— Keynote Address —

On the Art of Modeling; Illustrated with the Analysis of the Golf Swing Motion

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Abstract

The role of a model is to provide adequate knowledge to handle a particular problem. The work of modeling starts on the basis of the feel and knowledge of the object and proceeds by developing guesses about the structure of the object. In this paper characteristics of this process are demonstrated with the example of the analysis of the golf swing motion.

Keywords: intention, information, image, model, golf

1 Introduction

The introduction of AIC was based on two basic ideas. The first is the adoption of the expected predictive performance for the evaluation of a model. The second is the use of the log likelihood as the measure of the goodness of the model. The increasing number of successful applications of AIC proves the validity of these ideas.

Philosophically the second is more fundamental as it illuminated the intersubjective nature of the log likelihood as a relative measure of closeness of a model to the "truth" (Akaike [2]). The recognition of the possibility of comparing statistical models eliminated the controversy on the use of Bayesian models defined with a "subjective" prior distribution.

Statistical models hitherto developed are used mainly for the purpose of precise measurement. In a practical application the model is fitted to the observational data by adjusting the parameters and the result is interpreted as useful knowledge. The success of this approach depends on the choice of the structure of the basic model; however, conventional theory of statistics does not discuss the process of construction of this basic model.

The purpose of the present paper is to clarify the characteristics of the general process of modeling. The discussion of the golf swing motion will illustrate the complexity inherent in the modeling of a real object. The final result of this discussion is an extremely simple description of the swing motion that allows easy application. The simplicity is attained by accumulating the necessary knowledge through the process of refinement of the model.

The discussion of the golf swing in the present paper is a continuation of Akaike [1] with substantial expansion of the related IDS (Informational Data Set).

2 Some General Aspects of the Work of Modeling

Science progresses by developing models of objects. The model of an object suggests how to solve a problem related to the object. Science may thus be viewed as the activity to represent our accumulated knowledge in the form of models.

A model is typically a simplified representation of an existing thing, or a concretization of an image, or an example that represents the characteristics of a group of objects.

To make an adequate choice of the action for a particular problem the information provided by the data related to the situation, including prior information, is required. The work of modeling in this case is performed to extract the meaning or the semantic content of the data. Deep understanding of the problem is required for the extraction of such content.

The adoption of a model for the solution of a problem implicitly places the present situation within a group of similar situations represented by the model. This shows the essentially statistical nature of the work of modeling. The use of statistical models shows that the work of modeling is the activity of organizing the expectation for the selection of a particular action.

3 Informational Characterization of the Process of Modeling

A model may be considered as the representation of a hypothesis in the form of the image of the object. A hypothesis is obtained through the use of an appropriate IDS (Informational Data Set), where IDS is defined by

$$\text{IDS} = (\text{objective knowledge, empirical knowledge, observational data}).$$

The hypothesis is refined through the interaction between the modeler and the IDS, where the latter is successively expanded by the effort for the validation of the hypothesis.

Kuhn [4] emphasized the revolutionary nature of the progress of science. The work of modeling is always revolutionary in some sense, as it aims at changing the conventional view of the subject.

The followings are some of the characteristics of the work of modeling. They are almost obvious but often neglected.

1) The intention of the modeler directs all the activities of modeling.
2) Models may be explained only by verbal expressions.
3) The adoption of some 'eccentric' view is required.

These characteristics suggest that a keen sense of the nature of the object is required to perform the work of modeling. The necessity of 'sense' shows that the work of modeling is more an art than a science.

4 Golf Swing Motion Analysis as an Example of Modeling

This section is organized by the discussions successively developed in the following subsections. Abbreviated versions are included here.

4.1 The Role of Intention

When a golfer swings his club he is constructing the motion following an image of the swing motion. The image is a model that represents an ideal of the golf swing. The construction of such an image is performed by the intention of the golfer.

4.2 The Barrier of Conventional Image: Circular Locus of Swing Motion

An example of mathematical analysis based on the circular image of the swing motion is presented in Jorgensen [3]. The importance of the shift of the swing center is stressed but the problem of what shift action the golfer should use is left unsolved.

4.3 A Revelation: the 'Revolutionary Image'

In the backswing the right arm exhibits the complexity of the swing motion. The image of this motion is 'revolutionary' in the sense that it contrasts the complexity of the cooperative motion of the arms against the simplicity of the conventional circular image of the motion.

4.4 The Search for Necessary Knowledge

Some of the observations since the earlier work of Akaike [1] are listed and to cope with the complexity of the information structural approach is adopted, where the structure is defined by a system of elements and the functions realized by the elements of the system.

4.5 Systemic Decomposition for the Reduction of Complexity

The description of a structure can be simplified by the use of built-in functions but even with the simplifications thus obtained there remains the uncertainty in the motion of the arms.

4.6 Functional Decomposition of the Swing Motion

In this approach, the swing motion by each arm is modeled first and then the results are combined into the swing motion by the two arms. The result is the 'ultra-revolutionary image' of the swing motion.

4.7 Important Function of the 'Magic Move'

The motion by the 'ultra-revolutionary image' naturally accompanies the 'magic move' or the counterclockwise twist of the wrists at the start of the backswing. This is an effective use of fixators that tighten the joints to form firm bases for more distal joints to bear the load.

4.8 The 'Ultimate Image'

The 'ultimate image' of the swing motion is given as follows.

1) Start the backswing with the torsional motion of the upper body until the shoulders and legs are tightened up.
2) Keeping the tightness of the shoulders, swing down from the top by reversing the motion of the body at the lower end of the spine inside the back of the pelvis.
3) The backswing starts with the 'magic move' and reaches the top with a reversal of the move. The down swing is accompanied again with the 'magic move' of the original form to assure the tightness of the shoulders and arms to realize the swing of the club.

4.9 An Additional Observation

The construction of the 'ultra-revolutionary image' shows that the right arm introduces an effect equivalent to the shift of the swing axis of Jorgensen. The deficiency of the model introduced in the choice of the model cannot be recovered by the rigor of mathematical handling.

5 Concluding Remarks

The example of the golf swing analysis demonstrates the fact that without the feel of the nature of the subject of investigation it is impossible to perform the work of modeling.

References

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