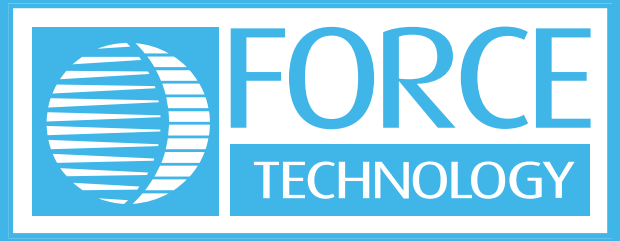
# AUTOMATIC EVALUATION OF ULTRASOUND DATA FROM BLADES



Niels Jeppesen

MADE
Manufacturing Academy of Denmark

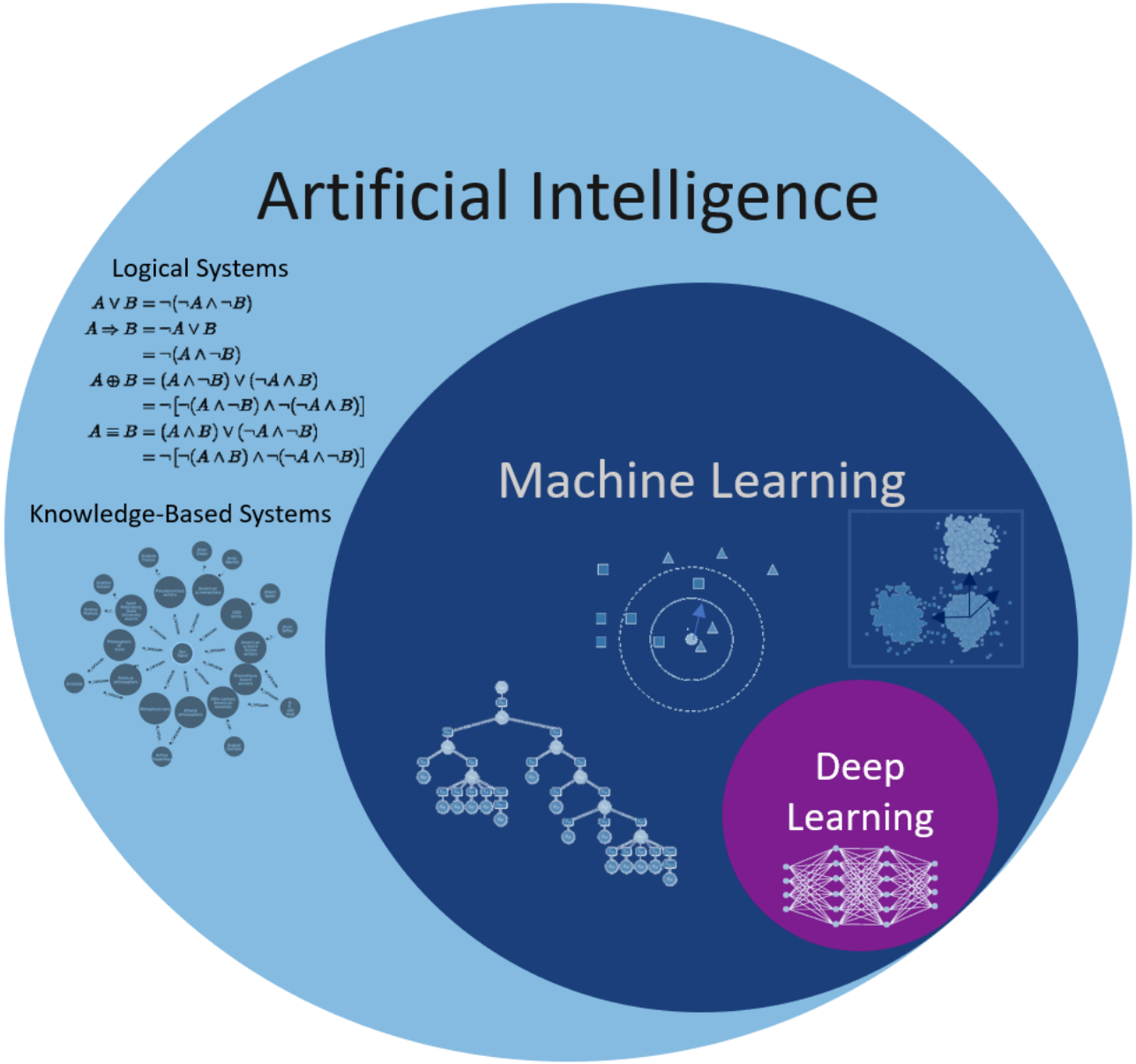
DTU
Technical University
of Denmark


FORCE
TECHNOLOGY


Vestas

# Using machine learning is easy,

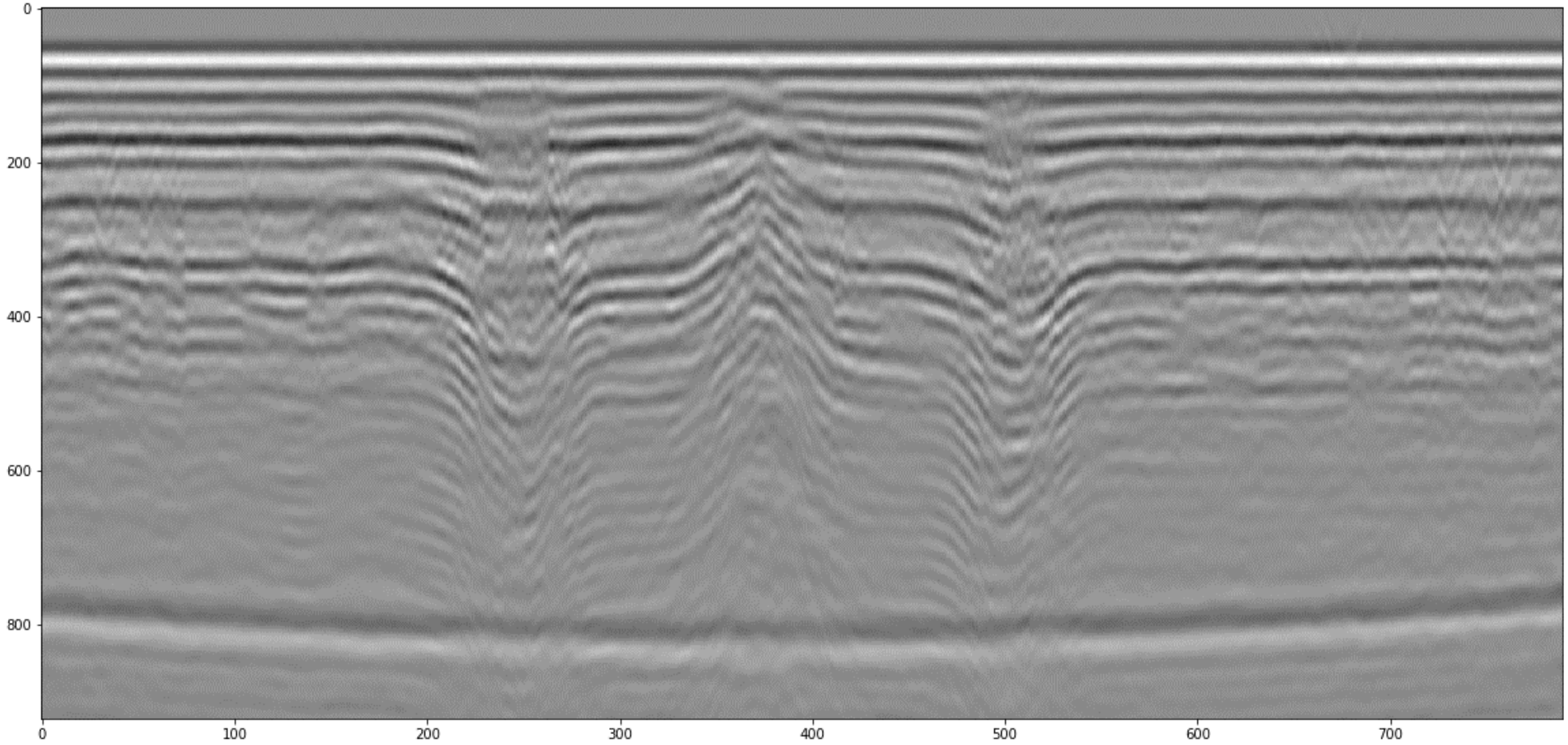
*…implementing machine learning is hard.*



