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The Decision Tree Algorithm Use in Supervised Machine Learning

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Abstract - Machine learning concept is handling the dataset and it is used to analyze the data recently machine learning is highly demanding approach, because of that machine learn itself like human without explicitly programmed it help to make faster decision with this dataset Machine learning is also handle computational data by using various type of algorithms, in this paper only focus the decision tree algorithm that is used in machine learning to take quick decision once analyze the problem. it predicts the output which is much faster.

***Key Words*:** Machine learning, Supervised, Decision Tree, and Regression.

1. INTRODUCTION

Machine learning is the part of Artificial Intelligence.AI is play vary vital role in machine learning. Because of AI we used Algorithm various techniques that is used to very power of our machine the machine has ability to think like human. Take decision in machine learning we can see those various types of algorithms used for the various types of algorithms used for predicts the output. With the base of previous experiences.

There are various categories of machine learning algorithm.

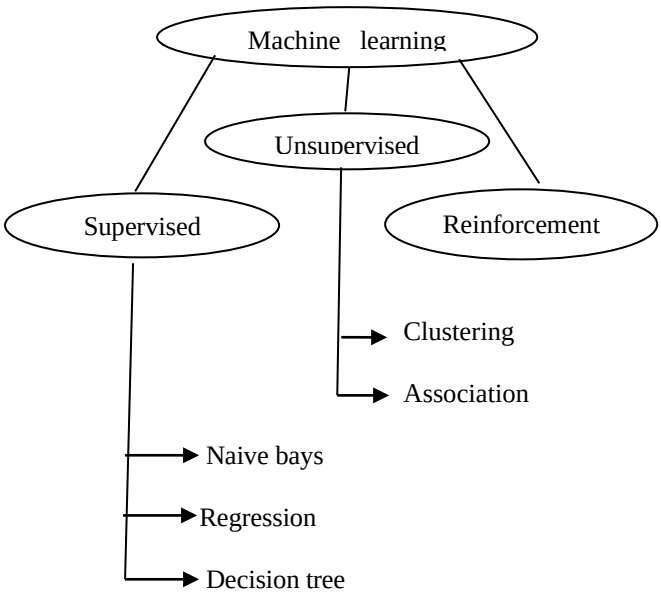


Fig: - Structure of machine learning

1.1. **Supervised Algorithm: -**In this type of algorithm the name says that it comes under the supervision. It is used to train the dataset here only need labeled data at the input side. When we got the predicted output, these techniques mostly used that means algorithm need one supervisor to predicting the output is already known in this type of learning. Supervised Algorithm can also solve regression & classification problems.

e.g.: the number of vehicles here we can predict the output with the help of vehicles name, model, color using classification concept.

1.2. **Unsupervised Algorithm: -** Unsupervised algorithm is the algorithm used unlabeled dataset, that means no sure of accurate output the unsupervised algorithm detects the hidden pattern and predicts the output.

E.g.: there are 25 shapes boxes around and we don't know the idea of regarding the boxes. Because we are not specifying any labeled .it is unlabeled data now what we can do we find the hidden pattern split the boxes four corner boxes group remaining of two corner boxes group make them clustering and after that think labeled are triangle rectangle, square.

1.3. Reinforcement algorithm: -this learn from feedback and what the previous experiences this algorithm is used with the help of past experiences.

2. Types of Supervised Learning Algorithm

2.1 Decision tree: -the decision tree algorithm is coming under the supervised learning algorithm is easy to take decision. As early as possible they have difference branches in these types of algorithms, such as root node, top node.

2.2 Naive bays: - this algorithm comes under classification technique it is independent algorithm based on the bays algorithm it is types of supervised algorithm it is used to quickly predicted the output.

2.3 Regression: -this technique is basically used prediction the analysis of the dependent variable is changing with

the independent variable it is in continuous nature which contains x axis& y axis.

2.4 Support vector machine: - this machine is help to learn internal structure of various and predicted the output.

3. Decision tree Algorithm

the decision tree algorithm types is the supervised learning algorithm technique that comes under the classification to different pattern and take quick decision, with the help of branches .it is as each branches is help to take decision minimum occurrences is there decision tree can be used in classification and regression .which is used to finding the logical condition .and let them classify this is under classification regression can handle the tree branches target value is numeric or continuous in nature it is simple to understand less data is required.

