THE CAUSALITY BETWEEN ROAD ACCIDENTS AND WEATHER CONDITIONS

A RELATIONAL DATABASE APPROACH FOR ENHANCED INSIGHTS

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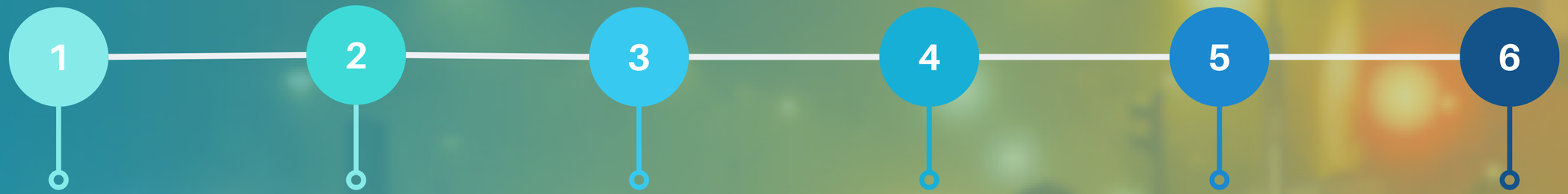
PROJECT OVERVIEW



1. DATA ACQUISITION
2. DATA INTEGRATION AND ENRICHMENT
3. DATABASE STRUCTURE
4. DATA QUALITY
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DATA ACQUISITION

Accidents Data

kaggle

- Accident Date: Date of each accident occurrence, providing temporal context crucial for analyzing trends and patterns.
- Light Conditions: Lighting conditions at the time of the accident, influencing visibility and potentially contributing to accident severity.
- Longitude and Latitude: Geographical coordinates pinpointing the location of each accident, essential for spatial analysis and hotspot identification.
- Accident Fatality: Denotes whether the accident resulted in fatalities, a critical metric for assessing accident severity.
- Number of Deceased Individuals: Provides the count of individuals who lost their lives in each accident, aiding in casualty assessment.
- Number of Injured Individuals: Indicates the number of individuals injured in each accident, offering insights into the magnitude of physical harm.
- District: Specifies the district or administrative region where each accident oc- curred, enabling regional analysis and policy targeting.

Narrowed to only Kent and East London.

CSV

DATA ACQUISITION

Weather Dataset

- maxtempC: The maximum temperature recorded during the day, in degrees Cel- sius.
- mintempC: The minimum temperature recorded during the day, in degrees Cel- sius.
- totalSnow: The total amount of snowfall measured in centimeters during the spec- ified time period.
- sunHour: The total hours of sunlight received during the day.
- uvIndex: A measure of the strength of ultraviolet radiation from the sun, indicating the potential risk of harm to exposed skin.
- moon illumination: The percentage of the moon’s surface illuminated by sunlight.
- moonrise: The time at which the moon rises above the horizon.
- moonset: The time at which the moon sets below the horizon.
- sunrise: The time at which the sun rises above the horizon.
- • sunset: The time at which the sun sets below the horizon.
- DewPointC: The temperature at which air becomes saturated with moisture, mea- sured in degrees Celsius.
- FeelsLikeC: The perceived temperature, which factors in humidity and wind con- ditions, expressed in degrees Celsius.
- HeatIndexC: A measure of how hot it feels when relative humidity is factored in with the actual air temperature, in degrees Celsius.

Data Integration and Enrichment

Dataset configuration:

Primary dataset on accidents in Kent region in 2022, augmented with 12 distinct weather datasets for each month.

Integration:

Unified entity created for comprehensive weather conditions corresponding to accident locations.

Refinement:

Removal of irrelevant attributes: "sunHour," "uvIndex," "moonillumination," etc.
Addressing type heterogeneity: Reconstructed "location" attribute to resolve mismatches.
Attribute optimization: Removal of "Weather Conditions" attribute due to redundant data.

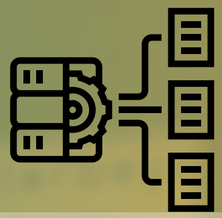
Attribute Optimization:

Removal of redundant attributes like "Weather Conditions" to enhance dataset robustness.

