

Roadmap to AI/ML in Aviation at the FAA

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Finding: Detail Phased Roadmap for Artificial Intelligence (AI) and Machine Learning (ML) - The Subcommittee on Aircraft Safety appreciates the response from the FAA regarding our recommendation from our Spring 2022 meeting regarding the need for industry to have a published phased roadmap for AI/ML regulatory guidance from the FAA. The Subcommittee on Aircraft Safety further appreciates the efforts in which FAA is working with NASA to develop an Autonomy V&V Vision 2045, with an associated roadmap.

However, the Subcommittee on Aircraft Safety views AI/ML as a different portfolio of technologies than autonomy technologies. While AI/ML technologies can be used for autonomous operations, it is also possible to use more traditional technologies such as deterministic systems for autonomous operations. Furthermore, AI/ML can be used for applications other than autonomy, such as providing advisory information to a flight crew, which is unrelated to autonomous operation of the air vehicle. Industry is reluctant to introduce AI/ML technologies into new products due to the current certification uncertainties.

The Subcommittee on Aircraft Safety re-emphasizes the importance of developing this roadmap with enough details to ensure it adequately informs industry on the sequence in which the FAA plans to release regulatory guidance on methods and procedures to (1) certify systems of various safety criticalities, (2) certify AI/ML based on various types and sources of AI/ML training and testing data, and (3) procedures for updating AI/ML models in previously certified systems based on updated training and test data sets. Other regulators have issued such a roadmap. However, they have been vague, ambiguous, and not useful to the industry in supporting their business models.

 <u>Recommendation</u>: -Given the speed at which demands for AI/ML technologies are being developed, the REDAC Subcommittee on Aircraft Safety reiterates its previous recommendation for the FAA to expeditiously prepare and published a detailed phased roadmap for AI/ML research and development required to formulate AI/ML regulatory guidance, taking into account the FAA safety continuum and use case to accelerate deployment for lower risk aviation applications.



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Agenda

- Introduction
- Background: Technology Assessment
- Goals
- Scope of Current Year 2023
- Methodology
- Work Breakdown Structure
- Schedule
- Supporting Research





Introduction

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 - a technical guidance is supported by R&D work that provides the core specific procedure/instruction for the implementation



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 - current definition/scope of Al is broad
 - one area of AI that receives considerable attention is machine learning (ML)
 - advantage: easy to use in the design process without requiring specific engineering knowledge
 - disadvantage: *difficult* to verify and validate (for certification)



Historical timeline





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Historical timeline





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 - to prepare a *feasible* roadmap for the FAA to *certify* AI/ML components in avionic/aviation systems
 - should use as much existing framework as possible
 - should harmonize with the international regulation communities
 - should leverage the FAA's safety continuum



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Hardware latent failure rate	DAL – Software & Hardware	Part 25	Part 23, Class IV	Part 23, Class III	Part 23, Class II	Part 23, Class I	Small Drone (D&R)
1e-2	Demo						Loss of drone*
1e-3	Demo (drone) SLV** (23) D	Minor	Minor	Minor	Minor	Minor	Loss of drone
1e-4	Demo (drone) SLV(23)					Major	Loss of drone
4 5	C						
1e-5	C	Major	Major	Major	Major	Hazardous	
1e-6	SLV C				Hazardous	Catastrophic	
1e-7	SLV				Catastrophic		
	С			Hazardous	Calastrophic		
	В	Hazardous	Hazardous				
1e-8	В			Catastrophic			
1e-9	A	Catastrophic	Catastrophic				



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- The scope of 2023 is to develop a roadmap to certify AI/ML systems to encourage industry to engage in innovative AI/ML
 - focusing on short-term goal allows feasible final deliverable product while gaining more insights on how to accomplish longterm goal



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 - certification is focused on the three overarching properties
 - OP 1: intended functionality
 - OP 2: correctness
 - OP 3: innocuity



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 - AI/ML terminologies are not even uniformly defined
 - using basic engineering terminologies allows a broader acceptance
 - cross-table lookup allows a synchronizing connection with existing documentations from other standard organizations and regulation authorities



• Examples of ML Trade Jargons

- uncertainty in learning



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- bias in artificial neural network



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Work Breakdown Structure





Schedule





University Research: efficient computational procedures to evaluate OP-1 and OP-2 for ML



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- Government Collaboration: runtime assurance of ML systems with safety analysis for OP-3
- Industrial Research: safety assurance and cybersecurity
- FAA Internal Research: to proceduralize and generalize ML certification process to all AI applications



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 - script programming language



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 - script programming language
 - numerical inputs, numerical outputs



```
for(int ii = 1; ii < nLayers; ii++)</pre>
  for(int jj = 0; jj < nNeurons[ii]; jj++)</pre>
  {
    input[ii][jj] = 0.0;
    for(int kk = 0; kk < nNeurons[ii-1]; kk++)</pre>
    {
      input[ii][jj] = input[ii][jj] + input[kk][jj] * weight[kk][jj];
    }
    input[ii][jj] = activation( ii, jj, input[ii][jj] );
```



```
Supporting Research (Software)
for(int ii = 1; ii <(nLayers;) ii++)</pre>
  for(int jj = 0; jj < nNeurons[ii]; jj++)</pre>
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 - cannot verify that the configuration of ANN fits the training data
 - cannot verify that the parameters of ANN satisfy the functional requirements
 - cannot enforce that the codes and parameter values are protected





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Final Remarks: History of SECOND



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Thank you very much Merci beaucoup **Muchas gracias** Cám ơn rất nhiều 非常感謝 **Grazie mille Muito obrigado Moltes gràcies**





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Hitchhiker's Guide to the Galaxy - Number 42

The Ultimate Question of Life



Hitchhiker's Guide to the Galaxy - Number 42





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Moral of the story: computers are numbercrunching machines, they just mimic the intelligence of human



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