

# Mining Toronto Fire Services Incident Data

## CKME 136 Capstone Project

Prepared for Dr. Ceni Babaoglu  
Ryerson University  
by Geoffrey Clark  
July 14th, 2018

### Outline

- Data Preparation
  - Import Data
  - Data Description
- Initial Analysis
  - Univariate Analysis
  - Bivariate Analysis
  - Multivariate Analysis
- Exploratory Analysis
- Dimensionality Reduction
- Experimental Design
- Modeling
- Evaluation
- Improving the Model
- Conclusions

## Data Preparation

### Import Data

The Toronto Fire Services Incident Data was obtained from the Toronto Open Data Catalogue in May, 2018. Observations represent a single incident involving Toronto's Fire Services including Medical, Fire and other types of events. Time data includes the years 2011 through 2016 and is provided as XML documents with the following nested tree structure:

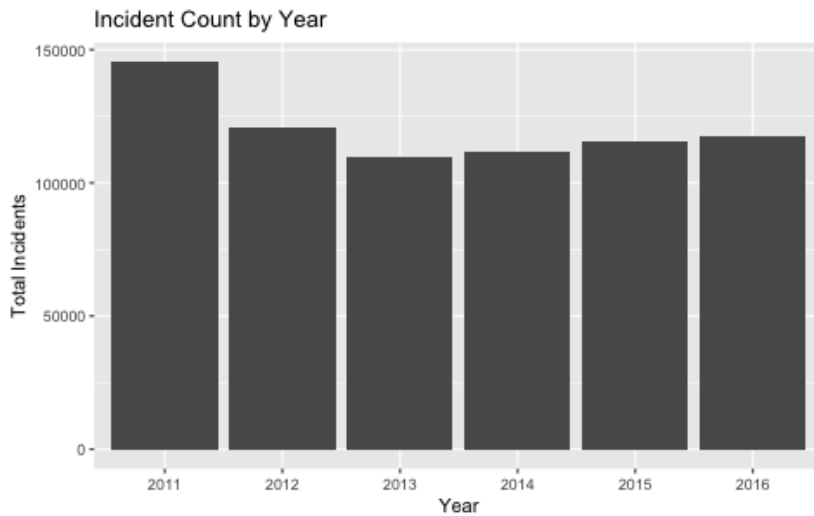
```
<?xml version="1.0" encoding="utf-8" standalone="yes"?>
<FIRE_DATA>
  <INCIDENT>
    <RespondingUnits>
    </RespondingUnits>
  </INCIDENT>
</FIRE_DATA>
```

The first step in this project was to convert the dataset to a usable rectangular structure. XQuery was used for the purpose of extracting INCIDENT observations from the XML documents as .CSV data tables for each year. The breakdown of INCIDENT observations by year is available in **Figure 1**. This

chart shows a consistent trend of 110,000 - 120,00 for all years in the data set except for 2011, the first year of the series, which is higher with around 145,000.

## Data Description

The INCIDENTS data set has the dimensions of 720,370 observations across 100 features. A detailed description of each individual feature is provided in Appendix-1. Generally speaking the majority of the variables are categorical and have been provided by the Office of the Fire Marshal's (OFFM) Standard Incident Report Codes List or the RMS System.



The features for all years are the same except for 2016 which includes an additional feature:

EVENT\_ALARM\_LEVEL. This feature corresponds to the highest alarm level of the event and, since is only available in 2016, was discarded for the use in this project.

*Figure 1*

# Initial Analysis

## Univariate Analysis

As mentioned in the Data Description the data set consists primarily of categorical features across approximately 100 features. The first task involves encoding the features in meaningful, useful way.

### Event Type & Property Type

Event types correspond to the type of incident being responded to. The 114 distinct event type levels can be assigned to 14 distinct groups (in descending order of incidents per group): Medical, Alarm, Vehicle, Fire, Carbon Monoxide, Rescue, Check Call, Utility, Natural Gas, Hazmat, Police Assist and Other.

