Toward an Image Database-Post-AI Computer for Thinking Environment-

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Toward an Image Database

——Post-AI Computer for Thinking Environment

Toru NISHIGAKI

Meiji University / Izumi

1—9—1, Eifuku, Suginami, Tokyo 168, JAPAN

1. Introduction

Modern electric media obviously have brought about a drastic change on our notion of what human thinking is. Especially it is worth while remarking that today's powerful computers are believed to be able to simulate, if not substitute for, human thinking processes. The Artificial Intelligence (AI), an ambitious attempt to realize human cognition and thinking in a computer, has been one of the most active computer science research fields throughout the world for these years. Many applications of AI technology are actually used in diverse industries. However, the efforts of AI researchers during '80s have also revealed that the current AI is too much limited to be called an authentic human-like machine. For instance, an AI computer system can never and probably will never be able to understand the *meaning* of human language. It has critical difficulties in interpreting verbal expressions reflecting various contexts.

There have been many related arguments and discussions [D1] [D2] [D3] [H1], but those most noteworthy were made by T. Winograd.

Almost fifteen years after the development of SHRDLU [W1], the successful and well-known robot system for natural language processing, he suddenly wrote a unique book with F.Flores titled "Understanding Computers and Cognition" in 1986 [W2]. In the book he criticized the methodology of current AI technology by referring to the philosophical theory of M.Heidegger and that of H.Maturana&F.Valera. The current AI technology depends upon a closed model, where logical symbol manipulations are executed on the assumption that everything in the world can be explicitly represented by an adequate symbol. The fatal shortcomings of this assumption were fully discussed by Winograd, with the suggestion for the necessary change of computer science research. His argument indicates that current computer science is approaching a major turning point in its research concepts.

Then, what kind of attempt should be made, instead of seeking after a human-like machine? —— This is the problem addressed by this paper. In order to investigate this problem, it would be useful to examine the history and the root of thinking machine. The author already indicated that thinking machines including modern AI were deeply rooted in the art of memory tradition [N1] [N2]. Especially we should pay more attention to the art of memory during the sixteenth century, which was a philosophical world view rather than a simple memorizing technique.

Based upon the philosophy of Neo-Platonism, the Renaissance art of memory incorporated the famous "Ars Combinatoria" of Ramon Lull which realized a sort of *concept calculation*, although it was naturally far from the logical inferential machine of modern AI. The main intention of the Renaissance art of memory was to build up a way for a human being to intuitively grasp, by the use of metaphorical correspondence, the

secret of the universe. The metaphorical correspondence and the logical calculation used to be mixed up in those days, and it was only after the seventeenth century that the latter began to exclude the former.

A thinking machine can be considered, from these historical contexts, as a tool for people to edit various images, stimulate intuitions, and exalt thinking abilities. Therefore it is desirable now to develop an *image database*, a computer system which helps the creative activities of people. This paper attempts to give a guideline for the study of image database. Even though a similar sort of human intelligence amplification is intended by systems termed hyper media [N4], the basic difference between hyper media and the above system lies in that the former is essentially a tool for an individual while the latter intends to be shared by people. The image database is basically open and provides people with multi-media information to promote their creations.

2. The State and Frustration of AI Technology

The AI is said to be born in 1956 at the famous Dartmouth conference, and therefore it is no new field in computer science. However, it was not until the introduction of *Knowledge Engineering* in the late '70s that the AI began to have its practical importance in industry. In many application systems, Knowledge Engineering exploits various kinds of human knowledge expressed in natural language. An *expert system* is a typical such example. A computer system which has a set of expert knowledge in its storage device is expected, at least to a certain extent, to behave just like a human expert [B1].

One of the simplest and most widely used expert system model is *production system*, where an inference engine produces propositions one

after another using "if-then rules". That is, *if* some conditions are met for current propositions, *then* a following proposition is inferred by applying relevant rules. Here the initial proposition is obviously the question itself. This deduction process is usually repeated until the answer (the final proposition) is obtained.

The essence of production system consists in "rules", but here we know that the understanding of those rules has nothing to do with computer system logic. Namely a computer system itself never needs to interpret the meaning of the words which compose the rules, although it may answer verbal questions like a human expert.

The more challenging AI research efforts have been made for natural language processing. The typical application is machine translation. If a computer successfully translates English into Japanese, or vice versa, it looks as if it were a genuine human-like machine who understands natural (human) language. But again this is an illusion. There are some working machine translation systems actually used by people, but they are far from truly understanding natural language.

The crucial part of natural language processing is composed of two phases : syntactic analysis and semantic analysis. The former analyses an input text and yields several internal expressions, each of which represents a grammatically correct sentence structure. The problem is that there are usually too many grammatically correct expressions. Therefore the second phase, semantic analysis, must follow in order to choose the most relevant sentence structure. Once the most likely structure has been chosen successfully, the system can fabricate a translated output text based on it.

