# Gerrymandering digital voting hypothesis for the 21st General Election in South Korea

by Roy Kim

## Abstract

The aim of this study is to investigate South Korea's 21st General Election voting results using a new digital gerrymandering hypothesis. In order to account for data irregularities and claims of fraudulence, in which previous studies have focused on the physical aspects of election fraud (ballot box stuffing, shredded ballots, Chinese-made Huawei communications technology found in electronic election systems and so on), this study will address data irregularities initially discovered by Professor Mebane. The digital gerrymandering hypothesis is a new approach that examines election day and early voting results from South Korea's 20th and 21st General Elections. The results of this study showed a target number of seats was made through the application of the gerrymandering hypothesis. It generated a target number of seats through real-time calculations during the vote counting process. The values moved to achieve the required number of seats could be found using the least squares method. Also, this study found an "Easter egg" hidden in the reconciled data by changing the hexadecimal number according to a specific ASCII code rule. Many election research scholars, cyber security experts, journalists, and legal experts may agree that the voting results of South Korea's April 15, 2020 parliamentary elections are consistent with fraudulent and manipulative election practices.

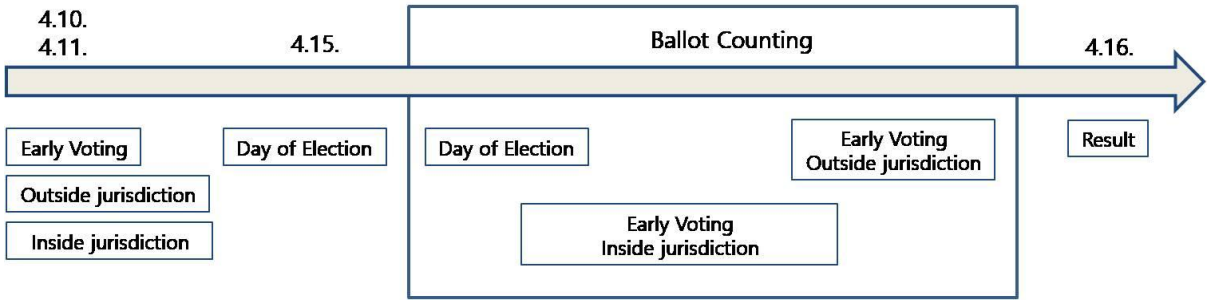
Keywords: Digital Gerrymandering, The least squares method, ASCII Code, Fraudulent election

## 1. Introduction

The 21st South Korean General Election, held on April 15th, has been riddled with allegations of fraud in the months since the election. Hardware experts point to "supercomputer" specifications made to election electronic systems using Huawei components manufactured in China, while election fraud experts highlight statistical anomalies in the data. They all point to fraud. According to Dr. Mebane's study, "Anomalies and Frauds in the Korea 2020 Parliamentary Election, SMD and PR Voting with Comparison to 2016 SMD," the 2020 election exhibited anomalies that suggest the election data was fraudulently manipulated. This study aims to compare the election results of South Korea's 21st General Election with the 20th General Elections in order to identify fraudulent "digital

gerrymandering" of the electoral districts. In South Korea's recent 21st General Election I hypothesize that the results have been electronically "gerrymandered" utilizing a simple algorithm that redistributes votes to districts proportionally based on their favorableness. I maintain that this has been achieved nationally and in real time on election day itself.

For any election in South Korea, you have two options to vote: Early Voting and Election Day voting. For the 21st General Election, early voting was held on April 11 and 12, and election day voting was held on April 15. Early Voting was designed for those who may not be able to vote on the day of election, with their votes being counted after the Election Day. In the April 15th, 2020 South Korean 21st General Election, the ruling party earned 10% more votes in early voting, on average, than its opponents. This study utilizes Early Voting data and election day data released by the South Korean National Election Commission (NEC). The data released by the NEC separated the election day vote counts from the other counts (i.e. blank ballots and spoilt ballots), but I combined all the counts for the purpose of this study. The data released by the NEC does identify whether the manipulated votes are from the Early Voting counts or election day voting counts. This study includes manipulated vote counts from Election Day voting. The details of the election timeline are shown below in <Figure 1>, and the data in <Figure 2>.




<Figure 1> Time line of the 21st General Election at S. Korea

| | |
|---|---|
| Total Population | 51,843,268 |
| Total population Voters | 43,994,247, (increased 4.5% than 20th general election) |
| 18years old Voters | 548,986, (1.2% out of total population voters) |
| No vote | 14,867,851(33.8%) |
| Early voting voters | 11,742,677(26.69%) |
| Election day voters | 17,385,363(39.51%) |
| Sum voters | 29,126,396(66.2%) |

<Figure 2> South Korean 21st General Election data.

### 1.2 Goal

In this paper I will prove that the data for the South Korean 21st General Election was digitally manipulated. It is impossible for these results to be anything other than manipulation.

### 1.3 Task

**A.)** To compare the results of the 21st and 20th General Elections under the same conditions to help understand any abnormal data. To then compare differences between the Early Voting results and Election Day results for these two elections and to look for any anomalies.

**B.)** To determine the required redistribution of Early Voting counts for a favorable outcome from the Election Day results.

**C.)** To use 3 types of simulations to confirm that the order and allocation of the votes counted did not change the target result.

**D.)** To calculate the actual shift value by using the least squares method.

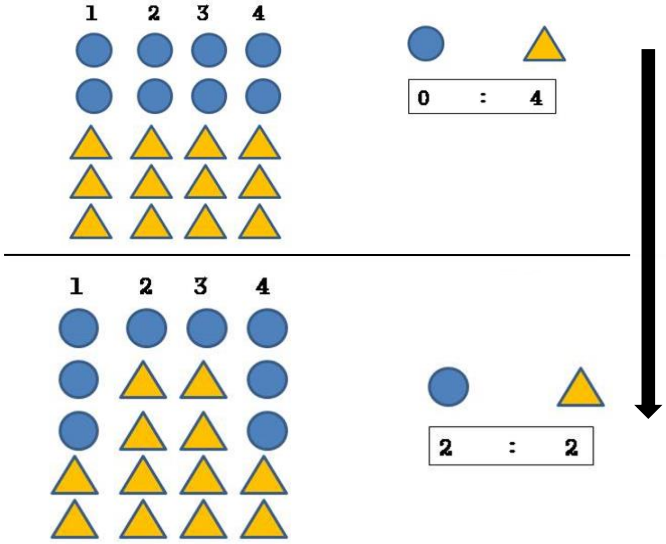
**E.)** To explain how to accommodate invalid votes in the process of achieving the goal.

