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Geographical tactical voting in Swedish parliament elections

Is it possible to gain additional parliament seats by moving votes between constituencies?

VICTOR KORONEN, PETTER SALMINEN

Bachelor's Thesis at CSC
Supervisor: Alexander Baltatzis
Examiner: Mårten Björkman

Abstract

The Swedish parliament elections utilize a system of proportional representation. Although election fraud is very uncommon, there remains one vulnerability – tactical voting. In this report the possible effects of *geographical* tactical voting is studied through simulation using data from real elections.

The results point towards that it would be fully possible to accomplish geographical tactical voting. They also show that the same total number of votes would not necessary result in the same distribution of seats for the parliament parties, it depends on how the votes are distributed across Sweden as a whole.

We conclude that the Swedish parliament election system would be vulnerable to geographical tactical voting in its current state if votes could be moved. The system itself should get an upgrade to a more sturdy one.

Referat

Geografisk taktikröstning i svenska riksdagsval

Till det svenska riksdagsvalet används ett system med proportionell representation. Valfusk är ovanligt, men det kvarstår en svaghet – taktikröstning. I denna rapport studerar vi de möjliga effekterna av *geografisk* taktikröstning genom simulering baserad på data från riktiga val.

Våra resultat pekar på att det skulle möjligt att åstadkomma geografisk taktikröstning i det svenska valsystemet. De pekar även på att samma antal röster inte nödvändigtvis skulle ge samma platsfördelning i Riksdagen, utan det beror på hur rösterna är fördelade över valkretsarna.

Vi slår fast att det svenska valsystemet i sin nuvarande form skulle vara sårbart mot geografisk taktikröstning om flyttning av röster tilläts. Systemet bör uppgraderas till ett mer robust system.

Foreword

We would like to thank the following people for their contributions.

Alexander Baltatzis For guiding us into this interesting subject.

Karl Johan Westrin For suggesting the subject in section 4.1 of [Wes11].

Paulina Salminen For giving us insights on the report from the view of a political scientist.

Statement of Collaboration

Although this paper is a common effort between the two authors, it might be worthwhile stating which author was responsible for what parts of the project.

Victor Koronen

Victor created the report skeleton (based on Serafim's template[1]), wrote the introductory chapter and wrote most of the code. He also gathered and formatted the sample data.

Petter Salminen

Petter wrote most of the body text and created all the images and tables in the report. He was also responsible for testing the code to guarantee its correctness and did most of the fuzz testing.

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[1] `http://www.nada.kth.se/~serafim/xjobb/`

Contents

Chapter 1

Introduction

The subject of democracy seems to be ever current. Across the Middle East and North Africa, numerous protests of varying magnitude were held during the first six months of 2011. The events later became known as the *Arab Spring* [Sha11]. The people demanded immediate resignation of leaders and institution of democracy, in some cases violently and resulting in the overthrowing of the government.

In Sweden there was a lot of commotion following the result of the 2010 parliamentary election. It turned out that for the first time the controversial party Sverigedemokraterna (SD), accused of being xenophobic, had received enough votes to make it into the Swedish Parliament. Bound to neither the left wing nor the right wing parties, they now play the role of weigher [Sti10]. This had people worried [Mos10]. Many parties feared that they would have to give in to demands of SD in order to win majority in parliament.

1.1 Problem statement

In a democratic society it is very important to have a fair and robust election system. All residents entitled to vote should be able to do so peacefully and have their vote kept secret, unless they themselves choose otherwise. Since the number of news reports regarding problems with these practicalities in Sweden is limited, one tends to assume that practicalities in this case are not an issue, allowing focus to be shifted towards the process of translating a distribution of votes to a distribution of parliament seats.

When it comes to assigning parliament seats, Sweden utilizes a system of proportional representation, meaning that parliament seats are to be divided proportionally between the parties, but also proportionally over Sweden [Val10]. The latter is made possible by the use of constituencies. Perfect proportionality however, is rarely accomplished.

