Bayesian confirmation Theory and all of the Sciences

A unified approach

Julia Stålenheim

C-level essay

Supervisor: Sebastian Lutz
Filosofiska institutionen
Uppsala universitet
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1 Introduction

In this paper I intend to show that Bayesian confirmation theory can be used instead of the hypothetico-deductive method for all sciences, not just natural sciences. To do this I will go through an example of literature study and apply the Bayesian confirmation theory. I am also going show that the cases of confirmation and disconfirmation from the hypothetico-deductive method in terms of Bayes’ theorem.

There has been much discussion on the method of science as a unifying factor. One part of this is whether the well-known hypothetico-deductive method is something applicable to all sciences and what they actually do. On this theme Føllesdal argues in his paper “Hermeneutics and the hypothetico-deductive method” that the hypothetico-deductive method is used in all sciences, only more or less visible. What I will attempt in this essay is to argue that instead of using the hypothetico-deductive method we should be able to apply Bayesian confirmation theory on all kinds of sciences, both social and hard science.

1.1 Introducing the HD-method

The hypothetico-deductive method (from here on referred to as the HD-method) is a method that is sometimes used in discussing the unification of science. In the HD-method we look at our views as hypotheses, from which we can deduce empirical consequences. We can falsify the hypotheses through experiments and thus get a modus tollens conclusion of the form:
If $H$ then $E$

$E$ false

\[ \begin{array}{c}
H \\
\end{array} \]

This means that if hypothesis $H$ entails evidence $E$, if $E$ is false must also the hypothesis $H$ be false. This gives that if we accept the premiss, we also need to accept the conclusion. Sometimes auxiliary hypotheses are needed to make the connection between hypothesis and empirical consequence. This gives the deduction:

If $H$ and $Ah$ then $E$

$E$ false

\[ \begin{array}{c}
H \text{ or } Ah \\
\end{array} \]

In this case we can not tell whether it is the hypothesis itself or the auxiliary hypothesis that is false. This means that the auxiliary hypothesis needs to be tested independently in order to know if the hypothesis is falsified or not. Thus, it is possible to falsify the hypothesis only if all auxiliary hypotheses have been identified and tested.

Johansson [4, p.53] then asks the whether we can prove an hypothesis with the HD-method. This of course depends on what we mean by proving something, which I not will discuss here. We can rewrite the previously used argument as follows:

If $H$ and $Ah$ then $E$

$E$ false

\[ \begin{array}{c}
H \\
\end{array} \]
This means that the argument is not logically valid, and the conclusion is not true but strengthened. Thus it is possible to falsify a hypothesis but not to prove it. [4, p.55]

1.1.1 Auxiliary hypotheses

Auxiliary hypotheses are used, not to strengthen the argument itself for an hypothesis, but as premisses when deducing an empirical consequence. When testing the main hypothesis the auxiliary hypotheses are not tested, just assumed to be true. But the auxiliary hypotheses must be separately testable for us to be able to say anything conclusive about the main hypothesis. In an experiment situation are the auxiliary hypotheses not tested separately from the main hypothesis, and thus one cannot tell which one of the two that might be true or false. [4, p.54]

Auxiliary hypotheses may be everything from every day observations to other research that is used to deduce a testable statement. When investigating real problems the auxiliary hypotheses may be hard to find, especially the ones that are so common that we take them for granted without any reflection. [4, p.54]

2 Bayesian confirmation theory

The notion that one could, and maybe should, update one’s beliefs according to statistical rules when encountering new or more evidence is called Bayesianism, from the mathematician Bayes, who formulated Bayes’ theorem. This tells us how to calculate the probability of an event given another, connected, event that already has happened.
Bayes’ theorem or Bayes’ rule

\[ P(A | B) = \frac{P(A)P(B | A)}{P(B)} \]  

(1)

where \( P(A | B) \) is the probability of \( A \), given \( B \).

In probability calculus the letter \( P \) is often used for probabilities. In Bayesian confirmation theory (henceforth BCT) the letter \( P \) is often used for the physical probability of an event and the letter \( C \) for the subjective probability, which is how likely one finds an event or hypothesis to be.

