Basic Java and Android Programming for kBeacon

Casper LI @ Big Dipper Studio

Introduction to Android

The “Software” running in your mobile computing device.

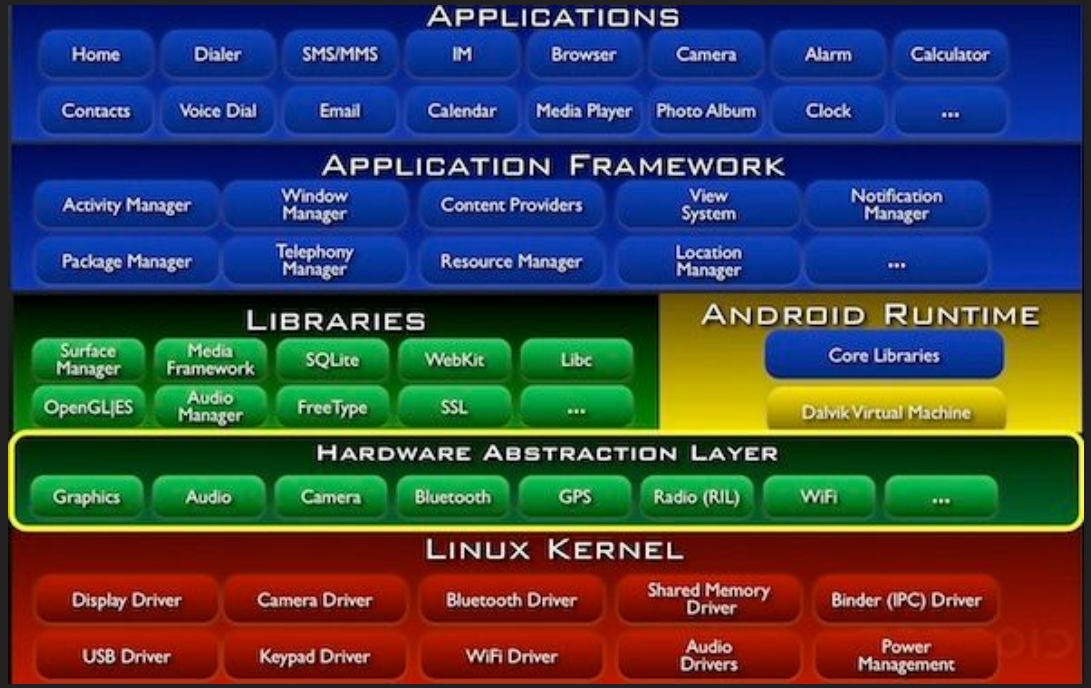
Linux and Android

Android is a large software running on top of **Linux**.

Android
Linux
Hardware

Just a Simplified Version

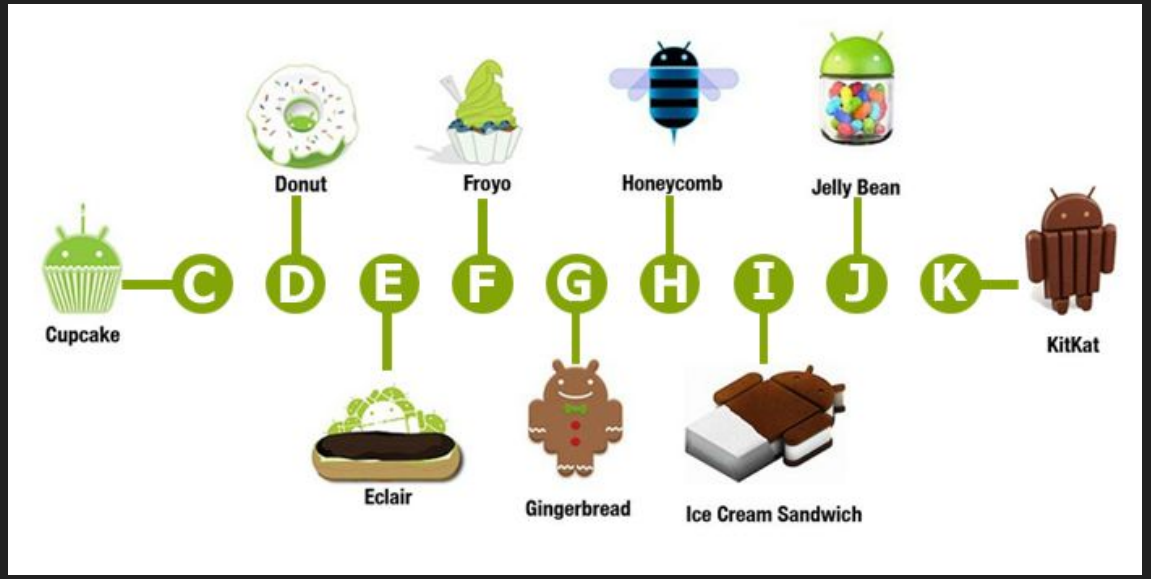
Android Architecture



Also a simplified version. The actual implementation is much much more complicated. But it is Not Required to Understand in current state.


OFF
0
1
ON

Android Version



A, B, C, D,E, F, G, H, I, J, K, L, M, N, O, P, ...

Go into the Programming World!

Android Studio

https://developer.android.com/studio/index.html

Android Studio

FEATURES USER GUIDE

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FEATURES

USER GUIDE

Android Studio

The Official IDE for Android

Android Studio provides the fastest tools for building apps on every type of Android device.

World-class code editing, debugging, performance tooling, a flexible build system, and an instant build/deploy system all allow you to focus on building unique and high quality apps.

DOWNLOAD ANDROID STUDIO 2.1
FOR WINDOWS (1187 MB)

Read the docs

See the release notes

Google

android studio

Learn Android Programming (Java) Step by Step

Welcome to Android Studio

iBeaconLocator
E:\Users\User\Doc...0.3\iBeaconLocator

E:\Users\User\Documents\GitHub\iBeaconLoc
E:\Users\User\Doc...0.2\iBeaconLocator

BeaconScanner
E:\Users\User\Des...lder\BeaconScanner

beacon
E:\Users\User\Desktop\beacon

E:\Users\User\Desktop\BeaconScanner
E:\Users\User\Desktop\BeaconScanner

Android Studio

Version 2.1.2

Start a new Android Studio project

Open an existing Android Studio project

Check out project from Version Control

Import project (Eclipse ADT, Gradle, etc.)

Import an Android code sample

Configure

Get Help

Create New Project

New Project

Android Studio

Configure your new project

Application name: My kBeacon

Company Domain: bds.hk

Package name: hk.bds.mykbeacon Edit

Project location: E:\Users\User\Documents\GitHub\iBeaconLocator\dev\v0.3\MykBeacon

Previous Next Cancel Finish

Create New Project

Target Android Devices

Select the form factors your app will run on

Different platforms may require separate SDKs

- [x] Phone and Tablet

  Minimum SDK: API 15: Android 4.0.3 (IceCreamSandwich)

  Lower API levels target more devices, but have fewer features available.

  By targeting API 15 and later, your app will run on approximately **97.4%** of the devices that are active on the Google Play Store.

  Help me choose

- [ ] Wear

  Minimum SDK: API 21: Android 5.0 (Lollipop)

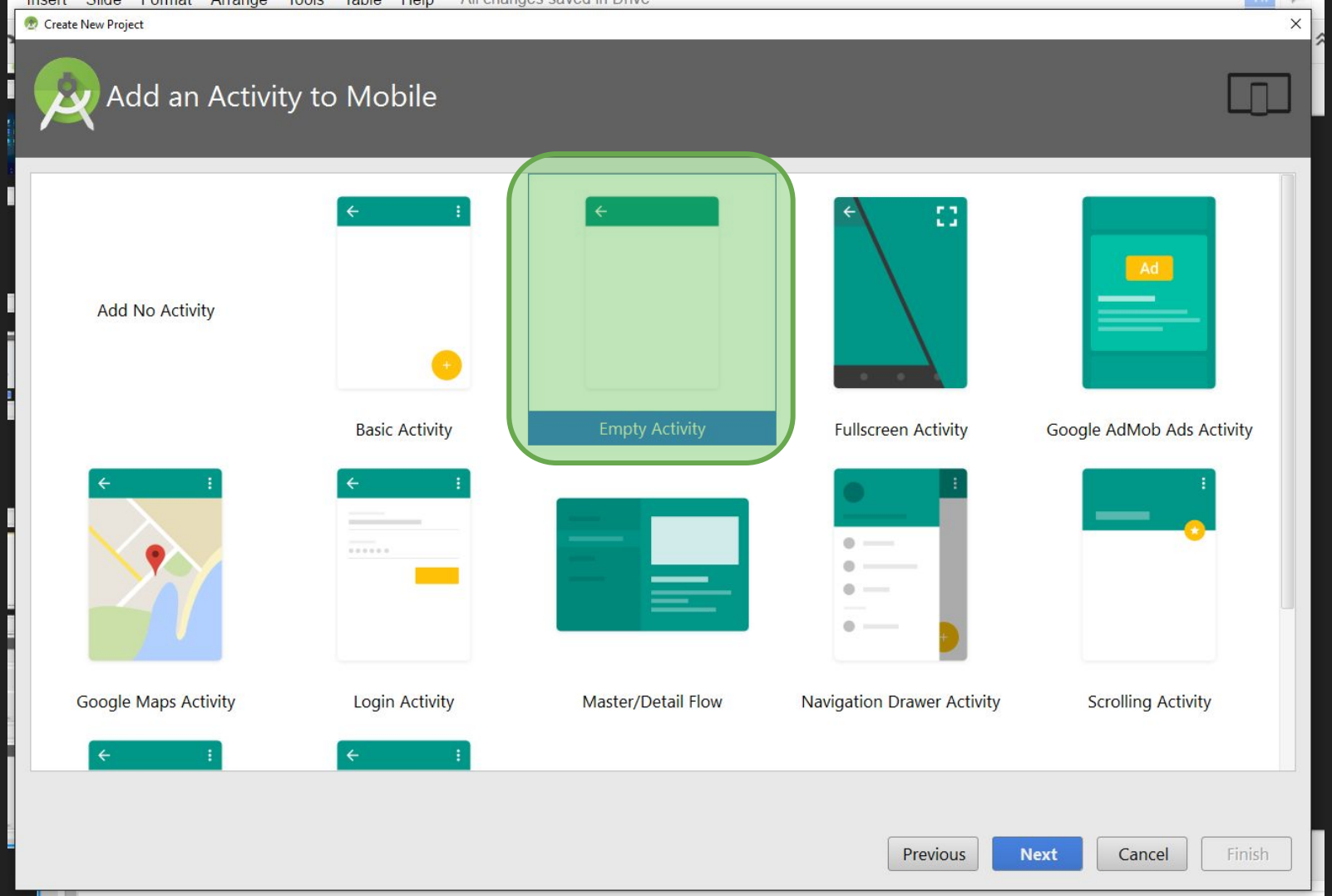
- [ ] TV

  Minimum SDK: API 21: Android 5.0 (Lollipop)