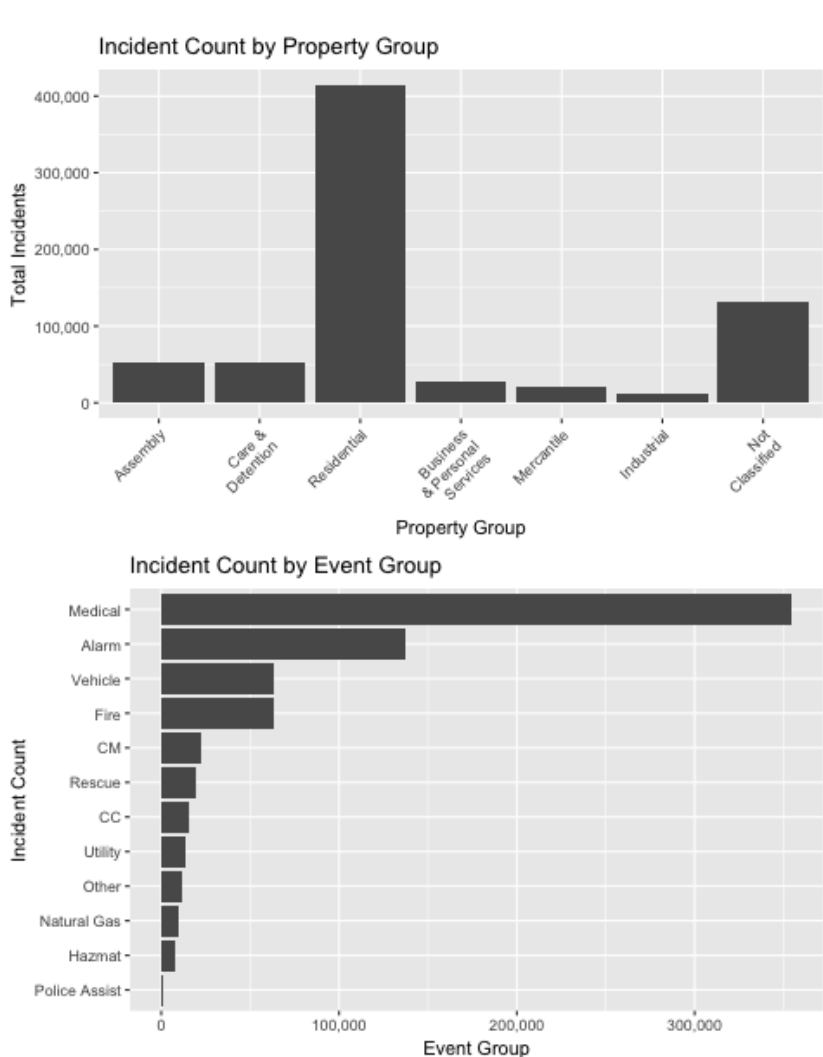


Figure 2

Interesting patterns can be observed from the dates and times. A breakdown of the INITIAL\_CALL\_HOUR is represented in Figure 3. It is observed that incident calls begin to be received around 8am and

Property types are encoded in the data set according to the OFM Standard Incident Report Codes List. The PROPERTY attribute itself includes 350 unique categorical variables with 9863 NA (1.37%). The OFM Standard Incident Report Codes list also includes 7 distinct category groupings for these categories: Assembly, Care & Detention, Residential, Business & Personal Services, Mercantile, Industrial and Other (Structures/Properties not classified by the Ontario Building Code). **Figure 2** displays Incident Count breakdowns by Property & Event Group.

### Date & Time

The data set includes several temporal features pertaining to the time of initial call, responding units' dispatch time, incident on scene arrival time and the corresponding dates. There is also date and time data pertaining to when control of the incident was obtained.

increase steadily until around 7pm where they begin to taper off and remain relatively low during the night. This could be attributed to reduced activity both at home, in the workplace and on roads.

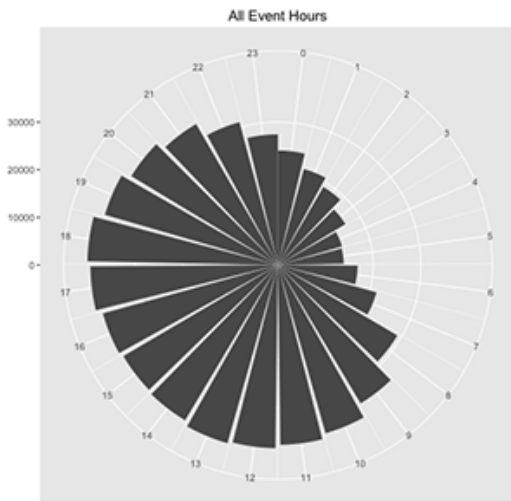


Figure 3

(Time-to-arrival) feature that is the difference between INITIAL\_CALL and ONSCENE times.

## Injuries and Fatalities

The data set includes counts of fatalities for both Fire Fighters and Civilians. However, the count of fire fighter fatalities is 0 for every observation and is thus dropped (low variance filter). There are 891 incidents that had one of the three remaining injury or fatality features: 213, 51 and 653 non-zero observations for fire fighter injuries, civilian fatalities and civilian injuries respectively. There is some overlap in

the data: the combinations of events

with two of the three features ranges from 5 to 18 but there are only two observed incidents that had non-zero entries for firefighter injury, civilian injury, and civilian fatality.

## Removing Features

ARRIVE\_DATE & FF\_FATALITIES are mentioned previously...

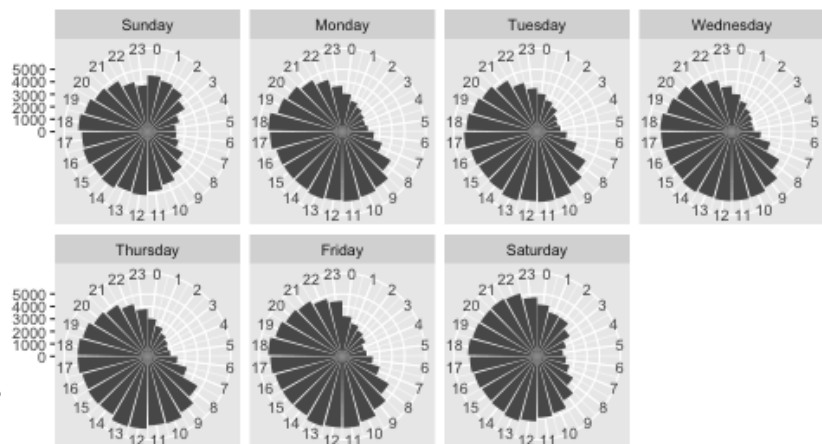
Some features in the data set are either redundant or not able to be used. These features are removed. An example of a redundant feature would be one of DISPATCH\_DATE and ARRIVE\_DATE: since these two features are identical there is no lost information by removing one. In this analysis ARRIVE\_DATE was arbitrarily chosen to be removed. FF\_FATALITIES is an aptly named feature which records the

