



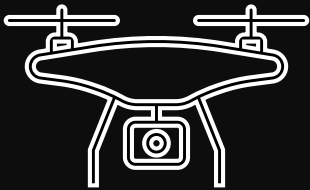
Challenges of machine learning in eVTOL aircraft systems reliability and safety

by Marcos Salvador
M. Sc. student Polytechnique Montréal /
Aerospace RAMS engineer

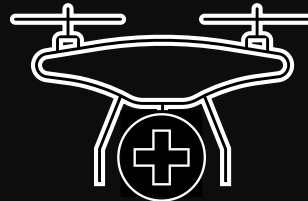
Urban Air Mobility (UAM)

“It is broadly defined as a spectrum of new aviation capabilities serving densely populated areas with a variety of public and commercial services”.

Main services:



- Small package delivery,
- Aerial photography,
- News reporting
- Infrastructure inspection,



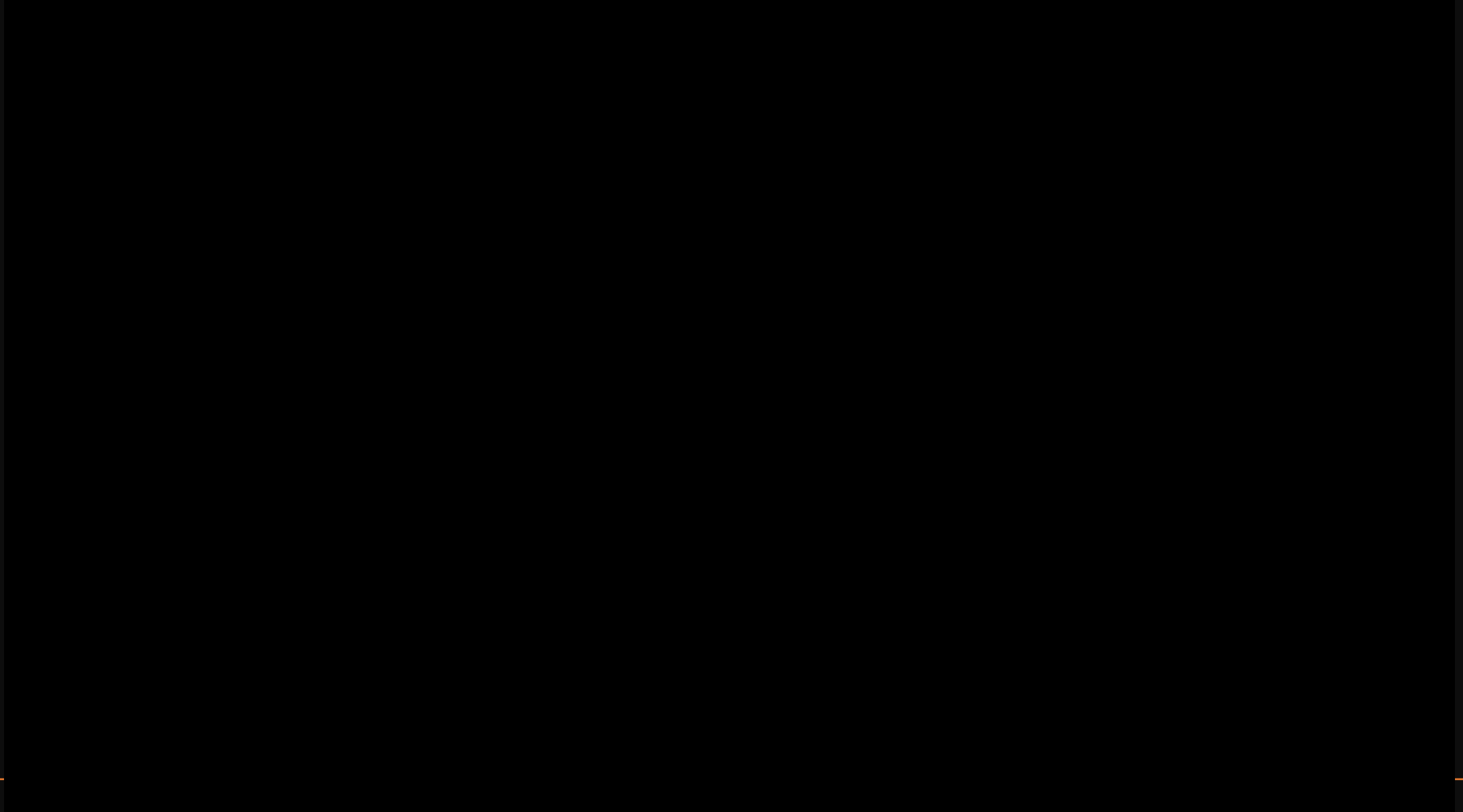
- First responders
- Law enforcement functions



