Remembering the Middle Passage

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Introduction

"I expected every hour to share the fate of my companions, some of whom were almost daily brought upon deck at the point of death, which I began to hope would soon put an end to my miseries."[1] These words were written by Olaudah Equiano, a captured and enslaved African, about his voyage to America in the 18th century.

This trans-Atlantic voyage from Africa to the Americas is called **the Middle Passage**. The goal of this project is to explore the mortality rates of enslaved Africans along the Middle Passage, and thus to remember the pain and persecution experienced by the victims of one of the gravest tragedies in human history.

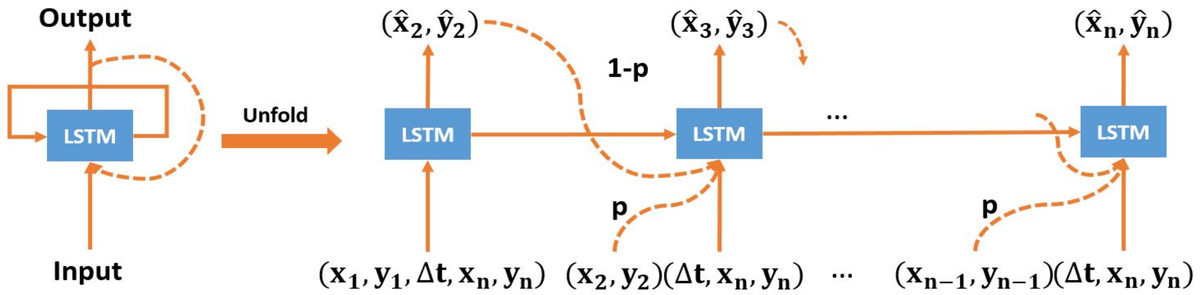
Objectives

Using the Trans-Atlantic Slave Trade (Trans-Atlantic) Database[2] and the Climatological Database for the World's Oceans (CLIWOC)[3], we aim to locate where and why enslaved Africans died along the Middle Passage.

We also aim to analyze the patterns of these mortality rates from different perspectives, such as how the mortality rate changed over time.

Methods

- The CLIWOC database contains detailed geographic coordinates and/or weather events for ships (not only slave ships) from 1750 to 1850, and the Trans-Atlantic Database includes 34,948 slave trade voyages from the mid-16th to mid-19th centuries, but without day-to-day geographical records.
- We merged these two databases based on ship names and found 316 ships with the same names and 35 matching voyages.
- Voyages in both databases**:** we refer to ship logs and historical archives to find where and how enslaved people died **(Figure 1).**
- Voyages only in the Trans-Atlantic Database: We used differential equations and recurrent neural networks to predict paths **(Figure 2).**
  - **Differential Equations:** Estimating wind speed and ship speed from the CLIWOC database and using the linear speed formula, we established a differential equation and solved it. Due to inaccurate input and the complexities of each voyage, this differential equation failed to accurately predict the voyage paths.
  - **Recurrent Neural Network (RNN):** Each path is a time-series data since the time interval influences the next ship position. Long short-term memory (LSTM) is an RNN architecture well-suited to processing time-series data and we use it to learn from the cleaned voyage paths obtained from the CLIWOC database to make predictions for voyages in the trans-Atlantic database.



- We then explored the correlation between the death rate and the number of enslaved people embarked (**Figure 5),** the distribution of the death rate (**Figure 4**), and how the death rate changes over the time **(Figure 3)**.

Data Visualizations

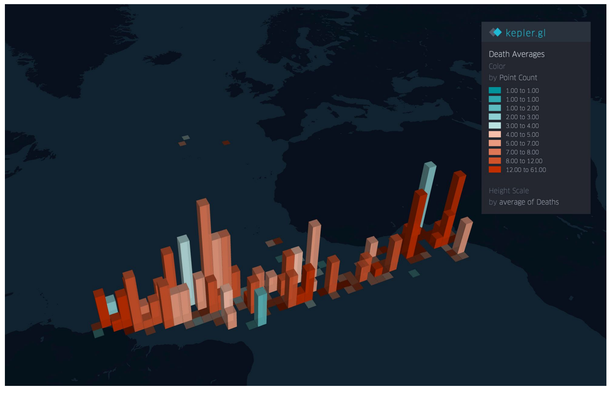


Figure 1: Dutch Slaving Voyages (1751-1795). The height of each bar corresponds to the average number of deaths per 150km^2 grid. The color of the bar corresponds to the number of ship locations recorded in each grid.

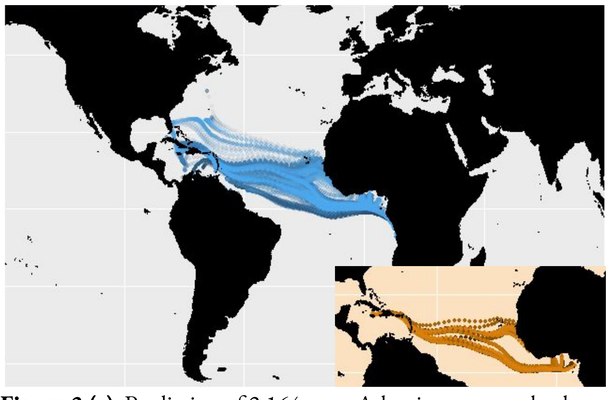


Figure 2 (a): Prediction of 2,164 trans-Atlantic voyage paths that ended in the northern hemisphere based on the LSTM model. **Figure 2 (b) (bottom-right)**: Prediction of 36 trans-Atlantic voyage paths based on LSTM model, all of which have reasonably smooth lines.

