Mobile and Ubiquitous Computing on Smartphones

Lecture 6a: Mobile and Location-Aware Computing

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Locations in Android: Some Updates

Location

- My slides: Covered Android.location:
  - As I mentioned, Google would prefer you NOT use this way to access location
  - But used by most books, available code

- Preferred way: Google Location Services API. Can retrieve
  - Geographical location (latitude, longtitude)
  - location updates at regular intervals using requestLocationUpdates( )

- Can also retrieve location object using fused location provider
  - Contains bearing (direction of horizontal travel), altitude, velocity

Location

- Official Google documentation for Google Location Services API looks good, adequate
  - Overview: https://developer.android.com/training/location
  - Request location permissions: https://developer.android.com/training/location/permissions
  - Get last known location: https://developer.android.com/training/location/retrieve-current
  - Change location settings (e.g. GPS vs WiFi): https://developer.android.com/training/location/change-location-settings
  - Request location updates: https://developer.android.com/training/location/request-updates
  - Access location in background: https://developer.android.com/training/location/background

GeoFencing in Android: Some Updates

GeoFencing: Old Way

- **Old way: GeofencingApi** deprecated
- Code sample in Android studio implements old way unfortunately
- **GeofencingApi** typically used in conjunction with a GoogleApiClient

```
new GoogleApiClient.Builder(context)
      .addApi(LocationServices.API)
      .addConnectionCallbacks(this)
      .addOnConnectionFailedListener(this)
      .build()
```

GeoFencing: New Way

- New way: GeofencingClient
- Create, start monitoring geoFences
  - Need to create instance of **GeofencingClient**
- Specify GeoFences using:
  - GeofencingRequest
  - GeofencingRequestBuilder
- Create broadcast receiver to be notified of geofence transitions
- Add geofences using GeofencingClient.addGeofences( )
- Remove geofences using geofencingClient.removeGeofences( )

GeoFencing

- Official Google documentation
  - https://developer.android.com/training/location/geofencing
  - https://developers.google.com/location-context/geofencing

- Good reference articles with good examples, gentle walkthrough:
  - https://techpaliyal.com/android-geofencing/

MediaPlayer in Android: Minor Updates

MediaPlayer

- Main API (MediaPlayer) is same
- Slight changes in some methods. Needs to be updated.
  - E.g Now set audio attributes using mediaPlayer.setAudioAttributes(..)
  - Also material on WakeLocks (Power savings), etc

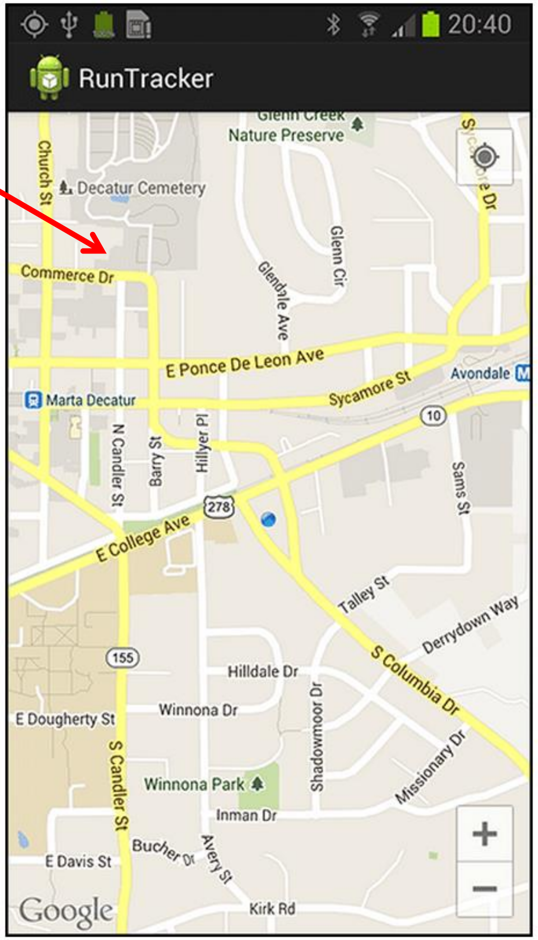
- Official Google documentation (looks good), adequate documentation:
  - https://developer.android.com/guide/topics/media/mediaplayer

Using Maps

MapView and MapActivity

- **MapView:** UI widget that displays maps

- **MapActivity:** java class (extends Activity), handles map-related lifecycle and management for displaying maps.



7 Steps for using Google Maps Android API

https://developers.google.com/maps/documentation/android-api/start

1. Install Android SDK (Done!!)
   - https://developer.android.com/studio/index.html
2. Add Google Play services to Android Studio
3. Create a Google Maps project
4. Obtain Google Maps API key
5. Hello Map! Take a look at the code
6. Connect an Android device
7. Build and run your app

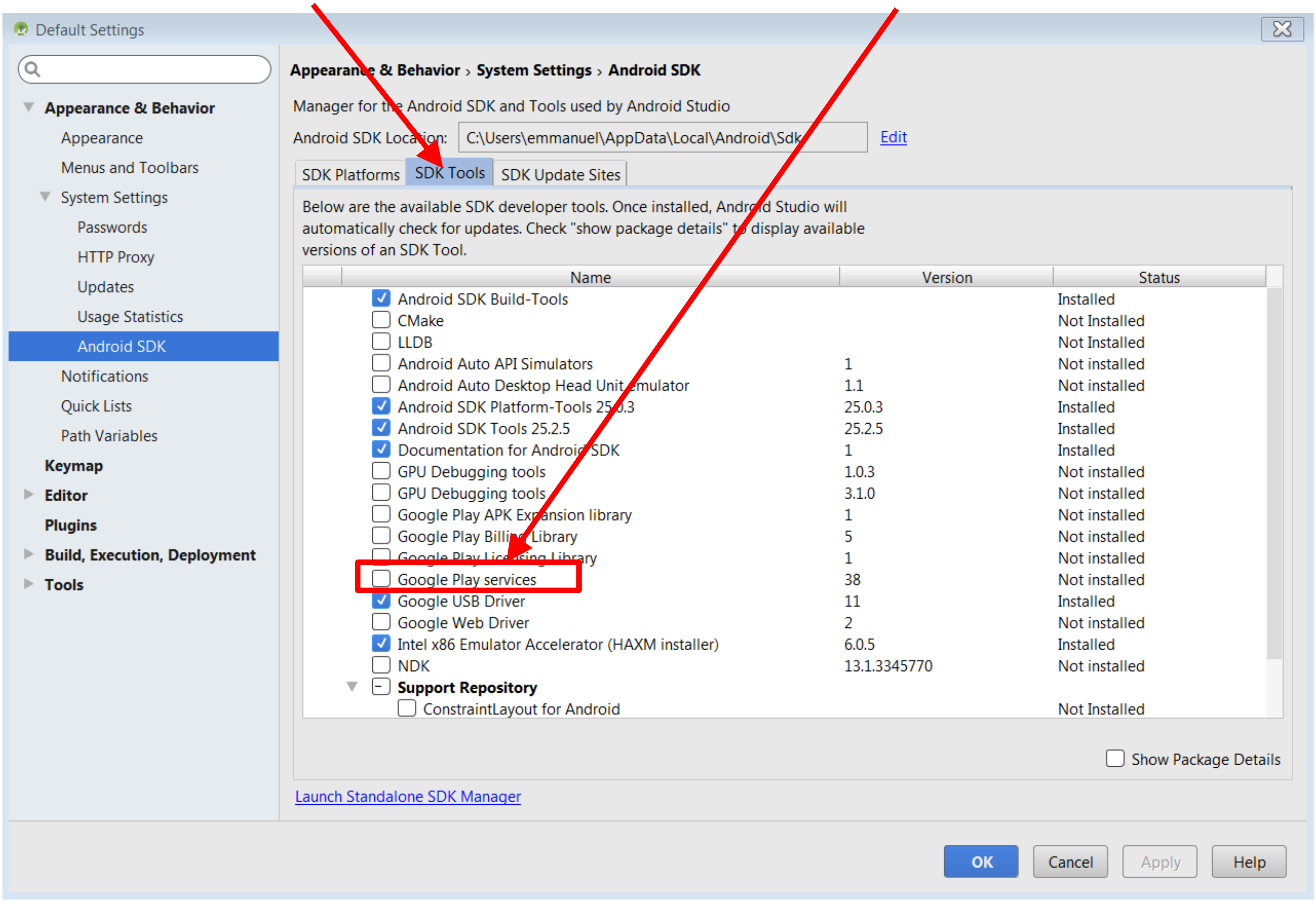
Step 2: Add Google Play Services to Android Studio

https://developers.google.com/maps/documentation/android-api/start

- Google Maps API v2 is part of Google Play Services SDK
- Use Android Studio SDK manager to download Google Play services

