# SafetyFirst

## Milestone 3 Process Book

*Urban Safety Through Data Visualization*


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May 29, 2025

# 1. Introduction

**Project Overview**

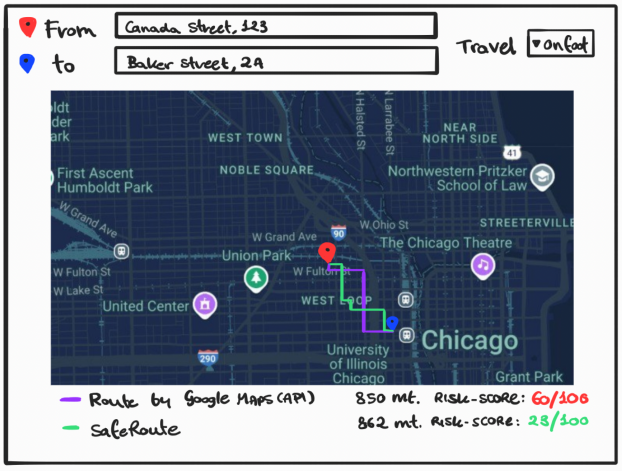
*SafetyFirst*[a] is an interactive web application that provides **safety insights for urban travelers** by leveraging historical crime data. Using interactive maps and dynamic visualizations, it raises awareness of high-risk areas in Chicago and provides travel routes that prioritize safety.

[a]Prototype link: https://com-480-data-visualization.github.io/SafetyFirst/

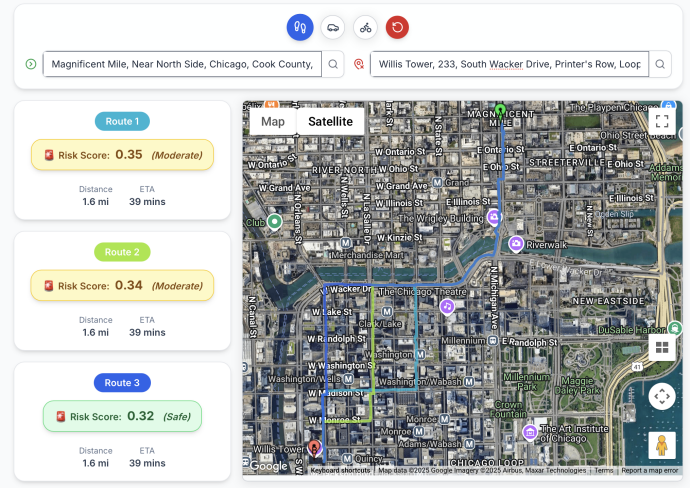
Our target users are mainly *university students* (especially those originally not from Chicago) and *tourists*. In fact, these categories are often not familiar with the different neighborhoods in the city and could take risky paths while moving around.

**Why Chicago?**

A city like Chicago, with its grid-like street pattern, is a compelling setting to demonstrate the utility of SafetyFirst, as its regular structure offers numerous potential routes between any two points. The website comprises two parallel **Data-Stories**, which guide users to learn about the most common crimes in the metropolis, and a **SafeRoute Tool** that computes safe paths to help people travel through the city securely.




(a) A sketch of our SafeRoute tool.




(b) Working SafeRoute prototype.

# 2. Path to Final Result

## 2.1. Development Journey

Our development of *SafetyFirst* followed an iterative approach, beginning with exploratory data analysis of Chicago's crime dataset and evolving into a comprehensive web application.

**Data Processing and Analysis** We started by downloading and processing over 8 million crime records from the Chicago Data Portal. Our initial challenge was handling this massive dataset efficiently. We implemented a multi-step preprocessing pipeline that filtered incomplete records, excluded non-street crimes (such as financial fraud), and categorized crimes into meaningful groups (Assault, Theft, Sex Offense, Minor, and Non-Street Crime). This categorization was crucial for creating intuitive visualizations that users could quickly understand.

