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Tynia Yang

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Clustered and Sorting Responses to Short Answers in Electronic Quiz

Abstract: A teacher can generate an electronic quiz with questions and model answers. Students will type or otherwise enter free-form responses to the questions. A computing system will cluster similar responses together, and sort the responses based on similarity to the model answer. The computing system will present the sorted responses to the teacher, and the teacher will enter scores for the responses. When subsequent teachers generate electronic quizzes with the same questions, the computing system can use scores entered by previous teachers to rank the responses provided by subsequent students.

Quizzes with free-form, open-ended answers can be difficult to grade electronically because students’ answers may not exactly match a model answer, yet still be considered correct. For example, an answer may be misspelled, use a different form of a name, and/or describe the same fact or event differently. Requiring teachers to enter all possible correct answers would be both tedious and ineffective, because it is unlikely that the teachers would be able to generate an exhaustive list of all possible correct answers.

To assist a teacher in grading a large number of quizzes, the computing system clusters similar responses and/or answers to questions, ranks the responses, presents the ranked responses to the teacher, and receives scores for the responses from the teacher. Grading responses to a single question at a time for all of the students can increase the teacher’s consistency in assigning scores for answers.

FIG. 1 is a flowchart for creating and scoring a quiz. The teacher creates the quiz (102). The teacher creates the quiz by entering questions and model answers into a teacher computing device. The teacher computing device into which the teacher enters questions and model answers can be a desktop computer, a laptop or notebook computer, a thin client, a tablet computer, or a smartphone, for example. In an example of a history quiz, a question could be, “Who was the First Lady between 1961 and 1963?,” and the model answer and/or canonical correct answer could be, “Jacqueline Kennedy.” The teacher computing device can send the questions and model answers to an intermediary server.
The computing system, which includes the teacher computing device, the intermediary server, and multiple student computing devices, sends the quiz to the students (104). The students can receive the quiz on student computing devices such as desktop computers, laptop or notebook computers, thin clients, tablet computers, or smartphones. The quiz can be sent to the student computing devices via a network such as a Local Area Network (LAN) including Institute of Electrical and Electronics Engineers (IEEE) 802.3 (Ethernet), a Wireless LAN (WLAN) including IEEE 802.11 (Wireless Fidelity or WiFi), or the Internet.

The computing system can receive responses from the students (106). The computing system can receive the responses by the students typing answers into hard keyboards or soft keyboards on their respective student computing devices. In an example in which a question is, “Who was the First Lady between 1961 and 1963?,” the students could type answers such as, “Jacqueline Kennedy,” “Jacueline Kennedy” (a misspelling of “Jacqueline Kennedy”), “Jackie Kennedy,” “Jacqueline Kennedy Onassis,” “Jackie Onassis,” “JFK,” “Eleanor Roosevelt,” and “?” or blank for students who do not answer the question. The student computing devices can send the student responses to the intermediary server.

The intermediary server can sort the responses (108). Sorting responses can include the intermediary server clustering similar responses. Responses can be clustered based on heuristic similarity measures such as textual distance (such as Levenshtein distance) from the model answer and/or canonically correct answer, or based on machine learning techniques determining how related the answers are to a similar entity (which may be the entity referred to by the model answer or other entities that the students may incorrectly refer to), so that the teacher will be able to view similar answers together. The machine learning techniques and/or algorithms can estimate similarity such as correcting mistakes in typing, whether the answers are related to a
same entity, or whether the answers map to a same entity. The heuristics can include ignoring
capitalization, ignoring whitespace, or textual distance. In an example implementation, the
heuristics of which types of typographical errors to ignore can be selected by the teacher via a
user interface presented by the teacher computing device.

Sorting the responses can also include the intermediary server ranking the clustered
responses by determining similarities of the clustered responses to the model answers, and/or
estimating a likelihood of correctness of the clustered responses based on the model answers.
The clustered responses can be sorted based on a combination of machine learning techniques
and heuristics. The clustered responses can be sorted in descending order based on similarity to
the model answer and/or likelihood of correctness. The clustered responses can be sorted based
on k-means clustering techniques and variations.

The computing system can present the responses (110) to the teacher. The computing
system can present the responses by the intermediary server sending the sorted responses to the
teacher computing device. The teacher computing device can present the sorted computing
device to the teacher via a quiz user interface.

