PAW Gov - Data Munging/Wrangling

Kenny Darrell, Lead Data Scientist - Elder Research

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What is it?

Data munging or data wrangling is the process of manually converting data from one “raw” form into another format that allows for more convenient consumption of the data.

The hidden aspect of Analytics

Predictive Analytics requires

1. Data Persistence to house data
2. Data Science to correctly answer questions
3. Data Products to visualize and consume results
4. Data Munging so that all the above are possible

Why, you ask?

- Data NEVER comes in the CORRECT format
- Data was collected for a DIFFERENT purpose
- Data comes from DISPERATE places
- Data CHANGES over time
- Data always has ERRORS in it

Data Janitor, the unsung hero of Data Science

This takes up roughly 80% of time/effort

You could double your time spent on analytics by reducing time on cleaning by only a quarter!

For Big-Data Scientists, 'Janitor Work' Is Key Hurdle to Insights

By STEVE LOHR AUG. 17, 2014

Monica Rogati, Jawbone's vice president for data science, with Brian Wilt, a senior data scientist.
Peter DaSilva for The New York Times

Pipes (brief detour)

- It is easier to munge data if we think in steps
- Using the pipe (%>%) construct helps
- Allows for left-to-right (not from the inside and out)
- make it easy to add steps anywhere in the sequence

Which is more readable

```
bop_on(scoop_up(hop_through(foo_foo, forest), field_mouse),
```

or

```
foo_foo %>%
  hop_through(forest) %>%
  scoop_up(field_mouse) %>%
  bop_on(head)
```

Setup

```
options(stringsAsFactors = FALSE)
library(dplyr)
library(lubridate)
library(purrr)
library(ggplot2)
library(stringr)
```

Where do we start?

Always start with a question!

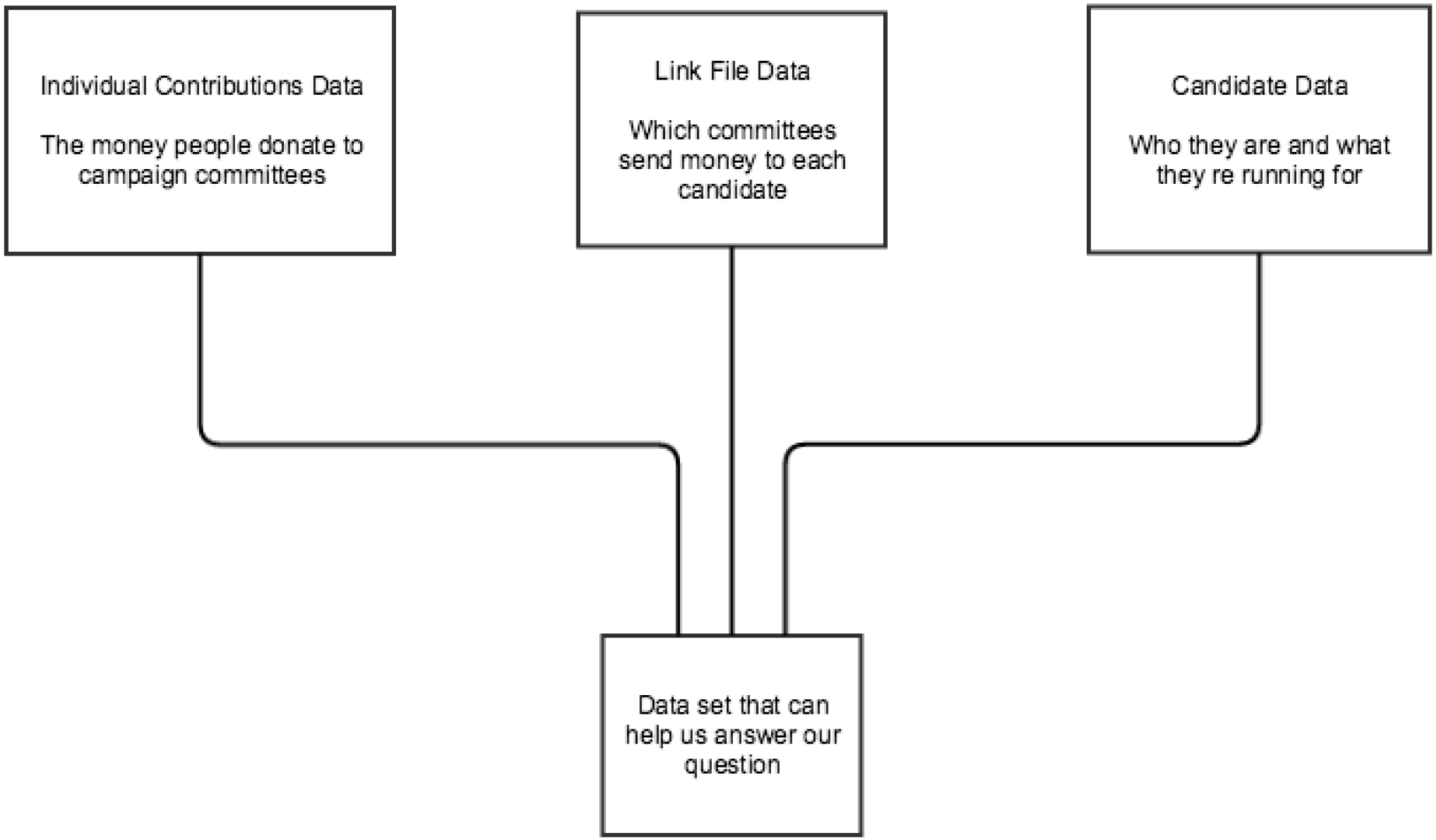
Which presidential candidate made more money?

