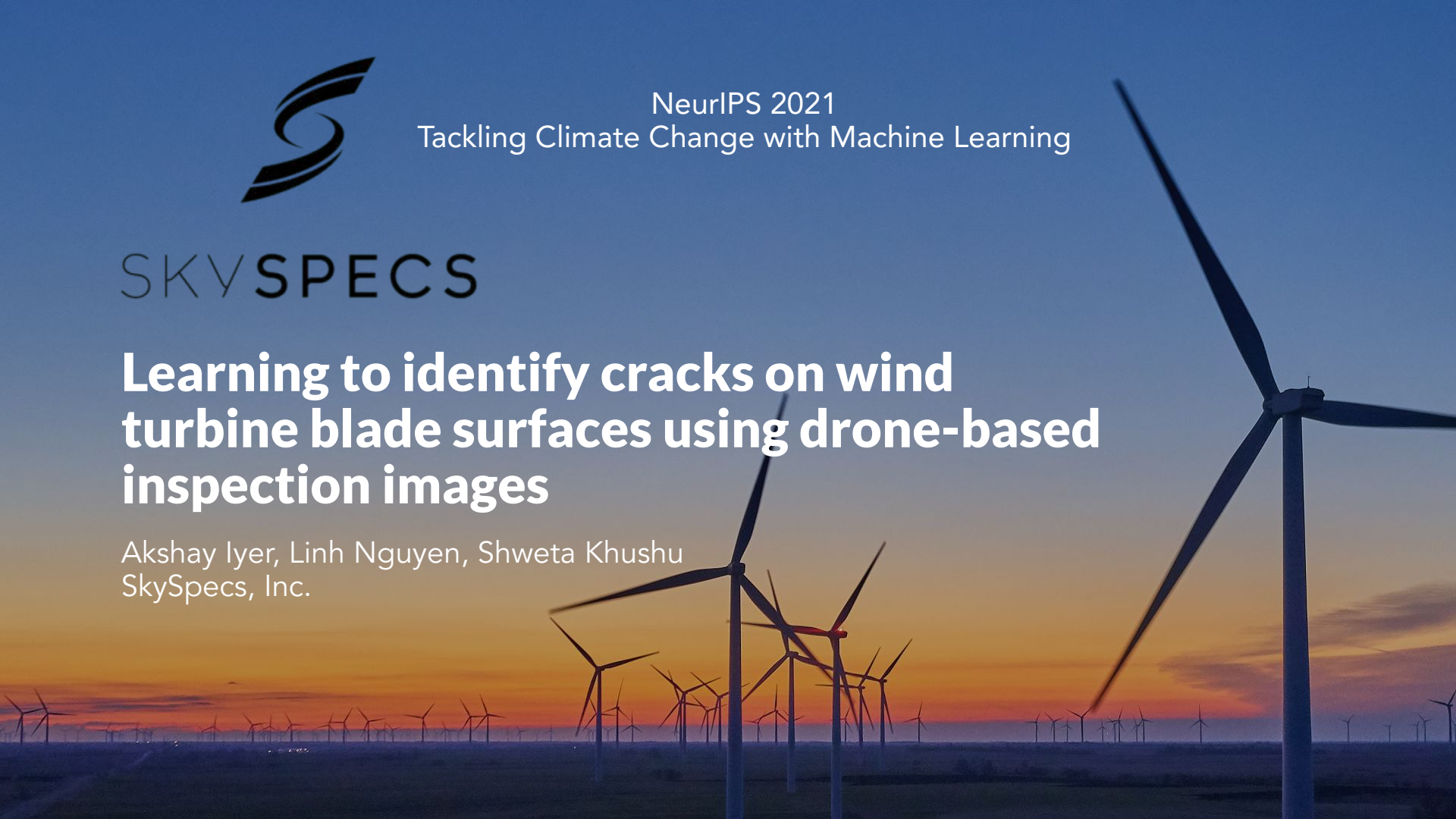


NeurIPS 2021
Tackling Climate Change with Machine Learning

SKYSPECS

Learning to identify cracks on wind turbine blade surfaces using drone-based inspection images

