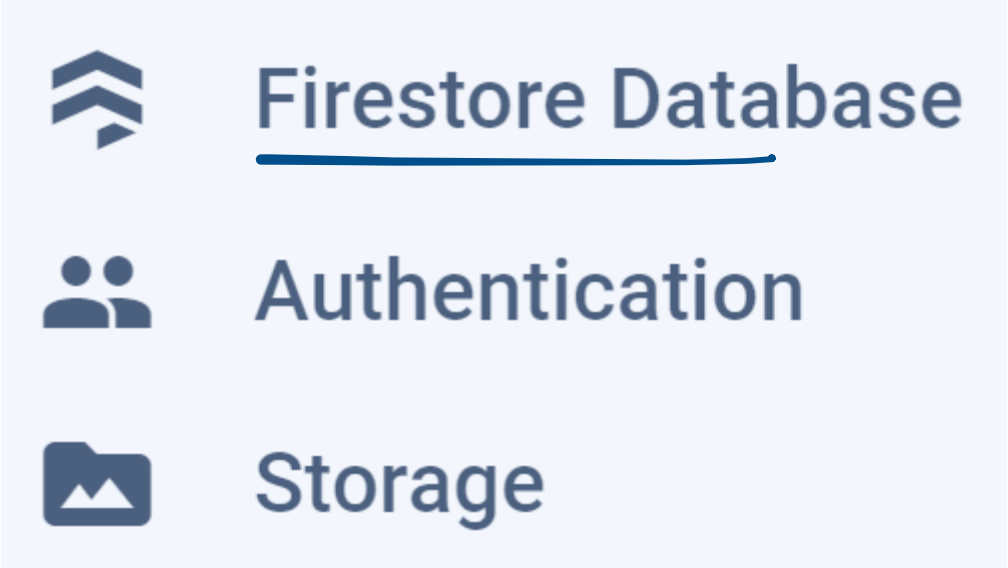
CMPS 312

Firebase Cloud Services



Dr. Abdelkarim Erradi

CSE@QU

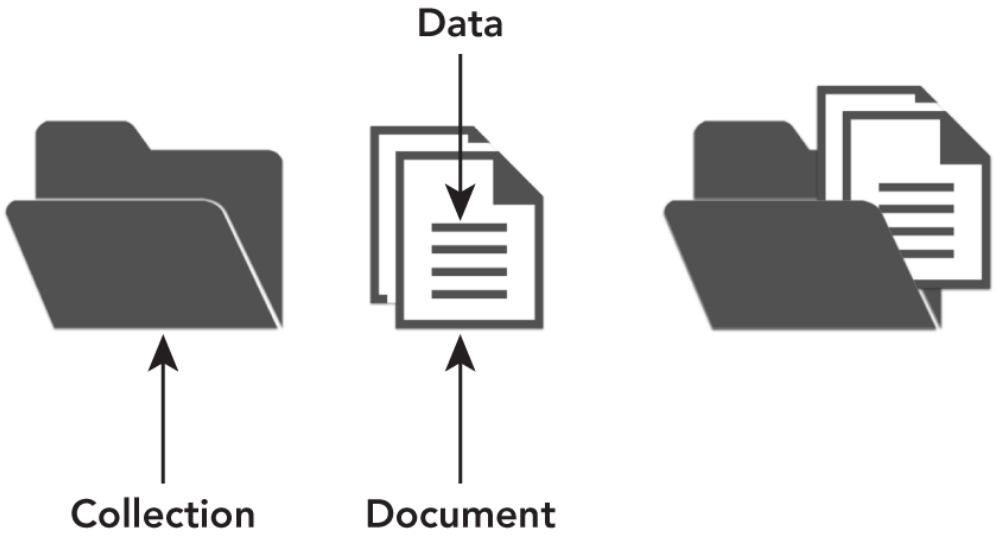
Outline

1. Firestore Data Model
2. Firestore CRUD Operations
3. Firebase Storage
4. Access Image Gallery and Camera
5. Firebase Authentication

Firebase Cloud Services

- Firebase is a **cloud platform** offering many **services** that work together as a backend server infrastructure for mobile/web apps
- We will focus on introducing:
  - **Firestore**: store/query documents in collections
  - **Storage**: store and retrieve files
  - **Firebase Authentication**: secure user authentication using various identity provides (e.g., email/password, Google Auth)

Firestore Data Model

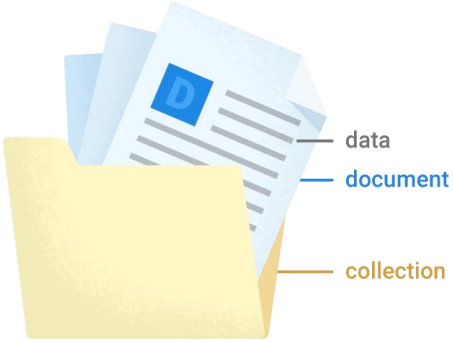


Back

Firestore Database

- Cloud-hosted **scalable** database to manage app data
  - No need to set up or maintain backend servers
- Provides real-time updates and offline support
- Uses a **document-oriented** data model
  - Data is organized in **collections**
  - Each collection contains documents, which can further include subcollections
  - Allowing you to build flexible and hierarchical data structures
- **NoSQL** (does not use SQL as a query language)
- Access controlled with **security rules**
- Includes a free tier (1 GB data, 50K reads/day and 20K writes/day) then pay as you use

