



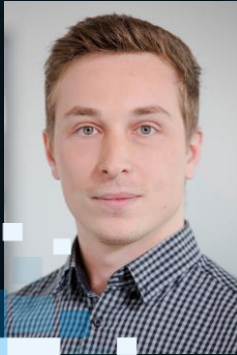
Augmented Intelligence

A Human-Machine Marriage on the Way to
Complete Intelligent Automation



craftworks

We develop prize-winning
Software & Industrial AI



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Data Scientist @ craftworks

Lecturer @ WU Wien & FH Wien

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We develop prize-winning
Software & Industrial AI



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OUR CLIENTS



Augmented Intelligence

A Human-Machine Marriage on the Way to
Complete Intelligent Automation

- ① The “i” in AI: Intelligence or Illusion?
- ② Augmented Intelligence
- ③ Industry Case



Intelligence
or
Illusion?

The “i” in AI: Intelligence or Illusion?

Have you ever googled

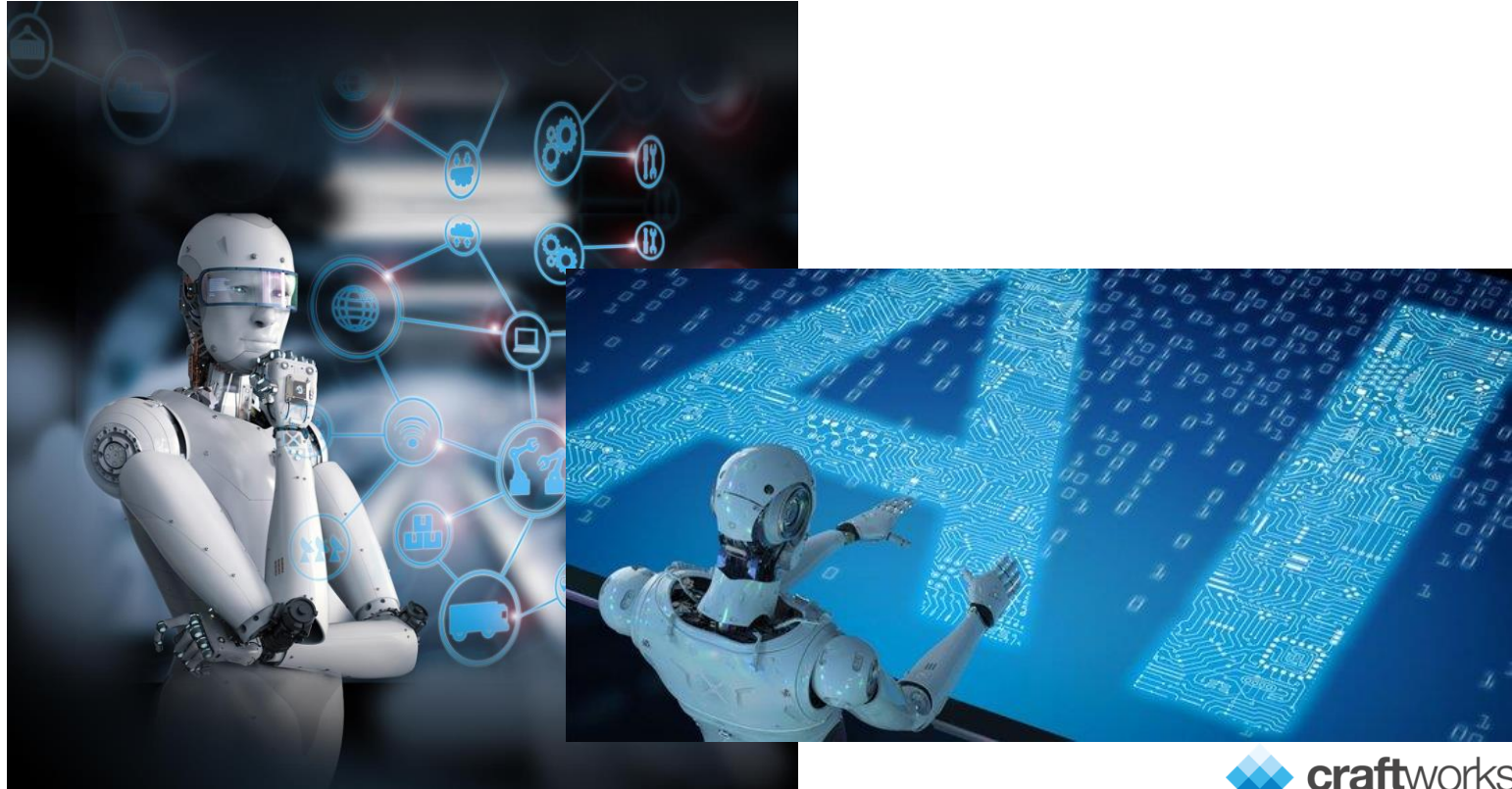
“Artificial Intelligence”



1

Intelligence
or
Illusion?

When you Google “Artificial Intelligence” ...



1

When you Google “Artificial Intelligence” ...

Intelligence
or
Illusion?



1

Intelligence
or
Illusion?

When you Google “Artificial Intelligence” ...





Intelligence
or
Illusion?

When you Google “Artificial Intelligence” ...

... you find many
illusions.



Intelligence
or
Illusion?

Illusions Originate from Divergence: Wish \leftrightarrow Reality

*“Illusion is an anodyne, bred by the
gap between **wish** and **reality**.”*

Herman Wouk

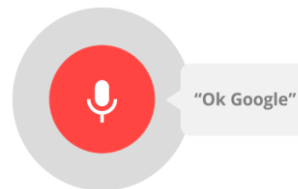
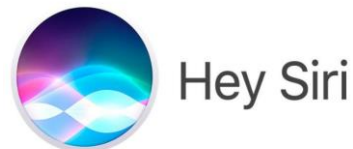
Fiction Author & Pulitzer Prize Winner



Intelligence
or
Illusion?

Reality is Promising

Natural Language Understanding



1

Intelligence
or
Illusion?

Reality is Promising Computer Vision

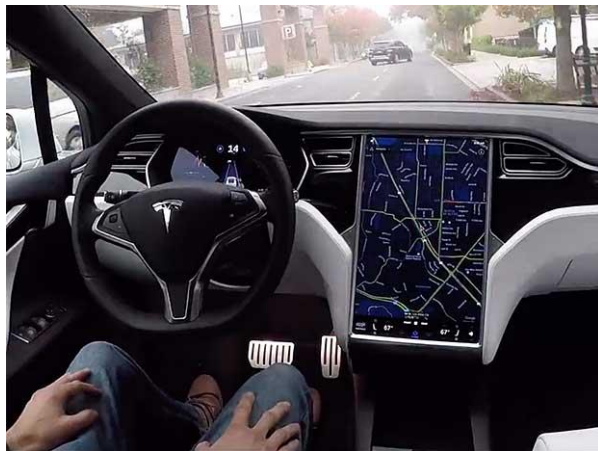


1

Intelligence
or
Illusion?

We are Beginning to Trust

Tesla Autopilot



Google Driverless Car





Intelligence
or
Illusion?

Yet our Trust is Limited

“Vast majority of people want to be able to take control over an autonomously driving car at any time.”

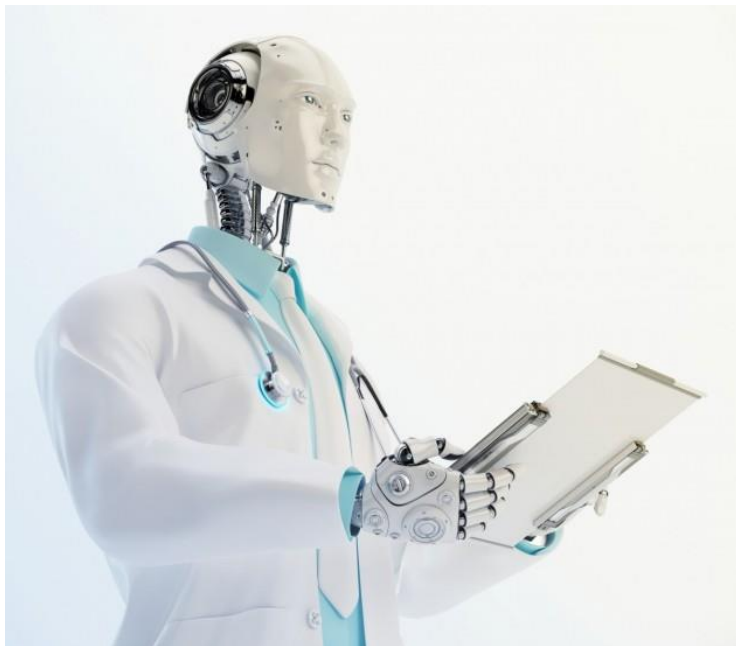
Study by Volvo (2016)





Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?



