Problem Chosen	2023 MCM/ICM Summary Sheet	Team Control Number
C		2321846

OUR TITLE
Our Title

Summary

Keywords:

Contents

1 Introduction

1.1 Background

1.2 Restatement of the Problem

problem 1 text

1.3 Our Work

☑

Here's our work:

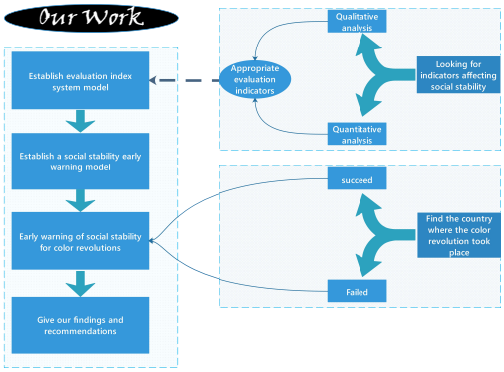


Figure 1: Our Work

2 Assumptions and Notations

2.1 Assumptions

To simplify our model, this paper makes following basic assumption, each of which is properly justified.

- We assume that

  ↪ **Justification:** Justification

2.2 Notations

Notations that we use in the model are shown in the Table 1:

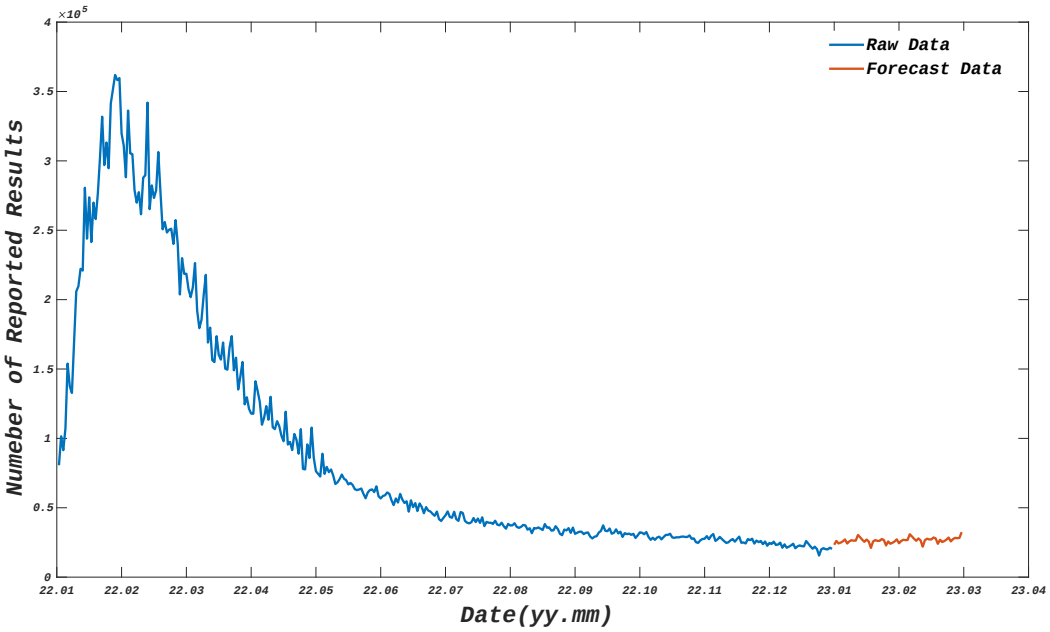


Figure 2: forecast

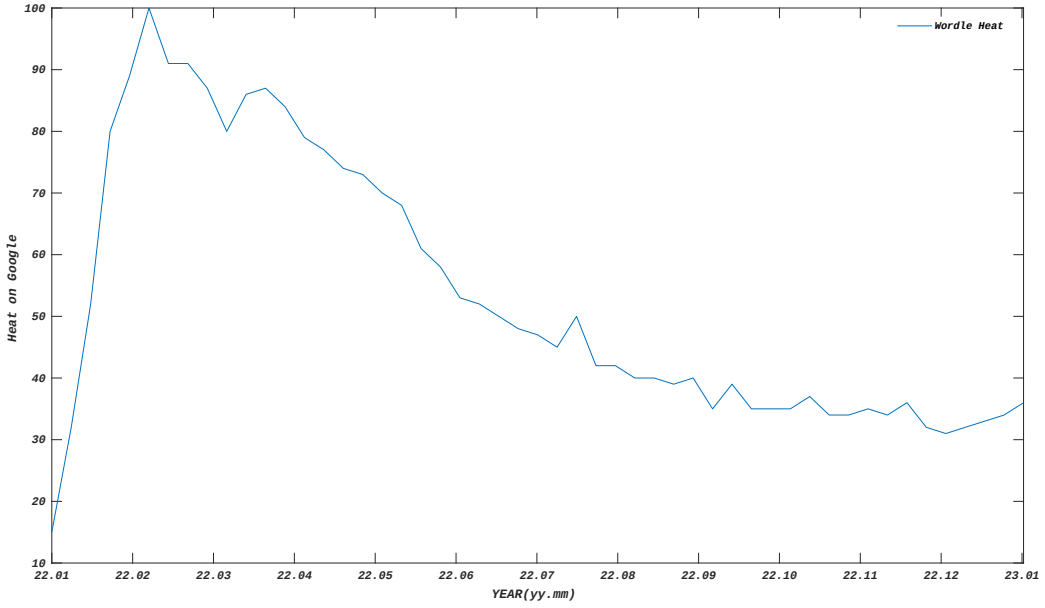


Figure 3: heat

Table 1: Notations

Symbol	*Description*	*Unit*
A_i	Level 1 indicators	-

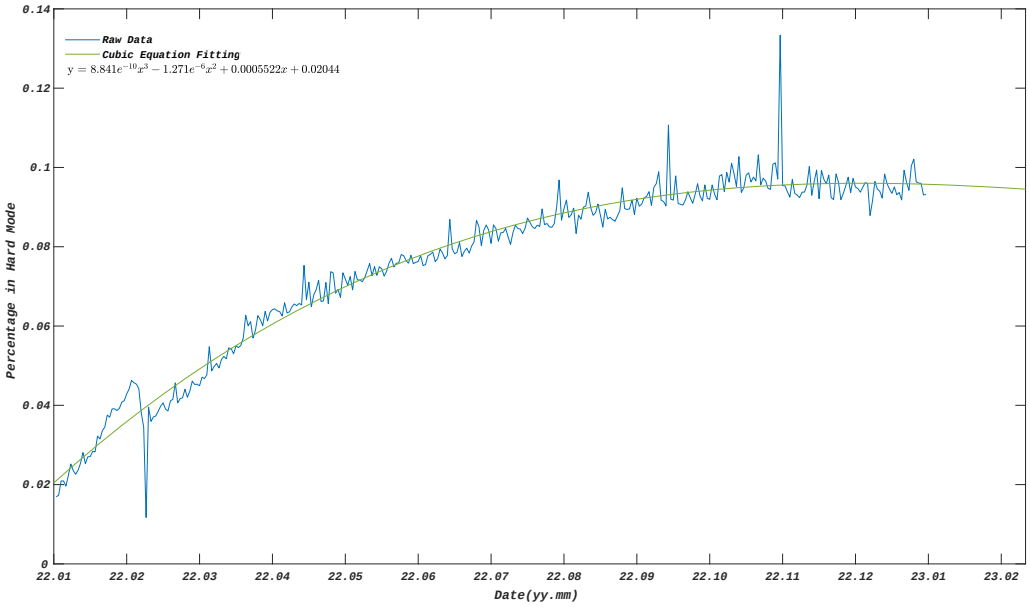
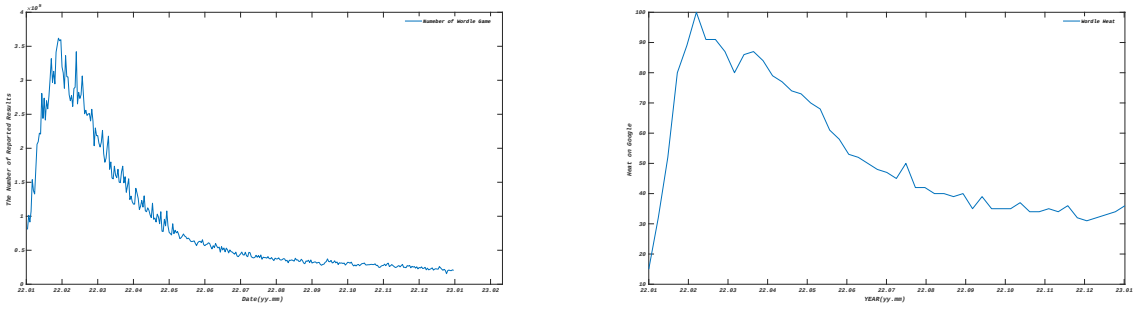