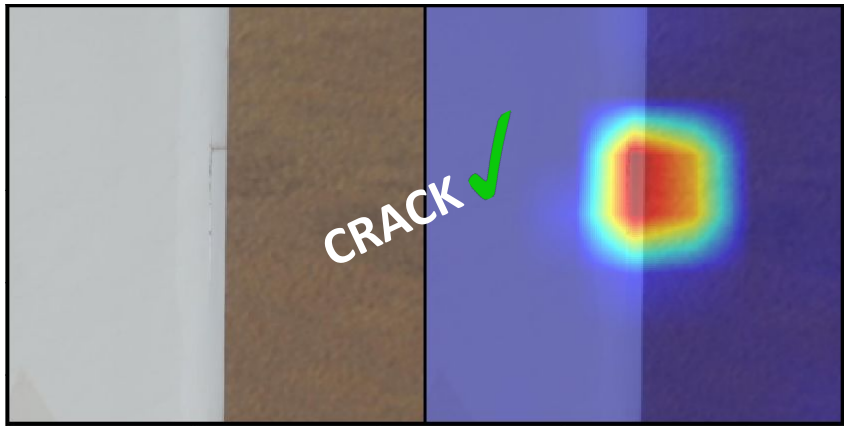
Akshay Iyer, Linh Nguyen, Shweta Khushu
SkySpecs, Inc.

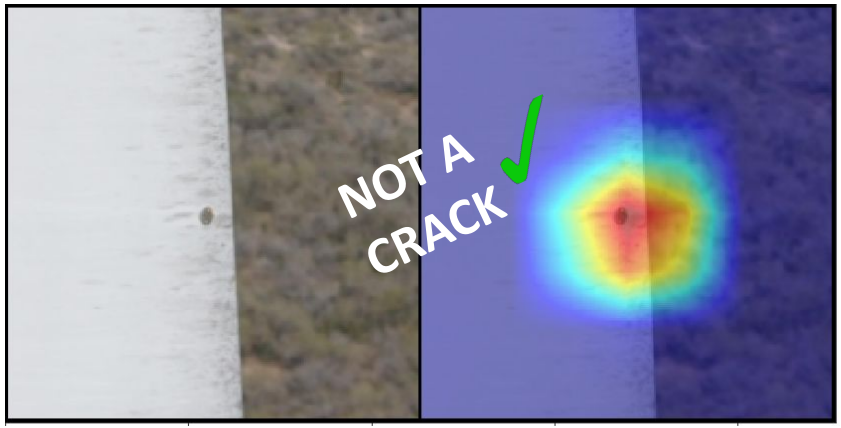
Goal of this work

Make our QC process to detect cracks:

- ❑ More accurate
- ❑ More objective
- ❑ More scalable
- ❑ Less time consuming

In order to correctly distinguish between ‘CRACKS’ and ‘OTHER DAMAGES’





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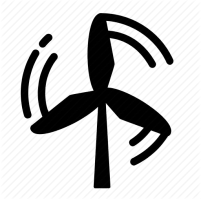
Motivation