- [ ] Android Auto
- [ ] Glass

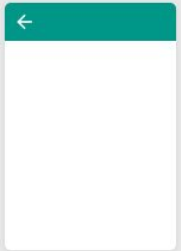
  Minimum SDK: Glass Development Kit Preview (API 19)

Previous | Next | Cancel | Finish


Create New Project
Add an Activity to Mobile
Add No Activity
Basic Activity
Empty Activity
Fullscreen Activity
Ad
Google AdMob Ads Activity
Google Maps Activity
Login Activity
Master/Detail Flow
Navigation Drawer Activity
Scrolling Activity
Previous
Next
Cancel
Finish

Create New Project

Customize the Activity



Empty Activity

Creates a new empty activity

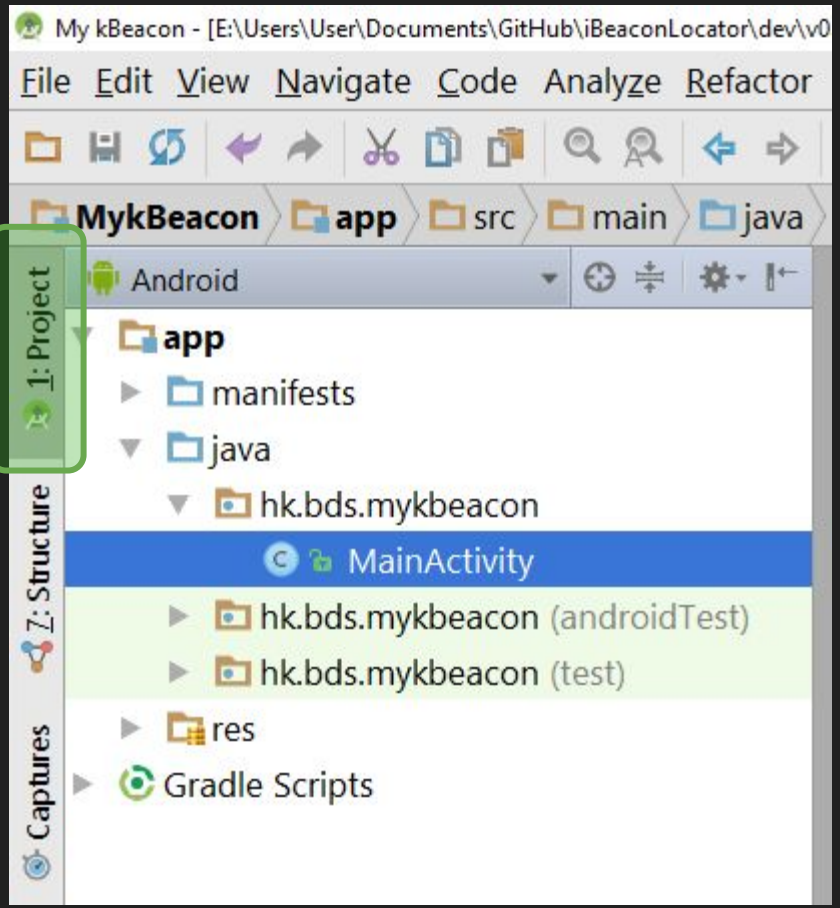
Activity Name: MainActivity

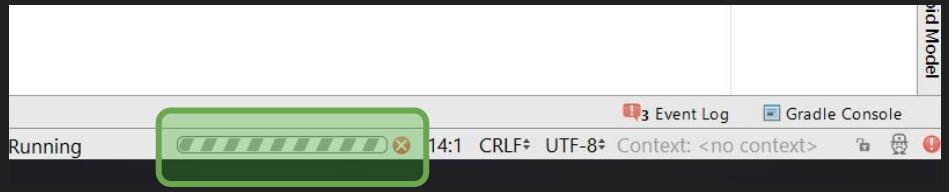
☑ Generate Layout File

Layout Name: activity_main

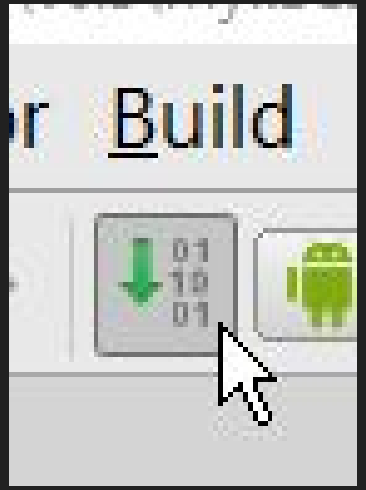
The name of the activity class to create

Previous | Next | Cancel | **Finish**


My kBeacon - [E:\Users\User\Documents\GitHub\iBeaconLocator\dev\v0
File Edit View Navigate Code Analyze Refactor
MykBeacon app src main java
1: Project
Android
app
manifests
java
hk.bds.mykbeacon
MainActivity
hk.bds.mykbeacon (androidTest)
hk.bds.mykbeacon (test)
res
Gradle Scripts
7: Structure
Captures


3 Event Log
Gradle Console
Running
14:1 CRLF UTF-8 Context: <no context>

Wait...

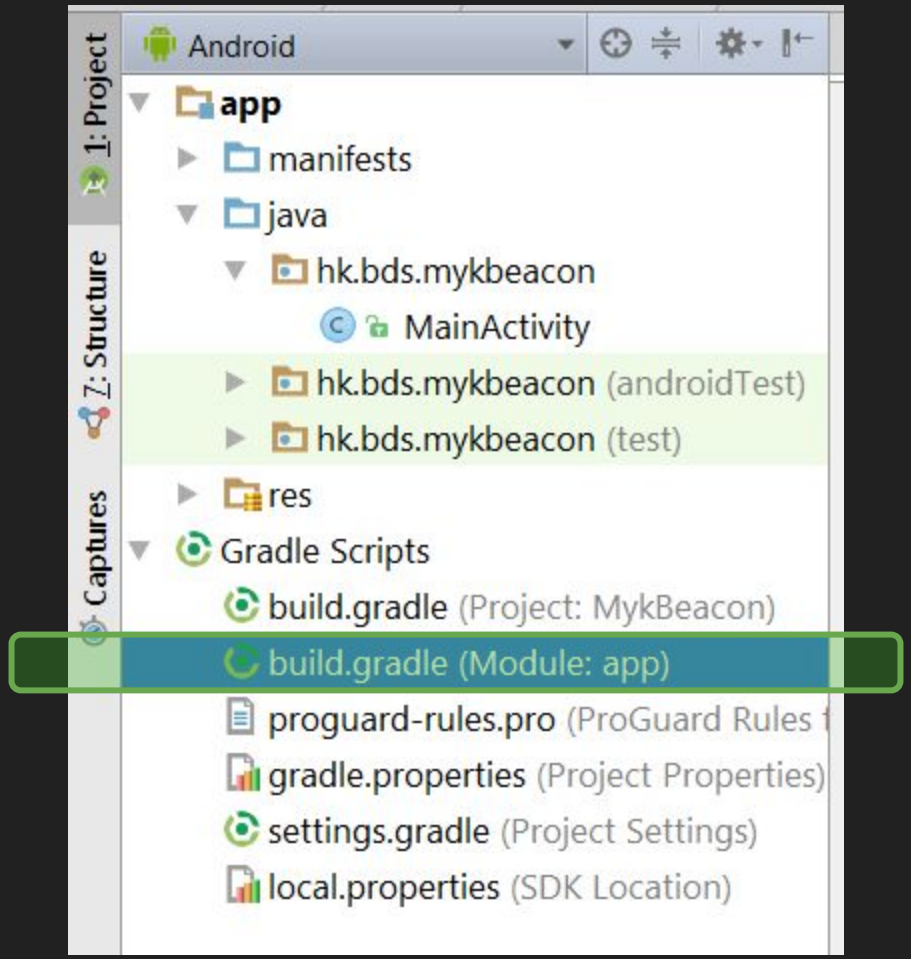


Try to Build!

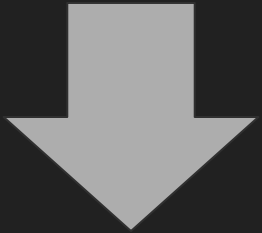
Messages Gradle Build

```
:app:generateDebugAndroidTestResources UP-TO-DATE
:app:mergeDebugAndroidTestResources UP-TO-DATE
:app:processDebugAndroidTestResources UP-TO-DATE
:app:generateDebugAndroidTestSources UP-TO-DATE
:app:mockableAndroidJar UP-TO-DATE
:app:preDebugUnitTestBuild UP-TO-DATE
:app:prepareDebugUnitTestDependencies
:app:incrementalDebugJavaCompilationSafeguard UP-TO-DATE
:app:compileDebugJavaWithJavac UP-TO-DATE
:app:compileDebugNdk UP-TO-DATE
:app:compileDebugSources UP-TO-DATE
:app:incrementalDebugAndroidTestJavaCompilationSafeguard UP-TO-DATE
:app:compileDebugAndroidTestJavaWithJavac UP-TO-DATE
:app:compileDebugAndroidTestNdk UP-TO-DATE
:app:compileDebugAndroidTestSources UP-TO-DATE
:app:incrementalDebugUnitTestJavaCompilationSafeguard UP-TO-DATE
:app:compileDebugUnitTestJavaWithJavac UP-TO-DATE
:app:processDebugJavaRes UP-TO-DATE
:app:processDebugUnitTestJavaRes UP-TO-DATE
:app:compileDebugUnitTestSources UP-TO-DATE
BUILD SUCCESSFUL
Total time: 1.528 secs
0 errors
0 warnings
See complete output in console
```