Figure 4: sanci



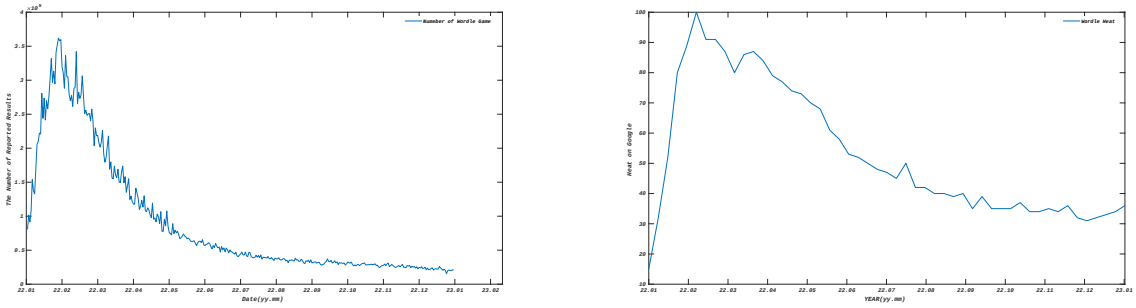
(a) The Number of Reported Results

(b) Heat on Google

Figure 5: Changing Trend of Number and Heat

3 The Number of Reported Results

In order to analyze and predict the number of reported results, we cleaned the data (it includes for words with incorrect number of three letters and removal of outliers from the data), and we considered the number of reports related to the Hot of the game. We represented the number of searches for "WORDLE" in Google as the game's hotness. They are listed in the following Figure:



(a) The Number of Reported Results

(b) Heat on Google

Figure 6: Changing Trend of Number and Heat

So we can easily get a preliminary conclusion: the number of reported results changes with the change in the heat of "WORDLE" on Google, and there is a positive correlation between the two before. We this explains the reason for the change in the number of reported results: because of the change in the heat of the game. Of course this is only a simple model, in order to get a concrete picture of how the number of reports changes and how the number of reports will change in the future, we will build a mathematical model below and get the number of reports in the interval of March 1, 2023.

3.1 Establishment of ARIMA Model

3.1.1 ARIMA Model Introduction

The Autoregressive Integrated Moving Average model (**ARIMA**) is a type of time series forecasting model that allows us to transform our non-stationary time series into a stationary time series after finite difference processing. ARIMA is the most common in the series family due to the adaptability of linear patterns amongst all time series strategies. Moreover, ARIMA model has the benefits of using a simpler algorithm and being a studied technology in comparison to the second generation of forecasting methods which is the artificial neural networks.

3.1.2 Mathematical Modeling of ARIMA

The mathematical model of ARIMA (p,d,q) is shown to be precise in the literature by combining AR (p) and MA (q), While Integrated (**I**) reflects the separation of raw observations to allow the time series to become stationary, the difference between the real data values, and the previous values are replaced with the data values. The finite distinction of the data points in ARIMA

(p,d,q) are used to transform the non-stationary time series to the steady one. The mathematical formulation of ARIMA (p,d,q) is demonstrated as following Equations.

$$\varphi(L)(1-L)^d y_t = \theta(L)\varepsilon_t \tag{1}$$

$$(1-\sum_{i=0}^{p}\varphi_i L^i)(1-L)^d y_t = (1+\sum_{j=1}^{q}\theta_j L^j)\varepsilon_t \tag{2}$$

$$Y_t = \phi_0 + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \varepsilon_t - \theta_1\varepsilon_{t-1} - \theta_2\varepsilon_{t-2} - \cdots - \theta_p\varepsilon_{t-p} \tag{3}$$

Where y_t and ε_t are the actual value and random error at time period t,respectively.$\varphi_1(i=1,2,\cdots,p)$ and $\theta_j(j=0,1,\cdots,q)$ are model paramenters. p,d and q are positive integers, referring to the order of the autoregressive, integrated, and moving average parts of the model, respectively. A typical method for identifying p and q is achieved by implementation of the Autocorrelation Function (**ACF**) and Partial Autocorrelation Functions (**PACF**) of the data. The PACF plot helps to decide if the ACF plot can classify non-stationary time series by the maximum order of AR (p).

