

# Modeling of human intelligence applied to general education of informatics in AI era

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## 「人間知能」のモデル化の提案とAI・データ科学の情報リテラシー教育

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### Abstract

A novel modeling of human intelligence is proposed. The current status of AI is found positioned in the model. The modeling is a decomposition of human intelligence into the four components, namely intellect, reasoning, sensitivity, and understanding. The decomposition is actually the links which connect the five states of information, namely data, information, knowledge, wisdom and unification. Thereupon the position of science is found inside the proposed mapping of information and intelligence. We note that this modeling of human intelligence is compatible with the historical Descartes' "reason" and Kant's "idealism". Since the relationships of these, namely of information and intelligence, are thus clarified objectively, it is found possible to position the AI of the present era. A proposal for an improvement of general education for informatics in AI era is also suggested, which is based on the modeling of human intelligence herein proposed.

### 1 Introduction

Ever since the naming of AI, the Artificial Intelligence, has been proposed in 1956 at Dartmouth by Jim McCarthy, probably because the naming AI was so catchy, that we the human has had a difficult time to express what is intelligence. In fact, the definition of AI is known to vary from scholar to scholar. This fact would have hampered any development of AI in otherwise possible fashion.

The lack of understanding on AI by scholar is not welcome since 1) social understanding becomes inevitably insufficient, 2) thus any application of AI would be hard to nourish, 3) then in turn the AI researchers would get annoyed without notice via the lack of social understanding.

In a sense AI loses opportunity for the development due simply to the catchy wording of "intelligence". Thus another definition of AI, without using "intelligence", has been actually

proposed in literature, such as the one: "continuing advance of automation" by Jerry Kaplan [1]. This definition of AI would be a good one in its functionality. But our profound question "what is intelligence?" still remains unanswered. This would make the intelligence more mysterious if we follow this alternative definition by Kaplan on the profound question of "intelligence".

In this paper we try to answer the question on human intelligence in a clear and straightforward manner. This clarity is achieved in our present approach by starting from the definition of information, in order finally to reach at the the definition of intelligence. Anybody knows the word "information". But it may not be trivial in the differentiation of data against information or that of information against knowledge. This questioning on the term "information" would help us to disclose a top secret of human intelligence.

In Section 2, we recapitulate the definition of data, information, and knowledge". In Section 3

and 4, we put up “wisdom” beyond knowledge, and further we position “unification” beyond wisdom. We then propose to position “science” in this context of the sequence of information in Section 5 and 6. In Section 7 and 8, we propose a decomposition of human intelligence into a set of four components, namely intellect, reason, sensitivity, and understanding. In Section 9, we thereupon demonstrate how we could apply the present proposed modeling of intelligence in the general education of informatics in the AI era. Summary and conclusion is in Section 10.

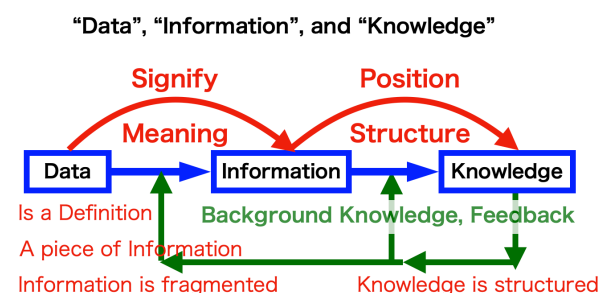
## 2 What is Data, Information and Knowledge ?

To begin with, we redefine the usual “data”, “information”, and “knowledge” in the following way.

Data is defined as a defined sequence of numbers or characters. Picture, for example, is also a sort of data, and it is data in the sense that it is expressed with a defined set of binary numbers, for example. There is a definition therein, but there is no meaning at this stage.

Information is defined as an attached meaning onto the data. In fact, the word of information is decomposed grammatically as in+form+ation, and “in” is a prefix to mean the forced direction of the following word “form”, meaning in total to create a form. This suggests in fact the present definition of information as an attached meaning, a sort of form.

Knowledge is defined as a structured set of an aggregate with plural pieces of information. Knowledge is at a higher level of information, since a piece of information is nothing but an existing piece of information, but once the knowledge structure is reduced into a randomized sequence of the same pieces of information, it is never again the knowledge. Knowledge is a



**Fig.1:** Definition of data, information, and knowledge.

defined structure.

