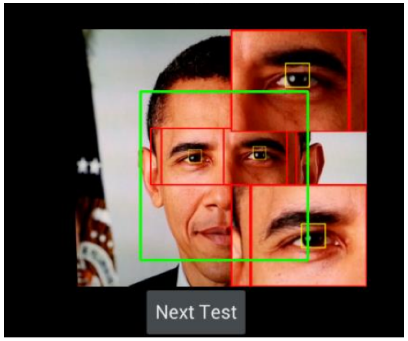
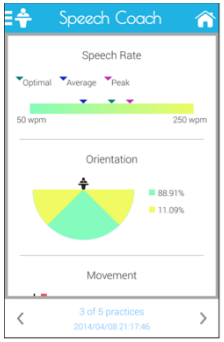
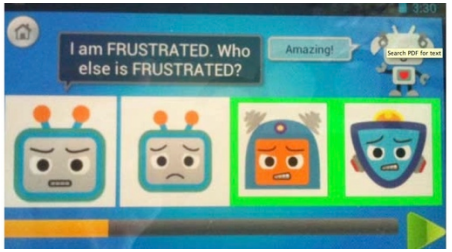


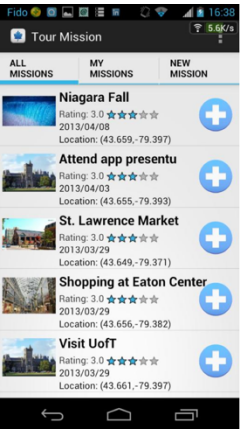


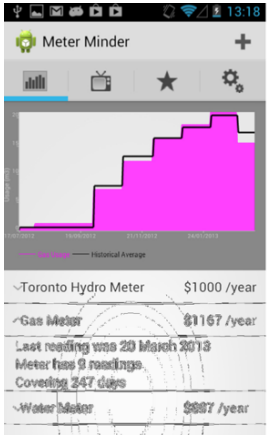


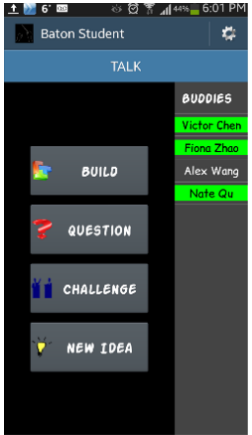
ECE 1778:
Creative Applications for Mobile Devices

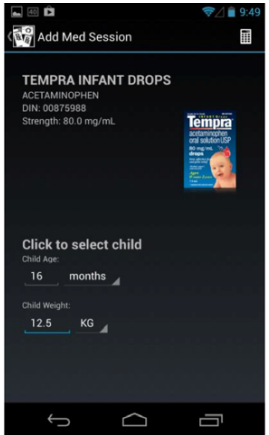
Instructor: Jonathan Rose

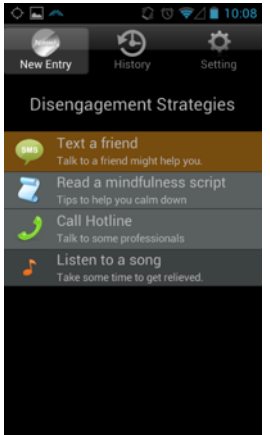
Department of Electrical & Computer Engineering











Welcome!

- There has been tremendous progress in mobile tech, software and applications in the past 6 years
  - They have changed the landscape of many human endeavors
- Which kind of mobile device do you carry?

Purpose of this Course

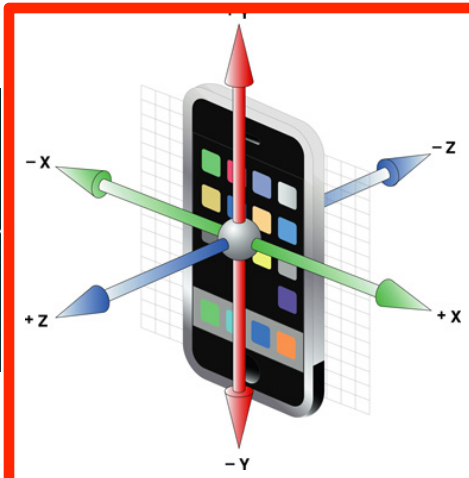
To bring together people from different disciplines, and create novel and useful mobile applications

Mobile Devices are Powerful

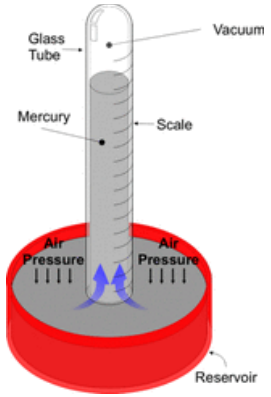
Because they contain in one portable package:

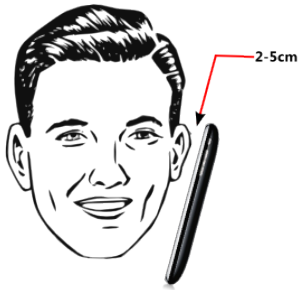
- A powerful computer you can carry in your pocket
  - More easily programmed than ever before
- Connected to the Internet
  - More knowledge & compute power
- Can **sense** its environment in many ways
- Can **speak** to its environment in several ways
- Can also make phone calls

There are many things in Your Phone:



9-Axis

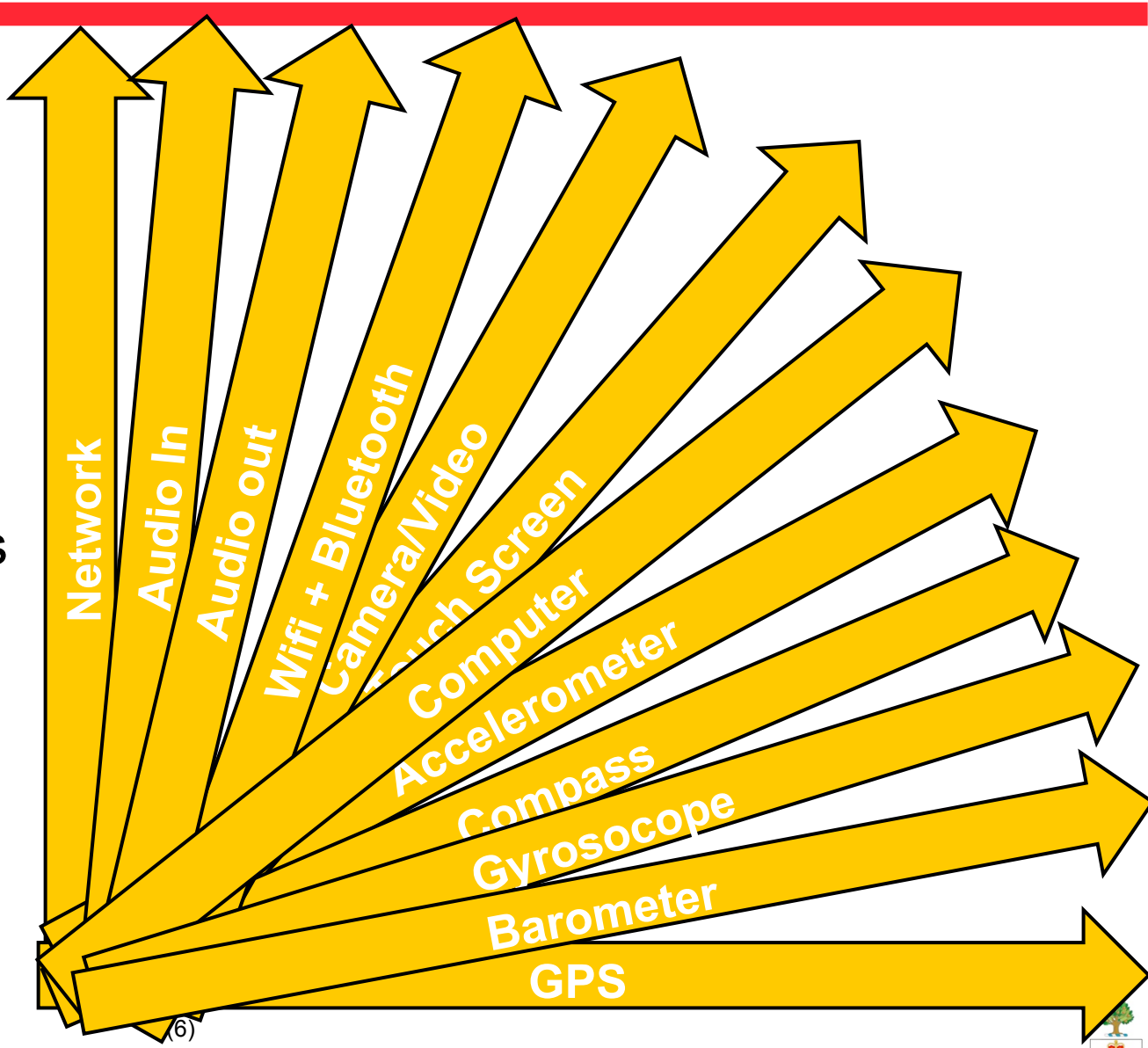




(5)

