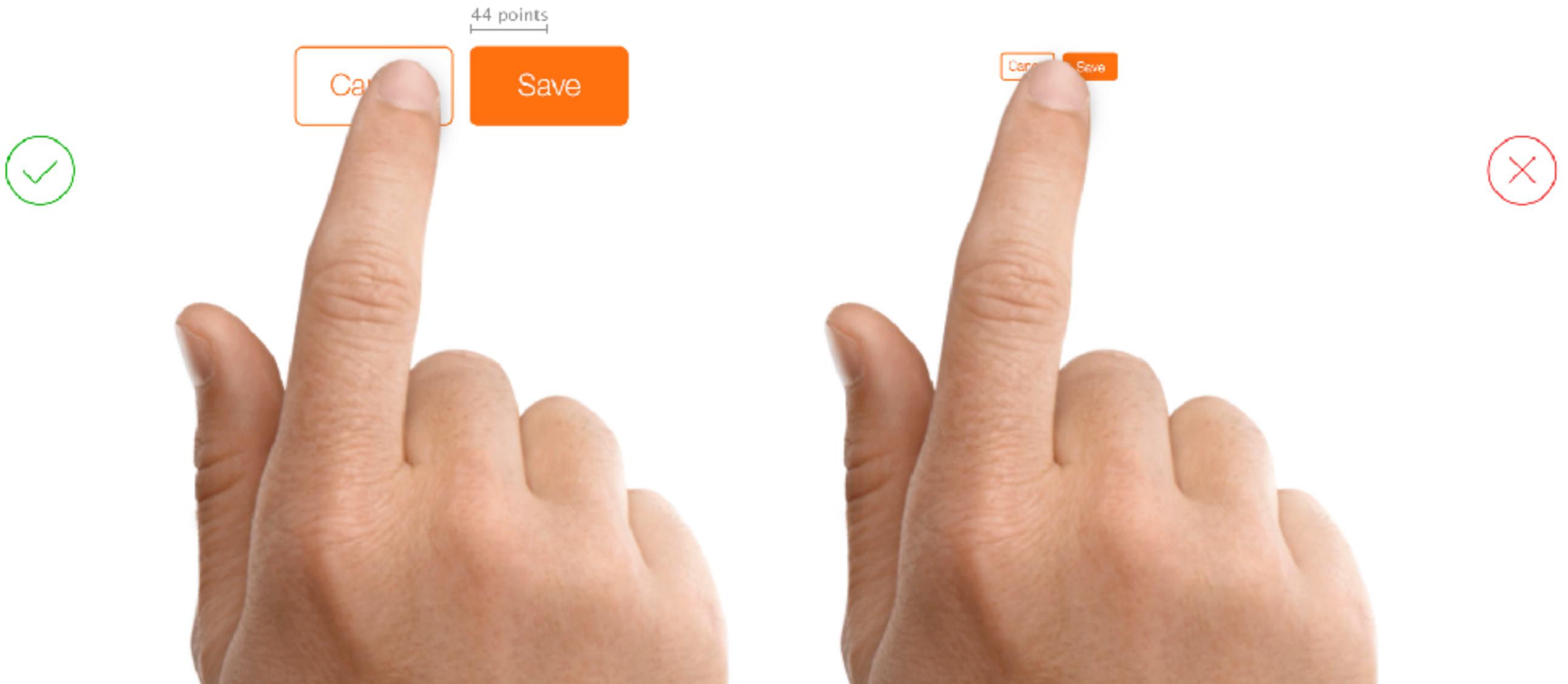
Date	October 11, 2013		4:00 PM
Tue Oct 8	1	57	
Wed Oct 9	2	58	
Thu Oct 10	3	59	AM
<b>Fri Oct 11</b>	<b>4</b>	<b>00</b>	<b>PM</b>
Sat Oct 12	5	01	
Sun Oct 13	6	02	
Mon Oct 14	7	03	

Time:  :  AM

Date:

S	M	T	W	Th	F	S
1	2	3	4	5	6	7
8	9	10	<b>11</b>	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

# design for taps



# legible text



## Heading

### Sub-Headline

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.

## Heading

### Sub-Headline

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.



# high contrast



## Heading

### Sub-Headline

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend.

## Heading

### Sub-Headline

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend.



# negative space



## Heading

### Sub-Headline

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend.



## Heading

### Sub-Headline

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend egestas nisl vehicula nec. Nullam varius est dui, nec accumsan lectus posuere ut. Nullam viverra purus laoreet euismod tempor.

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus. Duis vehicula elit nulla, eleifend.

# design for retina



# organize



Edit	
Coffee	28 g >
Grain Size	~113.3 µm >
Water	1241 ml >
Temperature	103°C >
Time	223 s >
Serving	310.25 ml >
Metric	English



coffee: 28 g. Edit grain size:  
~113.1 µm Edit water: 1241  
ml Edit temp: 103° Edit  
time: 223 s. Edit serving:  
310.25 ml Edit

Metric English  
Celsius Fahrenheit

# alignment



Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare.\*  
Curabitur semper vitae urna ac adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus.



*\*Ornare imperdiet blandit lectus. Morbi tristique*

**Continue**

Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus. Morbi tristique urna ut volutpat ornare\* Curabitur semper vitae urna ac tempus.



*\*ornare imperdiet blandit lectus.  
Morbi tristique*

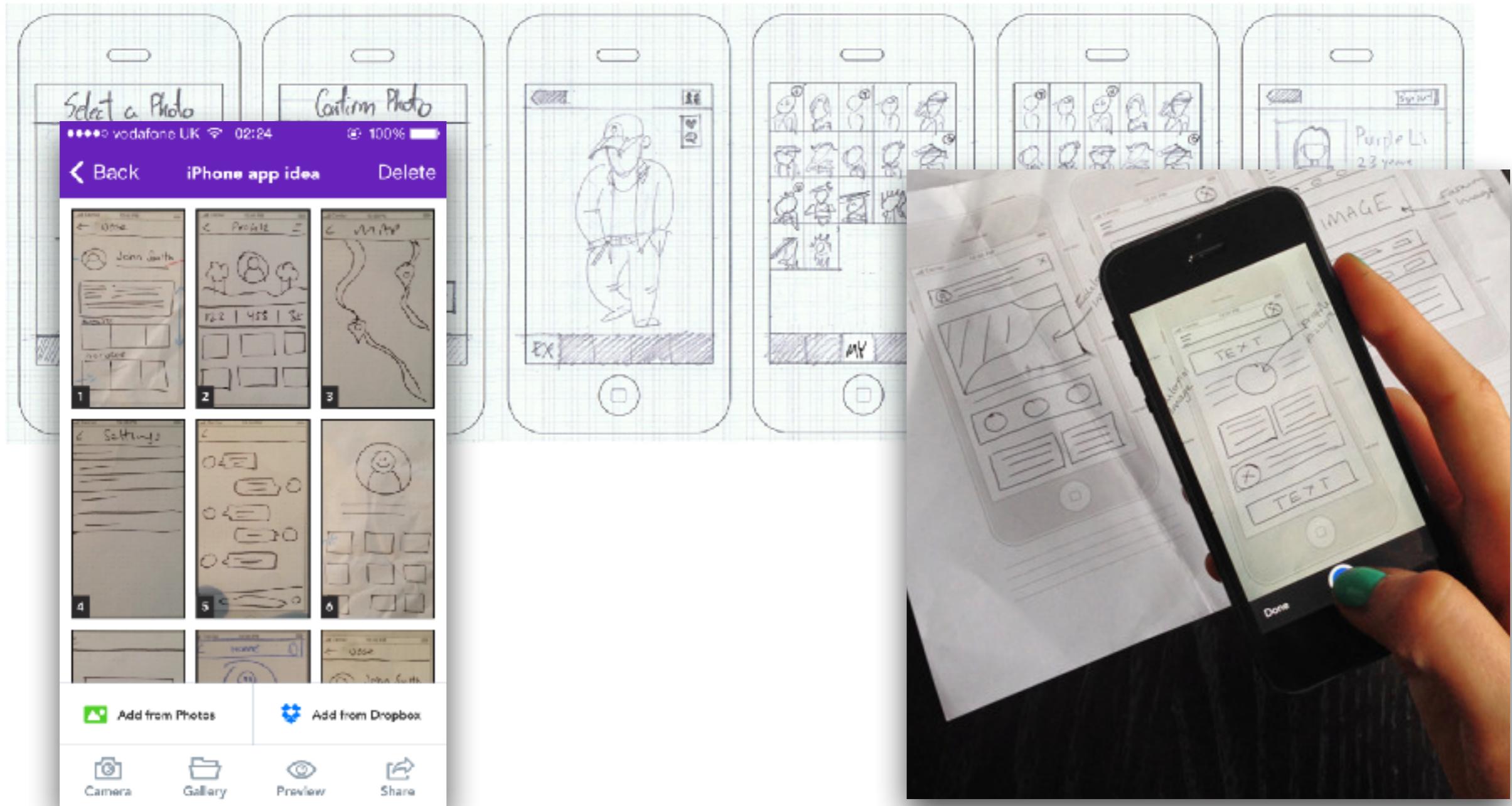
**Continue**



Adipiscing elit. Sed neque nisl, blandit vel ipsum eu, imperdiet blandit lectus.  
Morbi tristique urna ut volutpat ornare. Curabitur semper vitae urna ac tempus.

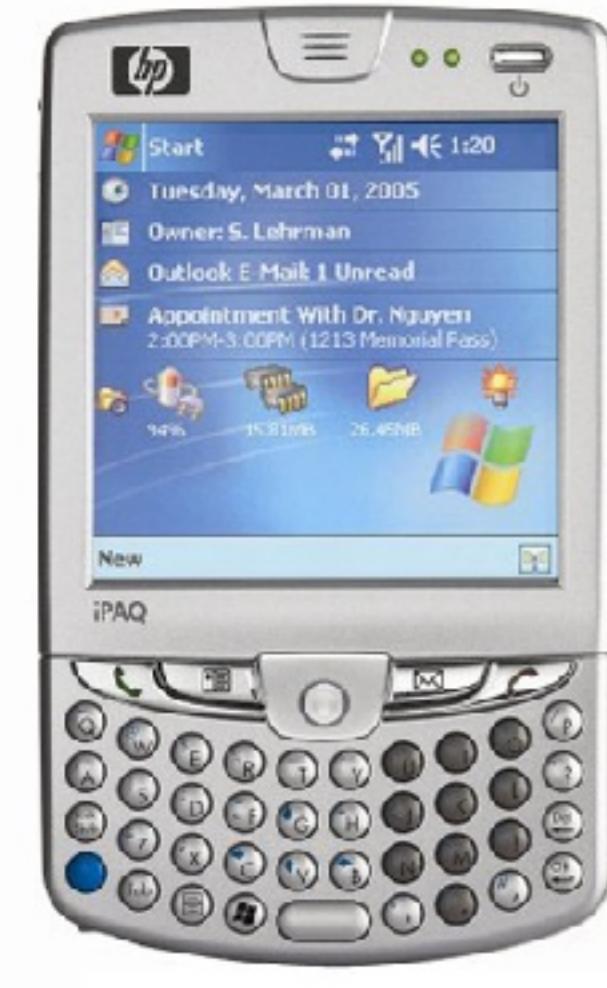
# get feedback early

## paper prototypes



# flat design

- HCI was built on the concept of metaphor since its inception
- called skeuomorphism
- mobile HCI breaks all these metaphors



# flat design

- no need for visual metaphor if intuitive
- make minimal and efficient
- color is king



# flat design

- main principles started in advertising
- the swiss style and minimalist style



# pure flat design

- minimal typography
  - Helvetica (Neue) / SF
  - text size gives importance
- colors are vibrant
  - set against light/dark
- no drop shadows
- no lightpoint gradients
- depth is for orienting only, never the UI elements



R 255  
G 59  
B 48

Red

R 255  
G 149  
B 0

Orange

R 255  
G 204  
B 0

Yellow

R 76  
G 217  
B 100

Green

R 90  
G 200  
B 250

Teal Blue

R 0  
G 122  
B 255

Blue

R 88  
G 86  
B 214

Purple

R 255  
G 45  
B 85

Pink

# pure flat design?

eric c. larson

HOME

PUBLICATIONS

TALKS

TEACHING

CV



Assistant Professor  
Computer Science and Engineering  
Bobby B. Lyle School of Engineering  
Southern Methodist University

twitter: @ec\_larson  
email: ec larson@lyle.smu.edu

CSE Office: 451 Caruth Hall  
Ph. (214) 758-7846  
Lyle School of Engineering  
Caruth Hall  
3145 Dyer Street, Suite 445  
Dallas, TX 75205

SMU UbiComp Lab:  
TRD



SMU

BOBBY B. LYLE  
SCHOOL OF ENGINEERING

## ABOUT ME

I am an Assistant Professor in Computer Science and Engineering in the [Bobby B. Lyle School of Engineering](#), Southern Methodist University.

