

COMP-1687

Web Application Development

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1 – PART A

1.1 GROUP WORK INTRODUCTION

Group work done with Gabriel Ciortea-Pop, 000968052.

For the group it was not the first time working together, and pair programming was a developing strategy already adopted in the past. Both members have always been keen to work together when facing new challenges as it speeds up the learning process. When pair programming the quality of the code also increases, and the developed solution becomes more robust. Besides, pair programming enables both team members to have an excellent understanding of the code as it requires engagement from both the driver and navigator.

The group started the assignment by designing the entity relationship diagram (ERD), which enabled the group to define the objects requiring abstract representation. After completing the initial ERD, it was decided not to use the university hosted SQL server as it would give less flexibility but to take advantage of the Microsoft Azure donation for students and to deploy a SQL Server instance on the cloud which would allow us to work from our devices from home or at university comfortably. To create an entity/model, the group decided to scaffold the database and use Entity Framework.

The use of Entity Framework extremely simplified the database management and enabled to quickly be able to develop a desktop application to perform create, read, update and delete (CRUD) operation for the employees. The entity framework scaffold was implemented as a separated project in the solution, and it enabled to require the entity/model on other projects in the same solution by adding a reference and the connection string the config file. This allowed updating the model in one point for all the projects each time the database was altered.

To handle the numerous windows required by the application, the group decided to take advantage of Winforms “User Controls” (UC) which enables to create views inside a single form dynamically. Each UC is controlled by a singleton pattern which restricts the application to only have a single instance of each user control at runtime. The advantage of the approach is to save memory and avoid a large number of user views instances. The approach has also enabled modulation of the front-end. The group has also decided to create two components: a new TextBox for password management, which inherits the properties of the standard TextBox but masks the input and enforces minimum and maximum chars. Also, a dynamic button was created, which was reused for different CRUD operations.

The group acknowledges that it is possible that the database and the design could further change, the trial and failure approach adopted is also a critical element in the learning process and what appeared correct in the initial analysis could turn out not to be ideal.

1.2 ENTITY RELATION DIAGRAM (ERD)

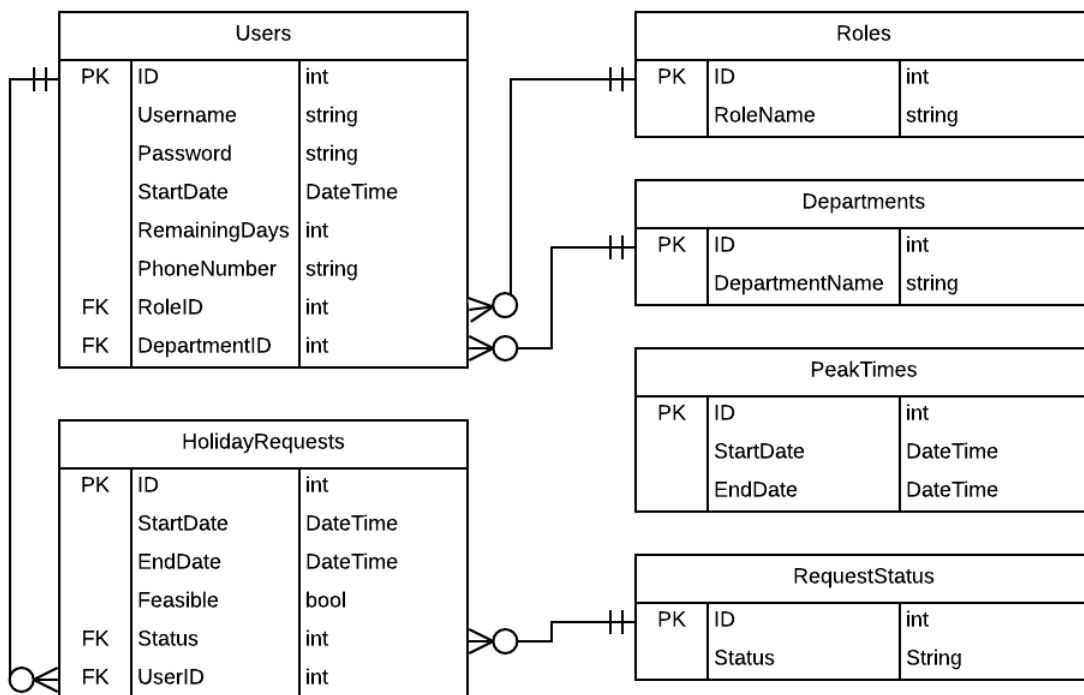


Figure 1 Initial Entity Relationship Diagram (ERD)

The above ERD diagram is the result of the group effort. The diagram was kept as simple as possible, for example users do not have a name or surname, but just their username which is a unique field. Additional details such as age, sex, address are not considered in the scope of this project. The main relationship is between Users and Holiday Requests, while the other linked table are simple look up table to manage a user role and department and the Request status for a Holiday Request.

PeakTimes is a table needed only to record the holiday requests peak time, it has no relationships and the purpose is to allow the admin users to edit the peak periods.

The group agrees that it is possible that the implementation could change while developing part B.

1.3 ARCHITECTURE DIAGRAM

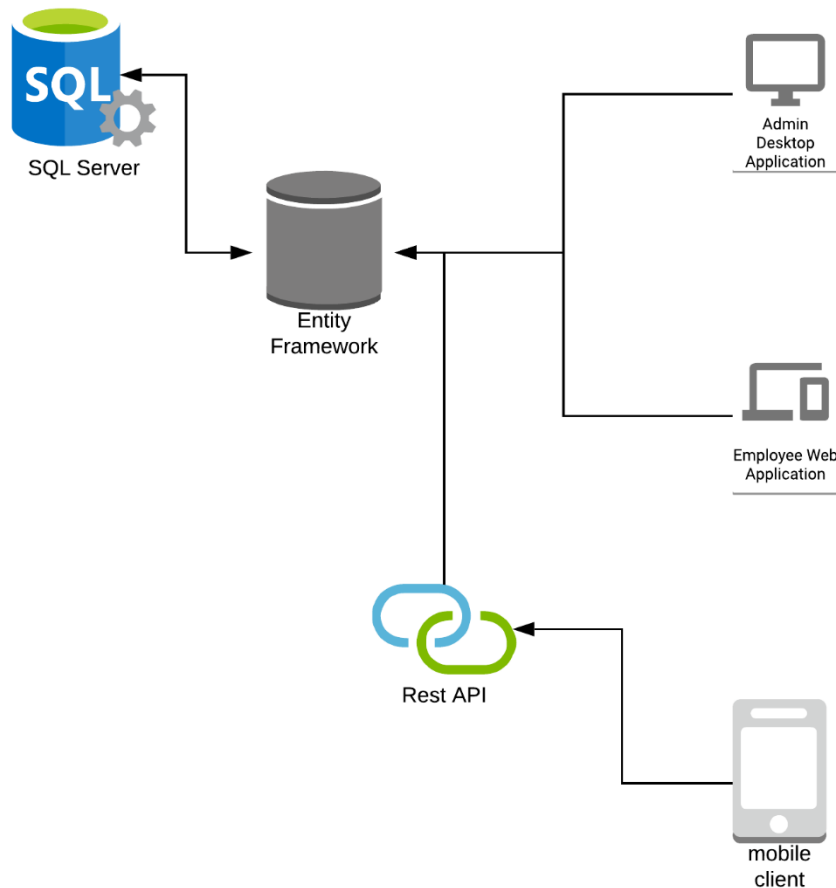


Figure 2 Initial envisioned architecture

The above diagram represents the architecture of the holiday booking system application. There is a SQL Server database stored on the cloud (MS Azure) and all operations are handled by the entity framework projects, which in fact operates as the middleman for all the other components in the diagrams. The Rest APIs will also provide a communication interface for the mobile client(s).

1.4 INDIVIDUAL REPORT

Gabriel and I worked previously in many different projects since year one, thus we knew each other's strengths and weaknesses. I strongly believe that we had a great team dynamic and managed to provide a good solution to the required tasks. As we both previously worked with C# we concluded that we still have different skillsets, as Gabriel did projects with windows forms before he clearly did a better job than I could have done on putting the different User Interface(UI) components together, and myself, I tried to add a bit of a styling so that the fonts and colors are nicer.

