BRIAN BLAIS

A MEASURE OF FAITH

PROBABILITY IN RELIGIOUS THOUGHT

FAITH IS TAKING THE FIRST STEP EVEN WHEN YOU DON'T SEE THE WHOLE STAIRCASE.

MARTIN LUTHER KING, JR.

LIFE'S MOST IMPORTANT QUESTIONS ARE, FOR THE MOST PART, NOTHING BUT PROBABILITY PROBLEMS.

PIERRE-SIMON LAPLACE

FAITH CONSISTS IN BELIEVING WHEN IT IS BEYOND THE POWER OF REASON TO BELIEVE.

VOLTAIRE

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1 Introduction

Life's most important questions are, for the most part, nothing but probability problems. - Laplace

1.1 Why write a book like this?

This book is written to address the role that the mathematics of probability can play when applied to topics in religion. Specifically, we have found that there are two primary purposes of this approach:

1. Bring clarity to other similar treatments of these topics. The mathematics of probability have, unfortunately, been used to give the veneer of authority and objectivity to an argument that is not well supported[1]. This is typically done by sneaking, possibly inadvertently, a bad assumption into an otherwise correct analysis. Understanding the structure of the mathematics can help in correcting this.

2. Bring concreteness and lucidity to more verbose and *murky* approaches. When talking about terms like *faith*, *miracles*, and *evidence* the mathematics forces the analysis to be both specific and complete, while at the same time having the benefit of the reducing the number of symbols used in the description. Thus, there is an economy of words which is achieved. Pages of philosophical exposition can often be summarized by a few equations[2]. This makes it much easier to explore special cases, and to see where analogies are successful and where they fail. This process gives the reader the ability to see connections between concepts, even when they seem opposed.

[1] Richard Swinburne. The resurrection of god incarnate. 2003

[2] Daniel Howard-Snyder. Propositional faith: What it is and what it is not. 2013

1.2 Who is this for?

Although we intend this book to be technical, we do not want to scare away those that are less mathematical. In fact, we would consider it a success if someone who is not particularly inclined in the mathematical arts would be able to get a new appreciation for these topics upon reading this book. Therefore, we will try to limit the technical aspects to that which is only absolutely necessary, and rely heavily on specific examples at all times.

1.3 Organization

In this chapter we outline the basics of probability, applied to a few simple cases. we then explore in subsequent chapters the details of specific concepts, including *faith*, *miracles*, and *historical methods*. Typically, these explorations center around responses to particular works, podcast discussions and debates.

1.4 Introduction to Probability

When we speak about probability, we speak about a percentage chance (0%-100%) for something to happen, although we often write the percentage as a decimal number, between 0 and 1. If the probability of an event is 0 then it is the same as saying that *you are certain that the event will never happen*. If the probability is 1 then *you are certain that it* will *happen*. Life is full of uncertainty, so we assign a number somewhere between 0 and 1 to describe our state of knowledge of the certainty of an event. The probability that you will get struck by lightning sometime in your life is $p = 0.0002$, or 1 out of 5000. Statistical inference is simply the inference in the presence of uncertainty. We try to make the best decisions we can, given incomplete information.

Pierre-Simon Laplace, who first formalized the mathematics of probability, spoke of an agent with perfect knowledge. This agent, Laplace claimed, would not need probability at all.

> *"We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.[3]"*

E.T. Jaynes would describe the "random process" as a mind-projection fallacy[4]: you have ignorance of the system, so you attribute its unpredictable behavior as a product of the system itself. A rolled die is following the laws of physics, deterministically, and detailed knowledge of the die, the roll, and the surface should allow you to predict 100% of the time what it will do. We lack that knowledge, thus the behavior becomes unpredictable. We often then attribute

[3] Pierre-Simon Laplace. *Philosophical essay on probabilities*. Dover Publications, 1814 English Edition 1951

[4] E. T. Jaynes. *Probability Theory: The Logic of Science*. Cambridge University Press, Cambridge, 2003. Edited by G. Larry Bretthorst

that unpredictable behavior as a "random die", as if it were the die that contains the randomness and not our own ignorance.

The Basic Rules of Probability

For a complete description of these rules, and their application in general statistical inference there are several books available, one of which from the present author[5].

[5] B.S. Blais. *Statistical Inference for Everyone*. printed by Createspace, http://tinyurl.com/sie-bblais, 2014

Rule 1 (Definition rule): $P(A)$ is a number between 0 and 1, representing the strength of belief in a statement, A

An example is

$$P(\text{you will get struck by lightning sometime in your life}) = 0.0002$$

which means that you believe it to be extremely unlikely that you will be struck by lightning in your life. This belief, as we will see, is not just a *guess* but is something arrived at through proper rational processes, or in other words, by adhering strictly to the rules of probability.

In terms of economy of symbols, we will often define a single symbol to represent an entire sentence, or collection of sentences. For example,

Because this is just a shorthand, we find it useful when the formalism gets too abstract to insert whatever statement for the shortcut you want. Thus, it helps your intuition to put in a specific example with each equation.

$$\begin{aligned} H &\equiv \begin{cases} \text{“you will get struck by light-} \\ \text{ning sometime in your life”} \end{cases} \\ P(H) &= 0.0002 \end{aligned}$$

means that you believe it to be extremely unlikely that you will be struck by lightning in your life.

Rule 2 (Negation rule):

$$P(A) + P(\textbf{not}\, A) = 1$$

In other words, either a statement is true or its negation is true.

$$\begin{aligned} H &\equiv \begin{cases} \text{“you will get struck by} \\ \text{lightning sometime in} \\ \text{your life”} \end{cases} \\ P(H) + P(\textbf{not}\, H) &= 1 \end{aligned}$$

means that you can be *certain* that either you will be struck by lightning in your life or you won't. This seems rather obvious, and you may be wondering why we even bring it up, but it becomes a source of one of the most common logical fallacies - the either-or fallacy.

Notice how this occurs. The following is correct logical inference:

$$\begin{aligned} B &\equiv \begin{cases}\text{“a playing card drawn} \\ \text{from a deck is black”}\end{cases} \\ P(B) + P(\textbf{not}\, B) &= 1 \end{aligned}$$

means that, if you draw a playing card from a deck, you can be *certain* that it is either black or it is not-black. This is true no matter what kind of deck of cards you are dealing with. The following, however, is not correct logical inference:

$$\begin{aligned} B &\equiv \begin{cases}\text{“a playing card drawn} \\ \text{from a deck is black”}\end{cases} \\ R &\equiv \begin{cases}\text{“a playing card drawn} \\ \text{from a deck is red”}\end{cases} \\ P(B) + P(R) &= 1 \leftarrow \underline{\textit{this is incorrect}} \end{aligned}$$

The key point here is that “not-black” is not the same as “red”, except in those cases where you can be certain that there are only those two possibilities. One has to be on the lookout for hidden possibilities - perhaps one has a *Five Crowns* deck which has green and yellow cards as well. Failure of imagination can easily lead to accidental either-or logical failures[6].

[6] An example seen later is an argument by a Christian examining the probability of theism (T) being true or atheism (A) being true. The argument hinges on $P(T) + P(A) = 1$, and trying to reduce $P(A)$ to win the argument. However, the proposition “theism is true” masks as many alternatives as “not-black” in the example here. One could have the Christian God, the Greek pantheon, the Cthulhu mythological structure, etc... and thus the argument does not perform what the Christian things it does.

Rule 3 (Conjunction rule):

$$P\,(A \text{ and } B) = P(B|A)P(A)$$

which is the probability of two statements both being true, A **and** B. We define a new symbol, |, which should be read as “given.” When there is information given we call this probability *conditional* on that information.

$$\begin{aligned} H &\equiv \begin{cases}\text{“you will get struck by} \\ \text{lightning sometime in} \\ \text{your life”}\end{cases} \\ G &\equiv \begin{cases}\text{“you like to play golf in} \\ \text{the rain”}\end{cases} \\ P\,(H \text{ and } G) &= P(H|G)P(G) \end{aligned}$$

means that the chance of you getting struck by lightning in your lifetime **and** you like to play golf in the rain is related to the probability of you liking to play golf in the rain ($P(G)$) and the probability that you will get struck by lightning in your lifetime *given that* you like to play golf in the rain ($P(H|G)$). There are a few points to be made here which become important in later examples.

1. Notice how concise the description is - the math can summarize the relationship between several concepts with few words or symbols.

2. $P(H|G)$ is probably higher than $P(H)$. In other words, knowing that a person likes to play golf in the rain makes it more likely that they will be struck by lightning in their lifetime.

3. Even if we don't have specific numbers, we can still reason about which probabilities are larger or smaller, or which ones are important or not.

4. $P(H \text{ and } G)$ is *always* less than $P(G)$ - the conjunction of two things is inherently (and mathematically) less probable than the individual components.

Sam Harris likes to humorously point out that Mormonism is *objectively* less likely than Christianity because Mormonism is Christianity **and** a number of implausible statements. This, however, is somewhat misleading because Christianity is also predicated on those so-called implausible statements being false. One has to be careful when constructing the probabilities!

Rule 4 (Bayes' rule): This rule is perhaps the most obtuse to see for the first time, but is by far the most important rule of them all so is worth the effort. Because of this, we will choose to write it in a somewhat more elaborated form, and rewrite it several ways.

$$P(\text{explanation}|\text{data}) = \frac{P(\text{data}|\text{explanation})\,P(\text{explanation})}{P(\text{data})}$$

where each term is described more fully as

- $P(\text{explanation})$ - this is the probability the explanation is correct *prior* to seeing the data. The term itself is often called the *prior*, and represents your beliefs before you see the data. Typically, more complex explanations are less likely a-*prior*i than simpler ones.

- $P(\text{explanation}|\text{data})$ - this is the probability the explanation is correct *after* seeing the data (a-*posteriori*). The term itself is often called the *posterior* for this reason, and represents your updated beliefs once you have data. Thus, Bayes' rule is a mathematical expression of *learning* from evidence.

- $P(\text{data}|\text{explanation})$ - this is the probability that the data can be explained with this particular explanation. The term itself is often called the *likelihood*, and can be thought of as a measure of how well the explanation fits the data. If the explanation fits the data well, this number will be high, for example.

- $P(\text{data})$ - this is the probability that of the data regardless of the explanation. It is easiest to understand this term with an example.

Imagine we are playing a game with several small decks of cards, defined here:

The analogy here is that the universe is set up with a set of rules that we are trying to determine. Thus, deciding on which deck we are holding is the analogous to deciding which universe we are in given my observations of the universe. In other words, providing an *explanation* of the data is really about determining which of the many possible universes we are in.

1. $E_1 : A♠, 2♥, 3♠, 4♠$

2. $E_2 : A♥, 2♥, 3♠, 4♠$

3. $E_3 : A♥, 2♥, 2♥, 4♠$

4. $E_4 : A\heartsuit, 3\spadesuit, 3\spadesuit, 4\spadesuit$

In the game someone has handed us one of the decks, but we don't know at all which one it is. We then draw the top card, observe that it is a $3\spadesuit$, and see if we can reason about which deck is likely to be the one we are holding. We choose such a small, simple system because it is easy to intuit the answers without the math. This intuition can provide a scaffold for understanding the mathematics, which can be used in more complex examples where one *doesn't* have a strong intuition. It is therefore worth going through at least one example in detail.

To begin, we need to assign the probabilities of the four cases *prior* to the data. Given total ignorance, we assign equal probabilities to the four cases[7]

$$\begin{aligned} P(E_1) &= 1/4 \\ P(E_2) &= 1/4 \\ P(E_3) &= 1/4 \\ P(E_4) &= 1/4 \end{aligned}$$

[7] Here the analogy breaks a bit, because not all explanations of the universe are equal a-priori.

The following are our intuitions, with the mathematics in parallel below. Since we drew a $3\spadesuit$, our intuition says that this should rule out E_3 altogether. Further, it says E_4 should be more likely than the other remaining two because it contains the observed card, $3\spadesuit$, more than one time - it is easier to get that particular card from the fourth deck than the others.

The mathematics would look like this

$$\begin{aligned} P(E_1|3\spadesuit) &= \frac{P(3\spadesuit|E_1)P(E_1)}{P(3\spadesuit)} \leftarrow \text{this term the same in all} \\ P(E_2|3\spadesuit) &= \frac{P(3\spadesuit|E_2)P(E_2)}{P(3\spadesuit)} \\ P(E_3|3\spadesuit) &= \frac{P(3\spadesuit|E_3)P(E_3)}{P(3\spadesuit)} \\ P(E_3|3\spadesuit) &= \frac{P(3\spadesuit|E_4)P(E_4)}{P(3\spadesuit)} \end{aligned}$$

where we already have

$$P(E_1) = P(E_2) = P(E_3) = P(E_4) = 1/3$$

Further, we have

$$P(3\spadesuit|E_1) = 1/4$$

because one card out of 4 in the first deck is the $3\spadesuit$. Likewise we have

$$P(3\spadesuit|E_2) = 1/4$$

$$\begin{aligned}
P(3\spadesuit|E_3) &= 0 \\
P(3\spadesuit|E_4) &= 2/4
\end{aligned}$$

Finally we have

$$P(3\spadesuit) = 4/16$$

because there are 4 cards out of all the 16 in the game. Plugging these numbers in to the above equations, and performing the arithmetic we have

$$\begin{aligned}
P(E_1|3\spadesuit) &= \frac{(1/4)\times(1/4)}{(4/16)} = 1/4 \\
P(E_2|3\spadesuit) &= \frac{(1/4)\times(1/4)}{(4/16)} = 1/4 \\
P(E_3|3\spadesuit) &= \frac{(0)\times(1/4)}{(2/12)} = 0 \\
P(E_4|3\spadesuit) &= \frac{(2/4)\times(1/4)}{(4/16)} = 1/2
\end{aligned}$$

which perfectly matches our intuition. Notice further that terms like $P(3\spadesuit|E_1)$ is another way of saying "how well is the observation of a 3♠ explained by the idea that we're holding the first deck?" The entire process can then be thought of as updating our initial beliefs with the new evidence.

> *Any process of reasoning, in any field whatsoever, is either consistent with this process of calculation or it is not rational.*

It is for this reason that we explore this process in such detail.

On another front, an alternate way to have calculated the shared bottom term, $P(3\spadesuit)$, is the following

$$\begin{aligned}
P(3\spadesuit) &= P(3\spadesuit|E_1)P(E_1) + P(3\spadesuit|E_2)P(E_2) + \\
&\quad P(3\spadesuit|E_3)P(E_3) + P(3\spadesuit|E_4)P(E_4) \\
&= (1/4)\times(1/4) + (1/4)\times(1/4) + (0)\times(1/3) + (2/4)\times(1/4) \\
&= 4/16
\end{aligned}$$

Why would one write it in this seemingly long-winded and complex way? Because it makes it easier to say, in words, what this term is doing. It is the sum of all of the probabilities for how well each explanation accounts for the data scaled by how likely that explanation was before seeing the data. In other words, proper rational inference requires that you re-weight the strength of your beliefs in an explanation not just by how well that explanation describes your observations, but also by how intrinsically likely that explanation is before your observations and how well all of the *alternatives* perform on those same observations. An observation can be very well explained by a particular explanation, but if it can be equivalently explained by other, simpler, explanations then your belief in that particular explanation may in fact *go down* with the new observation.

