Izveštaj rađen za stručni kurs ,,Razvoj bezbednog softvera”

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Uvod

Projekat se izvodi na aplikaciji Real Book Store koja pruža mogućnosti pretrage, ocenjivanja i komentarisanja knjiga.

Aplikacija RealBookStore omogućava sledeće:

Pregled i pretragu knjiga.

Dodavanje nove knjige.

Detaljan pregleda knjige kao i komentarisanje i ocenjivanje knjige.

Pregled korisnika aplikacije

Detaljan pregled podataka korisnika

Primena alata za statičku analizu

Analiza je izvršena korišćenjem SonarQube alata.
Rezultati su sledeći:

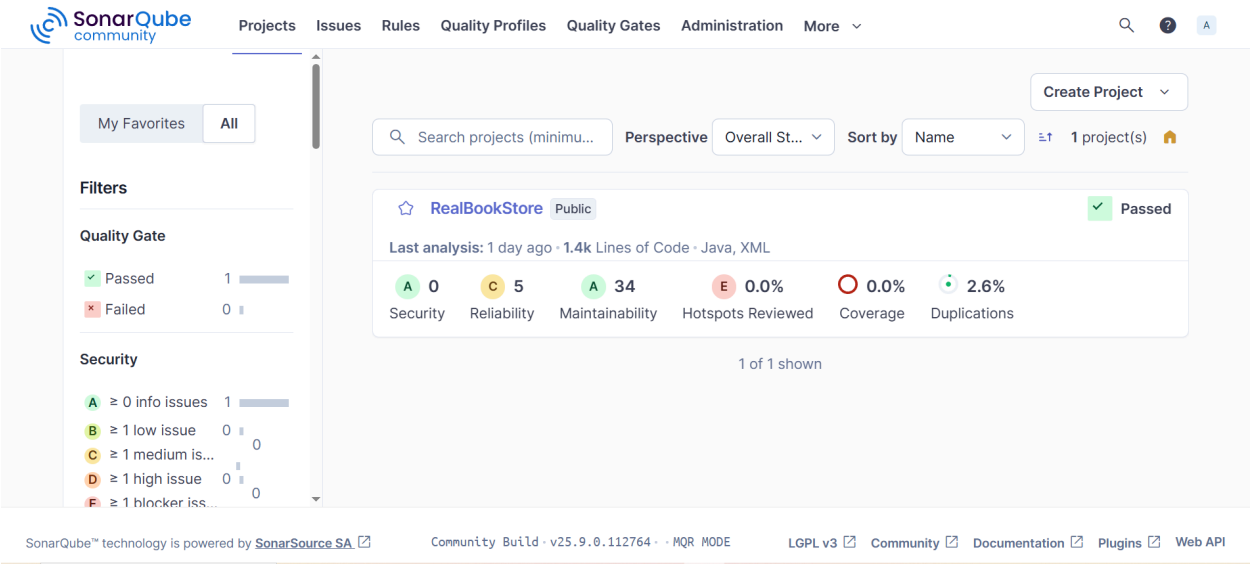
- **Security issues:** 0
- **Security Hotspots:** 0
- **Reliability issues:** 5

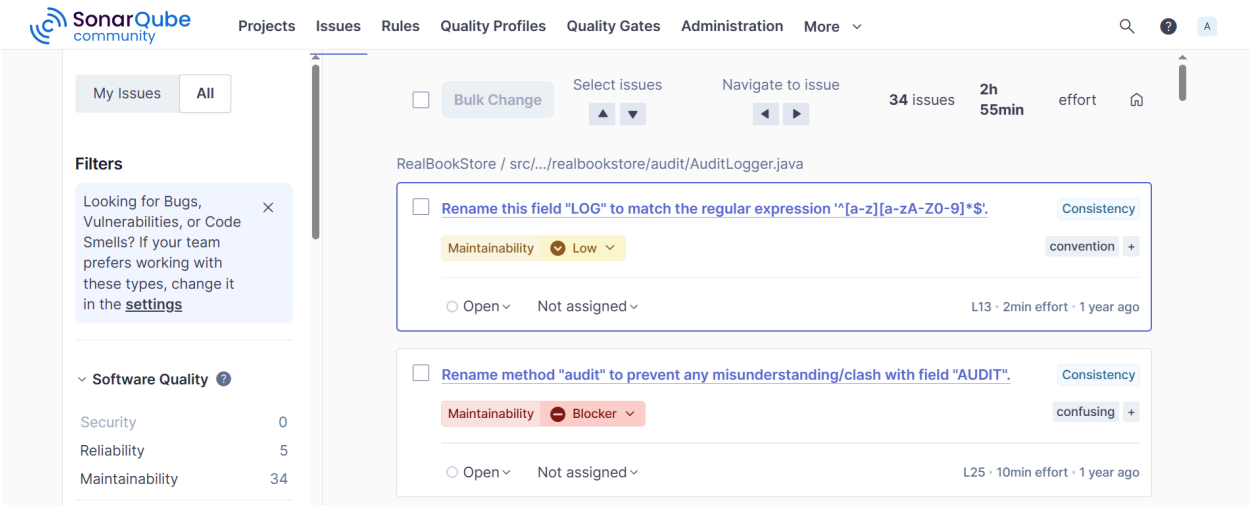
- **Maintainability issues (code smells):** 34

