Authentication & Authorization

Rujuan Xing

Basic Problem

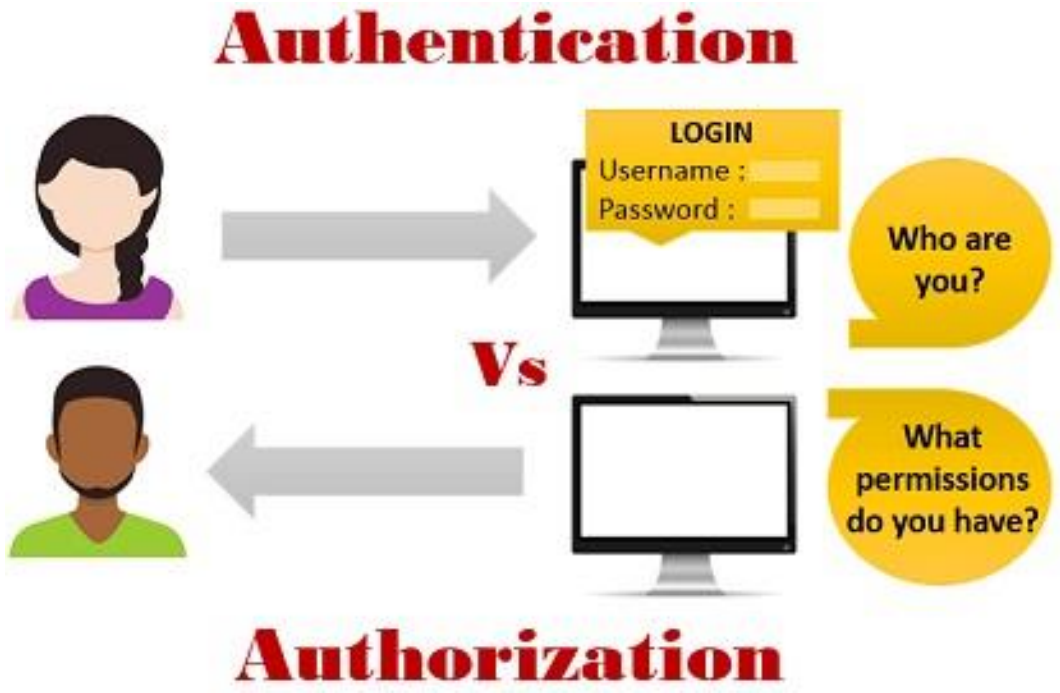
- How do you prove to someone that you are who you claim to be?