1.5 *On Simplicity*

Ockham's razor, which is the philosophical idea that simpler theories are preferred, is a consequence of Bayes' rule when comparing models of differing complexity[8]. We can see this by extending the card game example with a fifth possibility. Instead of giving the specific cards in this deck, we are simply told

[8] William H Jefferys and James O Berger. Sharpening ockhamÂŠs razor on a bayesian strop. *Dept. Statistics, Purdue Univ., West Lafayette, IN, Tech. Rep*, 1991

1. E_5 : the deck can have anywhere from zero to three 3♠, and enough other cards to make a total of four cards

This explanation of the universe of the game is plastic - depending on the data, we may infer a different value for the number of 3♠ in this deck. It may be heavily loaded toward 3♠, which would make the explanation explain the data very well, however it may have none, and not explain the data at all. Clearly, once you observe a 3♠, the "best" value for this deck is to have three of them - making it more likely than the previously most likely deck, E_4, which only had two.

In mathematical models, this is often referred to as having an *adjustable parameter* - a value in the model that is not specified ahead of time, but can be *fit* to the data, and an optimum value found.

However, this process of reasoning violates the laws of probability by not taking our uncertainty of this parameter (i.e. the number of 3♠ in the deck) into account. For simplicity, let's just consider the two decks in question, E_4 and E_5, and play the game with them (again, as before, drawing a 3♠ from the top).

1. $E_4 : A\heartsuit, 3\spadesuit, 3\spadesuit, 4\spadesuit$
2. E_5 : the deck can have anywhere from zero to three 3♠, and enough other cards to make a total of four cards

We set up the calculation as before

$$\begin{aligned} P(E_4|3\spadesuit) &= \frac{P(3\spadesuit|E_4)P(E_4)}{P(3\spadesuit)} \\ P(E_5|3\spadesuit) &= \frac{P(3\spadesuit|E_5)P(E_5)}{P(3\spadesuit)} \end{aligned}$$

We defer the calculation of the shared term, $P(3\spadesuit)$, and focus on the numerators of both calculations. First the one for E_4 (and remember, we have only two decks here),

Once we have the numerators, we can add them up to get the shared term $P(3\spadesuit)$

$$\begin{aligned} P(E_4|3\spadesuit) &\sim P(3\spadesuit|E_4)P(E_4) \\ &= (2/4) \times (1/2) = 1/4 \end{aligned}$$

Next with the E_5 deck,

$$\begin{aligned} P(E_5|3\spadesuit) &\sim P(3\spadesuit|E_5)P(E_5) \\ &= \underbrace{P(3\spadesuit|E_5)}_{\substack{\text{broken up into the} \\ \text{four possibilities from} \\ \text{zero to three } 3\spadesuit}} \times(1/2) \end{aligned}$$

Each of the possibilities (all equally likely, because we are given no other information) has the form of the fraction of $\spadesuit$ for that possibility times 1/4 because there are 4 total possibilities to consider, for example

$$P(3\spadesuit|E_5 \textbf{ and zero } 3\spadesuit)P(\text{zero } 3\spadesuit|E_5) = \underbrace{(0/4)}_{\#\spadesuit}\times(1/4)$$

Doing the same for all the possibilities, we get for the E_5 numerator,

$$\begin{aligned} P(3\spadesuit|E_5)P(E_5) &= [(0/4)\times(1/4)+(1/4)\times(1/4)+(2/4)\times(1/4)+(3/4)\times(1/4)]\times(1/2) \\ &= 3/16 \end{aligned}$$

Finally, we can get the shared term,

$$P(3\spadesuit) = 1/4 + 3/16 = 7/16$$

and the probabilities of each of the decks, given the observation of a $P(3\spadesuit)$,

$$\begin{aligned} P(E_4|3\spadesuit) &= \frac{1/4}{7/16} = 4/7 \\ P(E_5|3\spadesuit) &= \frac{3/16}{7/16} = 3/7 \end{aligned}$$

This means that, although E_5 contains the *possibility* of a better fit to the data, it is less *probable* because it has a flexible parameter that is unspecified *before* the data.

When we prefer a "simpler" model with Ockham's razor, simpler means fewer such adjustable parameters. It also means that the predictions are both *specific* and not *overly plastic*. For example, a hypothesis which is consistent with the observed data, and also be consistent if the data were the opposite would be overly plastic. An example of an infinitely plastic "explanation" is *magic did it*. Because it can "explain" anything, given that it is consistent with any possible observation, it explains nothing.

1.6 On Knowledge, Belief, and Proof

Now that we have the structure and notation of probabilities, we can address a number of related terms. We start with *belief*.

> We say we believe a proposition A when $P(A) > 0.5$. We say we believe *strongly* in a proposition A when $P(A) > 0.95$ or some other, somewhat arbitrary, high number. The strength of a belief is a *scale* measured my the probability assigned to that proposition.

What is knowledge? Plato gave the following definition of knowledge:

> Knowledge is justified true belief.[9]

[9] Gail Fine. Plato on knowledge and forms: selected essays. 2003

This is an unsatisfying definition because, it seems, in order to justifiably label anything as *knowledge* with this definition we'd need to be able to independently determine that the proposition is true. This presupposes that there is some "outside" knowledge, which I feel comes too close to assuming a religious justification at the outset. We believe there is likely to be a truth to be known, but that we can never truly know what it is for certain -but this is not a problem. It is a red herring to bring up 100% certainty for knowledge, because it is never achievable, and isn't what we practically call knowledge. We prefer a definition inspired by Stephen J Gould:

In this way, knowledge is a subset of belief.

> In science, 'fact' can only mean 'confirmed to such a degree that it would be perverse to withhold provisional assent. 'I suppose that apples might start to rise tomorrow, but the possibility does not merit equal time in physics classrooms.'[10]

[10] Stephen Jay Gould. Evolution as fact and theory. *Discover*, 2(5):34–37, 1981

Where it says "fact", read "knowledge". Where it says "science" read "life". We label things as knowledge in our lives when they are "confirmed to such a degree that it would be perverse to withhold provisional assent." Thus, $P(A) > 0.9999 \approx 1$. Notice that we don't need 100% certainty to claim knowledge, and that it is possible for the "knowledge" to be wrong (although, by definition, it is highly unlikely for this to be the case).

$P(A) \approx 1$ means that the probability of A is *approximately* equal to 1

Do *proof* and *evidence* mean the same thing? No, they don't. To summarize,

> *Proof* does not exist in science, only in math an philosophy.

The only place you can have proof is where you have *axioms* (i.e. unprovable assertions), and can then *prove* a number of consequences of those axioms. We can prove, for example, that the sum of the angles of a triangle is 180 degrees, if we start with the Euclidean axioms of geometry. Science doesn't have axioms, and thus there are no proofs - there is only evidence. We sometimes hear the term "proven scientifically", even from people who should know better[11].

[11] An example of someone who should know better is Richard Carrier in his "Is Philosophy Stupid" talk, his books, and his articles)

The mapping *proof* to probability theory is quite easy: proofs involve probabilities which are either $P(A) = 1$ or $P(A) = 0$ without any other values coming in. Another way of putting it is that probability theory contains deductive logic as a special case. As it applies to science, it has the following consequence

> All of the evidence in the universe cannot bring the probability of a scientific claim to certainty.

To see this directly, imagine we have two (and only two) hypotheses for the Earth - flat earth and round earth. We can write Bayes' rule for the probability of each given the data. Note that this data includes things like the experience of airplane flight, Magellan's trip, pictures from space - all of which could be faked! The flat earth hypothesis is not *logically* impossible, it's just been overwhelmed by the evidence.

$$P(\text{round}|\text{data}) = \frac{P(\text{data}|\text{round})P(\text{round})}{P(\text{data}|\text{flat})P(\text{flat}) + P(\text{data}|\text{round})P(\text{round})}$$

$$P(\text{flat}|\text{data}) = \frac{P(\text{data}|\text{flat})P(\text{flat})}{P(\text{data}|\text{flat})P(\text{flat}) + P(\text{data}|\text{round})P(\text{round})}$$

Notice that, no matter how well the round earth hypothesis explains the data,

$$P(\text{data}|\text{round}) \approx 1$$

and how unlikely you believe it is that the Earth is flat even *before* the data (a far too strong of an anti-flat Earth bias than is actually warranted),

$$P(\text{flat}) \ll 1$$

as long as there is some *possible* (even if seriously contrived) way to explain the data with the flat earth hypothesis,

$$P(\text{data}|\text{flat}) \neq 0$$

it is *mathematically impossible* to make the round earth hypothesis certain,

$$P(\text{round}|\text{data}) < 1$$

On the right-hand side of Bayes' Rule, the closer the round-earth terms and the flat-earth terms get to 1 and 0, respectively, the closer the left-hand terms get to 1 and 0, but they never *equal* 1 and 0. This does not mean that we can't be *confident* of claims, only that we cannot have *absolute certainty of anything* in science (and therefore, in life in general). Anyone who doesn't understand that does not understand science.

For it to be *reasonable to believe in something*, it must rise to a level of probability that you would label it as *belief*. Does this ever happen, or should this ever happen, with untrue things? Certainly. Here are a few that come to mind.

1. the world is flat - as long as you are constrained to not live near the shore, or see a lunar eclipse
2. life is designed - before the advent of Darwin's theory of natural selection
3. the Sun, and the stars, all go around the Earth - until the advent of physics

In each of these cases there is in fact strong evidence for the claims, and against the counter claims, to make it reasonable to believe them (at the time). It is no longer reasonable to believe these claims - the process of reason forces one to re-weight the probabilities of the hypotheses given new evidence, and to discard those hypotheses that become too improbable.

For example, proper reasoning concludes that special revelation is not reliable, and thus cannot be used as strong evidence for adjusting probabilities.

1.7 *Lessons from Probability*

The mathematics of probability theory is the gold standard for all statistical inference. It structures all inference in a systematic fashion. However, it can be used without doing any calculations, as a guide to qualitative inference. Some of the lessons which are consequences of probability theory are listed here, and will be noted throughout this text in various examples.

- Confidence in a claim should scale with the evidence for that claim
- Ockham's razor, which is the philosophical idea that simpler theories are preferred, is a consequence of Bayes' Rule when comparing models of differing complexity.
- Simpler means fewer adjustable parameters
- Simpler also means that the predictions are both *specific* and not *overly plastic*. For example, a hypothesis which is consistent with the observed data, and also be consistent if the data were the opposite would be overly plastic.
- Your inference is only as good as the hypotheses (i.e. models) that you consider.
- Extraordinary claims require extraordinary evidence.[12]
- It is better to explicitly display your assumptions rather than implicitly hold them.

[12] Carl Sagan. *Demon-Haunted World: Science as a Candle in the Dark*. Random House LLC, 1996

- It is a *good thing* to update your beliefs when you receive new information.
- Not all uncertainties are the same.

There is not a universal agreement for the translation of numerical probability values to qualitative terms in English (i.e. highly unlikely, somewhat unlikely, etc...). One rough guide is shown in Table 1.1. I will be following this convention throughout the book, but realize that the specific probability distinctions are a bit arbitrary.

term	probability
virtually impossible	1/1,000,000
extremely unlikely	0.01 (i.e. 1/100)
very unlikely	0.05 (i.e. 1/20)
unlikely	0.2 (i.e. 1/5)
slightly unlikely	0.4 (i.e. 2/5)
even odds	0.5 (i.e. 50-50)
slightly likely	0.6 (i.e. 3/5)
likely	0.8 (i.e. 4/5)
very likely	0.95 (i.e. 19/20)
extremely likely	0.99 (i.e. 99/100)
virtually certain	999,999/1,000,000

Table 1.1: Rough guide for the conversion of qualitative labels to probability values.

2 Simple Applications

In this chapter we explore a number of simple applications of the framework of probability on topics in religion.

2.1 Atheism and Agnosticism

Fewer words are as loaded and lead to disagreement on definitions as the terms *atheism* and *agnosticism* do. In this work, we will define these words in a particular way which we find the most consistent amongst the many different competing usages.

- Theism and atheism refer to *belief*
- Gnosticism and agnosticism refers to *knowledge* (which is a subset of belief)
- To be a *theist* simply means to believe in one, or more, personal gods. This is in contrast to a *deist* who believes in an impersonal god. Since deist beliefs are untestable, they are not addressed at all in this book. Typically, we will be addressing the Christian or other monotheist arguments, but occasionally bring in polytheist beliefs as they apply.
- To be an *atheist* simply means that one does not *believe* in the existence of any gods. It is a statement of being unconvinced. It is not a statement of confidence that there is no God, just that the arguments for the existence of God is unconvincing.
- *Agnostics* believe that they cannot *know* there is a God or not, whole *gnostics* claim that *knowledge* can be had for (or against) the existence of God. Thus, one can be an agnostic theist or agnostic atheist[1]. Also note, that *knowledge* is being used as described earlier, not as absolute certainty, but extremely high confidence.

[1] Sometimes an agnostic atheist is called a weak-atheist, and a gnostic atheist a strong atheist, but we find these terms a bit too pejorative to use.

An analogy can help sort things out. Say we have two explanations of the number of stars, one which says that there is an *even* number of stars and another that says that there is an *odd* number of stars. Pretty much we know that, at any given instant, one of these *must* be true. However strong belief in either one is completely unwarranted - there is simply no way to know. From a probabilistic framework, we express this as

$$
\begin{aligned}
P(\text{odd}) &= 0.5 \\
P(\text{even}) &= 0.5
\end{aligned}
$$

Anyone making the strong claim that, for example, $P(\text{even}) > 0.95$ would have to present compelling evidence. Someone who is an *evenist* (analogous to a *theist*) would be someone convinced by the evidence, and assigns a high probability for $P(\text{even})$. Someone who is unconvinced by the evidence, say, an *a-evenist* (analogous to an *a-theist*) could maintain a lower probability for $P(\text{even})$. A *gnostic evenist* would have a very high probability for $P(\text{even})$, while an *agnostic evenist* would have a high, but not very high, probability for $P(\text{even})$. Likewise, a *gnostic a-evenist* would have a very low probability for $P(\text{even})$ (and thus a high $P(\text{odd})$), whereas an *agnostic a-evenist* would have a low $P(\text{even})$, and possibly equal to $P(\text{odd})$.

Thus, for someone to be unconvinced of a claim (i.e. "there are an even number of stars") because they find the evidence unconvincing *does not* entail that they have a *belief* in the opposite (i.e. they do not necessarily believe there are an odd number of stars). This point can't be made enough, because it is an extremely common misunderstanding, typically by Christians about atheists.

Matt Dillahunty clearly defines atheism as a lack of belief, and in a court-room analogy says that he finds God "not guilty of existing". In court, you find the plaintiff "guilty" or "not guilty", not "guilty" or "innocent". The burden of proof lies squarely with the prosecution. If they haven't met that burden, then the jury finds the plaintiff "not guilty". They may, or may not, believe that the plaintiff is innocent. Establishing *innocence* in the crime changes the burden of proof to the defendant. The difference here comes down to priors, which we can see through some illustrative examples mapped to probability.

