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When passion meets innovation

Bridging the gaps: Deep learning to the manufacturing electronics factory line

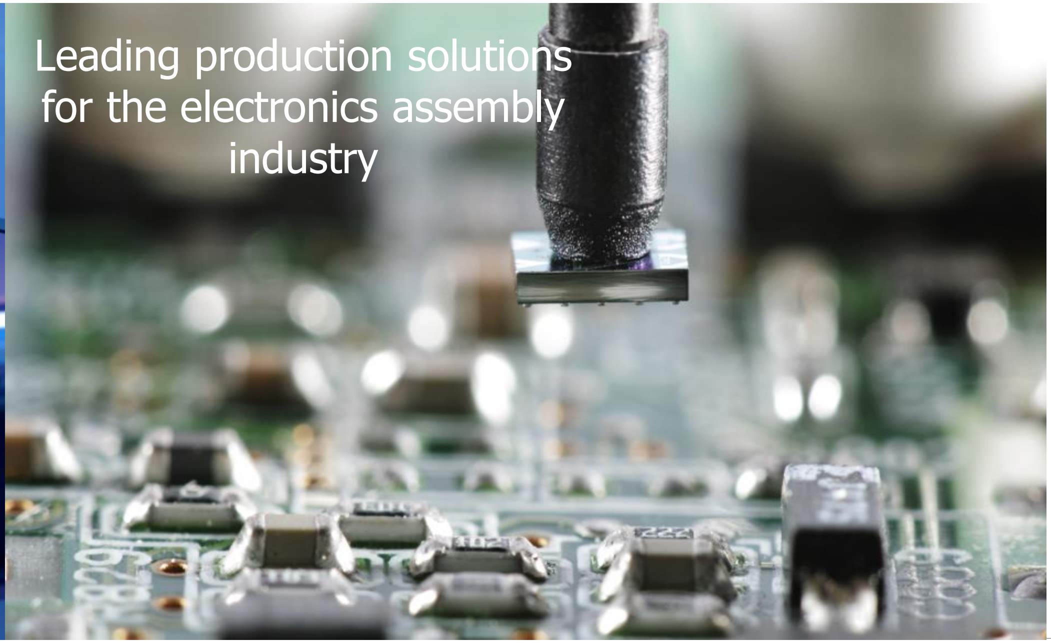
Speaker: Javier Cabello

Mycronic

Two business areas serving the electronics industry

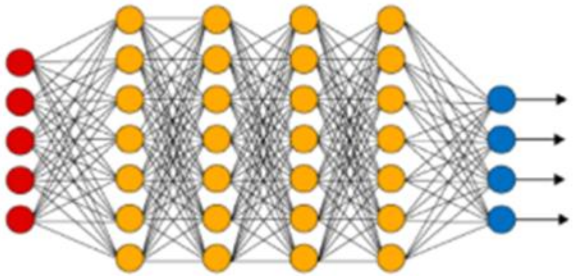
Pattern Generators

Assembly Solutions



CENTER FOR DEEP LEARNING IN ELECTRONICS MANUFACTURING

A PARTNERSHIP OF NUFLARE MYCRONIC D2S

MYCRONIC NUFLARE D2S +  = 

Industrial leaders with shared domain knowledge

Technical expertise within deep learning

Faster addition of business value:

Knowledge + increased performance

Machine learning paradigm

"Data is the new code"

Traditional programming

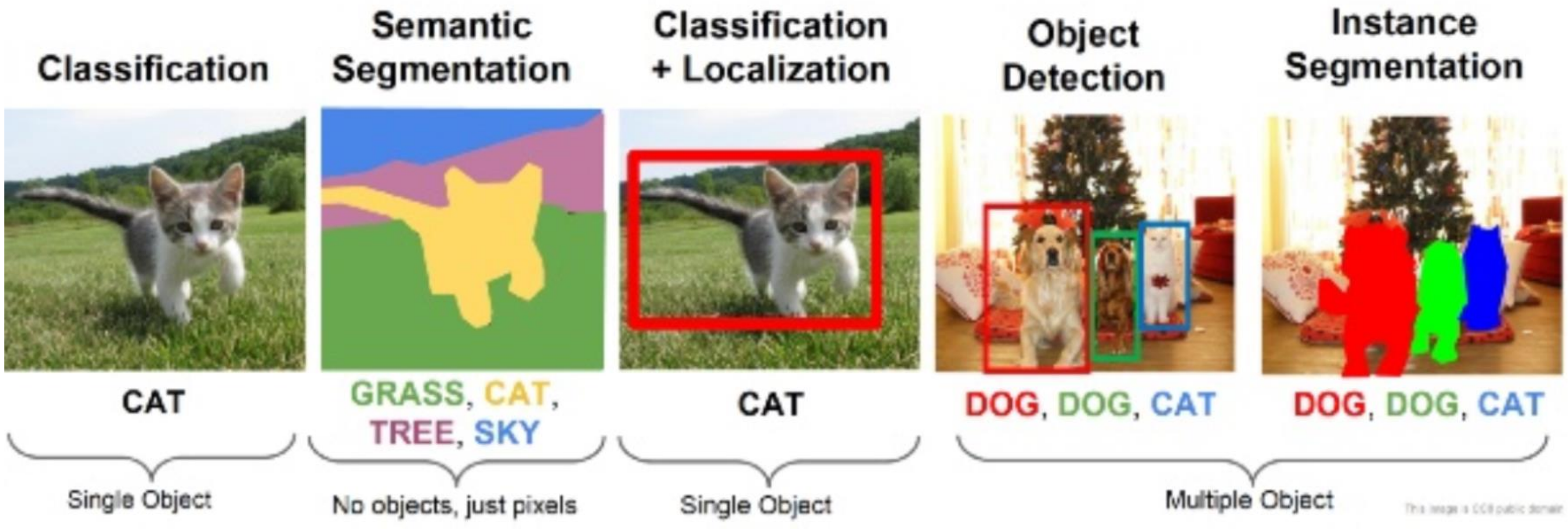
- A relatively easy set of rules works for say 99% of the cases.
- Solving the rest 1% can take 90% of the programming effort.

