About current limitations of CNN technology with remote sensing imagery

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2025.09.29, Arbeitskreis Fernerkundung, Bochum

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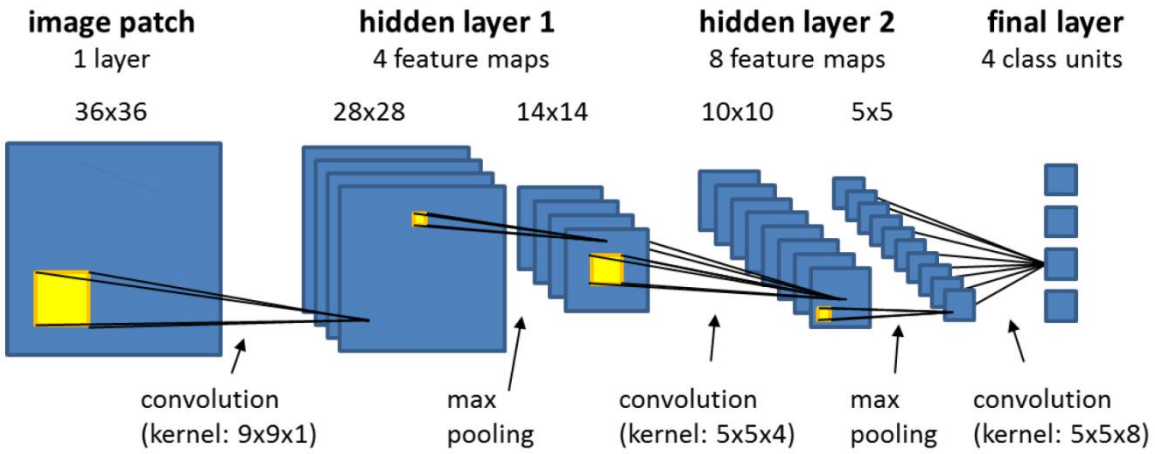
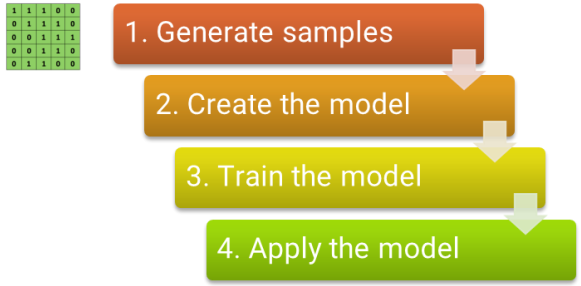
“Neural networks are the only way to go with imagery”. Really?



Schema of a CNN with 2 hidden layers [source: eCognition CNN Tutorial, Trimble 2017]



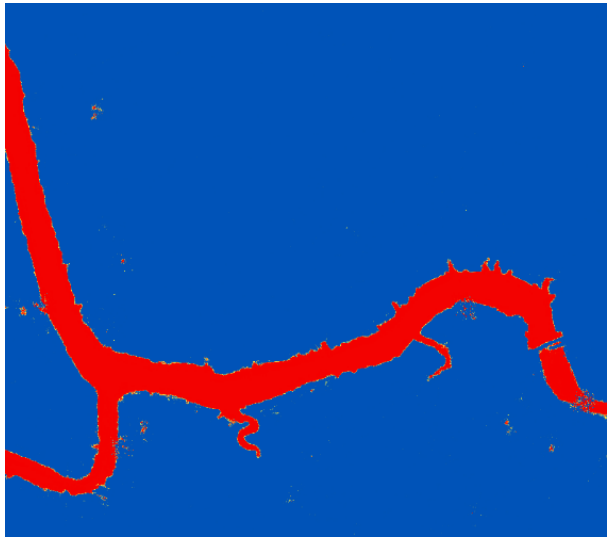
Result A: new raster layer (*heatmaps*) with values [0;1]
Result B: Segmentation based on heatmap

Internal and external CNNs

CNN algorithms in eCognition

Convolutional neural networks

- generate labeled sample patches
- delete sample space
- merge labeled sample spaces
- split labeled sample space
- shuffle labeled sample patches
- create convolutional neural network
- train convolutional neural network
- apply convolutional neural network
- save convolutional neural network
- load convolutional neural network
- convolutional neuronal network accuracy



