

MIA Lab

Final Presentation:

Hypothesis: Feature Extraction

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Feature extraction

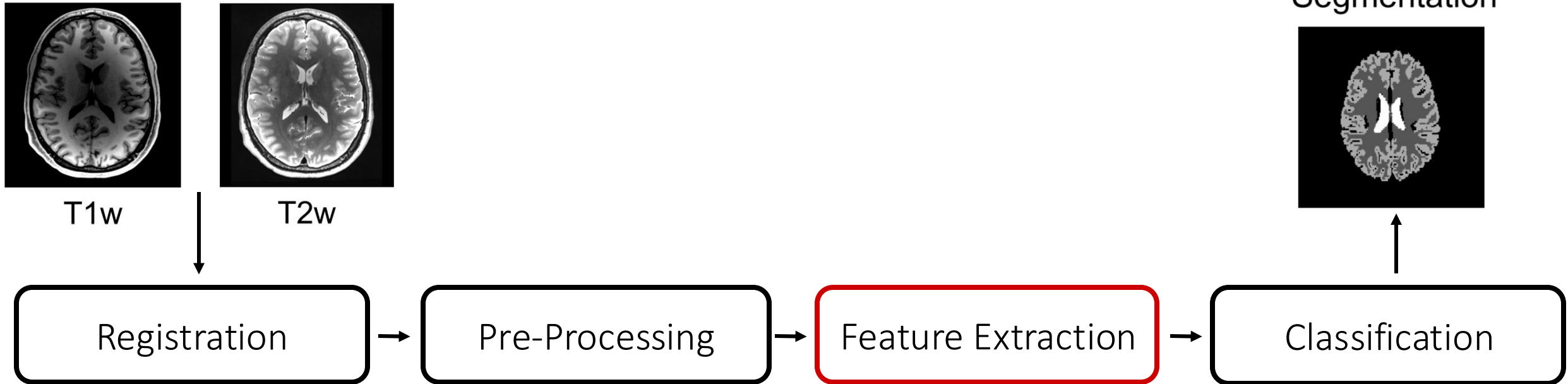
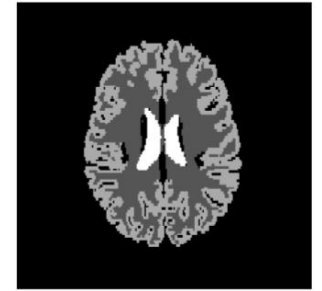
Hypothesis: A larger number of features increases segmentation performance.

Pipeline Adaption - Overview

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Segmentation



Started with a basic pipeline for automated brain tissue segmentation. We implemented **registration**, **preprocessing** and **experimented with feature extraction**.

Feature Combinations

Pre-Processing

Feature Extraction

pipeline.py

```
pre_process_params = {  
    'load_pre': False,  
    'skullstrip_pre': True,  
    'normalization_pre': True,  
    'registration_pre': True,  
    'save_pre': True  
}
```