Machine learning

- These 1% of odd cases can often be easy to collect
- Just feed the new data to the training of deep learning algorithms which will generate a new set of rules

Supervised machine learning

Annotation (even assigning labels) usually is expensive and error prone or ambiguous



from: Standford University 2016 winter lectures CS231n Fei-Fei Li & Andrej Karpathy & Justin Johnson

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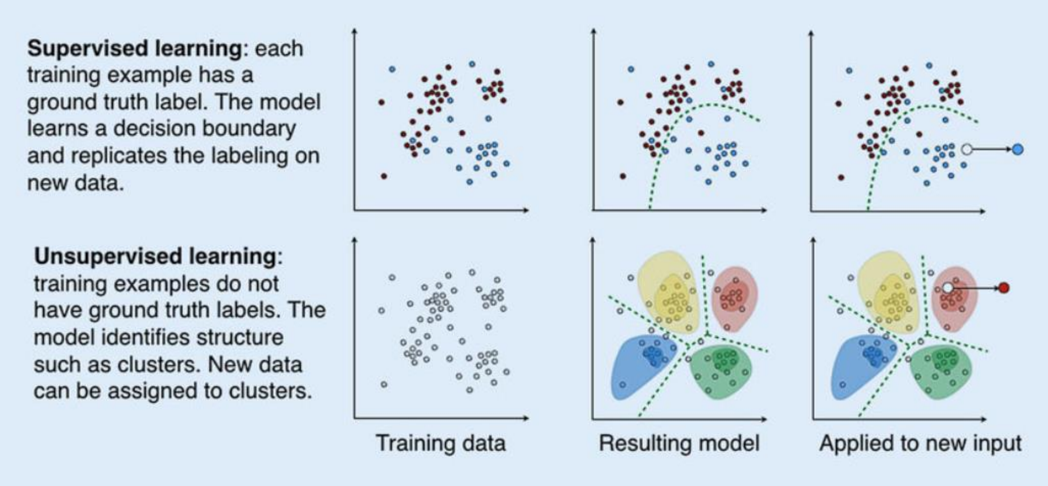
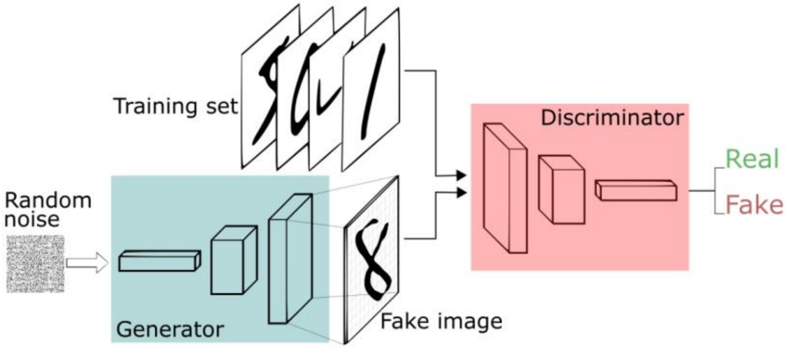
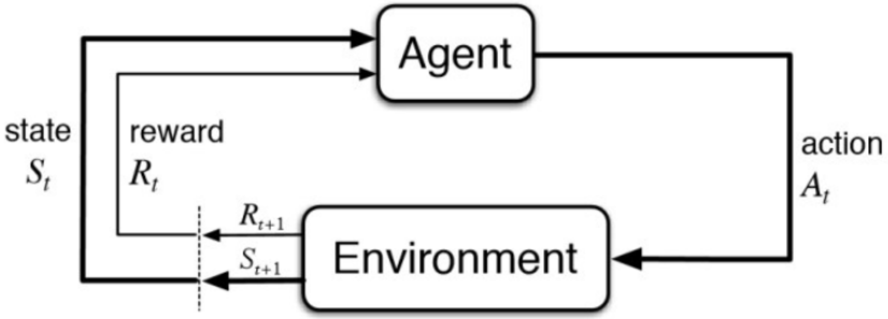
Non supervised machine learning

Unsupervised, generative deep learning and reinforcement learning







Which problems can be targeted better with deep learning?

List of projects/ideas

Bridging the gaps

1. Missing data
   - Store the data when available, not when needed
2. Good annotation is expensive
   - Use simulations and other generative methods when possible
   - Invest in good annotation tools
3. Computing and storage resources
   - For training (infrastructure)
   - For inference at the edge
4. Know-how
   - Expertise and transfer learning