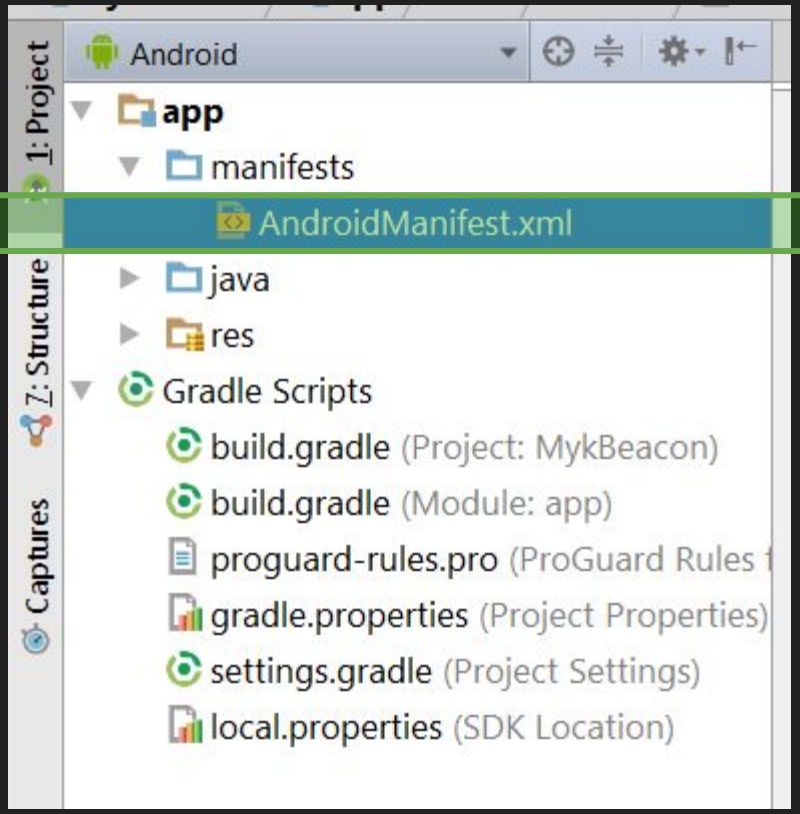
Everytime when you finished any little subsection of your program, verify whether it is bug free!


1: Project
7: Structure
Captures
Android
app
manifests
java
hk.bds.mykbeacon
MainActivity
hk.bds.mykbeacon (androidTest)
hk.bds.mykbeacon (test)
res
Gradle Scripts
build.gradle (Project: MykBeacon)
build.gradle (Module: app)
proguard-rules.pro (ProGuard Rules
gradle.properties (Project Properties)
settings.gradle (Project Settings)
local.properties (SDK Location)

```
dependencies {
    compile fileTree(dir: 'libs', include: ['*.jar'])
    testCompile 'junit:junit:4.12'
    compile 'com.android.support:appcompat-v7:24.0.0'
}
```



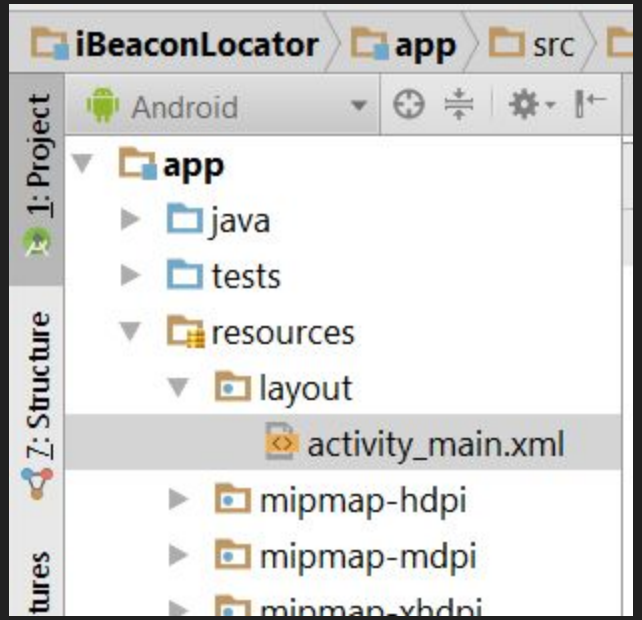
```
dependencies {
    compile fileTree(dir: 'libs', include: ['*.jar'])
    testCompile 'junit:junit:4.12'
    compile 'com.android.support:appcompat-v7:24.0.0'
    compile 'org.altbeacon:android-beacon-library:2+' // This is the dependency of Android Beacon Library
}
```


1: Project
7: Structure
Captures
Android
app
manifests
AndroidManifest.xml
java
res
Gradle Scripts
build.gradle (Project: MykBeacon)
build.gradle (Module: app)
proguard-rules.pro (ProGuard Rules f
gradle.properties (Project Properties)
settings.gradle (Project Settings)
local.properties (SDK Location)

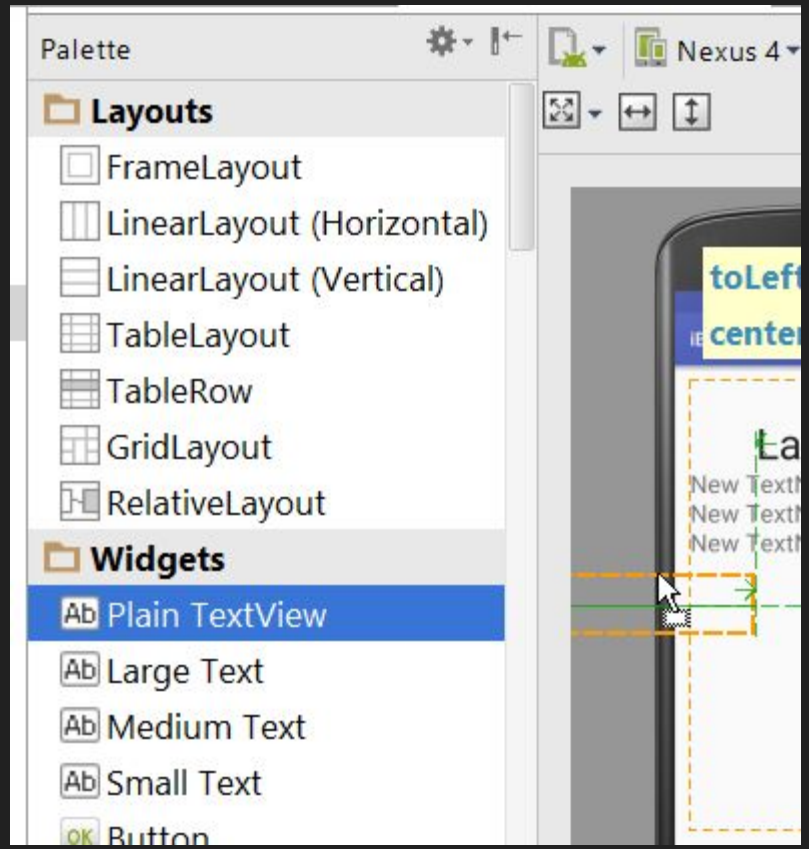
Get the permission to access the bluetooth and location services in your android phone.

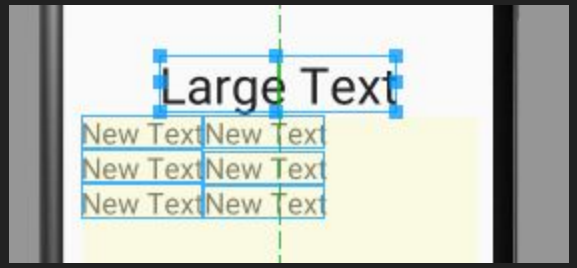
manifest

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="hk.bds.ibeaconlocator" >
    <uses-sdk
        android:minSdkVersion="18"
        android:targetSdkVersion="18" />
    <uses-permission android:name="android.permission.BLUETOOTH"/>
    <uses-permission android:name="android.permission.BLUETOOTH_ADMIN"/>
    <uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION"/>
    <uses-permission android:name="android.permission.ACCESS_FINE_LOCATION"/>

    <application
        android:allowBackup="true"
        android:icon="@mipmap/ic_launcher"
        android:label="iBeaconLocator"
        android:supportsRtl="true"
        android:theme="@style/AppTheme" >

        <activity android:name=".MainActivity" >
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />

                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>

</manifest>
```

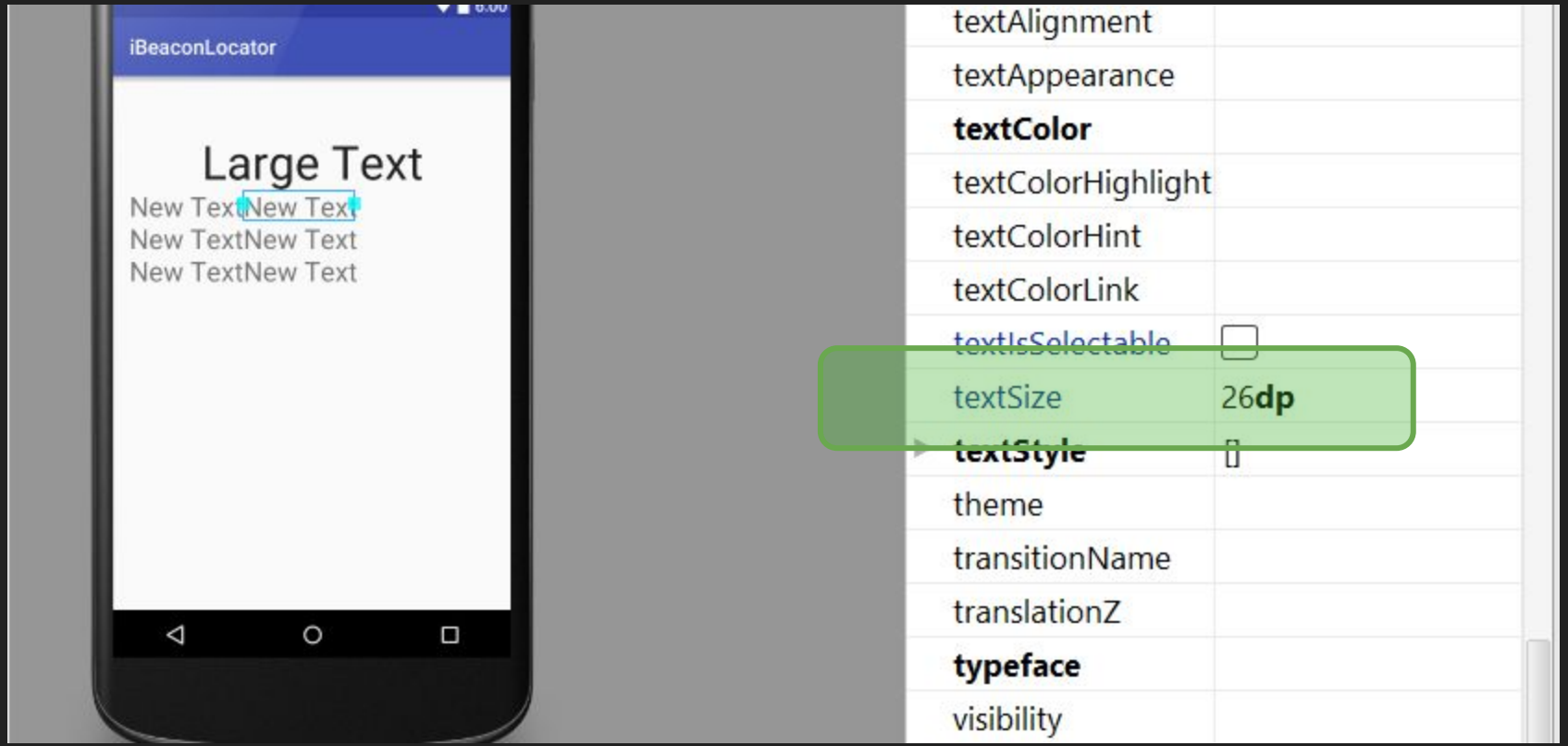

iBeaconLocator
app
src
Android
1: Project
7: Structure
app
java
tests
resources
layout
activity_main.xml
mipmap-hdpi
mipmap-mdpi

Drag and drop the TextView to the screen of the virtual android phone.

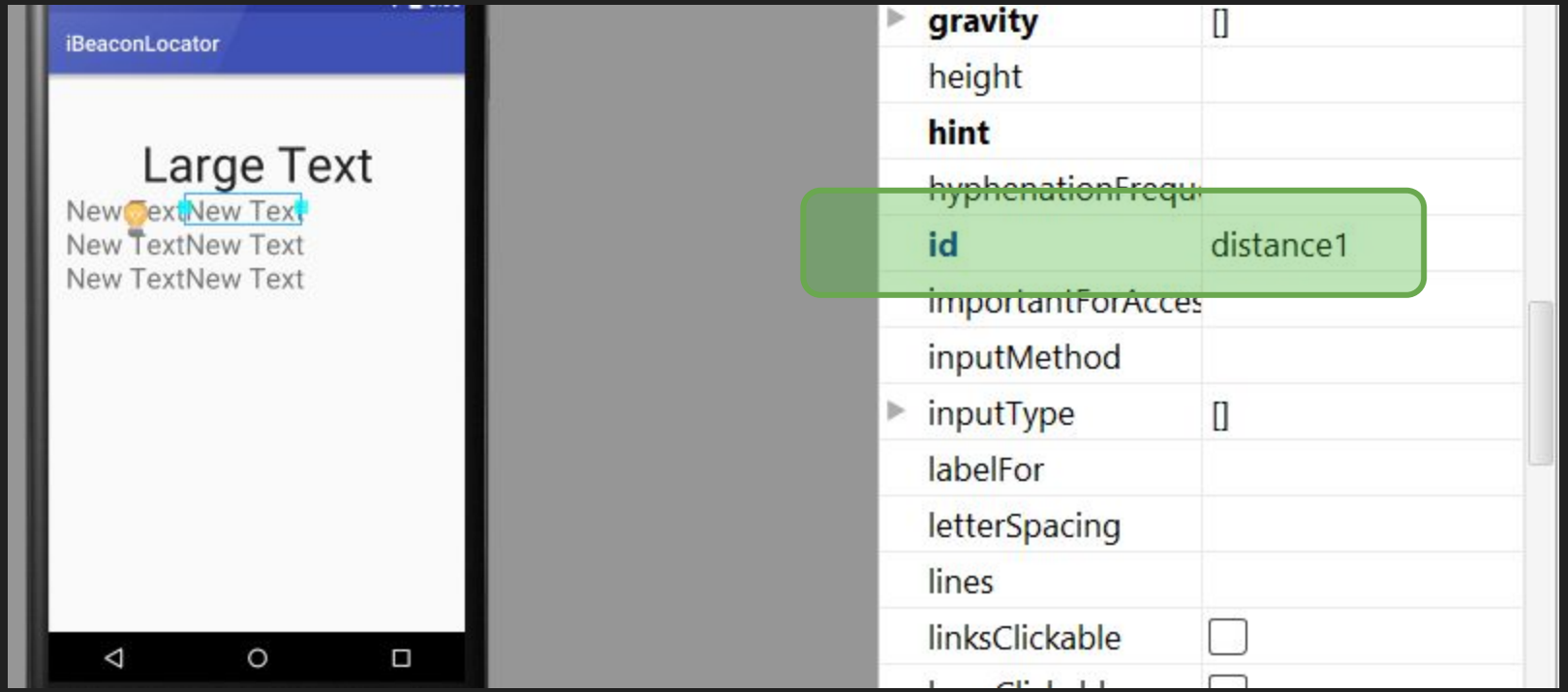



Large Text
New Text
New Text
New Text
New Text
New Text
New Text

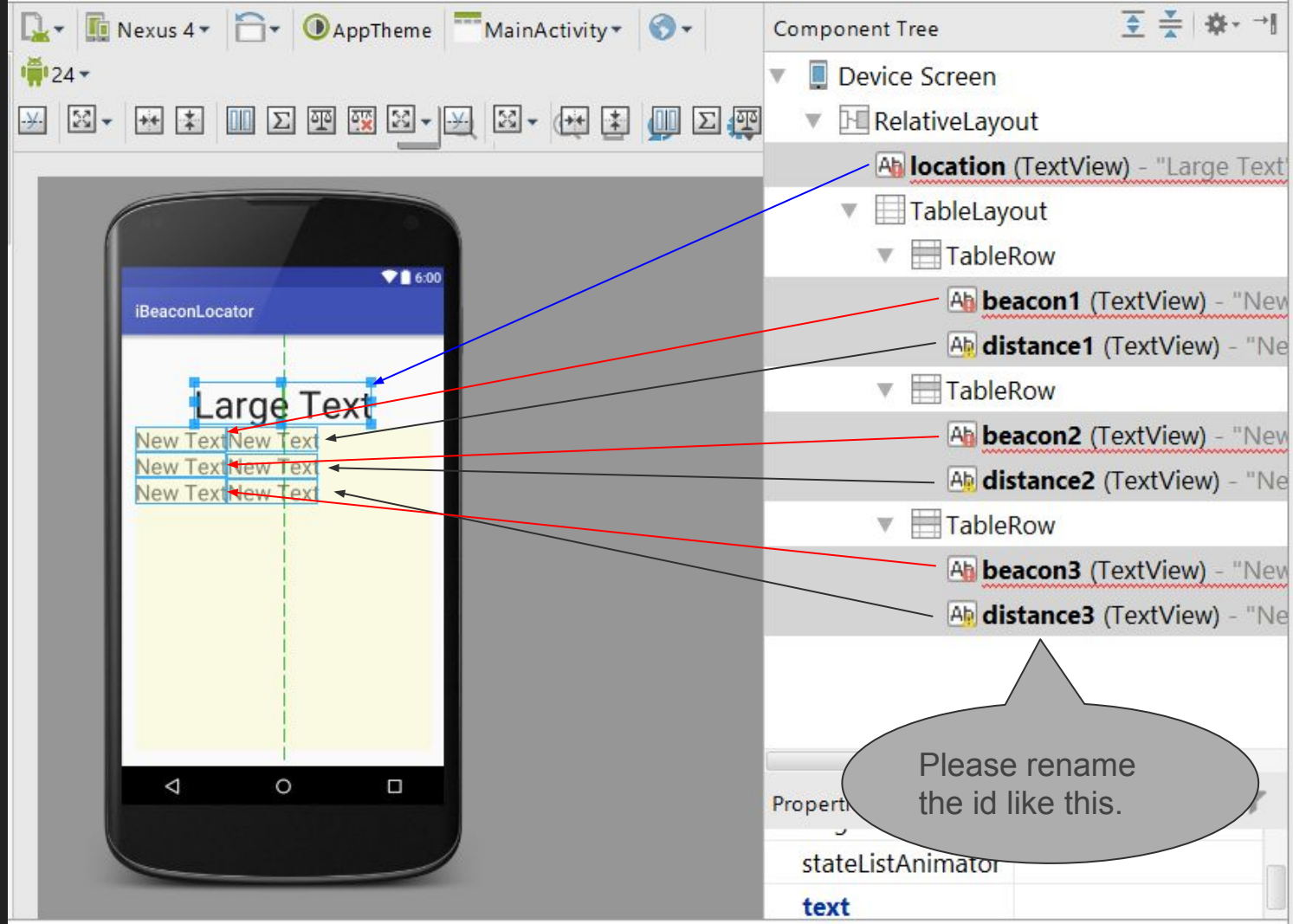
6 TextViews

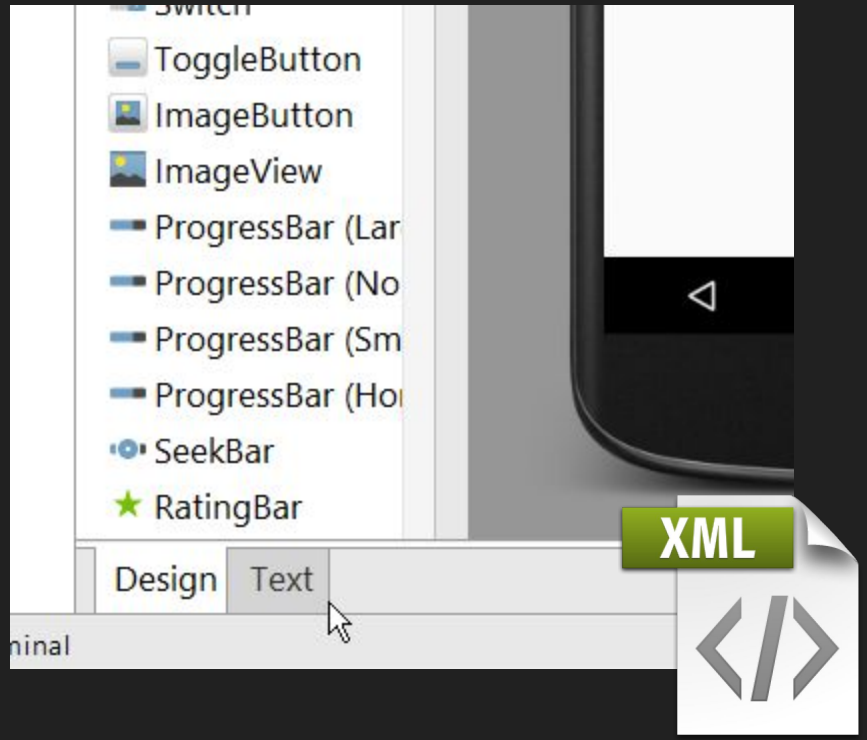


You can try to do some changes to the appearance in the property



The id of each element (e.g. TextView) is important for program to access it.


Nexus 4
AppTheme
MainActivity
24
Component Tree
Device Screen
RelativeLayout
location (TextView) - "Large Text"
TableLayout
TableRow
beacon1 (TextView) - "New
distance1 (TextView) - "Ne
TableRow
beacon2 (TextView) - "New
distance2 (TextView) - "Ne
TableRow
beacon3 (TextView) - "New
distance3 (TextView) - "Ne
6:00
iBeaconLocator
Large Text
New Text
New Text
New Text
New Text
New Text
New Text
Please rename the id like this.
stateListAnimator
text



You can view the XML source.

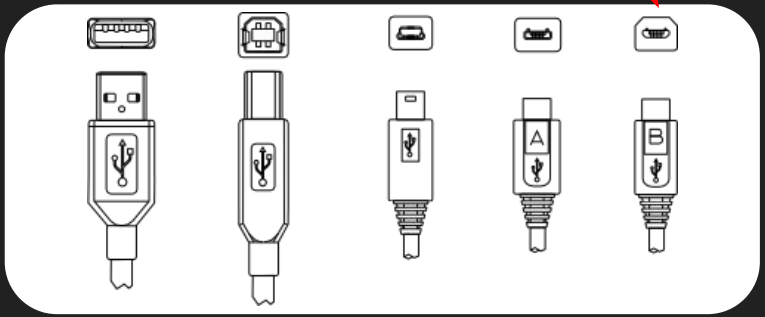
Actually, UI programmers prefer to use “Text” mode.

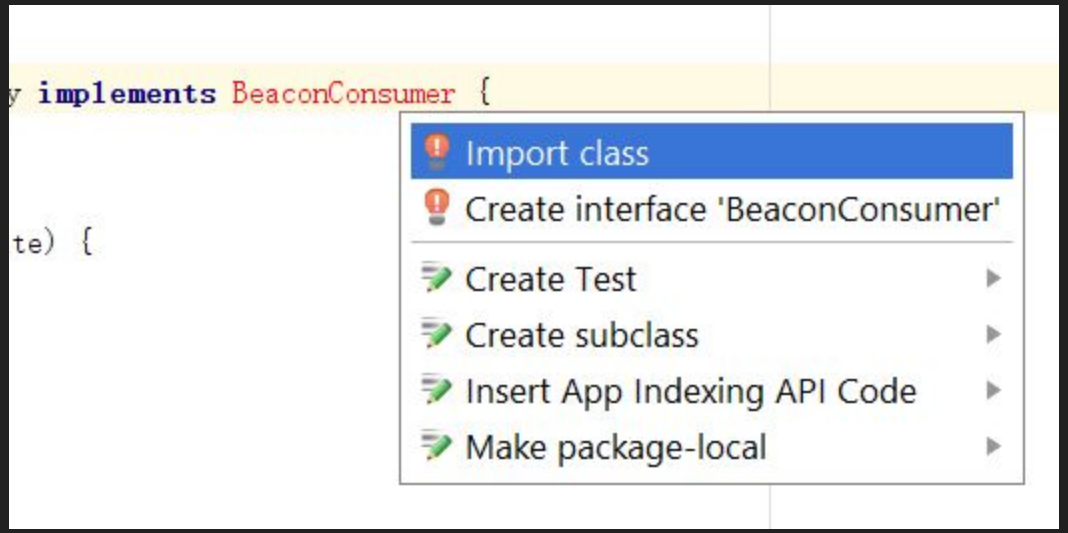
```java
import ...

