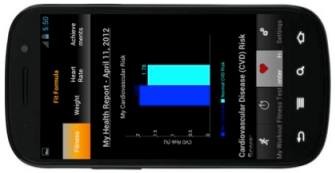
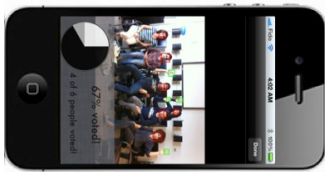
ECE 1778:
Creative Applications for Mobile Devices

Instructor: Jonathan Rose

Department of Electrical & Computer Engineering





Welcome!

- There has been an avalanche of progress in **mobile devices** in the past 5 years
- They are revolutionary
  - despite prior existence of both computers and cell phones

Smartphones are a Huge Leap:

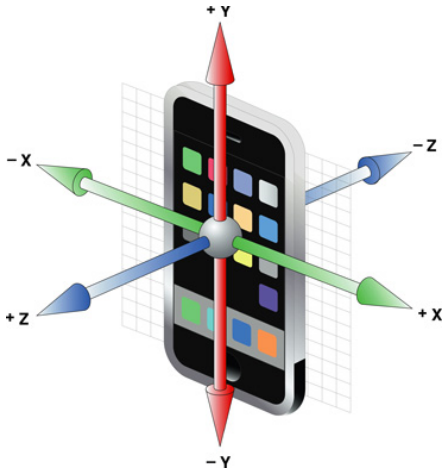
Because they contain in one portable package:

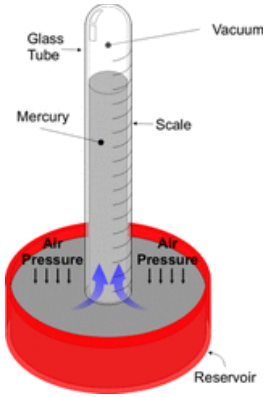
- A powerful computer you can carry in your pocket
  - More easily programmed than ever before
- Connected to the Internet
  - More knowledge & compute power
- Can **sense** its environment in many ways
- Can **speak** to its environment in several ways
- Can also make phone calls ☺

Fast Moving, Revolutionary Technology

From this week's Consumer Electronics Show:

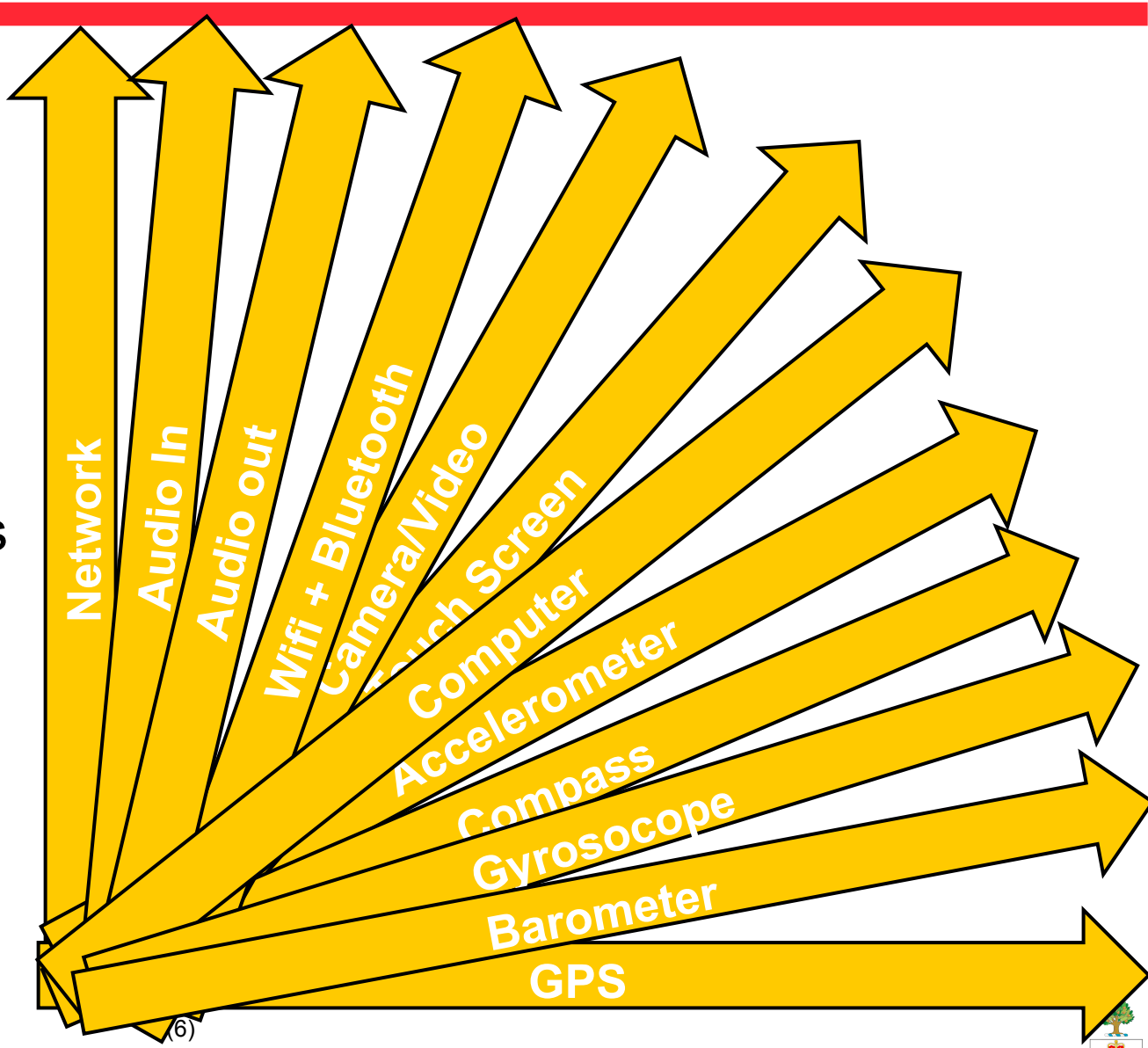
What's in a Smartphone? A lot!





Each Capability is an *Axis of Invention*

- Each kind of software capability is also an axis
- Each axis multiplies what is possible with the others!



