LAB 10- HEALTH AND FITNESS APPLICATION

Dynamic Web Applications

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Contents

Outline

The Clinic Appointment Manager is a web application that allows patients to book, view, and search for appointments at a clinic. It also includes a user authentication system for staff members, tracking login attempts in an audit log. The application is built using Node.js with Express as the web framework, MySQL for the database, and EJS for server-side templates. Users can submit appointment requests via forms, while staff can manage users and view logs of login activity.

Architecture

Technologies & Components:

- Application tier: Node.js, Express, EJS templates, bcrypt for password hashing
- Data tier: MySQL database with tables for `appointments`, `users`, and `login_audit`

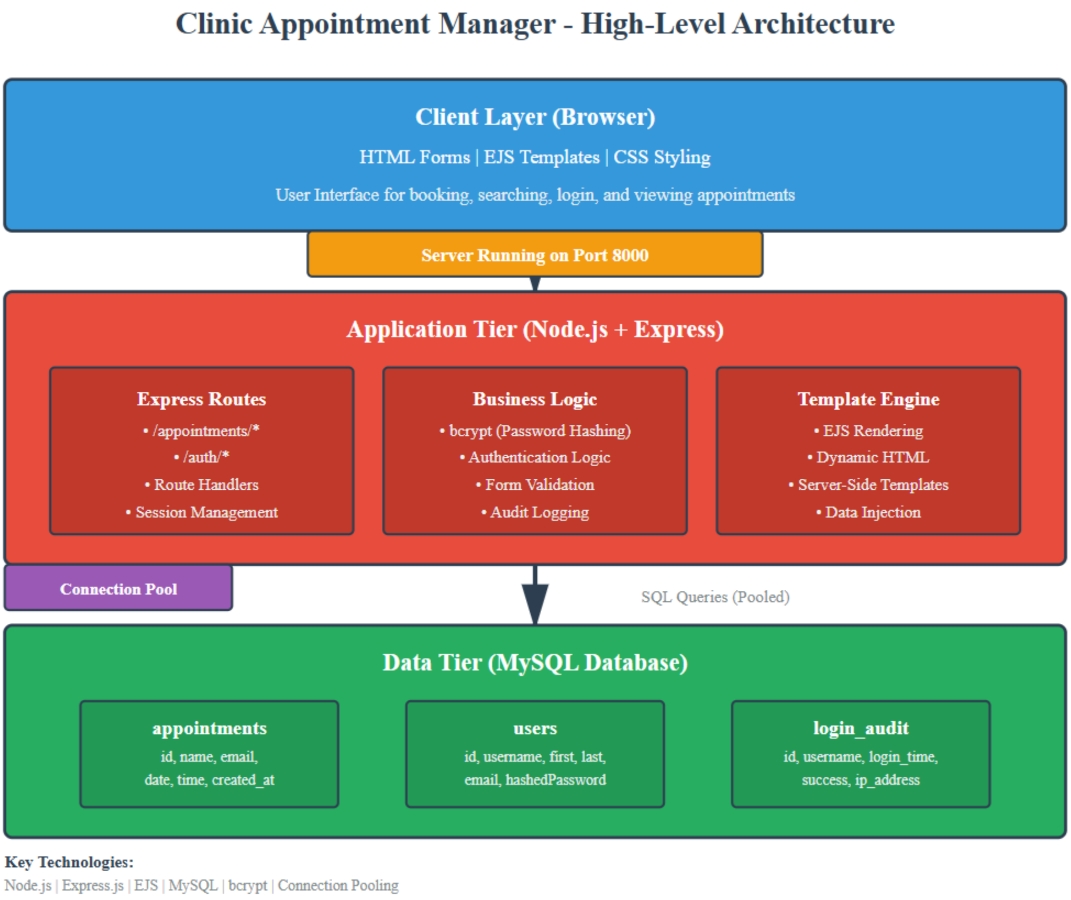
Deployment & Environment Configuration

The application is designed to be fully installable on the marker's machine. The environment variables required for database connection use the recommended configuration:

- HEALTH_HOST='localhost'
- HEALTH_USER='health_app'
- HEALTH_PASSWORD='qwertyuiop'
- HEALTH_DATABASE='health'

Running npm install installs all dependencies, and running node index.js starts the application on port eight thousand.

