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OPEN TECH THOUGHTS

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KI IM CAE-PROZESS

Dr. Christian Simmendinger – T-Systems

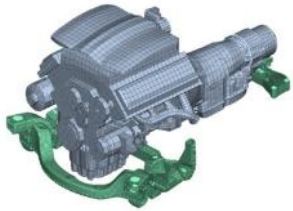
4. Juli 2018

OUTLINE

- **From CAD to CAE**
- **Deep Learning in CAD/CAE**
- **Methodology & Detection Process**
- **Results**
- **Outlook**



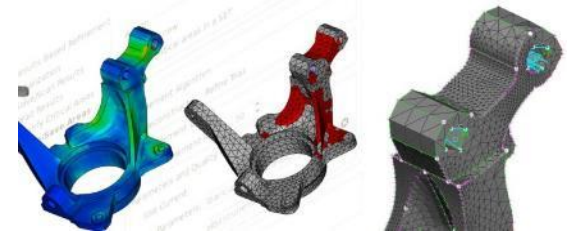
From CAD to CAE



CAD

CAE

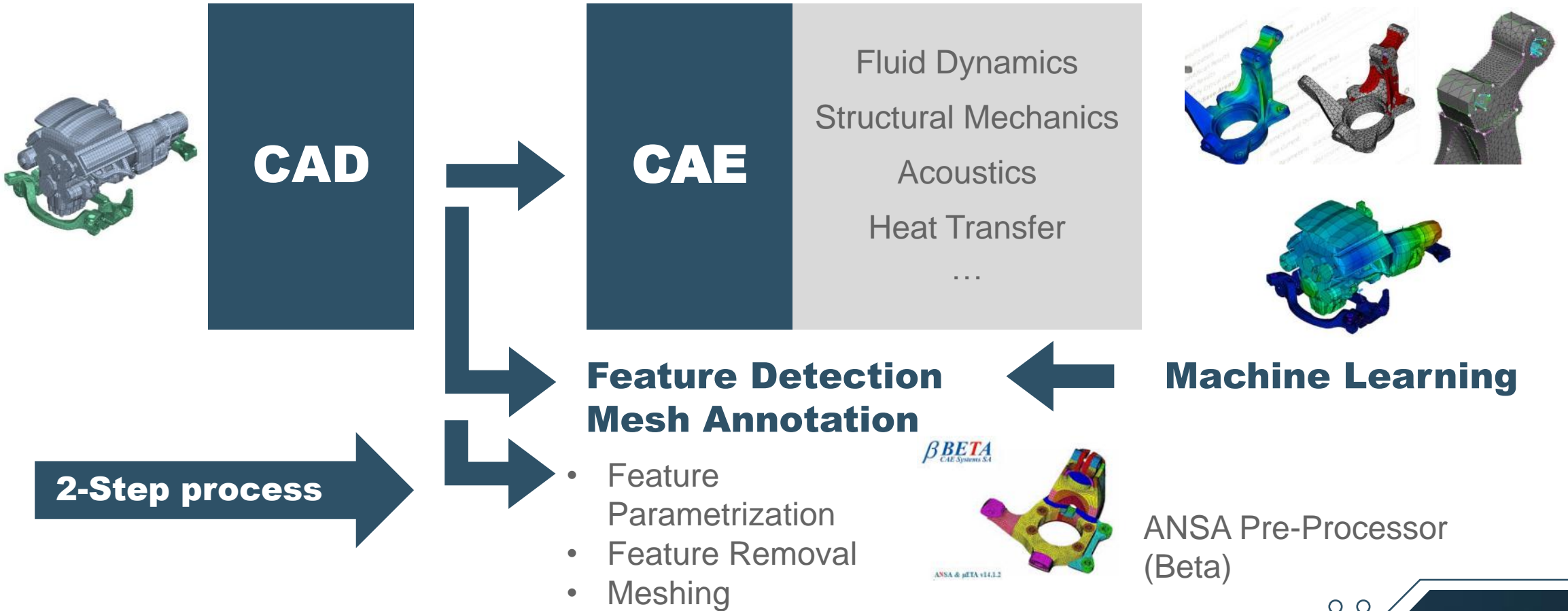
Fluid Dynamics
Structural Mechanics
Acoustics
Heat Transfer
...



Non-trivial

- Requires expert knowledge
- Substantial impact on algorithms, quality of results, time to solution, resource consumption.
- Manual process, frequently outsourced.
- Long turn around times, significantly slows down the design process
- Full automation of this process has been unresolved for ~30 years

From CAD to CAE



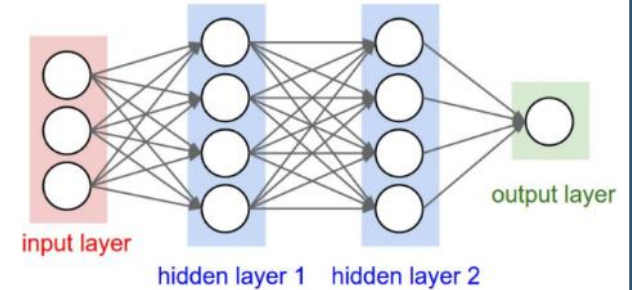
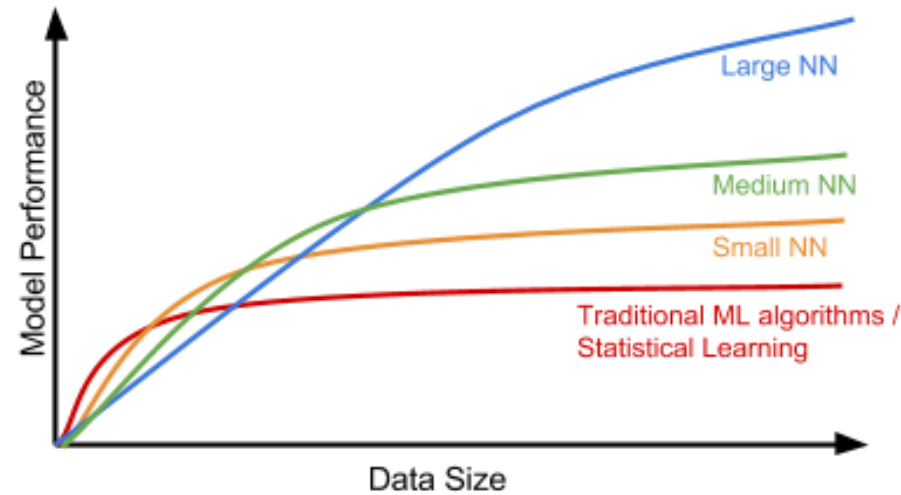