**F.)** Finally, to look for any rules hidden in the order of the corrections that might have been inserted. By applying these rules to the sequencing list, change it to ASCII Code and find “Easter eggs” hidden by malicious programmers.

## 2.. Gerrymandering Theory

I then applied the Gerrymandering theory to validate my reasoning that the aforementioned data was fabricated. Gerrymandering is a practice intended to establish an unfair political advantage for less favorable electoral constituencies by grouping more favorable electoral districts together with less favorable electoral districts, when dividing the electoral constituencies. Gerrymandering is the practice of redrawing electoral districts lines in order to obtain an advantage for a political party or candidate. For example, a political party can forcibly divide an electoral district or combine electoral

districts according to their favorableness in order to win and maintain political power. Elections are not fair if political parties or candidates have the authority to divide or combine the electoral districts to their advantage. In order to prevent such practices, the electoral constituencies must be set or defined by laws made by the South Korean National Assembly, and this particular principle in South Korea is known as the Legal Principle on Electoral Districts




<Figure 3> The Concept of Gerrymandering method

The concept of gerrymandering, the basis of this hypothesis, is to get a 2:1 result where the outcome is 1:2, win or lose. However, there is a big risk only bringing the opponents' votes. Then, in order to make 1:2 to 2:1, 1:2 should become 4:2 to get a result of 2:1. 1:2 is a total of 3 and 4:2 is a total of 6. In other words, you should have three more votes in one. In that case, the total amount needed must be doubled. In fact, the turnout rate for the early voting of the 21st election was 26.69%, more than twice from the early voting of the 20th election, which was 12.19%. The 21st early voting turnout rate was the highest ever in the history of South Korea.

In 1812, Massachusetts Governor Elbridge Gerry defined the electoral constituencies in a way that would benefit his political party. When mapped, one of the contorted districts was said to resemble the shape of a mythological salamander. In 1812,

Massachusetts Governor Gerry signed the amended Electoral District for Senators Act which benefited his Republican party. At this time, the newly designated constituency was formed in a strange shape, ignoring natural forms, culture, and customs, and a local newspaper reporter compared it to a salamander and synthesized it with Governor Gary's name to create the term "GerryMander." It was said that Republicans won 50,164 votes to 29 winners, while the opposition party won 51,766 votes but only to 11 winners.

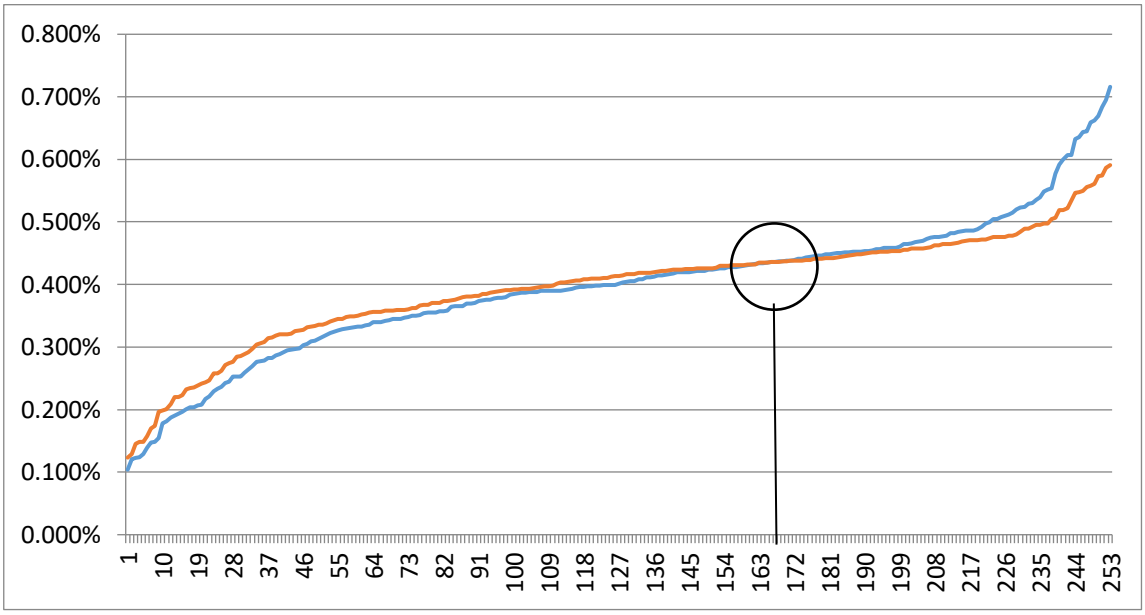
In the 21st South Korean General Election, the election system used Chinese Huawei 5G communication equipment. The election system is controlled by a central NEC server that collects and processes data coming in from every electoral district in South Korea. Voting has come a long way since physical ballots. It is now a nationwide connected electronic voting system. The digitization of voting, although convenient and efficient, allows for new avenues of fraud and corruption. In South Korea's recent 21st General Election, I hypothesize that electronic "Gerrymandering" in electoral districts nationwide happened in real-time, utilizing a simple algorithm that redistributes votes to districts proportionally based on their favorableness.

## 3. Methodology

From a programmer's point of view, the only way the location data can be obtained to produce early voting results is from the NEC's server. This is the data from Election Day voting and previous polls. Most programmers can design the algorithm used through the creation of a simple manipulation value. A program would simply have to calculate the winning and losing rates in every district, but this is too complicated and will create many variables. In the previous analysis, a district of 50% or more is a district that wins regardless of the opponent's polling rate. A very simple program can redistribute the value of the district that has 50% or more to a district of 50% or less. The program basically redistributes leftover votes from a district, where a preferred candidate achieves over 50% of the vote count, to another preferred candidate who is close to the 50% threshold. This program not only efficiently redistributes surplus votes to districts in need of votes, but it sends them specifically to districts where the preferred candidates are closest to breaking the 50% mark.