Axes are Different Kinds of Paint Brushes

Consider: Scape, a Musical Composer App

- A case study in inventiveness
  - Uses touch screen, sound and computer
- Make music that thinks for itself.
  - a new form music creation
- Musical elements can be endlessly recombined
  - behave intelligently: reacting to each other, changing mood together, making new sonic spaces.

- http://youtu.be/8zNLlKRrUVk

Painting & Programming

- We can create new things with mobile devices, more easily than ever before.
- But not so easily that everyone can do it
  - need ability to program
- The point of this course is to bring together people from different disciplines, including programmers, to be able to create new things on this remarkable canvas.

The Revolution Began July 2008

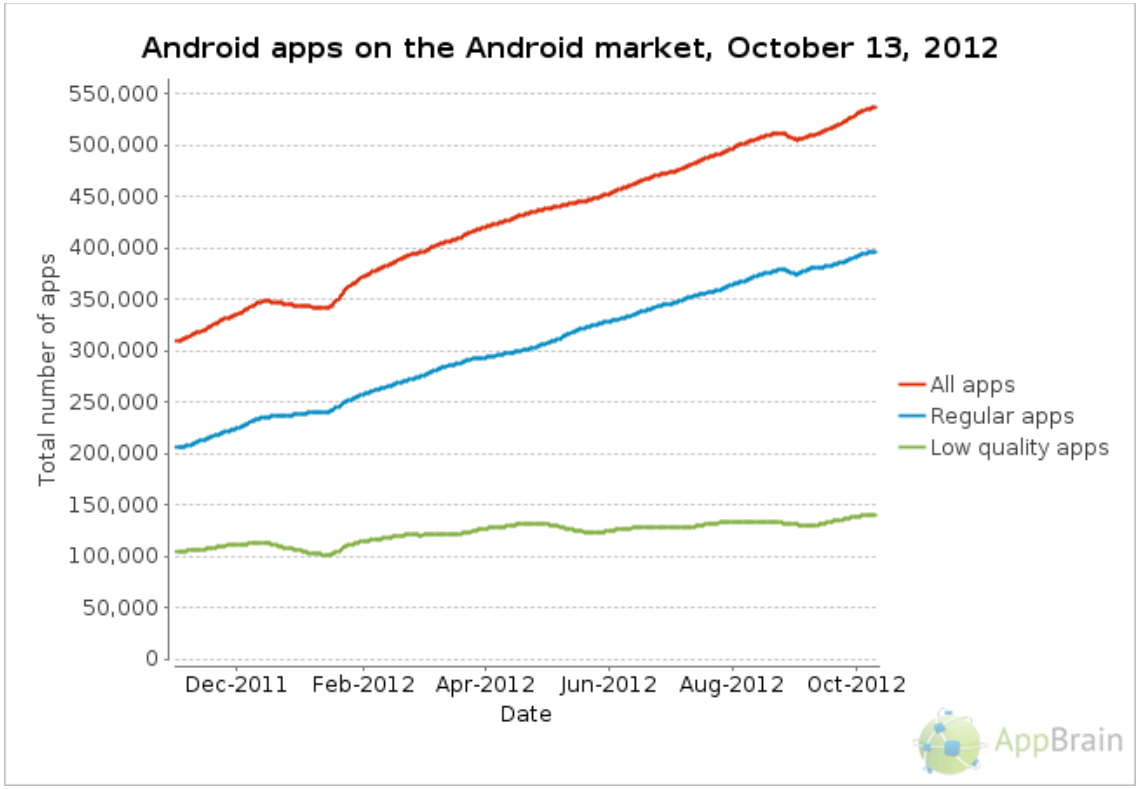
- With the advent of the Apple iPhone App Store
  - & associated development tools
- Today:

Hundreds of thousands of endless possibilities.

Built-in apps are just the beginning. Browse the App Store to find even more amazing apps designed specifically for iPhone — by Apple and by third-party developers. The more apps you download, the more you'll realize there's almost no limit to what iPhone can do.