**This could be a typical
doctor's appointment in 2040.**

Input

Symptoms
X-Ray Image

Task

Detect potential Disease



Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?



Input

Chest Pain, Cough
Chest X-Ray Image



AI System



Output

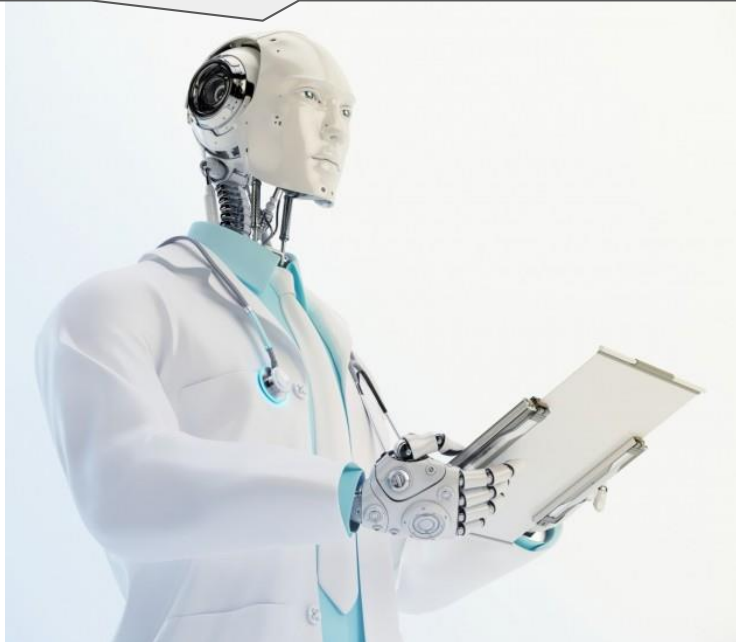
Pneumonia **5%**
Healthy **95%**



Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

“Probability threshold for Pneumonia infection not reached. You are likely to be healthy.”



Input
Chest Pain, Cough
Chest X-Ray Image



AI System



Output
Pneumonia **5%**
Healthy **95%**

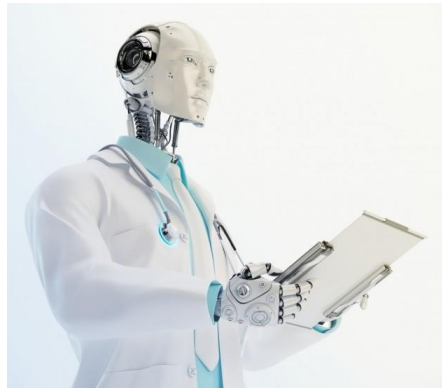


Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

Do you **Trust** the decision of

Artificial Intelligence



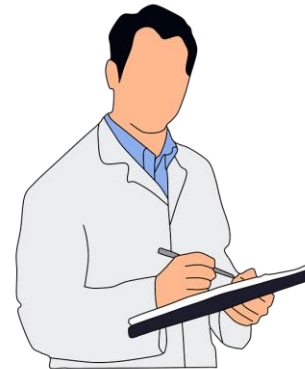
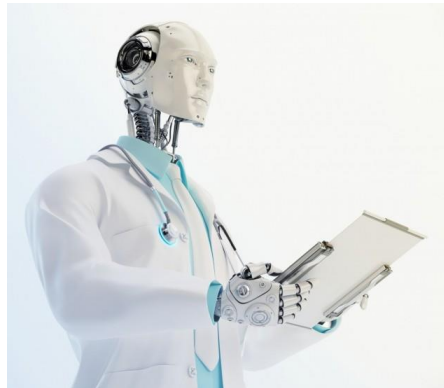


Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

Or do you prefer an **additional**

Human Opinion

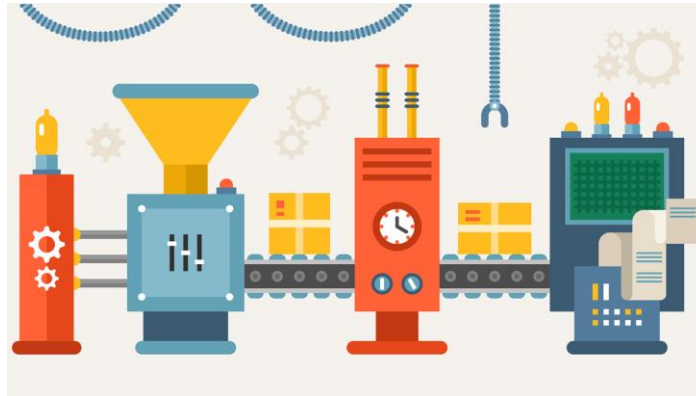




Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

| | Costs |
|--------------------------|-----------|
| Maintenance Stop: | 10,000 € |
| Fault Stop: | 200,000 € |





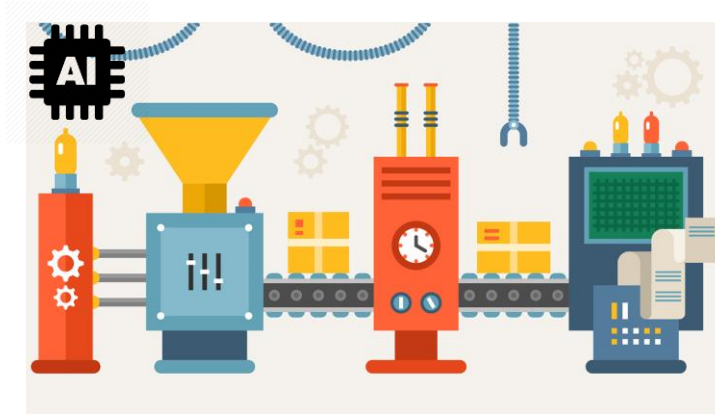
Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

Predictive Maintenance

Costs

| | |
|--------------------------|-----------|
| Maintenance Stop: | 10,000 € |
| Fault Stop: | 200,000 € |



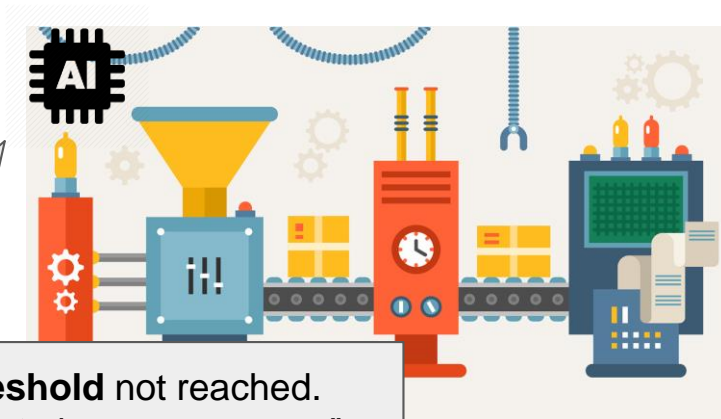


Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

Predictive Maintenance

| | Costs |
|-------------------|-----------|
| Maintenance Stop: | 10,000 € |
| Fault Stop: | 200,000 € |



“Probability threshold not reached.
Maintenance likely to be unnecessary.”

Input
Machine Sensor Data



AI System



Output

Machine Fault **10%**
OK **90%**

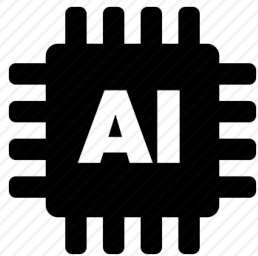


Intelligence
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Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

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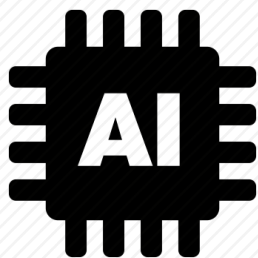


Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

Or do you prefer an **additional**

Human Opinion





Intelligence
or
Illusion?