Data Model



- Firestore is **Document Oriented Database**
  - Stores data as **documents** that utilizes a flexible, JSON-like data model
    - instead of rows and columns as done in a relational database
  - Documents are grouped into **collections**
  - **API to query** and manage documents

- Better alternative data management solution for Mobile/Web applications (compared to using a Relational DB)
  - Real-time synchronization capabilities
  - Scalable data management

Document

```
{
  "isbn" : 123,
  "title": "Mr Bean and the Forty Thieves",
  "category": "Fun",
  "pages": 250
  "authors": ["Mr Bean", "Juha Dahak"],
  "publisher": {
                "name": "MrBeanCo",
                "country": "UK“
               }
}
```

property : **value**

property : **array**

property : **map**

- **Document = JSON**-like object
- **Document = set of key-value pairs**
- **Document = basic unit of data** in Firestore
  - You can only fetch a document not part of it
- Analogous to **row** in a relational database
- Size limit to **1 MB** per document
- A document can optionally point to subcollections
- A Document **cannot** point to another document

Data Types

- Cloud Firestore supports a variety of data types for values:
  - boolean, number, string,
  - geo point, binary blob, and timestamp
  - arrays, nested objects (called maps) to structure a complex object (e.g., address) within a document

Document

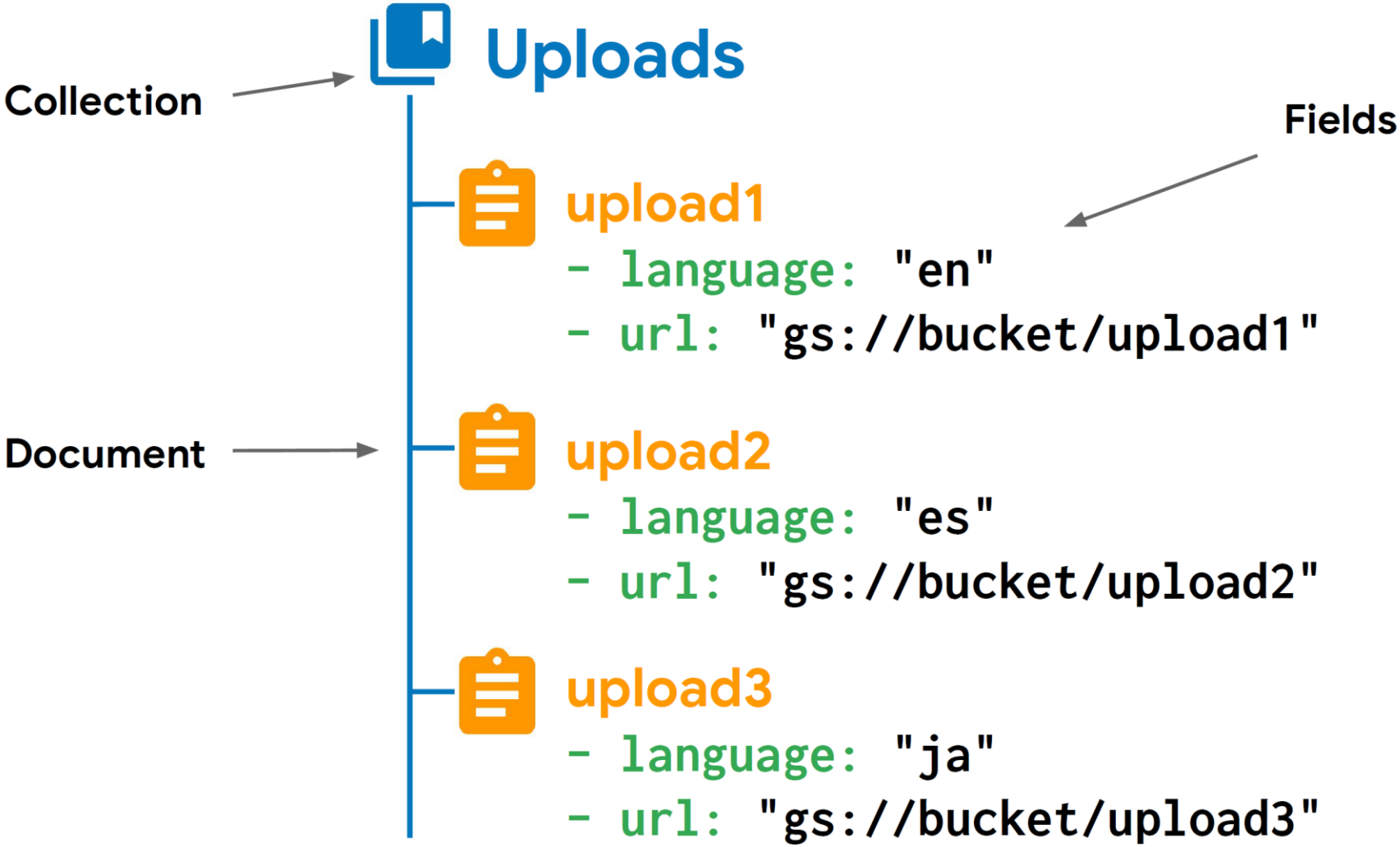
```
bird_type: "swallow"
airspeed: 42.733
coconut_capacity: 0.62
isNative: false
icon: <binary data>
vector:
    {x: 36.4255,
     y: 25.1442,
     z: 18.8816}
distances_traveled:
    [42, 39, 12, 42]
```

