CSCI3310 Mobile Computing & Application Development

Lab 08 – CU Eat @Firebase

Introduction

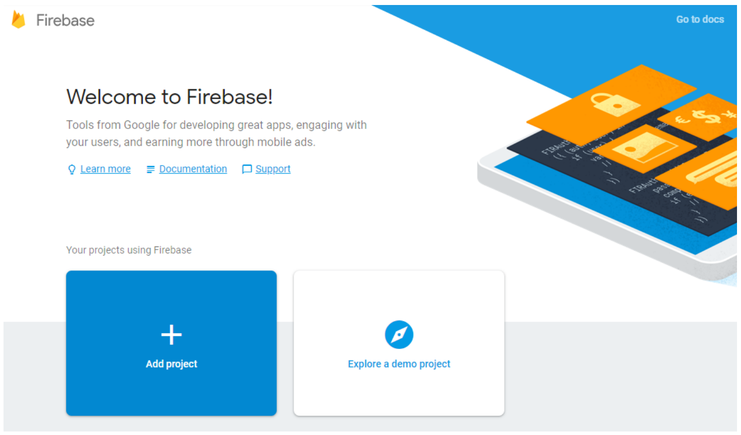
In this lab, which is adopted from the FriendlyEats Codelabs, you will extend our `CU Eats` app so that it can be backed by Cloud Firestore.

Todo

1) Read and write data to Firestore from an Android app
2) Listen to changes in Firestore data in realtime
3) Use Firebase Authentication and security rules to secure Firestore data
4) Write complex Firestore queries

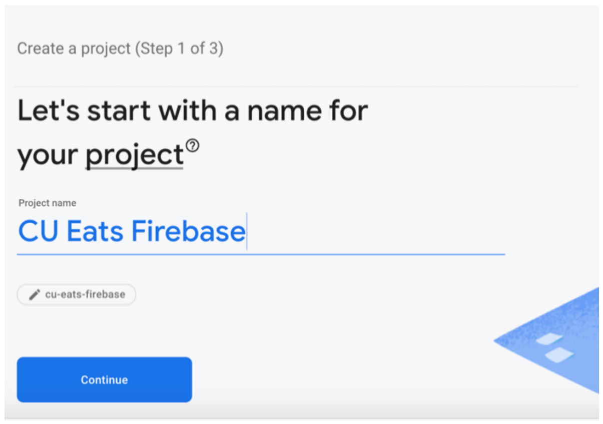
1. Create a Firebase project

1) Sign in to the Firebase console with your Google account.
2) In the Firebase console, click **Add project**.



Welcome to Firebase!

Tools from Google for developing great apps, engaging with your users, and earning more through mobile ads.



Let's start with a name for your project

Project name: CU Eats Firebase

cu-eats-firebase

1. As shown in the screencap below, enter a name for your Firebase project (for example, "CU Eats Firebase"), then set the country/region to our location. Leave “Cloud Firestore location” as “us-central”. Click **Create project**.
4. After a minute or so, your Firebase project will be ready. Click **Continue**.

Note: this lab will use the free Spark plan, which is sufficient for development purposes for most apps.

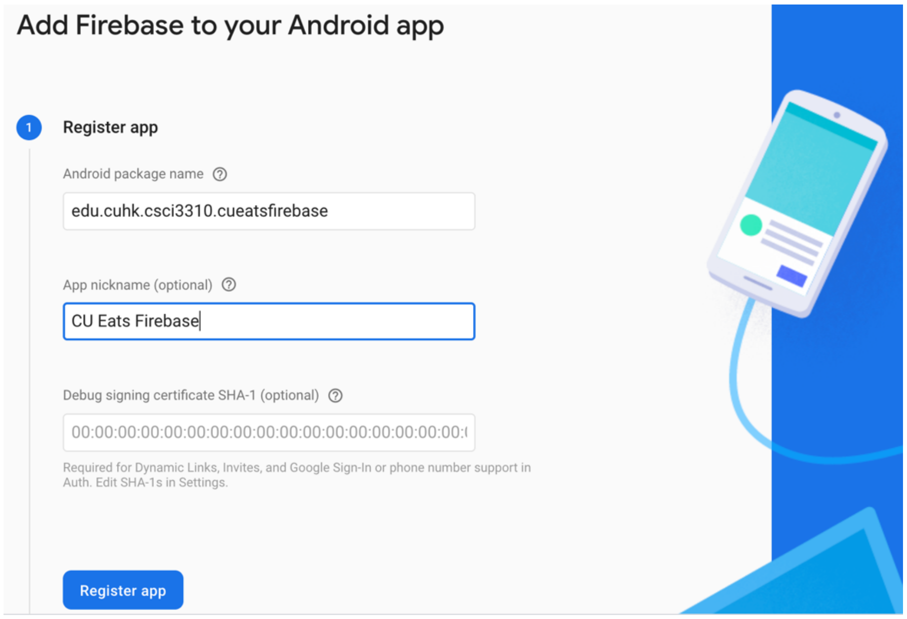
2. Set up the sample project

2.1 Download the Starter code

1) Download the sample code `CUEats-Firebase-Starter` from Blackboard for this lab.
2) Import the project into Android Studio. You will probably see some compilation errors or maybe a warning about a missing `google-services.json` file. We'll correct this in the next section.

