Quality evaluation of ancient digitized documents for binarization performances prediction

V. Rabeux, N. Journet, J.P. Domenger, A. Vialard

LaBRI (Laboratoire Bordelais de Recherche en Informatique)

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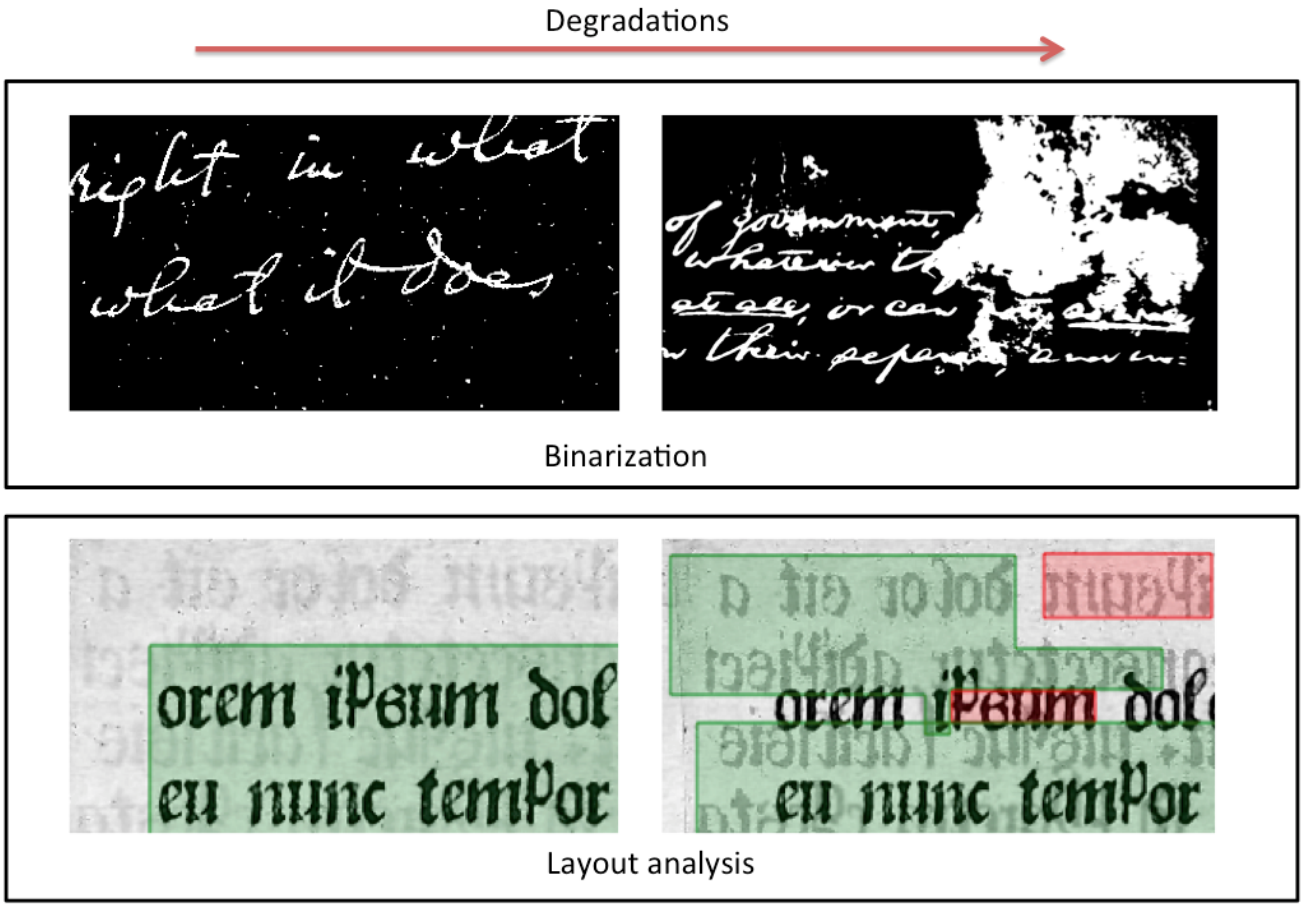
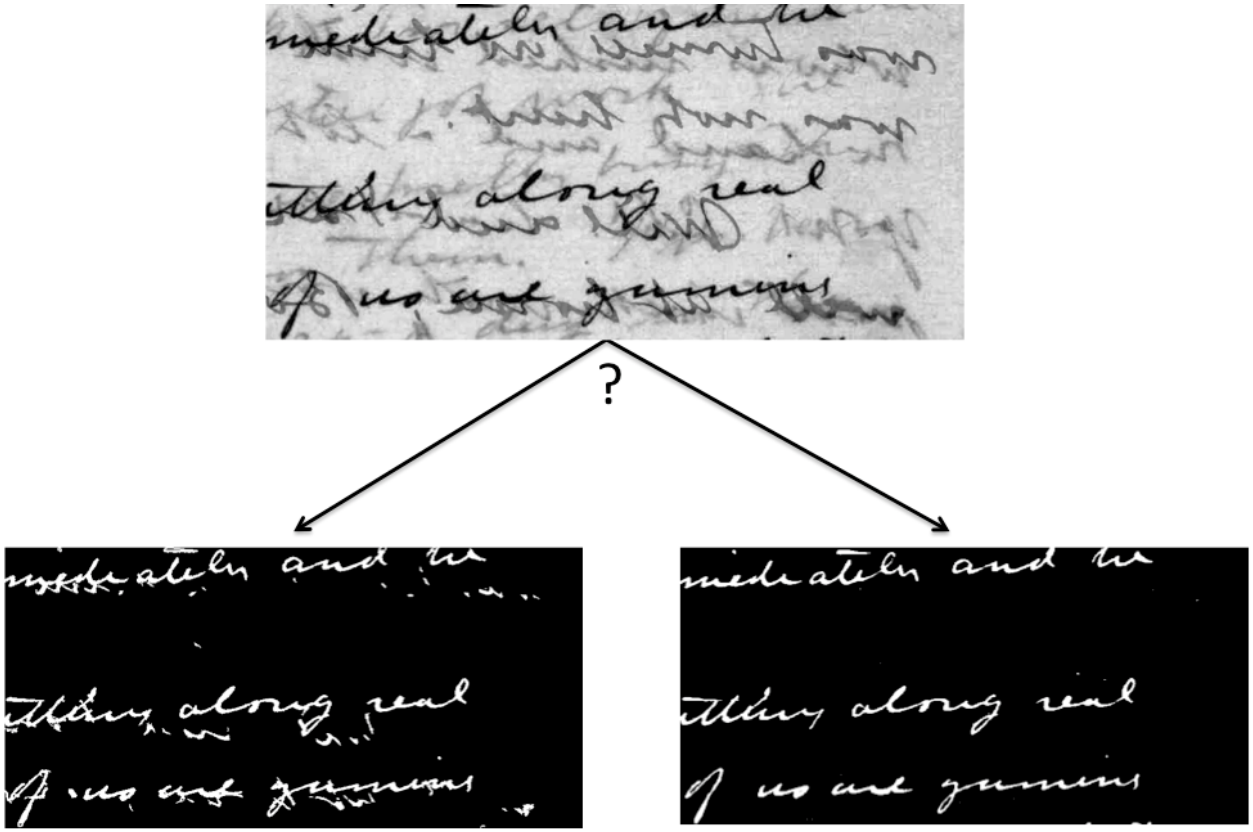
The image quality impacts algorithms performances.



