Recognition with eCognition

Skid trail detection with multiresolution segmentation in eCognition Developer

Presentation from Susann Klatt
Research Colloqium
4th Semester M.Sc. Forest Information Technology

Outline of Presentation

SUBJECT of research:
Detection and extraction of forest structures in particular skid trails using remote sensing data

Collection of spatial information in forests

- Importance of skid trails and forest roads:
  - Logistical issues
  - Wood harvesting
  - Wood transport

Source: Susann Klatt, Elmia Wood

REMOTE SENSING (RS) =

- collection of spatial information from space
  → SATELLITE IMAGES
- INTERPRETATION of satellite images in forestry for:
  - Monitoring
  - Cost reduction (vs. usual inventories)
  - Forest management support
  - Checking the compliance of PEFC guidelines (every 20m)

QUESTION:
WHICH resolution of satellite images and HOW to analyze?

1. Introduction

2. Material

2.1. WorldView2

2.2. Study Area

3. Image Analysis

3.1. Segmentation

3.2. Classification

4. Results

5. Discussion

6. Conclusion

7. References

Resolution of images and type of classification

Scale (Spatial resolution)	
Low resolution	**High resolution**
 Landsat 30m/pixel	 WorldView 1.84m/pixel
Identification of big areas like forests	Recognition of tree crowns, skid trails and forest roads

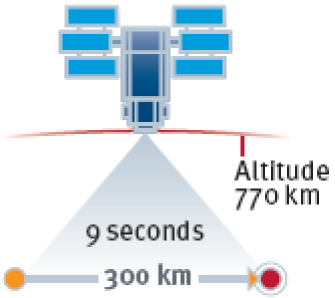
- TOOL to identify land cover features → CLASSIFICATION
- per pixel classification uses spectral characteristics (radiances)

PROBLEM: Forested areas difficult to classify (spectral similarity)

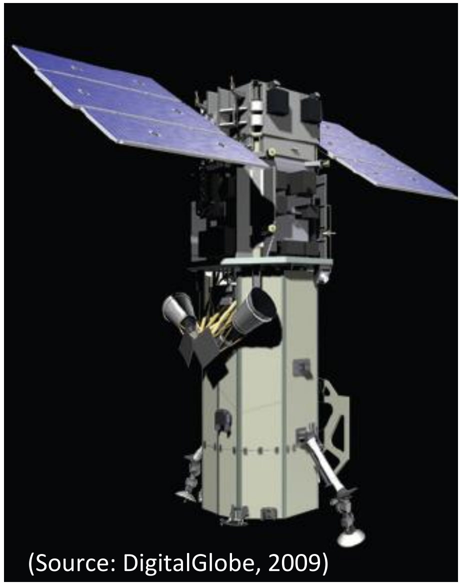
“Normal” classification = “salt & pepper” look → over classification

SOLUTION: object-oriented classification (OOC)

Satellite Image – WorldView2



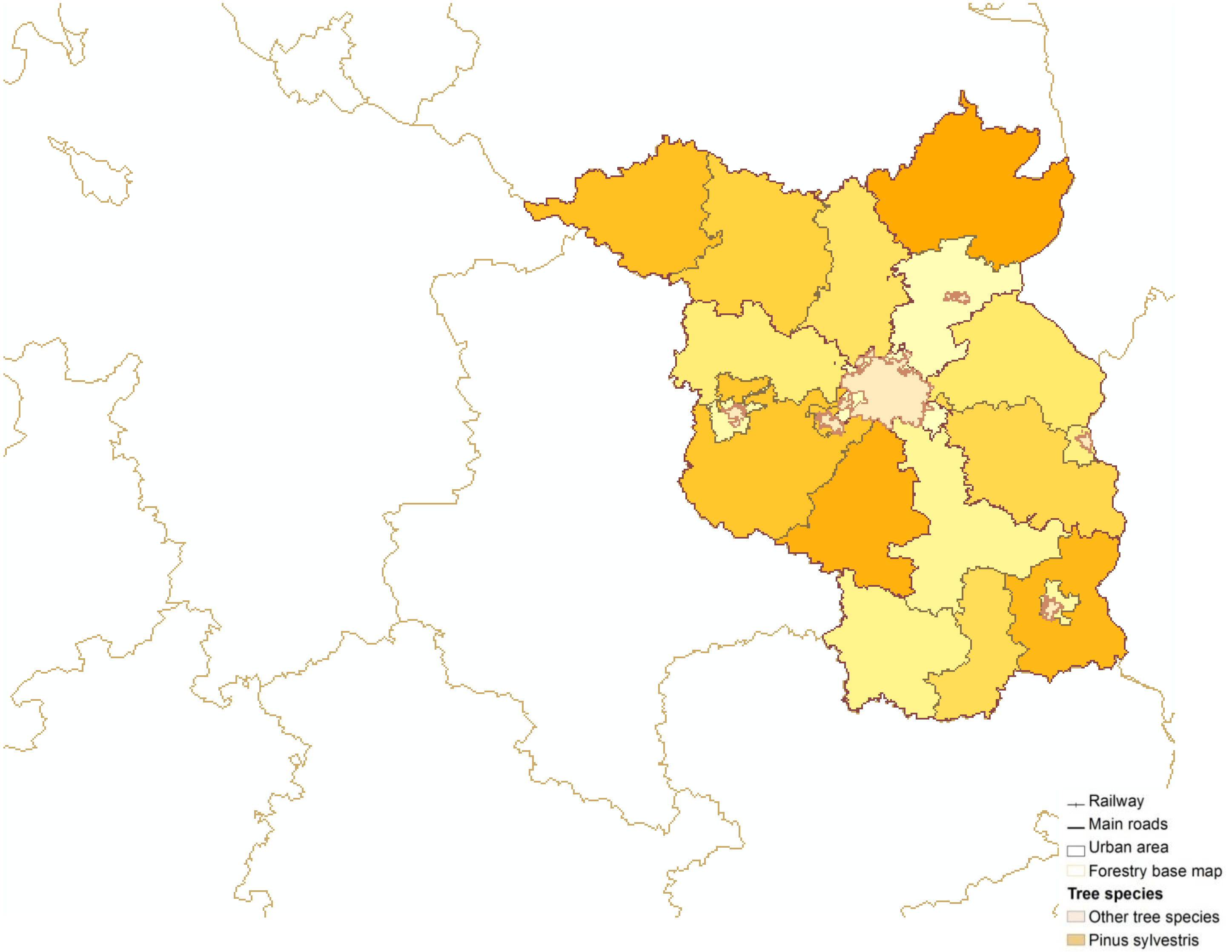
Resolution:	high
Orbit:	sun-synchronous orbit
Altitude:	770 kilometers altitude
Acquisition date:	24th of September 2010
Correction:	geometric, topographic, radiometric
Cloud cover:	0 %
4 standard colors:	red, blue, green, near-IR
4 new colors:	red edge, coastal, yellow & near-infrared 2



