Departamento Ingeniería
Eléctrica

Presentation Title

Presentation Subtile

February 23, 2019

M.Sc. Ricardo Moncayo
Advisor: Ph.D. Eduardo Romero

Pathological examination issues

- Due to the heterogeneity between the normal tissue and the disease most of the morphological indicators of prognosis are not quantified

Pathological examination issues

- Due to the heterogeneity between the normal tissue and the disease most of the morphological indicators of prognosis are not quantified
- Subjective observations are susceptible to inter and intra observer variations Imagenes con kappa

The Suitability of a Quantitative Estimation in Pathology Workflow

- Digital version of whole glass slide and image analysis are using to improve the diagnosis

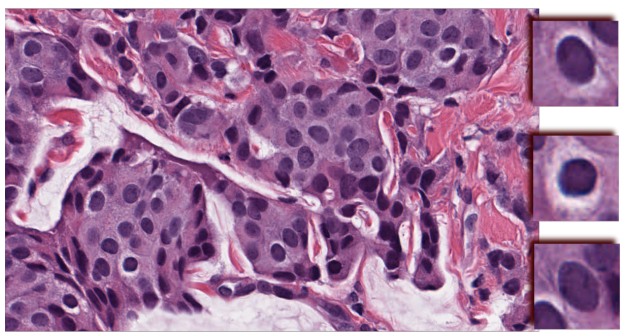
The Suitability of a Quantitative Estimation in Pathology Workflow

- Digital version of whole glass slide and image analysis are using to improve the diagnosis
- The Quantification of morphological structures to determine the predisposition of a disease and to deliver healthcareimagenes??

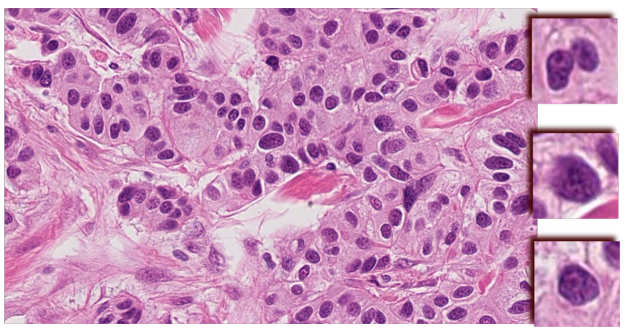
Nuclear Pleomorphism (NP) in Ductal carcinoma in situ (DCIS) - 2nd case of Study

Nuclear Pleomorphism

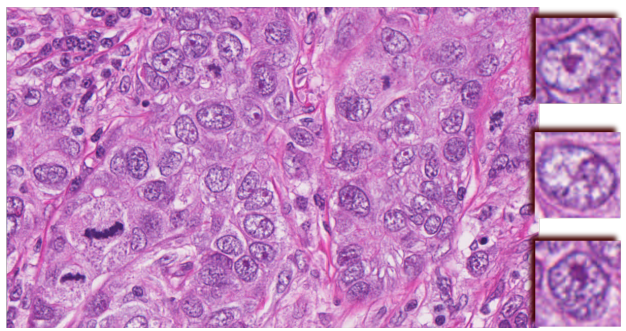
- The current research is about automatic strategies to quantify nuclear pleomorphism in breast cancer(NPBca).



grade 1



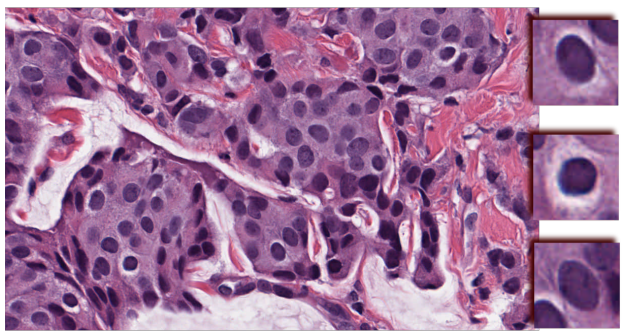
grade 2



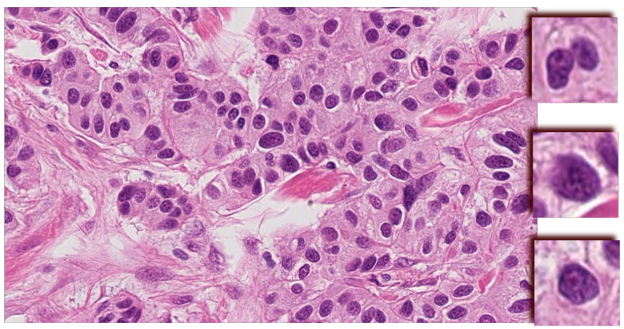
grade 3

Nuclear Pleomorphism

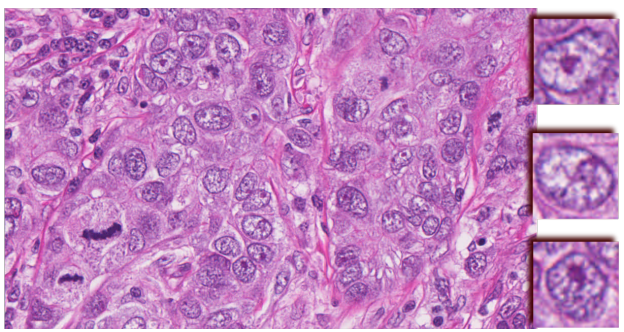
- The current research is about automatic strategies to quantify nuclear pleomorphism in breast cancer(NPBca).
- NPBca is an indicator of the aggressiveness of the disease



grade 1



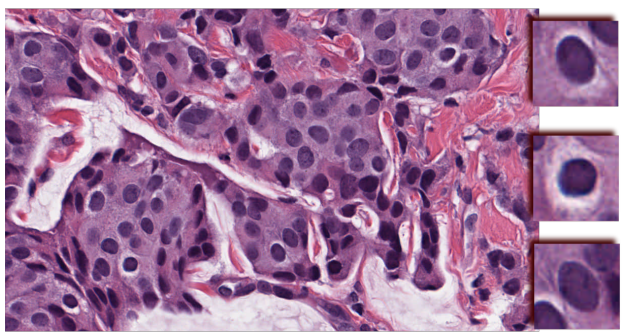
grade 2



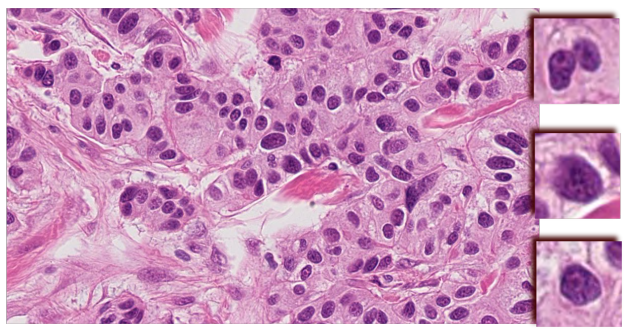
grade 3

Nuclear Pleomorphism

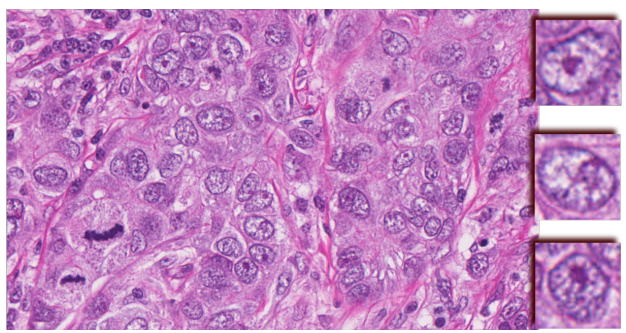
- The current research is about automatic strategies to quantify nuclear pleomorphism in breast cancer(NPBca).
- NPBca is an indicator of the aggressiveness of the disease
- A low inter-observer agreement ($0.3 < \kappa < 0.5$)