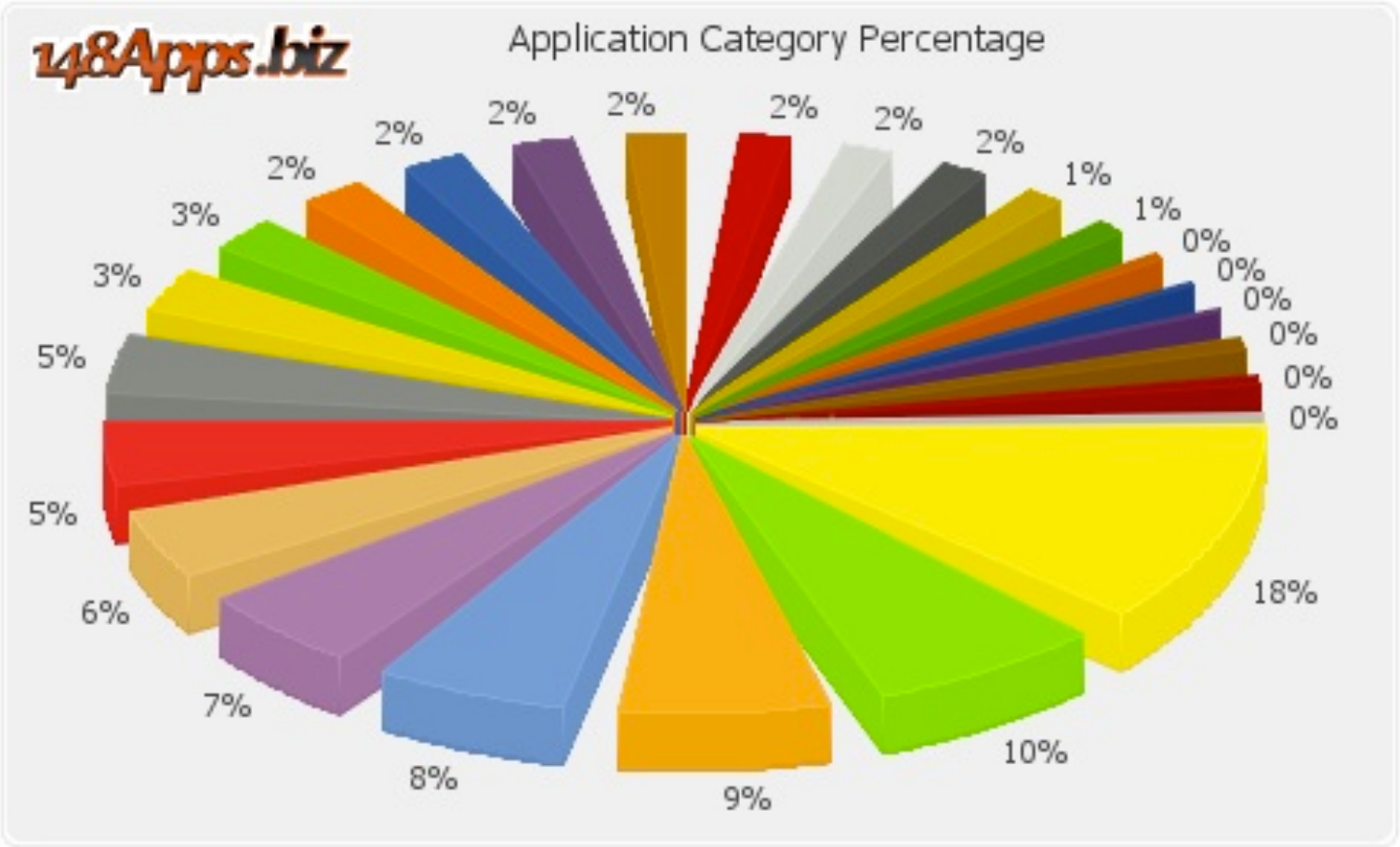
Given Rise to Thousands of Great Ideas

- Perhaps one of the greatest surges of creativity in human history has occurred in the past 4 years
- 700,000+ Apps in Apple App Store
- 500,000+ Apps in the Android App Store



Hundreds of Thousands of Great Ideas

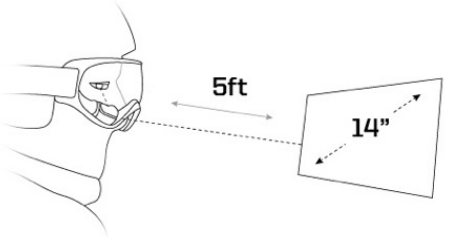
Apple App Store by Type of App



There are Many More Ideas to Come

1. We are not used to what is possible when all these things - powerful computer, sensors, internet, portability - are brought together
   - We're developing habits and understandings that will lead us
   - Have only scratched the surface of great ideas

2. <u>Monthly</u> progress in technology
   - intense competition: Apple, Samsung, HTC, Google, RIM
   - Economics of large-scale market
   - Technology that would otherwise be expensive in low volume, becomes inexpensive in high volume
     - Google Glasses
     - Recon Instruments' Headsup Ski Goggles



Course Goals & Outcomes

Goals of Course

1. Create an interesting & novel mobile application
   - In a group project
   - That enhances/enables research in a specific field
   - Or that enhances a specific field in a new way
   - That is of sufficient technical depth

2. Participate in a creative inter-disciplinary environment
   - Interaction between programming & non-programming disciplines
   - Interactions between many disciplines

3. Teach literacy in mobile programming & potential
   - Gain engineering project experience with hard deliverables

Two Kinds of Students/Paths in Course

1. **'Programmer'**
   - Engineering, Computer Science and other **graduate** students with good programming backgrounds
   - Undergraduates with permission of instructor

   - Should have undertaken serious programming projects in past
   - Taken courses beyond introductory programming

Two Kinds of Students/Paths

2. 'Apper'

- Graduate Students from other disciplines
- With some computer literacy
- A desire to create new app, in art, science, engineering
- YOU BRING EXPERTISE IN THAT DISCIPLINE

- e.g. from 2 years ago: **Wound Care**:
  - Robert Fraser was a registered Nurse
- e.g. last year **EncountAR**
  - Scott Pollock was in iSchool, Museum Studies Specialization

Programmer or Apper?

- All ECE and Computer Science students should be considered Programmers
  - unless lacking in the needed background

- You can separately make a case that you wish to drive the application, but must still take the **programmer** path through the course
  - Other thoughts on this later

A Few Example Projects

From previous years

MyWalk

Measuring and Correcting Step-Time *Asymmetry*

Justin Chee
Tuck-Voon How
Eric Wan

April 2012

Step-Time Asymmetry

- Is a walking problem
  - individual spends unequal time on each foot while walking
- Affects a wide range of patient populations
  - including stroke victims
- Has bad effects that worsen over time:
  - increased joint degeneration
  - musculo-skeletal pain
- Studies demonstrate that patients can improve with active feedback…

My Walk

- Measures step-time asymmetry
  - using accelerometer

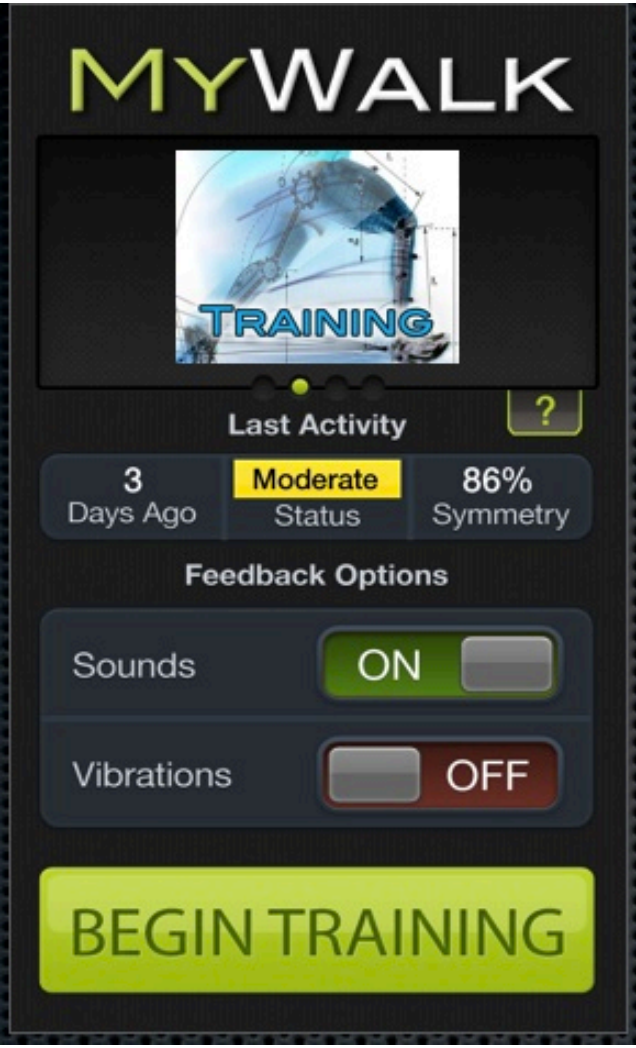
$$\text{Step Time Asymmetry} = \left(\frac{\text{Time spent on one foot (s)}}{\text{Time spent on other foot (s)}} \right) \times 100$$

