DIGITAL ACADEMY WEBINAR

Towards higher levels of automation – Artificial Intelligence (part 1 of 2), 22 July 2020

Questions and answers

Question	Answer
For Professors Pugh and Shand: did you studied in detail also Capacity Constraint Situations?	Heathrow is a classic example of a constrained environment where the runways are scheduled to 99% of declared capacity. This is what has driven the need to develop tools to get the most out of the constrained capacity. Heathrow is not unique, many airports have schedule peaks that can be helped by tools like TBS/IA. The benefit of this type of tool is that it can get the most out of the runways at much lower cost than alternatives like runway and taxiway infrastructure.
I think the first step to get reliable trustworthy to have a reliable data base	eTBS tuning is built on operational data both to understand the variation seen in the operation and the factors that influence that variation. Therefore a comprehensive set of data taken over several months/years is key.
What is the scalability of the distribution discriminator since it relied on splitting the input domain into hypercubes ?	Jesus Garcia: I have no context to reply in detail. In general, hypercubes have bad scaling with the number of input variables, requiring feature selection/transformation filters to improve performance, like PCA/LDA algorithms. Additional answer from Guillaume Soudain: with such an approach like using a distribution discriminator, scalability is surely an issue that may limit the complexity of applications. For safety-critical applications in aviation, we consider however that the proper management of the operational state space is essential when providing guarantees on the performance of the machine learning application with an adequate level of confidence.
Do you think that the Covid-19 crisis has an accelerating, slowing down or no effect at all on the integration of AI in ATM? And if so, which applications will accelerate?	The interaction between the Covid-19 crisis and innovation in ATM has the topic of discussion of a previous DIGITIAL SKY VODCAST. See our website for the recording of “HOW CAN ATM INNOVATION HELP AIRLINES AND AIRPORTS IN THE RECOVERY?
Hello Guillaume, do you think it will possible to specify explicitly requirements for complex data (e.g. images)?	Not sure if is it possible but this is not the direction we took in the EASA AI roadmap. Our proposed approach is rather based on the fact that the operational, safety and functional requirements should pre-exist the data. The datasets are then selected based on the need and verified for quality and completeness.
My understanding of Level 3 is that the AI starts being responsible for certain tasks. Within those tasks, the AI not only "proposes" actions to the users, but also takes decisions on those actions and implement them. Is this correct?	One should distinguish the levels of automation as defined in the European ATM masterplan from the waves of AI that are explained in the presentation of professor Garcia. Artificial intelligence is a only subset of automation as identified in the masterplan. Automation also includes conventional

	programming techniques like linear programming for which predictable and explainable behaviour is more straightforward. The strength of AI is in particular in the task of information analysis, where decision and action selection is more likely to remain in the hands of the controller. Additional answer from Guillaume Soudain: if you refer to the levels of AI/ML proposed in the EASA AI roadmap, then Level 3 is indeed corresponding to cases where the AI would take over some tasks, including the decisions on the actions to perform. We are not there yet but surely have to prepare for such applications.
1. Are there any thoughts of Algorithm Certification and maybe regular recertification?	Guillaume Soudain: we cannot talk of “algorithm certification” as EASA certifies only products (aircrafts, engines, propellers). However, in the future it could be envisaged to create a framework for easing the reuse of certain algorithms in some conditions but this is not a possibility for now. For instance, one limitation that will not disappear even with the use of ML algorithms is that safety-critical software has to be approved together with the hardware platform it is running on, so we could not “qualify” the algorithm independently.
Will we receive a copy of the presentations?	Yes and the webinar will be recorded so you can watch this back at a later stage
Was TBO deterministic? This is: should it be classified as a "first wave" Artificial Intelligence? Or is it really a "black box" algorithm?	It is probably more about using automation to simplify complex tasks for the controller than pure AI. ML may well have a role in continued monitoring and adaptation of system parameters.
Can the tool also be applied in case of bad weather conditions like fog, snow, fog, storm	Yes the tools allow application of spacing requested by tower or approach. minimum spacing for these rules is set by ATC.
Can algorithms from second/third waves be used to determine rules to be used by "first wave" interpretable algorithms ?	Only in particular aproaches the result of learning can be used as interpretable algorithm, this is the case of rule induction/tree induction algorithms or bayesian learning approaches, for instance. The decisions can be traced at logical level, and the learning result can be stored as solutions of “expert systems” type in the first wave. However, in general machine learning algorithms performing space transformations from the input variables to transformed features are very difficult to trace and explain, since new features have no semantics associated, losing the capability to reason about decisions.
Firstly - thanks for a very interesting webinar! A question related to AI and the importance of data quality, its' source and problem solution: How is the source and quality of data ensured? And how is it ensured that focus is on the "correct" problem that needs to be resolved?	We developed the tools and ran a period of shadow mode operation to validate them before they were used in live operation. There are key issues such as the Wind Condition Service which was validated with 1 year of real data before the system was first put live. Our focus was driven by our safety case and by feedback from the core ATC team that were involved in developing the tools.