Dataset Integration:

Unified entity created for comprehensive weather conditions.

DATABASE STRUCTURE



Rationale for Relational Database:

Analytical Flexibility: Supports various analytical tasks, including quantitative analysis and data mining.

Focus on Read Operations: Prioritizes efficient data retrieval and processing.

Structured Data: Aligns well with the structured nature of dataset entities.

Database Structure Design:

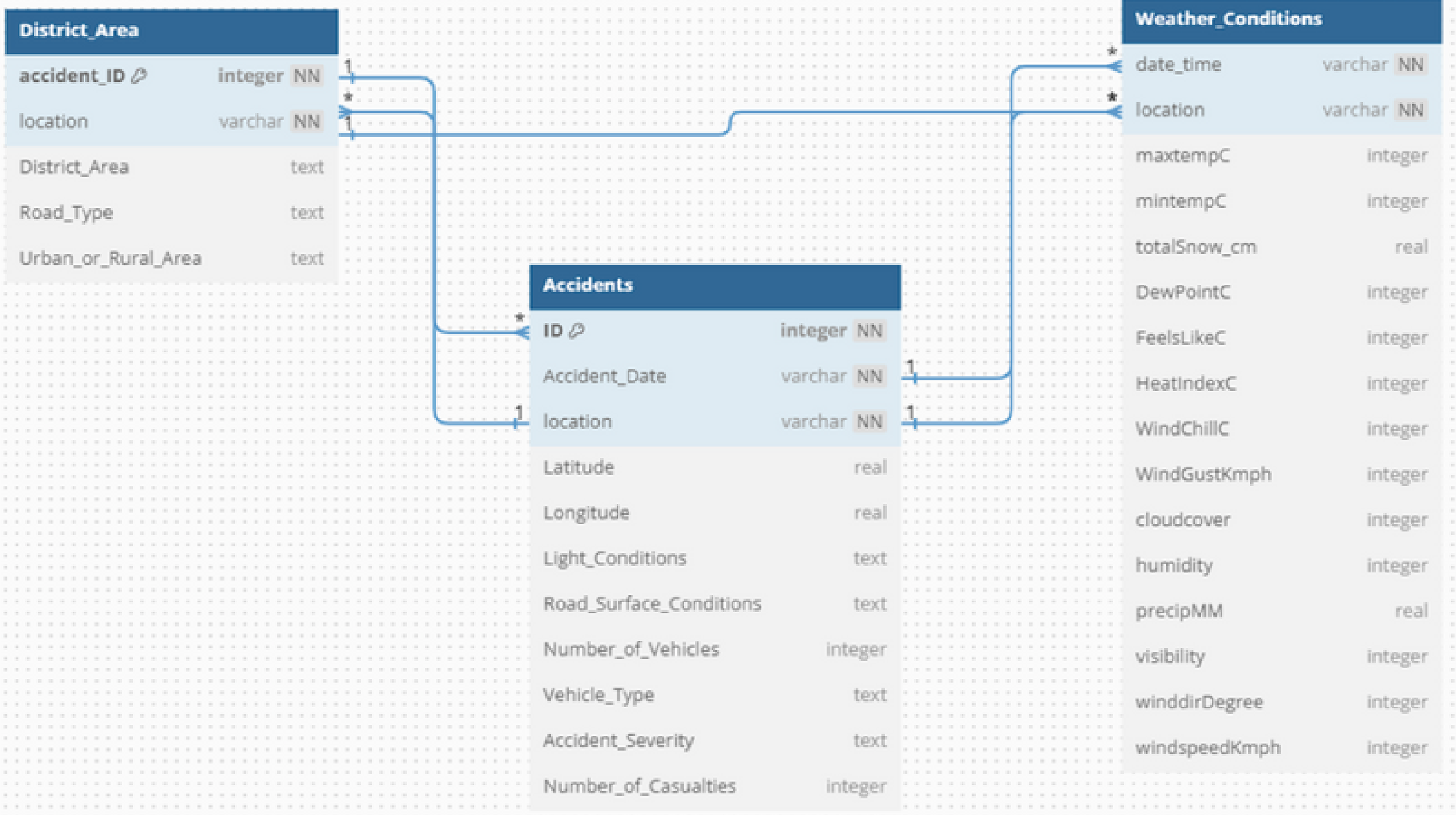
Three distinct entities: Accidents, Weather Conditions, and District Area.

