ECE 1778:
Creative Applications for Mobile Devices

Lecture 3

January 25th, 2011

ROGERS DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING UNIVERSITY of TORONTO

Today

1. Logistics – Project!
2. Assignments
3. What can a phone do?
   - Seeding ideas for projects
   - Small Case studies

Logistics

Assignments P1 & A1 were Due at 10am

- Programmers: **P1**
  - Any issues?
- Appers: **A1**
  - Any issues?

Today is the Deadline for Forming Groups

- 68 students registered in course
- 8 groups formed as of Tuesday January 25th, 9:00am
  - Total of 19 people
  - Will spend some of this class helping form groups

Once You Have a Group

- Send email to:
  - Me (jayar@eecg.utoronto.ca)
  - Course TA, Braiden Brousseau (braiden.brousseau@utoronto.ca)

- Provide:
  - Names
  - Student numbers
  - Mobile platform you plan to do the project on
    - one of Android, iPhone (others require a special discussion)
    - If thinking about using Tablet
    - **If you have your own device you can use**

Reminder: Project Milestones

1. **Forming Groups**
   - Today!
2. **One-Page Proposal**
   - Due February 1st; Must receive approval to proceed
3. **Design Plan**
   - Due Feb 8th
4. **Proposal & Plan Presentations**
   - Weeks of March 8 & 15
5. **Final Presentations**
   - Weeks of April 12 & 19
6. **Final Report Due April 26th**

Proposal: Due Next Week, Feb 1

- 1-2 Page Proposal for Project
  - Worth 10% of course grade

- What & Why
  - Describe the idea, and its motivation
  - Apper groups: make clear how this app fits within the field of the Apper, and the contribution it makes to that field
- Scope
  - Give me a sense of the full functionality – what is involved
  - Show me that you've thought about the pieces
  - So that I can **approve/advise**
  - **Suggest you send me prior emails asking for approval**

Plan Due the Following Week: Feb 8

1. Reprise of Goal statement, more precise
2. Rough design of what the user sees
   - Mock-ups of screens
3. Block Diagrams of Code
   - Top down
   - With short prose description of each

Plan, continued

4. Statement of Risks/Issues
   - What roadblocks/issues/challenges do you foresee?
   - App-wise, programming-wise, hardware-wise
5. What do you need to learn that you don't know (all members)
6. Apper groups: separate essay on how App relates to field of Apper.
   - 1000 words

- Plan, including presentation, worth 10%

Assignment P2
Containers, Select, Lists and Files

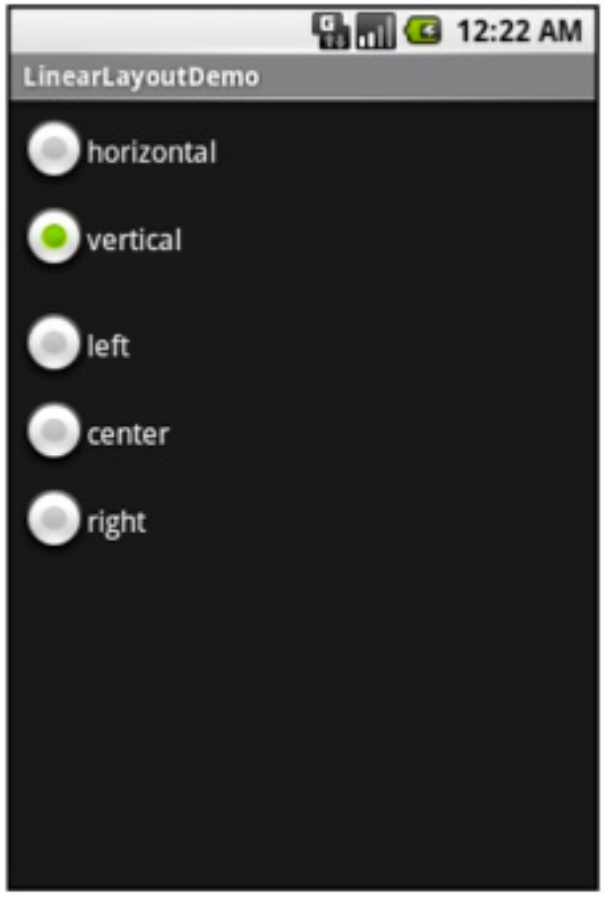
For Programmers

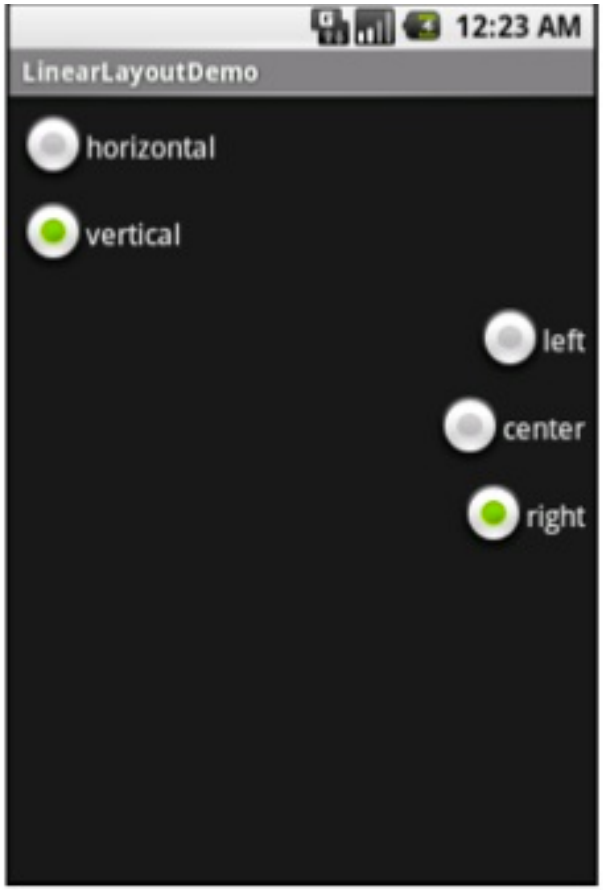
Now Posted on Course Website:

http://www.eecg.utoronto.ca/~jayar/ece1778/assignment-p2.pdf

Containers: Chapter 10

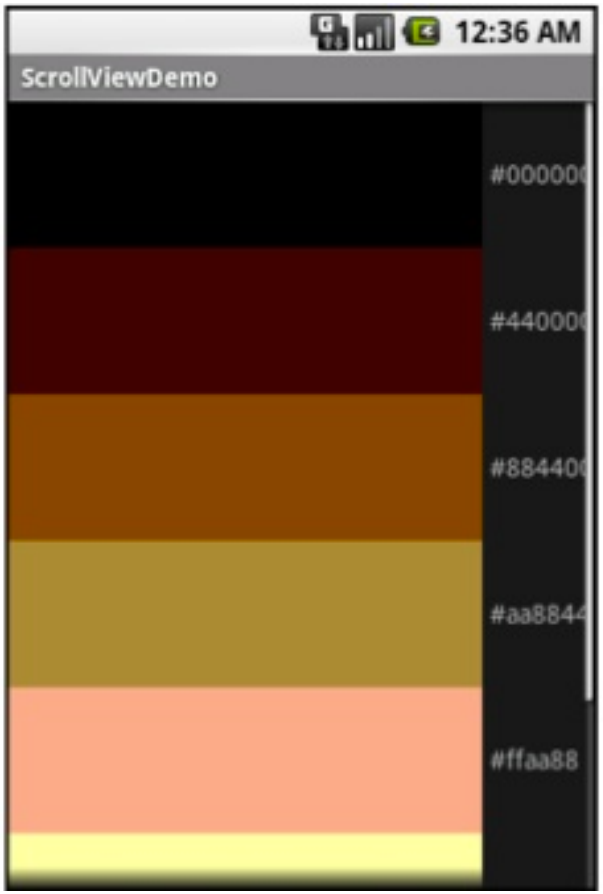
- How to use XML files to describe what you want to





