



Yi Jiang\*

# The relation of Peirce's abduction to inference to the best explanation

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**Abstract:** Peirce's pragmatic maxim is closely related to his conception of abduction. The acquisition of the actual effect required by the method of scientific reasoning expressed by Peirce's maxim must be accomplished by resorting to abductive logic. Abductive logic starts from a surprising fact, derives a hypothetical explanation about that fact, and finally arrives at the possibility that the hypothesis is true. This is the process of abductive reasoning, as provided by Peirce, which is distinct from induction and deduction and generates explanatory views. Peirce opposed a unified and unchangeable concept of causality. He used different interpretations of causality to illustrate the considerable differences in people's understanding of cause and effect in different periods. The concept of pragmatism, as developed from the pragmatic maxim to abduction and then to scientific inference to the best explanation, is precisely what Peirce initially proposed, and inference to the best explanation is the starting point and the final result of the pragmatic maxim.

**Keywords:** causality; explanatory views; Peirce's pragmatic maxim; scientific inference

## 1 Introduction

It seems to me that Peirce's maxim is closely related to his abductive reasoning. When he first put forward the maxim, Peirce wanted to express scientific reasoning to a large extent; that is to say, once the way of scientific reasoning is given, we can achieve the actual effect of the concept. The natural result must be obtained by resorting to abduction. Abduction is an original form of reasoning created by Peirce, a third reasoning form to complement the deductive and inductive reasoning we usually understand. In this paper, I aim to clarify the relation of Peirce's conception of abduction to inference to the best explanation as the reasoning of scientific discovery by discussing Peirce's motives for proposing abduction and its characteristics and its relation to inference to the best explanation. I will argue in the conclusion that

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\*Corresponding author: Yi Jiang, School of Philosophy, Shanxi University, Taiyuan, China,  
E-mail: yijiang@sxu.edu.cn

starting from the pragmatic maxim and proceeding to the account of abductive reasoning, it is a process that provides us with a guide to general action.

## 2 Abduction and causality in Peirce

Peirce's proposal of abduction is based in four main aspects:

- (a) the logic of scientific discovery or psychology as the starting point of anti-psychologism;
- (b) hypotheses or data as the foundations of natural science research;
- (c) classification of arguments and new forms of reasoning as the foundation of philosophy; and
- (d) laws of mind and the pragmatic maxim as constants in changing terminology.

Regarding (a), Peirce started from the logic of scientific discovery and pointed out that the way our concepts are constructed is part of scientific discovery. Therefore, the logic of scientific discovery is the most solid foundation for us to help ourselves find out how to form a concept and to allow ourselves to discover the existence of ideas. But a logic, or a solid foundation, such as this cannot be based on psychological explanations. In Peirce's time, at the end of the 19th century, psychology occupied the core and dominant position of the entire philosophical description. At that time, many fresh philosophical ideas, such as those proposed by Husserl, the founder of phenomenology, and Frege, the founder of analytic philosophy, started from anti-psychologism. Peirce also held an anti-psychological stance. He attributed the logic of his scientific discovery to abductive reasoning. This form of reasoning first opposed the infiltration of psychological explanations into logic. Therefore, Peirce tried to use abductive reason, a new mode of reasoning that we understand as a form of common sense, which excludes mental associations from the logic of explaining our scientific discoveries. This is the first motivation for Peirce to propose abductive reasoning.

Concerning (b), Peirce's starting point was an attempt to show that all methods of reasoning start from assumptions and not from data. According to the traditional understanding, all our reasoning activities start from the data. We need to accumulate a large amount of data before making reasonable reasoning based on the data, and the reasoning process is inductive. However, Peirce pointed out that logical reasoning requires more than just data, because if it is carried out exclusively based on data, then we cannot discover general rules. Therefore, we need to start with assumptions; we first put forward assumptions and then make judgments based on assumptions. Historically, starting from assumptions or data shows that philosophers and logicians develop different views of natural science. In the early 20th century, many scientists still insisted on inductively conducting scientific research.