grade 1

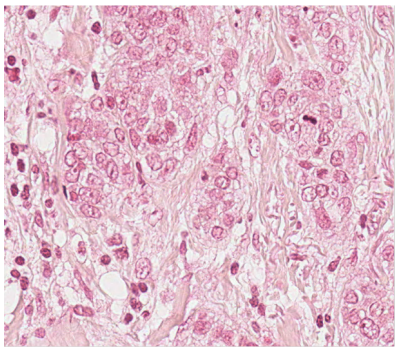


grade 2

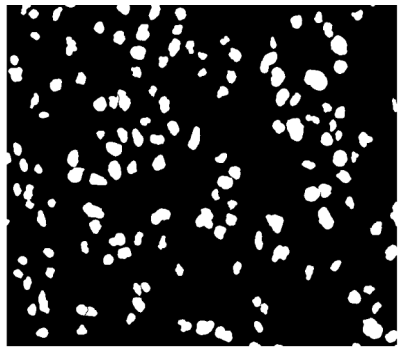


grade 3

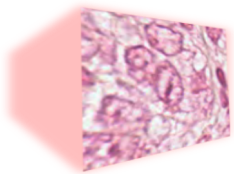
Spatial Pyramidal Characterization



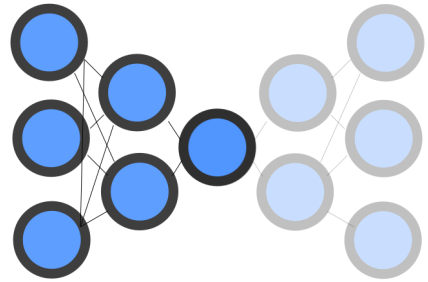
H&E Image



Nuclei Detection



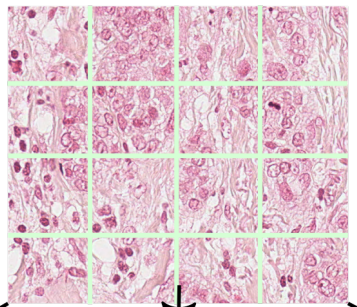
Nuclei Patches

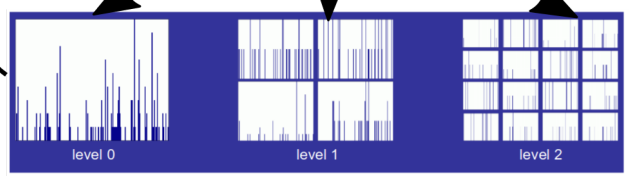


Dimensionality Reduction

Bag Of Features

- Dirichlet Process
- K-means
- PLSA



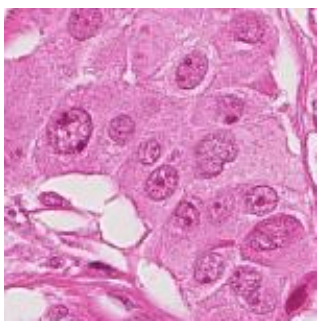


Spatial Pyramidal Matching

Classifier

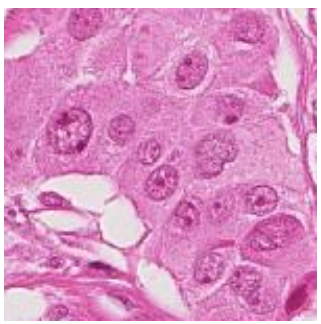
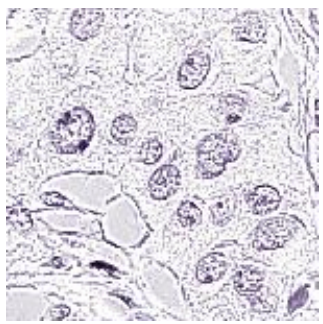
Nuclei Detection

- Using a color deconvolution technique the Hematoxylin (H) and eosin (E) stains are estimated



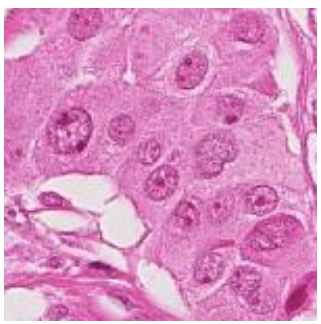
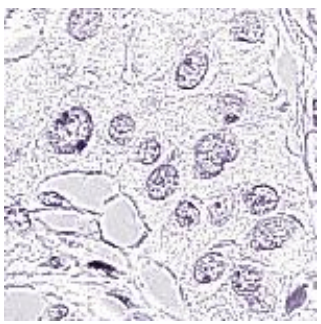
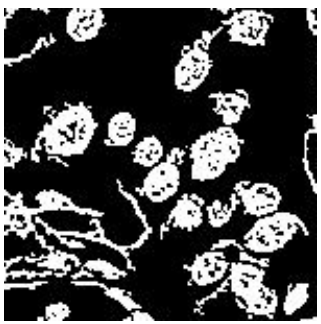
Nuclei Detection

- Using a color deconvolution technique the Hematoxylin (H) and eosin (E) stains are estimated

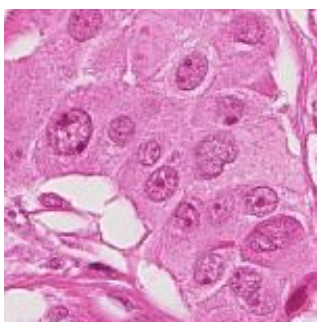
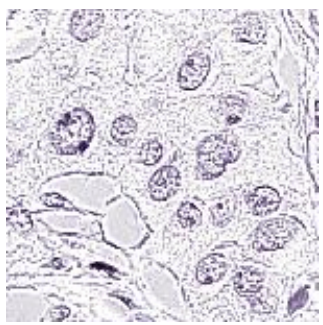
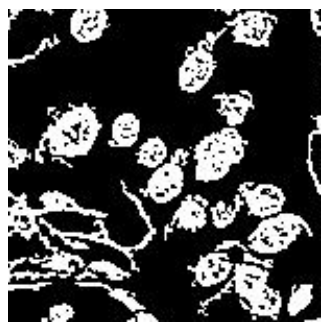
Nuclei Detection

- Using a color deconvolution technique the Hematoxylin (H) and eosin (E) stains are estimated
- Watershed algorithm is used to detect nuclei candidates in H stain

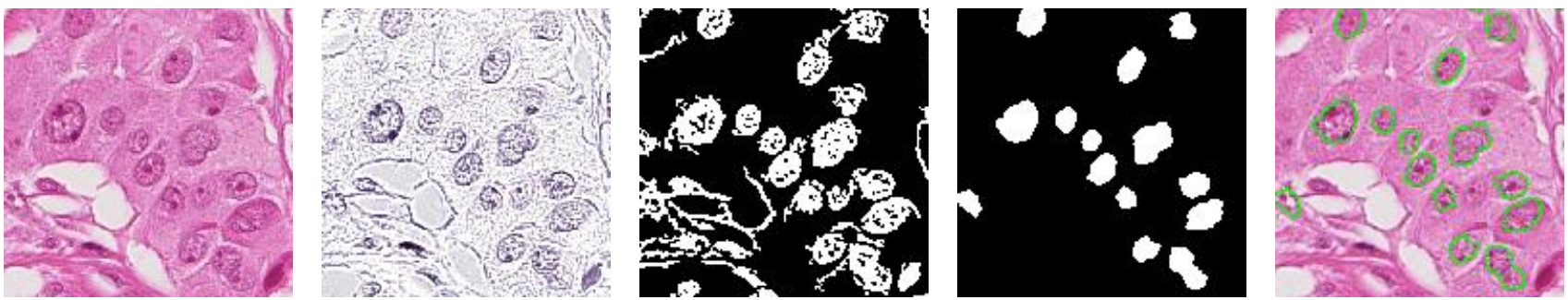
Nuclei Detection

- Using a color deconvolution technique the Hematoxylin (H) and eosin (E) stains are estimated
- Watershed algorithm is used to detect nuclei candidates in H stain
- Final candidates are found after morphological operations

