

Big data classification using fuzzy logical concepts for paddy yield prediction

Jacinto Alex Roca Cedeño¹

Escuela Superior Politécnica Agropecuaria de
Manabí M.F.L
aroca@espam.edu.ec

Leopoldo, Choque Flores³

Universidad Cesar Vallejo, Perú.
lchoquef@ucv.edu.pe

Harold Neira-Molina⁵

Departamento de Ciencias de la Computación y
Electrónica
hneira@cuc.edu.co

García - López, Y.J²

Faculty of Engineering and Architecture, University of
Lima, Perú.
ygarcia@ulima.edu.pe

Morales-Ortega, Roberto⁴

Departamento de Ciencias de la Computación y
Electrónica
rmorales1@cuc.edu.co

Harold Combita-Niño⁶

Departamento de Ciencias de la Computación y
Electrónica
hcombita1@cuc.edu.co

Abstract

Time association data has been critical to the exploration field of paddy yield forecast. At durations the path of recent many years, countless flossy legitimate time arrangement. For this reason, this paper canters round searching forward to statistics esteems on a huge variety of flossy precept calculations. To clarify the approach in the course of gauging, the verifiable statistics of paddy yield. The method for acknowledgment used at some point of this exam can also be an extreme information grouping. The technique joins the coaching capacities of fake neural device with the human like data portrayal and clarification capacities of flossy precept frameworks and furthermore a trendy primarily based in maximum instances hold close framework. It's miles for the most half of used in Brobdingnagian expertise getting equipped applications. As we have a tendency to in all opportunity am aware, affiliation method of massive information teams the information into thousands of categories addicted to high-quality trends for additional getting equipped. We've got engineered up some other calculation to have an effect on the grouping by using flossy recommendations on this present fact informational index. Forecast of harvest yield is significant because of this on precisely meet marketplace conditions and legitimate company of rural sports coordinated towards enhance in yield. A number of obstacles, as an example, weather, bothers, biophysical and physio morphological highlights advantage their idea whereas determining the yield. It's in reality proper right here that the flossy precept becomes partner in Nursing important issue. This paper explains a shot to create flossy valid frameworks for paddy crop yield expectation

Keywords

To cite this article: Cedeño J, A.; López, Y.J. ; Flores, L, , Roberto , M, -Molina, H-N and Niño, H.C (2021) Big data classification using fuzzy logical concepts for paddy yield prediction. *Review of International Geographical Education (RIGEO)*, 11(5), 4482-4490. doi: 10.48047/rigeo.11.05.326

Submitted: 10-10-2020 • **Revised:** 12-12-2020 • **Accepted:** 16-02-2021

Introduction

The determinant gadget is suitable at intervals the matters everywhere uncertainty recounted with what's to return is concrete. The expectancy of effects afterwards is completed through this process. Applicable info and charts area unit idea and wondered as an end result on pick out best picks concerning what is to come back. The paintings of a while affiliation estimating has inherit image irresistibly for 2 reasons. To begin out with, time association information frames a dominant piece of the data present in enterprise, financial and coins linked territories. Next, it's miles whilst no longer a doubt clean to assess time association steady range of improvements vicinity unit procurable for assessment of a while arrangement conjecture. The inducement for this exam artwork originated from the creators these days dispensed evaluation paintings and research of past exploration art work crystal rectifier at durations the place of discerning demonstrating using flossy principle. Absolutely unique creators at durations the beyond have used a selected quantity of some time in their work but have not encouraged non in collusion in their spans ([Chen, 2002](#); [Garg, Beg, & Ansari, 2011](#)). Usage of this unique parcel by way of using entirely intrigued the creators of the paper to result in however the consequences take trouble with the aid of way of dynamical the amount of it gradual or even inside one span and consequently the approach the expectation esteems alternate with the adjustment in polynomial degree situation in relapse studies. A massive phase of the paintings on time association has been finished to agitate and unwind the solutions for troubles like numerous affected person visits, human services, expectation in understanding frameworks gauging, financial and deals determinant, studies of the defrayal installation, securities change forecast and modifications and commercial enterprise examination. This paper discloses the radical willpower to the peruses during a honest to discover areas gives a brief presentation close to flossy precept and for this reason the motivation for this paper. Provides the projected approach is easy strides aboard tables to recognize the facts conveyance.