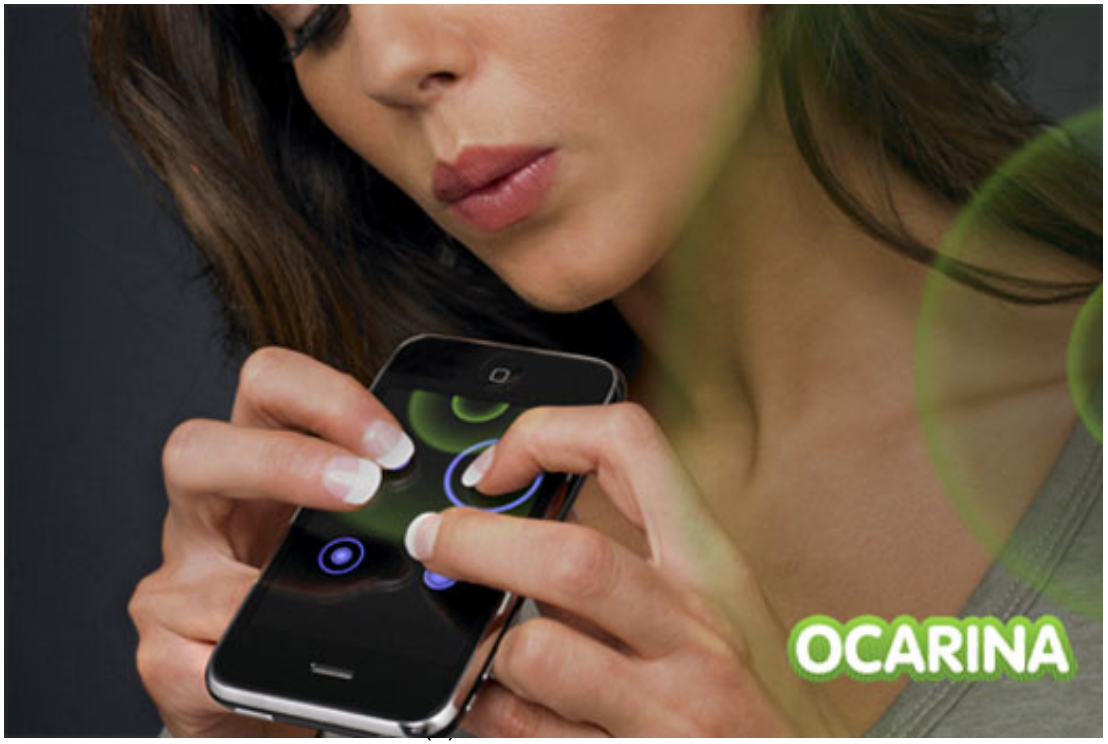
Great Ideas come from Combining These

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

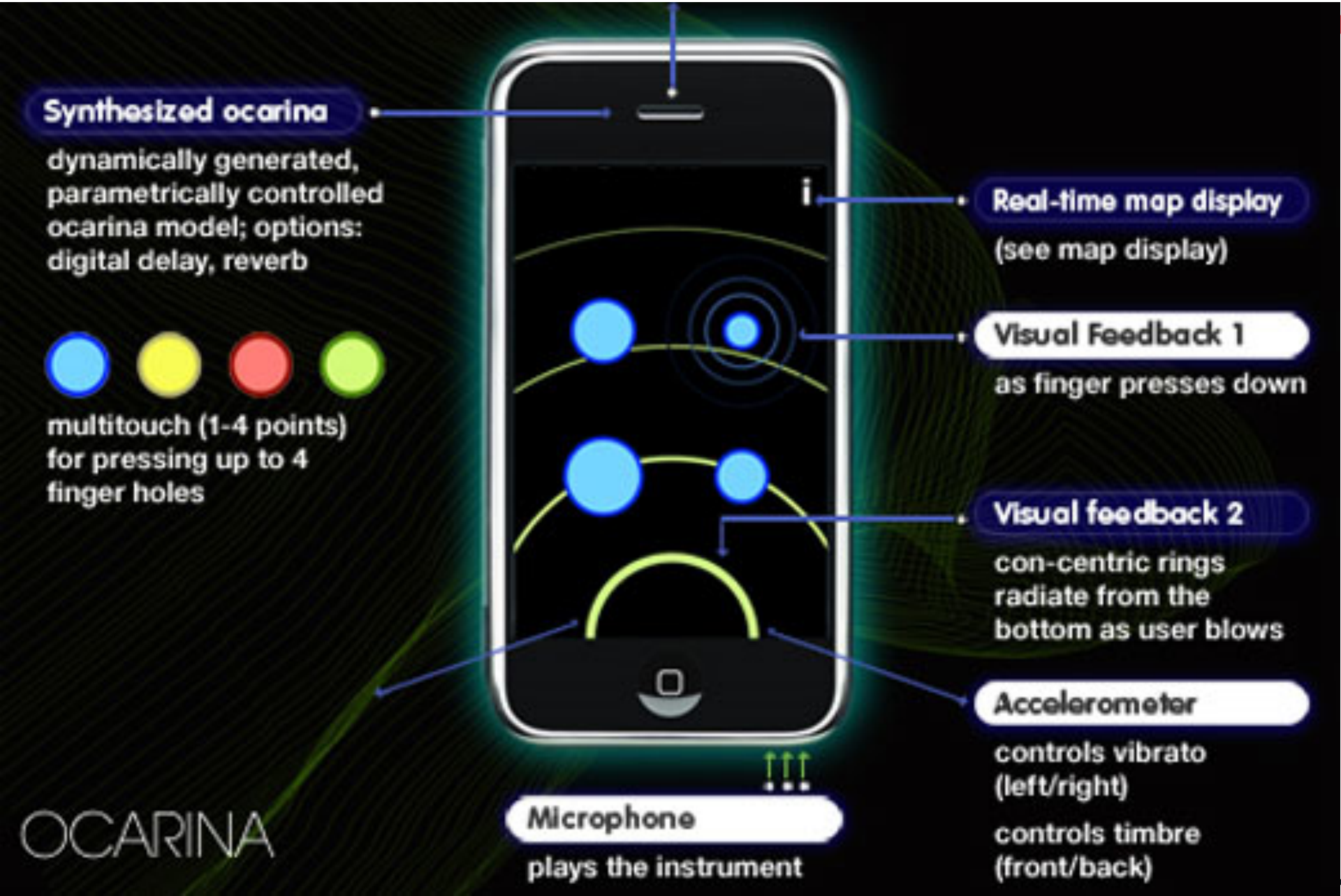


Consider: Ocarina Musical Instrument

- A case study in inventiveness
  - Using a novel combination of capabilities
  - “Blow” into microphone; multi-touch touch screen; speaker

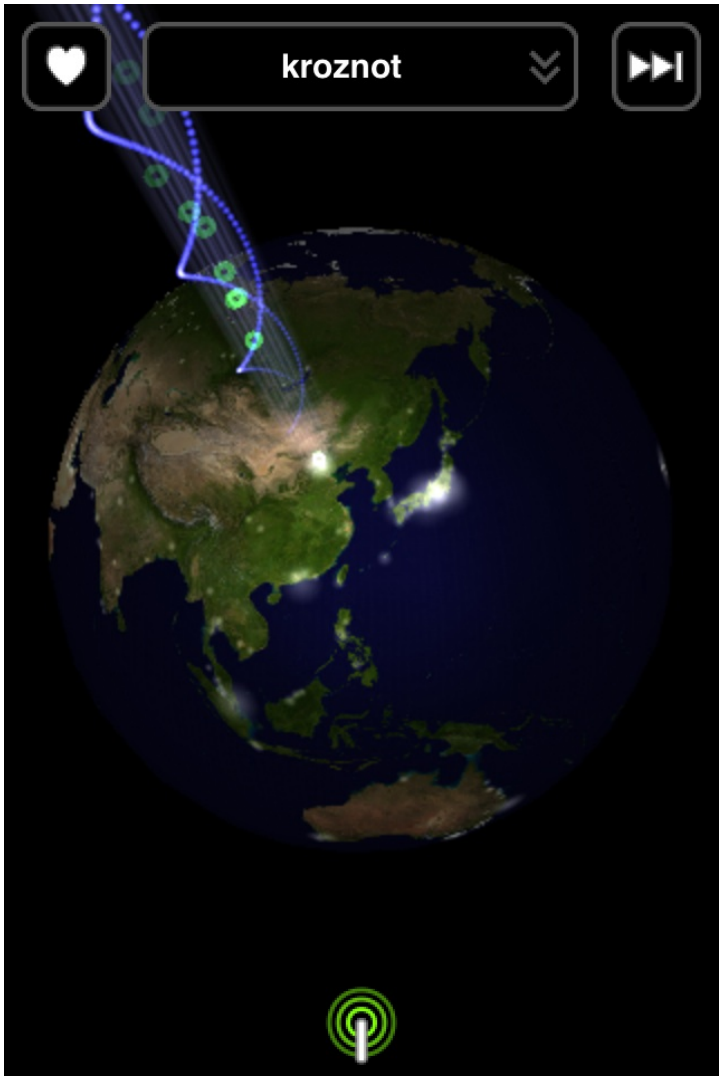


Ocarina


Synthesized ocarina
dynamically generated, parametrically controlled ocarina model; options: digital delay, reverb
multitouch (1-4 points) for pressing up to 4 finger holes
Real-time map display
(see map display)
Visual Feedback 1
as finger presses down
Visual feedback 2
con-centric rings radiate from the bottom as user blows
Accelerometer
controls vibrato (left/right)
controls timbre (front/back)
Microphone
plays the instrument
OCARINA

