Using Full-Traversal Addition-Subtraction Frequency (ASF) Method to Predict Possible El Nino Events in 2019, 2020 and so forth

Yunong Zhang[1], Ruifeng Wang[1], Min Yang[1], Mingjie Zhu[1], Chengxu Ye[2]

1. School of Information Science and Technology, Sun Yat-sen University (SYSU), Guangzhou, 510006, China
E-mail: zhynong@mail.sysu.edu.cn

2. School of Computer Science, Qinghai Normal University, Xining, 810008, China
E-mail: ycx@qhnu.edu.cn

Abstract: In this paper, an improved method named addition-subtraction frequency (ASF) method, which is based on commensurability method, is used to predict the possible El Nino events in the future. The paper first introduces commensurability method and clarifies the promotion of ASF method compared with the former. Additionally, this paper uses previous data to research the correct and inaccurate predictions of ASF method. Finally, ASF method is used to predict possible El Nino events in 2019, 2020 and so forth.

Key Words: Addition-subtraction frequency method, Commensurability method, El Nino events, Disaster prediction

1 INTRODUCTION

With the progress of the times and the development of science and technology, environmental issues are becoming more and more severe. El Nino is a phenomenon due to global warming and climate change, which causes unusual warmer temperature in the Eastern Pacific Ocean and the center of equator. This abnormal climate phenomenon led to many natural disasters just like drought, forest-fire and hurricane [1]. The biggest El Nino event from April 1982 to July 1983 killed more than 1300 people. Ecuador, Peru, Chile and the west coast of the United States were hit by floods. Besides, in places such as Australia and Indonesia, fires were caused by unusually high temperature. The direct economic losses reached 20 billion dollars [2]. Since the 21th century, many serious El Nino events have happened. The biggest of them happening from 2015 to 2016 caused extreme weather all over the world, especially in North America, South America, Asia, Australia and Pacific island countries [3]. Owing to the destructiveness, incidence and duration of this phenomenon, it is essential and important to predict the El Nino events in the future in order to make corresponding measures.

Commensurability method is a basis to predict natural disasters [4]. It originated from astronomy and was used to study the distance sequence of the planets in the solar system [5]. Commensurability method was presented to predict natural phenomena by Wenbo Weng, an academician of the Chinese Academy of Sciences. Using that method, as said, Weng predicted M7.3 earthquakes in Mexico and M7.4 earthquakes in California quite accurately. From 1982 to 1992, amongst 252 predictions of various kinds of natural disasters, 211 times are verified successfully, and the accuracy was up to 83.71% [6].

Based on the commensurability method, more and more people used the method itself or its improved methods to predict future disasters, and most of them made relative successes [7]–[13]. Nevertheless, those related methods still have uncertainty and ambiquity, where some of the predictions might be inaccurate [14]–[16]. To decrease the impact of subjective factors and manual interference, this paper uses the addition-subtraction frequency (ASF) method improved (i.e., generalized, scientificated and computerized) from commensurability method to make the predictions of El Nino events.

2 FROM COMMENSURABILITY TO ASF

Commensurability method is the basis of ASF method. Generally speaking, commensurability method and ASF method roughly have similar starting ideas and formulas. Due to the limitation of calculation method and the impact of subjective factors and manual interference, commensurability method may not be applied to current predictions as many more-accurate (e.g., floating-point) data come. This section first briefly introduces the commensurability method and then proposes the differences and improvements of ASF method compared with the former.

2.1 Commensurability Method

As the above section introduces, commensurability method is a way to predict the future disasters. Wenbo Weng believed that commensurability was an extrapolation of the periodicity concept, which can represent a pattern of occurrence in the natural world [6]. Just like periodicity and symmetry, commensurability may also transfer some kind of effective message of the natural world. The previous

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data are not haphazard. Therefore, through these data and the analyses of them, people may discover the rules of the natural world.

According to the commensurability method, there are some formulas used in predicting the future natural disasters, and the most important of them is the commensurability formula with three inputs,

$$x_{i+j-k} = x_i + x_j - x_k. \quad (1)$$

In this formula, i, j, k are subscripts, x_{i+j-k} is the predicted data, and x_i, x_j as well as x_k are sample data. Furthermore, commensurability formula with five inputs and commensurability formula with seven inputs, which have similar formats of the commensurability formula with three inputs, can also be used in some predictions.