Do we Trust Enough for Complete Intelligent Automation of Critical Tasks?

Many critical tasks will not be fully automated by AI in near future.



Intelligence
or
Illusion?

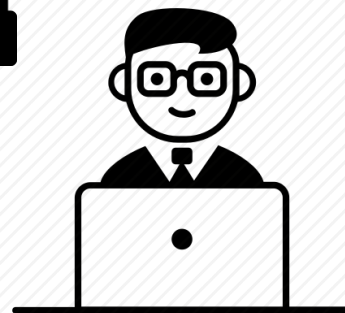
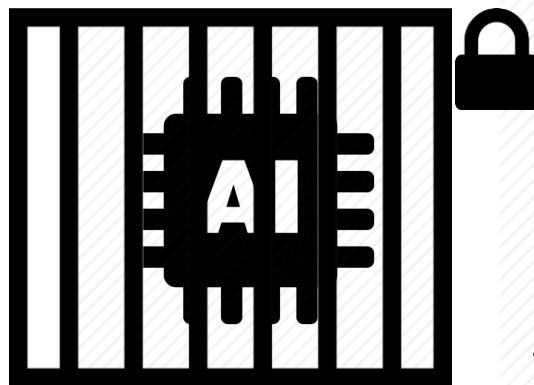
Many Critical Tasks won't be Completely Automated in Foreseeable Future

Why?

A

Limitations

AI is limited by the (human) specification of the model.





Intelligence
or
Illusion?

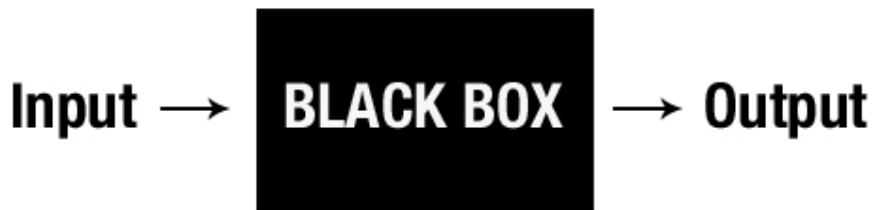
Many Critical Tasks won't be Completely Automated in Foreseeable Future

Why?

B

Lack of Understanding

AI seems like a Black Box. Humans don't trust Black Boxes.



Augmented Intelligence

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2

Augmented Intelligence

Augmented Intelligence

“Augmented Intelligence is the application of Artificial Intelligence technologies with the goal of improving human decision-making abilities.”



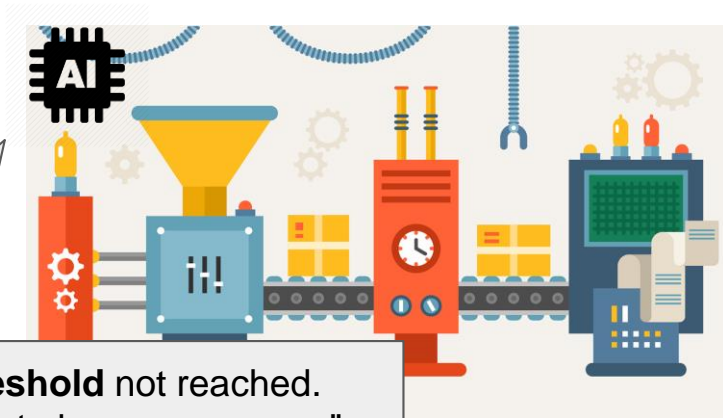
2

Augmented
Intelligence

Augmented Intelligence solves Existing Problems of Artificial Intelligence

Predictive Maintenance

| | Costs |
|-------------------|-----------|
| Maintenance Stop: | 10,000 € |
| Fault Stop: | 200,000 € |



“Probability threshold not reached.
Maintenance likely to be unnecessary.”