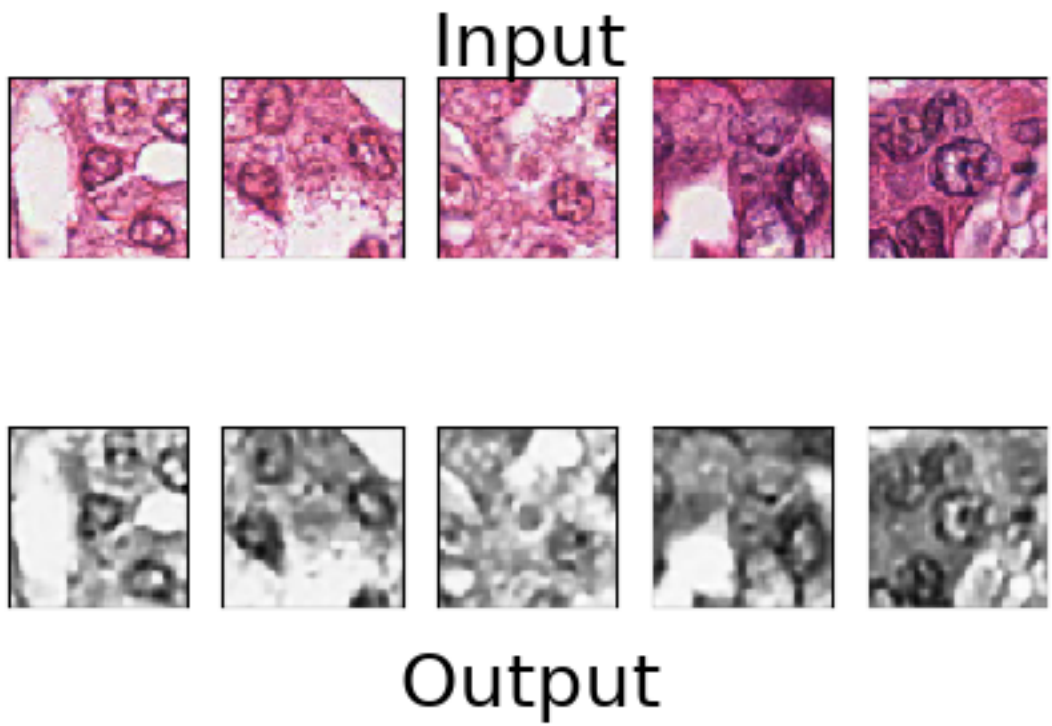

Nuclei Detection

- Using a color deconvolution technique the Hematoxylin (H) and eosin (E) stains are estimated
- Watershed algorithm is used to detect nuclei candidates in H stain
- Final candidates are found after morphological operations



Dimensionality Reduction- Convolutional autoencoder

- 3 convolutional layer for encoding and 3 for decoding poner modelo
- 2048 dimensions in coded representation for nuclei (22.5 compresion factor)



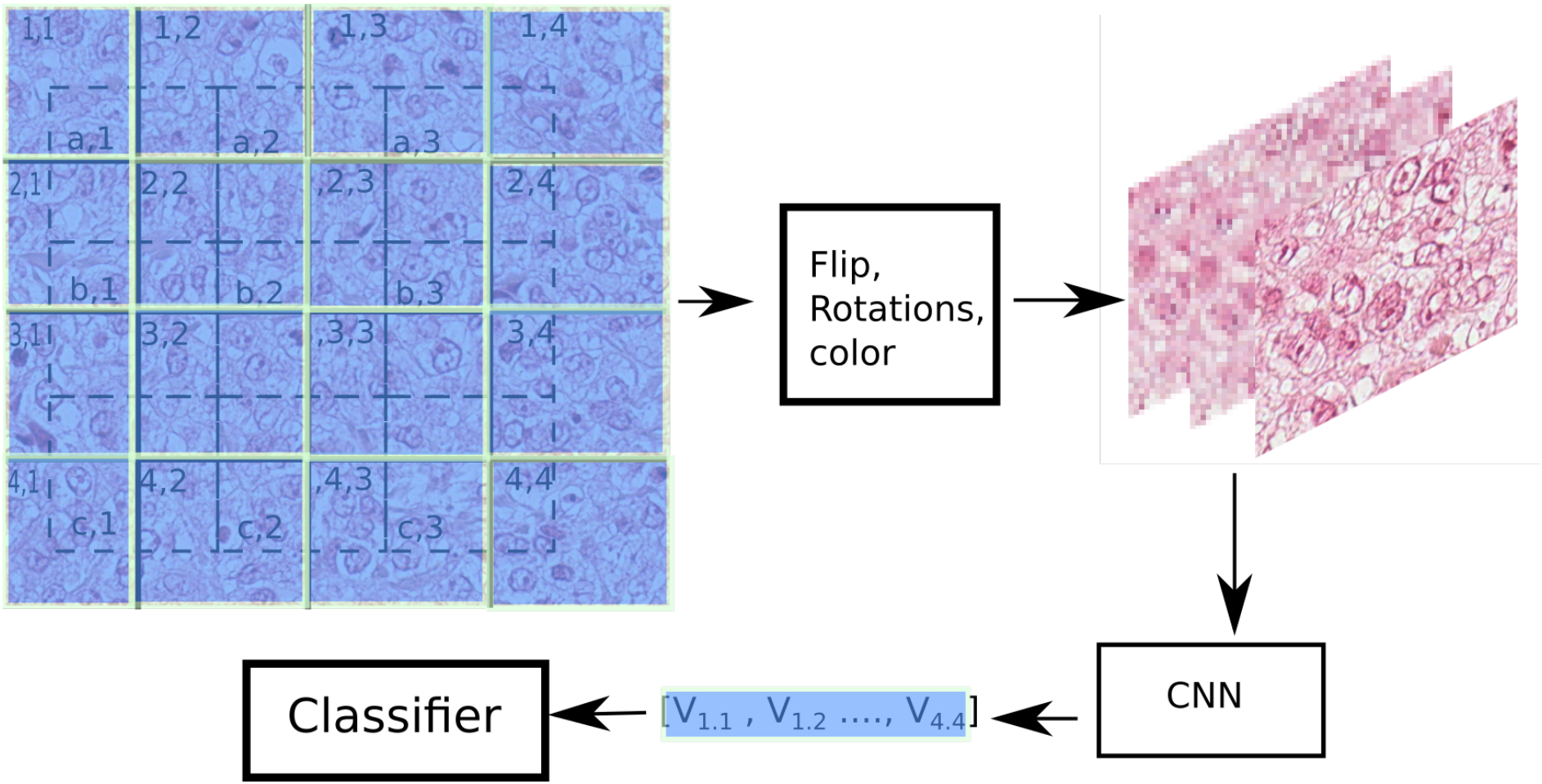
Autoncoder Reconstruction

Bag of Features

Results

	PS.	PS L0	PS L01	PS L2	BOF PY	BOF PY L0	BOF PY L1
3 Vs. 1 and 2	0.578	**0.630**	0.565	0.53	0.624	0.593	0.583
1 Vs. 2 and 3	0.624	0.564	0.520	0.489	**0.692**	0.642	0.678
1 Vs 2	0.473	0.597	0.542	0.573	0.650	**0.713**	0.660
2 Vs 3	0.560	0.603	0.606	0.632	0.722	0.660	**0.729**
1 Vs 3	0.623	0.716	0.639	0.632	0.628	0.675	**0.740**

CNN Framework



Dataset- Mitos Atypia 14

Grade	#40X images	Total Patches 344x344 pixels	Train	Validation
NP 1	92	21,344	18,144	3,200
NP 2	900	22,500	19,096	3,404
NP 3	208	20,800	17,764	3,036

Table: *Training and validation - 11 cases for training*

Grade	# 40X images
NP 1	152
NP 2	252
NP 3	92

Table: *Test dataset - 5 cases*

Results

	CNN (1024dim)	CNN (3dim)	VGG16	Alexnet	Resnet50
3Vs.1 and 2	0.635	0.523	0.629	0.493	**0.685**
1Vs.2 and 3	**0.676**	0.645	0.564	0.581	0.573
1 Vs 2	0.637	**0.664**	0.453	0.623	0.592
2 Vs 3	0.570	0.567	0.544	0.619	**0.670**
1 Vs 3	0.666	**0.672**	0.620	0.649	0.563

Nuclei Detection

- Color deconvolution to find hematoxylin channel (Macenko et al.)
- Watershed Algorithm to find connected components at different scales (Veta et al.)
- Patches are extracted using the nuclei centroid as seed (72x72 pixels)