DEEP LEARNING

Deep Learning - Scale

For large data sets
deep learning
will outperform
all traditional
ML algorithms

Andrew Ng “Nuts and Bolts
of Applying Deep Learning”



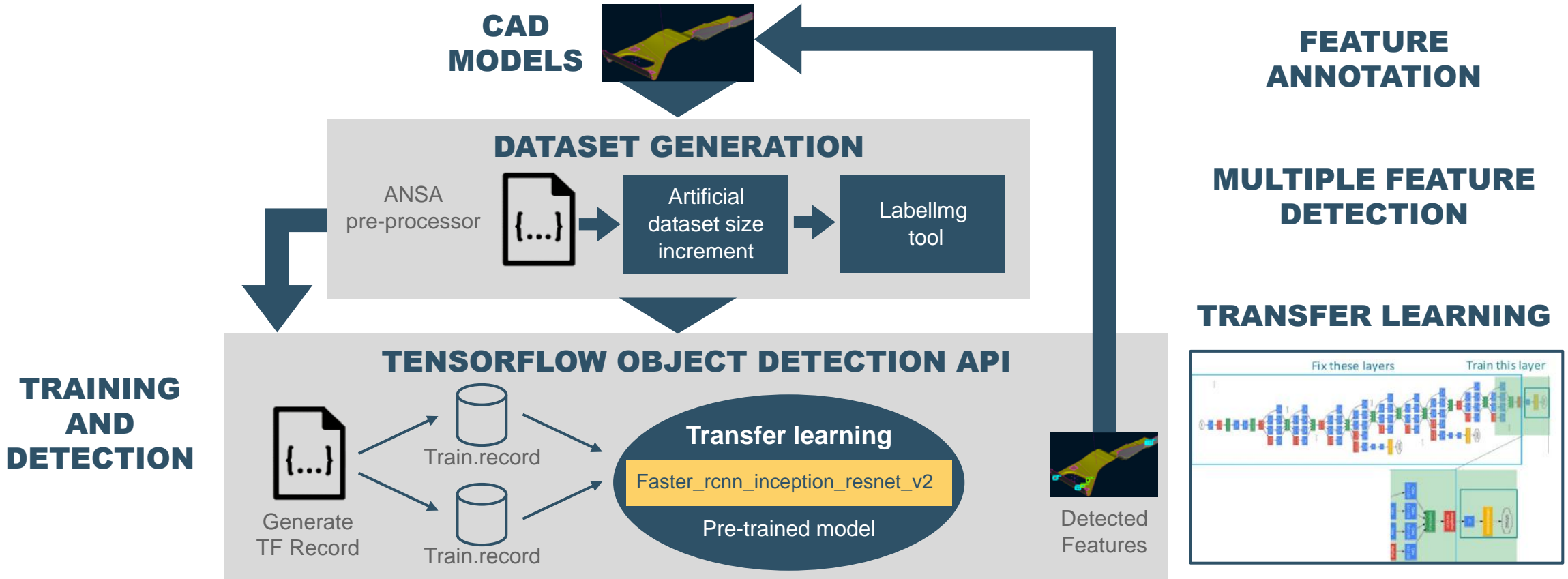
Deep Learning NN

Regression, RF, SVM, ..



METHODOLOGY

Methodology



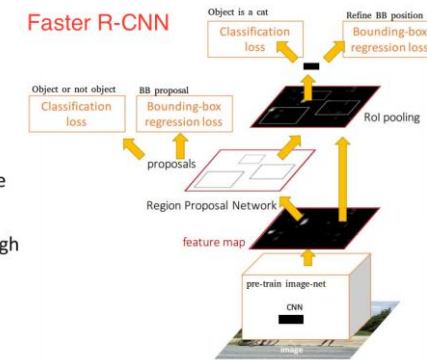
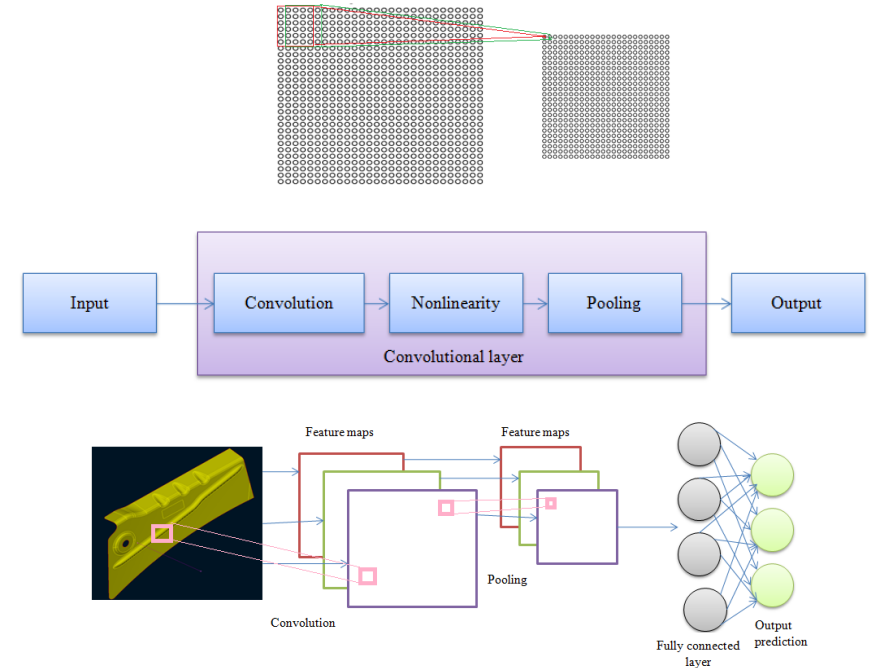
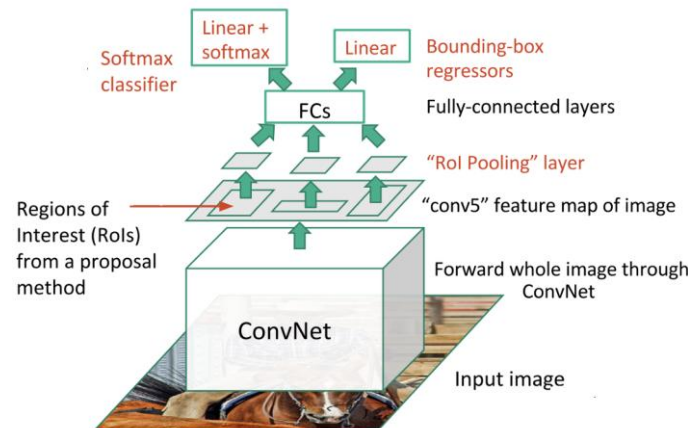
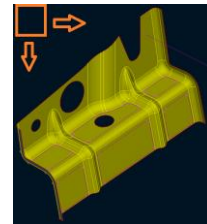
The background of the image is a dark blue gradient. Overlaid on this is a complex, light blue circuit board pattern. The pattern consists of numerous thin lines that branch out and connect to small circular nodes, resembling a dense network of electronic components or a stylized map of a city's infrastructure. The lines and nodes are more concentrated in the center and fade out towards the edges.