**Architecture and Technology Selection** We chose React.js 19 as our frontend framework for its component-based architecture and excellent ecosystem for data visualization. For the interactive visualizations, we integrated multiple libraries: Plotly.js for the stacked crime charts, React-Leaflet for the crime heatmap, and Google Maps API for the route planning feature. This multi-library approach allowed us to leverage the strengths of each tool while maintaining a cohesive user experience.

**Course Integration**

The following course lectures were especially crucial to the development of SafetyFirst: `Maps` [4] to guide our map visualizations; `Design` [2] and `Dos And Donts` [3] shape our UI for an intuitive user experience; `Interactions` [1] informs our interactive elements; and `Storytelling` [5] to keep users engaged while raising awareness about urban safety.

**User Experience Design** We developed a narrative-driven approach with two parallel data stories tailored to our target audiences (students and tourists). The landing page uses Framer Motion animations to create an engaging entry point, while the main application guides users through crime statistics, real-world context, and finally to the practical SafeRoute tool.

## 2.2. Technical Challenges and Solutions

**Performance with the Large Dataset** Loading and rendering millions of crime data points posed significant performance challenges. We addressed this by:

- Pre-aggregating data into yearly and hourly JSON files during the build process
- Implementing lazy loading for map components using React Suspense
- Using time-based filtering to reduce the number of rendered points on the heatmap

**Creating Intuitive Interactions** Making complex crime data accessible to users required thoughtful interaction design. We implemented:

- Click-to-explore functionality in stacked charts, allowing users to drill down into crime subcategories
- Synchronized time controls between the year selector and hourly time range slider
- Visual feedback through hover effects and smooth transitions

