Ranked_choice Voting

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Ranked-Choice Voting in Maine Congressional District 2: Nov. 6, 2018.

The data are published on a Maine Secretary of State website.

Click Here"Certified Updated Results"

Click Here"Ranked-Choice Rules"

Load libraries

```
suppressMessages(library(readr)) # fast load
suppressMessages(library(dplyr)) # filter
suppressMessages(library(ggplot2))
suppressMessages(library(forcats))
```

```
rm(list = ls())
path <- "https://raw.github.com/damonzon/Ranked_Choice_Voting_Maine/master/MaineTidyData2018.csv"
data <- read_csv(path)
start <- Sys.time()
data <- filter (data, first != "overvote")
table(data$first)
```

```
##
##      Bond    Golden      Hoar  Poliquin undervote
##     16415    131822      6782    133993      6641
```

```
round(prop.table(table(data$first)), 4)
```

```
##
##      Bond    Golden      Hoar  Poliquin undervote
##    0.0555    0.4459    0.0229    0.4532    0.0225
```

Write functions to shift column data to the left

```
shift_left <- function(x) {
    shift$first <<- shift$second
    shift$second <<- shift$third
    shift$third <<- shift$fourth
    shift$fourth <<- shift$fifth
    shift$fifth <<- "undervote"
}
```

```
shift_under <- function(x) {
    shift_left(shift)
    not_under <<- filter(shift, first != "undervote")
    shift <<- filter(shift, first == "undervote")
    shift_left(shift)
    shift <<- rbind(not_under, shift)
    shift <<- filter(shift, first != "undervote")
}
```

```
continue <- filter(data, first != "undervote")
table(continue$first)
```

```
##
##     Bond   Golden     Hoar Poliquin
##    16415   131822     6782   133993
```

```
shift <- filter(data, first == "undervote")
shift_left(shift)
shift <- filter(shift, first != "undervote" & first != "overvote")
continue <- rbind(continue, shift)
```

Round 1 Results

```
table(continue$first)
```

```
##
##     Bond   Golden     Hoar Poliquin
##    16552   132013     6875   134184
```

```
round(prop.table(table(continue$first)), 4)
```

```
##
##     Bond   Golden     Hoar Poliquin
##   0.0571   0.4558   0.0237   0.4633
```

The vote totals are identical to those in the updated certified report.

Poliquin with 134184 votes, led in Round 1 with 46.3%. According to the rules of ranked-choice voting, to be declared a winner, a candidate had to have at least as many votes as the winning threshold.

```
Poliquin <- nrow(filter(continue, first == "Poliquin"))
WT <- nrow(continue) * 0.5 + 1
cat("The winning threshold was", WT, "continuing votes")
```

