

Software Packages

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We would like to acknowledge Prof. W.L. Winston's "Operations Research: Applications and Algorithms" (slides submitted by Brooks/Cole, a division of Thomson Learning, Inc.) and Prof. J.E. Beasley's lecture notes which greatly influence these notes...

We retain responsibility for all errors and would love to hear from readers...

LINDO

LINDO

- Linear, **I**Nteractive, and **D**iscrete **O**ptimizer
 - A software for solving
 - Linear Programming
 - Integer Programming
 - Quadratic Programming
 - The underlying algorithm used by LINDO's internal engine is the Revised Simplex Method with Product form Inverse.
-

Classic LINDO Trial Version

- 150 constraints
- 300 variables
- 30 Integer variables

Installing Lindo

- Install trial version of Classic LINDO

<https://www.lindo.com/index.php/ls-downloads>

- by downloading the Lindo 6.1 zip file

<https://www.lindo.com/downloads/Ind61.zip>




User's Manual

<https://www.lindo.com/index.php/ls-downloads/user-manuals>

LINDO

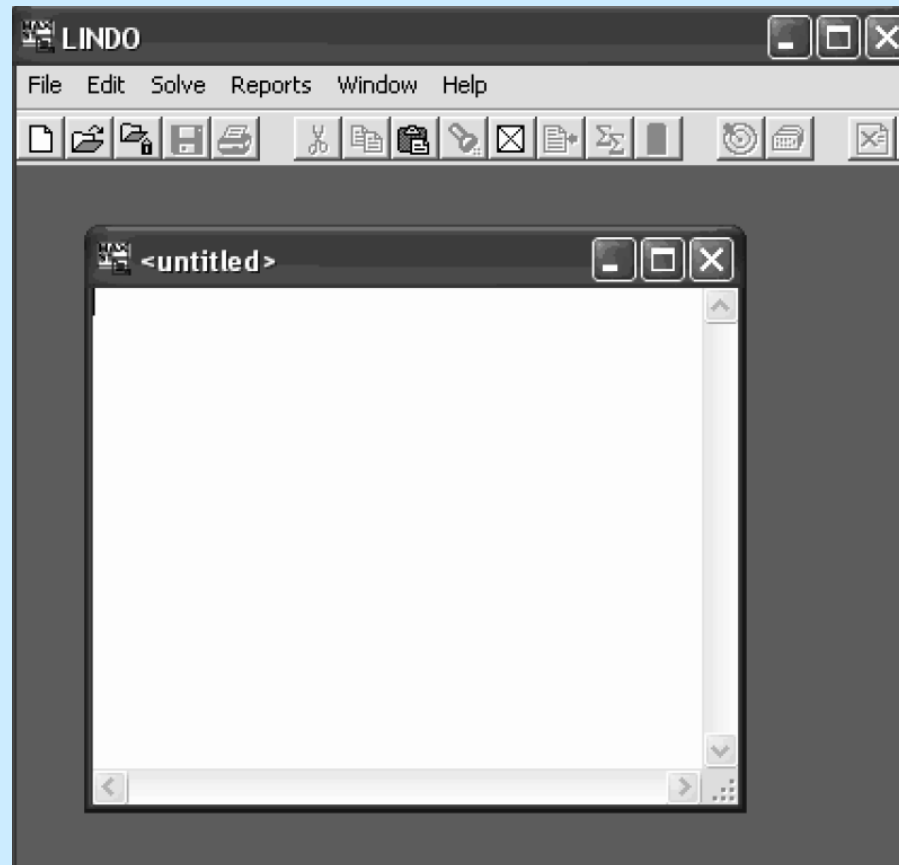
User's Manual

LINDO Systems, Inc. 