High-level Architecture Diagram:

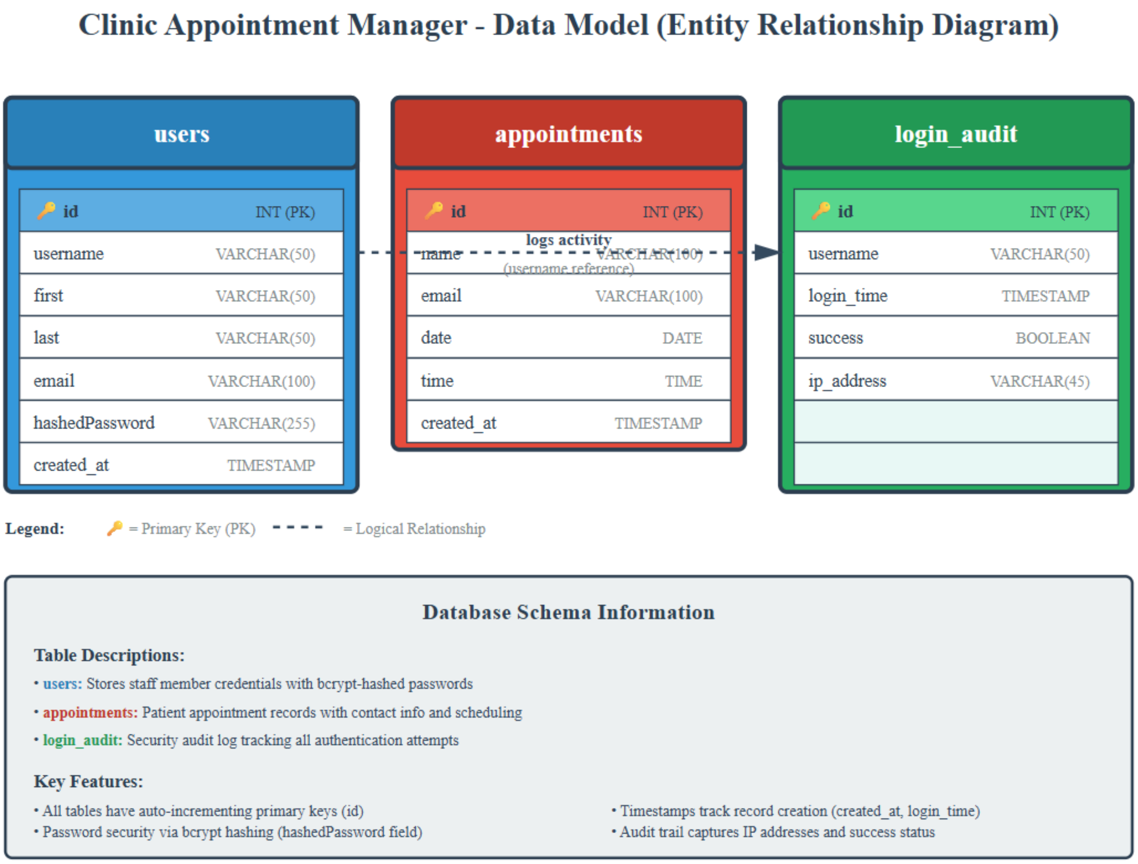

Clinic Appointment Manager - High-Level Architecture
Client Layer (Browser)
HTML Forms | EJS Templates | CSS Styling
User Interface for booking, searching, login, and viewing appointments
Server Running on Port 8000
Application Tier (Node.js + Express)
Express Routes
• /appointments/*
• /auth/*
• Route Handlers
• Session Management
Business Logic
• bcrypt (Password Hashing)
• Authentication Logic
• Form Validation
• Audit Logging
Template Engine
• EJS Rendering
• Dynamic HTML
• Server-Side Templates
• Data Injection
Connection Pool
SQL Queries (Pooled)
Data Tier (MySQL Database)
appointments
id, name, email, date, time, created_at
users
id, username, first, last, email, hashedPassword
login_audit
id, username, login_time, success, ip_address
Key Technologies:
Node.js | Express.js | EJS | MySQL | bcrypt | Connection Pooling

