Some notes on mean-median & partisan bias scores, and building **seats-votes curves** using lower house state legislative election results in the USA from 1971-2018. Also a place to organize some different non-geographical approaches to identifying partisan gerrymandering – eg – Warrington (2019); Warrington (2018); Gelman and King (1994); Katz, King, and Rosenblatt (2020).

State legislative election results

State House election results are made available here by Princeton University folks – which is apart of a larger ecosystem of tools/resources for investigating gerrymandering. Results are limited to lower houses for states with bicameral state legislatures.

```
library(tidyverse)
election_results <- read.csv(url(git_url)) %>%
  janitor::clean_names() %>%
  mutate(d_voteshare = round(d_voteshare, 3))
```

A sample of the data set is detailed below. Results are presented year, state, and state house district; the `d_voteshare` column specifies the vote share received by the Democratic candidate.

```
election_results %>%
  filter(state == 'CA', year == 1980) %>%
  slice(1:5) %>%
  select(-incumbent) %>%
  knitr::kable()
```

state	year	district	dem_votes	gop_votes	d_voteshare	party
CA	1980	1	0	114547	0.000	R
CA	1980	2	81884	36504	0.692	D
CA	1980	3	55339	75547	0.423	R
CA	1980	4	76013	35894	0.679	D
CA	1980	5	52121	75998	0.407	R

A super simple imputation method: Per approach described in Gelman and King (1994), winning parties of uncontested elections are re-assigned a vote share of 0.75, and losing parties 0.25.

```
election_results1 <- election_results %>%
  mutate(d_voteshare = ifelse(d_voteshare == 1, 0.75, d_voteshare),
         d_voteshare = ifelse(d_voteshare == 0, 0.25, d_voteshare))
```

Summarizing election results

Next, we summarize election results per legislature. Summary stats include:

- the number of seats in legislature,
- the number/proportion of seats won by Democrats,
- the average vote share received by Democratic candidates; and
- the median Democratic vote share.

Important to emphasize here is that the `v_mean` value specifies the average Democratic vote share across individual state house races in a given year, and not the aggregate statewide house results.

```
full_summary <- election_results1 %>%
  group_by(state, year) %>%
  mutate(dseat = ifelse(dem_votes > gop_votes, 1, 0),
         rseat = ifelse(dem_votes < gop_votes, 1, 0),
         d_above = ifelse(d_voteshare > mean(d_voteshare),
                          1, 0)) %>%

  summarize(district_n = n(),
            d_seats = sum(dseat),
            r_seats = sum(rseat),
            v_mean = mean(d_voteshare),
            v_median = median(d_voteshare),
            d_above = sum(d_above)) %>%
  mutate(seat_bar = d_seats/district_n) %>%
  ungroup()
```

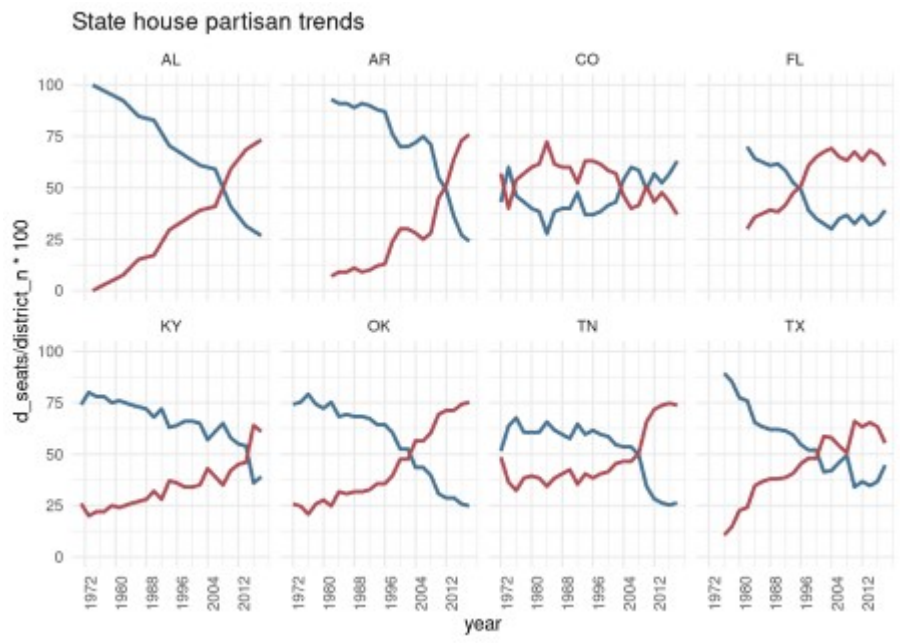
Election results for Colorado during the 2010s are presented below. So, Dems took the majority – and then some – in the Colorado State House during the previous decade.

```
full_summary %>%
  filter(state == 'CO',
         year > 2008) %>%
  select(-r_seats) %>%
  mutate(across(c(v_mean, v_median, seat_bar), ~round(., 2))) %>%
  knitr::kable()
```

