# 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.

*Code and data are available at: https://github.com/KCtt457/toronto-fires-data-summary.

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 the recorded fire incidents that Toronto Fire responded to during the period 2011-2019. It is has not been stated if this is a comprehensive set of all the fire incidents.

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 ("Toronto Fire Services 2019 Annual Report" (2019)). 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 ("Toronto Fire Services 2019 Annual Report" (2019)). 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. Since these values are mainly objective numbers, the data should be relatively unbiased. 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

Year alone is not a feature in the dataset, but it is present in the time variables such as TFS Alarm Time and TFS Arrival Time. TFS Alarm Time is the time when the TFS was notified of the incident, so we can

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) |

extract the year from this feature and plot the number of fires by year over the period from 2011-2019 in figure 1.

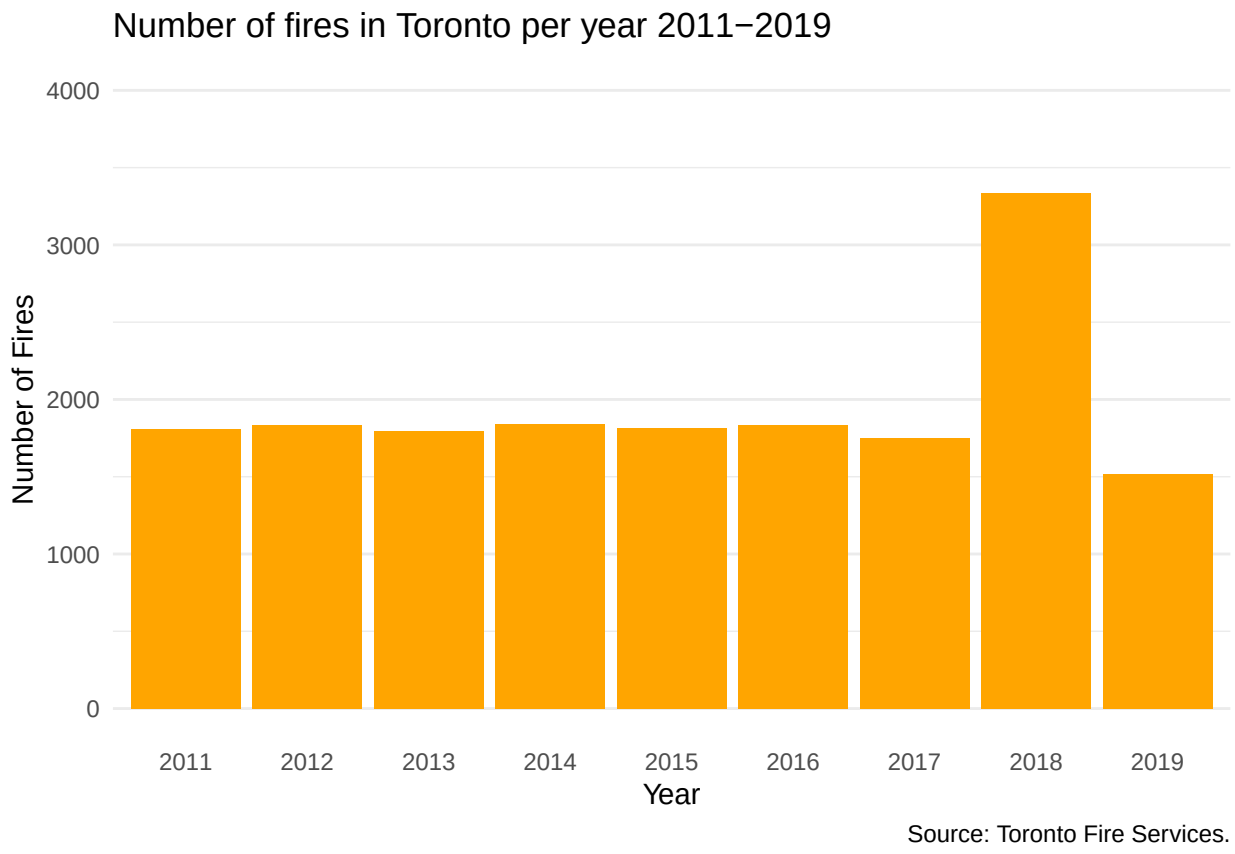



Figure 1: Number of fires in Toronto per year 2011-2019

The number of fires appears to fairly constant over the years, just under 2000 in number, but in 2018 there is a spike at 3334 fires. However, since some of the observations were removed due to privacy reasons, it is unclear if this is due to missing observations. Upon further investigation, I found that the TFS Annual Report 2019 featured emergency response statitics, and in it, 36,496 and 35,334 emergency fires were reported for 2018 and 2019 respectively ("Toronto Fire Services 2019 Annual Report" (2019)). Therefore the number of fire incidents per year is only a small subset of the actual number and we cannot necessarily draw inferences about the increase or decrease in number of fires over the 2011-2019 time period, and these fire incidents may not be representative of the larger set of fire incidents in a particular year.