public class MainActivity extends AppCompatActivity implements BeaconConsumer {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
}
```

This is called an “interface”

If you launch your app, the codes inside will be executed.

But if you just come back to the app, the codes will not be executed





Android Studio does not know what is “BeaconConsumer”.

[ALT] + [ENTER] to import class in order to let Android Studio know what is this.

```java
package hk.bds.mykbeacon;

import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;

import org.altbeacon.beacon.BeaconConsumer;

public class MainActivity extends AppCompatActivity implements BeaconConsumer {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
}
```

Now you imported the package of “BeaconConsumer”.

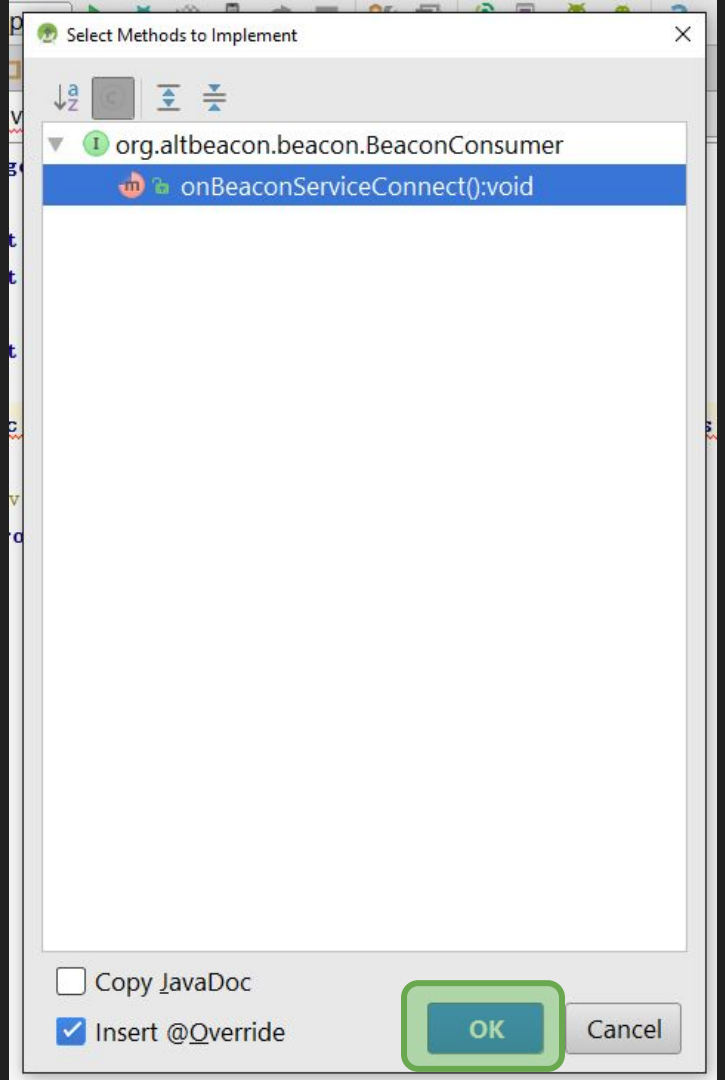
You can also type it by yourself. The effect is the same.

```
public class MainActivity extends AppCompatActivity implements BeaconConsumer {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
}
```

- Implement methods
- Make 'MainActivity' abstract
- Create Test
- Create subclass
- Insert App Indexing API Code
- Make package-local

Since you said you will make the interface “BeaconConsumer”, you need to implement it.

[ALT] + [ENTER] to implement method



For “BeaconConsummer”, you need to make this public method “onBeaconServiceConnect()”

public means that you can let other programs call this method in your program.

```
@Override
public void onBeaconServiceConnect() {

}
```

This method is now created.

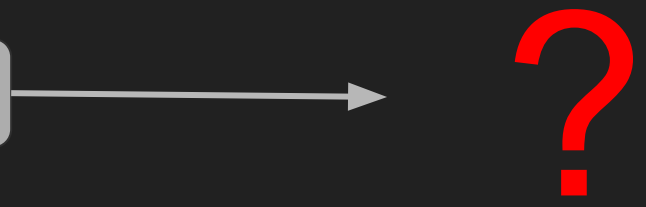
And we need to implement the content of this method.

Now we want to connect the UI to your program.

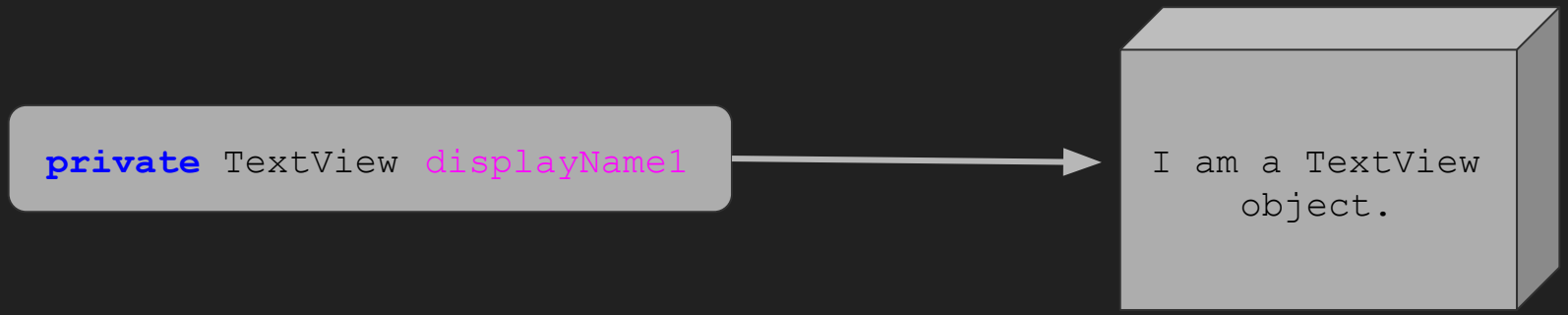
```java
public class MainActivity extends AppCompatActivity implements BeaconConsumer {

    private TextView   displayName1,
                       displayName2,
                       displayName3,
                       displayDistance1,
                       displayDistance2,
                       displayDistance3,
                       displayLocation;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
```

Now we need to declare the TextView objects.

