



**SpO<sub>2</sub>/FiO<sub>2</sub> ratio (SF ratio) as a predictor of  
mortality in ICU patients: Retrospective study  
using MIMIC Database.**

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**Capstone Final Report for BSc (Honours) in  
Mathematical, Computational and Statistical Sciences**

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# Contents

<b>1</b>	<b>Clinical Background</b>	<b>1</b>
1.1	Importance of Biomarkers in ICU Studies . . . . .	1
1.2	Problem: PF Ratio is an Important but Challenging Biomarker	2
1.3	Motivation: Can SF Ratio be an Alternative to PF Ratio and for who? . . . . .	3
1.4	Research Question . . . . .	5
<b>2</b>	<b>Data</b>	<b>6</b>
2.1	Data Overview . . . . .	6
2.1.1	Data Extraction . . . . .	6
2.1.2	Subsection 2 . . . . .	7
2.2	Main Section 2 . . . . .	7
<b>3</b>	<b>Methods: How to model ICU mortality?</b>	<b>8</b>
3.1	General Additive Models . . . . .	8
3.2	G-Computation . . . . .	8
3.3	Pre-Analysis Data Preparation . . . . .	8
3.3.1	Data Extraction . . . . .	8
<b>4</b>	<b>Covariates</b>	<b>10</b>
4.1	Covariate Selection . . . . .	10
4.1.1	To Ratio or not to Ratio . . . . .	10

4.1.2 Does Transformation help? . . . . .	10
4.2 Timeframe of SF Ratio aggregation . . . . .	10
5 < . . . . .	52
<b>Bibliography</b>	<b>71</b>
<b>A Other Figures</b>	<b>73</b>

## Chapter 1

# Clinical Background

### 1.1 Importance of Biomarkers in ICU Studies

Allocation of resources to patients to minimize mortality is a constant priority for healthcare professionals. This is especially important in the area of healthcare we have chosen to focus on in this paper: critical care, where resources such as equipment and attention of specialists are even more scarce. A critical care specialist focuses on the most vulnerable and urgent patients who are placed in an Intensive Care Unit (ICU). In this setting, the specialist is often faced with difficult decisions of which patients to allocate resources to. An unfortunate reminder that has recently put such decisions under the spotlight is the current COVID-19 global pandemic. A recent study on ICU capacity in Wuhan, the disease's epicentre in China, states that at a point during the current crisis the number of COVID-19 patients who need ICU resources is 1120 while only 600 ICU beds existed. As a result, only 25% of the patients who had died by the time of the study received the intubation and mechanical ventilation that they required (Wu and McGoogan, 2020). In Lombardy, the disease's epicentre in Italy, a study states that under pre-crisis conditions, the city's

total ICU capacity of 720 already operates at 85% - 90% during winter months. To make things worse, during the first two weeks after the city's first confirmed COVID-19 case, the number of COVID-19 related ICU admissions rose exponentially to 556. Moreover, estimates for the total number of COVID-19 ICU admissions in the following two weeks suggest an even more drastic shortage with linear estimates at 869 and exponential estimates at 14,542 (Grasselli, Pesenti, and Cecconi, 2020). Hence, ICU capacities are stressed under normal conditions and even further during times of crises. Faced with such a perpetual dilemma of resource allocation, a critical care specialist uses various biomarkers in order to try and predict severe outcomes in the patients cohort. As such, a persistent priority in medical research is the discovery and analysis of connections between various biomarkers and unfavourable patient outcomes.

## 1.2 Problem: PF Ratio is an Important but Challenging Biomarker

One such biomarker that is tracked in ICU settings is the  $\text{PaO}_2/\text{FiO}_2$  ratio (PF ratio). The numerator,  $\text{PaO}_2$  refers to the partial pressure of oxygen in arterial blood. It is measured in mmHg via drawing a sample of blood from an artery in the wrist or groin, and testing it in the laboratory. The denominator,  $\text{FiO}_2$  refers to the initial fraction of inspired oxygen and is approximately 21% in breathable atmospheric air. The PF Ratio is used to monitor the patient's pulmonary functions. In an ICU, it can also be controlled by providing the patient with a form of oxygen therapy through to the use of devices such as mechanical ventilators. In

terms of diagnosis, it is most notably used in the diagnosis of extreme illnesses such as Acute Respiratory Distress Syndrome (ARDS) (Bernard et al., 1994). Moreover, it has been shown to be a significant identifier of mortality risk the general ICU population (Villar et al., 2011) and as a predictor of mortality in specific subsets of patients such as newborns with Meconium Aspiration Syndrome (MAS) (Narayanan et al., 2019) and post-operation cardiac surgery patients (Esteve et al., 2014).

Despite the various merits of the PF Ratio in diagnosing patients and maintaining their stability, there is a major challenge associated with its use - the measurement of the numerator,  $\text{PaO}_2$ . The procedure is invasive and delayed, making it not feasible to track  $\text{PaO}_2$  at frequent intervals measure for all patients.

### **1.3 Motivation: Can SF Ratio be an Alternative to PF Ratio and for who?**

A biomarker that is more convenient to measure than  $\text{PaO}_2$  is  $\text{SpO}_2$  or peripheral capillary oxygen saturation. It is defined as the ratio of oxygenated haemoglobin to the total amount of haemoglobin in the blood. It is measured using a device called pulse oximeter, which uses the principle that oxygenated and deoxygenated haemoglobin absorb and radiate particular wavelengths of light to different extents (Jubran, 1999). The oximeter illuminates light at specific wavelengths through the skin (usually at the fingertips) and almost instantaneously calculates the ratio of absorption of these wavelengths to extrapolate the proportion of oxygenated haemoglobin in the blood, or  $\text{SpO}_2$  (Jubran, 2015). Therefore,

unlike  $\text{PaO}_2$ ,  $\text{SpO}_2$  can be measured in a non-invasive and instantaneous manner.

Using  $\text{SpO}_2$  instead of  $\text{PaO}_2$  in the calculation of the  $\text{PaO}_2/\text{FiO}_2$  ratio gives a different biomarker  $\text{SpO}_2/\text{FiO}_2$  ratio (SF ratio). Although the  $\text{SpO}_2/\text{FiO}_2$  ratio might seem as an intuitive replacement to the  $\text{PaO}_2/\text{FiO}_2$  ratio, a critical difference between  $\text{PaO}_2$  and  $\text{SpO}_2$  is that the former is a generally more accurate measure of a patient's oxygenation level since it is measured directly from a main artery while the latter is measured at the end of capillaries. Nonetheless, recent studies have shown that SF ratio has been shown to be a non-invasive surrogate for the PF ratio to diagnose certain subsets of patients such as children with ALI or ARDS (Rice et al., 2007) and children with smoke inhalation injury (Cambiaso-Daniel et al., 2017). Moreover, a retrospective study found that the  $\text{SpO}_2/\text{FiO}_2$  Time-at-Risk (SF-TAR), defined as the total time spent with severe hypoxemia (SF ratio  $\leq 145$ ), is not only significantly correlated with hospital mortality for mechanically ventilated patients, but is as good or a better predictor of it than arterial gas-derived measurements of the PF ratio. There have also been several studies that link  $\text{SpO}_2$  separately to mortality. For instance, the Tromsø study in 2015 concluded that an  $\text{SpO}_2 \leq 95\%$  is associated with all-cause mortality and mortality caused by pulmonary diseases (over a 10-year follow-up period) after adjusting for sex, age, history of smoking, self-reported diseases and respiratory symptoms, BMI, and CRP concentration. (Vold et al., 2015). In other words, both SF Ratio and  $\text{SpO}_2$  have been shown to be a significant predictor of mortality in specific conditions.

Nevertheless, not all studies investigating a link between  $\text{SpO}_2$  or



SpO<sub>2</sub>/FiO<sub>2</sub> ratio and mortality have yielded significant results. A prospectively planned meta-analysis study using participant data from 5 randomized clinical trials (conducted from 2005-2014) of infants born before 28 weeks' gestation period found no significant difference between a lower SpO<sub>2</sub> target range (85%-89%) and a higher SpO<sub>2</sub> target range (91%-95%) on mortality or major disability at a corrected age of 18 to 24 months (Askie et al., 2018). Therefore, it seems that the use of SpO<sub>2</sub> as a predictor of mortality might not be applicable to all patient phenotypes, with potential for further sub-phenotyping. Such differences between the subpopulation might also be expected for the SF ratio which includes SpO<sub>2</sub> in the numerator.

## 1.4 Research Question

The main goal of this capstone can be summarized as follows:

*Investigate whether SpO<sub>2</sub>/FiO<sub>2</sub> ratio is a statistically significant predictor of mortality in general ICU patient population or subsets thereof using a retrospective analysis of ICU patient records.*

By focusing on SpO<sub>2</sub>/FiO<sub>2</sub> ratio instead of only SpO<sub>2</sub>, we also implicitly hypothesize that the former is a more helpful predictor as it allows us to account for the different levels of mechanical ventilation that an ICU patient receives. In essence, it allows us to account for the patient's ability to convert inspired oxygen to peripheral oxygen saturation at the tissue level.

## Chapter 2

# Data

### 2.1 Data Overview

For this capstone I will be using **MIMIC III**, an openly available relational database developed by the MIT Lab for Computational Physiology. It contains de-identified data of 61,532 intensive care unit stays: 53,432 stays for adult patients and 8,100 for neonatal patients at the Beth Israel Deaconess Medical Center over the June 2001 - October 2012. It includes demographics, vital signs, laboratory tests, medications, mortality, etc. The database is divided into different tables of data that contain information about a patient's stay and are linked to each via identifiers such as a unique hospital admission ID and a unique patient ID.

#### 2.1.1 Data Extraction

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### 2.1.2 Subsection 2

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## 2.2 Main Section 2

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## **Chapter 3**

# **Methods: How to model ICU mortality?**

### **3.1 General Additive Models**

### **3.2 G-Computation**

### **3.3 Pre-Analysis Data Preparation**

The pre-analysis data preparation involved extraction of data from different tables, combining them and calculating the SF ratio. The following subsections describe these processes.

#### **3.3.1 Data Extraction**

For the patient and stay identifiers I extract SUBJECT\_ID, HADM\_ID from ADMISSIONS table and ICUSTAY\_ID from ICUSTAYS table. From the ADMISSIONS table I extract the time of death of the patient if applicable and if it lies between the ICU admission time and ICU discharge time in ICUSTAYS table I indicate ICU mortality. Similarly if the time of death

is between admission time and discharge time in the ADMISSIONS table, I indicate Hospital mortality. From the Patients table I extract the gender of the patients' and calculate their age.

For all patients and ICU stays I extract the  $\text{FiO}_2$  values and their chart times from the CHARTEVENTS table. Keeping in mind that at normal atmospheric conditions,  $\text{FiO}_2$  is around 21%, I apply the following transformations. For the values between 0 and 1, I convert them to percentages by multiplying by a 100 and only keep those between 21% and 100%. Next, if the reading is recorded as greater than 1 but lower than 21, the value is likely to be erroneous and I discard it. Next, if the value is between 21 and 100, the value is likely to already be a percentage and I take it as such. Finally, I discard all the values above a 100 that are remaining. From the same CHARTEVENTS table I extract the patients' height and weight.

From the CHARTEVENTS table, I also extract  $\text{SpO}_2$  values and chart times but I only keep those which indicate 0 for ERROR which stands for error in measurement. Moreover, I filter the values and I discard those below 10 and above a 100 since they are either physiologically impossible or unlikely.

At the end of this stage, the current dataset accounts for 46,476 Patients, 61,532 ICU Stays with 12,713,362 observations of either  $\text{SpO}_2$  or  $\text{FiO}_2$  or both. On further examination of the data, I find that for every  $\text{FiO}_2$  measurement for a given ICU stay, for a given unique patient, there is a corresponding  $\text{SpO}_2$  measurement at the same chart time but not vice versa. Accordingly, I restrict my data to only those chart times with both  $\text{SpO}_2$  and  $\text{FiO}_2$  measurements. This further subsets the number of observations further into 703,201 observations.

## Chapter 4

# Covariates

### 4.1 Covariate Selection

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#### 4.1.1 To Ratio or not to Ratio

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#### 4.1.2 Does Transformation help?