- Air Taxi (Flying cars)
*(scheduled services /
On-demand ride)*

NASA - National Aeronautics and Space Administration)

eVTOL – Electric Vertical Takeoff and Landing



eVTOLs - Commonalities

- Vertical takeoff and landing (operational versatility)
- Electric or hybrid propulsion for low cost and high reliability
- Multiple rotors (smaller and quieter than conventional helicopter rotors)



Photo credit: Lilium GMBH

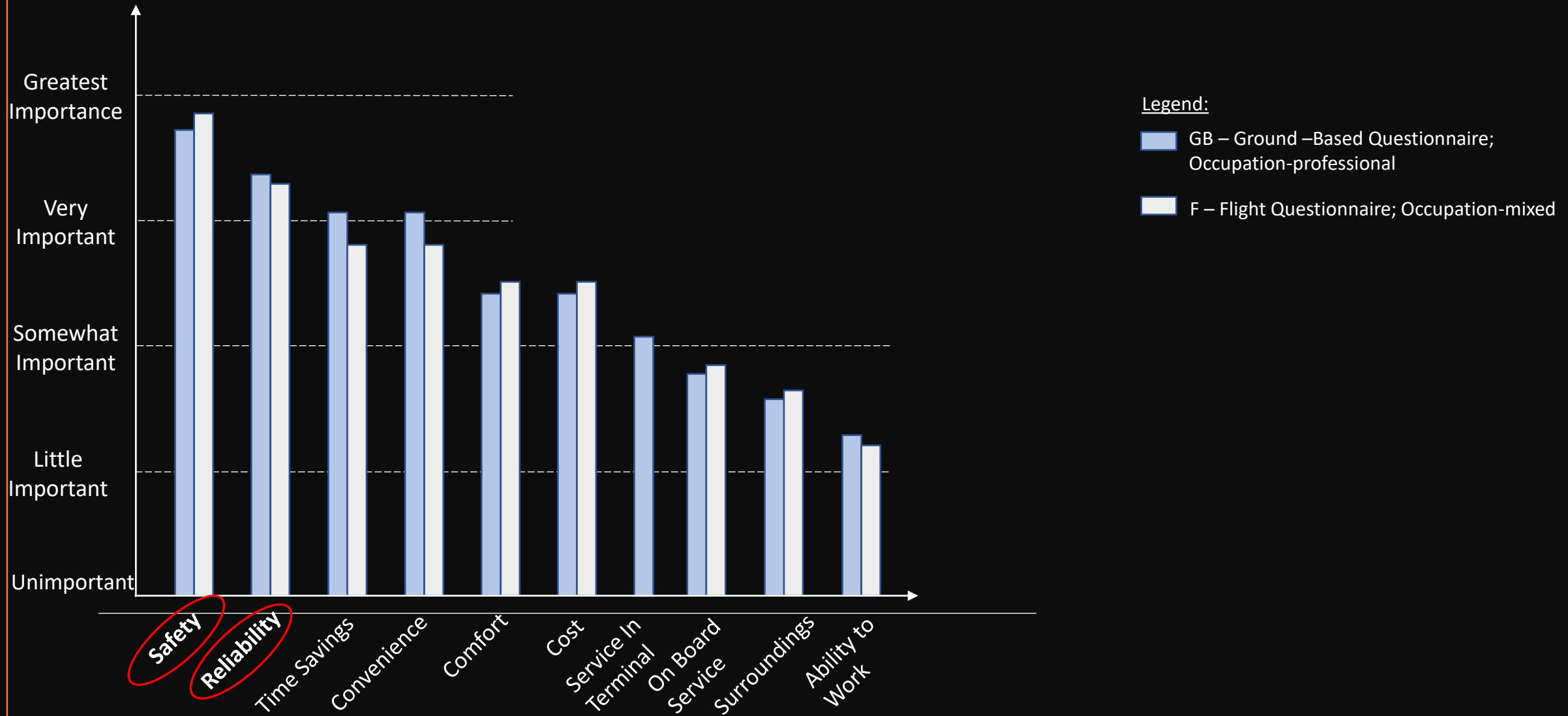


Photo credit: Joby Aviation



- Increasing number request received by EASA for eVTOL type certification