These definitions are depicted in Fig.1 as is clear form these into an ordered set of the boxes. We should note that without knowledge, no data has its meaning to become information, and without knowledge no information could be structured in any knowledge. In this sense,

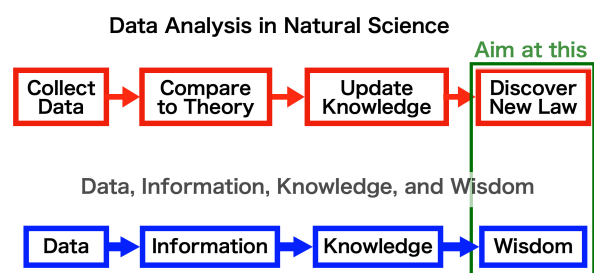
## 3 What is the next one to “Knowledge” ?

What is the next one to knowledge? It must be wisdom, since wisdom requires knowledge but it is not a part of the knowledge. In this sense, wisdom is defined as an emergent “some knowledge” based on the sub-level data, information, and knowledge.

The position of “wisdom” becomes clearer when we note an analogy between this ordering and what we do in science research.

Science research would start from data. We put those data into a graph to find the tendency. This is nothing but to find the meaning or information inside the data. We make use of the existing or known knowledge in order to interpret the data and information. If we get the interpretation successful, then we are happy. But if it is unsuccessful by any trial, then we are also happy. This is because it means that we must have discovered a new law of nature, which we may call wisdom, an emergent some knowledge.

The whole structure of these four, namely a sequence of data, information, knowledge, and wisdom, is depicted in Fig.2.



**Fig.2:** Analogous structure between 1) a method of data analysis in natural science, and 2) a sequence of data, information, knowledge and wisdom.

## 4 What is the next one to “Wisdom” ?

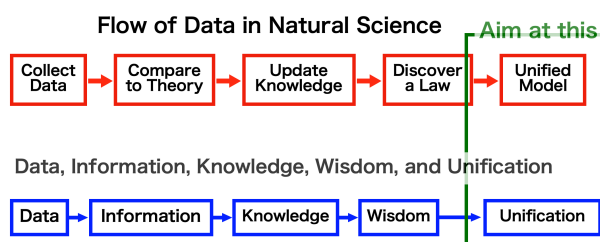
What is the next one to wisdom? It must be a unification. This view is again suggested by

science research, in particular by physics research.

In physics research, we may discover individual laws, one by one, inspired by individual experimental data. However, our aspiration would be to demand a unified view of the Nature. It is just like a unified theory of particle physics as it is at the present stage.

Just like this, we would never be satisfied by individual wisdom. We would also aspire a unified view with some unified object, or unification.

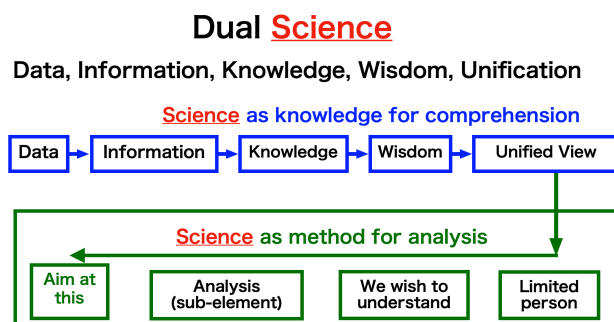
In Fig.3 we depicted this situation.



**Fig.3:** Analogous view of the flow data in Natural science and that of informatics, namely data, information, knowledge, wisdom, and unification.

## 5 What is the next one to “Unification” ?

What is the next one to unification? It must be “science” in the sense that 1) science is a process to quest for unification, and that 2) science is a process to analyze the unification for better comprehension. In fact what is unified would be highly abstract and complex, which would hamper for normal layperson to understand. But anyone must aspire for understanding the unification.



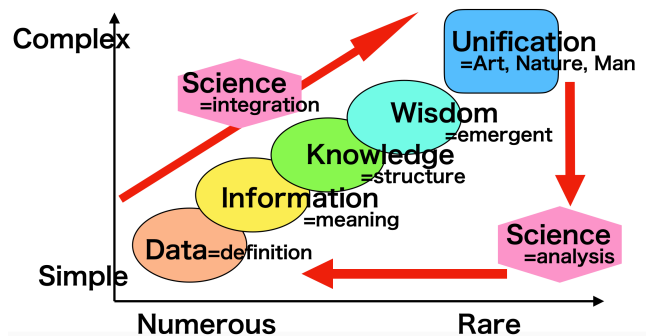
**Fig.4:** Dual process of science. One is the process from data to a unified view, the other (backward) is the one in order to analyze the unification.

This is just like a person facing at a beautiful and artistic painting, who would certainly wonder why it looks nice and beautiful. This is the beginning of the latter stage of science in its analysis phase.

This situation is depicted in Fig.4.

## 6 Model for “information development”

Now that we have reached at a stage of an interim summary, we now name the model: “**Model of information Development**”. This idea has been published in [2-4]. The interesting outcome of this model is that science produces the data, which themselves are the starting point of the whole process.