3.2 Solution of ARIMA Model

We will use matlab and the above model to explain and predict the changes in the number of reports as follows:

3.2.1 Determination of d

Before the ARIMA model, we first have to perform a smoothness test on the time series. And we use matlab to perform the smoothness test to find that the series is not smooth, after the first order difference, the time series is smooth, so we get $d=1$.

3.2.2 Determination of p,q

There is no good way to determine p and q, but the computer is obviously better than the naked eye for p,q. We select the better ARIMA model by a series of variations of p,q values.

3.2.3 Model Selection

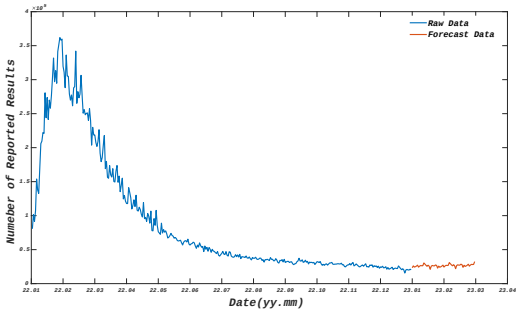
For the selection of the ARIMA model, we found the better set, which obtained the $Adjusted-R^2, AIC, SC, MAPE$ and $RMSE$ we shown it in Table 2:

3.3 Prediction of March 1, 2023

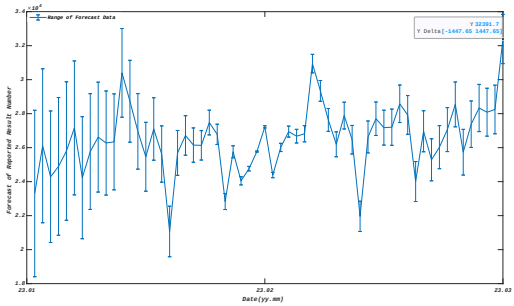
We chose ARIMA(5,1,2) as our final ARIMA model by which we forecast the March 1, 2023 quantity. And give the forecast interval based on the model error:**[30943, 33839]**.

Table 2: Test Index of Each Model

Index	ARIMA (1,1,0)	ARIMA (2,1,0)	ARIMA (3,1,0)	ARIMA (2,1,0)	ARIMA (5,1,0)	ARIMA (6,1,0)
Adjusted-R^2	0.351697	0.352447	0.139293	0.311184	0.394786	0.279782
AIC	7.514608	7.513726	7.784217	7.573689	7.449272	7.696297
SC	7.627180	7.626297	7.896789	7.686260	7.561843	7.808869
MAPE	6.576058	6.573973	8.285324	6.847210	5.991413	6.680915
RMSE	9.717137	9.713131	11.16802	10.01724	9.454456	10.66723
Index	**ARIMA (1,1,1)**	**ARIMA (2,1,1)**	**ARIMA (3,1,1)**	**ARIMA (4,1,1)**	**ARIMA (5,1,1)**	**ARIMA (6,1,1)**
Adjusted-R^2	0.282660	0.302913	0.224594	0.094755	0.282594	0.144170
AIC	7.505304	7.487031	7.574546	7.898818	7.505778	7.703474
SC	7.622254	7.603981	7.691496	8.011390	7.622728	7.820424
MAPE	5.495101	5.439750	5.682568	8.502531	5.430309	6.579909
RMSE	9.637975	9.514886	10.00691	11.98773	9.725911	10.72635
Index	**ARIMA (1,1,2)**	**ARIMA (2,1,2)**	**ARIMA (3,1,2)**	**ARIMA (4,1,2)**	**ARIMA (5,1,2)**	**ARIMA (6,1,2)**
Adjusted-R^2	0.066860	0.151594	0.356335	0.001429	***0.401740***	0.151327
AIC	7.869510	7.776217	7.507592	7.928901	***7.373051***	7.779057
SC	7.982082	7.888789	7.620164	8.041473	***7.490001***	7.891629
MAPE	7.673681	7.285152	6.719789	8.376965	***5.072340***	7.482382
RMSE	11.68773	11.14531	9.854205	12.19098	***8.884206***	11.26219
Index	**ARIMA (1,1,3)**	**ARIMA (2,1,3)**	**ARIMA (3,1,3)**	**ARIMA (4,1,3)**	**ARIMA (5,1,3)**	**ARIMA (6,1,3)**
Adjusted-R^2	0.013991	0.207111	0.292092	0.123519	-0.015869	0.149244
AIC	7.814235	7.635996	7.493233	7.721904	7.841370	7.692927
SC	7.931185	7.752946	7.610183	7.838854	7.958320	7.809877
MAPE	6.998548	6.020232	5.687182	6.844513	7.251816	6.197987
RMSE	11.41146	10.29992	9.765165	10.89394	11.70910	10.75731

