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Motion Visualization and Prediction Using ML: Fuzzy Logic-2

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Abstract: Machine Learning is a subset of Artificial Intelligence (AI). Huge set of data is provided to the machine which is trained using Logistic Regression algorithm. We have acquired data from real-time motion sensors continuously over a long period of time. Along with historical data stored in the database, the present runtime data is analysed and used to train the machine. The machine is provided with enough data to learn for itself creating a predictive model with a particular accuracy. Ultrasonic sensors [1] are mounted at different orientations, continuously gathering data of the ether. The data acquired is then analysed, visualized and used for future predictions/ conclusions. Accuracy check is carried out to verify the exactness of the predicted data. In this paper we carry out data visualization procedure and statistical analysis of the data which was acquired in our previous assignment, 'Motion Detection and Prediction Using ML: Logistic Regression'. The acquired data is made to correspond to a particular Fuzzy Logic by means of programming.

Keywords: Fuzzy Logic, Data Analytics and Machine Learning, Data pre-processing, Logistic regression, accuracy, precision, F1 score, categorical values, data analysis and visualization, an array of ultrasonic sensors is placed at different orientations, 'Motion Detection and Prediction Using ML: Logistic Regression' and Artificial Intelligence (AI).

I.INTRODUCTION

There are some characteristic properties of data obtained from the Ether:

- Huge data sets,
- Heterogeneity, and
- Uncertainty, due to:

i.presence of random variables,
ii.incomplete data or inaccurate data (inaccuracy of measurement),
iii.approximate estimations instead of measurements (due to technical or financial problems),
iv.incomparability of data (varying measurement or observation conditions),
v.qualitative instead quantitative information (due to technical or financial problems),
vi.incomplete or vague expert knowledge, and
vii.Subjectivity of the information obtained from expert.

These characteristics can be well represented by Fuzzy Logic instead of two extreme logical values of 1 and 0. Fuzzy logic includes 0 and 1 as extreme cases of truth, but also includes various states of truth in between them. Fuzzy logic is an extension of Boolean logic by Lotfi Zadeh in 1965 based on the mathematical theory of fuzzy sets, which is a generalization of the classical set theory. By introducing the notion of degree in the verification of a condition, thus enabling a condition to be in a state other than true or false, fuzzy logic provides a very valuable flexibility for reasoning, which makes it possible to take into account inaccuracies and uncertainties.

II.MOTIVATION

Fuzzy approach as a possible way to handle uncertainty is particularly useful for processing uncertain or imprecise environmental data. Environmental data or classes of ecological objects can be defined as fuzzy sets with not sharply defined boundaries that reflect better the continuous character of nature. The predicted data will be much more accurate than those which are predicted using only two logical levels. Fuzzy logic has the ability to modify categorical data sets to sub-categorical data sets

III.PROBLEM STATEMENT

An array of ultrasonic sensors is placed at different orientations collecting data for a particular interval of time. The acquired sensor values are subjected to pre-processing, data analytics and visualization. The acquired data is made to correspond to a particular Fuzzy Logic by means of programming .The prepared data needs to be fed to the machine,

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for it to learn. Various graphical and analytical tools have to be incorporated to achieve a relation between the so considered independent and dependent column attributes.

IV. BLOCK DIAGRAM

Figure 1 shows the block diagram of the proposed system. The sensors S1, S2, S3 and S4 are placed in an array at different orientations. More sensors could be added to obtain better result. An ultrasonic sensor continuously records data and is moved to the database. The data can be pre-processed before storing or formatted after, on the excel sheet.

