

Data Science and Imaging Informatics of Precision Medicine

Yuichi Motai, Ph.D. Department of Electrical and Computer Engineering, College of Engineering, Virginia Commonwealth University, Richmond, Virginia, USA ymotai@vcu.edu +01-804-828-1281

Overview

Collaborations Needed:

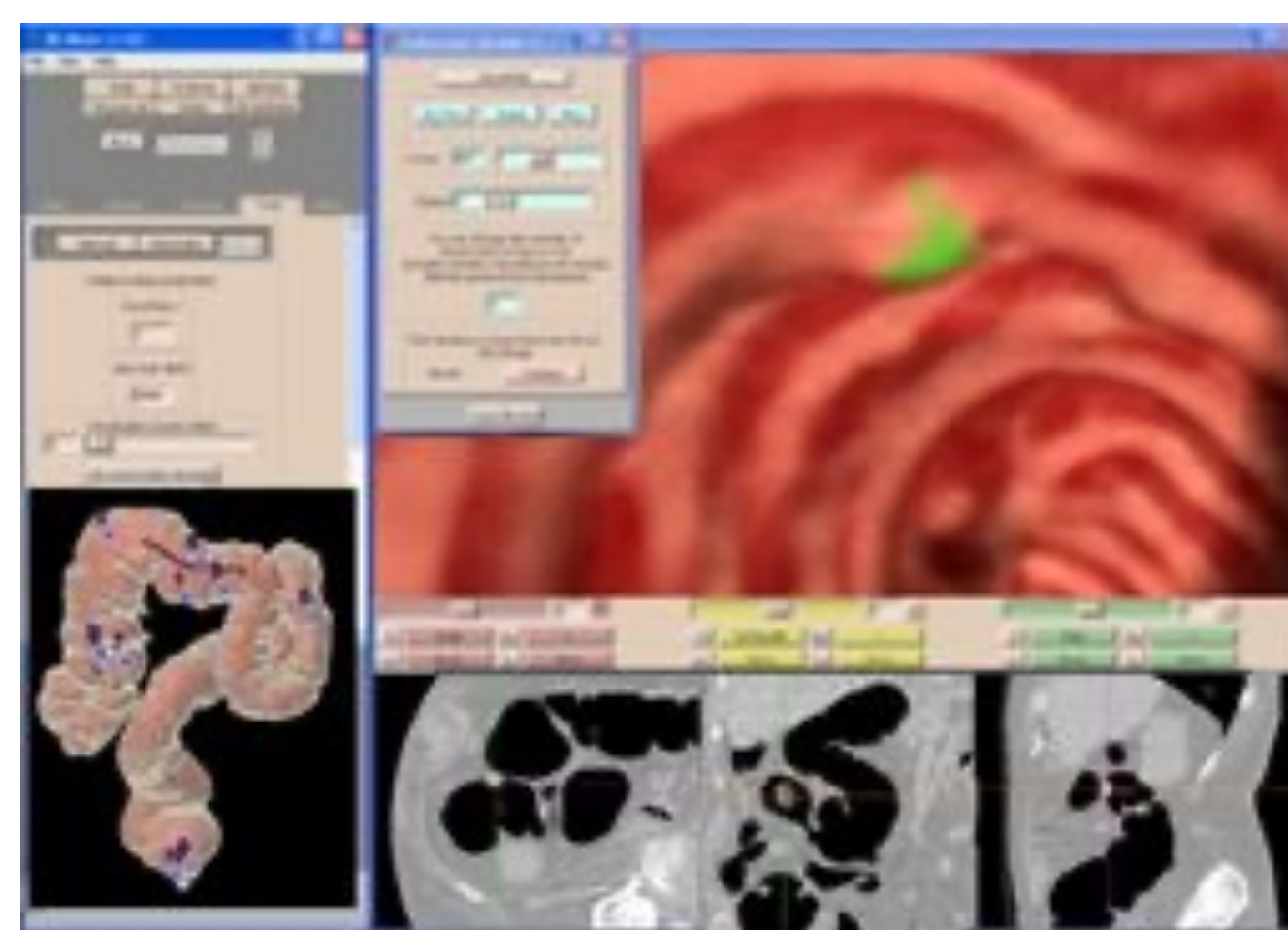
Collaborations on medical or multi-disciplinary research and development are wide open for specific problems, identified by the collaborators

Expertise of Motai's Group:
 [Data science] AI and machine learning
 [Systems Integration] Multiple-sensory fusion of complex systems
 [Adaptive Systems] Scale analysis such as micro and macro interaction
 [Dynamic Automation] Spatial-temporal integration for predictive automation

Potential Collaborators of AIBS communities:
 Some Research Experience
 Identify Fundable Problems
 Provide Required Datasets for Engineers
 Participate in Scholary Activities

