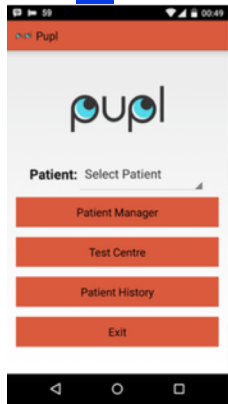
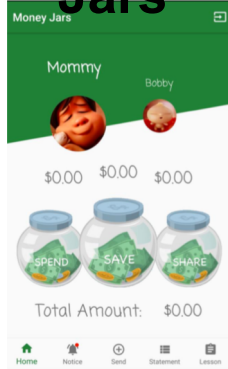


Creative Applications for Mobile Devices

PUPL



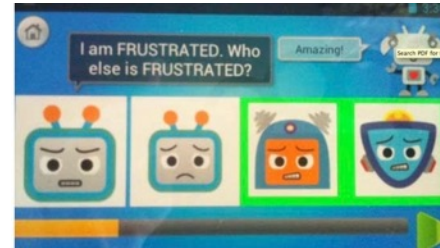
Money Jars



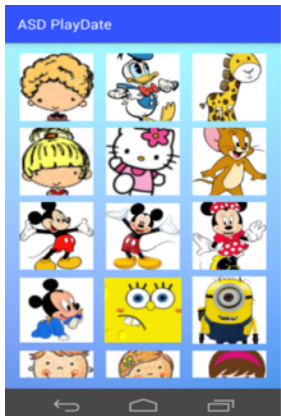
Speech Coach



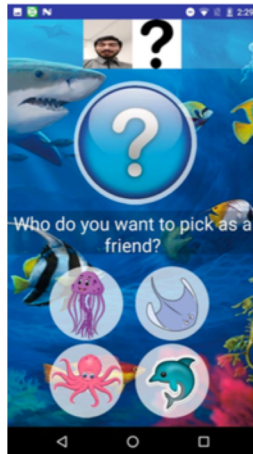
EYEDentify



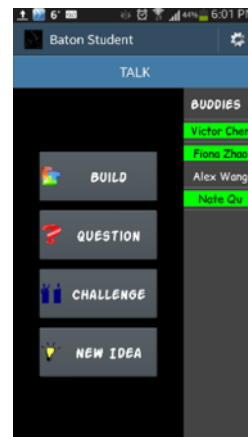
Mobile Stage



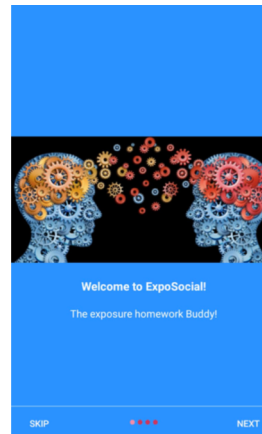
ASD Playdate



Trip Story



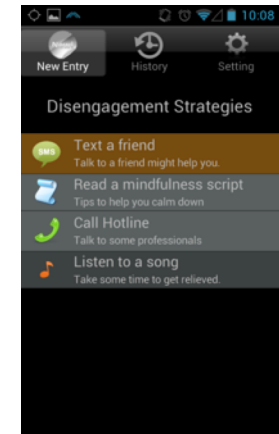
Baton⁽¹⁾



Expo Social



Practice Cactus



Mindful Me



ECE 1778: Creative Applications for Mobile Devices

Instructor: Jonathan Rose

Department of Electrical & Computer Engineering



Welcome!

- Advances in Mobile, Wearable, Internet and Machine Learning technology continue to change the landscape of many human endeavors
- Which kind of mobile device do you carry?
- Do you have some kind of wearable?



iPhone?



Android?



Purpose of this Course

To bring together people from different disciplines
to prototype novel and useful mobile applications

To Conceive and **Prototype** Interesting Projects
and
Learn in the **Doing**



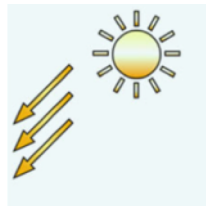
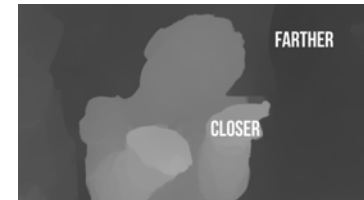
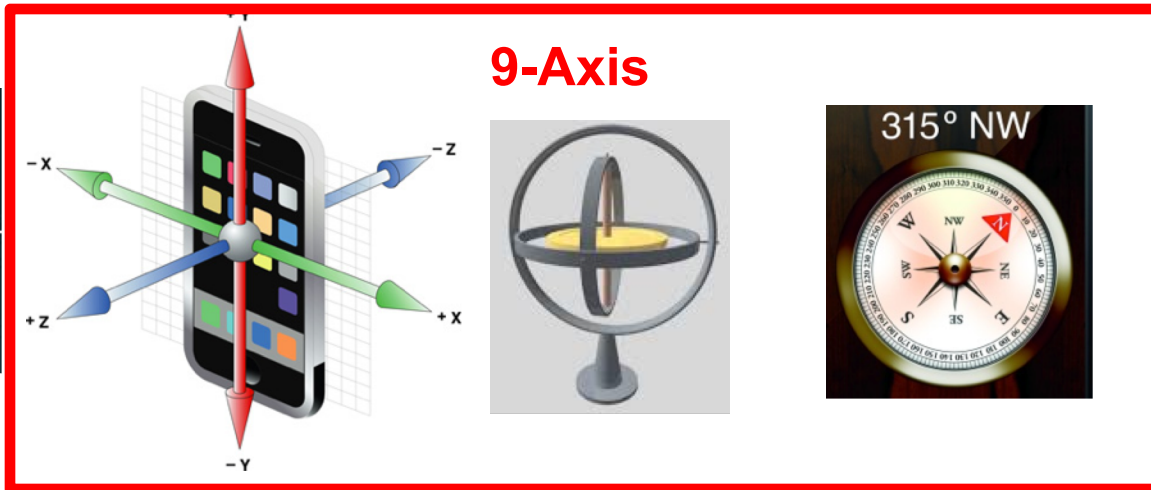
Mobile Devices are Incredibly Capable

Because they contain in one portable package:

- A powerful yet portable computer in your pocket
- Connected to the Internet
 - more knowledge, compute power & everyone else
- Can **sense** its environment in many ways
- Can **speak** to its environment in several ways
- Can also make phone calls



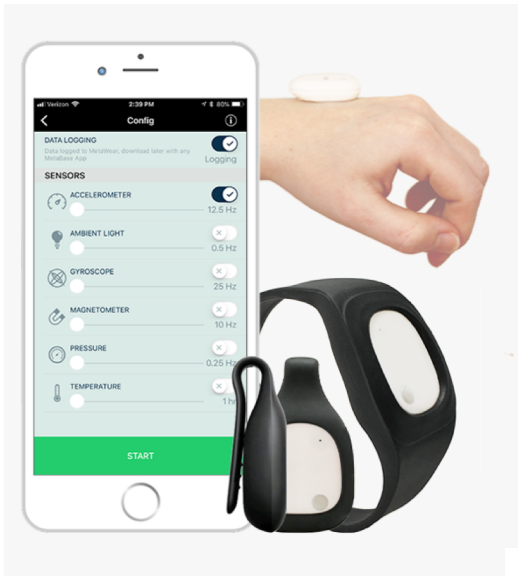
Mobile Device brings many things ...



(6)



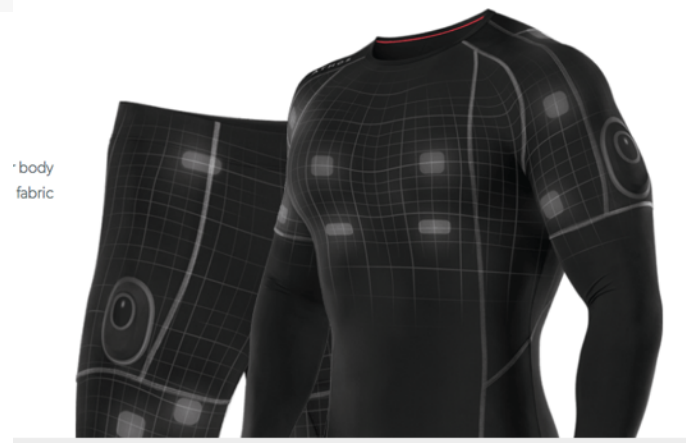
And in Connected/Wearables



Tile Mate



**Activity Trackers/
Health Monitors**



**Instrumented
Clothing**

Check This Out: \$35 Wireless Sensor

■ Texas Instrument's 'Sensor Tag'

- **Cost:** \$CAD 35
- **Bluetooth Connection**
- **Sensors:**
 - Accelerometer
 - Magnet sensor
 - Light sensor
 - Ambient temperature
 - Humidity
 - Two Buttons
 - Two lights



And With Web-based Software

Firebase

Products Use Cases Pricing Docs Support

Search Language Go to console

Firebase helps mobile and web app teams succeed

[Get started](#) [Watch the video](#)

Build apps fast, without managing infrastructure
Firebase gives you functionality like analytics, databases, messaging and crash reporting so you can move quickly and focus on your users.