The Data

2011 - 2012 Data Files

Name	Data File	Total Records	Updated	Format Description
Committee Master File	cm12.zip	14453	13-OCT-2015	CM Data Dictionary
Candidate Master File	cn12.zip	5628	13-OCT-2015	CN Data Dictionary
Candidate Committee Linkage File	ccl12.zip	6131	13-OCT-2015	CCL Data Dictionary
Any Transaction from One Committee to Another	oth12.zip	1012156	11-OCT-2015	OTH Data Dictionary
Contributions to Candidates (and other expenditures) from Committees	pas212.zip	396425	11-OCT-2015	PAS2 Data Dictionary
Contributions by Individuals	indiv12.zip	3352945	11-OCT-2015	INDIV Data Dictionary
Operating Expenditures	oppexp12.zip	1655885	11-OCT-2015	OPPEXP Data Dictionary

The real view



What does any of it mean

General Description

The individual contributions file contains each contribution from an individual to a federal committee if the contribution was at least $200.

Header file and file format information

A comma delimited header file is available for download.

The end-of-line (EOL) marker is line feed '\n' (LF, 0x0A, 10 in decimal). The Contributions by Individuals File contains the following information:

Column Name	Field Name	Position	Null?	Data Type	Description
CMTE_ID	Filer Identification Number	1	N	VARCHAR2 (9)	A 9-character alpha-numeric code assigned to a committee by the Federal Election Commission
AMNDT_IND	Amendment Indicator	2	Y	VARCHAR2 (1)	Indicates if the report being filed is new (N), an amendment (A) to a previous report, or a termination (T) report.
RPT_TP	Report Type	3	Y	VARCHAR2 (3)	Indicates the type of report filed. List of report type codes
TRANSACTION_PGI	Primary-General Indicator	4	Y	VARCHAR2 (5)	This code indicates the election for which the contribution was made. EYYYY (election plus election year) P = Primary G = General O = Other C = Convention R = Runoff S = Special

Load Individual Donations

```
ind <- read.csv('indiv12.txt', sep = '|',
                skipNul = T, na.strings = '',
                header = F, quote = "")
```

```
         V1 V2 V3   V4          V5 V6  V7
1 C00114132  A M2 <NA> 11930476682 15 IND     DAVIS, KAREN
2 C00114132  A M2 <NA> 11930476682 15 IND HOLLAND, MARK ROB
3 C00114132  A M2 <NA> 11930476682 15 IND  RICHARDS, GEORGE
4 C00114132  A M2 <NA> 11930476683 15 IND       KRAFT, WALI
5 C00114132  A M2 <NA> 11930476683 15 IND     BROWN, GARY S
6 C00114132  A M2 <NA> 11930476683 15 IND        DEE, LARRY
              V9 V10   V11                                V12
1 HENDERSONVILLE  NC 28791 NORTH STATE ANIMAL HOSPITAL VETE
2         PURVIS  MS 39475 HOLLAND VETERINARY HOSPITAL VETE
3        DANVILLE  IL 61834                VETERINARIAN VETE
4          PARIS  TX 75462       ANIMAL HEALTH CENTER VETE
5       PRINCETON  WV 24740         ANIMAL CARE CENTER VETE
6     HOLLYWOOD  FL 33021   HOLLYWOOD ANIMAL HOSPITAL VETE
```

