

1. Title: Diagnosis, Prescription, and Treatment
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6. Abstract: Diagnosis is a purposeful process whereby humans or machines classify objects. Diagnosis entails evaluating observable features called symptoms, whose presence or absence defines abnormal states. To be considered a symptom, a feature must be exhibiting a value outside of its normal range. The objects may be biological organisms, such as a person with a health problem, or they may be physical systems, such as a machine that is not functioning properly. The assignment of a diagnosis is a statement concerning the causal mechanism that has generated the observed pattern of symptoms. We explore ways in which the diagnostician initially acquires, and later accesses, information connecting symptoms and mechanisms. Diagnosis usually has a pragmatic goal, namely to restore the normal state. Restoration requires additional two steps, prescription and treatment. Prescription is the proposal of a course of action designed to alleviate the symptoms and thereby restore normal status. Treatment is the implementation of the recommendation. In general, there are far fewer prescriptions than causal mechanisms. Because diagnosis is an intermediate step toward prescription, and the two tasks are usually carried out by the same professional, it may be appropriate to replace the usual evaluation of expertise at the level of diagnosis with evaluation of prescription recommendations.

Full paper:

Diagnosis is a process whereby humans or machines classify cases. The cases may be biological organisms, such as a person with a health problem, or they may be physical systems, such as a machine that is not functioning properly. Diagnosis entails evaluating observable features called symptoms, whose presence or absence defines abnormal states. To be considered a symptom, a feature must be exhibiting a value outside of its normal range.

Diagnosis is an intellectual exercise that usually has a pragmatic goal, namely to restore the normal state. For example, professionals try to explain medical or psychological symptoms or observed flaws in mechanical systems. Diagnosis may also be carried out when corrective action is no longer possible. Coroners, detectives, and scientists diagnose in order to understand.

Although diagnosis may be carried out preventatively according to a schedule, usually the process is instantiated by an observation that at least one symptom is present. Symptoms occur over time, and this temporal information is itself a variety of symptom. The assignment of a diagnosis is a statement concerning the causal mechanism that has generated the observed pattern of symptoms.

Prior to having knowledge of causal mechanisms, observers attempt to identify constellations of symptoms. These constellations are sometimes given names, such as “black plague” or “hysteria” and are accordingly confused with true diagnoses, which imply mechanisms. Such labels convey little information that would be useful in developing treatments, and should be considered precursors to diagnoses.

Mechanisms vary in how well they are understood by diagnosticians. For a physical system built according to known specifications, the connection between symptoms and mechanism is generally known. Therefore, once the symptoms have been identified correctly, the diagnosis is essentially given. The blueprint simplifies symptom identification as well.

For biological organisms, the connections are less well known, and are therefore handled statistically. An incremental database is the diagnostician's approximation to the blueprint. There are two kinds of statistical information that need to be tracked in the diagnostician's database. These are the frequencies with which particular mechanisms have been observed to operate (base rates), and the frequencies with which known mechanisms have been observed to generate particular symptoms (symptom probabilities/mechanism). Because symptoms arise probabilistically, some cases will appear to be more typical instances of their mechanism than others; accordingly, they will be easier to diagnose. Often, the set of symptoms at hand will be insufficient to distinguish among multiple possible mechanisms. The diagnostician may try to obtain additional symptom information.

There are two major challenges to gathering symptom information. The first is the determination of relevance. Objects in the world emit constant streams of information. Which bits should be the focus of attention? The data base needs to specify which symptoms potentially have an appreciable probability of having been generated by the mechanism under consideration. Determining the unit of analysis is critical. Biological systems generally package the symptoms conveniently in one body, thereby defining the case. Symptoms that are separated spatially may impede the observation of a pattern.

The second issue is the presentation of symptom information. The case may cooperate in making information available, perhaps by explicit reporting. On the other hand, a mechanism may regard the diagnostician as an enemy and try to conceal symptom information. Concealment can also occur without an explicit oppositional motive, when exposure could have negative consequences unrelated to the mechanism. Some symptoms are not apparent to the case and can only be identified with specialized equipment. There are costs of several kinds to be considered in determining how extensively to pursue additional symptoms.

Restoration requires additional two steps, prescription and treatment. Prescription is the proposal of a course of action (or inaction, since some systems are self-correcting) designed to alleviate the symptoms and thereby restore normal status. In general, there are far fewer prescriptions available than there are causal mechanisms. The consequence of this disparity is that often, only a crude diagnosis will suffice to inspire the best available prescription. That is, even if the suggested mechanism is incorrect, there is little difference between the proposed prescription and the one that would be proposed if with a correct diagnosis.

Treatment is the implementation of the recommendation. There may be barriers that prevent a prescription from being carried out accurately. These include costs, availability, and inadequate skills or equipment. Lack of cooperation (noncompliance) is also a possibility in the case of a biological system.

In everyday practice, diagnosis is carried out with an eye toward treatment. Diagnostic proficiency is usually not evaluated in isolation, but is considered as part of a

chain leading toward resolution of the problem. If the problem is solved, then the diagnosis is presumed to have been correct. Thus, evaluation in the field is usually based on an outcome that confounds the implementation and efficacy of the recommended treatment with the accuracy of the diagnosis.

In laboratory studies, diagnosis is examined with reference to known correct answers. Proficiency is assessed by counting the proportion of responses in agreement with correct answers (Swets, Dawes, & Monahan, 2000). The limitation in this strategy is that correct answers are not always available, and the surrogates employed in their stead may reflect opinion rather than fact.

Expertise in diagnosis requires two kinds of skills. First, the diagnostician must collect and identify the symptoms accurately. These judgments may be aided by instruments. Second, the diagnostician must know the possible mechanisms and the associated probabilities that are consistent with the observations.

Restoring the normal state calls for additional skills. Because the outcome depends upon treatment, which is seldom completely under control of the prescriber, it is appropriate to evaluate the prescription recommendations. A methodology such as CWS may be suitable for such analysis. Prescription and treatment may need to be evaluated separately.