Open SDK Manager
Click on SDK Tools

Check Google Play Services, then Ok



Appearance & Behavior › System Settings › Android SDK

Manager for the Android SDK and Tools used by Android Studio

Android SDK Location: C:\Users\emmanuel\AppData\Local\Android\Sdk

Below are the available SDK developer tools. Once installed, Android Studio will automatically check for updates. Check "show package details" to display available versions of an SDK Tool.

Name	Version	Status
☑ Android SDK Build-Tools		Installed
☐ CMake		Not Installed
☐ LLDB		Not Installed
☐ Android Auto API Simulators	1	Not installed
☐ Android Auto Desktop Head Unit emulator	1.1	Not installed
☑ Android SDK Platform-Tools 25.0.3	25.0.3	Installed
☑ Android SDK Tools 25.2.5	25.2.5	Installed
☑ Documentation for Android SDK	1	Installed
☐ GPU Debugging tools	1.0.3	Not installed
☐ GPU Debugging tools	3.1.0	Not installed
☐ Google Play APK Expansion library	1	Not installed
☐ Google Play Billing Library	5	Not installed
☐ Google Play Licensing Library	1	Not installed
☐ Google Play services	38	Not installed
☑ Google USB Driver	11	Installed
☐ Google Web Driver	2	Not installed
☑ Intel x86 Emulator Accelerator (HAXM installer)	6.0.5	Installed
☐ NDK	13.1.3345770	Not installed
☐ **Support Repository**		
☐ ConstraintLayout for Android		Not Installed

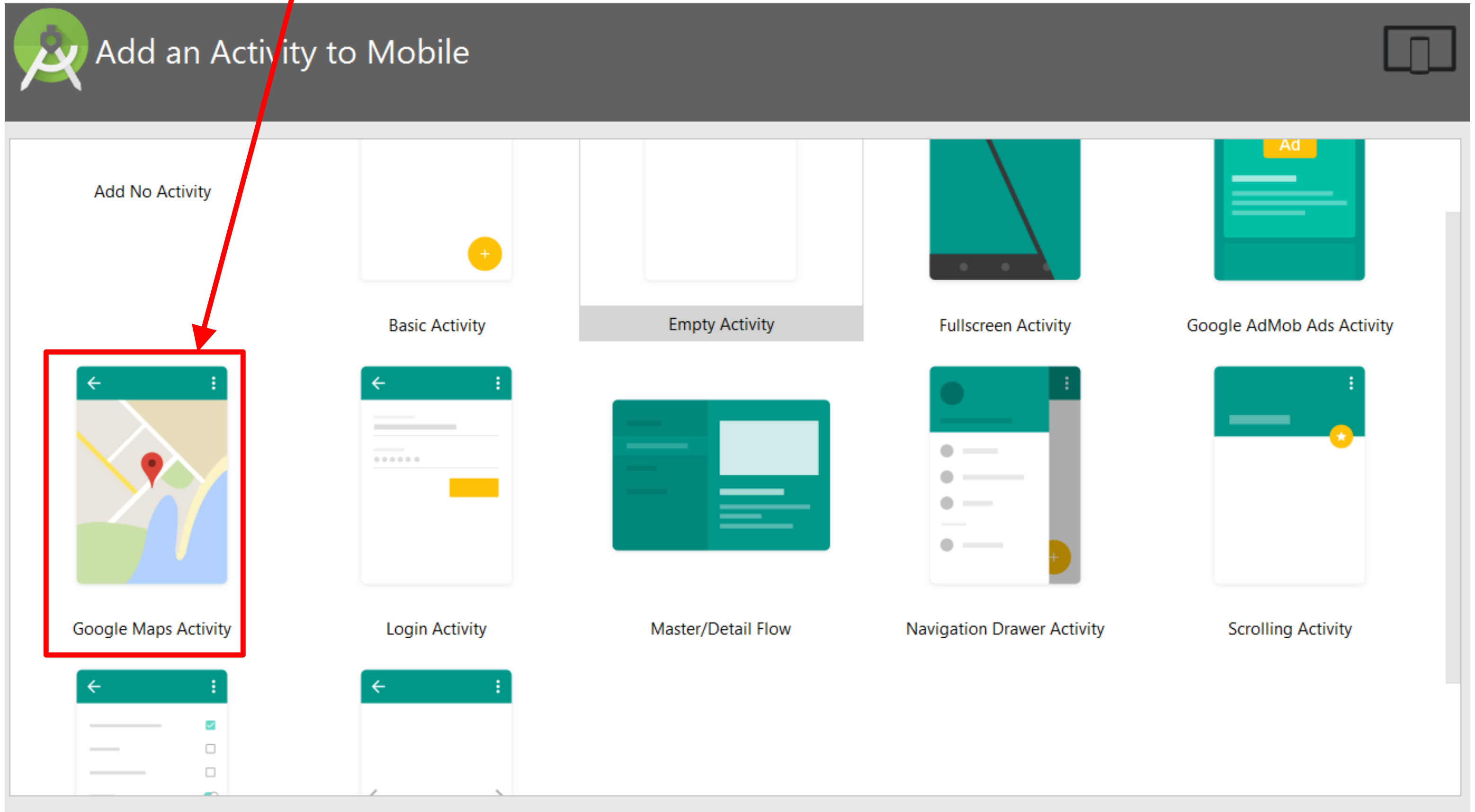
☐ Show Package Details

Launch Standalone SDK Manager

Step 3: Create new Android Studio Project

https://developers.google.com/maps/documentation/android-api/start

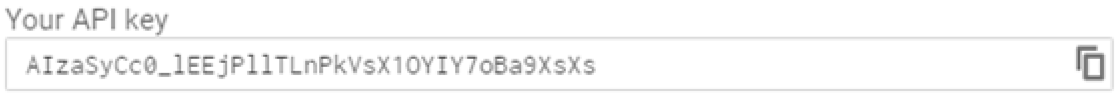
- Select "Google Maps Activity, click Finish



Step 4: Get Google Maps API key

https://developers.google.com/maps/documentation/android-api/start

- To access Google Maps servers using Maps API, must add Maps API key to app
- Maps API key is free. E.g.