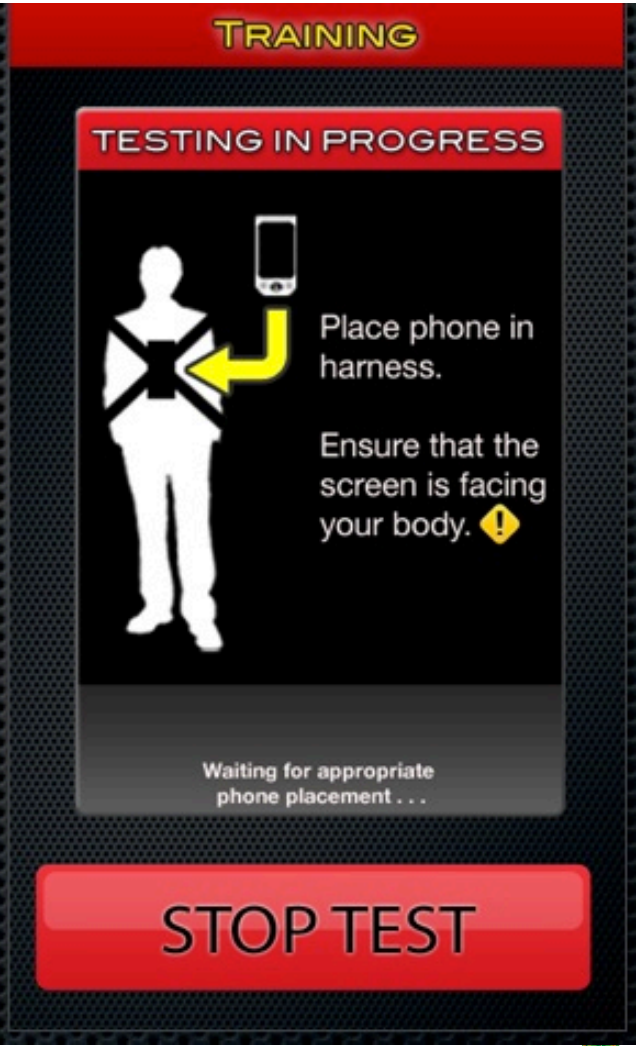
- Helps person correct it by providing timing 'beeps'

Table of Symmetry Value Meanings

Rating	Score	Meaning	Corresponding Populations
GOOD	> 91%	Symmetrical Gait	Able-bodied adults (Normative)
MODERATE	80-89%	Mild Asymmetry	Stroke patients (3 years post-stroke)
POOR	< 80%	Severe Asymmetry	Stroke patients (6 years post-stroke)

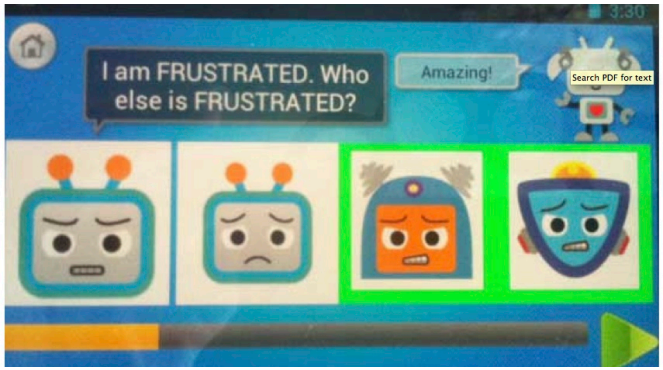
My Walk Screen Shots





EYEdentify

Teaching Emotion Recognition to Autistic Children



Rebecca Dreezer
Cindy Lau
Alexandra Makos

April 2012

Goal

- App to help kids learn to recognize 4 emotions:
  1. happiness
  2. sadness
  3. confusion
  4. frustration

