Leak Detection N-Grams

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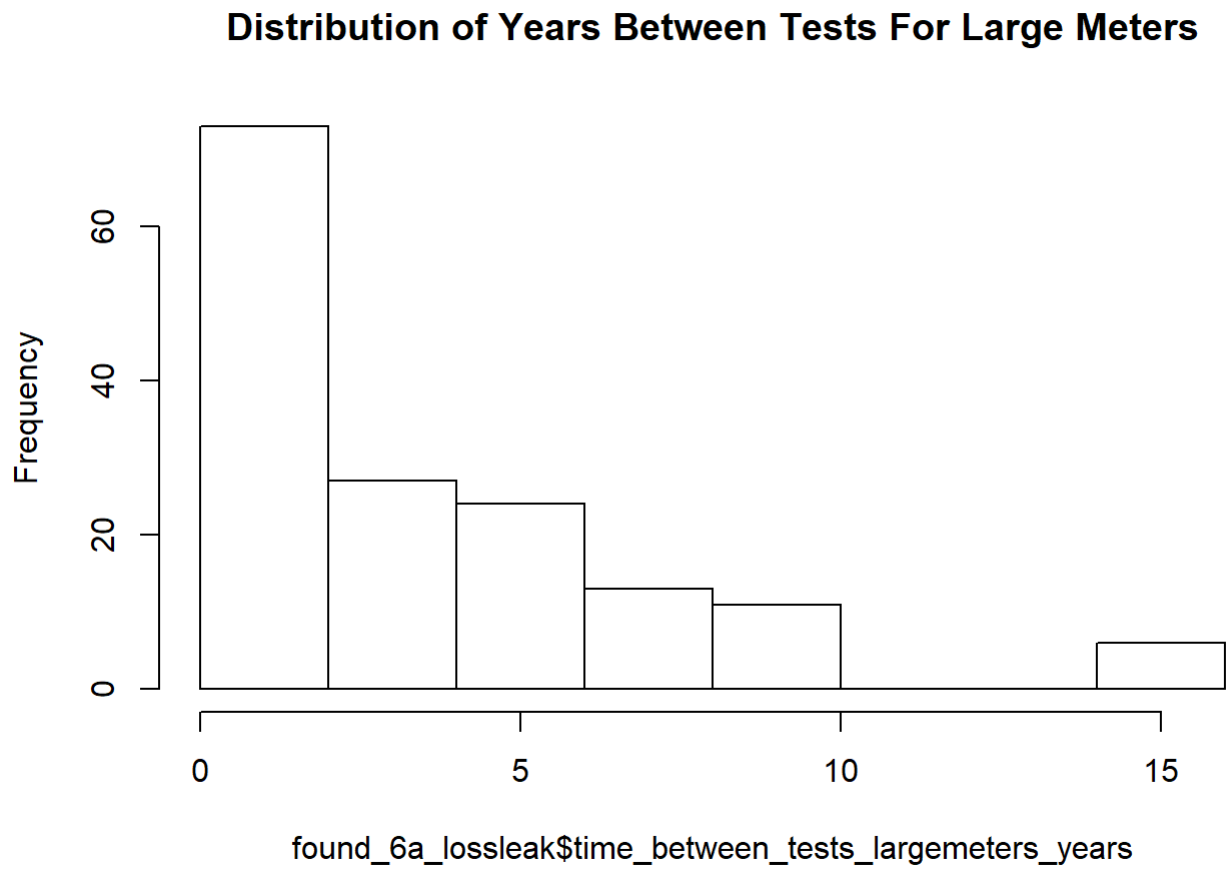
Purpose

- The purpose of this file is conduct text analysis on the leak_detection_field_technology column in the foundational_06a_loss_and_leak_detection file. Distributions of time between testing and age to replace small meters in years.
- This analysis creates token, bi-grams, tri-grams, and four-grams of this text field.
- The data can be found http://cowaterefficiency.com/unauthenticated_home (http://cowaterefficiency.com/unauthenticated_home) with permission. Once in the portal, all report years (2013-2017) were selected as well as all water providers.

