Climbing Everest

Insights into Ascents and Fatalities at the Roof of the World

December 15, 2024

1 Motivation

Climbing Mount Everest is an ambitious goal for many mountaineers. Since it was identified as the world's highest peak, many have attempted the climb. However, the journey to the summit is incredibly challenging, and many climbers have tragically lost their lives due to a range of factors—like insufficient preparation, severe weather, limited oxygen, avalanches, and other unpredictable obstacles.

This project seeks to shed light on ascent patters and bring forth more information about the causes of fatalities on Everest. Additionally, through recorded information on notes on death which in cases also mention the altitude of deatha dn the route taken, patches on route which have been historically the most fatal can be highlighted. By analyzing data on summit attempts and incidents, the intention is to highlight common risks and provide insights that might help future climbers prepare more effectively. Recognizing patterns—like the times of year favorable for summits or frequent causes of death—can offer valuable guidance for staying safer on the mountain.

This analysis also partly ties into Sustainable Development Goal (SDG) 3: Good Health and Well-Being. Training for challenging activities like mountaineering can boost physical fitness, mental resilience, and overall health, but it's essential to approach these pursuits with an awareness of the associated risks.

2 Some Expected Results

- Some of the records log the route taken to summit Everest. If prominent route(s) can be visualized along fatalities along that route, challenging areas or fatal areas can potentially be highlighted.
- Through visualising causes of fatalities (Exhaustion, Avalanche etc.), along with information on the stage of climbing (ascend, descent, route preparation etc.) can give insight into the high-risk factors. It can help explore questions like: Do most deaths occur during ascent or descent?
- With the advent of better tools, technology, weather forecast, and accessibility, the number of summits would be observed to increase over the years.

3 Themes and Storytelling

Route to the Summit: Identifying potential high-risk areas

If route data is available (Sufficient enough and if it's possible to be visualised as part of this project), it could be traced along with markers indicating fatalities along each path.

Impact: The visualisation of locations on the route where most climbers have died could help understand if there are some areas which need more caution (ex: Khumbu Icefall, located between Base camp and Camp-I on South Col. Route has been considered a tricky area due to the fact that various climbers have died navigating it.)

Understanding Risks: Common Causes of Death on Everest

A pie or donut chart could depict the distribution of fatality causes, like avalanches, falls, and altitude sickness. Visualizing these causes brings awareness to the specific hazards that climbers face. Furthermore, it would be good to know about details such as deaths during Route preparation, Ascent or Descent, among other facets.
Impact: This helps demystify the risks associated with Everest, offering a sobering reminder of the mountain's dangers and providing potential climbers with critical information on what precautions are most necessary.

Ascents over the years

A ridgeline plot showing the number of climbers along with their respective months and years. It can be a good representation of historical trends and observing any pattern.
Impact: Can reveal the trends of most preferred months to attempt summit.

4 Tools and Data

First task was to get co-ordinates to the Route data. South Col is the most commonly taken route on Everest, hence was chosen for the visualisation. For this, first the approximate points for the route were mapped on Google Earth Pro after referring to various source. However, a challenge came up wherein, only latitude and longitudes were downloaded in the route profile with no elevation data. To solve that issue, there is a platform that provides approximation of elevation given latitude, longitude co-ordinates Source: Find elevation profiles (click me!)

For the purposes of animation and interactive visualisation, plotly was used.

For ridgeplot visualisation, joyplot library in Python was used.

4.1 Dataset

The datasets that will be considered so far are from Kaggle Mount Everest Ascent Data (1953-2020)[4], Mount Everest Climbing Deaths[2], and lastly the dataset from github: Summiteers of Mt. Everest till December 2017[3], and Everest-Data (This dataset is subset from the Himalayan Database: https://www.himalayandatabase.com/)[1].