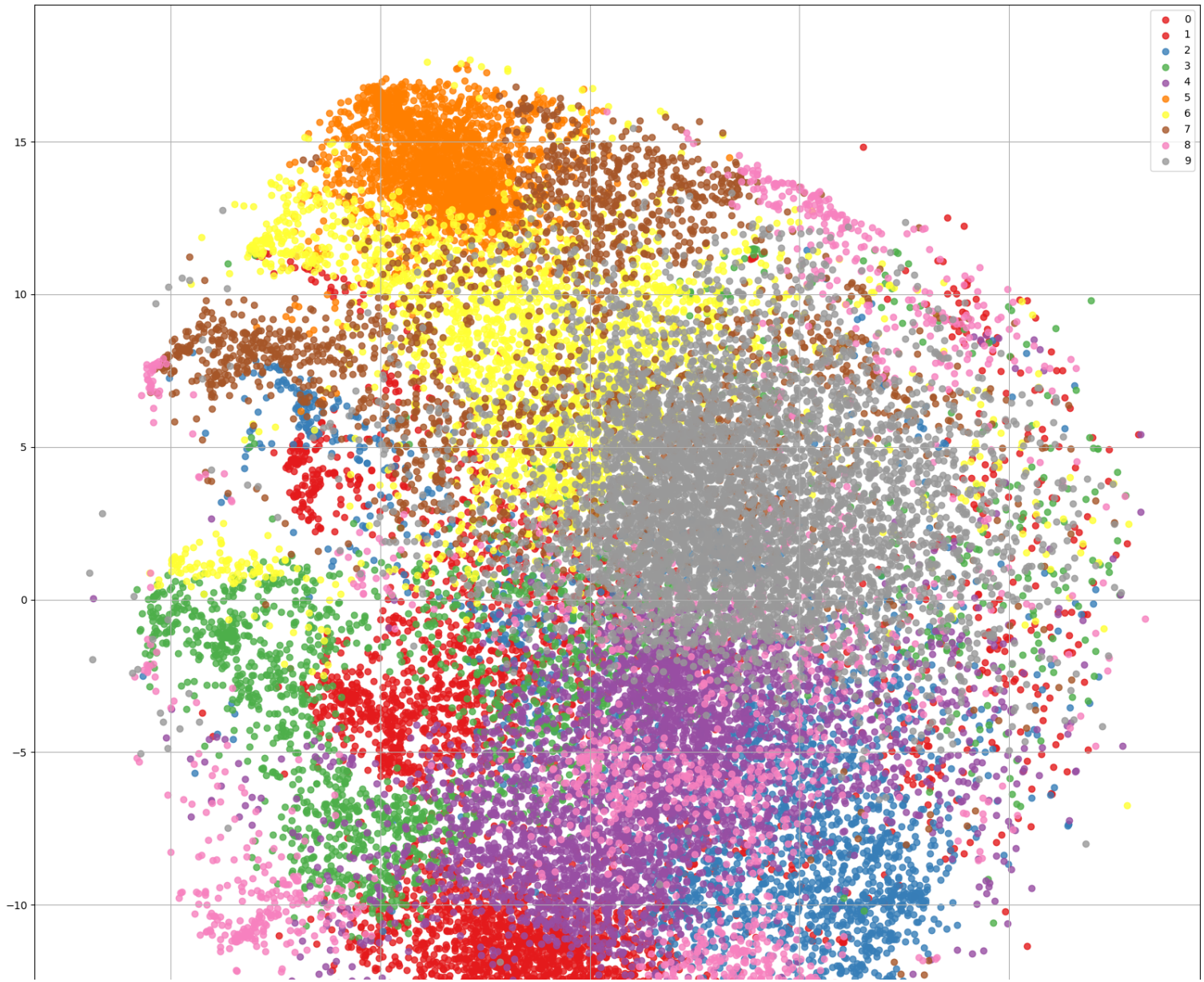
New Dataset

Grading	# Marked Areas
Grade 1	135
Grade 2	132
Grade 3	39
Total Cases	**24**

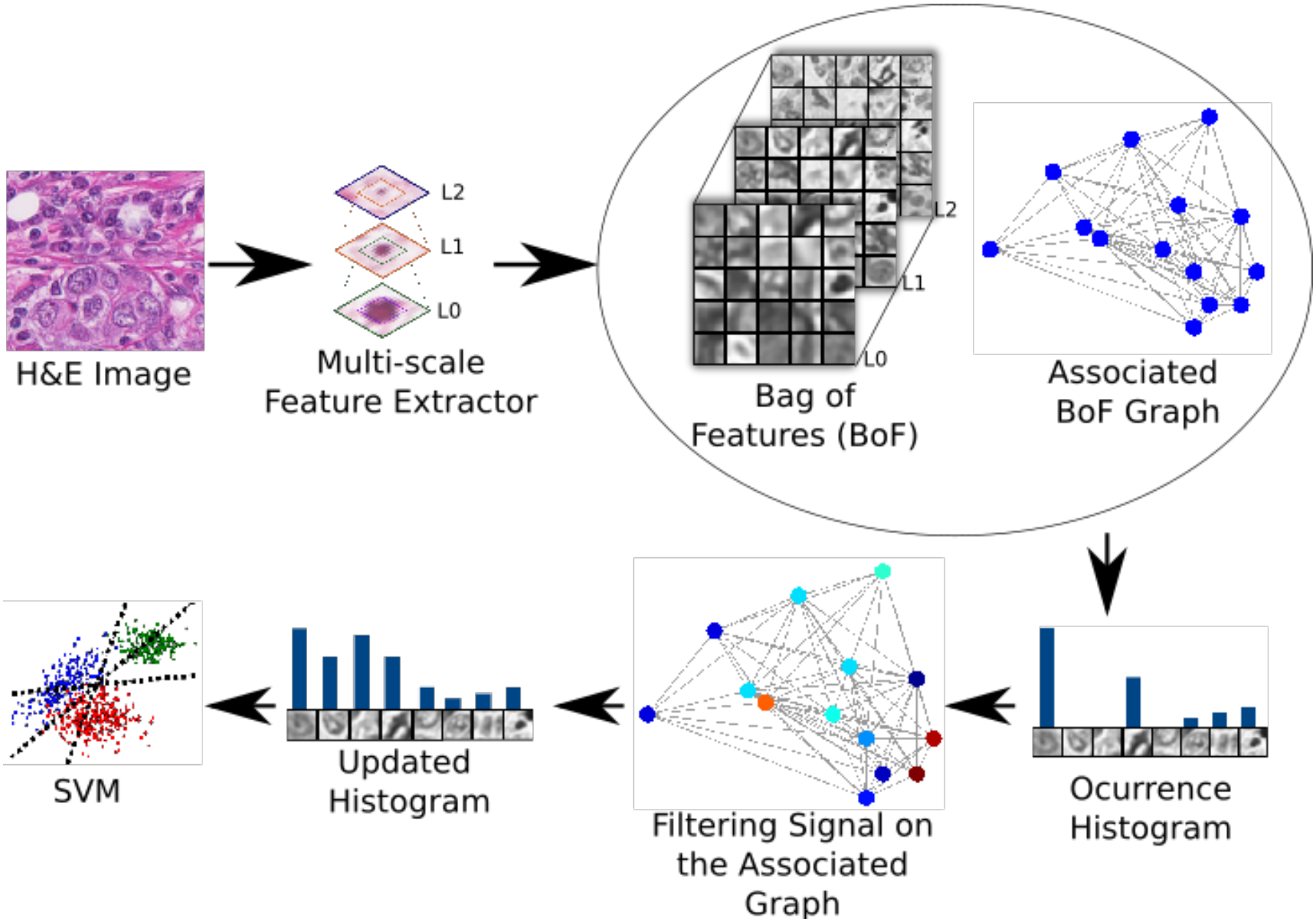
Final Remarks

- The Slightly variation between the NP grades and the high tissue variability makes difficult to find an adequate model.
- The CNN model could be improved if take advantage of the spatial information
- The auto-encoder representation and vocabulary construction maybe is not the most appropriate.

Thank you...