FASTER R-CNN

Region based Convolutional Neural Networks

Faster R-CNN

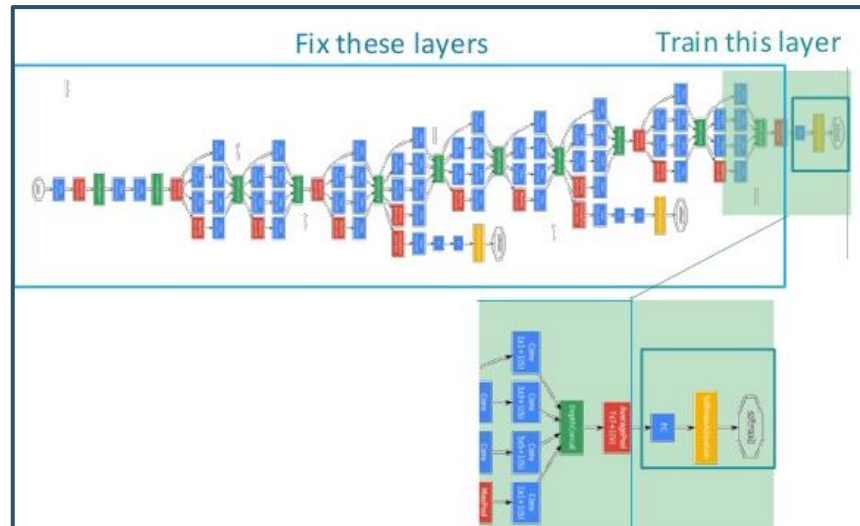
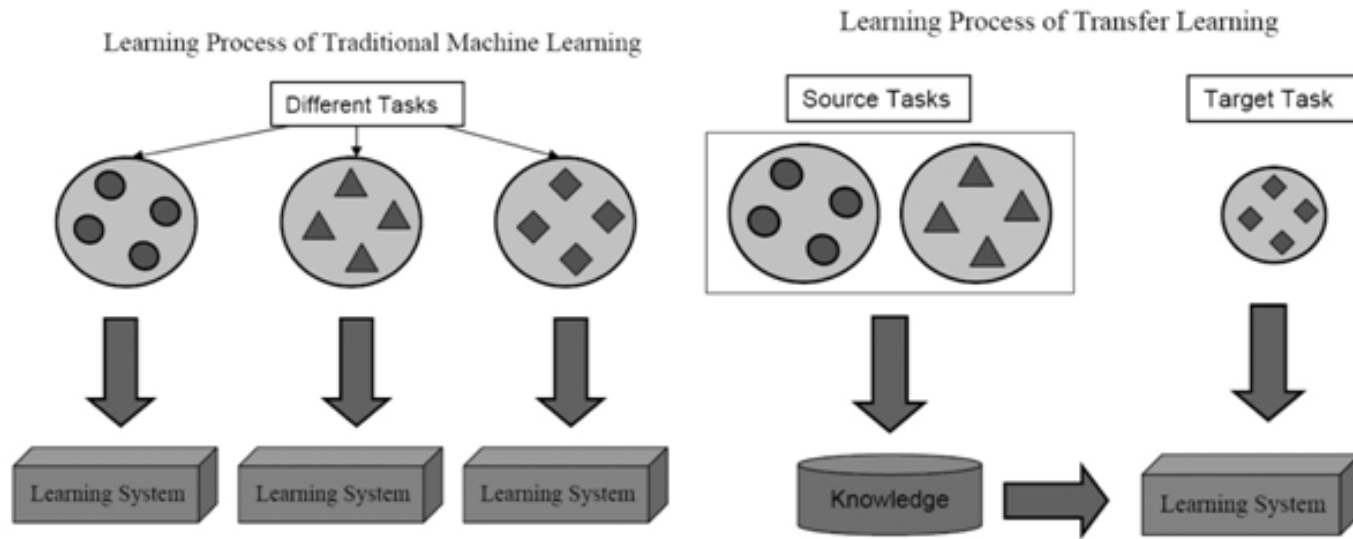
- Convolutional layer with local connectivity and spatial detection
- Rectified Linear Unit layer (ReLU)
- Max Pooling layers
- Fully connected layer
- Softmax loss layer
- Region of Interests
- Improved **object detection** with dedicated RP network.