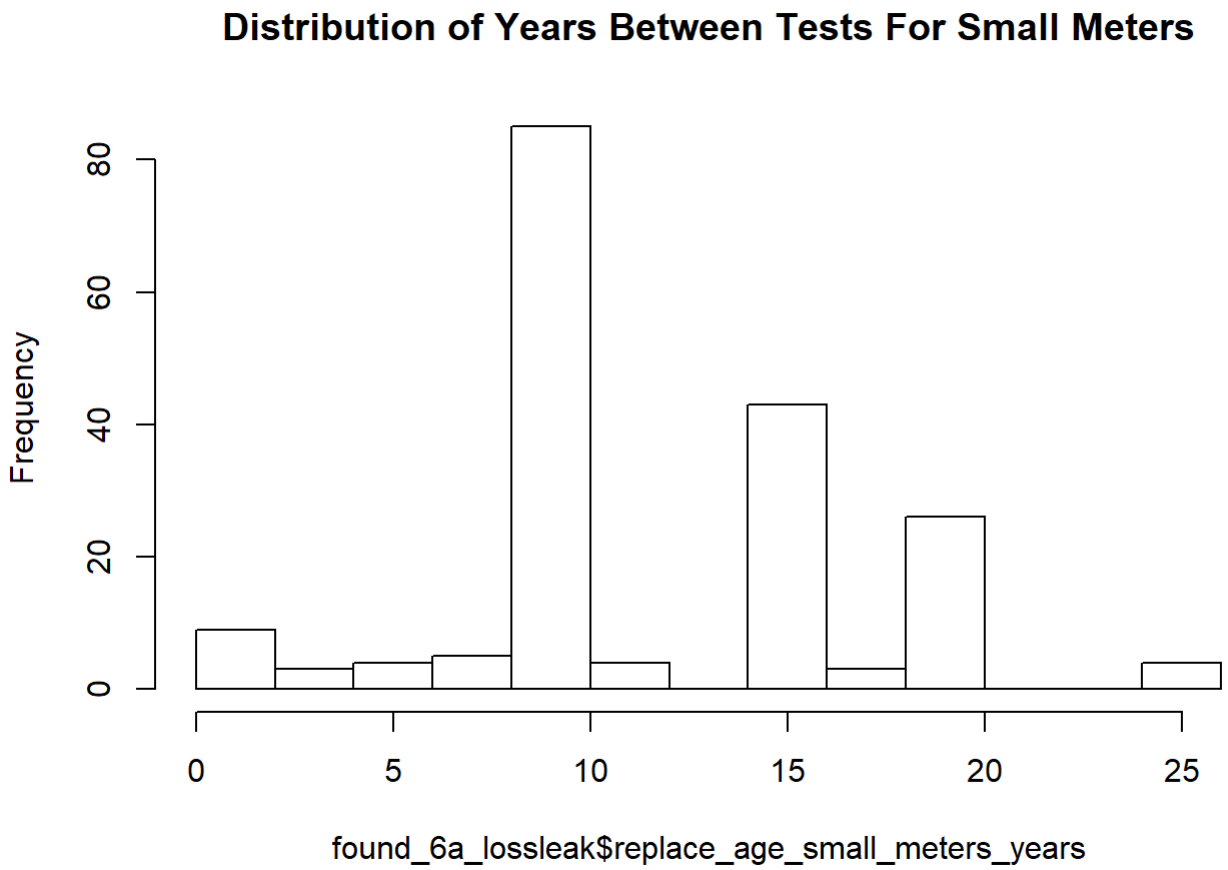
Recommendations

- Water detection technology could be a useful factor to correlate and predict with water loss. The current input method does not easily allow for this type of analysis.
- Our suggestion is to create a drop-down menu for this particular part of the reporting with the applicable leak detection technologies.

```
# read in data
found_6a_lossleak <- read.csv("EffDataPortal_Output_User690_20181112192716/foundational/foundational_06a_loss_and_leak_det.csv", stringsAsFactors = FALSE)
hist(found_6a_lossleak$time_between_tests_largemeters_years, main="Distribution of Years Between Tests For Large Meters")
```




```
hist(found_6a_lossleak$replace_age_small_meters_years, main="Distribution of Years Between Tests For Small Meters")
```



