International Journal of Technology Research and Management
ISSN (Online): 2348-9006
Vol 5 Issue 3 March 2018

A Predictive Analytical Model in Education Scenario based on Critical Thinking using WEKA

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Abstract: *Critical thinking has been a controversial issue among philosophers, researchers and educationalists, although there is no general consensus on a definition. Everyone thinks; it is our nature to do so. But much of our thinking, left to it-self, is biased, distorted, partial, uninformed or down-right prejudiced. Yet the quality of our life and that of what we produce, make, or build depends precisely on the quality of our thought. Excellence in thought, however, must be systematically cultivated. Critical thinking is that mode of thinking - about any subject, content, or problem - in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them. Critical thinking is not a matter of accumulating information. A person with a good memory and who knows a lot of facts is not necessarily good at critical thinking. A critical thinker is able to deduce consequences from what he/she knows, and he/she knows how to make use of information to solve problems, and to seek relevant sources of information to inform himself / herself. Critical thinking should not be confused with being argumentative or being critical of other people. Although critical thinking skills can be used in exposing fallacies and bad reasoning, critical thinking can also play an important role in cooperative reasoning and constructive tasks. Critical thinking can help us acquire knowledge, improve our theories, and strengthen arguments. It is self-guided, self-disciplined thinking which attempts to reason at the highest level of quality in a fair-minded way.*

Keywords: *CT, behavior, LT, sociocentrism, assumptions, information.*

1. INTRODUCTION

Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. Critical thinking can be seen as having two components:

1) A set of information and belief generating and processing skills, and

2) The habit, based on intellectual commitment, of using those skills to guide behavior.

Someone with critical thinking skills is able to do the following:

- Understand the logical connections between ideas
- Identify, construct and evaluate arguments
- Detect inconsistencies and common mistakes in reasoning
- Solve problems systematically
- Identify the relevance and importance of ideas
- Reflect on the justification of one's own beliefs and values.

Critical thinking can help us acquire knowledge, improve our theories, and strengthen arguments. Critical thinking of any kind is never universal in any individual; everyone is subject to episodes of undisciplined or irrational thought. Its quality is therefore typically a matter of degree and dependent on, among other things, the quality and depth of experience in a given domain of thinking or with respect to a particular class of questions. People who think critically consistently attempt to live rationally, reasonably, empathically. They are keenly aware of the inherently flawed

nature of human thinking when left unchecked. They use the intellectual tools that critical thinking offers – concepts and principles that enable them to analyze, assess, and improve thinking. They work diligently to develop the intellectual virtues of intellectual integrity, intellectual humility, intellectual civility, intellectual empathy, intellectual sense of justice and confidence in reason. They realize that no matter how skilled they are as thinkers, they can always improve their reasoning abilities and they will at times fall prey to mistakes in reasoning, human irrationality, prejudices, biases, distortions, uncritically accepted social rules and taboos, self-interest, and vested interest. They strive to improve the world in whatever ways they can and contribute to a more rational, civilized society. At the same time, they recognize the complexities often inherent in doing so. They avoid thinking simplistically about complicated issues and strive to appropriately consider the rights and needs of relevant others. They recognize the complexities in developing as thinkers, and commit themselves to life-long practice toward self-improvement. A well cultivated critical thinker:

- Raises vital questions and problems, formulating them clearly and precisely;
- Gathers and assesses relevant information, using abstract ideas to interpret it effectively comes to well-reasoned Conclusions and solutions, testing them against relevant criteria and standards;
- Thinks open mindedly within alternative systems of thought, recognizing and assessing, as need be, their assumptions, implications, and practical consequences;
- Communicates effectively with others in figuring out solutions to complex problems.

Critical thinking is, in short, self-directed, self-disciplined, self-monitored, and self-corrective thinking. It presupposes assent to rigorous standards of excellence and mindful command of their use. It entails effective communication and problem solving abilities and a commitment to overcome our native egocentrism and sociocentrism. We can use critical thinking to enhance work processes and improve social institutions.

2. THE IMPORTANCE OF CRITICAL THINKING

Critical Thinking is a meta-thinking skill. It requires careful reflection on the good principles of reasoning, making a conscious effort to internalize them and applying them in daily life.