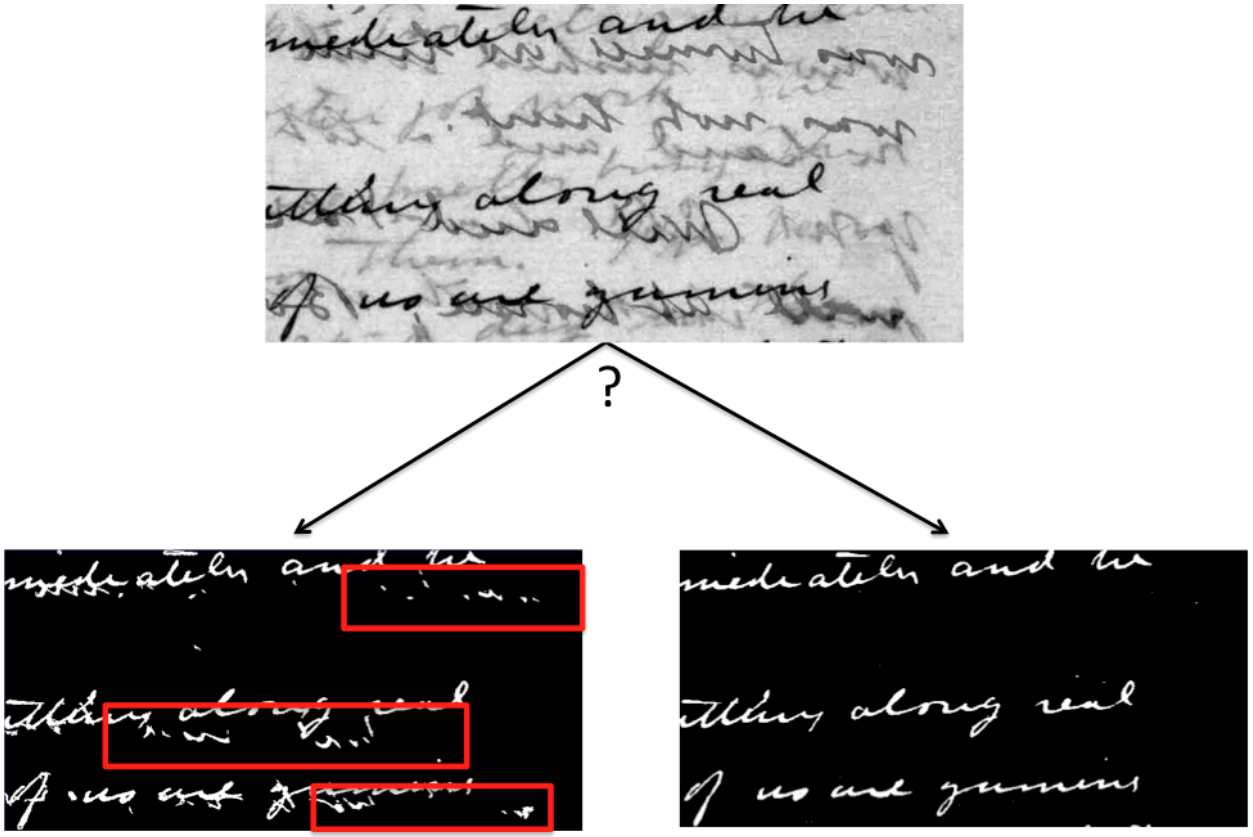
How to choose the best algorithm depending on the image degradation ?



Lu (Winner of ICDAR 2009)

Otsu

How to choose the best algorithm depending on the image degradation ?



Lu (Winner of ICDAR 2009)

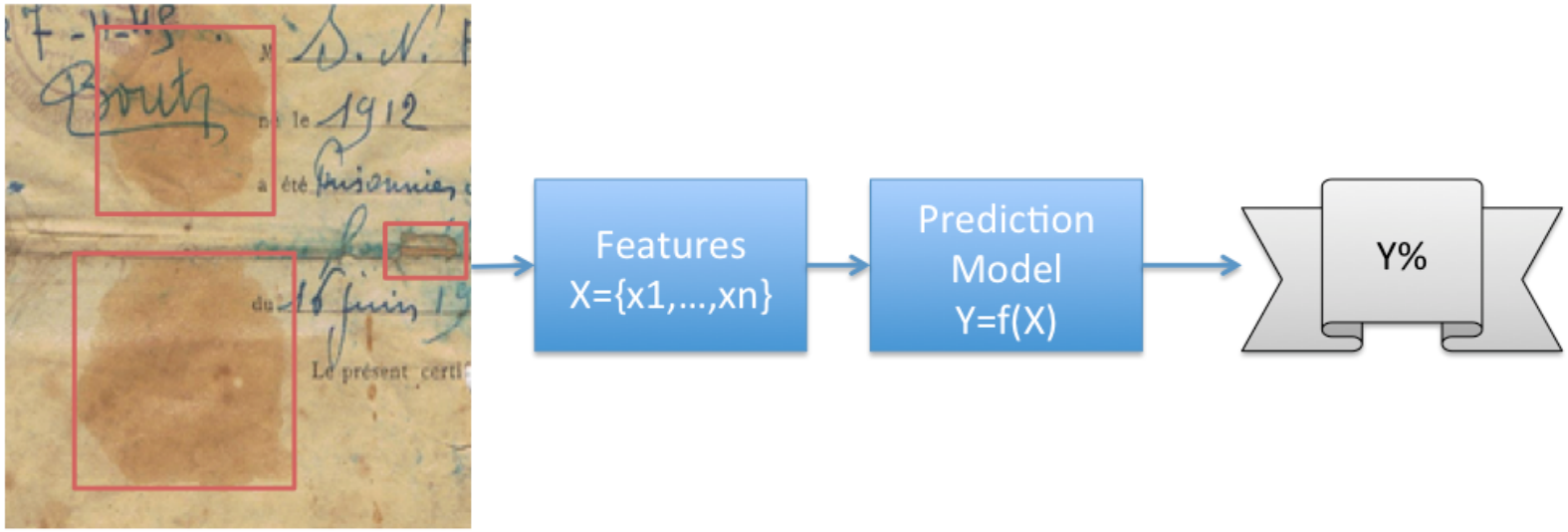
Otsu

Our approach

Predicting algorithm performance.

