

Von Punktwolken zu Erkenntnissen

Das Beispiel einer Korridoranalyse mit GeoAI



Matthias Stängel
Sales Engineer

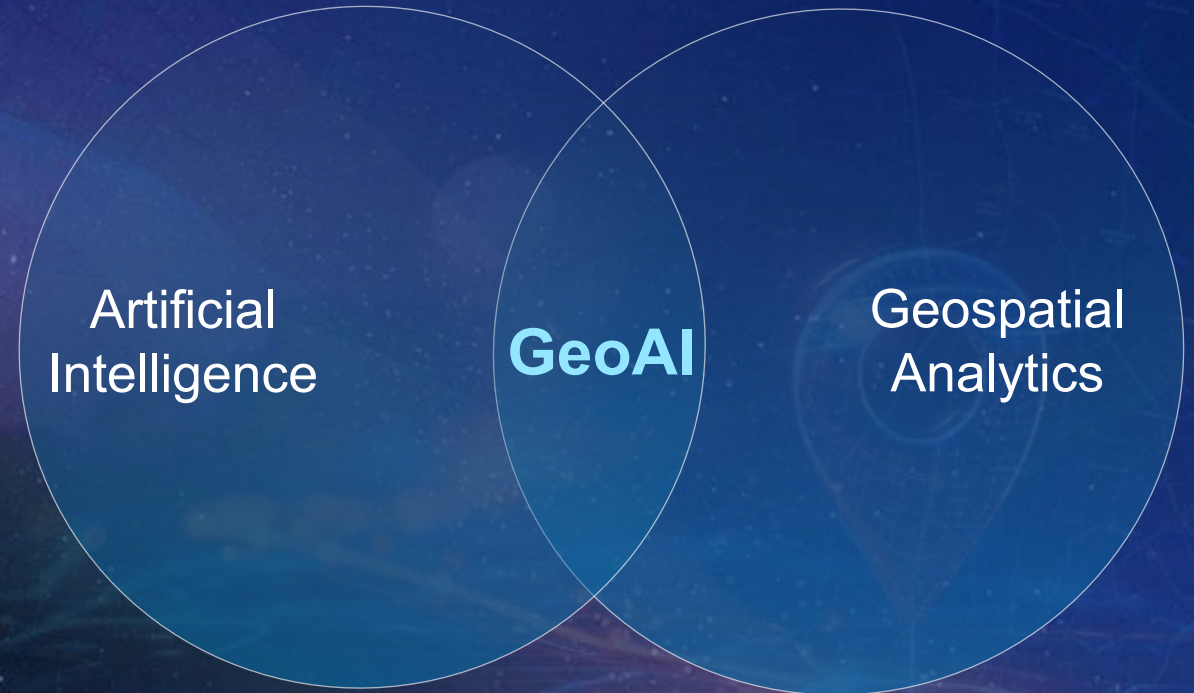
Esri Deutschland GmbH
esri.de



GeoAI in ArcGIS

GeoAI

Vorantreiben der GIS-Wissenschaft mit KI-Modellen, -Werkzeugen und -Techniken, um die **Datenextraktion in großem Maßstab zu automatisieren** und **wertvolle Erkenntnisse schneller** als je zuvor zu **gewinnen**.

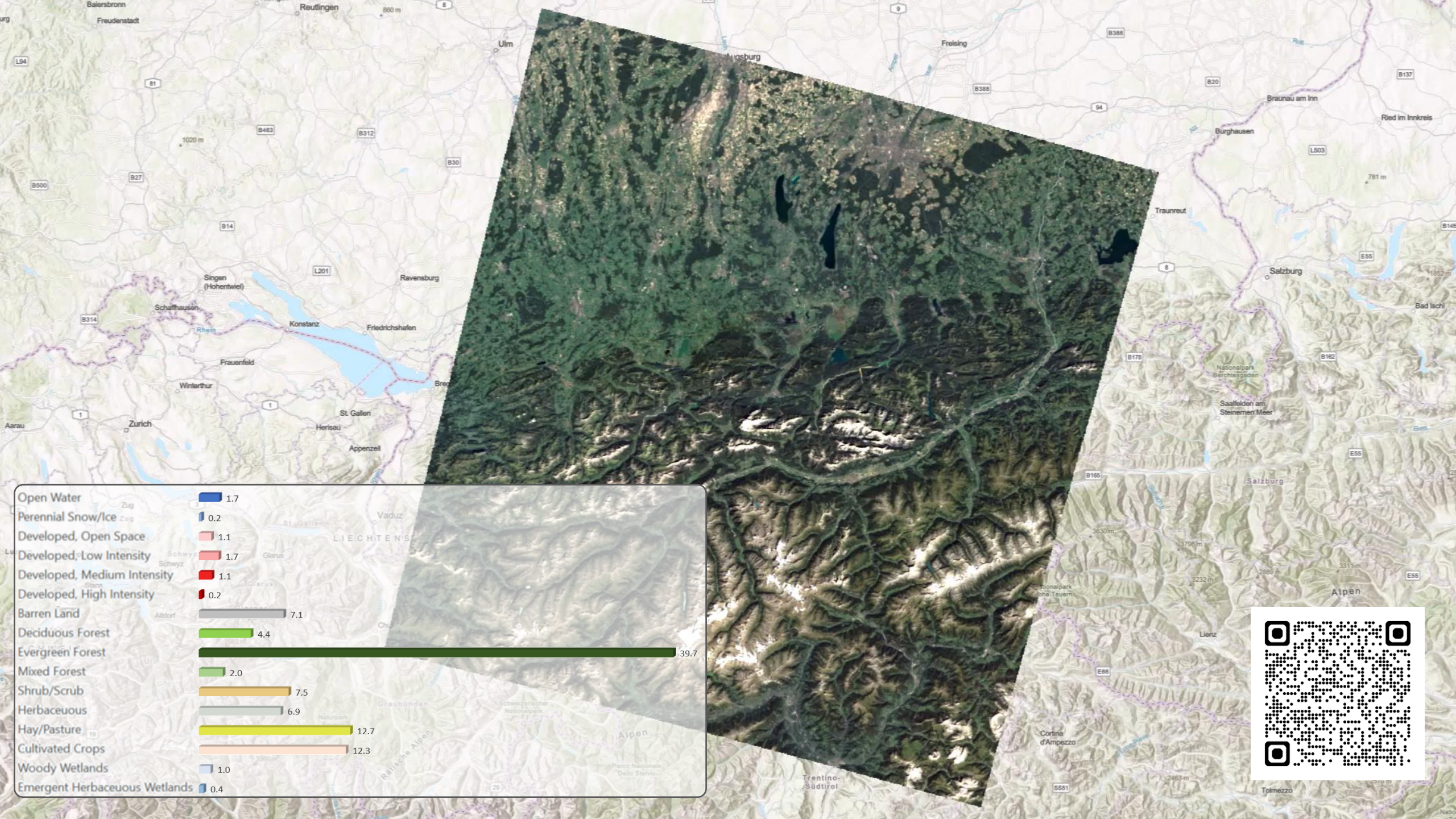


Ziel ist KI zu demokratisieren und Benutzern – unabhängig von ihrem technischen Hintergrund – dabei zu helfen, mit minimalen Investitionen in Rechenleistung oder Fähigkeiten hochwertige Erkenntnisse aus Daten zu gewinnen.

