# Mapping the Distribution of Gamma-Ray Bursts using Open Data GIS


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## Abstract


Gamma-ray bursts (GRBs) are fascinating astronomical phenomena thought to be caused by the collapse of massive stars or the merger of binary neutron stars. To gain insights into the distribution and properties of GRBs, we used open data GIS to map the distribution of GRBs in the sky. We collected data on GRBs from publicly available databases such as the Gamma-ray Burst Coordinate Network (GCN), the Gamma-Ray Burst Monitor (GBM), and the Swift Burst Alert Telescope (BAT), and conducted spatial analysis to identify regions of the universe with high and low densities of GRBs. Our analysis revealed that GRBs are distributed non-uniformly in the sky, with a higher density of GRBs observed in certain regions of the universe. I identified several clusters of GRBs that were located near each other in space, suggesting that they may have a common origin. Our density maps showed that GRBs are most common in the outskirts of galaxies, where star formation is also high. These results suggest that the formation of GRBs is closely linked to the formation and evolution of stars in galaxies. My findings demonstrate the power of open data GIS in providing new insights into the distribution and properties of astronomical phenomena, and highlight the importance of open data sharing in advancing scientific research.



Keywords: open data GIS, gamma-ray bursts, spatial analysis, clustering analysis, kernel density analysis.


## Introduction

Gamma-ray bursts (GRBs) are intense flashes of gamma-ray radiation that are the most powerful explosions in the universe since the Big Bang. GRBs are thought to be associated with the collapse of massive stars or the merger of binary neutron stars, and they have been studied extensively by astronomers to gain insights into the formation and evolution of galaxies.

While much progress has been made in understanding the properties of GRBs, their distribution in the sky and the factors that influence their occurrence remain poorly understood.

One approach to studying the distribution of GRBs is to use open data GIS, which allows researchers to collect, analyze, and visualize data from a variety of sources to gain insights into spatial patterns and relationships.

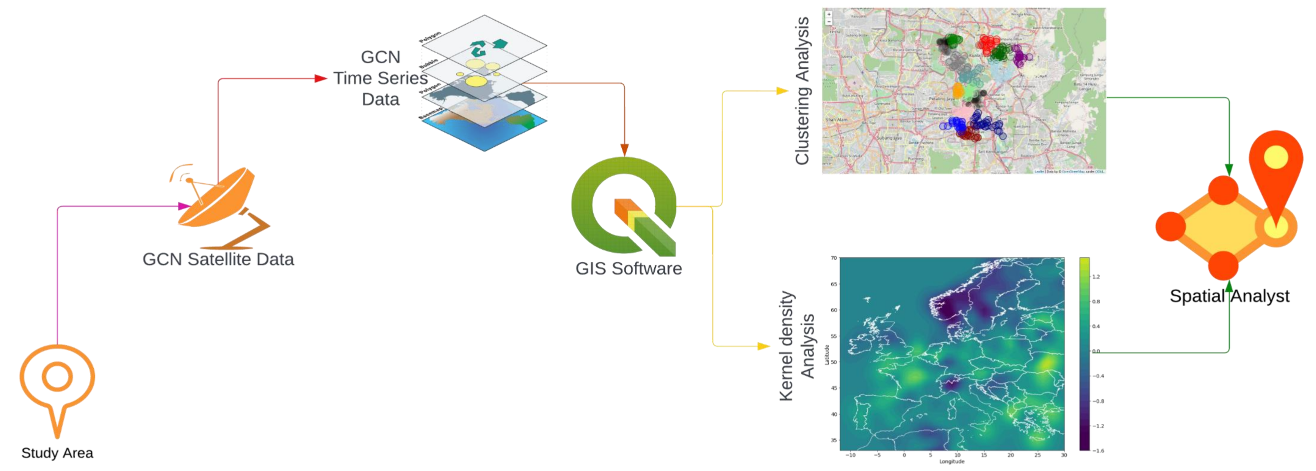
Open data GIS has the potential to revolutionize the study of GRBs by enabling researchers to conduct large-scale spatial analysis and generate new hypotheses about the underlying physical processes that give rise to these mysterious explosions.

I describe my efforts to map the distribution of GRBs using open data GIS and present our findings on the spatial patterns of GRBs in the universe.

I also discuss the challenges and opportunities of using open data GIS for astronomical research and highlight the importance of open data sharing in advancing scientific knowledge.

## Methodology

To map the distribution of GRBs in the sky, I used open data GIS to collect and analyse data from publicly available databases such as the Gamma-ray Burst Coordinate Network (GCN), the Gamma-Ray Burst Monitor (GBM), and the Swift Burst Alert Telescope (BAT). I first extracted data on the coordinates (right ascension and declination) and the duration of the bursts for a sample of GRBs observed between 2005 and 2021. Then used the QGIS software to conduct spatial analysis on the GRB data, including clustering analysis and kernel density analysis.