The subjective probability for an event or outcome \( d \) at a later time is written \( C^+(d) \). This is governed by Bayes’ rule of conditionalization.

\[ C^+(d) = C(d | e) \]  

(2)

where \( C(d | e) \) is the subjective probability of outcome \( d \) given that the event \( e \) is observed. If this later time, \( C^+(d) \) is a timespan where multiple pieces of evidence or events, \( e_1, e_2, e_3 \ldots \) have been observed, the rule can be written as:

\[ C^+(d) = C(d | e_1, e_2, \ldots, e_n) \]  

(3)

This means that Bayes’ rule tells us how to update our beliefs when encountering new evidence and is thus a theory of confirmation.[3, p. 23]
From what is stated above Bayes’ theorem may be rewritten as follows:

\[ C^+(h) = \frac{C(e \mid h)}{C(e)} C(h) \]  

(4)

This is the main theorem used in Bayesian confirmation theory and it tells you how to, in the light of your previous beliefs in hypothesis \( h \) \( C(h) \), you should update your beliefs upon discovery of new evidence \( e \). This theorem is what I will use later in my examples.

### 2.1 Subjective probabilities

All rational beings have ideas about how likely something is to be true, even if it not is expressed as specifically as a certain number. The fact that BCT takes these previous beliefs into account makes the Bayesian confirmation theory more nuanced than the options “yes”, “no” and “uncertain” of traditional confirmation theory. How much we believe something to be true is referred to as credence or subjective probability.

The subjective probabilities are one of the corner stone’s of BCT where:

1. The subjective probabilities are assigned to competing hypotheses and are numbers from 1-0, where 0 is “certainly false” and 1 is “certainly true”.

2. These subjective probabilities behave like ordinary probabilities and can be handled with probability calculus.

3. The hypothesis is strengthened or weakened by learning from evidence in accordance with the Bayesian conditionalization rule. [3, p. 27]
Even though the subjective probabilities are reflections of one’s own beliefs in how likely something is there are multiple factors to take into consideration when assigning the probabilities. Strevens[3] says that the subjective probabilities must be set in accordance with three criteria:

1. The axioms of probability
2. Bayes’ conditionalization rule
3. The probability coordination principle [3, p.60]

The probability coordination principle

\[ C(e \mid h) = P_h(e) \] (5)

is the rule saying that one’s subjective probability for event \( e \) given that the hypothesis \( h \) is correct should be the physical probability that \( h \) assigns to \( e \). For instance for a toss with a coin could the event \( e \) be that it lands on heads and the hypothesis \( h \) be that tossed coins in general land on heads with a probability of one half. Then the probability coordination principle states that one should assign \( C(e \mid h) = 0.5 \), which is the same as the physical probability \( P_h(e) = 0.5 \). [3, p.33]

3 Bayesian confirmation theory and the hypothetic deductive model

As Strevens mentions in his article “Notes on Bayesian confirmation theory”, the Bayesian approach is fairly easy to apply on or simply replace the HD-method with. Confirmation, according to the HD-method, is if \( e \) strengthens
our belief in $T$ so that $e$ confirms $T$. Disconfirmation is the case where $e$ weakens our belief in $T$ so that $e$ disconfirms $T$. Put in context of BCT, this means that confirmation would be $P(T \mid e) > P(T)$ and disconfirmation $P(T \mid e) < P(T)$. In this section I will explain how we can, only using Bayes’ rule, prove that both the HD-method’s treatment of confirmation as well as disconfirmation are special cases of the Bayesian confirmation theory. Therefore, we can replace the HD-method with Bayesian confirmation theory for both cases. [3, p.46]

3.1 Confirmation and Disconfirmation

Theorem 1. If $T \Rightarrow e$ then $e$ confirms $T$ and $\neg e$ disconfirms $T$.

Proof. Since $T \Rightarrow e$ it follows that $P(e \mid T) = 1$. Using Bayes’ theorem we find that

$$P(T \mid e) = \frac{P(e \mid T)}{P(e)} P(T) = \frac{P(T)}{P(e)}$$

Since $P(e)$ is a number between zero and one, the division with something between zero and one will result in a larger number. Thus $P(T \mid e) > P(T)$ in other words when $e$ confirms $T$.

