

Project Proposal

IPOPT Online Interface

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1 INTRODUCTION

Nonlinear programming (NLP) is the process of solving an optimization problem defined by a system of equalities and inequalities, collectively termed constraints, over a set of unknown real variables, along with an objective function to be maximized or minimized, where some of the constraints or the objective function are nonlinear. NLP is widely used for modelling and simulation, especially in chemical engineering, electrical engineering and business.

Interior Point OPTimizer (IPOPT) is a popular open source NLP solver which is designed for large scale systems. In that case, IPOPT is a important tool for solving NLPs.

For now, IPOPT provided the source code to users and users have to compile the code and also the model files(objective functions and constraints) separately. And then they can combine two compiled files and get the results. There are several drawbacks for this approach. Firstly, most IPOPT users do not have strong CS background. Even if we provided a nice instruction for them about how to install IPOPT, downloading all dependent packages and compiling them together are very hard to them. Secondly, most of our users are only familiar with windows system. However, it is very hard to run IPOPT on Windows due to some Fortran and C++ mixed compilation issues. Last but not the least, some of the users do not have the copyrights of model compiler. So even if IPOPT is free itself, there is no way for them to use it.

Based on the drawbacks listed above, we plan to build a web interface for IPOPT, so that users can submit their model code online and the server gets the model files, compiles them, solves the model by IPOPT and returns the results to the user. Actually, the system performs

like an online judgement system. Modelling language(GAMS or AMPL) are like coding language(such as java or C). IPOPT and model compiler performs as the code compiler. And the running results are returned to the user. Meanwhile, as the maintainer of IPOPT, a lot of models and data can be collected by this system which are very useful to find the bugs in IPOPT and also help them with the weakness of our algorithm.

2 SYSTEM DESIGN

In our design, we will provide lots of organized data to the maintain group which help the group to improve the method and also benefit the users for a very easy way to use IPOPT. Moreover, our web application will contain a discussion board to share their model code with other users and to ask for help. What's more, shared online model editor, automatically options recommendation are planned in our project.

2.1 ONLINE JUDGEMENT SYSTEM

Online judgement system is the main function of our project. As we described in the introduction, the user can upload their model code to the server and the server will return the results to the user. To implement this function, we need to connect our server with the popular model compiler (such as AMPL and GAMS) so that the user has more freedom to use their favourite modelling language.

2.2 USER SYSTEM

There are two kinds of user in our project, the maintainer and the IPOPT user. The maintainers can see all others' model code and the running results. The IPOPT users are managed as groups. Every user has their own model folder and they can decide the access permissions to each file. If they want to ask others for help, they can share the code to public. If it is unfinished model file, the permission is usually only for the editor himself. In addition, user collaboration system may be supported by our system.

2.3 DISCUSSION BOARD

Discussion board will be implemented in our system with multiple proposes, such as sharing their model code with others, asking others for help, reports the bugs of IPOPT to maintain group and so forth. It functions as a forum but is not exact the same. Since it should be connected with one's own model code folder so that he can share the model code with others and mark and discuss on them.

2.4 DYNAMIC OPTIONS RECOMMENDATION

As a numerical method, IPOPT has lots of (or too many) options which are useful for advanced user, but very confusing to the beginners. Our system can do better than default options

since we know their model and results, we can recommend the option set for them based on their model and results which is very useful for someone without the knowledge of numerical method.

2.5 DATA ANALYSIS

The system provides all data and statistics to the IPOPT maintainer as the graphics and text. Also, the maintainer can download the data for further analysis, and also search for the model code which contributes the most interesting data point.

3 TECHNOLOGIES

We plan to use Django as our website framework, Bootstrap as our frontend framework, jQuery as our Javascript library, and Postgresql as our database. We may also use Redis as our key-value in-memory database to store small pieces of data such as sessions. We will also create a lightweight RESTful web server on the solver server to communicate with our website server through HTTP protocol. For now, we will host the website on Wan's research group's machines. If everything goes well, we will eventually migrate the website to Amazon AWS for public use.

4 REFERENCE

Official website for IPOPT: <https://projects.coin-or.org/Ipopt>

Related paper: A. Wachter and L. T. Biegler, On the Implementation of a Primal-Dual Interior Point Filter Line Search Algorithm for Large-Scale Nonlinear Programming, *Mathematical Programming* 106(1), pp. 25-57, 2006