Creative Applications for Mobile Devices
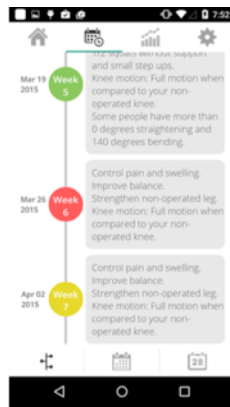
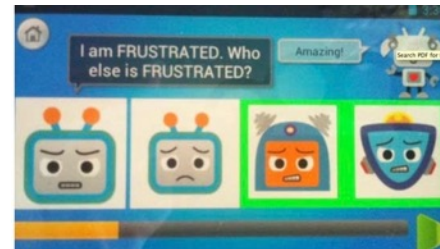**PUPL**
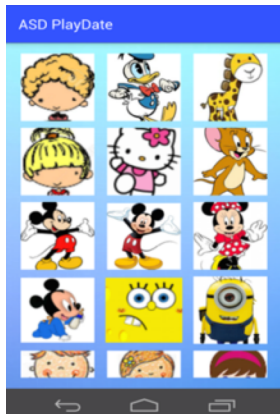
MyACL

Speech Coach

EYEDentify

Mobile Stage

ASD Playdate
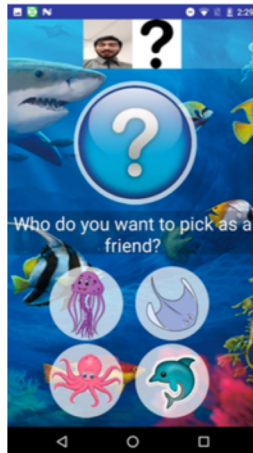
Trip Story
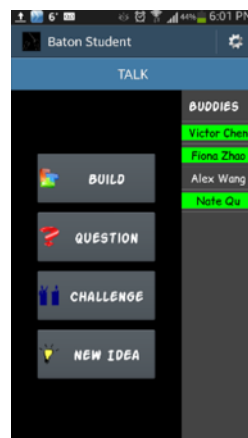
Baton [1]
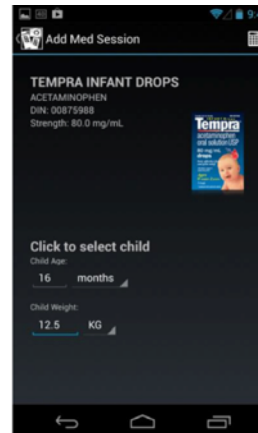
Snap N Dose

Practice Cactus
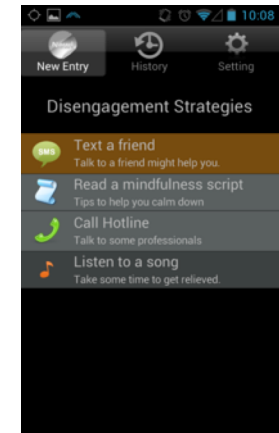
Mindful Me

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 continues 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 Engineer Interesting Things
and
Learn a lot in the Process

Mobile Devices are Incredibly Capable

Because they contain in one portable package:

- A powerful computer you can carry in your pocket
- 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

Many Capabilities in Mobile Device
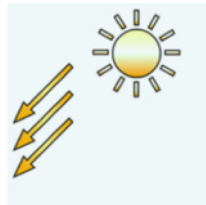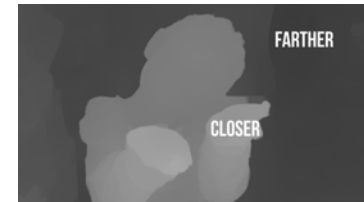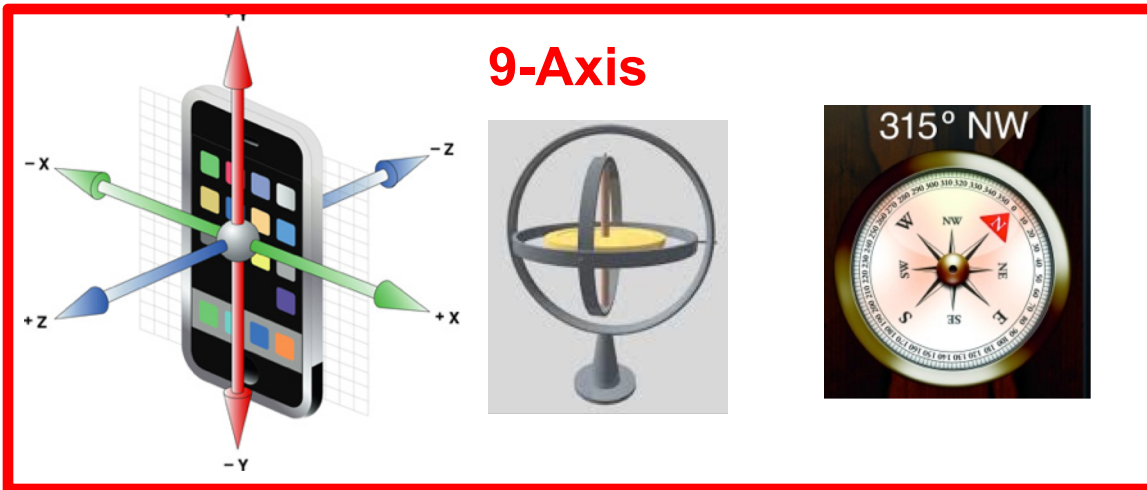
9-Axis

(6)