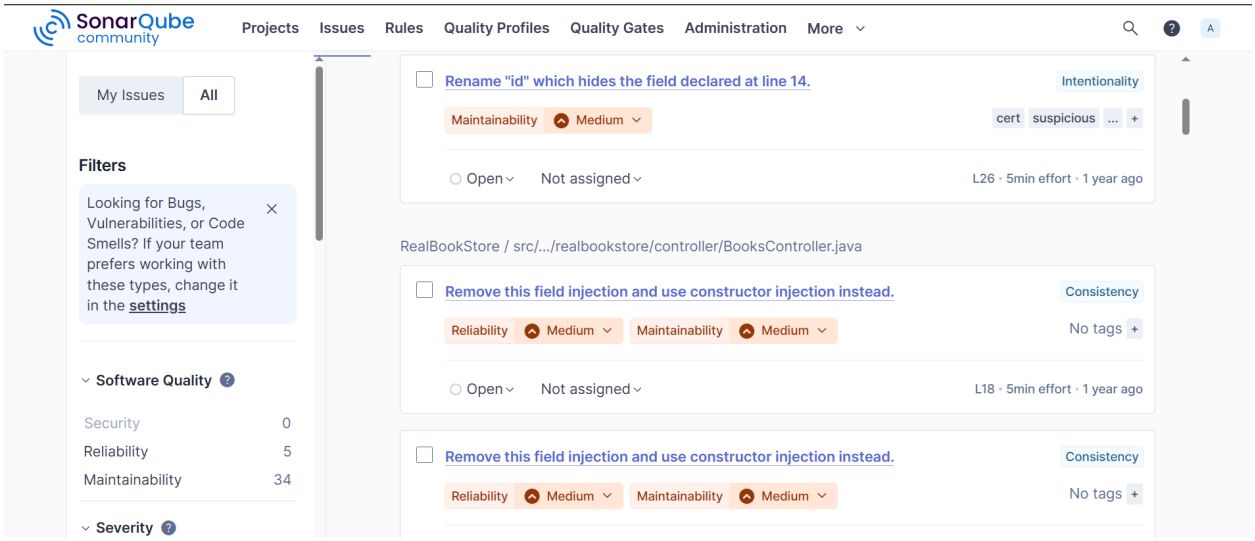
Primeri detektovanih problema:

1. **AuditLogger.java:13**
    - Problem: *Rename this field "LOG" to match the regular expression*
    - Tip: Maintainability (Low)
    - Ocena: False Positive (nema uticaja na sigurnost, samo konvencija imena)
2. **AuditLogger.java:25**
    - Problem: *Rename method "audit" to prevent clash with field "AUDIT"*
    - Tip: Maintainability (Blocker)
    - Ocena: True Positive (može zbuniti developere i izazvati bug)
3. **BooksController.java:18**
    - Problem: *Remove this field injection and use constructor injection instead*
    - Tip: Reliability & Maintainability (Medium)
    - Ocena: True Positive (injection može dovesti do problema pri testiranju)
4. **SomeClass.java:85**
    - Problem: *Replace Stream.collect(Collectors.toList()) with Stream.toList()*
    - Tip: Maintainability (Medium)
    - Ocena: False Positive (stari način i dalje funkcioniše, nije sigurnosni propust)

Na osnovu ovih rezultata zaključujemo da u kodu nisu pronađene sigurnosne ranjivosti, već samo problemi čitljivosti i održavanja.