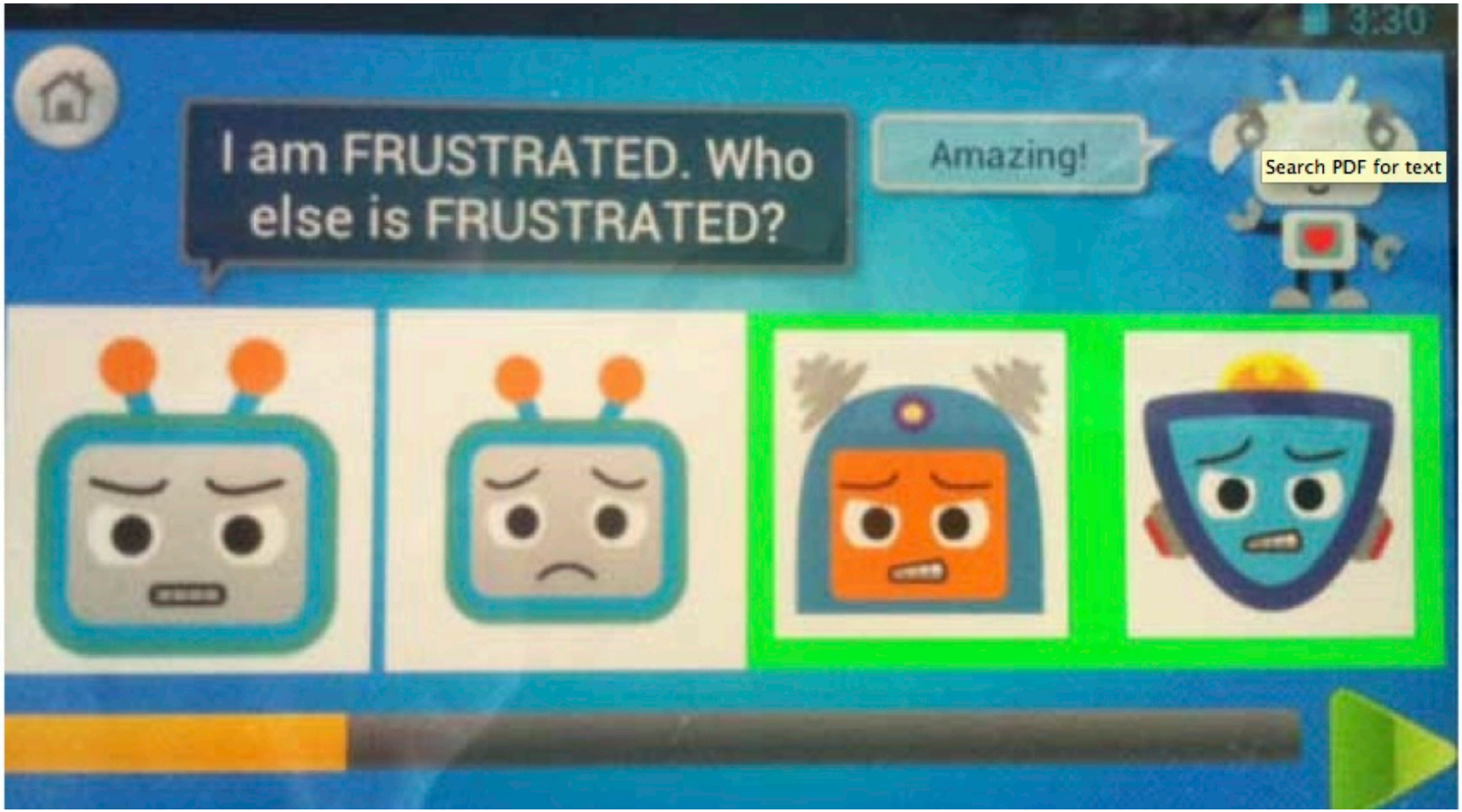
- A simple matching game
  - With an engaging user experience

Based on Research

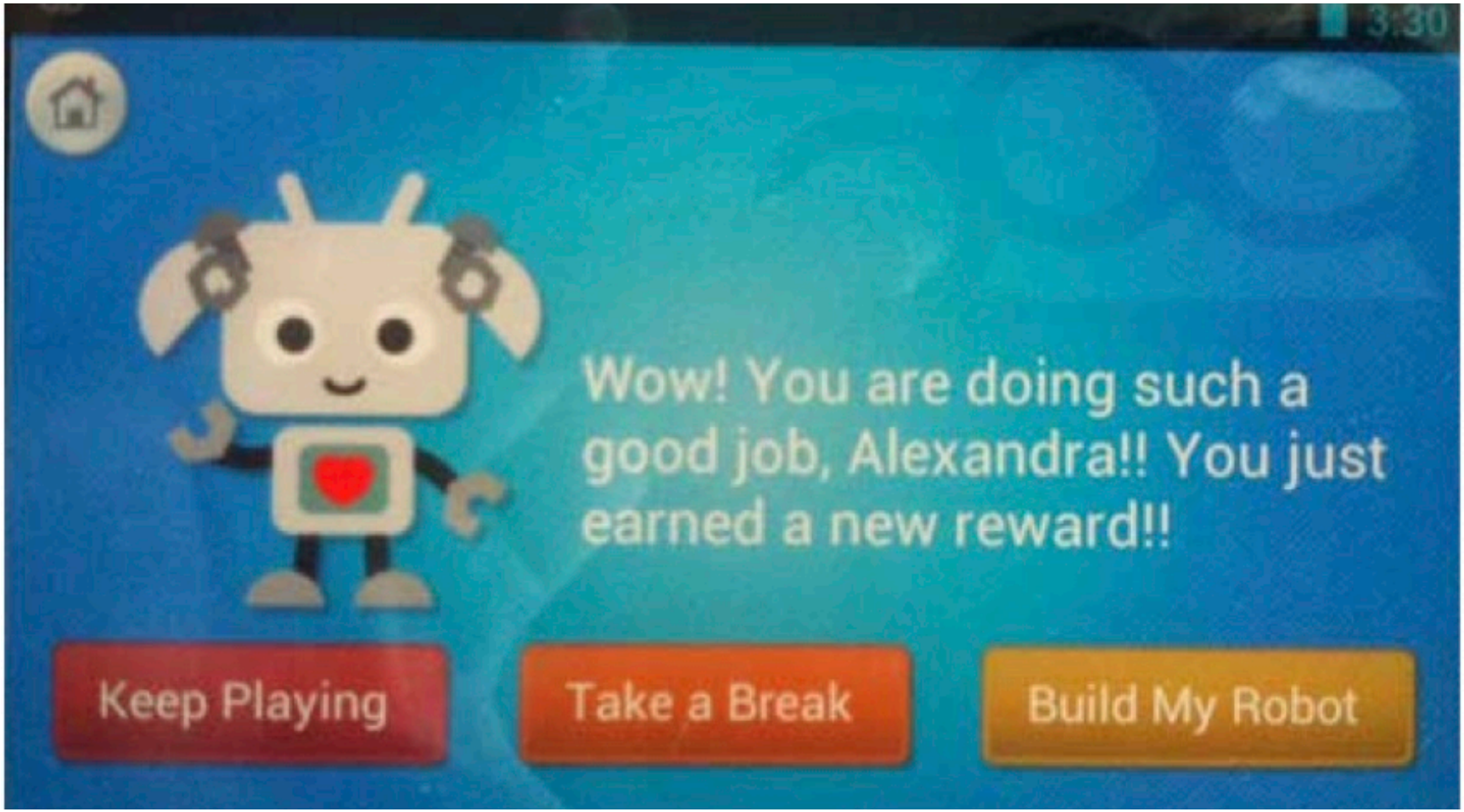
- Have 3 classes of “faces” that can be identified by players



