

Weather Forecast In Medan City With Hopfield Artificial Neural Network Algorithm

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Abstract: Many aspects are very influential for the continuity of Indonesian society, especially Medan. One of the aspects that affect the continuity of the people of Medan is the weather. Weather plays an important role in various sectors, such as agriculture, aviation, and many other sectors. Indonesian Agency for Meteorology, Climatology and Geophysics . (BMKG) is always trying to develop their innovations to be able to provide accurate weather information to the public. To assist the process of disseminating weather information to the public in Medan City, we need a Weather Forecast application that uses Website-based computer technology so that it can help disseminate weather information easily and effectively which is generated through the support of the Hopfield method by connecting the application with BMKG data. Based on the results of this study, starting with analyzing by applying the Hopfield algorithm combined with an artificial neural network, a weather forecasting application was successfully built to help disseminate weather information in Medan City to all Medan City people who want to get information about the weather.

Keywords: BMKG, Weather, Artificial Neural Network, Hopfield, Website

INTRODUCTION

Weather is very influential on human life, for example in the agricultural sector, aviation and many more.(de Rosnay et al., 2021) The difficulty of predicting the weather is due to many factors as a reference that determine the weather at this time, usually only by looking at the air conditions in a relatively short time, which can be explained by several attributes such as air pressure, wind speed, rainfall, temperature, and atmospheric phenomena as elements. Weather conditions are an important aspect and can never be separated from human life(De Rosnay et al., 2018).

The Meteorology, Climatology and Geophysics Agency or BMKG of North Sumatra Province is a government agency to handle management and is the core of data information in the weather forecasting sector which aims to provide flight information. BMKG North Sumatra Province wants to utilize technology as a medium of communication and a medium for sending weather data to other places.

The use of technology in providing weather information in the city of Medan is considered quite effective, because there are already many people in the city of Medan who understand technology and generally already have their own smartphone. With the existence of technology, the next step is to socialize the ways and benefits of the weather forecasting application that will be made.(Khairiyati et al., 2020)

Artificial Neural Networks are artificial representations of the human brain that are continuously trying to simulate the learning process in the human brain (Zhong et al., 2019). The term man-made here is interpreted as a neural network that is implemented using a computer programming language that can complete many calculation processes quickly during the learning process (Chan & Luo, 2020).

The Hopfield Neural Network is a suitable method to be used as a means of predicting the weather from the classification of the weather/climate elements. The network uses a classification technique, the Lyapunov energy function (symmetrical main diagonal weight zero (0) to get the output to be close to or equal to the input. Classification is carried out with discrete data (quantitative data or variables whose observations or measurements are in the form of whole numbers or the range of x countable. However, the Hopfield model with continuous data (data or variables whose observations or measurements are in the form of whole numbers or fractions or if x undergoes each price in an interval then the range x is said to be uncountable), is also very appropriate for classification (Susanty et al., 2019).

In this case, to overcome the above problems, the method that can be applied to Artificial Neural Networks (ANN) is the Hopfield Method which aims to simplify and assist in providing information related to the weather in Medan City. Using the Hopfield method can help the Meteorology, Climatology and Geophysics Agency for

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North Sumatra Province to provide information to the people of Medan City about the latest weather in Medan City. The system will work in a computerized manner by using some input elements of the weather so that it can produce accurate information about the current weather in the city of Medan.

LITERATURE REVIEW

Weather is a condition that occurs in the atmosphere, sky or air on the surface of the earth. Weather is the change in temperature, wind, rainfall, and sunlight. Temperature or air temperature is a measurement of hot or cold in an area every day. Physically, temperature is defined as the degree of movement that comes from the molecules of an object, the faster the movement of the molecules, the higher the temperature. Air humidity is the amount of water vapor that the air contains in the atmosphere. The humidity element in the weather makes for a warmer day and can be used to anticipate storms. Air pressure refers to the force exerted by the weight of air on the earth (He et al., 2021). It varies vertically and its value decreases with increasing height. It is primarily used in meteorology to monitor storms that develop suddenly and seem to come from nowhere. The presence of large rivers and lakes is a key element in changes in atmospheric pressure. Wind is a climate element that transports heat and moisture to an area. The climate of an area is often determined by the properties of temperature and humidity. Precipitation is any form of water that falls on the earth from clouds. It can fall in a liquid or solid state, in the form of snow, hail or rain. It is a weather element that, depending on its frequency, determines the water level in rivers and streams and influences the humidity of the environment in a given area.

Artificial Neural Networks are artificial representations of the human brain that are continuously trying to simulate the learning process in the human brain. The term man-made here is interpreted as a neural network that is implemented using a computer programming language that can complete many calculation processes quickly during the learning process (Dzikri & Kurniawan, 2018). The human brain contains millions of nerve cells whose job is to collect and process information. Each cell works like a simple processor. Each of these cells is interconnected to support the ability and intelligence of the human brain.

