CT Slice Localization via Instance-Based Regression

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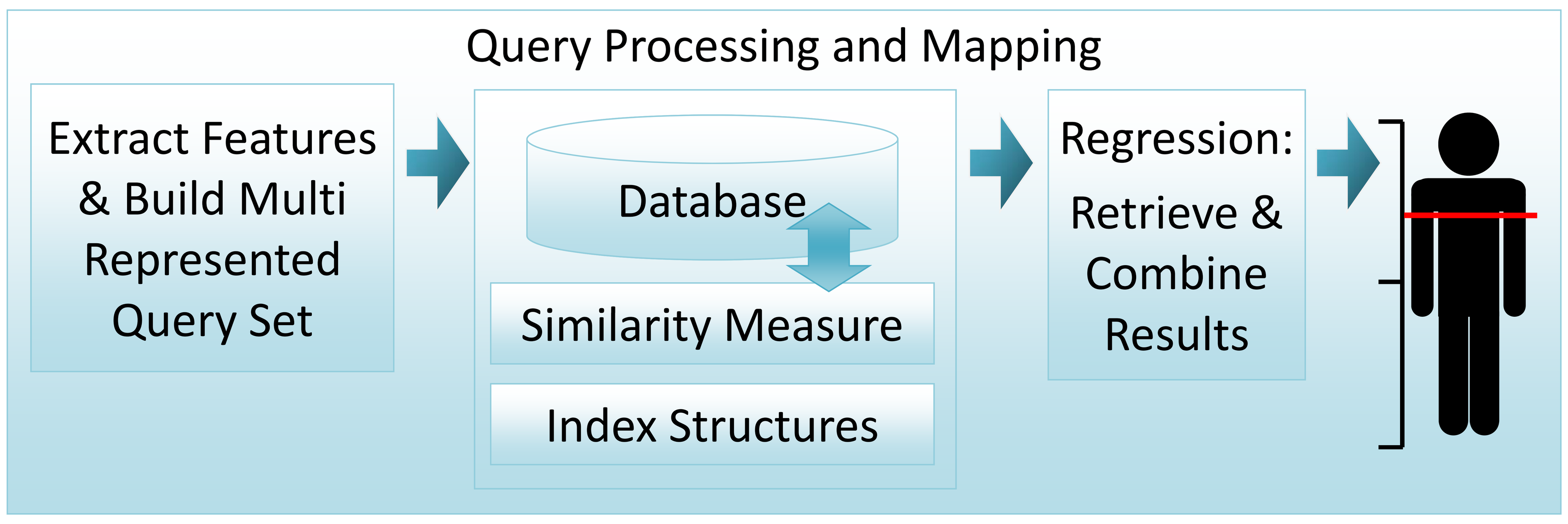
Goal:

- Localize CT-Slices in a fast and reliable way, in order to support attending doctors and to simplify navigation in data sets
- Annotate volume scans according to a normalized scale in order to compensate patients of varying height and pre-process CT-scans to obtain local sensitive features
- Compensate metadata errors in CT-scans referring to the patient's position
- Enrich CT-Scans by adding possible ontology concepts



Idea:

- Extraction of features with spatial sensitivity according to the displayed body region
- Usage of different feature types in order to match both bones and organ structure
  - Gradient features (histograms of oriented gradients - to match bone structure)
  - Texture features (Haralick - to match organ structure)
- Combine histograms of lower resolution (complete image) with higher resolution data (using bounded box around patient body)
- Nearest Neighbour classification for results in an error-interval acceptable by attending doctors
- Mapping results to an extended FMA ontology to provide ontological concepts related to the input image
- Similarity measure can be either a regular, euclidean metric or an adaptive similarity measure for better accuracy

