Algorithm for Automatic Evaluation of Single Sentence Descriptive Answer

Amarjeet Kaur, M Sasikumar, Shikha Nema, Sanjay Pawar

Abstract*—— Automation of descriptive answer evaluation process would be helpful for various universities and academic institution to efficiently handle the assessment of exam answer sheets of learners/students. Our objective is to design an algorithm for the automatic evaluation of single sentence descriptive answer. The paper presents an approach to check the degree of learning of the student/learner, by evaluating their descriptive exam answer sheets. By representing the descriptive answer in the form of graph and comparing it with standard answer are the key steps in our approach.

***Index Terms*— Descriptive answer, graphical representation, similarity measures, subjective evaluation, word Net**

I. INTRODUCTION

The purpose of providing education is to make learner learn a specific topic or domain, so that the learner is able to apply those knowledge and information in the practical field. This can be possible only if the learner is able to grasp it properly. So, its important to evaluate *how much knowledge has been absorbed by the learner?* For this, one has to find out the *degree of learning* of a learner by conducting some written test of specific pattern which may include descriptive/objective questions or through some practical examination and evaluating it to find the degree of learning. Evaluation of objective answer is comparatively easy and well supported in many systems but, in the case of descriptive answer, it is an open problem.

Evaluation work is very cumbersome as far as descriptive answer is concerned. So, how to automate this task? Our objective is to design an algorithm for the automation of evaluation process of single sentence descriptive answer.

Motivation behind automation of descriptive answer evaluation includes fast processing, less manpower, independent of change in psychology of human assessor, ease in record keeping and extraction. It also ensures uniform evaluation irrespective of any mood swings or change in perspective of human assessor.

In this paper, we have considered only text in single sentence descriptive answer which are grammatically correct and with no spelling mistakes. Our approach is to represent learners and standard answer in the form of graph and then comparing it, by applying some of the similarity measures for the allocation of marks.

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II. RELATED WORK

Many architectures and features have been proposed for descriptive answer evaluation. The approaches are mainly based on keyword matching, sequence matching and quantitative analysis [4], but semantic analysis of descriptive answer is still an open problem. Considering the general structure of text analysis in natural language processing, most of the work has been done for morphological and syntactic analysis [2], [3], [7], [8], but semantic, pragmatic and discourse are still being explored.

Online tools that support managing of online assessments such as Moodle and Zoho are based on string matching technique for short answers but long answer evaluation is still handled manually by most systems [7],[8].

Features which are available currently in online assessment are [7], [8]:

- Question paper setting
- Online Evaluation of objective type questions
- Question bank editor
- Spell checker
- Grammar checker
- Report generation of result

Descriptive answer evaluation is still an open problem.

III. PROPOSED APPROACH

The approach used for the development of the algorithm is to match learner's single sentence answer with the standard single sentence answer by converting both answers into a graphical form and then matching their nodes and labels is an intelligent way.

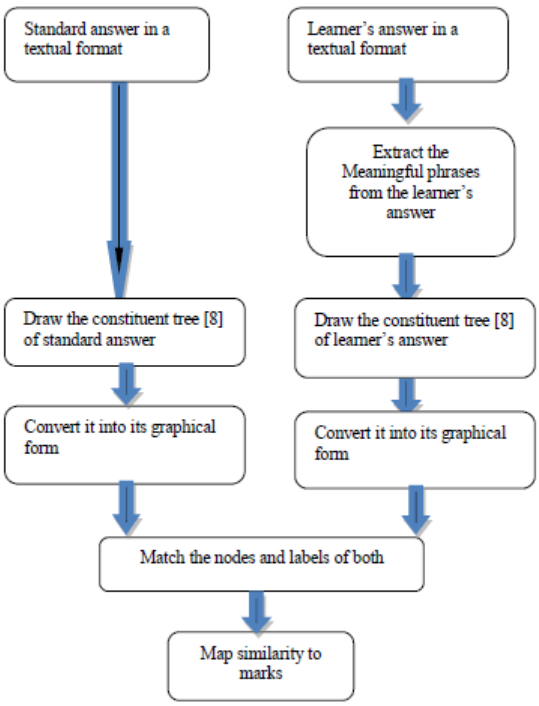


Fig. 1, The Broad Approach

i. The Graph Representation:

In the proposed approach, we have considered the graphical representation of descriptive answer to present complex information clearly and to represent knowledge in a machine interpretable form.
Any descriptive answer consists of set of phrases/words, where the noun phrases (NP), adjective phrases (ADJP), adverb phrases (ADVP) are considered as nodes of the graph and prepositional phrases (PP), verb phrases (VP), conjunctions, and disjunctions etc. as labels of the graph.
Let's consider one example,

Question: What is distributed computing system?

a. Answer in textual form: A distributed computing system is a collection of independent computers linked by a computer network that appear to the users of the system as a single coherent system.

b. Graphical form of textual answer:

