Description vs. explanation. The limits of description. Explanation and a priori.


In the first lecture, I touched upon the theme of the relationship between description and explanation. Now we examine this theme more closely.

When one says that science draws a world picture as the objective reality has been opened by us, he implies that science is a form of description of reality. Does science have to perform the function of description rather than explanation, i.e. to answer the question “how?” rather than “why?”, or does it pursue, after all, the aim of explaining reality? Traditionally, the main function of science was considered to be explanatory. Beginning as early as Aristotle, it was a common opinion that science has to seek for causes. According to Aristotle, to explain a phenomenon means to find out its causes. In mathematics, however, Aristotle admitted explanation through demonstration. But mathematics was not a science (ἐπιστήμη), in his mind. Anyway, explaining was thought by Aristotle as reducing a larger number of things to a smaller one. Thus a mathematical demonstration is a kind of explanation because in the last analysis it appeals to axioms which are less in number than the theorems based on them. Likewise, when a science investigates phenomena similar in some respects to each other, it explains them by pointing out their common causes, which, though few or limited in number, result in all of them (potentially infinite in the same sense). At his time, for example, Francis Bacon explained all thermal phenomena by subsuming them under the genus ‘motion’ as their formal cause. In his Novum organum we read: “Heat is a motion, expansive, restrained, and acting in its strife upon the smaller particles of bodies” (II, 20; transl. by J. Spedding, R. L. Ellis, and D. D. Heath). This causal mode of explanation, if continued, sets, however, a course of the ascent to metaphysical premises because reason requires the first cause in the sequence of the formal causes. Aristotelian metaphysics and medieval natural theology were products of such an aspiration of reason. A motion was just said to be the cause of heat. But what is the cause of that motion? If it is another motion, then what is the cause of this one? Continuing in such a way leads one to an idea of the Prime Motor (the first moving entity). So, in view of the metaphysical perspective, the advance along the way of why questioning is justified scientifically so far as it is based on experience. Science must keep itself from transforming into a “philosophical romance,” as Voltaire called the philosophical enterprise of Descartes. In fact, when Isaac Newton, who had an unsurpassed authority in Voltaire’s eyes, claimed his motto, “Hypotheses non fingo” (“I feign no hypotheses”), he opposed himself to those who follow the causal mode of explanation. Having established, in order to describe the observable motion of celestial bodies, that the gravity force between two of them is directly proportional to the product of their
masses and inversely proportional to the square of the distance separating their centers, Newton wrote in his famous book *Philosophiae Naturalis Principia Mathematica* (The Mathematical Principles of Natural Philosophy):

I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses; for whatever is not deduced from the phenomena is to be called a hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy. In this philosophy particular propositions are inferred from the phenomena, and afterwards rendered general by induction (transl. by Andrew Motte).

Just here we see a start point of the positivistic philosophy that came into existence later, in the first half of the XIXth century. Since Auguste Comte, the causal mode of explanation has been regarded as non-effective to be replaced by the explanation through referring phenomena to some general facts called “laws.” And though Comte himself still kept the term “explanation” for this latter mode, yet the followers of his doctrine were inclined to think that the laws as general facts have exclusively a descriptive meaning. The following passage from Karl Pearson’s *Grammar of Science* is indicative of this view:

The law of gravitation is a brief description of how every particle of matter in the universe is altering its motion with reference to every other particle. It does not tell us why particles thus move; it does not tell us why the earth describes a certain curve round the sun. It simply resumes, in a few brief words, the relationships observed between a vast range of phenomena. It economizes thought by stating in mental shorthand that routine of our perceptions which forms for us the universe of gravitating matter (1892, p. 119).