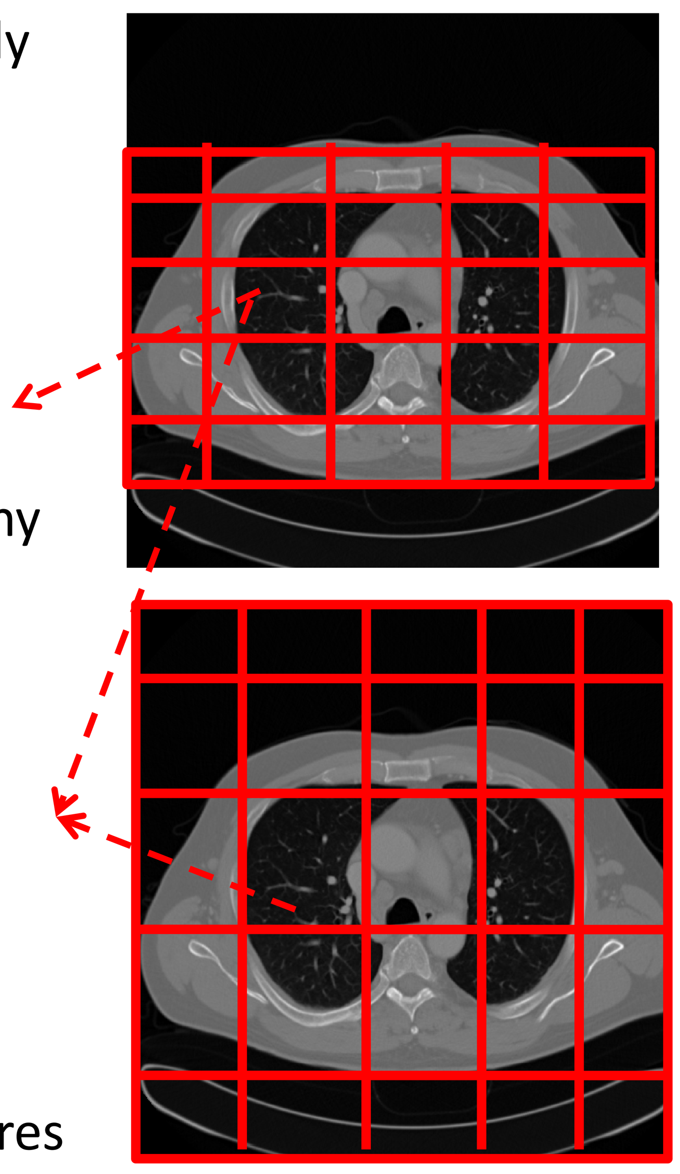
Feature Extraction:

Create duplicate representation:

- Extract bounding box around patient's body
- Ignore table, pillow, air around patient
- Partition images into 5x5 disjoint regions

Extract Image Features:

- Pyramid Histograms of Oriented Gradients (**PHOGs**)
  - Identify strong edges by applying a Canny edge detector
  - Build gradient histogram from pixels on strong edges
- Extract **Haralick** features from all regions of both images



Reduce Dimensionality:

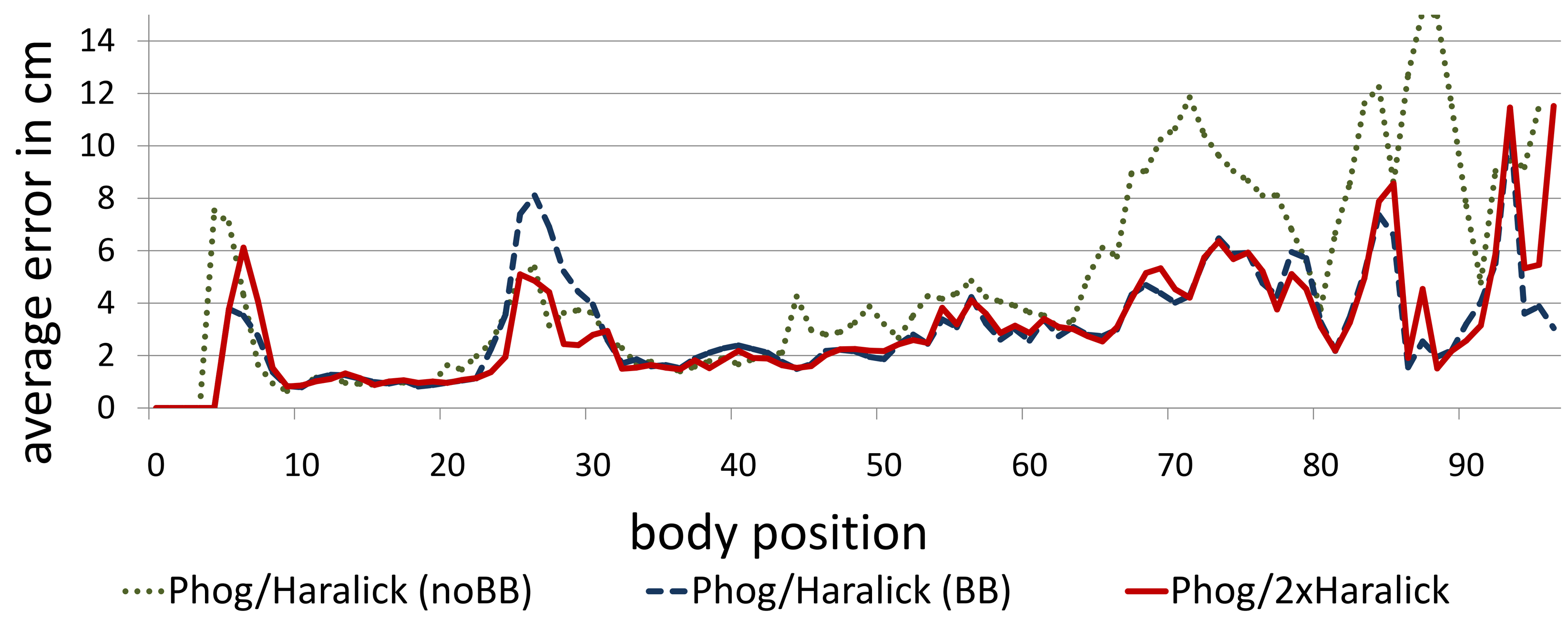
- Apply Principal Component Analysis (**PCA**) in order to remove highly correlated features
- Choose trade-off for dimensionality reduction between accuracy and the curse of dimensionality