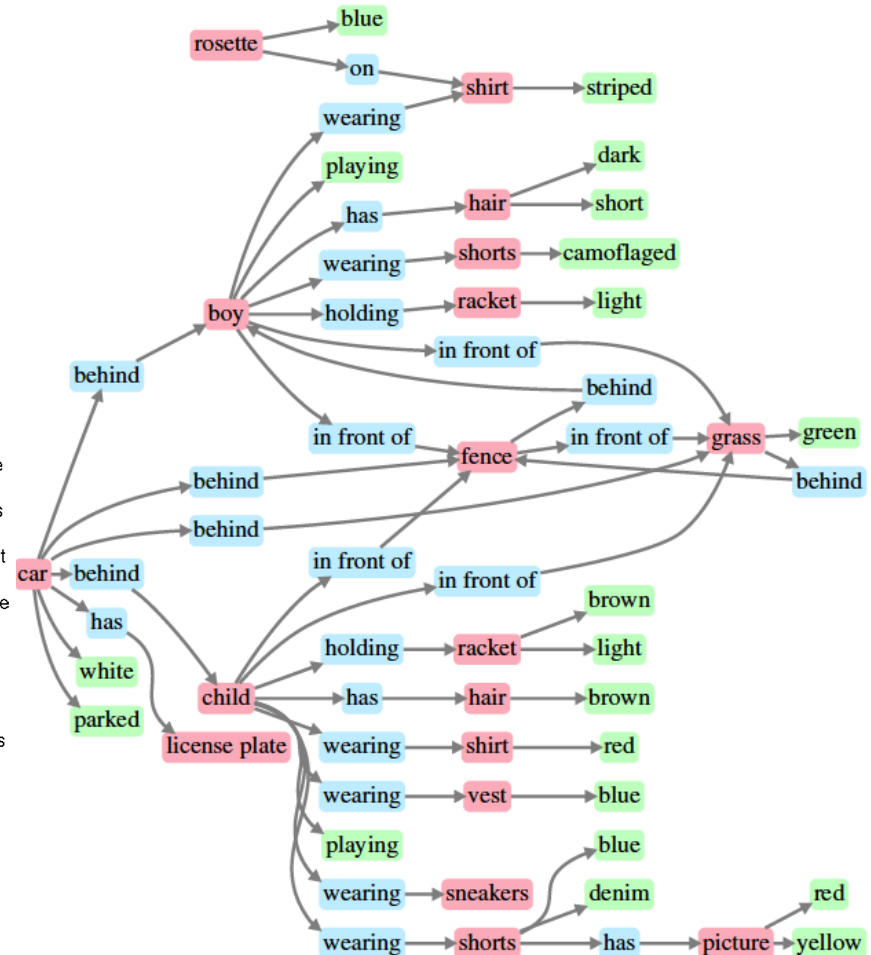
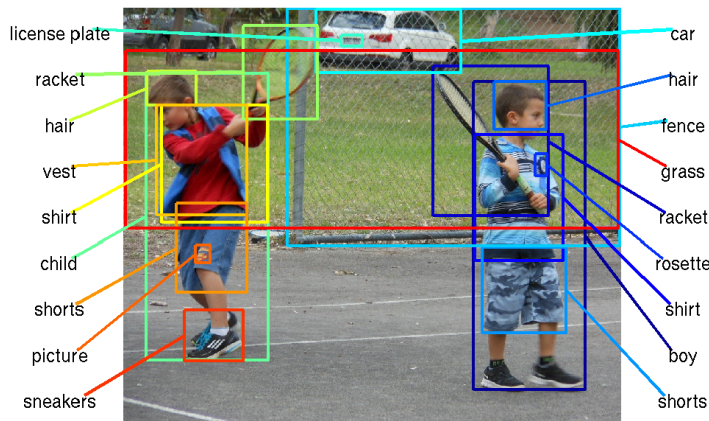
Backed by Google, trusted by top apps
Firebase is built on Google infrastructure and scales automatically, for even the largest apps.

One platform, with products that work better together
Firebase products work great individually but share data and insights, so they work even better together.

Firebase supports:



And Machine Learning



Johnson *et al.*, "Image Retrieval using Scene Graphs", CVPR 2015

Figures copyright IEEE, 2015. Reproduced for educational purposes



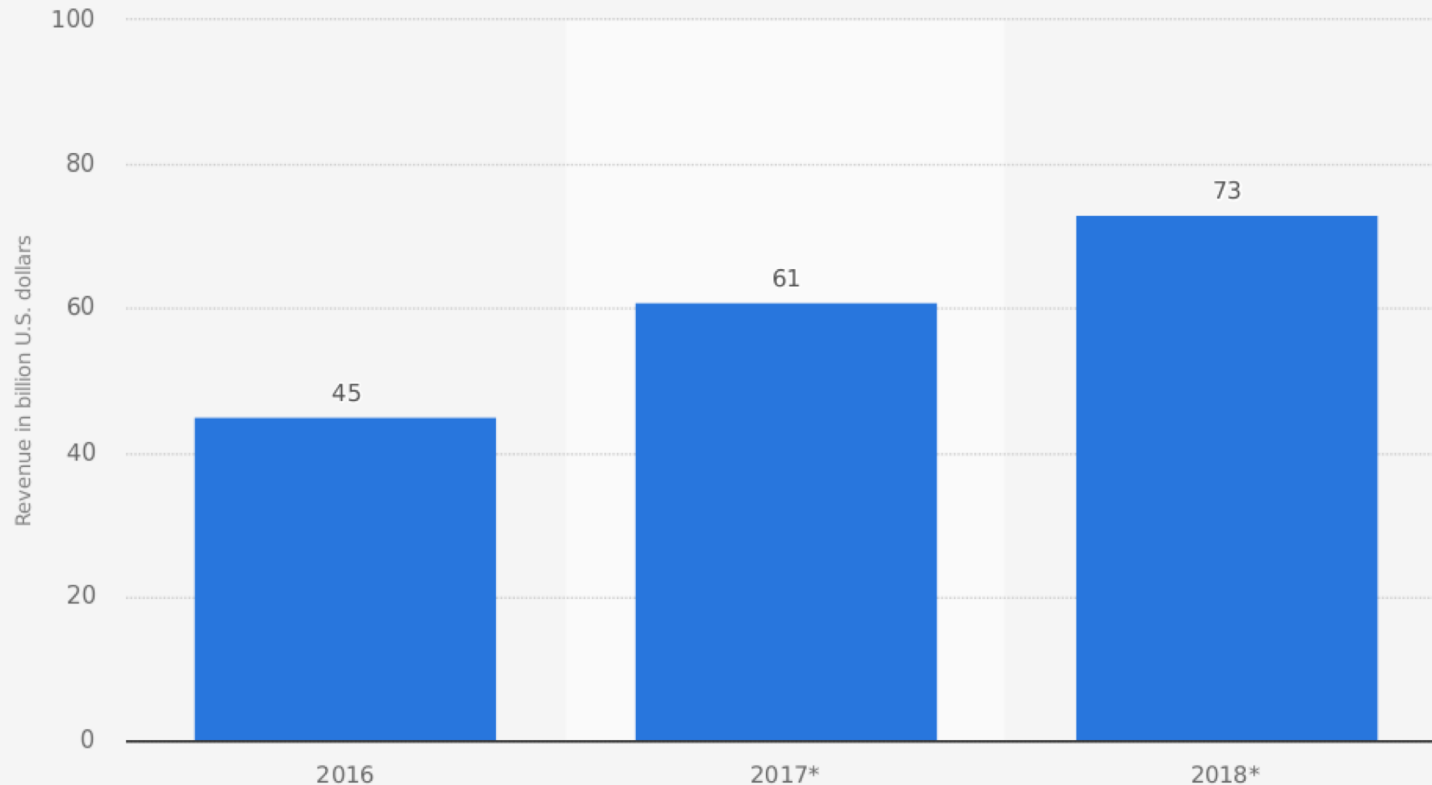
Given Rise to Thousands of Great Ideas

- Perhaps one of the greatest surges of creativity in human history has occurred in the past 11 years
- 1.8M Apps in Apple App Store
- 2.5 M Apps in Google Play Store



App Store Revenues are Rising

Combined global Apple App Store and Google Play app revenue from 2016 to 2018 (in billion U.S. dollars)



Sources

BMO Capital Markets; Investor's Business Daily Worldwide; BMO Capital Markets; 2016 to 2017