It should be remarked here, however, that the semantic analysis is

not "semantic" in its real sense. The semantic analysis program does not semantically interpret but syntactically examines the input text in detail. The use of *case grammar* [F1] in this phase is a typical example. Taking briefly, the semantic analysis is nothing but a more refined syntactic analysis.

This inability of current AI technology to understand human language in the way we do naturally causes practical problems. The meaning of words varies greatly depending on contexts and situations, but a computer is hard to recognize it. Consequently an expert system may produce a irrelevant answer, and a machine translator may give a wrong sentence. Here we need more theoretical arguments, because we must ensure whether or not these defects may be overcome by future technological improvements.

There have been long discussions on this topic. We do not like to repeat them in this paper except briefly summarizing the crucial point. Those who believe that AI can achieve a truly human-like machine assume basically that human cognition of the world is composed of computations of symbolic representations. An external world is pre-given and can be adequately represented by symbols. Human thinking process is nothing but manipulations of those symbols, which could be realized in a computer.

Winograd strictly criticizes this assumption as one of the leading AI researchers. Instead of representationalism, he insists that we live in a world which is not pre-given but brought forth by us, and therefore it is impossible to represent all world elements explicitly by symbols. The argument of Winograd is dependent upon the ontological philosophy of Heidegger and the biological "Autopoiesis System Theory" of Maturana

and Varela. According to Heidegger, representation is a "derivative phenomenon which occurs only when there is a *breaking down* of our concernful action". That is, things can be made explicit only through a breakdown —— some event of disturbing the current situation [W2].

The theory of Maturana&Valera proposes the idea that animal's nerve system does not have a representation of external world. An animal is an autopoietical system which keeps modifying itself in a way it does *structural couplings* with its environment [M1]. Winograd states that "the structural coupling generated by the demands of autopoiesis plays the role that we naively attribute to having a representation of the world" [W2]. The above argument demonstrates that a computer can never understand human language nor behave truly like a human being.

Instead of that, Winograd suggests a new direction for the future, which is the design of computer systems to facilitate human work and interaction. He calls it *ontological design* which attempts to specify in advance how and where breakdowns will show up [W2]. The system termed "the Coordinator" is an design example developed by him which is built on a distributed electric mail system. The basic approach of the Coordinator is to look language as something to coordinate human actions. By recognizing the state of conversation at each moment, the Coordinator is expected to improve the efficiency of group work by eliminating useless breakdowns.

Although this argument of Winograd is convincing, it should be noted that his research policy is too confined for future computer application. A computer has an ability to aid creative human activities in an organization. A breakdown is "not a negative situation to be avoided" as indicated by Winograd himself [W2]. It reveals the concealed part of

the world, and there is possibility that it can give us a creative perspective. The future computer system should provide us with a creative thinking environment which yields breakdowns, if necessary.

3. Art of Memory and Computer-based Pansophy

It may be useful to trace back the history and examine the studies related to thinking machines, in order to seek for the future direction of computers. Although the methodology of modern AI is said to be descended from the famous "Characteristica universalis" of Leibniz, we need to position it in wider cultural movement —— the art of memory [N1]. In fact, one of the reasons of AI frustration can be, as we will see later in this paper, considered that AI has inherited only the idea of universal calculus which is merely one aspect of great Leibniz.

Our purpose is to seek after the way how a computer can assist people to recall and edit affluent images. This naturally overlaps the aim of the ancient art of memory. Generally speaking, our thinking is heavily dependent upon our memory. Without it we can hardly take daily cognitive actions. Even though we can store information in external media such as books, it is too inefficient to refer to them at every moment we need. Moreover, external media used to be costly and bulky in old days. Therefore it was indispensable to keep information in brain by some artificial way. The art of memory used to be a branch of rhetoric in western tradition from ancient Greek to the Middle Age. The classic Cicero art of memory which utilized *places and images* was particularly useful to persuade people to do something. Moreover, it was also a technique to stimulate a mind and amplify human thinking ability.

Probably the Ars Combinatoria of Ramon Lull can lead us to the root

of AI. The similarity between AI and Lullism is widely known. Both AI and Ars Combinatoria manipulate symbols which represent concepts. In Ars Combinatoria a concept is decomposed into elementary atomic concepts, to each of which a symbol is allocated. These symbols are mechanically interrelated and combined using special tables and discs. Here we must not forget, however, that Lull was a Franciscan of the thirteenth century and his mission was to convert Muslims and Jews to Christians. His Ars Combinatoria was a pedagogic tool, which intended to make people easily memorize Christian doctrines. Namely Lullism was a kind of art of memory [Y1].