Data Model

The database has three main tables:

1. appointments – Stores patient appointments (id, name, email, date, time, created_at)
2. users – Stores staff user accounts (id, username, first, last, email, hashedPassword, created_at)
3. login_audit – Logs login attempts (id, username, login_time, success, ip_address)

Data Model Diagram:



Clinic Appointment Manager - Data Model (Entity Relationship Diagram)

users	
🔑 id	INT (PK)
username	VARCHAR(50)
first	VARCHAR(50)
last	VARCHAR(50)
email	VARCHAR(100)
hashedPassword	VARCHAR(255)
created_at	TIMESTAMP

appointments	
🔑 id	INT (PK)
name	VARCHAR(100)
email	VARCHAR(100)
date	DATE
time	TIME
created_at	TIMESTAMP

login_audit	
🔑 id	INT (PK)
username	VARCHAR(50)
login_time	TIMESTAMP
success	BOOLEAN
ip_address	VARCHAR(45)

Legend: 🔑 = Primary Key (PK) - - - - = Logical Relationship

Database Schema Information

Table Descriptions:

- users: Stores staff member credentials with bcrypt-hashed passwords
- appointments: Patient appointment records with contact info and scheduling
- login_audit: Security audit log tracking all authentication attempts

Key Features:

- All tables have auto-incrementing primary keys (id)
- Password security via bcrypt hashing (hashedPassword field)
- Timestamps track record creation (created_at, login_time)
- Audit trail captures IP addresses and success status

Database Installation Scripts

Two SQL scripts are included as required:

- **create_db.sql** – Creates the health database and defines all tables (appointments, users, login_audit).
- **insert_test_data.sql** – Inserts initial data including the default staff user (**gold/smiths**) and optional example appointments.

These scripts ensure the database can be recreated from scratch during marking.

User Functionality

1. Book Appointment – Users fill a form (`/appointments/book`) with name, email, date, and time. On submission, the appointment is stored in the database.
2. List Appointments – Users or staff can view all appointments (`/appointments/list`) in a table sorted by date and time.
3. Search Appointments – Users can search for appointments by patient name (`/appointments/search`).
4. User Authentication – Staff can register (`/auth/register`) and log in (`/auth/login`). Passwords are hashed with bcrypt.
5. Audit Log – All login attempts are stored in `login_audit`, accessible via `/auth/audit`. This logs username, IP address, success status, and timestamp.

The application includes a Home page that provides navigation to all major features of the system, and an About page describing the purpose of the clinic appointment manager and the technologies used.

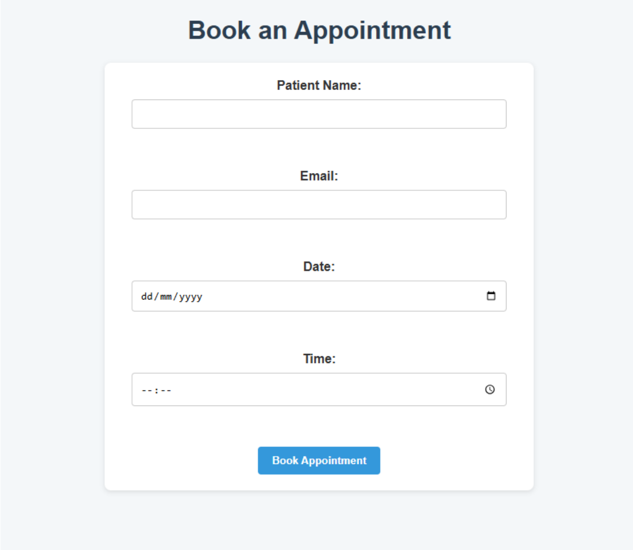
A default user account has been created as required by the brief:

- Username: gold
- Password: smiths

This account is inserted automatically through the insert_test_data.sql script when the application is deployed. It allows the marker to log in and access staff-only features such as viewing users and audit logs.

