



Android

Application Development

Lab 3 - Ασκήσεις μελέτης B2

Human-Computer Interaction, AUEB
Εαρινό εξάμηνο 2023-2024

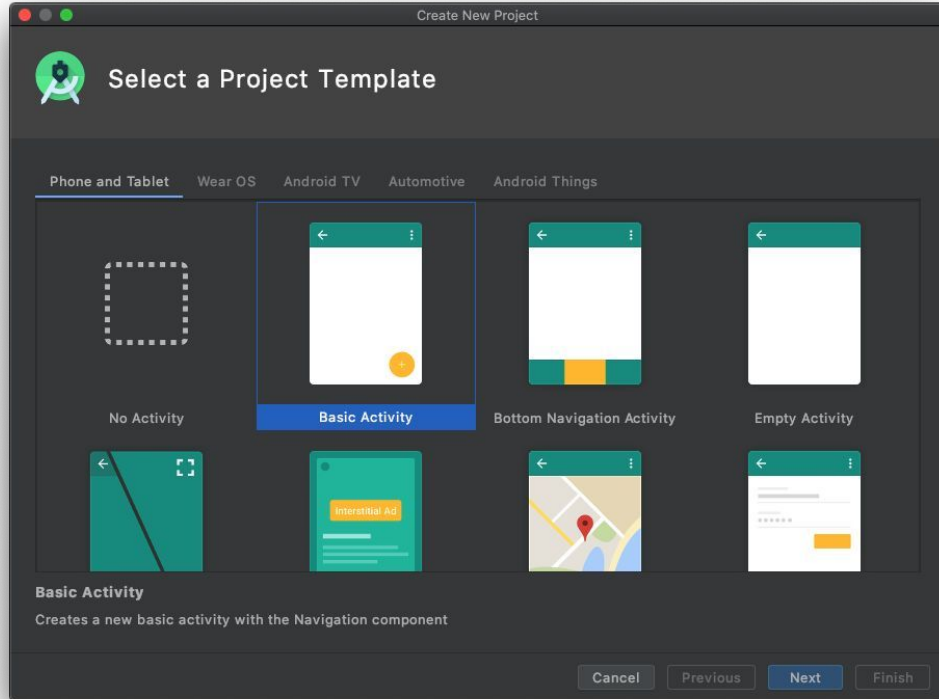
Lab Assistant: Sofia Eleftheriou



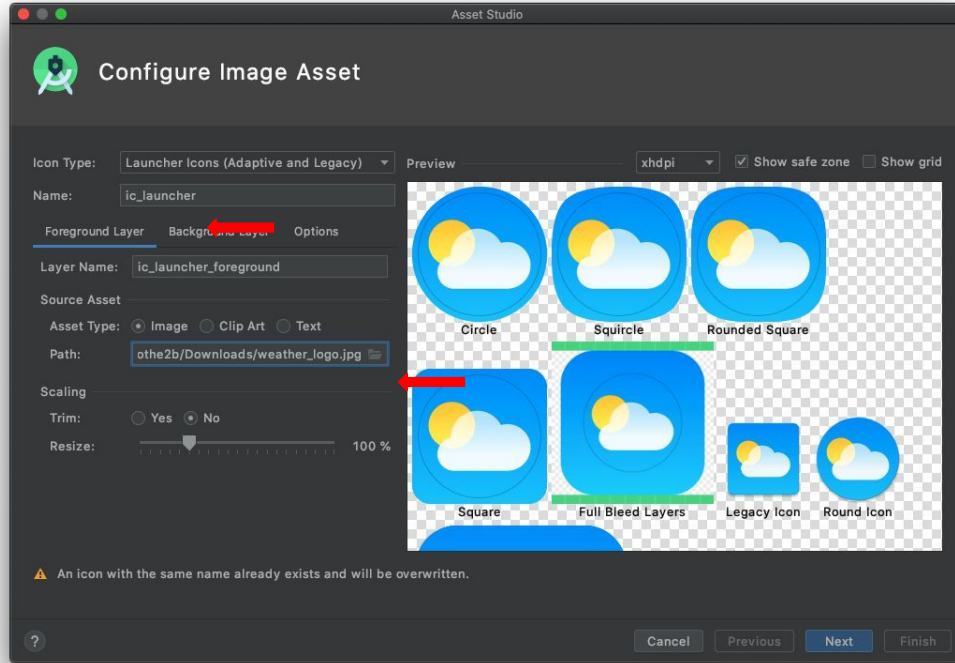
Android Development Advanced Use

- Catch up with Lab 1-2
- Add Voice Recognition functionality
 - Update Business Logic to use voice commands
 - Demonstrate updates