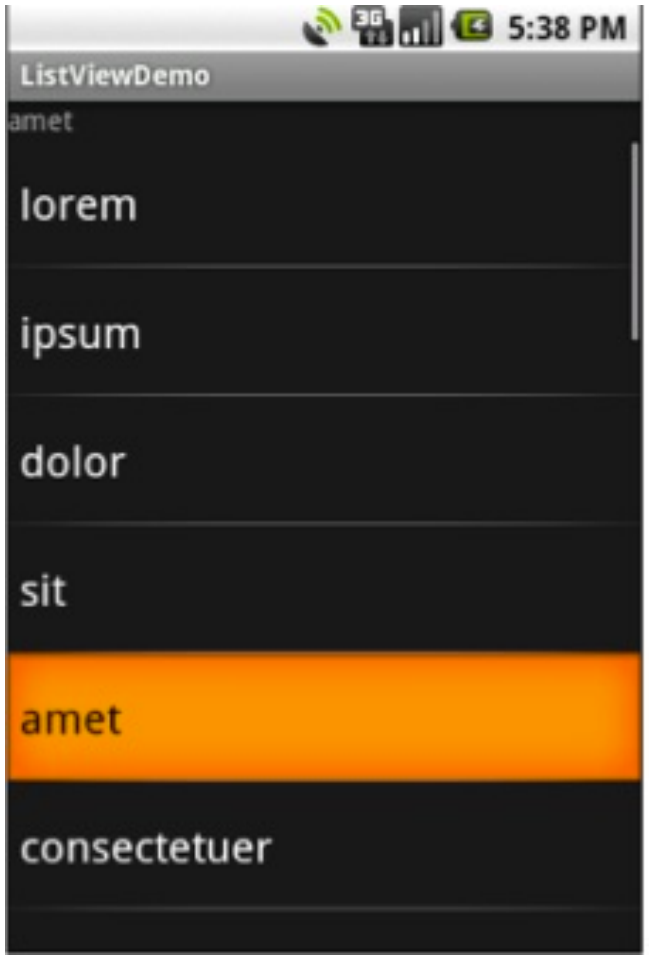
Containers

- Relative vs. Linear Layouts



Lists: Chapter 11, 12

- Very commonly used in all applications
  - Different ways to select, fill in



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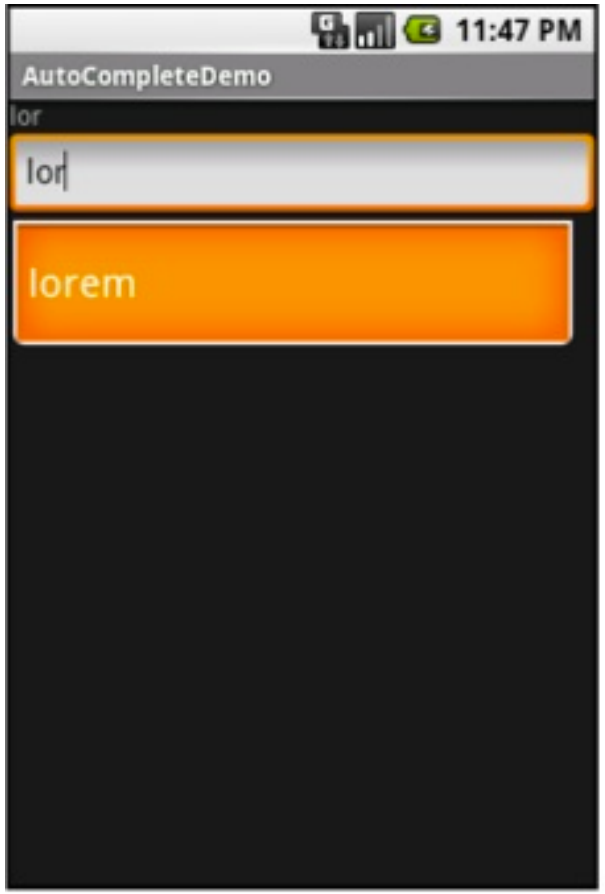
Autocomplete

- For text fields, based on contents of list



Files, Chapter 24

- There are several places to put files
- Anything that you place in res/raw project folder is shipped with the application
  - Can read it as described in Chapter 24
  - Static files, application can't change
- Can read/write files using basic Java I/O
  - See example; note '**on resume**' is in mobile context
  - Limited size ~ 70 Mbyte total
- Larger files can go on SD card
- 'Janky' code section also related to mobile context

iPhone Developers

- There is now an iPhone 4 text from LaMarche, Nutting and Mark
  - Link on course site, under Textbooks
  - Strongly suggest using text, I liked it a lot
  - Also an ‘advanced’ text by same people
  - Can purchase electronic version

- See chapters 4, 8 and 12 for Assignment P2

Assignment P2

- Make Android application that allows the user to
  - create a list of people
  - Stores their age and favourite sport,
  - Stores and loads different lists in multiple files on the device.

- Age is just entered as a number
- Favourite sport is selected from a list

Assignment A2: Using App Inventor

Now Posted on Course Website:

http://www.eecg.utoronto.ca/~jayar/ece1778/assignment-a2.pdf

Assignment A2, Part 1

- Create an app that has three buttons,
  - depending on which button is pressed, it displays a different picture.
  - You pick the pictures

Assignment A2, Part 2

- Do the tutorial on how to build an app that shows you how to build a quiz http://appinventor.googlelabs.com/learn/tutorials/quizme/quizme.html

- Modify this app in two ways:
  1. To be a 'name that tune' app by playing snippets of music and having the player give the name of the group or the song (pick one).
  2. To give the user a 'multiple choice' for answers.

Apper Thoughts

What Should Appers Do/Learn Here?

- Make the world of mobile applications comprehensible
  - So that you can engage with developers
  - Commission apps in the future
  - Gain a deeper understanding of what's possible & what it takes
- How?
  - Do some basic programming (Assignments)
  - Engage with developers to conceive and design app (Project)
    - Teach developers essentials of your field
    - Engage in iterative process of design
    - Test the results
    - Gain technology project experience
- I am open to ideas for deliverables, to achieve this

Overview of Smartphone Capabilities

To Get You Thinking about the Project

Based on iPhone, but Android Phones have same capabilities

A Smartphone is …

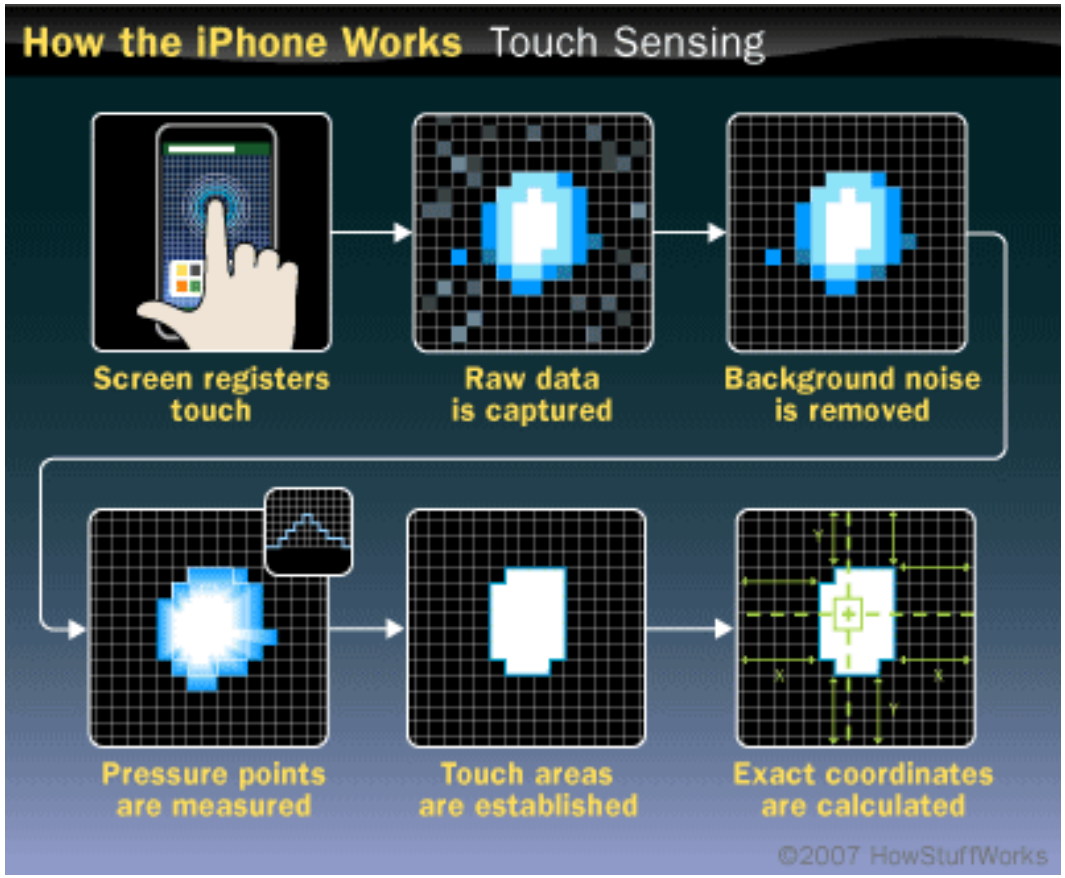
- A small computer that you can carry with you
  - Connected to the Internet
  - Can **sense** its environment in many ways
  - Can **speak** to its environment in several ways
  - Can also make phone calls

- A computer is
  - A willing slave that will do whatever you tell it to do
    - And never complain
  - Capable of sophisticated computation and analysis of its inputs
    - Sound and images

Inputs and Sensors

Touch Screen

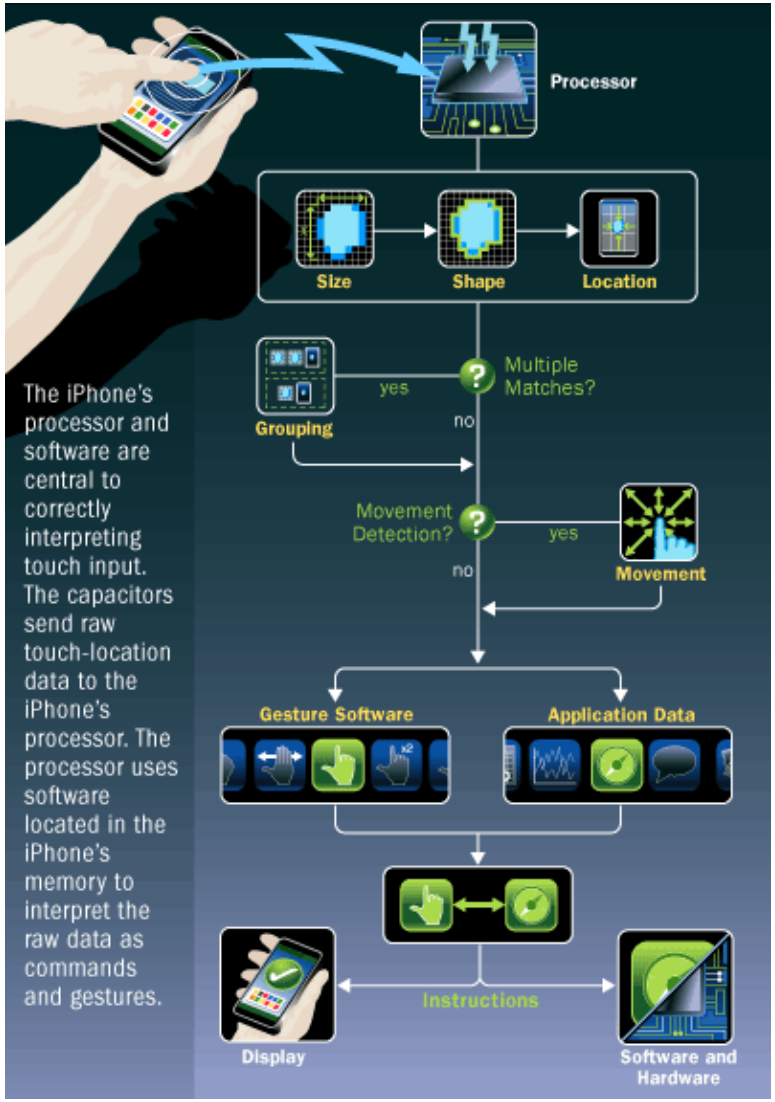
- The screen surface detects the touch of a finger
- Each touch can be turned into a specific coordinate,