Authentication

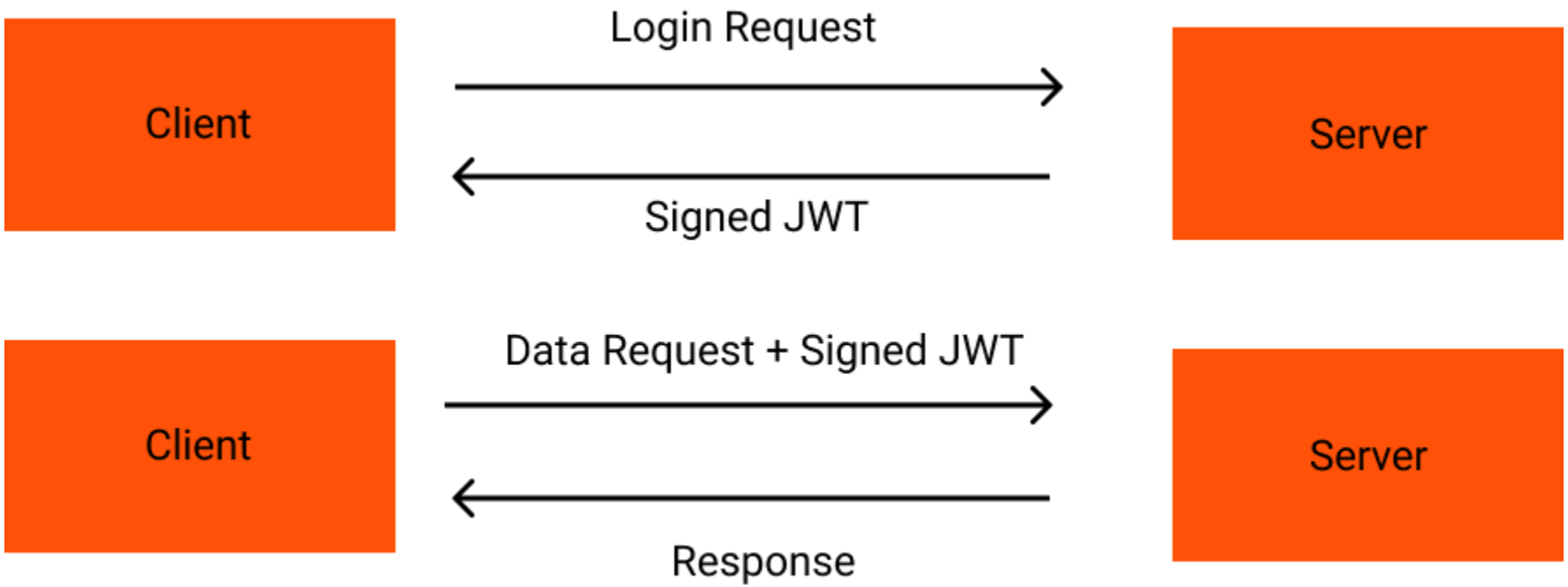
- Authentication is any process by which a system verifies the identity of a user who wishes to access it.
- Authentication may be implemented using Credentials, each of which is composed of a user Id and password. Alternately, Authentication may be implemented with Smart Cards, etc..

Authorization

- **Authorization** is the function of specifying access rights/privileges to resources, which is related to information security and computer security in general and to access control in particular.



Token-Based Authentication Systems



Token-based Authorization System

- Stateless: self contained
- Scalability: no need to store session in memory
- CSRF: no session being used
- Digitally-signed
- Decoupled

What is JSON Web Token?

- JSON Web Token (JWT) is an open standard (RFC 7519) that defines a compact and self-contained way for securely transmitting information between parties as a JSON object.
- JWTs can be signed using a secret (with the **HMAC** algorithm) or a public/private key pair using **RSA**.
- This information can be verified and trusted because it is digitally signed.
- **Compact**: Because of their smaller size, JWTs can be sent through a URL, POST parameter, or inside an HTTP header. Additionally, the smaller size means transmission is fast.
  - Simply a string in the format of **header.payload.signature**
- **Self-contained**: The payload contains all the required information about the user, avoiding the need to query the database more than once.

JSON Web Token Structure

- JSON Web Tokens consist of three parts separated by dots (.), which are:
  - header
  - payload
  - signature

- Therefore, a JWT typically looks like the following:
  - xxxxx.yyyyy.zzzzz
  - eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ.SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c

JWT Header

- The header *typically* consists of two parts: the type of the token, which is JWT, and the hashing algorithm being used, such as HMAC SHA256 or RSA.
- For example:

```
{
  "alg": "HS256",
  "typ": "JWT"
}
```

- Then, this JSON is **Base64Url** encoded to form the first part of the JWT.

eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ.SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c

HMAC SHA256 vs RSA SHA256 hashing algorithms

- HMAC SHA256: Symmetric Key cryptography, single shared private key. Faster, good between trusted parties.
  - A combination of a hashing function and one (secret) key that is shared between the two parties used to generate the hash that will serve as the signature.

- RSA SHA256: Asymmetric Key cryptography, public/private keys. Slower, good between untrusted parties.
  - The identity provider has a private (secret) key used to generate the signature, and the consumer of the JWT gets a public key to validate the signature.

