

Center for Discrete Mathematics and Theoretical Computer Sciences, DIMACS
REU-2017, Rutgers University

Spatiotemporal Big Data Analytics for Osteoarthritis Detection

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About Osteoarthritis Initiative (OAI)

Background Information

Project Description

Objectives & Source of Data

Methodologies

Next Steps



- ▶ Multi-center, longitudinal, prospective observational study of knee osteoarthritis (OA).
- ▶ Develop a public domain research resource.
- ▶ Provide database for osteoarthritis including clinical evaluation, biological specimens, and imaging data.



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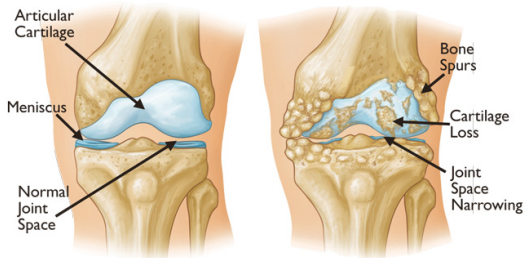


Figure 1: Normal Knee vs Affected Osteoarthritis Knee Image



Objectives:

- ▶ Identify clinical biomarkers for early detection of osteoarthritis
- ▶ Improve the prevention and intervention strategies of knee osteoarthritis

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Source of Data



Osteoarthritis Initiative:

- ▶ Baseline - MRI images for entire cohort (n = 4,796 participants)
- ▶ 12-month follow-up up to 96-month follow up



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Figure 2: No sign of osteoarthritis

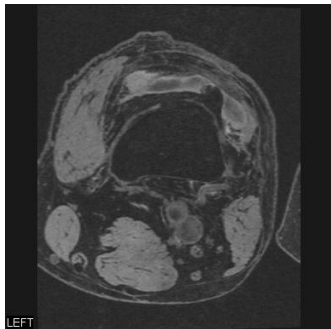


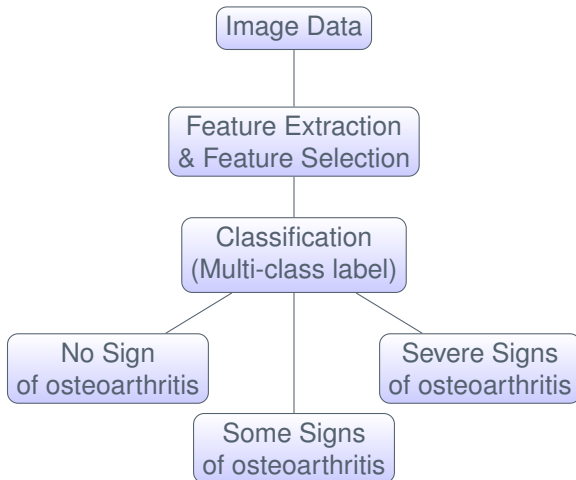
Figure 3: Severe signs of osteoarthritis

Project Description

Methodologies

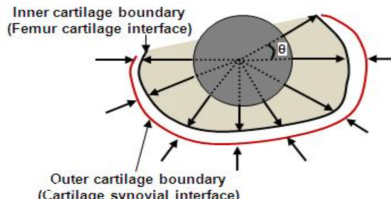
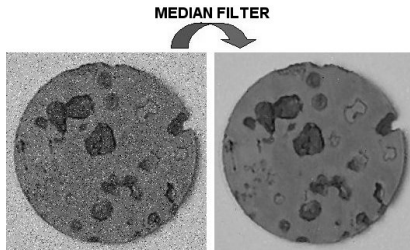


- ▶ **Method 1:** Image Processing
- ▶ **Method 2:** Tensor Decomposition



Method 1: Image Processing

1. Image Pre-processing
 - ▶ Median Filter
2. Image-Segmentation
 - ▶ Detection of Cartilage Boundary
3. Thickness Calculation
4. Classification



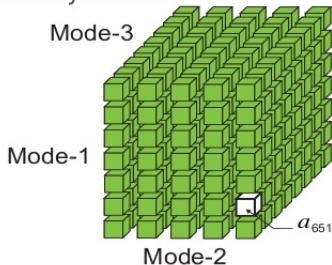


Method 2 - Tensor Decomposition

1. Arrange data in a tensor structure

WHAT IS A TENSOR?

A tensor is a multidimensional array
E.g., three-way tensor:





2. Tensor Decomposition

- ▶ Candecomp/Parafac (CP) Decomposition
- ▶ Tucker Decomposition
- ▶ Multi-linear Discriminate Analysis
- ▶ Multi-linear Principal Component Analysis (PCA)
- ▶ Uncorrelated Multi-linear PCA

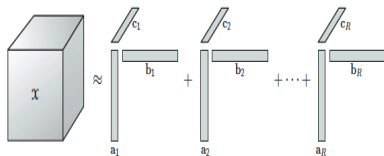


Fig. 3.1 CP decomposition of a three-way array.

3. Early Detection & Classification



- ▶ Week 2 - Week 4: Theoretically and Experimentally Framework for Method 1 + Analyze Results
- ▶ Week 5 - Week 9: Theoretically and Experimentally Framework for Method 2 + Analyze Results + Final Report



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Dr. Weihong Guo

DIMACS

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