1. Critical thinking is a domain-general thinking skill: The ability to think clearly and rationally is important whatever we choose to do. If work in education, research, finance, management or the legal profession, then critical thinking is obviously important. But critical thinking skills are not restricted to a particular subject area. Being able to think well and solve problems systematically is an asset for any career.
2. Critical thinking is very important in the new knowledge economy: The global knowledge economy is driven by information and technology. One has to be able to deal with changes quickly and effectively. The new economy places increasing demands on flexible intellectual skills, and the ability to analyze information and integrate diverse sources of knowledge in solving problems. Good critical thinking promotes such thinking skills, and is very important in the fast-changing workplace.
3. Critical thinking enhances language and presentation skills: Thinking clearly and systematically can improve the way we express our ideas. In learning how to analyze the logical structure of texts, critical thinking also improves comprehension abilities.
4. Critical thinking promotes creativity: To come up with a creative solution to a problem involves not just having new ideas. It must also be the case that the new ideas being generated are useful and relevant to the task at hand. Critical thinking plays a crucial role in evaluating new ideas, selecting the best ones and modifying them if necessary
5. Critical thinking is crucial for self-reflection: In order to live a meaningful life and to structure our lives accordingly, we need to justify and reflect on our values and decisions. Critical thinking provides the tools for this process of self-evaluation.
6. Good critical thinking is the foundation of science and democracy: Science requires the critical use of reason in experimentation and theory confirmation. The proper functioning of a liberal democracy requires citizens who can think critically about social issues to inform their judgments about proper governance and to overcome biases and prejudice.

This prime intellectual and practical skill seems to be something that majority of students coming into higher education and the workforce are not only lacking in application, but also in concept. Often, Critical Thinking has been overlooked at the elementary, middle, and high school levels where the primary focus is on rote learning of concepts rather than skillful application of ideas. When these students make it to the level of higher education or the corporate workforce, the educators/trainers are compelled to begin by

teaching the basics of Critical Thinking as opposed to sharing complex information that need analysis. Learning requires effort, but Critical Thinking requires maximum exertion of intellectual capacity. Hence, much of the Critical Thinking concept remains not only to be taught but; most importantly, to be aptly utilized in our day-to-day lives. There are a few reasons to introduce Critical Thinking in Higher Education-Campus Curriculum:

i. Logical Thinking and Problem Solving is an asset across careers: Critical Thinking is a domain-agnostic skill. Irrespective of whether one chooses to work in the field of education, research, finance, management or a legal profession, Critical Thinking is indispensable. Critical Thinking is not isolated but a seminal goal, the hub around which all other educational fields converge. As students learn to think more critically, they become more proficient at historical, scientific, and mathematical thinking. They develop skills, abilities and values critical for success in everyday life.
ii. It is what is required in today's times – Today in the internet era, access to reading material is not a privilege of those few enrolled in select institutions. Hence it is the disposition to enquiry and ability to think critically that is the real requirement of the current times.
iii. CT enhances language and presentation skills: Thinking in a structured manner can improve the way in which we express our ideas. In learning how to analyze the logical structure of texts, Critical Thinking improves comprehension abilities. It is the soul of effective communication.
iv. Critical Thinking also promotes creativity: Creative problem-solving mandates the generation of feasible and relevant ideas. Critical Thinking plays a crucial role in evaluating new ideas, selecting the best ones and improvising on them, as required. Creativity and Critical thinking go hand-in-hand.

It's not 'what' to think rather 'how' to think. It includes the ability to engage in independent, reflective thinking. A critical thinker should be able to do the following with ease:

a. Identify the relevance and importance of ideas
b. Understand the logical connections and establish linkages between ideas
c. Identify, construct and evaluate arguments
d. Detect inconsistencies and common mistakes (fallacies) in reasoning
e. Solve problems systematically
f. Reflect on the accuracy of one's own beliefs and values

A Critical Thinker is NOT neither an information hoarder who knows how to utilize information wisely to solve problems nor Critical of others. Although Critical Thinking skills can be used in exposing fallacies/bad reasoning, it facilitates cooperative and constructive reasoning.