Using the aforementioned formulas, by doing addition and subtraction calculation, people can use previous data to get predicted data results. As believed, for a certain (short) time period, the more frequently the different combinations of (1) with the same prediction result of x_{i+j-k} can be obtained in the calculation, the more possibly a disaster happens. So, it is essential to find the corresponding commensurability expressions in all various combinations of the known data for a certain time period.

2.2 ASF Method as Improved

Although the commensurability method can be used to make predictions, it still has some disadvantages owing to impact of subjective factors and manual interference. To decrease or even eliminate those disadvantages, the addition-subtraction frequency (ASF) method is developed. ASF method originates from commensurability method, trying to enhance the accuracy and efficiency of natural disasters projection. Compared with the commensurability method, the ASF method has following differences.

- **1. Nomenclature**
  Commensurability method originates from astronomy, but the concept is not clear and there is no explicit definition to commensurability. For mathematics, commensurability method is not rigorous enough. For machines like computers, its operability is relatively weak. ASF method results from commensurability method, and its name is clear. After making addition and subtraction operations, we easily use computers to calculate frequency.

- **2. Calculation Means**
  Commensurability method uses manual and direct calculation, as the sample size is relatively small. Commensurability method is thus not closely integrated with computers. As an improved version, ASF method uses computer to make addition and subtraction operations, which can handle very large sample size and thus breaks the historical limitations of commensurability method [17]–[20].

- **3. Data Types**
  Commensurability method deals only with integer data to apply the corresponding commensurability formula, while ASF method can handle both integer and decimal data. When we use ASF method, the accuracy and reserved digits of data results can be controlled, helping us select the frequency peaks (with drop-off) of data results. Furthermore, mutual conversions of data types provide new sets of formulas [18]–[20].

- **4. Formula Subscripts and Traversal**
  When we use commensurability method to make predictions, the formula with three inputs is $x_{i+j-k} = x_i + x_j - x_k$. It is noteworthy that the prediction index f and sample index i, j, k must satisfy the relation: $f = i + j - k$, which shows that commensurability method is more restrictive, needing a set of expressions. For example, when predicting x_7, at least three expressions consist of x_1, x_2, x_3, x_4, x_5 or x_6 should be needed. When we use ASF method to make a prediction, the formula with three inputs is $x_f = x_i + x_j - x_k$, where the subscripts do not have to satisfy that particular relation. Besides, ASF method uses different manners to traverse i, j and k, such as full-traversal method (i.e., traverse i, j, k from 1 to N, where N is the sample size), half-equal-traversal method (i.e., traverse i and k from 1 to N and j from i to N), half-unequal-traversal method (i.e., traverse i and k from 1 to N and j from $i + 1$ to N). Owing to accuracy and big amount of sample data, there are a lot of prediction expressions of $x_f = x_i + x_j - x_k$, and it is impossible to list all of them at a time by hand. Meanwhile, some predicted data results do not have a lot of corresponding expressions but they should still be considered. [17]–[20]

- **5. Potential Errors and Consistency Analysis**
  Since it is very difficult and challenging to predict the future, mistakes and accidents are unavoidable. Due to impact of manual interference, commensurability method may not find all expressions of data results. For example, there are six expressions which can get x_7, but only five of them are found, i.e., one of the expressions is missing. Furthermore, a part of data results may just have a fewer expressions but they are possible data, which may be ignored when using commensurability method. For example, x_{11} is a possible prediction, but it is missed because x_{11} is far from the sample data and has a fewer expressions. Compared with commensurability method, ASF method uses computers to decrease the occurrence of the above errors. Besides, a consistent analysis should be done to increase the error-tolerance and accuracy of the prediction. For example, prediction with years, prediction with years and months, prediction with years, months and days can be compared to get the final concordant results [5].