Your API key

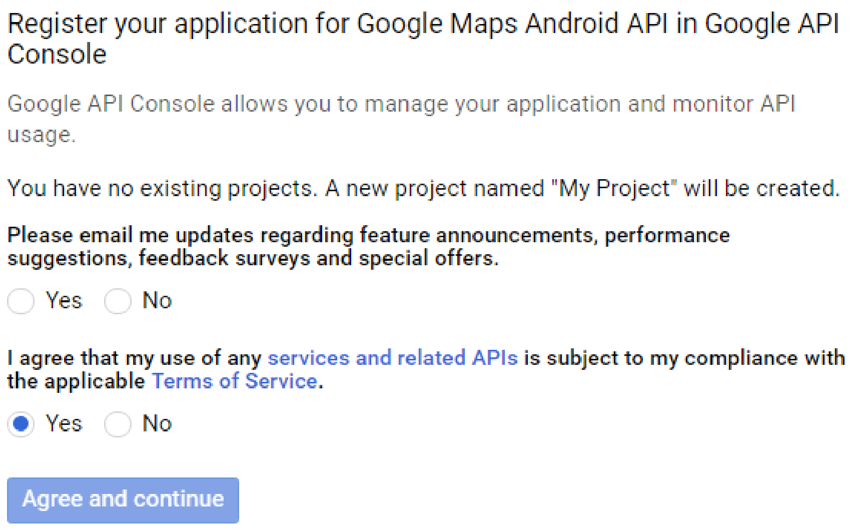
```
AIzaSyCc0_lEEjPllTLnPkVsX1OYIY7oBa9XsXs
```

- Google uses API key to uniquely identify your app, track its resource usage, etc

Step 4a: Fast, Easy way to get Maps API Key

https://developers.google.com/maps/documentation/android-api/start

- Copy link provided in **google_maps_api.xml** of Maps template into browser
- Goes to Google API console, auto-fills form
- Creates API key



Register your application for Google Maps Android API in Google API Console

Google API Console allows you to manage your application and monitor API usage.

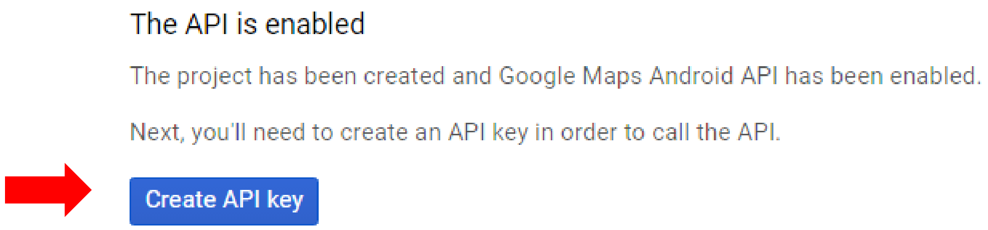
You have no existing projects. A new project named "My Project" will be created.

Please email me updates regarding feature announcements, performance suggestions, feedback surveys and special offers.

○ Yes ○ No

I agree that my use of any services and related APIs is subject to my compliance with the applicable Terms of Service.

● Yes ○ No



The API is enabled

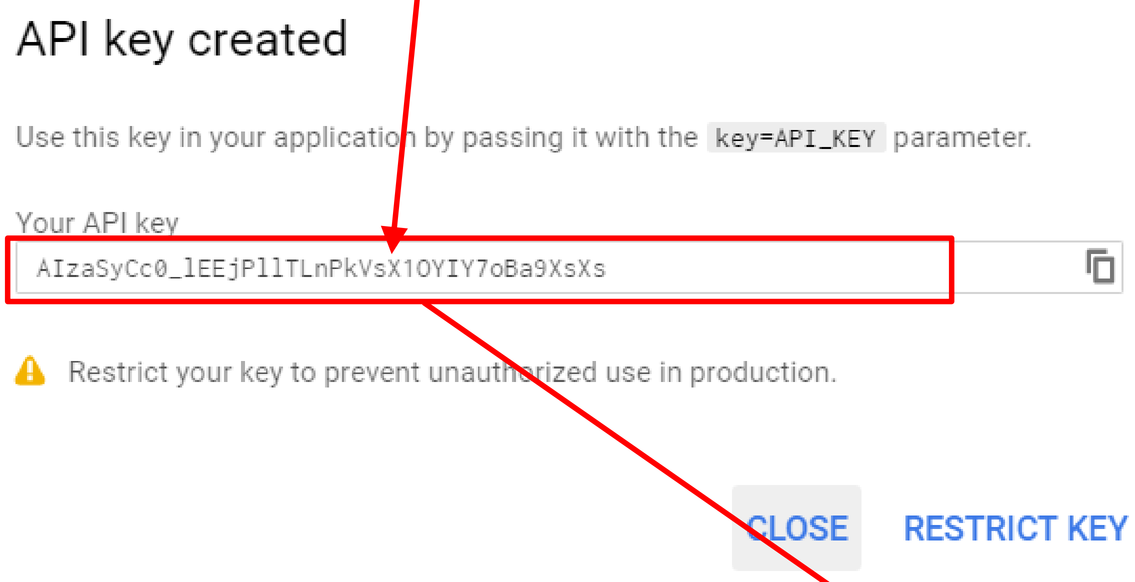
The project has been created and Google Maps Android API has been enabled.

Next, you'll need to create an API key in order to call the API.

Step 4a: Fast, Easy way to get Maps API Key

https://developers.google.com/maps/documentation/android-api/start

- If successful, Maps API key generated



API key created

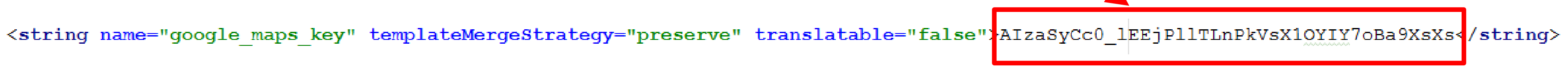
Use this key in your application by passing it with the `key=API_KEY` parameter.

Your API key

AIzaSyCc0_lEEjPllTLnPkVsX1OYIY7oBa9XsXs

⚠ Restrict your key to prevent unauthorized use in production.

- Copy key, put it in <string> element in **google_maps_api.xml** file



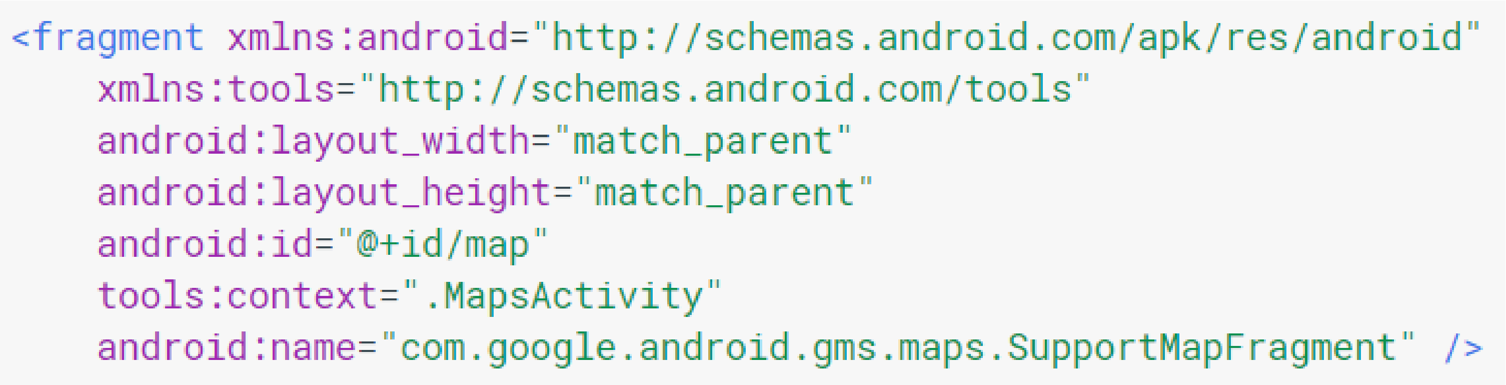
```
<string name="google_maps_key" templateMergeStrategy="preserve" translatable="false">AIzaSyCc0_lEEjPllTLnPkVsX1OYIY7oBa9XsXs</string>
```

Step 4b: Longer (older) way to API key

- If easy way doesn’t work, older way to obtain a Maps API key
- Follow steps at:
    - **See: https://developers.google.com/maps/documentation/android-api/signup**