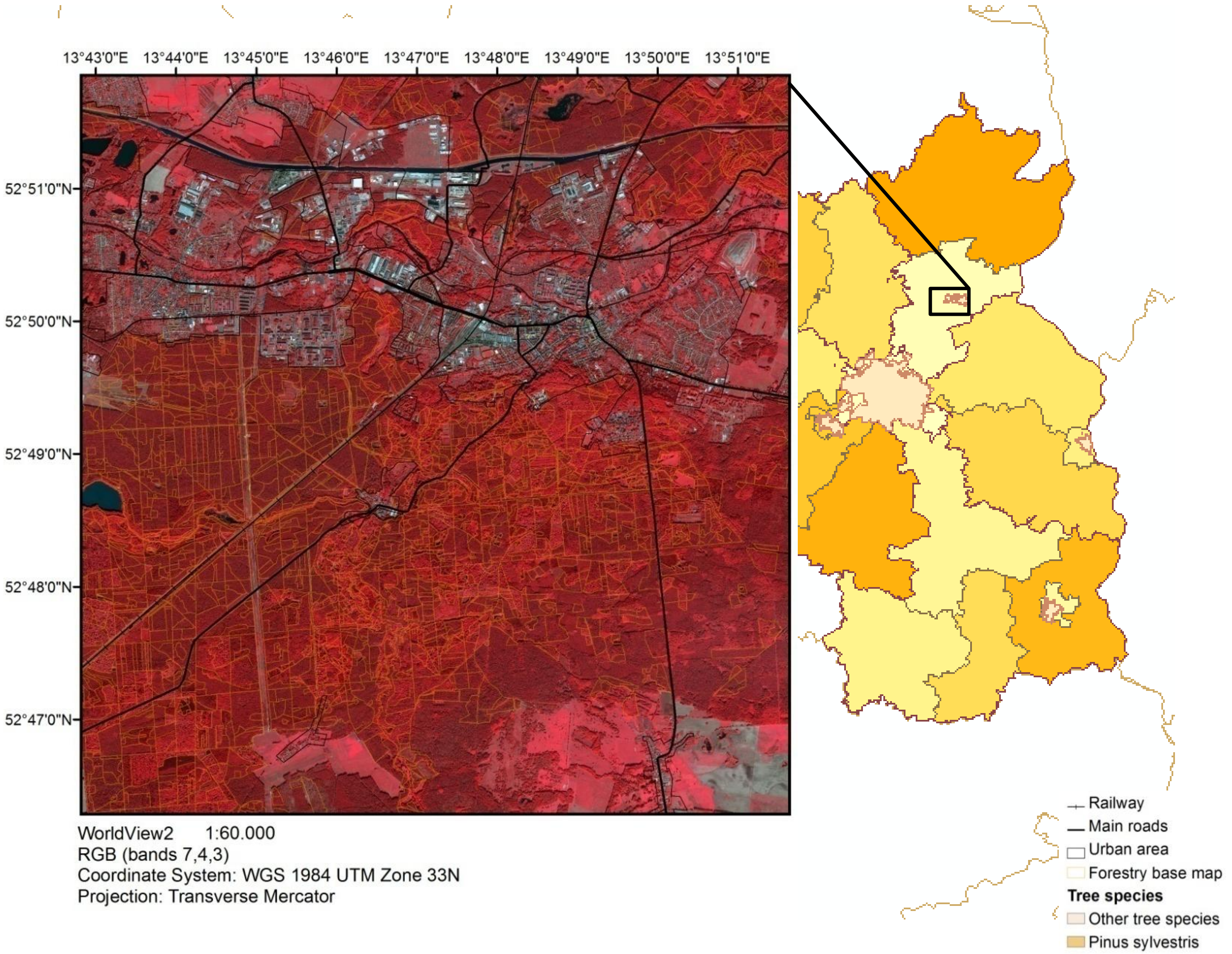
(Source: DigitalGlobe, 2009)

Data	Bands	Spatial resolution	Colors
Multispectral	1-8	1.84m	Coastal, blue, green, yellow, red, red edge, near-IR, near-IR2
Panchromatic	9	0.5m	grayscale