Different Data

If we imagine data that might actually affect this prior probability, the situation is a bit different. Let's imagine that through the laws of physics we could demonstrate that

1. stars are nearly always formed in pairs
2. single stars are very short-lived

we may actually have an argument for an even-number of stars in the universe. In this case, we have

$$P(O|\text{data}) \ll P(O)$$

and thus

$$P(E|\text{data}) \gg P(E)$$

Where one belief goes down, the other goes up. For our belief in odd-ness to go down our belief in evenness must go up. We no longer simply *lack* a belief in odd-ness we also both *believe* in evenness and *believe* in non-odd-ness.

More than two outcomes

Something interesting happens when there are more than two outcomes.

$$P(H) = P(R) = P(Y) = \frac{1}{3}$$

Some data that nearly rules out one hypothesis, say R, may not speak to either other hypothesis directly, so you get the equal redistribution like:

$$\begin{aligned} P(R) &\sim 0 \\ P(H) = P(Y) &\sim 1/2 \end{aligned} \tag{2.1}$$

or it might be the case that the data leaves unchanged the prior probability of one of the hypotheses, raising the probability of the other, like

$$\begin{aligned} P(R) &\sim 0 \\ P(H) &\sim 1/3 \qquad (2.2) \\ P(Y) &\sim 2/3 \qquad (2.3) \end{aligned}$$

Notice that it is possible to reduce the probability of one hypothesis (i.e. R) and not effect the probability of a separate hypothesis (i.e. H), when there are more than two outcomes. It is also possible for the probability of that separate hypothesis (i.e. H) to go up, or even go down. In other words, when there are more than one hypothesis, presenting evidence for (or against) one hypothesis does not always guarantee an adjustment in another hypothesis down (or up).

2.2 *Avoiding the Veneer of Objectivity*

There is a danger in this sort of thing of using mathematics to give the veneer of objectivity to an argument that is riddled with random guesses, ill-defined concepts, and unsupported premises. In this section we analyze some statements made in a podcast debate between theist Calum Miller and atheist James Crofta, expressed as probability statements[2].

[2] Justin Brierley. Is our universe more likely on atheism or theism? Calum Miller vs James Croft. Podcast, August 2014b. URL http://tinyurl.com/nxbqoxm

The Argument

> *"I think one useful way of thinking about is is to consider what evidence is in general. When we think about evidence for a theory, in this case the theory is that God exists - we want to explain some features of the world, we look for things (observations) which are surprising if the theory isn't true but which aren't that surprising if the theory is true."*

Calum Miller

Calum Miller then goes on to do an analogy with fingerprints on a murder weapon, as features of the world. He then points out the observation what he believes is evidence for God.

> *"There are a number of arguments that work this way. But one of the particular pieces of evidence that we want to discuss today is that the world exhibits a real kind of regularity and there are basic laws, science works, that we can understand the world. For all we know, the universe could have been chaotic, might not have been any laws at all, we might not have been able to do science - it might have been complete chaos."*

Calum Miller

Here he's describing the form of the argument, as it might apply to the sun rising.

> *"Even more basic things that we use scientific reasoning for, but do not always strike us as scientific truth. For example,* 'the sun will rise tomorrow'. *Most of us believe that; this is a common-sense inference from our observations. On atheism there is no reason to expect that regularity, because the sun could just fail to rise tomorrow. On theism we can expect that kind of regularity because God set it in place"*

Calum Miller

Calum Miller finishes by describing further how moral responsibility hinges on this regularity, because we need to know the likely effect of my actions on others in order to make moral decisions and be responsible for them. If things were chaotic, if my actions had random effects, then moral responsibility could not work.

The problem with the math - posteriors vs likelihoods

The first problem, from a math point of view, is that he is simply comparing *part* of Bayes' rule the likelihoods (i.e. how well the explanation fits the data) without looking at how likely, a-priori, those explanations are. He compares the terms

$$\frac{P(\text{data}|\text{theism})}{P(\text{data}|\text{atheism})}$$

and says that this is greater than one, and thus theism is more likely. That is just the wrong question to ask. What we really want to look at, even keeping the same structure, is the ratio of the *posterior* probabilities, or

$$\frac{P(\text{theism}|\text{data})}{P(\text{atheism}|\text{data})}$$

which is related to the likelihood ratio through Bayes' rule:

$$\frac{P(\text{theism}|\text{data})}{P(\text{atheism}|\text{data})} = \frac{P(\text{data}|\text{theism})}{P(\text{data}|\text{atheism})} \times \frac{P(\text{theism})}{P(\text{atheism})}$$

where we factor in the *prior* probabilities. Already, we have an issue, because the prior probability for the universe with an extra agent should be smaller than one without such an agent[3]. If you factor in the agent with many specific properties, then this is smaller still. By omitting this part, you could argue for anything. For example,

[3] Recall this as a consequence of the Conjunction rule above.

$$\frac{P(\text{data}|\text{fairies})}{P(\text{data}|\text{no} - \text{fairies})} > 1$$

or, in other words, the regularity of the universe is much more likely given fairies than no-fairies, so that is evidence for the fairies. Even if true, it is clearly an uninteresting and not a useful claim.

The problem with the premise regarding theism

The next problem is that it seems that Calum Miller is trying to sneak in many more details into his theism than his argument would warrant. He needs to *define* what he means by theism to state that it is more likely to result in a regular universe. This is where the mathematics forces one to be specific and thorough, and thus highlights problems in arguments that may seem fine at their face.

For example, a number of counter examples can be made:

- Under the Greek pantheon, it is more likely that things *would be chaotic*, at the will of capricious deities - thus $P(\text{data}|\text{theism})$ would be lower than Calum Miller claims

- Gods or divine beings, such as Cthulhu, revel in chaos and thus would make it even less likely to result in a regular universe

So when Calum Miller says "theism", what he seems to mean is the existence of "order-making God(s)", but then his argument is circular: a regular universe is more likely under a regular-universe-making God hypothesis than not.

The problem with the premise regarding atheism

Further, Calum Miller never supports that it is unlikely to have an ordered universe under atheism. "For all we know, the universe could be chaotic", Calum says. However, that needs to be *demonstrated*, not asserted, or it is an argument from ignorance in disguise. It is possible, and in fact cosmology seems to be pointing more in this direction, that the universe could not be any other way - that the regularity is the result of the production of any universe, and further that the production of universes is the only stable solution. The notion of philosophical "nothing" may be physically unstable and thus unlikely to ever exist.

Calum Miller's introduction of morality to the argument adds nothing, and only serves as a red herring. Without some regularity in the universe, even thought itself would be impossible . We couldn't even have the idea of a "being", or an animal, or life without regularity. Thus, our mere existence requires regularity - but one that need not be imposed from the outside, with a God.

So, in summary, introducing the notion of a generic theism causes more problems to the argument than it solves, because it includes Zeus and Cthulhu. Circularity results when restricting the relevant theism to exclude these possibilities. Even if Calum Miller solved this, he is still answering the wrong question by ignoring the prior probabilities, and is at best achieving an uninteresting and useless result.

2.3 *Will the Sun rise tomorrow?*

Continuing with the Miller-Croft debate, Miller eventually brings up the analogy with evidence for the sun coming up as an example of knowledge claims and models. The analogy fails when we look at the details of how this evidence is calculated.

Calum Miller describes philosopher David Hume on the justification for the sun rising tomorrow, and then continues with the analogy of model building in this situation,

> *"Hume basically noted that we don't have any non-circular justification for thinking that the universe will be regular, that it will continue to be regular in the future. [...] He doesn't just say that we have to be a bit unsure that the sun will rise tomorrow, he says that we have no good reason at all for thinking the sun will rise tomorrow. The most common justification that the sun will rise tomorrow is that it has risen every day in the past. But then if you compare two theories, one says that the sun rises everyday in the past and in the future and the other theory says that the sun rises everyday in the past but won't rise tomorrow. Both those theories predict the observations we already have, both those theories lead us to expect the observations, and so the observations we currently have don't distinguish between these two theories. And yet one of those theories predicts the sun will rise tomorrow and one of them predicts that the sun won't rise tomorrow. So, even though we have those observations, they don't really do an obviously good job of determining which of these theories is true. [...] He is saying that the past observations don't give us that good reason for thinking that the sun will rise tomorrow. This is the Problem of Induction and has perplexed philosophers for centuries."*

What does Hume say?

It is instructive to note that Hume predates the mathematics of probability, and see what Hume *actually* says about the Sun rising[4],

> *" Matters of fact, which are the second objects of human reason, are not ascertained in the same manner; nor is our evidence of their truth, however great, of a like nature with the foregoing. The contrary of every matter of fact is still possible, because it can never imply a contradiction, and is conceived by the mind with the same facility and distinctness, as if ever so conformable to reality. That the sun will not rise tomorrow is no less intelligible a proposition, and implies no more contradiction, than the affirmation, that it will rise. We should in vain, therefore, attempt to demonstrate its falsehood. Were it demonstratively false, it would imply a contradiction, and could never be distinctly conceived by the mind."*

[4] David Hume. *Philosophical Essays Concerning Human Understanding*. 1748. Chapter on Cause Effect

Here Hume is essentially stating that all propositions have a nonzero probability (however small they might be) unless they are *logically* impossible. This is not saying, at all, that we have no good reason to believe the sun will rise tomorrow.

> *"The bread, which I formerly ate, nourished me: that is, a body of such sensible qualities was, at that time, endued with such secret powers; but does it follow, that other bread must also nourish me at another time, and that like sensible qualities must always be attended with like secret powers? The consequence seems nowise necessary.*[5] *"*

[5] David Hume. *Philosophical Essays Concerning Human Understanding*. 1748. Chapter on Cause Effect

Again, although Hume predates probability theory, this is essentially what he is saying - the consequence is not logically *necessary* (i.e. $P(\text{consequence}|\text{observations}) < 1$). We see this as a direct application of probability theory, a totally uncontroversial application at that.

The so-called "problem of induction" to which Calum Miller refers is not really a problem. It is a direct consequence of the mathematics of probability, and thus is the result of mathematical axioms. Hume is not claiming that there is *no* good reason to see the consequence following from the the observations, only that he is unable to find a good reason,

> *" The connection between these propositions is not intuitive. There is required a medium, which may enable the mind to draw such an inference, if indeed it be drawn by reasoning and argument. What that medium is, I must confess, passes my comprehension, and it is incumbent on those to produce it, who assert that it really exists, and is the origin of all our conclusions concerning matter of fact. "*

The medium Hume refers to is simply the mathematics of probability, something which post-dates Hume's writings. Hume was being honest that he didn't see a way, and he did not claim that there was *no possible* way - that would be an "argument from ignorance" fallacy.

What does Laplace say?

Once we have probability theory, then we can actually do some simple calculations concerning the probability of the sun rising tomorrow. Of course these calculations are not a complete description of the problem, but give the flavor of it. Laplace used the sunrise problem as an example application of his Rule of Succession, which itself is derived from the rules of probability. The calculation goes something like this.

- Our model is that the sun rises with unknown probability p
- Given complete ignorance of p we assume an initial uniform probability (all values are equivalent)
- The sun has risen every day for the written record, say, 10000 years
- the probability for rising tomorrow, which is also the mean value of p over the posterior probability, is given by the Rule of Succession[6] (also known as the "assume one success and one failure"[7]):

[6] Wikipedia. Rule of succession — Wikipedia, the free encyclopedia, 2015b. URL `http://en.wikipedia.org/wiki/Rule_of_succession`

[7] B.S. Blais. *Statistical Inference for Everyone*. printed by Createspace, http://tinyurl.com/sie-bblais, 2014

$$
\begin{aligned}
P\left(\begin{array}{l|l} \text{rise} & \text{rose today,} \\ \text{tomorrow} & \text{rose yesterday,} \\ & \ldots, \\ & \text{on day 0} \end{array}\right) &= \frac{10000\text{year} \times 365\text{day}/\text{year} + 1}{10000\text{year} \times 365\text{day}/\text{year} + 2} \\
&= 0.9999997
\end{aligned}
$$

It gets messier when you can't even assume that both a failure and a success are possible, but it can still be done without any change to the qualitative result.

Clearly we have quite good reasons to believe the that sun will rise tomorrow.

Two theories

We go back to Calum Miller's two theories:

> *" If you compare two theories, one says that the sun rises everyday in the past and in the future and the other theory says that the sun rises everyday in the past but won't rise tomorrow. Both those theories predict the observations we already have, both those theories lead us to expect the observations, and so the observations we currently have don't distinguish between these two theories. "*

The situation for arguing a high probability of tomorrow's sun rise is far more compelling, however, because our information is not simply that the sun has risen in the past, but includes observations of the patterns of the seasons, the predictions of the phases of the moon and Venus, and a whole host of other factors which significantly increase the chance the sun will rise. Laplace knew this well, and was using this example not as a serious calculation, but as a pedagogical example.

As a consequence, both of Calum Miller's so-called theories do *not* predict the observations we already have - only one of them does. Even if we accept just the observations for which both theories are consistent in the past, one has to view this two-theory perspective from the point of prediction. Imagine it's now tomorrow, and "Theory B" doesn't work - so we modify it to say the sun won't rise *tomorrow* (the new tomorrow). That next day comes with a sunrise, and this "Theory B 2.0" is wrong (again) and has to be modified (again). It is clear that "Theory B" fails, and we should be less confident in it. That's why, in science, it isn't nearly enough to be consistent with past data - one must make predictions, not just post-dictions, and test it. It is often trivial to come up with "explanations" for data we already have - especially when we can be infinitely plastic in the models we propose.

2.4 *Belief, Knowledge, and Scientific Literacy*

Concepts about belief and knowledge arose in the National Science Foundation survey on scientific literacy. The NSF had decided to change the wording of two questions in the survey. The original wording is

> *"Human beings, as we know them today, developed from earlier species of animals,"*

and

> *"The universe began with a huge explosion."*

The new wording is

> *"According to evolutionary theory, human beings, as we know them today, developed from earlier species of animals" (emphasis mine)"*

and

> *"According to astronomers, the universe began with a huge explosion." (emphasis mine)"*

It is noted that there will be a transition period with the questions, with half of the surveys containing the new questions and half the old, to determine its effect.

The stated goal for this change, from the NSF, is to separate knowledge from belief. You might *believe* that humans are created in their present form, 6000 years ago, but the new questions try to ascertain whether you know that "evolutionary theory" says something different. Is this an important distinction? Is this what we really want to measure? Which is more important for a society? What is the difference between knowledge and belief in this context?

It is quite clear that there will be at least one effect for this rewording: given that the US falls way behind other countries on science literacy, especially with these particular questions, the rewording will most likely increase these numbers with no other work done.