Text Analysis of Leak Detection Type with N-grams

```
leaks <- found_6a_lossleak
head(leaks[order(leaks$ce_annual_ndx),], n=3)
```

```
##   ce_annual_ndx meter_test_program awwa_policy_adherence
## 1          1912               YES                   YES
## 2          1913               YES                    NO
## 3          1916               YES                    NO
##                                                                                 non_awwa_test_procedures
## 1
## 2                                                Test as needed to address non-reading or customer requests
## 3 We replace about 20-30 meters per year based on age and largely on reactionary measures due to leakage.
##
                                                                astest_largemeters_describe
## 1 Yes,  we field test using AWWA recommendations for yearly intervals between testing. Go to meter pit, test port, hose t
o field test unit which is calibratied to shop tanks. 1-1.5 are changing out not tested
## 2
                              yes- by contract on concurrent system - Ute Mountain Tribe
## 3
                                                                                  No
##   time_between_tests_largemeters_years replace_age_small_meters_years
## 1                                  3.5                              15
## 2                                  2.0                               3
## 3                                  0.0                              10
##                                                                                    water_loss_comments
## 1 4-12" meters are tested every year, 3" every 2 years, 2" every 4 years, for total average of 3.5 years
## 2
## 3
##
                                             leak_detection_field_technology
## 1 Leak correlators, loggers, and listening devices.  Correlators to locate known leaks/breaks, loggers for undiscovered l
eaks, and microphones on hydrants. Exceptions reporting utilized (attached).
## 2
                           visual, water loss-increased flows from water plant
## 3
                                                 Sonic, hydrostatic, visual
##   pctannual_leak_inspection pctannual_pipe_replaces
## 1                        35                     0.5
## 2                        70                     2.0
## 3                        20                     5.0
##                                                        leak_detection_comments
## 1 Very proactive (survey over 300 miles of pipe per year listening for leaks).
## 2
## 3
```

```
leaks_short <- leaks[,c(1,9 )]
head(leaks_short, n=3)
```

```
##   ce_annual_ndx
## 1          1912
## 2          1913
## 3          1916
##
                                          leak_detection_field_technology
## 1 Leak correlators, loggers, and listening devices.  Correlators to locate known leaks/breaks, loggers for undiscovered l
eaks, and microphones on hydrants. Exceptions reporting utilized (attached).
## 2
                         visual, water loss-increased flows from water plant
## 3
                                                Sonic, hydrostatic, visual
```

```
library(dplyr)
library(tidytext)
leaks_short2<- leaks_short %>% unnest_tokens(word, leak_detection_field_technology)

# get rid of stop words
tidy_leaks <- leaks_short2 %>% anti_join(stop_words)
```

Most used Words

- These are the top 20 most common words typed into the leak detection technology field.

