



Pattern Recognition & Image Analysis

Jean-Yves Ramel, N. Ragot



Tours - Loire valley - France



- 137 046 / 310 000 people
- 204 km southwest of Paris
- Region « Centre - Indre et Loire »
- 1h from Paris by high speed train
- Direct train connection to CDG
- Only airport in 2h00




Loire valley World heritage Unesco

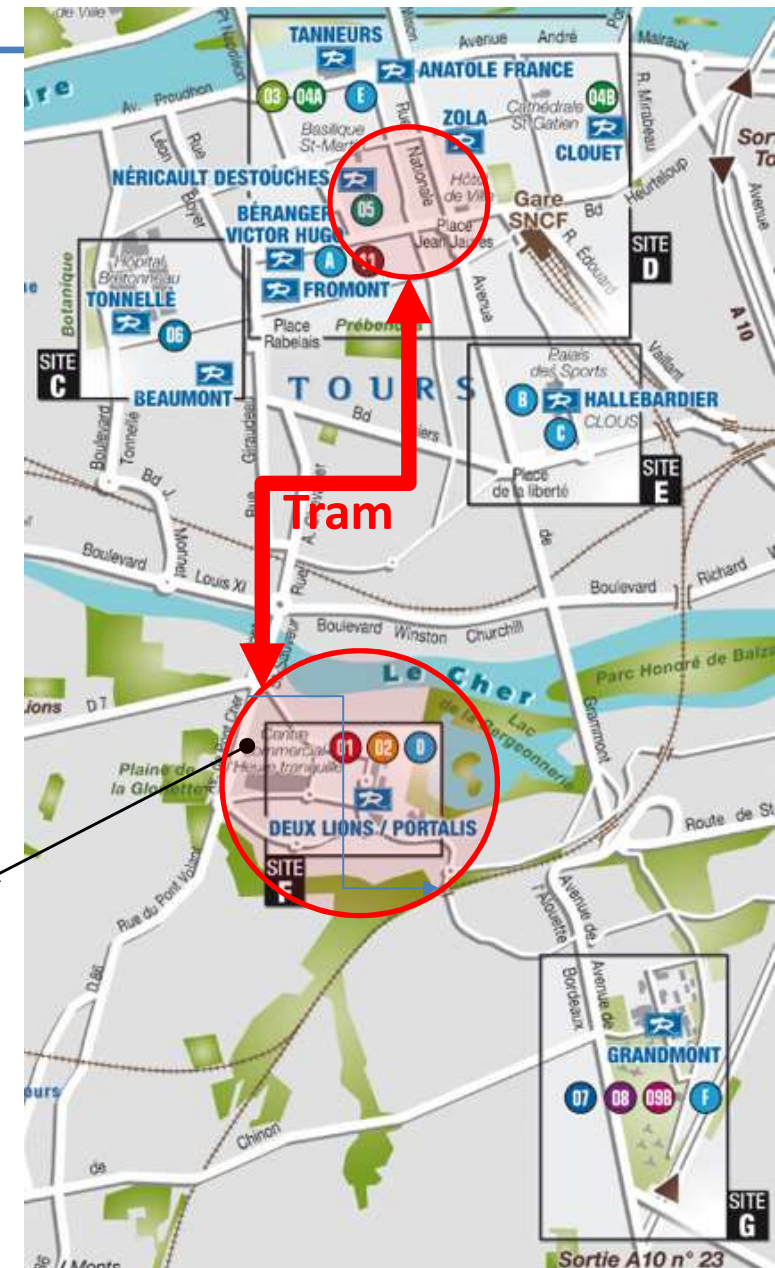
<http://loirevalley-worldheritage.org/>



François Rabelais
i.e. a famous French
writer of XV^o Century

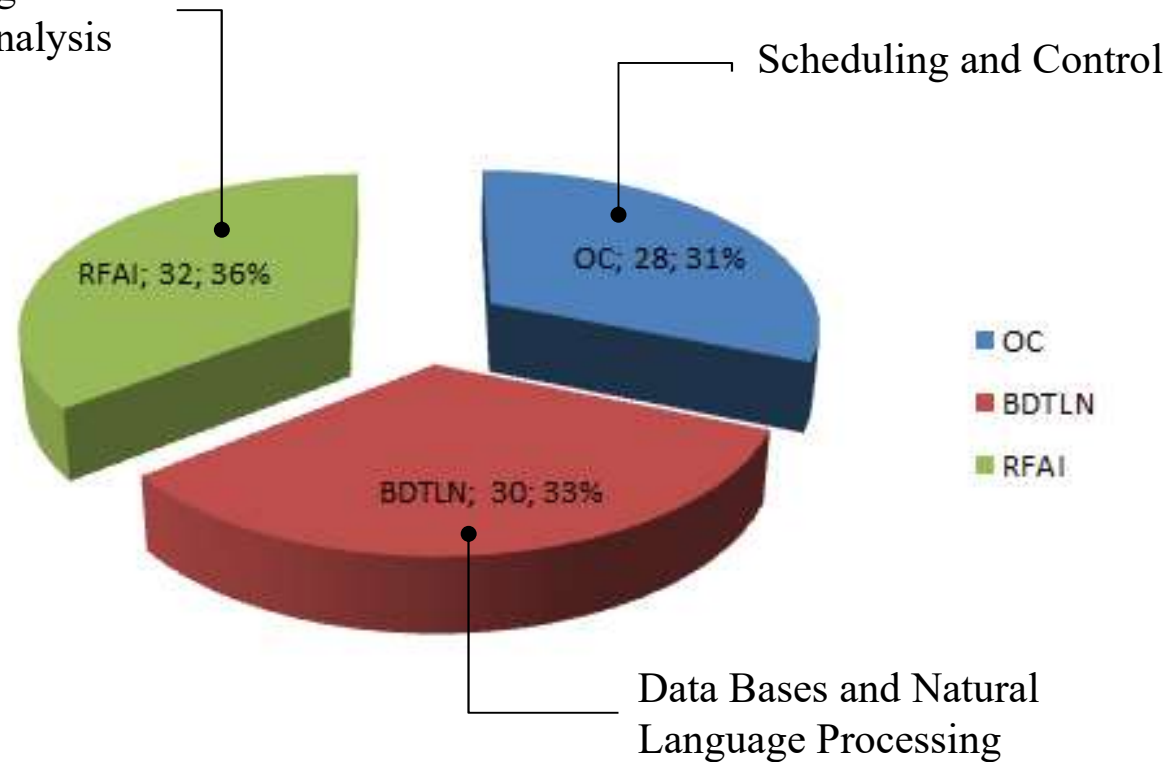
Faculties	Art & human sciences, Health, economy, business & management, information and technology
Students	25 000 (2 500 foreign students)
Teachers	1 300
Support staff	1000
Laboratories	40
Place	5

 <p>-720 students - 5 departments (with Labs)</p>	
Urban Planning	CITERES
Mechanics	LMR
Electronics	LMP
Computer Science	LI
Embedded computing	
CADS Master	



