XLII International School of Hydraulics
20 - 23 May 2025 • Radocza • Poland

VegMix

OBIA Classification of Riverine Vegetation in a Small Open Channel Using RGB Drone Imagery

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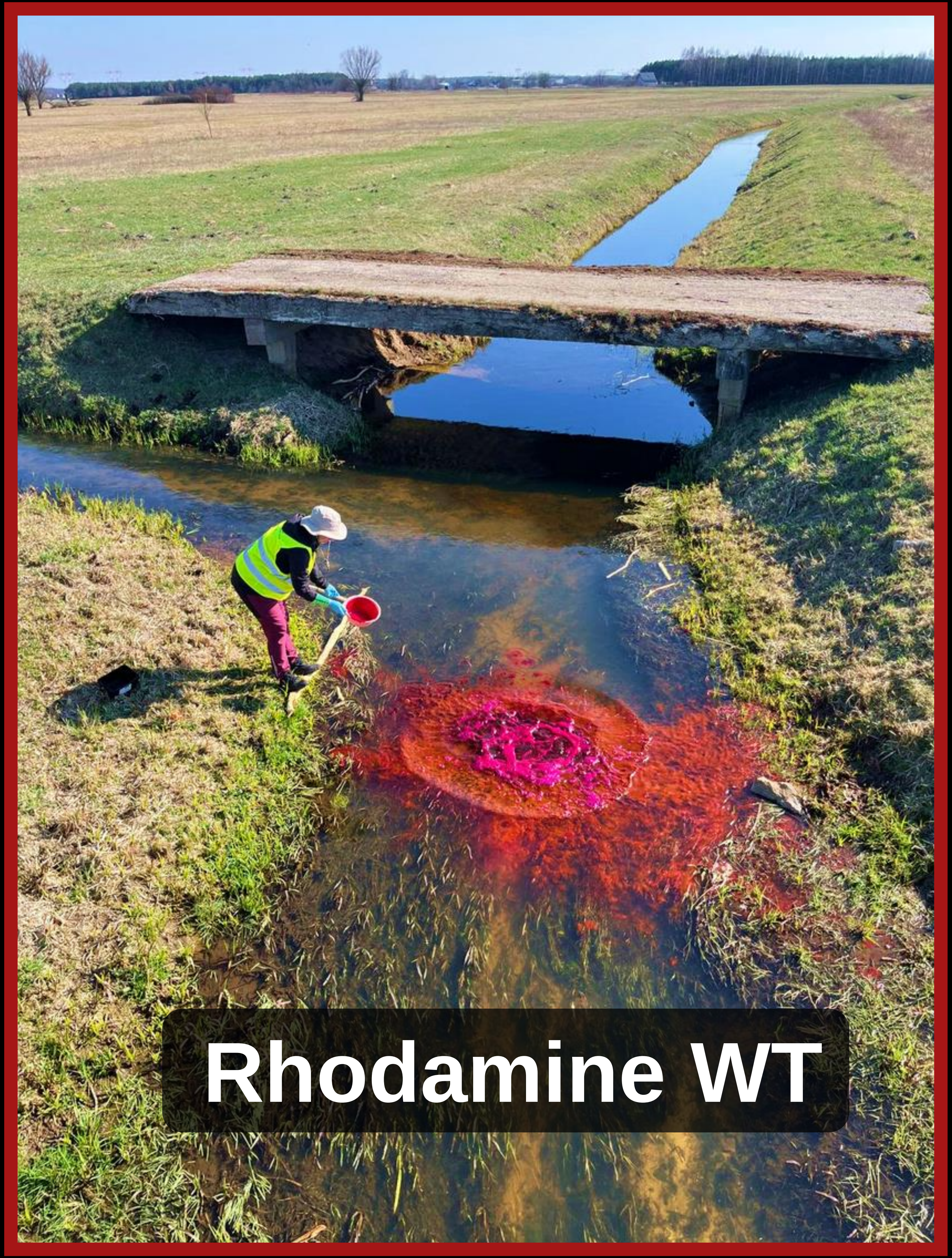
Tracer experiments

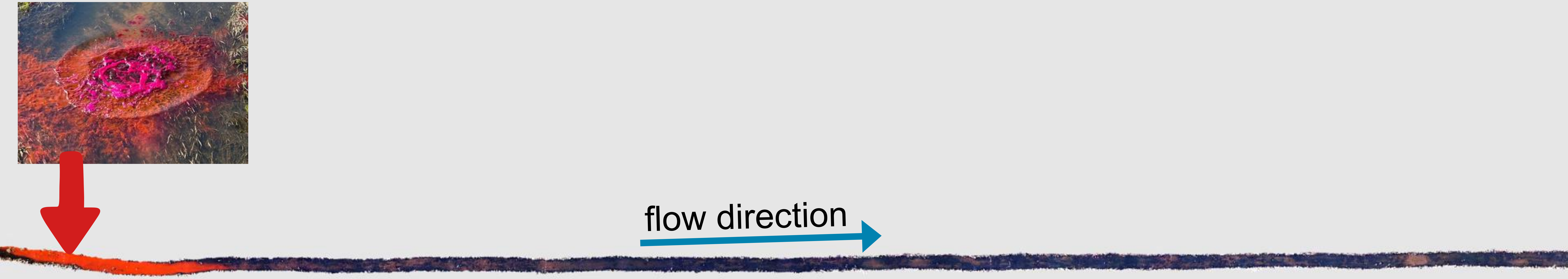


Author: Kmusser
Source: https://en.wikipedia.org/wiki/Vistula#/media/File:Vistula_river_map.png


Warsaw
Vistula


flow direction

Introduction



7th March 2025

DJI Phantom 4

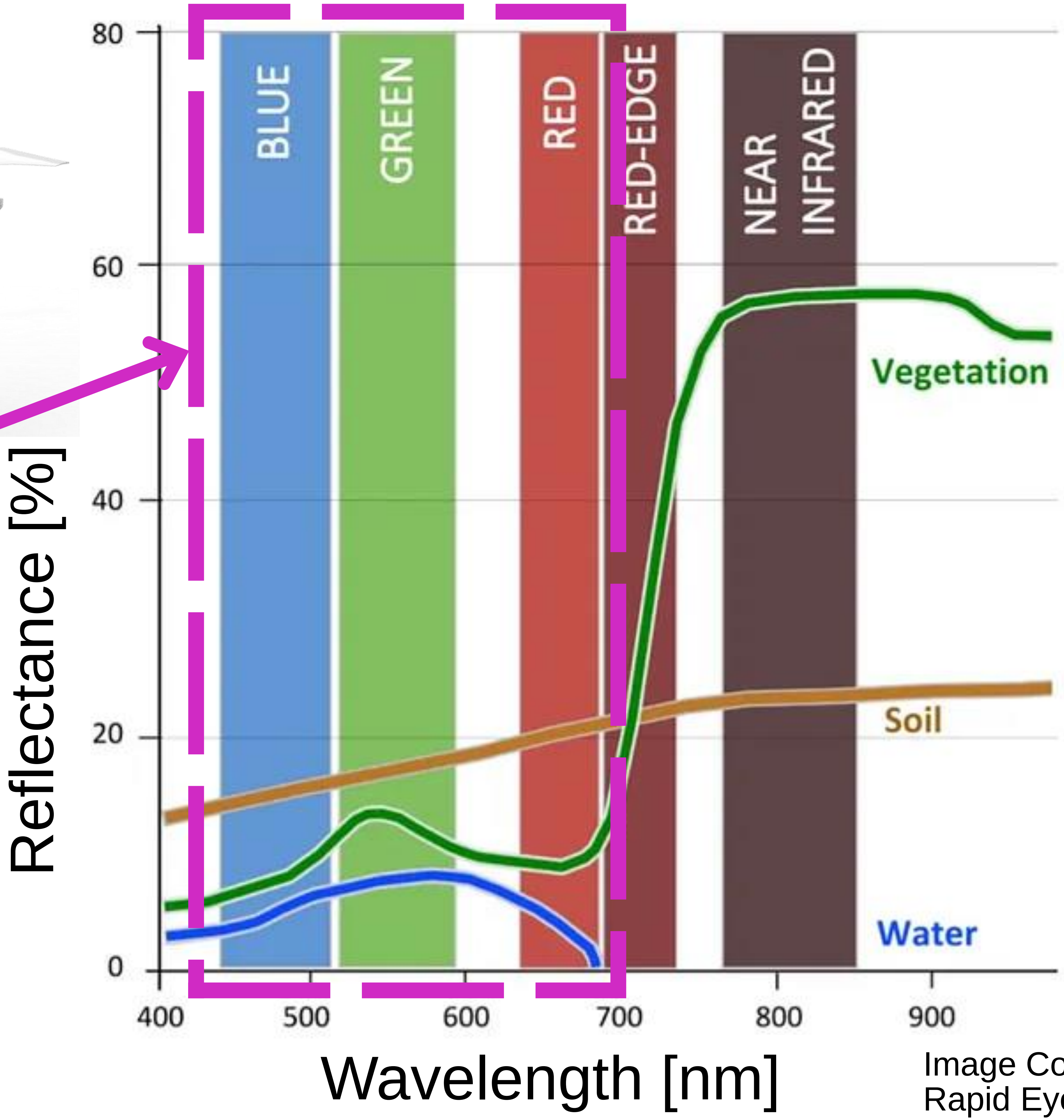
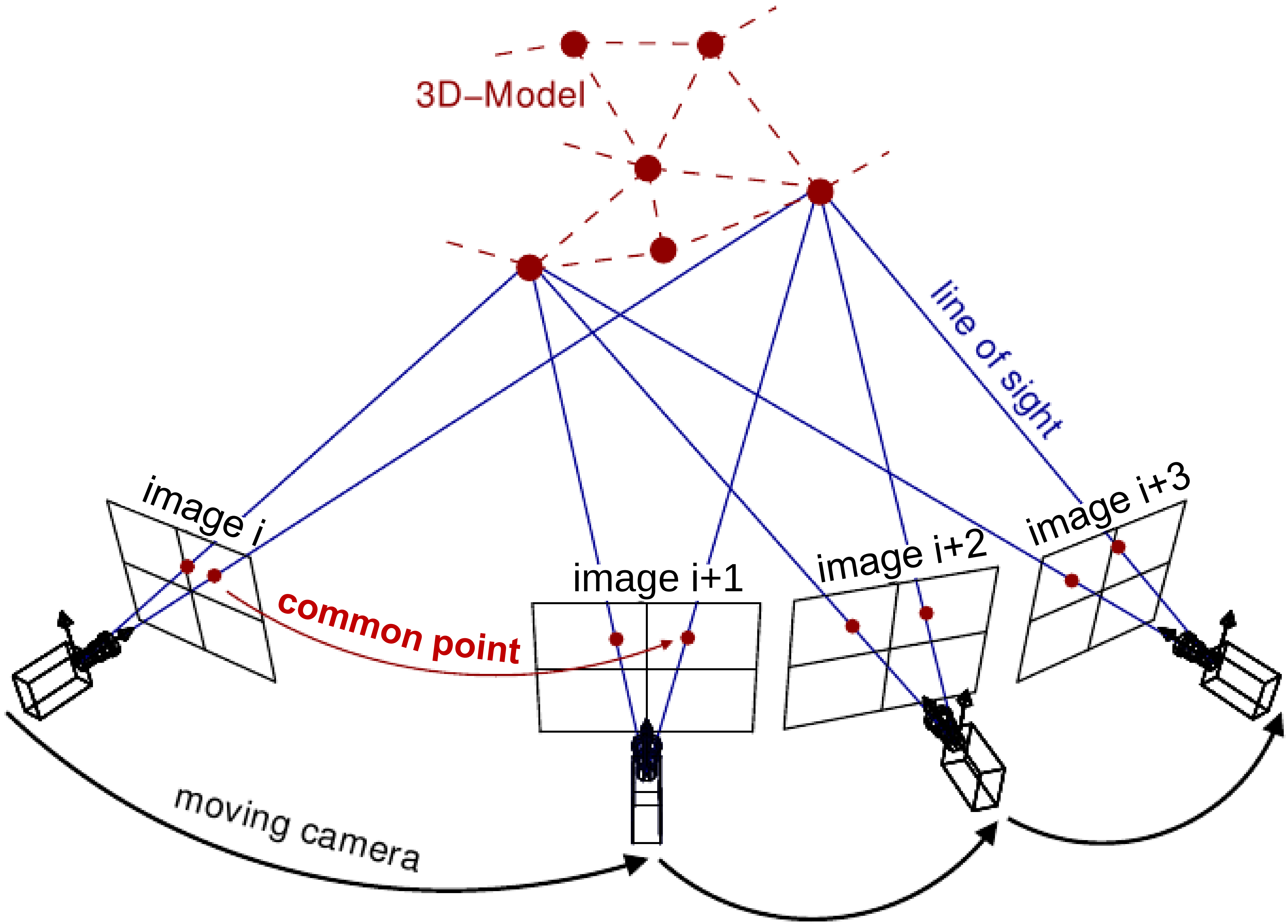