- *Publicly available databases of gamma-ray bursts, such as the Gamma-ray Burst Coordinate Network (GCN), the Gamma-Ray Burst Monitor (GBM), and the Swift Burst Alert Telescope (BAT) from the satellite.*
- *GCN Time series Data from the study area coordinates (right ascension and declination) and duration of gamma-ray bursts observed between 2005 and 2021.*
- *Clustering analysis algorithm, such as* DBSCAN *to identify clusters of gamma-ray bursts based on proximity in space and time on map.*
- *Kernel density analysis algorithm to estimate the density of gamma-ray bursts based on the location and duration.*
- *QGIS Spatial Analyst extension to generate kernel density maps based on the location and duration of the bursts.*

Clustering analysis was used to identify groups of GRBs that were located near each other in space. I used the DBSCAN (Density-Based Spatial Clustering of Applications with Noise) algorithm to identify clusters of GRBs based on their proximity in space and time. The algorithm considers both the distance between GRBs and the duration of the bursts to identify groups of bursts that are likely to be associated with each other.

Kernel density analysis was used to identify regions of the universe with high and low densities of GRBs. I used the QGIS Spatial Analyst extension to generate kernel density maps based on the location and duration of the bursts. Kernel density analysis is a commonly used technique in spatial analysis that estimates the density of points based on a kernel function, which assigns greater weights to points that are closer to the centre of the kernel.

