Chapter 2. A Constructive Approach To Models

Self-Modifying Systems in Biology and Cognitive Science Ch.2.

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Program in cognitive science

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2.7 The Concept of Information Set

- Definition

Description of specific observations on specific observables in a given time interval

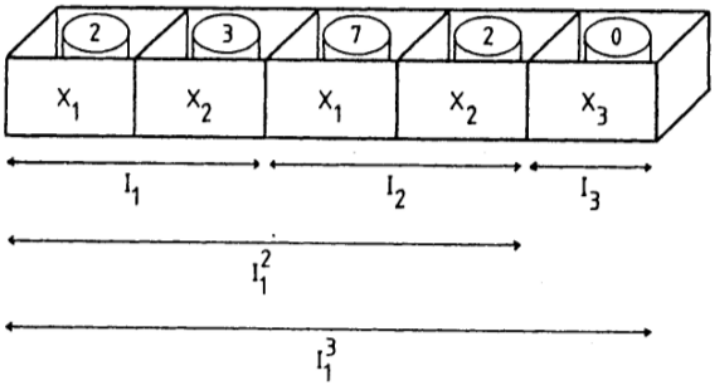


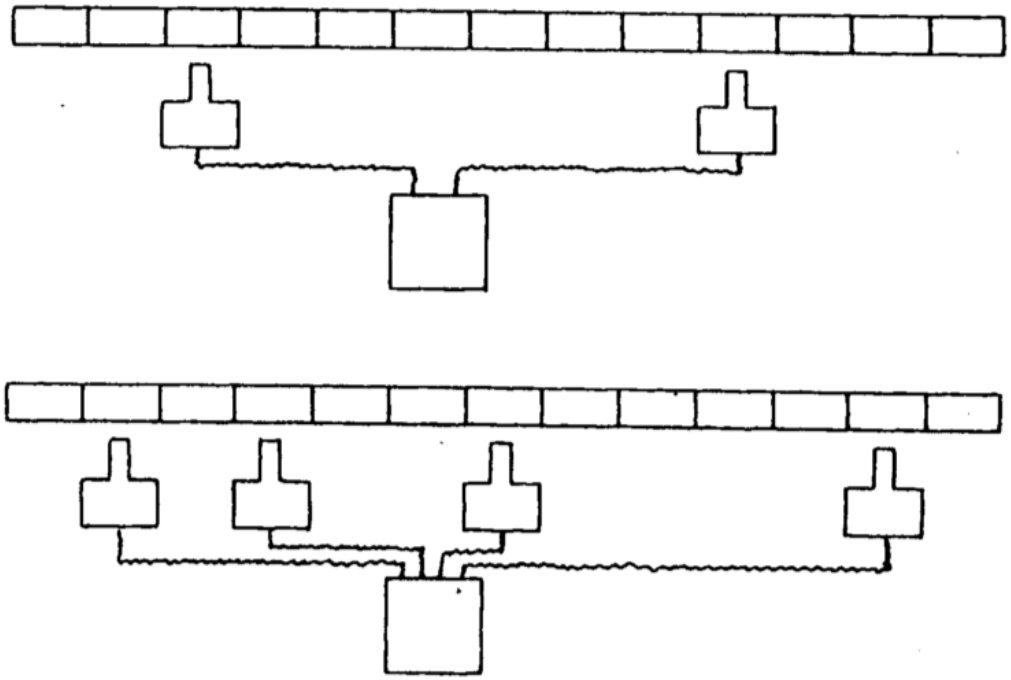
Figure 2.7. Visualization of an information set

$$I_i^j \in I_0^n \qquad ; \; i,j: \quad t_0 < t_i < t_j < t_n.$$

Look at the Figure 2.7. I1 means that we observed X1=2 and X2=3 at time step 1. I12 means that we observed X1=2 ,X2=3 at time step 1 and X1=7,X2=2 at time step 2

2.7 The Concept of Information Set

- Example



Now consider the machine with n heads. It will only take 1 time step to read whole tape.
Thus, the tape will be described as I1

2.7 The Concept of Information Set

- Complexity theorem and modelling

- A model needs empirical data and observables.

- Different models need different data or encoding operations.

- Information sets directly contribute to the number of encoding operation steps.

2.8 Encodings of Observables into Variables

- Encoding

- maps observables to variables

- encoding has a role similar to that of the empirical information about the system.