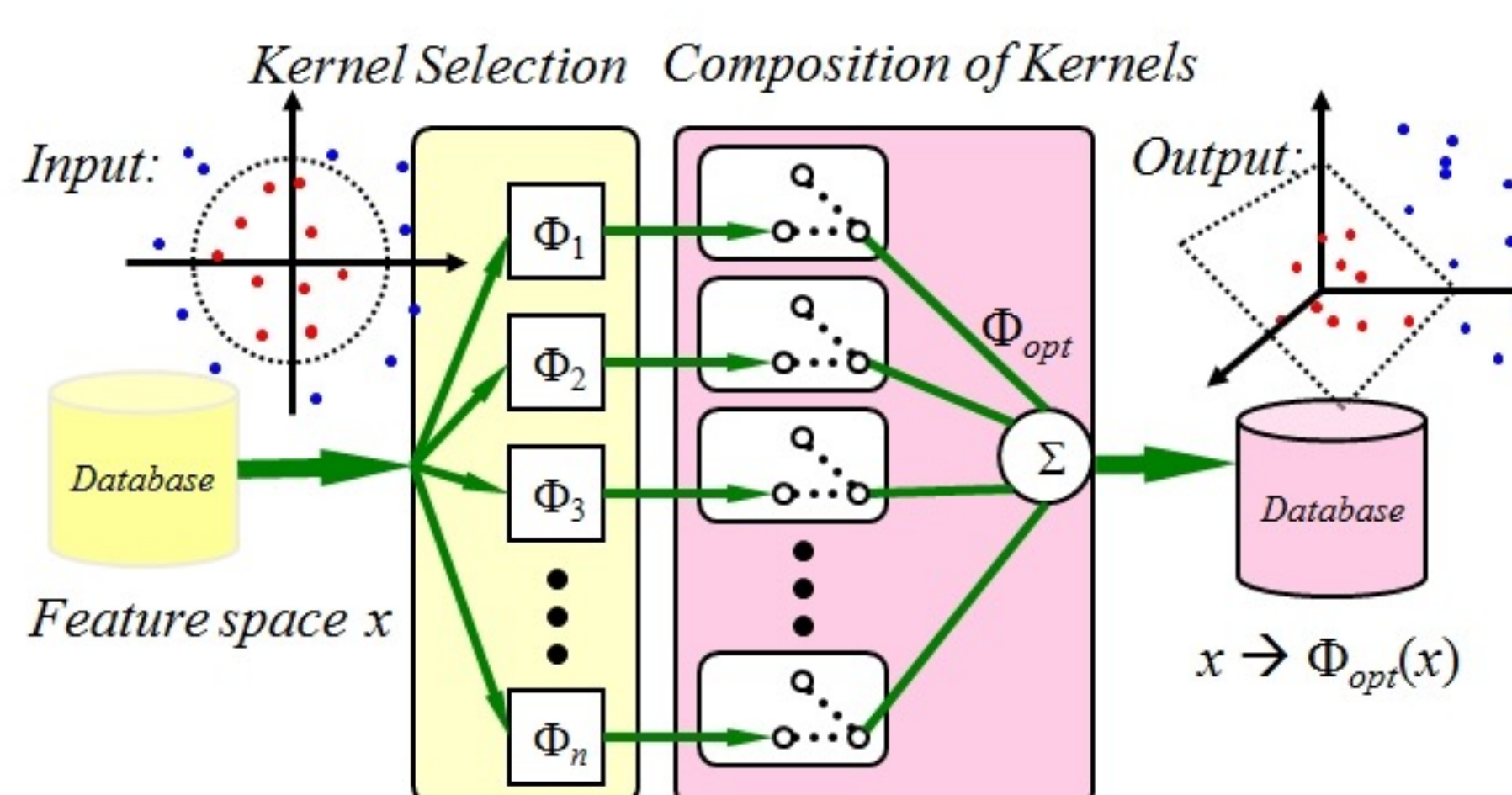
- Case studies in this poster are shown in the three departments: 1) cloud CT colonography, 2) personalized radiation therapy for lung tumors, and 3) heterogenous analysis to image-guided biopsy

1) Radiology



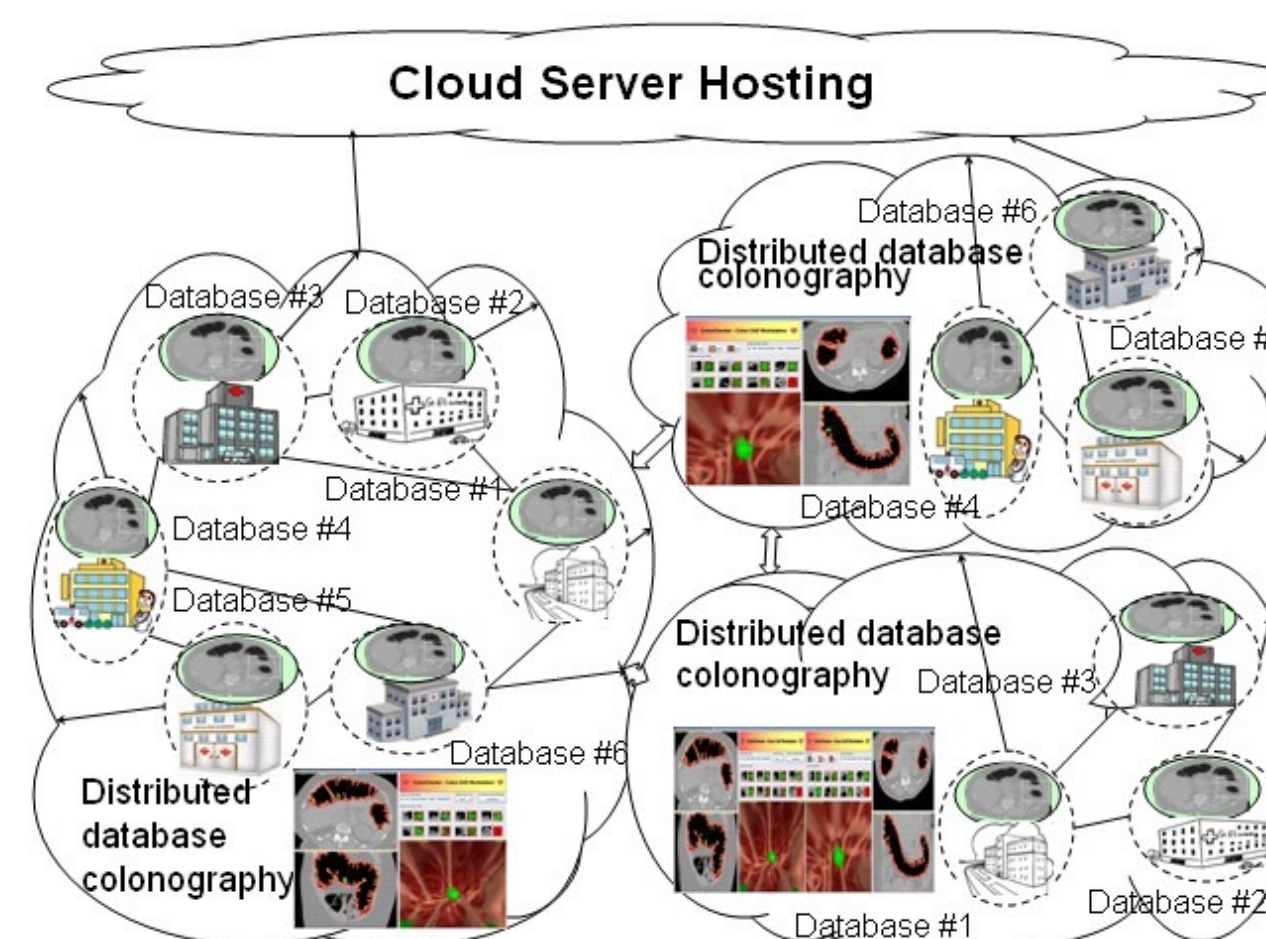
How to accurately classify data-variant targets:
 Online pattern clustering, longitudinal data analysis for cancer index