To the greatest extent, the inductive method was a method of reasoning using data, while Peirce emphasized conducting scientific research based on assumptions. This is the second motivation for him to propose abductive reasons.

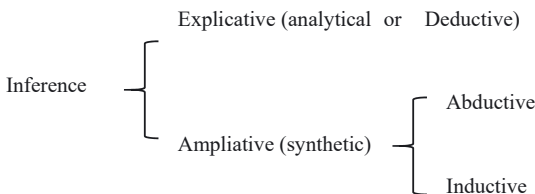
Regarding (c), Peirce tried to formulate a new explanation of forms of reasoning. He expanded the traditional forms of reasoning from two into three; in addition to the conventional deduction and induction, he proposed abductive reason and regarded abduction as the reasoning behind deduction and induction. By constructing this new form of reasoning, Peirce also made a new classification of forms of argumentation. In his view, the constructions of a new form of reasoning and of a new classification of forms of argumentation belong to the work that logic should complete. Discussing the forms of reasoning often constitutes the basis and foundation of an entire philosophical debate. This is the third motivation for Peirce's discussion of abduction.

Regarding (d), Peirce put forward abduction based on the pragmatic maxim, explaining that there are some so-called invariants in the changing terminology which can ensure the objectivity of our reasoning activities, not just the subjective satisfaction of psychological associative need. This is one of the essential starting points for Peirce to discuss abduction.

Next, let us discuss abduction in detail and clarify its essential characteristics. First, Peirce makes the following distinction between three forms of inference (Figure 1).

Among these three forms, explicative reasoning is traditional analytical or deductive reasoning. Ampliative reasoning is regarded as a kind of synthetic reasoning, which is divided into abductive reasoning and inductive reasoning. Peirce believes both abductive and inductive reasoning are forms of synthetic reasoning but simultaneously emphasizes the difference between the two. In his view, abductive reasoning has the following two purposes (Peirce 1958, VIII: 383–388):

- i. Get as many kinds of security (closer to determinism) for each type of reasoning as possible;
- ii. Get as much of the expected liberty or creative value of each type of reasoning as possible.



**Figure 1:** Distinction of inference (source: K. T. Fann 1970: 7).

In this view paraphrased here, extensive reasoning serves both ends: abductive reason is reasoning about adopting a hypothesis assuming a probable hypothesis cannot correctly be called inductive. The security (the degree of certainty that a certain conclusion follows from the premise) is significantly reduced from deduction to induction and then to abduction, but the degree of freedom is greatly improved. This one-up and one-down result meets the requirements for the above two purposes of logical research provided by Peirce. There is a conflict between the adoption of security and the need for freedom: the higher the security, the lower the degree of freedom. If the security is reduced, the degree of freedom will be promoted. When Peirce emphasized the process from deduction to induction and abduction, he adopted the second attitude: reduce security to meet the requirements for degrees of freedom.

Of course, this does not mean there is no need for security, but only that the security is limited to a minimal range, rather than this security being regarded as absolute security. We know that scientific or logical research cannot achieve a secure goal and result. Therefore, the so-called security requirements, or the deterministic requirements mentioned here, can only guarantee certainty within a specific range to the maximum extent. Still, these requirements cannot ensure confidence in all cases. But this reduction in assurance or certainty has brought about a result: its degree of freedom has been dramatically improved.

Later, when many scholars criticized Peirce's theory, they believed that the conflict between the two resulted in different consequences. In other words, the reduction of security does not necessarily guarantee the improvement of freedom. The reverse is also true; the advance of freedom does not necessarily need to be premised on reducing safety. These critics have views different from Peirce, but in Peirce's view, the view of security and degree of freedom mentioned here is a definition of the common characteristics of the whole set of examples we collect.

Inductive reasoning refers to the entire collection of some instances randomly selected, which should have all the characteristics of these extracted instances. An abductive argument is that a term necessarily refers to certain features that can be shown when that number of cases occurs, although not all relevant examples may have been singled out. We can assert that any object may have such characteristics. In other words, induction is defined as the whole set from which some instances are randomly drawn to have all the typical parts of those instances. In contrast, as an argument, abduction asserts that a term necessarily refers to certain features revealed but not singled out when they occur. Arguably, any object has all of these characteristics.

