

Introduction

- Concept maps are a pedagogical tool for visually organizing and representing knowledge
- However, assessing student concept maps is a manual, tedious, and time-consuming task for an instructor
- We propose Cronus that provides automated feedback similar to a manual assessment of a concept map
- Cronus identifies misconceptions in the student concept-map and finds the nodes, linking phrases, and branches matched or partially matched in the instructor's and student's concept map
- Cronus employs natural language processing to handle synonyms and different linguistic patterns

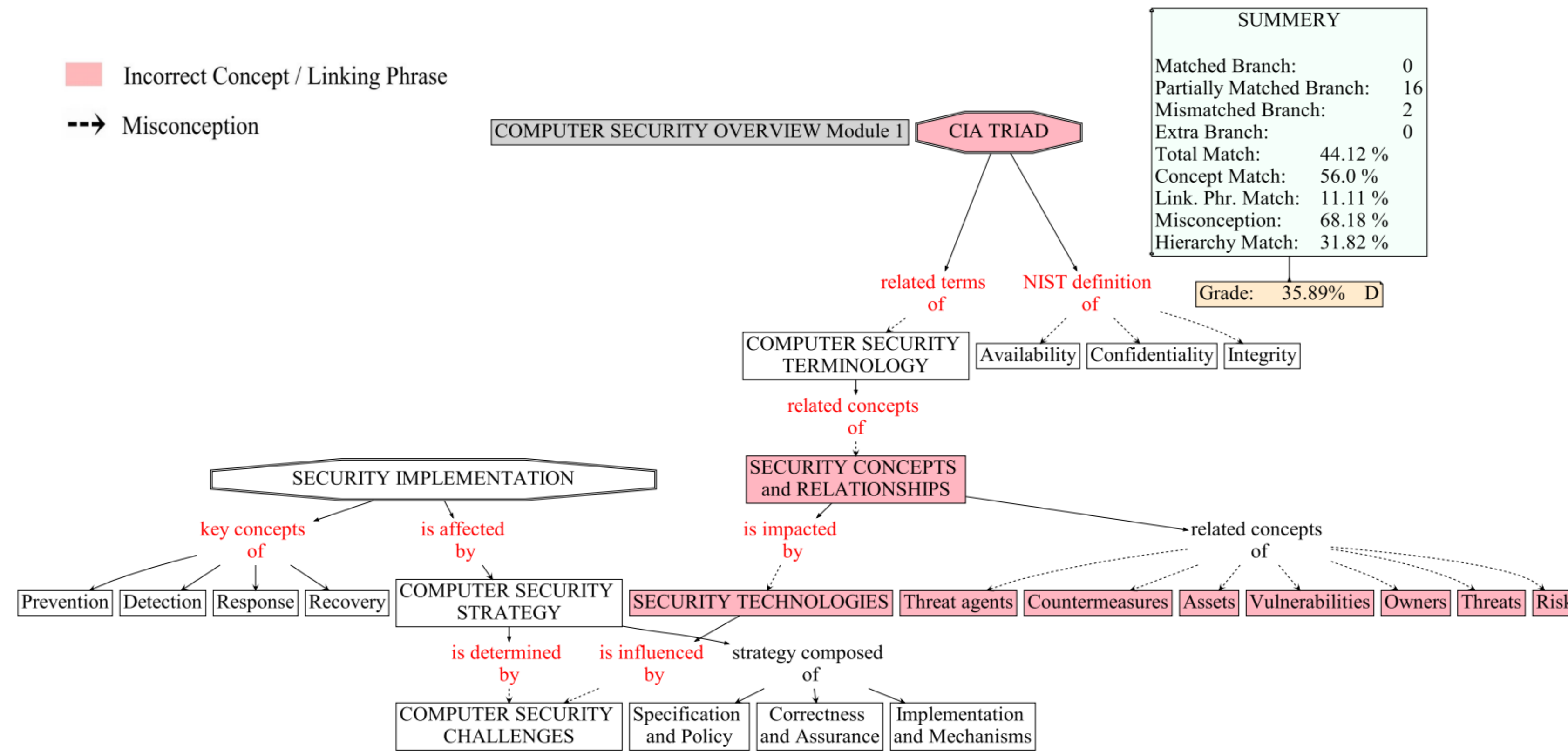


Figure 1: Cronus-generated contextual analysis graph

Methods

- **XML PARSING:** extracts data from the concept maps is the first step of the process
- **ROOT:** converts word into root words, and the stop words are removed
- **COMPARE:** compares the instructor dictionary with the student dictionary
- **REFORM:** detects misconceptions
- **DICTIONARY KEY:** isolates concepts and linking phrases
- **DIAGRAM:** construct two diagram from the data provided by the Analytics modules