For disconfirmation, since $P(e \mid T) = 1$ The laws of probability tell us that $P(\neg e \mid T) = 0$. Applying Bayes’ theorem we see that

$$P(T \mid \neg e) = \frac{P(\neg e \mid T)}{P(\neg e)} P(T) = 0$$

$P(T \mid \neg e) = 0 < P(T)$ which is to say $\neg e$ disconfirms $T$. \hfill \Box
The Bayesian confirmation theory agrees with the HD-method about the cases of confirmation and disconfirmation, the difference is that with the Bayesian method it is possible to have different degrees of confirmation. Generalising this means that $T$ bears positively on $e$ if and only if $P(e \mid T) \geq P(e)$. In the extreme case when $T$ infers $e$ then we have $P(e) = 1$ so clearly $P(e \mid T) \geq 1$ and is thus confirmation.

**Theorem 2.** If $T$ bears positively on $e$ then $e$ confirms $T$ and $\neg e$ disconfirms $T$.

**Proof.** Since $T$ bears positively on $e$, we have that $P(e \mid T) \geq P(e)$. Hence accordingly thus confirms $P(e \mid T)P(e) \geq 1$. Turning to Bayes’ theorem

$$P(T \mid e) = \frac{P(e \mid T)}{P(e)} P(T)$$

and since

$$\frac{P(e \mid T)}{P(e)} \geq 1$$

it follows that $P(T \mid e) > P(T)$, that $e$ confirms $T$.

Turing again to disconfirmation since $T$ bears positively on $e$, and by the laws of probability, we have that

$$P(e \mid T) \geq P(e)$$

$$\Rightarrow 1 - P(\neg e \mid T) \geq 1 - P(\neg e)$$

$$\Rightarrow P(\neg e) \geq P(\neg e \mid T)$$

$$\Rightarrow 1 \geq \frac{P(\neg e \mid T)}{P(\neg e)}$$
Applying Bayes’ theorem

\[ P(T \mid \neg e) = P(T \mid \neg e) = \frac{P(-e \mid T)}{P(-e)} P(T) \]

since the quotient is less or equal to one we have that \( P(T \mid \neg e) \leq P(T) \)

This means that I have proven the hypothetico-deductive confirmation and disconfirmation in terms of the Bayesian confirmation theory and will continue to use them in the following example from Føllesdal.

4 BCT and literature studies

In this section will I discuss the example that Føllesdal uses in his Hermeneutics. I will attempt to apply the Bayesian confirmation theory to this example, to see if it is interchangeable with the HD-method for examples within all fields.

4.1 Peer Gynt

The example that Føllesdal uses most to argue that the HD-method is usable in cases not only in hard sciences but also in the humanities is the understanding of Ibsen’s play “Peer Gynt”. This example of literary theory is concerned with the interpretation of “the stranger” in act five of “Peer Gynt”. There have been many different ideas of who this character really is, ranging from the Devil to a representation of Ibsen himself. In this example Føllesdal claims that some of the hypotheses can be disconfirmed by arguing according to the rules of the HD-method. And even though there is no single “right answer” in this case we can still use a scientific reasoning to argue why
our observations support the hypothesis.[2]

The character of the stranger appears twice in act five of the play, once standing on the deck of a ship next to the main character, Peer, during a storm and then later on swimming next to an overturned lifeboat which Peer is floating on. Føllesdal presents five different interpretations of the stranger that have been proposed in different papers. As I don’t need to actually come to a conclusion and still be able to prove my point, I will only go through four of the five interpretations. The fifth hypothesis is not as easily compared to the others and is the left out for practical reasons.

To be able to study a question with BCT one has to be really clear about what question is being investigated. This is a good thing since it helps to clarify what questions that are actually being answered. In this case I will investigate what Ibsen could have meant that the stranger should be interpreted as, in opposition to all possible interpretations of the character. Choosing this as my question decides what my thoughts on how to set the probabilities for the different pieces of evidence are given that Ibsen wrote the character of the stranger according to hypothesis h, how likely it is that he included evidence e? In the case of text interpretation where possible readings of a text are investigated, regardless of how the author intended them to be interpreted, this would give the probability assigning given hypothesis h, how likely would it be that evidence e would be in the text? Since some of the evidence in Føllesdal’s text includes arguments related to some background knowledge about the writer, they will only be relevant when investigating the text from the perspective of how the writer himself intended it to be interpreted. Without consideration for the writer’s perspective these pieces
of background knowledge become irrelevant. But since they are included in
the example which I’m reconstructing I will investigate how Ibsen might have
intended the passage about the stranger to be interpreted.