As we can see, Pearson understands scientific description in the spirit of Ernst Mach – as a realization of the principle of economy of thought. Hence, if so, the purpose of scientific description is to impart a unity to scientific knowledge. The important question is whether this unity has only the epistemological status, or also the ontological one. If the latter is true, the progress in the ordering of scientific knowledge in conformity with the ideal of a system, even though some new linking elements, not to say hypotheses, are needed for this, turns out also an advance in approximating to reality. This also means that the very description at some stage of the approximation of reality may be an explanation of the subject matter of description at the preceding stage. For instance, Maxwell’s displacement currents were that new element which provided a symmetric, uniform, and, therefore, economic way of description of electromagnetic phenomena. This description comprised the electromagnetic waves whose existence was thereby predicted. It turned out that these waves have the same properties as light. In this way the electromagnetic nature of light was established and the properties of light were explained. Thus light, having been an explanatory entity in the era of describing phenomena in terms of Newtonian mechanics, becomes a mere descriptive entity, as an electromagnetic wave, in the era of describing them in terms of fields. This attitude to the relationship between description and explanation was perfectly characterized by Cornelius Benjamin in his *Introduction to the Philosophy of Science*:

The ground for this attitude is the recognition that the distinction between description and explanation is not an ultimate one. When one describes, he explains in terms of the more obvious features of the given, and when he explains he describes in terms of the less obvious features. With the advance in instrumental techniques explanatory entities become descriptive entities, e. g., molecules, as seen in the Brownian
movement. The answer to the question why is not fundamentally different from the answer to the question how; when one explains he seems to be calling attention to the more basic but somewhat more elusive features of nature – he seems to be getting behind to enduring connections, more permanent substances, and the like. But it is the fate of all explanatory entities whose existence becomes well established that they become descriptive entities, which must in turn be explained by still more basic entities (1937, p. 10).

It is necessary to realize that description is always dealing with idealizations (with models in particular). They are conditions sine qua non descriptions. The degrees of idealization determine the levels and limits of description. I have already said on the lesson quantum theory has taught us, that, when describing reality, we do this through its representations whereof solely may be descriptions, which all together are, therefore, about the reality but not directly of it. If it is quantum theory that describes the reality through conceptual structures as deep as the description is possible at all, and if there is somewhat of truth in what is said about the relationship between description and explanation, then the very subject matter of that indirect description of the reality should seem to be eventually explainable from the impossibility to describe it directly. It is of utmost importance to recognize that reality is not description as well as description is not reality. This distinction marks, on the one hand, the finite limit of any description – that is reality – and, on the other hand, points out to its deficiency as a description. This is an interesting philosophical question: could this deficiency stem from the limitations having in reality itself the power of some constraints that generate the conditions of the possible experience? It is a very old idea that the phenomenal world derives itself from the tendency to replenish extensively the deficiency of its own subsistent intensity. Plato appeared to be not the first who expressed this idea metaphorically. The sensible world, according to him, is ὁντως οὐδέποτε ὄν (i.e., like a “shadow,” it never really is). It has a deficient existence, as the subject matter of an opinion. The Neoplatonists had been developing this idea. The deficiency (ἔλλειψις) of the inferior beings and their desire for the superior, which, if were satisfied, would make up that deficiency, were thought by the Neoplatonists as the very conditions of the inferior modes of existence. Plotinus explained the nature of time in such a way. According to him, the sensible world is set in motion by a word (λόγος), a rational principle called the World Soul, so that “what it utters, it utters because of its deficiency” (Enneades, III, 8, 6). Because “it is not full,” he says, “but has something wanting in relation to what comes before it” (ibid.), it “first of all put itself into time, which it made instead of eternity” (ibid., III, 7, 11; transl. by A. H. Armstrong). In the late Neoplatonism, the intuitions as to the “creative” replenishment for anything of being deficient were expressed in the technical terms “μονή” (permanence), “πρόοδος” (procession), and “ἐπιστροφή” (conversion). I believe these intuitions do matter for contemporary philosophy of science. If we are able to formulate mathematically the relationships between the levels of description of the reality, so that the principles of such formulations, called the bridge principles, or, in a broad sense, the correspondence principle, have an explanatory power, then the question can be asked: could these principles be extended to be of the very reduction of the reality to its description? I am inclined to think it might be so. Whereof one cannot speak, therefrom one must be explaining everything else.
The ideal of any explanation is the explanation “from first principles.” Such is, generally speaking, the way of reasoning in mathematics. Here every statement called a theorem is deduced from the well-established earlier propositions or assumed axioms. For example, it can be regarded as explained that the angles of any triangle give in sum two right ones, if one has demonstrated it, accepting the Euclidean axiom of parallels. This mode of justification of the truth of a statement was called “a priori,” that means, literally, in Latin “from what is before.” (В математике “априорные” объяснения финитны. Этого нельзя сказать об объяснении эмпирических фактов. Но мы пока не знаем, носит ли это “нельзя” принципиальный характер.) However, what is a good method as an ideal is not working so well to explain something within the sphere of the empirical. In mathematics, the “a priori” explanations or, speaking more strictly, justifications are finite processes. This cannot be said of the explanations of empirical facts. Be as it may be, we do not know so far whether this “cannot” is a matter of principle or not.

