module_prob2_lecture13

Fri, 1/21 12:45PM 16:29

SUMMARY KEYWORDS

probability, test, bayes rule, update, updating, bayes, applications, infected, belief, marginal probability, figure, posterior, based, rule, module, person, starting, false positives, event, situation

SPEAKERS

Sumon Majumdar

S Sumon Majumdar 00:04

So the last clip, I introduced you to the idea of the prior probability, which is the starting probability. And then once you get new information, how you update that probability using the Bayes rule, and you get what's called the posterior probe. So just to solidify this idea, so let's do a clicker question. So please read the situation in the clicker question. And then it's the question itself is pretty simple. But what I would like you to get from that is an understanding of what's a prior probability? And what are you looking for in terms of a posterior? So you may wish to stop the video at this point, and try out the clicker question. So hope you got the chance to do the clicker question. So the situation is this that Jim feels that he is infected with some infection. So you can think of it as COVID or anything else. And so he decides to take a test. So he starts out with a probability of being infected of point three, right? So that's a starting probability, or is prior problems. So so what did what the question asks for is that given like, it gives you the various probabilities of detection of infection by the test, and then that asks you what is Jim's prior probe? So, so what we're looking for is a starting probability, which is point three. So the correct answer here is .3. But if we go back to this situation, and this is a situation that always comes up in, in sort of medical testing, and other types of testing as well. So you go to a doctor, and you think that there is a probability that one has a disease or an infection. So right, so this is the starting or the prior probability of point three, and then the doctor recommends a test or you undertake a test. The problem is that the tests are not always completely accurate, right? So what is what is here, right, if you're infected, so the test can show you positive or negative, if you're infected, the probability of it showing your positive is point seven. But sometimes, even if you're not infected, the test can come up to be positive. And the probability of that is point one, right? It's lower than point seven, but there is still a possibility that the test can come out to the positive. And in medical testing, this is always the issue. So see, if we look at this, right that even though you're infected, right, so there is a probability that the test comes out to be negative. So what's the probability of that? It's the remaining right, so the probability of positive given in fact to this point seven, so the probability of negative given infected is .3. So this is called a false negative. That means even though you're infected, the test shows you to be a negative, right? So the probability of that is point three. The other type of error could be that we're not infected, right, but yet the test comes out to be passed. So that's called the false positive, and the probability of that is pointable. So nearly all medical tests have some probability of false negatives and false positives. So these

figures that I've given you here are our fingers that they have come when, from the rapid antigen tests for code for COVID detection. Right? Now, for us the PCR test these num, these probabilities are much smaller, right? So a more accurate test has lower false positives and lower false negative probabilities, but nearly all tests, none of them completely foolproof, there's always a little probability of not detecting infection, even though one has and the reverse of it saying that it's you're infected when you're actually not. Now coming back to the main, the main exercise here, right, so suppose you suppose the test comes out to be positive, right? What's the probability that we're actually affected given the The test is not fully 100% Perfect, but not 100%. Accurate, right? So that's the situation of using the Bayes rule. So what I would like you to do is that, do this as an exercise, try to figure out in this case, what's the prob updated probability, the posterior probability that one is infected, given a positive test. So what I would like you to do is use the Bayes rule, figure out what the numerator is, what the denominator is, right? And figure out this overall posterior probability. So in the next module, one of the first things I'll do is do this exercise, and you can check your results against that. But what I would like you to do it, try it out on your own. Now, I wish to end this module by talking about the many applications of Bayes rule in lots of variety of contexts, variety of areas. Some of you use consciously some of it, you use subconsciously, right, but one of the first applications is that you need read some news, right. And maybe you read some news about celebrate. And based on that news, you update your belief about that celebrate your that public thing. The updating could be positive, for example, you read news about how the celebrity help someone in need, right, and so you update your belief that he's probably a very generous person. Or it could also be negative when you read some comment about the celebrity or something bad that he has done. And maybe you update your belief negatively about whether he's conservative, liberal, racist, or, you know, or, or some other characteristic. But of course, in doing that updating, you know, that not all news is to be believed. Right? So some of it is concepts, some of it is just pure false. Right? So the question is, how do you update your belief about someone, given that the news need not be completely accurate? So what you can do is use the Bayes rule for such updating. And the idea is the same as we did with medical testing, that you get an information, you know that that information may not be completely accurate. But how do you update your belief based on that information? Now, you see also the use of Bayes rule a lot in artificial intelligence these days. So for example, if you look at Stanford street, so these are filters, which filter your email trying to determine if they are junk, or if they are genuinely, right. And most of the spam filters work in ways like this, that they look for this a word or some specific phrase in your email. And based on that they update the probability that this is a spam or it's not, right. So what they're looking for is things like words like a great discount. Or a big sum of money, right. So now, of course, great discount, most likely it's a spam. But it could also be an email from your cousin alerting you to a big discount on a particular product that you're looking to buy it. So the spam filters read based on the information on the email, the update the probability of whether this is a spam or not. And based on some cut off rule that they have, they either send it to the junk mail folder, or to your main folder. The same type of updating is also involved in the ads that you see all sometimes pop up on your web browser. Right? What they look at is your search history. And based on that they try and form a belief about you as a particular type of consumer who is interested in some particular things. Right? So for example, suppose you're searching history involved looking at vacation deeds, right? So they update the belief based on that, that you're probably someone who is interested in looking for a vacation in the near future. So based on that they send you more ads about about vacations. Now, if you click on one of those ads, now it adds to the information that they have to it kind of confirms or updates there. The probability that you are probably definitely looking for vacation and then they'll send you even more. So a lot of learning in a AI is based, basically on the Bayes' rule. Right? Now, what else? Right? So for example, the lots of drugs, vaccines, medical procedures, which are out there right. Now, how