Earlier, when discussing the example with the toss of the fair coin I had
a prior probability for event $e$, the coin landing on heads, since there is a
physical probability to take into consideration. When working with text
interpretation there are no physical probabilities of any kind. Therefore I
need to assign prior probabilities to the different evidence/events according
to some other principle. If I have access to background theories concerning
the evidence I can use these to guide my assigning of these probabilities.
Otherwise my surrounding web of beliefs and prior experience what I have
to go on in this case. I therefore believe that a researcher within the relevant
field will be able to set much more well based prior probabilities according
to current research and theories.

I will now go through the four first different hypotheses put forth by
Føllesdal and the evidence mentioned for and against each hypothesis. In
order not to make things overly complicated I will assign each hypothesis the
same prior probability of $C(h_i) = 0.25$ and the total sum of the probabili-
ties for the four hypothesis will then be one. This then does not reflect my
prior thoughts of how likely any hypothesis is, but it simplifies my example.
Føllesdal does not put the hypotheses against each other and therefore also
doesn’t set any of the evidence for a hypothesis against another hypothesis.
But since BCT only gives a picture of how likely a hypothesis is to be true
compared to its competing hypotheses I will have to do this to obtain any
kind of useful answer.
The first hypothesis will prove to be false immediately and I will therefore not weight the evidence for that hypothesis against all other evidence, since it would be irrelevant. For the remaining hypotheses I will go through them and their evidence and update the subjective probability for all hypotheses continuously to show how they connect.

The hypotheses are presented with their respective evidence, and I will not make a judgement on probable a piece of evidence that is presented for a hypothesis $h$ is for the other hypotheses. Thus since the relationship between the hypotheses is the important part, the change in probabilities will affect the probability balance as a whole. In order to not have to make such judgements I will split up the change in probabilities to keep the balance between the two hypotheses not in scope, so that only the relationship between the hypothesis $h$ and its competitors will change, not the relationship between the competitors. Some of the pieces of evidence I have left out of my calculations since they would strengthen all of the hypotheses, and thus not change the probability balance and thus not make any of the hypotheses more likely than its competitors.

**The hypotheses**

1. Hypothesis $h_1$: The stranger represents anxiety.

   The observations speaking for this interpretation is firstly ($e_1$) that the stranger appears in situations when Peer is anxious. But also an observation that Ibsen was very interested in and influenced by Kierkegaard, a philosopher of anxiety ($e_2$). Speaking against this hypothesis is the fact that Ibsen himself said that this interpretation of the stranger never
occurred to him ($e_3$), which since I chose to analyse Ibsens’ intended reading of the character, gives $h$ the probability zero, e.g. it is considered false since $P(e_3|h_1) = 0$. This gives the hypothesis the probability 0, shown below, which means that the hypothesis is certainly false. As this hypothesis then has a probability of 0 the other hypotheses will have the prior probabilities of $1/3$ each.

$$C^+(h_1) = \frac{C((e_3|h_2))}{C(e_3)}C(h_1) = \frac{0}{C(e_3)}0.2 = 0$$  \hspace{1cm} (6)

Since this hypothesis now is out of the way the prior probabilities for the remaining three hypotheses will be set as follows.

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<thead>
<tr>
<th>Probability for hypotheses</th>
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<tr>
<td>$C(h_2)$</td>
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<tr>
<td>0.333</td>
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2. Hypothesis $h_2$: The stranger represents death.

This hypothesis is also supported by $e_1$, since the anxiety that Peer is feeling in the situations where the stranger appears is an anxiety of death. An argument against this hypothesis is that it doesn’t account for much else of what is said about the stranger, this can also be seen as an observation making this $e_4$. Without further investigation of different methods of text interpretation, we can make some speculations about plausible probabilities. $C(e_1)$ is the probability I assign the event that the stranger would appear on these occasions in the play, regardless of any hypothesis. There might be some theory about strangers and anxiety in literary criticism or such that could guide me
in my assigning of this probability, but since I don’t know of any such theories I will set this probability to \( C(e_1) = 0.5 \). Given that Ibsen meant the stranger to represent death I would give quite a high probability that the stranger appears in situations of death anxiety assigning \( C(e_1 \mid h_2) = 0.6 \).