```
private TextView displayName1
```



Actually you have a pointer but it points to nothing.
You need to get the actual TextView object for it.


private TextView displayName1
I am a TextView object.

```java
@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);

    // Init displays
    setContentView(R.layout.activity_main);
    displayName1 = (TextView) findViewById(R.id.beacon1);
    displayName2 = (TextView) findViewById(R.id.beacon2);
    displayName3 = (TextView) findViewById(R.id.beacon3);
    displayDistance1 = (TextView) findViewById(R.id.distance1);
    displayDistance2 = (TextView) findViewById(R.id.distance2);
    displayDistance3 = (TextView) findViewById(R.id.distance3);
    displayLocation = (TextView) findViewById(R.id.location);
}
```

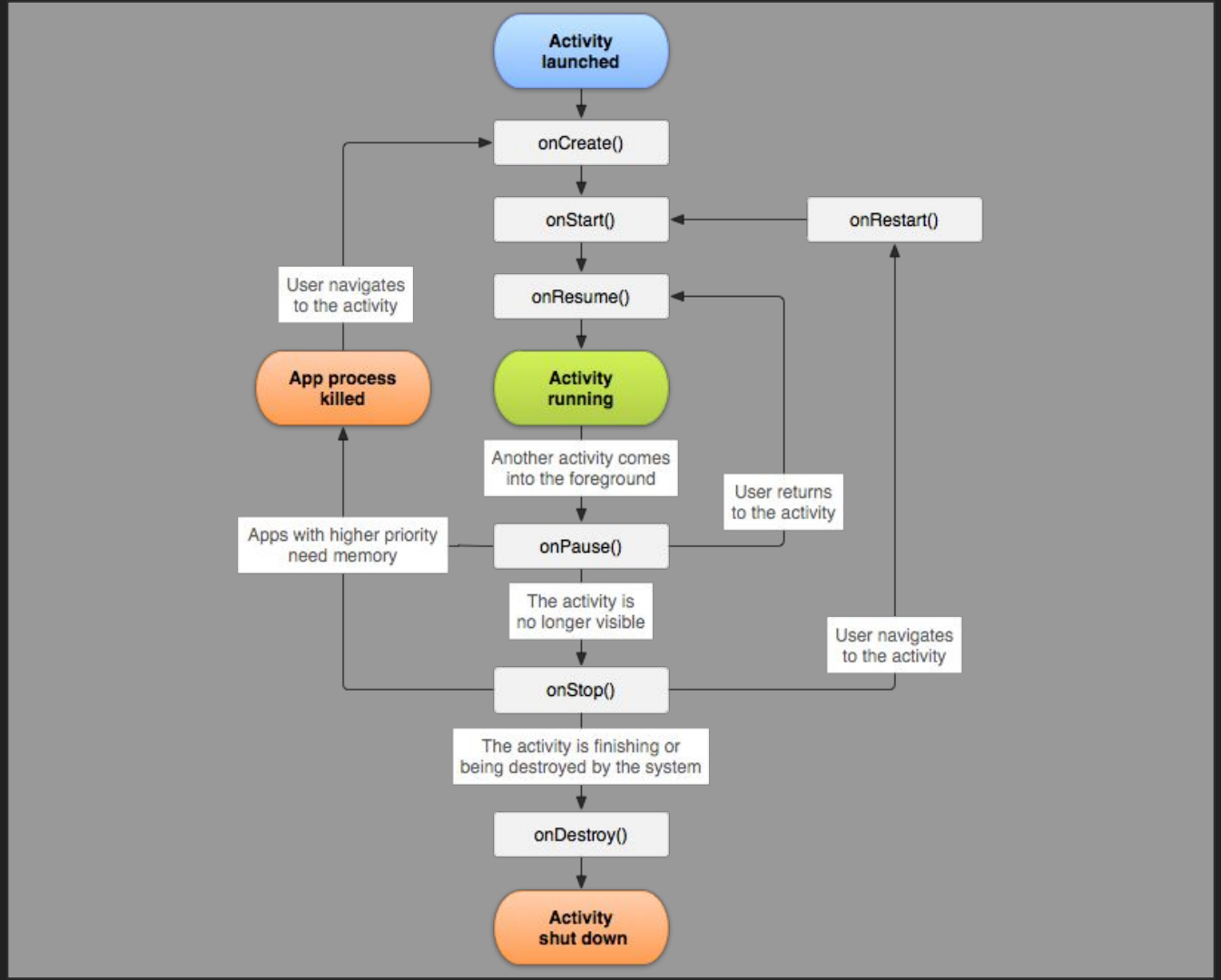
Now we need to get the TextView objects.

```
displayDistance1,
displayDistance2,
displayDistance3,
displayLocation;

private BeaconManager beaconManager;

@Override
protected void onCreate(Bundle savedInstanceState)
    super.onCreate(savedInstanceState);
```

```
displayName2 = (TextView) findViewById(R.id.beacon2);
displayName3 = (TextView) findViewById(R.id.beacon3);
displayDistance1 = (TextView) findViewById(R.id.distance1);
displayDistance2 = (TextView) findViewById(R.id.distance2);
displayDistance3 = (TextView) findViewById(R.id.distance3);
displayLocation = (TextView) findViewById(R.id.location);

// Init Beacon
beaconManager = BeaconManager.getInstanceForApplication(this);
beaconManager.getBeaconParsers().add(new BeaconParser().setBeaconLayout("m:2-3=0215,i:4-19,i:20-21,i:22-23,p:24-24"));
RangedBeacon.setSampleExpirationMilliseconds(1100);    // The refresh interval
Beacon.setHardwareEqualityEnforced(true);
beaconManager.setBackgroundBetweenScanPeriod(20);
beaconManager.setForegroundBetweenScanPeriod(20);
beaconManager.bind(this);
```

```
        });
    }

    @Override
    protected void onDestroy() {
        super.onDestroy();
        beaconManager.unbind(this);
    }

    @Override
    public void onBeaconServiceConnect() {
```

When you terminate the app, the codes inside will be executed.


Activity launched
onCreate()
onStart()
onRestart()
User navigates to the activity
onResume()
App process killed
Activity running
Another activity comes into the foreground
User returns to the activity
Apps with higher priority need memory
onPause()
The activity is no longer visible
User navigates to the activity
onStop()
The activity is finishing or being destroyed by the system
onDestroy()
Activity shut down

```java
    protected void onDestroy() {
        super.onDestroy();
        beaconManager.unbind(this);
    }

    @Override
    public void onBeaconServiceConnect() {
        //This method will be called when the Beacon Manager is binded.
        beaconManager.setRangeNotifier( new RangeNotifier() {
            @Override
            public void didRangeBeaconsInRegion(Collection<Beacon> beacons, Region region) {
                // This method will be executed many times according to the size of the refresh interval.
                // Try to update the distance of the devices
                if (beacons.size() > 0) {
                    // Do something
                }
            }
        });

        try {
            // Tells the BeaconService to start looking for beacons that match the passed Region object,
            // and providing updates on the estimated mDistance every seconds while beacons in the Region are visible.
            beaconManager.startRangingBeaconsInRegion(new Region("myRangingUniqueId", null, null, null));
        } catch (RemoteException e) {  /* Error is detected. */  }

    }
}
```

```java
// Try to update the distance of the devices
if (beacons.size() > 0) {
    // Do something
    for (Beacon b : beacons ) {
        // Access all detected beacons, one per a loop
        double distance = b.getDistance();  // Get the distance
        String macAddress = b.getBluetoothAddress();    // Get the beacon MAC address
    }
}
```

Now you can get the distances and MAC addresses of the bluetooth devices.

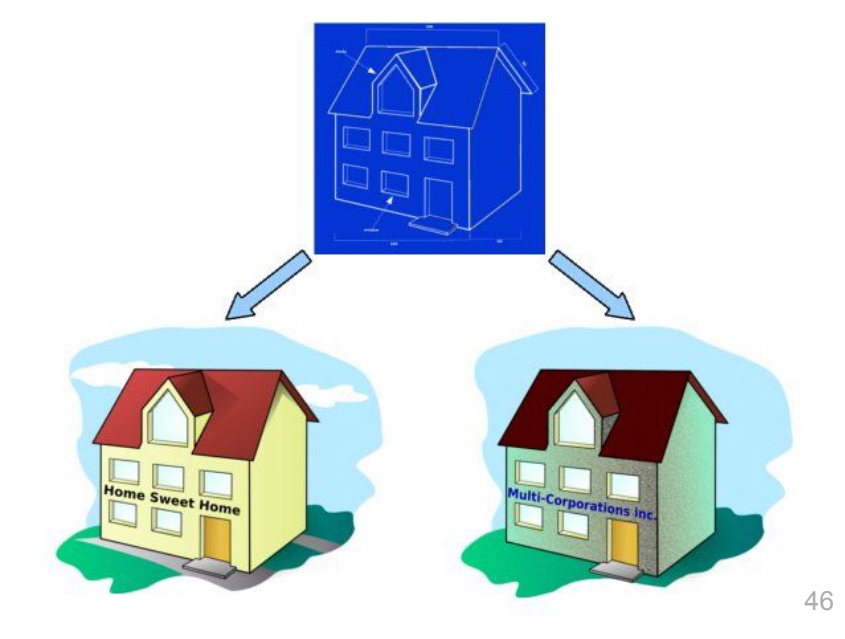
Now I want to determine the nearest kBeacon, and display it out.

But the program will get more and more complicated. So you have to create a data model

Object

Before you create any object, you need to have a blueprint and you use the blueprint to generate the object(s). The blueprint is called “class”

```
class House {

    // Data stored inside

    int height, width, length;

    int num_of_people;

    // Some methods for operating
       the data inside and outside

    // ...