And in Connected/Wearables

NODE
Wireless Sensor Platform

LUMA OXA
CLIMA THERMA
CHROMA

A Sensor for Every Application

TrackR

**Activity Trackers/
Health Monitors**

body
fabric
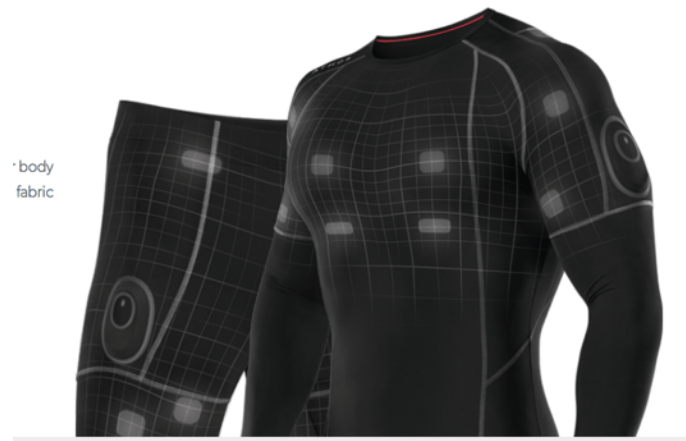
**Instrumented
Clothing**
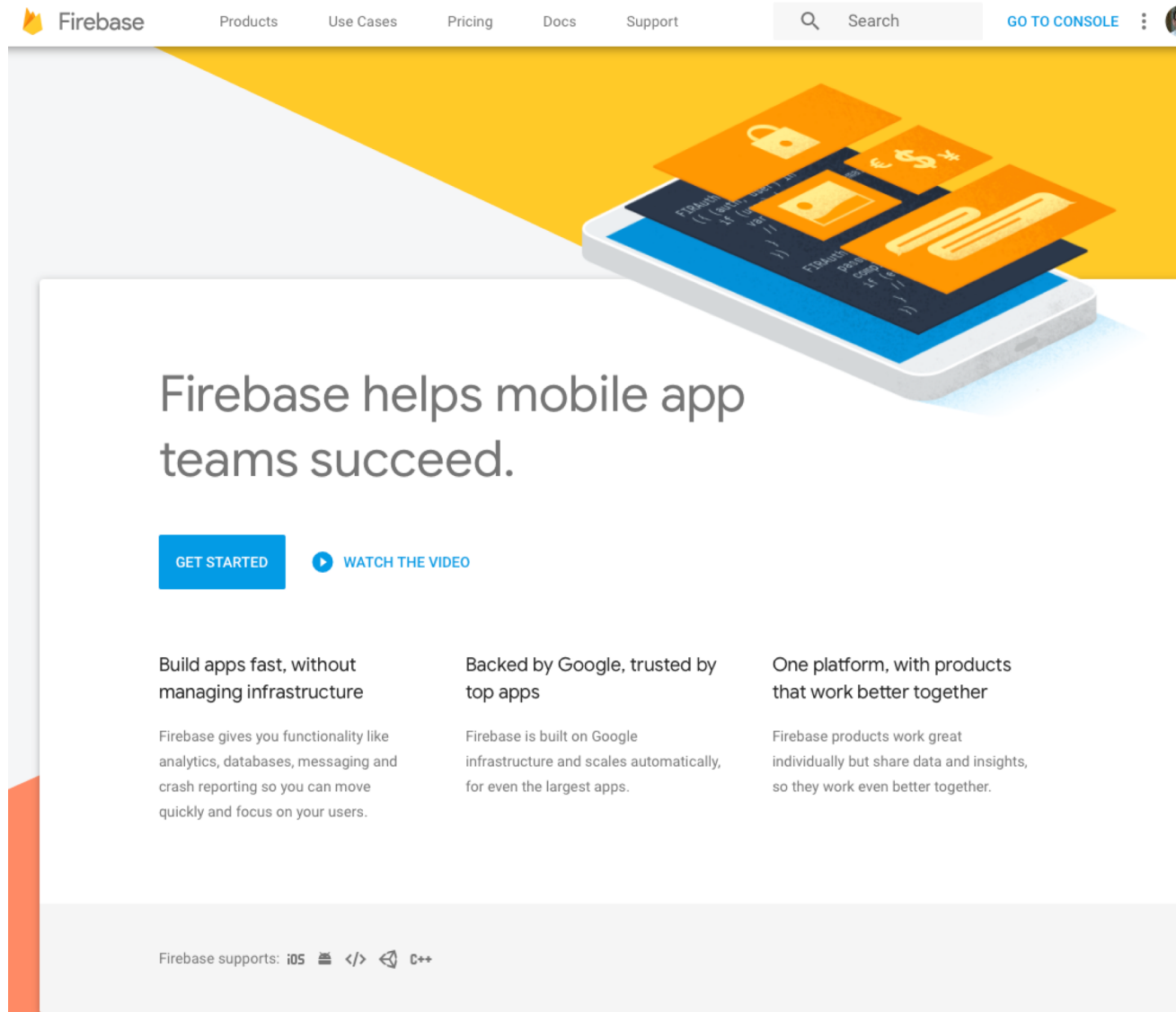
Check This Out: $29 Wireless Sensor

- Texas Instrument's 'Sensor Tag'
  - **Cost:** $35
  - **Bluetooth Connection**
  - **Sensors:**
    - 9 axis
    - Magnet sensor
    - Light
    - Ambient temperature
    - IR temperature
    - Humidity
    - Air pressure
    - Two Buttons, two lights, quiet buzzer!
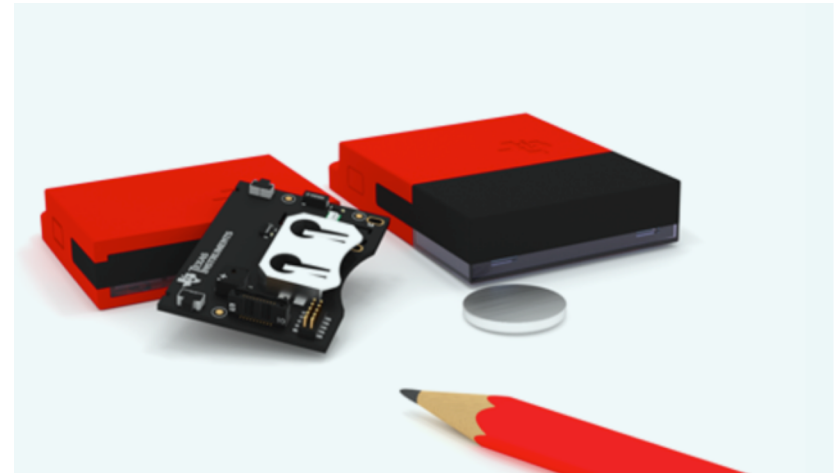
And With Web-based Software

And Machine Learning

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

Given Rise to Thousands of Great Ideas

- Perhaps one of the greatest surges of creativity in human history has occurred in the past 10 years
- 2M Apps in Apple App Store
- 2.1 M Apps in Google Play Store
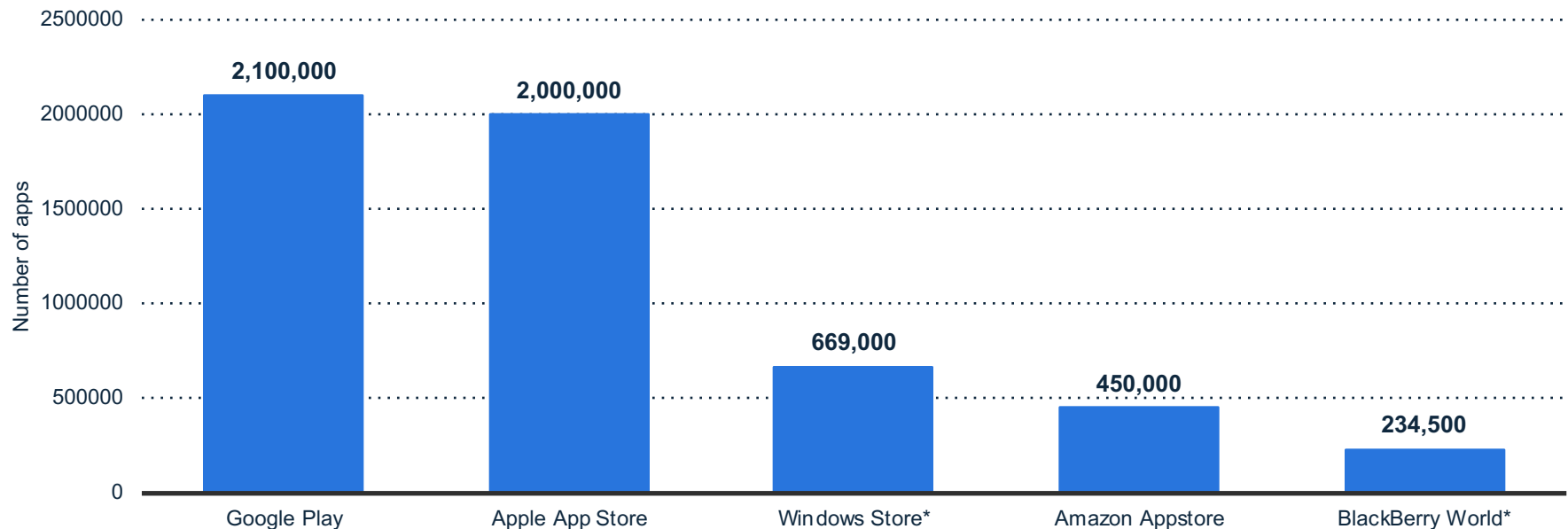
App Store Revenues are Rising