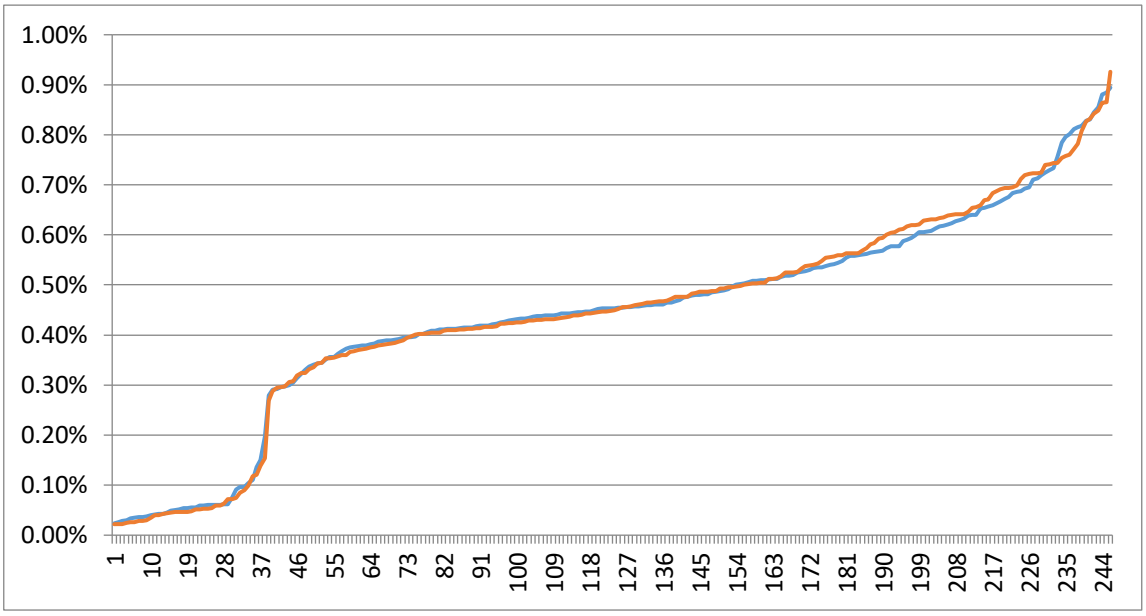
### 3.1. Methodology 1 – Analysis data graph and a histogram.

Obviously, Early Voting and Election Day voting differed and they yielded different vote counts. I grouped Early Voting and Election Day voting separately, and standardized both the Early Voting and Election Day voting variable in order to understand the measurable differences between Early Voting and Election Day voting. By doing so, I discovered how many votes were cast in each district (on the day of election) and compared this with the total vote count. This method was used to examine the early vote count as well. The figures below show the data derived from the methodology.



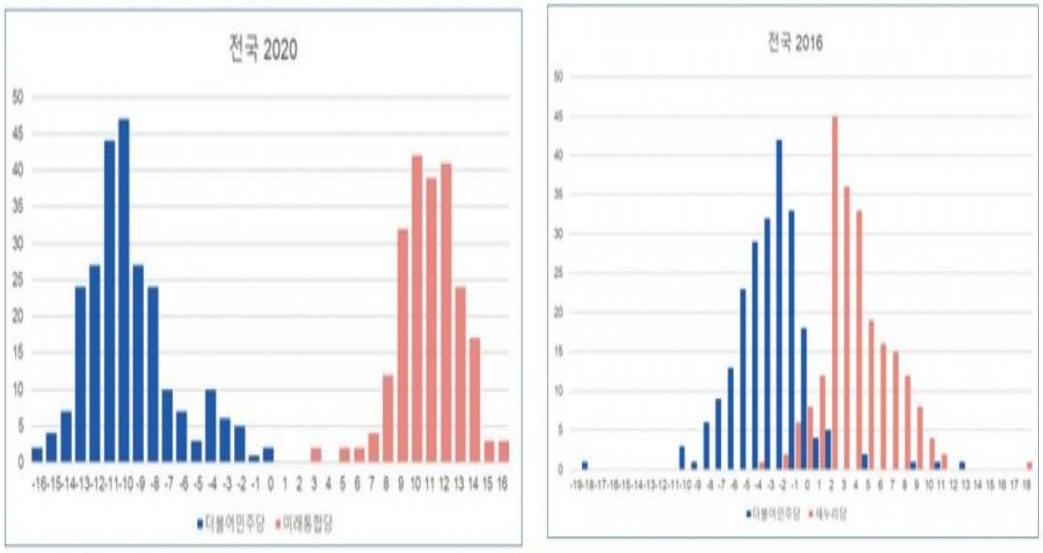

<Figure 4> The blue line represents election day vote counts and the red line represents early voting counts from South Korea's 21st General Election.vote counts and the red line represents the early voting vote counts.

This graph clearly shows an intersection point. This point shows the median (50%) of the vote counts. There are 89 districts above the median and 164 districts below the median. In order to compare the data shown in this graph, I have used the same methodology for the 20$^{th}$ General Election. This comparison graph is shown below.




<Figure 5> The blue line represents the vote counts for election day votes and the red line is for early voting from South Korea's 20th General Election.

This graph (Figure 5) does not show an intersection point for the 20th General Election. It shows that there was not much difference between the results of Early Voting and Election Day voting, which is normal for these two types of voting.




<Figure 6> The standard deviation on left shows the results of the 21st 2020 General Election. The standard deviation on right shows the results of the 20th 2016 General Election.

The two histograms above represent the distribution of the 21st and 20th South Korean General Election vote count by Early Voting and Election Day voting. As clearly shown in the histograms above, the graph for the 21st General Election illustrates an abnormal 10 distribution which doesn't follow the law of large numbers. According to the law of large

numbers, the difference between the distributions of two large numbers should approach zero. A normal distribution would be in the shape of a bell, like the graphs on the bottom and a graph with an abnormal distribution would show two bell-shaped bars like the graph on the top. This result indicates the significant possibility that the 21st General Election data is artificial or fabricated in a way that will clearly distort the results.

