
Three Types of Undecomposabilities in Complex Systems

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Reconsidering three types of decompositions that the conventional scientific methodology has made premise clarifies the characteristics of complex systems. Those decompositions are between “operators and operands”, “parts and whole”, and “observations and observed objects”.

Conventional descriptions are likely to divide an objective system into states and fixed functions governing the behavior of the states, or into a black box having certain functions and inputs to/outputs from the black box. Namely, the object is made to resolve into operators, what act on something, and operands, on what the operators act. This decomposition is not necessarily obvious for systems with self-referential and self-modification feature. Such systems can work both as an operator and an operand at the same time.

Dynamical systems such as language, cognitive development, and institutional changes are examples with this type of undecomposability. In such cases, the movement of the system acts on and changes the system itself. Language changes with our use of the language. Development proceeds through experiences of individuals based on their cognition. Social institutions regulate behavior of social members and are changed by the behavior the social members. This undecomposability brings the systems “rule dynamics”, i.e., rules describing the dynamics of the systems have dynamics.

In reductionism, temporal and spatial levels of an object of study are restricted. However, if a small change arises in a part of such system is expanded and spread to the whole system, the decomposition of levels and the reduction into partial systems become impossible. It is often said in most complex systems literatures that complex systems do not accept such decomposition.

This feature rejects another conventional decomposition, that between observation and an object of the observation. When a small fluctuation is expanded into the system level, influences of the observation may become apparent. Further, since biological organisms have subjective agency, and may react differently to the same situation, reproducible observations become difficult for biological systems. Accordingly, we should develop a methodology to treat systems with internal observers and with descriptive instability.