# GOT a Flight

http://www.delay.ml/demo/

by Aviators

Technical Specifications

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# Why GOT a Flight?

The potential and complexity of the solution is that the prediction is not based on old statistics, but it is based on the future and current forecasts combined with aviation reports and multiple factors that influence the weather-related delays, such as the position of the runways at the airport, the number of runways, the aircraft specifications, the conditions for emergency landings at the departure airport, the estimated flight time and the International Aviation Standards and Regulations. All of the variables are analyzed both at the departure and arrival airport, as the impediment of landing at the arrival airport is a possible reason for delay at the departure. This information is public; the key point is to combine the correct factors and to generate the most precise rules.

It is important to note that the first version of GOT a Flight has just five airports available because of the effort involved in extracting the position of the runways from the map of each airport. This data is crucial to calculate the effect of the wind and the delay generated by the traffic in relation to the number to of runways available per airport.

In addition, GOT a Flight introduces the new concept of “insurance” in the aviation sector by offering flight insurance policies to cover extra expenses incurred due to the delay.

As part of the project, we also present a roadmap with additional features aimed to improve the accuracy of the prediction.

<u>Note:</u> *The word “prediction” is used with its literal meaning, “to predict: to declare or tell in advance, foretell”. It is not making reference to predictive modeling, which uses statistics to predict outcomes.*

# Background

According to the Federal Aviation Administration (FAA) the 69% of flight delays in the National Airspace System are caused by adverse weather conditions. Currently, the cost to the air carrier operators for a one-hour delay ranges from $1,400 to $4,500, depending on the class of aircraft, and whether the delay is taken on the ground or in the air. If the value of passenger time is included, the cost goes up to an additional of $35 per hour (personal travel) or $63 per hour (business travel) for every person on board.

In the airports with the worst weather-related delays (i.e. New York), the percentage of delays caused by the weather could reach 80%.

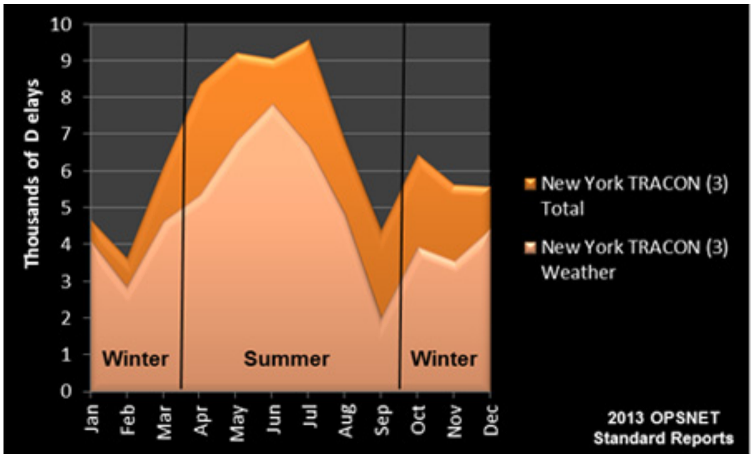


*Chart 1, Weather-related delays compared to total delays at Newark, LaGuardia and Kennedy airports*

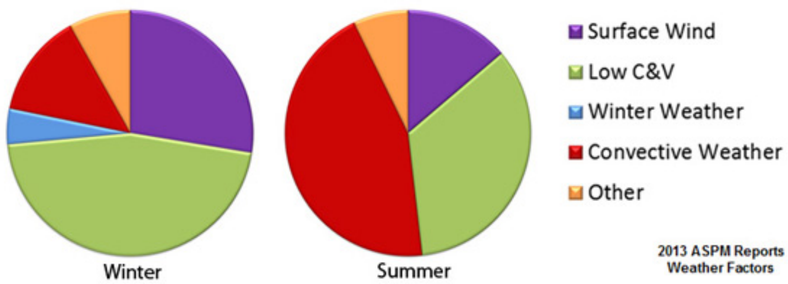


*Chart 2, Types of weather contributing to delays at Newark, LaGuardia and Kennedy*

Furthermore, a study carried out by researchers at the University of California, Berkeley, states that the cost to the passengers doubles the cost incurred by the airlines.