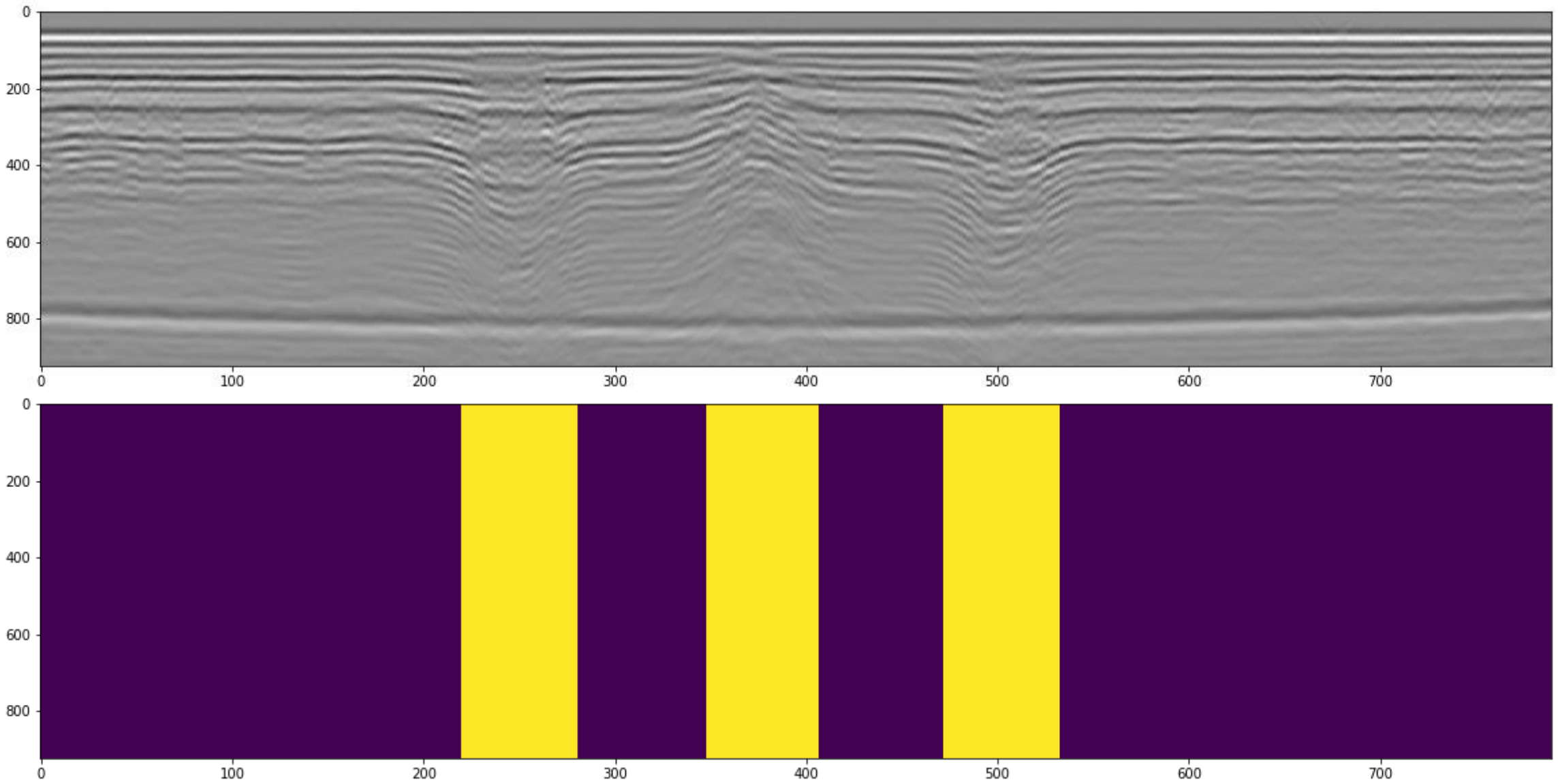

http://itsparkds.com/AI-and-Deep-Learning/

# Classifying wrinkles

Data by:
Smith, R. A., Nelson, L. J., Mienczakowski, M. J., & Wilcox, P. D. (2018). Ultrasonic Analytic-Signal Responses from Polymer-Matrix Composite Laminates. *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, *65*(2), 231–243. https://doi.org/10.1109/TUFFC.2017.2774776



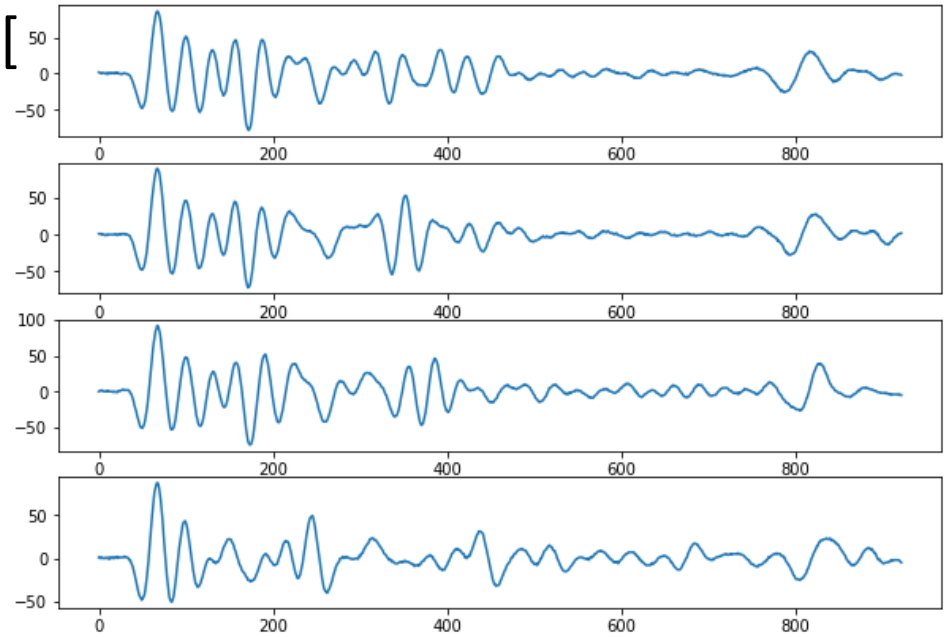
```
from sklearn.neighbors import KNeighborsClassifier

model = KNeighborsClassifier()
model.fit(x_train, y_train)
y = model.predict(x)
```


0
200
400
600
800
0
100
200
300
400
500
600
700
0
200
400
600
800
0
100
200
300
400
500
600
700

# X’s and Y’s

- Data and labels

X: [




...]

Y: [0, ← Not wrinkle

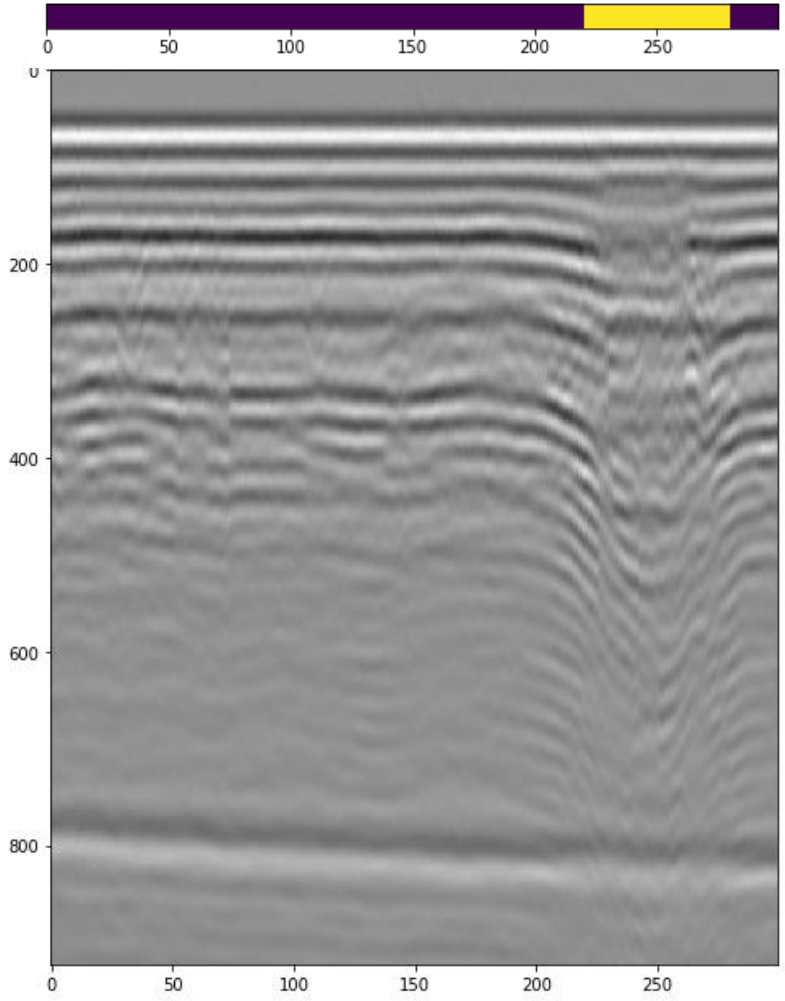
0,

0,

1, ← Wrinkle

...]