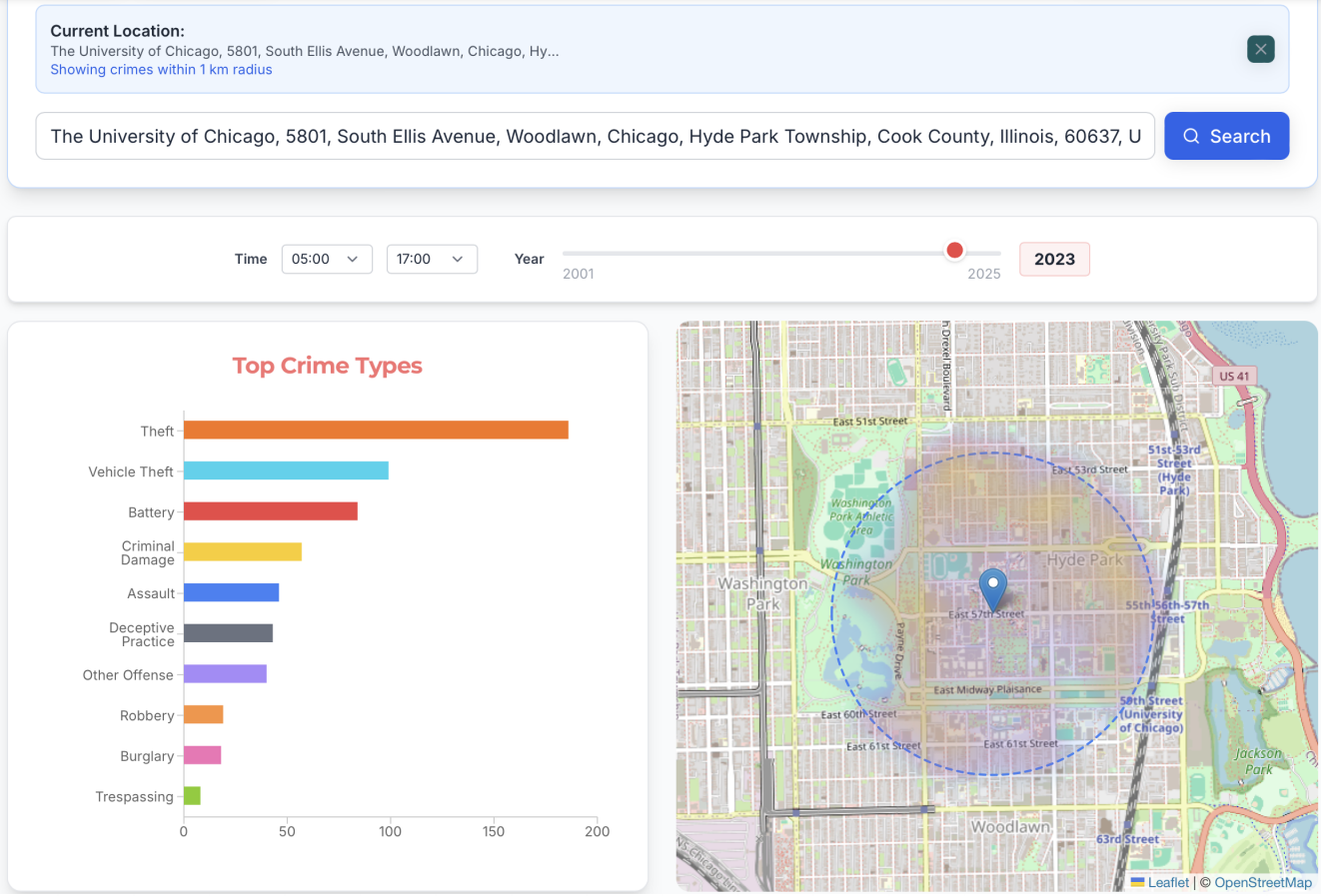



Figure 2: **Interactive heatmaps** and crime data on specified locations can **help our users quickly identify risky areas** and get a sense of historical trends.

**Implementing the SafeRoute Algorithm** The SafeRoute tool represents the culmination of our data analysis and visualization efforts. The system requests three alternative routes from the Google Maps API for any origin-destination pair. Each route will be analyzed by overlaying it with our processed crime data, calculating a "Risk score" based on: (1) historical crime frequency along the route segments, (2) time-of-day crime patterns, (3) crime severity weights, and (4) recent crime trends TO CHANGE. The algorithm will then recommend the safest route, displaying all three options with their respective safety scores for user selection.

### 2.3. Key Design Decisions

**Target Audience Focus**

Recognizing students and tourists as key target audiences, we developed separate data stories for each group. This personalized approach aims to forge a more meaningful connection with the data, thereby enhancing their awareness of potential risks they might encounter while exploring Chicago.

Rather than overwhelming users with all features at once, we designed a flow that progressively reveals complexity: starting with high-level crime trends, moving to temporal patterns, then geographic distributions, and finally the practical route planning tool.

**Visual Hierarchy and Accessibility** We employed a consistent color scheme with semantic meaning (red for danger, green for safety), used large, readable fonts, and ensured all interactive elements have clear hover states and visual feedback. All visualizations update dynamically based on user selections.

**Interactive Design Philosophy**

For example, when users adjust the time range on the crime heatmap, both the map markers and the accompanying statistics panel update immediately, providing instant feedback. This design choice was critical for enabling exploratory data analysis, allowing users to quickly test hypotheses about crime patterns (e.g., "Are late-night hours more dangerous?") without cognitive overhead. The immediate feedback loop builds trust in the system while transforming abstract crime statistics into actionable insights, particularly crucial for our target users—students and tourists—who need to make real-time safety decisions in an unfamiliar city.

## 3. Visualizations

Our visualizations follow a top-down approach. Starting from the most general statistics about crimes, like total number of reported crime by category, we start exploring specific patterns, all the way up to a crime heat-map displaying concentration of crime at each street corner (cf. figure 2).

**Stacked Plot** First, we show the trend over crime categories throughout the years (starting from 2001) using a stacked plot (see fig. 3). Upon clicking on any category, a further differentiation of more specific crimes gives extra information. In general, we would like to answer the following question: "*Has crime decreased over the years?*". Surprisingly, there are some categories for which the answer is no, such as *assault*, and we think this visualization keeps the user engaged while learning about crime patterns.