TRANSFER LEARNING

Transfer Learning





DEEP LEARNING FRAMEWORKS

DEEP LEARNING FRAMEWORKS

TensorFlow

- Active community: how fast can potential issues be solved.
- Provides object detection API: TensorFlow object detection API
- Availability of pretrained model - Transfer Learning
- Multi-GPU support
- Availability of learning materials
- Availability of debugging tools: (tensorboard for model visualization and checkpoints)
- Performance: (primarily cuDNN support)



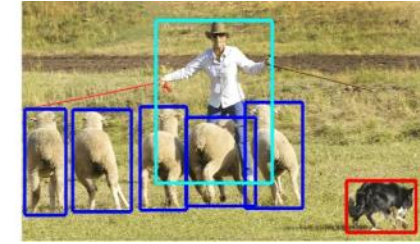
TensorFlow Object Detection API

- Small dataset, time constraints: Transfer learning
- TensorFlow object detection API:
- Part of the official TensorFlow research model.
- Provides pre-trained models.

Model name	Speed (ms)	COCO mAP[^1]	Outputs
ssd_mobilenet_v1_coco	30	21	Boxes
ssd_inception_v2_coco	42	24	Boxes
faster_rcnn_inception_v2_coco	58	28	Boxes
faster_rcnn_resnet50_coco	89	30	Boxes
faster_rcnn_resnet50_lowproposals_coco	64		Boxes
rfcn_resnet101_coco	92	30	Boxes
faster_rcnn_resnet101_coco	106	32	Boxes
faster_rcnn_resnet101_lowproposals_coco	82		Boxes
faster_rcnn_inception_resnet_v2_atrous_coco	620	37	Boxes