In my understanding current ROT increments on the indicator are spaced at increments of 0,5 nm. How would this work if ML is used to calculate ROT increments? Would a more diverse range of ROT increments be used? Making this more efficient but less predictive	ROT and Wake is in 0.1 nm increments. With Pairwise we are working to further optimise ROT to take into account the external factors that affect it such as weather.
How do you assure the reliability of the ML output and do apply tools like explanation tools like DALEX to understand the model.	We are working with Eurocontrol to assess the benefits and issues with using ML to tune the tools
How do you build&feed with data the reference system/model used for the algorithm safety assurance?	The Intelligent Approach Tool outputs parameters which we plug into a business information system to generate reports to allow tuning of the tool and we also update the system when changes like new aircraft types need to be accommodated. The reference system is maintained so that when we update the core software that is also updated in the separate reference system which we use for Complex Algorithm Verification. The CAV software is created independently from the Core IA software so that it can be used as a truly independent check
What aircraft parameters do you use from the Mode S to derive the wind data? Any rough approximation on how accurate your Mode S wind calculation is compared to the ADS-C solution?	We use Mode S DAPs and RADAR data and our error rate is c. 0.006% of samples have up to a 10 knot error. This is far better than any met system could provide and is proven over many years.
What is the nature of the independent reference model ? Is it qualified ? Thank you for this nice presentation	Thank you. The reference system was developed by a separate organisation that is part of our delivery team - Specifically by Think Research. We keep it up to date as we continue to update the Core Product software.
the IA System be pushed out to top of descent? Then the logical next step might be to upload the plan to the aircraft. The aircraft could then have a magenta 3D line to follow which would result in perfect spacing to touchdown.	One of the great benefits of IA is a very accurate wind model and the ability to provide controllers with separation and spacing that is automatically adapted for wind vectors. It is absolutely the intent to push this out further along the approach transitions and STARs. There is no reason in time why this target separation could not be uplinked to the aircraft but that is more of a question of airborne equipage. The great example is multiple transitions to a common merge
what kind of ML model is used to fine-tune the parameters of the ORD model ?	Currently it is done through data mining on 12-months of data. But in SESAR we are working with ECTL to understand if there is any opportunity to use ML by comparing the operational system with a ML version.
How much tolerance is there on the touchdown time?	The tools dynamically update with each RADAR update and using the real time wind data generated by the tools from Mode S. There is an allowance for error built into the safety case. The other thing we recommend is working with airlines and ATC to improve
Does this AI consider situations such as go-around and other common patterns?	The safety case considers go-around and ILS capture scenarios and the tools are calibrated for the airspace, runways and procedures for each airport.

Question for Professors Jesus and Marc: in your opinion, what will be the role of neuroscience (i.e. neuroergonomics) in human-machine interaction and future implementations (waves) of AI? Thank you.	There is a relation of mutual inspiration and joint development between AI and Neuroscience researchers. Human brain is the model for building machine learning new algorithms inspired in neuroscience. Conversely, AI boosts research in neuroscience, taking the behaviour of AI systems as help to interpret better our brains. Some interesting ideas and needs of interaction between these communities are mentioned in Deepmind web: https://deepmind.com/blog/article/ai-and-neuroscience-virtuous-circle An interesting challenge in modern AI solutions interacting with humans is how to transfer learning to human operators in order to deal with complex situations, how to transfer the context to make sensible decisions. In this sense, neuroscience would be very helpful to do this transfer in a progressive way and optimize the training time. Understanding task learning processes in human brains would optimize the interaction with AI systems.