Performance Analysis of Decision Support System for Waste-Water Management using SVM by ANOVA

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Abstract

To promote efficient wastewater management, global attention must be drawn towards wastewater reuse. As reuse is gaining popularity, there is challenge for the wastewater reusability also. In context with this there is needed to develop systems which help to decision maker where to use wastewater after treatment. Machine learning is a useful technology for decision support systems and assumes greater importance in research and practice.

In this research two machine learning techniques i.e. Decision tree and Support Vector Machine are used. In Decision Support System, a decisiontree can be used to visually and explicitly represent decisions. By using this wastewater can be classified into four classes. SVM is a supervised machine learning algorithm which can be used for classification. In this research it is used for more optimized classification.

Index Terms— *Cloud Computing, Waste water management, BOD, COD, PH, COLOR, MPN, TURBIDITY, TSS*

1. INTRODUCTION

Water is the most supportive predominant and natural key resource for the life on Earth. 97% of Earth's surface is occupied by saline water and the remaining 3% is fresh water. Out of this 2.4% is frozen in glaciers and polar ice caps and the rest 0.6% is in liquid fresh water forms and available in rivers, lakes, and ground water etc. (Figure 1.).

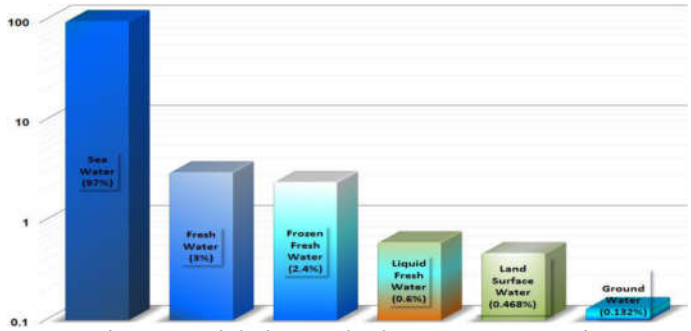


Figure 1. Global water budget percentages wise.

Today environmental pollution may be very huge and challenging trouble. As populace grows with rising general of living, greater wastewater is generated. Climate trade, populace growth and unreasonable exploitation of water sources have triggered environmental deterioration, the unavailability of freshwater and an imbalance among deliver and demand to a international extent[1]. In MNC waste water management mechanism, city government has the waste water records of all the special regions of the city. They have to manually analyze the data and ahead water flow to water treatment plant. After WW treatment they must determine the destiny utilization of the waste water. This challenge is tedious and time consuming. Our system makes this project autonomous and by way of deploying this device on cloud, they are able to get the effects on any laptop linked to the network.

The purpose of a decision support system is to assist a decision maker, in making the available knowledge needed, to solve difficult cases.[2] Decision support system (DSS) is a computer program application that analyzes and presents data so that users can make decisions more easily. This decision support system for wastewater management takes input as a wastewater parameter and by analyzing and computing it will provide best solution to user where to used treated wastewater. Then deployed this system on cloud so that it gives access to distributed location data to any computer which is connected in network

In this research paper contains are as follows 1. Introduction , 2. Proposed Architecture., 3. Design Model using SVM, 4 Proposed Algorithm, 5. Analysis of Variance(ANOVA) 6.Implementation , 7. Conclusion and Future Scope, 8. References.

2. PROPOSED ARCHITECTURE

The architecture of Decision Support System for Waste Water Management (DSSWWM) using SVM consist of five modules as shown in Figure.1

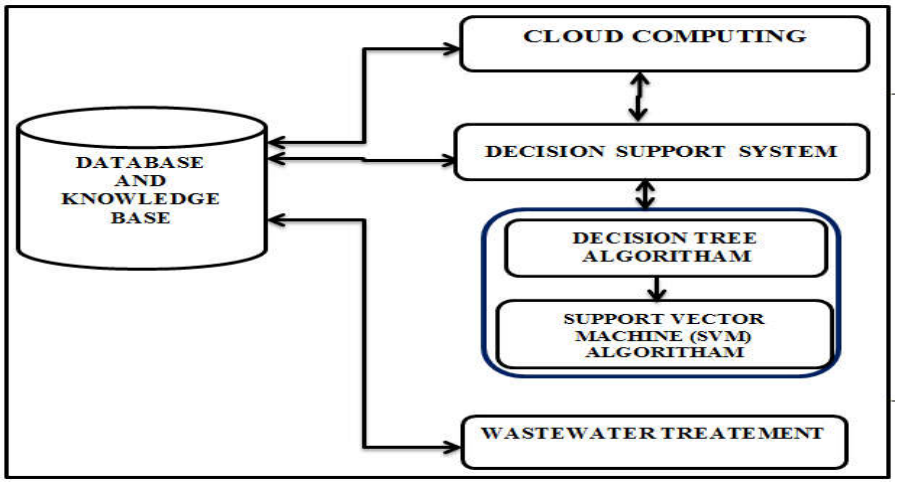


Figure 2. Basic architecture of DSSWWM using Machine Learning Techniques

Wastewater Management: For the reuse purpose, the wastewater is first getting treated. whatever parameters we get are given to the DSS. These are the input parameters for the DSS and after the computation it will produce the decision that is for what purpose user or planner can reuse this treated wastewater

