

The Not-so-great fires of Toronto*

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

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Abstract

The Great Fire of Toronto in 1849 was devastating in its spread, but how have fire incidents in Toronto changed since then? We explore the data on fire incidents in Toronto for the period 2011-2019 to investigate this question. The fires today are not able to be as great as the great fire of Toronto since the Toronto Fire Services works efficiently to control any spread.

1 Introduction

Toronto has a history with fires. The first Great Fire of Toronto occurred in 1849 and destroyed the St. James Cathedral. In 1890 on Valentine's Day, University College, 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. 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 ("Fire Services" (2022)). 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" ("The Office of the Fire Marshal" (2022)). We will cover an overview of the data and its features, and then look more deeply into it to answer the following research questions:

- How has the number of fires changed over the past decade?
- What are the main causes of fires in Toronto today?
- How fast are response times to fires?
- What is the most frequent extent of spread of fire incidents?

*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

Table 2: 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

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 (([activefire?](#))). 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” (“Fire Incidents” (2022)), which is the main leadership body on fire safety in Ontario (“The Office of the Fire Marshal” (2022)), 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 only show some in a few of the observations in table 1. See the 2.4 for the remaining variables.

While there are several key features, we will choose to explore TFS Alarm Time, TFS Arrival Time, Possible Cause, and Extent of Fire 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 extract the year from this feature and plot the number of fires by year over the period from 2011-2019 in figure 1.

