

# Research on Application of Abduction to Fire Investigation

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## Abstract

To solve the problem of fire investigation caused by lack of exacting logical reasoning, it is of significance in helping that abduction, an important logical thinking should be introduced to the field of fire investigation. This paper first analyzes the fundamental reasoning forms of abduction as well as its general situation of application. Combined with practical work experience, the mode of application of abduction to fire investigation is put forward. The author shows it in detail by analyzing a real fire case. It is north noting that some matters needing attention in application are presented in the end. This paper will be conducive to constructing the right logical reasoning model in fire investigation.

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## Nomenclature

P	phenomenon, observation
H	hypothesis, explanation

## 1. Introduction

The primary form of abduction is to put forward explanatory hypotheses for an amazing observation based on some causal rules [1]. This reasoning method plays an important role in our daily life or even the scientific discoveries. Unlike the deductive and inductive logical forms, it has logical implications which are coexistence of reasoning process and result and integration of theoretical choice and construction [2]. Fire investigation is a process where the causes are traced starting from the fire itself, thus research on abduction theories is beneficial to promoting fire investigation. This paper analyzes the feasibility and necessity of applying abduction to fire investigation through theoretical studies and questionnaire survey firstly, and then puts forward application modes and paradigms of abduction during fire investigation. Lastly, some noteworthy problems are clarified. The researches in this paper is helpful for the fire investigators to better understand and apply the abduction, and build up correct reasoning model based on the causal logic relationship implied in the fire scene, then activate their investigation thinking way and improve the investigation efficiency.

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## 2. Basic forms of abduction

### 2.1. Fundamental conception and reasoning form

Abduction is a form of logical inference which goes from an observed phenomenon to a theory which accounts for the observation, ideally seeking to find the most likely explanation. The mode of abduction can be summarized as follows (letter P represents the phenomenon, and H represents the hypothesis):

- The surprising fact, P, is observed.
- But if H were true, P would be a matter of course.
- There are no other causes that can explain P as well as H.
- Hence, there is reason to suspect that H is true [3] [4].

Its logic form can be simply presented as:

$$\frac{\begin{array}{c} P \\ H \rightarrow P \\ \hline H \end{array}}$$

In this logic form, " $\rightarrow$ " represents that there is a certain causal relation between H and P, namely, if related conditions or the cause H exists, the result P will be caused necessarily. But not vice versa, the phenomenon P can probably induce the cause H. After "the best explanation" is introduced into abduction, "there are no reasons that can explain P as well as H" is added to the basic mode, thus H is probably true. Although this inference may be wrong, this is the most likely explanation according to the existing information. To explore the objectivity and truth, abductive reasoning requires people depending on certain background theories to produce all possible reasons and find out the most likely explanation through comparison.

### 2.2. Overview of studies on abduction and its application

The logician C.S. Peirce is recognized as the founder of theory of abduction. He is the first one who carries out systematic studies on abduction, and argues that it is a scientific inference method as well as a necessary and instinctive process of thinking in people's daily life and puts it on a par with inductive reasoning and deductive reasoning. Peirce uses a syllogism to distinguish and compare these three reasoning forms:

#### **Deductive reasoning**

Rule — all marbles in this bag are red

Circumstance — these marbles are taken from this bag

Result — these marbles are red

#### **Inductive reasoning**

Circumstance — these marbles are taken from this bag

Result — these marbles are red

Rule — all marbles in this bag are red

#### **Abductive reasoning**

Rule — all marbles in this bag are red

Result — these marbles are red

Circumstance — these marbles come from this bag [5]

The above logic form shows that, deductive reasoning is a process of reasoning from one or more rules to reach a certain conclusion; Inductive reasoning is a process of reasoning certain rules from the facts; But abduction is a process of reasoning from already known observed circumstances to seek certain tenable condition or cause. By summarizing the views of Pierce, the philosopher Hanson defines abduction more clearly. He argues that abduction provides conjectural hypothesis for the cause of a result based on observations and related law knowledge, and also systematically expounds the abduction models in the scientific discoveries. Later, Josephson introduces the process of seeking for the best explanation into the theories of abduction and adds "there are no other reasons that can explain P as well as H" to the basic reasoning steps, thus C is most likely to be true. Although this inference may be wrong, this is the most likely explanation according to the existing information.

As abduction has the features of discovering new knowledge and exploring causal mechanism, it is becoming more and more important for our daily life and scientific discoveries. In 1987 International Congress of Logic Methodology and

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