Example Screenshot Descriptions:

Booking form submission



Book an Appointment

Patient Name:

Email:

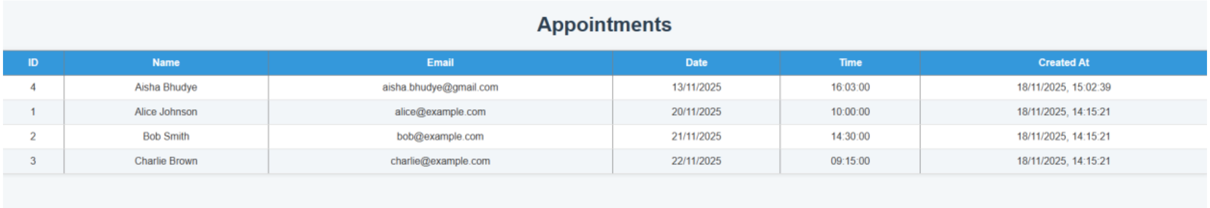
Date:

dd/mm/yyyy

Time:

--:--

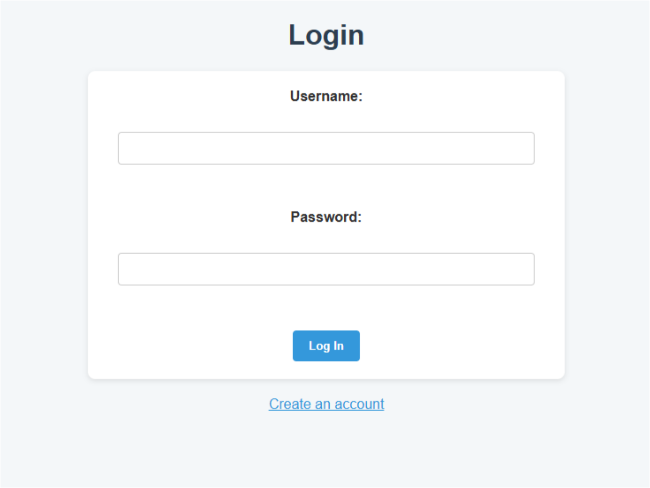
Appointment list table



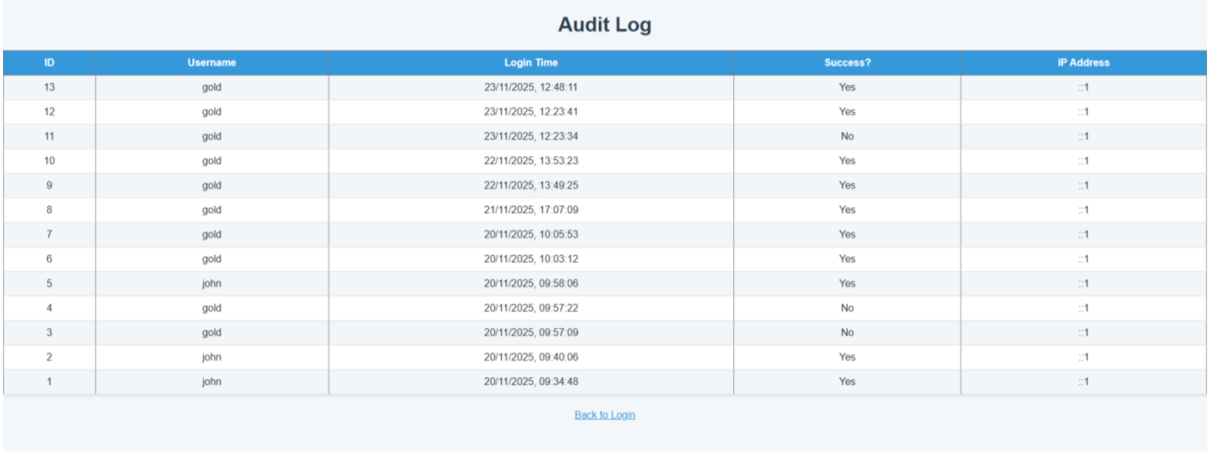
Appointments

ID	Name	Email	Date	Time	Created At
4	Aisha Bhudye	aisha.bhudye@gmail.com	13/11/2025	16:03:00	18/11/2025, 15:02:39
1	Alice Johnson	alice@example.com	20/11/2025	10:00:00	18/11/2025, 14:15:21
2	Bob Smith	bob@example.com	21/11/2025	14:30:00	18/11/2025, 14:15:21
3	Charlie Brown	charlie@example.com	22/11/2025	09:15:00	18/11/2025, 14:15:21

Login page



Audit log showing successful and failed login attempts.



