Artificial Intelligence for maintenance @ Airbus AI Research

AIRBUS

Smart Maintenance Conference – 2019/09/03

Airbus Central Research & Technology – Data Science

AIR
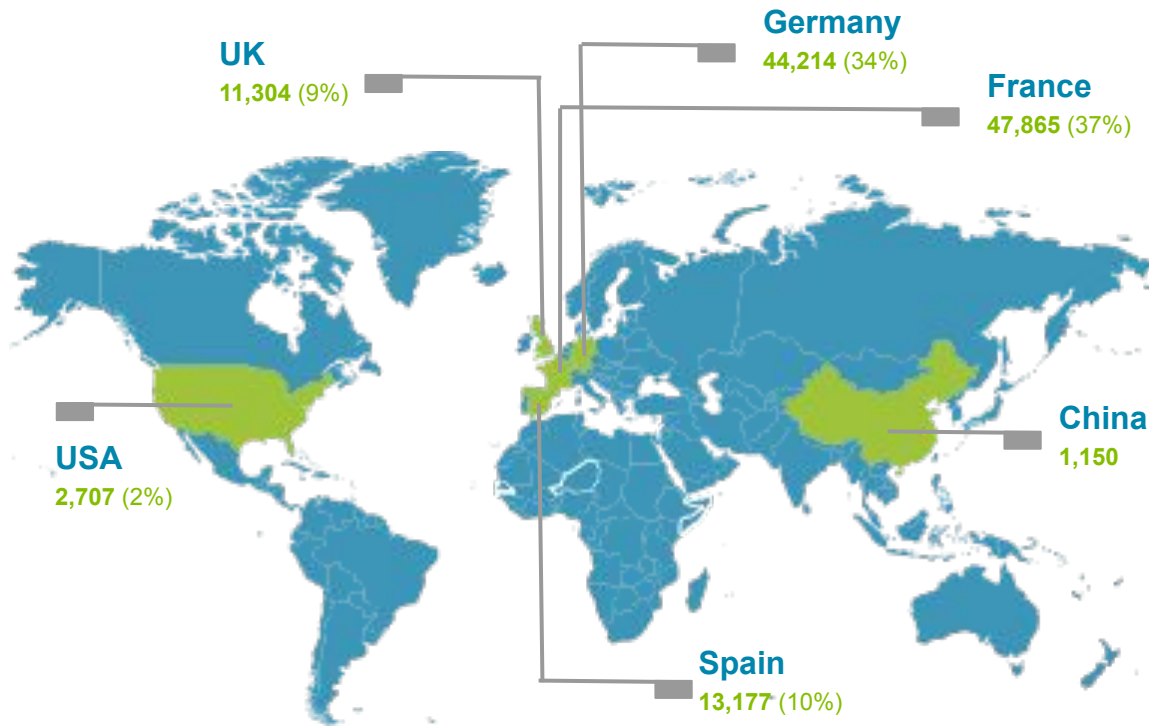Airbus AI Research

Airbus: an aerospace company

129,442
Total workforce

€997 billion
Order book

€59 billion
Annual revenue, restated IFSR 15

Airbus: a global company

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UK
11,304 (9%)

Germany
44,214 (34%)

France
47,865 (37%)

USA
2,707 (2%)

China
1,150

Spain
13,177 (10%)

129,442 employees

from **135** nationalities

Located across **35** countries
on more than **180** sites

International Sales
31% Europe
69% Non-Europe

Airbus AI Research

Toulouse: 12
Munich: 10
Bristol: 5

Data science & Artificial Intelligence
• Image processing
• NLP, StT, KE
• Optimization / RL
• ML / DL
• Uncertainties / Proba / Stats
• Time series

