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**"Gutenberg made everyone a reader,
Xerox made everyone a publisher,
the personal computer made everyone an author
the pocket telephone makes everyone a participant"**

Towards an Information Economy

The need for formal representation

To make possible relevant steps towards an Information Economy, it would be of great usefulness to be able to define models where information could be treated formally. It would concern network descriptions. In such a surrounding there would be need for common forms of "information currencies" to be used as payment in contacts between nodes in the network. In many application environments there is also need for some kind of model for exchange of values that are representations of such information that is relevant in the application in question.

There may exist different forms of such currencies, just as there exist different monetary currencies in different countries to-day. It is natural that each specific information currency in the beginning has a specific application environment as its own definition area. The contacts between countries, with national boarders, to-day, however, are getting less and less sharp.

As exchange between different monetary currencies to-day is being made more and more automatic, exchange between information currencies may become automated, with the help of formal representation models.

If all information representations would lack structural similarities, would differ from application to application, from model to model, from person to person, then there would seem to be small chances to find common schema for information currencies.

If, however, there exist model areas, with the same, or at least overlapping, frames of reference, then there might be a chance to define some kind of information currency that could be useful at least in these areas.

As an area for exemplification we might consider banking. The use of coins to-day has decreased to a level where in practise it is not too common, and even bank checks are scarcely used. What is more and more common is the use of bank credit cards. This development could be summarized as follows. There is a chain being defined by the changing situation that coins get replaced by banknotes, that get replaced by bank checks, that get replaced by credit card notes, that get replaced by terminal actions (for instance pushing of certain keys on a keyboard). This chain has the meaning that data representing financial values take different forms over time, while the data themselves are unchanged.

A piece of financial data has the form that:

An amount of cash - may be used by - the owner

By changing the reference to the owner, the amount of cash may be used by someone else.

Frames of reference rely on access to relevant data. A frame that can show relevance for a certain type of communication, relies on existance of relevant data for the application that is being communicated.

Frames of reference can be seen as object spaces, with boarders. Data represent statements, or attribute values, about objects. Data can exist on type level, and on instance level. There exists an infinite number of type levels above each other.

Types of access

Different forms of access to relevant types of information for everybody is being discussed widely. Increased individualization of information access is being noted as important in several environments. Everybody will have the chance to define her or his personal information profiles, and systems will be available for collection and distribution of such personally defined and demanded types of information.

What is being debated are the forms for this. In what manner are personal information profiles to be defined? How should one value, collect and distribute the different types of information that are asked for?

Network effects

Videotex and related types of communication technologies, seen in a broad context, are forms of technical means that may be able to provide a basic network structure for widespread information collection and distribution. On top of such networks there will be other logical networks, networks that may provide "higher", or more value-added, forms of information. They are higher "network types".

In France there is a common understanding that the road to new and more personalized information services goes via use of the Minitel. This represents a "low technology" move into the race towards more efficient communication between human beings.

The North Americans believe in another technical format. The Prodigy system holds for probable that soon (before the end of the century) more or less everybody will have access to a s private personal computer with a modem.

Both philosophies represent a certain type of understanding of networking:

It is in the network itself that some type of value addition "automatically" or "manually" is added, and not only in the nodes. The structure contains value.

By the concept of value addition we here refer to ability to access data plus some computational power.

Cooperation between the network nodes creates increased possibilities for data access, and thus value addition. In this sense the "intelligent sum" of the network parts may be greater than the sum of the intelligences in the nodes.

Thus, there may be a connection between network structure and value addition. If this is so, then different network structures have different value addition relevance.

In Sweden, where the mobile telephone is being spread with what probably is the worlds highest speed in the beginning of the 1990´s, one can already predict with some accuracy the timing for the situation where everybody will carry a private portable telephone of, perhaps, pocket size. Estimates have been given that before the end of the century, every second Swede will have access to a personal telephone. Soon this piece of equipment will be made intelligent. Innovations and market demand will transform it into some type of partable interactive personal computer.

Although the way to this in many countries will resemble the French Way, through Low Tech (the Minitel), it is now time to discuss effects of the situation where everybody has direct access to personal computer power, more or less 24 hours per day.

This development will blur the boarder between the Prodigy and the Minitel approaches.

Suppose that a human being and her portable terminal are considered as a whole, as an "informed person". Let us call our first such person IP1. The second such person we come across we call IP2. They both have access to specific computer power, especially in some sense relevant databases.
They are, logically seen, functions that in some sense value their access to data.

IP1 = IP1(girl1, terminal1);
IP2 = IP2(girl2, terminal2);

If the abilities of both IP1 and IP2 can be considered as logical sums of its parts, then

IP1 = IP1girl1 + IP1terminal1;
IP2 = IP2girl2 + IP2terminal2;

Then the difference between these two, IP1 - IP2, has two parts,
Q1 and Q2:

IP1 - IP2 = (IP1girl1 - IP2girl2) + (IP1terminal1 - IP2terminal2) =
Q1 + Q2;

What we noted Q1 = IP1girl1 - IP2girl2 is as undefined as its parts, IP1girl1 or IP2girl2. The difference between them might then be treated alone in our discussion. Let us leave it for the moment.