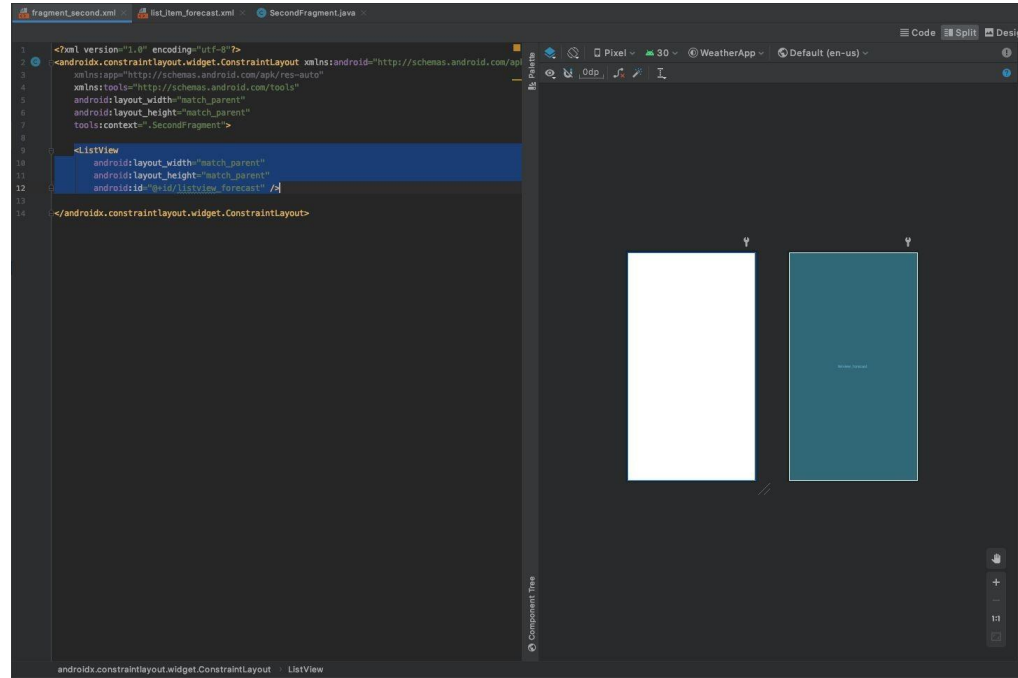
Catch up with Lab 1



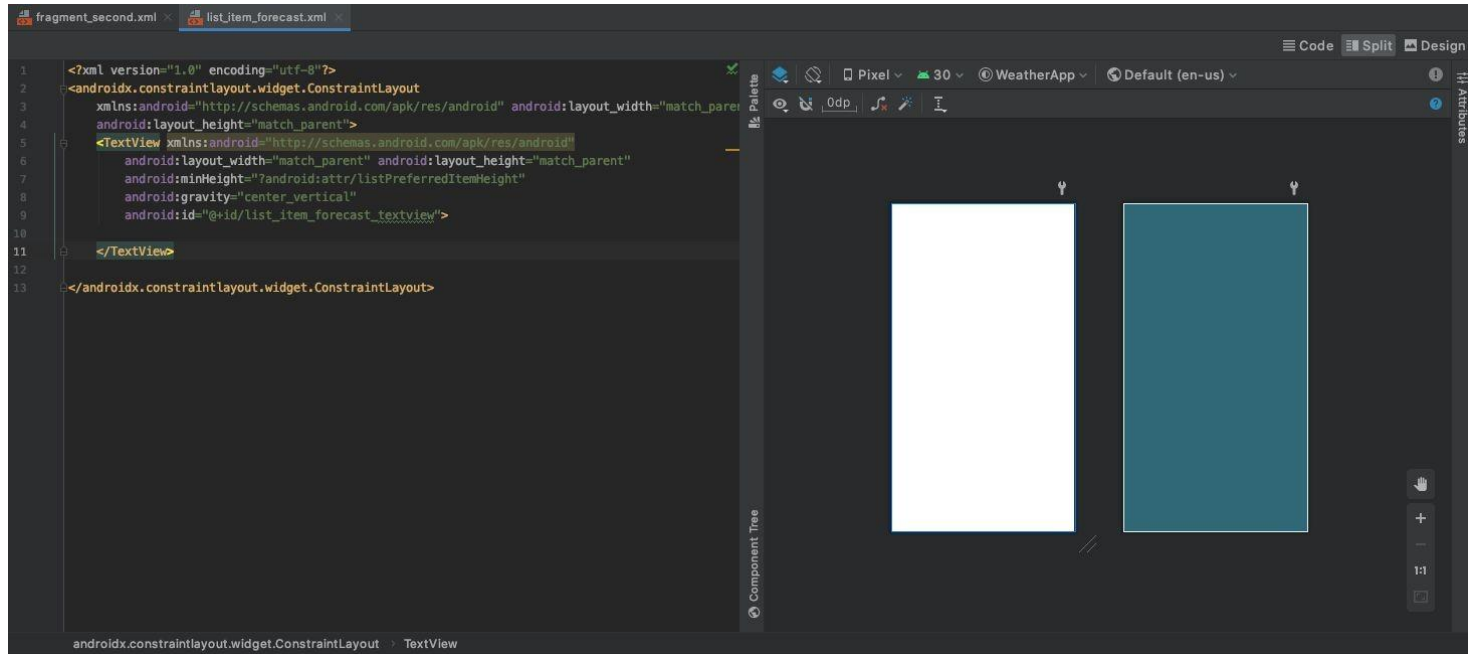
Create new project with Basic Activity



Change Application Icon



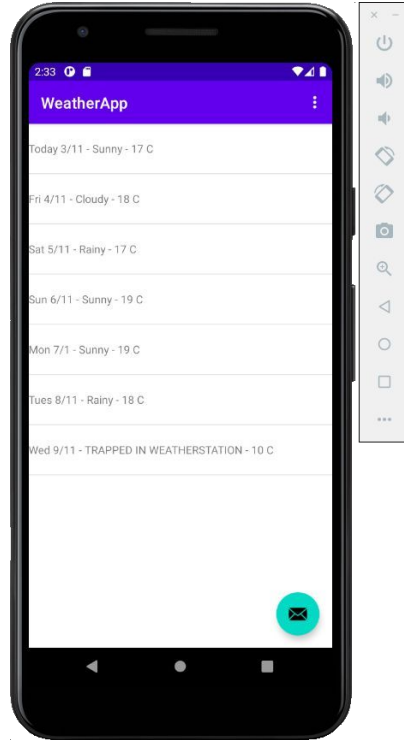
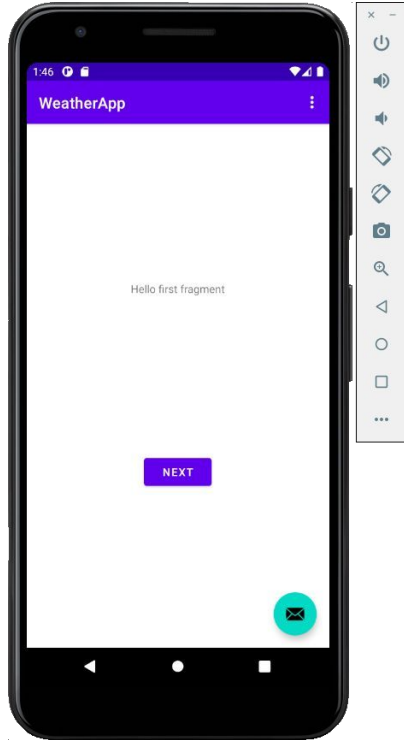
Add ListView to layout



Add new layout with TextView for list items

```
SecondFragment.java
1 package com.example.weatherapp;
2
3 import android.os.Bundle;
4 import android.view.LayoutInflater;
5 import android.view.View;
6 import android.view.ViewGroup;
7
8 import androidx.fragment.app.Fragment;
9 import androidx.appcompat.widget.Toolbar;
10 import androidx.recyclerview.widget.RecyclerView;
11 import androidx.recyclerview.widget.RecyclerView.ViewHolder;
12
13 public class SecondFragment extends Fragment {
14
15     @Override
16     public View onCreateView(
17         LayoutInflater inflater, ViewGroup container,
18         Bundle savedInstanceState) {
19
20         // Inflate the layout for this fragment
21         RecyclerView recyclerView = (RecyclerView) inflater.inflate(
22             R.layout.fragment_second, container, false);
23
24         // Create a mock data list
25         String[] data = {
26             "Today 3/11 - Sunny - 17 C",
27             "Fri 4/11 - Cloudy - 18 C",
28             "Sat 5/11 - Rainy - 17 C",
29             "Sun 6/11 - Sunny - 19 C",
30             "Mon 7/1 - Sunny - 19 C",
31             "Tues 8/11 - Rainy - 18 C",
32             "Wed 9/11 - TRAPPED IN WEATHERSTATION - 10 C"
33         };
34
35         // Create a RecyclerView.Adapter
36         RecyclerView.Adapter<ViewHolder> weekForecast = new RecyclerView.Adapter<ViewHolder>() {
37             @Override
38             public int getItemCount() {
39                 return data.length;
40             }
41
42             @Override
43             public ViewHolder onCreateViewHolder(ViewGroup parent) {
44                 // Create a new ViewHolder
45                 RecyclerView.ViewHolder viewHolder = new RecyclerView.ViewHolder(
46                     inflater.inflate(R.layout.fragment_second, parent, false));
47                 return viewHolder;
48             }
49
50             @Override
51             public void onBindViewHolder(RecyclerView.ViewHolder viewHolder, int position) {
52                 // Bind data to the ViewHolder
53                 viewHolder.itemView.setText(data[position]);
54             }
55         };
56
57         // Attach the adapter to the RecyclerView
58         recyclerView.setAdapter(weekForecast);
59
60         return recyclerView;
61     }
62 }
```

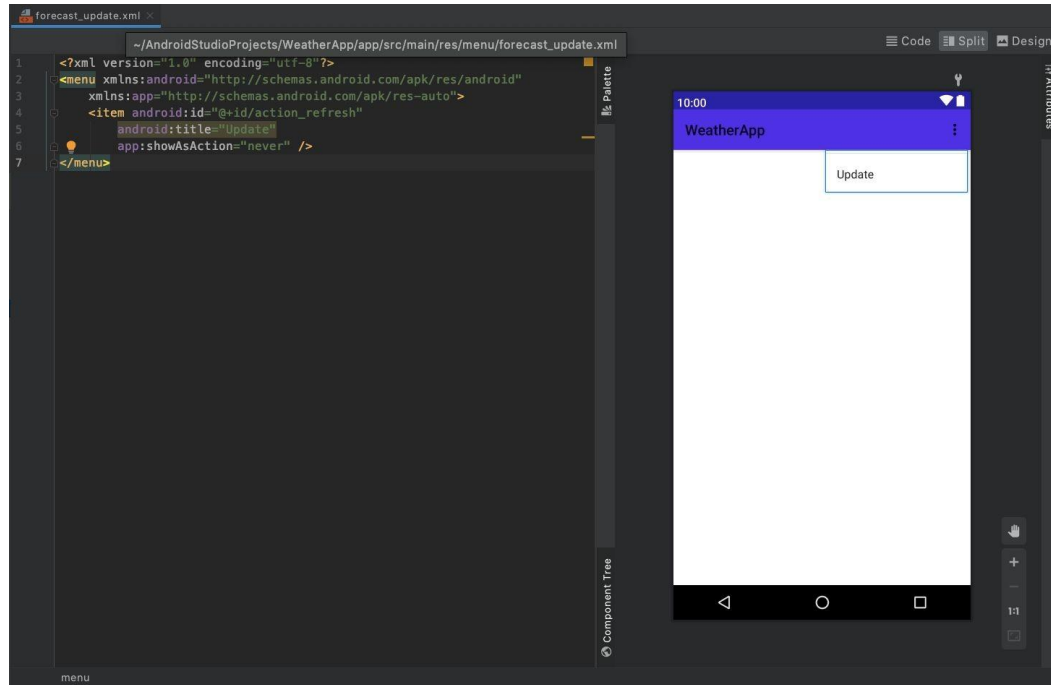
New business logic / Populate list with mock (fake) data



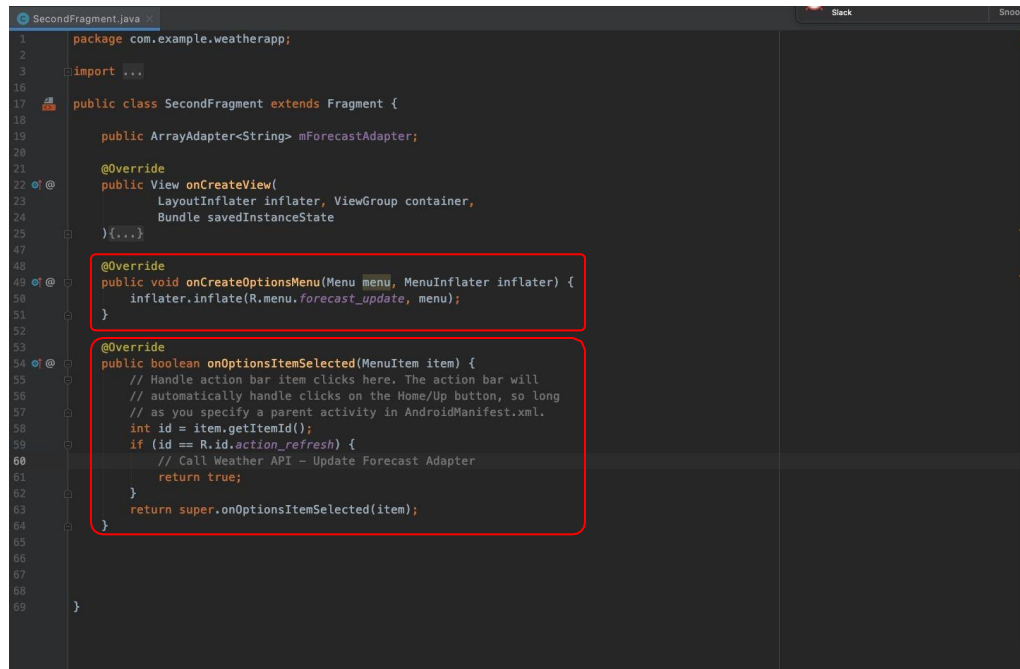
Catch up with Lab 2

```
SecondFragment.java | FirstFragment.java
3
12 import ...
13 public class SecondFragment extends Fragment {
14     public ArrayAdapter<String> mForecastAdapter;
15
16
17     @Override
18     public View onCreateView(
19         LayoutInflater inflater, ViewGroup container,
20         Bundle savedInstanceState
21     ){
22         String[] data = {
23             "Today 3/11 - Sunny - 17 C",
24             "Fri 4/11 - Cloudy - 18 C",
25             "Sat 5/11 - Rainy - 17 C",
26             "Sun 6/11 - Sunny - 19 C",
27             "Mon 7/1 - Sunny - 19 C",
28             "Tues 8/11 - Rainy - 18 C",
29             "Wed 9/11 - TRAPPED IN WEATHERSTATION - 10 C"
30         };
31
32         List<String> weekForecast = new ArrayList<>(Arrays.asList(data));
33         mForecastAdapter = new ArrayAdapter<String>(getActivity(), // The current context (this activity)
34             R.layout.list_item_forecast, // The name of the layout ID.
35             R.id.list_item_forecast_textview, // The ID of the textview to populate.
36             weekForecast);
37         View rootView = inflater.inflate(R.layout.fragment_second, container, attachToRoot: false);
38         ListView listView = (ListView) rootView.findViewById(R.id.listview_forecast);
39         listView.setAdapter(mForecastAdapter);
40         return rootView;
41     }
42 }
43
44 }
```