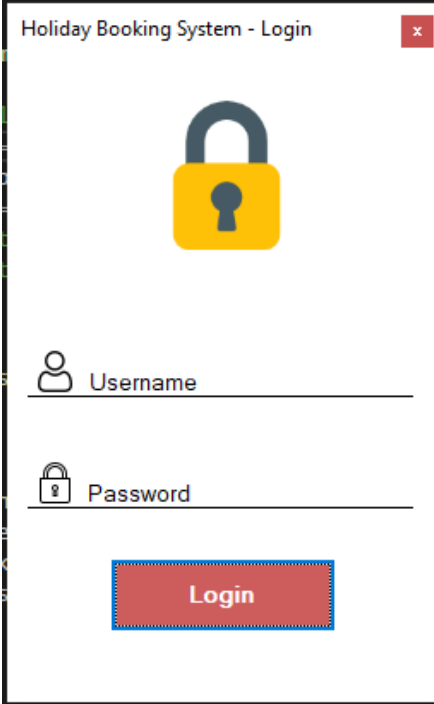
We worked on everything together, database, backend and frontend, I assisted with the database design and building it. Additionally, I helped at sampling the solution structure together as we managed to scaffold the database into an ADO.NET Entity Model and linked it to both Manager Windows Form Login and Employees ASP.NET web application. Additionally, I created the backend seed queries for populating the database with an admin and some default users, also worked on exception handling, and queries optimization as Gabriel had not use Entity Framework before to the extent I did.

Personally, I believe that our team dynamic did not disappoint, and we did good on pair programming, he was the main person typing and I was the one researching how to do things, supervise and assist him on writing code.

Since PART A did not seem very demanding we did not assign specific roles one to another, we did not discuss anything such as he was going to do the database and the frontend, and I would do the backend. However, if there were more requirements for this part, we would have been better off splitting the work accordingly, in different roles, not everyone working on everything. We mainly worked together on the day when the tutorial is scheduled and remained to carry on working after the tutorial has finished for few more hours.

1.5 SCREENSHOTS

1.5.1 Login



The screenshot shows a window titled "Holiday Booking System - Login". Inside the window, there is a yellow padlock icon with a keyhole. Below the icon, there are two input fields: the first is labeled "Username" with a person icon, and the second is labeled "Password" with a padlock icon. At the bottom of the form is a red button with the text "Login".

Figure 3 Desktop Login Form

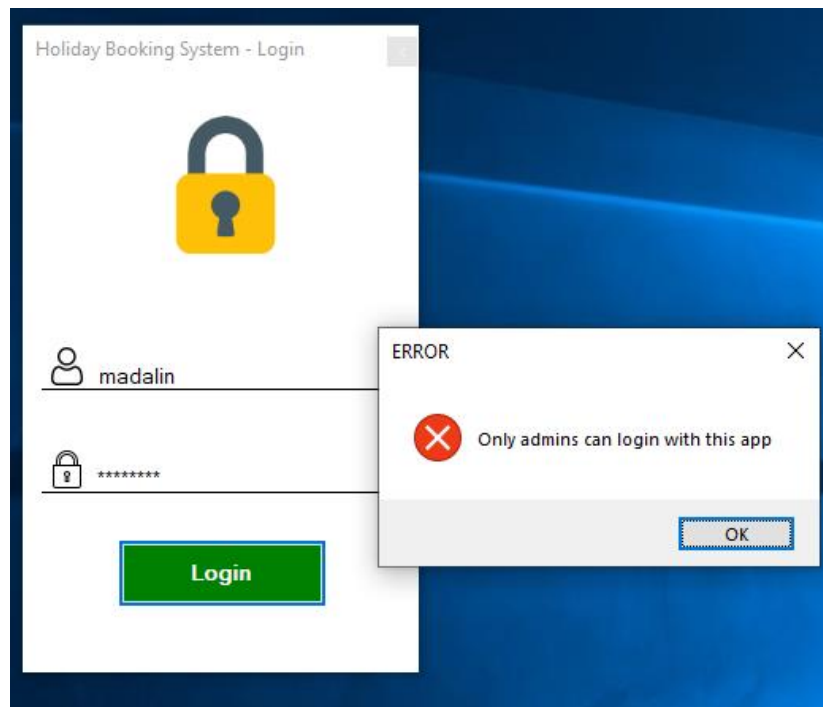


Figure 4 Attempting to sign in with employee account

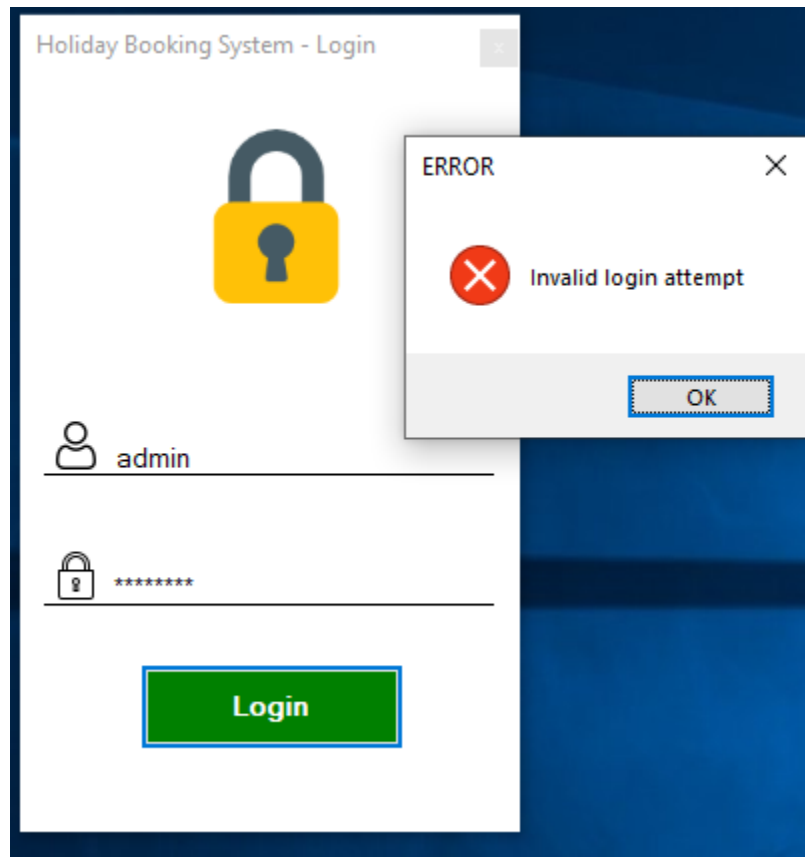


Figure 5 Typing wrong credentials on login

1.5.2 Add Employee

The image shows a desktop application dashboard. At the top, there are three tabs: "Manage Employees", "Holiday Requests", and "Calendar View". The "Manage Employees" tab is active, and within it, the "Add Employee" sub-tab is selected. On the left side of the dashboard, there is a vertical menu with buttons for "Add Employee", "Edit Employee", and "Delete Employee". The main area of the dashboard contains the "Add Employee" form. The form has the following fields: "Username:" with a text input field and a note below it stating "*must be above 6 characters and below 32"; "Password:" with a text input field; "Confirm Password:" with a text input field and a note below it stating "*must contain 1 uppercase, 1 number and 8 chars"; "Phone Number:" with a text input field; "Department:" with a dropdown menu; "Role:" with a dropdown menu; and "Start date:" with a date picker showing "09 March 2020". At the bottom of the form, there are two buttons: "Register" (red) and "Clear" (green).