Worldwide mobile app store revenues in 2015, 2016 and 2020 (in billion U.S. dollars)

Total global mobile app store revenues 2015-2020
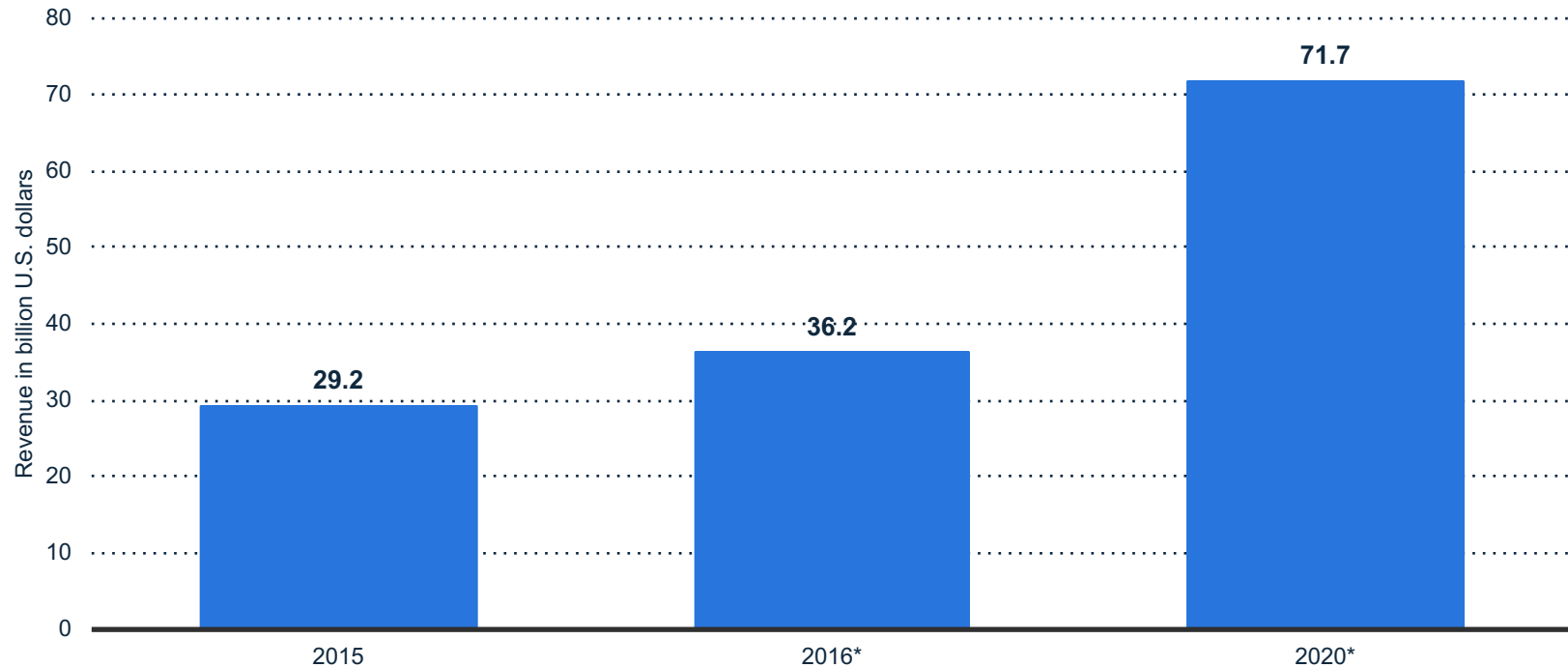
Note: Worldwide; 2015 to 2016
Further information regarding this statistic can be found on page 56.
Source(s): App Annie; ID 220186

Overview

Across a Wide Range of Areas

Most popular Apple App Store categories in September 2018, by share of available apps

Most popular Apple App Store categories 2018

Share of active apps

Category	Share
Games	24.86%
Business	9.77%
Education	8.5%
Lifestyle	8.32%
Entertainment	6.03%
Utilities	5.06%
Travel	3.9%
Health & Fitness	3.01%
Book	2.92%
Food & Drink	2.89%
Productivity	2.66%
Music	2.48%
Finance	2.27%
Photo & Video	2.2%
Reference	2.17%

Cropped Version
Double click to open excel file with complete data
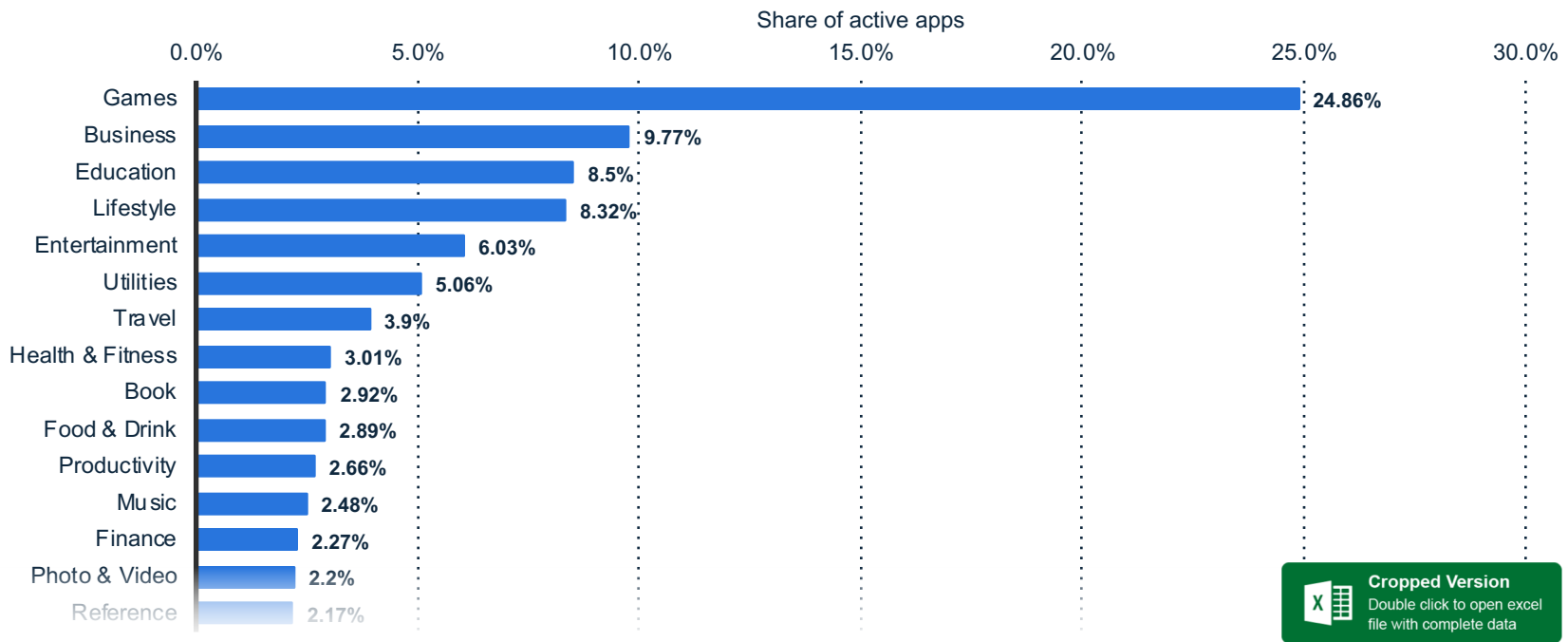
Note: Worldwide; September 2018; current active applications
Further information regarding this statistic can be found on page 81.
Source(s): PocketGamer.biz; ID 270291