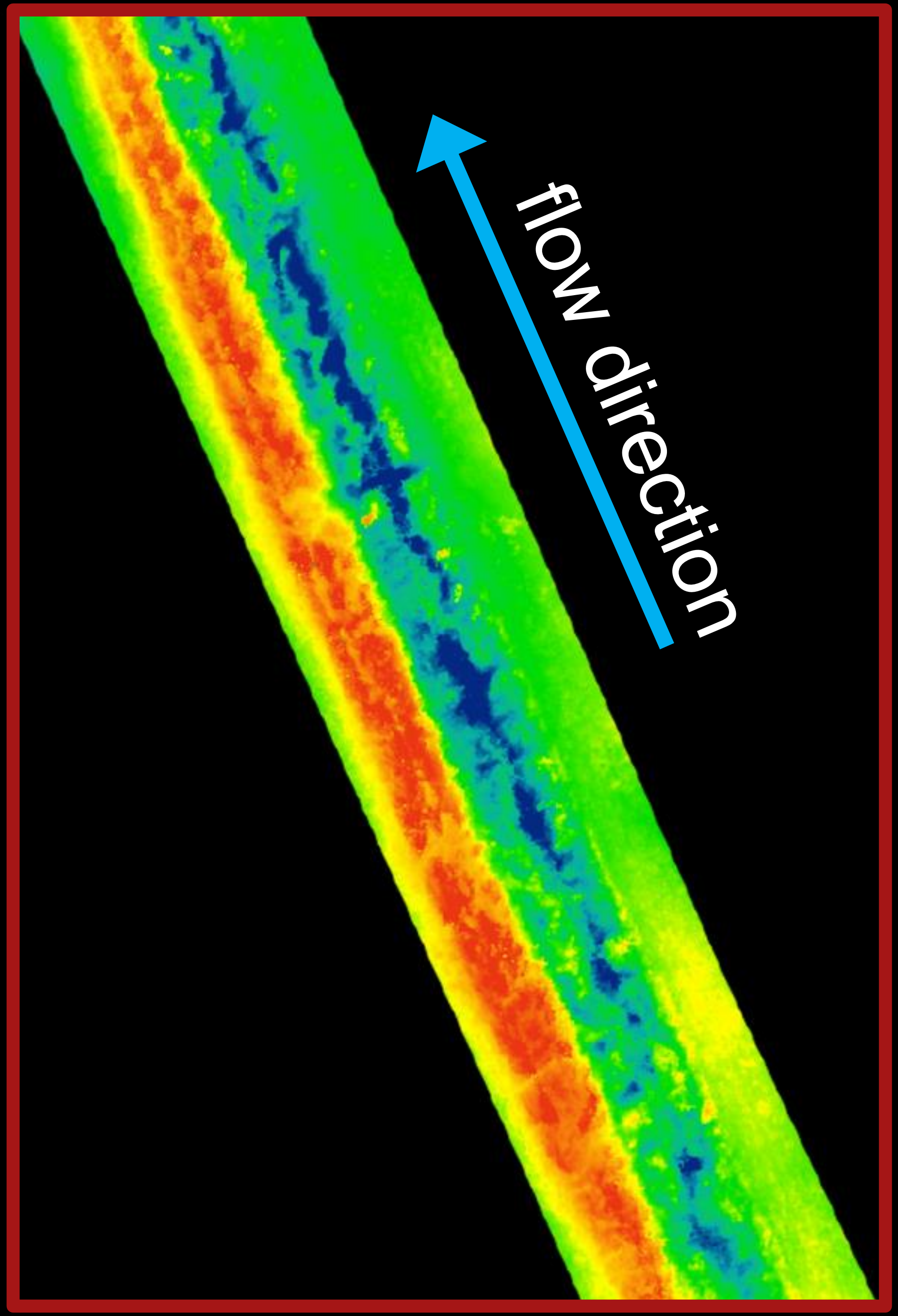
Image Courtesy:
Rapid Eye Whitepaper

Structure from Motion

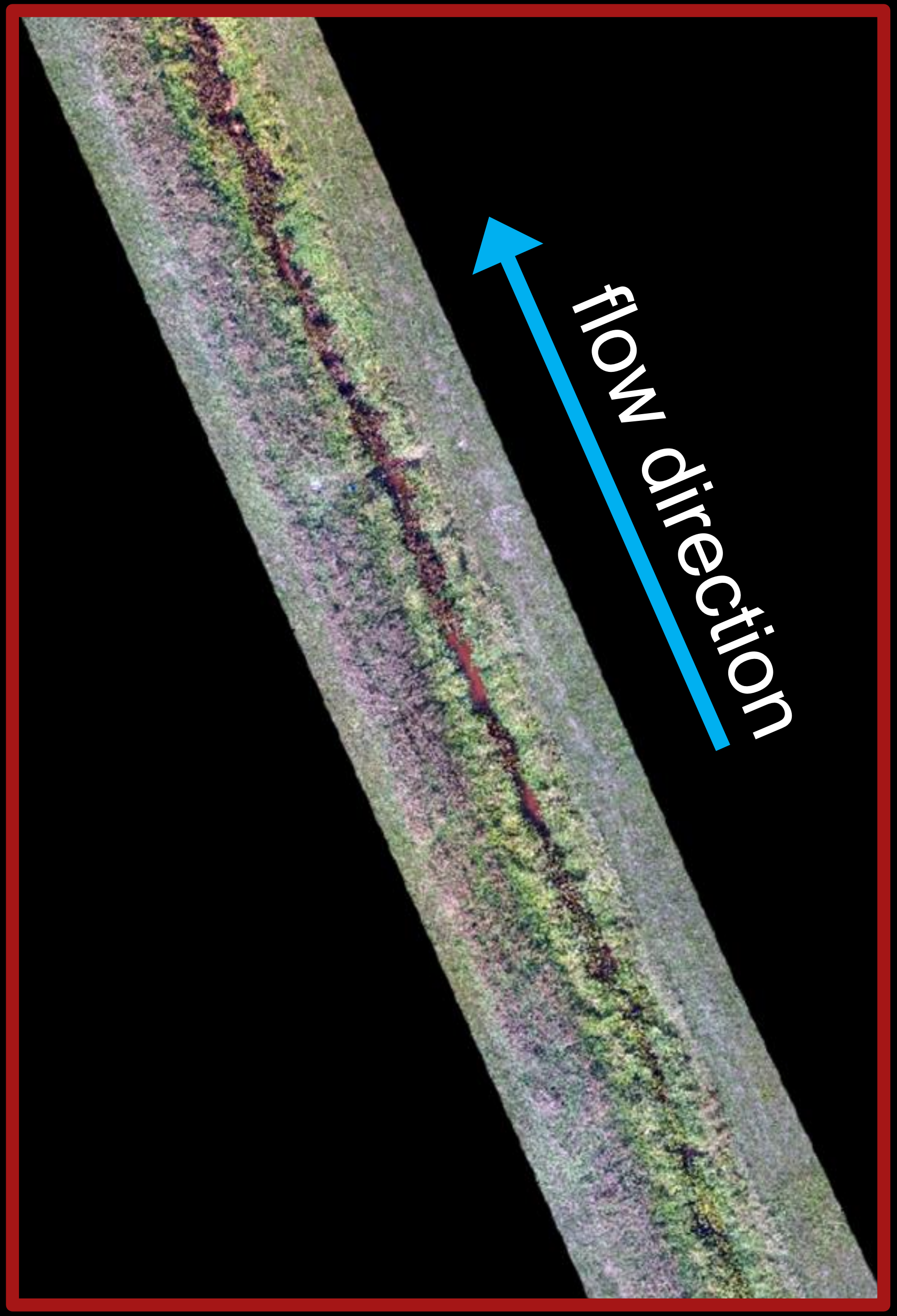


Source: Theia-sfm.org (2016)