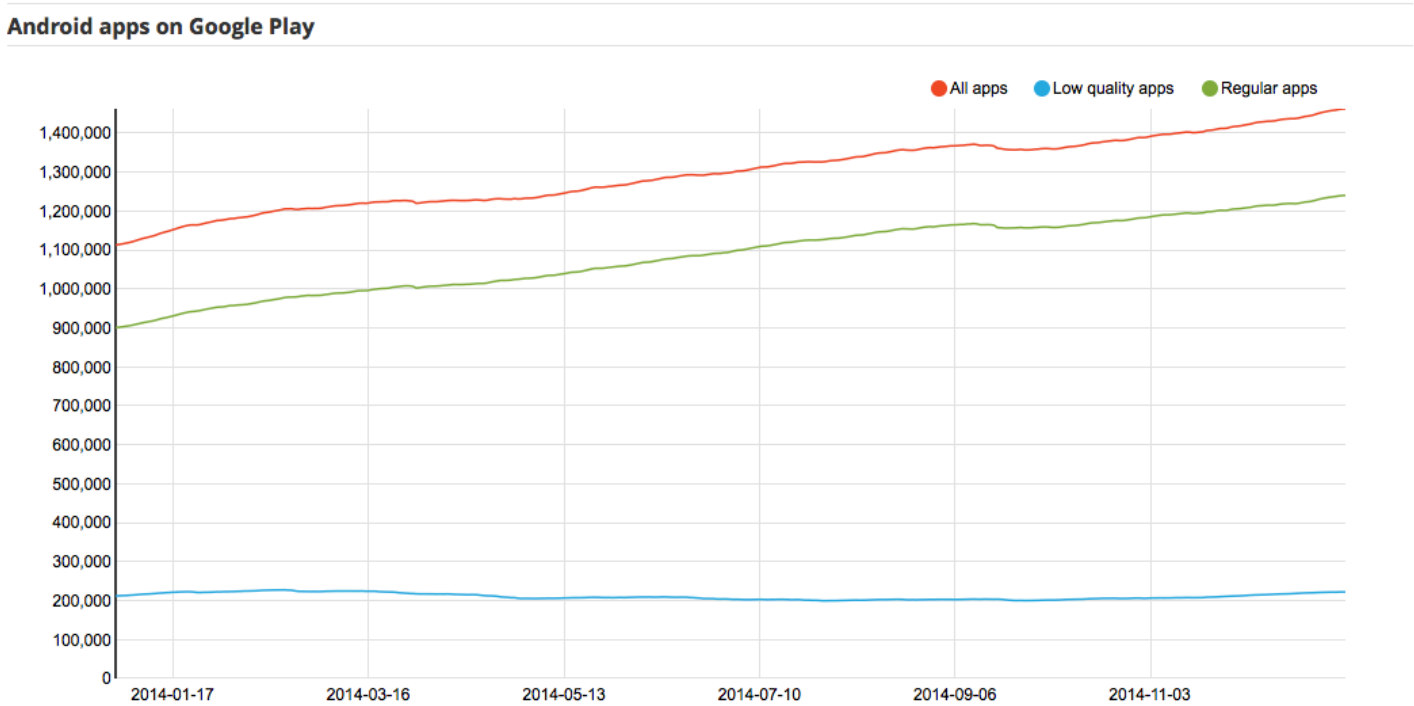
Ocarina: The Really Neat Part

- World map
  - uses GPS to locate users
  - White dots on globe show users
- Ocarina records the sound everyone plays *by default*
  - Dot ‘plays’ music from randomly chosen Ocarina player, anywhere in the world!
  - Nice graphic too;
  - Moving



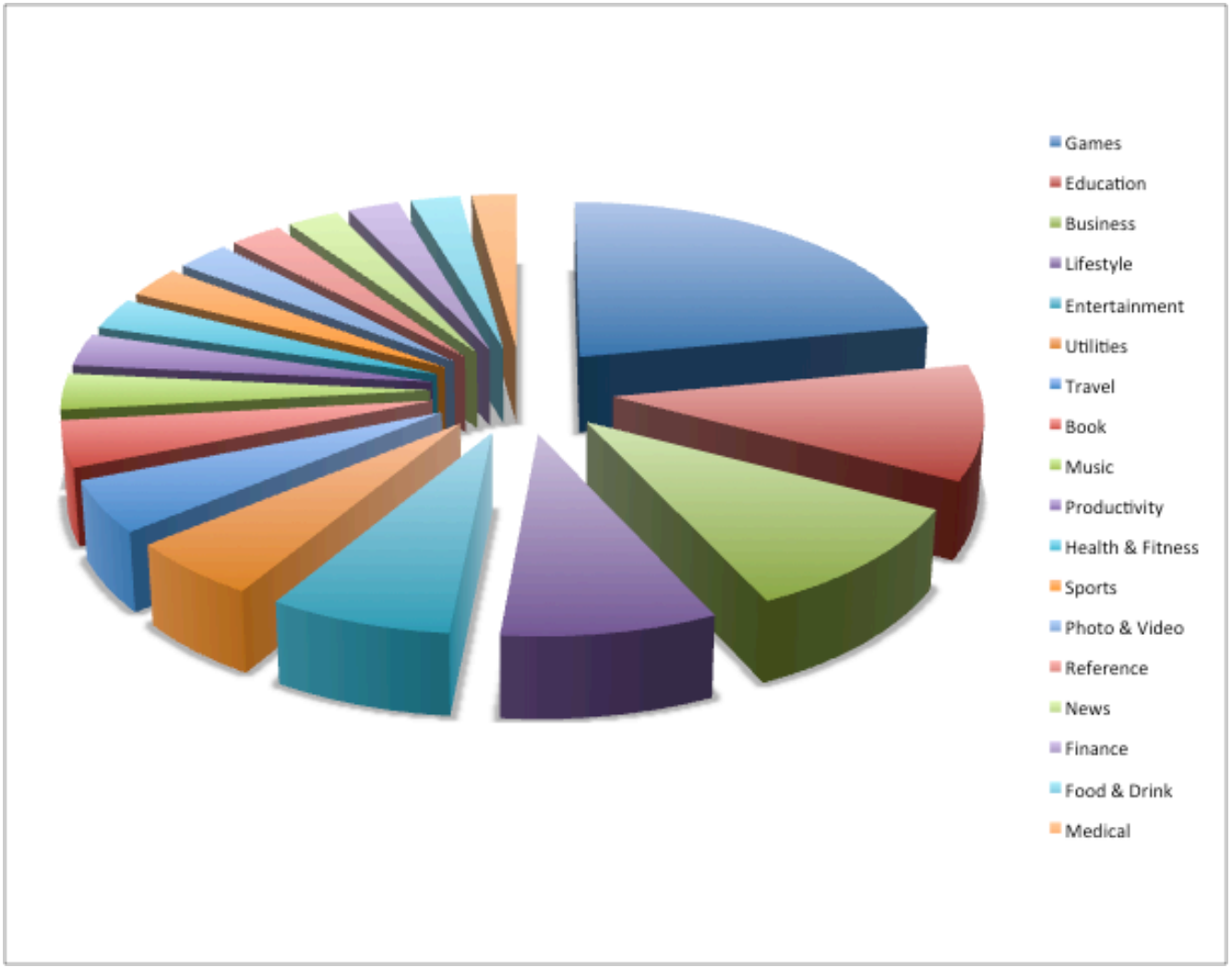
Given Rise to Thousands of Great Ideas

- Perhaps one of the greatest surges of creativity in human history has occurred in the past 6 years
- 1,450,009 Apps in Apple App Store
- 1,462,144 Apps in the Android Market



In Many Areas

Apple App Store by Type



There are Many More Ideas to Come

1. We are still not used to what is possible when all these elements are brought together
   - We're developing new habits and understandings

2. Monthly progress in technology
   - Fierce competition: Apple, Samsung, Google, Xiaomi …
   - Economics of large-scale market
   - Wearables/connected devices getting very interesting …

3. Have Not Yet Engaged Experts
   - Together with software & hardware folks
   - That is the purpose of this course!

Connected/Wearables

Button Tracker

Activity Trackers/ Health Monitors

Instrumented Clothing

Yesterday's Consumer Electronics Show

- Intel's 'Curie' platform for wearables
- Bluetooth LE
- low-power sensor hub
- pattern-matching accelerator that allows for accurate gesture recognition
- six-axis combination accelerometer and gyroscope

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 or other **graduate** students with good programming backgrounds
   - Skilled in the art of programming
   - Undergraduates with permission of instructor

   - Should have undertaken **serious** programming projects in past
   - Taken courses beyond introductory programming and have experience that includes larger-scale projects
     - 1000+ lines of code
     - Operating systems
     - Graphics
     - Design Project

Two Kinds of Students/Paths

2. 'Apper'

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

- 4 years ago: **Wound Care**
  - Robert Fraser was a registered Nurse, M.N. candidate
- 2 years ago: **Mozart's Ear**
  - Andrea Stewart, M.A. candidate in faculty of Music
- Last year: **Baton**
  - Zack Teitel was a High School Teacher, M.Ed. Candidate at OISE

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

This Course is a Bargain

- Between the 2 programmers and 1 Apper
  - Programmers bring skill and willingness
  - Apper brings expertise and efforts

- Together you will arrive at an interesting project!