2.8 Encodings of Observables into Variables

- Cases of encoding

(1) Dynamic observables and dynamic variables

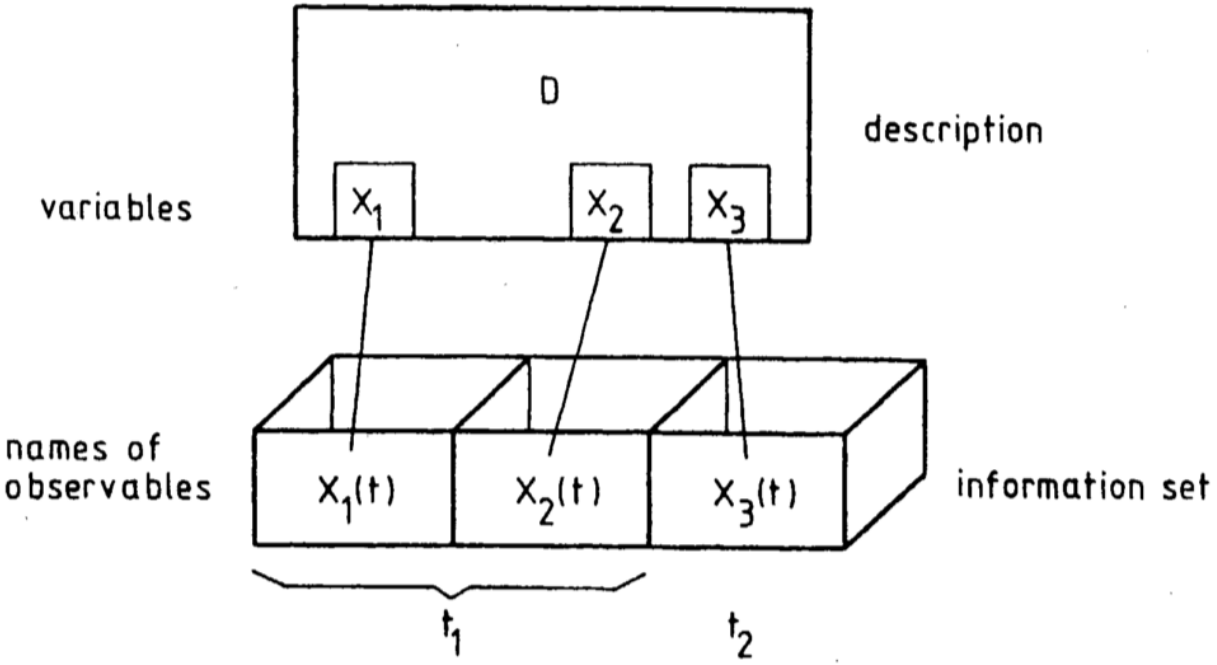


Figure 2.12. Encoding between dynamic observables and dynamic variables

In this case, the encoding is simply a list of paired dynamic variables and dynamic observables. They always have a one-by-one correspondence.

2.8 Encodings of Observables into Variables

- Cases of encoding

(2) Dynamic observables and Static variables

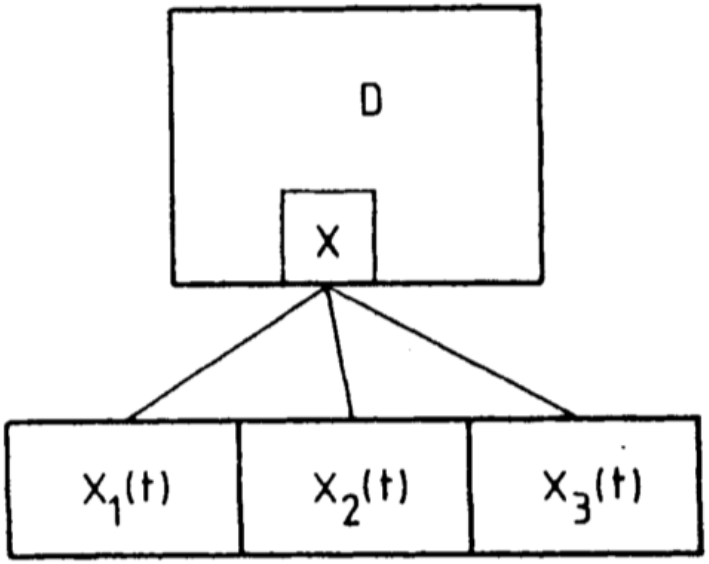


Figure 2.13. Dynamic observables and static variable

At different time, different antigens are present so there are great number of temporary observations. But we have one static variable that measures their total number.

