

A Boosting Approach for Prostate Cancer Detection using Multi-Parametric MRI

Quality Control by Artificial Vision
4th June 2015

Guillaume Lemaitre
guillaume.lemaitre@u-bourgogne.fr

Université de Bourgogne



① Introduction

Motivations

Screening

MRI modalities

The MedIA evil

② I2CVB

Overview

Prostate dataset

③ Classification framework

④ Results

Sensitivity & specificity

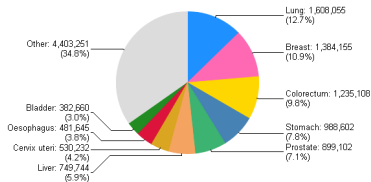
ROC curves

Conclusion

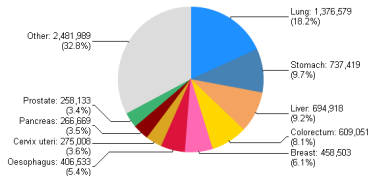


Introduction Motivations

Statistics



(a) # of cancer cases



(b) # of cancer deaths

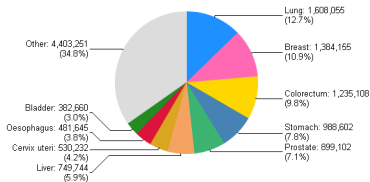
Implications

- ▶ 2nd most frequently diagnosed men cancer
- ▶ Accounting for 7.1% of overall cancers diagnosed
- ▶ Accounting for 3.4% of overall cancers death

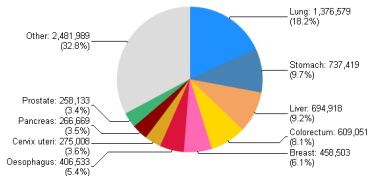


Introduction Motivations

Statistics



(a) # of cancer cases



(b) # of cancer deaths

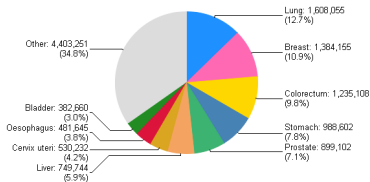
Implications

- ▶ 2nd most frequently diagnosed men cancer
- ▶ Accounting for 7.1% of overall cancers diagnosed
- ▶ Accounting for 3.4% of overall cancers death

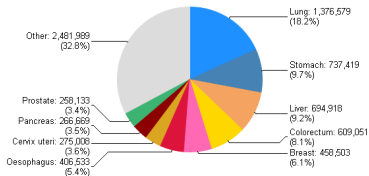


Introduction Motivations

Statistics



(a) # of cancer cases



(b) # of cancer deaths

Implications

- ▶ 2nd most frequently diagnosed men cancer
- ▶ Accounting for 7.1% of overall cancers diagnosed
- ▶ Accounting for 3.4% of overall cancers death



Introduction Screening

PSA level

→ Checking for a higher-than-normal PSA level

✗ Not reliable

“Blind” TRUS biopsy

→ Take several samples through biopsy at different prostate locations

✗ Invasive procedure

✗ Lead to false positives & negatives

Current trendy techniques: MRI

✓ Non-invasive technique

✗ Need further investigations regarding the potential of the different MRI modalities available



Introduction Screening

PSA level

→ Checking for a higher-than-normal PSA level

✗ Not reliable

“Blind” TRUS biopsy

→ Take several samples through biopsy at different prostate locations

✗ Invasive procedure

✗ Lead to false positives & negatives

Current trendy techniques: MRI

✓ Non-invasive technique

✗ Need further investigations regarding the potential of the different MRI modalities available



Introduction Screening

PSA level

→ Checking for a higher-than-normal PSA level

✗ Not reliable

“Blind” TRUS biopsy

→ Take several samples through biopsy at different prostate locations

✗ Invasive procedure

✗ Lead to false positives & negatives

Current trendy techniques: MRI

✓ Non-invasive technique

✗ Need further investigations regarding the potential of the different MRI modalities available



