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“Social Multi-Criteria Evaluation and Composite Indicators"

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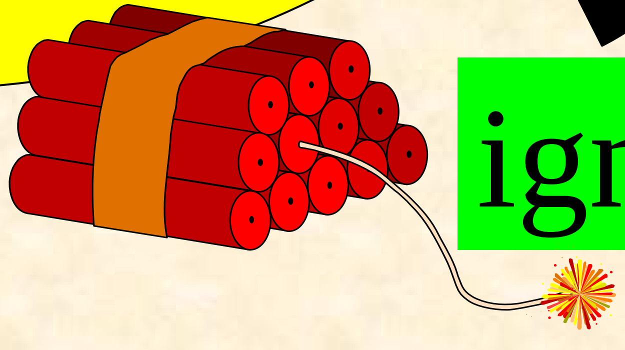
Structure of the presentation

- The need of a multidimensional framework
- A methodological proposal: Social Multi-Criteria Evaluation
- Numerical examples
- Conclusions

Complexity
is an inherent property
of natural and
social systems

addressed

ignored



COMPLEXITY

COMPLEX SYSTEMS

CANNOT BE CAPTURED

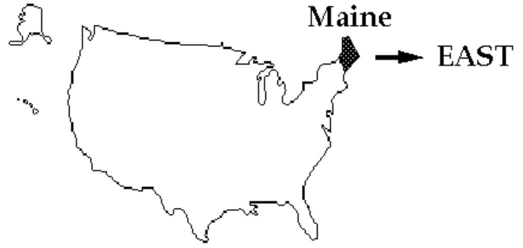
BY A SINGLE

DIMENTION/PERSPECTIVE

Complexity: the ontological dimension

the existence of *different levels and scales* at which a hierarchical system can be analyzed implies the unavoidable existence of non-equivalent descriptions of it

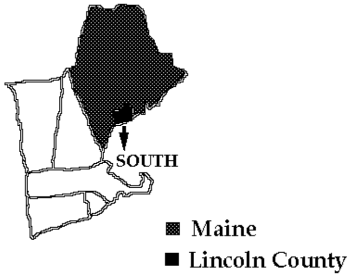
Orientation of the coastal line of Maine



Hierarchical Levels:

Federation (whole country)/State

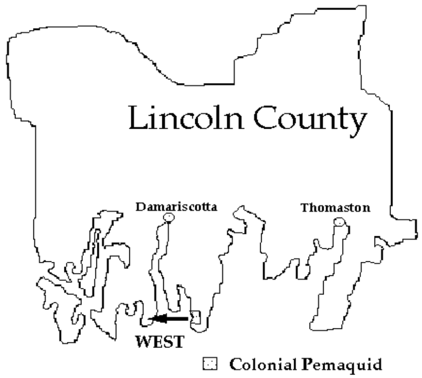
a.



Hierarchical Levels:

State/County

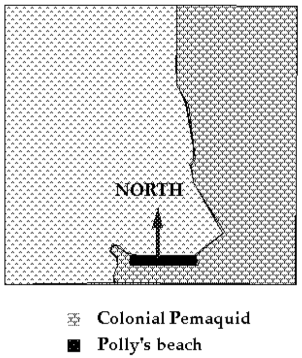
b.



Hierarchical Levels:

County/Village

c.