Challenges with dataset processing

- Non-standard conventions used in Names (such as having occupation or where they are from in brackets or other meta data mentioned in the name with or without brackets): This posed as a challenge because the idea was to combine the list from datasets having information on climbers who died and remove them from Ascent data. This was required because Ascent data describes all the climbers who have attempted to summit, and hence also includes people who start even before Base camp and having passed away before reaching there. However, with the nonstandard names in all three datasets, it is possible that some names still remain in the total climbers list (which in this project was intended to be used for total climbers who survived summiting Everest).

- Non-standard death notes: In some records of the climbers who died during their expedition, notes mention the elevation. However, there are few missing cases along with the cases of lack of details and only information being "disappeared/missing".

5 Information usability and Interaction

We believe aspiring mountaineers, researchers, and adventure tourism planners *will learn about* common risks, optimal climbing times, and historical trends in successful summits and fatalities *when interacting* with a dynamic visualization that illustrates key patterns on Mount Everest.

When observing animations or infographic style plots, they will learn useful information such as favorable weather patterns or risky routes. Additionally, interacting with the 3D plot of the route could also make them see the scale of it, to some extent.

We will know the visualization is effective when we see users frequently engaging via different camera angles on 3D plots, playing animations and viewing static plots, *indicating they are exploring* these patterns to make informed decisions.

Estimated Interaction Time: Each interaction (e.g., filtering by year or cause) should be quick, ideally under a few seconds, for efficient exploration. An average user may spend 5-10 minutes to gain a comprehensive view, although deeper analysis may require additional time.

Discussing the data:

In the Kaggle dataset for Mount Everest Climbing Deaths, there are 310 people, from 1992 to 2021, with cause of death and location as the data columns that will be used in this project. Similarly, from Mount Everest Ascent Data (1953-2020), the data is for the summits along with the information if climbers had help from locals (Sherpa people are native to the most mountainous regions, known for their excellent mountaineering skills, as part of their livelihood help climbers summit), with information such as date and in some cases, time of summit along with information in some cases of whether the climber died or not. The total people that have been logged are close to 10,000.
The opendatanepal dataset of Summiteers of Mt. Everest till December from 1953-2017 also contains information about names of climbers (approximately 5000), the year and the route they took. While the information doesn't have data about death, it is hoped that similar climber information can be found across these datasets. This particular dataset has more information on various routes taken till 2017 on Everest. Lastly, the github dataset (Everest-Data) contains information about climbers (approximately 300), their cause of death, the route which they had taken, death during ascent or descent, time and date. The earliest entry is from 1969 and latest being June 2024.

The information from all these 4 datasets combined would provide various insights on trends of climbing and deaths.

Quality and Accuracy: The data quality appears high for recent years due to improved record-keeping; however, older entries may carry some inaccuracies.

6 Impact of Time

Relevance of Time in Visualization

Long-Term Trends: Time allows us to show the growth in climbing attempts and fatalities over the years, highlighting shifts in popularity, accessibility, and risk. For example, we might see an increase in summits after significant improvements in gear or a drop in fatalities after implementing better safety practices. Seasonal Patterns: Everest's climbing seasons (primarily pre-monsoon and post-monsoon) are critical for understanding the best windows for safe summiting. Temporal data by season can illustrate the impact of weather and environmental conditions on success rates and fatal incidents. Impact of Specific Events: Time-based analysis helps pinpoint the effects of major events, such a major avalanche in a particular year or even affects of a pandemic, reflecting on ascents. Such events can be highlighted as inflection points in the temporal data.

Visualisation approach with Time-Series Line Charts and Animations:
Through animations depicting various patches on Route where deaths occurred can highlight if over later years, deaths have decreased or not. Additonally, ridgeline plots showing climbers on everest over decades Show overall trends in ascents allowing viewers to track increases or decreases over time.

7 Role of Places and Spatial Information

Spatial information plays a crucial role in analyzing trends on Mount Everest, especially for understanding the interactions between climbers and the geography they navigate. The dynamic and often

dangerous environment of Everest necessitates a spatial perspective to highlight risk zones and temporal patterns tied to specific routes or geographic features. While the following points have been a part of the information described so far, they can be specifically stated as follows-

Temporal-Spatial Analysis of Summit Attempts and Fatalities: By plotting fatalities over time and space, along with other plots that show ascents over time, can help to reveal significant trends, such as the influence of seasonal weather conditions on certain routes or how specific years saw increased fatalities due to natural disasters.