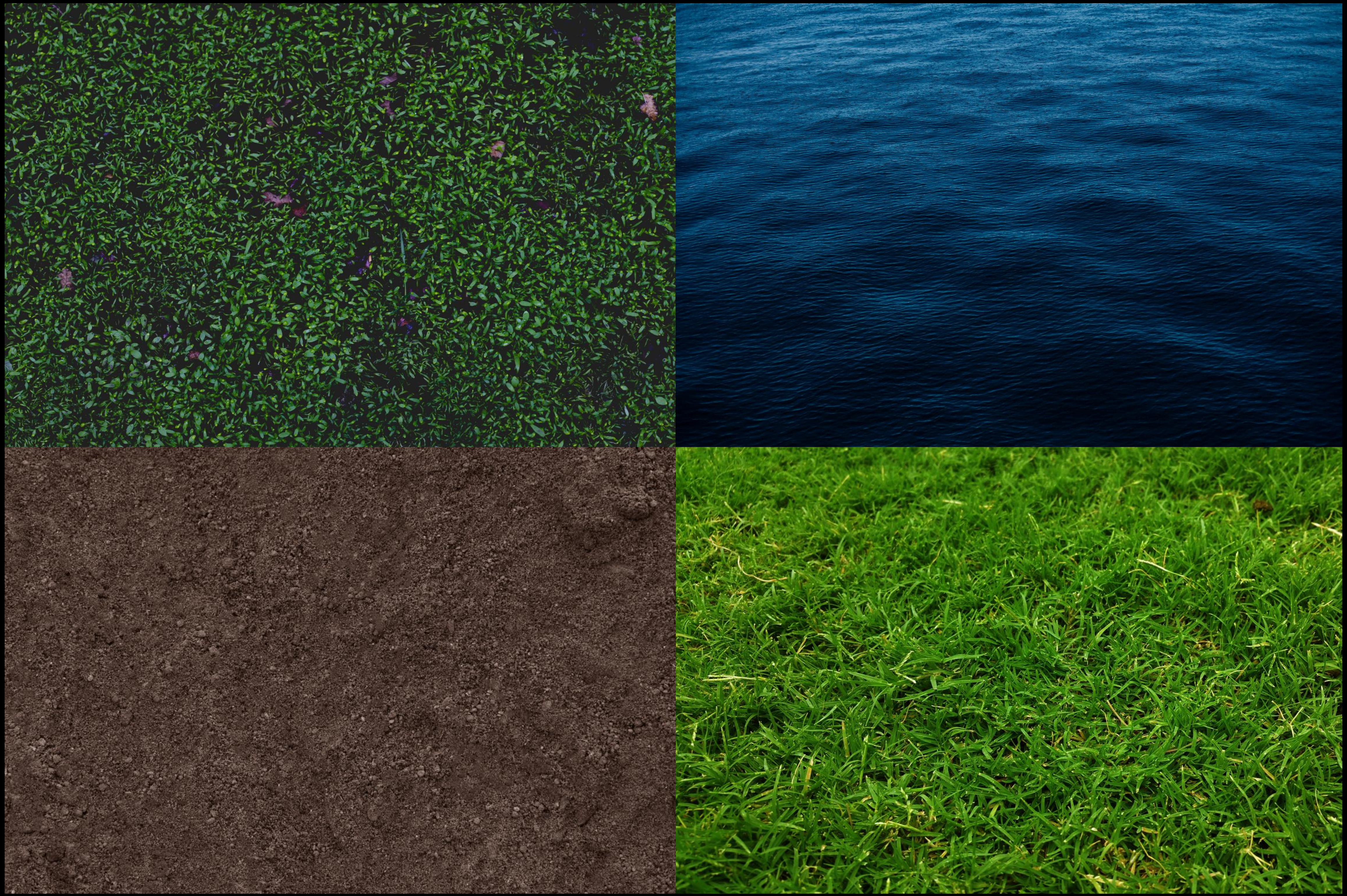
DEM

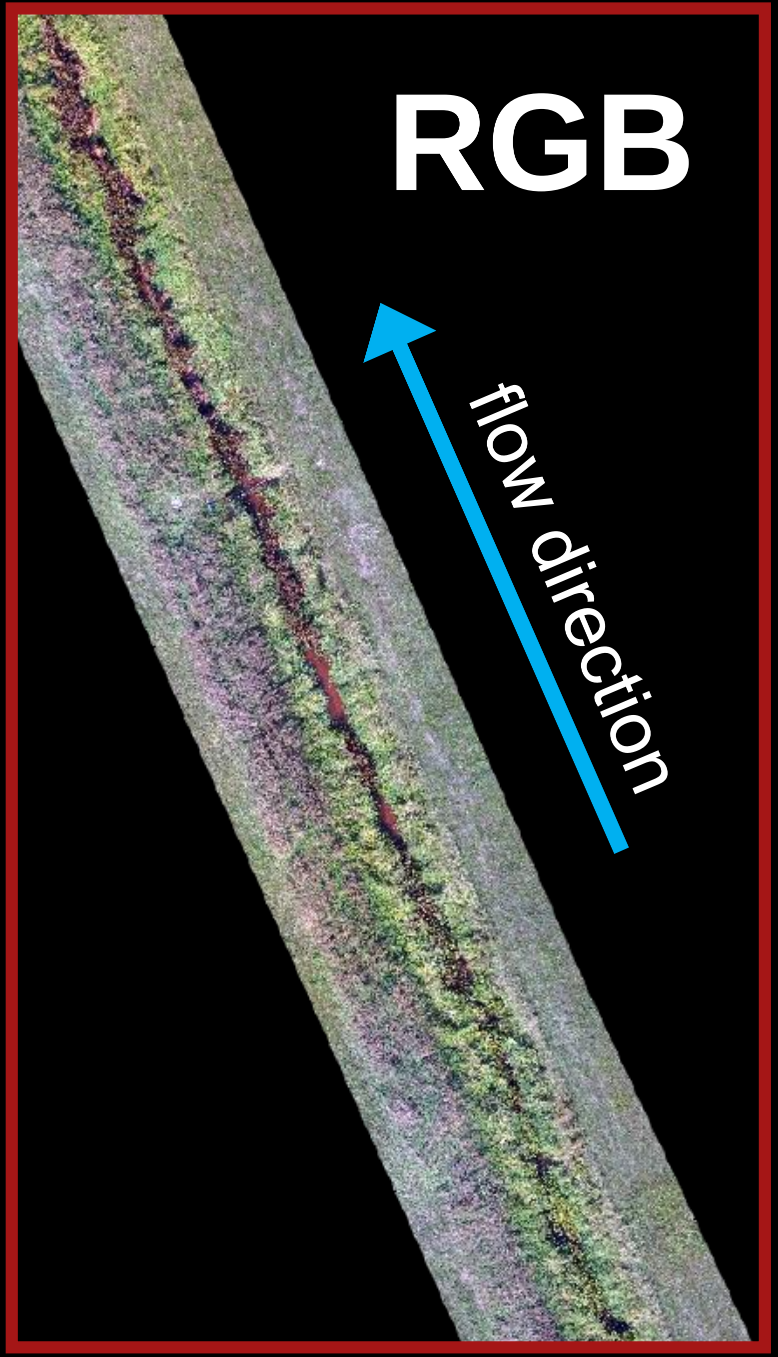


Orthomosaic

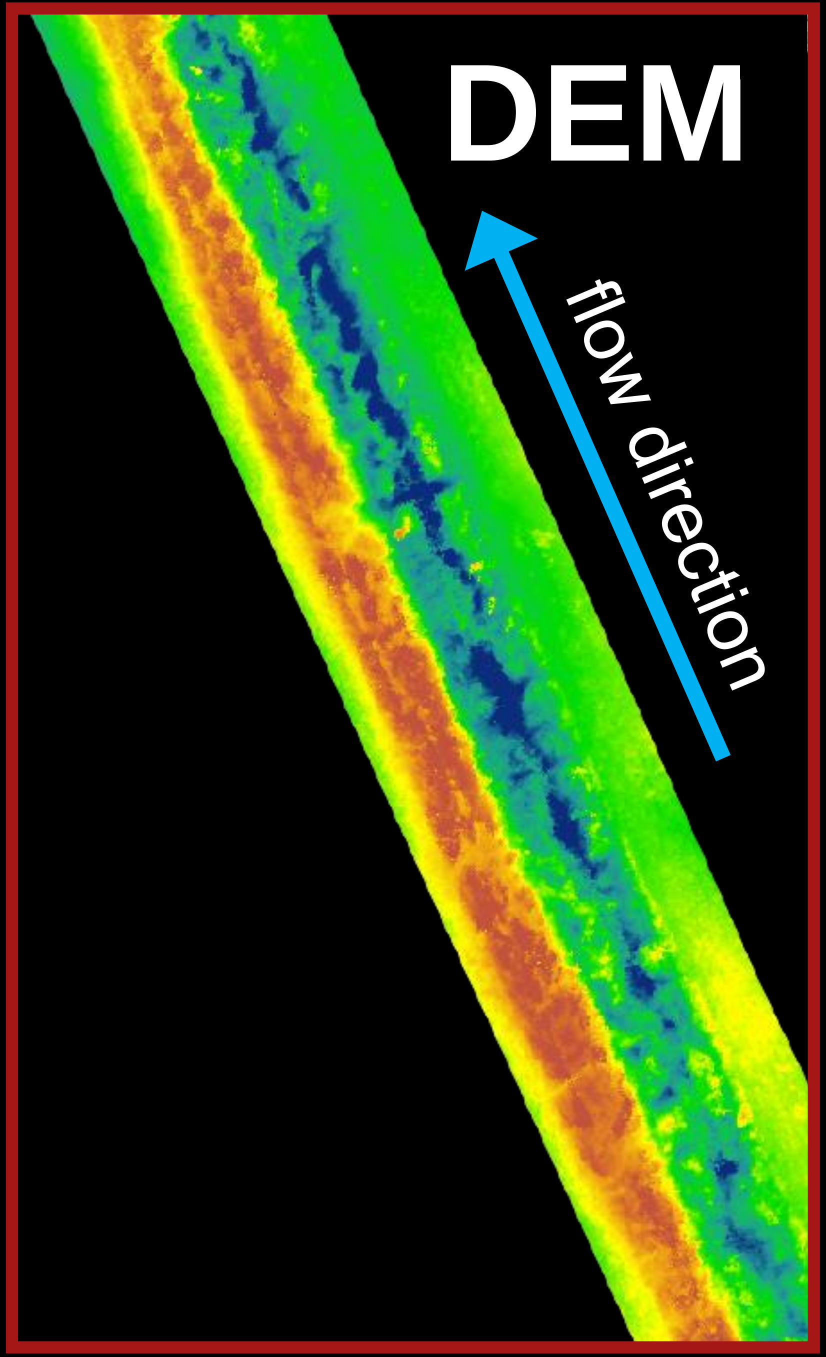


Haralick Texture Analysis





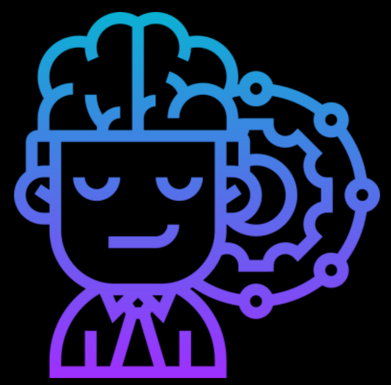
+



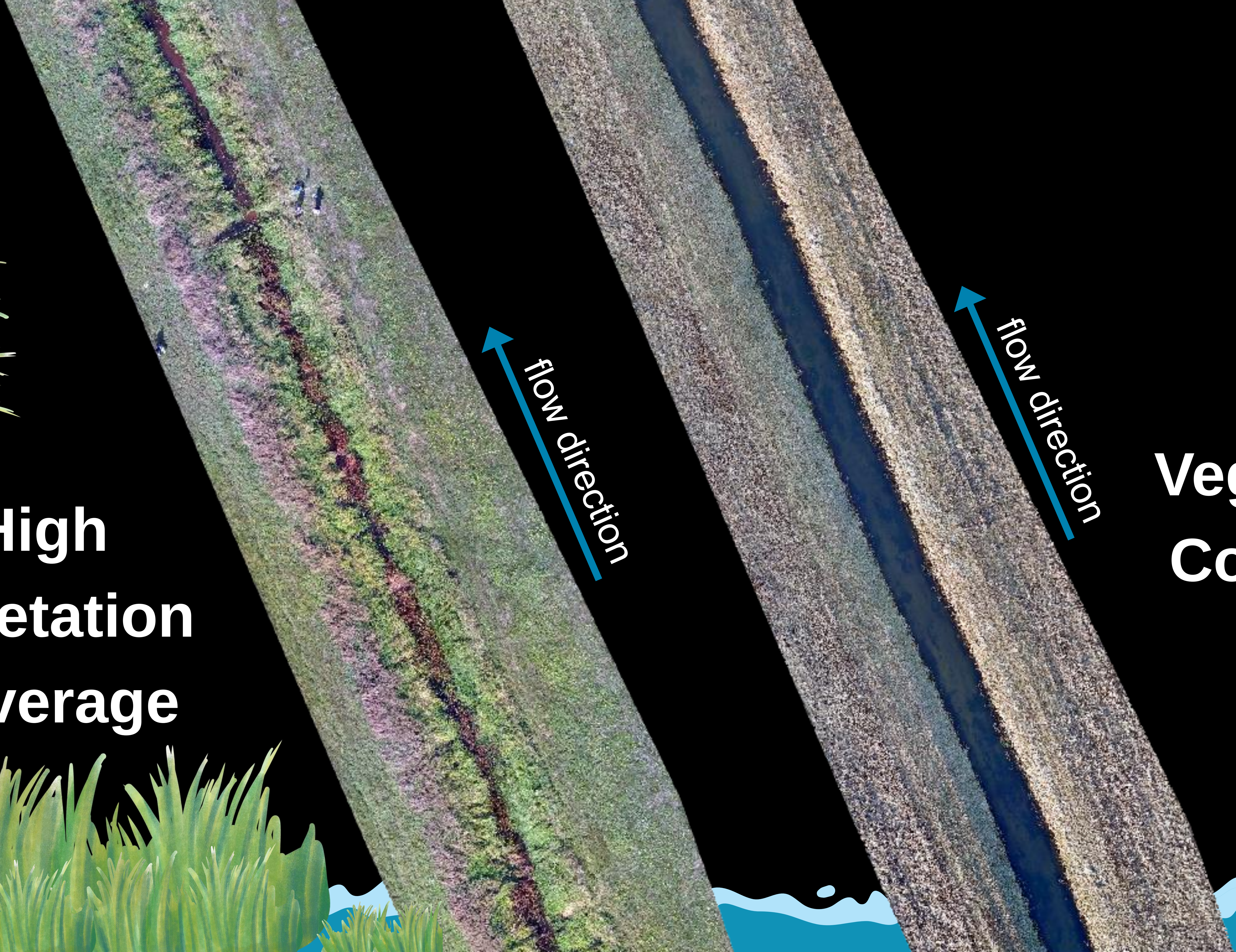
+

Haralick Texture Statistics

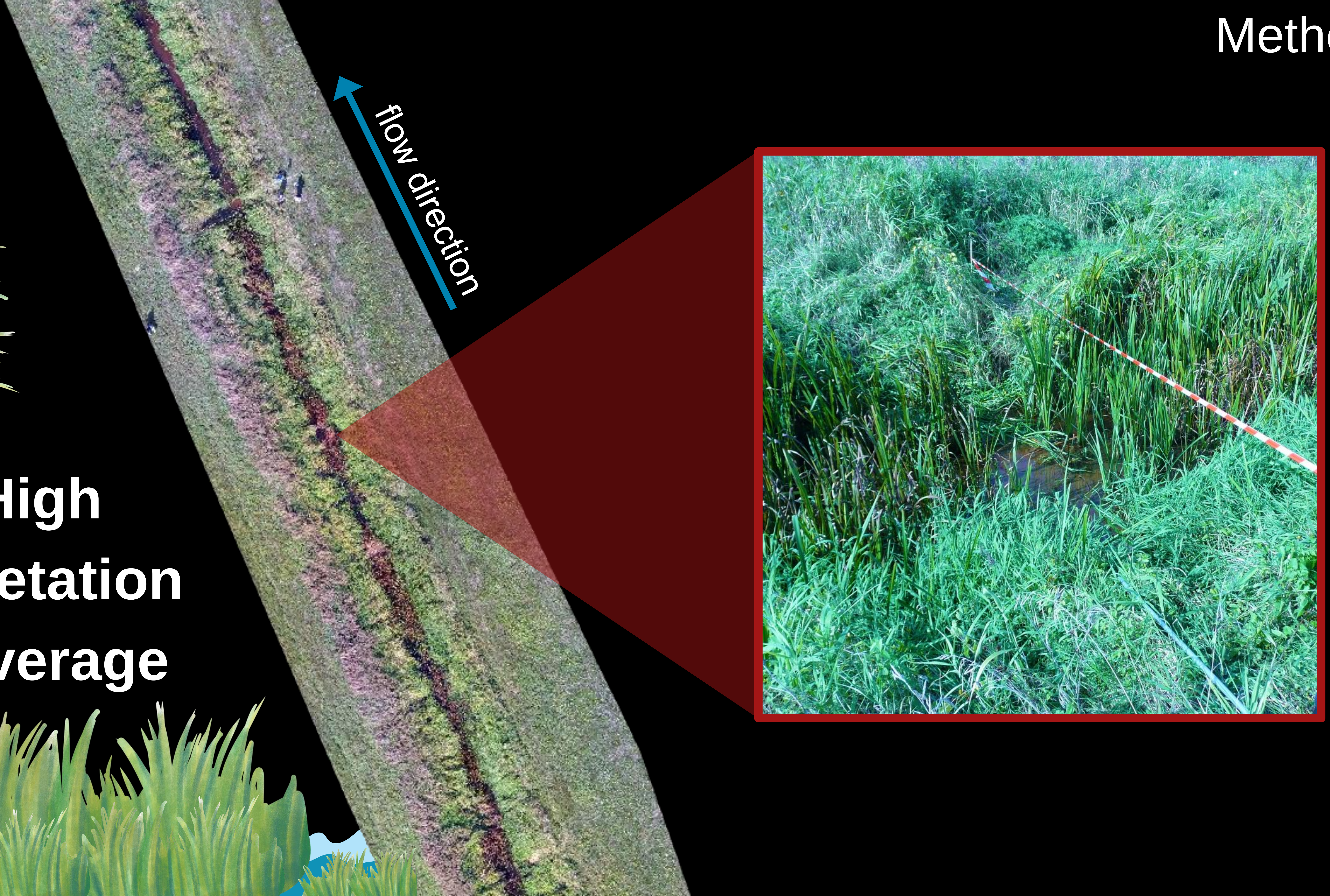
Machine Learning Algorithms



