Cancerous Tissue Detection Using DCE-MRI Time-Signal Intensity Curves

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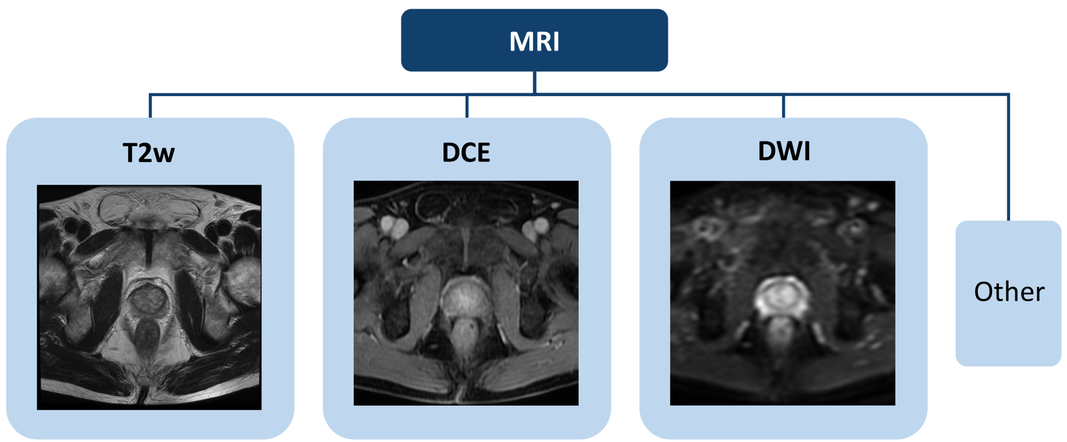
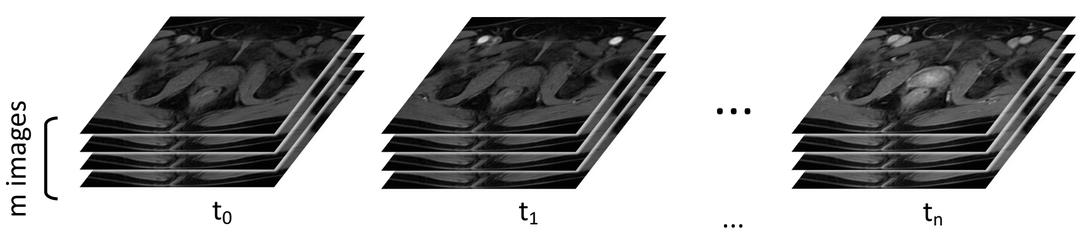
Introduction

Dynamic Contrast-Enhanced (DCE) imaging, one of MRI sequences, is often used to pinpoint tissues with higher vascular density, including cancerous growth. This research is focused on the usage of DCE data to detect prostate cancer in patients, potentially avoiding the need of biopsy which is an invasive, expensive, and unreliable alternative.



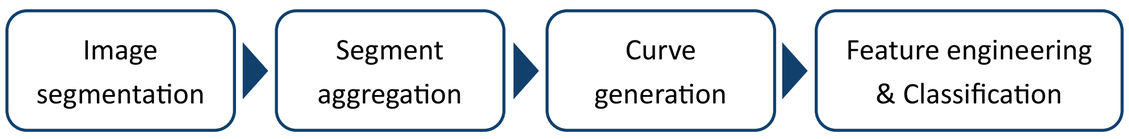
Data and Methods

DCE data is unique from other MRI output by having both spatial and temporal axes. Data for each patient consists of a number of axial cross-section 2D grayscale images over a period of time.



In addition, prostate and cancer regions were manually segmented by medical experts. Biopsy results were used as ground truth label.