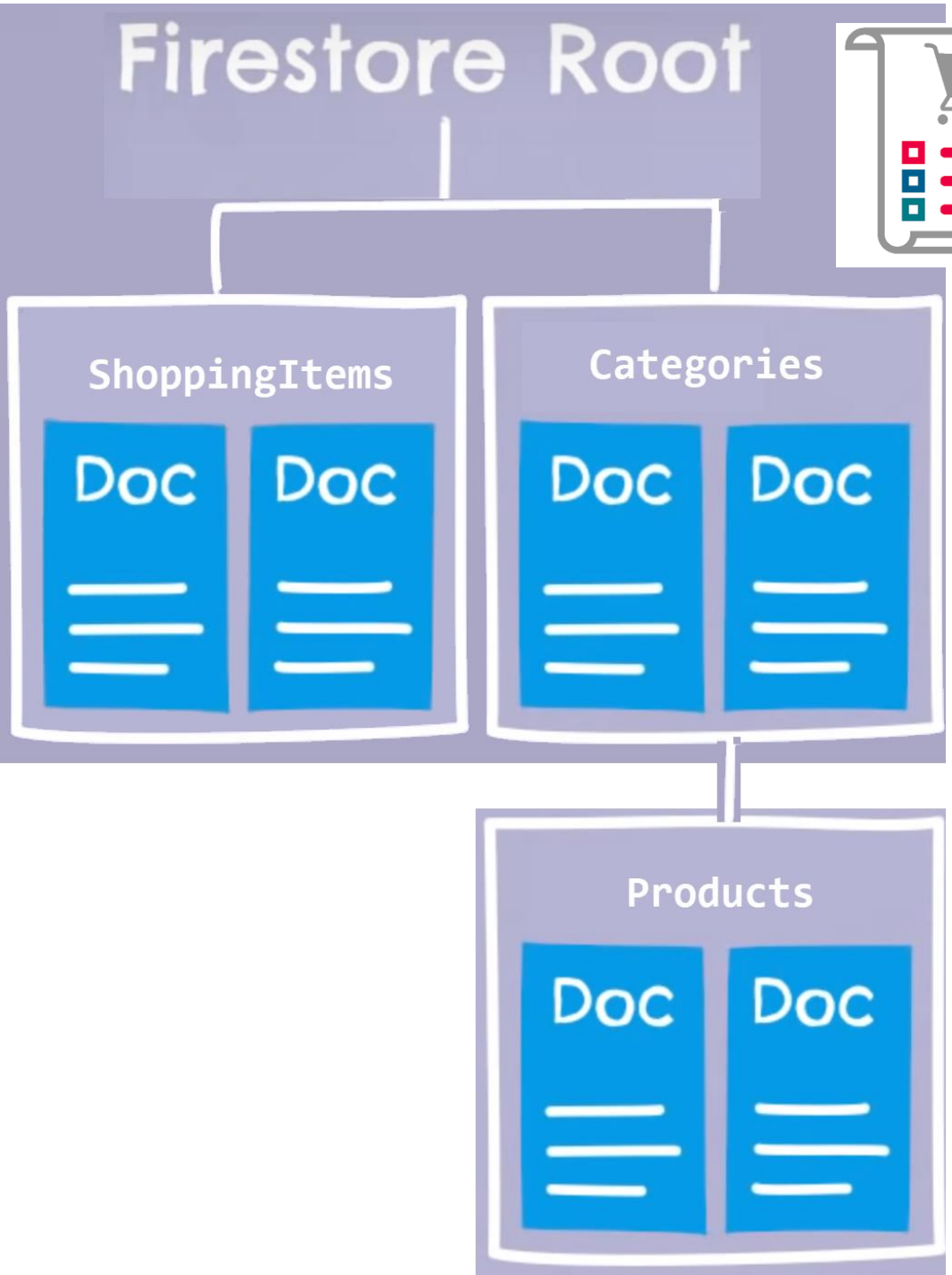
Collection

```
{
  "isbn" : "123",
  "title": "Mr Bean and the Forty Thieves",
  "authors": ["Mr Bean", "Juha Dahak"],
  "publisher": {"name": "MrBeanCo", "country": "UK"},
  "category": "Fun",
  "pages": 250
}
```

- **Collection = container** for documents
- Analogous to **table** in a relational database
- **Does not enforce** a schema
- Documents in a collection usually **have similar purpose** but they may have slightly different schema
- A collection <u>cannot</u> contain other collections

Example Collection & Documents





Shopping List App

- Database with 2 **top-level** collections: `ShoppingItems` and `Categories`
- Each category document has a `Products` sub-collection

Document Identifiers

- Documents within a collection have **unique identifiers**
  - You can provide your own keys, such as using the **email** as a unique identifier for users
  - You can let Cloud Firestore assign a random IDs
- You do not need to "create" or "delete" collections
  - A collection gets created after you create the first document in a collection
  - A collection is deleted when you delete all the documents in a collection
- Access a document using its **collection** and its doc **Id**

```
final FirebaseFirestore db = FirebaseFirestore.instance;
final u1DocRef = await db.collection("users").doc("u1@test.com").get();
```

Subcollections

- A subcollection is a collection associated with a specific document
  - E.g., A subcollection called messages for every room document in the rooms collection

