CMSC436: Programming Handheld Systems
Location & Maps
Today’s Topics

Location
Location support classes
Maps
Map support classes
Location Services

Mobile applications can benefit from being location-aware

Allows applications to determine their location and modify their behavior
Using Location Information

Find businesses near the user’s current location
Direct a user from a current location to a particular business
Define a geofence
Initiate action when user enters or exits the geofence
Location Architecture

Location
Permissions
FusedLocationProviderClient
LocationCallback
Location

Represents a position on the Earth

A Location instance consists of

- Latitude, longitude, timestamp
- Optionally: accuracy, altitude, speed, and bearing
Location Access Types

Category: Either foreground location or background location

Accuracy: Precise location or approximate location
Category

Foreground: app shares or receives location information only once, or for a defined amount of time

Background: app constantly shares location with other users or uses the Geofencing API
Accuracy

Approximate: Estimate typically accurate to 3km
Precise: Estimate typically accurate to 3m-50m
Permissions

Background locations require
ACCESS_BACKGROUND_LOCATION

Approximate accuracy requires
ACCESS_COARSE_LOCATION permission

Precise accuracy requires
ACCESS_FINE_LOCATION permission

Should also request ACCESS_COARSE_LOCATION, because user can restrict accuracy
Types of Location Providers

Network – WiFi and cell tower
GPS - Satellite
Passive – Piggyback on the readings requested by other applications
LocationProvider Tradeoffs

GPS – expensive, accurate, slower, available outdoors

Network - cheaper, less accurate, faster, availability varies

Cached information – cheapest, fastest, not always available
FusedLocationProviderClient

Location-providing class that fuses different location providers

Part of Google Play Services

See: https://developers.google.com/android/guides/setup
FusedLocationProviderClient methods

getLastLocation()
getCurrentLocation()
requestLocationUpdates()
Requesting Location Updates

Create FusedLocationProviderClient
Create and configure a LocationRequest
Check device settings
Implement LocationCallback interface
Register for location updates
LocationCallback

Defines callback methods that are called when FusedLocationProviderClient location information changes
LocationCallback Methods

onLocationAvailability(LocationAvailability locationAvailability) : Unit

onLocationResult(locationResult: LocationResult): Unit
Recipe for Obtaining and Using Location Information

Start listening for updates

Maintain a "current best estimate" of location

When estimate is “good enough”, stop listening for location updates

Use best location estimate
Determining Best Location

Several factors to consider

- Measurement time
- Accuracy
- Power usage
Application acquires and displays the last known location.
If necessary, acquires and displays new readings.
LocationGetLocationServices

LocationGetLocationServices to access this device's location?

- Precise
- Approximate

While using the app
- Only this time
- Don't allow

Accuracy: 5.000000
Time: 04/20/2022 19:46:53
Longitude: -76.474720
Latitude: 36.353923
Battery Saving Tips

Always check last known measurement
Return updates as infrequently as possible
Limit measurement time
Use the least accurate measurement necessary
Turn off updates in onPause()
Maps

A visual representation of area

Android provides Mapping support through the Google Maps Android API
Map Types

Normal – Traditional road map
Satellite – Aerial photograph
Hybrid – Satellite + road map
Terrain – Topographic details
Customizing the Map

Change the camera position
Add Markers & ground overlays
Respond to gestures
Indicate the user’s current Location
Some Map Classes

GoogleMap
MapFragment
Camera
Marker
Setting up a Maps Application

Set up the Google Play services SDK
Obtain an API key
Specify settings in Application Manifest
Add map to project

See: https://developers.google.com/maps/documentation/android/start
Map Permissions

<uses-permission android:name="android.permission.INTERNET"/>

<uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
Map Permissions

<uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>

<uses-permission android:name="com.google.android.providers.gsf.permission.READ_GSERVICES"/>

* For versions earlier than 8.3
Map Permissions

<uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION"/>

<uses-permission android:name="android.permission.ACCESS_FINE_LOCATION"/>
MapEarthQuakeMap

This application acquires earthquake data from a server.
Then it displays the data on a map, using clickable markers.
MapEarth QuakeMap
// Set up UI and get earthquake data
public override fun onCreate(savedInstanceState: Bundle?) {

    // The GoogleMap instance underlying the GoogleMapFragment defined
    // in main.xml
    val map = supportFragmentManager
        .findFragmentById(R.id.map)
        as SupportMapFragment?
    
    map?.getMapAsync(this)
}
// Called when Map is ready
override fun onMapReady(googleMap: GoogleMap) {
    mMapReady = true
    mMap = googleMap
    mMap!!.moveCamera(CameraUpdateFactory.newLatLng(LatLng(CAMERA_LAT, CAMERA_LNG)))

    if (mDataReady) {
        placeMarkers()
        mMapReady = false
    }
}
override fun onDownloadfinished() {
    mDataReady = true
    if (mMapReady) {
        placeMarkers()
        mDataReady = false
    }
}
private fun placeMarkers() { // Add a marker for every earthquake
    for (rec in mRetainedFragment?.data!!) {
        // Add a new marker for this earthquake
        mMap!!.addMarker(MarkerOptions() // Set the Marker's position
            .position(LatLng(rec.lat, rec.lng))
        // Set the title of the Marker's information window
        .title(rec.magnitude.toString())
        // Set the color for the Marker
        .icon(BitmapDescriptorFactory.defaultMarker(getMarkerColor(rec.magnitude))))
    }
}
Next Time

The ContentProvider Class
Example Applications

LocationGetLocationServices
MapEarthQuakeMap