Review of: "Notes on the Implications of Ignoring Bayes' Rule in Search and Rescue Practice in the UK"

Duncan Taylor[1]

1 Flinders University of South Australia

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The paper is quite interesting and presents a useful perspective on how using Bayes' rule in search and rescue can improve the ultimate outcome.

I have a few comments that could assist in improving the work.

On the initial page, I would suggest rewording the marble example. First (a minor point): I would change the word "likelihood" to "probability." Next, the sentence that says "....picking the yellow one having previously picked the red one is 16.5%...." I would change to something like "...picking the red marble followed by a yellow marble is 16.5%...". The text as it is sounds as though you are talking about Pr(Y|R), which is just Pr(Y) = 0.5, but you are talking about Pr(RY) = Pr(Y|R)Pr(R) = 0.5 * 0.33 = 0.165.

With the equations on page 2 that give the updated probabilities, and throughout the paper, I would suggest using more formal probability notation. It is not clear exactly what you are talking about, and I think that showing conditional probabilities will assist in making this clear. For example, define 'A' as some being in the area and 'D' as being detected. Then let the complements of these be 'not-A' and 'not-D' (in formula, this would be A and D with a bar over the top). Then POA = Pr(A) and POD = Pr(D). The advantage of this is that you can then start using conditional terms rather than talking about POA_new and POA_previous. For example, in the first equation, POA_new is actually the probability of the person being in section A_i, given that you have searched A_i and they weren't detected, i.e., Pr(A_i|not-D_i). This can be very neatly derived using Bayesian inference:

Pr(A|B) = Pr(B|A)Pr(A)/Pr(B)

or, in your case,

Pr(A_i|not-D_i) = Pr(not-D_i|A_i)Pr(A_i) / Pr(not-D_i)

= [1 - Pr(not-D_i|A_i)]Pr(A_i) / [Pr(not-D_i|A_i)Pr(A_i) + Pr(not-D_i|not-A_i)Pr(not-A_i)]

We know that if someone is not in an area, then they can't be found; therefore,

Pr(not-D_i|not-A_i) = 1

which simplifies the formula to:

Pr(A_i|not-D_i) = [1 - Pr(not-D_i|A_i)]Pr(A_i) / [Pr(not-D_i|A_i)Pr(A_i) + Pr(not-A_i)]

Then

Pr(A_i|not-D_i) = [1 - Pr(not-D_i|A_i)]Pr(A_i) / [(1 - Pr(D_i|A_i))Pr(A_i) + 1 - Pr(A_i)]

Then

Pr(A_i|not-D_i) = [1 - Pr(not-D_i|A_i)]Pr(A_i) / [1 - Pr(D_i|A_i)Pr(A_i)]

which is what you have in your paper.

But I can't replicate the second formula, and partly this is because I don't know if it is talking about the probability of the person being in any area other than A_i that you are updating, or whether you are talking about the probability that each of the other areas individually increases.

With the example figure on page 4, it is usual to reference figures in the main text of the paper somewhere. It is also useful to caption figures and, within the caption, provide some information about what the figure shows and how to read it. It wasn't until later in the paper that I understood the region boundaries were denoted by the blue grid lines.

I also wasn't clear in the paper how the probability of detection is updated for a region that has already been searched, i.e., if a region had Pr(D_i) = 0.7, is searched, and does not find the person, is the probability of detection still 0.7, or 0.49 (0.7 of 0.7), or 0.3 (if it is purely a percentage of the area searched thing)?

Anyway, I'll leave it there for now. An interesting article; I look forward to seeing how it progresses.