VLAIO TETRA

Machine Vision for Quality Control

(MV4QC)

Case 6

Detection of a sufficient presence of nuts and sauce on Cornetto’s

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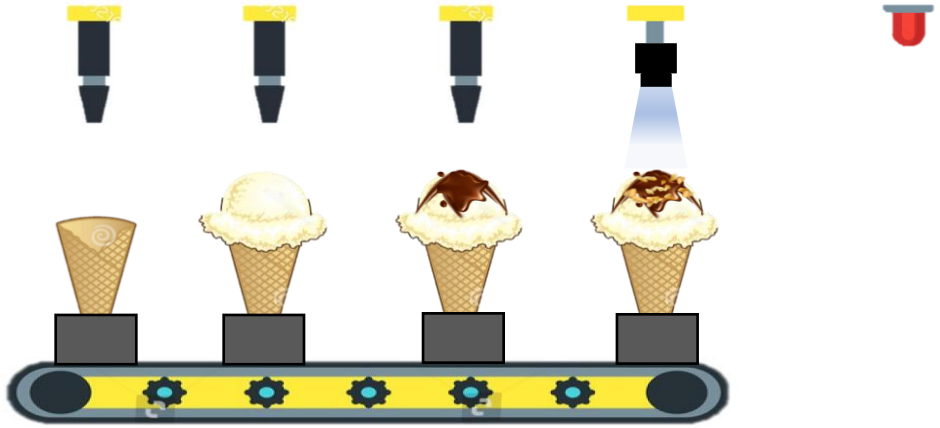
Case 6 – Introduction

- Quality control based on the topping present (sauce, nuts, curls, …) on Cornettos

- Production process:



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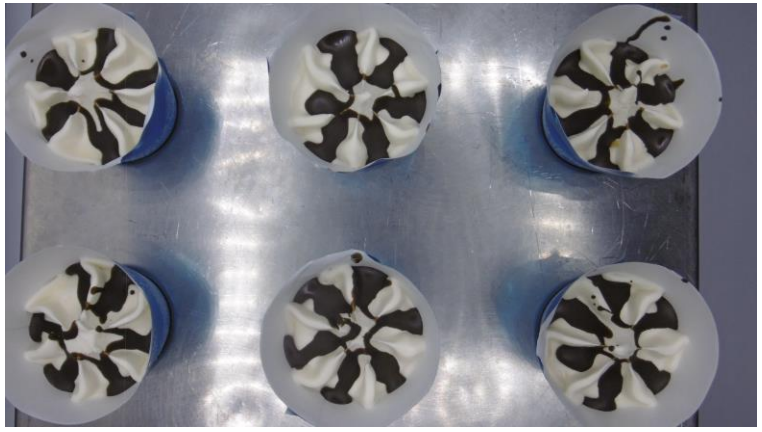
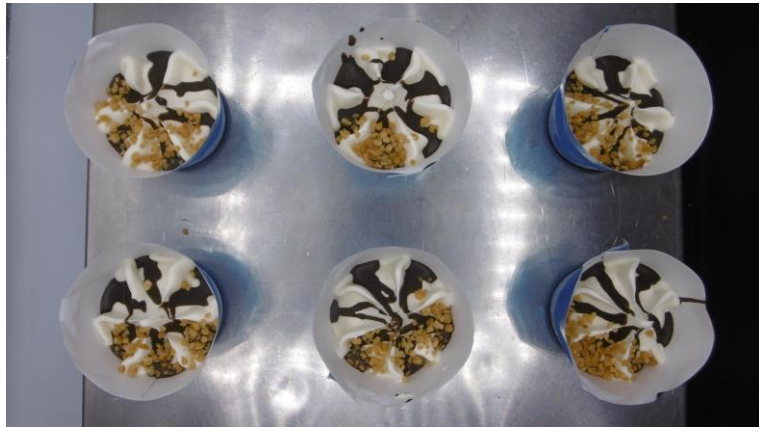
Case 6 – Data capturing