In a voting system that is supposedly fair and that exhibits a high degree of resistance against election fraud, there will always be one type of vulnerability that remains hard to tackle, if at all possible – tactical voting. Voters with decent knowl-

edge of how the voting system works and with a sense of the likely outcome (based on opinion polls, news reports etc.) may choose to vote on a different party. Doing so might be to the preferred party's advantage, ultimately resulting in additional parliament seats.

Another way of tactical voting has to do with constituencies and is henceforth referred to as *geographical tactical voting*. Since seats are first assigned in the constituencies, where your vote is counted may affect the outcome of the election. Fortunately, this kind of tactical voting is not allowed today in the Swedish election system due to regulations regarding the electoral roll [Val11, 5 kap., 4§]. It is possible to vote in advance at a polling station in another location, but the vote is still counted in your home constituency. But what if this restriction did not exist?

The aim of this paper is to study the effects of the geographical tactical voting, as explained in the previous section, in the context of Swedish parliament elections. The main objective is to determine the extent of this potential vulnerability, as determined by the number of parliament seats gained or lost compared to a baseline. This will be done by implementing a simulator, running modified data through it and observing the outcome.

1.2 Purpose

Public elections is the single most important mechanism for ensuring accountability in a democratic society, as it enables the people to hold politicians accountable for their actions by not voting for their political party. Our ambition that this report will be of use in keeping the Swedish representative democracy a healthy one by examining this possible vulnerability.

1.3 Limitations

This paper focuses on Swedish elections and more specifically Swedish parliament elections. Election systems in other countries and other elections held in Sweden, such as municipal council and county council elections, are not studied.

We also do not care about the 4% threshold, as it has already been taken into account in our source data and we only move votes around – we do not change them (more on this in section 2.1).

1.4 Glossary

Constituency A *constituency* is a sub-region to the election area.

Election area The *election area* is, as stated in [Val10],

> *the geographical area covered by the election e.g. a municipality or, in the case of the parliamentary election, the entire country.*

Election system The term *election system* encapsulates the whole process that is an election – everything from who is qualified to vote to how the votes are counted.

Party abbreviations

C Centerpartiet
FP Folkpartiet
KD Kristdemokraterna
M Moderaterna
MP Miljöpartiet
SD Sverigedemokraterna
S Socialdemokraterna
V Vänsterpartiet

Proportional representation *Proportional representation* is a way of distributing parliament seats to parties based on their relative share of valid votes, e.g. if a party receives 30% of the national votes, said party should receive about 30% of the parliament seats.

Chapter 2

Background

2.1 The Swedish election system

General elections in Sweden are generally held every four years. Election to parliament, to municipality and county councils all coincide and the seats are assigned in approximately the same way. Though as previously stated, this report will focus solely on parliament elections.

The process of assigning parliament seats can be roughly divided into three steps, as illustrated in figure 2.1.

The first step (see figure 2.2) is to distribute 310 static seats (about $^9/_{10}$ of the total number of seats) across Sweden's 29 constituencies [Val11, 4 kap., 2-3§]. This involves neither parties nor votes. The seats are distributed across the constituencies using *Hamilton's method* and every constituency receives a number of seats approximately proportional to its number of registered voters.

The next step (see figure 2.3) is to assign the previously mentioned static seats. In order for a party to attain seats, it must be a legitimately registered party, as described in [Val11, 2 kap., 1-7§]. The static seats of each constituency are assigned using the *modified Sainte-Laguë method* based on the votes in that constituency.

The last step (see figure 2.4) is to assign the remaining 39 seats (about $^1/_{10}$ of the total number of seats). These seats are referred to as *leveling seats* and are distributed across the whole country. Their main purpose is to adjust the distribution following the assignment of the static seats, making sure that it is proportional on a nationwide level, as well as on a regional level.

In order to accomplish this, a separate assignment of all 349 seats is made using the *modified Sainte-Laguë method*, treating the whole country as a single constituency. Using the results from this separate assignment, parties who have been assigned a sufficient number of seats (or more) are filtered out, as they are not in need of any leveling seats.

This leaves a list of parties all entitled to one or more leveling seat. The leveling seats are assigned, in order, to the parties with the highest remainders (see 2.2.3). In the case of multiple parties sharing the same remainder, the order is randomized.