2.2 Set up Firebase

1) In the Firebase Console, select **Project Overview** in the left nav. Click the "**+ Add app**" button at the top, then the **Android** button to select the platform. When prompted for a package name use `edu.cuhk.csci3310.cueatsfirebase`.



Add Firebase to your Android app

1 Register app

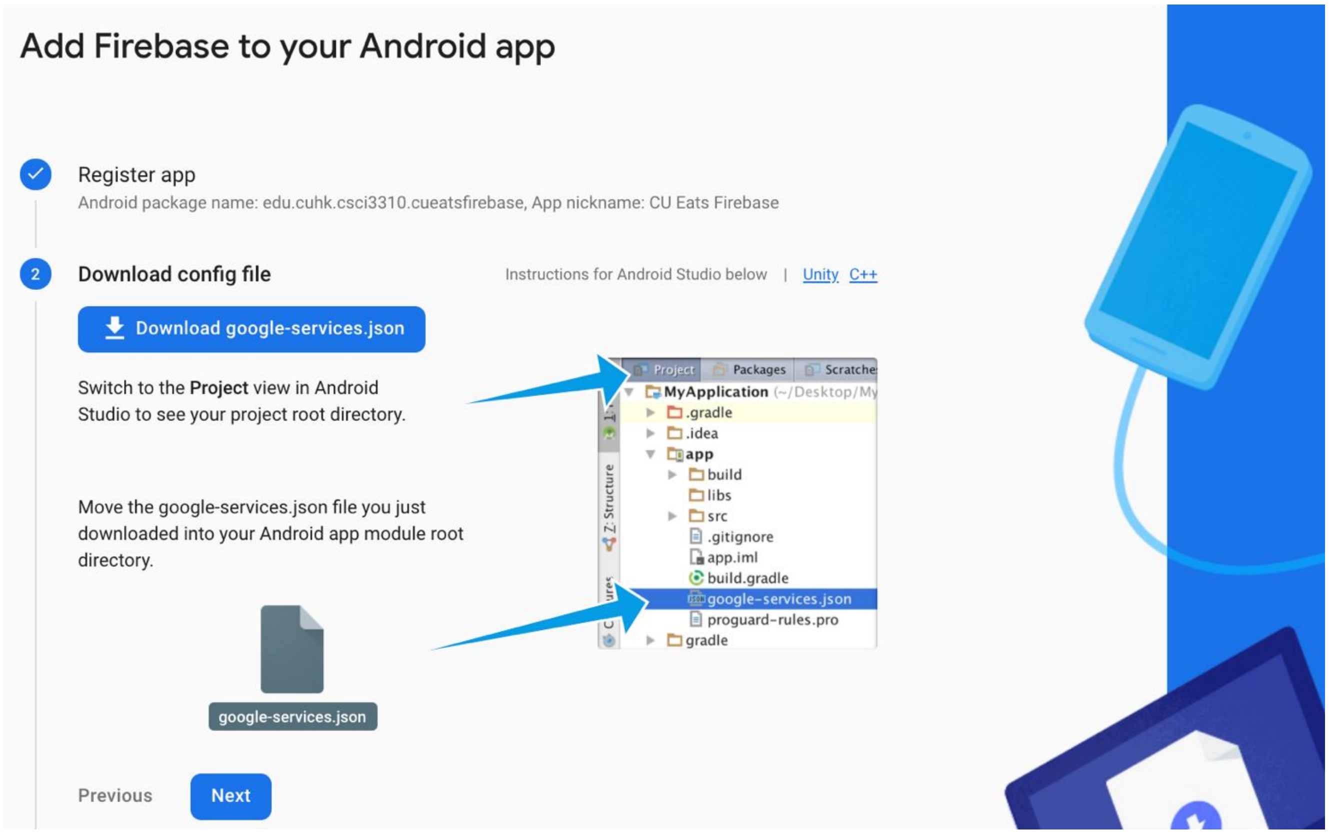
Android package name: edu.cuhk.csci3310.cueatsfirebase

App nickname (optional): CU Eats Firebase

Debug signing certificate SHA-1 (optional): 00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:00:0

Required for Dynamic Links, Invites, and Google Sign-In or phone number support in Auth. Edit SHA-1s in Settings.

2) Click **Register App** and follow the instructions to download the `google-services.json` file, and move it into the app/ folder of the sample code.