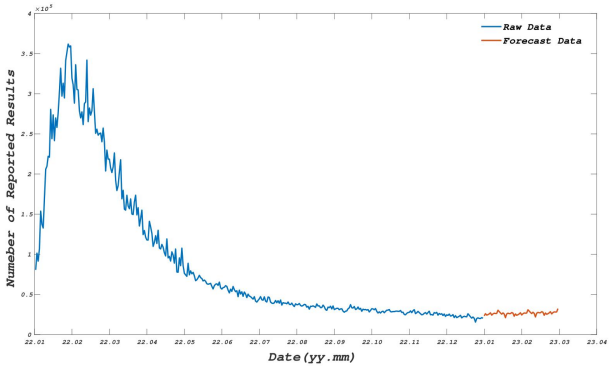


(a) Prediction Results

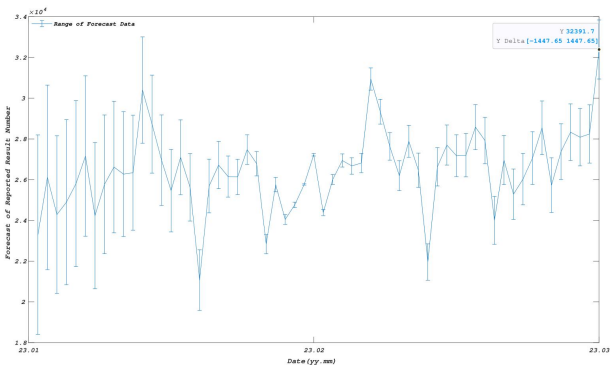


(b) Prediction Interval

Figure 7: ARIMA(5,1,2) Model Predict



(a) Prediction Results



(b) Prediction Interval

Figure 8: ARIMA(5,1,2) Model Predict

3.4 Model I

Step 1

4 Solution For Problem One

5 Analysis and Promotion of Our Model

5.1 Sensitivity Analysis of Our Model

5.2 Strengths and Weaknesses

Our research is basically based on the predecessors, and there are some improvements and shortcomings as follows:

5.2.1 Strengths

5.2.2 Weaknesses

5.3 Future Work

MEMO

To: MCM/ICM organizing committee
From: Team 000000
Date: February 18, 2023
Subject:

THE

- *Keep a firm grip on the local media to prevent public opinion from getting out of control. There is no substitute for the role of the media in regime change, and its entry into and occupation of a country's position of public opinion can help to bring down that country's regime. For the ruling party, therefore, to give ground. That means the beginning of the loss of power, public opinion out of control, not much time.*

Algorithm 1: Simulation-optimization heuristic

Data: current period t, initial inventory I_{t-1}, initial capital B_{t-1}, demand samples
Result: Optimal order quantity Q_t^*

$r \leftarrow t$;
$\Delta B^* \leftarrow -\infty$;
while $\underline{\Delta B \leq \Delta B^* \text{ and } r \leq T}$ **do**
  $Q \leftarrow \arg\max_{Q \geq 0} \Delta B_{t,r}^{Q}(I_{t-1}, B_{t-1})$;
  $\Delta B \leftarrow \Delta B_{t,r}^{Q}(I_{t-1}, B_{t-1})/(r-t+1)$;
  if $\underline{\Delta B \geq \Delta B^*}$ **then**
    $Q^* \leftarrow Q$;
    $\Delta B^* \leftarrow \Delta B$;
  end
  $r \leftarrow r+1$;
end

References

[1] Chômage au sens du BIT et indicateurs sur le marché du travail (résultats de lenquête emploi) (BIT) - troisième trimestre 2022.

Appendix