I received my Doctorate from the University of Washington where I was a Intel Science and Technology fellow. My dissertation entitled [Semi-Supervised Training for Infrastructure Mediated Sensing: Disaggregated Hot and Cold Water Sensing With Minimal Calibration](#) has garnered significant impact in the sustainability community and is the basis of the new product [Belkin WeMo Water](#), which won the "Best of CES 2015" award for most forward thinking iOS related product. At UW, I was co-advised by [Shwetak Patel](#) and [Les Atlas](#). I also have an MS in Image Processing from Oklahoma State University, where I was advised by [Damon Chandler](#). During my graduate studies, I was fortunate to intern at a number of great labs including [Intel Research](#) in Seattle and [Garmin Fitness](#).

My work has been published in numerous conferences and journals disseminated through many different cross-disciplinary venues: ICIP, UbiComp, CHI, DEV, WCCI, PerCom, PETRA, SPIE, and Pervasive, garnering numerous best paper nominations. Please see my [publication page](#) and/or [Google Scholar page](#) for more details.



## PROSPECTIVE STUDENTS

I am looking for [UNDERGRADUATE](#) and [GRADUATE STUDENTS](#) passionate about investigating the role of technology in solving impactful problems. If this interests you, please [contact me](#) so that we can setup a time to chat about mutual interests and potential research projects.

## TRAVEL

Aug 27 - 29, 2014  
Belkin Echo Water Consulting  
Los Angeles, CA

Sep 13 - 17, 2014  
UbiComp 2014  
Seattle, WA

Feb 2 - 7, 2015  
Masters in Data Science Filming  
Baltimore, MD

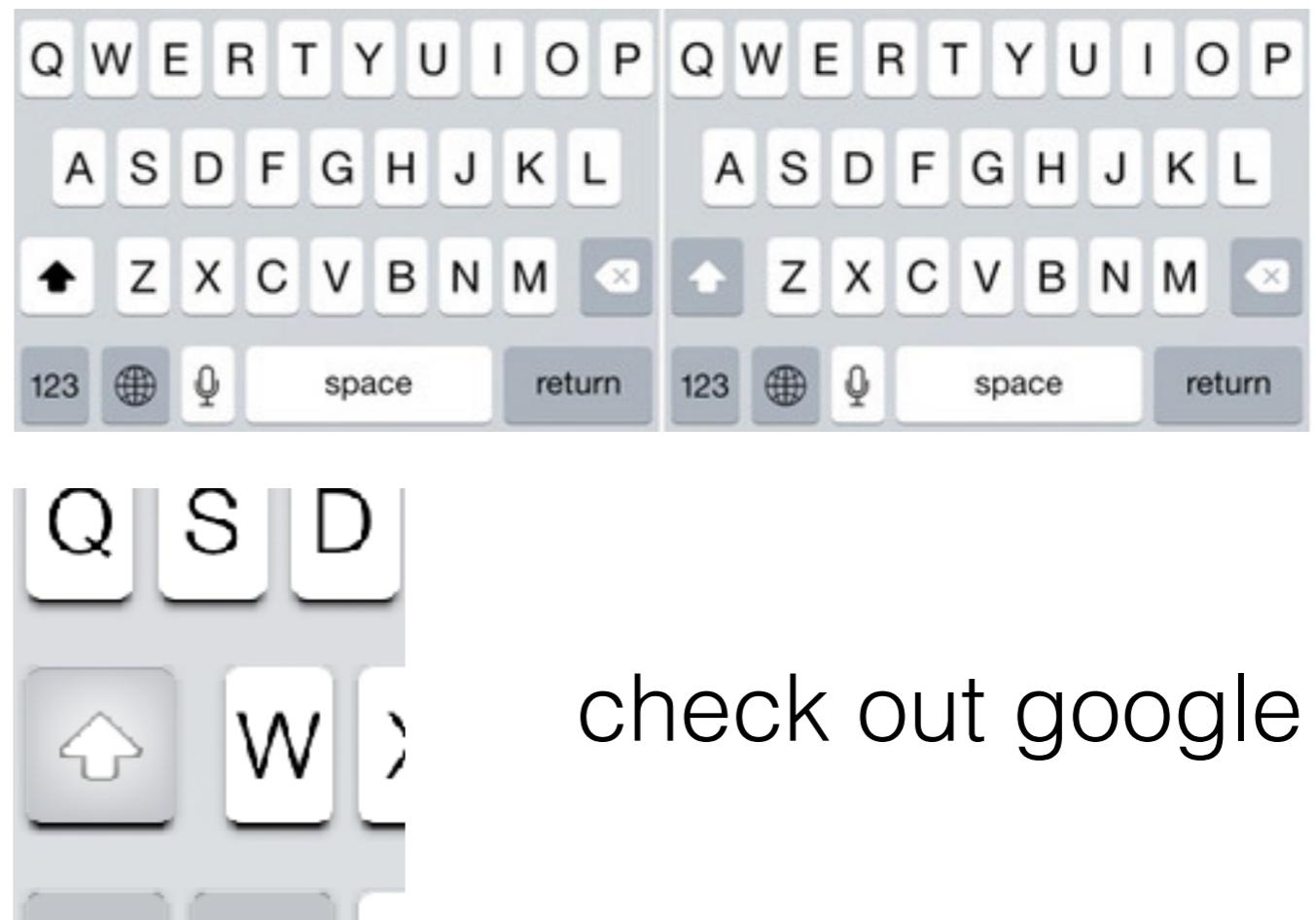
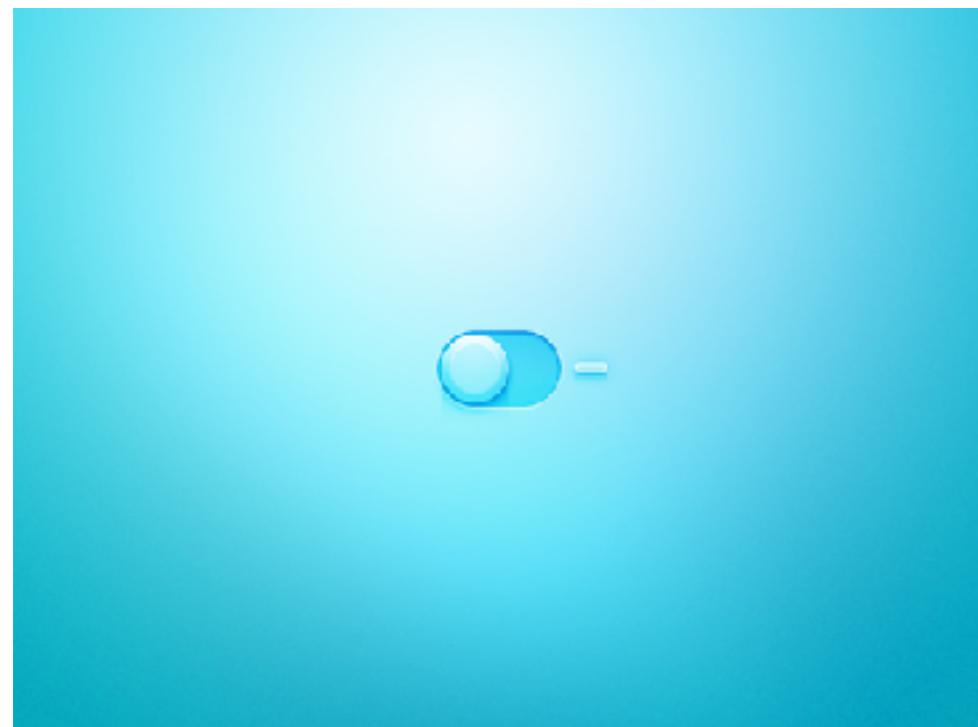
May 15 - 18, 2015  
UbiComp 2015 PC Meeting  
New York City

## NEWS

2.28 - DISSERTATION WORK WINS BEST OF CES  
Congratulations WeMo! WeMo® Water lands on the prestigious list of most forward-thinking, creative, and useful iOS-related products coming to market

# pure flat design?

- can be the enemy of HCI
- metaphor and depth are powerful visual cues
- **post flat design:** how to keep metaphor while using minimalism?



check out google



Upgrade to Google+

## Get more out of Google by using Google+

Whether you're using Gmail, Search, YouTube, Maps, or Blogger, Google+ gives you new ways to share the right things with the right people.

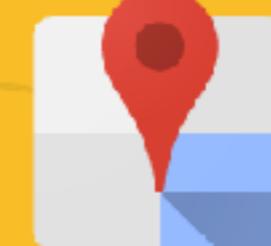


...  
.



Gmail »

Video Chat with up to nine people at once, find emails from the people you care about, share photos effortlessly and more.



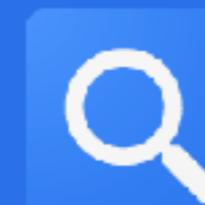
Maps »

Send directions and share the places you love with just the right people, right from Google Maps.



News »

Get the latest from your favorite authors, and see the articles your friends are sharing right in Google News.



Search »

Search everything on the web, plus your photos, posts from your circles, and the things your friends have shared with you.



Blogger »

Easily share your posts on Google+ so that you can expand the audience for your blog.



Chrome »

Recommend sites, share pages, and always stay up-to-date with the people in your Google+ circles.



Android »

Get photos that upload as you take them, group chats instead of multiple texts, and video chats with friends.



Music »

Give the people in your Google+ circles a free listen to the songs you buy through Google Music.



Earth »

Share images of the places you visit in Google Earth to just the right people using Google+.