A priori is a central notion of Immanuel Kant’s Critique of Pure Reason. A priori judgments had been defined by Kant to be universal and following from their premises with necessity. It is clear that such judgments are not dependent on experience, because the latter, being limited, has not the universal character and also has not the power of the logical necessity. From Kant’s standpoint, mathematics is an important example of a priori knowledge. He considered the two branches of mathematics: geometry and arithmetics. Both of them are a priori disciplines because find their basis in a pure intellectual intuition and logic.

Whereas Kant considered the reasoning in mathematics – in geometry as well as arithmetics – as extending our knowledge by means of so-called synthetic judgments, the distinguished German mathematician, logician and philosopher Gottlob Frege argued that this property is only of geometry, but not of arithmetics. He tried to show that all arithmetical proofs appeal to definitions only, and so arithmetics is the scope of analytic truths.

Another German philosopher, Hans Reichenbach, suggested two kinds of geometry to be distinguished in order for reconciling the Kantian theory of a priori in geometry with Einstein’s theory of relativity. The general theory of relativity as geometrodynamics (I am using the term introduced later by John Wheeler) takes geometry changeable to be governed by a dynamical law, so that Euclidean geometry, which was regarded by Kant as an a priori discipline, has no longer advantage over other geometries, being put together with them on the same footing as empirical facts. That is why Reichenbach subdivides geometry into two kinds, namely physical geometry and mathematical geometry, and ascribes the character of a priori to the latter only. A priori is realized here by mere logical means without using the axioms, the truth of which is a matter of experience and thus of physical geometry. (…)

The nature of scientific explanation came to be intensively discussed since Carl Hempel, who had published in 1965 his influential book Aspects of Scientific Explanation. In the spirit of logical positivism, Hempel regarded explanation as a form of logical inference, deductive or inductive. He proposed two models of explanation: the
deductive-nomological model, also known as the covering-law model, and the model of inductive-statistical explanation. Both the models are premised on laws, be these strict (deterministic) or probabilistic. And both of them show that,
given the particular circumstances and the laws in question, the occurrence of the phenomenon was to be expected; and it is in this sense that the explanation enables us to understand why the phenomenon occurred (p. 337).

Before discussing the deductive-nomological model, let me prevent a common problem with deduction. It is often said that deduction is ratiocination from the universal to the particular. Usually, textbooks give the following famous syllogism as an example of the deductive inference: All men are mortal; Socrates is a man; therefore, Socrates is mortal. It is plain that the major premise here – “all men are mortal” – is a more universal statement than the conclusion – “Socrates is mortal.” However, the founder of inductive logic John Stuart Mill doubted the validity of this traditional understanding of deduction. (…)

Hempel’s deductive-nomological model represents an explanation as a form of the deductive inference involving strict (deterministic) laws of nature. A set of premises, including, besides the laws, “antecedent” or “initial” conditions, is called the explanans; the fact (or event) that is to be explained is called the explanandum. The argument itself has the following structure (in Hempel’s designations):

\[
\begin{align*}
C_1, C_2, \ldots, C_k & \quad \text{Explanans} \\
L_1, L_2, \ldots, L_r & \\
E & \quad \text{Explanandum}
\end{align*}
\]

Here \(C_1, C_2, \ldots, C_k\) are conditioning factors (e.g., if we take Hempel’s example of the expanding and contracting soap bubbles, those are the temperatures of the air inside and outside the bubbles), \(L_1, L_2, \ldots, L_r\) are statements of laws (such as the ideal gas laws in the given example), and \(E\) is the conclusion expressing the fact under study (in our case, the expansion and contraction of the bubbles). When claiming the factors \(C_1, C_2, \ldots, C_k\) to cause the fact \(E\), we mean the nomological sufficiency of the initial conditions \(C_1, C_2, \ldots, C_k\) in virtue of relevant laws, for the event \(E\) to happen.