3 PREVIOUS CORRECT AND INCORRECT PREDICTIONS OF ASF METHOD

In Section 2, the basic principle of ASF method and its improvements compared with commensurability method are introduced. In this part, the paper uses existing data to research correct and incorrect predictions of ASF method. In

Table 1: El Nino years from 1950 to 1999 [14]

Year	Begin (month/year)	End (month/year)
1951	08/1951	04/1952
1953	04/1953	10/1953
1957	04/1957	07/1958
1963	07/1963	01/1964
1965	05/1965	04/1966
1968	10/1968	02/1970
1972	06/1972	04/1973
1976	06/1976	02/1977
1982	07/1982	09/1983
1986	10/1986	04/1988
1991	05/1991	08/1992
1993	04/1993	01/1994
1994	06/1994	04/1995
1997	05/1997	06/1998

order to simplify ASF model and get the intuitive projection results, 3 variables are configured as inputs during numerical experiments. The formula of ASF method is shown as follows:

$$x_f = x_i + x_j - x_k. \quad (2)$$

Based on equation (2), full-traversal ASF method is used to make the projection. Using Matlab [21] in computer, the previous n sample data are first stored in an array named S. Then a triple cycle is done to traverse array S, and the corresponding data results are stored in another array R. From array R, we can get the data results. By showing array R in a histogram, it is easy to select the peaks (with drop-off) of data results and make corresponding analysis. The following experiments are all based on the above ASF algorithm and procedure.

3.1 Correctly Predicting Year 1997 of Experiment 1

Although it is very hard and challenging to predict the future disasters, ASF method is a relatively scientific, feasible and routine way to make the prediction. With the help of computers and the support of scientific theory, more massive data can be handled, and the data results can be more precise. According to the El Nino events which have been recorded after 1950 in the 20th century from Table 1, we can verify the accuracy of ASF method.

To validate the accuracy of ASF method, we delete the year 1997 on the sample data and make it a validated year. In other words, we use the data in Table 1 except the year 1997 to see if 1997 is a peak value (with drop-off) of data results. With this condition, the sample size is 13 and the corresponding sample data set is as follows:

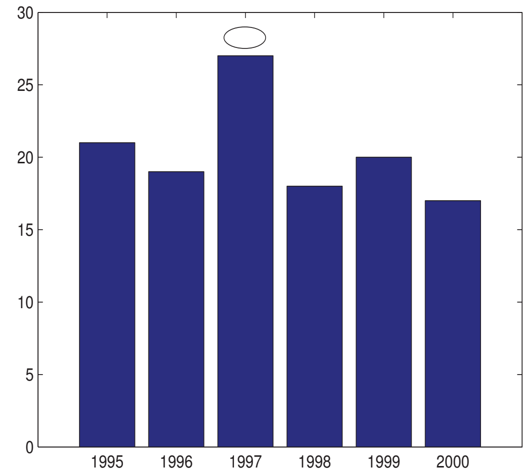

Figure 1: Frequency of years 1995 to 2000, especially of correctly predicted year 1997

Table 2: Specific frequency values (i.e., counts) of years 1995 to 2000, especially of correctly predicted year 1997, corresponding to Figure 1

Year	Count
1995	21
1996	19
1997	27
1998	18
1999	20
2000	17

{1951, 1953, 1957, 1963, 1965, 1968, 1972, 1976, 1982, 1986, 1991, 1993, 1994}.

Using full-traversal method in Matlab, we get the frequency (i.e., the general situation of counts) of years from 1995 to 2000, especially that of correctly predicted year 1997, which are shown in Figure 1. The frequency values (i.e., the counts, or say, the count values) of years 1995 to 2000 corresponding to Figure 1 are shown in Table 2. According to Figure 1 and Table 2, we can evidently see that the frequency in 1997 is up to 27, which is much larger than years surrounding it. Since 1997 is the peak of the data results, the El Nino event may happen with high possibility.

Actually, the El Nino event did happen from May 1997 to June 1998, which is the largest one being recorded in the 20th century. The natural disasters had caused great losses to people's properties in some parts of the world [22].

