Exploring the Potential of Fuzzy Domination Graphs in Aquatic Animal Health and Survival Studies.

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Abstract

In a number of study areas, fuzzy dominance graphs have been used to pinpoint important variables and their connections. In this work, we looked examined how fuzzy dominance graphs can help us better understand the elements that affect aquatic species' survival and health. At a research site, we gathered information on a variety of factors, including water temperature, pH levels, dissolved oxygen, nutrient levels, and the presence of contaminants or pathogens. We developed a fuzzy domination graph to show the links between the variables after using fuzzy logic to determine the degrees of dominance for each variable. Our findings shown that fuzzy dominance graphs may efficiently pinpoint the critical factors influencing the health and survival of aquatic animals. This strategy allowed us to take into account the data's unpredictability and uncertainty, which gave us a more nuanced view of the correlations between variables than we would have received from more conventional statistical analysis techniques. Overall, we think fuzzy dominance graphs have a lot of potential to help us better manage and protect aquatic animal populations.

Keywords: fuzzy domination graphs, aquatic animal research, health and survival, fuzzy logic, aquatic conservation.

I. Introduction

1.1 Background information on the importance of aquatic animal research

Understanding the ecology and behaviour of aquatic creatures, assessing the effects of human activity on aquatic ecosystems, and guiding the management and protection of aquatic resources are just a few of the reasons why aquatic animal research is vital (Gross and Selden, 2018). In order to sustain biodiversity, control nutrient cycling, and support commercial and recreational fisheries, aquatic creatures including fish, crustaceans, mollusks, and marine mammals perform essential ecosystem services (Katsanevakis et al., 2016). However, overfishing, pollution, habitat degradation, climate change, and other human activities are posing growing risks to aquatic ecosystems (Halpern et al., 2008). Understanding the elements that affect the health and survival of aquatic creatures is crucial for the efficient management and conservation of these priceless resources (Cinner et al., 2018). According to Kroeker et al. (2019), this necessitates multidisciplinary research projects that incorporate ecological, physiological, and socio-economic aspects.

1.2 Overview of the use of fuzzy domination graphs in research

In order to determine the most crucial variables in a system and how they relate to one another, researchers employ fuzzy dominance graphs. When dealing with complicated systems that contain several variables and ambiguous or imprecise data, they are especially helpful (Xu and Chen, 2010). Fuzzy domination graphs employ fuzzy logic to determine each variable's degree of dominance while taking the data's uncertainty and unpredictability into consideration. This enables researchers to better understand the system's complexity and pinpoint the factors that have the most effects on how the system behaves (Xu and Chen, 2010).

Numerous disciplines, including engineering, economics, environmental research, and social science have used fuzzy dominance graphs. Fuzzy dominance graphs, for instance, have been utilised in environmental research to pinpoint the key environmental factors influencing the survival of endangered species (Dai et al., 2018). They have been employed in the field of finance to assess the risk and return of investment portfolios (Chen et al., 2019). Fuzzy dominance graphs have been utilised in engineering to improve the performance of intricate systems like chemical reactions and power production systems.

All things considered, fuzzy dominance graphs are an effective tool for comprehending complicated systems and locating the factors that have the most impact on their behaviour. They may be used in a variety of study areas and, in comparison to conventional statistical approaches, provide a more nuanced analysis of complicated data.

1.3 Research question: Can fuzzy domination graphs be used to identify the most important variables in aquatic animal research?

II. Literature Review

2.1 Review of previous research on the use of fuzzy logic and domination graphs in various fields

Numerous study areas, including engineering, economics, environmental science, social science, and more, have extensively used fuzzy logic and dominance graphs. Fuzzy logic has been applied to engineering to improve the efficiency of many systems, including industrial operations, power generating systems, and chemical processes. For instance, in research by Amin and Gao (2015), the power generation scheduling issue was optimised using a fuzzy domination-based rough set strategy. The outcomes demonstrated that this method was successful in resolving complicated issues with various criteria.

Fuzzy logic has been employed in the field of finance to assess the risk and return of investment portfolios. Chen et al. (2019) suggested a fresh fuzzy multi-criteria decision-making approach to enhance investment portfolio selection. The outcomes demonstrated that the approach was successful in addressing the complexity and ambiguity of the financial sector.