Heatmap as a result of a CNN analysis

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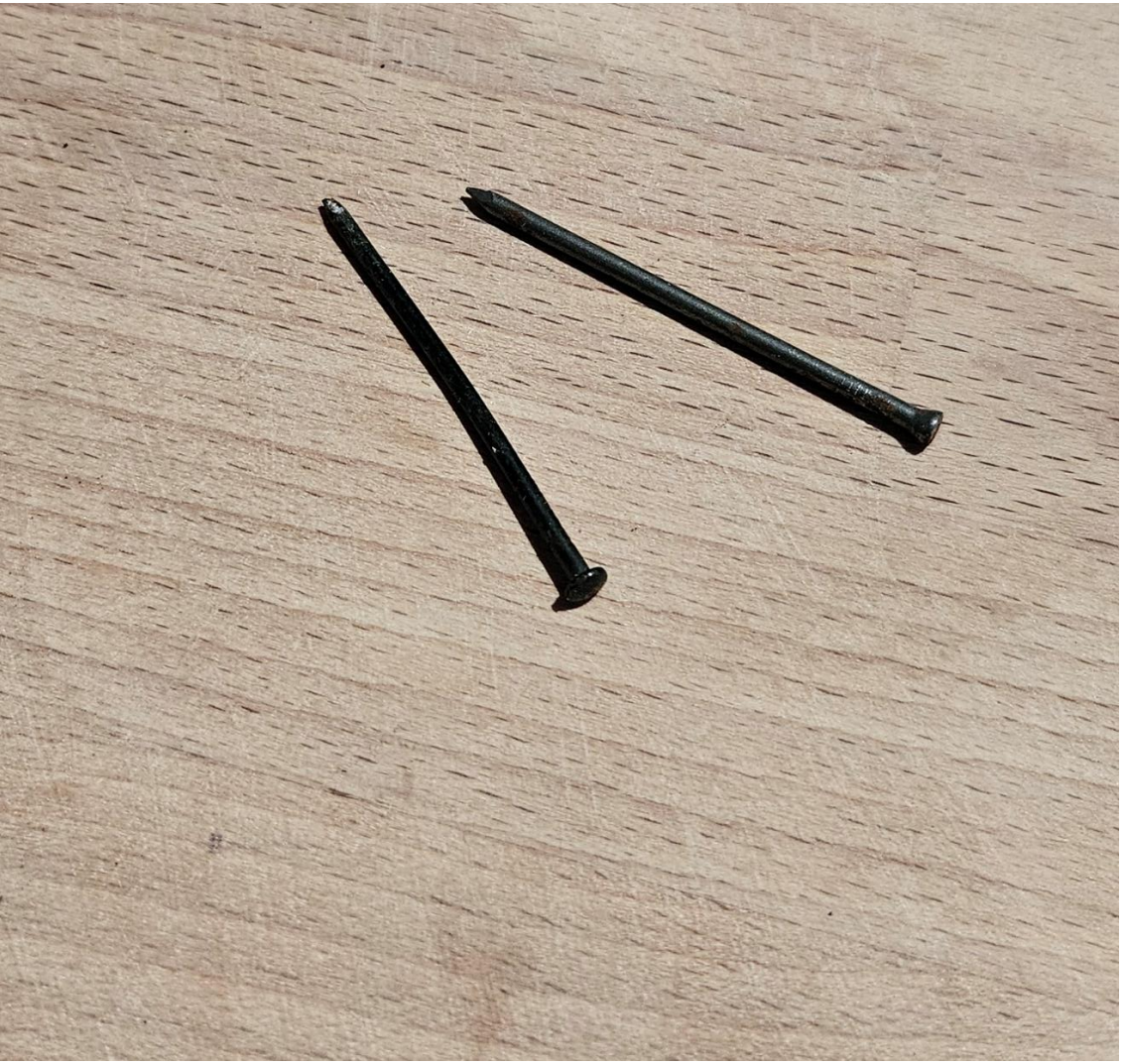

Let’s look at a simple problem as an analogy

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Simple problem, simple solution

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Same solution for different size problems

Low tech problem solving.
Just low tech?

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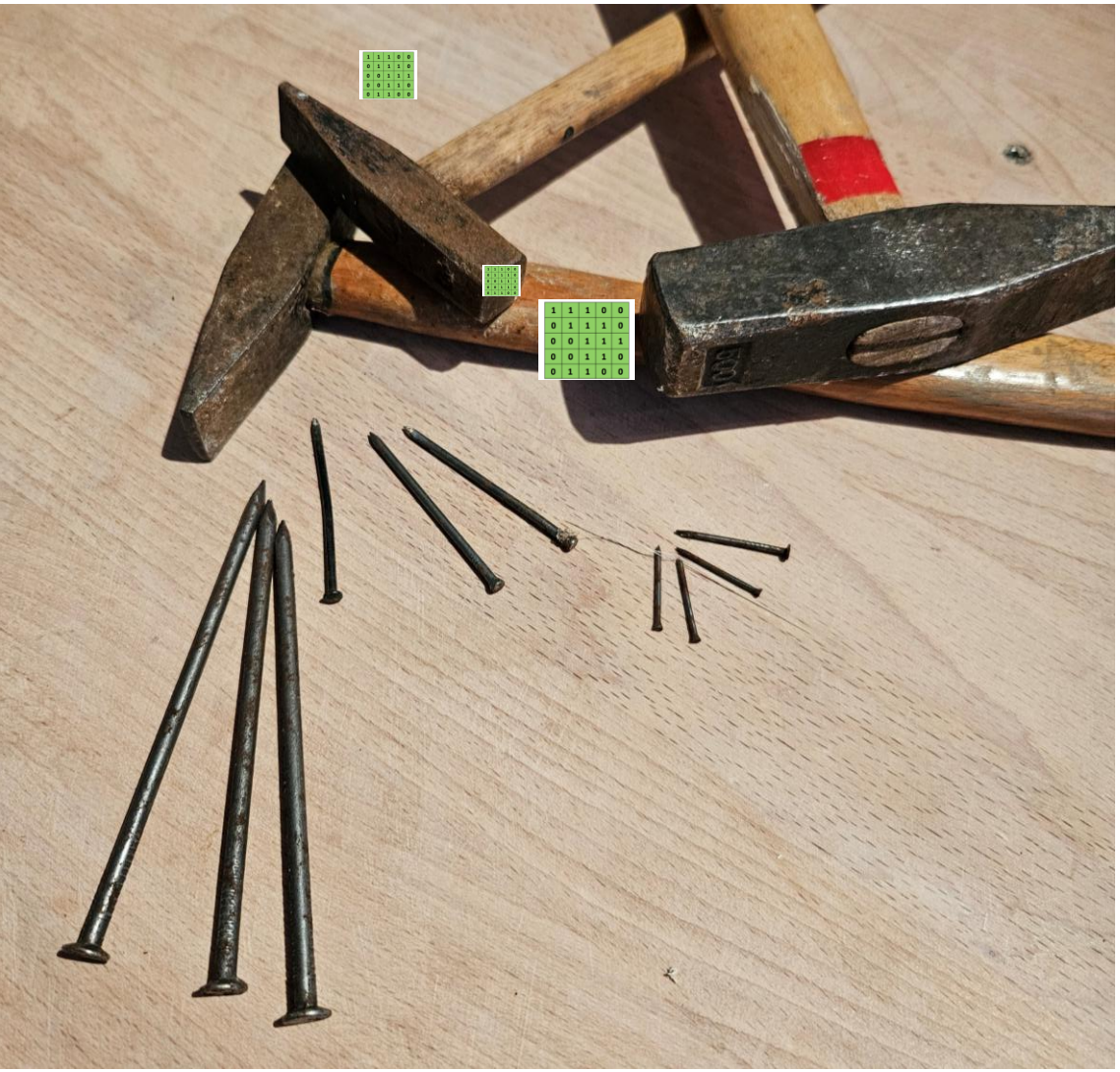
Solutions for different size of problems, but…



