

Hospital Bed Availability

CS 573 Group Project - Process Book

Akim Ndlovu, Noëlle Rakotondravony, Xiaoshuai (Maksim) Li

Table of Content

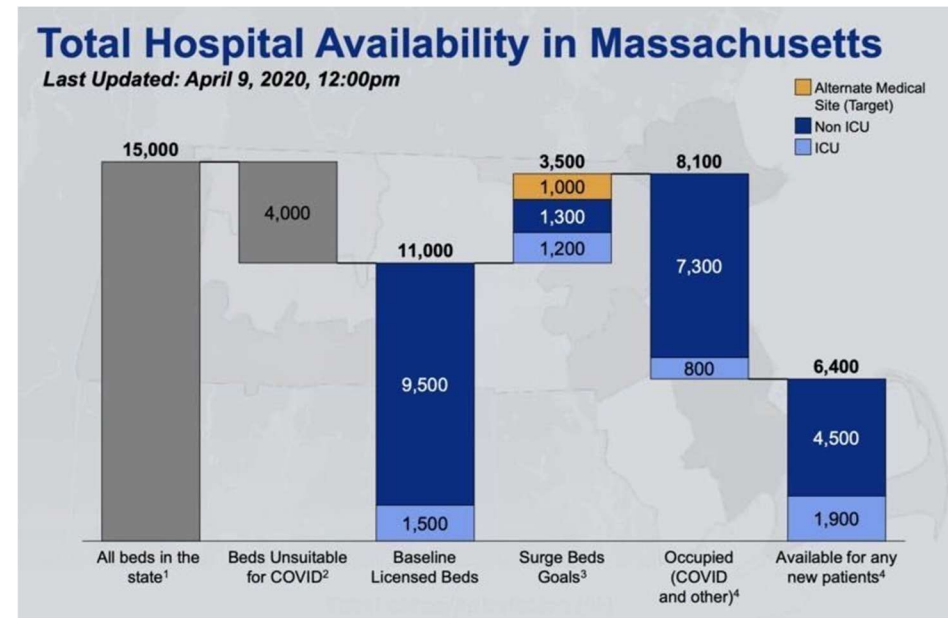
- Overview and Motivation
- Data
- Exploratory Data Analysis (EDA)
- Design Revolution
- Implementation
- Evaluation

Overview and Motivation

Overview and Motivation

The current covid-related visualizations have brought many questions related to visual design principles that are overlooked as designers rush to chart data at hand. This overlook can reduce confidence from the audience, in using visual communication channels to effectively and accurately communicate information. Visualizations that are developed without considering design principles can be ambiguous and misrepresent essential information.

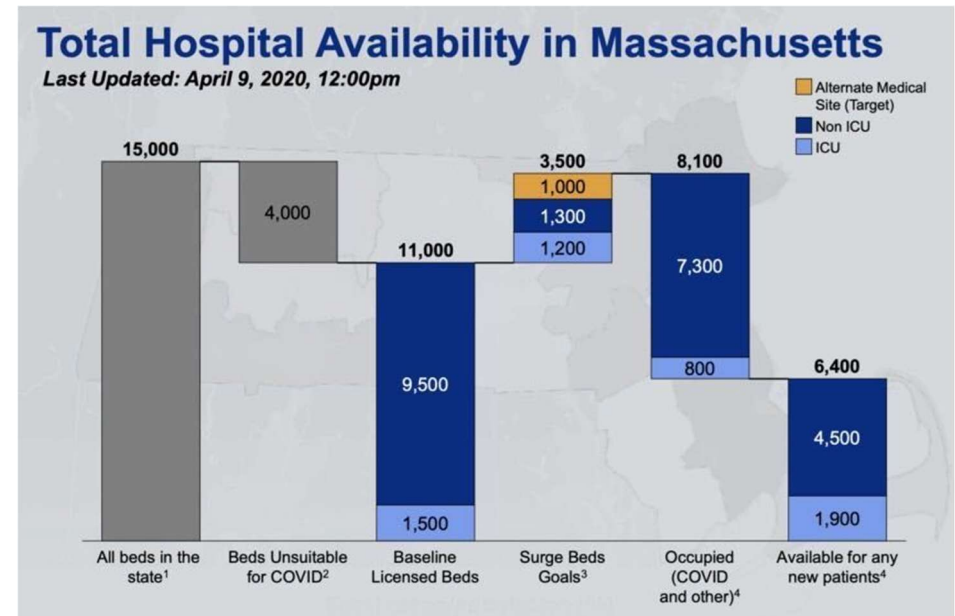
In April 2020, the state of Massachusetts released data about available hospital beds, accompanied with its visualization.



Overview and Motivation

Our critics for the visualization include:

- In comparison to a static visualization, interactivity gives a reader the possibility to explore the data, query necessary details, and update the visuals with most current data.
- For less astute individuals, the visualization requires a concise comprehension of the legend and the footnote definitions.
- Interactivity will allow simulation of what-if scenarios.

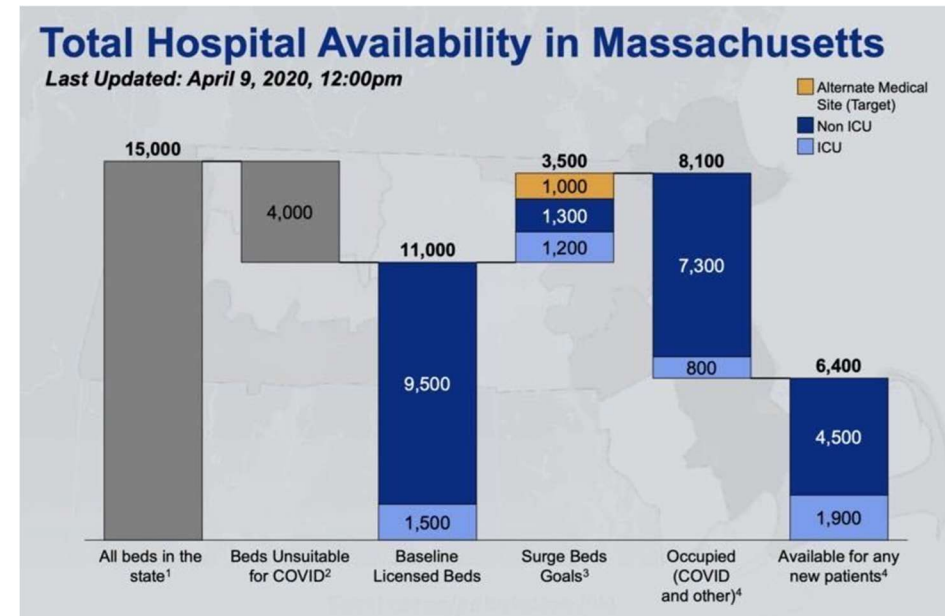


Overview and Motivation

In our project, we propose an alternative visualization with the following goals in mind

Provide an interactive tools that allows user enter hospital beds data and visualize up-to-date availability of hospital beds

- Provide interactivity to allow users query information on the chart when necessary
- Provide a generic tool that can be used by different regions or states to visualize their hospital bed availability and simulate what-if situations.
- Reorganize the bars in order to help the reader understand the context of the visualization.