- Traditional airplanes / helicopters manufactures and new players.
- Evolution of aircraft systems' monitoring technology and increasing amounts of data (Big Data)

Comparative Importance of Various Passenger Experience Factors when Evaluating a New Transportation Option



Aeronautical Accidents

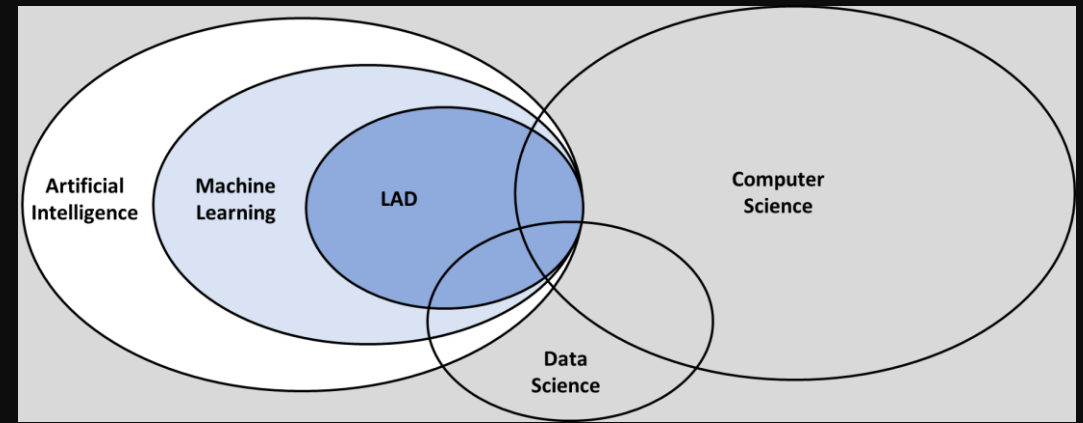


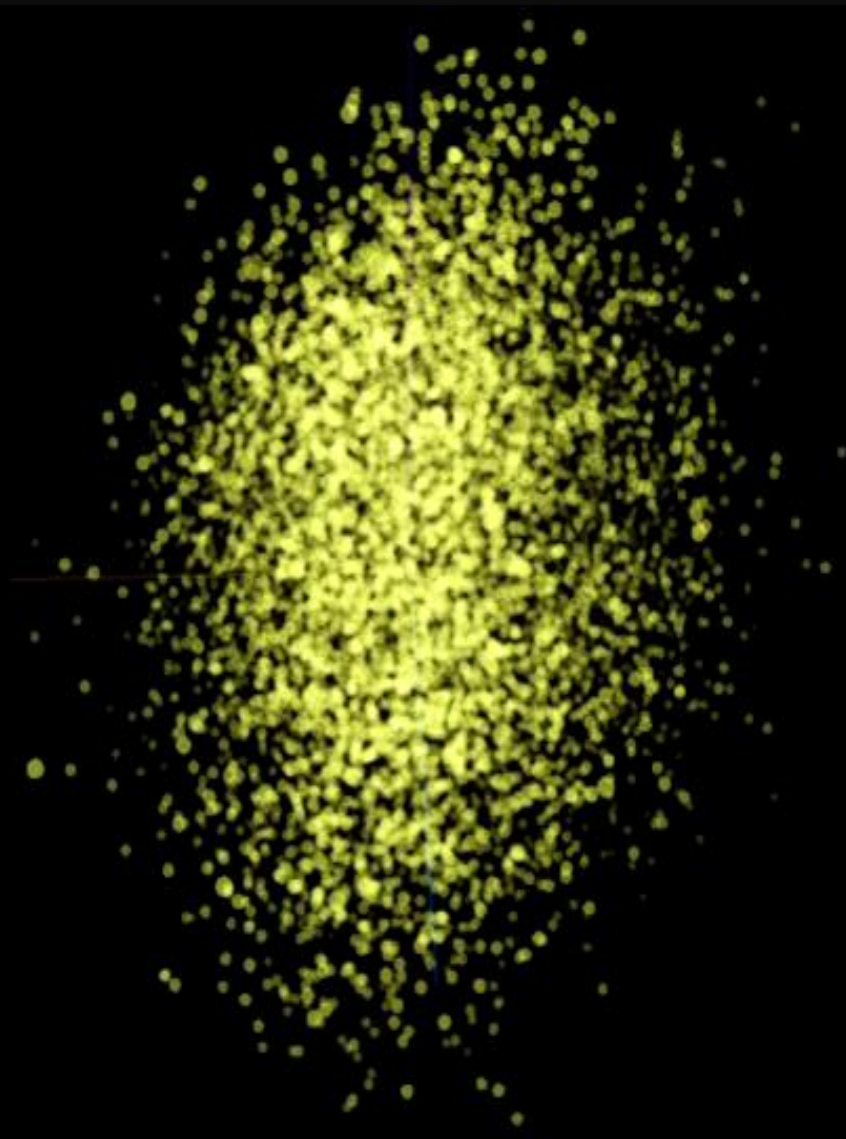
- The number of aeronautical accidents has decrease over the last years.
- 60 – 80% of those accidents are result of human-failure.

