

Data Mining Edmonton's 311 Service Requests Using Association Rules

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Introduction

311 is a service provided by the City of Edmonton for citizens to report and make service requests about issues that occur in the city. From the 311 data that the city has made public, it gives a good sense of the needs of citizens in Edmonton -- from pothole requests to dead animal removal. The goal of this project is to better understand 311 requests made in the City of Edmonton by finding what items frequently occur together when reporting and closing issues.

Previous Work

Data mining on 311 data has been done for many cities. In New York and Chicago, 311 data was clustered by areas leading to the discovery that different neighborhoods with different socioeconomic backgrounds have differing issues.^{1,2} In another project, New York's 311 data was analyzed using association rule mining to show that some issues occur more frequently in certain months and that some agencies are associated with more issues than others.³ In San Francisco, anomaly detection was performed on the city's 311 data to show that there were spikes in certain types of issues during certain months.⁴ While in Toronto, a correlation analysis was done to show that links between 311 and weather data were moderate to weak.⁵ Finally, an analysis of 311 data in Edmonton was performed to show that reporting methods differ between different socioeconomic backgrounds.⁶

Research Questions

By expanding on the association mining techniques performed for analyzing New York's 311 data, this project's goal is to gain a better understanding of Edmonton's 311 data in two perspectives: (1) the city's perspective of what can be associated when service requests are created, (2) the citizen's perspective of what can be associated when service requests are closed.

From these two perspectives and previous analyses on other 311 datasets, we seek to find answers for the following questions:

- Can highly frequent issues be associated to specific wards or neighbourhoods?
 - Why might there be more issues in these locations than others?

¹ "First World Problems: A Clustering of NYC's Zipcodes by 311 Complaints." 8 Apr. 2015, https://rstudio-pubs-static.s3.amazonaws.com/72195_3ca37a3dd3a2419c80dd64150be08fdf.html. Accessed 16 Dec. 2017.

² "Clustering analysis - dssg/411-on-311 Wiki · GitHub." 14 Oct. 2013, <https://github.com/dssg/411-on-311/wiki/clustering-analysis>. Accessed 16 Dec. 2017.

³ "GitHub - akshaisarma/AssociationRuleMining: Association Rule Mining." <https://github.com/akshaisarma/AssociationRuleMining>. Accessed 16 Dec. 2017.

⁴ "data-science-wg/projects-in-this-repo/SF_311_Data-Analysis ... - GitHub." https://github.com/data-science-wg/projects-in-this-repo/SF_311_Data-Analysis. Accessed 16 Dec. 2017.

⁵ "311 Toronto Analysis - 2may2017 - Enterprise Integration Laboratory." <http://eil.mie.utoronto.ca/wp-content/uploads/2015/06/311-Toronto-Analysis-2may2017.pdf>. Accessed 16 Dec. 2017.

⁶ "Characterizing New Channels of Communication: A Case Study - UWspace." 6 Jun. 2016, <https://uwspace.uwaterloo.ca/bitstream/handle/10012/11064/PJohnson03.pdf?sequence=1>. Accessed 16 Dec. 2017.

- Can highly frequent issues be associated to specific times?
- Can weather be associated with certain kinds of issues in terms of time?

Methods

To answer these questions, the FPGrowth algorithm is used to find frequent itemsets and their association rules. FPGrowth is similar to the Apriori algorithm to mine association rules. However, FPGrowth is an improvement compared to the Apriori algorithm since 2 passes of the database are needed to mine the data compared to the many passes that Apriori needs. FPGrowth works by first building a FPTree structure, and the FPTree structure is then traversed to find association rules.^{7,8}

In order to limit the running time of FPGrowth, minimum thresholds were set for the following association rule parameters:

- Support - how frequent itemset appears
- Confidence - how often rule is found to be true
- Lift - interestingness of rule
- Antecedent (left-hand side) and consequent (right-hand side) length

Challenges

There were issues with including unnecessary attributes, interpreting the massive amounts of rules being generated, and the computation time to generate the rules.

From looking at preliminary results a lot of rules had lift values greater than 100 which is really high. By looking closer at the rules, it appeared that the rules were also not very useful since they appeared to be closely related to each other. For example, from the association rule for when an issue is created: {July, High relative humidity, Strong Winds} → {Feels Somewhat Comfortable Outside (based on dew point)}, it is obvious that these attributes would be closely related in the month of July. In order to minimize rules like this, attribute values had to be adjusted and some attributes were eliminated. For instance, since dew point is related to humidity, the relative humidity attribute was eliminated. Furthermore, attribute values that appeared too often (e.g. feeling dry which occurs for most days of the year) were also eliminated since they would be associated with most things by appearing so often.

⁷ "Data Mining Algorithms In R/Frequent Pattern Mining/The FP-Growth" https://en.wikibooks.org/wiki/Data_Mining_Algorithms_In_R/Frequent_Pattern_Mining/The_FP-Growth_Algorithm. Accessed 16 Dec. 2017.

⁸ "The SPMF Open-Source Data Mining Library Version 2 | SpringerLink." 3 Sep. 2016, https://link.springer.com/chapter/10.1007/978-3-319-46131-1_8. Accessed 16 Dec. 2017.

There were also a massive amount of rules being generated (> 10 million) which is a problem to interpret. Therefore, the association rule parameters had to be tweaked in order to reduce the amount of rules being generated. In addition, instead of association rule mining all the merged data at once, the merged data was further divided into different wards and months of an issue. This allowed for a more accurate representation of what rules might occur in a ward and what issues might occur during a month. This also reduced the amount of rules being generated ($< 100\,000$ rules in total) and improved the efficiency of the FPGrowth algorithm.

Another issue was the amount of computation time needed to produce results. However, this was a simple fix as servers with more memory and computing power were used to run FPGrowth which reduced the computation time from minutes to seconds. Furthermore, by dividing the data into subsets of wards and months, it also helped to improve computation time.

Experimental Evaluation

Data mining was performed in 4 steps: (1) data cleaning, (2) data integration, (3) focusing on task relevant data by determining how the data will be used, (4) association rule mining. Most of the time in this project was spent in step 3 as outlined in the challenges section since too many attributes made the results non-interesting, incomprehensible and time consuming to produce.

Data Cleaning

4 datasets were used to find associations. Their attributes and description can be found in the appendices A,B,C at the end of this paper. The rows highlighted grey are the attributes kept for data integration. The rows that are white are ignored because of being too related to the highlighted rows, having incomplete information or having irrelevant information. In addition to removing attributes, the datasets were also reduced to the time range of January 1, 2013 until October 31, 2017. All of this was performed using the pandas python library.⁹

311 Data

Attributes and descriptions: Refer to Appendix A

Source: City of Edmonton Open Data¹⁰

⁹ "Pandas." <https://pandas.pydata.org/>. Accessed 16 Dec. 2017.

¹⁰ "311 Explorer - Edmonton - Open Data Portal - City of Edmonton." <https://data.edmonton.ca/Indicators/311-Explorer/ukww-xkmi>. Accessed 16 Dec. 2017.

Size before cleaning: 294 097 rows x 20 columns

Size after cleaning: 291 516 rows x 9 columns

Notes:

- Neighbourhood and Ward attributes were relabeled to be consistent using the Location attribute along with a spatial data file
- For values that did not exist in Service Code, the value of Service Category was used instead
- Data which had similar values were also changed to be consistent (e.g. 'Ward 01' is converted to '1')

Meeting Data

Attributes and descriptions: Refer to Appendix B

Source: City of Edmonton Open Data¹¹

Size before cleaning: 719 rows x 6 columns

Size after cleaning: 531 rows x 2 columns

Note:

- The 'MEETING_TYPE' values were first changed to be: Committee, Council, Hearing
 - Days were then merged and categorized as having meeting values of: Committee, Council, Hearing/Committee, Council/Hearing, Hearing, Council/Hearing/Committee.