8 Visualisations and Discussions

8.1 3D visualisation

This is an interactive plot, which can be moved across and around axes. The idea is to get a feel of the elevation through interacting with it.

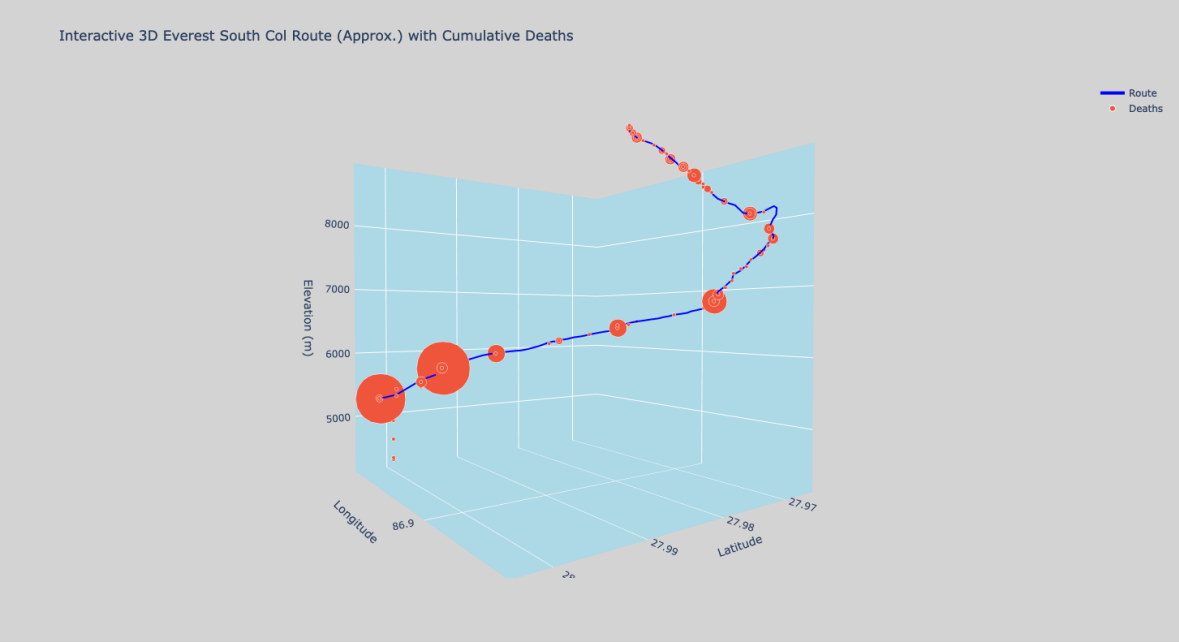

Figure 1: Snapshot of 3D route plot with cumulative deaths on various regions of the route. (Filename:everest_route_with_deaths_3d.html)

8.2 Time-series animation

As a next step, it would also be good to visualise how and where climbers died, particularly in context of annotations of the camps. Due to ease of producing annimation and annotation of routes, this was done on a 2D mapping of the same route. Below is a snapshot of the time-series animation in 2.

8.3 What are the causes?

Analysing fatalities by type

By analysing records of death notes for various climbers, few things stand out in 3. - Certain extreme events like Avalanches, although not a frequent cause of death, still can claim many lives at once, becoming the most fatal reason recorded resulting in death for many climbers.
- The second highest reason is falling. This could be by slipping, being exhausted and losing control/grip towards the climbing/guide rope. Or, this may include falling into a crevasse. - Third highest reason is AMS (Altitude Mountain Sickness), which can be something that slowly catches up to a person. Lack of acclamatisation or the body's inability to operate at those pressures may take