Figure 6 Desktop App Dashboard with Add Employee Form

Username: Username must be above 6 characters
**must be above 6 characters and below 32*

Password: Password field must be filled

Confirm Password: Passwords do not match
**must contain 1 uppercase, 1 number and 8 chars*

Phone Number: 3213214124124 The phone number entered is not in a valid format

Department: Please select department

Role: Please select role

Start date: 09 March 2020

Figure 7 Create Employee Form Inputs Validation

Username: john bet
**must be above 6 characters*

Password: *****

Confirm Password: *****
**must contain 1 uppercase,*

Phone Number:

Department: Carpentry

Role: Junior

Start date: 09 March 2020

Success


 Employee successfully registered

Figure 8 Successful employee registration

1.5.3 Edit Employee

Edit Employee

Username:

Search

Show All

| ID | Username | Role | Department |
|----|---------------|-------------|-------------|
| 5 | madalin | Head | Engineering |
| 6 | gabriel | Deputy Head | Engineering |
| 7 | alex | Apprentice | Engineering |
| 8 | chris | Senior | Engineering |
| 9 | bianca | Junior | Engineering |
| 10 | carla | Manager | Engineering |
| 11 | anna | Senior | Engineering |
| 12 | roxanne | Apprentice | Engineering |
| 13 | kate | Manager | Engineering |
| 14 | jim kendricks | Apprentice | Carpentry |
| 15 | john bet | Junior | Carpentry |

Selected Employee

User Details

Username:

john bet

Department:

Carpentry

Role:

Junior

Start date:

09 March 2020

Phone Number:

Update

Update Password

Password:

Confirm Password:

*must contain 1 uppercase, 1 number and 8 chars

Update

Figure 9 Edit employee details

Username:

Search

Show All

| ID | Username | Role | Department |
|----|----------|------------|-------------|
| 9 | bianca | Junior | Engineering |
| 11 | anna | Senior | Engineering |
| 12 | roxanne | Apprentice | Engineering |

Figure 10 Search employee by Regular Expression match

Username:

| ID | Username | Role | Department |
|----|---------------|-------------|-------------|
| 5 | madalin | Head | Engineering |
| 6 | gabriel | Deputy Head | Engineering |
| 7 | alex | Apprentice | Engineering |
| 8 | chris | Senior | Engineering |
| 9 | bianca | Junior | Engineering |
| 10 | carla | Manager | Engineering |
| 11 | anna | Senior | Engineering |
| 12 | roxanne | Apprentice | Engineering |
| 13 | kate | Manager | Engineering |
| 14 | jim kendricks | Apprentice | Carpentry |
| 15 | john bet | Junior | Carpentry |

User Details
Username:
Department:
Role:
Start date:
Phone Number:

Update Password
Password:
Confirm Password:

** must contain 1 uppercase, 1 number and 8 chars*

Figure 11 Editing selected employee details

User Details
Username: Must have least 6 characters
Department:
Role:
Start date:
Phone Number:

Update Password
Password: Not meeting password criteria
Confirm Password: Passwords do not match

** must contain 1 uppercase, 1 number and 8 chars*

Figure 12 Input validation for editing employee details

1.5.4 Delete Employee

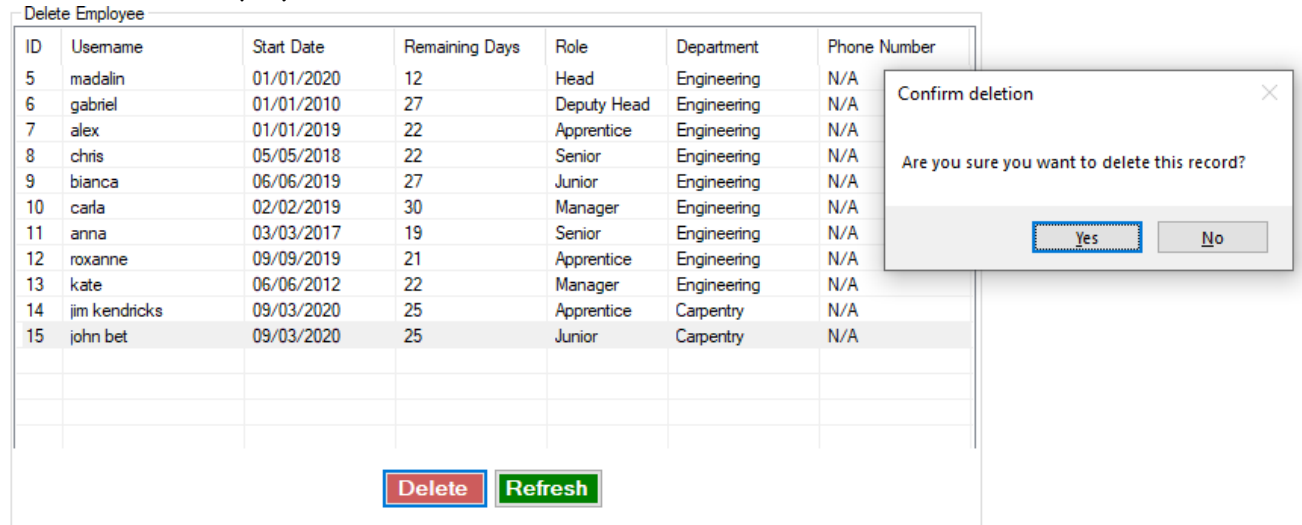


Figure 13 Delete Employee asking for confirmation

| Delete Employee | | | | | | |
|-----------------|---------------|------------|----------------|-------------|-------------|--------------|
| ID | Username | Start Date | Remaining Days | Role | Department | Phone Number |
| 5 | madalin | 01/01/2020 | 12 | Head | Engineering | N/A |
| 6 | gabriel | 01/01/2010 | 27 | Deputy Head | Engineering | N/A |
| 7 | alex | 01/01/2019 | 22 | Apprentice | Engineering | N/A |
| 8 | chris | 05/05/2018 | 22 | Senior | Engineering | N/A |
| 9 | bianca | 06/06/2019 | 27 | Junior | Engineering | N/A |
| 10 | carla | 02/02/2019 | 30 | Manager | Engineering | N/A |
| 11 | anna | 03/03/2017 | 19 | Senior | Engineering | N/A |
| 12 | roxanne | 09/09/2019 | 21 | Apprentice | Engineering | N/A |
| 13 | kate | 06/06/2012 | 22 | Manager | Engineering | N/A |
| 14 | jim kendricks | 09/03/2020 | 25 | Apprentice | Carpentry | N/A |
| | | | | | | |

Figure 14 Once employee deleted the list refreshes

2 – PART B

2.1 IMPLEMENTATION INTRODUCTION

During the development process of the individual part of the implementation for this module it became obvious that the previously solution built as a group is not suitable to fulfill all the requirements expected to be accomplished for this coursework as the full functionality was not thoroughly assessed.

Therefore, changes have occurred and they have been illustrated in the adapted diagrams that can be found in the following section. There were not major changes to be done, but rather small changes. As it can be seen in the ERD (Figure 16), PeakTimes table was removed, and ConstraintsBroken table was added, and there were also changes in the Users and HolidayRequests tables. Also, the architecture diagram was changed (Figure 17), now the Web Service (SOAP instead of REST) for employee app resides on the Web application, meaning that they could run together on the same server.

