CSC5240: Tutorial #4

Spencer Fung
8 Oct, 2003
Tools for Optimization

- **ILOG CPLEX** is a tool for solving linear optimization and related problems.
- **SICStus Prolog** real arithmetic libraries includes an implementation of the simplex algorithm.
- In short, they solve linearly constrained optimization problems where the objective to be optimized can be expressed as a linear function.
ILOG CPLEX comes in three forms to meet various users' needs.

- **Interactive Optimizer** is an executable program that can read a problem interactively, solve the problem, and deliver the solution interactively.

- **Concert Technology** is a set of libraries offering an API that includes modeling facilities to allow the programmer to embed ILOG CPLEX optimizers in C++ and Java applications.

- **Callable Library** 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.
The procedure of solving a LP in CPLEX.

1. Enter the problem name
2. Define the objective function min or max
3. Define the constraints (st)
4. Define the bounds for each variables
5. End the problem declaration with the keyword “end”

Solve the problem by typing optimize.
How to read the results?

- Enter the display menu to read the solution and other information you are interested.
- CPLEX> display solution

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>basis</td>
<td>display a range of basic constraints or variables</td>
</tr>
<tr>
<td>bestbound</td>
<td>display the current MIP best bound</td>
</tr>
<tr>
<td>dual</td>
<td>display a set of solution dual values</td>
</tr>
<tr>
<td>kappa</td>
<td>display the condition number of the basis matrix</td>
</tr>
<tr>
<td>objective</td>
<td>display solution objective value</td>
</tr>
<tr>
<td>quality</td>
<td>display quality of solution</td>
</tr>
<tr>
<td>reduced</td>
<td>display a set of solution reduced costs</td>
</tr>
<tr>
<td>slacks</td>
<td>display a set of solution slack values</td>
</tr>
<tr>
<td>variables</td>
<td>display a set of solution variable values</td>
</tr>
</tbody>
</table>
This clp(Q,R) system is an instance of the general Constraint Logic Programming scheme introduced by [Jaffar & Michaylov 87].

SICStus Prolog offers the user an interactive programming environment with tools for incrementally developing programs.

Under UNIX shell, SICStus Prolog is started by typing,

```bash
> sics [options] [-a argument...]
```
The system presents a prompt to the user

```
?-
```

In order to use the arithmetic constraint solving facilities one needs to load one of the constraint solving libraries wither by typing:

```
?- use_module(library(clpq)).
```

To load the rational number solver, or

```
?- use_module(library(clpr)).
```

To load the floating point solver.
Solving LP

- Use the float point solver to invoke simplex algorithm.

- Two functions to define the problem objectives: \( \text{inf} \) and \( \text{sup} \).
  - \( \text{inf} \) (infimum) represents minimization
  - \( \text{sup} \) (supremum) represents maximization
How does it solve the problem?

- To minimize
  - $3X + 2Y - Z + 1$

- Subject to
  - $X + Y = 3$
  - $-X - 3Y + 2Z + T = 1$
  - $X \geq 0$ and $Y \geq 0$ and $Z \geq 0$ and $T \geq 0$

- We can type

  ```
  $3X + 2Y - Z + 1$,
  $X \geq 0$, $Y \geq 0$, $Z \geq 0$, $T \geq 0$,
  inf($3X + 2Y - Z + 1$, Inf).
  ```
Try this...

Minimize

-3X - 2Y - 4Z

Subject to

X + Y + 2Z ≤ 42
X + 2Z ≤ 52
X + Y + 3Z ≤ 7

Where X ≥ 0, Y ≥ 0, Z ≥ 0
References

- http://www.sics.se/isl/sicstus.html
- http://www.ubmail.ubalt.edu/~harsham/opre640A/partIV.htm
- http://www.grabitech.com/simplex_b.htm
- http://www.isye.gatech.edu/~spyros/LP/LP.html
Any Questions...