IERG 4210 Tutorial 08

Securing web page (II):

- In principle: Cookie related security issues

- In practice: Point by point checklist for Phase 4A

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Logistics

- Content for today:
  - Provide sample codes for most check points specified in Phase 4A.
  - Cover the principle interpretation of cookie related security issues (CSRF, session maintenance, authentication remember, etc.).
- This tutorial only provides one type of implementation.
  - There is no necessity to completely follow the tutorial if your think you are a strong student. Your creativity is strongly encouraged. A good usage of this tutorial tends to be like this: you only refer to the part where you cannot figure out.
  - If you choose to follow, then thinking while copying.
  - There might exist somewhere not suitable to your current project, you need to modify and debug yourself.
  - Please follow tutorial 8, if there exists differences between tutorial 7 and 8.
  - Logistics on submission (branch info and README) please refer to Page 18 of tutorial 7.

Project structure review

Better to do the modularizing, though a very long app.js also works.

- App/server.js: entry of project (other name needs specifying in package.json for eb's reference).
- Shop***.config.js: configuration for database connection, etc. (Optional)
- Public/ : contain client-side elements: css style sheets / image source / form handling javascript.
- Views/ : html templates if you use handlebars.
- Routes/ : server side node scripts under express routing.
- Node_modules/ : Your installed off-the-shelf packages, ignored by git.
- ***.sql : (Optional) better include this initial database generating script file so that TA is able to run your codes locally, maybe to do some modifications.

Task 5.1 Create user table

- Here password column refers to two elements: salt and salted password (or you can specify same salt for all users).
- In sample codes, there are two users: shopadmin (password: 123456) and shopcommon (password: 234567). (In your implementation please rename the username and password. Better use email add for username.)
- In sample codes each user is assigned a different salt. It is your choice whether using a unique salt throughout or do it like I do.
- This step has nothing to do with the project, but in the offline fashion. But you need your project configuration to generate the salt and salted password.

Task 5.1 Create user table

- Create databse: in mysql console type

```
CREATE DATABASE users;
```

- Write a simple script (put it anywhere existing node configure, e.g. the root directory of your project) foo.js:

→_→

- You need to npm install crypto package.
- You don’t need to submit this source file as source code.

foo.js

```
var crypto = require('crypto');

function hmacPassword (password)
{
var salt = 'as3qw4taegtgew5t4';
var hmac =
crypto.createHmac('sha256', salt);
console.log(salt); // zhu
hmac.update(password);
return hmac.digest('base64');
}

console.log(hmacPassword(‘123456'
))
```

Task 5.1 Create user table

- For each user, you just input different user plain text password and run it: node foo.js, to see the result: two lines, one for salt and one for salted password.
- How to generate salt? You can randomly generate using program, or a much simpler method: turn to random.org for salt generation.
- Now you can insert new user record:

```
CREATE TABLE `users` (
  `uid` int(11) NOT NULL AUTO_INCREMENT,
  `username` varchar(512) NOT NULL,
  `salt` varchar(512) NOT NULL,
  `saltedPassword` varchar(512) NOT NULL,
  `admin` int(1) DEFAULT NULL,
  PRIMARY KEY (`uid`)
) ENGINE=InnoDB AUTO_INCREMENT=3 DEFAULT CHARSET=utf8;
```

```
INSERT INTO `users` VALUES
(1,'shopadmin','as3qw4taegtgew5t4','
TqgwkZHcXmM+yt7zqRjxy5WBgeZEfp1Yq2ag
UI6ppwI=',1),(2,'shopcommon','asgfpe
gb34qwhehesbsb','
XFeZwHpF6nWyt/3DTZWQLj4pAc9wVf3puL76
gsG/nvg=',0);
```

Task 5.1 Create user table

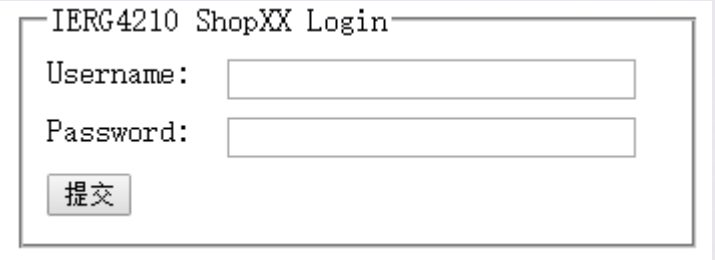
- Your users table in the database should look like this:

uid	username	salt	saltedPassword	admin
1	shopadmin	as3qw4taegtgew5t4	TqgwkZHcXmM+yt7zqRjxy5WBgeZEfp1Yq2agUI6ppwI=	1
2	shopcommon	asgfpegb34qwhehesbsb	XFeZwHpF6nWyt/3DTZWQLj4pAc9wVf3puL76gsG/nvg=	0

- Do not directly copy my salt and password. Otherwise -> you might face troubles!
- If you want to add features like changing password via email in the future, I suggest that you force the username to be the email address (which coincidence with the lecture notes), and the username type becomes ‘email’ (next page).
- Suggest to restrict the username or email to be unique.