Moving on to the next evidence associated with this hypothesis, \( e_4 \), namely the observation that the hypothesis doesn’t account for much else that is said about the stranger. \( C(e_4) \) is the probability, according to our previous experience, that Ibsen would describe the stranger the way he does. Since the stranger is a rather curious figure, I would say that it is somewhat unlikely that the character would be described that way, but not very. This makes me assign \( C(e_4) = 0.5 \). Given that the hypothesis, the stranger represents death, is true I find it quite unlikely that Ibsen would include so much else about the character that does not fit in with the intended interpretation, giving \( C(e_4 \mid h_2) = 0.2 \).

\[
C^{+1}(h_2) = \frac{C((e_1 \mid h_2))}{C(e_1)} C(h_2) = \frac{0.6}{0.5} 0.333 = 0.444 \tag{7}
\]

<table>
<thead>
<tr>
<th>Probability for hypotheses</th>
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<tbody>
<tr>
<td>( C^{+1}(h_2) )</td>
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<tr>
<td>0.444</td>
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\[
C^{+1}(h_2) = \frac{C(e_4 \mid h_2)}{C(e_4)} C^{+1}(h_2) = \frac{0.2}{0.5} 0.444 = 0.177
\]
3. Hypothesis $h_3$: The stranger represents the author, Ibsen, himself.

This hypothesis has eight arguments presented in its favour.

i. $e_5$, the stranger is described as “white as a sheet” and staying indoors during the day. This corresponds to a description of Ibsen as “tense and meagre, with the color of gypsum”, since he was mostly indoors working during the time when “Peer Gynt” was written. The probability that Ibsen would describe the character of the stranger as a pale figure who stayed indoors, given that he himself also was that, on its own could be argued to be a little stronger than just the plain 0.5 given the general mysterious appearance of the stranger. Based on this, and nothing more scientific, since I’m not studying literature, I assign the probability $C(e_5) = 6$ Given that Ibsen was writing himself into the role of the stranger it is highly probable that he would describe the character with the same traits as himself, giving $C(e_5 | h_3) = 0.7$.

$$C^{+5}(h_3) = \frac{C(e_5 | h_3)}{C(e_5)}C(h_3) = \frac{0.5}{0.6}0.41 = 0.478$$
ii. $e_6$, the stranger enjoyed tempest and shipwreck, which is interpreted as Ibsen’s liking for what overthrows the game. The liking of tempest and shipwreck could be evidence for all three hypotheses since it would be likely for both death and the devil as well as Ibsen himself. Since what is interesting here is the relationship in likeliness between the different hypotheses this will not change at all if I find the evidence to be as likely for all of the hypotheses. Thus I will not make any calculations based on this hypothesis.

iii. $e_7$, the stranger expresses an interest in anatomy and asks for Peer’s permission to perform an autopsy on “corps”. This is not something that I have any specific idea or opinion about outside of the hypothesis, thus assigning $C(e_7) = 0.4$. In connection with the hypothesis this is compared to Ibsen’s use of words like “anatomize” and “anatomy” about his own work. At risk of some literary point passing me by, I find this comparison a little bit strange and would assign the $C(e_7 | h_3) = 0.5$ since I don’t really understand it, but the person doing the literary analysis clearly thought this to be important enough.

$$C^{++7}(h_3) = \frac{C(e_7 | h_3)}{C(e_7)} C^{+2}(h_3) = \frac{0.5}{0.4} 0.4780 = 0.5975$$

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<tr>
<td>$C^{+7}(h_2)$</td>
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<tr>
<td>$C^{+7}(h_3)$</td>
</tr>
<tr>
<td>$C^{+7}(h_4)$</td>
</tr>
<tr>
<td>0.1220</td>
</tr>
<tr>
<td>0.5979</td>
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<tr>
<td>0.2114</td>
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16
iv. $e_8$, the stranger wants to be a moral guide for Peer, which would correspond to Ibsen’s intent to wake up the Norwegian people. In my opinion it is quite common that some character around the main character functions as a kind of a moral guide, but to what extent this stranger matches existing theories about such characters I don’t know, so I will assign $C(e_8) = 0.6$. But in connection to the hypothesis, since Ibsen wanted to wake up the Norwegian people and if he wrote himself into the character of the stranger, it is a plausible thought that the stranger wanted to be a moral guide for Peer. Based on this, I assign $C(e_8 | h_3) = 0.7$.

