

ESOPO: an Environment for Solving Optimization Problems Online

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In the last years many collaborative research efforts have been addressed to the design and development of the so-called Problem Solving Environments (PSE), whose overall aim is to provide the scientific communities with easy and friendly to use tools to solve a class of problems [4]. To get this goal, the promotion of the development and evaluation of reliable software that can be integrated in a common and standard computational framework is of primary importance. The availability of such environments allows users to access and use the software components. The current trend is to equip the environment with suitable tools that allow users to access the available resources from any WEB connection (see <http://research.cs.vt.edu/pse/examples.html>). PSEs involve both developers, that make new algorithms and codes available to the end users, and software infrastructure builders, that define standards and abstractions, and create interfaces. Finally, PSEs provide an integrated computational environment for solving problems in a particular domain, without the end user needing to be an expert in the technologies used to effect the solution.

Within the outlined context, the aim of this paper is to present ESOPO (<http://www.esopo.unina2.it>) an Environment for Solving Optimization Problems Online [2]. ESOPO is a collaborative research effort that aims to develop an homogeneous environment where different optimization codes, organized according to unifying criteria, can be easily accessed by users to solve their problems. The ESOPO project was born in the context of an Italian research project (MIUR-FIRB Project Large Scale Nonlinear Optimization, http://www.firb_lsno.unina.it), whose general aim is to develop methods, algorithms and software for solving large scale nonlinear optimization problems arising in many application fields. Following the successful NEOS Server design guidelines (see <http://www-neos.mcs.anl.gov>) the basic goal of ESOPO is to provide Internet access to a library of optimization software with user interfaces that make simple and intuitive the problem solving process. Indeed, optimization codes developed by researchers working into the cited project have

been collected and integrated in a homogeneous computational environment. The integration process aims to abstract the users as much as possible from the optimization software, and to provide a unified problem solving procedure, which has the same aspect regardless of which solver the user is accessing. Each solver is equipped with drivers for using the most common problem modeling languages, and with dynamic graphical interfaces for its friendly usage. Furthermore, ESOPPO has been equipped with a large set of test problems from well-known collections (for instance, CUTER - <http://cutter.rl.ac.uk/cuter-www/>), with test problem generators produced by people working in the project, and with up-to-date tools for software evaluation and comparison. Finally, ESOPPO makes available some well-established optimization software packages, like Lancelot [1], KNITRO [5]. The complete list of these software is available at the ESOPPO home page.

At present, ESOPPO is able to supply two main services. It allows to remotely solve a problem, either submitted by the user observing one of the expected input formats, or chosen from available collections. Meaningful results are automatically sent by an e-mail message to the user. On the other hand, ESOPPO supplies, when requested, profiles of performance comparisons of a set of available solvers on a set of problems. The performance profiles used by ESOPPO are currently based on the performance metric introduced by Dolan and Moré [3].

We first outline the basic hardware and software structure and the most important functionalities of ESOPPO. The ESOPPO architecture model is very simple and can be viewed as a three levels virtual machine. The outer level is a simple web connection that allows users to access the ESOPPO home page and to submit a job. The ESOPPO system consists of the server and the computing levels. The server is the kernel of the ESOPPO model and it represents the main user interface, providing all the tools needed for job submission and execution. On the server, a set of application tools is implemented, that permits users identification, solver selection and jobs scheduling as well as job assignment to one of workstations that form the computing level, where the solvers are located together with their drivers. Once the solver execution is terminated, the workstation sends the results to the web server, which forwards them to the user by an e-mail message.

We also discuss about the main issues related to the usage of ESOPPO, to the development of the services that it provides to the users and to the management of the available optimization software.

Furthermore, we describe how to solve a problem with ESOPPO. From the user point of view, ESOPPO allows users to access and use the available services by simple web connections and tools. The solver selection process starts with the specification of the main problem features (optimization process type, objective function type, constraints type) using a web interface (solver selection). The next interface lists all codes able to solve the specified problem. Then, users make their choice, and subsequent interfaces (solver usage) allow to select the problem modeling language, to set some input parameter values (for instance, tolerance values to be used into the stopping criteria), and to upload the file containing the problem description. For each available solver there is a software card containing information about the implemented optimization method as well as the solver usage documentation.

Finally, a brief description of the performance evaluation tools currently available in ESOPPO is given.

We hope that ESOPO will be a reference point not only for the national activities concerning numerical optimization, and that it will benefit from contributions of all people working in the field of optimization software. We plan to add solvers for nonlinear optimization as well as in areas that are not currently covered. Work is currently aimed at improving the interaction between users and ESOPO, allowing, for example, to access job intermediate and final results online. Finally, we are adding other metrics to the performance evaluation tool, such as number of function evaluations and quality of the computed solution.

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