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Apple App Store

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. <u>Regular</u> progress in technology
   - Fierce competition: Apple, Samsung, Google, Huawei …
   - 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

(16)

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

Bad   **Good**
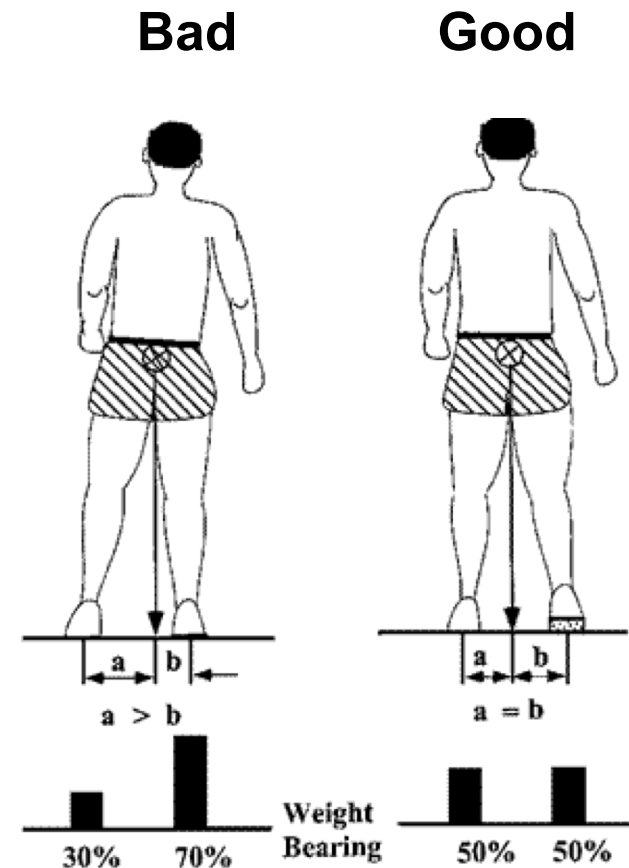
Measuring Step-Time Asymmetry

- MyWalk measures the amount of time spent on each foot using the **Accelerometer** in phone

- Phone is strapped to chest

Place phone in harness.

Ensure that the screen is facing your body. ⚠
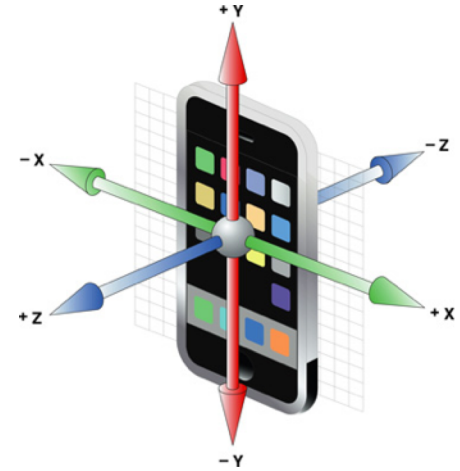
My Walk

- 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

(23)

MyAlly

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

- **Uses 'Dialectical Behaviour Therapy'**
  - A cousin of 'Cognitive' Behaviour Therapy

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

Exercises to Help Stress and Worries

1. Balloon Breathing
2. Muscle Relaxation
3. Mind Jar
4. Thought Diffusion
5. Diary Card
6. World Community

- <u>Taken from known literature</u>
  - Based on specialists expertise and knowledge