# On–Going Airbus AI Research Projects

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|		
ADvISED	Anomaly Detection in Time Series Data	Time series analysis, high dimensional anomaly detection, functional data analysis, deep learning for time series
Learning to Fly	Learn control laws to increase the flight domain of the auto-pilot	Deep Reinforcement Learning, Critical Scenario Generation, flight simulation
DiMP	Digital Material & Processes	Automatic fault detection in 3D CT-data of additive manufactured products. Automatic characterization of material failures from SEM fracture surface images.
DONUT	Dynamic Optimization Under Uncertainties	Planning, scheduling, evolutionary optimization heuristics
LEA	Learning Assistant	NLP, conversational agent, Q/A, semantic information retrieval, reinforcement learning, speech-to-text
XAI	Explainable AI	Model evaluation, model analysis, model checking

new projects on graph machine learning and safety critical AI
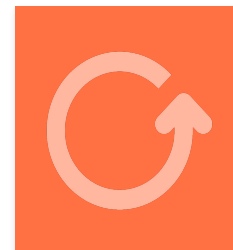
AIRBUS
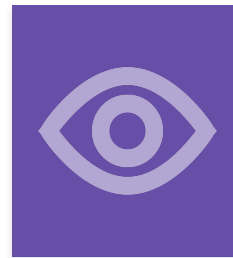
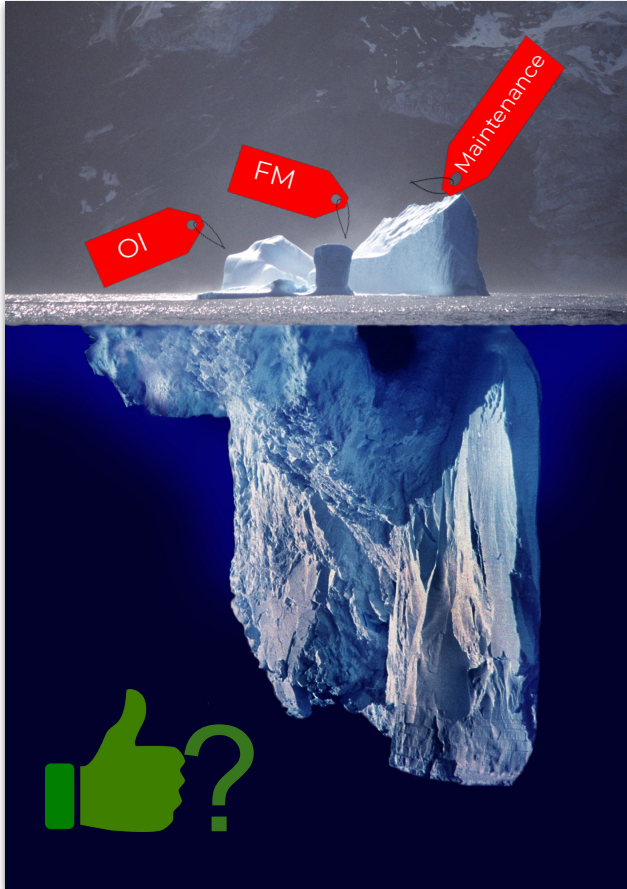**Anomaly Detection**

Computer Vision
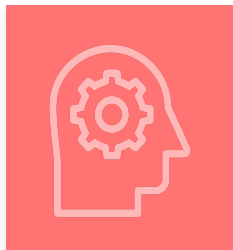
Knowledge Extraction
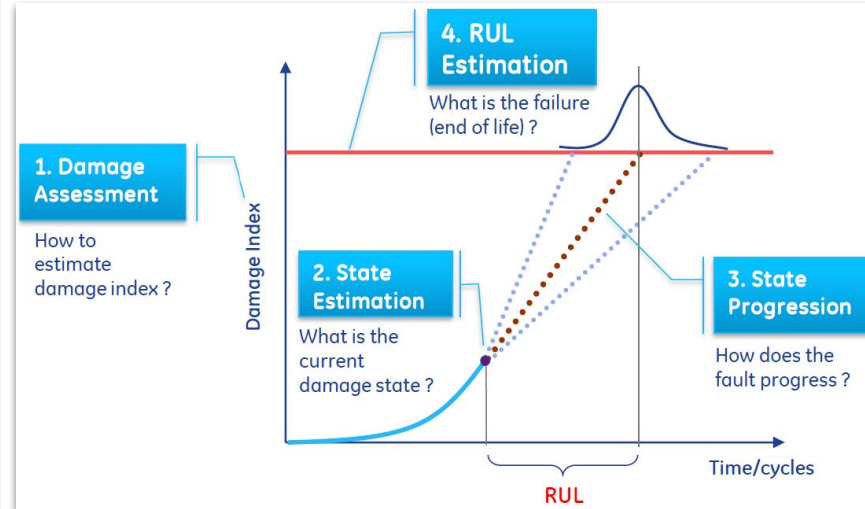
Conversational Assistance