Laboratoire d'Informatique Fondamentale et Appliquée de Tours

Pattern Recognition
and Image Analysis

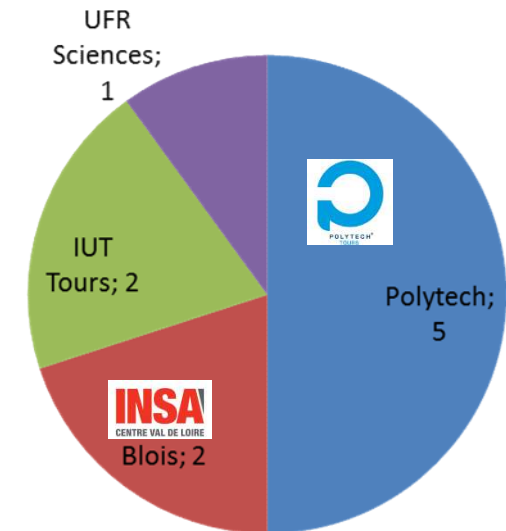


Graphic from 2015 : 90 people, 3 research groups

RFAI : Composition and organization

Around 31 members in 2015

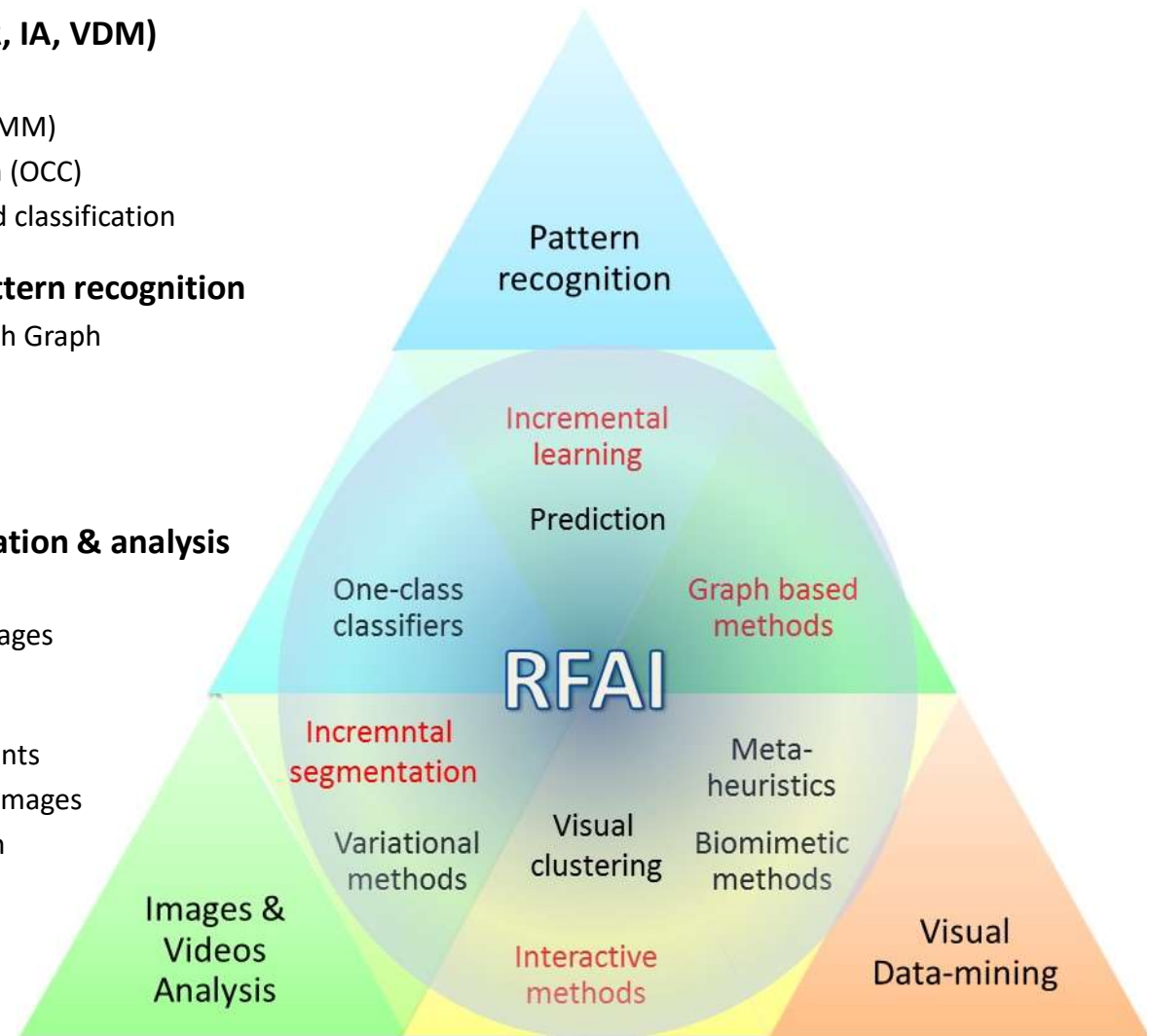
- 5 Full Prof – 15 Assistant Prof (1 HDR) – 3 Post-Docs – 10 PhD – 1 ATER
- Permanent staff
 - Stable around 20
 - Dispatched on different sites
- PhD, ATER, PostDoc, Engineers
 - Always around 6 to 10 each year



Prof	5	F. Bouali (Lilles)	M Slimane	H. Cardot	J.Y. Ramel	G. Venturini	
MCF	14	S Aupetit	S. Barrat	T. Brouard	M. Delalandre	D. Conte (HDR)	P. Gaucher
		M. Hidane	P Makris	J Mille	N Monmarché	J. Olivier	N. Ragot
PostDoct	3	N. Girard		B. Serres	T. Mondal Besu		
PhD Ater	9	Z. Abu-Aisheh					
Doct. 3-4		A. Tarafdar		F Rayar	J Berrouet		
Doct. 1-2		G Galisot		Carvalho Paulo Da Silva		HADJERCI Oussama	
Doct. 0		M Martineau		M Darwich	Shah SHIVANI (CEA)		
IGE/R	1	D. Letienne					

Main scientific skills

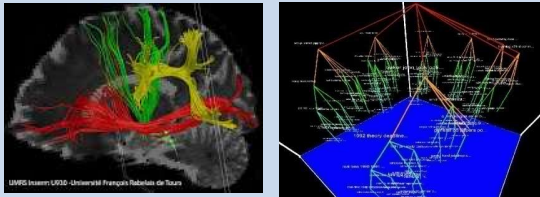
- **Adaptive and interactive methods (in PR, IA, VDM)**
 - Visual Data Mining techniques
 - Adaptive models for machine learning (HMM)
 - Active learning and dynamic classification (OCC)
 - Interactive systems for image analysis and classification
- **Graph based methods and structural pattern recognition**
 - Images analysis and data visualization with Graph
 - Structural methods for Video Analysis
 - Graph embedding, S+SPR
 - Anytime and distributed Graph matching
- **Variational methods for Image segmentation & analysis**
 - Optimization of Active contours methods
 - Extension to Multimodal and complex images
- **Document Image Analysis**
 - Content spotting and Indexing in Documents
 - Binary template matching for Document Images
 - Quality measurement and OCR prediction



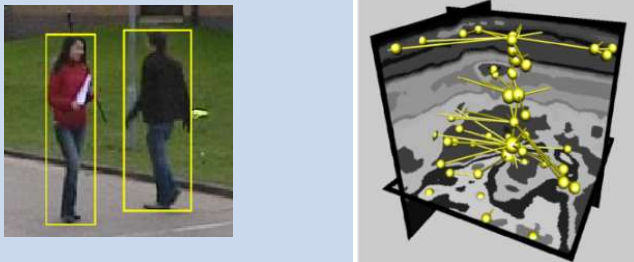
Main application Domains

Health and Disability

Medical data analytics and prediction



Segmentation and tracking in medical images



Video based assistive systems for health and disabled



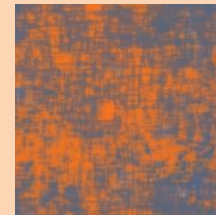
Digital Humanities



Object detection & retrieval in images and videos



3D scene acquisition and analysis (sculptures, monuments, archeology, ...)