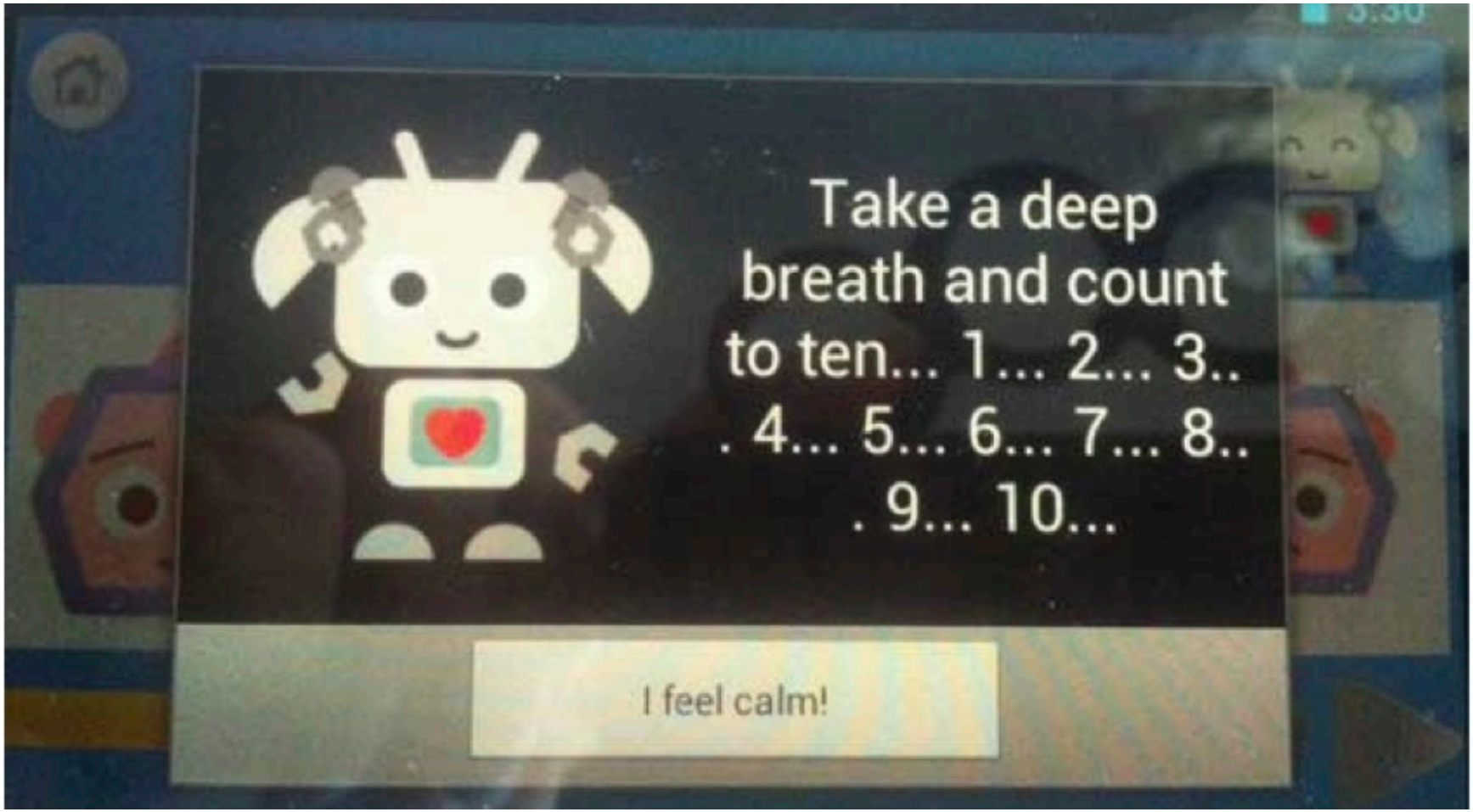
Games Screen



Choices


Wow! You are doing such a good job, Alexandra!! You just earned a new reward!!
Keep Playing
Take a Break
Build My Robot

Accelerometer Detected Frustration



Declaration (non-binding)

Raise Your Hand if you Think you are a Programmer

Raise Your Hand if you Think you are an Apper

Sign Up Sheet

- Name
- Student Number
- Department
- Degree
- Taking Course for credit
  - Yes/Maybe
  - Audit: cannot without special permission; can't do project as an auditor
- Programmer/Apper self designation
  - Can check both
- Phone Type: What kind of smartphone do you have?
  - Android/iphone/Blackberry/Windows …

Learning/Outcomes

- Knowledge & Experience
  - **Programmer:** How to program in a mobile environment
  - **Apper:** Capabilities of mobile devices & basic technical understanding & how it can be applied to your discipline
- How to Work across disciplines
  - Inter-disciplinary creativity
- Project Experience
  - With tangible deliverables
- Clear, Concise Presentation Experience/Feedback
- Advance of research capability through use of mobile dev

This is an Experimental Course

- Open to students from *all* disciplines
  - Multi-disciplinary project-based course
- Third time taught
  - course has evolved each time
- We welcome suggestions for improvement
  - will continue to adjust as we go along this year
- It will be quite a bit of work

- **Key**:
  - to reach across the boundaries of disciplines
  - learn the language of the 'other' discipline

Instructor Bio: Jonathan Rose

- Professor in Electrical & Computer Eng since 1989
  - Bachelor's, Master's & PhD from here, last in 1986
  - Post-Doc at Stanford 86-89
- Research Field: Field-Programmable Gate Arrays
  - 'Soft' hardware that can be programmed to become any circuit
- Entrepreneurial/Business Experience:
  - Co-founder of Right Track CAD Corp in 1998
  - Senior Software Engineering Director of Altera 2000-2003
  - Run the Engineering Entrepreneurship Seminar Series
- Administration:
  - Dept. Chair of ECE 2004-2009;
  - Director of Eng Biz Minor; Chair of Eng **Hatchery** Board
- F.IEEE, F.ACM, F.CAE, FA NAE, FRSC, Sr Flw Massey College

Why I'm Teaching this Course

- Aside from my research field, I have always felt that mobile devices would one day take a central role to human progress
- I've always been thrilled with possibilities of small, portable, highly integrated computers
- That time is now upon us; let's make interesting things happen!