Main Screens
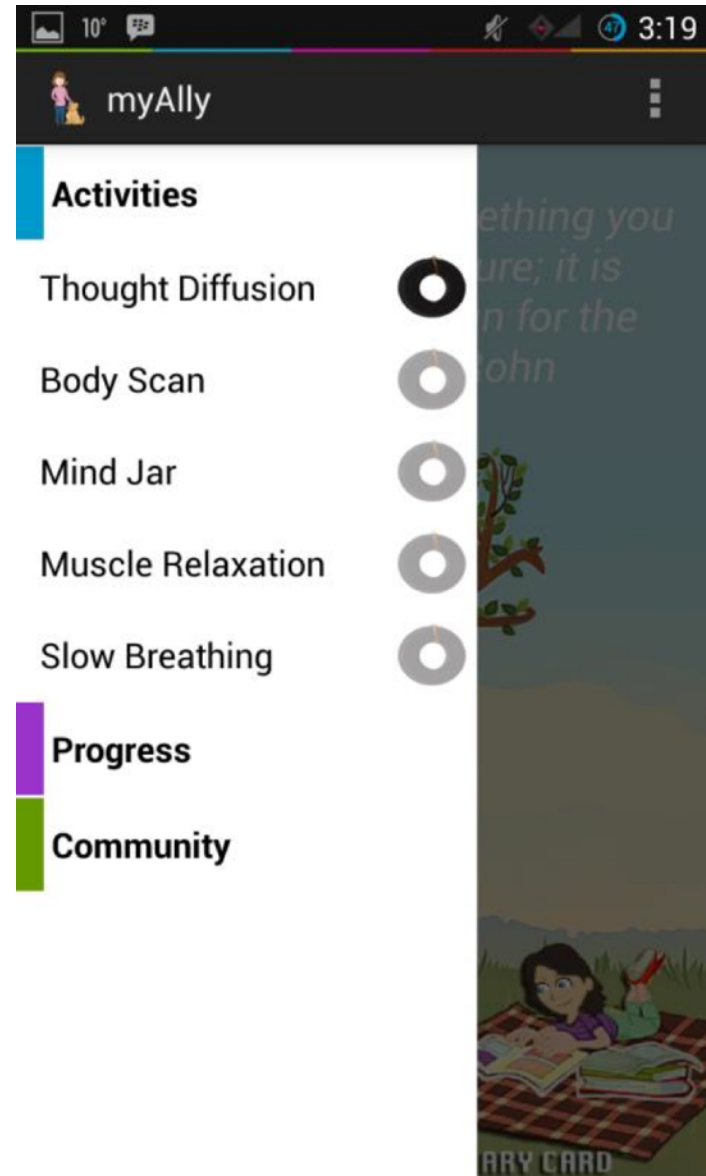
Emotion Characterization
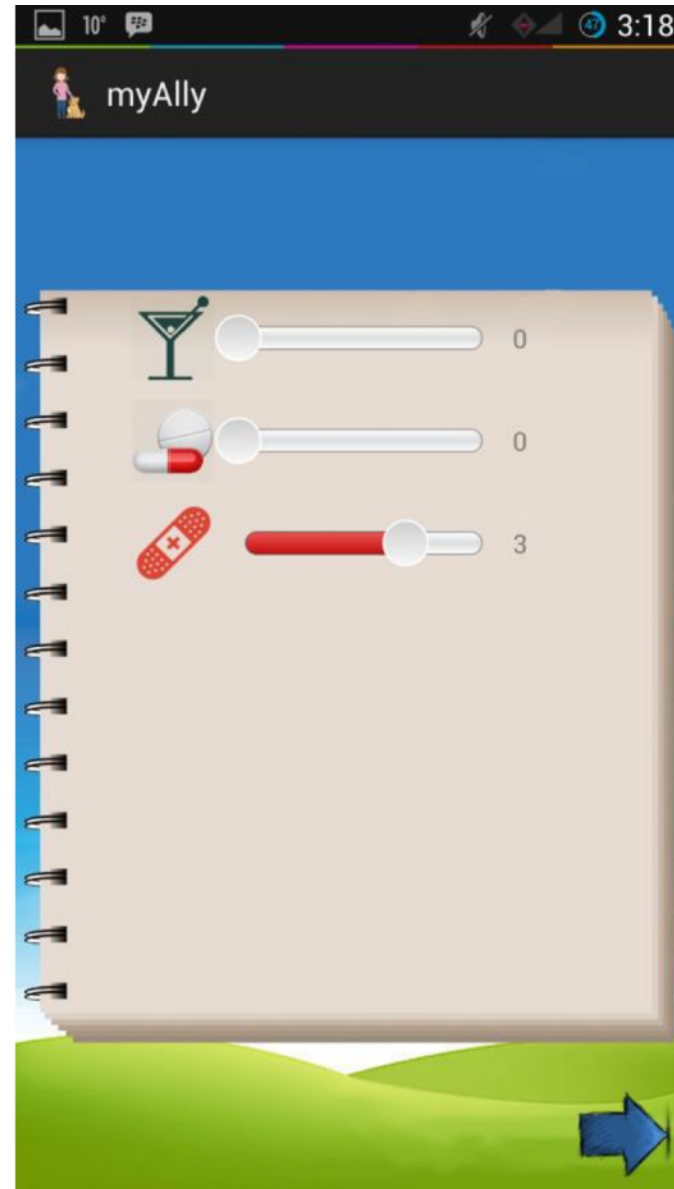
Emotion & Heart Rate Measurement
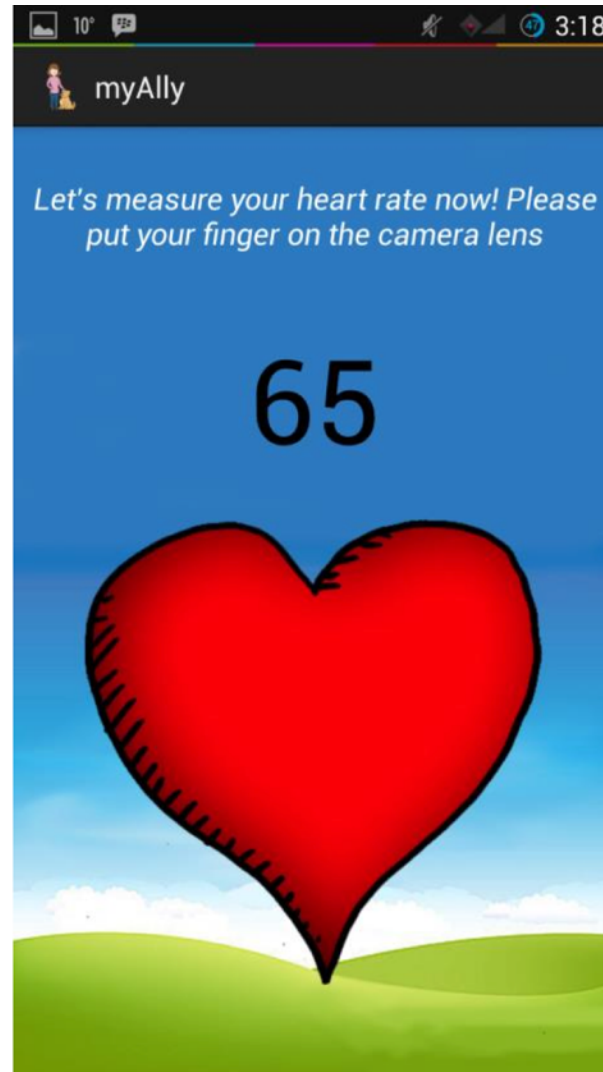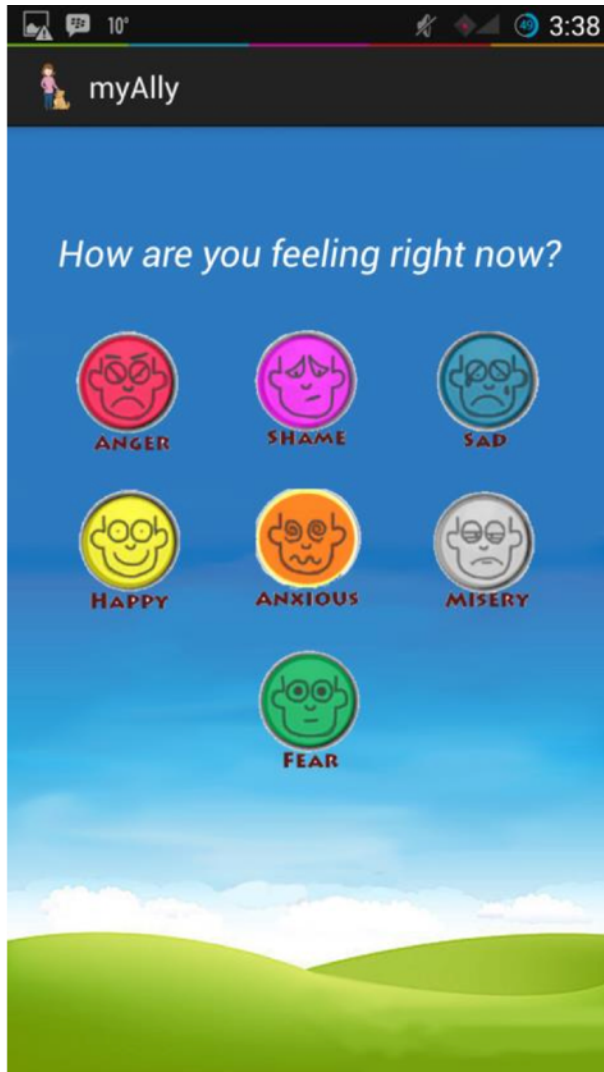
Thought Diffusion Exercise