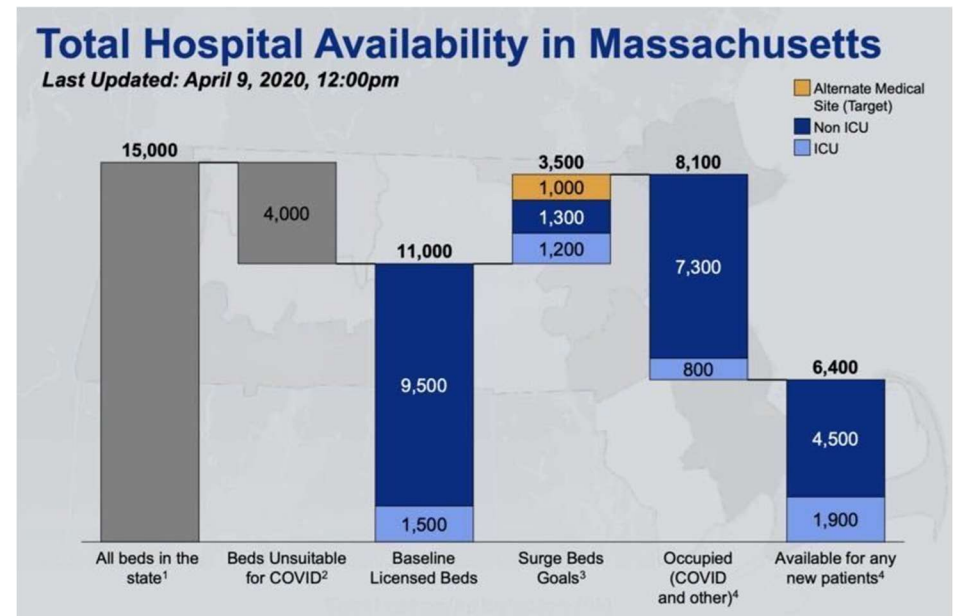


Data & Exploratory Data Analysis

Data & Exploratory Data Analysis

Data Source

[Coronavirus in Massachusetts Governor and Health Officials](#)



Data & Exploratory Data Analysis

The image to the right shows the breakdown of the original design.

Data visualization story line

There is a total of 15,000 bed in the state, of which

4,000 are unusable for covid and

11,000 are baseline licensed beds

Of the 11,000 usable beds for covid,

9,500 are non ICU beds

1,500 are ICU beds

As of the time the chart was published, of the baseline beds,

8,100 are occupied for both covid and other → leaving a total of 2900 available beds (all categories)

Of the occupied beds,

7,300 are non ICU → leaving $9,500 - 7,300 = 2,200$ available non ICU beds

800 are ICU beds → leaving $1,500 - 800 = 700$ available ICU beds

Moreover, the state targets a total of 3,500 surge beds that can be made available as ICU or non ICU beds if needed:

1,000 are from alternate medical site → making a total of $2,200 + 1000 = 3,200$ non ICU beds

1,300 non ICU beds → making a total of $3,200 + 1300 = 4,500$ non ICU beds

1,200 ICU beds → making a total of 1,900 ICU beds

Therefore, the total number of available beds is $4,500 + 1,900 = 6,400$ beds

Design Evolution

Design Evolution

Stage 1 - Brainstorming Project Ideas

The first stage of our visualization process consisted of brainstorming project ideas. Group members proposed some project ideas that might be ideal for the course's finals. We also shared reasons and concerns over all proposed topics. Prof. Lane Harrison also shared some project ideas for us to consider.

After reviewing the pros and cons of all ideas we had, we selected the idea proposed by the Professor.


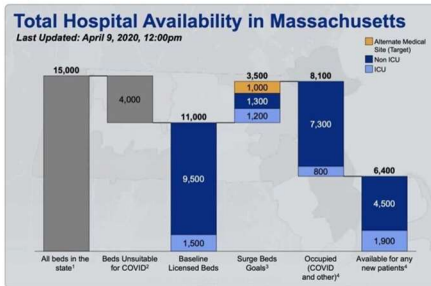
 ltharrison 4:59 PM

Image edition! Remake this and extend it. Get data sources. Critique design using book principles. Connect to parameters to explore "what if" scenarios.

Image from iOS



CS573 Project Idea Brainstorming

"Professor"

- What can surprise Maps tell us?
- on Variance in Measures given Mid-size Government Responses to COVID.
- Remake the visualization of "Total Hospital Availability in Massachusetts" and extend it!

"Noëlle"


- Dance & Visualization
- Ballet
- Want to visualize how people move on stage to see how they occupy the stage during the performance.

"Akim"

- Visualization of Regional conflict in Africa.

"Maksim"

- climate change & wildfire
- COVID-19 related topics



Design Evolution

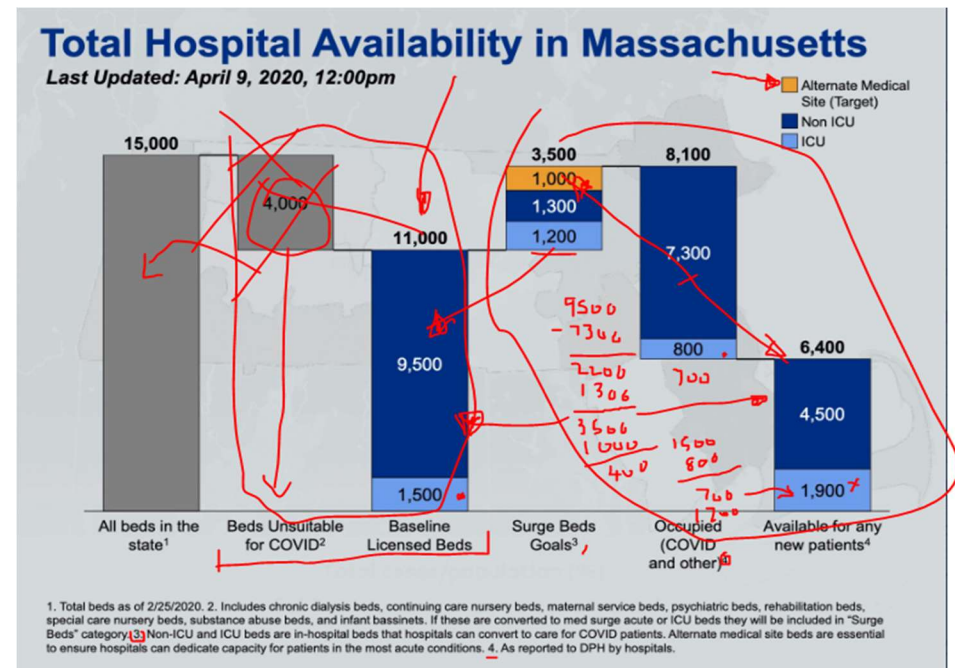
Stage 2 - Analyse The Original Design

In this stage, we tried to understand and critically analyse the original visualization (shown on the right). The visualization encodes a line mark with a vertical spatial position channel for the number of beds, and a horizontal spatial position channel for the different categories that the beds fall into. The visualization implements the use of a color channel to further split the categories into ICU, None ICU and Alternate Beds.

Evaluation for the original design:

Pros about original design: simple, direct and custom.

Cons about original design: very static and lack of interactivity.



Original Design with our sketches of calculation

Design Evolution

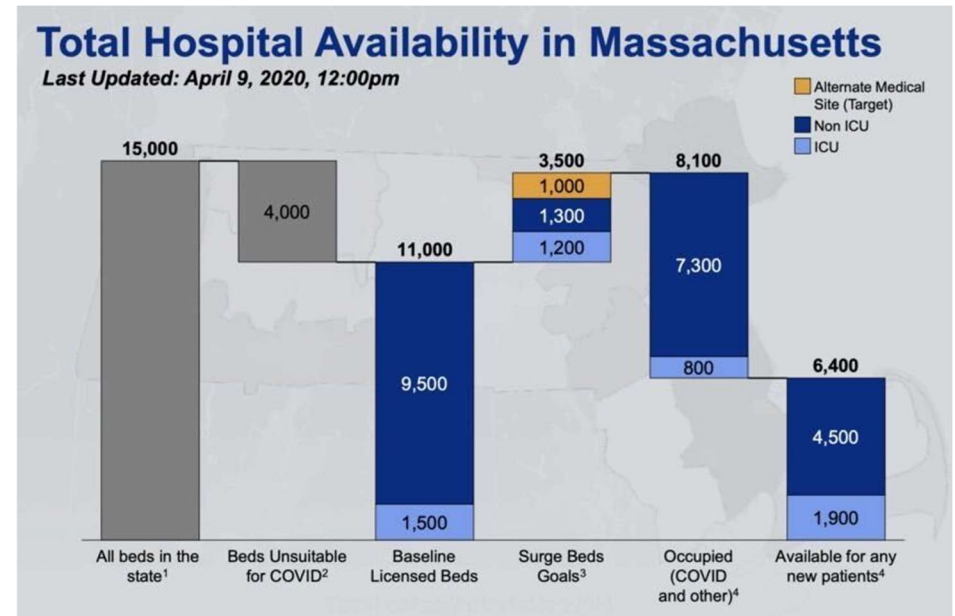
Stage 3 - Design Goal and Plan

After analysing the original design of the visualization, we focused on the design plan for the project.