The other part, Q2, is built up of the expression
IP1terminal1 - IP2terminal2;

In situations where this can be considerad useful, this may be a manageable formula. Suppose, for instance, that the two extended persons in the relevant time interval have access to the same database. Then the difference between their functions of access can be seen as zero.

If, on the other hand, IP1 has access to more relevant data than IP2, then the difference gives a positive result. Without giving exact measures concerning these items, we thus have at least relations between them.

This is simple linear arithmetics. More complex expressions may be evaluated into other forms. Certain types of these may be able to be treated formally. What type of relational algebra could be defined on this base? Here is a need for continued research.

A notation for comparisons concerning information value

Without actually defining the concept of "information", we can develop an algebra with which certain calculations, or comparisons, are possible. The basis for this is the understanding that access to information is dependent on time.

Availability of a certain quantity of information I_1 depends on how long time it takes to reach it. Let us with t_n denote the time it takes to reach a certain piece of information I_n. This has two components:

- the way to define the piece of information
- the physical time that is needed to locate it in its database

each own

Each component c_n can be looked on as a element of communication in a certain dimension.

In many applications there is a balance, often an alternative, between retrieving a piece of information in a database, and obtaining the piece of information as a result from a process of communication. When one of them is increased, the other need not be. To increase the information value V(t), either I(t) or C(t) may be increased.

This balance can be formulated in the way that the two are reciprocal to each other:

$V(t) = C(t) * I(t)$;

It is appropriate to include user availability in this. Let us define an availability function A(t) apart from I(t). What is left in I(t) then can be seen as a more pure information quantity :

$V(t) = A(t) * I(t) * C(t)$;

We recall that $I(t) = dK(t)/dt$;

with K(t) = the knowledge function, making available those data that are stored in the database that are relevant for the actual application.

A security function, S(t), can be useful when there is a need to regulate a person´s access to certain data. Such a function quite naturally is binary, i e it can be given the values 0 or 1 only. It can also be seen as a lock, a logical function. In its binary form:

S(t) = 0 or 1 ; ← Kan också vara kombinerlig fkn!

This regulates the physical access to the information.

So we see that the value of information in this model has several components:

- security
- user availability
- communication possibility, including speed, chance of retrieval (?)
- change in knowledge

$V(t) = S(t) * A(t) * C(t) * dK(t)/dt$;

$V = S \cdot A \cdot \frac{D}{t} \cdot \frac{dD}{dt}$;

What can be said about this fkn?
- Decreasing with t
- Dependant of S and A - how?
D - how?

Values and costs

The cost of a piece of information has both semantical and practical components:

Information cost = cost of information content +
+ cost of adaption to the user environment +

+ cost of transport to the user ;

Let us denote this:

$C_I = c_{cont} + c_{env} + c_{trp}$;

A comparison with the market of selling ordinary goods shows an important difference. The person who sells a bicycle has not the bicycle in posession after the deal. The person who sells a piece of information, however, still has access to that same piece of information after the deal. What is sold in the latter case is simply the access to the piece of information. What also might be included in the deal, naturally, is adaption to the user environment plus transportation to the buyer.

The business deal of selling a piece of information therefore can be formulated in the way that the buyer p_1 at time t_1 with the deal gets authority to the piece of information. The variable Auth (p_1, t_1) is changed from 0 to 1.

If the deal is of a regular nature, and contains delivery of the same type of information, but updated, at regular time intervals, then both the cost of adaption to the user environment and the transportation cost are the same at the different regular occations:

$C_{I1} + C_{I2} = c_{cont,1} + c_{cont,2} + 2\, c_{env} + 2\, c_{trp}$;

If the costs for environmental adaption and for transport are independant of the number of times the deal is repeated, then:

$\sum_n C_{In} = \sum_n c_{cont,\, n} + n * (c_{env} + c_{trp})$;

It is, however, common in many applications that both c_{env} and c_{trp} decrease when repeated. The cost of selling information repeatedly decreases with the number of occations.

The updating of $c_{cont,\, n}$ may be formalized. How?
The adaptation to the user environment, the trouble to find a piece of data in a database increases with database size. How?

If a person A has access to greater amounts of knowledge K than the person B, then A is in the position to be able to sell this excess knowledge to B.

Payment for pieces of information can be given in the form of access to newly created comments, or to other pieces of data.
Suppose B pays A by giving the a comment to A:s question. C does the same, i e pays by giving her comment to A:s (same) question. A appreciates and accepts both B:s comment and C:s comment. But how are these two comments related?
What value does B put on C:s comment?
How are the values of comments added, when they get to become numerous?

Information is change in knowledge!

$D(t) =$ data quantity

$$V(t) = S(t) * A(t) * \frac{D(t)}{t} * \frac{dD(t)}{dt};$$

$$C(t) = \frac{D}{t}$$

$$\because V = S \cdot A \cdot \frac{D\,dD}{t\,dt}$$

$$V(t) \cdot t\,dt = S \cdot A \cdot D\,dD$$

$$\int_t V(t) \cdot t\,dt = S \cdot A \cdot \int_t D\,dD = S \cdot A \int_t D \frac{dD}{dt} dt$$

To be continued.