Teaching Assistants

- Braiden Brousseau
  - TA'd course for last 2 years
  - Ph.D. Candidate in ECE
  - M.A.Sc. thesis: Accelerating computer vision for smartphones using FPGA hardware
  - braiden.brousseau@utoronto.ca
- Alexandra Makos
  - Ph.D. Candidate, OISE
  - Took course last year, as Apper (see project above)
  - alexandra.makos@utoronto.ca

The Project

The Project Group

- Done in Groups of 3
  - 2 Programmers
  - 1 Apper
- Need enough programmers : appers to make this work
  - otherwise will have to restrict enrolment
- OK to have groups of programmers-only, if extra, but only if no Appers left

Rules on Project App

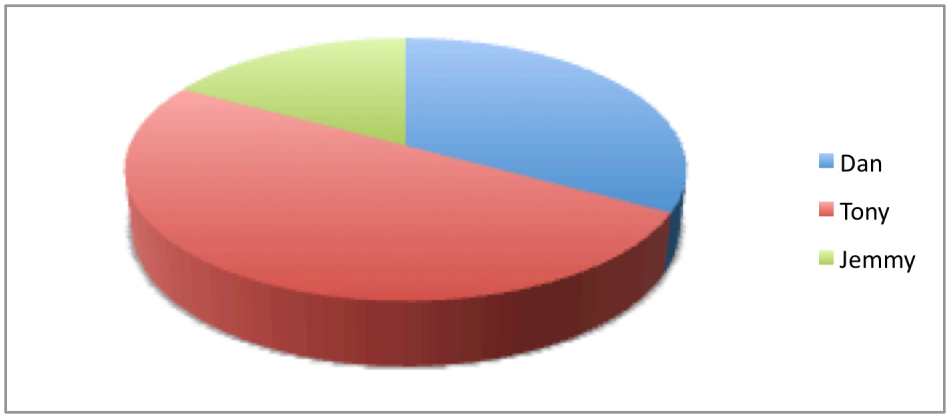
1. Subject **Must be in the discipline of the Apper**
   - an idea to support research
   - or something useful/worthwhile/interesting within the discipline
   - should leverage expertise that discipline
   - Message to those who want to be programmer+appers: wait
     - Should first hear ideas
     - I will (mostly) enforce pure Apper-driven projects

2. Must have sufficient technical depth
   - Will be an approval step in process to ensure this

3. *Should* be a new idea
   - Can be variant of existing app if enough different

e.g.: Measure the Fraction of Conversation

- Listen to a conversation, and measure the fraction of the conversation that each participant takes up!
- Daniel DiMatteo's (one of my grads) undergraduate thesis
  - Known as 'Diarization'
  - Using open source software
- Could be used to measure 'turn taking' behaviours in different cultures in Anthropology



Project Stages

1. **Forming Groups**
   - Within 2 weeks; special get together Wed Jan 16 @6:30pm
2. **One-Page Proposal**
   - Due January 30th; Must receive approval to proceed
3. **Project Plan**
   - Due Feb 6th
4. **Proposal & Plan Presentations**
   - February 11 & 13
   - **NOTE EXTRA LECTURE Monday Feb 11, 6-8pm, MP 137**
5. **Spiral 2 & Spiral 4 Presentations**
   - 2: March 6/13 4: March 20/27
6. **Final Presentations**
   - Weeks of April 3 & 10
7. **Final Report Due April 12th**

Note: I am on Sabbatical This Year

- I am not required to do any teaching this year, but I didn't want to lose the momentum we've built up with this course
- However, I had also planned to travel
  - Originally planned to have month-long trip to Shanghai last term, but planning didn't work out
- Am going February 15 - March16
  - Overlaps with Reading week, no lecture then
  - Moving 2nd proposal lecture to Feb 13 (or so) – Good thing
  - Guest lecture on User Experience and Design on Feb 27
  - Will attend Spiral 2 presentations via Skype, TAs also overseeing

Course Material

There are Three Course Websites:

- http://www.eecg.utoronto.ca/~jayar/ece1778/
  - Has link to videos & reports from previous years' projects
  - Assignments will be placed here

- Plus Blackboard Portal for basic stuff
  - Grades
  - Announcements
  - Handing in Assignments

- **Pepper** system from OISE for interaction & upload
  - See announcement on Portal that tells you how to access

Course Material

- Lectures
  - Basic phone capabilities
  - Thinking/discussion about how to use capabilities in project
  - Programming concepts and some details
  - Project basics
  - Case Studies of interesting/inspiring apps
  - Visitors planned:
    1. User Experience
    2. Interesting Apps.
- Mostly presentations from class – proposal, progress, final

Course Material, cont'd

- 4 Weekly Assignments in first 5 weeks
- Programmers:
  - learning basic SDK
  - Mobile programming – sensors, database
  - Leveraging the experience requirement
- Appers:
  - case studies;
  - learning 'design' software;
  - learning technology

Mobile Platform - Android

- We will focus on, and I will teach to, Google's Android
  - Widely available, works on all major operating systems (Windows, Mac, Linux)
  - Many phones available
  - Is successful
  - **Con**: Eclipse environment not very clean;
  - Programming Language: **Java**

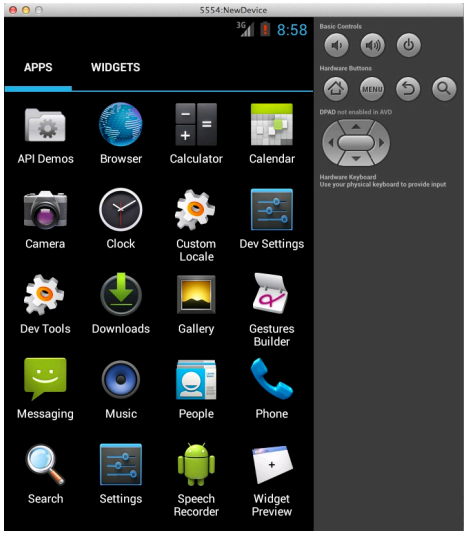
Alternative, if you have a Mac & iPhone

- If you wish to do assignments & project on iPhone, that is allowed, but talk to me first
  - **Pro:** Better development environment
  - **Con:** less common language: Objective C
  - **Con:** Must have a Mac computer
- Assignments are set up to be for Android, though, but are easily ported to iPhone
- Other platforms possible, with permission, at user's risk.
  - Need to know that project partners agree with platform