**Figure 4** reveals a daily breakdown of all incident call

hours. It is observed that weekdays experience similar hourly call distributions as the aggregate but that the weekends, Saturday & Sunday, deviate from this norm and experience higher relative call volumes. This is most prominent in the relative call volumes on Sunday between the hours of Midnight and 3am. Such a deviation is perhaps attributed to a difference in activity and behaviour on weekends among individuals and groups.

The data set includes INITIAL\_CALL, DISPATCH, and ONSCENE times each encoded as HOUR, MIN and SEC as separate features. Combining these times with the

Daily breakdown of event hours



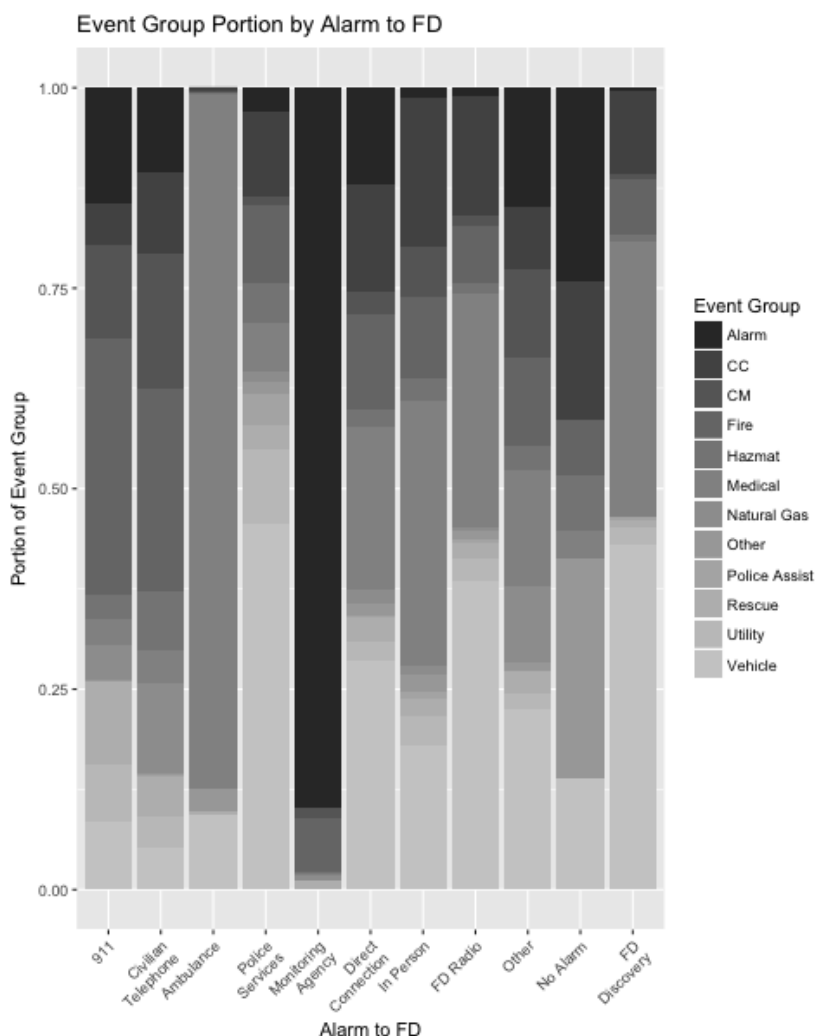
quantity of fire fighter fatalities which occurred during the incident. However, every observation is 0 and so this feature is dropped also.

A further questionable feature is FD\_STATION. This is reportedly the "Fire Department Station", however, the data is inconsistent. To begin with, there are 375,478 unique entries whereas the Toronto Website (<https://www.toronto.ca/community-people/public-safety-alerts/understanding-emergency-services/fire-station-locations/>) only lists 85 different Fire Stations. Further, in all but 30 observations this feature is either the INCIDENT\_NUMBER, the INCIDENT\_NUMBER padded with trailing zeroes, or simply zeroes. Accurate fire department station data would be useful for an analysis but since this column doesn't appear to contain such data it is safely dropped.

## Bivariate Analysis

### Alarm to Fire Department, Event Group

The Alarm to Fire Department feature, ALARM\_TO\_FD, describes from where the incident was reported. EVENT\_GROUP is a grouping of different types of event. The features are related in the sense that ALARM\_TO\_FD is the input source (911, Police, etc) whereas EVENT\_GROUP describes what type of incident the call turned out to be. Perhaps a reasonable expectation would be that certain types of calls correspond to certain types of events. **Figure 5** shows the portions of Event Type group by Call source.