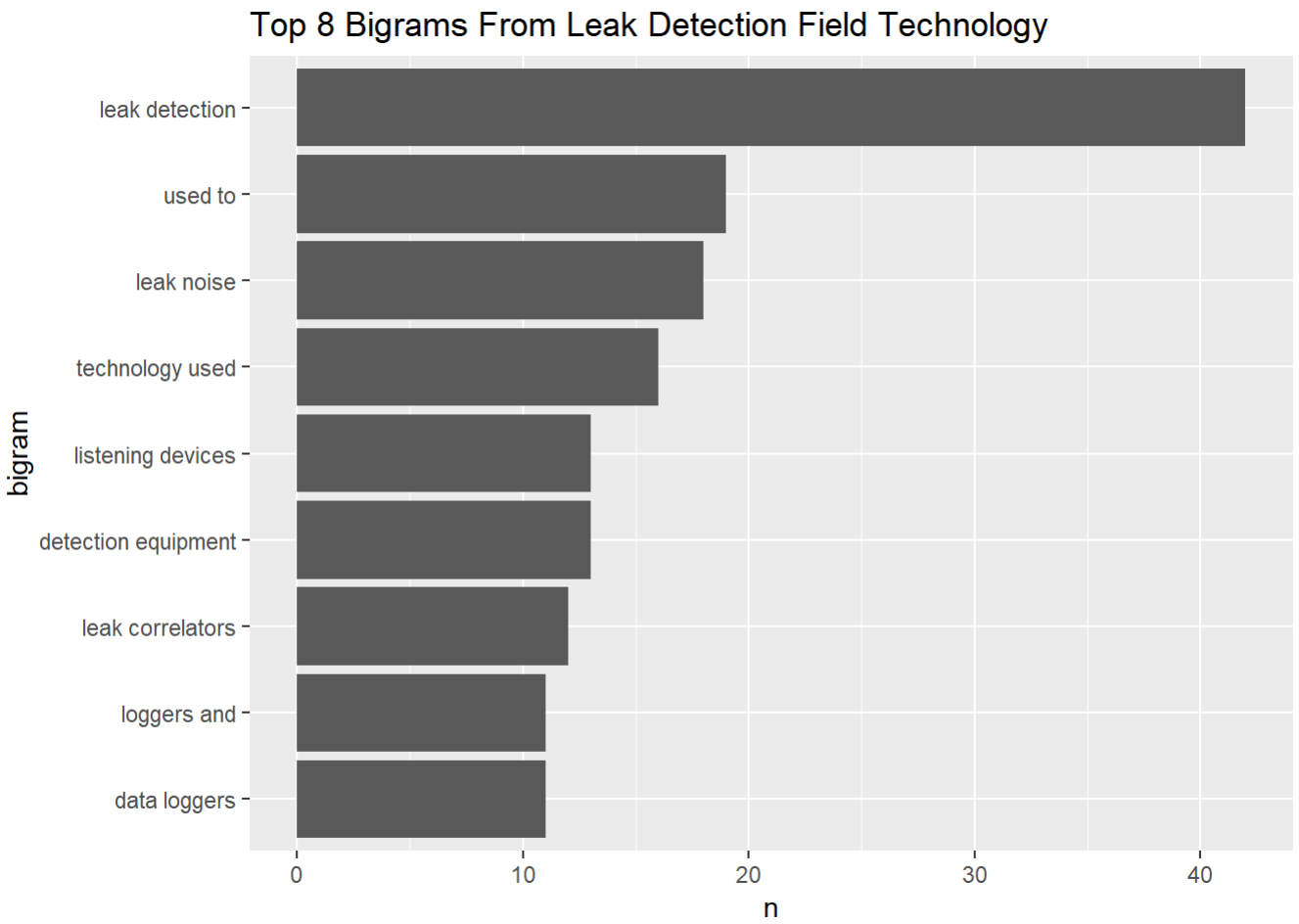
```
head(tidy_leaks %>% count(word, sort=TRUE), n=20)
```

```
## # A tibble: 20 x 2
##    word            n
##    <chr>       <int>
##  1 leak           96
##  2 detection      50
##  3 water          32
##  4 correlators    31
##  5 visual         29
##  6 leaks          28
##  7 loggers        28
##  8 data           27
##  9 surface        22
## 10 listening      21
## 11 technology     21
## 12 noise          20
## 13 system         20
## 14 equipment      19
## 15 acoustic       18
## 16 sonic          17
## 17 field          16
## 18 devices        14
## 19 meter          14
## 20 subsurface     13
```