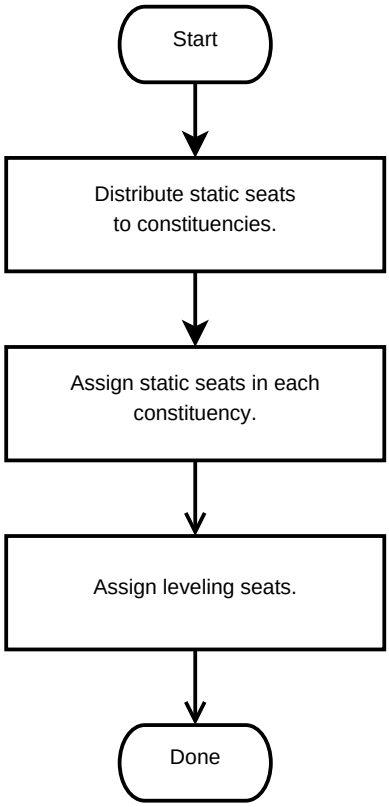

Figure 2.1. A schematic overview of how the votes are translated into an assignment of seats.

The *Sainte-Laguë method* is then used to determine which constituencies these seats should belong to. This assignment though is irrelevant for our purpose, as we do not care about *where* these seats are gained or lost.

2.2 Apportionment methods

In the sections below, we will use the following notation.

- C is the set of all constituencies
- P is the set of all parties
- S is the set of all parliament seats
- V is the set of all valid votes
- $|X_y|$ is the number of seats/votes (X) associated with constituency/party y

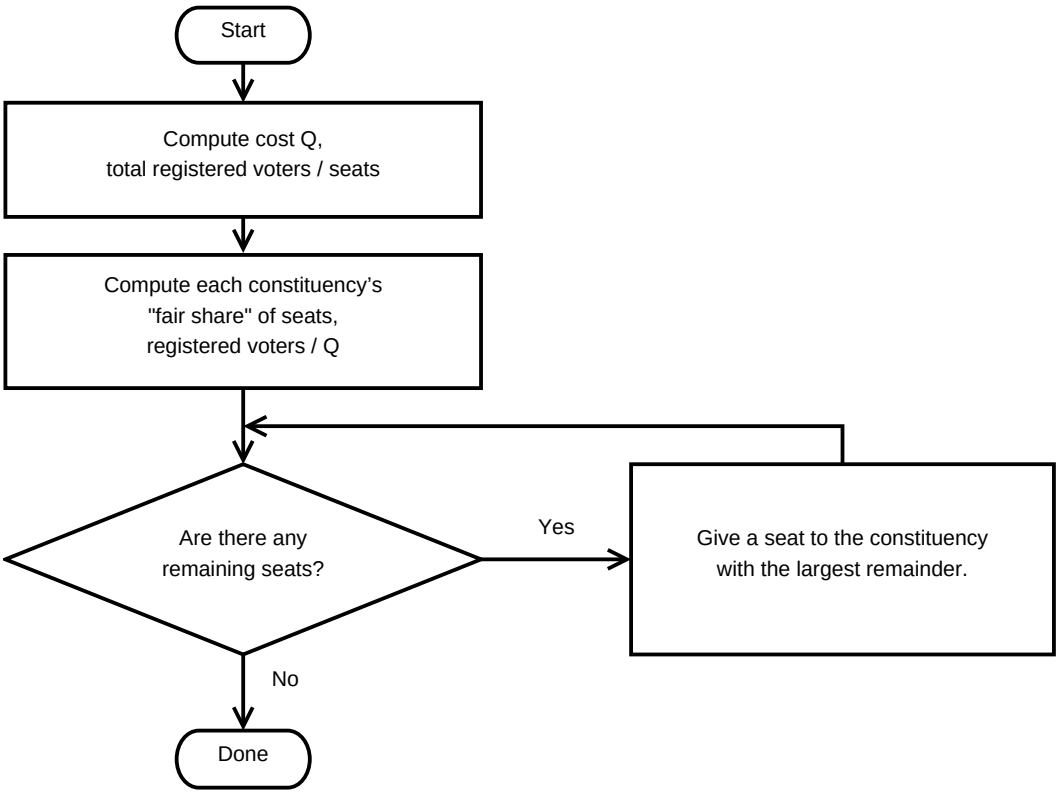

Figure 2.2. Distribution of static seats.