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### 4.2 Timeframe of SF Ratio aggregation

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suggestions js-jump-to-suggestions-container">
        <ul class="d-none js-jump-to-suggestions-template-container">
            <li class="d-flex flex-justify-start flex-items-center p-0 f5 navigation-
item js-navigation-item js-jump-to-suggestion" role="option"> <a tabindex="-
1" class="no-underline d-flex flex-auto flex-items-center jump-to-suggestions-
path js-jump-to-suggestion-path js-navigation-open p-2" href=""> <div
class="jump-to-octicon js-jump-to-octicon flex-shrink-0 mr-2 text-center

```

```

d-none"> <svg height="16" width="16" class="octicon octicon-repo flex-
shrink-0 js-jump-to-octicon-repo d-none" title="Repository" aria-label="Repository"
viewBox="0 0 12 16" version="1.1" role="img"><path fill-rule="evenodd"
d="M4 9H3V8h1v1zm0-3H3v1h1V6zm0-2H3v1h1V4zm0-2H3v1h1V2zm8-
1v12c0 .55-.45 1-1 1H6v2l-1.5-1.5L3 16v-2H1c-.55 0-1-.45-1-1V1c0-.55.45-1
1-1h10c.55 0 1 .45 1 1zm-1 10H1v2h2v-1h3v1h5v-2zm0-10H2v9h9V1z"/></svg>
<svg height="16" width="16" class="octicon octicon-project flex-shrink-0
js-jump-to-octicon-project d-none" title="Project" aria-label="Project" view-
Box="0 0 15 16" version="1.1" role="img"><path fill-rule="evenodd" d="M10
12h3V2h-3v10zm-4-2h3V2H6v8zm-4 4h3V2H2v12zm-1 1h13V1H1v14zM14
0H1a1 1 0 00-1 1v14a1 1 0 001 1h13a1 1 0 001-1V1a1 1 0 00-1-1z"/></svg>
<svg height="16" width="16" class="octicon octicon-search flex-shrink-0
js-jump-to-octicon-search d-none" title="Search" aria-label="Search" view-
Box="0 0 16 16" version="1.1" role="img"><path fill-rule="evenodd" d="M15.7
13.3l-3.81-3.83A5.93 5.93 0 0013 6c0-3.31-2.69-6-6-6S1 2.69 1 6s2.69 6 6 6c1.3
0 2.48-.41 3.47-1.11l3.83 3.81c.19 2.45 3.7 3.25 0 .52-.09 7-.3a.996.996 0 000-
1.41v.01zM7 10.7c-2.59 0-4.7-2.11-4.7-4.7 0-2.59 2.11-4.7 4.7-4.7 2.59 0 4.7
2.11 4.7 4.7 0 2.59-2.11 4.7-4.7 4.7z"/></svg> </div>

<img class="avatar mr-2 flex-shrink-0 js-jump-to-suggestion-avatar d-
none" alt="" aria-label="Team" src="" width="28" height="28">

<div class="jump-to-suggestion-name js-jump-to-suggestion-name flex-
auto overflow-hidden text-left no-wrap css-truncate css-truncate-target">
</div>

<div class="border rounded-1 flex-shrink-0 bg-gray px-1 text-gray-
light ml-1 f6 d-none js-jump-to-badge-search"> <span class="js-jump-to-
badge-search-text-default d-none" aria-label="in this repository"> In this

```

```

repository </span> <span class="js-jump-to-badge-search-text-global d-
none" aria-label="in all of GitHub"> All GitHub </span> <span aria-
hidden="true" class="d-inline-block ml-1 v-align-middle"></span> </div>
    <div aria-hidden="true" class="border rounded-1 flex-shrink-0 bg-gray
px-1 text-gray-light ml-1 f6 d-none d-on-nav-focus js-jump-to-badge-jump">
Jump to <span class="d-inline-block ml-1 v-align-middle"></span> </div>
</a> </li>
</ul>
<ul class="d-none js-jump-to-no-results-template-container"> <li class="d-
flex flex-justify-center flex-items-center f5 d-none js-jump-to-suggestion
p-2"> <span class="text-gray">No suggested jump to results</span> </li>
</ul>
<ul id="jump-to-results" role="listbox" class="p-0 m-0 js-navigation-
container jump-to-suggestions-results-container js-jump-to-suggestions-
results-container">
    <li class="d-flex flex-justify-start flex-items-center p-0 f5 navigation-
item js-navigation-item js-jump-to-scoped-search d-none" role="option">
    <a tabindex="-1" class="no-underline d-flex flex-auto flex-items-center
jump-to-suggestions-path js-jump-to-suggestion-path js-navigation-open
p-2" href=""> <div class="jump-to-octicon js-jump-to-octicon flex-shrink-
0 mr-2 text-center d-none"> <svg height="16" width="16" class="octicon
octicon-repo flex-shrink-0 js-jump-to-octicon-repo d-none" title="Repository"
aria-label="Repository" viewBox="0 0 12 16" version="1.1" role="img"><path

```

```

fill-rule="evenodd" d="M4 9H3V8h1v1zm0-3H3v1h1V6zm0-2H3v1h1V4zm0-
2H3v1h1V2zm8-1v12c0 .55-.45 1-1 1H6v2l-1.5-1.5L3 16v-2H1c-.55 0-1-.45-
1-1V1c0-.55.45-1 1-1h10c.55 0 1 .45 1 1zm-1 10H1v2h2v-1h3v1h5v-2zm0-
10H2v9h9V1z"/></svg> <svg height="16" width="16" class="octicon octicon-
project flex-shrink-0 js-jump-to-octicon-project d-none" title="Project" aria-
label="Project" viewBox="0 0 15 16" version="1.1" role="img"><path fill-
rule="evenodd" d="M10 12h3V2h-3v10zm-4-2h3V2H6v8zm-4 4h3V2H2v12zm-
1 1h13V1H1v14zM14 0H1a1 1 0 00-1 1v14a1 1 0 001 1h13a1 1 0 001-1V1a1
1 0 00-1-1z"/></svg> <svg height="16" width="16" class="octicon octicon-
search flex-shrink-0 js-jump-to-octicon-search d-none" title="Search" aria-
label="Search" viewBox="0 0 16 16" version="1.1" role="img"><path fill-
rule="evenodd" d="M15.7 13.3l-3.81-3.83A5.93 5.93 0 0013 6c0-3.31-2.69-
6-6-6S1 2.69 1 6s2.69 6 6 6c1.3 0 2.48-.41 3.47-1.11l3.83 3.81c.19.245.3.7.3.7.25
0 .52-.09.7-.3a.996.996 0 000-1.41v.01zM7 10.7c-2.59 0-4.7-2.11-4.7-4.7 0-2.59
2.11-4.7 4.7-4.7 2.59 0 4.7 2.11 4.7 4.7 0 2.59-2.11 4.7-4.7 4.7z"/></svg>
</div>

```

```

<img class="avatar mr-2 flex-shrink-0 js-jump-to-suggestion-avatar d-
none" alt="" aria-label="Team" src="" width="28" height="28">

```

```

<div class="jump-to-suggestion-name js-jump-to-suggestion-name flex-
auto overflow-hidden text-left no-wrap css-truncate css-truncate-target">
</div>

```

```

<div class="border rounded-1 flex-shrink-0 bg-gray px-1 text-gray-
light ml-1 f6 d-none js-jump-to-badge-search"> <span class="js-jump-to-
badge-search-text-default d-none" aria-label="in this repository"> In this

```

```
repository </span> <span class="js-jump-to-badge-search-text-global d-
none" aria-label="in all of GitHub"> All GitHub </span> <span aria-
hidden="true" class="d-inline-block ml-1 v-align-middle"></span> </div>
```

```
    <div aria-hidden="true" class="border rounded-1 flex-shrink-0 bg-gray
px-1 text-gray-light ml-1 f6 d-none d-on-nav-focus js-jump-to-badge-jump">
Jump to <span class="d-inline-block ml-1 v-align-middle"></span> </div>
</a> </li>
```

```
    <li class="d-flex flex-justify-start flex-items-center p-0 f5 navigation-
item js-navigation-item js-jump-to-global-search d-none" role="option">
    <a tabindex="-1" class="no-underline d-flex flex-auto flex-items-center
jump-to-suggestions-path js-jump-to-suggestion-path js-navigation-open
p-2" href=""> <div class="jump-to-octicon js-jump-to-octicon flex-shrink-
0 mr-2 text-center d-none"> <svg height="16" width="16" class="octicon
octicon-repo flex-shrink-0 js-jump-to-octicon-repo d-none" title="Repository"
aria-label="Repository" viewBox="0 0 12 16" version="1.1" role="img"><path
fill-rule="evenodd" d="M4 9H3V8h1v1zm0-3H3v1h1V6zm0-2H3v1h1V4zm0-
2H3v1h1V2zm8-1v12c0 .55-.45 1-1 1H6v2l-1.5-1.5L3 16v-2H1c-.55 0-1-.45-
1-1V1c0-.55-.45-1-1-1h10c.55 0 1 .45 1 1zm-1 10H1v2h2v-1h3v1h5v-2zm0-
10H2v9h9V1z"/></svg> <svg height="16" width="16" class="octicon octicon-
project flex-shrink-0 js-jump-to-octicon-project d-none" title="Project" aria-
label="Project" viewBox="0 0 15 16" version="1.1" role="img"><path fill-
rule="evenodd" d="M10 12h3V2h-3v10zm-4-2h3V2H6v8zm-4 4h3V2H2v12zm-
1 1h13V1H1v14zM14 0H1a1 1 0 00-1 1v14a1 1 0 001 1h13a1 1 0 001-1V1a1
```



```
1 0 00-1-1z"/></svg> <svg height="16" width="16" class="octicon octicon-
search flex-shrink-0 js-jump-to-octicon-search d-none" title="Search" aria-
label="Search" viewBox="0 0 16 16" version="1.1" role="img"><path fill-
rule="evenodd" d="M15.7 13.3l-3.81-3.83A5.93 5.93 0 0013 6c0-3.31-2.69-
6-6-6S1 2.69 1 6s2.69 6 6 6c1.3 0 2.48-.41 3.47-1.11l3.83 3.81c.19.245.37.325
0 .52-.09.7-.3a.996.996 0 000-1.41v.01zM7 10.7c-2.59 0-4.7-2.11-4.7-4.7 0-2.59
2.11-4.7 4.7-4.7 2.59 0 4.7 2.11 4.7 4.7 0 2.59-2.11 4.7-4.7 4.7z"/></svg>
</div>
```

```
<img class="avatar mr-2 flex-shrink-0 js-jump-to-suggestion-avatar d-
none" alt="" aria-label="Team" src="" width="28" height="28">
```

```
<div class="jump-to-suggestion-name js-jump-to-suggestion-name flex-
auto overflow-hidden text-left no-wrap css-truncate css-truncate-target">
</div>
```

```
<div class="border rounded-1 flex-shrink-0 bg-gray px-1 text-gray-
light ml-1 f6 d-none js-jump-to-badge-search"> <span class="js-jump-to-
badge-search-text-default d-none" aria-label="in this repository"> In this
repository </span> <span class="js-jump-to-badge-search-text-global d-
none" aria-label="in all of GitHub"> All GitHub </span> <span aria-
hidden="true" class="d-inline-block ml-1 v-align-middle"></span> </div>
```

```
<div aria-hidden="true" class="border rounded-1 flex-shrink-0 bg-gray
px-1 text-gray-light ml-1 f6 d-none d-on-nav-focus js-jump-to-badge-jump">
Jump to <span class="d-inline-block ml-1 v-align-middle"></span> </div>
</a> </li>
```

```
<li class="d-flex flex-justify-center flex-items-center p-0 f5 js-jump-to-
suggestion">  </li>
```

```
</ul>
```

```
</div> </label> </form> </div> </div>
```

```
<nav class="d-flex flex-column flex-lg-row flex-self-stretch flex-lg-self-
auto" aria-label="Global"> <a class="Header-link d-block d-lg-none py-2
py-lg-0 border-top border-lg-top-0 border-white-fade-15" data-ga-click="Header,
click, Nav menu - item:dashboard:user" aria-label="Dashboard" href="/dashboard">
Dashboard </a>
```

```
<a class="js-selected-navigation-item Header-link mr-0 mr-lg-3 py-2
py-lg-0 border-top border-lg-top-0 border-white-fade-15" data-hotkey="g
p" data-ga-click="Header, click, Nav menu - item:pulls context:user" aria-
label="Pull requests you created" data-selected-links="/pulls /pulls/as-
signed /pulls/mentioned /pulls" href="/pulls"> Pull requests </a> <a
class="js-selected-navigation-item Header-link mr-0 mr-lg-3 py-2 py-lg-0
border-top border-lg-top-0 border-white-fade-15" data-hotkey="g i" data-
ga-click="Header, click, Nav menu - item:issues context:user" aria-label="Issues
you created" data-selected-links="/issues /issues/assigned /issues/men-
tioned /issues" href="/issues"> Issues </a> <div class="mr-0 mr-lg-3 py-
2 py-lg-0 border-top border-lg-top-0 border-white-fade-15"> <a class="js-
selected-navigation-item Header-link" data-ga-click="Header, click, Nav
menu - item:marketplace context:user" data-octo-click="marketplace_click" data -
octo - dimensions = "location : navbar" data - selected - links = "/marketplace" href =
"/marketplace" > Marketplace < /a >
```

```
</div>
```

```
<a class="js-selected-navigation-item Header-link mr-0 mr-lg-3 py-2
py-lg-0 border-top border-lg-top-0 border-white-fade-15" data-ga-click="Header,
click, Nav menu - item:explore" data-selected-links="/explore /trending
```

```

/trending/developers /integrations /integrations/feature/code /inte-
grations/feature/collaborate /integrations/feature/ship showcases showcases_earchsho
"/explore" > Explore < /a >

```

```

<a class="Header-link d-block d-lg-none mr-0 mr-lg-3 py-2 py-lg-0
border-top border-lg-top-0 border-white-fade-15" href="https://github.com/ahmedgobba
<!-- </textarea></xmp> -></option></form><form
action="/logout" accept-charset="UTF-8" method="post"><input type="hidden"
name="authenticity_token" value = "fOt63u6SleCAOFk5TjrNPtxMINJ6VREhiANIafEc2
"/ >< buttontype = "submit"class = "Header-linkmr-0mr-lg-
3py-2py-lg-0border-topborder-lg-top-0border-white-fade-
15d-lg-nonebtn-linkd-blockwidth-fulltext-left"data-ga-click =
"Header,signout,icon:logout"style = "padding-left:2px;" >< svgclass =
"octiconocticon-sign-outv-align-middle"viewBox = "001616"version =
"1.1"width = "16"height = "16"aria-hidden = "true" >< pathfill -
rule = "evenodd"d = "M129V7H8V5h4V3l43-43zm-23H6V3L21h8v3h1V1c0-
.55-.45-1-1-1H1C.4500.4501v11.38c0.39.22.73.55.91L616.01V13h4c.5501-
.451-1V8h-1v4z"/ >< /svg > Signout < /button >< /form ><
/nav >

```