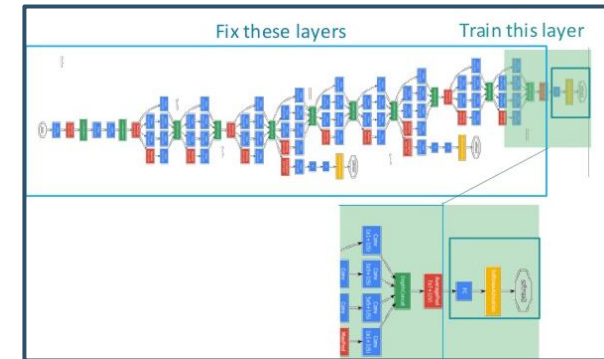


(a) Image classification



(b) Object localization

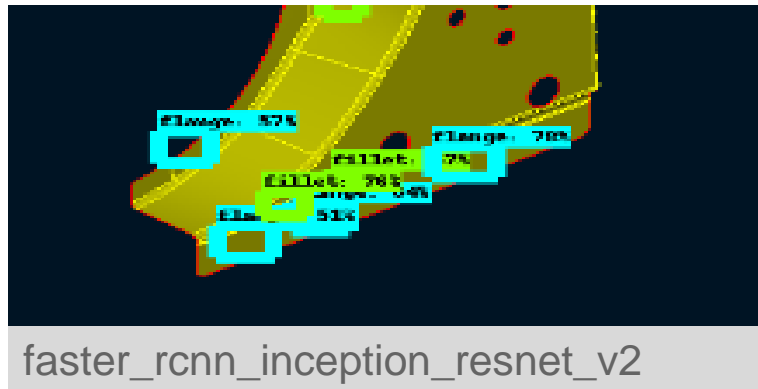
TensorFlow
detection
model zoo





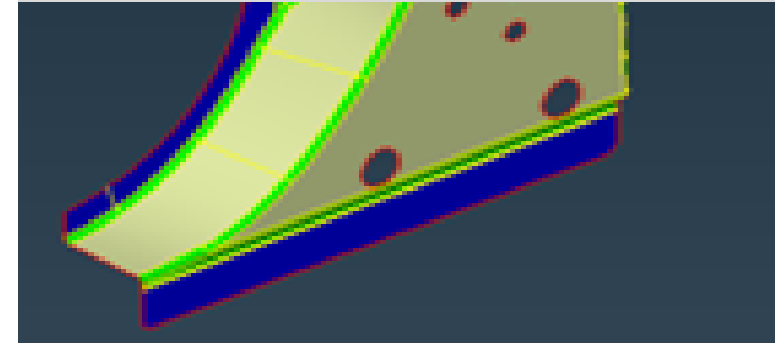
DATASET GENERATION

Feature Detection / Feature Extraction



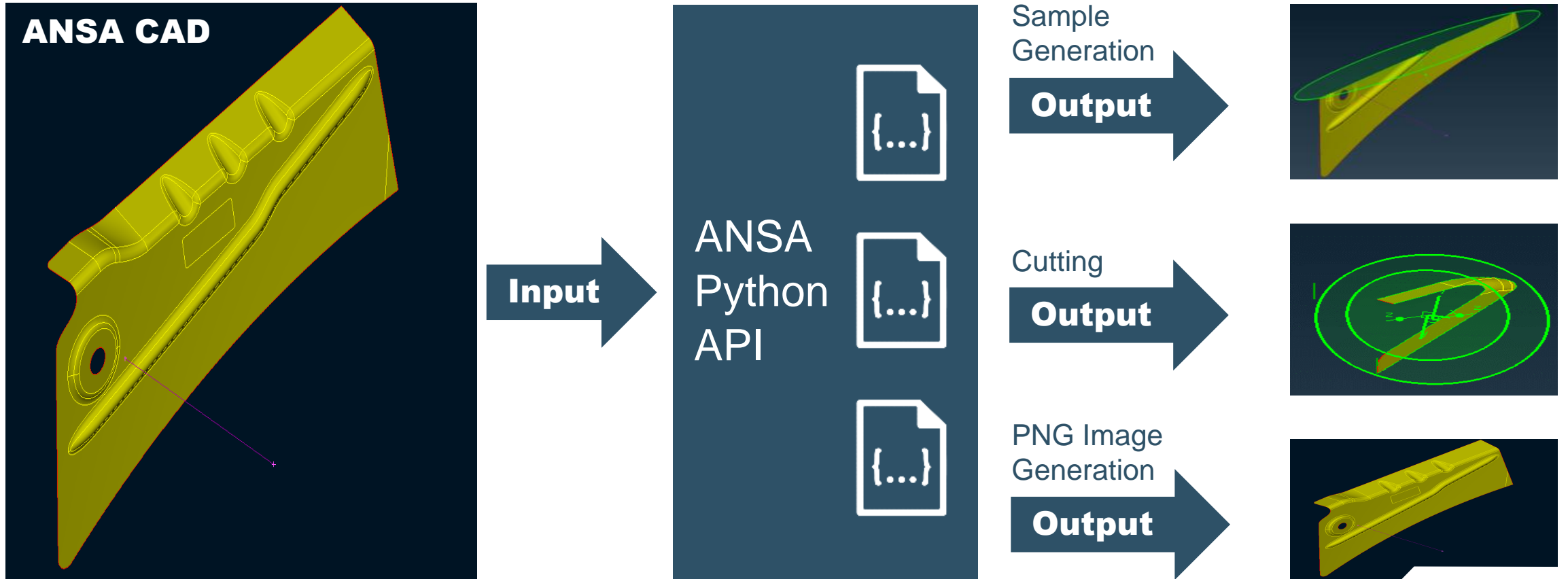
Machine Learning

model

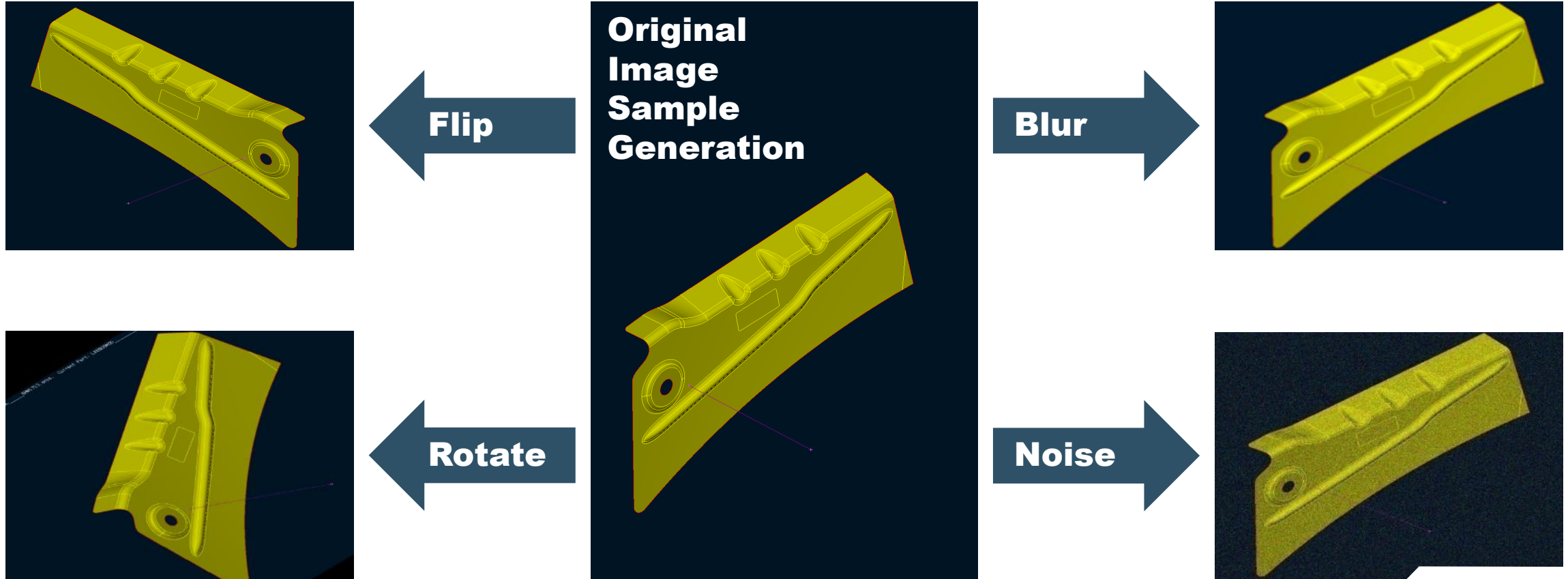


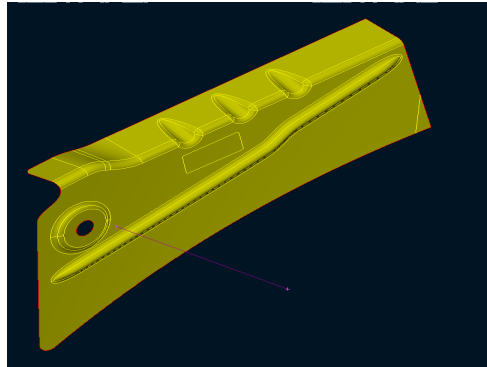
Training + Inference