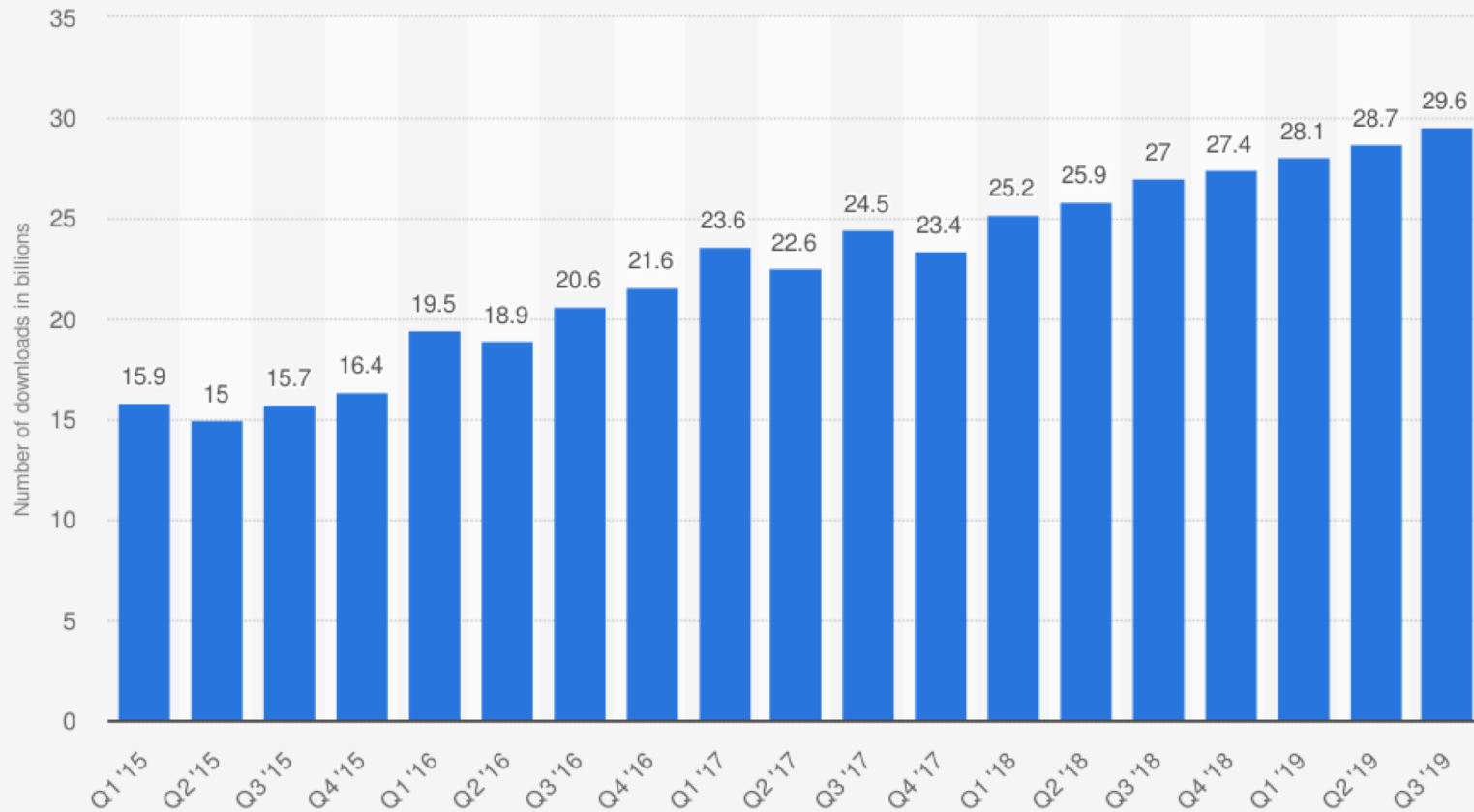
© Statista 2018

Additional Information:



App Store Downloads

Combined global Apple App Store and Google Play app downloads from 1st quarter 2015 to 3rd quarter 2019 (in billions)



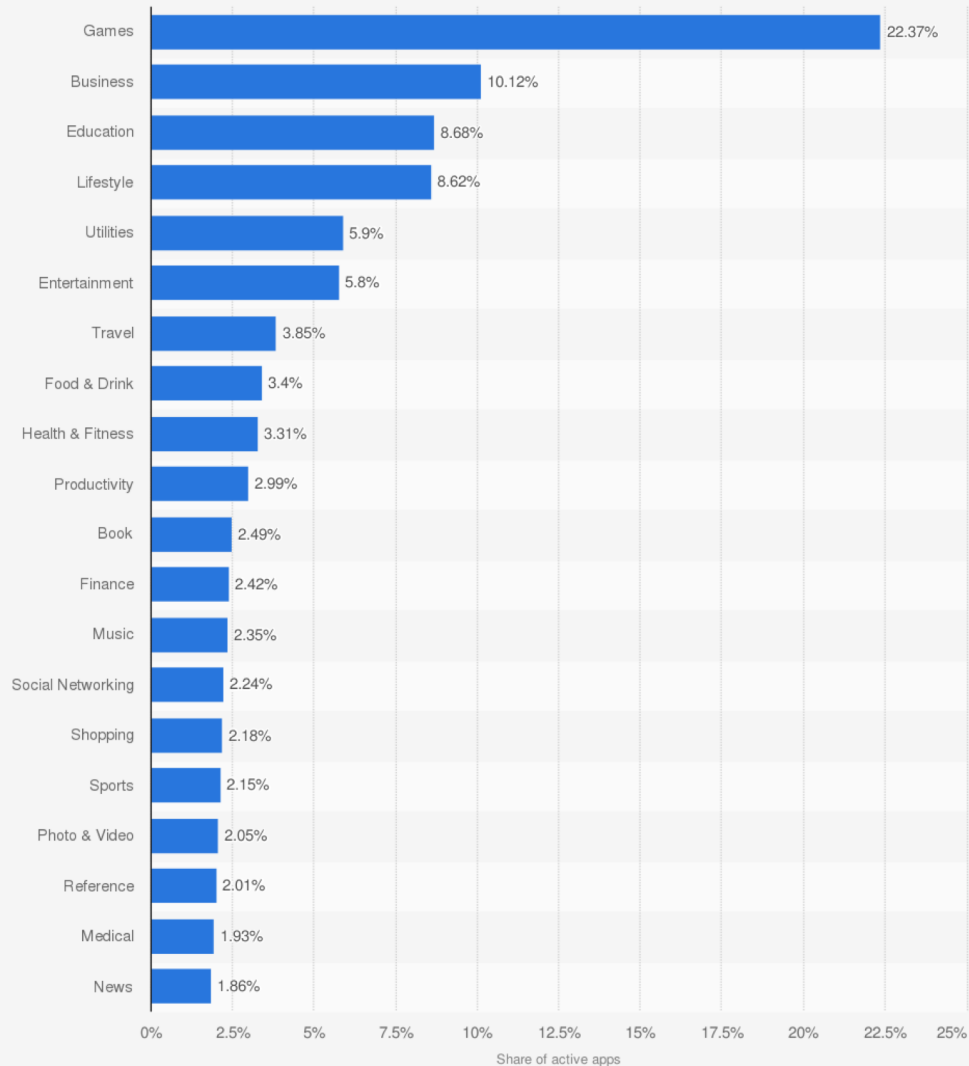
Source
Sensor Tower
© Statista 2019

Additional Information:
Worldwide; Sensor Tower; Q1 2015 to Q3 2019



Across a Wide Range of Areas

Most popular Apple App Store categories in November 2019, by share of available apps



There are Many More Great Ideas to Come

1. We are still not used to what is possible when all these elements are brought together
 - **We** are evolving
2. Regular progress in technology & software
 - Fierce competition: Apple, Amazon, Google, Huawei Samsung, Microsoft
 - Economics of large-scale market
3. Not Enough Expertise has been Combined with Tech
 - Experts + software & hardware folks
 - **That** is the purpose of this course!