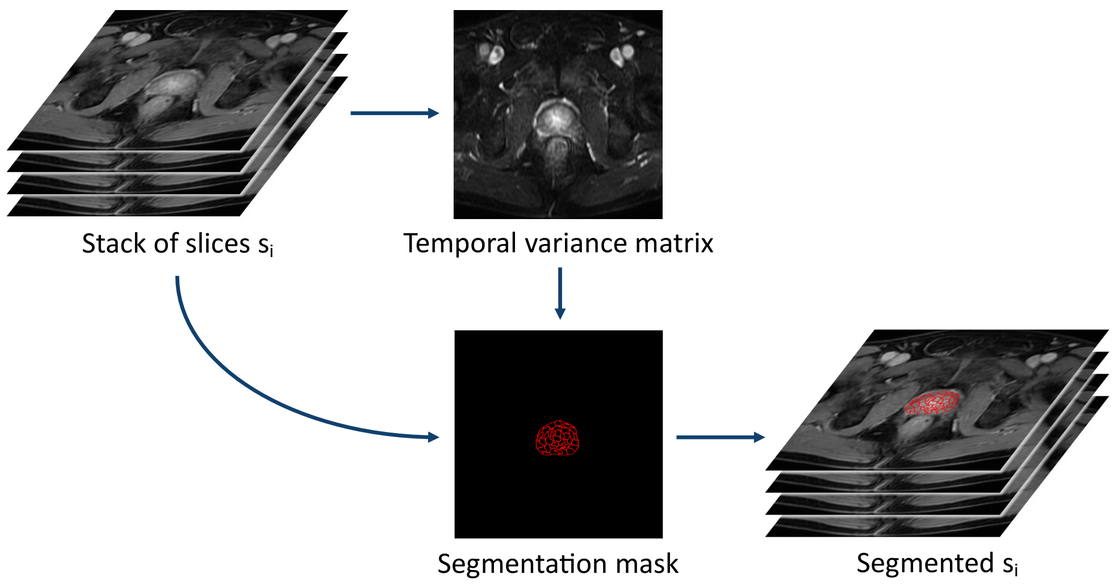
The aim is to use DCE images to construct time-signal intensity curves which act as a feature engineering base for a classification model.



Workflow

Image segmentation

Simple Linear Iterative Clustering (SLIC) is a segmentation algorithm based on k-means clustering. SLIC is applied to prostate region of a generated temporal variance matrix for a selected slice to segregate different zones by pixel intensity change and location similarity which are projected onto every corresponding slice.



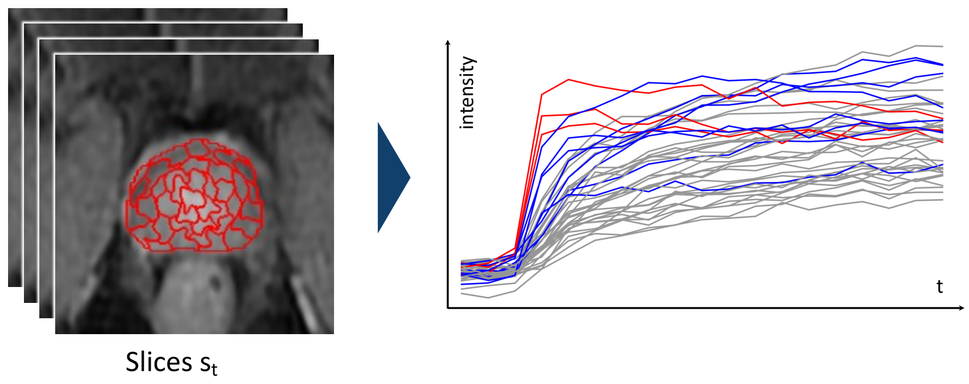
Segment aggregation

To aggregate pixel intensities on segment level, several descriptive statistics were tested: mean, median, minimum, maximum, 10th percentile, 90th percentile. The mean statistic outperformed at separating malignant and benign segments.

Curve generation

The resulting values are plotted as time-series curves for each slice and time moment. In addition, a differentiated time-series is calculated.

Curves are plotted and separated by color into 3 groups: >80%, 0-80%, and zero intersection with cancer region(s).



Conclusion

Findings:

- Optimal SLIC parameters are compactness = 7 (balance between pixel similarity grouping and maintaining coherent shape), and number of segments around 40-50
- With higher segment number of SLIC, some pairs of aggregation methods converge (e.g. maximum & 90th percentile)
- Due to varying behavior of time-signal curves, a robust method should be considered for classification

Further research:

- Explore segmentation alternatives to temporal variation matrix
- Apply Functional Data Analysis methods for:
  - Curve smoothing
  - Additional features: derivative, 2nd derivative
  - Curve registration
- Construct classification model