Bilddaten in ArcGIS

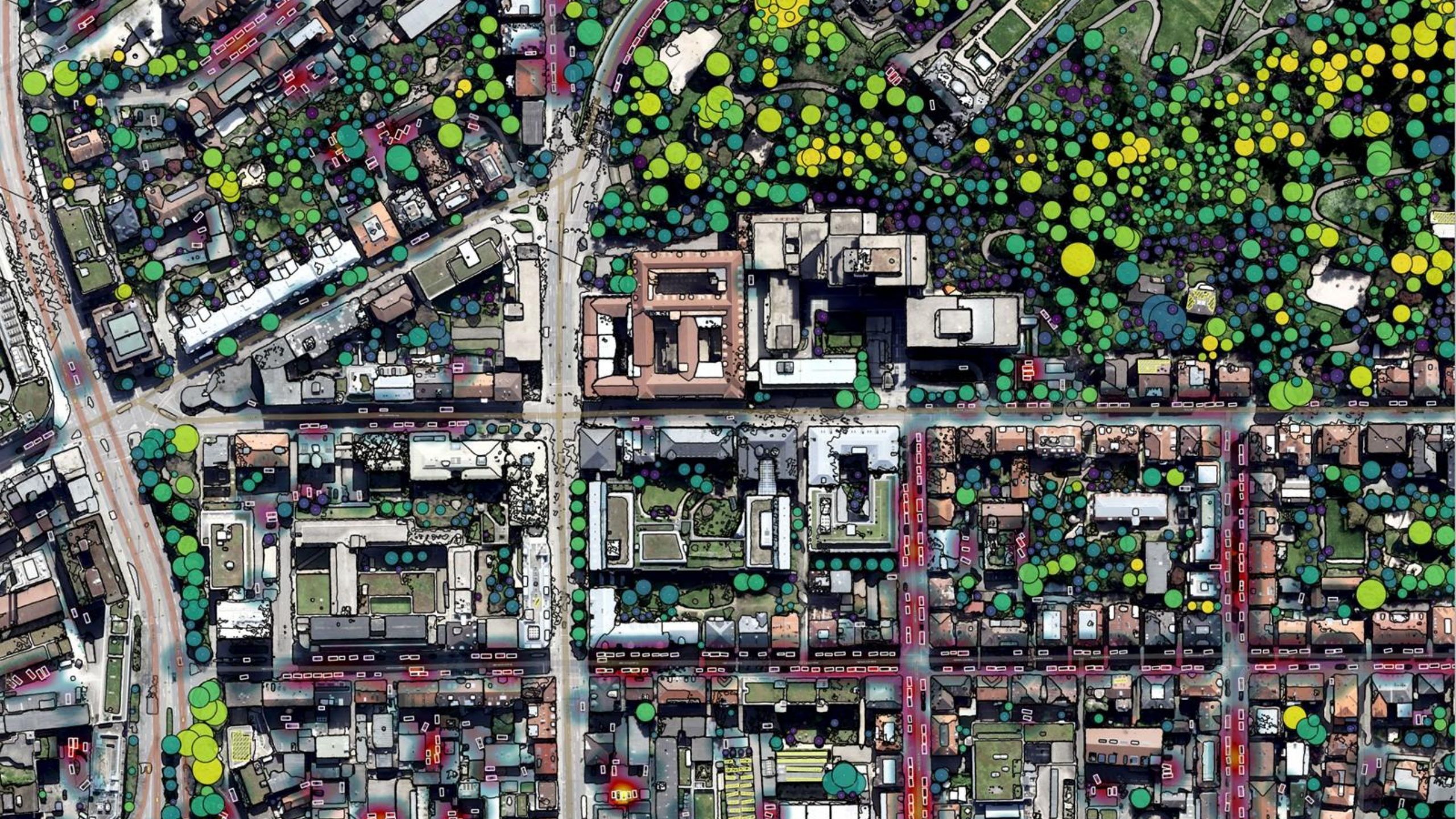
Nahtloser End-to-End-Workflow





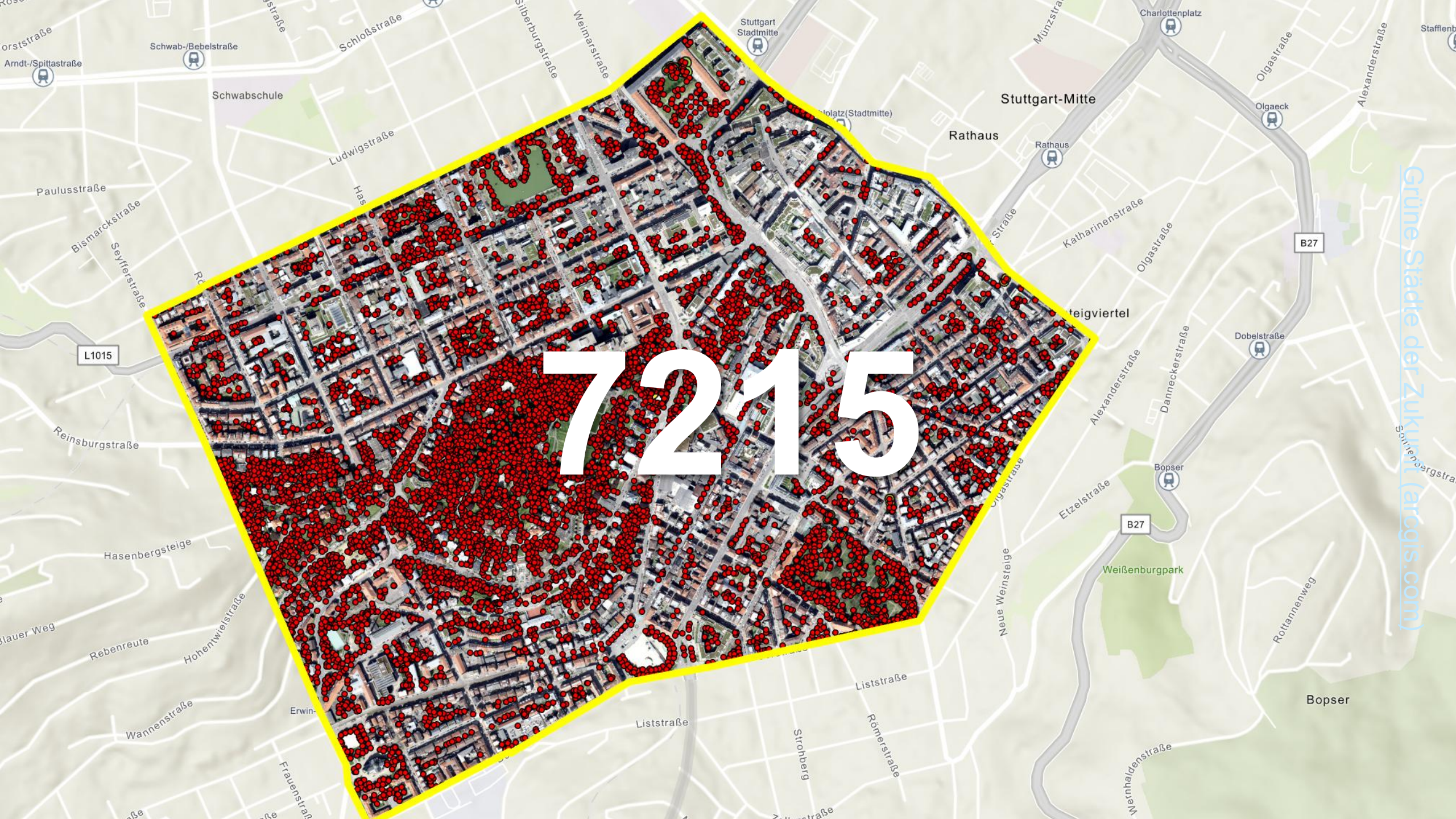


Data Credits: 2023 GeoFly GmbH /
City of Stuttgart, Ultracam Osprey
4.1, Data processed by Esri



An aerial photograph of a central urban area in Stuttgart, Germany, enclosed by a thick yellow boundary. The area is densely packed with buildings, mostly with red-tiled roofs, and interspersed with green spaces and trees. A large white text overlay is centered on the image. Surrounding the yellow boundary are various streets and landmarks, including the city center (Stuttgart-Mitte) to the north and east, and the B27 highway to the east. The text 'Wie viele Bäume?' is written in a large, white, sans-serif font across the middle of the image.

Wie viele Bäume?



7215



Wie viele Autos?





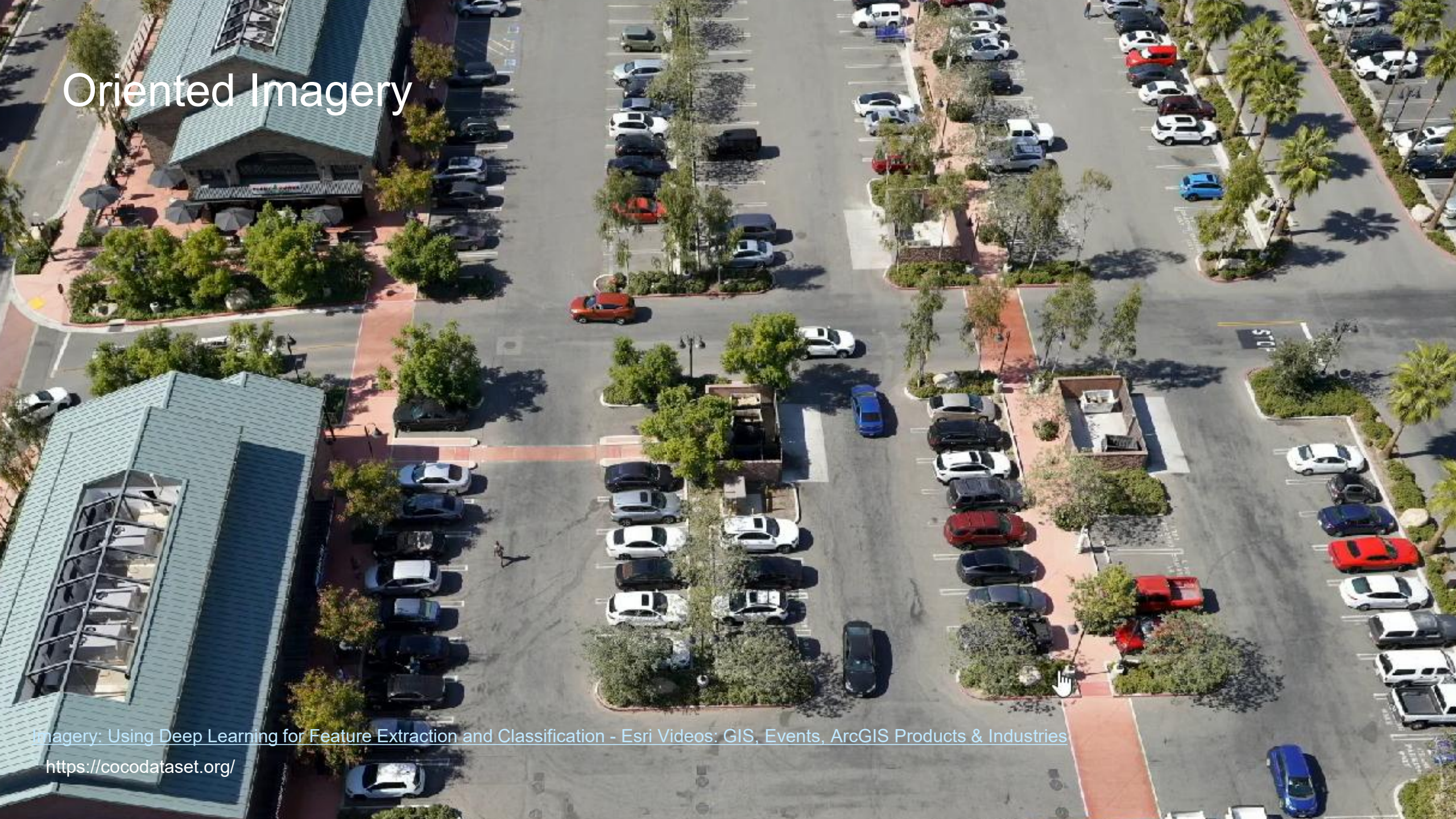
4114







Oriented Imagery



Imagery: Using Deep Learning for Feature Extraction and Classification - Esri Videos: GIS, Events, ArcGIS Products & Industries