A Few Example Projects

From previous years

MyWalk

Measuring and Correcting Step-Time *Asymmetry*

Apper: Justin Chee
Programmers: 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

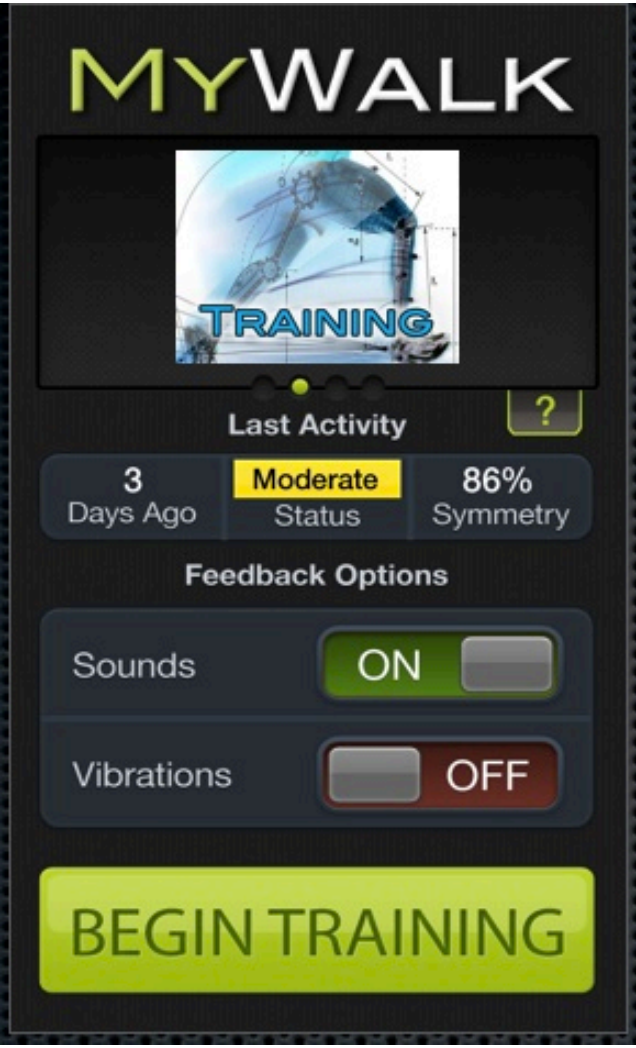
$$\text{Step Time Asymmetry} = \left(\frac{\text{Time spent on one foot (s)}}{\text{Time spent on other foot (s)}} \right) \times 100$$

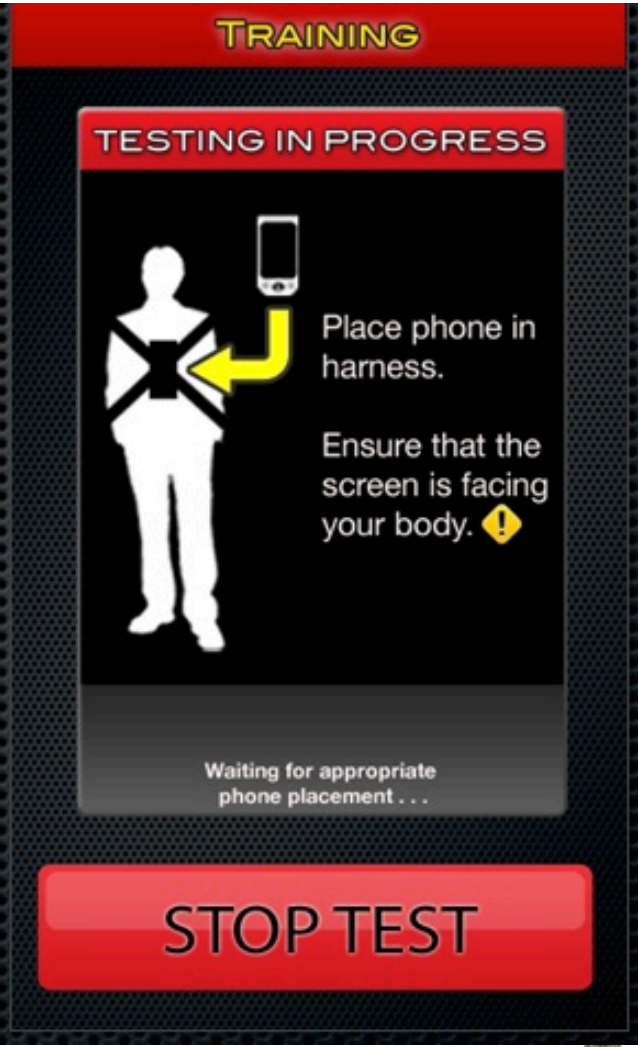
- Helps person correct it by providing timing 'beeps'

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)

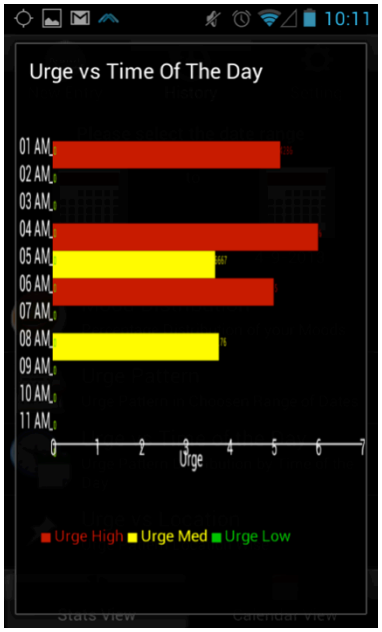
My Walk Screen Shots





Mindful Me

Journaling for Addiction and Intervention



Apper: Elizabeth Glenn Guy
Programmers: Shobhit Puri
Yvonne Chen

April 2013

Addictions Ruin Lives

Part of Addiction Treatment

- Write down cravings in a *diary*
  - To review & reflect on vulnerable *contexts*
- **Problem with paper-based journaling**:
  - Privacy (‘hey what’re you doing?’)
  - Tedious
- **Solution:** use mobile device to aid journaling
  - Increase journaling frequency → efficacy:
  - Easy to use interface
  - Automatic location identification/data processing
  - Data visualization & vulnerable location identification

But then …. The Big Idea

- With a phone, you can not only record the issues/ cravings, but it can record:
  - Where you are
  - How you were moving
  - What you were hearing
  - Perhaps what you were seeing

- It could learn that a certain location is a problem for you (e.g. near a Bar that an Alcoholic frequents)

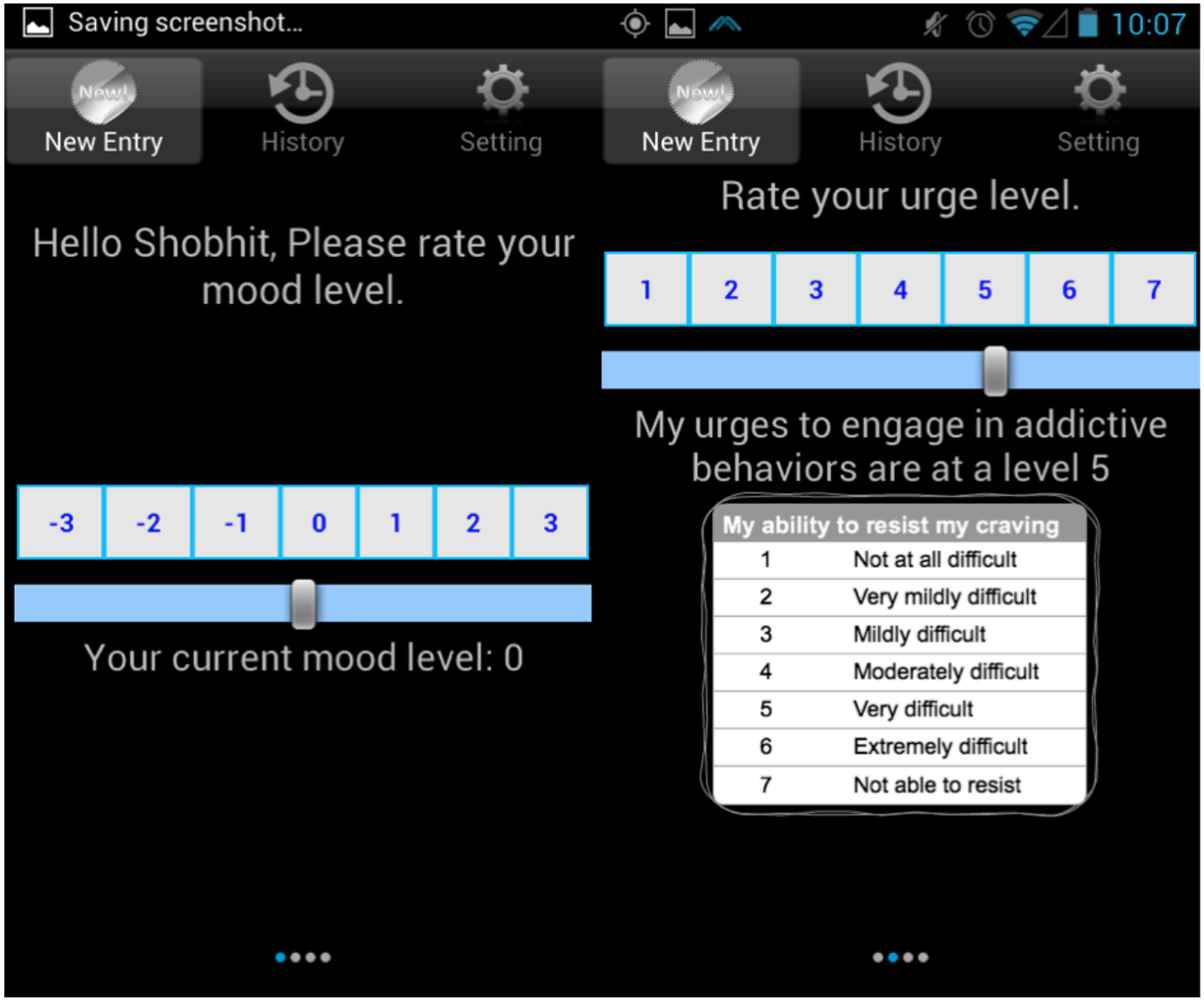
- It could then **intervene**

Interventions?