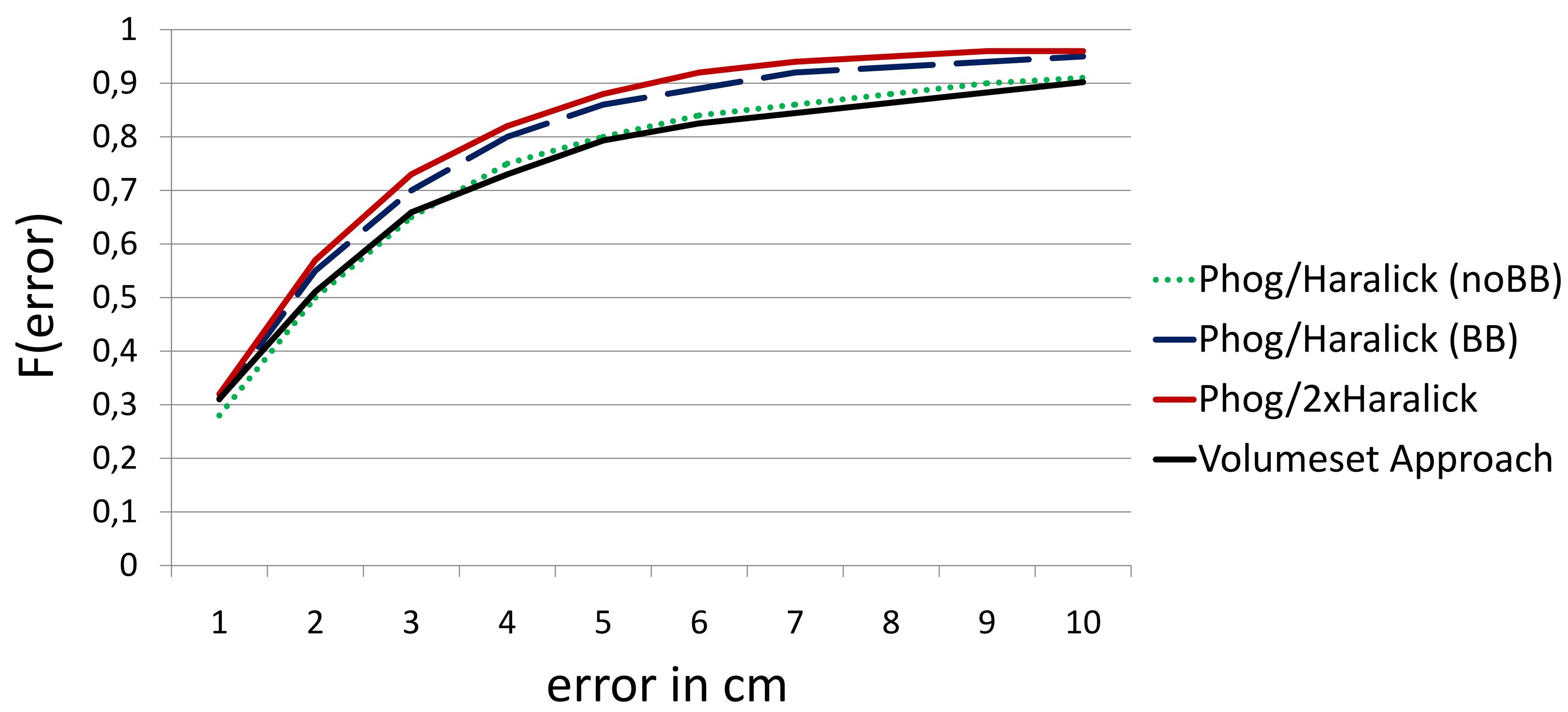
K-nn Regression:

- Iterate over all scans (of different patients)
  - For each scan, search for the first nearest neighbour for each of the representations extracted from the query
- Build intervals of z-values of the top *k*-nns for each representation
- Chose the interval with the lowest extent and return the average value of this interval as prediction for the query slice

Experiments:

- Clinical real-world dataset of 34 volume scans from 24 patients (10,443 images) with complete heterogeneous recording modes according to slice thickness, kVp value, volume height, contrast media, etc.
- Leave-one-out validation across volume scans
- Measured: average error, cumulative distribution function, impact of *k* and PCA compared to volume-based approach





Conclusion:

Improved state of the art by

- requiring just a single query slice instead of volume sets of more than 44mm thickness
- Even lower error rates if adaptive similarity measures are applied
- No offline training required

Market Exploitation:

- Clinical PACS could benefit from more specific queries instead of always loading complete volume sets
- Assist attending doctors in finding same positions in different volume scans when comparing scans of the same patient

References:

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