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# Improvement of layered directed acyclic graph layout in CourseViewer

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**Abstract**
CourseViewer is a software that uses interactive diagrams to assist students, teachers, and course coordinators in analyzing information related to academic transcripts and course curriculum, which are represented as layered directed acyclic graphs of subjects and prerequisites. Recent improvements in the layout of these graphs included edge crossing minimization and better horizontal positioning of nodes. This work continues this list of improvements by means of researching edge bundling techniques that group edges of layered directed acyclic graphs, in order to simplify graph understanding. We selected and implemented an edge bundling technique in CourseViewer. We also exemplify course curricula in which we applied this technique.

***Key words:***
*Edge bundling, graph layout, Information Visualization*

## Introduction

CourseViewer is a system that allows for visual and interactive representation of course curricula and academic transcripts. It focus on the representation of subjects and their prerequisites by layered directed acyclic graphs (LDAG). Its nodes, edges and layers represent, respectively, subjects, prerequisites and semesters. The tool aims to help student and faculty users to make decisions through the presentation of the subjects by directed graphs, in which it is possible to reorganize disciplines.

The goal of this work was to improve graph layout by using edge bundling techniques. They group edges in bundles, in order to simplify graph understanding by users. We studied and implemented Pupyrev et al.'s approach[1] for LDAG. First, this approach identifies groups of equivalent nodes, i.e., "dummy nodes" that are neighbors in the same layer. For each group, the algorithm runs an exhaustive search in order to find which subgroups of nodes it should make horizontally closer, in order to minimize the use of ink.

## Results and Discussion

We implemented Pupyrev et al.'s algorithm inside a LDAG layout class based on Prefuse[2] visualization library. Figure 1 shows a complete curriculum without the use of edge bundling. Figure 2 represents the same curriculum with edge bundling; there are bundles in the paths that depart from the subjects TT106 and SI201. We draw the edges of each bundle with a slight displacement between them, to show the existence of more than one edge.

## Conclusions

We added edge bundling to CourseViewer graph layout procedures and we perceived that the bundles reduced visual cluttering as expected.

Future works include: executing more tests with a larger set of curricula and transcripts, in order to verify possible layout inconsistencies; and replacing straight edges by curved ones.

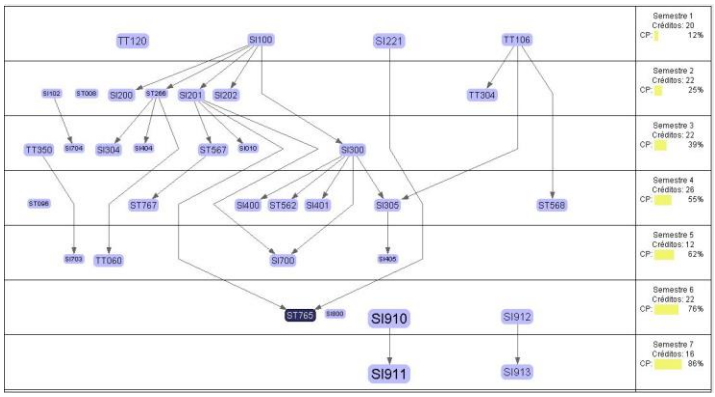


**Figure 1.** Curriculum visualization without edge bundling.

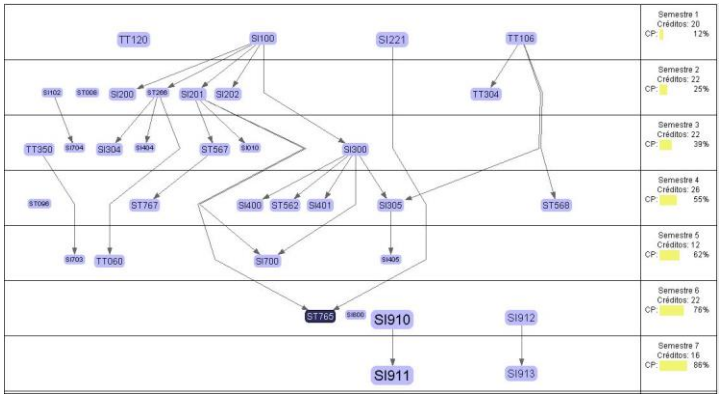


**Figure 2.** Curriculum visualization with edge bundling.

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[2] HEER J., CARD S. K., LANDAY J. A. Prefuse: a toolkit for interactive information visualization. *Proceedings of the SIGCHI conference on human factors in computing systems*, pp. 421-430, 2005.