Secondly, Peirce pointed out that abductive reasoning has the following primary forms:

A surprising fact C is observed;  
 If A is true, C is, of course, true;  
 Therefore, it is reasonable to presume that A is true. (CP 5.189)

It can be seen that abductive reasoning proceeds from a surprising fact to a hypothetical explanation of that fact, which is also an inference of that fact. Finally, the probability that this hypothesis is true is obtained. Peirce believes that what he provided is abductive reasoning, which is the process of forming explanatory views. He says, "Abduction is the process of forming an explanatory hypothesis. It is the only logical operation that introduces any new idea; induction does nothing but determine a value, and deduction merely evolves the necessary consequence of a pure hypothesis" (Peirce 1982, CP 5.171). In this respect, abductive reasoning is distinguished from induction and deduction.

Peirce once said, "A priori reasoning (deduction) is to infer effects from causes. A posteriori reasoning (hypothesis) is to infer causes from effects. It is obvious that there is a third way of reasoning which infers reciprocal relations of a cause with various effects; this is induction (or analogy)" (Peirce, cited in Murphy 1961: 61). It is now sufficient for us to see the difference between these three forms of reasoning.

Let us begin by briefly discussing the relation of abduction to causality. First, it is necessary to clarify two concepts in Peirce: abduction and retroduction. Although the two words are similar in meaning – at least in Peirce's writings, the two words are used interchangeably – there is a subtle difference in meaning between the two. As far as abduction is concerned, it means "away" or "toward a new direction," so it refers to a "deviation." According to Peirce, abduction is an explanation from result to cause, from effect to cause, so it is interpreted as "abductive reasoning" (Peirce 1958, VIII: 238). Retroduction refers to "looking back" (backward); we can interpret it as "backtracking reasoning." Many scholars have explained abductive reasoning. For example, Phyllis Chiasson (2001: Pub. 121217-1944a) pointed out that abductive reasoning should be regarded as a "force" or one aspect of retroductive reasoning. Chiasson's explanation has not been widely recognized. Most scholars believe that abductive and retroductive reasoning is the same, but Chiasson's description expresses a significant point of view. That is, abductive reasoning means the reasoning pattern from effect to cause. However, retroductive reasoning may have more aspects to it. It can also illustrate our understanding of the original cause of known facts, although the cause may not necessarily be earlier. Still, the cause and effect can happen simultaneously, for such a cause can appear as an event rather than a thing.

Peirce had different understandings of the two concepts of abduction and retroduction at different stages. Early on, Peirce regarded the two concepts as identical but later distinguished them, mainly because of his diverse understandings of causality.

So, how exactly did Peirce understand causality? It is generally believed that Peirce opposed the concept of causality, but this does not mean that he completely denied causality. He regards causality as a term people discuss or use in different historical periods. The concept of causality used by people in different periods is inconsistent. Therefore, we have no way of regarding causality as a concept with a unified connotation that everyone can accept. From ancient times to the present, the idea of causality we get is only consistent in name, but it is different in concept. In this regard, Peirce writes,

Those who make causality one of the most primordial elements of the universe or one of the fundamental categories of thought – and you will see I am not – have a very embarrassing fact to explain. People's views on causes differ and are inconsistent at different stages of scientific culture. The great principle of causality, which we know and absolutely must believe in, is one proposition at one period of history, a quite different proposition at another, and a third proposition for the modern physicist. The only thing that stands up to it [...] is its name. :(Peirce 1992; Peirce and Ketner 1992,197)

Menno Hulswit (2001: Pub.120809-1715a) gave three different definitions of the concept of cause in one of his articles, namely Aristotle's concept of cause, modern science's concept of cause, and the concept of cause of mental activity, and pointed out Peirce's different interpretations of these three concepts. In short, Peirce opposed a unified and unchangeable concept of causality. He used different variations of causality to illustrate the vast differences between people's understanding of cause and effect in different periods. Therefore, the "cause" in the concept of abductive inference he explained also differs from the above three concepts of cause.