Energy demands

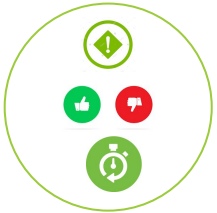


Wind - the hope

O&M costs of damages

Cracks - most severe

Ambiguous appearances



Current manual process

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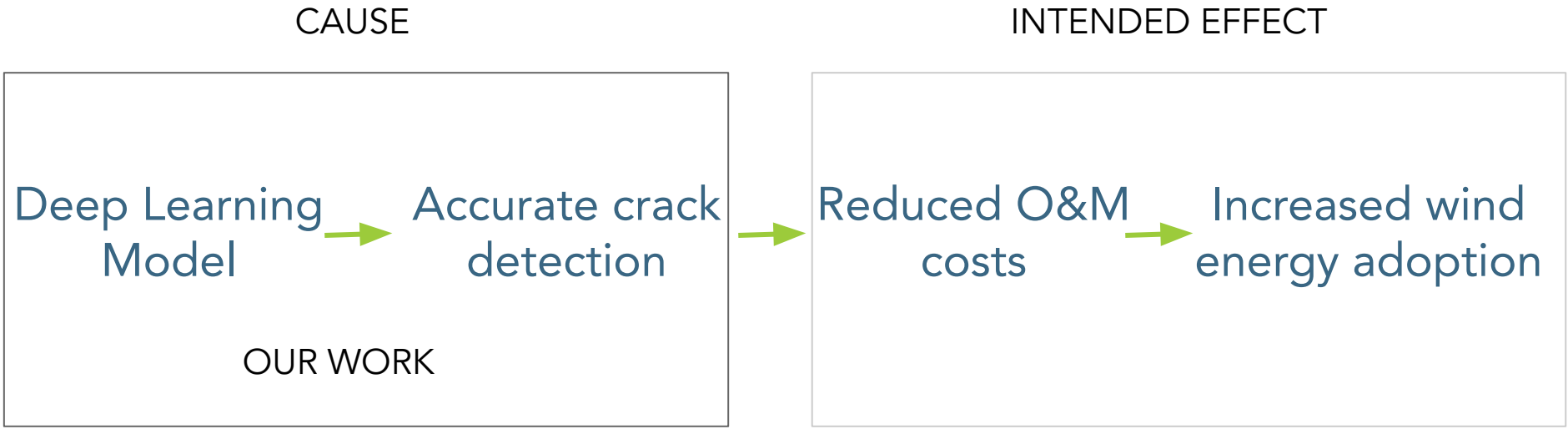
Motivation



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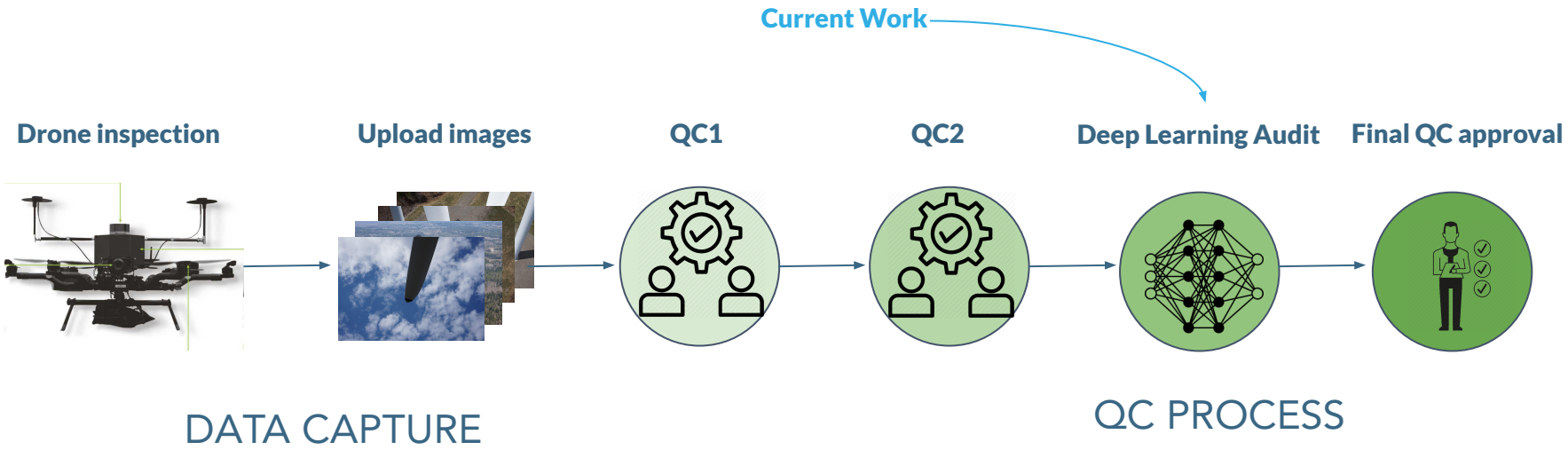
Background