The data has no names

```
names(ind) <- names(read.csv('indiv_header_file.csv'))
```

```
    CMTE_ID AMNDT_IND RPT_TP TRANSACTION_PGI   IMAGE_NUM TR
1 C00114132         A     M2             <NA> 11930476682
2 C00114132         A     M2             <NA> 11930476682
3 C00114132         A     M2             <NA> 11930476682
4 C00114132         A     M2             <NA> 11930476683
5 C00114132         A     M2             <NA> 11930476683
6 C00114132         A     M2             <NA> 11930476683
  ENTITY_TP                      NAME           CITY STATE
1       IND     DAVIS, KAREN LEIGH DR HENDERSONVILLE    NC
2       IND HOLLAND, MARK ROBERSON DR        PURVIS    MS
3       IND  RICHARDS, GEORGE E DR JR       DANVILLE    IL
4       IND       KRAFT, WALLACE E DR         PARIS    TX
5       IND     BROWN, GARY STEVEN DR      PRINCETON    WV
6       IND       DEE, LARRY GENE DR      HOLLYWOOD    FL
                    EMPLOYER   OCCUPATION TRANSACTION_DT T
1 NORTH STATE ANIMAL HOSPITAL VETERINARIAN        1052011
```

Select

Decrease the width of your data

```
ind %>%
  select(CMTE_ID, TRANSACTION_TP, ENTITY_TP,
         TRANSACTION_DT, TRANSACTION_AMT) -> ind
```

```
    CMTE_ID TRANSACTION_TP ENTITY_TP TRANSACTION_DT TRANSAC
1 C00114132             15       IND        1052011
2 C00114132             15       IND        1032011
3 C00114132             15       IND        1052011
4 C00114132             15       IND        1052011
5 C00114132             15       IND        1112011
6 C00114132             15       IND        1112011
```

Filter

Decrease the height of your data

```
ind %>%
  filter(TRANSACTION_TP == '15') %>%
  select(-TRANSACTION_TP) -> ind
```

	CMTE_ID	ENTITY_TP	TRANSACTION_DT	TRANSACTION_AMT
1	C00114132	IND	1052011	550
2	C00114132	IND	1032011	535
3	C00114132	IND	1052011	535
4	C00114132	IND	1052011	250
5	C00114132	IND	1112011	5000
6	C00114132	IND	1112011	5000

The process

- Load Data
- Give it correct names
- Select fields (columns) we need
- Filter rows (observations) that are relevant
- Rinse and repeat for other data sets

Remove code noise

```
add_names <- function(df, file) {
  names(df) <- names(read.csv(file))
  df
}

read_fec <- function(file) {
  read.csv(file, sep = '|', skipNul = T, na.strings = '',
           header = F, quote = "")
}
```

Candidate Data

```
'cn12.txt' %>%
  read_fec %>%
  add_names('cn_header_file.csv') %>%
  select(CAND_ID, CAND_NAME, CAND_ELECTION_YR, CAND_OFFICE)
  filter(CAND_OFFICE == 'P')  %>%
  select(-CAND_OFFICE) -> cand
```

	CAND_ID	CAND_NAME	CAND_ELECTION_YR
1	P00000133	MCDANIELS, EDISON PENROW	2008
2	P00000679	CARROLL, JERRY LEON	2012
3	P00000729	MUZYK, GEORGE ALEXANDER	2000
4	P00001792	ENGLERIUS, MAXIMUS T	2012
5	P00002295	BYERLEY, LESTER F JR	2012
6	P00002568	LEVINSON, MICHAEL STEPHEN	2012