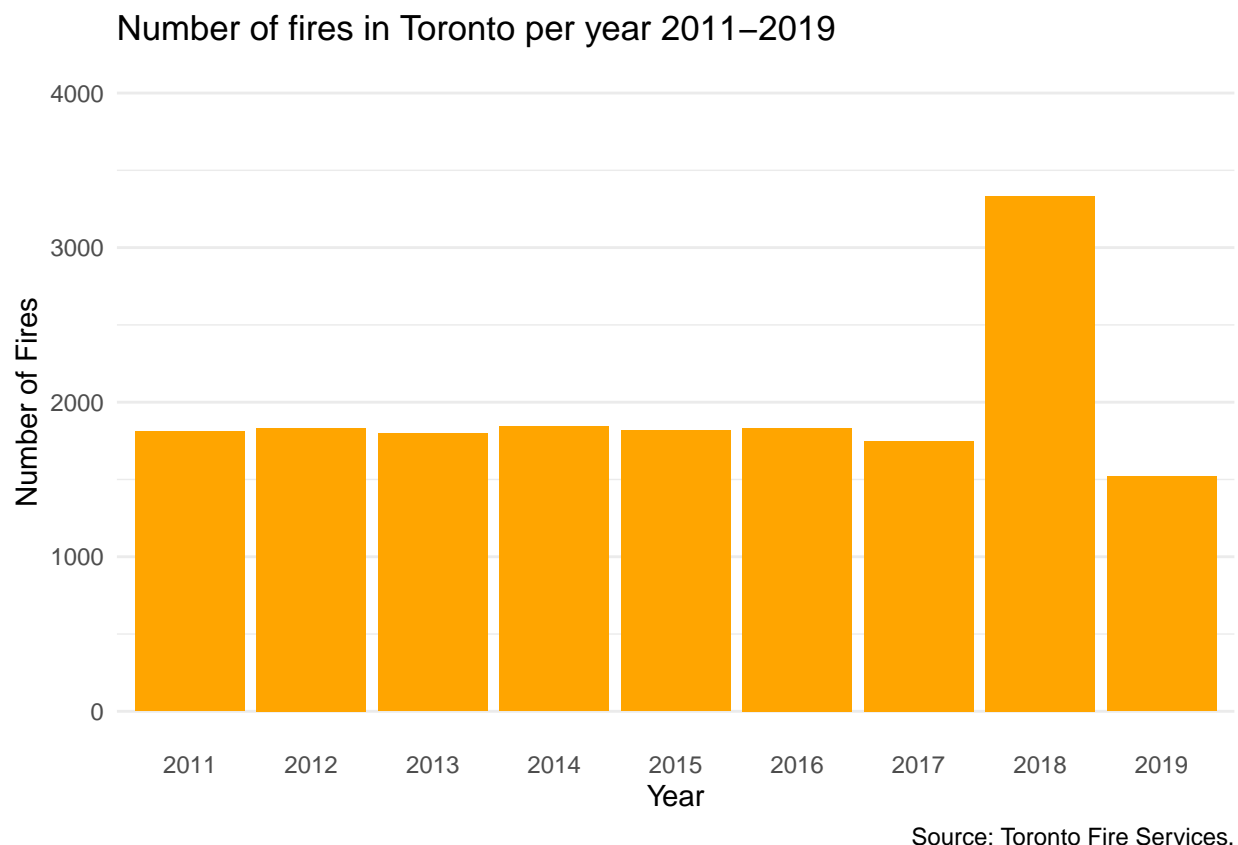


Figure 1: Number of fires in Toronto per year 2011-2019

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 statistics, 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.

Table 3: 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

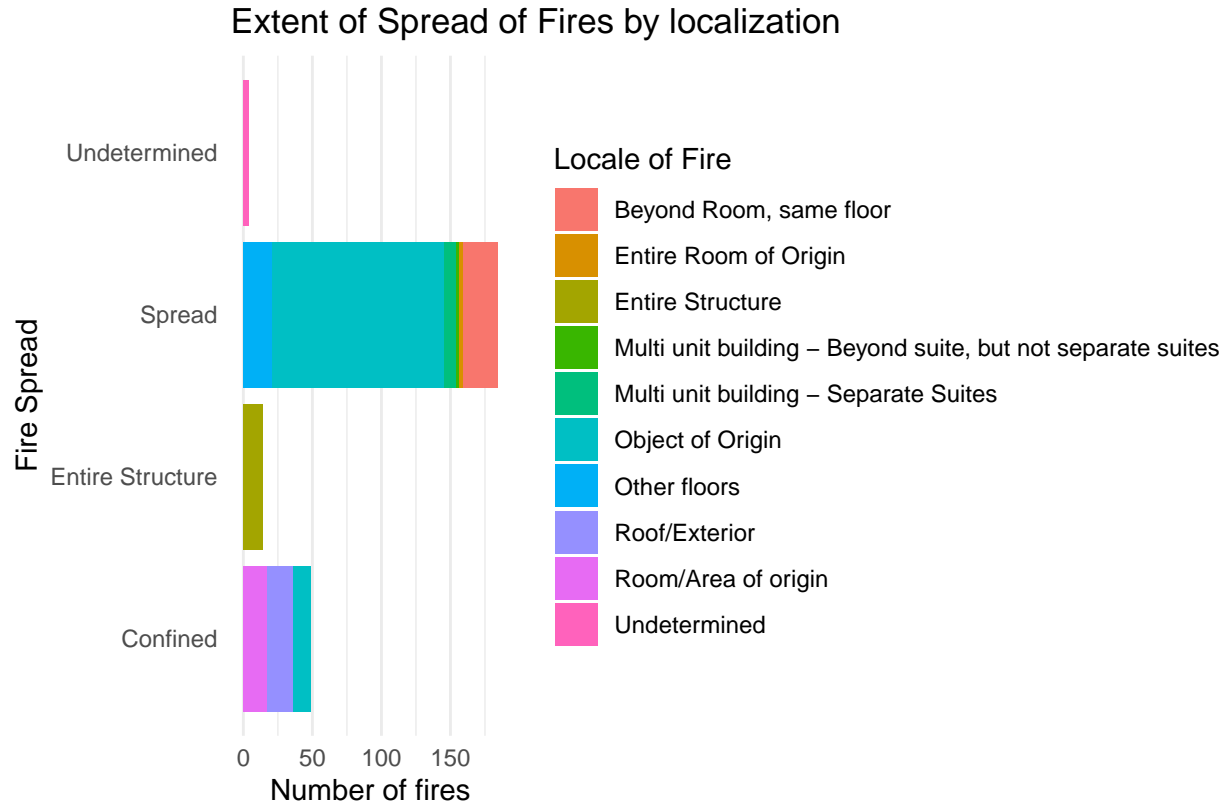
2.2 Main causes of fires in Toronto

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 3.

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 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 figure ??.