0
1
2
3
4
5
6
7
8
9
15
10
5
0
−5
−10

Proposed Grading Methodology



Bag of Features Construction

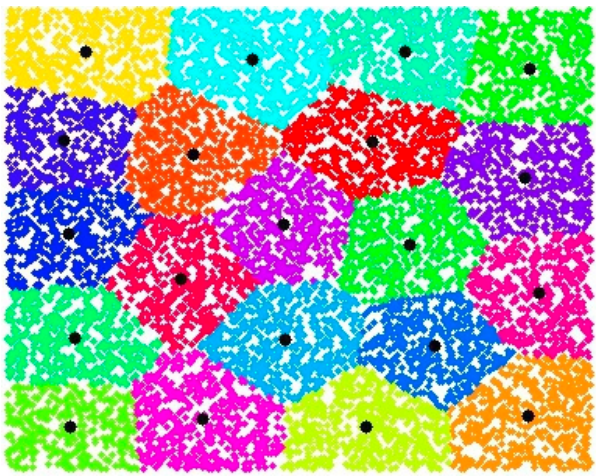


Figure: *K-means Algorithm*

- The multi-scale feature space is partitioned with a *k*-medoids algorithm

Bag of Features Construction

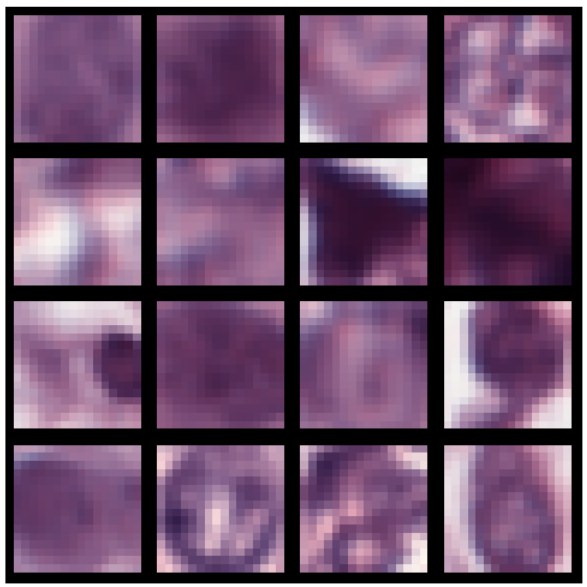


Figure: *Dictionary with L0*

- The multi-scale feature space is partitioned with a *k*-medoids algorithm
- Each medoid correspond to a visual word in the BoF

Bag of Features Construction

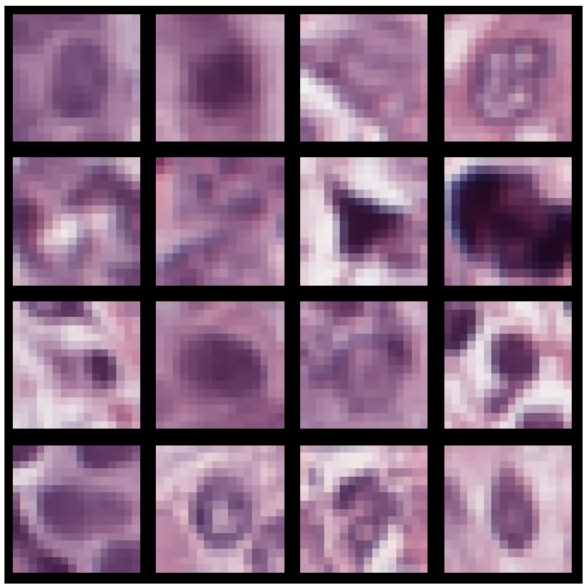


Figure: *Dictionary with L1*

- The multi-scale feature space is partitioned with a *k*-medoids algorithm
- Each medoid correspond to a visual word in the BoF

Bag of Features Construction

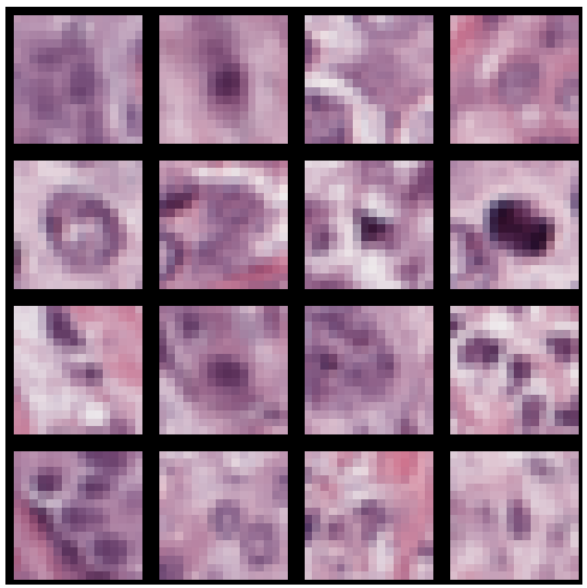


Figure: *Dictionary with L2*

- The multi-scale feature space is partitioned with a *k*-medoids algorithm
- Each medoid correspond to a visual word in the BoF

Bag of Features Construction

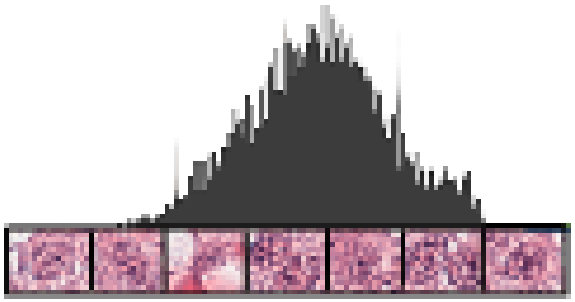


Figure: *Occurrence histogram for one image*

- The multi-scale feature space is partitioned with a *k*-medoids algorithm
- Each medoid correspond to a visual word in the BoF
- Each new candidate from a train or test image is represented by some atom in the dictionary, using a cosine distance to find the nearest.

Bag of Features Construction

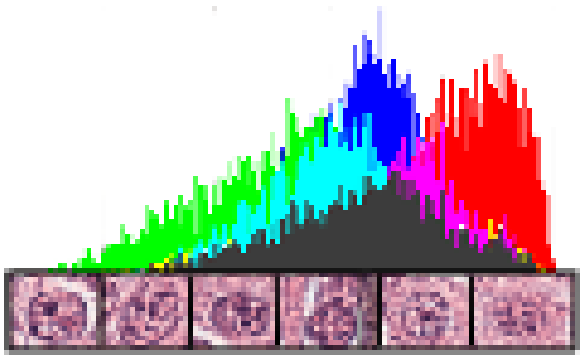
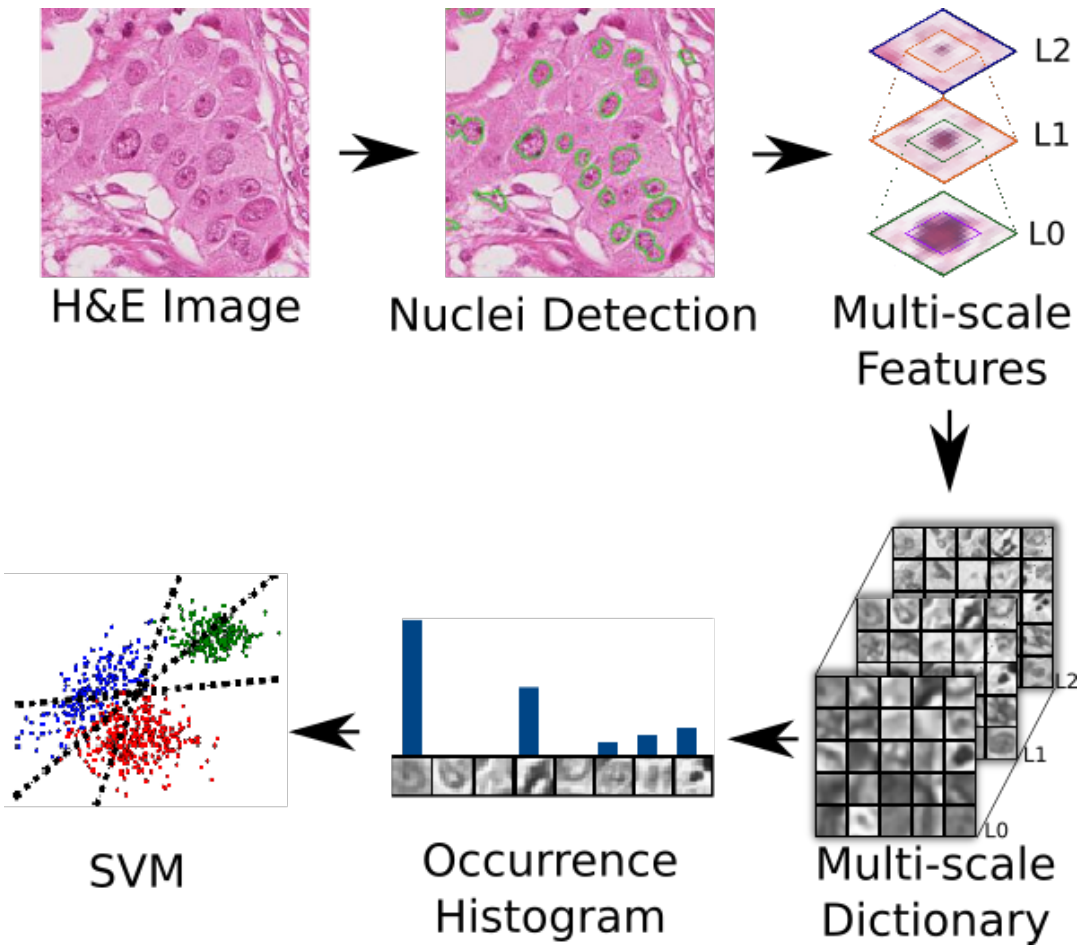