3. PREFACE OF THE WORK

Critical Thinking Ability forms a very important part of our aptitude. There are many skills that are required for a student to develop into an efficient individual. For many competitive exams, these skills are used to find out the best candidates. Proficiency in written and verbal communication in languages, general knowledge, interpretation of data, logical ability and critical thinking skills. These play vital role in securing seats in various government exams for jobs and for acquiring seats in colleges by entrance exams. These exams usually check the aptitude of the applicant. Here is mentioned objective:

- To propose some changes in higher education sector in India through analytical process of critical thinking.

4. NATIONAL INSTITUTE RANKING FRAMEWORK

The National Institutional Ranking Framework (NIRF) was approved by the MHRD and launched by Honourable Minister of Human Resource Development on 29th September 2015. This framework outlines a methodology to rank institutions across the country. The methodology draws from the overall recommendations broad understanding arrived at by a Core Committee set up by MHRD, to identify the broad parameters for ranking various universities and institutions. The parameters broadly cover "Teaching, Learning and Resources," "Research and Professional Practices," "Graduation Outcomes," "Outreach and Inclusivity," and "Perception". The silent features of NIRF are:

1. Methodology is based on developing a set of metrics for ranking of academic institutions, based on the parameters agreed upon by the core committee.
2. These parameters are organized into five broad heads, and have been further elaborated into suitable sub-heads. Each broad head has an overall weight assigned to it. Within each head, the various sub-heads also have an appropriate weight distribution.
3. An attempt is also made to identify the relevant data needed to suitably measure the performance score under each sub-head. Emphasis here is on identifying data that the institution can easily provide or is easy to obtain from third party sources and easily verifiable,

where verification is needed. This is important in the interest of transparency.

4. A suitable metric is then proposed based on this data, which computes a score under each sub-head. The sub-head scores are then added to obtain scores for each individual head. The overall score is computed based on the weights allotted to each head. The overall score can take a maximum value of 100.
5. The institutions can then be rank-ordered based on their scores.

5. METHODOLOGY

Here we have taken some major parameters based on which the dataset has been created. Areas are NIRF ranking, Academic area, Library, Infrastructure, Faculty, Graduate students, Placements, Examination. Here it has been mentioned that Grade has been taken as class attributes.

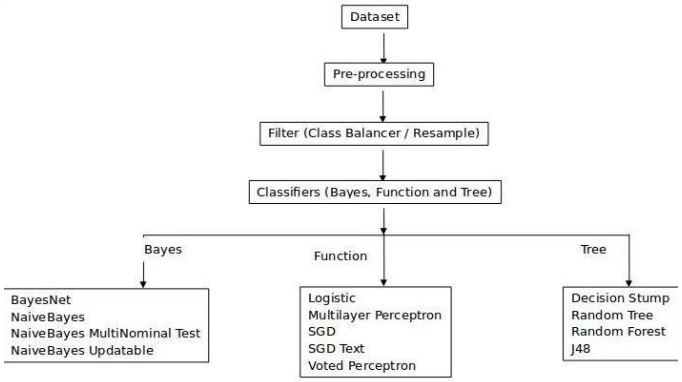

Fig 1: Methodology

Class-Balancer: It re-weights instances in datasets so that each class has the same total weight whose summation across all instances will be maintained. Only the weights in the first data batch received by this filter are changed, so it may be used with the Filtered Classifier. If the class is numeric, it is discredited using equal-width discretization to establish pseudo classes for weighting.

Naive Bayes classifier: This algorithm is a probabilistic classifier. It is based on probability models that incorporate strong independence assumptions. A Naive Bayes model consists of a large cube that includes the following dimensions:

a) Input field name
b) Input field value for discrete fields, or input field value range for continuous fields. Continuous fields are divided into discrete bins by the Naive Bayes algorithm
c) Target field value

This means that a Naive Bayes model records how often a target field value appears together with a value of an input field.