Weather Data

Attributes and descriptions: Refer to Appendix C

Source: WeatherStats.ca via Environment Canada¹²

Size before cleaning: 1782 rows x 59 columns

Size after cleaning: 1765 rows x 9 columns

Notes:

- Dew point and humidity are related measurements so dew point was kept
- Average values were kept because it is a more accurate representation of what happens over a day compared to max or min

¹¹ "2013-2017 Council And Committee Meetings - Attendance | Edmonton" <https://data.edmonton.ca/City-Administration/2013-2017-Council-And-Committee-Meetings-Attendanc/prdj-dgnz>. Accessed 16 Dec. 2017.

¹² "Data Download for Edmonton - Edmonton Weather Stats." 5 Dec. 2017, <https://edmonton.weatherstats.ca/download.html>. Accessed 16 Dec. 2017.

Holiday Data

This data consisted of 58 rows and 1 column consisting of the dates when holidays occurred in Edmonton. To find the dates, the algorithms implemented in the python-holidays library were used.¹³ The resulting dataset only had one attribute containing the days where holidays occurred.

Data Integration

The data was merged based on creation and closing dates creating 2 datasets. In figures 1,3,4,5 tables of attributes kept are shown.

311 Data

Reference Number	This is kept to sort the requests in the order that they were made.
Date Created	The is kept to merge with other datasets.
Date Closed	This is kept to merge with other datasets.
Status Detail	Could lead to some interesting associations as it provides information about the request made.
Service Code	Could lead to some interesting associations as it provides a general description of the service request.
Business Unit	Could lead to some interesting associations as different business units can deal with the same kinds of service requests.
Neighbourhood	Could lead to some interesting associations from the City neighbourhood where the service request is located.
Ward	Could lead to some interesting associations from the City Ward associated with the location.
Ticket Source	Could lead to lead some interesting associations from how requests were made.

Figure 1. 311 Data attributes and justifications

By also doing an exploratory visual analysis, it can be easy to see why some attributes should be kept.

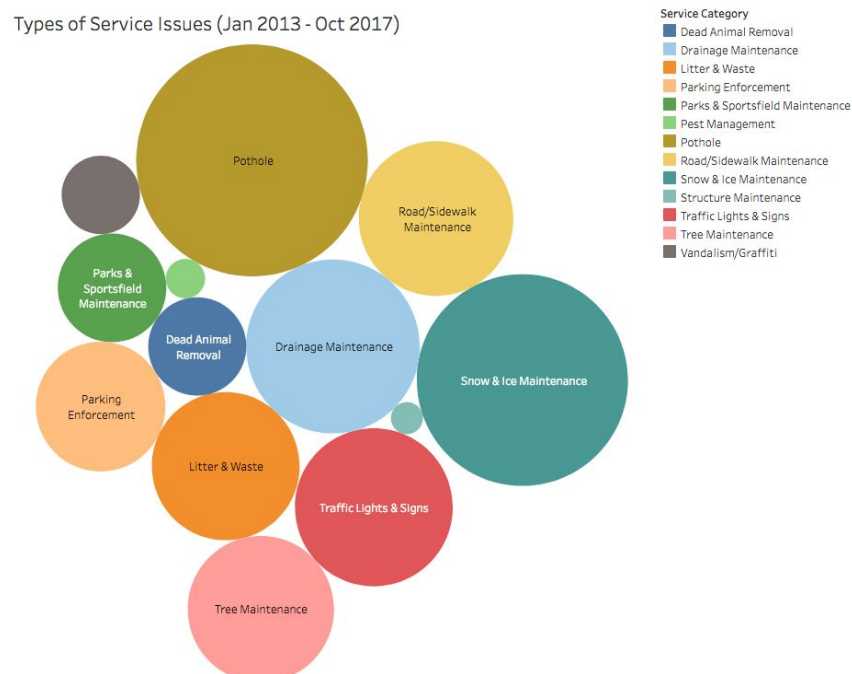


Figure 2. Plot of most common types of service issues

¹³ "holidays 0.8.1 : Python Package Index - PyPI - Python.org." <https://pypi.python.org/pypi/holidays>. Accessed 16 Dec. 2017.

Clearly some service requests for issues occur more frequently than others. We would like to know how they are associated with the other attributes chosen.

Meeting Data

MEETING_TYPE	Could lead to some interesting associations from whenever there is a meeting.
MEETING_DATE	This is kept to merge with other datasets.

Figure 3. Meeting Data attributes and justifications

Weather Data

date	This is kept to merge with other datasets.
avg_hourly_temperature	Could lead to some interesting associations from any heat warnings based on the temperature.
min_windchill	Could lead to some interesting associations from the windchill value.
avg_dew_point	Could lead to some interesting associations from the comfort level in the environment.
max_wind_gust	Could lead to some interesting associations based on the wind speed.
wind_gust_dir_10s	Could lead to some interesting associations based on wind direction.
avg_health_index	Could lead to some interesting associations based on the air quality.
precipitation	Could lead to some interesting associations based on whether or on not it rained/hailed/snowed.
sunlight	Could lead to some interesting associations based on how much sunlight there is in a day.

Figure 4. Weather Data attributes and justifications

Holiday Data

date	This is kept to merge with other datasets and indicate when there is a holiday. This could lead to some interesting associations based on holidays.
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Figure 5. Holiday Data attribute and justification

Merged Data

After merging all the above datasets, the resulting sizes were obtained:

- Merging on creation date: 291516 rows x 18 columns
- Merging on closing date: 290851 rows x 18 columns

Note that issues that were not closed are removed for merging on closing date.

Focusing on Task Relevant Data

This process involved discretizing attributes, binarizing the attributes and splitting the data to be mined more efficiently. Data was discretized using common value scales or through visualization of their distributions. Additional attributes were also created.

Additional Attributes Created

Month Created/Closed

Attributes for the month of when a request was created and closed were created so that it can be used to separate the data.

Day of Week Created/Closed

Attributes for the day of a week a request was created and closed were created because after plotting the number of requests as seen in Figure 6, it becomes clear that requests occur more often on weekdays than weekends.

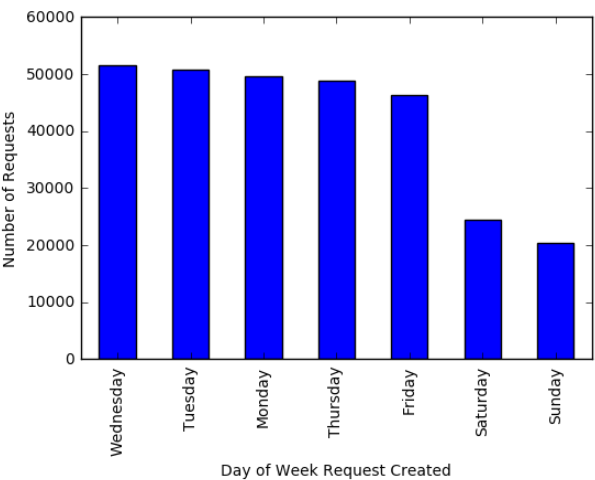


Figure 6. Histogram of amount of requests created for each day of the week

Days to Resolution

An attribute for days to resolution was created since it can be a good indicator of how proactive the city is in dealing with issues. From Figure 7, it can be seen that most issues are resolved within 2 days. It would be interesting to know which sort of issues may be associated with a less timely resolution.

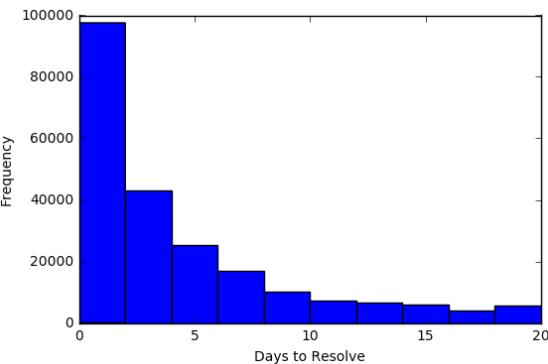


Figure 7. Histogram of number of days it took to resolve an issue

The values that are created after visualizing multiple histograms is resolution within: {<2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 40, 60, 80+} days.

Data Quantization

Average Hourly Temperature

This was used to categorize when the day is considered to be hot. As a guideline we use Environment Canada’s criteria for a heat warning which is when two or more consecutive days have forecasted daily maximums greater than or equal to 29°C and a minimum nighttime temperature of 14°C or higher.¹⁴ We then use the average of the guideline as $\text{floor}((29+14)/2) = 21$ to define ‘hot’. Therefore, if any temperature was $\geq 21^\circ\text{C}$ a value of ‘hot’ was given, otherwise no value is given.