Step 5: Examine Code Generated buy Android Studio Maps Template

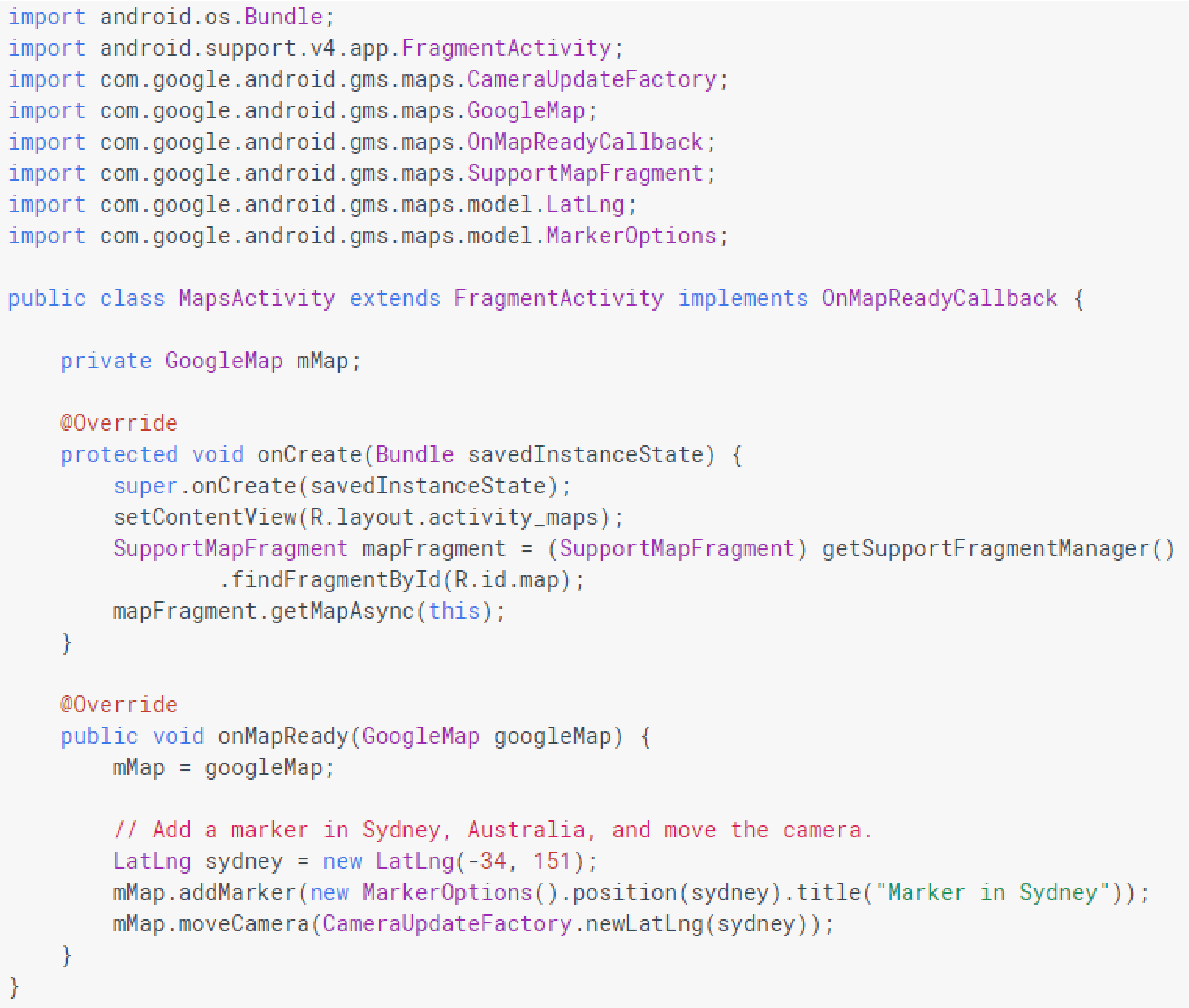
- XML file that defines layout is in **res/layout/activity_maps.xml**



```
<fragment xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:id="@+id/map"
    tools:context=".MapsActivity"
    android:name="com.google.android.gms.maps.SupportMapFragment" />
```

Step 5: Examine Code Generated buy Android Studio Maps Template

- Default Activity file is **MapActivity.java**



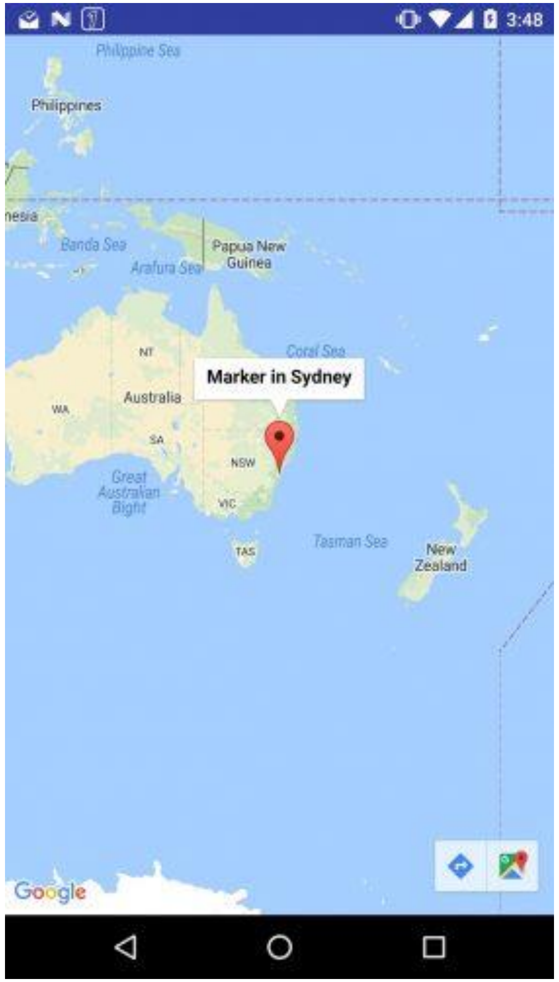
```
import android.os.Bundle;
import android.support.v4.app.FragmentActivity;
import com.google.android.gms.maps.CameraUpdateFactory;
import com.google.android.gms.maps.GoogleMap;
import com.google.android.gms.maps.OnMapReadyCallback;
import com.google.android.gms.maps.SupportMapFragment;
import com.google.android.gms.maps.model.LatLng;
import com.google.android.gms.maps.model.MarkerOptions;

public class MapsActivity extends FragmentActivity implements OnMapReadyCallback {

    private GoogleMap mMap;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_maps);
        SupportMapFragment mapFragment = (SupportMapFragment) getSupportFragmentManager()
                .findFragmentById(R.id.map);
        mapFragment.getMapAsync(this);
    }

    @Override
    public void onMapReady(GoogleMap googleMap) {
        mMap = googleMap;

        // Add a marker in Sydney, Australia, and move the camera.
        LatLng sydney = new LatLng(-34, 151);
        mMap.addMarker(new MarkerOptions().position(sydney).title("Marker in Sydney"));
        mMap.moveCamera(CameraUpdateFactory.newLatLng(sydney));
    }
}
```

Steps 6, 7

- **Step 6:** Connect to an Android device (smartphone)

- **Step 7:** Run the app
  - Should show map with a marker on Sydney Australia

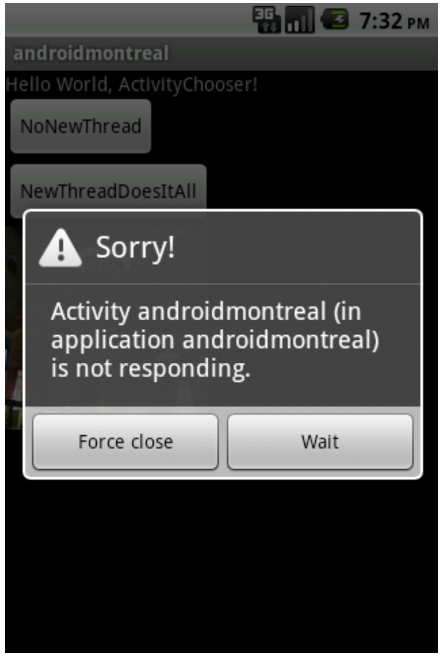
- More code examples at:
  - https://github.com/googlemaps/android-samples