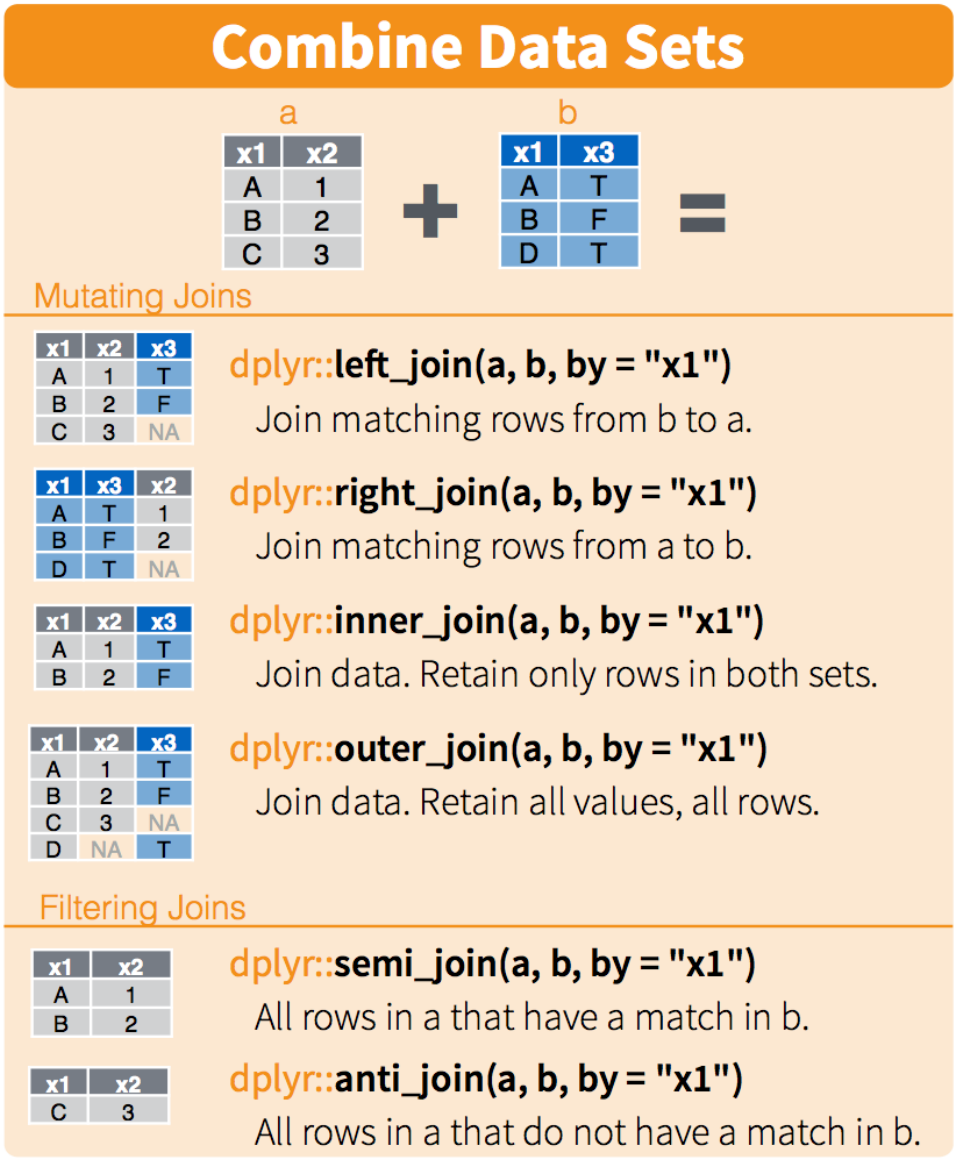
Link Data

```
'ccl12.txt' %>%
  read_fec %>%
  add_names('ccl_header_file.csv') %>%
  select(CAND_ID, CAND_ELECTION_YR, CMTE_ID) -> link
```

```
    CAND_ID CAND_ELECTION_YR   CMTE_ID
1 H0AK00089              2010 C00466698
2 H0AK00097              2012 C00525261
3 H0AL00016              2012 C00464040
4 H0AL01030              2012 C00459495
5 H0AL02087              2012 C00493783
6 H0AL02087              2012 C00488874
```

Joins

How do we turn three data sets into one?



Joins

This will increase the width of the data

```
cand %>%
  inner_join(link, by = c("CAND_ID", "CAND_ELECTION_YR")) -
```

```
    CAND_ID                 CAND_NAME CAND_ELECTION_YR   CM
1 P00000133 MCDANIELS, EDISON PENROW             2008 C0044
2 P00000679      CARROLL, JERRY LEON             2012 C0021
3 P00000729  MUZYK, GEORGE ALEXANDER             2000 C0028
4 P00002295     BYERLEY, LESTER F JR             2012 C0049
5 P00003186    THOMPSON, FRED DALTON             2008 C0043
6 P00003236          PRATTAS, JAMES              2012 C0049
```

Joins

```
df %>%
  inner_join(ind, by = "CMTE_ID") -> df
```

```
    CAND_ID                CAND_NAME CAND_ELECTION_YR   CMTE
1 P00003392 CLINTON, HILLARY RODHAM              2008 C00431
2 P00003392 CLINTON, HILLARY RODHAM              2008 C00431
3 P00003392 CLINTON, HILLARY RODHAM              2008 C00431
4 P00003392 CLINTON, HILLARY RODHAM              2008 C00431
5 P00003392 CLINTON, HILLARY RODHAM              2008 C00431
6 P00003392 CLINTON, HILLARY RODHAM              2008 C00431
  TRANSACTION_DT TRANSACTION_AMT
1        2082011             -250
2        2082011              250
3        1112011              300
4        1112011              700
5        1062011              500
6        2052011             -250
```

Cleanup

```
df %>%
  select(-CAND_ID, -CMTE_ID) -> df
```

```
                  CAND_NAME CAND_ELECTION_YR ENTITY_TP TRANSA
1 CLINTON, HILLARY RODHAM              2008       IND
2 CLINTON, HILLARY RODHAM              2008       IND
3 CLINTON, HILLARY RODHAM              2008       IND
4 CLINTON, HILLARY RODHAM              2008       IND
5 CLINTON, HILLARY RODHAM              2008       IND
6 CLINTON, HILLARY RODHAM              2008       IND
  TRANSACTION_AMT
1            -250
2             250
3             300
4             700
5             500
6            -250
```