Minimum Windchill

The windchill was categorized to the scale described by Environment Canada in Figure 8:

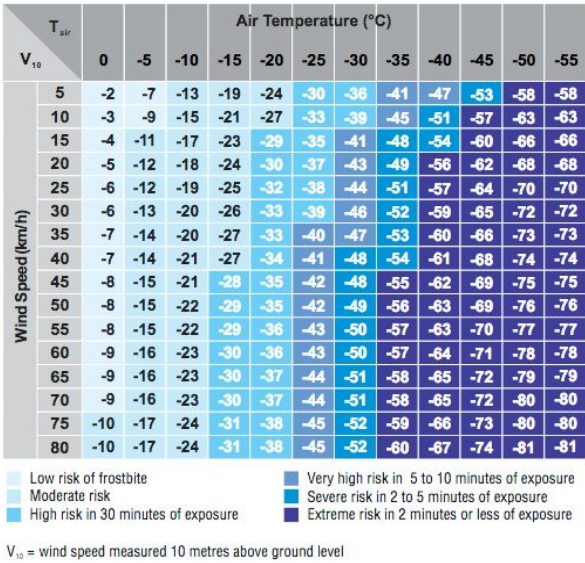


Figure 8. Scale used to calculate wind chill risk¹⁵

Precipitation

If there was any precipitation then it was indicated with a ‘yes’, otherwise no value is given.

Average Dew Point

The average dew point was categorized to a scale described by Wikipedia in Figure 9.

¹⁴ "Criteria for public weather alerts - Canada.ca." 8 Jun. 2017, <https://www.canada.ca/en/environment-climate-change/services/types-weather-forecasts-use/public/criteria-alerts.html>. Accessed 16 Dec. 2017.

¹⁵ "CANADA'S WIND CHILL INDEX." https://ec.gc.ca/meteo-weather/80B0F2AF-9697-4BEE-AB17-D401EBBA5B4B/WindChill_poster_EN.pdf. Accessed 16 Dec. 2017.

Dew Point	Human Perception
Over 26 °C	Severely high, even deadly for asthma related illnesses
24–26 °C	Extremely uncomfortable, oppressive
21–24 °C	Very humid, quite uncomfortable
18–21 °C	Somewhat uncomfortable for most people at upper edge
16–18 °C	OK for most, but all perceive the humidity at upper edge
13–16 °C	Comfortable
10–12 °C	Very comfortable
Under 10 °C	A bit dry for some

Figure 9. Scale for perceiving dew point¹⁶

It should be noted that since most days are dry, it is excluded from the data.

Health Index

The health index was categorized to the air quality index provided by Environment Canada in Figure 10.

Health Risk	Air Quality Health Index	Health Messages	
		At Risk Population*	General Population
Low	1 - 3	Enjoy your usual outdoor activities.	Ideal air quality for outdoor activities.
Moderate	4 - 6	Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.	No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High	7 - 10	Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High	Above 10	Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

Figure 10. Air Quality Health Index and Health Risk¹⁷

It should be noted that since “low” was very common, it is excluded from the data.

Max Wind Gust

This was categorized into three values: windy with direction, strong winds, windy.

Windy with direction was when max wind gust speeds exceeded 29 km/h. Windy occurred when a max wind gust value was measured. Strong winds were anything exceeding 40 km/h (based on the Beaufort Scale).¹⁸

Wind Gust Direction

Since the direction is given in degrees, the degrees were approximated to their cardinal directions: N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, NNW.

¹⁶ "Dew point - Wikipedia." https://en.wikipedia.org/wiki/Dew_point. Accessed 16 Dec. 2017.

¹⁷ "Understanding Air Quality Health Index messages - Canada.ca." 23 Nov. 2015. <https://www.canada.ca/en/environment-climate-change/services/air-quality-health-index/understanding-messages.html>. Accessed 22 Dec. 2017.

¹⁸ "Beaufort scale - Wikipedia." https://en.wikipedia.org/wiki/Beaufort_scale. Accessed 16 Dec. 2017.

Sunlight

Sunlight was discretized based on the histogram in Figure 11 of the value frequencies:

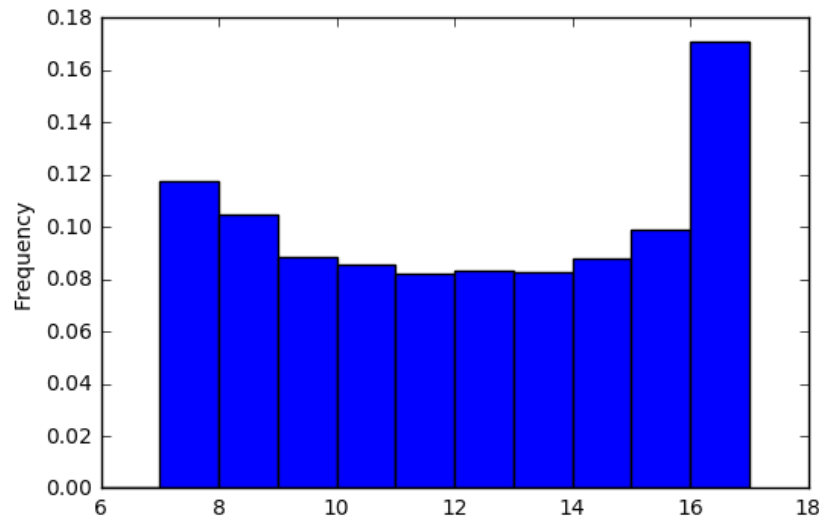


Figure 11. Histogram of sunlight frequencies

These were the resulting discretized values: <8, 8, 9, 10, 11, 12, 13, 14, 15, 16+

Data Binarization

All attributes need to be binarized in order to perform association rule mining. After binarizing the two datasets (date created and date closed), the resulting dataset sizes were:

- Creation date binarization: 291516 rows x 653 columns
- Closing date binarization: 290851 rows x 653 columns

Data Splitting

The datasets were further split into different datasets by wards and months. This was done because the results without splitting created too many rules and were not interpretable.

12 wards + Areas outside Edmonton

Splitting the datasets into the 12 wards of Edmonton was decided because it appears that more reports come from certain areas than others as seen in Figure 12. Therefore, it is interesting to find out what kind of associations may happen in specific areas of the city. It should be noted that some issues occurred in areas outside the city boundaries and were separated into the label 'nan'.

Reports Per Neighbourhood (2013-2017) Quintiles

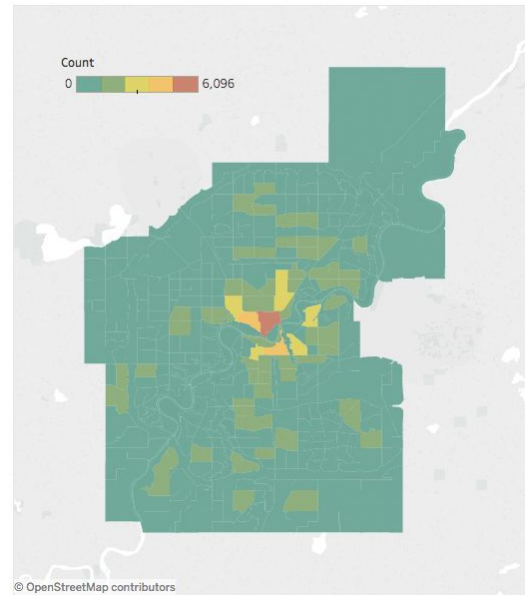


Figure 12. Amount of Reports Per Neighbourhood

12 months

The datasets were also split into 12 months after seeing the visualization in Figure 13.