3.2 Wrongly Predicting Year 2012 of Experiment 2

People know that it is hard and challenging to predict the future disasters. Although ASF method is a relatively pre-

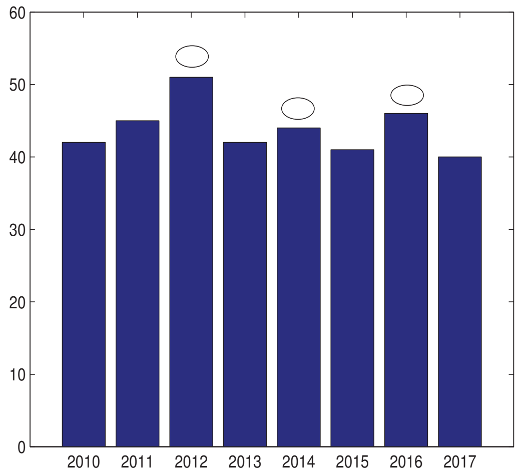

Figure 2: Frequency of years 2010 to 2017, especially of wrongly predicted year 2012 and correctly predicted years 2014 and 2016

cise method to make the prediction, some mistakes may still occur. According to the records all over the world, since 21th century, El Nino events have happened in 2002, 2004, 2006, 2009, 2014, 2015 and 2016 [23]. As the above subsection mentions, we add 2002, 2004, 2006, 2009 to the sample data set, thus 2014, 2015 and 2016 are validated years. With this condition, the sample size is 18, and the corresponding sample data set is thus as follows:

{1951, 1953, 1957, 1963, 1965, 1968, 1972, 1976, 1982, 1986, 1991, 1993, 1994, 1997, 2002, 2004, 2006, 2009}.

Similarly, we get the histogram of years from 2010 to 2017, which are shown in Figure 2. The frequency of years from 2010 to 2017 corresponding to Figure 2 is shown in Table 3. From Figure 2 and Table 3, the frequency value of year 2012 is up to 51, which is the peak of data results. This indicates that El Nino event may happen in 2012 also with high possibility. Besides, the frequency of year 2014 is up to 44 and the frequency of year 2016 is up to 46, which are both local peaks of their nearby years, and they are both possible years in which El Nino may happen.

According to ASF method, 2012 is considered to be one of the years when El Nino events may happen. Actually, from the record there was no El Nino event happening in 2012, but the big El Nino event happened in 2014 (relatively weak), 2015 and 2016, which shows that ASF method wrongly predicted year 2012 and correctly predicted years 2014 and 2016 with year 2015 missed. Although ASF method made a wrong prediction on year 2012, ASF is still a way to make a prediction, in view of the fact that it is inherently difficult and challenging to predict future disasters. Actually, from the above data results, we can not consider that the whole prediction is a completely wrong prediction. Year 2012 is indeed a wrong prediction but years 2014 and 2016 are both correct predictions. Year 2015 is a surrounding year of years 2014 and 2016. Considering the effect of continuity, the frequency of year 2015

Table 3: Specific frequency values (i.e., counts) of years 2010 to 2017, especially of wrongly predicted year 2012 and correctly predicted years 2014 and 2016, corresponding to Figure 2

Year	Count
2010	42
2011	45
2012	51
2013	42
2014	44
2015	41
2016	46
2017	40

is 41 and may be influenced by years 2014 and 2016. With this condition, 2014, 2015 and 2016 are all possible years in which El Nino event(s) may happen, showing the prediction correctness of ASF method to some extent.

4 USING ASF METHOD TO PREDICT FUTURE YEARS OF EL NINO EVENTS

After validating the accuracy of ASF method and researching its wrong predictions, the paper uses this method to predict El Nino events in the future and make corresponding analysis as well. Owing to the long period of El Nino event which might last for more than one year, it is meaningless, challenging and inaccurate to predict El Nino event in some months or even on some days. Thus the paper makes the prediction about the starting year of an El Nino event. According to the records of El Nino events happening after 1950, the sample size is 21, and the sample data set is

{1951, 1953, 1957, 1963, 1965, 1968, 1972, 1976, 1982, 1986, 1991, 1993, 1994, 1997, 2002, 2004, 2006, 2009, 2014, 2015, 2016}.