Touristic and artistic data analytics

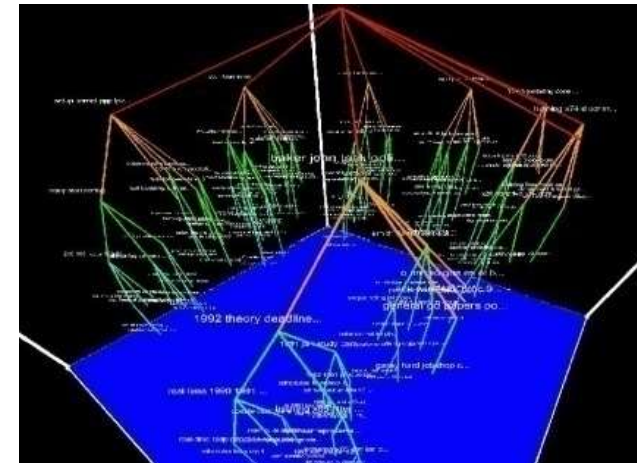
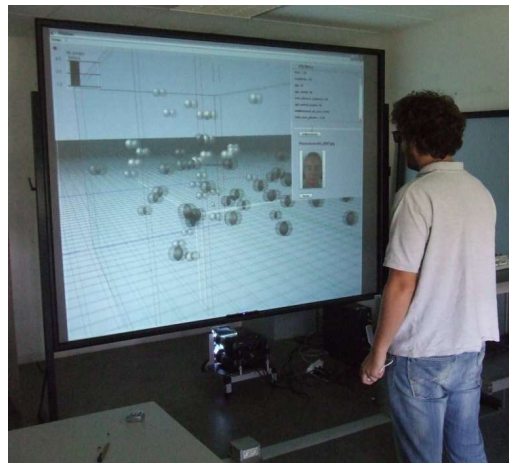
Adaptive & Interactive methods for VDM

- **Methods**

- Visual Data mining on complex data by using virtual reality (stereovision)
- New devices for interactive data mining
- Graphical interaction and GPU based methods
- Numeric, symbolic, hierarchical, relationnal (graph) data processing

- **Applications**

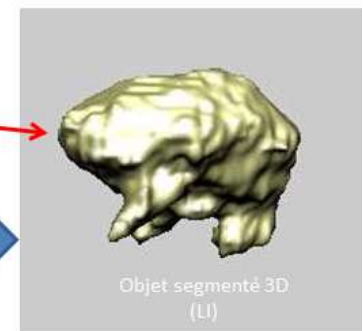
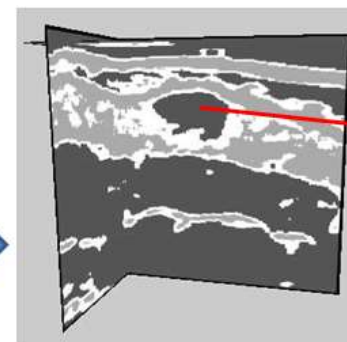
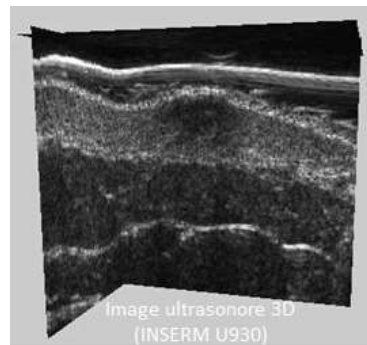
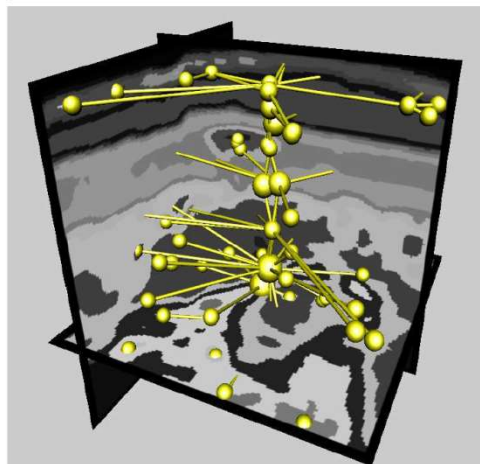
- Knowledge extraction from data (groups, isolated cases, relations between data types)
- Application in dermatology and cosmetology
- Ongoing contact with the Clinical Investigation Center of Tours (INSERM, CHRU, Univ. Tours)
- Fibratlas ANR



Adaptive & interactive methods for IA

For 3D image segmentation

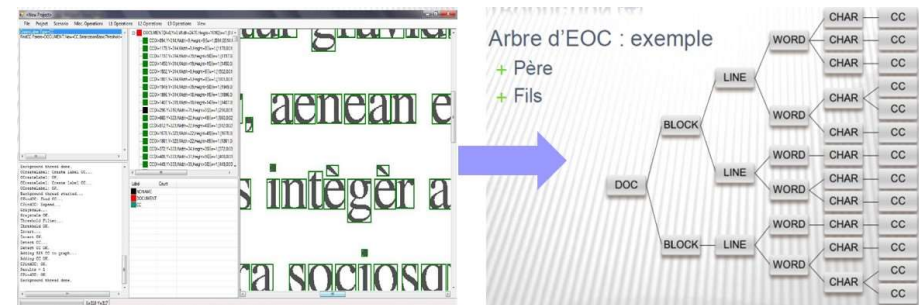
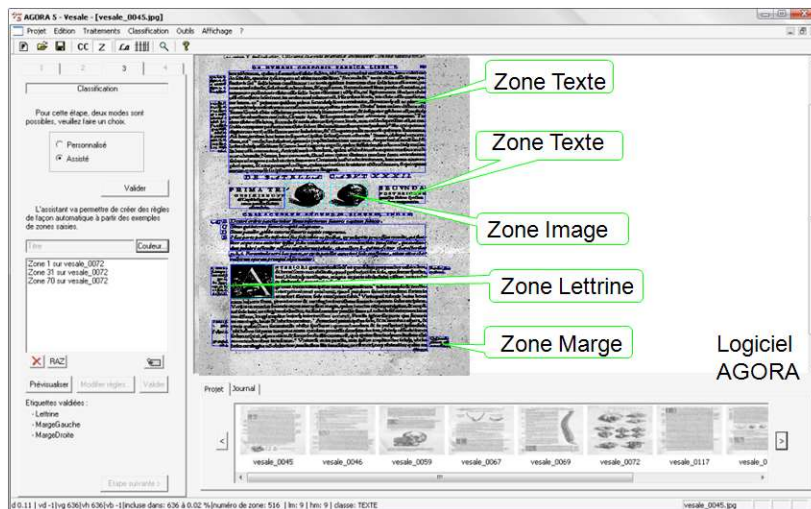
- Interactive segmentation of 3D medical images
 - Combining Region Adjacency Graph and Hierarchical Classification Tree during incremental analysis (Dermlab3D)
 - Graph based segmentation (regularization, topology)
- Visual characterization of 3D textured images
 - Proposition of new visual features (easily understandable)
 - Multi-resolution approaches for 3D texture characterization



Adaptive & interactive methods for IA



- Interactive Indexation and transcription of old documents
 - User-driven methods for layout analysis of old books
 - User defined Content extraction in historical documents
 - Agora – Google Award: <https://sites.google.com/site/paradiitproject/>