Decision Making

Anomaly detection (multivariate sensor data)

When a fault occurs, it is too late.
➢ unlabelled sensor data

1. Damage Assessment
How to estimate damage index ?

2. State Estimation
What is the current damage state ?

3. State Progression
How does the fault progress ?

4. RUL Estimation
What is the failure (end of life) ?

Damage Index

Time/cycles

RUL

signal processing, functional data analysis
machine learning, deep learning
anomaly detection

Anomaly detection (multivariate sensor data)
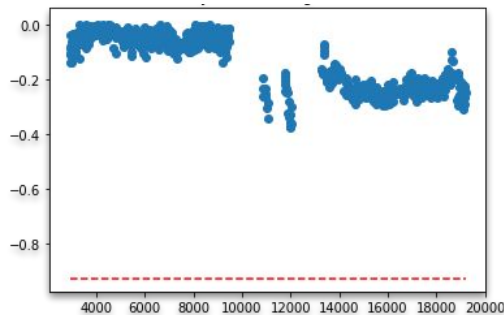
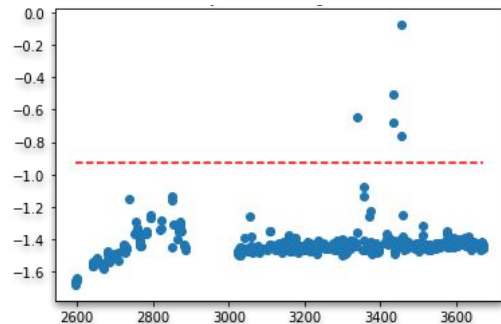normal
flight

abnormal
flight

CHALLENGES
➤ dimensionality
➤ volume
➤ interpretation
➤ link with physics

time series analysis toolbox
(possibly open source)

Decision making

Take the next decision based on the context and on the decision–aiding system

plan/schedule **under uncertainty**

Update the **decision tree** branched on possible upcoming scenarios given the context

Learn the operators decisions and uncertain events dynamics

Sense the environment, the mission status and the system health

Send the next best decision to the aerial platform

Execute the decision sent by the control center

Current project on flight planning, fleet mission planning and satellites mission tasking under uncertainty

CHALLENGES
➢ planning under uncertainty is hard
➢ dimensionality of the problems (assets, states, actions…)