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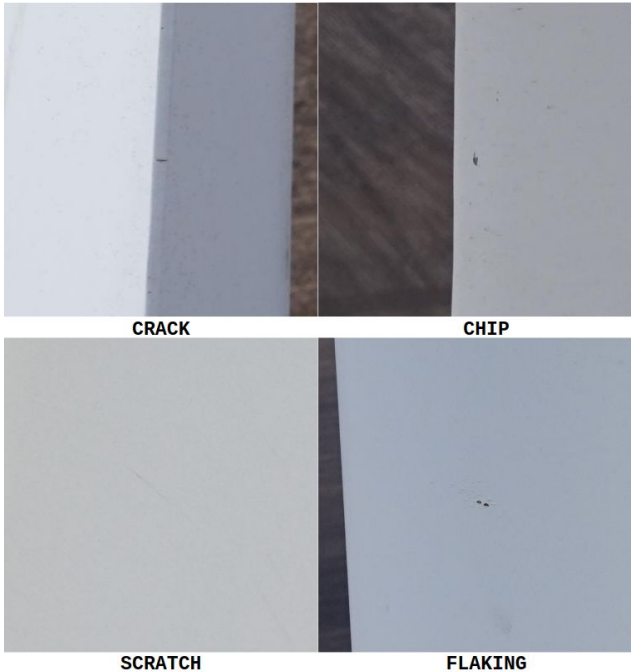
Methods - Data

- Chips, flaking, and scratch most confused with cracks
- 71k images chosen from datasets with QC approval
- Target labels: [‘Crack’, ‘Not a Crack’]
- Train-val split of 64k-7k images
- Stratified as per target labels
- Geometric and lighting-oriented augmentations



Methods - Network and Training

Network:

- ResNet50 | PyTorch | g4dn.xlarge GPU EC2 instance

Training:

- Adam LR 3e-3 Betas 0.9, 0.999 | BCEWithLogits Loss

Experiments:

- Custom stratified sampling for higher severity | GradCAM++ | EarlyStopping

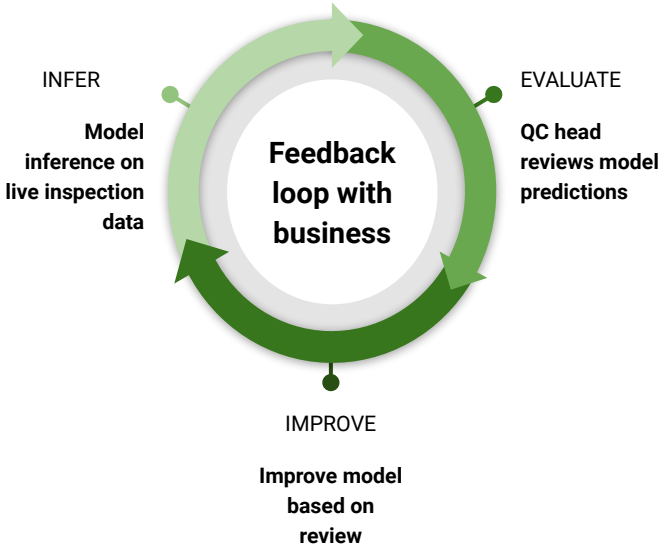
ML Metrics:

- Precision and Recall

Evaluation

1

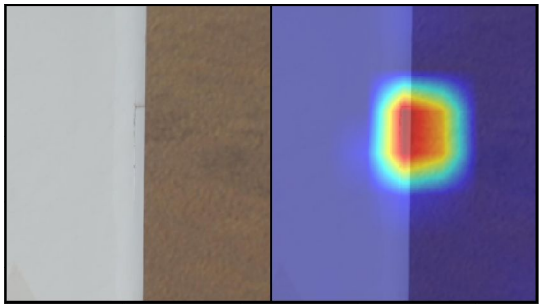
Feedback loop with business:

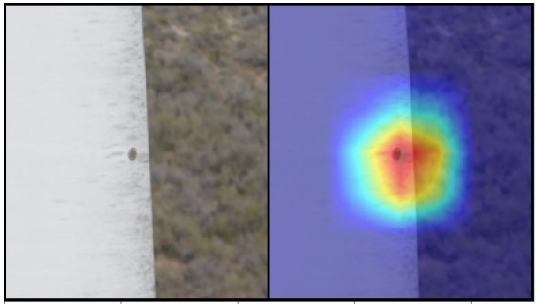


2

GradCAM++ visualization

Visualize what model is looking at before making its decision to debug and increase trust in model