A Few Example Projects

From previous years in this course



MyWalk

Measuring and Correcting Step-Time *Asymmetry*

Specialist: Justin Chee

Programmers: Tuck-Voon How

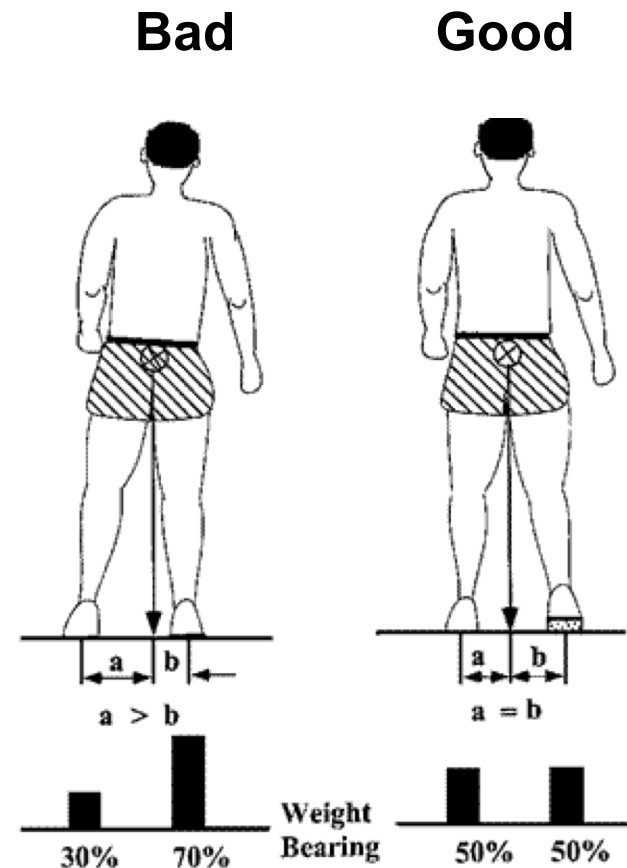
Eric Wan

April 2012



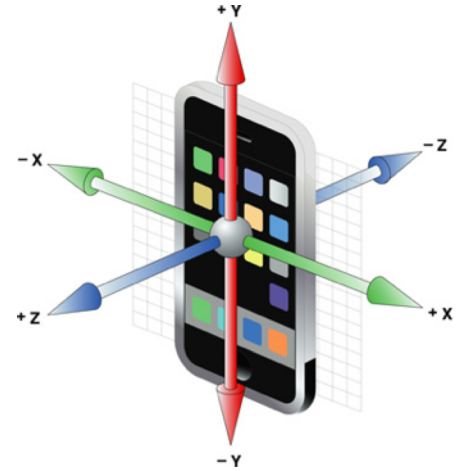
Walking Unevenly is Bad For You

- Asymmetric walking is caused by a stroke or other injury
- Has bad effects that worsen over time:
 - increased joint degeneration
 - Pain
- Can **measure** by measuring amount of **time** spent on each footfall



Measuring Step-Time Asymmetry

- MyWalk measures the amount of time spent on each foot using the **Accelerometer** in phone
- Phone is strapped to chest






My Walk

- Measures step-time asymmetry using **accelerometer**

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

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)

Corrective Action

- Helps person correct it by providing timing 'beeps'



Flip the Script

Learning Second Language with a Dual Language Book



Specialist: Sameen Ahmad

Programmers: Yuxin Cheng

Maosen Wang

April 2016

Flip the Script: Goal & Motivation

‘Flip the Script’ is a dual language storybook app. Children can read and engage in a story while making connections between English and their mother tongue. Features include:

- a) translation highlight**
- b) dialogue and questions**
- c) read-aloud**
- d) record your own**



MyAlly

Helping At-Risk Teens



Specialist: Sharon To
Programmers: Mario Badr
Ilona Wong

April 2014

(25)



MyAlly

- For Troubled Adolescents
 - Borderline Personality Disorder
 - With Suicidal Tendencies

- Uses ‘Dialectical Behaviour Therapy’
 - A cousin of ‘Cognitive’ Behaviour Therapy

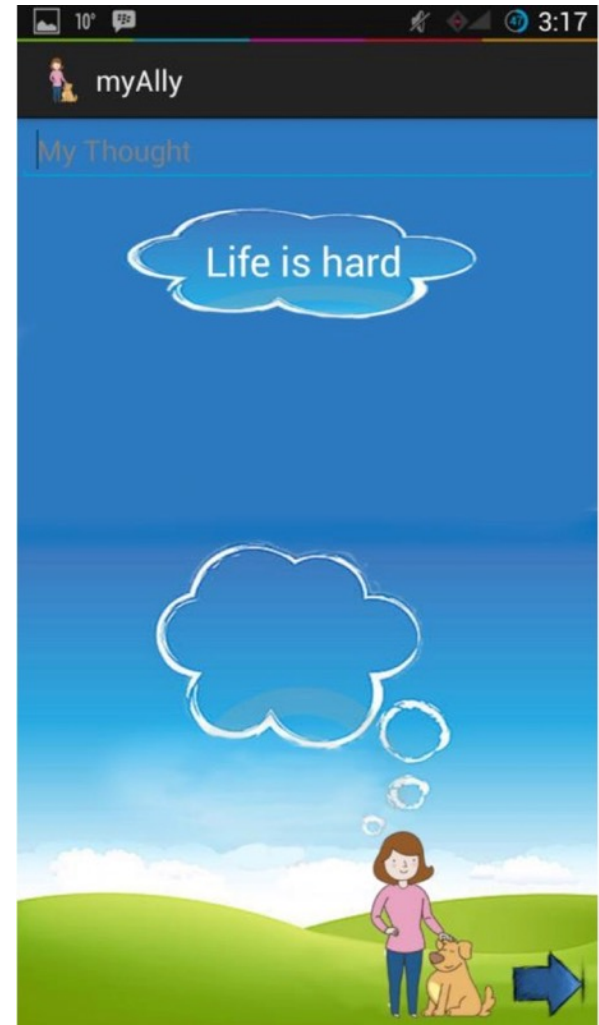
- Taken from known literature
 - Based on specialist’s expertise and knowledge

- Four modules/approaches:
 1. Mindfulness
 2. Distress Tolerance
 3. Emotion Regulation
 4. Interpersonal Effectiveness



Thought Diffusion Exercise

- Push unwanted thoughts away



(27)

Mind Jar Exercise

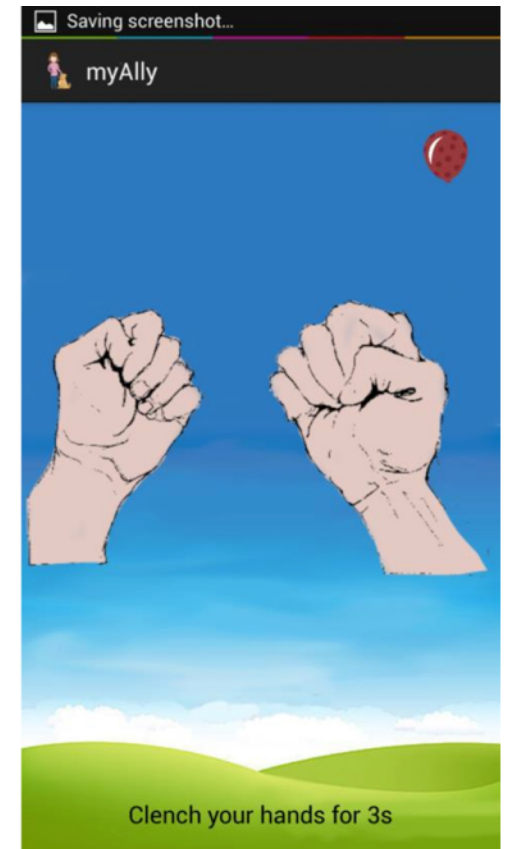
- Allow thoughts to settle



(28)