Input
Machine Sensor Data



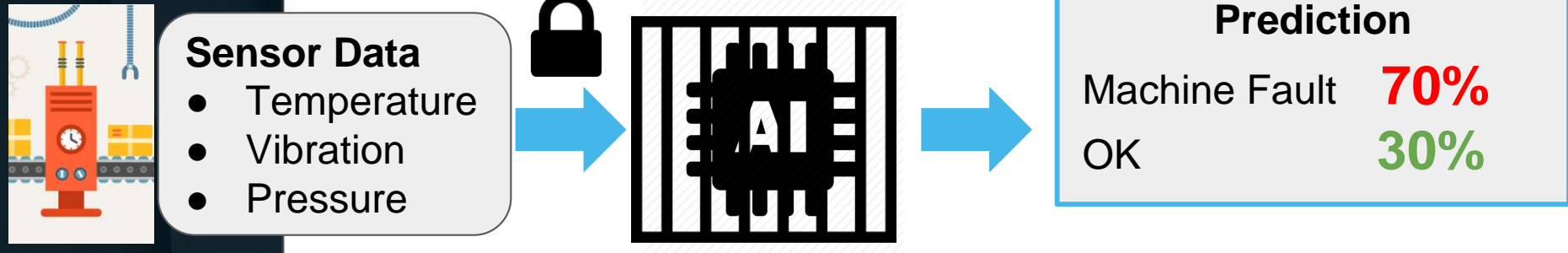
AI System



Output
Machine Fault %
OK %

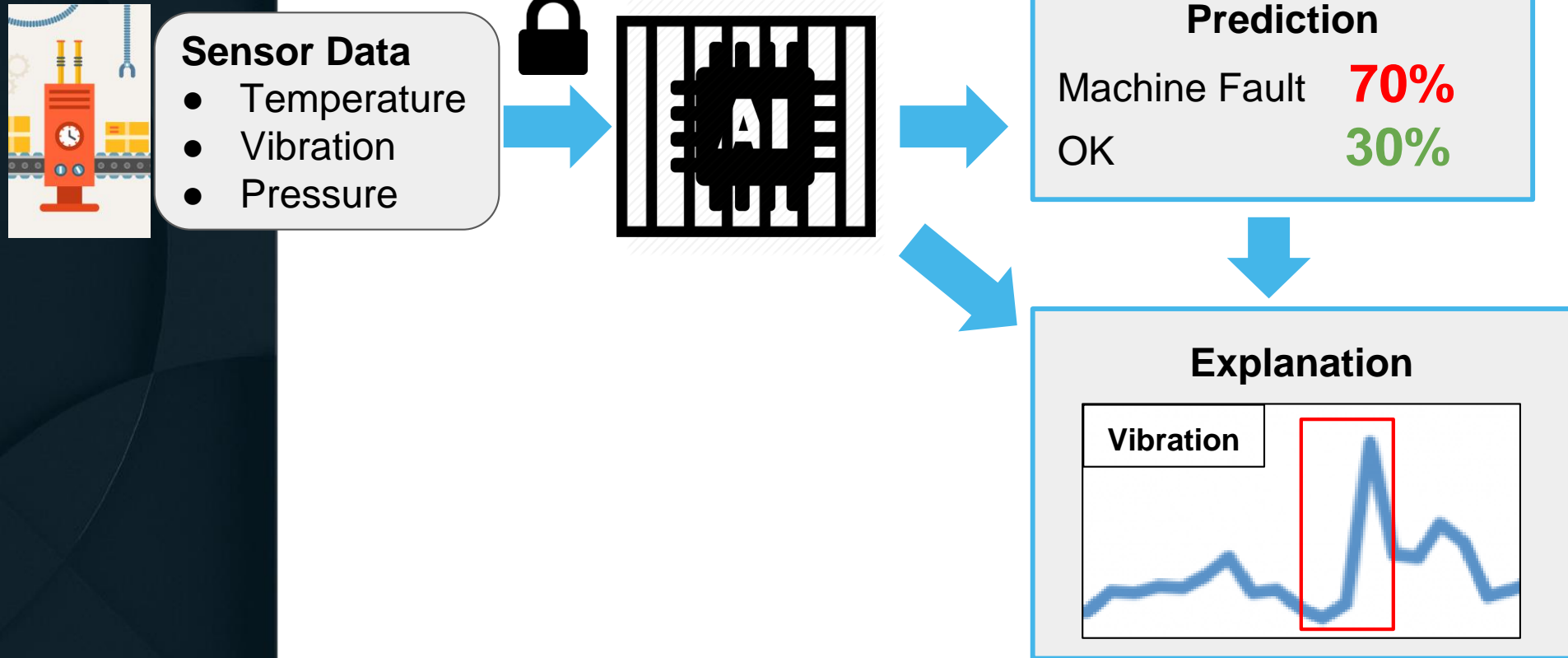
2

Looking beyond the Prediction



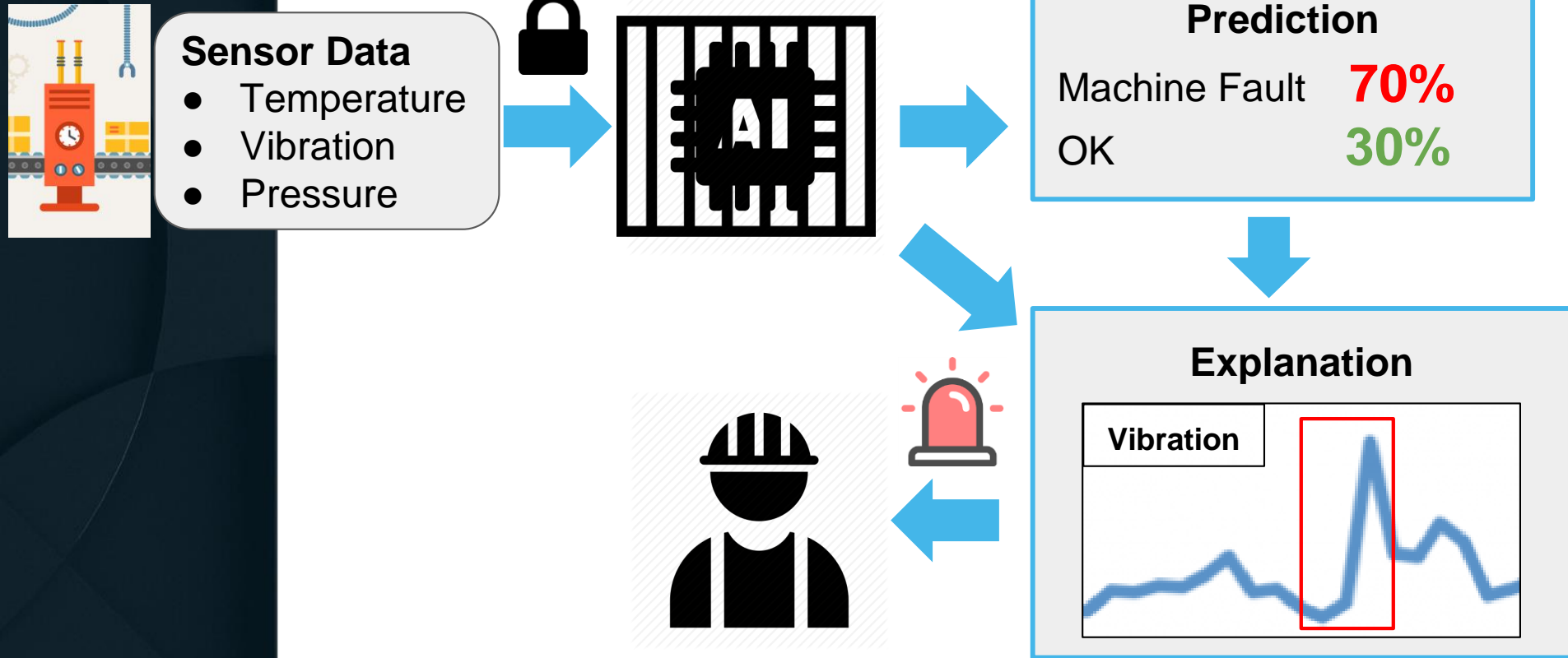
2

Looking beyond the Prediction



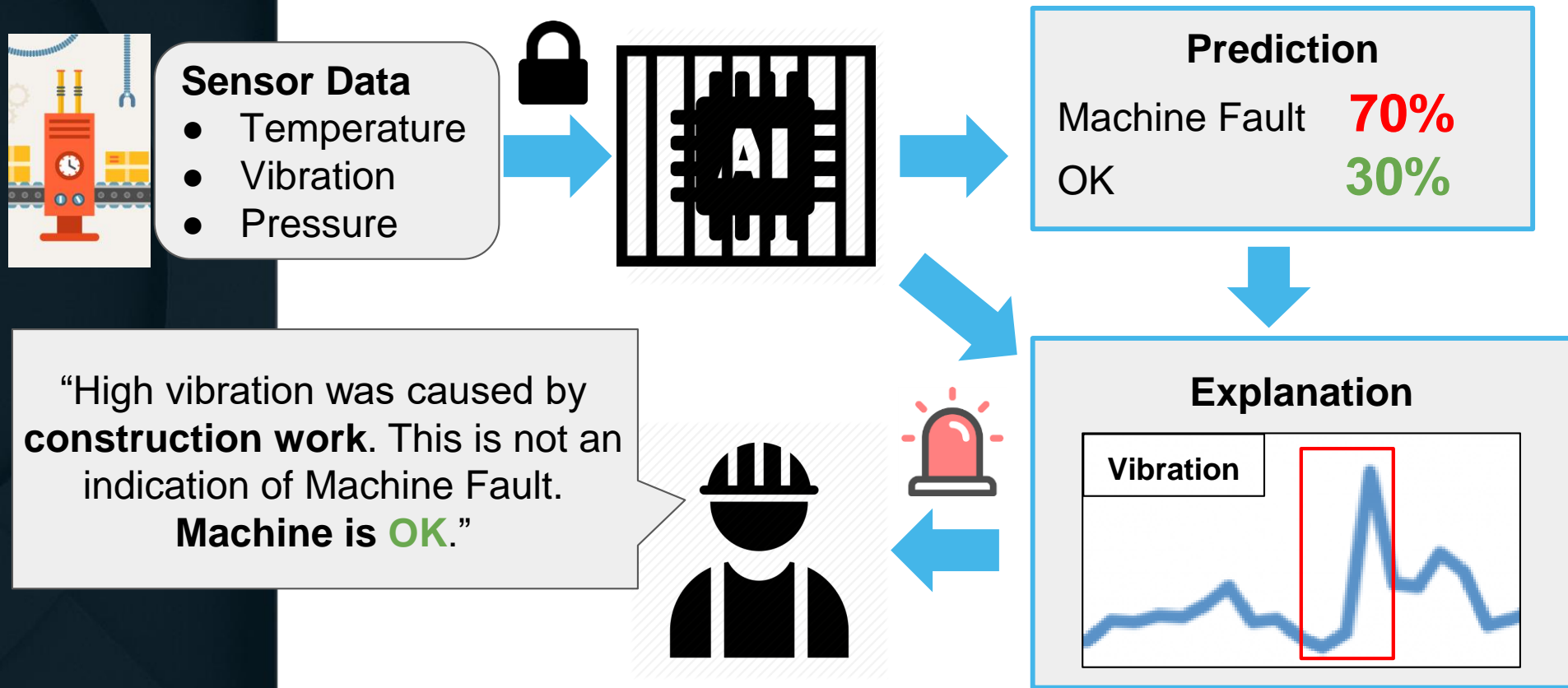
2

Looking beyond the Prediction



2

Looking beyond the Prediction

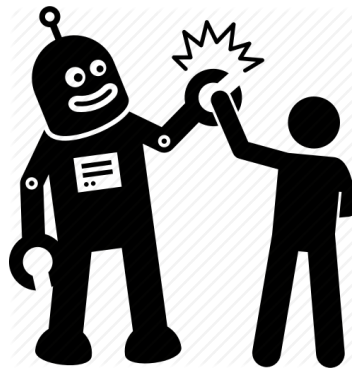


2

Augmented Intelligence

Augmented Intelligence is not a Compromise

**Augmented
Intelligence**

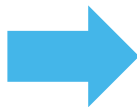


2

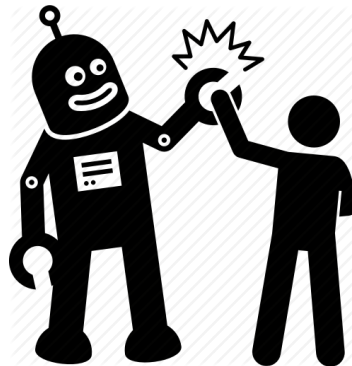
Augmented Intelligence

Augmented Intelligence is not a Compromise

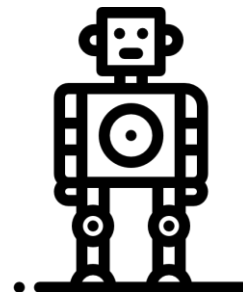
**Human
Intelligence**



**Augmented
Intelligence**



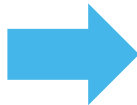
**Artificial
Intelligence**



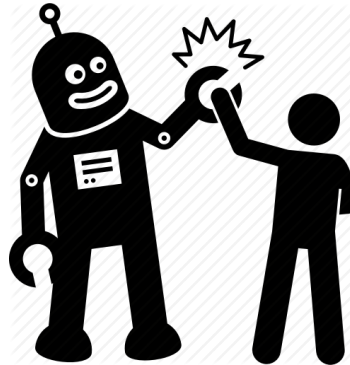
Augmented Intelligence is not a Compromise

Augmented Intelligence is an indispensable **step towards complete intelligent automation** through Artificial Intelligence.

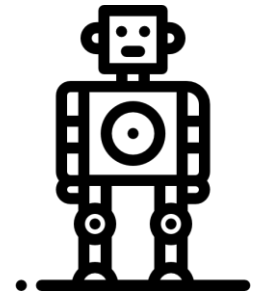
Human
Intelligence



Augmented
Intelligence



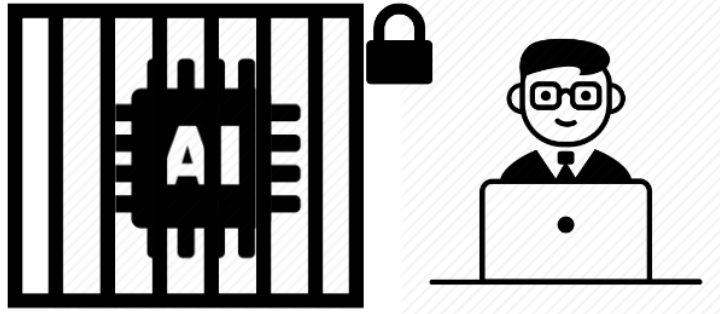
Artificial
Intelligence



Augmented Intelligence solves Existing Problems of Artificial Intelligence

Limitations

AI is limited by the (human) specification of the model.



2

Augmented Intelligence

B

Lack of Understanding