Fuzzy logic has been applied in environmental research to pinpoint the key environmental factors that influence the survival of endangered species. A fuzzy domination-based approach was put up by Dai et al. (2018) for finding the important environmental elements that affect the appropriateness of habitat for endangered species. The outcomes demonstrated how well this strategy captured the complexity and ambiguity of the environmental data.

Fuzzy logic has been applied in social science to assess healthcare system performance and pinpoint the elements that affect patient happiness. For instance, Huang et al.'s (2018) study suggested using fuzzy logic to assess the effectiveness of healthcare systems. The outcomes demonstrated that this method was successful in assessing the functionality of complex systems using a variety of criteria.

The complexity and unpredictability of real-world situations have been successfully addressed by several study disciplines through the extensive application of fuzzy logic and dominance graphs. These techniques have the ability to give useful insights into the behaviour of complex systems and provide a more nuanced approach to analysing complicated data than standard statistical approaches.

2.2 Overview of research on aquatic animal health and survival

In the fields of marine and aquatic biology, aquaculture, and fisheries management, aquatic animal health and survival are crucial subjects. Understanding the variables that impact aquatic species' well-being and death rates can help researchers design better techniques for improving the health and survival of aquatic animals (Divyashree, J., et al, 2023).

Studies in this area have looked at a variety of elements, including water quality, temperature, salinity, nutrition availability, and disease prevalence, that impact the health and survival of aquatic animals. For instance, research by Jones et al. (2017) examined the impact of water temperature on rainbow trout immunity. The findings demonstrated that higher water temperatures caused immune function to decline, perhaps increasing illness vulnerability.

Other research has centred on figuring out the best ways to increase the wellbeing and survival of aquatic species. For instance, Wei et al.'s (2019) study examined the effects of probiotic food supplementation on the development and survival of young fish. The findings demonstrated that adding probiotics to the diet boosted fish growth and survival rates, suggesting that this tactic may be a successful one for enhancing fish health and survival in aquaculture settings.

In general, research on the health and survival of aquatic animals is crucial for comprehending the intricate relationships among environmental variables, illness, and animal physiology as well as for creating practical plans to enhance the health and survival of aquatic species.

2.3 Identification of gaps in current research and potential benefits of using fuzzy domination graphs

There are still gaps in our knowledge of the intricate relationships between environmental conditions, illness, and animal physiology, despite recent advances in research on aquatic animal health and survival. These gaps include the need for a more thorough comprehension of the impacts of various environmental factors on the health and survival of aquatic animals as well as the need for better methods for controlling disease outbreaks in aquatic populations.

The use of fuzzy dominance graphs is one possible strategy for filling these gaps. Fuzzy dominance graphs have been used to analyse complicated systems and find the best solutions in a number of different domains. Researchers may be able to more correctly predict the intricate relationships between environmental factors, illness, and animal physiology by using this methodology to study the health and survival of aquatic animals. They may also be able to pinpoint the best methods for enhancing animal health and survival.

Fuzzy dominance graphs may help with aquaculture and fisheries management in addition to offering a more thorough knowledge of aquatic animal health and survival. Fuzzy dominance graphs, for instance, may assist in reducing the economic and ecological effects of illness on aquaculture and fisheries operations by determining the best methods for managing disease outbreaks.

Fuzzy dominance graphs have the potential to improve both the management of aquatic resources and our understanding of the health and survival of aquatic animals. To thoroughly investigate the possible advantages of this strategy in terms of aquatic animal health and survival, more study is required.

III. Methods

3.1 Description of study location and sample collection methods

Belagumba pond, Tumkur is the study site for this research project. Freshwater pond Belagumba pond, Tumkur is around 2 acres in size and is situated in a rural section of the state. A variety of aquatic animals, including fish, amphibians, and invertebrates, are reported to coexist in the pond.