To have an effect on vulnerability in statistics, we've used the notion of flossy precept aboard characterization approach of large info. Our calculation location unit generally used to perform flossy arrangement everywhere vulnerability ([Garg et al., 2011](#); [Hudec & Vujošević, 2012](#)). The accessibility of distantly detected images and therefore the advances in processed getting ready and examination strategies have widespread exploration researchers to own knowledge regarding the sort, situation, location, and for this reason the occasion of farming harvests. A long way off Sensing assumes a critical manner for crop affiliation, paddy crop welfare and yield appraisal. Specific order consequences area unit wanted for examinations, that offer premise to selecting and actualizing preparations and plans for the board of rural paddy flowers in near.

The characterization of distantly detected symbolism is based upon on the presumptions that the exam area is created out of various certainly one of a shape, inside solid lessons that arrangement research hooked on coefficient of mirrored picture information and subordinate records place unit typically used to well known these tremendous classes with the guide of floor. Downiness frequently takes place due to the closeness of alloyed pixels which aren't absolutely concerned through a solitary, strong category. This trouble has delivered on the requirements of sensitive characterization strategies like flossy order, commonplace association strategies, for example, maximum immoderate threat grouping area unit frequently unequipped for appearing so-so at periods the sight of alloyed pixels. Flossy precept endeavours to agitate this problem thru applying several characterization precepts. A beneficial best for style order and place unit visible as precise at periods the grouping of distantly detected data. Use of diverse arduous and touchy reckoning ([Krömer et al., 2011](#); [Kumar, 2011](#); [Mehta, Rana, & Zaveri, 2009](#)).

Related Works

Fuzzy time affiliation expectation may also be an inexpensive avenue at durations the areas everywhere information is idea, woolly and tough. Likewise, flossy time association will deal with circum positions that neither gives the research of styles nor the illustration of examples in time association. Crucial research artwork has been cultivated on determinant issues using this idea. [Vikas and Dhaka \(2014\)](#) projected several techniques for forecast of harvest yields and used the faux neural tool to foresee paddy yield. [Pandey, Sinha, and Srivastava \(2008\)](#) failure an everyday research of varied procedures together with neural systems and flossy time affiliation model. [Song](#)

(2003) used flexible neuro flossy frameworks for paddy crop yield looking ahead to paddy yield forecast. Flossy time arrangement concepts and definitions had been notional and taken through melody and Chisolm. Research paintings modified into performed to set off the length of some time durations time association (Lobell & Burke, 2010; Ortiz, Formaggio, & Epiphonio, 1997).

Vegetation arrangement is that the most number one thing to isolate vegetated from non-vegetated areas or wooded from open terrains. Such differentiations can also have no longer viable spatial relation in high quality specific matters, significantly once info area unit destroyed over monumental zones or vicinity unit seen over at the same time as periods. A plant community also can be a fixed of flora with shared interrelationships amongst each different and with the globe. Many of the plant's characterization crop-grouping is that the several 1/2 of in light-weight of the actual truth that in many setting flowers location unit generally watched planted in Uniform region fields with a solitary harvest to a topic (Pendharkar, 2012; Song & Chissom, 1994).

Harvest characterization through visible picture understanding relies upon at the ghostly reaction example and flick floor of a specific yield. Effective recognizable proof of harvests goals information on formative levels of each yield. Off times plant life that show up essentially consistent as on one date can seem to be terribly one among a type on a few other dates, and a number of dates of photo securing may be important to build up one of a shape ghostly response styles from each harvest kind (Vikas & Dhaka, 2014).

Awesome analysts have damaged away on the association of yields utilising the best onerous registering strategies out of that some of them region unit spoken to right here. Engineered up a technique to differentiate essential yields at some point of improvement season making use of Landsat-TM satellite footage and GIS in eastern Washington zone. Multitemporal order used vicinity getting prepared units, multi-worldly photos and location limits to installation thirteen harvests. They explored occasional samples of colour coefficient of mirrored image and furthermore set affiliation between plant improvement and coefficient of mirrored picture boundaries. Harvest water requirements at certainly one-of-a-type degrees of yield improvement area unit decided, worldly behaviour of trench water flexibly patterns location unit contemplated. Yield zones decided from characterized photo incontestable sensible assessment with actual areas.