Task 5.2 login page

- Create a new html template in views/: You may name it as login.handlebars. Do some decoration.
- Make sure it has a form containing username input (or email add input) and plaintext password input, and the submit button.
- The simplest views looks like this:



- It seems the submit button does not need to implement on your own. Why?
- Hints: `<div><input type="submit" /></div>` is enough for the button.
- Similarly, use `type="text" / "email"` and `type="password"` .

Task 5.2 login page

- Client side input validation, for user friendliness purpose.
- For example, if you want the password only matches such pattern: maximum length 512, only contain digits ranged between 20 to 10,000,000 (occurrence between 6 and 512)
- You can use:

```
<div><input type="password" name="password" required maxlength="512"
pattern="^[\x20-\x7E]{6,512}$" title="Invalid Password" /></div>
```

- Notice the regexp, refer to http://www.w3schools.com/jsref/jsref_obj_regexp.asp
- Similarly for the username (which could contain word besides digits), you can use: `pattern="^[\w- ']{4,512}$"`

Task 5.2 login page

- You can change the pattern as you like, e.g. also permit word characters in password. (pure digit password could be hacked with brute-force)
- The most important prevent of SQL injection is actually the prepare statement, demonstrated later.
- Now comes the exciting part: form action.
- `<form method="POST" action="api/login"> … </form>`
- You need to use POST as method instead of GET, since this submission contains sensitive info (password) and should be transparent to users.
- We need to implement the action function.
- By the way do you know how to handle form submission in the express framework?

Task 5.2 login, server side action function

- Under this framework, server side action function are implemented and stored in the routes/ directory.
- Inside the functions are grouped like this:

```
// Global variables:
Var config = require(…), …;
// Global functions:
Function hmacPassword(…) {
        …
}
// functions for actions
Module.exports(pool, path) {
        var app = express.Router();
        app.use(…) / get(…) / post(…) {
                …
        }
```

Task 5.2 login, server side action function

- As we are developing login authentication functionality, we create a new file auth.api.js (or anything else you like).

Auth.api.js

```
// TODO: require your needed packages, define your
global functions (e.g. hmacPassword) here.
// functions for actions
Module.exports(pool, path) {
        var app = express.Router();
        app.post('/api/login',function (req,res){
                // TODO:
                // 1. Input validation / sanitization
                // 2. Quit if input invalid
                // 3. Quiry database with prepare …
                        // 3.1 if error , then …
                        // 3.2 if no record, then …
                        // 3.3 if OK, then …
        });
}
```

Your form action addr.

```
req.checkBody('username', 'Invalid
Username').
isLength(4, 512)
.matches(Your regexp);

req.checkBody('password', 'Invalid
Password').
isLength(6, 512)
.matches(Your regexp);
```

Express-validator package required

```
if (req.validationErrors()) {
        return
        res.status(400).json({'Invalid
Input': req.validationErrors()}).end();
}
```

Task 5.2 login, server side action function

- Query the database with prepare statement (to avoid SQL injection).

```
function hmacPassword (password,salt) {
        var hmac = crypto.createHmac('sha256', salt);
       //console.log(salt); // zhu
        hmac.update(password);
        return hmac.digest('base64');
}
// 3. Quiry database with prepare statement
// Please note the codes posted on the lecture notes
7 Page 27 only uses one single salt for all users,
which is different from my implementation.
// Sample codes see next page.
```

- Routes with /admin prefix(before /api/login), check this issue if a bug arises.
- Note it is only a part of this source file, we need to add more in later development.

Task 5.2 login, server side action function

```
pool.query('SELECT * FROM users WHERE username = ? LIMIT 1',
                        [req.body.username],
                        function (error, result) {
                                if (error) {
                                        console.error(error);
                                        return res.status(500).json({'dbError': 'check server log'}).end();
                                }

                                var submitedSaltedPassword = hmacPassword(req.body.password,result.rows[0].salt);

                                //console.log(submitedSaltedPassword); //I made a mistake here and this is how to debug
                                //console.log(result.rows[0].saltedPassword); // Output in the right position.

                                // Didn't pass the credential.
                                if (result.rowCount === 0 || result.rows[0].saltedPassword != submitedSaltedPassword) {
                                        return res.status(400).json({'loginError': 'Invalid Credentials'}).end();
                                }

                                req.session.regenerate(function(err) {
                                     //The purpose for these parts of codes would be covered later.
                                        req.session.username = req.body.username;
                                        req.session.admin = result.rows[0].admin;
                                        res.status(200).json({'loginOK': 1}).end();
                                });
                        }
                );
```

Task 5.2 login, server side action function

- Have we finished? NO. You can even not able to access the login page.
- Let's have a look at how the project runs, and how the login source script takes effect in the project.