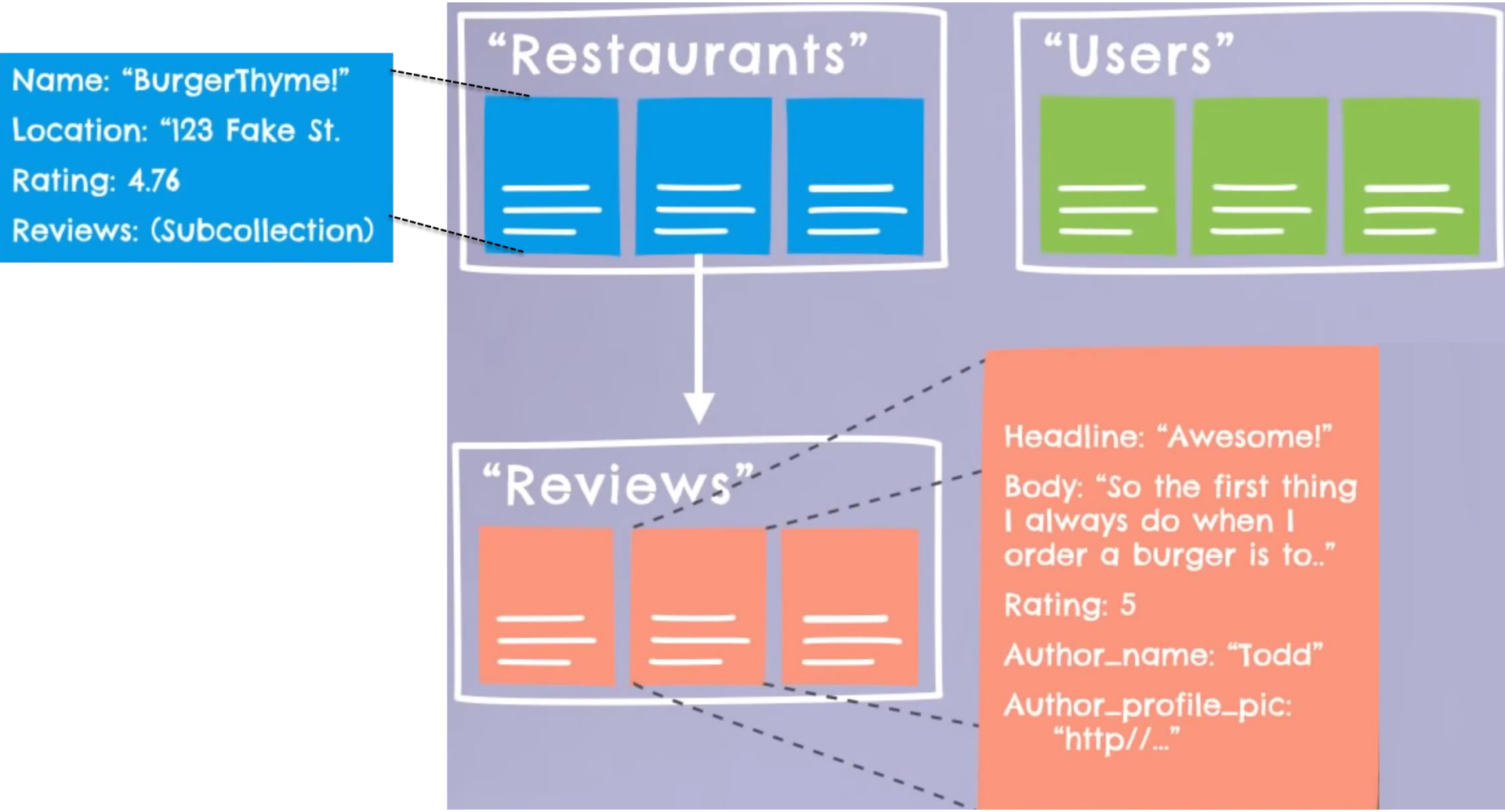
```
rooms
    roomA
    name : "my chat room"
        messages
            message1
            from : "alex"
            msg : "Hello World!"
            message2
            ...
    roomB
    ...
```

- Get a reference to a message in the subcollection

```
final FirebaseFirestore db = FirebaseFirestore.instance;

final message1DocRef =
     db.collection("rooms").document("roomA")
       .collection("messages").document("message1");
```