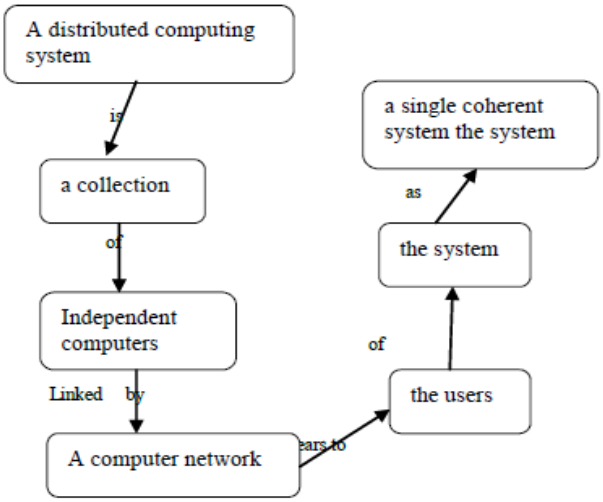


Fig. 2, The Graph Representation of Textual Answer

ii. Similarity Matching:

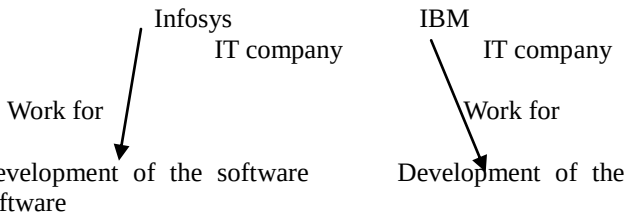
After converting the teacher's answer and student's answer into its graphical form, we will match the similarity between both the answers by applying some of the similarity measures to the nodes and labels of the graph. Similarity matching between the nodes of teacher and student graph through a number of matching features gives the similarity score between them. The similarity score will gives us the parameter to judge or evaluate the degree of correctness of nodes and labels in the student graph.
Some of the similarity measures are as follows:

1. String match:
   a) Partial string match
      i. Abbreviation
      ii. Case change
      iii. Morphological change
      iv. Tense change
      v. Change in Word category
      vi. Part of string
   b) Full string match
2. WordNET:
   i.Similar_to
   ii.Is_apart_of
   iii.Attribute_of
   iv.Is_aform_of
   v.Subset_of or Superset_of or Derived_from
   vi.Is_value_of
   vii.Is_astate_of_being
   viii.Pertains_to orbe_relevant _to
   ix.Purpose_of or Is_used_for
   x.Is_involved_in
   xi.Opposite_of

3. Spreading Process:
Go to the next level of current unmatched node i.e the successor and predecessor of it and again apply the string match and wordNet similarity measures for finding out the similarity match between the current unmatched teacher's node and student's node in the graph.
Example: MATCH "Infosys" with "IBM"

Apply Various Similarity Measures:

1) No String Match
2) WordNet: No match
3) Spreading process:



YES, now we can say that both are "Semantically Similar".

iii. Similarity Score:

i. Table no. 1, String Match

Sno.	Type of similarity measure	Points to be given
1	Full string match	1
	Partial string match	{0.9-0.1}
	•Part of string {0.9-0.1 }	{0.9-0.1}
	•Case change	0.9
	•Morphological change	0.8
	•Tense change	0.7
	•Word category	0.6
	•Abbreviation	0.5

ii. Table no. 2, WordNet

Type of similarity	Point to be given	Path length =1	=2	=3	=4	=5	=6	=7	=8	=9	>9
Similar to	0.9	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
Is_aform of	0.8	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0	0.0
Attribute of	0.7	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0
Subset of or supers-etof or derived from	0.6	0.6	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0
Purpose of or Is used	0.5	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0
Is value of	0.4	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Is a state of being	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pertains to or be relevant _to or involved _in	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Is_apartof	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opposite of	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

iii. Table no. 3, Spreading Process

Type of Similarity Measure	Points to be given	Similarity Measure	
		String Match	Word Net
Spreading process	{0.9-0.1}	refer Table no. 1	refer Table no. 2
Level 1 =1	0.9		
2	0.8		
3	0.7		
4	0.6		
5	0.5		
6	0.4		
7	0.3		
8	0.2		
9	0.1		
Level number >9 or level number> root node level	0		

IV. ALGORITHM GENERATION

Let's consider,

Teacher graph: t € {t1, t2, t3……tn}
Lt € {Lt1, Lt2, Lt3……Ltm}

Student graph: s € {s1, s2, s3……sn}
Ls € {Ls1, Ls2, Ls3……Lsm}

Where n is the total number of nodes and m is the total number of labels in the graph.

1. Draw the Constituent Tree [6] of standard/teacher's answer and student's/Learner's answer.
2. Give the graph representation of teacher's/standard answer and student's/learner answer.
3. Match the nodes and labels of the teacher's and student's graph.