1. **Identify** and **characterize** degradations in the document image and create **dedicated features**.
2. Use the features to **predict** the algorithm performances.

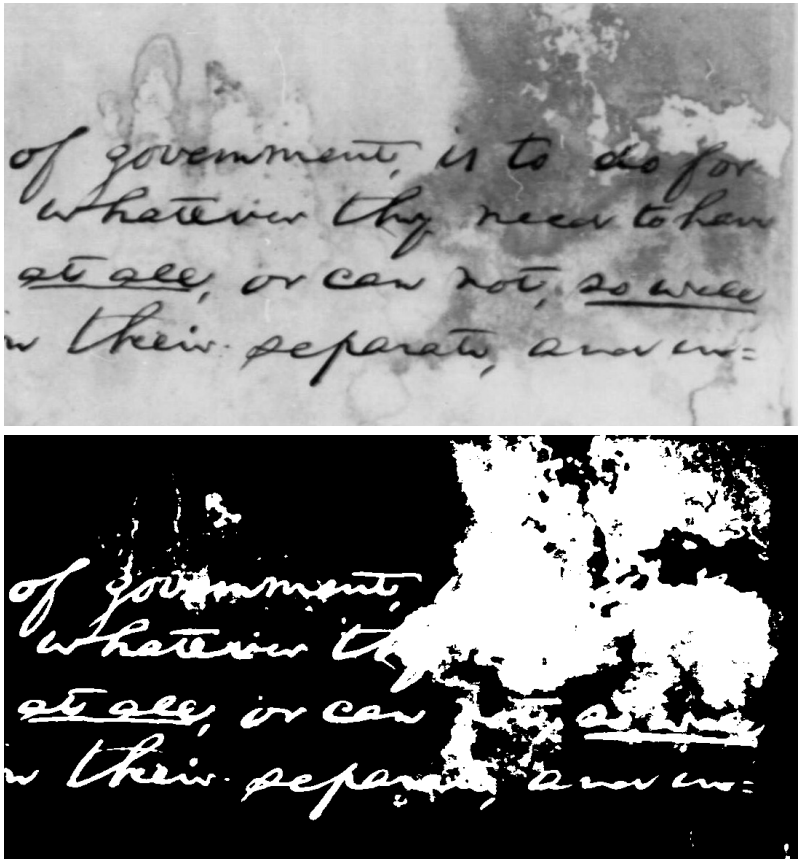
=> **Select** the most effective algorithm for each image.

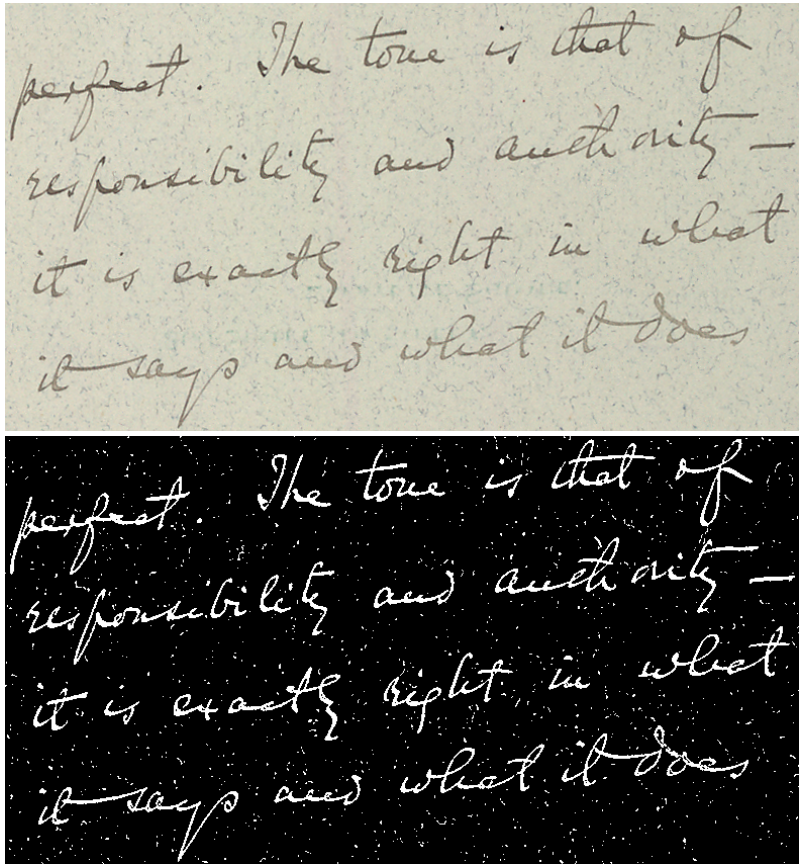


1. Indentify and characterize degradations
   - [Step 1] Algorithms errors and characterization of degradations.
   - [Step 2] Ink, degradations and background pixels extraction.
   - [Step 3] Features definition.

2. Algorithm performances prediction.
   - Prediction model creation and validation.
   - Predicting binarization methods performances.
   - Automatic selection of the best binarization method.

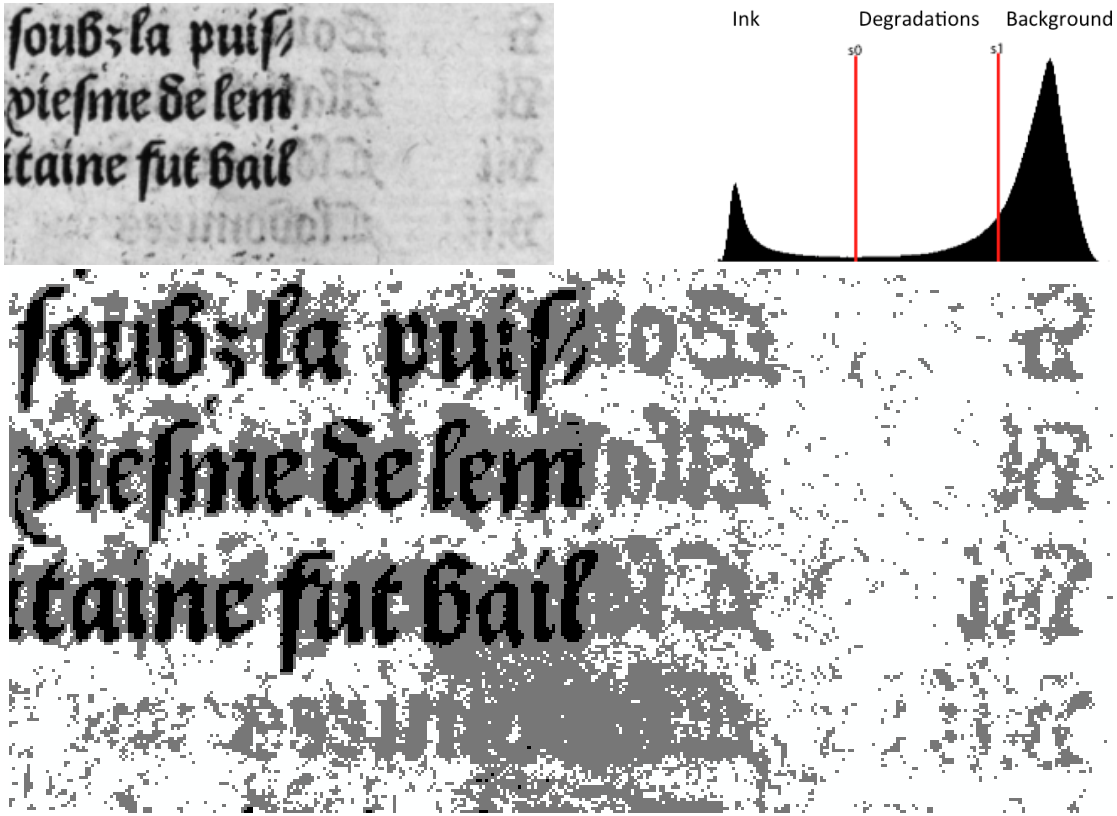
[Step 1] Algorithms errors and characterization of degradations.