AI seems like a Black Box. Humans don't trust Black Boxes.

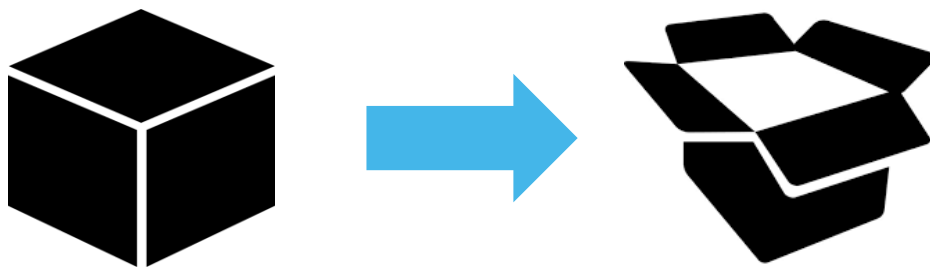


Explainable AI

Demystifying the Black Box

Selection of Techniques for Explainable AI

- Local Interpretable Model-agnostic Explanations - **LIME**
- Shapley Additive Explanations - **SHAP**
- **Attention Mechanisms**



2

Augmented Intelligence

SHAP ... on Tabular Data

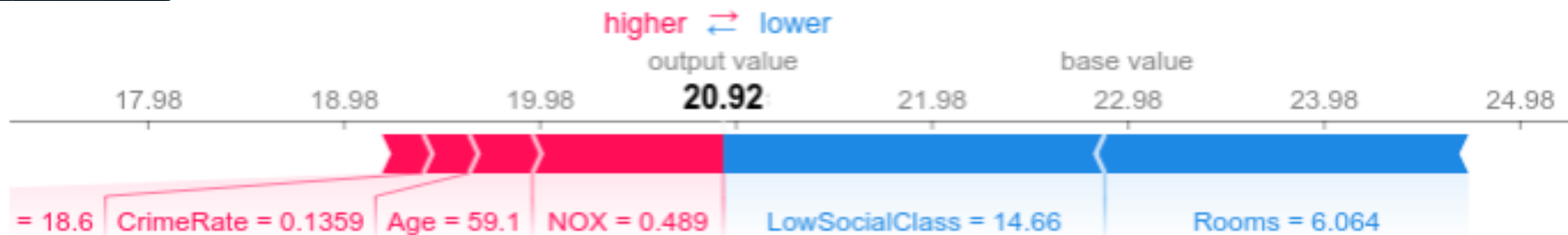
```
# ...
import shap

x_train, x_test, y_train, y_test = train_test_split(df_x, df_y)

xgbreg = XGBRegressor(random_state=0)
xgbreg.fit(x_train, y_train)

explainer = shap.TreeExplainer(xgbreg)
shap_values = explainer.shap_values(x_test)

SELECT_SAMPLE = 0
shap.force_plot(explainer.expected_value, shap_values[SELECT_SAMPLE,:],
                x_test.iloc[SELECT_SAMPLE,:])
```



Code Example

You can find an example Jupyter Notebook on the  **craftworks** github account showing basic usage of SHAP:

github.com/craftworksgmbh/wad-ai-congress-2018



Augmented Intelligence

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Augmented Intelligence

Industrial Augmented Intelligence

Detecting and Explaining Defects in
Industrial Parts



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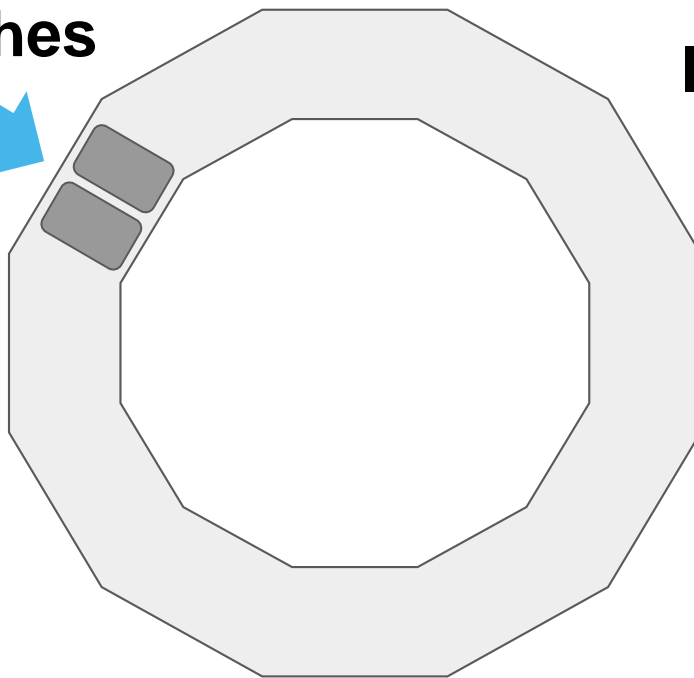
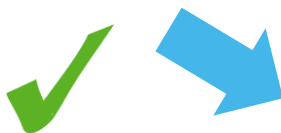
craftworks

3

Industry
Case

Industrial Augmented Intelligence Detecting and Explaining Defects in Industrial Parts