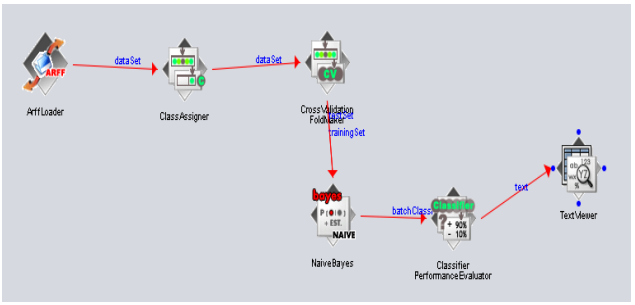

Fig 2: Knowledge Flow for Bayes classifier

Function Classifier: Perceptron consists of weights (including bias), the summation processor and activation funtion. A perceptron takes a weighted sum of inputs and outputs:

1 if the sum > some adjustable threshold value (θ)
0 otherwise

W1X1+W2 X2+…+W nXn> θ output will be 1
W1X1+W2 X2+…+W nXn≤ θ output will be 0

The inputs and connection weights are typically real values. The input values are presented to the perceptron and if the predicted output is the same as the desired output, the performance is considered satisfactory and no changes to the weights are made. However, if the output does not match the desired output, then the weights needs to be changed to reduce the errors.

A multilayer perceptron has a same structure of a single layer perceptron with one or more hidden layer.

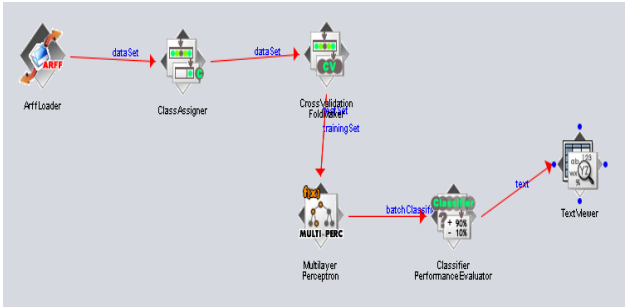

Fig 3: Knowledge Flow for Multilayer Perceptron

Tree Classifier: A decision stump is a machine learning model consisting of a one-level decision tree. That is, it is a decision tree with one internal node (the root) which is immediately connected to the terminal nodes (its leaves). A decision stump makes a prediction based on the value of just a single input feature. Sometimes they are also called 1-rules. For nominal features, one may build a stump which contains a leaf for each possible feature value or a stump with the two leaves, one of which corresponds to some chosen category, and the other leaf to all the other categories. For binary features these two schemes are identical. A missing value may be treated as a yet another category. For continuous features, usually, some threshold feature value is selected, and the stump contains two leaves — for values below and above the threshold. However, rarely, multiple thresholds may be chosen and the stump therefore contains three or more leaves. Decision stumps are often used as components (called "weak learners" or "base learners") in machine learning ensemble techniques such as bagging and boosting.

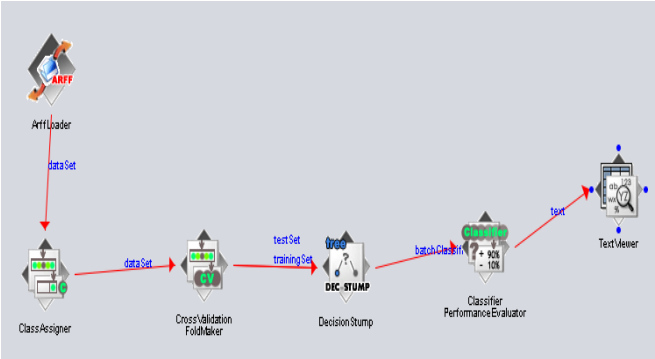

Fig 4: Knowledge Flow for Decision Stump

Resample:"Re-sampling" means combining interpolation and decimation to change the rate of sampling by a rational factor. It is usually done to interface two systems which have different sampling rates. If the ratio of two system's rates happens to be an integer, decimation or interpolation can be used to change the sampling rate (depending on whether the rate is being decreased or increased); otherwise, interpolation and decimation must be used together to change the rate.

6. RESULTS AND ANALYSIS

Here, we have taken two results: one is for class balancer and another one is for re-sample. When class balancer is used at that time Bayesian, Function and Tree classifiers has been used accordingly. These are the results for class balancer based on 2017 NIRF datasets. Now following table shows the comparative analysis of best accuracy given by the algorithms in Bayes, Function and Tree classifiers.