2.2 FINAL DIAGRAMS

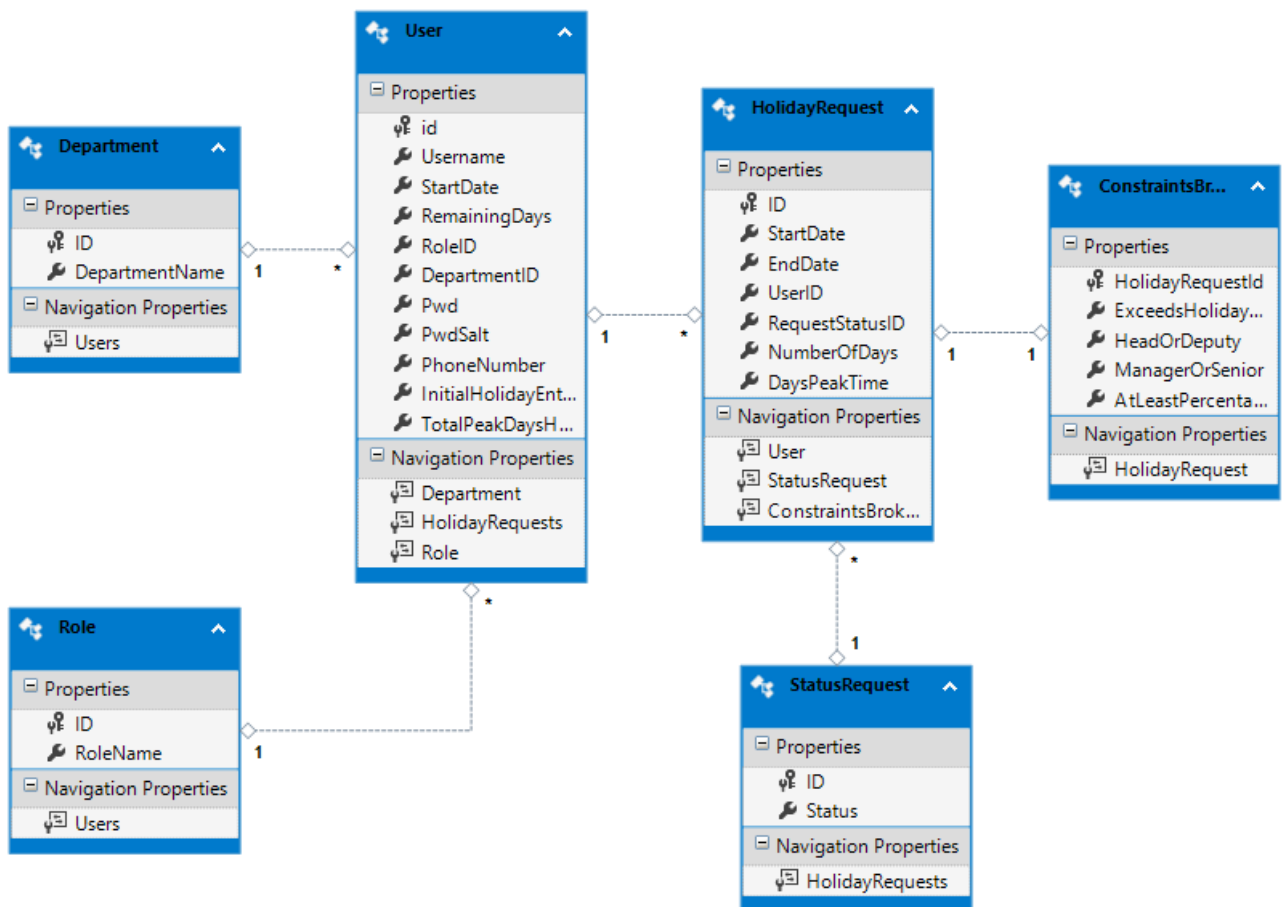


Figure 15 Entity Framework generated model of database

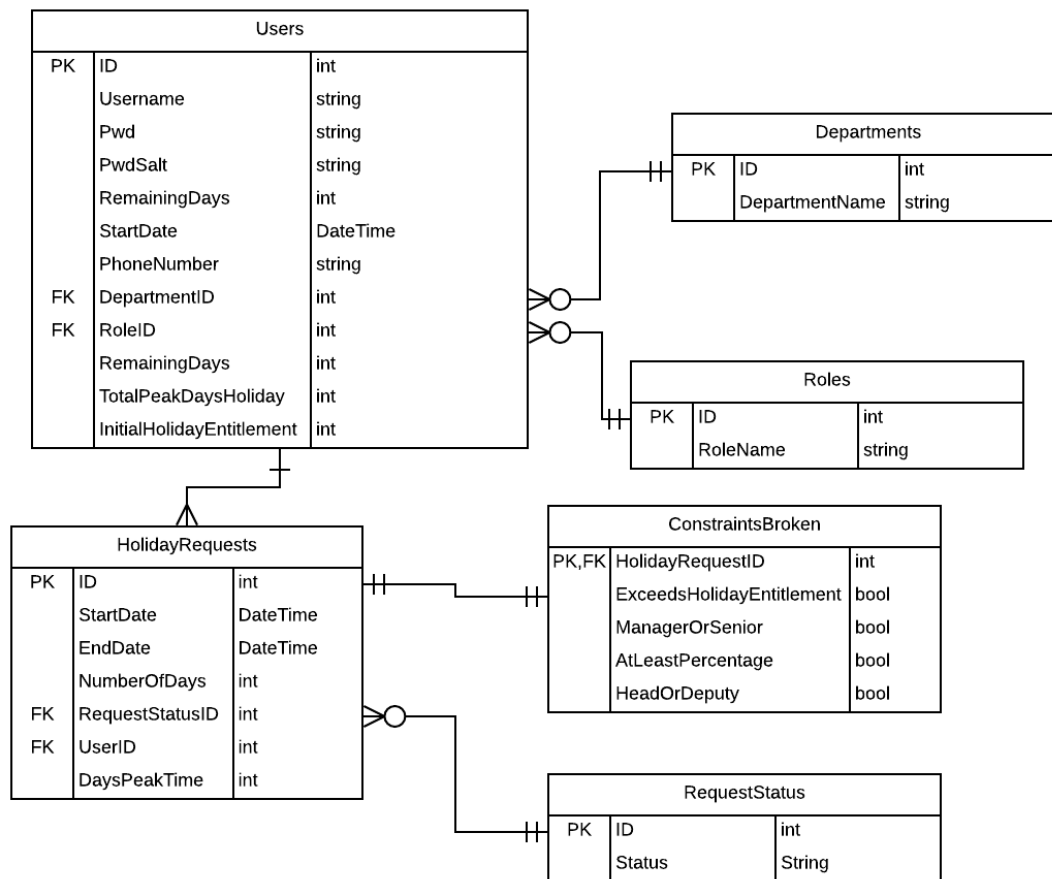


Figure 16 Final Entity Relationship Diagram

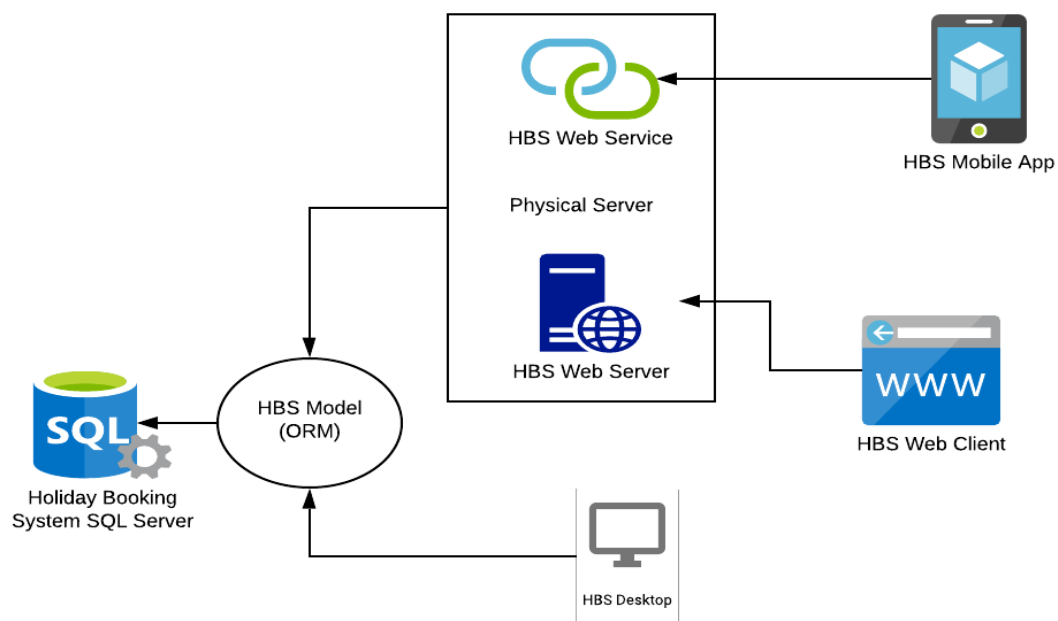


Figure 17 Final Architecture Diagram

2.3 SCREENSHOTS

This are screenshots taken from the final version of the coursework.