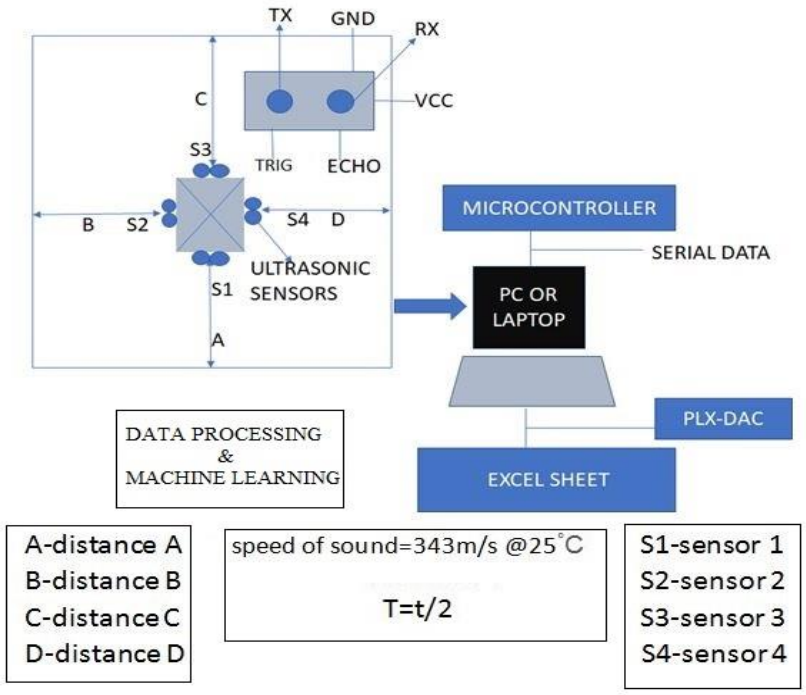

Figure 1 shows the block diagram of the proposed system.

```
In [2]:
1 import pandas as pd
2 import numpy as np
3 import seaborn as sns
4 %matplotlib inline
5 import matplotlib.pyplot as plt
6 df = pd.read_csv(r'C:\Users\dell\Desktop\sen.csv')
```

Figure 2 shows the Python code to import libraries.

V. METHODOLOGY

The work process can be achieved in the following steps

i. Data acquisition from the sensor array and storing in the database. Figure 2 shows the Python code to import libraries. [2]

ii. The data may contain noise, NaN values, and information that should be treated before analysis or visualization. This is called data pre-processing. Figure 3 shows the dataset before pre-processing and removal of NaN values. [3]

iii. The pre-processed data is now eligible for data analytics and data visualization. Graphs and statistical formulas enhance the process of AI.

iv. The data-set is now made into a Fuzzy logic as shown in figure 4.

v. Data visualization is carried out on the formatted data set. Figure 5 shows the graph of fuzzy logic count. Figure 6 shows a line graph of fuzz vs. format.

vi. Heatmap analysis is done for knowledge of correlation. The data is split into train and test using a particular randomness factor 'X'. [4] Figure 7 shows the heatmap of the assignment.

vii. A predictive model is designed using Logistic regression and its accuracy is verified. [5]. Figure 8 shows the result with accuracy.

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	TIME	DISTANCEA	DISTANCEB	FUZZA	CATA	CATB	FUZZB	FOR
0	0	48.0	80.0	1.020	1.0	0.0	NaN	1.0
1	1	7.0	50.0	1.020	4.0	0.0	NaN	1.0
2	2	62.0	80.0	1.010	2.0	3.0	1.0	1.0
3	3	48.0	70.0	1.005	4.0	0.0	1.0	0.0
4	4	51.0	80.0	1.010	2.0	0.0	1.0	1.0
5	5	60.0	90.0	1.015	3.0	0.0	NaN	NaN
6	6	68.0	70.0	1.010	0.0	0.0	NaN	1.0
7	7	24.0	NaN	1.015	2.0	4.0	1.0	0.0
8	8	52.0	100.0	1.015	3.0	0.0	1.0	0.0
9	9	53.0	90.0	1.020	2.0	0.0	0.0	0.0
10	10	50.0	60.0	1.010	2.0	4.0	NaN	0.0
11	11	63.0	70.0	1.010	3.0	0.0	0.0	0.0
12	12	68.0	70.0	1.015	3.0	1.0	NaN	1.0
13	13	68.0	70.0	NaN	NaN	NaN	NaN	NaN
14	14	68.0	80.0	1.010	3.0	2.0	1.0	0.0
15	15	40.0	80.0	1.015	3.0	0.0	NaN	1.0

Figure 3 shows the dataset before pre-processing and removal of NaN values.