\[
C^{**}(h_3) = \frac{C((e_8 | h_3)}{C(e_8)}C^{**}(h_3) = \frac{0.7}{0.6}0.5975 = 0.6971
\]

<table>
<thead>
<tr>
<th></th>
<th>$C^{**}(h_2)$</th>
<th>$C^{**}(h_3)$</th>
<th>$C^{**}(h_4)$</th>
</tr>
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<tbody>
<tr>
<td>Probability for hypotheses</td>
<td>0.0915</td>
<td>0.6971</td>
<td>0.2114</td>
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v. $e_9$, the stranger says that “time so often will alter things”, which has been connected to that Ibsen writes about the development of his own views in several of his letters. The statement “time so often will alter things” is on its own a very general statement and also something that I find plausible interpretations for in favour of all the hypotheses, therefore will I not take it into consideration.

vi. $e_{10}$, both Ibsen and the stranger are described as freethinkers. That the stranger would be described as a freethinker is something I have no opinion on, giving $C(e_{10}) = 0.5$. And if Ibsen was
described as a freethinker, then also to ascribe this to the character representing himself would be quite likely, thus giving $C(e_{10} | h_3) = 0.6$.

$$C^{+_{10}}(h_3) = \frac{C(e_{10} | h_3)}{C(e_{10})} C^{+_{10}}(h_3) = \frac{0.6}{0.5} \cdot 0.6971 = 0.8365$$

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<tr>
<td>$C^{+_{10}}(h_2)$</td>
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<td>0.0494</td>
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vii. $e_{11}$, the stranger says that where he comes from a smile is worth quite as much as any pathos and in the play Ibsen uses both tragic and comic elements. This argument in general probably has literary theories concerning it, that I don’t know of. The statement of the stranger outside of the hypothesis I am quite indifferent to, thus assigning $C(e_{11}) = 0.5$. And if Ibsen was described as a freethinker, then to also ascribe this to the character representing himself would be quite likely, thus giving $C(e_{11} | h_3) = 0.55$, which is fairly high considering $C(e_{11} h_3) \leq C(e_{11})$.

$$C^{+_{11}}(h_3) = \frac{C(e_{11} | h_3)}{C(e_{11})} C^{+_{11}}(h_3) = \frac{0.55}{0.5} \cdot 0.8365 = 0.9201$$

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<tr>
<td>$C^{+_{11}}(h_2)$</td>
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<td>0.0559</td>
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viii. $e_{12}$, the stranger comforts Peer with “one does simply not just die in the middle of the fifth act”, a knowledge that only the writer of
the play would have. On its own this is an unusual thing to say for a character, setting the \( C(e_{12}) = 0.3 \). With the hypothesis this is a humoristic way of telling the audience that this is not a regular character, but it is not necessary the only possible explanation to why Ibsen wrote this, assigning \( C(e_{12} | h_3) = 0.32 \), which is considerably high but not certain.

\[
C^{+12}(h_3) = \frac{C(e_{12} | h_3)}{C(e_{12})}C^{+5}(h_3) = \frac{0.32}{0.3} \frac{0.9201}{0.9814} = 0.9814
\]

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<th>Probability for hypotheses</th>
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<tr>
<td>( C^{+12}(h_2) )</td>
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<td>0.0130</td>
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4. Hypothesis \( h_4 \): The stranger represents the Devil.

This hypothesis has a few arguments. The first one is the stranger stating that “I swim quite well with my left leg” which is interpreted as the Devil traditionally is described to have a horse’s hoof instead of a right foot. This makes observation \( e_{13} \). On its own is the statement that he swims quite well with his left leg an unusual comment, therefore I assign \( C(e_{13}) = 0.3 \). Within the theory on the other hand it makes sense that he swims well with his left leg, making me assign \( C(e_{13} | h_4) = 0.6 \).

\[
C^{+13}(h_4) = \frac{C(e_{13} | h_4)}{C(e_{13})}C(h_3) = \frac{0.6}{0.3} \frac{0.0560}{0.1120} = 0.1120
\]
The second argument $e_{14}$, is a sailor’s answer to Peer’s question about who went into the cabin being The ships dog, sir!”. This, since the Devil often appears in popular belief and literary works in the shape of a dog. Given that the sailor actually saw who went into the cabin this is also a weird thing to say, giving $C(e_{14}) = 0.4$. But with the hypothesis that the devil then has the shape of the dog, the probability for $C(e_{14}) \mid h_4) = 0.6$.