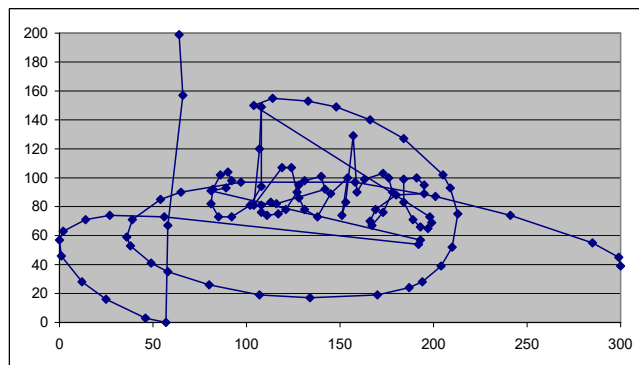
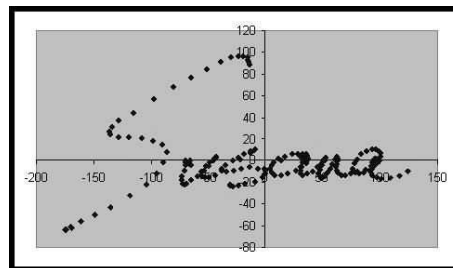
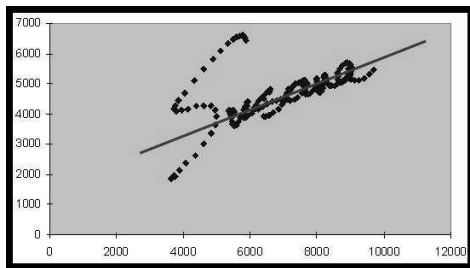


Examples of extracted data: <http://www.bvh.univ-tours.fr>



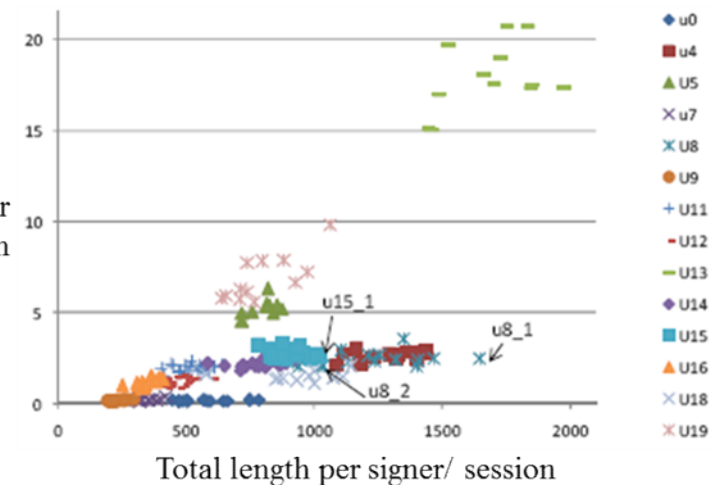
Adaptive & interactive methods for PR

- Personalization of biometric classifiers
 - Study of the temporal variability of handwritten signatures along time
 - Automatic creation of new classes of users – Reject management
 - Automatic adaptation of the parameters & hyper-parameters of the classifiers



Total duration per signer/ session

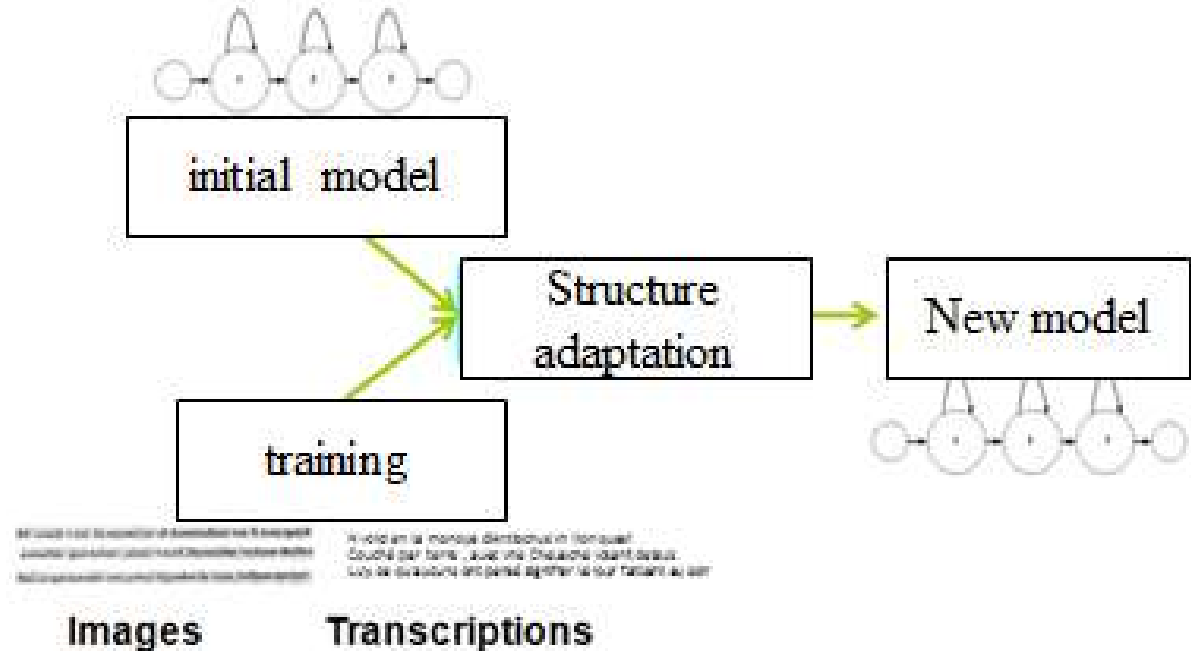
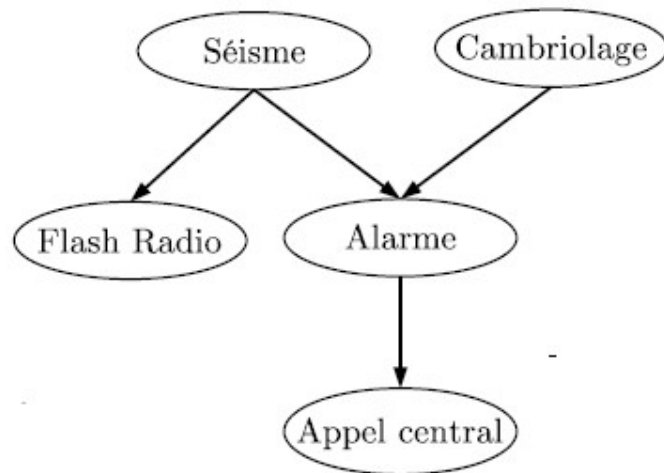
	variation	correlation	
Speed	variation	yes	no
Length	variation		
Duration	stable		



Adaptive & interactive methods for PR



- Automatic learning of the structure of Bayesian Networks
 - Structure selection with biomimetic / evolutionary algorithms (GA)
- Supervised Adaptation of HMM structure
 - Modification of HMM parameters to better fit to the data
 - Application on OCR dedicated to old documents (BNF)

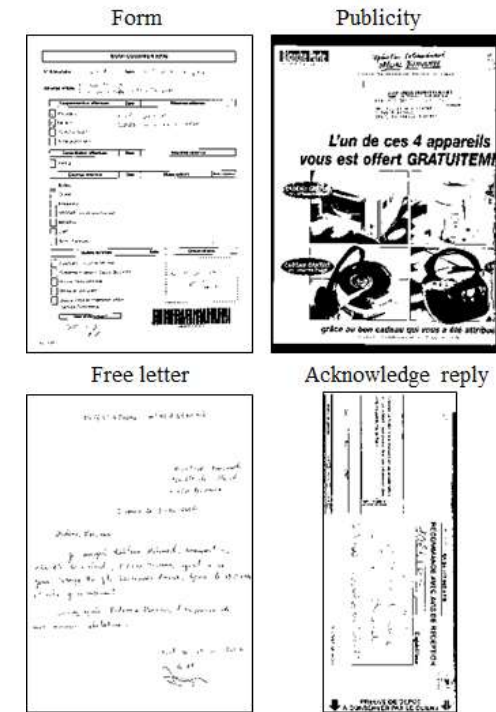


Interactive definition and tuning of One-class classifiers

- Combination of local and global features
- Interactive tuning (features and samples selection)
- Combination of One-class classifiers (One class kNN, symbolic OCC, ...)