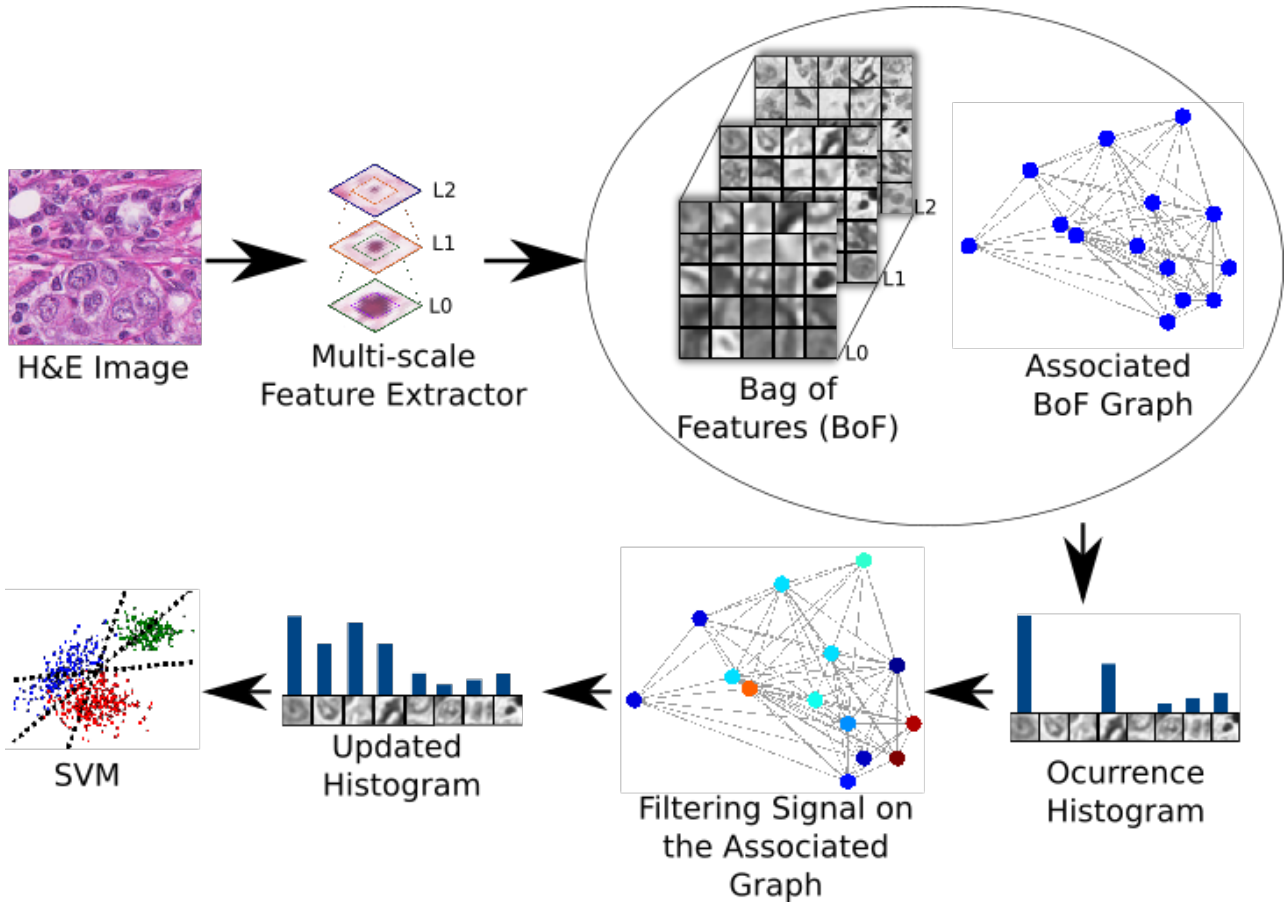
Figure: *Occurrence histogram for Train images*

- The multi-scale feature space is partitioned with a k-medoids algorithm
- Each medoid correspond to a visual word in the BoF
- Each new candidate from a train or test image is represented by some atom in the dictionary, using a cosine distance to find the nearest.

Previous: A Bag of Features Based Strategy



Previous: A Bag of Features onto a Graph Strategy



Research Products

- Moncayo, R., Romo-Bucheli, D., Romero, E. **A Grading Strategy for Nuclear Pleomorphism in Histopathological Breast Cancer Images Using a Bag of Features (BOF)**. In Progress in Pattern Recognition, Image Analasys, Computer Vision and Applications, Pages 75-82, november 2015. ISBN 978-3-319-25751-8
- Romo-Bucheli, D., Moncayo, R., Cruz, A., Romero, E., **Identifying histological concepts on basal cell carcinoma images using nuclei based sampling and multi-scale descriptors**. In 2015 IEEE 12th International Symposium on Biomedical Imaging (ISBI), April 2015, pages 1008-1011, ISSN 1945-7928
- Moncayo, R., Romo-Bucheli, D., Arias, V., Romero, E., **Scoring Nuclear pleomorphism using a visual BoF modulated by a graph structure**, In the 13th International Symposium on Medical Information Processing and Analysis, October 2017

The Next Step

The use of nuclear pleomorphism grade would be correlated with the patient outcome resulting in a reliable measure for the patient

Materials

Coming soon...