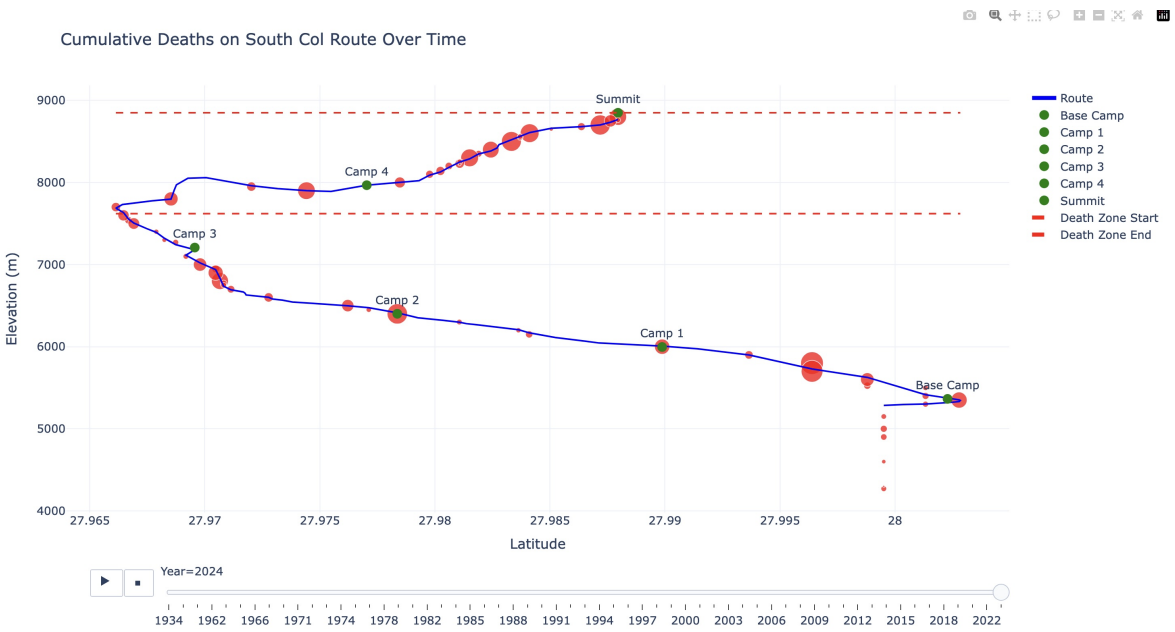

Figure 2: Snapshot of 2D animated route plot with cumulative deaths on various regions of the route. (Filename:2d_animations_everest_route_with_annotations_camps.html

unexpected tolls for many, or perhaps undermining it altogether in some cases.

