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Abstract: Proposing the similarity measures formula between Vague sets E and G. Concluding Vague resistance analysis. The concrete application steps were:①Establishing comprehensive characters set; ②Screening excellent varieties set; ③Extracting theory optimal varieties set; ④The single-value date transformed into Vague date, obtaining different varieties Vague sets; ⑤Vague resistance analysis 1,the similarity measures were calculated between the excellent varieties Vague sets and the theory optimal varieties Vague sets, obtaining more suitable for people's needs varieties among excellent varieties; ⑥Vague resistance analysis 2, the weighted similarity measures were calculated between the excellent varieties Vague sets and the theory optimal varieties Vague sets, obtaining more suitable for people's needs resistance varieties among excellent varieties. According to specific needs of the problem, selecting and applying the steps ⑤ or ⑥. Vague resistance analysis was applied to strawberry varieties resistance analysis, the analysis result was satisfactory. The similarity measures formula between Vague sets E and G was the application basis of Vague resistance analysis.

Key words: Vague sets; Similarity measures formula; Vague resistance analysis; Strawberry varieties; Resistance analysis

1 Introduction

Strawberry is rich nutrition and has a variety of organic acids, minerals and vitamins, especially rich in vitamin c. It is red tender, juicy, sweet delicious and fragrant. It is often known as the empress of the fruit and health food enjoyed by young and old. In recent years, Hainan has actively introduced strawberry fine varieties from home and abroad. This paper intends to use vague resistance analysis to research strawberry varieties resistance analysis, so as to screening fine strawberry varieties more suitable for planting in Hainan.

2 Basic concepts

2.1 Vague sets definition

Definition 1[1] Set non-empty universe Z. For $z \in Z$, regulations interval $[t_E(z), 1 - f_E(z)]$ for Vague sets E of Z at dot z Vague value or Vague membership, among them $0 \le t_E(z) \le 1, 0 \le f_E(z) \le 1$, and meets constraints $t_E(z) + f_E(z) \le 1$. $t_E(z)$ 、 $f_E(z)$ 、 $\pi_E(z)(= 1 - t_E(z) - f_E(z))$ is called respectively truth-membership function, false-membership

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Introduction of authors:
Yan Zhang (1968-), female, associate professor. Research for resource plant chemistry.
Hongxu Wang (1946-), male, professor. Research of fuzzy control and information processing.
Hongbin Zhang (1966-),male, professor. Research of physiology.

function and uncertain function of Vague set E.

When $Z = \{z_1, z_2, \cdots, z_n\}$ for discrete universe, its Vague sets E can be written as $E = \sum_{i=1}^{n}[t_E(z_i), 1 - f_E(z_i)] / z_i$, or $E = \sum_{i=1}^{n}[t_{e_i}, 1 - f_{e_i}] / z_i$.

2.2 Creating Vague environment

Creating Vague environment is that original data is transformed into Vague data. It is the application premises of Vague resistance analysis. The following only introduces the definition that the single-value data transformed into theVague data.

Definition 2[2] Set $Z = \{z_1, z_2, \cdots, z_n\}$ as discrete universe, Z has sets $E_i (i = 1,2,\cdots,m)$, E_i as the single-value data $z_{ij} (\geq 0)$ that represents the original data of comprehensive characters $z_j (j = 1,2,\cdots n)$.

a. Vague conditions $0 \leq t_{ij} \leq 1 - f_{ij} \leq 1$;

b. Output conditions If $0 \leq z_{kj} < z_{ij}$, the single-value data z_{ij} and z_{kj} are respectively transformed into the Vague data $E_i(z_j) = z_{ij} = [t_{ij}, 1 - f_{ij}]$ and $E_k(z_j) = z_{kj} = [t_{kj}, 1 - f_{kj}]$ meet: $t_{kj} \leq t_{ij}, 1 - f_{kj} \leq 1 - f_{ij}$. Called single-value data $z_{ij} (\geq 0)$ that meets Vague conditions and output conditions transformed into the Vague data $E_i(z_j) = z_{ij} = [t_{ij}, 1 - f_{ij}]$ type of conversion formula for the output-based conversion formula.

c. Investment conditions If $0 \leq z_{kj} < z_{ij}$, the single-value data z_{ij} and z_{kj} are respectively transformed into the Vague data $E_i(z_j) = z_{ij} = [t_{ij}, 1 - f_{ij}]$ and $E_k(z_j) = z_{kj} = [t_{kj}, 1 - f_{kj}]$ meet: $t_{kj} \geq t_{ij}, 1 - f_{kj} \geq 1 - f_{ij}$. Called single-value data $z_{ij} (\geq 0)$ that meets Vague conditions and investment conditions transformed into the Vague data $E_i(z_j) = z_{ij} = [t_{ij}, 1 - f_{ij}]$ type of conversion formula for the investment-based conversion formula.

