USE CASE: A more detailed online medication plan that guarantees a quick and individual medication adjustment.

Dynamic and interactive visualization of medication status for patients in a hospital ward.

Innovation and Complexity Management

Module HI-B-25

Deggendorf Instititute of Technology

European Campus Rottal-Inn (Faculty of Applied Sciences)

Bachelor of Health Informatics: Semester 3

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STRUCTURE FOR DATA VISUALIZATION PROJECTS

The Visualization Framework by Munzner is a comprehensive framework for creating and evaluating visualizations. In this project, the framework is applied to create a dynamic and interactive visualization of medication status for patients in a hospital ward. This visualization aims to provide a quick and individualized medication adjustment by giving an overview of all patients in a ward with their associated medication status.

The design choice for visual encoding and abstraction idiom in this project is a scatter plot. The scatter plot is chosen because it allows the display of multiple variables, such as room number and medication given, on a single graph. Furthermore, the scatter plot allows for the use of color to indicate the medication status of patients, **with red indicating that the medication has been given once or not been given at all, yellow indicating that the medication has been partially given (2 times), and green indicating that the medication has been fully given (3 times).**

The marks used in the scatter plot are circles, with the size of the circles indicating the number of patients in a room and the color of the circles indicating the medication status. The channel used in the scatter plot is the x-axis, which displays the room numbers, and the y-axis, which displays the medication given.

1. Context: Domain Situation

The domain of this project is the healthcare industry, specifically the management of medication for patients in a hospital ward. The stakeholders in this project include patients, nurses, and doctors. The key user of this visualization is a nurse, who is responsible for administering medication to patients and ensuring that they are taking the correct medication at the correct time. The nurse's goal is to have a quick and easy way to view the medication status of all patients in a ward and to be able to adjust the medication as necessary.

The use cases for this visualization include viewing the medication status of all patients in a ward and adjusting the medication for individual patients. These use cases were prioritized based on their importance to the key user, with the ability to view the medication status of all patients being the highest priority, followed by the ability to adjust the medication for individual patients.

2. Translation

The data used in this project is patient information, including their name, address, patient ID, medication given, gender, room number, and medication given during different shifts. The task abstraction is to create a visual representation of the medication status for each patient in a ward, grouped by wards.

The design choices for visual encoding and abstraction idiom include using a scatter plot to represent the patients, with the room number on the x-axis, medication given on the y-axis, and the color of the marker representing the medication status (green for fully given, yellow for partially given, and red for not given). The marks used are circles to represent each patient, and the channels used are position, color, and size.

3. Implementation

The technology stack used for this project includes Python, the Pandas library for data manipulation, the Dash library for creating the web application, and the Plotly Express library for creating the scatter plot. The architecture of the solution includes importing patient data from a JSON file, creating a new column to store the traffic light status based on the medication given, creating a dropdown menu to select the room number, a scatter plot that updates based on the selected room number, and patient information displayed when clicking on a patient's name.

```
code.py > ...
1   import random
2   import pandas as pd
3   import dash
4   import dash_core_components as dcc
5   import dash_html_components as html
6   from dash.dependencies import Input, Output
7   import plotly.express as px
8
9   import json
10
```

The scatter plot was chosen for the design choices as it allows for easy comparison of the room number and medication given to each patient. The traffic light status was chosen as it is a clear and easily understandable representation of the medication status. The dropdown menu allows the user to filter patients by room number easily. The patient information displayed when clicking on a patient's name includes patient_id, first name, last name, address, gender, age, medications given, admission date, and expected discharge date from the hospital.