JWT Payload

- The second part of the token is the payload, which contains the claims.
- **Claims** are statements about an entity (typically, the user) and additional metadata. There are three types of claims:
  - *Reserved/Registered*
    - These are a set of predefined claims which are not mandatory but recommended, to provide a set of useful, interoperable claims. Some of them are: **`iss`** (issuer), **`exp`** (expiration time), **`sub`** (subject), **`aud`** (audience), and **`others`**.
  - *Public*
    - These can be defined at will by those using JWTs. But to avoid collisions they should be defined in the IANA JSON Web Token Registry or be defined as a URI that contains a collision resistant namespace.
  - *Private*
    - These are the custom claims created to share information between parties that agree on using them and are neither registered or public claims.

JWT Payload

- For example:

```
{
  "sub": "1234567890",
  "name": "John Doe",
  "iat": 1516239022
}
```

- The payload is then **Base64Url** encoded to form the second part of the JSON Web Token.

eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ.SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c

JWT Signature

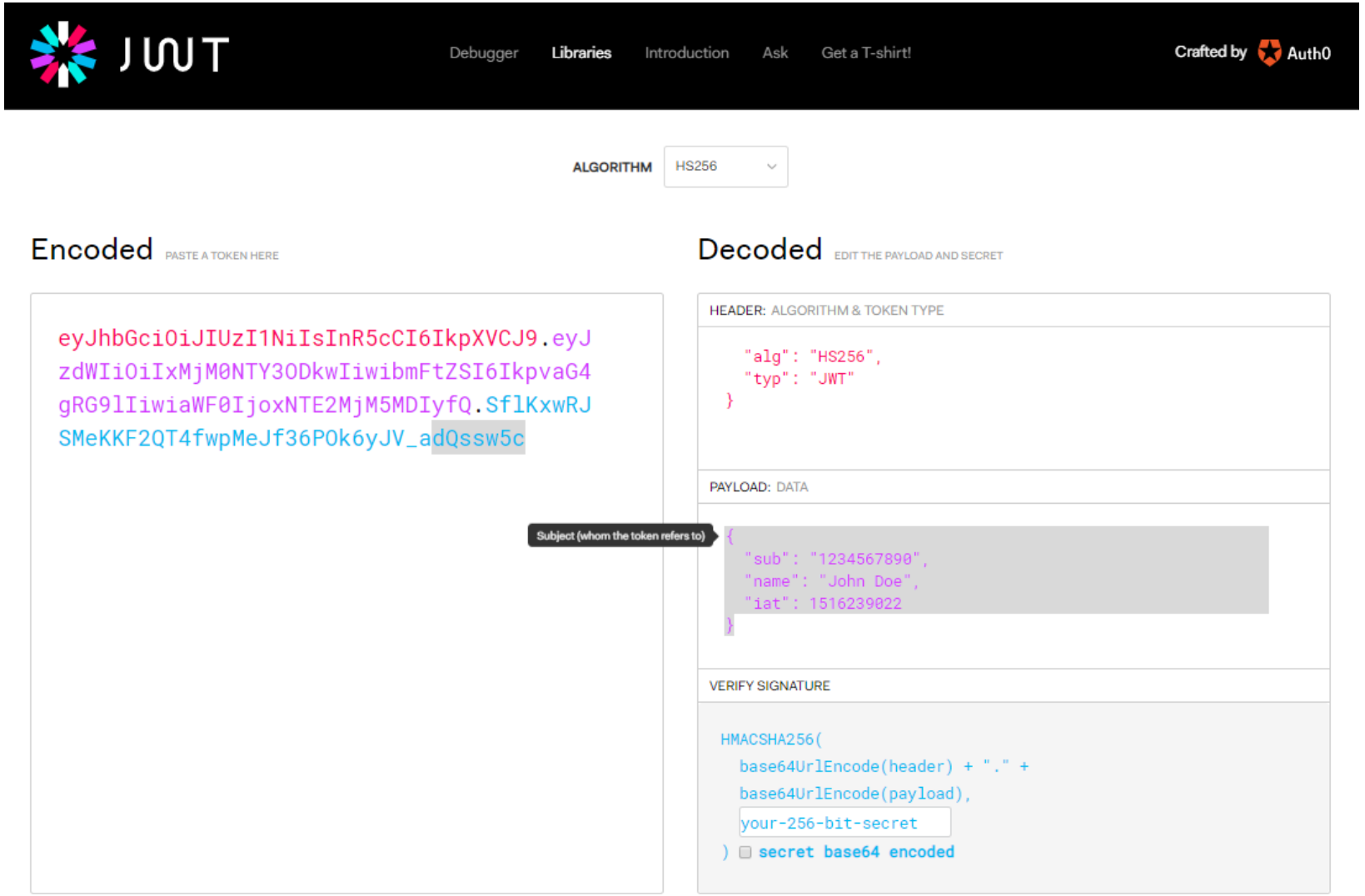
- To create the signature part you have to take the encoded header, the encoded payload, a secret, the algorithm specified in the header, and sign that.
- The signature is used to verify that the sender of the JWT is who it says it is and to ensure that the message wasn't changed along the way.
- For example if you want to use the HMAC SHA256 algorithm, the signature will be created in the following way:

```
HMACSHA256(
  base64UrlEncode(header) + "." +
  base64UrlEncode(payload),
  your-256-bit-secret
) ☐ secret base64 encoded
```

- eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4gRG9lIiwiaWF0IjoxNTE2MjM5MDIyfQ.SflKxwRJSMeKKF2QT4fwpMeJf36POk6yJV_adQssw5c

jwt.io

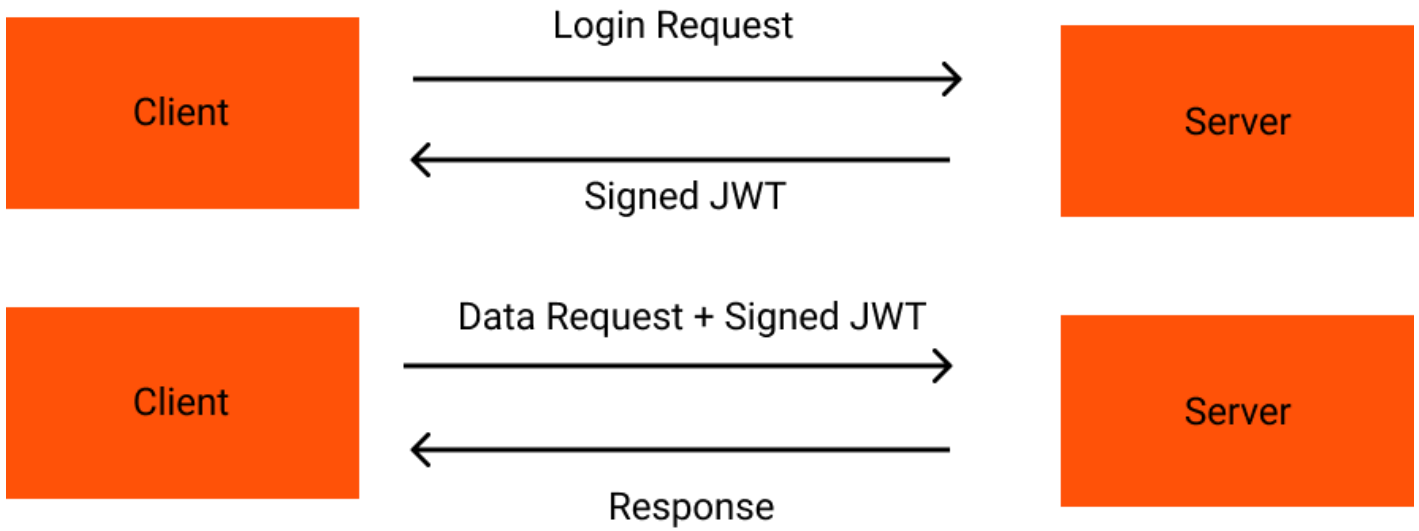
- JWT.IO allows you to decode, verify and generate JWT.