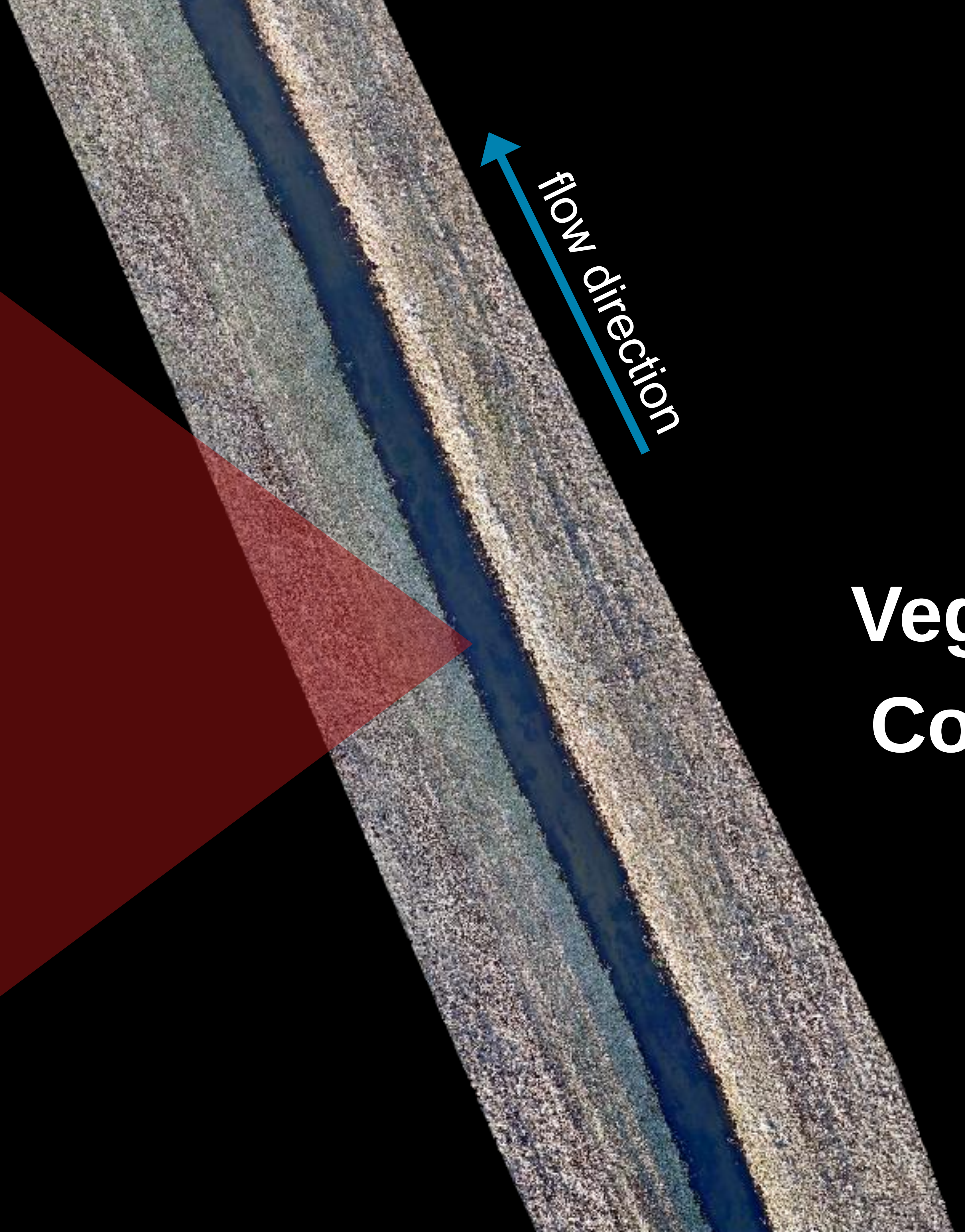
High Vegetation Coverage



Low Vegetation Coverage



High Vegetation Coverage



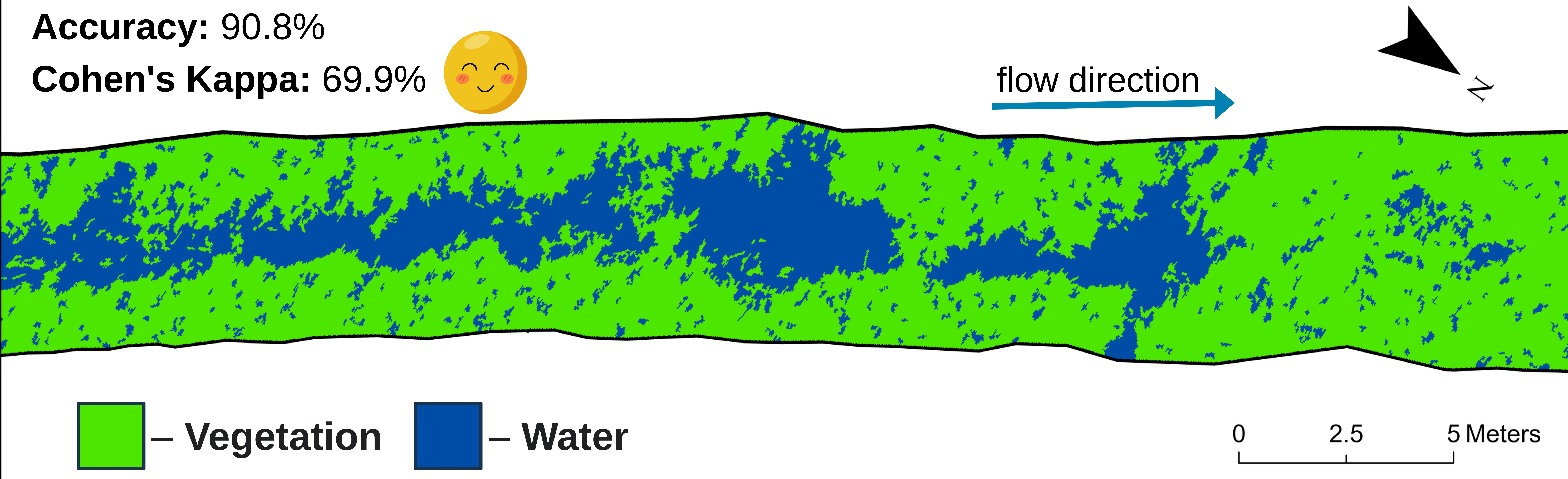
Low Vegetation Coverage

Support Vector Machine (RGB+DEM)

Vegetation Coverage: 80.7%

Accuracy: 90.8%

Cohen's Kappa: 69.9%



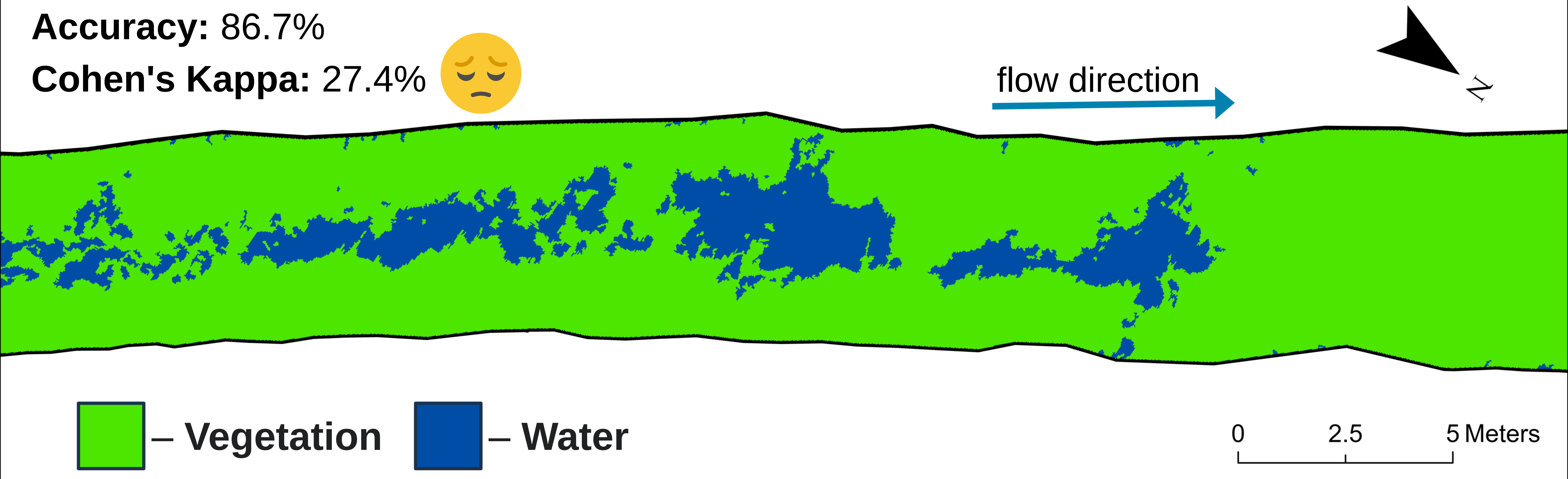