SonarQube community
Projects
Issues
Rules
Quality Profiles
Quality Gates
Administration
More
My Issues
All
Filters
Looking for Bugs, Vulnerabilities, or Code Smells? If your team prefers working with these types, change it in the settings
Software Quality
Security 0
Reliability 5
Maintainability 34
Severity
Rename "id" which hides the field declared at line 14.
Intentionality
Maintainability Medium
cert suspicious ... +
Open
Not assigned
L26 • 5min effort • 1 year ago
RealBookStore / src/.../realbookstore/controller/BooksController.java
Remove this field injection and use constructor injection instead.
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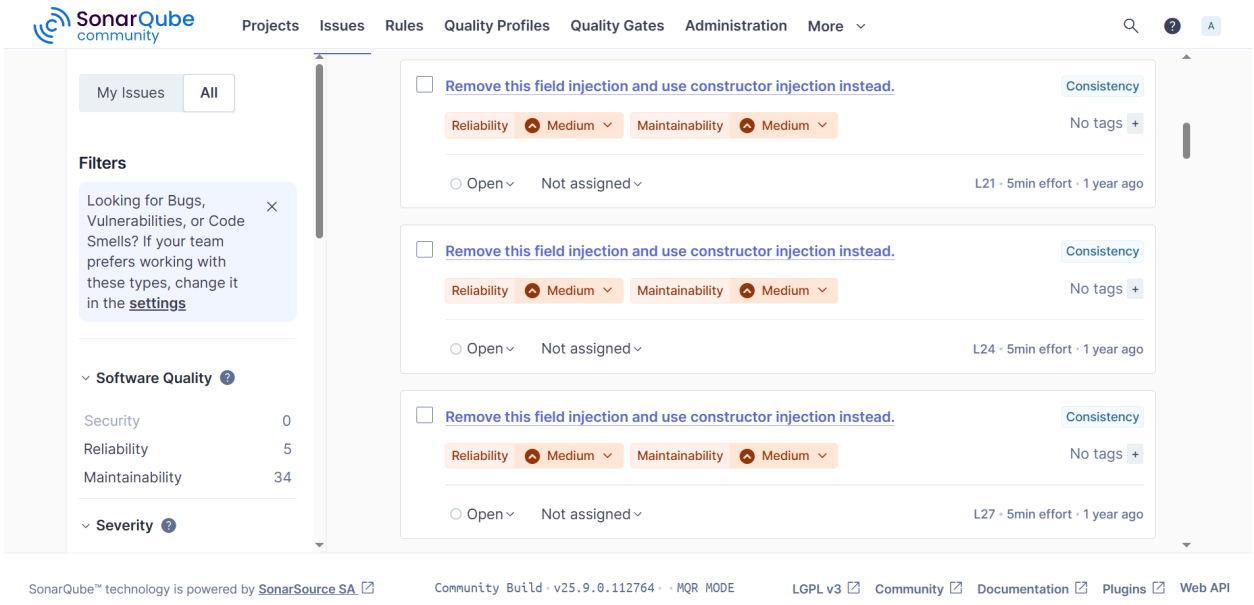
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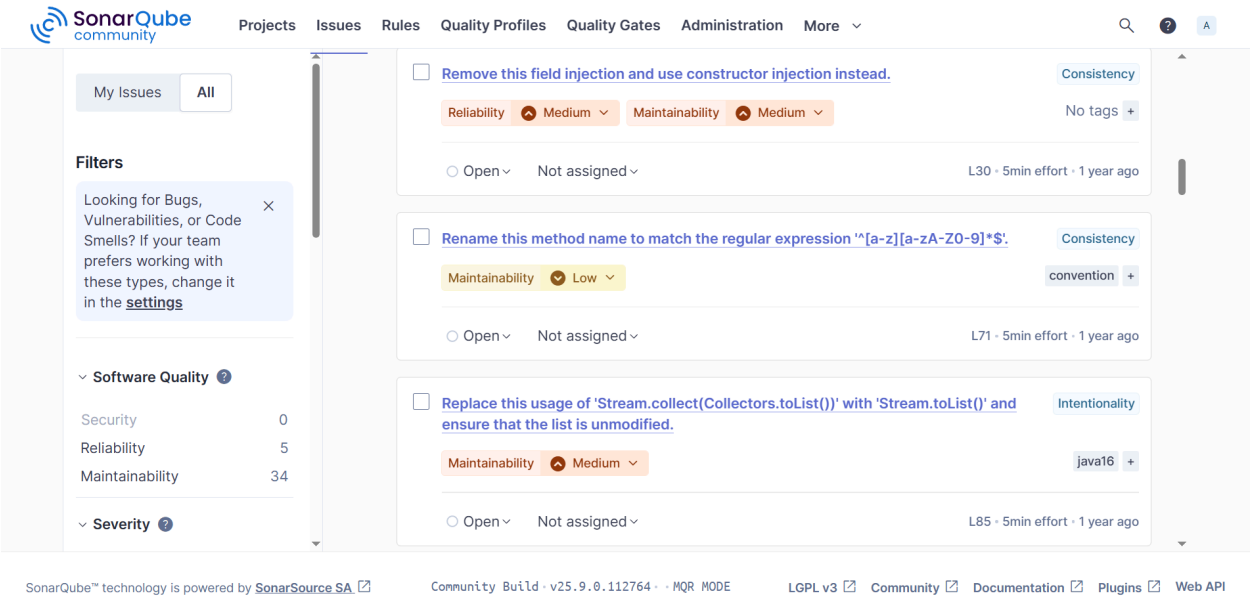
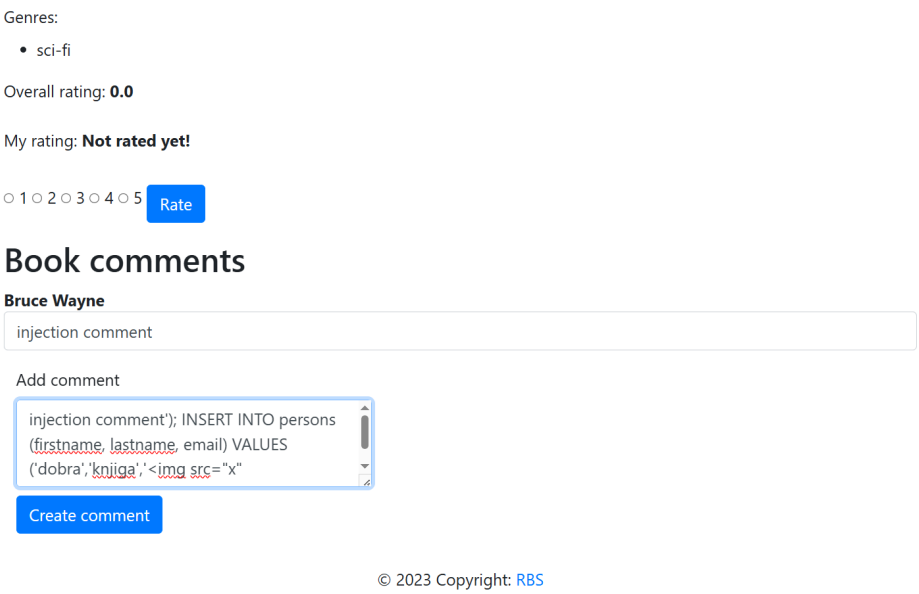


