

## **1. A DESKTOP-BASED TOOL TO USE MULTI-ATTRIBUTE UTILITY MODEL**

A desktop-based tool in C# programming language is developed. The tool enables the application of Multi-Attribute Utility model on any discrete asset types. This folder contains

1. A paper that quantify the performance goals and propose a multi-attribute utility model. The proposed model is illustrated on bridge dataset.
2. The dataset used in the paper to illustrate the multi-attribute utility model.
3. A desktop-application developed in C# programming language that implements the concepts of multi-attribute utility model.

Before using the software, ensure that you have read the paper and you have understood the relevant concepts. All the performance goals must be quantified before using the software. You may use the sample data directly. Please note the software works only with numerical input. First install the Setup.exe file given in MAUT folder. Once the software is installed, follow the below given instructions on its use.

# A Tool for Multi-Attribute utility theory

2

Choose CSV File

Browse

Ensure that csv file has headers and no null values

Data

Clean data

Single-attribute utility computation

Multi-attribute utility Computation

Instructions to upload file

1

Determine performance indicators and alternatives prior to using this tool.  
Once the file is ready, follow these steps to use the tool

1. Upload file with numeric performance indicators (in \*.CSV file format)
2. Click Next to remove any additional text columns from file
3. Click Next to define single attribute utility theory by following steps.
  - i. Click on the header of column, the name of the column will appear at the right
  - ii. Analyse Max, Min and Expected Values
  - iii. Enter Certainty Equivalent values as,  $CE = EV$  (risk neutral),  $CE > EV$  (Risk taking),  $CE < EV$  (Risk Avoiding)
  - iv. Enter risk tolerance value, preferably lower than CE
  - v. Enter importance weight of an attribute
  - vi. Click on set, a utility score of attribute will be added
  - vii. Change the CE, and RT scores to adjust the plot shape as per preferences
  - viii. Repeat process i-vii until utility scores of all attributes has been determined
4. Click on Next and analyse total multi-utility score. Computed scores can also be download as a file.

1. Load CSV file.

3

Next

Figure 1: Welcome window of the tool providing the instructions. The number present the task to follow in order to use the tool. First read the instructions careful. Second, upload the file having computed performance indicators (A sample file will be provided). Third, click on 'Next' to move to another screen.

## A Tool for Multi-Attribute utility theory

Choose CSV File

**Browse**

Ensure that csv file has headers and no null values

Data Clean data Single-attribute utility computation Multi-attribute utility Computation

CI	OC	UDC	EC	Alternatives
2.77	139.35	39.70	0.86	Alternative 1
1.89	126.41	27.50	0.21	Alternative 2
2.15	115.67	25.57	0.57	Alternative 3
2.73	42.94	3.41	0.02	Alternative 4
2.00	68.16	12.40	0.53	Alternative 5
2.12	149.21	47.89	0.23	Alternative 6
2.10	169.56	57.79	0.48	Alternative 7
2.42	88.60	13.11	1.25	Alternative 8
2.22	45.82	35.89	1.26	Alternative 9
2.34	115.93	30.80	0.43	Alternative 10
2.42	39.42	12.69	0.23	Alternative 11
3.46	69.61	12.12	0.03	Alternative 12
1.92	38.14	7.99	0.03	Alternative 13
2.18	84.89	14.42	1.05	Alternative 14
2.43	46.89	4.59	0.00	Alternative 15
1.67	175.33	28.51	0.68	Alternative 16
2.08	161.48	55.25	0.37	Alternative 17
2.30	158.89	51.04	0.22	Alternative 18
2.58	65.90	8.79	0.10	Alternative 19
1.96	62.22	22.83	0.42	Alternative 20
2.02	84.82	25.70	0.28	Alternative 21
2.34	152.60	42.91	0.27	Alternative 22

Clean data with any string columns been removed!

1

**Next**

Figure 2: Window showing only relevant (numeric) performance indicators: This window shows the uploaded data file and eliminates any irrelevant data columns by keeping only numeric values. An additional column labeling each row with alternative number is also added in this window. Click on the Next button to compute single attribute utility function.