Turn Array Adapter should be public to be amendable




Add menu option (Update Forecast)



```
1 package com.example.weatherapp;
2
3 import ...
4
16
17 public class SecondFragment extends Fragment {
18
19     public ArrayAdapter<String> mForecastAdapter;
20
21     @Override
22     public View onCreateView(
23         LayoutInflater inflater, ViewGroup container,
24         Bundle savedInstanceState
25     ){...}
26
47
48     @Override
49     public void onCreateOptionsMenu(Menu menu, MenuInflater inflater) {
50         inflater.inflate(R.menu.forecast_update, menu);
51     }
52
53
54     @Override
55     public boolean onOptionsItemSelected(MenuItem item) {
56         // Handle action bar item clicks here. The action bar will
57         // automatically handle clicks on the Home/Up button, so long
58         // as you specify a parent activity in AndroidManifest.xml.
59         int id = item.getItemId();
60         if (id == R.id.action_refresh) {
61             // Call Weather API - Update Forecast Adapter
62             return true;
63         }
64         return super.onOptionsItemSelected(item);
65     }
66
67
68
69 }
```

Update business logic to support new menu




```
1 <?xml version="1.0" encoding="utf-8"?>
2 <manifest xmlns:android="http://schemas.android.com/apk/res/android"
3 package="com.example.weatherapp">
4 <uses-permission android:name="android.permission.INTERNET"/>
5 <application
6     android:allowBackup="true"
7     android:icon="@mipmap/ic_launcher"
8     android:label="WeatherApp"
9     android:roundIcon="@mipmap/ic_launcher_round"
10    android:supportRtl="true"
11    android:theme="@style/Theme.WeatherApp">
12    <activity
13        android:name=".MainActivity"
14        android:label="WeatherApp"
15        android:theme="@style/Theme.WeatherApp.NoActionBar">
16        <intent-filter>
17            <action android:name="android.intent.action.MAIN" />
18
19            <category android:name="android.intent.category.LAUNCHER" />
20        </intent-filter>
21    </activity>
22 </application>
23
24 </manifest>
```

manifest > uses-permission

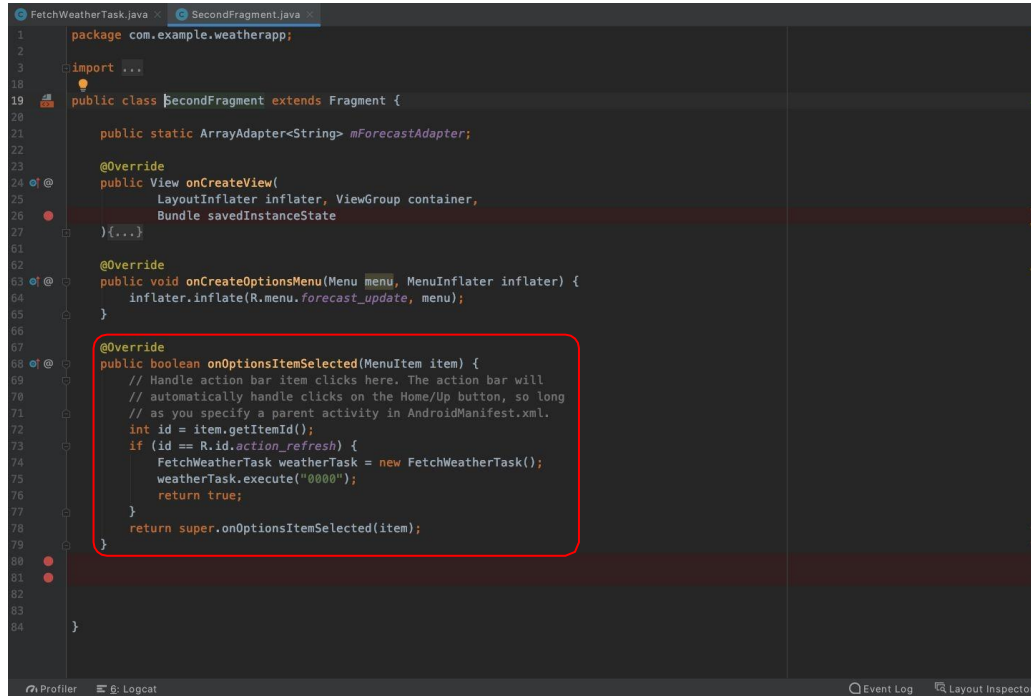
Text Merged Manifest

Add permission for internet in manifest



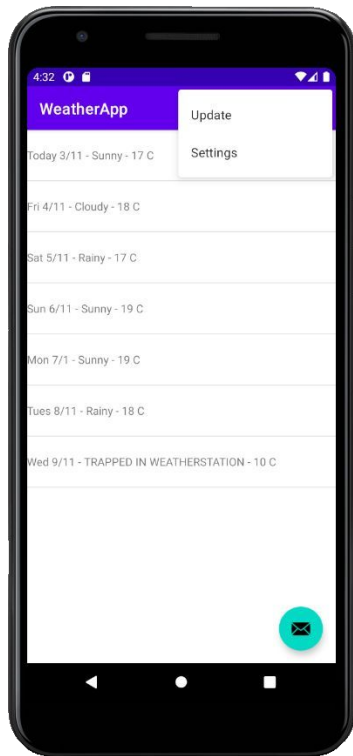
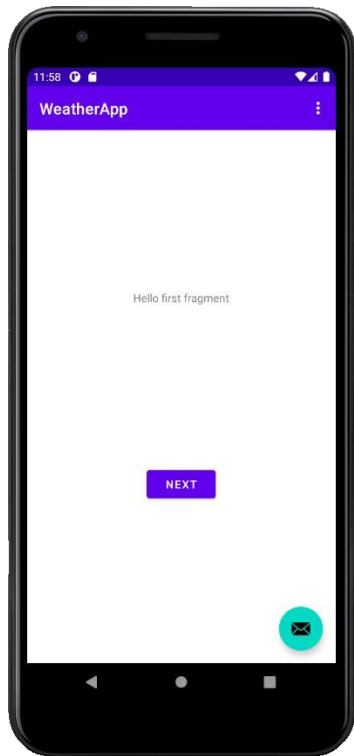
```
1 package com.example.weatherapp;
2 import ...
17
18 public class FetchWeatherTask extends AsyncTask<String, Void, String[]> {
19     private final String LOG_TAG = FetchWeatherTask.class.getSimpleName();
20
21     /** Prepare the weather high/low for presentation. */
24     @ private String formatHighLows(double high, double low) {...}
32
33     /** Take the String representing the complete forecast in JSON Format and ...*/
40     @ private String[] getWeatherDataFromJson(String forecastJsonStr, int numDays)
41         throws JSONException {...}
96
97     @Override
98     @ protected String[] doInBackground(String... params) {...}
176
177     @Override
178     @ protected void onPostExecute(String[] result) {...}
187 }
188
```

Build business logic to fetch and preview forecast

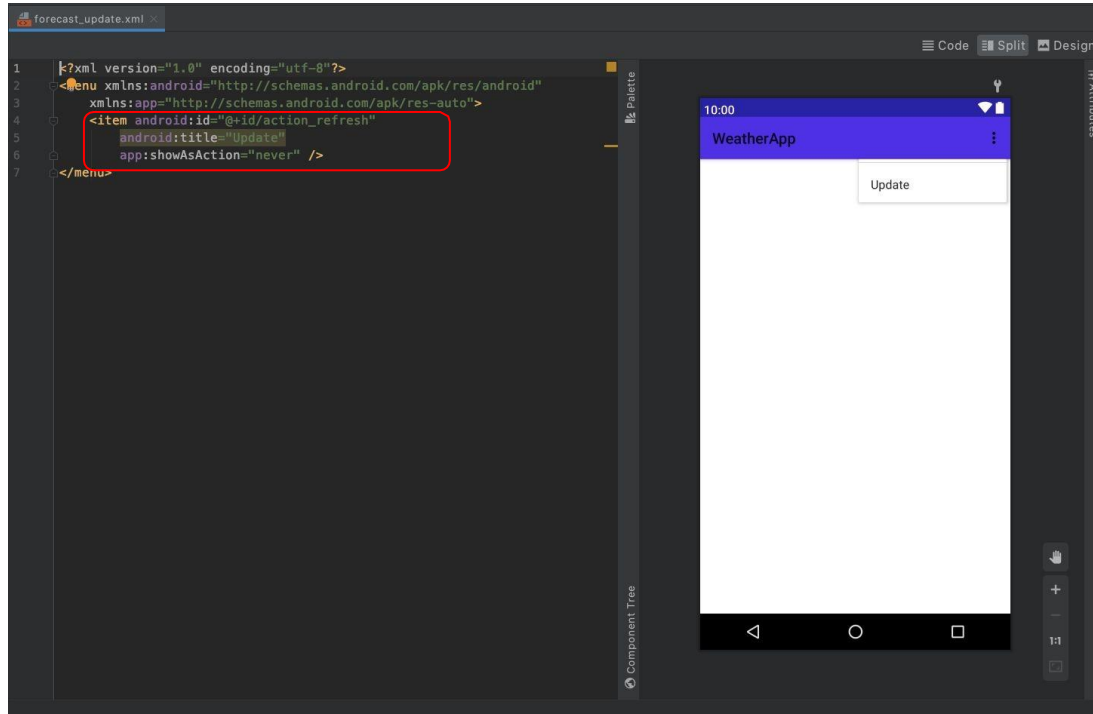


```
1 package com.example.weatherapp;
2
3 import ...
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19 public class SecondFragment extends Fragment {
20
21     public static ArrayAdapter<String> mForecastAdapter;
22
23     @Override
24     public View onCreateView(
25         LayoutInflater inflater, ViewGroup container,
26         Bundle savedInstanceState
27     ){...}
28
29
30
31
32
33
34
35
36
37
38     @Override
39     public void onCreateOptionsMenu(Menu menu, MenuInflater inflater) {
40         inflater.inflate(R.menu.forecast_update, menu);
41     }
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58     @Override
59     public boolean onOptionsItemSelected(MenuItem item) {
60         // Handle action bar item clicks here. The action bar will
61         // automatically handle clicks on the Home/Up button, so long
62         // as you specify a parent activity in AndroidManifest.xml.
63         int id = item.getItemId();
64         if (id == R.id.action_refresh) {
65             FetchWeatherTask weatherTask = new FetchWeatherTask();
66             weatherTask.execute("0000");
67             return true;
68         }
69         return super.onOptionsItemSelected(item);
70     }
71
72
73
74
75
76
77
78
79
80
81
82
83
84 }
```