Out[3]:

	current time	Distance in cm	distaA in cm	formatA	format	fuzzA	fuzz
0	12:13:11	200.00	26.10	1	0	0.20	0.0
1	12:13:11	8.45	27.75	1	1	0.20	0.1
2	12:13:12	8.35	12.61	1	1	0.10	0.1
3	12:13:12	9.76	12.19	1	1	0.10	0.1
4	12:13:12	8.35	12.62	1	1	0.10	0.1
5	12:13:12	8.45	13.89	1	1	0.10	0.1
6	12:13:12	8.35	12.18	1	1	0.10	0.1
7	12:13:13	8.47	12.61	1	1	0.10	0.1
8	12:13:13	8.33	41.93	1	1	0.20	0.1
9	12:13:13	8.76	10.07	1	1	0.10	0.1
10	12:13:13	9.76	10.08	1	1	0.10	0.1

Figure 4 shows Fuzzy logic implementation.

```
f= plt.subplots(figsize=(22, 5))
color_types=['#FF0000','#00000F','#AAAAAA','#00FF00']
sns.countplot(x="fuzzA", palette=color_types, data=df).set_title('chem pass');
```

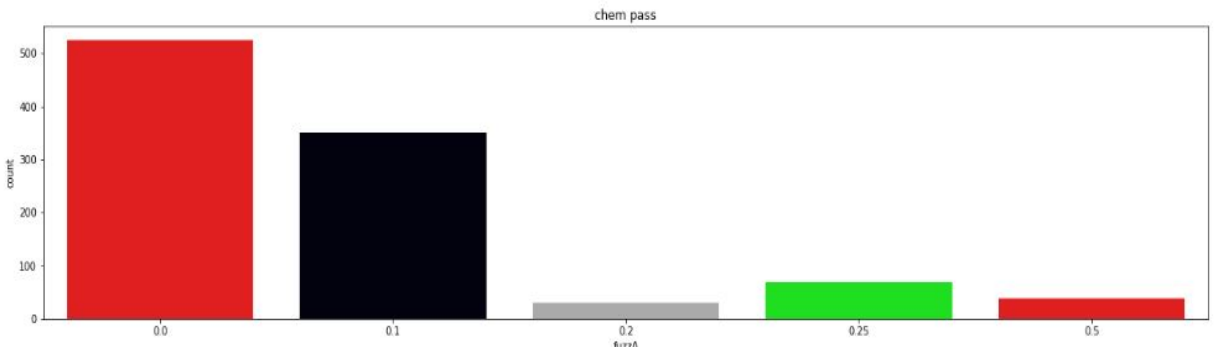

Figure 5 shows the graph of fuzzy logic count.