Youtube »

See which videos your friends are sharing and watch any video with up to nine friends at once.

defining your style

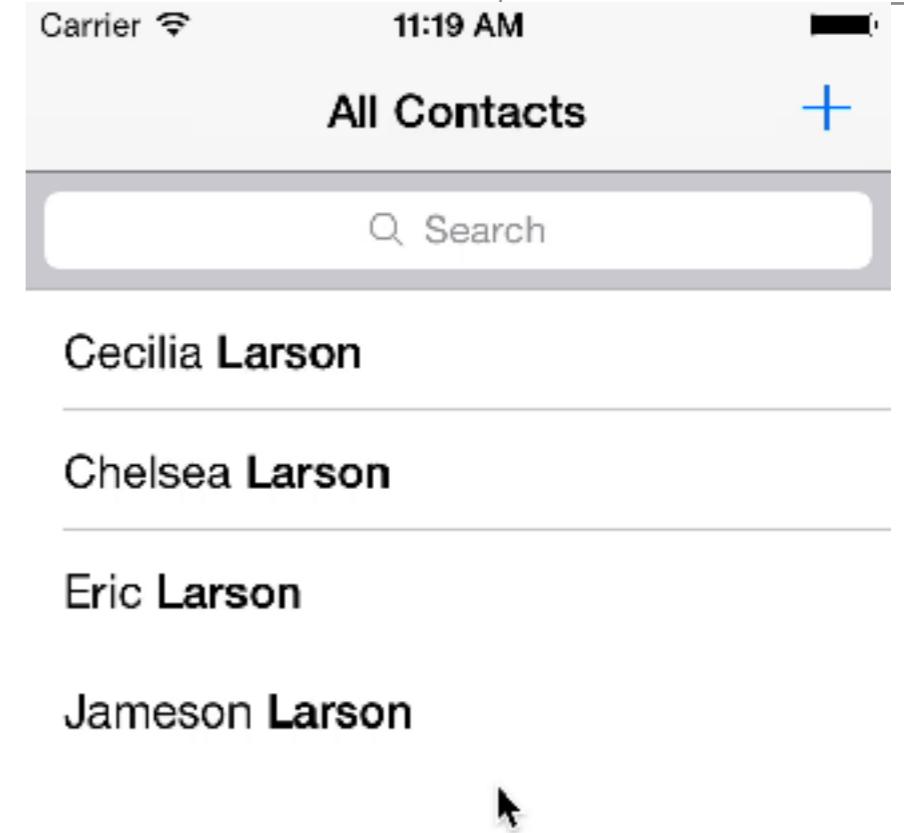
# know your app

## style basics

design is flat

- color exposes purpose
- negative space
- subtle bordering when needed

- no shadows or bordering
- text filled minimally and descriptive
- **color** conveys interaction possible
- borders when ambiguous

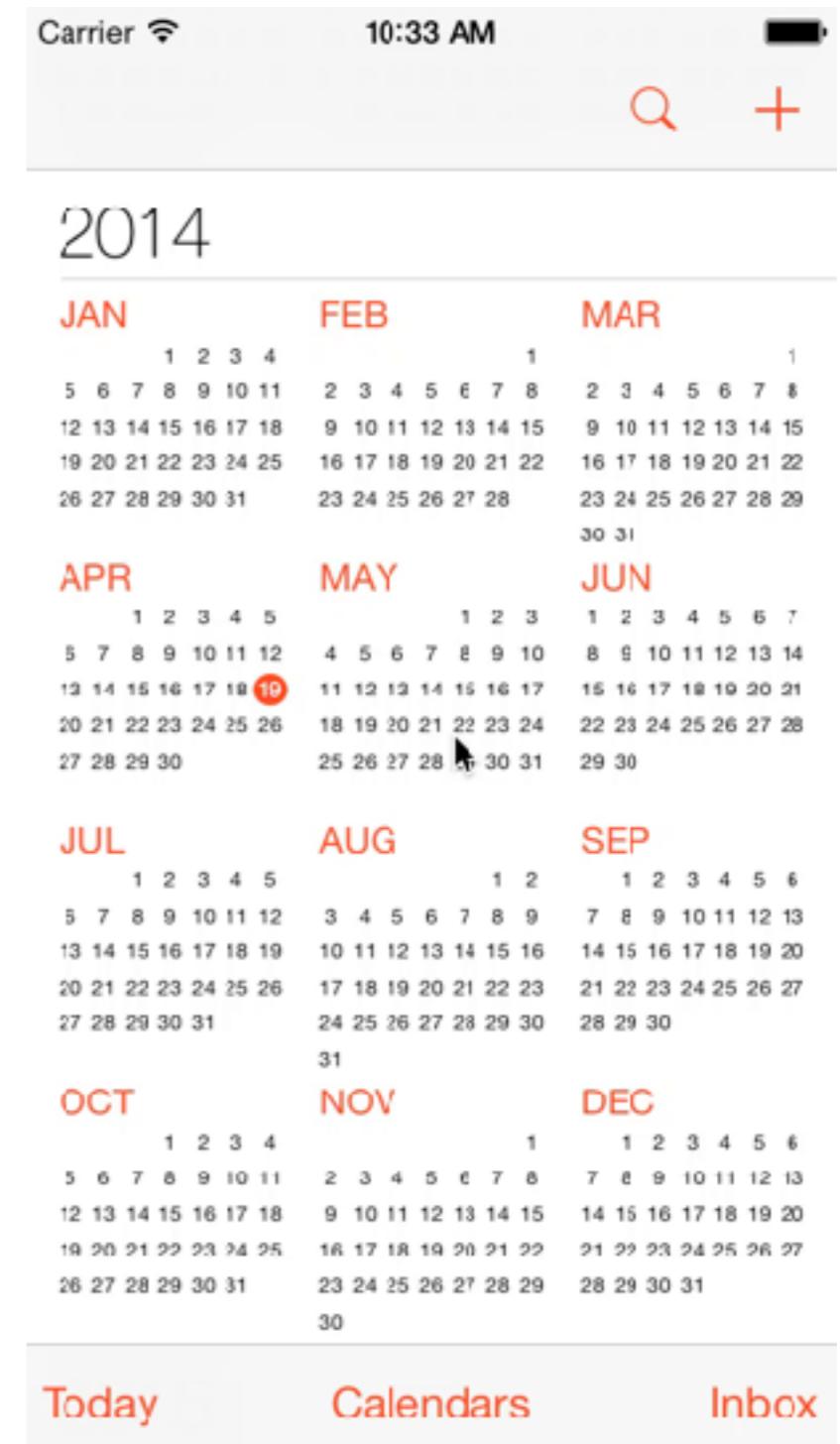


# know your app

## productivity apps

enables detailed manipulation

- organizing
  - adding and subtracting
  - drill down for detail
- 
- depth conveys hierarchy
  - transition motion orients user
  - detail view takes over the screen
  - manipulation tabs change with depth



# know your app

## utility

simple task, minimal input

- highly visual
  - enhanced display of info
  - no hierarchy
  - glance-able
- 
- entire screen is used
  - navigation is flat
  - input is exploratory
  - no elements are in competition

