The Not-so-great fires of Toronto*

Fire incidents 2011-2019 under control by the Toronto Fire Services

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Abstract

First sentence. Second sentence. Third sentence. Fourth sentence.

1 Introduction

Toronto has a history with fires. The first Great Fire of Toronto occurred in 1849 and destroyed the St. James Cathedral [what area? what damage?]. In 1890 on Valentine's Day, University College, [relation to UofT], burned down during the annual student ball. Then came Toronto's second great fire, the Great Fire of 1904, which remains Toronto's largest fire to date [what area? what damage?]. To this day the cause of the fire remains unknown. Back then however, many buildings were constructed using wood and the fire companies were not well trained.

Fortunately we have come a long way since then, with the formal establishment of the Toronto Fire Services in 1998. In fact, in 2019 the Toronto Fire Services earned accredited agency status from the Commission on Fire Accreditation International (CFAI), making the City of Toronto the largest city in North America to have an accredited fire service (https://www.toronto.ca/city-government/accountability-operations-customer-service/city-administration/staff-directory-divisions-and-customer-service/fire-services/). The Toronto Fire Services offers many services including education programs, fire safety inspections and investigations, emergency and disaster response, and event support.

The Toronto Fire Services also provided the data that we will be analyzing in this paper, which is of fire incidents in Toronto that they responded to in the time frame (TODO). This data is similar to what is submitted to the Ontario Fire Marshal and is processed and used to develop "fire prevention and public education programs, community risk assessments, [and] legislation that helps protect people, property and the environment" (https://www.ontario.ca/page/office-fire-marshal). We will cover an overview of the data and its features, and then look more deeply into it to answer the following research questions: - What are the main causes of fires in Toronto today? - How has the number of fires changed over the past decade? - How fast are response times to fires and times for bringing them under control? - What is the estimated damage costs of fires per year? - What parts of the house do most of the fires begin in?

You can and should cross-reference sections and sub-sections. For instance, Section 2. R Markdown automatically makes the sections lower case and adds a dash to spaces to generate labels, for instance, Section 5.1.

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*Code and data are available at: LINK.

Table 1: First ten rows of the location features of a dataset of fire incidents in Toronto from 2011-2019

Id	Incident Station Area	Incident Ward	Intersection	Latitude	Longitude
2139825	441	1	Dixon Rd / 427 N Dixon Ramp	43.7	-79.6
2139826	116	18	Sheppard Ave E / Clairtrell Rd	43.8	-79.4
2139827	221	21	Danforth Rd / Savarin St	43.7	-79.2
2139828	133	5	Keele St / Lawrence Ave W	43.7	-79.5
2139829	132	8	Replin Rd / Tapestry Lane	43.7	-79.4
2139830	215	25	Lawrence Ave E / Beechgrove Dr	43.8	-79.2
2139831	235	19	Westview Blvd / Holland Ave	43.7	-79.3
2139832	231	24	Peking Rd / Nelson St	43.7	-79.2
2139833	332	10	Bay St	43.7	-79.4
2139834	426	4	Roncesvalles Ave / Dundas St W	43.7	-79.5

2 Data

The data was obtained from the Toronto Fire Services (TFS) and downloaded through the Open Data Toronto portal. It consists of all the recorded fire incidents that Toronto Fire responded to during the period 2011-2019.

When a fire occurs, an individual can alert the TFS by calling 9-1-1. Response to these calls and dispatching the units is handled by the TFS Communications Centre (Annual report). The Communications Centre also appears to be responsible for actively monitoring and updating information on current fire incidents, as there is a page on the City of Toronto website with active fire incidents, updated at 5-minute intervals (https://www.toronto.ca/community-people/public-safety-alerts/alerts-notifications/toronto-fire-active-incidents/). The data on fire incidents may also be processed by the Fire Investigation Division of the TFS to add more details such as fire cause, origin and circumstances (Annual Report). This dataset is described to be "similar to what is sent to the Ontario Fire Marshal" (https://open.toronto.ca/dataset/fire-incidents/), which is the main leadership body on fire safety in Ontario (https://www.ontario.ca/page/office-fire-marshal), one of whose functions is to collect comprehensive data on fire incidents from all Ontario fire departments. However, personal information and some of the observations were removed from this dataset for privacy purposes. The dataset received a Gold data quality score on the Open Data Toronto portal, which is the highest badge based on rated data features of accessibility, completeness, freshness, metadata and usability.