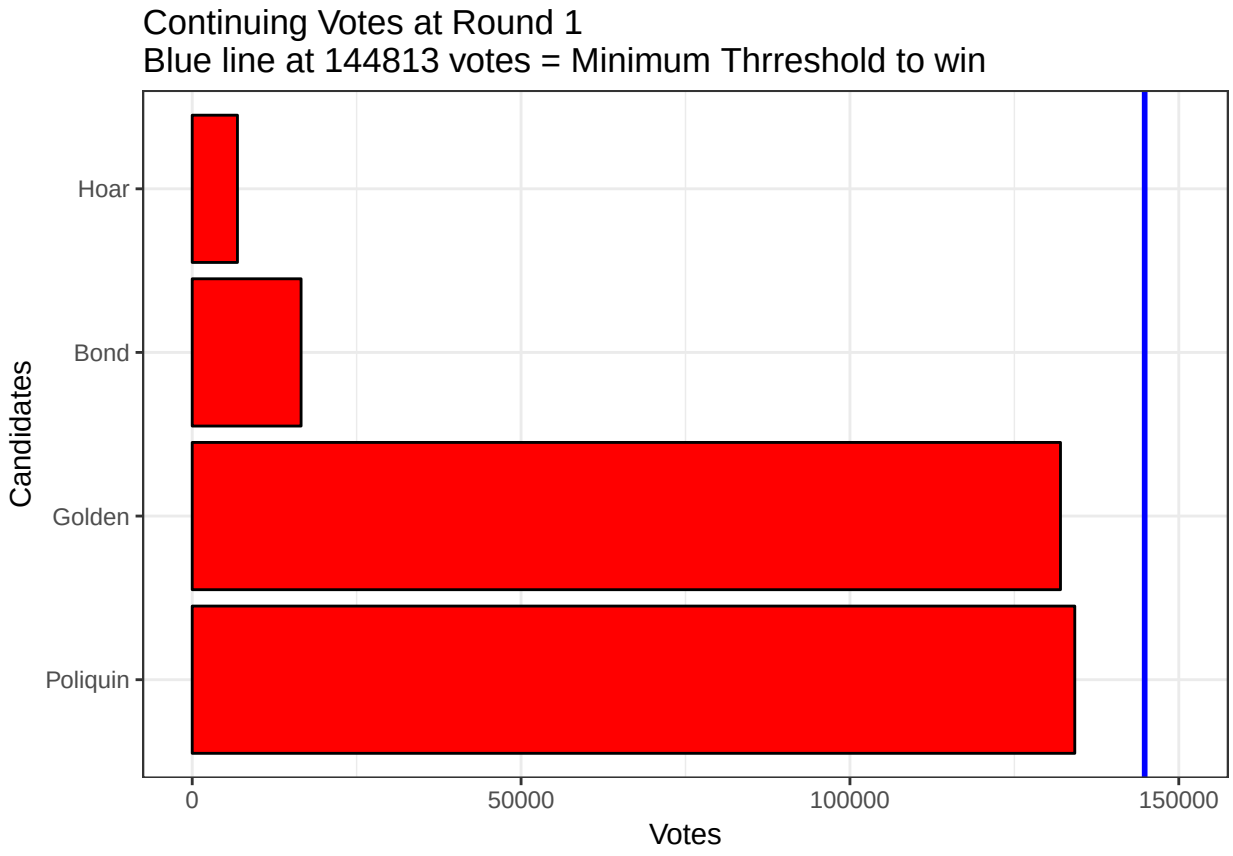
```
## The winning threshold was 144813 continuing votes
```

```
cat("Poliquin fell short of winning by", WT - Poliquin, "votes")
```

```
## Poliquin fell short of winning by 10629 votes
```

Plot Round 1

```
congress<- as.factor(continue$first)
p <- ggplot(continue, aes(fct_infreq(congress))) +
    geom_bar(fill="red", color="black") +
    theme_bw() +
    ggtitle("Continuing Votes at Round 1\nBlue line at 144813 votes = Minimum Thrreshold to win") +
    xlab("Candidates") +
    ylab("Votes") +
    geom_hline(yintercept = 144813, linetype = "solid", color = "blue", size=1) +
    ylim(0, 150000) +
    coord_flip()
p
```



We now proceed to the next round by dropping the candidate with the fewest votes: Hoar.

```
shift <- filter(continue, first == "Hoar")
shift_under(shift)
shift <- filter(shift, first != "undervote")
right1 <- shift
table(right1$first)
```

```
##
##     Bond   Golden     Hoar overvote Poliquin
##     2606     1194      141       21      886
```

```
shift <- filter(right1, first == "Hoar")
shift_under(shift)
shift <- filter(shift, first != "undervote")
right2 <- shift
table(right2$first)
```

```
##
##     Bond   Golden     Hoar Poliquin
##       11        8      106        2
```

```
shift <- filter(right2, first == "Hoar")
shift_under(shift)
shift <- filter(shift, first != "undervote")
right3 <- shift
table(right3$first)
```

```
##
##     Bond   Golden     Hoar Poliquin
##        2        1       98        1
```

```
shift <- filter(right3, first == "Hoar")
shift_under(shift)
shift <- filter(shift, first != "undervote")
right4 <- shift
table(right4$first)
```

```
##
## Bond Hoar
##    2   93
```

```
continue <- rbind(continue, right1, right2,
    right3, right4)
continue <- filter(continue,
    first != "Hoar")
continue <- filter(continue,
    first != "overvote")
```

Results after dropping Hoar

```
table(continue$first)
```

```
##
##     Bond   Golden Poliquin
##    19173   133216   135073
```

```
round(prop.table(table(continue$first)), 4)
```

```
##
##     Bond   Golden Poliquin
##   0.0667   0.4634   0.4699
```

All three remaining candidates gained votes from the alternative choices of the Hoar voters. Now Poliquin led with 47.0 to 46.3 for Golden, but the tally was still less than 50% +1.