Autonomous Flight

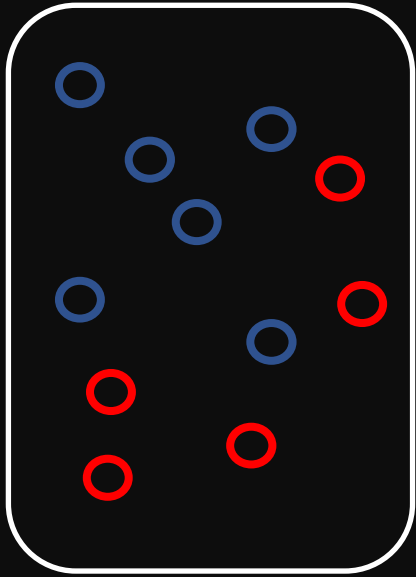
- Several eVTOL operators intent to have the autonomous fly capability
- Current aircraft have had their systems being automated for years. Challenges: Diagnosis, Addressing ambiguity and etc.
- In initial stages of eVTOL implementation Machine Learning can support in the safety assessment process (identification of unknown-unknown failure scenarios / support pilots predicting system failures and improving reliability and safety).
- In an advanced stage of eVTOL operation, ML may support to reduce the human interaction with eVTOL, that opens possibilities for an autonomous aircraft

Logical analysis of data (LAD)

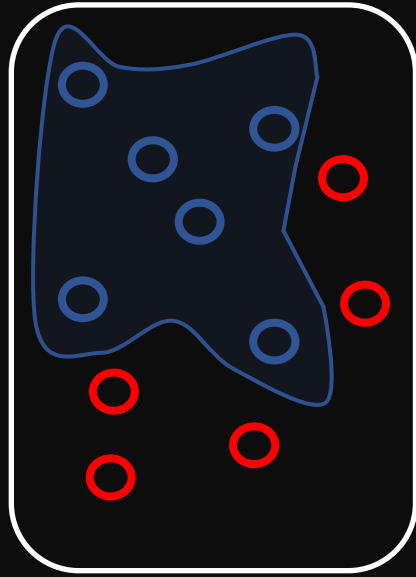




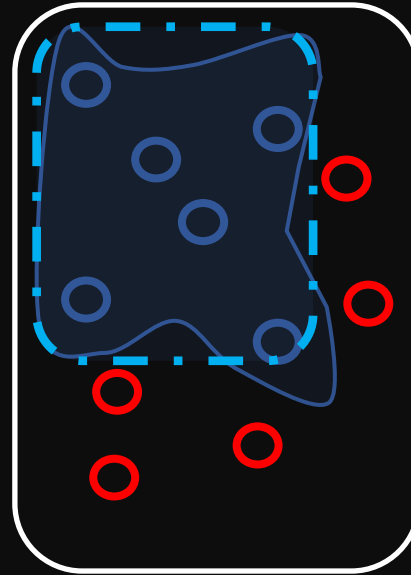
- **Logical Analysis of Data** makes it possible for input signals variables or condition indicators of different physical components to be combined and compared in multiple scenarios, in a process known as pattern recognition and interpretation of physical condition.
- Targeting: Risk assessment, Reliability, and Cost Reduction