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E-mail: info@lindo.com
WWW: <http://www.lindo.com>

Opening Window

- When you start LINDO, there will be a blank window



Entering a model

- A LINDO model has a minimum requirement of three things:
 - an objective
 - variables
 - constraints
 - The first word in a model must be either **MAX** or **MIN**
 - After MAX or MIN, enter the **formula** (*objective function*)
 - The variables of the formula are *decision variables*
 - Enter the letters **ST** (subject to, s.t.) on the next line
 - Enter the *constraints* in the following lines in the order of
 - **Formula, constraint sign** (<, >, =), **constant**
 - The end of the constraints is signified with the word **END**
-

Modeling Statements

- They may appear after the **END** statement in a mode
 - **FREE** continuous variable
(The default: sign restriction ' ≥ 0 ')
 - **GIN** integer variable
 - **INT** 0-1 variable

Model Syntax

- LINDO has a limit of eight characters in the names of variables and constraints
- Names must begin with an alphabetic character followed by additional characters with the exception of the following: !) + - = < >
- LINDO is not case sensitive. All input is converted to upper case internally by LINDO
- LINDO recognizes only five operators: +, -, >, <, =
- LINDO will not accept parentheses as indicators of a preferred order of precedence. All operations in LINDO are ordered from left to right.

4 (x1 + x2) *WRONG*

4 x1 + 4 x2 *RIGHT*

Model Syntax

- Only variables and their coefficients are permitted on the left-hand side of a constraint equation
 - Only constant values are permitted on the right-hand side of a constraint equation
 - Objective functions and constraints may be split over multiple lines
 - Comments may be placed anywhere in a model
A comment is denoted by an exclamation mark '!'
Anything following the exclamation mark on the current line will be considered as a comment.
 - To name a constraint, you must start the constraint with its name terminated with a right parenthesis ')'
-

Example: A staff scheduling model

! X<day> = Number of employees we start on day <day>

MIN 100 XMON + 100 XTUE + 100 XWED + 100 XTHU + 100 XFRI
+ 100 XSAT + 100 XSUN

SUBJECT TO

SUN) XWED + XTHU + XFRI + XSAT + XSUN >= 18

MON) XMON + XTHU + XFRI + XSAT + XSUN >= 16

TUE) XMON + XTUE + XFRI + XSAT + XSUN >= 15

WED) XMON + XTUE + XWED + XSAT + XSUN >= 16

THU) XMON + XTUE + XWED + XTHU + XSUN >= 19

FRI) XMON + XTUE + XWED + XTHU + XFRI >= 14

SAT) XTUE + XWED + XTHU + XFRI + XSAT >= 12

END

GIN 7

Formulation Report

- Select the **Formulation** command from the **Reports menu**
 - Select **All** for rows to view
 - There will now be a new window on your screen titled "Reports Window"
-

Solving the model

- Select the **Solve** command from the **Solve menu**
 - LINDO will begin by trying to compile the model
 - If there are errors, it displays "Lindo Error Message Window"
 - If there are no errors, it displays a "Status Window"
 - When the solver is finished, it will prompt you to determine if you wish to do sensitivity and range analysis.
 - Optimal solution (and allowable ranges) will be inserted at the "Reports Window"
-

OPEN SOLVER

OpenSolver

- An Excel VBA add-in that extends Excel's built-in Solver with more powerful solvers
 - OpenSolver is free, open source software
 - No limits on the size of problem you can solve
As many variables and constraints as your computer memory allows
Be aware that large problems can be slow to solve
-