According to (Ertuğrul et al., 2017) The Hopfield model is the same as the symmetric matrix. Hopfield network is a fully connected artificial neural network method, meaning that each unit is connected to other units. In general, the output value of an artificial neural network is determined by the input value, weight, and activation function. (Georgopoulos et al., 2019) The activation function is defined based on the problem to be solved. If the Hopfield network is made to classify binary patterns composed of a combination of numbers 0 and 1, then a step function is set with two values (0 and 1) as the activation function. According to (Hamdani et al., 2020) When classifying bipolar patterns, two values (-1 and 1) are used for the step function. In this Hopfield architectural model there are four symmetrical neurons, namely the targeted output must be the same as the input (Prashant Mahasagara et al., 2017).

In this research will develop an application in implementing it in everyday life. most of the transitions are triggered by the completion of the previous state (internal processing). The supporting tool applications in running a system include: Sublime Text is a text editor that is often used by programmers, especially a Web Developer and Crystal Report is a software to print a report from various programs including Microsoft Visual Basic 6.0, Java, Delphi, C ++ , Mysql and others (Chunqiao et al., 2018).

METHOD

In the concept of writing and making system development modeling applications is one of the most important elements or elements in research. In a particular software system development model or software can take several types of methods including the waterfall algorithm or commonly called the waterfall algorithm. The following is a picture of the waterfall method or the waterfall method. The waterfall method or often referred to as the classic life cycle is a software development model that provides pressure sequential and systematic phases, through planning, modeling, construction, and deployment processes (Casro et al., 2020). This study also uses the Hopfield method as a system algorithm. The system algorithm is an explanation of each step in solving a problem in the design of an artificial neural network system in predicting the weather in the city of Medan accurately and reliably. In determining the weather forecast for Medan City, the Meteorology, Climatology and Geophysics Agency (BMKG) for North Sumatra Province required several stages of the Hopfield method in completing the calculation, namely:

1. Calculation of weather aspects, such as temperature, wind speed, air humidity, and air pressure.
2. Input the output of temperature, wind speed, air humidity, and air pressure.
3. Determine the calculations as recommended to produce weather predictions.
4. Ensuring that the output of digital calculations is correct so that people get reliable information
5. Updating weather information in Medan City.

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RESULT

The research data used is real time data for 2022 which will predict the weather for the 2022 period. The research data comes from the Medan Meteorology, Climatology and Geophysics Agency (BMKG). Data input consists of air temperature (°C), air humidity (%), air pressure (mb). While the output data consists of wind speed (m/s), rainfall (millimeters). The forecast data processing diagram used at the Medan BMKG is as follows.

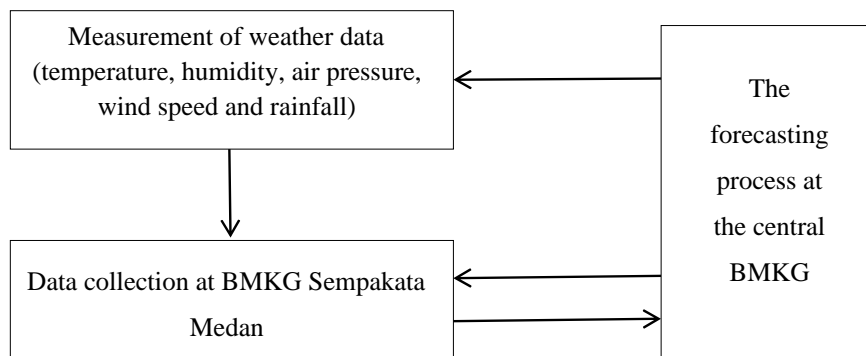


Figure. 1 Data Processing Diagrams

Figure 1 explains the data processing process at the BMKG Sempakata Medan by carrying out data measurements at Kuala Namu International Airport using related instruments. The data that has been obtained is periodically sent to the BMKG Sempakata Medan to be collected with data from several different places. The data obtained by BMKG Sempakata Medan will be processed into a weather forecast using statistical methods. BMKG Sempakata Medan processes data and publishes weather forecast applications sent to users or general users of the Medan community who want to get information about the weather in the city of Medan. The initial data obtained will be transformed and shared. Data transformation is performed according to the activation function used. This study uses the binary sigmoid activation function with a value range of 0 to 1. On . The data transformation process is calculated using the following formula:

$$x' = \frac{(x - x \text{ min})(b - a)}{(x \text{ max} - x \text{ min})} + a$$

Data sharing was done by dividing the data into two parts, namely 80% or 1753 training data and 20% or 439 validation data.