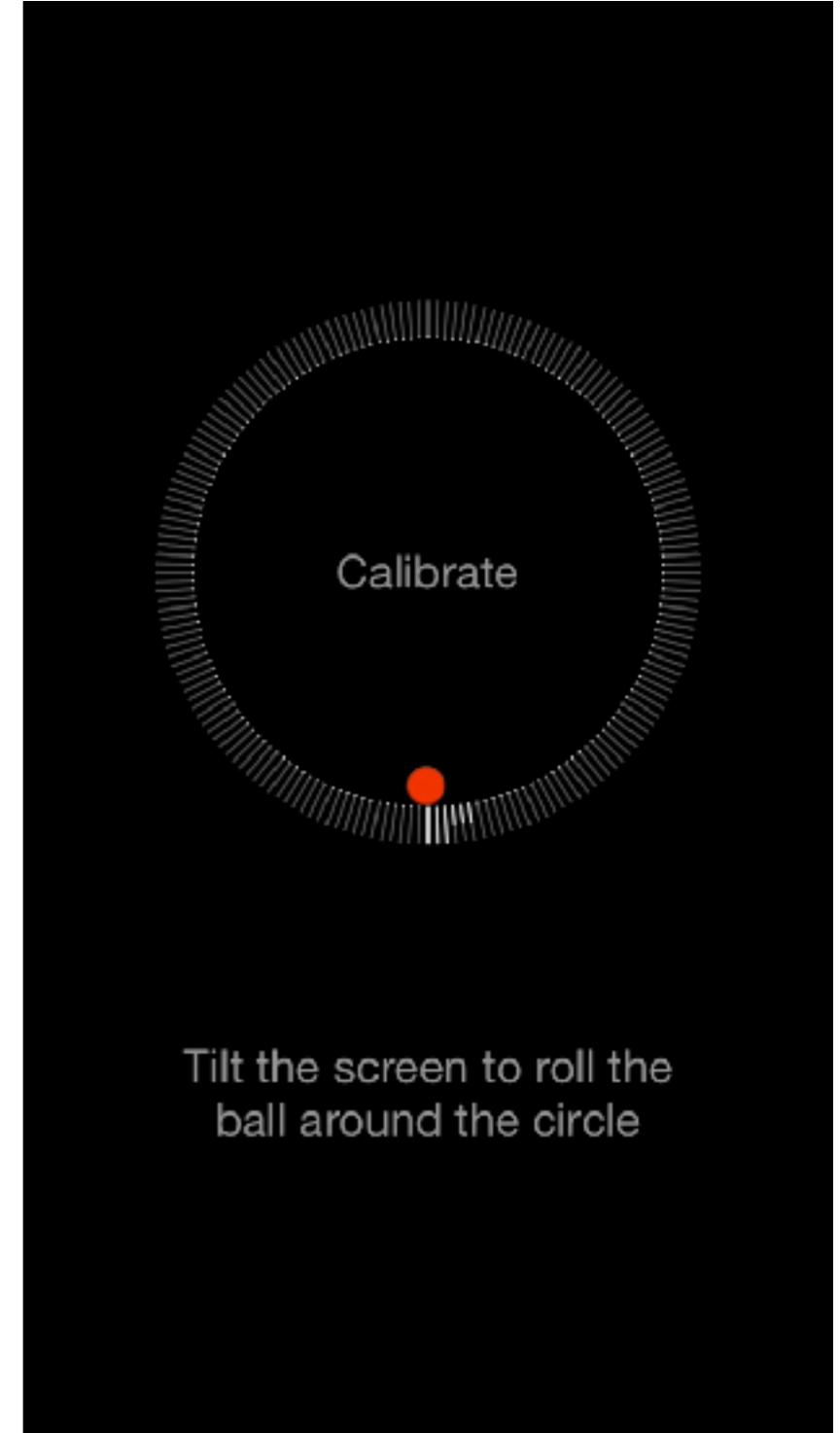


# know your app

## immersive

high interaction, visual experience

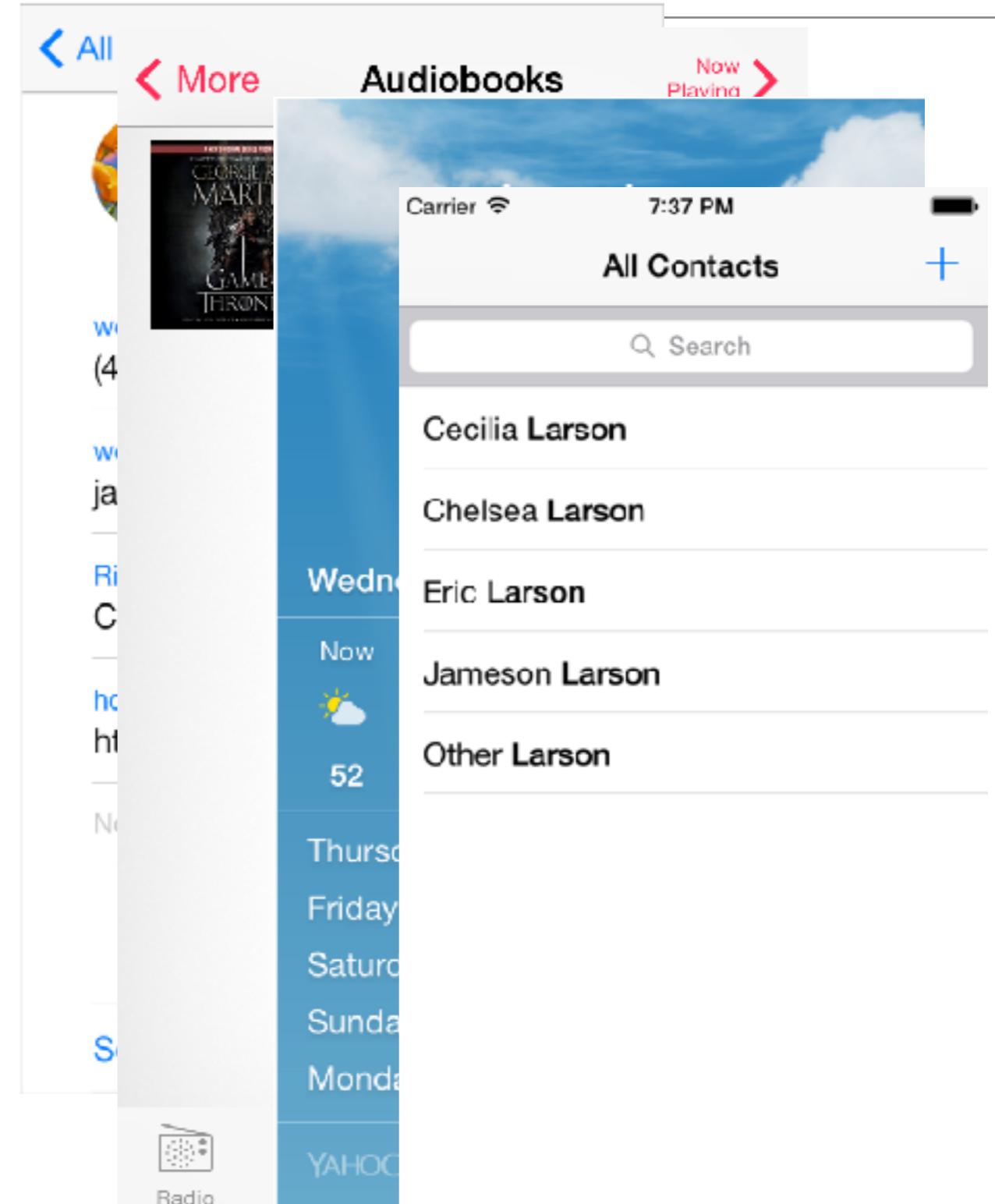
- hide UI elements
- nonstandard controls
- information centered on story, gameplay, experience



Tilt the screen to roll the ball around the circle

# navigation is orientation

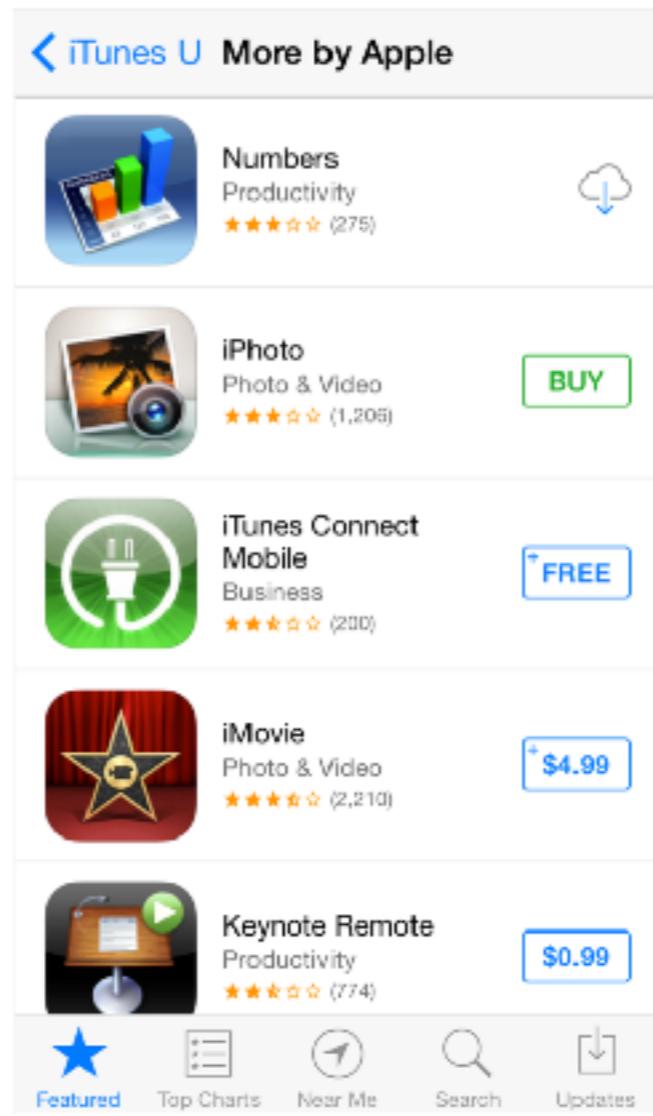
- the user must always know **where they are** in the app
- the **navigation bar** is the most understandable form of hierarchy, even when using animated hierarchy
- **tab bar** is for parallel content (peers)
  - each peer is different in function
- **page control** is for identical views, with new content
- **table view** is for master/detail
- only have **one way** of navigating to a view



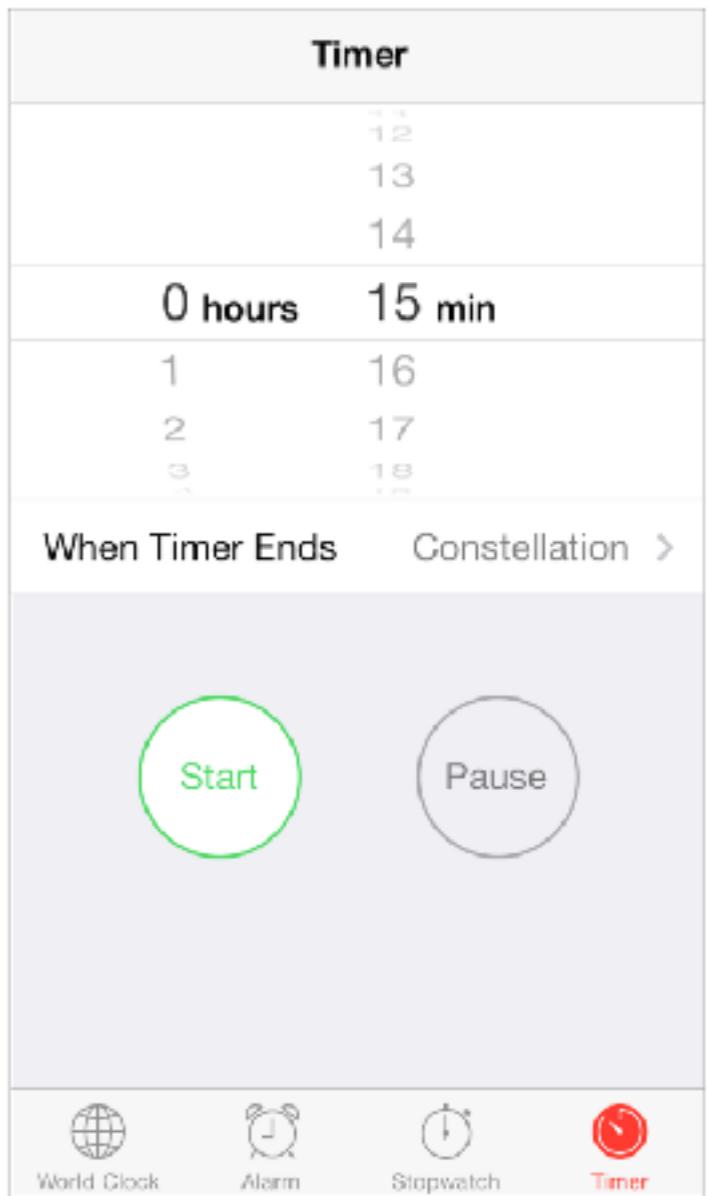
# button design

- embrace the borderless
- until you need a border

distinguish  
“tap button”  
from “tap row”



most  
important  
interaction



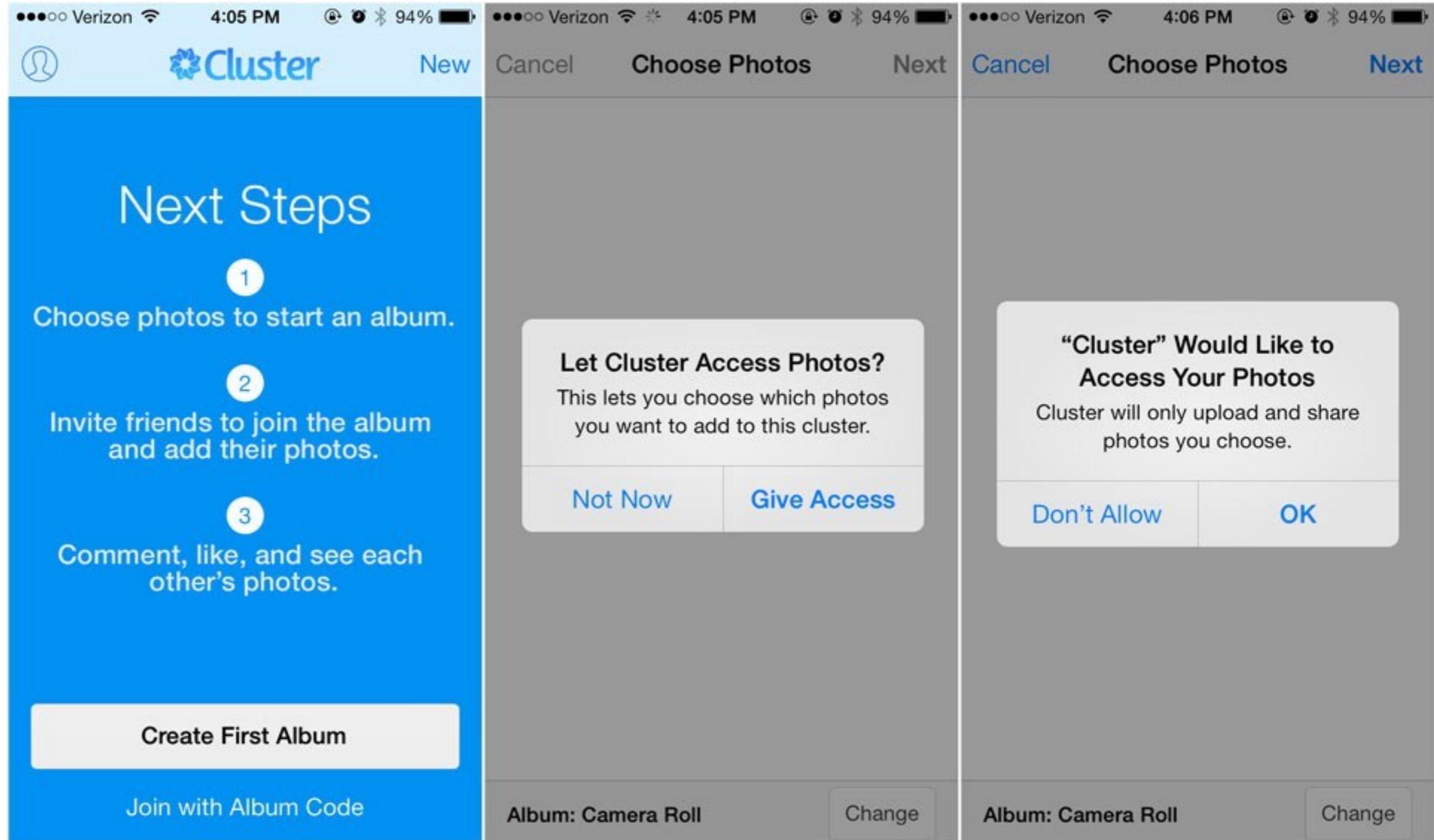
# principles summary

- stay consistent
- use design elements that don't distract
  - for a game, engagement is king
  - for productivity, keep animation subtle and quick
- visible feedback and direct manipulation
- use metaphor to promote intuitive interaction
  - flick / tap / pinch
- give the user the control
  - the user always has control of their information