Since beliefs are representations of the world that we hold to be correct for the real world. . . as opposed to hopes, which are also representations of the world but not ones that we hold to be necessarily correct. Knowledge is, as we have defined, simply that collection of beliefs that we hold with such high probability or, in other words, with such confidence that we do not significantly doubt them. The belief that the sun rises in the east each morning is considered knowledge for the reason that we hold it with an extremely high probability.

The NSF defines scientific literacy as "knowing basic facts and concepts about science and having an understanding of how science works." Why is literacy important? Again, the NSF: "It [literacy] is valuable not only in keeping up with important science-related issues, but also in evaluating and assessing the validity of any type of information and participating meaningfully in the political process."

The question we must then ask is, does the new wording measure scientific literacy better than the old wording? To do this, we need to outline the four possible types of people answering the two forms of the questions:

1. people who answer "yes" to the old and "yes" to the new
2. people who answer "no" to the old and "no" to the new

3. people who answer “no” to the old and “yes” to the new
4. people who answer “yes” to the old and “no” to the new

The wording change doesn’t change cases 1 and 2, adds case 3 to the “yes” category and it introduces the erroneous case 4. The cases can be summarized in another way, like

1. people who know both that, say, the universe began with a big explosion and that astronomers claim that this is true. This is indicative of scientific literacy.
2. people who don’t know, or do not believe, that the universe began with a big explosion and that also don’t know that astronomers claim that this is true. This is indicative of scientific *illiteracy*.
3. people who don’t *believe* that the universe began with a big explosion but know that astronomers claim that this is true. (more on this below)
4. people who know that the universe began with a big explosion, but do not believe that astronomers claim that this is true. This might at first seem to be a totally unreasonable and marginal case, but we think it is more significant than perhaps is generally appreciated. These people might think that the new wording is a trick question (e.g. they might think, for example, that *physicists*, as opposed to astronomers, claim that it is true). I’ve had students answer questions in this way, so it is not quite as uncommon as one might think. These students overthink the problem: they know the fact, but are distracted by the extra complexity of the question, thinking that the test is trying to trick them.

Case 3: The Religious Believer

The only reason these particular questions were modified was because of the prevalence of religious belief. How do we know this? We don’t see a proposal to change “The Earth orbits around the Sun and takes a year to do it” to “According to astronomers, the Earth orbits around the Sun and takes a year to do it.” Why? Because no religion (now) has a stake in the answer to that question, and thus have no objection to the claim. Of course, if you go back to the days of Copernicus this was a different story and people were severely punished for too strongly making such a claim. The two questions that are proposed to be changed in this way are precisely the two concepts that crop up in every creationist tract, and are clearly the two major stumbling blocks for a literalist reading of the Bible or the Quran.

Aside from the motivation for the change, we can ask the question whether it is accomplishing something important anyway. Are these Case 3 people, who would answer “no” to the old question but “yes” to the new question, demonstrating scientific literacy? No. What they've confirmed is that they know that some scientists *claim* that the universe began with an explosion, but they don't believe it. This means that they don't accept either the data, or the methods, or both. If the question were about something on the fringes of science, then perhaps this is fine, but it isn't the case with these two questions. Evolution theory, for example, is as well established as the Round Earth theory and the Germ theory of disease. To deny it is to deny all of the *independent* work in molecular biology, embryology, ecology, etc... which support it. Even though they may know that fact that biologists support Evolution theory, they have not demonstrated any scientific literacy in terms of "evaluating and assessing the validity of any type of information and participating meaningfully in the political process." The same can be said of the Big Bang theory, to a slightly lesser degree (i.e. there isn't *quite* the volume of completely independent *fields* of study supporting it, as there is for Evolution, but the data is nearly incontrovertible anyway). To deny either idea is akin to denying the Germ theory of disease.

Imagine someone answering "no" to the question "The world is round" but answers "yes" to "According to geographers, the world is round". Would they be demonstrating scientific literacy? The difference between belief, knowledge, and the claims of others is quite apparent in this application.

2.5 *Communicating Science*

Joan Roughgarden in Beyond Belief made a very astute observation of a problem, and then proposed a lousy solution to it. The problem she was addressing had to do with the public perception of evolution as something quite uncertain scientifically ("theory vs fact"). She observed that the public sees science changing its stance on many things, especially in medicine. One day, you should eat bran. The next, bran is bad for you. The next, bran is good for you again. As a result the public observes that *some* sciences are uncertain, and can't distinguish one field from another or one type of claim from another, so they apply doubt to *all* of science even when it is not warranted by the science. Her solution involves using religious analogies, interpreting phrases in the Bible to explain things like natural selection and mutations, in order to communicate it to a group of people who share and value that vocabulary. Dawkins rightly chews her out for this approach, pointing out how far she is stretching the meaning of the phrases just to fit her philosophy.

The problem she is stating, however, is quite real. How can we expect the public to make decisions about medicine, global warming, evolution, the big bang, etc... when they (somewhat rightly, somewhat wrongly) observe that the scientists themselves are arguing about it? The Intelligent Design proponents are currently using this observation to sow doubt with the public in their efforts to "teach the controversy" of evolution to inject creationism into the schools. It is a failure of the scientists, and the media that covers them, to communicate with the public. Can we do better?

Here is a proposal, which we'll sketch out in a toy example. The problem is not the communication of facts, or even of the procedures of science. The problem is with the communication of *uncertainties* - and thus the probabilities - associated with measurement. In day-to-day life, we easily handle claims with different levels of uncertainties. The sun rises in the east each morning has low uncertainty. The claims of the auto salesman or the politician have higher uncertainty. Quantifying it is, of course, more challenging but the qualitative features of uncertainty are known to nearly everyone. So scientists and journalists really need to take efforts to communicate the uncertainty of every claim, not just the fact of the claim or how the new observations differ from the old observations. How could this be done? We think, at least roughly, one should include a plot of the probability distribution with any claim. This distribution is a graphical representation of the weights of ones beliefs over all of the possible values of the measured quantity. One doesn't need to know advanced math to see the picture. If every claim is accompanied by a plot of the uncertainties, the public will get used to reading them. Let us demonstrate with a toy example.

Say, we am trying to determine the origin year of *homo sapiens*. we realize there isn't just one year, and there is a process, but it is not much harder to include those in this simple analysis. We have several *homo sapiens* fossils where we've measured the age, allowing us to calculate our best guess of the age, and the distribution of our uncertainty shown here.

The details of this are unimportant, because the picture is pretty clear regardless of the details. A few observations are in order here:

1. Our "best guess" is around the middle of this distribution, but it really can't be interpreted as "homo sapiens originated 250,000 years ago" as it might read in a newspaper
2. there are many possible values for the origin time of *homo sapiens* that lie well outside of our data yet have non-zero probability. This means that these values could very well be the truth, and we are being up front about it.

Now, we have a new paper that adds another fossil much older than than the previous ones, around 340000 years ago. Currently,

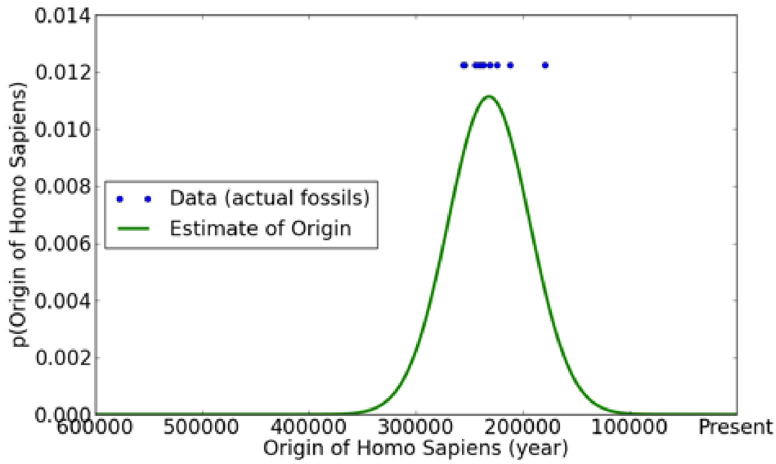


Figure 2.1: Hypothetical distribution of ages for *homo sapiens*.

newspapers often make claims like "origin of homo sapiens 150% older than originally thought", or "estimates of the origin of humans overthrown by new data". How might it look with the uncertainties plotted?

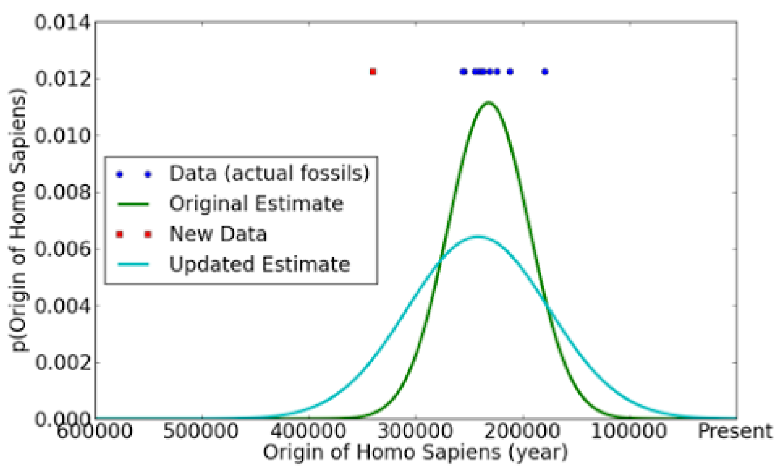


Figure 2.2: Hypothetical distribution of ages for *homo sapiens*, with one added data point.

There are a number of lessons that can be read from this.

1. the new data updates our "best estimate" by only a little - the old data, combined with the new data, are used for the estimate
2. our uncertainties have widened - by having a larger range of data, our uncertainties may have increased with new data.

In reality, estimating an origin (first event) will update a bit differently than this example shows. For example, the uncertainties in the right-half of the distribution may not be affected at all by an older observation. If this data were in medicine, however, and we were estimating the effect of some new treatment, then the update would be very similar. A single result of a strong effect may not increase our best estimate for that effect by a huge amount. The uncertainties in many medical treatments, or dietary recommendations, straddle the origin: there is significant probability for *no effect*. It would be fruitful to see the plot of uncertainties, pushed a little this way and that, updated in perhaps a wiki style by scientists as new data come in. There would be many lessons, all of which would help the public understanding of science.

1. observations rarely overturn well-supported scientific understanding
2. not all topics have equal uncertainties - doubting everything the same amount is not rational
3. certainty is never an option, but sometimes the uncertainty is so low that there is a practical certainty
4. nature itself, not authority, determines our best guess and some of our uncertainty
5. if the thing you are measuring has a small effect, then you should expect a series of measurements of the effect to change sign: bran is good, bran is bad, bran is good, etc. . . . This doesn't mean that the scientists are waffling, it only means that the effect is small and difficult to detect - and probably meaningless.

I think the public could learn to, at least qualitatively, understand and use plots like these. Perhaps there is a better way to display it that does not do violence to the truth, and I'd be open to that. we think getting in the habit of making plots like this would be good for the scientist as well, forcing them to address and communicate the actual uncertainties in their claims. When we explore specific religions topic like miracles, this sort of thinking and communication of data could be critical.

3 Faith: A Matter of Definitions

The word *faith* has many definitions, some which seem conflicting. However, as it is commonly used, the definitions point to a single quantity. It is easiest to see this in the exploration of faith from specific examples.

3.1 Introduction to Faith and Probability

Statements about Faith

It may be helpful to start with the dictionary definition, and then follow with a number of statements about *faith* to see where the common usages fall.

- faith (noun)[1]
  - strong belief or trust in someone or something
  - belief in the existence of God
  - strong religious feelings or beliefs
  - a system of religious beliefs
- Now faith is confidence in what we hope for and assurance about what we do not see. [2]
- Faith is trusting in, holding to, and acting on what one has good reason to believe is true in the face of difficulties. The difficulties may be where you have to take an action where the outcome is beyond your control. (Tim McGrew)[3]
- Belief without evidence. Pretending to know things you do not know. (Peter Boghossian)[4]
- One of the things that becomes apparent in serious Christian literature is that no one uses 'faith' in the sense of *believing things without reasons*. That might be Richard Dawkins' preferred definition - except when he was publicly asked by Oxford's Professor John Lennox whether he had 'faith' in his lovely wife - but it is important to know that in theology 'faith' always means

[1] Merriam-Webster Online. Merriam-Webster Online Dictionary, 2009. URL http://www.merriam-webster.com

[2] Hebrews 11:1, New International Version

[3] Justin Brierley. Peter Boghossian vs Tim McGrew - a manual for creating atheists. Podcast, May 2014a. URL http://tinyurl.com/ogurmpm

[4] Justin Brierley. Peter Boghossian vs Tim McGrew - a manual for creating atheists. Podcast, May 2014a. URL http://tinyurl.com/ogurmpm

> *personal trust* in the God whose existence one accepts on other grounds. I think God is real for philosophical, historical, and experiential reasons. Only on the basis of my reasoned conviction can I then *trust* God - have faith in him - in the sense meant in theology.[http://mobile.abc.net.au/news/2014-04-18/dickson-tips-for-atheists/5397892][empasis in original]

From these few definitions, we can already see a few things. First, people use the term in different ways, at different times, so it will be critical that we tack down a particular definition. It is also critical to recognize which definition someone is using, so we don't inadvertently straw-man their argument. Second, the two primary components that seem to make up all definitions of faith are *belief* and *trust*. Faith seems to not be a synonym of either, but a particular combination of them with some restrictions - not all beliefs or acts of trust require faith.

Belief, Trust, and Faith

We have already seen that *belief* is represented mathematically by *probability*, so where *faith* requires belief we will employ probabilities. *Trust*[5] is "belief that someone or something is reliable, good, honest, effective, etc." So it would seem that trust is a subset of belief, like knowledge is a subset, pertaining specifically to the reliability or goodness of the thing believed.

[5] Merriam-Webster Online. Merriam-Webster Online Dictionary, 2009. URL http://www.merriam-webster.com

Faith, however, seems to go a bit further than trust and involve *action* or the willingness to act. When asked by Peter Boghossian, *"why don't we say that we have faith in the existence of chickens?"*, Tim McGrew replies,

> *"We are venturing nothing on the existence of chickens. When I believe that chickens exist and I act on that belief I am not taking any step that places outcomes I care about beyond my direct control. [In the case of religion], people are placing the outcome of their eternal soul out of their control. They are taking a risk where the outcomes matter. The decision itself is evidenced but the outcome is uncertain."*

Utility - Probability and Action

Probability relates to belief, a measure of state of knowledge about a claim or set of claims. We can use the mathematics of probability to determine the most likely claim, and use it to inform our actions, but it isn't enough to truly determine the best course of action. For that, we need to extend the mathematics to include the notion of *utility*, an extension commonly referred to as *decision theory*. Because faith seems to involve action or potential actions, it to will need to be formulated in this way.

Decision theory uses the idea of expected value to aid in making decisions, defined as[6]

> The idea of expected value is that, when faced with a number of actions, each of which could give rise to more than one possible outcome with different probabilities, the rational procedure is to identify all possible outcomes, determine their values (positive or negative) and the probabilities that will result from each course of action, and multiply the two to give an expected value. The action to be chosen should be the one that gives rise to the highest total expected value.

