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THE LOGIC OF EVENTS

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Some of the earliest work in the logic of events appears in Hempel [2]. Here are some examples of what he meant by "event": "the first solar eclipse of the twentieth century," "the eruption of Mt. Vesuvius in A.D. 79," "the assassination of Leon Trotsky," "the stock market crash of 1929." The events are whatever these phrases refer to.

Events occur in both time and space, but the edges of the event may be fuzzy. An event like the collapse of the German economy during the 1920s or an increase in tension between Russia and China is not the sort of thing that can be confined to a definite region of space-time. Still, even though the location is vague or fuzzy, it always makes sense to ask where and when an event is located. The German banks, bankers, and householders that fell victim to the economic collapse were located in Germany; and the increase in tension between Russia and China includes editorials, posters, speeches, military movements, and the hearts and minds of people at definite points within the two countries. Similarly, it makes sense to inquire when an event occurs, even when the time boundaries are fuzzy. So we can always include a place and time reference in our descriptions of events, even though the edges of the events may be blurred.

A major problem in the development of a logic of events has been a criterion of identity for events, that is a way of telling when two descriptions refer to the same event. A single set of objects in a single space-time segment may be involved in an indefinitely large number of events. A Russian soldier near the Chinese border squeezes the trigger of his rifle. Among the many events which occur are these: (1) various neurological and physiological events in the Russian's body, together with physical processes associated with the firing of the rifle, and the resulting physiological processes in the body of the Chinese soldier who is killed by the bullet; (2) an attack on a Chinese outpost; (3) from a psychological point of view, a Russian soldier's expression of his boredom, frustration, and contempt for the Chinese; (4) the first incident in a major Russian-Chinese war.

Some people, like Anscombe, would prefer to say that only one event has occurred and that we have given four different descriptions of it. Goldman and others have shown that these cannot be regarded as a single event [1]. His proof, which is very simple, is this: We may say that the Russian, in this example, expressed his boredom by firing his rifle; we say that the shooting constituted an attack on the Chinese outpost; and we say that the killing became an international incident because of later reactions to it. We would not speak in this way if all of these were descriptions of the same event, because the converse of these statements would not be true. We would not say that the soldier fired his rifle by expressing his boredom, or that an attack on the outpost constituted the

shooting, or that an international incident became a killing. If (1), (2), (3), and (4) above were identical, then relationships among them should be symmetrical; but they are not. For this reason they are not descriptions of the same event.

The important thing is that it will be impossible to specify an event unambiguously simply by specifying the objects and the portions of space and time in and to which it occurred. Since an indefinitely large number of events may occur at the same point in space and time, we need additional specifications in order to describe an event uniquely.

Distinguishing among events is important for current events analysis, because different events will have different consequences. The psychological state of an isolated Russian soldier is likely to be unimportant to the current affairs historian; but the outbreak of a war along the Russian-Chinese border is of major importance. An effective system for current events analysis will identify the event in terms of its relevance to the historian's goals.

Suppose that, following the incident, a Chinese radio broadcast is heard to characterize the shooting as "inhuman butchery" and to describe the incident in other emotionally loaded terms. We can say (1) that the Chinese reported on the shooting, and (2) that the Chinese attacked the Russians as "butchers." Precisely the same broadcast, at precisely the same time, used the same set of words to perform both of these actions. But the event reported as (2) is more significant for the historian than the event reported as (1). From the historian's point of view (1) and (2) are different events.

In the symbolism developed by Jaegwon Kim [3,4] an event is represented by an expression of the form:

$$[(x_1, \ldots, x_n, t), P^n]$$

where $(x_1, \ldots, x_n)$ is an ordered n-tuple of concrete objects, P^n is an n-adic empirical attribute, and t is the time at which $(x_1, \ldots, x_n)$ is said to exemplify the attribute P^n. The n-tuple of objects may be written in vector notation as X_n. The event is said to "exist" if and only if X_n does exemplify P^n at time t. (The place can be included among the x_i.)