AsyncTask API

AsyncTask API

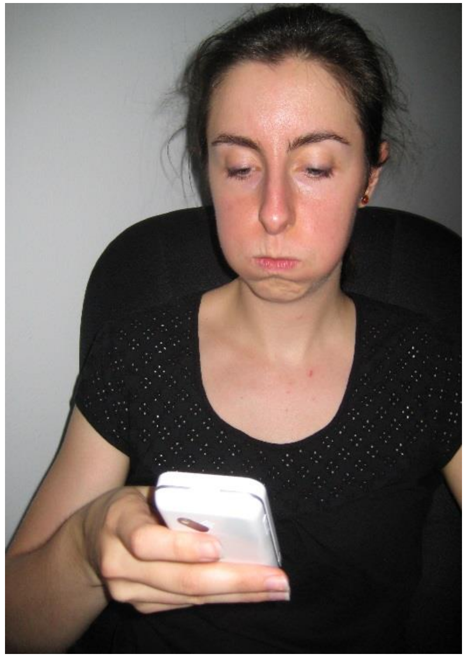
- For compute intensive tasks, remote or tasks that take a long time, doing it in main activity blocks
- **AsyncTask:** spawn separate thread to offload such task, free up main Activity



Hello World, ActivityChooser!

Sorry!

Activity androidmontreal (in application androidmontreal) is not responding.



One thread

=

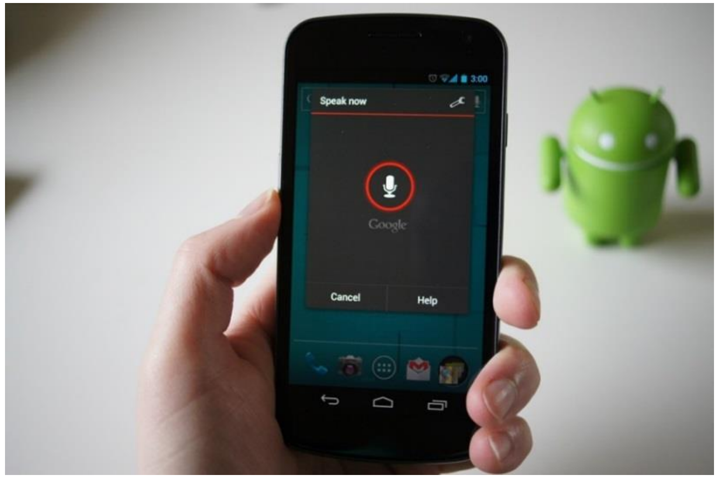
Frustrated user !

What other Android APIs may be useful for Mobile/ubicomp?

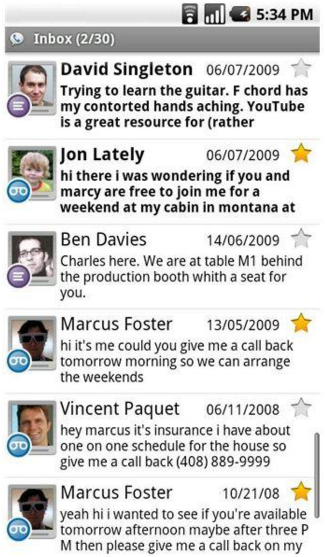
Speaking to Android

http://developer.android.com/reference/android/speech/SpeechRecognizer.html
https://developers.google.com/voice-actions/

- **Speech recognition:**
  - Accept inputs as speech (instead of typing) e.g. dragon dictate app?
  - Note: Requires internet access
- Two forms
  1. **Speech-to-text**
     - Convert user’s speech to text. E.g. display voicemails in text
  2. **Voice Actions:** Voice commands to smartphone (e.g. set alarm)



Speech to text


5:34 PM

Inbox (2/30)

David Singleton 06/07/2009
Trying to learn the guitar. F chord has my contorted hands aching. YouTube is a great resource for (rather

Jon Lately 06/07/2009
hi there i was wondering if you and marcy are free to join me for a weekend at my cabin in montana at

Ben Davies 14/06/2009
Charles here. We are at table M1 behind the production booth whith a seat for you.

Marcus Foster 13/05/2009
hi it's me could you give me a call back tomorrow morning so we can arrange the weekends

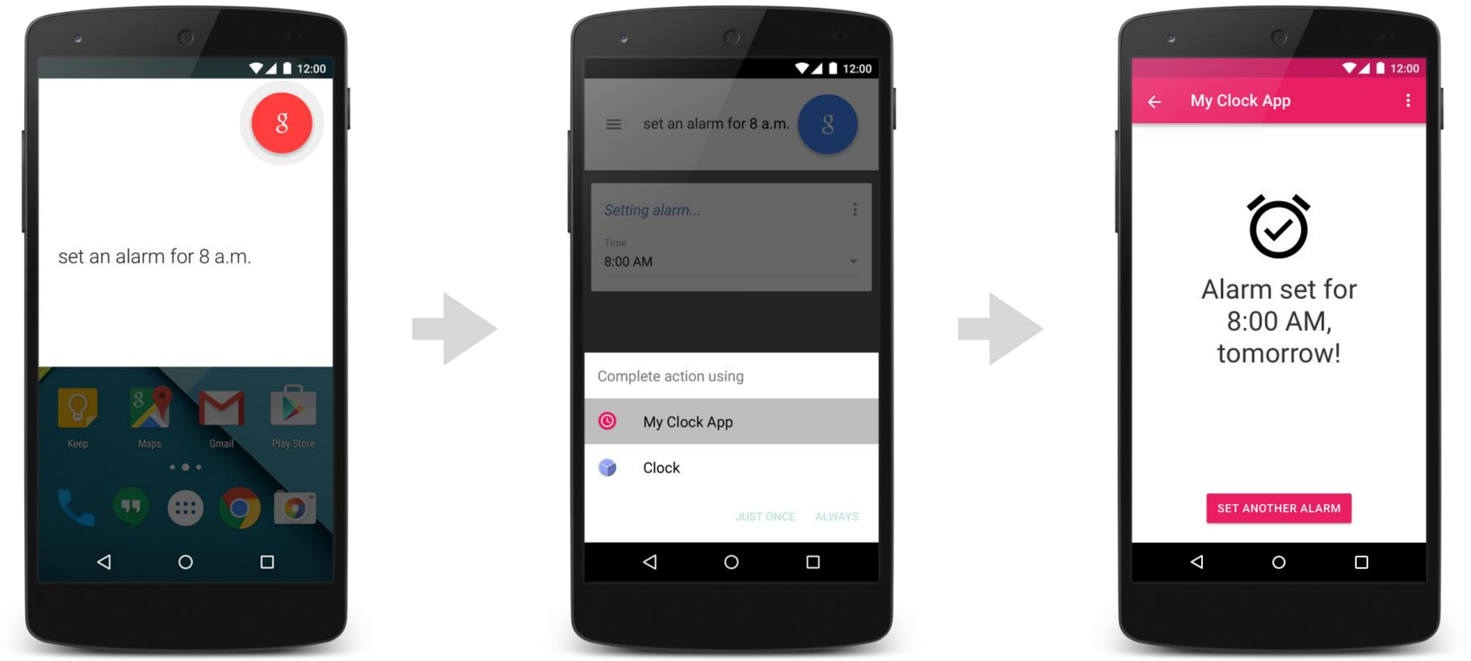
Vincent Paquet 06/11/2008
hey marcus it's insurance i have about one on one schedule for the house so give me a call back (408) 889-9999

Marcus Foster 10/21/08
yeah hi i wanted to see if you're available tomorrow afternoon maybe after three P M then please give me a call back on my

Google Voice Actions

https://developers.google.com/voice-actions/

- E.g. Tell Google to set an alarm



set an alarm for 8 a.m.

set an alarm for 8 a.m.

Setting alarm...

