Thayer School of Engineering at Dartmouth

Bayesian Statistical Modeling and Computation

ENGG 107

TA Office Hour 1

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Do you want to become rich? Perhaps Bayesian statistics can help!
https://fivethirtyeight.com/features/how-data-nerds-found-a-131-year-old-sunken-treasure/
The above ship was found using Bayesian approaches and the methodology is well documented [1]. Search problems commonly use Bayesian approaches. This office hour is largely inspired by the real-world applications of using Bayesian statistics [2].

1. **Airplanes often fly over a hypothetical devil's triangle. In the last few years, many airplanes have crashed into the ocean at this location. The debris of all the planes that have crashed into the ocean has been found in has been found exclusively in grid A or grid B. In order to aid the search for the debris, satellite imaging is used. The satellite is a dumb satellite, though, it can only tell if something that looks like a debris exists, without specifying the exact location.**

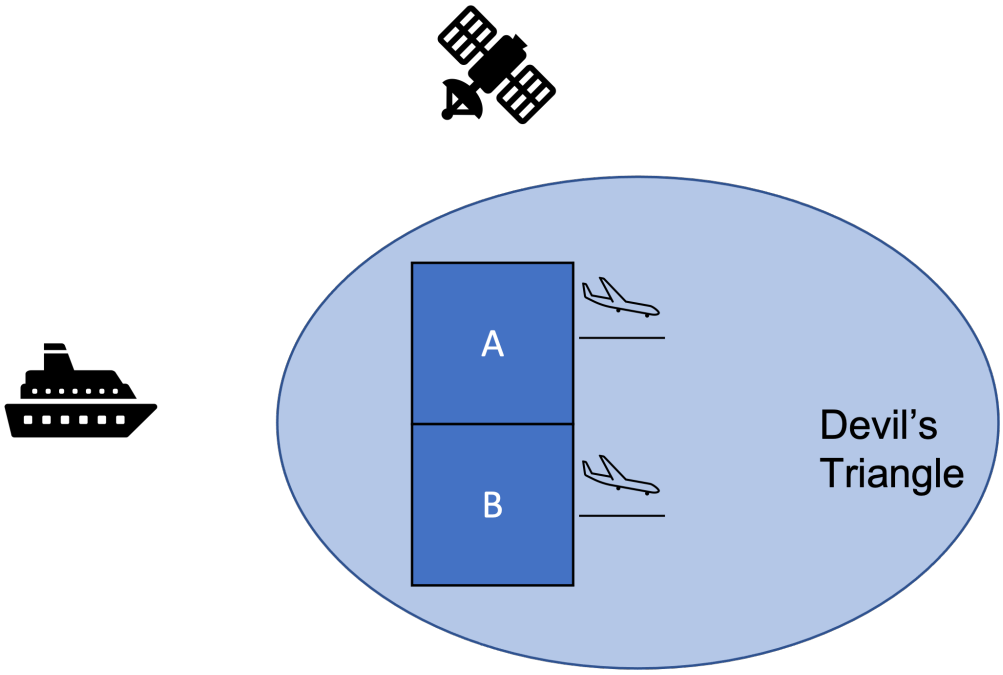

Figure 1: Two grid cell aircraft debris problem

In the last 10 years, the results of all the searches that have been conducted can be found in the table below:

Debris location using image template

Debris location	I	$\sim I$	Σ
A	**15**	**135**	**150**
B	**5**	**15**	**20**
Σ	**20**	**150**	**170**

I when the satellite locates something like an airplane debris in the triangle, $\sim I$ otherwise. Which grid should we search first? Would you come to the same conclusion using a Frequentist approach and a Bayesian approach? The links below might be a useful read
https://stats.stackexchange.com/questions/43471/examples-of-bayesian-and-frequentist-approach-giving-different-answers

Examples in section 2.8 of book `https://sites.math.rutgers.edu/~zeilberg/EM20/Lambert.pdf`.