Results

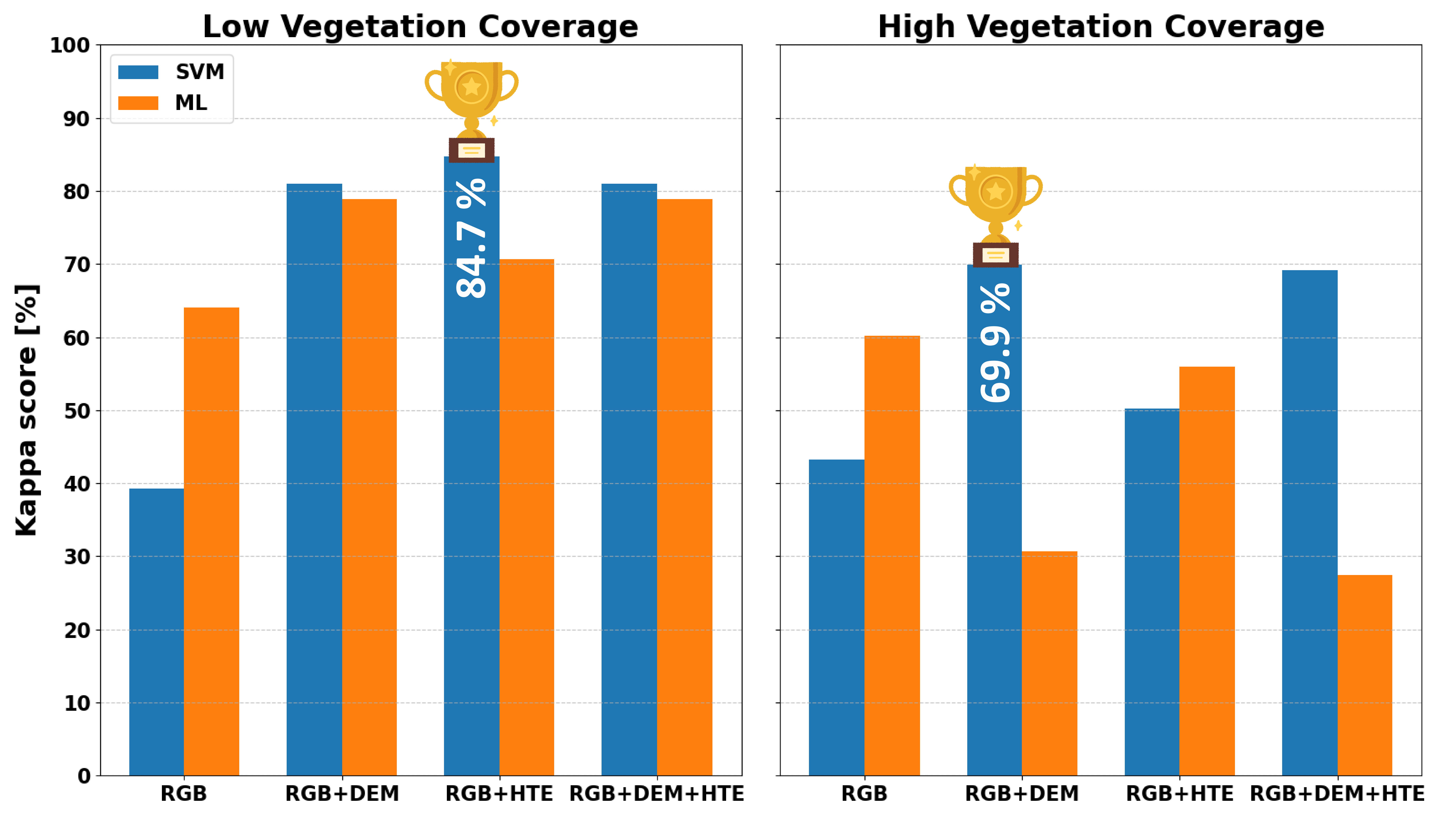
Maximum Likelihood (RGB+DEM+Haralick)

Vegetation Coverage: 96.7%

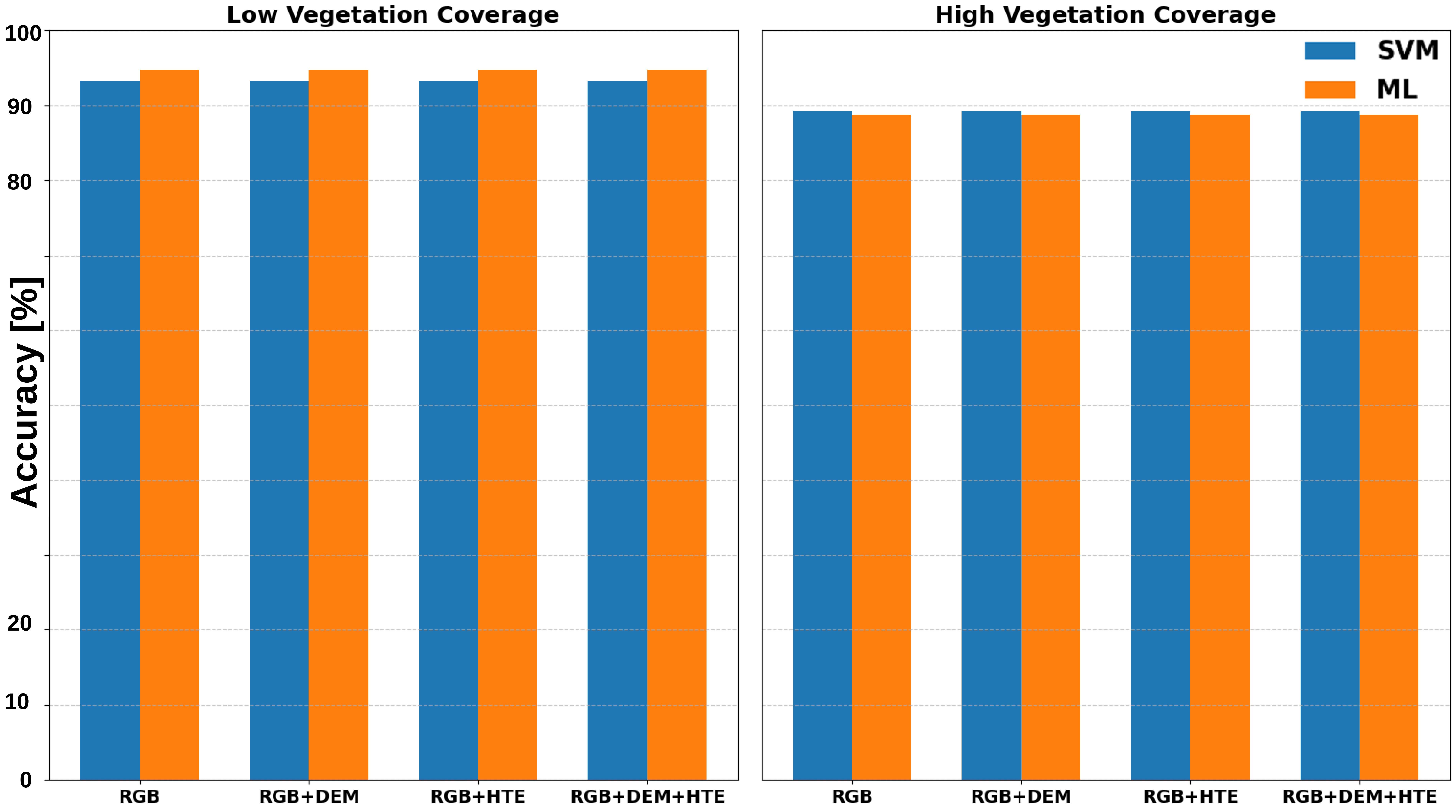
Accuracy: 86.7%

Cohen's Kappa: 27.4%





Low Vegetation Coverage
High Vegetation Coverage
Kappa score [%]
SVM
ML
84.7 %
69.9 %
0
10
20
30
40
50
60
70
80
90
100
RGB
RGB+DEM
RGB+HTE
RGB+DEM+HTE