Audit Log

ID	Username	Login Time	Success?	IP Address
13	gold	23/11/2025, 12:48:11	Yes	::1
12	gold	23/11/2025, 12:23:41	Yes	::1
11	gold	23/11/2025, 12:23:34	No	::1
10	gold	22/11/2025, 13:53:23	Yes	::1
9	gold	22/11/2025, 13:49:25	Yes	::1
8	gold	21/11/2025, 17:07:09	Yes	::1
7	gold	20/11/2025, 10:05:53	Yes	::1
6	gold	20/11/2025, 10:03:12	Yes	::1
5	john	20/11/2025, 09:58:06	Yes	::1
4	gold	20/11/2025, 09:57:22	No	::1
3	gold	20/11/2025, 09:57:09	No	::1
2	john	20/11/2025, 09:40:06	Yes	::1
1	john	20/11/2025, 09:34:48	Yes	::1

Advanced Techniques

1. Password Hashing with bcrypt

All passwords are stored securely using bcrypt with a salt round of ten. This ensures that even if the database is compromised, passwords cannot be easily reversed. Example from routes/auth.js:

```
const bcrypt = require('bcrypt').

const saltRounds = 10.


// Hashing password during registration

bcrypt.hash(plainPassword, saltRounds, (err, hashedPassword) => {

  if (err) return next(err).
  const sql = `
    INSERT INTO users (username, first, last, email, hashedPassword)
    VALUES (?, ?, ?, ?, ?)
  `;
  const params = [username, first, last, email, hashedPassword].

  global.db.query(sql, params, (err) => {
    if (err) return next(err).
    res.send(` Registration Successful` ).
  });
});
```

During login, passwords are compared using bcrypt's compare function:

```
bcrypt.compare(password, hashedPassword, (err, match) => {
  if (match) {
    req.session.userId = username.
    // Log successful login
    global.db.query(
      "INSERT INTO login_audit (username, success, ip_address) VALUES (?, ?, ?)",
      [username, true, req.ip]
    );
    return res.send("Login successful! Welcome " + username).
  }
  // Manage failed login
});
```

2. Input Validation with express validator

The application implements server-side input validation using the express-validator middleware to prevent malformed or malicious data from being processed. Validation rules are applied to the registration route in routes/auth.js:

```
const { check, validationResult } = require("express validator").


router.post(
"/registered",
[
  check("email")
    .isEmail()
    .withMessage("Invalid email"),

  check("username")
    .isLength({ min: five, max: 20 })
    .withMessage("Username must be 5–20 characters"),

  check("password")
    .isLength({ min: 8 })
    .withMessage("Password must be at least 8 characters"),

  check("first")
    .notEmpty()
    .withMessage("First name is required"),

  check("last")
    .notEmpty()
    .withMessage("Last name is required")
],
async (req, res, next) => {
  const errors = validationResult(req).

  if (!errors.isEmpty()) {
    // Re-render form with validation errors
    return res.render("register", {
      clinicData: req.app.locals.clinicData,
      errors: errors.array()
    });
    }

    // Proceed with registration if validation passes
    // ...
  }
);
```

This validation ensures:

- Email addresses are properly formatted.
- Usernames are between 5-20 characters.
- Passwords are at least eight characters long.
- First and last names are not empty.

If validation fails, the form is re-rendered with specific error messages displayed to the user, improving user experience and data quality.