Training Dataset



Hidden Patterns

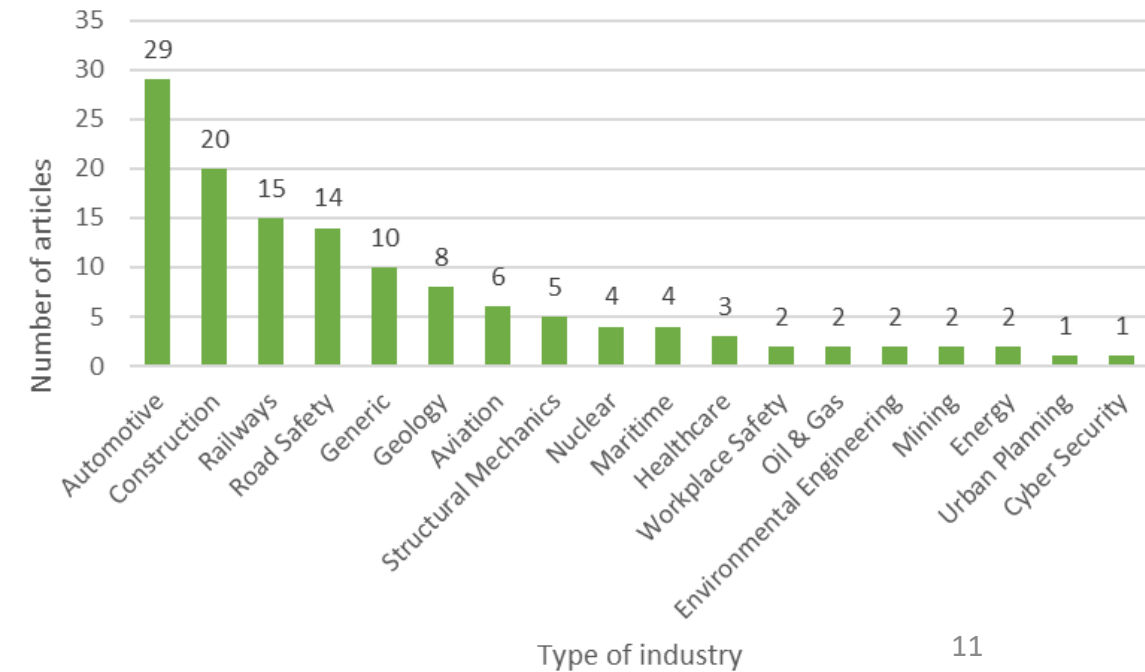
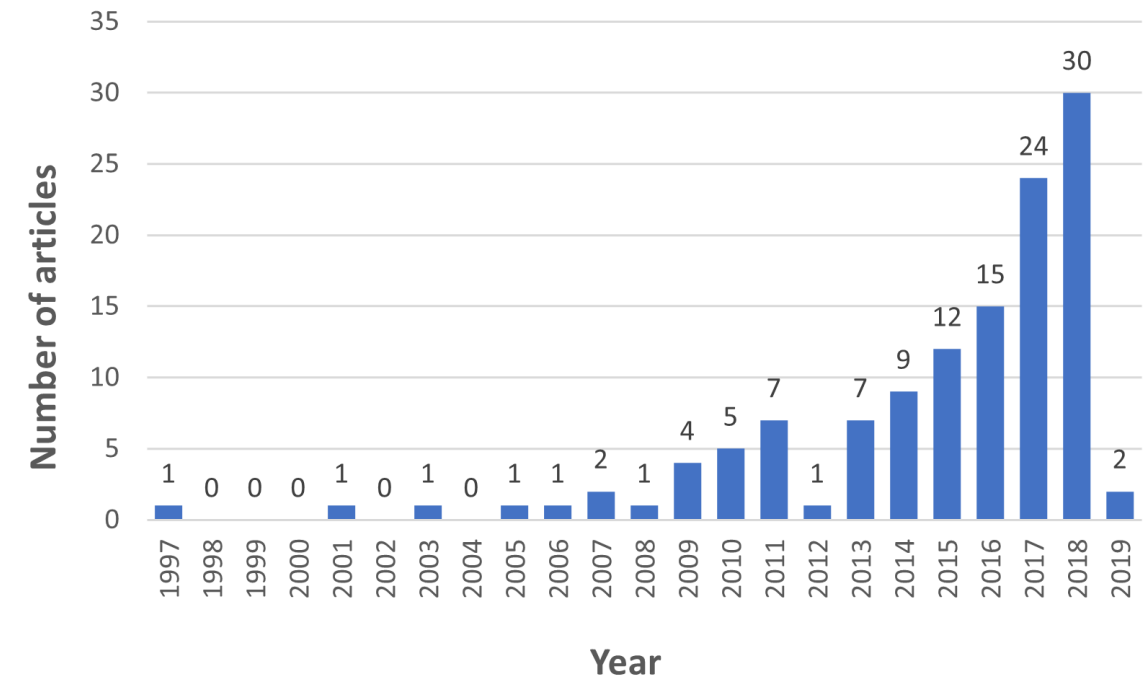