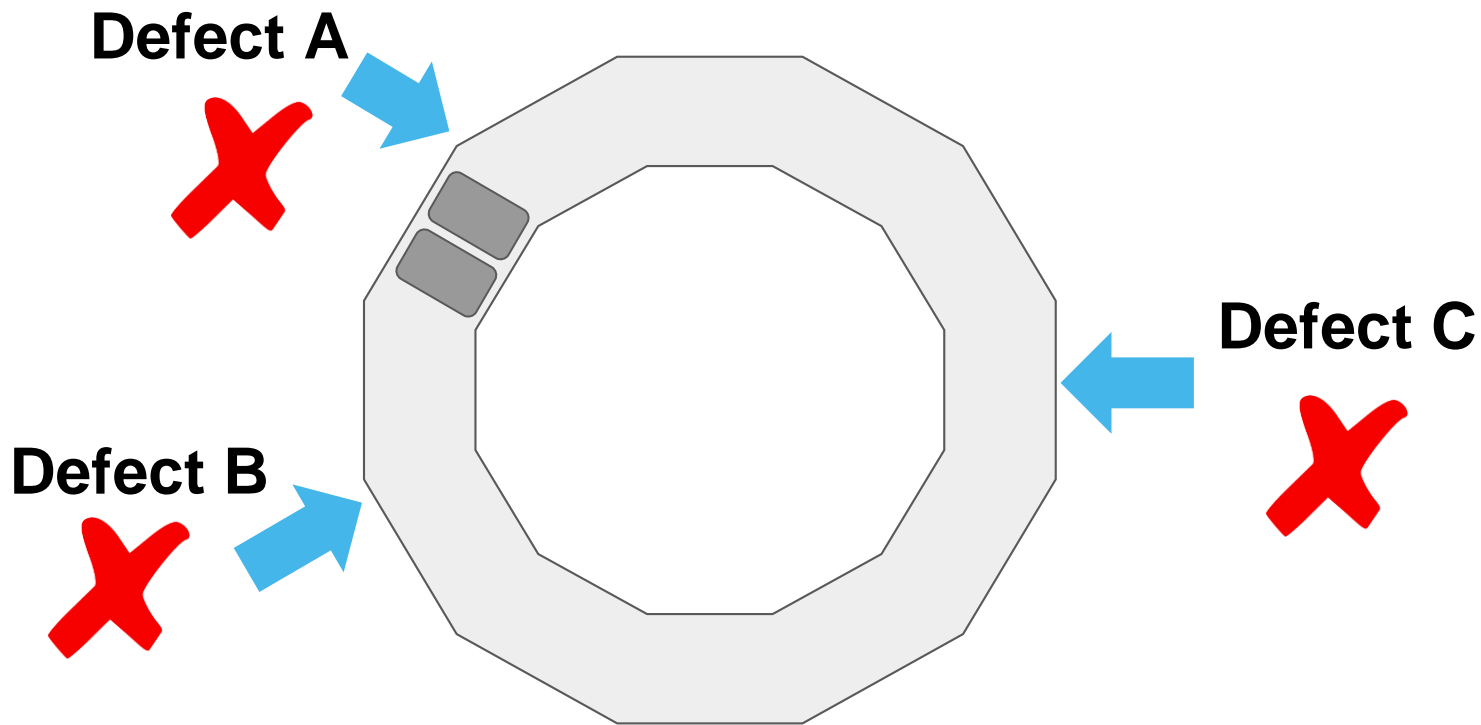
Glued Patches



Industrial Part

Industrial Augmented Intelligence

Detecting and Explaining Defects in Industrial Parts



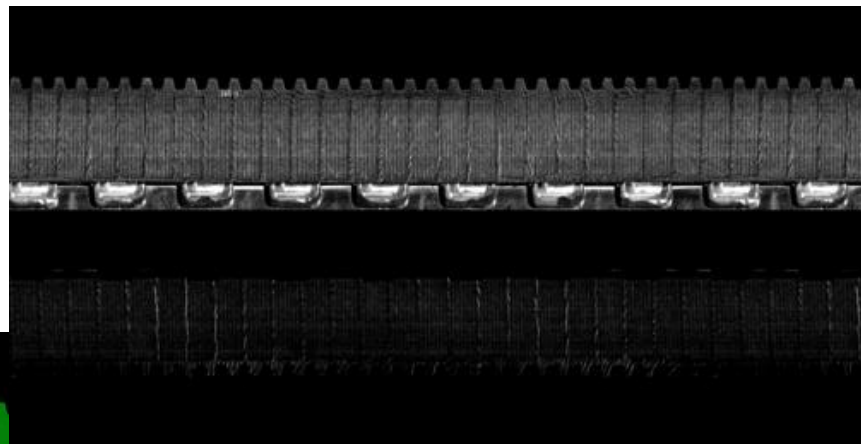
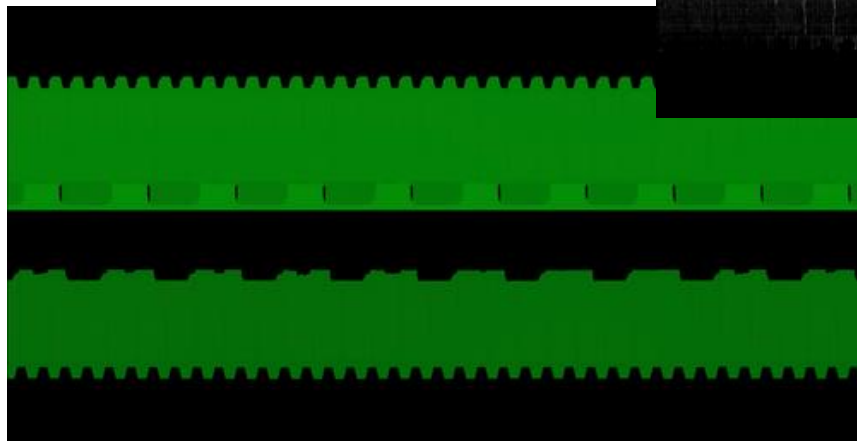
3

Industry Case

Industrial Augmented Intelligence

Detecting and Explaining Defects in Industrial Parts

Depth



Brightness





Industry Case

Industrial Augmented Intelligence

Detecting and Explaining Defects in Industrial Parts

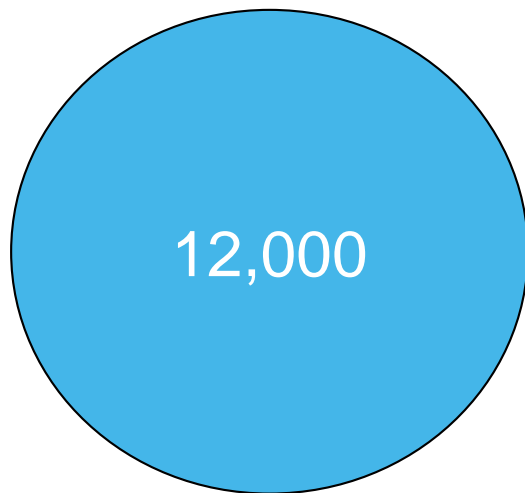
Goals

- **Self-Learning** System
 - Perfect Classification in **OK / Defect**
 - Best Possible Classification of **Type of Defect**
-
- **Inspection** Capabilities
 - **Explanation** of Model Output
 - **Feedback** to ensure Continuous Learning

Industrial Augmented Intelligence

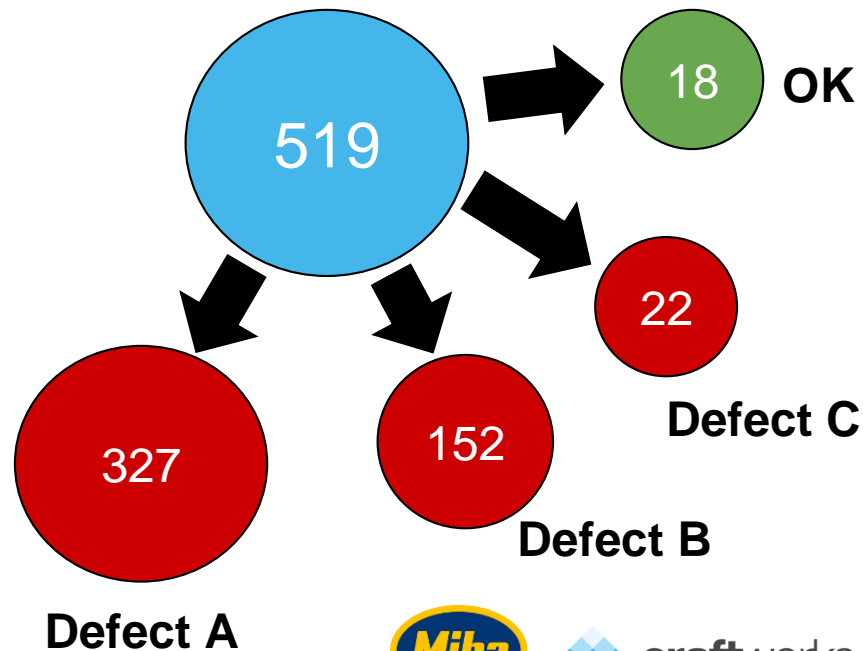
Detecting and Explaining Defects in Industrial Parts