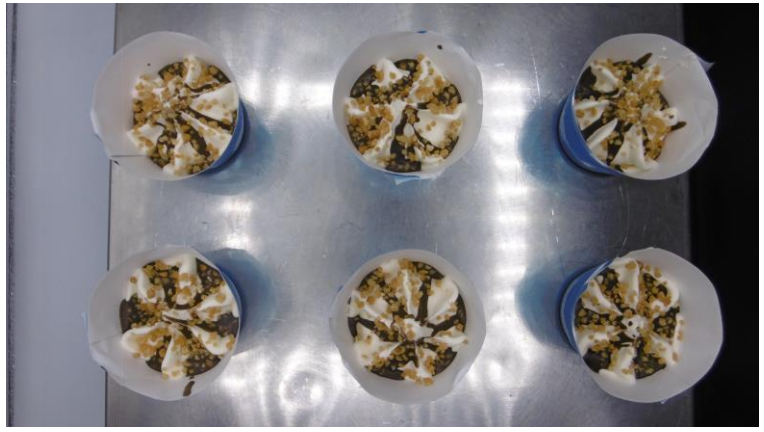
Handmade Cornetto’s with different gradations of defects



No nuts



Half coverage of the nuts



Full coverage of the nuts

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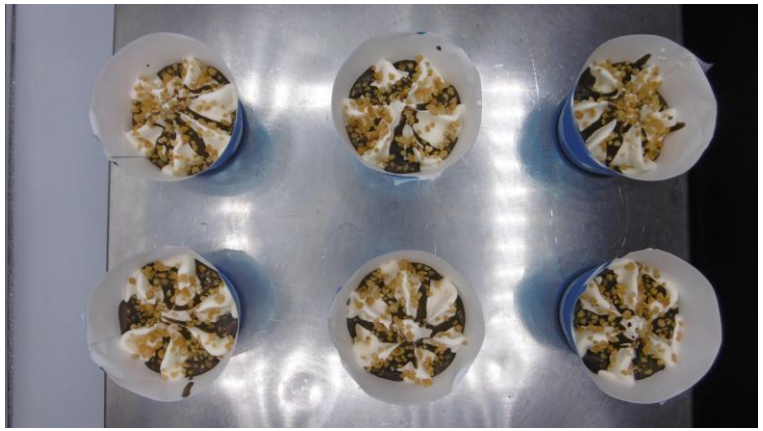
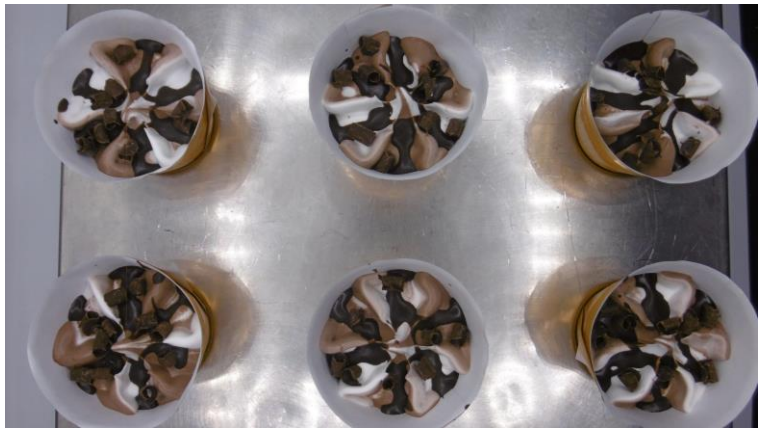
Case 6 – Data capturing

3 different variants labelled by quality control technicians



2g sauce + 2g nuts → OK

4g sauce → OK



2g sauce + 1,5g curls → OK

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Case 6 – Data pre-processing

3 variants:

1. Vanilla variant: 14 images with 6 ice cream cones
   - ➢ 84 samples: 60 ☒ en 24 ☑

2. Strawberry variant: 14 images with 6 ice cream cones
   - ➢ 84 samples: 60 ☒ en 24 ☑

3. Chocolate variant: 13 images with 6 ice cream cones
   - ➢ 78 samples: 54 ☒ en 24 ☑

➢ Imbalanced datasets

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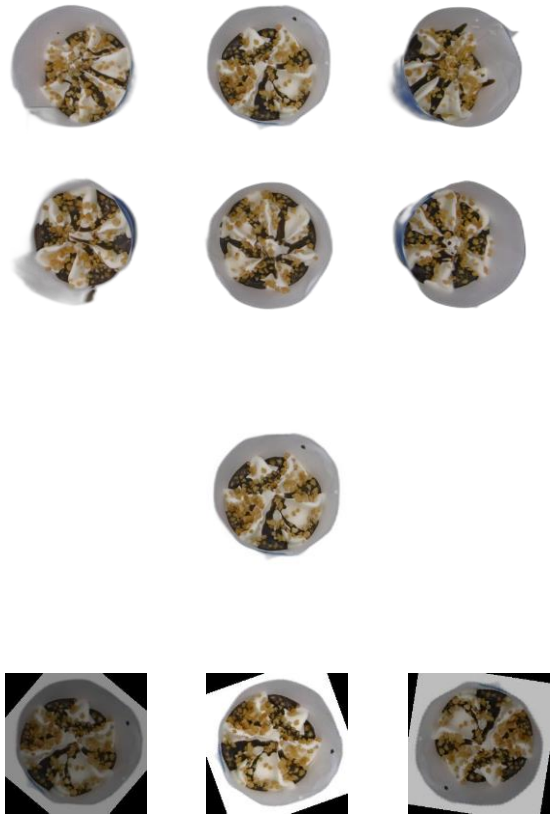
Case 6 – Data pre-processing

1. Background removal

2. Manual cropping

3. Data augmentation



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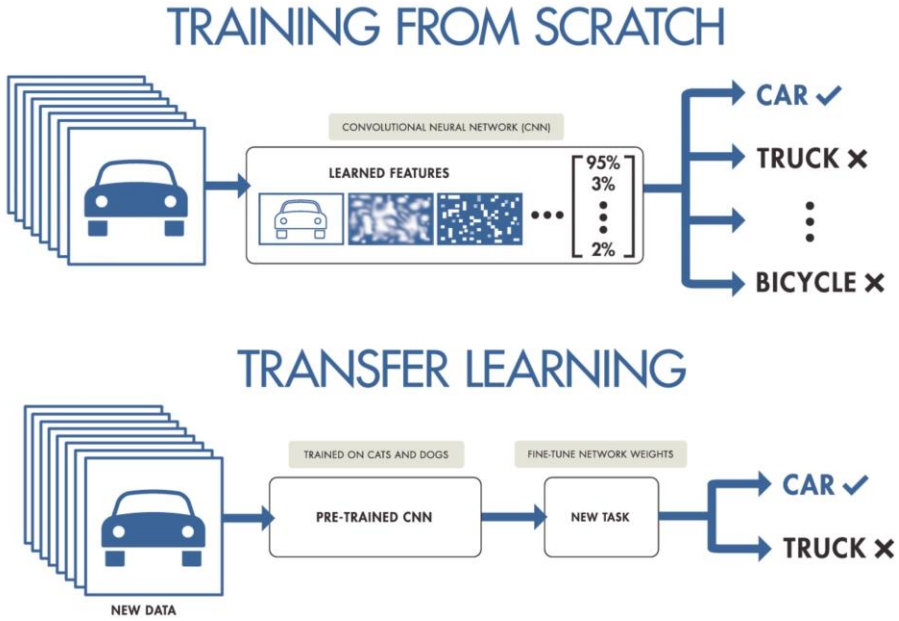
Case 6 – Model training

- Different approaches:
  1. Binary classification model
  2. Multi-label classification model

Quality	Sauce	Nuts/Curls
Good	Good	Good
Bad	Bad	Good
Bad	Good	Bad
Bad	Bad	Bad

- Transfer learning



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Case 6 – Model evaluation

- P = bad quality; N = good quality

Accuracy	VS	F1 score
$\frac{\#\ correct\ predictions}{\#\ total\ predictions}$		Harmonic mean precision and recall
Data distribution ✗		Data distribution ✓