/* Assuming, five nodes in teacher's tree and four nodes in student's tree and four labels in teacher's tree and three labels in students tree. */

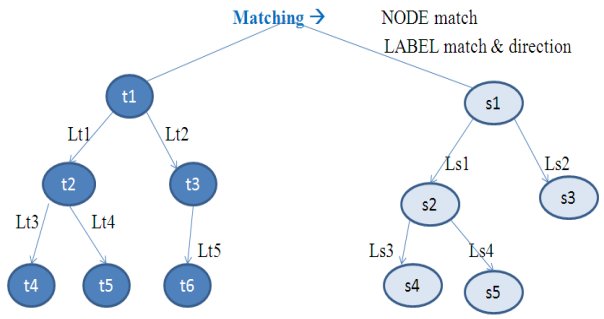


Fig. 3(a), Standard answer Fig. 3(b), learner Answer

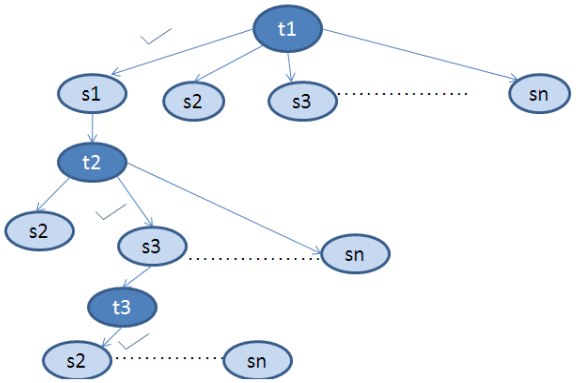


Fig. 3(c), Match graph

4. Create MATCH table:

Table no. 4, MATCH table

ti	sj	Ls_{j-1}	Lt_{i-1}	Ls_{j+1}	Lt_{i+1}	Match or not ?	Reason
t1	s1	Ls0	Lt0	Ls2	Lt2	N	Various similarity measures
	s2	Ls1	Lt0	Ls3	Lt2	N	
	s3	Ls2	Lt0	Ls4	Lt2	Y	
t2	s1	Ls0	Lt1	Ls2	Lt3	N	
	s2	Ls1	Lt1	Ls3	Lt3	Y	
t3	s1	Ls0	Lt2	Ls2	Lt4	Y	

5. Find out the similarity score:

If { { DO(sj)=DO(ti) }= =TRUE }
// Domain Ontology (DO)

THEN refer table 1, 2, 3
If ti=sj
return the similarity score between {1.0-0.1},

else
return 0.0
else
return 0.0

6. Map similarity to marks obtained:
Marks obtained:
⇨ (Total marks allocated/ n) x similarity score
Where n -> total number of nodes in teacher's graph
7. Repeat the step 5 and step 6 untill, Number of iteration <= total number of nodes in a teacher graph.
8. Total marks obtained= sum of marks obtained for each node of the student graph
9. Return the value of Total marks obtained.
10. EXIT

V. RESULT

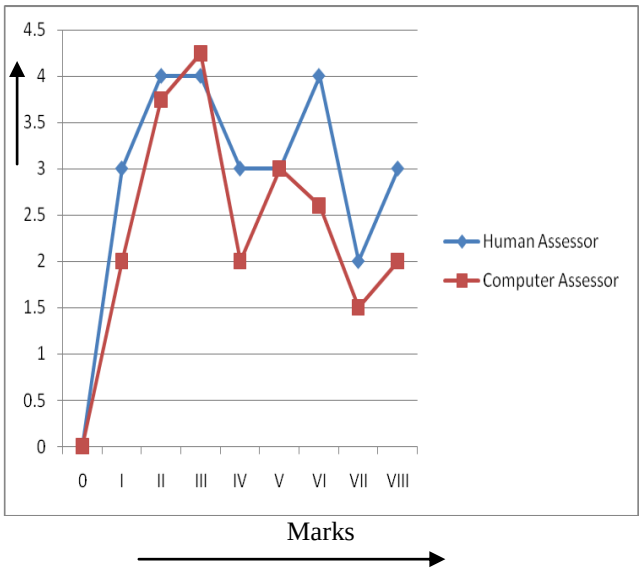


Fig. 4, Results after implementation of the algorithm

VI. CONCLUSION

The learner's descriptive answer and standard answer is converted into its graphical form and then, to apply some of the similarity measures such as string match, wordNet and spreading process for the calculation of similarity score are the major steps in the proposed algorithm. The algorithm provides a solution for the automation of descriptive answer evaluation process. Automatic evaluation of single sentence descriptive answer would be beneficial for the universities, schools and colleges for academic purpose by providing ease to faculties and the examination evaluation cell.

VII. FURTHER WORK

More analysis would be required for similarity matching. Derive a method to check the domain ontology of two phrases .Find out an appropriate technique to minimize the gap between human and computer assessor. Upgrade the algorithm for the evaluation of multiple sentences answer.

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