Build business logic to fetch and preview forecast



Add Voice Recognition Functionality



We need a new option in the menu to initiate speech recognition

The image shows the Android Studio IDE with the following components:

- Code Editor:** Displays the XML file `forecast_update.xml`. The code is as follows:

```
1 <?xml version="1.0" encoding="utf-8"?>
2 <menu xmlns:android="http://schemas.android.com/apk/res/android"
3     xmlns:app="http://schemas.android.com/apk/res-auto">
4     <item android:id="@+id/action_refresh"
5         android:title="Update"
6         app:showAsAction="never" />
7     <item android:id="@+id/voice_commands"
8         android:title="Ask me!"
9         app:showAsAction="never" />
10 </menu>
```

The line for the "Ask me!" item (lines 7-9) is highlighted with a red box.
- Preview:** Shows a mobile app interface titled "WeatherApp" with a blue header bar. A white menu is displayed with two options: "Update" and "Ask me!".
- UI Elements:** The interface includes a status bar at the top showing "10:00", signal strength, Wi-Fi, and battery icons. At the bottom, there is an Android navigation bar with back, home, and recents buttons.
- Toolbars:** The top right has "Code", "Split", and "Design" tabs. The bottom right has zoom controls (+, -, 1:1) and a "Component Tree" sidebar.

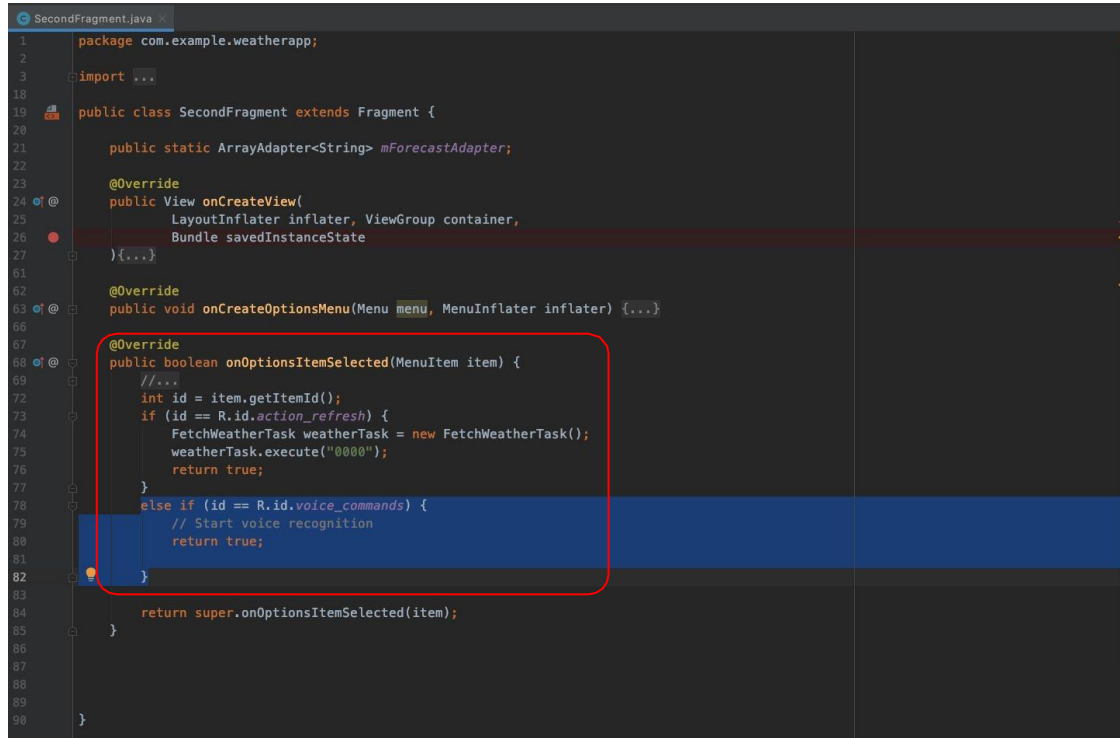
Add new option "Ask me!"



```
<?xml version="1.0" encoding="utf-8"?>
<menu
xmlns:android="http://schemas.android.com/apk/res/android"
xmlns:app="http://schemas.android.com/apk/res-auto">
  <item android:id="@+id/action_refresh"
        android:title="Refresh"
        app:showAsAction="never" />
  <item android:id="@+id/voice_commands"
        android:title="Ask me!"
        app:showAsAction="never" />
</menu>
```

```
SecondFragment.java
1 package com.example.weatherapp;
2
3 import ...
18
19 public class SecondFragment extends Fragment {
20
21     public static ArrayAdapter<String> mForecastAdapter;
22
23     @Override
24     public View onCreateView(
25         LayoutInflater inflater, ViewGroup container,
26         Bundle savedInstanceState
27     ){...}
61
62     @Override
63     public void onCreateOptionsMenu(Menu menu, MenuInflater inflater) {...}
66
67     @Override
68     public boolean onOptionsItemSelected(MenuItem item) {
69         //...
70         int id = item.getItemId();
71         if (id == R.id.action_refresh) {
72             FetchWeatherTask weatherTask = new FetchWeatherTask();
73             weatherTask.execute("0000");
74             return true;
75         }
76         return super.onOptionsItemSelected(item);
77     }
78
79
80
81
82
83
84 }
```

We also need to support this option in our code



```
1 package com.example.weatherapp;
2
3 import ...
18
19 public class SecondFragment extends Fragment {
20
21     public static ArrayAdapter<String> mForecastAdapter;
22
23     @Override
24     public View onCreateView(
25         LayoutInflater inflater, ViewGroup container,
26         Bundle savedInstanceState
27     ){...}
61
62     @Override
63     public void onCreateOptionsMenu(Menu menu, MenuInflater inflater) {...}
66
67     @Override
68     public boolean onOptionsItemSelected(MenuItem item) {
69         //...
70         int id = item.getItemId();
71         if (id == R.id.action_refresh) {
72             FetchWeatherTask weatherTask = new FetchWeatherTask();
73             weatherTask.execute("0000");
74             return true;
75         }
76         else if (id == R.id.voice_commands) {
77             // Start voice recognition
78             return true;
79         }
80     }
81
82     return super.onOptionsItemSelected(item);
83
84 }
85
86
87
88
89
90 }
```

We also need to support this option in our code

```
SecondFragment.java
24 public class SecondFragment extends Fragment {
25
26     public static ArrayAdapter<String> mForecastAdapter;
27
28     @Override
29     public View onCreateView(
30         LayoutInflater inflater, ViewGroup container,
31         Bundle savedInstanceState
32     ){...}
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48     @Override
49     public void onCreateOptionsMenu(Menu menu, MenuInflater inflater) {...}
50
51
52
53     @Override
54     public boolean onOptionsItemSelected(MenuItem item) {
55         //...
56         int id = item.getItemId();
57         if (id == R.id.action_refresh) {
58             FetchWeatherTask weatherTask = new FetchWeatherTask();
59             weatherTask.execute("0000");
60             return true;
61         }
62         else if (id == R.id.voice_commands) {
63             // Start voice recognition
64             startSpeechRecognizer();
65             return true;
66         }
67     }
68
69     return super.onOptionsItemSelected(item);
70 }
71
72
73 private void startSpeechRecognizer() {
74     int REQUEST_SPEECH_RECOGNIZER = 3000;
75     Intent intent = new Intent
76         (RecognizerIntent.ACTION_RECOGNIZE_SPEECH);
77     intent.putExtra(RecognizerIntent.EXTRA_LANGUAGE_MODEL, value: "en-US");
78     intent.putExtra(RecognizerIntent.EXTRA_PROMPT, value: "City of Interest?");
79     startActivityForResult(intent, REQUEST_SPEECH_RECOGNIZER);
80 }
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100 }
```

Add new function to initiate speech recognition using API



@Override

```
public boolean onOptionsItemSelected(MenuItem item) {  
    // Handle action bar item clicks here. The action bar will  
    // automatically handle clicks on the Home/Up button, so long  
    // as you specify a parent activity in AndroidManifest.xml.  
    int id = item.getItemId();  
    if (id == R.id.action_refresh) {  
        FetchWeatherForecast weatherTask = new FetchWeatherForecast();  
        weatherTask.execute("37.98", "23.73");  
        return true;  
    }  
    else if (id == R.id.voice_commands) {  
        // Start voice recognition  
        startSpeechRecognizer();  
        return true;  
    }  
    return super.onOptionsItemSelected(item);  
}
```



```
private void startSpeechRecognizer() {  
    int REQUEST_SPEECH_RECOGNIZER = 3000;  
    Intent intent = new Intent  
        (RecognizerIntent.ACTION_RECOGNIZE_SPEECH);  
    intent.putExtra(RecognizerIntent.EXTRA_LANGUAGE_MODEL, "en-US");  
    intent.putExtra(RecognizerIntent.EXTRA_PROMPT, "City of Interest?");  
    startActivityForResult(intent, REQUEST_SPEECH_RECOGNIZER);  
}
```

```
27 public class SecondFragment extends Fragment {
28
29     public static ArrayAdapter<String> mForecastAdapter;
30     public static String mAnswer;
31
32     @Override
33     public View onCreateView(
34         LayoutInflater inflater, ViewGroup container,
35         Bundle savedInstanceState
36     ){...}
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71     @Override
72     public void onCreateOptionsMenu(Menu menu, MenuInflater inflater) {...}
73
74
75
76     @Override
77     public boolean onOptionsItemSelected(MenuItem item) {...}
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97     private void startSpeechRecognizer() {...}
98
99
100
101
102
103
104
105
106     @Override
107     public void onActivityResult(int requestCode, int resultCode,
108         Intent data) {
109         int REQUEST_SPEECH_RECOGNIZER = 3000;
110         super.onActivityResult(requestCode, resultCode, data);
111         Log.i( tag: "DEMO-REQUESTCODE", Integer.toString(requestCode));
112         Log.i( tag: "DEMO-RESULTCODE", Integer.toString(resultCode));
113         if (requestCode == REQUEST_SPEECH_RECOGNIZER && resultCode == Activity.RESULT_OK && data != null){
114             ArrayList<String> text = data
115                 .getStringArrayListExtra(RecognizerIntent.EXTRA_RESULTS);
116             mAnswer = text.get(0);
117             Log.i( tag: "DEMO-ANSWER", text.get(0));
118             FetchWeatherTask weatherTask = new FetchWeatherTask();
119             int city_id = 0;
120             switch (mAnswer.toLowerCase()){...}
121             Log.i( tag: "DEMO-CITY_ID", Integer.toString(city_id));
122             weatherTask.execute(Integer.toString(city_id));
123         }
124         else{...}
125     }
126
127
128
129
130
131
132 }
```

