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The Study of Hazards of Plastic Pollution Using Induced Fuzzy Coginitive Maps (IFCMS)

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Abstract - Plastic is one of the chemical materials which poses Environmental problem. Plastic is made up of various chemical elements.Therefore, it is regarded as a highly contagious material that does not easily degrade in the natural environment after its usage or utility period.Plastic causes serious damage to environment during its production and disposal process. Poly ethylene, polyvinyl chloride, polystyrene are largely used in the manufacture of Plastics.Hence, this paper analyzes the hazards of Plastic pollutionusing InducedFuzzy Cognitive Maps (IFCMs). IFCMs area fuzzy-graph modeling approach based on expert's opinion.

Keywords-Induced fuzzy Cognitive Maps (IFCMS),Plastic Pollution, Health Hazards.

I. INTRODUCTION

Plastic in the Environment is regarded to be more an aesthetic nuisance than a hazard, since the material is biologically quite inert.Plastics are used because they are easy and cheap to make and they can last for a long time. Unfortunately these same useful qualities can make Plastic a huge pollution problem. Because the Plastic is cheap it gets discarded easily.But its persistence in the environment can do a great harm.The United Nations Environmental Programme(UNEP)2011 yearbook considers Plastic pollution in the ocean to be one of the three greatest emerging environmental problems in the world [1]. When exposed to natural elements, Plastic breaks down into tiny molecules but never fully biodegrades. Plastic is a commodity that is consumed on a large-scale all around the world. The production as well as disposal of Plastic, pose a great threat to all the life forms on earth. This material takes years to discompose, which is one of the factors that kill many animals in water as well as on land. During the manufacture of Plastic, many hazardous chemicals are emitted which has resulted into dreadful disorders and diseases in humans [2]. Ethylene oxide, xylene and benzene are some of the chemical toxins present inPlastic that has miserable effects on the environment.

Any form of Plastic disposal too, causes harm to the environment in which we dwell. Burning the Plasticcauses contamination of atmosphere due to the release of poisonous chemicals [3]. Disposing Plastic into water or land causes contamination and even increases the mortality rate of animals. The rural areas are more prone to any kind of pollution due to poor disposable systems. The people from rural areas often use Plastic bags and bottles on a large-scale. Unaware of the harm caused due to Plastic, rural people are a contributing factor to pollution. Also wind carry and deposit the Plastic from one place to other, littering the land. It also gets stuck on fences, trees and water bodies. Any animal that comes in the vicinity of plastic, might even get tangled and suffocate to death.The maximum damage is done by Plastic carry bags[4]. Shops delivering goods in Plastic bags and the people who insist on having Plastic carry bags when they buy goods are responsible for Plasticpollution. Therefore Plastic management or Plastic waste management [5] involves the techniques to be used to manage the Plastic waste in an environment friendly way and helping in the proper utilization of Plastic material.This paper deals withthe environmental hazards and some remedial measures for Plastic pollution using Induced Fuzzy Cognitive Maps (IFCMs) based on gathered information.Section two presents the basic definitions and section three presents the analysis using the IFCM model. In fourth section we draw the conclusions from our analysis and proposed remedial measures.

II. BASIC NOTION AND DEFINITIONS

We proceed to state the definitions of IFCMS model.

A. Definition

FuzzyCognitiveMaps (FCMs) aredigraphsthatcapturethe cause/effect relationship inasystem. Nodesofthegraphstand fortheconceptsrepresentingthekey factorsandattributesof the modeling system, such asinputs, variable states, components factors,events,actionsof anysystem.Signedweightedarcs describe thecasual relationships, whichexists amongconcepts and interconnect them, with adegreeof causality. The constructed graph clearly shows how concepts influence each otherandhowmuchthedegreeofinfluenceis. Cognitive Maps (CMs) wereproposed fordecision making by Axelrod [6][7] for the firsttime. Using two basic types of elements;concepts and casual relationship, the cognitive map canbeviewed asasimplified mathematical model ofabelief system.FCMswereproposedwiththe extensionof thefuzzified casualrelationships. Kosko[7][8],introducedFCMsasfuzzygraph structuresforrepresenting casualreasoning.Whenthenodesof theFCMarefuzzysetsthentheyarecalledfuzzynodes.FCMs withedgeweightsorcausalitiesfromtheset{-1,0, 1} arecalled simpleFCMs. Consider thenodes/concepts P_1,P_2, P_3,…,$P_n$oftheFCM. Supposethedirectedgraphisdrawnusingedgeweight$e_{ij}$from {-1, 0, 1}.

B. Definition

Thematrix Mbedefined by$M$= (e_{ij}) wheree_{ij}isthe weightof thedirectededgeP_iP_j.$M$is calledthe adjacency matrixoftheFCM,alsoknownasconnectionmatrix.Thedirected edgee_{ij}fromthecasualconcept $P_i$to concept $P_j$measureshowmuch-$P_i$causesP_j.Theedgee_{ij}takesvaluesintherealinterval[−1,1].e_{ij}

=0indicatesnocausality.