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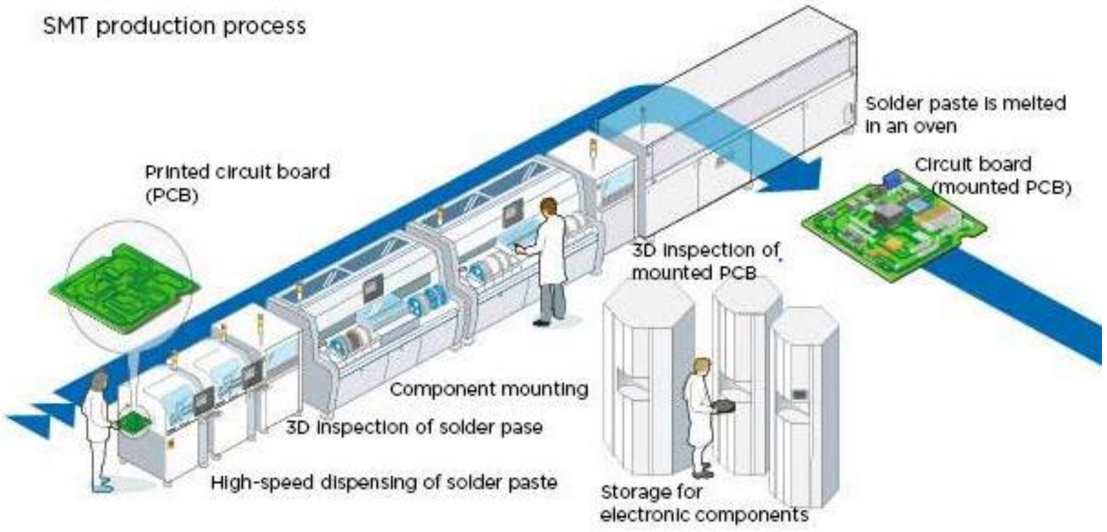
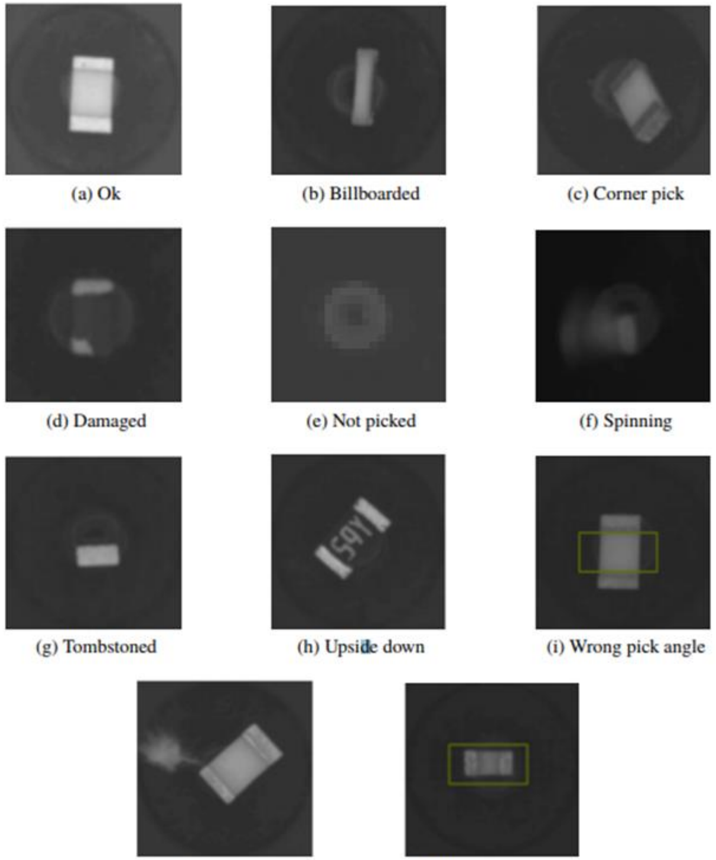
Bridging the gaps: Collecting data

Change mindset: Collect the data before you think you need it





(a) Ok (b) Billboarded (c) Corner pick (d) Damaged (e) Not picked (f) Spinning (g) Tombstoned (h) Upside down (i) Wrong pick angle (j) Stop production (k) Wrong component

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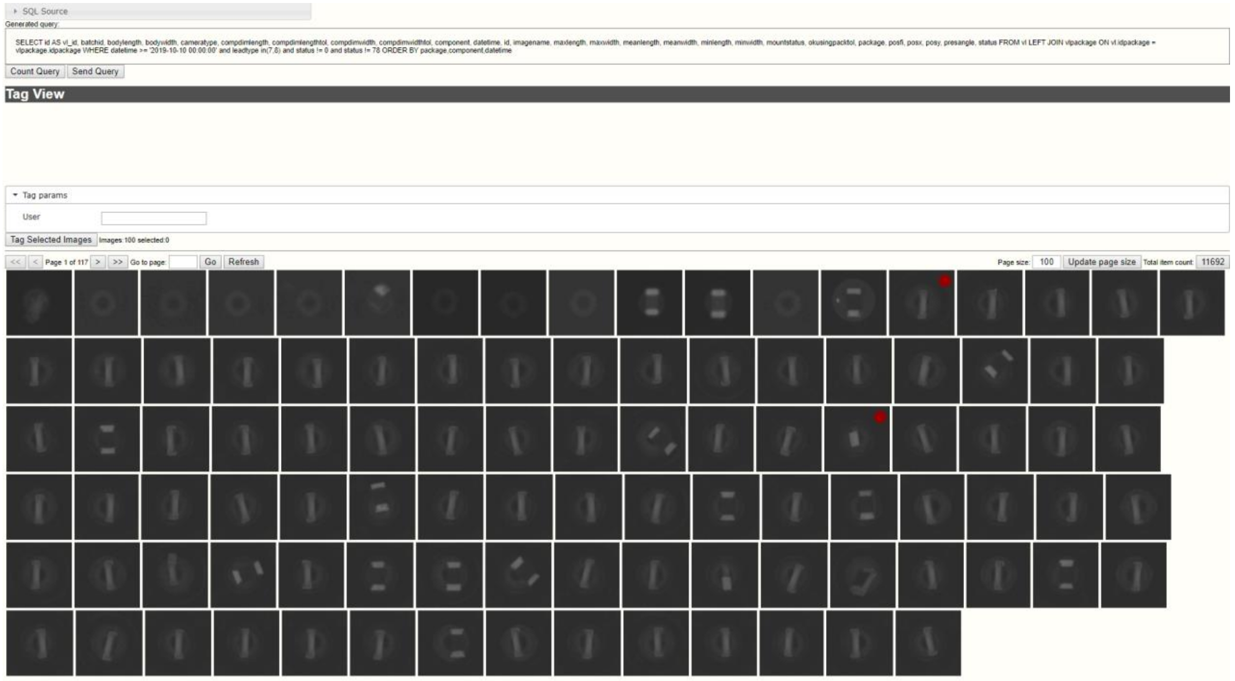
Bridging the gaps: Annotating the data