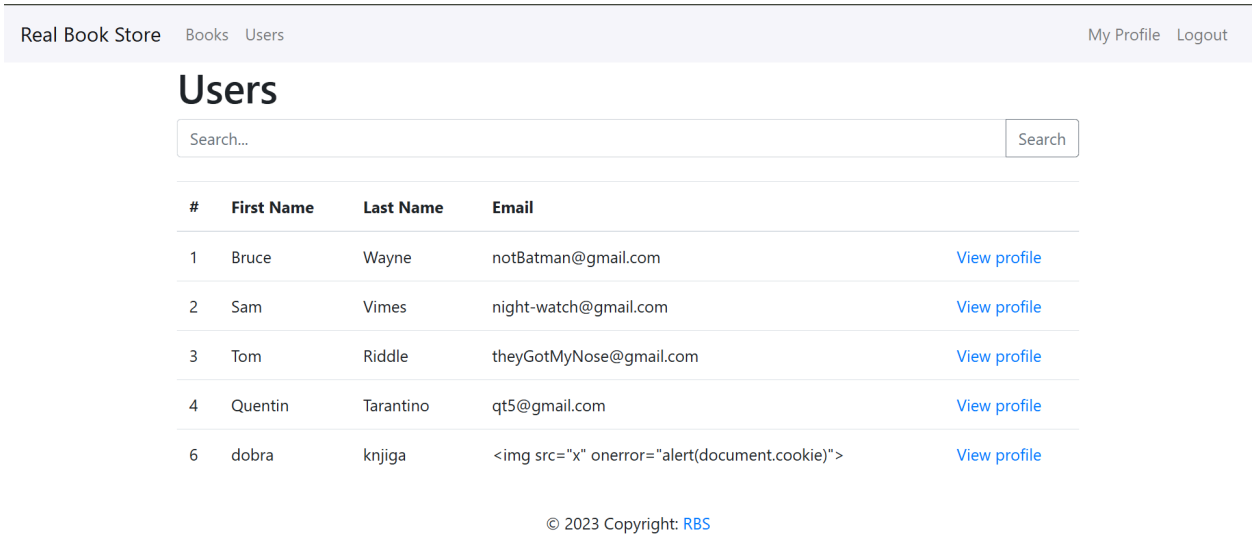
SQL Injection i Cross-site scripting

Na stranici za komentarisanje knjiga (`/books/{id}`) pronađena je ranjivost koja omogućava SQL Injection.

U polje za unos komentara ubačen je sledeći payload:

injection comment'); INSERT INTO persons (firstname, lastname, email) VALUES ('milica','sopalovic','<img src="x" onerror="alert(document.cookie)">'); –



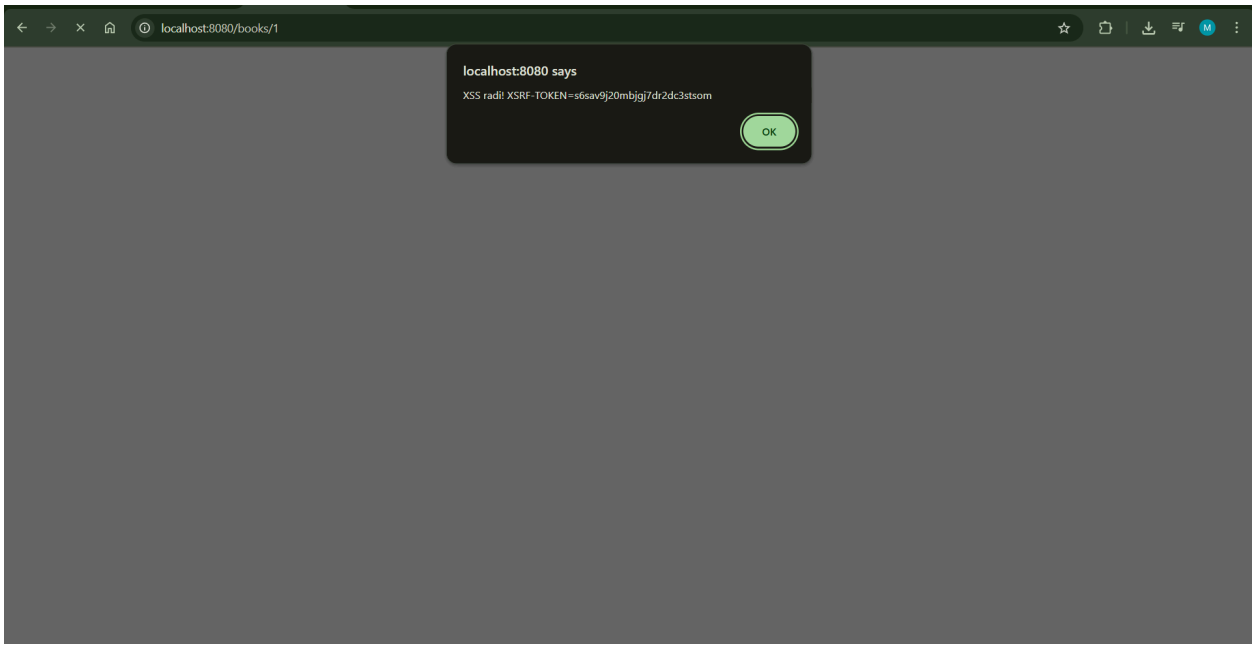


Ovime je ubačen novi korisnik u tabelu `persons`.
Na stranici **Users (persons.html)** korisnik se zatim pojavljuje sa malicioznim e-mail atributom, koji pri učitavanju pokreće **XSS skriptu** i ispisuje kolačiće sesije u konzoli.