[Step 2] Ink, degradations and background pixels extraction

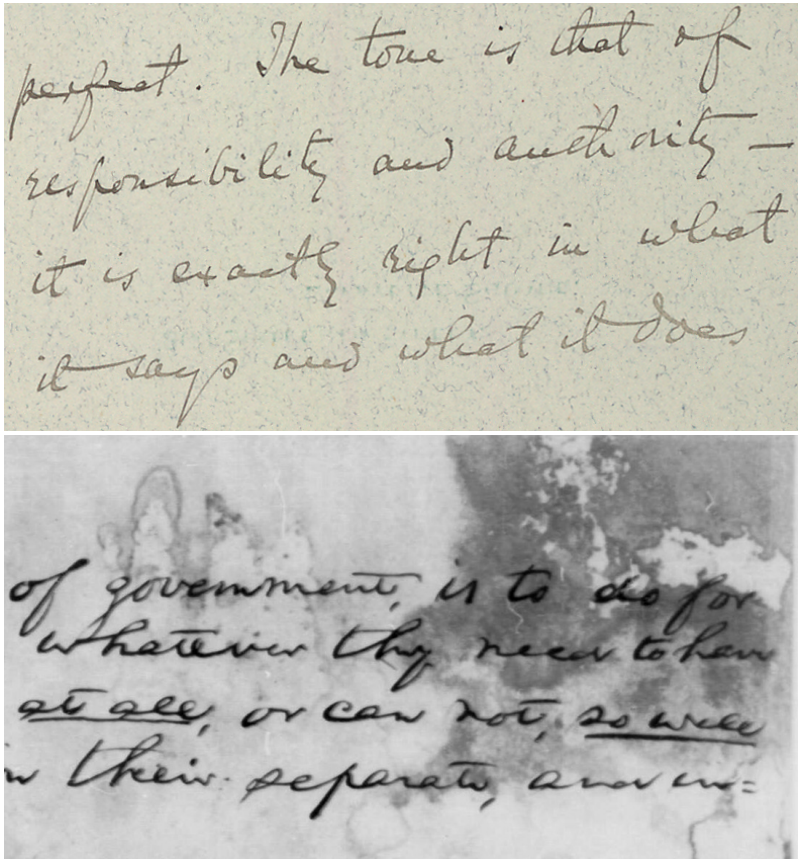
Extraction of 3 layers [MC09] : ink, degradations and background.

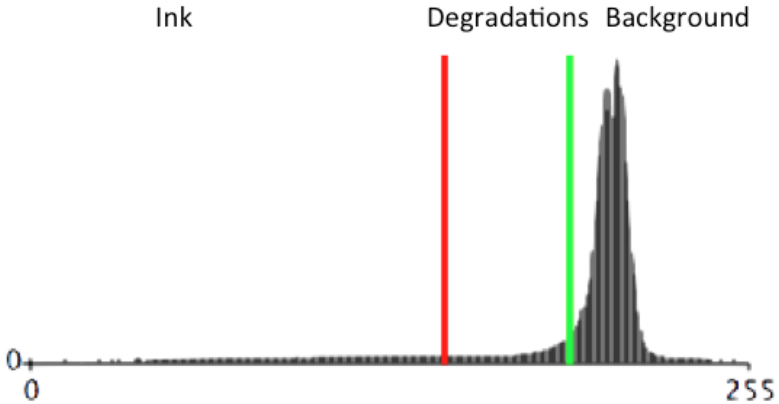


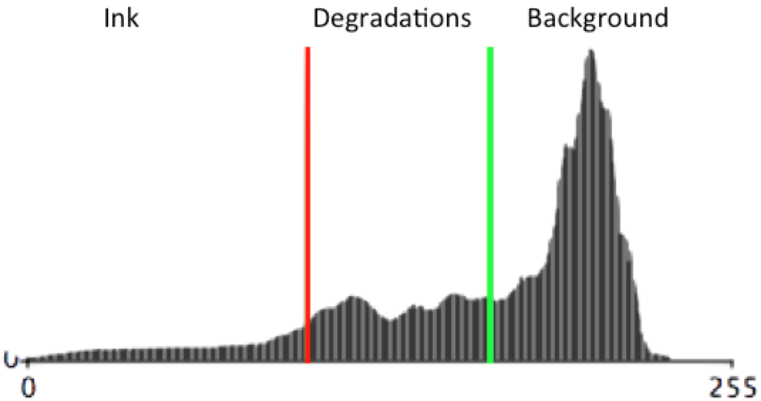
[Step 3] Features definition

15 Global features

Characterization of the overall distribution of the different layers.



