Mathematical Contest in Modeling
Summaries and Results
Simpson College
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Improving Safety and Reducing Workload

by
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Meritorious

The addition of up-to-date software is essential to improving the safety of air travel. Currently, it is the air traffic controllers' sole responsibility to read and analyze radar scopes and flight patterns. We have developed software that will ultimately detect potential airplane conflicts and alert the air traffic controller to take action to resolve such possible problems. This software is designed to provide the opportunity to take care of the impending conflicts before a crisis evolves.

Our software works in a way such that each plane in flight is assigned a point of origin and a vector in a three-dimensional coordinate system. The flight patterns are then determined by the software to be intersecting, skew, parallel, or coinciding. If the paths are projected to intersect, the exact point of intersection is calculated, along with the time that it will take each airplane to reach that point. If the planes are predicted to reach the point of intersection simultaneously, an alert signal will be given to the air traffic controller.

We then experiment with many models and test many situations regarding the time and distance involved in collisions. After analyzing the resulting data, we will set a standard for the distance between which two planes must maintain. From our products we will establish a level-based warning parameter which surrounds each plane. The outer level will alert the air traffic controller; using an orange signal on the scope, to contact the pilots and make them aware of the possible conflict should they maintain their flight path. The next level is the red alarm which tells the air traffic controller that the planes must avert from the initial flight path immediately.

The safety of an airplane is also related to the workload of an air traffic controller. This position does not allow for falling behind or making mistakes. The goal of our software is also to reduce the workload and complexity of the air traffic controllers. The provisions of this software should require less time analyzing the scope. The crucial data on the airplanes in the sector will be printed on the scope, reducing the time spent on the radio transferring this information. The alert signals will be color coded, drawing attention to the priority situations. The only added complexity that is uncovered is the initial learning and adjusting process that is ordinary and likely when changing systems. In its entirety, this software will create the safest and most efficient air traffic control system to date.

Air Traffic Control

By
Katie Braden, Heather Layman and Jonathan Tyler
Successful Participant

Safety is an important issue in the field of aviation. The Federal Aviation Agency (FAA) has asked us to look at factors that affect safety. Our job is to determine guidelines for the separation of airplanes in flight. To do this, we need to decide a minimum safe distance between aircraft in flight, and to determine when intervention is required for a situation.

Another area of concern for the FAA is air traffic controller workload. The FAA's goal is to quantify the complexity of a controller's workload. The reasoning behind this "is the complexity of the airborne situation that is most important in determining whether the task confronting the controller is difficult or easy and, thus, what the ensuing workload might be" (Lamoureux 1482). In order to quantify the complexity, we are to take into account instantaneous complexity, complexity over a given interval of time, and complexity at a particular time of day and how the number of planes in airspace sector affects this. After complexity is determined, we are then to decide whether or not the addition of software to automatically predict possible conflicts and alert the controller will reduce or add to the complexity. For this model, we isolated pertinent variables in order to write a complexity function. We consulted existing standards and modified them for our specific tasks. Taking our function and standards, we were able to arrive at a conclusion for the problems. Safety is an important issue in the field of aviation. The Federal Aviation Agency (FAA) has asked us to look at factors that affect safety. Our job is to determine guidelines for the separation of airplanes in flight. To do this, we need to decide a minimum safe distance between aircraft in flight, and to determine when intervention is required for a situation. Another area of concern for the FAA is air traffic controller workload. The FAA's goal is to quantify the complexity of a controller's workload. The reasoning behind this "is the complexity of the airborne situation that is most important in determining whether the task confronting the controller is difficult or easy and, thus, what the ensuing workload might be" (Lamoureux 1482). In order to quantify the complexity, we are to take into account instantaneous complexity, complexity over a given interval of time, and complexity at a particular time of day and how the number of planes in airspace sector affects this. After complexity is determined, we are then to decide whether or not the addition of software to automatically predict possible conflicts and alert the controller will reduce or add to the complexity.

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Stop the Static!

By
Jeffrey Anderson, Kirstin Ehm, Arthur Silbernagel
Successful Participant

We developed a basic pattern that could be used to determine channel assignments with the smallest span. We clarified the constraints placed upon the transmitters, and modeled a simple solution from the basic pattern of channels. The pattern is 4 rows of 3 repeating integers.

We then tested our model for its ability to repeat over an arbitrary area in any direction. The model had no problems in its ability to repeat in any direction and the pattern still maintains 4 rows of 3 repeating integers.

We extended our model to include varying values of K, the difference of the channel values within a specified distance. We produced solution sets from the extended model and developed a relationship between K and the span. A general pattern was developed from this relationship.

We tested our model against problems caused by varying conditions such as irregular transmitter placements, spurious emissions from transmitters, high voltage lines, and detection of weak signals from other channels.

Strengths and weakness of our model were considered. Our general solution allows for easy assignment of channels with minimal span under most conditions.

Minimizing Mayhem

by
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Successful Participant

Our paper addresses first the minimum safe proximity from the controller's perspective. We propose an Artificial Intelligence rule-based reasoning system solution to this problem and support the economic validity of the model.

The next issue our paper addresses is the complexity of any given air sector from a controller workload perspective. We proposed a model that related the number of airplanes to the magnitude of the variance in velocities. External environmental factors such as inclement weather and ensuing complications are accounted for in the model. The model is very simple, but also adaptable. The limitations of our complexity model, such as the need to further develop the quantification of the role played by each contributing factor, could be developed with more time.

Economic feasibility of computer enhancements has made improvements, that once would have cost millions of dollars per life saved, now more reasonable. Computers are also necessary to improve complexity modeling by statistical means. This improvement in measurement of complexity will lead to a better knowledge of how to distribute workload among controllers and divide up air sectors. This will ultimately lead to an easier job for controllers and therefore make it easier for them to keep the sky safe.