<https://cocodataset.org/>

Oriented Imagery

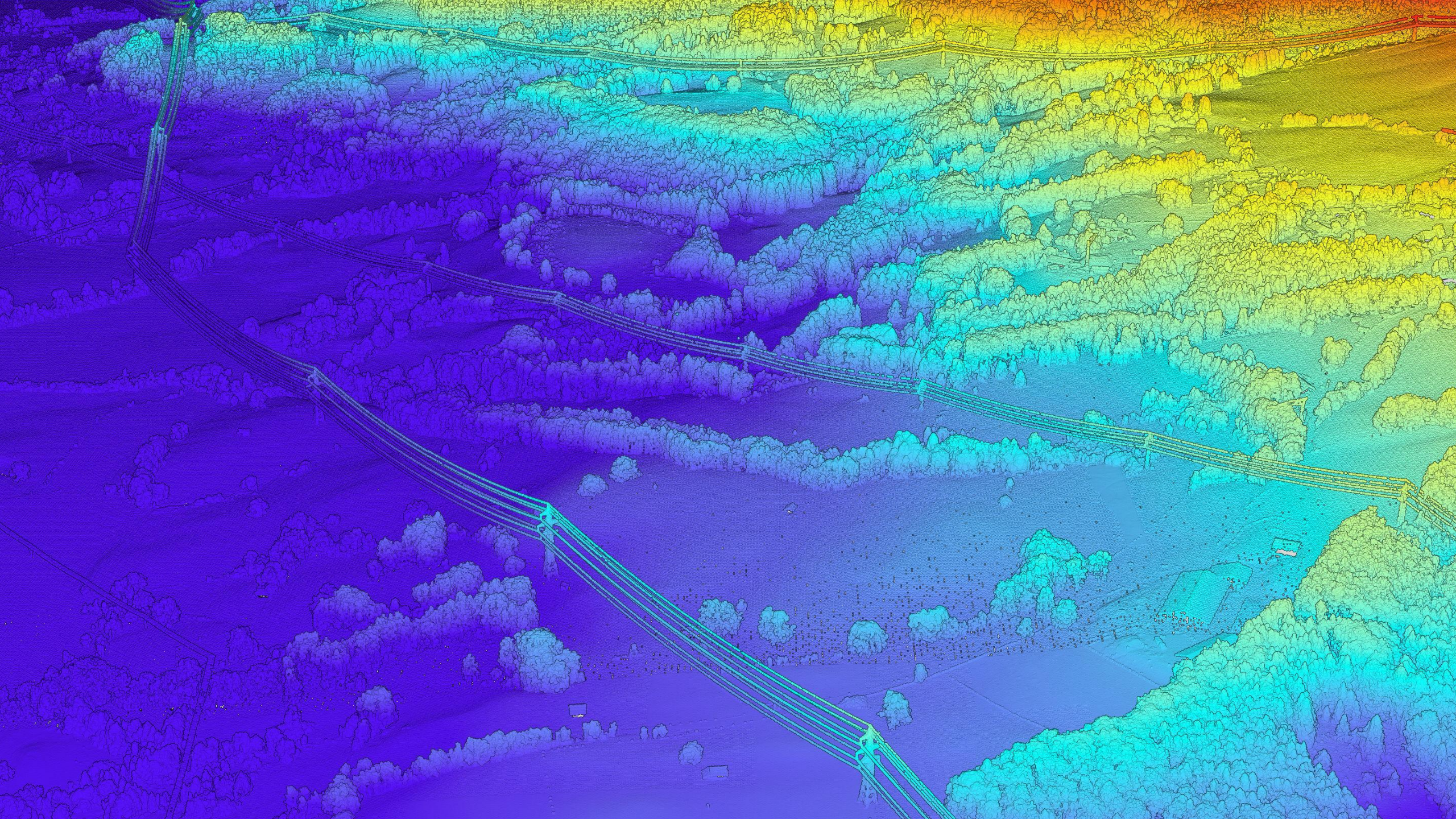


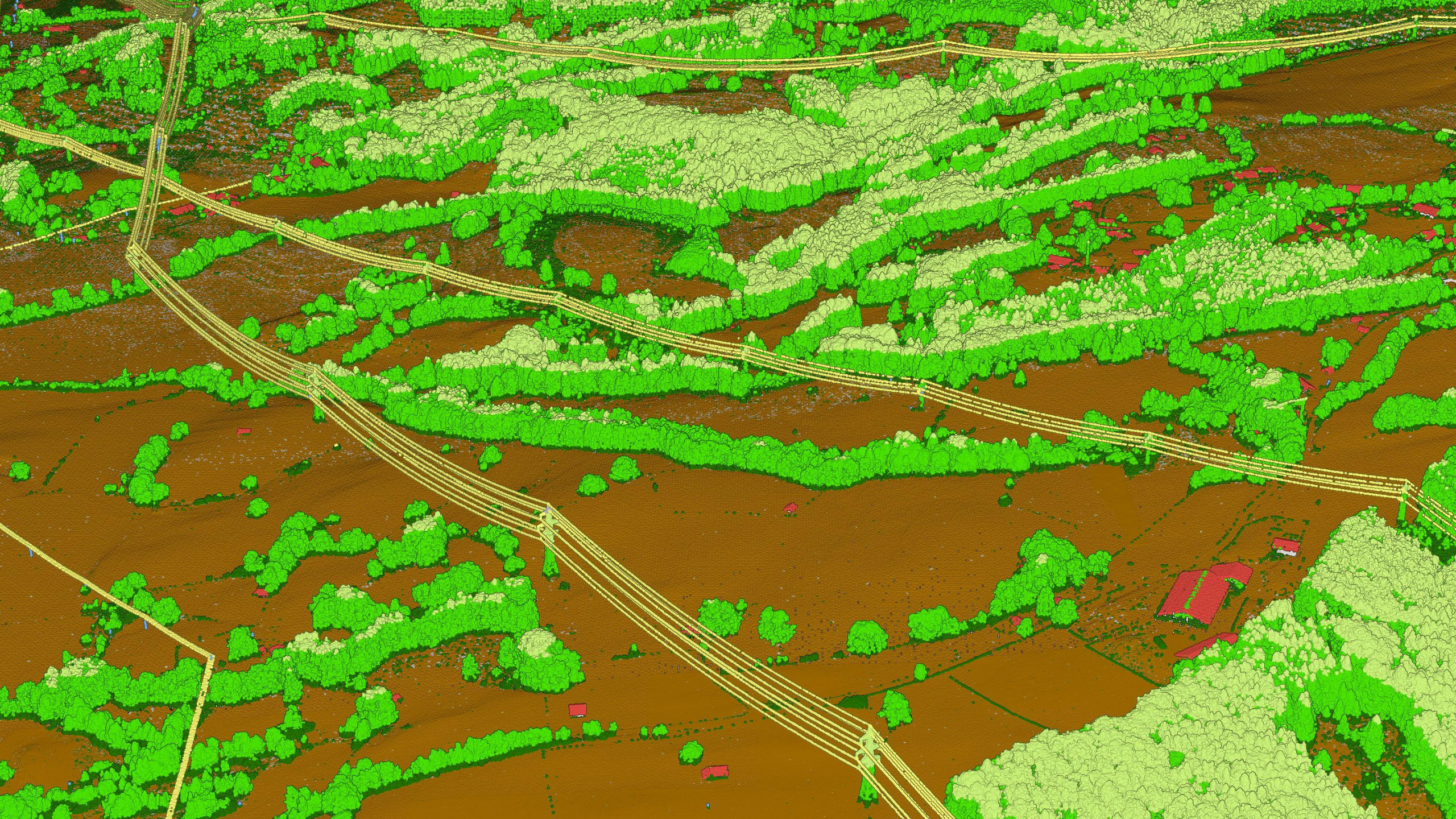
Imagery: Using Deep Learning for Feature Extraction and Classification - Esri Videos: GIS, Events, ArcGIS Products & Industries

<https://cocodataset.org/>











Warum?

Automatisierte
Merkmalsextraktion

Skalierbarkeit

Anpassungsfähigkeit

Integration
in ArcGIS

Hohe Genauigkeit
und Präzision

90%

aller Daten wurden
in den letzten 2 Jahren erfasst



2.5TB

an Daten werden von Sentinel-2
pro Tag generiert!