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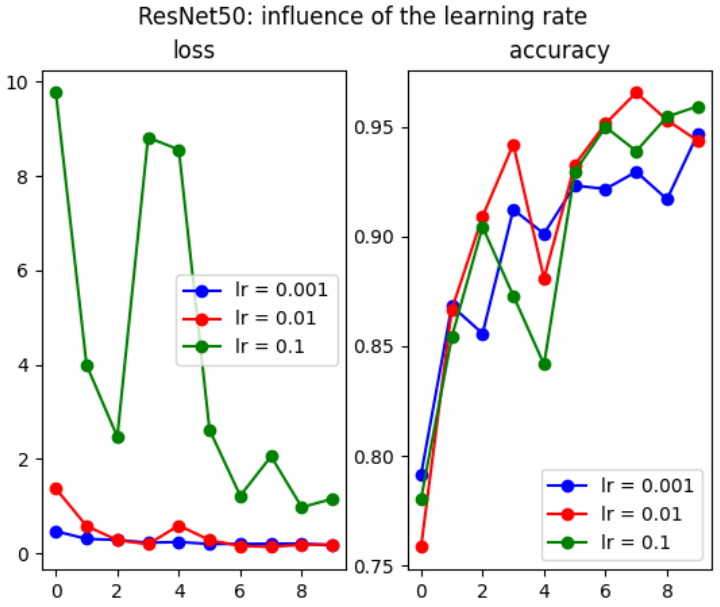
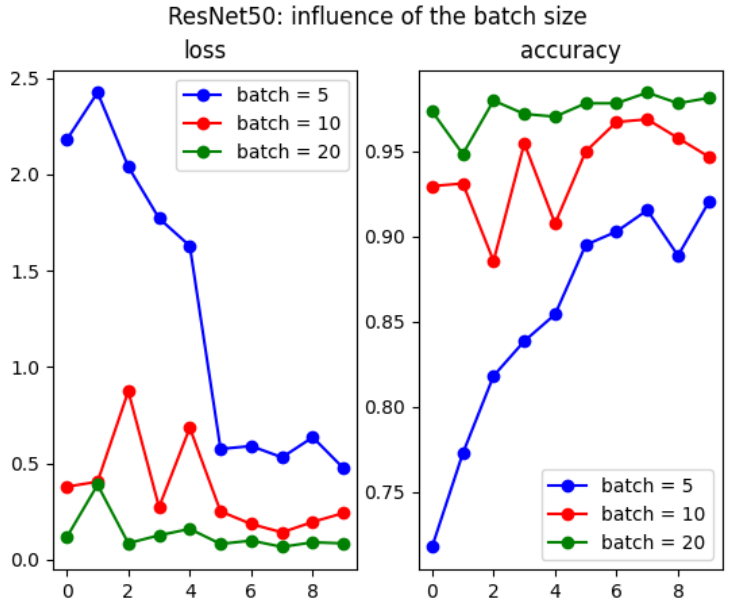
Case 6 – Binary classification results

- ResNet 50
- Hyperparameters:

Epochs	Learning rate	Batch size
10	0.01	20





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Case 6 – Binary classification results

- Best models:

Variant	Precision (%)	Recall (%)	F1 score (%)
Vanilla	98.48	100.0	99.24
Strawberry	94.17	97.94	95.80
Chocolate	94.94	94.41	94.68