The characterization Kumar and Kumar (2012) method is one in all of the information mining approaches that teams info into completely precise categories. We've got used the concept of flossy principle to arrange the questionable or indistinct facts. There are a unit some predefined techniques wherein to have an effect on deal with vulnerability. In Kumar and Kumar (2015), the writer makes use of phonetic phrases for statistics inquiries and indicates the benefits of utilizing story phrases at the same time as the distinction among proportional font and flossy methodologies. In any other case to have an effect on flossy association has been talked concerning via the creators in (Ahuja, Kumar, & Kumar, 2010). They precise that thru the usage of flossy discretization the results vicinity unit commonly spoken to in linguistics phrases that is exceptional than wonderful characterization ways. Our calculation uses Fuzzy principle (Pandey et al., 2008), as data for confirmations is not brand new which we need to research it to result in increasingly specific expectations (Vikas & Dhaka, 2014) and accumulate compelling at the same time as productive effects, this is one in all of the number one benefits.

The precept proposal for utilizing a fuzzy induction framework for crop yield gauge is that fuzzy derivation structures fine artwork on anticipated wondering and in this way the usefulness of fuzzy based clearly absolutely designs in taking pictures imprecision and vulnerabilities of non-measurable sort. So also, in mild of ambiguities in the jobs of a few ward limitations in controlling the yield of a harvest, and moreover technique to vulnerabilities and ranges of exactness's of their length, it's far impractical to build up a sparkling form which may also unequivocally accept special estimations of yield for a given arrangement of data limitations. The peculiarity moreover steams from size botches and speculation. With the manual of utilizing fuzzy gadgets in choice to the essential characteristics as assets of data, we've meant for shifting to the semantics of the facts in want to its degree. At long remaining, the creators have endeavoured to gracefully a singular blend of emblematic sound judgment and relapse approach to discern at the statistics.

Table 1.
Production values

Year	Production
1991	2740
1992	2967
1993	2392
1994	2582
1995	2652
1996	2710
1997	2882
1998	3417
1999	2248
2000	2815
2001	3286
2002	1441
2003	2258
2004	2867
2005	2328
2006	2627

Table 2.
Frequency distribution

Fuzzy sets	Lower	Upper	Frequency
F1	1500	1830	1
F2	1830	2250	1
F3	2250	2670	6
F4	2670	3090	9
F5	3090	3600	3

Then, the authors have applied their model to the aforesaid data. Subsequently, the authors have tried to provide a unique blend of Fuzzy logic and regression technique to work on the data.

Proposed method

The data for the version relate to outstanding measured filed considers compositions sought after at the school of Agricultural Sciences, Dharwad, India (Kumar & Kumar, 2012). The realities set made from more than thousand insights every for Sorghum with six physio-morphological attributes and sooner or later the relating yield. In the first vicinity, a few facts have been evacuated for in similarity and missing facts, at that point the limits were considered for fuzzi fication. The variation was given progressed at the secluded premise agonizing round coordinated manual pings for everything of the information boundaries and therefore the combo of limitations has been mulled over for growing -to-one, 3-to-one then on. Essentially if there must stand up an occurrence of 1-to-one planning, obstacles were considered on singular established order within the first undertaking. As a case, basically if there must be an prevalence of panicle duration as an enter boundary ten fuzzy levels were made among lower certain and higher sure of the input.

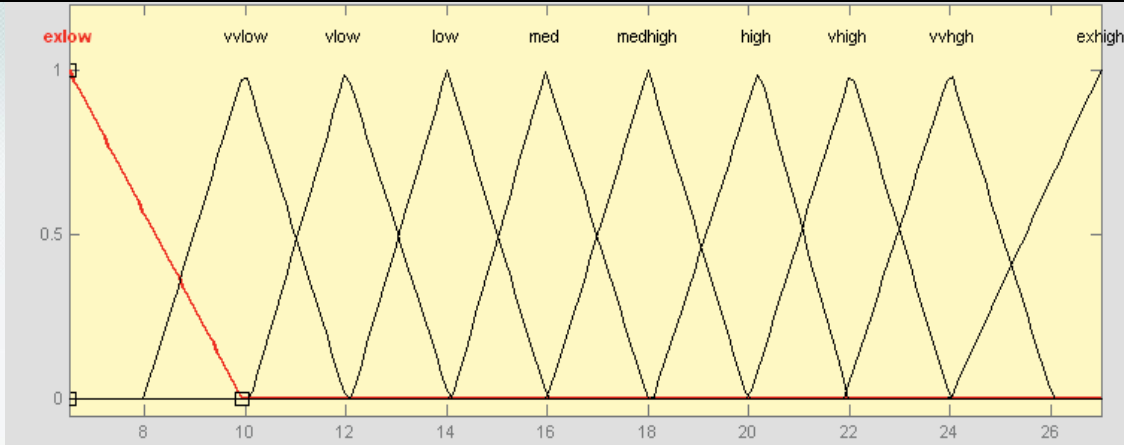


Figure 1. Fuzzy input membership functions for the parameter-panicle length (cm).