Using ASF method with three inputs and with full-traversal in Matlab, we get the frequency of all predicted future years of El Nino events which are shown in Table 5. From these predicted future years, we select the data which are larger than 17 and gather them in Figure 3.

According to Figure 3, we know that year 2019 (A1) is the highest peak of all data values, the frequency value of which is up to 68. Besides, the next year 2020 (A2) also has a big frequency value 67, which shows that next El Nino event may happen in year 2019 and 2020 with high possibility. Furthermore, there are many other local peaks of their surrounding years which are shown in Figure 3 and they are all possible situations. We use different letters to mark them and gather them in Table 4. Note that Table 4 and Table 5 are shown on the last page of this paper.

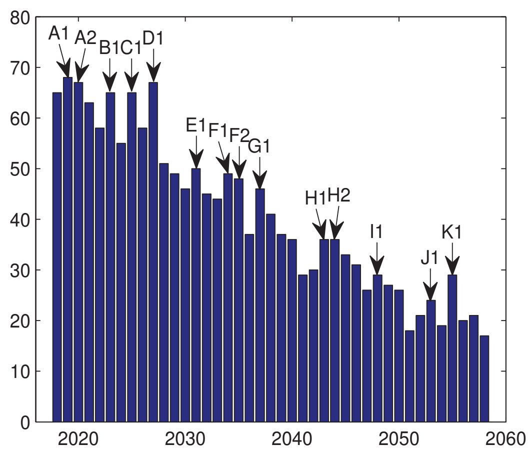

Figure 3: Frequency of predicted future years of El Nino events with values larger than 17

5 CONCLUSION

In this paper, commensurability method has been first briefly introduced. On the basis of that method, a generalized, scientificated and computerized method, i.e., ASF method, has been presented. Then, the paper has focused on not only the differences between commensurability and ASF method but also the improvements of ASF method compared with the former, which are listed from five perspectives. In addition, sample data have been used to analyze correctly and incorrectly predictions of ASF method. Finally, combined with El Nino event records, full-traversal ASF method has been used to predict possible El Nino events in 2019, 2020 and so forth. It is pointing out at the end of the paper that the ASF method, the prediction results and the paper could and should be applied to practice carefully so as to prevent any potential damage. Besides, as the authors of the paper believe, having a scientific prediction paper is better than having no such paper. But, completely relying on the paper may be even worse than having no such paper.

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Table 4: Specific frequency values of predicted future years of El Nino events, corresponding to Figure 3

Year	Count	Year	Count	Year	Count
2019 (A1)	68	2020 (A2)	67	2023 (B1)	65
2025 (C1)	65	2027 (D1)	67	2031 (E1)	50
2034 (F1)	49	2035 (F2)	48	2037 (G1)	46
2043 (H1)	36	2044 (H2)	36	2048 (I1)	29
2053 (J1)	24	2055 (K1)	29		

Table 5: Fully specific frequency values of years 2017 to 2082, especially of predicted future years of El Nino events, corresponding to Figure 3

Year	Count	Year	Count	Year	Count	Year	Count	Year	Count	Year	Count
2017	63	2018	65	**2019** (A1)	**68**	**2020** (A2)	**67**	2021	63	2022	58
2023 (B1)	**65**	2024	55	**2025** (C1)	**65**	2026	58	**2027** (D1)	**67**	2028	51
2029	49	2030	46	**2031** (E1)	**50**	2032	45	2033	44	**2034** (F1)	**49**
2035 (F2)	**48**	2036	37	**2037** (G1)	**46**	2038	41	2039	37	2040	36
2041	29	2042	30	2043 (H1)	36	2044 (H2)	36	2045	33	2046	31
2047	26	2048 (I1)	29	2049	27	2050	26	2051	18	2052	21
2053 (J1)	**24**	2054	19	**2055** (K1)	**29**	2056	20	2057	21	2058	17
2059	15	2060	16	2061	12	2062	13	2063	9	2064	9
2065 (L1)	**13**	2066	10	**2067** (M1)	**15**	2068	8	2069	7	2070	4
2071	5	2072 (N1)	6	2073	5	2074	4	2075	2	2076	2
2077	4	2078	4	2079	4	2080	2	2081	1	2082	0