```

</div>

```

```

<div class="Header-item Header-item-full flex-justify-center d-lg-none
position-relative"> <div class="css-truncate css-truncate-target width-fit

```

```

position-absolute left-0 right-0 text-center"> <svg class="octicon octicon-
repo" viewBox="0 0 12 16" version="1.1" width="12" height="16" aria-
hidden="true"><path fill-rule="evenodd" d="M4 9H3V8h1v1zm0-3H3v1h1V6zm0-
2H3v1h1V4zm0-2H3v1h1V2zm8-1v12c0 .55-.45 1-1 1H6v2l-1.5-1.5L3 16v-
2H1c-.55 0-1-.45-1-1V1c0-.55.45-1 1-1h10c.55 0 1 .45 1 1zm-1 10H1v2h2v-
1h3v1h5v-2zm0-10H2v9h9V1z"/></svg> <a class="Header-link" href="/ahmedgobba">
/ <a class="Header-link" href="/ahmedgobba/capstone-latex">capstone-
latex</a>

</div> </div>

<div class="Header-item mr-0 mr-lg-3 flex-order-1 flex-lg-order-none">
  <a aria-label="You have no unread notifications" class="Header-link
notification-indicator position-relative tooltiped tooltiped-sw js-socket-
channel js-notification-indicator" data-hotkey="g n" data-ga-click="Header,
go to notifications, icon:read" data-channel="notification-changed:54692930"
href="/notifications/beta"> <span class="js-indicator-modifier mail-status
"></span> <svg class="octicon octicon-bell" viewBox="0 0 14 16" ver-
sion="1.1" width="14" height="16" aria-hidden="true"><path fill-rule="evenodd"
d="M14 12v1H0v-1l.73-.58c.77-.77.81-2.55 1.19-4.42C2.69 3.23 6 2 6 2c0-
.55.45-1 1-1s1 .45 1 1c0 0 3.39 1.23 4.16 5 .38 1.88.42 3.66 1.19 4.42l.66.58H14zm-
7 4c1.11 0 2-.89 2-2H5c0 1.11.89 2 2 2z"/></svg> </a> </div>

<div class="Header-item position-relative d-none d-lg-flex"> <details
class="details-overlay details-reset"> <summary class="Header-link" aria-
label="Create new. . ." data-ga-click="Header, create new, icon:add"> <svg
class="octicon octicon-plus" viewBox="0 0 12 16" version="1.1" width="12"
height="16" aria-hidden="true"><path fill-rule="evenodd" d="M12 9H7v5H5V9H0V7h5V

```

```

<span class="dropdown-caret"></span> </summary> <details-menu class="dropdown-
menu dropdown-menu-sw">
    <a role="menuitem" class="dropdown-item" href="/new" data-ga-click="Header,
create new repository"> New repository </a>
    <a role="menuitem" class="dropdown-item" href="/new/import" data-
ga-click="Header, import a repository"> Import repository </a>
    <a role="menuitem" class="dropdown-item" href="https://gist.github.com/"
data-ga-click="Header, create new gist"> New gist </a>
    <a role="menuitem" class="dropdown-item" href="/organizations/new"
data-ga-click="Header, create new organization"> New organization </a>
    <div role="none" class="dropdown-divider"></div> <div class="dropdown-
header"> <span title="ahmedgobba/capstone-latex">This repository</span>
</div> <a role="menuitem" class="dropdown-item" href="/ahmedgobba/capstone-
latex/issues/new/choose" data-ga-click="Header, create new issue" data-
skip-pjax> New issue </a>
</details-menu> </details>
</div>
<div class="Header-item position-relative mr-0 d-none d-lg-flex">
<details class="details-overlay details-reset js-feature-preview-indicator-
container" data-feature-preview-indicator-src="/users/ahmedgobba/feature_preview/ind
<summary class="Header-link" aria-label="View profile and more" data-
ga-click="Header, show menu, icon:avatar"> </span> <span class="dropdown-caret"></span> </summary>
<details-menu class="dropdown-menu dropdown-menu-sw mt-2" style="width:

```

```
180px"> <div class="header-nav-current-user css-truncate"><a role="menuitem"
class="no-underline user-profile-link px-3 pt-2 pb-2 mb-n2 mt-n1 d-block"
href="/ahmedgobba" data-ga-click="Header, go to profile, text:Signed in
as">Signed in as <strong class="css-truncate-target">ahmedgobba</strong></a></div>
<div role="none" class="dropdown-divider"></div>
```

```
<div class="pl-3 pr-3 f6 user-status-container js-user-status-context pb-
1" data-url="/users/status?compact=1&link_mentions=0&truncate=
1">
```

```
<div class="js-user-status-container user-status-compact rounded-1 px-
2 py-1 mt-2 border " data-team-hovercards-enabled> <details class="js-
user-status-details details-reset details-overlay details-overlay-dark"> <sum-
mary class="btn-link btn-block link-gray no-underline js-toggle-user-status-
edit toggle-user-status-edit" role="menuitem" data-hydro-click=""event_type";:
";user_profile.click";,";payload";:";profile_user_id";: 54692930,";ta
hydro-click-hmac="69d6ec053452117e881ffaabb09394a51c9c1851ec2d8fe537bf66b285
divclass="d-flex"><divclass="f6lh-condenseduser-status-
headerd-inline-blockv-align-middleuser-status-emoji-only-
headercirclepr-2"style="max-width:29px"><divclass="user-
status-emoji-containerflex-shrink-0mr-1mt-1lh-condensed-
ultrav-align-bottom"style=""><svgclass="octiconocticon-
smiley"viewBox="001616"version="1.1"width="16"height="16"aria-
hidden="true"><pathfill-rule="evenodd"d="M80C3.58003.5808s3.58888-
3.588-8-3.58-8-8-8zm4.8112.81a6.726.72001-2.171.45c-.83.36-
1.72.53-2.64.53-.920-1.81-.17-2.64-.53-.81-.34-1.55-.83-
2.17-1.45a6.7736.773001-1.45-2.17A6.596.590011.218c0-.92.17-1.81.53-
2.64.34-.81.83-1.551.45-2.17.62-.36-1.112.17-1.45A6.596.5900181.21c.9201.81.
```

```
.171.81 – .532.64 – .34.81 – .831.55 – 1.452.17zM46.8v – .59c0 – .66.53 –
1.191.2 – 1.19h.59c.6601.19.531.191.19v.59c0.67 – .531.2 – 1.191.2H5.2C4.53847.4746.8zm50
.59c0 – .66.53 – 1.191.2 – 1.19h.59c.6601.19.531.191.19v.59c0.67 – .531.2 –
1.191.2h – .59C9.53897.4796.8zm43.2c – .721.88 – 2.913 – 53s – 4.28 – 1.13 –
5 – 3c – .14 – .39.23 – 1.66 – 1h8.59c.410.89.61.751z"/ >< /svg >< /div ><
/div >< divclass = "d – inline – blockv – align – middle
css-truncate css-truncate-target user-status-message-wrapper f6" style="line-
height: 20px;" > <div class="d-inline-block text-gray-dark v-align-text-
top text-left"> <span class="text-gray ml-2">Set status</span> </div>
</div></div></summary> <details-dialog class="details-dialog rounded-
1 anim-fade-in fast Box Box-overlay" role="dialog" tabindex="-1"> <!-- ""
--><!-- </textarea></xmp> --></option></form><form class="position-
relative flex-auto js-user-status-form" action="/users/status?compact=1amp;link_mentions
0amp;truncate = 1"accept – charset = "UTF – 8"method = "post" ><
inputtype = "hidden"name = "method"value = "put"/ >< inputtype =
"hidden"name = "authenticity_token"value = "WxOkzBNeyq/nFi7mn1Ogty/UZF5cndqto
"/ >< divclass = "Box – headerbg – grayborder – bottomp – 3" ><
buttonclass = "Box – btn – octiconjs – toggle – user – status – editbtn –
octiconfloat – right"type = "reset"aria – label = "Closedialog"data –
close – dialog >< svgclass = "octiconocticon – x"viewBox = "001216"version =
"1.1"width = "12"height = "16"aria – hidden = "true" >< pathfill –
rule = "evenodd"d = "M7.488l3.753.75 – 1.481.48L69.48l – 3.753.75 –
1.48 – 1.48L4.528.774.25l1.48 – 1.48L66.52l3.75 – 3.751.481.48L7.488z"/ ><
/svg >< /button >< h3class = "Box – titlef5text – boldtext – gray –
dark" > Editstatus < /h3 >< /div >< inputtype = "hidden"name =
"emoji"class = "js – user – status – emoji – field"value = "" >< inputtype =
```

---

```

"hidden" name = "organization_id" class = "js - user - status - org - id -
field" value = "" >< divclass = "px - 3py - 2text - gray - dark" ><
divclass = "js - characters - remaining - containerposition - relativemt -
2" >< divclass = "input - groupd - tableform - groupmy - 0js - user -
status - form - group" >< spanclass = "input - group - buttond -
table - cellv - align - middle" style = "width : 1 < buttontype = "button" aria -
label = "Choose an emoji" class = "btn - outlinebtnjs - toggle - user -
status - emoji - pickerbtn - open - emoji - pickerp - 0" >< spanclass =
"js - user - status - original - emoji" hidden >< /span >< spanclass =
"js - user - status - custom - emoji" >< /span >< spanclass = "js -
user - status - no - emoji - icon" >< svgclass = "octiconocticon - smiley" viewBox =
"001616" version = "1.1" width = "16" height = "16" aria - hidden =
"true" >< pathfill - rule = "evenodd" d = "M80C3.58003.5808s3.588888 -
3.588 - 8 - 3.58 - 8 - 8 - 8zm4.8112.81a6.726.72001 - 2.171.45c - .83.36 -
1.72.53 - 2.64.53 - .920 - 1.81 - .17 - 2.64 - .53 - .81 - .34 - 1.55 - .83 -
2.17 - 1.45a6.7736.773001 - 1.45 - 2.17A6.596.590011.218c0 - .92.17 - 1.81.53 -
2.64.34 - .81.83 - 1.551.45 - 2.17.62 - .621.36 - 1.112.17 - 1.45A6.596.5900181.21c.9201.81.
.171.81 - .532.64 - .34.81 - .831.55 - 1.452.17zM46.8v - .59c0 - .66.53 -
1.191.2 - 1.19h.59c.6601.19.531.191.19v.59c0.67 - .531.2 - 1.191.2H5.2C4.53847.4746.8zm50
.59c0 - .66.53 - 1.191.2 - 1.19h.59c.6601.19.531.191.19v.59c0.67 - .531.2 -
1.191.2h - .59C9.53897.4796.8zm43.2c - .721.88 - 2.913 - 53s - 4.28 - 1.13 -
5 - 3c - .14 - .39.23 - 1.66 - 1h8.59c.410.89.61.751z"/ >< /svg >< /span ><
/button >< /span >< text - expanderkeys = " : @" data - mention -
url = "/autocomplete/user - suggestions" data - emoji - url = "/autocomplete/emoji" >
inputtype = "text" autocomplete = "off" data - no - org - url = "/autocomplete/user -
suggestions" data - org - url = "/suggestions?mention_suggester = 1" data -

```



```

maxlength = "80" class = "d-table-cellwidth-fullform-controljs-user-status-message-fieldjs-characters-remaining-field" placeholder =
"What'shappening?" name = "message" value = "" aria-label = "What is your current status"
/text-expander > < div class = "error" > Could not update your status, please try again. <
/div > < /div > < div style = "margin-left : 53px" class = "my-1 text-small label-characters-remainingjs-characters-remaining" data-
suffix = "remaining" hidden > 80 remaining < /div > < /div > <
include-fragment class = "js-user-status-emoji-picker" data-url = "/users/status/emoji" > < /include-fragment > < div class =
"overflow-auto ml-n3 mr-n3 px-3 border-bottom" style = "max-height : 33vh" > < div class = "user-status-suggestionsjs-user-status-suggestions collapsed overflow-hidden" > < h4 class = "f6 text-normal my-3" > Suggestions : < /h4 > < div class = "mx-3 mt-2 clearfix" > < div class = "float-left col-6" > < button type = "button" value =
" : palm-tree : " class = "d-flex flex-items-baseline flex-items-stretch lh-condensed f6 btn-link link-gray no-underline js-predefined-user-status mb-1" > < div class = "emoji-status width mr-2 v-align-middle js-predefined-user-status-emoji" > < g-emoji alias =
"palm-tree" fallback-src = "https://github.githubassets.com/images/icons/emoji/unicode/1f344.png" > < /g-emoji > < /div > < div class = "d-flex flex-items-center no-underline js-predefined-user-status-message w-normal text-left" style =
"border-left : 1px solid transparent" > On vacation < /div > < /button > <
button type = "button" value = " : face with thermometer : " class = "d-flex flex-items-baseline flex-items-stretch lh-condensed f6 btn-link link-gray no-underline js-predefined-user-status mb-1" > <
div class = "emoji-status width mr-2 v-align-middle js-predefined-

```