# Proposed solution

The complex work of predicting a flight delay was resolved by merging data from diverse sources: weather conditions, aircraft specs, airport design and International Standards and Regulations.

The result is an application that predicts the probability of a flight being delayed because of the weather conditions. Moreover, it offers the possibility to take out an insurance policy to cover the expenditures incurred due to the delay, thus proposing an innovative business model to the aviation market.

According to the FAA, the airports that have the worst weather-related delays in USA are New York (3), Chicago, Philadelphia, San Francisco and Atlanta. In order to address this scenario, GOT a Flight has been implemented for those airports to address those 120,000 weather delays.

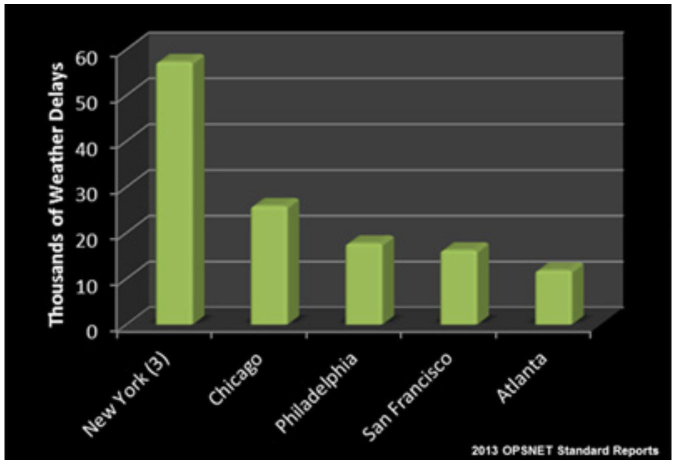


*Chart 3, Airports with the worst weather-related delay*

The application was implemented for Boeing 737, which is the best-selling plane in the aviation history. Moreover, it is one of the most used airplanes in the US and the largest 737 operator in the world is an American airline. This aircraft is a great representative of those used for regional flights.

As explained in the sections below, the aircraft is not indifferent as the calculations depend on the specifications of each particular plane.

# Prediction - How it works

GOT a Flight predicts the weather conditions by analyzing parameters within different categories and by combining all the variables involved in a flight delay:

- **Aircraft specifications:** Aircraft specs are one of the most important factors when it comes to defining minima or limitations. For example, the range of acceptable crosswinds, the certification to operate in icing conditions operations and runway limitations are all parameters given by the manufacturer. This means the delays will depend on the aircraft and that is one of the most difficult challenges of building the application.

- **National and International Aviation Standards and Regulations:** FAA and NOAA regulations and Manual of All-Weather Operations, DOC 9365, from the International Civil Aviation Organization (ICAO).

- **Weather forecast and pre-flight reports:** The application combines long term forecasts taken from forecast.io and aviation reports from the National Oceanic and Atmospheric Administration (NOAA) and the Aviation Weather Center (AWC), which are used by pilots to plan the flights.

These aviation reports include METAR, TAF, SIGMET and AIRMET, and the variables are temperature, wind speed and direction, humidity, precipitations, visibility and ceiling.

- **The position of the runways in the airport and crosswind**: The orientation (*Image 1*) is needed to calculate the crosswind, the orthogonal component of the wind toward the runway (*Image 2*). I.e., if the orthogonal component is higher than 34 knots, then the conditions are not good for the aircraft to take off. The maximum crosswind component is limited by the aircraft model and is given by the manufacturer. It is common for airports and/or airlines to have their own limitations, lowering this maximum. There might even be more limitations if there’s reduced visibility or low ceiling. In this case, the range of acceptable crosswind was taken from one of the Boeing 737 specifications document.