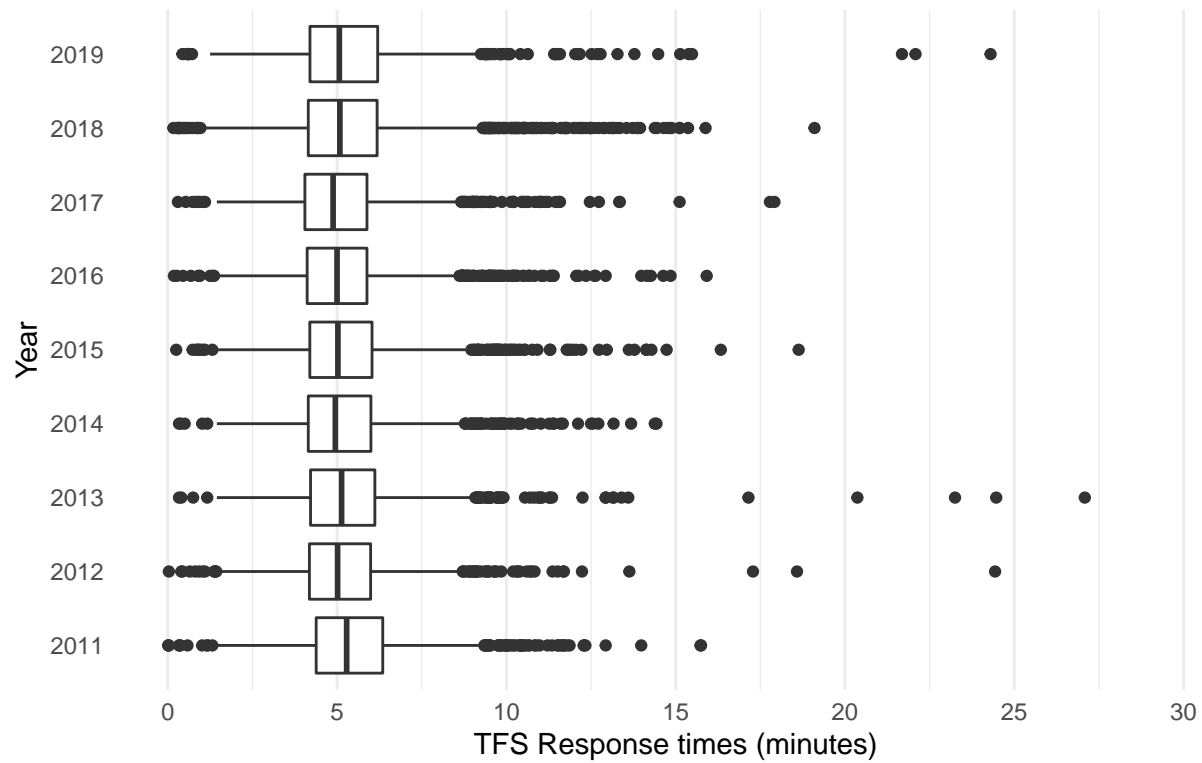
Source: Toronto Fire Services

The majority of the fire incidents reported to the TFS are fires that have spread beyond their original source, with more than half of these coming from an object. This aligns with some of the popular causes of fire incidents which include electrical incidents, improperly discarded object or unattended object. The distribution of fires between spread, confined, entire structure and undetermined also seems plausible since most people would deem the fire an emergency if it has gotten out of control or spread.

2.4 Fire Services Response Times

We can define the time it takes between the initial call and the arrival time of the TFS on the scene to be the response time, which we calculate by taking the difference of the variables TFS Alarm Time and TFS Arrival Time. TFS Arrival time is given as the time of the first arriving unit to the incident and TFS Alarm Time is the time when the TFS was notified of the incident. We visualize how the response time of the TFS is distributed per year in the boxplot in figure ??.

Distribution of TFS Response times per year 2011–2019



Source: Toronto Fire Services.

Response time is pretty fast after receiving the 911 call, on average about 5 minutes and little deviation from this average 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.

Table 4: 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 5: 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)

Appendix

A Additional details

References

- “Fire Incidents.” 2022. Open Data Toronto Portal. <https://open.toronto.ca/dataset/fire-incidents/>.
- “Fire Services.” 2022. City of Toronto. <https://www.toronto.ca/city-government/accountability-operations-customer-service/city-administration/staff-directory-divisions-and-customer-service/fire-services/>.
- “The Office of the Fire Marshal.” 2022. Government of Ontario. <https://www.ontario.ca/page/office-fire-marshal>.
- “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>.