Goal: Propose an alternative interactive visualization to effectively conveying the same information.

Plans:

1. Decide the required features that need to be implemented.
2. Create prototype of the design
3. Implement the original static design with D3.js.
4. Make the original design interactive by adding more features to the visualization (mouse overs)
5. Try alternate visualization that presents the same idea as the original design.
6. Create a webpage including the original chart, redesigned chart, and new visualization.
7. Evaluate the final project deliverable.



Original Design

Design Evolution

Required Design Features:

- Project description
- A web page to narrate all the designs
- Original static design
- New interactive visualization
- User input section where a user could input different numbers which will be reflected on the new design
- User input validation
- Alternate visualization that represents the same idea as original design
- Demo video
- Link to the project process book
- Group member evaluation

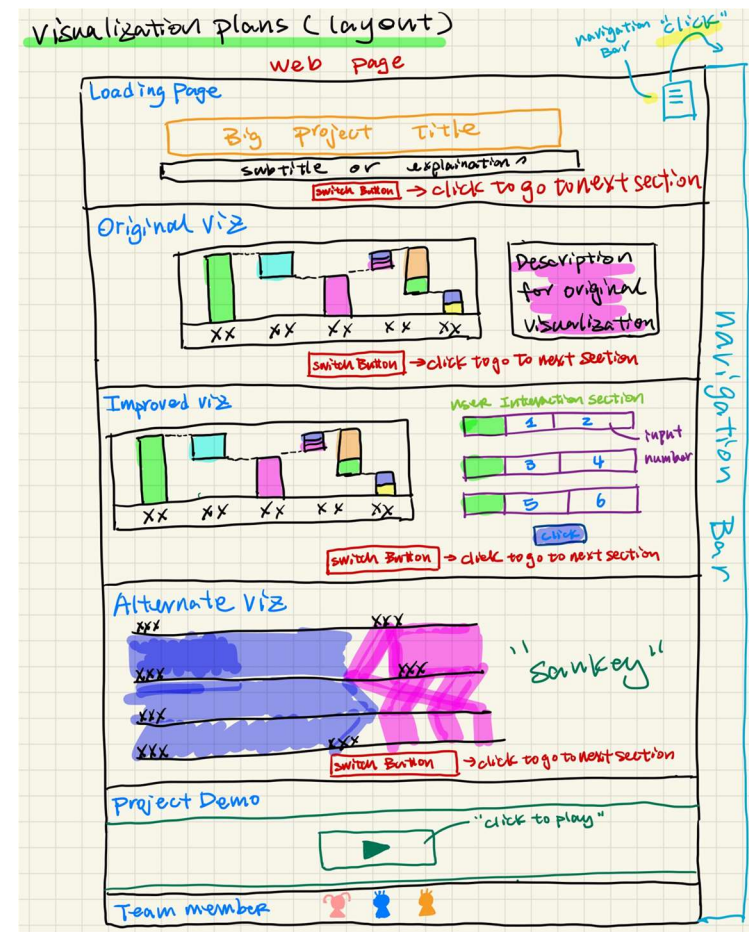
Design Evolution

Stage 4 - Web Page Layout

In this stage, we designed the general layout of our web page where all of our final visualizations locate. The figure on the right is the sketch of our web page layout of our visualization project.

We thought about various plans for layout and finally decided to adopt the design of single page view, which would make the flow of the navigation smooth.

The final visualization web page are divided into 6 sections: *Loading Page*, *Original Viz*, *Improved Viz*, *Alternate Viz*, *Project Demo*, and *Team Members*. Users can navigate by clicking the “switch button” on the bottom of each section or by using the pinned vertical navigation bar.



Design Evolution

Design Tools



Design Evolution

Design Process by Sections

Our final visualization design will consist 6 parts:

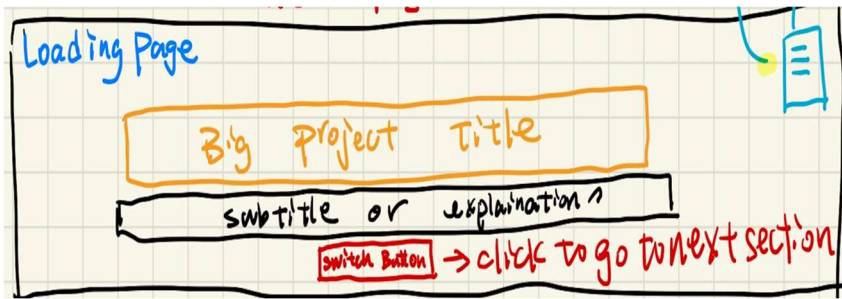
Loading Page, Original Visualization, Improved Visualization, Alternate Visualization, Project Demo, and Team Members.

The design goal is to add interactivity to the original design and provide some alternate visualizations which will present the same information in different perspectives. We explored couple of types of visualization and only kept ones that fit our project the best.

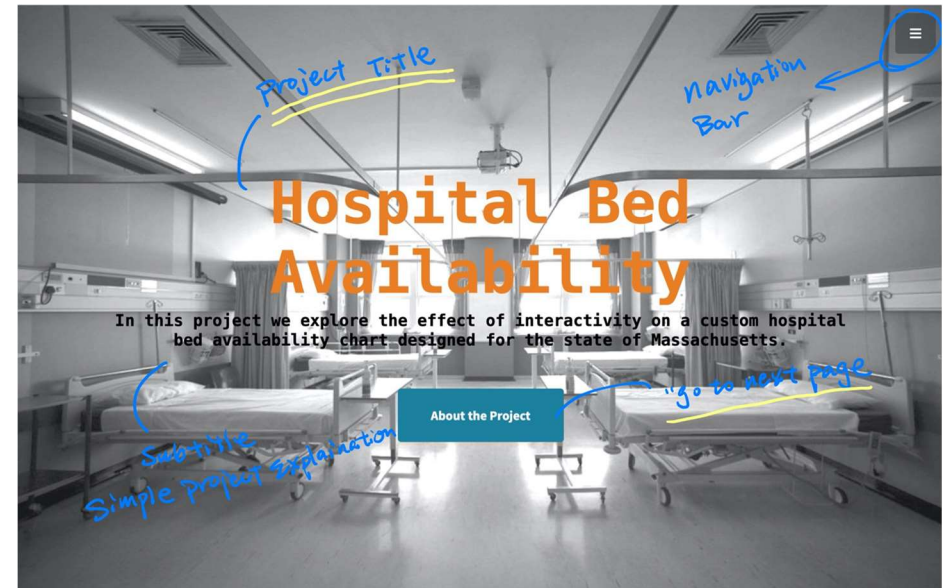
We hope our interactive design can make the audience become more engaged and eventually improve the user experience of the visualization.

Design Evolution

Part 1 - Loading Page (Cover Page)



The Prototype of the Loading Page



Final Loading Page

Two pictures above show the design evolution of our landing page. We chose the picture of hospital beds in grey as the background of the landing page. Given the color scheme of the background page, we decided to use a warmer color for the project title to show some visual contrast. We decided to use a small navigation bar which could be expanded to show the whole navigation sections when clicked which makes the whole design clean and simple.