To test the hypothesis that EVENT\_GROUP and ALARM\_TO\_FD are independent a Chi square test of independence was used. The test of hypothesis was as follows:

**H<sub>0</sub>:** EVENT\_GROUP and ALARM\_TO\_FD are independent

**H<sub>1</sub>:** EVENT\_GROUP and ALARM\_TO\_FD are dependent

The result of Pearson's Chi-Square test of independence concludes that there is statistically significant evidence to reject the null hypothesis that EVENT\_GROUP and ALARM\_TO\_FD are independent. This conclusion supports the notion that the source of incident call impacts the probability of incident type.

Figure 5

**Note:** I tried a few different settings using R, both shown below. I experimented with merging columns so that there were fewer 0s (notably in columns 10 & 11, both of which are similar categories. None of my attempts made much difference: if I set 'simulate.p.value' = T then degrees of freedom would be NA (df = NA). Alternatively, if I didn't set this parameter in the chisq.test() method call it returned a df = 121 but gave me a warning that the Chi-squared approximation may be incorrect. I am confused about this and then was informed, by Dr. Ceni, that this might have been an improper test to use in this scenario.

```
> chisq.test(table(I$EVENT_GROUP, I$ALARM_TO_FD), simulate.p.value = T)
```

Pearson's Chi-squared test with simulated p-value (based on 2000 replicates)

```
data: table(I$EVENT_GROUP, I$ALARM_TO_FD)
X-squared = 1091400, df = NA, p-value = 0.0004998
```

```
> chisq.test(table(I$EVENT_GROUP, I$ALARM_TO_FD))
```

Pearson's Chi-squared test

```
data: table(I$EVENT_GROUP, I$ALARM_TO_FD)
X-squared = 1091400, df = 121, p-value < 2.2e-16
```

Warning message:

```
In chisq.test(table(I$EVENT_GROUP, I$ALARM_TO_FD)) :
  Chi-squared approximation may be incorrect
```

```
> table(I$EVENT_GROUP, I$ALARM_TO_FD)
```

	1	2	3	4	5	6	7	8	9	10	11	<NA>
Alarm	21346	1748	128	605	113377	143	52	36	322	7	2	0
CC	7854	1698	1754	2219	129	162	725	503	171	5	45	1
CM	17199	2811	327	197	1545	33	246	42	238	0	3	0
Fire	47269	4171	315	1993	8439	143	395	235	241	2	31	0
Hazmat	4483	1227	690	1049	169	26	110	45	67	2	3	0
Medical	4964	697	344383	1270	431	241	1301	984	316	1	151	3
Natural Gas	6321	1849	60	256	810	22	39	16	206	0	0	0
Other	237	48	11088	293	74	18	85	33	22	8	0	0
Police Assist	221	24	15	803	4	1	39	15	2	0	2	0
Rescue	15205	850	1136	643	1156	37	86	65	60	0	4	0
Utility	10561	623	53	1924	63	29	143	96	42	0	10	0
Vehicle	12590	880	37338	9419	126	341	703	1293	490	4	189	0

- |  |  |   |
|--|--|---|
| 1 911                                      | 5 From Monitoring agency               | 9 Other alarm   |
| 2 Telephone From Civilian (other than 911) | 6 Direct Connection                    | 10 No alarm Received - No response                      |
| 3 From Ambulance                           | 7 Verbal Report to Station (in person) | 11 No alarm rcv'd - incident discovered by FD personnel |
| 4 From Police Services                     | 8 Two-way radio (fire department)      |   |

Table 1: ALARM\_TO\_FD Levels

## Event Group, Time to Arrival

The box plot in Figure 6 depicts Time to Arrival against Event Groups. This relationship might suggest different response times depending on the type of incident. All Event Group categories, save Medical, are statistically significant predictors of Time-to-arrival as displayed in the below linear model summary.

Call:  
lm(formula = TTA ~ EVENT\_GROUP, data = I)

Residuals:

Min	1Q	Median	3Q	Max
-973	-75	-18	46	82928

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	301.248	1.397	215.626	< 2e-16 ***
EVENT_GROUPCC	138.562	4.490	30.861	< 2e-16 ***
EVENT_GROUPCM	79.791	3.721	21.441	< 2e-16 ***
EVENT_GROUPFire	60.224	2.495	24.137	< 2e-16 ***
EVENT_GROUPHazmat	83.990	6.025	13.939	< 2e-16 ***
EVENT_GROUPMedical	2.218	1.652	1.343	0.17941
EVENT_GROUPNatural Gas	45.950	5.480	8.384	< 2e-16 ***
EVENT_GROUPOther	15.271	5.013	3.046	0.00232 **
EVENT_GROUPPolice Assist	201.005	15.954	12.599	< 2e-16 ***
EVENT_GROUPRescue	45.990	4.086	11.256	< 2e-16 ***
EVENT_GROUPUtility	673.128	4.684	143.698	< 2e-16 ***
EVENT_GROUPVehicle	54.480	2.533	21.506	< 2e-16 ***

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 518.2 on 704908 degrees of freedom  
(15450 observations deleted due to missingness)  
Multiple R-squared: 0.03235, Adjusted R-squared: 0.03233  
F-statistic: 2142 on 11 and 704908 DF, p-value: < 2.2e-16