Before move to example following formula is used in decision tree algorithm

A) Information gain: the information gain is used for when the decision tree is divided in sub branches the entropy will change when the attribute is decided.

Information gain used to apply each attribute to find I (Pi, Ni)

Where I: Information
P: it is positive value/high
N: Negative values/low

Alternatively main formula

IG (SA) =H(S)-H (S, A)

Where S: Change in the entropy after deciding particular attribute A

B) Entropy: $H(S) = \sum P(x)\ \mathbf{log\,2}\ \frac{1}{P(x)}$

P(x) – probability of event x
H(s) –Entropy of information gain

Gain=Entropy of class-Entropy of Attribute

4. Example:

The decision tree algorithm is classification & regression now here take one example of loan marketing.

Age	income	Job type	Profit
Old	High	Private	Min
Old	Low	private	Min
Old	Low	government	Min
Mid	High	private	Min
Mid	High	government	Min
Mid	Low	government	Max
Mid	Low	private	Max
New	High	private	Max
New	Low	government	Max
New	Low	private	Max

Above table is the dataset of the loan marketing example having attribute, age, income, job type, profit, here very first think to do decide, target attribute. Is selected it is also called as class attribute and find the possibility of 'yes' & 'no', here the profit is the target attribute, there is the possibility of.

Positive (P)	Negative(N)	Total
5	5	10

Now next step to find entropy of profit

Entropy: $H(S)= \sum P(x)\ \mathbf{log\,2}\ \frac{1}{P(x)}$

$=\frac{-5}{10}\mathbf{log\,2}\left(\frac{5}{10}\right)-\frac{5}{10}\mathbf{log\,2}\left(\frac{5}{10}\right)$

Profit = 1

Next step is to find the entropy of each attribute

Age:

Age	Pi	Ni	I(Pi, Ni)
Old	0	3	0
Mid	2	2	1
New	3	0	0

Here,

Positive		negative	
P1	0	N1	3
P2	2	N2	2
P3	3	N3	0

Find the information gain I(Pi, Ni)

I (P1, N1) $= \frac{-0}{0+3}\log 2(\frac{0}{0+3}) - \frac{3}{0+3}\log 2(\frac{3}{0+3})$

= 0

I (P2, N2) $= \frac{-2}{2+2}\log 2(\frac{2}{2+2})$

= 1

I (P3, N3) $= \frac{-3}{3+0}\log 2\left(\frac{3}{3+0}\right) - \frac{0}{3+0}\log 2(\frac{0}{3+0})$

= 0

Entropy of Age $= \sum \frac{Pi+Ni}{P+N} I(Pi, Ni)$

$= \frac{0+3}{5+5}(0) + \frac{2+2}{5+5}(1) + \frac{3+0}{5+5}(0)$

$Age_{E=0.4}$

Gain=class entropy-entropy of age

Gain=class entropy-entropy of age
1-0.4

gain=0.6

Income:

income	Pi	Ni	I(Pi, Ni)
High	1	3	0.811
Low	4	2	0.4282

I (P1, N1) $= \frac{-1}{1+3}\log 2\left(\frac{1}{1+3}\right) - \frac{3}{1+3}\log 2(\frac{3}{1+3})$

=0.811

I (P2, N2) $= \frac{-4}{4+2}\log 2\left(\frac{4}{4+2}\right) - \frac{2}{4+2}\log 2(\frac{2}{4+2})$

=0.4282

Entropy of income

$= \frac{1+3}{10}(0.811) + \frac{4+2}{10}(0.428)$

$Income_E$=0.5812

Gain= 1-0.5812

Gain=0.4188

Job Type:

Job Type	Pi	Ni	I(PiNi)
Private	3	3	1
government	2	2	1

$= \frac{-3}{6}\log 2\left(\frac{3}{6}\right) - \frac{3}{6}\log 2(\frac{3}{6})$

I (P1, N1) = 1

$\mathbf{I(P2N2)} = \frac{-2}{4}\log 2\left(\frac{2}{4}\right) - \frac{2}{4}\log 2(\frac{2}{4})$