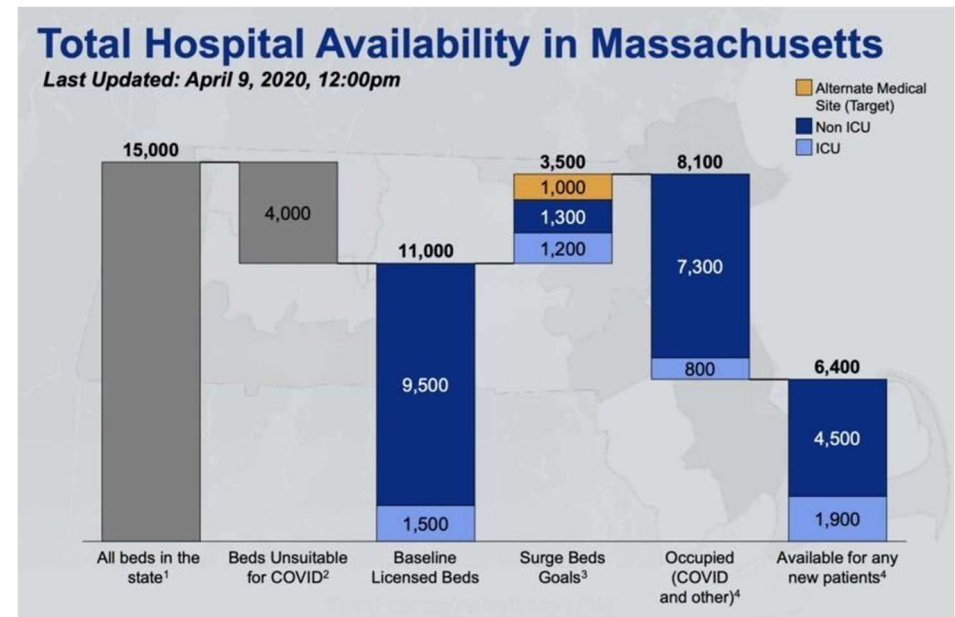
Design Evolution

Part 2 - Original Visualization

The first visualization that is going to be presented in our web page is the original visualization “Total Hospital Availability in Massachusetts”. We present this visualization design in the very beginning to show audience the root of our visualization project before presenting the branches. It is the essential part of “before vs. after” effect.

The original visualization design makes use of the visualization channel of bar chart to present the total hospital availability in Massachusetts during the COVID-19 pandemic. The original designer tried to use a set of bar charts in the same coordinate to show the hierarchical levels of bed categories and capacity in Massachusetts.

One major problem with this design is its lack of interactivity with audience. It is a pure static design. Our goal of this project is to offer this design more interactivity to engage the audience into the design and maximize the functionality of this visualization design.



Original Visualization

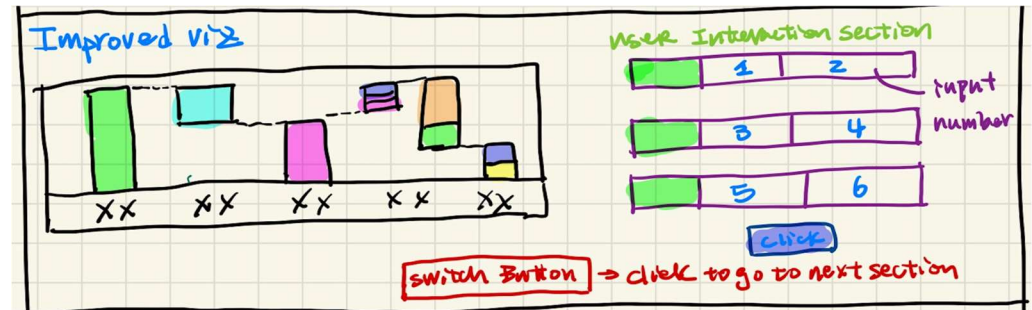
Design Evolution

Part 3 - Improved Visualization

This section is the quintessential part of our project. We hope to come up with an improved version of the original visualization.

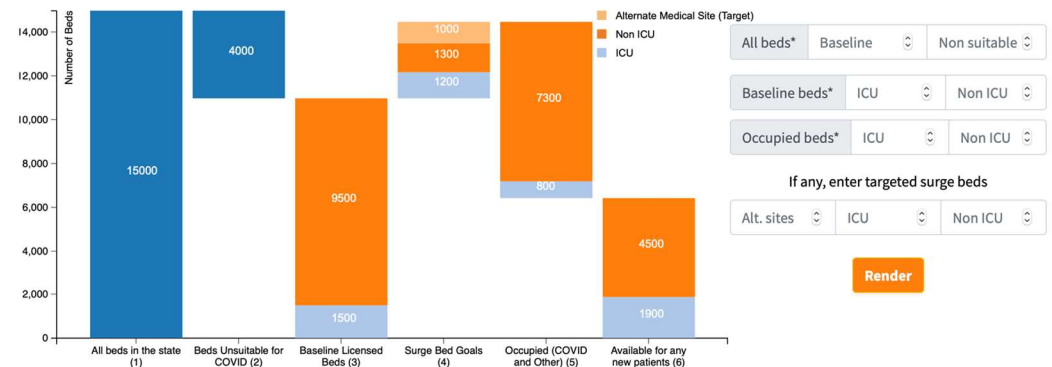
We keep the layout of original visualization but add a new section of input where audience can customize the visualization based on the values entered. The change of default values in the input section will trigger the values on the visualization.

We also added a validation function to make sure the value audience input reasonable values and maintain smooth user experience when interacting with the visualization.



The Prototype of the Improved Visualization

Total Hospital Bed Availability



1. Total Beds. 2 Includes chronic dialysis beds, continuing care nursery beds, maternal service beds, psychiatric beds, rehabilitation beds, special care nursery beds, substance abuse beds, and infant bassinets. If these are converted to med surge acute or ICU beds they will be included in "Surge Beds" category. 3. Non-ICU and ICU beds are in-hospital beds that hospitals can convert to care for COVID patients. Alternate medical beds are essential to ensure hospitals can dedicate capacity for patients in the most acute conditions. 4. As reported.

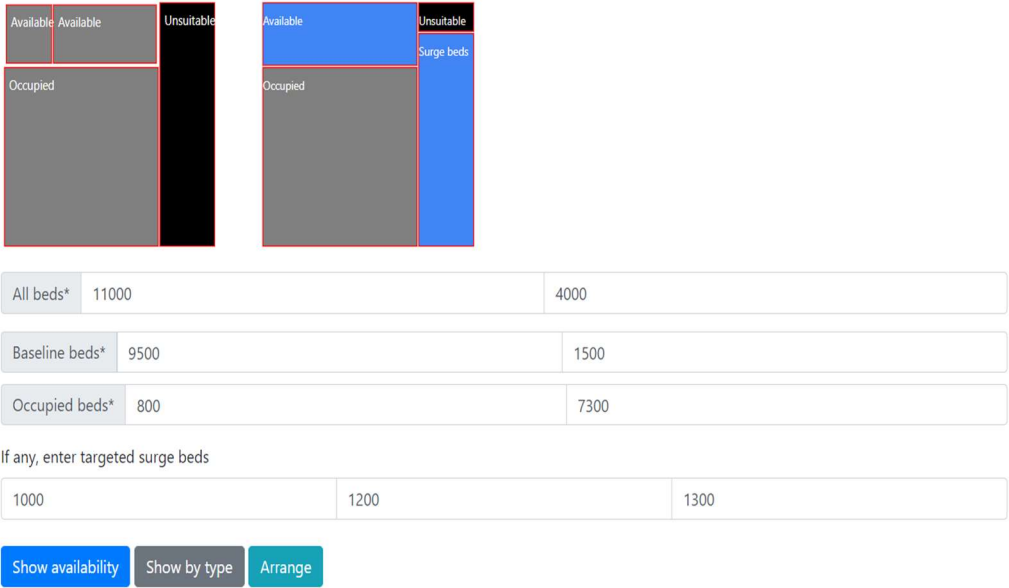
Final Improved Visualization

Design Evolution

Part 4 - Alternate Visualization - Tree Map (X)

In an early design, we proposed a treemap to visualize the detailed distribution of hospital beds capacity in terms of their functionality. This design allows to compare the relative number of available and occupied number hospital beds .