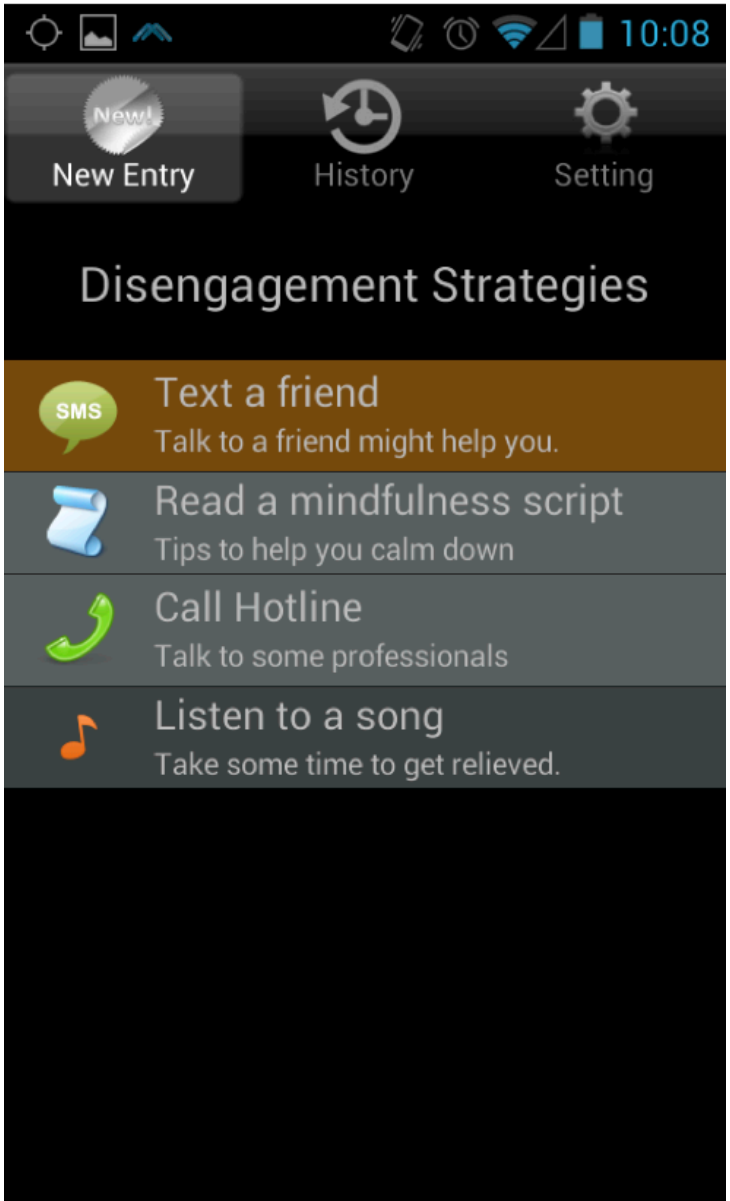
- Call your Alcoholics Anonymous Sponsor **for you**
- Play a song
- Send you a text
- Play a game
- Help with breathing exercises

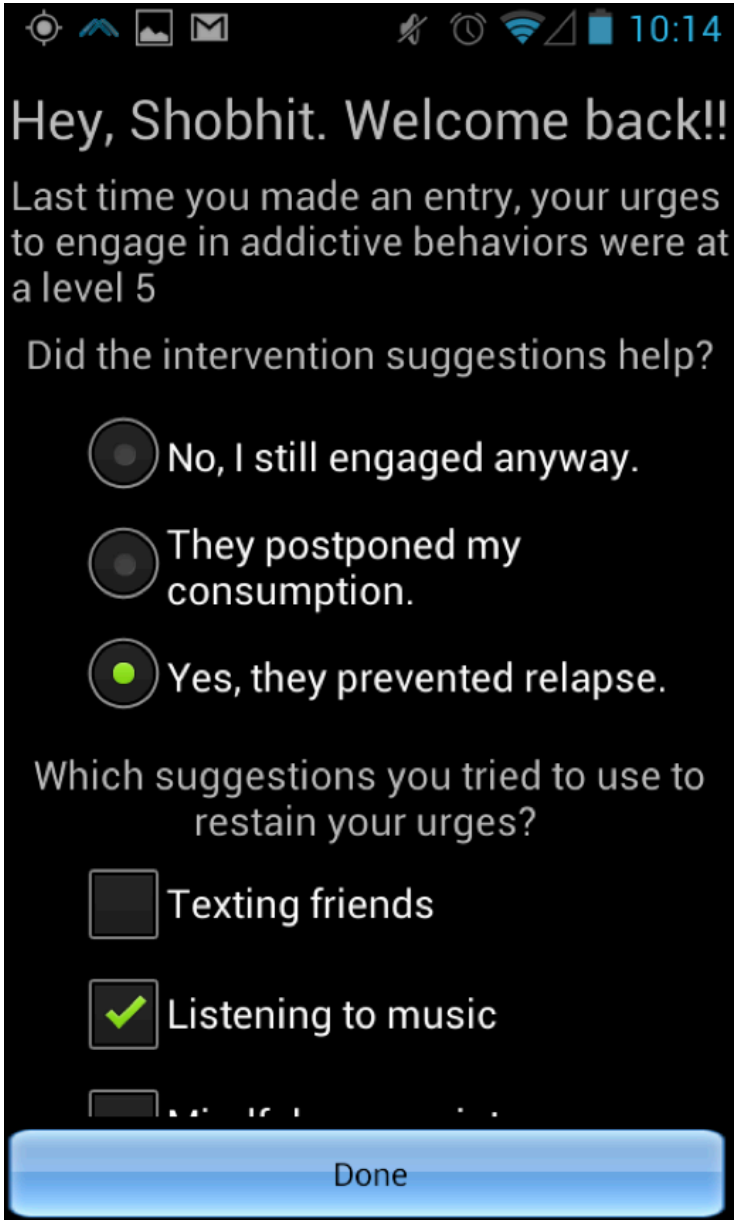
- Many other possible ideas!

Journal Screens



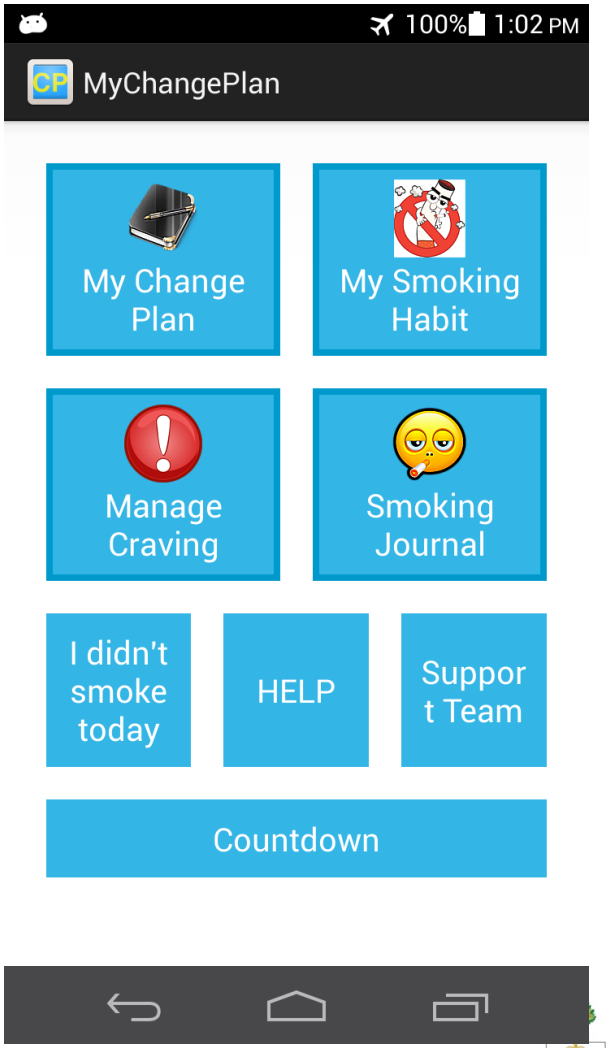
Intervention Suggestions





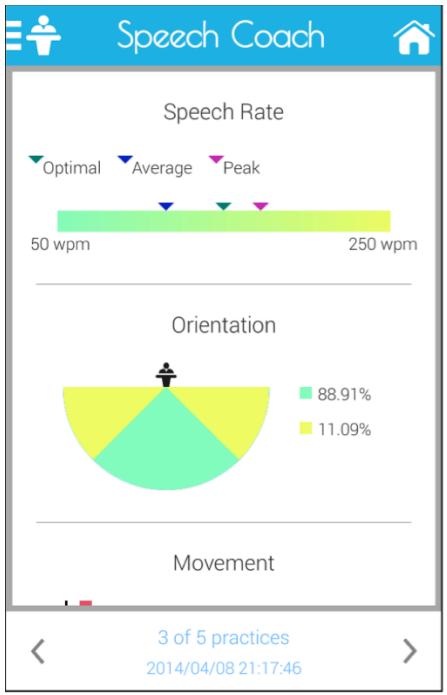
New Work in this Direction

- *Mindful Me* was general app done in grad course
- Past summer, launched project to help people stop smoking
  - in collaboration with Nicotine Dependence Clinic, part of CAMH
- Now exploring an app version of the 'My Change Plan' Booklet
- Also exploring data collection from device & prediction of smoking triggers