}
```



Create a Class “MyBeacon”

```java
class MyBeacon {
    public String name;
    public String macAddress;
    public double distance = 0d; // initially the distance is 0.
    //public double predistance = 0d;

    // Display reference pointers.
    public TextView displayName;
    public TextView displayDistance;


    public MyBeacon(String _name, String _macAddress, TextView _displayName, TextView _displayDistance) {
        name = _name;
        macAddress = _macAddress;
        displayName = _displayName;
        displayDistance = _displayDistance;
        displayName.setText(name + " :  ");
    }

    public boolean updateDistance(Beacon _beacon) {
        if (_beacon.getBluetoothAddress().equals(this.macAddress)) {
            distance = _beacon.getDistance(); // Calculate the distance based on RSSI.
            return true;
        } else
            return false;
```

```java
public boolean updateDistance(Beacon _beacon) {
    if (_beacon.getBluetoothAddress().equals(this.macAddress)) {
        distance = _beacon.getDistance(); // Calculate the distance based on RSSI.
        return true;
    } else
        return false;
}

public void updateDistance(Collection<Beacon> beacons) {
    for (Beacon theBeacon : beacons) {
        if (updateDistance(theBeacon))
            return;
    }
    distance = 0d;

}

public void updateDisplayDistance() {
    String str;
    if (distance == 0d)
        str = "UNDETECTED";
    else
        str = String.format("%.4f", distance);
```

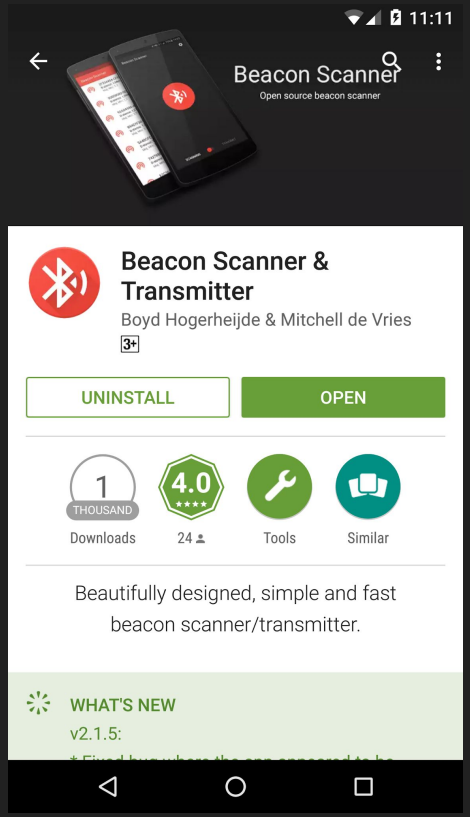
```java
    }

    public void updateDisplayDistance() {
        String str;
        if (distance == 0d)
            str = "UNDETECTED";
        else
            str = String.format("%.4f", distance);
        displayDistance.setText(str);
    }

    public String toString() {
        String str = "";
        str += "\n==================================";
        str += "\nBeacon Name: " + this.name;
        str += "\nMac Address: " + this.macAddress;
        str += "\nDistance   : " + this.distance;
        str += "\n==================================";
        return str;
    }
}
```

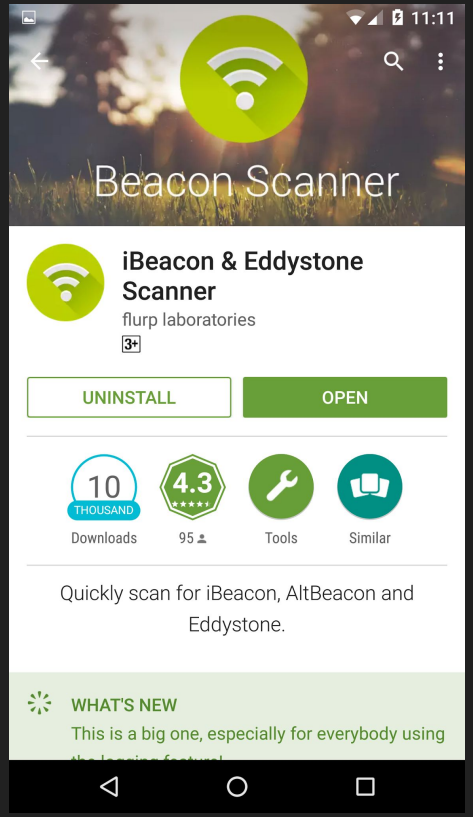
Create Objects of the Class

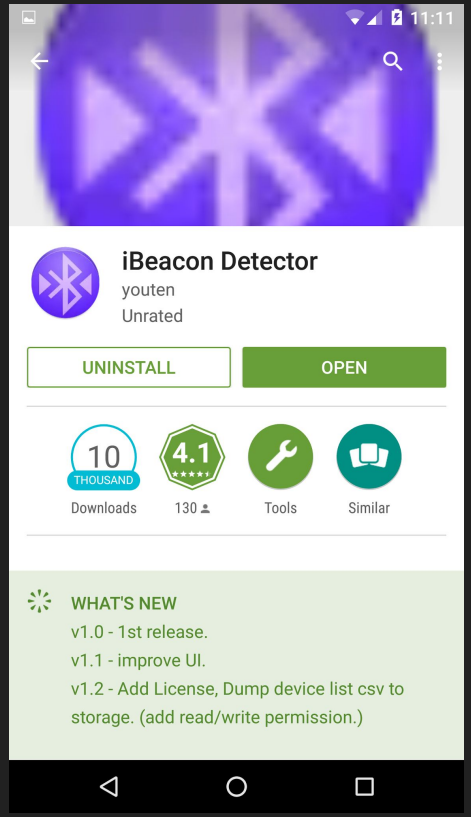
```java
private BeaconManager beaconManager;

private MyBeacon b1, b2, b3, theNear;

@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
```

```java
// Init Beacon
beaconManager = BeaconManager.getInstanceForApplication(this);
beaconManager.getBeaconParsers().add(new BeaconParser().setBeaconLayout("m:2-3=0215,i:4-19,
RangedBeacon.setSampleExpirationMilliseconds(1100);    // The refresh interval
beaconManager.setBackgroundBetweenScanPeriod(20);
beaconManager.setForegroundBetweenScanPeriod(20);
beaconManager.bind(this);

// Init beacon devices
b1 = new MyBeacon("Room S505", "BC:6A:29:25:0F:52", displayName1, displayDistance1);
b2 = new MyBeacon("Room S506", "BC:6A:29:27:A4:2D", displayName2, displayDistance2);
b3 = new MyBeacon("Room S507", "BC:6A:29:28:01:BD", displayName3, displayDistance3);
```

How to find out the MAC address of your beacon?







```java
    private MyBeacon getMinOne(MyBeacon a, MyBeacon b) {
        if (a != null && b != null) {
            if ((a.distance > 0d && b.distance > 0d) && !(a.distance == b.distance)) {
                if (b.distance < a.distance)
                    return b;
                else
                    return a;
            } else if ((a.distance <= 0d && b.distance <= 0d) || (a.distance == b.distance)) {
                return null;
            } else {
                if (a.distance == 0d)
                    return b;
                else
                    return a;
            }
        } else if ((a == null && b == null) || (a == null && b.distance <= 0d) || (b == null && a.distance <= 0d)){
            return null;
        } else {
            if (a != null)
                return a;
            else
                return b;
        }
    }

}
```

This method is used to find out the nearest MyBeacon from the 2 MyBeacon a and b.

```java
// Try to update the distance of the devices
if (beacons.size() > 0) {
    // Do something
    for (Beacon b : beacons ) {
        // Access all detected beacons, one per a loop
        double distance = b.getDistance();  // Get the distance
        String macAddress = b.getBluetoothAddress();    // Get the beacon MAC address
    }
}
```

Delete those codes inside and we can do a little bit more.

```java
public void didRangeBeaconsInRegion(Collection<Beacon> beacons, Region region) {
    // This method will be executed many times according to the size of the refresh interval.
    // Try to update the distance of the devices
    b1.updateDistance(beacons);
    b2.updateDistance(beacons);
    b3.updateDistance(beacons);
    theNear = getMinOne(getMinOne(b1, b2), b3);
```

Update the distances of the MyBeacon objects

and

Find out the nearest one.

Actually, this is a equation. We assume that the distance of b1 > b2 > b3

(b3 is the nearest one)

```
theNear  = getMinOne(getMinOne(b1,b2),b3)
         = getMinOne(b2, b3)
         = b3
```

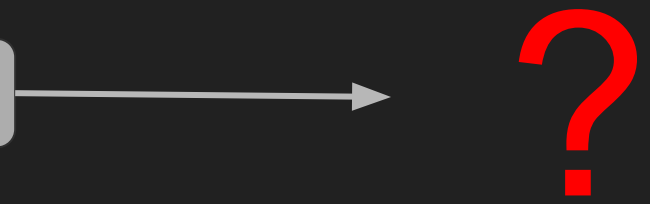
Now we know that theNear is b3.

```java
b3.updateDistance(beacon3);
theNear = getMinOne(getMinOne(b1, b2), b3);

// Update Displays
MainActivity.this.runOnUiThread( new Runnable() {
    public void run() {
        if (theNear != null && theNear.distance < 0.35) {
            // If the near beacon is inside the range, do this action
            displayLocation.setText(theNear.name); // Update the largest text.

        } else {
            // You are not close enough to the near one.
            displayLocation.setText("UNCERTAIN");
        }
        // Update the distance display
        b1.updateDisplayDistance();
        b2.updateDisplayDistance();
        b3.updateDisplayDistance();
    }
});
```

Now we already get all required information.

We can display them to the UI.

```
private MyBeacon theNear
```



null

Since we cannot determine the nearest one,
the “`getMinOne(getMinOne(b1,b2),b3)`” method give me “null”.

```
theNear = null
```

Now we make it speak what is the location of the nearest kBeacon detected.

Google TextToSpeech

```
displayLocation;
private BeaconManager beaconManager;
private TextToSpeech ttobj;
private MyBeacon previousLocation = null;
```

```
b3 = new MyBeacon("Room S507", "BC:6A:29:28:01:BD", displayName3,

// Create Google TextToSpeech Object
ttobj = new TextToSpeech(getApplicationContext(), (status) -> {
        if(status != TextToSpeech.ERROR) {
            ttobj.setLanguage(Locale.UK); // Set to "UK" language
        }
});
}
```

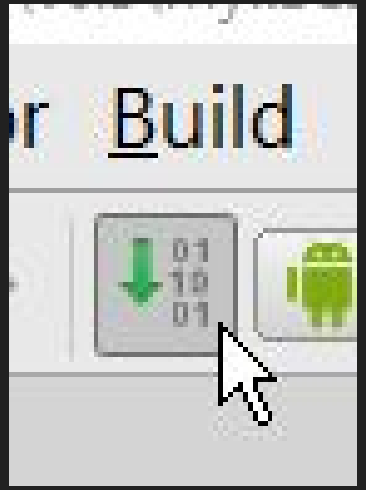
Create an object of Google TextToSpeech service.