The main objection against the deductive-nomological argument is that it fails to be a genuine explanation. It is not hard to offer arguments that, though having the same structure as the deductive-nomological argument, explain nothing. For instance, following the well-known “flagpole’s shadow counterexample” by Sylvan Bromberger, we can try to “explain” the height of a pyramid in such manner, comparing the length of its shadow with the shadow of a gauge rod of known length (these data will be antecedent conditions) and taking as a statement of a law that light propagates in a straight line. This procedure will be, of course, a measurement, but not an explanation of why the pyramid has the height it does. Generally speaking, any method of measuring in physics has the logical form of the deductive-nomological argument. But it would be an error to identify measurement with explanation.
Another objection is that a vast number of explanations do not refer to any law at all. For instance, I can explain why I gave a student a certain exam mark without referring any law of nature. This explanation is obviously not satisfying the deductive-nomological model. The moral of the given counterexamples is that this model fails just because it ignores the role of the relations between cause and effect in explanation, i.e. so-called causation.

In the example à la Bromberger, the form of deductive-nomological argument would be fitting an explanation, if we knew the height of the pyramid and measured the length of its shadow. It is allowable to say that a pyramid casts the shadow of such-and-such length, because itself is of such-and-such height, but not conversely. The relationship between a cause and its effect possesses an asymmetry, which is left out of account by the deductive-nomological model. Philip Kitcher supposes that the asymmetry signaling the causal asymmetries might be the explanatory one that is proper to the unification model of explanation supported by him. He writes:

What is distinctive about the unification view is that it proposes to ground causal claims in claims about explanatory dependency rather than vice versa (Kitcher, Ph. Explanatory Unification and the Causal Structure of the World, in Scientific Explanation, ed. by Ph. Kitcher, and W. C. Salmon, 1989; p. 436).

What is this model?

It was said earlier in this lecture that the advance of science along the way of a more and more economic description of reality is a progress in both the unification of scientific knowledge and, thereby, the explanation of the phenomenal world. This idea branches out into the unificationist models of explanation. Michael Friedman was seemingly the first who supposed the essence of scientific explanation to consist in that science increases our understanding of the world by reducing the total number of independent phenomena that we have to accept as ultimate or given. A world with fewer independent phenomena is, other things equal, more comprehensible than one with more (Friedman, M. Explanation and Scientific Understanding, Journal of Philosophy, 1974, 71, p. 15).

By phenomena Friedman means laws of nature as regularities expressed by the universal statements which allow no partition into two or more generalizations acceptable independently (he calls such statements “K-atomic sentences”). Friedman’s conception had faced the objections by Wesley Salmon who stated that “it seems impossible to have any K-atomic statements – at least, any that could plausibly be taken as fundamental laws of nature” (see for details Salmon, W. Causality and Explanation, 1998, p. 70).

Kitcher proposed a more viable model. Instead of individual explanations he suggested considering scientific explanation as being assessed within the context of a system of deductive derivations which employ “argument patterns”, so called by him. These latter capture structural or conceptual similarities between the derivations and allow one to reduce the largest possible number of laws to the more fundamental and comprehensive laws taken as few in number as possible. So minimizing the number of the entities to be explained, one finds a better explanation of nature. The explanation is believed by Kitcher to be implicating the causal relationship between phenomena. This is because the causal processes, as being markable, transmit information and, as such, are subsumed ultimately under the categories of description and explanation.
Kitcher, “the ‘because’ of causation is always derivative from the ‘because’ of explanation” (Kitcher, Ph. Op. cit.; p. 477). He completes his essay on explanatory unification with the “top-stone”:

The growth of science is driven in part by the desire for explanation, and to explain is to fit the phenomena into a unified picture insofar as we can. What emerges in the limit of this process is nothing less than the causal structure of the world (Ibid.; p. 500).