There are 43 variables in the dataset and 17536 observations. Each observation represents a single fire incident, with details about the location, time, persons affected, cause and extent of the fire. The many variables allows an excess of details about each incident to be provided and a lot of room for data exploration, but there is also a large number of missing values. With 17536 observations, it is a fairly large dataset which is good for data analysis.

Since there are so many variables, we will group them by similarity and show a glimpse of some of the data observations. This is shown in tables 1

While there are several key features, we will choose to explore Civilian_Casualties, TFS_Alarm_Time, TFS_Arrival_Time, Possible_Cause, Estimated_Dollar_Loss and Area_of_Origin in the interest of our research questions.

2.1 Number of fires over the past decade

TFS_Arrival_Time

Table 2: First ten rows of the time features of a dataset of fire incidents in Toronto from 2011-2019

| Id	Ext Agent Time	Tfs Alarm Time	Tfs Arrival Time	Fire under Control Time	Last Tfs Unit Clear Time
2139825	2018-02-25 02:12:00	2018-02-25 02:04:29	2018-02-25 02:10:11	2018-02-25 02:15:40	2018-02-25 02:38:31
2139826	2018-02-25 02:29:42	2018-02-25 02:24:43	2018-02-25 02:29:31	2018-02-25 02:32:24	2018-02-25 02:35:58
2139827	NA	2018-02-25 18:29:59	2018-02-25 18:36:49	NA	2018-02-25 19:14:03
2139828	2018-02-25 19:19:25	2018-02-25 19:13:39	2018-02-25 19:18:07	2018-02-25 19:20:00	2018-02-25 20:07:42
2139829	NA	2018-02-25 23:20:43	2018-02-25 23:26:19	NA	2018-02-25 23:34:24

Table 3: First ten rows of the person-related features of a dataset of fire incidents in Toronto from 2011-2019

Id	Civilian Casualties	Count of Persons Rescued	Estimated Number of Persons Displaced	Tfs Firefighter Cas
2139825	0	0	NA	
2139826	0	0	NA	
2139827	0	0	NA	
2139828	0	0	0	
2139829	0	0	NA	

Table 4: First ten rows of the other features of a dataset of fire incidents in Toronto from 2011-2019

Id	Incident Number	Extent of Fire	Final Incident Type
2139825	F18020956	NA	01 - Fire
2139826	F18020969	NA	01 - Fire
2139827	F18021182	NA	03 - NO LOSS OUTDOOR fire (exc: Sus.arson,vandal,child playing,recycling or dump fires)
2139828	F18021192	1 - Confined to object of origin	01 - Fire
2139829	F18021271	NA	03 - NO LOSS OUTDOOR fire (exc: Sus.arson,vandal,child playing,recycling or dump fires)

Number of fires in Toronto per year 2011–2019
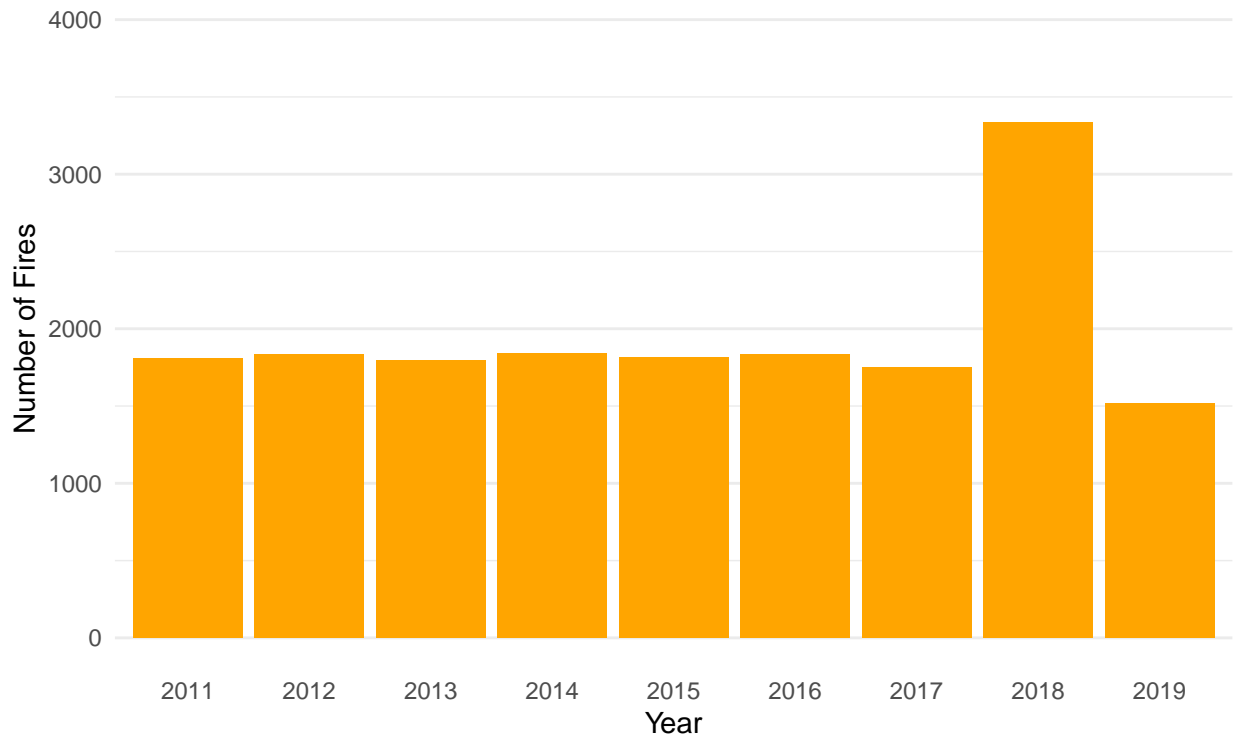
Source: Toronto Fire Services.