Annotation: When the value of comprehensive characters is bigger always better, the output-based conversion formula is suitable used. And when the value of comprehensive characters is smaller always better, the investment-based conversion formula is suitable used.

2.3 A kind Vague membership data mining

Definition 3[3] The method of a kind Vague membership data mining is: Vague membership $e = [t_e, 1 - f_e]$, denoted by $t_e^{(0)} = t_e, f_e^{(0)} = f_e, \pi_e^{(0)} = \pi_e = 1 - t_e - f_e$. When $m = 1,2,\cdots$, and regulations $t_e^{(m)} = t_e \cdot (1 + \pi_e + \pi_e^2 + \cdots \pi_e^m), f_e^{(0)} = f_e \cdot (1 + \pi_e + \pi_e^2 + \cdots + \pi_e^m), \pi_e^{(m)} = \pi_e^{m+1}$.

Lemma 1[3] $e^{(m)} = [t_e^{(m)}, 1 - f_e^{(m)}]$ is Vague membership.

Annotation: Definition 3 has put forward the method of Vague membership data mining, it regards Vague membership $e = [t_e, 1 - f_e]$ mining into Vague membership $e^{(m)} = [t_e^{(m)}, 1 - f_e^{(m)}]$ ($m = 1,2,\cdots$) . This paper by means of Vague membership data mining constructs the new similarity measures between Vague membership.

2.4 Similarity measures between Vague membership

Definition 4[4] Set $e = [t_e, 1 - f_e]$ and $g = [t_g, 1 - f_g]$ as two Vague membership. The formula $M(e, g)$ is called similarity measures between Vague membership e and g. If the formula meets the following conditions:

a. Trivial conditions $M(e, g) \in [0,1]$;

b. Symmetric conditions $M(e,g)=M(g,e)$;

c. Reflexive conditions $M(e,e)=1$;

d. Minimum conditions When $e=[0,0], g=[1,1]$ or $e=[1,1], g=[0,0]$, they all guarantee $M(e,g)=0$.

The definition of the similarity measures and the weighted similarity measures between Vague sets may be similar to definition 4, here is omitted.

Annotation: $M(e,g)$ expresses similar degree between Vague value e and g. Its meaning is that the larger of the value of $M(e,g)$ expresses more similar between Vague value e and g; Especially when $M(e,g)$ takes maximum 1, expressing most similar between Vague value e and g; The smaller of the value of $M(e,g)$ expresses more dissimilarity between Vague value e and g; Especially when $M(e,g)$ takes minimum 0, expressing most dissimilarity between Vague value e and g.

3 New theorem and new method

Theorem 1 $z_{j\min}=\min\{z_{1j},z_{2j},\cdots,z_{mj}\}$, $z_{j\max}=\max\{z_{1j},z_{2j},\cdots,z_{mj}\}$. then

$$\text{a. } E_i(z_j)=z_{ij}=[t_{ij},1-f_{ij}]=\left[\frac{z_{ij}-z_{j\min}}{z_{j\max}-z_{j\min}},\left[\frac{z_{ij}-z_{j\min}}{z_{j\max}-z_{j\min}}\right]^{\frac{1}{2}}\right] \quad (1)$$

It is conversion formula $E_i(z_j)=z_{ij}=[t_{ij},1-f_{ij}]$ of single-value data $z_{ij}(\geq 0)$ transformed into Vague data for output-based conversion formula.

$$\text{b. } E_i(z_j)=z_{ij}=[t_{ij},1-f_{ij}]=\left[1-\left[\frac{z_{ij}-z_{j\min}}{z_{j\max}-z_{j\min}}\right]^{\frac{1}{2}},1-\frac{z_{ij}-z_{j\min}}{z_{j\max}-z_{j\min}}\right] \quad (2)$$

It is conversion formula $E_i(z_j)=z_{ij}=[t_{ij},1-f_{ij}]$ of single-value data $z_{ij}(\geq 0)$ transformed into Vague data for investment-based conversion formula.

Theorem 2 Set $e=[t_e,1-f_e]$ and $g=[t_g,1-f_g]$ for two Vague membership. The following formula is similarity measures between Vague membership e and g ($m=0,1,2,\cdots$):

$$M_m(e,g)=\frac{1+\min\{t_e^{(m)}-t_g^{(m)},f_e^{(m)}-f_g^{(m)}\}}{1+\max\{t_e^{(m)}-t_g^{(m)},f_g^{(m)}-f_g^{(m)}\}}. \quad (3)$$

Application literature[2] method, not difficult checking out that resolution of formula (3) is higher. Similar theorem 2 obtains the following results.