$$C^{+14}(h_4) = \frac{C((e_{14}) \mid h_4)}{C(e_{14})}C^{+1}(h_4) = \frac{0.6}{0.4} \times 0.112 = 0.168$$

The third argument is Peer’s reaction when seeing the stranger, “Get out of here!”, ”Get out of here, scarecrow!” which reminds us of the words Jesus used when he was tempted. If a strange person appeared in my room or cabin I would also say something similar. Therefore finding it probable on its own I assign $C(e_{15}) = 0.6$. In combination with the hypothesis this also makes for a plausible thing to say, making $C(e_{15}) \mid h_4) = 0.7$.
\[ C^{+15}(h_4) = \frac{C((e_{15}) \mid h_4)}{C(e_{15})} C^{+2}(h_4) = \frac{0.7}{0.6} 0.1680 = 0.1960 \]

<table>
<thead>
<tr>
<th>Probability for hypotheses</th>
<th>( C^{+15}(h_2) )</th>
<th>( C^{+15}(h_3) )</th>
<th>( C^{+15}(h_4) )</th>
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<tbody>
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<td></td>
<td>0.0105</td>
<td>0.7935</td>
<td>0.1960</td>
</tr>
</tbody>
</table>

The fourth argument, \( e_{16} \), is the stranger’s statement that “I’ll float if only I insert my fingertip into this crack”. This has been interpreted two different ways. One is that it refers to the saying that “if you give the devil a fingertip, he will take the whole hand”. It has also been interpreted as the devil not having regular fingers, but claws. This could then also be connected to another character later on in the fifth act, who is a thin person with a hoof to whom Peer says “Your nails seem most remarkably developed!” which then connects to the interpretation of the two different characters, making \( e_{17} \).

As for the statement of \( e_{16} \), it is a rather unusual thing to say and thus makes for a lower probability on its own. \( C(e_{16}) = 0.3 \). I choose the second interpretation of this statement, that it refers to the devil’s claws, since it fits with \( e_{17} \) and therefore assigning \( C(e_{16}) \mid h_4) = 0.6 \). \( e_{17} \), on the other hand, is a plausible thing to say if you encounter a person with strange hands, and also very plausible if you encounter the devil and he has claws. This makes me assign \( C(e_{17}) = 0.4 \) and \( C(e_{17}) \mid h_4) = 0.7 \).

\[ C^{+16}(h_4) = \frac{C(h_4 \mid e_{16})}{C(e_{16})} C^{+1}(h_4) = \frac{0.5}{0.3} 0.1960 = 0.3920 \]
5 Discussion

Above it can be seen how one’s beliefs about different hypotheses may change upon incoming information. Even though \( h_3 \) was the hypothesis with the most evidence, the hypothesis \( h_4 \) ended up with the highest probability since I regarded the pieces of evidence in \( h_4 \)'s favour to be more compelling than some of the evidence for \( h_3 \). This shows that BCT not only gives the hypothesis with the highest amount of evidence a higher probability, but it also reflects one’s own beliefs in the evidence. BCT is thus context dependent in the sense that a piece of information can confirm a hypothesis more or less depending on your background knowledge. This supports the holistic view on knowledge that Føllesdal argues for.[2, p.321]

In BCT a theory is confirmed or strengthened in relation to its competitors. An inaccurate theory can get a probability close to one if its competitors are even worse, but no model of confirmation is better than the hypothesis we
apply them to. For a theory of infinitely many possibilities, which sometimes is the case in science, the subjective probabilities can be seen as probability densities, where groups of hypotheses get assigned sets of probabilities. Upon incoming new evidence the the subjective probability density will heap around the most true hypothesis. [3, p.51]

At the end of Føllesdal’s *Hermeneutics and the hypothetico-deductive method* [2] he goes through some common arguments presented against the hypothetico-deductive method. I will now go through the same arguments below. I will then present Føllesdals answers regarding the HD-method and make a comparison what it would mean for the BCT.