The screenshot displays the ITESOFT software interface, which is divided into several functional areas:

- Feature Selection:** A table with columns for 'Select', 'Name', 'Score', 'Min', 'Max', and 'Average'. It lists various features such as 'ratio', 'density', 'center_of_gravity...', and 'hpraj_0' through 'hpraj_9', along with 'vpraj_0' and 'vpraj_1'. Each feature has a checkbox for selection.
- ACP Visualization:** A scatter plot titled 'Visualiser l'ACP' showing data points in a 2D space. The plot is divided into four quadrants by a vertical and a horizontal line. Red 'x' marks represent data points, and a yellow bar at the bottom indicates the projection coordinates: 'Y0031667_7737_3650337_7480040.tif'. Below the plot, it states 'La projection contient 63,7804503584168% d'information.'
- Sample Selection:** A grid of document thumbnails with checkboxes for selection. One thumbnail is highlighted with a blue box and labeled '76 pages 13 conditions générales_page_004.tif'. Below the grid, there are buttons for 'Toutes', 'Inverse', 'Aucune', 'Apply Stability selection', and 'rb Feature Threshold'.
- Agrandissement:** A large view of a selected document page, showing dense text.

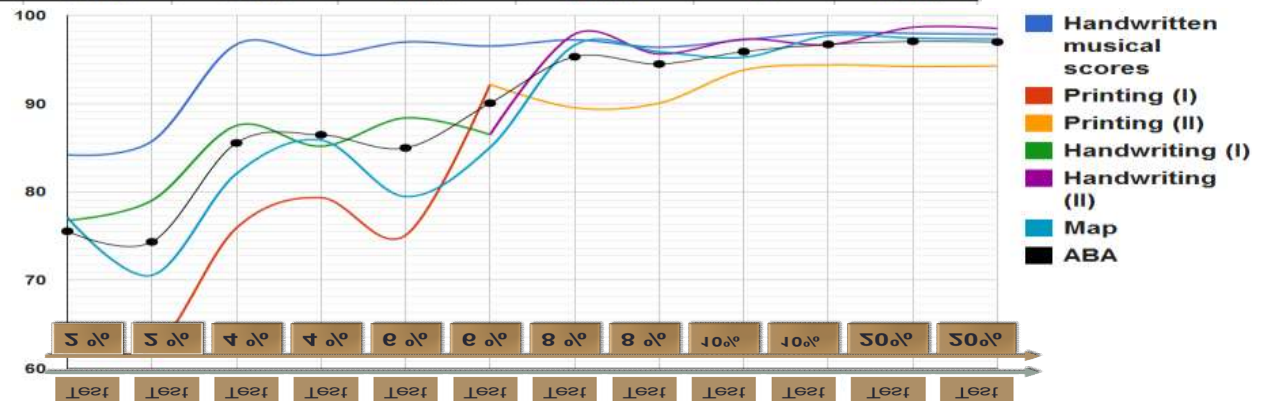


Adaptive & interactive methods for PR

- **One-Class Incremental SVM** for document classification in a non-stationary environment
- Each One class SVM is trained incrementally at each step
- Syed procedure : the classic SVM learning procedure with old support vectors together with new data corresponding to the class the SVM is modeling.
- Use of negative data (when available) during the parameter selection process

	Handwritten musical scores	Printing I	Printing II	Handwriting I	Handwriting II	Map	ABA
Binary SVM	99.95	99.53	98.88	99.52	100	99.96	99.64
One-Class SVM	97.94	72.9	93.78	88.73	99.42	82.71	89.25
mOCiSVM	98.33	72.31	93.78	88.51	99.46	83	89.23

- Incremental learning
- Adding new concept
- Concept drift
- *Concept extension*
- *Concept split and merge*
- ...



12 successive learning steps T_i .

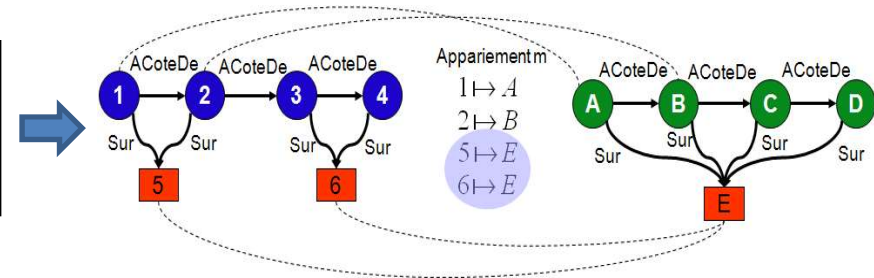
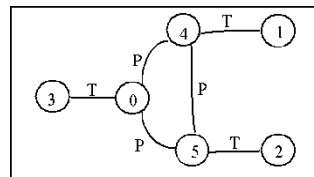
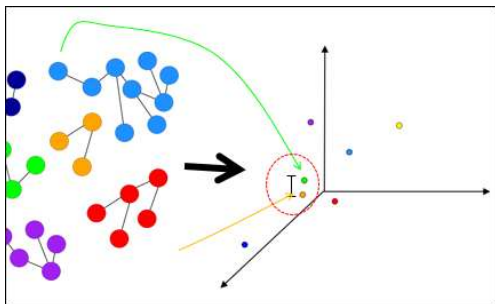
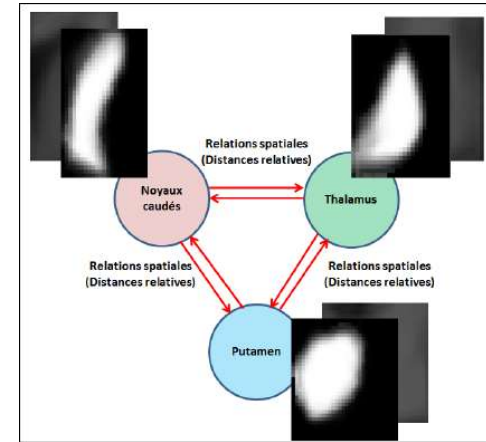
Each set is mutually exclusive and contains respectively 2%, 2%, 4%, 4%, 6%, 6%, 8%, 8%, 10%, 10%, 20%, and 20% of the training data, drawn randomly.