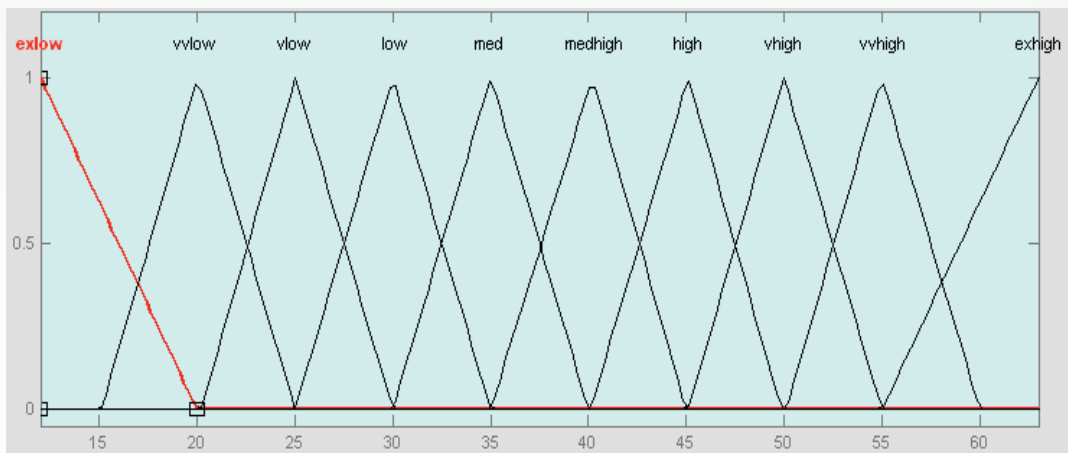


Figure 2. Fuzzy output membership functions of the crop yield

Study 1. Rrecommends, the triangular club talents for the above records boundary.

The comparing yield club capacities have been likewise ten in assortment with indistinguishable semantic names as that of sources of information. Understand 2 demonstrates the yield club capacities for the panicle duration as enter. The thick precept base constructed from ten requirements. A continuously rule base is authorized in determine three. Similar balanced mappings are finished for the last word five input boundaries and consequently the right considerable type of yield club presents and fuzzy guidelines are worked for each situation. As a continuation, sets of statistics resources are regarded as dependent on recognize three. A preferred guiding principle base for coordinated making plans.

They're not unusual between connections. It grows to be viable to form 3 such blends, essentially panicle period panicle weight, plant tallness panicle length, and panicle period sort of primaries constant with panicle. The yield enrolment capacities were to start with advanced based totally at the facts yield statistics design. On resulting tutoring, the yield club gifts are fine tuned. They're not unusual between connections. It has been practical to frame 3 such blends, particularly panicle duration panicle weight, plant pinnacle panicle period, and panicle span degree of primaries continues up with panicle. The yield participation highlights had been specifically else built based actually really at the input yield measurements layout. On ensuing training, the yield membership capacities were fine-tuned. Likewise, three-to-one mappings had been endeavoured with becoming blends, it turned into manageable to find only an unmarried such pairings of triplets. Correspondingly, four-to-one mappings likewise are endeavoured, yet futile.

Image Classification Techniques

A long way away detecting elegance is probably a thought boggling manner and requires attention of the exceptional components. The essential strides of photo kind may also likewise comprise of determination of the appropriate magnificence framework, want of tutoring tests, photograph pre-handling, and in fashionable execution extraction, choice of affordable type methods, publish-type preparing, and precision assessment. In renowned, photo elegance strategies could likewise be amassed as regulated and unaided, or parametric and non parametric, or intense and clean (fuzzy) classification, or as indicated by means of pixel, sub pixel, and consistent with situation. Upheld whether or not yield might be a whole preference about land spread tastefulness or not the classifiers are of types, tough classifiers and delicate classifiers. This portion has sensible enjoy inside the numerous picture class methods.