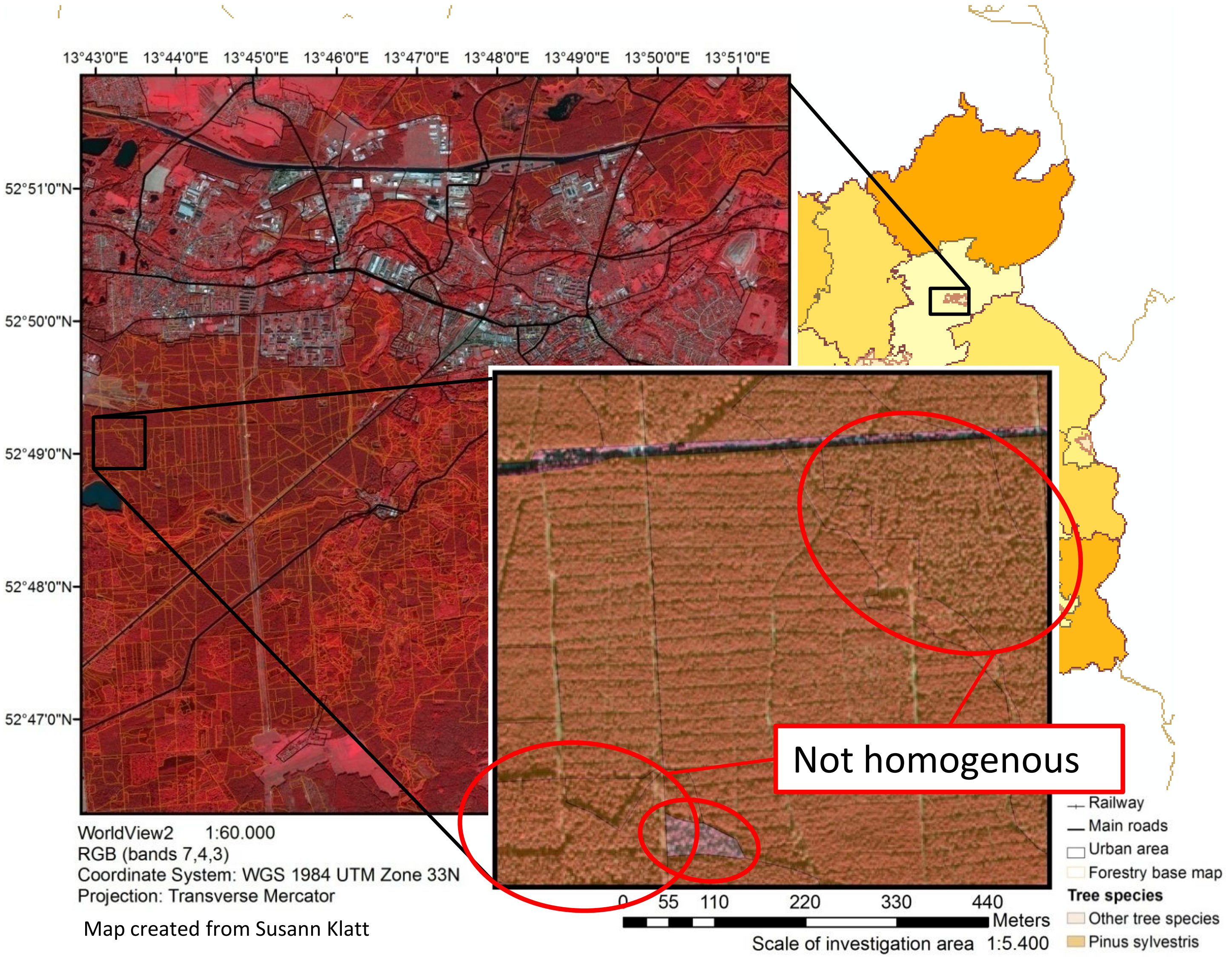
Study Area in Brandenburg



Study area in Eberswalde, Barnim, Brandenburg



Subset of study area in Barnim



WorldView2 1:60.000
RGB (bands 7,4,3)
Coordinate System: WGS 1984 UTM Zone 33N
Projection: Transverse Mercator

Map created from Susann Klatt

Software for Segmentation and OOC

Software for OOC	References
eCognition	Baatz & Schäpe, 2000; Eckert et al., 2005; Mathieu et al., 2007
Feature Analyst	Weih and Riggan, 2009
SAGA	Stock, 2005; Böhner et al., 2006; Bechtel et al., 2008
Erdas IMAGINE Objective	?

eCognition Developer 64 8.7

- Quick Map Mode: easy to use
- Rule Set Mode: to develop advanced rule sets

FOCUS: training/ understanding of software, algorithms & processes

Source: http://www.optron.com/system-files/ecognition-1305376726.jpg

Source: http://farmershowcase.com/wp-content/uploads/2011/08/trimble.jpg

Idea of object-oriented classification (OOC)

Per pixel classification ⟷ **Object-oriented classification**

Per pixel classification

- based on the spectral values of pixels

spectral pattern recognition

Object-oriented classification

- uses spectral & spatial patterns

spatial pattern recognition

OOC = 2-step process:

1. SEGMENTATION:
   image separation into objects/segments (groups of homogenous pixels)
2. CLASSIFICATION:
   identification of objects depending on their attributes/characteristics/ features

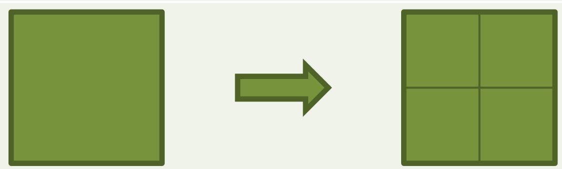
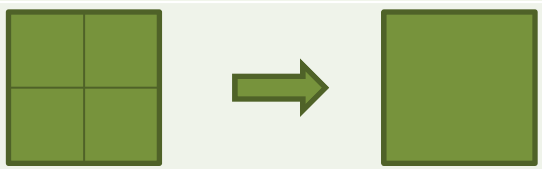
characteristics to classify objects	
intrinsic values	**relationships among objects**
spectral properties, texture, shape etc.	connectivity, position to other objects

Segmentation approach

- Segmentation = object creation/ change based on neighboring pixels and their spectral and spatial properties (texture, context)