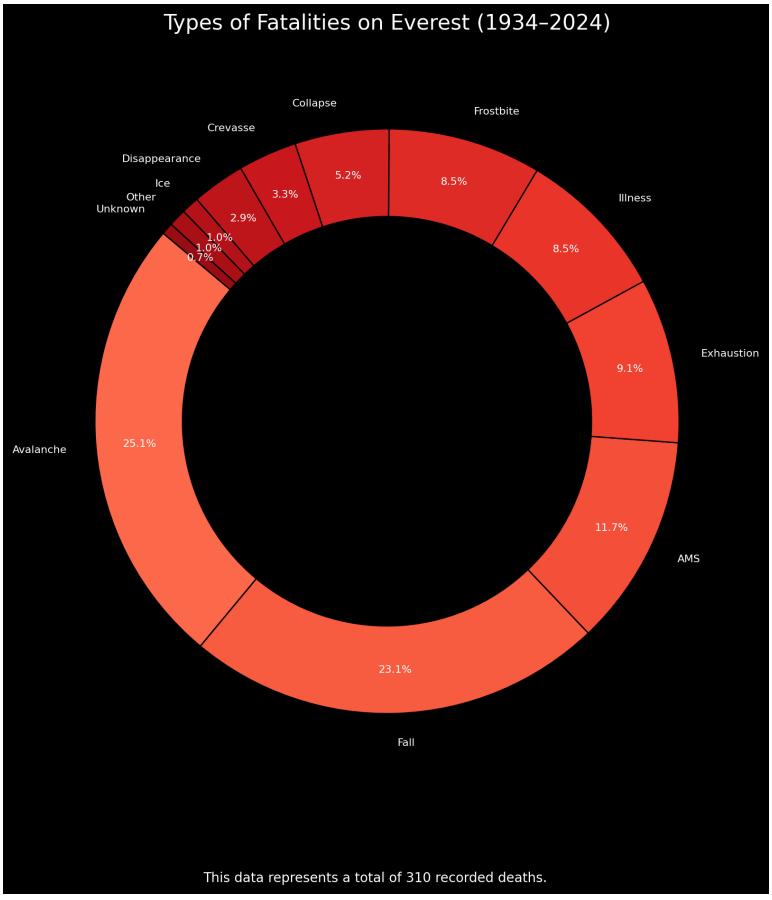

Figure 3: Types of Fatalities (Filename: types_of_fatalities.png)

Causes of death in various phases of the expedition

Another aspect that was important to highlight was, during which part of the expedition do climbers typically succumb to death? Is the ascent the most challenging part, or the descent? Or something else entirely? Based on the available recorded data as visualised in 4, it's during route preparation. Route preparation typically entails setting up guide ropes/lines with proper anchors and ladders through the route, over dangerous crevises and icefalls. Given that the first ever people who set the guides for the rest of the members to hold on to, have the most difficulty due to lack of any guide ropes, it can be easier for climbers to unknowingly fall prey to any dangers. However, by a way larger margin, most people die during descent. This is often due to the fact that people spend a lot of their energy in ascent, and having not adequate energy and resources (depleted oxygen due to heavy breathing during ascent), people can get exhausted during ascent and unfortunately die.

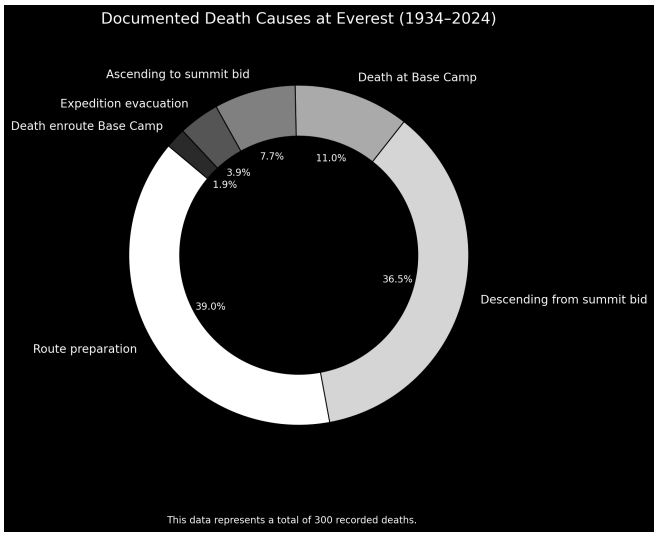

Figure 4: Death causes during various expedition phases (Filename: pie_chart_death_causes.png)

8.4 Ascents on Everest

Successful Summits are based on many factors, some of which include favorable weather and chosen time to do the expedition. By analysing Ascent data, some trends might be observable that can help one be informed about which seasons/months are chosen the most of summits, and historical trends are also a useful resource to know about the history as well.

Based on the ridgeline plot in 5, certain patterns are immediately observable.

-Way more climbers have been attempting to summit since early 2000's, and the growth is big and sudden compared to earlier years. Post 2000s, most climbers choose (Apr-Jun), with few choosing (Oct-Nov) period.