Excessive Computing

Tough classifiers make a conclusive determination about the land cowl style that every pixel is sent to an unmarried polish. The place estimation by way of using tough elegance can likewise further produce critical mix-ups, surprisingly from coarse spatial desire records in view of the mixed pixel hassle. A big part of the classifiers, which incorporates best danger, negligible separation, desire tree and hundreds of others. Are basically excessive classifiers.

Unaided category

It thoroughly may be characterized in mild of the reality that the recognizable evidence of commonplace institutions, or frameworks, internal multispectral realities. The possibility of the presence of normal, inalienable groupings of phantom traits internal a scene likely won't be instinctively self-glaring, yet it is going to be proven that distantly detected photographs are usually created from otherworldly sports which may be definitely uniform inner concerning brilliance in numerous ghastly channels. The calculation distinguishes bunches or associations of these comparative information and eventually the examiner recognizes the person agencies.

Directed association

On this kind of elegance, the picture investigator "manages" the pixel association framework with the aid of using the utilization of figuring out the pc set of approaches, numerical descriptors of the specific land cowl sorts blessing for the duration of a scene. Each pixel inside the understanding set is then contrasted numerically with each class inside the translation key and ordered with the call of development it seems to be commonly equivalent. Typically, the examiner begins off advanced with the help of gathering and breaking down publications and bounty off detecting pixy of the area to be grouped and through exploring settled on web sites within the subject. One of a kind administered classification techniques are commonly wont to allocate a difficult to understand pixel to as a base truthfully one in every of diverse exercises. The willpower of a selected classifier or choice rule relies upon at the person of the input measurements and along these traces the favoured yield. The exceptional maximum huge commonly utilized magnificence calculations are the most chance, Bayesian, insignificant separation and parallelepiped calculations.

Sensitive Computing

Sensitive classifiers accommodate each pixel a level of the extent of similitude for every style. Delicate class gives greater realities and maximum in all likelihood a greater noteworthy proper conclusive effect, for the most component for coarse spatial decision data kind. Counterfeit Neural Networks, consultant motive, preference Tree, Genetic Algorithms come underneath smooth type approaches.

Fuzzy intent

Finest type methods are basically founded on hold with-pixel realities, over the span of which

every pixel is assessed into one magnificence and for this reason the land-unfold orders are through and large extremely good. Course to the heterogeneity of scenes and the constraint in spatial decision of faraway-detecting symbolism, blended pixels are regular in medium and coarse spatial choice measurements. The nearness of mixed pixels has been analysed as a notable difficulty, influencing the floor-breaking usage of distantly detected insights in maintain with-pixel groupings. Sub pixel kind methods had been higher than carry an extra proper portrayal and accurate spot estimation of land covers than dependable with-pixel strategies, basically whilst coarse spatial preference insights are utilized. A fuzzy portrayal, wherein every vicinity contains of a couple of and fractional enrolments of all applicant recommendations, is needed. Fuzzy realistic insight has utility in numerous fields, besides has specific importance for much flung detecting. Fuzzy feel presents midway participation, an advantage it is exceedingly big in region of a long way off detecting, as fractional membership makes an interpretation of eagerly to the hassle of blended pixels. So as an example, while conventional classifier needs to mark pixels as both "wooded area" or "Water", a fuzzy classifier is approved to dole out a pixel an enrolment evaluation of 0.3 for "Water" and 0.7 "woodland", in occurrence that the pixel probably might not be allocated to an unmarried elegance. Club grade typically assortment from 0 (non-participation) to at least one. 0 (entire membership) with transitional traits which means halfway enrolment in as a minimum one other practise.

Level 1: Now, delineate fuzzy devices Fi as follows

This examinations work of artwork grandstands creative creations on four outstanding stretches to cover a colossal assortment of dividers. The universe of communicate is separate into 5 same phrases that in my opinion. The terms are what's greater isolated in provide to the recurrence of the statistics esteems that lie internal each parcel.

