Map labelling

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This project is inspired by the problem of labelling towns and cities on maps so that the text labels do not overlap, and this may have other applications. The intention is to explore exact algorithms and heuristics for this problem. The general problem concerns packing a number of rectangles of different sizes into a small area without overlap. The problem is NP-complete and in general can only be solved by spatial discretization and either a branch-and-bound exact optimization, or a heuristic.

We are given a number of tuples $(d_i, r_i, g_i), i = 1, 2, \ldots, n$. Here:

- d_i is a *dot* — a zero-area point in the plane. Its position is fixed and never moves during the optimization process.
- r_i is a *rectangle* — with sides parallel to the coordinate axes. It may be translated by not resized or rotated. It represents an enclosing rectangle for the text label.
- g_i is a *gap* — the minimum allowed spacing between d_i and r_i.

We are also given an objective function, which can be, for example, the maximum separation of a dot from its rectangle. The optimization problem is to minimize the objective function while satisfying all constraints: that no pair of rectangles overlap and no rectangle has any dot in its interior.

The method will first be to explore branch-and-bound exact optimization, and compare performance with heuristics. Interesting extensions would be to allow rectangle rotation, and to formulate an objective function incorporating some aesthetic criteria. Programming in C or C++ will be necessary, for best speed.

These papers (findable by google) will be useful: Zoraster: Practical experience with a map label placement program (old); Zoraster: Integer programming applied to map label placement problem (old); Kameda et al: Map label placement for points and curves (2003); Christensen et al: An empirical study of algorithms for point-line placement (recent, no date given); Bekos: Map labeling algorithms with application in graph drawing and cartography (PhD, Athens 2008); Genisa et al: Consistent labeling of rotating maps (2011).