Dataset Generation



Dataset Generation

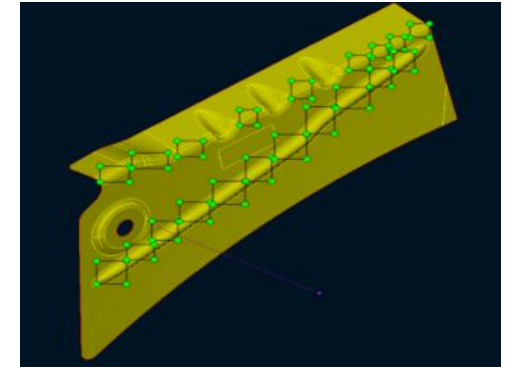




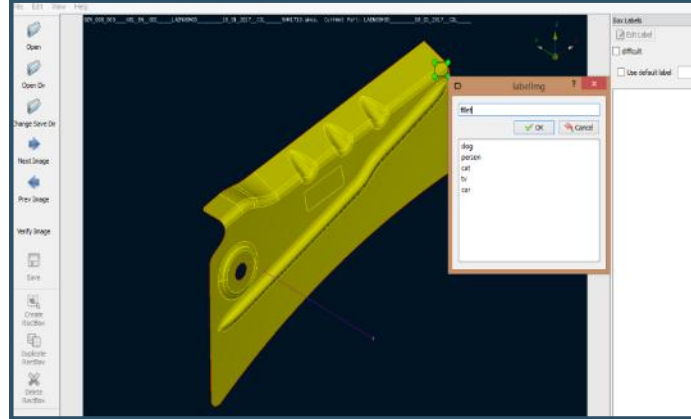
Input


Labelling Image Annotation Tool

Output



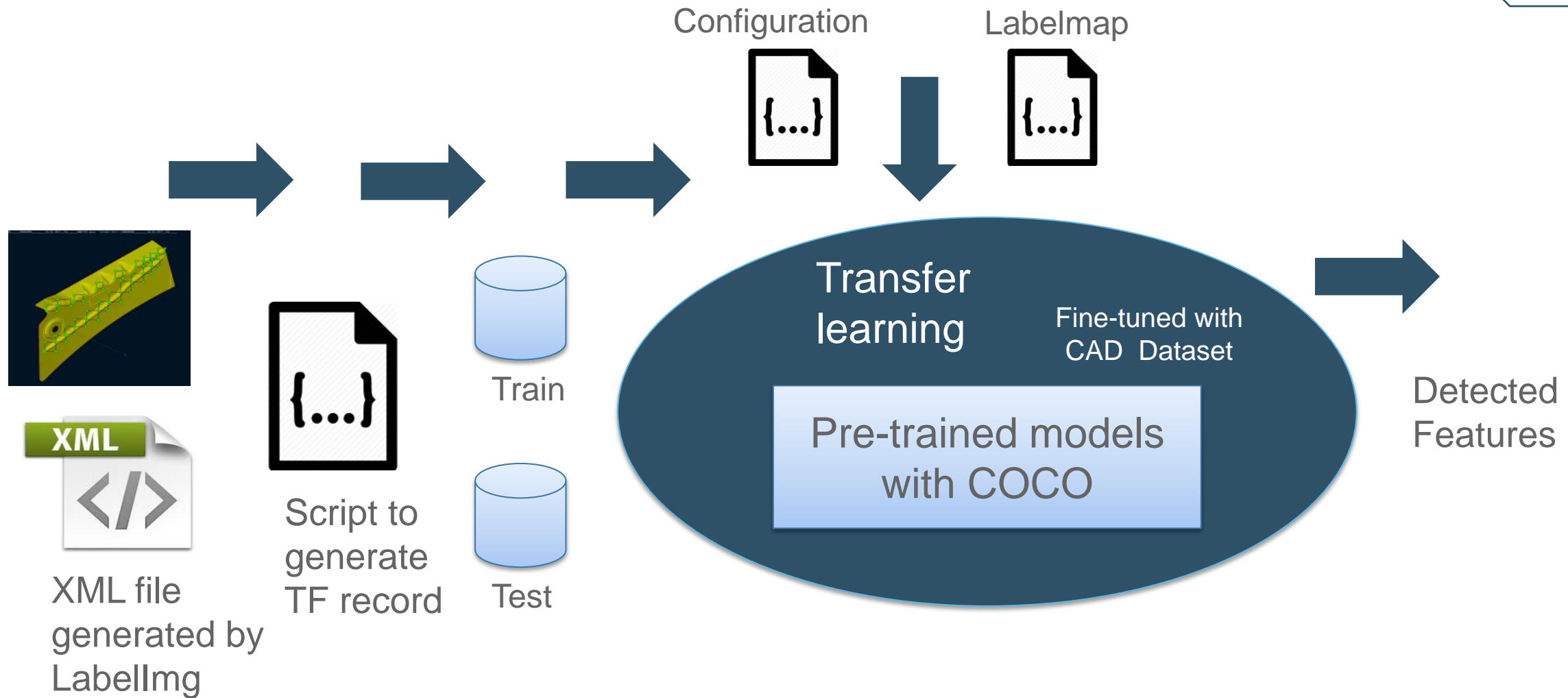
Output





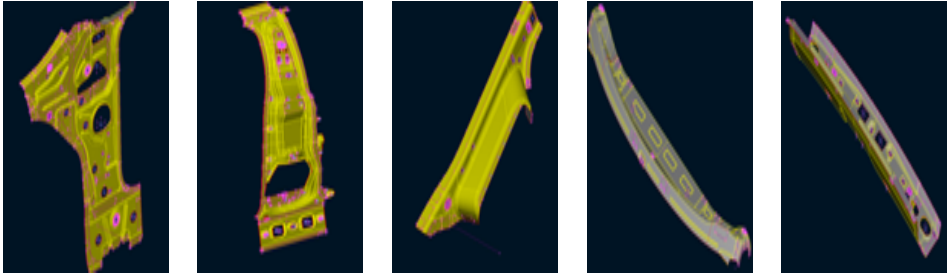
DETECTION PROCESS

Detection Process

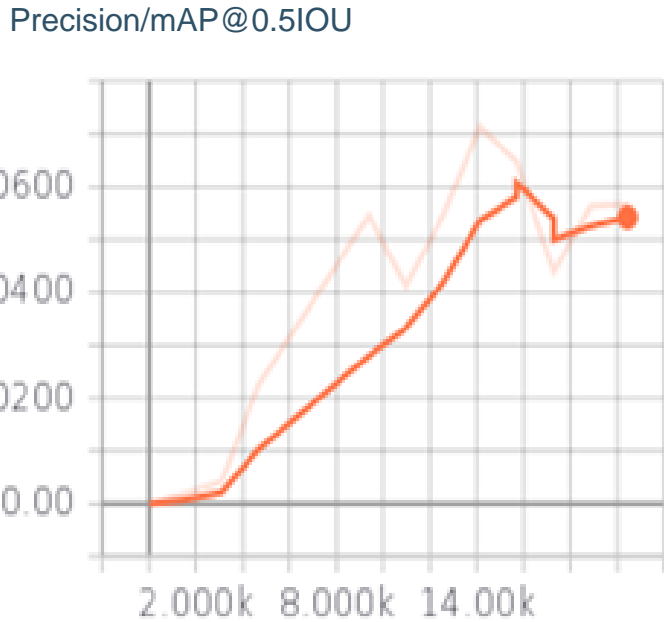
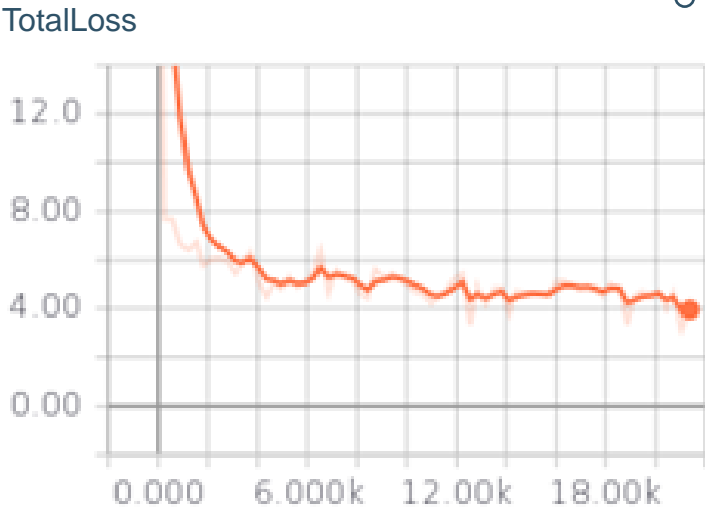


RESULTS

Results

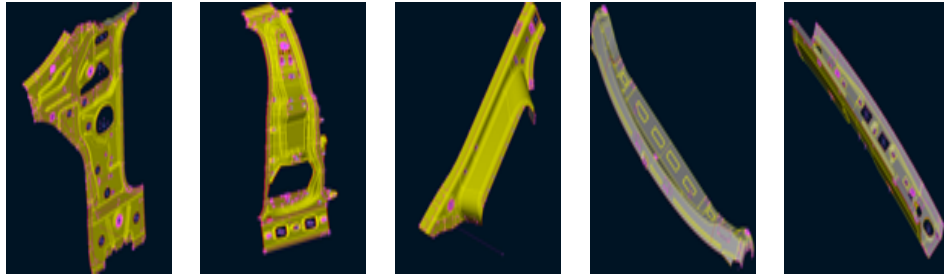