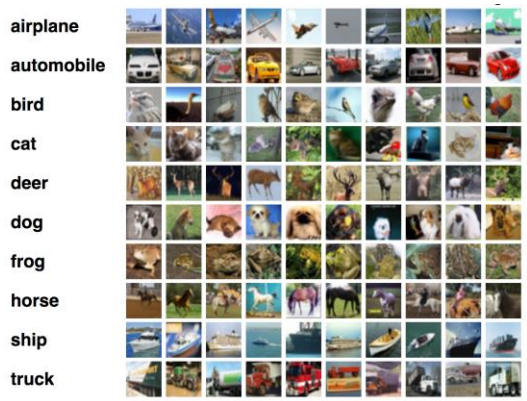
# Training data

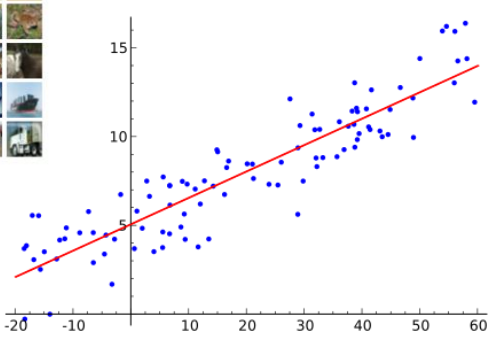


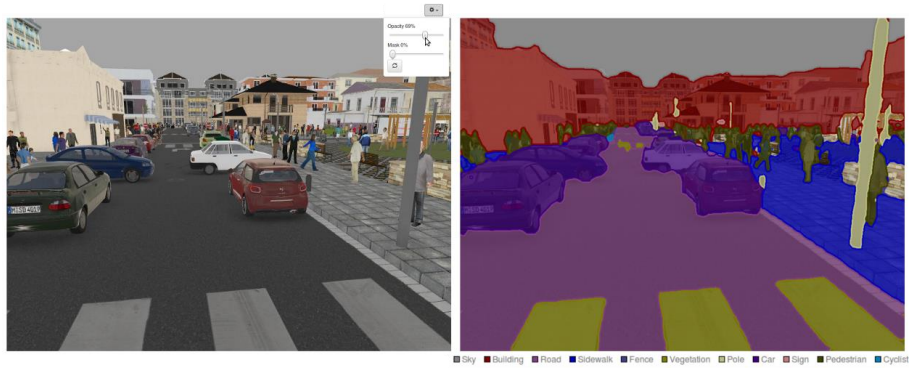
# Labels (whY's)

- Why are we 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?
- …

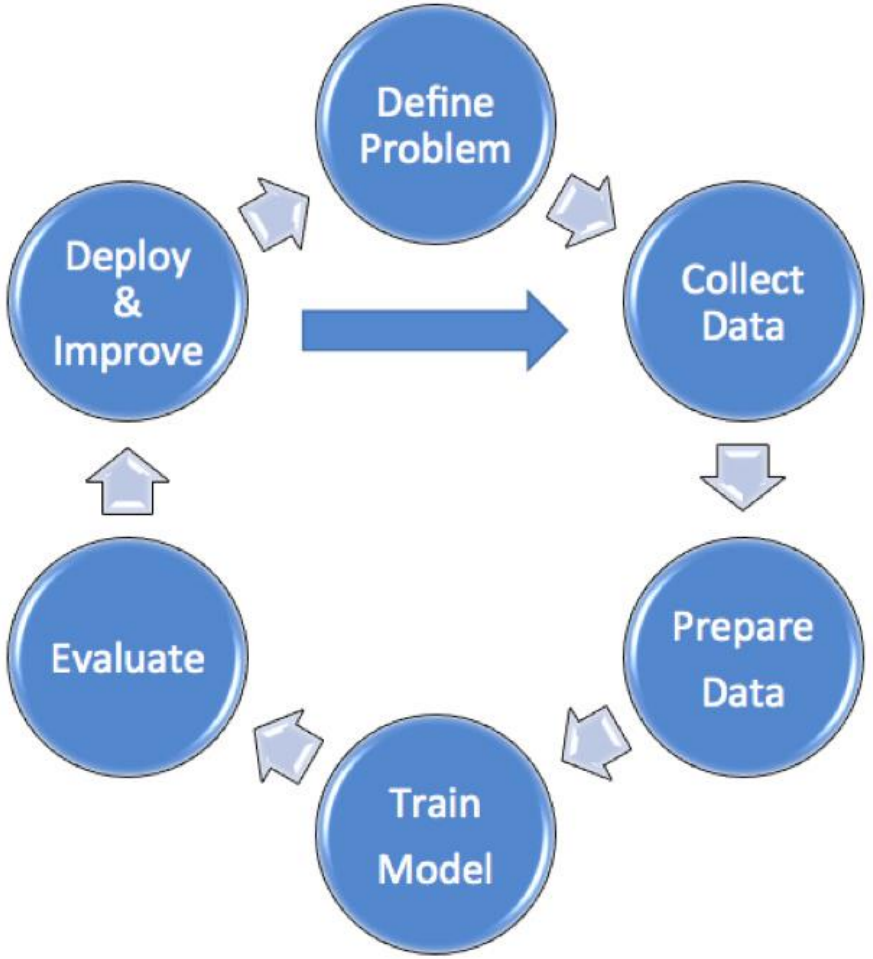


https://medium.com/@tifa2up/image-classification-using-deep-neural-networks-a-beginner-friendly-approach-using-tensorflow-94b0a090ccd4
https://en.wikipedia.org/wiki/Regression_analysis
https://medium.com/nanonets/how-to-do-image-segmentation-using-deep-learning-c673cc5862ef

