Automatic Assessment of Student Answers Consisting of Venn and Euler Diagrams

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Abstract— Venn & Euler diagrams are a significant part of communication, especially in exams of secondary education, such as London Ordinary Level and SAT Mathematics. Significant research has been done to understand mathematical diagrams in few domains such as charts [1] (bar charts, pie charts) as well as coordinate graphs [2]. Since online based education popularity increases such as MOOCs (Massive open online courses) which needs automatic assessment facilities for diagrams. However, there is no research done to assess Venn and Euler diagrams.

To address the problem of automatic assessment of Venn and Euler diagrams, we present a methodology that first extracts set details from a vector image and produces the output as an XML structure. This XML structure is assessed according to a marking rubric. Our system accepts the input images as vector images in SVG (scalable vector graphics) format.

In vector images, sets can be represented using labelled Jordan Curves such as circles, ellipses, rectangles and closed curves. A set usually has an attached label. In the label identification, only nominal text labels are accepted as set labels while resolving the label ambiguities using various heuristics. After identifying the sets, minimal regions and zone elements are identified. After extracting all the Venn information, extracted data is output in a structured XML format that can describe any Venn or Euler diagram.

Marking rubric structure is introduced to capture the marking rubric that is provided in an exam. A teacher has to provide a model diagram answer and a marking rubric to generate marking rules to grade student diagrams.

In the assessment, the structure of the student diagram is validated against the model answer. Corresponding sets from the model diagram and student diagram are matched by applying a sentence similarity matching algorithm to set labels. After identifying relevant sets student answer is graded against the marking rubric. Marking rubric may contain alternative marking methods for a same question/ sub-question. Maximum collective mark is extracted as the final mark for a student answer.

For the evaluation, the system is tested using 77 collected Venn & Euler diagrams for a Venn and Euler diagram question paper with four questions taken from the Mathematics paper of the GCE O/L examination in the Sri Lanka. We manually graded those answer sheets according to the marking rubric. Marking results produced from the system were validated against the manual marking, which showed an accuracy of 94.8%.

REFERENCES

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