Continuing the study, I computed the difference in proportions between Early Voting and Election Day voting. When subtracting Election Day voting results from Early Voting results, all the districts which had more than 50% of vote counts on Election Day yielded negative numbers, while all the districts with less than 50% vote counts yielded positive numbers. The sum of the difference between all the districts with higher than 50% vote counts is (-)2.468% while that of all the districts with less than 50% vote counts is (+)2.468%. I was able to confirm that an equal amount of the percentage shifted. This means that the vote count at the 50% point was indeed an intersection point.

### 3.2. Methodology 2 – Calculate Total Shift Value (Target number of seats)

The number of seats won by more than 50% on the day of election and its percentage is calculated by the number of seats where more than 50% of the votes are earned, regardless of winning or losing. In fact, there are districts where the polling rate is higher than the opponent, even if the number of seats earned is less than 50%.

| **Results of election day** | **Less than 50%section** | **More than 50% section** | **sum** |
|---|---|---|---|
| **# of seats** | **164** | **89** | **253** |
| **% of seats** | **64.8%** | **35.2%** | **100%** |

<Figure 7> 21st South Korean General Election Day results, district over and under 50%.

On the day of election, 89 seats were considered safe seats, with more than 50% of the vote earned. In South Korea, there are a total of 253 districts, half of 253 is 126.5 seats. Any party with the majority of seats (127 seats or more), will have the legal authority to carry out their legislation. With 127 seats as the threshold for holding a majority, I created three ratios based on 126 seats, 127 seats, and 128 seats.

| Target # of seats | 126 | 127 | 128 |
|---|---|---|---|
| % of seats | 49.70% | 50.20% | 50.70% |

<Figure 8> 21st South Korean General Election Day results, target number of seats.

The number of seats required to reach 126 seats from 89 seats is 37 (14.50%); the number required to reach 127 seats is 38 (15.00%), and finally, to reach 128 seats is 39 (15.50%). If the Election Day portion varied and became like (Figure 4), the shift value assigned to the Election Day portion should be the same as the difference between the ratio of the number of seats before and after shifting. In other words, it will shift as many seats as needed. I took a look at the polling rate on the day of election in 89 districts and 164 districts based on 50% polling rate for the day.

| Results of election day | Less than 50% section | More than 50% section | sum |
|---|---|---|---|
| # of seats | 164 | 89 | 253 |
| sum of the polling rate | 6350.56% | 5140.38% | 11490.94% |
| Election day portion | 55.27% | 44.73% | 100.00% |

<Figure 9> 21st South Korean General Election Day results.

The sum of the polling rate of 89 seats, in a district with more than 50% is 5140.38%, and the sum of the polling rate of 164 seats, in a district with less than 50% vote is 6350.56%. The two account for 55.24% versus 44.73%. The differences in the polling rate is about 10.54% (55.27%-44.73%). The equation below expresses the portion of Election Day voting shifted as much as the number of seats required.

**Ratio of the seats needed = the difference in the election day portion + shift value**

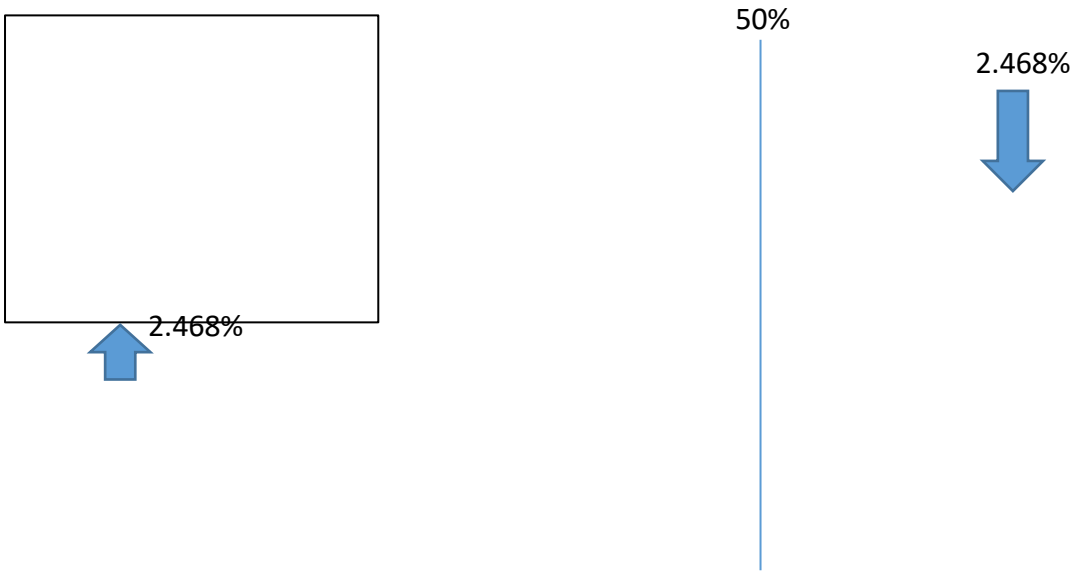
| target seat # | 126 | 127 | 128 |
|---|---|---|---|
| # of seats needed | 37 | 38 | 39 |
| Ratio of the seats needed | 14.50% | 15.00% | 15.50% |
| value subtracted the difference of the election day portion 10.53% = shift value | 3.97% | 4.47% | 4.97% |

<Figure 10> 21st South Korean General Election Day results, calculation of shift value

I calculated the shift value by subtracting the difference of the election day portion from the number of seats required. The shift value required to become 126 seats is 3.97%, 127 seats is 4.47%, and 128 seats is 4.97%. This shift value is the sum of the total shift values in all districts. You can subtract half of this shift value from districts where more than 50% votes were earned and redistribute it to districts below 50%. Analysis of the South Korea's 20th General Election data shows that 2.468%, half of 4.97% of the target seats (128), decreased 13 from districts with more than 50% and was added to districts below 50%. If you check the last decimal point of the shift value, the numerical result is as follow:

**[ (15.50412868172670% - 10.53165908172670%) / 2 = 2.4862348000% ]**

2.4862348000% shift value is 100% consistent with the difference between the portion of the election day and that of early voting.