How does JWT work?

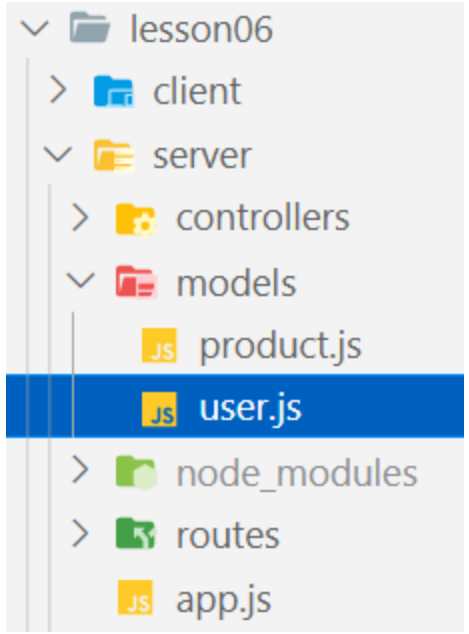
- In authentication, when the user successfully logs in using their credentials, a JSON Web Token will be returned and must be saved locally (typically in local storage, but cookies can be also used).
- Whenever the user wants to access a protected route or resource, the user agent should send the JWT, typically in the **Authorization** header using the **Bearer** schema. The content of the header should look like the following:

```
Authorization: Bearer <token>
```

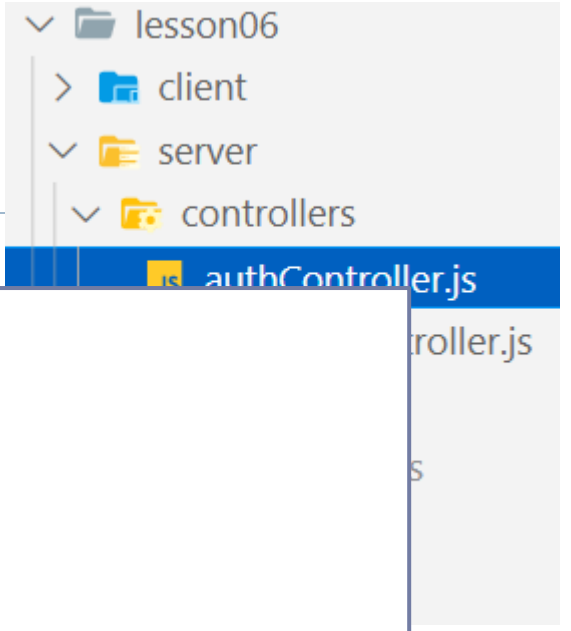


Auth Demo - Model

```
const mongoose = require('mongoose');
const { Schema } = mongoose;

const userSchema = new Schema({
    username: {
        type: String,
        unique: true
    },
    password: String,
    role: String
});

module.exports = mongoose.model('User', userSchema);
```



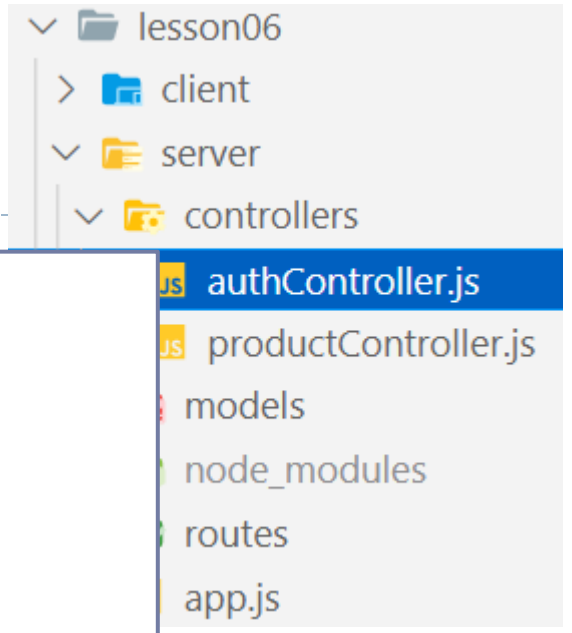
Auth Demo - Controller




```
const jwt = require('jsonwebtoken');
const User = require('../models/user');

const accessTokenSecret = 'MSD CS477';

exports.login = async (req, res, next) => {
    const user = await User.findOne({ username: req.body.username, password:
req.body.password });

    if (user) {
        const accessToken = jwt.sign({ username: user.username, role: user.role
}, accessTokenSecret);
        res.json({ accessToken });
    } else {
        res.status(401).json({ 'error': 'username or password is invalid' });
    }
}
```

