NoSQL

SWE 432, Fall 2017

Design and Implementation of Software for the Web

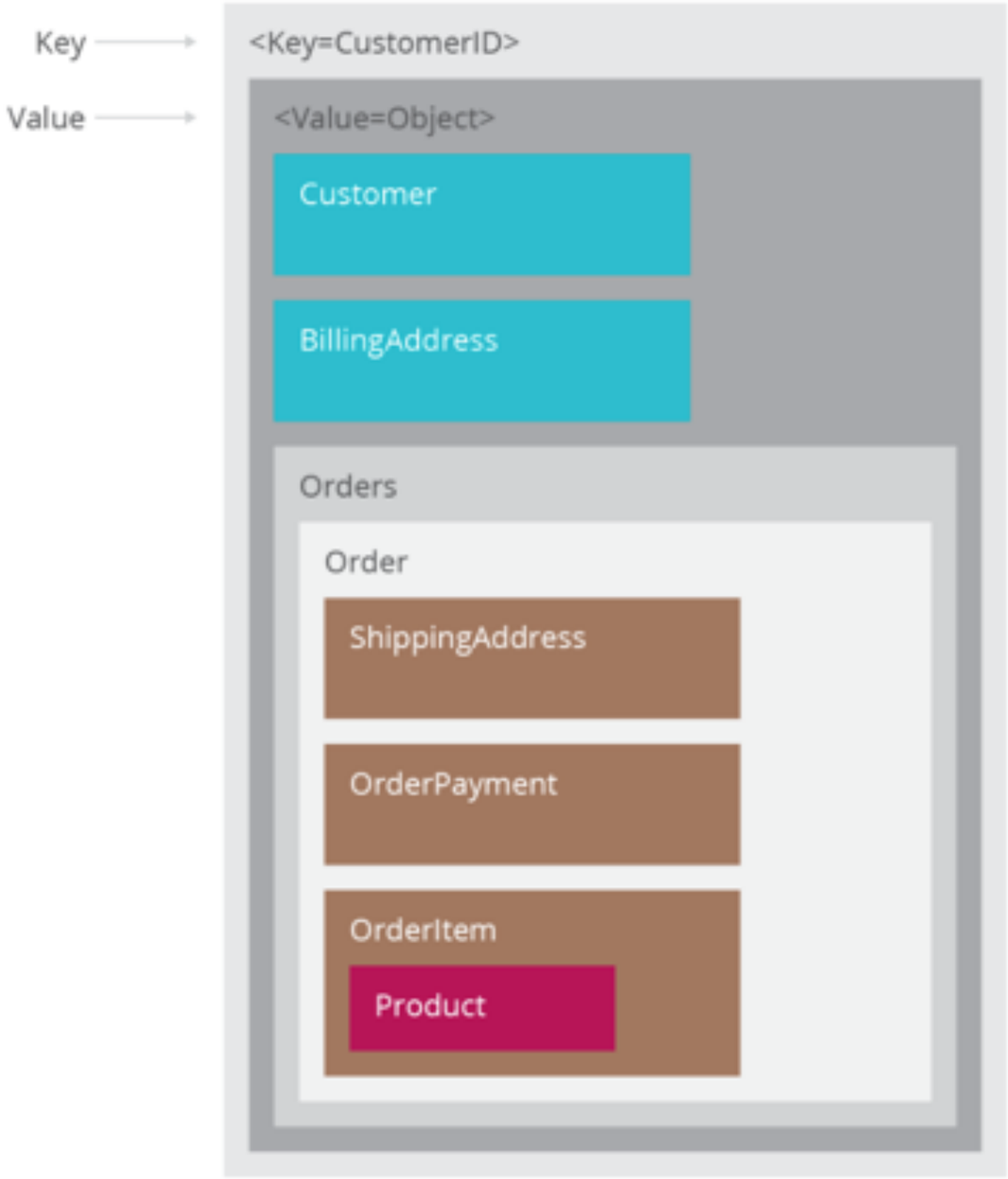
Today

- What is NoSQL?
- How can you create a NoSQL app with Firebase?

NoSQL

- non SQL, non-relational, "not only" SQL databases
- Emphasizes simplicity & scalability over support for relational queries
- Important characteristics
  - Schema-less: each row in dataset can have different fields (just like JSON!)
  - Non-relational: no structure linking tables together or queries to "join" tables
  - (Often) weaker consistency: after a field is updated, all clients *eventually* see the update but may see older data in the meantime
- Advantages: greater scalability, faster, simplicity, easier integration with code
- Several types. We'll look only at key-value.