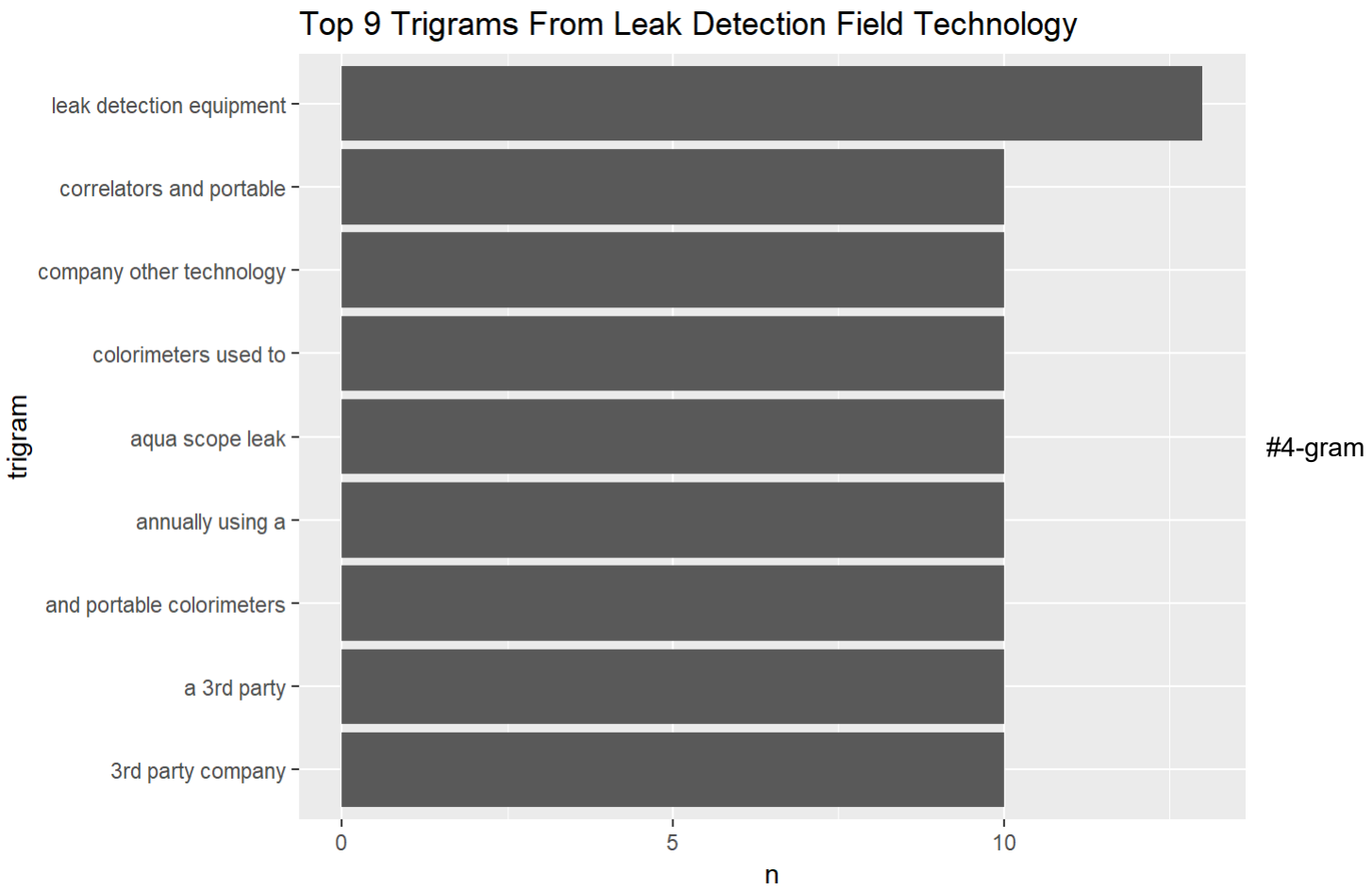
Finding n-grams

- These are the top 10 bi, tri, and 4-grams for the leak detection technology column.