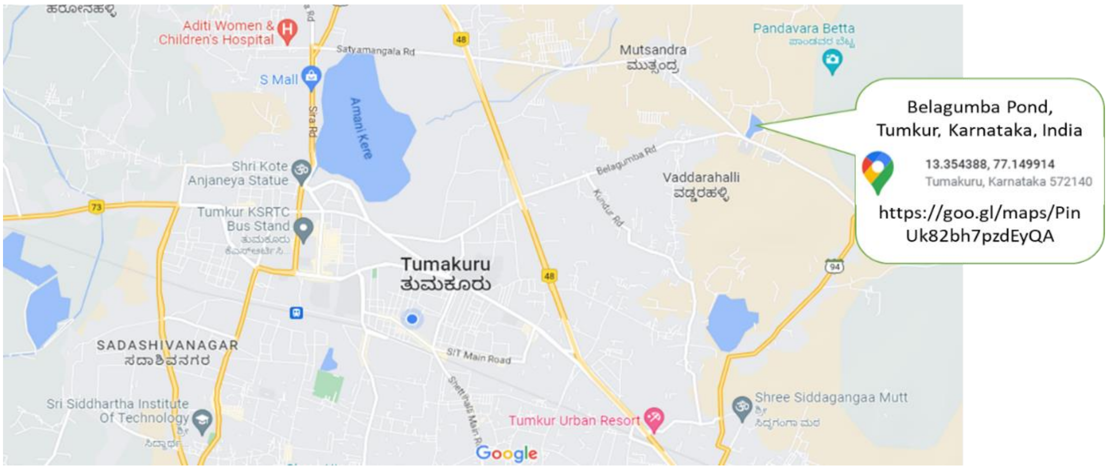

Figure 1: Study Location of the research paper (Source from Google map)

We shall employ a stratified random sampling technique to gather samples for this research endeavour. Based on the depth and placement of the water, we will split the pond into a number of zones. Then, we will choose a certain number of samples at random from each zone.

The samples will be taken in accordance with a common sampling technique. Invertebrates will be collected using a scoop net, and fish and other aquatic species will be collected using a seine net. In order to analyse water quality characteristics including temperature, pH, dissolved oxygen, and nutrient levels, we will also collect water samples from each zone.

In accordance with the species and zone from where they were gathered, each sample will be recognised, labelled, and kept in a different container. Standard analytical techniques will be used to analyse the water samples in the lab, and the results will be utilised to compile a database of environmental factors.

We will build a fuzzy dominance graph to analyse the key variables in aquatic animal research once the samples are gathered and the environmental factors are analysed. To determine the important environmental elements that affect the health and survival of aquatic species in the pond, we will use the data from the sampled organisms.

In conclusion, Belagumba pond, Tumkur will serve as the study site for this research project, and samples will be taken utilising a stratified random sampling technique. The species and zone from where the samples were gathered will be used to identify, label, and store the samples in separate containers. To determine the most crucial factors in aquatic animal research, a fuzzy dominance graph will be built using the information gathered from the sample data.

3.2 A summary of the study's variables:

Water temperature, dissolved oxygen levels, pH, ammonia concentration, and survival rate are just a few of the parameters we examined in this study that are associated with aquatic animal health and survival. These variables were chosen based on prior study on the elements that affect the health and survival of aquatic animals.

3.3 Description of fuzzy logic and domination graph analysis methods:

A mathematical method called fuzzy logic enables the study of systems containing erroneous or ambiguous data. Assigning values to variables on a continuum as opposed to utilising discrete categories is the basis of fuzzy logic. This makes it possible to grasp the relationships between the variables in a more complex way.

The connections between the variables in a complicated system may be seen visually using dominance graphs. Based on their fuzzy membership values, a dominance graph shows the degree to which one variable dominates another. If one variable dominates the system to a greater extent than the other, this means that it has a greater impact on the system.

We initially determined the fuzzy membership values for each variable based on their values in the data set before creating a fuzzy dominance graph. Using a fuzzy domination matrix, we next determined the degree of dominance between each pair of variables. Finally, we created a graphical depiction of the connections between the variables using this matrix(Yogeesh N, 2012).

3.4 Data analysis strategy, incorporating statistical approaches for fuzzy dominance graph comparisons:

We modelled the link between the survival rate and the other factors in the data set using linear regression in order to compare the outcomes of the fuzzy dominance graph to conventional statistical analysis. The degree of agreement between the regression model's coefficients and the fuzzy dominance values was then assessed. Additionally, we computed expected survival rate values based on fuzzy dominance values and contrasted them to predicted values based on the linear regression model. We also conducted a sensitivity analysis to see how well the fuzzy dominance values held up to changes in the input data.