Low Vegetation Coverage
High Vegetation Coverage
SVM
ML
Accuracy [%]
100
90
80
20
10
0
RGB
RGB+DEM
RGB+HTE
RGB+DEM+HTE
RGB
RGB+DEM
RGB+HTE
RGB+DEM+HTE

Conclusions

- **Very good** results for **low V_C**

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- **Very good** results for **low V_C**
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- Adding **DEM** or **HTE** to **RGB enhances** performance
- **SVM** performed **better** than **ML**
- **RGB + HTE** best for low **V_C**
- **RGB + DEM** best for high **V_C**
- **RGB drone images** provide sufficiently good results

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Cohen's kappa

$$\frac{TP + TN}{Total}$$

Observed agreement

$$\kappa = \frac{p_o - p_e}{1 - p_e}$$

$$P_e = (P_{\text{true},1} \cdot P_{\text{pred},1}) + (P_{\text{true},2} \cdot P_{\text{pred},2})$$

Expected agreement if random judgment

Value of κ	Strength of Agreement
< 0.20	Poor
$0.21 - 0.40$	Fair
$0.41 - 0.60$	Moderate
$0.61 - 0.80$	Good
> 0.80	Very Good

Henry et al. (2016)

Kappa corrects accuracy for chance agreement, especially useful with imbalanced classes

Situation: 900 pixels of vegetation and 100 pixels of water

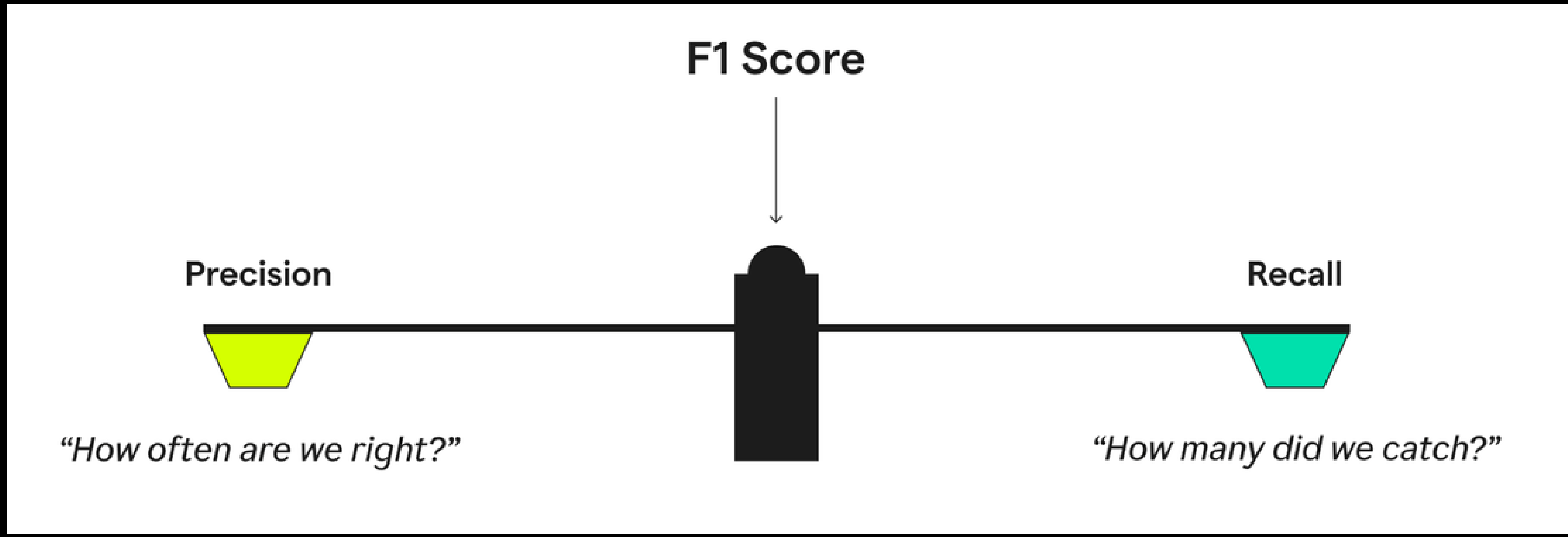
model ignores water and
predicts only vegetation

Accuracy = 900 / 1000 = 90% 🎉
F1 score for water = 0 ✕
Kappa value ≈ low ✕

F1 Score vs Cohen's Kappa

focuses on a single class

measures overall agreement between the classification and ground truth, while correcting for chance agreement