Hempel’s deductive-nomological model and the above-discussed unification model come within the wider scope of nomological explanation. As we have seen, these models are hardly compatible with causation, if at all. The root of the problem may be traced in the long perplexing puzzle of how the universal meets various particulars. Causation eventually concerns individual facts while the natural legislation refers to universal laws. Is it possible for explanations to be mere causal without referring to laws? There are philosophers who give an affirmative answer to this question. According to David Lewis, for example, to explain some event is to provide one with the causal history of it in terms of so-called counterfactuals (subjunctive “if… then…”-conditionals with the antecedent being a condition sine qua non the consequent, a necessary condition). In Michael Scriven’s view, the causal history may be a narrative description; in this case the description itself has an explanatory power. Identifying explanation with causation is objectionable, however. Likewise as things were with the deductive-nomological argument, explanation requires actually sufficiency, or the nomological sufficiency in particular, for antecedent conditions, while causation demands them be necessary. But sufficiency and necessity do not coincide, generally speaking. The counterfactual, “Had A not occurred, B would not have occurred”, would be not only an expression of causation, pointing out A as a cause of B, but an explanation of why B has occurred, if A were a sufficient as well as necessary condition. Besides, both the mentioned modes of causal explanation face difficulties when there are alternatives among the possible causes of a given event (this problem of so-called “preemption” makes difficulties also for the deductive-nomological model of explanation).

These problems with causal explanation could be illustrated by examples from Salmon’s book Causality and Explanation. At first Salmon cites John Mackie:

[L]et us consider three different shilling-in-the-slot machines, K, L, and M. Each of them professes to supply bars of chocolate; each of them also has a glass front, so that its internal mechanism is visible. But in other respects, the three are different. K is deterministic, and conforms to our ordinary expectations about slot-machines. It does not always produce a bar of chocolate when a shilling is put in the slot, but if it does not there is some in principle discoverable fault or interference with the mechanism. Again, it can be induced to emit a bar of chocolate without a shilling’s being inserted, for example by the use of some object which sufficiently resembles a shilling. … Inserting a shilling is neither absolutely necessary nor absolutely sufficient for the appearance of a bar of chocolate, but in normal circumstances it is both necessary and sufficient for this. … L, on the other hand, is an indeterministic machine. It will not, indeed, in normal circumstances produce a bar of chocolate unless a shilling is inserted, but it may fail to produce a bar even when this is done. And such failure is a matter of pure chance. L’s failures, unlike K’s, are not open to individual explanation even in principle, though they may be open to statistical explanation. With L, in normal circumstances, putting a shilling in the slot is necessary, but not sufficient, for the appearance of a bar of chocolate. M is another indeterministic machine, but its vagaries are opposite to L’s. M will, in ordinary circumstances, produce a bar of chocolate whenever a shilling is inserted; but occasionally, for no reason that is discoverable even in principle, the mechanism begins to
operate even though nothing has been inserted, and a bar of chocolate comes out. With $M$, in normal circumstances, putting a shilling in the slot is sufficient, but not necessary, for the appearance of a bar of chocolate (Mackie, J. L., *The Cement of the Universe: A Study of Causation*, 1974; pp. 40–41).

Then Salmon gives his own analysis:

The deductivist can maintain that, with the deterministic machine $K$, we can explain why the chocolate bar is forthcoming in terms of the insertion of the coin in a machine of that sort. Causation and explanation coincide in this case. With the other two machines this correspondence does not obtain. Applying the D-N schema, we find that we can explain the appearance of the candy bar in terms of the insertion of the shilling if putting in the coin is sufficient for the result. This is the situation for machine $M$. Moreover, if putting in the coin is necessary but not sufficient, it cannot provide a D-N explanation of the emission of the candy bar. This characterizes machine $L$. To those of us who see a close relationship between causation and explanation, this outcome seems wrong. If one were to accept Mackie’s account of causality and the deductivist’s account of explanation, it would be necessary to conclude that putting the coin in machine $L$ causes the candy bar to come out but does not explain its appearance, whereas putting the coin in machine $M$ explains the appearance of the chocolate bar but does not cause it to emerge. This result is quite paradoxical.

