# Prelude {.unnumbered}

Part IV of the book is by far the most theoretical, focusing as it does

on the theory of statistical inference. Over the next three chapters my

goal is to give you an [Introduction to probability] theory, sampling and estimation in the chapter on [Estimating unknown quantities from a sample] and statistical [Hypothesis testing]. Before we get started though, I want

to say something about the big picture. Statistical inference is

primarily about learning from data. The goal is no longer merely to

describe our data but to use the data to draw conclusions about the

world. To motivate the discussion I want to spend a bit of time talking

about a philosophical puzzle known as the riddle of induction, because

it speaks to an issue that will pop up over and over again throughout

the book: statistical inference relies on assumptions. This sounds like

a bad thing. In everyday life people say things like **, and psychology classes often talk about assumptions**

**and biases as bad things that we should try to avoid. From bitter**

**personal experience I have learned never to say such things around**

**philosophers!**

**## On the limits of logical reasoning {-}**

**> \*The whole art of war consists in getting at what is on the other side**

**> of the hill, or, in other words, in learning what we do not know from**

**> what we do.\***

**> - Arthur Wellesley, 1st Duke of Wellington**

**I am told that quote above came about as a consequence of a carriage**

**ride across the countryside.[^IV-1] He and his companion, J.**

**W. Croker, were playing a guessing game, each trying to predict what**

**would be on the other side of each hill. In every case it turned out**

**that Wellesley was right and Croker was wrong. Many years later when**

**Wellesley was asked about the game he explained that .**

**Indeed, war is not special in this respect. All of life is a guessing**

**game of one form or another, and getting by on a day to day basis**

**requires us to make good guesses. So lets say that W refers to a Wellesley victory**

**and C refers to a Croker victory. After three hills, our data set looks**

**like this:**

**$WWW$**

**Our conversation goes like this:**

**> you: Three in a row doesnm a bit**

**of a gambler. It informative and I see no reason to prefer Wellesleys. I canve organised the data into blocks of three so that you can see which batch corresponds to the observations that we had available at each step in our little side game. After seeing this new batch, our conversation continues:**

**> you: Six wins in a row for Duke Wellesley. This is starting to feel a**

**bit suspicious. Is going to**

**win the next one too.**

**> me: I guess I dont see any logical reason why**

**that means hem okay with my**

**choice.**

**For a second time you were right, and for a second time I was wrong. Wellesley wins the next three hills, extending his winning record against Croker to 9-0. The data set available to us is now this: $WWW$ $WWW$ $WWW$ And our conversation goes like this:**

**> you: Okay, this is pretty obvious. Wellesley is way better at this game.**

**We both agree hed have said they were all equally likely. I**

**assume you would have too, right? I mean, that**no ideat it?

> you: I suppose so.

> me: Well then, the

observations weve encountered so far, arens changed

then? At the start of our game, youve encountered has

discriminated between these two possibilities. Therefore, both of these

possibilities remain equally plausible and I see no logical reason to

prefer one over the other. So yes, while I agree with you that

Wellesleyt think of a

good reason to think hem still willing to chance it. Is winning streak continues for the next three hills. The score in the Wellesley-Croker game is now 12-0, and the score in our game is now 3-0. As we approach the fourth round of our game, our data set is this: $WWW$ $WWW$ $WWW$ $WWW$ and the conversation continues:

> you: Oh yeah! Three more wins for Wellesley and another victory for me.

Admit it, I was right about him! I guess wet know what to think. I feel like

wet already been ruled out, $WWW$ $WWW$ $WWW$ $WWW$ $C$ and $WWW$

$WWW$ $WWW$ $WWW$ $W$. Itt these two be

equally sensible now given that our observations dons the logical evidence that the streak will continue?

> you: I think youre the expert on statistics and

youre

losing. Im winning. Maybe you

should switch strategies.

> me: Hmm, that is a good point and I donm afraid I dond have observed is a run of

three wins to you. Their data would look like this: $YYY$. Logically, I

dont seem like a lot of

evidence, and I see no reason to think that your strategy is working out

any better than mine. If I didnre better at

ours?

> you: Okay, now I think yout see the logical evidence for that.

## Learning without making assumptions is a myth {-}

There are lots of different ways in which we could dissect this

dialogue, but since this is a statistics book pitched at psychologists

and not an introduction to the philosophy and psychology of reasoning,

Ive described above is sometimes referred to

as the riddle of induction. It seems entirely reasonable to think that a

12-0 winning record by Wellesley is pretty strong evidence that he will

win the 13th game, but it is not easy to provide a proper logical

justification for this belief. On the contrary, despite the obviousness

of the answer, itt have any

logical justification for.

The riddle of induction is most associated with the philosophical work

of David Hume and more recently Nelson Goodman, but you can find

examples of the problem popping up in fields as diverse as literature

(Lewis Carroll) and machine learning (the **theorem).**

**There really is something weird about trying to . The critical point is that assumptions and**

**biases are unavoidable if you want to learn anything about the world.**

**There is no escape from this, and it is just as true for statistical**

**inference as it is for human reasoning. In the dialogue I was taking aim**

**at your perfectly sensible inferences as a human being, but the common**

**sense reasoning that you relied on is no different to what a**

**statistician would have done. Your half of the dialog**

**relied on an implicit assumption that there exists some difference in**

**skill between Wellesley and Croker, and what you were doing was trying**

**to work out what that difference in skill level would be. My rejects that assumption entirely. All I was willing to accept**

**is that there are sequences of wins and losses and that I did not know**

**which sequences would be observed. Throughout the dialogue I kept**

**insisting that all logically possible data sets were equally plausible**

**at the start of the Wellesely-Croker game, and the only way in which I**

**ever revised my beliefs was to eliminate those possibilities that were**

**factually inconsistent with the observations.**

**That sounds perfectly sensible on its own terms. In fact, it even sounds**

**like the hallmark of good deductive reasoning. Like Sherlock Holmes, my**

**approach was to rule out that which is impossible in the hope that what**

**would be left is the truth. Yet as we saw, ruling out the impossible**

**never led me to make a prediction. On its own terms everything I said in**

**my half of the dialogue was entirely correct. An inability to make any**

**predictions is the logical consequence of making . In**

**the end I lost our game because you did make some assumptions and those**

**assumptions turned out to be right. Skill is a real thing, and because**

**you believed in the existence of skill you were able to learn that**

**Wellesley had more of it than Croker. Had you relied on a less sensible**

**assumption to drive your learning you might not have won the game.**

**Ultimately there are two things you should take away from this. First,**

**as Ill often point out the assumptions that underpin a**

**particular statistical technique, and how you can check whether those**

**assumptions are sensible.**

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**[^IV-1]: [http://www.bartleby.com/344/400.html](%0A%20http://www.bartleby.com/344/400.html)**