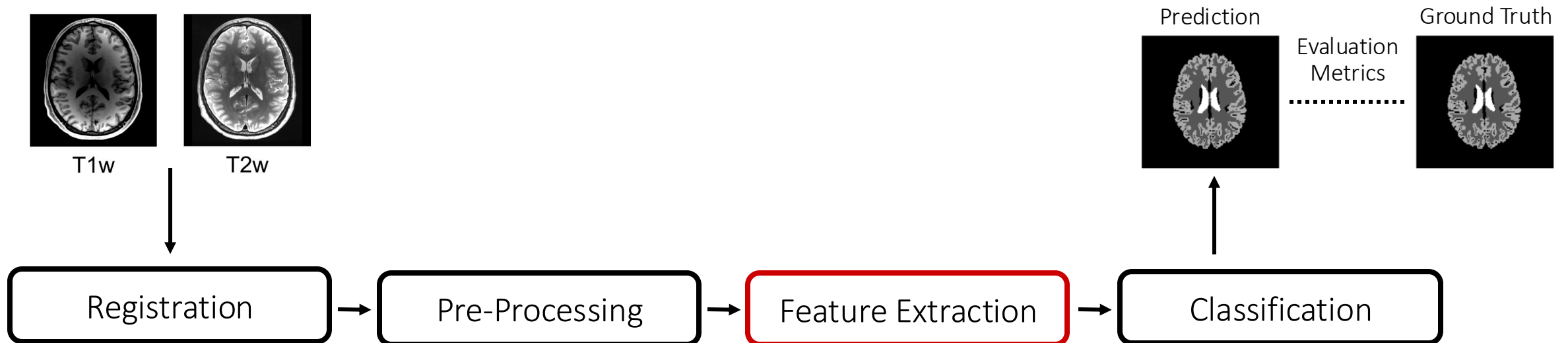
✓ Load preprocessed data → significant runtime reduction

```
fixed_feature_extraction_params = {  
    'load_features': False,  
    'save_features': True,  
    'overwrite': True,  
}  
  
binary_feature_extraction_params = {  
    'intensity_feature': True,  
    'coordinates_feature': True,  
    'gradient_intensity_feature': True,  
    'texture': True,  
    't2_features': True,  
    'edge_feature': True  
}
```

run_pipeline.py

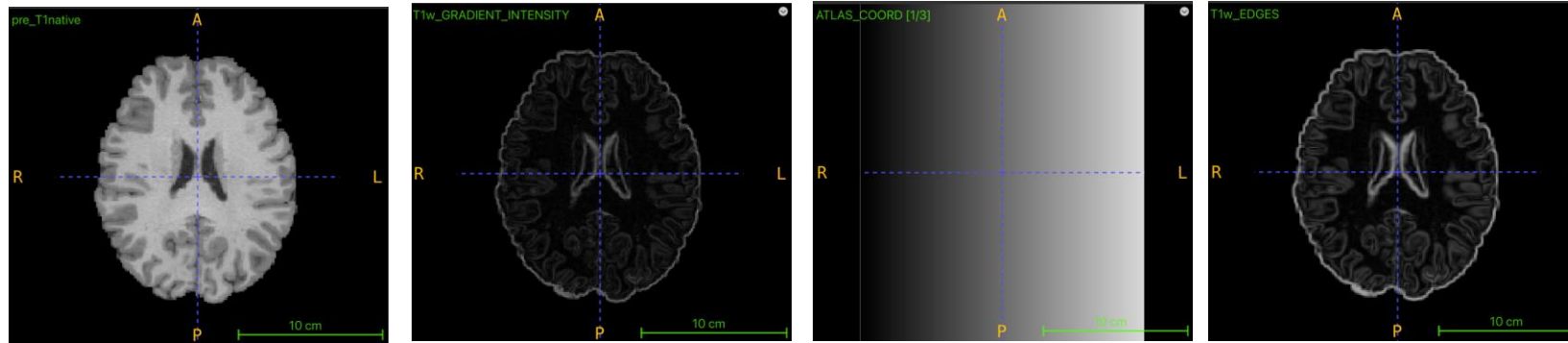
Metrics

- Added Hausdorff Distance (95th percentile), complementing Dice Score
 - Better captures smaller anatomical regions (Amygdala and Hippocampus) in comparison to Dice
- Results logged as CSV files and visualizations shown as boxplots and feature importance plots
- Used **mean Dice** over all regions as the main metric



Features extraction

To test the hypothesis, the following features were extracted:

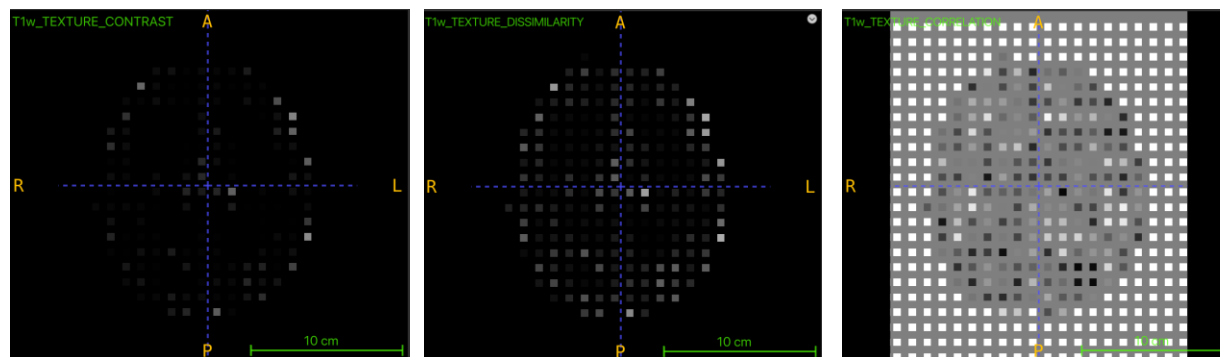


intensity

gradient

coordinates

edges



contrast

dissimilarity

correlation

Visualisations cover the features computed for **T1 weighted** images. Features for **T2 weighted** images were also used in experiments.

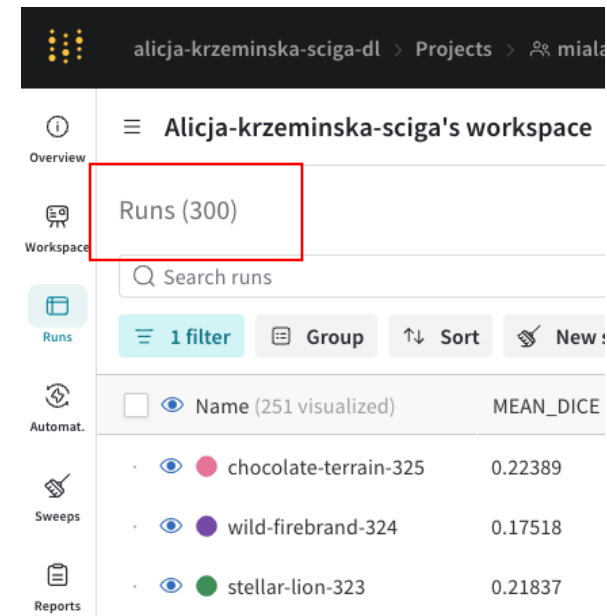
Experiments

Three types of experiments were performed:

1. **Verification of the main hypothesis.**
2. Verification of the impact of the number of estimators in Random Forest Classifier on the results.
3. Verification of the texture window size on the results.

Technical details:

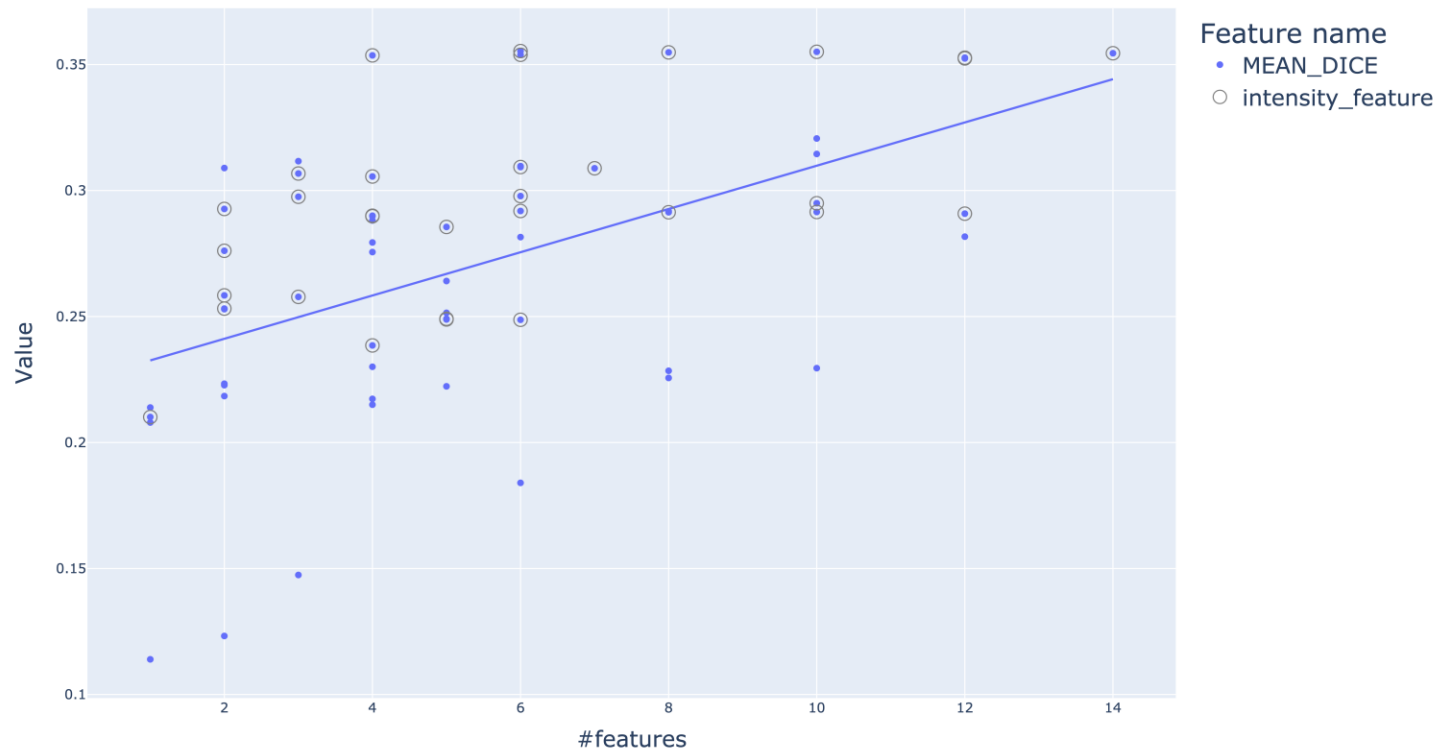
- To verify the main hypothesis (the more features, the better results), all combinations of extracted features were tested.
- To keep track on the experiments, all metrics were logged to W&B.
- All experiments were run on the UBELIX.



Results

Verification of the main hypothesis

Metrics values with respect to features number (n_estimators=100, texture_window: 5)