Operations: subdividing/ splitting, merging/ reshaping

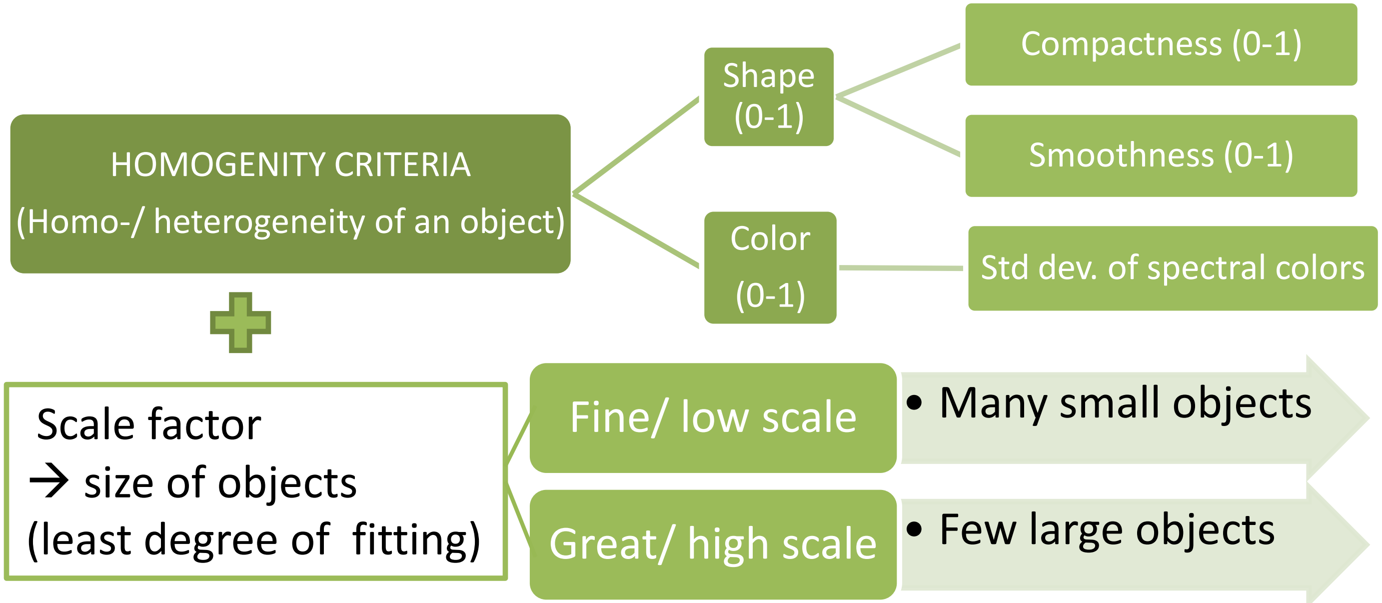
Basic **segmentation principles**:

top-down strategy	bottom-up strategy
cutting something big into smaller pieces	small pieces are merged to get greater ones
	

Multiresolution segmentation = bottom-up optimization process
→ decreasing average heterogeneity & increasing homogeneity
→ If homogeneity criterion is fullfilled, pixels/ objects are merged with neighboring ones

WHAT is the homgenity criterion and HOW to get it?

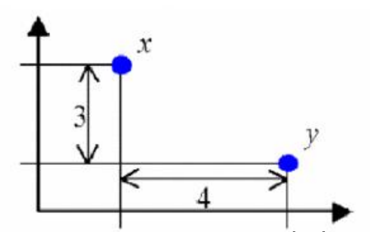
Segmentation parameters and priciples of pixel merging (1)



- 2 image objects = similar if near to each other
- for d-nr. of characteristics degree of fitting h is

$$h = \sqrt{\sum_{d} (f_{1d} - f_{2d})^2}$$

Source: Batz, Schaepe 2000



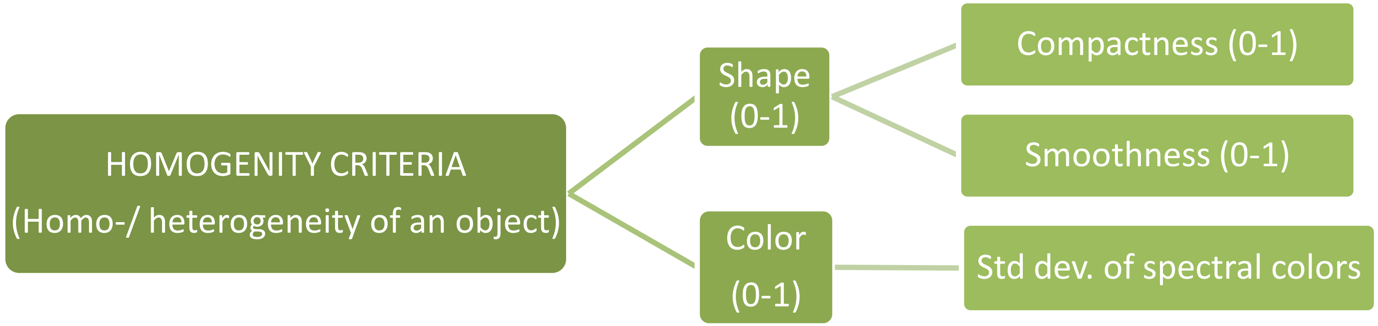
Source: Schultz

- image object merged to that image object that has a minimum increase of heterogeneity
- degree of fitting: calculation change of heterogeneity change (h_{dif}) of 2 image objects

$$h_{diff} = h_m - \frac{h_1 + h_2}{2}$$

Source: Batz, Schaepe 2000

Segmentation parameters and priciples of pixel merging (2)



- deviation from ideal compact form : relation of edge length l & root of object size n in pixels

$$h = \frac{l}{\sqrt{n}}$$

Source: Batz, Schaepe 2000

Different combination scale & homogeneity

→ hierarchical network of image objects from higher order (larger) & lower order (smaller)