The test set used at each step is remaining part of the data set left apart by cross-validation



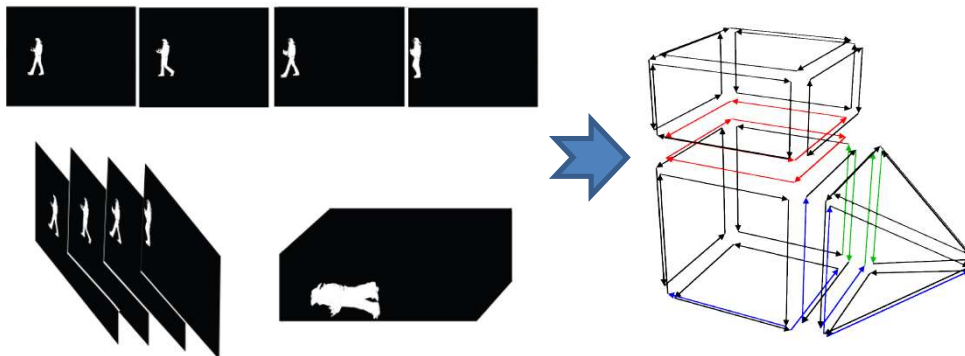
Graph based methods

- Graph based representation of image content
 - Combination of statistical and structural descriptors
 - ROI detection using graph representation
 - A priori knowledge representation with graphs
 - Interactive Segmentation using graph manipulation and transformation
- New Graph matching and indexing techniques
 - “Soft” graph matching algorithms - Similarity measure between graphs
 - Topological Graph embedding - Fuzzy Graph embedding
 - Distributed and Anytime GED
 - Graph Matching using O.R. methods
 - GDR4GED graph repository and metrics



Structural methods for Video Analysis

- Object Tracking by Particle Filters
 - States and observations are represented using graphs
 - One state \rightarrow all the scene where objects are moving
 - The weights of particle graphs are computed by means of Graph kernel
- Structural De-noising of Foreground Mask
 - Representation of the 3D (2D+T) Structure for an Image Sequence by 3D Combinatorial Maps
 - Noise removal according Topological properties of the Combinatorial Map
 - Noise regions \rightarrow Many tunnels/voids
 \rightarrow High Value of Betti Numbers



Variational methods for IA

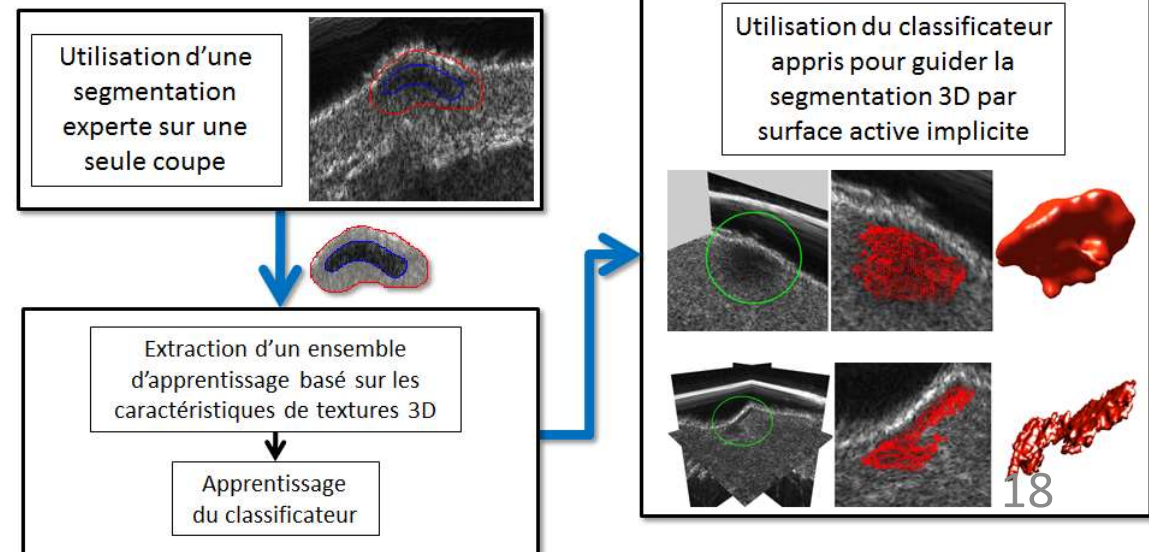
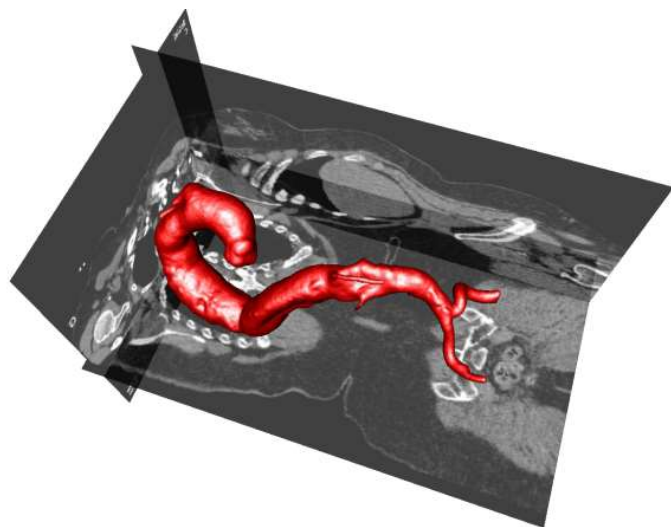
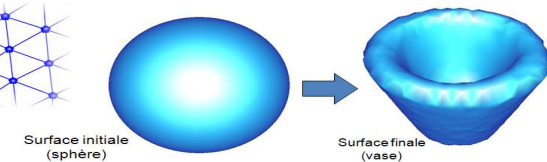
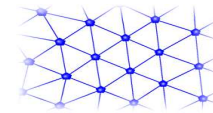
- **Prior knowledge integration in Active Contours**

- Narrow band region-based active contours and surfaces for 2D and 3D segmentation
- Active Contours Driven by Supervised Binary Classifiers for Texture Segmentation
- Supervised learning for the optimization of the parameters used in AC



- **Extension to Multimodal and complex images**

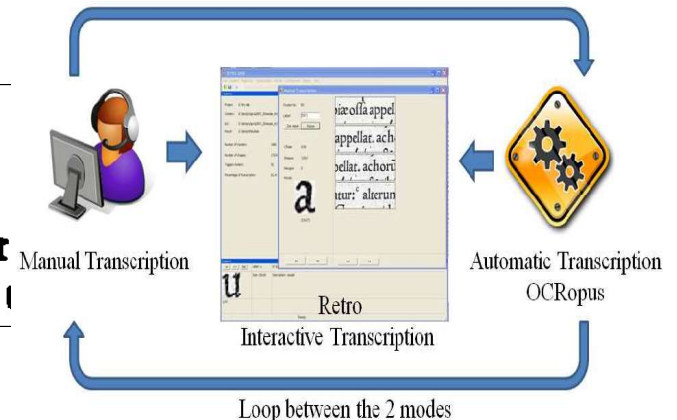
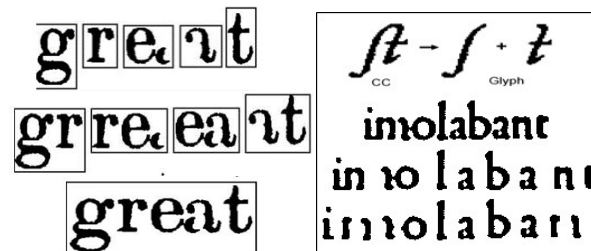
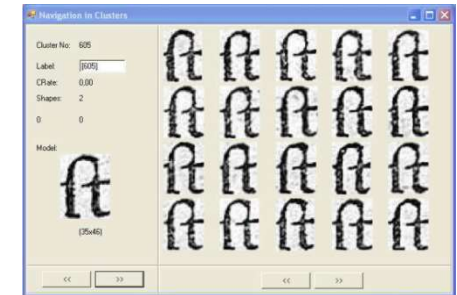
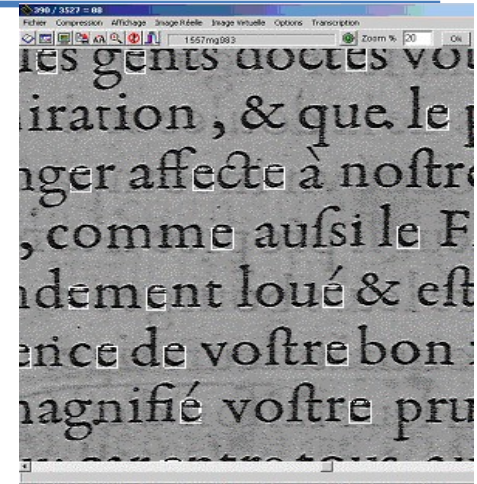
- Extension to 3D+T (ultrasound video)
- OCT, confocal microscopy