3. Input Sanitization

To prevent XSS (Cross-Site Scripting) attacks, all user inputs are sanitized before being stored in the database. The application uses the expressSanitizer middleware to clean input data in routes/auth.js:

```
// Sanitise fields before database insertion
let first = req.sanitize(req.body.first).
let last = req.sanitize(req.body.last).
let username = req.sanitize(req.body.username).
let email = req.sanitize(req.body.email).
```

Sanitization removes or escapes potentially dangerous HTML and JavaScript code from user inputs, preventing malicious scripts from being injected into the application. This is configured in index.js:

```
const expressSanitizer = require('express sanitizer').
app.use(expressSanitizer()).
```

This technique protects against attacks where users might try to inject scripts like <script>alert('XSS')</script> into form fields.

4. Session-Based Authentication with Middleware

The application implements session-based authentication to protect sensitive routes. A custom middleware function redirectLogin ensures that only authenticated users can access protected pages. Implementation in routes/auth.js:

```
const redirectLogin = (req, res, next) => {
  if (!req.session.userId) {
    res.redirect("./login").
  } else {
    next().
  }
};

// Protected routes using the middleware
router.get("/list", redirectLogin, (req, res, next) => {
  const sql = `SELECT username, first, last, email FROM users`.
  global.db.query(sql, (err, results) => {
    if (err) return next(err).
    res.render("listusers", { users: results }).
  });
});

router.get("/audit", redirectLogin, (req, res, next) => {
  const sql = `
    SELECT id, username, login_time, success, ip_address.
    FROM login_audit
    ORDER BY login_time DESC
  `;
  global.db.query(sql, (err, results) => {
    if (err) return next(err).
    res.render("audit", { audits: results }).
  });
});
```

When a user successfully logs in, their username is stored in the session:

req.session.userId = username.

The redirectLogin middleware checks if req.session.userId exists before allowing access to protected routes. If not authenticated, users are automatically redirected to the login page. This prevents unauthorized access to sensitive functionality like user lists and audit logs.

Logout functionality destroys the session completely:

```
router.get("/logout", redirectLogin, (req, res) => {
  req.session.destroy(err => {
    if (err) return res.redirect("/").
    res.send("You are now logged out. <a href='/'>Home</a>").
  });
});
```

5. Database Connection Pooling

Using mysql2.createPool to manage multiple simultaneous connections efficiently in index.js:

```
const db = mysql.createPool({
  host: 'localhost',
  user: 'clinic_app',
  password: 'qwertyuiop',
  database: 'clinic_db',
  connectionLimit: ten
});
global.db = db.
```

Connection pooling creates a pool of reusable database connections rather than opening a new connection for each query. This significantly improves performance under high load by:

- Reducing connection overhead
- Managing concurrent requests efficiently
- Automatically managing connection failures and reconnections
- Limiting total connections to prevent database overload

The connectionLimit: ten parameter ensures a maximum of ten simultaneous database connections, preventing resource exhaustion.

6. Comprehensive Audit Logging

Every login attempt is logged with SQL insertions directly in the /auth/login route, capturing both successful and failed authentication attempts. Implementation in routes/auth.js:

```
const ipAddress = req.ip.


// Log failed login (user not found)
if (result.length === 0) {
  global.db.query(
    "INSERT INTO login_audit (username, success, ip_address) VALUES (?, ?, ?)",
    [username, false, ipAddress]
  );
  return res.render("login", {
    errors: [{ msg: "User not found" }]
  });
}

// Log successful login
if (match) {
  req.session.userId = username.
  global.db.query(
    "INSERT INTO login_audit (username, success, ip_address) VALUES (?, ?, ?)",
    [username, true, ipAddress]
  );
  return res.send("Login successful! Welcome " + username).
}

// Log failed login (incorrect password)
global.db.query(
  "INSERT INTO login_audit (username, success, ip_address) VALUES (?, ?, ?)",
  [username, false, ipAddress]
);
```

The audit log captures:

- **Username** - Who attempted to log in.
- **Timestamp** - When the attempt occurred (automatically via CURRENT_TIMESTAMP)
- **Success status** - Boolean indicating if login succeeded.
- **IP address** - Source IP of the request (req.ip)

This provides a complete security trail that can be used to:

- Detect brute force attacks (multiple failed attempts)

- Identify unauthorized access attempts.
- Track user activity for compliance.
- Investigate security incidents.