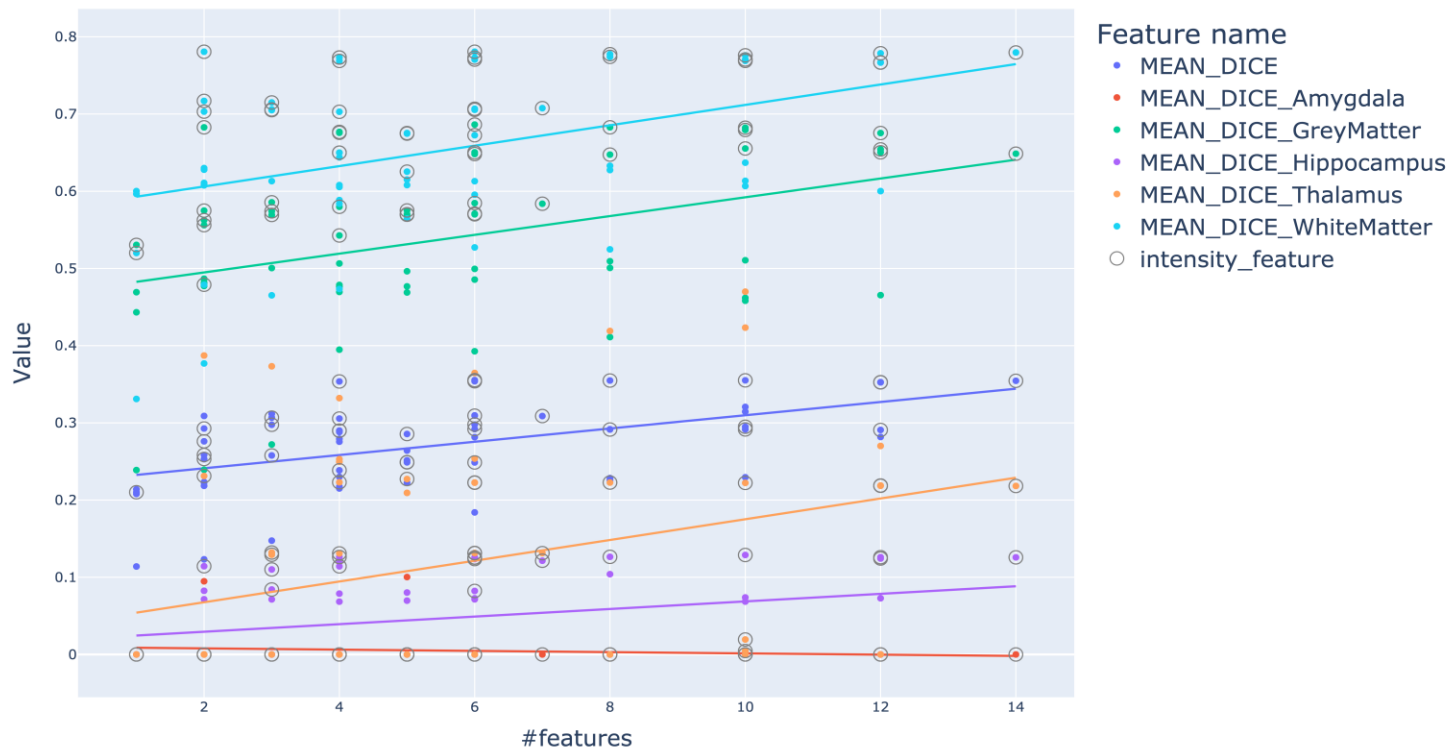
Observations:

- In the results we can see that in general, the more features is added, the better is Dice Score.
- The best Dice Scores are computed for the runs where the intensity feature is active.

Results

Verification of the main hypothesis

Metrics values with respect to features number (n_estimators=100, texture_window: 5)