```

user – status – emoji" >< g – emoji:alias = "face_with_thermometer" fallback –
src = "https://github.githubassets.com/images/icons/emoji/unicode/1f912.png" ><
/g – emoji >< /div >< div: class = "d – flex flex – items – center no –
underline js – predefined – user – status – message w – normal text – left" style =
"border – left : 1px solid transparent" > Outsick < /div >< /button ><
/div >< div: class = "float – left col – 6" >< button: type = "button" value =
" : house : " class = "d – flex flex – items – baseline flex – items – stretch lh –
condensed f6 btn – link link – gray no – underline js – predefined – user –
status mb – 1" >< div: class = "emoji – status – width mr – 2v – align –
middle js – predefined – user – status – emoji" >< g – emoji:alias = "house" fallback –
src = "https://github.githubassets.com/images/icons/emoji/unicode/1f3e0.png" ><
/g – emoji >< /div >< div: class = "d – flex flex – items – center no –
underline js – predefined – user – status – message w – normal text – left" style =
"border – left : 1px solid transparent" > Working from home < /div ><
/button >< button: type = "button" value = " : dart : " class = "d –
flex flex – items – baseline flex – items – stretch lh – condensed f6 btn –
link link – gray no – underline js – predefined – user – status mb – 1" ><
div: class = "emoji – status – width mr – 2v – align – middle js – predefined –
user – status – emoji" >< g – emoji:alias = "dart" fallback – src = "https :
//github.githubassets.com/images/icons/emoji/unicode/1f3af.png" ><
/g – emoji >< /div >< div: class = "d – flex flex – items – center no –
underline js – predefined – user – status – message w – normal text – left" style =
"border – left : 1px solid transparent" > Focusing < /div >< /button ><
/div >< /div >< /div >< div: class = "user – status – limited –
availability – container" >< div: class = "form – checkbox my – 0" ><
input: type = "checkbox" name = "limited_availability" value = "1" class =

```

```

"js - user - status - limited - availability - checkbox" data - default -
message = "Imaybeslowtorespond." aria - describedby = "limited - availability -
help - text - truncate - true - compact - true" id = "limited - availability -
truncate - true - compact - true" >< labelclass = "d - blockf5text -
gray - darkmb - 1" for = "limited - availability - truncate - true - compact -
true" > Busy < /label >< pclass = "note" id = "limited - availability -
help - text - truncate - true - compact - true" > Whenothersmentionyou,assignyou,orreq
/p >< /div >< /div >< /div >< divclass = "d - inline - blockf5mr -
2pt - 3pb - 2" >< divclass = "d - inline - blockmr - 1" > Clearstatus <
/div >

```

```

<details class="js-user-status-expire-drop-down f6 dropdown details-
reset details-overlay d-inline-block mr-2"> <summary class="f5 btn-link
link-gray-dark border px-2 py-1 rounded-1" aria-haspopup="true"> <div
class="js-user-status-expiration-interval-selected d-inline-block v-align-baseline">
Never </div> <div class="dropdown-caret"></div> </summary>

```

```

<ul class="dropdown-menu dropdown-menu-se pl-0 overflow-auto"
style="width: 220px; max-height: 15.5em"> <li> <button type="button"
class="btn-link dropdown-item js-user-status-expire-button ws-normal"
title="Never"> <span class="d-inline-block text-bold mb-1">Never</span>
<div class="f6 lh-condensed">Keep this status until you clear your sta-
tus or edit your status.</div> </button> </li> <li class="dropdown-
divider" role="none"></li> <li> <button type="button" class="btn-link
dropdown-item ws-normal js-user-status-expire-button" title="in 30 min-
utes" value="2020-03-21T21:18:39+08:00"> in 30 minutes </button> </li>
<li> <button type="button" class="btn-link dropdown-item ws-normal
js-user-status-expire-button" title="in 1 hour" value="2020-03-21T21:48:39+08:00">

```

```

in 1 hour </button> </li> <li> <button type="button" class="btn-link
dropdown-item ws-normal js-user-status-expire-button" title="in 4 hours"
value="2020-03-22T00:48:39+08:00"> in 4 hours </button> </li> <li> <but-
ton type="button" class="btn-link dropdown-item ws-normal js-user-status-
expire-button" title="today" value="2020-03-21T23:59:59+08:00"> today </but-
ton> </li> <li> <button type="button" class="btn-link dropdown-item
ws-normal js-user-status-expire-button" title="this week" value="2020-03-
22T23:59:59+08:00"> this week </button> </li> </ul> </details> <input
class="js-user-status-expiration-date-input" type="hidden" name="expires_at" value =
"" > </div>

```

```

<include-fragment class="js-user-status-org-picker" data-url="/users/status/organiza-
tion"> </div> <div class="d-flex flex-items-center flex-justify-between
p-3 border-top"> <button type="submit" disabled class="width-full btn
btn-primary mr-2 js-user-status-submit"> Set status </button> <button
type="button" disabled class="width-full js-clear-user-status-button btn
ml-2"> Clear status </button> </div> </form> </details-dialog> </de-
tails> </div>

```

```

</div> <div role="none" class="dropdown-divider"></div>

```

```

<a role="menuitem" class="dropdown-item" href="/ahmedgobba" data-
ga-click="Header, go to profile, text:your profile">Your profile</a>

```

```

<a role="menuitem" class="dropdown-item" href="/ahmedgobba?tab=repositories"
data-ga-click="Header, go to repositories, text:your repositories">Your
repositories</a>

```

```

<a role="menuitem" class="dropdown-item" href="/ahmedgobba?tab=projects"
data-ga-click="Header, go to projects, text:your projects">Your projects</a>

```

```

<a role="menuitem" class="dropdown-item" href="/ahmedgobba?tab=stars"

```

```

data-ga-click="Header, go to starred repos, text:your stars">Your stars</a>
<a role="menuitem" class="dropdown-item" href="https://gist.github.com/mine"
data-ga-click="Header, your gists, text:your gists">Your gists</a>
  <div role="none" class="dropdown-divider"></div>
  <div id="feature-enrollment-toggle" class="hide-sm hide-md feature-
preview-details position-relative"> <button type="button" class="dropdown-
item btn-link" role="menuitem" data-feature-preview-trigger-url="/users/ahmedgobba/
feature - preview - close - details = "quot;event_typequot;; quot;feature_preview.clicks.clos
feature - preview - close - hmac = "513b13ccbda9cc2aea11e57406c29598acb4b25f5a92400
hydro - click = "quot;event_typequot;; quot;feature_preview.clicks.open_modalquot;; , quot;pa
hydro - click - hmac = "7f19d237187ffcb570327d05b1243e3f610e58825b076647847aaa71c
Featurepreview < /button > < spanclass = "feature - preview - indicatorjs -
feature - preview - indicator"hidden > < /span > < /div >
  <a role="menuitem" class="dropdown-item" href="https://help.github.com"
data-ga-click="Header, go to help, text:help">Help</a> <a role="menuitem"
class="dropdown-item" href="/settings/profile" data-ga-click="Header,
go to settings, icon:settings">Settings</a> <!-- "" --><!-- </textarea></xmp>
--></option></form><form class="logout-form" action="/logout" accept-
charset="UTF-8" method="post"><input type="hidden" name="authenticity_token" value =
"9/nmaimSfjNsk5/lvBSz2S3oN4n4dDuMwibjXddpJVw5vsmzjS5BGMm5IlvbutrouoSv
"/ >
  <button type="submit" class="dropdown-item dropdown-signout" data-
ga-click="Header, sign out, icon:logout" role="menuitem"> Sign out </but-
ton> <input type="text" name="required_field_3c6d"hidden = "hidden"class =
"form - control" / > < inputtype = "hidden"name = "timestamp"value =
"1584794919970"class = "form - control" / > < inputtype = "hidden"name =

```

```

"timestamp_secret" value = "971f4d87b4100ecbcbbc30e62019fc0541ae35363775b6007ddc6e6
"form - control" / >< /form >< /details - menu >< /details >
</div>
</header>
</div>
<div id="start-of-content" class="show-on-focus"></div>
<div id="js-flash-container">
</div>
<include-fragment class="js-notification-shelf-include-fragment" data-
base-src="https://github.com/notifications/beta/shelf"></include-fragment>
<div class="application-main " data-commit-hovercards-enabled> <div
itemscope itemtype="http://schema.org/SoftwareSourceCode" class="">
<main >
<div class="border-bottom shelf intro-shelf js-notice mb-0 pb-4"> <div
class="width-full container"> <div class="width-full mx-auto shelf-content">
<h2 class="shelf-title">Learn Git and GitHub without any code!</h2>
<p class="shelf-lead"> Using the Hello World guide, you'll start a branch,
write comments, and open a pull request. </p> <a class="btn btn-primary
shelf-cta" target="_blank" data-hydro-click = "quot;event_typequot;; quot;repository.click
hydro-click-hmac = "5d36a116df902b8c8e3729ec945fadaa6fa1dec224eeb8e2672175949
"https://guides.github.com/activities/hello-world/" > Read the guide <
/a >< /div ><! - -'"" - - ><! - - < /textarea >< /xmp >
-- >< /option >< /form >< formclass = "shelf-dismiss js -
notice-dismiss" action = "/dashboard/dismiss_bootcamp" accept-charset =
"UTF-8" method = "post" >< inputtype = "hidden" name = "method" value =
"delete" / >< inputtype = "hidden" name = "authenticity_token" value =

```

```

"6/cnyG + ZqcJxn0yW9 + INgj7HSMQZ7WSkBe4eG0T2TOTaccome00Fl21VXEbTY170
"/ >< buttonname = "button" type = "submit" class = "mr - 1close -
buttontooltippedtooltipped - w" aria - label = "Hidethisnoticeforever" data -
hydro - click = "quot;event_typequot;; quot;repository.clickquot;; quot;payloadquot;; quot;
hydro - click - hmac = "5a5e2f4c16b34b43c0c9966722bae4085fae77d5d67409af5608784bf
svgaria - label = "Hidethisnoticeforever" class = "octiconocticon - xv -
align - text - top" viewBox = "001216" version = "1.1" width = "12" height =
"16" role = "img" >< path fill - rule = "evenodd" d = "M7.488l3.753.75 -
1.481.48L69.48l - 3.753.75 - 1.48 - 1.48L4.528.774.25l1.48 - 1.48L66.52l3.75 -
3.751.481.48L7.488z"/ >< /svg >< /button >< /form >< /div ><
/div >
<div class="pagehead repohead hx_repoheadreadability - menubg - gray -
lightpb - 0pt - 0pt - lg - 3" >
<div class="d-flex container-lg mb-4 p-responsive d-none d-lg-flex">
<div class="flex-auto min-width-0 width-fit mr-3"> <h1 class="public
d-flex flex-wrap flex-items-center break-word float-none "> <svg class="octicon
octicon-repo" viewBox="0 0 12 16" version="1.1" width="12" height="16"
aria-hidden="true"><path fill-rule="evenodd" d="M4 9H3V8h1v1zm0-3H3v1h1V6zm0-
2H3v1h1V4zm0-2H3v1h1V2zm8-1v12c0 .55-.45 1-1 1H6v2l-1.5-1.5L3 16v-
2H1c-.55 0-1-.45-1-1V1c0-.55.45-1 1-1h10c.55 0 1 .45 1 1zm-1 10H1v2h2v-
1h3v1h5v-2zm0-10H2v9h9V1z"/></svg> <span class="author ml-1 flex-
self-stretch" itemprop="author"> <a class="url fn" rel="author" data-hovercard-
type="user" data-hovercard-url="/users/ahmedgobba/hovercard" data-
octo-click="hovercard-link-click" data-octo-dimensions="link_type : self" href =
"/ahmedgobba" > ahmedgobba < /a >< /span >< span class = "path -
divider flex - self - stretch" > / < /span >< strong itemprop = "name" class =

```

"mr - 2flex - self - stretch" >< adata - pjax = "js - repo - pjax - container"href = "/ahmedgobba/capstone - latex" > capstone - latex < /a >< /strong >

</h1>

</div>

<ul class="pagehead-actions flex-shrink-0 " >

<li hidden> <include-fragment src="/ahmedgobba/capstone-latex/used<sub>b</sub>y<sub>c</sub>ount"acce  
"text/fragment + html" >< /include - fragment >< /li >

<li>

<!-- "" -><!-- </textarea></xmp> -></option></form><form data-remote="true" class="clearfix js-social-form js-social-container" action="/notifications/sul  
accept-charset="UTF-8" method="post"><input type="hidden" name="authenticity<sub>t</sub>oken"  
"IyyeWbYvxtermQDz8ZHMursObdFqgjBFMyTQWnuampQDJ65Jlscw5DeK3Kos +  
rgmmxNBOhRDcDvKofeXjHXSbg == "/ >< inputtype = "hidden"name =  
"repository<sub>i</sub>d"value = "248283018" >

<details class="details-reset details-overlay select-menu float-left"> <sum-  
mary class="select-menu-button float-left btn btn-sm btn-with-count" data-  
hydro-click="quot;event<sub>t</sub>ypequot;; quot;repository.clickquot;; quot;payloadquot;;  
quot;targetquot;; quot;WATCH<sub>B</sub>UTTONquot;; quot;repository<sub>i</sub>dquot;; 248283018, quot; o  
hydro - click - hmac = "2abe74f689e0e692fbca61d997919b23c3af351abbf8efdaf5dfa4a69  
ga - click = "Repository,clickWatchsettings,action : blobshow" >< spandata -  
menu - button >< svgclass = "octiconocticon - eyev - align - text -  
bottom"viewBox = "001616"version = "1.1"width = "16"height = "16"aria -  
hidden = "true" >< pathfill - rule = "evenodd"d = "M8.062C320808s368.066C13141681  
3 - 6 - 7.94 - 6zM812c - 2.20 - 4 - 1.78 - 4 - 40 - 2.21.8 - 44 - 42.22041.84402.22 -  
1.784 - 44zm2 - 4c01.11 - .892 - 22 - 1.110 - 2 - .89 - 2 - 20 - 1.11.89 -