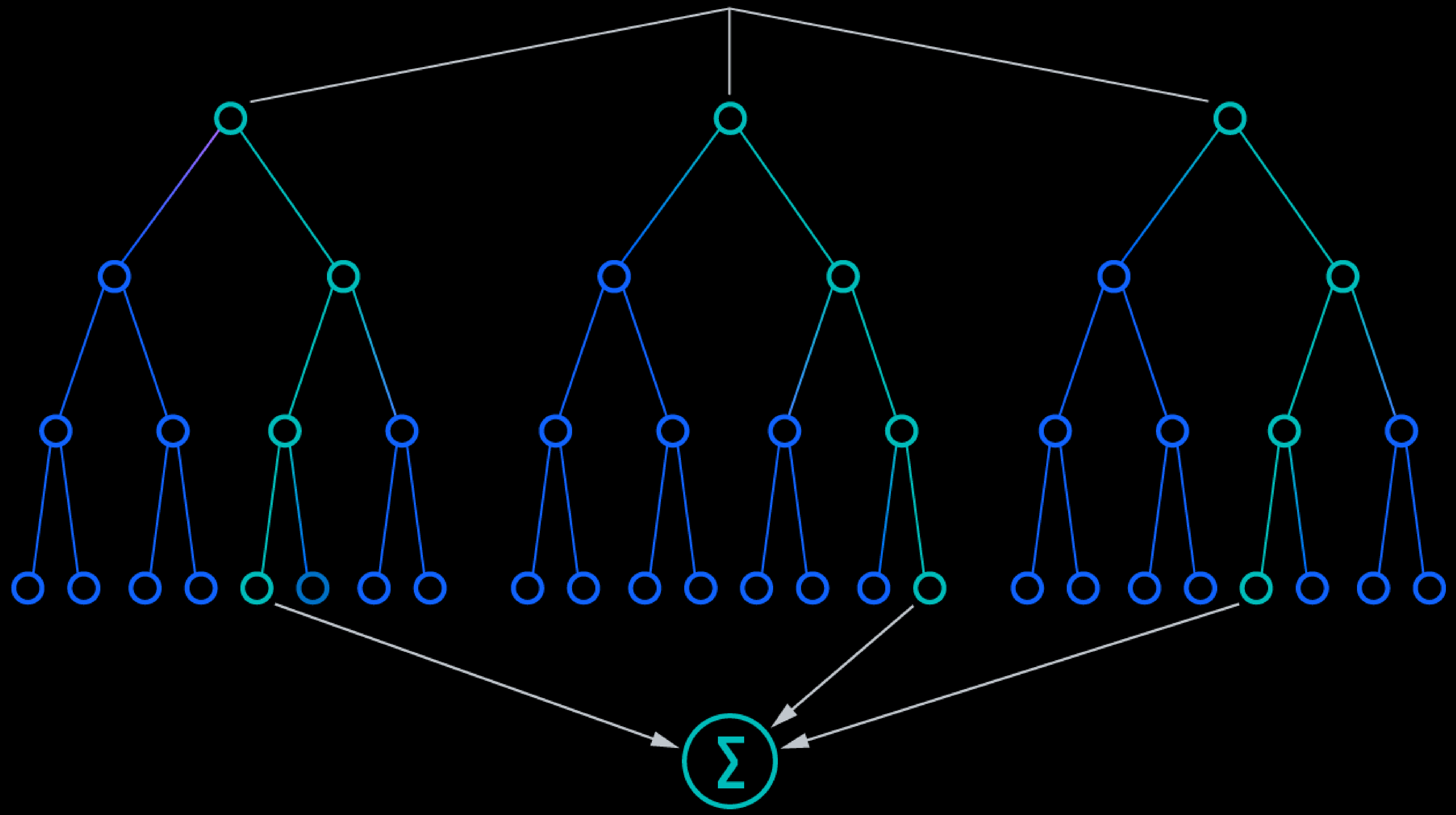


$$\kappa = \frac{p_0 - p_e}{1 - p_e},$$

$$F1 = \frac{2 \times Precision \times Recall}{Precision + Recall}$$

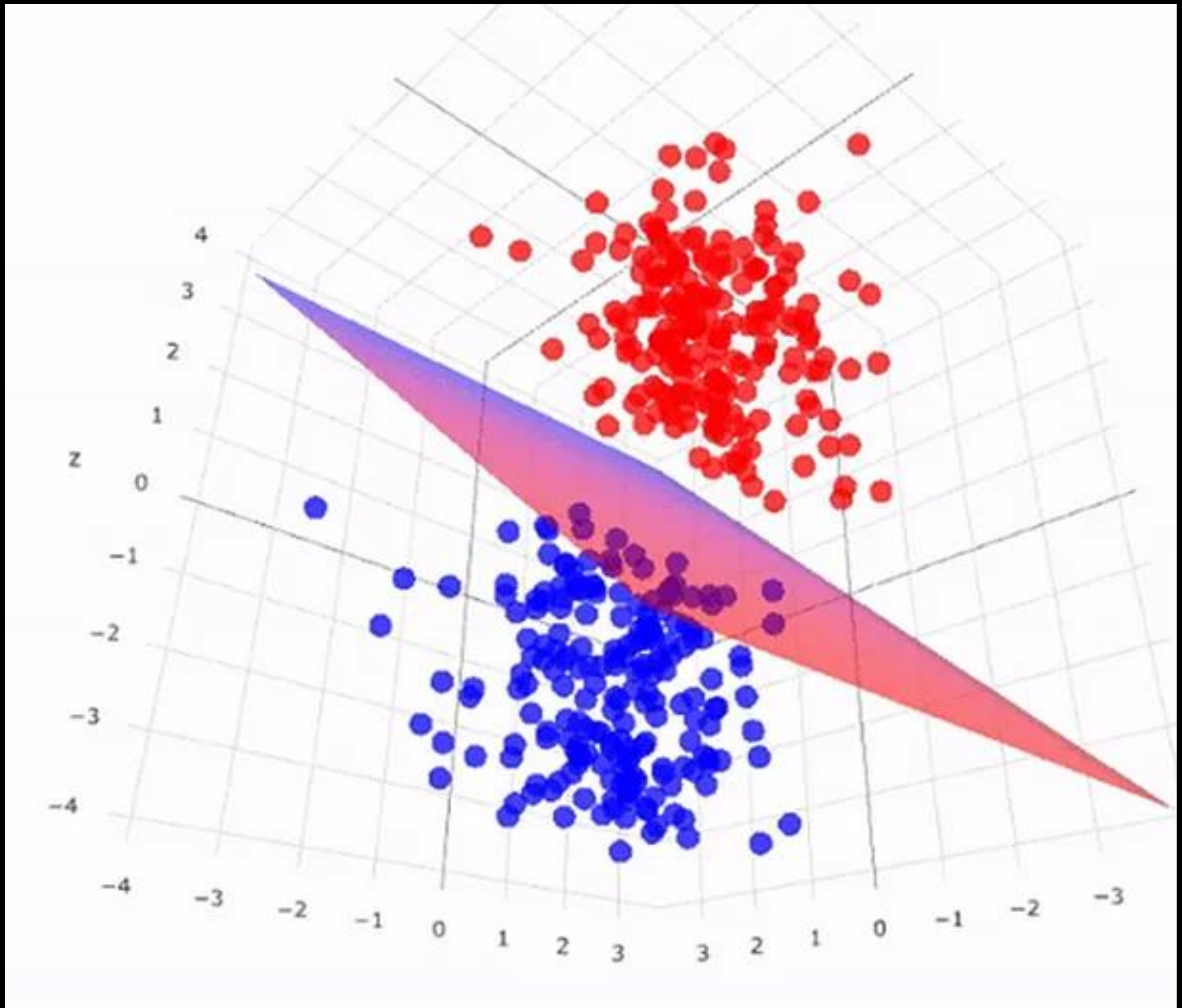
Random Forest

1. Constructing a flowchart of questions and answers leading to a decision
2. The wisdom of the (random and diverse) crowd

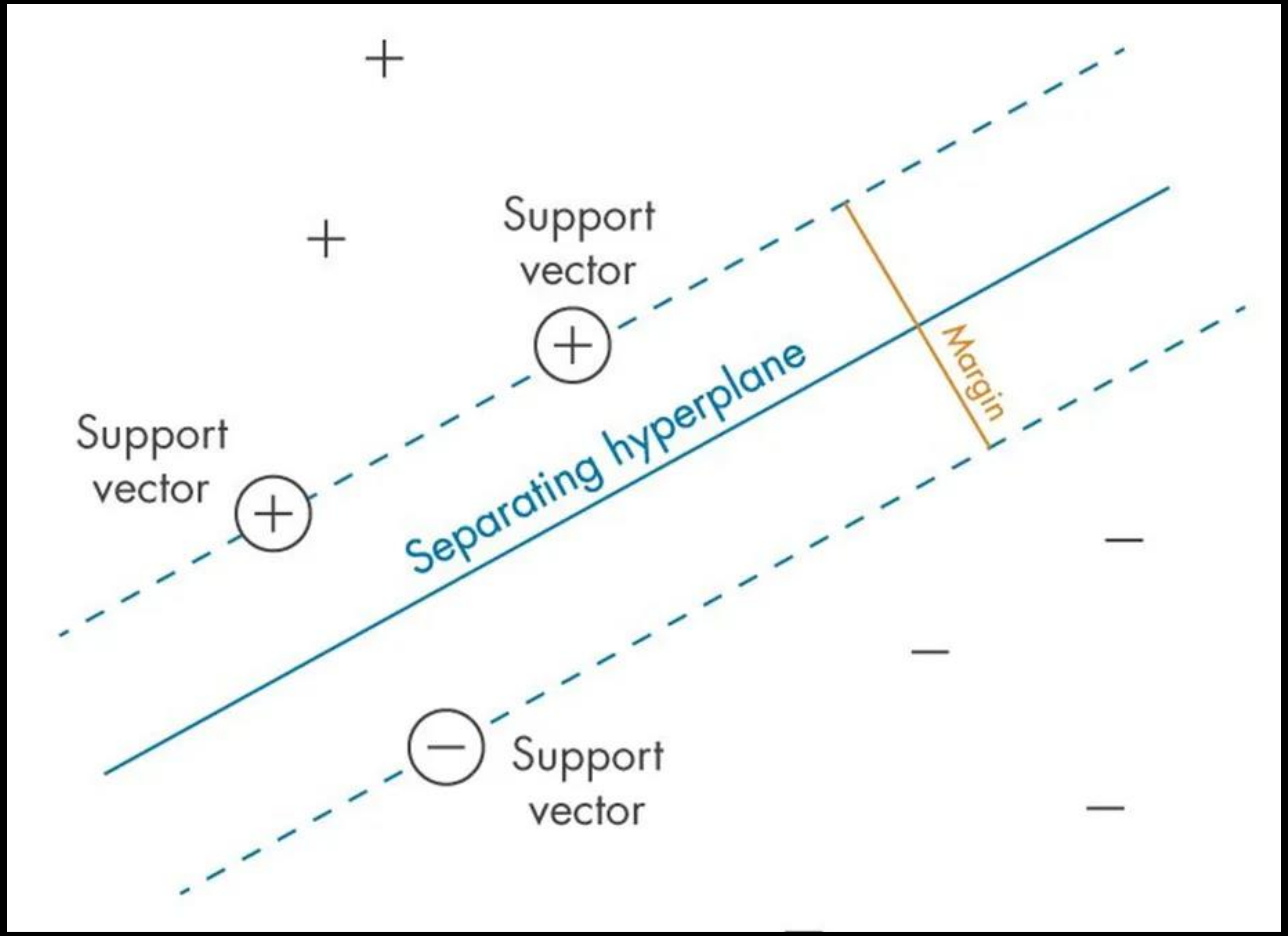


Huang, Boming (2024)