OpenSolver

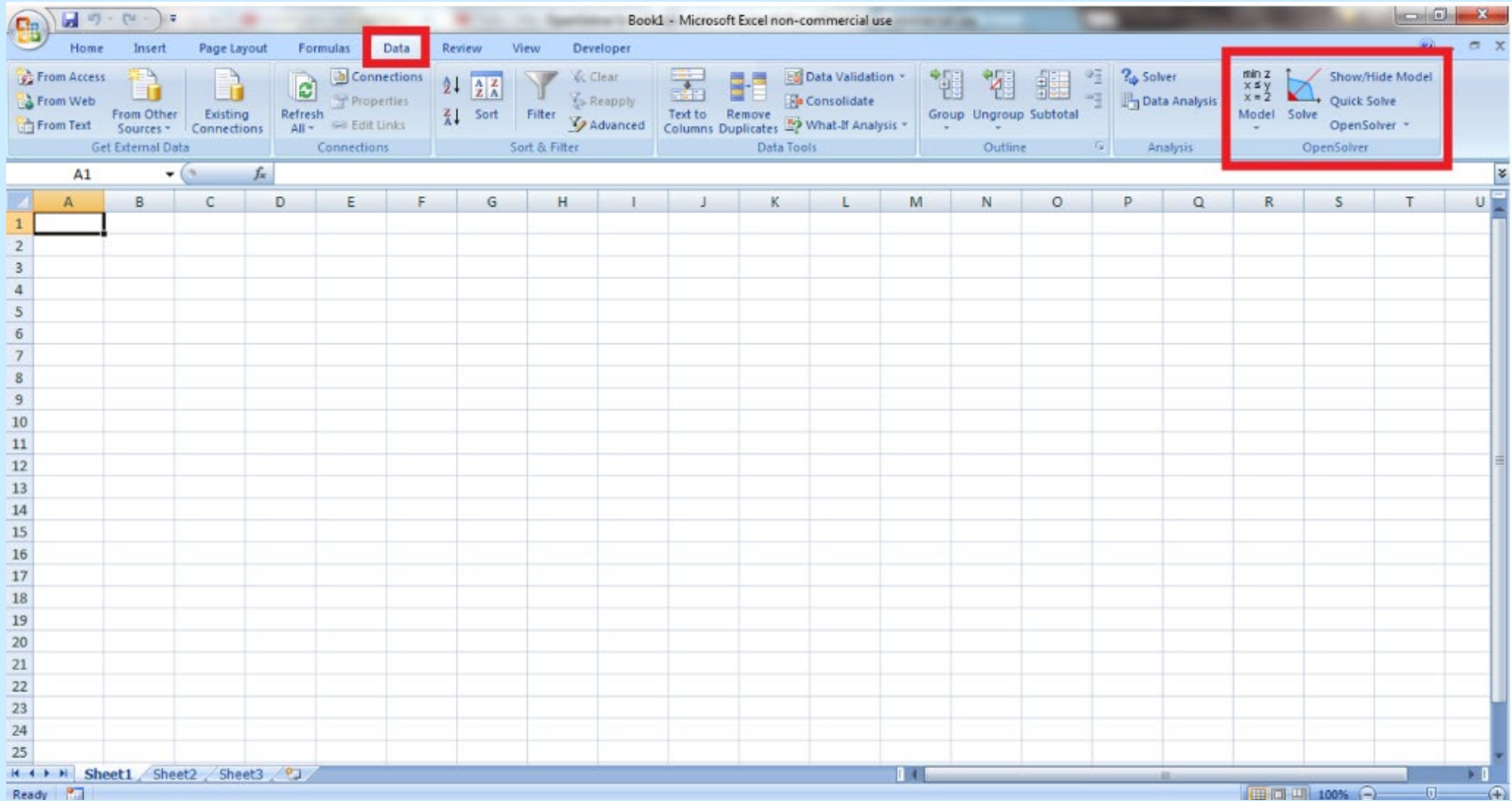
- OpenSolver offers a range of solvers for use in Excel, including Open Source, [COIN-OR CBC optimization engine](#) which can solve large Linear and Integer problems.
-

Installing OpenSolver

- Install freeware OpenSolver
<https://opensolver.org/installing-opensolver/>
 - by downloading the OpenSolver Linear zip file
<https://sourceforge.net/projects/opensolver/files/latest/download>
 - Extract the files from the .zip file to create your **OpenSolver folder**
 - Then double click on the **OpenSolver.xlam** file. This will open Excel and load OpenSolver
 - A window will automatically pop-up in Excel, click "Enable Macros"
-

Installing OpenSolver

- You can now find OpenSolver in your "Data" tab in Excel on the top right side of your spreadsheet



Installing OpenSolver

- In the Data tab, **Click OpenSolver – About OpenSolver**
- Check the box “Load OpenSolver when Excel Starts”

The screenshot shows the Microsoft Excel interface with the Data tab selected in the ribbon. The OpenSolver menu option is highlighted in the ribbon. The OpenSolver - About dialog box is open, displaying the following information:

OpenSolver
Version 2.9.0 (2017.11.10) running on 64-bit Windows 10.0 with VBA7 in 64-bit Excel 16.0
<http://www.OpenSolver.org>

Copyright (c) 2011-2017: Andrew J. Mason
Developed by Andrew Mason, Iain Dunning and Jack Dunn, with coding assistance by Kat Gilbert, Matthew Milner, Kris Atkins.
Various contributions have been made by Andres Sommerhoff, and assistance with Mac version was given by Zhanibek Datbayev.
Department of Engineering Science
University of Auckland, New Zealand

Excel 2003 Menu Code
Provided by Paul Becker of Eclipse Engineering (<http://www.eclipseeng.com>)

OpenSolver allows the Coin-OR CBC optimization engine to be used to solve linear integer programming problems in Excel as well as the NOMAD optimization engine to solve non-linear programming problems. OpenSolver also offers the choice of solving linear problems with the Gurobi optimizer if this is installed.