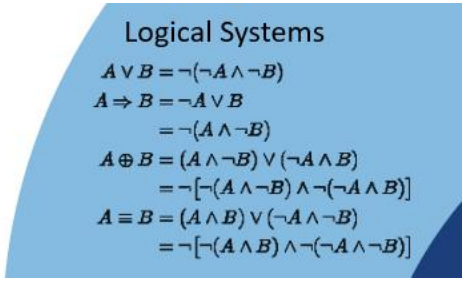
# Machine learning process




https://dzone.com/articles/machine-learning-in-plain-english

# Explicit rules and measurements

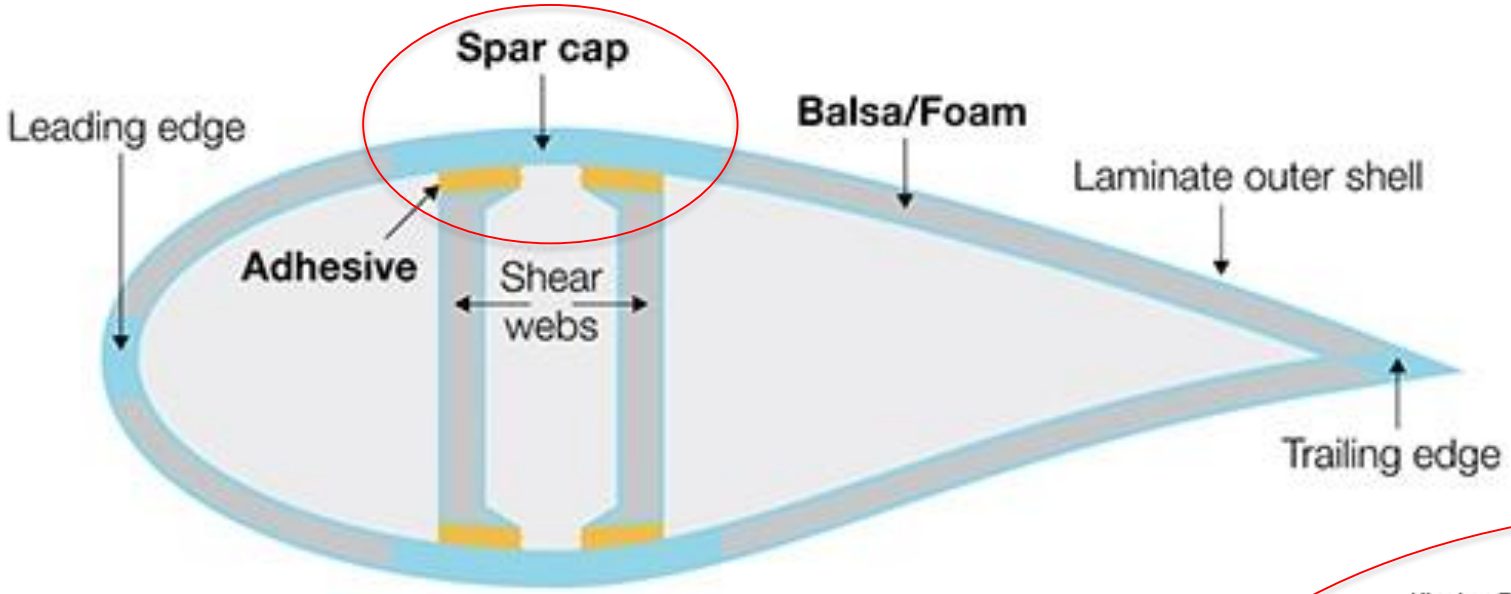
- Explicit requirements are usually set by designers
  - Void must by less than 20x40 mm OR less than 10x80 mm OR …
  - Thickness must be less than 3 mm from spec, unless…
  - …