Number of 311 Requests Per Month

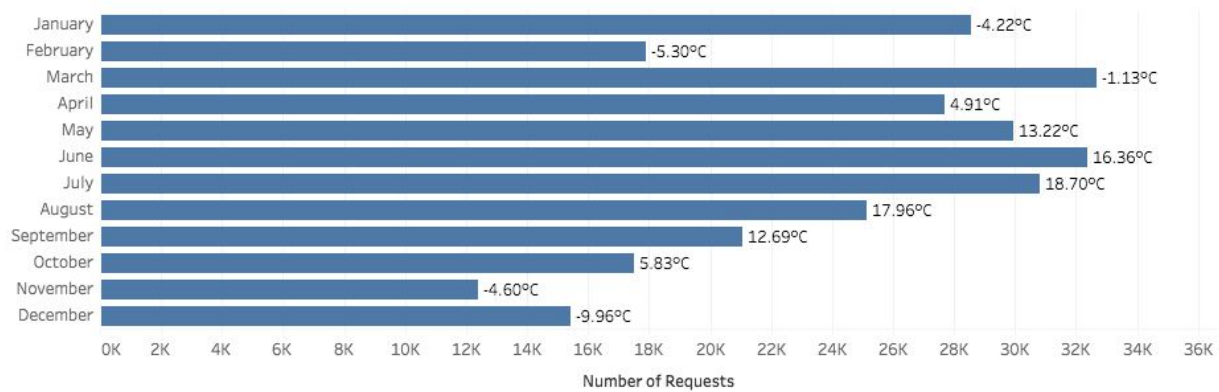


Figure 13. Amount of issues per month and the average temperature of each month

It can be seen that clearly more issues occur in certain months than other. It would be interesting to find out what kind of associations between weather and issues happen in these months.

Association Rule Mining

To determine minimum support multiple different values were tried and 1% was chosen since it produced a good amount of rules to process as seen in Figure 14.

Minimum Support	Average File Size (approx)	Average # of Rules (approx)	Average Processing Time (approx)
5%	5Kb	100	< 1s
2.5%	20Kb	300	< 1s
1%	500Kb	4000	< 1s
0.05%	40Mb	160 000	~ 1.5s

Figure 14. Average performance of FPGrowth with different parameters for each subset

Minimum confidence was set at 50% since the rule should at least be found at least 50% of the time. Minimum lift was set to 1 since any rule greater than 1 is considered interesting. The antecedent (left hand side) and consequent (right hand side) of the rules were also limited to a maximum size of 5 and 1. This is because having more than one consequent makes interpreting rules more difficult. In addition, by limiting the antecedent and consequent, the search space is limited and computation time is improved.

Results

Because of the significant amount of results, the top 3 non-redundant rules based on lift for each ward and each month were chosen to be shown in appendices D,E,F,G.

Interpretation of Results

First, we refer back to the research questions posed and answer them from the perspective of the city when issues are created and the perspective of a citizen when issues are closed. We answer the questions using appendices D,E,F,G.

Can highly frequent issues be associated to specific locations?

We specifically look at the association rules mined from the data split by wards to answer this question.

From the perspective of the city when issues are created, we can see that potholes have high lift associations in the wards. There is also high lift associations for abandoned vehicles in wards 1,2,3,4,9, and 11. Although potholes may not be very interesting, it is clear that abandoned vehicles do not occur as often in wards 5,6,7,8,10 and 12. This is interesting because the city can use this information to send out more bylaw officers to enforce parking the wards where abandoned vehicles occur more often. Furthermore, abandoned vehicles that occur in the wards can also explain other phenomenon. For instance, by looking at the population of the City of Edmonton and a map of the wards in Edmonton (Figure 15). It is clear that abandoned vehicles occur more frequently in areas that are less populated.

So perhaps, people may be leaving their vehicles on the street as they assume that nobody would be checking.

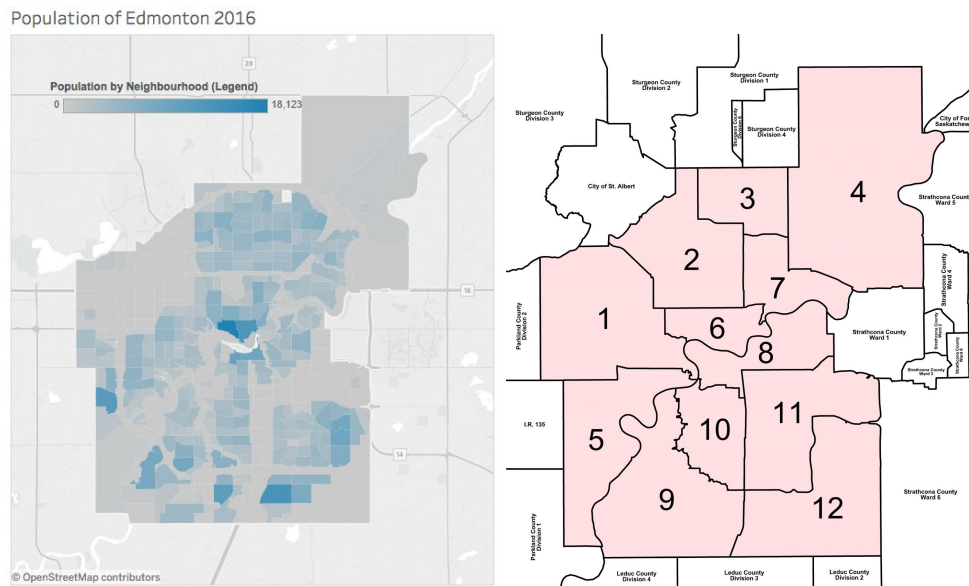


Figure 15. Edmonton population and ward boundaries

From the perspective of a citizen when issues are closed, it appears that potholes are resolved within 2 days which is good to hear. It also appears that once citizens are notified of their abandoned vehicles, it is removed within 2 days. This supports the theory that people are leaving their vehicles on the street because they assume that there will be no parking enforcement in these wards.

Can highly frequent issues be associated to specific times?

We look at the association rules mined from the dataset split by months to answer this question.

From the perspective of the city when issues are created, it appears that there is association with requests being created anytime a city meeting occurs. This is interesting as it seems like citizens become more aware of issues and would like to report them when a city meeting occurs. This may be because of the media which often publicizes what happens in city meetings. Another interesting association rule to note is that in March, there is a high lift with requests being made during a holiday. This may be because of the upcoming Spring and the fact that it is the Easter holiday where people start going outside and begin to notice issues around their neighborhood.

From the perspective of a citizen when issues are closed, it also appears that there is high lift association with issues being closed when the city holds meetings. Perhaps this is due to the fact that citizens may be reporting issues to bring up at the city meetings and the issues are resolved when the

day of the meetings occur. Another thing to note is that in March there is high lift association with issues being closed during the holidays. This is likely attributed to the fact that more issues are being created during the Easter holiday explained earlier by people noticing more issues when going outside.

Can weather be associated with certain kinds of issues in terms of time?

Weather attributes appear in the association rules from both datasets. However, weather appears to have more associations in the dataset split by months than the dataset split by wards.

From the perspective of the city when issues are created, it appears that association rules for abandoned vehicles occur in the warmer months from March until August. Then there is a change of association rules for snow removal in the winter months. We also see much more association rules for potholes from September until February. This suggests that the city should be sending out more crews to deal with potholes and snow removal from September until February and sending out more bylaw enforcement for finding abandoned vehicles from March until August.

From the perspective of a citizen when issues are closed, we can see an association rule in June where it took 60-80 days to resolve an issue. This means that there are indeed issues that may not be able to be solved until summer weather occurs. However, it is difficult to determine what the issue is from just the association rule.

Conclusion

In this project, association rule mining was performed using the FPGrowth algorithm to gain insights on Edmonton's 311 data. First, data cleaning was performed in order to integrate the 311 dataset, weather dataset, holiday dataset and meetings dataset. Then data integration was performed and a large portion of the project's time was spent determining the task relevant data in the integrated dataset. Next, association rules were generated on the two split datasets based on ward and months. From the rules generated, we find interesting associations of vehicle abandonment in less populated wards. Furthermore, we see spikes in issues when the Easter holiday occurs or when the city holds council meetings. Finally, we see associations with weather as potholes and snow removal occurs in the colder months and vehicle abandonment occurs in the warmer months.