>1.000

Erdbeobachtungssatelliten,
befinden sich derzeit im Orbit

GeoAI in ArcGIS

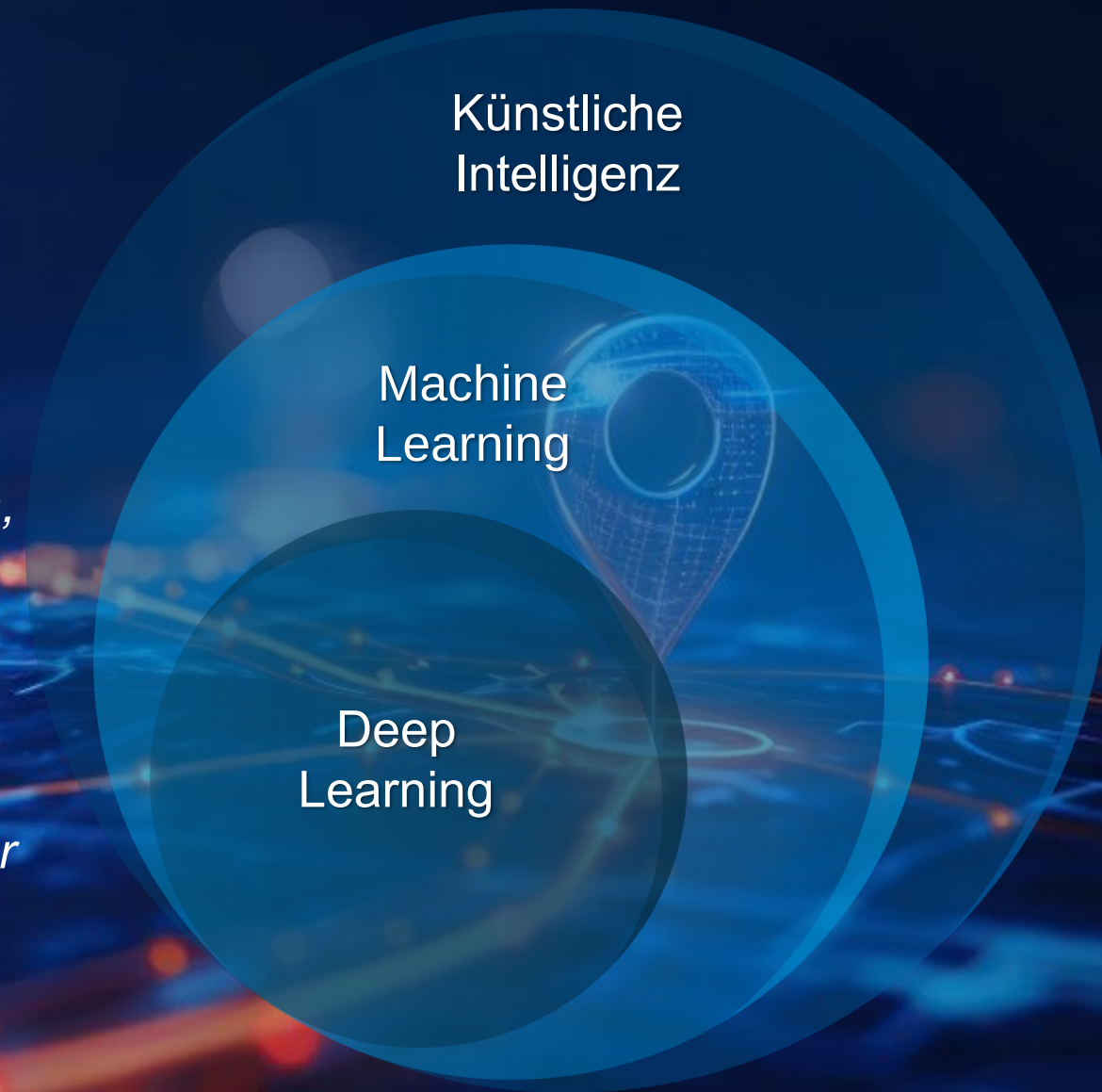
„Es ist keine Magie, es ist eine Methode!“

„Höchstwahrscheinlich wird die Anwendung einer Methode nicht die gewünschten Ergebnisse liefern, die Methodenfusion jedoch schon!“

„Ich empfehle mit vortrainierten Modellen zu starten, um einen Workflow zu testen!“

„Die Nachbearbeitung schließt die Lücke zwischen KI-Ergebnissen und praktischer GIS-Nutzung.“

„Deep Learning liefert Ihnen die rohen Zutaten, aber die Nachbearbeitung ist der Koch, der sie in eine Fünf-Sterne-GIS-Mahlzeit verwandelt. 🍴🍷“

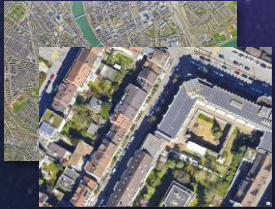


Deep Learning Integration

Erstellen Sie Ihr eigenes Modell

Daten

Satellitenbilder, Luftbilder, Drohnen, Mobile Daten usw.



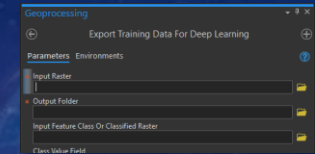
Trainingsdaten digitalisieren

Gute Trainingsdaten ;)



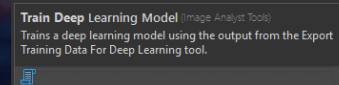
Exportieren von Trainingsdaten

Exportieren von Trainingsdaten für Deep Learning



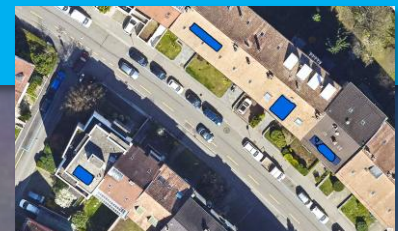
Modell trainieren

Deep Learning Model trainieren



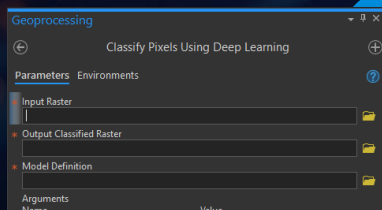
Ergebnisse prüfen

Wenn die Genauigkeit gering ist, passen Sie die vorherigen Schritte bei Bedarf an.



Modell anwenden

Pixeln mit Deep Learning klassifizieren



[Deep learning model architectures—ArcGIS Pro | Documentation](#)

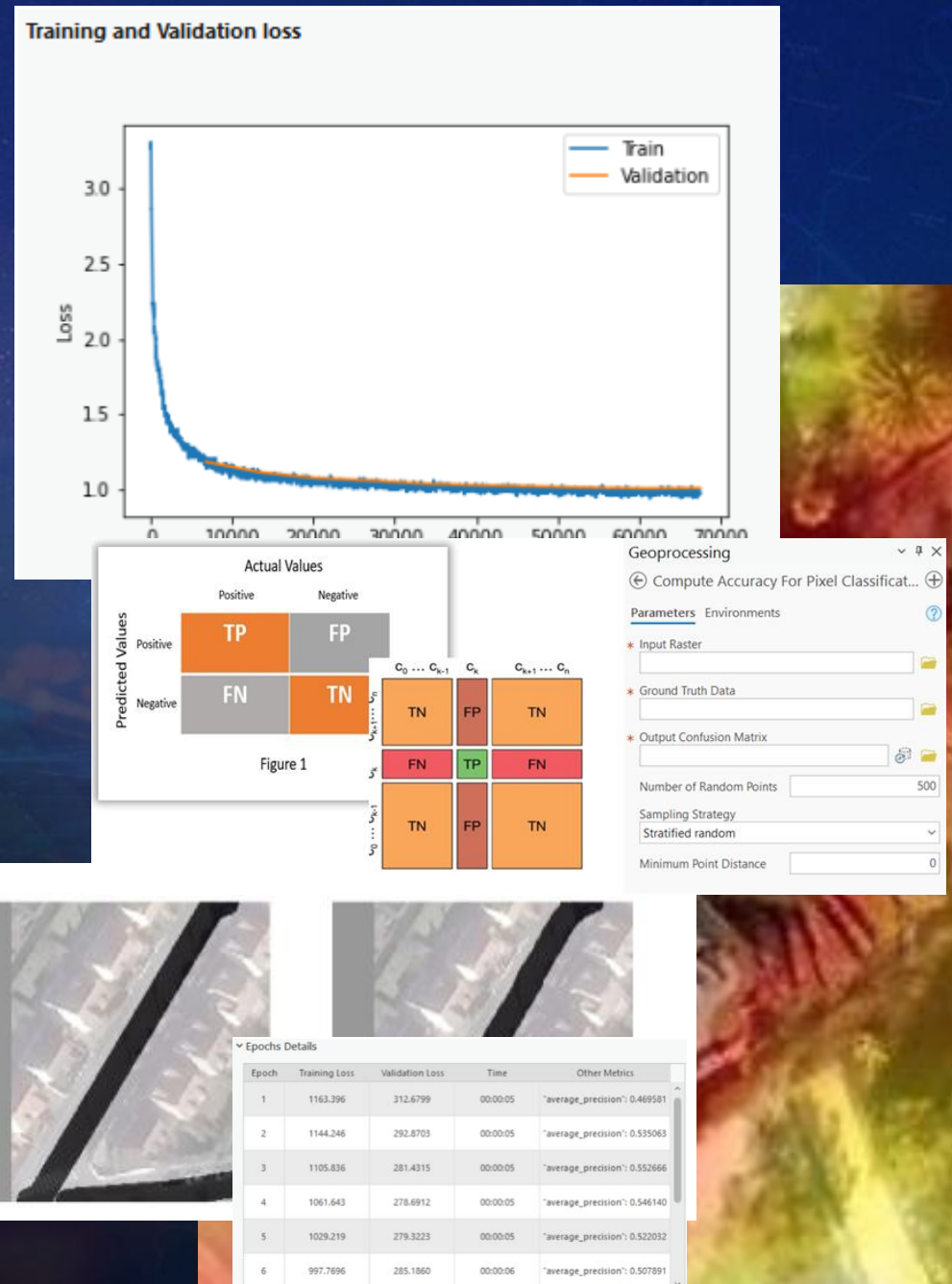
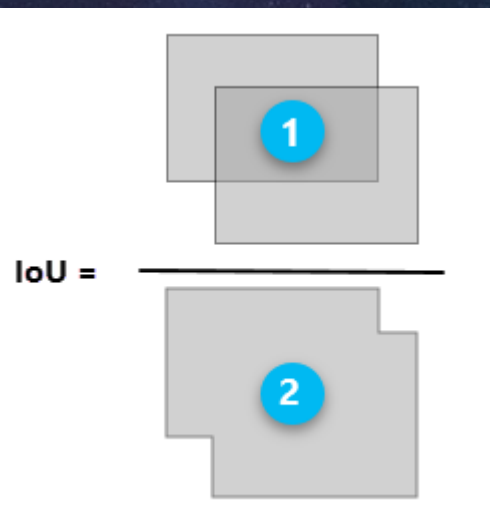
Überprüfen der Ergebnisse

