# Probabilistic Prediction of Time To Fly using Quantile Regression Forest

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Abstract— The air traffic is mainly divided into en-route flight segments, arrival and departure segments inside the terminal maneuvering area, and ground operations at the airport. In our contribution we will focus on the prediction of arrival procedures, in particular the time to fly from turn onto final approach course to threshold, which supports utilizing available capacity more efficiently. Most prediction methods developed so far provide a sole point estimate for the time to fly. We see the need to cover the uncertain nature of aircraft movement by the implementation of an probabilistic approach. This becomes very important in cases where the air traffic system is operated at its limits to prevent safety critical incidents, e.g. separation infringements due to very tight separation. Our approach is based on the Quantile Regression Forest technique that is able to provide a measure of uncertainty of the prediction, instead of a single value only. While the data preparation, model training and tuning steps are identical to classic Random Forest methods, in the prediction phase, Quantile Regression Forests provide a quantile function to express the uncertainty of the prediction. After developing the model, we further investigate in the interpretation of the results and provide different ways of deriving a probability function from it. We found, the Skew Normal Distribution provides an affirmative fit to reflect the characteristics of uncertainty in prediction. With this contribution, there becomes a tool available that allows to predict time to fly more sophisticated, depending on the specific needs of the use case.