In fact Cicero art of memory and Lullism were both integrated into the Renaissance art of memory in the sixteenth century [R1]. The Renaissance art of memory, built up by such scholars as Cornelius Agrippa, Giulio Camillo, Giordano Bruno, etc., was a sort of world view rather than a simple technique for memorizing. The Renaissance Neo-Platonism which was based on Hermetic and Cabalistic tradition endeavored to recognize the profound truth by gaining an insight into the universe. It shared with modern AI the ambition for the wholeness. Nevertheless we should note that it was metaphorical correspondence that played the essential role in the Renaissance art of memory. The exclusion of metaphor began in the seventeenth century, thus making the Renaissance art of memory quite different from modern AI which respects pure logical inference.

In the seventeenth century the *universal language* movement in England took over the art of memory tradition. Researchers labored to find the universal language on "real characters", which were to correctly represent world's objects. And these efforts came straight out of the art

of memory where adequate signs and symbols were sought to use as memory images. Moreover, the universal language were considered to aid the human ability for recalling and memorizing. F. Yates described as follows: "The seventeenth-century universal language enthusiasts are translating into rational terms efforts such as those of Giordano Bruno" [Y1].

Despite that, we ought not to forget that the seventeenth century was the age of *order*, where the representation system completed within itself [F2]. The essence of the seventeenth century epistemology consisted not in metaphorical correspondence but in systematic order of symbols. This attitude was best demonstrated in "Charateristica universalis" of Leibniz, which aimed at universal calculus rather than universal language. The Characteristica universalis was a scholastic effort to find the ideal mathematical symbol system which *expressio* the world as a whole, and to lead to the truth by the calculation on such symbol system. Here we can find the same hypothesis as in modern AI that closed logical inference on symbols always yields relevant solutions. This hypothesis, however, often brings about doubtful results as is shown in practical difficulty in AI.

It should be emphasized that Leibniz was also an encyclopedist, and he had a full knowledge of the Renaissance art of memory. In fact his famous "monad" was borrowed from G. Bruno. Therefore we may conclude that the problem is caused by that the encyclopedic aspect of Leibniz has been neglected and only his idea of universal symbol manipulation has been inherited in modern AI.

Another noteworthy activity in the art of memory of the seventeenth century was "Pansophy" of J. A. Comenius. Comenius took over the

Renaissance art of memory tradition through *Rosicrucianism* movement, but the point was that he translated the occult esotericism into the plain illuminatism. His Pansophy was for everybody to know everything. Comenius came to London in 1641, and it was after his visit that English people became enthusiastic about universal language. The universal language researchers like Bisterfield, Dalgano, Wilkins, etc. are considered to have been influenced by the Pansophy of Comenius.

Roughly speaking, Pansophy was an integrated encyclopedic project, which sought after the method and language to obtain supreme intelligence, based on exhaustive knowledge of nature, human and God. We can see the idea of Comenius in his best seller, "Orbis Sensualium Pictus", which was a text for teaching children Latin by means of pictures. It was a kind of visual education, and this visualism and rationalism were main features of Pansophy. Here we even find a tendency toward modern multi-media technology.

Multi-media easily stimulate human imagination, and they allow plural rather than unique interpretation. Thus we can see the way to develop "Computer-based Pansophy", which enlarges the domain of human imagination through multi-media interactions between people and computers. It is interesting to see that a new enormous information space begins to emerge as a result of such frequent interactions. This may be called the *pan-memory space*, where the information in human brains and that in computer storage supplement each other. The pan-memory space evolves by making the outputs of computers the inputs of people, and vice versa. This evolving information space becomes the basis of Computer-based Pansophy. Since the pan-memory space is shared by people, it requires a sort of multi-media database system.

4. Dramaturgy using Image Database

It must be emphasized that Computer-based Pansophy does not presuppose individualism. It means that we never assume such individualism as tries to conquer and exploit our surroundings. Instead, Computer-based Pansophy helps people tune their surroundings together with their community members in harmony with the environment [N3].

Since old times a human being is said to have been working in *meute* (a group of about 10 to 20 members) according to E. Canetti [C1]. It has been the case not only in hunting and fishing but also in creative intelligent activities, as we can see its classic examples in the great conversations of Christ and Buddha with their followers. The salons and clubs in the eighteenth century, and even the research teams of modern high-tech laboratories are also good examples.

This comes from the mechanisms of our brains. Our brains process information while we are dreaming as well as we are awake. What makes the information processing in a dream different from a usual one is in *constraints* caused by the stimuli of external world. I.Tsuda, a researcher of brain science, describes as follows: "The basic states of the mental association in our brains are those which we have while dreaming. When we are awake (except for having daydreams or illusions), these basic states are interrupted by outer stimuli and there appear such states as being highly correlated to the stimuli" [T1]. The stimuli caused by outer world may be physical and/or social ones. Based on these constraints, we build up the world image. For instance, we get burnt on our finger if we touch a hot teapot. Such a feedback from outer world makes us share the common world image —— *the reality*.