“If you only have a hammer every problem looks like a nail”

This trap is not limited to blue collar work.

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Problems in a rich environment

Being a grand master with one tool doesn't mean you know whether other tools may be superior for particular questions

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Rich environments. Complex solutions.

Drill, baby drill.

Geospatial data can be a really rich environment. Your toolbox and your skillsets at hand may become a craft on its own.

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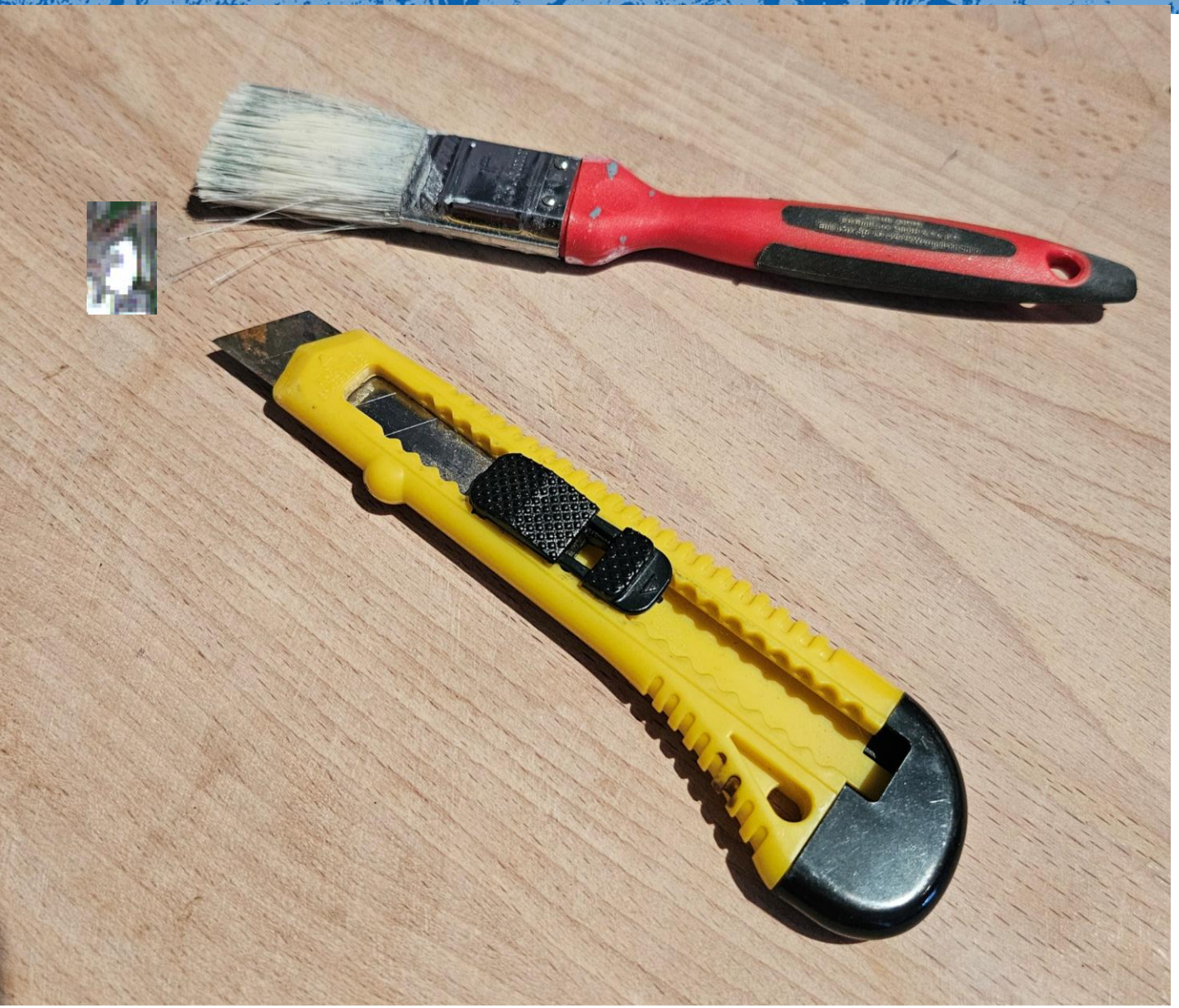

New environments. May also be requiring old solutions.

Solutions to problems we currently don't have but will likely run into.