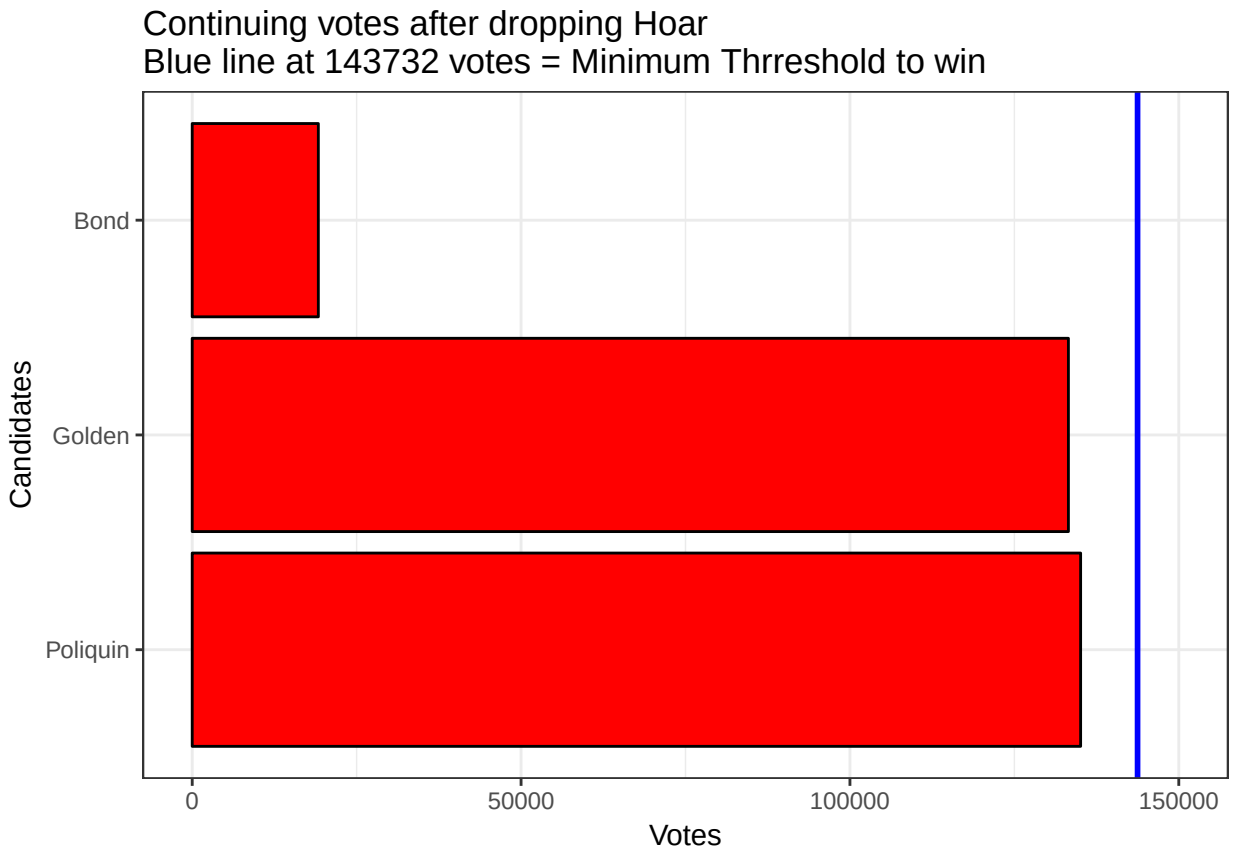
```
Poliquin <- nrow(filter(continue, first == "Poliquin"))
WT <- nrow(continue) * 0.5 + 1
cat("The winning threshold was", WT, "continuing votes")
```

```
## The winning threshold was 143732 continuing votes
```

```
cat("Poliquin fell short of winning by", WT - Poliquin, "votes")
```

```
## Poliquin fell short of winning by 8659 votes
```

```
congress<- as.factor(continue$first)
p <- ggplot(continue, aes(fct_infreq(congress))) +
    geom_bar(fill="red", color="black") +
    theme_bw() +
    ggtitle("Continuing votes after dropping Hoar\nBlue line at 143732 votes = Minimum Thrreshold to wi
    xlab("Candidates") +
    ylab("Votes") +
    geom_hline(yintercept = 143732, linetype = "solid", color = "blue", size=1) +
    ylim(0, 150000) +
    coord_flip()
p
```



