

DATA SCIENCE IN AVIATION

2018 WORKSHOP

11th october

EASA HEADQUARTERS

Machine Learning; forecasting safety risk and performance

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Machine learning to predict safety events



Risk Analysis Tool (RAT) is a methodology used to classify safety related occurrences in the Air Traffic Management (ATM) domain. Events which involve a loss of standard separation between aircraft and for which an air navigation service provider (ANSP) had some contribution are those which score what is referred to as "RAT ATM ground points". ANSPs try to minimise the occurrence of all safety related occurrences, whether RAT-scoring or not.

There are a small number of events making the operation relatively safe but what can we do to improve/enhance the operation and make it more resilient?

- Short term forecasting
- Long term forecasting

Part 1: Short term forecasts

Last year we introduced machine learning to help us predict the likelihood of potential safety events – such as **aircraft level busts**, or **airspace infringements** – in our London Terminal Control operation.

Complex issue with possible links to many variables such as:

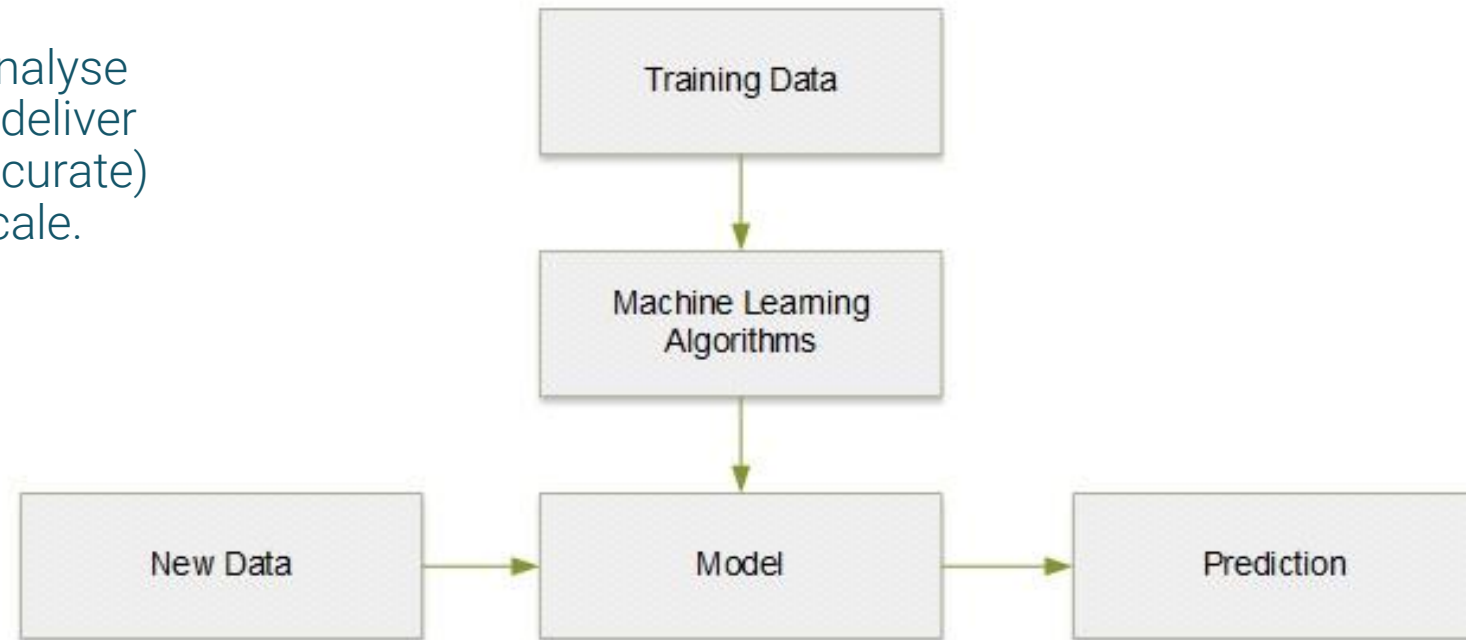
- Traffic volume
- Airport runway direction
- Weather conditions
- And more!