Invest in tools that help to structure, annotate and select the data for training

“More data beats better algorithms”:

- Odd cases might be difficult to either collect or simulate but are a success factor
- Annotation is expensive and human error prone but…
- Deep learning is robust to non-systematic annotation errors



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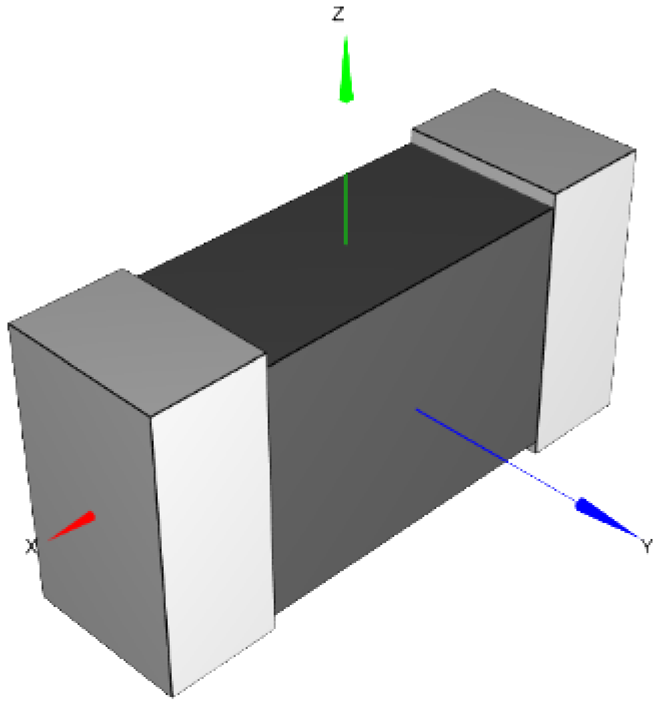
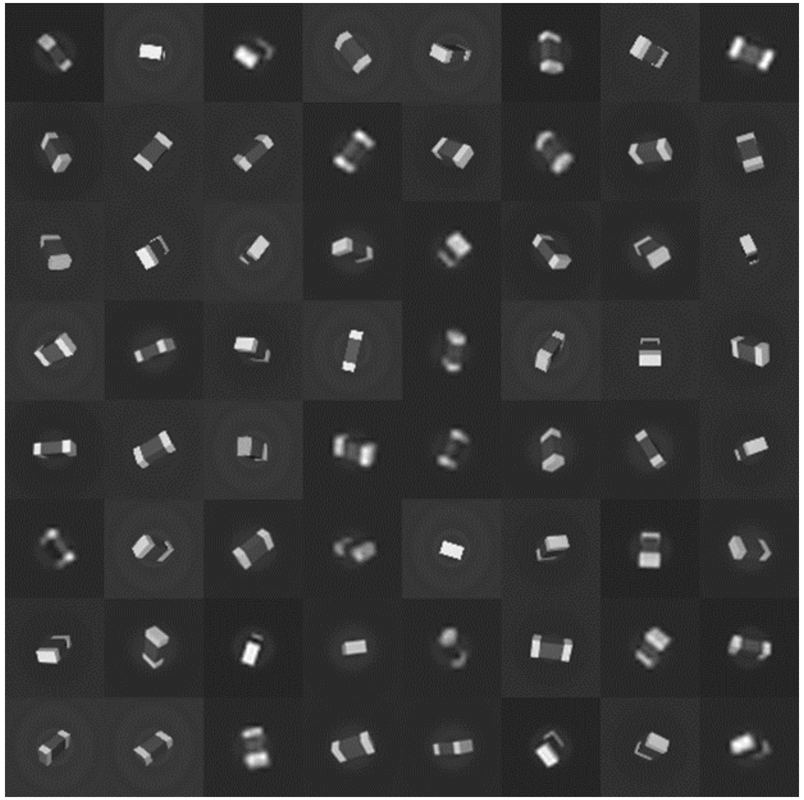
Bridging the gaps: Augmenting the data

Creating simulations for rare cases (that you can figure out ☺)





