Software Packages

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

LINDO

LINDO

- **L**inear, **IN**teractive, 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/lnd61.zip

User's Manual

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

LINDO

User's Manual

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Opening Window

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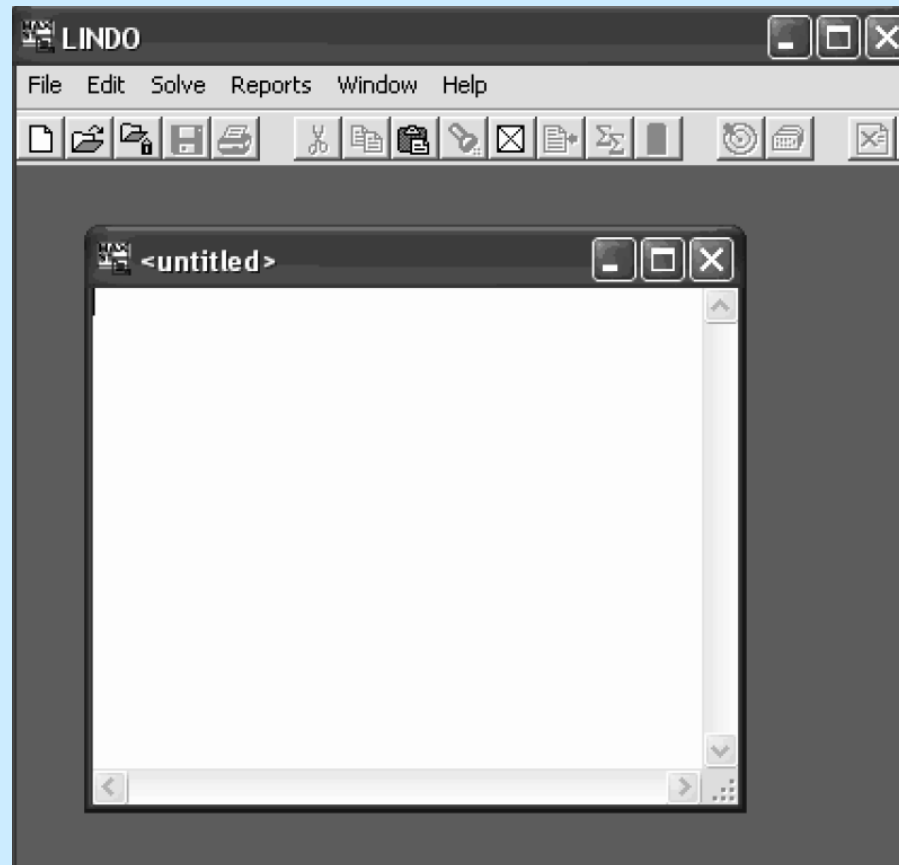
Entering a model

- 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** urs 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  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 diplays "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
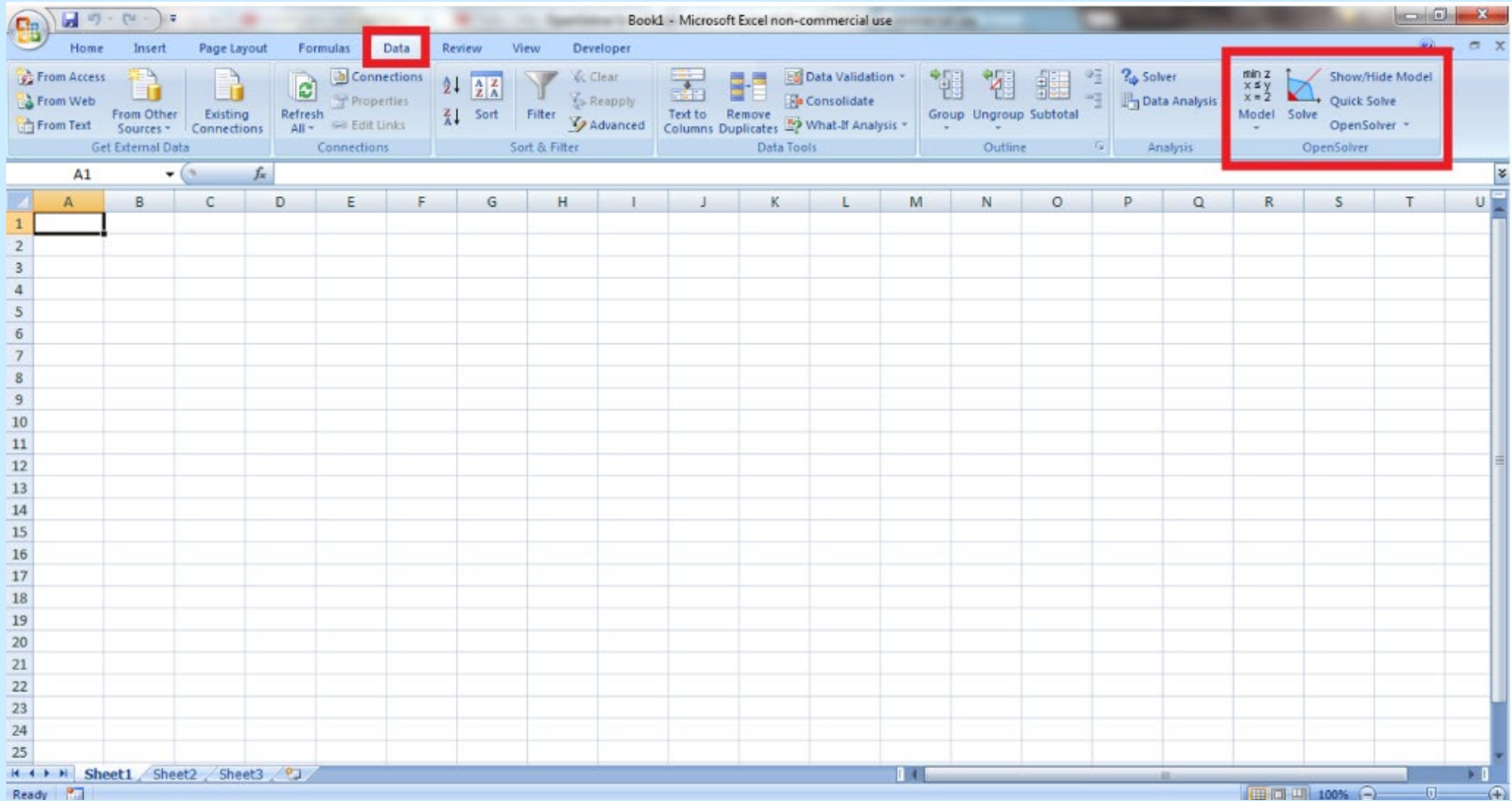
Installing OpenSolver

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

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

Example

Example

Example

Example

Example

	A	B	C	D	E	F
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