### 3 Abduction and inference to the best explanation

Next, we discuss the grounds for interpreting Peirce's abductive reasoning as being provided with inference to the best explanation. The concept of pragmatism being developed from the pragmatic maxim to abductive logic and then to scientific inference to the best explanation is, in my opinion, precisely what was put forward by Peirce, and inference to the best explanation is also the starting point and the end point of the pragmatic maxim. According to our previous discussion, this inference consists in putting forward the logic of scientific discovery and finding a logical explanation that conforms with the actual field of science. Peirce uses abductive reasoning to explain the logic of scientific discovery so that we can arrive at the best explanation for scientific discovery from abductive reasoning.

But there are many questions on the path from abductive reasoning to scientific discovery. First, we need a way to fully understand how to define the role of

abductive reasoning in the logic of scientific discovery. From the perspective of the connotation of abductive reasoning, is it reasoning from effect to cause, reasoning generating explanatory hypotheses, or selecting the best explanation from a set of alternative views? The second question is, how does abductive reasoning work as a means of scientific discovery from the perspective of the novelty of abductive reasoning? Faced with this problem, many scientists and philosophers who oppose abductive reasoning believe it is difficult for abductive reasoning to make fundamental contributions to scientific discoveries like deductive reasoning or inductive reasoning do. The actual effect of the process could be more extensive. The third question is, what is the relationship between inductive and deductive reasoning by analogy and reasoning from the best explanation regarding how abductive reasoning relates to other forms of reasoning? Can abductive reasoning be formally described from the perspective of the relationship between abductive reasoning and situational reasoning? If Peirce regarded abductive reasoning as a third form of reasoning beside inductive and deductive reasoning, then he should be able to characterize it formally.

Of course, the concept of “reasoning” has a history of development in Peirce’s philosophy. Peirce was born in 1839. When he was just 21 years old, he read Kant’s *Lectures on logic*. Already at that time, Peirce began thinking of how to derive the third way of reasoning from deductive and inductive reasoning. Peirce believed that Kant’s philosophy provided a third kind of reasoning. In Kant’s critical philosophy, the purpose of transcendental reasoning is mainly to complete the regulation of rational ability. Peirce found it difficult for us to use this mode of transcendental reasoning, so he tried to propose another method of reasoning: abduction.

Peirce’s initial expression of “abductive reasoning” was very superficial. As mentioned earlier, Peirce formalized this idea around 1867, when he used the form of syllogism provided by Aristotle to illustrate the basic logic of abductive reasoning. In 1868, Peirce published a paper in the *Journal of Speculative Philosophy* and elaborated abductive reasoning comprehensively. In this regard, we can make a more specific explanation. K. T. Fann determined that Peirce’s concept of reasoning underwent the following development process:

1860: Thinking of the trichotomy of reasoning from Kant’s logic

1865: Establishing the trichotomy as the logical consequence of the interrelationship of the three forms of reasoning

1866: Discovering the irreducibility of the three syllogisms

1867: The idea of abductive reasoning was first proposed in “Natural Classification of Arguments”

1868: The theory was first comprehensively discussed in the *Journal of Speculative Philosophy* (Fann 1970: 13–14)

In 1860, Peirce believed that the inference we get from a class of things is nothing other than what is directly expressed by the argument subsumed under the syllogism “Barbara”; that is, what is valid for the entire course must be true for each member of this class; thus, all other syllogisms can be reduced to Barbara. In 1861, Peirce first proposed how abductive reasoning could make it a process of deriving a conclusion from a major and minor premise. He proposed that the operation of the sense data produced in cognition is reasoning and that every judgment consists of deducing the subject from the predicate. The predicate is the thought, and the subject is just what the thought thinks. The element of the predicate is experience or an expression of experience. The subject is by no means empirical but merely an assertion of experience. Therefore, every judgment is an inference from what has been experienced or known to what has been asserted or unknown. This is an explanation of phenomena through hypotheses, a kind of reasoning. Therefore, all cognition is inferential, and all the logic can be reduced to the universal affirmation. From this, it can be deduced that every awareness is derived from a major and a minor premise. Since this first premise cannot be derived from experience, only the minor premise can be derived from experience. A major antecedent and a minor premise can help us arrive at this inference, but this inference cannot explain the facts we get in experience. Therefore, we should also consider new things or other things, and these so-called other things, in Peirce’s view, explain the expression of facts unknown to us.