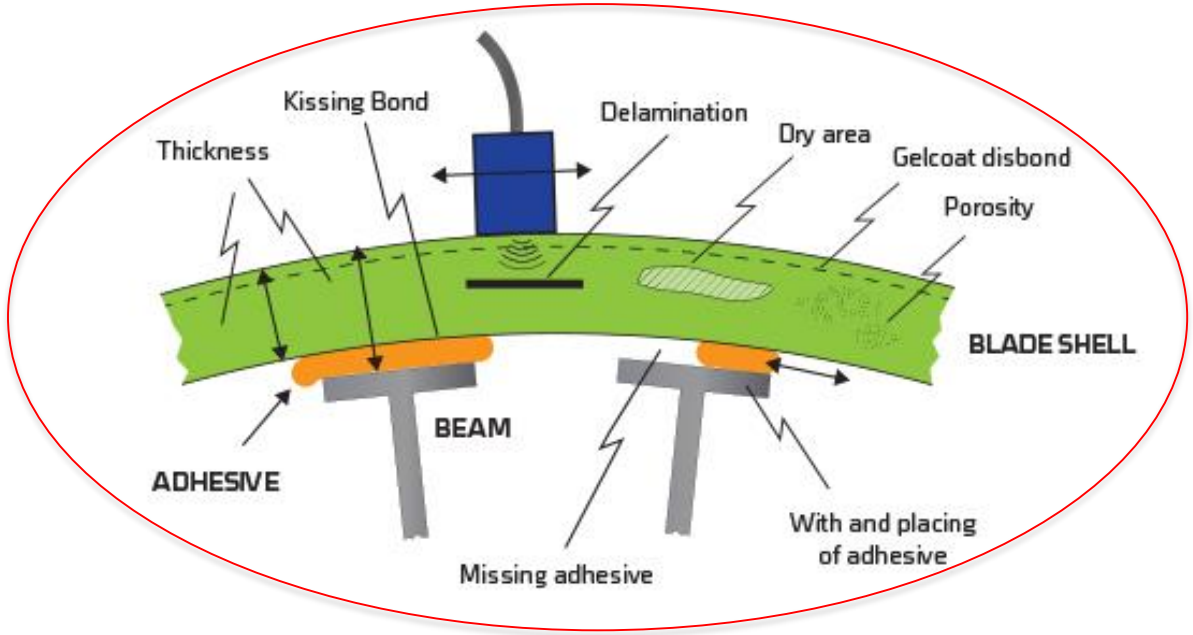



- How to measure using ML?
  - Not classification!
  - Regression?
  - Segmentation!