The difficulty that arises in connection with machine $M$, it should be noted, strongly resembles a well-known problem for D-N explanation, namely, the problem of preemption. Consider a California ticky-tacky house built near the San Andreas Fault. If an earthquake measuring 7.0 or greater on the Richter scale is centered nearby, the house will collapse. Likewise, if a tornado touches down right there, the house will also collapse. One day a major earthquake does occur in that area and the house collapses. We have all the makings of a D-N explanation. However, the collapse of the house is not a result of the earthquake, for a tornado knocks it down just before the earthquake occurs. In the case of machine $M$, it may be that the candy bar would have been delivered quite by chance, and thus that the insertion of the shilling had nothing to do with its appearance (1998; p. 146).

So we have discussed two kinds of causation as a relation of dependence between discrete events: nomological dependence and counterfactual dependence. Also there can be a probabilistic dependence between a pair of events understood as a cause and its effect, as is the case when the occurrence of the former rises the probability of that the latter will occur. Another approach to causation grasps it as a relation of production. Thus, manipulation theory understands causes as recipes for producing or preventing their effects. This theory was first developed by Georg Henrik von Wright and later by James Woodward. The concept of production is shared also by so-called “transference” models.

In fact, the transference model of explanation was put forward by Descartes. He regarded causation as a productive relation: when $x$ causes $y$ a property of $x$ is communicated to $y$. Nowadays, transference models have been focused on physical properties such as energy-momentum. These models have been developed within the framework of mechanistic theories of causation. According to those theories there is a mechanism connecting cause and effect. One of such approaches was offered by Salmon. He claimed that an event $c$ causes an event $e$ if and only if there is a causal process connecting $c$ and $e$. Afterwards, he proposed causation to be a process of exchanging or transferring some conserved quantity, such as energy-momentum or charge. The advantage of this theory is that it may be applied to physical causation. Yet, it is questionable whether it can be generalized to cover all cases of causation, especially the cases in psychology or social sciences.
One more understanding of the notion of “cause” goes back to Aristotle. Among the four causes that he enumerates in *Metaphysics* we find what he designates as “wherefore” (τὸ οὗ ἐνεκα). Later on, in scholastic literature, the Latin term “causa finalis” (“final cause”) becomes frequent in use for that type of cause. An action or process’s final cause is their purpose or aim to which those are directed and ordered. Explanations tied to final causes are called teleological, from the Greek τέλος, which means end, aim, goal or purpose. Such explanations are not adopted when the objects under study are physical systems. But if the matter in question is the functioning of living systems, humans or society in particular, this kind of explanation proves to be almost certainly necessary. It is usual in this case to explain the existence and constitution of the systems’ parts by the functions they carry out within the wholes. Such a functional explanation has been irreducible to physical causation. Hempel tried to incorporate this kind of explanation into the deductive-nomological model. For instance, the presence of the heart in the human body could be explained by showing that the heartbeat fulfils the function of pumping the blood, which is necessary for supplying nutriment and removing waste, and consequently for the proper working of the organism as a whole. To present this case as the deductive-nomological argument, I use an example from Stuart Glennan’s encyclopedic article “Explanation” (see in *The Philosophy of Science: An Encyclopedia*, ed. by S. Sarkar and J. Pfeifer, 2006; p. 286):

(An antecedent condition:) Joe’s body functions properly.

(A law-like statement:) Pumping blood is an essential activity in the proper functioning of a body, and a heart is a body component that functions as a blood pump.

(The conclusion:) Joe’s body has a heart.

Certain difficulties with the functional explanation arise when there are different ways for performing a certain function (for instance, artificial heart might serve as a blood pump). To avoid these difficulties, Ernst Nagel suggested that a living system in question can be characterized in such a way that only one kind of mechanism will carry out the required function. Nagel illustrated his idea with the following example:

(An antecedent condition:) This plant performs photosynthesis.