- [Deep learning model review—ArcGIS Pro | Documentation](#)
- [How Compute Accuracy For Object Detection works—ArcGIS Pro | Documentation](#)
- [Quick Image Classification Accuracy Assessment in ... - Esri Community](#)
- [GeoAI in ArcGIS Pro 3.5 Image Analyst](#)



Number	Description
1	True positive—The model predicted that there is a tree, and it is correct.
2	False positive—The model predicted that there is a tree, and it is incorrect.
3	False negative—The model predicted that there is no tree, and it is incorrect.
4	True negative—The model predicted that there is no tree, and it is correct.

Intersection over Union (IoU) ratio



New Workspace

Georeference

Raster Functions

Function Editor

Change Detection

Classification Wizard

Classification Tools

Deep Learning Tools

Point

Distance

Area

Results

Process

Indices

Pixel Editor

Image Information

Create Hosted Imagery

Video Search

Motion Imagery

Ortho Mapping

Alignment

Analysis

Image Classification

Mensuration

Tools

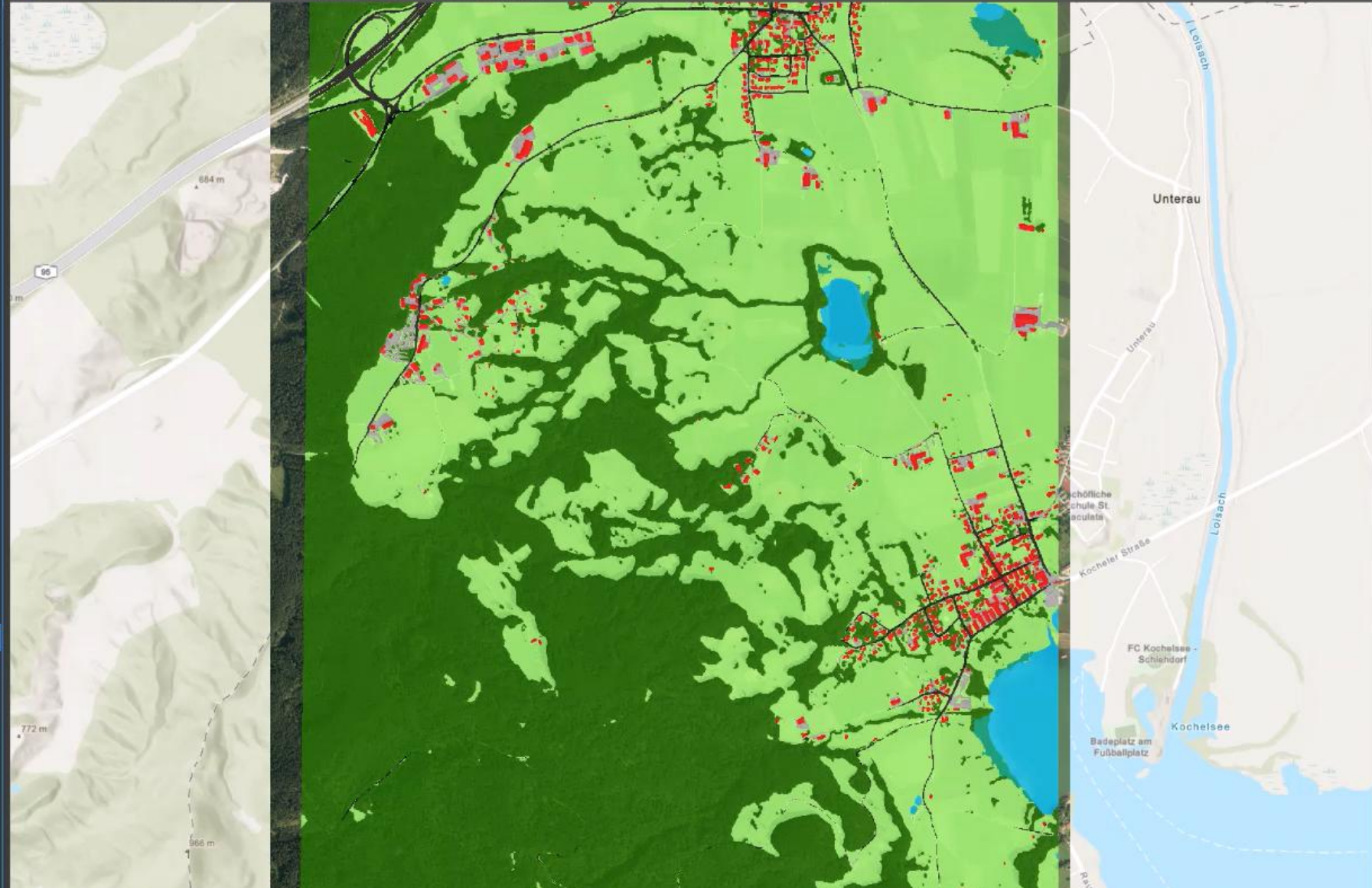
Share

Motion Imagery

Search

Drawing Order

- 2D Map Raster DL
 - ☐ Raster
 - ☒ Local_Maxima.tif
 - Value
 - 0
 - 1
 - ☒ nDSM.tif
 - ☐ DTM.tif
 - ☐ DSM.tif
 - ☐ single_trees_focal3_rastercalc_t...
 - ☒ LCC_Classification_High_Resol...
 - Class
 - Water
 - Wetlands
 - Tree Canopy
 - Shrubland
 - Low Vegetation
 - Barren
 - Structures
 - Impervious Surfaces
 - Impervious Roads
 - ☒ Bayern_VC_MSD_20cm
 - ☐ Boundary
 - ☐ Footprint
 - ☒ Image
 - RGB
 - Red: Red
 - Green: Green
 - Blue: Blue



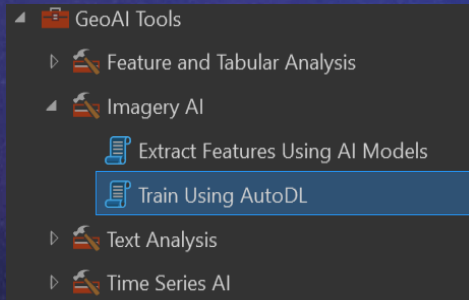
Catalog

Project Portal Computer Favorites

Search Project

- Maps
- Toolboxes
- Databases
- Styles
- Folders
- Locators

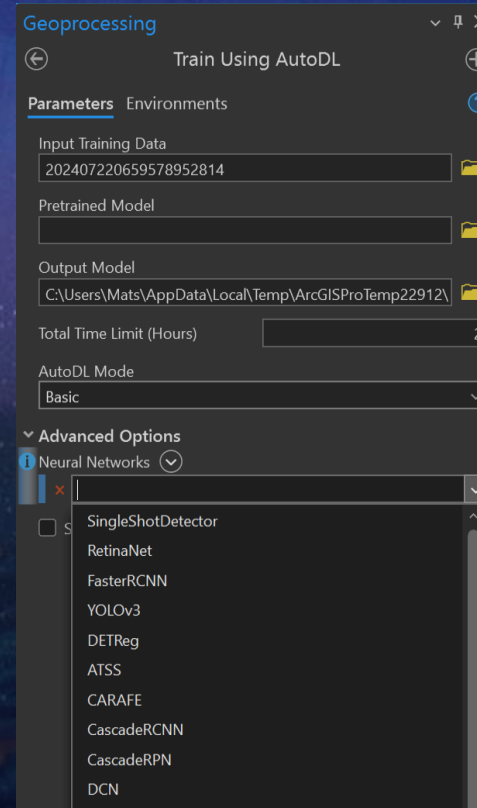
Welchen Modeltyp?



GPU is being used.
Given time to process the dataset is: 4.00 hours.
Number of images that can be processed in the given time: 377.
Time required to process the entire dataset of 377 images is 1.53 hrs.
Starting the training process.

Model	Train Loss	Valid Loss	Accuracy	Dice	Learning Rate	Time	Backbone
PSPNetClassifier	0.744	0.684	0.83144	0.831	0.0014454	0:11:49	resnet50
UnetClassifier	0.699	0.642	0.75981	0.760	0.0000525	0:06:03	resnet34
HRNet	1.067	0.986	0.66279	0.663	0.0020893	0:01:18	resnet34

C:\Users\...\Documents\ArcGIS\Packages\AutoDL tutorial e9d018\ClassifiedSAR\LULC\F
Training completed.