[6] Wikipedia. Decision theory — Wikipedia, the free encyclopedia, 2015a. URL http://en.wikipedia.org/wiki/Decision_theory

The utility values, costs and benefits, could be written in monetary terms, but need not. One needs only to have a scale to represent how good or bad an outcome is. The total expected value, also called the average utility, is just the sum of the individual costs and benefits associated with possible outcomes, weighted by their probability - more likely outcomes are weighted more than less likely ones. An example will help.

The example here is called the "farmer's dilemma"[7], concerns a farmer who can plant one of three crops (labeled A, B, and C) with the possibility of three different environments out of the farmer's control, *perfect weather*, *fair weather*, and *bad weather*. Each of the three crops fare differently in different weather, and thus provide different costs and benefits to the farmer depending on the environment. Crop A, for example, does very well in good weather but very badly in bad, whereas crop C doesn't do as well but is more consistent, with crop B in between. This can be summarized by the following table of utilities showing benefits (positive) and costs (negative) for each possible combination:

[7] Ian Jordaan. *Decisions under uncertainty: probabilistic analysis for engineering decisions*. Cambridge University Press, 2005

Utility (benefits and costs)			
	perfect weather	*fair weather*	*bad weather*
plant crop A	11	1	-3
plant crop B	7	5	0
plant crop C	2	2	2

Any decision the farmer makes must include the probabilities (his state of knowledge) of the weather environments. At the extremes, it is easy to see this. If perfect weather is nearly guaranteed, for example, then planting crop A is of course the best option, whereas if bad weather is guaranteed, then planting crop C is the best. How does one handle the decision away from the extremes? This is done by asking, what is the average utility (benefit or cost) for each action, and then choosing the action which maximizes this. Imagine that the farmer consults a meteorologist, and they determine the following probabilities for the weather environment

It is possible in some cases that the environmental state also depends on the actions taken. This is easy to add to this framework, but makes this particular example needlessly complex.

$$P\left(\text{perfect weather}\right) = 0.1$$

$$\begin{aligned} P\,(\text{fair weather}) &= 0.5 \\ P\,(\text{bad weather}) &= 0.4 \end{aligned}$$

The average utility for each action is simply the sum of the probabilities of each environment times the utility for that environment given the action, such as

Average, or expected, value of a variable U is denoted with angle brackets, $\langle U \rangle$

$$\begin{aligned} \langle U_A \rangle &= P\,(\text{perfect weather}) \times \text{U}(\text{perfect weather}|\text{plant crop } A) + \\ & \quad P\,(\text{fair weather}) \times \text{U}(\text{fair weather}|\text{plant crop } A) + \\ & \quad P\,(\text{fair weather}) \times \text{U}(\text{bad weather}|\text{plant crop } A) \\ &= 0.1 \times 11 + 0.5 \times 1 + 0.4 \times (-3) = 0.4 \end{aligned}$$

Performing the same calculation for all of the actions yields,

$$\begin{aligned} \langle U_A \rangle &= 0.1 \times 11 + 0.5 \times 1 + 0.4 \times (-3) = 0.4 \\ \langle U_B \rangle &= 0.1 \times 7 + 0.5 \times 5 + 0.4 \times 0 = 3.2 \\ \langle U_C \rangle &= 0.1 \times 2 + 0.5 \times 2 + 0.4 \times 2 = 2.0 \end{aligned}$$

and the best action would be planting crop B, because it has the highest expected utility.

The primary point about this process that is relevant to our discussion of faith is that the process involves two separate entities - the probability of various states and the value those states are to us given our actions. This maps directly to the concepts of *belief* and *trust*, respectively. One can focus on each one individually, but it is the combination that is important.

Although there are cases where the average utility is a bad guide, it is a very useful framework to structure a problem. It should be noted that *utility* does not need to be restricted to money, but can include things like comfort and discomfort. For example, someone could be *risk averse*, which means that they put a utility on some psychological comfort at the expense of some monetary loss. Thus the utility value would combine both.

3.2 *Rollercoasters: Faith in Everyday Life*

Words have meaning, and if we are going to communicate with each other we need to make sure to use words as carefully as we can. Otherwise, misunderstandings abound. It seems very common that a word like "faith" is used by different people for different ends, and the definition shifts even within an argument. Take for example, the video by Rich Spear[8]. In it, Spear presents a distinction drawn between "faith" and "belief", using an analogy of a roller-coaster -

[8] Rich Spear. Reason blog - isn't faith blind?, 2013. URL https://www.youtube.com/watch?v=UH8np-WBa_o

belief in the ride being safe vs trusting it being safe enough to ride on. Notice that his focus is on trust, and thus on *action*.

It is clear that one must *at least* believe the ride is safe as a prerequisite for trusting it. Since when we say we believe *strongly* in a proposition A when $P(A) > 0.95$ (or some other, somewhat arbitrary, high number), we can map this prerequisite to something like the following

$$P(\text{safe}) = 0.99$$
$$P(\text{unsafe}) = 0.01$$

Once you believe it is safe, do you trust it to ride? This brings in decision theory, where we mix probabilities with utility measures. You could believe it to be safe at the $P(\text{safe}) = 0.99$ level, but still not trust it "with your life" because of the *cost* associated with being wrong. A utility table might look like

	Utility (benefits and costs)	
	safe	*unsafe*
ride	10	-1000
don't ride	0	0

Calculating the average utility for each action we get

$$\begin{aligned} \langle U_{\text{ride}} \rangle &= 0.99 \times 10 + 0.01 \times (-1000) = -0.1 \\ \langle U_{\text{don't ride}} \rangle &= 0.99 \times 0 + 0.01 \times 0 = 0 \end{aligned}$$

so it is better not to ride.

As a result, *trust* requires both belief and a sufficiently positive net utility. Placed in these terms it is much more clear how the argument is set up.

- when the Spear says that "faith" is like "trust", he is already approaching the problem with strong belief, and is assessing utility - and he rightly claims that belief is not enough.
- when the atheists say that "faith" is "belief without evidence", they are addressing the strength of the evidence to obtain strong belief in the first place - and claiming that the evidence is not sufficient.
- when the Spear and others say that "faith is rational" they are either talking about utility, not belief, or they are claiming that the evidence is in fact good enough for strong belief, and then consequently high utility.

In all cases, it seems as if for the religious, utility and belief are muddled when using the word "faith". For the atheist, "faith" is always first and foremost about belief, because even the usage involving trust has belief as a prerequisite. Perhaps if we frame the problem in terms of belief (probability) and utility we can clear up the fog surrounding discussions of the term *faith*.

3.3 Faith and Trust

We see the same structure occurring in an "*Unbelievable*" podcast[9] between theist Tim McGrew and Peter Boghossian. Because they were not thinking in terms of the framework presented here, they talked past each other through most of the episode. In this discussion, Boghossian insists that faith is "belief without evidence" or "pretending to know things you do not know", and Tim McGrew insists that faith is more like trust. The discussion then devolved into a back and forth with both sides claiming that "all the people I know use my definition", and was generally unproductive. It is clear, however, that in the expected utility equation,

[9] Justin Brierley. Peter Boghossian vs Tim McGrew - a manual for creating atheists. Podcast, May 2014a. URL http://tinyurl.com/ogurmpm

$$\begin{aligned}\langle U_{\text{action } A}\rangle &= P(\text{outcome 1}) \times U(\text{outcome 1}|\text{action } A) + \\ & P(\text{outcome 2}) \times U(\text{outcome 2}|\text{action } A) + \\ & \vdots\end{aligned}$$

Boghossian is focusing on the probabilities ($P(\text{outcome 1})$, $P(\text{outcome 2})$, etc...) and McGrew is focussing on the utilities ($U(\text{outcome 1}|\text{action } A)$, $U(\text{outcome 2}|\text{action } A)$, etc...)

The Discussion

McGrew says that very few Christians (less than 1%) would use Boghossian's definition of faith, "pretending to know things you do not know". We agree that no Christian would *articulate* this definition of faith, however they may be *functionally* using it, which we will address later.

McGrew opens with

> *"Faith is trusting in, holding to, and acting on what one has good reason to believe is true in the face of difficulties. The difficulties may be where you have to take an action where the outcome is beyond your control."*

The example he gives is jumping out of an airplane, where one has faith in ones instructor to have packed your parachute properly. Ones act of jumping draws the distinction between faith and *hope* (if you just *hoped* your instructor packed it, you wouldn't jump), and the decision is made in the face of evidence, not despite it or without it.

Boghossian's general strategy is to ask a series of questions, to try to highlight the critical points. For example, we get the following exchange:

- Boghossian: *"what do people mean when they accuse someone of having 'faith in evolution' "*?
- McGrew: *"You're trusting in something that you cannot completely verify because it doesn't lie open to your senses."*
- Boghossian: *"what do people mean when they say 'I don't have enough faith to be an atheist' "*?
- McGrew: *"They have belief in something in the face of certain difficulties, where the weight of the difficulties is greater on one side compared to the other."*
- Boghossian: *"Why don't we say that we have faith in the existence of chickens?"*
- McGrew: *"We are venturing nothing on the existence of chickens. When I believe that chickens exist and I act on that belief I am not taking any step that places outcomes I care about beyond my direct control. [In the case of religion], people are placing the outcome of their eternal soul out of their control. They are taking a risk where the outcomes matter. The decision itself is evidenced but the outcome is uncertain."*
- Boghossian: *"Do you have faith or evidence that Islam is false?"*
- McGrew: *"Why would I use the word 'faith' when I am venturing nothing on Islam? I am a little bit confused about the framing of the question that way. I think I have evidence that it is false, but since I am not venturing on Islam, I'm not sure why the word faith would come in."*

Addressing the Definitions

Clearly claims using expected utility require that probability assignments have already been made, so claims of utility must necessarily be probability claims as well. When translated into these more precise terms, both McGrew's and Boghossian's claims begin to make more sense. It will also show that McGrew is in fact using the Boghossian's definition, in some cases even while denying it.

> You have faith that your instructor packed your parachute, as opposed to Peter packing it. Your act of jumping makes faith more than simply hope (if you just hoped your instructor packed it, you wouldn't jump), and the decision is made in the face of evidence, not despite it or without it.
>
> The equations are:
>
> $$\begin{aligned}\langle U_{\text{jump}}\rangle &= P\left(\text{instructor packed}\right)\times U\left(\text{instructor packed}|\text{jump}\right)+\\ &\quad P\left(\text{Peter packed}\right)\times U\left(\text{Peter packed}|\text{jump}\right)\end{aligned}$$

$$\begin{aligned}\langle U_{\text{don't jump}}\rangle &= P\left(\text{instructor packed}\right) \times U\left(\text{instructor packed}|\text{don't jump}\right) + \\ &\quad P\left(\text{Peter packed}\right) \times U\left(\text{Peter packed}|\text{don't jump}\right)\end{aligned}$$

with a possible utility table

	Utility (benefits and costs)	
	Who packed the parachute?	
	Instructor	*Peter*
jump	100	-10000
don't jump	0	0

For this analysis to work, we would have at least,

- $P\left(\text{instructor packed}\right) \sim 1$: one is nearly certain the instructor packed the parachute
- $P\left(\text{Peter packed}\right) \sim 0$: one is nearly certain that Peter *didn't* pack the parachute
- $U\left(\text{instructor packed}|\text{jump}\right) \gg 1$: good benefit from jumping, with instructor packing the parachute
- $U\left(\text{Peter packed}|\text{jump}\right) \ll 0$: large cost from jumping, with Peter packing the parachute
- $U\left(\text{Peter packed}|\text{don't jump}\right) = U\left(\text{instructor packed}|\text{don't jump}\right) \sim 0$: neutral gain for not jumping in either case

Analyzing the Responses

Notice, for McGrew to have "faith in his instructor", two things must be true:

1. $P\left(\text{instructor packed}\right) \sim 1$: one is nearly certain the instructor packed the parachute
2. $U\left(\text{instructor packed}|\text{jump}\right) \gg 1$: good benefit from jumping, with instructor packing the parachute

McGrew wants to focus on point (2), while Boghossian wants to focus on point (1). Once seen this way, it is very easy to understand the responses.

For example, why don't we say that we have faith in the existence of chickens? Because,

$$U\left(\text{chickens exist}|\text{action}\right) \sim U\left(\text{chickens don't exist}|\text{action}\right) \sim 0$$

for all actions - we have nothing at stake, there is no utility, even if we are confident that chickens exist (i.e. $P(\text{chickens exist}) \sim 1$).

Does McGrew have have faith or evidence that Islam is false? McGrew claims he has evidence that Islam is false, $P(\text{Islam}|\text{data}) \ll 1$, but is not venturing anything on Islam (or more accurately, on his choice to not follow Islam), $U(\text{not-Islam}|\text{action}) \sim 0$. Again, Boghossian sees the first part (the probabilities), yet ignores the second part (the utilities).

Going back to the exchange, we note, however, that sometimes McGrew is also using Boghossian's definition:

- Boghossian: *"what do people mean when they accuse someone of having 'faith in evolution' "*?
- McGrew: *"You're trusting in something that you cannot completely verify because it doesn't lie open to your senses."*

Now I can think of no way to understand this statement from the perspective of McGrew's definition:

> *"When I act on that belief I am taking some step that places outcomes I care about beyond my direct control."*

What outcomes are you placing beyond your control believing in evolution? What obvious utility are you weighing in this case? As far as we can see there is none, and so *faith* in this context is in fact being used here as "belief without sufficient evidence".

Priors and Faith

We think this brings in another aspect of faith, which we believe applies to all of the cases explored so far, and that is that faith is used only in contexts with low *prior* probability. In this conversation, they spoke of faith in the context of the supernatural, extreme activities (i.e. jumping out of planes), events beyond our immediate senses - all of which coincide with lower *prior* probability, and need *more* evidence than is typical to overcome them. They may, or may not, also have high utility. We don't have faith in the existence of chickens because the existence of chickens has high *prior* probability.

Because of this, it makes sense that there are those who are not convinced by the evidence for things others have *faith* in, because of the necessary quantity and quality to bring a low *prior* probability up to a significant *posterior* probability. For those who are convinced by the evidence, it also makes sense that they would then focus on the *utility* of the claims. The problem that arises, however, is a problem with the word *faith*. Since it is referring to two distinct components, the apologist can easily switch between them without even noticing it themselves. Again, we put forward the suggestion to discuss things in terms of decision theory and avoid words with multiple meanings.

Without Evidence

Although a bit shorter and punchier, the term "belief without evidence" is misleading, even if you know you are focussing on the probability side of the analysis. The more honest phrase would be "belief without *sufficient* evidence". When people say there is no evidence for something (like God, UFOs, astrology, psychic phenomena, etc...), they really mean that there is terrible evidence for something. Even in the case of something so poorly supported as astrology, there is *some* evidence for its claims - the probability is not zero. It may be very small, but one could imagine evidence in principle that would convince you, which means that the probability is indeed non-zero. The exaggerated, more simple, phrase of "belief without evidence" is counterproductive, especially when the more accurate phrase, "belief without *sufficient* evidence", is nearly as simple.