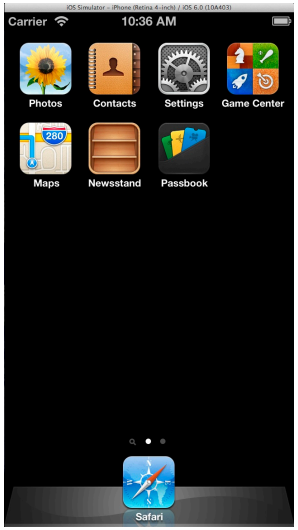
Physical Phones

- Have some phones donated to help with assignments and projects
  - good, also, if you have one yourself
- It is much better (and sometimes necessary) to have an actual phone to develop on
- Can use the emulator; OK on android; good on iphone

Android Emulator



iPhone Emulator



Textbooks for Programmers & Appers:

Android

By Mark Murphy:

1. The Busy Coder's Guide to Android Development
   - $40 buys all current versions, and a year's subscription to the updates, that come out with each new version of Android
   - Murphy gives free 4 months licenses for students
     - Ask TA Braiden Brousseau for License key by email
   - Although this is largely for programmers, I suggest that Appers read through the first 9 chapters as well.
   - This year, have found that the Android development website is good or better for some things:

     http://developer.android.com/sdk/index.html

Textbook for Programmers:

iPhone

Beginning iOS 6 Development, Apress

- by David Mark, Jack Nutting, Jeff LaMarche, Fredrik Olsson

See: http://www.apress.com/9781430245124

$40 for printed book

$28 for e-book

- Currently only available as an Alpha e-book
  - Purchasing it will get you the right to acquire final version when available

Assignments!

Part 1: Due next week: **Tuesday** January 15, 6pm

Part 2: Due in 2 weeks: **Tuesday** January 22, 6pm

Programmer Assignment P1

For Programmers

Prog Assign Part 1: Describe Yourself

1. In Writing
   - Give your background – what undergraduate & graduate program you've taken/are in
   - List the programming courses you've taken
   - List the major programming projects you've undertaken (& size)
   - Give the names of all company(s) you've worked for as professional/programmer (either as co-op, summer, or full time)

2. In a video, no more than 2 minutes;
   - Describe the projects and work you listed above

Prog Assign Part 1: Describe Yourself

- Upload both on **Pepper**
  - the website we'll use to interact
- Purpose
  - for Appers to get to know you;
  - for us to check background

- Part I is due Tuesday January 15th, at 6pm
  - Sooner is better, so we can get to know each other
  - Late penalty

Assignment P1 for Programmers, Part 2

- Acquire textbook – Android or iPhone
- **Need some basic Java knowledge**
  - Get a Java book
  - http://en.wikibooks.org/wiki/Java_Programming/Language_Fundamentals
- Download Android Environment
- Do “Hello World” tutorial; make it work on an emulator
- Read 120 pages of text, do small coding exercises
- Write simple android application
- Part 2 due Tuesday January 22nd, 6pm; late penalty
  - Posted under Assignments on Course Website & Portal

Apper Assignment A1

For Appers

Apper Assign Part 1: Describe Yourself

1. In Writing
   - Write 250 words that describe your field to a lay person
   - Give your background – what undergraduate & graduate program you've taken/are in
   - Describe what the focus of your degree/research is (e.g. 'my thesis topic is …')
   - Brief history of work, if any

2. In a video, no more than 2 minutes;
   - Name your field, give quick description of it
   - Describe other things you might bring to the project – skills, access to a lab for measurements, job experience

Apper Assign Part 1: Describe Yourself

- Upload both on **Pepper**
  - the website we'll use to interact
- Purpose
  - for Programmers to get to know you;

- Part I is due Tuesday January 15th, at 6pm
  - Sooner is better, so we can get to know each other
  - Late penalty

Assignment A1 for Appers, cont'd

1. Find 5 apps in your field and describe each in 100 words
2. Choose the best of those 5 and do deeper case study:
   - Get it, use it, described it. 1000 words max
   - Mark penalty for too many words

- Part 1 due Tuesday January 15th at 6pm; late penalty
- Part 2 due Tuesday January 22, 6pm; late penalty
- Posted under Assignments on Course Website & Portal

Other Assignments

Date Assigned	Assignment	Due
January 23	P2/A2	January 30
February 6	P3/A3	February 13
February 13	P4/A4	February 27

Grading

- Assignments: **16%**
  - 4 assignments
- Class Participation: **9%**

- Project: **75%**
  - Proposal 5%
  - Plan (incl presentation) 10%
  - Spiral 2 Presentation 10%
  - Spiral 4 Presentation 10%
  - Presentation/Demo 10%
  - Final Report 30%

Commercialization & Intellectual Property

Commercialization

- If your group wishes to create an app for sale, feel free to do so
- If not, consider giving away if useful

Commercialization & Intellectual Property

- University of Toronto Intellectual Property Rules apply
  - Work that makes significant use of UofT resources
    - Requires disclosure & extraction of Universities' rights in exchange for fraction of licensing revenue
  - However, these rules aren't well set-up for apps/app store
  - However, if more than person contributes – group partner, your research supervisor, then their rights must be respected

- Note: the scope of course project is broader than those apps that are commercializable
  - Apps can be motivated by research goals

Warning on Intellectual Property

- In my experience, all talk of IP tends to make people think about keeping secrets; that's bad
  - Most ideas live and grow well in 'the light'
  - Don't get caught up in the IP side

Project Step 1:
Getting To Know Potential Partners

Why

- The key part of this course is the project
- You need to get to know each other, to explore who might work well together
- Assignment 1 asks you to write & speak about yourself
- Also: we will hold an extra course meeting explicitly for the purpose of forming groups:

Date: Wednesday January 16 at 6:30pm

Location: Galbraith Building room 244

- We will use the remainder of this lecture for introductions

Introduce Yourself

1. Name
2. Taking Course for Credit – yes, no, maybe
3. What discipline you work in & degree sought
4. What your thesis topic is (if doing thesis)
5. If you work, where & what you do.
6. Why you're taking this course
7. What kind of phone you're carrying
8. Apper: What idea you have for an app
9. Programmer: What you're interested in doing app on.