FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Master‘s Thesis Presentation

Semi-Automatic Spine Labeling on T1- and T2-weighted MRI Volume Data

Master‘s Degree:
Medical Informatics

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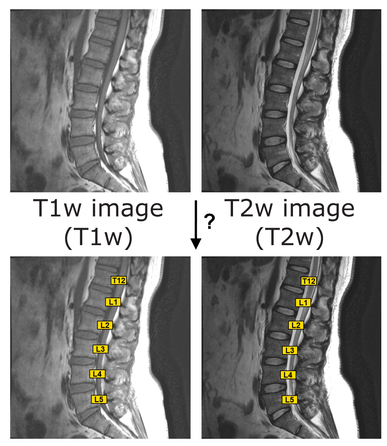
Motivation

Problem:
- Spinal column is a **frame of reference** in medical diagnosis
- Magnetic Resonance Imaging (MRI) scans do not exhibit a standardized intensity scale
- **Varying intensities** for the same tissue due to different scanners, changes in the image acquisition, etc.

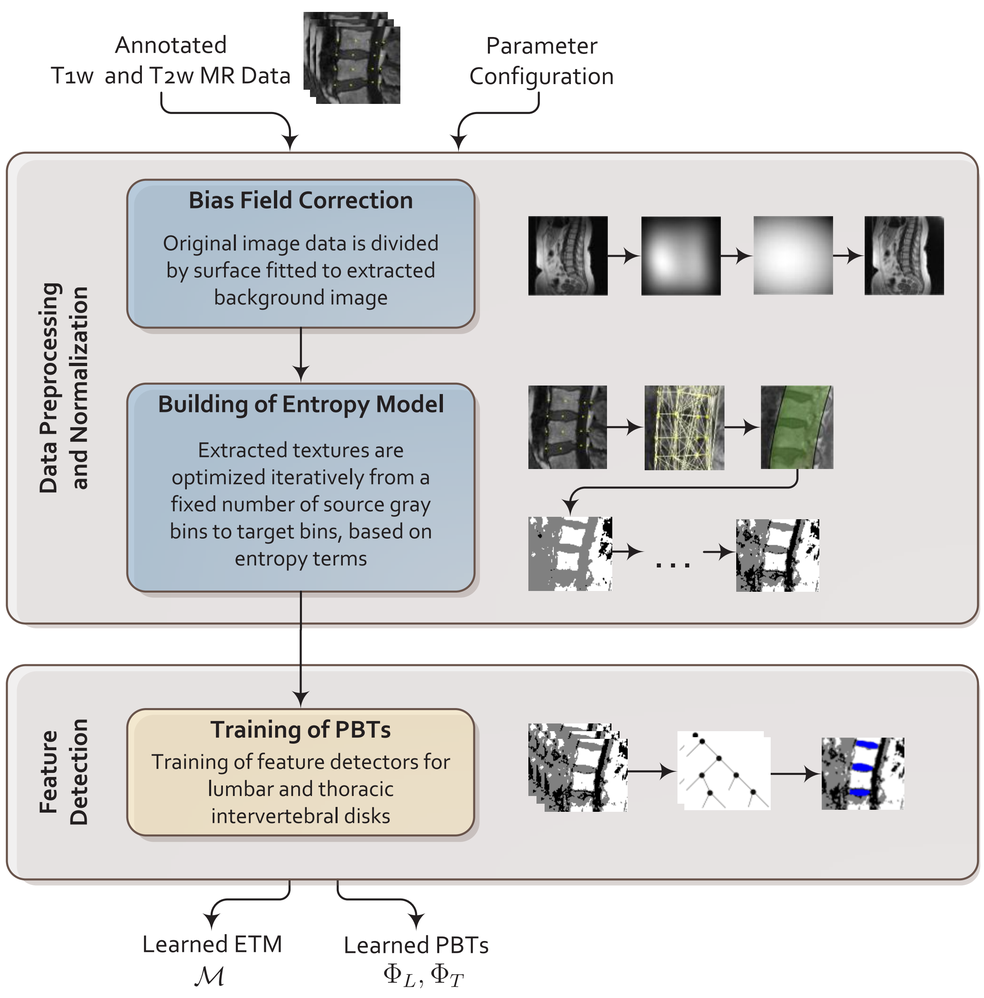
Goal:
- **Normalize T1- and T2- weighted MR volumes** to a reduced, standardized intensity scale
- **Localize intervertebral disks and vertebrae** in the normalized data
- Semi-automatic system, where a user provides an initial click position