state	year	district_n	d_seats	v_mean	v_median	d_above	seat_bar
CO	2010	65	32	0.48	0.50	35	0.49
CO	2012	65	37	0.51	0.54	37	0.57
CO	2014	65	34	0.48	0.51	37	0.52
CO	2016	65	37	0.50	0.54	37	0.57
CO	2018	65	41	0.55	0.59	36	0.63

The plots below illustrate the shifting partisan balance for a selection of state houses since 1972.

```
south <- c('CO', 'FL', 'AL', 'TX',
           'AR', 'TN', 'OK', 'KY')

full_summary %>%
  filter(state %in% south) %>%
  ggplot() +
  geom_line(aes(x = year,
                y = d_seats/district_n * 100),
            color = '#437193', size = 1) +
  geom_line(aes(x = year,
                y = r_seats/district_n * 100),
            color = '#ae4952', size = 1) +
  facet_wrap(~state, ncol = 4) +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 90, hjust = 1)) +
  scale_x_continuous(breaks=seq(1972, 2018, 8)) +
  ggtitle('State house partisan trends')
```



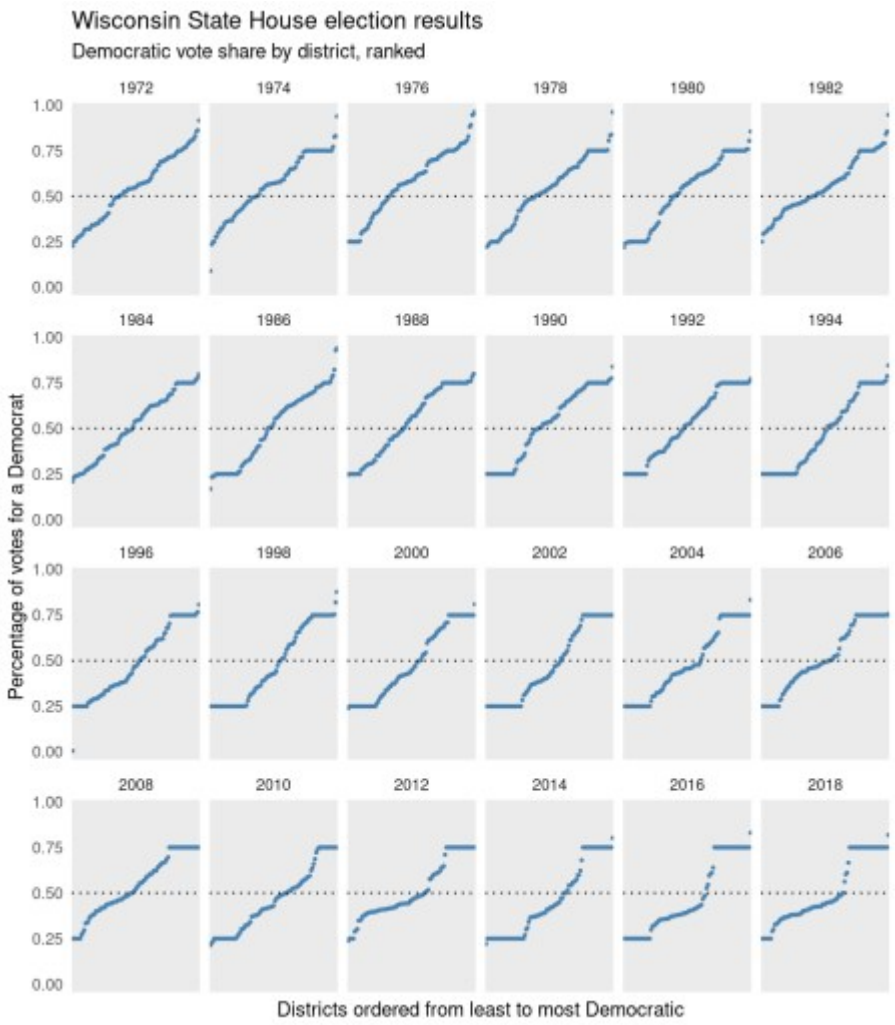
Historical vote distributions

```
details1 <- election_results1 %>%
  #filter(party %in% c('D', 'R')) %>%

  left_join(full_summary) %>%
  group_by(state, year) %>%

  mutate(swing = 0.5 + v_mean - d_voteshare,
         rank = rank(d_voteshare, ties.method = 'first'),
         seat_share = rank/n(),
         seat_share = 1 - seat_share) %>%

  ## still not correct exactly --
  mutate(swing = ifelse(seat_share == seat_bar, v_mean, swing)) %>%
  arrange(seat_share) %>%
  ungroup()
```