OpenSolver is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License, or (at your option) any later version. License copyright years may be listed using range notation (e.g. 2011-2016) indicating that every year in the range, inclusive, is a copyrightable year that would otherwise be listed individually.

The COIN-OR solvers (CBC, Couenne and Bonmin) are licensed under the Eclipse Public License while the NOMAD software is subject to the terms of the GNU Lesser General Public License.

OpenSolver is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details. You should have received a copy of the GNU General Public License along with OpenSolver. If not, see <http://www.gnu.org/licenses/>

OpenSolver is correctly installed ✓

OpenSolver file: "C:\Program Files\OpenSolver2.9.0_LinearWin\OpenSolver.xlam"

Load OpenSolver when Excel starts

Buttons: Check for updates, Update Check settings..., OK

The OpenSolver menu in the Data tab ribbon is open, showing the following options:

- Set Quick Solve Parameters...
- Initialize Quick Solve
- Solve Relaxation
- View Last Model .lp File
- View Last AMPL File
- View Last Log File
- View Last CBC Solution File
- Open Last Model in CBC...
- View Last Gurobi Solution File
- Online Help...
- About OpenSolver...**
- About Coin-OR...
- Open OpenSolver.org
- Open COIN-OR.org

User's Manual

<https://opensolver.org/using-opensolver/>

Example

	A	B	C	D	E	F	G
1							
2		Desks	Tables	Chairs			
3							
4		60	30	20			
5		8	6	1		48	
6		4	2	1.5		20	
7		2	1.5	0.5		8	
8			1			5	
9							
10							

Example

	A	B	C	D	E	F
1						
2		Desks	Tables	Chairs		
3						
4		60	30	20	=SUMPRODUCT(B\$3:D\$3;B4:D4)	
5		8	6	1	=SUMPRODUCT(B\$3:D\$3;B5:D5)	48
6		4	2	1.5	=SUMPRODUCT(B\$3:D\$3;B6:D6)	20
7		2	1.5	0.5	=SUMPRODUCT(B\$3:D\$3;B7:D7)	8
8			1		=SUMPRODUCT(B\$3:D\$3;B8:D8)	5
9						
10						

Example

The screenshot shows Microsoft Excel with a linear programming problem set up in a spreadsheet. The spreadsheet has columns for Desks, Tables, and Chairs, and rows for resource constraints. The Solver tool is open, and the 'Model' option is highlighted.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1																			
2		Desks	Tables	Chairs															
3																			
4		60	30	20	0														
5		8	6	1	0	48													
6		4	2	1.5	0	20													
7		2	1.5	0.5	0	8													
8			1		0	5													
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			

The Solver tool is open, and the 'Model' option is highlighted. The Solver Parameters dialog box is visible, showing the objective function and constraints.

min z
x ≤ y
x = z
Model Solve Quick Solve
OpenSolver -
Model...
Quick AutoModel
AutoModel And Solve
Solver Engine...
Options...

Example

OpenSolver - Model

What is AutoModel?

AutoModel is a feature of OpenSolver that tries to automatically determine the problem you are trying to optimise by observing the structure of the spreadsheet. It will turn its best guess into a Solver model, which you can then edit in this window.