So we now remove Bond votes and continue the analysis.

```
data <- continue
continue <- filter(data, first != "Bond")
shift <- filter(data, first == "Bond" | first == "Hoar")
shift_under(shift)
right1 <- filter(shift, first != "overvote")
shift <- filter(right1, first == "Bond" | first == "Hoar")
shift_under(shift)
right2 <- filter(shift, first != "overvote")
shift <- filter(right2, first == "Bond" | first == "Hoar")
shift_under(shift)
right3 <- filter(shift, first != "overvote")
shift <- filter(right3, first == "Bond" | first == "Hoar")
shift_under(shift)
right4 <- filter(shift, first != "overvote")
continue <- rbind(continue, right1, right2, right3, right4)
continue <- filter(continue, first != "Bond" & first != "Hoar")
```

```r
table(continue$first)
```

```
##
##   Golden Poliquin
##   142440   138931
```

```r
round(prop.table(table(continue$first)), 4)
```

```
##
##   Golden Poliquin
##   0.5062   0.4938
```

```r
end <- Sys.time()
round(end - start,3)
```

```
## Time difference of 3.445 secs
```

Final Results

The ranked-choice process has produced a clear winner. Golden now has 142440 (50.62%) of the continuing votes, compared to 138931 (49.38%) for Poliquin.