Speech Coach

Feedback on Public Speaking



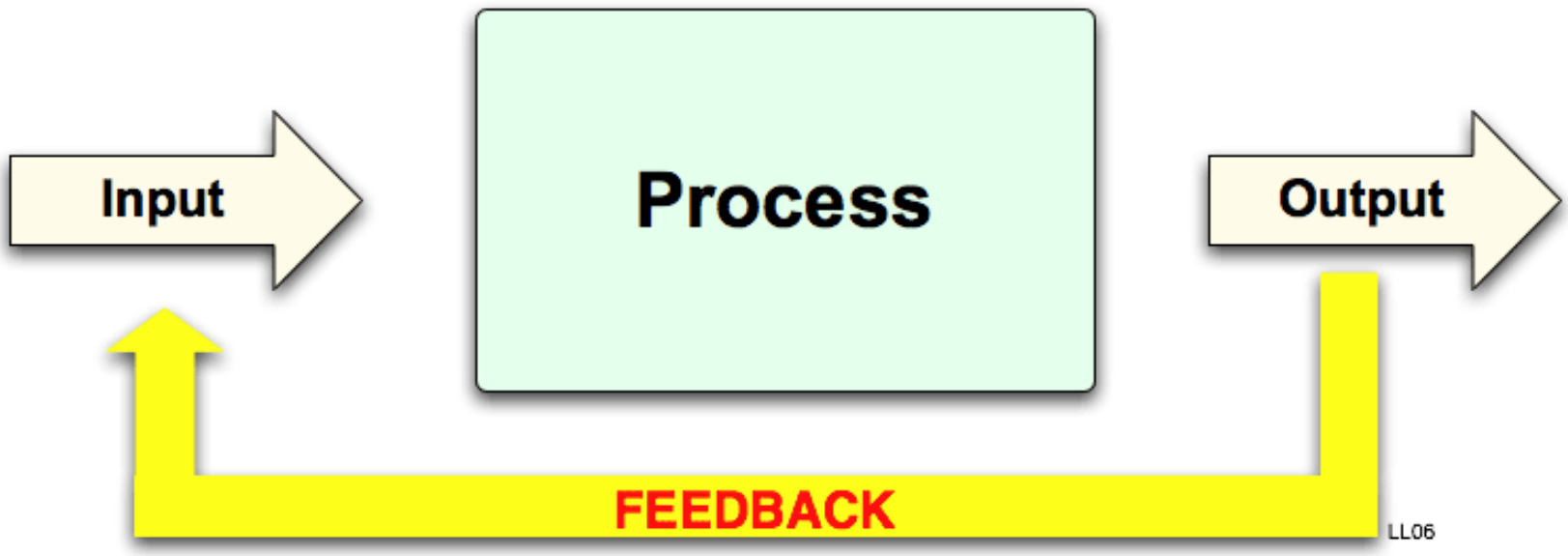
Nicole Smith
Andrew Bitar
Lanny Lian

April 2014

Use the Phone to Measure

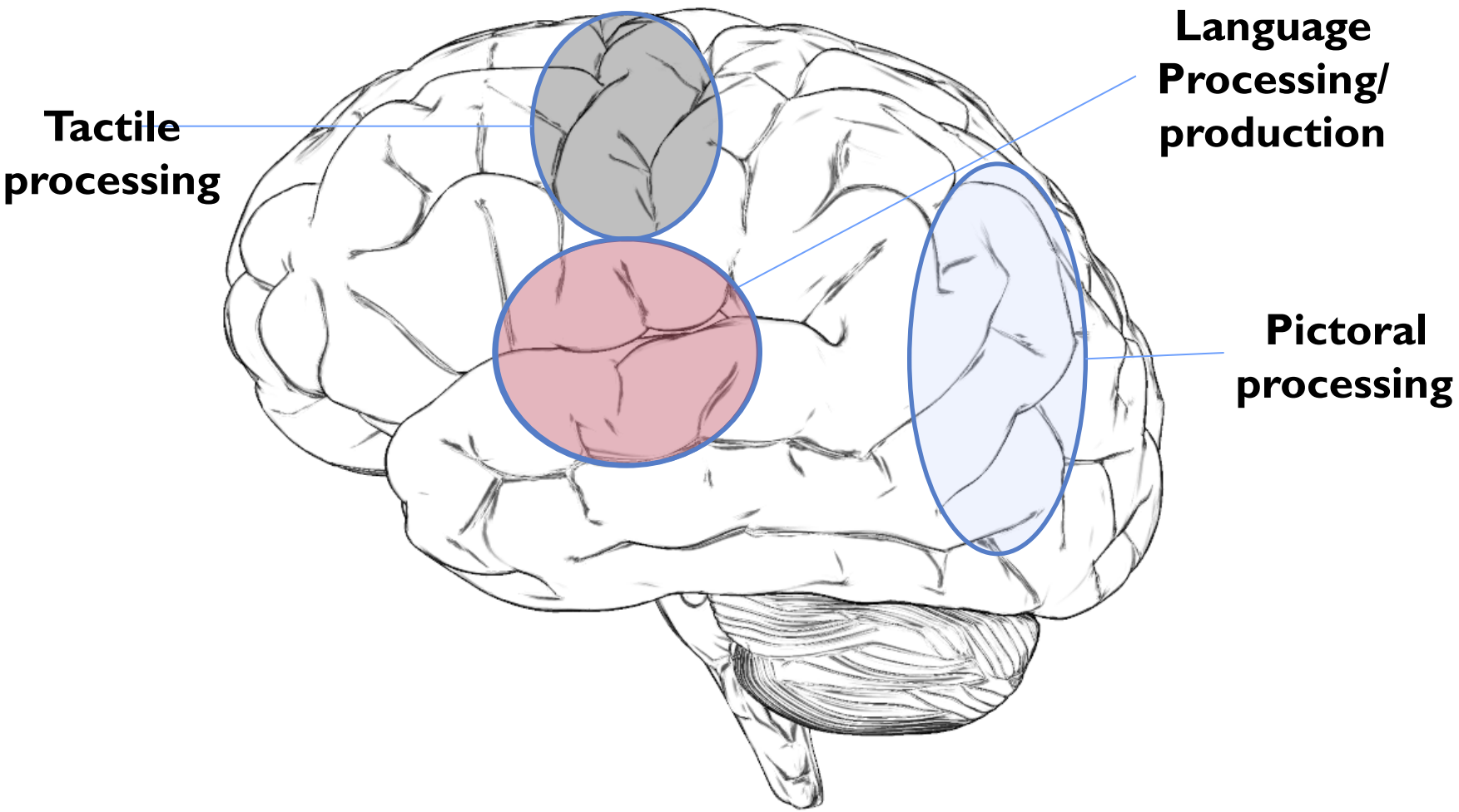
- Rate of speaking (words per minute)
  - Don’t want to talk too fast or too slow
- Direction of Facing
  - Better to face audience as much as possible
  - Using Compass
- Motion
  - Don’t move too much or too little
  - Using accelerometer

Feedback on Talking Performance

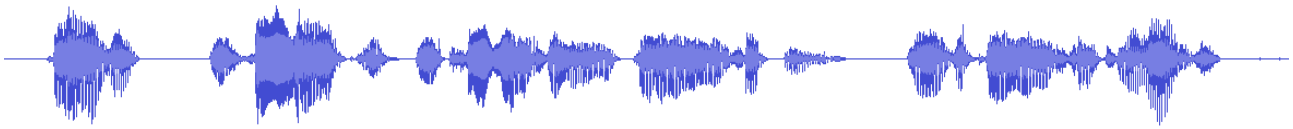


- Feedback both during talk and after

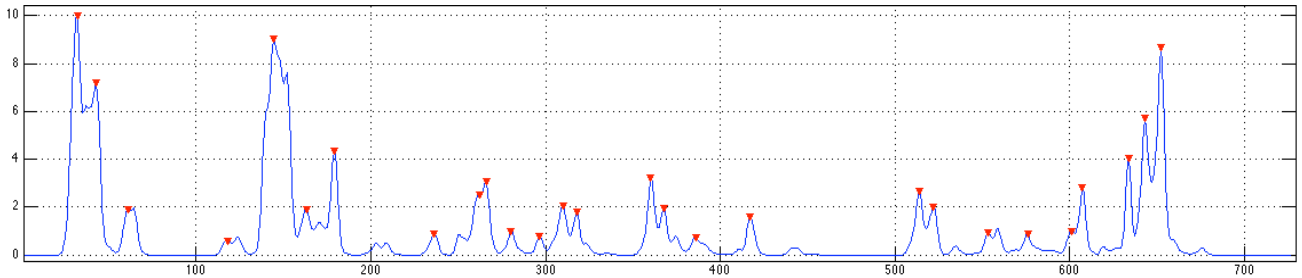
What Kind of Feedback? Tactile



Speech rate (syllable detection)