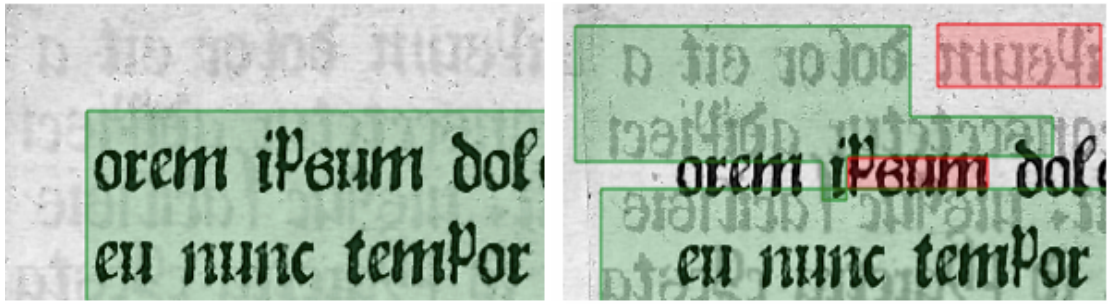




[Step 3] Features definition

15 Global features

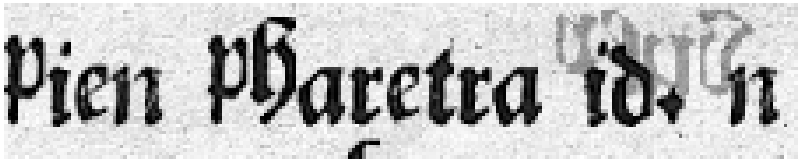
1. Distance between the ink average grayscale and the degradations average grayscale.
2. Distance between the degradations average grayscale and the background average grayscale.

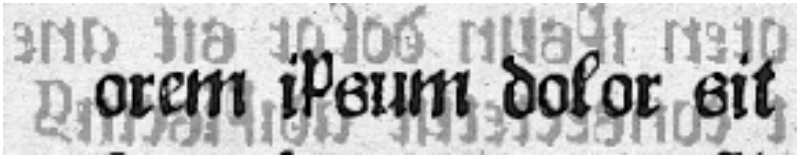


[Step 3] Features definition

15 Global features

The amount of degradation pixels (with proportion to the amount of ink).

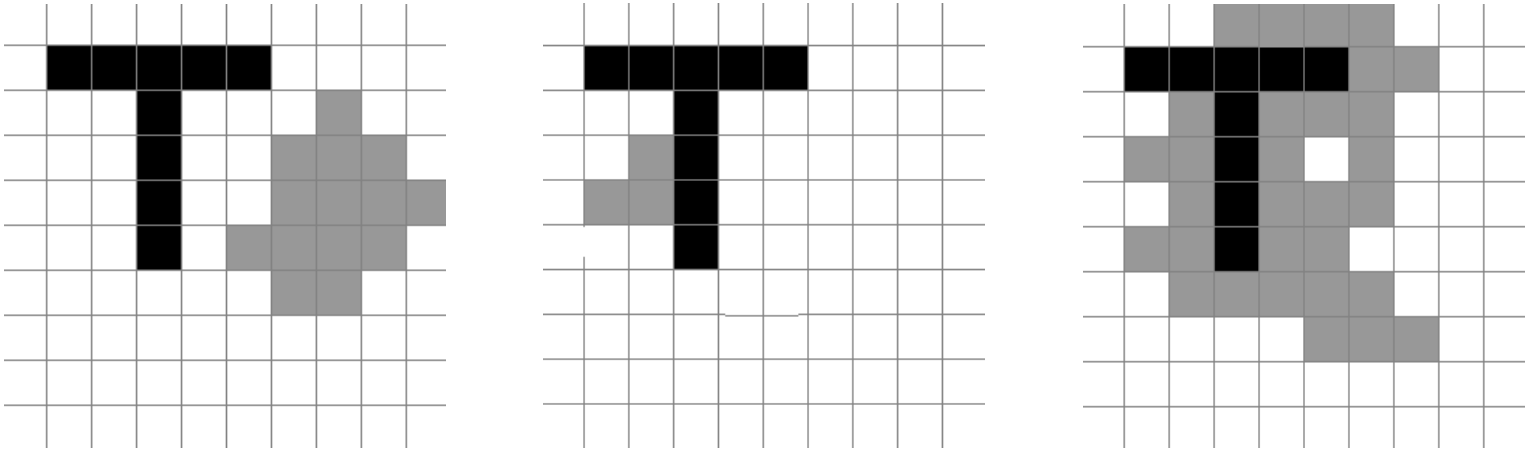




[Step 3] Features definition

3 Local features

Localization of degradations pixels in regards to the localization of ink pixels.



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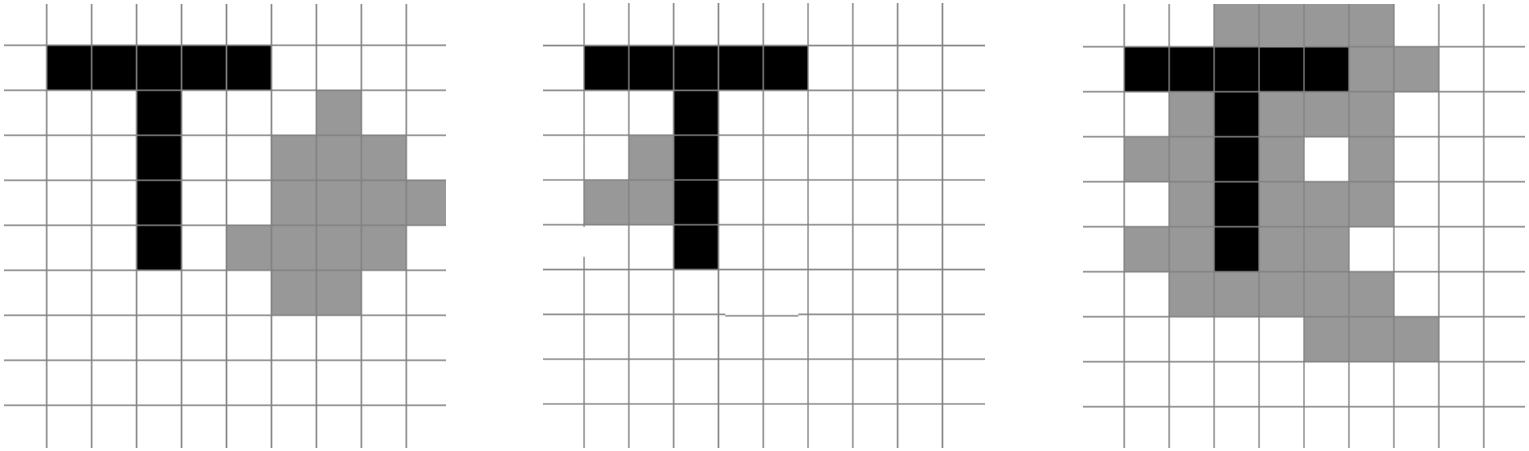

- Amount of degradation CCs *not connected* to an ink CC.

