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ELASTICITY OF INFORMATION

The elasticity of information is the term mainly concerned as its usability properties of qualitative type and interactions with the surround. In minority it is related to quantitative aspects derived from Shannon's theory. Elasticity of information may also be joined with a rationality of decision making and economic aspects of necessary accuracy. It is also an important aspect in symantic web design, where restriction of interpretation vulnerability of a problem is crucial in the process of right variant choosing by a web 3.0 class computer system. Therefore the problem of information elasticity in interesting for management sciences and decision making systems. In this paper a concept of evaluation the elasticity of information was presented from its importance for management processes point of view. The relationship between Shannon's theory and Gossen's law of of diminishing marginal utility was pointed. The role of pragmatic and apobetic context in the elasticity of information was discussed.

1.   INTRODUCTION

The elasticity of the information is the term mainly understood as its usability properties of qualitative type and interactions with the surround. In minority it is related to quantitative aspects derived from Shannon's theory[8]. Elasticity of information may also be joined with a rationality of decision making and economic aspects of necessary accuracy[10]. It is also an important aspect in semantic web design, where restriction of interpretation freedom of a problem is crucial in the process of right variant choosing by a web 3.0 class computer system. Therefore the problem of information elasticity is interesting for management sciences and decision making systems[5]. In this paper a concept of evaluation the elasticity of information was presented from its importance for management processes point of view. The relationship between Shannon's theory and Gossen's law of of diminishing marginal utility was pointed[4]. The role of pragmatic and apobetic context in the elasticity of information was discussed.

2.   ONTOLOGY OF INFORMATION

In this paper, the following definition of information will be used: *information is such processing and organization of data or signals, which causes an increasing of knowledge level of the receiver or induces defined activity.* Despite of physical and cognitive meaning of the presented definition, it should be noticed that information is a typical nonmaterial entity, because it is an idea, it has no mass, it is not a material property and has no binding with it.

Information may be recorded on physical carriers, what means that it behaves some quantitative properties according to Shannon's theory. He found close correlation between thermodynamic description of entropy and the least average information quantity necessary for encoding any incident of the event from the set of events with a given probability of existing. The theory treats information quantitatively only, regardless the message content and the sender's or receiver's knowledge and his abilities. Also it is not important the evaluation of transmitted message usability. Therefore it is universal theory, because it describes only quantified conditions which have to be met by any form of the message exchanged between machines and peoples. It was widely expanded by cybernetics and today it is the base of artificial intelligence theory and practice [9].

From Shannon's theory it follows: *Message contains as much information as low is the probability of its occurrence. The quantity of information depends only on the probability of occurrence of the signal containing its.*

Parallel to development of Shannon's theory, different researchers introduced qualitative elements to the theory of information. According to Gitt, information contains the following qualitative descriptors[2]:

– Statistic of information – understanding as specific indexation of its elements (signs, experimental data, impulses, etc.) into sets, forming the message.
– Syntactic of information – specific code in a symbolic language, containing grammar and logic rules, allowing to form correct formula and sentences, abstracting from the logical sense of the formed lingual structures.
– Semantic of information – property of logical and cognitive sense of the used signs or data for forming the message, understanding for an agent, allowing on mental transformations of the used syntactic symbols onto real world objects.
– Pragmatic of information – property of the message allowing its practical use or evaluation as being useful in a given moment and in a given surround (context).
– Apobetic of information – specific property of the message allowing to profit generate derived direct from its use in real world processes, what usually is equivalent to achieve any logical goal

The above properties of message should be concerned as the set of good descriptors for evaluate its as the information. *If any signal or message does not contain even one of the described properties – it should not be concerned as the information.* Therefore the definition of information is based on fulfilling the criterion of containing all, five properties by any message.