2.3.1 Functionality A

2.3.1.1 Outstanding Requests

| Pending Requests | Outstanding Holiday Requests | | | |
|------------------|------------------------------|------------|------------|-------------|
| Holiday Bookings | ID | StartDate | EndDate | WorkingDays |
| Day View | | | | |
| | 15 | 11/08/2020 | 13/08/2020 | 3 |
| | 20 | 17/03/2020 | 18/03/2020 | 2 |
| | 21 | 14/05/2020 | 28/05/2020 | 11 |
| | 22 | 19/06/2020 | 25/06/2020 | 5 |
| | 23 | 22/10/2020 | 29/10/2020 | 6 |
| | 19 | 07/04/2020 | 08/04/2020 | 2 |
| | 24 | 15/07/2020 | 27/07/2020 | 9 |
| | 26 | 15/07/2020 | 27/07/2020 | 9 |
| | 25 | 15/07/2020 | 27/07/2020 | 9 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Approve/Reject Request

Breaking Constraints

No employee can exceed the number of days of holiday entitlement

Either the head or the deputy head of the department must be on duty

At least one manager and one senior staff member must be on duty

At least 60% of a department must be on duty

Approve

Decline

Figure 18 Outstanding Holiday Requests (includes the functionality with prioritization and constraints checking)

Approve/Reject Request

Request 20 Declined

Figure 19 Declining a request

Approve/Reject Request

Request 22 Approved

Figure 20 Approving a request

2.3.1.2 All holiday bookings and filter by employee

Holiday Bookings

| ID | Start Date | End Date | Working Days | Peak Time Days |
|----|------------|------------|--------------|----------------|
| 5 | 07/08/2020 | 21/08/2020 | 11 | 11 |
| 6 | 06/04/2020 | 15/04/2020 | 8 | 8 |
| 7 | 07/08/2020 | 21/08/2020 | 11 | 11 |
| 8 | 07/08/2020 | 21/08/2020 | 11 | 11 |
| 9 | 07/07/2020 | 17/07/2020 | 9 | 3 |
| 10 | 02/08/2020 | 13/08/2020 | 9 | 9 |
| 11 | 07/09/2020 | 11/09/2020 | 5 | 0 |
| 12 | 12/10/2020 | 21/10/2020 | 8 | 0 |
| 13 | 01/05/2020 | 06/05/2020 | 4 | 0 |
| 14 | 08/05/2020 | 12/05/2020 | 3 | 0 |
| 18 | 15/04/2020 | 17/04/2020 | 3 | 3 |
| 22 | 19/06/2020 | 25/06/2020 | 5 | 0 |

Filtered Search

By Employee Name

Please select department

Please select employee

Show all

Figure 21 All holiday bookings

Holiday Bookings

| ID | Start Date | End Date | Working Days | Peak Time Days |
|----|------------|------------|--------------|----------------|
| 5 | 07/08/2020 | 21/08/2020 | 11 | 11 |
| 13 | 01/05/2020 | 06/05/2020 | 4 | 0 |
| 14 | 08/05/2020 | 12/05/2020 | 3 | 0 |

Filtered Search

By Employee Name

Please select department

Engineering

Please select employee

madalin

Show all

Figure 22 Holiday Requests filtered by employee

2.3.1.3 Employees working and on leave on a selected date

Employees

Currently selected date 15/04/2020

Working

| ID | Employee Name | Department |
|----|---------------|-------------|
| 5 | madalin | Engineering |
| 6 | gabriel | Engineering |
| 8 | chris | Engineering |
| 10 | carla | Engineering |
| 11 | anna | Engineering |
| 12 | roxanne | Engineering |
| 13 | kate | Engineering |
| 14 | jim kendricks | Carpentry |

On Holiday

| ID | Employee Name | Department |
|----|---------------|-------------|
| 7 | alex | Engineering |
| 9 | bianca | Engineering |

Date Selection

Please select a day

April 2020

| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
|-----|-----|-----|-----|-----|-----|-----|
| 30 | 31 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Today: 09/03/2020

Figure 23 Employees working and employees on holiday

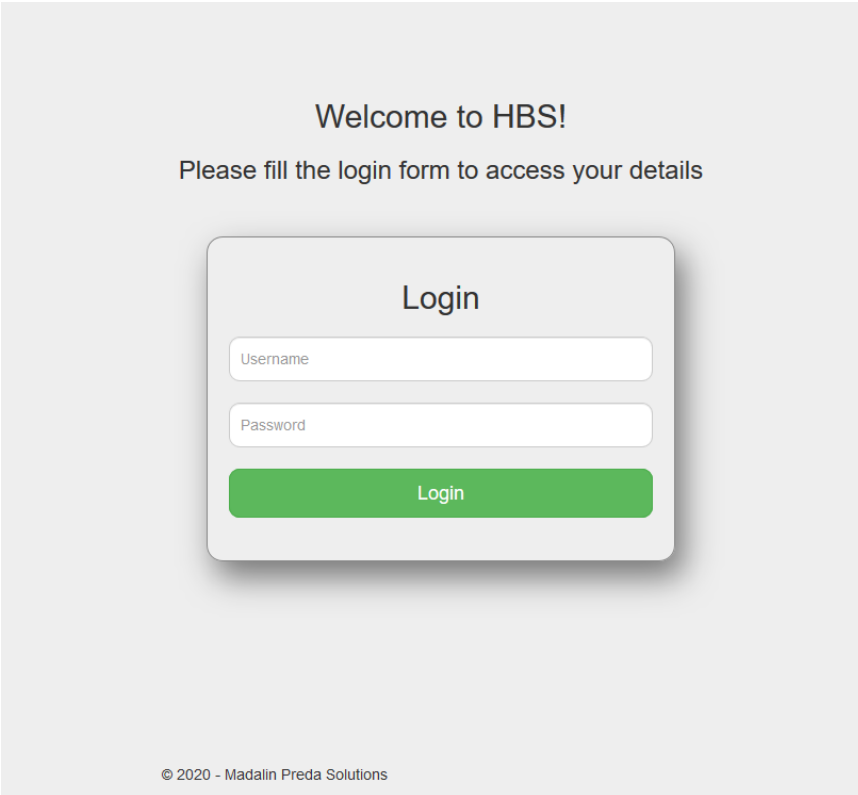
2.3.2 Functionality B

2.3.2.1 Phone Text Box Component

Phone Number:

Figure 24 Text becomes red if invalid input and only numbers allowed

2.3.2.2 ASP.NET Web forms Login



Welcome to HBS!

Please fill the login form to access your details

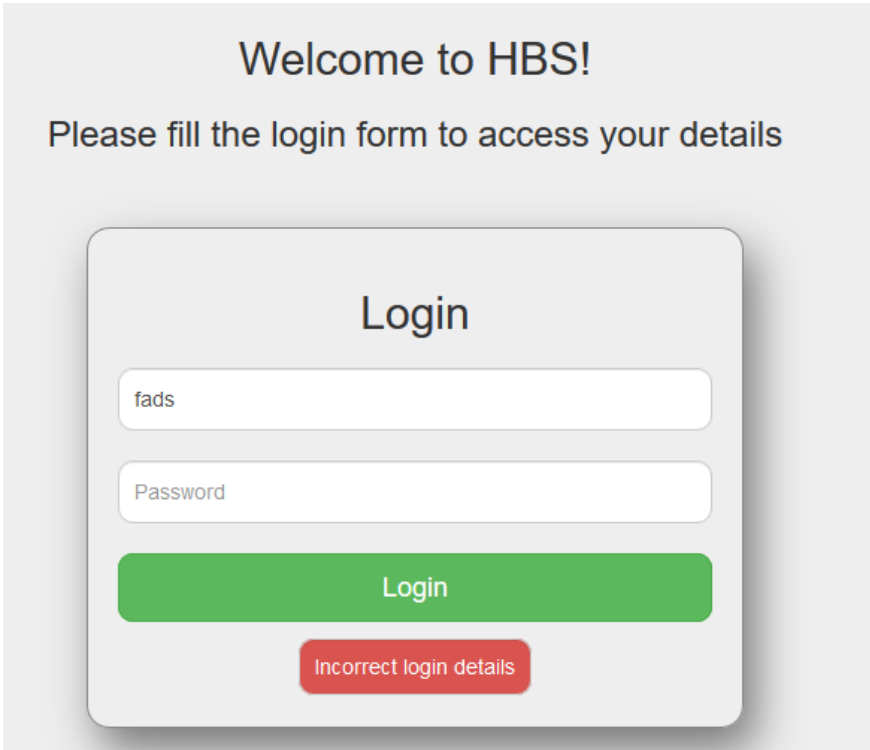
Login

Login

© 2020 - Madalin Preda Solutions

This screenshot shows a web form titled 'Welcome to HBS!' with a sub-header 'Please fill the login form to access your details'. The form is a light gray box with rounded corners. It contains a title 'Login', two input fields labeled 'Username' and 'Password', and a green 'Login' button. At the bottom, there is a copyright notice '© 2020 - Madalin Preda Solutions'.

Figure 25 Login Form



Welcome to HBS!

Please fill the login form to access your details

Login

Login

Incorrect login details

This screenshot shows the same login form as Figure 25, but with a failed login attempt. The 'Username' field now contains the text 'fads'. Below the 'Login' button, a red button with the text 'Incorrect login details' is visible.