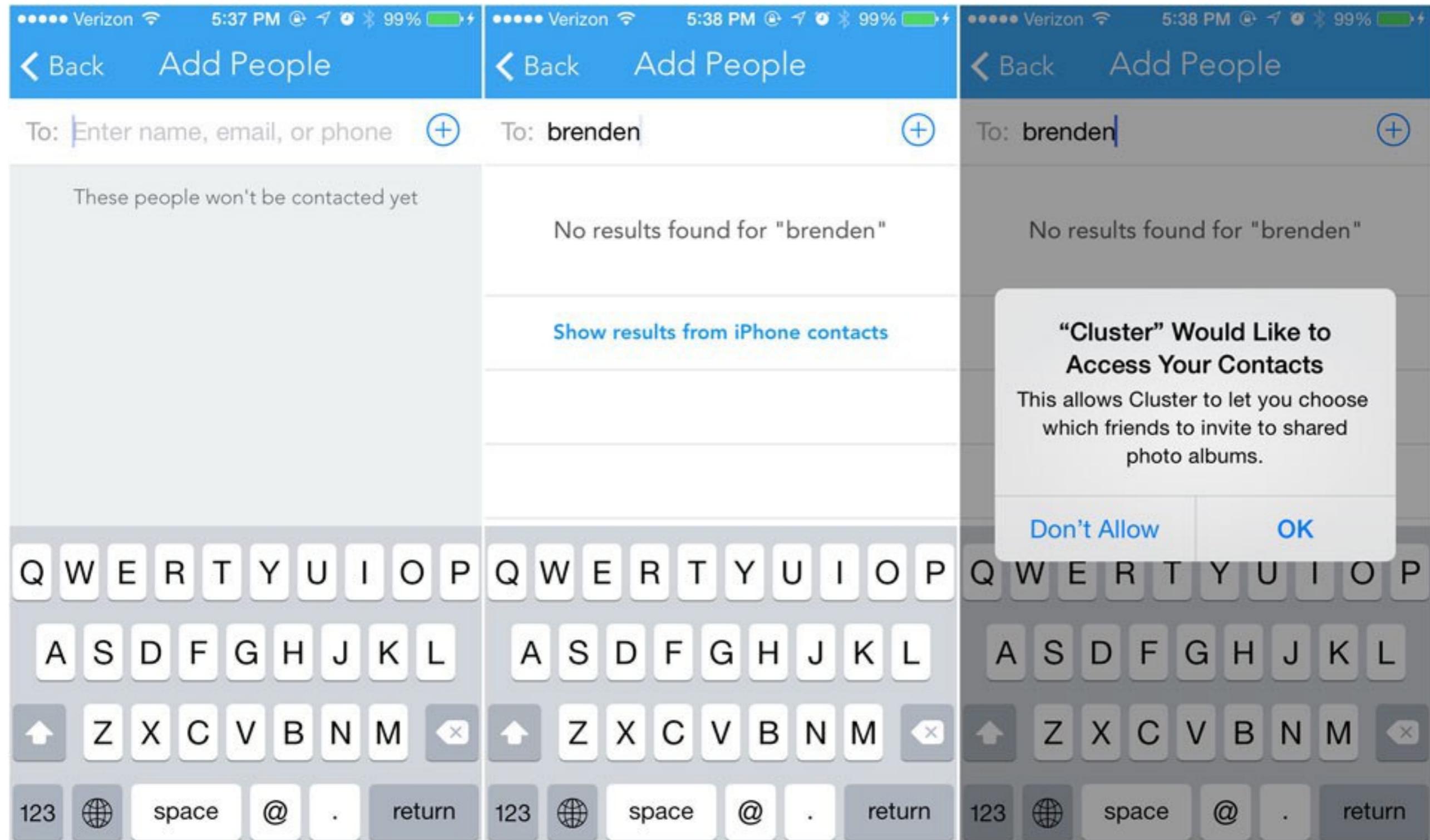
# user control

- don't ask until you need it
- make sure the user knows the tradeoff
- use “benefit->explanation”
  - ask twice, showing the benefit in your own words

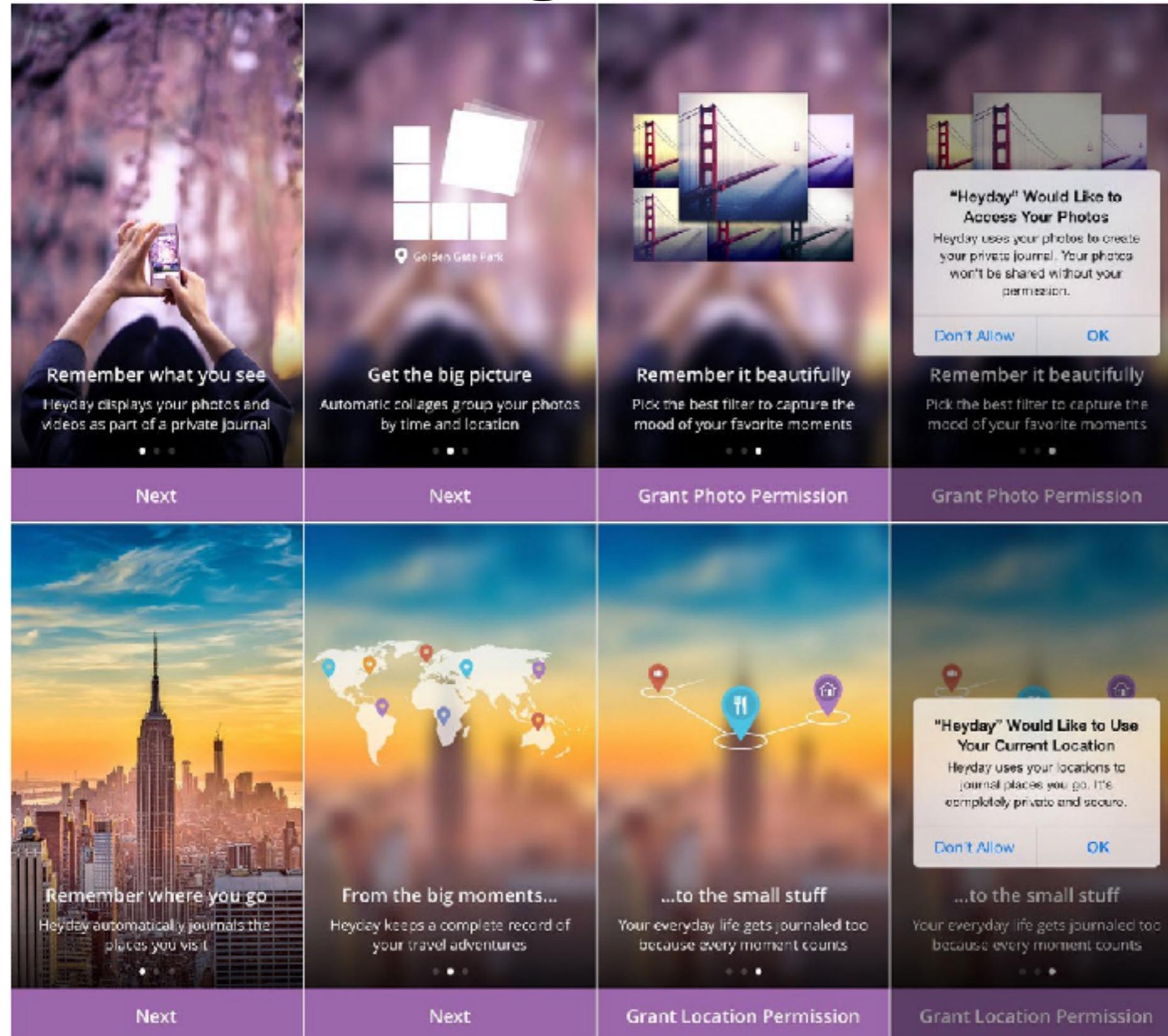
# when asking for access



# when asking for access



# is this right?



what is good?

what is bad?