```

22 – 21.1102.8922z" / >< /svg > Unwatch < /span >< /summary ><
details – menuclass = "select – menu – modalposition – absolutemt –
5"style = "z – index : 99;" >< divclass = "select – menu – header" ><
spanclass = "select – menu – title" > Notifications < /span >< /div ><
divclass = "select – menu – list" >< buttontype = "submit" name =
"do" value = "included" class = "select – menu – itemwidth – full" aria –
checked = "false" role = "menuitemradio" >< svgclass = "octiconocticon –
checkselect – menu – item – icon" viewBox = "001216" version = "1.1" width =
"12" height = "16" aria – hidden = "true" >< pathfill – rule = "evenodd" d =
"M125l – 88 – 4 – 41.5 – 1.5L410l6.5 – 6.5L125z" / >< /svg >< divclass =
"select – menu – item – text" >< spanclass = "select – menu – item –
heading" > Notwatching < /span >< spanclass = "description" >
Benotifiedonlywhenparticipatingor@mentioned. < /span >< spanclass =
"hidden – select – button – text" data – menu – button – contents >< svgclass =
"octiconocticon – eyev – align – text – bottom" viewBox = "001616" version =
"1.1" width = "16" height = "16" aria – hidden = "true" >< pathfill –
rule = "evenodd" d = "M8.062C320808s368.066C1314168168s – 3 – 6 –
7.94 – 6zM812c – 2.20 – 4 – 1.78 – 4 – 40 – 2.21.8 – 44 – 42.22041.84402.22 –
1.784 – 44zm2 – 4c01.11 – .892 – 22 – 1.110 – 2 – .89 – 2 – 20 – 1.11.89 –
22 – 21.1102.8922z" / >< /svg > Watch < /span >< /div >< /button >
<button type="submit" name="do" value="releaseonly" class = "select –
menu – itemwidth – full" aria – checked = "false" role = "menuitemradio" ><
svgclass = "octiconocticon – checkselect – menu – item – icon" viewBox =
"001216" version = "1.1" width = "12" height = "16" aria – hidden =
"true" >< pathfill – rule = "evenodd" d = "M125l – 88 – 4 – 41.5 –
1.5L410l6.5 – 6.5L125z" / >< /svg >< divclass = "select – menu –

```

```

item – text" >< spanclass = "select – menu – item – heading" > Releasesonly <
/ span >< spanclass = "description" > Benotifiedofnewreleases,andwhenparticipatingon
/ span >< spanclass = "hidden – select – button – text" data – menu –
button – contents >< svgclass = "octiconocticon – eyev – align – text –
bottom" viewBox = "001616" version = "1.1" width = "16" height = "16" aria –
hidden = "true" >< pathfill – rule = "evenodd" d = "M8.062C320808s368.066C13141681
3 – 6 – 7.94 – 6zM812c – 2.20 – 4 – 1.78 – 4 – 40 – 2.21.8 – 44 – 42.22041.84402.22 –
1.784 – 44zm2 – 4c01.11 – .892 – 22 – 1.110 – 2 – .89 – 2 – 20 – 1.11.89 –
22 – 21.1102.8922z" / >< /svg > Unwatchreleases < /span >< /div ><
/button >

```

```

<button type="submit" name="do" value="subscribed" class="select-
menu-item width-full" aria-checked="true" role="menuitemradio"> <svg
class="octicon octicon-check select-menu-item-icon" viewBox="0 0 12 16"
version="1.1" width="12" height="16" aria-hidden="true"><path fill-rule="evenodd"
d="M12 5l-8 8-4-4 1.5-1.5L4 10l6.5-6.5L12 5z"/></svg> <div class="select-
menu-item-text"> <span class="select-menu-item-heading">Watching</span>
<span class="description">Be notified of all conversations.</span> <span
class="hidden-select-button-text" data-menu-button-contents> <svg class="octicon
octicon-eye v-align-text-bottom" viewBox="0 0 16 16" version="1.1" width="16"
height="16" aria-hidden="true"><path fill-rule="evenodd" d="M8.06 2C3
2 0 8 0 8s3 6 8.06 6C13 14 16 8 16 8s-3-6-7.94-6zM8 12c-2.2 0-4-1.78-4-4 0-
2.2 1.8-4-4-4 2.22 0 4 1.8 4 4 0 2.22-1.78 4-4 4zm2-4c0 1.11-.89 2-2 1.11
0-2-.89-2-2 0-1.11.89-2 2-2 1.11 0 2 .89 2 2z"/></svg> Unwatch </span>
</div> </button>

```

```

<button type="submit" name="do" value="ignore" class="select-menu-
item width-full" aria-checked="false" role="menuitemradio"> <svg class="octicon

```

```

octicon-check select-menu-item-icon" viewBox="0 0 12 16" version="1.1"
width="12" height="16" aria-hidden="true"><path fill-rule="evenodd" d="M12
5l-8 8-4-4 1.5-1.5L4 10l6.5-6.5L12 5z"/></svg> <div class="select-menu-
item-text"> <span class="select-menu-item-heading">Ignoring</span> <span
class="description">Never be notified.</span> <span class="hidden-select-
button-text" data-menu-button-contents> <svg class="octicon octicon-mute
v-align-text-bottom" viewBox="0 0 16 16" version="1.1" width="16" height="16"
aria-hidden="true"><path fill-rule="evenodd" d="M8 2.81v10.38c0 .67-.81
1-1.28.53L3 10H1c-.55 0-1-.45-1-1V7c0-.55.45-1 1-1h2l3.72-3.72C7.19 1.81 8
2.14 8 2.81zm7.53 3.22l-1.06-1.06-1.97 1.97-1.97-1.97-1.06 1.06L11.44 8 9.47
9.97l1.06 1.06 1.97-1.97 1.97 1.97 1.06-1.06L13.56 8l1.97-1.97z"/></svg>
Stop ignoring </span> </div> </button> </div> </details-menu> </de-
tails> <a class="social-count js-social-count" href="/ahmedgobba/capstone-
latex/watchers" aria-label="1 user is watching this repository"> 1 </a>
</form> </li>

<li> <div class="js-toggler-container js-social-container starring-container
"> <form class="starred js-social-form" action="/ahmedgobba/capstone-
latex/unstar" accept-charset="UTF-8" method="post"><input type="hidden"
name="authenticity_token" value = "nGXoRSQOouj/DzU6uAxAzSofNzeF5o7ILXAQIg3
"/ >< input type = "hidden" name = "context" value = "repository" ><
/input >< button type = "submit" class = "btn btn - sm btn - with -
count js - toggler - target" aria - label = "Unstar this repository" title =
"Unstar ahmedgobba/capstone - latex" data - hydro - click = "quot;event_typequot;; quot;
hydro - click - hmac = "6d9b6b274b32a6a5aecb88aa6ec714f48f31d3dcf44309c63249098ce3
ga - click = "Repository,clickunstarbutton,action : blobshow;text : Unstar" ><
svg height = "16" class = "octicon octicon - star v - align - text - bottom" vertical_align =

```

```
"text_botttom"viewBox = "001416"version = "1.1"width = "14"aria -
hidden = "true" >< pathfill - rule = "evenodd"d = "M146l - 4.9 -
.64L714.95.3606l3.63.26L2.6714711.6711.3314l - .93 - 4.74L146z"/ >< /svg >
```

```
Unstar </button> <a class="social-count js-social-count" href="/ahmedgobba/capstone-
latex/stargazers" aria-label="0 users starred this repository">0 </a> </form>
<form class="unstarred js-social-form" action="/ahmedgobba/capstone-
latex/star" accept-charset="UTF-8" method="post"><input type="hidden"
name="authenticity_token" value = "TYeHFAGh8Jro2XI2UCOE0a/u +
lNy5xTW5WJMXyKXLMbKzMzty1Irrw/0H2gzb8UpMhBM6yY8f7awIfJ6kKeUgrg ==
"/ >< inputtype = "hidden"name = "context"value = "repository" ><
/input >< buttontype = "submit"class = "btn btn - sm btn - with -
count js - toggler - target"aria - label = "Unstarthisrepository"title =
"Starahmedgobba/capstone - latex"data - hydro - click = "quot;event_typequot;; quot;rep
hydro - click - hmac = "a45380602b4632fcd70175f06f6ad3b0eae6810bec5a3484166962a43.
ga - click = "Repository,clickstarbutton,action : blobshow;text : Star" ><
svgheight = "16"class = "octiconocticon - starv - align - text - bottom"vertical_align =
"text_botttom"viewBox = "001416"version = "1.1"width = "14"aria -
hidden = "true" >< pathfill - rule = "evenodd"d = "M146l - 4.9 -
.64L714.95.3606l3.63.26L2.6714711.6711.3314l - .93 - 4.74L146z"/ >< /svg >
```

```
Star </button> <a class="social-count js-social-count" href="/ahmedgobba/capstone-
latex/stargazers" aria-label="0 users starred this repository">0 </a> </form>
</div>
```

```
</li>
```

```
<li> <span class="btn btn-sm btn-with-count disabled tooltiped tooltiped-
sw" aria-label="Cannot fork because you own this repository and are
```

not a member of any organizations."> <svg class="octicon octicon-repo-forked v-align-text-bottom" viewBox="0 0 10 16" version="1.1" width="10" height="16" aria-hidden="true"><path fill-rule="evenodd" d="M8 1a1.993 1.993 0 00-1 3.72V6L5 8 3 6V4.72A1.993 1.993 0 002 1a1.993 1.993 0 00-1 3.72V6.5l3 3v1.78A1.993 1.993 0 005 15a1.993 1.993 0 001-3.72V9.5l3-3V4.72A1.993 1.993 0 008 1zM2 4.2C1.34 4.2.8 3.65.55-1.2 1.2-1.2.65 0 1.2.55 1.2 1.2 0 .65-.55 1.2-1.2 1.2zm3 10c-.66 0-1.2-.55-1.2-1.2 0-.65-.55-1.2 1.2-1.2.65 0 1.2.55 1.2 1.2 0 .65-.55 1.2-1.2 1.2zm3-10c-.66 0-1.2-.55-1.2-1.2 0-.65-.55-1.2 1.2-1.2.65 0 1.2.55 1.2 1.2 0 .65-.55 1.2-1.2 1.2z"/></svg>  
 Fork </span> <a href="/ahmedgobba/capstone-latex/network/members" class="social-count" aria-label="0 users forked this repository"> 0 </a>  
 </li> </ul>

</div>

<nav class="hx,eponavreponavjs – repo – navjs – sidenav – container – pjaxclearfixcontainer – lgp – responsived – noned – lg – block"itemscopeitemtype = "http : // schema.org /BreadcrumbList"aria – label = "Repository"data – pjax = "js – repo – pjax – container" >

<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement">  
 <a class="js-selected-navigation-item selected reponav-item" itemprop="url" data-hotkey="g c" aria-current="page" data-selected-links="repo\_source\_repo\_downloads\_repo\_latex"href = "/ahmedgobba/capstone – latex" >< divclass = "d – inline" >< svgclass = "octiconocticon – code"viewBox = "001416"version = "1.1"width = "14"height = "16"aria – hidden = "true" >< pathfill – rule = "evenodd"d = "M9.53L84.511.58811.59.5131489.53zm – 50L08l4.55L611.52.5864.54.53z"/ >< /svg >< /div >< spanitemprop = "name" > Code < /span >< metaitemprop = "position"content = "1" >< /a >< /span >

```

<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"
<a itemprop="url" data-hotkey="g i" class="js-selected-navigation-item
reponav-item" data-selected-links="repo_issuesrepo_labelsrepo_milestones/ahmedgobba/capstone-latex/issues"href = "/ahmedgobba/capstone-latex/issues" >< divclass =
"d - inline" >< svgclass = "octiconocticon - issue - opened"viewBox =
"001416"version = "1.1"width = "14"height = "16"aria - hidden =
"true" >< pathfill - rule = "evenodd"d = "M72.3c3.1405.72.565.75.7s -
2.565.7 - 5.75.7A5.715.710011.38c0 - 3.142.56 - 5.75.7 - 5.7zM71C3.14104.1408s3.147777 -
3.147 - 7 - 3.14 - 7 - 7 - 7zm13H6v5h2V4zm06H6v2h2v - 2z"/ >< /svg ><
/div >< spanitemprop = "name" > Issues < /span >< spanclass =
"Counter" > 0 < /span >< metaitemprop = "position"content =
"2" >< /a >< /span >

```