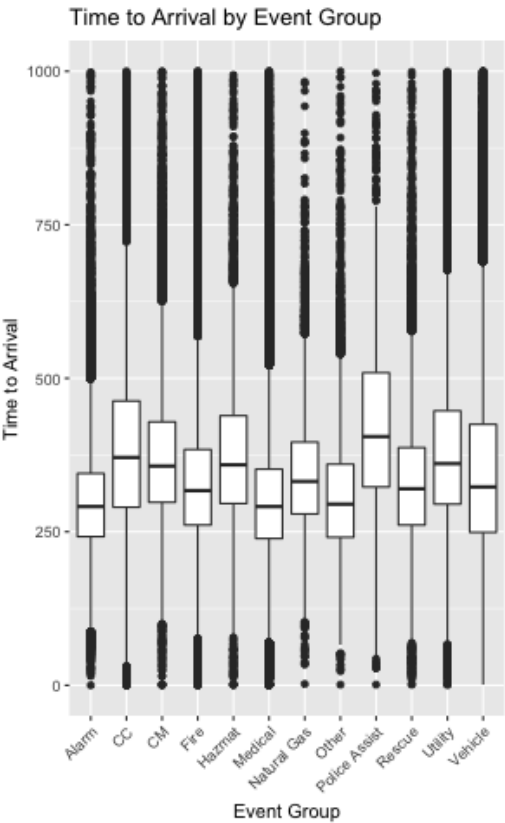


Figure 6

## Multivariate Analysis

### Fire Classification

In *Modeling the risk of structural fire incidents using a self-organizing map* Asgari et. al classify fire risk level into 5 distinct categories based on fatalities, injuries and damage. The levels are defined as follows:

- **Very Low:** 0 Fatalities, 0 Injuries, Damage < \$5000
- **Low:** 0 Fatalities, 0 Injuries, \$5000 <= Damage < \$10,000
- **Moderate:** 0 Fatalities, 0 Injuries, \$10,000 <= Damage < \$50,000 or 0 Fatalities, 1 Injury, Damage < \$50,000
- **High:** 0 Fatalities, Injuries <= 1, \$50,000 <= Damage < \$100,000 or Injuries > 1, Damage < \$100,000
- **Very High:** Fatalities > 0 or Damage >= \$100,000

**Table 2** contains a yearly breakdown of incident classification by year and displays relatively consistent class levels for all years in the data set. However, there is a major class imbalance problem when classifying fires in this way. The 'Very Low' level contains 99.2% of the incidents. Such discrepancy between classes introduces potential problems with machine learning algorithms and classifiers (Krishna Veni, Rani 2011).

Year	VL	L	M	H	VH
2011	144517	235	399	102	112
2012	119651	223	442	103	126
2013	108675	224	422	113	142
2014	110805	229	488	126	146
2015	114749	218	451	118	128
2016	116437	233	483	123	150
Total	714834	1362	2685	685	804

Table 2

Class imbalance problems such as this are a prevalent problem in machine learning and thus potential solutions have been the subject of various research (López et al.). Techniques to deal with this issue include undersampling, oversampling or hybrid methods which combine both. Synthetic Minority Oversampling TEchnique (SMOTE) and Cost-Sensitive Learning are two popular techniques to deal with class imbalance issues.

### Class Imbalance: Binary Class & Features

It is possible to consider additional features and thresholds in the above classification in order to help reduce the class imbalance problem. The following are some potential suggestions:



1. Reduce class levels to binary, *Critical* or *Non-critical*: In the previous classification *Very Low* is considered *Non-critical* whereas *Low*, *Medium*, *High*, and *Very High* are considered critical.
2. Damage (EST\_LOSS): There are a total of 10,480 incidents with Damage > 0. Perhaps all of these should be considered *critical* incidents.
3. Responding Units: The 99th percentile of RESPONDING\_UNITS is 7 units. Perhaps consider any incident with seven or more responding units *critical*.
4. Rescues: There are 7907 incidents where RESCUES > 0.
5. Office of the Fire Marshall Investigations: there are 1144 observations in the data set where OFM\_INVESTIGATIONS\_CONTACTED is TRUE.
6. Estimated value at risk: This data set also contains a feature EST\_VALUE\_AT\_RISK which is categorical and contains levels pertaining to dollar value estimates. There are 9565 observations with non-zero value estimates for this feature.

After implementing the above features the class imbalance problem is reduced to a 95.9 to 4.1% ratio. This is a significant improvement with absolute values depicted in **Table 3**.

### Class Imbalance: Subsetting

The class levels described by Asgari et al.—applied to this data set—were originally proposed for fire incidents. Although not exclusive, most features used to describe the fire classification levels pertain to fire related incidents. Fire incidents account for only 8.8% of the incidents but contain 74% of the *Low* through *Very High* incidents. Vehicle incidents account for most of the remaining *Low*, *Very Low*, *Medium*, *High* and *Very High* incidents. **Table 4** illustrates this relationship.