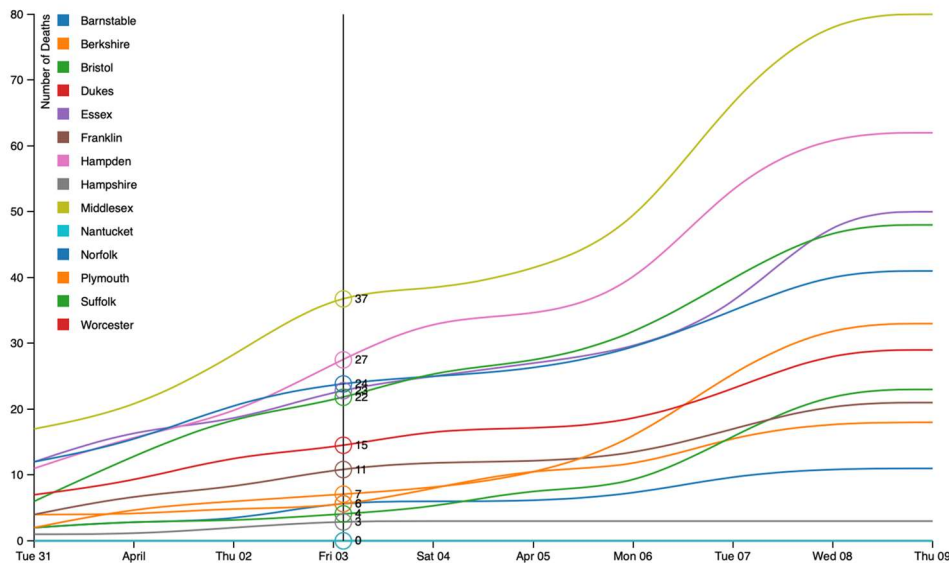
However, comparing sizes of each category in the heatmap did not allow the user to perform better than with the original visualization. Therefore, we discarded this design after few iteration in the project.



Alternate Viz - Tree Map

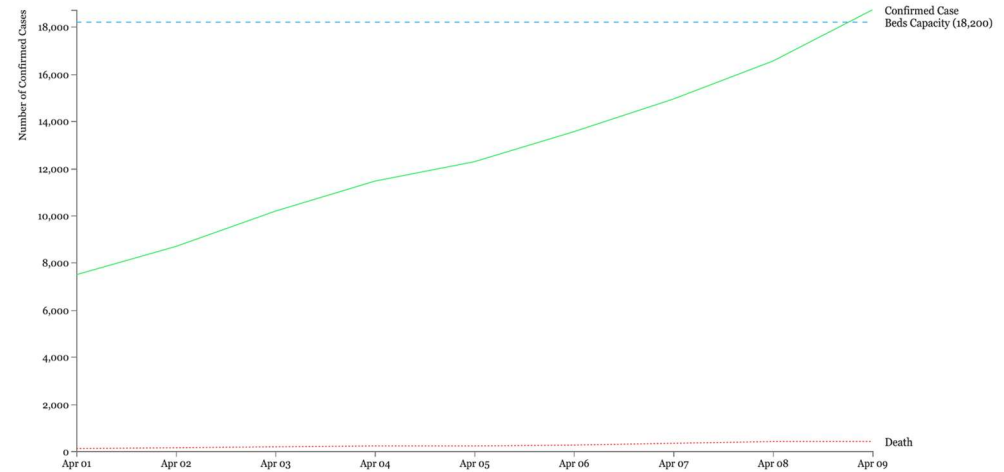
Design Evolution

Part 4 - Alternate Visualization - Line Chart (X)



COVID-19 Related Death Cases in MA

Alternate Viz - Interactive Line Chart



Alternate Viz - Interactive Line Chart

The Line chart is another type of visualization we explored in the early stages of design. We proposed a set of three line charts to visualize the COVID-19 related statistics:

- confirmed COVID-19 cases and beds capacity in state of MA
- confirmed COVID-19 cases by county in MA
- COVID-19 related death cases by county in MA

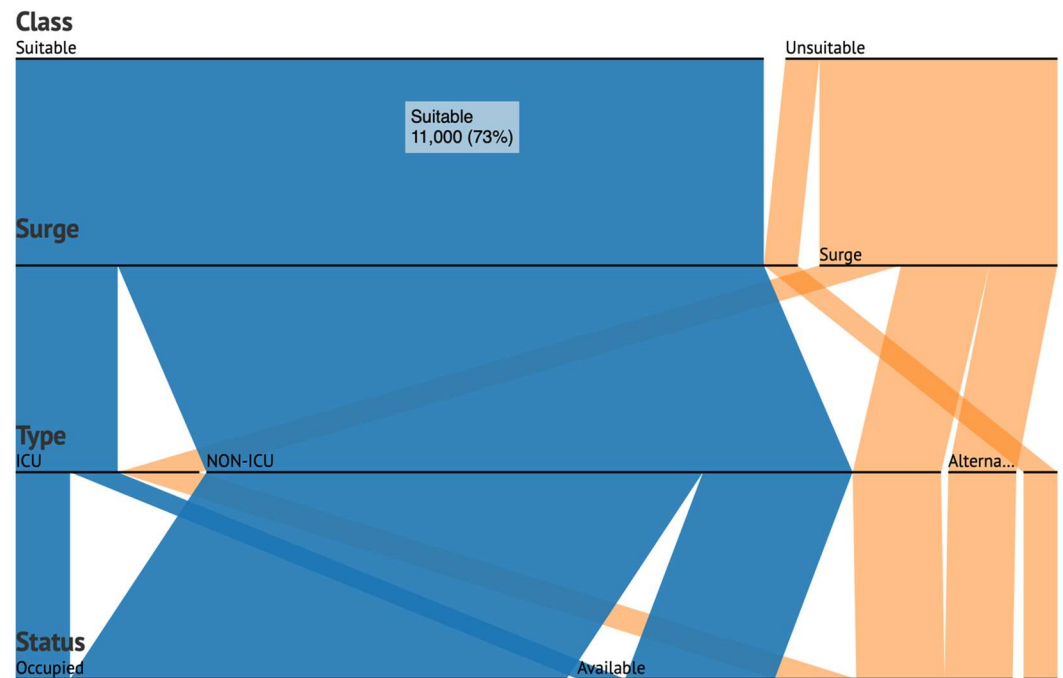
This set of visualization provided additional info about COVID-19 in MA. However, due to lack of data adequate data we decided not to include them in the final design.

Design Evolution

Part 4 - Alternate Visualization - Sankey Diagram (✓)

Apart from the visualizations discussed before, another type of alternate visualization we explored is the sankey diagram. Sankey diagram helps to depict a flow from one set of values to another and illustrate a many-to-many mapping between two domains or multiple paths through a set of stages.