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```
1 ax=sns.lineplot(x="fuzzA", y="formatA", data=df)
```

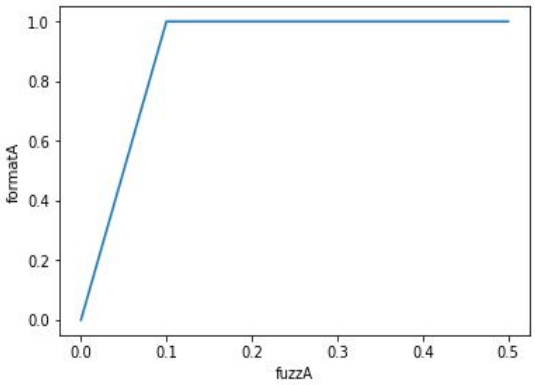

Figure 6 shows a line graph of fuzz vs. format.

	Distance in cm	distaA in cm	formatA	format	fuzzA	fuzz
Distance in cm	1.000000	-0.018671	0.028335	-0.978855	0.023904	-0.360664
distaA in cm	-0.018671	1.000000	-0.570074	0.018835	-0.382703	0.020258
formatA	0.028335	-0.570074	1.000000	-0.032605	0.709676	0.001149
format	-0.978855	0.018835	-0.032605	1.000000	-0.034827	0.501482
fuzzA	0.023904	-0.382703	0.709676	-0.034827	1.000000	-0.021508
fuzz	-0.360664	0.020258	0.001149	0.501482	-0.021508	1.000000

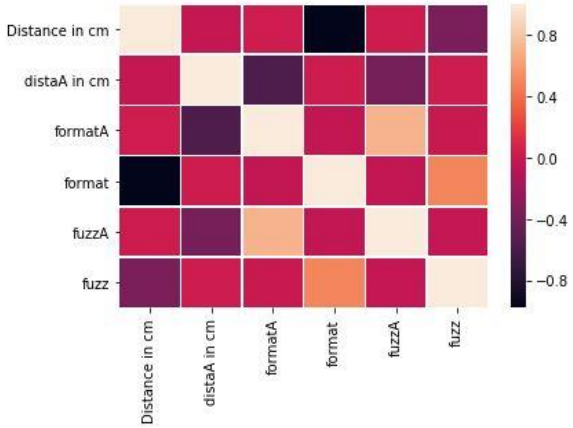

Figure 7 shows the heatmap of the assignment.

In [86]:

```
predictions= logmodel.predict(X_test)
predictions
from sklearn.metrics import confusion_matrix
confusion_matrix(y_test,predictions)
from sklearn.metrics import accuracy_score
accuracy_score(y_test,predictions)
```

Out[86]:

```
0.9833333333333333
```

Figure 8 shows the result with accuracy.

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VI. CONCLUSIONS

Motion detection is a simple task because of the improvement in the sensor technology and with ever increasing accuracy of the same. The major challenge that we have encountered is the prediction of motion of any object with the existing data and runtime data. This can be done by Machine Learning algorithms which allow the machines to learn on their own. Logistic regression is one such Machine Learning algorithm used to model the probabilities for classification problems with two possible outcomes. Ultrasonic sensors were mounted at different orientations, continuously gathering data of the ether. The data acquired is then analysed, visualized and used for future predictions/ conclusions.

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BIOGRAPHY

VISHESH S (BE, MBA, PGDIB, (MTech)) born on 13th June 1992 hails from Bangalore (Karnataka) and has completed B.E in Telecommunication Engineering from VTU, Belgaum, Karnataka in 2015. He also worked as an intern under Dr. Shivananju BN, former Research Scholar, Department of Instrumentation, IISc, Bangalore. His research interests include Embedded Systems, Wireless Communication, BAN and Medical Electronics. He is also the Founder and Managing Director of the corporate company Konigtronics Private Limited. He has guided over a thousand students/interns/professionals in their research work and projects. He is also the co-author of many International Research Papers. He has recently completed his MBA in e-Business and PG Diploma in International Business. Presently Konigtronics Private Limited has extended its services in the field of Software Engineering and Webpage Designing. Konigtronics also conducts technical and non-technical workshops on various topics. Real estate activities are also carried out under the guidance of Siddesh B S BE (civil). Vishesh S along with his father BS Siddesh has received various awards and applauses from the scientific and entrepreneurial society. He was appointed as the MD of Konigtronics Pvt Ltd (INC. on 9th Jan 2017) at an age of 23 years. His name is indexed in various leading newspapers, magazines, scientific journals and leading websites & entrepreneurial forums. He is also the guide for many international students pursuing their Masters.