	Critical	Non-critical
Count	29782	690588
%	4.1	95.9

Table 3

	VL	L	M	H	VH
Alarm	137691	24	42	5	4
CC	15243	11	10	0	2
CM	22639	0	2	0	0
Fire	59153	848	1888	598	747
Hazmat	7866	2	2	0	1
Medical	354719	0	22	1	0
Natural Gas	9574	2	3	0	0
Other	11895	1	5	3	2
Police Assist	1126	0	0	0	0
Rescue	19238	0	3	0	1
Utility	13541	0	3	0	0
Vehicle	62069	474	705	78	47

Table 4

By subsetting the data to include only fire, or perhaps fire and vehicle, incidents the class imbalance problem can be reduced significantly. Furthermore, by applying subsetting and the aforementioned binary class and augmented threshold techniques previously mentioned together the ratio of *Non-critical* to *critical* incidents can be further balanced to 79% and 21% respectively.

## Association Rules

Association rules were run on all observations of the following features: EVENT\_GROUP, ALARM\_TO\_FD, RESPONSE\_GROUP, PROPERTY\_GROUP, MONTH, DAY, HOUR, EVENT\_TYPE\_CD. No rules were found with the three temporal features (MONTH, DAY, HOUR), however, other interesting patterns were discovered.

#	Rules	Support	Confidence	Lift	Count
1	{EVENT_GROUP=Alarm,PROPERTY_GROUP=C} => {ALARM_TO_FD=5}	0.1019	0.8294	4.7289	73398
2	{EVENT_GROUP=Alarm} => {RESPONSE_GROUP=E}	0.1564	0.8178	3.9498	112659
3	{EVENT_GROUP=Alarm,ALARM_TO_FD=5} => {RESPONSE_GROUP=E}	0.1282	0.8145	3.9340	92345
4	{RESPONSE_GROUP=I,EVENT_TYPE_CD=Medical} => {EVENT_GROUP=Medical}	0.1920	1.0000	2.0307	138287
5	{ALARM_TO_FD=3,EVENT_TYPE_CD=Medical} => {EVENT_GROUP=Medical}	0.2123	1.0000	2.0307	152920

1. {Event group = Alarm, Property Group = Residential} => {Alarm to Fire Department = From Monitoring Agency}

This rule describes incidents where the Fire Services responded to Residential Alarms. Of these alarms, 82% (confidence) were received from a monitoring agency.

2. {Event group = Alarm} => {Response Group = False Fire Calls}

This simple statistic, also with high lift, shows that 81% of the alarms that the fire services respond to are false fire calls. This is an incredibly high percentage and represents approximately 15% of all incidents in this dataset.

3. {Event group = Alarm, Alarm to Fire Department = From Monitoring Agency} => {Response Group = False Fire Calls}

This rule elaborates on rule #2 by showing that a high percentage (~ 82%) of aforementioned false alarm calls are received from a monitoring agency.

Letter	Response Group
A	Property Fires/Explosions
B	Overpressure rupture/explosion (no fire)
C	Pre fire conditions/no fire
D	Burning (controlled)
E	False fire calls
F	CO False calls
G	Public Hazard
H	Rescue
I	Medical/resuscitator call
J	Other response

Table 5: Response Group Levels

Letter	Property Group
A	Assembly
B	Care and Detention
C	Residential
D	Business & Personal Services
E	Mercantile
F	Industrial
O	Structures/Properties not classified by the Ontario Building Code

Table 6: Property Group Levels

4. {Response group = Medical/resuscitator call, Event type call as dispatched = Medical} => {Event group => Medical}

This rule perhaps seems obvious but is worth noting: with a confidence of 100%, all incidents responded to as medical calls, which were dispatched as medical calls, ended up being classified as medical calls. This data set has a high proportion of medical calls. Note that only 138,000 of the some 350,000 medical incidents in this data set fit that pattern. This suggests that there is some variability among these features of medical calls.

5. {Alarm to Fire Department = From Ambulance, Event type call as dispatched = Medical} => {Event group => Medical}

As with rule #4 this is perhaps a sanity check (despite a lift value of 2) and may seem as expected: Every incident received from an Ambulance is dispatched as Medical with an event type categorized as Medical. This stipulates that ambulances make no other calls to the fire services besides medical calls.