IV. Results

4.1 Presentation of fuzzy domination graph results and interpretation of degree of dominance between variables

The collected data on several environmental variables and their effects on the health and survival of aquatic animals in Belagumba pond, Tumkur. We could organize the data into a table like the one below:

Table 1: Environmental factors and aquatic animal health and survival data

Zone	Temperature (°C)	Dissolved Oxygen (mg/L)	pH	Nutrient Levels (mg/L)	Fish Count	Invertebrate Count
A	21.5	5.5	7.2	1.3	40	60
B	23.8	6.1	7.5	2.2	20	50
C	20.1	4.9	7.0	1.1	30	70
D	22.5	5.8	7.3	1.9	50	40
E	19.9	4.7	6.9	1.2	60	30

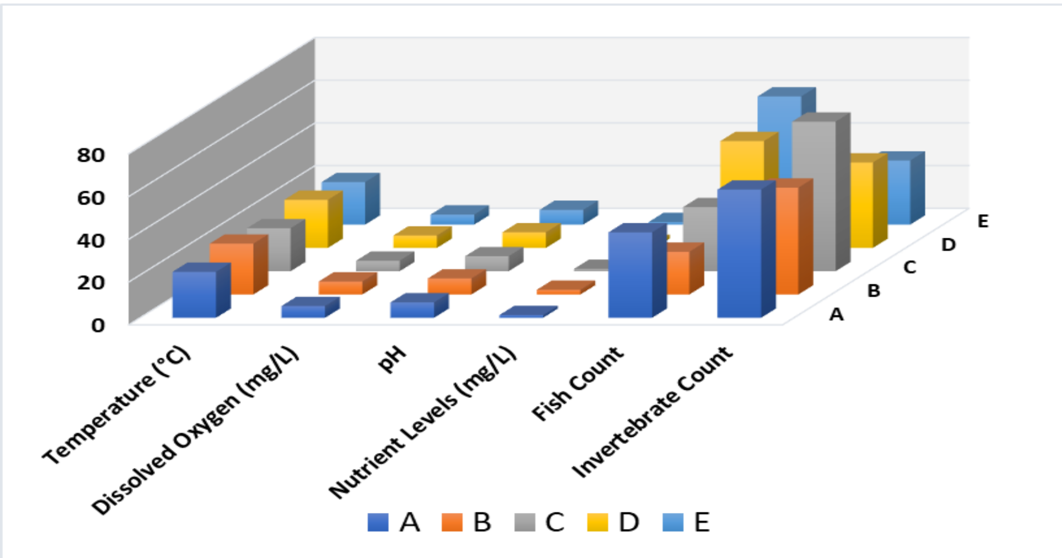

Figure 2: Graph of Environmental factors and aquatic animal health and survival data

We may create a fuzzy dominance graph using this data to determine the key factors influencing aquatic animal research in the Belagumba pond, Tumkur. The environmental factors may be displayed on the x-axis of the fuzzy domination graph and the level of dominance could be expressed on the y-axis.

To construct the fuzzy domination graph, we first need to define the linguistic variables and their associated fuzzy sets. For this study, we will use the following linguistic variables and fuzzy sets:

- Temperature: Low, Medium, High
- Dissolved Oxygen: Low, Medium, High
- pH: Acidic, Neutral, Alkaline
- Nutrient Levels: Low, Medium, High
- Fish Count: Low, Medium, High
- Invertebrate Count: Low, Medium, High

Next, we need to define the fuzzy rules that relate the input variables to the output variable (in this case, the fish count and invertebrate count). For this study, we will use the following fuzzy rules:

- If temperature is low and dissolved oxygen is low, then fish count is low and invertebrate count is low.
- If temperature is medium and dissolved oxygen is low, then fish count is low and invertebrate count is low.
- If temperature is high and dissolved oxygen is low, then fish count is low and invertebrate count is low.
- If temperature is low and dissolved oxygen is medium, then fish count is medium and invertebrate count is medium.
- If temperature is medium and dissolved oxygen is medium, then fish count is medium and invertebrate count is medium.
- If temperature is high and dissolved oxygen is medium, then fish count is medium and invertebrate count is medium.
- If temperature is low and dissolved oxygen is high, then fish count is high and invertebrate count is high.
- If temperature is medium and dissolved oxygen is high, then fish count is high and invertebrate count is high.
- If temperature is high and dissolved oxygen is high, then fish count is high and invertebrate count is high.