The audit log is accessible through a protected route (/auth/audit) that displays all login attempts in reverse chronological order.

7. Dynamic Templating with EJS

EJS is used to render appointment lists, login pages, and validation errors dynamically with server-side data. Example from views/register.ejs:

```
<% if (errors.length > 0) { %>
  <div class="alert alert-danger">
    <ul>
      <% errors.forEach(function(error) { %>
        <li><%= error.msg %></li>
      <% }); %>
    </ul>
  </div>
<% } %>
```

This allows validation errors to be displayed dynamically to users, showing specific error messages for each field that fails validation. Similarly, appointment lists and audit logs are rendered dynamically by iterating over database results passed from route handlers to EJS templates, providing a seamless integration between backend data and frontend presentation.

Summary of Security Enhancements

The application implements multiple layers of security:

1. **Password Security** - bcrypt hashing with salt rounds.
2. **Input Validation** - express-validator ensures data integrity.
3. **XSS Prevention** - Input sanitization removes malicious code.
4. **Authentication** - Session-based access control with middleware
5. **Audit Trail** - Comprehensive logging of all authentication attempts.
6. **Performance** - Connection pooling for efficient database access

These techniques work together to create a secure, robust web application that protects user data and prevents common web vulnerabilities.

8. RESTful API Implementation

The application provides a comprehensive RESTful API that allows external applications to access clinic appointment data in JSON format. This enables integration with other systems and provides machine-readable access to appointment information, following industry-standard REST principles.

The API is implemented in a separate route handler (routes/api.js) and uses query parameters for flexible filtering and sorting. Implementation follows the same pattern as demonstrated in Lab 9 (Providing APIs):

```
router.get('/appointments', function (req, res, next) {
  // Get query parameters
  const searchName = req.query.search.
  const searchDate = req.query.date.
  const sortBy = req.query.sort.

  // Build base SQL query
  let sqlquery = "SELECT * FROM appointments.”
  let conditions = [].
  let params = [].

  // Add search condition if provided
  if (searchName) {
    conditions.push("name LIKE ?").
    params.push(`%${searchName}%`).
  }

  // Add date condition if provided
  if (searchDate) {
    conditions.push("date = ?").
    params.push(searchDate).
  }

  // Add WHERE clause if there are conditions
  if (conditions.length > 0) {
    sqlquery += " WHERE " + conditions.join(" AND ").
  }

  // Add ORDER BY clause
  if (sortBy === 'name') {
    sqlquery += " ORDER BY name.”
  } else if (sortBy === 'date') {
    sqlquery += " ORDER BY date, time.”
  } else {
    sqlquery += " ORDER BY date DESC, time DESC.”
  }

  // Execute the sql query
  global.db.query(sqlquery, params, (err, result) => {
    // Return results as a JSON object
    if (err) {
      res.json(err).
      next(err).
    }
    else {
      res.json(result).
    }
  });
});
```

API Endpoints:

The API provides multiple endpoints for accessing appointment data:

- **GET /api/appointments** – Returns all appointments in JSON format.
- **GET /api/appointments?search=john** – Search appointments by patient name (partial matching supported)
- **GET /api/appointments?date=2025-11-20** – Filter appointments by specific date
- **GET /api/appointments?sort=name** – Sort appointments alphabetically by patient name

- **GET /api/appointments?sort=date** – Sort appointments chronologically by date and time
- **GET /api/stats** – Returns aggregate statistics including total appointments, unique patients, and date range.

Query Parameter Handling:

The API demonstrates advanced query parameter handling, allowing multiple parameters to be combined for refined searches. Parameters are extracted from the URL using req.query and validated before processing:

```
const searchName = req.query.search || '‘.

const searchDate = req.query.date.

const sortBy = req.query.sort.
```

Multiple parameters can be combined in a single request. For example:

- ?search=smith&sort=date – Find all appointments for patients named "smith", sorted by date
- ?date=2025-11-20&sort=name – Get all appointments on a specific date, sorted alphabetically
- ?search=john&date=2025-11-20 – Search for "john" on a specific date

The search functionality uses SQL LIKE queries with wildcard characters (%) for partial matching, allowing flexible searches that match any part of the patient’s name.