```

<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"
<a data-hotkey="g p" data-skip-pjax="true" itemprop="url" class="js-selected-
navigation-item reponav-item" data-selected-links="repo_pullschecks/ahmedgobba/capstone-latex/pulls"href = "/ahmedgobba/capstone-latex/pulls" >< divclass =
"d - inline" >< svgclass = "octiconocticon - git - pull - request"viewBox =
"001216"version = "1.1"width = "12"height = "16"aria - hidden =
"true" >< pathfill - rule = "evenodd"d = "M1111.28V5c - .03 - .78 -
.34 - 1.47 - .94 - 2.06C9.462.358.782.0382H7V0L43l33V4h1c.27.02.48.11.69.31.21.2.3.42.31
3.72zm - 12.92c - .660 - 1.2 - .55 - 1.2 - 1.20 - .65.55 - 1.21.2 - 1.2.6501.2.551.21.20.65 -
.551.2 - 1.21.2zM43c0 - 1.11 - .89 - 2 - 2 - 2a1.9931.993000 - 13.72v6.56A1.9931.9930002
3.72V4.72c.59 - .341 - .981 - 1.72zm - .810c0.66 - .551.2 - 1.21.2 - .650 -
1.2 - .55 - 1.2 - 1.20 - .65.55 - 1.21.2 - 1.2.6501.2.551.21.2zM24.2C1.344.2.83.65.83c0 -
.65.55 - 1.21.2 - 1.2.6501.2.551.21.20.65 - .551.2 - 1.21.2z"/ >< /svg ><
/div >< spanitemprop = "name" > Pullrequests < /span >< spanclass =

```

"Counter" > 0 < /span >< metaitemprop = "position"content =  
"4" >< /a >< /span >

<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"  
class="position-relative float-left"> <a data-hotkey="g w" data-skip-pjax="true"  
class="js-selected-navigation-item reponav-item" data-selected-links="repo\_actions/ahmedgobba/capstone-latex/actions"href = "/ahmedgobba/capstone-latex/actions" >< divclass =  
"d-inline" >< svgclass = "octiconocticon-play"viewBox = "001416"version =  
"1.1"width = "14"height = "16"aria-hidden = "true" >< pathfill =  
rule = "evenodd"d = "M148A7701108a77001140zm-8.2233.482l4.599-  
3.066a.5.50000-.832L5.7774.518A.5.500054.934v6.132a.5.5000.777.416z"/ ><  
/svg >< /div > Actions < /a >< /span >

<a data-hotkey="g b" class="js-selected-navigation-item reponav-item"  
data-selected-links="repo\_projectsnew\_repo\_projectrepo\_project/ahmedgobba/capstone-latex/projects"href = "/ahmedgobba/capstone-latex/projects" >< divclass =  
"d-inline" >< svgclass = "octiconocticon-project"viewBox = "001516"version =  
"1.1"width = "15"height = "16"aria-hidden = "true" >< pathfill =  
rule = "evenodd"d = "M1012h3V2h-3v10zm-4-2h3V2H6v8zm-  
44h3V2H2v12zm-11h13V1H1v14zM140H1a11000-11v14a1100011h13a110001-  
1V1a11000-1-1z"/ >< /svg >< /div > Projects < spanclass =  
"Counter" > 0 < /span >< /a >< aclass = "js-selected-navigation-itemreponav-item"data-hotkey = "gw"data-selected-links = "repo\_wiki/ahmedgobba/capstone-latex/wiki"href = "/ahmedgobba/capstone-latex/wiki" >< divclass =  
"d-inline" >< svgclass = "octiconocticon-book"viewBox = "001616"version =  
"1.1"width = "16"height = "16"aria-hidden = "true" >< pathfill =  
rule = "evenodd"d = "M35h4v1H3V5zm03h4V7H3v1zm02h4V9H3v1zm11-  
5h-4v1h4V5zm02h-4v1h4V7zm02h-4v1h4V9zm2-6v9c0.55-.451-

---

```

11H9.5l – 11 – 1 – 1H2c – .550 – 1 – .45 – 1 – 1V3c0 – .55.45 – 11 –
1h5.5l111 – 1H15c.5501.4511zm – 8.5L7.53H2v9h6V3.5zm7 – .5H9.5l – .5.5V12h6V3z"/ >
/svg >< /div > Wiki < /a >< adata – skip – pjax = "true"class =
"js – selected – navigation – itemreponav – item"data – selected – links =
"securityalertspolicytoken_scanningcode_scanning/ahmedgobba/capstone –
latex/network/alerts"href = "/ahmedgobba/capstone – latex/network/alerts" ><
divclass = "d – inline" >< svgclass = "octiconocticon – shield"viewBox =
"001416"version = "1.1"width = "14"height = "16"aria – hidden =
"true" >< pathfill – rule = "evenodd"d = "M02l7 – 272v6.02C1412.698.6916716c –
1.690 – 7 – 3.31 – 7 – 7.98V2zm1.75L71l61.75v5.268C1312.1048.44915715c –
1.4490 – 6 – 2.896 – 6 – 6.982V2.75zm1.75L72v12c – 1.2070 – 5 – 2.482 –
5 – 5.985V3.5z"/ >< /svg >< /div > Security < /a >< aclass =
"js – selected – navigation – itemreponav – item"data – selected – links =
"repo_graphsrepo_contributorsdependency_graphdependabot_updatespulsepeople/ahmedgobba/
latex/pulse"href = "/ahmedgobba/capstone – latex/pulse" >< divclass =
"d – inline" >< svgclass = "octiconocticon – graph"viewBox = "001616"version =
"1.1"width = "16"height = "16"aria – hidden = "true" >< pathfill –
rule = "evenodd"d = "M1614v1H0V0h1v14h15zM513H3V8h2v5zm40H7V3h2v10zm40h –
2V6h2v7z"/ >< /svg >< /div > Insights < /a >< aclass = "js –
selected – navigation – itemreponav – item"data – selected – links = "repo_settingsrepo_branches
latex/settings"href = "/ahmedgobba/capstone – latex/settings" >< divclass =
"d – inline" >< svgclass = "octiconocticon – gear"viewBox = "001416"version =
"1.1"width = "14"height = "16"aria – hidden = "true" >< pathfill –
rule = "evenodd"d = "M148.77v – 1.6l – 1.94 – .64 – .45 – 1.09.88 –
1.84 – 1.13 – 1.13 – 1.81.91 – 1.09 – .45 – .69 – 1.92h – 1.6l – .631.94 –
1.11.45 – 1.84 – .88 – 1.131.13.911.81 – .451.09L07.23v1.59l1.94.64.451.09 –

```



.881.841.131.131.81 – .911.09.45.691.92h1.59l.63 – 1.941.11 – .451.84.881.13 –  
 1.13 – .92 – 1.81.47 – 1.09L148.75v.02zM711c – 1.660 – 3 – 1.34 – 3 – 3s1.34 –  
 33 – 331.3433 – 1.343 – 33z"/ >< /svg >< /div > Settings < /a ><  
 /nav >

<div class="reponav-wrapper reponav-small d-lg-none"> <nav class="reponav  
 js-reponav text-center no-wrap" itemscope itemtype="http://schema.org/BreadcrumbList"  
 <span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"  
 <a class="js-selected-navigation-item selected reponav-item" itemprop="url"  
 aria-current="page" data-selected-links="repo\_source\_repo\_downloads\_repo\_commits\_repo\_releases\_repo\_wiki\_repo\_graphs"/> </a>  
 <span itemprop="name"> Code </span> <span itemprop="position" content="1"> </a> <  
 /span >

<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"  
 <a itemprop="url" class="js-selected-navigation-item reponav-item" data-  
 selected-links="repo\_issues\_repo\_labels\_repo\_milestones"/> </a>  
 <span itemprop="name"> Issues </span> <span class="Counter"> 0 </span> <  
 meta itemprop="position" content="2"> </a> </span>

<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"  
 <a itemprop="url" class="js-selected-navigation-item reponav-item" data-  
 selected-links="repo\_pulls\_checks"/> </a>  
 <span itemprop="name"> Pull requests </span> <span class="Counter"> 0 </span> <  
 meta itemprop="position" content="4"> </a> </span>

<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"

```
<a itemprop="url" class="js-selected-navigation-item reponav-item" data-
selected-links="repo_projectsnew_repo_projectrepo_project/ahmedgobba/capstone –
latex/projects"href = "/ahmedgobba/capstone – latex/projects" >< spanitemprop =
"name" > Projects < /span >< spanclass = "Counter" > 0 < /span ><
metaitemprop = "position"content = "5" >< /a >< /span >
```

```
<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"
<a itemprop="url" class="js-selected-navigation-item reponav-item" data-
selected-links="repo_actions/ahmedgobba/capstone – latex/actions"href =
"/ahmedgobba/capstone – latex/actions" >< spanitemprop = "name" >
Actions < /span >< metaitemprop = "position"content = "6" ><
/a >< /span >
```

```
<span itemscope itemtype="http://schema.org/ListItem" itemprop="itemListElement"
<a itemprop="url" class="js-selected-navigation-item reponav-item" data-
selected-links="repo_wiki/ahmedgobba/capstone – latex/wiki"href = "/ahmedgobba/capstone –
latex/wiki" >< spanitemprop = "name" > Wiki < /span >< metaitemprop =
"position"content = "7" >< /a >< /span >
```

```
<a itemprop="url" class="js-selected-navigation-item reponav-item" data-
selected-links="security alerts policy tokenscanningcode_scanning/ahmedgobba/capstone –
latex/network/alerts"href = "/ahmedgobba/capstone – latex/network/alerts" ><
spanitemprop = "name" > Security < /span >< metaitemprop =
"position"content = "8" >< /a >< aclass = "js – selected – navigation –
itemreponav – item"data – selected – links = "pulse/ahmedgobba/capstone –
latex/pulse"href = "/ahmedgobba/capstone – latex/pulse" > Pulse <
/a >< spanitemscopeitemtype = "http://schema.org/ListItem"itemprop =
"itemListElement" >< aitemprop = "url"class = "js – selected – navigation –
itemreponav – item"data – selected – links = "community/ahmedgobba/capstone –
```

---

```

latex/community"href = "/ahmedgobba/capstone – latex/community" >
Community < /a >< /span >

</nav> </div>

</div>

<include-fragment class="js-notification-shelf-include-fragment" data-
base-src="https://github.com/notifications/beta/shelf"></include-fragment>

<div class="container-lg clearfix new-discussion-timeline p-responsive">

<div class="repository-content ">

    <a class="d-none js-permalink-shortcut" data-hotkey="y" href="/ahmedgobba/capstone
latex/blob/fc2fdee32746ff4e4ff10492f4cc1bd4a19f9f7b/chapters/chapter4.tex">Permalink
    <!-- blob contrib key: blob_contributors : v22 : 2297977299da2542353a473e4908e684 –
    – >

    <div class="d-flex flex-items-start flex-shrink-0 flex-column flex-md-
row pb-3"> <span class="d-flex flex-justify-between width-full width-md-
auto">

        <details class="details-reset details-overlay branch-select-menu " id="branch-
select-menu"> <summary class="btn btn-sm css-truncate" data-hotkey="w"
title="Switch branches or tags"> <i>Branch:</i> <span class="css-truncate-
target" data-menu-button>master</span> <span class="dropdown-caret"></span>
</summary>

        <details-menu class="SelectMenu SelectMenu–hasFilter" src="/ahmedgobba/capstone
latex/refs/master/chapters/chapter4.tex?source_action = show&source_controller =
blob"preload > <div class = "SelectMenu – modal" > <include – fragment class =
"SelectMenu – loading" aria – label = "Menu is loading" > <svg class =
"octicon octicon – octoface anim – pulse" height = "32" viewBox = "001616" version =
"1.1" width = "32" aria – hidden = "true" > < path fill – rule = "evenodd" d =

```

"M14.75.34c.13 – .32.55 – 1.59 – .13 – 3.3100 – 1.05 – .33 – 3.441.3 – 1 –  
.28 – 2.07 – .32 – 3.13 – .32s – 2.13.04 – 3.13.32c – 2.39 – 1.64 – 3.44 –  
1.3 – 3.44 – 1.3 – .681.72 – .262.99 – .133.31C.496.2107.3308.69013.843.33157.9815S1613.84  
1.36 – .49 – 2.48 – 1.3 – 3.35zM814.02c – 3.30 – 5.98 – .15 – 5.98 – 3.350 –  
.76.38 – 1.481.02 – 2.071.07 – .982.9 – .464.96 – .462.0703.88 – .524.96.46.65.591.021.31.022.  
2.683.35 – 5.983.35zM5.499.01c – .660 – 1.2.8 – 1.21.78s.541.791.21.79c.6601.2 –  
.81.2 – 1.79s – .54 – 1.78 – 1.2 – 1.78zm5.020c – .660 – 1.2.79 – 1.21.78s.541.791.21.79c.6601.  
.81.2 – 1.79s – .53 – 1.78 – 1.2 – 1.78z"/ >< /svg >< /include – fragment ><  
/div >< /details – menu >< /details >

<div class="BtnGroup flex-shrink-0 d-md-none"> <a href="/ahmedgobba/capstone-  
latex/find/master" class="js-pjax-capture-input btn btn-sm BtnGroup-item"  
data-pjax data-hotkey="t"> Find file </a> <clipboard-copy value="chapters/chapter4.tex"  
class="btn btn-sm BtnGroup-item"> Copy path </clipboard-copy> </div>  
</span> <h2 id="blob-path" class="breadcrumb flex-auto min-width-0  
text-normal flex-md-self-center ml-md-2 mr-md-3 my-2 my-md-0"> <span  
class="js-repo-root text-bold"><span class="js-path-segment"><a data-pjax="true"  
href="/ahmedgobba/capstone-latex"><span>capstone-latex</span></a></span></sp  
class="separator">/</span><span class="js-path-segment"><a data-pjax="true"  
href="/ahmedgobba/capstone-latex/tree/master/chapters"><span>chapters</span></a>  
class="separator">/</span><strong class="final-path">chapter4.tex</strong>  
</h2>

<div class="BtnGroup flex-shrink-0 d-none d-md-inline-block"> <a  
href="/ahmedgobba/capstone-latex/find/master" class="js-pjax-capture-  
input btn btn-sm BtnGroup-item" data-pjax data-hotkey="t"> Find file  
</a> <clipboard-copy value="chapters/chapter4.tex" class="btn btn-sm  
BtnGroup-item"> Copy path </clipboard-copy> </div> </div>