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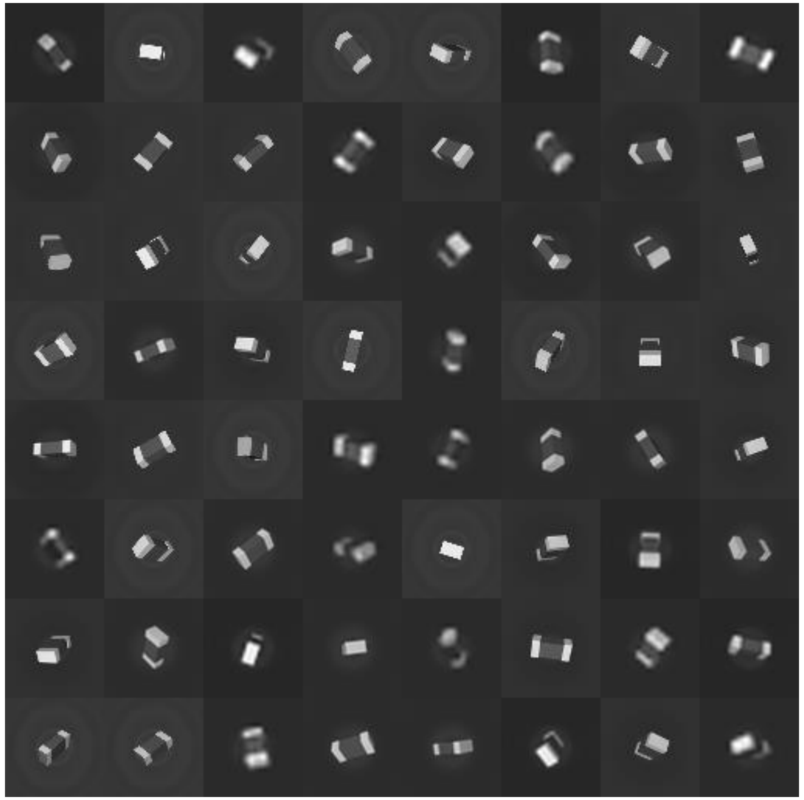
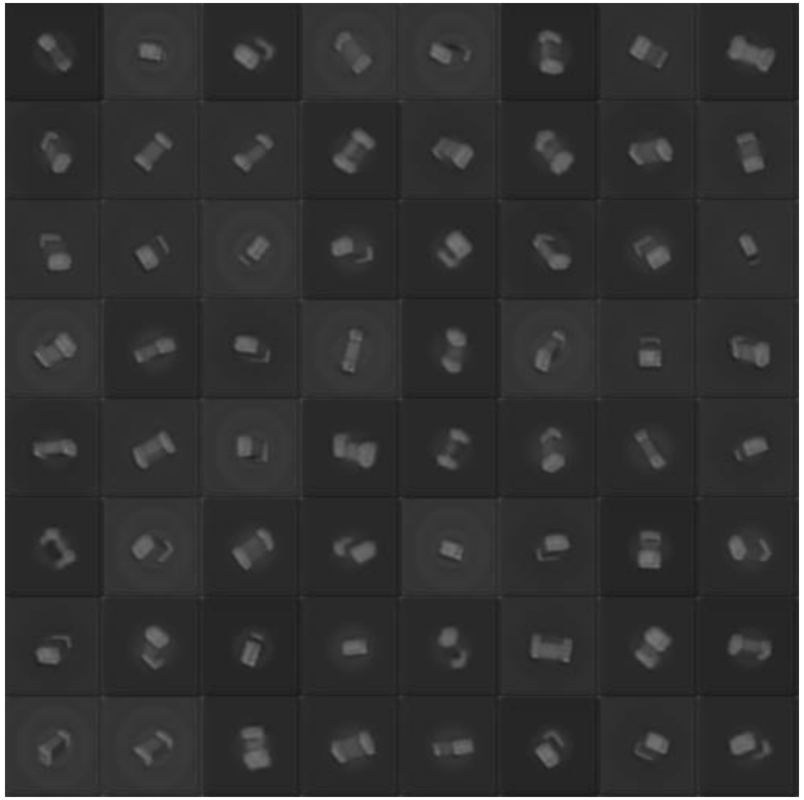
Bridging the gaps: Augmenting the training data

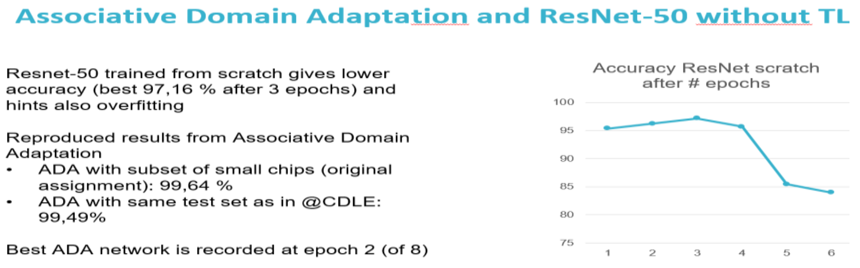
From simulations + generative models: you get the annotations for free





Bridging the gaps:

Collaboration and share of computing and know-how resources in Silicon Valley

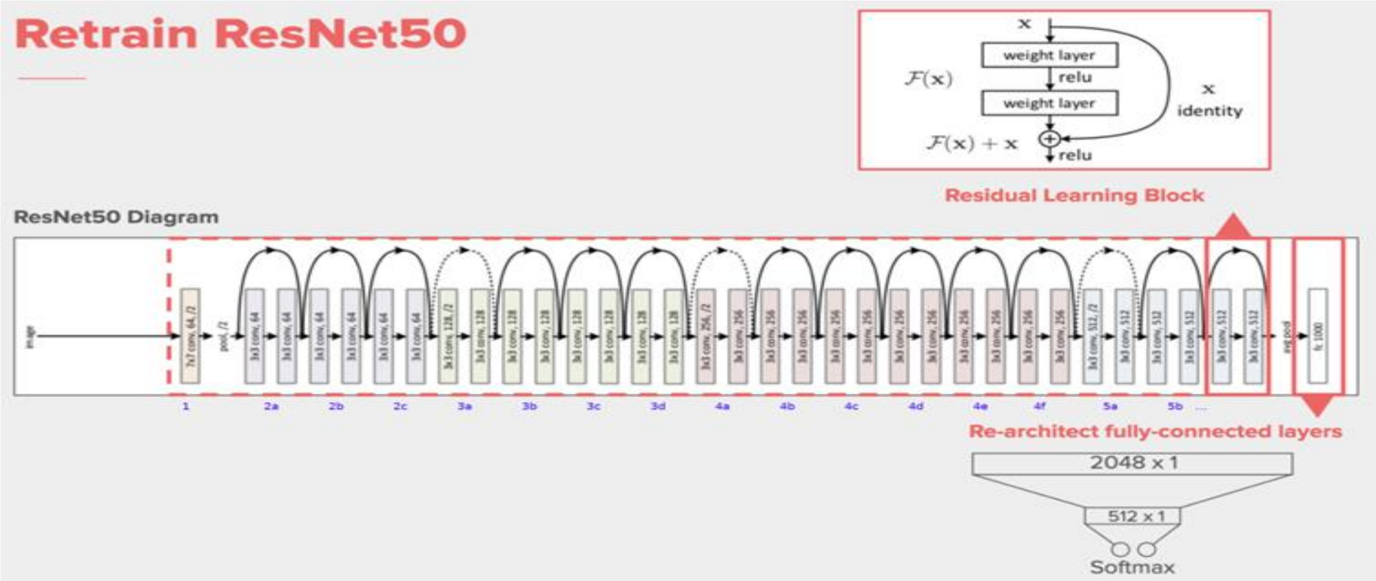


CDP38:
4000 TFLOPS of computing performance

Bridging the gap: Know how

Transfer Learning

- For many tasks the rules generated for solving a task generalize well to other tasks by just retraining the neural network with fewer data samples from the new task.
- Only some layers of the network are retrained (“finetuned”) depending on how much the data sets differ
- Specific requirements on the industry:
  - Very high accuracy: At least close to on par with current performance
  - Gathered data sets are very skewed: Many samples of OK cases compared with NOK



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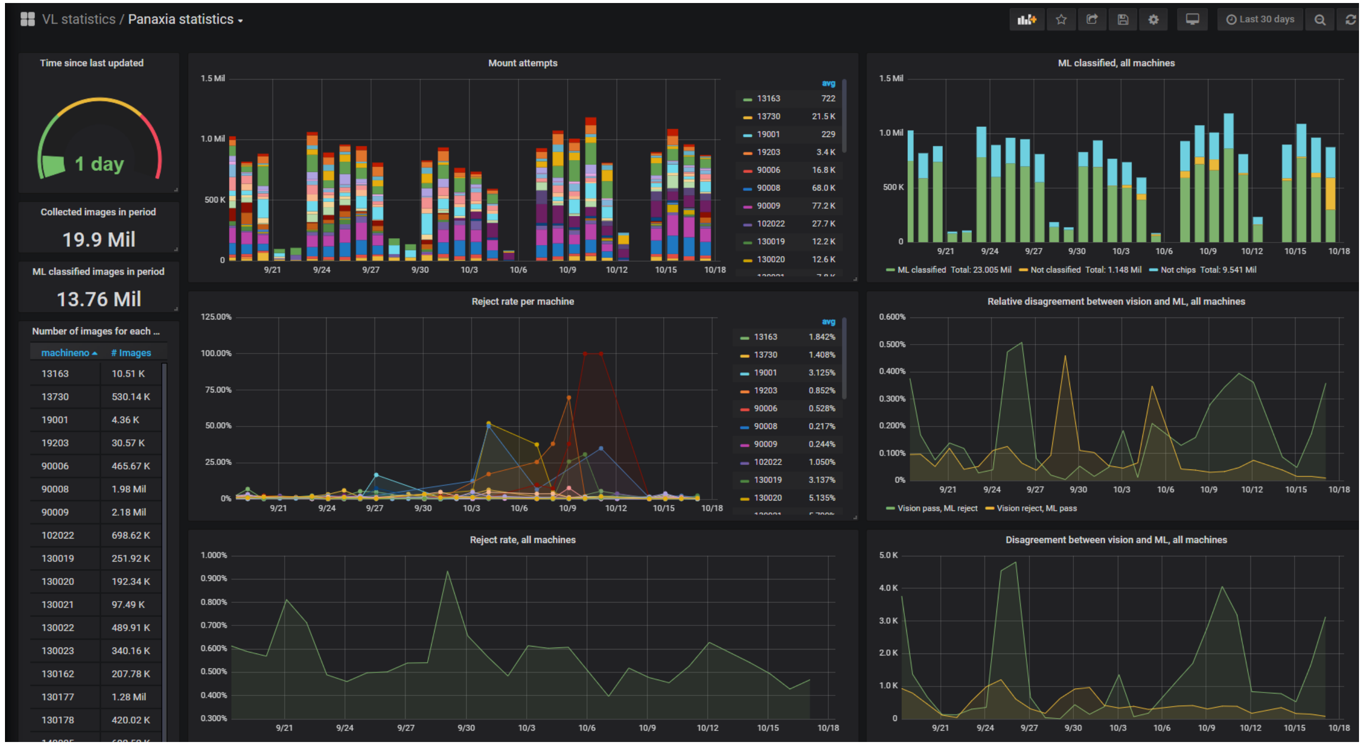
Creating business value