Handle transcription of speech

```
SecondFragment.java
105
106 @Override
107 public void onActivityResult(int requestCode, int resultCode,
108                               Intent data) {
109     int REQUEST_SPEECH_RECOGNIZER = 3000;
110     super.onActivityResult(requestCode, resultCode, data);
111     Log.i("tag: DEMO-REQUESTCODE", Integer.toString(requestCode));
112     Log.i("tag: DEMO-RESULTCODE", Integer.toString(resultCode));
113     if (requestCode == REQUEST_SPEECH_RECOGNIZER && resultCode == Activity.RESULT_OK && data != null){
114         ArrayList<String> text = data
115             .getStringArrayListExtra(RecognizerIntent.EXTRA_RESULTS);
116         mAnswer = text.get(0);
117         Log.i("tag: DEMO-ANSWER", text.get(0));
118         FetchWeatherTask weatherTask = new FetchWeatherTask();
119         int city_id = 0;
120         switch (mAnswer.toLowerCase()){
121             case "athens" : city_id = 264371; break;
122             case "london" : city_id = 2643743; break;
123             case "paris" : city_id = 2988507; break;
124             default: city_id = 0;
125         }
126         Log.i("tag: DEMO-CITY_ID", Integer.toString(city_id));
127         weatherTask.execute(Integer.toString(city_id));
128     }
129     else{
130         System.out.println("Recognizer API error");
131     }
132 }
133
134
135
136
137
138
139 }
```


Naive control for voice commands (Support 3 cities)

@Override

```
public void onActivityResult(int requestCode, int resultCode,
                             Intent data) {
    int REQUEST_SPEECH_RECOGNIZER = 3000;
    super.onActivityResult(requestCode, resultCode, data); Log.i("DEMO-REQUESTCODE",
Integer.toString(requestCode)); Log.i("DEMO-RESULTCODE", Integer.toString(resultCode));
    if (requestCode == REQUEST_SPEECH_RECOGNIZER && resultCode == Activity.RESULT_OK && data != null){
        ArrayList<String> text = data
            .getStringArrayListExtra(RecognizerIntent.EXTRA_RESULTS);
        mAnswer = text.get(0);
        Log.i("DEMO-ANSWER", text.get(0));
        FetchWeatherForecast weatherTask = new FetchWeatherForecast();
        double city_lat = 0;
        double city_long = 0;
        switch (mAnswer.toLowerCase()){
            case "athens" : city_lat = 37.98; city_long = 23.73; break;
            case "elefsina" : city_lat = 38.04; city_long = 23.54; break;
            case "london" : city_lat = 51.51; city_long = 0.13; break;
            case "paris" : city_lat = 48.86; city_long = 2.35; break;
            case "αθήνα" : city_lat = 37.98; city_long = 23.73; break;
            case "ελευσίνα" : city_lat = 38.04; city_long = 23.54; break;
            case "λονδίνο" : city_lat = 51.51; city_long = 0.13; break;
            case "παρίσι" : city_lat = 48.86; city_long = 2.35; break;
            default : city_lat = 38.04; city_long = 23.54;
        }
        Log.i("LAT", Double.toString(city_lat));
        Log.i("LONG", Double.toString(city_long));
        weatherTask.execute(Double.toString(city_lat), Double.toString(city_long));
    }
    else{
        System.out.println("Recognizer API error");
    }
}
```



```
import android.content.Intent;  
import android.speech.RecognizerIntent;  
import android.app.Activity;  
import android.util.Log;  
  
public static String mAnswer;
```



```
@Override
protected String[] doInBackground(String... params) {
    // These two need to be declared outside the try/catch
    // so that they can be closed in the finally block.
    HttpURLConnection urlConnection = null;
    BufferedReader reader = null;

    if (params.length == 0) {
        return null;
    }

    int numDays = 7;

    // Will contain the raw JSON response as a string.
    String forecastJsonStr = null;

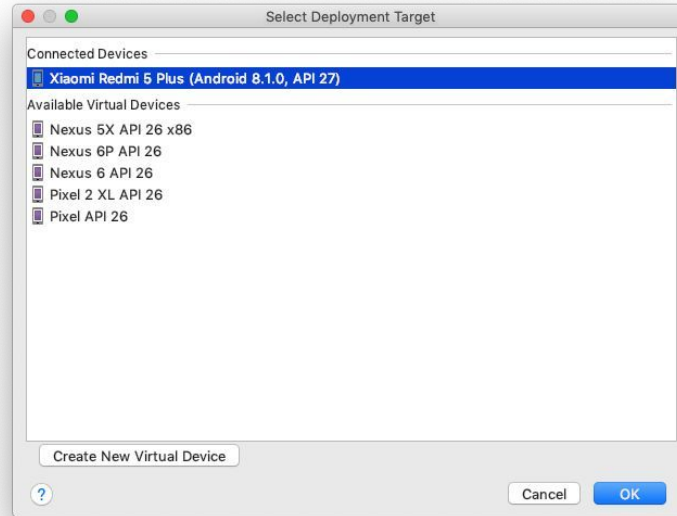
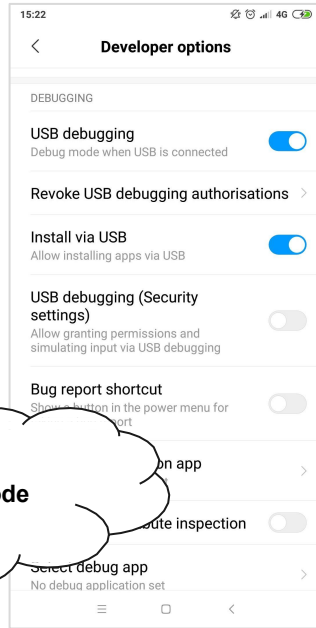
    try {
        // Construct the URL for the OpenWeatherMap query
        // Possible parameters are available at OWM's forecast API page, at
        // http://openweathermap.org/API#forecast
        //String baseUrl = "https://api.openweathermap.org/data/2.5/forecast?lat=38.04&lon=23.54&units=metric&cnt=7";
        String baseUrl = "https://api.openweathermap.org/data/2.5/onecall?units=metric&exclude=minutely,current,alerts,hourly";
        baseUrl = baseUrl+"&lat="+params[0]+"&lon="+params[1];
```

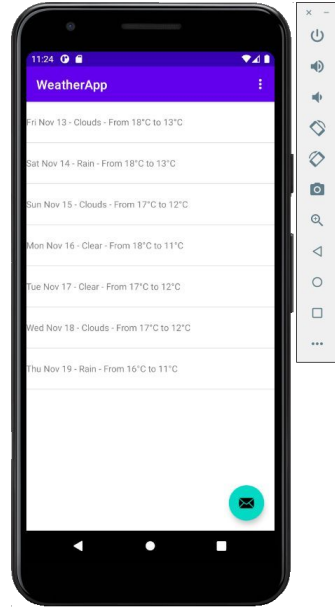
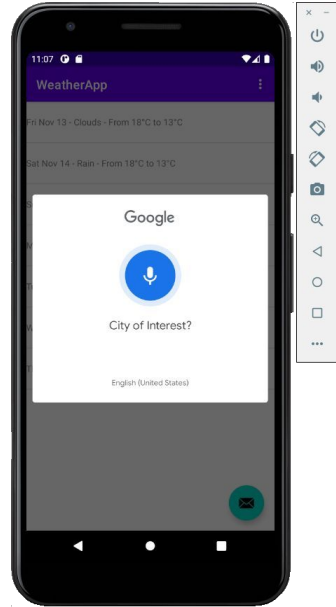
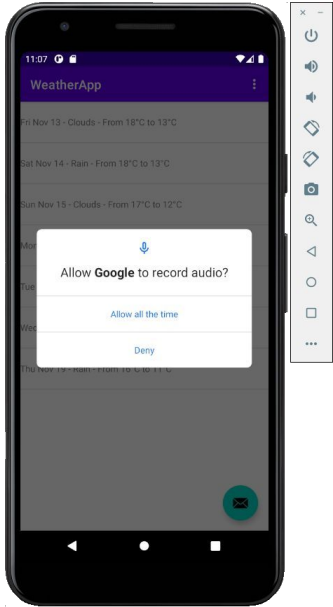
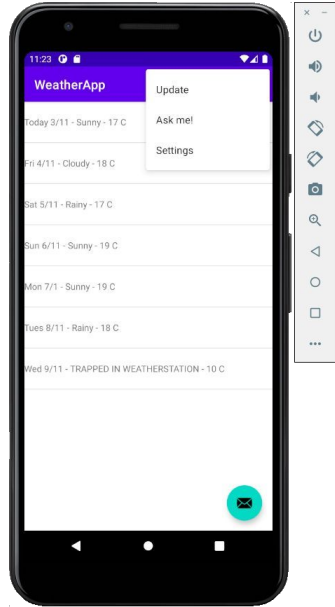
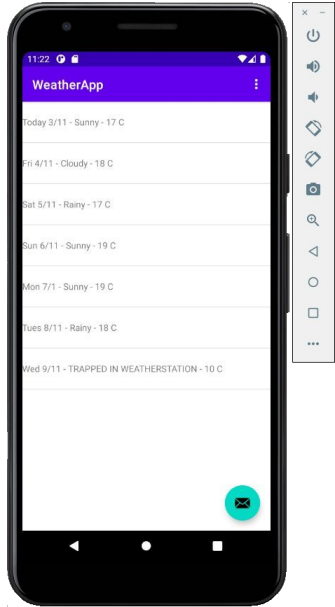
Use input params in FetchWeatherForecast Task