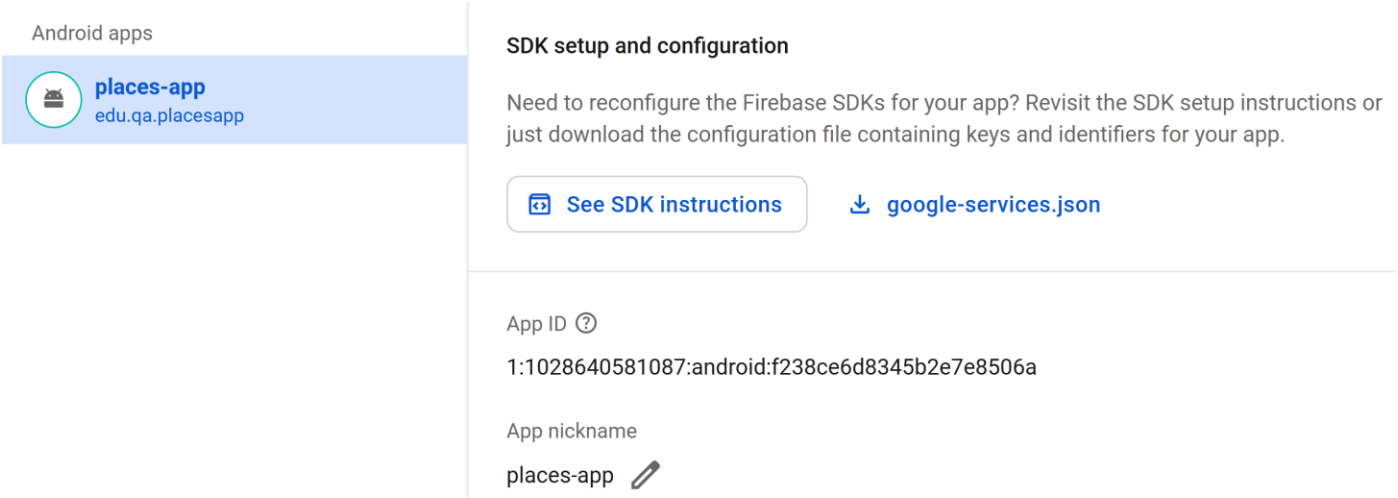
Example Restaurant Review App



Source: https://www.youtube.com/watch?v=v_hR4K4auoQ

Add Firebase to your Flutter project

- Login to https://console.firebase.google.com/
- Create a **project** (give it a meaningful name, see the steps at this link)
  - to keep it simple disable Google Analytics for the project
- Create Firestore database (see the steps at this link)
- Select the **Project settings** and add an Android app



- Download `google-services.json` and place it under **`\android\app`** subfolder

Dependencies

- Add to **`pubspec.yaml`**:

```
dependencies:
  firebase_core: ^3.6.0
  cloud_firestore: ^5.4.4
```

- Install Firebase CLI

```
npm install -g firebase-tools
```

- Install FlutterFire CLI

```
dart pub global activate flutterfire_cli
```

(add the folder in the Warning message to Windows/MacOS System's environment path)

- Generate **`firebase.json`** and **`firebase_options.dart`** config files to connect to Firebase

```
firebase login
flutterfire configure
```

Easier way to Flutter app to use Firebase

- Add to `<project>/build.gradle`

```
plugins {
  // Add the dependency for the Google services Gradle plugin
  id 'com.google.gms.google-services' version '4.4.2' apply false
}
```

- Add to `<project>/app/build.gradle`

```
plugins {
    ...
    // Add the Google services Gradle plugin
    id 'com.google.gms.google-services'
}

  defaultConfig { ...
      minSdk = 23
```

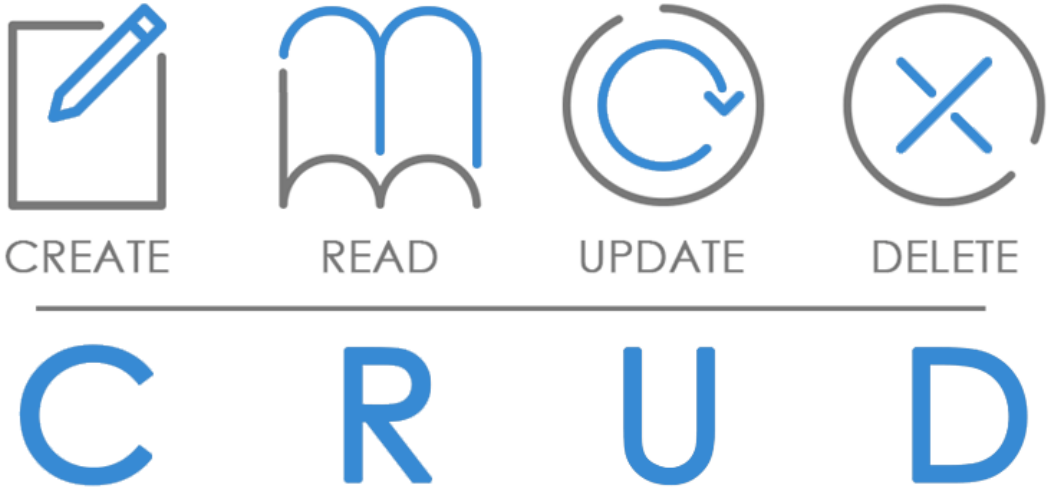
Set the min SDK version to 23

Initialize Firebase in Your Flutter App

- Open the main function initialize Firebase before running the app

```
void main() async {
  WidgetsFlutterBinding.ensureInitialized();
  await Firebase.initializeApp();
  runApp(
    const ProviderScope(
      child: MyApp(),
    ),
  );
}
```

Firestore CRUD Operations



Back

Create Data Classes Mapped to Firestore Docs

- Normal **classes** having the same structure as Firebase docs
  - Map fields to/from Firestore using a fromJson and toJson method

```
class Category {
  String id;
  String name;
  // Default constructor
  Category({this.id = '', this.name = ''});
  factory Category.fromJson(Map<String, dynamic> data) {
     return Category(
      id: data['id'],
      name: data['name'] ?? '',
    );
  }
  Map<String, dynamic> toJson() {
    return {
      'name': name,
    };
  }
}
```

Query – return all documents

- Using **collection reference** use the **`.get`** method to return the collection documents
  - You can sort the results using **`.orderBy`**
  - Use the same technique to get documents from a subcollection associated with a particular document

```
Future<List<Product>> fun getProducts(categoryId: String) async {
  final queryResult = await categoryCollectionRef.doc(categoryId).collection("products")
                          .orderBy("name", Query.Direction.DESCENDING).get();
  List<Product> products = queryResult.docs.map((doc) {
      final data = doc.data() as Map<String, dynamic>;
      return Product.fromMap(data);
  }).toList();
  return products;
}
```