LAD Approximation

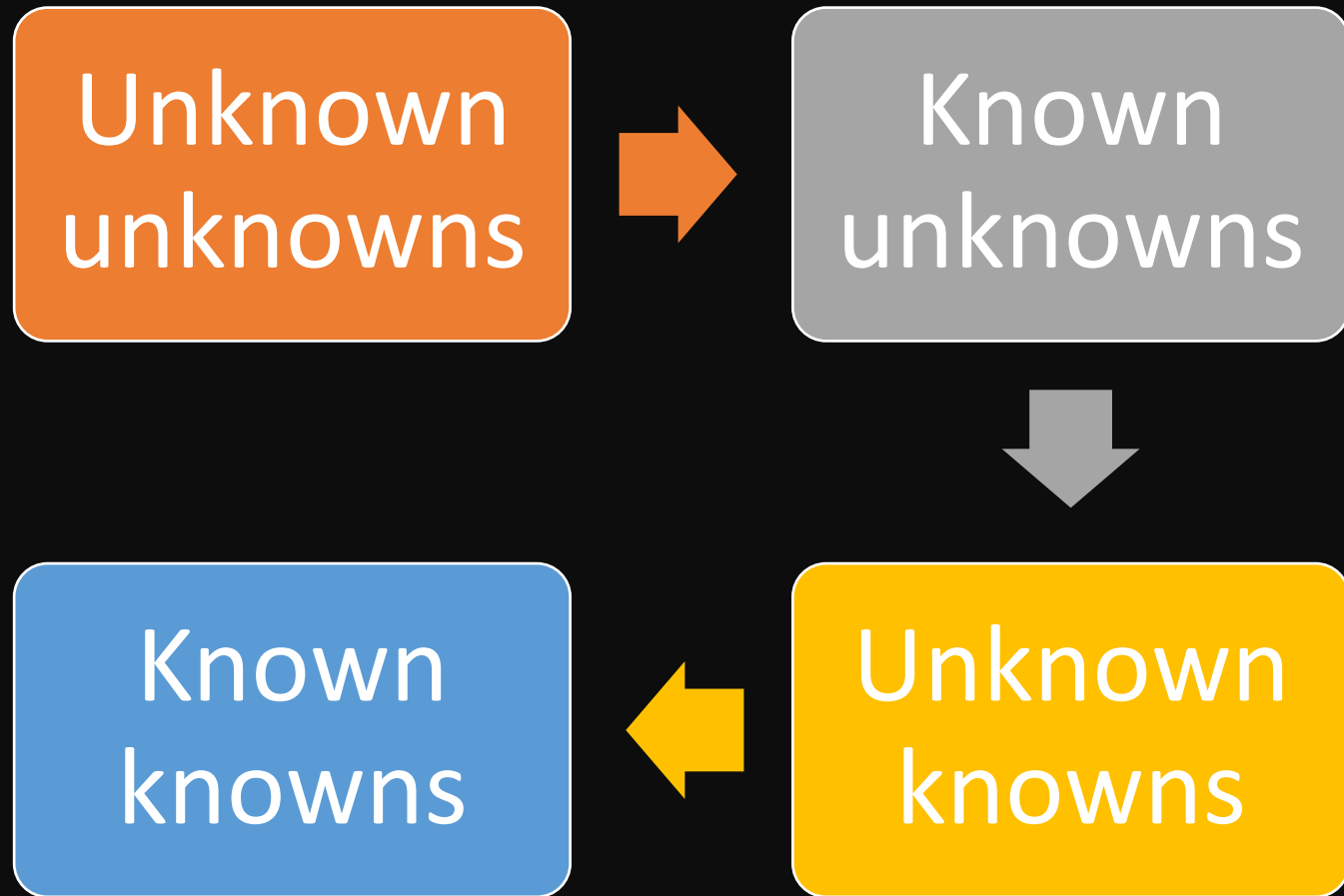
Advantages of LAD

- Transparency
- Not based on statistical Analysis
- No restriction with any type of data