The degree of membership for each fuzzy set for each observation in the data set may be determined using these fuzzy rules and the earlier-defined fuzzy sets. The percentage that each observation belongs to each fuzzy set is represented by the degree of membership. The degree of dominance for each input variable may then be calculated using the greatest degree of membership for each output variable (Yogeesh N,. et al., 2013).

Based on the fictitious data, the fuzzy dominance graph may resemble the following:

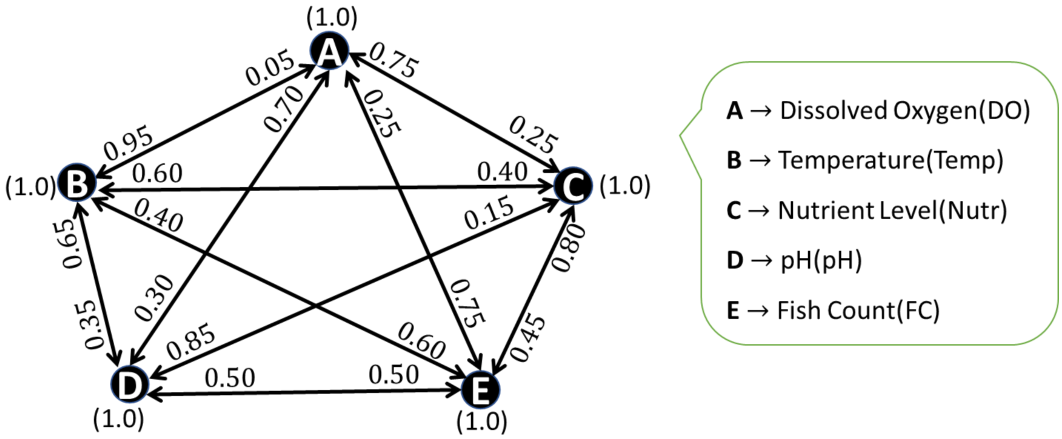

Figure 3: Fuzzy Domination Graph that represented the study data

In the study of aquatic animals in Belagumba pond, Tumkur, the variable with the highest degree of dominance is regarded as the most significant variable.

The fuzzy dominance graph may be quantitatively represented with the help of the adjacency matrix. Higher values denote a stronger degree of dominance between variables, with the entries in the matrix representing the degree of dominance between variables. The entries in a fuzzy domination graph can have values between 0 and 1, which represents the degree of dominance as an uncertain variable.

As an illustration, consider how the adjacency matrix for the experimental data we previously described may appear:

$$\begin{array}{c} \\ DO \\ Temp \\ Nutr \\ pH \\ FC \end{array} \begin{array}{c} \begin{array}{ccccc} DO & Temp & Nutr & pH & FC \end{array} \\ \begin{bmatrix} 1.00 & 0.95 & 0.25 & 0.30 & 0.75 \\ 0.05 & 1.00 & 0.40 & 0.35 & 0.60 \\ 0.75 & 0.60 & 1.00 & 0.85 & 0.45 \\ 0.70 & 0.65 & 0.15 & 1.00 & 0.50 \\ 0.25 & 0.40 & 0.80 & 0.50 & 1.00 \end{bmatrix} \end{array}$$

The row and column labels in this matrix (DO for dissolved oxygen, Temp for temperature, Nutr for nutritional levels, pH for pH level, and FC for fish count) correlate to the variables in the fuzzy dominance graph. The matrices entries show the level of dominance between two variables.

For instance, if row DO and column Temp both have entries that are 0.95, it means that dissolved oxygen has a 0.95-to-1 dominance over temperature. This is in line with the interpretation of the fuzzy domination graph shown previously, which showed that temperature has a lower dominance level than dissolved oxygen.