3.4 *Does Science Have Faith?*

In his talk, "Life: Creation or Evolution"[10], Ken Miller makes the point that science should inform faith and faith should inform science. He cites Paul Davies, a physicist who has an interest in theism, and whose article "Taking Science on Faith"[11] takes the position that science itself is a faith-based activity. Ken Miller points out, and one can confirm in Paul Davies' article, that there are two tenets in science that are taken on faith:

[10] Kenneth Miller. Life: Creation or Evolution? In *James Gregory public lectures on science and religion*, 2009. URL https://www.youtube.com/watch?v=Sf9do_KDGh8

[11] Paul Davies and Ariz Tempe. Taking science on faith. *New York Times*, 2007

1. the universe is ultimately knowable and understandable

2. knowledge is better than ignorance

These concepts, however, are fundamentally different than faith, or even axioms. Even here, it is plain that the claims are referring to the *belief* part of faith, and not the *trust* part of faith. The entire phrase "taken on faith" is a signal to the listener that this is so.

The first idea, that the universe is knowable, needs to be a bit more specific: what does it mean to be *knowable*? Prior to 1900, it was believed that the pieces of a physical model, such as the force of gravity, or the electric and magnetic fields of Maxwell were "real": there was one-to-one correspondence between the model components and things in the real world. Thus, it was believed, that knowing the model you would know nature. After 1900, with the advent of quantum mechanics, physical models were evaluated based on their predictive value: those models that predicted well were good models. It was not believed that there was necessarily a correspondence between the model components and the real components in nature.

Aspects of the model, such as the wave function in quantum mechanics, were not believed to be real but simply useful in making predictions. To know the world is to be able to predict what would happen.

Let's say we replace "understandable" with "predictable", a replacement which we think makes practical sense (how else would you determine that you understand something?), and is directly in line with modern physical thinking. Doing this, then tenet (1) ceases to be an axiom, or something we take without sufficient evidence ("on faith"), but is observable. If the universe is unpredictable, then all attempts at making prediction will fail. This is not what we observe at all. Surely there are still things that are unpredictable, such as the simultaneous value of the position and momentum of the electron, or the positions of every molecule of air in this room, but even there we can make specific predictions about average quantities or the values of other variables of interest. Practically, the universe has demonstrated itself to be understandable, on the whole. This is not a matter of faith.

The second tenet (2) I would wager is too vague. What does "better" mean? Better for whom, or for what? Psychologically, one might argue something akin to "ignorance is bliss", and there might be something to that. If we define, however, "better" to be higher standard of living (longer, healthier, more free life) then knowledge can be argued to have a demonstrable benefit over ignorance. The results of science has doubled the life expectancy in the past 100 years, and has allowed us to live more free and healthy lives. As Carl Sagan says, science delivers the goods. Is there any convincing argument that ignorance is better, or that we really can't decide which is better?

There is a danger in using the word *faith* in these contexts. It can communicate to the unaware that there are things that one should justifiably believe on insufficient evidence - a direct violation of the laws of probability. It can also imply, for those who take *faith* to mean *trust*, that the scientists using the term are somehow admitting an agency in the universe that they don't intend. It serves only to propagate sloppy thinking in both the fields of science and religion.

3.5 Another Interaction - McGrath and Dawkins

As part of the "Root of All Evil" program, Richard Dawkins conducted many interviews with theists. One in particular, with the theologian Alister McGrath, deals with the notion of faith[12]. They start with a discussion about the term *faith*, and McGrath says

> *" We're dealing with a different situation than, for example, evidence that the moon orbits the earth at a certain distance "*

[12] Richard Dawkins and Alister McGrath. Richard Dawkins vs Alister McGrath. URL https://www.youtube.com/watch?v=vt95KHe6hUU

and

" There are many possible ways of explaining [the world], and we have to make the very difficult judgement of which is the best of these [explanations]... evidence takes us thus far, but then when it comes to deciding between a number of competing explanations, it is extremely difficult to make an evidence-driven argument. "

and

" I believe faith is rational, in the sense that it tries to make the best possible sense of things... even though we believe this is the best possible sense of things, we cannot prove *this is the case... there is a point where [faith] goes* beyond *the evidence "*

By this point, the reader should be able to tell that McGrath is employing the *belief* part of the expected utility form of *faith*. One wonders in these cases why he doesn't simply talk about evidence, and the weight of probabilities? Historians, for example, don't use the word *faith* even though they deal with probabilities, some of which are highly uncertain. Scientists all the time deal with probabilities, without invoking the word *faith* in any paper.

Further, McGrath ignores the fact that there already is a proper and rational method to address the "decision between a number of competing explanations", that *doesn't* go beyond the evidence, and doesn't claim more knowledge than is justified. What is this method? It's called the mathematics of probability! So, McGrath is claiming there is a problem that faith solves, which is not a problem at all, and he is using the word faith (at the moment) as synonymous with probability.

Why is he doing this? It seems as if it is because McGrath is holding to a double standard, and shifts the definitions of concepts around whenever pressed. He doesn't like the notion of believing strongly without sufficient evidence (which, as we've seen, is one use of the word faith), so he defines it (at the moment) to be equivalent to probabilities.

Inference to the Best Explanation

Then McGrath continues to talk about probabilistic reasoning, and says that with faith one is doing *inference to the best explanation*, given a number of competing multiple explanations. As we stated earlier, if all he means is that faith is probabilistic reasoning, then we don't have an argument - except that we think he can make things more clear. We would contend, along with Dawkins, the *vast* majority of people do not take it to mean this - even the notion of *faith* as *trust* isn't the same as this.

However, we'd like to challenge his basic premise: that in dealing with multiple competing explanations that one should try to "infer to the best explanation", and *believe strongly in that explanation*. A simple example introduced in Section 2.1 on page 27, suffices to see this. In this example, we have two explanations of the number of stars, one which says that there is an *even* number of stars and another that says that there is an *odd* number of stars. Pretty much we know that, at any given instant, one of these *must* be true. However strong belief in either one is completely unwarranted - there is simply no way to know. From a probabilistic framework, we express this as

$$P(\text{odd}) = 0.5 \tag{3.1}$$
$$\tag{3.2}$$
$$P(\text{even}) = 0.5 \tag{3.3}$$

However, it is worse than that. Let's say we had a smidgen of evidence toward the even-star model, such that we had:

$$P(\text{odd}) = 0.499995 \tag{3.4}$$
$$\tag{3.5}$$
$$P(\text{even}) = 0.500005 \tag{3.6}$$

Even though there is a *best* explanation here (*even* is slightly more probable than *odd*), and we have the exact probabilities, it is *still irrational* to hold strong belief in either explanation. One really does have to look where the weight of the probabilities lay. Inference to the best explanation fails as a guiding principle in the face of uncertainty, and is not well defined in all contexts.

What is happening here is that on the face of it, "inference to the best explanation" sounds like a great thing - something we should always strive for. However, when you look at what it *actually* means, it falls short unless you are in a situation where the best explanation is also very probable. Belief is only justified when the claim is very probable, not just that is is the most probable amongst a number of (possibly nearly equivalent) alternatives.

Shifting Sands

One of the benefits of seeing these arguments in the light of the framework of probability is that it makes one sensitive to shifting definitions. We saw that earlier in Section 3.3 where Tim McGrew changes his usage of the term *faith* depending on the response. Here, McGrath does the same thing.

First it was "faith is reasonable", based on evidence, going beyond the evidence to the "inference to the best explanation" and that as a result one can have a reasonable faith in God. Then, when asked about his belief in a creator, and the evidence for it, despite having difficulty with the implied complexity of such a creator, he says

> *" I want to go back to CS Lewis who says I believe in Christianity as I believe the Sun has risen, not simply because I see **it** by **by it** I see everything else. Belief in God gives you a way of seeing the world that makes an awful lot of sense of it. "*

When pressed on what this implies, he says that

> *"there are many reasons I believe in God and that [origins] is not even the primary one...religion really isn't much about where things came from, about things in the distant past, but really about how things are now. How to live your life, how to be moral, etc... "*

which then becomes

> *"the key reason for believing God is Jesus, that there is something [in the Jesus story] that needs explanation. "*

and then, this becomes that it is not really about the life of Jesus, and his historicity, but how he was perceived by his followers - the significance they saw in the life and teaching of Jesus.

Notice how this keeps shifting? At first, it is about belief, and then it is about significance (which one could argue is a kind of utility). Every time he gets pushed on the specific consequences of his statement, he retreats, redefines, and redirects the conversation.

He doesn't seem to realize that any explanation, even of things currently, entails assumptions that can be tested - perhaps with observations about the past. He can't simply say that religion is "not about where things came from", when they explicitly make statements of origins - statements which have been universally discredited. The atonement, for example, *does* depend critically on the existence of Jesus, the existence the "Fall", and a creator of the universe - for none of which did McGrath provide evidence. If Jesus didn't exist as a real person (or even if he was just an ordinary guy) then it doesn't matter that his followers simply *believed* that Jesus was God incarnate when determining ones belief in the doctrine of salvation. The demonstration of the historicity of the events claimed is *necessary* for the doctrinal belief. If you don't have strong evidence of the former, then you are not rational to believe strongly in the latter - you'd be claiming to know things you could not know.

As a scientist, one takes an idea, and pushes the idea to it furthest consequences to see where it breaks, or to see what it depends on. McGrath seems to change the topic whenever this is done - he does not seem to want to face the very real, specific consequences of his stated beliefs and refuses to see the connections between the things that may be confirmable (apparent design in the biology and the universe itself, historicity of people and events, alleged miracle claims, etc. . .) and the things that make him feel good, but are unmeasurable (existence of heaven, the atonement of sins, etc. . .).

3.6 I don't have enough faith to be an atheist

In their book *I don't have enough faith to be an atheist*[13], Norman Geisler and Frank Turek are playing with the word *faith* to make a humorous title. In their book, however, they too exhibit the dual-usage of the word **faith** as in *belief* and as in *expected utility*.

[13] Norman L Geisler and Frank Turek. *I Don't Have Enough Faith to Be an Atheist*. Crossway, 2004

[MUCH MORE TO DO HERE]

3.7 Pascal's Wager

Blaise Pascal, a French philosopher, put forward an argument referred to now as "Pascal's Wager"[14] for the religious life . The argument is based on decision theory, and is one of the first uses of this theory on any topic. In the "Wager", Pascal states that people choose to believe or not believe in God, and the possible environments they find themselves in are the God either exists or doesn't. He then sets up the utility table,

[14] Wikipedia. Pascal's Wager — Wikipedia, the free encyclopedia, 2015c. URL http://en.wikipedia.org/wiki/Pascal%27s_Wager

	Utility (benefits and costs)	
	God Exists	*God Does Not Exist*
Believe in God	$+\infty$ (infinite gain)	-1 (finite loss)
Don't Believe in God	$-\infty$ (infinite loss)	+1 (finite gain)

It is clear then that the best course of action, given this utility table, is to believe. There are many problems with this argument, some which impact the mathematics and others that are theological. An example of the former is the analysis assumes only one possible God - what if you choose the wrong God? Extending the table to include this would make the "best choice" not as clear cut. An example of the latter is the idea that one cannot simple *choose* to believe, and the act of pretending to believe would go against the dictates of God.

Pascal's Wager is, however, a useful starting point for a discussion and highlights some of the issues one faces when applying decision theory too simplistically.

3.8 A More Formal Exploration

In the philosophical literature, there are more formal explorations of these concepts. These explorations can be helped by casting the ideas into the probabilistic framework. For example, Daniel Howard-Snyder considers what he calls "Propositional Faith"[15]. He immediately recognizes, as we do here, that the word *faith* has many usages which he clears away as being not on topic, and focuses on the use of faith in a sentence like *"A wife might have faith that her marriage will survive a crisis"* or *"Frances has faith that her young songs will live long and fulfilling lives."* Each of these cases has the sentence structure of "*A* has *faith that B*". In his clearing of other uses, Howard-Snyder removes the following usages,

[15] Daniel Howard-Snyder. Propositional faith: What it is and what it is not. 2013

- Faith as a noun (e.g. "earnestly content for *the faith*")
- Faith as a process (e.g. the process of coming to believe the Gospel as a result of the Holy Spirit)
- Taking something *on faith* (i.e. taking on authority or testimony)
- Faith as assent to a proposition with certainty
- Faith as a kind of knowledge

It is interesting to see what Howard-Snyder considers propositional faith, and some of the considerations around it. We believe he is still using the term inconsistently, in two ways - one which matches the structure we've been exploring in this book, and the other as a direct synonym for *hope*. Consider the following case from his paper.

> *"Propositional faith does not require 'certainty', without any hesitation or hanging back. A wife might have faith that her marriage will survive a crisis, while harboring doubts about it. Indeed, propositional faith is precisely that attitude in virtue of which she might possess the inner stability and impetus that enables her to contribute to the realization of that state of affairs, despite her lack of certainty."*

This case matches decision theory quite nicely. The equations are:

$$\begin{aligned}
\langle U_{\text{action}} \rangle &= P\left(\text{successful marriage}|\text{action}\right) \times U\left(\text{successful marriage}|\text{action}\right) + \\
&\quad P\left(\text{failed marriage}|\text{action}\right) \times U\left(\text{failed marriage}|\text{action}\right) \\
\langle U_{\text{inaction}} \rangle &= P\left(\text{successful marriage}|\text{inaction}\right) \times U\left(\text{successful marriage}|\text{inaction}\right) + \\
&\quad P\left(\text{failed marriage}|\text{inaction}\right) \times U\left(\text{failed marriage}|\text{inaction}\right)
\end{aligned}$$

where the probabilities of the outcomes, as well as the utilities, clearly change with the the possible actions. For example, we expect action to have a positive effect on the probability of a successful marriage, $P\left(\text{successful marriage}|\text{action}\right) > P\left(\text{successful marriage}|\text{inaction}\right)$.

A possible utility table, which reflects the idea that, if the marriage is successful without action then there was time and resources saved, but if the marriage failed without action there is a penalty in the form of guilt over lost opportunity. Obviously there are many complications that this table overlooks, and should be seen as a basic approximation.

Utility (benefits and costs)		
	How is the marriage?	
	successful marriage	*failed marriage*
action	90	-100
inaction	100	-110

The high positive utility that the wife puts on her successful marriage, and high negative utility to its failure, directs her to make actions in her marriage's favor despite having lower probability of its success. This is the notion of *faith* worked out.

Another case is

> *"But one can have faith that something is thus-and-so without entrusting one's welfare to it in any way, as when I have faith that Emily will survive breast cancer but I do not entrust my well-being to her or her survival"*

where as far as we can see, the use of *faith* here is completely indistinguishable from *hope*. There is no utility explicit in the statement, and the probability is presumed to be low.

4 *Considering Miracles*

This chapter explores the concept of *miracles*, and how probability can be used to describe them and their evidential support. We defer a discussion of Christianity's foundational miracle, the Resurrection of Jesus, to Chapter 5

4.1 *How to Approach Miracles*

I listened to a recent interview (Part 2) with Matthew Ferguson on the Don Johnson show, which I found pretty impressive. Matthew Ferguson has a very interesting blog that I just found, and have been enjoying reading.