Appendix A: Attributes and Descriptions of 311 Data

Reference Number	The unique identifier (number) for the service request.
Date Created	The date the service request was submitted.
Date Closed	The date the service request was acted upon. The appropriate City department has investigated the concern and identified steps to resolve your request. Action for resolving the issue may be deferred as work may be dependent on priority and weather conditions or your issue has been closed due to lack of information including contact details.
Request Status	Status of the request. It can be either Open or Closed. Open means the service request has been received and assigned to the appropriate City area for review and action. Response times can be dependent on several factors including weather conditions, availability of resources and assessed priority of the work required. Closed means the appropriate City area has investigated your concern and has taken the necessary action to resolve your request. Please call 311 if further information is required.
Status Detail	Certain request types may include additional details describing the progress or action associated with the request.
Service Category	The type of activity or service request.
Service Code	Provides a general description of the service request.
Business Unit	The business area that is responsible for the service
Neighbourhood	The City neighbourhood where the service request is located.
Community League	The Community League associated with the location of the service. (If applicable)
Ward	The City Ward associated with the location.
Address	The location of the service request.
Lat	Horizontal Geographic Coordinate
Long	Vertical Geographic Coordinate
Location	Spatial coordinates for the location of the issue that has been identified.
Ticket Source	The channel or method in which the service request was initiated. Examples will include telephone, 311 app or email.
Calendar Year	Year when Service Ticket was created.
Count	Number of service requests - usually 1. To be used for reporting purposes.
Posse_Number	Unique Identifier generated by POSSE
Transit_Ref_Number	A ticket number from any Transit application

Appendix B: Attributes and Descriptions of Meeting Data

MEETING_ID	Primary Key / Unique meeting identifier
MEETING_TYPE	Name of Committee or the type of Council Meeting
RECORD_TYPE	Indicates whether the Agenda or Minutes are available for this meeting
MEETING_DATE	Date of meeting
MEETING_TIME	Time for start of meeting
MEETING_LOCATION	Location of Meeting

Appendix C: Attributes and Descriptions of Weather Data

date	Date of the weather data.
max_temperature	Maximum temperature reached in the day.
avg_temperature	The average between the daily maximum temperature and the daily minimum temperature.
avg_hourly_temperature	The average of all the hourly temperatures within the day.
min_temperature	Minimum temperature reached in the day.
max_humidex	An index number used by to describe how hot the weather feels to the average person
min_windchill	The lowest perceived decrease in air temperature felt by the body on exposed skin due to the flow of air
max_relative_humidity	Highest ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature.
avg_relative_humidity	Average ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature.
min_relative_humidity	Lowest ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature.

max_dew_point	The highest temperature to which air must be cooled to become saturated with water vapor
avg_dew_point	The average temperature to which air must be cooled to become saturated with water vapor
min_dew_point	The lowest temperature to which air must be cooled to become saturated with water vapor
max_wind_speed	The highest speed of motion of air in kilometres per hour (km/h) usually observed at 10 metres above the ground.
avg_wind_speed	The average of motion of air in kilometres per hour (km/h) usually observed at 10 metres above the ground.
min_wind_speed	The lowest speed of motion of air in kilometres per hour (km/h) usually observed at 10 metres above the ground.
max_wind_gust	The speed in kilometres per hour (km/h) of the maximum wind gust during the day.
wind_gust_dir_10s	The direction of the maximum gust (in degrees) from which the wind blows. This value is only reported if the maximum gust speed for the day exceeds 29 km/h.
max_pressure_sea	The maximum sea level pressure recorded out of all stations.
avg_pressure_sea	The atmospheric pressure at mean sea level usually determined from the observed station pressure. Mean sea level pressure is computed from the station pressure and reported so that the barometric pressures at stations of different elevations can be compared at a common level for analysis purposes.
min_pressure_sea	The minimum sea level pressure recorded out of all stations.
max_pressure_station	The maximum atmospheric pressure in kilopascals (kPa) at the station elevation out of all stations.
avg_pressure_station	The average atmospheric pressure in kilopascals (kPa) at the station elevation out of all stations.
min_pressure_station	The minimum atmospheric pressure in kilopascals (kPa) at the station elevation out of all stations.
max_visibility	Maximum visibility in kilometres (km) is the distance at which objects of suitable size can be seen and identified.
avg_visibility	Average visibility in kilometres (km) is the distance at which objects of suitable size can be seen and identified.
min_visibility	Minimum visibility in kilometres (km) is the distance at which objects of suitable size can be seen and identified.
max_health_index	Maximum air quality health index.
avg_health_index	Average air quality health index.
min_health_index	Minimum air quality health index.
heatdegdays	Each degree Celsius that the daily mean temperature departs below the baseline of 18 degrees Celsius. It is used to estimate energy requirements and is an indication of fuel consumption.
cooldegdays	Each degree Celsius that the daily mean temperature departs above the baseline of 18 degrees Celsius. It is used to estimate energy requirements and is an indication of fuel consumption.
growdegdays_5	Measure of heat accumulation used by horticulturists, gardeners, and farmers to predict plant and animal development rates using 5 degrees as its base
growdegdays_10	Measure of heat accumulation used by horticulturists, gardeners, and farmers to predict plant and animal development rates using 10 degrees as its base
precipitation	The amount of rain/snow/etc received. Snow is melted to create a water equivalent. 1cm snow is approx 1mm of precipitation, but the exact amount depends on the snow density (eg corn snow vs light fluffy snow).
rain	The amount of precipitation, not including snow. Measured in mm.
snow	The amount of snow. Measured in cm.
snow_on_ground	Amount of snow measured from the ground.
sunrise	Time of sunrise.
sunset	Time of sunset.
sunlight	Amount of sunlight (hours) from sunrise until sunset.
sunrise_f	Hours from midnight of previous day until sunrise.
sunset_f	Hours from midnight of previous day until sunset.
min_uv_forecast	The lowest UV (ultraviolet) index recorded for the day. Used to estimate amount of protection needed from sun's UV rays.
max_uv_forecast	The highest UV (ultraviolet) index recorded for the day. Used to estimate amount of protection needed from sun's UV rays.
min_high_temperature_forecast	The minimum highest temperature forecasted.
max_high_temperature_forecast	The maximum highest temperature forecasted.
min_low_temperature_forecast	The minimum lowest temperature forecasted.
max_low_temperature_forecast	The maximum lowest temperature forecasted.
solar_radiation	Amount of radiation measured.
max_cloud_cover_4	Maximum cloud cover measured on a scale of 4 (https://www.weatherstats.ca/faq/#cloud_cover).
avg_cloud_cover_4	Average cloud cover measured on a scale of 4 (https://www.weatherstats.ca/faq/#cloud_cover).

min_cloud_cover_4	Minimum cloud cover measured on a scale of 4 (https://www.weatherstats.ca/faq/#cloud_cover).
max_cloud_cover_8	Maximum cloud cover measured on a scale of 8 (https://www.weatherstats.ca/faq/#cloud_cover).
avg_cloud_cover_8	Average cloud cover measured on a scale of 8 (https://www.weatherstats.ca/faq/#cloud_cover).
min_cloud_cover_8	Minimum cloud cover measured on a scale of 8 (https://www.weatherstats.ca/faq/#cloud_cover).
max_cloud_cover_10	Maximum cloud cover measured on a scale of 10 (https://www.weatherstats.ca/faq/#cloud_cover).
avg_cloud_cover_10	Average cloud cover measured on a scale of 10 (https://www.weatherstats.ca/faq/#cloud_cover).
min_cloud_cover_10	Minimum cloud cover measured on a scale of 10 (https://www.weatherstats.ca/faq/#cloud_cover).