8.5 Useful resources

- Guides to using joyplot to visualise ridgelines leotac,github
- Inspiration for ridgeline plots at https://clauswilke.com/dataviz/boxplots-violins.html
- An amazing book written on analysing Himalayan Mountain range, Summits, Deaths by numbers "The Himalaya by the Numbers - A Statistical Analysis of Mountaineering in the Nepal Himalaya". https://www.himalayandatabase.com/downloads/hbnsampl.pdf

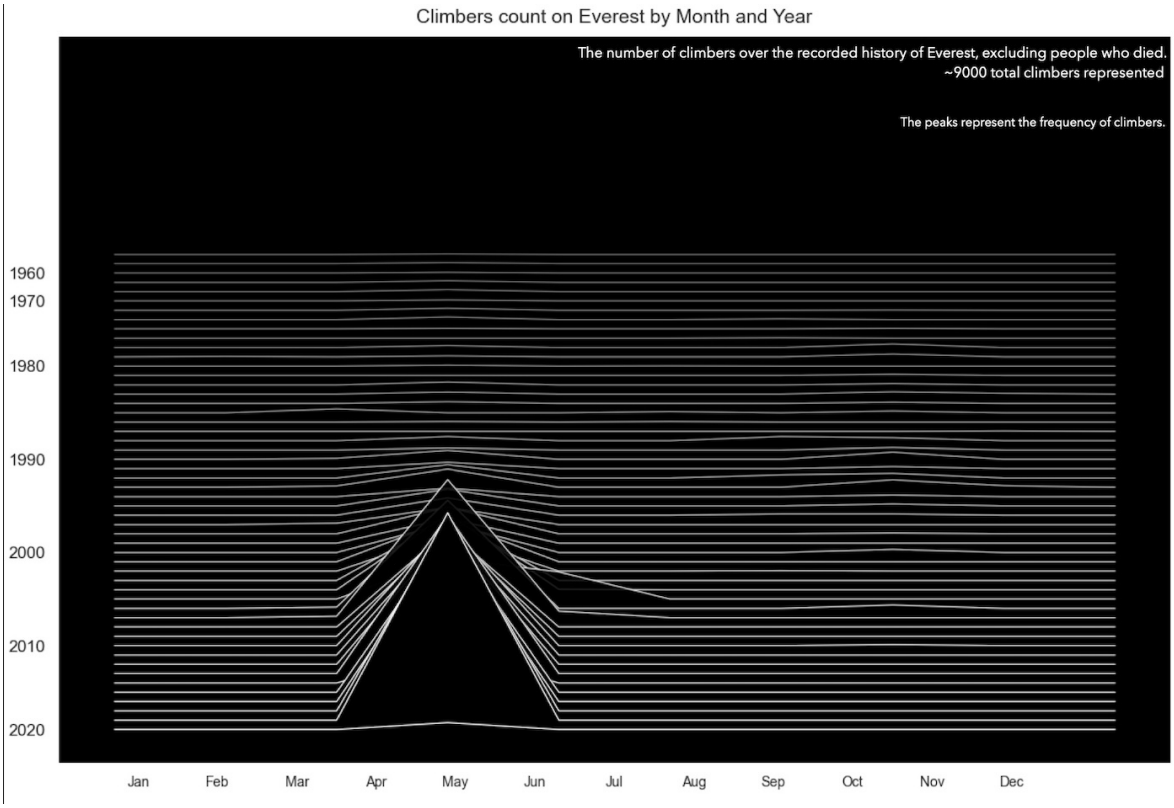

Figure 5: Climbers on Everest visualised over decades (Filename: ridge_with_caption.jpg)

References

[1] Everest-data (this dataset is subset from the himalayan database: https://www.himalayandatabase.com/). https://github.com/kierstenorning/Everest-Data.

[2] Mount everest climbing deaths. https://www.kaggle.com/datasets/shivamb/mount-everest-climbing-deaths.

[3] Summiteers of mt. everest till december 2017. https://opendatanepal.com/dataset/summiteers-of-mt-everest-till-december-2017/resource/a43e064a-3907-4c5f-8892-da38b593f7a6.

[4] Mount everest ascent data (1953-2020). https://www.kaggle.com/datasets/ropandey12/mount-everest-ascent-data-19532020, 2020.