Initial Comments

However, I did find several points in the informal debate that I thought could be handled better (from my armchair, of course!). Just to note that although I think that if I were there, I might have been able to deal with some of the questions better, I also think that nearly all of the debate was handled much better than I could have done. What struck me at one point, in Part 2, was Don's zeal for the miracles collection by Craig Keener (review of Keener's book here). He seemed to think that because there were hundreds of thousands of miracle reports, that that was evidence for their truth. He was, however, quick to dismiss any comparison with other pseudosciences. Ferguson admits on his blog that the "debate came off as a little ambushy" on this point, because he hadn't read this book, and clearly couldn't respond to all of them, but I think that misses the point. I think one can address the miracle claims without being entirely dismissive (and sounding closed minded) but putting them in their proper context.

Evaluating Miracle Claims - Some Lessons from UFOs

So in Keener's book, there is a **huge** collection of claims of miracles. We could find an equally large collection of UFO sightings. Now, Don and other Christians would be quick to dismiss UFO sightings as irrelevant, but I would raise the questions:

- Given a set of claims, how do we determine whether they are true?
- Are any of them true?
- Do the number of claims contribute to their truth value?

I believe that the methods we use to determine the veracity of UFO claims can be used to investigate any claims, remarkable or not, including miracle claims. To start, we clearly we can't personally investigate every single claim, and thus cannot comment on ones we haven't investigated except to note where it seems similar to ones that we have. I have a friend who I managed (over several years) to break of his UFO enthusiasm - he was convinced by all of these television shows claiming evidence for alien spacecraft observations and visitations. He invited me over to his house periodically to watch these shows to get my reaction. This is the process that I would use:

1. I would write down each specific claim - what was *actually* being claimed, and what details were there? (names of places, time, who saw what, etc. . .)
2. I would note any initial inconsistencies (for example, there was once where, in the interview process, the different witnesses actually described *different* things! this seemed to go unnoticed by the reporter)
3. I would go home, and try to find out as much about the *original* details of the events. It would take me probably at least an hour for each case, and some I couldn't track down. However, many of them I could. I would read the claims again, and the skeptical accounts, and the responses to the skeptics. I would try to see what the actual data was, how it was collected, when it was reported, etc. . .

What I found for *every* case that I personally investigated was the following:

1. Most of the *actual*, original claims were mundane. Lights in the sky, marks on the ground, etc. . . . No hard evidence of anything remarkable.
2. Misinterpretation of a known object, or objects, in the sky or on the ground.
3. The reporting of the claims grew more and more remarkable. A particularly good example was the Rendelsham Forest UFO case where the initial reports were just lights, and the later reports involved spacecraft, alien code-books, etc. . .

4. There were serious inconsistencies between reports, or anomalous non-reports (i.e. people who *should* have seen something but didn't). A good example of this was a Chicago airport sighting where a small group of people, in a localized area of the airport, saw something yet the large number of other people in the nearby areas of the airport reported nothing.

I repeat - in *every single case* that I personally investigated, these points were in evidence. Then I look through something like the Condon report where they go through something like 30 years of data in the height of the UFO craze and don't come up with even a single item that is not mundane in its nature. After that, new UFO claims I see with suspicion even if I don't check them out. If something seems straightforward to check out, I might do it, but I don't feel it is my job to investigate every claim. If there had been even a single case which pointed to something probably remarkable, I'd have a different attitude.

Lesson: if the claims made shrink and disappear at critical and skeptical investigation, the claim is not likely to be true.

Miracles

The Catholic Church has a division to investigate miracles, and has determined that some of them are genuine. However, the Catholic Church often has significant blinders, and definitely takes a long time to adjust to obvious mistakes (Galileo anyone?).

Take, for example, this site on top 10 miracles. I've personally researched about 3 or 4 of these, and it is quite clear that those are definitely frauds (#1, 2, 3, and 5 I've checked). Yet, do we get any retraction from the Catholic Church? Do we get *any* hint of skepticism? None at all.

Again, I follow the same steps as above. I do not take someone else's word, necessarily, and I don't discount them out of hand. The miracles of Fatima are a great example. First, we have "visions" from highly impressionable children, one of whom was known to have made up fanciful stories in the recent past. These children are the only ones who "see" it, until the last vision where hundreds claimed to see the "Miracle of the Sun". The problem? The initial stories did not agree, and we only get a semi-consistent story after the various witnesses spoke with each other and to a priest collecting the reports. Check out The Real Secrets of Fatima for the details. All of the elements spoken about above can be seen - initial mundane experiences, misinterpretation of known objects (i.e. the sun, and clouds), the exaggeration of stories in later recollection, serious inconsistencies in reports and notable non-reports.

The same goes for every faith-healer I've read about. A little digging, and a little skepticism, and the entire enterprise come crashing down. Many times it doesn't take much digging!

> If the truth is there, then it shouldn't retreat under investigation.

This is not a matter of being *too skeptical*. It is a matter of not being credulous.

4.2 Healing Miracles

Unbelievable? 17 Nov 2007 - Are miracles evidence for God? - 17 November 2007 – Miracles and healing - is it evidence for the truth of Christianity?

As part of the Unbelievable Project, I am taking notes and "armchair" responding to each of the Unbelievable podcast episodes satisfying a set of simple rules.

For a full RSS Feed of the podcasts see here.

Description of Episode

- Full Title: *Unbelievable? 17 Nov 2007 - Are miracles evidence for God? - 17 November 2007 – Miracles and healing - is it evidence for the truth of Christianity?*

  > Agnostic sceptic Stephen Pilcher believes that Christian claims to healing are tricks of the mind. Can John Ryeland of the Christian Healing Mission persuade him differently? Also features personal stories from people who claim to have been miraculously healed.

  Download mp3.

- Justin Brierley - Christian Moderator
- John Ryeland - Christian
- Heather Riley - Christian
- Stephen Pilcher - Agnostic

Notes Stephen - *"I'm a church-going, Bible-reading agnostic"*

Me - That's pretty funny, because it is very close to what I am. I am a church-going, Bible-reading atheist. Although I have read the Bible at least once cover-to-cover a few years ago, I have lost patience with reading it now. There is so much repetitious and tedious material, both Old and New Testament, that I find it hard to read for long without thinking I have better things to do with my time.

Stephen - There are a large number of *"miracles"* that aren't miracles at all, and non-Christians can have healings as well.

Heather - Her story is at 24:40, in case you want to listen to the original. Here is a quick summary. She pursued a psychology degree, studied the paranormal. About 3 or 4 months ago, she went to a chiropodist (aka podiatrist) who told her that one leg was longer than another (by an inch). She then went, unplanned, to a religious gathering. During the meeting the preacher gave her some very specific information about he from several years ago, some comforting words, and a moving message. And then he healed the asymmetric leg. She said she felt like she was *"on show"* and that *"God's really got to do something"*. She also said that she didn't feel any different, but a friend of hers observing saw the leg lengthening. So then she went back to the chiropodist. She determined he was Christian, told the entire story, he repeated the measurement and then did some more *robust* measurements, and found no difference in leg length. And since then, her shoes are no longer asymmetric.

Stephen - People have done studies of faith healings and always come up short.

Me - When I first heard that story, a year or so ago when I first listened to this episode, I recall being pretty impressed with the healing. Since then, after much reading, and hearing this again I am not. (It is interesting that I recall it being more impressive, and if I never heard the story again, might have started to spread a more impressive story if I told it again. This is a nice reminder of how these stories, working with the limitations of memory, can grow in the telling and quickly become unfactual).

**

Anyway, why am I not impressed? There are a number of little details that she dropped in that I find curious. Consider two models (there are probably more!):**

1. **There is a God, and he decides to heal this leg, but not other ailments, and not her husbands problems. This is hard to reconcile even on the face of it, and later in the show she talks about this somewhat.**
2. **There is no God, these things don't happen, and there are other mundane explanations**

**

Turns out that leg-lengthening is a very common form of *"healing"* in these sorts of situations (see "The Faith Healers" by James Randi), because it looks impressive and is a straightforward trick. That's why it is important to have magicians as well as scientists investigate such claims, because scientists are terrible at detecting dishonesty and trickery. The fact that she had no idea that one leg was longer, until a few days before, that she did not feel the healing, and only went on the word of the friend because she was expecting something to happen, that she was impressed with the *"prophecy"* that the preacher said, referring to things he would have no idea about. James Randi speaks about this at length, and shows how preachers will use planted people, microphones, and other techniques to appear to know things they wouldn't already know. Even if they aren't being deceptive, they may hear in conversations with the friends ahead of time about Heather's problems, and then work it into the *"prophecy"*. When she goes back to the chiropodist she finds out he is a Christian, and *before* he redoes the measurement she tells the story. Now, this chiropodist has a vested interest in confirming the healing, because it will confirm his worldview. This is why we have double-blind measurements, because we *know* people bias the measurement, the reporting, the memory of it because of their worldview. In fact, she tells that the chiropodist had to do more robust measurements to confirm the equal leg length. Perhaps there was an error in the first measurement. Perhaps the first measurement was overestimated. Perhaps it wasn't, and *she* reported it rounding up (i.e. he says a bit more than 1/2 inch, she tells her friends around an inch, and then remembers it as such, etc. . .). Perhaps the equipment for the first test has a bias, which might have motivated him to make the more robust measurements. There are many possibilities that do not require dishonesty, deliberate deception, incompetence, and are completely mundane.**

So which model can explain each of these? It seems clear to me that there are perfectly good mundane explanations for nearly every detail of the story, that the story is inconsistent even with a *"real"* healing, and that model 2 is definitely better. What about her asymmetric shoes, and the pain that occured and went away after a while after the *"healing"*? My shoes tend to get asymmetric over time (not with each other, but each pushed off to the outside) and when I get new shoes, and they are flat, I have a little pain walking and running that goes away as I adjust. Notice that these events happened *3 or 4 months ago*. There is no way that her new shoes would have become asymmetric in that time *anyway*.

John - *"There is an awful lot of anecdotal evidence, and I don't want to be skeptical of it simply because it is not documented. What else. . . .is she not telling the truth? Of course she's telling the truth!"*

Me - All we need is a slightly overzealous preacher, a slightly sloppy chiropodist, and a small amount of congitive bias. It really is that simple, and it doesn't require us to disparage the character of *anyone* in the story.

John - *"How high should we set the bar to know that this is a proper healing story?"*

John - *"For some people they want to make it so hard to call it a miracle that nothing could ever satisfy that. I want to take Heather's story, listen to it, and ask 'How did it change her'? If it is a story, told with integrety, seems to have a lasting effect, of course it would be better if it were documented, but we don't have the ability to get the documentation."*

**Me - I listen to this talk about documentation, and about how it's *"so hard*", some people are *"so skeptical"* and I have to think *"cry baby, cry baby, cry baby"*. I even hear the little whining voice in my head.

"People should be more believing of my miracle claims", *"You're being too skeptical"*, etc... Of course, when it comes to *other* people's miracle claims, they are just as skeptical! It's only the ones that support their worldview that they consider for special treatment. Sorry, that's not good enough. Even Heather points this out, saying that she feels that people are more skeptical of religious claims than claims of the paranormal (which she saw in her studies of the paranormal). She's noting, in others, the same thing she is doing with her worldview. I've posted specifically about this problem here.**

**

In science, say you are trying to publish a paper, and the editor or reviewer returns it saying that they are not convinced of your conclusions, you don't go *"Oh, you're being too hard on me, too skeptical. Getting the documentation for this effect I am claiming exists is just too hard."* That is just ridiculous. You find a way to document it, with careful measurements, and you convince the skeptics if it is true, or not if it is false. Truth should convince even the skeptics, especially if you're claiming a large effect.**

**

Take the Higgs boson, as an example of an unseen entity for which we only can get indirect inference of its existence. It was proposed *50 years ago*, and although people may have thought it was likely to be there, they didn't *believe* it was there until the proper measurements were done. Measurements which took decades to set up, required hundreds of people as a team, and has cost billions of dollars, just to get the documentation for the existence of something which doesn't even seem to violate physical law. Think about that next time you hear someone claim that getting documentation for healing is hard, or that the effect seems to disappear whenever you look into it carefully, and that is the reason there isn't any evidence for it.**

If the claimed effects of so-called faith-healings are real, they should be *trivial* to demonstrate, document, and convince the skeptics.

5 On the Resurrection of Jesus

5.1 Is the resurrection 97% likely?

The Probability of the Resurrection - Calum Miller & Chris Hallquist - Unbelievable? - 06 July 2013 – Is the resurrection 97% likely as Swinburne claims? As part of the Unbelievable Project, I am taking notes and "arm-chair" responding to each of the Unbelievable podcast episodes satisfying a set of simple rules.

See here for a full RSS Feed of the podcasts.

Description of Episode

- Full Title: *The Probability of the Resurrection - Calum Miller & Chris Hallquist - Unbelievable? - 06 July 2013 – Is the resurrection 97% likley as Swinburne claims?*

  > Christian philosopher Richard Swinburne has used probability theory to show that the likelihood of the resurrection of Christ is 0.97.
  > Calum Miller is a Christian apologist and student of Swinburne. He talks about why he believes that probability theory can be used to show that the resurrection is highly likely to be true.
  > Chris Hallquist is an atheist blogger who argues that the resurrection is not well supported by evidence or probability.
  > For more debates visitwww.premier.org.uk/unbelievable
  > Join the conversation viaFacebookandTwitter
  > For Calum Miller http://www.dovetheology.com
  > For Apologetics UK http://apologeticsuk.blogspot.co.uk/
  > For Chris Hallquist http://www.patheos.com/blogs/hallq
  > Get the MP3 podcast of Unbelievable?http://ondemand.premier.org.uk/unbelievable/AudioFeed.aspxor ViaItunes
  > You may also enjoy:
  > Unbelievable? 16th April 2011 - Biblical evidence for the Resurrection - Bart Ehrman & Mike Licona.
  > Unbelievable? 7 April 2012 - Are the Jesus Scandals evidence for Easter? David Instone-Brewer vs Bob Price.

  Download mp3.

- Justin Brierley - Christian Moderator

- Calum Miller - Christian
- Chris Hallquist - Atheist

Notes **Me - I was really looking forward to this episode. What was not to like? Probability theory, ancient religions, evidence for Christianity... bring it on! Unfortunately, it really wasn't that impressive.**

Calum - *"There's what's called the confirmation of resurrection, the explanatory power. And this is basically the idea that there is a lot of evidence which, if the resurrection happened would be expected but if the resurrection didn't happen, it would be very improbable. And if this is true, if there really is that kind of evidence, then it follows from probability theory that our confidence in the resurrection should be greatly increased by this evidence. [Concerning the prior], more extraordinary or extreme events are more improbable to begin with, and so you would need more evidence to confirm them. So a lot of the debate about the resurrection comes down to the prior probability, whether we think it is actually really improbable and that no possible evidence could ever make us convinced of it."*

Me - He basically has the distinction between the following as the basis for all of the "calculation":

1. **evidence that, if it existed, would be very common if the resurrection *did* happen**
2. **evidence that, if it existed, would be very rare if the resurrection *didn't* happen**
3. **the prior probability for the resurrection**

where he admits that *"the debate about the resurrection comes down to the prior probability*". Anyone doing probabilistic inference knows that it should never come down primarily to your choice of priors. The data needs to rise above the prior, and the prior needs to be an honest -ideally objective- assessment of the pre-data probability assignments or, often, the initial state of ignorance. By admitting this, Calum is essentially saying either that:

1. **the data are not strong enough to constrain a diffuse prior, and thus is unconvincing or...**
2. **you have to come into the debate with a *sharp* prior which admits to a presupposition of the strength of the claim.**.