Information is not a free object in the space. It is strongly connected by relations with sender-receiver system and data being the base to give the signal all properties of the information. Information subjected further metaanalyses form higher layers of interoperation degree, named knowledge and wisdom (see Fig. 1). There are placed elements of pragmatic and apobetic layers of the information system. According to the pragmatic criterion, the meaning of information, its range of interaction and usability depend on context.
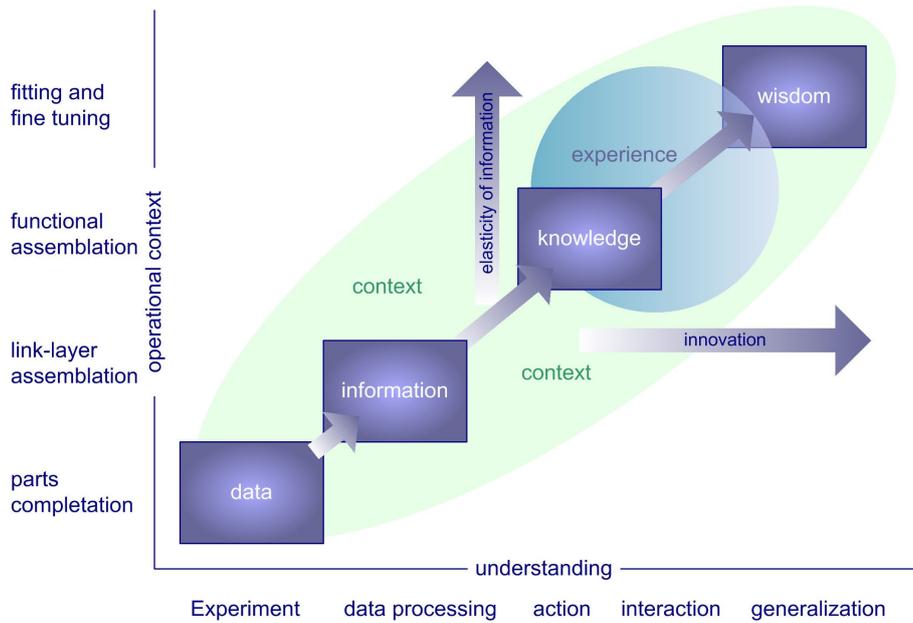
Fig. 1 From information to wisdom [source: self elaboration based on [1]]

Provided on the data layer level it is possible only to complete the set of signals, for which some characteristics of the information will given. On the level of generalizations, an assembly of knowledge into theories or assemblation of elements into individually designed sets is possible. On the Fig. 2 it is shown an interesting generalization of the context and interoperationality between abstraction layers.
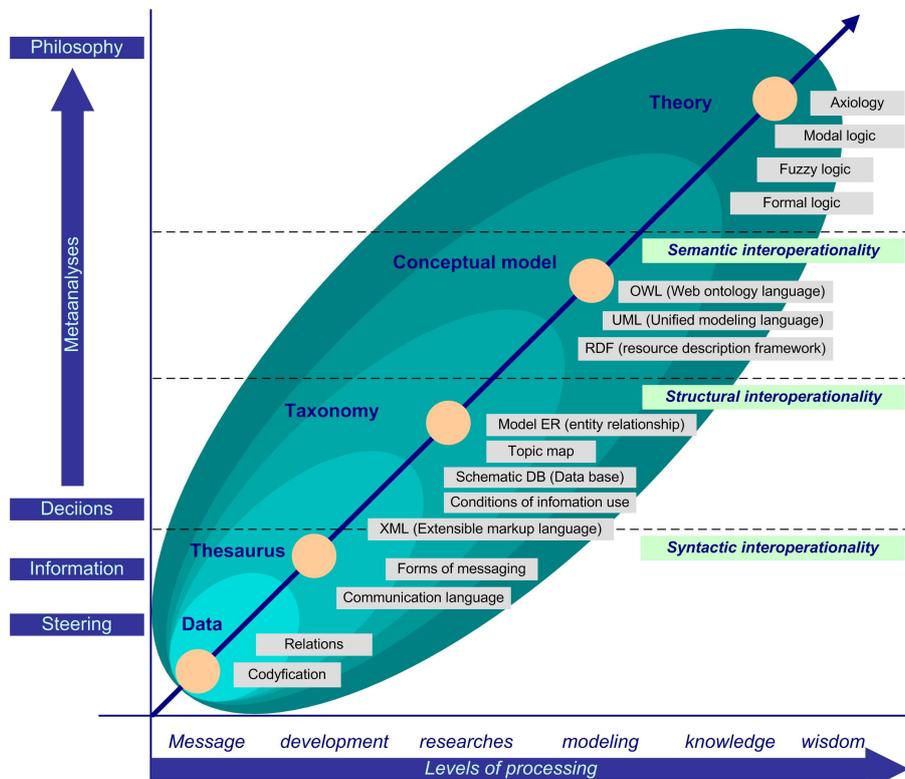