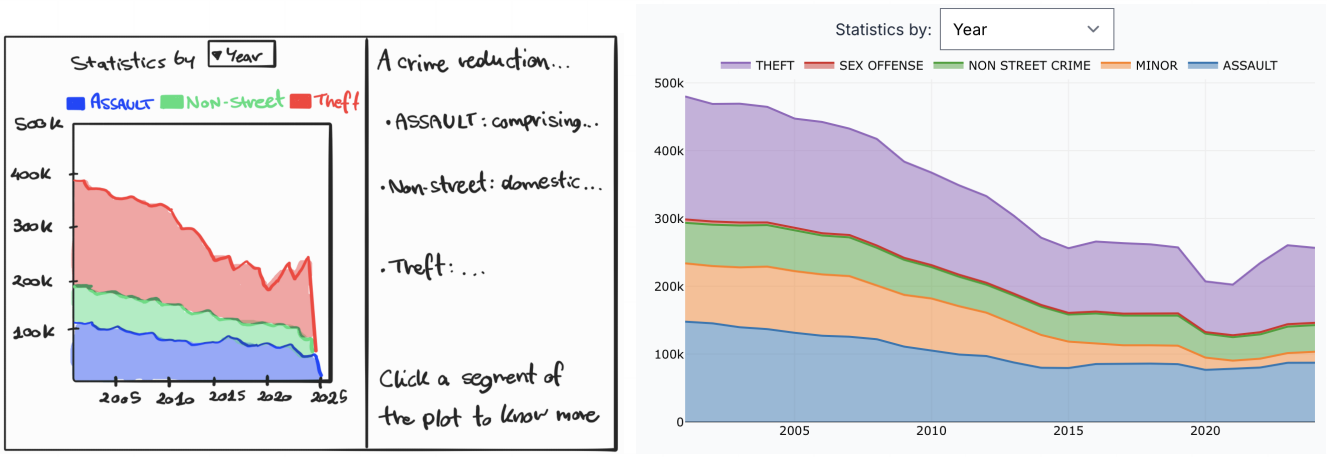



Figure 3: Stacked plot for **primary categories**. Original sketch on the left, working prototype on the right.

**Stories** Next, we want to keep users engaged by showing stories of real crimes, reminding that there are real people behind this numbers and statistics (cf. fig 4. The emotional side is extremely important for our story-telling and we decided to deviate from the sketch to emphasize the articles, associating the image of the touristy place (or university campuses) rather than showing their location on the map. In fact, having another map here is redundant and not important for these stories.

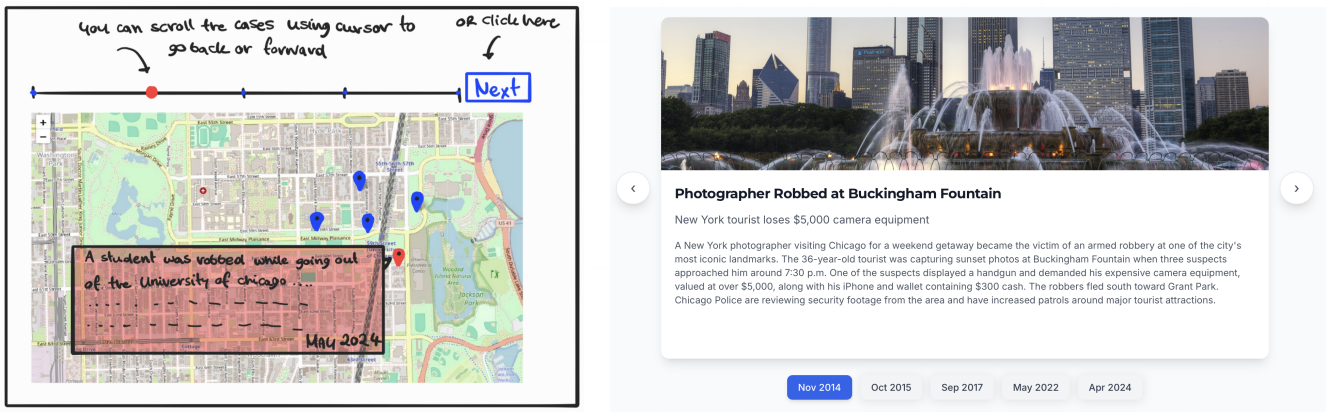



Figure 4: **Newspaper article stories**. The initial sketch (left) included a map visualization while we opted for a more article-centered one in the final prototype (right).