We can see that the number of fires has remained fairly constant over the years around 2000, but in 2018 there is a spike at 3334. However, since some of the observations were removed due to privacy reasons, it is unclear if this is due to missing observations. Another possible explanation for this increase is the wild fires (https://www.cbc.ca/news/canada/british-columbia/state-emergency-bc-wildfires-1.4803546).

2.2 Main causes of fires in Toronto

Possible_Cause

We can analysze the causes of fires by looking at the Possible Cause variable which is the cause as determined by the OFM code. There are 24 possible causes given in this dataset and 1913 observations have missing values for this variable. We have removed the missing values and show the causes ranked by largest number of fires in table 5.

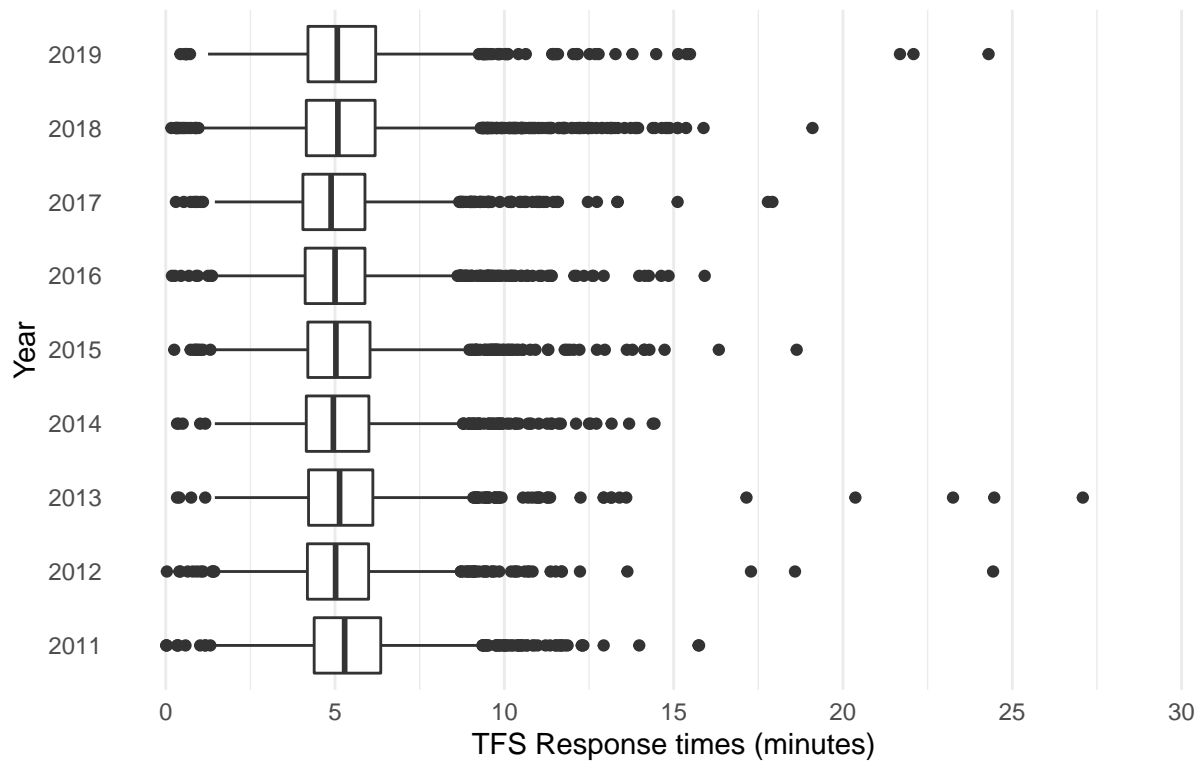bubble chart to correlate possible cause with area of origin?