Touch Screen

- Coordinates can be turned into several different types of input:

1. Gestures
2. Selection actions
3. Tap counters
   - Double-tap
   - Triple-tap
4. Two Finger touch
5. Three Finger Touch …

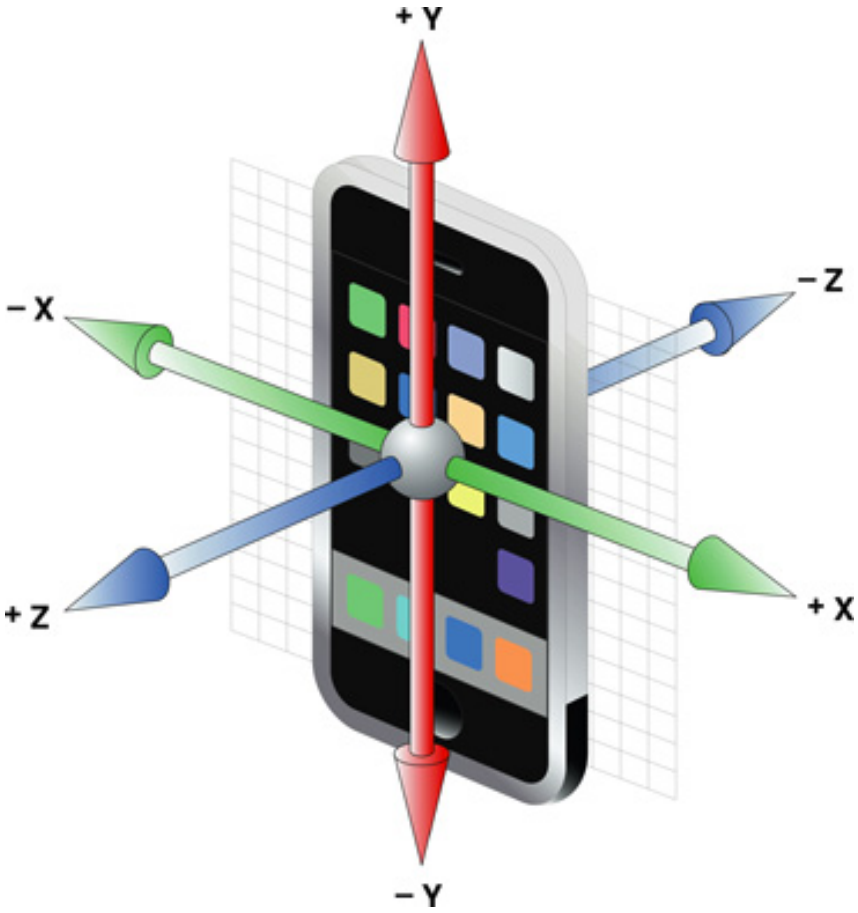


Can Touch Screen Be More?

- Could this sensor be used to measure something about the finger?
  - Blood flow
  - Blood Pressure
  - Heart Rate
- Use for?
  - Medical Diagnosis
  - Lie Detector

Accelerometer

- Can measure acceleration in 3-dimensions as shown
- Measured in G's
  - 1G = Acceleration due to gravity
  - Get measurement in each dimension X,Y,Z
- Phone gives can give a 'reading' 100 times/s



Can Feel What the User is Doing

- Walking – step counting
- Running – speed measurement

- Can it tell something about the user's Gait?
  - "Implementation of an iPhone as a wireless accelerometer for quantifying gait characteristics"
  - LeMoyne et. al, 32nd Annual International Conference of the IEEE EMBS Buenos Aires, Argentina, August 31 - September 4, 2010
  - See other posts online

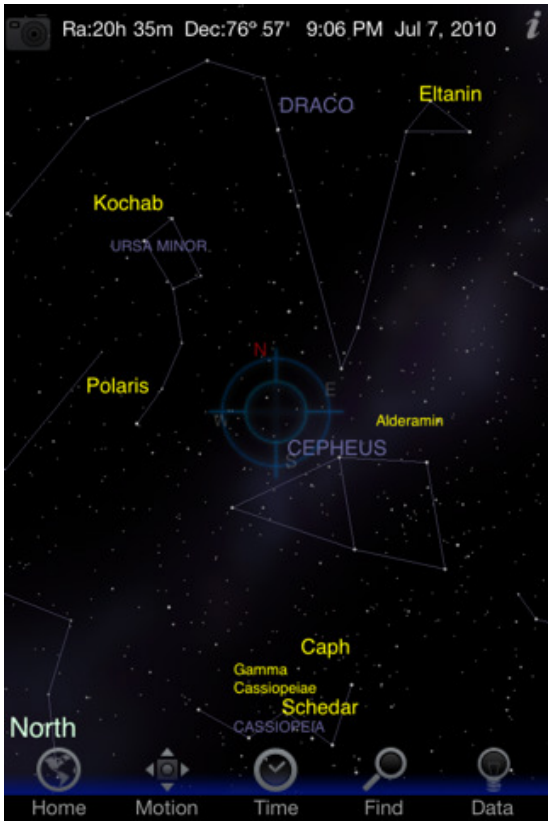
Other Motion Sensing

- Can tell if the phone is being shaken
  - Can use as an input
  - How sensitive is it?
  - Can it be used to measure Parkinsons tremors, in a medical application?

- Could perhaps detect if person fell down
  - could alert someone

Motion Sensing with Accelerometer

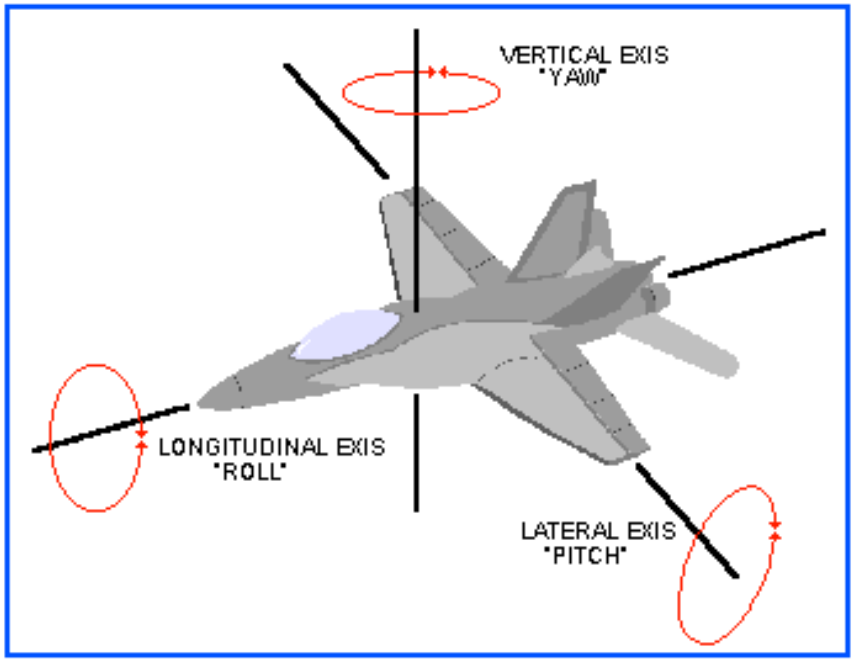
- Gravity causes acceleration of 1**G**
  - If the phone is not accelerating (i.e. you're not moving it)
  - can determine the orientation of the phone,
  - by looking at which dimension has the '**G**':
    - X or Y or Z or some combination



- Used by stargazer apps to know where you're looking in the sky …

Gyroscope

- Gives: pitch, roll, and yaw
  - of phone
  - Rotation rate in radians/s
  - Along X,Y,Z axis
- Gives a better sense of the motion of the phone
- iPhone 4 and Samsung models have this, but not many Androids do



Compass

- Really a magnetometer
  - Can measure the magnetic field in 3 directions, X, Y, Z
  - Can use to make compass
  - Could also use as an instrument to measure presence of magnetic fields
- Where do magnets exist?
  - Speakers, motors, screens, medical imaging
- What are they used for?

GPS Receiver

Global Positioning Satellite (**GPS**) Receiver

- Can determine the location of the phone in the geographic coordinate system
- Quickly accurate to within 100 meters, takes longer to do better
  - Does not work inside buildings
    - **Hospital Directions?**
  - Will have more trouble when lots of buildings around
- Knowing where you are is incredibly useful in business

Where Am I?