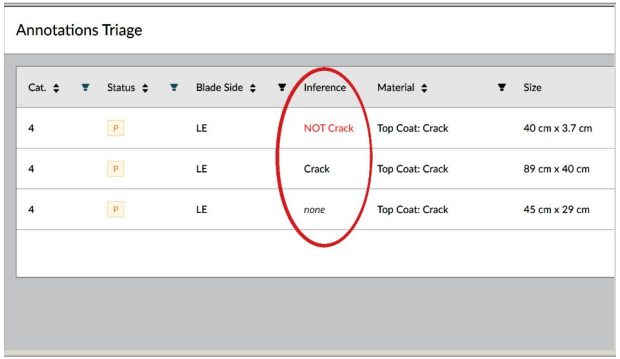




3

Model Deployment

- Optimize model for deployment
- Serve using Torchserve
- Host on sagemaker endpoint
- Integrate into QC application



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Results and Discussion

Data	Recall	Precision	F1-score
Complete test data	0.96	0.85	0.90
Only higher severity images (before severity sampling)	0.92	0.98	0.95
Only higher severity images (after severity sampling)	0.96	0.98	0.97

- Processed more than a million damages
- Metrics calculated on 46k prod images
- High precision as well as recall
- Very fast inference times of 0.15 secs on a c4.xlarge CPU instance
- Correctly caught 23.2k/ 24.2k cracks
- And caught several cracks which even experts missed
- Stratified severity sampling resulted in statistically significant improvements

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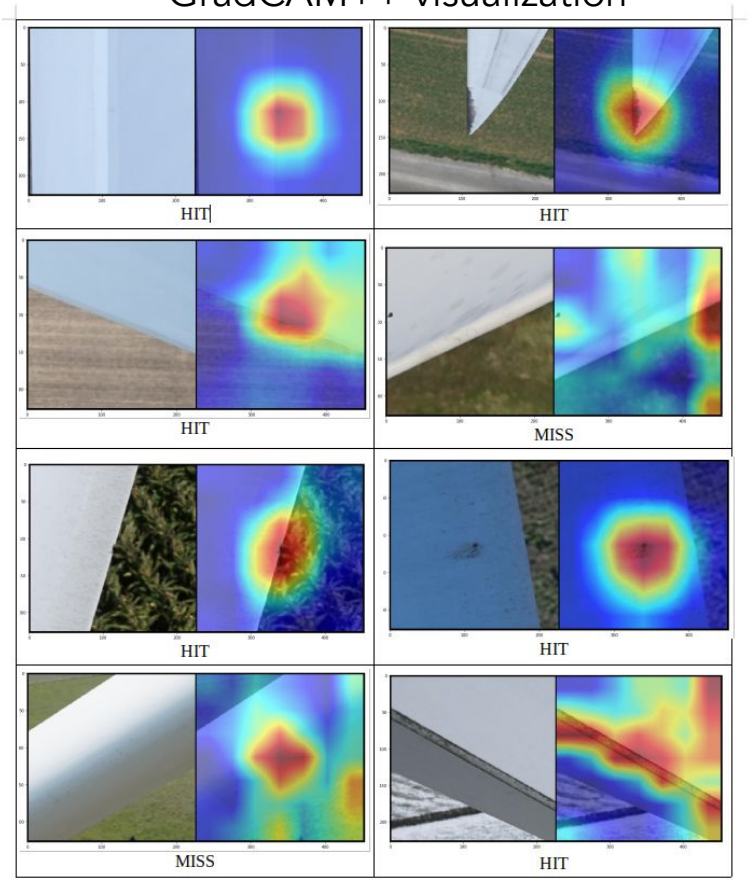
Results and Discussion

GradCAM++ visualization



Damage propagation

Conclusion

In this work, we started with the goal of making our QC process to detect cracks:

- ☑ More accurate - caught 23.2k out of 24.2 cracks
- ☑ More objective - predictions independent of analyst
- ☑ More scalable - modular API based AWS architecture
- ☑ Less time consuming - inference of 0.15 seconds on a CPU

Thus, we create one of the first large-scale damage classifiers which is integrated into a commercial product already realizing real-world impact having made predictions for more than a million damages already

Next steps involve iteratively improving model performance and add granular crack sub-types in consultation with the business

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