

-WISDOM-

a Weightless Incremental Selection, Decision and Ordering Method

by Kees van Overveld
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1. Introduction

A very common problem in virtual all design situations is the selection of a single best concept from a list of options, say different means for transportation, such as 'train', 'bus', 'car', 'bicycle'. The notion of 'best' is usually expressed in terms of a number of quality criteria, such as 'price', 'energy consumption', 'safety', et cetera. A common way to approach such selection problems is to develop a matrix of the form

	price	energy consumption	safety
train			
bus			
car			
bicycle			

Next, all cells in the matrix are assigned some ordinal value (e.g., a number between 1 – 10). Finally, the various criteria are assigned weights (e.g., expressing that safety is twice as important as price, etc.), and for each concept the total score is computed as the sum over all cell values multiplied by the weight of the respective criterion. The concept with the highest score is assumed to be 'the best'.

There are several shortcomings with this method.

1. for many criteria, it is not at all clear what values to fill in in the cells. For instance, 'train' is probably safer than 'car', but is it twice as safe, or just 5% safer. Even more importantly: it is not clear if the numerical value really matters. It could be that the same assignment of 'the best' concept would have been obtained with very different numerical entries – on the other hand, it could be that small differences in numerical values lead to different assignments of 'the best';
2. the assignment of numerical weights to criteria is highly dubious;
3. the final outcome can only be assessed after the entire exercise is completed. As a consequence, we have little idea of the importance (or the sensitivity) of a particular numerical value in the table. This often causes a large amount of discussion that, in the end, may turn out to be pointless;
4. finally, the requirement to fill in all entries of the table may suggest that all concepts are fully ordered with respect to all criteria. This may not at all correspond to our intuition. Suppose, for instance, that with respect to 'safety' we would assign, respectively, (9,7,7,5) for (train, bus, car, bicycle). This may be partially justifiable: it could be that we find that train is safer than bicycle, and bus is also safer than bicycle. But it may very well be that we have no intuition as to the relative safety of bus and car; still we are enforced to put

some numbers there. Assigning a 7 to both of them gives the wrong impression – as if we would think they are equally safe.

A method that does not suffer from these shortcomings should be characterized by the following characteristics:

1. Rather than absolute (ordinal) values, we should give our opinions in the form of 'better than' or 'worse than'. Most often, this is much easier and requires substantially less discussion;
2. the same applies for weights: we probably can give statements such as 'safety is more important than price', but we may not be able to assign numerical values to safety and price;
3. the selection process is an incremental process. Opinions can arise one by one, and every new observation may cause a change of the currently 'best' option. A system to select 'the best' concept should therefore allow incremental operation;
4. the system should be able to give the best possible verdict based on partial information. That is: given any amount of opinions of the form 'a is better than b' (for concepts with respect to criteria) and/or 'a is more important than b' (with respect to criteria), the system should inform us about the currently best estimate for which concept is optimal.

The WISDOM-system (a Weightless Incremental Selection, Decision and Ordering Method) is a tool that supports selection processes in accordance with the above characteristics. Elsewhere (see XXX) we report on the theoretical background of WISDOM; this document gives a manual to operate the WISDOM system.

2. Manual

2.1 Components

WISDOM is a Visual Basic application running within MS EXCEL® . It consists of a worksheet, two selection boxes and three buttons. See figure 1.

train	price		train	bus	car	bicycle	
bus	energy	price	train	0	0	0	-1
car	safety		bus	0	0	0	0
bicycle			car	0	0	0	0
			bicycle	1	0	0	0
clicking means 'more'			train	bus	car	bicycle	
clicking means 'less'		energy	train	0	0	0	0
			bus	0	0	0	0
			car	0	0	0	0
			bicycle	0	0	0	0
sloppy			train	bus	car	bicycle	
relaxed		safety	train	0	0	0	0
strict			bus	0	0	0	0
very strict			car	0	0	0	0
			bicycle	0	0	0	0
running or maintenance			price	energy	safety		
			price	0	1	0	
			energy	-1	0	-2	
			safety	0	2	0	
build tables							
reset tables							

2.1.1 The worksheet

In the worksheet, the leftmost column (column A) contains the concepts from which we want to select the best one. The second column (column B) contains the criteria that should be used to make the selection. The entries in these two columns are entered by the user; all other tables are automatically generated by WISDOM when the button 'build tables' is pressed (see section 2.2) . The concepts and criteria entries are entered from the top row downwards. WISDOM can handle up to 30 concepts and 30 criteria in one simultaneous selection session.

To the right of the user-entered columns, we find the tables that are generated by WISDOM. For N concepts (in our example, N=4) and M criteria (in our example, M=3), WISDOM generates M tables with N x N entries and one table with M x M entries. The first M tables contain, for each criterion C, all opinions of the form 'concept A is, with respect to criterion C, better (or worse) than concept B'. In case no such opinion has (yet) been issued, the entry contains a '0'. If there is a '1' on the row corresponding to concept A and the column corresponding to concept B, this means 'A is better than B'. For instance, with respect to 'price', the concept 'bicycle' is better than the concept 'train'. In the

same situation, the row corresponding to B and the column corresponding to A contains a '-1', meaning that 'B is worse than A'. If a cell contains '2' or '-2', this means 'much better' (or: 'much worse'). Similar, '3' ('-3') means 'much, much better' ('much, much worse'), et cetera. Notice that any two entries that are symmetric with respect to the main diagonal of a table have opposite sign and equal absolute value. For easier reference, entries in the tables are color encoded. Positive values are warm colors (orange, red) and negative values are cold colors (cyan, green). Neutral (=value 0: no opinion has been given) is encoded as yellow.