Fig. 2 Context processing of information [source: self elaboration based on [7].

Complexity of metaanalyses and fuzziness of the context increase according to the level of abstraction layer.

At the semantic layer, formal processing of data is finish, and from that moment it is possible to build organization's knowledge and establish some feedbacks which causes effects of the information interactions in pragmatic and apobetic sense with the surround.

3.   THE CONCEPT OF THE INFORMATION ELASTICITY.

Classic understanding of elasticity derived from the model of volume distortion of a material under the force pressure. It is elastic in 100% if after the release of distorting force the material returns back to the original shape. Quantitatively, this phenomenon in mechanics is described by Hook's law and there is existing mathematical analog of algebraic function elasticity. It may be formulated as follows: *elasticity of any differentiable function is the ratio of incremental percentage change of the function with respect to the incremental percentage change of its argument.*

In relation to the information elasticity the following definition should be introduced:

Let be given the defined numeric representation of information as a variable x (e.g. usability), and let be given the second representation of the same information or its context, being in relation with as a variable y (e.g. interaction area), then: elasticity of information in respect to variables x, y is the ratio of relative change of y in respect to relative change of x.

−   On syntactic level the elastic information is characterized by a rigid code on all noises. All stochastic noises from a context interfering has only a minor influence on the message content.
−   On semantic level, elastic information means ambiguous, uncertain, letting interpret into the dubious way oneself, possible to processing into the uncertain knowledge, and in addition induces decisions burdened with the risk.
−   If any information may be used within a wide context, and despite of it causes some important consequences for the given receiver, regardless some changes of the context, it may be recognized as the elastic one in pragmatic sense.
−   If using the information is giving determined benefits for the receiver, and some changes in the context don't resulting important changes of the economic usability, it may be recognized as the elastic one in apobetic sense.

Therefore information may be elastic in syntactic, semantic, pragmatic and apobetic sense. Each of the mentioned aspects is important from the management of organization point of view and processes of decision making. The management is always operating in the area of significant elasticity of information. The problem is to define the borders of uncertainty. For example on the semantic level the following question may be put: is it possible to make a certain conclusion based on the uncertain, highly semantically elastic information? Acceptble rational answer may be derived from good defined neural network which is making decision about hypothesis verification. In this case, the following rule is valid: *if initial data are linear independent and the number of errors is restricted, then the network converges to the consistent result* [6]. In other words, semantic elasticity and fuzzy concluding not always lead to bad choices and decisions. Good processing of information and metaanalyses cause the most important influence on decision quality (at least in artificial intelligence systems). Main rules of semantic concluding are restricted by the context. Intuition suggests the existing of a border for uncertainty of the information acceptable for right decision making in the given context and time. All deviations and interferences of information are decreasing its usefulness and the level of certainty of decision making [8]. This is joined direct with

elasticity relations of information and managing processes. It seems to be obvious, that highly elastic syntactically information is preferred.

A certain non-elastic information, subjected to classic Boolean logic is useful in decision making processes on an operational level, based on experimentally measured technological data or ex-post bookkeeping. Its usefulness in processes of organizational knowledge building and metaanalyses is more proving and reference character, than creating area of uncertain knowledge. In conclusion making all those information extending the area of certain knowledge. But forecasting ex-ante is always joined with at least elastic semantically information.