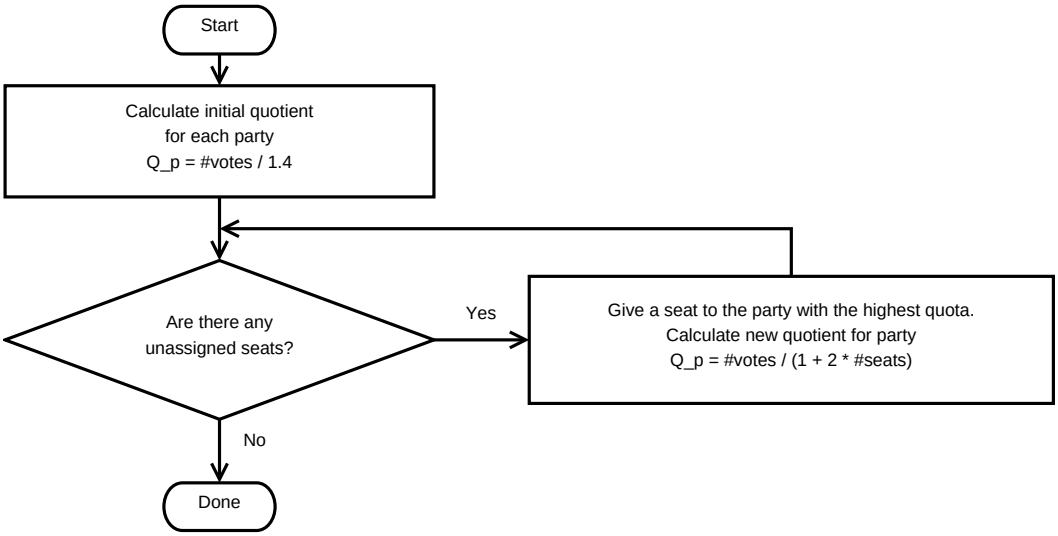

Figure 2.3. Assignment of static seats.