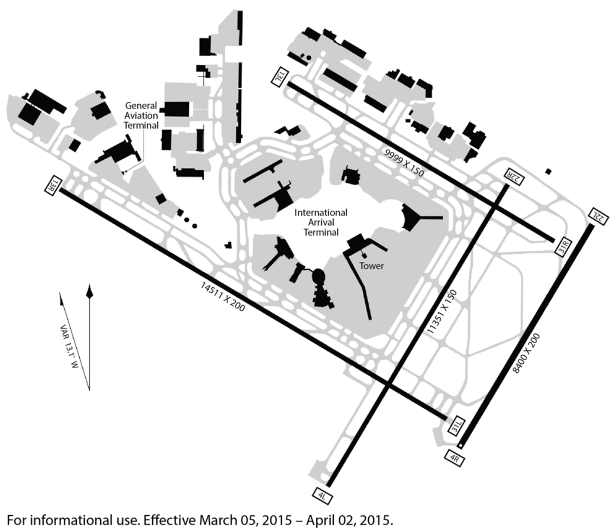


*Image 1, JFK airport map, FAA (source)*

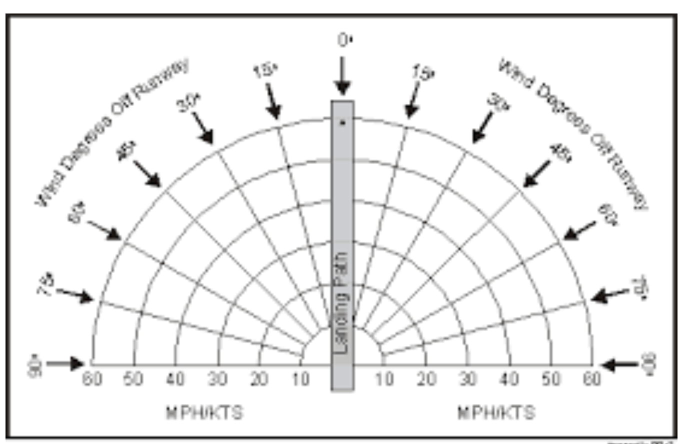


*Image 2, Wind components*

- **The number of runways available in the airport:** If any of the runways cannot be used because of the weather conditions, then the same number of departures and arrivals has to be distributed between the remaining number of available runways. This situation will also generate a delay.

- **Departure and arriving airports**: The departure of an aircraft could be delayed by weather conditions at the departure airport, but it could also be delayed due to the bad conditions at the arriving airport. There are regulations that have to be met at both the departure and the arriving airports.

- **Emergency landing at the departure airport:** For flight initiation, departure weather minima at an airport should not be less than the applicable minima for landing at that airport unless a suitable take-off alternate aerodrome is available.

- **En route analysis:** The weather during the flight itself could affect the length of the flight, causing delays at the arrival. But as this app is intended to predict delays at the departure, these conditions have not been considered.

- **Arriving airport:** The weather parameters analyzed at the arriving airport are the same as the ones at the departure (in accordance to the ICAO's Manual of All-Weather Operations). The only difference is the time these parameters are taken at: the estimated flight length is added to the scheduled departure time.

- **Visibility:** Even if the international and national standards and regulations allow take-off and landing with almost no visibility and ceilings as low as 200ft, the delays start as soon as the pilot needs to take off or land with IFR. What's more, in the most crowded airports delays could start with MVFR procedures. The limits of each type of flight can be found in NOAA's documents.

- **Icing conditions:** Most of the commercial aircraft are certificated to fly up to moderately icing conditions, but is highly recommendable to avoid flying in severe icing conditions. Even if the plane can take-off in such conditions, it is plausible that after a long taxing, the aircraft might be de-iced, resulting in delays.

- **Ceiling:** The thickness and height of clouds covering the sky, within the limits of the different flight categories: Visual Flight Rules (VFR), Marginal Visual Flight rules (MVFR), Instrument Flight Rules (IFR) and Low Instrument Flight Rules (LIFR).

# Model validation

The model has proven to have accurate results, following two different kinds of tests:

1) The prediction of the application was compared with the actual status of the flights and airports.

   For instance, the case below was recorded on April 26th, 2016, at 8 PM CT, at JFK (New York) airport. *Image 3* shows the status of the airport regarding delays due to bad weather conditions, and *Image 4* presents the prediction of GOT a Flight to fly from New York to Philadelphia on April 26th, 2016, at 8 PM CT.