The interpretation of the expression of the unknown fact here is what he calls the interpretants by appeal to signs because the sign explains the hypothesis we provide about the unknown facts. He believes that we can understand the unspeakable through the reasoning of signs. Since intuitions involve the existence of transcendental objects, which are ineffable, the only way of knowing the ineffable is by reason from signs. “The only justification for an inference from a sign is that the conclusion explains the fact. It is inexplicable to assume that the fact is unspeakable, and such an assumption is therefore impermissible” (CP 5.265). It is a logical postulate that everything can be said.

This understanding can remind us that Wittgenstein also expressed similar views in *Tractatus Logico-Philosophicus*. Wittgenstein believed that what could be defined clearly could be explained logically. Conversely, everything can be explained logically, and this kind of explainable thing is what Peirce called the interpretants of signs or the interpretation of hypotheses. In this sense, Peirce distinguishes between the introduction and translation of signs. The former is the result of hypothetical reasoning, and the latter is the explanation of the hypothesis, which is used to explain the introduction of perceptual judgment and universal minor premise.

In 1910, Peirce explicitly separated hypothetical and inductive reasoning by writing, “I still think it to be well founded. It is only in what I have published before the turn of the century that I have a more or less confused hypothesis with induction



**Table 1:** Deduction.

Rule	Example	Conclusion
The beans in this bag are all white.	These beans come from this bag.	These beans are white.
Anyone infected with the new coronavirus will have shadows on their lungs.	Zhang now has shadows on his lungs.	Zhang has been infected by the new coronavirus.

**Table 2:** Induction.

Example	Conclusion	Rule
These beans come from this bag.	These beans are white.	The beans in this bag are all white.
Zhang now has shadows on his lungs.	Zhang has been infected by the new coronavirus.	Anyone infected with the new coronavirus will have shadows on their lungs.

**Table 3:** Hypothesis.

Conclusion	Example	Rule
These beans are white.	These beans come from this bag.	The beans in this bag are all white.
Zhang has been infected by the new coronavirus.	Zhang now has shadows on his lungs.	Anyone infected with the new coronavirus will have shadows on their lungs.

less [...] Now I think that hypothetical reasoning refers to the process of formulating a hypothesis, while induction is the confirmation of a hypothesis" (CP 8.227). To illustrate the difference between the three forms of reasoning (Tables 1–3), I borrow an example from Peirce and add one of my own:

Deduction starts from a rule, finds an example, and then draws a conclusion. Induction starts from an example, finds a conclusion, and then draws a rule. Hypothesis begins with a conclusion, then an individual example is discovered, and finally, a rule is introduced.

Let us examine the differences between these three forms of reasoning. In Tables 1–3, Peirce's example is above, and my example is below. For the convenience of understanding, I will use my example to discuss the point. Among them, the rule is: "Everyone infected by the new coronavirus will have shadows on their lungs." Then, if Zhang has shadows on his lungs now, Zhang will be infected by the new

coronavirus. This is the deductive reasoning model. Inductive reasoning follows the path that if Zhang has shadows on his lungs, and the new coronavirus has infected him, presumably everyone infected by coronavirus will have shadows on their lungs. Hypothetical reasoning is that the new coronavirus infected Zhang, and Zhang now has shadows on his lungs, so it is believed that anyone infected by the new coronavirus will have shadows on their lungs.

Following hypothetical reasoning, the premise is that the new coronavirus infected Zhang, and the fact can be obtained through representation. Nevertheless, we don't know whether he actually was infected. We only know that this fact results from being infected by the new coronavirus, but we don't know why. Therefore, from the fact that Zhang has shadows on his lungs now, we can deduce a sense that anyone infected by the new coronavirus will have shadows on their lungs. The example of Zhang proves the truth of our discovery that the new coronavirus infected Zhang. It is a mode of explanatory reasoning.