Time: 8:00 AM

Complete action using

My Clock App

Clock

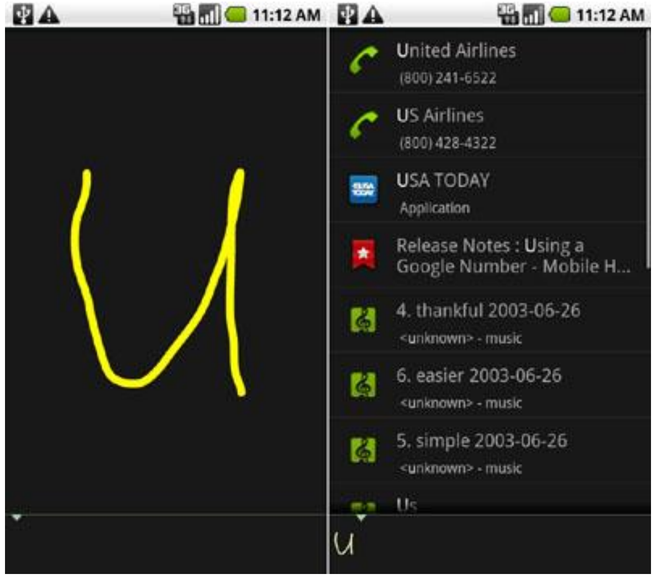
Alarm set for 8:00 AM, tomorrow!

Gestures

https://developer.android.com/training/gestures/index.html

http://www.computerworld.com/article/2469024/web-apps/android-gestures--3-cool-ways-to-control-your-phone.html

- **Gesture:** Hand-drawn shape on the screen, swipe pattern
- Example uses:
  - Search your phone, contacts, etc by handwriting onto screen
  - Speed dial by handwriting first letters of contact’s name
  - Multi-touch, pinching



United Airlines
(800) 241-6522

US Airlines
(800) 428-4322

USA TODAY
Application

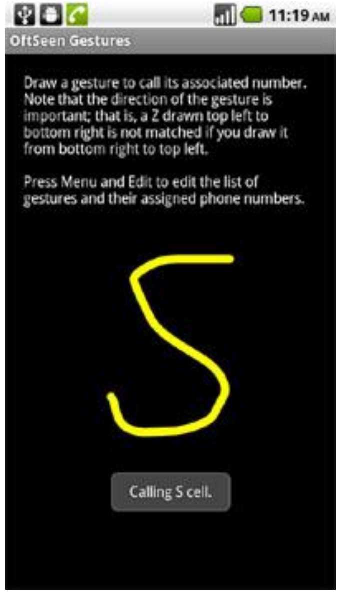
Release Notes : Using a Google Number - Mobile H...

4. thankful 2003-06-26
<unknown> - music

6. easier 2003-06-26
<unknown> - music

5. simple 2003-06-26
<unknown> - music

Us



Draw a gesture to call its associated number. Note that the direction of the gesture is important; that is, a Z drawn top left to bottom right is not matched if you draw it from bottom right to top left.

Press Menu and Edit to edit the list of gestures and their assigned phone numbers.

Calling S cell.

More MediaPlayer & RenderScript

http://developer.android.com/guide/topics/renderscript/compute.html
https://developer.android.com/reference/android/media/MediaRecorder

- MediaRecorder is used to **record** audio
  - Manipulate raw audio from microphone/audio hardware, PCM buffers
    - E.g. if you want to do audio signal processing, speaker recognition, etc
    - **Example:** process user's speech, detect emotion, nervousness?
  - Can playback recorded audio using MediaPlayer

- **RenderScript**
  - High level language for computationally intensive tasks/GPGPU,
  - Can be used to program phone CPU, GPU in a few lines of code
  - Use Phone's Graphics Processing Unit (GPU) for computational tasks
  - Useful for heavy duty tasks. E.g. image processing, computational photography, computer vision

Wireless Communication

http://developer.android.com/guide/topics/connectivity/bluetooth.html
http://developer.android.com/reference/android/net/wifi/package-summary.html

- Bluetooth
  - Discover, connect to nearby bluetooth devices
  - Communicating over Bluetooth
  - Exchange data with other devices
  - Killer app now: COVID contact tracing,

    Too Close for Too Long (< 6 ft for > 15 mins)

- WiFi
  - Scan for WiFi hotspots
  - Monitor WiFi connectivity, Signal Strength (RSSI)
  - Do peer-to-peer (mobile device to mobile device) data transfers

Wireless Communication

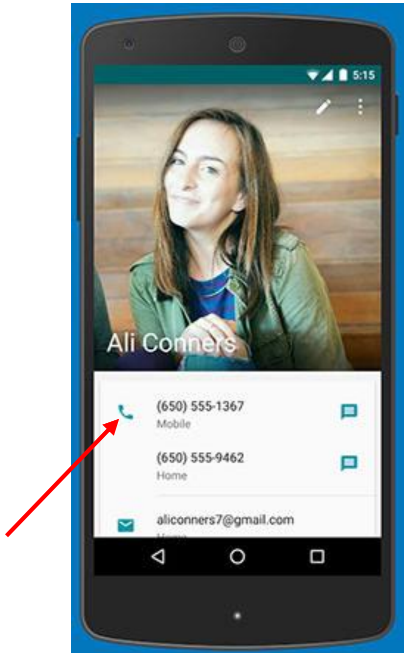
http://developer.android.com/guide/topics/connectivity/nfc/index.html

- NFC:
  - Contactless, transfer small amounts of data over short distances
  - **Applications:** Share spotify playlists, Google wallet
  - **Android Pay**
    - Store debit, credit card on phone
    - Pay by tapping terminal

Telephony and SMS

http://developer.android.com/reference/android/telephony/package-summary.html
http://developer.android.com/reference/android/telephony/SmsManager.html

- **Telephony:**
  - Initiate phone calls from within app
  - Access dialer app, etc
- **SMS:**
  - Send/Receive SMS/MMS from app
  - Handle incoming SMS/MMS in app



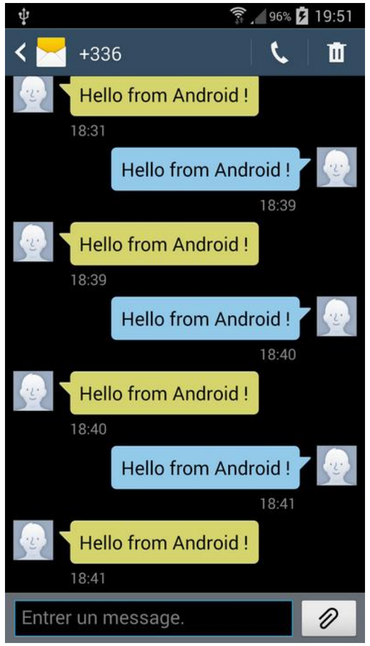
Ali Conners

(650) 555-1367
Mobile

(650) 555-9462
Home

aliconners7@gmail.com

Dialer



Hello from Android !
18:31

Hello from Android !
18:39

Hello from Android !
18:39

Hello from Android !
18:40

Hello from Android !
18:40

Hello from Android !
18:41

Hello from Android !
18:41

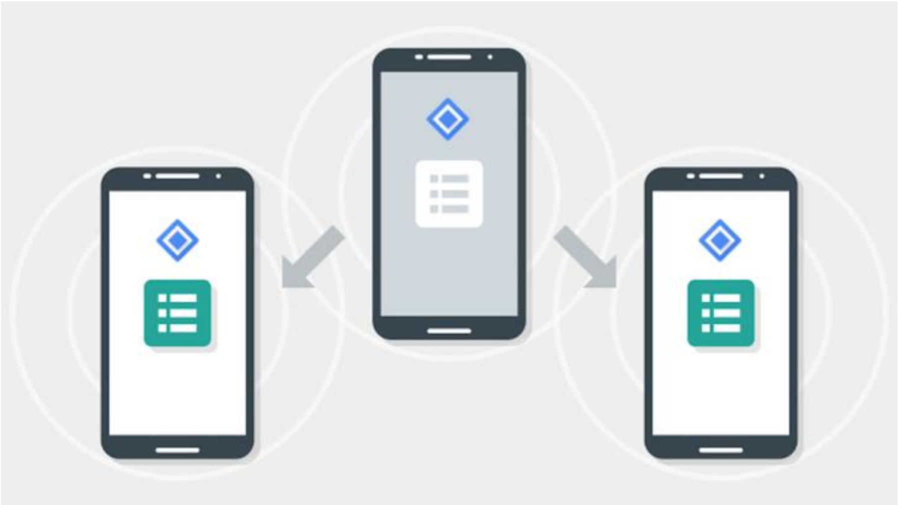
Entrer un message.