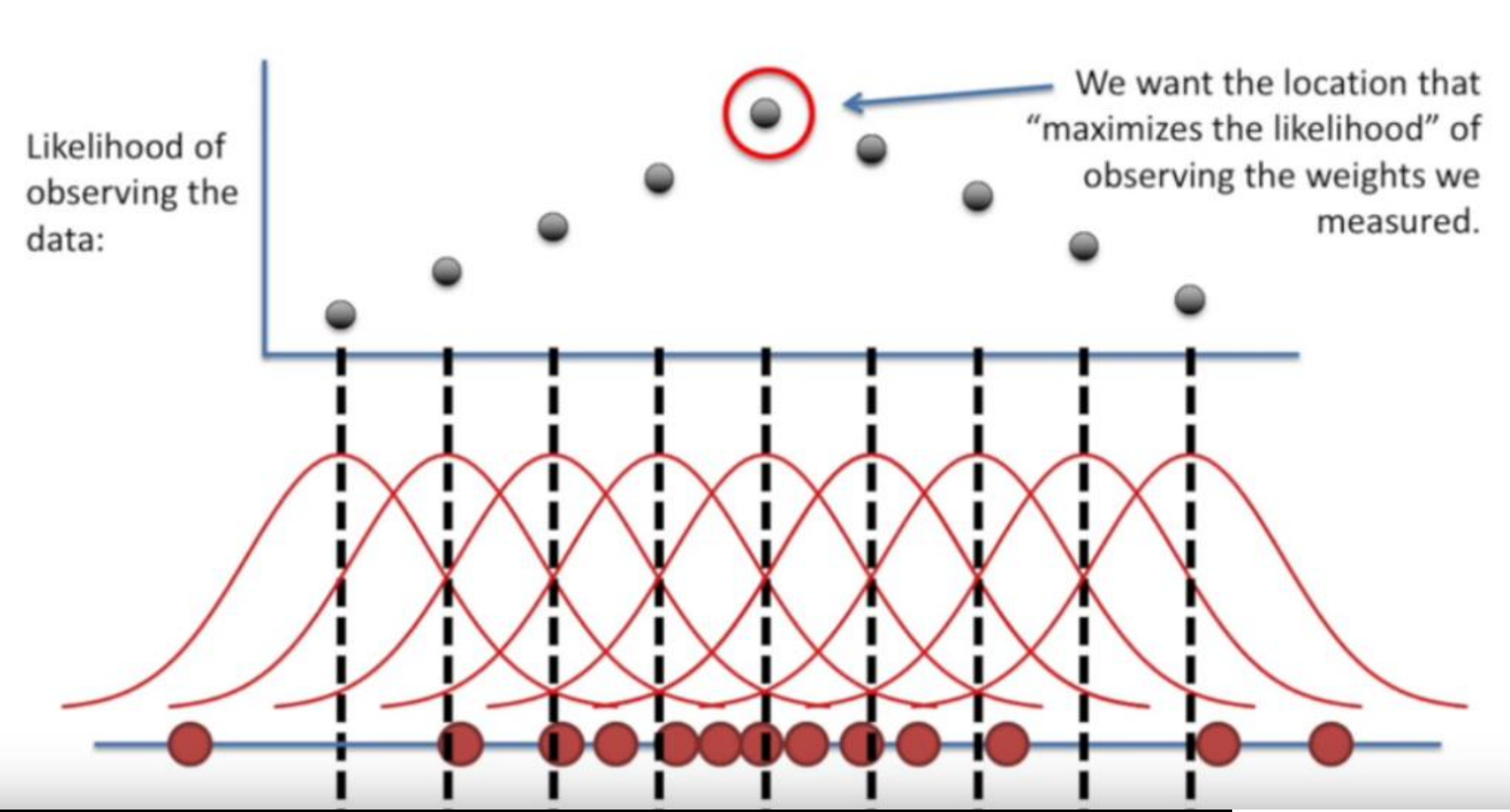
Support Vector Machines



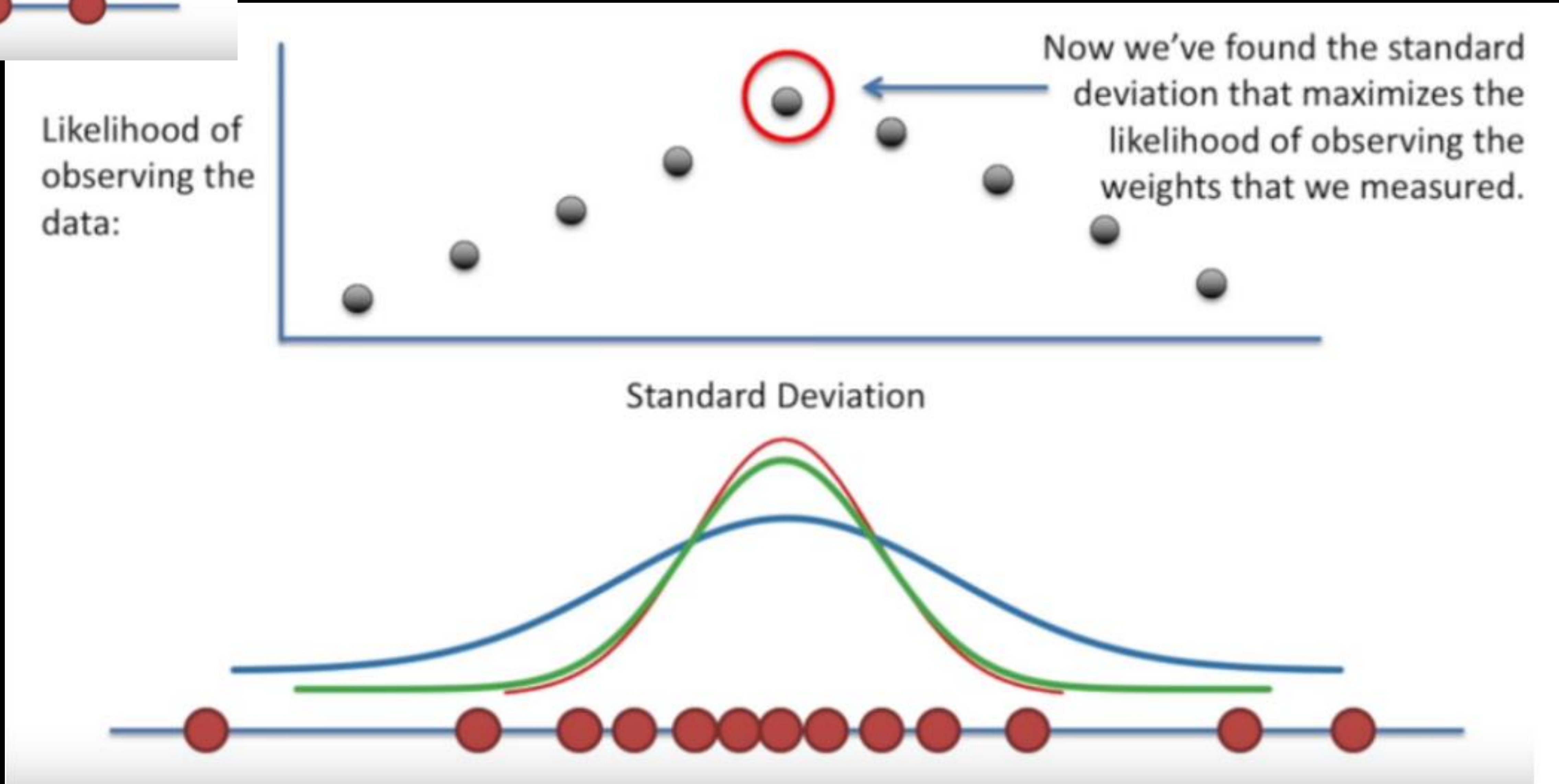
↗ margin = ↗ degree of confidence



GOAL : find the hyperplane that maximizes the margin



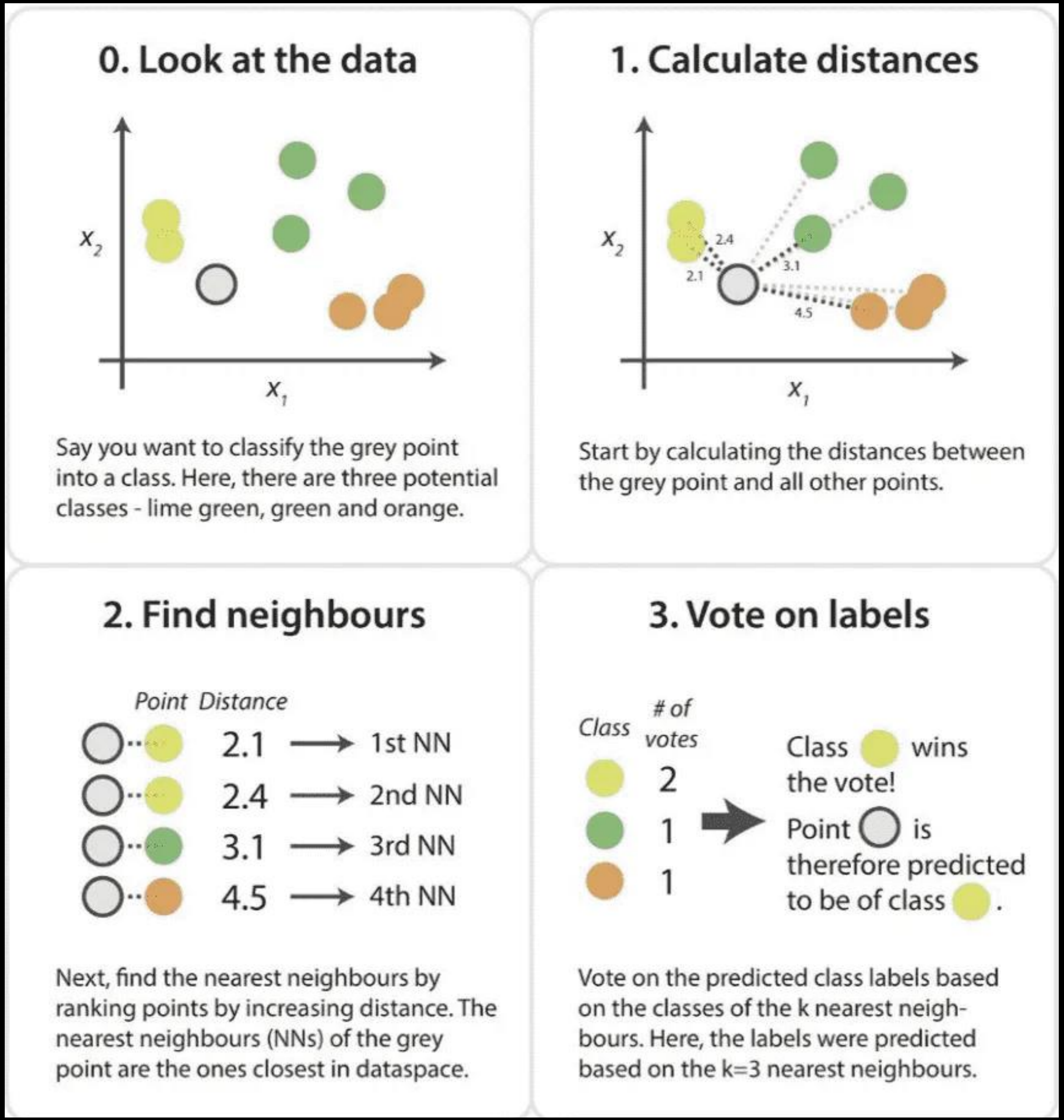
Maximum Likelihood

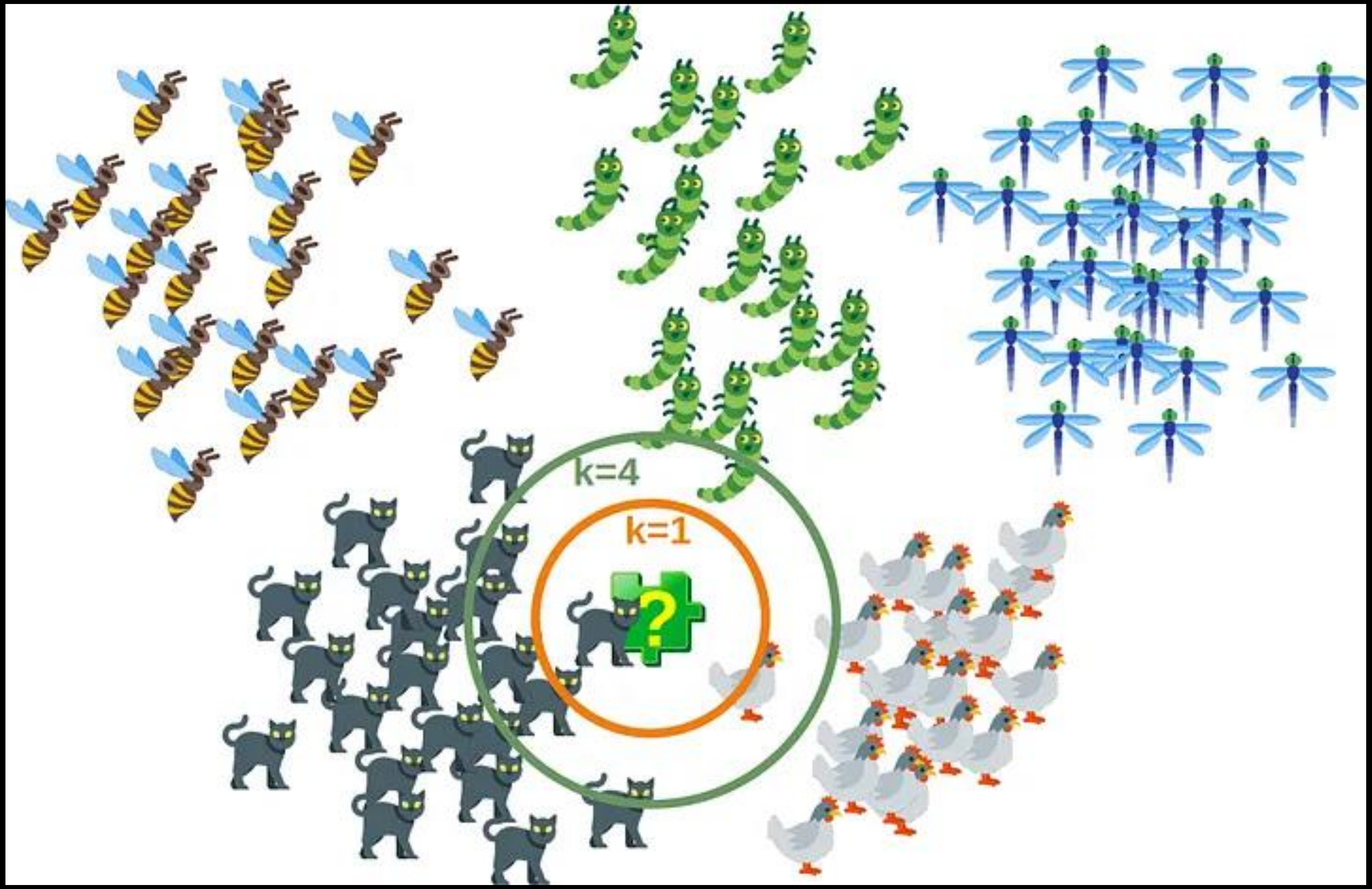


Likelihood = L(θ/events)

The images were taken by "StatQuest, MLE" from YouTube

K-Nearest Neighbor





https://medium.com/swlh

Gray-Level Co-occurrence Matrix