Key-Value NoSQL



https://www.thoughtworks.com/insights/blog/nosql-databases-overview

Firebase Realtime Database

- Example of a NoSQL datastore
- Google web service
  - https://firebase.google.com/docs/database/
- Realtime database
  - Data stored to remote web service
  - Data synchronized to clients in real time
- Simple API
  - Offers library wrapping HTTP requests & responses
  - Handles synchronization of data
- Can also be used on frontend to build web apps with persistence without backend

Setting up Firebase

- Detailed instructions to create project, get API key
  - https://firebase.google.com/docs/web/setup

```
<script src="https://www.gstatic.com/firebasejs/3.4.0/firebase.js"></script>
<script>
// Initialize Firebase
// TODO: Replace with your project's customized code snippet
var config = {
    apiKey: "<API_KEY>",
    authDomain: "<PROJECT_ID>.firebaseapp.com",
    databaseURL: "https://<DATABASE_NAME>.firebaseio.com",
    storageBucket: "<BUCKET>.appspot.com",
};
firebase.initializeApp(config);
</script>
```

Setting up Firebase Realtime Database

- Go to https://console.firebase.google.com/, create a new project
- Install firebase module

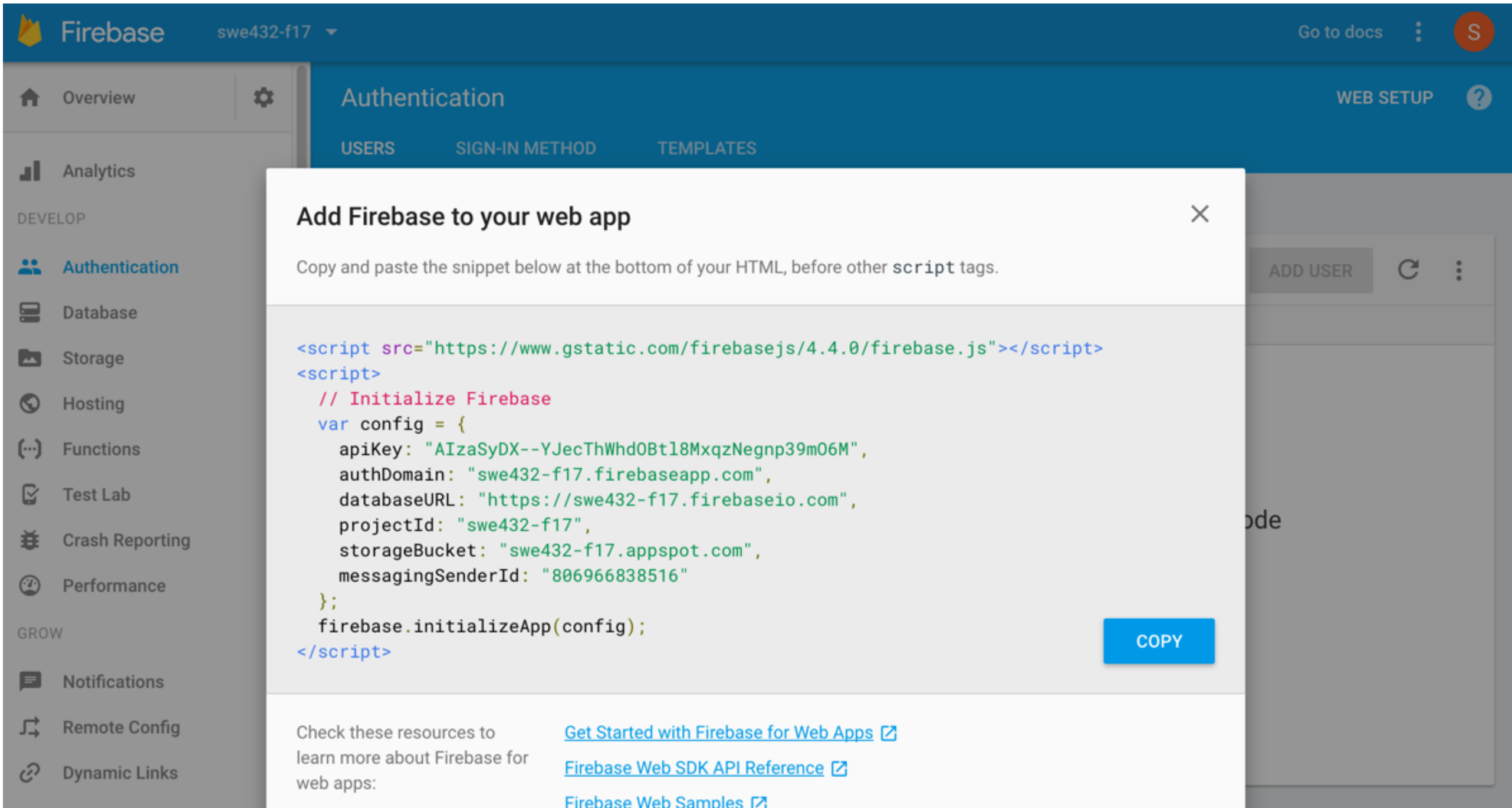
```
npm install firebase
```

- Include Firebase in your web app

```
const firebase = require("firebase");

// Initialize Firebase
// TODO: Replace with your project's customized code snippet
const config = {
  apiKey: "<API_KEY>",
  authDomain: "<PROJECT_ID>.firebaseapp.com",
  databaseURL: "https://<DATABASE_NAME>.firebaseio.com",
  storageBucket: "<BUCKET>.appspot.com",
};
firebase.initializeApp(config);
```