Introduction Screening

PSA level

→ Checking for a higher-than-normal PSA level

✗ Not reliable

“Blind” TRUS biopsy

→ Take several samples through biopsy at different prostate locations

✗ Invasive procedure

✗ Lead to false positives & negatives

Current trendy techniques: MRI

✓ Non-invasive technique

✗ Need further investigations regarding the potential of the different MRI modalities available



Introduction Screening

PSA level

→ Checking for a higher-than-normal PSA level

✗ Not reliable

“Blind” TRUS biopsy

→ Take several samples through biopsy at different prostate locations

✗ Invasive procedure

✗ Lead to false positives & negatives

Current trendy techniques: MRI

✓ Non-invasive technique

✗ Need further investigations regarding the potential of the different MRI modalities available



Introduction Screening

PSA level

→ Checking for a higher-than-normal PSA level

✗ Not reliable

“Blind” TRUS biopsy

→ Take several samples through biopsy at different prostate locations

✗ Invasive procedure

✗ Lead to false positives & negatives

Current trendy techniques: MRI

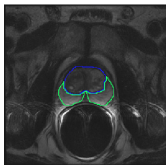
✓ Non-invasive technique

✗ Need further investigations regarding the potential of the different MRI modalities available

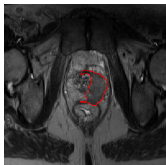


Introduction MRI modalities

T₂W MRI



(a) Healthy



(b) CaP PZ



(c) CaP CG

Features for CaP

- ▶ Low-SI
- ▶ Ill-defined shape



Introduction MRI modalities

DCE MRI

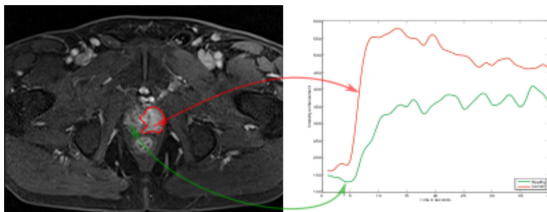


Figure : Green: healthy - Red: CaP

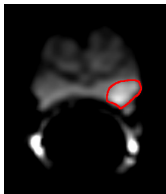
Features for CaP

- ▶ Faster wash-in, wash-out, time-to-peak enhancement
- ▶ Higher integral under the curve, max SI

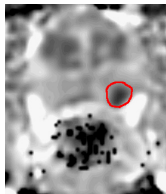


Introduction MRI modalities

DW MRI - ADC



(a) DW MRI



(b) ADC

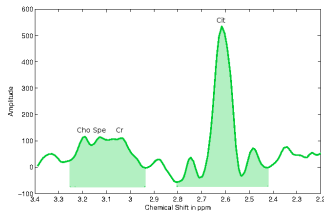
Features for CaP

- ▶ DW MRI - Higher SI
- ▶ ADC - Low-SI

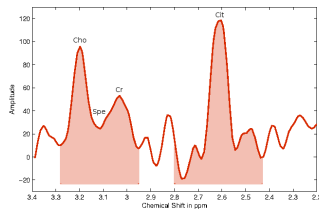


Introduction MRI modalities

MRSI



(a) Healthy



(b) CaP

Features for CaP

- ▶ Decrease of citrate and spermine
- ▶ Increase of choline



The Medical Imaging evil

The reasons of a nightmare

→ Multidisciplinary competences: medical doctors vs. computer scientists

Some examples

- ▶ Delay in the data acquisition
 - ▶ Interest differences between the different core competences
- Lack of interest

The keystones needed

- ▶ Common datasets
- ▶ Algorithms comparisons
- ▶ Full benchmarking



The Medical Imaging evil

The reasons of a nightmare

→ Multidisciplinary competences: medical doctors vs. computer scientists

Some examples

- ▶ Delay in the data acquisition
- ▶ Interest differences between the different core competences
- Lack of interest

The keystones needed

- ▶ Common datasets
- ▶ Algorithms comparisons
- ▶ Full benchmarking



The Medical Imaging evil

The reasons of a nightmare

→ Multidisciplinary competences: medical doctors vs. computer scientists

Some examples

- ▶ Delay in the data acquisition
- ▶ Interest differences between the different core competences
- Lack of interest