## Appendix: Data Dictionary

### Original Features

Feature	Type	NA	Description	Summary
INCIDENT_NUMBER	character	6	Unique ID	Primary Key
EVENT_TYPE	factor	80	Event Type as Dispatched	114 Levels
DISPATCH_DATE	date	16802	On-scene date & time	2011:2016
ARRIVE_DATE	date	16802	Identical to DISPATCH_DATE	2011:2016
EVENT_TYPE_CD	factor	32	Event Code Dispatched	130 Levels
MAIN_STREET	factor	420556	Main Street of Incident	8932 Levels
CROSS_STREET	factor	390349	Closest Cross Street	11026 Levels
FSA	factor	355138	Postal Code FSA	119 Levels
RESPONDING_UNITS	continuous	32	No. of units responding	Min 1 1 Med 1 Ave 2.3 3 Max 4 453
FD_STATION	factor	0	Fire Department Station	375,478 levels
OFM_INVESTIGATIONS_CONTACTED	factor	0	???	Binary: (0, 1) = (719226, 1144) 2 Levels: (1, 4) = (12408, 707962)
AID_TO_FROM_OTHER_DEPTS	factor	0	???	
INCIDENT_DATE	date	0	Initial Call Date	2011:2016 Inclusive
INITIAL_CALL_HOUR	continuous	0	Initial Call Hour	0:23
INITIAL_CALL_MIN	continuous	0	Initial Call Minute	0:59
INITIAL_CALL_SEC	continuous	0	Initial Call Second	0:59
DISPATCH_HOUR	continuous	177	Dispatch Hour	0:23
DISPATCH_MIN	continuous	177	Dispatch Minute	0:59
DISPATCH_SEC	continuous	177	Dispatch Second	0:59
ONSCENE_HOUR	continuous	15371	On-scene Hour	0:23
ONSCENE_MIN	continuous	15371	On-scene Minute	0:59
ONSCENE_SEC	continuous	15371	On-scene Second	0:59
INITIAL_UNIT_PERSONNEL	continuous	0	Number of People Responding on First Apparatus	Min 0 4 Med 4 Ave 3.8 3 Max 4 75
TOTAL_NUM_PERSONNEL	continuous	0	Total number of personnel responding	Min 0 4 Med 4 Ave 8.0 3 Max 13 1277
EST_KM	continuous	0	Estimated Distance from station to incident	Min -1 2 Med 2 Ave 2.5 3 Max 99
ALARM_TO_FD	factor	1	Alarm Source	11 Levels
RESPONSE_TYPE	factor	0	Response Type	68 Levels
RESCUES	continuous	0	Total no. of persons rescued	Min 0 0 Med 0 Ave 0.0 3 Max 0 43
FF_INJURIES	continuous	0	No. of fire fighters injured	Min 0 0 Med 0 Ave 0.0 3 Max 0 4
FF_FATALITIES	continuous	0	No. of fire fighter fatalities	Min 0 0 Med 0 Ave 0.0 3 Max 0 0
AGENT_APP_HOUR	continuous	708040	Application of agent or decision to defer hour, min, sec	0:23
AGENT_APP_MIN	continuous	708040		0:59
AGENT_APP_SEC	continuous	708040		0:59
CONTROL_DATE	continuous	478833	Date fire under control	2000:2016
CONTROL_HOUR	continuous	707821		0:23
CONTROL_MIN	continuous	707821	Hour, min, sec fire under control	0:59
CONTROL_SEC	continuous	707821		0:59
STATUS_ON_ARRIVAL	factor	708040	Status on Arrival	9 Levels
WATER	factor	708040	Hydrant proximity	6 Levels

FIRE_CONTROL	factor	708040	Extinguish Action Taken	5 Levels
PROPERTY	factor	9863	Residential, Industrial,...	350 Levels
AREA_OF_ORIGIN	factor	708040	Outside, Storage, Functional,...	72 Levels
IGNITION_SOURCE	factor	708040	Cooking, heating, electrical,...	84 Levels
FUEL_OF_IGNITION_SOURCE	factor	708040	Gasoline, diesel, propane,...	18 Levels
OBJECT_OR_MATERIAL_FIRST_IGNITED	factor	708040	Building, furniture, soft goods...	54 Levels
POSSIBLE_CAUSE	factor	708040	Intentional, unintentional,...	22 Levels
VEH_PURPOSE	factor	718631	Vehicles only Purpose	10 Levels
VEH_FUEL	factor	718631	Vehicles only Fuel	9 Levels
EST_LOSS	continuous	0	Estimated \$ loss (dollars only) Binary Insurance Estimate: Yes, No, NA, Undetermined	Min 0 1 0 Med 0 Ave 465 3 0 Max 1.3e7 4 Levels
INSURANCE_ESTIMATE	factor	707958	No, NA, Undetermined	4 Levels
EST_VALUE_AT_RISK	factor	707958	Value based estimate categories	11 Levels
CIVILIAN_FIRE_INJURY	continuous	0	Number of Civilian fire injuries & fatalities	Min 0 1 0 Med 0 Ave 0.0 3 0 Max 12
CIVILIAN_FIRE_FATALITY	continuous	0		Min 0 1 0 Med 0 Ave 0.0 3 0 Max 3
RESCUED_CHILDREN	continuous	0	Numbers of children, adults and seniors rescued	Min 0 1 0 Med 0 Ave 0.0 3 0 Max 6
RESCUED_ADULTS	continuous	0		Min 0 1 0 Med 0 Ave 0.0 3 0 Max 40
RESCUED_SENIORS	continuous	0		Min 0 1 0 Med 0 Ave 0.0 3 0 Max 10
PHYSICAL_CONDITION_1	factor	708041		10 Levels
PHYSICAL_CONDITION_2	factor	720323	Rescued Persons' Physical Condition	6 Levels
PHYSICAL_CONDITION_3	factor	720363		3 Levels
CIV_FIRE_CONTROL	factor	708041	Civilian Action: Fire Control	5 Levels
CIV_EVACUATION	factor	708041	Civilian Evacuation: All, None, etc	5 Levels
CIV_EVACUATION_REASON_1	factor	708041	Civilian Action: Reasons for not evacuating	9 Levels
CIV_EVACUATION_REASON_2	factor	720265		8 Levels
OPP	factor	719431		1 Level
MOE	factor	719011		1 Level
TSSA	factor	719822		1 Level
ESA	factor	720080		1 Level
MOL	factor	720080		1 Level
EMS	factor	720325	Other agencies, municipalities and services contacted	1 Level
CANUTEC	factor	720138		1 Level
GAS	factor	715150		1 Level
HYDRO	factor	715966		1 Level
MUNICIPAL_BUILDING_OFFICE	factor	720142		1 Level
MUNICIPAL_HEALTH_OFFICE	factor	719008		1 Level
MUNICIPAL_POLICE	factor	718973		1 Level
OTHER	factor	717388		1 Level
INITIAL_DETECTION	factor	711584	How fire was detected	9 Levels
EXTENT_FIRE	factor	711585	Extent of Fire: confined, spread etc Spread of smoke: Confined, spread...	12 Levels
EXTENT_SMOKE	factor	711585	Estimated number of persons displaced	Min 0 1 0 Med 0 Ave 0.2 3 0 Max 999 10 Levels
EST_NUM_PERSONS_DISPLACED	continuous	0		
POSSIBLE_BUSINESS_IMPACT	factor	711585	Possible business impact Type of complex (airport, apartment, etc)	7 Levels
COMPLEX	factor	711589	Occupancy Status: Permanent, seasonal...	23 Levels
OCC_STATUS	factor	711589		8