```

<include-fragment src="/ahmedgobba/capstone-latex/contributors/master/chapter
class="Box Box-condensed commit-loader"> <div class="Box-body bg-
blue-light f6"> Fetching contributorshellip; </div>

<div class="Box-body d-flex flex-items-center">  <span class="text-red
h6 loader-error">Cannot retrieve contributors at this time</span> </div>
</include-fragment>

<div class="Box mt-3 position-relative ">

<div class="Box-header py-2 d-flex flex-column flex-shrink-0 flex-md-
row flex-md-items-center"> <div class="text-mono f6 flex-auto pr-3 flex-
order-2 flex-md-order-1 mt-2 mt-md-0">

<span class="file-mode" title="File mode">executable file</span> <span
class="file-info-divider"></span> 81 lines (63 sloc) <span class="file-info-
divider"></span> 4.58 KB </div>

<div class="d-flex py-1 py-md-0 flex-auto flex-order-1 flex-md-order-
2 flex-sm-grow-0 flex-justify-between">

<div class="BtnGroup"> <a id="raw-url" class="btn btn-sm BtnGroup-
item" href="/ahmedgobba/capstone-latex/raw/master/chapters/chapter4.tex">Raw</a>
<a class="btn btn-sm js-update-url-with-hash BtnGroup-item" data-hotkey="b"
href="/ahmedgobba/capstone-latex/blame/master/chapters/chapter4.tex">Blame</a>
<a rel="nofollow" class="btn btn-sm BtnGroup-item" href="/ahmedgobba/capstone-
latex/commits/master/chapters/chapter4.tex">History</a> </div>

<div> <a class="btn-octicon tooltipped tooltipped-nw js-remove-unless-
platform" data-platforms="windows,mac" href="x-github-client://openRepo/https://gi
latex?branch=master&filepath=chaptersaria-label="Open this file in GitHub

```

```
Desktop" data-ga-click="Repository, open with desktop"><svg class="octicon
octicon-device-desktop" viewBox="0 0 16 16" version="1.1" width="16"
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.55 0-1 .45-1 1v9c0 .55.45 1 1 1h5.34c-.25.61-.86 1.39-2.34 2h8c-1.48-.61-
2.09-1.39-2.34-2H15c.55 0 1-.45 1-1V3c0-.55-.45-1-1-1zm0 9H1V3h14v8z"/></svg>
</a>
```

```
<!-- --><!-- </textarea></xmp> --></option></form><form class="inline-
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"/ >< buttonclass = "btn - octicontooltippedtool tipped - nw" type =
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9.3L12693l1.3 - 1.3a.996.9960011.410l1.591.59c.39.39.391.0201.41z"/ ><
/svg >< /button >< /form ><!-- -- --><!-- -- </textarea><
/xmp> -- >< /option >< /form >< formclass = "inline - form"action =
"/ahmedgobba/capstone - latex/delete/master/chapters/chapter4.tex"accept -
charset = "UTF - 8"method = "post" >< inputtype = "hidden"name =
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"Deletethisfile" data - disable - with >< svgclass = "octiconocticon -
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"16"aria - hidden = "true" >< pathfill - rule = "evenodd"d = "M112H9c0 -
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```
.55 - .45 - 1 - 1 - 1H5c - .550 - 1.45 - 11H2c - .550 - 1.45 - 11v1c0.55.45111v9c0.55.4511
.451 - 1V5c.5501 - .451 - 1V3c0 - .55 - .45 - 1 - 1 - 1zm - 112H3V5h1v8h1V5h1v8h1V5h
10H2V3h9v1z"/ >< /svg >< /button >< /form >< /div >< /div ><
/div >
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code-inner js-file-line"><span class="pl-c"><span class="pl-c"></tr> <tr>
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<td id="LC2" class="blob-code blob-code-inner js-file-line"> </td> </tr>
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<td id="LC3" class="blob-code blob-code-inner js-file-line"><span class="pl-
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## Chapter 5

<

```

/ span> < span class="pl-en">Analysis and Findings</ span> < span class="pl-
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```







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class="pl-smi">tabular</span>|l|c|c|c|c|c|</td> </tr> <tr> <td
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```

```

|</span></td> </tr> <tr> <td id="L25" class="blob-num
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class="pl-c1"></span><span class="pl-mb">Feature</span> amp;
<span class="pl-c1">< s pan>1l| <span class="pl-c1"></span><span
class="pl-mb">Estimate</span> amp; <span class="pl-c1">< s
pan>1l| <span class="pl-c1"></span><span class="pl-mb">Std.
Error</span> amp; <span class="pl-c1">< s pan>1l| <span
class="pl-c1"></span><span class="pl-mb">z-value</span> amp;
<span class="pl-c1">< s pan>1l| <span class="pl-c1"></span><span

```

class="pl-mb">p-value</span>

---

<span class="pl-c1">  
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 class="blob-code blob-code-inner js-file-line">Intercept amp; -0.3427213  
 amp; 0.2362569 amp; -1.451 amp; 0.147

---

<span class="pl-c1">  
 </span></td> </tr> <tr> <td id="L27" class="blob-num  
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 class="blob-code blob-code-inner js-file-line">Average SF Ratio amp;  
 -0.0097838 amp; 0.0008024 amp; -12.193 amp; <span  
 class="pl-c1"></span> 2e-16

---

<span class="pl-c1">  
 </span></td> </tr> <tr> <td id="L28" class="blob-num  
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 class="blob-code blob-code-inner js-file-line">Gender (M) amp;  
 -0.3579267 amp; 0.0585947 amp; -6.109 amp; 1.01e-09

---

<span class="pl-c1">  
 </span></td> </tr> <tr> <td id="L29" class="blob-num  
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 0.0005280 amp; 8.551 amp; <span class="pl-c1"></span> 2e-16

---

<span class="pl-c1">  
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class="blob-code blob-code-inner js-file-line">BMI amp; -0.0316707 amp;  
0.0044837 amp; -7.063 amp; 1.62e-12

---

<span class="pl-c1">  
</span></td> </tr> <tr> <td id="L31" class="blob-num

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class="blob-code blob-code-inner js-file-line">Sofa Total Score amp;  
0.1964941 amp; 0.0083214 amp; 23.613 amp; <span

class="pl-c1"></span> 2e-16

---

<span class="pl-c1">  
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</tr> <tr> <td id="L33" class="blob-num js-line-number" data-line-number="33"></td>

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class="blob-num js-line-number" data-line-number="34"></td> <td id="LC34"

class="blob-code blob-code-inner js-file-line"><span class="pl-k">/span><span

---

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class="pl-v">tab:logisitic</span></td> </tr> <tr> <td id="L35" class="blob-
num js-line-number" data-line-number="35"></td> <td id="LC35" class="blob-
code blob-code-inner js-file-line"><span class="pl-c1">/span><span class="pl-
smi">table</span></td> </tr> <tr> <td id="L36" class="blob-num js-
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code blob-code-inner js-file-line"> </td> </tr> <tr> <td id="L37" class="blob-
num js-line-number" data-line-number="37"></td> <td id="LC37" class="blob-
code blob-code-inner js-file-line">Hence, the Average SF ratio is signifi-
cantly correlated with Hospital Mortality and a unit increase in SF ratio
decreases odds of</td> </tr> <tr> <td id="L38" class="blob-num js-line-
number" data-line-number="38"></td> <td id="LC38" class="blob-code
blob-code-inner js-file-line">hospital mortality by 1.19<span class="pl-
cce">%</span>. </td> </tr> <tr> <td id="L39" class="blob-num js-line-
number" data-line-number="39"></td> <td id="LC39" class="blob-code
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c"><span class="pl-c"></tr> <tr> <td id="L42" class="blob-num js-line-
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blob-code-inner js-file-line"><span class="pl-c"><span class="pl-c"></tr>
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<tr> <td id="L44" class="blob-num js-line-number" data-line-number="44"></td>

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data-line-number="63"></td> <td id="LC63" class="blob-code blob-code-
inner js-file-line">Average SF Ratio amp; 6.968 amp; 8.078 amp; 957 amp;
<span class="pl-c1"></span>2e-16
<span class="pl-c1">

```

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|</span></td> </tr> <tr> <td id="L64" class="blob-num js-line-number"
data-line-number="64"></td> <td id="LC64" class="blob-code blob-code-
inner js-file-line">Age amp; 5.582 amp; 6.665 amp; 411.2 amp; <span
class="pl-c1"></span>2e-16

```

```

<span class="pl-c1">
</span></td> </tr> <tr> <td id="L65" class="blob-num js-line-number"
data-line-number="65"></td> <td id="LC65" class="blob-code blob-code-
inner js-file-line">Length of ICU Stayamp; 5.262 amp; 6.268 amp; 306.8
amp; <span class="pl-c1"></span>2e-16

```

```

<span class="pl-c1">
</span></td> </tr> <tr> <td id="L66" class="blob-num js-line-number"
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</tr> <tr> <td id="L67" class="blob-num js-line-number" data-line-number="67"></td>

```

---

```

<td id="LC67" class="blob-code blob-code-inner js-file-line"><span class="pl-
c1">/span>Results of GAM</td> </tr> <tr> <td id="L68" class="blob-
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code blob-code-inner js-file-line"><span class="pl-k">/span><span class="pl-
v">tab:GAM</span></td> </tr> <tr> <td id="L69" class="blob-num js-
line-number" data-line-number="69"></td> <td id="LC69" class="blob-
code blob-code-inner js-file-line"><span class="pl-c1">/span><span class="pl-
smi">table</span></td> </tr> <tr> <td id="L70" class="blob-num js-
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num js-line-number" data-line-number="71"></td> <td id="LC71" class="blob-
code blob-code-inner js-file-line">The result of the model in table <span
class="pl-k">5.2</span><span class="pl-c1">tab:GAM</span> shows that
there is a statistically significant correlation between Hospital Mortality
and Average SF Ratio. I visualize this relationship below in fig <span
class="pl-k">5.2</span><span class="pl-c1">fig:GAM</span>. The visu-
alizations for all the predictors can be found in Appendix <span class="pl-
k">5.2</span><span class="pl-c1">AppendixA</span>. </td> </tr> <tr>
<td id="L72" class="blob-num js-line-number" data-line-number="72"></td>
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<td id="LC73" class="blob-code blob-code-inner js-file-line"><span class="pl-
c1">/span><span class="pl-smi">figure</span>[H]</td> </tr> <tr> <td
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<td id="LC74" class="blob-code blob-code-inner js-file-line"> <span class="pl-
c1"></span></td> </tr> <tr> <td id="L75" class="blob-num js-line-number"

```

```

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inner js-file-line"> <span class="pl-c1">/span>[width=0.9<span class="pl-
c1"></span>]figures/GAM-AVGSF.pdf</td> </tr> <tr> <td id="L76" class="blob-
num js-line-number" data-line-number="76"></td> <td id="LC76" class="blob-
code blob-code-inner js-file-line"> <span class="pl-c1">/span>Results of
GAM model for relationship between Average SF Ratio and log odds
of Hospital Mortality</td> </tr> <tr> <td id="L77" class="blob-num js-
line-number" data-line-number="77"></td> <td id="LC77" class="blob-
code blob-code-inner js-file-line"> <span class="pl-k">/span><span class="pl-
v">fig:GAM</span></td> </tr> <tr> <td id="L78" class="blob-num js-
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code blob-code-inner js-file-line"><span class="pl-c1">/span><span class="pl-
smi">figure</span></td> </tr> <tr> <td id="L79" class="blob-num js-
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code blob-code-inner js-file-line"> </td> </tr> <tr> <td id="L80" class="blob-
num js-line-number" data-line-number="80"></td> <td id="LC80" class="blob-
code blob-code-inner js-file-line">From fig <span class="pl-k">5.2</span><span
class="pl-c1">fig:GAM</span> we see that a increase in Average SF Ra-
tio from around 100 to around 200 causes a reduction in the log odds
of Hospital Mortality with minimal standard error. </td> </tr> <tr> <td
id="L81" class="blob-num js-line-number" data-line-number="81"></td>
<td id="LC81" class="blob-code blob-code-inner js-file-line"> </td> </tr>
</table>

```

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<details class="details-reset details-overlay BlobToolbar position-absolute
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```

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octicon ml-0 px-2 p-0 bg-white border border-gray-dark rounded-1" aria-
label="Inline file action toolbar"> <svg class="octicon octicon-kebab-horizontal"
viewBox="0 0 13 16" version="1.1" width="13" height="16" aria-hidden="true"><path
fill-rule="evenodd" d="M1.5 9a1.5 1.5 0 100-3 1.5 1.5 0 000 3zm5 0a1.5 1.5
0 100-3 1.5 1.5 0 000 3zM13 7.5a1.5 1.5 0 11-3 0 1.5 1.5 0 013 0z"/></svg>
</summary> <details-menu> <ul class="BlobToolbar-dropdown dropdown-
menu dropdown-menu-se mt-2" style="width:185px"> <li> <clipboard-
copy role="menuitem" class="dropdown-item" id="js-copy-lines" style="cursor:pointer;">
Copy lines </clipboard-copy> </li> <li> <clipboard-copy role="menuitem"
class="dropdown-item" id="js-copy-permalink" style="cursor:pointer;">
Copy permalink </clipboard-copy> </li> <li><a class="dropdown-item
js-update-url-with-hash" id="js-view-git-blame" role="menuitem" href="/ahmedgobba/c
latex/blame/fc2fdee32746ff4e4ff10492f4cc1bd4a19f9f7b/chapters/chapter4.tex">View
git blame</a></li> <li><a class="dropdown-item" id="js-new-issue" role="menuitem"
href="/ahmedgobba/capstone-latex/issues/new">Reference in new is-
sue</a></li> </ul> </details-menu> </details>
</div>
</div>
<details class="details-reset details-overlay details-overlay-dark"> <sum-
mary data-hotkey="l" aria-label="Jump to line"></summary> <details-
dialog class="Box Box-overlay d-flex flex-column anim-fade-in fast line-
jump" aria-label="Jump to line"> <!-- "" --><!-- </textarea></xmp> --></option></form>
class="js-jump-to-line-form Box-body d-flex" action="" accept-charset="UTF-
8" method="get"> <input class="form-control flex-auto mr-3 linejump-
input js-jump-to-line-field" type="text" placeholder="Jump to linehellip;"