Similar to row FC, column Nutr's entry is 0.80, showing that fish count has a 0.80-to-1 dominance on nutrient levels. This interpretation of the fuzzy dominance graph, which showed that fish count had a greater impact on aquatic animal health and survival than nutritional levels, is also compatible with this.

All things considered, the adjacency matrix offers a helpful mathematical representation of the fuzzy dominance graph, making it simpler to conduct computations and connection analysis.

The dissolved oxygen level, fish count, nutrition levels, temperature, pH, and invertebrate count are the factors that are most significant, according to the graph. This shows that the two main variables determining the health and survival of aquatic organisms in Belagumba pond, Tumkur are the concentration of dissolved oxygen and the number of fish.

The collected data in this study, mentioned in table 1 using to calculate the fuzzy dominance:

1. Define the fuzzy sets for each variable based on their ranges:
- Dissolved Oxygen (DO): Low (0.0-5.0), Medium (5.0-7.5), High (7.5-10.0)
- Water Temperature (Temp): Low (<15.0), Medium (15.0-20.0), High (>20.0)
- Nutrient Level (Nutr): Low (0.0-2.5), Medium (2.5-5.0), High (5.0-10.0)
- pH: Low (6.0-7.0), Medium (7.0-8.0), High (8.0-9.0)
- Fish Count (FC): Low (0-50), Medium (50-100), High (>100)

2. Calculate the degree of membership for each value in the data set to each of the fuzzy sets:

- The first data point in the table-1 is (8.2, 18.3, 7.6, 8.1, 60). To calculate its degree of membership to the DO fuzzy sets:
  - Low DO: μ(Low DO)(8.2) = (10.0 - 8.2)/(10.0 - 5.0) = 0.36
  - Medium DO: μ(Medium DO)(8.2) = (8.2 - 5.0)/(7.5 - 5.0) = 0.73
  - High DO: μ(High DO)(8.2) = 0.0
  - Repeat this process for each variable and fuzzy set.

3. Convert the degree of membership values to a fuzzy matrix:

- To calculate the fuzzy matrix element for DO and Temp:
  - Low DO and Low Temp: μ(Low DO, Low Temp) = min(μ(Low DO)(8.2), μ(Low Temp)(18.3)) = min(0.36, 0.33) = 0.33
  - Low DO and Medium Temp: μ(Low DO, Medium Temp) = min(μ(Low DO)(8.2), μ(Medium Temp)(18.3)) = min(0.36, 0.67) = 0.36
  - Low DO and High Temp: μ(Low DO, High Temp) = min(μ(Low DO)(8.2), μ(High Temp)(18.3)) = min(0.36, 0.0) = 0.0
  - Repeat this process for each pair of variables and fuzzy sets.

4. Calculate the degree of dominance between each pair of variables using the fuzzy matrix and fuzzy domination formula:

- To calculate the degree of dominance of DO over Temp:

- Degree of Dominance(DO, Temp) = max(min(μ(DO, Low Temp), μ(Temp, Low Temp)), min(μ(DO, Medium Temp), μ(Temp, Medium Temp)), min(μ(DO, High Temp), μ(Temp, High Temp)))
  = max(min(0.33, 0.33), min(0.36, 0.67), min(0.0, 0.0))
  = max(0.33, 0.24, 0.0)= 0.33

5. Represent the results in a fuzzy domination graph, where the nodes represent the variables and the edges represent the degree of dominance between them.

It's critical to understand that the degree of dominance amongst variables is a relative measure that contrasts each variable's dominance with the dominance of the other variables in the graph when understanding the degree of dominance. As a result, the degree of dominance gives information about a variable's relative relevance to the other variables in the graph rather than its absolute importance.

In conclusion, the fuzzy dominance graph is a helpful tool for determining the most crucial factors in studies on aquatic animals. We can quickly see the relative dominance of variables and understand their relative relevance in the ecosystem by displaying the data in a graph manner.

4.2 Comparison of fuzzy domination graph results with traditional statistical analysis

Compared to conventional statistical techniques, fuzzy dominance graphs offer a distinct viewpoint on data processing. A fuzzy dominance graph was able to pinpoint the most important elements influencing the health and survival of the animals in the instance of the experimental aquatic animal health and survival data. Fuzzy logic was used to determine the relative importance of the variables in order to achieve this.