■ Push unwanted thoughts away
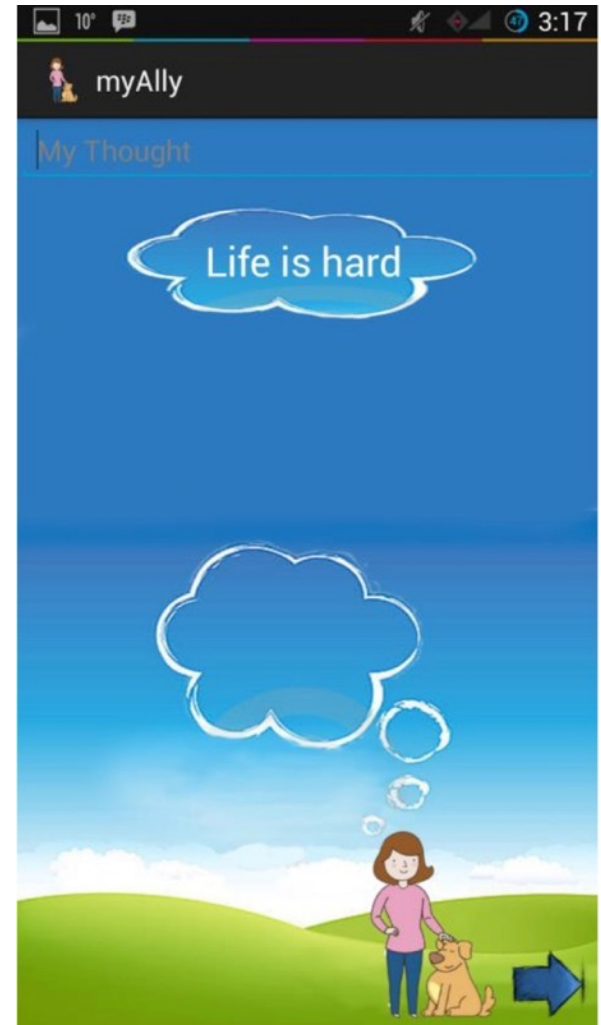
Mind Jar Exercise

- Allow thoughts to settle

(30)

Muscle Relaxation Exercise

- Identify parts of body with mind
- Clench and relax

Examine the length of your legs

Clench your hands for 3s
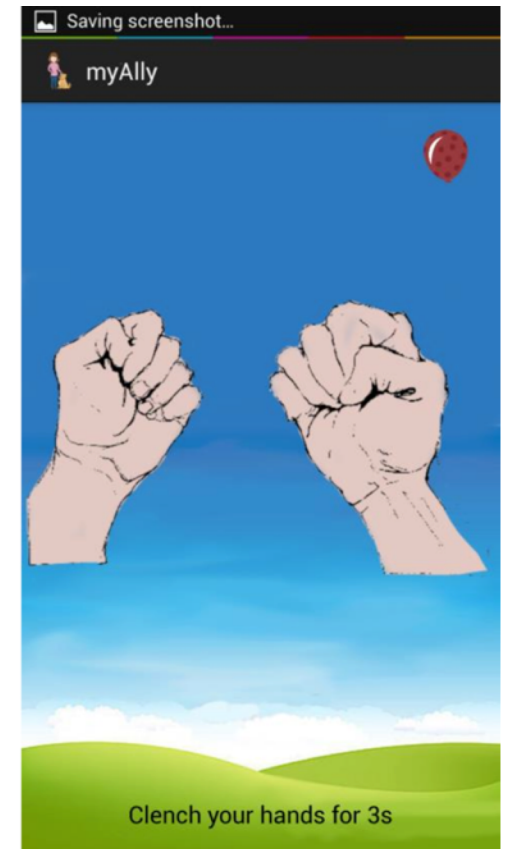
Breathing Exercise

■ Balloon animates inflation/deflation to pace breathing to
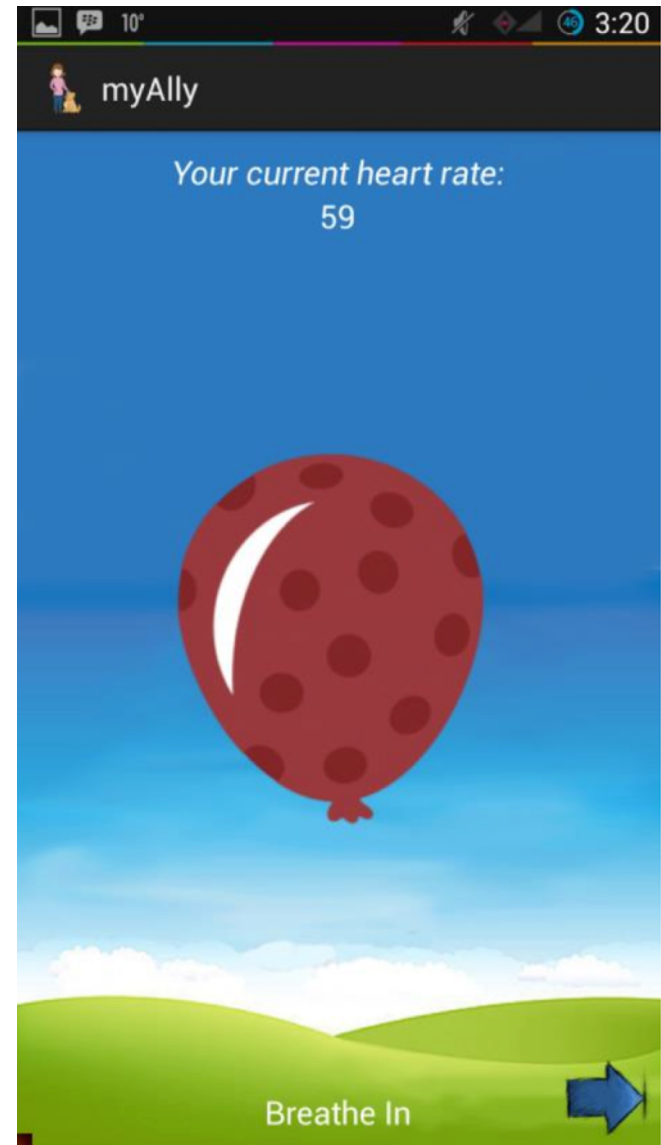
Other Sample Projects from Prior Years

PUPL
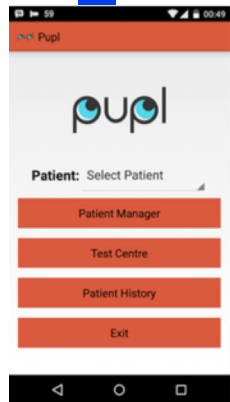
MyACL
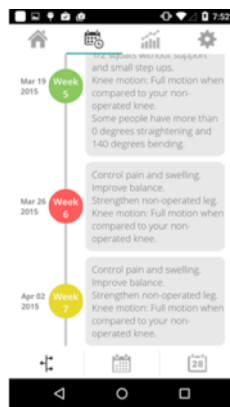
Speech Coach
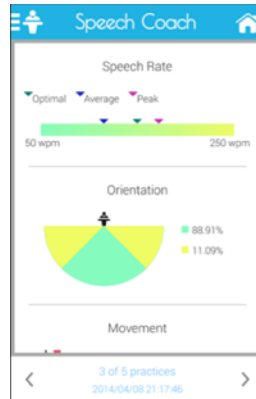
EYEDentify
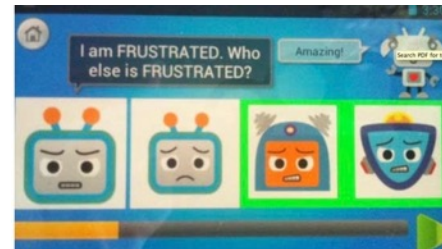
Mobile Stage
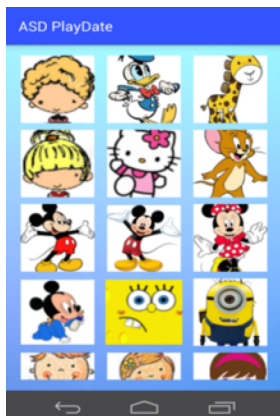
ASD Playdate
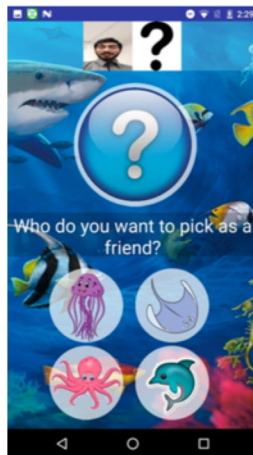
Trip Story
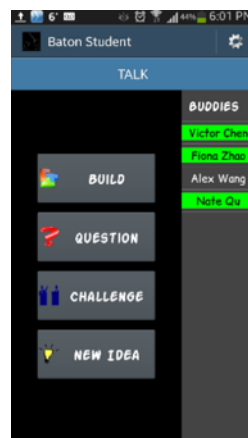
Baton (33)
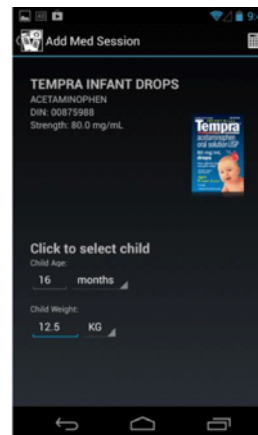
Snap N Dose