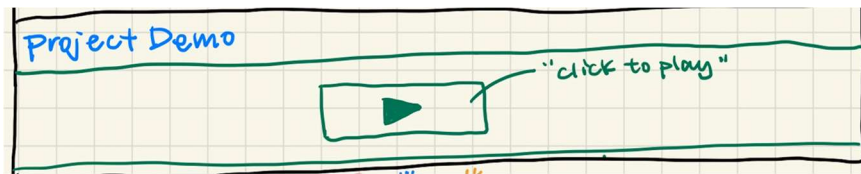
For our project, a sankey diagram could help us show the hierarchical levels of bed categories and capacity in Massachusetts. A Sankey diagram could help deliver the same information like what original bar chart visualization does. Therefore, we decided to use this visualization in our final design.



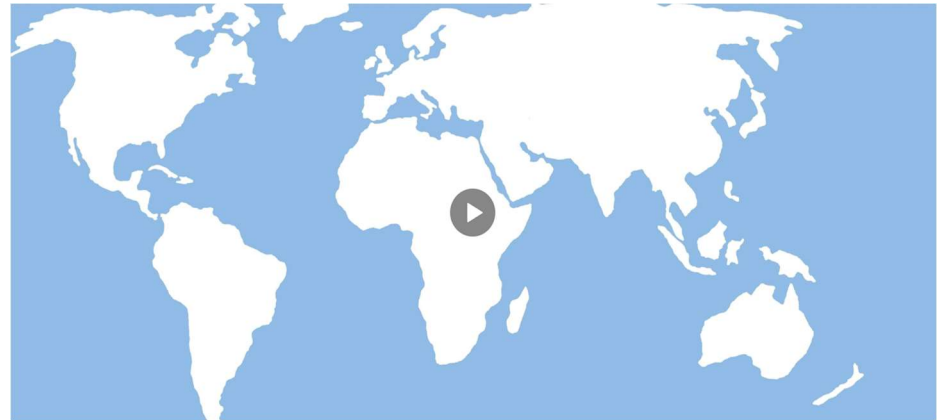
Alternate Viz - Sankey Diagram

Design Evolution

Part 5 - Project Demo



The Prototype of Project Demo



Final Project Demo

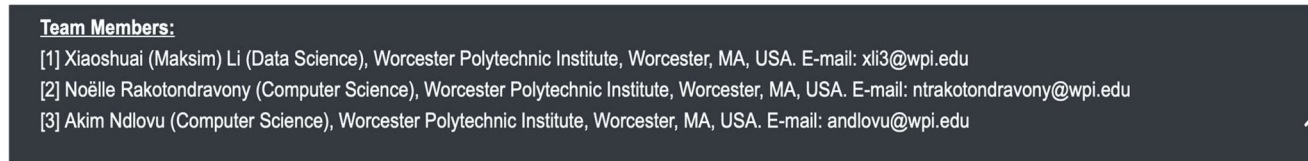
This section of our visualization is simply to provide audience a quick access to our project demo. The audience can enjoy a short video clip of our project demo directly on the same page without being directed elsewhere.

Design Evolution

Part 6 - Team Members



The Prototype of Project Demo



Final Project Demo

The last section of our project is just the place where audience can find information of our project group members which include name, academic department, and email address.

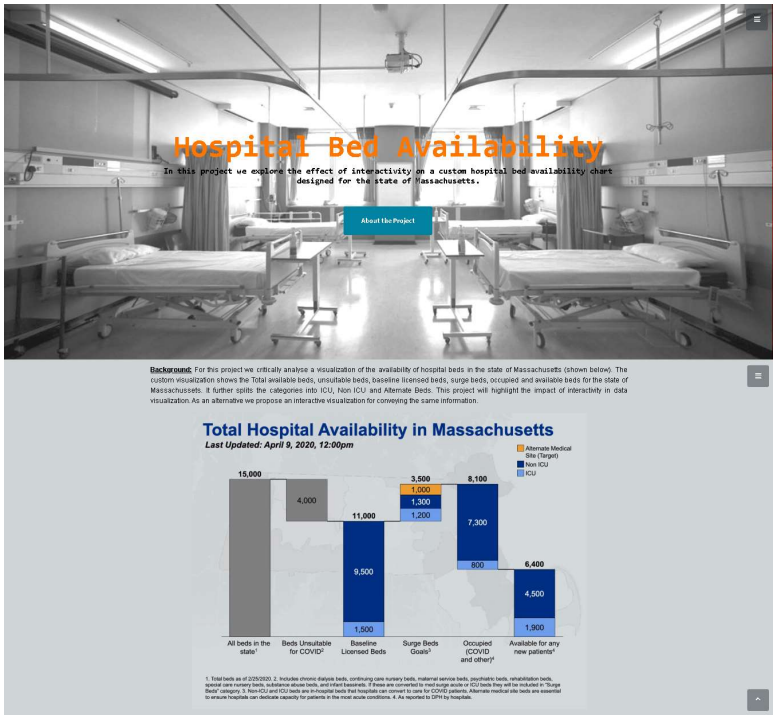
Implementation

Implementation

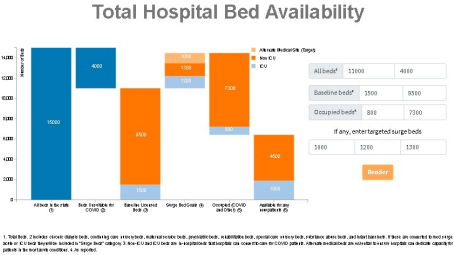
Final Design

We provide an overview of all sections of the webpage.

Our group project visualization includes a cover page, the original chart, 2 alternative visualizations, a project demo, and group member information.

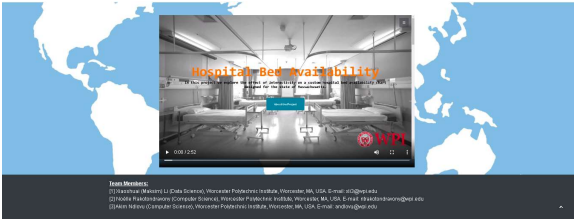
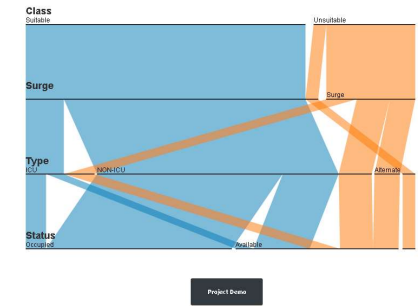


Proposed Visualization: As a proposed solution we allow the audience to dynamically create a similar visualization based on the values they desire. The visualization uses tooltips for quick reference of the respective values. A validation mechanism is put in place to guard against incorrect values.



Alternate Visualization: In addition to the interactive chart, we propose an additional visualization - a Sankey diagram, which offers a complementary perspective on the data. The sankey diagram helps distinguish the categories of bed (ICU, non ICU, surge beds) that are available and unavailable.

Alternate Visualization: In addition to the interactive chart, we propose an additional visualization - a Sankey diagram, which offers a complementary perspective on the data. The sankey diagram helps distinguish the categories of bed (ICU, non ICU, surge beds) that are available and unavailable.