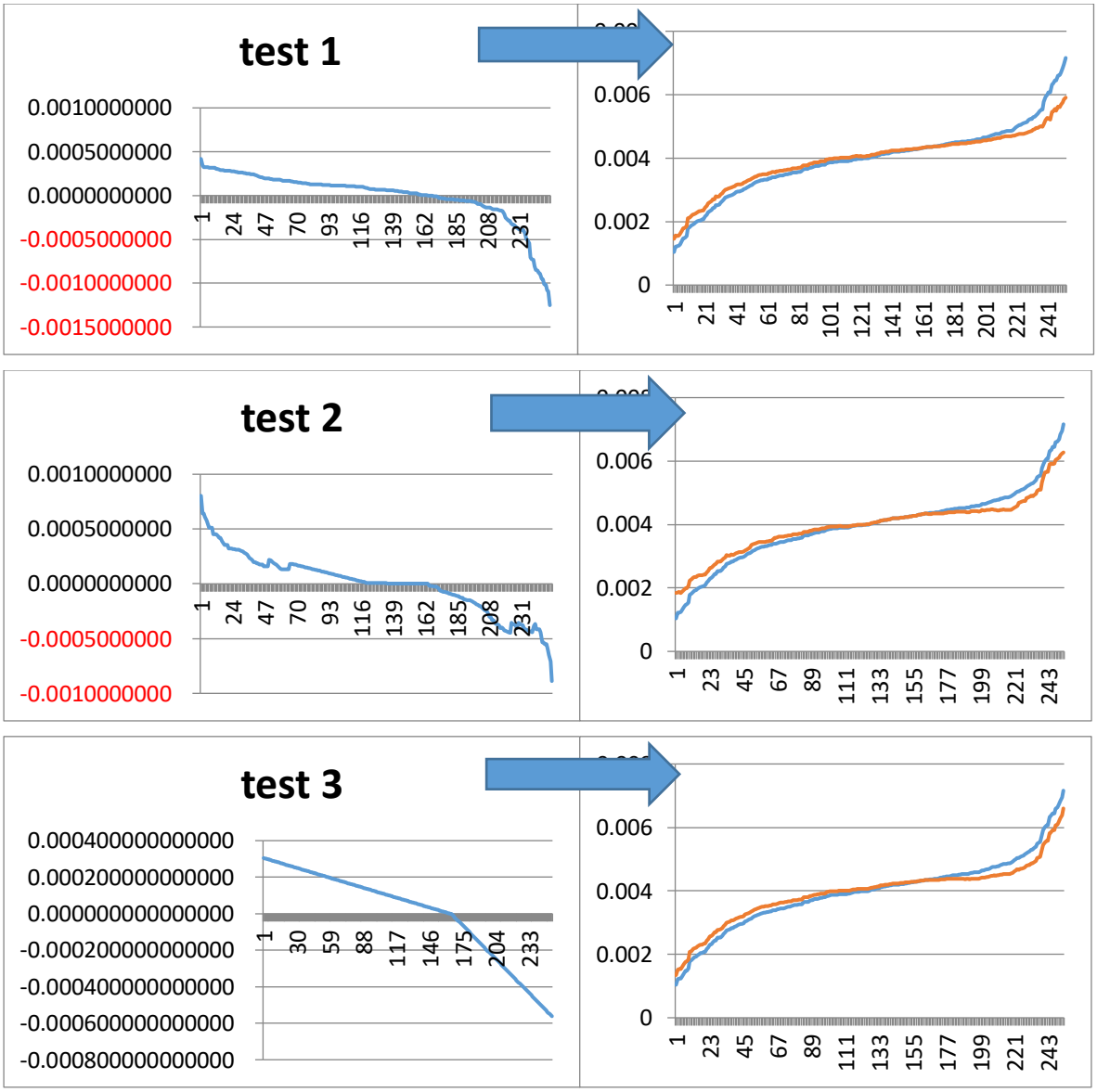



<Figure 11> Election Day in red, Early Voting in blue after applying shift value.

### 3.3. Methodology 3 - Simulation Data

The graph shows a 2.468% shift. Examining the amount of increase and decrease by 2.468% for each district in detail, I found something very unusual. In order to find out the effect of the 2.468% shift value on the result of the number of seats, I have rearranged

the order of the shift value to be different from the real data. In this way we can analyze the actual early voting results and examine whether the results are changed by manipulating the value in different districts. However, the total amount of 2.468% remained unchanged. In the first test, we changed the actual shift values in descending order and shifted the election day portion. The result of the number of seats, 128, remained unchanged.