FIG. 2 is a diagram of a quiz user interface 202. The quiz user interface 202 can be
presented by a display of the teacher computing device.

The quiz user interface 202 can include a title 204 of the quiz. In this example, the title
204 is, “History Quiz.” The quiz user interface 202 can also include the question 206 for which
responses are being presented and graded. In this example, the question 206 is, “Who was the
First Lady between 1961 and 1963?”

The quiz user interface 202 can include the sorted responses 208, 210, 212, 214, 216,
218, 220, 222. The sorted responses 208, 210, 212, 214, 216, 218, 220, 222 can each represent
clusters of similar responses. For example, the response 208 can represent all student responses identical to the model answer, “Jacqueline Kennedy,” the response 210 can represent all student responses with a misspelling within a range of textual distances from the model answer, the response 212 can represent all student responses with a nickname for Jacqueline Kennedy (such as “Jackie Kennedy”), the response 214 can represent all student responses with the name of Jacqueline Kennedy after her second marriage (which was not her name while she was the First Lady), the response 216 can represent all student responses with Jacqueline Kennedy’s nickname and her last name after her second marriage, the response 218 can represent all student responses that refer to Jacqueline Kennedy’s husband while she was First Lady (such as “JFK,” “John F. Kennedy,” or, “Jack Kennedy”), the response 220 can represent all student responses that refer to First Ladies of the United States other than the First Lady from 1961 to 1963, and the response 222 can represent non-responsive student responses, such as question marks, blanks, or gibberish. The responses 212, 214, 216, 218, 220 can also include misspellings of deviations from the model answer. The responses 208, 210, 212, 214, 216, 218, 220, 222 can each display a single representative response from the cluster, or all variations of responses within the cluster.

The responses 208, 210, 212, 214, 216, 218, 220, 222 can also include indications of numbers of students who gave the particular response 208, 210, 212, 214, 216, 218, 220, 222. The responses 208, 210, 212, 214, 216, 218, 220, 222 can also include identifiers of students (such as names) who gave the particular response 208, 210, 212, 214, 216, 218, 220, 222, or the responses 208, 210, 212, 214, 216, 218, 220, 222 can be anonymized to eliminate and/or reduce bias, or perception of bias, in grading the answers. Presenting all of the students’ responses to a given question at once can improve consistency in scoring the responses to the question.

Presenting the responses in sorted order of similarity to the model question and/or predicted
likelihood of correctness can improve efficiency by enabling the teacher to quickly mark responses closer to the top as correct and responses closer to the bottom as incorrect, and focusing on responses in the middle to determine correctness. After the teacher has indicated that he or she is finished scoring the responses, the computing system can re-sort the responses to group all correct responses together and group all incorrect responses together, or in the case of questions worth multiple points, group responses with same scores together in descending or ascending order. The teacher still has control over the final decision of how to score each response.

Returning to FIG. 1, the computing system can receive scores (112) from the teacher. Returning to FIG. 2, the computing system can receive the scores via the quiz user interface 202. As labeled for the first response 208, the responses 208, 210, 212, 214, 216, 218, 220, 222 can also include interfaces for the teacher to score the responses 208, 210, 212, 214, 216, 218, 220, 222. The responses 208, 210, 212, 214, 216, 218, 220, 222 can include buttons 230, 232 for the teacher to mark answers as incorrect or correct, or a field 234 for the teacher to assign a number of points earned out of a number 236 of possible points for the response 208, 210, 212, 214, 216, 218, 220, 222.

When subsequent teachers present the same or similar questions to students, the intermediary server may utilize previous teachers’ scores as data in predicting scores for, and/or ranking or sorting, responses using machine learning techniques. The computing system can thereby become more efficient by clustering more responses together and generating more accurate predictions of scores for questions.
Create quiz
102

Send quiz to students
104

Receive responses
106

Sort responses
108

Present responses
110

Receive scores
112

FIG. 1
Who was the First Lady between 1961 and 1963?

- Jacqueline Kennedy
- Jacueline Kennedy
- Jacqueline Kennedy Onassis
- Jackie Onassis
- JFK
- Eleanor Roosevelt
- ?

FIG. 2