(A law-like statement:) Chlorophyll is a necessary condition for plants to perform photosynthesis.

(The conclusion:) This plant contains chlorophyll.

There is no hint of teleology in this type of functional explanation. Though having the form of deductive-nomological argument, this functional explanation is not causal, which was emphasized by Nagel. As we have seen, however, explanation and causation do not coincide, generally speaking, so that causation is not necessary for explanation.

In the case of the deductive nomological argument, as we have seen, a conclusion (*explanandum*) is derivated from *explanantia* on the basis of a strict law. But when such a
law is not established, we, as a rule, explain a singular event on the basis of our experience. For instance, if we were asked why a certain person has recovered, we could answer that the recovery has occurred because he (or she) has been taking a certain medicine, for we know on the ground of experience that taking this medicine ensures recovery as a result. This inference is inductive. Induction, in contrast to deduction, is the process of inferring a universal law from particular instances. In our case, we regards the statement that taking a certain medicine results in recovery as a law that is obtained inductively. An approach of this kind gives rise to the model of inductive explanation that will be discussed a little later.

But before this, let me say about a problem that arises in connection with induction. It is the problem of justifying the inference from particular data to their generalization. The problem of the rational grounds for induction was posed by David Hume. He doubted that a regularity that has been observed in the past can be continued to hold in the future. Thus, having observed that the sun rose every morning up to now one cannot, nevertheless, conclude that it will rise tomorrow. At the turn of the XIXth century, the problem of induction was realized by John Venn as the problem of justifying the belief in the uniformity of nature. He believed that the principle of uniformity of nature should be taken as a logical postulate. As for the origin of the principle, he thought that this issue should be dealt with by psychology. John Stuart Mill supposed this principle to be inferred by a second-order induction from first-order regularities which in their turn have been discovered by a first-order induction from the phenomena. Nevertheless, nature seems to be not uniform in all respects and, therefore, the principle of uniformity of nature has not a universal status, so that the problem of induction remains unresolved.

Probabilistic dependence between two events does not allow one to use the deductive-nomological model based on strict laws for explaining why the given singular event occurs. Hempel developed for this purpose the inductive-statistical model of explanation, which is an extension of the covering-law model with taking a statistical law instead of deterministic one as an explanatory ground. Following Hempel’s example, suppose a certain person to have caught a mild infection. Suppose further that after having taken some dose of a certain medicine he achieves quick recovery. Although there is no deterministic law stating that all people who are suffering from this infection and taking this medicine will recover quickly, yet there is its statistical generalization according to which whoever is suffering from this infection and taking this medicine has a high probability (close to one) of recovery. Inasmuch as the probability of this event is very high, one has inductive reasons to expect whomever to recover in cases where the conditions for this are present.

Let I be the event of having been infected, M be that of taking the corresponding medicine, and R be that of quick recovery. Then the explanatory argument might be framed in the following logical scheme:

(Antecedent conditions, or “premises”:) I & M
(A statistical law:) Prob(R || I & M) is close to 1
Hempel writes:

In this schema, the double line separating the “premises” from the “conclusion” is to signify that the relation of the former to the latter is not that of deductive implication but that of inductive support, the strength of which is indicated in square brackets (Aspects of Scientific Explanation, 1965; p. 708).

Note that the requirement for the probability of R given I and M to be high (close to one) is essential to the inductive-statistical model. Improbable events if do occur do not fit with this model, though they are in need of explanation.

An attempt to improve the inductive-statistical model was made by Salmon. His idea was to combine the probabilistic dependence approach to causation that I have mentioned above with an explanatory scheme of this kind. Namely, he had formulated a more strict criterion for judgment whether some factor c is relevant to the explanation of an event e than Hempel’s requirement for the probability of e given c to be close to one. This criterion includes the two clauses: (1) the probability of e given c is greater than probability of e given not-c, and (2) there is no other factor c’ such that the probability of e given c and c’ is equal to the probability of e given not-c and c’. The latter clause allows an explainer to screen off the factor c as a relevant one. This model is called the statistical-relevance model of explanation.