I(P2, N2)=1

Entropy of type

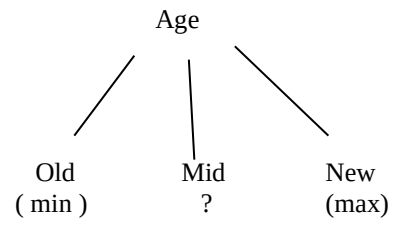
$= \frac{3+3}{10}(1) + \frac{2+2}{10}(1)$

$Type_E = 1$

Gain= 1-1
=0

Now the information gain of all Attributes is

Age	0.6
Income	0.58
type	0



age	Profit
New	Max
New	Max
New	Max

age	Profit
old	Min
Old	Min
Old	min

Same Same

now only mid case two values are min and two values are maximum so, again same the Mid part are also calculated

Age	income	Job types	profit
mid	high	private	min
mid	high	government	min
mid	low	government	max
mid	low	private	max

Positive(N)	Negative(N)	total
2	2	4

$$= \frac{-2}{4}\log 2\left(\frac{2}{4}\right) - \frac{2}{4}\log 2\left(\frac{2}{4}\right)$$

Entropy=1

income	Pi	Ni	I(Pi,Ni)
High	0	2	0
high	2	0	0

$$\mathbf{I(P1N1)} = \frac{\mathbf{0}}{\mathbf{0+2}}\log 2\left(\frac{\mathbf{0}}{\mathbf{0+2}}\right) - \frac{\mathbf{2}}{\mathbf{0+2}}\log 2\left(\frac{\mathbf{2}}{\mathbf{0+2}}\right)$$

$$\boxed{\mathbf{I(P1N1) = 0}}$$

$$\mathbf{I(P1N1)} = \frac{\mathbf{2}}{\mathbf{2+0}}\log 2\left(\frac{\mathbf{2}}{\mathbf{2+0}}\right) - \frac{\mathbf{0}}{\mathbf{2+0}}\log 2\left(\frac{\mathbf{0}}{\mathbf{2+0}}\right)$$

$$\boxed{\mathbf{I(P2N2) = 0}}$$

Entropy = $\frac{\mathbf{0+2}}{\mathbf{4}}(\mathbf{0}) + \frac{\mathbf{2+0}}{\mathbf{4}}(\mathbf{0}) = 0$

Gain = 1 – 0 = 1

Job type	Pi	Ni	I(Pi,Ni)
private	1	1	1
Government	1	1	1

$$\mathbf{I(P1N1)} = \frac{-\mathbf{1}}{\mathbf{2}}\log 2\left(\frac{\mathbf{1}}{\mathbf{2}}\right) - \frac{\mathbf{1}}{\mathbf{2}}\log 2\left(\frac{\mathbf{1}}{\mathbf{2}}\right)$$

= 1

$$\mathbf{I(P2N2)} = \frac{-\mathbf{1}}{\mathbf{2}}\log 2\left(\frac{\mathbf{1}}{\mathbf{2}}\right) - \frac{\mathbf{1}}{\mathbf{2}}\log 2\left(\frac{\mathbf{1}}{\mathbf{2}}\right)$$

= 1

Entropy = $\frac{\mathbf{1+1}}{\mathbf{4}}(\mathbf{1}) + \frac{\mathbf{1+1}}{\mathbf{4}}(\mathbf{1})$

= 1

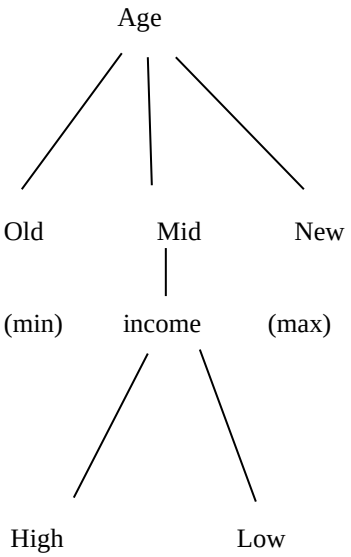
Gain=1-1

=0

Information gain :

income	**1**
job	**0**

There for the income is the root node



income	Profit
High	Min
High	Min

income	Profit
Low	Max
Low	Max

Same Same

5. Conclusion: - The decision tree algorithms are used for the supervised machine learning according to the analysis. It is easier to predicated. It is used in classifications and regression the decision tree have simple to understand their accuracy is 99% using this algorithm

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