**Fig.5:** Model of “information development”

That is to say, it is a **helix model** to predict that the humankind would live the process forever (until no one survives our world) to aim at a better world. This suggestion seems highly pedagogical for pupil and students at schools and universities in the sense that they can embrace this model with the so-called “sustainable development; our common future” or SDGs.

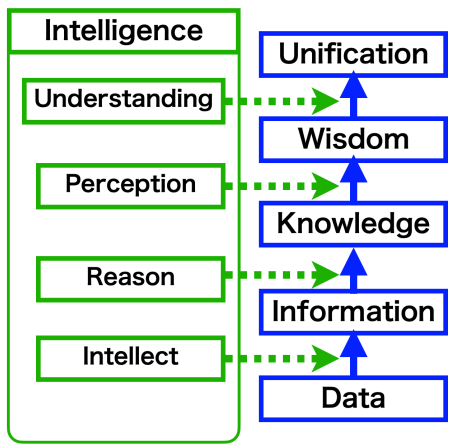
No one would object against “Our Common Future” nor deny the SDGs. In this sense, SDGs must be consistent with our future of “science and technology” or current era of IT and AI (Artificial Intelligence). The above proposed “model of information development” satisfies this condition, since it is a dynamical model for the future with a convergent characteristics (not divergently uncontrolled).

The trouble is that it is not so evident where to put the AI in this model, although AI is just akin to IT or information itself.

### 7 Decomposition of Human Intelligence

It is interesting to note that by way of the model of “information development”, we notice a possibility of a decomposition of human intelligence. Human intelligence could be decomposed into at least four components, such as intellect, reason, sensibility, and understanding.

The decomposition is not unique evidently. But it is clearly possible since we found just five stages in “information development”, and therefore we have to utilize four = (five-1) different kind of intelligence. It is thus depicted as follows in Fig.6.



**Fig.6:** Decomposition of human intelligence corresponding to “information development” in Fig.5

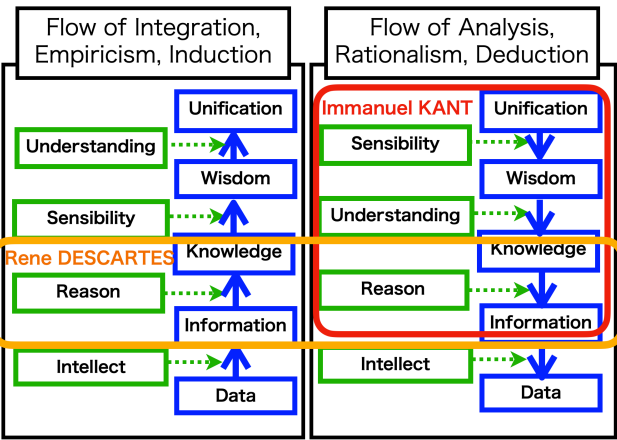
### 8 Induction and Deduction in Intelligence

We are now able to compare our modeling of intelligence with the other models of intelligence by historical philosophers, such as Rene Descartes or Immanuel Kant. In doing so, our model of intelligence is found related to empiricism and rationalism, or induction and deduction. This generalization is performed by inverting the model of intelligence (like Fig.6) into the opposite ordering. This operation is

inspired by the helix feature of “information development” as in Fig.5.

The result is depicted in Fig.7. Here we add two important note. One is that in the backward flow in the righthand part of Fig.8, the ordering of intelligence as Sensibility and Understanding is just inverted. This is because, in this way, the concept of epistemology with intelligence discussed by Immanuel Kant becomes identical with our model. Second note is that we find again an interesting correspondence of Rene Descartes “Reason” described in “Discourse of Method” just with our model of intelligence.

This beautiful correspondence may be an implicit justification of our model of human intelligence, at least in a historical context of philosophy. In fact, since human intelligence must be generated by “material” in our brain or genetic information, only a span of 400 years since Descartes must be too short to alter our intelligence. We must be treating the same human intelligence.



**Fig.7:** Correspondence of our model of intelligence with the historical epistemology of I.Kant and the Reason theory of methodology by R.Descartes.

### 9 Where is “AI” in Human Intelligence?

Finally we try to place our friend AI (Artificial Intelligence) into the present mapping (modeling) of human intelligence. It is clear that AI’s intelligence is only at the left bottom corner in the mapping of human intelligence. It is depicted in Fig.8. This is because 1) AI requires data input, so

that it must include “Intellect”, 2) human started to understand our own “Reason” only during the last 400 years since Descartes, so that we are insufficiently competent to perform programming our “Reason” into computer.

Fig.8 shows where AI sits in data, information and human intelligence. AI resides only at a left-bottom corner, presently. This picture may dictate a proper positioning of present AI, free from over/under estimation if any.