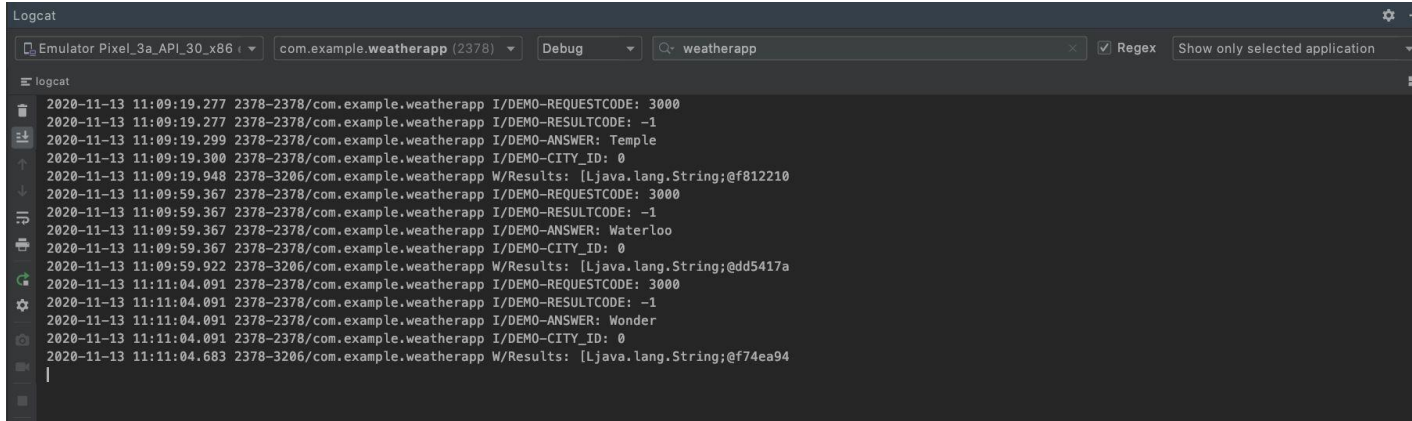


```
String baseUrl = "https://api.openweathermap.org/data/2.5/onecall?units=metric&exclude=minutely,current,alerts,hourly";  
baseUrl = baseUrl+"&lat="+params[0]+"&lon="+params[1];
```


Deploy Application on real device







The screenshot shows the Logcat window in Android Studio. The top bar indicates the device is 'Emulator Pixel_3a_API_30_x86', the package is 'com.example.weatherapp (2378)', and the log level is 'Debug'. The search filter is 'weatherapp'. The log messages are as follows:

```
2020-11-13 11:09:19.277 2378-2378/com.example.weatherapp I/DEMO-REQUESTCODE: 3000
2020-11-13 11:09:19.277 2378-2378/com.example.weatherapp I/DEMO-RESULTCODE: -1
2020-11-13 11:09:19.299 2378-2378/com.example.weatherapp I/DEMO-ANSWER: Temple
2020-11-13 11:09:19.300 2378-2378/com.example.weatherapp I/DEMO-CITY_ID: 0
2020-11-13 11:09:19.948 2378-3206/com.example.weatherapp W/Results: [Ljava.lang.String;@f812210
2020-11-13 11:09:59.367 2378-2378/com.example.weatherapp I/DEMO-REQUESTCODE: 3000
2020-11-13 11:09:59.367 2378-2378/com.example.weatherapp I/DEMO-RESULTCODE: -1
2020-11-13 11:09:59.367 2378-2378/com.example.weatherapp I/DEMO-ANSWER: Waterloo
2020-11-13 11:09:59.367 2378-2378/com.example.weatherapp I/DEMO-CITY_ID: 0
2020-11-13 11:09:59.922 2378-3206/com.example.weatherapp W/Results: [Ljava.lang.String;@dd5417a
2020-11-13 11:11:04.091 2378-2378/com.example.weatherapp I/DEMO-REQUESTCODE: 3000
2020-11-13 11:11:04.091 2378-2378/com.example.weatherapp I/DEMO-RESULTCODE: -1
2020-11-13 11:11:04.091 2378-2378/com.example.weatherapp I/DEMO-ANSWER: Wonder
2020-11-13 11:11:04.091 2378-2378/com.example.weatherapp I/DEMO-CITY_ID: 0
2020-11-13 11:11:04.683 2378-3206/com.example.weatherapp W/Results: [Ljava.lang.String;@f74ea94
```

Logging of interaction through voice commands



Review of Lab 3 - Android Application Development

- Catch up with Lab 1-2
- Add Voice Recognition functionality
 - Rename Activity
 - Make property publicly available
 - Update Business Logic to use the Asynchronous task - Involve "Ask me!" Option
 - Demonstrate updates



Ασκήσεις μελέτης B2



Άσκηση B2.2

α)

Χρησιμοποιώντας τις παρακάτω προτάσεις ως (μικροσκοπικό) σώμα κειμένων εκπαίδευσης:

<start> he plays football

<start> he plays cricket

<start> she enjoys good football

<start> she plays good music

<start> he prays to god

<start> please buy me the other ball

<start> he pleases the other players by playing good football

εκτιμήστε τις πιθανότητες $P(t_1^4)$ που θα επέστρεφε ένα γλωσσικό μοντέλο διγραμμάτων με εξομάλυνση Laplace για κάθε μία από τις δύο παρακάτω προτάσεις

t_1^4 : <start> he please god football

t_1^4 : <start> he plays good football

Υποθέστε ότι το λεξιλόγιο V περιέχει όλες τις λέξεις του σώματος κειμένων (εξαιρώντας το <start>), οπότε $|V| = 21$. Δείξτε λεπτομερώς τους υπολογισμούς σας, χωρίς να εκτελέσετε τις τελικές αριθμητικές πράξεις.



- $P(\langle \text{start} \rangle, \text{he, please, god, football}) = P(\text{he} \mid \langle \text{start} \rangle) P(\text{please} \mid \text{he}) P(\text{god} \mid \text{please}) P(\text{football} \mid \text{god}) = (4+1)/(7+21) (0+1)/(4+21) (0+1)/(1+21) (0+1)/(1+21)$
- $P(\langle \text{start} \rangle, \text{he, plays, good, football}) = P(\text{he} \mid \langle \text{start} \rangle) P(\text{plays} \mid \text{he}) P(\text{good} \mid \text{plays}) P(\text{football} \mid \text{good}) = (4+1)/(7+21) (2+1)/(4+21) (1+1)/(3+21) (2+1)/(3+21)$

Σημείωση: Στην πράξη αποφεύγουμε διαδοχικούς πολλαπλασιασμούς πιθανοτήτων, υπολογίζουμε συνήθως τον λογάριθμο της πιθανότητας μιας ακολουθίας λέξεων, δηλαδή θα υπολογίζαμε το $\log P(\langle \text{start} \rangle, \text{he, please, god, football})$, αντί του $P(\langle \text{start} \rangle, \text{he, please, god, football})$, οπότε θα καταλήγαμε στο παρακάτω άθροισμα τεσσάρων λογαρίθμων, αντί του παραπάνω γινομένου τεσσάρων πιθανοτήτων: $\log[(4+1)/(7+21)] + \log[(0+1)/(4+21)] + \log[(0+1)/(1+21)] + \log[(0+1)/(1+21)]$



β)

Υποθέστε ότι ένας χρήστης έγραψε στο πληκτρολόγιο του κινητού του την παρακάτω ακολουθία λέξεων w_1^4 : <start> he pls gd ftball

Εκτιμήστε τις πιθανότητες $P(t_1^4 | w_1^4)$ των δύο υποθέσεων (ακολουθιών λέξεων που ίσως ήθελε να γράψει) t_1^4 του σκέλους (α), χρησιμοποιώντας ένα μοντέλο θορυβώδους καναλιού (βλ. σχετικές διαφάνειες) και το γλωσσικό μοντέλο διγραμμάτων του σκέλους (α).

Θεωρήστε ότι $P(w_i | t_i) \approx 1/(LD(w_i, t_i)+1)$, όπου $LD(w_i, t_i)$ η απόσταση Levenshtein από τη λέξη w_i στην t_i . Δείξτε λεπτομερώς τους υπολογισμούς σας, χωρίς να εκτελέσετε τις τελικές αριθμητικές πράξεις και χωρίς να υπολογίσετε τις αποστάσεις Levenshtein.



Χρησιμοποιώντας το θορυβώδες κανάλι των διαφανειών της διάλεξης, έχουμε:

$$P(t_1^4 | w_1^4) = P(t_1^4) P(w_1^4 | t_1^4) / P(w_1^4)$$

Για $t_1^4 = \langle \text{start} \rangle$ he please god football:

$$P(t_1^4) = P(\langle \text{start} \rangle, \text{he}, \text{please}, \text{god}, \text{football})$$

$$P(w_1^4 | t_1^4) / P(w_1^4) = P(\langle \text{start} \rangle \text{ he pls gd fball} | \langle \text{start} \rangle, \text{he}, \text{please}, \text{god}, \text{football}) / P(w_1^4)$$

Η πιθανότητα $P(\langle \text{start} \rangle, \text{he}, \text{please}, \text{god}, \text{football})$ εκτιμάται από το γλωσσικό μοντέλο, όπως στο σκέλος (α).

Χρησιμοποιώντας την προσέγγιση $P(w_i | t_i) \approx 1/(LD(w_i, t_i)+1)$ της εκφώνησης (βλ. και διαφάνειες), η πιθανότητα $P(w_1^4 | t_1^4) = P(\langle \text{start} \rangle \text{ he pls gd fball} | \langle \text{start} \rangle, \text{he}, \text{please}, \text{god}, \text{football})$ γίνεται:

$$P(\text{he}, \text{he}) P(\text{pls}, \text{please}) P(\text{gd}, \text{god}) P(\text{ftball}, \text{football}) = \\ 1/(LD(\text{he}, \text{he})+1) 1/(LD(\text{pls}, \text{please})+1) 1/(LD(\text{gd}, \text{god})+1) 1/(LD(\text{ftball}, \text{football})+1)$$

Η πιθανότητα $P(w_1^4)$ δεν χρειάζεται να εκτιμηθεί, γιατί είναι ίδια και για τις δύο υποθέσεις $t_1^4 = \langle \text{start} \rangle$ he please god football και $t_1^4 = \langle \text{start} \rangle$ he plays good football.

