Abstract The problem of crossing minimization in k-page book drawings is in general NP-hard [1]. Thus, it is common to use heuristics. Among these, simple heuristics presented in literature, compute a vertex order and an edge distribution for a book drawing independently. We present several new simple heuristics, including full drawing heuristics, that compute vertex order and edge distribution at the same time, and their experimental evaluation together with the most promising simple heuristics from the literature. Simple heuristics not considered in this paper were outperformed by the presented ones. More complex heuristics, based on neural networks [7,11,13,16], simulated annealing and evolutionary techniques [2,5,8,11,14,15], are out of the focus of this paper.

Discussion The best heuristic combination depends not only on the number of pages and the density of the graphs, but remarkably also on their structural properties. E.g., the combination conGreedy+ cellFloor+ performs best on planar and 1-planar graphs, while conGreedy+, as full drawing heuristic, performs best on random graphs with the same density. We observe that our first extension of the vertex order heuristic conCro to conGreedy, produces results with fewer crossings. The second extension of conGreedy to the full drawing heuristic conGreedy+ sometimes achieves even fewer crossings. However, both these extensions come with the cost of higher running time, which was clearly noticeable in the experiments (see, e.g., figure on the right). Furthermore, we could observe that conGreedy+ cellFloor+ slan achieves crossing-free book drawings of hypercubes Qd when p = pagenumber (tested up to d = 10).

The figure on the left illustrates the evaluation of the heuristics on different graph classes and different number of pages p. The maximal used number of pages was determined either by the pagenumber of the graph, or when the best heuristic produced no more than 1 crossing on average. Big tiles represent the heuristic combination or full drawing heuristic that performed best in terms of average number of crossings, computed for 200 instances for the specific case. The upper-left part of a tile is coloured according to vertex order heuristic, and the bottom-right according to edge distribution heuristic; it is subdivided into two parts if two heuristics perform equally. The small tiles on the right of a big tile represent heuristics following in the performance, from top to bottom, if their performance is within 10% of the winning one. Our best suite contained among others two sets of random graphs with a linear number of edges, m ≈n, and with a quadratic number of edges, given by edge probability q = 0.3 in the Erdős-Rényi model, as well as planar, 1-planar, 4-tree, cartesian cycle product (C3 ×Cj, i · j = n) and hypercubes. See [12] for the complete results of the experiment.

Average running time as a function of the density, for random graphs with quadratic number of edges, n = 150 and four pages.

References