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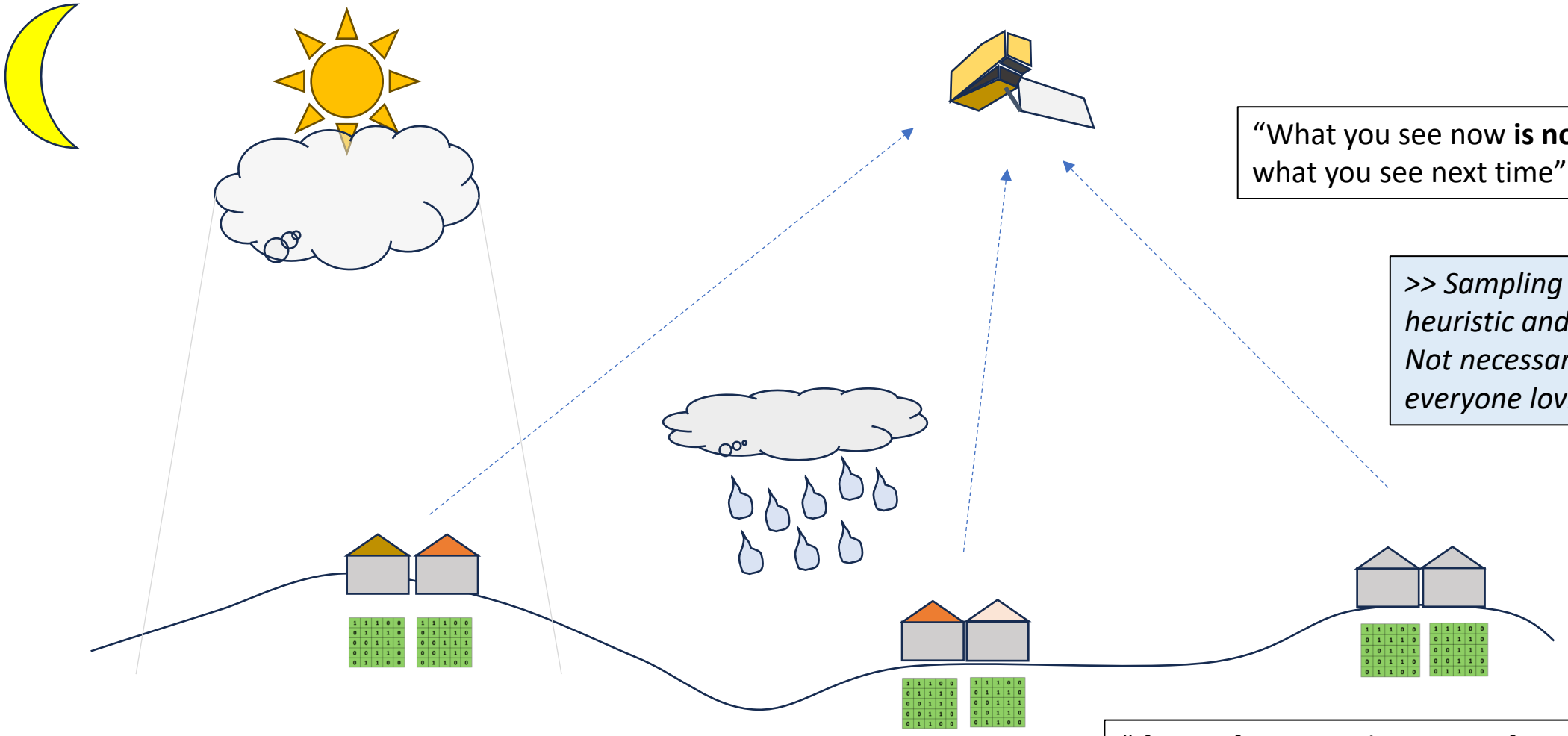
“How to achieve top recognition rates”? By working under lab conditions.
“How about the earth’s atmosphere”? It depends how much time you invest



“What you see now **is not** what you see next time”

>> Sampling becomes a heuristic and boring task. Not necessarily a favorite of everyone loving mathematics <<

We need “good samples and many, many of them”

“If one of ten samples is out of target class, your chances of reaching 90% accuracy are tiny”

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A rare event for a small building

unless you live in the Nordics

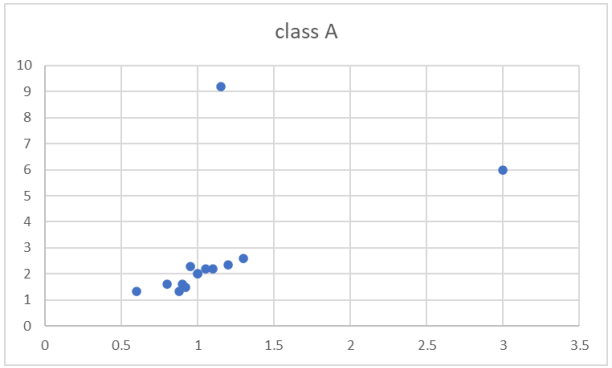
Do you put this the sample box „small building“ or „vegetation“ or ignore it?

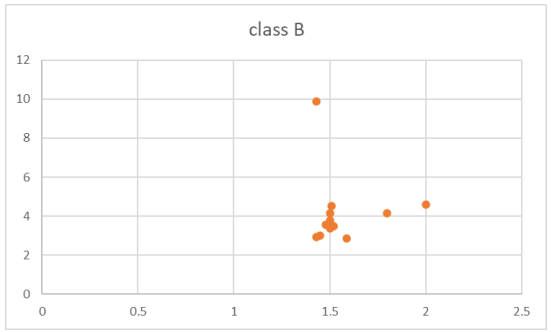
I guess it depends on what you want to map.