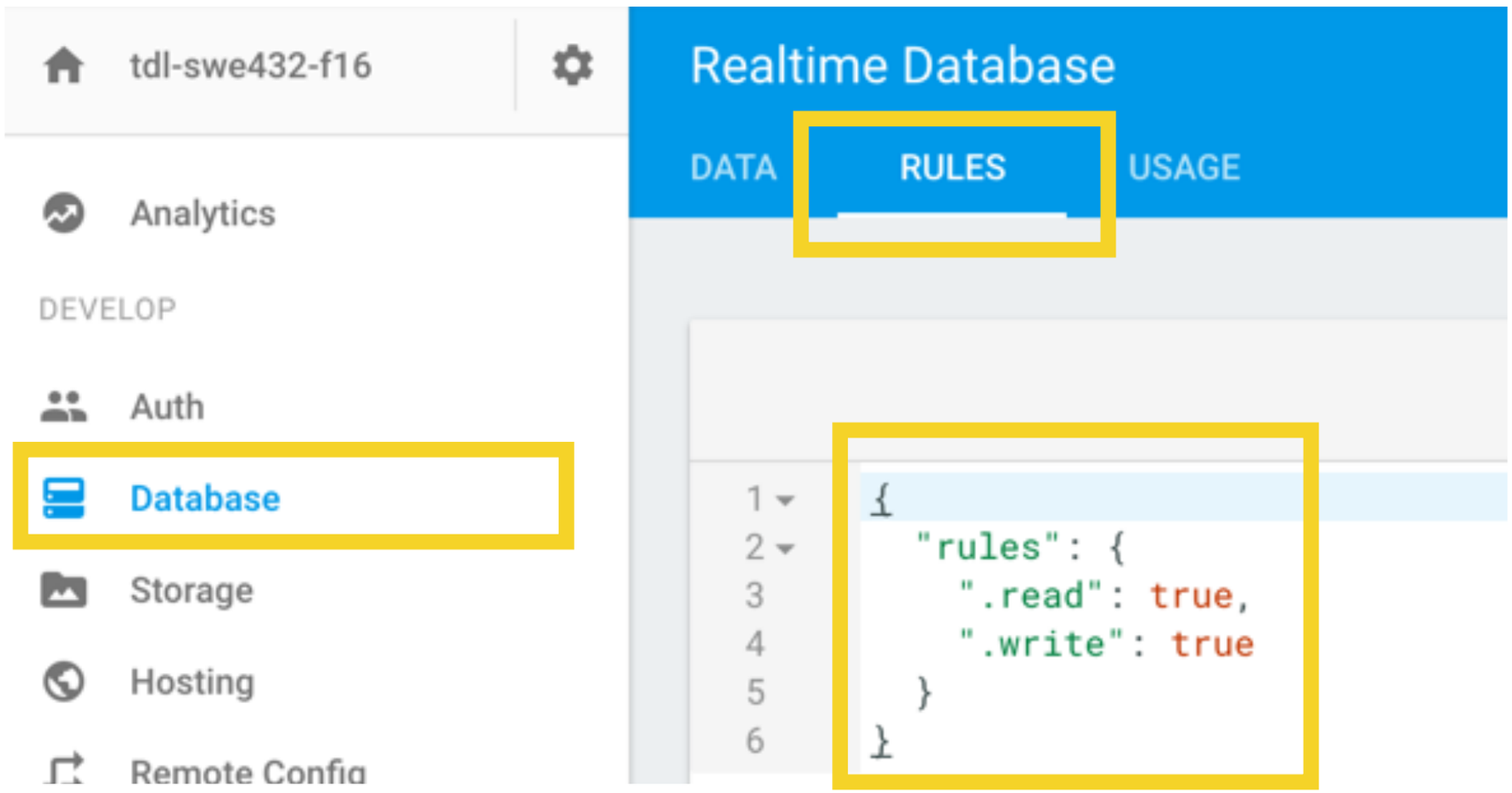
Get Config Object for your Project

- Go to Authentication, Click "Web Setup" in the upper right corner



Permissions

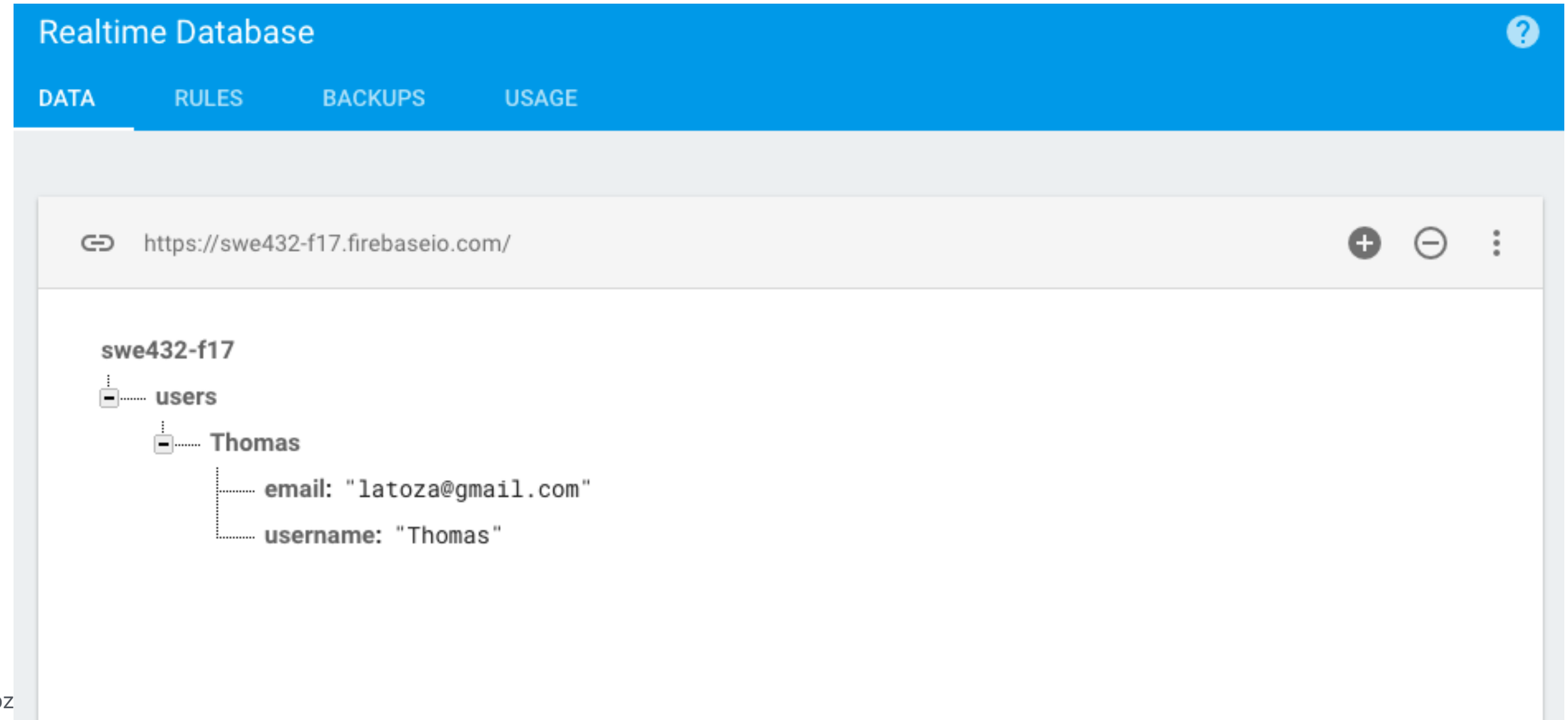
- By default, Firebase *requires* authentication
  - All unauthenticated requests will be refused
  - Do not want anyone with your URL to steal, destroy your production data
  - Will look at authentication in later lecture
  - For development, ok to allow anonymous access