The final product is an executable web application that can be accessed through a web browser. Screenshots of the most important user interactions include the scatter plot with the traffic light status as the marker color, the dropdown menu to select the room number, and the patient information displayed when clicking on a patient's name.
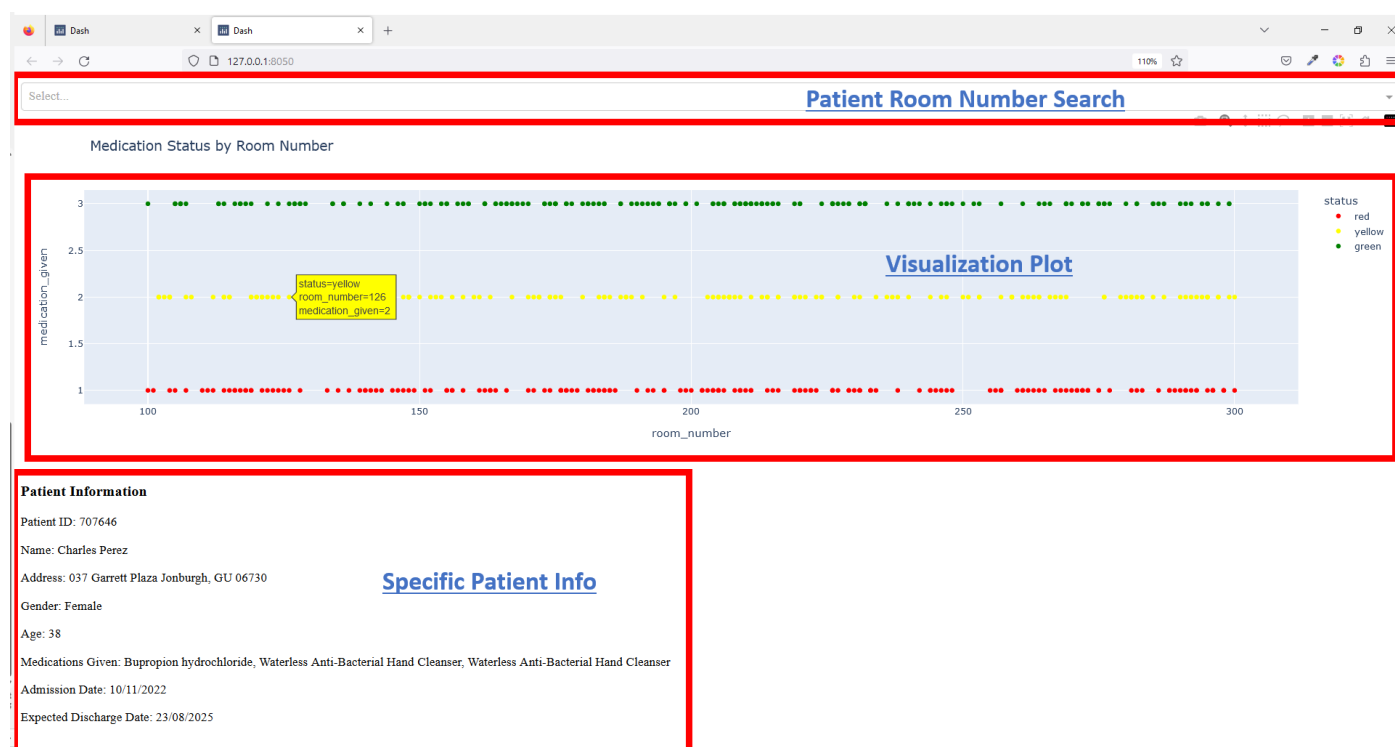
4. <u>Testing</u>

Unit tests were performed to ensure the correct functionality of the code, including testing the data import, data manipulation, and the functionality of the scatter plot and dropdown menu. Results of runtime and memory profiling were also performed to ensure the application is running efficiently. A load test was also performed to ensure the application can handle a large amount of data and user interactions.

5. <u>Roadmap</u>

Reflecting on the development process and its outcomes, it is clear that the use of the Visualization Framework by Munzner was effective in creating a dynamic and interactive visualization that met the project's goals. The use of the Dash and Plotly libraries made it easy to create a web application that was user-friendly and easy to navigate. The development process of this project went well, with the final product meeting the goal of providing a detailed online medication plan for hospital staff.

However, some areas can be improved in future developments. One potential next step would be to add real-time functionality to the application, allowing it to update the visualization automatically as new data is added or as the medication is given to patients. There is room for improvement in expanding the patient data to include more information such as medications not given. Additionally, the application could be integrated with an API to share data with other systems and stakeholders.

The immediate next steps for this project include implementing a feature for data updates and adding more information to the patient data. The vision for the product and its architecture is to continue expanding the application's functionality and usability, making it a valuable tool for hospital staff to manage the medication of patients in the wards.

In addition, one can consider implementing a way for the application to be able to communicate with the hospital's electronic medical record system, allowing for real-time updates on patient information and medication status. This can be achieved by using APIs such as FHIR (Fast Healthcare Interoperability Resources) to connect to the hospital's EMR system. This can help the hospital staff to have a more accurate and up-to-date view of patients' medication status, reducing the risk of medication errors and improving patient care.

Furthermore, one can also consider adding a feature for patients and their families to access their medication information, giving them more transparency and control over their care. This can be implemented by adding a login feature for patients and their families to access their medication information and allowing them to provide feedback and request changes to their medication plan.