Missing values

```
df %>% filter(is.na(TRANSACTION_DT))
```

```
                          CAND_NAME CAND_ELECTION_YR ENTITY_TP
1 ROMNEY, MITT / RYAN, PAUL D.                2012       <NA>
2 ROMNEY, MITT / RYAN, PAUL D.                2012        IND
  TRANSACTION_AMT
1             250
2             250
```

Date is not really date

```
str(df)
```

```
'data.frame':   1125121 obs. of  5 variables:
 $ CAND_NAME        : chr  "CLINTON, HILLARY RODHAM" "CLINTO
 $ CAND_ELECTION_YR: int  2008 2008 2008 2008 2008 2008 200
 $ ENTITY_TP        : chr  "IND" "IND" "IND" "IND" ...
 $ TRANSACTION_DT   : int  2082011 2082011 1112011 1112011 1
 $ TRANSACTION_AMT : int  -250 250 300 700 500 -250 250 200
```

Mutate to the Rescue

```
df %>%
  filter(!is.na(TRANSACTION_DT)) %>%
  mutate(date = as.Date(mdy(TRANSACTION_DT))) %>%
  select(-TRANSACTION_DT) -> df
```

```
                  CAND_NAME CAND_ELECTION_YR ENTITY_TP TRANSA
1 CLINTON, HILLARY RODHAM              2008       IND
2 CLINTON, HILLARY RODHAM              2008       IND
3 CLINTON, HILLARY RODHAM              2008       IND
4 CLINTON, HILLARY RODHAM              2008       IND
5 CLINTON, HILLARY RODHAM              2008       IND
6 CLINTON, HILLARY RODHAM              2008       IND
        date
1 2011-02-08
2 2011-02-08
3 2011-01-11
4 2011-01-11
5 2011-01-06
```

Too verbose

```
df %>%
  rename(  name = CAND_NAME,
         amount = TRANSACTION_AMT,
           type = ENTITY_TP,
           year = CAND_ELECTION_YR) -> df
```

	name	year	type	amount	date
1	CLINTON, HILLARY RODHAM	2008	IND	-250	2011-02-08
2	CLINTON, HILLARY RODHAM	2008	IND	250	2011-02-08
3	CLINTON, HILLARY RODHAM	2008	IND	300	2011-01-11
4	CLINTON, HILLARY RODHAM	2008	IND	700	2011-01-11
5	CLINTON, HILLARY RODHAM	2008	IND	500	2011-01-06
6	CLINTON, HILLARY RODHAM	2008	IND	-250	2011-02-05

Names look pretty rough

```
df$name %>%
  str_split(", ") %>%
  map_chr(~ paste(.[[2]], .[[1]])) -> df$name
```

	name	year	type	amount	date
1	HILLARY RODHAM CLINTON	2008	IND	-250	2011-02-08
2	HILLARY RODHAM CLINTON	2008	IND	250	2011-02-08
3	HILLARY RODHAM CLINTON	2008	IND	300	2011-01-11
4	HILLARY RODHAM CLINTON	2008	IND	700	2011-01-11
5	HILLARY RODHAM CLINTON	2008	IND	500	2011-01-06
6	HILLARY RODHAM CLINTON	2008	IND	-250	2011-02-05

Just one election

```
df %>%
  filter(year == 2012) %>%
  select(-year) -> df
```

```
          name type amount       date
1 HERMAN CAIN  IND    250 2011-10-31
2 HERMAN CAIN  IND    250 2011-11-01
3 HERMAN CAIN  IND    500 2011-10-26
4 HERMAN CAIN  IND    250 2011-10-25
5 HERMAN CAIN  IND   1000 2011-11-02
6 HERMAN CAIN  IND    250 2011-10-28
```

Only People

```
df %>%
  filter(type %in% c('IND', 'CAN')) %>%
  select(-type) -> df
```

```
            name amount       date
1 HERMAN CAIN     250 2011-10-31
2 HERMAN CAIN     250 2011-11-01
3 HERMAN CAIN     500 2011-10-26
4 HERMAN CAIN     250 2011-10-25
5 HERMAN CAIN    1000 2011-11-02
6 HERMAN CAIN     250 2011-10-28
```