## A Tool for Multi-Attribute utility theory

▢ ✕

Choose CSV File Browse

Ensure that csv file has headers and no null values

Click on header of data to select

Maximum value Max

Minimum value Min

Expected value Expected value 3

Certainty Equivalent Enter CE 4

Risk Tolerance Enter risk tolerance 5

Weights Enter weights 6

Set

Repeat with all the columns

Data	Clean data	Single-attribute utility computation	Multi-attribute utility Computation	Alternatives
<span style="border: 1px solid black; border-radius: 50%; padding: 2px 5px;">2</span>	CI	OC	UDC	EC
	2.77	139.35	39.70	0.86
	1.89	126.41	27.50	0.21
	2.15	115.67	25.57	0.57
	2.73	42.94	3.41	0.02
	2.00	68.16	12.40	0.53
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	2.42	88.60	13.11	1.25
	2.22	45.82	35.89	1.26
	2.34			
	2.42			
	3.46			
	1.92			
	2.18			
	2.43			
	1.67	175.33	28.51	0.68
	2.08	161.48	55.25	0.37
	2.30	158.89	51.04	0.22
	2.58	65.90	8.79	0.10
	1.96	62.22	22.83	0.42
	2.02	84.82	25.70	0.28
	...	...	...	...

Instruction ✕

Click on a column name to set its variables at left

1
OK

Clean data with any string columns been removed!

Next

Figure 3: Window to compute single attribute utility functions: This window enables the computation of single utility function. The numbers shows the actions to follows: First read the instructions and click ok. Second click on the name of column. Third assign the CE, RT and weights of selected columns. Finally click on set. REPEAT the same process to set single utility values of all the columns

## A Tool for Multi-Attribute utility theory

Choose CSV File

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### UDC

Maximum value 57.79

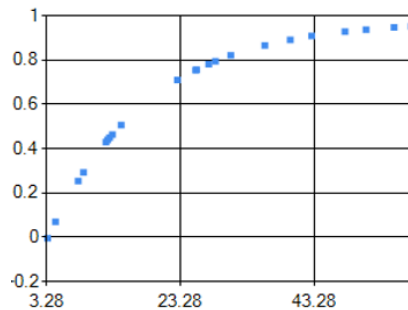
Minimum value 3.41

Expected value 30.5

Certainty Equivalent

Risk Tolerance

Weights



Data Clean data Single-attribute utility computation Multi-attribute utility Computation

EC	Alternatives	utility_CI	utility_OC	utility_UDC
0.03	Alternative 12	0.803	0.445	0.429
0.53	Alternative 5	0.254	0.429	0.439
0.23	Alternative 11	0.499	0.009	0.449
1.25	Alternative 8	0.499	0.611	0.464
1.05	Alternative 14	0.372	0.583	0.507
0.42	Alternative 20	0.225	0.361	0.709
0.57	Alternative 3	0.353	0.761	0.754
0.28	Alternative 21	0.268	0.582	0.756
0.21	Alternative 2	0.171	0.801	0.781
0.68	Alternative 16	-0.026	0.907	0.794
0.02	Alternative 4	0.624	0.074	-0.004
0.43	Alternative 10	0.46	0.762	0.82
1.26	Alternative 9	0.395	0.124	0.866
0.86	Alternative 1	0.638	0.84	0.891
0.00	Alternative 15	0.504	0.142	0.07
0.27	Alternative 22	0.46	0.87	0.908
0.23	Alternative 6	0.335	0.863	0.928
0.22	Alternative 18	0.439	0.882	0.938
0.37	Alternative 17	0.309	0.886	0.948
0.48	Alternative 7	0.322	0.899	0.953
0.03	Alternative 13	0.194	-0.016	0.254

Repeat the same process for each attribute.

1

Figure 4: Results of single utility scores added to data: This window shows the computed utility values of each column and the its respective risk attitude graph. The same process must be repeated to add utility scores of each column. Click on next to obtain multi-attribute score.