Measuring current system performance without relying on other machines

➢ We can roughly compute errors made by the Pick & Place machines by annotating much fewer images (1/1000 of the total)



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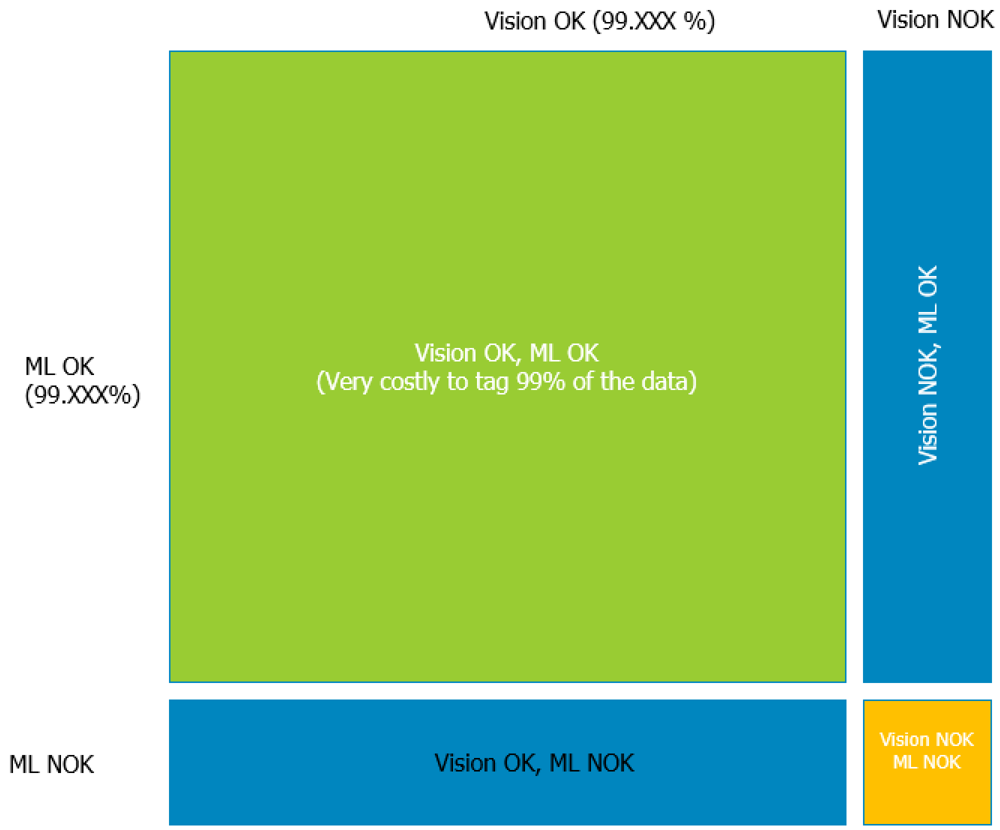
Creating business value: Enhancing performance

- Accuracy requirements are very high but we can take advantage of already very accurate processes



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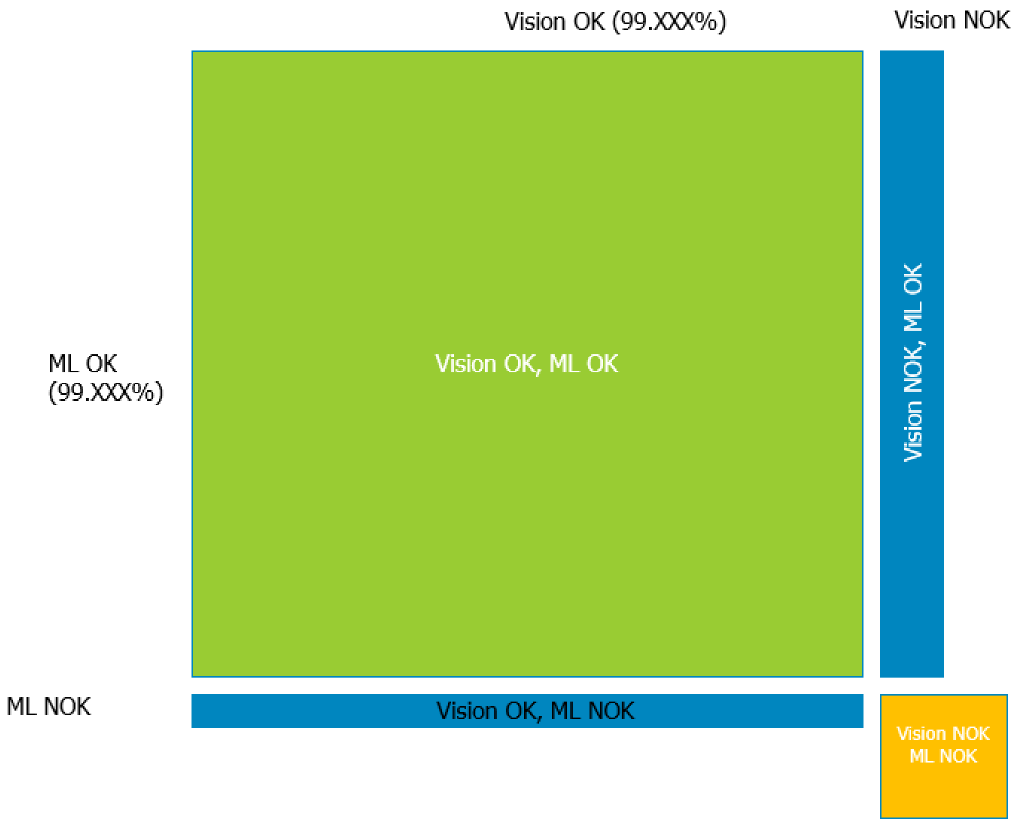
Enhancing performance