Level	Image object domain	Scale	Color	Shape	Compactness	Smoothness	Image layer weights
1	Pixel level	11	0,8	0,2	0,2	0,8	0,1,0,0,0,1,1,1,3
2	Image object level (1)	18	0,8	0,2	0,2	0,8	0,1,0,0,0,1,1,1,1
3	Image object level (2)	26	0,7	0,3	0,1	0,9	0,1,0,0,0,1,1,1,0
4	Image object level (3)	60	0,7	0,3	0,1	0,9	0,1,0,0,0,1,1,1,0

Basic principles of classification algorithms to label objects

Nearest Neighbor (NN) Classification:
assigns classes to image objects based on minimum distance measurement

1. System training:
selecting representative image objects samples to assign membership values

2. Classification: „labeling“ of image objects on their nearest sample neighbors

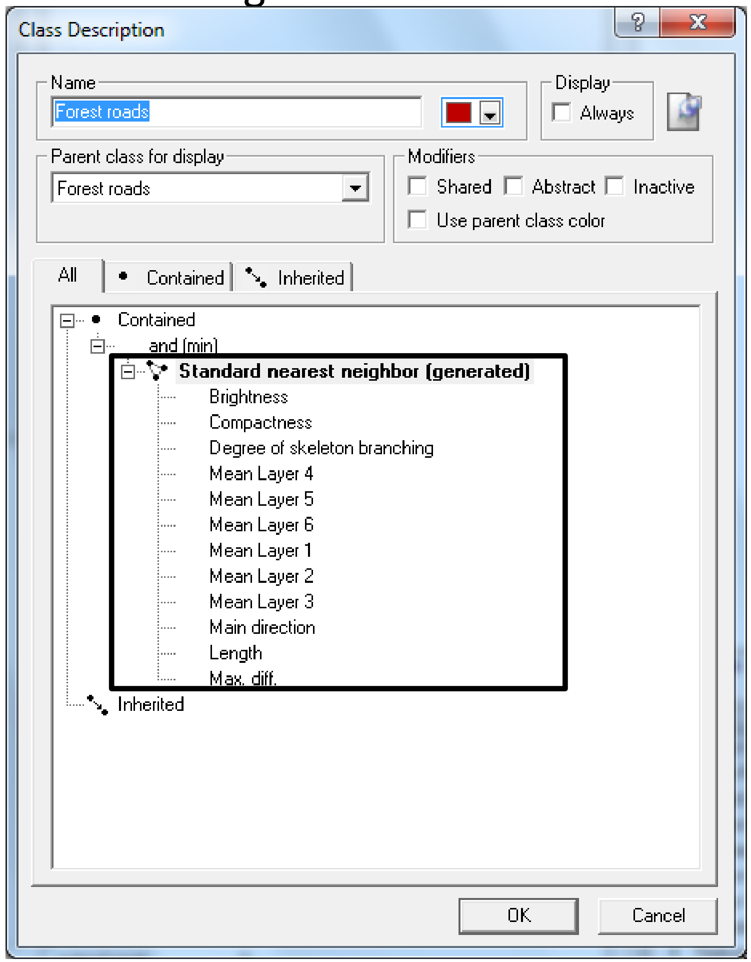
nearest neighbor classifier: calculates membership value betw. 0-1
→ based on image object's feature space (characteristics) distance to its nearest neighbor
NNC = 1 → image object identical to sample
NNC < 1 → image object differs from sample

- feature space distance has a fuzzy dependency on the feature space distance to the nearest sample of a class

→ objects characteristics described by means of fuzzy logic

Basic principles of classification algorithms to label objects

- Feature space of „forest roads“ class to calculate membership value in eCognition



