# I-K-I: A Unified Theory of Information-Knowledge-Intelligence

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**Abstract**– The inherent links among information, knowledge, and intelligence were recently discovered by the author of the paper, that is., **information can be refined to knowledge while the latter can further be activated to intelligence**. An attempt was thus made to establish a unified theory of information, knowledge and intelligence which may mean something significant.

**Key Words:** Comprehensive Information,, Knowledge Creation, Intelligence Generation
Unified Theory of Information-Knowledge-Intelligence

## 1. Introduction

Information, knowledge, and intelligence are commonly regarded the most important wealth in information age. They have widely, and yet separately or independently, been studied for quite a long time in history. The deep links among the three were recently discovered by the author of the paper after his 30 years' continuing investigations. A unified theory of information, knowledge, and intelligence was established as results. It is the author's belief that the new theory may be of great significance as the transformation from information to knowledge and further to intelligence has to be the real soul of the advanced information processes of any kinds.

In section 2 of the paper, a brief explanation on the concepts of Shannon Information, Comprehensive Information, knowledge and intelligence as well as the relationship among them are given. In section 3, the main body of the unified theory of information, knowledge, and intelligence will be presented. Finally, a brief conclusion is made in section 4.

## 2.Fundamental Concepts

**Definition 2-1** ***Shannon Information*** is understood as something able to reduce the stochastic uncertainty [1].

**Definition 2-2** ***(Comprehensive) Information*** about an object is something able to show the possible *states* of the object and the *manner* with which the states of the object vary, including the states-manner's form, meaning , and value toward the user [2].

The form of the states-manner is termed ***syntactic information***, the meaning of the states-manner the ***semantic information***, and the value the ***pragmatic information*** while the entirety of the three the ***comprehensive information***.

**Definition 2-3** ***Knowledge*** concerning a category of objects is something able to show the possible *states* of the objects and the *law* with which the states of the objects vary.

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**Definition 2-4** Any knowledge should have three components, i.e., ***formal knowledge*** concerning the formal description of the knowledge, ***content knowledge*** concerning the meaning of the knowledge, and ***utility knowledge*** concerning the utility of the knowledge with respect to the user.

It is clear from the Definitions above that knowledge can be refined from the (comprehensive) information as the *law* can be summarized from great number of specific *manners*. However, knowledge can not sufficiently be refined from Shannon Information for it is merely a stochastic form of the comprehensive information without meaning and vale factors considered.

**Definition 2-5** For given problem, the environmental constraint of the problem, and the goal that one would like to achieve in solving the problem, the ***intelligence*** is an ability to do the following:

-- purposively acquire the *information* concerning the problem and environment of interest,

-- properly manipulate the information acquired so as to create the related *knowledge*,

-- reasonably produce a *strategy* for solving the problem through the integration of the created knowledge and the given goal, and

-- effectively utilize the strategy to solve the problem, achieving the goal under the environment given [3].

It is seen from definition 2-5 that intelligence, as an entire ability, consists of four components, the ability to obtain information, the ability to create knowledge, the ability to produce strategy, and the ability to utilize strategy for solving the problem. As the embodiment of intelligence, the creation of strategy is directly based on information and knowledge.

## 3. Unified Theory of Information, Knowledge and Intelligence

Due to the time and space limitations, the unified theory of information, knowledge and intelligence will briefly be presented here, without any explanations, by merely giving the central algorithms which transform information into knowledge and further into intelligence. Other aspects of the unified theory will have to be discussed elsewhere.

## 3-1Knowledge Creation from Information

There are two approaches to knowledge creation in general. The first is the one to create knowledge through induction from specific information and the second is to create new knowledge via deduction from the existed knowledge. Because of the special interest in concerning the relation between knowledge and information, the stress is placed here on the induction approach.

### 3-1-1The Mechanism of Formal Knowledge Creation from Syntactic Information

Concepts are the elements of knowledge. It is reasonable to investigate the mechanism of formal knowledge creation by looking at the mechanism of formal concept formation from information.

**Algorithm 3-1-1 Mechanism of Concept Formation**

(1) Observing a sample $S_1$ of syntactic information that is randomly given, try to extract its syntactic features.