Query – filer using .where

- Use **.where** to filter the documents to return from a collection

```
final citiesRef = db.collection("cities");
final stateQuery = citiesRef.where("state", isEqualTo: "CA");
final populationQuery = citiesRef.where("population",
                isLessThan: 100000);
final nameQuery = citiesRef.where("name", isEqualTo: "Doha");
final notCapitals = citiesRef.where("capital", isNotEqualTo: true);
final cities = citiesRef.where("country", whereIn: ["USA", "Japan"]);
```

```
Future<Category?> getCategory(categoryName: String) async {
  final queryResult = await categoryRef.where("name", isEqualTo:categoryName).get();
  if (queryResult.docs.isNotEmpty) {
    return Category.fromJson(queryResult.docs.first.data());
  }
  return null;
}
```

and / or filter condition

- Filter condition connected with **and**

```
citiesRef.where("state", isEqualTo: "CA")
         .where("population", isLessThan: 1000000);
```

- Filter condition connected with **or**

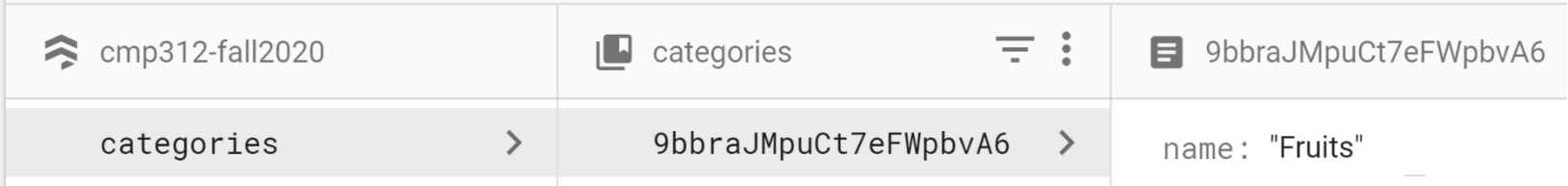
```
var query = db.collection("cities").where(
    Filter.or(
      Filter("capital", isEqualTo: true),
      Filter("population", isGreaterThan: 100000),
    ),
  );
```

Add a document to a Collection

- Get a collection reference

```
var collectionRef = db.collection("colName")
```

- Call **.add** method and pass the object to add the collection
  - Firebase adds the object to the collection and returns the auto-assigned **docId**

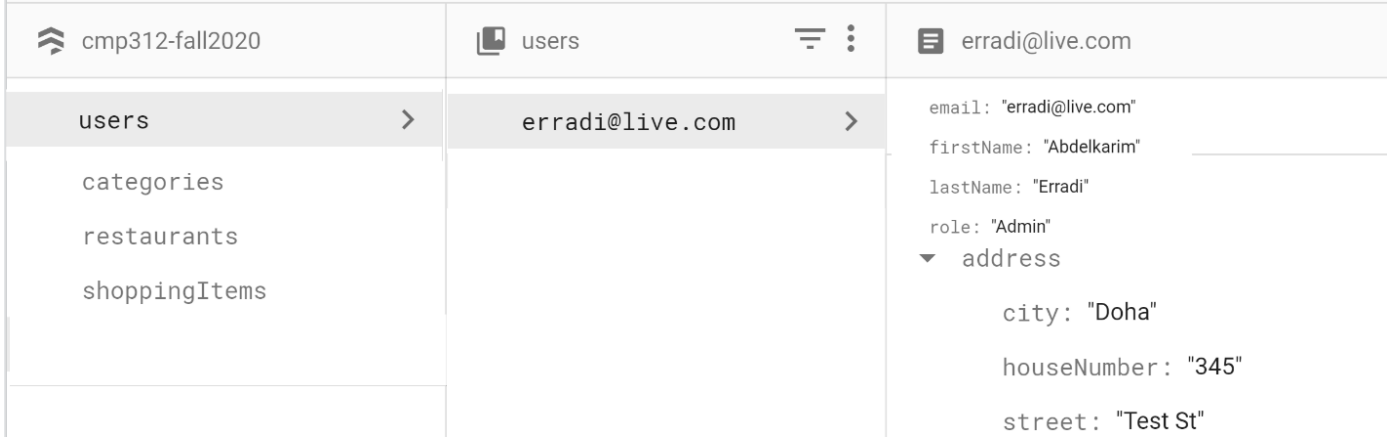



```
final category = Category("Fruits");
final categoryRef = db.collection("categories");
final queryResult = await categoryRef.add(category);
final categoryId = queryResult.id;
```

Add a document and set DocId

- First specify the desired **docId** to be assigned to the new doc
  `collectionRef.doc(docId)`
- Call **.set** method and pass the object to add to the collection
  - Firebase adds the object to the collection and the id of the new doc is **docId** passed to **.doc** method

```
Future<void> addUser(User user) async {
  var userCollectionRef = FirebaseFirestore.instance.collection("users");
  await userCollectionRef.doc(user.email).set(user.toJson());
}
```