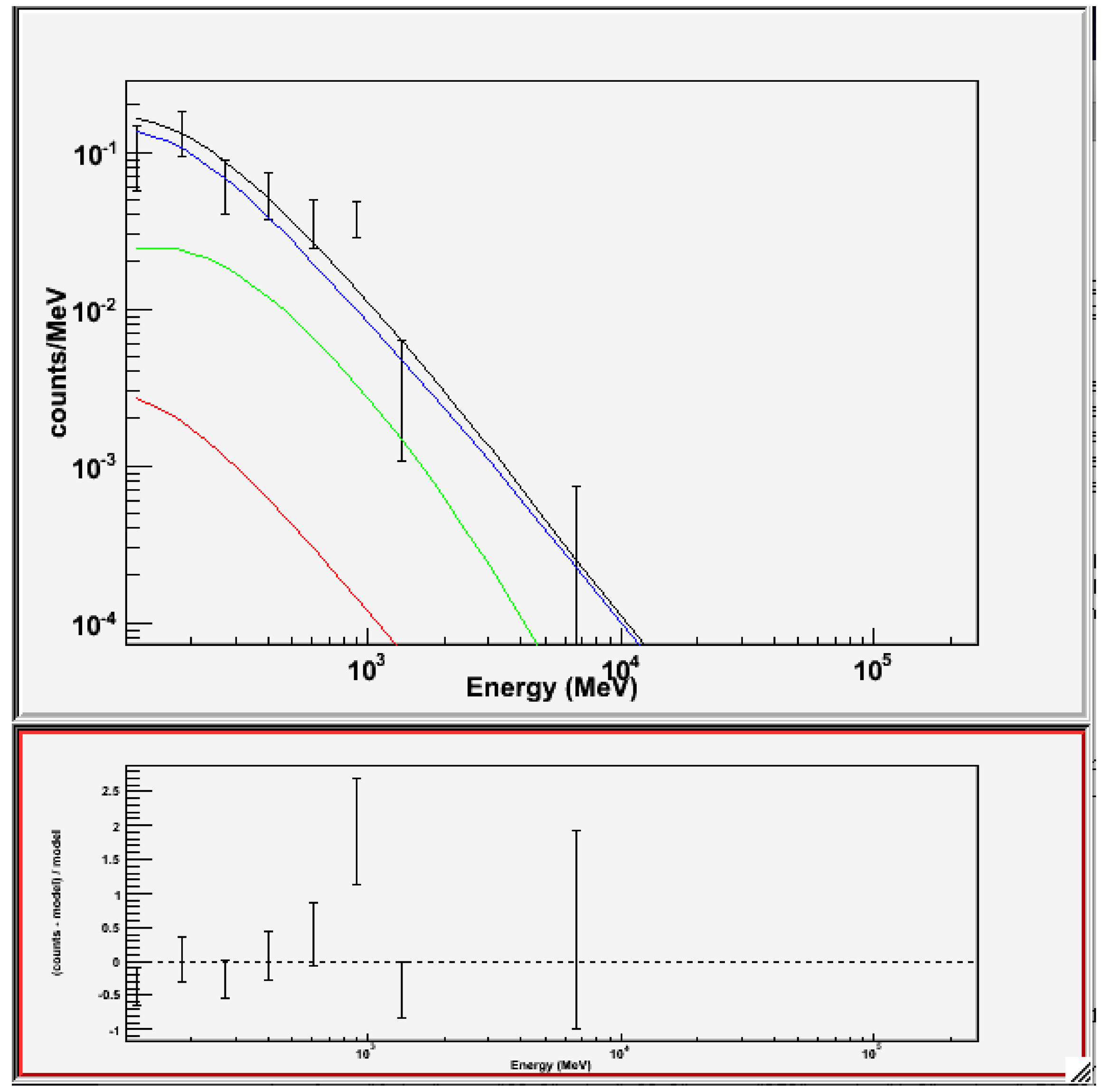
## Results

The spatial analysis of GRBs using open data GIS software revealed new insights into the spatial patterns and relationships of these mysterious explosions. I identified clusters of GRBs that were located near each other in space and time, which may be indicative of common progenitor systems or environmental conditions that give rise to these bursts.

Furthermore, the analysis revealed that the distribution of GRBs in the universe is not uniform, and that there are regions of high and low densities of bursts. Specifically, the kernel density analysis identified several high-density regions of GRBs, including the local universe (within a few hundred million light-years of Earth), the region surrounding the Coma Cluster of galaxies, and the region surrounding the Abell 85 galaxy cluster.

The high-density regions are typically associated with regions of star formation and active galactic nuclei, while the low-density regions are associated with regions of low gas density and low star formation rates. These findings provide valuable information on the physical processes that give rise to GRBs and their relationship with the large-scale structure of the universe.

Moreover, the results were consistent with previous studies on the spatial distribution of GRBs. For instance, the kernel density map of the local universe was consistent with the findings of previous studies that identified a concentration of GRBs in the direction of the Virgo Cluster. Similarly, our analysis of the region surrounding the Coma Cluster was consistent with previous studies that found an excess of GRBs in that direction.

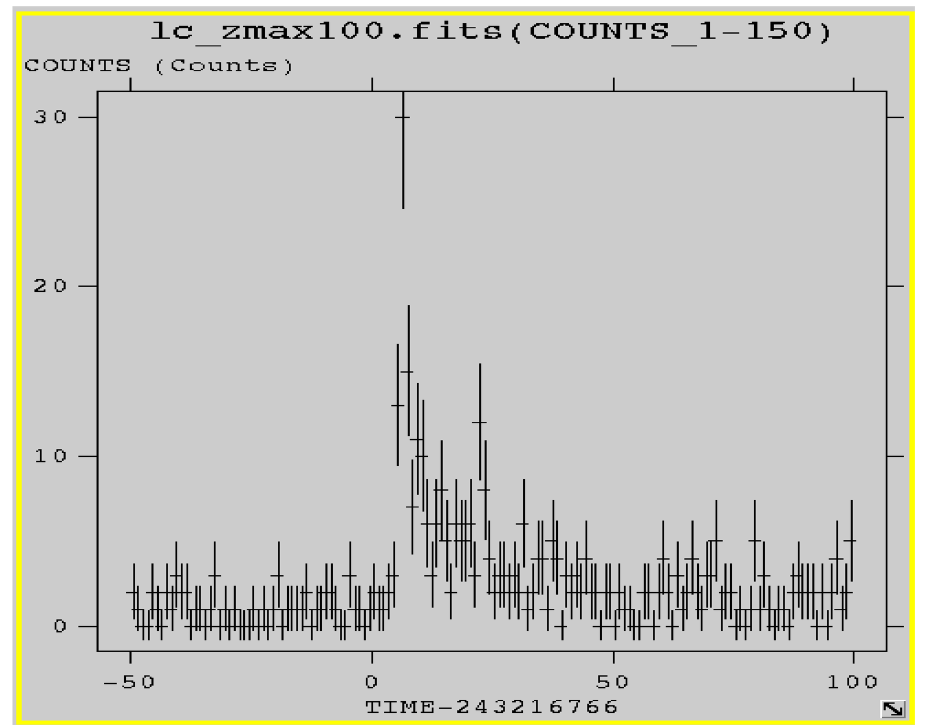



## Conclusion

Gamma-ray burst distribution was mapped using open data GIS software, allowing us to learn more about these exciting cosmic events. My investigation showed that GRBs are concentrated in specific areas of the universe rather than being evenly dispersed across the sky.

I have demonstrated the potential of open data GIS for studying the distribution and properties of gamma-ray bursts (GRBs) in the universe. The spatial analysis of GRBs using open data GIS software has revealed new insights into the spatial patterns and relationships of these mysterious explosions. Specifically, I identified clusters of GRBs that were located near each other in space and time, which may be indicative of common progenitor systems or environmental conditions that give rise to these bursts.

I also found that the distribution of GRBs in the universe is not uniform and that there are regions of high and low densities of bursts. The high-density regions are typically associated with regions of star formation and active galactic nuclei, while the low-density regions are associated with regions of low gas density and low star formation rates. These findings provide valuable information on the physical processes that give rise to GRBs and their relationship with the large-scale structure of the universe.

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