Name	CAD_Model_dataset
Total size	750 Images
Training set	700 Images
Test set	50 Images
Number of Classes	3
Classes	Fillet, Flange, Bead



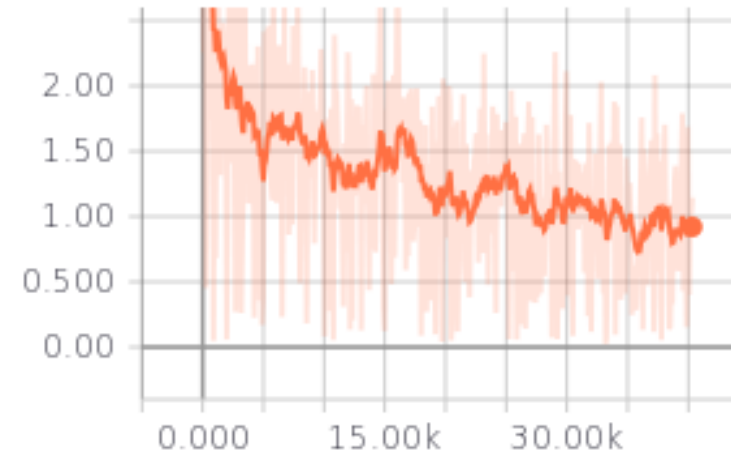
ssd_inception_v1_coco

Results

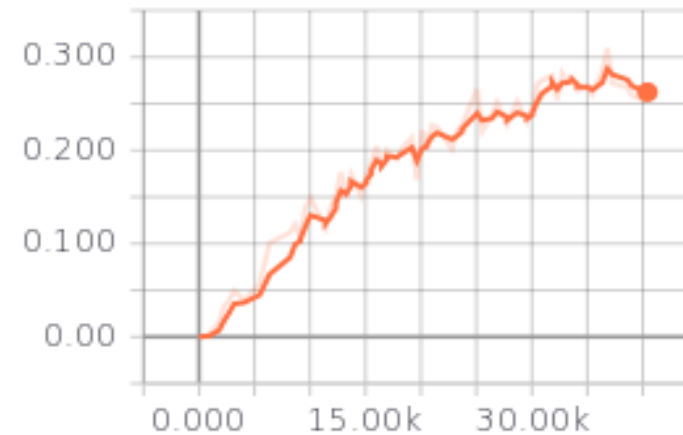


Name	CAD_Model_dataset
Total size	750 Images
Training set	700 Images
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Number of Classes	3
Classes	Fillet, Flange, Bead