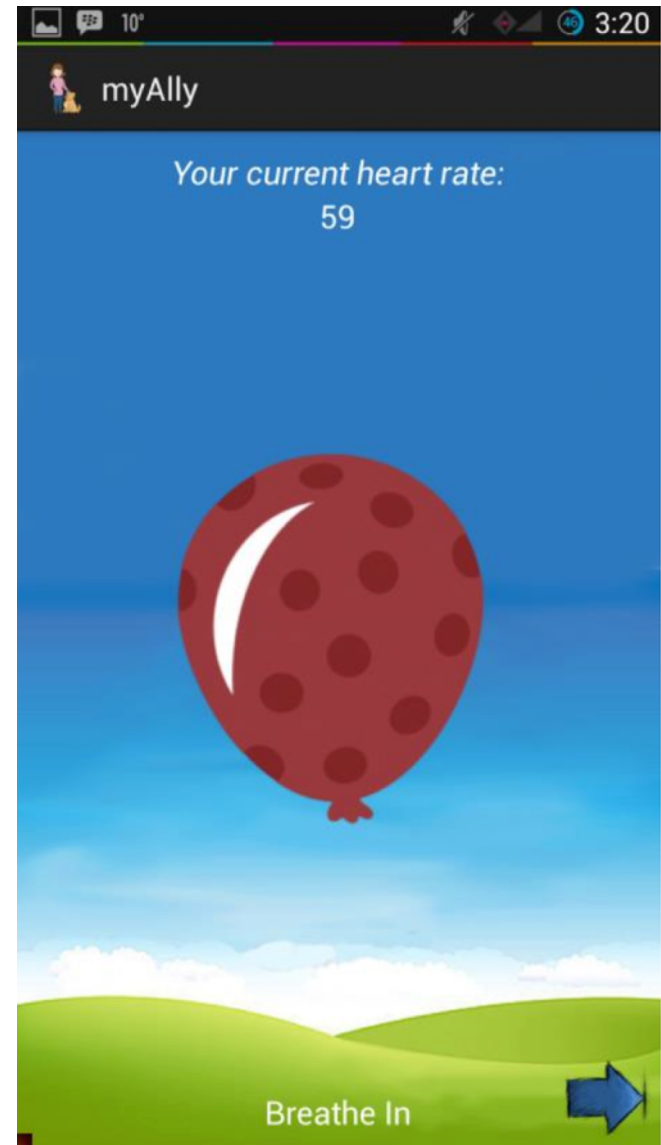
Muscle Relaxation Exercise

- Identify parts of body with mind
- Clench and relax



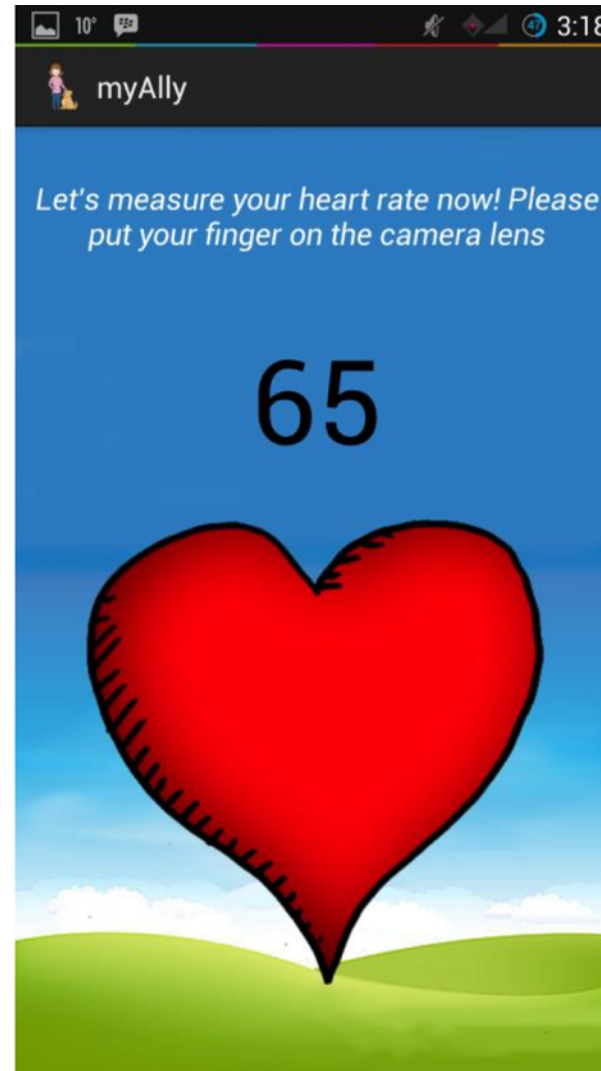
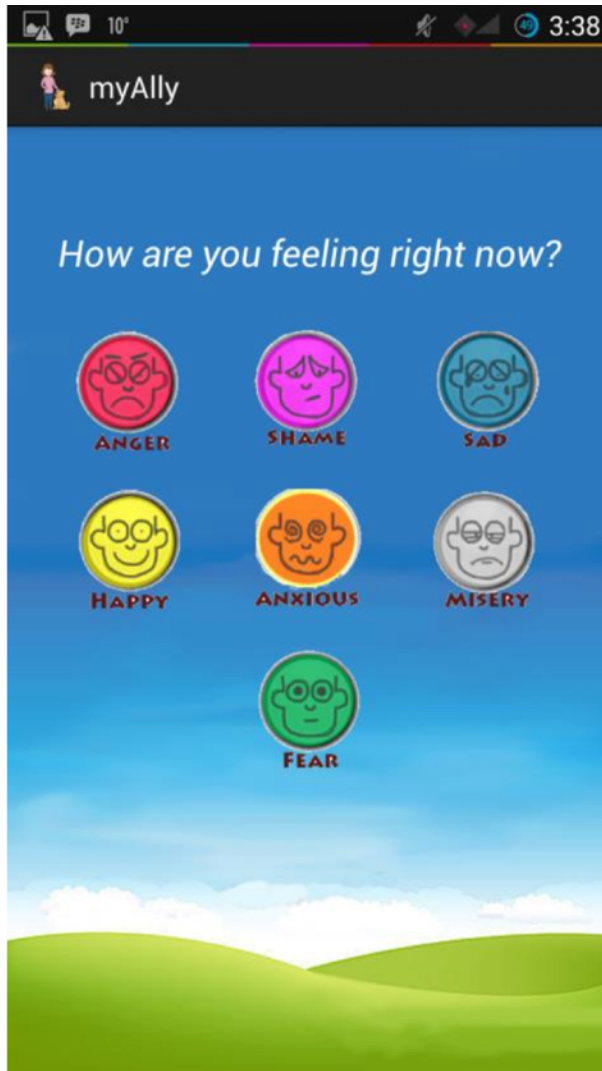
Breathing Exercise

- Balloon animates inflation/deflation to pace breathing to

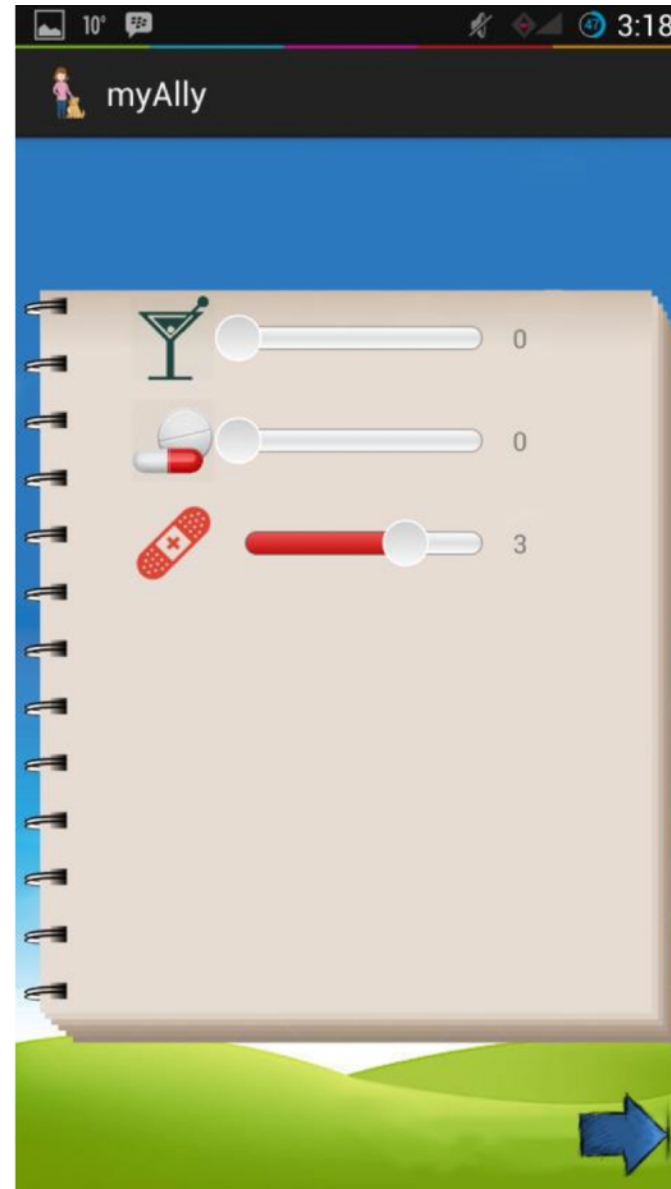


(30)