Appendix D: Top 3 Association Rules for Each Ward When Issues are Created

Rule	Support	Confidence	Lift	Ward
{Service Code_Abandoned Vehicle} → {Status Detail_Citizen Complied}	0.2095	0.5286	30.3456	1
{Ticket Source_Posse Auto, Days to Resolution_[0, 2]} → {Service Code_Safety & Other}	0.1989	0.6995	25.2054	1
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.2890	0.6933	21.1272	1
{Service Code_Abandoned Vehicle} → {Status Detail_Citizen Complied}	0.2401	0.5180	35.3365	2
{Status Detail_Vehicle Gone Upon Arrival} → {Service Code_Safety & Other}	0.2369	0.6032	21.4201	2
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.4682	0.7494	20.6680	2
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]} → {Status Detail_Citizen Complied}	0.1437	0.7625	32.6178	3
{Service Code_Pothole, max_wind_gust Created_windy_direction} → {Ticket Source_Web Form}	0.1401	0.7854	24.9662	3
{Service Code_Pothole, MEETING_TYPE Created_Committee} → {Ticket Source_Web Form}	0.1220	0.7613	24.1981	3
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]} → {Status Detail_Citizen Complied}	0.1991	0.7380	31.4708	4
{Service Code_Pothole, MEETING_TYPE Created_Committee} → {Ticket Source_Web Form}	0.1810	0.7266	22.7437	4
{Ticket Source_Web Form, precipitation Created_yes} → {Service Code_Pothole}	0.1767	0.9951	22.0259	4
{Service Code_Abandoned Vehicle} → {Status Detail_Citizen Complied}	0.1786	0.5879	34.6311	5
{Ticket Source_Posse Auto, Days to Resolution_[0, 2]} → {Service Code_Safety & Other}	0.1720	0.7357	26.3120	5
{Service Code_Pothole, precipitation Created_yes} → {Ticket Source_Web Form}	0.1669	0.6849	24.1131	5
{Service Code_Pothole, sunlight Created_16+} → {Ticket Source_Web Form}	0.2922	0.8372	22.8998	6
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.3977	0.7668	20.9746	6
{Service Code_Pothole, max_wind_gust Created_strong_winds} → {Ticket Source_Web Form}	0.2549	0.7169	19.6089	6
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.2664	0.8007	28.2988	7
{Ticket Source_Web Form, precipitation Created_yes} → {Service Code_Pothole}	0.1849	1	26.1661	7
{Ticket Source_Web Form, max_wind_gust Created_windy_direction} → {Service Code_Pothole}	0.1953	1	26.1661	7
{Status Detail_Vehicle Gone Upon Arrival, Days to Resolution_[0, 2]} → {Service Code_Safety & Other}	0.2962	0.5588	20.6509	8
{Service Code_Pothole, sunlight Created_16+} → {Ticket Source_Web Form}	0.3585	0.8116	18.9331	8
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.4650	0.7862	18.3392	8
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]} → {Status Detail_Citizen Complied}	0.1729	0.7525	28.2223	9
{Service Code_Pothole} → {Ticket Source_Web Form}	0.3258	0.6900	27.9454	9
{Service Code_Road Snow Removal, Day of Week Request Created_Thursday, max_wind_gust Created_windy_direction, sunlight Created_8} → {wind_gust_dir_10s Created_W}	0.2067	0.9914	12.9524	9
Service Code_Pothole, sunlight Created_16+} → {Ticket Source_Web Form}	0.2393	0.8555	17.6954	10
{Service Code_Pothole, max_wind_gust Created_strong_winds} → {Ticket Source_Web Form}	0.3151	0.7628	15.7770	10
Service Code_Pothole, MEETING_TYPE Created_Committee} → {Ticket Source_Web Form}	0.3121	0.75	15.5115	10
{Service Code_Abandoned Vehicle} → {Ticket Source_Posse Auto}	0.2404	0.6384	29.3636	11
{Service Code_Pothole, sunlight Created_16+} → {Ticket Source_Web Form}	0.3224	0.8316	16.3372	11
{Service Code_Pothole, Day of Week Request Created_Wednesday} → {Ticket Source_Web Form}	0.2221	0.7027	13.8059	11
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.1550	0.8202	30.7919	12
{Service Code_Pothole, max_wind_gust Created_windy_direction} → {Ticket Source_Web Form}	0.1785	0.6949	26.08604	12
{Service Code_Pothole, precipitation Created_yes} → {Ticket Source_Web Form}	0.1594	0.6931	26.0209	12
Ticket Source_Telephone call, Day of Week Request Created_Monday, wind_gust_dir_10s Created_SSE, sunlight Created_15} → {MEETING_TYPE Created_Hearing/Committee}	0.0010	0.8888	24.5777	nan

{Service Code_Pothole, Days to Resolution_[0, 2], sunlight Created_14} → {Ticket Source_Web Form}	0.0007	1	23.0416	nan
{Service Code_Pothole, Days to Resolution_[0, 2], precipitation Created_yes} → {Ticket Source_Web Form}	0.0014	0.9166	21.1215	nan

Appendix E: Top 3 Association Rules for Each Ward When Issues are Closed

Rule	Support	Confidence	Lift	Ward
{Service Code_Abandoned Vehicle} → {Status Detail_Citizen Complied}	0.2142	0.5286	30.2669	1
Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.2954	0.6933	21.0724	1
{Service Code_Pothole, max_wind_gust Closed_windy_direction} → {Ticket Source_Web Form}	0.2073	0.6751	20.5186	1
{Service Code_Abandoned Vehicle} → {Status Detail_Citizen Complied}	0.2555	0.5189	35.3189	2
Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.4983	0.7494	20.7390	2
{Service Code_Pothole, MEETING_TYPE Closed_Committee} → {Ticket Source_Web Form}	0.3367	0.7044	19.4953	2
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]} → {Status Detail_Citizen Complied}	0.0817	0.7625	32.5238	3
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.1293	0.7590	24.1058	3
{Service Code_Pothole, MEETING_TYPE Closed_Committee} → {Ticket Source_Web Form}	0.0796	0.7490	23.7882	3
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]} → {Status Detail_Citizen Complied}	0.1095	0.7380	31.3506	4
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.1622	0.7200	22.4876	4
{Ticket Source_Web Form, max_wind_gust Closed_windy_direction} → {Service Code_Pothole}	0.0996	1.0000	22.0751	4
{Status Detail_Citizen Complied} → {Service Code_Abandoned Vehicle}	0.1958	0.6993	34.5811	5
{Ticket Source_Web Form, MEETING_TYPE Closed_Committee} → {Service Code_Pothole}	0.1674	1.0000	23.8082	5
{Ticket Source_Telephone call, Day of Week Request Closed_Thursday, min_windchill Closed_moderate, sunlight Closed_9} → {Days to Resolution_(60, 80]}	0.1866	0.5217	13.3203	5
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.4975	0.7668	20.9163	6
{Service Code_Pothole, sunlight Closed_16+} → {Ticket Source_Web Form}	0.3137	0.7271	19.8317	6
{Service Code_Pothole, precipitation Closed_yes} → {Ticket Source_Web Form}	0.4061	0.7067	19.2767	6
Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.3650	0.8007	28.2374	7
{Service Code_Abandoned Vehicle} → {Ticket Source_Posse Auto}	0.3233	0.7534	28.0589	7
{Ticket Source_Telephone call, Days to Resolution_[0, 2], min_windchill Closed_high} → {sunlight Closed_<8}	0.2600	0.6082	7.9051	7
{Ticket Source_Posse Auto, Days to Resolution_[0, 2]} → {Service Code_Safety & Other}	0.4035	0.5977	22.0429	8
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.5502	0.7862	18.3168	8
{Service Code_Pothole, sunlight Closed_16+} → {Ticket Source_Web Form}	0.3455	0.7500	17.4731	8
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]} → {Status Detail_Citizen Complied}	0.2676	0.7526	28.1489	9
{Ticket Source_Web Form} → {Service Code_Pothole}	0.5032	0.9982	27.9077	9
{Ticket Source_Telephone call, Day of Week Request Closed_Thursday, min_windchill Closed_moderate, max_wind_gust Closed_windy_direction, sunlight Closed_8} → {wind_gust_dir_10s Closed_W}	0.2218	0.8996	14.5715	9
{max_wind_gust Closed_windy_direction, wind_gust_dir_10s Closed_NNW, sunlight Closed_13} → {min_windchill Closed_low}	0.2765	0.9587	42.9942	10
{Service Code_Pothole, sunlight Closed_15} → {Ticket Source_Web Form}	0.2000	0.7730	15.9751	10
{Day of Week Request Closed_Thursday, min_windchill Closed_low, max_wind_gust Closed_windy_direction, sunlight Closed_13} → {wind_gust_dir_10s Closed_NNW}	0.2766	1.0000	15.8472	10
{Service Code_Abandoned Vehicle} → {Ticket Source_Posse Auto}	0.2699	0.6385	29.3224	11
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.5326	0.7822	15.3438	11
{Service Code_Pothole, sunlight Closed_16+} → {Ticket Source_Web Form}	0.2601	0.7080	13.8897	11
{Service Code_Pothole, Days to Resolution_[0, 2]} → {Ticket Source_Web Form}	0.1604	0.8203	30.7166	12
{Service Code_Abandoned Vehicle, Ticket Source_MobileApp, Days to Resolution_(2, 4]} → {Status Detail_Citizen Complied}	0.1865	0.7695	18.6525	12
{Status Detail_Enforcement Action Taken, Days to Resolution_[0, 2]} → {Service Code_Safety & Other}	0.2144	0.7677	11.6997	12
{Service Code_Pothole, Days to Resolution_[0, 2], sunlight Closed_14} → {Ticket Source_Web Form}	0.0004	1.0000	23.0000	nan
{Ticket Source_Telephone call, sunlight Closed_16+, MEETING_TYPE Closed_Hearing/Committee} → {Days to Resolution_(60, 80]}	0.0005	0.5833	21.4667	nan
{Service Code_Pothole, Day of Week Request Closed_Monday, avg_dew_point Closed_very humid} → {MEETING_TYPE Closed_Hearing/Committee}	0.0004	1.0000	20.4444	nan