[Step 3] Features definition

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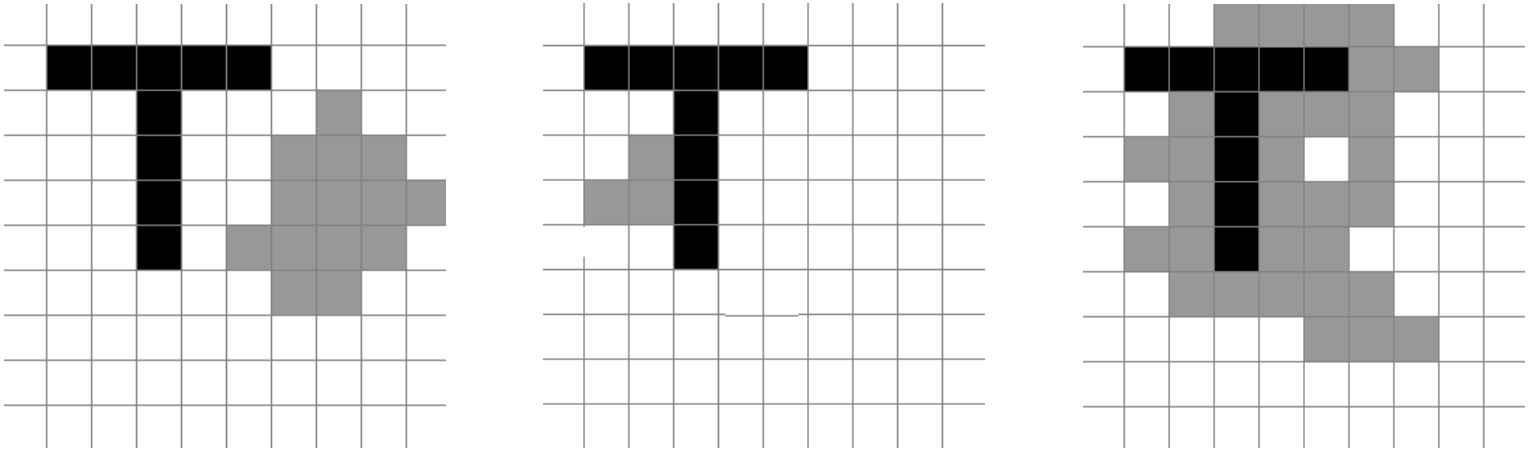
Localization of degradations pixels in regards to the localization of ink pixels.

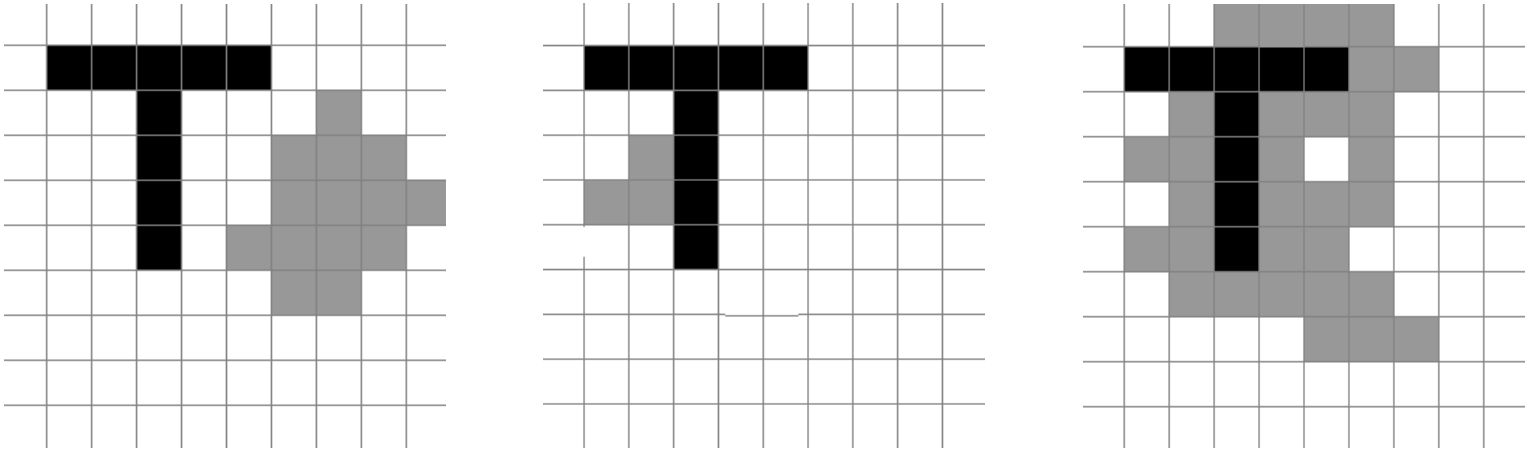


- Amount of degradation CCs *not connected* to an ink CC.
- Amount of degradation CC *connected* to an ink CC.

[Step 3] Features definition

3 Local features

Localization of degradations pixels in regards to the localization of ink pixels.



- Amount of degradation CCs *not connected* to an ink CC.
- Amount of degradation CC *connected* to an ink CC.
- Distortion of an ink CC (when connected to a degradation CC).

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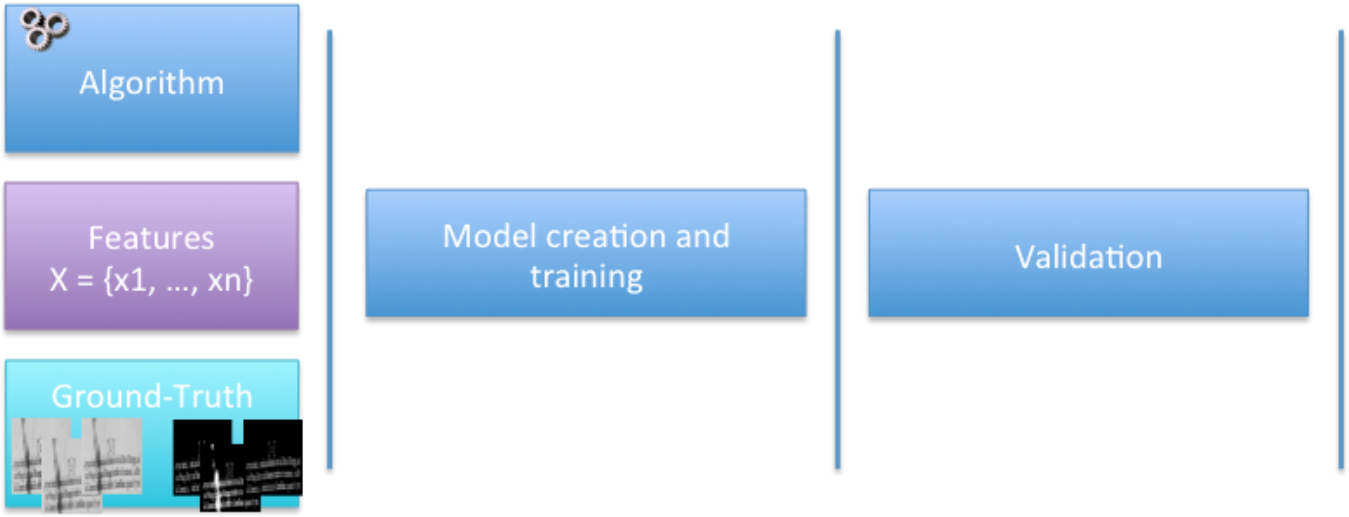
The overall workflow : Model creation and validation.