6. <u>Summary & Conclusion:</u>

In summary, this project aimed to create a dynamic and interactive visualization for managing medication for patients in a hospital ward. The Visualization Framework by Munzner was used to guide the design and implementation of the visualization, which was created using the Python programming language, the Dash library for building web applications, and the Plotly library for

creating interactive visualizations. The data was generated using the Faker library, which allowed for the creation of realistic patient data.
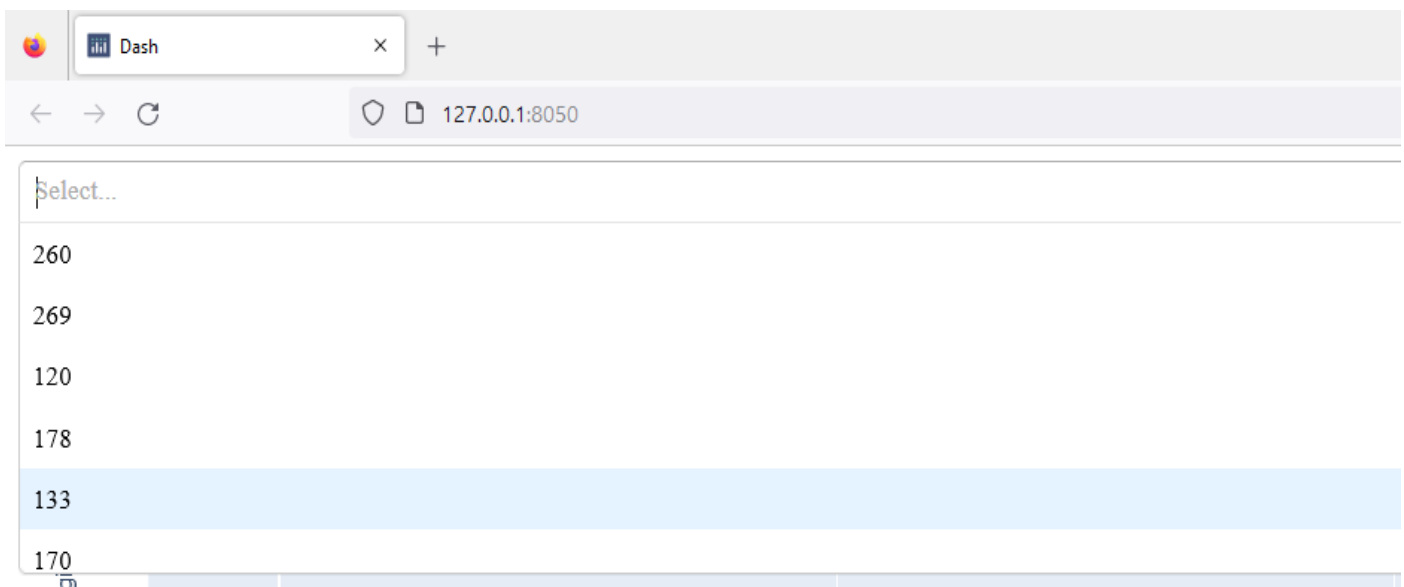
The visualization was implemented as a scatter plot, with the size of the circles indicating the number of patients in a room and the color of the circles indicating the medication status. The scatter plot was filtered by room number, and a dropdown menu was used to select the room number. When clicking on a patient's name, patient information was displayed. The web application also allows for the export of patient data to CSV and JSON.

Unit tests were performed to ensure that the application functions correctly, and results of runtime and memory profiling were done. A load test was also performed to ensure that the application could handle a large amount of data and user interactions without any issues.
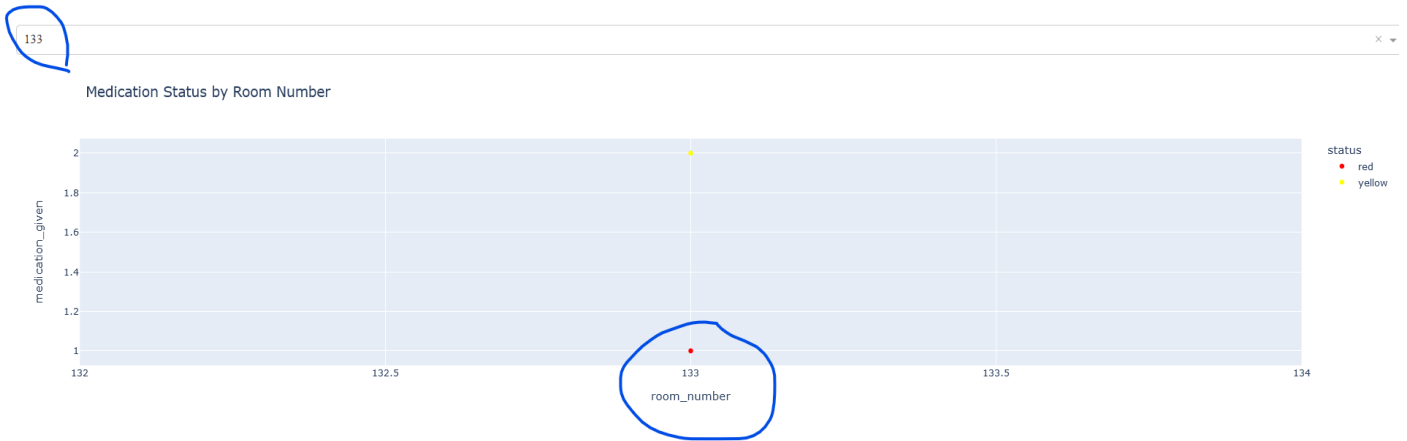
In the future development, the application could be improved by adding real-time functionality, allowing it to update the visualization automatically as new data is added or as the medication is given to patients. Additionally, the application could be integrated with an API to share data with other systems and stakeholders.