Add Firebase to your Android app

Register app
Android package name: edu.cuhk.csci3310.cueatsfirebase, App nickname: CU Eats Firebase

Download config file
Instructions for Android Studio below | Unity C++

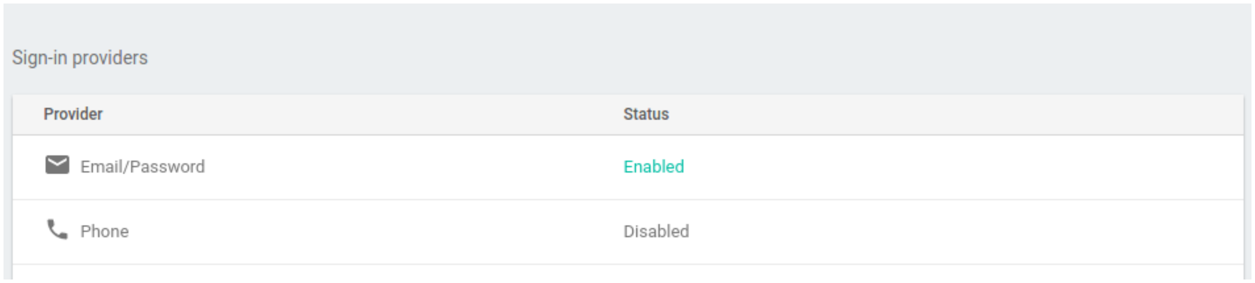
Switch to the **Project** view in Android Studio to see your project root directory.

Move the google-services.json file you just downloaded into your Android app module root directory.

Follow the instructions to add the Firebase SDK dependencies to your Gradle files (if not added), then run the app.

2.3 Configure Firebase

1) In the Sign-in providers tab of the Firebase console (under the Develop/Authentication section), enable Email Authentication:



Sign-in providers

Provider	Status
Email/Password	Enabled
Phone	Disabled

2) Next, follow the steps under Cloud Firestore to enable it for your project. Create a new database in **Lock Mode** first.

Access to data in Cloud Firestore is controlled by Security Rules. We'll talk more about rules later in this lab but first, we need to set some basic rules on our data to get started.

3) In the Rules tab of the Firebase console (under the Develop/Database section) add the following rules and then click **Publish**.

```
service cloud.firestore {
  match /databases/{database}/documents {
    match /{document=**} {
      allow read, write: if request.auth != null;
    }
  }
}
```

The rules above restrict data access to users who are signed in, which prevents unauthenticated users from reading or writing.

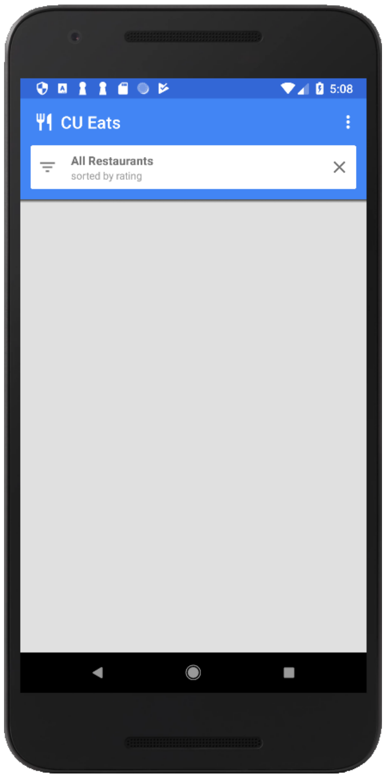
2.4 Run the app

If you have set up your app correctly, the project should now compile.

1) In Android Studio click **Build** > **Rebuild Project** and ensure that there are no remaining errors.

2) Now run the app on your Android device.

At first, you will be presented with a "Sign in" screen. You can use an email and password to sign in to the app. Once you have completed the sign-in process you should see the app home screen:



3. Write data to Firestore

In the next section, we will add some data to populate the home screen.

In this section, we will write some data to Firestore so that we can populate the home screen. You can enter data manually in the Firebase console, but we'll do it in the app itself to demonstrate how to write data to Firestore using the Android SDK.

The main model object in our app is a restaurant (see `model/Restaurant.java`). Firestore data is split into documents, collections, and sub-collections. We will store each restaurant as a document in a top-level collection called `"restaurants"`. To learn more about the Firestore data model, read about documents and collections in the documentation.

1) First, let's get an instance of `FirebaseFirestore` to work with.
2) Edit the `initFirestore()` method in `MainActivity`:

```
private void initFirestore() {
    mFirestore = FirebaseFirestore.getInstance();
}
```

3) For demonstration purposes, we will add functionality in the app to create ten random restaurants when we click the "Add Random Items" button in the overflow menu. Fill in the `onAddItemsClicked()`:

```
private void onAddItemsClicked() {
    // Get a reference to the restaurants collection
    CollectionReference restaurants = mFirestore.collection("restaurants");

    for (int i = 0; i < 10; i++) {
        // Get a random Restaurant POJO
        Restaurant restaurant = RestaurantUtil.getRandom(this);

        // Add a new document to the restaurants collection
        restaurants.add(restaurant);
    }
}
```

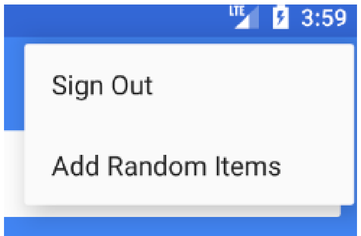
There are a few important things to note about the code above:

We started by getting a reference to the `"restaurants"` collection.