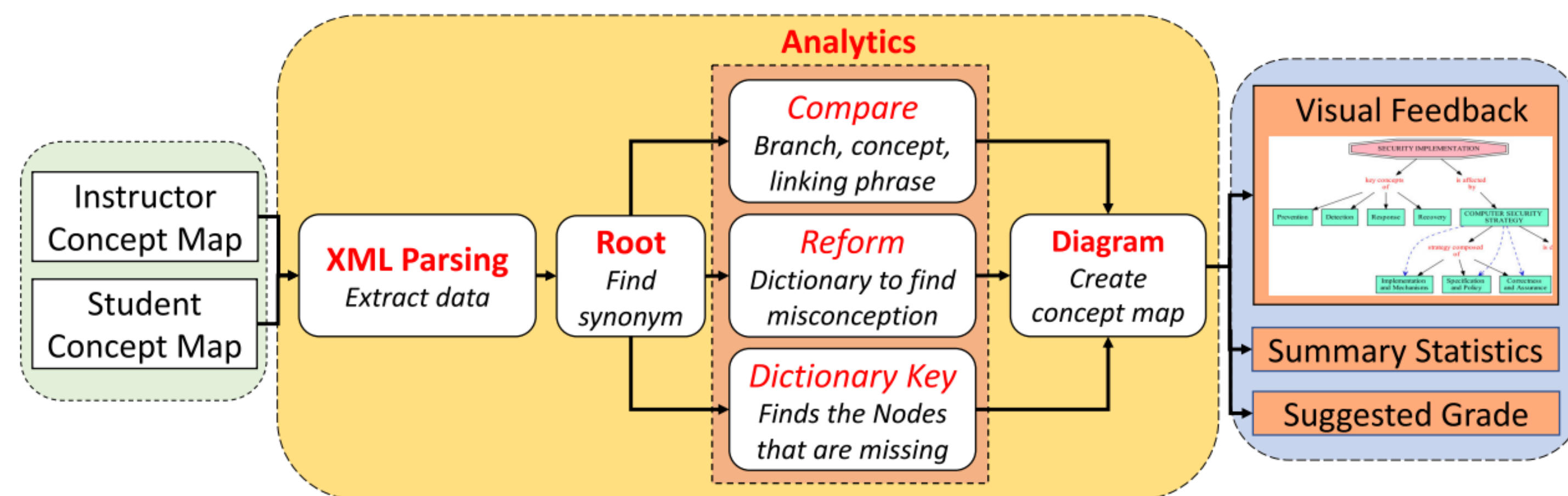


Figure 1: Cronus Framework

Publication

- M. A. Dahir, S. A. Qasim and I. Ahmed, "Cronus: An Automated Feedback Tool for Concept Maps," in IEEE Access, vol. 9, pp. 119564-119577, 2021, doi: 10.1109/ACCESS.2021.3106509

Results

- We evaluated Cronus with 78 student concept maps against 3 instructor concept maps and found an accuracy rate of 90% ($R^2 = 0.91, 0.91, \text{ and } 0.88$)
- We released our data set of over 1000 concept map comparison (both contextual analysis graph and topological analysis graph) and code base at [GitHub](https://github.com)

$$\text{Grading Formula: Grade} = \frac{1}{2}(\text{Total Match}) + \frac{1}{2}(\text{Hierarchy Match}) + \frac{1}{2}(100 - \text{Misconception})$$

- We found an average difference of 5.6 between the manual grading and Cronus grading for the "user authentication" module
- This small difference in the manual and Cronus grading for the above two parameters can be isolated into five categories: Pleonasm and multi-concept, Abbreviation of concepts, Misspell, Vague synonym, and Irrelevant orphan