## 2.2 Main causes of fires in Toronto

To analyze the causes of fires in Toronto, we can look at the Possible Cause variable which is the cause as determined by the Ontario Fire Marshal (OFM) codes with their description. There are 24 possible causes which appear 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.

From this summary, the majority of the fires appear to have unintentional or undetermined causes, or are the result of some mechanical failure. A fire is deemed 'undetermined' when its cause "cannot be proven to an acceptable level of certainty" ("Toronto Fire Services 2019 Annual Report" (2019)). Relatively few fire incidents are caused by criminal activity such as arson and vandalism. These causes may be determined

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 |

through investigation by the Fire Investigation Division of the TFS. However, in the TFS 2019 Annual report, only 172 fire investigations were conducted about the origin, cause and circumstances of fire incidents compared to the 35,334 emergency fires, so the cause may also be recorded when the TFS units arrive on the scene of a fire.

## 2.3 Extent of damage

Extent of Fire is the extent to which the fire has spread as determined by OFM code, with their description. There are 10 possible extent of fire codes that appear in this dataset, which are characterized by whether they spread or not and the objects, rooms or buildings they spread to. We process this variable and divide it into two: (1) for if it spread, and (2) the localization of the spread and plot it in 2.

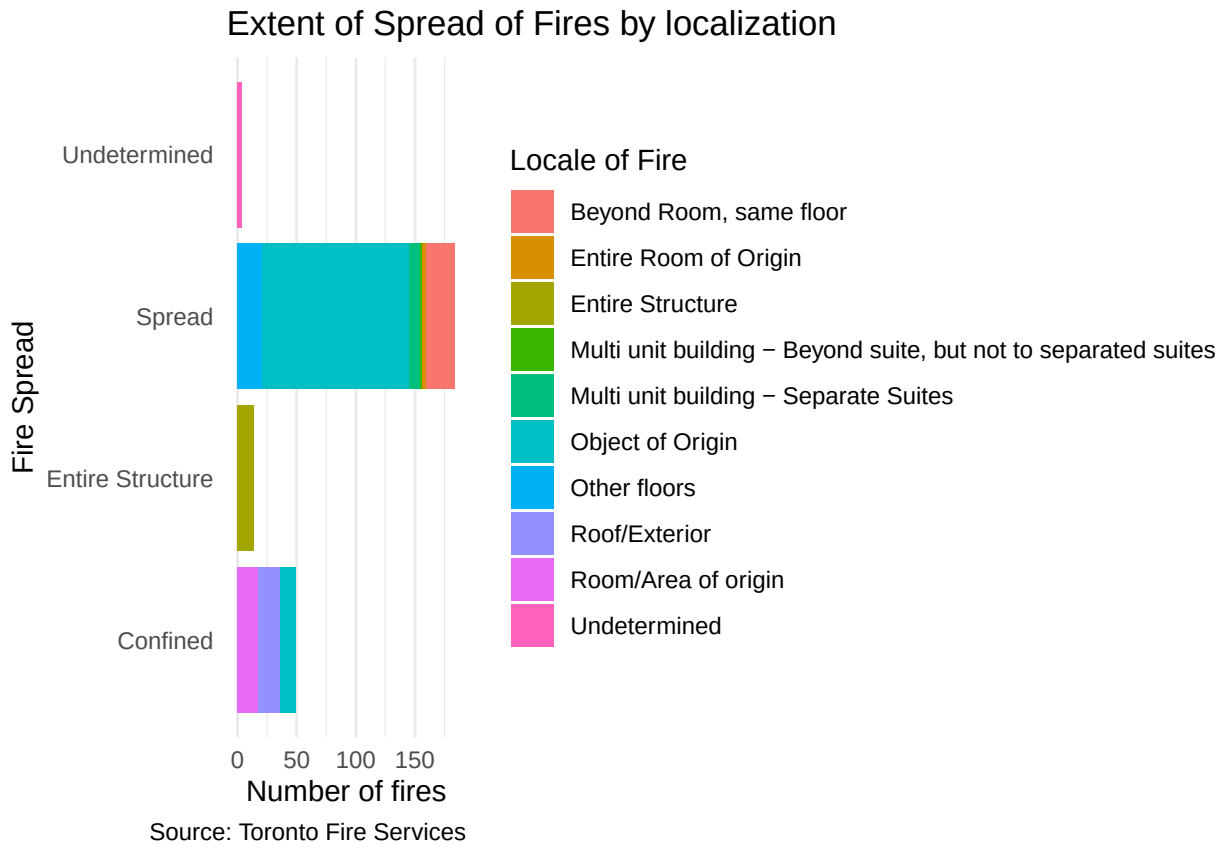
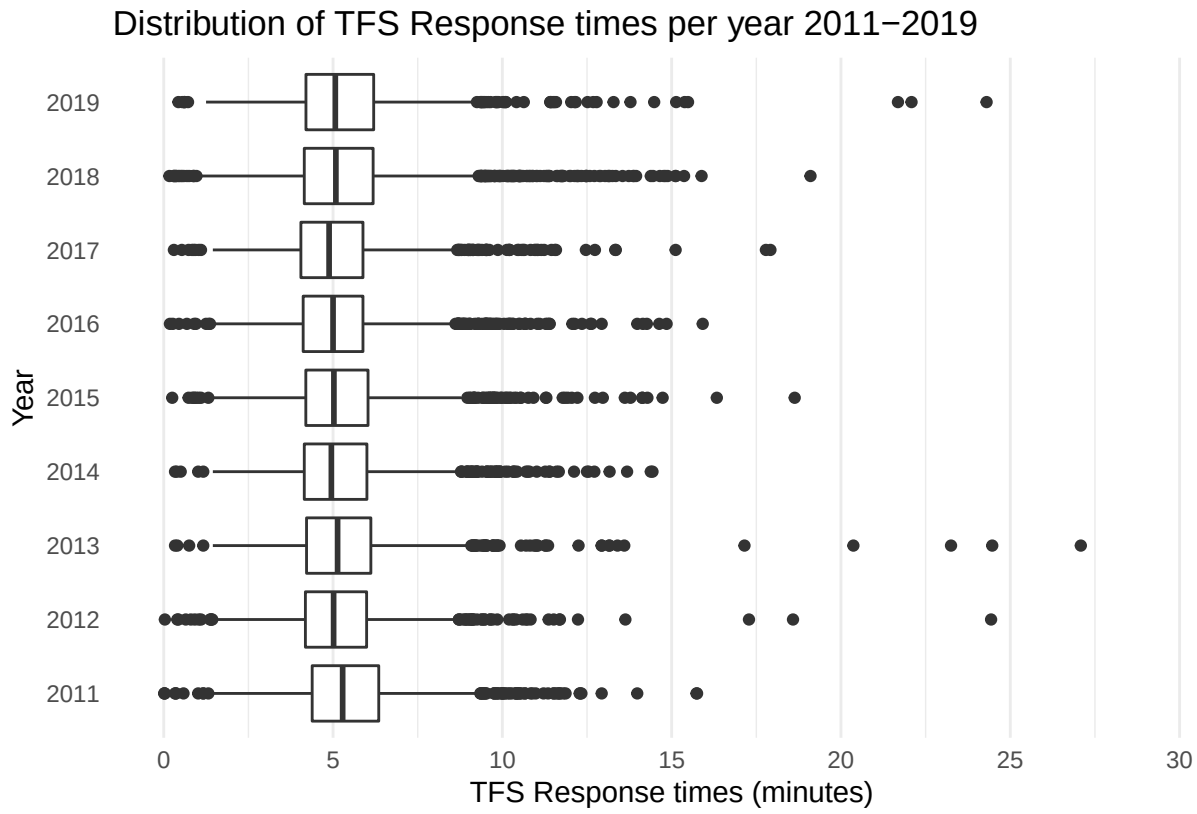



Figure 2: Extent of Spread of Fires by localization

## 2.4 Fire Services Response Times

Boxplot




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.

# 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 $\theta$.

# 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/.

"Toronto Fire Services 2019 Annual Report." 2019. Toronto Fire Services. https://www.toronto.ca/wp-content/uploads/2020/12/8d66-TFSAnnualReport-Web-AODA-5-RS1.pdf.

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.