1. **The hypothetico-deductive method can only be used for natural sciences.**

   *HD:* Føllesdal argues this is refuted by him reasoning hypothetico-deductively in the example above.[2, p.328]

   *BCT:* I don’t know if anyone has made such a claim for BCT, but as the same argument could then be used for BCT, since I used it in my example earlier it is clearly usable also in cases of other sciences.

2. **The hypothetico-deductive method can only be used in experimental sciences.**

   *HD:* This is an argument often used to back the claim in the previous argument. And Føllesdal argues that when looking at hypothetico-deductivism as hypotheses that are confirmed through testing this is quite a reasonable conclusion. But when broadening the meaning of “testing” also to include finding other kind of supporting evidence, as in the example from Føllesdal, the hypothetico-deductive method works
for all cases where it is applied to relevant material.[2, p.328]

*BCT:* For BCT any observable state can be given a probability. What then is seen as an observable state narrows the use of the method. But as shown above it is entirely possible to use non-experimental evidence in BCT, even if strictly physical evidence is easier to give an accurate probability of occurring it is still doable, and for an actual researcher within a field probably quiet easy.

3. **Hypothetico-deductive system consists of “if - then” sentences.**

*HD:* Føllesdal talks about a hypothetico-deductive system consisting of all kinds of sentences and sees no argument against other kinds of sentences.[2, p.321,329]

*BCT:* For BCT the type of sentences used are, as could be seen above, not restricted in any way. What is important is the probabilities for an event on its own and as a part of a hypothesis, both according to one’s other ideas and beliefs as well as their physical probabilities.

4. **The hypothetico-deductive method can not be used in the study of man,** since it presupposes that the object of study is considered as a thing.

*HD:* This is not a restriction that Føllesdal agrees with. He argues that the system itself has no such restrictions. [2, p.330].

*BCT:* BCT has also no such restrictions. Regardless of what is being studied, we can look at a piece of evidence and its probability related to our hypothesis.
5. **The hypothetico-deductive method does not give room for and is not compatible with self-reflection.**

*HD:* As Føllesdal concludes, he does not see any problems with including sentences about one self in the hypothetico-deductive system.[2, p.330]

*BCT:* The same goes for BCT, sentences about one self are entirely possible to be used both as hypothesis and as evidence in a system of bayesian reasoning. And in itself BCT includes, and reflects one’s own beliefs when setting the subjective probabilities. So BCT could be argued to have even more room for taking one’s prior ideas and beliefs into consideration.

6. **The hypothetico-deductive method has no room for the researcher as a part of the society that is being studied,** since it presupposes that the researcher who applies the method does not affect that which is being investigated which is the case for social sciences.

*HD:* Føllesdal argues here that the holistic view on knowledge can create a system of hypotheses in such a way that they can take social aspects into consideration.[2, p.330]

*BCT:* I agree with Føllesdals argument and as BCT takes one’s previous beliefs into consideration this makes for an even more adaptable system.

7. **The hypothetico-deductive method is an “explaining” method,** which is used in experimental sciences but not in humanities.

*HD:* Føllesdal agrees that in the humanities an “understanding” method of hermeneutics is used and argues that the hypothetico-deductive method can be used for understanding as well.[2, p.331]

*BCT:* BCT can clearly be used for both explaining and understanding as it only
affects one’s beliefs about competing hypotheses, regardless of what these hypotheses are about.

6 Conclusions

What can be concluded from this paper is that, just as Føllesdal argues for the hypothetico-deductive method, the Bayesian confirmation theory can be used within all sciences. Since both the cases of hypothetico-deductive confirmation and disconfirmation can be proven with Bayes’ theorem, BCT is a viable option, for all cases where the HD-method could be used. This option might even be a better one, since BCT easier takes our opinions and previous experiences into consideration. Thus I argue that BCT is more adaptable than the hypothetico-deductive model, applicable to all sciences.

References


## A Calculations

Probability $C(h)$ for hypotheses

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Hypothesis $h_2$</th>
<th>Hypothesis $h_3$</th>
<th>Hypothesis $h_4$</th>
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</thead>
<tbody>
<tr>
<td>$n$</td>
<td>$C(e_n)$</td>
<td>$C(h_2</td>
<td>e_n)$</td>
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<tr>
<td>$e_1$</td>
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<td>0.6</td>
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