Ομοίως εκτιμούμε την πιθανότητα $P(t_1^4 | w_1^4)$ για την υπόθεση $t_1^4 = \langle \text{start} \rangle$ he plays good football.

Επιλέγουμε τελικά την υπόθεση t_1^4 με το μεγαλύτερο $P(t_1^4 | w_1^4)$.

Σημείωση: Και πάλι στην πράξη θα υπολογίζαμε τον λογάριθμο κάθε γινομένου πιθανοτήτων, οπότε θα καταλήγαμε σε αθροίσματα λογαρίθμων πιθανοτήτων, αντί γινόμενα πιθανοτήτων.



Υ)

Εξηγήστε αναλυτικά πώς θα γινόταν η αποκωδικοποίηση με beam search (διαφάνειες «Beam search decoder»), αν ο χρήστης γράψει στο πληκτρολόγιο την ακολουθία λέξεων w_1^4 του σκέλους (β). Χρησιμοποιούμε πάλι το γλωσσικό μοντέλο διγραμμάτων λέξεων του σκέλους (α), εκπαιδευμένο στο μικροσκοπικό σώμα εκπαίδευσης εκείνου του σκέλους, μαζί με το μοντέλο θορυβώδους καναλιού του σκέλους (β).

Θεωρήστε ότι το πλέγμα (lattice) αναζήτησης είναι το ακόλουθο, δηλαδή περιλαμβάνει 4 κοντινές (κατά απόσταση διόρθωσης) υποψήφια σωστές λέξεις (του λεξικού), για κάθε λέξη w_i που έχει γράψει ο χρήστης. Σε κάθε βήμα του beam search, κρατάμε τα $b = 2$ καλύτερα μονοπάτια.



start

$t_1 = \text{he}$

$t_2 = \text{please}$

$t_1 = \text{god}$

$t_1 = \text{football}$

$t_1 = \text{her}$

$t_1 = \text{plays}$

$t_1 = \text{good}$

$t_1 = \text{ball}$

$t_1 = \text{she}$

$t_1 = \text{players}$

$t_1 = \text{gone}$

$t_1 = \text{volleyball}$

$t_1 = \text{here}$

$t_1 = \text{pleases}$

$t_1 = \text{goat}$

$t_1 = \text{basketball}$

$k = 0$

$k = 1$
 $w_1 = \text{he}$

$k = 2$
 $w_2 = \text{pls}$

$k = 3$
 $w_3 = \text{gd}$

$k = 4$
 $w_4 = \text{ftball}$



k = 0

k = 1
 $w_1 = he$

k = 2
 $w_2 = pls$

k = 3
 $w_3 = gd$

k = 4
 $w_4 = ftball$



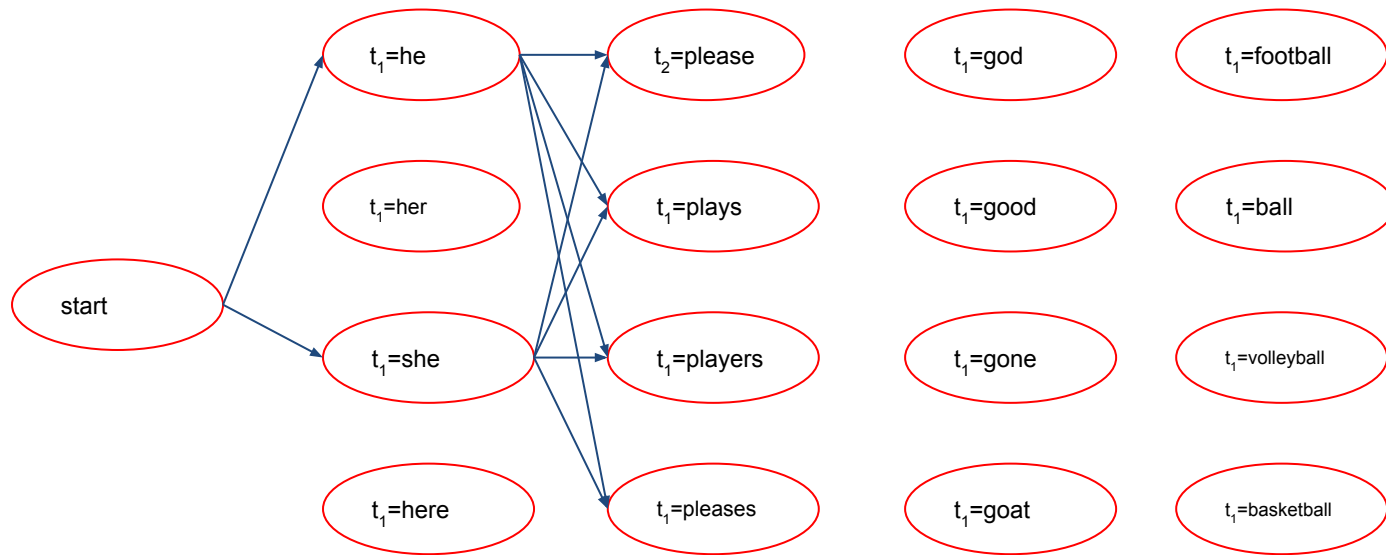
Για $k=1$

$$\langle \text{start, he} \rangle: P(\text{he}|\text{start}) P(\text{he}|\text{he}) = (4+1)/(7+21) \cdot 1/(0+1) = 5/28 = \mathbf{0.179}^{**}$$

$$\langle \text{start, her} \rangle: P(\text{her}|\text{start}) P(\text{he}|\text{her}) = (0+1)/(7+21) \cdot 1/(1+1) = 1/28 \cdot 1/2 = 0.018$$

$$\langle \text{start, she} \rangle: P(\text{she}|\text{start}) P(\text{he}|\text{she}) = (2+1)/(7+21) \cdot 1/(1+1) = 3/28 \cdot 1/2 = \mathbf{0.054}^{**}$$

$$\langle \text{start, here} \rangle: P(\text{here}|\text{start}) P(\text{he}|\text{here}) = (0+1)/(7+21) \cdot 1/(2+1) = 1/28 \cdot 1/3 = 0.012$$



$k = 0$

$k = 1$
 $w_1 = he$

$k = 2$
 $w_2 = pls$

$k = 3$
 $w_3 = gd$

$k = 4$
 $w_4 = ftball$



Για $k=2$

<start, he, please>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{please}|\text{he}) P(\text{pls}|\text{please}) = 5/28 (0+1)/(4+21) 1/(3+1) = 0.0018$

<start, he, plays>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) = 5/28 (2+1)/(4+21) 1/(1+2) = \mathbf{0.0071}^{**}$

<start, he, players>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{players}|\text{he}) P(\text{pls}|\text{players}) = 5/28 (0+1)/(4+21) 1/(4+1) = 0.0014$

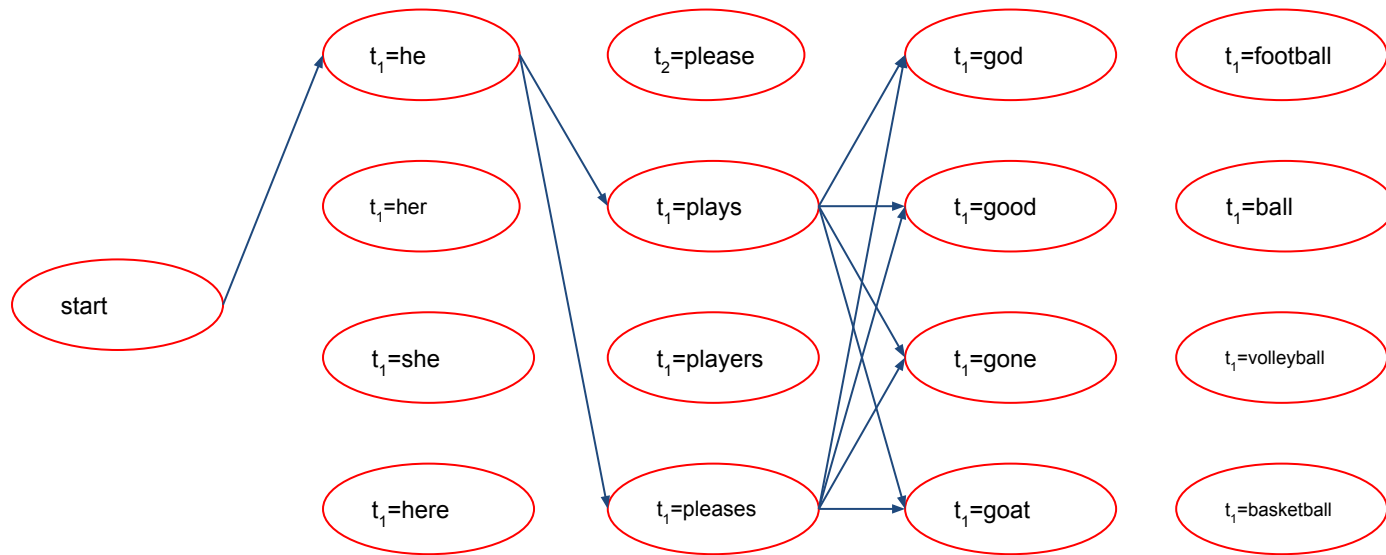
<start, he, pleases>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{pleases}|\text{he}) P(\text{pls}|\text{pleases}) = 5/28 (1+1)/(4+21) 1/(4+1) = \mathbf{0.0029}^{**}$

<start, she, please>: $P(\text{she}|\text{start}) P(\text{he}|\text{she}) P(\text{please}|\text{she}) P(\text{pls}|\text{please}) = 3/56 (0+1)/(2+21) 1/(3+1) = 0.0006$

<start, she, plays>: $P(\text{she}|\text{start}) P(\text{he}|\text{she}) P(\text{plays}|\text{she}) P(\text{pls}|\text{plays}) = 3/56 (1+1)/(2+21) 1/(2+1) = 0.0016$