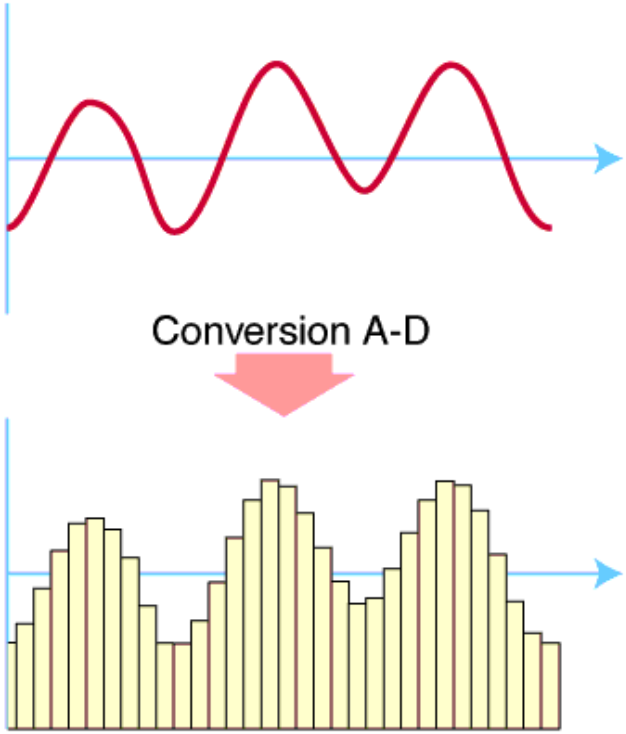
Latitude:	37° 19' 54.0804"
Longitude:	-122° 1' 50.6316"

Ambient Light Sensor

- Used to set the brightness of the screen
- Could be used for quick sensing of light,
  - but could also use the camera(s) for more detail

Microphone

- Converts sound into data
  - Microphone converts sound waves into voltage
    - Which varies over time
  - Circuit converts voltage into into digital values
  - Sound becomes a series of digital values
    - Get samples at 48K samples/s
    - Good quality sound!
- Sound Processing
  - aka **Digital Signal Processing**



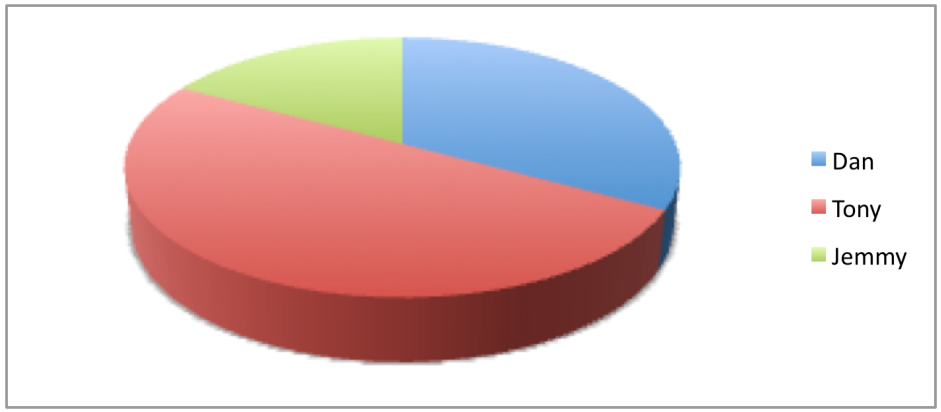
Sound Processing Example 1

- Famous **Shazam** app
  - Listens to 15 seconds of song playing
  - Can tell you what the song is
  - Sends sound sample up to server to do this work
  - Lets you buy song

- Most processing is done on a server

Sound Processing Example 2

- Listen to a conversation, and measure the fraction of the conversation that each participant takes up!



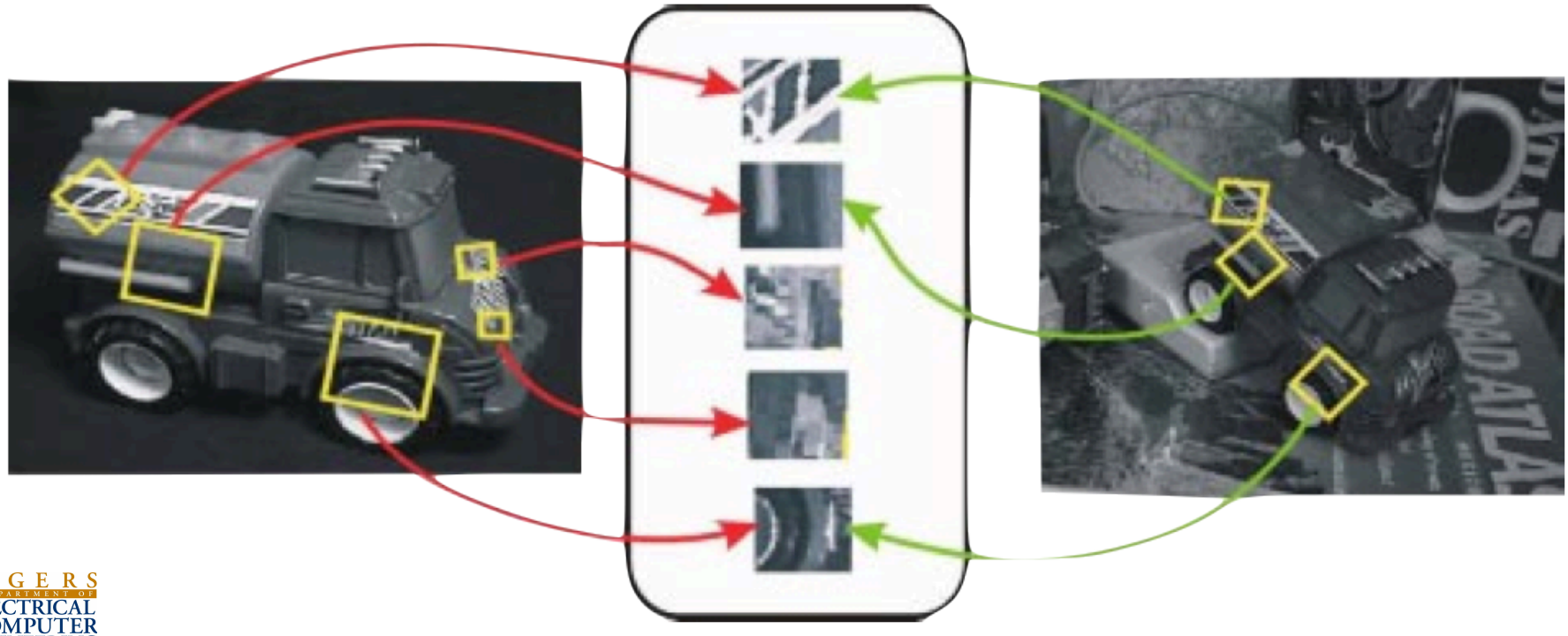
- Currently working on this one with Daniel DiMatteo, 4th Year Undergraduate
  - Known as 'Diarization'
  - Open source software
  - LIUM_SpkDiarization (Java-based)

Camera

- Can record images
  - Large files with high resolution
    - 2MPixels – 8 MPixels
- Can record video
  - ~ 30 frames/second of pictures
- Can we use it to “see things”?
  - Yes!
  - Computer Vision field
  - Difficult, slow
  - OpenCV open source software

Computer Vision

- Automated machine extraction of information from images
- Allows computers ‘see’ the world in much the same way that people see the world



Computer Vision

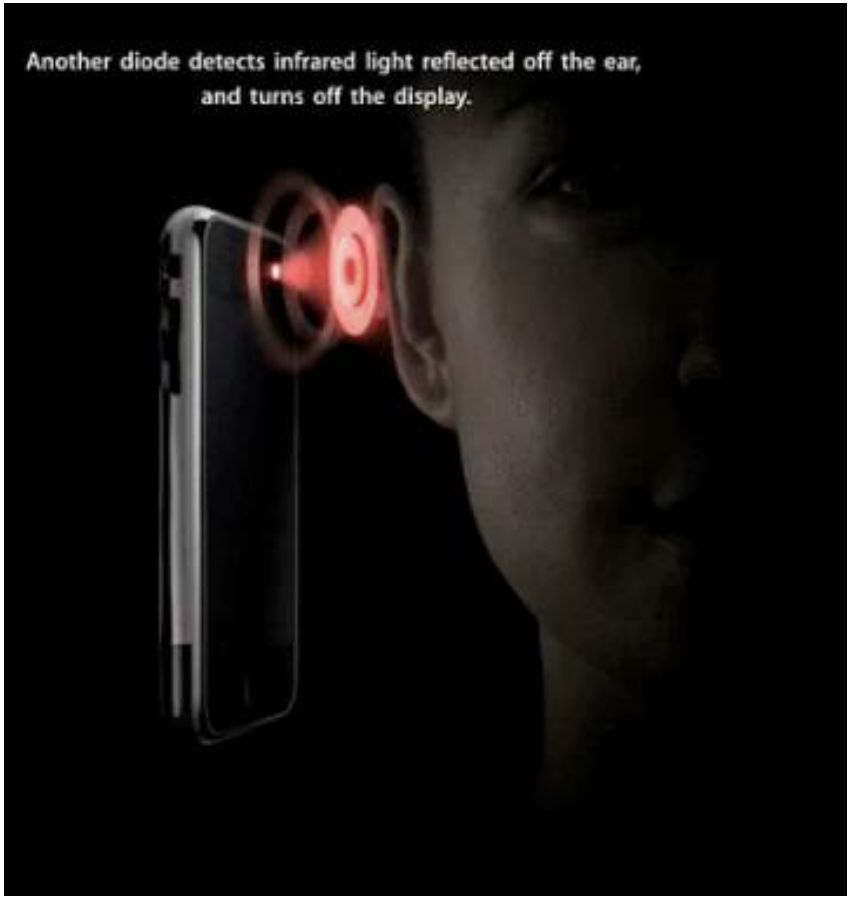
- too slow to do in real time
- There is some open-source software, OpenCV, which can do many things, but not very quickly
- Braiden's Master's thesis is about speeding it up on Android using an FPGA
- He can help with using OpenCV