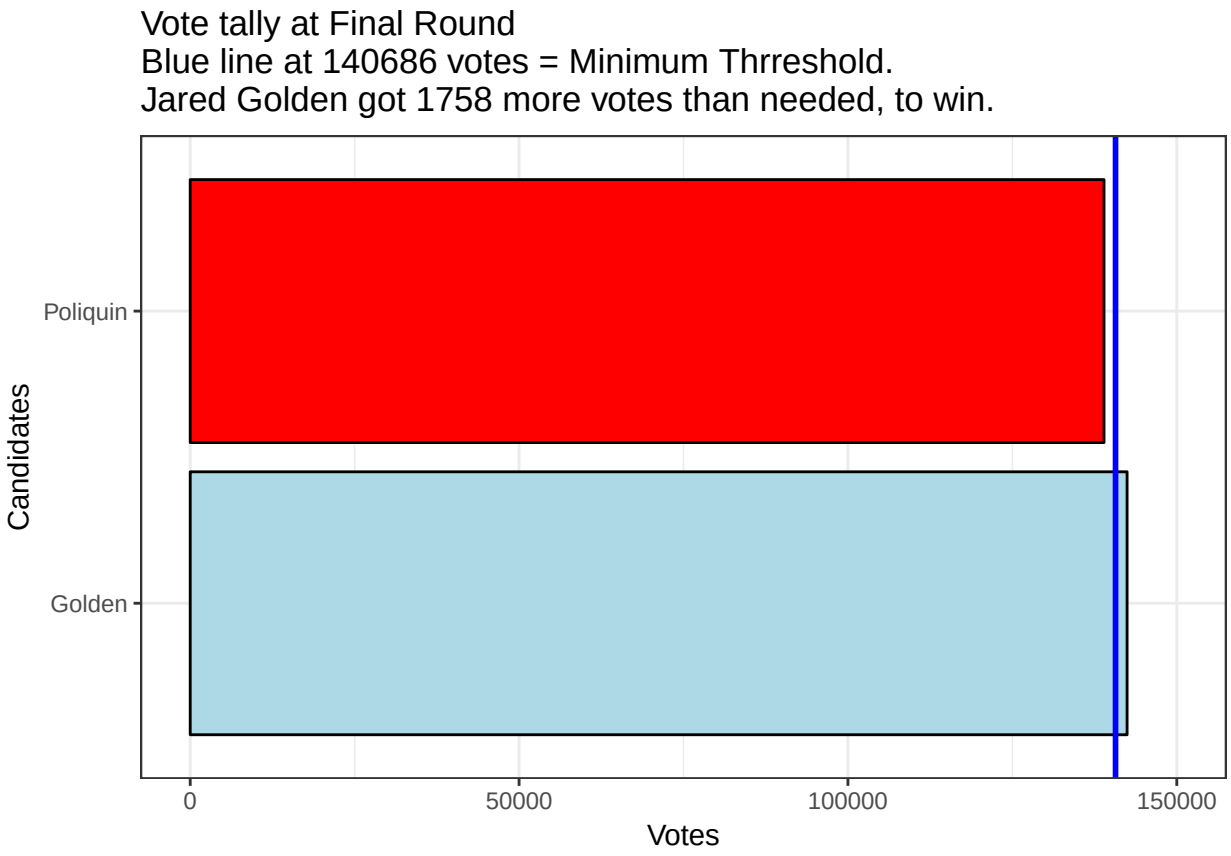
```r
Golden<- nrow(filter(continue, first == "Golden"))
WT <- round(nrow(continue) * 0.5 + 1)
cat("The winning threshold was", WT, "continuing votes")
```

```
## The winning threshold was 140686 continuing votes
```

```r
cat("Golden exceeded the minimun threshold by",Golden - WT, "votes")
```

```
## Golden exceeded the minimun threshold by 1754 votes
```

```r
win <- factor(c("lightblue","red"))
congress<- as.factor(continue$first)
p <- ggplot(continue, aes(fct_infreq(congress))) +
    geom_bar(fill= win, color="black") +
    theme_bw() +
    ggtitle("Vote tally at Final Round\nBlue line at 140686 votes = Minimum Thrreshold.\nJared Golden g
    xlab("Candidates") +
    ylab("Votes") +
    geom_hline(yintercept = 140686, linetype = "solid", color = "blue", size=1) +
    ylim(0, 150000) +
    coord_flip()
p
```



Some have questioned the validity of the election results, because the software used by the Secretary of State was "propriety". In other words, we don't know what it is and what algorithms it used. Thus it was important to demonstrate that "open" software, available to all, can get the identical results, and give voters confidence that the process is fair, accurate and transparent.

The gold standard for data analysis in science, elections, etc. is "Reproducibility". This analysis was done with the programming language "R", using Rmarkdown to produce this pdf file. It could also be output to Word and html formats.

Here are results obtained by the "Python" programming language.

Click Here"Maine Congressional District 2: Replication"

A	B	C	D	E	F	G
Report Name	**Summary Report**					
Election Name	**General Election**					
Election Date	**11.06.18**					
Office Title	**Congressional District 2**					
	Round 1			**Round 2**		
Candidate Names	**Votes**	**Percentage**	**Transfer**	**Votes**	**Percentage**	**Transfer**
Bond, Tiffany L.	16552	05.71%	-16552	0	00.00%	0
DEM Golden, Jared F.	132013	45.58%	**10427**	**142440**	**50.62%**	**0**
Hoar, William R.S.	6875	02.37%	-6875	0	00.00%	0
REP Poliquin, Bruce	**134184**	**46.33%**	**4747**	138931	49.38%	0
Ballot Exhausted						
By Overvotes	435		98	533		0
By Undervotes	6018		7820	13838		0
By Exhausted Choices	0		335	335		0
Continuing Ballots	289624		0	281371		0
TOTAL	**296077**		**0**	**296077**		**0**
Winning threshold by round	144813			140686		
Generated: 11/21/2018 19:36						
Total = Ballot Exhausted by Overvotes + Ballot Exhausted by Undervotes + Exhausted Ballot + Continuing Ballots						
Winning Threshold = [Continuing ballots/(Vote for [number] +1)] + 1						
"*" symbol signifies elimination due to Tie Resolution.						

Figure 1: Maine Secretary of State Spreadsheet