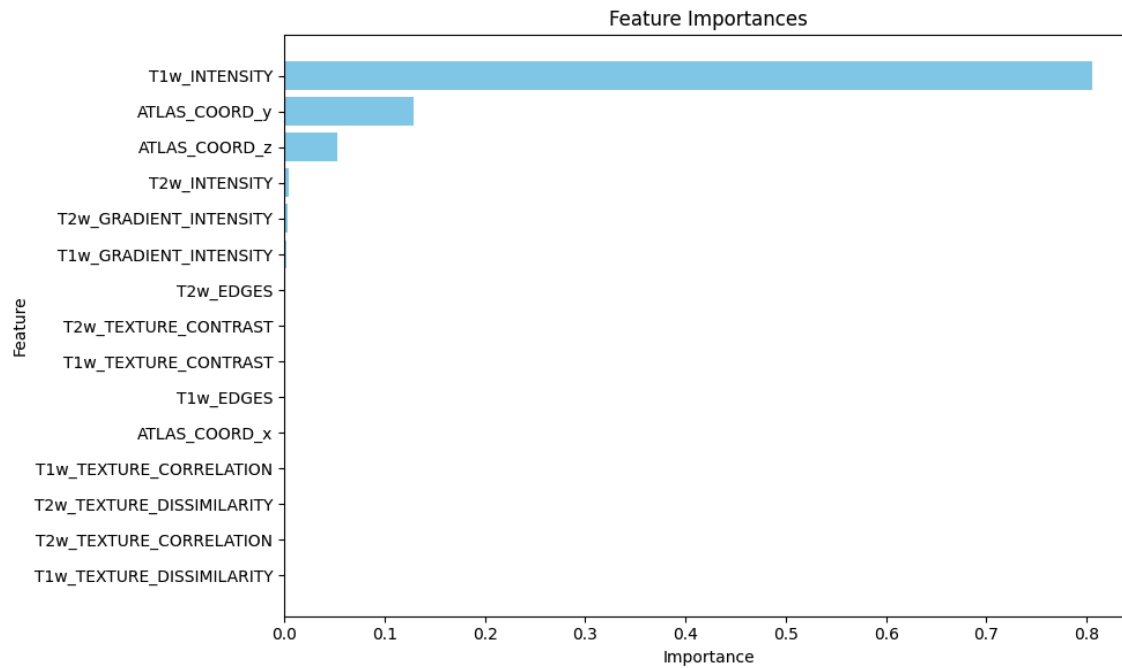


Observations:

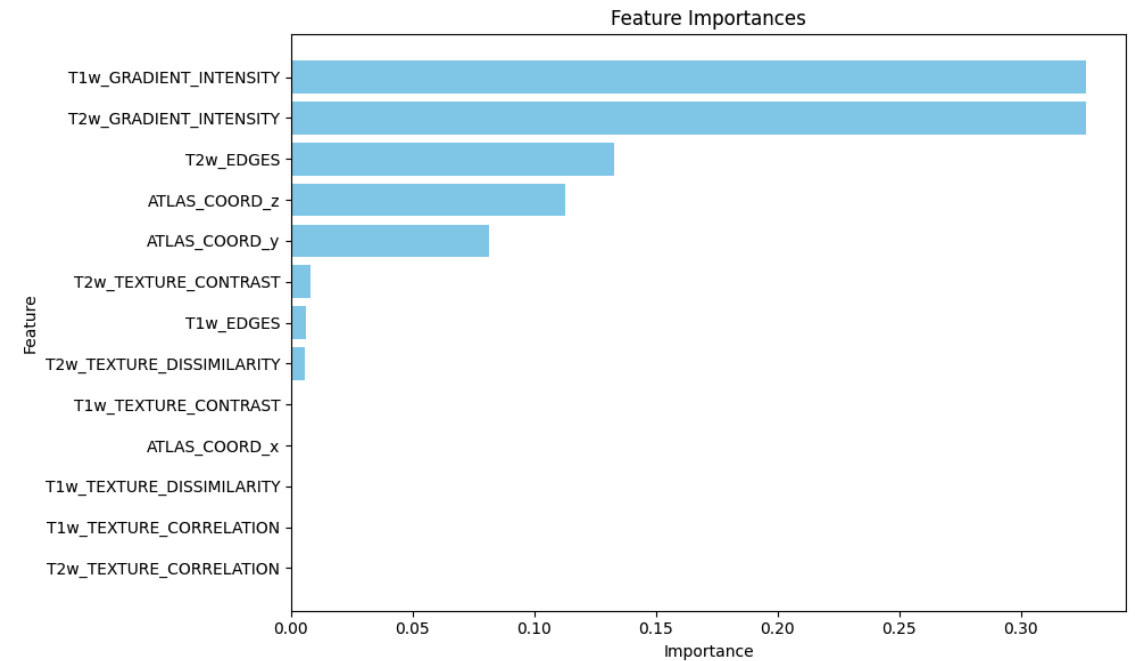
- In the results we can see that in general, the more features is added, the better is Dice Score.
- The best Dice Scores are computed for the runs where the intensity feature is active.
- The greatest value of Dice Score is assigned to the classes that represent relatively big organs.