Dokaz uspešnog napada:

- novi korisnik se vidi u tabeli (dobra knjiga)

- u **developer tools konzoli** ispisan je sadržaj `XSRF-TOKEN`.
- na alert prozoru pojavio se tekst `"XSS radi! TOKEN=..."`



Predlog odbrane:
Implementirati čuvanje komentara koristeći **PreparedStatement** umesto običnog **Statement**, čime se onemogućava ubacivanje proizvoljnog SQL koda (SQL Injection).

Umesto koda (ranjiva implementacija):

```
public void create(Comment comment) {
    String query = "insert into comments(bookId, userId, comment) values ("
        + comment.getBookId() + ", "
        + comment.getUserId() + ", '"
        + comment.getComment() + "')";
    try (Connection connection = dataSource.getConnection()) {
        Statement statement = connection.createStatement();
        statement.execute(query);
    } catch (SQLException e) {
        e.printStackTrace();
    }
}
```

Potrebno je koristiti sledeću implementaciju (bezbedna verzija):

```
public void create(Comment comment) {
    String query = "insert into comments(bookId, userId, comment) values (?, ?, ?
    try (Connection connection = dataSource.getConnection()) {
        PreparedStatement preparedStatement = connection.prepareStatement(query);
        preparedStatement.setInt(1, comment.getBookId());
        preparedStatement.setInt(2, comment.getUserId());
        preparedStatement.setString(3, comment.getComment());
        preparedStatement.executeUpdate();
    } catch (SQLException e) {
        e.printStackTrace();
    }
}
```

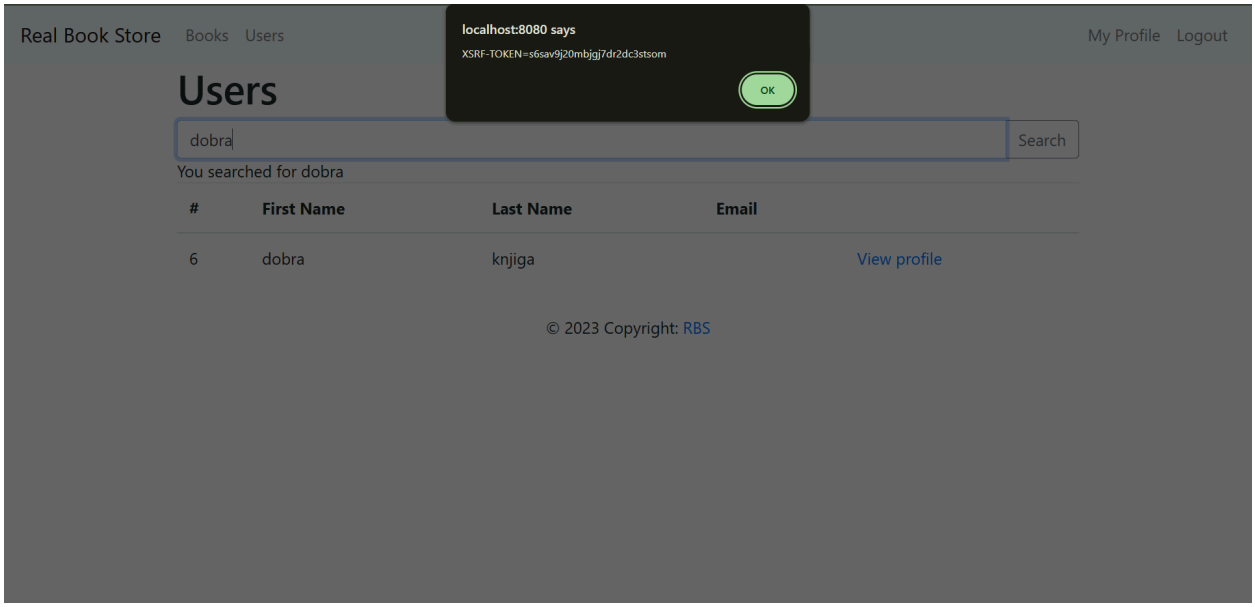
Razlika je u tome što se u PreparedStatement vrednosti prosleđuju kroz metode (`setInt`, `setString`) i tretiraju se kao obični podaci, a ne kao deo SQL upita. Na taj način napadač ne može da „ubaci“ dodatne SQL komande kroz polje komentara.

Napad: Prikazivanje kolačića korisnika

Metod napada:
Na stranici *Persons* aplikacije postoji ranjivost koja omogućava XSS napad.
U polje za e-mail (koje se puni kroz SQL injection) ubacili smo sledeći payload:

<img src="x" onerror="alert(document.cookie)">

Nakon što se izvrši pretraga korisnika, pregledač interpretira HTML i pokreće `alert` sa vrednošću kolačića sesije, što potvrđuje uspešan XSS napad.



Predlog odbrane:

Kako bi se sprečila injekcija HTML/JavaScript koda, potrebno je da se prilikom prikazivanja vrednosti u tabeli ne koristi `innerHTML`, već `textContent`. Na taj način se uneti sadržaj tretira isključivo kao tekst, a ne kao izvršiv kod.