- Kernel data-association [IEEE TNNLS 2014]
- Predictive Cancer indexing [IEEE TII 2015]



- Kernel-based Classification [IEEE TDKE 2013]

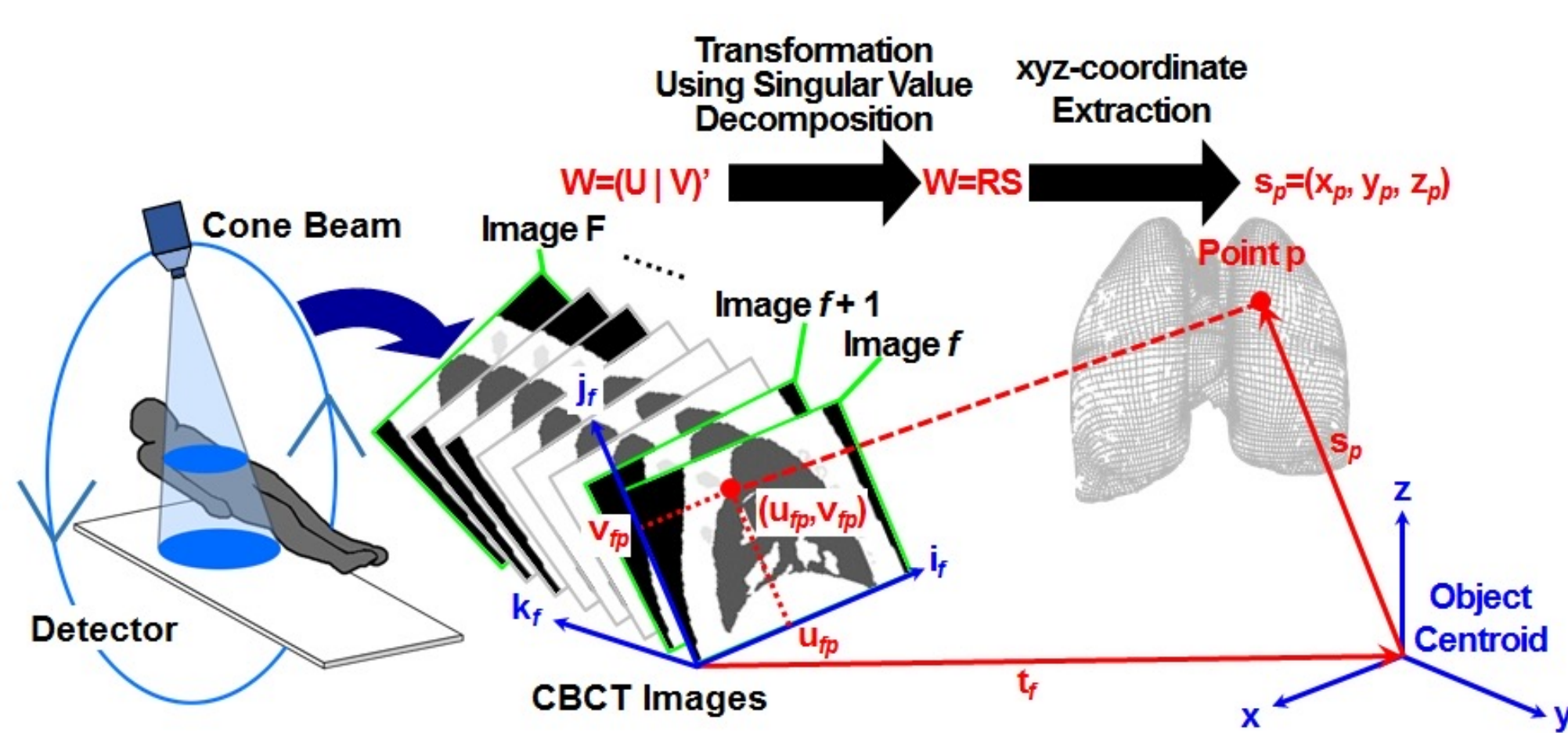
Computer-aided diagnosis:
 Unsupervised learning, activity recognition, unlabeled data with machine annotation



- Distributed-database Multi-institutions [ACM TIST 2014]
- Cloud Colonoscopy [IEEE TCC 2015]

