Instinct Driven Engineering

Shuichi Fukuda

Keio University, System Design and Management Research Institute
4-1-1, Hiyoshi, Kohoku-Ku, Yokohama, 223-8526, Japan

ABSTRACT

Our engineering has been Euclidean, but the Real World is changing rapidly. Now, data contain a wide variety of information. Therefore, it becomes increasingly difficult to apply mathematical approaches. And what makes the problem further difficult is the number of dimensions increases exponentially. So, we cannot solve the problem mathematically. Traditional engineering pursued How. But What is needed now. We should find the appropriate goal. This paper points out Instinct plays a very effective role to cope with these issues. It helps us to perceive the situation holistically and guides us to make decisions and take actions appropriately. To enhance such capabilities, a support tool to evaluate its performance is strongly called for. This paper points out the important role of Instinct in engineering and describes how we can support it.

Keywords: Open World · Non-Euclidean · Instinct · Perception · Strategic Decision Making · Performance Indicator

THE REAL WORLD YESTERDAY AND TODAY

Figure 1 shows the change of the Real World from yesterday to today. Yesterday, changes were smooth, so we could differentiate them and predict the future. But today, they change sharply. Therefore, we cannot predict the future. And our world was closed with boundary yesterday, but it is expanding rapidly, and the boundary disappeared. Now it is an open world without boundary. Another great change is materials are getting softer and softer with the remarkable progress of material engineering.

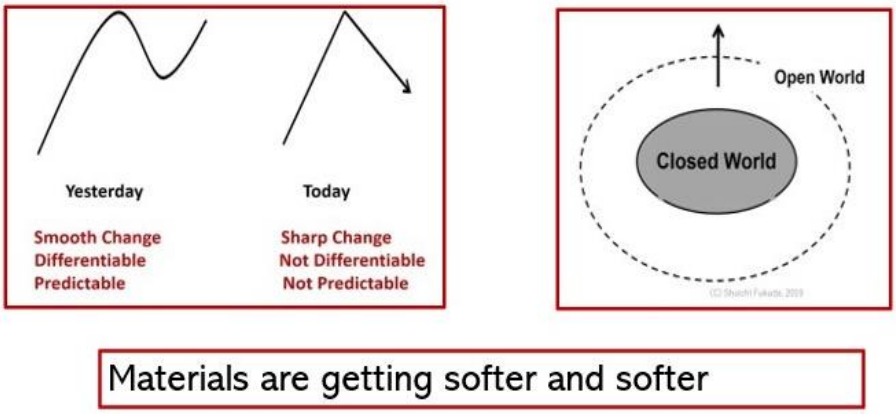

Figure 1. Real world is changing

Up to now, we could easily understand how to handle objects with our eyes alone, even from a distance. But as materials are getting soft, we need to directly interact with them. In other words, object handling has been tactical up to now. In other words, it was a problem of how. But with soft materials, we need to introduce a pragmatic approach. We need to find out what we should do by trial or error. Sensing and Actuation

This is the problem of sensing and actuation and VAK plays an important role. The softer materials become, the more we need directly interaction to understand how we should handle them. In other words, we need to perceive the situation through our movements.

Visual means eyes. They have played a very important role until now. But now we need additional sensing and actuation functions. Auditory does not mean only regular function of ears. What is more important is three semicircular canals. They help us to perceive the environment and situation through movement. They work for sensing the position of our body and for balancing them. Kinesthetics are movements.

HUMAN MOVEMENTS

Human movements are divided into two. One is Motion, which can be observed from outside. The other is Motor, which is movements inside of our body, such as muscles, etc.

Nikolai Bernstein clarified Motion (Bernstein.1967). At the early stage, our trajectories vary widely. This is because we coordinate many body parts and balance our body to adapt to the environment and the situation. But when we get close to the target object, our muscles harden, and they move together with our skeleton, forming a musculoskeletal system. So, we can easily identify parameters and apply mathematical approaches. Traditional engineering has focused on this stage. And control was our main focus.

But now the Real World is changing frequently, extensively, and unpredictably. So, it becomes more and more important how we coordinate many elements. This holds true not only with human movements, but also with many issues today, when environments and situations change frequently, extensively, and unpredictable.

EUCLIDEAN SPACE AND NON-EUCLIDEAN SPACE

Traditional computing processes numbers, based on 0 or 1 framework. Data was represented as numbers. This Euclidean approach requires its datasets to be orthonormal and interval-based distance with units. But as the world becomes increasingly complex and complicated, datasets come to be composed of a wide variety of elements. So, they do not satisfy these requirements anymore. Therefore, we need to develop non-Euclidean approach.

Our information processing has been problem solving. But today, goal finding becomes our major task. We need to find our goals by trial and error and prioritize our strategic plan.