Classification in eCognition Developer

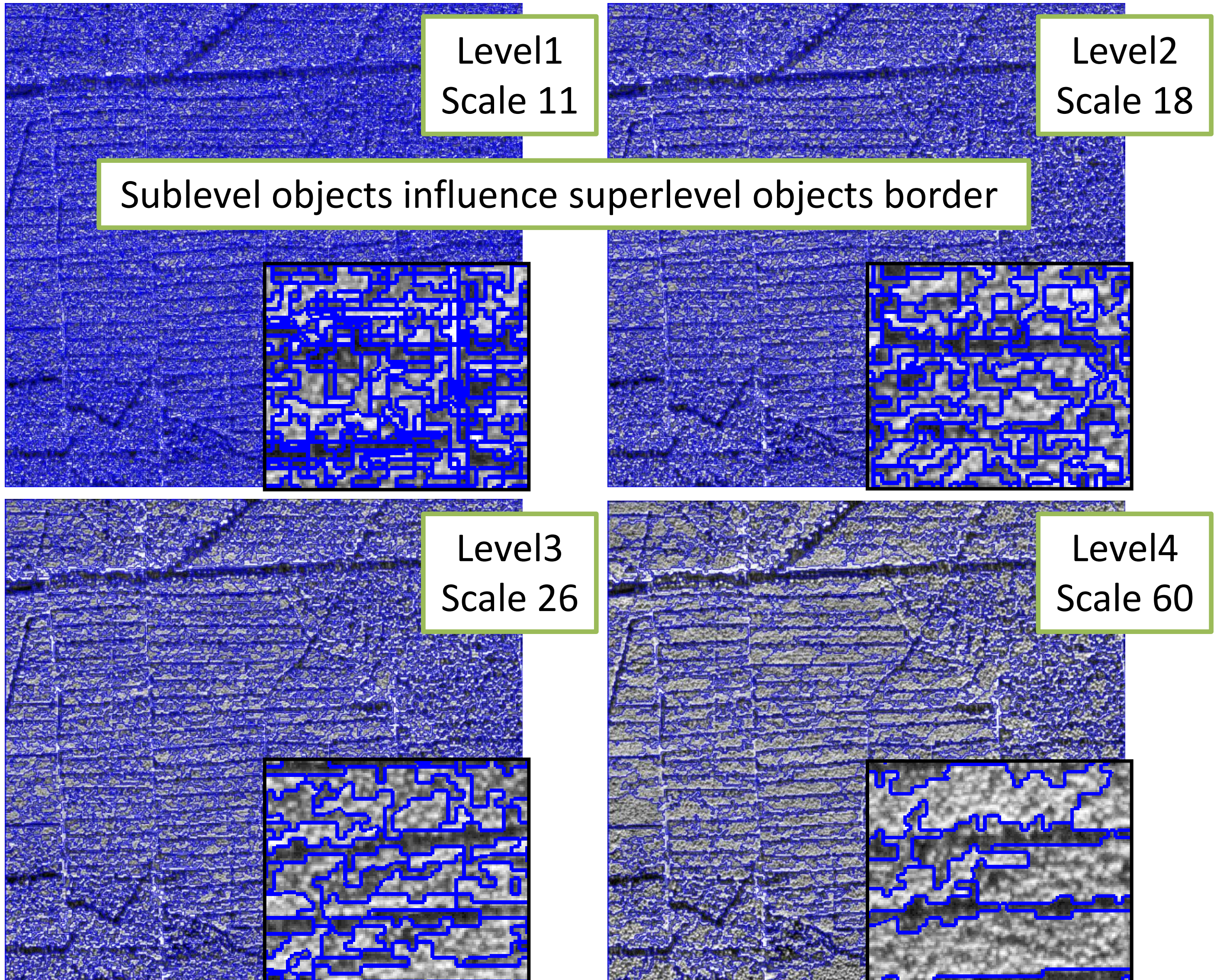
Level	Mode	Features	Classes
1	Quick Map / Rule Set	standard nearest neighbor + additional features	Forest, ways
2	Quick Map	standard nearest neighbor	Forest, light ways (bright white shining ways)
4	Quick Map	standard nearest neighbor	Forest, ways

Rule Set Mode:

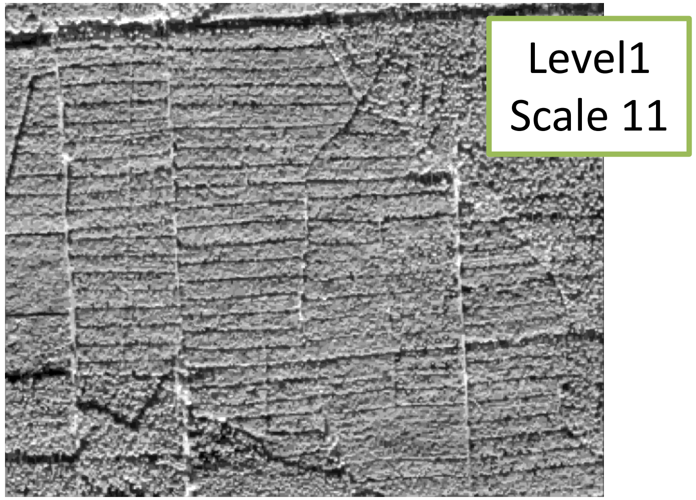
user is able to choose/ modify the features for the feature space

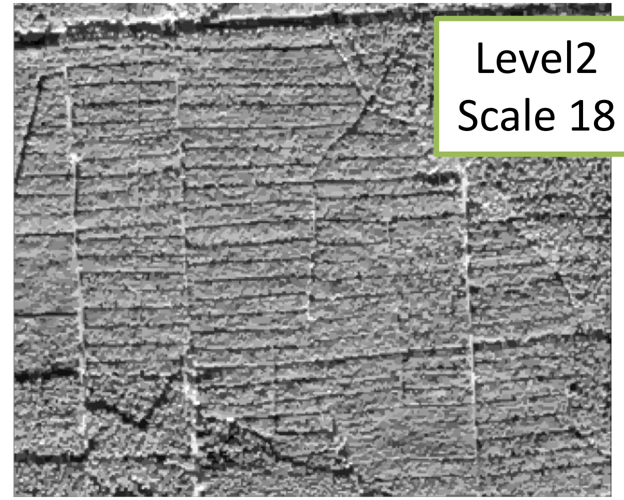
→ appears as class description & used for classification

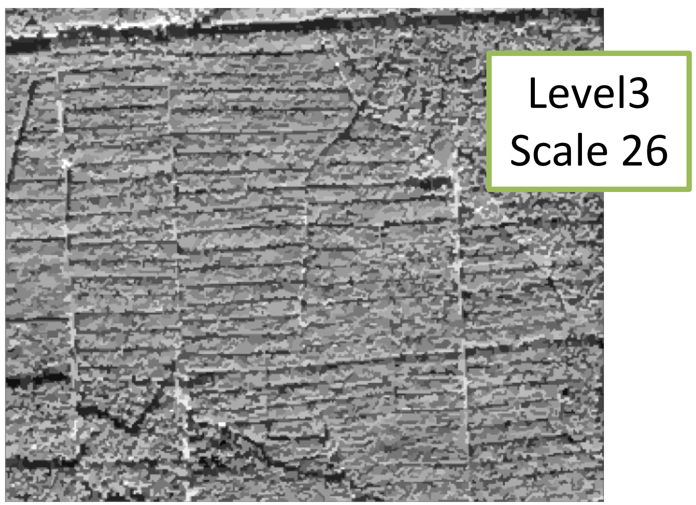
Image object levels as result of multiresolution segmentation