Open Source toolbox for Reinforcement Learning and Automated Planning & Scheduling (currently named AIRLAPS)
PhD launched in 2019 to optimize maintenance taking into account components health with uncertainties (Ilyass Haloui)
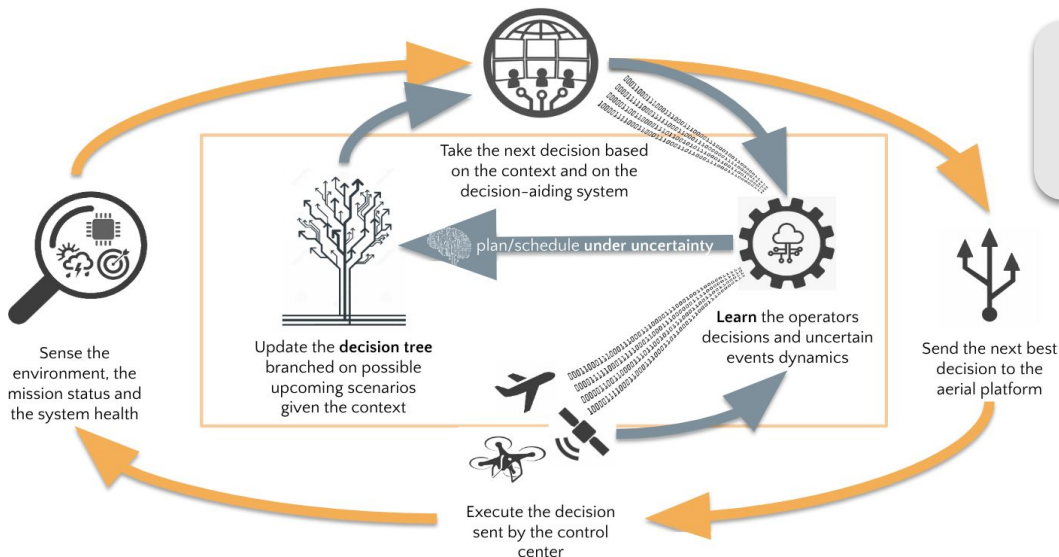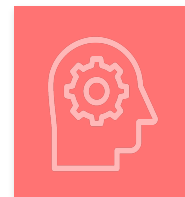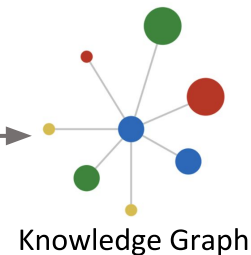
Knowledge extraction

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Various (un)structured document types → documents, text, images, tables... → **Knowledge Extraction** → nodes, relations → Knowledge Graph
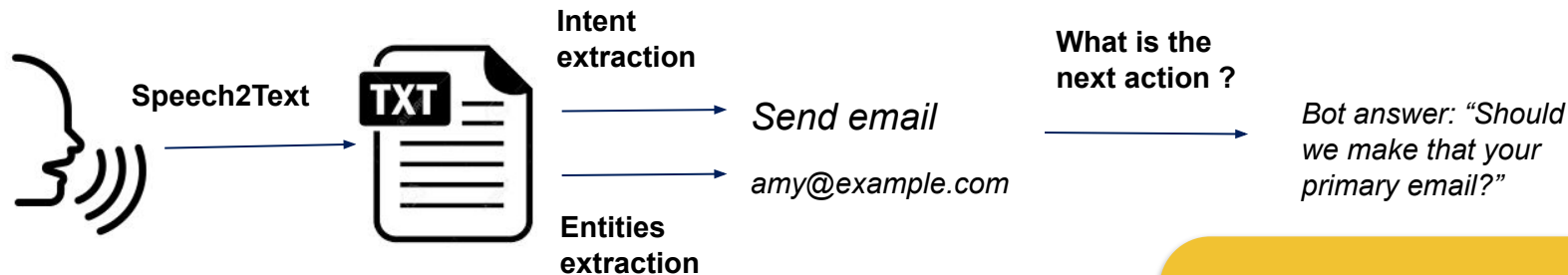

CHALLENGES
➢ need to improve SoA
➢ diversity of documents
➢ NLP bricks need to be adapted to aeronautics domain

Automatic pdf annotation tool
Automatic extraction of figures, tables, schematics, text

Conversational assistance

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Intent extraction

Send email

amy@example.com

Entities extraction

What is the next action ?

Bot answer: "Should we make that your primary email?"

Speech2Text

TXT

"Please send the confirmation to amy@example.com"

CHALLENGES
- ➢ NLP bricks need to be adapted to aeronautics domain
- ➢ Still use case oriented

chatbot factory
domain-adapted S2T library
chatbot examples for Structure Repair

LARA | CGM explorer — NIGHT MODE

Chat

Welcome
Hello, I'm LARA, your repair learning assistant. How may I help you?