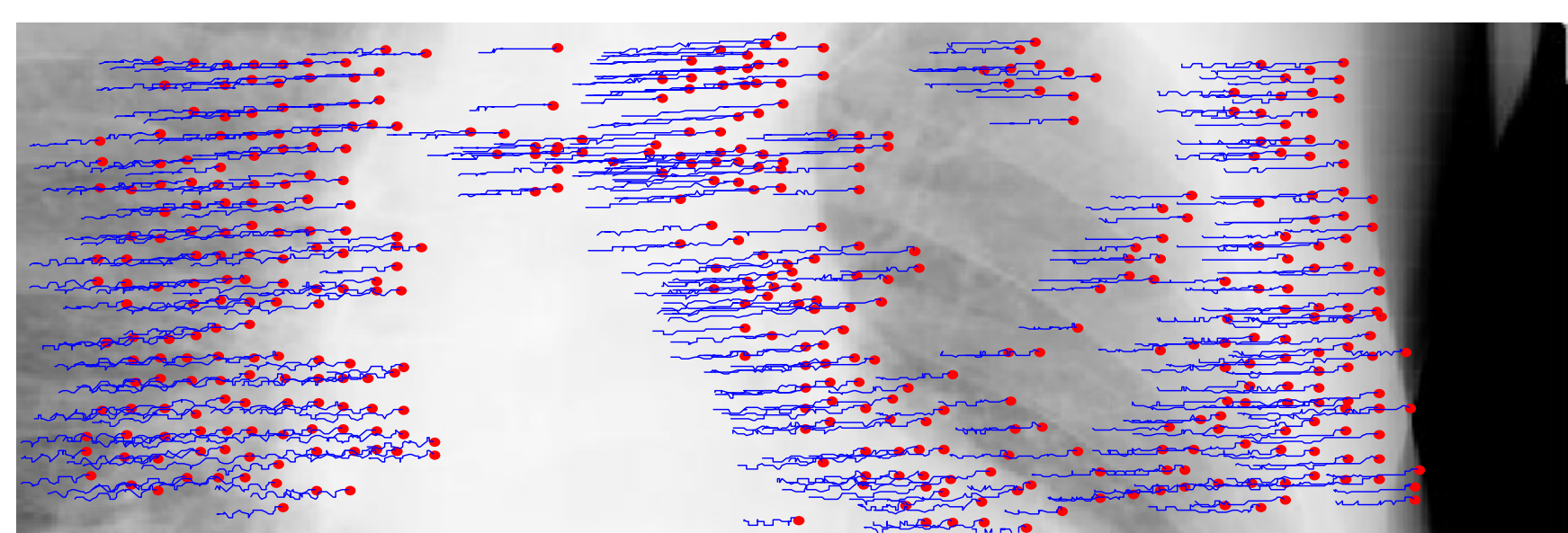
Distributed databases in multi-institutions:
 Collaborative learning among multiple-layer structure databases

2) Radiation Oncology



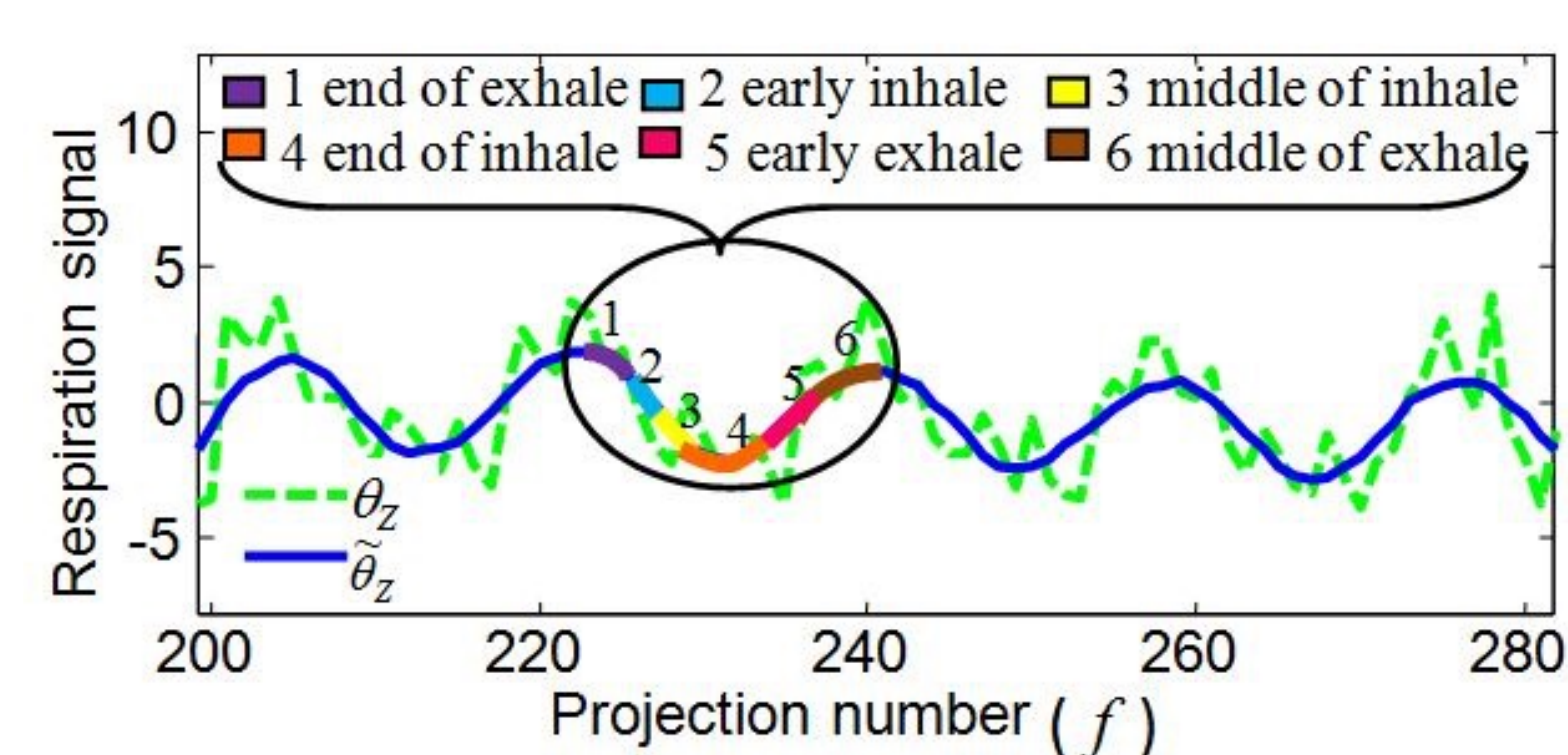
4D reconstruction using factorization:
 Factorize target CT images into movement and structure

- Cone beam CT Projection based on image Registration [IEEE TMI 2017]



How to acquire informatic image of target region for oncology:
 Tumor tracking via breathing