Unlabelled



Vast majority of
unlabelled data is
OK

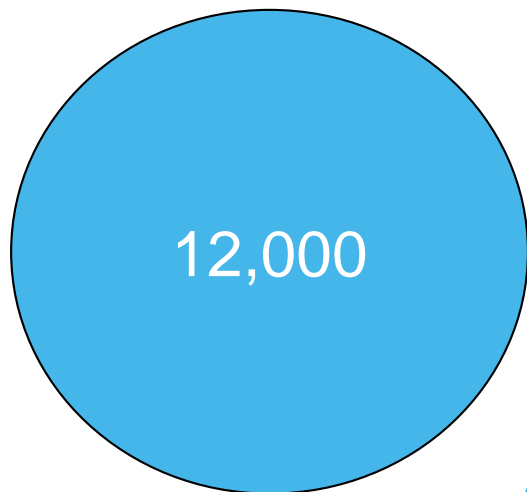
Labelled



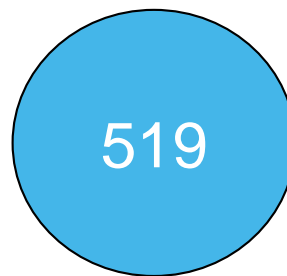
Industrial Augmented Intelligence

Detecting and Explaining Defects in Industrial Parts

Unlabelled



Labelled



Challenge

Very Few Labelled Images

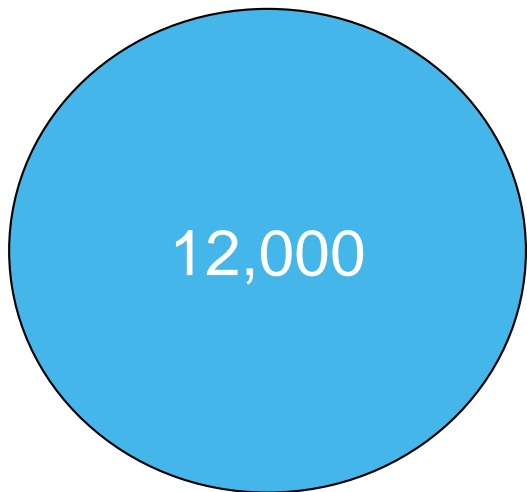
3

Industry
Case

Industrial Augmented Intelligence

Detecting and Explaining Defects in Industrial Parts

Unlabelled



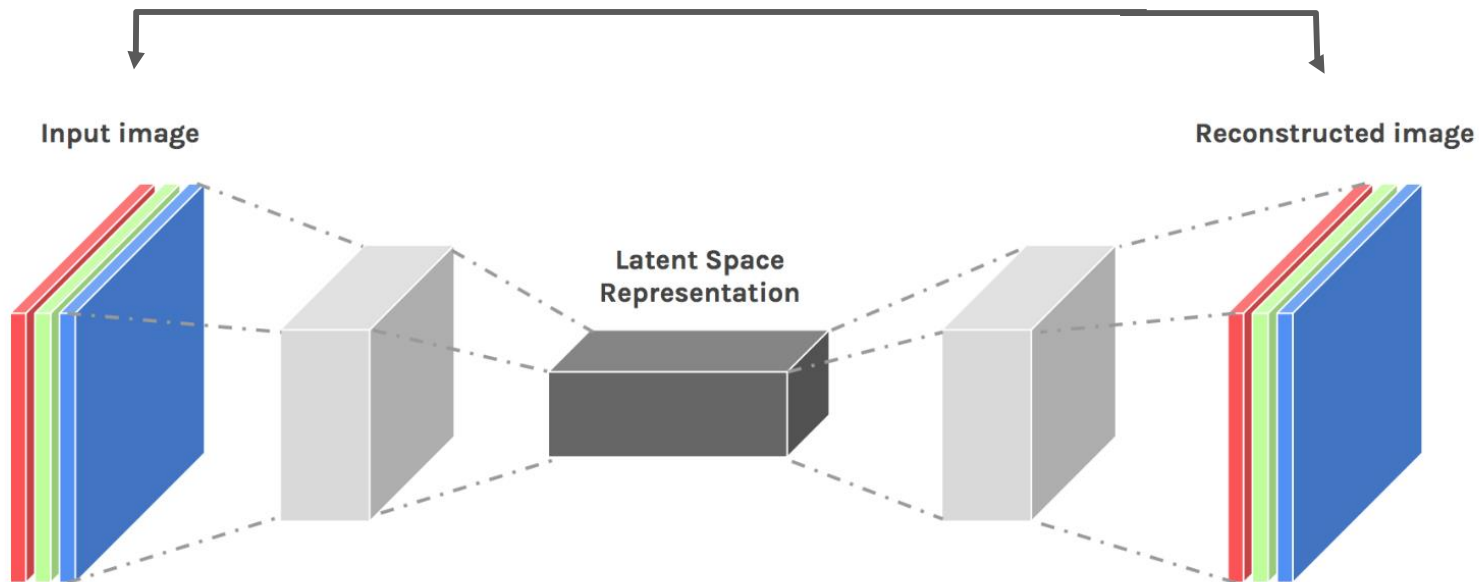
3

Industry Case

Industrial Augmented Intelligence

Deep Convolutional Autoencoder

Minimize Difference between **Input** and **Output**



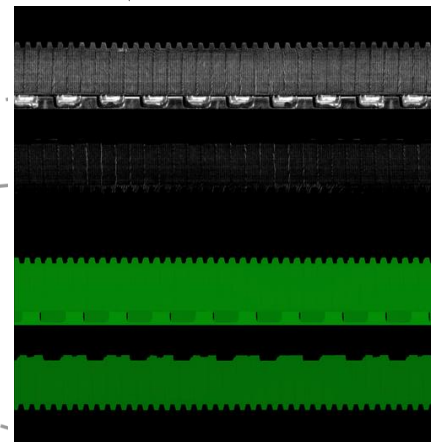
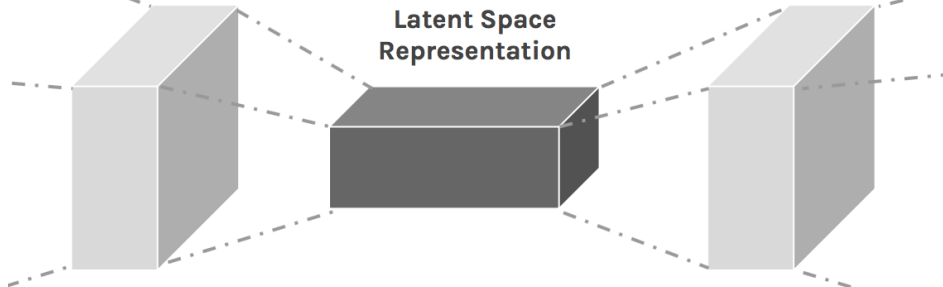
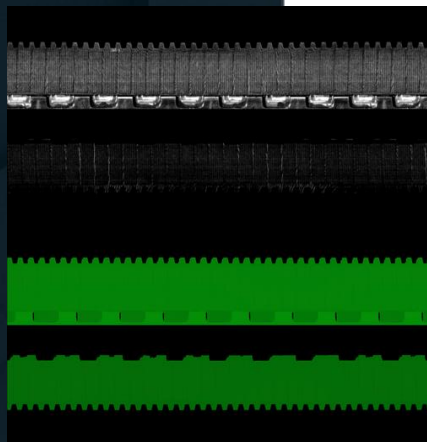
3