Front Facing Camera

- Allows for video interaction
  - Skype now uses this
  - Lower resolution than back camera
- Can look at you and see how you're feeling
- Can maybe track your eye movements as you watch things
- Diagnose depression?
  - eyes are the window to the soul

Proximity Sensor

- Can detect if phone is near to something, particularly the head
- Helps turn off touch screen when phone to ear.
- Simple Near/Not input
  - Doesn't give distance, yet



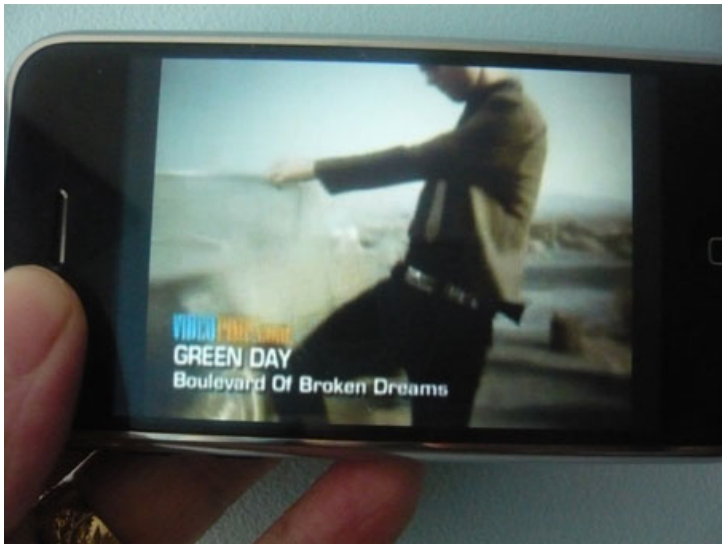
Output Devices

Hi-Resolution Screen

- Most recent phones have very high quality screens
  - Quality is the # pixels
- Resolution of Samsung Vibrant
  - 480x800 total resolution
- Cheaper phones have less:
  - Hua Wei U8100 240x320
  - Alcatel OT-981A 240x320

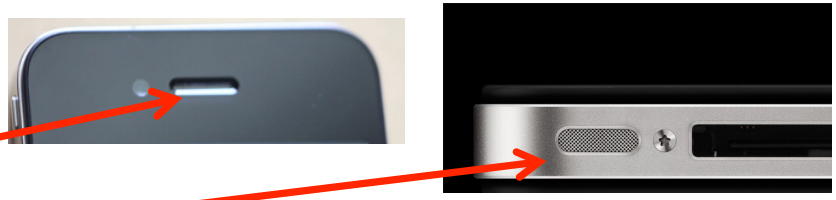
Video

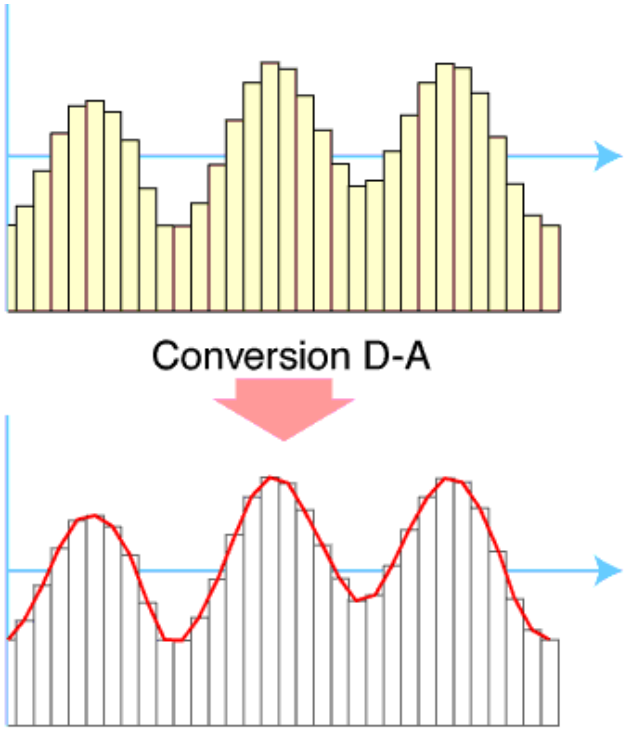
- Special hardware to enable 30 frames/second video
- Displaying video can use up much or all of the processor's computational capacity;
  - Most phones have special hardware to handle this task



Speakers/Audio Out

- Sound Output
  - Two speakers
    - Quiet one for ear
    - Loud speaker
- Play previously recorded files
  - Should be able to do **text-to-speech**
- Many possible sound filters –
  - Auto-tune voices to make at right pitch
  - Make funny voices
  - Synthesized Musical instruments





Vibration Output

- Can create a short buzz
- Can control vibration pattern, duration and intensity

- This can be a significant output device – ‘haptic’ feedback

Camera Flash

- Bright White LED
  - Meant for taking pictures
  - Can be used to light up a room
  - Signal someone
  - (transmit data?)

- Undergraduate project:
  - Evoke red-eye effect **on purpose**
  - Is a picture of retina
  - To do eye-disease diagnosis
    - with computer vision

The Computer: Storage, Networking and External Devices

Computer

- What can a computer do?
  - Processors are powerful
  - 500Mhz – 1GHz ARM processors
- Many things!
  - Optimization
  - Search
  - Sort
  - Artificial Intelligence

Storage Capacity

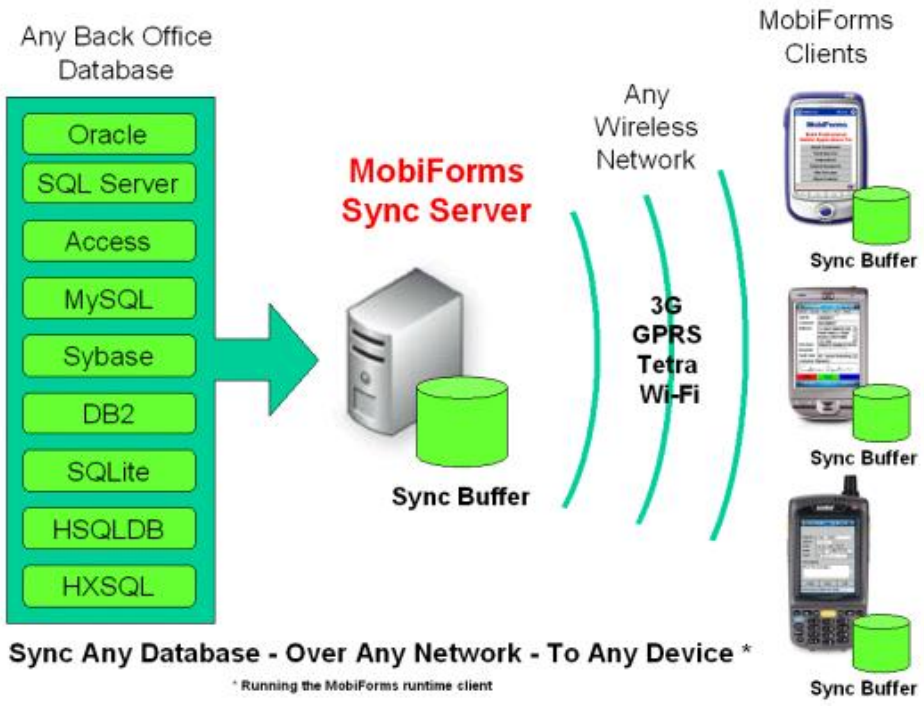
- Local storage of 2 to 32 Gbytes of permanent storage
  - Flash-based solid-state disk
- Can load many databases locally onto the device
  - Dictionaries, no problem!
  - Maps
  - Phonebooks
  - Location Services

Network – 3G/Wifi: Gateway to the Internet

- All phones have at least 2 ways to talk to the internet
  - Local WIFI
  - 3G cellular data networks
- Connection to more computing and storage
- Connection to other phones

Not Just App: Probably Need Web Site

- Many apps need 'backing' website/ database
- Provides phone with:
  - Communication to other people
  - Data
  - Backup
  - Information from Internet