Objective Cell: \$E\$4

maximise minimise target value: 0

Variable Cells: \$B\$3:\$D\$3

Constraints:

<Add new constraint>

Make unconstrained variable cells non-negative

Show named ranges in constraint list

Sensitivity Analysis

List sensitivity analysis on the same sheet with top left cell: []

Output sensitivity analysis: updating any previous output sheet on a new sheet

Solver Engine: Current Solver Engine: CBC

Show model after saving

Clear Model Options... Save Model Cancel

	A	B	C	D	E	F
1						
2		Desks	Tables	Chairs		
3						
4		60	30	20	0	
5		8	6	1	0	48
6		4	2	1.5	0	20
7		2	1.5	0.5	0	8
8			1		0	5
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						

Example

Book1.xlsx - Excel

File Home Insert Page Layout Formulas Data Review View Acrobat Tell me what you want to do... Share

Get External Data New Query Recent Sources Get & Transfor... Show Queries From Table Refresh All Edit Links Connections Properties Edit Links

OpenSolver - Model

What is AutoModel? AutoModel

AutoModel is a feature of OpenSolver that tries to automatically determine the problem you are trying to optimise by observing the structure of the spreadsheet. It will turn its best guess into a Solver model, which you can then edit in this window.

Objective Cell: maximise minimise target value:

Variable Cells:

Constraints:

<Add new constraint>

model!\$E\$5:\$E\$8

model!\$F\$5:\$F\$8

Add constraint Cancel

Delete selected constraint

Make unconstrained variable cells non-negative

Show named ranges in constraint list

Sensitivity Analysis List sensitivity analysis on the same sheet with top left cell:

Output sensitivity analysis: updating any previous output sheet on a new sheet

Solver Engine: Current Solver Engine: CBC Solver Engine...

Show model after saving Clear Model Options... Save Model Cancel

	A	B	C	D	E	F
1						
2		Desks	Tables	Chairs		
3						
4		60	30	20	0	
5		8	6	1	0	48
6		4	2	1.5	0	20
7		2	1.5	0.5	0	8
8			1		0	5
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						

model

Ready

20°C Sunny 17:43 23.10.2021

Example

Book1.xlsx - Excel

File Home Insert Page Layout Formulas Data Review View Acrobat Tell me what you want to do... Share

Get External Data New Query Recent Sources Get & Transform

Show Queries From Table Refresh All Edit Links Connections Properties Edit Links

OpenSolver - Model

What is AutoModel? AutoModel

AutoModel is a feature of OpenSolver that tries to automatically determine the problem you are trying to optimise by observing the structure of the spreadsheet. It will turn its best guess into a Solver model, which you can then edit in this window.

Objective Cell: model!\$E\$4 maximise minimise target value: 0

Variable Cells: model!\$B\$3:\$D\$3

Constraints:

<Add new constraint>

\$E\$5:\$E\$8 <= \$F\$5:\$F\$8

\$F\$5:\$F\$8

Update constraint Cancel

Delete selected constraint

Make unconstrained variable cells non-negative

Show named ranges in constraint list

Sensitivity Analysis List sensitivity analysis on the same sheet with top left cell:

Output sensitivity analysis: updating any previous output sheet on a new sheet

Solver Engine: Current Solver Engine: CBC Solver Engine...

Show model after saving Clear Model Options... Save Model Cancel

model

Sum Product: =SUMPRODUCT(B\$3:D\$3;B\$4:D\$4)

	A	B	C	D	E	F
1						
2		Desks	Tables	Chairs		
3						
4		60	30	20	0	
5		8	6	1	0	48
6		4	2	1.5	0	20
7		2	1.5	0.5	0	8
8			1		0	5
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						

Average: 10.125 Count: 8 Sum: 81

20°C Sunny 17:25 23.10.2021

Example

Book1.xlsx - Excel

File Home Insert Page Layout Formulas Data Review View Acrobat Tell me what you want to do... Share

Get External Data - New Query - Recent Sources - Get & Transform

Refresh All - Properties - Edit Links - Connections

Sort Filter - Clear - Reapply - Advanced - Sort & Filter

Text to Columns - What-If Analysis - Forecast Sheet - Data Tools

Group - Ungroup - Subtotal - Outline

Data Analysis - Solver - Analyze

min z
x ≤ y
x = 2
Model Solve - OpenSolver - OpenSolver

Show/Hide Model Quick Solve

AK5

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
1																				
2		Desks	Tables	Chairs																
3		2	0	8																
4		60	30	20	280															
5		8	6	1	24	48														
6		4	2	1.5	20	20														
7		2	1.5	0.5	8	8														
8			1		0	5														
9																				
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21																				

model

Ready

18°C Sunny 17:56 23.10.2021