Geoxam: Decision Support Tool for Geographically Distributed Exam Scheduling

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Abstract

The proposed tool supports human planners in certifying organizations in their task of scheduling geographically distributed certification exams. It is highly configurable and provides an effective cost-quality tradeoff for the organization.

1 Problem, purpose and user groups

The present demo paper considers the planning of certification exams, e.g. within Microsoft/Cisco/Apple certification program, or qualification exams for auditors and experts. These exams are carried out by certifying organizations, who typically employ human planners to schedule the examinations. Due to the high volume of participants and the different equipment requirements for each exam (such as computers, or projectors), it is no longer possible to schedule all exams in the same location [2]. For this reason exams need to be geographically distributed across multiple locations, still taking into account the travel distance of participants. With tens of exams in a single day and thousands of participants, the scheduling complexity approaches that of elections. The proposed decision support tool, called Geoxam, is developed for certifying organizations to assist their human planners in the challenging task of scheduling geographically distributed certification exams [3]. Geoxam aims to: (1) reduce planning time and human errors incurred by the complexity of the scheduling task; (2) minimize the cost of certifying organizations for booking rooms and hiring exam supervisors; and (3) minimize the travel distance of all participants to their respective exams.

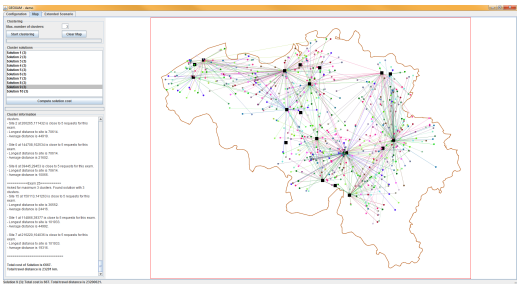

Figure 1: Geoxam GUI

2 Geoxam

The following describes the process of scheduling multiple exams in a single day when using Geoxam.

Each participant registers for an exam through the website of the certifying organization and specifies their home location. After the registration deadline has passed, the certifying organization opens Geoxam, which displays a map of the country (in this demo — Belgium) and the possible sites where an exam can be scheduled, e.g. public buildings, universities, etc. Each site (or possible exam location) has a number of rooms that can be booked for exams. In addition to exam sites, the tool displays the home locations of all

participants as dots on the map. Each dot has a color according to the exam for which the corresponding participant is registered. In this demo we artificially generate home and exam locations. Nevertheless, Geoxam supports the input of XML configuration files that specify the complete problem information, so that it can work with real data.

Once the above data is generated and displayed on the map, the planner has the option to perform automated k-means clustering with a user-defined number of clusters k. The latter procedure assigns participants to exam locations, such that participants who registered for the same exam are distributed to at most k different sites. Each exam is assigned to take place in a site that is closest to the cluster centroid. Note that an exam location can be the closest to two or more centroids. Thus k specifies the maximum number of different sites for each exam. The minimum number of participants per exam is also defined by the user, forcing small clusters to be merged with nearby ones. Higher values for k yield more clusters per exam, resulting in shorter travel distances for participants, but more rooms to book and supervisors to hire. If k is low, on the other hand, more participants will be clustered in the same location, requiring fewer larger rooms to be booked and potentially lowering the costs for the organization.

k-means clustering generates different solutions with each random initialization of cluster centroids [1]. For this reason, Geoxam repeats clustering multiple times until a certain qualitative requirement is met, as defined by the organization. A clustering solution displays the assignment of participants to sites as lines connecting home to exam locations in the color of the corresponding exam. The tool stores all generated solutions and displays detailed information over each solution, such as number of participants per location, total travel distance of all participants, average and longest distances, etc. In this way the planner has an overview of each generated assignment and can examine specific details of the solution, in order to decide when to stop the clustering process.

After selecting a cluster solution that meets the quality requirements of the organization, the user can then explore the allocation of exams to rooms within the chosen day in each site. For each opened site, the tool performs an initial allocation using a first fit constructive heuristic that takes into account the size of the exam, its equipment requirements and the occupancy schedule of the rooms. A backtracking algorithm is then applied to minimize the solution costs in terms of number and size of used rooms within the site. At any time the user can manually rearrange the proposed solution, fix the start time and/or room of exams and then ask the tool to recompute a schedule that takes into account the imposed constraints.

In addition to minimizing the number of used rooms within each site, Geoxam allows the user to reschedule an exam to a different site in order to free a room that has only one scheduled exam. Such rescheduling results in lower solution cost at the expense of longer travel distance for participants.

3 Demonstration

Geoxam runs on Windows and requires moderate computational resources, such as those in a regular desktop or laptop computer. The tool can be demonstrated within 5 minutes and allows for interaction with the audience.

References

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