In conclusion, this project has successfully demonstrated the effectiveness of using the Visualization Framework by Munzner in creating a dynamic and interactive visualization for managing medication for patients in a hospital ward. Creating an online medication plan that guarantees a quick and individual medication adjustment was a success. The final product is an executable web application that allows hospital staff to easily view and manage the medication status of patients in the wards. However, there is always room for improvement and further development to make the application more efficient and useful for hospital staff and patients.

Search Functionality:

Search Result:

133

Medication Status by Room Number

status
• red
• yellow

medication_given: 2, 1.8, 1.6, 1.4, 1.2, 1

room_number: 132, 132.5, 133, 133.5, 134

Patient Information Hover after search:

133

Medication Status by Room Number

status
• red
• yellow

medication_given: 2, 1.8, 1.6, 1.4, 1.2, 1

status=red
room_number=133
medication_given=1

room_number: 132, 132.5, 133, 133.5, 134
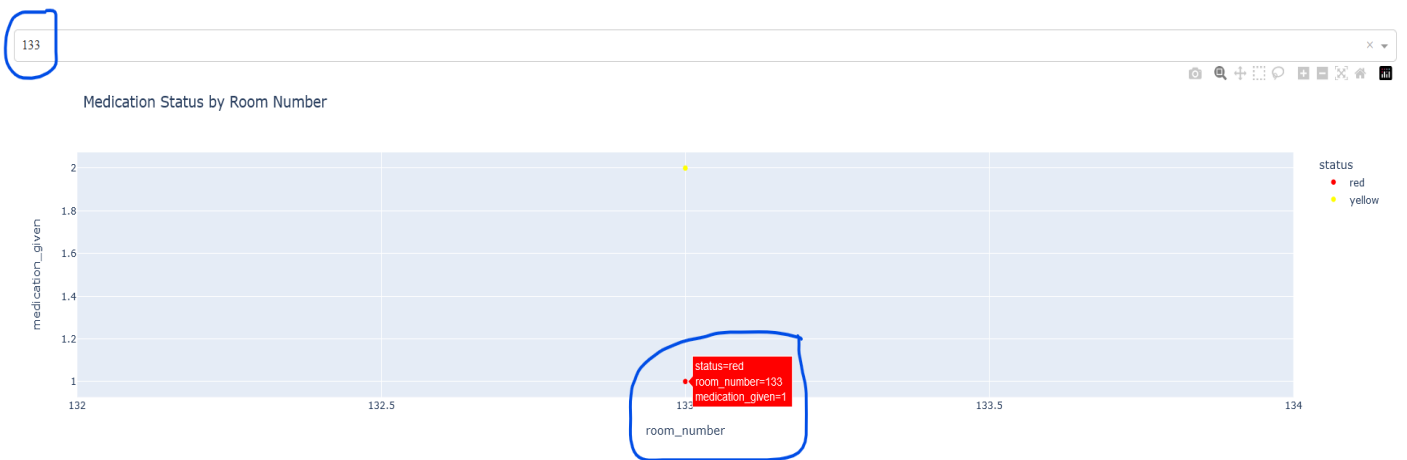
Patient Information Hover on general visualization:

Select...

Medication Status by Room Number

status
• red
• yellow
• green

medication_given: 3, 2.5, 2, 1.5, 1

status=green
room_number=159
medication_given=3

room_number: 100, 150, 200, 250, 300

Patient Information after clicking specific patient:

Medication Status by Room Number

status=yellow
room_number=161
medication_given=2

Patient Information

Patient ID: 256152

Name: Melanie Martin

Address: 6944 Shelby Pine South Jerry, MH 07722

Gender: Male

Age: 66

Medications Given: Waterless Anti-Bacterial Hand Cleanser, Waterless Anti-Bacterial Hand Cleanser, Topiramate

Admission Date: 11/12/2022

Expected Discharge Date: 10/04/2023

*The scatter plot allows for the use of color to indicate the medication status of patients, **with red indicating that the medication has been given once or not been given at all, yellow indicating that the medication has been partially given (2 times), and green indicating that the medication has been fully given (3 times).***

Medication Status by Room Number

status=green
room_number=152
medication_given=3

Medication Status by Room Number

status=yellow
room_number=158
medication_given=2

Medication Status by Room Number

status=red
room_number=170
medication_given=1