Umesto koda:

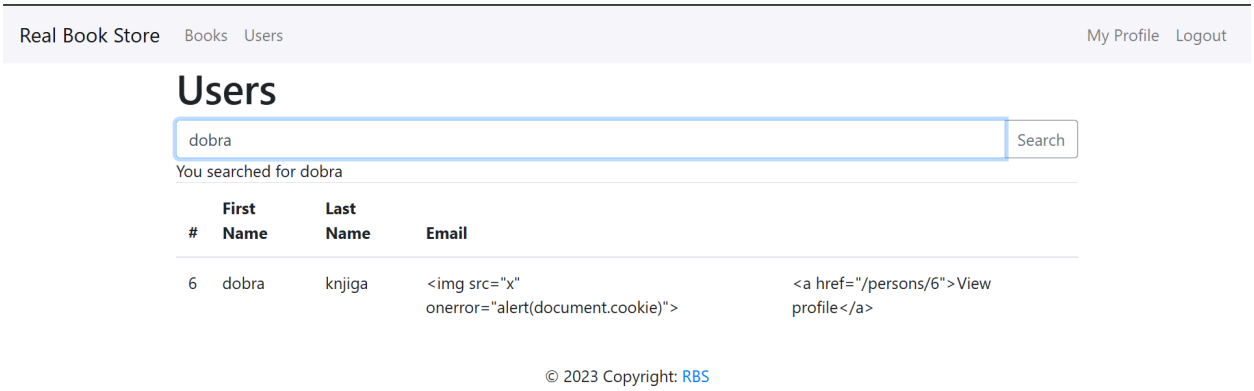
tdElement.innerHTML = person.email; itd

Potrebno je koristiti:

```
persons.forEach(function(person) {
    const tableRowElement = document.createElement(
    let tdElement = document.createElement("td");
    tdElement.textContent = person.id;
    tableRowElement.appendChild(tdElement);
    tdElement = document.createElement("td");
    tdElement.textContent = person.firstName;
    tableRowElement.appendChild(tdElement);
    tdElement = document.createElement("td");
    tdElement.textContent = person.lastName;
    tableRowElement.appendChild(tdElement);
    tdElement = document.createElement("td");
    tdElement.textContent = person.email;
    tableRowElement.appendChild(tdElement);
    tdElement = document.createElement("td");
    tdElement.textContent = '<a href="/persons/' +
    tableRowElement.appendChild(tdElement);

    tableContent.appendChild(tableRowElement);
});

document.getElementById('searchContainer').classNam
document.getElementById('searchTerm').textContent =
```



Nakon što je izvršena izmena koda (zamena `innerHTML` sa `textContent`), pokušaj XSS napada sa unosom `<img src=x onerror="alert(document.cookie)">` više se ne izvršava. Kod se sada prikazuje samo kao običan tekst, bez pokretanja JavaScript-a. Time je ranjivost uspešno uklonjena, a funkcionalnost aplikacije je ostala nepromenjena.

Cross-Site Request Forgery (CSRF)

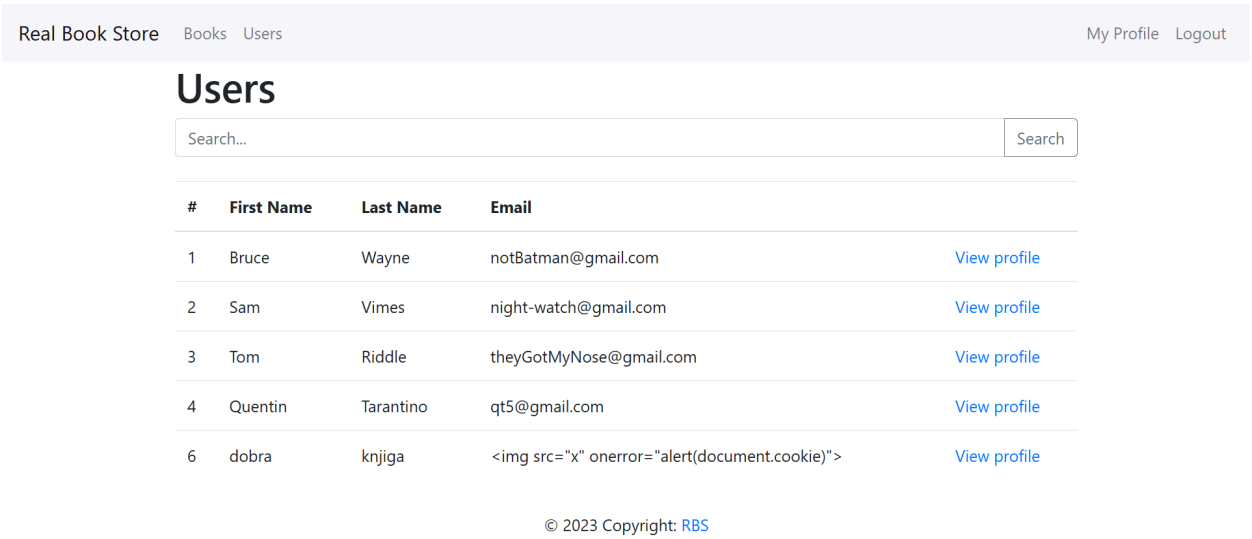
Napad

Aplikacija u početnoj verziji nije imala nikakvu zaštitu od CSRF napada. To znači da je bilo moguće izvršiti **neautorizovane promene podataka** tako što bi korisnik, dok je ulogovan, bio prevaren da klikne na stranicu koja u pozadini šalje zahtev prema aplikaciji.