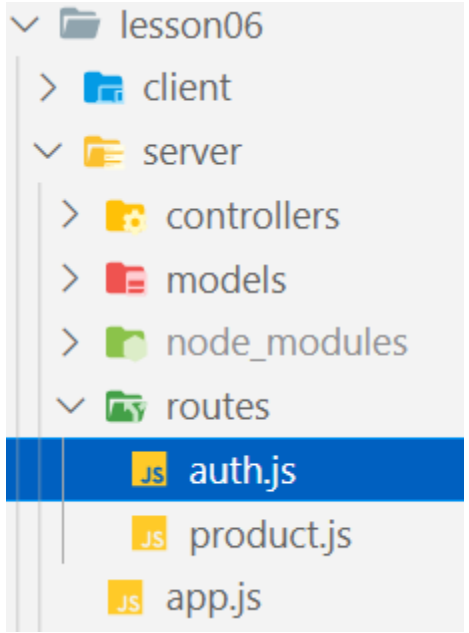
Auth Demo – Controller (Cont.)

```
exports.authorize = async (req, res, next) => {
    const authHeader = req.headers.authorization;
    if(authHeader) {
        const [, token] = authHeader.split(' ');
        jwt.verify(token, accessTokenSecret, (err, user) => {
            if(err){
                res.status(403).json({ 'error': 'Unauthorized' });
            } else {
                req.user = user;
                next();
            }
        })
    } else {
        res.status(401).json({ 'error': 'Please login' });
    }

}
```



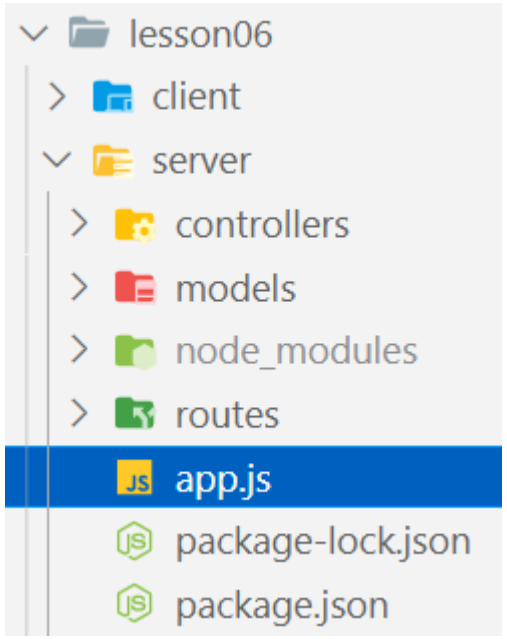
Auth Demo - Router

```
const express = require('express');
const authController = require('../controllers/authController');
const router = express.Router();

router.post('/login', authController.login);
router.use(authController.authorize);

module.exports = router;
```



Auth Demo – app.js

```
const authRouter = require('./routes/auth');


app.use(authRouter); //all urls access after authRouter needs JWT
app.use('/products', productRouter);
```



Resources

- https://stackabuse.com/authentication-and-authorization-with-jwts-in-express-js
- https://jwt.io/
- https://www.npmjs.com/package/jsonwebtoken