<start, she, players>: $P(\text{she}|\text{start}) P(\text{he}|\text{she}) P(\text{players}|\text{she}) P(\text{pls}|\text{players}) = 3/56 (0+1)/(2+21) 1/(4+1) = 0.0005$

<start, she, pleases>: $P(\text{she}|\text{start}) P(\text{he}|\text{she}) P(\text{pleases}|\text{she}) P(\text{pls}|\text{pleases}) = 3/56 (0+1)/(2+21) 1/(4+1) = 0.0005$



$k = 0$

$k = 1$
 $w_1 = \text{he}$

$k = 2$
 $w_2 = \text{pls}$

$k = 3$
 $w_3 = \text{gd}$

$k = 4$
 $w_4 = \text{ftball}$



Για $k=3$

<start, he, plays, god>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{god}|\text{plays}) P(\text{gd}|\text{god}) = 0.0071 (0+1)/(3+21) 1/(1+1) = \mathbf{0.00015}^{**}$

<start, he, plays, good>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{good}|\text{plays}) P(\text{gd}|\text{good}) = 0.0071 (1+1)/(3+21) 1/(2+1) = \mathbf{0.0002}^{**}$

<start, he, plays, gone>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{gone}|\text{plays}) P(\text{gd}|\text{gone}) = 0.0071 (0+1)/(3+21) 1/(4+1) = 0.00006$

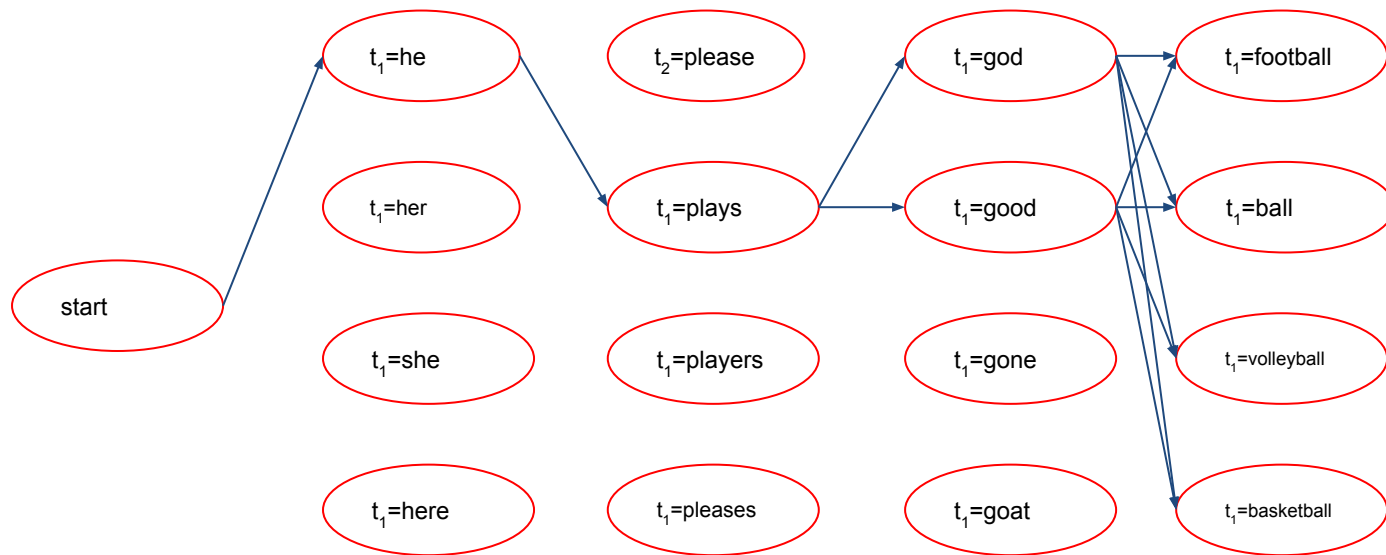
<start, he, plays, goat>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{goat}|\text{plays}) P(\text{gd}|\text{goat}) = 0.0071 (0+1)/(3+21) 1/(4+1) = 0.00006$

<start, he, pleases, god>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{pleases}|\text{he}) P(\text{pls}|\text{pleases}) P(\text{god}|\text{pleases}) P(\text{gd}|\text{god}) = 0.0029 (0+1)/(1+21) 1/(1+1) = 0.00007$

<start, he, pleases, good>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{pleases}|\text{he}) P(\text{pls}|\text{pleases}) P(\text{good}|\text{pleases}) P(\text{gd}|\text{good}) = 0.0029 (0+1)/(1+21) 1/(2+1) = 0.00004$

<start, he, pleases, gone>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{pleases}|\text{he}) P(\text{pls}|\text{pleases}) P(\text{gone}|\text{pleases}) P(\text{gd}|\text{gone}) = 0.0029 (0+1)/(1+21) 1/(4+1) = 0.00003$

<start, he, pleases, goat>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{pleases}|\text{he}) P(\text{pls}|\text{pleases}) P(\text{goat}|\text{pleases}) P(\text{gd}|\text{goat}) = 0.0029 (0+1)/(1+21) 1/(4+1) = 0.00003$



k = 0

k = 1
 $w_1 = he$

k = 2
 $w_2 = pls$

k = 3
 $w_3 = gd$

k = 4
 $w_4 = ftball$



Για $k=3$

<start, he, plays, god, football>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{god}|\text{plays}) P(\text{gd}|\text{god}) P(\text{football}|\text{god})$
 $P(\text{ftball}|\text{football}) = 0.00015 (0+1)/(1+21) 1/(2+1) = 0.0000023$

<start, he, plays, god, ball>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{god}|\text{plays}) P(\text{gd}|\text{god}) P(\text{ball}|\text{god})$
 $P(\text{ftball}|\text{ball}) = 0.00015 (0+1)/(1+21) 1/(2+1) = 0.0000023$

<start, he, plays, god, volleyball>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{god}|\text{plays}) P(\text{gd}|\text{god})$
 $P(\text{volleyball}|\text{god}) P(\text{ftball}|\text{volleyball}) = 0.00015 (0+1)/(1+21) 1/(8+1) = 0.00000076$

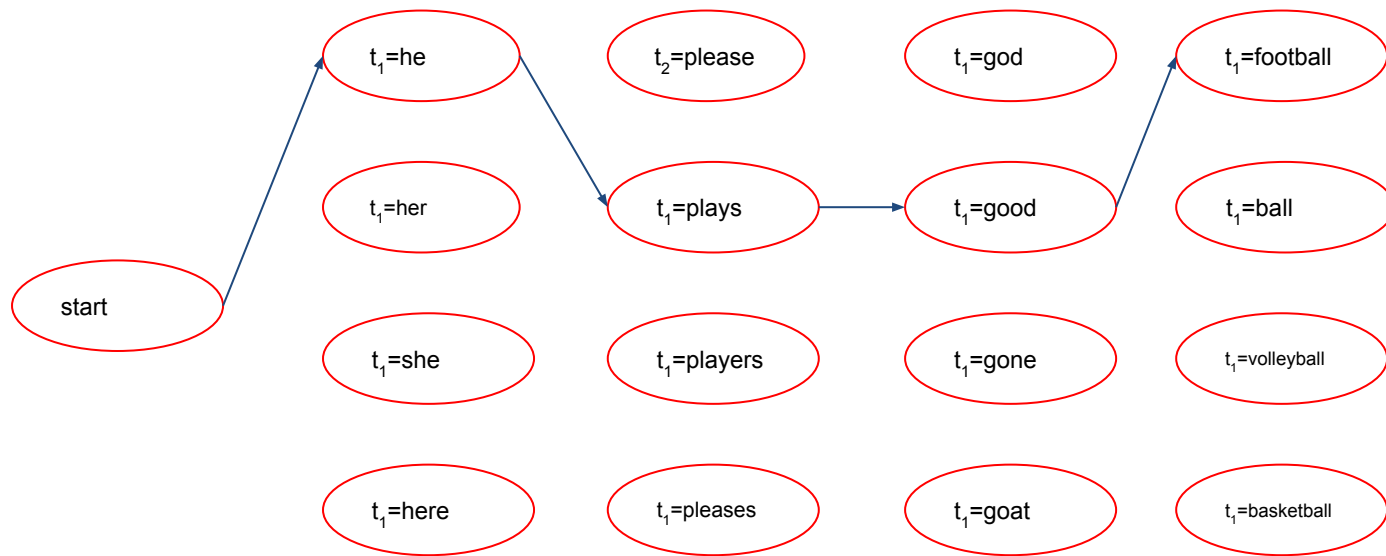
<start, he, plays, god, basketball>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{god}|\text{plays}) P(\text{gd}|\text{god})$
 $P(\text{basketball}|\text{god}) P(\text{ftball}|\text{basketball}) = 0.00015 (0+1)/(1+21) 1/(6+1) = 0.00000097$

<start, he, plays, good, football>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{good}|\text{plays}) P(\text{gd}|\text{good})$
 $P(\text{football}|\text{good}) P(\text{ftball}|\text{football}) = 0.0002 (2+1)/(3+21) 1/(2+1) = \mathbf{0.0000083}^{**}$

<start, he, plays, good, ball>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{good}|\text{plays}) P(\text{gd}|\text{good}) P(\text{ball}|\text{good})$
 $P(\text{ftball}|\text{ball}) = 0.0002 (0+1)/(3+21) 1/(2+1) = 0.0000028$

<start, he, plays, good, volleyball>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{good}|\text{plays}) P(\text{gd}|\text{good})$
 $P(\text{volleyball}|\text{good}) P(\text{ftball}|\text{volleyball}) = 0.0002 (0+1)/(3+21) 1/(8+1) = 0.00000093$

<start, he, plays, good, basketball>: $P(\text{he}|\text{start}) P(\text{he}|\text{he}) P(\text{plays}|\text{he}) P(\text{pls}|\text{plays}) P(\text{good}|\text{plays}) P(\text{gd}|\text{good})$
 $P(\text{basketball}|\text{good}) P(\text{ftball}|\text{basketball}) = 0.0002 (0+1)/(3+21) 1/(6+1) = 0.0000012$



k = 0

k = 1
 $w_1 = \text{he}$

k = 2
 $w_2 = \text{pls}$

k = 3
 $w_3 = \text{gd}$

k = 4
 $w_4 = \text{ftball}$