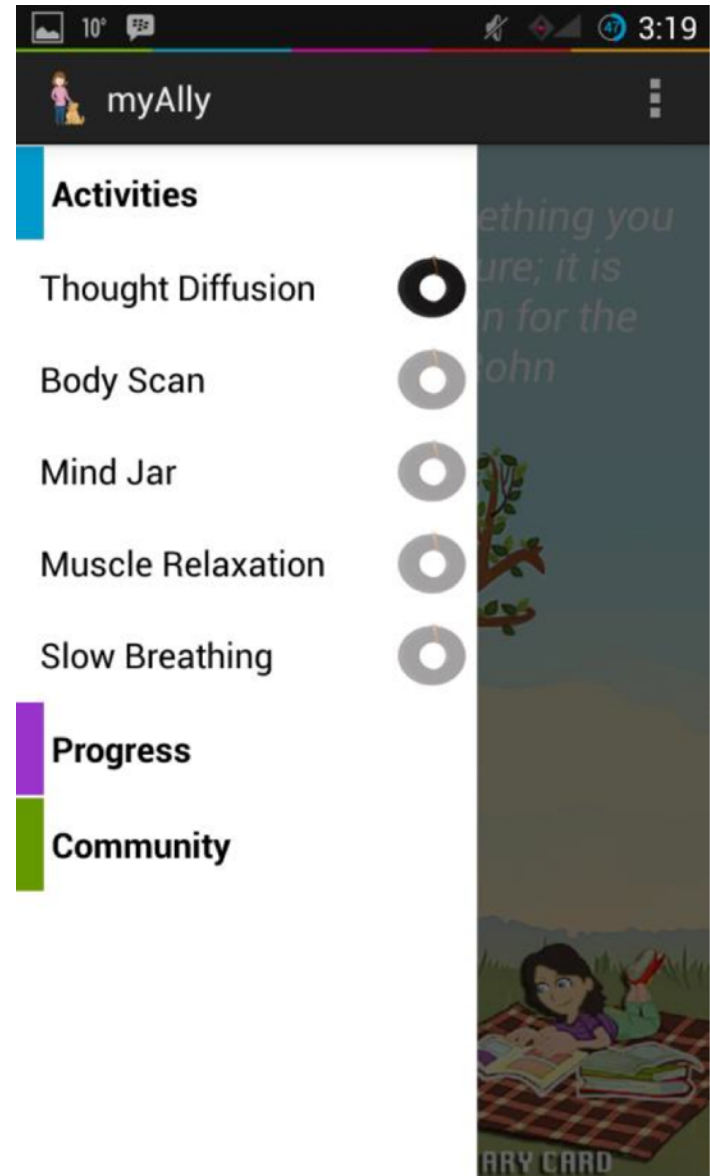
Emotion & Heart Rate Measurement



Emotion Characterization

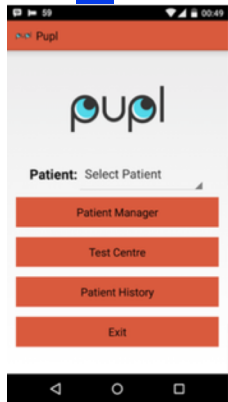


Main Screen

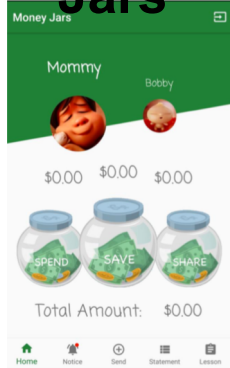


Other Sample Projects from Prior Years

PUPL



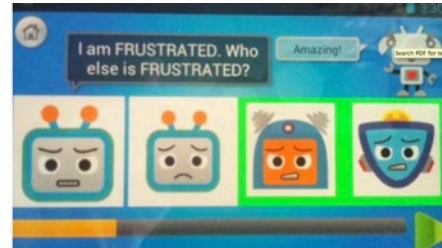
Money Jars



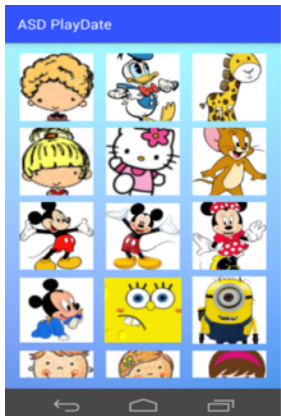
Speech Coach



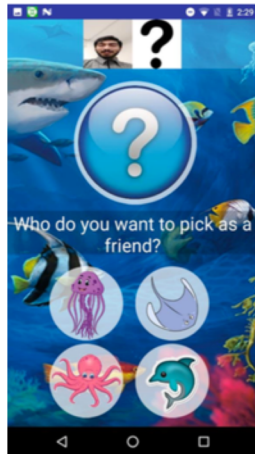
EYEDentify



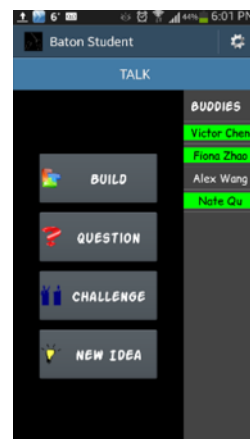
Mobile Stage



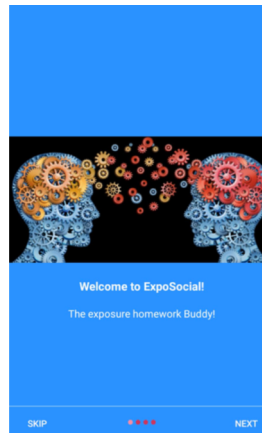
ASD Playdate



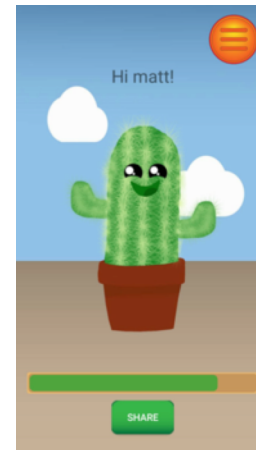
Trip Story



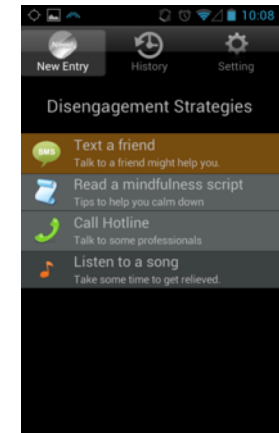
Baton⁽³⁴⁾



Expo Social



Practice Cactus



Mindful Me



Course Structure



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 software & other disciplines
 - Interactions between many disciplines
3. Experience in mobile programming & software project
 - Gain engineering project experience with hard deliverables
4. Effective Project Planning & Communication
 - Through experience and several in-class presentations



Two Kinds of Students in Course

1. 'Programmer'

- Engineering, Computer Science or other **graduate** students with **good** programming backgrounds
- 'Graduate-level' Programmers:
- Have undertaken **significant** programming projects in past – 1000+ lines of code
- Courses: well beyond introductory programming
- Including several of: Operating Systems, Software-based Data Structures and Algorithms, Graphics and significant software final year Capstone Design Project
- In assignment P1, Part I, you will describe software background
- **Why?** Our past experience in this course has shown that insufficient software background makes course impossible.



Two Kinds of Students

2. 'Specialist'

- Graduate Students from every discipline or external specialist
- With some computer literacy
- A desire to create new app, in art, science, engineering
- Willingness to learn basic app 'design' software
- YOU BRING EXPERTISE IN THAT DISCIPLINE



External Specialists

- Are Post-docs, Psychiatrists, Speech Pathologists and Professors, Journalists, Lawyers
 - Who are not registered students!
 - Who I have personally vetted
 - Who have agreed to commit the time necessary to guide the team as a specialist (and participate in presentations)
- Have been successful partners in all cases in the past



Example Specialists from the Past

- 9 years ago: **Wound Care**
 - Robert Fraser was a registered Nurse, M.N. candidate
- 7 years ago: **Mozart's Ear**
 - Andrea Stewart, M.A. candidate in Faculty of Music
- 6 years ago: **Baton**
 - Zack Teitel, High School Teacher, M.Ed. Candidate at OISE
- 4 years ago: **ASD Playdate**
 - Ian Roth, Speech Pathologist, Toronto Western Hospital
- 3 years ago: **HIt It!**
 - Dana Swarbrick, MSc candidate in Rehabilitation Sciences
- Last year: **Brain Pain**
 - Sandhya Mylabathula, PhD. Candidate in KPE



This Course is a Bargain/Agreement

- Between group of 2 programmers and 1 Specialist
 - Programmers bring skill and willingness
 - Specialist brings expertise and efforts
- Together you will arrive at an exciting project!
 - and work in partnership



Programmer or Specialist?

- All ECE and Computer Science students should be considered Programmers
- You may make a case (to me) that you wish to drive the application and **also** take the specialist role
 - because of a separate expertise
 - but should still take the **programmer** path through the course



Which Kind of Student are You?

Specialist or Programmer?



Declaration (non-binding)

Raise Your Hand if you are a Specialist

Raise Your Hand if you are a Programmer



Sign Up Sheets – Circulating

- Name
- Department/Field
- **Degree**
- Taking Course for credit
 - Yes or Maybe
 - Cannot audit without very special permission
- Full time or Part Time student
- Programmer/Specialist/external self designation
 - Can check both
- Phone Type: What kind of smartphone do you have?
 - Android/iPhone ... other



Course Learnings & Outcomes

- Knowledge & Experience
 - **Programmer:** Mobile/Web Software Experience
 - **Specialist:** 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
 - Dealing with tangible deliverables and hard deadlines
- **Clear, Concise Presentation Experience**
- Advance of Research Capability



Instructor Bio: Jonathan Rose

- Professor in Electrical & Computer Eng since 1989
 - Bach, Master's & PhD from UofT, Post-Doc at Stanford
- Research: Automation of Medicine/Mental Health
 - 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
- Administration:
 - ECE Dept. Chair of ECE 2004-2009;
 - Chair Engineering Entrepreneurship **Hatchery** Advisory Board
- F.IEEE, F.ACM, F.CAE, FA NAE, FRSC, Sr Fellow Massey College
- Board of Directors of *Academics without Borders*



Why I Began Teaching this Course

- I always felt that mobile devices would one day take a central role in human progress
- Am thrilled with possibilities of small, portable, highly integrated computers
- Has come to pass; still many interesting things to build!