Machine learning

Learns from previous data and computations to predict decisions and results for new, unseen data.

Can produce models that can analyse bigger, more complex data and deliver faster (and often times more accurate) results – even on a very large scale.

Typical Machine Learning Process Flow

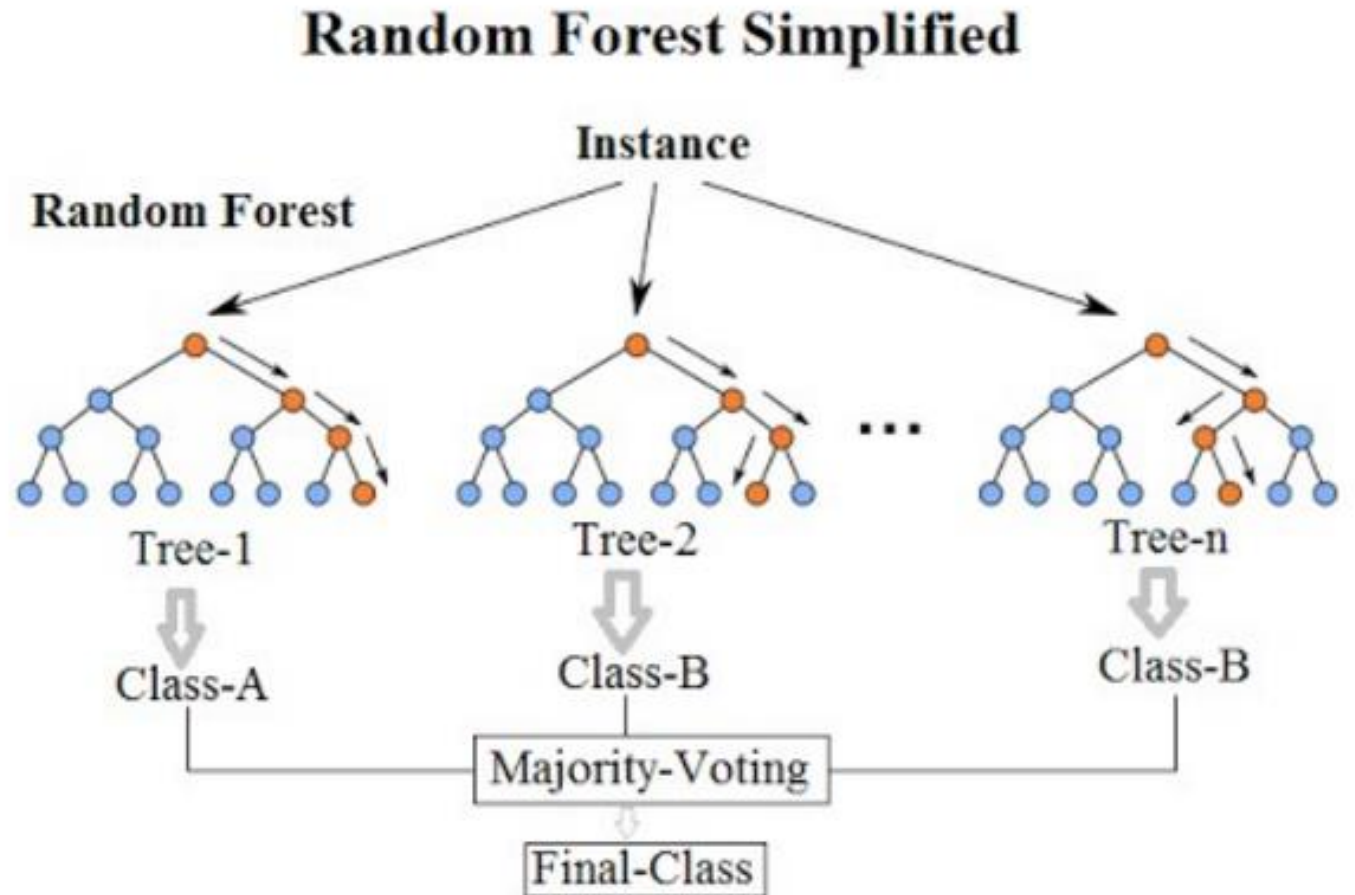


https://cdn.infoq.com/statics_s2_20170411-0445/resource/articles/apache-spark-machine-learning/en/resources/fig1.jpg

Random Forest

Fits a number of decision tree classifiers on various sub-samples of data and uses averaging / majority vote to predict classification.

Improved accuracy vs. standard decision tree and helps control over-fitting.



https://d2wh20haedxe3f.cloudfront.net/sites/default/files/random_forest_diagram_complete.png