`Collections` are created implicitly when documents are added, so there was no need to create the collection before writing data.

Documents can be created using `POJOs`, which we use to create each Restaurant doc.

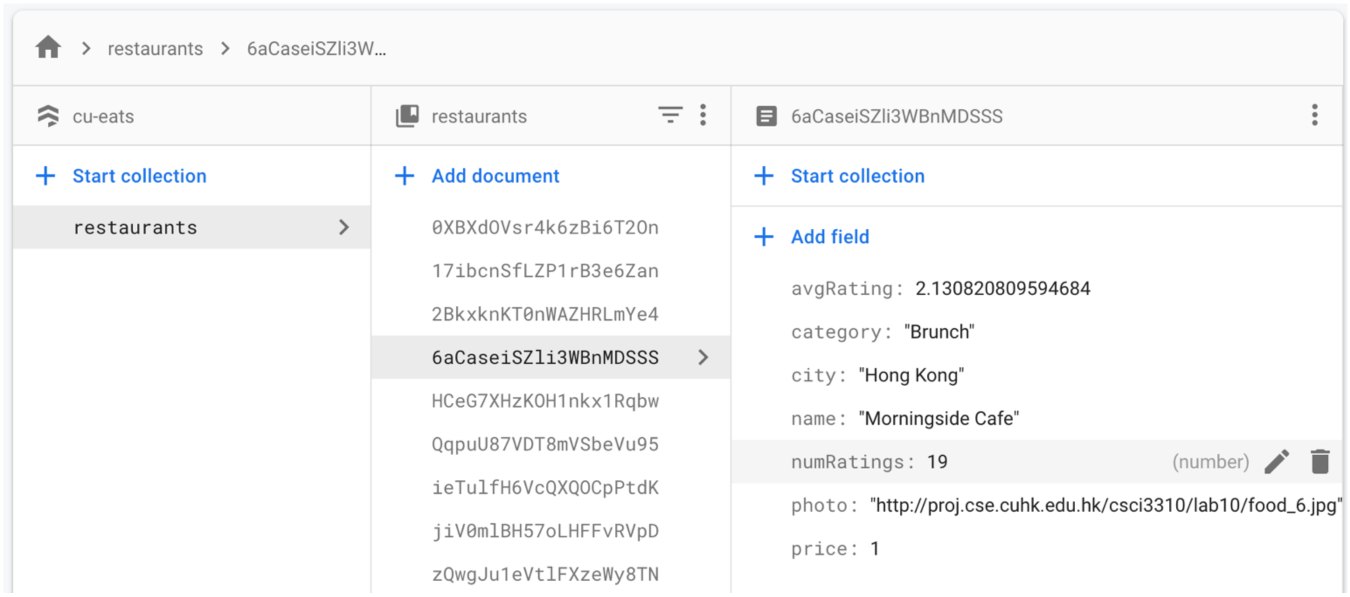
The `add()` method adds a document to a `collection` with an auto-generated ID, so we did not need



to specify a unique ID for each `Restaurant`.

Now run the app again and click the **"Add Random Items"** button in the overflow menu to invoke the code you just wrote:

If you navigate to the Firebase console, you should see the newly added data:



```
0XBXdOVsr4k6zBi6T20n
17ibcnSfLZP1rB3e6Zan
2BkxknKT0nWAZHRLmYe4
6aCaseiSZli3WBnMDSSS
HCeG7XHzKOH1nkx1Rqbw
QqpuU87VDT8mVSbeVu95
ieTulfH6VcQXQOCpPtdK
jiV0mlBH57oLHFFvRVpD
zQwgJu1eVtlFXzeWy8TN
```

```
avgRating: 2.130820809594684
category: "Brunch"
city: "Hong Kong"
name: "Morningside Cafe"
numRatings: 19  (number)
photo: "http://proj.cse.cuhk.edu.hk/csci3310/lab10/food_6.jpg"
price: 1
```

4. Display data from Firestore

In this step, we will learn how to retrieve data from `Firestore` and display it in our app. The first step to reading data from Firestore is to create a `Query`.

1) Modify the `initFirestore()` method:

```
    private void initFirestore() {
        mFirestore = FirebaseFirestore.getInstance();

        // Get the 50 highest rated restaurants
        mQuery = mFirestore.collection("restaurants")
                .orderBy("avgRating", Query.Direction.DESCENDING)
                .limit(LIMIT);
    }
```

Now we want to listen to the query so that we get all matching documents and are notified of future updates in real-time. Because our eventual goal is to bind this data to a `RecyclerView`, we need to create a `RecyclerView.Adapter` class to listen to the data.