- SingleShotDetector - SingleShotDetector is used for object detection.
- RetinaNet - RetinaNet is used for object detection.
- **FasterRCNN** - FasterRCNN is used for object detection.
- **YOLOv3** - YOLOv3 is used for object detection.
- HRNet - HRNet is used for pixel classification.
- ATSS - ATSS is used for object detection.
- CARAFE - CARAFE is used for object detection.
- CascadeRCNN - CascadeRCNN is used for object detection.
- CascadeRPN - CascadeRPN is used for object detection.
- DCN - DCN is used for object detection.
- DeepLab - DeepLab is used for pixel classification.
- UnetClassifier - UnetClassifier is used for pixel classification.
- DeepLabV3Plus - DeepLabV3Plus is used for pixel classification.
- PSPNetClassifier - PSPNetClassifier is used for pixel classification.
- ANN - ANN is used for pixel classification.
- APCNet - APCNet is used for pixel classification.
- CCNet - CCNet is used for pixel classification.
- CGNet - CGNet is used for pixel classification.
- DETReg - DETReg is used for object detection.
- DynamicRCNN - DynamicRCNN is used for object detection.
- EmpiricalAttention - EmpiricalAttention is used for object detection.
- FCOS - FCOS is used for object detection.
- FoveaBox - FoveaBox is used for object detection.
- FSAF - FSAF is used for object detection.
- GHM - GHM is used for object detection.
- LibraRCNN - LibraRCNN is used for object detection.
- PaFPN - PaFPN is used for object detection.
- Res2Net - Res2Net is used for object detection.
- SABL - SABL is used for object detection.
- VFNet - VFNet is used for object detection.
- DMNet - DMNet is used for pixel classification.
- DNLNet - DNLNet is used for pixel classification.
- FastSCNN - FastSCNN is used for pixel classification.
- FCN - FCN is used for pixel classification.
- GCNet - GCNet is used for pixel classification.
- MobileNetV2 - MobileNetV2 is used for pixel classification.
- NonLocalNet - NonLocalNet is used for pixel classification.
- OCRNet - OCRNet is used for pixel classification.
- PSANet - PSANet is used for pixel classification.
- SemFPN - SemFPN is used for pixel classification.
- UperNet - UperNet is used for pixel classification.
- **MaskRCNN** - MaskRCNN is used for object detection.

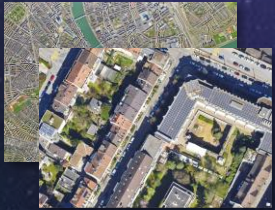
- [Deep learning model architectures—ArcGIS Pro | Documentation](#)
- [Train Using AutoDL \(Image Analyst\)—ArcGIS Pro | Documentation](#)

Deep Learning Integration

Erstellen Sie Ihr eigenes Modell

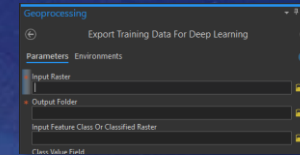
Daten

Satellitenbilder, Luftbilder, Drohnen, Mobile Daten usw.



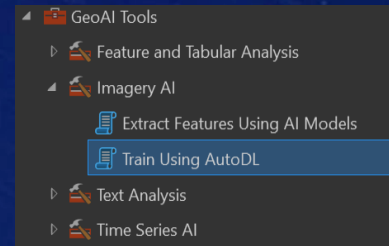
Trainingsdaten erstellen

Gute Trainingsdaten ;)



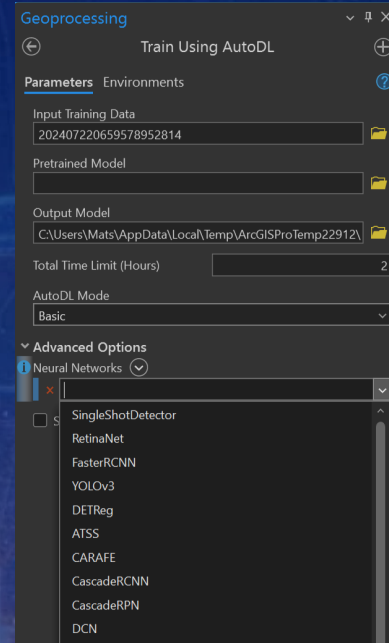
Exportieren von Trainingsdaten

Exportieren von Trainingsdaten für Deep Learning



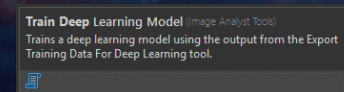
Auto DL

Trainieren Sie mehrere Deep-Learning-Modelle und vergleichen Sie Leistungsmetriken



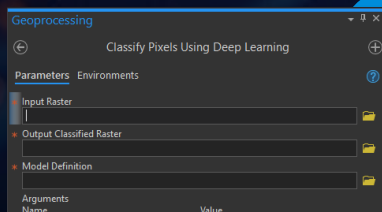
Modell trainieren

Deep Learning Model trainieren



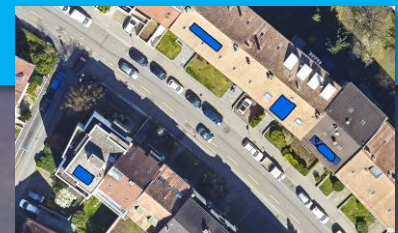
Modell anwenden

Pixeln mit Deep Learning klassifizieren



Ergebnisse prüfen

Wenn die Genauigkeit gering ist, passen Sie die vorherigen Schritte bei Bedarf an.



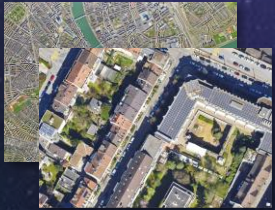
[Deep learning model architectures—ArcGIS Pro | Documentation](#)

Deep Learning Integration

Erstellen Sie Ihr eigenes Modell

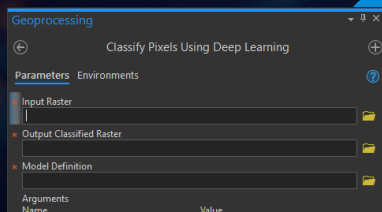
Daten

Satellitenbilder, Luftbilder,
Drohnen, Mobile Daten usw.



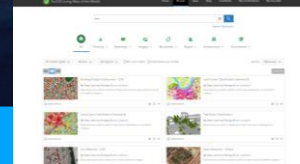
Modell anwenden

Pixeln mit Deep Learning klassifizieren



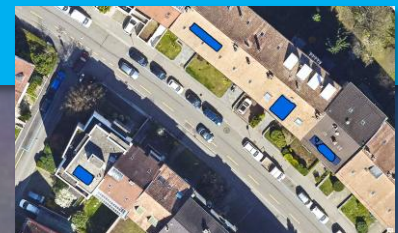
Modell laden

[Living Atlas of the World](#)

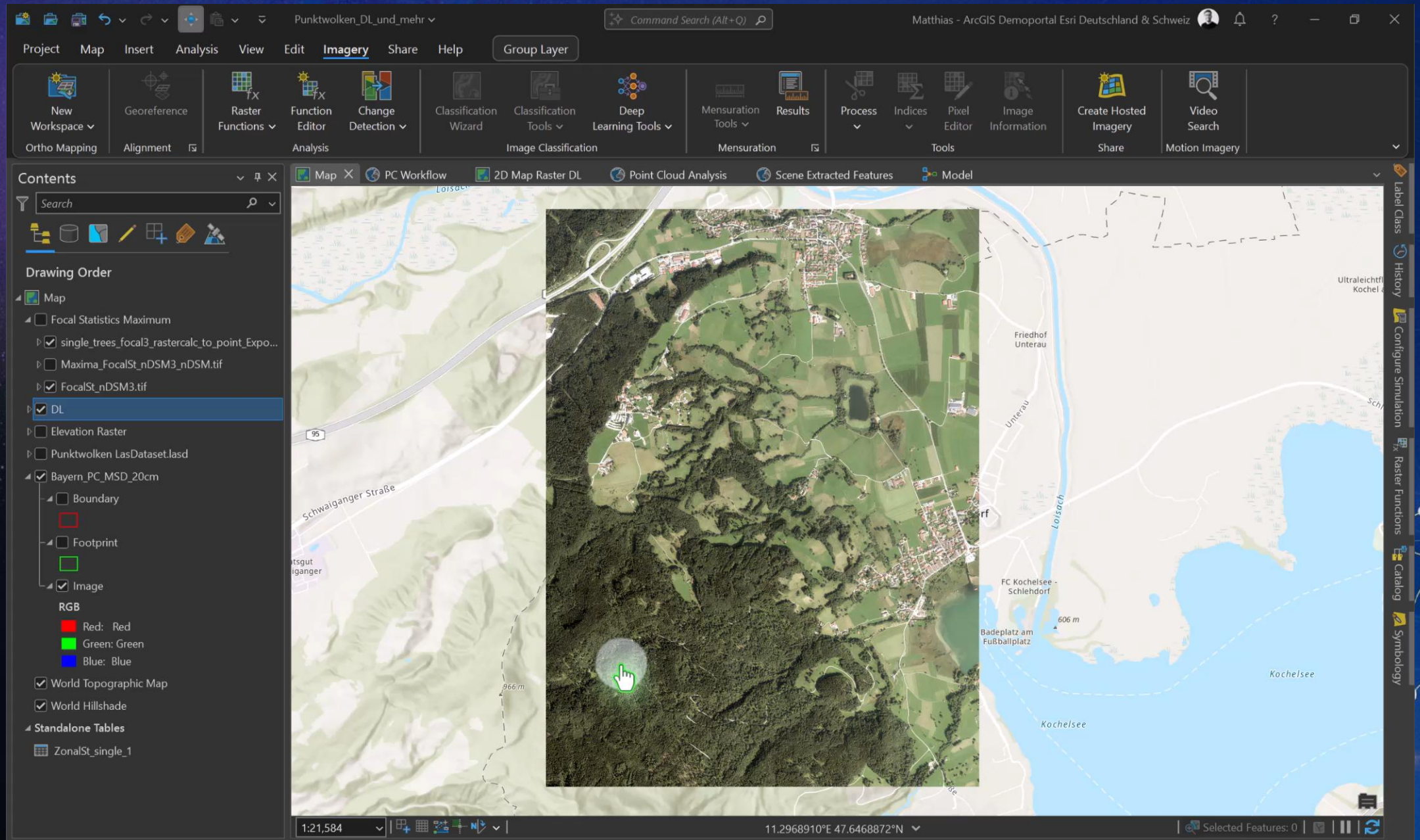


Ergebnisse prüfen

Wenn die Genauigkeit gering ist, passen Sie die vorherigen Schritte bei Bedarf an.



