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Introduction to Xpress

Course summary

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`http://www.fico.com/xpress`

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Contents

Introduction

This training course aims to

- familiarize you with optimization models and techniques, and the terminology used to describe them;

- rapidly build up an understanding of the Xpress-Mosel model programming language and familiarity with Xpress-IVE

- teach you how to apply optimization models and techniques using Xpress, and give you lots of practice doing so through a series of linked projects that illustrate the underlying LP and MIP concepts;

- give you practice and confidence formulating optimization models and understanding their solution;

- show you how to embed an optimization model within an application/solution using Dash's optimization components.

Most topic areas include practical work to reinforce the contents of the presentation, giving you practice and confidence so you are able to apply the techniques in your specialist area. At the end of the course, you will be able to build sophisticated models, exploit powerful MIP techniques to model discrete decisions and logical conditions, build applications that incorporate optimization functionality using the Xpress-Mosel component library, and understand how to solve the problems and interpret the solutions obtained.

The course is not a replacement for the reference manuals, but concentrates on the topics which are important in practice. You will be encouraged to use the reference manuals throughout the course, to gain familiarity the topics covered and to become aware of the full range of functionality.

Requirements

Experience required: a basic understanding of algebra and familiarity with standard Windows applications would be an advantage. Some experience of programming development, using C/C++, Java, or VB/VBA is required for the final section on embedding optimization.

Resources required: the course is built around a series of linked projects for which participants will use the Xpress-IVE optimization and modeling development environment, and the Xpress-Mosel libraries.

- Participants will need to bring a laptop computer running one of the Windows platforms supported by Xpress. (Please refer to the Xpress web site under Products ≫ Platforms to check currently supported Windows platforms.)

- The latest Xpress software will be provided on CD-ROM at the beginning of each course. If your computer does not have a CD-ROM drive, or you foresee any problems installing Xpress on your computer at the beginning of the course, please contact the Xpress team to arrange to have Xpress installed in advance. Temporary Xpress software based licenses and data files for the practical work will be emailed to participants in advance of the course.

- Part of the course covers importing/exporting data to/from external data sources using ODBC, and this is illustrated using Microsoft Excel. You will find it very useful to follow these practical exercises and we recommend that participants have Microsoft Excel (2000 or more recent) installed on their computers.

- The final section of the course shows how to embed an optimization model within an application, and full practical exercises are included. Participants may choose to complete these exercises in C/C++, Java, or VB/VBA, and must have suitable software.

Synopsis

Day 1

9.15 *welcome*

9.30 **Introduction**

1-1 Introduction to the training course

Overview of Xpress

Why use modeling software?

Xpress-IVE demonstration

models: new, saving, opening, switching - bars: editor, entity, info, output (run) - editor: colours, auto-complete, tool tips - compile, run - output bar: log, stats, matrix, graphs, tree - viewing solution values - search, bookmark - help

1-2 Setting up Xpress

installation - directories and files - licenses - documentation - support - using Xpress-IVE [P-1]

Linear Programming

1-3 Model development basics

starting and ending - preamble - decision variables - bounds - constraints - objective function - optimization [P-2.1]

10.30 *break*

Model development basics continued

1-4 Optimization and debugging

debugging models - viewing the matrix - viewing the solution [P-2.2]

1-5 Basic concepts and solution techniques

definition - assumptions - notation - solutions - basic solutions - simplex algorithm - dual problem - interior point methods - which LP algorithm to use? - presolve - tolerances and scaling

1-6 Developing large scale models

constant data - variable data - summations - loops - conditions [P-3.1] - model building style - comments - index ranges [P-3.2]

1.00 *lunch*

2.00 **Accessing Data Sources**

1-7 Accessing text-based data sources

separation of problem logic and data - reading data in from text files - writing data out to text files [P-3.3] - sparse data format [P-3.4] - user defined data formats

3.00 *break*

1-8 Accessing ODBC-based data sources

data transfer using ODBC [P-3.5]

1-9 Data driven model files

index sets - dynamic arrays [P-3.6] [P-3.7] - run-time parameters [P-3.8] - data driven model files

5.00 *close*

Day 2

   9.00   *welcome*

   9.15   **Mixed Integer Programming**

       2-1   MIP formulation basics

           binary variables - logical conditions - minimum activity level - fixed costs - disjunctions - integer variables - batch sizes [P-7] [P-8]

  10.30   *break*

       2-2   Advanced MIP formulations

           formulating models - standard model formulations - assignment problem - knapsack problem - set covering, packing and partitioning problems [P-9] *- MIP formulation techniques - minimum values - maximum values - absolute values - binary variables: minimum, maximum, multiplication - product values - special ordered sets (type 2) - price breaks - non-linear functions* [P-3.9]

       2-3   Basic concepts and solution techniques

           definition - applications - branch and bound - cut-off - best bound - presolve - strong formulations - branch and cut

  12.30   *lunch*

           Embedding Models in Applications

       2-4   Introduction to the Mosel API

           initialization - compilation - execution [P-10.1]

   2.30   *break*

           Executing a model

           executing a model source file - setting model parameters [P-10.2] *- deploying with IVE* [P-10.3]

           Accessing solution statistics

           model pointers - using the model return code - solution status - objective value [P-10.4]

   4.30   *questions*

   4.30   *close*

[P] indicates practical work, with a reference to the project number in the projects handout.

Further reading

Getting Started with Xpress. Dash Optimization, 2003.

C. Guéret, C. Prins, M. Sevaux (ed./trans. S. Heipcke). **Applications of Optimization with Xpress-MP**. Dash Optimization, 2002. ISBN 0-9543503-0-8.

V. Chvatal. **Linear Programming**. W H Freeman, 1983. ISBN 0-716-71587-2.

H.A. Taha. **Operations Research: An Introduction** (fourth edition). Prentice Hall, 1992. ISBN 0-131-87659-7.

L. Wolsey. **Integer Programming**. John Wiley & Sons, 1998. ISBN 0-471-28366-5.

H.P. Williams. **Model Building in Mathematical Programming** (fourth edition). John Wiley & Sons, 1999. ISBN 0-471-92580-2.