2.8 Encodings of Observables into Variables

- Cases of encoding

(3) Static observable and static variable

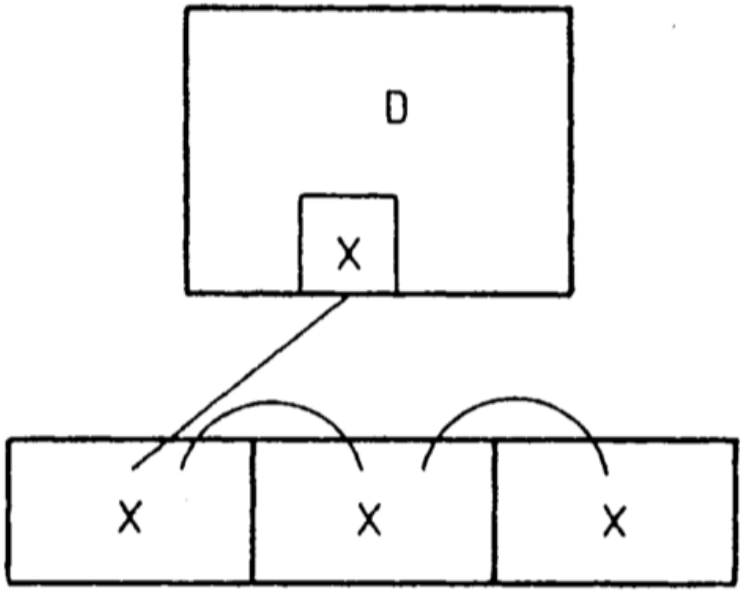


Figure 2.15. Static observable and static variable; relabelling is done by the measuring device

For example, we can use thermometer's state to encode energy state of water.

2.8 Encodings of Observables into Variables

- Encoding for modelling

- The structure of the measuring device and the structure of the studied process must be kept unrelated. (otherwise, best measuring device will be dynamics itself)

- Encodings must be done separately from dynamics

2.9 The Modelling Relation

- Natural systems (N)

- Domain of reality delimited by interaction

- Cannot be defined by a description or a model

- often being defined by natural entities.

2.9 The Modelling Relation

- Abstraction

- Subset of natural system

- narrowing down interest from a totality of potentially measurable qualities to the subset which will be studied

- Dynamic observables can be not available at the time when we form the abstraction. So the focus can only be defined as a phenomenal domain.

2.9 The Modelling Relation

- Description Frame (d-frame)

- unified notion to thefactors that influence model building.