Firebase Console

- See data values, updated in realtime
- Can edit data values

https://console.firebase.google.com



Simple test program

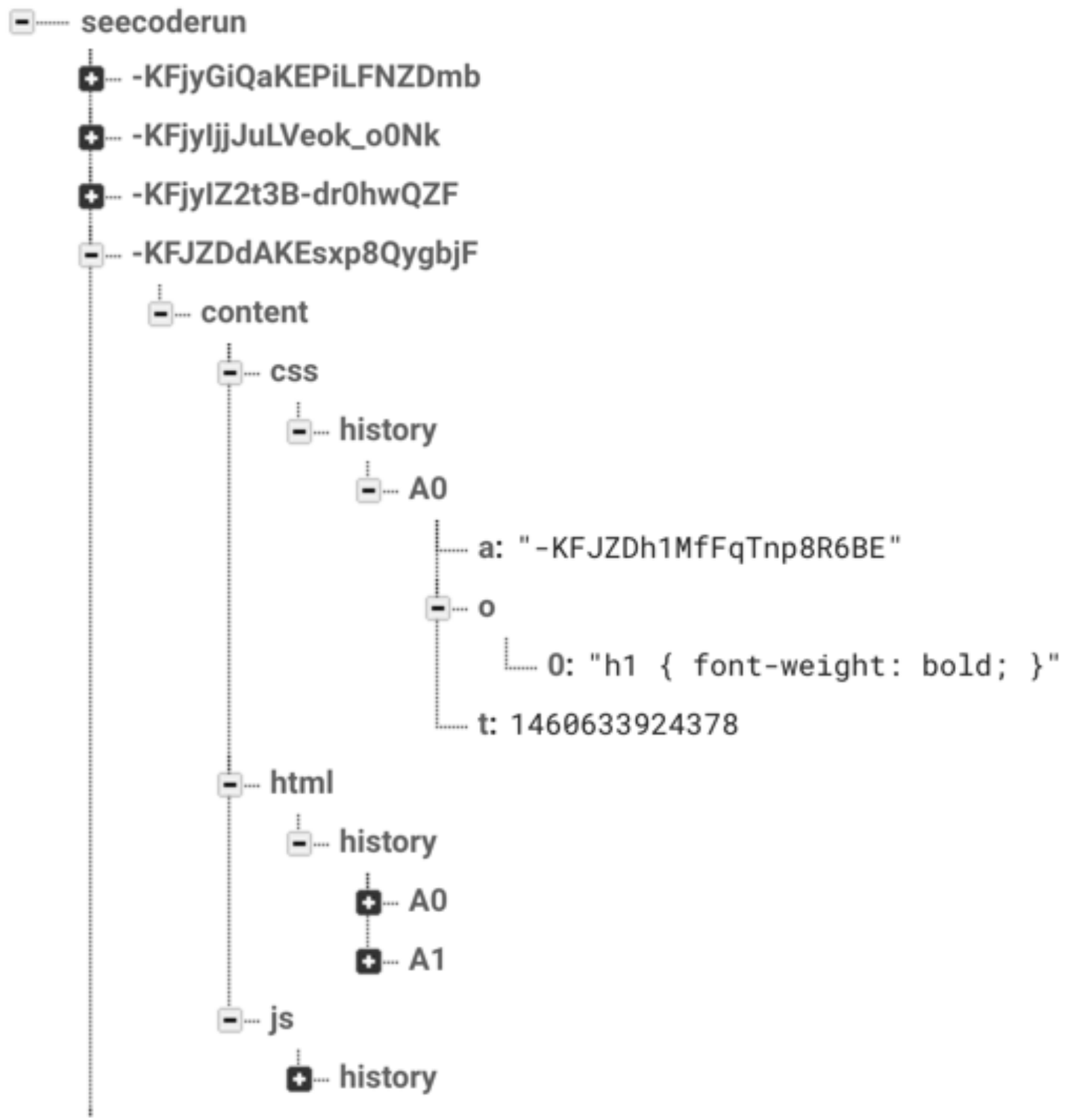
- After successfully completing previous steps, should be able to replace config and run this script. Can test by viewing data on console.

```
const firebase = require("firebase");

// Initialize Firebase
const config = {
    ... [copied from your config object on Firebase]
};
firebase.initializeApp(config);

let database = firebase.database();
database.ref('users/' + 'Josh').set(
    { username: 'Josh', email: 'josh@gmail.com'
    });
```