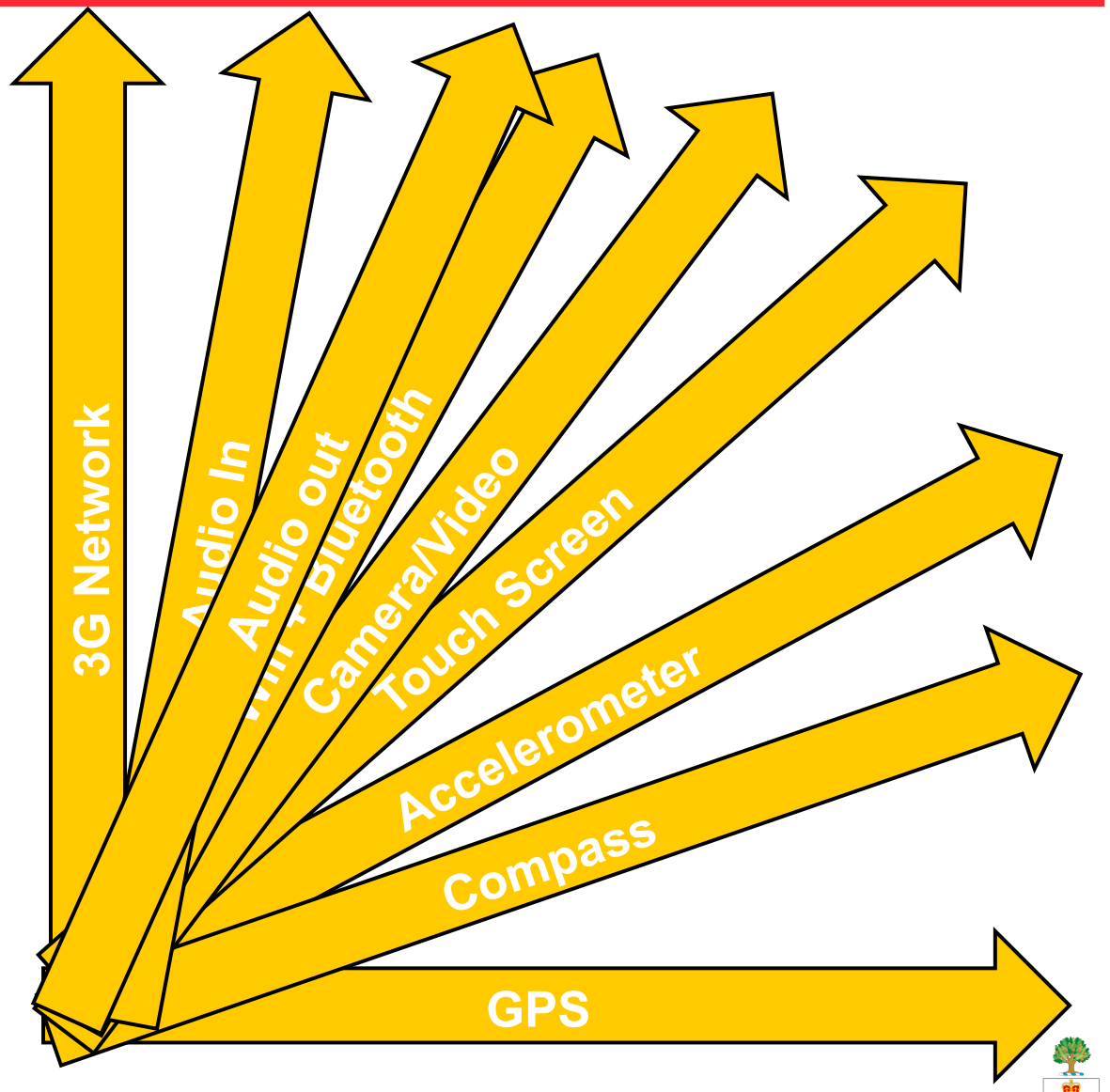
Bluetooth Connection

- Connect to a whole class of external devices, wirelessly
  - earphones
  - small spy cameras
- Could be important way to add other devices without physical connection
  - Make use of phone's capabilities without holding it

Case Study 1: Ocarina

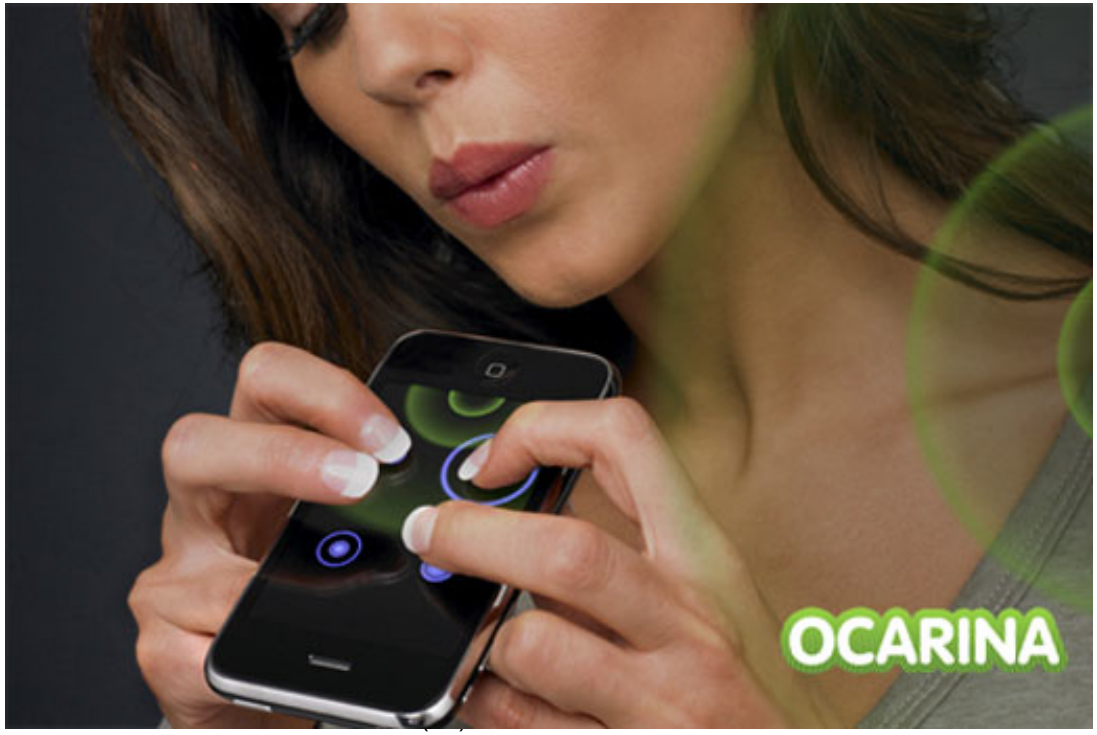
Best Example of A New Point in Space:

- Each capability is an axis
- Each axis multiplies what is possible with the others!
- Ocarina: combines
  - Touch screen
  - Audio out
  - Network/server
  - GPS
  - Display

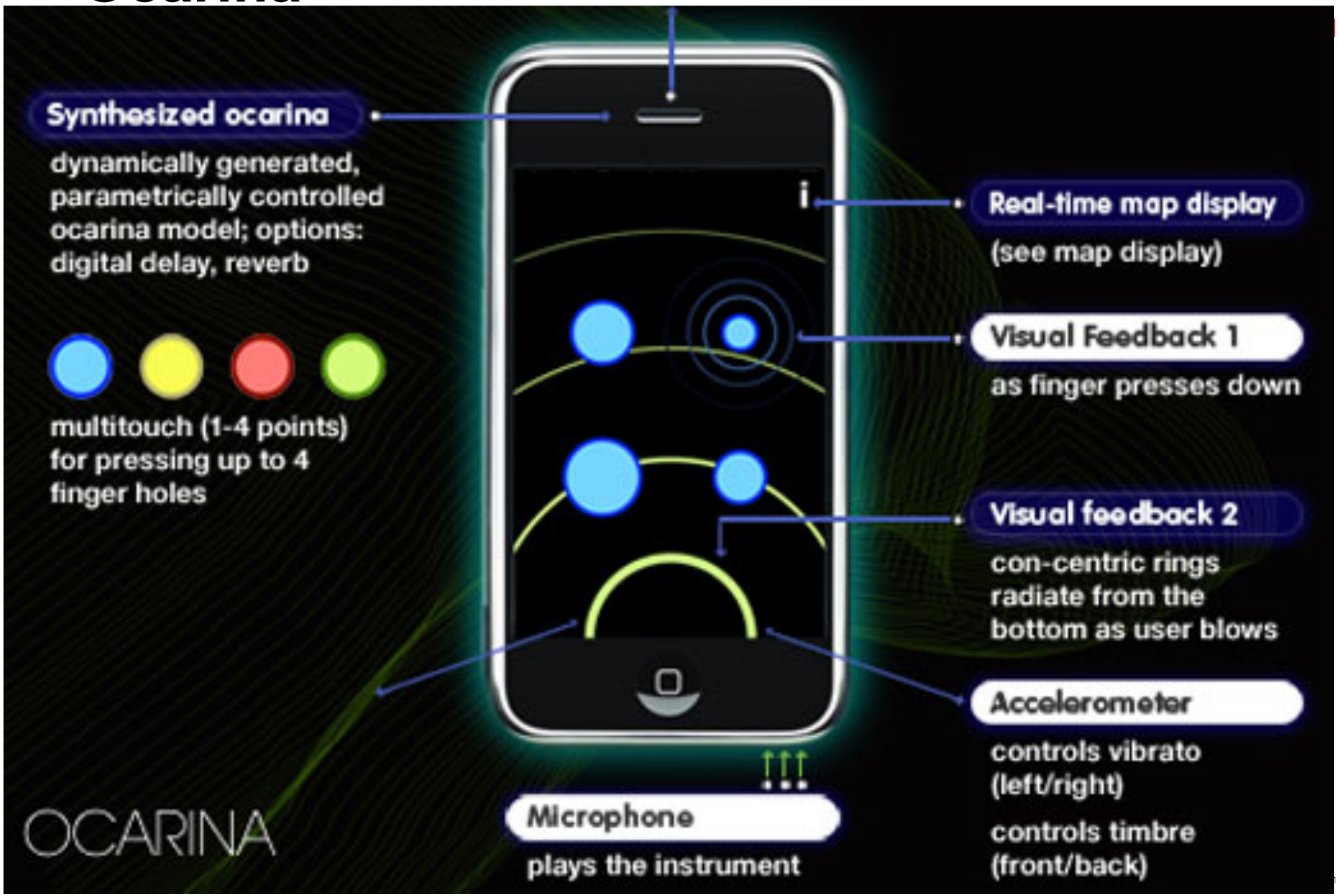


Case Study: Ocarina Musical Instrument

- A case study in inventiveness
  - Using a novel combination of capabilities
  - “Blow” into microphone:
  - http://www.youtube.com/watch?v=RhCJq7EAJJA

