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A Datamining Based Decision Support System For Fruit Manufacturing

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Abstract: Agricultural activities provide one of the main sources of living in many regions of the world. Such products play significant roles for the survival of living organisms. Farmers all around the world work towards reaching their economic goals through agricultural activities. By doing this, they invest both their capital and time. In some occasions, such investments end up with serious losses and planted products either grow in low levels or do not grow at all. In this study, in order to avoid such situations and guide the investors intelligently, a decision support system based on decision tree is developed. Related parameters in accordance with the climatic and geographic characteristics of the region are determined within this proposed system. Then, appropriate types of fruits are proposed to the users as the outcome of the system based on these parameters. By doing this, producing more efficient and profitable products is aimed.
Keywords: Decision tree; Pomiculture; Classification of fruits; Decision support system.

1. Introduction

Agricultural activities provide one of the main sources of living for the human kind. Countries have developed employment fields in agriculture in accordance with aim of their economic survival through exporting the products they grow. Agriculture industry is a sector where millions of people make a living with. Significant investments are made with farmers and the governments every year and profit is expected accordingly. One of the critical points is coming up with the right policies. Wrong investment policies cause high levels of costs and result in infertile lands. A database is generated within the scope of this research considering a set of fruits and a decision support system is developed to help the investors in choosing the appropriate fruits to grow by linking them with the required geographic and climatic characteristics for growing these fruits. Although there are many studies in the literature about fruit growing but the amount of studies related to datamining or decision support system is quite limited. Jean Pennington and Fisher have classified the fruits and vegetables in terms of botanic family, color, part of the tree that it grows on, and total antioxidant in order to regulating feeding behavior and guiding it [1]. Lu et al. have developed a hybrid solution approach in classification of the fruits in their research. They combined PSO, ABC, and SLFN methods and stated that the proposed method outperforms existing methods at 85% accuracy [2]. Zhang et al., developed a solution methodology in which they combined a forward feeding neural network method with a chaotic artificial bee algorithm to classify the fruits in reference with the scanned fruit pictures. They concluded that 1653 fruit pictures from 18 categories were classified with 89.1% accuracy [3]. Gill et al. considered fruits such as apple, grape, peach, orange, banana, and mango in their research by evaluating the studies in the literature classifying according to computer software techniques and reported their findings systematically [4]. Mercol et al. studied the problem of automatically classifying oranges by the use of datamining techniques and scanning process. Within the solution of the problem, they used six different methods including five different decision trees and one rule-based classification. They claimed that they obtained effective solutions with sufficient accuracy rate and low calculation cost [5]. Many studies related to decision trees exist in the literature and a selection of them is presented in Table 1.

The definition and the characteristics of the problem is provided in the second part of the study. The third part presents information regarding the solution methodology. The forth part provides information about the application study. The last part includes results obtained and future direction for the research.

2. Problem definition

Fruit growing has great significance for the World both from ecological and economical perspectives. Using land efficiently and survival of biological variety is only possible through increasing the green fields. Fruit growing is

one of the most imprint sectors contributing to this aim. Moreover, considering that fruit growing is related to the fields such as pharmacy, cosmetics, food, and cleaning, the width of the field becomes more apparent.

Table 1. Studies on Decision trees

Author	Year	Method	Author	Year	Method
Balkaya et al. [6]	2010	Main element analysis, Cluster analysis	Sert et al., [13]	2010	Image processing technique
Balci et al. [7]	2016	Image processing technique, Artificial neural network	Sabzi et al., [14]	2014	Image processing and ANFIS
Kahya and Arin[8]	2014	Image processing technique	Durmus et al. [15]	2003	
Basayigit and Senol[9]	2008	Geographic information systems	Wang et al., [16]	2015	WE, PCA, FNN, FSCABC, BBO
Sabancı et al., [10]	2012	Image processing technique, Artificial neural network	Zhang et al., [3]	2014	Forward artificial neural network
Ozalp and Ucar[11]	2016	Artificial neural network and K-Closest neighborhood algorithm	Uçar et al., [17]	2017	Classification and Regression Trees
Kurtulmus et al., [12]	2013	Computer aided techniques, Artificial neural network, Statistical classifiers	Yoo et al., [18]	2016	ANN, CART and other algorithms

Many countries import fruits due to their geographic and climatic characteristics and lack of water. The decision support system developed within this research aims to help determining the types of fruits that are feasible to produce domestically using scientific methods and invest accordingly, thus using the lands more efficiently. It is projected that such systems have the potential of guiding policy-makers come up with more appropriate employment policies and new employment opportunities and even increase export levels consequently.

Initially within the scope of the problem, some of the geographic and climatic factors having effect on the growth of a fruit are determined. Then, the properties of the fruits included in the research are associated with these parameters to generate a database. The resulting database is later used within the decision tree structure with the effort of developing an interactive decision support system. The fruits included in the study and the parameters effecting the growth of them are provided in Table 2 and 3, respectively.