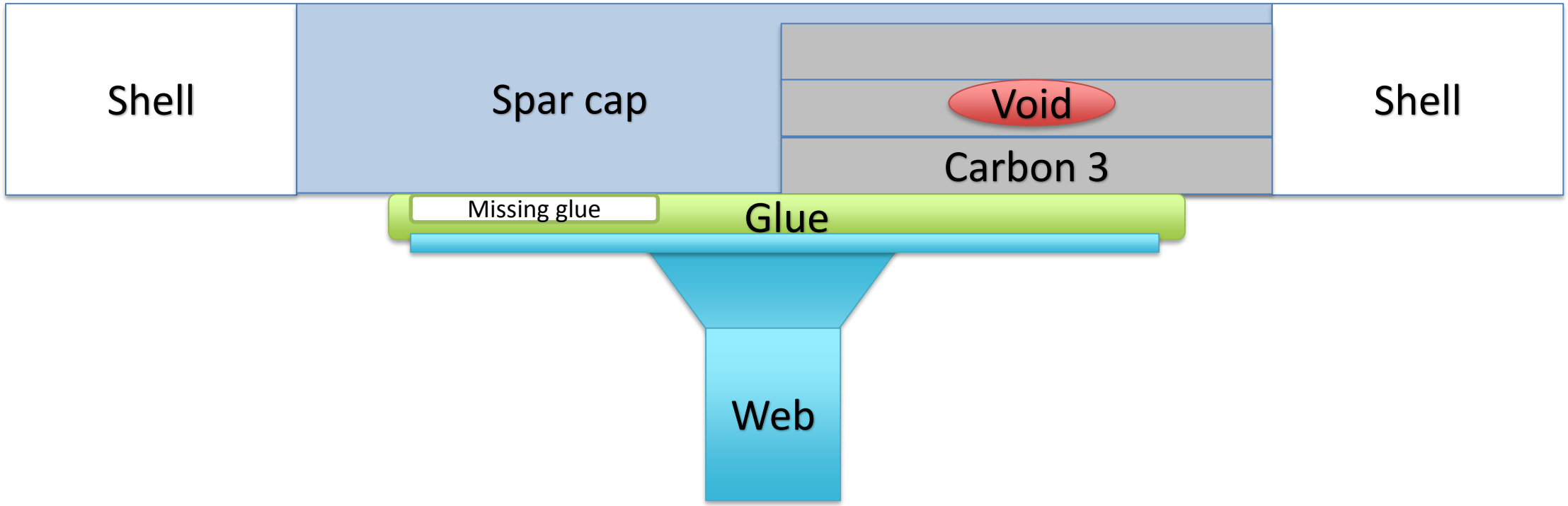

https://www.youtube.com/watch?v=qWl9idsCuLQ

https://www.azom.com/article.aspx?ArticleID=16218

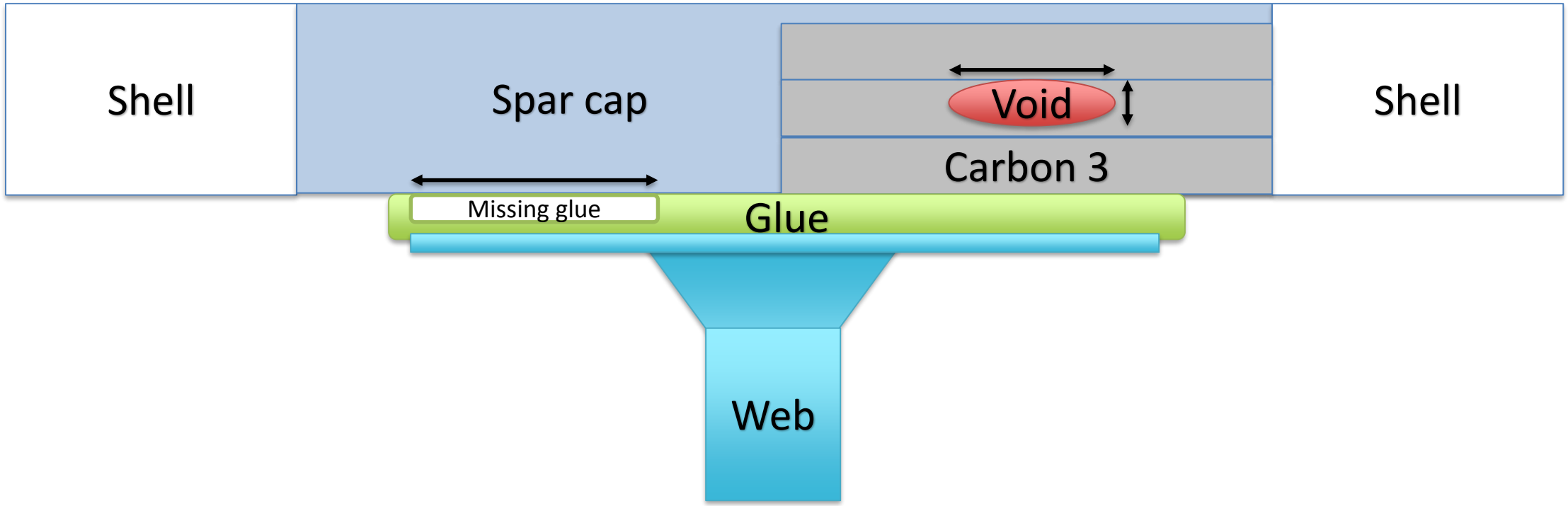


# Segmenting structure

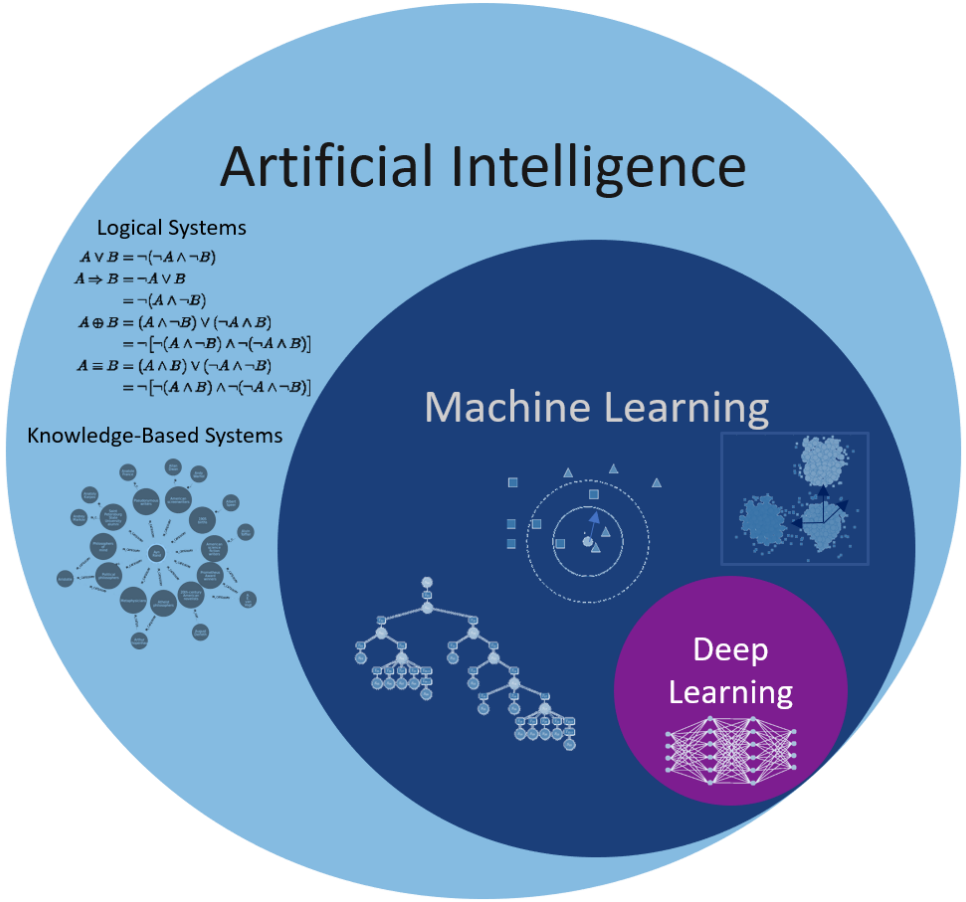


# Measure defects



# Ensemble models

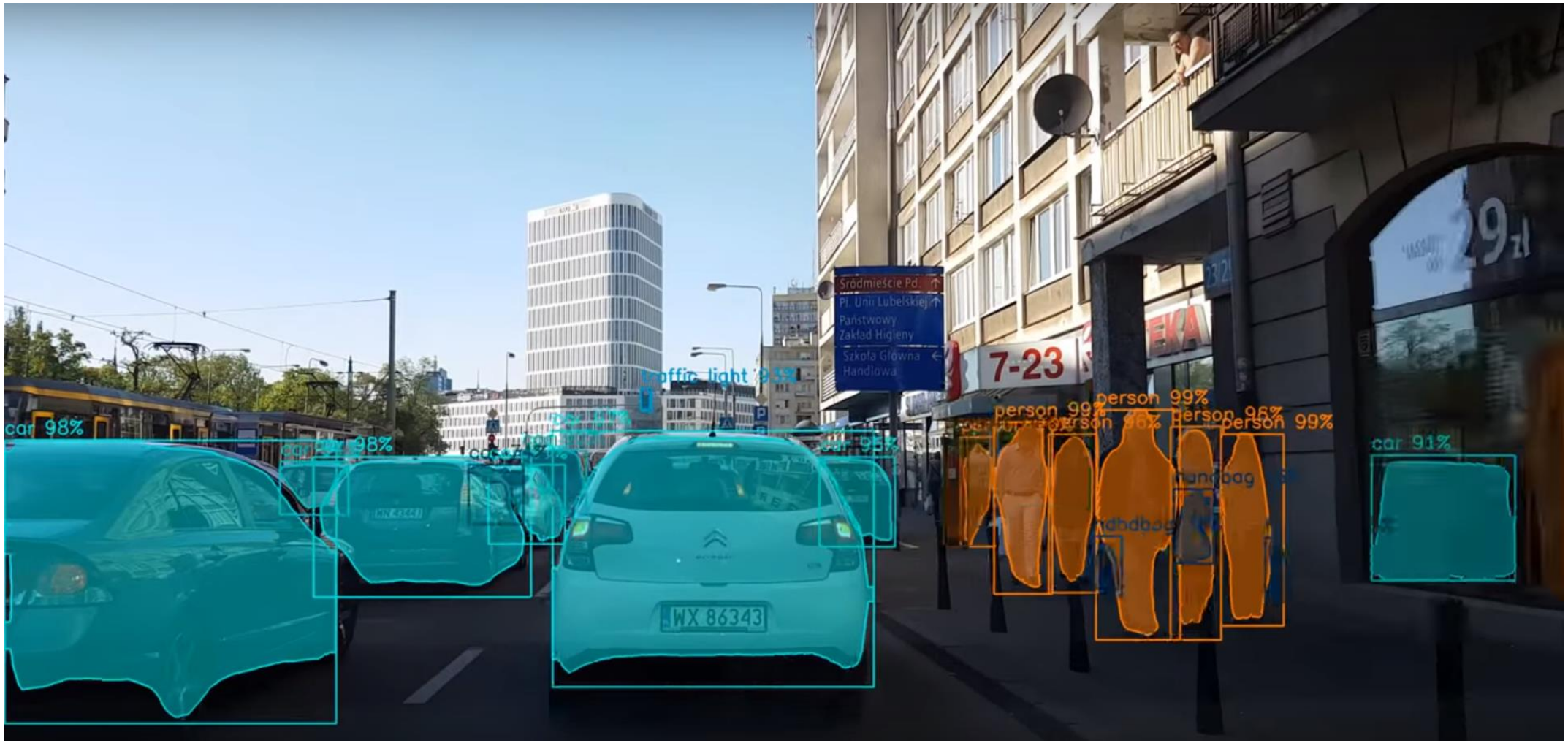