2) Open the FirestoreAdapter class, which has been partially implemented already. First, let's make the adapter implement EventListener and define the onEvent function so that it can receive updates to a Firestore query:

```
public abstract class FirestoreAdapter<VH extends RecyclerView.ViewHolder>
        extends RecyclerView.Adapter<VH>
        implements EventListener<QuerySnapshot> {

    // ...

    @Override
    public void onEvent(QuerySnapshot documentSnapshots,
                        FirebaseFirestoreException e) {

        // Handle errors
        if (e != null) {
            Log.w(TAG, "onEvent:error", e);
            return;
        }

        // Dispatch the event
        for (DocumentChange change : documentSnapshots.getDocumentChanges()) {

            // Snapshot of the changed document
            DocumentSnapshot snapshot = change.getDocument();

            switch (change.getType()) {
                case ADDED:
                    // TODO: handle document added
                    break;

                case MODIFIED:
                    // TODO: handle document modified
                    break;

                case REMOVED:
                    // TODO: handle document removed
                    break;

            }
        }

        onDataChanged();
    }

  // ...

}
```

On initial load, the listener will receive one **ADDED** event for each new document. As the result set of the query changes over time, the listener will receive more events containing the changes. Now let's finish implementing the listener.

3) First add three new methods: onDocumentAdded, onDocumentModified, and on onDocumentRemoved:

```
protected void onDocumentAdded(DocumentChange change) {
    mSnapshots.add(change.getNewIndex(), change.getDocument());
    notifyItemInserted(change.getNewIndex());
}

protected void onDocumentModified(DocumentChange change) {
    if (change.getOldIndex() == change.getNewIndex()) {
        // Item changed but remained in same position
        mSnapshots.set(change.getOldIndex(), change.getDocument());
        notifyItemChanged(change.getOldIndex());
    } else {
        // Item changed and changed position
        mSnapshots.remove(change.getOldIndex());
        mSnapshots.add(change.getNewIndex(), change.getDocument());
        notifyItemMoved(change.getOldIndex(), change.getNewIndex());
    }
}

protected void onDocumentRemoved(DocumentChange change) {
    mSnapshots.remove(change.getOldIndex());
    notifyItemRemoved(change.getOldIndex());
}
```

4) Then call these new methods from onEvent:

```
@Override
public void onEvent(QuerySnapshot documentSnapshots,
                    FirebaseFirestoreException e) {
    // ...
    // Dispatch the event
    for (DocumentChange change : documentSnapshots.getDocumentChanges()) {
        // Snapshot of the changed document
        DocumentSnapshot snapshot = change.getDocument();

        switch (change.getType()) {
            case ADDED:
                onDocumentAdded(change);
                break;
            case MODIFIED:
                onDocumentModified(change);
                break;
            case REMOVED:
                onDocumentRemoved(change);
                break;
        }
    }
    onDataChanged();
}
```

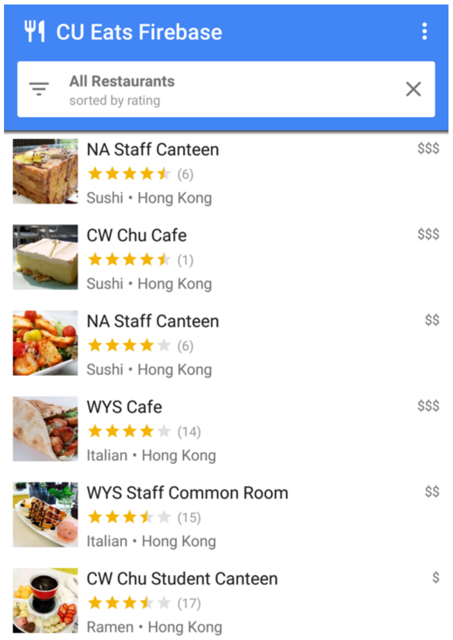
5) Finally implement the startListening() method to attach the listener:

```
public void startListening() {
    if (mQuery != null && mRegistration == null) {
        mRegistration = mQuery.addSnapshotListener(this);
        }
    }
```

Note: This lab demonstrates the real-time capabilities of Firestore, but it's also simple to fetch data without a listener. You can call get() on any query or reference to fetch a data snapshot.

Now the app is fully configured to read data from Firestore. **Run** the app again and you should see the restaurants you added in the previous step:

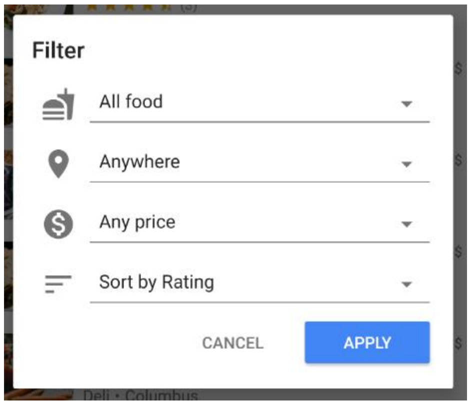
Now go back to the Firebase console and edit one of the restaurant names. You should see it change in the app almost instantly!


CU Eats Firebase

All Restaurants
sorted by rating

NA Staff Canteen	(6) Sushi • Hong Kong	$$$
CW Chu Cafe	(1) Sushi • Hong Kong	$$$
NA Staff Canteen	(6) Sushi • Hong Kong	$$
WYS Cafe	(14) Italian • Hong Kong	$$$
WYS Staff Common Room	(15) Italian • Hong Kong	$$
CW Chu Student Canteen	(17) Ramen • Hong Kong	$

5. Sort and filter data


Filter

All food
Anywhere
Any price
Sort by Rating

CANCEL APPLY

The app currently displays the top-rated restaurants across the entire collection, but in a real restaurant app, the user would want to sort and filter the data. For example, the app should be able to show **"Top Coffee restaurants "** or **"Least expensive pizza"**.

