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Extraction of Winter Temperature Patterns for Agricultural Operations.

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ABSTRACT

Agriculture is essentially a combination of processes designed to promote, artificially, a favourable environment for growth. All crops have their climatic limits for economic production. In their influence on crops, the climatic factors are closely interrelated. The effect of each is modified by the others. Daily, seasonal, or annual variations in any or all the climatic elements are of importance in determining the efficiency of crop growth. The emphasis of this study is to extract the weather patterns of January and February months of winter season over the coastal station Karaikal (Latitude 10°43' N / Longitude 79°49' E) of east coast of India using association rule mining. This work proposes a data mining model which can predict the occurrence of cold day during winter months with the help of local weather data for a specific station. This study is attempted to get weather patterns for agricultural operations on winter months of the specified location. This model helps to perform agricultural operations during winter environment on location specific weather data.

Keywords: Data mining, environment, agriculture, association rule mining.

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INTRODUCTION

Present practice of forecasting temperature is with respect to climatic normal. A few studies have been made regarding the long term trends, if any of temperatures [1,2]. But these may not be helpful to forecast exactly the maximum or minimum temperature range. Usually synoptic weather systems are identified and as per the characteristics of the system temperature fall or rise are assessed and forecast is given. Similarly the wind flow as per the marked synoptic system or systems are seen and depending on the likely wind continental or maritime, temperature forecast is given as to the occurrence of 'above normal' or 'below normal' temperatures. However a subjective forecast with threshold value can be given that will be more useful. Recently few studies have been contributed for weather forecasting using specific station weather data [3-7]. The crops green gram, black gram, cotton and etc crops are planted on the specific location Karaikal during winter months. If the farmers know the weather patterns well advance, they will plan their agricultural operations. At present all prediction models are available only in synoptic situation. This study is driven to focus a model to extract winter weather patterns. An attempt is made towards that direction here.

DATA AND METHOD

Karaikal (Latitude 10°43' N / Longitude 79°49' E) is a coastal station of east coast of India which is considered to this study. The global summary of the surface daily data for the period of 1961-2010 is collected from the National Climatic Data Centre, Asheville, USA at ncdc.noaa.gov. The January and February months were considered for extraction of extreme winter day and normal winter day weather patterns using association rule mining of data mining technique. The atmospherically parametric quantity of Maximum_Temperature(MAXT), Minimum_Temperature(MINT), Dew_Point(DEWP), Wind-Speed(WS) and Visibility(VISI) were argued for analysis [Table 1]. After applying the data preprocessing techniques finally a sum of 1350 and 1638 data objects were analyzed for extreme winter day and normal winter day prediction during winter months for 24 hours ahead and 48 hours ahead respectively. Extreme winter day is called as cold day(CD) of winter months over the Karaikal station. A best fit ranges of 5 atmospheric constraints describes in [Table 2] as a nominal values of the coastal station.

WEATHER PATTERNS OF WINTER SEASON

The associations and relationships can be presented in the form of rules. These rules can be extracted using association rule mining technique. A few attempts have been made on temperature pattern analysis using data mining technique [8-10]. This study describes the forecasting model for a specific location rather than region or state or country. The extracted weather patterns for the occurrence of the normal winter day and extreme winter day (cold day) are extracted using machine learning tool Weka. The patterns are presented in the form of association rules which describes the associations and relationships among the weather data with class label POST_MIN. The values of the class label POST_MIN is "nor" for normal winter day and "low" for extreme winter day. The threshold value for the cold day prediction during winter season is 67 º Fahrenheit (20 ºC). The weather patterns for 24 hour advance and 48 hour advance cold day prediction is presented in [Table 3] and [Table 4] respectively.

Table 1: Attributes of weather data set.

Attribute	Type	Description
Year	Number	Year considered
Month	Number	Month considered
Day	Number	Day considered
MAXT	Number	Real maximum temperature for the day in degrees Fahrenheit to tenths. (Celsius to tenths for metric version)
MINT	Number	Real minimum temperature for the day in degrees Fahrenheit to tenths. (Celsius to tenths for metric version)
DEWP	Number	Real mean dew point for the day in degrees Fahrenheit to tenths. (Celsius to tenths for metric version).
WS	Number	Real mean wind speed for the day in knots to tenths. (Meters/second to tenths for metric version).
VISI	Number	Real mean visibility for the day in miles to tenths. (Kilometers to tenths for metric version).

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Table 2: Nominal values of weather parameters.