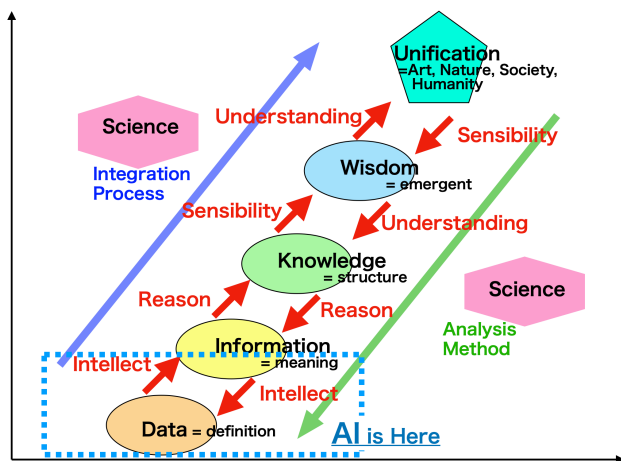


Fig.9: Region of AI inside a summary of “information development” (middle blob), science (left/right pinky blob), and “human intelligence” (red arrows).

On top of Fig.9, three names of Kant, Descartes, and Mizuno (author) are added just for a guide, because the picture is fully complicated.

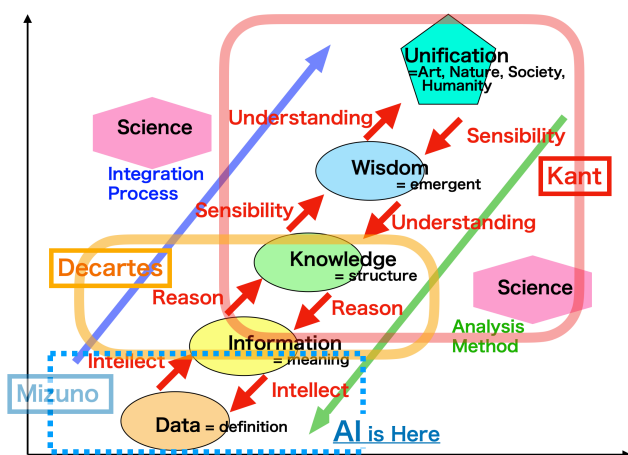


Fig.10: Names of Kant, Descartes and Mizuno (author), added on Fig.9.

## 10 Human Intelligence Model in Education

In general education of informatics or data science at university level, it would be standard to start from the definition of data or digitization of information. Already at this stage, data and information have a tendency to get confused. If we do so, then, students are also confused between data and information. Therefore, it is far better to teach the keen distinction between data and information at the very start of teaching/learning.

Only in this way, it is possible to recognize the “information development”, as has been emphasized repeatedly in this paper. Only in this way, it is possible to gain the important insight into our human intelligence. Only in this routing, it is possible to properly position the AI at our present era.

Without any cognitive image, education would fail. This is because if we have no map for navigation, then, any navigation would result in somewhere which may not be our purpose land.

## 11 Summary and Conclusion

In this paper, we have shown three things. One is that information is reinterpreted as a part of the model of “information development”. Second is that “science” can be reinterpreted inside this development model. In this context, science has a dual meaning in that it is a process of integration of information as contents, and also it is a process of analysis as a method as well. Thirdly, human intelligence is shown to be decomposed into four components. These are namely, intellect, reason, sensibility, and understanding with a reference to historical philosophers, I.Kant and R.Descartes.

Also proposed explicitly in this paper is that we are able to position the AI (weak AI of the present era) in the above-mentioned model of “information development”, science, and “human intelligence”.

It is thereupon proposed that it would be possible to improve the general education for informatics or data science by suggesting the possibility of modeling on the information, science and intelligence.

Further studies are required in order to improve the present proposed model with reference to other related

works and/or historical thoughts.

## References

1. Jerry Kaplan, “Artificial Intelligence: what everyone needs to know”, Oxford University Press, 2016.
2. Y.Mizuno, “Development model of ‘information’ in information society” (in Japanese), Proceedings of 24th Annual meeting of Japan Society of Social Informatics, pp.184-187, 2009.
3. Y.Mizuno, “Active learning of AI ethics based on ‘informed consent’” (in Japanese), Proceedings of Annual meeting of JUCE (Japan Universities Association for Computer Education), 2019.
4. Y.Mizuno, “Revitalize ICT general education on informatics for humanities students—from Active Learning (AL) to Artificial Intelligence (AI)” (in Japanese), in “Thoughts on ICT education — present status and issues of ICT education in humanity faculties”, pp.33-85, noa Publishing, 2020.