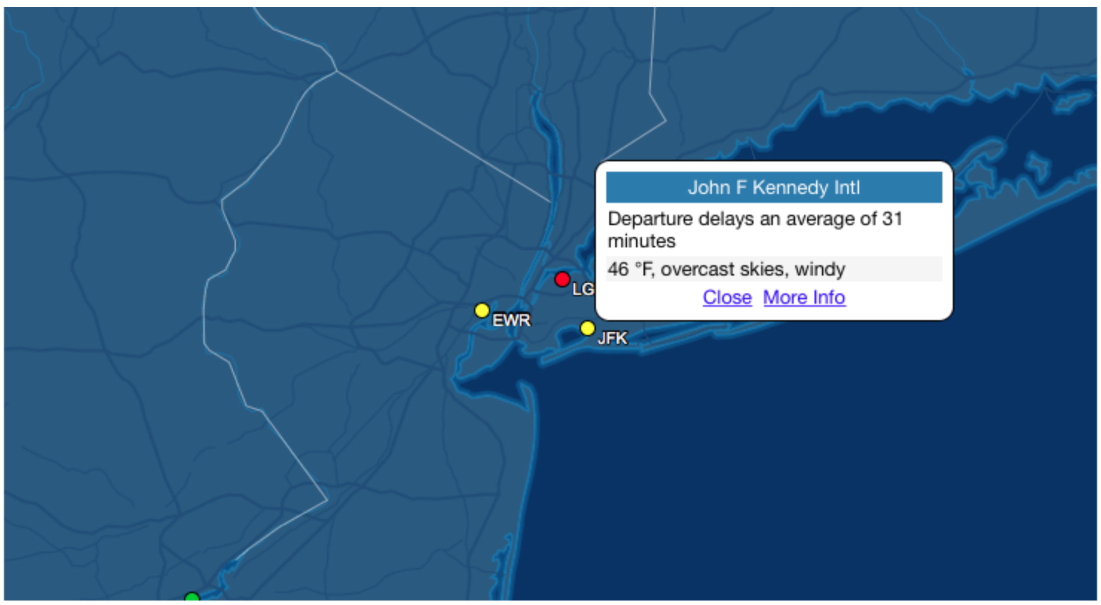


*Image 3, JFK airport delayed on April 26th, 2016, 8PM CT*
*Source http://flightaware.com/live/airport/delays*

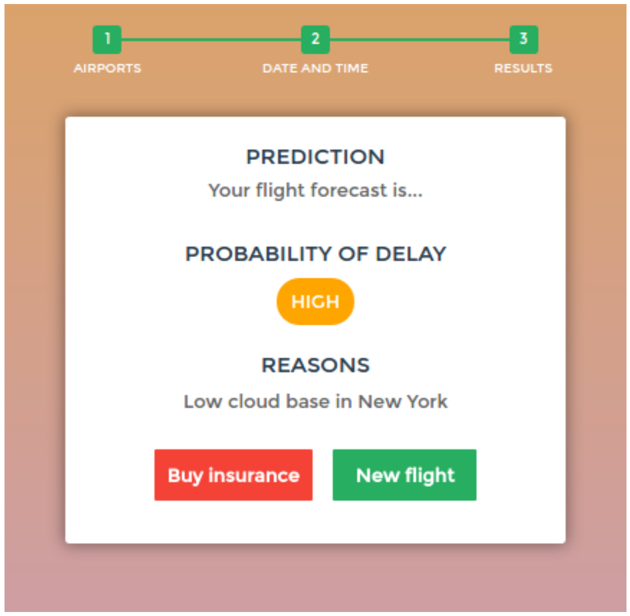


*Image 4, GOT a Flight prediction to fly from New York to Philadelphia on April 26th, 2016, 8PM CT*

2) Some historic TAF and METAR reports available in the United States Department of Transportation were selected and those data were used as input to test the logic of the application.

   For example, on January 1st, 2015, 22% of the flights were delayed in New York due to bad weather conditions, especially because of the wind speed. The wind speed and direction were extracted from the archive of TAF and METAR and the analysis suggested that 2 out of 4 runways could not be used because the crosswind was almost 28 KT. As GOT a Flight takes into account the level of availability of each runway, the prediction for that particular situation was Medium, which matches 22% of weather-related flight delays.

