Creating Explanatory Visualizations of Algorithms for Active Learning

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Abstract

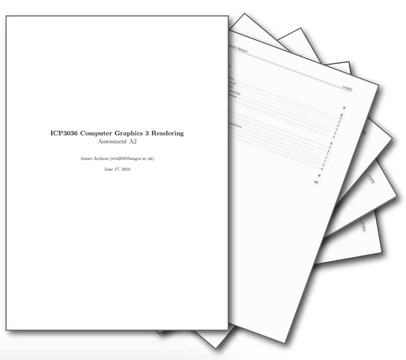
Visualizations have been used to explain algorithms to learners, in order to help them understand complex processes. These ‘explanatory visualizations’ can help learners understand computer algorithms and data-structures. But most are created by an educator and merely watched by the learner.

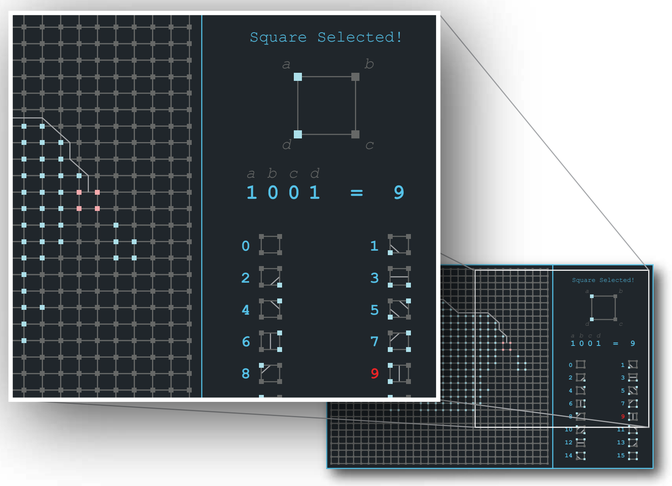
In this paper, we explain how we get learners to plan and develop their own explanatory visualizations of algorithms. By actively developing their own visualizations learners gain a deeper insight of the algorithms that they are explaining. These depictions can also help other learners understand the algorithm.

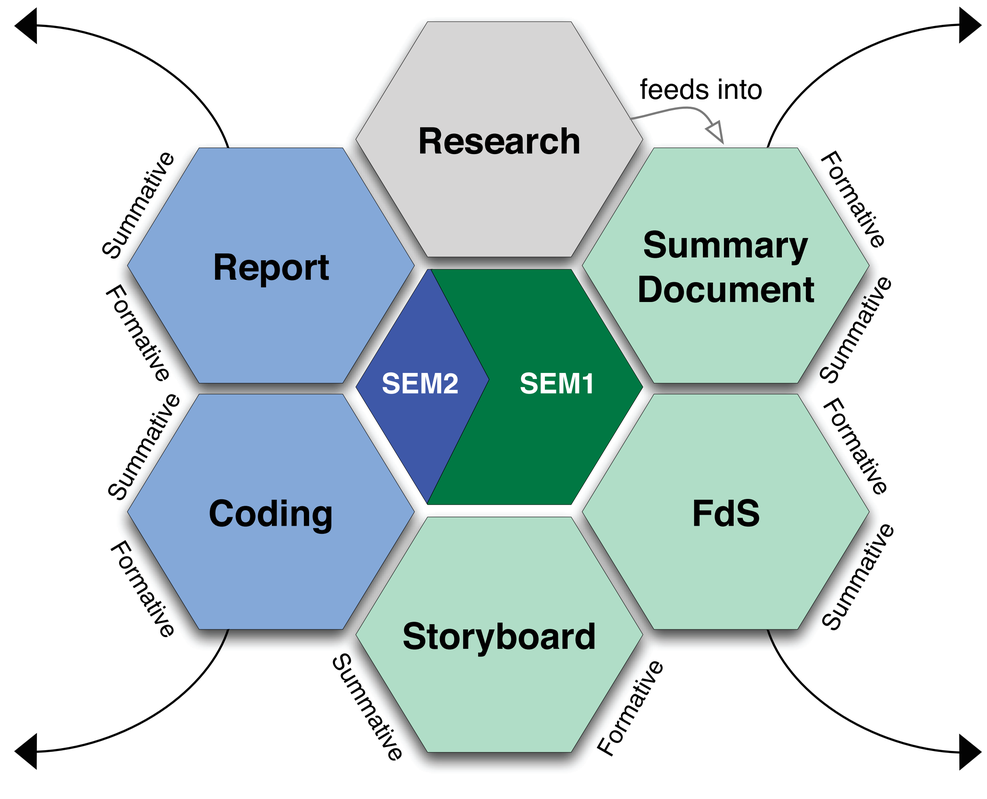
Background

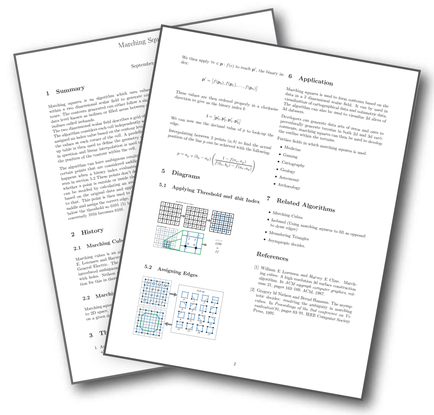
While different styles of visualization exist, our approach focuses on explanatory techniques.We focus on our third year Computer Graphics & Visualization course for Computer Science undergraduate-major students. These students are studying for their three-year BSc honors degree in the UK. In Semester 1, learners perform all the research and planning stages, and in Semester 2 they start coding, reflect on their code and demonstrate their solutions.

Active learning techniques [1] enable learners to proactively interact with the material engaging multi-sensory learning, rather than merely listening passively to the teacher. Students can become motivated by the task, if the task is something interesting and they see it being worthwhile.









Methodology

Our formal structure follows six parts. At each stage, work is evaluated formatively, learners improve this version and submit for summative assessment. Students are asked to pick an algorithm or technique. Plagiarism is avoided as topics are unique for each student.

1 **Research**
Students look at books, papers and other resources online to understand the algorithm or technique.

2 **Summary-document**
Comprising: History, Pseudo code, Maths, Diagram, Application, Similar techniques, References.

3 **Design-by-sketching**
Students use the Five Design-Sheet methodology [2] to sketch different visualization concepts.

4 **Storyboard**
The learners create a storyboard to describe the main key stages of their explanatory visualization.

5 **Code**
Students develop the visualization using a prescribed graphics library over a 3 month (1 semester) period.

6 **Technical Report**
Finally, students write a technical report on their work, including a critical evaluation of the project.

Discussion and Conclusions

We have made a preliminary evaluation of the process. Students completed an anonymous questionnaire of 10 questions. We received positive and encouraging feedback.

- The summary-document allows the students to explore the subjects and allows the teacher to asses current levels of understanding.
- The FdS method allows for structured creativity and produced good results.
- The 6-part structure garnered better, average, results and implementations than previous years.
- By ensuring that topics were unique to each student, we observerd no plagiarism amongst submissions

We recommend other educators to use a similar *active learning* strategy and to use explanatory visualization in learning as students perform better, and understand the work more deeply.

References

[1] C. Meyers and T. B. Jones. *Promoting Active Learning. Strategies for the College Classroom.* ERIC, 1993.
[2] J. C. Roberts, C. Headleand, and P. D. Ritsos. *Sketching designs using the five design-sheet methodology.* IEEE Trans. on Vis. and Comp. Graph., 22(1):419–428, Jan 2016.

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