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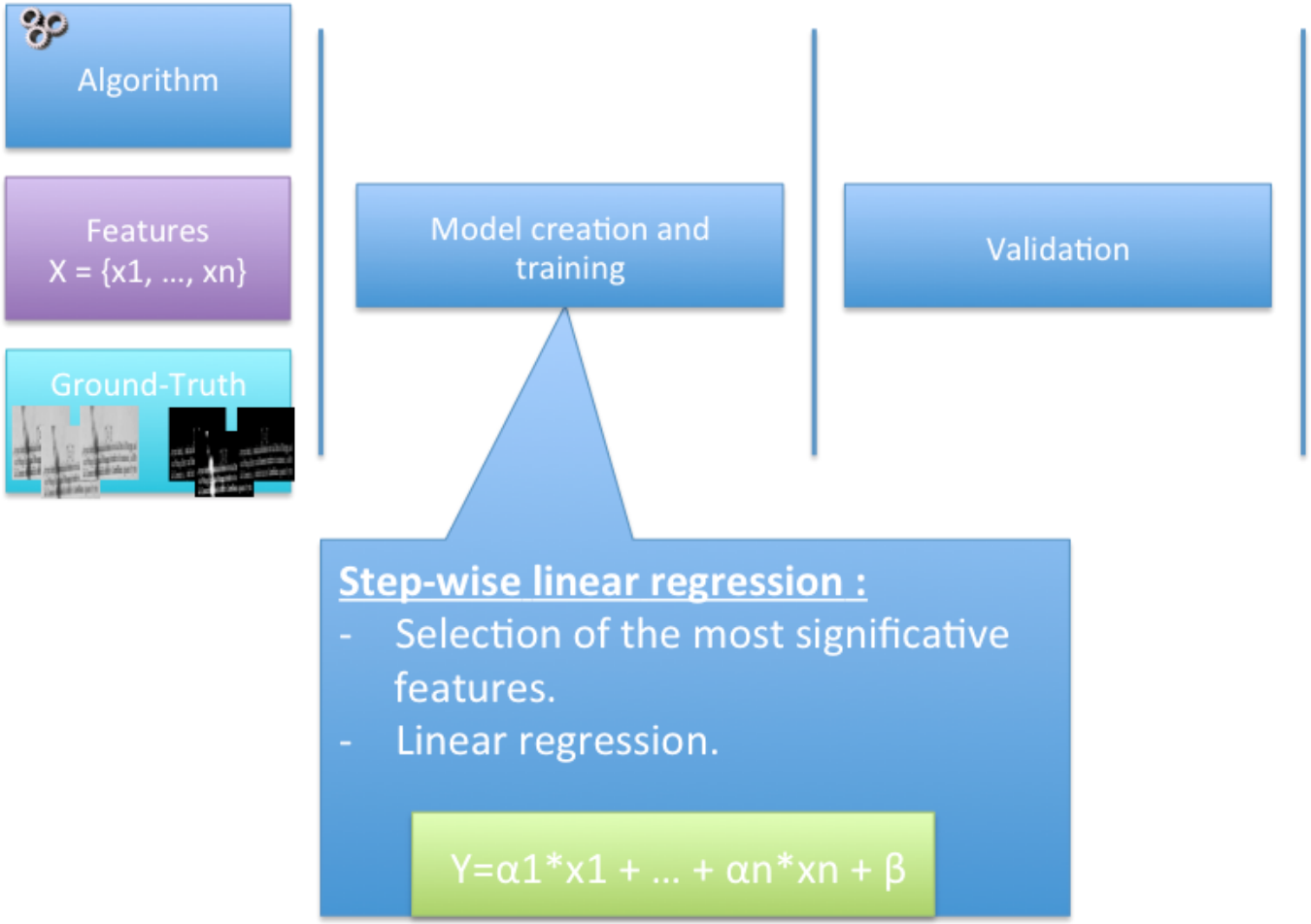

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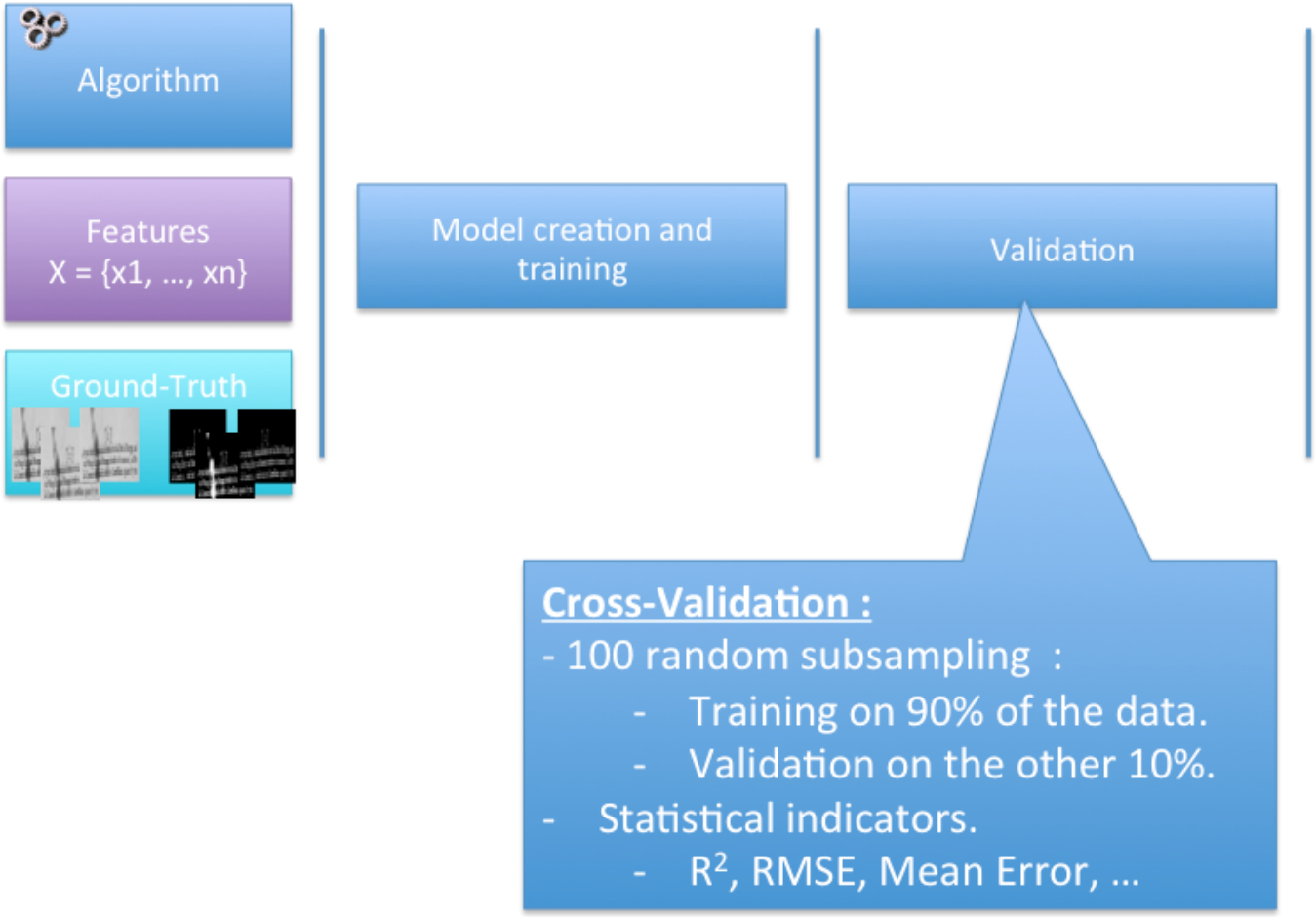