- Deep learning models have to match to a very high extent current image analysis processes as we know they already very accurate.
- This allows us to disregard DL some algorithms without needing to tag huge amount of data



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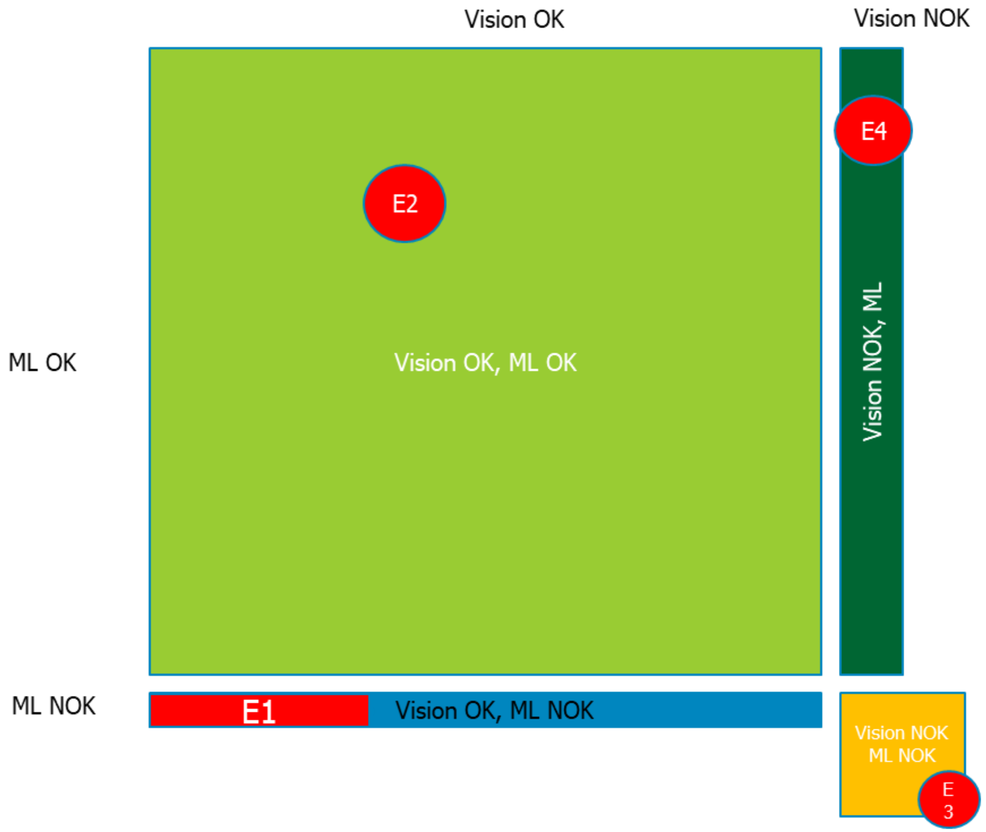
Creating business value: Enhancing performance trade-offs

- Detect as many possible False Positives at the cost of as low as possible False Negatives

- First results show FP reduced by > 50 % (expensive errors) at the cost of FR increased by < 20 % (cheaper errors)



Deployment issues

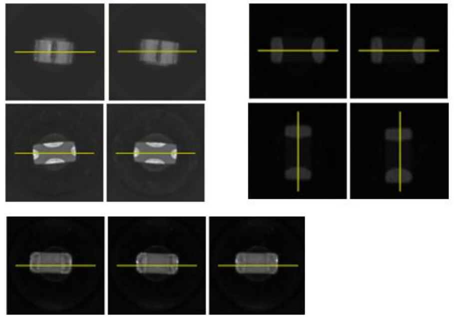
Reliability and performance

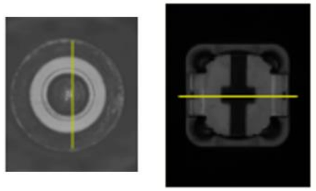
When to let DL be part in the decision making

- Never seen data in the training process is likely to be classified incorrectly.
- But if performance of current process and DL is close or better than already very accurate systems you can start trusting DL for specific tasks

Performance without losing accuracy:

- Model compression techniques
- Plug-in HW accelerators





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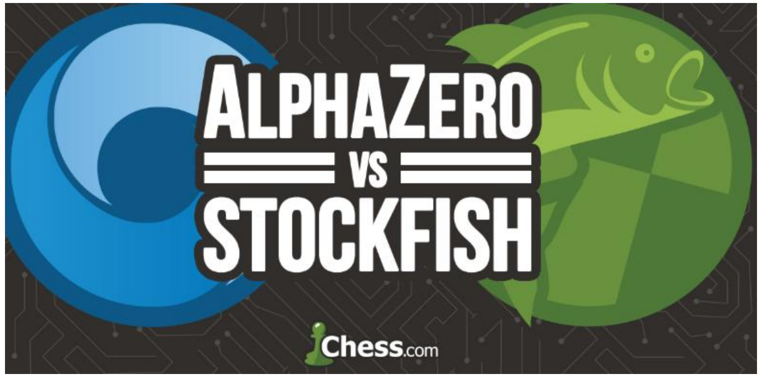
Deep learning is here to help us to take the next leap in electronics manufacturing process reliability



Thank you for listening!

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