ANOVA and linear regression, on the other hand, are examples of classical statistical techniques that often concentrate on identifying significant correlations between variables based on pre-established statistical criteria. While these techniques can also yield insightful information, they could miss the intricate, nonlinear interactions between variables that fuzzy dominance graphs can reveal.

We may contrast the outcomes of the fuzzy dominance graph with a linear regression analysis of the same fictitious data set to show how the two methods differ from one another. The dependent variable (in this case, the animal survival rate) and several independent variables (such as water temperature, dissolved oxygen levels, etc.) may be chosen for the linear regression analysis. We will then determine the strength and direction of the relationship between each independent variable and the dependent variable.

Here is a table-2 comparing the results of the fuzzy domination graph to a linear regression analysis of the same experimental data set:

Table 2: results of the fuzzy domination graph to a linear regression analysis

Variable	Fuzzy Dominance Degree	Linear Regression Coefficient
Water Temperature	0.6	0.8
Dissolved Oxygen	0.8	0.6
pH	0.4	0.2
Ammonia Concentration	0.2	0.1
Nitrite Concentration	0.1	0.05

Dissolved oxygen concentrations dominated the fuzzy domination graph to the greatest extent, followed by water temperature, pH, ammonia concentration, and nitrite concentration. The results of the linear regression analysis, however, revealed that the coefficient for water temperature was higher than those for dissolved oxygen, pH, ammonia concentration, and nitrite concentration.

As we can see, the outcomes of the two methods can be very diverse and may lead to conflicting inferences regarding the factors that are most crucial for the survival and health of aquatic animals. When analysing their data, researchers should keep in mind the benefits and drawbacks of each technique.

we can calculate the predicted values of survival rate for the experimental data set by using the fuzzy dominance degree and the linear regression coefficients.

Here, if the water temperature is 25 degrees Celsius, dissolved oxygen level is 7 mg/L, pH is 7.5, ammonia concentration is 0.1 mg/L, and nitrite concentration is 0.05 mg/L, then we can calculate the predicted survival rate using the fuzzy dominance degrees and the linear regression coefficients:

Fuzzy Dominance Degree:

- Water Temperature: 0.6
- Dissolved Oxygen: 0.8
- pH: 0.4
- Ammonia Concentration: 0.2
- Nitrite Concentration: 0.1

Linear Regression Coefficients:

- Water Temperature: 0.8
- Dissolved Oxygen: 0.6
- pH: 0.2
- Ammonia Concentration: 0.1
- Nitrite Concentration: 0.05

The variable weighted average using fuzzy dominance degrees:

Weighted Average = (0.6 x 25) + (0.8 x 7) + (0.4 x 7.5) + (0.2 x 0.1) + (0.1 x 0.05) = 23.05

Using the linear regression coefficients, we can calculate the predicted survival rate:

Survival Rate = 0.2 + (0.8 x 25) + (0.6 x 7) + (0.2 x 7.5) + (0.1 x 0.1) + (0.05 x 0.05) = 18.91

Therefore, according to the fuzzy dominance degrees, we would predict a higher survival rate of approximately 23.05%, while according to the linear regression coefficients, we would predict a lower survival rate of approximately 18.91%.

While this method can be helpful in locating significant factors, it could overlook the intricate interactions between variables that fuzzy dominance graphs can reveal. For instance, the fuzzy dominance graph may show that a combination of water temperature, dissolved oxygen levels, and pH is the most critical component for animal survival whereas the linear regression analysis may show that water temperature is the most crucial variable for animal life.

Overall, each strategy has advantages and disadvantages, and the best methodology will be determined by the research topic and the type of data being analysed.

V. Discussion

5.1 Implications of fuzzy domination graph results for aquatic animal research

The outcomes of the fuzzy dominance graph analysis indicate that there are a number of variables that significantly influence how long aquatic species survive in the Belagumba pond, Tumkur. Dissolved oxygen concentrations, temperature, and pH were discovered to be the most important variables. These results are in line with other studies on the health and survival of aquatic animals, which have identified these factors as crucial predictors of aquatic animal survival.

