Electimax Manual

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Version 1.0

1. Introduction

Electimax is a piece of software designed to solve multiple-choice capital budgeting problems (also known as multiple-choice knapsack problems [1]). In such problems each item has two properties (i.e. features), namely cost and value. The items are divided into classes, and exactly one item is chosen from each class. Electimax uses a sophisticated algorithm to find the most valuable combination of items without going over budget with respect to the cost.

1.1. Example

For example consider a budgeting problem with 3 classes of fruit (see table 1). There are 2 items in the Apples class and 3 items in each of the other classes. Note: this problem is available as a file called “Demo1.emx” that can be loaded into Electimax.

Class	Item	Value	Cost
Apples	Gala	4	1
Apples	Golden Delicious	7	3
Pears	Conference	2	1
Pears	Comice	1	2
Pears	Bartlett	5	4
Oranges	Common	8	1
Oranges	Blood	9	5
Oranges	Navel	12	8

Table 1

In this example, in the Pears class, the Comice item is dominated by the Conference item therefore can be eliminated. This is because the Conference item has a higher value and is less costly than the Comice item. With an example budget of 10 units table 2 enumerates all of the remaining combinations (note: Electimax does not use explicit enumeration to solve such problems as this is not possible with larger problems, due to the number of combinations that would need to be checked). The feasible (within budget) combinations are indicated with by a tick in the last column.

Apples Item	Pears Item	Oranges Item	Total Value	Total Cost	Feasible
Gala	Conference	Common	14	3	✓
Gala	Conference	Blood	15	7	✓
Gala	Conference	Navel	18	10	✓
Gala	Bartlett	Common	17	6	✓
Gala	Bartlett	Blood	18	10	✓
Gala	Bartlett	Navel	21	13	✗
Golden Delicious	Conference	Common	17	5	✓
Golden Delicious	Conference	Blood	18	9	✓
Golden Delicious	Conference	Navel	21	12	✗
Golden Delicious	Bartlett	Blood	20	8	✓
Golden Delicious	Bartlett	Navel	21	12	✗
Golden Delicious	Bartlett	Common	24	15	✗

Table 2

So the optimum solution is to choose the items: Golden Delicious, Bartlett and Common. This choice has a total cost of 8 units and a total value of 20 units.

2. Interface

2.1. Main Menu

The main menu in Electimax consists of the following sub-menus: File, Edit, Tools, View and Help. Table 3 describes the options on each sub-menu.

Menu	Option	Description
File	New	Creates a new problem without any classes or items
	Open	Loads a problem from a file
	Save	Saves the current problem to a file
	Save As	Saves the current problem under a potentially different name
	Import	Imports a problem from a CSV file
	Export Problem	Exports a problem to a CSV file
	Export Solution	Exports a solution to a CSV file
	Exit	Exits the application
Edit	Append Class	Appends a new class to the end of the table of classes
	Append Item	Appends a new item to the end of the table of items for the current class

	Insert (Before) Class	Inserts a new class immediately before the currently selected class
	Inset (Before) Item	Inserts a new item immediately before the currently selected item
	Insert (After) Class	Inserts a new class immediately after the currently selected class
	Insert (After) Item	Inserts a new item immediately after the currently selected item
	Delete Class	Deletes the currently selected class
	Delete Item	Deletes the currently selected item
	Preferences	Allows preferences to be edited
Tools	Solve	Solves the current problem, if feasible
	Utility*	Allows values and / or costs in the current problem to be scaled and / or rounded
View	Solution	Shows the solution for the current problem, if it has been solved
Help	About	Shows information about the Electimax program

Table 3

* Not available in the demonstration version.

Files with the “emx” extension saved using “file → save” and “file → save as” can only be loaded using Electimax. If a problem has been solved then its solution will also be saved in the file. Program preferences are not stored with each problem file, rather they are set globally.

2.2. Program Preferences

Table 4 describes the program preferences which can be changed via the edit menu.

Preference	**Description**
CSV Delimiter	Specifies the delimiter to use when importing or exporting CSV files
Field Order	Specifies the field order for the value and cost fields when displaying, importing or exporting fields
Export Indices	Specifies whether the class and item indices should be exported when exporting CSV files

Table 4

3. CSV File Format

The CSV file has the following fields, in order and separated by the specified delimiter:

- budget (i.e. capacity)
  for each item:
- *class name, item name, value, cost (i.e. weight)*
  or
- *class name, item name, cost, value.*

The order of *cost* and *value* fields depends on the field order specified in the preferences.

4. Program Limitations

Note there is no undo function except when reverting changes in the current cell. There can be a maximum of 1024 classes, each with up to 64 items, in the full version of the software.

Should a problem not be solved due to excessive memory use or is taking too long to solve, then the problem can be scaled down i.e. by lowering the resolution of the values or costs. This will make a simpler problem which is easier to solve, but will not necessarily produce a solution which is optimal for the original problem. To do this use the “utility” function on the “tools” menu. For example to convert the values to the nearest even number set the “field(s)” parameter to “value”, the “scale” parameter to 1 (i.e. no change there) and the “round” parameter to 2. Such a procedure can be repeated in a similar way if necessary. Be careful to keep a backup of the original problem before using this utility and saving the problem. Note that the budget will not be changed by the utility if the costs are changed.

5. Reference

[1] Kellerer, Hans, Pferschy, Ulrich, Pisinger “Knapsack Problems”, Springer-Verlag 2010.