Update a document

- Use **`.update`** and pass the fields to update and their new values as a Map
  - Or use **`.set`** to replace the whole document

```
Future<void> updateQuantity(String itemId,
      int quantity) async {
  await shoppingItemRef.doc(itemId).update(
      {'quantity': quantity});
}

Future<void> updateItem(ShoppingItem item) async {
  await shoppingItemRef.doc(item.id).set(item);
}
```

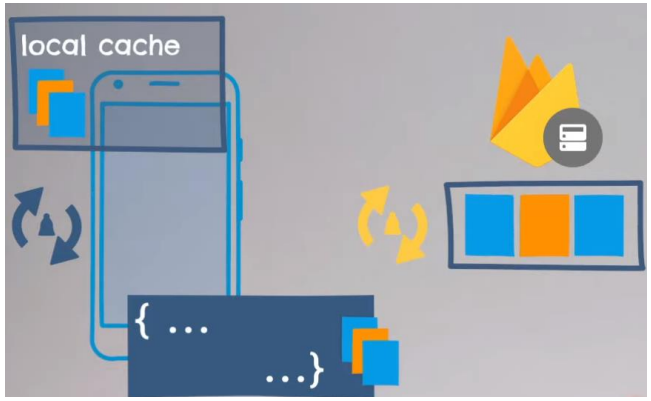
Delete a document

- Use **`.delete`** method to delete a document

```
Future<void> deleteItem(ShoppingItem item) async {
  await shoppingItemRef.doc(item.id).delete();
}
```

Subscribing to collection/document Realtime Updates

- Use `.snapshots()` to observe the changes of a collection/document and get near **real-time updates**




```
Stream<List<ShoppingItem>> observeShoppingListItems() {
  final uid = FirebaseAuth.instance.currentUser?.uid;

  if (uid == null) return Stream.value([]);

  return FirebaseFirestore.instance
      .collection('shoppingItems')
      .where('uid', isEqualTo: uid)
      .snapshots()
      .map((snapshot) => snapshot.docs
          .map((doc) => ShoppingItem.fromJson(doc.data()))
          .toList());
}
```

Securing Data

- Cloud Firestore **Security Rules** consist of:
  - **match statements**, which identify documents in the database, and
  - **allow expressions**, which control access to those documents

```
// Allow read/write access on all documents to any user signed in to the app
service cloud.firestore {
  match /databases/{database}/documents {
    match /{document=**} {
      allow read, write: if request.auth.uid != null;
    }
  }
}
```

Firebase Storage

Back

Firebase Storage

- Firebase Cloud Storage
  - Store and serve files
  - Robust
  - Secure
  - Access controlled with security rules
- To access to the Firebase Storage service:

```
final storageRef = FirebaseStorage.instance.ref();
```

`.ref()` creates a reference to the root path. You can append **`.child()`** to this reference to navigate to specific paths.

Firebase Storage File Operations

- Upload Operations
  - putBytes(byte[]): UploadTask
  - putFile(Uri): UploadTask
- Download Operations
  - getBytes(long): Task<byte[]>
  - getFile(Uri): FileDownloadTask
  - getFile(File): FileDownloadTask
- Delete
  - delete(): Task<Void>
- List
  - list(int): Task<ListResult>
  - list(int, String): Task<ListResult>
  - listAll(): Task<ListResult>

List

- Get URLs of files in particular subfolder

```
Future<List<String>> getImageUrls() async {
  List<String> imageUrls = [];
  try {
    // Reference to the 'images/' directory in Firebase Storage
    final storageRef = FirebaseStorage.instance.ref().child("images/");

    // List all items in the 'images/' directory
    final result = await storageRef.listAll();

    // Loop through the items and get the download URL for each image
    for (var image in result.items) {
      String url = await image.getDownloadURL();
      imageUrls.add(url);
    }
  } catch (e) {
    print('Error fetching image URLs: $e');
  }
  return imageUrls;
}
```

Add file

```
final storageRef = FirebaseStorage.instance.ref();
// Upload file
await storageRef.child("images/$filename")
                .putFile(filePath);
```

Delete file

```
await storageRef.child("images/$filename").delete();
```

Download file

```
Future<void> downloadFile(String filename, String destinationPath) async {
  try {
    // Get reference to the file in Firebase Storage
    final ref = FirebaseStorage.instance.ref('files/$filename');

    // Download the file to the destination path
    await ref.writeToFile(File(destinationPath));

    print('File downloaded successfully to $destinationPath');
  } catch (e) {
    print('Error downloading file: $e');
  }
}
```