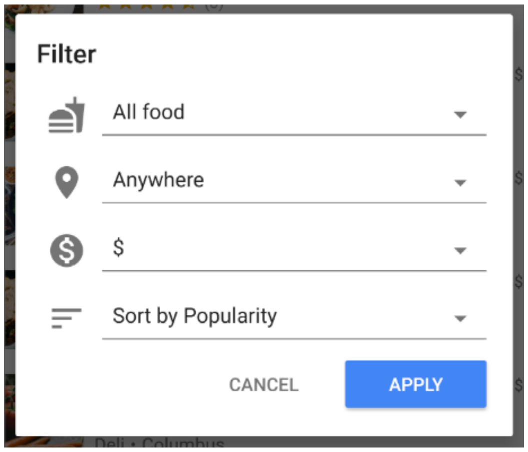
Clicking white bar at the top of the app brings up a filters dialog. In this section we'll use Firestore queries to make this dialog work:

1) Let's edit the `onFilter()` method of `MainActivity.java`. This method accepts a `Filters` object which is a helper object we created to capture the output of the filters dialog. We will change this method to construct a query from the filters:

```
@Override
public void onFilter(Filters filters) {
    // Construct query basic query
    Query query = mFirestore.collection("restaurants");

    // Category (equality filter)
    if (filters.hasCategory()) {
        query = query.whereEqualTo("category", filters.getCategory());
    }

    // City (equality filter)
    if (filters.hasCity()) {
        query = query.whereEqualTo("city", filters.getCity());
    }

    // Price (equality filter)
    if (filters.hasPrice()) {
        query = query.whereEqualTo("price", filters.getPrice());
    }

    // Sort by (orderBy with direction)
    if (filters.hasSortBy()) {
        query = query.orderBy(filters.getSortBy(), filters.getSortDirection());
    }

    // Limit items
    query = query.limit(LIMIT);

    // Update the query
    mQuery = query;
    mAdapter.setQuery(query);

    // Set header
    mCurrentSearchView.setText(Html.fromHtml(
        filters.getSearchDescription(this)));
    mCurrentSortByView.setText(filters.getOrderDescription(this));

    // Save filters
    mViewModel.setFilters(filters);
}
```

2) In the snippet above we build a `Query` object by attaching `where` and `orderBy` clauses to match the given filters.

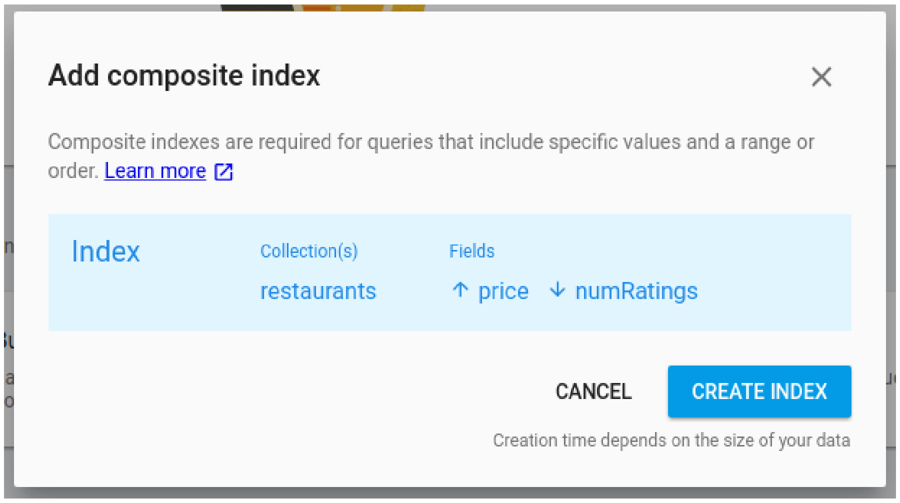
3) **Run** the app again and select the following filter to show the most popular low-price restaurants:



If you view the app logs using `adb logcat` or the **Logcat** panel in Android Studio, you will notice some warnings:

```
W/Firestore Adapter: onEvent:error
com.google.firebase.firestore.FirebaseFirestoreException: FAILED_PRECONDITION: The query
requires an index. You can create it here:
https://console.firebase.google.com/project/firestore-lab-
android/database/firestore/indexes?create_index=EgtyZXN0YXVyYW50cxoJCgVwcmljZRACGg4KCm51bVJ
hdGluZ3MQAxoMCghfX25hbWVfXxAD
    at com.google.android.gms.internal.ajs.zze(Unknown Source)
    // ...
```