2. **Because the grid-cells above were too large and the search party wanted to save money, the two grid cells in the were divided into four. The probabilities of finding the debris in each of these four new grid cells is shown in Figure 3 (A). Our dumb satellite either detects something that looks like a debris in the devil's triangle or nothing at all. Figure 3 (B) shows us the probability that the treasure is actually in a specified grid cell if the satellite detects a debris-type image. In which cell should we search for the debris first?**

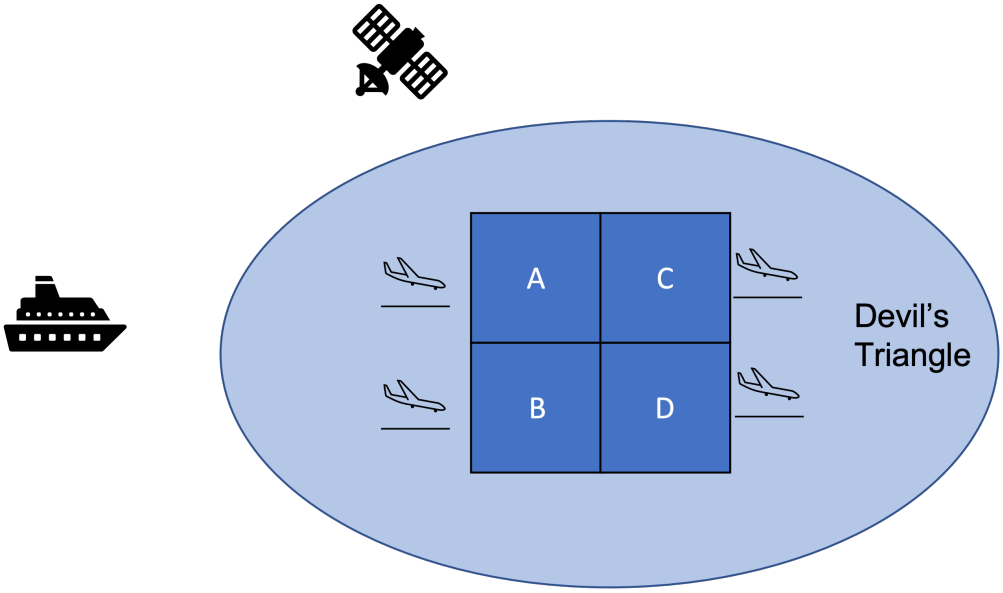

Figure 2: Four grid cell aircraft debris problem

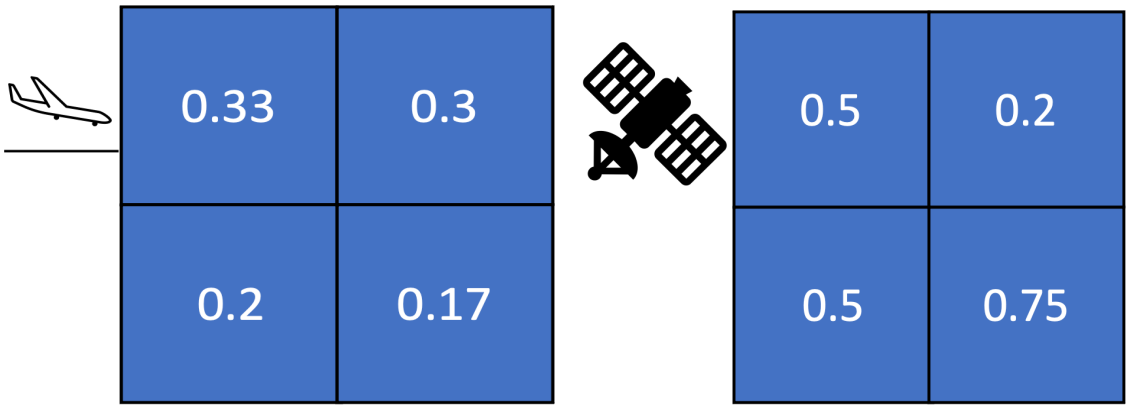

Figure 3: (A) Probability of finding debris in each of the grid cells based on past data. (B) Probability that the debris is actually present in each grid cell if the satellite recognizes something that looks like a debris in the Devil's triangle

References

[1] Lawrence D. Stone, *Stone, L. D. (1992). Search for the SS Central America: Mathematical treasure hunting. Interfaces, 22(1), 32-54.* https://doi.org/10.1287/inte.22.1.32

[2] Stone, L. D., Keller, C. M., Kratzke, T. M., Strumpfer, J. P. (2014). *Search for the wreckage of Air France Flight AF 447. Statistical Science, 29(1), 6980.*

[3] Lambert, B. (2018). A student's guide to Bayesian statistics. Sage.