SMS

Google Play Services: Nearby Connections API

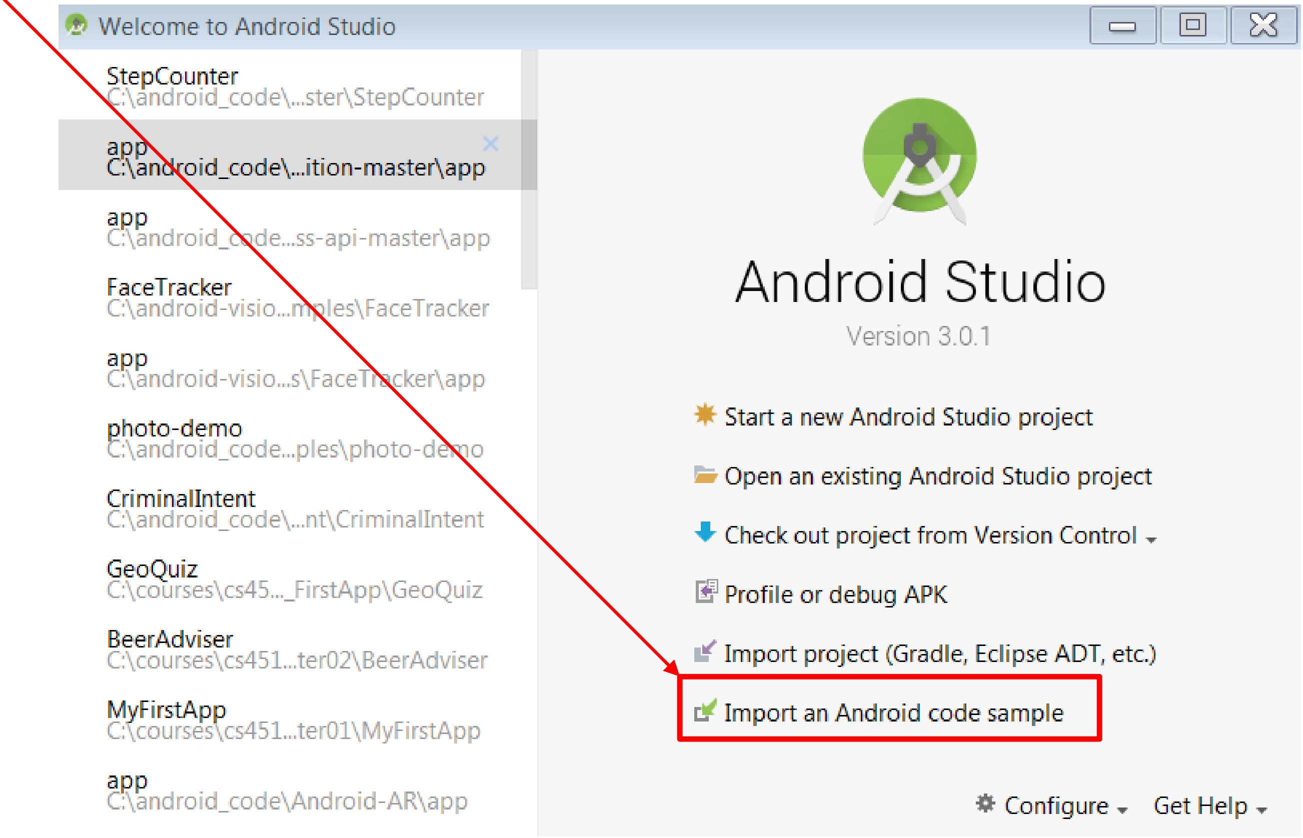
https://developers.google.com/nearby/connections/overview

- Peer-to-peer networking API, allows devices communicate over a LAN
- One device serves as host, advertises
- Other devices can discover host, connect, disconnect
- **Use case:** Multiplayer gaming, shared virtual whiteboard