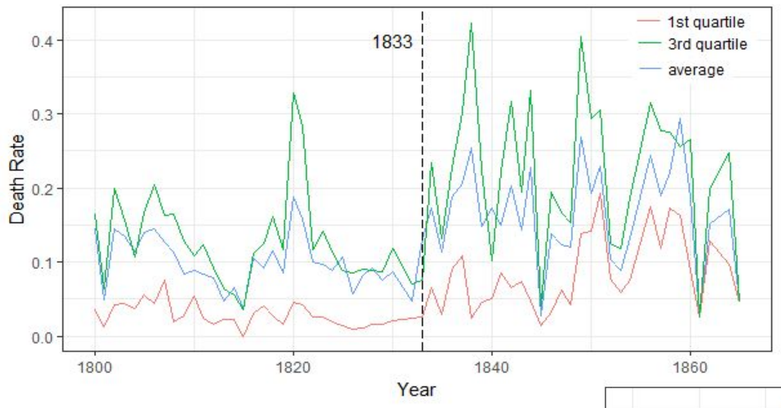


Figure 3: The annual mortality rate from 1800 to 1865. We observed an increase in the mortality rate after 1833. Ironically, this increase corresponds to the Slavery Abolition Act in 1833. Possible explanations for this contradiction are the ineffectiveness of the Slavery Abolition Act[4] and the dominance of Portuguese ships in the trans-Atlantic slave trade[5] after the British Empire exited the market.

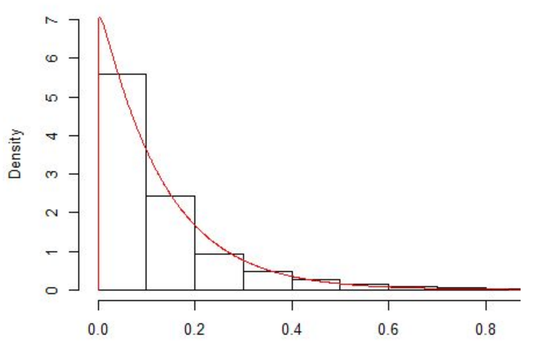


Figure 4: Histogram of the death rate of 6,221 voyages fitted by the gamma distribution (shape = 1.03, rate = 7.93). It shows that 1 in 8 enslaved people died during the Middle Passage.

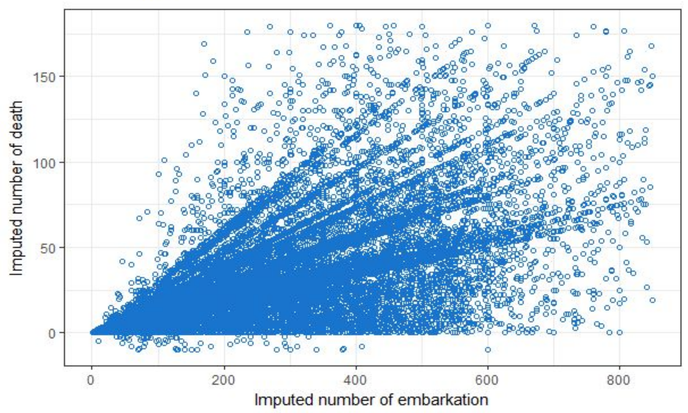


Figure 5: The number of enslaved people embarked and died among 25,184 voyages. We found that the straight lines are caused by imputation and the pattern doesn't exist in the original dataset.

Conclusions

From the data visualizations of the death locations, we found that on average there was a higher mortality rate closer to the embarkation points in Africa. Two of the many potential reasons we find from scholarly works are: 1) the movement of the captives from inland Africa to the coast resulted in diseases[6]; 2) some violent actions and decisions of captains and the crew of slave ships at the beginning of the voyage resulted in many deaths[7].

In our data analysis, sometimes we observed interesting patterns in the visualizations. However, we must deal carefully with imputed data, and confirm through archival sources, since these patterns might not exist in the actual data.

Ethical Challenges

We need to constantly ask ourselves ethical questions throughout the project: 1) Is it ethical to represent individual tragedies with data? 2) The databases we use are compiled from ship logs of slave trade companies and journals of captains, who are all exploiters in slave trade history.

Is it ethical to analyze the the victims' deaths based on data that comes from these exploiters? These questions also point out the potential bias of all our data analysis. With these considerations in mind, we chose to use the language of "enslaved people" instead of "slaves."

Future Directions

- Because LSTM uses discrete layers to pass the data forward, some path predictions are unsmooth. Neural ordinary differential equations (odenet), which use an ODE solver might provide smoother paths.
- Since the CLIWOC database doesn't contain many voyages from south Africa to the Americas, data collection could be an important next step.

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