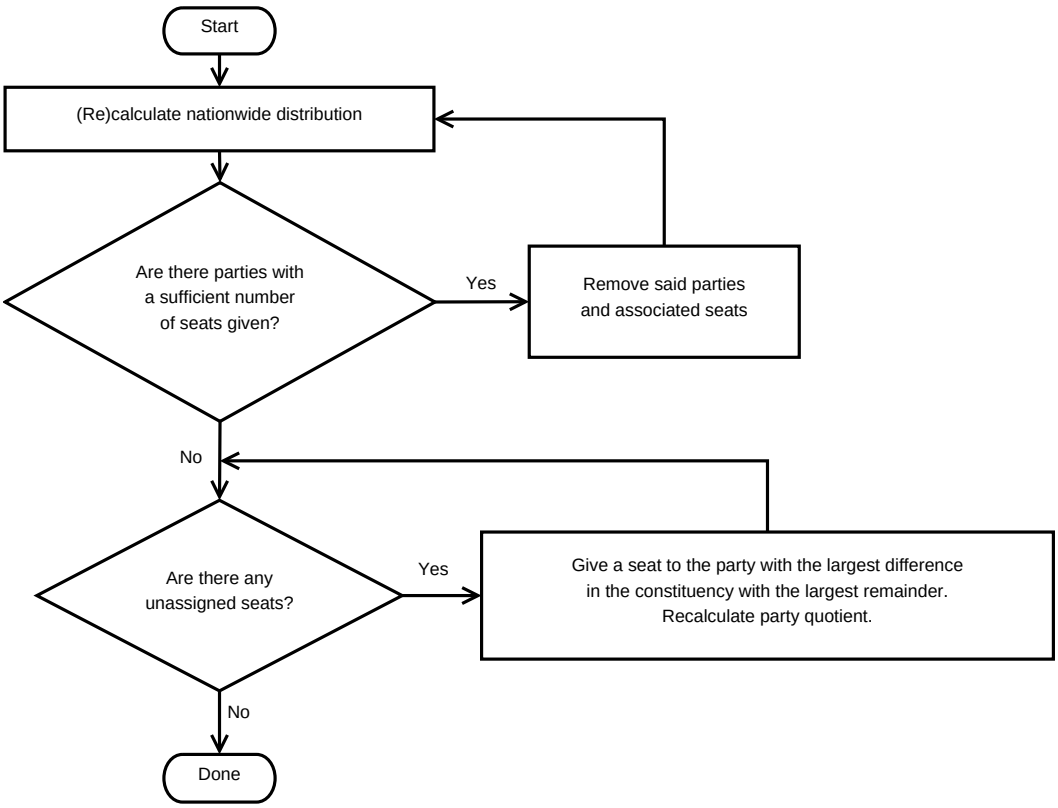

Figure 2.4. Assignment of leveling seats.

2.2.1 Hamilton's method

Hamilton's method, also known as the *method of largest remainders*, solves the apportionment problem by first giving each constituency its "fair share" of seats and then giving out remaining seats to constituencies in order of largest remainder (see figure 2.2).

The method takes as input the number of registered voters in each constituency. In the context of Swedish parliament elections, these figures are gathered from the Swedish Tax Agency's (*Swedish: Skatteverkets*) database [Val11, 4 kap., 1§].

Detailed description

1. Calculate the "cost" Q of a parliament seat in number of votes.

$$Q = \frac{|V|}{|S|}$$

2. Calculate the "fair share" F_c for each constituency $c \in C$.

$$F_c = \frac{|V_c|}{Q}$$

3. Floor each fair share quotient F_c to get a preliminary number of seats S_c and save the remainder R_c for each constituency $c \in C$.

$$S_c = \lfloor F_c \rfloor, R_c = F_c - \lfloor F_c \rfloor$$

4. Give out the remaining seats in order of largest remainder R_c for each constituency $c \in C$.

Example application

As a demonstration of how Hamilton's method works, we will apply the method to an election in the example country Midgard.

Midgard is a small democratic nation with 123 parliament seats to be shared proportionally among its three constituencies. The island has just had an election and the seats are divided as can be seen table 2.1.

Constituency	**A**	**B**	**C**	Total
Number of voters	1337	4711	2345	8393
Fair Share	19.59	69.04	34.37	
Seats	19	69	34	122
Remainder	0.59	0.04	0.37	
Adjustment seats	+1	0	0	+1
Total seats	20	69	34	123

Table 2.1. Seat distribution in Midgard.

Distributing the parliament seats among the constituencies of Midgard is quite an easy task, as there is only one the extra seat to be given to the constituency with the largest remainder, in this case A.

2.2.2 Sainte-Laguë method

The Sainte-Laguë method is one of many algorithms that translate a set of votes into an assignment of seats to parliament. The algorithm aims to make the number of seats allocated to a given party approximately proportional to the number of votes that a party has received in the election.

It is a modified version of the *d'Hondt method*, another widely used apportionment method. The Sainte-Laguë method is usually preferred over the d'Hondt method since the d'Hondt method favors bigger parties over smaller ones and is one of the least proportional apportionment methods [Wes11].

The basic idea behind the method is quite simple. First off, each party is given a quotient proportional to the number of votes it has received. The seats are then assigned to the party with the largest quotient, one at a time, until there are no more seats to assign. After a party has been given a seat, their quotient is recalculated.

The quotient Q_p used in the *Sainte-Laguë method* can be mathematically described as follows.

$$Q_p = \frac{|V_p|}{2 \cdot |S_p| + 1}$$

Example application

In order to demonstrate how the Sainte-Laguë method works, we will use data on the Jämtland constituency from the 2010 elections and simulate the assignment of four seats using the Sainte-Laguë method.