Neither of these stances is convincing in the slightest.

Further, in response to this set up, he ignores the most important thing in any Bayesian treatment is the set of models that you are using to compare. You cannot simply test the truth of a single model in isolation, nor is it generally informative to compare

model A true or false. Instead one wants to set up a list of models, hypotheses, theories to explain the data and evaluate those multiple models. Instead of,

$latex
P({\rm resurrection}|{\rm data})
$
and
$latex
P(\mbox{not resurrection}|{\rm data})
$
you'd want
$latex
P({\rm resurrection}|{\rm data}), P({\rm hallucination}|{\rm data}), P({\rm legend}|{\rm data}), P({\rm literary}|{\rm data}), P({\rm hoax}|{\rm data}),$ etc...

where of course each of these models would have many details beyond the simple label I'm putting in here. By being explicit with what you're comparing to, it is easier to see where the different prior probabilities come in. Are you really going to suggest that someone rising from the dead is on par, prior to the data, with a legendary construction given how many legendary constructions we've seen and how many dead rising we've *not* seen?

What is clear is that all of these other models must, a priori, be more probable than rising from the dead *even if a God exists*. Just because you believe miracles *could* happen does not mean that you believe every miracle claim is true, and given the number of clearly false miracle claims, the prior probability for any miracle claim must be quite low - even if you believe miracles actually occur.

Another point about the data which Calum never deals with is that it should include things we *don't* see, not just things we do. If we expect something to occur with a claim, and we don't see it, that is in fact evidence against the claim.

Chris - Most Christians might discount the claim that the miracles around African religions seem to disappear in the US and UK because of lack of faith. Or perhaps the miracle stories around Mormonism. What makes the miracles of Jesus different than these ones? Once you accept the idea that resurrection claims can exist quite commonly in a group of religiously charged people, it is no longer quite so hard to understand the resurrection claims in the Bible.

Calum - The reports of an empty tomb are exactly what you'd expect if the resurrection actually happened, and would be unlikely in the case of a non-resurrection event.

Me - Dealing with this is actually very simple. He is correct that *if the resurrection occurred*, then the report of an empty tomb would

very likely be given, and I would add that it would also be very likely to be reported in the earliest accounts we have of the resurrection. Is this what we see? No! The empty tomb is not mentioned in Paul, neither are the physical visitations, both of which you'd expect to see if the Resurrection actually occurred. Even the visitations are not mentioned in Mark! So, from a probabilistic point of view, this is the exact opposite of what we'd expect to see if the resurrection actually occurred. In fact the descriptions of the resurrection get more elaborate and more physical the later the text (Paul has visions, Mark has no visitations but the empty tomb, Matthew and Luke have visitations, John has the doubting Thomas story, etc. . .). This is exactly what we'd expect for legendary development, or a story that has been embellished over time.

The other thing, is it really all that unlikely to have an empty tomb story with no resurrection? Notice, I'm not saying to have an empty tomb, but to have an empty tomb *story*. There are several different routes to get that. One is as a literary device. I believe Richard Carrier supports this, as a reference to Daniel. Another is a deliberate counter to Docetism, to gain favor and win an argument.

Calum - *"It is not necessarily helpful to have just some kind of religious context, it must be the right kind of one. So, for example, I can see very good reasons why God would want to vindicate Jesus' teaching by resurrecting him because I think Jesus taught a lot of very good things, I thought he was (obviously as a Christian) I think he was a very sincere, a very good person. And I can think of a lot of good reasons why God would choose Jesus to be a prophet and to become incarnate in him. Whereas I don't see comparably good reasons why God would want to vindicate Mormon teaching. Obviously a lot of that is because I don't know a lot about Mormonism but there's still the asymmetry there."*

Chris - The positive evidence for Mormonism is a lot better than for Christianity. We have signed documents by the early followers and founders attesting to the miracles. The best we can say about Paul's evidence is that he had a vision. We have a lot of negative evidence for Mormonism, to be sure, but if we knew more about Christianity perhaps things would be different.

Me - I would add that we have this *pro-Christian* filter for all of our documents, a filter called the Middle Ages, where documents supporting Christianity had a much better probability of surviving (i.e. copied) than ones critical of Christianity. The only reason we have the Nag Hammadi texts is that the monks refused to burn them, as ordered by the Christian orthodoxy at the time, and instead chose to store them in a cave. Think about that campaign of whitewashing for hundreds of years! Actually, the fact that we have so little actual documentary support for Christianity coming

from the first century, despite this huge bias, to me argues against Christianity.

Chris- How do you know Jesus was sincere or not? Seems like the same could be said for Joseph Smith.

Afterward - a bit about priors (this section is all **Me -**, so I won't put it in bold.)

I don't really think that when Calum is referring to priors that he really means that in the same way as *before the data*. It seems to me, and I believe Swinburne's analysis reflects this, that the prior for *this* calculation is really the posterior for a *previous* calculation regarding the existence and properties of God. This is perfectly legitimate Bayesian procedure, but it makes the argument a different one. Because of this, Swinburne's calculation for the probability of God needs to be addressed before we can even deal with the priors in this resurrection argument. That will have to be another post entirely, but at any rate Calum did not do it a service in this debate, having not really gotten to the meat of it when he could have.

5.2 *Resurrection and Regression*

Dan Barker has written an Easter Challenge[1] for any Christian to come up with a seamless account of what happened on the day of the Resurrection.

> *"The conditions of the challenge are simple and reasonable. In each of the four Gospels, begin at Easter morning and read to the end of the book: Matthew 28, Mark 16, Luke 24, and John 20-21. Also read Acts 1:3-12 and Paul's tiny version of the story in I Corinthians 15:3-8. These 165 verses can be read in a few moments. Then, without omitting a single detail from these separate accounts, write a simple, chronological narrative of the events between the resurrection and the ascension: what happened first, second, and so on; who said what, when; and where these things happened.*
>
> *Since the gospels do not always give precise times of day, it is permissible to make educated guesses. The narrative does not have to pretend to present a perfect picture–it only needs to give at least one plausible account of all of the facts. Additional explanation of the narrative may be set apart in parentheses.* The important condition to the challenge, however, is that not one single biblical detail be omitted."

[1] Dan Barker and Dan Barker. *Losing faith in faith: From Preacher to Atheist*, chapter Chapter 24. Leave No Stone Unturned: An Easter Challenge For Christians. FFRF, Incorporated, 1992. URL http://ffrf.org/legacy/books/lfif/?t=stone

Andy Bannister has written a response to this challenge[2], which we must admit is in fact consistent with every detail of the story and supposed contradiction. In many ways it is impressive.

[2] Andy Bannister. The resurrection of jesus - a harmony of the resurrection accounts. URL http://www.answering-islam.org/Andy/Resurrection/harmony.html

[DESCRIBE HIS METHOD HERE QUICKLY]

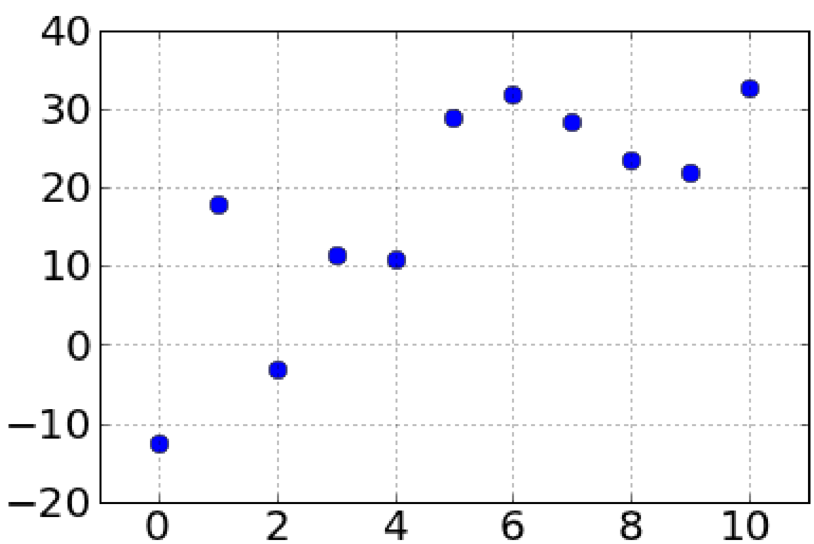
However, there is a significant problem with the method he employs, which can be elucidated with an analogy to a situation which commonly arises in mathematics, in the process of fitting a line to data.

Regression

In linear regression, we might have, say, a handful of data points:

X	**Y**
0.0	-12.5
1.0	17.9
2.0	-3.2
3.0	11.4
4.0	10.8
5.0	28.8
6.0	31.8
7.0	28.3
8.0	23.4
9.0	21.9
10.0	32.7

Which is plotted as

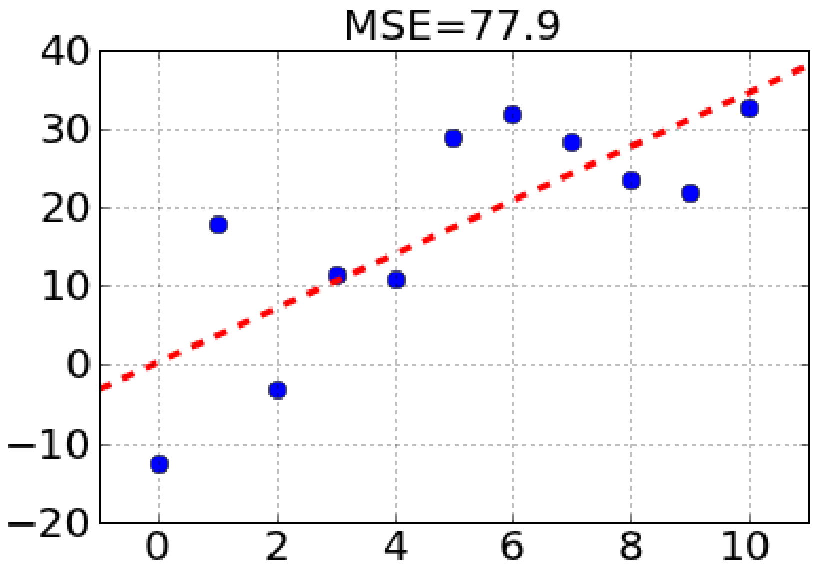


When we do a linear regression, we fit to a standard "$y = mx + b$" form. For this data, the best fit is

$$y = 3.4x + 0.27,$$

with a mean squared error of 77.9. This difference from the line to the data is one measure of how well the line compares to the data -

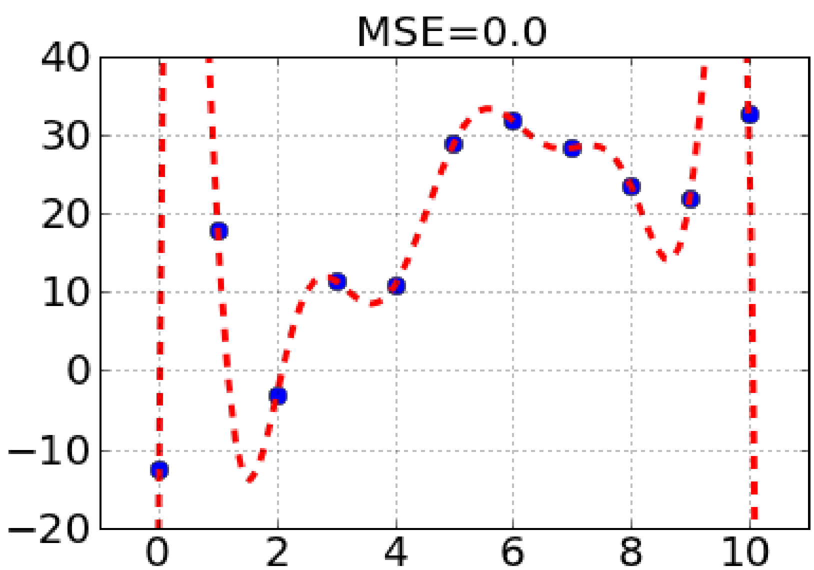
lower values means a better fit, a mean squared error of zero means a *perfect* fit.



Overall, not a bad looking fit. However, if we fit to a more complex function, say a 10th polynomial, we can get even better!

$$y = -0.0007039x^{10} + 0.0363x^9 - 0.8051x^8 + 10.04x^7 - 77.13x^6 + 376.5x^5 - 1159x^4 + 2152x^3 - 2163x^2 + 891.8x^1 - 12.54$$

with a Mean Squared Error of *zero*.



In the field of statistics, this is referred to as *over-fitting*, and is the result of fitting the variation and not the overall pattern. In other words, it is fitting the meaningless differences from one point to another by adding a tunable parameter for each detail in the data. With each new parameter we get a "better" fit, by the criterion of mean squared error, but we lose sight of the meaning. This is the mathematical equivalent of losing sight of the forest for the trees.

Parameters and Ockham's Razor

When fitting a line, the result is choosing the values of the parameters that have the highest probability given the data. However, when those parameters can take on any possible value, the overall probability of the model is reduced - this is the probabilistic equivalent of Ockham's Razor which we've seen before in Section **??** on page **??**.

We make the problem worse by adding more and more parameters, giving more possible explanatory freedom to our model. The more freedom we have in choosing the parts of the model, the less explanatory power this model actually has. One way that statisticians avoid this problem is to fit the model to half of the data, and see how it works on the other half - a process called cross-validation. A simple model, like a straight line, will do about as well on both. An overly complex one will do well on the data used to fit it, but will do poorly on new data.

[DO AN EXAMPLE OF THIS IN THIS CASE]

Back to the Resurrection

If we look at Andy Bannister's very clever solution, we notice something quite interesting: for every single difference between the Gospel accounts, he adds a detail not found in the story to explain it. One can pretty much do this for any two accounts that don't say logically contradictory things, and can be seen as an example of over-fitting.

Another way of looking at it is that, if Bannister had constructed his story from, say, two of the Gospel stories and then compared it to the other two he'd have a problem. Even if he took details from all four accounts, but constructed a story from half of them and then used the other half to confirm it wouldn't work.

As a result, the Easter Challenge, as phrased, is probably not a very good one. One can Rube-Goldberg a story together to fit any amount of details. Perhaps that is the point, to highlight to what lengths someone has to go to in order to reconcile the four accounts. However, we think something motivated from cross-validation might be a bit more persuasive.

6 Historical Methods

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Appendix A
Test