**Heatmap** The most complete and fine-grained visualization is the *heatmap* (figures 2 and 5 for comparison with the sketch). This visualization is completely customizable, an user can search for any address in Chicago and select any time of interest. It serves two purposes:

- Using the year scroll, it allows to visualize how crimes vary over time in arbitrary locations and what categories of crimes are most common.
- It is a tool to spot crime hotspots, places with an high concentration of crime. This way, users can understand what places to avoid and what to watch out for.

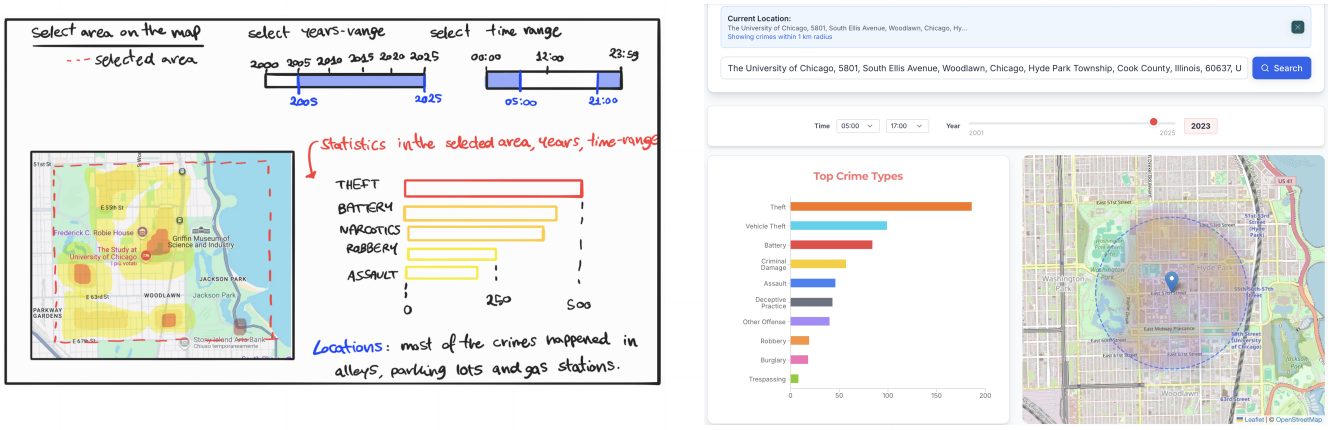



Figure 5: **Crime heatmap visualization**. The initial sketch on the left, the working prototype on the right

# 4. Conclusion

The SafetyFirst project, as detailed in this Process Book, has successfully culminated in the development of an interactive website designed to enhance urban safety awareness for travellers in Chicago. By transforming extensive historical crime data into accessible and engaging visualizations, SafetyFirst aims to empower its primary users—university students and tourists—to make more informed decisions as they navigate the city.

Our journey involved substantial data preprocessing and analysis of over eight million crime records to the careful selection of a robust technology stack and a design philosophy centered on user experience. Key outcomes include the creation of two tailored data stories that guide users through Chicago's crime landscape and the development of the innovative SafeRoute tool. Addressing challenges such as large-scale data rendering and the design of intuitive interactions has been central to our efforts throughout this milestone. We believe that SafetyFirst provides a valuable resource, leveraging the power of data visualization to contribute positively to the urban experience in Chicago. This milestone represents a significant step towards realizing our vision of safer urban navigation through technology.

# 5. Peer Assessment

**Team Contributions**

The motivation and idea behind the project was developed by all members in an iterative way. On the practical side, group members have all cooperated on several parts of the website (color scheme, buttons, etc.) and put equal effort. In particular,

- **Marco** has focused more on the news section, the heatmap, and the "address-to-map" functionality.
- **Antonio** has focused on the general design of the website, the datastories and the stacked plot.
- **Ahmed** set up the SafeRoute tool, the Google Maps API and the risk score computation.

# References

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