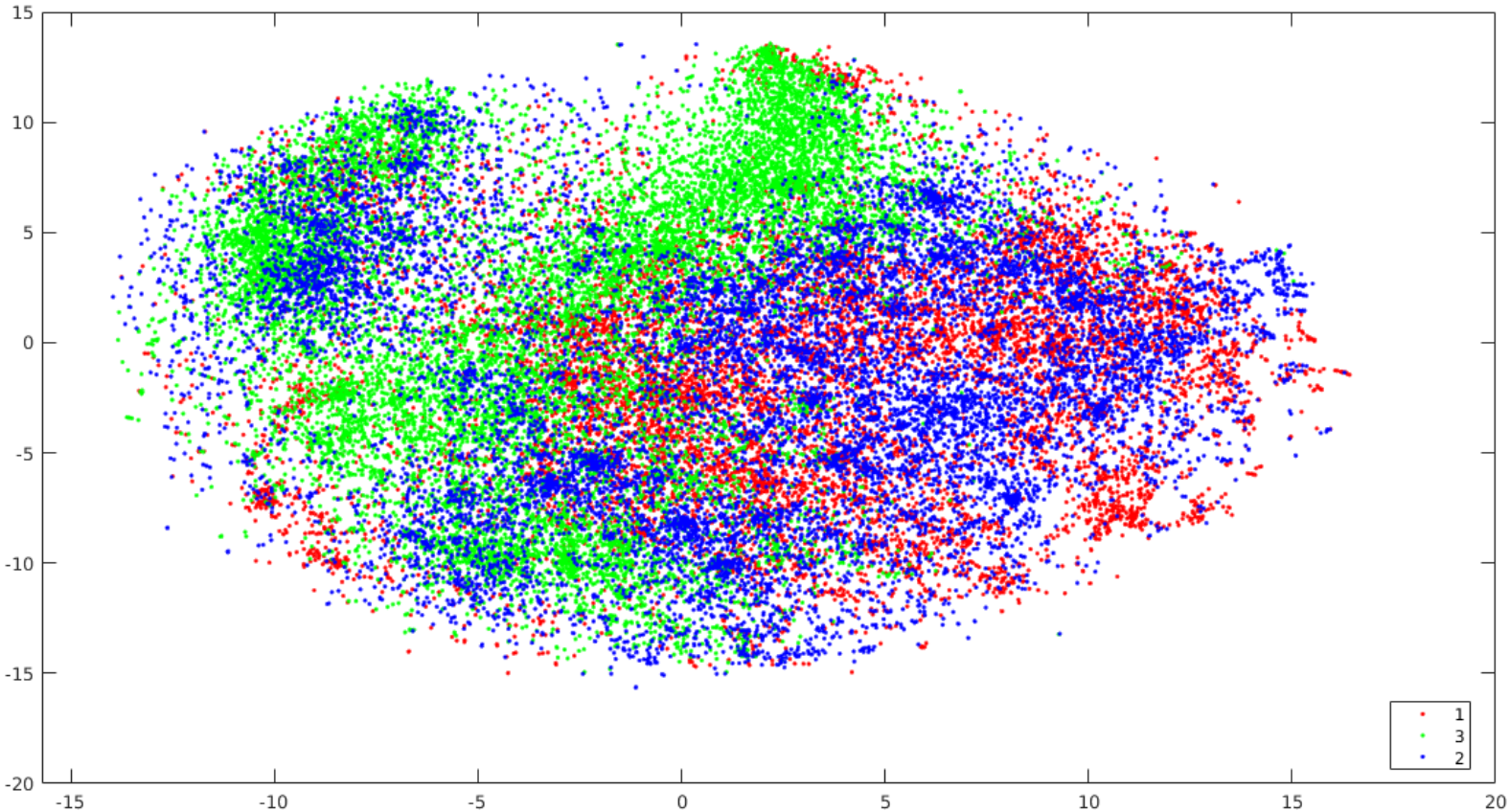
Probabilistic Latent Semantic Analysis(PLSA)

- Each multiscale representation is used as a **document** for build a PLSA model to find some topics

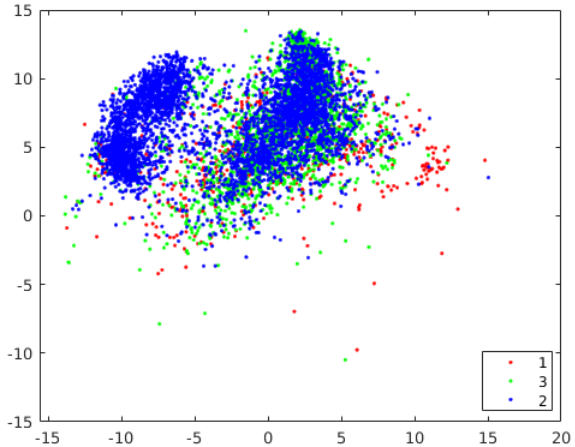
Probabilistic Latent Semantic Analysis(PLSA)

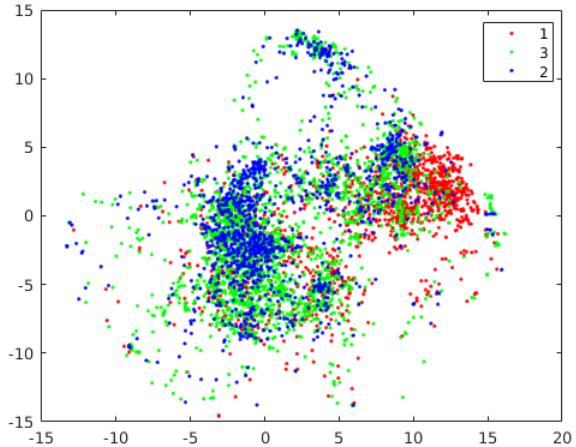
- Each multiscale representation is used as a **document** for build a PLSA model to find some topics
- T-sne is used to visualize the original space and the PLSA generated