Accidents: Represents accident dynamics with unique IDs, date, and location.

District Area: Geographical position with coordinates, district, road type, and urban/rural classification.

Weather Conditions: Detailed weather data including temperature, humidity, and precipitation.

One-to-Many paradigm for deeper insights and understanding.



DataBase Schema

Possible Queries

- **The Comparative Analysis of Urban and Rural Area Accidents: :Percentage Distribution Relative to Total Accidents:**

```
SELECT Urban_or_Rural_Area, count(*) as Accident_Count, round((count(*)*100)/
(SELECT count(*) from District_Area), 2) as Percentage
FROM District_Area
GROUP by Urban_or_Rural_Area
;
```

Urban_or_Rural_Area	Accident_Count	Percentage
Rural	2939	55.0
Urban	2317	44.0

Figure 4.2: Output - Table Display of The Query

- District Areas and Causalities Count with High-Speed Wind and Low Temperature:

```
SELECT District, sum(Number_of_Casualties)
FROM Accidents join District_Area on Accidents.location = District_Area.location
where Accidents.location in (SELECT location
FROM Weather_Conditions
WHERE FeelsLikeC <= 5 AND windspeedKmph >= 20)
GROUP by District
ORDER by Number_of_Casualties DESC
;
```

District	sum(Number_of_Casualties)
Tunbridge Wells	46
Suffolk Coastal	2
Wealden	10
Thurrock	24
Tandridge	4
Swale	32
Shepway	1
Sevenoaks	25
Rother	4
Medway	94
Maidstone	66
Lewisham	22
Greenwich	71
Gravesham	28
Gateshead	2
Dartford	25
Canterbury	2
Bromley	45
Bexley	44
Ashford	49