Of course, there are many problems in this reasoning mode itself because it is too probable, making it impossible for us to truly determine the conclusion we have drawn and how high the certainty is that this is the truth. This is a flaw in Peirce's abductive or hypothetical reasoning, so it could not be agreed that the conclusions drawn by appealing to this mode of reason have a high degree of truth.

Of course, according to Fann's interpretations for Peirce, there are different categories of explanatory hypotheses, namely, the following three:

- (1) hypotheses about unobserved but observable facts that the hypothesis assumes;
- (2) hypotheses that cannot be observed, such as hypotheses about historical facts;
- (3) hypotheses of entities that are neither factually nor theoretically observable by current knowledge. (Fann 1970: 21–22)

In addition, Peirce also proposed three rules for progressing from hypothesis selection to scientific discovery, which he expressed as follows:

- 1) A hypothesis must explicitly ask questions and then make observations to test its truth; in other words, we must try to discover the expected results that may arise from this hypothesis;
- 2) The similarity of interest must be taken at random; we cannot regard a specific prediction as the best choice for the hypothesis;
- 3) One must be honest about the success or failure of forecasts. The entire process must be impartial and free from bias. (CP, 2.834)

The first rule is the rule of hypothesis, which is that we must first propose the hypothesis. The second rule requires a lot of data collection to see the similarity between these data, which is a rule for verifying hypotheses. The third rule is the criterion of evaluation.

Starting from these three rules, we can see that abductive reasoning can fully meet the inference requirements for the best explanation. Abductive reasoning is an inference to the best explanation. In his book *Patterns of discovery: An inquiry into the conceptual foundations of science* (1958), N. R. Hanson put forward the position of abductive reasoning as inference to the best explanation. He said:

Physical theories provide patterns in which data appear intelligible. They constitute a 'conceptual gestalt'. A theory is not pieced together from observed phenomena; rather, it makes it possible for us to observe phenomena as something and relate them to other phenomena. Theories place phenomena in systems. They are built 'inversely' – retroductively. A theory is a set of conclusions looking for premises. From observed properties of a phenomenon, the physicist deduces a key idea from which those properties can be logically explained. The physicist seeks not a set of possible objects, but a set of possible explanations. (Hanson 1958: 90, 95)

Gilbert Harman also attributed inference to the best explanation to Peirce's abductive reasoning. He wrote:

The inference to the best explanation is intended to explain in part science and everyday life with inductive reasoning. At the beginning of this century, Peirce proposed a version of this model called 'Abduction,' developed and discussed considerably in the past 25 years. Its leading idea is that explanatory considerations guide inference; that is, scientists infer hypotheses from the evidence, and if it is true, the hypotheses can best explain that evidence. The inference to the best explanation can be seen as an extension of the "self-evident" explanation, in which the explained phenomenon provides an important part of the reasons for believing that the explanation is correct. (Harman 1965: 88–95)

## 4 Conclusions

I have provided a coherent account of the passage from Peirce's original pragmatic maxim to abductive inference and then to models of inference to the best explanation. This process goes from general principles to specialized fields of study to solving specific problems in scientific discoveries. Thus, starting from the pragmatic maxim and proceeding to the account of abductive reasoning, this process provides us with a guide to general action.

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## Bionote

### Yi Jiang

School of Philosophy, Shanxi University, Taiyuan, China

[yijiang@sxu.edu.cn](mailto:yijiang@sxu.edu.cn)

Dr. Yi Jiang (b. 1961) is a Distinguished Professor at Shanxi University in Taiyuan, China. His research interests include Charles S. Peirce, pragmatism, the history of analytic philosophy, and Wittgenstein. He is the author of *Wittgenstein and the development of contemporary philosophy* (2021) and *Philosophical analysis of contemporary issues* (2022). He also co-authored *Modern Anglo-American analytic philosophy* with Yajun Chen (2023). He is the editor-in-chief of the yearbook, *Analytic philosophy in China*.