Figure 26 Failed login

2.3.2.3 Submit holiday request

Submit a Holiday Request

Select Start Date

| < March 2020 > | | | | | | |
|----------------|-----|-----|-----|-----|-----|-----|
| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
| 24 | 25 | 26 | 27 | 28 | 29 | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | 1 | 2 | 3 | 4 | 5 |

Select End Date

| < March 2020 > | | | | | | |
|----------------|-----|-----|-----|-----|-----|-----|
| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
| 24 | 25 | 26 | 27 | 28 | 29 | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | 1 | 2 | 3 | 4 | 5 |

Submit

Figure 27 Submit Holiday Request

Please select a start date for at least 5 days in future.

Please select a start date first.

Please select a start date for at least 5 days in future.

You selected weekend days, no need for holiday allowance

End date must come after start date

Figure 28 Types of error messages

Submit a Holiday Request

Select Start Date

| < March 2020 > | | | | | | |
|----------------|-----|-----|-----|-----|-----|-----|
| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
| 24 | 25 | 26 | 27 | 28 | 29 | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | 1 | 2 | 3 | 4 | 5 |

Select End Date

| < March 2020 > | | | | | | |
|----------------|-----|-----|-----|-----|-----|-----|
| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
| 24 | 25 | 26 | 27 | 28 | 29 | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | 1 | 2 | 3 | 4 | 5 |

You requested 5 day(s) of holiday allowance from 19/03/2020 to 25/03/2020. Please submit if you are satisfied with your selection

Submit

Figure 29 Valid holiday request submission

Straight Walls Ltd - Holiday Booking system.

Success! Request submitted.

Holiday Request History

| Start Date | End Date | Duration | Status | Extra |
|------------|------------|----------|----------|----------|
| 07/08/2020 | 21/08/2020 | 11 | ACCEPTED | No Extra |
| 08/05/2020 | 12/05/2020 | 3 | ACCEPTED | No Extra |
| 01/05/2020 | 06/05/2020 | 4 | ACCEPTED | No Extra |
| 19/03/2020 | 25/03/2020 | 5 | PENDING | No Extra |

Figure 30 Confirmation request submitted

2.3.2.4 List of employee holiday requests and their status

| HBS | Submit Request | Requests History | Welcome, gabriel! | Logout |
|--|----------------|------------------|-------------------|----------|
| Straight Walls Ltd - Holiday Booking system. | | | | |
| Holiday Request History | | | | |
| Start Date | End Date | Duration | Status | Extra |
| 07/09/2020 | 11/09/2020 | 5 | ACCEPTED | No Extra |
| 11/08/2020 | 13/08/2020 | 3 | PENDING | No Extra |

Figure 31 List of employee's holiday requests

2.3.3 Functionality C

2.3.3.1 Constraint Checking Errors Display

| Outstanding Holiday Requests | | | |
|------------------------------|------------|------------|-------------|
| ID | StartDate | EndDate | WorkingDays |
| 15 | 11/08/2020 | 13/08/2020 | 3 |
| 21 | 14/05/2020 | 28/05/2020 | 11 |
| 23 | 22/10/2020 | 29/10/2020 | 6 |
| 19 | 07/04/2020 | 08/04/2020 | 2 |
| 24 | 15/07/2020 | 27/07/2020 | 9 |
| 26 | 15/07/2020 | 27/07/2020 | 9 |
| 25 | 15/07/2020 | 27/07/2020 | 9 |
| 27 | 19/03/2020 | 25/03/2020 | 5 |
| | | | |

Figure 32 Requests breaking constraints (red), valid requests (green)

| Outstanding Holiday Requests | | | | Approve/Reject Request | |
|------------------------------|------------|------------|-------------|------------------------|--|
| ID | StartDate | EndDate | WorkingDays | | |
| 15 | 11/08/2020 | 13/08/2020 | 3 | | |
| 21 | 14/05/2020 | 28/05/2020 | 11 | | |
| 23 | 22/10/2020 | 29/10/2020 | 6 | | |
| 19 | 07/04/2020 | 08/04/2020 | 2 | | |
| 24 | 15/07/2020 | 27/07/2020 | 9 | | |
| 26 | 15/07/2020 | 27/07/2020 | 9 | | |
| 25 | 15/07/2020 | 27/07/2020 | 9 | | |
| 27 | 19/03/2020 | 25/03/2020 | 5 | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Breaking Constraints

No employee can exceed the number of days of holiday entitlement

Either the head or the deputy head of the department must be on duty

At least one manager and one senior staff member must be on duty

At least 60% of a department must be on duty

Figure 33 Constraints Broken Highlights

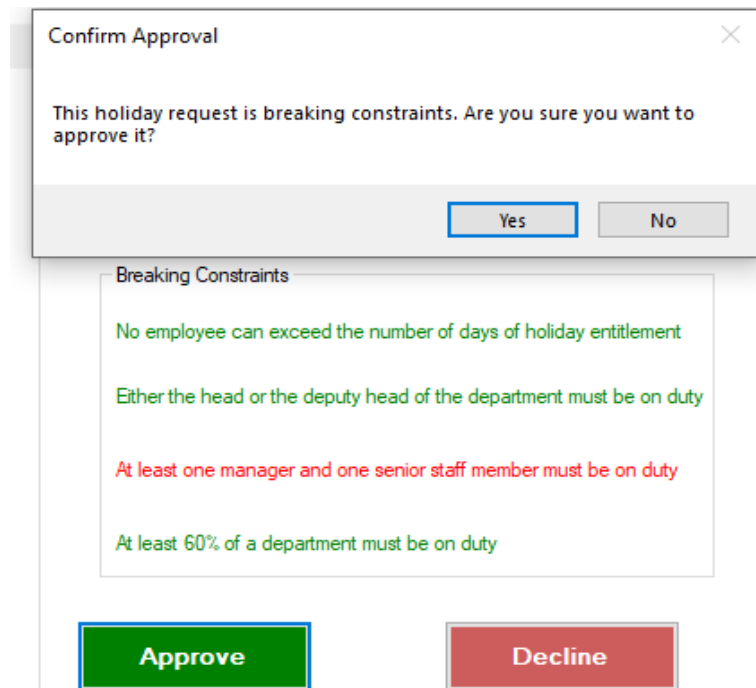


Figure 34 Approving holidays that break constraints

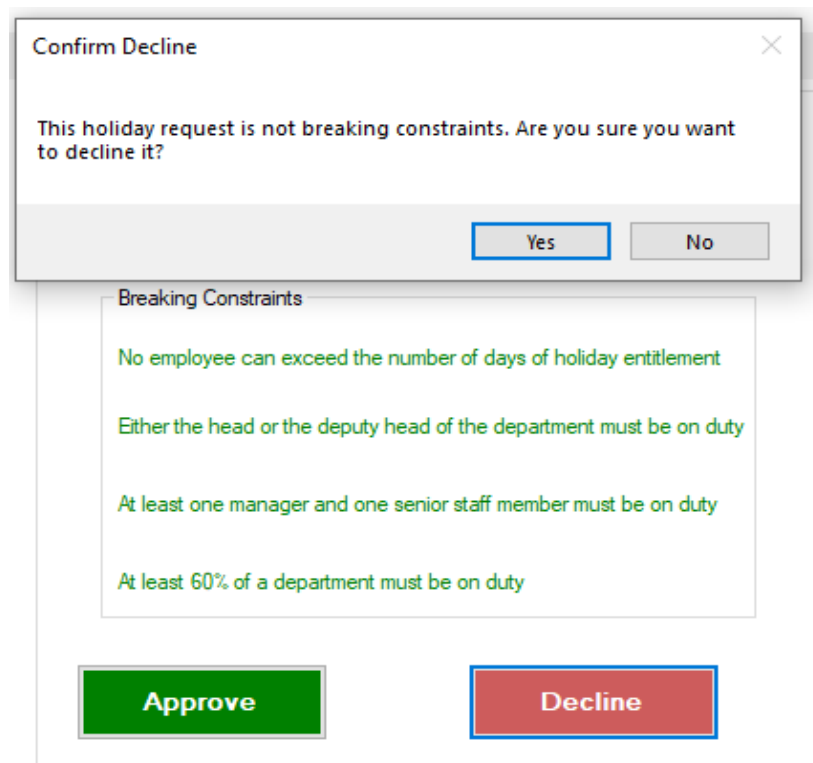


Figure 35 Declining holidays that do not break constraints

2.3.4 Functionality D

2.3.4.1 Web Service

EmployeeService

The following operations are supported. For a formal definition, please review the [Service Description](#).