Document image Analysis



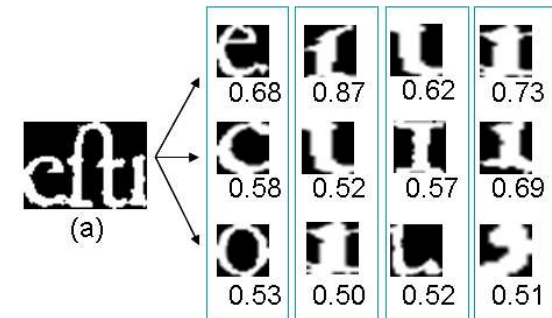
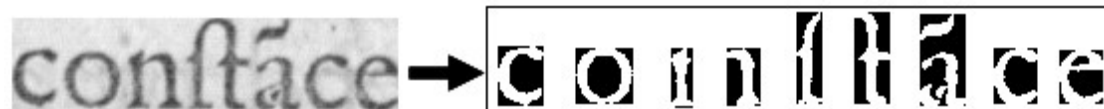
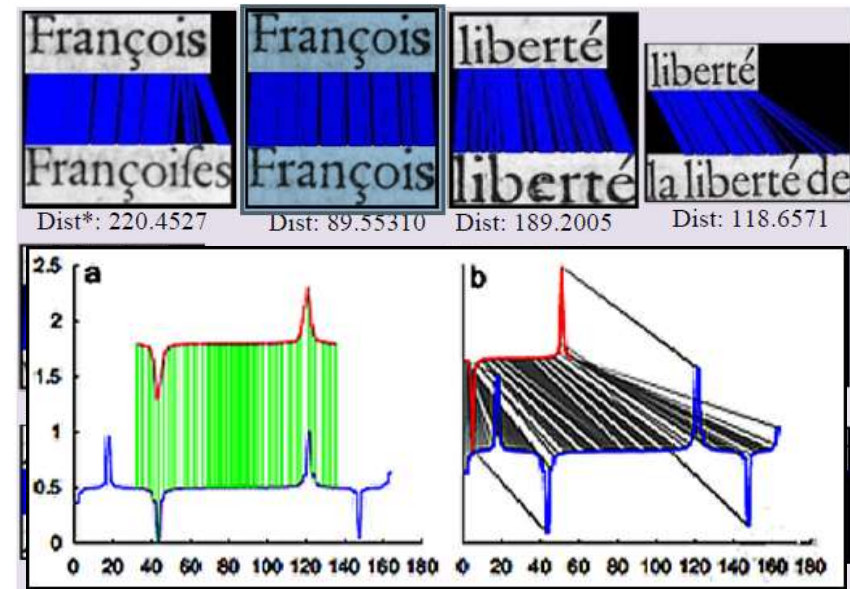
- Goal: Analyzing redundancy in images (text and graphics)
 - A text, ancient or not, is made up of sequences of similar patterns
- Methods: Clustering of similar patterns to create groups (classes)
 - Comparison of patterns (matching techniques)
 - Without prior knowledge about the meaning of these patterns
- Constraints are that the techniques should:
 - Produce very homogeneous clusters (without error)
 - Produce a minimal number of clusters
- What could be a pattern?
 - Connected components [Lebourgeois95]
 - Words [Kluzner&Al2009]
 - Others [Roy&Al2011]
 - Redundancy rate > 80 %
- Semi-automatic transcription



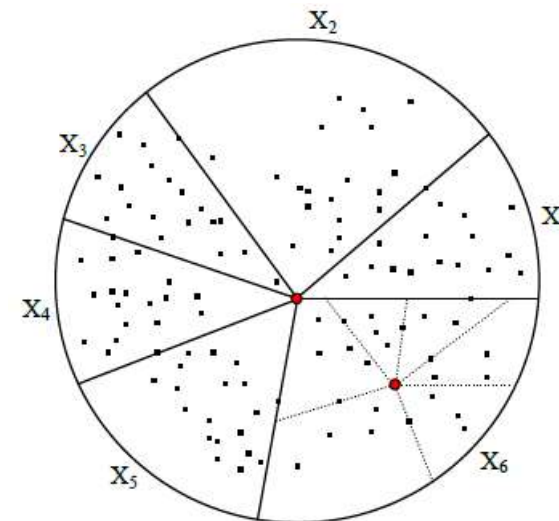
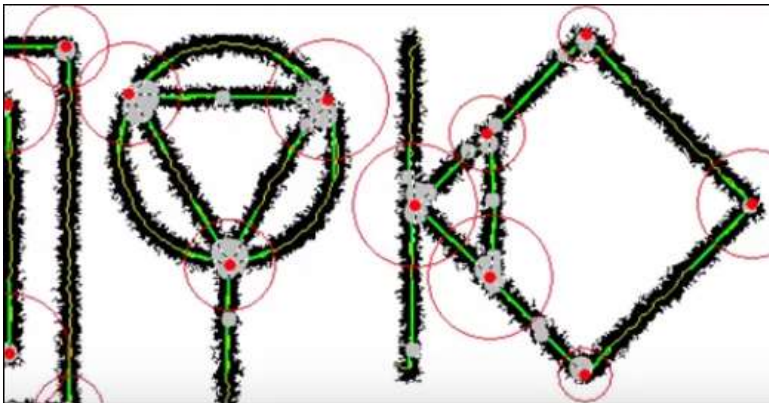
Word Spotting



- Improvement of elastic word matching techniques
 - Comparison of DTW, MVM and other approaches
 - Adaptation for word spotting purpose (indexing and retrieval)
 - Should work for Multiple scripts (bangla, ...)
- Multi-oriented Word spotting (in Maps)
- Multi-level word spotting (Renom project)
 - Coarse (CC) to fine (Stroke) approach
 - Using Redundancy analysis → Codebook
 - Word spotting for Named entities localisation in historical documents
 - Renom 2 : Using Language model in word spotting (?)



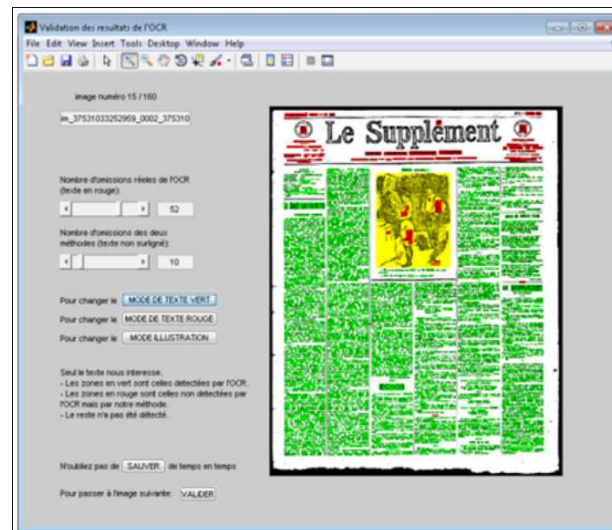
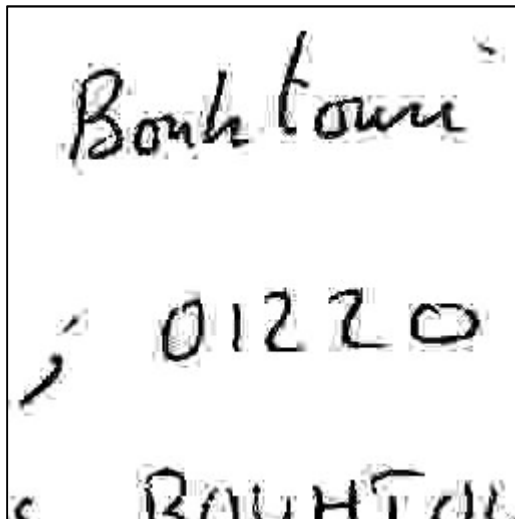
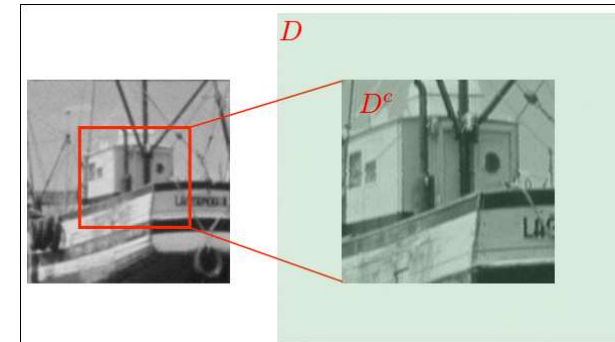
- Extraction and characterization of salient elements (in documents)
 - Keypoint detection method dedicated to binary images (junctions, ...)
 - New shape descriptors (for junctions or extremities)
 - Fast binary template matching methods (logo detection, ...)
- Graphical document indexing and symbol spotting
 - Sesyd database for GREC contests
 - Indexing scheme based on 2 linked-node m-ary tree structure