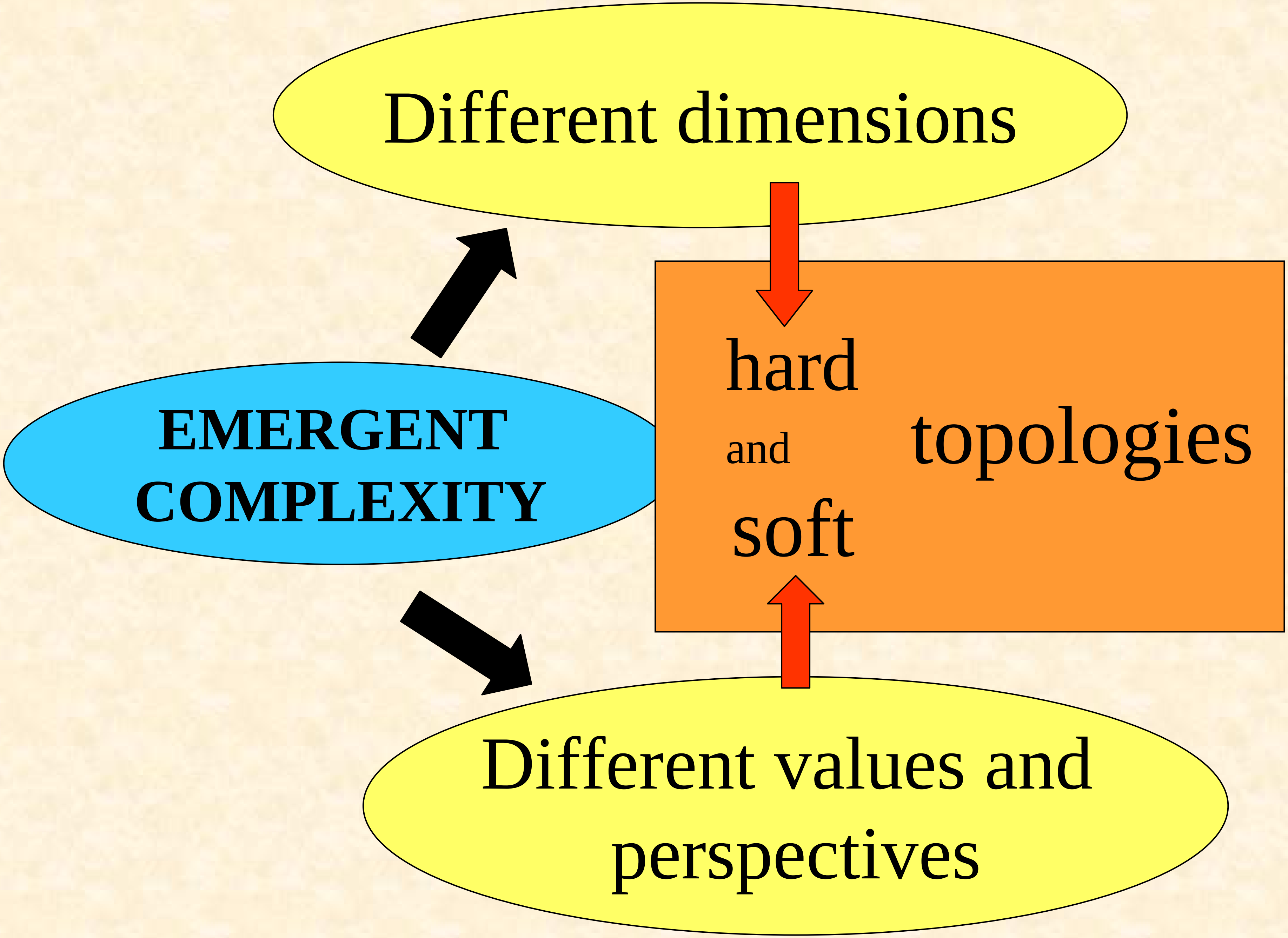


Hierarchical Levels:

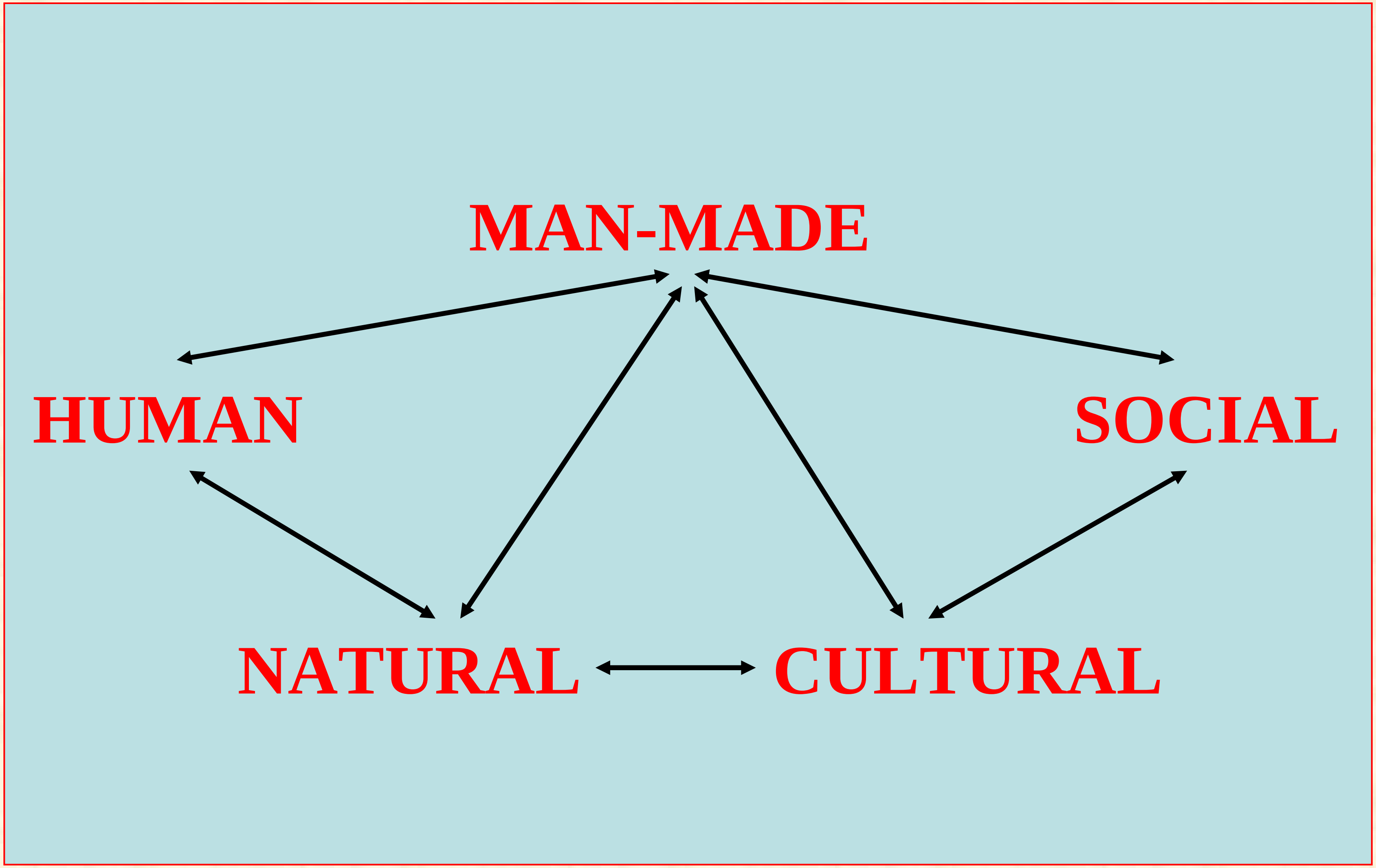
Village/specific beach

d.

Complexity: the epistemological dimension


Different dimensions
EMERGENT COMPLEXITY
hard
and
soft
topologies
Different values and perspectives

What is a city?



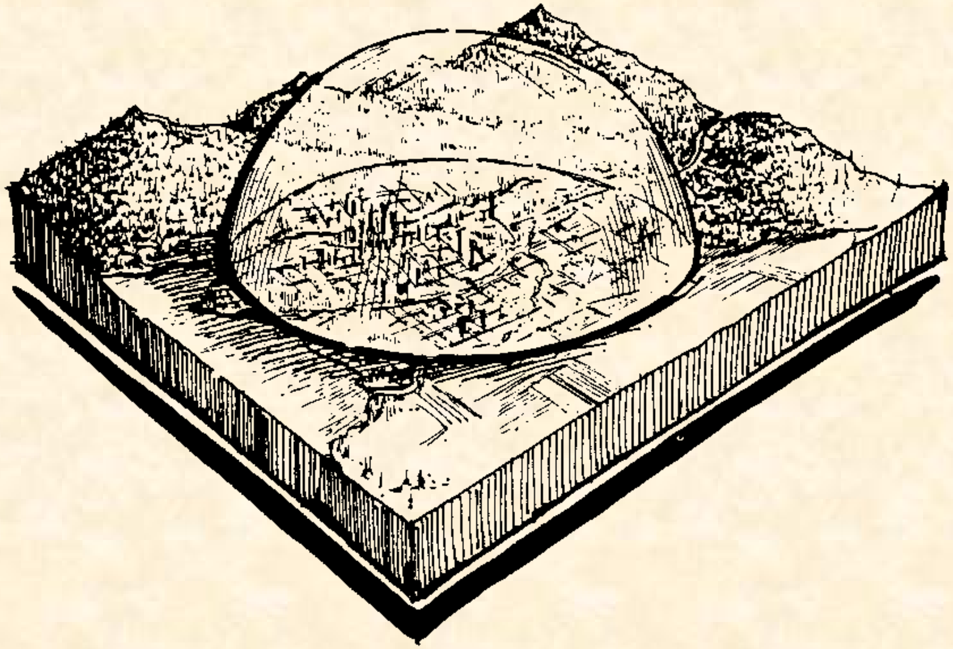
A co-evolutionary interpretation of a city

