The keyboard layout problem

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Subject

We all know the standard QWERTY keyboard that is used for computers and smartphones alike. It is known however, that this keyboard is not optimized for typing speed. In fact, it was originally designed for typewriters to avoid the type bars (little metal arms) getting stuck together.

It is possible to design a different keyboard layout where keys that are often used together are also close together on the keyboard; this to optimize typing speed. This is particularly interesting for smartphone keyboards where typing is usually done with one or two fingers, and one may easily reconfigure the keyboard layout.

One possible formulation of this problem is as a quadratic assignment problem, a type of combinatorial optimization problem. In words: we have to decide which letter or symbol to assign to which key on the keyboard, in a way that minimizes the typing speed. (The typing speed depends on the keyboard layout and the language in question.)

Objective

Design a keyboard that is better suited for the Dutch (or English) language than the QWERTY keyboard, by solving a suitable quadratic assignment problem.

Procedure

1. Generate data by analyzing certain texts (Dutch or English) to understand the relative frequency where two given letters are used consecutively.
2. Evaluate the literature to understand the ergonomics of typing speed: how does the typing speed for two consecutive letters in a word depend on the distance between the corresponding keys?
3. Learn about the quadratic assignment problem, and why the keyboard design problem may be modeled in this way.
4. Program a suitable heuristic for the quadratic assignment problem and apply it to your problem formulation.
5. Compare your final keyboard design to the QWERTY keyboard in terms of typing efficiency.
6. Discuss the pros and cons of implementing your new keyboard design in practice.

Learning goals

- Practice the collecting of data and modeling a design problem as a mathematical optimization problem.
- Learn about, and implement heuristics for the quadratic assignment problem, and apply them.
- Learn to analyze your model and results critically in terms of correctness and usefulness.