Process
Show

Show cgm

Write something...

Results Viewer

CARDS | TABLE

n_sr_531111_1_5aqm000g_01_03	CGM
n_sr_531111_1_5aqm000v_01_03	CGM
n_sr_531111_1_5aqm000r_01_03	CGM
n_sr_531111_1_5aqm000v_01_03	CGM
n_sr_531111_1_5aqm000y_01_03	CGM
n_sr_532111_1_5awm000g_01_04	CGM

Document Viewer

• ZONE 1,
• SEE TASK 53-11-11-205-001

FR24
FR1
A

FASTENER ROW   FASTENERS ROWS

STGR36RH

15 mm (0.59 in)   15 mm (0.59 in)   15 mm (0.59 in)

A - A
TYPICAL
(ONLY VALID IN RIVETED AREA)

NOTE:
ZONE 1, SEE TASK 53-11-11-205-001
ZONE 3, SEE TASK 53-11-11-205-001
ZONE 4, SEE TASK 53-11-11-205-001
EXCLUDED AREA
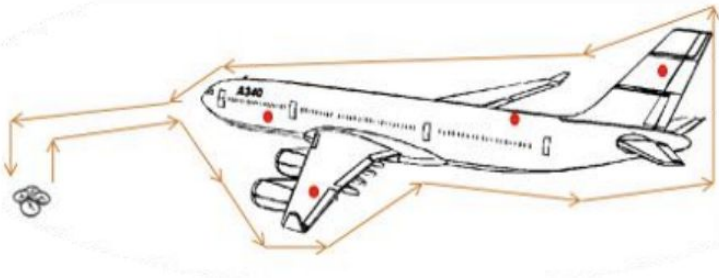FOR DEFINITION OF EXCLUDED/LIMITED AREAS AND FOR EXCLUDED/LIMITED AREAS WITH

FR8 FR9 FR11 FR12 FR13 FR14

A
FWD

Computer vision

Automated failure analysis of fracture surfaces from SEM data

CHALLENGES
➤ Labelled data costly to generate
➤ Robustness to variability in light, conditions, etc.
➤ Collaboration of swarms

Automated inspection by (swarm of) drones (not done in CRT)
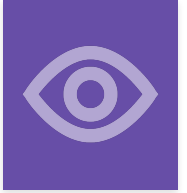
Third Eye demonstrator
Failure mode identification with additional informations (# stripes, size of defect…)

Key takeaways

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➢ Airbus invests a lot on Artificial Intelligence (research, digital transformation, digital academy, in all functions)

➢ Artificial intelligence can be used in maintenance in many different ways
  ○ supports PHM with enhanced data-driven techniques
  ○ improves decision making
  ○ improves interaction with documentation and historical tech requests
  ○ virtual assistance for maintenance
  ○ computer vision for inspection tasks

➢ Airbus AI Research develops **generic tools** for our BUs based on representative use cases

Open challenges

➢ Many challenges for each AI pillars

➢ Certain levels of certification will be required
  - AI trustability
    - Robustness
    - Explainability
    - Interpretability

  - Collaborate with partners and authorities
    - Airbus AI gym: https://aigym.airbus.com
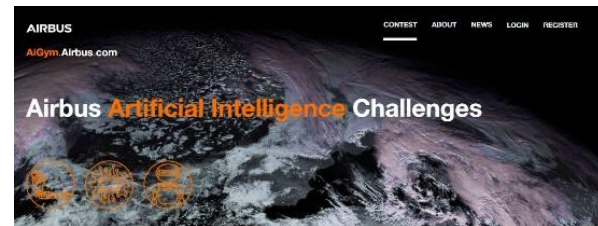
Thank you!

Contact: jayant.sengupta@airbus.com

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