



DAEDALEAN

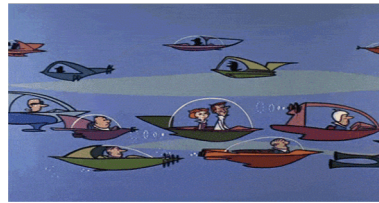
APPLIED INTELLIGENCE

# Opportunities and Challenges when Building AI for Autonomous Flight

AMLD EPFL - 28 January 2020

David Haber

@davhab - dh@ddl.n.ai





## No autonomy without AI.

And even today, AI can deliver substantial value to **increase situational awareness** in piloted operations.

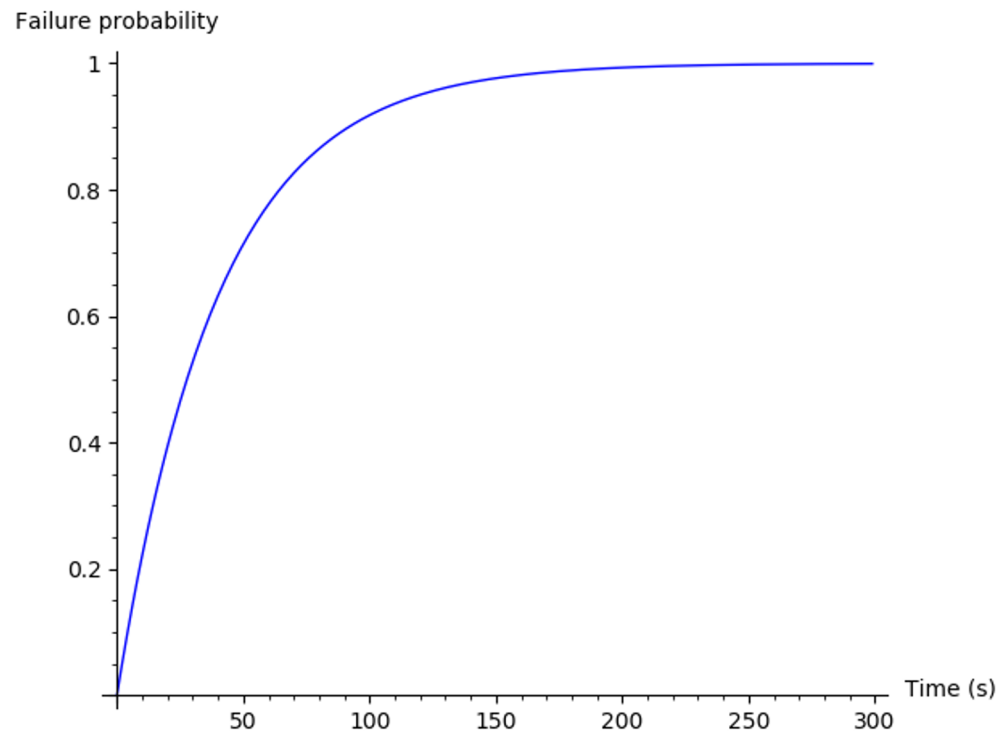
We cannot compromise **safety**!

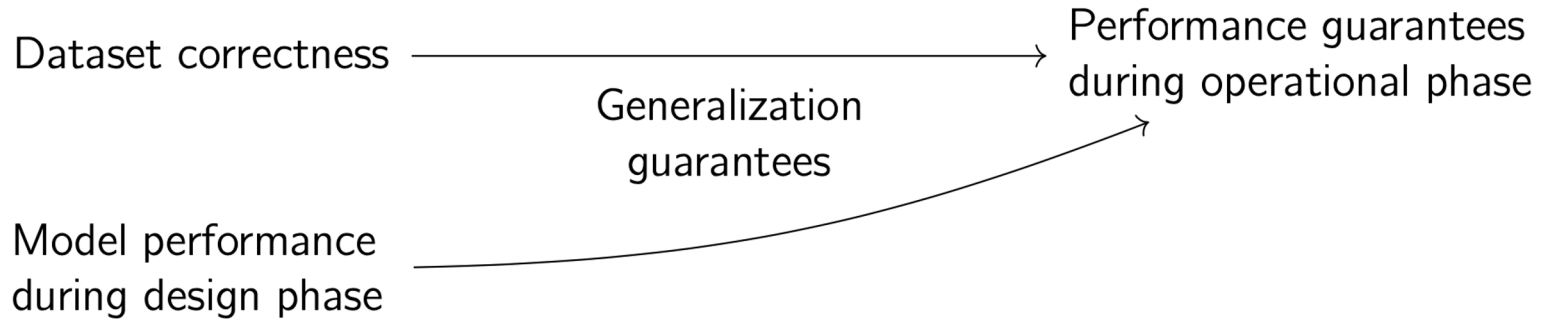


**$10^{-9}$**

**Your system cannot fail in  $10^9$  flight hours (on average).**







# Generalization Bounds

with high probability  $> 1 - \delta$  :

“Probably”

$$|E_{\text{out}} - E_{\text{in}}(\text{data})| < \varepsilon(\delta, \#\text{data}, \dots)$$

“Approximately Correct”

	Learning algorithm $\mathcal{F}$	
Data $\mathcal{X}$	Independent	Dependent
Independent	VC-dimension	—
Dependent	Rademacher complexity	PAC-Bayesian bounds





# First Step

Identify input probability space  $\mathcal{X}$  :

*“All 512 x 512 RGB images you could possibly ever record over Switzerland”*

Easy to talk about, hard to describe mathematically.