Vote distributions for election results in Wisconsin since 1972 are illustrated below. Districts have been sorted in increasing order of **Democratic vote share**.

```
details1 %>%
  filter(state == 'WI') %>%

  ggplot() +
  geom_point(aes(x = factor(rank),
                 y = d_voteshare),
             color = 'steelblue',
             size = .5) +

  geom_hline(yintercept = 0.5, lty = 3) +
  facet_wrap(~year, ncol = 6) +
  theme_minimal() +
  theme(axis.text.x=element_blank()) +
  xlab('Districts ordered from least to most Democratic') +
```

```
  ylab('Percentage of votes for a Democrat') +
  labs(title = 'Wisconsin State House election results',
       subtitle = 'Democratic vote share by district, ranked')
```



Seats-votes curves

There are a host of metrics that aim to capture partisan asymmetries in vote distributions (see Warrington 2019 for a comparison). Here, we focus on mean-median scores and partisan bias scores, mainly because they are closely tied to the seats-votes curve.

The **mean-median score** is the difference between a party's median *vote share* and its mean *vote share* – divergence between these two values suggests a vote distribution that is skewed in favor of a particular party. In contrast, the **partisan bias score** is the difference between (1) a party's actual *seat share* and (2) that party's hypothetical *seat share* if it garnered 50% of the statewide *vote share*. Both metrics are calculated below:

```
full_summary1 <- full_summary %>%
  mutate(mm = 0.5 + v_mean - v_median,
         pb = (d_above - 1) /district_n) ##
```

As an example, we consider results from the **Wisconsin State House in 2018**. Again, results are presented from the perspective of Democrats.

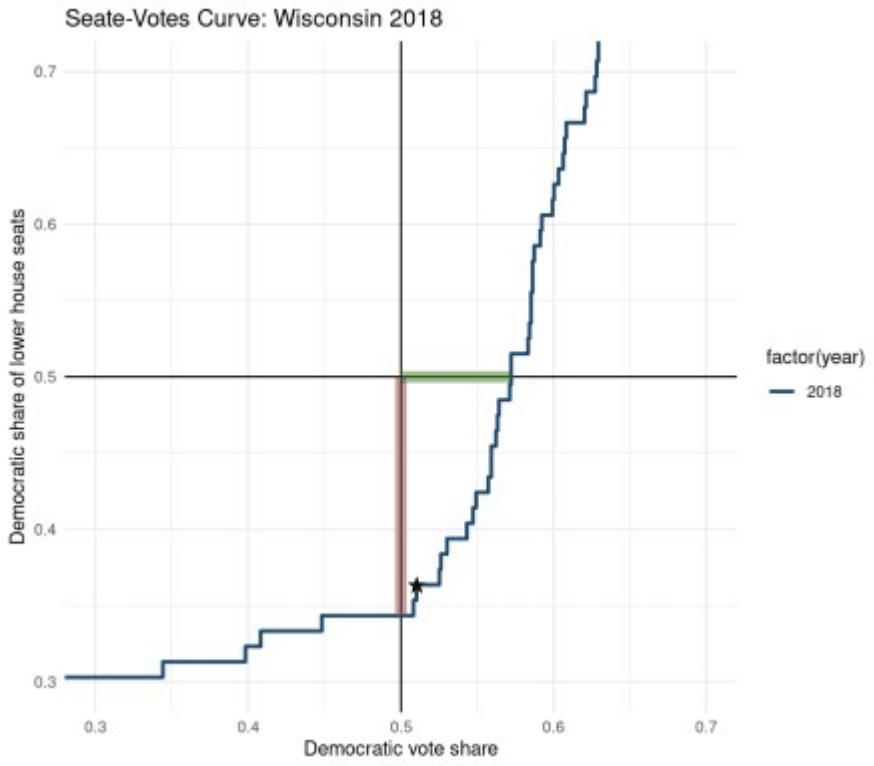
```
xmm <- full_summary1 %>% filter(state == 'WI', year == 2018)
```