TotalLoss



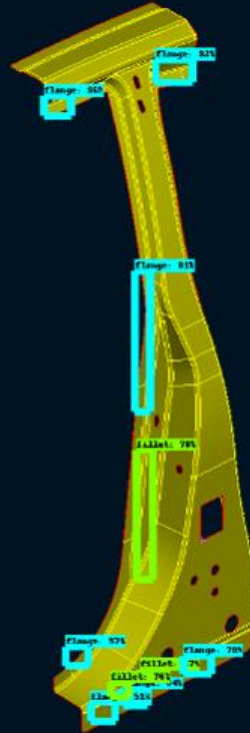
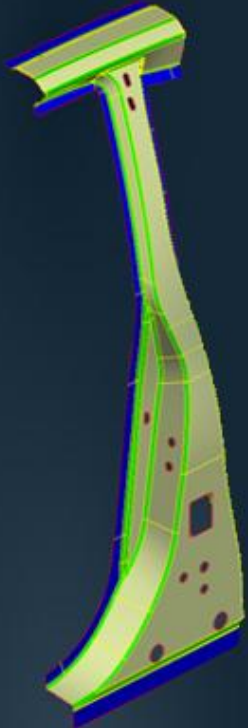
CAL/Precision/mAP@0.5IOU



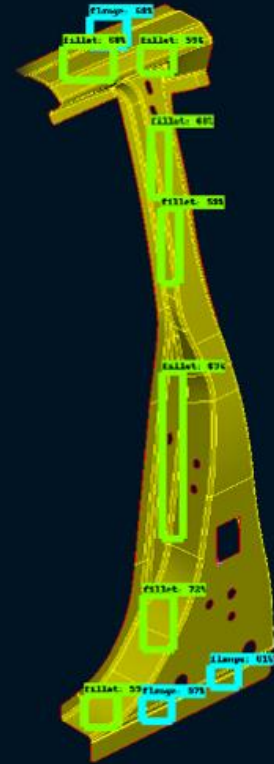
faster_rcnn_inception_resnet_v2

Results

Multiple Features:
Blue = flange, Green = fillet



faster_rcnn_inception_resnet_v2



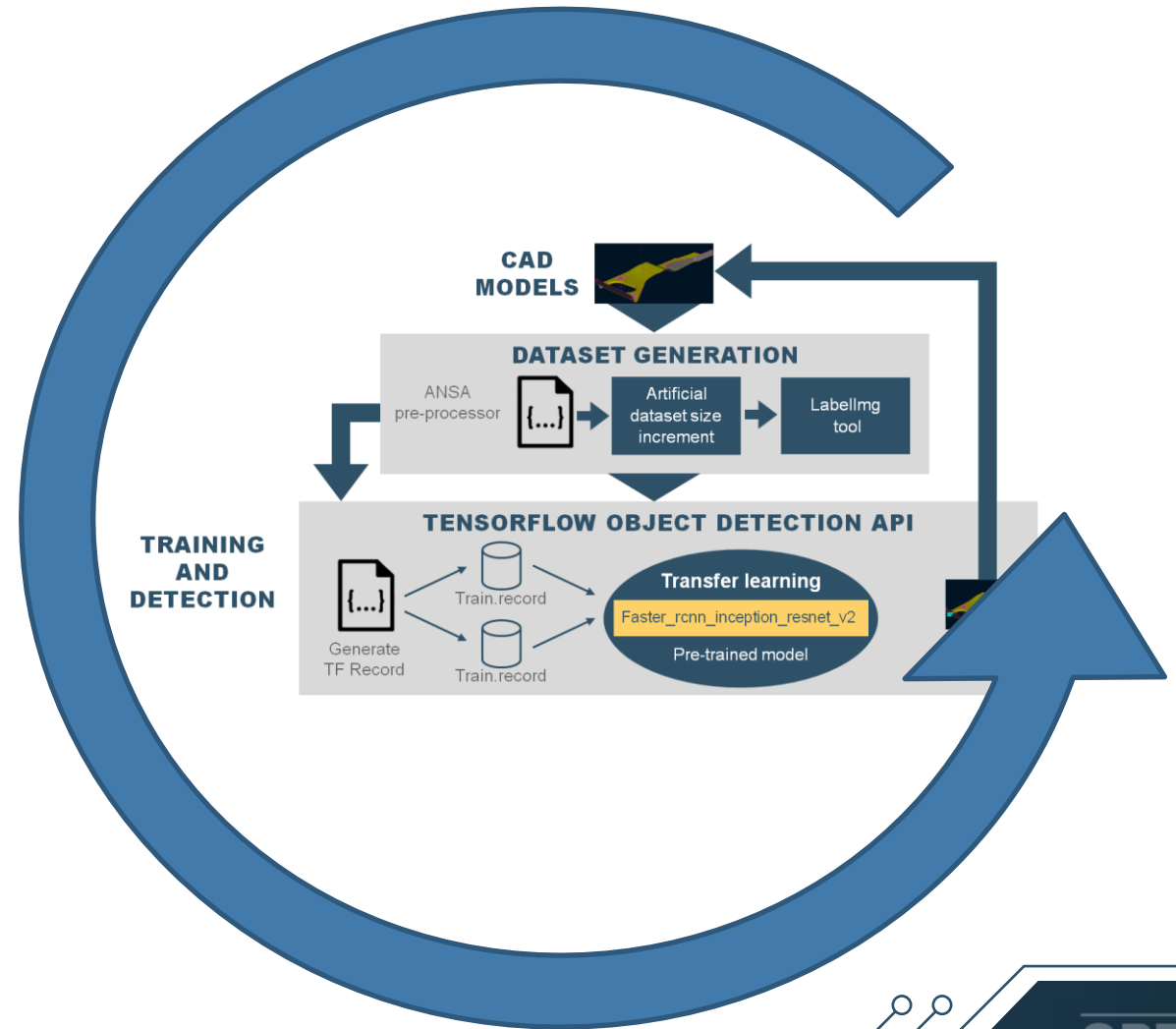
ssd_inception_v2



OUTLOOK

Improved learning

- Full Integration in ANSA Pre-Processing
- Improved learning via annotation and 3D model rotation



Outlook

- Generic feature detection in 3D Data-Sets
- Classification of 3D Data-Sets



**THANK
YOU!**