It is estimated that more accurate classifications can be made possible by increasing the number of the fruits and the parameters.

Table 2. Fruits considered within this research

Fruit	Fruit	Fruit	Fruit
Apple [19, 20]	Cherry [28]	Melon [37]	Erik [49]
Apricot [21]	Cranberry [29]	Kumquat [38,39]	Nar [50]
Pear [22]	Date palm [30]	Lemon [40]	Raspberry [51]
Banana [23]	Fig [31]	Mango [41]	Strawberry [52]
Blackberry [24]	Grapefruit [32]	Nectarine [42,43]	Mandarin [53]
Blueberry [25]	Grape [33]	Orange [44,45]	Watermelon [54]
Blackberry strawberry [26]	Guava [34,35]	Peach [46,47]	Chestnut [55]
Cantaloupe [27]	Kiwi [36]	Ananas [48]	Berry [56]

3. Decision tree method

Decision trees are ways of stating the learned tree structure within decision logic through the use of known sample data. In this structure, large amount of data is divided into small groups of data within the framework of certain rules. This is a widely used classification model due its easiness to use and evaluate as well as its ability to combine with other systems [57]. Decision trees have many different types including ID3, C4.5, Classification and regression trees (CRT), Automatic Chi-Square Matching, Chi-Square Automatic Interaction Detector (CHAID) [58]. CRT and C5.0 trees are used within this research when making classifications.

4. Application

Parameters and methods provided in Part 2 and 3, respectively are associated using Clementine 12.0 program and a decision tree is obtained. Tree structure is expressed as in Table 4 due to the difficulty of showing the whole structure together. The screenshot of the program is provided in Figure 1. Decision trees obtained according to CRT and C5.0 methods are provided in Table 4 and 5, respectively. The branches stated in Table 4 can be summarized as follows: for instance, number 13 states that if the climate is half hot or hot, the land is clay-loamy, the best option is growing apricot.

Analyzing CR05 method, it becomes apparent that the decision tree is formed through climate and rain properties. For instance, number five states that in a region where the climate is soft, the land is not deep and rain amount is at middle level, growing blackberry, lemon, pomegranate, and nectarine would be more efficient.

It can be observed that some factors are not considered by both of the methods. Main reason of this is that the related solution methodology does not need these parameters when making the classification. Lack of data, having both quantitative and qualitative data together, and insufficient data for the related fruit can be mentioned as the main reasons.

Table 3. Factors considered within this research

Climate Type	**Soil Type**	**Water Req.**	**Humidity Req.**	**Avg. Temperature**	**Sub**
Mild	Pebble loamy	Very low	Very low	Very low	Very low
Cold mild	Loamy	Low	Low	Low	Low
Half hot	Sandy loamy	Middle	Middle	Middle	Middle
Dry	Clayey loamy	High	High	High	High
Tropical	Deep	Very high	Very high	Very high	Very high
Subtropical	Mineral				
Desert	Acidic				
	Aired				
	Sandy clayey				
	Sandy				
	Clayey				
	Organic				
	Strainer				
	Hot				
	Humic				
	Volcanic				
	Mild sandy				

Table 4. Decision tree obtained from CRT method

1	Mild climate→Cold mild climate→Half hot climate: %100 plum
2	Mild→Cold Mild→Not half hot→Sandy Loamy soil: %100 Peach
3	Mild→Cold Mild→Not half hot→Sandy Not loamy soil: %100 Kiwi
4	Mild→Cold Not mild→Half hot: Watermelon
5	Mild→Cold Not mild→Not half hot→Dry: %100 Melon
6	Mild→Cold Not mild→Not half hot→Not Dry →Tropical: %33 Date, %33 Mango, %33 Nar
7	Mild→Cold Not mild→Not half hot→Not Dry →Not Tropical: %14,286 Ananas, %14,286 Pear, %14,286 Blackberry, %14,286 Limon, %14,286 Mandarin, %14,286 Nectarine, %14,286 Orange
8	Mild→Cold Mild→Dry: %100 Strawberry
9	Mild→Cold Mild→Not Dry →Subtropical: %100 Grapefruit
10	Mild→Cold Mild→Not Dry →Not Subtropical →Pebble Loamy soil: %100 Elma
11	Mild→Cold Mild→Not Dry →Not Subtropical →Pebbly Not loamy soil: %20 Raspberry, %20 Blackberry strawberry, %20 Berry, %20 Cranberry, %20 Bilberry
12	Mild→Not Cold Mild →Half hot→Loamy soil: %100 Grape
13	Mild→Not Cold Mild →Half hot→Not loamy soil→Clayey Loamy soil: %100 Apricot
14	Mild→Not Cold Mild →Half hot→Not loamy soil→Clayey Not loamy soil: %100 Melon
15	Mild→Not Cold Mild →Not half hot→Tropical→Subtropical→%50 Guava, %50 Kumquat
16	Mild→Not Cold Mild →Not half hot→Tropical→Not Subtropical → %100 Banana
17	Mild→Not Cold Mild →Not half hot→Not Tropical: %100 Fig