System Modeling

Modeling on a system aims to create a modeling of the basic framework or initial framework of the Hopfield method of artificial neural network systems that will be used for weather forecasting applications, required input or input systems, expected output or output, as well as procedures or steps for using the system. . The stages or steps that will be carried out in the Unified Modeling Language system modeling stage include use case diagrams, activity diagrams, and class diagrams.

1. Use Case Diagram. The following is a use case diagram in system modeling.

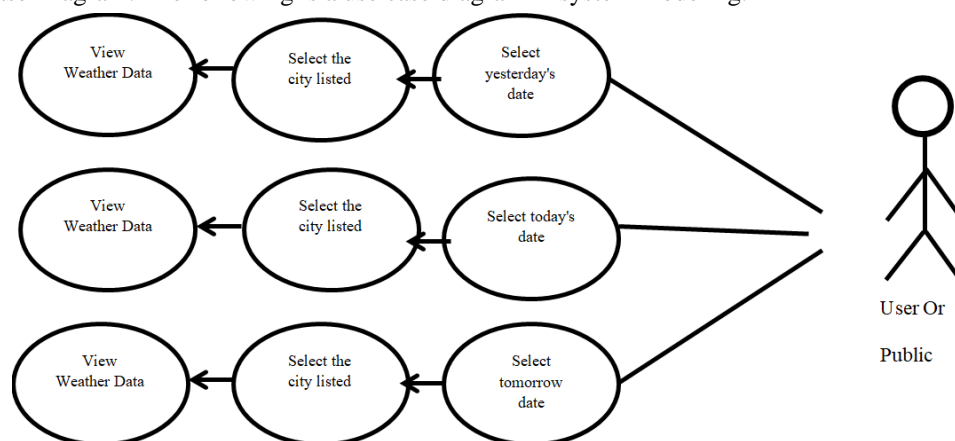
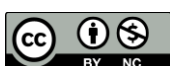


Fig. 2 Use Case Diagram

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2. Class Diagram. The Class Diagram of the Weather Forecast Application can be described as follows.

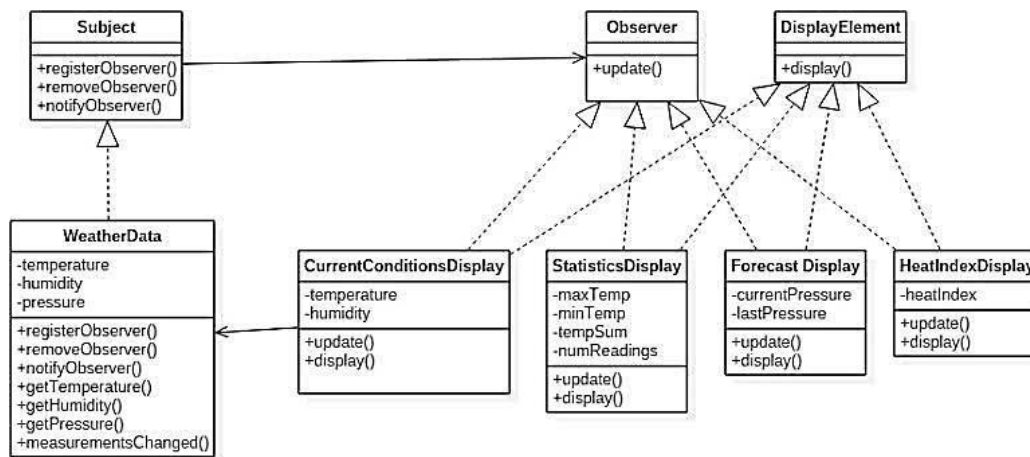


Fig. 3 Class Diagram

System Implementation

Implementation is a step used to operate the system to be built. This chapter will explain how to run some examples of the systems that have been built. The following is a display of the implementation in the Artificial Neural Network in predicting the weather in Medan City.

1. Loading page / waiting page display



Fig. 4 Loading Page / Waiting page

2. Yesterday's weather data form display

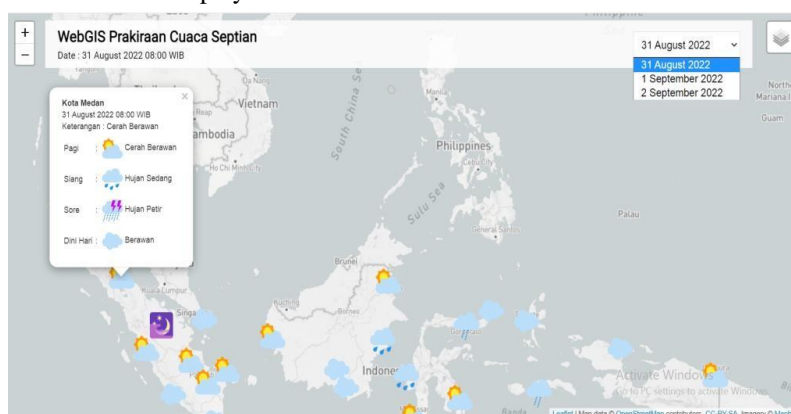


Fig. 5 Yesterday's Weather Data Display Form

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3. View of Today's Weather Data Form