Practice Cactus
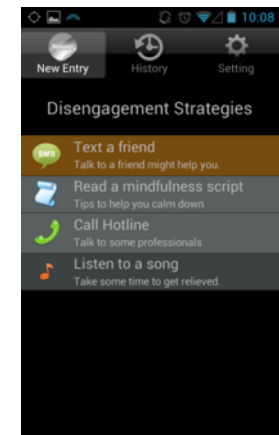
Mindful Me

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
   - <u>That is of sufficient technical depth</u>
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
- <u>YOU BRING EXPERTISE IN THAT DISCIPLINE</u>

Example Specialists from the Past

- **8 years ago: Wound Care**
  - Robert Fraser was a registered Nurse, M.N. candidate
- **6 years ago: Mozart's Ear**
  - Andrea Stewart, M.A. candidate in Faculty of Music
- **5 years ago: Baton**
  - Zack Teitel, High School Teacher, M.Ed. Candidate at OISE
- **3 years ago: ASD Playdate**
  - Ian Roth, Speech Pathologist, Toronto Western Hospital
- **2 years ago: HIIt It!**
  - Dana Swarbrick, MSc candidate in Rehabilitation Sciences

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

(39)

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

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

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**
  - 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 <u>Engineering Hatchery Entrepreneurship Seminar</u>
- **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**

Why I Began Teaching this Course

- Have 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

- This has come to pass, yet 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

- **Braiden Brousseau**
  - TA'd course for last 7 years
  - Ph.D. Candidate in ECE
  - Thesis: Eye Tracking in Mobile Devices & Application
  - braiden.brousseau@utoronto.ca

- **Daniel Di Matteo**
  - TA'd course for 4 years
  - Ph.D. Candidate in ECE
  - Thesis: Measurement of Social Anxiety using Mobile Technology
  - dandm@ece.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, but only if no Specialists available**

Rules on Project App

1. <u>Subject</u> **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 <u>Wed Jan 23rd @6:30pm</u>
2. **Project Approval-in-Principle**
   - via email; due January 29th
3. **Project Proposal/Plan**
   - Document Due February 6th
4. **Proposal & Plan Presentations**
   - February 13th
   - **NOTE EXTRA LECTURE Wed February 13th, 6-8pm**
5. **Spiral 2 & Spiral 4 Presentations**
   - 2: March 6/13 4: November 20/27
6. **Final Presentations**
   - Weeks of April 3/10
7. **Final Report Due April 17th**

Which Platform – Android or iOS?

On the One Hand, the War is Over

Smartphone installed base share by operating system worldwide from 2013 to 2017

Share of global smartphone installed base by operating system 2013-2017
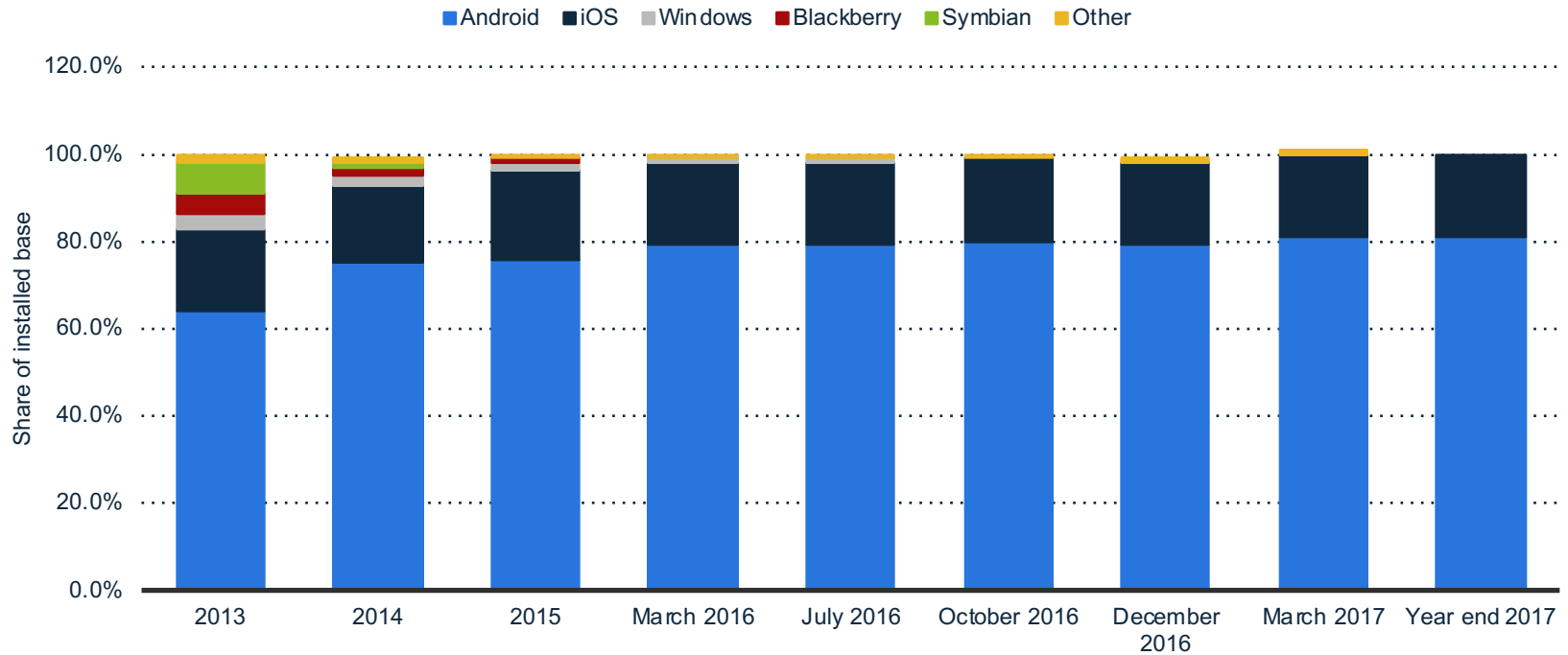
Note: Worldwide; 2013 to 2017
Further information regarding this statistic can be found on page 71.
Source(s): Communities Dominate Brands (Tomi T. Ahonen); ID 385022