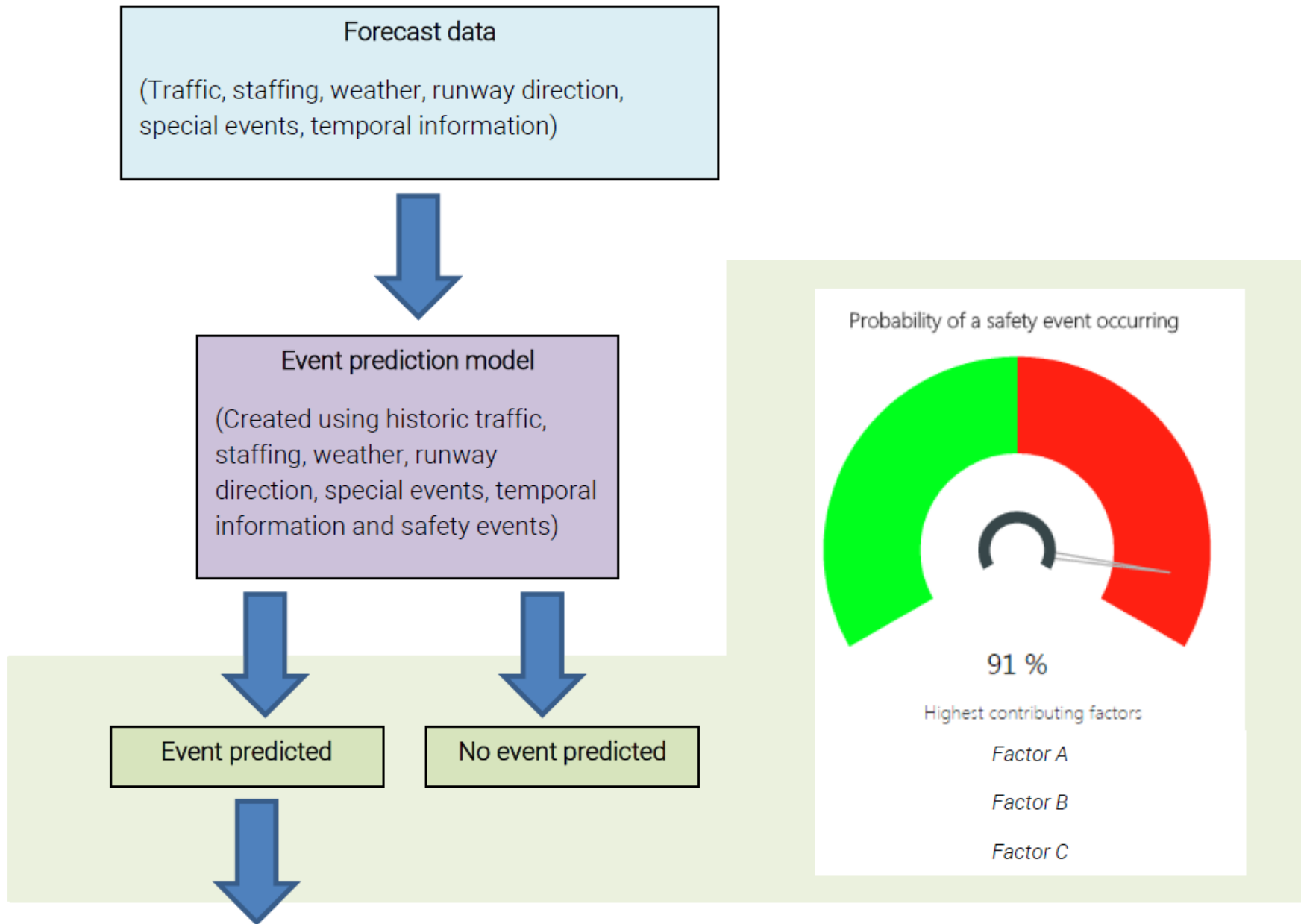
Weekly risk forecast

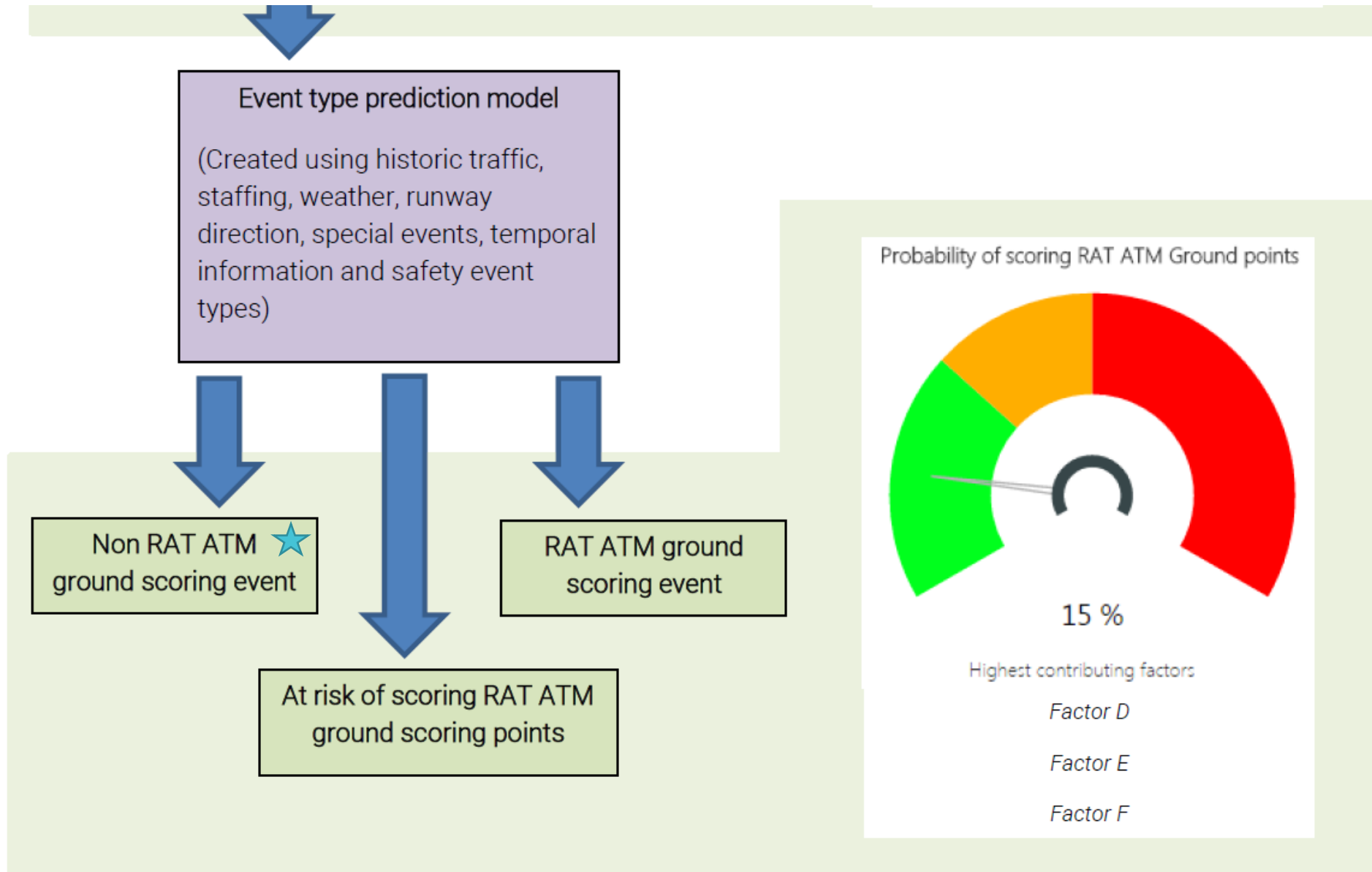


Since March 2017, we've been using this data to present a weekly forecast to our colleagues at London Terminal Control that can alert them if our modelling suggests corrective action could avoid a potential issue days before it might occur.

Date	Risk
23/04/2018	Medium
24/04/2018	Low
25/04/2018	Medium
26/04/2018	Medium
27/04/2018	Low
28/04/2018	High
29/04/2018	Medium

Note: example output only





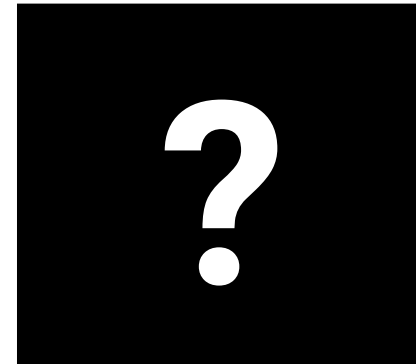
★ Aircraft level bust,
airspace infringement
of Air Traffic
Controller overload.

Black box

Aviation – extremely secure device designed to provide investigators with highly factual information about any anomalies that may have led to incidents during a flight.



Machine learning – data goes in and an answer comes out, what happens in the box is unknown.



Opening the box



By understanding the decisions the algorithm is making and the factors that contribute to them we can be better informed in our own decision making.

Depending on the situation we could reduce risk by:

- Applying regulations on traffic flows
- Splitting bandboxed sectors
- Having an extra controller on hand
- Generally being aware of the situation