Quality measurement and OCR prediction



- Quality measurement and image enhancement
 - Impact of compression on Document images
 - Effective Decompression of JPEG Document Images
 - Image Zoom Completion (super-resolution)
- OCR Prediction (BnF)
 - Adaptive detection of missed text areas in OCR outputs for automatic assessment of OCR quality
 - OCR performance prediction using cross-OCR alignment



Raw image detail	JPEG, 300dpi, quality 20	JPEG, 100dpi, size=DjVu	IW44, 300dpi, size=DjVu	DjVu compressed
20640K	292K 70:1	50K 412:1	61K 338:1	52K 396:1
9534K	116K 82:1	17K 560:1	20K 476:1	19K 501:1

International collaborations

International Projects

- IFCPAR-CEFIPRA with l'Indian Statistical Institute (Kolkata, Inde) - 2 PhD et 10 publications
- Osaka Prefecture University - Grant JSPS Japan
- Computer Vision Center – Co-supervised PhD
- Paradiit : Google / Succeed Award

Visiting Professors

- U Pal, M Blumenstein, G. Boccignone

Scientific animation

- Int. workshop DAS 2014
- Newsletter TC15 de l'IAPR



Computer Vision Center
Document Analysis Group
Barcelona - Spain
“J. Lladós, E. Valveny”



Dept. of Computer Science and IS
Osaka Prefecture University
Osaka - Japan
“K. Kise”



Indian Statistical Institute
Kolkata - India
“U. Pal”



Università de Salerne Italy -
Groupe Mivia –
“M. Vento”



Griffith University– Australie
“M. Blumenstien”

National collaborations

National Projects

- Project OSEO DOD managed by Itesoftware during 4 years
- ANR Projects DIGIDOC (2010-14) & Fibratlas (2014-18)
- Co-supervision of PhD LITIS / BNF, LIRIS, ...

Participation to national research groups

- Participation to Program committees
- Organization of national conferences (CIFED, EGC, EA, GDR ISIS, ...).
- Research associations : GRCE, AFRIF, EGC, EA, IFRATH, ...



Laboratoire Bordelais de
Recherche en Informatique
(Bordeaux)



Laboratoire d'InfoRmatique
en Image et Systèmes
d'information (Lyon)



BnF Bibliothèque Nationale
de France (Paris)



Laboratoire d'Informatique
de Traitement
de l'Information (Rouen)



Laboratoire d'informatique
image et interaction
(La Rochelle)



Groupe de Recherche
en Informatique
de Caen

Local collaborations

Collaborative Projects

- INRA de Nouzilly : Interactive segmentation of 3D MRI, sheep tracking in video for behavior analysis (projets Ovin2A, NeuroGeo)
- Laboratoire PRISME ; nerf segmentation in ultrasound images (projet Région DANIAEL 1 et 2)
- INSERM CHRU : Projet ANR (Fibratlas II)
- IRBI + CETU Inophyt (valorisation) Interactive recognition of insects from smartphone images (PhD , patent)
- CESR, CITERES : Renom , Valmod, Sculpture 3D : Interactive Visualization of work of art and castles

Research animation

- Participation to the SFR-FED 4226 (Neuro-Imagerie Fonctionnelle)
- Participation to the network «Réseau Thématique de Recherche Images »



Industrial Collaborations

Projets industriels

- Projet OSEO DOD with Itesoftware – Classification, compression, logo detection
- Specific studies or transferts for Choregi, Nexter, Ceries et Ologram

CIFRE

- PhD CIFRE with PME CosmoLab – segmentation of confocal images

Futures CIFREs

- CIFRE with IMASCAP (Brest) – Shoulder surgery Enhanced by Augmented Reality Techniques
- CIFRE with CYRES – Incremental Classification and deep learning for fraud detection

The logo for ITESOFT, featuring the word "ITESOFT" in a bold, black, sans-serif font with a yellow circle above the letter "O".The multi-colored Google logo in its standard font.The logo for COSM'D LAB, consisting of the text "COSM'D LAB" in white, uppercase letters inside a green rectangular box with a thin black border.The logo for NEXTER SYSTEMS, with "NEXTER" in a large, bold, black font and "SYSTEMS" in a smaller, spaced-out font below it.The logo for ARKHÊNUM, featuring the word "ARKHÊNUM" in a stylized, bold font with a black background behind the letters, and the tagline "Patrimoine du futur" in a smaller font below.The logo for C.E.R.I.E.S., with the acronym in a bold, black font and a red swoosh underline.

CEntre de Recherches et d'Investigations
Épidémiologiques et Sensorielles de CHANEL

The logo for choregie, featuring a row of stylized human figures in various shades of blue and green above the word "choregie" in a bold, lowercase font.The logo for i2S, with "i2S" in a large, stylized font where the "2" is a blue square, and "innovative imaging solutions" in a smaller font below.

Open data

VDM tools VizAssist et DataTube 2	G. Venturini, F. Bouali	en moyenne 2 utilisateurs par jour - 50% des sessions sont issues de l'étranger : Inde, USA, Allemagne, Autriche Espagne, Hong-Kong, Australie, Chine, etc	http://www.vizassist.fr/
Library Comb-pgeo-paths	J Mille, S Bougleux (Greyc)	Combination of piecewise-geodesic paths for interactive segmentation	https://github.com/julienmille/comb-pgeo-paths
Graph database GDR4GED - ICPR 2016 contest GDC	Zeina AbuAsheih, R Raveau, JY Ramel	référencement sur le site IAPR TC15	http://www.rfai.li.univ-tours.fr/PublicData/GDR4GED/home.html
Doc images SESYD et ISRC.- "International Symbol Recognition Contest" du TC10	M Delalandre	97 citations sur PubPerish 2016	http://iapr-tc10.univ-lr.fr/
Agora et Retro - open source (projet Paradiit)	JY Ramel, P. Bourquin	1 formation par an aux 15 étudiants du master PEEN du CESR + téléchargements occasionnels	https://sites.google.com/site/paradiitproject/
3D Image databases Textures 3D	L Paulhac, JY Ramel, P Makris	13 citations en 2016	http://www.rfai.li.univ-tours.fr/fr/resources/3Dsynthetic_images_database.html

Some pictures...