Appendix F: Top 3 Association Rules for Each Month When Issues are Created

Rule	Support	Confidence	Lift	Month
{Ticket Source_Telephone call, Day of Week Request Created_Tuesday, wind_gust_dir_10s Created_NW, MEETING_TYPE Created_Council/Committee} → {max_wind_gust Created_windy}	0.0696	1.0000	44.9182	1
{Service Code_Road Snow Removal, Day of Week Request Created_Monday, min_windchill Created_moderate, sunlight Created_8} → {MEETING_TYPE Created_Hearing/Committee}	0.0702	0.6571	14.7357	1

{Ticket Source_Telephone call, Day of Week Request Created_Tuesday, wind_gust_dir_10s Created_NW}→{max_wind_gust Created_windy}	0.0696	0.7149	13.9699	1
{max_wind_gust Created_windy_direction, avg_health_index Created_moderate, sunlight Created_10}→{wind_gust_dir_10s Created_NNE}	0.0510	1.0000	53.1662	2
{Service Code_Pothole, precipitation Created_yes, sunlight Created_10, MEETING_TYPE Created_Committee}→{Ticket Source_Web Form}	0.0278	0.7797	23.1278	2
{Day of Week Request Created_Thursday, max_wind_gust Created_strong_winds}→{min_windchill Created_low}	0.0690	0.8507	22.9561	2
Day of Week Request Created_Tuesday, min_windchill Created_moderate, max_wind_gust Created_strong_winds, wind_gust_dir_10s Created_SE, sunlight Created_12}→	0.0631	1.0000	66.1680	3
{Day of Week Request Created_Friday, avg_health_index Created_moderate, precipitation Created_yes, sunlight Created_12}→{Holidays Created_True}	0.0932	1.0000	57.9557	3
{Ticket Source_Posse Auto, Days to Resolution_[0, 2]}→{Service Code_Safety & Other}	0.0724	0.6946	24.2838	3
Day of Week Request Created_Monday, avg_health_index Created_moderate, sunlight Created_13}→{wind_gust_dir_10s Created_NNE}	0.0749	1.0000	53.9630	4
{Day of Week Request Created_Monday, wind_gust_dir_10s Created_SSW, sunlight Created_13, MEETING_TYPE Created_Committee}→{max_wind_gust Created_windy}	0.0410	1.0000	42.4586	4
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]}→{Status Detail_Citizen Complied}	0.0542	0.8337	32.6906	4
{avg_hourly_temperature Created_hot, precipitation Created_yes, sunlight Created_16+}→{wind_gust_dir_10s Created_SW}	0.0946	1.0000	47.8227	5
{Ticket Source_Telephone call, Day of Week Request Created_Monday, wind_gust_dir_10s Created_ESE, sunlight Created_16+}→{MEETING_TYPE Created_Hearing}	0.0802	1.0000	41.2924	5
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]}→{Status Detail_Citizen Complied}	0.0793	0.8224	34.7755	5
{Day of Week Request Created_Wednesday, max_wind_gust Created_windy_direction, wind_gust_dir_10s Created_W}→{MEETING_TYPE Created_Hearing}	0.0792	1.0000	45.3885	6
{Service Code_Abandoned Vehicle}→{Status Detail_Citizen Complied}	0.0708	0.6320	31.2239	6
{Service Code_Pothole, max_wind_gust Created_strong_winds, precipitation Created_yes, sunlight Created_16+}→{Ticket Source_Web Form}	0.0536	0.9674	26.7341	6
{Day of Week Request Created_Monday, avg_hourly_temperature Created_hot, avg_dew_point Created_very humid, max_wind_gust Created_windy_direction}→{MEETING_TYPE Created_Hearing/Committee}	0.0421	1.0000	56.9464	7
{avg_dew_point Created_very humid, max_wind_gust Created_windy, wind_gust_dir_10s Created_N, sunlight Created_16+}→{MEETING_TYPE Created_Hearing}	0.0574	1.0000	45.5066	7
Service Code_Abandoned Vehicle, sunlight Created_16+}→{Status Detail_Citizen Complied}	0.0467	0.6110	29.5980	7
{Ticket Source_Telephone call, avg_hourly_temperature Created_hot, wind_gust_dir_10s Created_S, sunlight Created_14}→{avg_dew_point Created_ok}	0.0782	1.0000	34.7911	8
{Day of Week Request Created_Thursday, max_wind_gust Created_strong_winds, sunlight Created_15, MEETING_TYPE Created_Committee}→{wind_gust_dir_10s Created_NE}	0.0719	1.0000	33.7638	8
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]}→{Status Detail_Citizen Complied}	0.0736	0.8445	32.3821	8
{max_wind_gust Created_windy_direction, precipitation Created_yes, sunlight Created_12, MEETING_TYPE Created_Committee}→{wind_gust_dir_10s Created_ENE}	0.1176	1.0000	52.5312	9
{Ticket Source_Telephone call, Day of Week Request Created_Tuesday, max_wind_gust Created_windy_direction, sunlight Created_12}→{MEETING_TYPE Created_Council/Committee}	0.1058	0.6935	48.2098	9
{Service Code_Pothole, MEETING_TYPE Created_Committee}→{Ticket Source_Web Form}	0.0994	0.9359	29.0349	9
{Day of Week Request Created_Tuesday, max_wind_gust Created_windy_direction, precipitation Created_yes, sunlight Created_10}→{wind_gust_dir_10s Created_ENE}	0.1041	0.6865	33.6359	10
{Service Code_Pothole, Days to Resolution_[0, 2]}→{Ticket Source_Web Form}	0.1070	0.9355	27.7818	10
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4]}→{Status Detail_Citizen Complied}	0.1385	0.7364	22.3625	10
{max_wind_gust Created_strong_winds, precipitation Created_yes, sunlight Created_8}→{wind_gust_dir_10s Created_NE}	0.0263	0.5320	41.7441	11
{Service Code_Pothole, sunlight Created_8}→{Ticket Source_Web Form}	0.0225	0.7584	41.6061	11
{Ticket Source_Telephone call, Days to Resolution_[0, 2], Day of Week Request Created_Tuesday, wind_gust_dir_10s Created_NNW, MEETING_TYPE Created_Council}→{max_wind_gust Created_windy}	0.0232	1.0000	37.3434	11
Ticket Source_Telephone call, Day of Week Request Created_Tuesday, max_wind_gust Created_strong_winds, precipitation Created_yes}→{wind_gust_dir_10s Created_SW}	0.0206	1.0000	67.1522	12
{min_windchill Created_high, wind_gust_dir_10s Created_SSE}→{max_wind_gust Created_windy}	0.0257	1.0000	60.3320	12
{Service Code_Road Blocked By Snow, max_wind_gust Created_strong_winds, precipitation Created_yes, MEETING_TYPE Created_Council}→{wind_gust_dir_10s Created_NNW}	0.0246	1.0000	14.3275	12