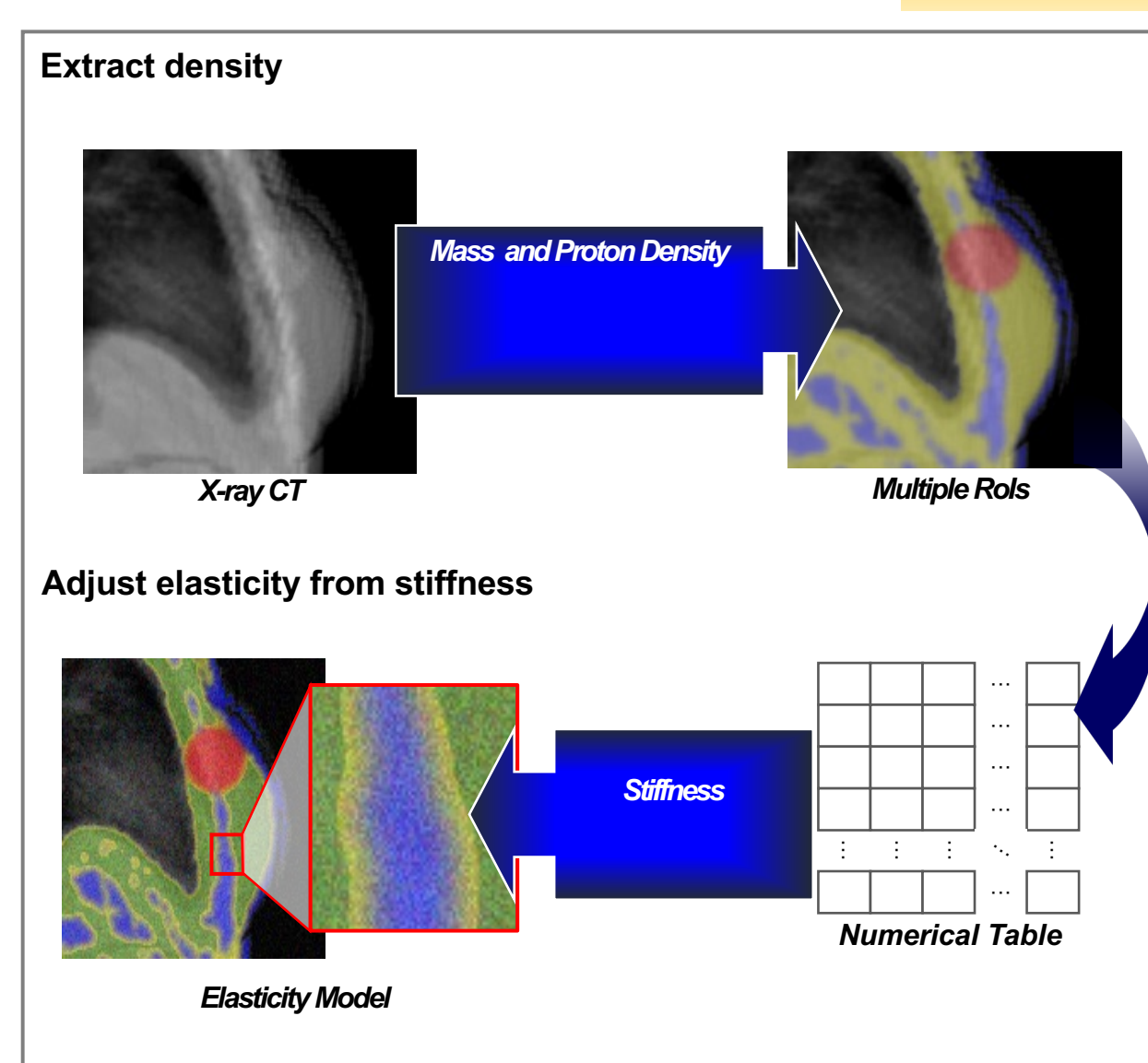
- Autoencoder-inspired Convolution Network Based Super-Resolution Method in MRI [IEEE JTEHM 2021]



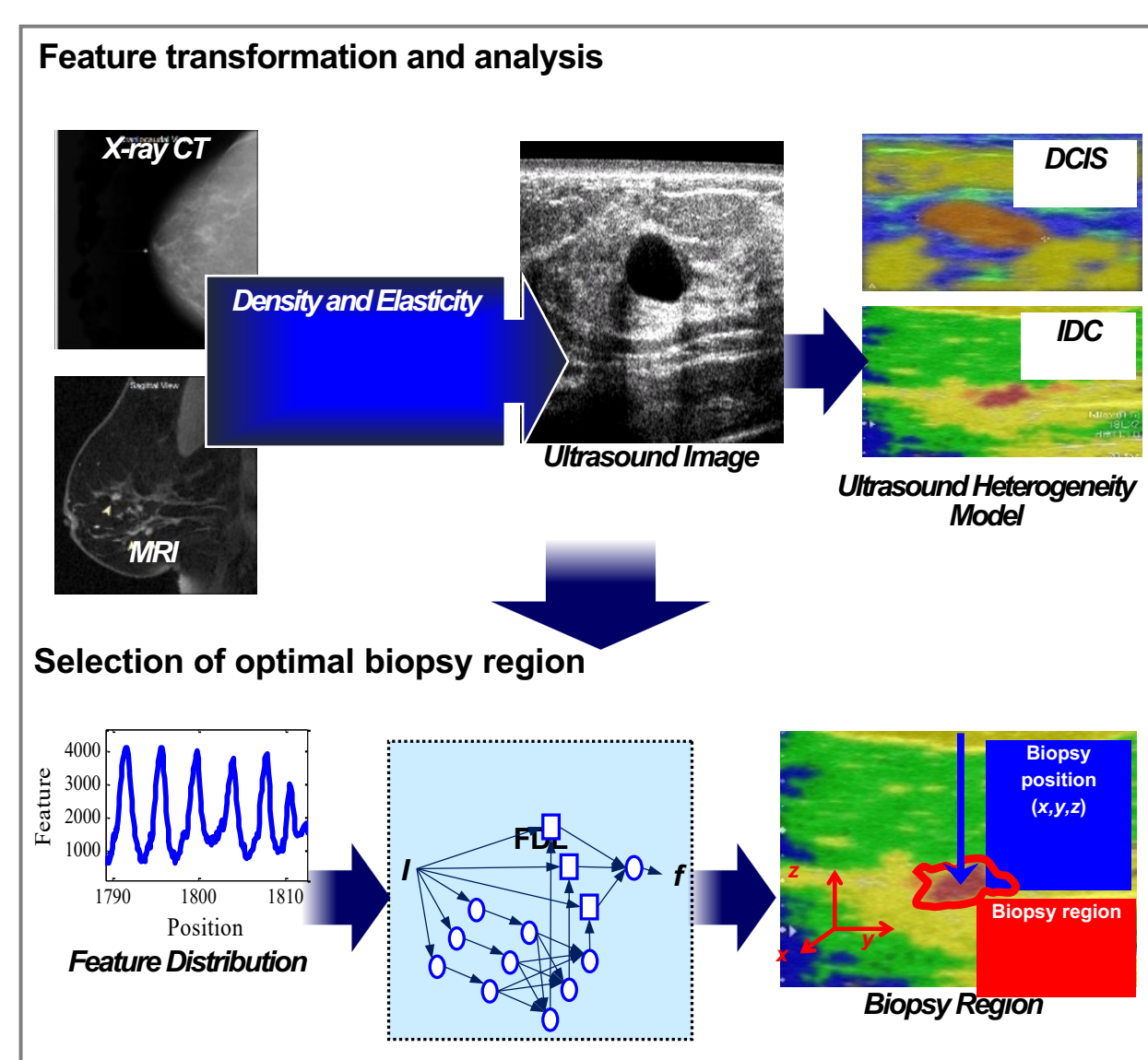
- Breathing Phase Tracking Estimating the Average Phase Shift [IEEE TBME 2013]