# some great examples

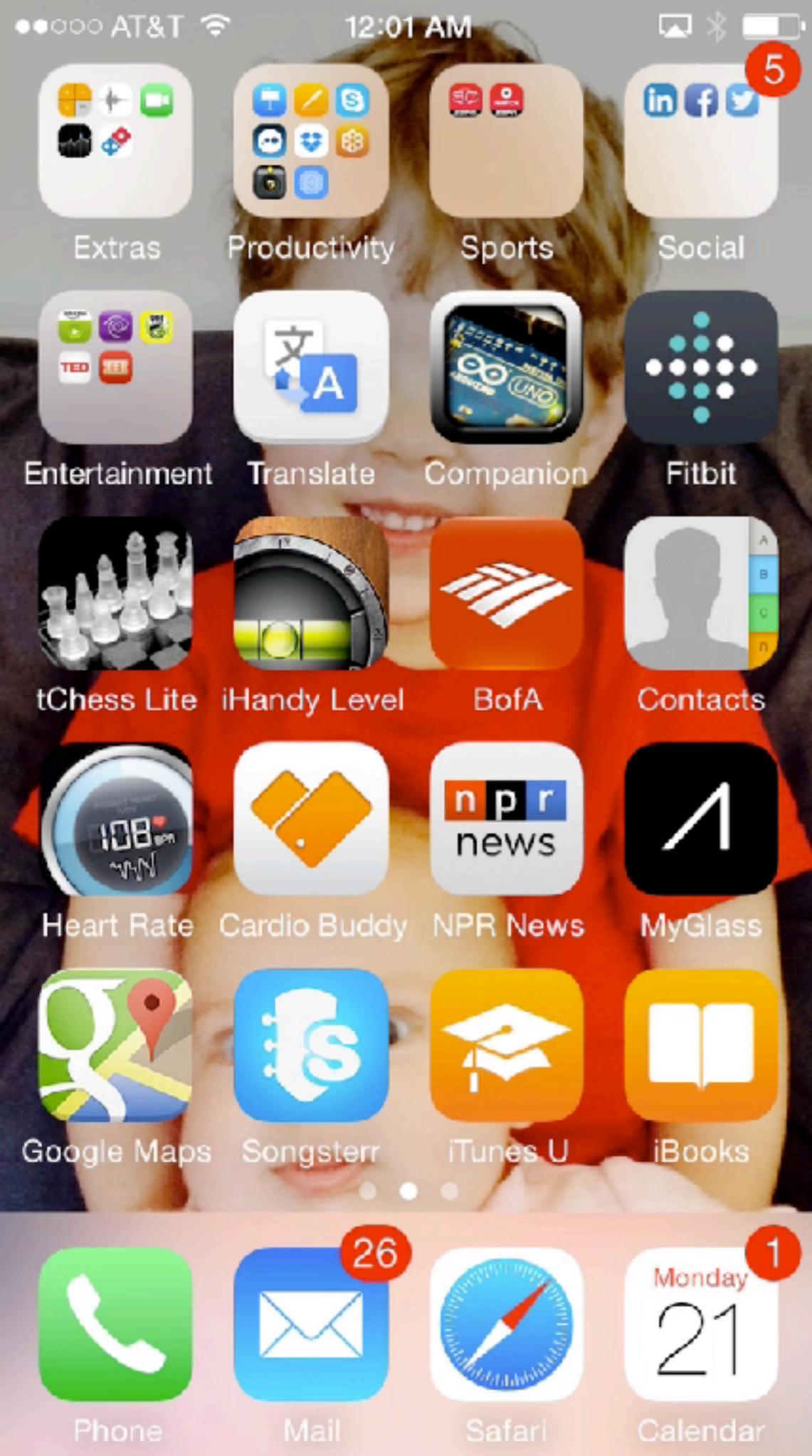


# some great examples





an example

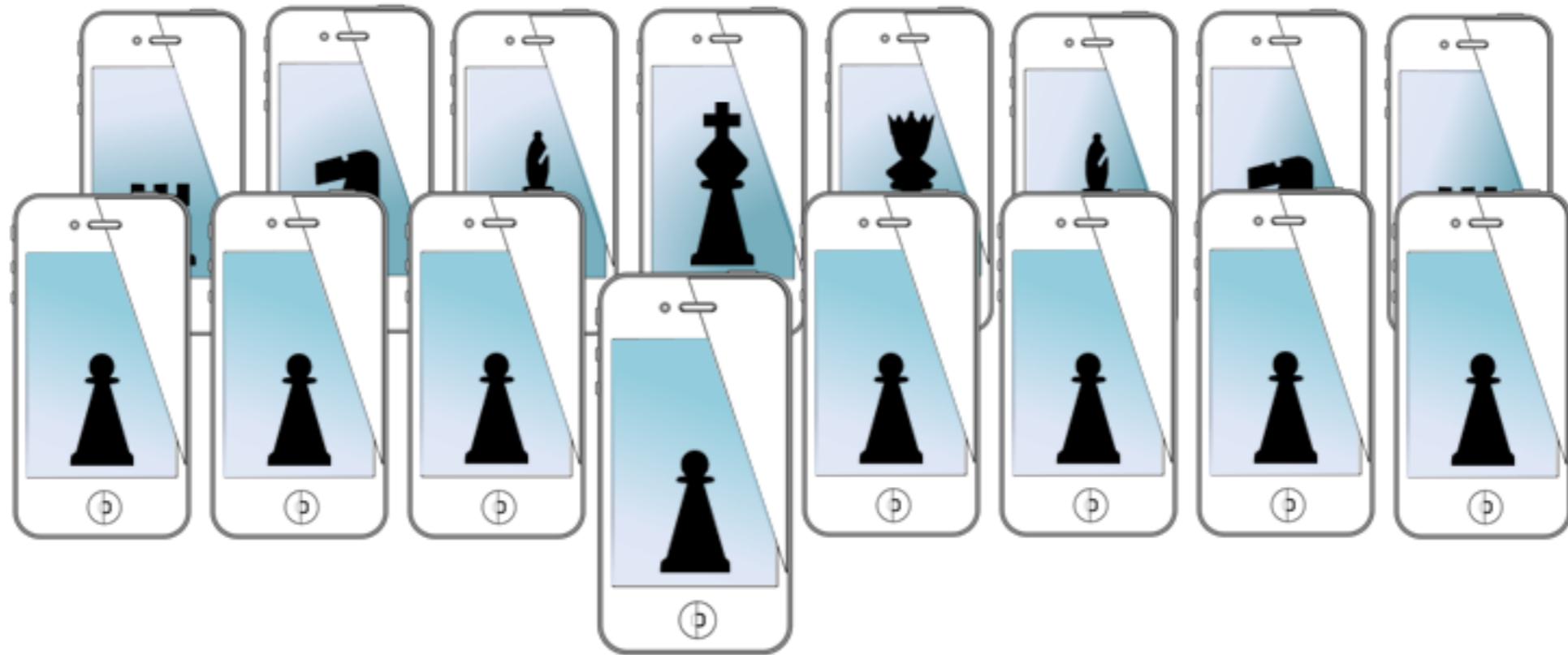


a **really** excellent  
example

# for next time...

- concurrency in iOS
- blocks
- introduction to audio sensing

# MOBILE SENSING LEARNING

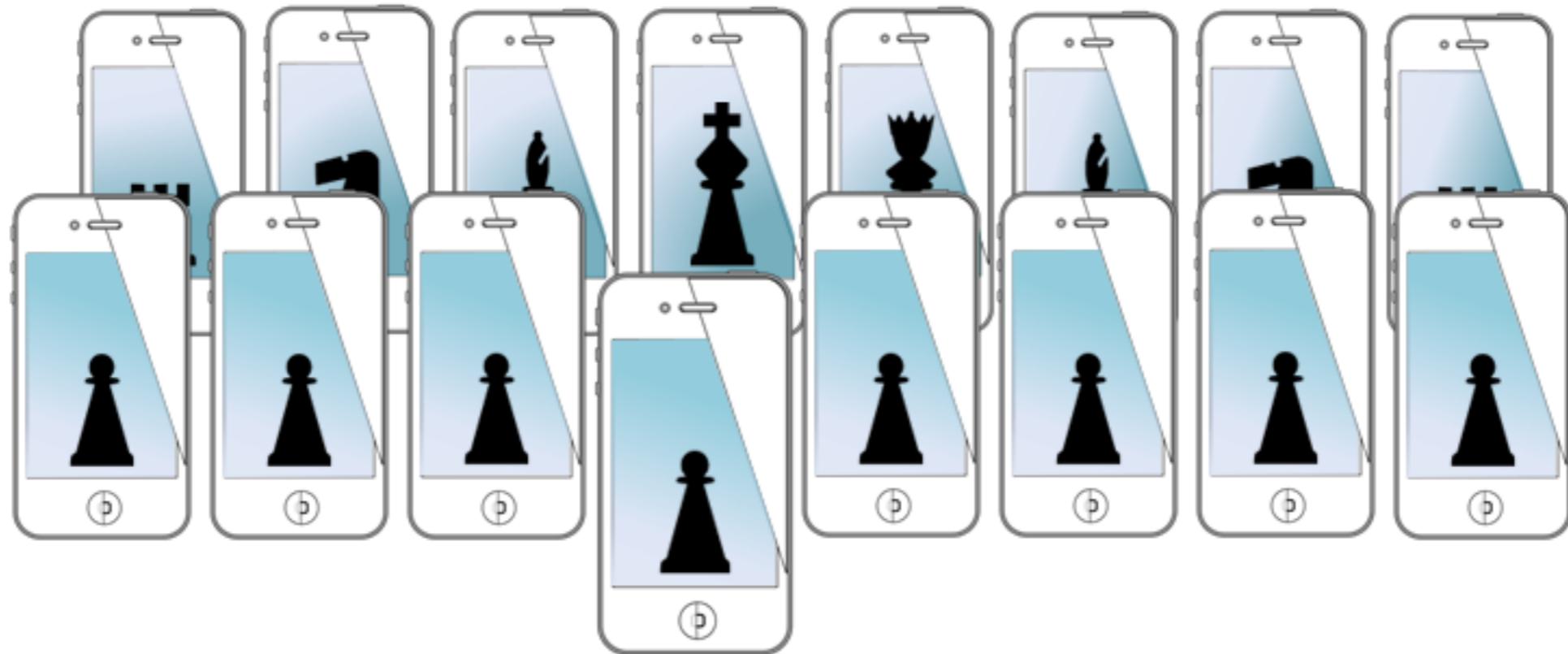


**CSE5323 & 7323**  
Mobile Sensing and Learning

week 3, lecture one: mobile design and interaction

Eric C. Larson, Lyle School of Engineering,  
Computer Science and Engineering, Southern Methodist University

# MOBILE SENSING LEARNING



**CSE5323 & 7323**  
Mobile Sensing and Learning

week 3, lecture two: queues, blocks, C++, audio session

Eric C. Larson, Lyle School of Engineering,  
Computer Science and Engineering, Southern Methodist University

# agenda

- blocks and multi-threading
- objective c++ (no longer needed!)
- core audio intro

# blocks

- not callback functions (but similar)
  - created at runtime
  - once created, can be called multiple times
  - can access data from scope when defined
  - syntax is ^( ... )
- not exactly a lambda (*but similar*)
  - but it acts like an object that can be passed as an argument or created on the fly
- also used in swift (called closures)

# block syntax

return type

```
// create a block on the fly
float (^onTheFlyBlockThatAddsTwoInts)(int,int); // declare the block, try not to make unclear
// define the behavior of the block
onTheFlyBlockThatAddsTwoInts =^(int a, int b){
    return (float)(a+b);
};
// use the block
NSLog(@" On the fly value: %.4f",onTheFlyBlockThatAddsTwoInts(5,6));
```

block name

param types

define code that will execute

```
typedef float(^TypeDefinedBlock)(float,float);
```

type define, more like callback

```
TypeDefinedBlock blockAsObject = ^(float arg1, float arg2){
    return arg1 / arg2;
};
```

```
-----
//execute the block from typedef
float value = blockAsObject(22.0,44.0);
NSLog(@" Val = %.4f",value);
```

syntax to call block

```
-----
//enumerate an Array with a block
NSArray *myArray = @[@34.5,@56.4567,@(M_PI)];
```

enumerate with block

```
// here the block is created on the fly for the enumeration
[myArray enumerateObjectsUsingBlock:^(NSNumber *obj, NSUInteger idx, BOOL *stop) {
    // print the value of the NSNumber in a variety of ways
    NSLog(@"Float Value = %.2f, Int Value = %d",[obj floatValue],[obj integerValue]);
}];
```

# some semantics

- variables from same scope where block is defined are **read only**

```
NSNumber * valForBlock = @5.0;
```

- Unless you use keyword:

```
__block NSNumber * valForBlock = @5.0;
```

- classes hold a **strong** pointer to blocks they use
- blocks hold a **strong** pointer to \_\_block variables
  - so using “self” would create a retain cycle

```
self.value = (some function in block)
```

