AUTOMATIC EVALUATION OF ULTRASOUND DATA FROM BLADES
Using machine learning is easy,

...implementing machine learning is hard.
Artificial Intelligence

Logical Systems

\[ A \lor B = \neg(\neg A \land \neg B) \]
\[ A \rightarrow B = \neg A \lor B \]
\[ A \land B = \neg(\neg A \lor \neg B) \]

Knowledge-Based Systems

Machine Learning

Deep Learning

Classifying wrinkles

Data by:
from sklearn.neighbors import KNeighborsClassifier

model = KNeighborsClassifier()
model.fit(x_train, y_train)
y = model.predict(x)
X’s and Y’s

- Data and labels

X: [...

Y: [0,
0,
0,
1,
...]

Not wrinkle
Wrinkle
Training data
Labels (whY’s)

• Why are we doing this?
• What is required to evaluate our data?
• What should be the output of the model?

• Classification
  – Does the data contain a wrinkle?
• Regression
  – What is the maximum angle of the plies?
• Segmentation
  – Which parts of the data contain a wrinkle?
• ...

https://medium.com/@tifa2up/image-classification-using-deep-neural-networks-a-beginner-friendly-approach-using-tensorflow-f4b0a090ccdc4
https://en.wikipedia.org/wiki/Regression_analysis
https://medium.com/nanonets/how-to-do-image-segmentation-using-deep-learning-c673cc5862ef
Machine learning process

Explicit rules and measurements

- Explicit requirements are usually set by designers
  - Void must by less than 20x40 mm OR less than 10x80 mm OR ...
  - Thickness must be less than 3 mm from spec, unless...
  - ...

- How to measure using ML?
  - Not classification!
  - Regression?
  - Segmentation!

https://www.youtube.com/watch?v=qWl9idsCuLQ
Segmenting structure

- Shell
- Spar cap
- Void
- Carbon 3
- Glue
- Missing glue
- Web
Measure defects
Ensemble models

- Combine different models with different strengths

- Determine structure using segmentation
  
  What is the actual structure and are there defects?

- Evaluate structure using logical expressions
  
  Are the defects permissible or do they require repair?
Object detection + instance segmentation

https://www.youtube.com/watch?v=OOT3UXZztE
Ensemble models

- Advanced ML and image analysis methods for analyzing the data automatically
  “Black box”
  Requires training/advanced modelling

- Logical expressions for evaluating the results of the analysis
  Explicit
  Easy to change

COCO object segmentation

- [https://www.youtube.com/watch?v=OOT3UIXZztE](https://www.youtube.com/watch?v=OOT3UIXZztE)
THANK YOU!