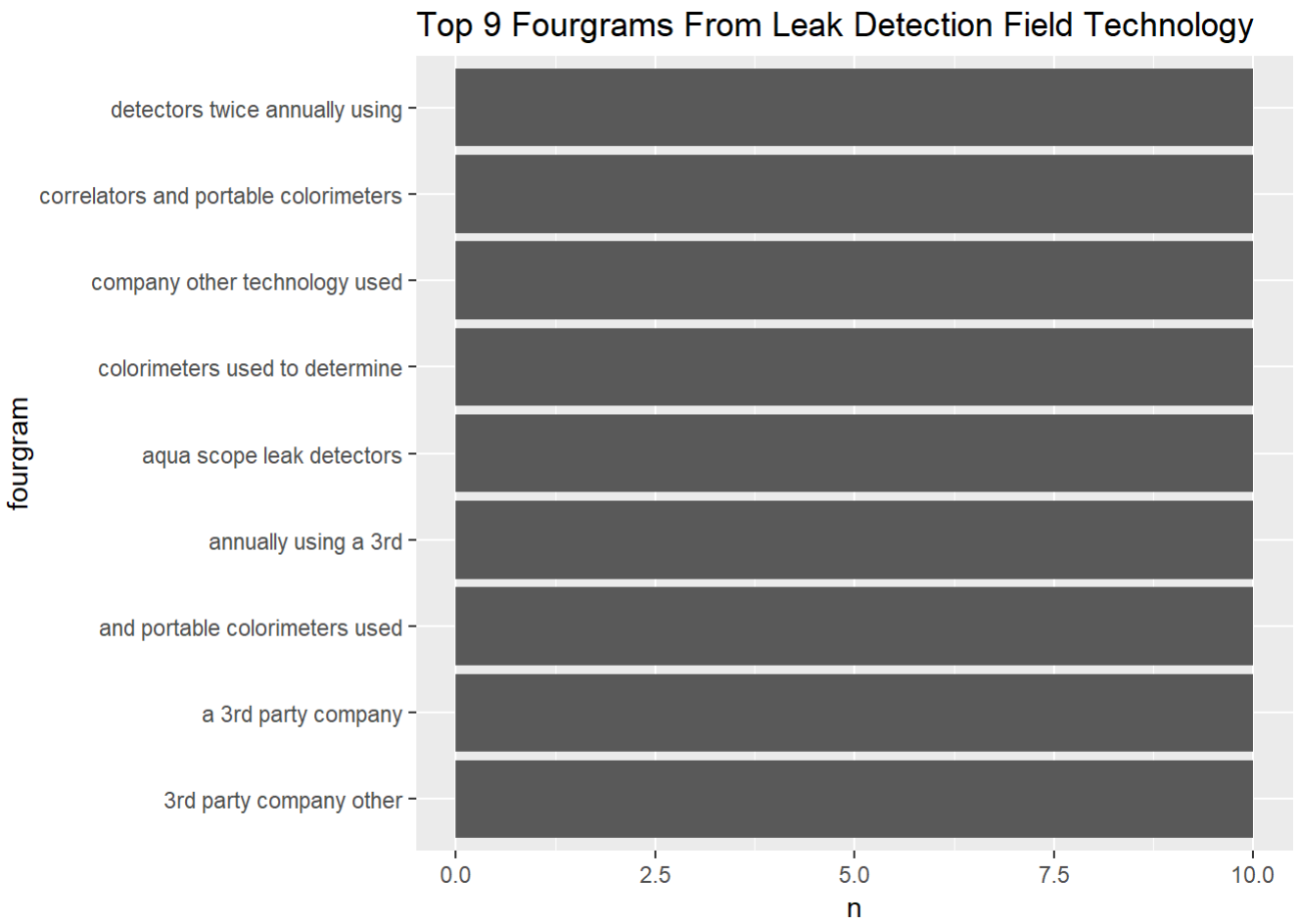
```
#2-gram
tidy_bigram <- leaks_short %>% unnest_tokens(bigram,leak_detection_field_technology, token="ngrams", n=2)
bill10 <- head(tidy_bigram %>% count(bigram, sort=TRUE), n=10)
# remove NA ( reorder)
bill10 <- bill10[!is.na(bill10$bigram),]
bill10 <- bill10 %>% mutate(bigram=reorder(bigram, n))

   ggplot(bill10, aes(bigram, n))+
  geom_col()+
  coord_flip()+
  ggtitle("Top 8 Bigrams From Leak Detection Field Technology")
```




```
#3-gram
tidy_trigram <- leaks_short %>% unnest_tokens(trigram,leak_detection_field_technology, token="ngrams", n=3)
tri10 <- head(tidy_trigram %>% count(trigram, sort=TRUE), n=10)

# remove NA ( reorder)
tri10 <- tri10[!is.na(tri10$trigram),]
tri10 <- tri10 %>% mutate(trigram=reorder(trigram, n))

   ggplot(tri10, aes(trigram, n))+
  geom_col()+
  coord_flip()+
  ggtitle("Top 9 Trigrams From Leak Detection Field Technology")
```




```
tidy_fourgram <- leaks_short %>% unnest_tokens(fourgram,leak_detection_field_technology, token="ngrams", n=4)
four10 <- head(tidy_fourgram %>% count(fourgram, sort=TRUE), n=10)

# remove NA ( reorder)
four10 <- four10[!is.na(four10$fourgram),]
four10 <- four10 %>% mutate(fourgram=reorder(fourgram, n))

   ggplot(four10, aes(fourgram, n))+
  geom_col()+
  coord_flip()+
  ggtitle("Top 9 Fourgrams From Leak Detection Field Technology")
```


Top 9 Fourgrams From Leak Detection Field Technology
fourgram
detectors twice annually using
correlators and portable colorimeters
company other technology used
colorimeters used to determine
aqua scope leak detectors
annually using a 3rd
and portable colorimeters used
a 3rd party company
3rd party company other
0.0
2.5
5.0
7.5
10.0
n