Weather parameter	Nominal attribute	24 hr advance	48 hr advance
Maximum temperature in Fahrenheit	T_{LOW}	<81º	<81º
	T_{MED}	81º-87º	81º-87º
	T_{HIGH}	>87º	>87º
Minimum temperature in Fahrenheit	T_{LOW}	<70º	<70º
	T_{MED}	70º-75º	70º-75º
	T_{HIGH}	>75º	>75º
Dew point in Fahrenheit	D_{LOW}	<73º	<73º
	D_{MED}	68º-73º	68º-73º
	D_{HIGH}	>68º	>68º
Visibility in mile	V_{LOW}	<3	<3
	V_{MED}	3-4	3-4
	V_{HIGH}	>4	>4
Wind speed in knot	W_{LOW}	<6	<6
	W_{MED}	6-10	6-10
	W_{HIGH}	>10	>10
POST-MIN	LOW	≤67 º(20 ºC)	≤67 º(20 ºC)
	NORMAL	>67 º(20 ºC)	>67 º(20 ºC)

Table 3: Weather patterns for 24 hour advance CD prediction during winter.

ASS Rule ($X \Longrightarrow Y$)	**SUP ($X \cup Y$)**	**CONF P(Y/X)**
MAXT='(81.4-87.1]' MINT='(-inf-69.566667]' DEWP='(68.166667-73.333333]' VISI='(4.033333-inf)' WS='(-inf-5.9]' ==> POST_MIN=low	8	0.91691
MAXT='(87.1-inf)' ==> POST_MIN=nor	115	0.99489
MINT='(69.566667-74.733333]' ==> POST_MIN=nor	192	0.99488
MINT='(74.733333-inf)' ==> POST_MIN=nor	92	0.99481
DEWP='(73.333333-inf)' 86 ==> POST_MIN=nor	86	0.99478
DEWP='(-inf-68.166667]' 57 ==> POST_MIN=nor	57	0.99454
VISI='(3.066667-4.033333]' ==> POST_MIN=nor	110	0.99432
WS='(9.7-inf)' ==> POST_MIN=nor	42	0.99427
VISI='(-inf-3.066667]' ==> POST_MIN=nor	16	0.99286

Table 4: Weather patterns for 48 hour advance CD prediction during winter.

ASS Rule ($X \Longrightarrow Y$)	**SUP ($X \cup Y$)**	**CONF P(Y/X)**
MAXT='(81.4-87.1]' VISI='(4.033333-inf)' WS='(5.9-9.7]' ==> POST_MIN=nor	90	0.99326
MINT='(-inf-69.566667]' VISI='(4.033333-inf)' WS='(5.9-9.7]' ==> POST_MIN=nor	23	0.99297
MAXT='(81.4-87.1]' MINT='(-inf-69.566667]' DEWP='(68.166667-73.333333]' VISI='(3.066667-4.033333]' ==> POST_MIN=low	13	0.9878
MINT='(69.566667-74.733333]' ==> POST_MIN=nor	190	0.99479
DEWP='(73.333333-inf)' ==> POST_MIN=nor	83	0.99461
MAXT='(87.1-inf)' WS='(-inf-5.9]' ==> POST_MIN=nor	62	0.99436
WS='(9.7-inf)' 42 ==> POST_MIN=nor	42	0.99391

Table 5: Stratified cross validation summary of cold day prediction.

Measures	CD prediction	
	24 Hrs A-Head	48 Hrs A-Head
Total number of instances	1350	1638
Correctly classified instances	1330	1327
Incorrectly classified instances	20	311
Correctly classified in %	98 %	81 %
Incorrectly classified in %	2 %	19 %
Mean absolute error	0.0279	0.2533
Root mean squared error	0.1176	0.3528

VALIDATION

Validation is done to find out the reliability of the generated results and to show whether they can be used in real time for the prediction of extreme winter day from winter weather patterns using the mining approach. The stratified 10 fold cross validation has been made and its summary is presented in [Table 5]. The correctly classified instances for the 24 hour and 48 hour advance prediction is 98% and 81% respectively. The results are more or less same and consistently above 80%. Hence this model can work for 48 hour ahead prediction for extreme winter day.

CONCLUSION

A weather forecast for predicting the extreme winter day during January and February months of winter season over Karaikal station using association rule mining of data mining technique has been proposed. The results are encouraging and interesting. The main advantage of this model is that we need data only for a particular specific location instead of region. The extracted weather patterns are represented in the form of association rules. The association rules describe the normal winter days and extreme winter days. This model helps that the crop managers can take decision well advance for their agricultural operations during winter season over this location.

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