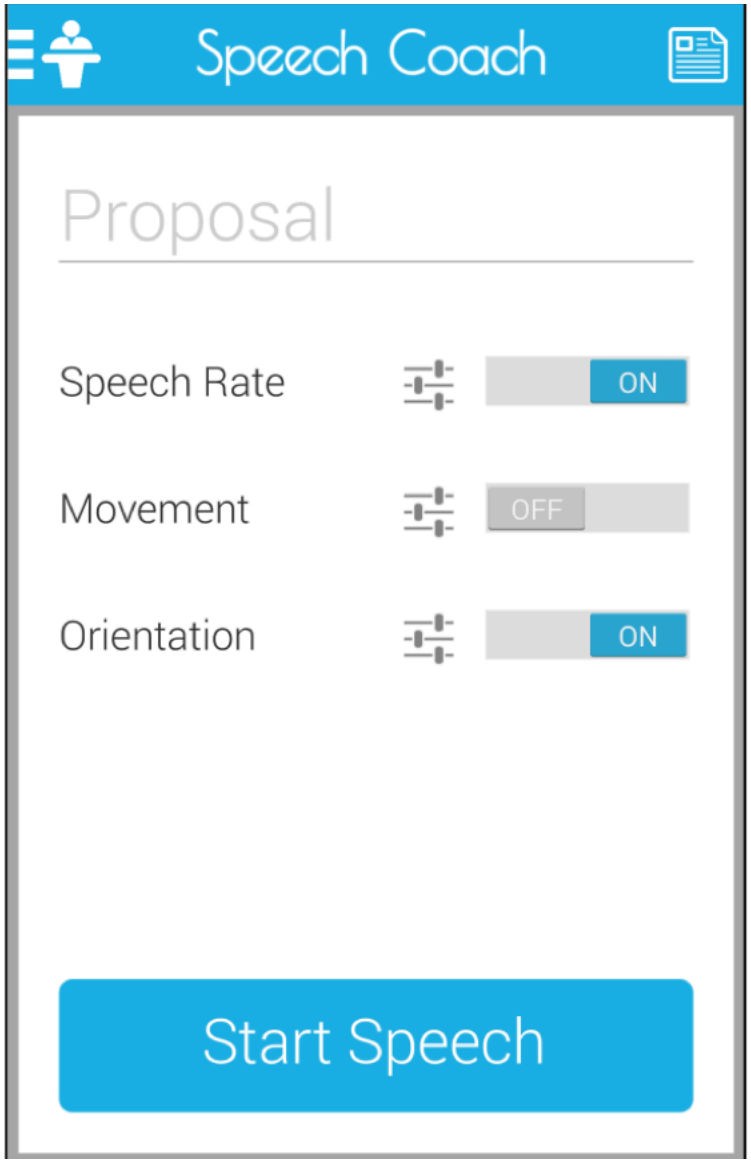


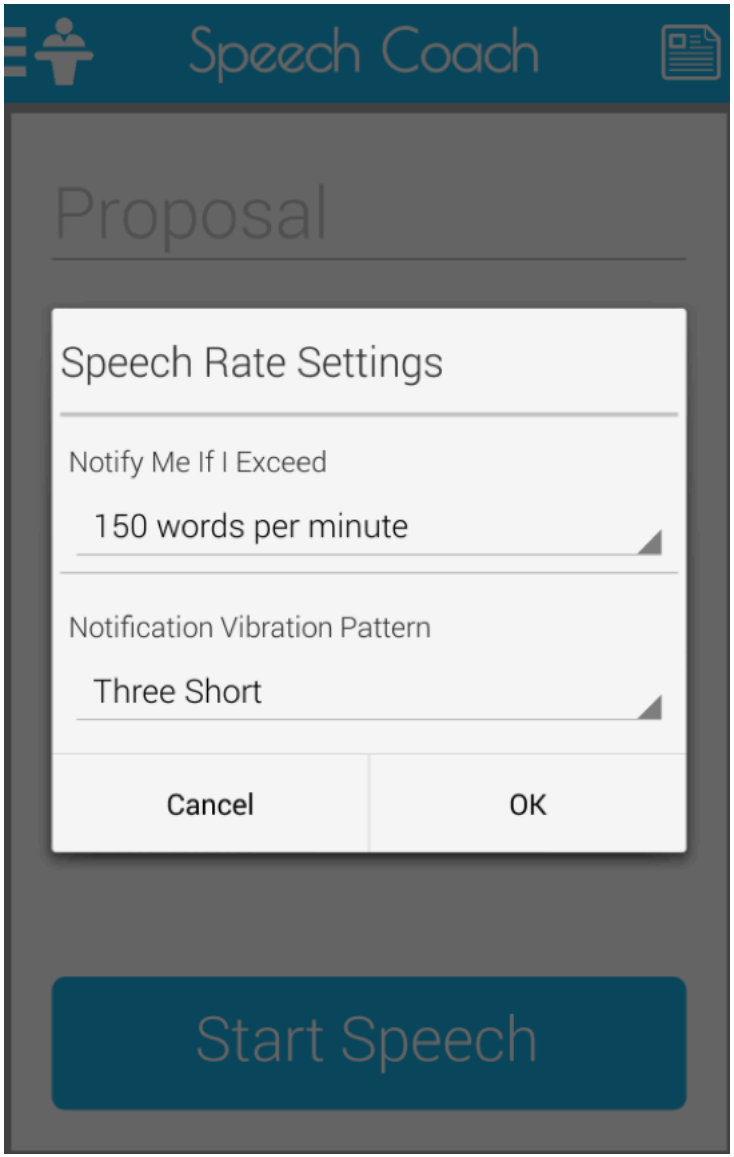
Digital Signal Processing



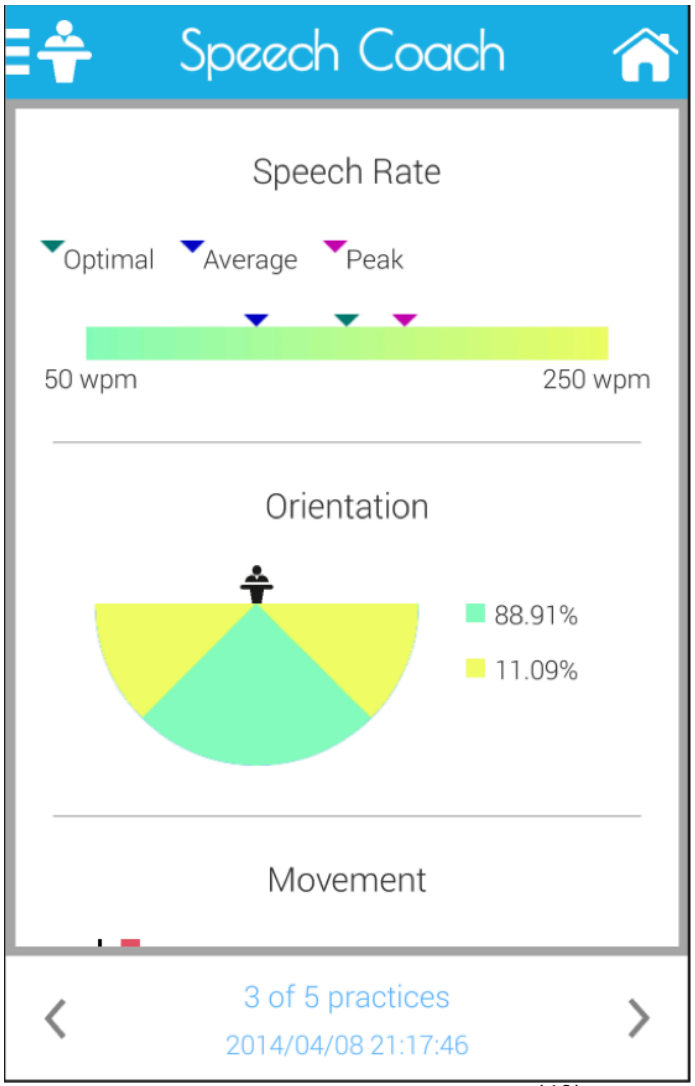
Number of Syllables / 1.6 ≈ Number of Words

Set-up


Speech Coach
Proposal
Speech Rate
ON
Movement
OFF
Orientation
ON
Start Speech


Speech Coach
Proposal
Speech Rate Settings
Notify Me If I Exceed
150 words per minute
Notification Vibration Pattern
Three Short
Cancel
OK
Start Speech

Results


Speech Coach
Speech Rate
Optimal
Average
Peak
50 wpm
250 wpm
Orientation
88.91%
11.09%
Movement
3 of 5 practices
2014/04/08 21:17:46

Which Kind of Student are You?

Apper or Programmer?