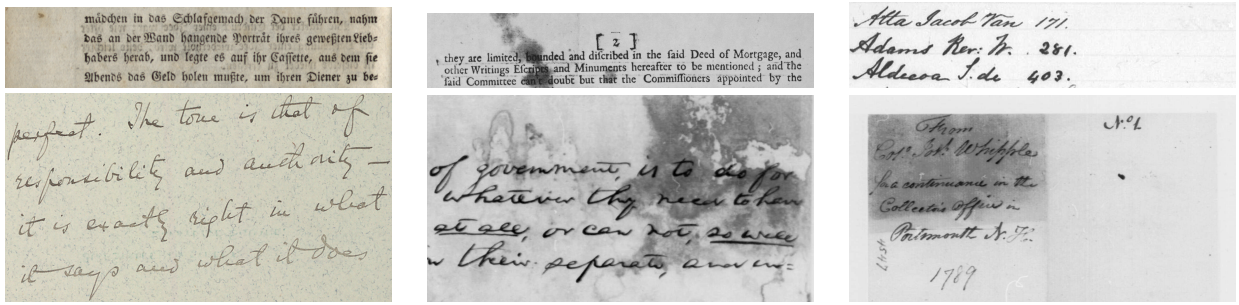
Selected binarization methods

11 binarization methods selected :

1. Globals :
   - Kittler [KI85], Otsu [Ots75], Ridler [C+78], Kapur [KSW85], Li [LT98], Sahoo [SWY97], Shanbag [Sha94]
2. Locals :
   - Bernsen [Ber86], White [WR83], Sauvola [SP00]
3. ICDAR 2009 winner : Lu [SLT11]

The training and validation dataset.

- Ground Truth (DIBCO & H-DIBCO) :



- 36 document images.
- Performances measured with the F-Score.
- Well distributed on the dataset and the set of binarization methods :
  - mean : 0.6; min : 0.1; max : 0.9.

Example : the Sauvola prediction model

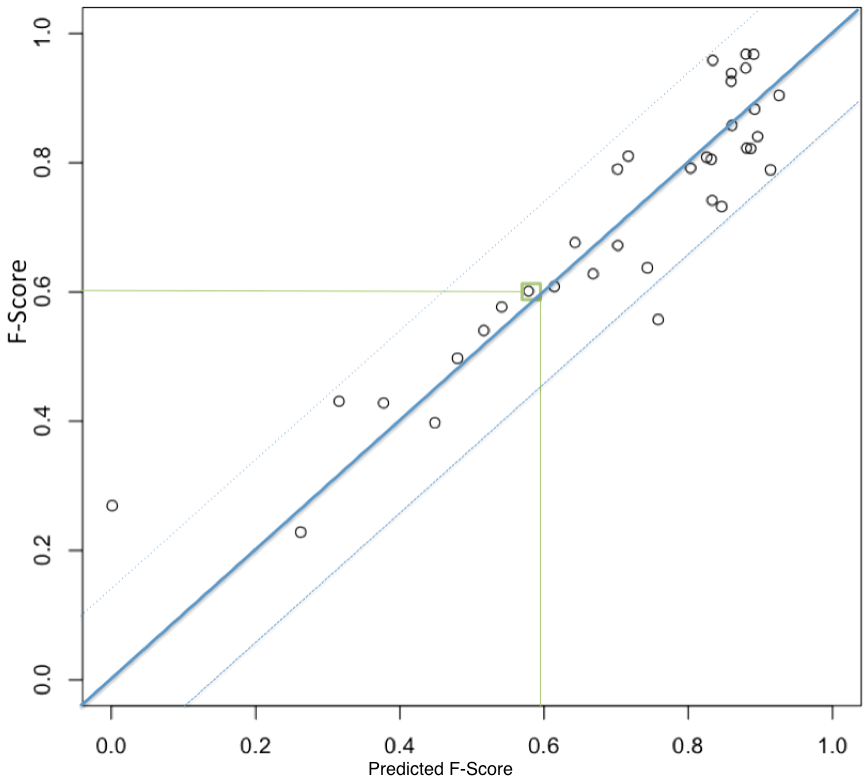
Selected features :

- Distance to the ink,
- Amount of degradations,
- Ink distribution,
- CCs not connected to the ink.

Cross-Validation (means) :

- R^2 : 0.99,
- Coefficient : 1.0007.
- Mean error : 10%

Object lesson : The Sauvola accuracy prediction model.



Prediction model results

Binarization method	Number of selected features	Mean Error
Sauvola	7	10%
Otsu	6	5%
Lu	7	4%
Bernsen	6	6%
Kapur	5	2%
Kittler	7	5%
Li	8	11%
Riddler	4	5%
Sahoo	6	5%
Shanbag	7	6%
White	7	7%

Prediction models accuracy

- Consistent selection of the most significant descriptors.
- About 5.6% of average error on the overall set of models.

Automatic selection of the best binarization method.

Lu (ICDAR 2009 Winner) :

Mean F-Score	Min F-Score
0.89	0.21

Automatic selection of the best binarization method :

Ground-Truth (best case) :

Mean F-Score	Min F-Score
0.91	0.77

Using the prediction models :

Mean F-Score	Min F-Score
0.90	0.61

Conclusion

- Close to the best case.
- **Good detection of difficult images**.

Thank you !

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Fork us on Bitbucket :

https://bitbucket.org/digidoc
https://bitbucket.org/vrabeux/qualityevaluation

E-mail :

vincent.rabeux@labri.fr

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