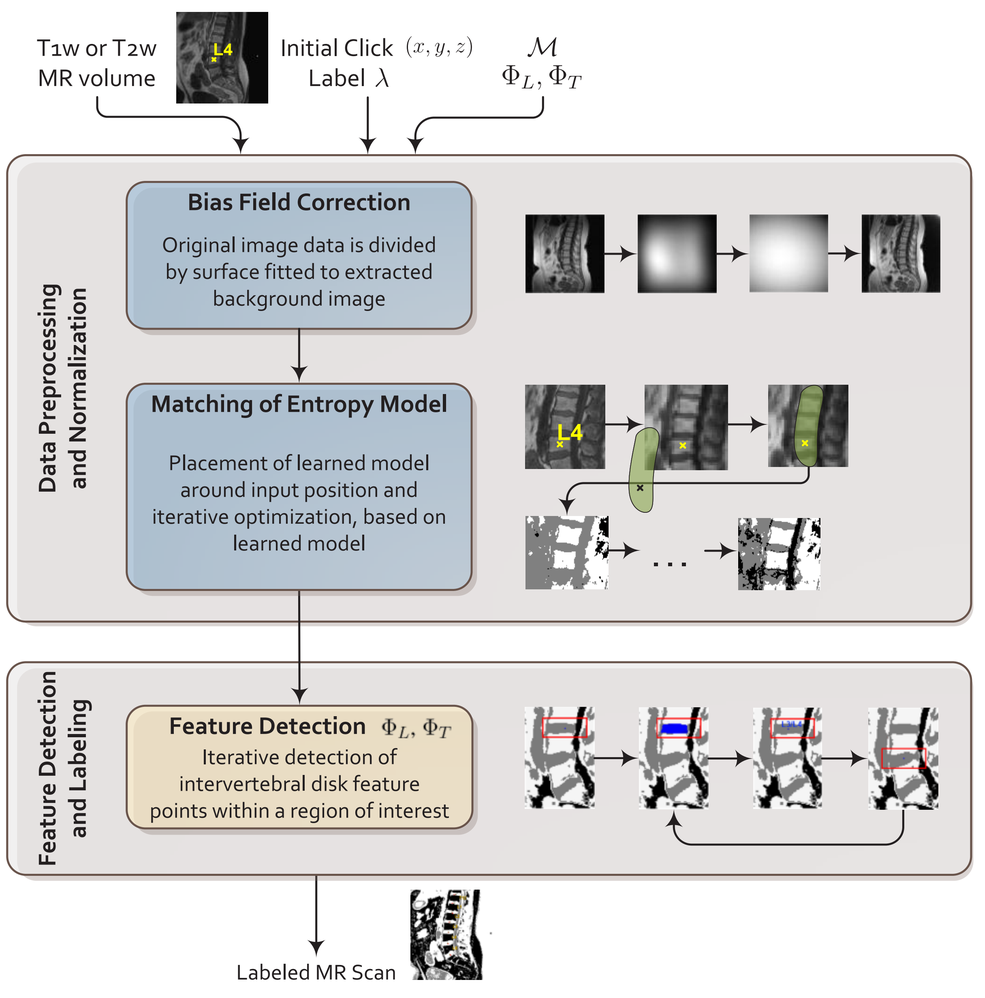
Basic Approach

- Learning-based system
- Preprocessing of MR scans with **bias field correction** method by Juntu et al. [1]
- Normalization of preprocessed scans with **Entropy-optimized Texture Models (ETMs)** by Zambal et al. [2]
- Intervertebral disk detection with optimized **Probabilistic Boosting Trees (PBTs)** by Schulze et al. [3]