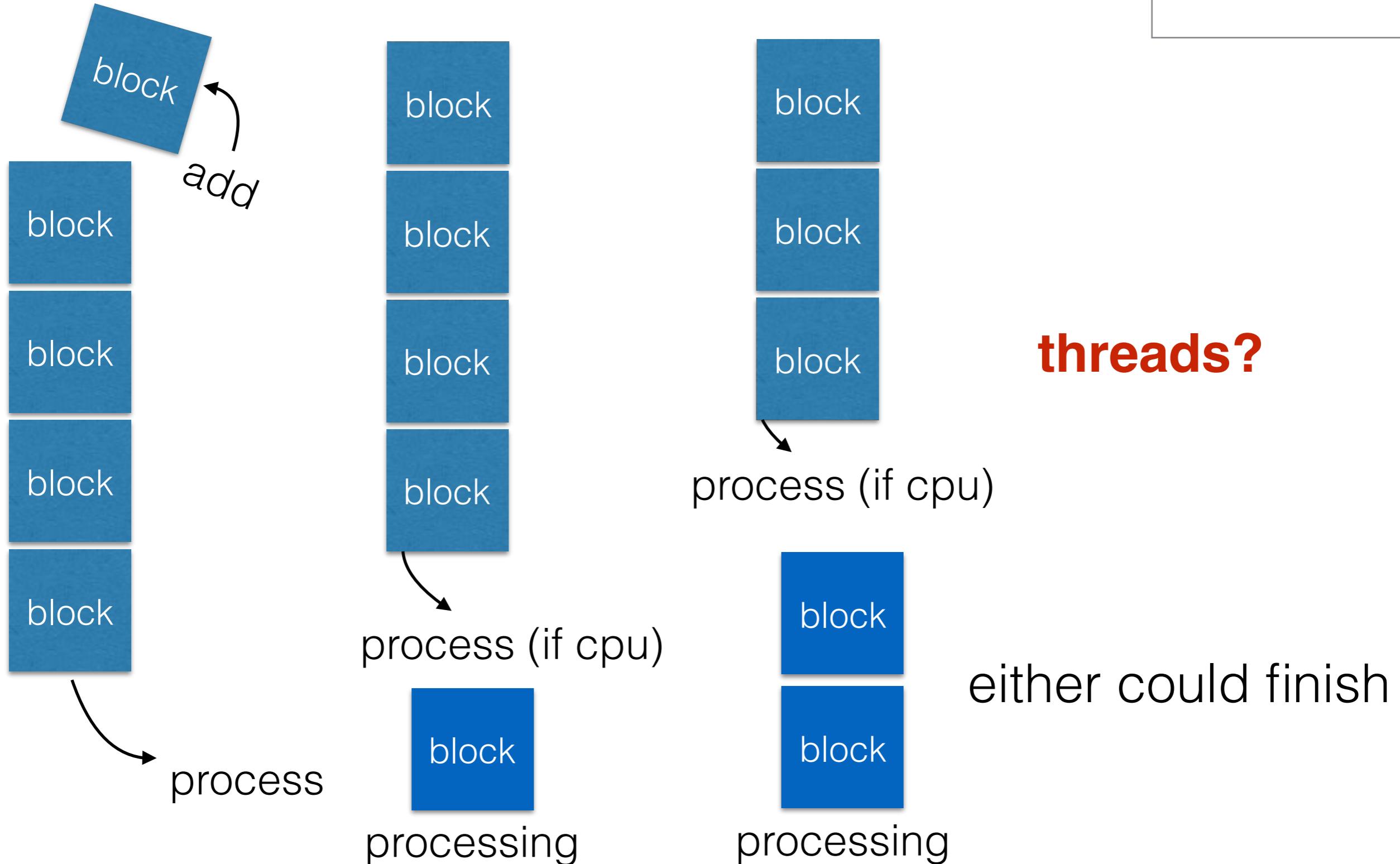
```
__block ViewController * __weak weakSelf = self;
```

```
weakSelf.value = (some function in block)
```

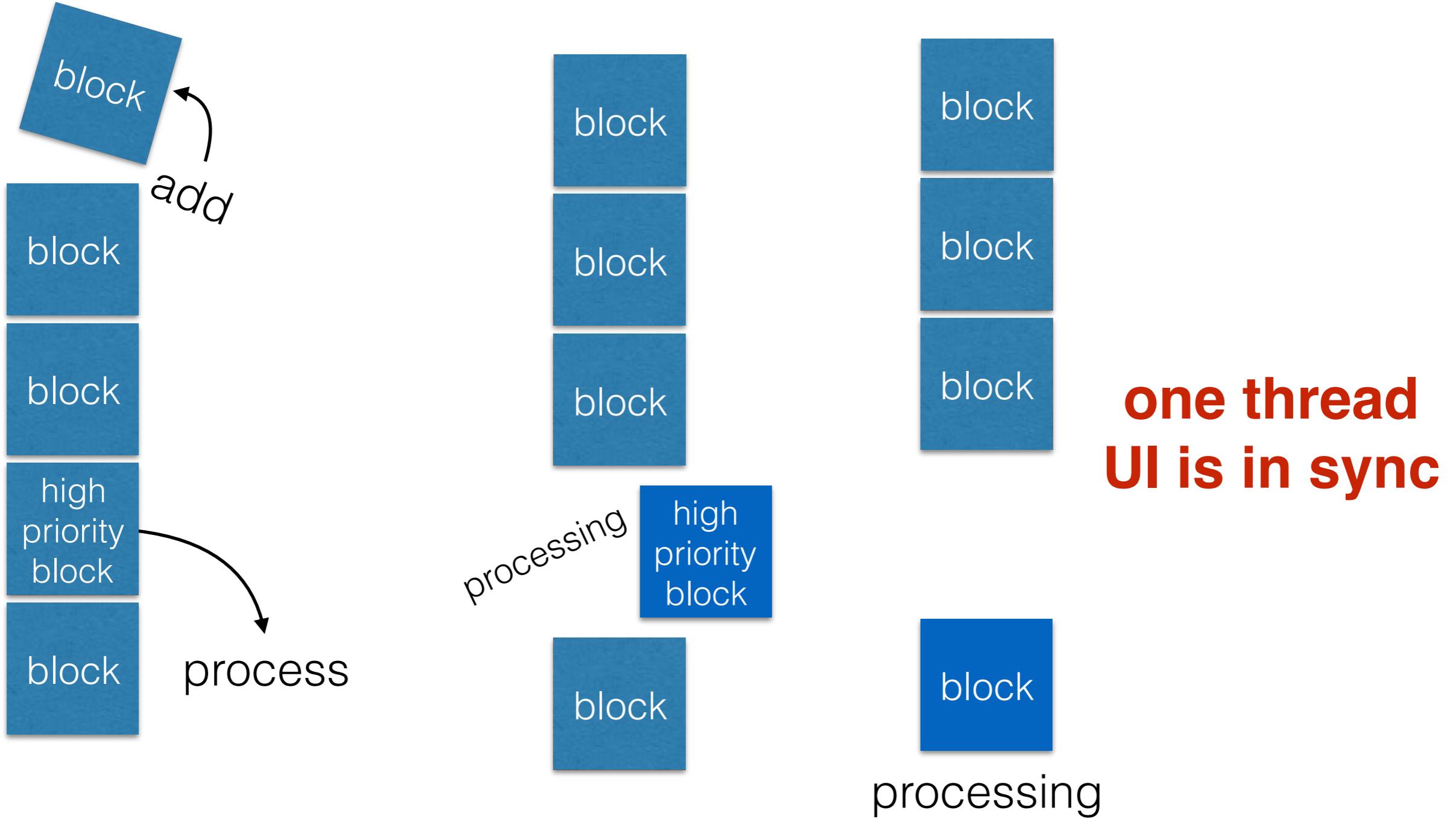
# Concurrency in iOS

- grand central dispatch (GCD) handles all operations
  - GCD looks at “queues” of **blocks** that need to be run
  - GCD and the Xcode compiler work deep inside the OS, actually in the kernel – they are optimized
  - for a **serial queue** each block is run sequentially
  - for **concurrent queues** the first block is dequeued
    - if CPU is available, then the next block is also dequeued, but could finish any time
- the **main queue handles all UI operations** (and no other queue should generate UI changes!!)
  - so, **no updating of** the views, labels, buttons, (image views\*) **except from the main queue**

# concurrent queues



# the main queue



# queue syntax

create new queue

```
// using c code:  
dispatch_queue_t someQueue = dispatch_queue_create("myCreatedQueue", DISPATCH_QUEUE_CONCURRENT);  
dispatch_async(someQueue, ^{  
    // your code to execute  
    for(int i=0;i<3;i++)  
        NSLog(@"I am being executed from a dispatched queue");  
  
    // now I need to set something in the UI, but I am not in the main thread!  
    // call from main thread  
    dispatch_async(dispatch_get_main_queue(), ^{  
        self.label.text = [NSString stringWithFormat:@"Finished running %d times, Safe",3];  
    });  
}); // this operation adds the block to the queue in a single clock cycle, then returns
```

define block

serial or concurrent

update UI, main thread

```
NSOperationQueue *newQueue = [[NSOperationQueue alloc] init];  
newQueue.name = @"ObjCQueue";  
[newQueue addOperationWithBlock:^{  
    // your code to execute  
    for(int i=0;i<3;i++)  
        NSLog(@"I am being executed from a dispatched queue, from objective-c");  
  
    // now I need to set something in the UI, but I am not in the main thread!  
    // call from main thread  
    [self performSelectorOnMainThread:@selector(setMyLabel)  
        withObject:nil  
        waitUntilDone:NO];  
};
```

define block

create new queue

update UI, main thread

# queue syntax

- using global queues

```
// An example of using already available queues from GCD
dispatch_async(dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0), ^{
    // your code to execute
    for(int i=0;i<3;i++)
        NSLog(@"I am being executed from a global concurrent queue");

    // now I need to set something in the UI, but I can't do it in the main thread!
    // call from main thread
    dispatch_async(dispatch_get_main_queue(), ^{
        self.label.text = @"Finished running from GCD global";
    });
});
```

access a global queue

not on main queue!!

main queue!

DISPATCH\_QUEUE\_PRIORITY\_LOW

DISPATCH\_QUEUE\_PRIORITY\_DEFAULT

DISPATCH\_QUEUE\_PRIORITY\_HIGH

DISPATCH\_QUEUE\_PRIORITY\_BACKGROUND

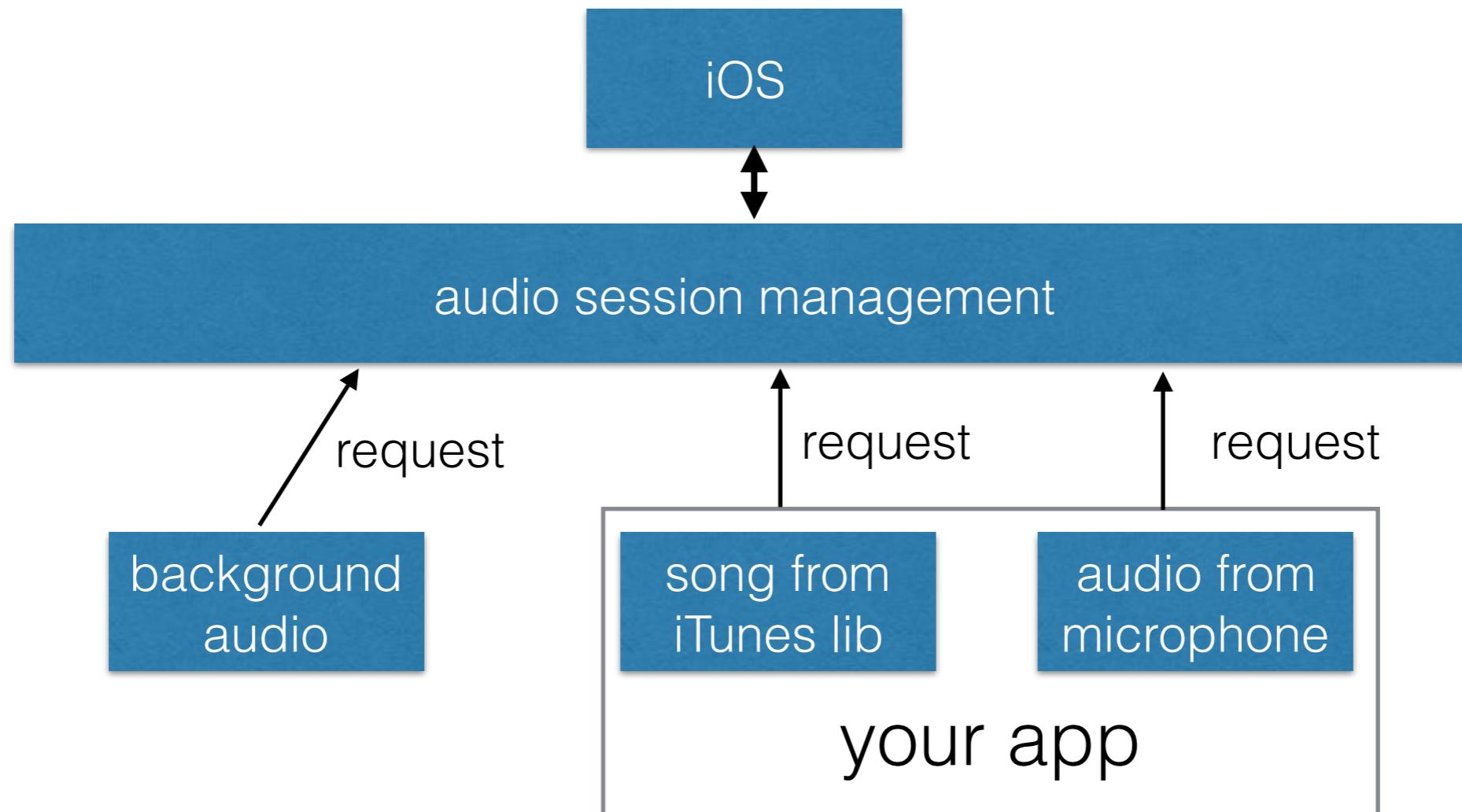
# objective C++ (aside)