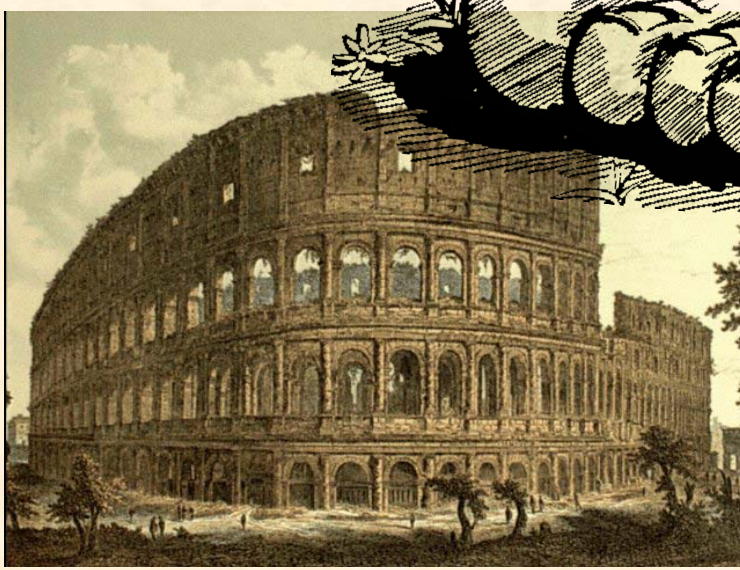
Ecosystems can be divided into three categories (Odum, 1989):

1) ***natural environments*** or natural solar-powered ecosystems

2) ***domesticated environments*** or man-subsided solar-powered ecosystems

3) ***fabricated environments*** or fuel-powered urban-industrial systems





- TECHNICAL INCOMMENSURABILITY
- SOCIAL INCOMMENSURABILITY

K. Arrow, H. Raynaud (1986):
"Social choice and multicriterion decision making"

THE AXIOMATIZATION ISSUE

A typical composite indicator, I, is built as follows (OECD, 2003, p. 5):

$I = \sum_{i=1}^{N} w_i X_i$, where X_i is a normalised variable and w_i a weight attached to X_i,

$\sum_{i=1}^{N} w_i = 1$ and $0 \le w_i \le 1$, $i = 1, 2, ..., N$.

It is clear that from a mathematical point of view a composite indicator
entails a weighted ***linear aggregation rule*** applied to a set of variables.

- ***Weights*** in linear aggregation rules have always the meaning of trade-off ratio. In all constructions of a composite indicator, weights are used as importance coefficients, as a consequence, ***a theoretical inconsistency exists.***
- The assumption of ***preference independence*** is essential for the existence of a linear aggregation rule. Unfortunately, this assumption has very strong consequences which often ***are not desirable*** in a composite indicator.
- In standard composite indicators, ***compensability*** among the different individual indicators is always assumed; this implies complete substitutability among the various components considered. For example, in a sustainability index, economic growth can always substitute any environmental destruction or inside e.g., the environmental dimension, clean air can compensate for a loss of potable water. ***From a descriptive point of view, such a complete compensability is often not desirable.***

- Both social choice literature and multi-criteria decision theory agree that whenever the majority rule can be operationalized, it should be applied. However, the majority rule often produces undesirable intransitivities, thus ***"more limited ambitions are compulsory. The next highest ambition for an aggregation algorithm is to be Condorcet"*** (Arrow and Raynaud, 1986, p. 77).

Sustainability Indicator

Indic.		GDP	Unemp. Rate	Solid wastes	Inc. disp.	Crime rate
Country						
A		25,000	0.15	0.4	9.2	40
B		45,000	0.10	0.7	13.2	52
C		20,000	0.08	0.35	5.3	80
weights		0.165	0.165	0.333	0.165	0.165

	A	B	C
A	0	0.666	0.333
B	0.333	0	0.333
C	0.666	0.666	0

ABC = 0.666 + 0.333 + 0.333 = 1.333

BCA = 0.333 + 0.666 + 0.333 = 1.333

CAB = 0.666 + 0.666 + 0.666 = 2

ACB = 0.333 + 0.666 + 0.666 = 1.666

BAC = 0.333 + 0.333 + 0.333 = 1

CBA = 0.666 + 0.333 + 0.666 = 1.666

The Computational problem

Moulin (1988, p. 312) clearly states that the Kemeny method is ***"the correct method"*** for ranking alternatives, and that the "*only drawback of this aggregation method is the difficulty in computing it when the number of candidates grows*".