Decision Support System:The main purpose of our research is to develop DSS for wastewatermanagement. This is the computational model of the system. It takes input value as a parameter values of the treated wastewater then it compute by comparing it with all database values. For this we apply Decision Tree Algorithm for classification and Support Vector Machine (SVM) for sub-classification. Finally system will produce optimized solution.

Decision Tree Algorithm: This is one of supervised machine learning algorithm we suppose to apply in our system for the classification. There are basic four categories Irrigation, Industrial, Domestic, and Other.

Support Vector Machine (SVM).This is another Machine Learning technique. Support Vector Machine (SVM) is mostly used in classification problems. Here for sub-classification we use Support Vector Machine (SVM). We define sub-classification as **Irrigation (Agriculture , Landscape, Park ,Crops Irrigation Etc..), Industrial (System Cooling, Boiler Feed & Process Water Etc..), Domestic (Car Washing, Toilet Flushing, Public Park), Other (Construction Work, Flushing Street, Fire Protection Etc…..).**

Cloud Computing: Finally the System is deployed on Cloud, Cloud computing is used so that it gives us access to remote servers hosted on the internet.

Database and knowledge Base: Here we generate database and knowledge base for preparationof data set which is useful for supervised learning that is for both Decision Tree and SVM.[4]

3. DESIGN MODEL USING SVM

The architecture shows the system handling all necessary issues and deployed on Cloud platform. This Decision support system using supervised machine learning technique is helpful for handling the decisions dynamically. Figure2 shows the flow of actions described using the SVM for CBDSSWWM.

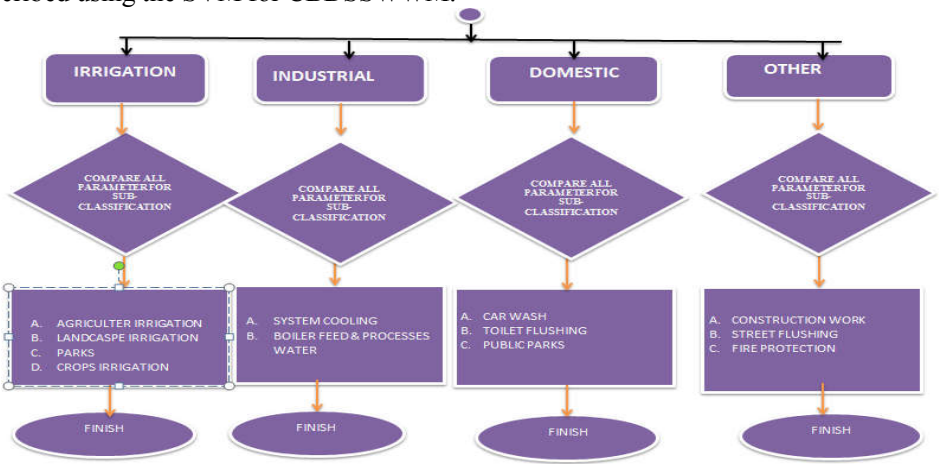


Figure 3. SVM of CBDSSWWM

4. PROPOSED ALGORITHM

To maintain waste water source usage, proposed algorithm in this research paper works as follows:

[1] Callsystem.
[2] To access system, user needs to register on system. Registration will be authenticated by administrator of system.
[3] Login credentials will be verified in order to prevent system from other interference.
[4] After positive log-in, next user has to enter treated wastewater parameters value as input (BOD, COD, pH, COLOR, MPN, TURBIDITY, TSS,) for classification.
[5] Decision tree algorithm is used for classification and decisions related to waste water parameters
[6] After computation system will provide optimized decision that is where to use this waste water like IRRIGITION, INDUSTIRAL, DOMESTIC, and OTHER ACTIVITIES.
[7] For the more optimized solution Support Vector Machine (SVM) algorithm is used. which provide percentagewise solution for the reuse of wastewater.
[8] system will provide Result summery to concerned user
[9] End of system.