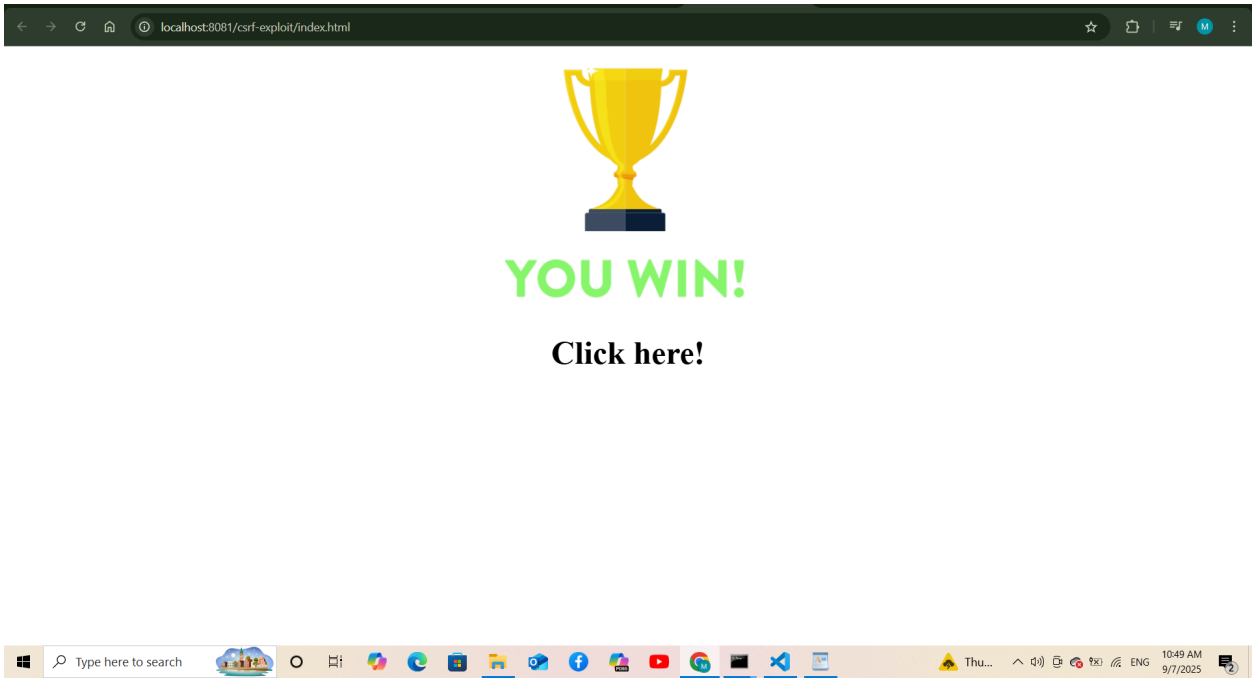
Za demonstraciju je iskorišćen folder `csrf-exploit` u okviru projekta. Unutar fajla `index.html` nalazi se skripta sa funkcijom `exploit()`, koja prilikom klika na element *"Click here!"* šalje **POST zahtev** ka endpointu `/update-person` iz klase `PersonsController.java`.
U zahtevu se prosleđuju parametri:

- `id = 1`
- `firstName = "Batman"`
- `lastName = "Dark Knight"`

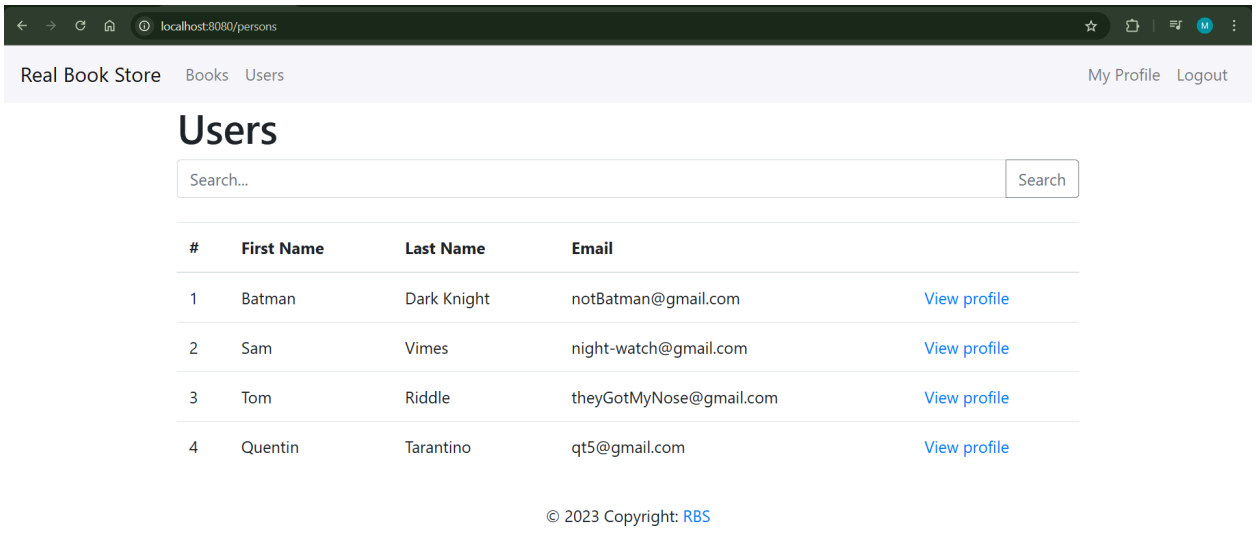
Users tabela (pre napada) korisnik sa `id=1` ima vrednosti Bruce Wayne:



CSRF exploit stranica prikazan je izgled lažne stranice sa porukom "You Win!":



Users tabela (posle napada) isti korisnik je promenjen u *Batman Dark Knight*, što potvrđuje uspešan CSRF napad.