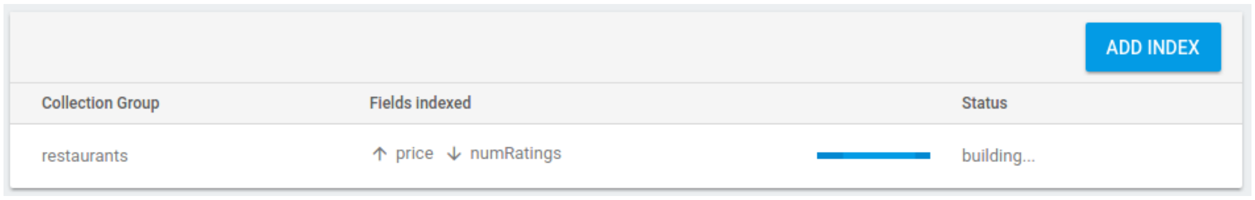
The query could not be completed on the backend because it requires an index. Most Firestore queries involving multiple fields (in this case price and rating) require a custom index. Clicking the link in the error message will open the Firebase console and automatically prompt you to create the correct index:


Add composite index

Composite indexes are required for queries that include specific values and a range or order. Learn more

Index	Collection(s)	Fields
	restaurants	↑ price ↓ numRatings

4) Clicking **Create Index** will begin creating the required index. When the index is complete your query should succeed:



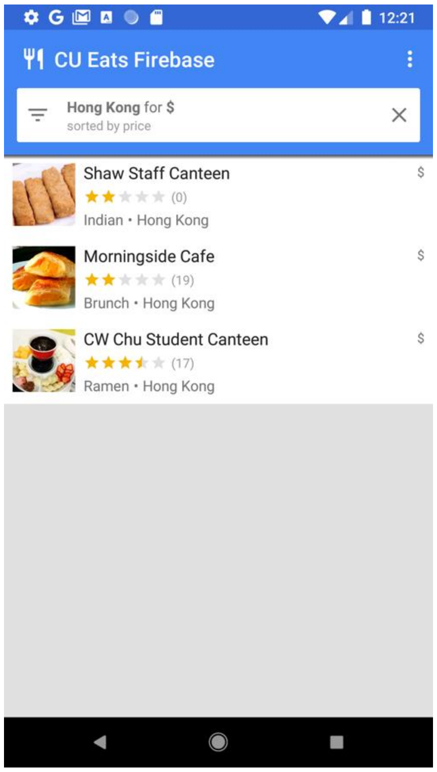
ADD INDEX

Collection Group	Fields indexed	Status
restaurants	↑ price ↓ numRatings	building...

Note: the Firestore Android SDK caches documents offline and will return those results in the event of a server error. If you execute a query without a matching index you may still see results in your UI but it's important to check the logs to make sure you have all required indexes.

Now that the proper index has been created, run the app again and execute the same query. You should now see a filtered list of restaurants containing only low-price options.

If you've made it this far, you have now built a fully functioning restaurant recommendation viewing app on Firestore! You can now sort and filter restaurants in real-time. In the next few sections, we posting reviews and security to the app.



6. Organize data in sub-collections

In this section, we'll add ratings to the app so users can review their favorite (or least favorite) restaurants.

6.1 Collections and sub-collection

So far, we have stored all restaurant data in a top-level collection called `"restaurants"`. When a user rates a restaurant, we want to add a new `Rating` object to the restaurants. For this task, we will use a sub-collection. You can think of a sub-collection as a collection that is attached to a document. So each restaurant document will have a rating sub-collection full of rating documents. Sub-collections help organize data without bloating our documents or requiring complex queries.

1) To access a sub-collection, call `.collection()` on the parent document:

```
CollectionReference subRef = mFirestore.collection("restaurants")
        .document("abc123")
        .collection("ratings");
```

You can access and query a sub-collection just like with a top-level collection, there are no size limitations or performance changes. You can read more about the Firestore data model here.

6.2 Writing data in a transaction

Adding a `Rating` to the proper sub-collection only requires calling `.add()`, but we also need to update the `Restaurant` object's average rating and a number of ratings to reflect the new data. If we use separate operations to make these two changes there are a number of race conditions that could result in stale or incorrect data.

To ensure that ratings are added properly, we will use a transaction to add ratings to a restaurant. This transaction will perform a few actions:

- Read the restaurant's current rating and calculate the new one
- Add the rating to the sub-collection
- Update the restaurant's average rating and number of ratings

1) Open `RestaurantDetailActivity.java` and implement the `addRating` function:

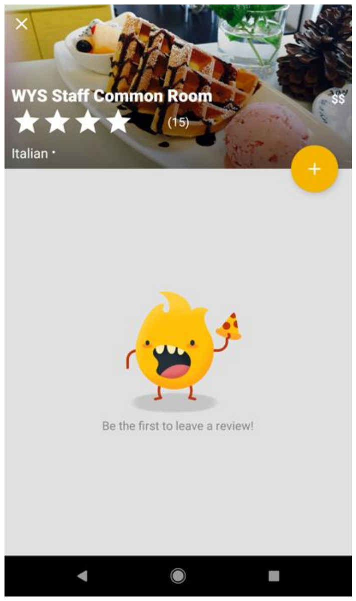
```
    private Task<Void> addRating(final DocumentReference restaurantRef,
                                 final Rating rating) {
        // Create a reference for new rating, for use inside the transaction
        final DocumentReference ratingRef = restaurantRef.collection("ratings")
                .document();

        // In a transaction, add the new rating and update the aggregate totals
        return mFirestore.runTransaction(new Transaction.Function<Void>() {
            @Override
            public Void apply(Transaction transaction)
```