Implementation

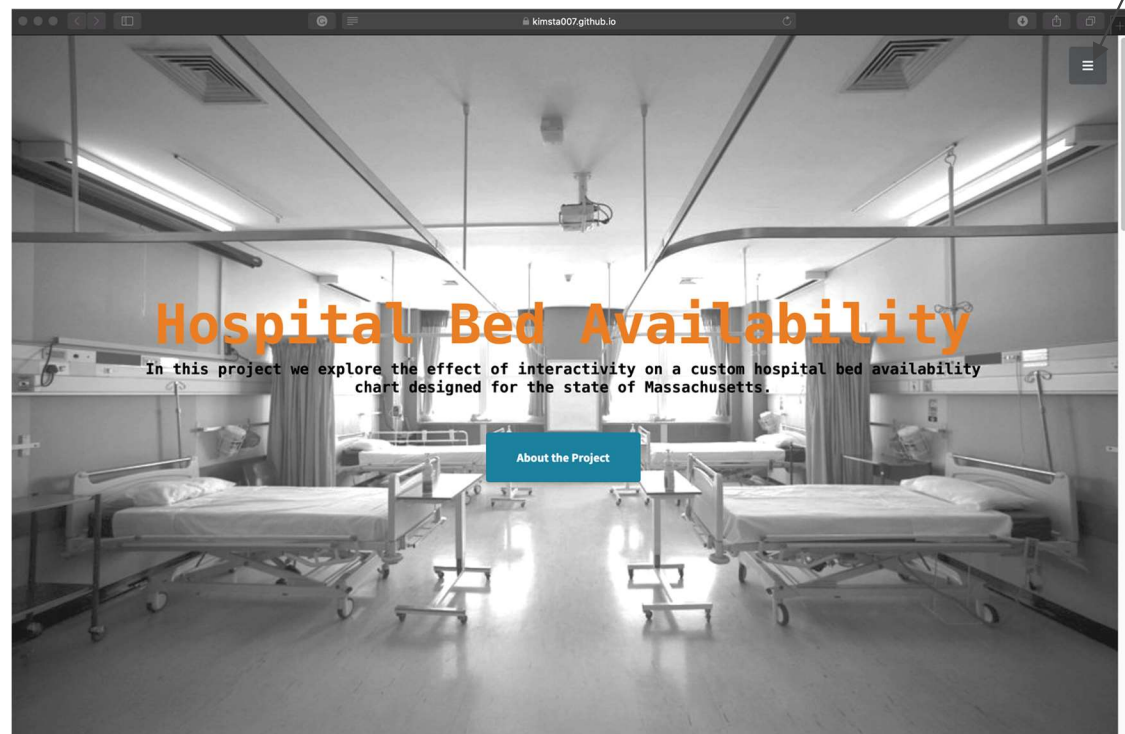
Cover (Landing) Page

Audience's journey on our visualizations starts from viewing the cover page of our web page. The cover page is a picture of hospital room which fits well with our theme and immediately leads audience's attention to our project

Navigation Bar

In order to make our design as clean and tidy as possible, we try to minimize the size of navigation bar. Another reason we don't intend to present a complete navigation bar is that audience can travel from one section to another by clicking the button provided on the bottom of each section of the webpage.

The audience can still access the full navigation by clicking the navigation bar sign on the right upper corner of the web page. The full sized navigation bar is presented on the right side of the web page.

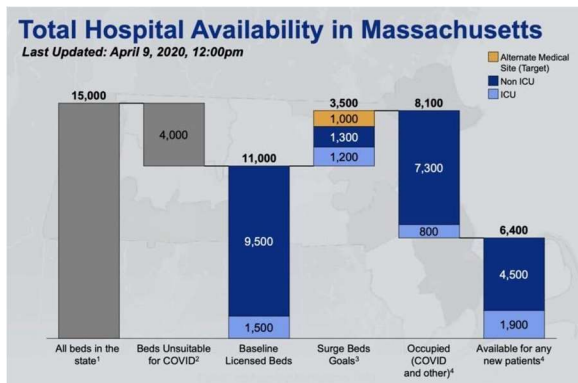


Navigation Bar

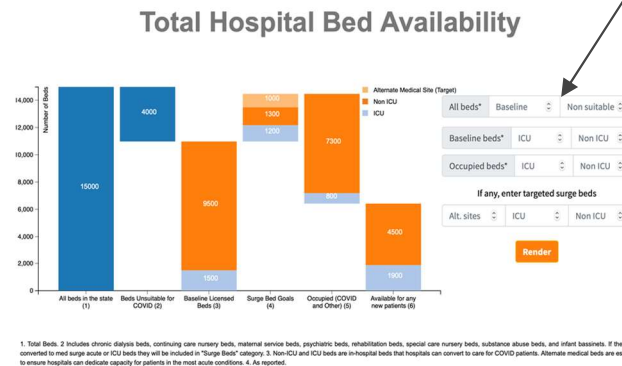
Implementation

Final Design

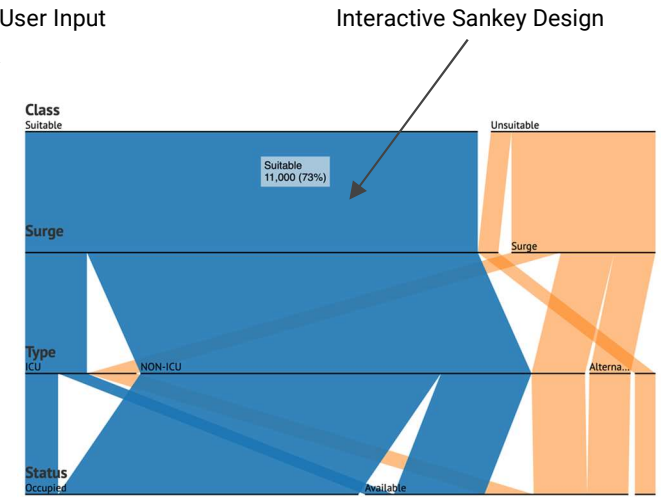
Major Visualizations



Original Design



Improved Design



Alternate Design

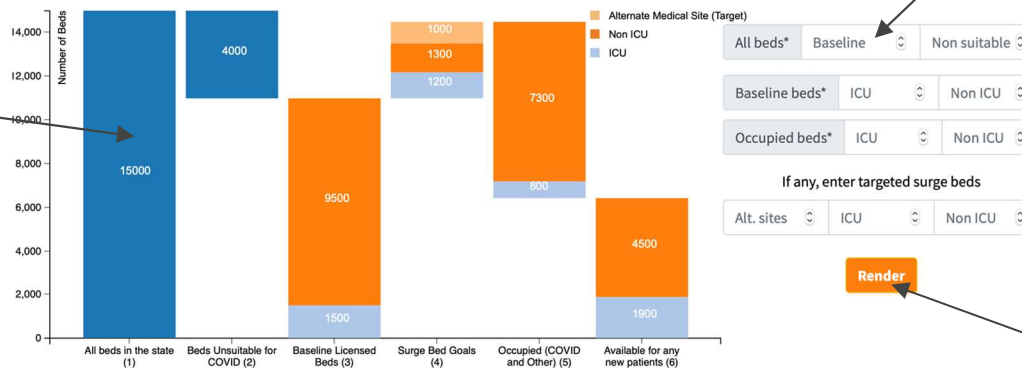
The original design is a static. We improved it and presented the one in the middle which allows the user to input custom values for the number of beds and the bar chart reflects the changes made. The one on the right is a proposed alternate sankey design which explore different ways of viewing the same data.

Implementation

Final Design

Improved (Proposed) Design

Total Hospital Bed Availability



1. Total Beds. 2 Includes chronic dialysis beds, continuing care nursery beds, maternal service beds, psychiatric beds, rehabilitation beds, special care nursery beds, substance abuse beds, and infant bassinets. If these are converted to med surge acute or ICU beds they will be included in "Surge Beds" category. 3. Non-ICU and ICU beds are in-hospital beds that hospitals can convert to care for COVID patients. Alternate medical beds are essential to ensure hospitals can dedicate capacity for patients in the most acute conditions. 4. As reported.