These constraints are often too strong when we are alone, and they tend to make us look the reality too solid to achieve a creative jump in our thinking. On the other hand, when we are in a group, adequate communication can bring about *sympathetic resonance* among our world images along with the disclosure of their slight differences. Through breakdowns continuously occurring in conversations, our own world images begin to be shaken, and we can be navigated to a new way of thinking, hopefully a innovative one. (Naturally a person sitting alone can achieve creative activities. But in those cases, he is likely to *simulate* a group communication by some means such as reading.)

It is worth while mentioning that a very large amount of information is recalled in such a creative group communication. The personal memories of group members, coupled with cultural and biological background memories, come back again all at once in a compressed and intermingled way. The events and affairs happened in a long spell of time reappear in quite a few seconds. Probably it is in these special situations that religious intuitions and inspirations could be obtained. These mystic situations, in a sense, may have been what the Renaissance art of memory was seeking after to attain the utmost truth. To this end we must put into computers various images shared by people, which we can retrieve and update freely. Let us call such a system " image database", which is expected to realize the pan-memory space and can be used by Computer-based Pansophy.

The image database is a kind of multi-media database. At present the most well formulated database model is the relational database (RDB). The RDB has been proposed by E.Codd in 1970 [C2], where any sort of information retrieval/updating is executed in terms of set opera-

tions on special *tables* called "relations". This is a model which represents everything by a *tuple* —— a set of data corresponding to a row of the table (relation). Note that the data in this model are, at least in principle, numerals and/or alphabetical characters of fixed length. In order for the RDB to incorporate multi-media data such as picture, sound and animation, a fundamental model extension is necessary [S1].

Probably it is the Object-Oriented Database (OODB) model that is said to be most suitable for the multi-media database [A1] [M2]. The OODB model basically comes from traditional computer simulation technology. In the object-oriented programming language such as "Smalltalk-80", everything is represented as an *object* which has the description of *state* and *behavior*. A typical OODB is obtained by making an object be a "persistent object" in a program written in object-oriented programming language [C3]. In this case, the objects are kept and saved even after a program completion, in order to be reused by other programs.

The OODB model is easier than the RDB model to handle multi-media data, but its mathematical definition is yet unclear. Moreover, the OODB has another problem. An object in OODB generally belongs to a certain *class*, where the class structure corresponds to a conceptual hierarchy. Here we encounter the same problem as we saw in the effort of seeking after the universal language. That is, there is no absolute universal class structure on the earth. In spite of that, we need to assume, at least to a certain degree, the common class structure to make effective use of the OODB. This leads to practical problems.

Therefore neither RDB nor OODB can provide us with an ideal model for our image database. Moreover even if a satisfactory image database model is obtained, there remain another problems —— how to develop,

use, and maintain the image database. Since it is in a dramatic situation that image database takes an effect, what is needed is the efforts to seek after a suitable dramaturgy. It is a pity that the study of the dramaturgy has not yet begun which enables creative image processing by computers.

It should be noted that the art of memory tradition gives us a certain kind of suggestion for it. The Renaissance Neo-Platonism disappeared from the main stream of epistemology because of its magical elements. Nevertheless it has survived in *Mannerism* art. In a narrow sense, Mannerism is referred to as the art style in western Europe (especially in Italy) from the sixteenth to seventeenth century. But we can still find the spirit of Mannerism in the works of S.Mallarmé, P.Valéry, J.Joyce, S. Dali, M.Ernst, A.Breton, etc. [H2] [H3]. Namely the essence of Mannerism lies in the effort to seek after the ultimate beauty and reconstruction of the whole world by the use of very sophisticated technique and logical combination of symbols. This obviously reminds us of the Renaissance Neo-Platonism and a certain aspect of modern AI technology. Probably we can obtain some useful suggestions from this kind of study in our investigation into multi-media dramaturgy.

5. Conclusion

A guideline has been introduced for a new creative computer-based thinking environment. The failure of modern AI technology in realizing a truly human-like thinking machine may have been already anticipated in the seventeenth century. Those efforts which try to shut up whole intelligence in the confined domain of representative symbols bring about the limited applicability of AI. The manipulation of symbols within the domain does not always lead to desired solutions.

It is interesting that old Pansophy and Mannerism help us give insights into the way modern multi-media computer technology should follow. Today's computer system of logical calculation machine needs to be transformed into artistic image editing machine. This makes the research of Computer-based Pansophy very promising. In a creative computer-based thinking environment, a group of people get involved in resonant information flow on a vast scale. What is required here is the image database which stores an enormous amount of image stock of the human race. The current multi-media database model of RDB and OODB are both expected to achieve further improvement to become an ideal model of image database.

In search of future development of computers, it is indispensable to study the image database technology together with artistic multi-media dramaturgy. This study will be our future work.

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