```
private BeaconManager beaconManager;
private TextToSpeech ttobj;
private MyBeacon previousLocation = null;

@Override
```

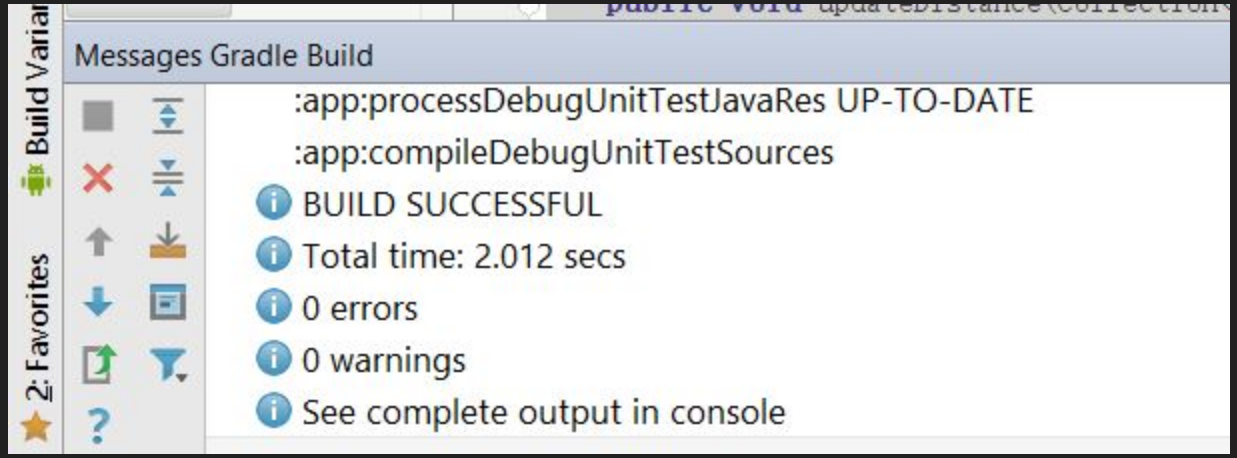
We need an object to store the previous detected beacon.

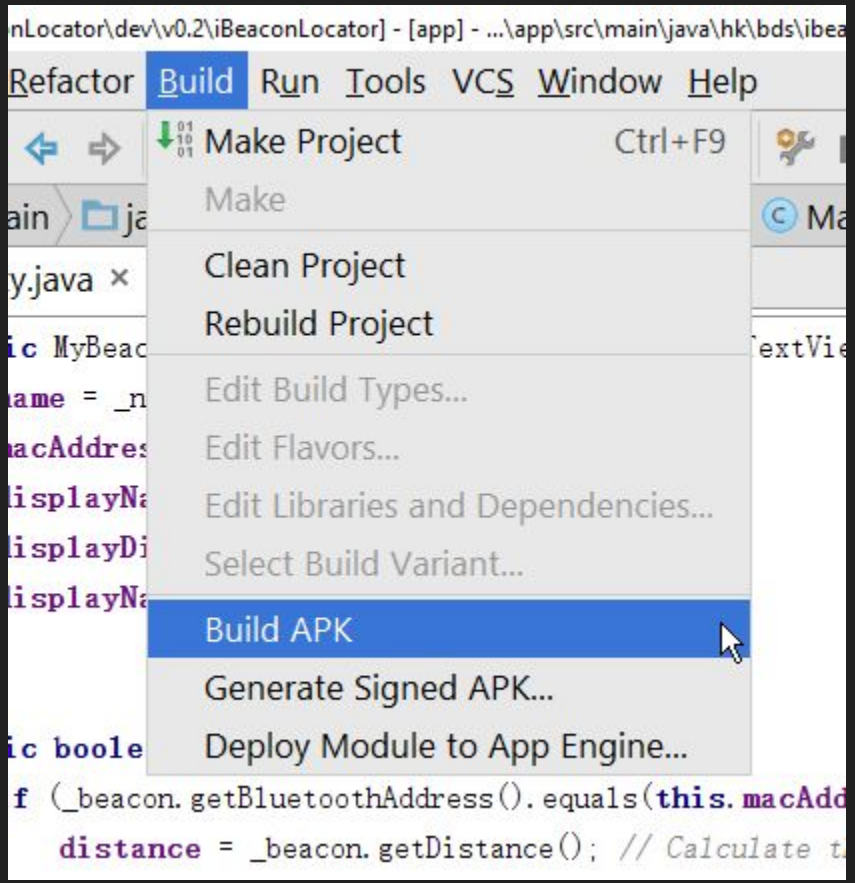
This is used for determining the change of location.

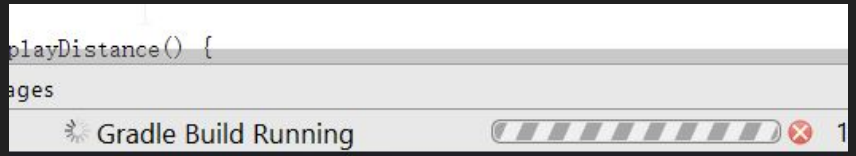
```java
MainActivity.this.runOnUiThread( new Runnable() {
    public void run() {
        if (theNear != null && theNear.distance < 0.35) {
            // If the near beacon is inside the range, do this action
            displayLocation.setText(theNear.name); // Update the largest text.

            if (theNear != previousLocation) {
                // If you just enter the area
                String toSpeak = "" + theNear.name;
                ttobj.speak(toSpeak, TextToSpeech.QUEUE_FLUSH, null); // Speak
            }

        } else {
            // You are not close enough to the near one.
            displayLocation.setText("UNCERTAIN");
            previousLocation = null;
        }
        previousLocation = theNear; // Store the previous location
        // Update the distance display
        b1.updateDisplayDistance();
        b2.updateDisplayDistance();
        b3.updateDisplayDistance();
    }
});
```



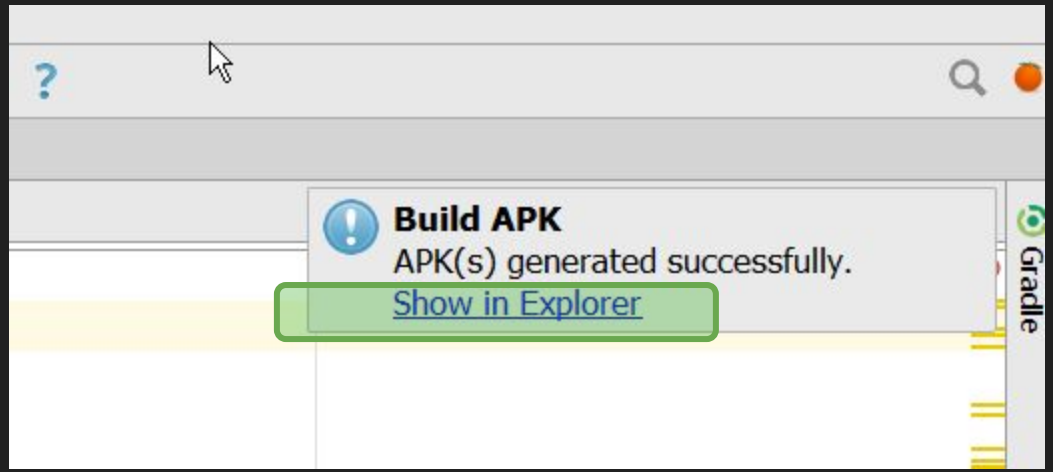
Try to Build!

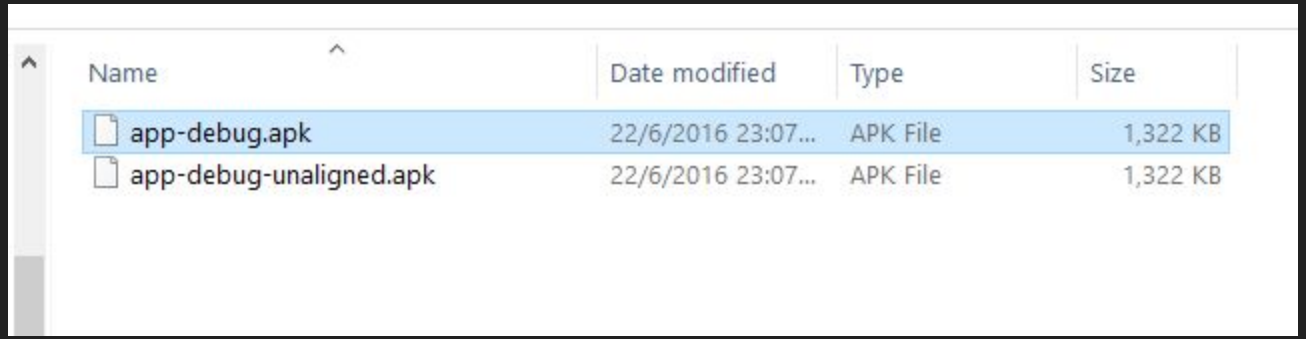

Build Variant
2: Favorites
Messages Gradle Build
:app:processDebugUnitTestJavaRes UP-TO-DATE
:app:compileDebugUnitTestSources
BUILD SUCCESSFUL
Total time: 2.012 secs
0 errors
0 warnings
See complete output in console


nLocator\dev\v0.2\iBeaconLocator] - [app] - ...\app\src\main\java\hk\bds\ibea
Refactor
Build
Run
Tools
VCS
Window
Help
Make Project
Ctrl+F9
Make
Clean Project
Rebuild Project
Edit Build Types...
Edit Flavors...
Edit Libraries and Dependencies...
Select Build Variant...
Build APK
Generate Signed APK...
Deploy Module to App Engine...
y.java
ic MyBeac
ame = _n
acAddres
isplayNa
isplayDi
isplayNa
ic boole
f (_beacon.getBluetoothAddress().equals(this.macAdd
distance = _beacon.getDistance(); // Calculate t


playDistance() {
ages
Gradle Build Running

Wait...


Build APK
APK(s) generated successfully.
Show in Explorer
Gradle



Name	Date modified	Type	Size
app-debug.apk	22/6/2016 23:07...	APK File	1,322 KB
app-debug-unaligned.apk	22/6/2016 23:07...	APK File	1,322 KB

Install it on your android device.

Big Dipper

your I.T. guiding star

END