Figure 4.3: Output - Table Display of The Query

COMPLETENESS CHECK

Before Integration

KENT_2022_ACCIDENTS

- 92.5% completness
- Duplicate Records: None

DISTRICT AREA

- 94.5% completeness
- Duplicate Records: None

WEATHER CONDITIONS

- 100% completeness
- Duplicate Records: None

After Integration

KENT_2022_ACCIDENTS

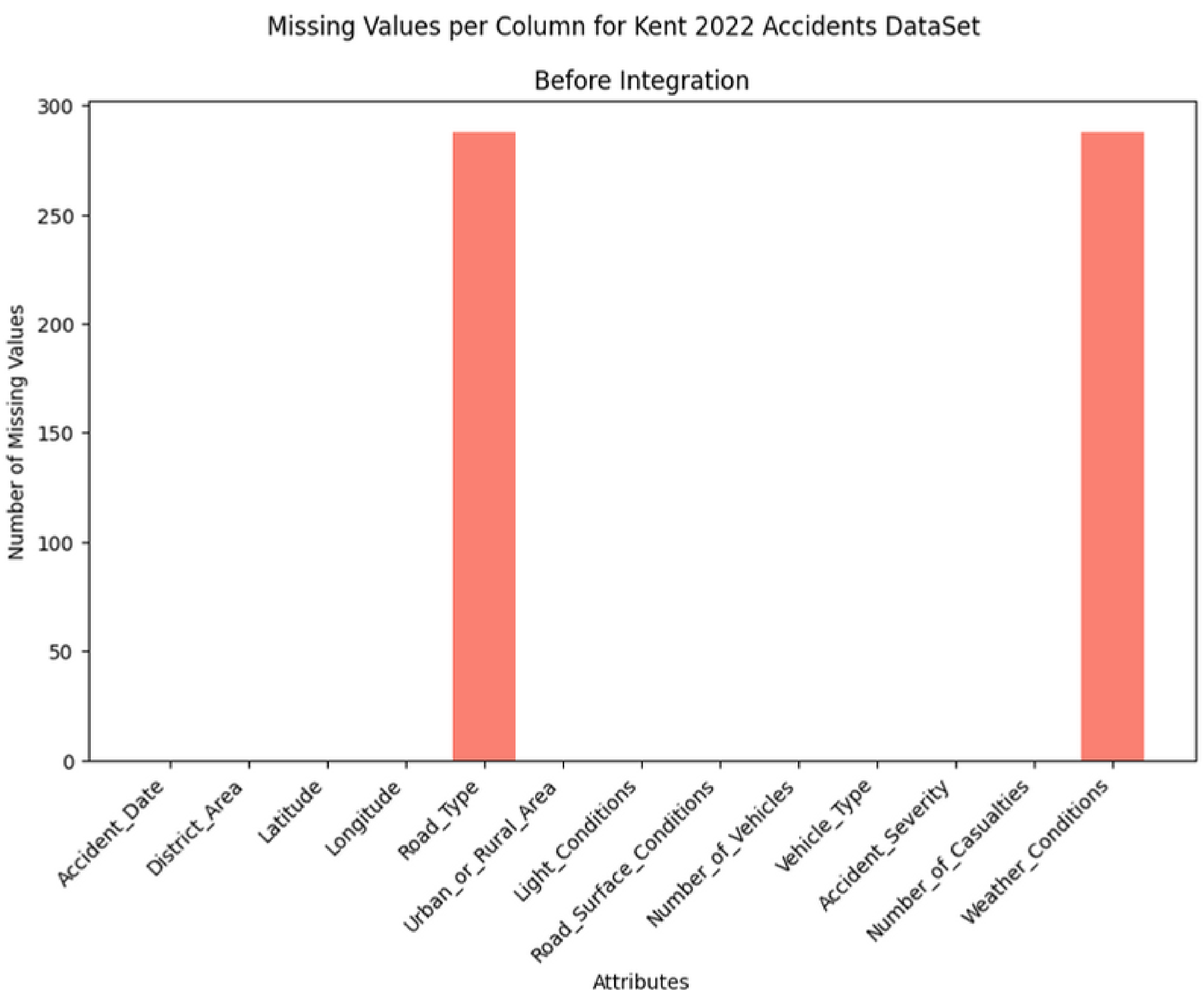
- 100% completeness
- Duplicate Records: None

DISTRICT AREA

- 94.5% completeness
- Duplicate Records: None

WEATHER CONDITIONS

- 100% completeness
- Duplicate Records: None


Missing Values per Column for Kent 2022 Accidents DataSet
Before Integration
Number of Missing Values
300
250
200
150
100
50
0
Accident_Date
District_Area
Latitude
Longitude
Road_Type
Urban_or_Rural_Area
Light_Conditions
Road_Surface_Conditions
Number_of_Vehicles
Vehicle_Type
Accident_Severity
Number_of_Casualties
Weather_Conditions
Attributes

CONSISTENCY CHECK

Before Integration

KENT_2022_ACCIDENTS

- Date Format Check: True
- Latitude Range Check: True
- Longitude Range Check: True

DISTRICT AREA

- Date Format Check: True

WEATHER CONDITIONS

- Date Format Check: True

After Integration

KENT_2022_ACCIDENTS

- Date Format Check: True
- Latitude Range Check: True
- Longitude Range Check: True