Appendix G: Top 3 Association Rules for Each Month When Issues are Closed

Rule	Support	Confidence	Lift	Month
{Day of Week Request Closed_Tuesday, wind_gust_dir_10s Closed_NW, MEETING_TYPE Closed_Council/Committee}→{max_wind_gust Closed_windy}	0.0419	1.0000	51.1593	1
{Service Code_Pothole, min_windchill Closed_moderate}→{Ticket Source_Web Form}	0.0392	0.5306	38.2434	1
{max_wind_gust Closed_windy, wind_gust_dir_10s Closed_NW}→{MEETING_TYPE Closed_Council/Committee}	0.0419	1.0000	21.7005	1
{Day of Week Request Closed_Friday, min_windchill Closed_high, max_wind_gust Closed_windy_direction, precipitation Closed_yes, sunlight Closed_9}→{wind_gust_dir_10s Closed_E}	0.0307	1.0000	58.0256	2
{Ticket Source_Telephone call, Day of Week Request Closed_Tuesday, min_windchill Closed_high, precipitation Closed_yes}→{MEETING_TYPE	0.0343	0.7364	36.0541	2

Closed_Council}				
{Ticket Source_Telephone call, Day of Week Request Closed_Thursday, max_wind_gust Closed_windy_direction, MEETING_TYPE Closed_Committee}→{wind_gust_dir_10s Closed_SSE}	0.0300	0.7926	32.4824	2
{Day of Week Request Closed_Friday, avg_health_index Closed_moderate, precipitation Closed_yes, sunlight Closed_12}→{Holidays Closed_True}	0.0444	1.0000	85.1772	3
Days to Resolution_[0, 2], Day of Week Request Closed_Tuesday, max_wind_gust Closed_strong_winds, wind_gust_dir_10s Closed_SE, sunlight Closed_12}→{MEETING_TYPE Closed_Council/Committee}	0.0400	1.0000	48.2366	3
{Ticket Source_Posse Auto, Days to Resolution_(2, 4]}→{Service Code_Abandoned Vehicle}	0.0396	0.9514	34.8877	3
{Day of Week Request Closed_Monday, min_windchill Closed_moderate, max_wind_gust Closed_strong_winds, precipitation Closed_yes, sunlight Closed_13}→{wind_gust_dir_10s Closed_NNE}	0.0295	1.0000	92.9408	4
Ticket Source_Telephone call, Days to Resolution_(80, inf], Day of Week Request Closed_Wednesday, max_wind_gust Closed_strong_winds, wind_gust_dir_10s Closed_NNW}→{sunlight Closed_12}	0.0340	1.0000	44.7765	4
{Status Detail_Citizen Complied, Days to Resolution_(2, 4]}→{Service Code_Abandoned Vehicle}	0.0363	0.8698	34.1311	4
{Days to Resolution_[0, 2], Day of Week Request Closed_Wednesday, avg_hourly_temperature Closed_hot, precipitation Closed_yes}→{wind_gust_dir_10s Closed_SW}	0.0695	1.0000	45.0121	5
{Day of Week Request Closed_Monday, wind_gust_dir_10s Closed_ESE, sunlight Closed_16+}→{MEETING_TYPE Closed_Hearing}	0.1121	1.0000	44.6261	5
{Day of Week Request Closed_Friday, avg_health_index Closed_moderate, sunlight Closed_15}→{min_windchill Closed_low}	0.0673	0.5609	36.3929	5
{Day of Week Request Closed_Wednesday, avg_dew_point Closed_very humid, max_wind_gust Closed_strong_winds, MEETING_TYPE Closed_Committee}→{wind_gust_dir_10s Closed_WSW}	0.0411	1.0000	56.9875	6
{avg_dew_point Closed_very humid, max_wind_gust Closed_windy_direction, wind_gust_dir_10s Closed_W, precipitation Closed_yes, sunlight Closed_16+}→{MEETING_TYPE Closed_Hearing}	0.0509	1.0000	52.1122	6
{Service Code_Abandoned Vehicle, Days to Resolution_(2, 4], sunlight Closed_16+}→{Status Detail_Citizen Complied}	0.0438	0.8732	36.5982	6
{Day of Week Request Closed_Tuesday, max_wind_gust Closed_windy, wind_gust_dir_10s Closed_N}→{MEETING_TYPE Closed_Council/Committee}	0.0308	1.0000	98.1516	7
{Day of Week Request Closed_Thursday, max_wind_gust Closed_strong_winds, avg_health_index Closed_moderate, sunlight Closed_16+}→{wind_gust_dir_10s Closed_WSW}	0.0330	1.0000	50.0700	7
{avg_dew_point Closed_very humid, max_wind_gust Closed_strong_winds, wind_gust_dir_10s Closed_WSW, precipitation Closed_yes, sunlight Closed_16+}→{avg_health_index Closed_moderate}	0.0330	1.0000	40.6398	7
{Day of Week Request Closed_Monday, avg_dew_point Closed_very humid, max_wind_gust Closed_windy_direction, precipitation Closed_yes, sunlight Closed_14}	0.0532	1.0000	89.8836	8
{max_wind_gust Closed_windy_direction, sunlight Closed_15, MEETING_TYPE Closed_Committee}→{wind_gust_dir_10s Closed_ESE}	0.0499	1.0000	36.3500	8
{Day of Week Request Closed_Thursday, max_wind_gust Closed_strong_winds, sunlight Closed_15, MEETING_TYPE Closed_Committee}→{wind_gust_dir_10s Closed_NE}	0.0695	1.0000	35.1108	8
{Day of Week Request Closed_Friday, max_wind_gust Closed_windy_direction, precipitation Closed_yes, sunlight Closed_13}→{wind_gust_dir_10s Closed_SW}	0.1041	0.7179	66.6877	9
{Day of Week Request Closed_Tuesday, max_wind_gust Closed_windy_direction, wind_gust_dir_10s Closed_WSW}→{MEETING_TYPE Closed_Council/Committee}	0.1071	1.0000	62.1479	9
{Day of Week Request Closed_Monday, wind_gust_dir_10s Closed_NNE}→{MEETING_TYPE Closed_Council/Hearing/Committee}	0.1239	1.0000	53.4848	9
{Ticket Source_Telephone call, Day of Week Request Closed_Tuesday, max_wind_gust Closed_strong_winds, sunlight Closed_10, MEETING_TYPE Closed_Committee}→{wind_gust_dir_10s Closed_W}	0.1106	1.0000	41.0154	10
{Ticket Source_Telephone call, wind_gust_dir_10s Closed_S, precipitation Closed_yes}→{max_wind_gust Closed_windy}	0.1015	0.9677	39.4898	10
{Day of Week Request Closed_Tuesday, max_wind_gust Closed_windy_direction, precipitation Closed_yes, sunlight Closed_10}→{wind_gust_dir_10s Closed_ENE}	0.1030	0.6478	37.4511	10
{Day of Week Request Closed_Wednesday, min_windchill Closed_moderate, max_wind_gust Closed_windy_direction, precipitation Closed_yes}→{wind_gust_dir_10s Closed_NNE}	0.0289	1.0000	57.4980	11
{Ticket Source_Telephone call, Day of Week Request Closed_Tuesday, precipitation Closed_yes, sunlight Closed_8, MEETING_TYPE Closed_Council}→{max_wind_gust Closed_windy}	0.0293	1.0000	37.2839	11
{Service Code_Pothole, sunlight Closed_8}→{Ticket Source_Web Form}	0.0511	0.8060	25.1409	11
{Day of Week Request Closed_Friday, wind_gust_dir_10s Closed_SSE}→{max_wind_gust Closed_windy}	0.0359	1.0000	58.3835	12
{min_windchill Closed_moderate, wind_gust_dir_10s Closed_SE}→{MEETING_TYPE Closed_Hearing/Committee}	0.0442	1.0000	47.3517	12
{Ticket Source_Telephone call, Day of Week Request Closed_Friday, min_windchill Closed_moderate, avg_health_index Closed_moderate}→{MEETING_TYPE Closed_Committee}	0.0598	1.0000	10.7306	12