Google Android Samples

- Android Studio comes with many sample programs
- Just need to import them



Welcome to Android Studio

StepCounter
C:\android_code\...ster\StepCounter

app
C:\android_code\...ition-master\app

app
C:\android_code...ss-api-master\app

FaceTracker
C:\android-visio...mples\FaceTracker

app
C:\android-visio...s\FaceTracker\app

photo-demo
C:\android_code...ples\photo-demo

CriminalIntent
C:\android_code\...nt\CriminalIntent

GeoQuiz
C:\courses\cs45..._FirstApp\GeoQuiz

BeerAdviser
C:\courses\cs451...ter02\BeerAdviser

MyFirstApp
C:\courses\cs451...ter01\MyFirstApp

app
C:\android_code\Android-AR\app

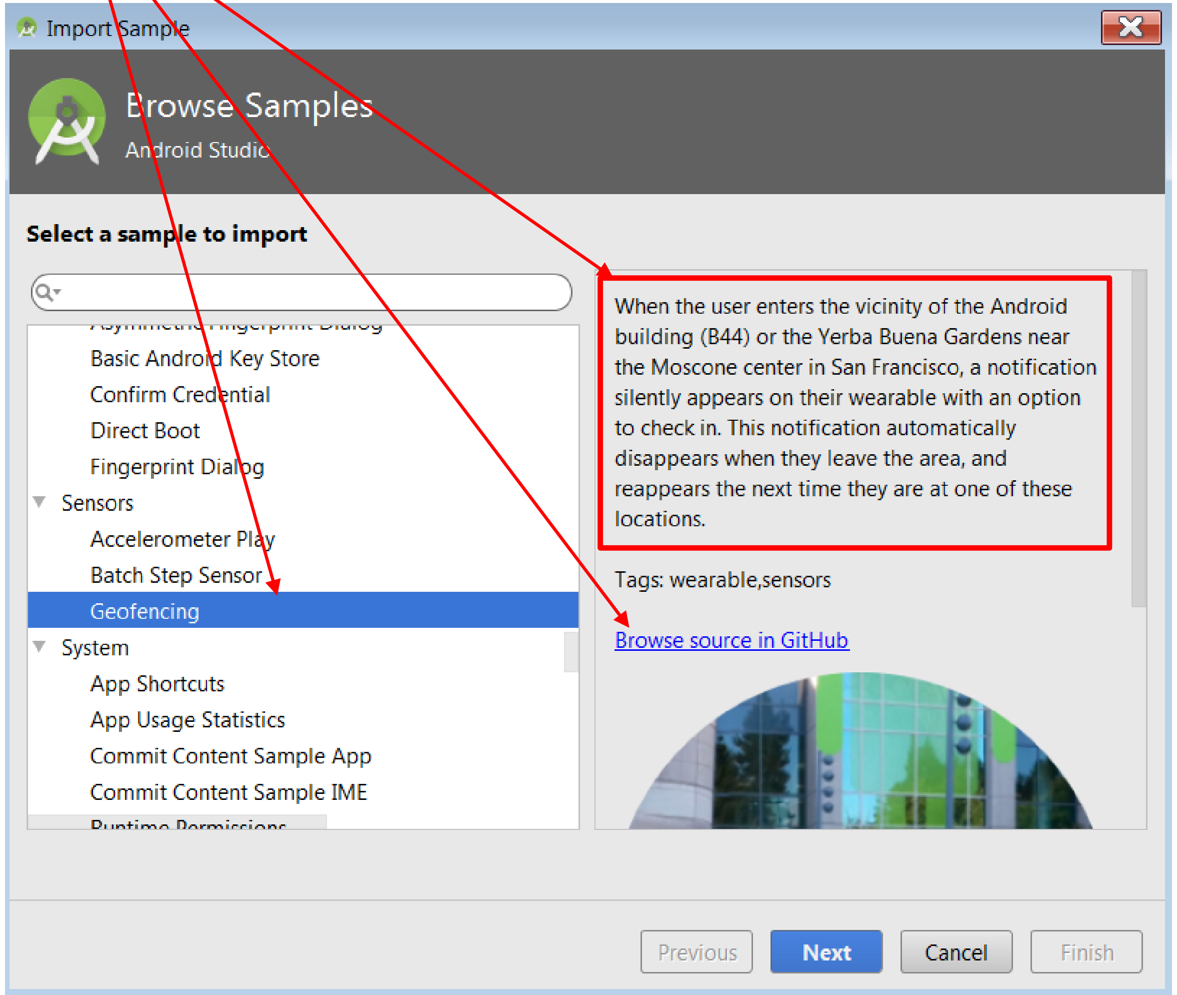
Android Studio

Version 3.0.1

Start a new Android Studio project
Open an existing Android Studio project
Check out project from Version Control
Profile or debug APK
Import project (Gradle, Eclipse ADT, etc.)
Import an Android code sample
Configure
Get Help

Google Android Samples

- Can click on any sample, read overview
- Source code available on github
- Tested, already working
- **Note:** Some code may use deprecated APIs



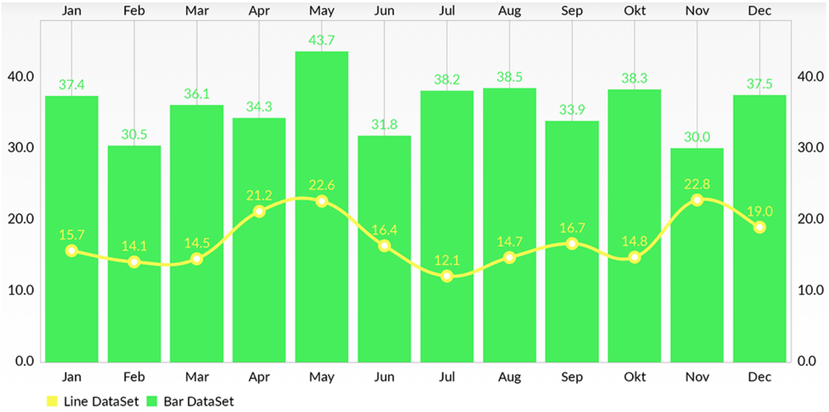
When the user enters the vicinity of the Android building (B44) or the Yerba Buena Gardens near the Moscone center in San Francisco, a notification silently appears on their wearable with an option to check in. This notification automatically disappears when they leave the area, and reappears the next time they are at one of these locations.

Tags: wearable,sensors

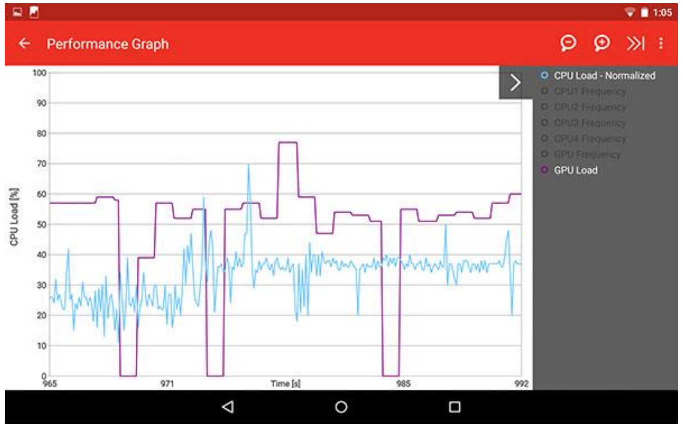
Other 3rd Party Stuff

http://web.cs.wpi.edu/~emmanuel/courses/ubicomp_projects_links.html
https://developer.qualcomm.com/software/trepn-power-profiler

- **MPAndroid:** Add charts to your app



- **Trepn:** Profile power usage and utilization of your app (CPU, GPU, WiFi, etc)
  - By Qualcomm

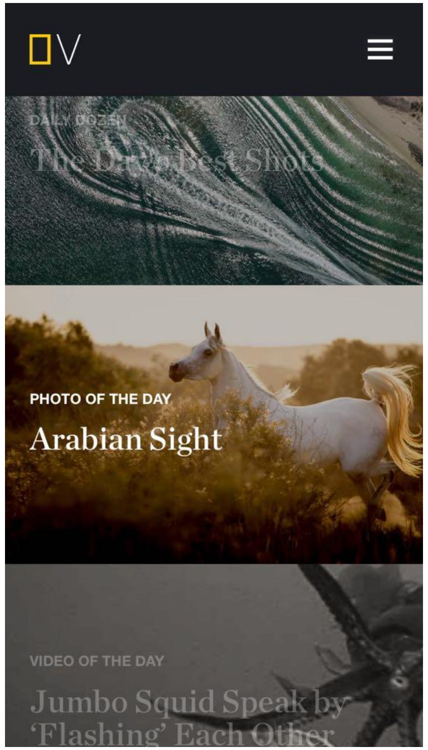


Other 3rd Party Stuff

http://web.cs.wpi.edu/~emmanuel/courses/ubicomp_projects_links.html

- **Programmable Web APIs:** 3rd party web content (e.g RESTful APIs) you can pull into your app with few lines of code
  - **Weather:** Weather channel, yahoo weather
  - **Shared interests:** Pinterest
  - **Events:** Evently, Eventful, Events.com
  - **Photos:** flickr, Tumblr
  - **Videos:** Youtube
  - **Traffic info:** Mapquest traffic, Yahoo traffic

- **E.g. National Geographic:** picture of the day



More Android APIs for Mobile Computing

- Depth Sensing: Project Tango (Dead? Delete?)
- MPAndroid: 3rd party charts
- Trepn: Measure resource consumption (power, CPU, GPU, etc)
- Programmable Web APIs: E.g. National Geographic API, new picture in your app daily
- Augmented Reality: ARtoolkit, vuforia, EasyAR
- Mobile Commerce:
  - Android Pay
  - Analytics
  - Advertising: E.g. Adwords, Admobs

- Other Google APIs (that could be used by mobile devices):
  - Google Fit: Health and fitness, nutrition, steps, etc
  - Google Cast: allows screen-sharing

More Android APIs for Mobile Computing

- Mobile Communication:
  - Wireless Communication: Bluetooth, WiFi, NFC, etc
  - Telephone/SMS
  - Nearby Connections API
- Mobile Cloud:
  - Google Drive API, Google cloud, etc
- Mobile computation:
  - Renderscript: Easy computational programming (smartphone GPU, CPU)

Other Mobile Technology

- Mobile programming/develpment:
  - Kotlin
  - iPhone development
  - 3rd part libraries, app frameworks: Xamarin, flutter, ionic, etc
  - Mobile web programming
  - PhoneGap
  - AppInventor
  - Mobile game development tools: Unity,
- Machine/Deep Learning:
  - Deep Learning/machine learning in Android: Tensorflow, etc
  - Mobile machine/deep learning support in MATLAB
  - Keras support for Android Deep learning
  - Neural Networks API (NNAPI)

References

- John Corpuz, 10 Best Location Aware Apps
- Liane Cassavoy, 21 Awesome GPS and Location-Aware Apps for Android,
- Head First Android
- Android Nerd Ranch, 2nd edition
- Busy Coder's guide to Android version 6.3
- CS 65/165 slides, Dartmouth College, Spring 2014
- CS 371M slides, U of Texas Austin, Spring 2014