>> choose your samples wisely <<

Sampling of rare events, cost of incorrect classifications

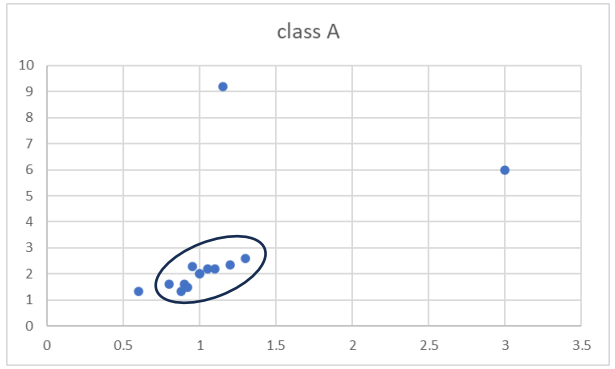
RAW DATA

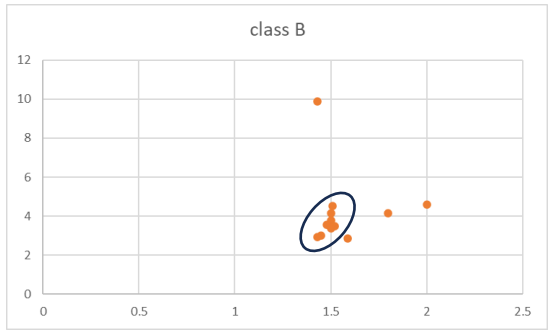




„does the data really say enough about the target classes“

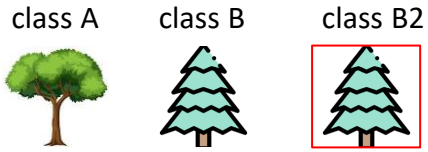
SAMPLING „STRATEGY“





„sure + hmm“

ACCURACY ASSESSMENT



cost of confusion										
actual	#	readou	correct	incorre	B>A	B2>A	A>B	B2>A	A>B2	B>B2
class A	300	289	267	22	21	1				
class B	200	210	198	12			11	1		
class B2	3	4	2	2					1	1
	503	503	467	36						

465 trees mapped (tagged) correctly
35 trees to be (field) corrected
2 unneccesary alarms
1 problem not found

„you will appreciate a platform which allows you to efficiently modify your sampling strategy to re-run your analysis more effectively according to the cost model of the confusion“