Theorem 3 Set $Z=\{z_1,z_2,\cdots,z_n\}$ as the universe, Z has Vague sets $E=\sum_{i=1}^{n}[t_E(z_i),1-f_E(z_i)]/z_i$ and $G=\sum_{i=1}^{n}[t_G(z_i),1-f_G(z_i)]/z_i$.

Abbrevd $E=\sum_{i=1}^{n}[t_{e_i},1-f_{e_i}]/z_i$, $G=\sum_{i=1}^{n}[t_{g_i},1-f_{g_i}]/z_i$.

The following formula is similarity measures between Vague sets E and G $(m=0,1,2,\cdots)$:

$$M_m(E,G)=\frac{1}{n}\sum_{i=1}^{n}\frac{1+\min\left\{t_{e_i}^{(m)}-t_{g_i}^{(m)},f_{e_i}^{(m)}-f_{g_i}^{(m)}\right\}}{1+\max\left\{t_{e_i}^{(m)}-t_{g_i}^{(m)},f_{e_i}^{(m)}-f_{g_i}^{(m)}\right\}}. \quad (4)$$

Theorem 4 Set element z_i weight $0\leq w_i\leq 1$, and $\sum_{i=1}^{n}w_i=1$. On conditions theorem 3, the following formula is weighted similarity measures between Vague sets E and G $(m = 0,1,2,\cdots)$:

$$WM_m(E,G) = \sum_{i=1}^{n} w_i \cdot \frac{1+\min\left\{t_{e_i}^{(m)} - t_{g_i}^{(m)}, f_{e_i}^{(m)} - f_{g_i}^{(m)}\right\}}{1+\max\left\{t_{e_i}^{(m)} - t_{g_i}^{(m)}, f_{e_i}^{(m)} - f_{g_i}^{(m)}\right\}}. \quad (5)$$

Vague resistance analysis

Concluding literature[4] Vague sets comprehensive decision rules for Vague resistance analysis. The concrete application steps are: ①Establishing comprehensive characters set; ②Screening excellent varieties set; ③Extracting theory optimal varieties set; ④The single-value date transformed into Vague date, obtaining different varieties Vague sets; ⑤Vague resistance analysis 1,the similarity measures are calculated between the excellent varieties Vague sets and the theory optimal varieties Vague sets, obtaining more suitable for people's needs varieties among excellent varieties; ⑥Vague resistance analysis 2, the weighted similarity measures are calculated between the excellent varieties Vague sets and the theory optimal varieties Vague sets, obtaining more suitable for people's needs resistance varieties among excellent varieties. According to specific needs of the problem, selecting and applying the steps ⑤ or ⑥.

4 Strawberry varieties resistance comparison

Strawberry cultivation range is very wide, in recent years, Hainan has actively introduced strawberry fine varieties from home and abroad. Selection excellent comprehensive characters strawberry varieties is main work for improving strawberry cultivation yield, therefore, we screened five varieties for Frandy, Maiterli, Kinuama, Rafi, Fengxiang and developed five varieties resistance comparison experiment. We applied Vague resistance analysis to analyse, in order to select excellent varieties more appropriate Hainan plastic greenhouse cultivation, to improve strawberry cultivated benefit and economic benefit.

4.1 Establishing comprehensive characters set

Establishing comprehensive characters set $Z = \{z_1, z_2, \cdots, z_8\}$:

Index z_1: survival rate of seedlings (%); z_2: survival rate of plant (%); z_3: yield(t/hm^2); z_4: fruit commodity rate(%); z_5: leaves heating-damage rate(%); z_6: young fruit freezing-damage rate(%); z_7: blight incidence(%); z_8: grey cinerea incidence(%).

4.2 Screening excellent varieties set

Selecting Hainan plastic greenhouse cultivation main fine varieties for excellent varieties sets $E = \{E_1, E_2, E_3, E_4, E_5\}$, among them E_1: Frandy; E_2: Fengxiang; E_3: Maiterli; E_4: Kinuama; E_5: Rafi. They all are sets of comprehensive characters set $Z = \{z_1, z_2, \cdots, z_8\}$. Resistance comparison experiment original data shown in Table 1.

4.3 Extracting theory optimal varieties set

Because the value of z_1, z_2, z_3, z_4 is bigger always better, the value of z_5, z_6, z_7, z_8 is smaller always better. So extraction theory optimal varieties G concrete data shown in Table 1.