OCC_TYPE	factor	711589	Occupancy Type: Owner, renter...	7 Levels
BLD_STATUS	factor	711589	Building Status: Normal, reno...	7 Levels
BLD_HEIGHT	factor	711589	Number of Stories, Other or Undetermined	70 Levels
LEVEL_OF_ORIGIN	factor	711589	Floor, Basement, Other, NA or Undetermined	57 Levels
AGE_OF_STRUCTURE	factor	711589	Historic, before 1946, after 1946...	7 Levels
SMOKE_ALARM_PRESENCE_AND_OPERATION_MAIN_FLOOR	factor	711589	No smoke alarm, present and operated....	5 Levels
SMOKE_ALARM_FAILURE_TO_OPERATE	factor	711589	No battery, dead battery...	11 Levels
SMOKE_ALARM_TYPE	factor	711589	Battery, hardwired, wireless...	6 Levels
SMOKE_ALARM_OTHER_FLOOR_PRESENCE	factor	711589	No smoke alarms, present and operated...	6 Levels
SMOKE_ALARM_ON_ALL_FLOORS	factor	711589	Yes, not all operational,...	6 Levels
SMOKE_ALARM_IMPACT_ON_EVAC	factor	711589	All persons self-evacuated,...	7 Levels
SMOKE_ALARM_IMPACT_ON_NUM_EVAC	continuous	0	Continuous & Categorical Fire alarm system present, no fire alarm,...	0:99, 99+, Undetermined
FIRE_ALARM_SYSTEM_PRESENCE	factor	711589	Operated, did not operate,...	4 Levels
FIRE_ALARM_SYSTEM_OPERATION	factor	711589	All persons evacuated, some persons....	4 Levels
FIRE_ALARM_SYSTEM_IMPACT	factor	711589	Full sprinkler system, partial...	7 Levels
SPRINKLER_SYSTEM_PRESENCE	factor	711589	Activated, did not activate, ...	4 Levels
SPRINKLER_SYSTEM_ACTIVATION	factor	711589		7 Levels

#### Data Sources

All data obtained from either RMS or Standard Incident Report

Above table information is prior to cleaning & not always consistent with "acceptable" values (i.e negative distance, years outside of range, etc) or possible values as described on OFM Standard Incident Report Codes List.

## Dropped Features

Feature	Reason
ARRIVE_DATE	Identical to DISPATCH_DATE
FF_FATALITIES	Every observation is 0
FD_STATION	No information: Either INCIDENT_NUMBER, 0, or INCIDENT_NUMBER padded with one or more 0s
EVENT_ALARM_LEVEL	This feature was only available for the incidents in the year 2016.

## Added Features

Feature	Type	Description	
TTA	Continuous	Time to Arrival in. Difference between ONSCENE time and INITIAL_CALL time measured in seconds.	
INCIDENT_DAY	Factor	Day of week extracted from INCIDENT_DATE	7 Levels
EVENT_GROUP			
PROPERTY_GROUP			
RESPONSE_GROUP			
FIRE_CLASS	Factor	Severity of fire classification based on parameters put forth by Asgari et. al	5 Levels

# Glossary

RMS - ???

CAD - Computer Aided Dispatch

OFM - Office of the Fire Marshall

FSA - Forward Sorting Area



## References

Mendenhall, W., Beaver, R., & Beaver, B. (2013) *Introduction to Probability and Statistics*. Boston, MA: Brooks/Cole

KrishnaVeni, C.V, & Rani, T.S. (2011) On the Classification of Imbalanced Datasets. *International Journal of Computer Science & Technology*. 145-148. Retrieved from <http://ijcst.com/icaccbie11/sp1/krishnaveni.pdf>

López, V., Fernandez, A., Garcia, S., Palade, V., & Herrera, F. (2013) An Insight into Classification with Imbalanced Data: Empirical Results and Current Trends on Using Data Intrinsic Characteristics. *Information Sciences*, 250, 113-141.doi:10.1016/j.ins.2013.07.007