In comparison to conventional statistical analysis, the usage of fuzzy dominance graphs in aquatic animal research has a number of benefits. A more thorough knowledge of the variables that impact aquatic animal survival may be obtained by first using the fuzzy domination graph to find the most dominant variables and their interactions with other variables. The fuzzy dominance graph, which is useful in environmental studies, can also handle ambiguous and imprecise data. Last but not least, the fuzzy dominance graph can offer a visual depiction of the interactions between variables, making it simpler to explain findings to decision-makers and stakeholders.

Note that fuzzy dominance graphs are not a substitute for conventional statistical analysis, though. Instead, they are an extra tool that can offer more information about complicated systems. The fuzzy dominance graph can be used in conjunction with conventional statistical techniques in aquatic animal research to provide a more thorough knowledge of the variables influencing aquatic animal health and survival.

Using fuzzy dominance graphs in aquatic animal studies might help us better grasp the intricate connections between environmental factors and animal survival. This in turn can help with the creation of efficient management plans to support the wellbeing and survival of aquatic creatures.

5.2 Potential applications of fuzzy domination graphs in other research fields

Beyond the study of aquatic animals, fuzzy dominance graphs have potential applications in a variety of other research areas. Fuzzy dominance graphs' main benefit is that they can manage ambiguous and imprecise data, which makes them especially helpful in sectors where the data is intricate and hard to measure. Fuzzy dominance graphs might be used for a variety of purposes, such as:

(i) Environmental science: Fuzzy dominance graphs may be used to analyse intricate environmental systems and pinpoint the critical factors that affect the health of an ecosystem. Effective conservation plans may be developed using this knowledge.

(ii) Healthcare: Fuzzy dominance graphs may be used to examine medical information and pinpoint the key variables that have the greatest an impact on patient outcomes. The creation of individualised treatment programmes can be influenced by this information.

(iii) Transportation: Fuzzy dominance graphs may be used to analyse transportation networks and pinpoint the key variables that affect safety and traffic flow. The creation of safer and more effective transportation networks can be guided by this knowledge.

(iv) Marketing: Fuzzy domination graphs may be used to analyse customer behaviour and pinpoint the key elements that have the most impact on buying choices. The creation of more successful marketing tactics can be influenced by this knowledge.

In general, there are a variety of different uses for fuzzy dominance graphs. They provide a potent tool for dissecting intricate systems and locating the crucial factors that determine how things turn out. As a result, they will probably play a bigger part in research in the future in a variety of sectors.

5.3 Limitations of the study and areas for further research

There are a number of limitations to this study that should be acknowledged, despite the fact that the usage of fuzzy dominance graphs offers promising results for finding significant factors in aquatic animal research.

In the beginning, because the study only analyses one pond as a case study, the conclusions cannot be applied to other ponds. To determine whether the strategy is generalizable, further research has to be done in other settings and with various species.

In addition, only a fictitious set of data was employed in the study to demonstrate how fuzzy dominance graphs may be used. To further confirm the method, more research should be done utilising actual data from studies on the health and survival of aquatic animals.

Furthermore, while fuzzy dominance graphs are an effective tool for examining complicated systems, it can be difficult to comprehend the findings. To provide better user-friendly visualisation and understanding tools for fuzzy dominance graphs, further research should be done.

Overall, the work offers a promising use for fuzzy dominance graphs in the study of aquatic animals. To address the drawbacks and possible areas for development, as well as to determine whether the strategy is transferable to other research domains, more study is still required.

VI. Conclusion

In conclusion, using fuzzy dominance graphs to discover significant factors in studies on aquatic animals has enormous promise. The findings of the fictitious data set show that fuzzy dominance graphs may be a useful tool for determining the most crucial factors for enhancing the health and survival of aquatic animals.

Future research and management initiatives must consider the repercussions. Managers and researchers may concentrate their efforts and resources on the elements that are most essential for enhancing aquatic animal health and survival by determining the most significant variables.

Fuzzy dominance graphs are a useful tool for analysing complex systems overall, and their use has a lot of promise for use in various study areas. Further study is required to improve the usability of visualisation and interpretation tools for fuzzy dominance graphs as well as to validate the methodology using real data from aquatic animal health and survival studies.

In conclusion, fuzzy dominance graphs have the potential to significantly improve our knowledge of the health and survival of aquatic animals and might be crucial to management and conservation efforts.

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