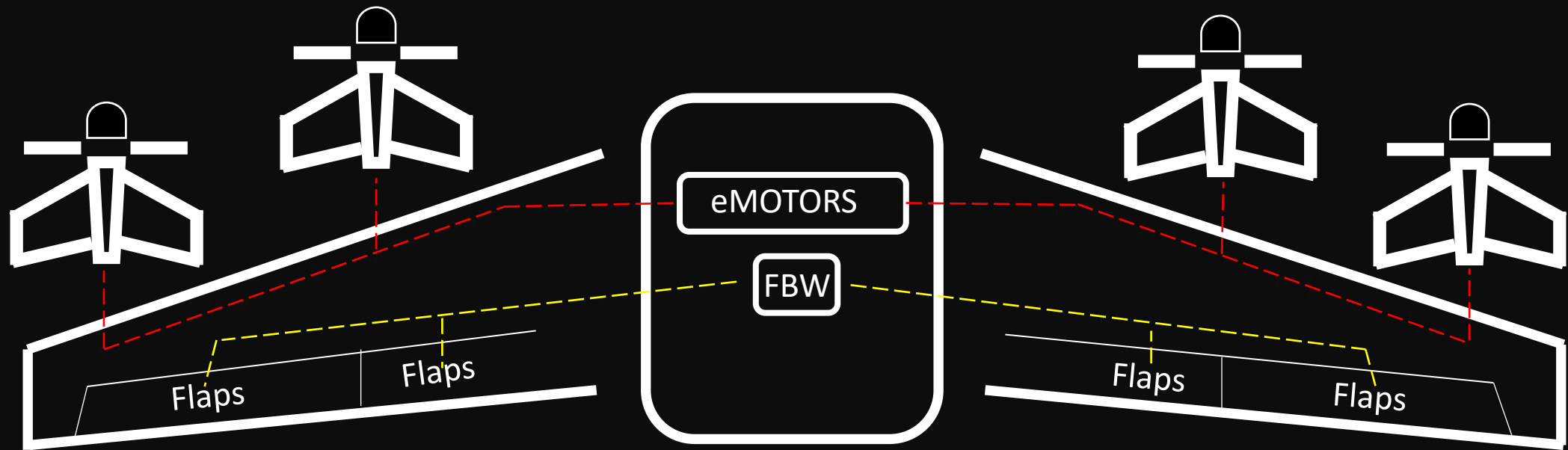
- Annual distribution of published journal articles focusing on the use of machine learning methods to perform risk assessment