[Deep learning model architectures—ArcGIS Pro | Documentation](#)



Deep Learning Integration

Verwenden von vortrainierten Deep-Learning-Modellen

- Cars
- License Plate Blurring
- Parking Lots
- **Land Cover**
- Parking Spots
- Humans
- Crowd Counting
- Face Blurring
- **Buildings**
- Roads
- Parcels
- Ag Fields
- Swimming Pools
- Well Pads
- Oil Spills
- Palm Trees
- Power Lines
- **Transmission Towers**
- Insulator Defects
- Wind Turbines
- Solar Arrays
- Solar Panels
- Ships
- Shipwrecks
- **Segment Anything Model (SAM)**
- Trees
- Plant Leaf Disease
- Common Object Detection
- Text Parsing from Photo
- **Object Tracking**

new

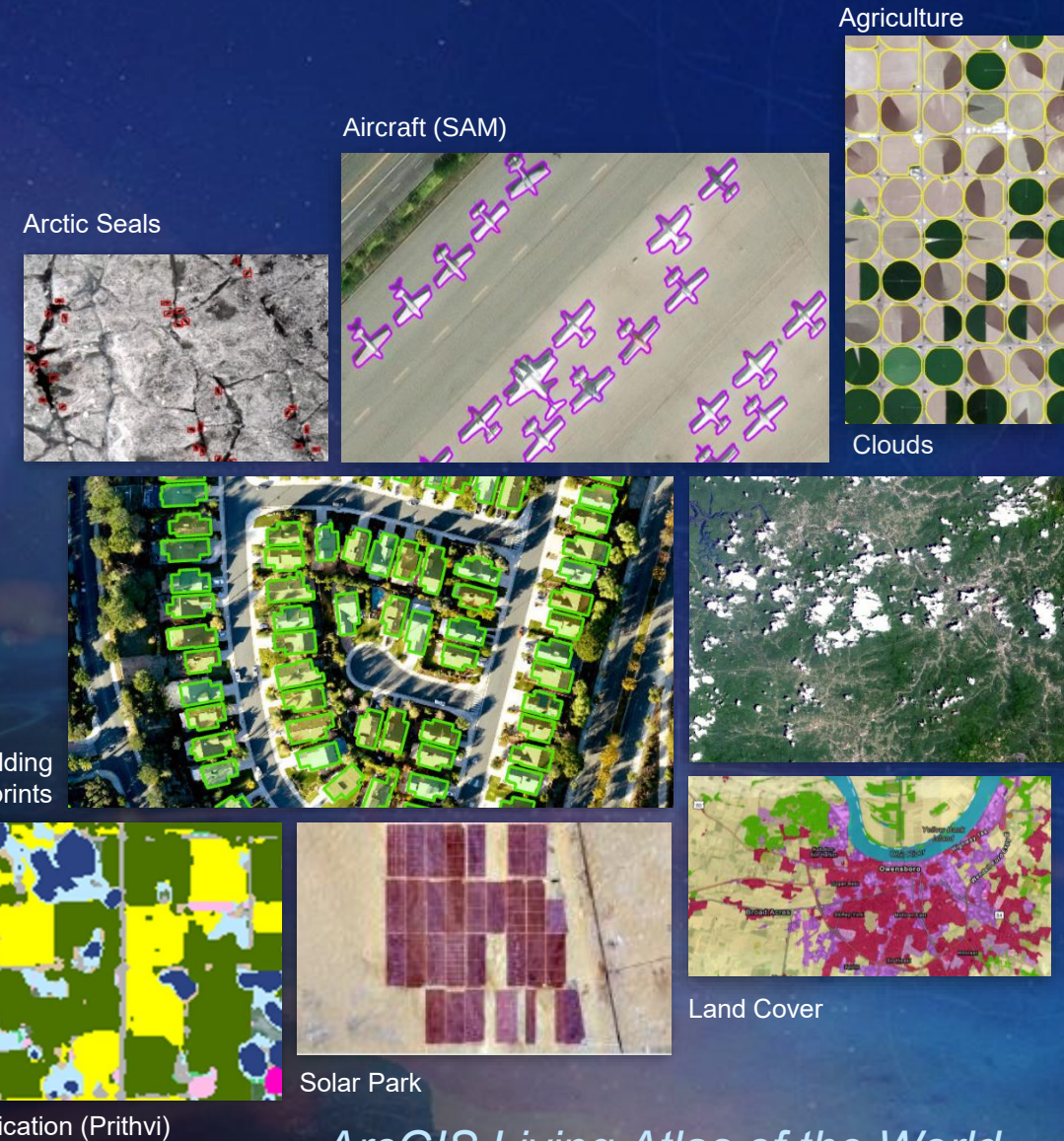
- Text SAM
- **Prithvi**
(Crops, Burn Scars, Floods)
- Cloud Mask Generation
- Tree Segmentation
- Agricultural Field Boundaries
- Oil Tanks
- Pylons
- Cooling Towers
- Ships
- Transmission H-Structures
- **3D Building Points**
- **Classification**
- Wildfire Delineation
- Optical Character Recognition

!!!UPDATES!!!

[What's new in ArcGIS pretrained models—ArcGIS pretrained models | Documentation](#)

... Automating Workflows
... Creating New Data Layers

Reality Mapping - Analyse in ArcGIS



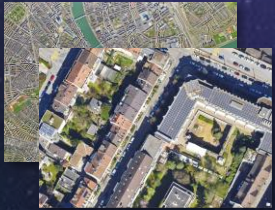
[ArcGIS Living Atlas of the World](#)

Deep Learning Integration

Modelle nachtrainieren

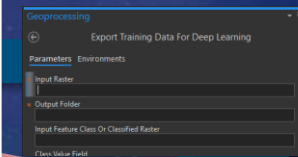
Daten

Satellitenbilder, Luftbilder,
Drohnen, Mobile Daten usw.



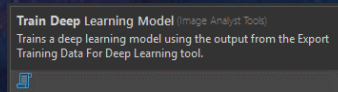
Exportieren von Trainingsdaten

Exportieren von Trainingsdaten für Deep Learning



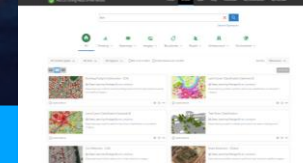
Modell trainieren

Deep Learning Model trainieren



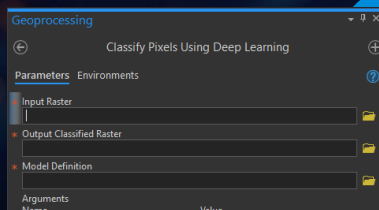
Modell laden

[Living Atlas of the World](#)



Modell anwenden

Pixeln mit Deep Learning klassifizieren



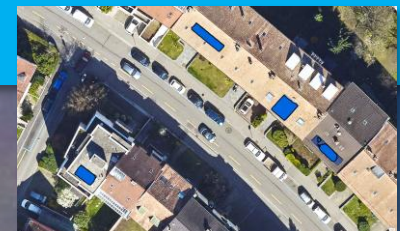
Trainingsdaten erstellen

Gute Trainingsdaten ;)



Ergebnisse prüfen

Wenn die Genauigkeit gering ist, passen Sie die vorherigen Schritte bei Bedarf an.



Individuelle Anpassung!

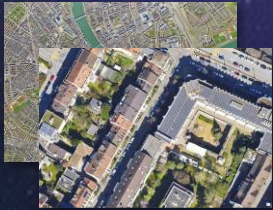
[Deep learning model architectures—ArcGIS Pro | Documentation](#)

Deep Learning Integration

Pseudo-Labeling

Daten

Satellitenbilder, Luftbilder, Drohnen, Mobile Daten usw.



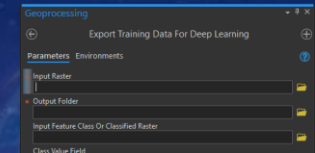
Verwenden der Ergebnisse als Trainingsdaten

Gute Trainingsdaten ;)



Exportieren von Trainingsdaten

Exportieren von Trainingsdaten für Deep Learning



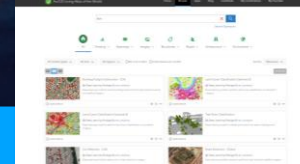
Modell trainieren

Deep Learning Model trainieren

Train Deep Learning Model (Image Analyst Tool)
Trains a deep learning model using the output from the Export Training Data For Deep Learning tool.