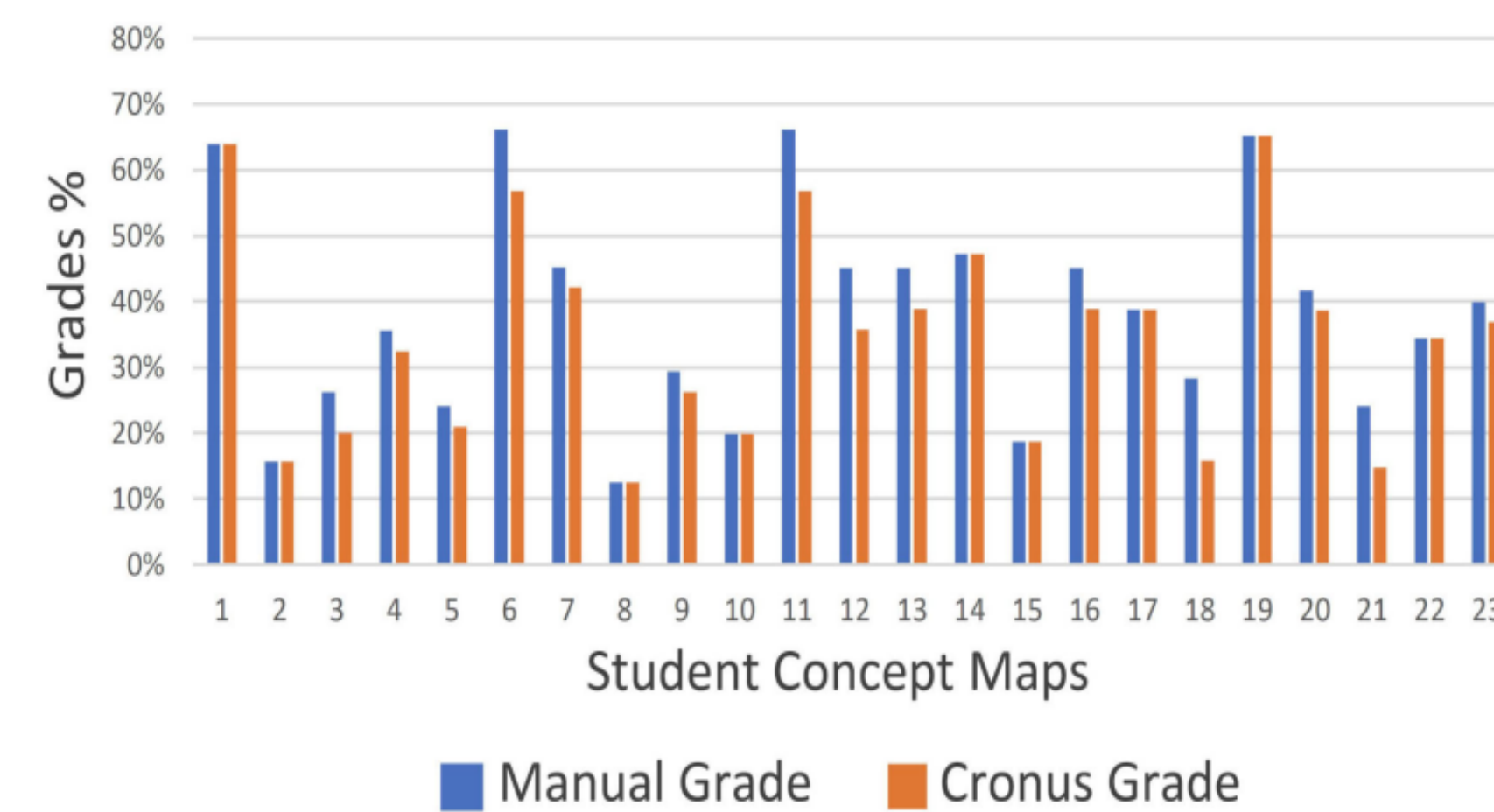


Figure 3: Grading comparison for "user authentication" module

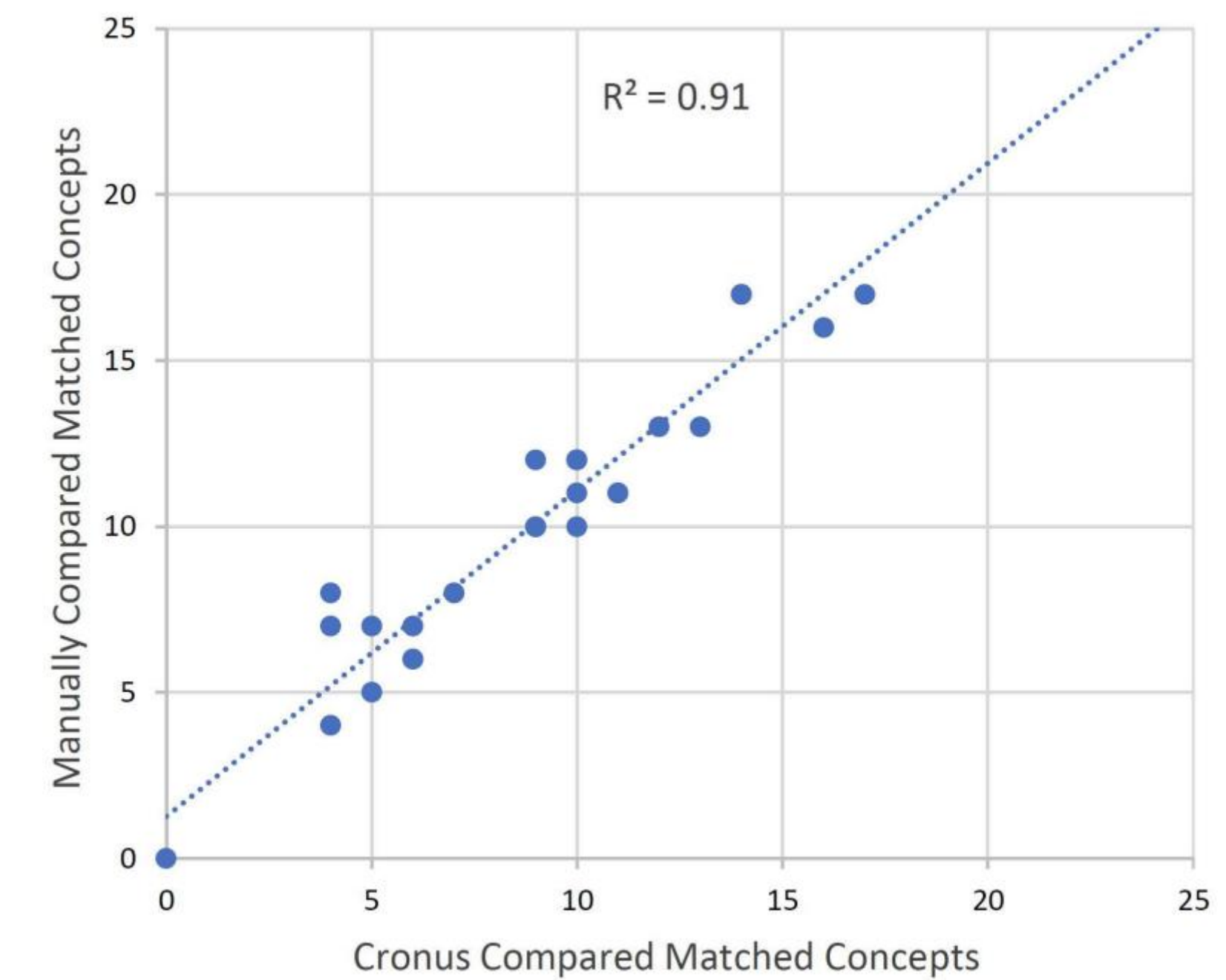


Figure 4: Difference between manual grading and cronus grading

Discussion

- In this paper, we presented Cronus, an automated tool for evaluating concept maps
- Unlike other tools, Cronus provided a comparison of student's concept maps with the instructor's concept maps and generated visual feedback for quick assessment of student concept maps
- It further quantified the feedback into useful summary statistics of evaluation parameters and suggested grades based on the grades and predefined instructor criteria for the maps
- Our Results showed that the grading done by Cronus was significantly closer to the manual grading and can be used by instructors to evaluate concept maps for larger classes

Acknowledgments

- This work was in part supported by the NSF CyberTraining Grant, Federal Award ID Number 2017337.