Dynamic SQL Query Construction:

The API dynamically builds SQL queries based on provided parameters, adding WHERE clauses and ORDER BY clauses conditionally:

```
let sqlquery = "SELECT * FROM appointments.”

let conditions = [].

let params = [].


if (searchName) {

  conditions.push("name LIKE ?").

  params.push(` %${searchName}%` ).

}


if (searchDate) {

  conditions.push("date = ?").

  params.push(searchDate).
}

if (conditions.length > 0) {
  sqlquery += " WHERE " + conditions.join(" AND ").
}
```

This approach ensures that:

- Queries remain efficient by only adding necessary conditions.
- SQL injection is prevented through parameterized queries
- Multiple filters can be applied simultaneously.
- The base query works without any parameters (returns all appointments)

Error Handling:

The API implements consistent error handling across all endpoints. When database errors occur, the error object is returned in JSON format:

```
if (err) {
  res.json(err).
  next(err).
}
```

This provides developers with detailed error information for debugging while maintaining the JSON response format expected by API consumers.

Statistics Endpoint:

In addition to appointment data, the API provides an aggregate statistics endpoint that uses SQL aggregate functions:

```
router.get('/stats', function (req, res, next) {
  let sqlquery = `
    SELECT
      COUNT(*) as total_appointments,
      COUNT(DISTINCT email) as unique_patients,
      MIN(date) as earliest_appointment,
      MAX(date) as latest_appointment
    FROM appointments
  `;
  global.db.query(sqlquery, (err, result) => {
    if (err) {
      res.json(err).
      next(err).
    }
    else {
      res.json(result[0]).
    }
  });
});
```

This endpoint returns statistics in a single JSON object, demonstrating the use of SQL aggregate functions (COUNT, MIN, MAX) and DISTINCT for unique value counting.

Integration with Main Application:

The API routes are integrated into the main Express application in index.js:

```
const apiRoutes = require('./routes/api').

app.use('/api', apiRoutes).
```

This modular approach keeps API code separate from the main application routes, improving code organization and maintainability.

Comparison with Web Interface:

The API provides the same data as the web interface but in machine-readable JSON format:

- **Web Interface:** /appointments/list returns HTML table for human viewing
- **API:** /api/appointments returns JSON array for programmatic access

This dual approach allows the application to serve both human users (via web pages) and external applications (via API) using the same underlying database and business logic.

Benefits of the API Implementation:

1. **External Integration –** Other applications can retrieve appointment data programmatically.
2. **Flexibility** – Query parameters allow customized data retrieval without multiple endpoints.
3. **Consistency** – JSON format is universally supported across programming languages.
4. **Documentation –** Interactive documentation improves developer experience.
5. **Scalability** – RESTful design allows easy addition of new endpoints and features.

This API implementation demonstrates professional web development practices and enables the clinic system to integrate with external applications, mobile apps, or data analysis tools while maintaining data security and integrity through the existing database connection pooling and error handling mechanisms.

A links.txt file is provided in the root of the GitHub repository, containing direct links to the deployed application pages, including Home, About, Search, Appointment Booking, Login, and Audit Log.

AI Declaration

I acknowledge the use of ChatGPT (OpenAI, 2025) and Grammarly (Grammarly Inc., 2025) to assist with proofreading, grammar checking, and improving sentence structure and clarity in this assessment. Both tools were used solely for language refinement; no generated text, ideas, or analytical content were included in the submitted work. ChatGPT was also used to help create the diagrams in this report. ChatGPT was accessed via https://chat.openai.com/ in November 2025 using the prompt:

“Proofread and improve the grammar and flow of my report.”

Grammarly was used for grammar correction and sentence structure review via https://www.grammarly.com/.

Reference List

OpenAI (2025) ChatGPT [Generative AI model]. Available at: https://chat.openai.com/ (Accessed: 10 November 2025).

Grammarly Inc. (2025) Grammarly [AI writing assistance tool]. Available at: https://www.grammarly.com/ (Accessed: November 2025).