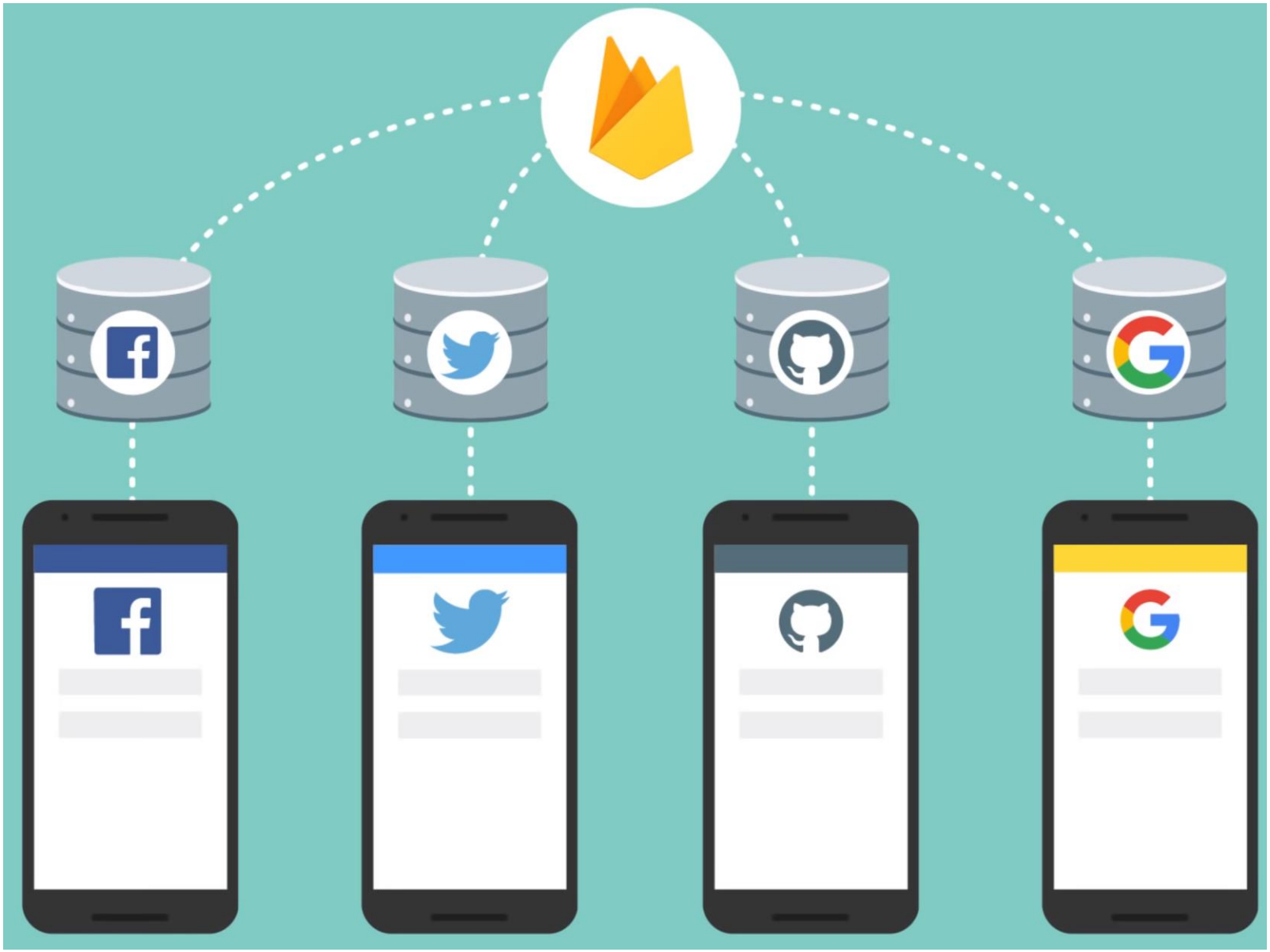
Firebase Authentication

Back

Firebase Authentication

- **Authentication** = **Identity verification**:
  - Verify the identity of the user given the credentials received
  - Making sure the user is who he claims to be
- Every user gets a unique ID
- Restrict who can read and write what data

Multiple Identity Providers can be used for Authentication



Sign in

- Sign in using Firebase authentication

```
final authResult = await FirebaseAuth.instance.signInWithEmailAndPassword(
  email: email,
  password: password,
);
print(">> Debug: signIn.authResult : ${authResult.user?.uid}");
```

Sign up

- Sign up and the user details to Firebase authentication

```
Future<User?> signUp(User user) async {
  try {
    // Create a new user with email and password
    User authResult = await FirebaseAuth.instance.createUserWithEmailAndPassword(
      email: user.email,
      password: user.password,
    );

    // If the user was created successfully, update their profile
    if (authResult.user != null) {
      await authResult.user!.updateDisplayName('${user.firstName} ${user.lastName}');
      await authResult.user!.updatePhotoURL('http://test.com/spongebob.png');
      // Refresh the user to apply changes
      await authResult.user!.reload();
    }

    return authResult;
  } catch (e) {
    print('Error during sign up: $e');
    return null;
  }
}
```

Sign out

- Sign out from Firebase auth

```
await FirebaseAuth.instance.signOut();
```

- Anywhere in the app you can access the details of current user

```
void getCurrentUser() {
  User? user = FirebaseAuth.instance.currentUser;
  if (user != null) {
    print('User is signed in! Email: ${user.email}');
  } else {
    print('No user is signed in.');
  }
}
```

Summary

- **Cloud Firestore** database store/query app's data
  - Data model consists of collections to store documents that contain data as a key-value pair similar to JSON
- Firebase **Cloud Storage** is used to store and retrieve files
- **Firebase Authentication** provides built-in backend services to ease user authentication
  - email/password authentication allows users to register and log in to the app
  - Secure user's authentication using various identity provides (e.g., email/password, Google Auth)

Resources

- Cloud Firestore
  - https://firebase.google.com/docs/firestore/
- Get to know Cloud Firestore
  - https://www.youtube.com/playlist?list=PLl-K7zZEsYLluG5MCVEzXAQ7ACZBCuZgZ
- Firestore codelab
  - https://firebase.google.com/codelabs/firebase-get-to-know-flutter
- Firebase Auth codelab
  - https://firebase.google.com/codelabs/firebase-auth-in-flutter-apps