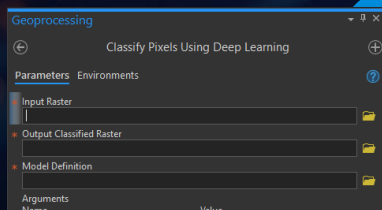
Modell laden

Living Atlas of the World



Modell anwenden

Pixeln mit Deep Learning klassifizieren



Ergebnisse prüfen

Wenn die Genauigkeit gering ist, passen Sie die vorherigen Schritte bei Bedarf an.



Individuelle Anpassung!

[Deep learning model architectures—ArcGIS Pro | Documentation](#)



Data Credits: 2023 GeoFly
GmbH /City of Stuttgart,
Ultracam Osprey 4.1, Data
processed by Esri with ArcGIS
Reality Studio

Deep Learning Integration

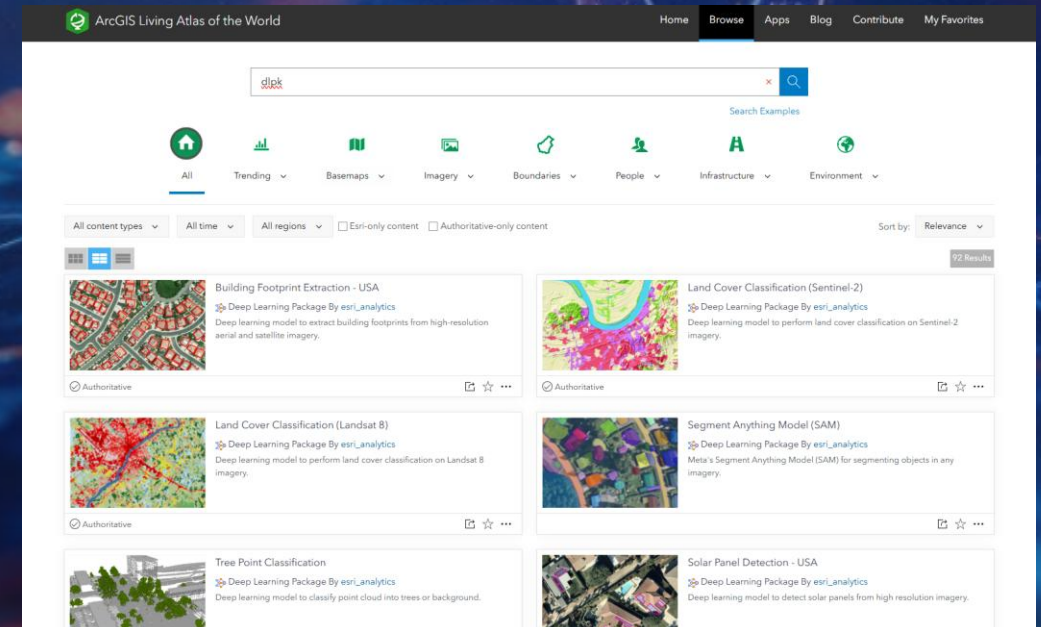
Verwenden von vortrainierten Deep-Learning-Modellen

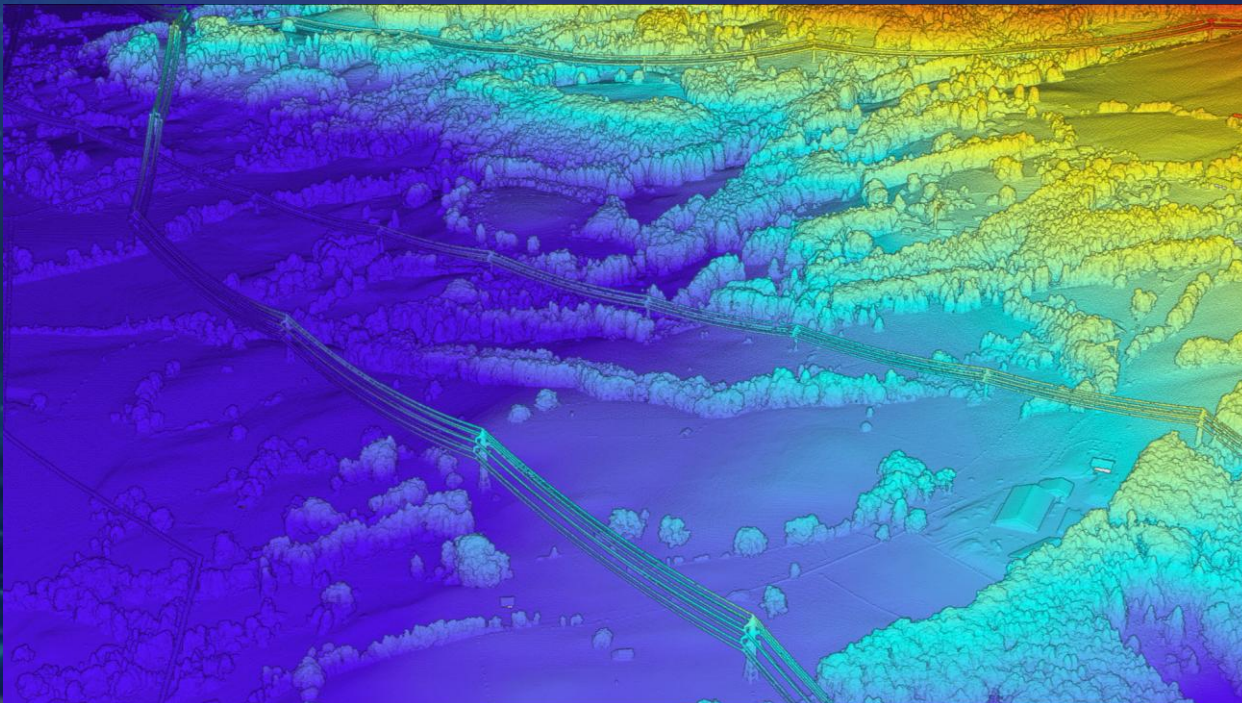
- [Tree Detection – Overview](#)
- [Tree Segmentation – Overview](#)
- [Tree Point Classification – Overview](#)
- [Land Cover Classification \(Aerial Imagery\) – Overview](#)
- [Prompt Based Segmentation – Overview](#)
- [GroundingDINO – Overview](#)
- [Text SAM – Overview](#)
- [HF Object Detection – Overview](#)
- [HF Pixel Classification - Overview](#)

[Reality Mapping - Analyse in ArcGIS](#)

Individuelle Anpassung!

- Parametrisierung anpassen
- Nachtrainieren
- Pseudo-Labeling



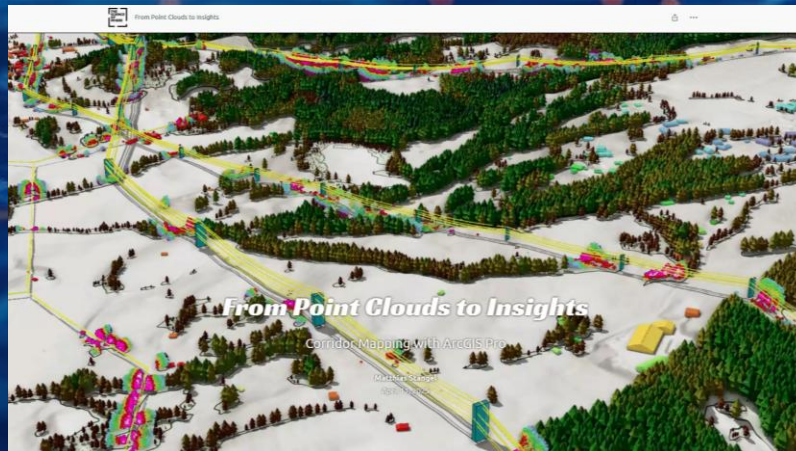


Von Punktwolken zu Erkenntnissen

LiDAR Punktwolke, LAZ, ~20pts/m²

Von Punktwolken zu Erkenntnissen

Ideen und Anregungen für Ihre Rasteranalyse...



Imagery Lernressourcen



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Enter a product name or keyword like 'Get started'

Filter

GeoAI

All Products

All Topics

All Types

All Levels

All Accounts

Clear Filters

Filters GeoAI X Clear Filters

Extract informal settlements with SAMLoRA

Train a SAMLoRA (Segment Anything Model with Low Ranking Adaptation) deep learning model in ArcGIS Pro to extract informal settlement building footprints from drone imagery.

45mins Intermediate

Extract high-resolution land cover with GeoAI

Use a deep learning pretrained model to extract land cover from high-resolution drone imagery.

30mins Intermediate

Train a model using automated deep learning

Use the Train Using AutoDL tool to train several deep learning models and pick the best performing one for a pixel-level land cover classification task.

40mins Intermediate

Map floods with SAR data and deep learning

Use a deep learning pretrained model to extract water pixels from pre- and post-flood Sentinel-1 datasets, and perform change detection analysis to identify flooded areas in the St. Louis, Missouri region in 2019.

45mins Intermediate

Learn.arcgis

Browse by Topic

Getting Started

ArcGIS Products

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Mapping

Spatial Analysis & Data Science

Field Operations

Scripting & Development

Imagery & Remote Sensing

3D Visualization & Analytics

Select a Focus Area

Get Started

Manage Imagery

Analyze Imagery

Visualize and Exploit Imagery

Map Imagery



Esri Academy

Von Punktwolken zu Erkenntnissen

Das Beispiel einer Korridor Analyse mit GeoAI



Matthias Stängel
Sales Engineer

Esri Deutschland GmbH
esri.de