Spine Model Building



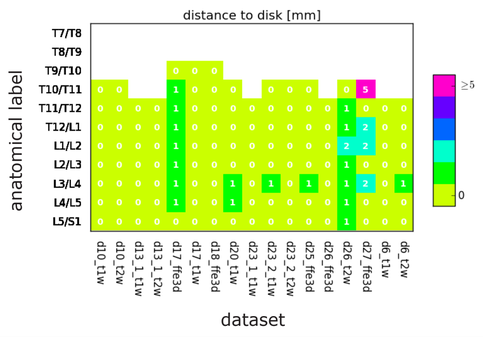
Semi-Automatic Labeling of Unseen Dataset



Results

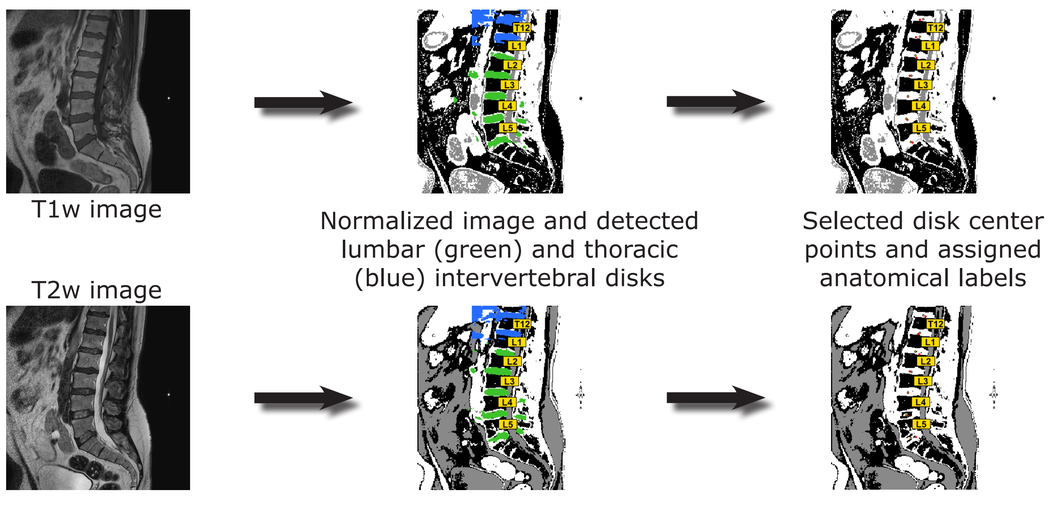
- **Parameter space exploration** for various parameters of entropy models
- Training of entropy models and boosting trees on eleven T1w and T2w volume datasets
- Evaluation of labeling pipeline on **18 unseen lumbar T1w and T2w MR volumes**

- Disk localization **precision of 91.9 %** at a **recall of 91.7 %**
- Mean overall processing time of **6.0 s per dataset** (0.8 s per detected disk)



Mean distance-to-disk-cylinder error for a complete data normalization and labeling run, with initial click position in a specific disk (y-axis) in a dataset (x-axis)

Sample result yield with learned model and classifier:



Conclusion

- We present a novel pipeline for the labeling of **different kinds of MR datasets**.
- We learn only **one model**, which captures the intensity variation in T1-weighted and T2-weighted MR volume data.
- Without prior knowledge about the weighting of an unseen dataset, we can **reduce its intensity scale** and **successfully localize and label intervertebral disks** in a semi-automatic way.

Acknowledgements

This thesis was carried out at the **VRVis Research Center Vienna** in cooperation with our project partner **AGFA HealthCare**.

References: [1] J. Juntu, J. Sijbers, D. Van Dyck and J. Gielen. *Bias Field Correction for MRI Images*. In Computer Recognition Systems, volume 30, pages 543 - 551, 2005.
[2] S. Zambal, J. Hladůvka and K. Bühler. *Entropy-optimized Texture Models*. In MICCAI 2008, volume 5242, pages 213 - 221, 2008.
[3] F. Schulze, D. Major and K. Bühler. *Fast and Memory Efficient Feature Detection using Multiresolution Probabilistic Boosting Trees*. In Journal of WSCG, volume 19, pages 33 - 40, 2011.

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