Why I Am Still Teaching this course

1. The inter-disciplinary mixing has kept it interesting
 - Seems like an important thing, in an era of ever-more specialization
2. The project and communication learning is equally important
3. Software keeps getting more powerful, enabling all other disciplines to do more
 - Automation, enhancement



Teaching Assistants

■ Daniel Di Matteo

- TA'd course for 4 years
- Ph.D. Candidate in ECE
- Thesis: Inferring Mental Health using Mobile Devices
- dandm@ece.utoronto.ca

■ Kia Shakiba

- Took this course last year
- Ph.D. Candidate in ECE
- Thesis: Cloud-based Cache Optimization
- kia.shakiba@mail.utoronto.ca



The Project



The Project Group

- Done in Groups of 3
 - 2 Programmers
 - 1 Specialist

- OK to have groups of programmers-only
 - only if extra programmers, and only if no Specialists available



Rules on Project App

1. Subject **Must be in the Discipline of the Specialist**
 - an idea to support research
 - **or** something useful/worthwhile/interesting within the discipline
 - **must** leverage Specialist's expertise
 - to those who want to be both programmer & specialist: **wait**
 - Should first hear ideas
 - I will (mostly) enforce pure specialist-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 up Programmers, then together find Specialist
- Form group in 3 weeks; extra meet Wed Jan 22nd @6:30pm

2. Project Approval-in-Principle

- via email; due January 28th

3. Project Proposal/Plan

- Document Due February 5th

4. Proposal & Plan Presentations

- February 12th
- **NOTE EXTRA LECTURE Wed February 12th, 6-8pm**

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 15th

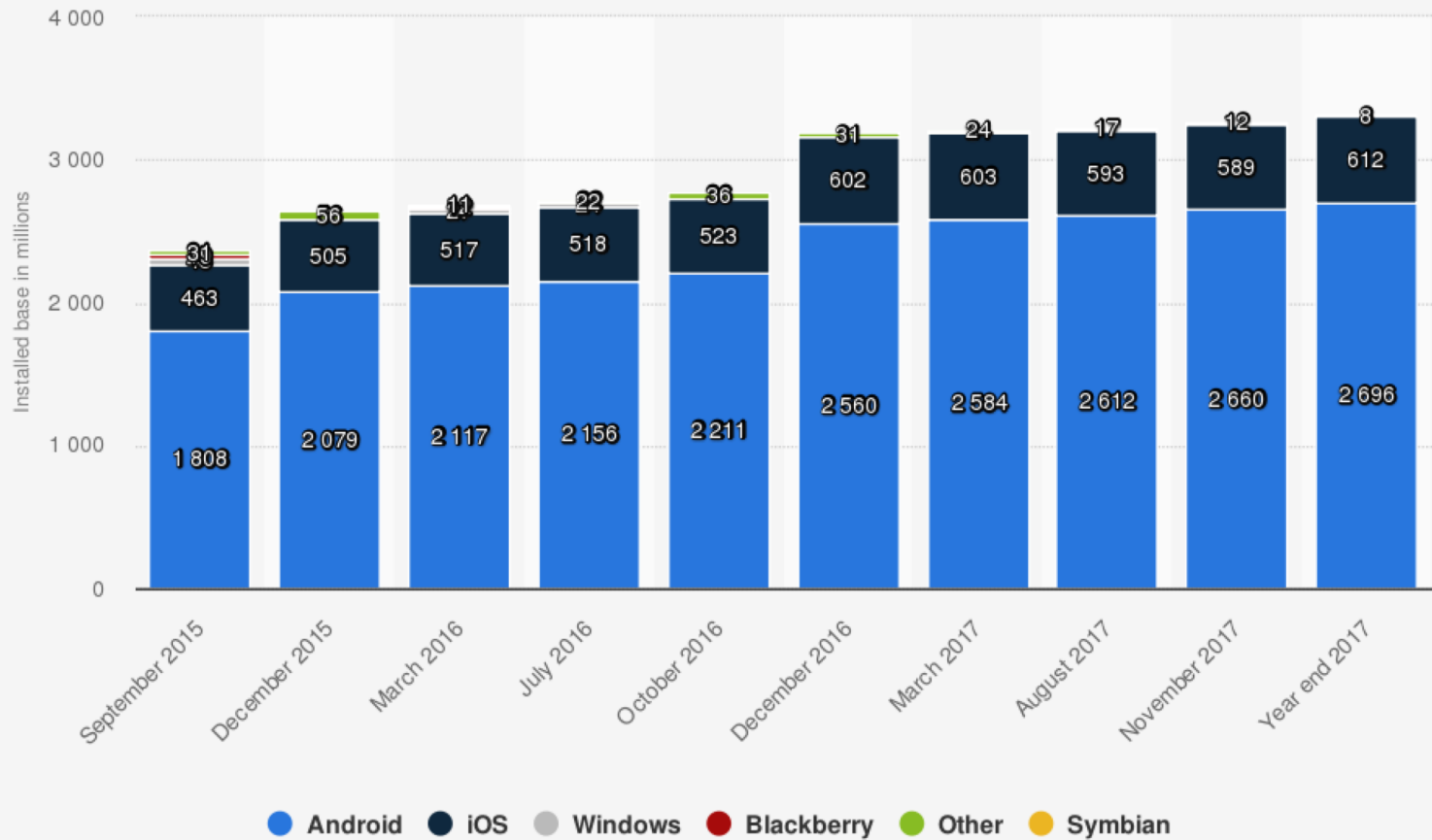


Which Platform – Android or iOS?



On the One Hand, the War is Over

Installed base of smartphones by operating system from 2015 to 2017 (in million units)



Source

Communities Dominate Brands (Tomi T. Ahonen)
© Statista 2019

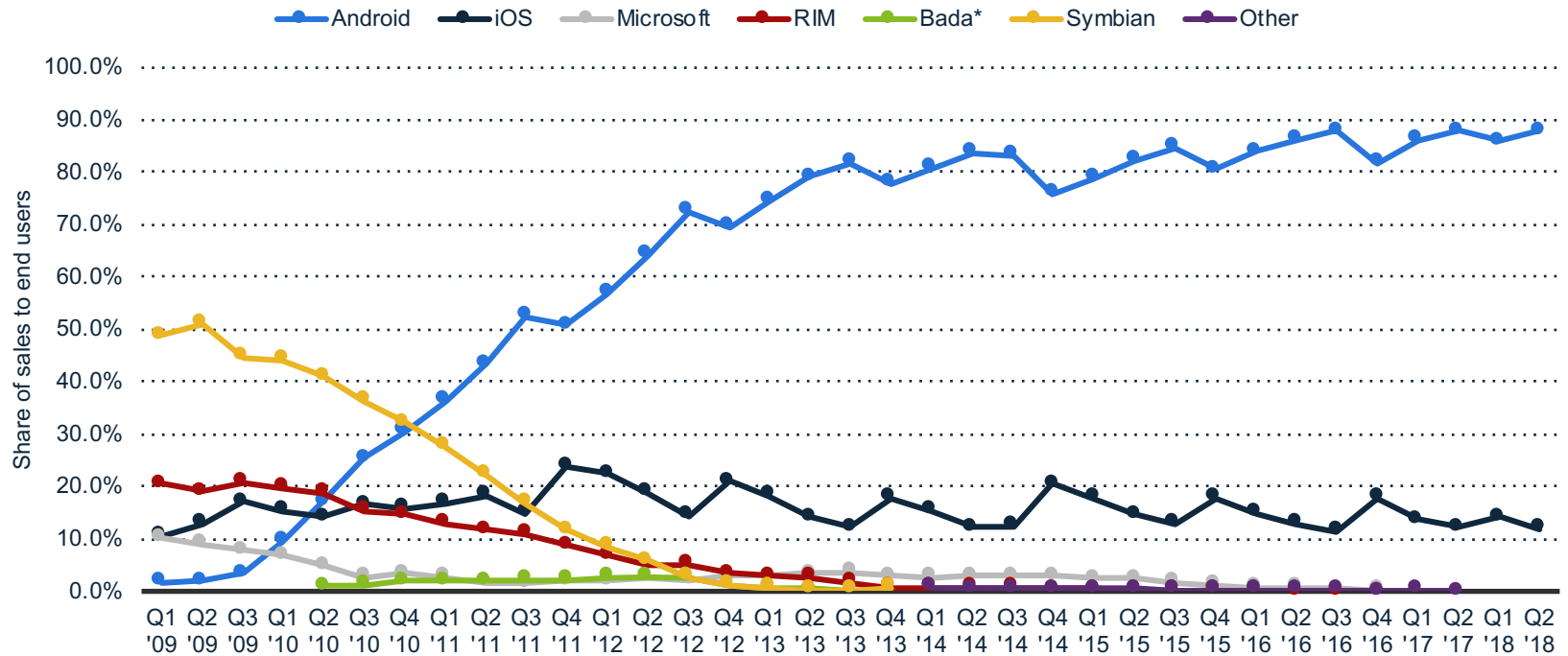
Additional Information:

Worldwide; Communities Dominate Brands (Tomi T. Ahonen); 2015 to 2017



Global market share held by the leading smartphone operating systems in sales to end users from 1st quarter 2009 to 2nd quarter 2018

