

Model of Fuzzy & Statistical Method for Mango Grading

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Abstract

Classification is vital for the evaluation of agricultural produce. However, the high costs, subjectivity, tediousness, labor requirements, availability and inconsistency associated with manual sorting have been forcing the post harvest industry to mango automation in sorting operations. Statistical method & Fuzzy logic were applied as a decision making support to grade mangos in this study. Quality features such as the colour, fertilizers used, height, surface area, weight, taste measured through different equipment. The same set of mangos was graded by both a human expert and the introduced system designed for this purpose. Grading results obtained from the system showed almost same general agreement with the results from the human expert, providing good flexibility in reflecting the experts' expectations and grading standards into the results. This high-tech application of mango grading can be fully automated by measuring the required features by means of sensors or machine vision and making the grading decision using Statistical method & Fuzzy logic.

Keywords: Fuzzy Mathematics, Statistical method, Agriculture, interdisciplinary work, Mango grading, Parameters, grades, Max-Min principle, weighed mean.

OBJECTIVES

1. To design a technique to classify mangos according to their external features developing effective fuzzy membership functions and fuzzy rules for input and output variables based on quality standards and expert expectations.
2. To design a technique by using statistical method & particularly weighted mean concept from the method for automated grading.
3. To compare the classification results from the Fuzzy logic approach as well as from Statistical method approach and from sensory evaluation by a human expert.

4. To establish a multi-sensor measuring system for quality features in the long term.

METHODOLOGY

First the information about process of finding gradation of mangoes from various mango traders in Ratnagiri was collected. Then parameters which will be useful for gradation of mangoes were decided. Then the range for parameters was determined. Later the fuzzy membership functions were defined and the graphs of corresponding functions were drawn. Each function will give some grades for the corresponding parameter. By using these grades calculations were done by Fuzzy & Statistical Method. Fuzzy method calculations are based on Max-min principle & in statistical method calculations weighted mean concept is used. This calculations lead to selection of best expert quality mangoes. Computer software is developed which will avoid the complicated calculations and result will be displayed on just one click.

Decided Parameters:

- | | |
|-----------------|---------------|
| 1. Weight | 4. Colour |
| 2. Height | 5. Fertilizer |
| 3. Surface Area | 6. Taste |

Functions corresponding to parameters:

1) Weight:

- i) $F(x) = (x-220)/45$ if $220 \leq x < 265$
- ii) $f(x) = (355-x)/45$ if $310 \leq x < 355$
- iii) If $f(x) = 265 \leq x \leq 310$ then $f(x) = 1$

2) Height:

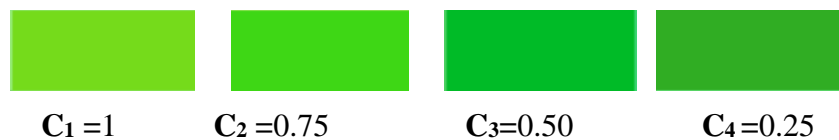
- i) $F(x) = (9.5-x)/0.5$ if $9 < x < 9.5$
- ii) $f(x) = (x-7.5)/0.5$ if $7.5 < x < 8$
- iii) $F(x) = 1$ if $8 \leq x \leq 9$

3) Surface area:

- i) $F(x) = 1$ if $71 \leq x \leq 75$
- ii) $f(x) = (x-67)/4$ if $67 < x < 71$
- iii) $F(x) = (79-x)/4$ if $75 < x < 79$

4) Colour:

- i) If $f(x) = C_1$ then $f(x) = 1$
- ii) If $f(x) = C_2$ then $f(x) = 0.75$
- iii) If $f(x) = C_3$ then $f(x) = 0.50$
- iv) if $f(x) = C_4$ then $f(x) = 0.25$



5) Fertilizers:

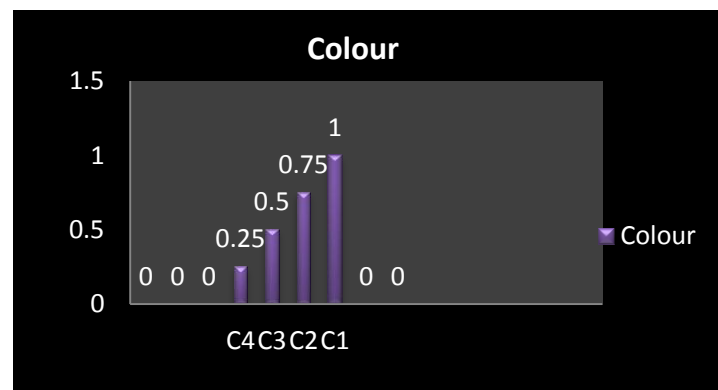
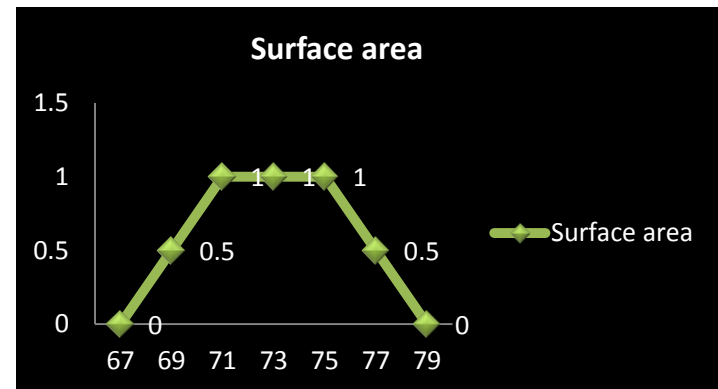
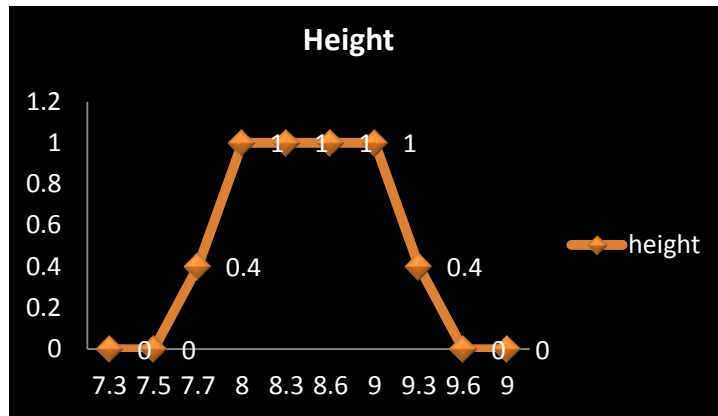
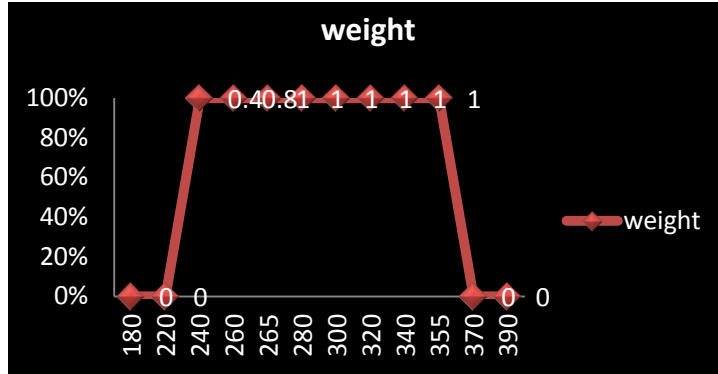
If $f(x)$ =chemical fertilizer then $f(x) = 0$ & if $f(x)$ =organic fertilizer then $f(x) = 1$

6) Taste:

For this parameter some geographical locations from Ratnagiri & Sindhudurg district were selected which are the manufacturers of Alphonso mangoes. The selected locations are **Ratnagiri ,Devgad ,Pawas ,Malvan ,Rajapur ,Kudal ,Kankavali & Nanij**. Also nearby area of 30 kms around the selected locations was considered. Then with the opinions of traders & customers the grades for each selected locations were decided. Decided gradations are noted in following table.

Selected location	Grades
Ratnagiri	1
Devgad	0.98
Pawas	0.96
Malvan	0.96
Rajapur	0.95
Kudal	0.94
Kankavali	0.92
Nanij	0.90

Graphs of decided parameters:



Example:

Method 1: Fuzzy Method

Parameter	Mango 1	Grades	Mango 2	Grades	Mango 3	Grades
Weight (gm)	275	1	300	1	315	0.40
Height (cm)	9	1	8.97	0.40	9	1
Surface Area (cm ²)	71	1	71	0.25	70	0.75
Colour	C1	1	C4	0.25	C2	0.75
Fertilizer	Organic	1	Chemical	0	Organic	0
Taste	Rantagiri	1	Devgad	0.98	Nanij	0.90

These grades are calculated by using previously generated functions. Using these grade values further Fuzzy sets are formed.

Fuzzy sets:

P1: {1/1+1/2+0.40/3}

P2: {1/1+0.40/2+1/3}

P3: {1/1+0.25/2+0.75/3}

P4: {1/1+0.25/2+0.75/3}

P5: {1/1+0/2+1/3}

P6 :{ 1/1+0.98/2+0.90/3}

After forming Fuzzy sets Max-min principle of Fuzzy logic is used for further calculations.

What is Max-Min principle?

We use Max-Min principle in our daily life situations. If there are number of options in front us then we think about the options which will give us minimum output. After

choosing all such options which will lead to minimum result, we will choose the option which is leading to maximum output. That maximum output will be the resulting output.

In this example the same principle is used to calculate resulting grade of mango. From all fuzzy sets of decided parameters, minimum grade value will be selected by comparing all the fuzzy sets. In this example, this comparison is done for 3 mangoes. After selecting minimum grade values, the maximum grade is chose as a resulting grade.

i.e. $P1 \wedge P2 \wedge P3 \wedge P4 \wedge P5 \wedge P6 = \{1, 0, 0.40\}$

As we are using max-min principle now we have to choose maximum value among these minimum values & i.e.1

Method 2: Statistical Method

To deal with this method same parameters & generated functions are used. We are considering the same demo example but it includes additional thins i.e. Weightages. These weightages are fixed after discussing with mango manufacturers, customers & mango traders. Their preference for each parameter while purchasing or selling the mango is taken in consideration.

Parameters	Weight (gm)	Height (cm)	Surface Area (cm ²)	Colour	Fertilizer	Taste	Total	A.I.
Mango 1	1	1	1	1	1	1	1	1
Mango 2	1	0.40	0.25	0.25	0	0.98	0.60	0.60
Mango 3	0.40	1	0.75	0.75	1	0.90	0.76	0.76
Wtages	0.25	0.12	0.11	0.12	0.15	0.25		

Here for calculations of statistical method weighted mean concept is used.

What is weighted mean?

Sum of product of weightage value & grade value is considered as weighted mean.

This concept is used here. So the mango with higher acceptance index grade will be the mango of export quality mango.

In this particular example Mango 1 has higher acceptance index i.e. 1.

CONCLUSION

According to both the methods we can conclude that Mango 1 is the export quality mango. Mango 2 & Mango 3 are 2nd & 3rd grade mangoes. Both the methods give the same results hence we can say that by using these methods one can maintain accuracy in throughout the process of mango grading.

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