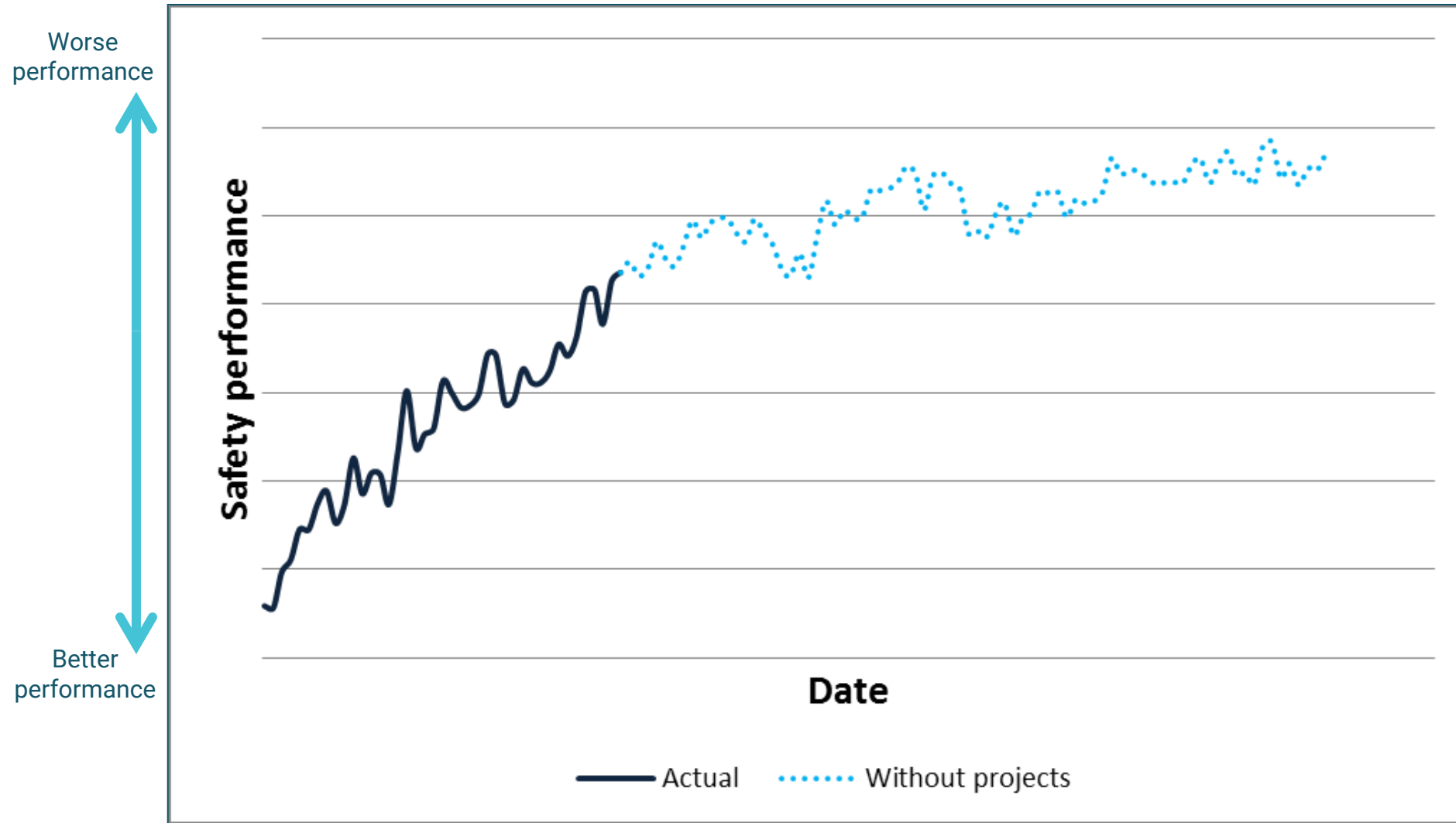
Part 2: Long term forecasts



A holistic model to help us better understand the challenge of rising growth in aviation traffic and the impact it could have on our operation.

This holistic model sees us take our traffic predictions up to 2024 using bespoke algorithms and historic data from the operation. We apply machine learning to forecast the potential impact of the rise in traffic per sector on **delays, safety** and the **environment** if the current capacity and ways of working remained the same.