P. C. Mahalanobis proposed Mahalanobis Distance (MD) (Mahalanobis. 1936). to remove outliers. Although his datasets are Euclidean, MD itself is non-Euclidean. It is ordinal. Therefore, if we ignore the relationship between datasets, and regard MD just how far away the point P is from the mean of an individual dataset, we can utilize it for developing a non-Euclidean approach.

In other words, MD provides us with a qualitative performance indicator. Most of the current performance indicators are quantitative. But as datasets today are composed of a wide variety of elements, MD provides us with a very appropriate tool to cope with the frequently, extensively, and unpredictably changing environments and

situations.

MIND-BODY-BRAIN

It is our body that directly interacts with the outside world. Brain collects information from Body, and it accumulates them and structures them into knowledge. When changes were smooth and the future was predictable, Knowledge helped us to realize adequate plan. Brain played a crucial role.

We should remember Mind accommodates both of Body and Brain. Currently, brain science is getting wide attention, but Brain cannot react immediately. We should pay attention to Body which reacts in real time.

In fact, we say “Make up your Mind”. We do not say “Make up your Brain”. And Blood supports Body. But we should remember Blood is analog. We should harmonize digital and analog processing.

The octopuses teach us how important Instinct is. They die immediately after their babies are born. So, they do not inherit knowledge from their previous generation. They have no other way than to live on their Instinct alone. But they are known as the expert of escape. They can escape even from a screwed container. But they need to repeat many trials and errors. If a appropriate performance indicator will be provided, how much it will reduce their burden.

PATTERN

MD provides us with the ordinal based selection tool, but it deals with only one dataset. As datasets come to include a wide variety of data, i.e., information, we need to perceive the whole picture how they are related.

Fukuda and his group used to study on detecting emotion from face. After many trials, Fukuda suddenly realized that we can easily detect emotions from characters in a cartoon. So, we developed a cartoon face model, and succeeded to detect emotions in a very short time (Kostov et al. 2001). We learned patterns play a very important role for nonverbal communication.

MAHALANOBIS DISTANCE-PATTERN (MDP): AN INSTINCT SUPPORT TOOL

To cope with the drastically changing Real World today. MDP is proposed to assist Instinct (Fukuda. 2021).

Dynamic data processing is easily done by introducing Recurrent Neural Network (RNN). But RNN assigns weights to inks randomly. So, it is a black box. To solve this problem, we can introduce Reservoir Computing (RC). Then, we can adjust at the output (Figure. 2).

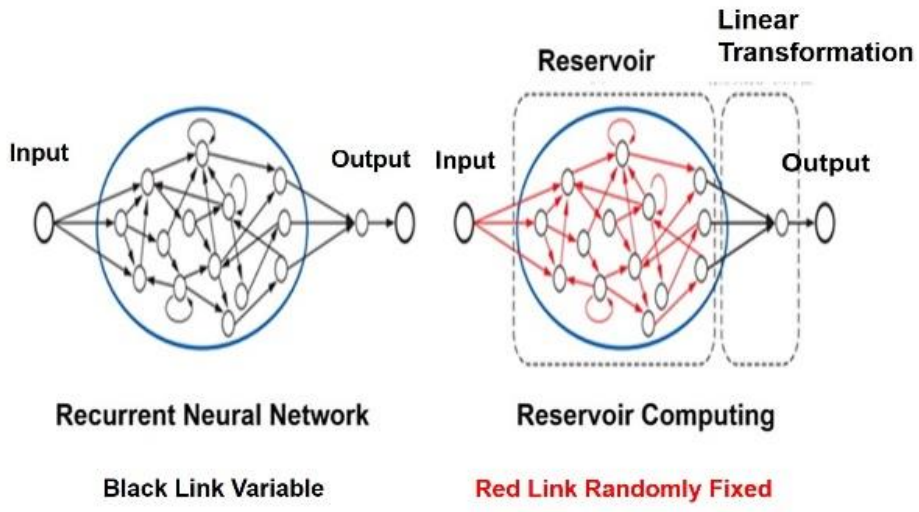

Figure 2. Reservoir Computing

Reservoir Computing (RC) has many benefits, in addition to providing us with the system manipulation function. Another great advantage is it enables us to introduce micro technologies. So, we can make sensors and actuators extremely small and make them part of our body. It realizes Things Team in IoT and realizes Human Enhancement. Besides, this enables robots, if they work separately from us to sense the situations and lead them to respond to the desired actions.

REFERENCES

Bernstein, N. (1967). The Co-ordination and Regulation of Movements, Oxford, Pergamon Press.

Fukuda, S. (2021). PDSA Computing, Computing Conference (2021).

Kostov, V., Fukuda, S., Johansson, M. (2001). Method for Simple Extraction of Paralinguistic Features in Human Face, Image & Visual Computing, 30 (2), 111-125.

Mahalanobis, P. C. (1936). On the Generalized Distance in Statistics, Proceedings of the National Institute of Science of India, 2 (1), 49-55.