Thus $[(x_1, x_2, t), P^2]$ might signify the event of an Israeli F-4 Phantom-II aircraft flying over the Suez Canal at 4:06 a.m. on August 4, 1982. Here, x_1 represents the aircraft, x_2 the Suez Canal, t the time, and P^2 the attribute of overflying. (The superscript "2" indicates that it is a two-place predicate.) It may seem somewhat strange to speak of an event like "overflying" as an attribute, but this generalization makes the symbolism applicable to states, conditions, and other qualities, as

well as to events.

A problem of particular importance for the designer of an event logic will be that of determining when two descriptions refer to the same event. In the example just given, when we receive a dozen reports of an F-4 flight over the Suez Canal, we will want to know whether there was just one flight or a dozen flights. Goldman and Kim propose a rather strong criterion of identity for two events: $[(x,t),P] = [(y,t'),Q]$ if and only if $x=y$, $t=t'$, and $P=Q$. This makes "flies over the Suez Canal" a different event from "threatens Egyptian frontiers." From a pragmatic point of view, the role of these two descriptions in an information system will be different, and we will take them as representing different events, even though the physical objects and their raw, physical motions are the same.

The description of the flight as a "threat" depends on the context of world events in which it takes place. Although the flight is located in the area of the canal, its significance is not located there at all. The significance of the flight is in the various government officials whose attitudes make it a threat. It would not be a threat if it were not for these attitudes. The claim that the threat is located only along the flight path is what Whitehead called the "fallacy of simple location".

A complete analysis of the logic of events will provide us with rules for going from one event description to another. We will want to know, for example, how to go from "Israeli plane flies over Suez Canal" to "Israel threatens Egyptian frontier." Border violations are events that can, in the aggregate, provide evidence for a current historian that tension is rising between two countries.

To show how the logic works, consider the following hypothetic event. Let us suppose that a Soviet officer at the Chinese border, one General Sayev Andronovich, is promoted to Field Marshall. In itself, this event does not have any clear significance for the historian. However, if we add the information that Andronovich is noted for his outspoken anti-Chinese attitudes, then his promotion becomes a significant predictor for future Soviet-Chinese relations. At least two events have taken place: (1) a Soviet officer named Andronovich has been promoted; and (2) anti-Chinese attitudes have been encouraged in the USSR.

Now, if we know that Andronovich is anti-Chinese in attitude, then we know that he belongs to the class of anti-Chinese Soviet officials. Our event logic should permit us to say that anything which happens to Andronovich is also an event which happens to an anti-Chinese official of the USSR. From this, it should be possible to derive the more general event, in which anti-Chinese attitudes have been encouraged. Finally, from this event, it should be possible to predict deterioration of Soviet-Chinese relations. The role of the logical apparatus is to provide the hypotheses upon which the historian can predict the deterioration of relations.

In an automated system for current events analysis a central problem will be to determine, from a general description of an event, which properties are going to be significant -- which properties are "constitutive" of the particular event, and which are merely "exemplified" by the event. It is just conceivable, for instance, that the historian is collecting the names of Soviet officers that begin with the letter "A" -- for some obscure reason we can only guess at -- and the important information is the first letter of the name of the new Field Marshall. (This would be part of the historian's "user view," the viewpoint from which he or she would want to look at the data.) The first letter of the name would be constitutive of the significant event (in the sense that it would be that which makes it signficant), and the political attitudes of the Marshall would then be nothing more than irrelevant noise.

The problem is in distinguishing the significant or constitutive features of an event. For human observers there is little difficulty in locating just those features of an event which are relevant to their interests. One fascinating characteristic of human perception is the way in which humans fail to notice elements in a situation which have no interest for them. For an automated information system, however, the problem of relevance becomes acute, because the machine has no interests of its own. We must be able to tell the machine how to locate those features in the information which will be useful in discriminating among relevant patterns of events [5].

In summary, the problem for analysis is determining those features, among the infinite number of features which can be extracted from the world around us, which will be significant for the goals of the current historian -- such as the detection of a potential world conflict.

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