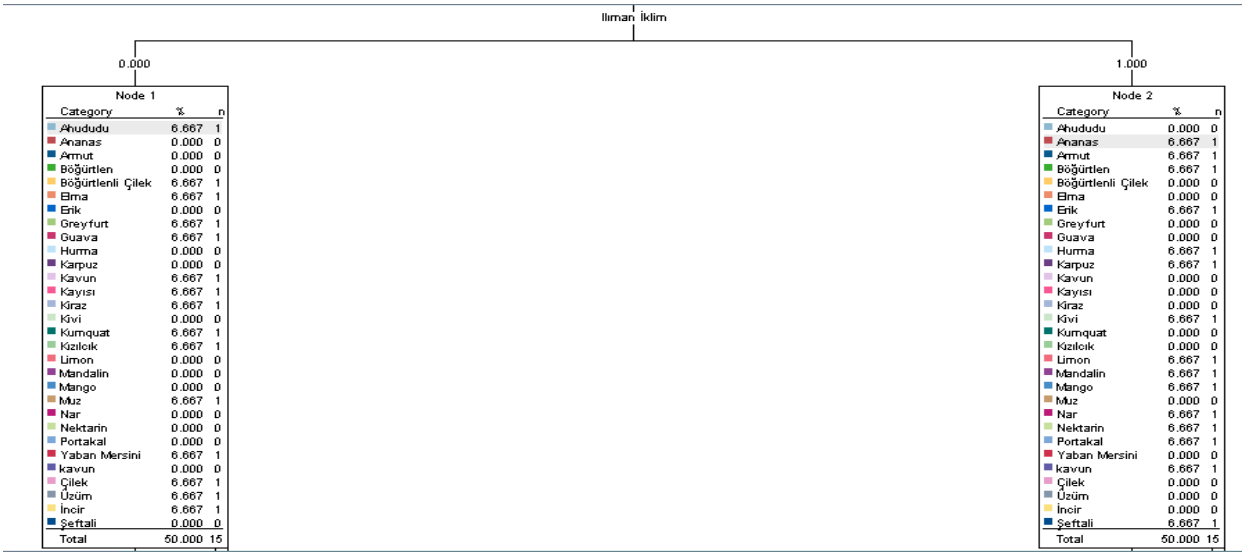

Figure 1. Decision tree structure obtained from Clementine 12.0 program

Table 5. Decision tree obtained from C5.0 method

1	Mild→Deep Soil→Su/Rainfall Low: %100 Watermelon
2	Mild→Deep Soil→Su/Rainfall Mid: %50 Erik, %50 Peach
3	Mild→Deep Soil→Su/Rainfall High: %25 Ananas, %25 Kiwi, %25 Mango, %25 Orange
4	Mild→Not Deep Soil →Su/Rainfall Low:%33 Pear, %33 Date, %33 Melon
5	Mild→Not Deep Soil →Su/Rainfall Mid: %25 Blackberry, %25 Limon, %25 Nar, %25 Nectarine
6	Mild→Not Deep Soil →Su/Rainfall High: %100 Mandarin
7	Mild→ Cold Mild→Insolation Low: %100 Bilberry
8	Mild→ Cold Mild→Insolation Mid: %50 Grapefruit, %50 Cranberry
9	Mild→ Cold Mild→Insolation High→Low Humid: %100 Strawberry
10	Mild→ Cold Mild→Insolation High→Mid Humid: %50 Apple, %50 Cherry
11	Mild→ Cold Mild→Insolation High→High Humid: %50 Raspberry, %50 Blackberry Strawberry
12	Mild→Cold Not mild→Water/Rainfall Low: %100 Melon
13	Mild→Cold Not mild→Water/Rainfall Mid: %50 Apricot, %50 Grape
14	Mild→Cold Not mild→Water/Rainfall High: %25 Guava, %25 Kumquat, %25 Banana, %25 Fig

5. Results and conclusions

Agricultural activities are vital for all countries both in terms of economic value and survival of human kind. Agricultural sector has also strategic importance for efficient use of land and continuity of ecologic cycle. Fruit growing is one of the main agricultural activities. It is related to many industries since fruits are used in various fields such as medicine, chemistry, and cosmetics. Many investors every year invest significant amounts of capital in line with various agricultural policies. However, wrong investment policies cause infertility of the lands, thus resulting in great losses. In this research, a decision support system based on decision trees is developed in order to make feasible investment policies and grow more efficient fruits. Parameters having impact on the growth of fruits are determined initially and correlated with the fruits considered in the research to be able to develop the decision support system. By the use of this developed system, feasible fruits to be grown in any geographic region are provided for the users.

A new approach to the fruit growing is provided with this research, thus the number of parameters and fruits are kept limited. Parameters as well as the correlation between the parameters and the fruits need to be determined accurately, so that the relationship between the geographic properties and fruits can be developed. It is projected that better solutions can be obtained through more efficient solution methods and the addition of more fruits and different properties in future research.

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