Who?

```
df %>%
  group_by(name) %>%
  summarise(obs = n()) -> popular
```

	name	obs
1	BARACK OBAMA	598632
2	CHARLES E. ''BUDDY'' III ROEMER	11
3	CHRISTINA (VICE PRES) LOPEZ	28
4	EDGAR A LAWSON	2
5	FRED KARGER	93
6	GARY EARL JOHNSON	1887
7	HERMAN CAIN	11713
8	JAMES R (RICK) PERRY	12079
9	JARED BLANKENSHIP	50
10	JILL ANN REED	24
11	JILL STEIN	872
12	JOHN DAVIS HAYWOOD	1
13	JON HUNTSMAN	3042

Who?

```
popular %>% top_n(10, obs) -> most_popular
```

	name	obs
1	BARACK OBAMA	598632
2	GARY EARL JOHNSON	1887
3	HERMAN CAIN	11713
4	JAMES R (RICK) PERRY	12079
5	JON HUNTSMAN	3042
6	MITT / RYAN ROMNEY	417746
7	NEWT GINGRICH	19027
8	RICHARD J. SANTORUM	16575
9	RON PAUL	38477
10	TIMOTHY PAWLENTY	3831

Not Everybody

```
df %>%
  semi_join(most_popular, by = 'name') -> df
```

```
             name amount       date
1 BARACK OBAMA    5000 2011-11-19
2 BARACK OBAMA     500 2011-10-04
3 BARACK OBAMA   30800 2011-12-31
4 BARACK OBAMA   10000 2011-10-26
5 BARACK OBAMA   10000 2011-11-22
6 BARACK OBAMA     250 2011-11-03
```

Back to the Future

```
df %>%
  filter(date < as.Date(mdy('11152012'))) -> df
```

```
            name amount       date
1 BARACK OBAMA    5000 2011-11-19
2 BARACK OBAMA     500 2011-10-04
3 BARACK OBAMA   30800 2011-12-31
4 BARACK OBAMA   10000 2011-10-26
5 BARACK OBAMA   10000 2011-11-22
6 BARACK OBAMA     250 2011-11-03
```

From average people

```
df %>%
  filter(abs(amount) < 100000) -> df
```

```
            name amount       date
1 BARACK OBAMA    5000 2011-11-19
2 BARACK OBAMA     500 2011-10-04
3 BARACK OBAMA   30800 2011-12-31
4 BARACK OBAMA   10000 2011-10-26
5 BARACK OBAMA   10000 2011-11-22
6 BARACK OBAMA     250 2011-11-03
```

Aggregations

```
df %>%
  group_by(name, date) %>%
  summarise(total = sum(amount)) -> df
```

```
Source: local data frame [6 x 3]
Groups: name

           name       date   total
         (chr)     (date)   (int)
1 BARACK OBAMA 2011-04-04 1194427
2 BARACK OBAMA 2011-04-05  822770
3 BARACK OBAMA 2011-04-06  919561
4 BARACK OBAMA 2011-04-07  823532
5 BARACK OBAMA 2011-04-08 1168861
6 BARACK OBAMA 2011-04-09  228749
```

Add in missing days

```
allDates <-
  data.frame(date = as.Date(min(df$date) : max(df$date),
                            origin = origin))

df %>%
  split(.$name) %>%
  map( ~ full_join(., cbind(allDates, name = .$name[1]),
                   by = c("name", "date"))) %>%
  bind_rows %>%
  arrange(name, date) -> df
```

```
Source: local data frame [6 x 3]

          name       date total
         (chr)     (date) (int)
1 BARACK OBAMA 2008-03-27    NA
2 BARACK OBAMA 2008-03-28    NA
3 BARACK OBAMA 2008-03-29    NA
```

Zero

```
df$total <- ifelse(is.na(df$total), 0, df$total)
```

```
Source: local data frame [6 x 3]

           name       date total
         (chr)     (date) (dbl)
1 BARACK OBAMA 2008-03-27     0
2 BARACK OBAMA 2008-03-28     0
3 BARACK OBAMA 2008-03-29     0
4 BARACK OBAMA 2008-03-30     0
5 BARACK OBAMA 2008-03-31     0
6 BARACK OBAMA 2008-04-01     0
```

Order them

```
df %>%
  arrange(name, date) -> df
```

```
Source: local data frame [6 x 3]

           name       date total
         (chr)     (date) (dbl)
1 BARACK OBAMA 2008-03-27     0
2 BARACK OBAMA 2008-03-28     0
3 BARACK OBAMA 2008-03-29     0
4 BARACK OBAMA 2008-03-30     0
5 BARACK OBAMA 2008-03-31     0
6 BARACK OBAMA 2008-04-01     0
```