5. ANALYSIS OF VARIANCE (ANOVA)

Analysis of variance refers to the examination of differences among the samples.It is used to examine the significance of the difference amongst more than two sample .

In this research, for the significance of the classification two-way ANOVA technique is used. Two variance consider are Classification and Parameter (wastewater), as shown table1.

Table1.Classification & Parameter of Wastewater Reuse

CLASSIFICATION / PARAMETER	DOMESTIC (C1)	IRRIGATION (C2)	INDUSTRIAL (C3)	OTHER (C4)

BOD	P1	4	9	17.5	20
COD	P2	8	22.5	10	9
PH	P3	0.5	6	1.2	4
COLOUR	P4	10	13.5	4	4
MPN	P5	1.1	2.6	1.75	3.25
TURABIDITY	P6	0.75	5	4	9.5
TSS	P7	3	7	10	10.5

SOLUTION:

STEP 1:

Calculate Total Number of Value = T= 201.55

Calculate Total Number of Item = N= 28

STEP 2:

Correction Factor = T^2 / N = $(201.55)^2$ / 28 = 1450.80

STEP 3:

Square of all items= 2324.525

STEP 4:

Total sum of squares (SST)= Square of all items- correction factor= 2324.525 - 1450.80
=873.725

STEP 5:

Sum of squares between varieties of classification

SS Between Columns=$((\sum(c1))\ \hat{}\ 2\ /N) + (\sum(c2))\ \hat{}\ 2\ /N) + ((\sum(c3))\ \hat{}\ 2\ /N) + (\sum(c4))\ \hat{}\ 2\ /N) -$ Correction Factor = 124.74

STEP 6:

Sum of square between parameters or SS between Rows

SS Between Row = $((\sum(P1))\ \hat{}\ 2\ /N) + (\sum(P2))\ \hat{}\ 2\ /N) + ((\sum(P3))\ \hat{}\ 2\ /N) + (\sum(P4))\ \hat{}\ 2\ /N) + (\sum(P5))\ \hat{}\ 2\ /N) + ((\sum(P6))\ \hat{}\ 2\ /N) + (\sum(P7))\ \hat{}\ 2\ /N) -$ Correction Factor= 379.21

STEP 7:

SS for error (SSE)

SSE = SST-(SSC+SSR)=Total sum of squares – (Sum of squares between columns + Sum of squares between rows)

SS for error SSE = Total SS – (SS between columns + SS between rows)
= [Value of step 4] - [Value of step 5 + Value of step 6]= 369.775

STEP 8:

Degrees of freedom

d.f. for total variable = (C * r-1) = (4 * 7-1) = 27

d.f. for total variable between columns = (C – 1)= (4 – 1)= 3

d.f. for total variable between rows= (r – 1)= (7 – 1)= 6

d.f. for residual variance = (c - 1)(r – 1)=3*6= 18

STEP 9:

MS between columns (MSC) = SS between columns / (c-1)

i.e., MSC = SSC / (c-1)

STEP 10:

Setting two way ANOVA Table

Table 2. Setting Two Way ANOVA Result

Sources of Variation	**Sum of Squares SS**	**D.f.**	**Mean Squares Ms**	**F-Calculated Value**	**F-Table Value at 5%**
Between Columns	124.74 (SSC)	3	41.58 (MSC)	F=MSC/MSE F= 2.079	19.16

Between row	379.21 (SSR)	6	63.20 (MSR)	F=MSR/MSE F= 3.07	8.94
SSresidual or error	369.775 (SSE)	18	20.55 (MSE)		
Total	873.725	27			

STEP 11:

As per table of F distribution: critical values of F (5% significance level)Table shows the F-ratio concerning classification (2.079) is less than table value (19.16) also the F-ratio concerning the parameters of wastewater (3.07) is also less than table values (8.94). Therefore the differences are insignificant. Hence the wastewater which consist of operational parameter (P1:BOD, P2:COD,P3: pH, P4:MPN,P5 :COLOUR,P6: TSS, and P7: TURIBILITY) within the above mentioned range or value can be significantly reuse.