- [EmployeeLogin](#)
- [HolidayRequest](#)

Figure 36 SOAP Web Service exposed methods

2.3.4.2 Mobile App Employee Login

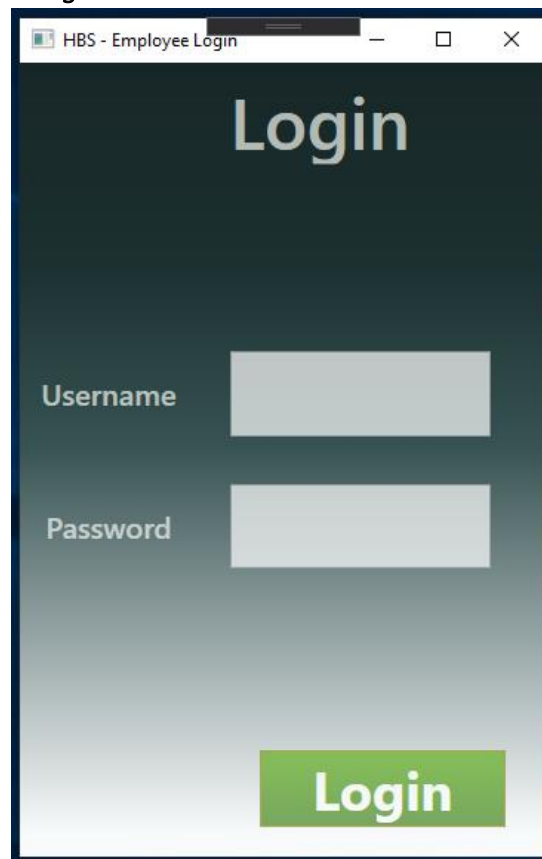
A screenshot of a mobile application window titled "HBS - Employee Login". The window displays a login form with a dark blue header containing the word "Login" in white. Below the header, there are two input fields: "Username" and "Password", each with a light gray rectangular input box. At the bottom of the form, there is a green rectangular button with the word "Login" in white text. The background of the form is a gradient from dark blue at the top to light gray at the bottom.

Figure 37 Login form employee app

The screenshot shows a web browser window titled "HBS - Employee Login". The page has a dark blue header with the word "Login" in white. Below the header, there are two input fields: "Username" with the value "klfdasmfk" and "Password" with masked characters. A red error message "Invalid login attempt" is displayed below the password field. At the bottom, there is a green "Login" button.

Figure 38 Attempt to login with wrong credentials

2.3.4.3 Employee app make holiday request

The screenshot shows a web browser window titled "HBS - Holiday Request". The page has a dark blue header with a green "Logout" button. Below the header, the title "Request Holiday" is displayed. There are two date input fields: "Start Date" with the value "14/03/2020" and "End Date" with the value "14/03/2020". At the bottom, there are two buttons: a red "Reset" button and a green "Submit" button.

Figure 39 Submit holiday request

The screenshot shows a web browser window titled "HBS - Holiday Request". The page has a dark blue header with a "Logout" button. Below the header, the title "Request Holiday" is centered. There are two date input fields: "Start Date" with the value "26/03/2020" and "End Date" with the value "27/03/2020". Both fields have a calendar icon to their right. Below the date fields, a red error message states: "End date must come after start date". At the bottom of the form, there are two buttons: "Reset" (orange) and "Submit" (green).

Figure 40 Making an invalid request

The screenshot shows the same "HBS - Holiday Request" form. The "Start Date" field now contains "21/03/2020" and the "End Date" field contains "26/03/2020". Below the date fields, a green success message states: "You are asking for 4 day(s) of holiday allowance." The "Reset" and "Submit" buttons remain at the bottom.

Figure 41 App checks how many days user asked for

The screenshot shows a web browser window titled "HBS - Holiday Request". At the top left is a green "Logout" button. The main heading is "Request Holiday". Below it are two date pickers: "Start Date" set to "21/03/2020" and "End Date" set to "22/03/2020". Both date pickers have a small calendar icon with the number "15" on the right. Below the date pickers, a green message states: "You are asking for 0 day(s) of holiday allowance." At the bottom are two buttons: a red "Reset" button and a green "Submit" button.

Figure 42 App lets user know if they select weekend days

The screenshot shows the same "Request Holiday" form. The "Start Date" is now "23/03/2020" and the "End Date" is "26/03/2020". Below the date pickers, a green message states: "Holiday Request Submitted". The "Reset" and "Submit" buttons remain at the bottom.

Figure 43 Feedback on request submission

2.3.5 Functionality E

2.3.5.1 Prioritization of Holiday Requests

| Outstanding Holiday Requests | | | |
|------------------------------|------------|------------|-------------|
| ID | StartDate | EndDate | WorkingDays |
| 28 | 23/03/2020 | 26/03/2020 | 4 |
| 15 | 11/08/2020 | 13/08/2020 | 3 |
| 23 | 22/10/2020 | 29/10/2020 | 6 |
| 26 | 15/07/2020 | 27/07/2020 | 9 |
| 25 | 15/07/2020 | 27/07/2020 | 9 |
| 21 | 14/05/2020 | 28/05/2020 | 11 |
| 19 | 07/04/2020 | 08/04/2020 | 2 |
| 27 | 19/03/2020 | 25/03/2020 | 5 |

Figure 44 Rows are ordered by priority

2.3.5.2 Suggestions of Suitable Holiday

| Outstanding Holiday Requests | | | |
|------------------------------|------------|------------|-------------|
| ID | StartDate | EndDate | WorkingDays |
| 28 | 23/03/2020 | 26/03/2020 | 4 |
| 15 | 11/08/2020 | 13/08/2020 | 3 |
| 23 | 22/10/2020 | 29/10/2020 | 6 |
| 26 | 15/07/2020 | 27/07/2020 | 9 |
| 25 | 15/07/2020 | 27/07/2020 | 9 |
| 21 | 14/05/2020 | 28/05/2020 | 11 |
| 19 | 07/04/2020 | 08/04/2020 | 2 |
| 27 | 19/03/2020 | 25/03/2020 | 5 |

Approve/Reject Request

[Check suggestions](#)

Breaking Constraints

No employee can exceed the number of days of holiday entitlement

Either the head or the deputy head of the department must be on duty

At least one manager and one senior staff member must be on duty

At least 60% of a department must be on duty

Figure 45 Suggestions button shows if request falls during peak times

Approve/Reject Request

[Check suggestions](#)

List of Suggestions

| Start Date | End Date |
|------------|------------|
| 04/08/2020 | 06/08/2020 |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

Please select one suggestion

[Ask employee](#)

Figure 46 If suggestions available a list is returned

Approve/Reject Request

Check suggestions

List of Suggestions

| Start Date | End Date |
|------------|----------|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

No suggestions found

Figure 47 If no suggestions available

2.3.6 Functionality F

2.3.6.1 Custom Holiday Bookings Visualization Component

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|--------|---------|-----------|----------|--------|----------|--------|
| ► | | | | | | | 1 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| | 30 | 31 | | | | | |
| | | | | | | | |

Figure 48 Calendar Visualization Component

Employee Bookings

Selected Month: March 2020

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|--------|---------|-----------|----------|--------|----------|--------|
| ▶ | | | | | | | 1 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| | 30 | 31 | | | | | |

Selection

Department:

Employee:

Year:

Month:

Find Holidays

Figure 49 User Control integrating the component

Employee Bookings

Selected Month: August 2020

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|--------|---------|-----------|----------|--------|----------|--------|
| ▶ | | | | | | 1 | 2 |
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| | 24 | 25 | 26 | 27 | 28 | 29 | 30 |

Selection

Department:

Employee:

Year:

Month:

Find Holidays

Figure 50 Displaying Days employee is on holiday

3 EVALUATION

Before starting to work on the coursework it seemed a nearly impossible task to finish all the requirements because we had to develop various applications (Web, Desktop and Mobile Applications) that do not entirely behave the same, especially when it comes to User Interface (UI) design and components control. Although the tools that come together with ASP.NET looked similarly on the surface, such as Visual components like TextBox, Button and others, they would have few differences when discussing matters such as properties and exposed events, this has been observed by comparing those elements from Windows Forms to Web Forms to Windows Presentation Foundation pages. Such

difficulties required more time to be spend on understanding the way things work within each of the app building formats mentioned previously so that implementations can benefit from similar quality of User Interface, Input checks and validation, and error handling.