district_n d_seats v_mean v_median d_above seat_bar mm pb

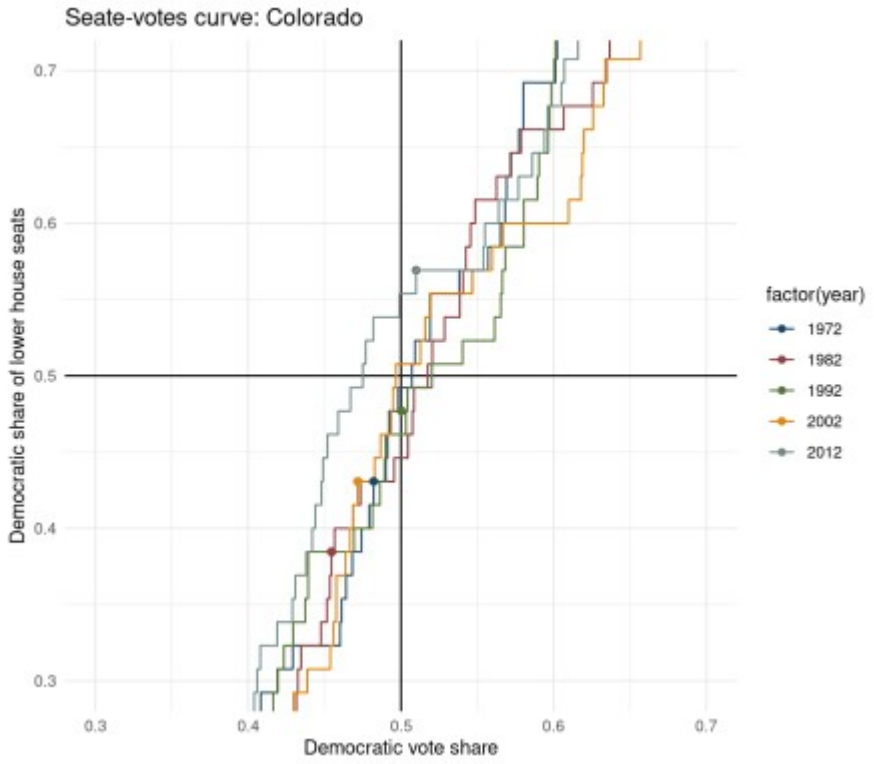
district_n	d_seats	v_mean	v_median	d_above	seat_bar	mm	pb
99	36	0.51	0.44	35	0.36	0.57	0.34

Per plot below, the green bar specifies the mean-median value; the red bar specifies the partisan bias score. So, if a seats-votes curve populates quadrant I, Democrats are over-represented in the legislature based on their statewide vote share; quadrant III, under-represented. The star specifies actual election results. **Extreme values in either quadrant are symptomatic of gerrymandering**.

```
see <- details1 %>%
  filter(state == 'WI', year == 2018)

see %>%
  ggplot() +
  geom_hline(yintercept = .50) +
  geom_vline(xintercept = .50) +
  geom_step(aes(x = swing,
                y = seat_share,
                color = factor(year)),
            size = 1) +
  geom_point(aes(x = v_mean,
                 y = seat_bar),
             pch="\u2605",
             size = 4) +

  annotate('segment',
           x = 0.5,
           y = xmm$pb,
           xend = 0.5,
           yend = 0.5,
           color = '#913a40', size = 3, alpha = .5) +
  annotate('segment',
           x = xmm$mm,
           y = 0.5,
           xend = 0.5,
           yend = 0.5,
           color = '#3c811a', size = 3, alpha = .5) +

  theme_minimal() +
  theme(legend.position = 'right')+
  ggthemes::scale_color_stata() +
  coord_equal(xlim = c(0.3, 0.7),
              ylim = c(0.3, 0.7)) +
  ggtitle('Seate-Votes Curve: Wisconsin 2018') +
  ylab('Democratic share of lower house seats') +
  xlab('Democratic vote share')
```



A historical example from the state of Colorado –



Resources

Gelman, Andrew, and Gary King. 1994. “A Unified Method of Evaluating Electoral Systems and Redistricting Plans.” *American Journal of Political Science*, 514–54.