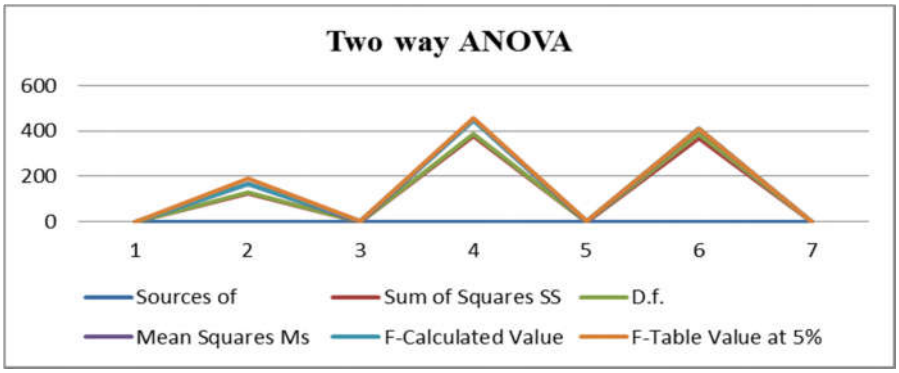


Figure 4. Two Way ANOVA Result Graph

6. Implementation

Table 4 is used to declare all wastewater parameter as a variable in Sql Database. For the SVM

Table 4. Data set for classification (Decision Tree Algorithm)

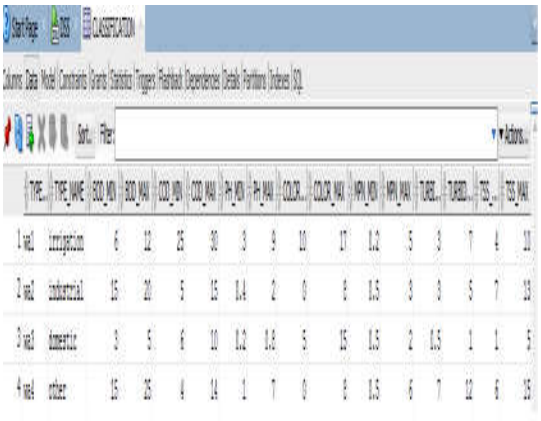
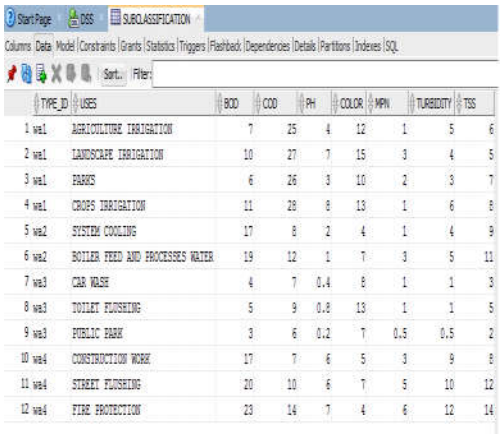
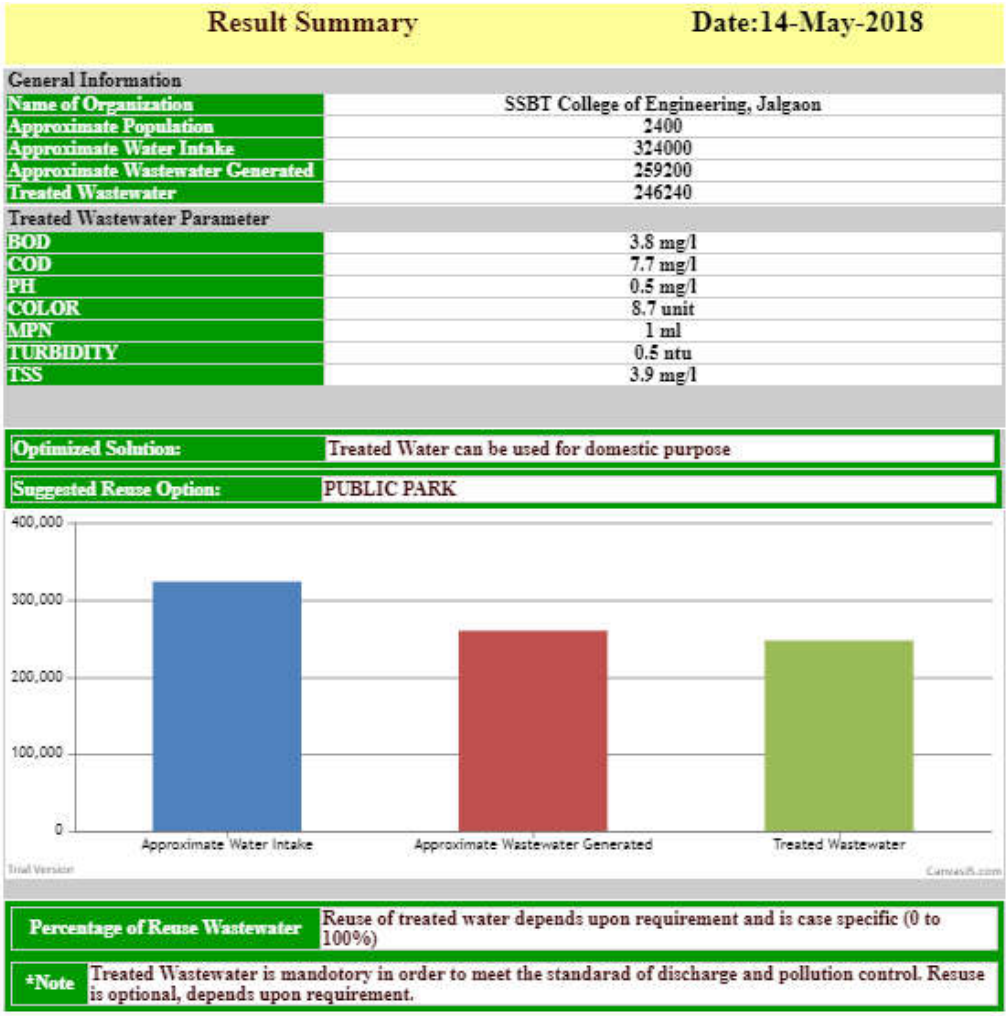