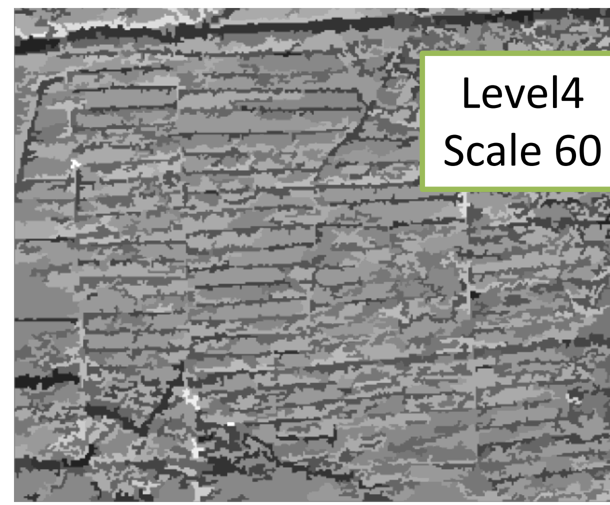


Object mean view of image object levels

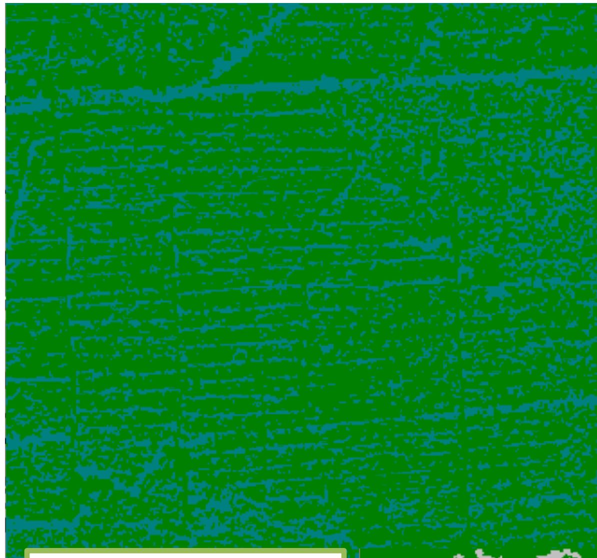




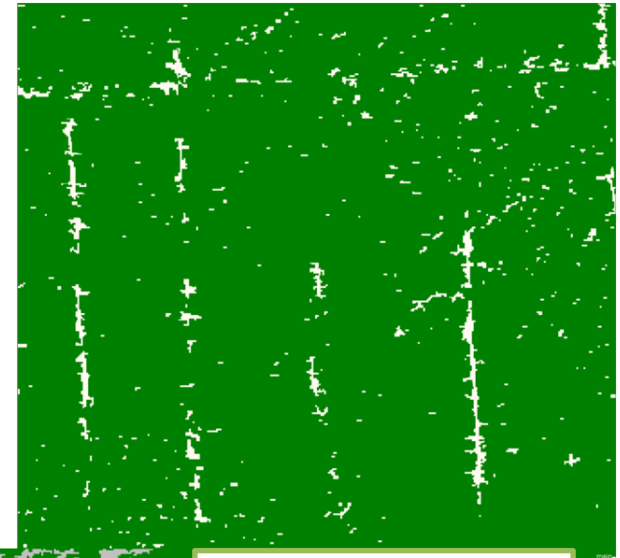




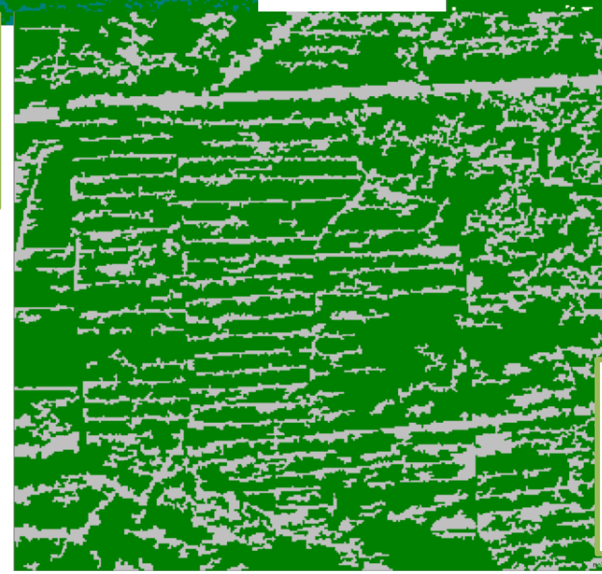
Results of Nearest Neighbor Classification in Quick Map M.



