

1 - INTRODUCTION

Providing computer tools regarding hepatic imaging is an actual challenging study field. Liver cancer is the eighth cancer in the world in frequency terms.

In this work, we first evaluate the potential improvement of multi-phase X-Ray Computed Tomography acquisitions compared to single-phase images. Comparison to two different radiologist results is then made in order to validate our system.

2 - DATA

Our hepatic focal lesion database contains 107 nodules from 7 classes. These CT acquisitions are multi-phase, which means a contrast media was injected to the patient and four different images were taken at different times.

We work on the ellipse included in a rectangular bounding box manually delineated by a radiologist on the DICOM slices.



Lesion bounding box in liver CT image

PHASE \ LESION	Abcess	Adeno ma	Cyst	FNH	Haema ngioma	HCC	Metast asis
Lesion number	6	10	25	8	8	13	38
1 pre-injection							
2 arterial phase							
3 portal phase							
4 late phase							

3 - METHODS

Automatic tool

Our framework is a three-step method:

- data pre-processing
- feature extraction
- classification and evaluation

Visual feature extraction

79 measures from 4 different sets were extracted from the images:

- statistics on grey-level histogram
- texture measures from Law
- Gaussian Random Markov Fields
- Unser histograms (equivalent to Haralick texture measures)

The values are concatenated into a single vector.

Classification and evaluation

- Classification: Support Vector Machine (SVM)
- Evaluation: Leave-One-Out (LOO) cross-validation

Read ref [1] for details on our system

Expert Analysis

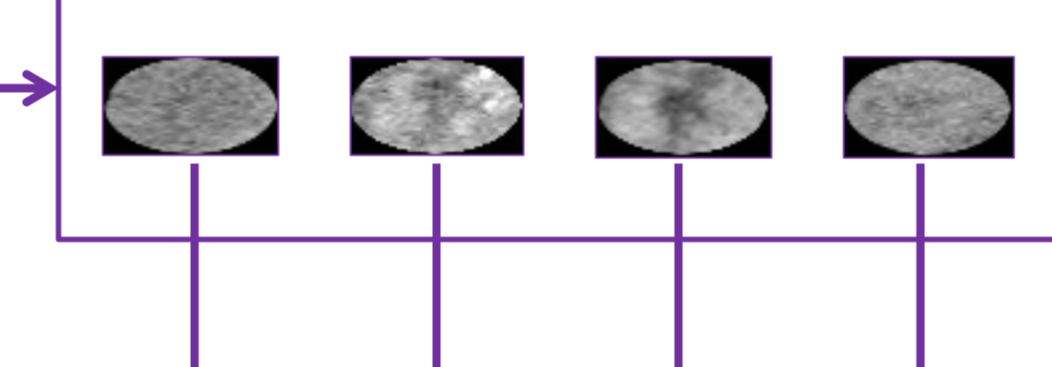
Two radiologists have determined a diagnosis class for each lesion.

They had no indication regarding the context, neither visual (only the ROI was visible, the rest of the image being blackened), nor clinical (DICOM files were anonymised and there was no access to the patient medical information).

1 PRE-PROCESSING



4-phase lesion zones of interest



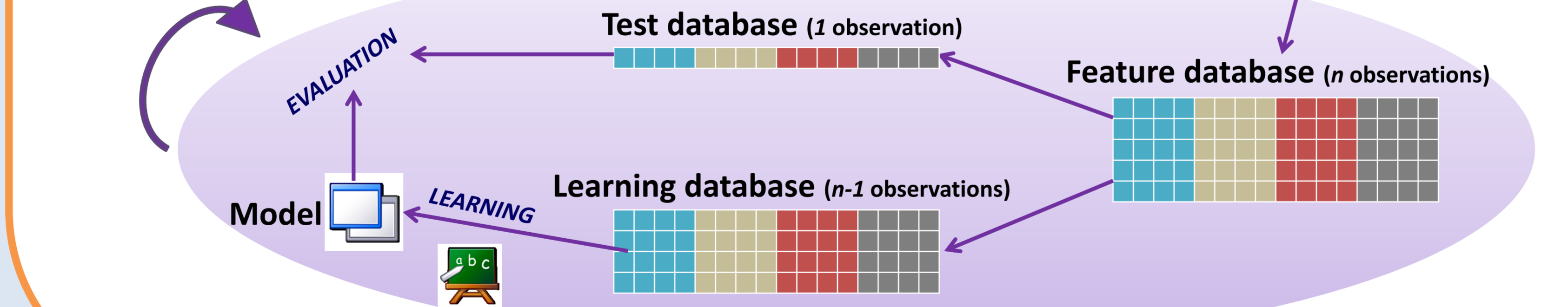
2 FEATURE EXTRACTION

All visual feature measures concatenated into single vector



3 CLASSIFICATION AND EVALUATION

n times LOO cross-validation



Classification software general framework

4 - RESULTS

Single versus multi-phase automatic classification

The confusion matrices show an overall improvement of 8.4% (True Positive score) of the classification on multi-phase images.

Haemangiomas and HCC recognition get high benefits from multi-phase introduction. These lesions are hypervascular, which means they present a strong enhancement pattern over the phases.

TRUE CLASS \ FOUND	PORTAL PHASE							MULTI-PHASE						
	Ab	Ad	Cy	FN	Ha	HC	Me	Ab	Ad	Cy	FN	Ha	HC	Me
Abcess	2	0	1	1	1	1	0	1	0	0	1	0	0	3
Adenoma	0	10	0	0	0	0	0	0	9	0	0	0	0	1
Cyst	0	1	23	0	0	0	1	0	0	24	0	0	0	1
FNH	0	0	0	0	2	0	4	0	0	0	1	0	1	4
Haemangioma	3	1	0	2	2	0	1	0	1	1	0	7	0	0
HCC	1	2	0	0	0	3	7	0	0	1	0	1	6	5
Metastasis	4	2	3	1	2	2	24	3	1	1	3	0	5	25

Confusion matrices on classification results over single and multi-phase CT acquisitions

Expert versus automatic classification

Recognition rate is similar between the clinicians and our automatic tool on abscesses, cysts, FNH and haemangiomas. Our system outperforms in these particular experimental conditions on adenomas, HCC and metastasis.

The similarity measurement between the two result sets, known as Dice coefficient, is also presented. Its range goes from 0 to 1, being 1 when the sets are identical.

Class	Abce.	Aden.	Cyst	FNH	Haem.	HCC	Meta.	TOTAL	
Lesion Number	6	10	25	6	9	13	38	107	
Success	Experts	1	0	25	1	7	0	17	51
	Tool	1	9	24	1	7	6	25	73
Dice coeff.	0.000	0.000	0.958	0.000	0.667	0.000	0.468	0.618	

5 - CONCLUSION

We proposed the assessment of an automatic hepatic lesion classification system, with comparison to human expertise, which recognizes 7 classes of focal lesions in multi-phase CT scan images.

Results on our database underline the importance of multi-phase acquisitions, especially for hypervascular lesions. The results on expert analysis validate our model.

As a future work, we plan to study temporal changes over the CT phases features.

REFERENCES

- 1 A. Quatrehomme, I. Millet, D. Hoa, G. Subsol and W. Puech, *Assessing the Classification of Liver Focal Lesions by Using Multi-phase Computer Tomography scans*, Third MICCAI International Workshop MCBR, v. 7723 p. 80 – 91, 2012.