```

```
aria-label="Jump to line" autofocus> <button type="submit" class="btn"
data-close-dialog>Go</button> </form> </details-dialog> </details>
</div> </div>
```

```
</main> </div>
```

```
</div>
```

```
<div class="footer container-lg width-full p-responsive" role="contentinfo">
<div class="position-relative d-flex flex-row-reverse flex-lg-row flex-wrap
flex-lg-nowrap flex-justify-center flex-lg-justify-between pt-6 pb-2 mt-6
f6 text-gray border-top border-gray-light "> <ul class="list-style-none d-
flex flex-wrap col-12 col-lg-5 flex-justify-center flex-lg-justify-between mb-
2 mb-lg-0"> <li class="mr-3 mr-lg-0">copy; 2020 GitHub, Inc.</li> <li
class="mr-3 mr-lg-0"><a data-ga-click="Footer, go to terms, text:terms"
href="https://github.com/site/terms">Terms</a></li> <li class="mr-3
mr-lg-0"><a data-ga-click="Footer, go to privacy, text:privacy" href="https://github.com/
<li class="mr-3 mr-lg-0"><a data-ga-click="Footer, go to security, text:security"
href="https://github.com/security">Security</a></li> <li class="mr-3
mr-lg-0"><a href="https://githubstatus.com/" data-ga-click="Footer, go
to status, text:status">Status</a></li> <li><a data-ga-click="Footer, go
to help, text:help" href="https://help.github.com">Help</a></li>
</ul>
```

```
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d-lg-block mx-lg-4" href="https://github.com"> <svg height="24" class="octicon
octicon-mark-github" viewBox="0 0 16 16" version="1.1" width="24" aria-
hidden="true"><path fill-rule="evenodd" d="M8 0C3.58 0 0 3.58 0 8c0
3.54 2.29 6.53 5.47 7.59.47.09.54.07.55-.17.55-.38 0-.19-.01-.82-.01-1.49-2.01-3.72-2.53-
.49-2.69-.94-.09-.23-.48-.94-.82-1.13-.28-.15-.68-.52-.01-.53.63-.01 1.08.58 1.23.82.72
```

1.21 1.87.87 2.33.66.07-.52.28-.87.51-1.07-1.78-.2-3.64-.89-3.64-3.95 0-.87.31-  
1.59.82-2.15-.08-.2-.36-1.02.08-2.12 0 0 .67-.21 2.2.82.64-.18 1.32-.27 2-.27.68  
0 1.36.09 2 .27 1.53-1.04 2.2-.82 2.2-.82.44 1.1.16 1.92.08 2.12.51.56.82 1.27.82  
2.15 0 3.07-1.87 3.75-3.65 3.95.29.25.54.73.54 1.48 0 1.07-.01 1.93-.01 2.2 0  
.21.15.46.55.38A8.013 8.013 0 0016 8c0-4.42-3.58-8-8-8z"/></svg> </a>

<ul class="list-style-none d-flex flex-wrap col-12 col-lg-5 flex-justify-center  
flex-lg-justify-between mb-2 mb-lg-0"> <li class="mr-3 mr-lg-0"><a data-  
ga-click="Footer, go to contact, text:contact" href="https://github.com/contact">Contact  
GitHub</a></li> <li class="mr-3 mr-lg-0"><a href="https://github.com/pricing"  
data-ga-click="Footer, go to Pricing, text:Pricing">Pricing</a></li> <li  
class="mr-3 mr-lg-0"><a href="https://developer.github.com" data-ga-click="Footer,  
go to api, text:api">API</a></li> <li class="mr-3 mr-lg-0"><a href="https://training.gith  
data-ga-click="Footer, go to training, text:training">Training</a></li>  
<li class="mr-3 mr-lg-0"><a href="https://github.blog" data-ga-click="Footer,  
go to blog, text:blog">Blog</a></li> <li><a data-ga-click="Footer, go to  
about, text:about" href="https://github.com/about">About</a></li> </ul>  
</div> <div class="d-flex flex-justify-center pb-6"> <span class="f6 text-  
gray-light"></span> </div> </div>

<div id="ajax-error-message" class="ajax-error-message flash flash-error">  
<svg class="octicon octicon-alert" viewBox="0 0 16 16" version="1.1" width="16"  
height="16" aria-hidden="true"><path fill-rule="evenodd" d="M8.893 1.5c-  
.183-.31-.52-.5-.887-.5s-.703.19-.886.5L138 13.499a.98.98 0 000 1.001c.193.31.53.501.886.501h  
0 .704-.19.877-.5a1.03 1.03 0 00.01-1.002L8.893 1.5zm.133 11.497H6.987v-  
2.003h2.039v2.003zm0-3.004H6.987V5.987h2.039v4.006z"/></svg> <but-  
ton type="button" class="flash-close js-ajax-error-dismiss" aria-label="Dismiss  
error"> <svg class="octicon octicon-x" viewBox="0 0 12 16" version="1.1"



width="12" height="16" aria-hidden="true"><path fill-rule="evenodd" d="M7.48 8l3.75-1.48 1.48L6 9.48l-3.75 3.75-1.48-1.48L4.52 8 .77 4.25l1.48-1.48L6 6.52l3.75-3.75 1.48 1.48L7.48 8z"/></svg> </button> You can't perform that action at this time. </div>

```
<script crossorigin="anonymous" async="async" integrity="sha512-o4vS4IKrjdy/HD+
type="application/javascript" id="js-conditional-compat" data-src="https://github.github
bootstrap-a38bd2e0.js"></script> <script crossorigin="anonymous" integrity="sha512-
6XqOrpzsRfeWz1MuH9q2GuzW4Ktvt+kA5KbChOp1ZjaoGbRl3tBng8HiA5B/lClMvkkj
type="application/javascript" src="https://github.githubassets.com/assets/environment
bootstrap-e97a8eae.js"></script> <script crossorigin="anonymous" async="async"
integrity="sha512-1/6VVx6z9r6uphSoGlmYgbqD5KaY+GVMt1Gqa3DIa0U+3Pv2SWu8F
type="application/javascript" src="https://github.githubassets.com/assets/vendor-
d7fe9557.js"></script> <script crossorigin="anonymous" async="async"
integrity="sha512-RDggGUYWJq0pjfr/60y4ITVdK0zFDicDs0h46xLtUfsgDq6L6OWInB0
type="application/javascript" src="https://github.githubassets.com/assets/frameworks
44382019.js"></script>
```

```
<script crossorigin="anonymous" async="async" integrity="sha512-aIrRO9Sji3VKn3U  
type="application/javascript" src="https://github.githubassets.com/assets/github-  
bootstrap-688ad13b.js"></script>
```

<svg class="octicon octicon-alert" viewBox="0 0 16 16" version="1.1" width="16" height="16" aria-hidden="true"><path fill-rule="evenodd" d="M8.93 1.5c-.183-.31-.52-.5-.887-.5s-.703.19-.886.5L138 13.499a.98.98 0 00 1.001c.193.31.53.501.886.501.354.001.704-.19.877-.5a1.03 1.03 0 00 .01-1.002l-.893 1.5zm.133 11.497H6.987v-2.003h2.039v2.003zm0-3.004H6.987V5.987h2.039v4.006z"/></svg>You signed in with another

```

tab or window. <a href="">Reload</a> to refresh your session.</span>
<span class="js-stale-session-flash-signed-out" hidden>You signed out in
another tab or window. <a href="">Reload</a> to refresh your session.</span>
</div> <template id="site-details-dialog"> <details class="details-reset
details-overlay details-overlay-dark lh-default text-gray-dark hxrsm"open ><
summaryrole = "button"aria-label = "Closedialog" >< /summary ><
details-dialogclass = "BoxBox --overlayd --flexflex --columnanim --
fade --infasthxrsm --dialoghxrsm --modal" >< buttonclass = "Box --
btn --octiconm --Obtn --octiconposition --absoluteright --0top --0"type =
"button"aria-label = "Closedialog"data-close-dialog >< svgclass =
"octiconocticon --x"viewBox = "001216"version = "1.1"width = "12"height =
"16"aria-hidden = "true" >< pathfill-rule = "evenodd"d = "M7.488l3.753.75 -
1.481.48L69.48l - 3.753.75 - 1.48 - 1.48L4.528.774.25l1.48 - 1.48L66.52l3.75 -
3.751.481.48L7.488z"/ >< /svg >< /button >< divclass = "octocat --
spinnermy - 6js - details - dialog - spinner" >< /div >< /details -
dialog >< /details >< /template >

```

```

<div class="Popover js-hovercard-content position-absolute" style="display:
none; outline: none;" tabindex="0"> <div class="Popover-message Popover-
message-bottom-left Popover-message-large Box box-shadow-large" style="width:360px,
</div> </div>

```

```

<div aria-live="polite" class="js-global-screen-reader-notice sr-only"></div>
</body> </html>

```

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# Appendix A

## Other Figures

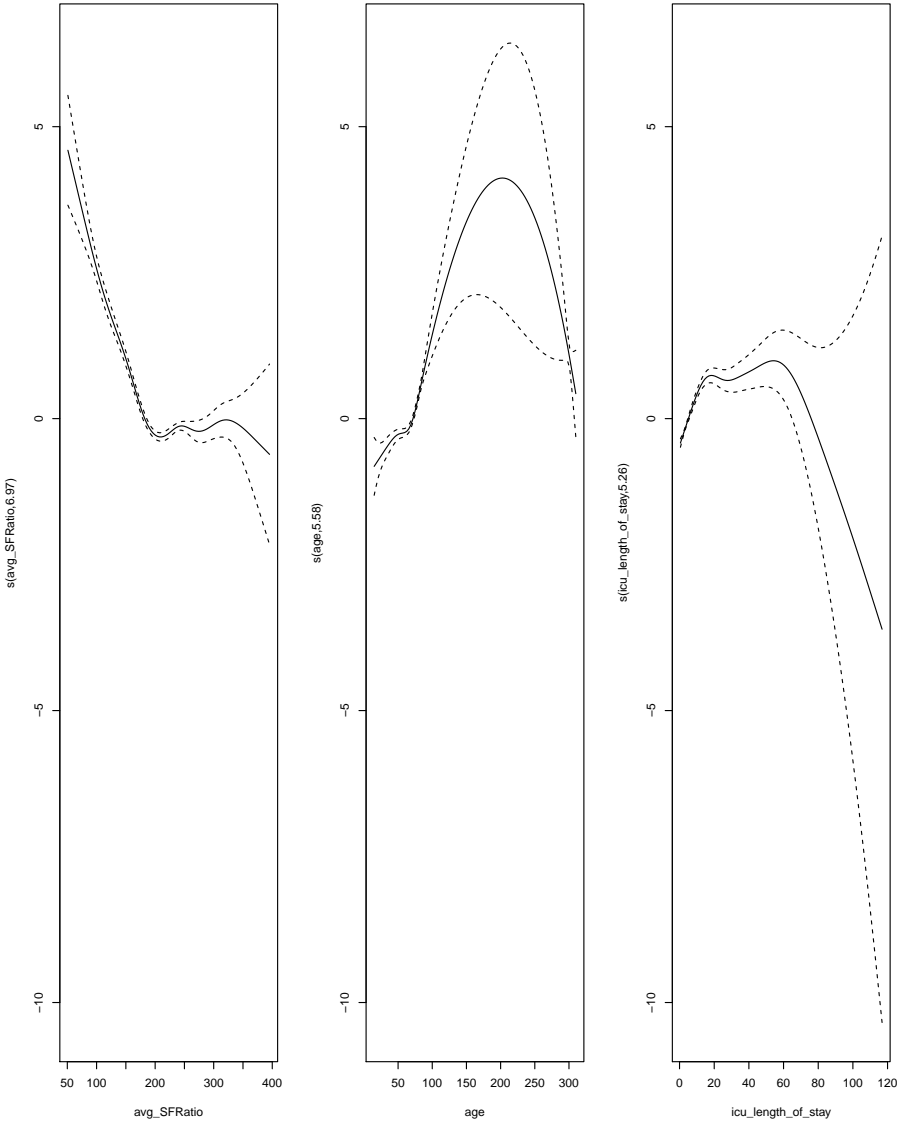


FIGURE A.1: Results of GAM model