Level1
Ways: blue
Forests: green

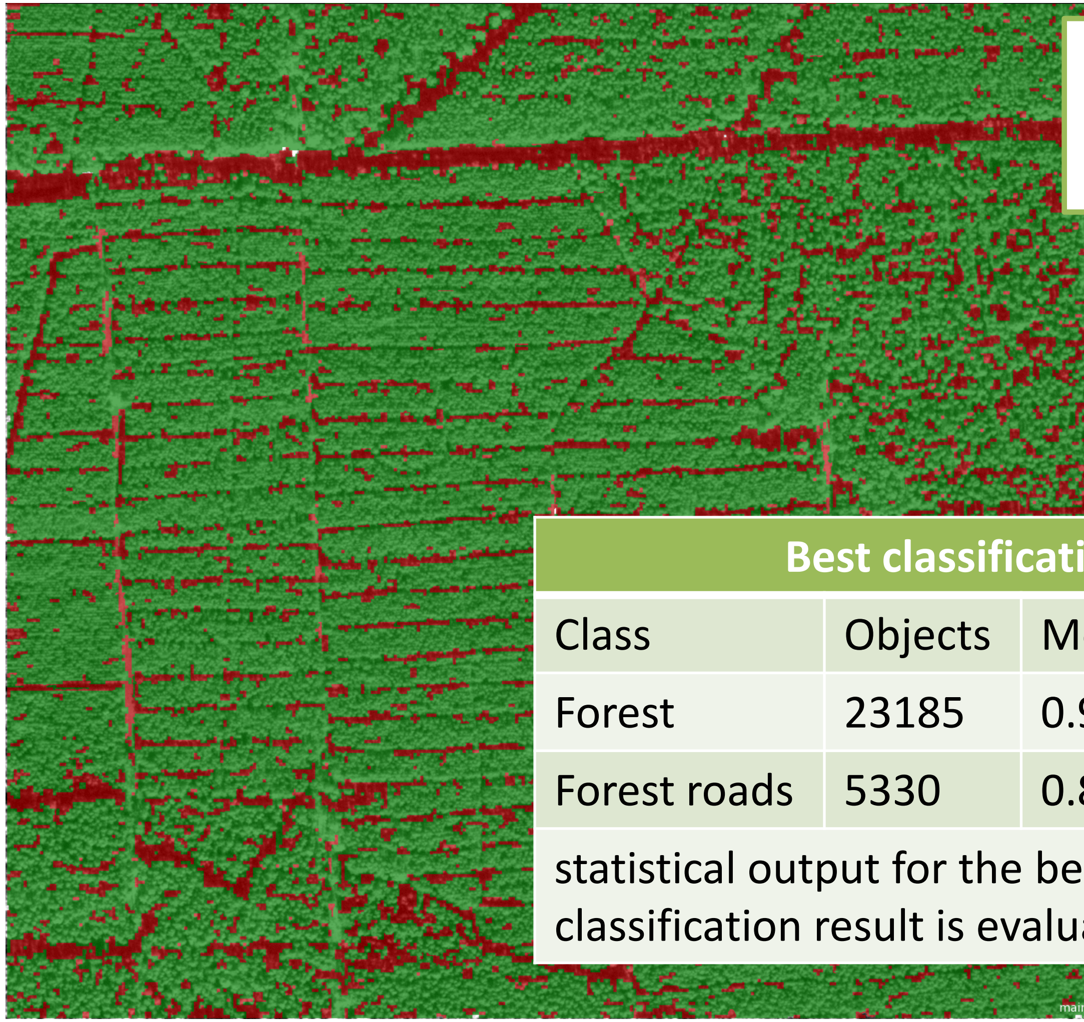


Level2
Light ways: white
Forests:green



Level4
Ways: gray
Forests:green

Results of Nearest Neighbor Classification in Rule Set M.



Level1
Ways: red
Forests: green

Best classification			
Class	Objects	Mean	StDev
Forest	23185	0.9095	0.0801
Forest roads	5330	0.8778	0.1102
statistical output for the best classification result is evaluated per class			

Classification of level 1 in Rule Set Mode

Improvement of segmentation and classification

- increasing visual interpretability of images

→ By increasing distinctions between features

→ image enhancement: contrast manipulation, level slicing, contrast stretching or similar operations

- classification improvement: own membership functions based on user-defined functions of object features
(contrast: Nearest Neighbor classification uses set of samples of different classes to assign membership values)

- use of skeletons & edge detection algorithms

- creation of advanced classification algorithms to classify objects by finding minimum/ maximum values of functions, or connections within objects

Evaluation of segmentation and classification

- In how many percent of the investigation area are skid trails detected?
- Areas with no detected skid trails may have no skid trails at all?

Accuracy assessment:

- error matrices for evaluation of classification result quality

→ error matrix based on a Test and Training Area (TTA) Mask

→ test areas used as reference to check classification by comparing classification with reference values from ground truth

- detection of skid trails using segmentation and OOC should be tested in mixed stands
- or exclusion of mixed stands in application on greater areas

Conclusion

SOFTWARE:

- training in software → **time intensive**
- potential of software has not yet been fully exploited
- **Quick Map Mode**: for quick segmentation/ classification BUT limited in functionality (black box)
- **Rule Set Mode**: for more complex operations

SEGMENTATION:

- choice of scale, homogeneity parameter & weighting of bands most important in segmentation → iterative process

GENERAL:

- it is possible to extract skid trails with multiresolution segmentation from high resolution satellite images
- further research is needed!

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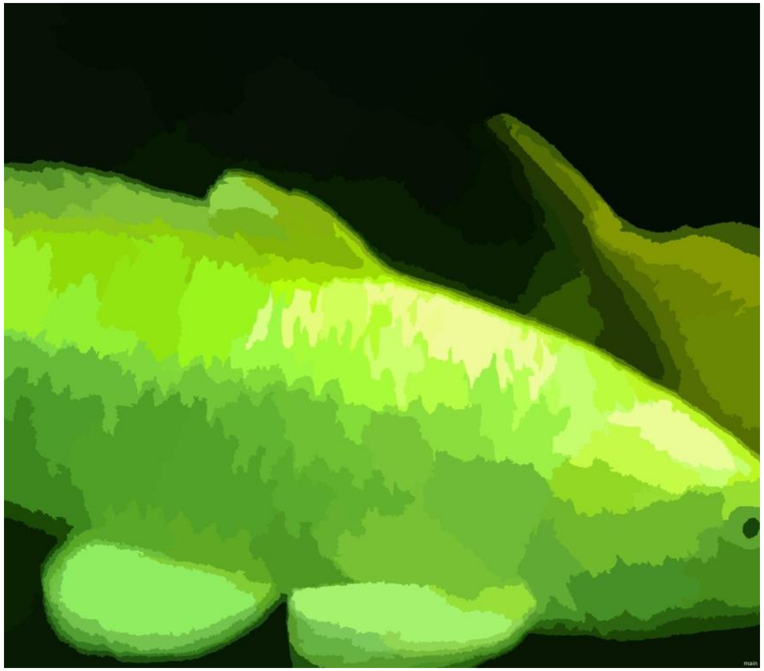

Thank you for your attention!

Do you have questions or hints?