   TAF for JFK on 01-01-2015:

```
#####################################
#  TAF LARGOS de KJFK
#####################################
201501010321 TAF AMD KJFK 010321Z 0103/0206 24012KT P6SM SKC FM010700 25015G23KT
                       P6SM SKC FM011100 26016KT P6SM SKC FM011600
                       24019G27KT P6SM FEW250 FM020100 25017KT
                       P6SM SKC=
201501010539 TAF KJFK 010539Z 0106/0212 25016KT P6SM SKC FM011600 25020G28KT
                       P6SM FEW250 FM020600 26014KT P6SM SKC=
201501010841 TAF AMD KJFK 010841Z 0109/0212 25016KT P6SM SKC FM011600 25020G28KT
                       P6SM FEW250 FM020600 26014KT P6SM SKC=
201501011139 TAF KJFK 011139Z 0112/0218 25016KT P6SM SKC FM011600 24020G28KT
                       P6SM FEW250 FM020400 26014KT P6SM SKC FM021500
                       28012KT P6SM FEW250=
201501011431 TAF AMD KJFK 011431Z 0115/0218 26014G23KT P6SM FEW050 FEW250 FM011700
                       24020G28KT P6SM FEW250 FM020400 26014KT
                       P6SM SKC FM021500 28012KT P6SM FEW250=
201501011721 TAF KJFK 011721Z 0118/0224 24020G28KT P6SM SCT250 FM020000 25016G22KT
                       P6SM SCT250 FM020300 26013KT P6SM BKN250
                       FM021400 28014G20KT P6SM BKN250 FM022200
                       29011KT P6SM BKN250=
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201501012333 TAF KJFK 012333Z 0200/0306 23018G26KT P6SM FEW250 FM020500 26014KT
                       P6SM SKC FM021400 28015G23KT P6SM SCT250
                       FM022200 29013KT P6SM SCT250 FM030300 30007KT
                       P6SM SKC=
```

*Image 5, TAF for JFK on 01-01-2015*

- The TAF shows a wind speed between 23 KT and 28 KT, and wind direction 240º.
- JFK has 4 runways with the following orientation: 40º, 130º, 220º and 310º. Runways with an orientation of 130º and 310º could be delayed because of the crosswind, so the remaining ones needed to handle almost all of the airport traffic.

# Business Model – Insurance policy

In order to take advantage of the predictions generated by GOT a Flight, the passengers are offered the possibility to take out an insurance policy to cover extra expenses incurred because of the potential delay. As the prediction is based on a probability, the model is compatible with an insurance policy structure.

As in initial approach, one of the possibilities is to negotiate with insurance companies that are not associated with the airlines and to offer an insurance package based on the predictions. The price and terms of the policy will be dependent on the probability of occurrence. Aviators will offer the companies a service ensuring the application is updated, that it contains reliable data and will offer them additional details that could be useful to be competitive in the insurance market. This insurance policy would be completely independent from any compensation paid afterwards by the airlines.

At this point, further research on the insurance policy market is needed to determine which the proper business model would be, but the main idea is to use the predictions to offer insurance policies to revolutionize the air travel business.

# Roadmap - Improvements Aviators is working on

- Implement Supervised machine learning techniques to gain even more accuracy upon each delayed flight predicted. Currently the application is hosted in IBM Bluemix, so a potential candidate could be the Watson service.
- Add more forecast sources and validate estimates: detect if the weather prediction of a particular source is not reliable at a particular time.
- Include historical statistics and compare them with each prediction to test the results and adjust the estimate if found beneficial.
- Check and analyze non-weather data to cover more delay factors, apart from weather conditions.
- Load more aircraft models and airports with the corresponding specifications.
- Insert the flight number instead of the itinerary.

# Resources

- Aeronautical Information Publication (AIP)
- National Oceanic and Atmospheric Administration (NOAA)

- Aviation Weather Center (AWC)
- Federal Aviation Administration (FAA)
- Aeronautical Charts (Instrument Flight Rules Enroute High Altitude Charts) - FAA
- Boeing 737 - 600/700/800/900 Flight Crew Training Manual
- International Civil Aviation Organization (ICAO): Manual of All-Weather Operations - DOC 9365
- United States Department of Transportation, Bureau of Transportation Statistics
- Forecast.io
- University of California, Berkeley: Flight Delay Study - http://its.berkeley.edu/node/2299
- IBM Bluemix