do you know about the efficacy of that you run tests? Right? And based on the test results, right, or the or the trial results, right, you update the belief about whether a drug works or whether a procedure works or doesn't. Right? And again, that updating you, is you what's used is based, right? Because some of the trials, although they give positive results, they could be false positives, right? Similarly, little scientific theories, people propound scientific theories, and then you test it, right. And then you you do lab experiments to try and test it. And based on the results of those lab experiments, you confirm those theories, or you invalidate those theories. Okay. One of the early applications that we did in this course, was remember that, that there was an accident that no, you're trying to determine whether this person is drunk or not. Right? So a lot of cases in criminality regarding the innocence of defendants is based on testimonies and evidence right now, you as a jury member or as Judge, right, you, you hear this different pieces of evidence, different testimonies, and based on that you update your probability of whether this person is actually liable, whether he or she has committed the crime or not. Right. So what you're doing in a sense, is you have a prior about this person. And based on the evolving evidence, right, you're updating that prior and coming to a posterior. Right. And, and typically, if you're now pretty much convinced that this person is as a crime has done the crime, then you give him the punishment, if not electrical. So all of these are applications, basically, of the base route. And that's why I keep on harping. This point that Bayes rule is, is a very important concept in probability. So So hopefully, going forward, you will do some of the practice questions to get yourself a better handle on how to use Bayes rule in lots of different contexts. Now, before finishing off this module, let me do a very quick recap of what we did in this module. So we started with the idea of conditional probability. So the probability of B given A so the idea of how one event occurrence of one event can influence the probability of the occurrence of another. Now, one other thing that we did is the general multiplication rule. So this is the probability of A and B occurring together. So A intersection B is given by this multiplication rule. So it's the probability of A time's the probability of B given that he has. So this is a general multiplication rule, because remember, if A and B were independent, right, in the case of independent probability of B given A is just probability of B. Because a in that case doesn't influence the probability of of B. And in that case, the multiplication rule would just be P of B times B. All right, but if they are dependent, so the general multiplication rule is P of A times will be given. The third thing that we did is talk about this idea of total or marginal probability. So if you're looking at the probability of B or Greek, it can occur either because he has occured or because the opposite event which is a complementary, so the total probability of B is probability of A times probability of B given A Right, plus probability of A complement times probability of B given A. And even a more general version of that is that suppose B can occur through lots of different ways through the occurence of A one, A two, so on up to a n, then what you have to do is add up each of those, right, so this is B of A one times B of B given A one plus B of a two times probability of B given A two, and so on. So then we did probability trees and two way table. So these were two convenient ways of depicting events. And from there, we can figure out probabilities of some combination of events, marginal probabilities, things like and then we ended the section with Bayes rule, I introduced you to the idea of Bayes rule, we set up the main formula and did some applications. So in the next clip, I'm going to start out again with Bayes rule, and just make sure that we are on the same page regarding this important. So let's end this module here. And I do hope you will attend the practice problems