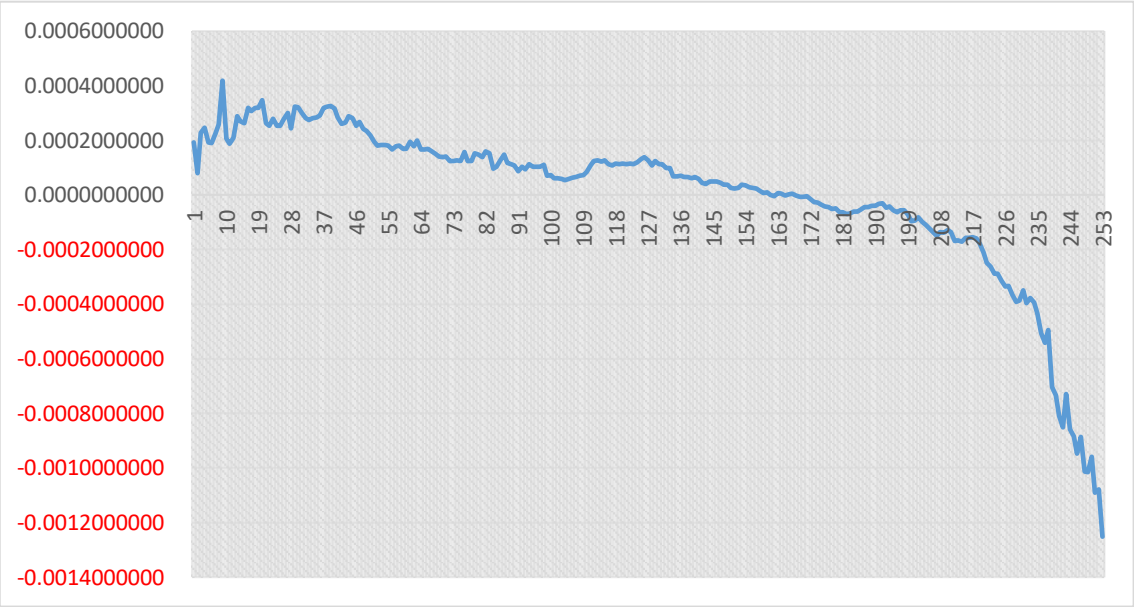

<Figure 12> Test1. Shift value change in descending order / Test2. Shift value atypical form applied. / Test3. Evenly distributed shift values applied.

In tests 1, 2, and 3 all districts increased or decreased by 2.468%, but we could see that 128 seats were obtained, even if artificially different orders or arrangements were applied.

In other words, no matter how you chose to allocate 2.486%, you can obtain the target number of seats without affecting the overall results.

### 3.4. Methodology 4 – The least square method for actual shift value (reconciled data)

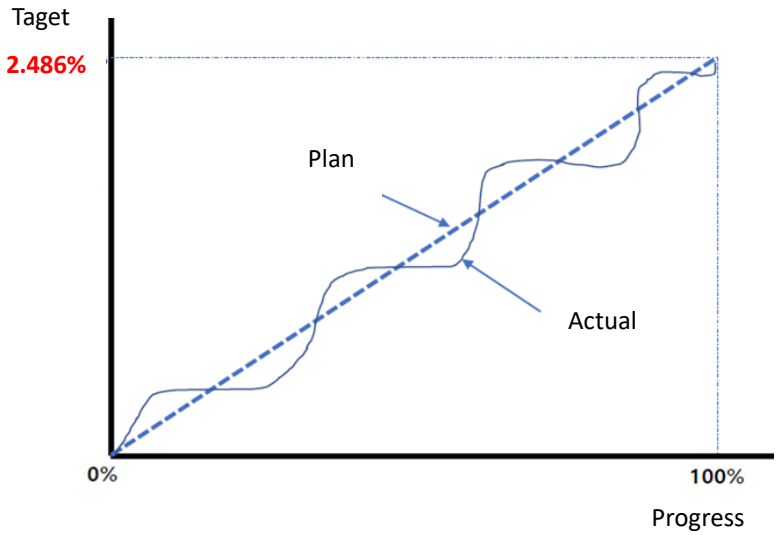
By using the least squares method, the algorithm achieves the target number of seats. Using the shift value, the data is analyzed in real time and generates the target number of seats during the vote counting process.




<Figure 13> the shift value change as votes are counted.

### 3.5. Methodology 5 – Control Invalid vote

Vote counting begins on election day and districts with high polling rates can achieve more than 50% of the polling rate, earlier than other districts. The higher the polling rate, the more the shift value will be subtracted, and the lower the polling rate, the more the shift value will be added. This is because the algorithm can calculate and send the shift value until the end of voting on Election Day. Regarding a district near 50%, we don't know whether it will be a winning or losing district, so it becomes the smallest section that brings and receives the shift value. In fact, in the 1% section of 49.3% to 50.3%, the shift value close to 0 was applied. In other words, the shift value is determined according to vote counting time, and the amount and order are distributed according to the flow of time without affecting the result. This method gives the programmer the ability to decide the outcome of each electoral district.




<Figure 14> Target Logic progress

Applying the process of achieving the target to elections can predict how the blank votes are handled. If the performance is lower than planned, one of the parties will receive a blank vote, and if the performance is higher than planned, the blank will be redistributed as an invalid vote. To do this, many invalid votes will have to be issued. In the 21st General Election, the invalid vote was the highest in South Korean recorded history: 4.21 % (1,226,532 out of 29,126,396).

| Times | Years | Voters | Invalid vote | Invalid vote% |
|---|---|---|---|---|
| 17th | 2004 | 21,581,550 | 295,566 | 1.37% |
| 18th | 2008 | 17,415,920 | 284,383 | 1.63% |
| 19th | 2012 | 21,806,798 | 474,737 | 1.63% |
| 20th | 2016 | 24,430,746 | 669,769 | 2.74% |
| 21th | 2020 | 29,126,396 | 1,226,532 | 4.21% |

<Figure 15> History of invalid votes.

### 3.6. Methodology 6 – ASCII Code

Malicious programmers often leave behind evidence known as an “Easter egg” in the system they compromised. In this study, evidence was discovered of malicious programmers through an inspection of common “Easter egg” practices in the programmer community. First, I examined the order of the election data shift value and found it to be jagged. I then investigated the reason for the shift value’s jagged nature, but it was

difficult to find any regularity on the surface. In order to find out if it was made for any kind of hidden purpose, I divided the districts and made the district's sequence numbers into a printable number (close to 100) and transformed it into letters using the ASCII code and constructed a letters table.

| Converted letter | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ` | k | f | i | k | m | ^ | l | b | _ | _ | g | ` | o | h | n |
| | a | l | g | j | l | n | _ | m | c | ` | ` | h | a | p | i | o |
| | b | m | h | k | m | o | ` | n | d | a | a | i | b | q | j | p |
| | c | n | i | l | n | p | a | o | e | b | b | j | c | r | k | q |
| | d | o | j | m | o | q | b | p | f | c | c | k | d | s | l | r |
| | e | p | k | n | p | r | c | q | g | d | d | l | e | t | m | s |
| | f | q | l | o | q | s | d | r | h | e | e | m | f | u | n | t |
| | g | r | m | p | r | t | e | s | i | f | f | n | g | | o | u |
| | | | n | q | s | u | f | t | j | g | g | o | h | | p | v |
| | | | o | | t | v | g | u | k | h | h | p | i | | q | w |
| | | | p | | u | w | | v | l | i | i | q | | | r | x |
| | | | q | | v | | | w | | | | r | | | s | y |
| | | | r | | | | | | | | | s | | | t | z |
| | | | | | | | | | | | | t | | | u | { |
| | | | | | | | | | | | | u | | | v | \| |
| | | | | | | | | | | | | v | | | | } |

<Figure 16> letter table.