App.js

```
var app = express();
app.engine('handlebars', exphbs({defaultLayout: 'main'}));
app.set('view engine', 'handlebars');

// serve static files from the public folder
app.use(express.static('public'));

// for parsing application/x-www-form-urlencoded
app.use('/admin/api', bodyParser.urlencoded({extended:true}));
// this line must be immediately after express.bodyParser()!
// Reference: https://www.npmjs.com/package/express-validator
app.use('/admin/api', expressValidator());

// authentication routers run really first
app.use('/admin', authAPIRouter(dbPool));

// backend routers run first
app.use('/admin/api', backEndAPIRouter(dbPool));
app.use('/admin', backEndRouter(dbPool));

// frontend router runs last
app.use('/', frontEndRouter(dbPool));
```

Task 5.2 login, server side action function

- Usually if someone wants to access the admin page, he always inputs /admin instead of /admin/login.
- As stated before, we cannot access the login page before credential validation.
- Hence, we need to redirect unauthorized admin page, and always render the login page at initial state, and authentication failure state.

Auth.api.js

```
…
Module.exports = function (pool, path) {
        var app = express.Router();
        console.log('login:A');
        // TODO: path add prefix '/admin'
        // TODO: use session (discussed later)

        app.get('/login', function (req, res) {
                // TODO: render login page
                console.log('login:B');
        });
        app.post('/api/login', function (req, res) {
                console.log('login:C');
                // TODO: I have shown in Page 12-14
        });
        app.use('/', function (req, res, next) {
                console.log('login:D');
                // TODO: if OK, then next route (admin)
                // otherwise back to the login page
        });
}
```

Covered later.

Do it yourself.

Covered later.

Task 5.2 login, server side action function

- Notice the console output ABCD, can you guess what would be outputted at each of following moment in the procedure:
- You just node app.js? Output: login:A
- You visit /admin? Output: login:D and login:B
- You refresh the page? Output: login:B
- You type in with a wrong credential? Output: login:C and login:B
- You then type in the correct one? Output: login:C and login:D
- Why?

Task 5.3 Session management

- Actually your authentication is recorded via the session management.
- Hence, your login implementation involves session management.
- Also in order to remember authentication, we apply cookie manipulation.
- Since we are using the express-session framework, I would like to recommend you have a deep reading on the documentation https://github.com/expressjs/session
- Answers are mostly covered in the documentation.

Task 5.3 session management

- Session handler configuration.

```
app.use(session({
        name: // set your cookie name
        secret: // similar to how you generate salt
        resave: false,
        saveUninitialized: false,
        cookie: { path: path, maxAge: 1000*60*60*24*3,
httpOnly: true }
})
```

- In page 14, after authenticating the credential (correct case), we store the info in session object, which would be used when redirect to the admin page.
- The regenerate function is to avoid session fixation vulnerability. (Always change session id when reach credential validation part)

Task 5.4 Validate the token

- Steps in 5.3 only validate the credential (which earns a session token), but we haven't validate the token itself. Maybe the token isn't desired by the current user.
- In page 16, the last part of the code -> where we do the token validation.

```
app.use('/', function (req, res, next) {
        if (req.session && req.session.admin)
                return next();
        return req.xhr ?
res.status(400).json({'loginError': 'Session
Expired'}).end() : res.redirect('/admin/login');
}); // This defines a response to the /admin request.
// next: You have implement another routes response
for /admin in Phase 3. Here 'next' just calls for
that function (implemented in backend.js).
// Hence the running order defined in app.js (Page 15)
is rather crucial.
```

Task 5.5 log out feature

- If everything goes smoothly, you should now be able to login to see your lovely admin page again!
- Congrats!
- Idea of implementing the logout feature: (suppose happened in admin page)
- In admin page, add a form (e.g. only a button), whose action function is defined in another routes, called /admin/logout.
- Implement the action function, destroy the session and redirect to the /admin/login page function (the one do the login page render work).
- You may want to refer to the express-session documentation to find how to destroy session.

Task 1-4

- For task 1-4, first you need to do a global check and modification on your project.
- Task 1: (Non-specific check) **ALL** input form content restriction, server side content sanitization.
- Task 2: Put **ALL** sql query into prepare statement.
- Task 3: Apply the csurf package, covered in next page. Better first read the documentation: https://www.npmjs.com/package/csurf
- Task 4: Avoid global variable. More precisely, all user-specific data must not appear in global variables.
  - Specifically be careful in function, don't miss 'var', otherwise becomes global.

Task 3 Preventing CSRF using csurf

- For all the form – action function pair, this involves two changes.
- In the form, add a new line for receiving the hidden nonce from server:

```
<input type="hidden" name="_csrf" value="{{csrfToken}}">
```

- When submitting the form, the received hidden nonce are also submitted.
- In the action function, two functions are involved:
  - The one do the render work, add a new csrf object as function param, and inside the function, pass it to the handlebar: `res.render('send', { csrfToken: req.csrfToken() })`
  - The one do the credential validation, add a new csrf object as function param to receive the nonce. The checking process is automatically done by the package.

Task 1 Context-dependent output sanitization

- One more thing, besides some general checking on each form and server side sanitization, you also need to perform context-dependent sanitization.
- You don’t need to do the actual implementation since packages have been there for you.
- Do some slight modification, e.g. the way to require package, to achieve this goal.

Interactive Q&A session for phase 4A

- Thanks you!