Running total

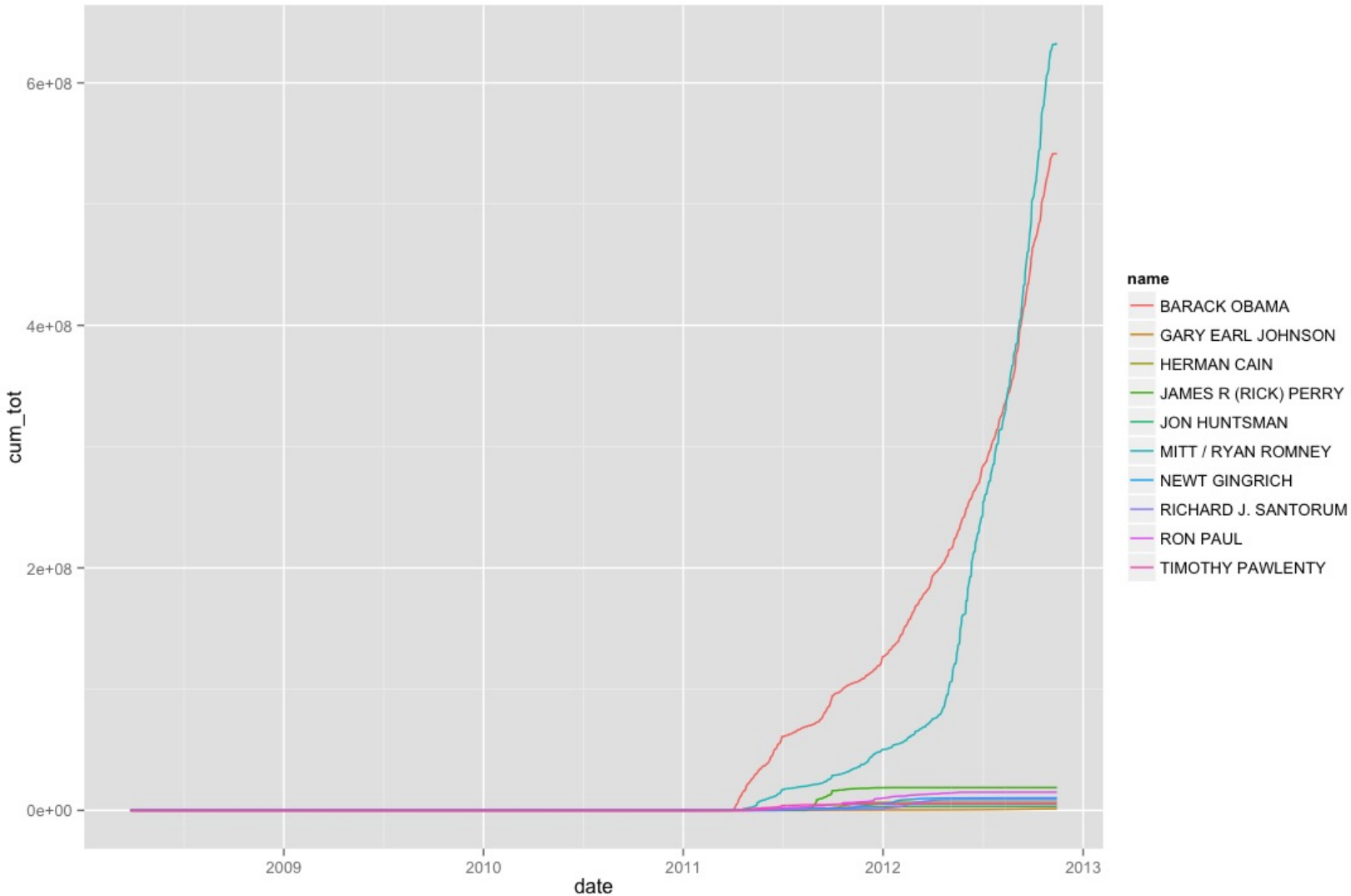
```
df %>%
  group_by(name) %>%
  mutate(cum_tot = cumsum(total)) -> tot
```

```
Source: local data frame [6 x 4]
Groups: name

           name       date total cum_tot
          (chr)     (date) (dbl)   (dbl)
1 BARACK OBAMA 2008-03-27     0       0
2 BARACK OBAMA 2008-03-28     0       0
3 BARACK OBAMA 2008-03-29     0       0
4 BARACK OBAMA 2008-03-30     0       0
5 BARACK OBAMA 2008-03-31     0       0
6 BARACK OBAMA 2008-04-01     0       0
```

Result

```
ggplot(tot, aes(x = date, y = cum_tot,
                color = name, group = name)) + geom_line()
```