Breathing phase tracking:
 Project sorting by estimating phase shift from 4D cone-beam CT images

3) Surgery



Enhance cancer heterogeneity for breast surgery from image-guided biopsy
 Elastic feature extraction from mammogram images



Validate clinical benefits of ultrasound-guided biopsy
 Fuse microscopy images and mammogram for modeling heterogeneity

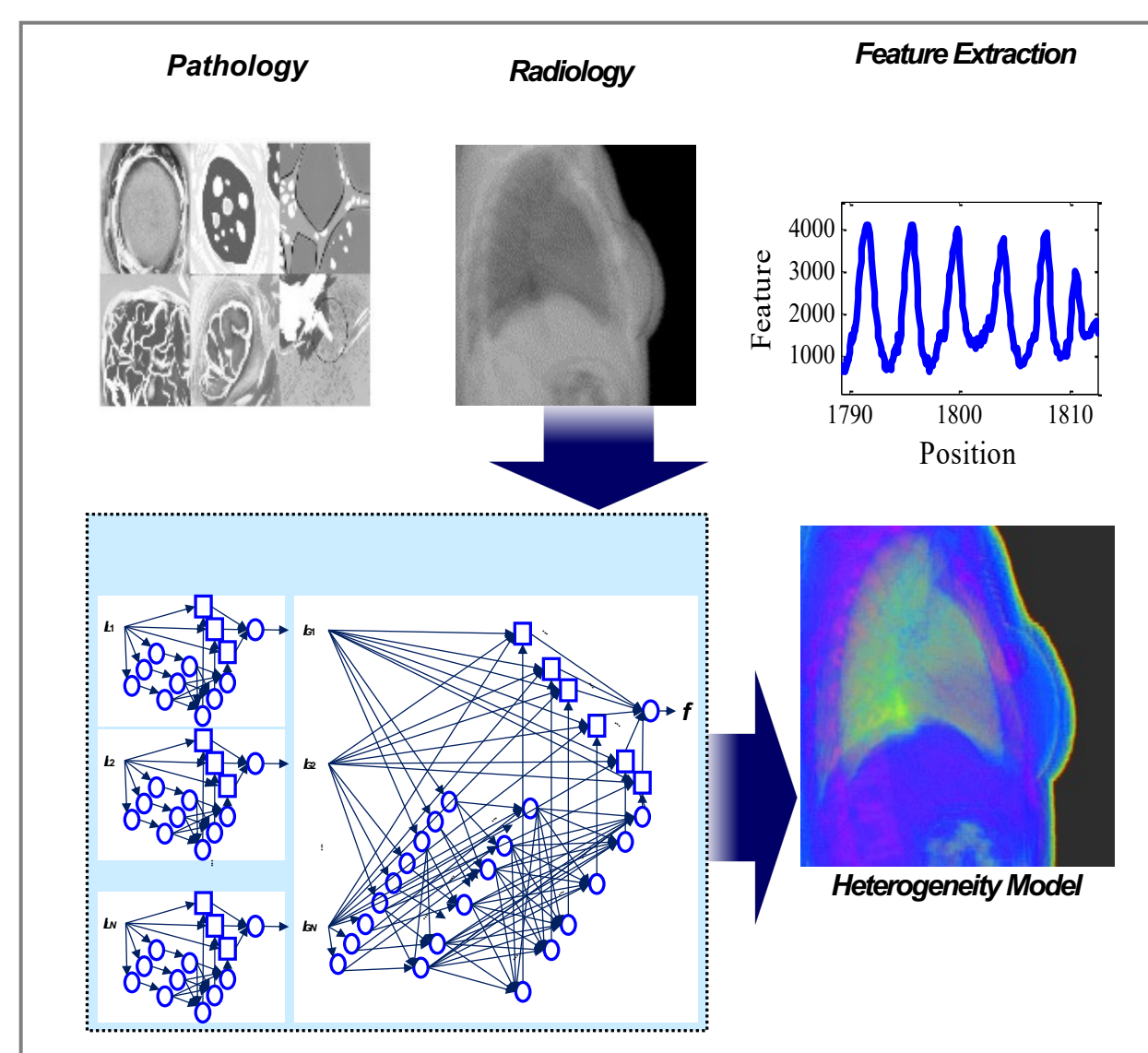
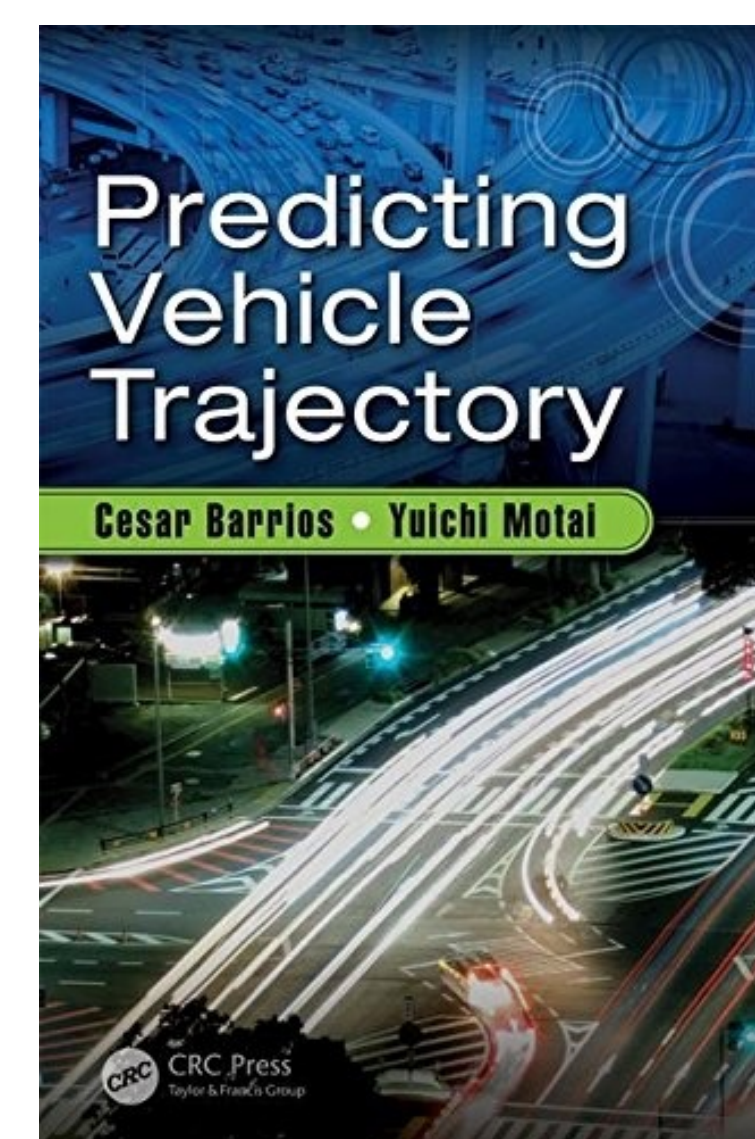
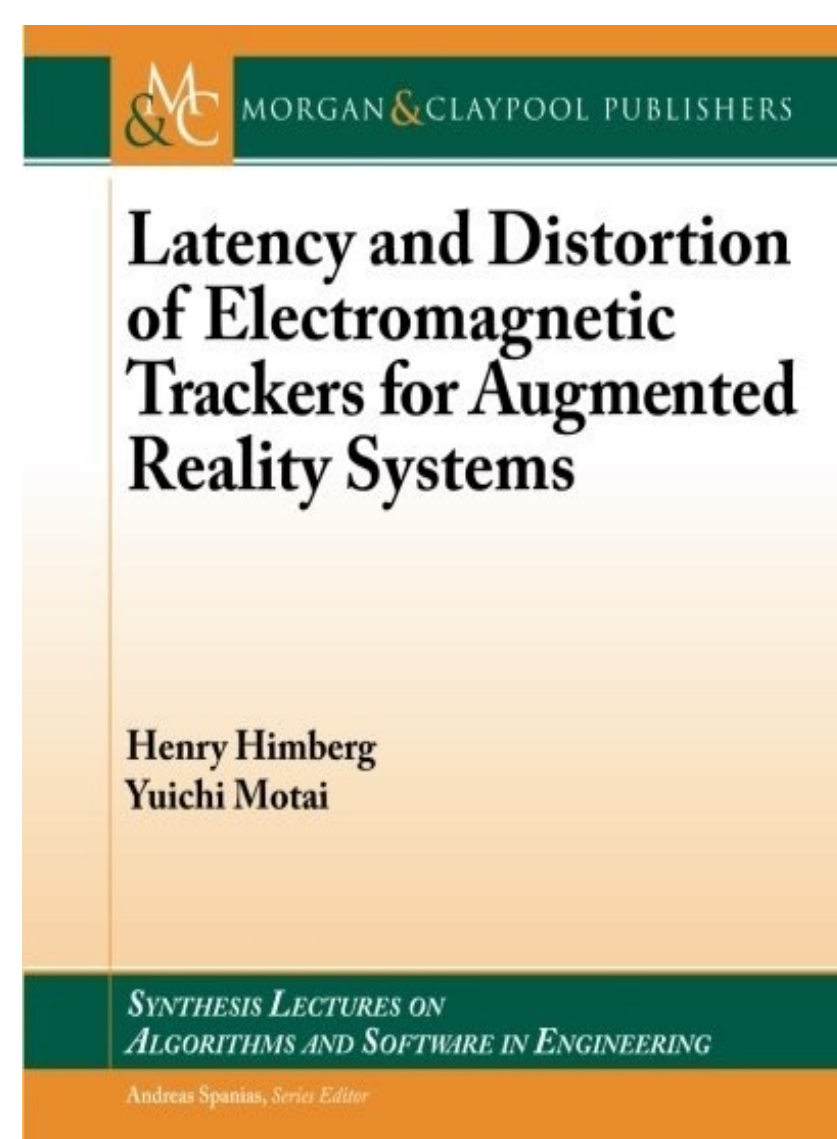
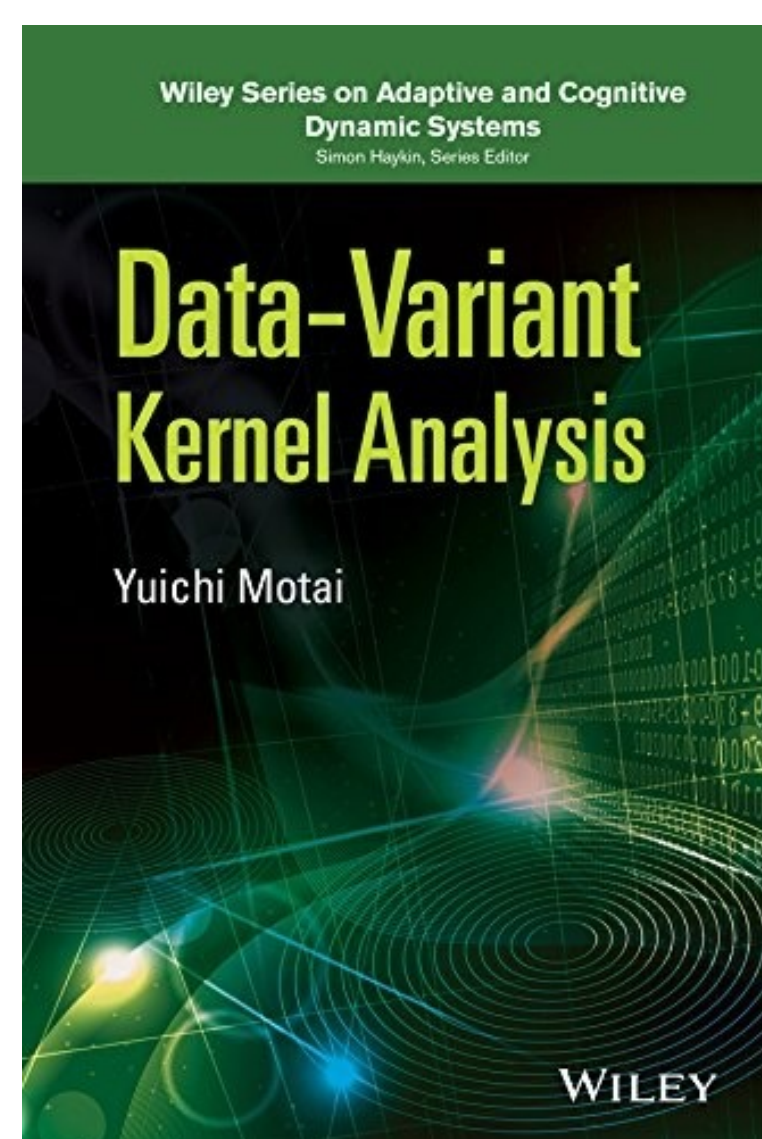
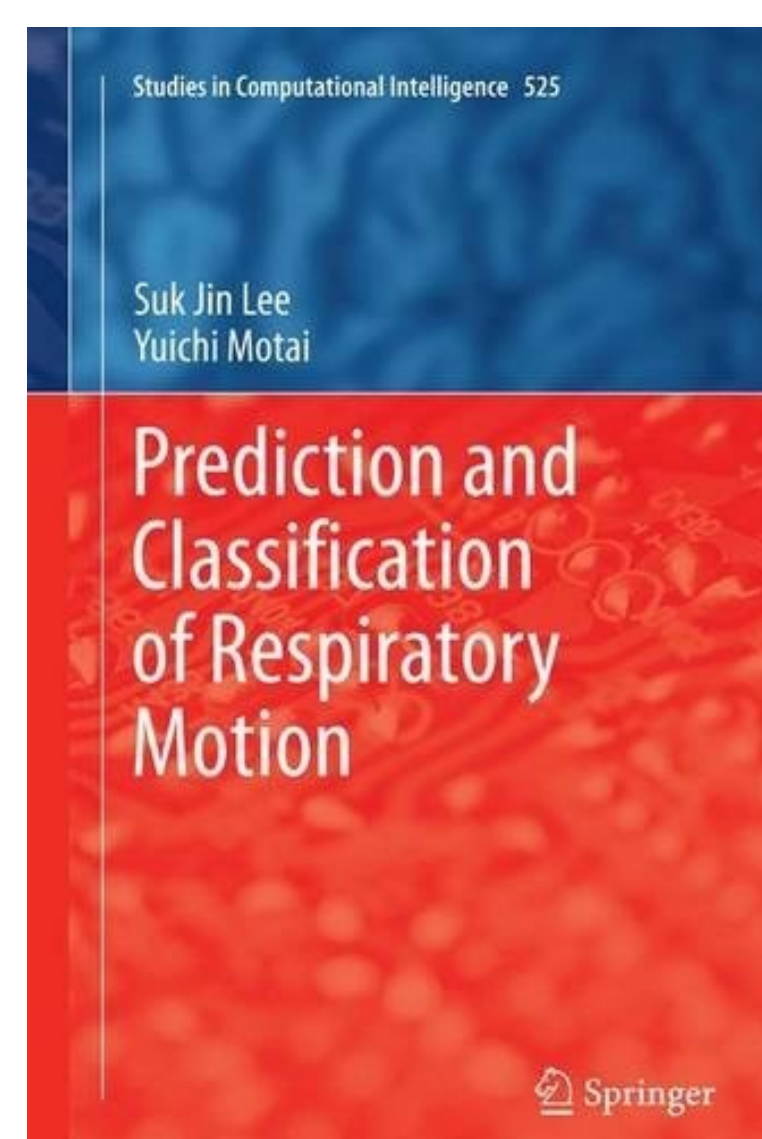


Image-based elasticity in comparison to pathology
 Develop deep learning algorithm to detect cancerous tissues with elasticity feature from microscopic and radiological images



Research Interests:
 Data science AIBS
 Biomedical applications
 Sensory intelligence
 Online machine learning
 Spatiotemporal prediction