Operating systems

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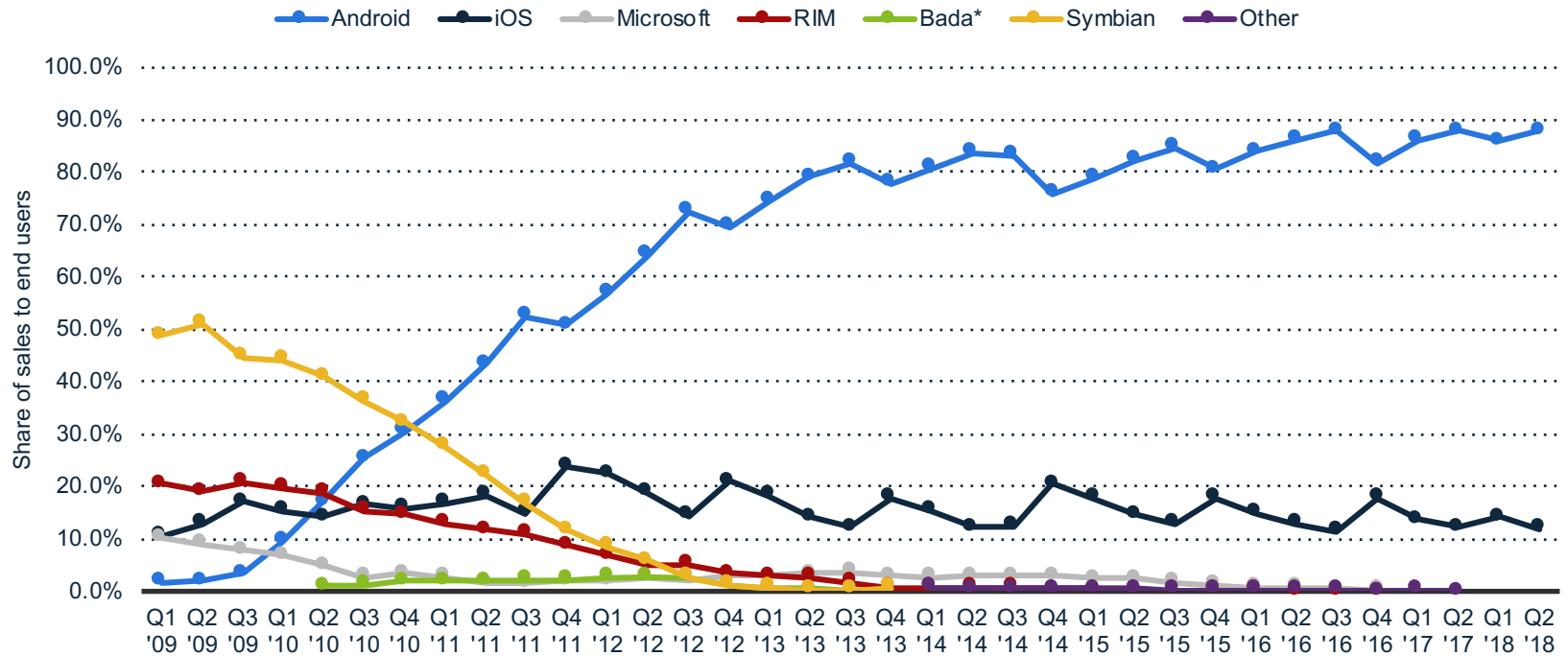
Note: Worldwide; 2009 to 2018
Further information regarding this statistic can be found on page 75.
Source(s): Gartner; ID 266136

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Operating systems

On the Other, Fragmentation vs. Adoption
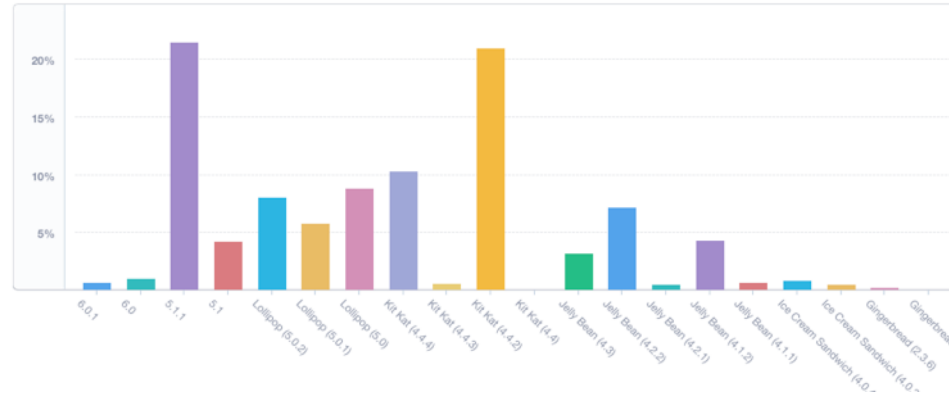
Android Fragmentation

iOS 9 Adoption

Sam Vafaee 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**

Alternative, <u>If</u> 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
  - **Con:** Must have a Mac computer

- Assignments are set up for **both** Android and iPhone
- **Important: your project partners must agree**
- Other kinds of phone operating systems?
  - Not sensible at this point. ☹

Physical Phones

- Have some older phones donated and some new phones donated
  - 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

Nexus 6P

Android Emulator   **iPhone Emulator**
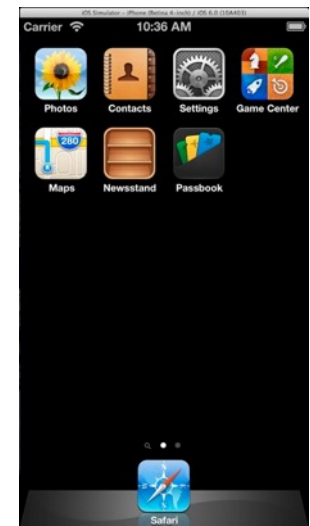
Textbooks for Programmers

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 4**
  - by Molly Maskrey
  - Free download if you are inside the University of Toronto network:

  https://link.springer.com/book/10.1007/978-1-4842-3072-5

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

(65)

Course Material

- **Lectures**
  - Basic phone capabilities
  - Thinking/discussion about how to use capabilities in project
  - Programming concepts, **but not much** ⬅
    - Prior years' feedback has complained about this, but it will not change, and will likely decrease
  - Project basics; block diagrams
  - Case Studies of interesting/inspiring apps
  - Guest Lecture:
    - Design for User Experience

Course Material, cont'd

- <u>Mostly</u> presentations from class
    - proposal, progress x2, final
- Assignments …
- Meetings with your Project Partners!

Assignments!

Part 1: Due next week: **Tuesday** January 16, 6pm

Part 2: Due in 2 weeks: **Tuesday** January 23, 6pm

Programmer Assignment P1

Describe Prog 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**
  - the website we'll use to interact
- **Purpose**
  - for **Specialist** to get to know you;
  - for us to check that your background is sufficient

- **Part I is due Tuesday January 15th, 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 22nd, 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**
  - the website we'll use to interact
- **Purpose**
  - for Programmers to get to know you;
  - for us to establish your field of expertise

- **Part I is due Tuesday January 15th, 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 15, 6pm; late penalty
- Part 2 due **Tuesday** January 22, 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 23	P2	February 5
February 6	P3	February 20

Specialists:

Date Assigned	Assignment	Due
January 23	S2	January 29
January 30	S3	February 12
February 13	S4	February 20

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

- 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 23rd at 6:30pm

  Location: Galbraith Building Room 220

- 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?