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e_{ij}>0indicatescasualincrease/positivecausality.
e_{ij}<0indicatescasualdecrease/negativecausality.

Simple FCMs provide quick first-hand information to an expert's stated causal knowledge. Let P_1,P_2, P_3,…,$P_n$be the nodesof FCM. Let A=(a_1,a_2, …,a_n) iscalledastate vector whereeithera_i=0or1.Ifa_i=0,theconcept$a_i$intheOFFstate and ifa_i=1, theconcept$a_i$intheONstate,for$i$=1,2, …,n. LetP_1P_2, P_2P_3, …,P_iP_j.betheedgesoftheFCM ($i \neq j$). Thentheedgesformadirectedcycle.

C . Definition
AnFCMissaidtobecyclicifitpossessesadirectedcycle.
AnFCMwithcyclesis saidtohaveafeedback,whenthereisa feedbackinanFCM,i.e.,whenthecausalrelationsflowthrough acycleinarevolutionary way,theFCMiscalledadynamical system.The equilibrium state for the dynamical system is called the hidden pattern.If the equilibrium stateofadynamical state isa uniquestatevector,itiscalledafixedpointorlimitcycle. Inferencefromthehiddenpatternsummarizesthejointeffectsof allinteractingfuzzyknowledge.

D. AlgorithmicapproachtoIFCM
EventhoughIFCM isanadvancement ofFCMitfollows thefoundationof FCM,ithasa slightmodificationonlyin Algorithmic approaches [9][10][11]. Toderiveanoptimistic solutiontothe problem with anunsupervised data,the following steps tobe followed:

Step 1:Forthegivenmodel(problem),collecttheunsupervised datathatisindeterminantFactorscallednodes.

Step 2: According to the expert opinion, draw the directed graph.

Step 3: Obtain theconnectionmatrix, M,from the directed graph (FCM). Herethenumber ofrowsinthegivenmatrix = numberofstepstobeperformed.

Step 4: Consider thestatevector $S(X_1)$. By setting c_1 inONposition thatisassigningthefirst componentofthevectortobe1andthe rest of thecomponents as 0.Find $S(X_1) \times M$.The state vector isupdated and thresholdat eachstage.

Step 5: Threshold value is calculated by assigning 1 for the values>0and0forthevalues<1.Thesymbol'↪'represents thethresholdvaluefortheproductofthe result.

Step 6:Now eachcomponent in theC_1vectoris taken separatelyand productof the givenMatrixis calculated. The vector which has maximum number of one'sis found. The vectorwithmaximumnumberof one'swhichoccursfirstis consideredasC_2.

Step7:Whenthesamethresholdvalueoccurstwice.Thevalue isconsideredasthefixedPoint.Theiterationgetsterminated

Step8:ConsiderthestatevectorC_1bysettingC_2inONstatethatisassigningthesecondcomponentofthevectortobe1andthe rest of thecomponents as 0. Precedethe calculations discussedinSteps4to6.

Step9:Continue Step9 for all the state vectors and find hidd pattern.

III. ANALYSIS USING IFCMS MODEL

We take the following attributes in the case of Environmental Hazards:

C_1- Plastics blocks the open sewage system and results in stagnation of sewage water, becomes breeding place for mosquitoes which leads to the spread of water and air borne diseases.
C_2- Plastics dumped on the soil prevents water percolation into the ground, reduces ground water level and also the poison in the waste Plastics mix with rain water, seep through the ground and drain into nearby streams and lakes.
C_3- Burning of Plastics results in releasing of toxins in the atmosphere which causes dreaded diseases like cancer and associated with skin, respiratory problems by exposure and inhalation of toxic fumes.
C_4- Due to improper disposal systems,many cattle's and other animals consuming Plastics results in ending of their life. Birds are also affected by eating Plastics.
C_5- Plastic waste dumped into rivers, find its way to ocean and seas affects the marine life. Marine creatures such as dolphins, turtles, whales, penguins are killed every year by these Plastics. Many animals mistaking them as food and the ingested Plastics remain after death and decomposition of the animals.
C_6-The Manufactures of Plastics dispose the Plastic waste and chemicals used in the process of manufacturing Plastic material into water channels causing health hazards to living organisms in and around it.
C_7-Plastics which affect the marine life in turn pose a direct threat to human beings who consume fish that have taken Plastics.
C_8-InPlastic manufacturing, it releases chemicals such as Biphenyl, Styrene Trimer and Styrene Monomer, which alters the reproductive systems of human beings.