Area_of_Origin

2.3 Fire Services Response Times

Boxplot

4

Table 5: Causes of Fires in Toronto

Possible Cause	Number of Fires
99 - Undetermined	3143
52 - Electrical Failure	2555
45 - Improperly Discarded	1811
44 - Unattended	1594
60 - Other unintentional cause, not classified	1243
98 - Unintentional, cause undetermined	1011
47 - Improper handling of ignition source or ignited material	882
51 - Mechanical Failure	655
20 - Design/Construction/Installation/Maintenance Deficiency	620
28 - Routine maintenance deficiency, eg creosote, lint, grease buildup	557
46 - Used or Placed too close to combustibles	406
50 - Other misuse of ignition source/material ignited	307
01 - Suspected Arson	206
12 - Vehicle Accident/Collision	202
49 - Improper Storage	117
11 - Children Playing (Ages 11 and under)	79
48 - Used for purpose not intended	65
03 - Suspected Vandalism	60
73 - Natural Cause	44
80 - Exposure fire	22
04 - Suspected Youth Vandalism (Ages 12 to 17)	17
72 - Rekindle	15
990 - Under Investigation	11
02 - Riot/Civil Commotion	1

Distribution of TFS Response times per year 2011–2019

Response time is pretty fast after receiving the 911 call, on average about 5 minutes and this remains about the same over the 2011-2019 period. Almost all responses have been under 30 minutes, except for 3 responses in the years 2012, 2018 and 2018 which were 682, 36 and 298 minutes respectively. These outliers are not shown in the boxplot.

2.4 Estimated Dollar Loss

No description is provided for this variable, although we can safely deduce that it is the estimated cost of damages due to the fire in Canadian dollars.

How does delay in response affect the cost in damages? Does time == money?

```
# fires_by_response_time %>%
#   filter(Estimated_Dollar_Loss < 1000000, response_time < 200) %>%
#   ggplot(mapping = aes(x = Estimated_Dollar_Loss, y = response_time)) +
#   geom_point()
```

- max dollar loss, average dollar loss, aggregated per year

- total per year

- What is the estimated damage costs of fires per year?

- What parts of the house do most of the fires begin in?

Table 6: Control of Fires in Toronto

Extent of Fire	Number of Fires
1 - Confined to object of origin	5123
2 - Confined to part of room/area of origin	4084
3 - Spread to entire room of origin	481
4 - Spread beyond room of origin, same floor	469
9 - Confined to roof/exterior structure	342
7 - Spread to other floors, confined to building	274
11 - Spread beyond building of origin, resulted in exposure fire(s)	120
8 - Entire Structure	99
99 - Undetermined	91
10 - Spread beyond building of origin	56
5 - Multi unit bldg: spread beyond suite of origin but not to separated suite(s)	41
6 - Multi unit bldg: spread to separate suite(s)	34

2.5 Extent of damage

Have fires gotten as out of control as in the Great Toronto Fire?

3 Model

$$Pr(\theta|y) = \frac{Pr(y|\theta)Pr(\theta)}{Pr(y)} \tag{1}$$

Equation (1) seems useful, eh?

Here's a dumb example of how to use some references: In paper we run our analysis in R (R Core Team 2020). We also use the `tidyverse` which was written by Wickham et al. (2019) If we were interested in baseball data then Friendly et al. (2020) could be useful.

We can use maths by including latex between dollar signs, for instance θ.

4 Results

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

A   Additional details

References

Friendly, Michael, Chris Dalzell, Martin Monkman, and Dennis Murphy. 2020. *Lahman: Sean 'Lahman' Baseball Database.* https://CRAN.R-project.org/package=Lahman.

R Core Team. 2020. *R: A Language and Environment for Statistical Computing.* Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.