- this is no longer required for audio, but is good to know for later in the class when we use OpenCV...
- actually, its just c++
- ...but need to tell compiler we are using c++
- add any **#include** statements
- change **extensions to .mm** where you use c++ class(es)
- ARC won't help you for *malloc*, *calloc*, or ***new***
  - so explicitly call *dealloc* and your class destructor
  - ***delete*** or *free*

# Core Audio

- many **audio packages** exist, but we want **low level signals**
- **Audio Sessions** (high level, completely overhauled starting iOS7)
  - shared instance (for all applications)
  - set category (play, record, both)
    - choose options: like mixing with ambient sources
  - set audio route (new starting in iOS7)
    - set specific hardware within audio route
- **Audio Units** (more low level, output, input)
  - set stream format, buffer sizes, sampling rate,
  - initialize memory for audio buffers
  - set callback rendering procedure

# audio sessions

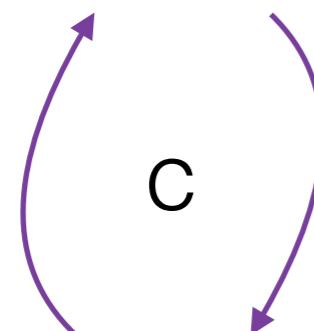
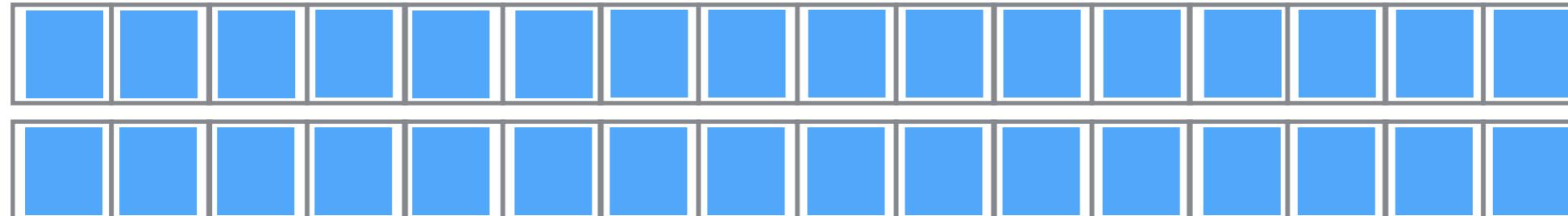


any request can alter management of other audio requests

mixing can be automatic — this is impressive

# audio units

audio input buffer procedure, double buffer shown



sent to audio session callback

copy over samples, convert  
exit from call as soon as possible!

do not allocate memory, take locks, or waste time!!

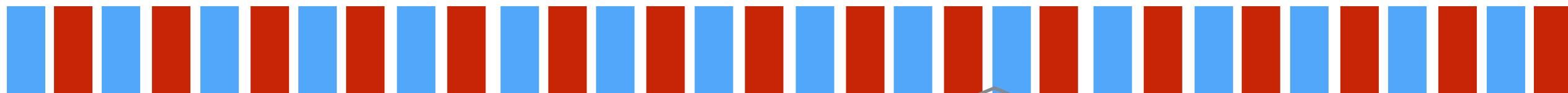


# audio unit formats

microphone (input)

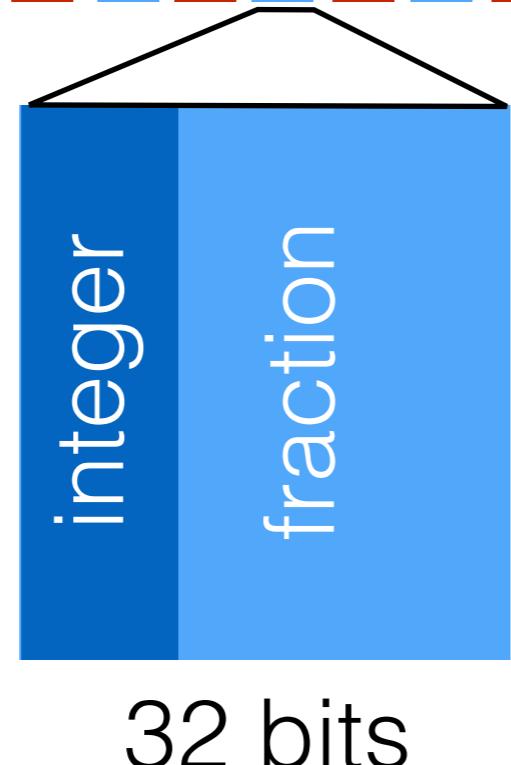


stereo could be interleaved (output)



right speaker

left speaker



callback preallocates buffers  
developer fills the output buffer  
OS handles playing the buffer  
if you don't fill fast enough,  
audio is choppy

wouldn't it be **great** if there was a module that **handled** all the specifics of **audio units for us?**

**Novocaine:** takes the pain out of audio processing

Originally developed by **Alex Wiltschko**

Heavily manipulated by **eclarson**



**Alex Wiltschko**  
alexbw

 Twitter  
 Boston, MA  
 [alex.bw@gmail.com](mailto:alex.bw@gmail.com)  
 Joined on Dec 4, 2009

# audio made easy

- Novocaine (I mean real easy!!)

```
@property (strong, nonatomic) Novocaine *audioManager;
@property (strong, nonatomic) CircularBuffer *buffer;

_audioManager = [Novocaine audioManager];
_buffer = [[CircularBuffer alloc] initWithNumChannels:1 andBufferSize:BUFFER_SIZE];
```

declare properties

```
-(void)viewWillAppear:(BOOL)animated{

    __block ViewController * __weak weakSelf = self;
    [self.audioManager setInputBlock:^(float *data, UInt32 numFrames, UInt32 numChannels){
        [weakSelf.buffer addNewFloatData:data withNumSamples:numFrames];
    }];

    [self.audioManager setOutputBlock:^(float *data, UInt32 numFrames, UInt32 numChannels)
    {
        [weakSelf.buffer fetchInterleavedData:data withNumSamples:numFrames];
    }];
}
```

setup audio and init buffer

microphone samples as float array

data to write to speakers

# novocaine setup demo

source code on GitHub, **uses submodules**



And now its  
time for a demo

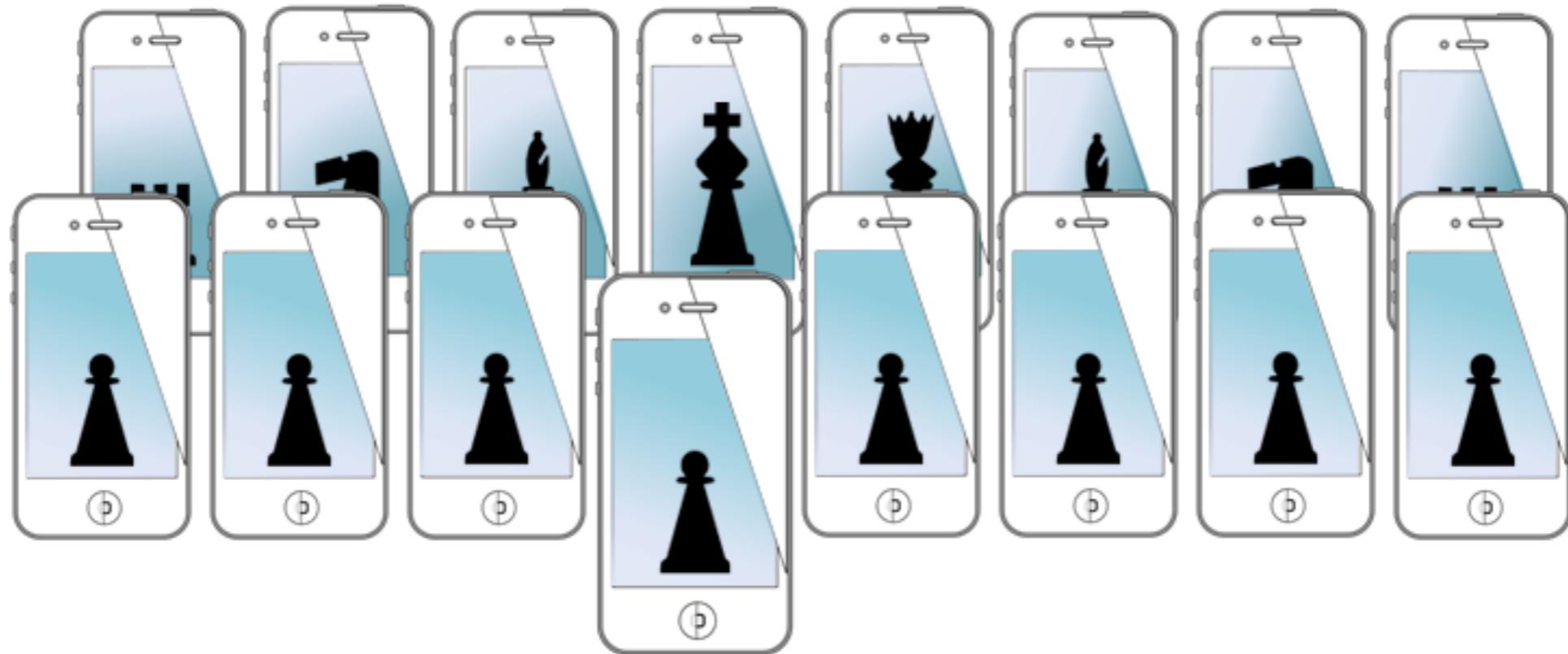


and rolling stones, if time

# for next time...

- more core audio
  - playing songs (if not covered today)
  - getting samples from microphone
    - showing samples with OpenGL
  - working with sampled data
  - the accelerate framework

# MOBILE SENSING LEARNING



**CSE5323 & 7323**  
Mobile Sensing and Learning

week 3, lecture two: queues, blocks, C++, audio session

Eric C. Larson, Lyle School of Engineering,  
Computer Science and Engineering, Southern Methodist University