User Input Section:

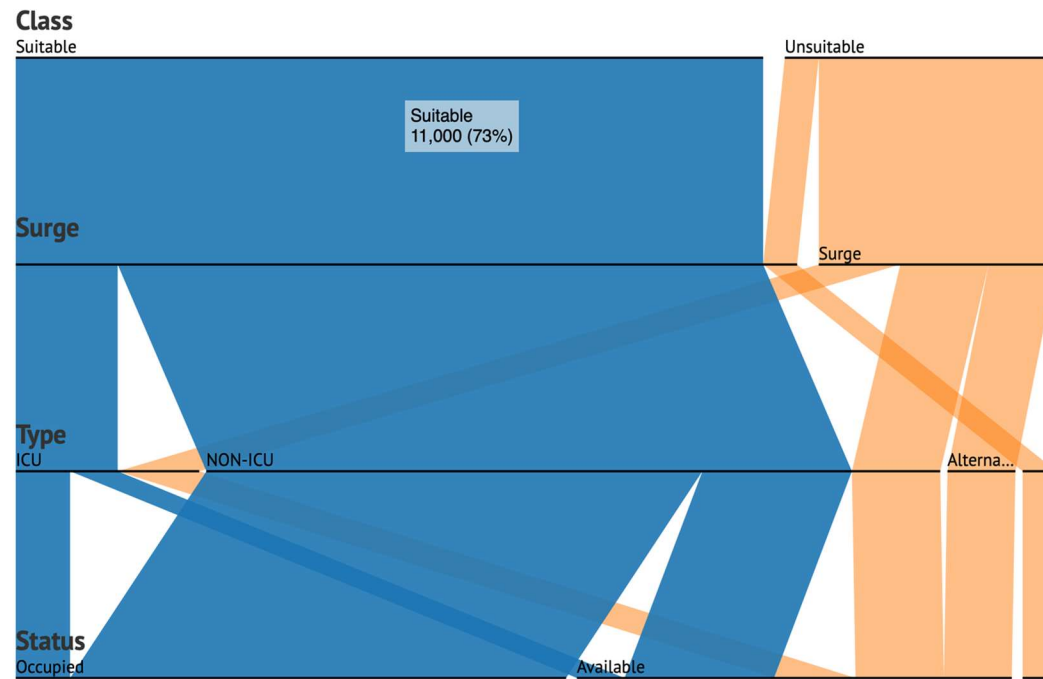
- **Functionality**
Audience can customize the value of each category of hospital beds by entering different numeric values.
- **A default value** is provided when the page is loaded.
- **Validation** is enforced to ensure that user input is reasonable.

- After filling in the customized values, clicking the "Render" button will trigger the changes on the barchart.

Implementation

Final Design

Alternate Design



Website Link

<https://kimsta007.github.io/viz-final/>

Demo Video

<https://kimsta007.github.io/viz-final/>

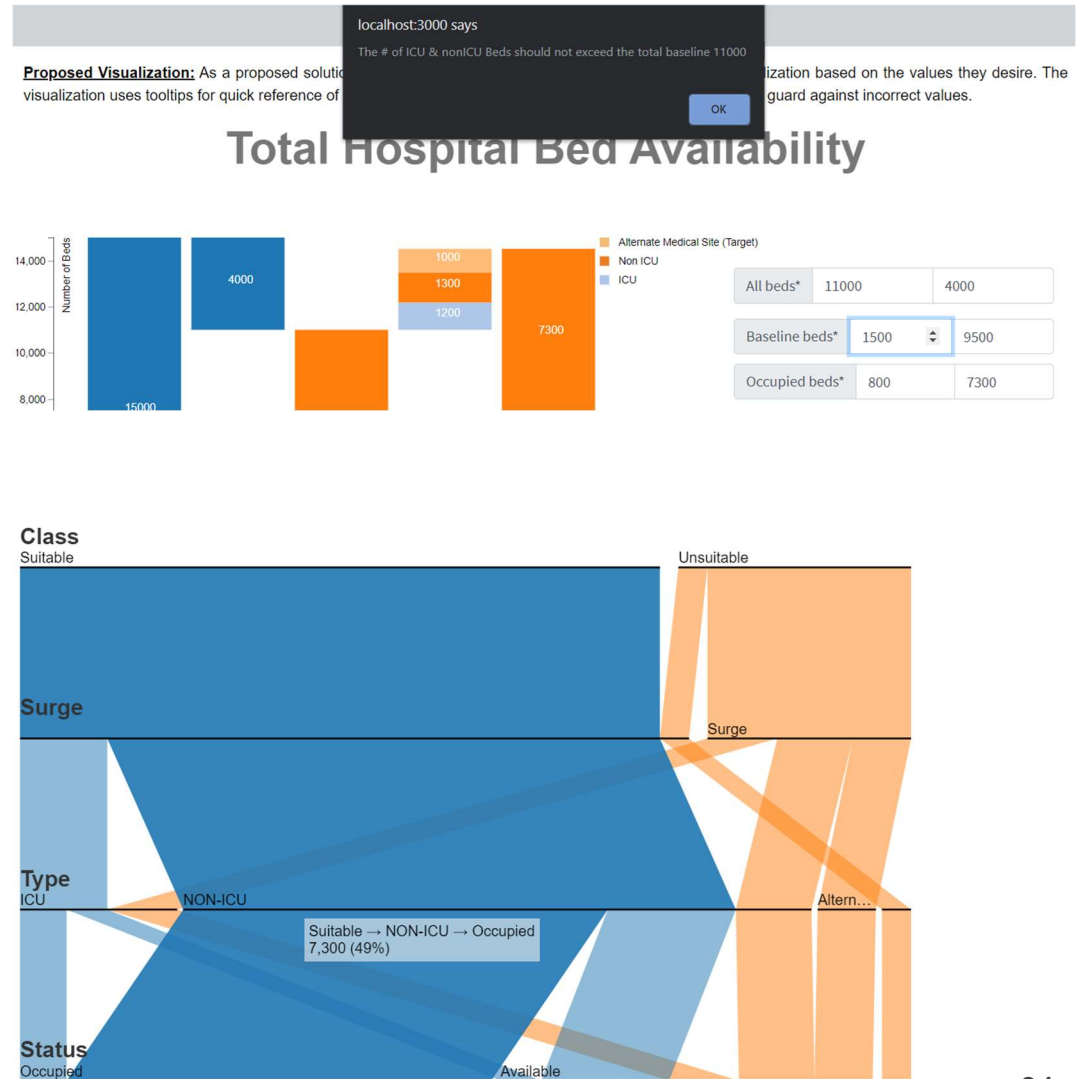
Evaluation

Evaluation

The story telling feel of the website allows us to walk the user through ideology behind our project.

Although we give the user the freedom to input different values for the number of beds, especially for simulating what-if situations, we allowed only valid values. This allows us to maintain realistic scenarios.

While the bar chart only provides an overview of beds availability, the sankey diagram gives a clearer view of the different classes of the available beds (appear when hovering over the diagram). This makes the two visualizations complementary.



Outlook

Features that we think would be interesting to have in the future include:

- the possibility to compare between different states or different regions. Especially, if these are neighboring regions, such comparison could help figuring out to which hospital to assign or transfer patients if necessary (or if that's allowed by the law.)
- An additional chart that compares the current values of beds availability in a region with its number of patients requiring hospitalization. This would help authorities make decisions on the required number of surge beds.

Team's reflection



Noëlle Rakotondravony

This project was quite an adventure. It was (almost) always fun to explore different perspectives of a same project, try out a new idea, drop it, try it again, drop again or make it better. The core idea of the project moved from starting something from scratch to enhancing an existing one. It was an enjoyable process, because as designers we could see how theories on interactions, and visual channels apply to real uses cases for making the user experience better.

The timelines for this project tested my ability to work in a team and under pressure. The whole experience was worthwhile. I built upon the knowledge gained from the assignments given to us and extended most of it to this project. The project offered an opportunity to critically analyze an existing visualization and reproducing the same visualization without losing the meaning portrayed by the original visualization was quite the challenge.



Akim Ndlovu



Xiaoshuai (Maksim) Li

This project offered me such an amazing opportunity to experiencing the complete process of a data visualization project. I improved my skills of implementing a interactive line chart as well as other web design elements. The fastidious process of preparing for the project process book really makes me have an epiphany and realize how concept and visions Prof. Harrison introduced to the class actually changes my way of thinking and doing data visualization. Hope in the future I could make my data viz clean but more interactive.

The End