(2) Observing the second sample $S_2$, also randomly given, extract its syntactic features as did in step 1 and then compare them with the ones obtained previously. If the features of the second sample are the same with the ones of the first sample, keep it.

Otherwise, ignore it.

(3) Repeat the step 2 for N times, N is a sufficient large positive integer. A set of features { $f_k$ }, k = 1, 2, …, K, that are same within the N' $\leq$ N samples, can then be found and is termed the Common Feature Set (CFS) of the N' samples, where N-N' samples were ignored, K>0, the dimension of common feature vectors, is an integer.

(4) The remaining N' samples are named a basic set of the samples. When N and N' are sufficiently large and CFS is stable, a concept, abstracted from the class of information samples, is thus formed. The CFS, { $f_k$ }, is called the intention of the concept whereas all the members of the class are the extension of the concept.

(5) Otherwise, return to step 3, till CFS is stable.

**3-1-2 The Mechanism of Utility Knowledge Creation from Pragmatic Information**

In the context of the paper, it is assumed that any concerned subject should have a clearly defined goal and the value of a piece of information toward a certain subject (pragmatic information) is then judged in terms of the contribution that the information may make to the implementation of the goal. A specific way for obtaining the utility knowledge from the faced information is to observe, or predict, the fact that whether the subject's goal be threatened or be supported by the information.

**Algorithm 3-1-2 Utility Knowledge Creation**

(1) Define the general goal for the concerned subject: $G = \{G_n\}_{n=1}^{N}$, that are easy to test to see whether any sub-goal being threatened or encouraged.

(2) Input a piece of information X, the subject records the syntactic features, D(X), of X including the description about its states and the manner the states vary.

(3) Observe or predict the influence that the information makes to $\{G_n\}$ : whether any sub-goal suffers threatening or gained supporting from the information (the pragmatic information). The former indicates the positive utility, $u_n^+$, and the latter the negative, $u_n^-$, for all n. Sometimes, an average value of utility, $u$, may need to consider.

(4) Set up the descriptor $\{D(X), G; u\}$ which means that the information with the syntactic descriptor *D(X)* may provide a utility *u* to the subject whose goal is *G*.

(5) For any new information received, the utility knowledge can be obtained by comparing the syntactic description of the new information with *D(X)*. As long as the new information has the syntactic feature similar to *D(X)*, it will be regarded to have utility *u* to the subject having goal *G* in accord with $\{D(X), G; u\}$ . Otherwise, a loop from step 1 to 4 will be needed.

**3-1-3Mechanism of Content Knowledge Creation**

**Algorithm 3-1-3 Content Knowledge Creation**

(1) Establish the related formal knowledge, $K_F$, by Algorithm 3-1-1;

(2) Establish the related utility knowledge, $K_U$ , by algorithm 3-1-2;

(3) The establishment of a linkage between $K_F$ and $K_U$ such that $K_C : K_F \; a \; K_U$

(4) The content knowledge is "$K_F \; a \; K_U$" in which $a$ expresses the logic relationship between $K_F$ and $K_U$ such as "be", "have", “do”, “take”, and so on.

(5) Name the meaning of the content knowledge by a term.

## 3-2 Intelligence Creation from Knowledge

The creation of intelligence from knowledge is embodied by the formation of strategy for solving the problem and yet the strategy itself is formed by the use of knowledge under the guidance of goal seeking.

**Algorithm 3-2: Generation of Intelligence Based on Knowledge Activation**

Given problem, the knowledge about the problem (rules base and knowledge base), and the goal of problem solving,

(1) Select a rule from rule base given.

(2) Apply the selected rule to the knowledge base representing the current state of the problem and then a new state is produced.

(3) Compare the new state of the problem with the goal, a difference indicator is obtained.

(4) If the difference tends to decrease, the strategy for rule selection is accepted. Otherwise, go back to step 1 for reselection.

(5) Go back to step 1 for next selection until the difference approaches to small-enough value. The sequence of the selected rules is accepted as a good strategy for problem solving.

## 4 Concluding Remarks

It is clearly shown from the sections 2 and 3 of the paper that knowledge can be created from information via the algorithms of induction and intelligence can be created from knowledge via the algorithm of knowledge activation. These results form a framework of the unified theory of information, knowledge, and intelligence which is the soul, or backbone, of advanced information processes of any kinds both for machines and humans in reality

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