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RELATIONS AND DECISION MAKING

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ABSTRACT

The literature of decision making gives too little attention to the structure of decision analysis. Fundamental aspects are not well clarified, and credibility suffers as a result. If careful attention is given to selecting the contextual relations to be used, both theory and applications will benefit. The time required to reach a decision may be shortened considerably without lowering the quality of the decision. To facilitate the selection of a contextual relation, classifications of them are being developed. Contextual relations are tentatively classified as (1) comparative relations, (2) influence relations, and (3) neutral relations. Examples and elaborations of each class are given. These classes and their descriptions are useful in choosing contextual relations for structuring information relevant to decision making.

INTRODUCTION

In recent years analysis of the structural basis for decision making has received attention in an attempt to make explicit certain aspects of the decision making process that frequently have been neglected. Interpretive Structural Modeling (ISM)[1] is a process that provides an approach to such analysis. It provides a method for developing interpretive structural models efficiently. Such models help people organize and understand empirical, substantive knowledge about complex systems or issues. The basic concepts involve "elements" and "contextual relations". Commonly used elements are the problems facing decision makers, options open to them, and the consequences of pursuing various options. A contextual relation is a verb phrase in a colloquial language, used to clarify the interconnection between any pair (and hence an entire set) of elements. Typical contextual relations involved in decision making are: "is preferred to", "may lead to", and "dominates".

In a given situation the set of elements typically is given much more thought than the contextual relation(s). It is often difficult to determine what contextual relation(2) is considered most relevant in a given study. A possible explanation is that there exists an implicit belief by the analyst or decision maker that the element set is adequate to specify the topic being examined, and that the contextual relations are obvious. Since the structures developed by analysis are often quite sensitive to the choice of contextual relation(s), this choice deserves very careful consideration.

Structuring an element set with respect to several different types of relations may provide insight into several aspects of the issue under study. For example, use of the relation "will help accomplish" in a structural modeling exercise may help define the constraints germane to an issue, while use of "is preferred to" may indicate desirable options to pursue. Analysis of the models resulting from separate use of both relations provides the decision maker with greater perspective than a single-relation analysis.

Careful choice and definition of the contextual relation(s) to be used in structuring an element set should help eliminate confusion both during the structuring process and in later stages of the decision analysis. Classification of relations provides aid in selecting the appropriate relation(s) for a given structural modeling task.

CLASSIFICATION OF CONTEXTUAL RELATIONS

Three factors are important in classifying contextual relations: (1) syntax, (2) semantics, and (3) potential use. Many syntactic and semantic studies of the English verb system have been performed by linguists[2],[3],[4]. However these studies do not seem to provide classifications oriented toward potential use. Hence the potential use of contextual relations provides the broad basis for classification. Within this broad basis, syntax and semantics play a useful role. Knowing the syntax is helpful in forming similar relations for application to sets of elements, while knowing the semantic implications of a relation is essential for deciding whether that relation holds between a given pair of elements.

Contextual relations are placed tentatively in three user-oriented classes, which are: (1) comparative relations, (2) influence relations, and (3) neutral relations. Each class will be defined briefly, and the most common syntactic forms will be outlined.

Some examples of each class will be presented. The neutral relations make up a very large class. It may be desirable eventually to enlarge the number of classes by subdividing the class of neutral relations.

The initial concern in choosing a contextual relation is often with the type of structure to be developed; e.g., an intent structure is useful when a set of objectives is to be interrelated, while a preference structure is used when what is sought is collective preference of a group. Since a large set of application-specific structural types remains to be defined, it is appropriate to avoid tying contextual relations to specific types of structures for the present. The classification can be tied to specific types of structure when a versatile set of useful structures has been thoroughly tested.

Comparative Relations

The class of comparative relations is the easiest of the three classes to describe. It includes all verb phrases that allow a comparison to be made between pairs of elements that involves a value judgment. Use of a comparative relation leads to the formation of comparison structures, which may be of various types. Such structures may be based entirely on subjective grounds without reference to explicit criteria, as when the relation "is preferred to" is used. Or they may be based on a mixture of subjective and objective considerations.