4. SEMANTIC CONTEXT OF INFORMATION ELASTICITY

Information with high level of semantic elasticity are the most important in quantitative modeling of management processes. It allows to involve a lot of different phenomena under one semantic description, e.g. analogy to the well known nature law. This problem is also important by designing of Semantic Web, where the computer system will decide about the method of the model use. The more elastic model the lower probability of erroneous choice of the appropriate way of use it. But free application of too general information (e.g. Euler-Lagrange equation) will restrict the unique character of metaanalyses performed by the system and result some differences between model and observations. For that reason a lot of minimax problems will be impossible with such elastic method to describe. Reduction of the freedom of possible solutions by introducing constraints is a practical example of extending accuracy of the method to a given case and reducing elasticity of semantic meaning of the model.

5. INTERACTION OF INFORMATION AND PRAGMATIC CONTEXT

Analyzing pragmatic aspect of the information elasticity it should be noticed the interesting property of the message, before one calls its an useful information. There are three levels of importance of the signal for a given receiver:
- **Filtration threshold** – is determined by syntax of the message, which allows for automatic deletion of the unwanted information or classified it as either spam or unnecessary information in a given context, despite of the level of its importance at any other.
- **Interaction threshold –** It is semantic level of the information accuracy in relation to its context. From that moment it is concerned by the recipient as conditionally important. For the decision about starting any physical activity it is necessary to reduce the context range or some additional data.
- **Reaction threshold** – This is the level of the pragmatic importance, from which the information is becoming the reason of taking physical reaction (as the reaction one should concerned either adding information to a knowledge base, or taking any physical action).

These thresholds are not possible to quantifying, but some qualitative observations allow on the statement that they are characteristics of any information in a given context. It may be noticed that crying of a baby is a signal carrying less precise information, but inducing immediate reaction of its mother. This way, the filtration and reaction thresholds are overlapping each other. If not for the situational context, such an information would be rejected on the level of the threshold of the filtration (similar signal from a TV set will be ignored).

Similar functionality one could observed in the case of spam auto filtration. Information is delivered to the local computer and the first action is showing the email subject. At this moment, based on the syntactic properties, regardless the context, the firewall system may block further

processing of the message. This way, the subject is the message on the filtration threshold level allowing rejecting the content of message, what reduces the context. It is possible to state some semantic rules for the incoming post in a such way, that a subject and key words of the message would be applied as an intelligent agent without the necessary of watching full content of a message (automatic deletion of unwanted information).

Let us allow that in the following part of this work, unwanted information will be out of the subject. Main attention will be focused on the information which will pass the interaction threshold, and their further accuracy optimization allow to achieve the reaction threshold.

All managers wish to make their decisions based on full accurate, precise, actual and clear information. From the practice it follows that such information are usually not available, and that their costs are growing exponentially along the accuracy increasing. Usually it is not possible to receive exact and precise information. Therefore managing any economic process especially on strategic level ex-ante, decision maker must applied more or less uncertain and elastic information. The higher level of forecasting, the most uncertain knowledge is the base of concluding. There are derive the following optimization aspects, required explanation:

1. *To what extent in the process of managing does the elasticity of the used information let for accepting the hypothesis on the high probability of taking correct decisions?*
2. *What permissible level of the information elasticity on account of the safety of business decisions taken is?*
3. *How to measure the level of the information elasticity?*
4. *What level of the elasticity of information forming knowledge and experience of business organization should be?*
5. *How to reduce the global information context for a managed process?*

As it was mentioned earlier, usable properties of the information are determined by its surround (pragmatic context). The wider pragmatic context, the greater probability of information receiving and more elastic content is in it included. There are not appropriate definition of the pragmatic context. One should however notice the following regularities:

- Information is assembled from data, signals and context.
- Content and the context of the information are independent on the of the identity of the person or his legal status as recipients.
- The context has the subjective-spatial orientation (concerns the any recipient on determined territory).
- It is possible to introduce the phase space of the context, as the function of two variables: numerical representation of recipients amount and numerical representative of area which it concerns.
- The context is deciding about the importance of the information for a given recipient. From that reason it determines the gravity level of the information at making a decision or adding it to knowledge resource.
- The context may be restricted with some additional data linked to the original message, forming together complete information.
- The narrower pragmatic context, the most usable is the information, and its elasticity decreasing.
- The more usable and precise in the context sense is the information, the more difficult and expensive is its receiving.
- The probability of using the information grows together with narrowing the pragmatic context. This increase is more and more small all the way to the certain threshold, when action follows and more further narrowing doesn't already make sense.

