In the name of God

Part 3. ILOG CPLEX

3.1. Introducing ILOG CPLEX

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Overview

- **ILOG CPLEX** is a tool for solving linear optimization problems, commonly referred to as **Linear Programming (LP)** problems
- CPLEX is named for the SIM**PLEX** method and the **C** programming language
- History:
  - It was originally developed by **Robert E. Bixby** and sold via **CPLEX Optimization Inc**.,
  - **CPLEX Optimization Inc** was acquired by **ILOG** in 1997
  - ILOG was subsequently acquired by **IBM** in January 2009.

Overview

- **Linear Programming (LP)** problem form:

Maximize (or Minimize) $c_1 x_1 + c_2 x_2 + \ldots + c_n x_n$

subject to

$$a_{11} x_1 + a_{12} x_2 + \ldots + a_{1n} x_n \sim b_1$$

$$a_{21} x_1 + a_{22} x_2 + \ldots + a_{2n} x_n \sim b_2$$

$$\ldots$$

$$a_{m1} x_1 + a_{m2} x_2 + \ldots + a_{mn} x_n \sim b_m$$

with these bounds

$$l_1 \leq x_1 \leq u_1$$

$$\ldots$$

$$l_n \leq x_n \leq u_n$$

Overview

- where
  - ~ can be ≤, ≥, or =, and
  - the upper bounds u_i lower bounds l_i may be positive infinity, negative infinity, or any real number.
- The elements of data you provide as input for this LP are:

Objective function coefficients	$c_1, c_2, \ldots, c_n$
Constraint coefficients	$a_{11}, a_{21}, \ldots, a_{n1}$
	...
	$a_{m1}, a_{m2}, \ldots, a_{mn}$
Righthand sides	$b_1, b_2, \ldots, b_m$
Upper and lower bounds	$u_1, u_2, \ldots, u_n$ and $l_1, l_2, \ldots, l_n$

Overview

- The **optimal solution** that ILOG CPLEX computes and returns is:

$$\text{Variables} \quad x_1, \; x_2, \; \ldots \; , \; x_n$$

Overview

- ILOG CPLEX also can solve several extensions to LP:
  - **Network Flow problems**
    - a special case of LP that CPLEX can solve much faster by exploiting the problem structure.
  - **Quadratic Programming (QP) problems**
    - where the LP objective function is expanded to include quadratic terms.
  - **Quadratically Constrained Programming (QCP) problems**
    - that include quadratic terms among the constraints.
  - **Mixed Integer Programming (MIP) problems**
    - where any or all of the LP, QP, or QCP variables are further restricted to take integer values in the optimal solution

ILOG CPLEX components

- **ILOG CPLEX components**
  - **CPLEX Interactive Optimizer**
  - **Concert Technology**
  - **CPLEX Callable Library**

ILOG CPLEX components

- **CPLEX Interactive Optimizer**
  - It is an executable program that can read a problem interactively or from files in certain standard formats,
  - It solves the problem, and deliver the solution interactively or into text files.
  - The program consists of the file **cplex.exe** on Windows platforms.

ILOG CPLEX components

- **Concert Technology**
  - It is a set of C++, Java, and .NET class libraries offering an API that includes modeling facilities to allow the programmer to embed CPLEX optimizers in C++, Java, or .NET applications.
  - Concert Technology libraries. lists the files that contain the libraries.

ILOG CPLEX components

- **Concert Technology libraries**

	Microsoft Windows
C++	`ilocplex.lib concert.lib`
Java	`cplex.jar`
.NET	`ILOG.CPLEX.dll` ILOG.Concert.dll

ILOG CPLEX components

- **CPLEX Callable Library**
  - It is a C library that allows the programmer to embed ILOG CPLEX optimizers in applications written in C, Visual Basic, FORTRAN, or any other language that can call C functions.

Optimizer Options

	LP	Network	QP	QCP	MIP
Dual Optimizer	yes		yes		
Primal Optimizer	yes		yes		
Barrier Optimizer	yes		yes	yes	
Mixed Integer Optimizer					yes
Network Optimizer	Note 1	yes	Note 1		
Note 1: The problem must contain an extractable network substructure.					

References

References

- ILOG CPLEX, **Getting Started with ILOG CPLEX,** ILOG CPLEX, 2008.

The End