Syntactically these relations take one of the four forms given and illustrated in Table 1.

TABLE 1
Syntax for Comparative Relations

Form 1: is + comparative adjective phrase + than
Examples: is more significant than
is less significant than
is more important than
is less desirable than
is easier to implement than
is less effective than
Form 2: is + comparative adjective phrase + to
Examples: is preferred to
is superior to
Form 3: is at least as + adjective phrase + as
Examples: is at least as good as
is at least as bad as
is at least as happy as
is at least as difficult to implement as
Form 4: verb phrase + comparative adverb phrase + than
Examples: accomplishes more than
performs worse than
impacts on _____ more than
Form 5: verb phrase + at least as + adverb phrase + as
Examples: performs at least as well as
accomplishes at least as much as

Semantically, ISM lends itself to a mode of operation in which each element of a pair is independently compared to a standard when deciding if a given relation holds. The standard may be objective, as when the relation "gets more miles per gallon than" is used with reference to automobiles, and Environmental Protection Agency ratings are used. However this semantic property should not obscure the central importance of value judgment in the comparative relations, hence objective standards correspond to the limiting situation where the value content of the relation approaches zero.

Most of the comparative contextual relations appear to be mathematically transitive* because of the implications of the words "more", "less", "better", "worse", and "at least as".

Influence Relations

The class of influence relations includes all verb phrases that imply some influence (one-way or mutual) between two elements. Typically if such a relation holds, an action by one element will be accompanied by a response by the other or, alternatively, changes in one are accompanied by changes in the other. The most common use of influence relations has been to develop intent structures. Another use is to develop "problem structures", i.e., structures whose elements are problems. The contextual relation "aggravates" has been used in developing problem structures.

The simplest syntactic forms of this class are given in Table 2.

TABLE 2
Syntax of Influence Relations

Form 1: Third person present
Examples: causes
accomplishes
intensifies
aggravates
interacts with
influences
Form 2: helps + infinitive
Examples: helps cause
helps lead to
helps inhibit
helps support
Form 3: will + infinitive
Examples: will influence
will bring about
Form 4: irregular forms
Examples: is a function of
is the sole cause of

With few exceptions, forms of influence relations are gramatically transitive*. However mere adherence to syntactic form does not suffice for membership in the class. For example, the relation "talks to" is in the third person present form, but it is not an influence relation. The combination of syntax and semantics must be considered in assigning membership.

Verb phrases for influence relations can be scaled by strength of effect, and the presence of certain auxiliary words allows a second scale to portray strength of assurance. Combining these two scales leads to the two-dimensional portrayal in Fig. 1.

* For a definition of "mathematically transitive",

see Ref. 1, p. 1-9. The phrase "gramatically transitive" refers to a verb phrase that can take a direct object.