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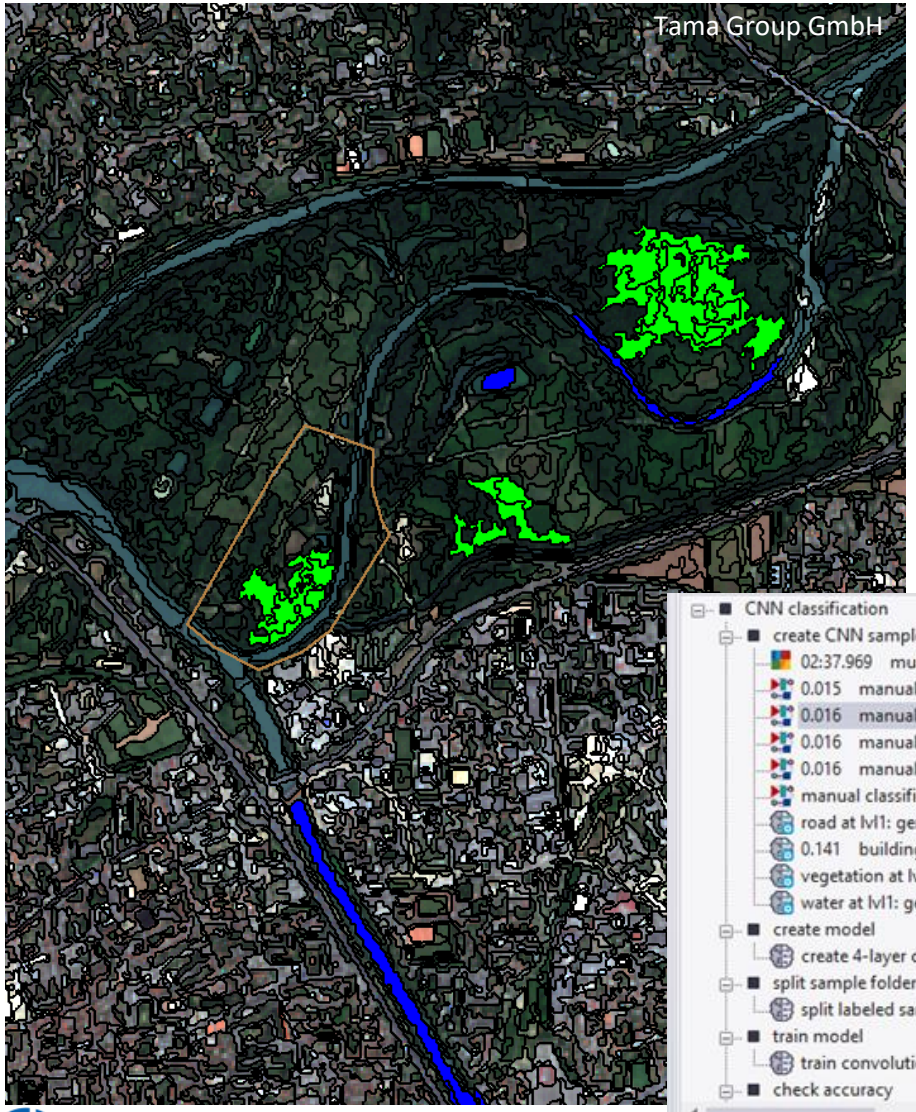
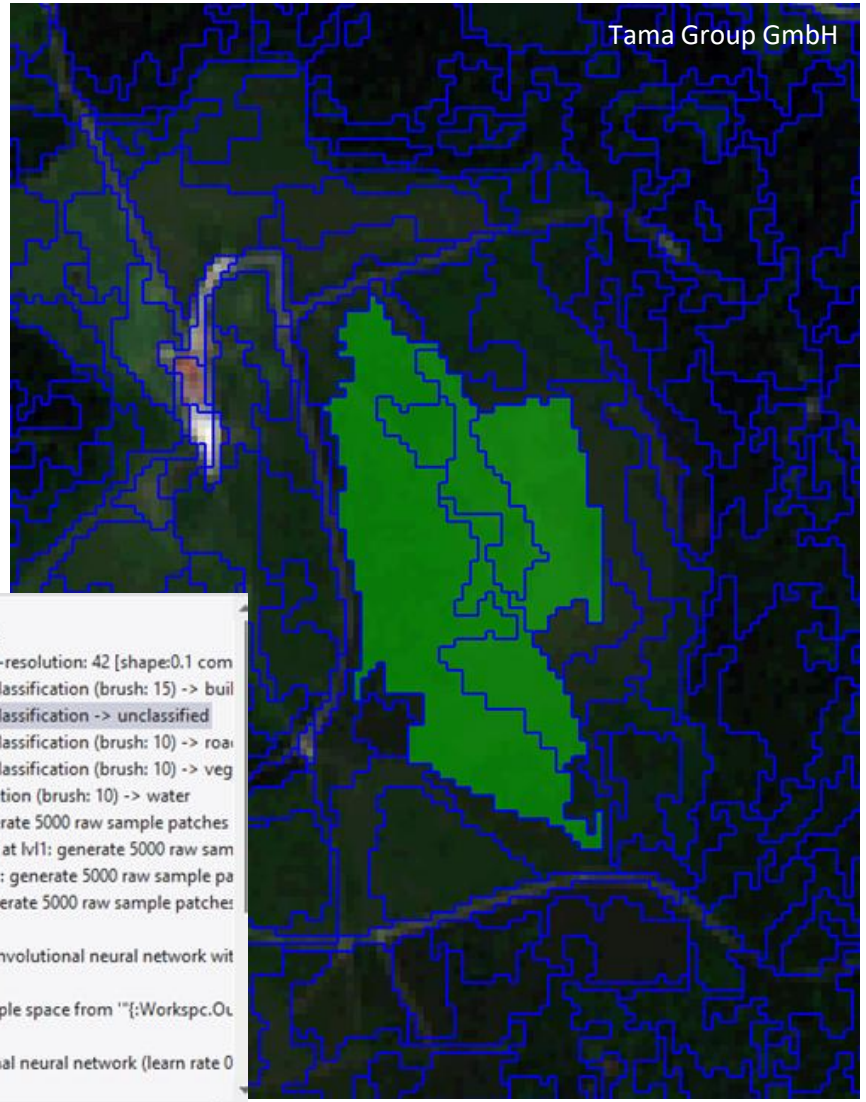
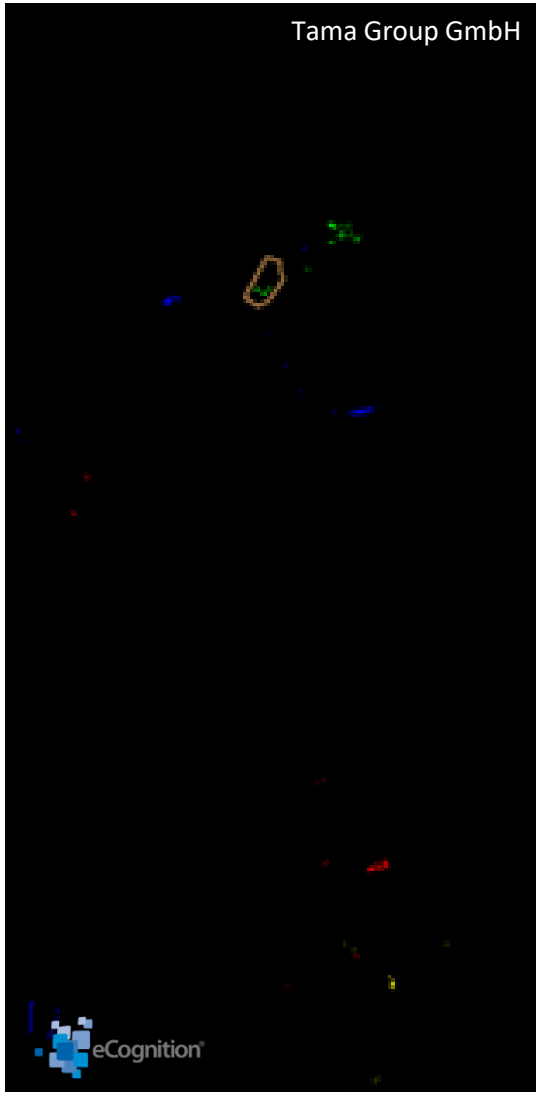
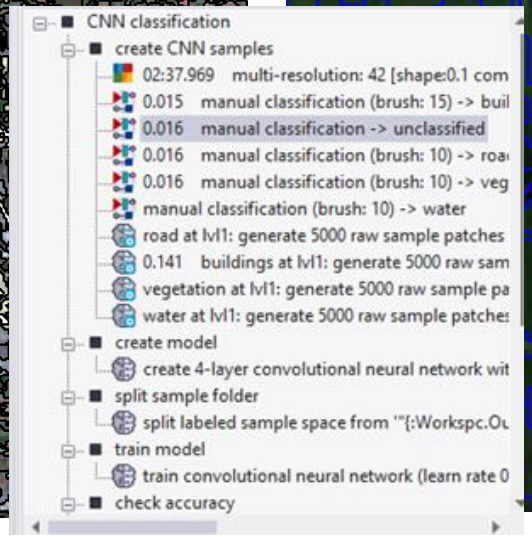
To make sampling a bit more fun than plain digitization