Party name	**# votes**	**1st seat**	**2nd seat**	**3rd Seat**	**4th seat**
Moderaterna	18 193	18 193	**18 193**	6 064	6 064
Centerpartiet	10 487	10 487	10 487	10 487	**10 487**
Folkpartiet	3 155	3 155	3 155	3 155	3 155
Kristdemokraterna	2 340	2 340	2 340	2 340	2 340
Socialdemokraterna	33 013	**33 013**	11 004	**11 004**	2 201
Vänsterpartiet	5 340	5 340	5 340	5 340	5 340
Miljöpartiet	5 339	5 339	5 339	5 339	5 339
Sverigedemokraterna	947	947	947	947	947

Table 2.2. Assignment of four seats using data on Jämtland from the 2010 elections.

As can be seen in table 2.2, the first seat goes to Socialdemokraterna and their number of votes gets divided by three. The second seat goes to Moderaterna and the third seat goes to Socialdemokraterna, as they once again have the largest quotient. Lastly, Centerpartiet gets the fourth seat. By now all the seats have been distributed, so the algorithm stops.

2.2.3 Modified Sainte-Laguë method

The modified Sainte-Laguë method is essentially the same algorithm as the regular Sainte-Laguë method with the only distinction that the first divisor 1 is exchanged for the divisor 1.4. This gives a minor advantage to larger parties over very small parties, where as, in contrast, the regular Sainte-Laguë method favors small parties, making it easier for them to receive their first parliamentary seat. The updated first divisor fixes this issue [Wes11].

Example application

To demonstrate the use of the modified Sainte-Laguë method, we will calculate the seat assignment for the Gotland constituency using data from the 2010 election. Gotland was chosen as it has only two seats to assign.

Party name	**# votes**	**1st seat**	**2nd seat**
Moderaterna	9 731	6 951	**6 951**
Centerpartiet	5 657	4 041	4 041
Folkpartiet	1 785	1 275	1 275
Kristdemokraterna	1 128	806	806
Socialdemokraterna	12 855	**9 182**	4 285
Vänsterpartiet	2 342	1 673	1 673
Miljöpartiet	3 259	2 328	2 328
Sverigedemokraterna	658	470	470

Table 2.3. Assignment of Gotland's two seats using data from the 2010 elections.

As can be seen in the table 2.3, the first step is to divide the number of votes for each party by the number 1.4. The first seat then goes to Socialdemokraterna, their quotient is updated and the second seat goes to Moderaterna. As there are no more seats to assign, the algorithm stops.

2.3 Hypothesis

Having studied the relevant algorithms, we draw the conclusion that it is difficult, though not impossible, to assign seats to parliament in a perfectly proportional manner. This would open up the possibility of geographical tactical voting.

We suspect that a contributing cause of this issue can be found in the way that static seats are distributed to constituencies. They are distributed according to the number of registered voters living there, instead of according to the total number of votes in that constituency. This effectively makes votes count less in constituencies with high voter participation, which is not only unjust, but also discourages high voter participation.

We predict that our framework will provide us with data proving that it is indeed possible to gain additional seats to parliament by simply moving votes around between constituencies.

Chapter 3

Analysis

3.1 Implementation of simulator

3.1.1 Choice of platform

As with all programming projects we too were faced with the choice of programming language and platform. Among the choices were compiled languages like C and Java, and scripting languages like Python and Ruby. Out of these these languages, there was only one language that we both felt comfortable with in both reading and writing, and that language was Java.

3.1.2 Component description

On the bottom of the class hierarchy tree lies the `VotingSystem` class. It contains implementations of the generic voting algorithms described in the previous chapter, such as the Sainte-Laguë method.

To preserve the Law of Delimiter [Mar09, p. 97], there is a helper class called `Constituency`, which is an abstraction of a constituency containing data such as its name, its number of registered voters and the set of all votes cast in the constituency.

The class `SwedishParliamentElection` extends `VotingSystem` and contains all logic associated with Swedish parliament elections. It also contains methods for reading and writing voting data to and from files, allowing us to load real election data into the system.