- Link between description D to a natural system N

- abstraction, information set, encoding, postulates

2.9 The Modelling Relation

- Overall scheme of the modelling relation

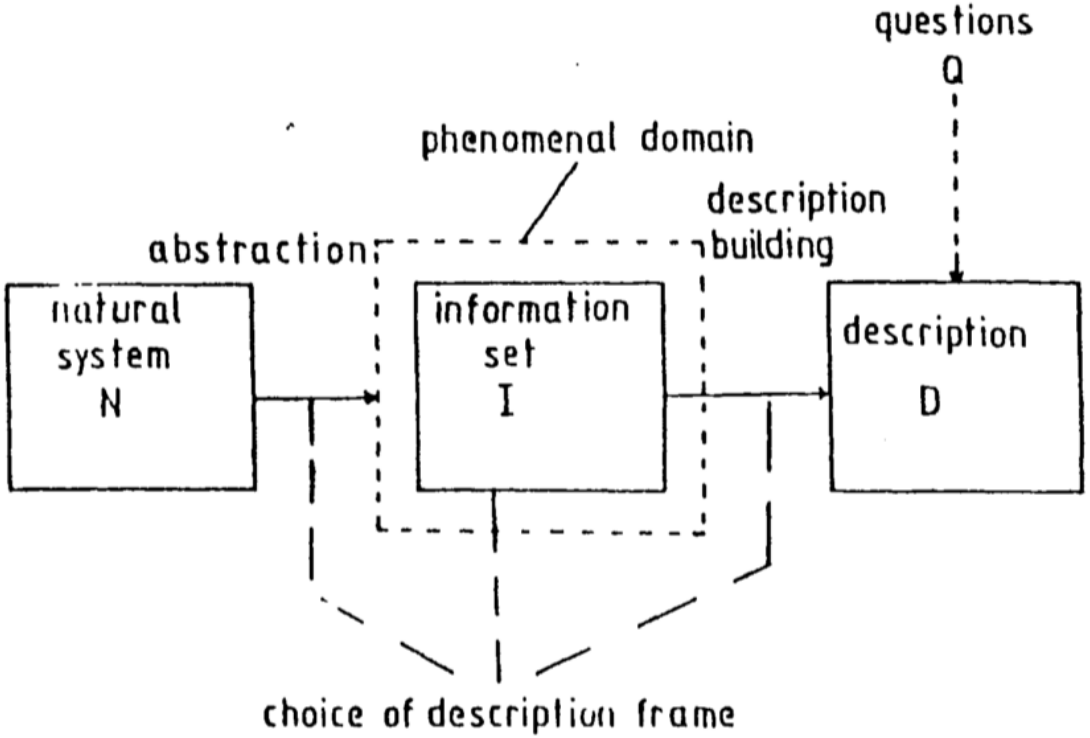


Figure 2.16. The scheme of the modelling relation

A model is not just a description. A model is a description plus a description frame together.

2.9 The Modelling Relation

- Interpretation

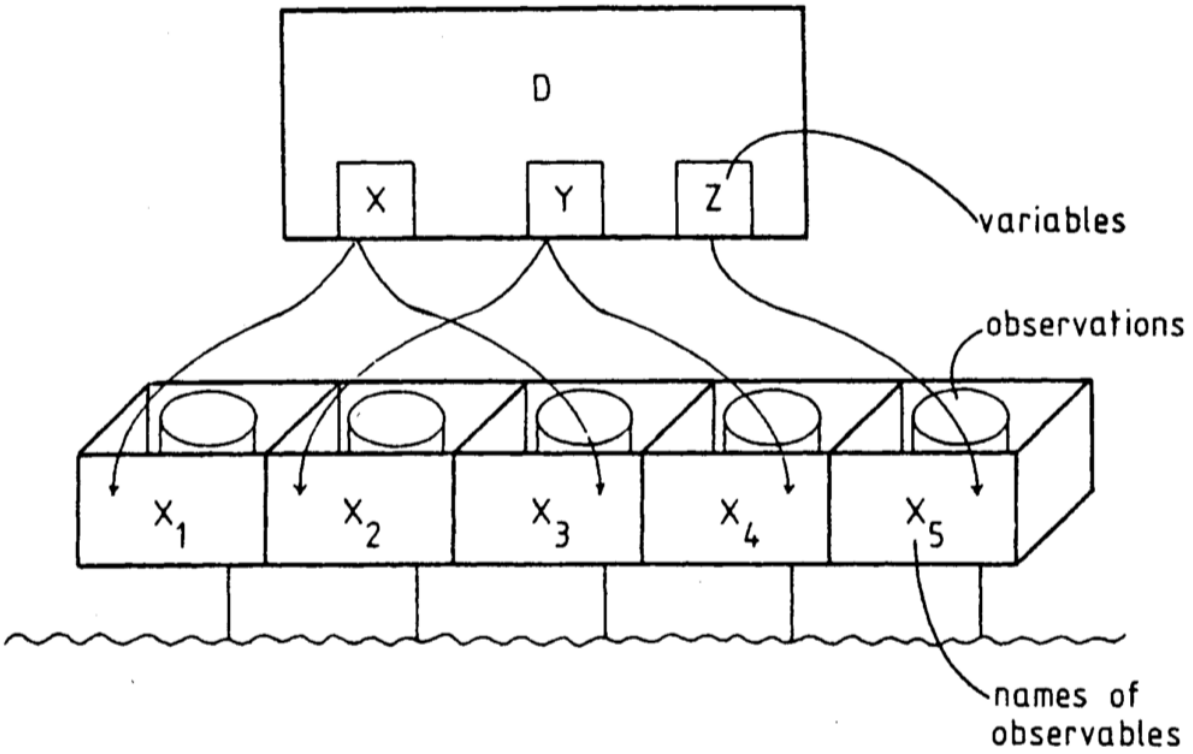


Figure 2.17. Interpretation

Lastly, postulates such as time or causality need to be identified.
And then, information set used by the description has to be identified.

2.10 Implications

- Relevance of Models

- Which model is better between equally valid descriptions?
- adequacy : questions asked by the observer can be encoded into the description
- interpretable : model is possible to assign an interpretation to it and the interpretation is acceptable.
- Relevant : adequacy + interpretable -> good model

2.10 Implications

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2.10 Implications

- Reduction and Equivalence

- reduction : One model can be mapped to another

- weak(mathematical) equivalence : mathematical descriptions are mathematically identical

- strong equivalence : weak equivalence + equivalence of interpretations

- strongly equivalent descriptions can replace one another

Questions & Disussions