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Our recommendation: distinguish between “CNN fine” and “not fine” features, and fuse the results

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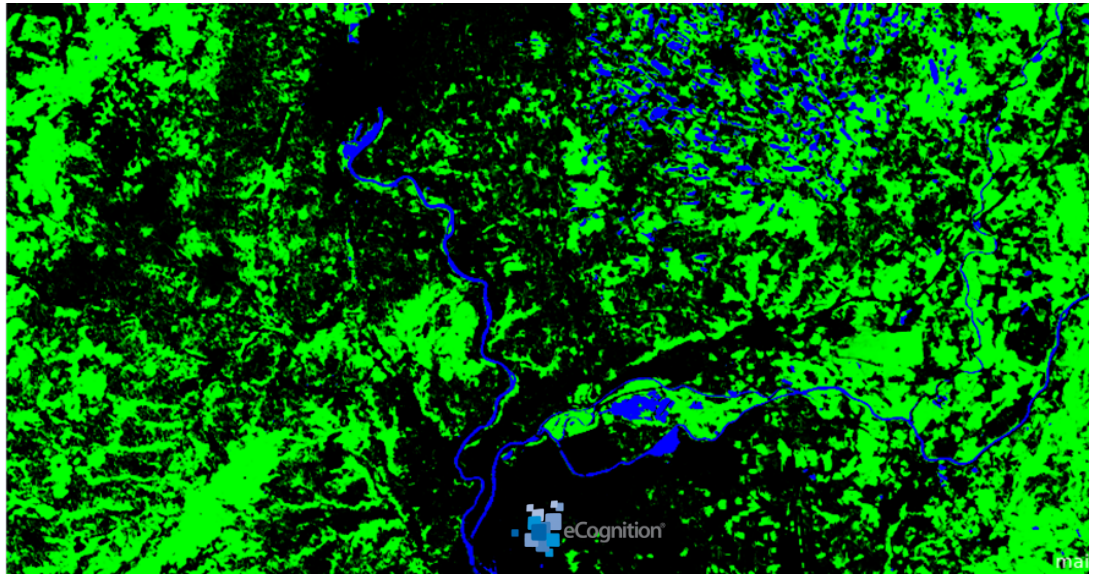
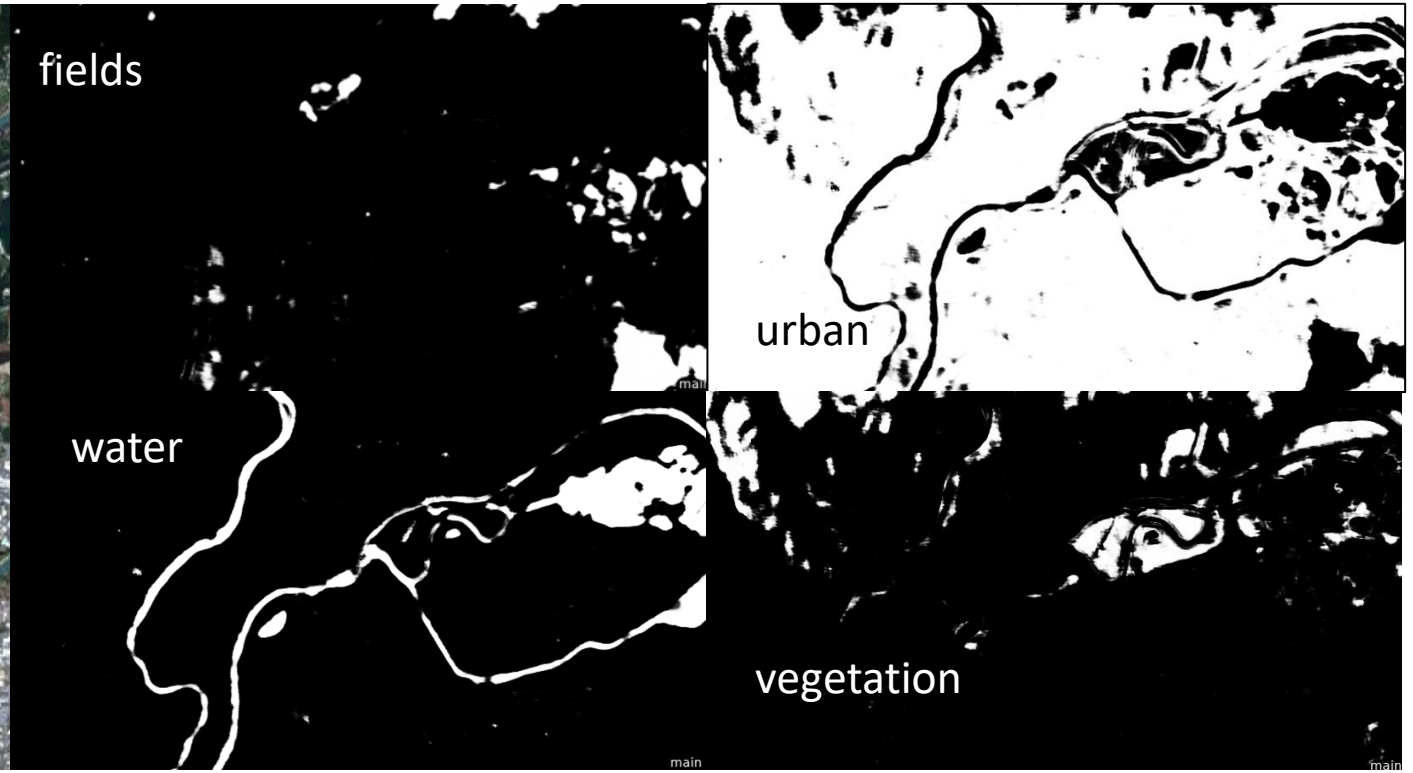