Total Money

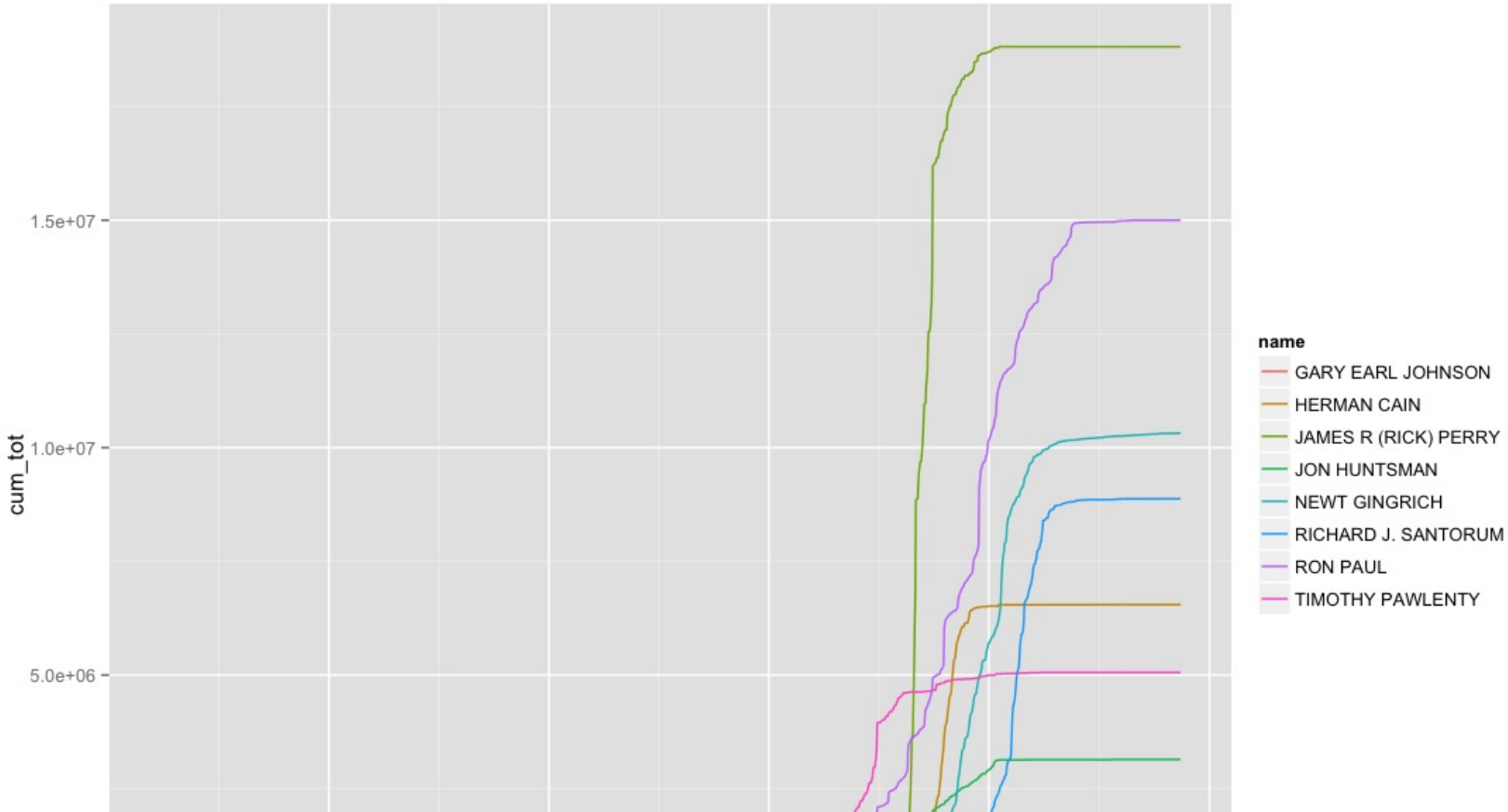
```
tot %>%
  group_by(name) %>%
  summarise(max = max(cum_tot)) %>%
  arrange(desc(max)) -> totals
```

```
Source: local data frame [10 x 2]

                     name       max
                    (chr)     (dbl)
1    MITT / RYAN ROMNEY 632468656
2          BARACK OBAMA 541859246
3  JAMES R (RICK) PERRY  18817834
4              RON PAUL  14998597
5          NEWT GINGRICH  10317229
6   RICHARD J. SANTORUM   8875965
7            HERMAN CAIN   6548949
8      TIMOTHY PAWLENTY   5057130
9          JON HUNTSMAN   3145329
```

Modified Result

```
tot %>%
  anti_join(totals %>% top_n(2, max), by = 'name') %>%
  ggplot(aes(x = date, y = cum_tot,
             color = name, group = name)) +
  geom_line()
```



What did we answer

We changed the question quite a bit.

Which presidential candidate made more money?

Of the popular candidates in the 2012 Presidential Election, who received the most contributions from average people using observations that made temporal sense.

For some definition of the words popular and average.