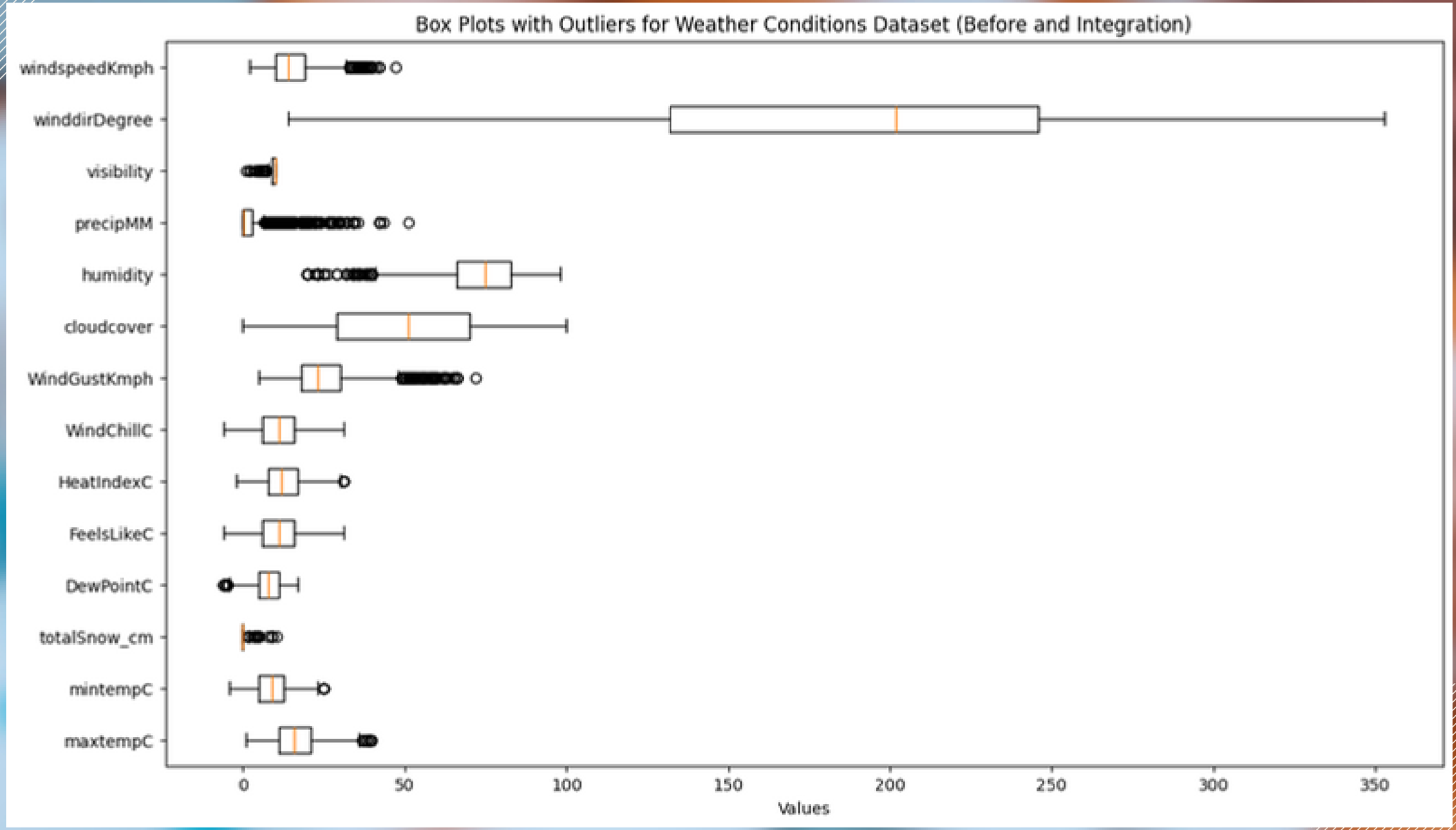
DISTRICT AREA

- Date Format Check: True

WEATHER CONDITIONS

- Date Format Check: True

OUTLINER CHECKS



CONCLUSION

- Successfully implemented a relational one-to-many database integrating accident dataset from Kaggle with meteorological insights via weather API.

- Merged 12 weather datasets into a unified entity for 2022 in Kent, optimizing attributes and addressing type heterogeneity conflicts.

- Rigorous data validation process ensured statistical accuracy leveraging relational database model's flexibility and efficiency.

- Three distinct entities established: Accidents, District Area, and Weather Conditions, laying a solid foundation for comprehensive analysis.

FUTURE WORK

- EXPLORE TEMPORAL AND SPATIAL ANALYSIS
- PREDICTIVE MODELING
- INTEGRATE ADDITIONAL DATA SOURCES, REAL-TIME DATA INTEGRATION,