- Where CNN works fine: water bodies, general vegetation, objects that look (widely) the same such as cars and photovoltaik panels
- where CNN doesn‘t work so well: large objects which look always different, rare events where finding samples becomes a challenge, some long thin objects

For many tasks CNNs work rather well



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At first, we check how far we get with CNN analytics. For certain questions we keep on with object-based image analysis (OBIA) and fast pixel analytics. Once through all of the automation, let‘s see how much of the question at hand requires additional manual clean-up.

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What‘s next

Classic methods

Segmentation, edge and object detection

Spectal analysis

Change detection

Maschine learning & AI

Supervised Classification (RF, SVM,..)

Unsupervised Clustering (k-Means..)

Deep Learning (CNNs for objects –streets, buildings, cars, vegetation)

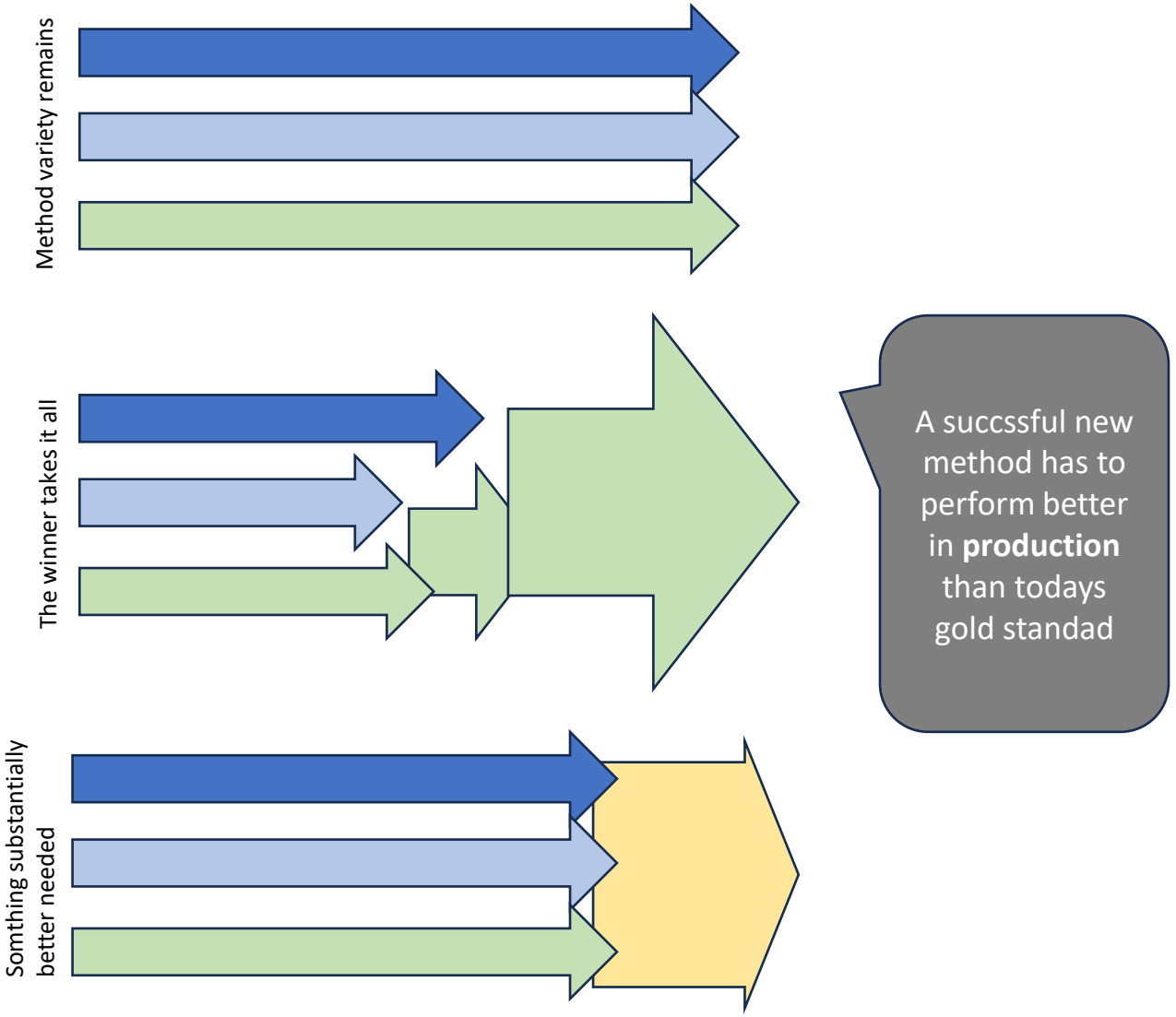
Transfer Learning with models like ResNet, U-Net, SegNet for Semantic Segmentation

Method fusion

Classic, ML & AI

Nobody knows.

Even classic methods can innovate.



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