There is one more helper class called `SeatDistribution`, which is used as a storage class storing the distribution of seats between constituencies and parties. As with `VotingSystem`, and for the same purpose, this class contains methods for reading and writing the structure to and from files.

3.2 Fuzzing

The testing was conducted through applying data altering methods in manner similar to a technique commonly referred to as *fuzzing*, or *fuzz testing*. Fuzzing is a

technique usually associated with application security testing and can be outlined as follows [Har06]:

1. Prepare a correct file to input to your program.
2. Replace some part of the file with random data.
3. Open the file with the program.
4. See what breaks.

There are a number of classes that implement algorithms for moving votes around according to some set of predefined rules. The fuzzing algorithms themselves can be tweaked through a few parameters, but from there on, everything is totally automated. This approach will provide easy access to a wide range of voting data without going through the trouble of manually altering the data.

3.2.1 Data sources

Our main source of sample data has been real election data published by Statistics Sweden [Cen10]. Statistics Sweden (*Swedish: Statistiska Centralbyrån*) is the governmental organ responsible for gathering national statistics in a large variety of fields, ranging from demographics to election results. For some elections, though, the data appears to be corrupt – it did not yield the correct results when processed by our framework.

Our suspicions were confirmed by our secondary source of data, the Swedish Election Authority *Swedish: Valmyndigheten*, who also keep records of election data. Some figures differed, such as the number of registered voters in the 2002 election. Replacing said figures with values from the Swedish Election Authority fixed the problem.

3.2.2 Methodology

As previously mentioned, we have implemented a couple of different methods for moving votes around. Some of them move votes randomly and some try to be clever. Worth repeating is that none of the methods below change the party of a vote, they only move votes between different constituencies.

`RandomFuzzer` was the first method to be implemented. It picks a number of constituencies, a number of parties and a number of votes and shuffles them around in circles.

`FocusFuzzer` tries to gather a large number of voters to vote for a single party in a single constituency.

3.3 Results

3.3.1 RandomFuzzer results

Constituency	**S**	**M**	**KD**	**MP**	**SD**	**FP**
Kronobergs	-505	+331	-133			
Uppsala	-119	+464		-178		
Södermanland	+527	-460	-9			
Östergötland	-67	-186	-32	-424		
Gotland	+431	+638	+174		+27	
Gävleborg	+83	-1 061		-210	-49	
Värmland	+274	+189		+812		
Göteborg	-474	-576			-908	
VästergötlandVäst	-150	+661			+930	
Total change	0	0	0	0	0	0
Seat change	-3	+1		+1		**+1**

Table 3.1. A selection of results from the RandomFuzzer for of fuzzing data from the election of 2010. Where we after fuzzing the data between constituencies get a large change in the distribution of seats

Constituency	**V**	**S**	**MP**	**C**	**M**	**KD**	**FP**	**SD**
Halland		-251	-73	-202			-603	2 994
Kronobergs			-884				-888	-181
Uppsala	-4 432		-1 696		-2 488	-4 513	-4 513	-4 612
Örebro		3 605		3 882			865	
Gotland	-2 294				-876	1 410		
Jämtland	2 669				1 255	2 703		
VästergötlandSyd		-1 759	2 653	-1 565			6 976	1 799
Värmland	4 057	-1 595		-2 115	2 109	-867	-1 837	
Total change	0	0	0	0	0	0	0	0
Seat change		-1	+1		-1		+1	

Table 3.2. A selection of results from the RandomFuzzer for of fuzzing data from the election of 2010. Where we after fuzzing the data between constituencies get a large change in the distribution of seats

3.3.2 FocusFuzzer results

After several runs we have found a few interesting results from our framework as follows on the tables following.

# Votes	From	To
521	VästergölandNord	Kalmar
389	Östergötland	Kalmar
611	Gotland	Kalmar
109	Norrbotten	Kalmar
231	Västmanland	Kalmar
247	Gävleborg	Kalmar
507	Värmland	Kalmar
184	Skånesyd	Kalmar
567	VästergötlandVäst	Kalmar
541	Dalarna	Kalmar
+3 907		Kalmar

Table 3.3. FocusFuzzer: Voter movement to Kalmar for Folkpartiet 2010.