Industry
Case

Industrial Augmented Intelligence

Visualizing Anomalies using Reconstruction Error

Reconstruction Error

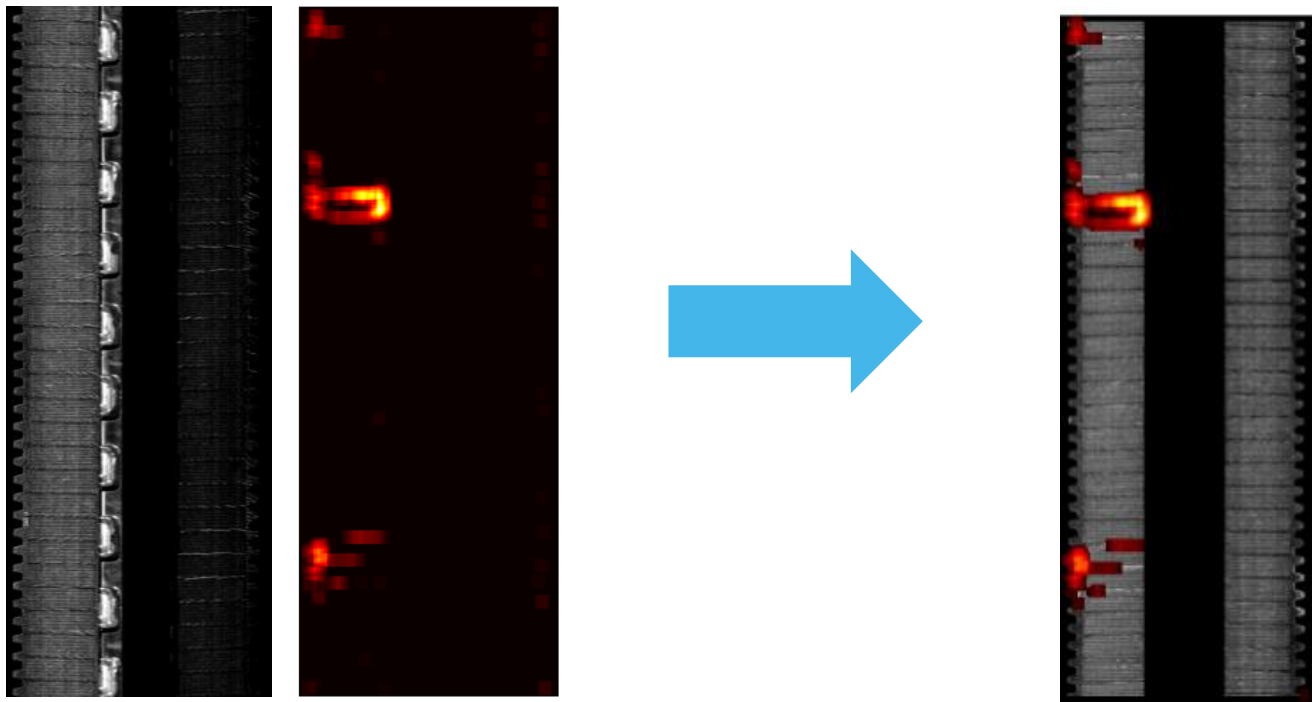


3

Industry
Case

Industrial Augmented Intelligence

Visualizing Anomalies using Reconstruction Error



3

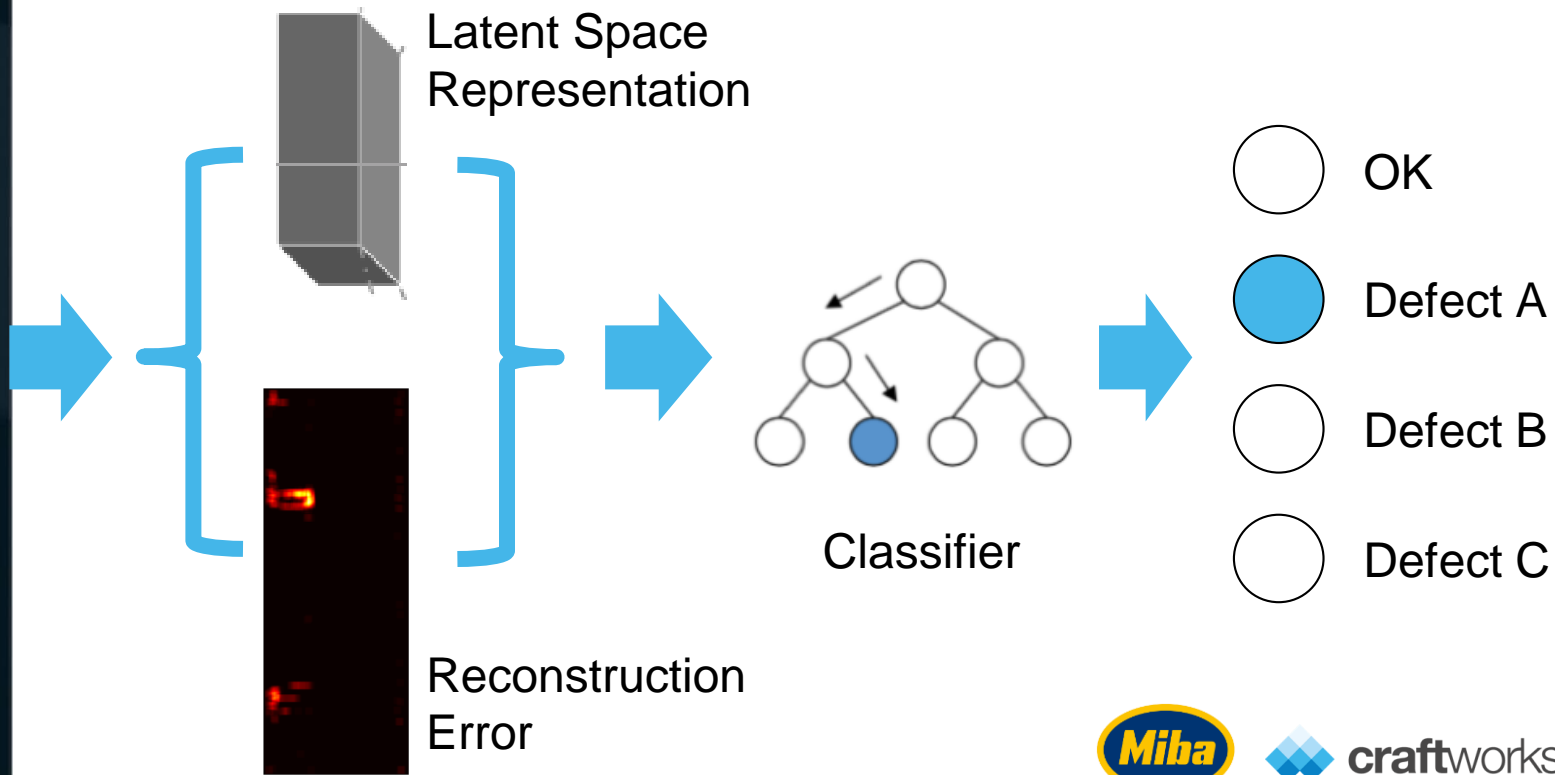
Industry
Case

Labelled

519

Industrial Augmented Intelligence

Classifying Parts using Extracted Features



Predictive Quality

ALT + KLIICK um Bereiche einzuzeichnen

SHIFT + MAUSRAD um zu zoomen



0

Show Z-Information



Detected Error

Defect R

Show root causes

Next Image >

3

Industry Case

Industrial Augmented Intelligence

Augmented Intelligence in Action

A

Overcome existing Limitations



B

Foster Understanding



Augmented Intelligence

A Human-Machine Marriage on the Way to
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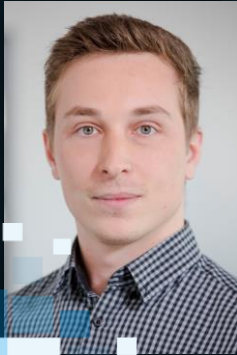


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Software & Industrial AI



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