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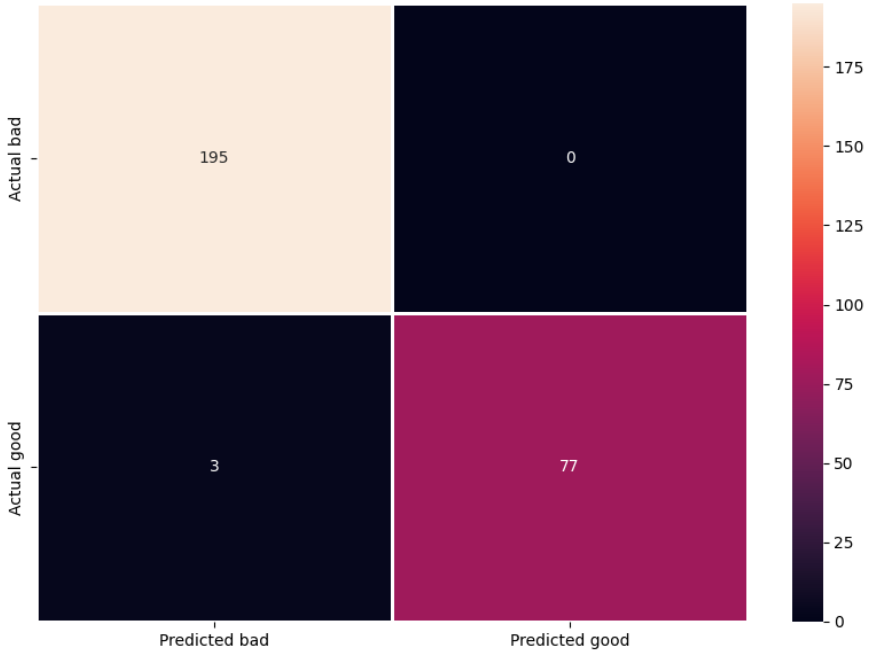
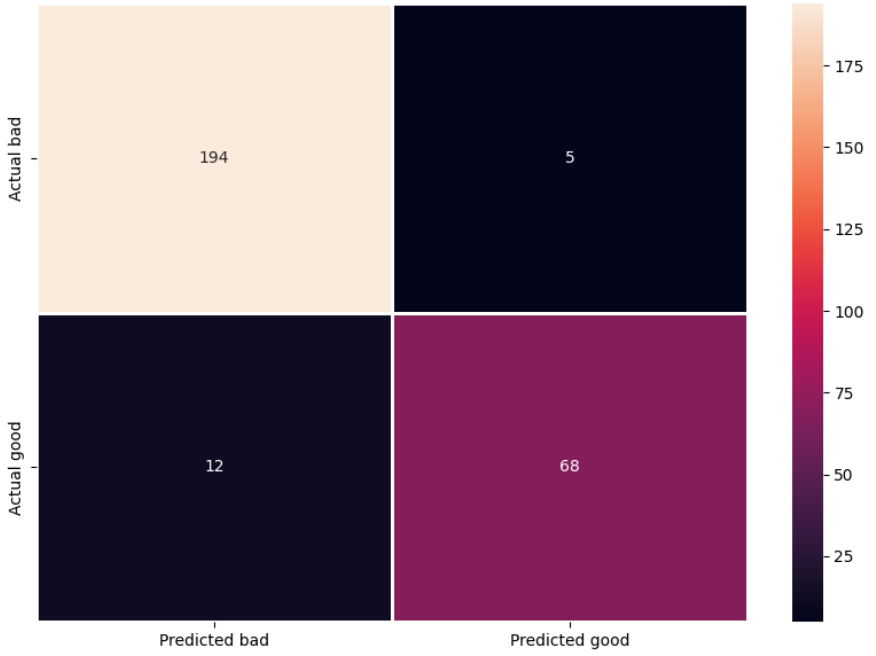
Case 6 – Binary classification results

- Confusion matrices:

Vanilla



Strawberry



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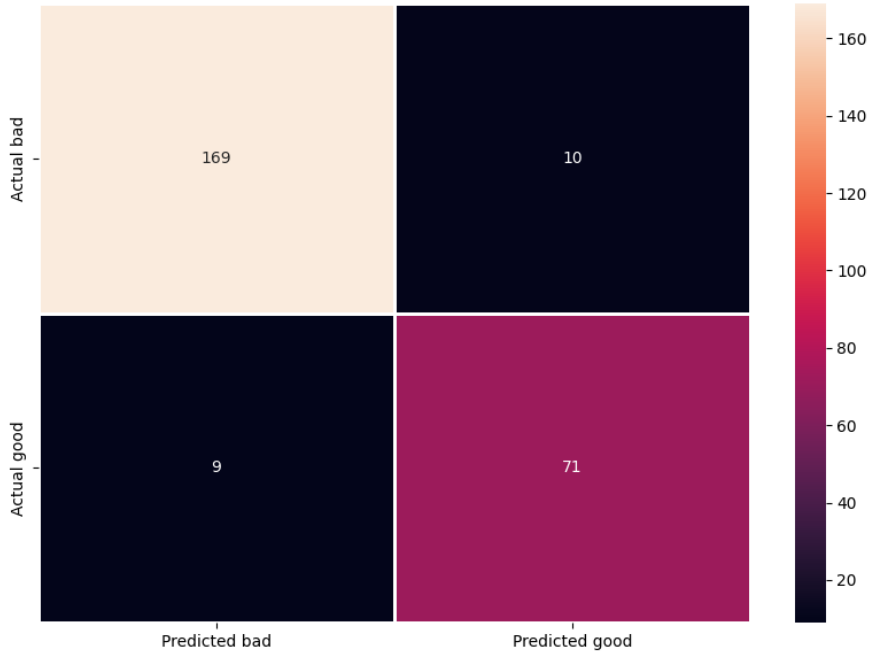
Case 6 – Binary classification results

- Confusion matrices:

Chocolate



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Case 6 – Binary classification results

- Possible reason for drop in performance:
  - Strawberry:

  - Chocolate:

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Case 6 – Multi-label classification results

- ResNet 50
- Hyperparameters:

Epochs	Learning rate	Batch size
10	0.01	10

- Only vanilla and chocolate variants

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Case 6 – Multi-label classification results

- Best models:

Variant	Label	Precision (%)	Recall (%)	F1 score (%)
Vanilla	Sauce	98.31	99.15	98.72
	Nuts	99.07	99.07	99.07
	Quality	98.45	98.96	98.71
Chocolate	Sauce	96.23	94.44	95.33
	Curls	94.84	90.18	92.45
	Quality	94.09	95.63	94.85

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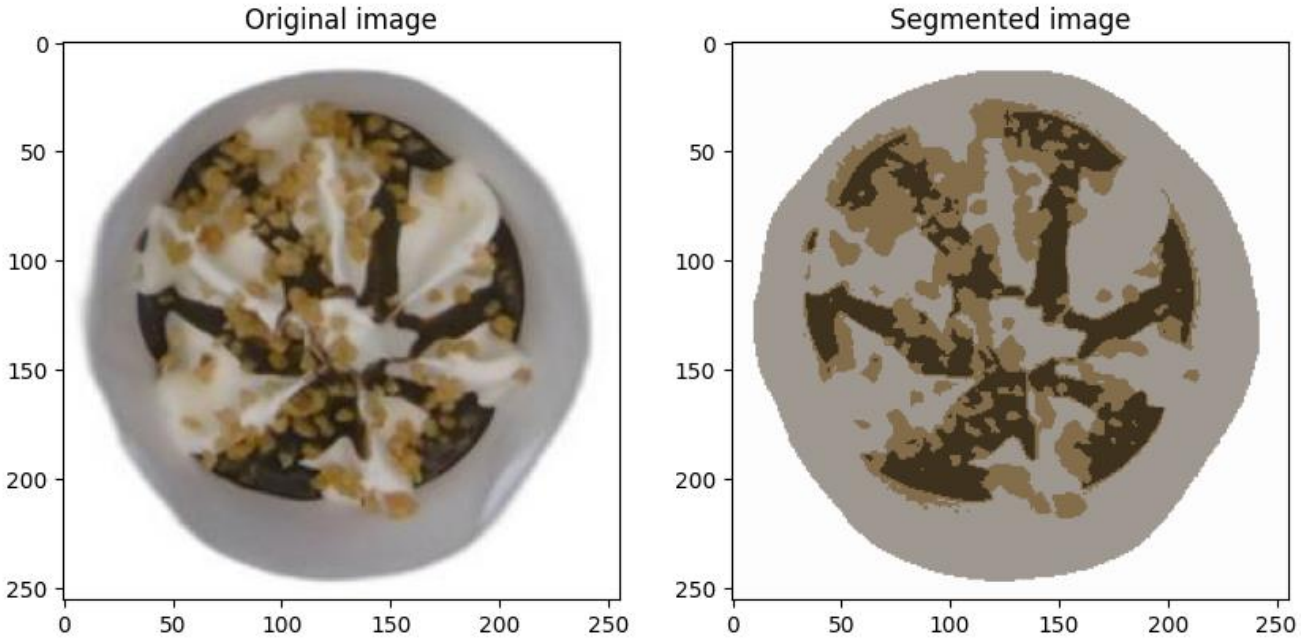
Case 6 – Segmentation