- Combine different models with different strengths
- Determine structure using segmentation
  What is the actual structure and are there defects?
- Evaluate structure using logical expressions
  Are the defects permissible or do they require repair?




http://itsparkds.com/AI-and-Deep-Learning/

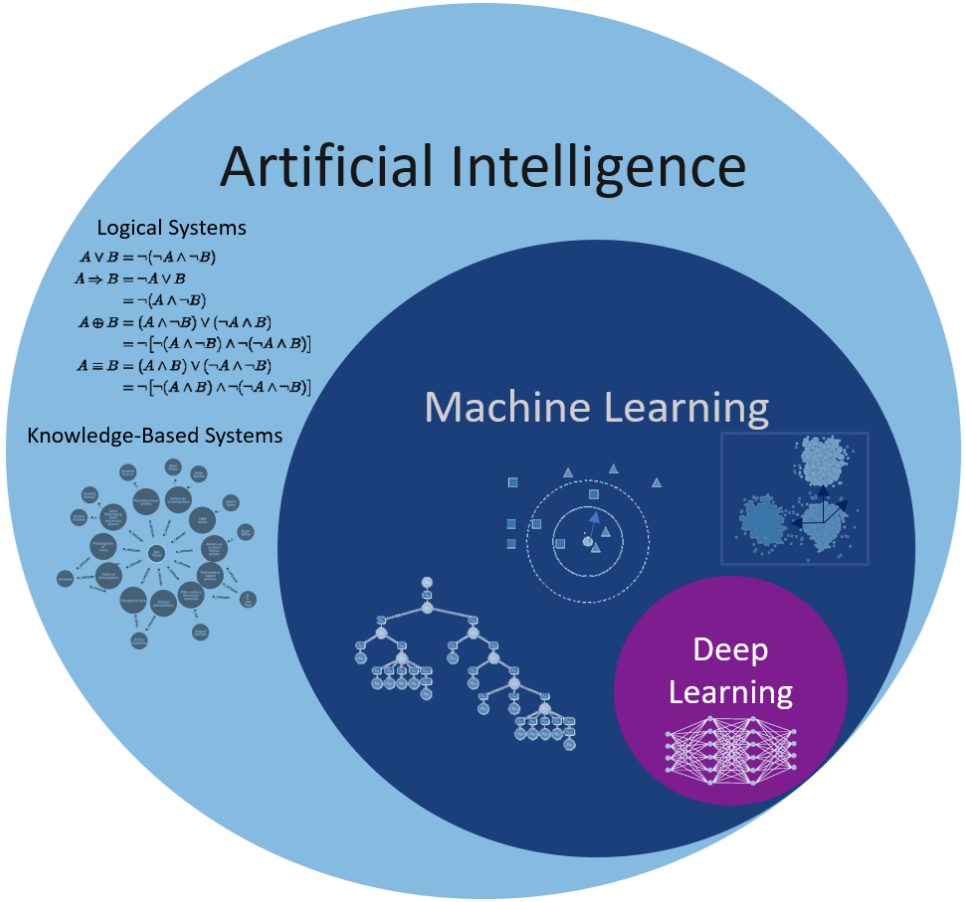
# Object detection + instance segmentation

https://www.youtube.com/watch?v=OOT3UIXZztE



# 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




http://itsparkds.com/AI-and-Deep-Learning/

# COCO object segmentation

- https://www.youtube.com/watch?v=OOT3UIXZztE

# THANK YOU!