I searched for a meaningful word or sentence from the letter table. As a result, I found the sentence "Follow the Party." We can assume that the programmer mixed the order of the shift value to insert this "Easter egg" into the data. In other words, we can assume that according to the linear arrangement of the shift value, the programmer planted "Follow the Party" in the sequence number of the Election Day results and mixed the order to hide it. "Follow the Party" is a Chinese communist slogan. Other words such as "Ghost," "Hippo," and "Harpy," were also found. "Ghost" is a specter, and it can be expressed as communism is a specter. Augustine of Hippo's view of history gave a great impression to Karl Marx, and in the West, Mao Zedong was called "Hippo." "Harpy" is a monster with a Greek mythical bird and a human figure that symbolizes Marxism. Just by looking at all the words in the table, it would not be such a difficult task for a programmer who can freely choose the order and arrangement of the shift values to plant

these “Easter eggs.”

## 4. Conclusion,

As we have shown, the digital age has ushered in new avenues and methods for election fraud: “digital gerrymandering” or “electronic gerrymandering.” These new digital methods of fraud are nearly impossible to detect and only exposed when the voting results are shown as explained above. Before the election, digital election systems afford us the ability to predict the polling rate. If you can predict the number of seats that can be secured 100% by winning more than 50% of the votes, you can know the range of the estimated amount that needs to be manipulated in advance and redistribute the real vote counts (physical ballots) for the desired results. Incidentally, stiff ballots that seemed to come directly from the printing shop were also found at election sites.

Due to the way it is calculated as the target value, surplus ballots that are made meeting the target value or exceeding the population may be found in large quantities as a blank ballot. Finally, because the value of percent is calculated, the decimal point unit will be rounded up, and the result table may show a difference of +1 vote than the number of voters.

In conclusion, the important point of this gerrymandering digital voting hypothesis is that it has shifted the portion of the favorable district to a weak district and made a weak district a strong favorable district in Early Voting. We found that the portion of votes that earned over 50% on Election Day were shifted by 2.468% to the less than 50% districts. We were also surprised to find that the shift value (2.468%) is 100% identical to the 1/2 value of the ratio of the required number of seats, minus the portion of the Election Day.

**Appendix A:** < Raw data released by the National Election Commission (NEC), Data released by NEC (http://info.nec.go.kr/), 2020/4/18 17:00..>

| | 20th the General Election | | | | 21th the General Election | | | |
|---|---|---|---|---|---|---|---|---|
| | election day | early Voting | election day / Total | early voting/Total | election day | early Voting | election day / Total | early voting/Total |
| sum | 9887.71% | 8985.01% | 100.00% | 100.00% | 11490.94% | 14071.69% | 100.00% | 100.00% |
| 1 | 2.00% | 1.95% | 0.02% | 0.02% | 11.94% | 17.34% | 0.10% | 0.12% |
| 2 | 2.00% | 2.13% | 0.02% | 0.02% | 13.94% | 18.18% | 0.12% | 0.13% |
| 3 | 2.06% | 2.35% | 0.02% | 0.03% | 14.09% | 20.46% | 0.12% | 0.15% |
| 4 | 2.26% | 2.51% | 0.02% | 0.03% | 14.22% | 20.86% | 0.12% | 0.15% |
| | | | ~ | | | | ~ | |
| 244 | 78.48% | 72.84% | 0.79% | 0.81% | 72.65% | 76.89% | 0.63% | 0.55% |
| 245 | 78.55% | 73.21% | 0.79% | 0.81% | 73.07% | 77.05% | 0.64% | 0.55% |
| 246 | 84.06% | 73.98% | 0.85% | 0.82% | 74.01% | 77.30% | 0.64% | 0.55% |
| 247 | | | | | 74.08% | 78.23% | 0.64% | 0.56% |
| 248 | | | | | 75.74% | 78.48% | 0.66% | 0.56% |
| 249 | | | | | 76.06% | 78.86% | 0.66% | 0.56% |
| 250 | | | | | 76.92% | 80.69% | 0.67% | 0.57% |
| 251 | | | | | 78.53% | 80.81% | 0.68% | 0.57% |
| 252 | | | | | 79.82% | 82.57% | 0.69% | 0.59% |
| 253 | | | | | 82.27% | 83.14% | 0.72% | 0.59% |

**Appendix B:** Moving Shit Values (reconciled data)

| Moving Shift Values(reconciled data) | | |
|---|---|---|
| | Less than 50% section 2.486234789227% | More than 50% section -2.486234789227% |
| 1 | 0.019297133074% | -0.000245527677% |
| 2 | 0.007913978943% | 0.000226771453% |
| 3 | 0.022735370801% | 0.000394240320% |
| 4 | 0.024506594216% | -0.000264940001% |
| | ~ | ~ |
| 161 | -0.000063594273% | |
| 162 | -0.000602348264% | |
| 163 | 0.000722280072% | |
| 164 | 0.000490824941% | |

**Appendix C:** Rules for understanding the ASCII table.

Rule:

1). Selection rule 1,2 for divided 1,2 is based on the first letter “l”. Rule 1 for small or rule 2 for larger or equal.

2-1) Rule 1: Divided 1 : TRUNC(sum/100,0) +1 / Divided 2: TRUNC(sum/100,0)

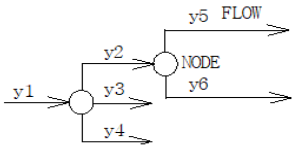
2-2) Rule 2: Divided 1: TRUNC(sum/100,0) / Divided 2: TRUNC(sum/100,0) -1

* Trunc is a function used by IT such as Excel and is a function that throws out a decimal point or lower. For example 924/100=9.24 , trunk = 9.