Table 1: Results against Bayes Classifier

Classifiers	Accuracy	Recall/sensitivity (%)	Specificity (%)	Precision (%)
BayesNet	47.199005	38.99502	59.4	48.99
NaiveBayes	69.781095	100	43.56	63.92
NaiveBayes MultiNominal Text	47.552239	10	89.1	47.86
NaiveBayes Updateable	69.781095	100	43.56	63.92

Table 2: Results against Function Classifier

Classifiers	Accuracy	Recall/sensitivity (%)	Specificity (%)	Precision (%)
MultiLayer Perceptron	85.049751	84	90.1	89.46
Logistics	39.291478	41.0009	41.58	41.24
SGD	35.341426	43.0007	31.68	38.63
SGDText	47.552239	10	89.1	47.86
SimpleLogistic	45.328358	60	34.66	47.87
SMO	38.321377	45.0005	35.64	41.15
VotedPerception	49.70887	45.0005	58.42	51.98

Table 3: Results against Tree Classifier

Classifier	Accuracy	Recall/sensitivity (%)	Specificity (%)	Precision (%)
Decision Stump	98	100	100	100
Hoeffding Tree	69.288557	100	42.58	63.52
J48	55.338308	82	32.68	54.91
LMT	96.502413	97.00468	100	100
Random Forest	55.248756	64	50.5	56.39
Random Tree	59.238806	70	52.48	59.56
Reptree	48.880597	78	23.76	50.57

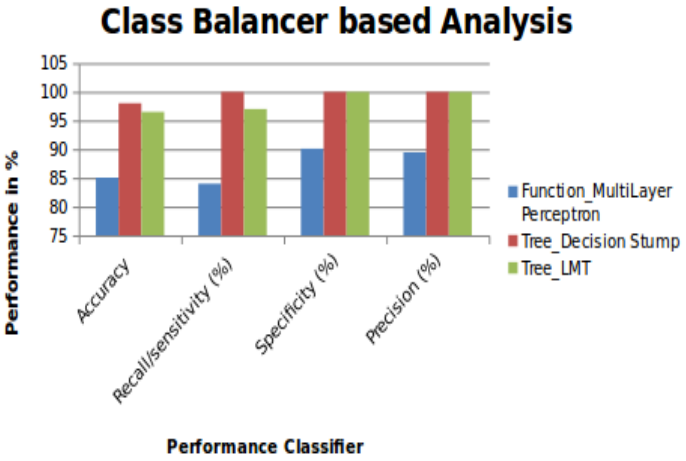

Fig 5: Performance analysis based on class balancer

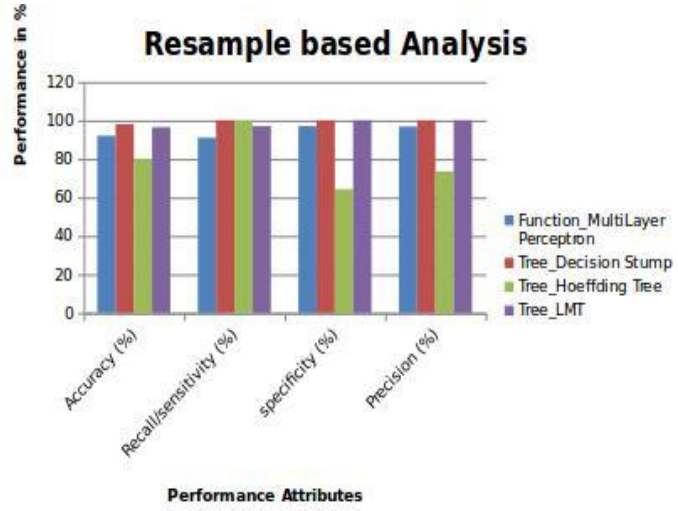

Fig 6: Performance analysis based on resamples

7. CONCLUSION

These results examined that for class balancer decision stump algorithm under tree classifier is giving better accuracy than others. And when re-sample is used decision stump algorithm under tree classifier is giving better accuracy than others. So when any new university come into higher studies they must be ranked by NIRF. Before applying to be ranked universities will use such predictive model to examine whether they will achieve a good rank or not. By virtue of this, students may be facilitated with a good NIRF ranked university for their valuable career and can generate innovative ideas that will help in their future research work. This approach has to be implemented in a software module.

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