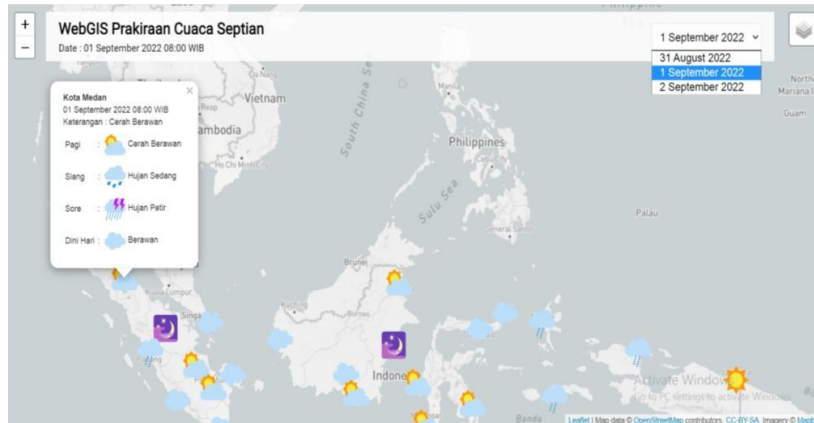


Fig. 6 View of Today's Weather Data

4. View of Tomorrow's Weather Data Form

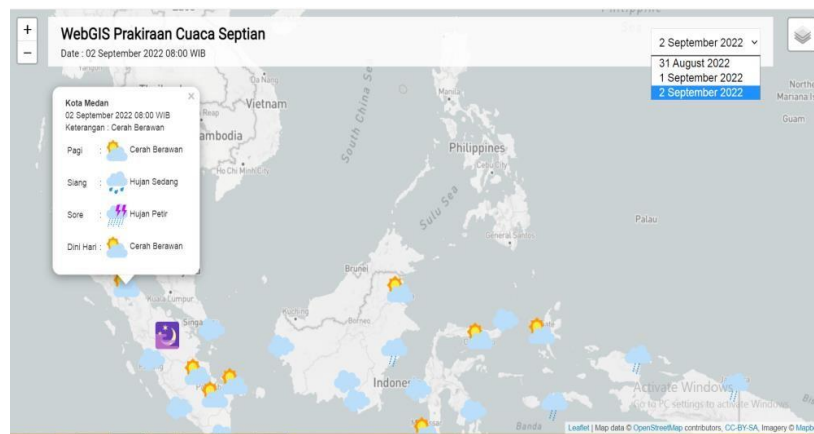




Fig. 7 View of Tomorrow's Weather Data

System testing is done by black box testing

Yesterday's Data Display Test

Testing the yesterday's data display menu aims to find out whether the data that appears is as expected

Table 1 Testing Shows Yesterday's Data

No	Test Scenario	Test Case	Expected results	Test result	Information
1	Shows Yesterday's Data		Displays yesterday's data according to today's date		Succeed

Testing Shows Today's Data

Testing the data display menu today aims to find out whether the data that appears is as expected.

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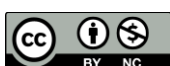




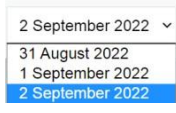

Table 2 Testing Shows Today's Data

No	Test Scenario	Test Case	Expected results	Test result	Information
1	Shows Yesterday's Data		Displays yesterday's data according to today's date		Succeed

Testing Shows Data Tomorrow

Testing the data display menu tomorrow aims to find out whether the data that appears is as expected.

Table 3 Testing Data Shows Tomorrow

No	Test Scenario	Test Case	Expected results	Test result	Information
1	Shows Yesterday's Data		Displays yesterday's data according to today's date		Succeed

DISCUSSIONS

After carrying out the process of implementing and testing the system using the Hopfield method, this system has several weaknesses and advantages to the system, and this system still requires development in stages. Meanwhile, there are still some system weaknesses. These results are only used for weather forecasts in big cities in Indonesia. This application lacks good data security because it does not use data security algorithms. The system can only follow weather forecast data from BMKG. And there are also system advantages; the system can be used easily, which is adjusted to the ability level of system users. The application's appearance is easy to run and constantly updated according to data from the BMKG.

CONCLUSION

The conclusions in this study resulted in several tests being carried out. Based on the analysis and research results, the application built can accurately and responsibly predict the weather in Medan City accurately and responsibly. And Based on the results of the application using research, the Hopfield method can provide information and solve problems faced by the general public to obtain accurate weather information. Based on the results, the system is declared fit for use by the general public.

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