Hausen Airport (LSZN), Switzerland



# Explicit Operating Parameters

$$OS = P_1 \times \cdots \times P_n$$

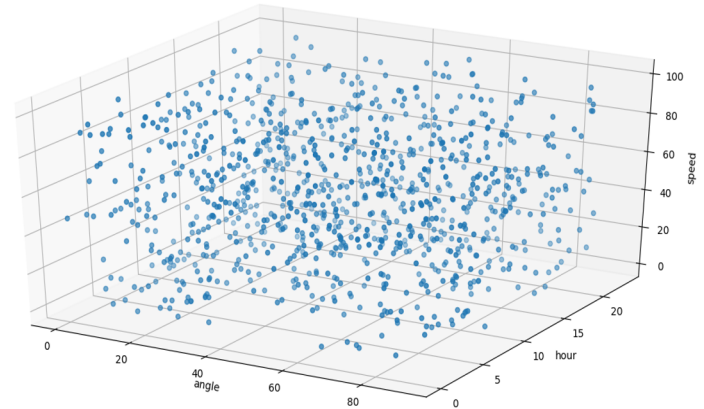
$$\varphi : X \rightarrow OS, \quad x \mapsto (\varphi_1(x), \dots, \varphi_n(x))$$

$\varphi_1$  = angle of approach in  $P_1 = [0, 90]$

$\varphi_2$  = time of day in  $P_2 = [6, 21]$

$\varphi_3$  = speed in  $P_3 = [60, 90]$

$\varphi_4 = \dots$



# Data Distribution

Show  $D_{train}, D_{val}, D_{test}$  are independently distributed in the operating space  $OS$ .

*...not enough!*

Show  $D_{train}, D_{val}, D_{test}$  are independently sampled from the input space  $\mathcal{X}$  and independent from each other.

Build an input distribution discriminator  $\mathcal{D} : \sqcup_{n \geq 1} \mathcal{X}^n \rightarrow [0, 1]$



# “Concepts of Design Assurance for Neural Networks”

Propose a first set of **guidelines** for NN-based systems facilitating **backward & future compatibility** with the existing regulatory framework.

A **whitepaper** will be released soon.

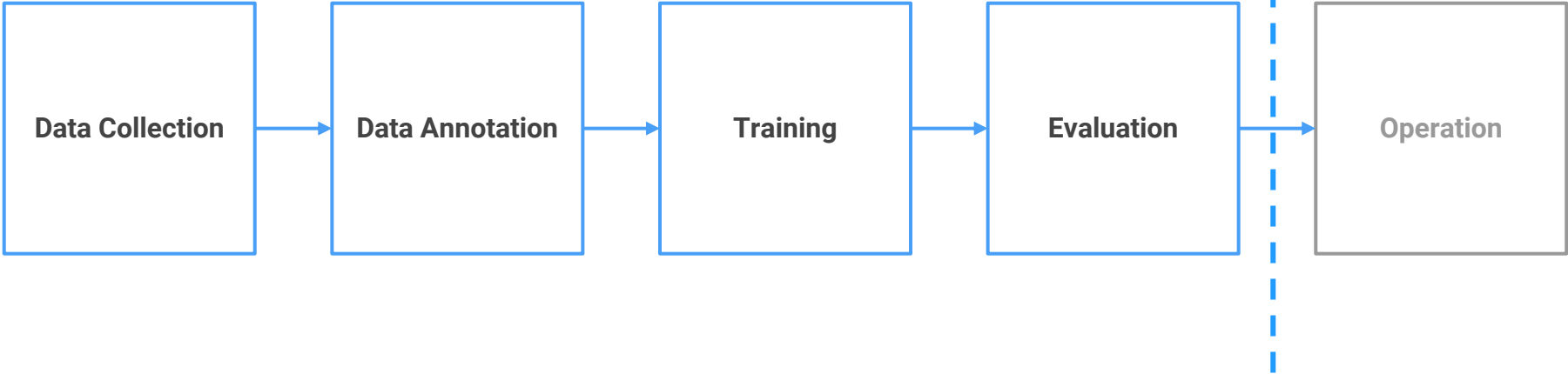


+



**Design Phase**

**Operational Phase**



# Our Team

Strong software/aerospace pedigree:

- Computer Vision, Machine Learning, Robotics, Control
- Experience with safety critical software development

Aviation experience:

- Multiple PPL(H)s
- Multiple PPL(A)s
- Gliding License

Focus on regulatory approval:

- Dedicated regulatory compliance team
- Aviation certification specialist on advisory board



## We are based in Zürich



# Get in touch: [dh@ddln.ai](mailto:dh@ddln.ai)