Activity: Set up Firebase Realtime Database

Firebase data model: JSON

- JSON format data
  - Hierarchic tree of key/value pairs
  - Can view as one big object
  - Or describe path to descendent and view descendent as object



Structuring data

- How do you organize lots of data?

- One idea: just have a hierarchic structure
  - Level 1: most general elements
  - Level 2: elements that belong to Level 1 elements
  - Level n: elements that belong to Level n-1 elements

- What are the pros and cons of this approach?

Structuring data

- Should be considering what types of records clients will be requesting.
  - Do not want to force client to download data that do not need.
- Better to think of structure as **lists** of data that clients will retrieve
- Can duplicate deeply nested structures with separate indexes

```
// Chats contains only meta info about each conversation
// stored under the chats's unique ID
"chats": {
  "one": {
    "title": "Historical Tech Pioneers",
    "lastMessage": "ghopper: Relay malfunction found. Cause: moth."
    "timestamp": 1459361875666
  },
  "two": { ... },
  "three": { ... }
},

// Conversation members are easily accessible
// and stored by chat conversation ID
"members": {
  // we'll talk about indices like this below
  "one": {
    "ghopper": true,
    "alovelace": true,
    "eclarke": true
  },
  "two": { ... },
  "three": { ... }
},
```

Activity: Design a data model

- Imagine you are designing a data model for a restaurant review site.
  - Each user has a profile, may submit reviews (linked to the user) for a restaurant, and may upvote, downvote, and comment on reviews (linked to the reviewer and restaurant).

- How would you structure this data?

Storing Data: Set

```
function writeUserData(userId, name, email, imageUrl) {
    firebase.database().ref('users/' + userId).set({
    username: name,
    email: email,
        profile_picture : imageUrl
    });
}
```

"On the active firebase database"

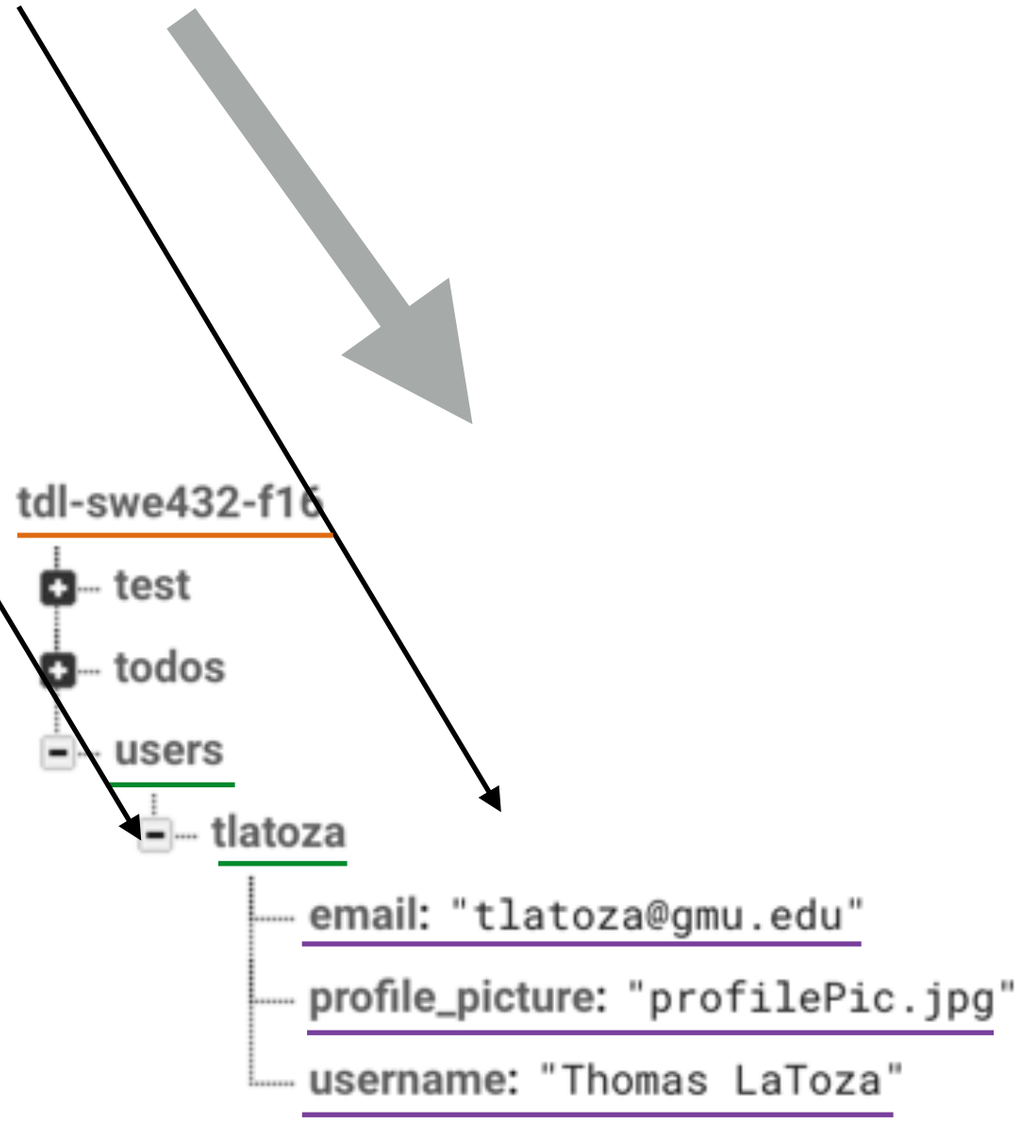
Must be initialized first (coming soon….).

