In this paper, we develop a model for finding a plane that was lost over a large body of water. Our model is very robust and can be used by searchers throughout the entire search process.

Using only basic information about the flight and its last known location and heading, we are able to carefully calculate the area where the plane might have gone down. This area is not just a simple circle - the area is limited by the turn radius of the plane and by the maximum distance the plane could have traveled after losing communications.

Once our initial search area is determined, our model calculates how ocean currents would cause the search area would move from day to day, as well as change shape. And when debris has been found, the same ocean current calculations can be used in reverse to trace debris back to the original location of the crash.

Our model also implements three different algorithms for searching the area determined by our previous calculations. Our algorithms are very flexible, and adapt to changing weather conditions, number of search planes available, and the size of the area to search. Based on detailed analysis of these three algorithms in over 900 unique search scenarios, our model was able to recommend the ideal algorithm for finding any lost plane. Given any combination of factors for a search, our model can predict the number of days it will take to find debris in that region.

So You Lost a Plane?

February 10, 2015

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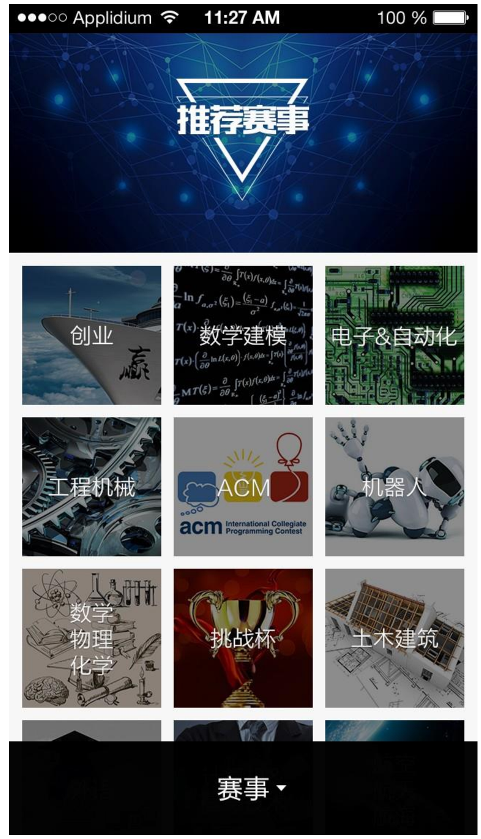
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1 Introduction to Problem

The problem we chose to solve was how to most effectively search for a lost airplane that is expected to have gone down over a large body of water. We developed a method to find lost planes in the least amount of time, which entails obtaining an accurate estimation of where the plane may have gone down, developing a fast and efficient search algorithm that adapts to new information, and calculating the location of the lost plane based on ocean currents.

2 Assumptions and Parameters

2.1 Assumptions and Justifications

Our model makes the following assumptions:

1. Generally speaking, the plane crash will occur in the way that will make the search the most difficult. This is justified because assuming the most difficult scenario in modeling makes the model compatible with the most plane crash scenarios.

2. We assume that air drag will not affect the distance a plane travels in a crash. The first reason we do not consider air drag is because it greatly complicates the model. Second, data necessary for calculating air drag such as the cross-sectional width of the planes and the coefficient of air drag of the planes was not readily available. Finally, in determining the distance that a plane will travel while crashing, air drag will both limit the distance and increase the distance. This is because air drag opposes the forward motion of the plane but also increases the time that the plane remains in forward motion by limiting the speed with which the plane falls.

3. Due to the small size of airplane debris, search planes will not be able to use infrared or radar and will have to rely on visual search alone, even in very calm seas. Our source indicated that even in rather calm seas, forward-looking airborne radar and infrared technology would be completely unable to detect small debris.[2]

4. The field of debris will not scatter so far from the site of the crash that it will change our overall search area. Justification for this assumption can be found in Section 4.2.

5. The area in which the plane crashes is completely water and is flat enough to be modeled as a geometric plane. The curvature of the ocean is extremely small and would be insignificant for all calculations.

6. Fatigue of searchers will not impact their effectiveness. Fatigue is too difficult to model because it has different effects on different individuals, and we can assume further that individuals impaired by fatigue would not be allowed to participate in the search.

7. All search planes are assumed to take off 200 nautical miles from the search location. We consider this a reasonable distance, since our model does not know where the nearest land mass or aircraft carrier may be. (A discussion of this assumption can be found in Section 7.)

8. There will be sufficient daylight for searching for only 10 hours each day. In most locations, this will let searchers start at least one hour after sunrise and end at least one hour before sunset.

9. Floating debris will not sink until after the search has been completed. Because it's impossible to accurately model when the debris will sink, we must assume that it has not sunk yet.

2.2 Parameters

Our model uses several parameters to help determine where a plane was likely to crash. We use the altitude, velocity, and mass of the downed plane as parameters to help determine how far the plane likely traveled while crashing. The wind speed at the time of the crash is also considered when determining this distance.