Global market share held by smartphone operating systems 2009-2018, by quarter



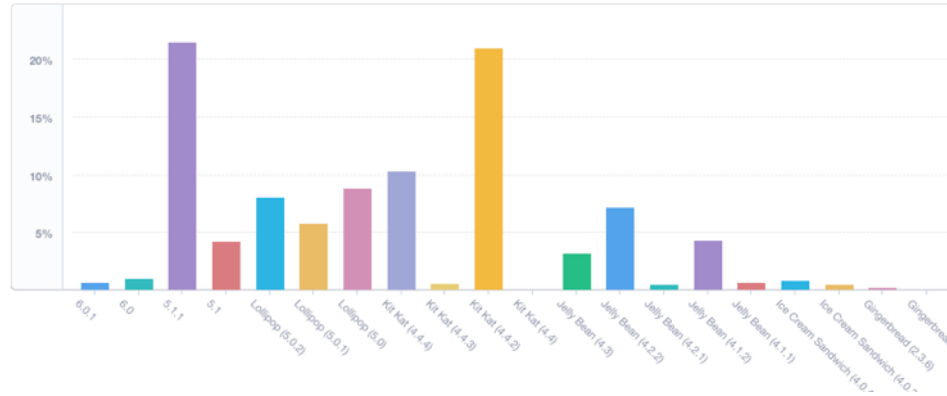
Note: Worldwide; 2009 to 2018
 Further information regarding this statistic can be found on [page 75](#).
 Source(s): Gartner; [ID 266136](#)



On the Other, Fragmentation vs. Adoption

Android OS versions

Nov 29th, 2015 - Dec 29th, 2015 DONE



**Android
Fragmentation**

iOS 9 adoption

Sep 1, 2015 - Dec 29, 2015 Hour Day



**iOS 9
Adoption**



Sam Vafae https://mixpanel.com/trends/#report/android_frag

https://mixpanel.com/trends/#report/ios_9

Like · Reply · 1 · December 7 at 5:27pm

**Former ECE Student
who works at Apple**



Other Relevant Facebook Comments



Bijan Vaez As a qualitative measure across our millions of users - we look at the graph mentioned in this article, then look at our own usage stats and realize we still have 60%+ iOS users on our platform. Our end users are general consumers from high school students to 60 year old surgeons. Our surveys indicate that most of the people who have an android do it because it's the defacto cheap standard and all they want to do is text, phone and maybe now & then check Facebook. From our surveys they do not install apps, have no idea what the google play store even is or what 'apps' do 😊 quite interesting.

Unlike · Reply ·  3 · December 7 at 5:48pm

Primary Mobile Platform: Android

- We will focus on the Android System because:
 - Widely available & can develop on all major operating systems (Windows, Mac, Linux)
 - Many phones available, some donated for class
 - Is successful
- Using Android Studio environment
 - Programming Language: **Java or Kotlin**



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: Swift 5
 - **Con:** Must have a Mac computer



Can do Assignments on Android or iOS

- **Important: your project partners must agree on OS**
- Other kinds of phone operating systems?
 - Not sensible at this point. ☹️
- What about cross-platform systems?
 - e.g. **React Native**; do not permit



Textbooks for Programmers

Android

By Mark Murphy:

1. The Busy Coder's Guide to Android Development v8.13
 - <http://commonsware.com>
 - Cost: \$20 for 6 month 'license'
 - Also suggest using the codelabs from Google:
 - <https://developer.android.com/courses/fundamentals-training/toc-v2>



iOS Textbook for Programmers:

■ Beginning iPhone Development with Swift 5

- by Wallace Wang
- Free download if you are inside the University of Toronto network:

<https://link.springer.com/book/10.1007/978-1-4842-4865-2>



Course Material




Three Course Websites:

- <http://www.eecg.utoronto.ca/~jayar/ece1778/>
 - Has link to videos & reports from previous years' projects
 - Assignments will be placed here
 - Lectures posted here
- UofT Quercus for basic stuff
 - Grades
 - Announcements
 - Assignments also released here, handed in here
- **Piazza** website for interaction & upload
 - See announcement on Quercus that tells you how to access
 - Email me if you don't have access to Quercus & I will add you



Course Material

■ Lectures

- Basic phone capabilities
- Thinking/discussion about how to use capabilities in project
- **No programming** 
 - Please be clear on this, programmers
 - TAs are available to guide, **but** you're expected to learn on your own
 - This is not an undergraduate programming course
- Project basics: block diagrams
- Case Studies of interesting/inspiring apps
- Guest Lecture:
 - Design for User Experience



Course Material, cont'd

- Mostly presentations from class
 - proposal, progress x2, final
- Assignments ...
- Meetings with your Project Partners!



Assignments!

Part 1: Due next week: **Tuesday** January 14, 6pm

Part 2: Due in 2 weeks: **Tuesday** January 21, 6pm



Programmer Assignment P1

Describe Programming Background
& Introduce Yourself

Instagram Login and Profile



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)
- I 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
- Indicate what areas of projects you'd like to work in



Prog Assign Part 1: Describe Yourself

- Upload both on **Piazza**
 - Put video on YouTube, link in to Piazza
- Purpose
 - for **Specialist** to get to know you;
 - for us to check that your background is sufficient
- Part I is due **Tuesday** January 14th, at 6pm
 - However, do it right away, so people can get to know you!
 - Late penalty



Assignment P1, Part 2

- Acquire textbook – Android or iPhone
- **Android: Need some basic Java knowledge**
 - Get a Java book
 - http://en.wikibooks.org/wiki/Java_Programming/Language_Fundamentals
- Download Android Environment
- Walk through initial Android Websites; read/skim Text
- **Instagram Login and Profile Page**
- Part 2 due Tuesday January 21st, 6pm; late penalty
 - Assignment posted under Assignments in Quercus and Course:
<http://www.eecg.utoronto.ca/~jayar/ece1778/assignments.html>



Specialist Assignment S1

Introduce Yourself
Explore Apps in Your Field



Specialist 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
- A rough idea of what you're thinking about as an App



Specialist Assign Part 1: Describe Yourself

- Upload both on **Piazza**
 - Put video on YouTube, link in to Piazza
- Purpose
 - for Programmers to get to know you;
 - for us to establish your field of expertise
- Part I is due **Tuesday** January 14th, at 6pm
 - However, do it right away, so people can get to know you!
 - Late penalty



Assignment S1 for Specialists, 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 **Tuesday** January 14, 6pm; late penalty
 - Part 2 due **Tuesday** January 21, 6pm; late penalty
 - Available on Course Website
<http://www.eecg.utoronto.ca/~jayar/ece1778/assignments.html>
 - Hand in on Quercus Assignment Page



Other Assignments

Programmers:

Date Assigned	Assignment	Due
January 22	P2	February 4
February 5	P3	February 19

Specialists:

Date Assigned	Assignment	Due
January 22	S2	January 28
January 29	S3	February 11
February 12	S4	February 19



Grading

■ Assignments: **20%**

- 3 for Programmers
- 4 for Specialists

■ Project: **80%**

- Proposal/Plan (incl presentation) 10%
- Spiral 2 Presentation 10%
- Spiral 4 Presentation 10%
- Final Presentation/Demo 10%
- Final Report 20%
- Individual Contribution 15% [included in group report]
- Peer Review 5%



Peer Review

- Each individual student will be asked to provide feedback to other groups on each of **three** presentations
 - Proposal
 - Spiral 2
 - Spiral 4
- You will be assigned to 1 group each period
- Asked to provide specific, useful feedback to that group's presentation
- Your feedback/commentary will be graded for quality
 - By the group it is about
- Has side effect that you must attend all classes, not just the one that you'll be presenting in.



A Note to ECE M.Eng Students

- Raise your hand if you are in ECE and the M.Eng (professional master's) program
 - How many are full time/part time
- ECE does not limit the number of courses you can take.
- However, other ECE grad students are not allowed to take more than 3 courses in a term.
- You should not take this course if plan to take more than three courses per term. It is too much work.
- If you are part-time (presumably with a full-time job?) then you should not take more than this one course.
 - I suggest that all prospective project partners ask each other what their course load is;



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: scope of project is *broader* than those apps that are commercializable
 - Apps can be motivated by research, curiosity & not-for-profit 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 other people make contributions – supervisors, or UofT employees, then UofT rules will apply
- Law of the land does apply – all inventors have rights



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
- My advice: don't get too caught up in worrying about IP during this course
 - If you don't believe this, talk to me afterwards, there is more to say



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 22nd at 6:30pm**
 - Location: Rosebrugh Building Room 208**
- We will use the remainder of this lecture for introductions



Suggestion for Team-Forming

- Programmers first 'pair-up' with compatible partner
 - Do this by mid-next week
- Then seek mutually agreeable Specialist & project
 - Needed the week after
- When contemplating projects, feel free to communicate with us (myself and all TAs) for fast feedback



Please Introduce Yourself

1. Name
2. Discipline you work in & degree sought
3. Taking Course for Credit – yes or maybe?
4. Part time or full time student?
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. **Specialist:** What idea, if any yet, you have for an app
10. **Programmer:** What areas are you interested in?