Long term forecasts



Note: example output only

Benefit assessments

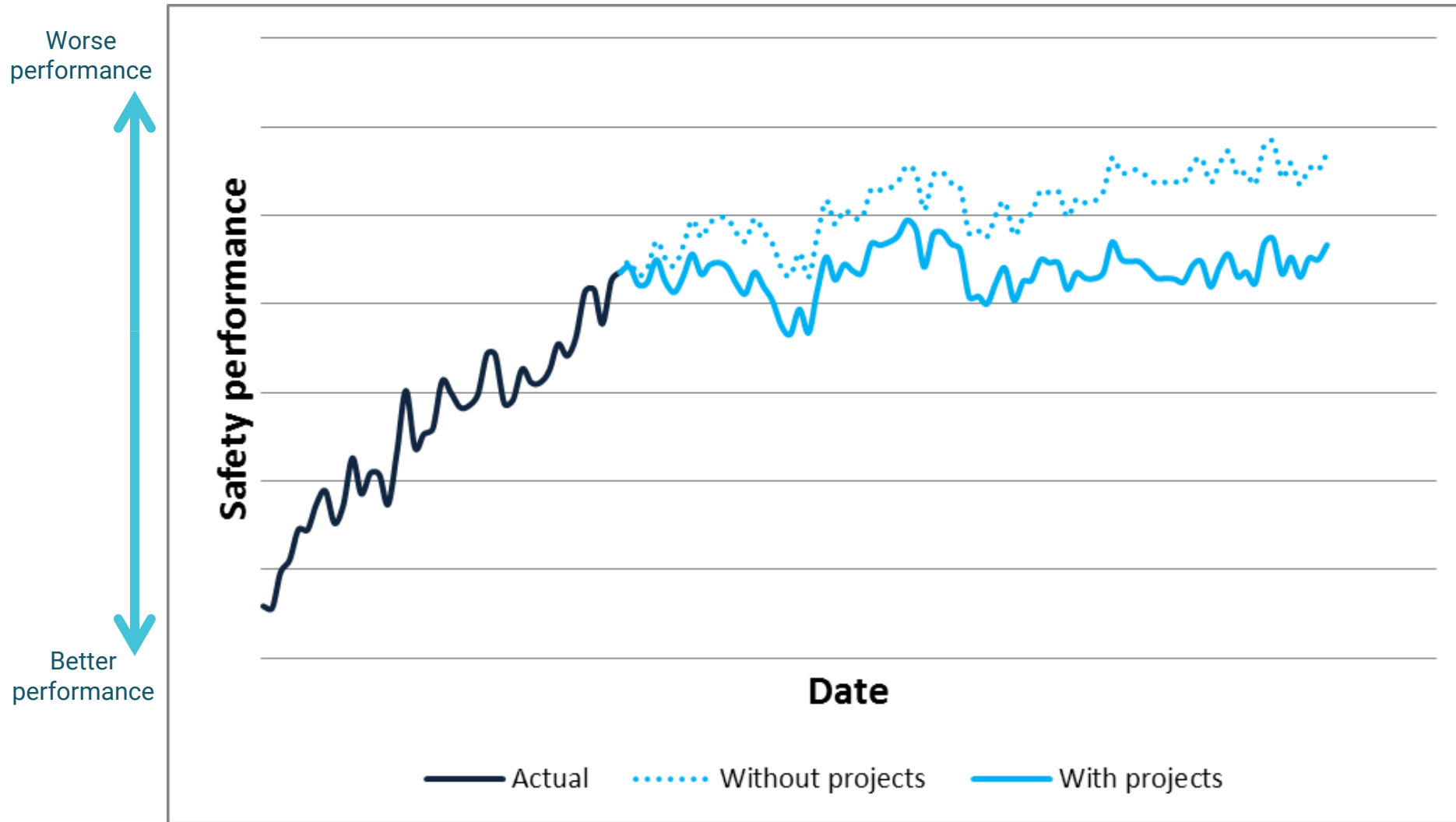


To adjust the forecast to take account of future planned projects we need an estimate of the percentage change on the safety performance of projects.

In early stages estimates are constructed with project teams but Air Traffic Controllers are felt best placed to relate the changes in tasks to their ability to control effectively so final assessment is from them.

Percentage changes are adjusted to take into account the area affected by the project as well as the frequency of relevant events.

Long term forecasts



Note: example output only

Long term forecasts



- Helps give us the 'big picture' of what to expect
- Allows us to drill down and take a closer look at how our ongoing and upcoming transformation projects could have an individual effect on efficiency, safety and the environment.
- Able to model varying timings and scope for projects, and optimise decision-making to help meet the future regulatory targets.
- Could be used to make the case to key policy and decision makers in the aviation industry, and to our customers.

Any Questions?