"Get the users/ [userID] node"

Arbitrary nodes in the tree can be addressed by their path.

"Set value"

Sets the value to specified JSON.



Storing Data: Push

```
var key = firebase.database().ref().child('posts').push(
    { author: username, uid: uid, body: body, title: title });
```

- What about storing collections?
  - Use push to create key automatically
    - All data MUST have a key so it can be uniquely referenced
      - Arrays given index keys
    - Should never have multiple clients synchronizing an array
      - Local indexes could get of sync with remote keys
      - Instead, use JSON object with number as key

Storing Data: Delete

```
firebase.database().ref().child('posts').remove();
```

Removes the 'posts' subtree.

- Can delete a subtree by setting value to null or by calling remove on ref
  - If you want to store null, first need to convert value to something else (e.g., 0, '')

Listening to data changes

```
var starCountRef = firebase.database().ref('posts/' + postId + '/starCount');
starCountRef.on('value', function(snapshot) {
    updateStarCount(postElement, snapshot.val());
});
```

"When values changes, invoke function"

Specify a subtree by creating a reference to a path. Listen to one or more events by using on(eventName, eventHandlerFunction(snapshot))

- Read data by *listening* to changes to specific subtrees
- Events will be generated for initial values and then for each subsequent update

Data Update Events

- Types of events
  - value: entire contents of a path
  - child_added
  - child_changed
  - child_removed
- Can listen to events on any part of subtree
  - Could have subtrees that correspond to different collections of data
  - Should always listen to *lowest* subtree of interest to minimize extraneous communication
- Can read data exactly one time (and not get updates) using once

Ordering data

- Data is by, default, ordered by key in ascending order
  - e.g., numeric index keys are ordered from 0…n
  - e.g., alphanumeric keys are ordered in alphanumeric order
- Can get only first (or last) n elements
  - e.g., get n most recent news items

```
var recentPostsRef = firebase.database().ref('posts').limitToLast(100);
recentPostsRef.once('value', function(snapshot) {
    displayPost(snapshot.val());
});
```

Activity: Persist restaurant data in Firebase

- Assume you have some endpoints to gather submitted data from users for previous scenario.
- Using data submitted through these endpoints, store to Firebase.
- Offer endpoints for retrieving this data back from Firebase.

Reading for next time

- Intro to CORS: https://www.moesif.com/blog/technical/cors/Authoritative-Guide-to-CORS-Cross-Origin-Resource-Sharing-for-REST-APIs/