## A Tool for Multi-Attribute utility theory

Choose CSV File

**Browse**

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Clean data Single-attribute utility computation Multi-attribute utility Computation Visualisation

Alternatives	utility_CI	utility_OC	utility_UDC	utility_EC	MAUT_score
Alternative 15	0.236	0.054	0.046	0	0.094
Alternative 4	0.331	0.012	-0.009	0.064	0.099
Alternative 12	0.505	0.26	0.328	0.094	0.322
Alternative 13	0.034	-0.042	0.186	0.094	0.058
Alternative 19	0.285	0.23	0.216	0.279	0.248
Alternative 2	0.02	0.58	0.659	0.496	0.438
Alternative 18	0.19	0.683	0.856	0.512	0.573
Alternative 6	0.12	0.656	0.841	0.527	0.544
Alternative 11	0.233	-0.028	0.345	0.527	0.218
Alternative 22	0.204	0.666	0.812	0.585	0.57
Alternative 21	0.078	0.369	0.632	0.598	0.392
Alternative 17	0.103	0.689	0.873	0.698	0.582
Alternative 20	0.052	0.2	0.583	0.742	0.337
Alternative 10	0.204	0.536	0.702	0.75	0.52
Alternative 7	0.112	0.708	0.882	0.786	0.604
Alternative 5	0.069	0.249	0.336	0.817	0.301
Alternative 3	0.132	0.535	0.63	0.838	0.493
Alternative 16	-0.088	0.721	0.673	0.883	0.511
Alternative 1	0.342	0.626	0.789	0.929	0.634
Alternative 14	0.144	0.369	0.395	0.955	0.395
Alternative 8	0.233	0.393	0.358	0.97	0.418
Alternative 9	0.16	0.043	0.757	0.97	0.393

The last column must be the final scores.

**Next**

Figure 5: Final scores showing the multi-utility scores: This window shows the final multi-utility score computed from previously defined single utility scores. The data with computed scores can also be downloaded in the local machine.

## A Tool for Multi-Attribute utility theory

Choose CSV File

**Browse**

Ensure that csv file has headers and no null values

Multi-attribute utility Computation Visualisation of results

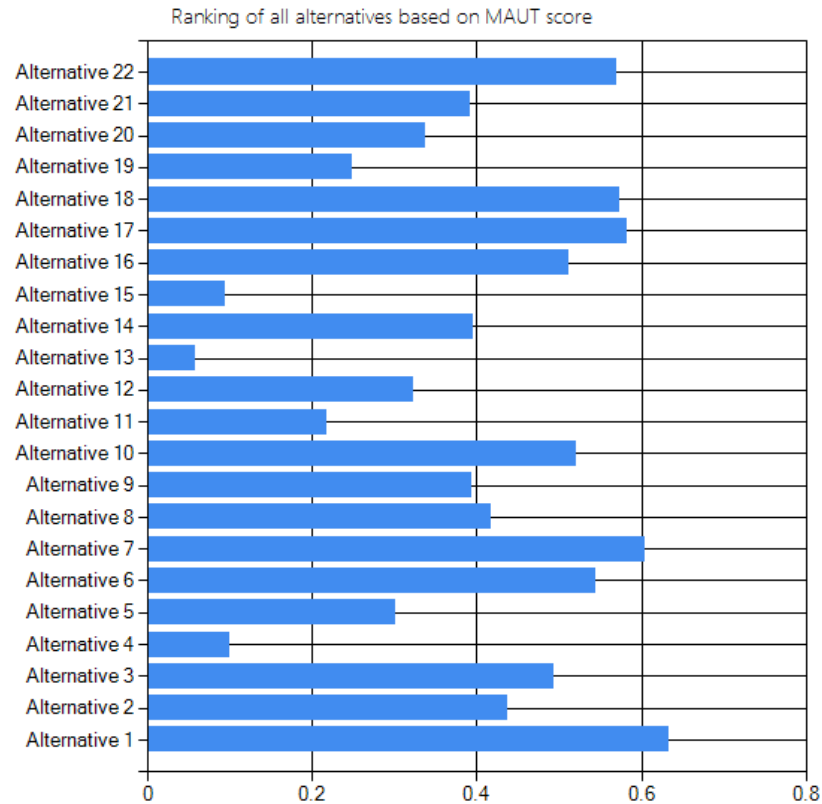


Figure 6: Ranking of all alternatives