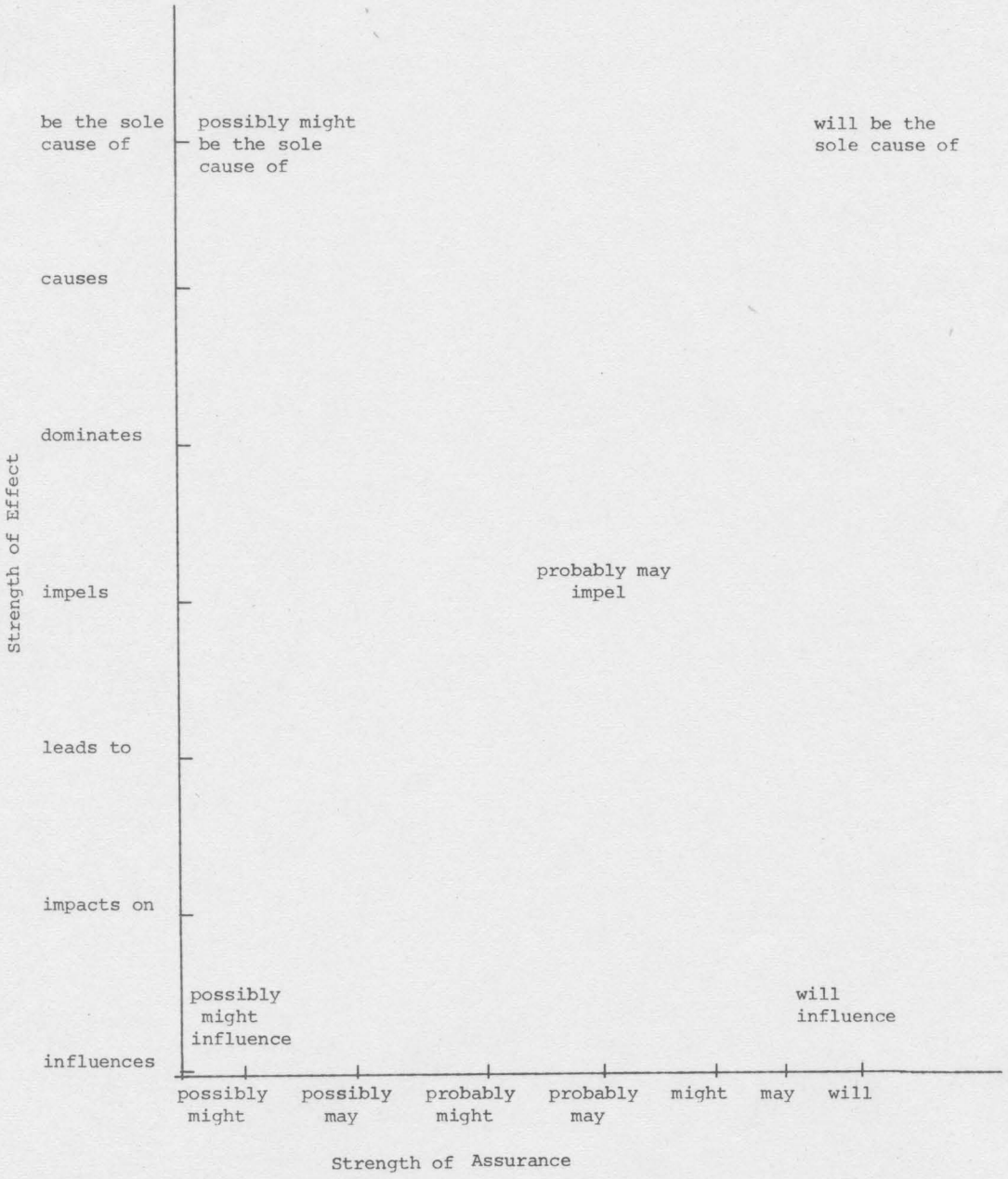

Figure 1. Ranking of Influence Relations

The column ranking according to strength of effect is based on the definitions of these verbs[5]. The row presents a ranking of several auxiliary words in order of strength of assurance, partly based on Chapter 11 of Ref. 3.

None of the influence relations is necessarily mathematically transitive. Many of them may be, depending on the element set which is to be used and the exact definition adopted for the relation. It is desirable to document the reasoning whereby a particular influence relation is construed to be mathematically transitive in relation to any structure based on that relation.

Neutral Relations

The class of neutral relations appears to be the largest of the three classes. It is the class least used to date in ISM exercises. The relations in this class are neutral in the sense that they imply little need for value judgment on the part of the modeler in deciding whether a relation holds between two elements. Some common neutral relations are "precedes", "reports to", "obeys", "contains", "tests", "teaches", and "speaks to". The class is relevant to organization charts and PERT charts.