Table 5. Data set for sub-classification (SVM Algorithm)



	TYPE_ID	USES	BOD	COD	PH	COLOR	MPN	TURBIDITY	TSS
1	wa1	AGRICULTURE IRRIGATION	7	25	4	12	1	5	6
2	wa1	LANDSCAPE IRRIGATION	10	27	7	15	3	4	5
3	wa1	PARKS	6	26	3	10	2	3	7
4	wa1	CROPS IRRIGATION	11	28	8	13	1	6	8
5	wa2	SYSTEM COOLING	17	8	2	4	1	4	9
6	wa2	BOILER FEED AND PROCESSES WATER	19	12	1	7	3	5	11
7	wa3	CAR WASH	4	7	0.4	8	1	1	3
8	wa3	TOILET FLUSHING	5	9	0.8	13	1	1	5
9	wa3	PUBLIC PARK	3	6	0.2	7	0.5	0.5	2
10	wa4	CONSTRUCTION WORK	17	7	6	5	3	9	8
11	wa4	STREET FLUSHING	20	10	6	7	5	10	12
12	wa4	FIRE PROTECTION	23	14	7	4	6	12	14

Table: 4& Table 5are used to define the Classification and sub classification model to compare all possibility in Database and show the best optimized solution.



Result Summary **Date:14-May-2018**

General Information	
Name of Organization	SSBT College of Engineering, Jalgaon
Approximate Population	2400
Approximate Water Intake	324000
Approximate Wastewater Generated	259200
Treated Wastewater	246240
Treated Wastewater Parameter	
BOD	3.8 mg/l
COD	7.7 mg/l
PH	0.5 mg/l
COLOR	8.7 unit
MPN	1 ml
TURBIDITY	0.5 ntu
TSS	3.9 mg/l

Optimized Solution:	Treated Water can be used for domestic purpose
Suggested Reuse Option:	PUBLIC PARK

Percentage of Reuse Wastewater	Reuse of treated water depends upon requirement and is case specific (0 to 100%)
*Note	Treated Wastewater is mandotory in order to meet the standarad of discharge and pollution control. Resuse is optional, depends upon requirement.

Figure 5. Result Summery of date 14- May-2018

After the selection of optimize solution system will generate the result summery sheet in which the details of the organization, population, wastewater generated and solution is provided. It will generate datewise. Lastly system stored and provides the datewise report whenever required.

8. CONCLUSION AND FUTURE SCOPE

As reuse is gaining recognition, there's venture for the wastewater reusability additionally. Now a day's plenty of studies work are in boon for such gadget.Various approaches for realizing the application of Water reuse has been undertaken by various researchers across the globe, still leaving a scope of automation in this field specifically grabbing an effective usage of Cloud Computing and Machine learning.

In this research work, developed DSS provide the effective solution for wastewater reuse. As per the given parameter values developed DSS system shows the output graph so that accordingly user can reuse the water for the particular domestic usage.For feasible and effective decision for wastewater reuse, machine learning technique is used. So for effective classification we applied Decision Tree Algorithm and for sub classification we used Support Vector Machine Algorithm.

Machine learning is perfectly determined at its significance level. To maximizes its derivation and significance of these variable(operational parameter of the system), the statistical tool using ANNOVA method is deployed

In future we are able to interface this CBDSSWWM with IOT with a view to guide automation in detection purity degree inside the water and can lead a machine for automatic selection making without guide intervention. This clever gadget will provide on the spot decision to person in which they could reuse the handled wastewater.

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