Declaration (non-binding)

Raise Your Hand if you Think you are an Apper

Raise Your Hand if you Think you are a Programmer

Sign Up Sheet

- Name
- Student Number
- Department/Field
- **Degree**
- Taking Course for credit
  - Yes or Maybe
  - Cannot audit without very special permission
- Full time or Part Time
- Programmer/Apper self designation
  - Can check both
- Phone Type: What kind of smartphone do you have?
  - Android/iPhone/Blackberry/Windows …

Course Learning's & 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
  - **Key**: to reach across the boundaries of disciplines, learn the language of the 'other' discipline
- 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
- 5th 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

Instructor Bio: Jonathan Rose

- Professor in Electrical & Computer Eng since 1989
  - Bach, Master's & PhD from UofT, Post-Doc at Stanford
- Research: High-Impact Interdisciplinary Mobile Apps
  - Recently switched into this area, because of this course ++
  - Previously: Field-Programmable Gate Arrays (FPGAs)
- Entrepreneurial/Business Experience:
  - Co-founder of Right Track CAD Corp in 1998
  - Senior Software Engineering Director of Altera 2000-2003
  - Run the Engineering Hatchery Entrepreneurship Seminar
- Administration:
  - ECE 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 Fellow Massey College

Why I Began Teaching this Course

- I have always felt that mobile devices would one day take a central role in 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 4 years
  - Ph.D. Candidate in ECE
  - M.A.Sc. thesis: Accelerating computer vision for smartphones using FPGA hardware
  - Ph.D. Thesis: Eye Tracking in Mobile Devices & Application
  - braiden.brousseau@utoronto.ca
- Alexandra Makos
  - Ph.D. Candidate, OISE
  - Ph.D. Thesis: the nature and impact of non-task social interaction on productive discourse in online learning environments
  - Took course last year, as Apper in 2012, TA'd in 2013, 2014
  - 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 available
  - Have a few ‘external’ Appers that I have pre-approved in the case that there are insufficient Appers

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 Apper's 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
4. Must be approved
   - By me

Project Stages

1. **Forming Groups**
   - Pair Programmers, then find Apper
   - Within 3 weeks; special get together Wed Jan 21 @6:30pm
2. **Project Approval-in-Principle**
   - Done via Pepper website Discussion Group/email
   - Due January 28th prior to class; Must have approval to proceed
3. **Project Proposal/Plan**
   - Document Due Feb 4th
4. **Proposal & Plan Presentations**
   - February 11 & 12
   - **NOTE EXTRA LECTURE Thursday Feb 12, 6-8pm, Loc:TBD**
5. **Spiral 2 & Spiral 4 Presentations**
   - 2: March 4/11 4: March 18/25
6. **Final Presentations**
   - Weeks of April 1 & 8)
7. **Final Report Due April 9th**

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 and on Blackboard
  - Lectures posted 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, but not much
  - Project basics; block diagrams
  - Case Studies of interesting/inspiring apps
  - Visitor planned:
    - Design for User Experience Lecture

- Mostly presentations from class
  - proposal, progress x2, final

Course Material, cont'd

- 4 Assignments in first 5 weeks!
- Programmers:
  - Introduce yourself
  - Learning basic development in mobile
  - Mobile programming – sensors, database
  - Leverages the experience requirement

- Appers:
  - Introduce yourself, float ideas
  - Case studies
  - Learning 'design' software;
  - Learning technology concepts

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, some donated for class
  - Is successful

- **New this year:** using new Android Studio environment
  - Previous big 'con' against Android was Eclipse environment
  - Programming Language: **Java**

Alternative, if You Have Mac & iPhone

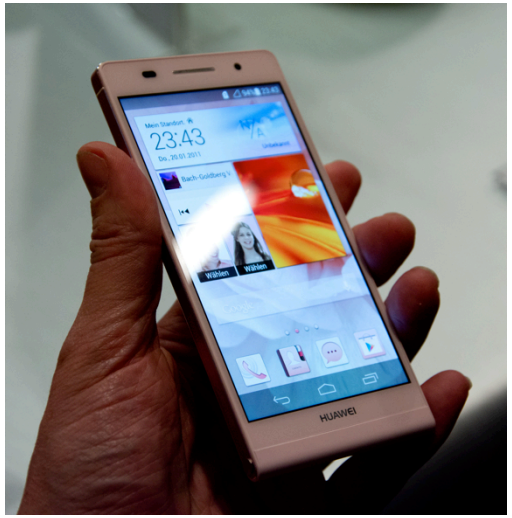
- If you wish to do assignments & project on iPhone, that is allowed, but talk to me first
  - **Pro:** Better development environment
  - **Con:** less common language: Objective C
    - Even less common new one: Swift
  - **Con:** Must have a Mac computer
- Assignments are set up to be for Android and iPhone
- Other platforms?
  - Not sensible unless can find group of like-minded

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 develop on actual phone
- Can use the emulator;
  - Getting better on android;
  - Good on iphone

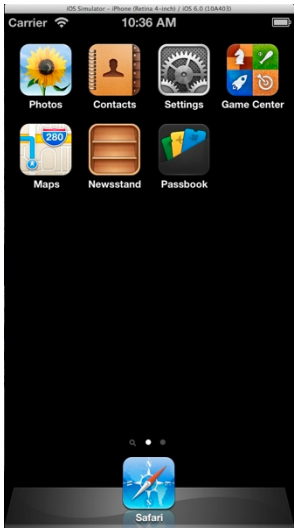
HUAWEI

Ascend P6



Android Emulator

iPhone Emulator



Textbooks for Programmers & Appers:

Android

By Mark Murphy:

1. The Busy Coder's Guide to Android Development
   - http://commonsware.com
   - Murphy gives free 4 months licenses for students
     - Ask TA Braiden Brousseau for License key by email
   - $40 buys all current versions, and a year's subscription to the updates, that come out with each new version of Android
   - Appers may wish to browse too
   - 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 7 Development, Apress

- by David Mark, Jack Nutting, Jeff LaMarche, Fredrik Olsson
- http://www.apress.com/9781430260226
- Not yet one for iOS 8; may be due to switch to Swift?

~$30 cost

Assignments!

Part 1: Due next week: **Monday** January 12, 6pm

Part 2: Due in 2 weeks: **Tuesday** January 20, 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)
   - We reserve the right check that your capability is at the right level

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 Monday January 12th, at 6pm
  - However, do it right away, so people can get to know you!
  - 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
- Walk through initial Android Websites; read/skim Text
- Write simple android application
- Part 2 due Tuesday January 20th, 6pm; late penalty
  - Posted under Assignments on Course Website and Blackboard

http://www.eecg.utoronto.ca/~jayar/ece1778/assignments.html

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 currently in
   - Describe what the focus of your degree/research is (e.g. 'my thesis topic is …', or 'I'm taking courses in..')
   - 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 & what you're interested in working on

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 Monday January 12th, at 6pm
  - However, do it right away, so people can get to know you!
  - Late penalty

Assignment A1 for Appers, Part 2

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:
   - Obtain app, use it, describe it. 1000 words max
   - Mark penalty for too many words

- Part 1 due Monday January 12th at 6pm; late penalty
- Part 2 due Tuesday January 20th, 6pm; late penalty
- Available on Course Website and Blackboard Portal
  http://www.eecg.utoronto.ca/~jayar/ece1778/assignments.html
- Hand in on Blackboard Portal

Other Assignments

Date Assigned	Assignment	Due
January 21	P2/A2	January 28
January 28	P3/A3	February 11
February 11	P4/A4	February 25

Grading

- Assignments: **20%**
  - 4 assignments

- Project: **80%**
  - Proposal/Plan (incl presentation) 10%
  - Spiral 2 Presentation 10%
  - Spiral 4 Presentation 10%
  - Presentation/Demo 10%
  - Final Report 25%
  - Individual Contribution 15%

Commercialization & Intellectual Property

Commercialization

- If group wishes to commercialize App, feel free to do so
- If not, consider giving away if useful
  - In previous years, people have given away source code for others to use/view
- Note: the scope of course project is broader than those apps that are commercializable
  - Apps can be motivated by research goals

Commercialization & Intellectual Property

- University of Toronto Intellectual Property Rules
- Work that makes significant use of UofT resources
  - Requires disclosure & extraction of Universities' rights in exchange for fraction of licensing revenue, or some other deal
  - These rules aren't well set-up for apps/app store

- In my view, **nothing** in this regular course work makes significant use of UofT resources
- If more than one person contributes – group partner, your research supervisor, then their rights must be respected

Warning about 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'
  - This is true for startups as well
  - Advice: Don't get too caught up in worrying about IP

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 21 at 6:30pm

  Location: Fitzgerald Building Room 103
- We will use the remainder of this lecture for introductions

New Approach This Year

- Programmers first ‘pair-up’ with compatible partner
  - Do this by mid-next week
- Then seek mutually agreeable Apper/project
  - Needed the week after

- When contemplating projects, feel free to communicate with us for fast feedback

Please Introduce Yourself

1. Name
2. What discipline you work in & degree sought
3. Taking Course for Credit – yes, maybe
4. Part time or full time
5. What your thesis topic is (if doing thesis)
6. If you work, where & what you do.
7. Why you're taking this course
8. What kind of phone you're carrying
9. **Apper**: What idea, if any yet, you have for an app
10. **Programmer**: What you're interested in doing app on.