Every row in each of the first M tables is labeled by the name of one of the concepts. These names are color-encoded as well, on the basis of the criterion of the present table. So, since the label 'train' in the first row of the first table is orange and 'bicycle' is light green, this means that, as far as 'price' is concerned, 'train' is relatively inferior to 'bicycle' with respect to 'price'.

Below the first M tables that each correspond to one of the criteria, there is one final M x M table where the relative importance of all pairs of criteria are administrated. The same conventions apply both to values in the cells and color encoding. The present example can be interpreted as :

- price is more important than energy;
- safety is much more important than energy;
- as a result, energy is 'quite unimportant' (dark orange); price is slightly important and safety is quite important.

2.1.2 The selection boxes

WISDOM contains two selection boxes. These are the light blue rectangular areas underneath the concepts and criteria columns.

The text in the boxes appears when a new session is started, that is after the green button containing the text 'build tables' is pressed (see below).

The topmost selection box allows choosing between two options: whether opinions are expressed as 'A is better (more important) than B' or 'A is worse (less important) than B'. In section 2.2 we explain how an opinion is entered into the system by means of clicking cells in one of the two leftmost columns but now we know that the interpretation of clicking these cells is determined by the present setting of the topmost selection box.

The lowermost selection box allows controlling the algorithm that derives the final verdict (=which concept is the best according to all entered opinions). As we explain in elsewhere (see XXX), there is a parameter involved in the derivation of the verdict. If this parameter is set to a very low value, we can draw conclusions after relatively few opinions have been entered, but these conclusions are not very rigorously justified; if the parameter has a high value, we can only draw conclusions after more (extreme) opinions have been entered, but these conclusions are more rigorously justified.

2.1.3 The buttons

There are three buttons in WISDOM. The topmost button is yellow and it determines in which of two states the program is. These states are 'running' and 'maintenance', and clicking the button toggles from one state to the other.

the maintenance state

In this state, a new problem setting can be entered. That is, we can type concepts in column A and criteria in column B. In this state, WISDOM acts exactly the same as EXCEL without any macros in action: cells can be coloured, moved, deleted, copied, pasted, ... Make sure that there are at least two concepts and two criteria: due to an inconsistency in the operation of EXCEL, WISDOM does not work properly with fewer than 2 concepts or fewer than 2 criteria. In the 'maintenance' state, the red button is disabled (it contains no label and it has no function); the green button is labelled 'build tables'.

Pressing the green button in the 'maintenance' state creates the tables and initialises all entries to 0.

the running state

Clicking the yellow button in the 'maintenance' state switches WISDOM to the 'running' state. In this case, the label of the green button becomes 'make consistent'; the red button is labelled 'reset tables'.

Pressing the green button enforces WISDOM to check the tables for consistency. Suppose that we have entered the opinion 'train is better than car with respect to price', 'car is better than bicycle with respect to price', and 'bicycle is better than train with respect to price'. Each of these opinions may be OK, but they cannot be true simultaneously. This is an example of inconsistency. WISDOM attempts to correct all tables in order to remove consistencies of various kinds. It is advisable to press the 'make consistent' button frequently (at least after every few entered opinions) to avoid large changes in the tables in the case of inconsistencies. Indeed: experience shows that inconsistencies may happen very easily, and the correction of even small inconsistencies may involve many opinions to have to be reset to 0 – which is a waste of effort if many opinions have been entered.

Pressing the red button in the 'running' state clears all tables: all entries are reset to 0.

2.2 Operation

Once a problem definition has been set up, the main purpose of WISDOM is to collect and administrate opinions, to ensure consistency, and to draw conclusions. To perform these actions, the yellow button has to be clicked so that it is in the 'running' state.

In order to enforce consistency checking, the green button, labelled 'make consistent' has to be clicked.

Conclusions are drawn automatically, and the result is constantly updated in the form of colour encoding of the concepts in column A. Initially, all concept entries in column A are coloured yellow (neutral). As soon as WISDOM can draw a conclusion that a concept is inferior to others, it is coloured in some shade of red (orange, dark orange, red or dark red – depending on the amount of evidence). Similarly, as soon as WISDOM can draw a conclusion that a concept is superior to others, it is coloured in some shade of green (cyan, light green, middle green or dark green – depending on the amount of evidence).

In order to enter an opinion, items in the first two columns (concepts and/or criteria) have to be clicked. The following sequences are recognised by WISDOM:

1. click concept A
2. click criterion B
3. click concept C

means: 'concept A is, with respect to criterion B, better than concept C'.

1. click concept A
2. click concept C

means: 'concept A is, with respect to the most recently used criterion, better than concept C'.

1. click concept A
2. (click zero or more times on several criteria)
3. click criterion B
4. click concept C

means: 'concept A is, with respect to criterion B, better than concept C'. In other words, as long as a second concept has not been clicked, we can revise our choice of criterion. In this way, WISDOM allows handling mistakes with respect to the criterion.

1. click criterion A
2. click criterion C

means: 'criterion A is more important than criterion C'.

All the above examples assume that the first selection box has been set to the modus 'click means more'. In the other modus ('click means less'), the opposite opinions are intended.

Every time an opinion has been entered, the affected entries are indicated by a thin borderline, as an aid to memorise which opinions have been entered. A thick border indicates the most recently affected entries.

3 Disclaimer

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Kees van Overveld
k.van.Overveld@wxs.nl