Additional problems emerged from the use of Entity Framework and integrating the Web Service with the mobile application. Generating an ADO.NET Data model from a database it is quite a simple task when using Entity Framework to take care of it. However, when it comes to changes that take place within the database and the model is required to update, it will suffer at times, in particular when a table is deleted or a column is changed, in such case scenarios there are times when errors occur and is hard to discover how to fix those problems, few times the model was deleted and completely scaffolded again, and this used to fix everything. The SOAP (Simple Object Access Protocol) Web Service is another example of struggles that I encountered, first time I created a separated project and added it there, but there seemed to be an issue when reopening the solution, such that the mobile app should run a command to update the service reference before actually running the app. Moreover, when the Web Service was moved to reside inside the Web application, the session used with the Web Service started malfunctioning so that once user logged in, the session ID changes when making the second request from the mobile app. Nevertheless, a temporary solution was found so that user credentials are stored in the mobile app and sent together with other data for submitting a holiday request, even though SSL (Secure Sockets Layer) is enabled on the Web Service, it still represents a risk. Preventing the exposure mentioned before can be done by using a token (JSON Web Token is quite popular) and passed with data on every request, that could have been accomplished if there was more time to work on it.

The solution is meant to provide high quality code as subsequent components were created to have high cohesion and low coupling as it is quite important in software design for object-oriented programming. Although, some classes might depend a bit more on others, in some cases polymorphism was used to reduce coupling, so that some dependencies can be at times avoided, for example the case of using classes like HolidayRequests when only StartDate and EndDate are needed can be avoided, by using the example of DateRange class which can store those two values and avoid carrying Navigation Properties from Entity Framework and other irrelevant data. However, it was not always the case that this has been attempted, thus some refactoring might decrease coupling between components.

There were some additions that were not required, but I decided they might be useful such that both, web application and mobile app allow users to log out. Additionally, the mobile app was designed with Windows Presentation Foundation pages which comes in XAML (Extensible Application Markup Language) format that describe user interface elements for software applications designed for Windows Phone apps, meaning that they could potentially be used for actual phones already, the coursework was merely asking for a desktop app prototype. Moreover, the implementation provides an individual helper class Desktop app, which is called DesktopAppUtils, and is mainly used for seeding the database if no data records are found, so that testing can be done with some fictional data. Furthermore, a SolutionUtils project was created and contains some of the components required as part of functionalities for PART B, however there is an additional class called GeneralUtils which is a static type, designed to provide typical functions that need to be used across the different projects created and provide with Constants/Variables so that very little hardcoded values are used within the solution, thus when in need of changing a role name, department name or boundaries for some conditions it can be done from within this class.

The naming conventions used were mainly similar to JavaScript camelCase notation for methods and variables, although C# seems to have use a different naming convention for those, nevertheless classes and namespaces were always named starting with uppercase letter. Sensible naming standards were used throughout and comments added were things might be confusing. Adding code on top the existing one should be quite easy, and changing the data source should not represent a problem as all the projects are bound to the same object meaning that a change in there should be reflected in all three, Desktop app, Web app and Web service.

One of the downsides of my solution is that it lacks of unit testing, although a lot of white box testing was performed, this would never be enough, therefore unit testing should be a must. Another disadvantage might be that it technically works only for the current year to make holiday requests, thus this is clearly a limitation, if more time was available the system would have been designed so that it would overcome this impediment, therefore moving to a new year will mean resetting holiday entitlement manually for each user for now. Also, for making suggestions the assumption was that they will only be available for users breaking constraints during peak times, and once a suggestion seems feasible to the administrator, it is reflected for the specific employee on the Web application side, however he cannot accept, nor decline the suggestion for now, it could be implemented if more time was given. Furthermore, constraint checking should also be done every time when outstanding

holidays are viewed by the administrator in the desktop app because if a request is accepted, then the next one selected may break a constraint and if that happened the two may interfere if they had intercalating dates span.

4 ALGORITHM

The constraint checking implementation has been done by creating a class called `ConstraintChecking` which resides inside `SolutionUtils` project since it is needed to be used in three places, Desktop Application, Web Service and Web forms. The component exposes few methods, amongst which one is a static method that allows checking if a `ConstraintsBroken` class contains any broken constraints. There are two constructors created, one of them expects two parameters which are of `User` and `HolidayRequest` types such that when the object is created, all the users from the given department of the user passed as an argument are fetched from database. The component allows changing the holiday request that is being evaluated and there are two public methods available for checking if any constraints are broken, `getBrokenConstraints()` returning an object containing the status of the constraints that are checked, the other called `isItBreakingConstraints()` which returns whether any constraint is broken or not.

The most important method, that resides at the base of most algorithms that require checks of whether two date spans (example: 03/11/2011-07/12/2011 and 06/11/2011-10/11/2011) have any intersecting dates in between, is called `isOverlappingDateRanges()` (also, `isOverlappingHolidayRequests()` for `HolidayRequests` arguments type) and since the checks are always done for possible holiday bookings, meaning that they should be situated somewhere in the future, this is one of the first checks done within the function. The algorithm is shown down below (Figure 51).

```
public static bool isOverlappingDateRanges(DateRange existing, DateRange newAdded)
{
    return existing.EndDate > DateTime.Now
        && ((existing.EndDate >= newAdded.StartDate && existing.EndDate <= newAdded.EndDate)
            || (existing.StartDate <= newAdded.EndDate && existing.StartDate >= newAdded.StartDate)
            || (existing.StartDate <= newAdded.StartDate && existing.EndDate >= newAdded.EndDate));
}
```

Figure 51 Overlapping date ranges

The algorithm written for the purpose of prioritizing holiday requests makes use of a custom class called `PriorityRequest` which stores data related to a `HolidayRequests`, `Users` and `ConstraintsBroken` tables from the database. This custom class implements the `IComparable` interfaces so that a custom

sorting can be implemented for this class, thus some conditions were written to meet the prioritisation criteria required within the coursework specification. PriorityRequest makes use of another class called BreakingConstraints which contains same properties as ConstraintsBroken class which is part of the Database Model generated by Entity Framework, but I decided not to use that one so as to reduce the dependencies. The component that takes care of requests prioritisation (PrioritiseRequests class) exposes two methods, one that returns the list of holiday requests in a prioritized order and a second method, daysFallPeakTimesCount, which returns the number of days that fall during peak time periods for a given range of dates. The conditions for prioritisation can be seen in Figure 52.

```
//when x should go first, return -1. When y should go first, return 1.
if(x.InitialHolidayEntitlement - x.RemainingDays > y.InitialHolidayEntitlement - y.RemainingDays)
    return 1;
if (x.TotalPeakDaysHoliday > y.TotalPeakDaysHoliday)
    return 1;
if (x.RemainingDays >= y.RemainingDays)
    return -1;
if (x.DaysPeakTime == 0)
    return -1;
if (y.DaysPeakTime == 0)
    return 1;
return 0;
```

Figure 52 Conditions for prioritization

The component used to find suggestions for a holiday request that breaks constraints exposes only one method which returns a list of DateRange objects. The algorithm is designed so as to make suggestions by checking within a given range of the currently analyzed holiday request, however the limit can be changed for both ends by editing the value of the constant SUGGESTIONS_MAX_DAYS_BOUNDARY that can be found in GeneralUtils class. Before starting the calculus for possible suggestions, the algorithm checks if the broken constraint is the one regarding the Holiday Entitlement Exceeded, if that is the case then the holiday length is reduced to the number of days left from holiday entitlement and suggestions are made based on a new holiday end date calculated from the difference between the holiday entitlement left and the number of days requested initially. There are two methods that make suggestions by keeping the same length of the initial holiday request, calculateSuggestionsBeforeStartDate and calculateSuggestionsBeforeEndDate, which attempt to make suggestions by equally moving the given number of days before the selected start date, respectively after the selected end date. Moreover, there are two other methods that perform calculus for suggestions by gradually reducing the number of days to half, calculateSuggestionsByReducingDaysFromStart and calculateSuggestionsByReducingDaysFromEnd,

by using the same start date, respectively the same end date. All the suggestions are done by checking whether any constraints are broken before adding it to the list of suggestions, therefore any suggestion will not break any constraint. Also, a limit can be set to the number of returned suggestions by editing the value of the constant field `MAX_SUGGESTIONS_COUNT` which can be found inside `GeneralUtils` class.