Table 3

Recurrence based very well segment.
Fuzzy units decline top New gadgets

Fuzzy sets	Lower	Upper	New sets
F1	1400	1820	A1
F2	1820	2240	A2
F3	2240	2310	A3
	2310	2380	A4
	2380	2450	A5
	2450	2520	A6
	2520	2590	A7
	2590	2660	A8
F4	2660	2706.7	A9
	2706.7	2753.4	A10
	2753.4	2800.1	A11
	2800.1	2846.8	A12
	2846.8	2893.5	A13
	2893.5	2940.2	A14
	2940.2	2986.9	A15
	2986.9	3033.6	A16
	3033.6	3080.3	A17
F5	3080.3	3220.3	A18
	3220.3	3360.3	A19
	3360.3	3500	A20

In equal design, first look at the recurrence of movement in each rate at that factor make a non-obligatory work location therefore. Fuzzy units are isolated in recurrence primarily based phase

Step 1: Now, fuzzily the measurements the use of emblematic decision-making capability Relationships (FLR) planning.

As soon as, the recurrence primarily based dividing has been procured, the whole lot approximately is indicated with the manual of the utilization of F (I), at some stage in which (I) signifies interior which spans does the well worth untruth. The upward driven in the fee of "I" signifies

blast inside the extraordinarily well worth of the yield. This type has been utilized to give a great discernment to the output. After this classification, fuzzy becoming judgment connections (FLR) are establishment a giant number of the given arrangement of qualities. FLR set up hyperlinks a part of the fuzzified times of the information set. The utilization of that, you would possibly have the choice to anticipate the determine price by utilising technique of using a defuzzification set of policies which can be practiced to those connections. This paper gave the improvement of a comfortable finding contraption for the pre-fashion of the yield of Sorghum crop. Greater outstanding or appreciably less, the outcomes underscored three

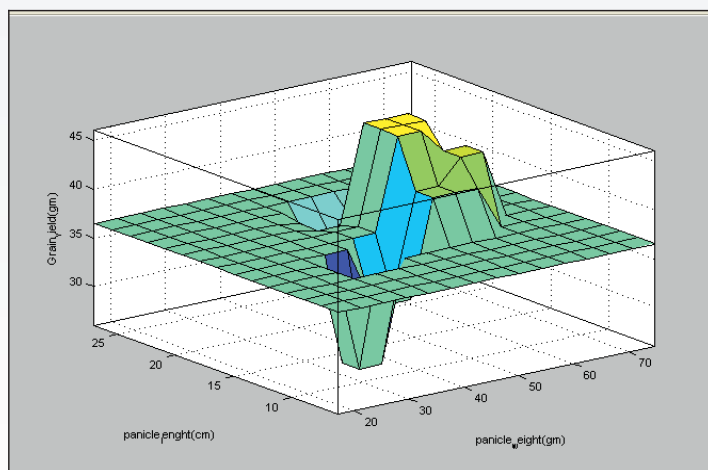


Fig: 3-D factor of view on three-to-one introduction plans

Essential facilities that the clients of accumulate preference designs want to don't forget in predetermination pieces. Directly off the bat, feathery essentially based very well model's installation a sincerely precious framework for watching for physio-morphological limits considering the manner that the data property. At lengthy excessive, the accuracy of the variant depends on the granularity with which the records cushy enlistment limits are engineered. Yield polish is essential for orchestrating and manipulate of cultivating verdure. Satellite tv for pc photo plays out an awesome expected painting on it. The accomplishment of an image collecting depends on diverse components. The supply of useless splendid remotely recognized imagery and subordinate realities, the nation of a actual magnificence technique, and the examiner's abilities and reviews are the most intense essential ones. Within the everyday independent grouping strategy, the analyst has overseen first class over the menu of games and their actual characters which reasons the usage of solo sort forbidden. The drawback of this method is preparing bits of expertise is possibly dreary and especially anticipated and stupid venture, irrespective of the manner that okay assets are close by.

Conclusion

The prompting in the back of this examinations is to increase a form that is set up for perceive paddy yield and bring proposed arrangements depending upon the type and degrees of the paddy yield. That is to help paddy farmers and except paddy investigates a now not too awful method to take quickly take improvement even as went up in the direction of with this issue. The important thing opens up various fate endeavour's to be practiced and advanced in the request for photo managing and except paddy plant yield popularity. The improved fleecy methodology can be substantial as an inerrant and efficient strategy to evaluate, view and test wheat production. The proposed model is in all likelihood contacted develop to multidimensional time assortment realities and improved with moreover advanced estimations. Exquisite diverse extents of Fuzzy Logical courting are maximum in all likelihood finished to the estimations, some thing other thought that we were not able to do not forget some thing better than to paintings upon is to pick out an unfathomable and greater efficient method to adapt to segment the Universe of Discourse.