V	S	MP	C	KD	FP	M	SD
	-1				+1		

Table 3.4. FocusFuzzer: Parliament seats gained or lost.

# Votes	From	To
2 900	StockholmsLän	VästergötlandNord
1 483	VästergötlandÖst	VästergötlandNord
1 612	Östergötland	VästergötlandNord
4 634	Jämtland	VästergötlandNord
2 270	Malmö	VästergötlandNord
925	VästergötlandSyd	VästergötlandNord
2 332	Gävleborg	VästergötlandNord
2 234	Göteborg	VästergötlandNord
2 305	VästergötlandVäst	VästergötlandNord
2 287	Dalarna	VästergötlandNord
+22 982		VästergötlandNord

Table 3.5. FocusFuzzer: Voter movement to VästergötlandNord for Centerpartiet 2010.

V	S	MP	C	KD	FP	M	SD
	+2		-1				-1

Table 3.6. FocusFuzzer: Parliament seats gained or lost.

3.3.3 Summary

As demonstrated by `FocusFuzzer` in table 3.7, if people were allowed to move their votes to Malmö, Moderaterna could have been given two more seats to parliament.

# Votes	From	To
1 939	VästergötlandNord	Malmö
262	Kronobergs	Malmö
3 434	Blekinge	Malmö
4 848	StockholmsKommun	Malmö
4 846	Västerbotten	Malmö
4 357	Västmanland	Malmö
4 440	Jönköping	Malmö
3 274	VästergötlandVäst	Malmö
4 790	Dalarna	Malmö
+28 599		Malmö

Table 3.7. FocusFuzzer: Voter movement to Malmö for Moderaterna 2010.

V	S	MP	C	KD	FP	M	SD
	+1		-2		+1	+2	-2

Table 3.8. FocusFuzzer: Parliament seats gained or lost.

Swedish media has also highlighted the fact that if Folkpartiet would have received seven more votes in Värmland in the 2010 election, they would have taken an extra seat from Socialdemokaterna [Lin11, p. 27].

Some interesting results are found in the table 3.5 on `FocusFuzzer`. Note that moving votes can give unexpected turnouts. In this case Socialdemokraterna got additional seats from *VästergötlandVäst* and *Jämtland* both taken from Centerpartiet. Centerpartiet then gets one seat in *VästergötlandNord* taken from Miljöpartiet and one from the distribution of leveling seats. A seat that was normally assigned to Sverigedemokraterna. Miljöpartiet takes back one seat in *Gävleborg* from Centerpartiet thus staying on a total change of zero.

Worth noting is that, due to the way seats are assigned, moving the votes for one party may result in changes in seat allocation for multiple different parties. This is what happened to Folkpartiet, as demonstrated in table 3.1. They get one additional seat without moving any of their own votes.

Chapter 4

Conclusions

As our results show, updating the legislation regarding the electoral roll and simply removing the geographical restriction would introduce injustice and seemingly unpredictable behavior into the Swedish parliament election system. Although we did not find an optimal algorithm taking full advantage of this flaw, we can only assume that someone else will.

Given the vastly different end results, despite having the same number of votes, still suggests that the current seat allocation method might need further improvements in order to ensure the equal value of every vote. Another interpretation could be that the algorithm is too complex and should be simplified. One way to perform such a simplification could be to do reduce the number of static seats, as Carlström suggests in [Car07]. In any case, it is our recommendation that any changes are thoroughly tested before being put into law.

4.1 Suggestions for further studies

As previously mentioned, we did not find an optimal algorithm. Finding such an algorithm would constitute a subject for further research. This algorithm would utilize data about the current and previous distributions of seats along with polls and output suggestions on how to maximize the amount of assigned seats for a given party or bloc.

When such an algorithm is found, an interesting extension of this research would be to evaluate the practical aspect of it all, seeing as we have only studied the theoretical aspect. With today's modern means of communication, would it be possible to mobilize enough people while keeping control of their actions in order to make a noticeable impact?

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