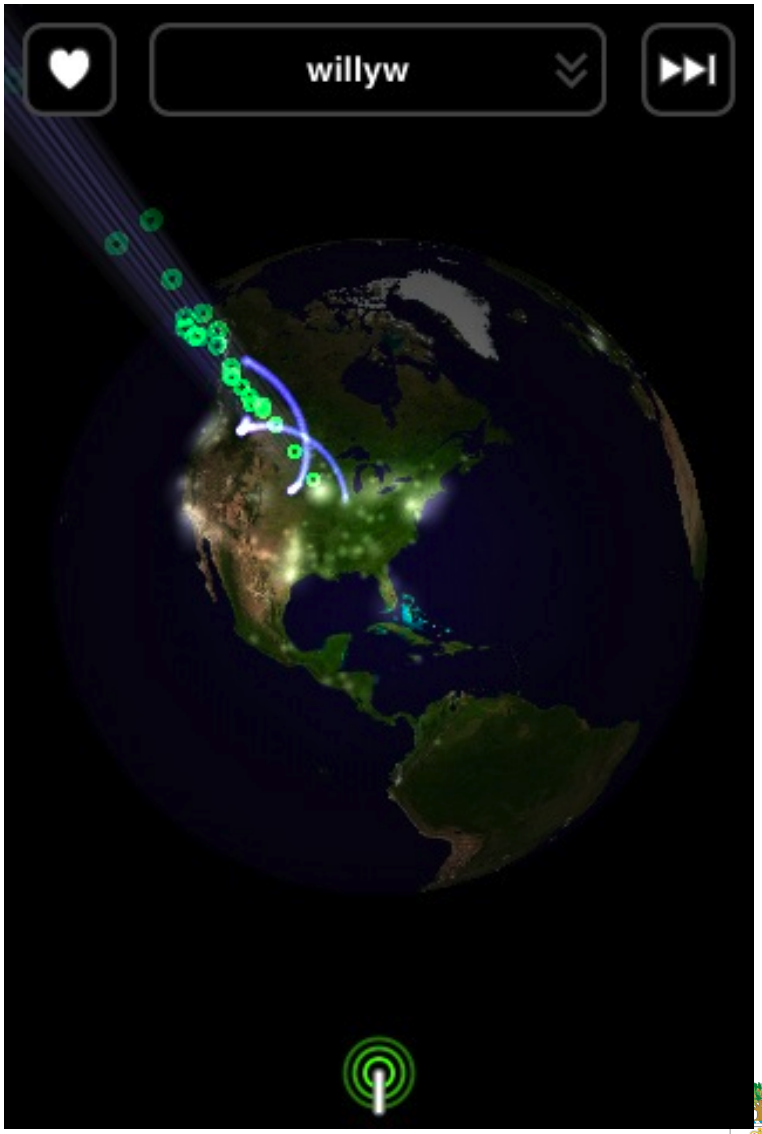


Ocarina


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
- Company records the sound everyone plays *by default*
  - Dot 'plays' music from randomly chosen Ocarina player, anywhere in the world!
  - Nice graphic too;
  - Moving
- Top 20 iphone app of all time, according to Smule



Another Great Instrument: Seline

- A new natural keyboard
- Great sound!
- http://amidio.com/seline

Case Study 2: TeamChooser

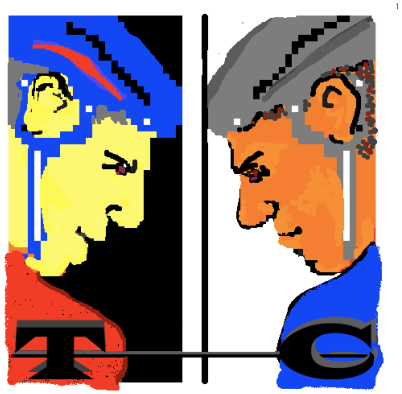
Solving a Problem

The Problem

- In pick-up team sports games, we like to have fun
- It is good if the teams are ‘even’ so that the game is fair
- Someone usually has to pick the teams
  - That is hard to do well
  - People get mad at that person when the game is uneven
- Random teams can be bad
- Using Team Captains to select
  - means someone is selected last ☹

The Solution: TeamChooser

- Wouldn't it be great if an App made the teams?
  - No one to yell at
  - Possibly give better teams



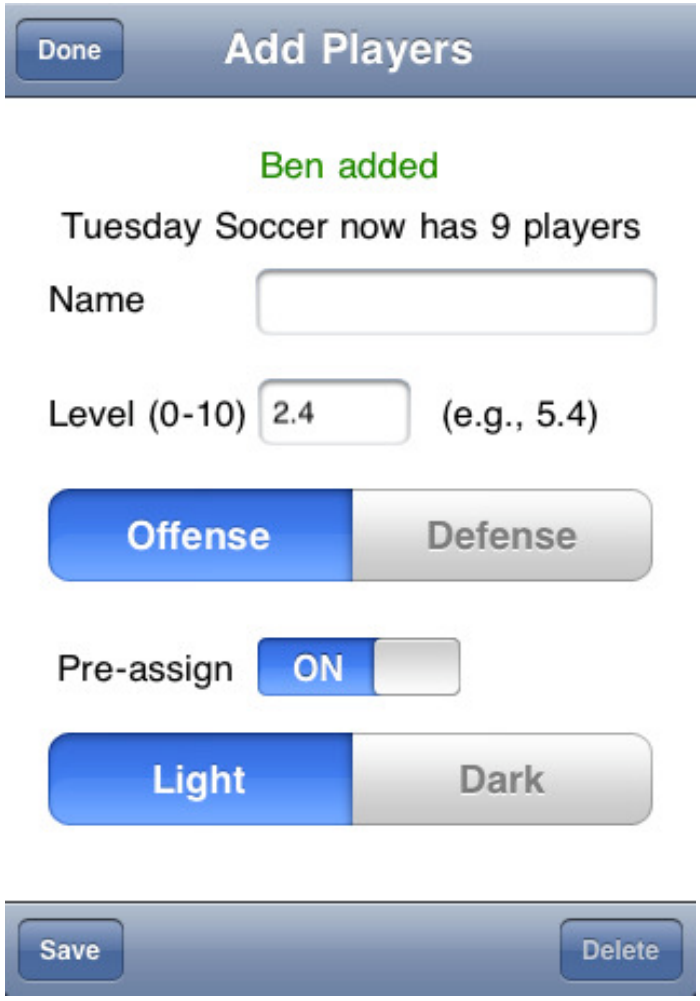
- Who needs this?

- Every pick-up hockey, soccer, basketball game around!

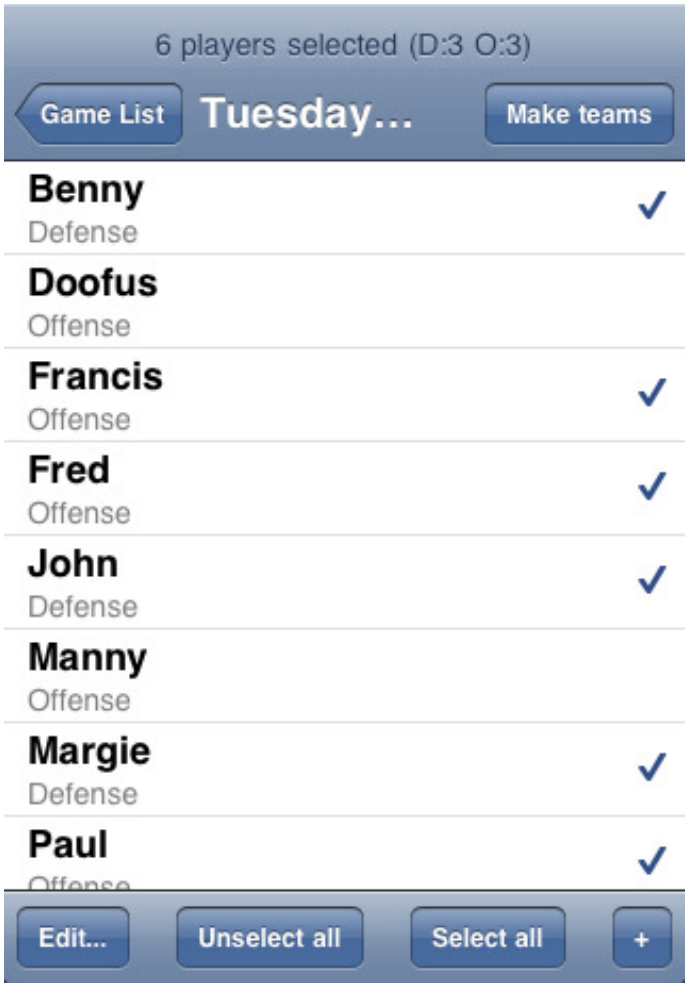
TeamChooser: How It Works

- Enter every user in advance of game day
  - Player's name
  - Preferred position (offence or defense)
  - **A rating, from 1-10, as to how effective player is**
    - Rating is the trickiest part
    - Key: keep ratings secret from all but a few
    - (apps **are** personal)
- On game day – select all players present
- Push 'Make Teams'
  - And voila, two evenly matched teams