- K-means segmentation
- Vanilla variant:



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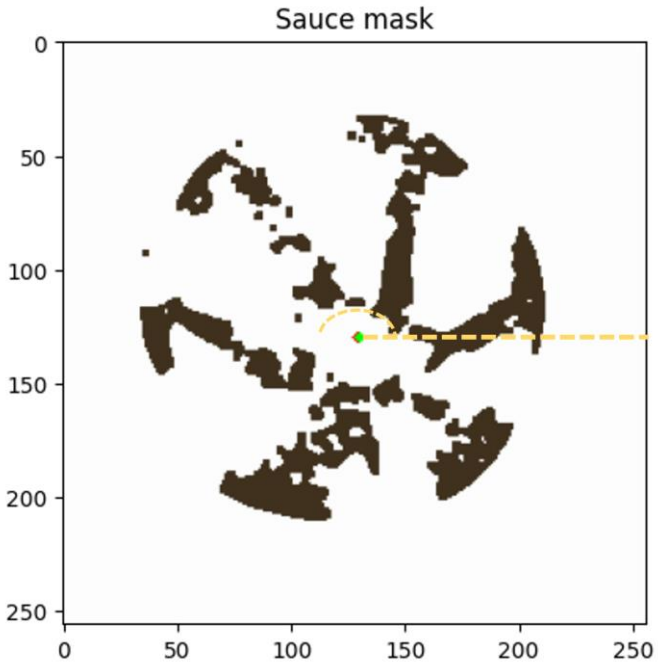
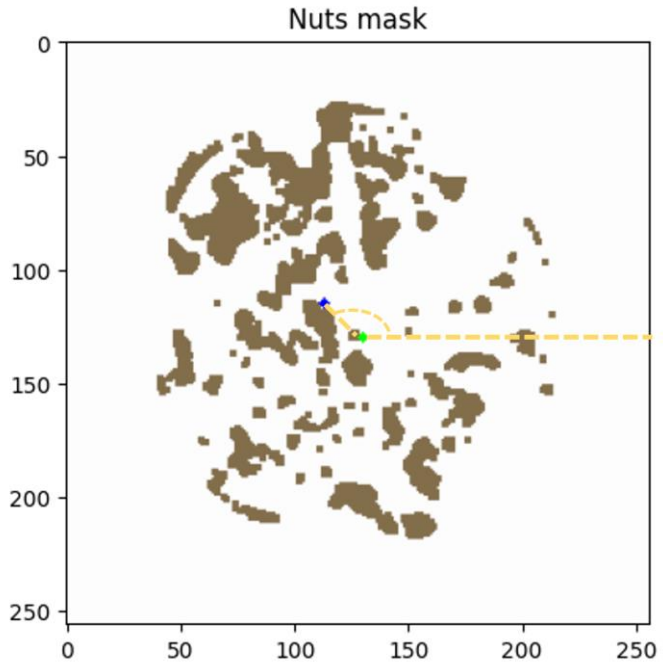
Case 6 – Segmentation





Mask	Centroid (x,y)	Size (w,h)	Position (d,a)
Sauce	(129,130)	(178,178)	(1,180°)
Nuts	(113,115)	(192,175)	(23,139°)

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Case 6 - Conclusion

- Good performance for both approaches
- Explainability vs performance
- Segmentation provides usefull insights
- Chocolate variant
- Further work

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