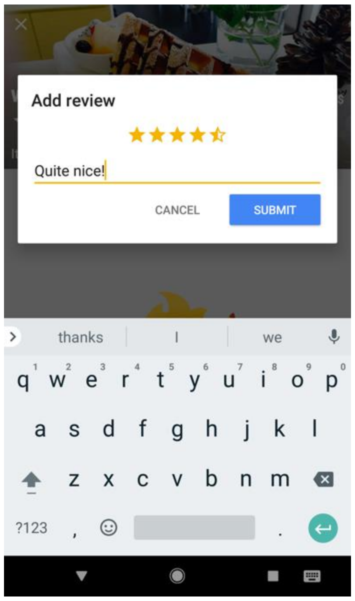
```
                    throws FirebaseFirestoreException {

                Restaurant restaurant = transaction.get(restaurantRef)
                        .toObject(Restaurant.class);

                // Compute new number of ratings
                int newNumRatings = restaurant.getNumRatings() + 1;

                // Compute new average rating
                double oldRatingTotal = restaurant.getAvgRating() *
                        restaurant.getNumRatings();
                double newAvgRating = (oldRatingTotal + rating.getRating()) /
                        newNumRatings;

                // Set new restaurant info
                restaurant.setNumRatings(newNumRatings);
                restaurant.setAvgRating(newAvgRating);

                // Commit to Firestore
                transaction.set(restaurantRef, restaurant);
                transaction.set(ratingRef, rating);

                return null;
            }
        });
    }
```

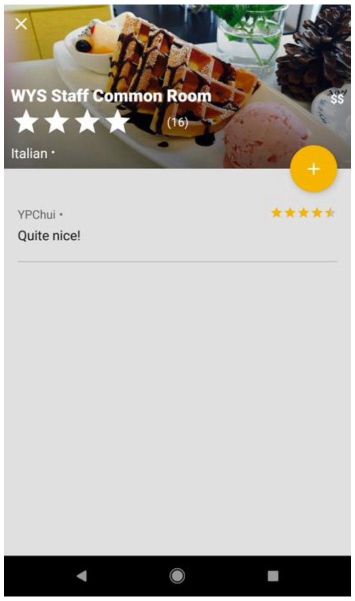
2) The `addRating()` function returns a `Task` representing the entire transaction. In the `onRating()` function listeners are added to the task to respond to the result of the transaction.

3) Now **Run** the app again and click on one of the restaurants, which should bring up the restaurant detail screen.

4) Click the **+** button to start adding a review. Add a review by picking a number of stars and entering some text.







5) Hitting **Submit** will kick off the transaction. When the transaction completes, you will see your review and an update to the restaurant's review count.

7. Secure your data

At the beginning of this lab, we set our app's security rules to prevent unauthenticated access. In a real application, we'd want to set much more fine-grained rules to prevent undesirable data access or modification.

1) Open the rules tab of the console and change the security rules to the following:

Note: rules changes can take up to a minute to take effect.

```
service cloud.firestore {

  // Determine if the value of the field "key" is the same
  // before and after the request.
  function unchanged(key) {
    return (key in resource.data)
      && (key in request.resource.data)
      && (resource.data[key] == request.resource.data[key]);
  }

  match /databases/{database}/documents {
    // Restaurants:
    //   - Authenticated user can read
    //   - Authenticated user can create/update (for demo)
    //   - Validate updates
    //   - Deletes are not allowed
    match /restaurants/{restaurantId} {
      allow read, create: if request.auth != null;
      allow update: if request.auth != null
                    && (request.resource.data.keys() == resource.data.keys())
                    && unchanged("name");
      allow delete: if false;

      // Ratings:
      //   - Authenticated user can read
      //   - Authenticated user can create if userId matches
      //   - Deletes and updates are not allowed
      match /ratings/{ratingId} {
        allow read: if request.auth != null;
        allow create: if request.auth != null
                      && request.resource.data.userId == request.auth.uid;
        allow update, delete: if false;

      }
    }
  }
}
```

These rules restrict access to ensure that clients only make safe changes. For example updates to a restaurant, the document can only change the ratings, not the name or any other immutable data. Ratings can only be created if the user ID matches the signed-in user, which prevents spoofing.

References

To read more about Security Rules, visit the documentation.

You have now created a fully-featured app on top of the Firestore. You learned about the most important Firestore features including:

- Documents and collections
- Reading and writing data
- Sorting and filtering with queries
- Sub-collections
- Transactions

If you want to keep learning about Firestore, here are some good places to get started:

1) Choose a data structure
2) Simple and compound queries