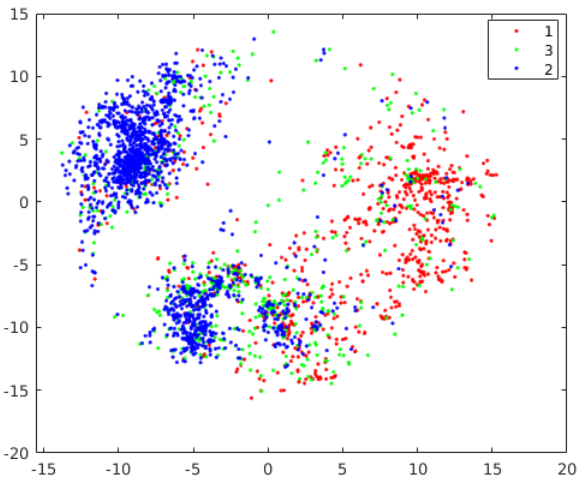
Visual Results - Original Space

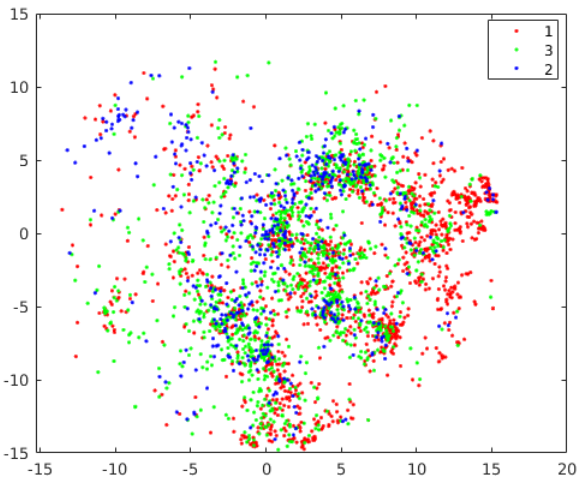


Visual Results - Space by topic

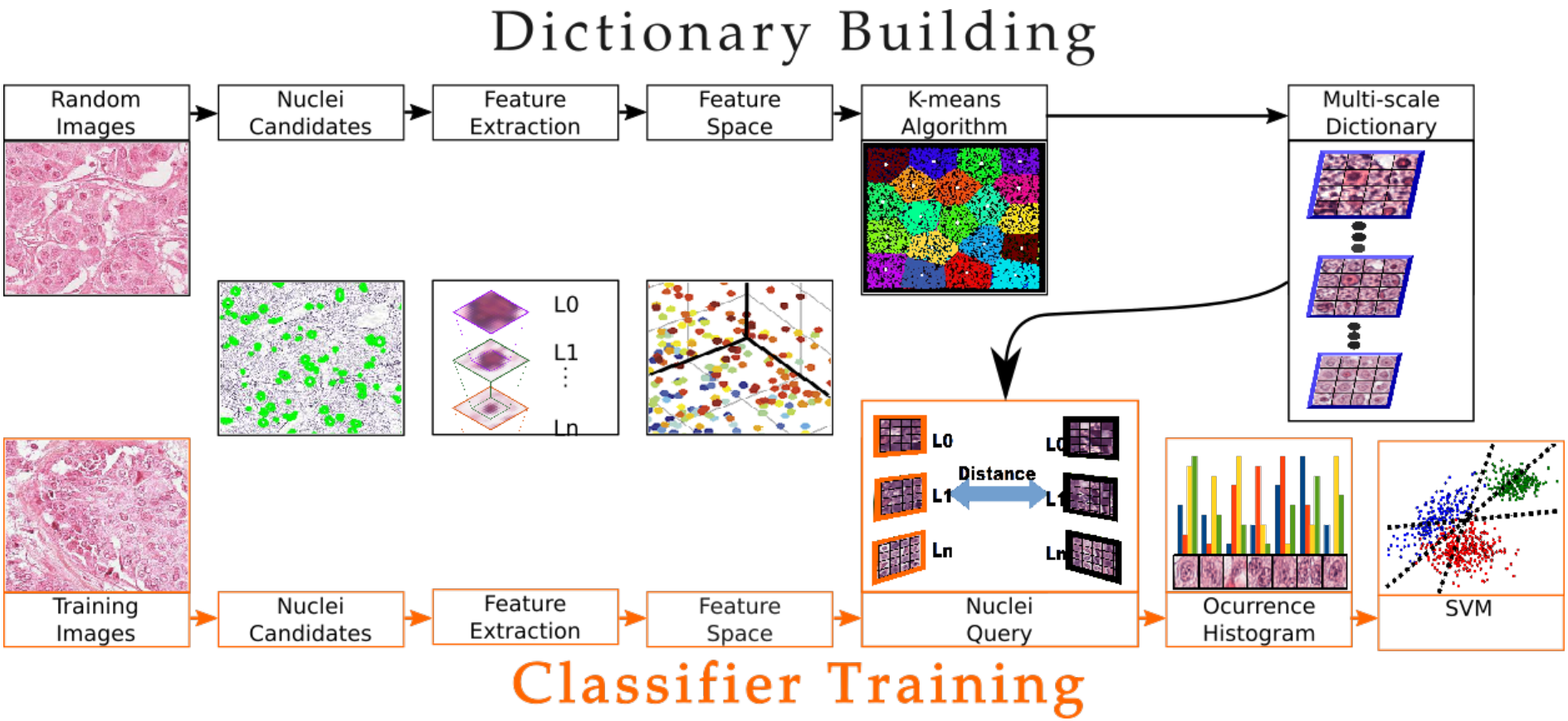






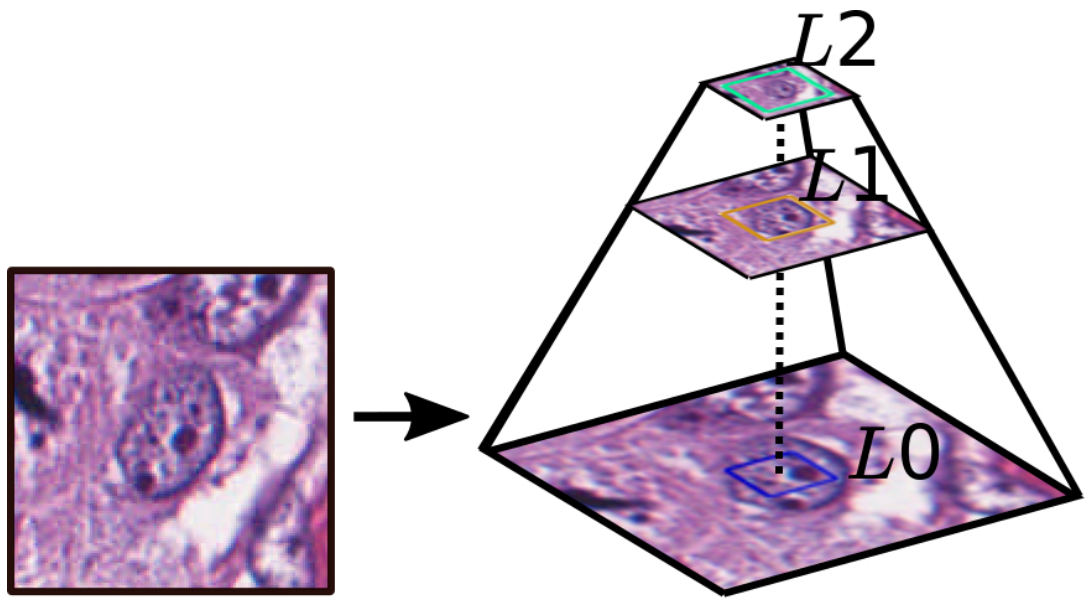


First Aproach



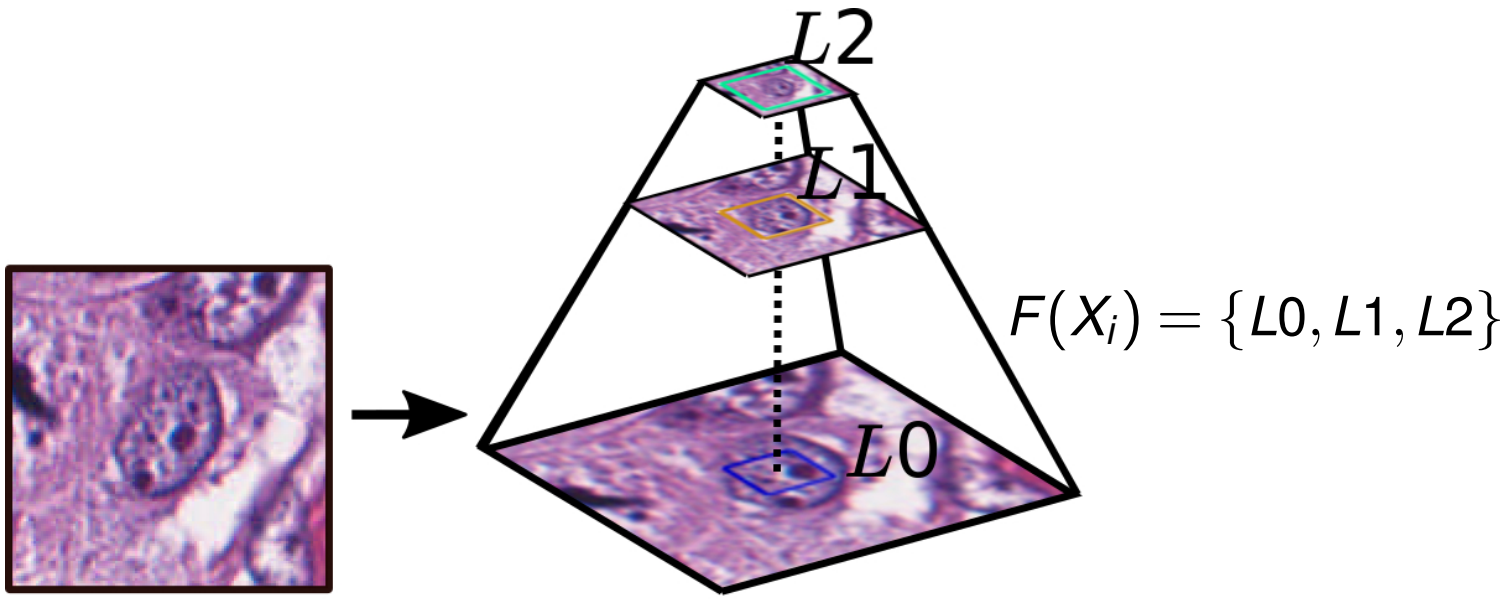
Multi-scale Feature Extractor

- The characterization of each nucleus candidate was performed by analyzing multiple scales



Multi-scale Feature Extractor

- The characterization of each nucleus candidate was performed by analyzing multiple scales
- The feature vector corresponds to the information from RGB patches which are concatenated along one dimension.



Results F1-Score

The F-score is used to evaluate the classification

$$F_\beta = (1+\beta^2).\frac{precision.recall}{(\beta^2.precision)+recall} \quad (1)$$

$\beta = 1$ is used this is the harmonic mean between precision and recall

Dataset - Mitos Atypia 14

Grade	#40X images
NP 1	92
NP 2	900
NP 3	208

Table: *Training and validation - 11 cases for training*

Grade	# 40X images
NP 1	152
NP 2	252
NP 3	92

Table: *Test dataset - 5 cases*

Results

Experiment/S.Patch	32x32 L2	20x20 L2
1 vs 2 and 3	**0.593**	0.434
3 vs 1 and 2	**0.642**	0.47
1 vs 2	**0.7128**	0.47
1 vs 3	0.660	**0.7029**
2 vs 3	**0.6759**	0.5813

Table: *Results Bag Of Features*

Current Work

- **To enhance the automatic nuclear pleomorphism grading**
- To find out if there is a relationship between the nuclear grade quantification with the cancer recurrence

CNN Framework