The syntax of neutral relations is the same as that of the influence relations. Both classes permit the use of the same auxiliary phrases to indicate stronger or weaker assurance of connection. For example, variants of "teaches" include "can teach", "may teach", "might teach", and "might possibly teach". Any of the neutral relations that use such auxiliary phrases might be chosen for structuring information, depending on how strong a connection between related elements is desired in constructing a model. However each of them should be inspected to determine whether mathematical transitivity applies in a given ISM exercise.

Some neutral relations are always mathematically transitive. Examples are: "contains", "is necessary for", "precedes", "is sufficient for". Others may or may not be, depending on the element set and the precise interpretation of the contextual relation.

CHOOSING RELATIONS

Any English verb that is to be used alone as a contextual relation should be capable of taking either an object or a predicate noun, because a contextual relation is used to relate two elements to one another. Gramatically transitive verbs and forms of "to be" are of this type. Verbs that are not of this type generally can be used as contextual relations as part of a larger verb phrase. For example, "precedes" can be used alone as a relation as in the expression "sixteen precedes seventeen". The verb "stands" cannot be used alone, but can be used as part of the phrase "stands on", as in "the dog stands on the table". In an ISM exercise, a contextual relation that can meaningfully take every member of the element set as either subject or object is desirable. In choosing a contextual relation for use in ISM, it is appropriate to: (1) establish the element set, (2) choose a standard type of structure if one exists that is appropriate to the aims of the work, and then (3) choose a relation from one of the three classes outlined, with due consideration of mathematical transitivity.

A difficulty inherent in decision analysis is the ambiguity of the English language. Any word might be interpreted in a multitude of ways. A method of reducing the ambiguity is to keep contextual relations as simple as possible; thereby reducing the number of words in a verb phrase that is subject to misinterpretation. This method can be supplemented, when necessary, by generating adjunct examples to illustrate the kind of meaning intended, keeping the examples simple as well.

When the contextual relation consists of the basic verb and a modifying phrase, the definition of the basic verb can be formalized for general use, and an appropriate modifying phrase can be tailored to a specific application.

A method of changing the strength of assurance implied by a relation through changes in the verb auxiliary was illustrated in connection with the influence relations. Other auxiliaries not mentioned herein are available which may change other aspects of the contextual relation. Such auxiliaries allow expansion of the repertoire of contextual relations. Modification by an auxiliary may change the class of the relation, and this can even require a change in the element set. The type of structure may be inadvertently affected, without the change being immediately apparent. For example the auxiliary word "should" is commonly interpreted in two ways. One interpretation implies a sense of propriety, as in "the wedding ceremony should precede the wedding reception". Another interpretation implies subjectivity on the part of the speaker, as in "the Cabots should talk to the Lowells". The latter usage can result in a preference structure. The second usage is semantically equivalent to "the Cabots talking to the Lowells is preferred to the Cabots not talking to the Lowells". Thus the neutral relation "talks to" can be converted to a comparative relation by the addition of "should".

DECIDING WHEN A CONTEXTUAL RELATION HOLDS

Tversky[6] suggests that people choose alternatives by internally establishing ranked aspects or criteria of judgment, then eliminating choices that do not meet the most important criterion, then choices that do not meet the next most important criterion, and so forth until a choice is made. In the light of this, an effective means of facilitating a decision of whether a relation holds between two elements may be to verbalize both the criteria by which the decision can be made and the structuring of the criteria. This method seems most applicable to modeling exercises involving relational decisions to be made on an objective basis. In exercises involving subjective decisions, more insight into the issue may be gained by deferring identification of the criteria and their structure until after the subjectively-based topical structure has been initially determined. This will avoid

overconstraining the individuals engaged in the structuring process. There is always a danger of so constraining the process that it becomes ineffective. Iteration is a strong antidote to the proclivity for overconstraining a structuring effort.

CONCLUSION

Interpretive structural modeling can be a valuable tool in decision making, helping the decision maker organize and understand empirical knowledge or belief about complex issues. Close attention needs to be paid to contextual relations used in structuring. Classification of relations according to their potential use facilitates the definition and choice of appropriate contextual relations for use in structuring.

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