Results

Verification of the main hypothesis



All the features included

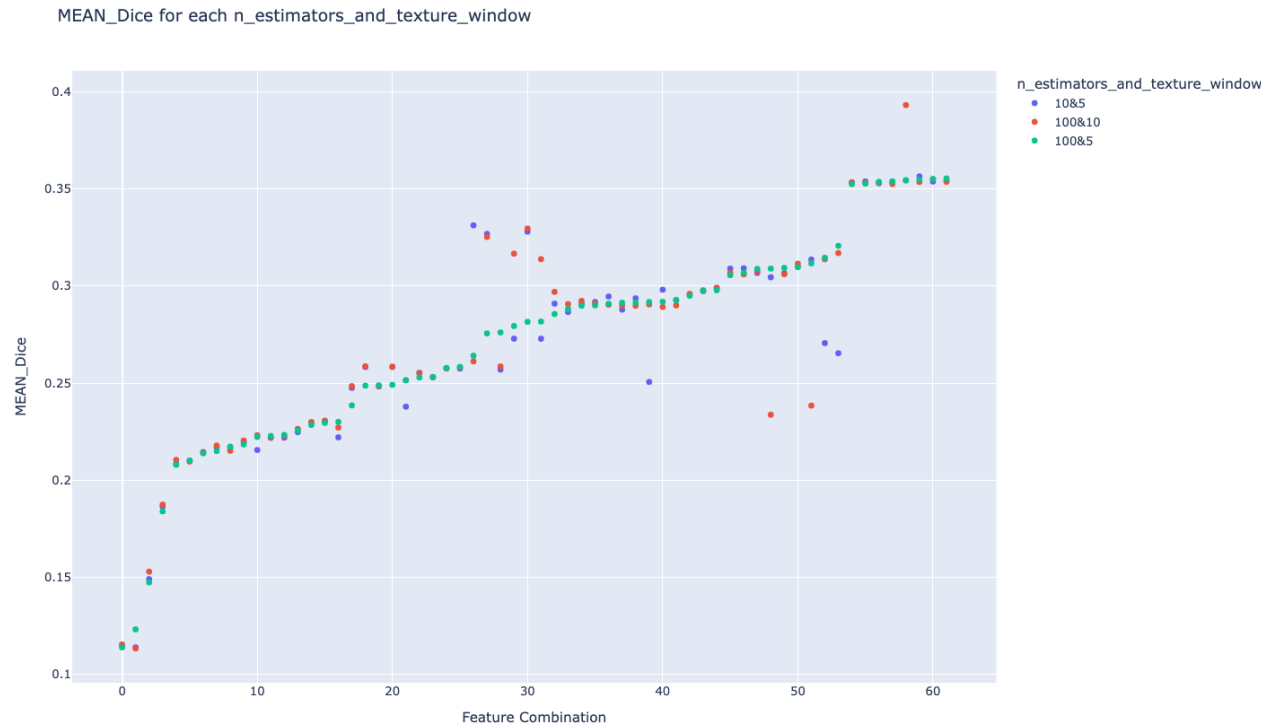


Intensity features not included

Results – side hypotheses

Verification of the impact of the number of estimators in RFC on the results

Verification of the texture window size on the results



Observations:

- Update of $n_estimators$ or $texture_window$ leads to a difference in the performance of the model.
- The difference in the number of estimators in Random Forest doesn't impact the results significantly.
- Smaller texture window does not impact the results significantly.

Conclusion

- Our hypothesis: A larger number of features increases segmentation performance
 - Increased slope with a larger number of features supports our hypotheses
 - With intensity features, other features become less important
 - Changes in the size of the texture window or the number of estimators in the random forest do not have a significant impact.
- Larger regions, like Gray matter or White matter have higher mean Dice Scores.

Outlook

- Pre-processing should be further improved.
- Focus on small regions extraction, like the Amygdala, by exploring texture or intensity variations.
- Compare different classifiers.
- Other comparison metrics than mean Dice could be further investigated.

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