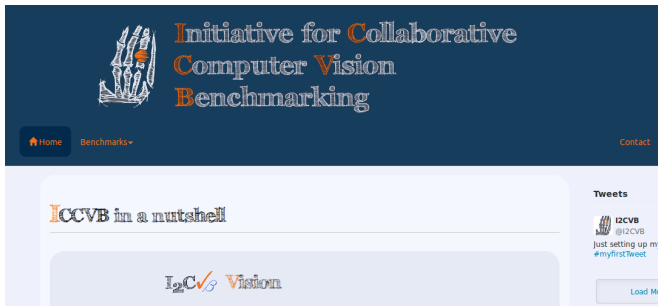
The keystones needed

- ▶ Common datasets
- ▶ Algorithms comparisons
- ▶ Full benchmarking



Overview

I2CVB Platform

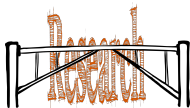


- Development of a web platform



Manifesto

I2CVB Vision



- Democratization of the ability to research

I2CVB Mission



- Open data; evaluation methods; comparison framework; reporting platform

I2CVB Protagonists



- Research groups and individuals from all walks of life to shape a transparent community

I2CVB Strategy



- Transferring successful practises from Free Software and Quality Management



I2CVB Prostate dataset

Multi-parametric MRI

- ▶ Cohort of 20 patients
- ▶ T₂W MRI, DCE MRI & ADC
- ▶ 3 Tesla whole body MRI without endorectal coil

Ground-truth

- ▶ Delineations: prostate - zones - CaP
- ▶ Healthy: 2 vs. CaP: {PZ: 13, CG: 3, PZ + CG: 2 }



Classification framework

Pre-processing

- ▶ Resampling data to T_2W MRI dataset
 - ▶ Balancing data using random sampling without replacement
- 218,423 voxels

Features extraction

- ▶ Voxel-based " $V(\cdot)$ ": intensities of T_2W MRI, ADC, DCE MRI & zonal information (PZ vs. CG)
- ▶ 3D-texton-based " $T(\cdot)$ ": $(9 \times 9 \times 3)$ intensities of T_2W MRI, ADC, DCE MRI & zonal information (PZ vs. CG)

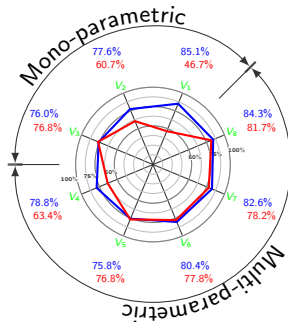
Features classification

- Gradient Boosted Trees classifier

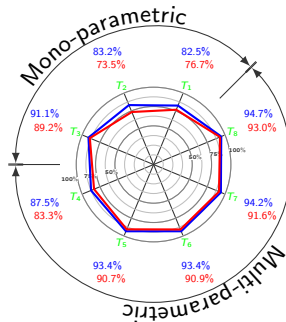


Results

Sensitivity & Specificity



(a) Voxel-based

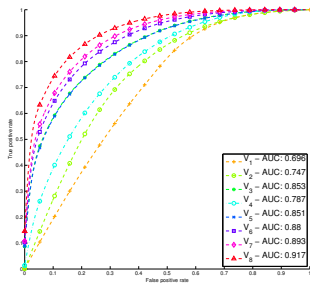


(b) 3D-texton-based

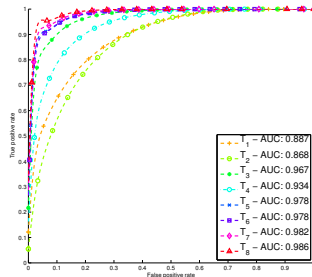


Results

ROC curves



(a) Voxel-based



(b) 3D-texton-based



Conclusion

Discussions

- ▶ DCE MRI is the most discriminative feature
- ▶ Combinations of all the modalities lead to better performance
- ▶ 3D-texton and neighbourhood information significantly improve the performance

Future works

- ▶ Normalisation of the data in a patient-based fashion
- ▶ Use more complex features
- ▶ Perform LOPO cross-validation
- ▶ Perform a full benchmark study of the current methods!!!!