One should note that the number of permutations can easily become unmanageable; for example when 10 alternatives are present, it is 10!=3,628,800.

$$
\left\{
\begin{array}{lll}
a_j P a_k & \Leftrightarrow & g_m(a_j) > g_m(a_k) + p \\
a_j Q a_k & \Leftrightarrow & g_m(a_k) + p \geq g_m(a_j) > g_m(a_k) + q \\
a_j I a_k & \Leftrightarrow & \left\{ \begin{array}{l} g_m(a_k) + q \geq g_m(a_j) \\ g_m(a_j) + q \geq g_m(a_k) \end{array} \right.
\end{array}
\right\}
$$

Taking into account *intensity of preference*

Matrix type Impact Case Study

Criteria \ Alternatives	Budapest	Moscow	Amsterdam	New York
Houses owned (%)	50.5	40.2	2.2	10.3
Residential density (pers. /hectare)	123.3	225.2	152.1	72
Use of private car (%)	31.1	10	60	32.5
Mean travel time to work (minutes)	40	62	22	36.5
Solid waste generated per capita (t./year)	0.2	0.29	0.4	0.61
City product per person (US$/year)	4750	5100	28251	30952
Income disparity (Q5/Q!)	9.19	7.61	5.25	14.81
Households below poverty line (%)	36.6	15	20.5	16.3
Crime rate per 1000 (theft)	39.4	4.3	144.05	56.7

$$I = \sum_{i=1}^{N} w_i x_i$$

Normalisation technique used for the different measurement units dealt with.

Scale adjustment used, for example population or GDP of each country considered.

Common measurement unit used (money, energy, space and so on).

100	78.674	0	16.770
33.485	100	52.28	0
42.2	0	100	45
45	100	0	36.25
0	21.95	48.78	100
0	1.335	89.691	100
41.213	24.686	0	100
100	0	25.462	6.018
25.116	0	100	37.495

Normalized Impact Matrix

100	78.674	0	16.770
66.515	0	47.72	100
57.8	100	0	55
55	0	100	63.75
100	78.05	51.22	0
0	1.335	89.691	100
58.787	75.314	100	0
0	100	74.538	93.982
74.884	100	0	62.505

Normalised Impact Matrix Accounting for Minimisation Objectives

Budapest = 512.986

Moscow = 533.373

Amsterdam = 463.169

New York = 492.052

From where are these results coming from?

Information available

Indicators chosen

Direction of each indicator

Relative importance

Aggregation Procedure

	Budapest	Moscow	Amsterdam	New York
Budapest	0	4	4	5
Moscow	5	0	5	6
Amsterdam	5	4	0	3
New York	4	3	6	0

Outranking Matrix of the 4 Cities According to the 9 Indicators

B	**A**	**D**	**C**	**31**	C	B	D	A	27
B	**D**	**C**	**A**	**31**	D	B	A	C	27
A	B	D	C	30	D	C	B	A	27
B	D	A	C	30	A	C	B	D	26
B	C	A	D	29	A	D	C	B	26
B	A	C	D	28	D	A	B	C	26
B	C	D	A	28	D	C	A	B	26
C	B	A	D	28	D	A	C	B	25
D	B	C	A	28	C	A	D	B	24
A	B	C	D	27	C	D	B	A	24
A	D	B	C	27	A	C	D	B	23
C	A	B	D	27	C	D	A	B	23

B	A	D	C	31
B	D	C	A	31

Where A is Budapest, B is Moscow, C is Amsterdam and D is New York.

Economic dimension

City product per person

Environmental dimension

Use of private car

Solid waste generated per capita

Social dimension

Houses owned

Residential density

Mean travel time to work

Income disparity

Households below poverty line

Crime rate

A reasonable decision might be to consider the three dimensions equally important. This would imply to give the same weight to each dimension considered and finally to split this weight among the indicators. That is, each dimension has a weight of 0.333; then the economic indicator has a weight of 0.333, the 2 environmental indicators have a weight of 0.1666 each, and each one of the 6 social indicators receives a weight equal to 0.0555. As one can see, if dimensions are considered, weighting indicators by means of importance coefficients is crucial.

	Budapest	Moscow	Amsterdam	New York
Budapest	0	0.3	0.4	0.4
Moscow	0.7	0	0.5	0.6
Amsterdam	0.6	0.5	0	0.3
New York	0.6	0.4	0.7	0

Weighted Outranking Matrix

B D C A

Where A is Budapest, B is Moscow, C is Amsterdam and D is New York.

CONCLUSION:

Results are heavily dependent on the ***problem structuring step!!***

QUALITY OF PRODUCT

PROCEDURAL RATIONALITY

LEARNING HOLARCHIES

MCDA

ETHICS
RESPONSIBILITY

QUALITY OF “SOCIAL” PROCESS

TRANSPARENCY

PARTICIPATION

MULTI/INTER-DISCIPLINARITY

CONSISTENCY

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