- The probability of receiving the information grows together with the scope of the context (it results from the general theory of the usefulness).

Because of high elastic information results always uncertainty of concluding, the following facts should be taken into account when its forming:
- Uncertainty of base knowledge (e.g. exact value of merchandises on the stock is not known in the nearest future).
- Uncertainty of acting description (acting in economic processes is represented always be a simplified model with relative short list of the initial conditions. In real world the number of variables and facts to taking into account may be big).
- Uncertainty of detection and cognition (the recipient of information is not equipped with the appropriate number of sensors and tools necessary for converting the obtained signals onto knowledge).

To make a decision it is necessary to find the optimum level of uncertainty in all three area, modeling suitable pragmatic context of information. This is specific feedback derived from the management process of knowledge. Self consistent context convergence and reduction of the level of acceptable pragmatic elasticity of information.
Theorem
There do exist the threshold of the information uncertainty defined by the pragmatic context, from which a physical acting of the system interacting is initiated. It is the border level of the pragmatic information elasticity.

The following precising of the information or add more data, gives no extra knowlegde for making decision. The elasticity level described by the pragmatic context has achieved the optimum level. It is great analogy to the Gossen's law of of diminishing marginal utility [4].

6.   APOBETIC CONTEXT OF INFORMATION

Regardless the context, information may induced at the recipient different reactions or nothing. These reactions may be controlled, cyclic, chaotic or even catastrophic. In the case of economic decisions they are represented numerically by a capital measure, which is changed due to use the information for physical interactions of the organization wit the surround. Therefore the numerical information as a value of capital changes may be use as a representation of information interaction with the economic surround, narrowed to the pragmatic context. Then it seems to be right to use the general usability theory and Gossen's law in relation to the information. It may be said that:
These information are the most valuable, which lead to the most changes of capital of the economically interacting system.
But there is no relation to the information elasticity and its quantity. The elasticity is momentum property of the information which induced physical interactions of the economic system in the defined context. In respect to assumption about the information elasticity on account of use the information, it is necessary to introduce the **apobetic information context**, which is the diminishing of the pragmatic context to these stakeholders, who had used the information. Therefore apobetic context is included in pragmatic one. The most prospective concept seems to be the probability of receiving the information inducing multidimensional, physical interactions. Then it is natural to define the information elastically useful.

Information elastically useful induces multiple interactions possible, stabilizing the system around the equilibrium state, minimizing the results of this information use by the surround.
Information non-elastically useful induces only one such interaction.

The above definition of the information elasticity in apobetic sense allows for two dimensional evaluation from the recipient point of view:
- pragmatic elasticity on account of the context,
- apobetic elasticity on account the induced interactions.

One should notice that, the above definition is a logical complement of pragmatic elasticity (the surround receives information and uses them free but the system must physically interact in optimum way to remain in steady state of economic equilibrium).
An example:
Let us assume that producing metal elements economic system is informed about the serious price change of the raw material on LME. This information is surrounded by the wide context, but can trigger the entire range of the reaction in the form of concrete capital action:
- *Producers of the raw material:* sell futures contracts or insure selling with derivatives.
- *Profiteers or banks*: make options put or sell options call.
- *Purchaser*: buy now or later? As the futures or contango? Buy derivatives?

From a point of view of each stakeholder, the above information is high-elastic and induces determined economic mechanisms for preserving the market balance. It is also high-elastic on account of the pragmatic context since it includes wide groups of stakeholders on entire world. It is obvious, that narrowing the context by adding the size of the sale and defining metal (e.g. copper) it will lower the elasticity of the information, it will exclude the entire row of stakeholders and will cause, that spectrum of actions against the mentioned changes will be limited.