Table 1 The original data of resistance comparison experiment

	E_1	E_2	E_3	E_4	E_5	G
z_1	96.60	92.20	97.30	95.30	94.80	97.30
z_2	93.80	90.70	96.60	93.80	91.10	96.60
z_3	15.79	11.38	16.00	11.94	13.91	16.00
z_4	87.80	71.40	81.20	72.20	86.40	87.80
z_5	9.20	28.10	6.60	24.50	19.70	6.60

z_6	52.10	60.80	54.80	49.40	55.50	49.40
z_7	16.60	8.50	5.80	5.80	27.20	5.80
z_8	8.00	18.80	11.60	15.20	6.90	6.90

4.4 The single-value date transformed into Vague date, obtaining different varieties Vague sets

Can be seen from 4.3, application formula(1) to comprehensive characters z_1, z_2, z_3, z_4, application formula(2) to comprehensive characters z_5, z_6, z_7, z_8, they make the original data in Table 1 transform into Vague data and obtain different varieties Vague sets(see table 2).

4.5 Vague resistance analysis 1

Application formula(4)(take $m=2$) calculates the similarity measures between the excellent varieties Vague sets and the theory optimal varieties Vague sets, the results show: $M_2(E_1,G)=0.70, M_2(E_2,G)=0.09, M_2(E_3,G)=0.77,$ $M_2(E_4,G)=0.42, M_2(E_5,G)=0.41$. The preferential order of strawberry varieties adaptation Hainan is: Maiterli(E_3), Frandy(E_1), Kinuama(E_4), Rafi(E_5), Fengxiang(E_2). First choice Maiterli.

4.6 Vague resistance analysis 2

The cold resistant strawberry varieties need to be considered at slightly cold incidental heavy fetch in middle of Hainan.

Application formula(5) (take $m=2$), take weight:

$w_1=0.1, w_2=0.1, w_3=0.1, w_4=0.1, w_5=0.1, w_6=0.3, w_7=0.1, w_8=0.1$

the weighted similarity measures are calculated between the excellent varieties Vague sets and the theory optimal varieties Vague sets, the results show:

$WM_2(E_1,G)=0.67, WM_2(E_2,G)=0.07, WM_2(E_3,G)=0.66, WM_2(E_4,G)=0.53,$ $WM_2(E_5,G)=0.37$. The preferential order of strawberry varieties adaptation slightly cold incidental heavy fetch in middle of Hainan is: Frandy(E_1), Maiterli(E_3), Kinuama(E_4), Rafi(E_5), Fengxiang(E_2). First choice Frandy.

Table 2 Vague data of resistance comparison experiment

	E_1	E_2	E_3	E_4	E_5	G
z_1	[0.92,0.96]	[0.00,0.00]	[1.00,1.00]	[0.61,0.78]	[0.51,0.71]	[1.00,1.00]
z_2	[0.53,0.73]	[0.00,0.00]	[1.00,1.00]	[0.53,0.73]	[0.07,0.26]	[1.00,1.00]
z_3	[0.96,0.98]	[0.00,0.00]	[1.00,1.00]	[0.12,0.35]	[0.55,0.74]	[1.00,1.00]
z_4	[1.00,1.00]	[0.00,0.00]	[0.60,0.77]	[0.05,0.22]	[0.92,0.96]	[1.00,1.00]
z_5	[0.65,0.88]	[0.00,0.00]	[1.00,1.00]	[0.09,0.17]	[0.22,0.39]	[1.00,1.00]
z_6	[0.51,0.76]	[0.00,0.00]	[0.31,0.53]	[1.00,1.00]	[[0.27,0.47]	[1.00,1.00]
z_7	[0.29,0.50]	[0.65,0.87]	[1.00,1.00]	[1.00,1.00]	[0.00,0.00]	[1.00,1.00]
z_8	[0.70,0.91]	[0.00,0.00]	[0.37,0.61]	[0.17,0.30]	[1.00,1.00]	[1.00,1.00]

5 Conclusion

Through strawberry varieties Vague resistance analysis, it gave a new method to study such problems, but also it enriched Vague pattern recognition theory. The method was a kind of pattern recognition method, it made pattern recognition between excellent varieties and theory optimal varieties. The recognition tool was the similarity measures formula between Vague sets and the weighted similarity measures formula between Vague sets. New formula(1)～(5) was used in Vague resistance analysis, especially new formula(4)～(5) was corroborated, such formula was indispensable for Vague pattern recognition theory[5].

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