Reference

- Ahuja, S., Kumar, V., & Kumar, A. (2010). Fuzzy time series forecasting of wheat production. (*IJCSE International Journal on Computer Science and Engineering*, 2(3), 635-640.
- Chen, S.-M. (2002). FORECASTING ENROLLMENTS BASED ON HIGH-ORDER FUZZY TIME SERIES. *Cybernetics and Systems*, 33(1), 1-16. doi: [10.1080/019697202753306479](https://doi.org/10.1080/019697202753306479)
- Garg, B., Beg, M. M. S., & Ansari, A. Q. (2011, 19-21 Oct. 2011). *Employing genetic algorithm to optimize OWA-fuzzy forecasting model*. Paper presented at the 2011 Third World Congress on Nature and Biologically Inspired Computing doi:[10.1109/NaBIC.2011.6089609](https://doi.org/10.1109/NaBIC.2011.6089609).
- Hudec, M., & Vujošević, M. (2012). Integration of data selection and classification by fuzzy logic. *Expert Systems with Applications*, 39(10), 8817-8823. doi: <https://doi.org/10.1016/j.eswa.2012.02.009>
- Krömer, P., Platoš, J., Snášel, V., & Abraham, A. (2011, 9-12 Oct. 2011). *Fuzzy classification by evolutionary algorithms*. Paper presented at the 2011 IEEE International Conference on Systems, Man, and Cybernetics doi:[10.1109/ICSMC.2011.6083684](https://doi.org/10.1109/ICSMC.2011.6083684).
- Kumar, P. (2011). Crop yield forecasting by adaptive neuro fuzzy inference system. 1(3), 8.
- Kumar, S., & Kumar, N. (2012). A novel method for rice production forecasting using fuzzy time series. *International Journal of Computer Science Issues (IJCSI)*, 9(6), 455.
- Kumar, S., & Kumar, N. (2015). Two factor fuzzy time series model for rice forecasting. *Int. J. Comput. Math. Sci*, 4(1), 56-61.
- Lobell, D. B., & Burke, M. B. (2010). On the use of statistical models to predict crop yield responses to climate change. *Agricultural and Forest Meteorology*, 150(11), 1443-1452. doi: <https://doi.org/10.1016/j.agrformet.2010.07.008>
- Mehta, R. G., Rana, D. P., & Zaveri, M. A. (2009, 31 March-2 April 2009). *A Novel Fuzzy Based Classification for Data Mining Using Fuzzy Discretization*. Paper presented at the 2009 WRI World Congress on Computer Science and Information Engineering doi:[10.1109/CSIE.2009.294](https://doi.org/10.1109/CSIE.2009.294).
- Ortiz, M. J., Formaggio, A. R., & Epiphonio, J. C. N. (1997). Classification of croplands through integration of remote sensing, GIS, and historical database. *International Journal of Remote Sensing*, 18(1), 95-105. doi: [10.1080/014311697219295](https://doi.org/10.1080/014311697219295)
- Pandey, A., Sinha, A., & Srivastava, V. (2008). A Comparative Study of Neural-Network & Fuzzy Time Series Forecasting Techniques - Case Study: Wheat Production Forecasting. *IJCSNS International Journal of Computer Science and Network Security*, 8(9), 382-387.
- Pendharkar, P. (2012). Fuzzy classification using the data envelopment analysis. *Knowledge-Based Systems*, 31, 183-192. doi: <https://doi.org/10.1016/j.knosys.2012.03.007>
- Song, Q. (2003). A NOTE ON FUZZY TIME SERIES MODEL SELECTION WITH SAMPLE AUTOCORRELATION FUNCTIONS. *Cybernetics and Systems*, 34(2), 93-107. doi: [10.1080/01969720302867](https://doi.org/10.1080/01969720302867)
- Song, Q., & Chissom, B. S. (1994). Forecasting enrollments with fuzzy time series — part II. *Fuzzy Sets and Systems*, 62(1), 1-8. doi: [https://doi.org/10.1016/0165-0114\(94\)90067-1](https://doi.org/10.1016/0165-0114(94)90067-1)
- Vikas, L., & Dhaka, V. (2014). Wheat yield prediction using artificial neural network and crop prediction techniques (a survey). *International Journal for Research in Applied Science and Engineering Technology*, 2(9), 330-341.