**Appendix D:** Calculating Early Voting %

Early Voting(%) = ((election day % / total of election day % + Shift Value(Reconciled

Data))* Real time Optimization




$$\text{Object} \; ; \; \underset{\hat{x}}{Min} \left( \frac{(\hat{x}_1 - y_1)^2}{\sigma_1^2} + \frac{(\hat{x}_2 - y_2)^2}{\sigma_2^2} + \frac{(\hat{x}_3 - y_3)^2}{\sigma_3^2} + \frac{(\hat{x}_4 - y_4)^2}{\sigma_4^2} + \frac{(\hat{x}_5 - y_5)^2}{\sigma_5^2} + \frac{(\hat{x}_6 - y_6)^2}{\sigma_6^2} \right)$$

$$\text{Constraint} \; ; \; \hat{x}_1 - \hat{x}_2 - \hat{x}_3 - \hat{x}_4 = 0$$
$$\hat{x}_2 - \hat{x}_5 - \hat{x}_6 = 0$$

$\hat{x}_i$ ; Reconciled Value of i Stream
$y_i$ ; Measurement Value of i Stream
$\sigma_i$ ; Tolerance of i Stream

<Figure 6> Least Square Method

It is an algorithm that uses the least square method to achieve the target number of seats. Shift value is reconciled data in real time.

## **Appendix E:** 37 groups created by dividing the total number of districts by 7

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 217 | 169 | 161 | 14 | 132 | 130 | 197 | 119 | 17 | 9 | 211 | 122 | 166 | 233 | 107 |
| 98 | 202 | 214 | 205 | 210 | 213 | 215 | 120 | 152 | 13 | 140 | 83 | 85 | 106 | 225 | 178 |
| 218 | 206 | 94 | 135 | 117 | 150 | 12 | 185 | 30 | 27 | 131 | 141 | 186 | 34 | 209 | 19 |
| 99 | 96 | 208 | 220 | 172 | 10 | 149 | 88 | 90 | 104 | 28 | 115 | 165 | 86 | 195 | 118 |
| 95 | 168 | 207 | 92 | 219 | 116 | 139 | 21 | 148 | 87 | 29 | 170 | 24 | 253 | 191 | 125 |
| 93 | 204 | 216 | 18 | 192 | 11 | 97 | 126 | 252 | 171 | 103 | 15 | 1 | 114 | 212 | 2 |
| 221 | 154 | 20 | 203 | 158 | 121 | 89 | 155 | 105 | 133 | 32 | 129 | 128 | 250 | 249 | 127 |

| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 162 | 231 | 177 | 184 | 39 | 236 | 52 | 112 | 102 | 57 | 78 | 238 | 67 | 47 | 82 | 157 |
| 49 | 71 | 239 | 199 | 16 | 229 | 201 | 45 | 61 | 142 | 237 | 53 | 123 | 76 | 180 | 137 |
| 8 | 75 | 183 | 251 | 5 | 234 | 187 | 134 | 190 | 7 | 241 | 181 | 156 | 246 | 84 | 245 |
| 91 | 111 | 35 | 196 | 153 | 69 | 194 | 64 | 56 | 144 | 110 | 248 | 175 | 227 | 147 | 38 |
| 145 | 138 | 81 | 164 | 160 | 55 | 163 | 66 | 101 | 230 | 189 | 198 | 167 | 70 | 113 | 48 |
| 36 | 176 | 6 | 25 | 146 | 50 | 43 | 80 | 3 | 72 | 51 | 60 | 26 | 44 | 4 | 244 |
| 224 | 200 | 33 | 22 | 31 | 188 | 124 | 193 | 37 | 226 | 109 | 173 | 136 | 65 | 46 | 23 |

| 33 | 34 | 35 | 36 | 37 |
|---|---|---|---|---|
| 77 | 240 | 151 | 59 | 235 |
| 68 | 179 | 159 | 247 | |
| 40 | 174 | 232 | 54 | |
| 182 | 42 | 79 | 222 | |
| 228 | 62 | 143 | 73 | |
| 243 | 41 | 108 | 74 | |
| 242 | 58 | 223 | 63 | |

## **Appendix F:** Result range table

| Group | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Districts No. sum** | **924** | **1,247** | **1,128** | **845** | **1,292** | **826** | **711** | **652** | **855** | **521** | **939** | **700** | **862** | **666** | **711** | **990** |
| Divided1 | 10.000 | 12.000 | 11.000 | 8.000 | 12.000 | 7.000 | 7.000 | 6.000 | 9.000 | 6.000 | 10.000 | 7.000 | 9.000 | 6.000 | 7.000 | 9.000 |
| Divided2 | 9.000 | 11.000 | 10.000 | 7.000 | 11.000 | 6.000 | 6.000 | 5.000 | 8.000 | 5.000 | 9.000 | 6.000 | 8.000 | 5.000 | 6.000 | 8.000 |
| Range from | 92 | 104 | 103 | 106 | 108 | 118 | 102 | 109 | 95 | 87 | 94 | 100 | 96 | 111 | 102 | 110 |
| ~ end | 103 | 113 | 113 | 121 | 117 | 138 | 119 | 130 | 107 | 104 | 104 | 117 | 108 | 133 | 119 | 124 |
| Group | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** |
| **Districts No. sum** | **1,230** | **662** | **955** | **768** | **1,003** | **1,090** | **757** | **1,130** | **567** | **598** | **1,128** | **721** | **966** | **1,025** | **998** | **666** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Divided1 | 13.000 | 6.000 | 9.000 | 8.000 | 10.000 | 10.000 | 7.000 | 10.000 | 6.000 | 6.000 | 12.000 | 7.000 | 10.000 | 10.000 | 9.000 | 6.000 |
| Divided2 | 12.000 | 5.000 | 8.000 | 7.000 | 9.000 | 9.000 | 6.000 | 9.000 | 4.000 | 5.000 | 11.000 | 6.000 | 9.000 | 9.000 | 8.000 | 5.000 |
| Range from | 95 | 110 | 106 | 96 | 100 | 109 | 108 | 113 | 95 | 100 | 94 | 103 | 97 | 103 | 111 | 111 |
| ~ end | 103 | 132 | 119 | 110 | 111 | 121 | 126 | 126 | 142 | 120 | 103 | 120 | 107 | 114 | 125 | 133 |