Odbrana

Odbrana je implementirana korišćenjem **CSRF tokena** koji se generiše i čuva u sesiji svakog korisnika (`CsrfHttpSessionListener`).

- U metodama `GET /persons/{id}` i `/myprofile` token se dodaje u **model** i zatim u formu kroz hidden input:

<input type="hidden" name="csrfToken" th:value="${CSRF_TOKEN}">

Mehanizam:

```
@GetMapping("/persons/{id}")
@PreAuthorize("hasAuthority('VIEW_PERSON')")
public String person(@PathVariable int id, Model model, HttpSession session) {
    model.addAttribute("CSRF_TOKEN", session.getAttribute("CSRF_TOKEN"));
    model.addAttribute("person", personRepository.get("" + id));
    return "person";
}
```

```
@PostMapping("/update-person")
@PreAuthorize("hasAuthority('UPDATE_PERSON')")
public String updatePerson(Person person, HttpSession session, @RequestParam("csrfToken") String csrfToken) throws AccessDeniedExceptior
    String csrf = session.getAttribute("CSRF_TOKEN").toString();
    System.out.println(csrf + " " + csrfToken + "kraj");
    if (!csrf.equals(csrfToken)) {
        throw new AccessDeniedException("Forbidden");
    }
    Authentication authentication = SecurityContextHolder.getContext().getAuthentication();
    String username = authentication.getName();
    System.out.println(username + " " + person.getFirstName());

    if(!username.equalsIgnoreCase(person.getFirstName())){
        throw new AccessDeniedException("Forbidden");
    }
    personRepository.update(person);
    return "redirect:/persons/" + person.getId();
}
```

Napad vise nijeuspesan :)

```
Live reload enabled.                                          index.html:53
Access to fetch at 'http://localhost:8080/update-person'      index.html:1
from origin 'http://localhost:8081' has been blocked by CORS policy: No
'Access-Control-Allow-Origin' header is present on the requested
resource.
Failed to load resource: net::ERR_FAILED          :8080/update-person:1
Uncaught (in promise) TypeError: Failed to fetch      index.html:20
    at exploit (index.html:20:17)
```

Autorizacija

Autorizaciju sam uradila pomoću Spring Security-ja i metodskih anotacija `@PreAuthorize`, a zaštitu od CSRF-a sam dodala tokenom koji se čuva u sesiji i šalje kroz formu. Da bi metodska autorizacija radila, u klasi bezbednosne konfiguracije uključila sam `@EnableMethodSecurity`.

Permisije su primenjene kroz `@PreAuthorize` na kontrolerskim metodama, u skladu sa tabelom zadatka:

- **VIEW_PERSON** – pregled detalja osobe:

```
@GetMapping("/persons/{id}")
@PreAuthorize("hasAuthority('VIEW_PERSON')")
public String person(@PathVariable int id, Model model, HttpSession session) {
    model.addAttribute("CSRF_TOKEN", session.getAttribute("CSRF_TOKEN"));
    model.addAttribute("person", personRepository.get("" + id));
    return "person";
}
```

VIEW_MY_PROFILE – pregled sopstvenog profila:

```
@GetMapping("/myprofile")
@PreAuthorize("hasAuthority('VIEW_MY_PROFILE')")
public String self(Model model, Authentication authentication, HttpSession session) {
    String csrf = session.getAttribute("CSRF_TOKEN").toString();
    model.addAttribute("CSRF_TOKEN", session.getAttribute("CSRF_TOKEN"));
    User user = (User) authentication.getPrincipal();
    model.addAttribute("person", personRepository.get("" + user.getId()));
    return "person";
}
```

UPDATE_PERSON – izmena detalja osobe (isto važi i za brisanje):

```java
@PostMapping("/update-person")
@PreAuthorize("hasAuthority('UPDATE_PERSON')")
public String updatePerson(Person person, HttpSession session, @RequestParam("csrfToken") String csrfToken) throws AccessDeniedExceptior
    String csrf = session.getAttribute("CSRF_TOKEN").toString();
    System.out.println(csrf + " " + csrfToken + "kraj");
    if (!csrf.equals(csrfToken)) {
        throw new AccessDeniedException("Forbidden");
    }
    Authentication authentication = SecurityContextHolder.getContext().getAuthentication();
    String username = authentication.getName();
    System.out.println(username + " " + person.getFirstName());

    if(!username.equalsIgnoreCase(person.getFirstName())){
        throw new AccessDeniedException("Forbidden");
    }
    personRepository.update(person);
    return "redirect:/persons/" + person.getId();
}
```

U klasi `WebSecurityConfig` omogućen je mehanizam metodske bezbednosti:

```java
@Configuration
@EnableWebSecurity
@EnableMethodSecurity
```

DevOps

U okviru projekta izvršena je izmena svih mesta gde se koristio `printStackTrace()` tako da se greške sada loguju pomoću SLF4J logera. Na ovaj način obezbeđeno je centralizovano i čitljivije praćenje grešaka, kao i lakša dijagnostika problema u produkcionom okruženju.

Umesto dosadašnjeg:

```
catch (SQLException e) {

    e.printStackTrace();

}
```

Sada se koristi:

```
catch (SQLException e) {

    LOG.error("Greška pri izvršavanju upita.", e);
```

}

Na ovaj način stack trace se i dalje beleži, ali kroz standardizovan logger sistem, što omogućava filtriranje, čuvanje i analizu logova, kao i integraciju sa alatima za monitoring.