7. ELASTICITY OF INFORMATION AND MARGINAL UTILITY THEORY

In previous sections problems of the information context, pragmatic and apobetic elasticity were presented. An aspect of usefulness of the economic information on account of Gossen's laws is still left as not quantified. Usage of the information requires the exceeding of threshold of the reaction what is taken place with narrowing the context from the level determined by the threshold of the importance i.e. to the level satisfying such uncertainty, by which making a decision is becoming probable. From this moment resulting benefit from everyone, next increasing the precision (or narrowing its context) diminishes marginal utility of the information. From here it is possible to deduce the Gossen's law for the information in the following for:
Theorem:
Every, consecutive narrowing the pragmatic context of the information from the importance threshold reducing its elasticity has the more and more low marginal utility for decision makers.
Let us determine the function of value of the information ε_x concerning the phenomenon "x" on account of its economic benefit to the recipient, notified as $W=\varepsilon_x(p, o, t)$. In can have the dimension of the change of capital connected with using the information. The initial context for the interaction threshold is determined as a vector $(p, o, t)_0$, and the appropriate function is labelled as $\varepsilon_x(0)$. After the k-th iteration until the reaction threshold the vector of new context is denoted as $(p, o, t)_k$ whereas the function εx is labelled as $\varepsilon_x(k)$. Then according to the Gossen's law the differential of the function ε_x is decreasing.

p = numerical representative of stakeholders for which the information is essential, and which will let describe himself in the dimension of capital with.

o = numerical representative of geographical area which is bound with the weight of the importance level of the stakeholders capital change (measured as net profit per capita). The same information will induce different capital changes at single stakeholder depending on the region.

t = variable of the time which influences for limiting the context. The reliable information is losing meaning together with time. A significant elimination of stakeholders quantity which won't be able to react physically after some time may occur.

Function $\varepsilon = |\mathcal{E}_x(0)-\mathcal{E}_x(k)|/\mathcal{E}_x(0)$ determines the information elasticity on account the phenomenon „x" and its economic importance. The value $\Delta\mathcal{E} = |\mathcal{E}_x(k)-\mathcal{E}_x(0)|$ means the capital changes derived from the information use in the context denoted as $(p,o,t)_k$ in relation to the global change of capital evaluated for the global context range denoted as $(p,o,t)_0$.

A time relation of the elasticity is also an essential problem of the information and its usefulness. It can undergo essential alterations, on account of limiting the context in the time. It is third independent variable in the function of the elasticity

Presented above conception of estimating the level of the elasticity of the information from the moment when the message can be left recognized as the information till the moment when it induces action, quantitative taking hold of the problem of the influence of the elasticity on decisions enables
− Conclusion 1:
  The economic usefulness of the information from a reasoning point of view is inversely proportional to a degree its elasticity.
− Conclusion 2:
  There do exist a level of the information elasticity (optimal context), which the message is achieving the threshold of the interaction and the reaction at the same time for.
− Conclusion 3:
  If the information was published in the optimal context, all further fine-tuning its gives no useful value.

Gossen's law in relation to the value of used information seems to be very important criterion its elasticity. A contradiction between the marginal usefulness in economics and usefulness of the information in the introduced decision-making model, wasn't found. The elasticity of information is the important perimeter in construction of the optimum information resources of organization [3].

8. SUMMARY

Introduced conception of the information elasticity, based on the pragmatic and apobetic context is offering the possibility of the new attempt at analyses from the scope of decision making. A three-layer model of using the message for decision making, basing on which the information elasticity is defined was shown. A qualitative relation between the Gossen's law and the information theory showing the information value changes on account the context and time variable for making decisions was led. The economic quantification of the information derived from the capital context was suggested. A method of estimation the functional elasticity of information was introduced. The presented conclusions are useful in designing artificial intelligence systems which make choices with the use of neural networks.

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