According toan Ecologist opinion, the same set of 8 attributes has been converted into a connection matrix M.

$$M = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 \end{bmatrix}$$

Analysis using IFCMS:
Step 1:
Let C_1 (1 0 0 0 0 0 0 0)
C_1 M= (0 1 0 0 0 0 0 0) = C_1'
C_1'M≈
(0 1 0 0 0 0 0 0)M= (1 0 0 1 1 0 1 0) = C_2
C_2 M = (1 0 0 1 1 0 1 0) M = (1 2 0 2 2 2 2 1)
↪ (1 1 0 1 1 1 1 1) = C_2'

C_2' M≈
(1 0 0 0 0 0 0 0)M= (0 1 0 0 0 0 0 0)
(0 1 0 0 0 0 0 0)M= (1 0 0 1 1 0 1 0)

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(0 0 0 1 0 0 0 0)M= (1 1 0 0 1 1 1 0) = C_3
(0 0 0 0 1 0 0 0)M= (0 0 0 0 0 1 1 0)
(0 0 0 0 0 1 0 0)M= (0 1 0 0 0 0 0 1)
(0 0 0 0 0 0 1 0)M= (0 0 0 0 1 0 0 1)
(0 0 0 0 0 0 0 1)M= (0 0 1 1 0 1 0 0)
C_3M = (1 1 1 0 0 1 1 1)M = (1 2 0 1 2 1 2 2)
(1 1 0 1 1 1 1 1)= C_3'
C_3 'M ≈

(1 0 0 0 0 0 0 0)M= (0 1 0 0 0 0 0 0)
(0 1 0 0 0 0 0 0)M= (1 0 0 1 1 0 1 0)
(0 0 0 1 0 0 0 0)M= (1 1 0 0 1 1 1 0) = C_3
(0 0 0 0 1 0 0 0)M= (0 0 0 0 0 1 1 0)
(0 0 0 0 0 1 0 0)M= (0 1 0 0 0 0 0 1)
(0 0 0 0 0 0 1 0)M= (0 0 0 0 1 0 0 1)
(0 0 0 0 0 0 0 1)M= (0 0 1 1 0 1 0 0)
(1 1 0 0 1 1 1 0) is the fixed point and the triggering pattern is $C_1 \rightarrow C_2 \rightarrow C_4 \rightarrow C_4$when the first attribute is kept in on state. The following table gives the triggering patterns when other attributes are kept in ON state consecutively.

Table-1 Induced Patterns for M by IFCM

Number	Attribute ON state	Triggering pattern
Step1	C_1	$C_1 \rightarrow C_2 \rightarrow C_4 \rightarrow C_4$
Step2	C_2	$C_2 \rightarrow C_4 \rightarrow C_4$
Step3	C_3	$C_3 \rightarrow C_8 \rightarrow C_8$
Step4	C_4	$C_4 \rightarrow C_2 \rightarrow C_4$
Step5	C_5	$C_5 \rightarrow C_6 \rightarrow C_6$
Step6	C_6	$C_6 \rightarrow C_2 \rightarrow C_2$
Step7	C_7	$C_7 \rightarrow C_8 \rightarrow C_8$
Step8	C_8	$C_8 \rightarrow C_4 \rightarrow C_4$

Merging all these induced graphs on a single graph, we obtain the following graph.

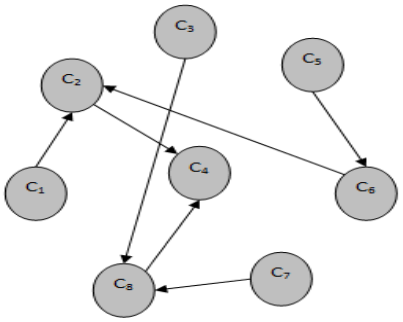

Fig 1: Induced graphs on a merged graph

The interrelationship between the attributes revealsthatC_2[- Plastics dumped on the soil prevents water percolation into the ground, reduces ground water level and also the poison in the waste Plastics mix with rain water, seep through the ground and drain into nearby streams and lakes], C_4 [Due to improper disposal systems, many cattle's and other animals consuming Plastics results in ending of their life. Birds are also affected by eating Plastics] and C_8 [In Plastic manufacturing, it releases chemicals such as Biphenyl, styrene Trimer and styrene Monomer, which alters the reproductive systems of human beings]plays theimportant rolein this study.Thelimitpointscorresponding toC_2(10011010), C_4(11001110) and C_8(00110100)highlights almost alltheattributes which seems to be major causes of Plastic pollution.

IV. CONCLUSION

It requires self-discipline to solve this Plastic pollution caused by using Plastic things in our day today life. Our Dependence on the private organization and government will not solve these problems.The useof Plastic is a part of human need.Therefore, we have to follow some simple ways to solve this existing problem. So, we suggest the following remedial measures.Limited usage of Plastic carry bags will help the environment free from pollution.Using glass bottles, cloth and paper bags which are biodegradable and recyclable will reduce Plastic pollution.Using Plastic carry bags again and again for our daily shopping, instead of throwing them out in the first use itself will reduce the manufacture of Plastic carry bags.
Collect all waste Plastics in our home and donate it to the recycling centers, will help road constructions, save cattle's life and also prevents other pollutions.Avoid burning the things made up of Plasticswhich will help us to control the air pollution and also by doing so our respiratory disease gets reduced.

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