Entering Players



Selecting Present & Making Teams



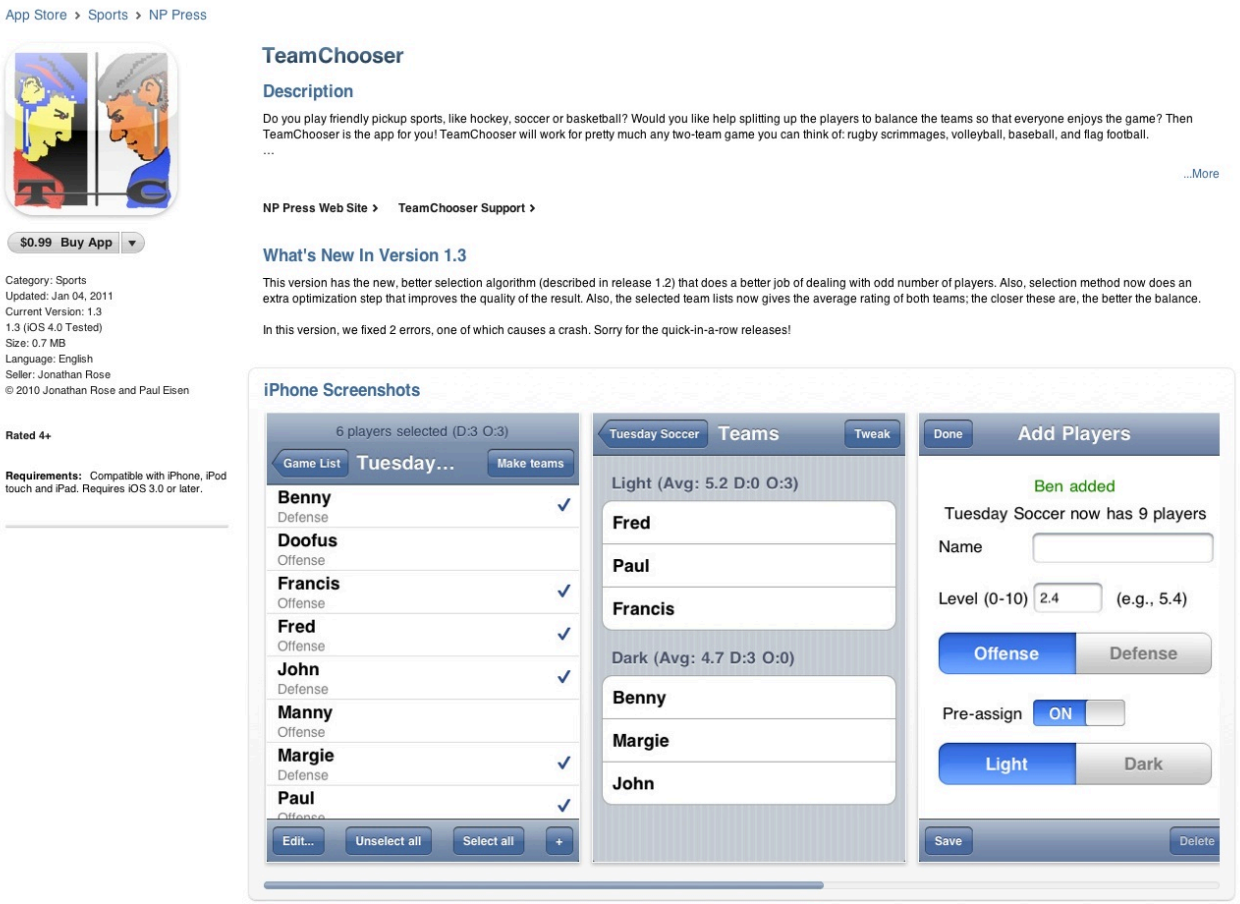
Team Selection Method

- A good method, used over the years
  - Sort in order
  - Top goes to team A
  - Next 2 to team B
  - Next 2 to team A …
- More complex when dealing with pre-assigns, or making incremental changes to teams when someone shows up late; new release including special ‘odd man’ algorithm
- Many discussions from CS and ECE Professors over algorithms in hockey game

Does it Work?

- Yes!
- I've been using it with friends in roughly 40 hockey games and it has almost always done a good job.
  - We've tweaked it's algorithms here and there
  - Added some features
- The rating of players gives rise to some unusual issues, sometimes funny, sometimes not.
  - Apps are **personal**

On iPhone App Store Since May



- 60+ Sales
- Mostly in US/ Canada, but a few in UK, Ireland, Japan, Norway and Romania

Improvements Needed

- **Really** needs a backing website
  - To share teams/ratings between people
  - Is currently a hidden feature, could have people pay for it
  - To support a business model of advertising, promotions related to sports

- Much discussion about using results of games to determine better ratings
  - Rating players is the most difficult part of using

Is Anyone Using it Who Bought It?

- Instrumented Using Flurry.com
  - Analytics for iPhone, Blackberry and Android
- Reports:
  - # of users sessions, amount of time spent on app
  - Specific pages/events, as you wish from each user
  - Location of user, if already use GPS (no other ID).
  - **Anything I wish to report!**

Dashboard
Usage
Audience
Events
Technical
Manage

DASHBOARD

All Versions | Across All Time

Sessions

Explain | View Report

Zoom: days | **weeks** | months

Application Usage

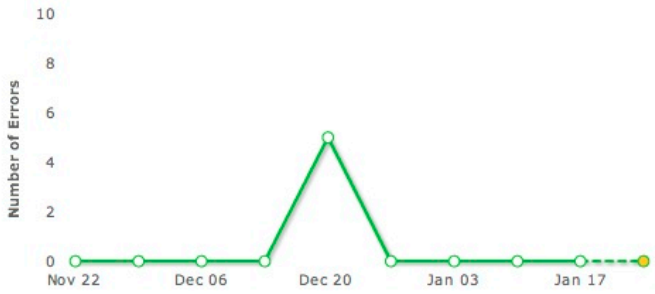
463 Sessions

51.3 secs Median Session Length

30 New Users

Total Exceptions

View Report



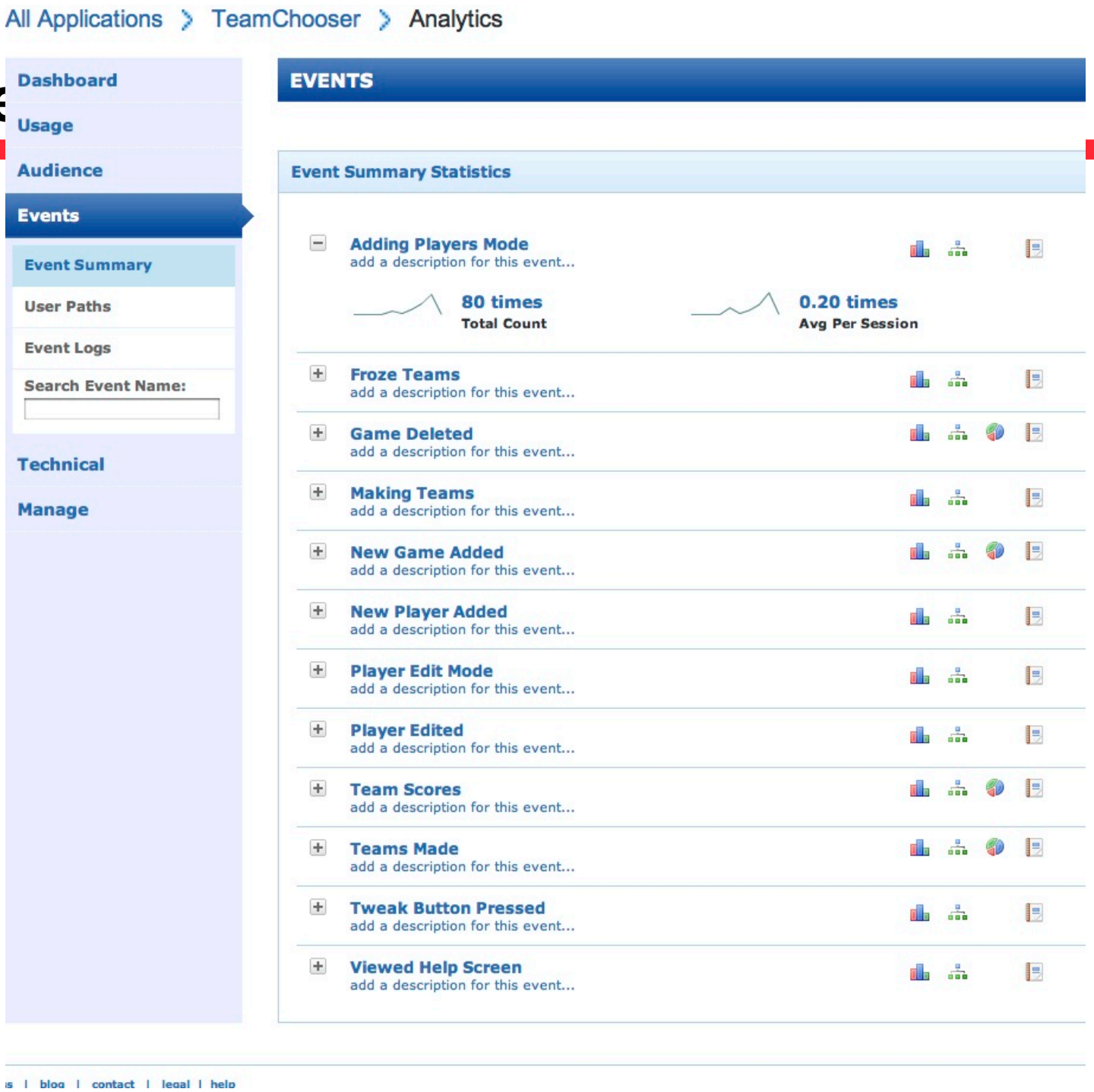
Sessions Per Week

View Report

Sessions	User-Weeks*	% of User-Weeks
1	21	33.3%
2 - 3	16	25.4%
4 - 6	8	12.7%
7 - 9	3	4.8%
10 - 19	10	15.9%
20 - 49	5	7.9%
50 - 99	0	0.0%
100+	0	0.0%

* - User-Weeks represent one unique user over the period of one Week.

Eve



ROGERS DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING UNIVERSITY of TORONTO

Group Forming

Group Forming

- Appers without Groups
- Programmers