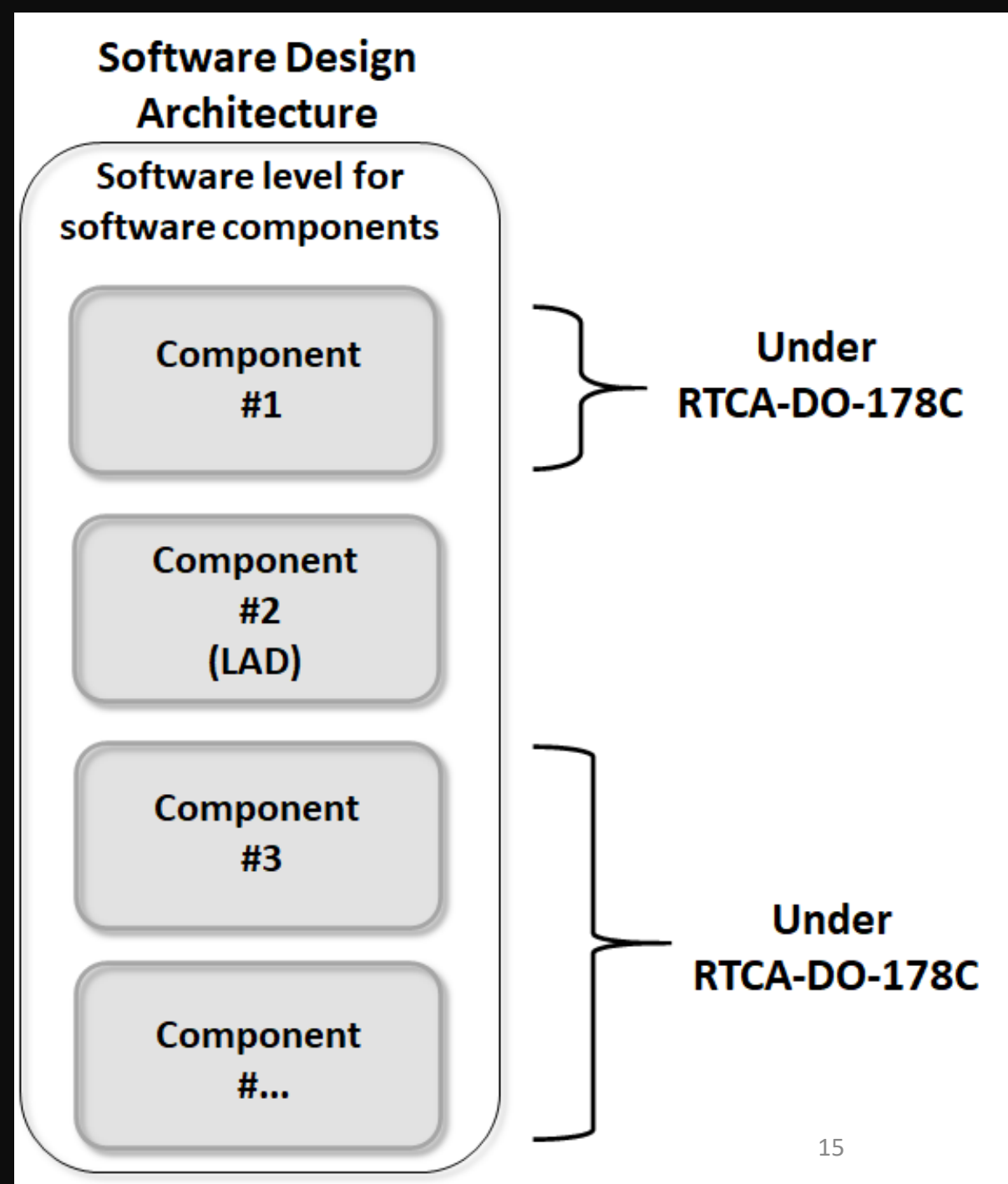
		Risk				Probability
		Catastrophic	Hazardous	Major	Minor	
Probable		Extremely High	High	Medium	Low	
Remote		High	Medium	Low	Low	
Extremely Remote		Medium	Low	Low	Low	
Extremely Improbable		Low	Low	Low	Low	
		Severity				



Scenario #1 – Predicting Failures in the eVTOL systems



Scenario #2 - Aircraft Certification Aspects



Conclusion

- Pattern generation has potential applications in the eVTOLs
- For “classical” software approach: more research is thus necessary





Thank you

Marcos Salvador
marcos.Salvador@polymtl.ca