



# Do (colored) backgrounds matter? An experiment on artificially augmented ground truth for handwritten text recognition applied to historical manuscripts

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# Do (colored) backgrounds matter?

of a variable day depth. The effect of day depths upon the surfacing of various animals has been reviewed elsewhere. Anomalies. In spite of the variability

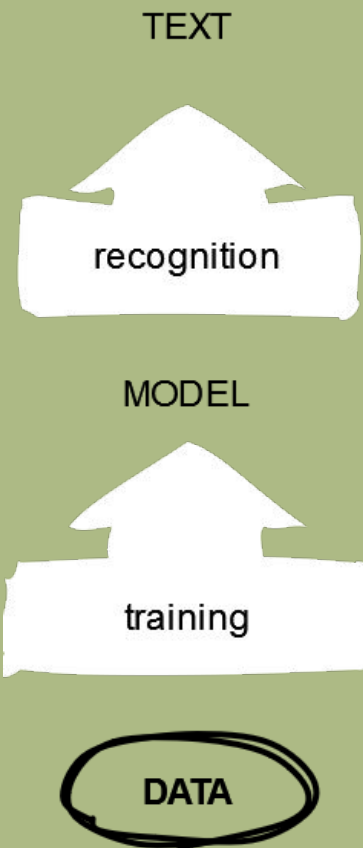
of a variable day depth. The effect of day depths upon the surfacing of various animals has been reviewed elsewhere. Anomalies. In spite of the variability of migrational behaviour, some kinds of anomalies may be recognized. Vertical movement occurs in some forms

**An experiment on artificially augmented ground truth for handwritten text recognition applied to historical manuscripts**

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# Handwritten Text Recognition (HTR)

- supervised machine learning
- retrieve text from manuscripts
- requires annotated data
- data production is a challenge
  - variety of scripts
  - homogeneity of annotations
  - availability and findability
- reusing datasets is important



# The IAM Dataset

We used the IAM Dataset for our experiment:

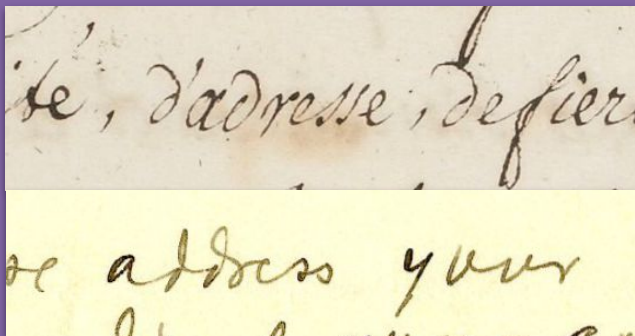
- created by the IAM institute at the University of Bern between 1999 and 2002
- 13K annotated text lines written in English
- 657 different writers
- distributed in the form of words, text lines, sentences or pages
- black ink on white background (grayscale images)

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# The IAM Dataset & historical documents

A sample of handwritten text from the IAM Dataset, showing the phrase "don't address me" in a cursive script on a white background.

IAM Dataset

Two samples of handwritten text from historical documents. The top sample is on aged, yellowed paper and reads "se, d'adresse, defier". The bottom sample is on a yellow background and reads "address your".

18th / 20th centuries

- can we make datasets like IAM look more like historical documents?
- binarization is no longer necessary and recent historical document digitizations are rarely black and white
- can we upgrade the IAM Dataset instead of downgrading historical datasets? (artificial colorization/decolorization of the images)
- is it just a question of color or are the accidents in the background also meaningful?

# Our questions and contribution

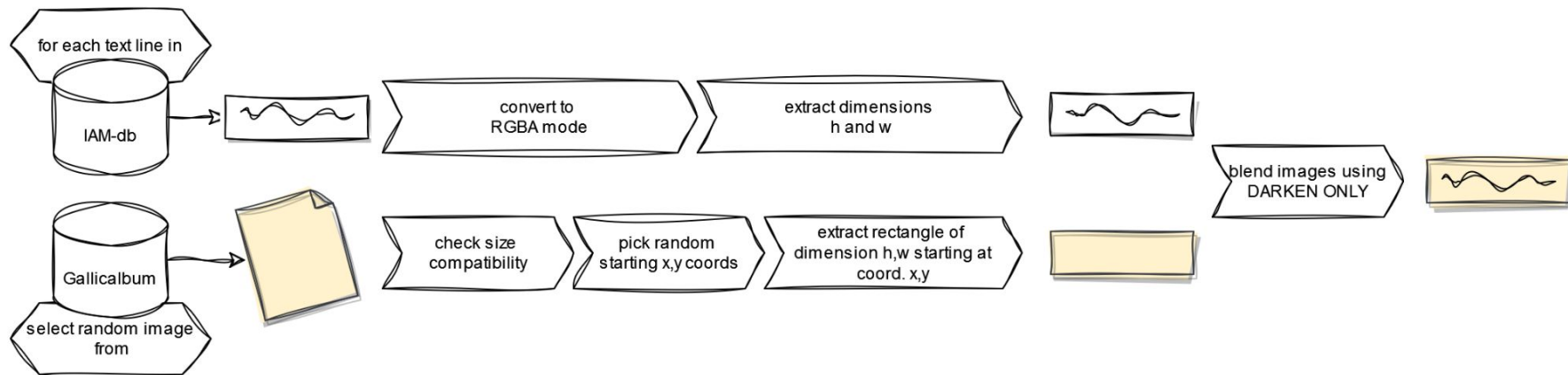
- can we make the IAM Dataset useful for historical HTR?
- are colored text lines more efficient to train HTR models rather than grayscale images?
- is it more environmentally cost-effective to use poorer grayscale images rather than rich colored images?

## Additionally:

- we proposed a simple image manipulation method to add colored backgrounds
- we created an open dataset of real blank page documents

# Our method

- augment a dataset with a simple image manipulation: add a richer realistic background
- train model on the original / enhanced IAM Dataset
- test resulting models on the IAM Dataset test set
- further test resulting models on real historical data





# Dataset of real blank pages: Gallicalbum

- we create a dataset of real blank pages, found in Gallica
- 111 blank images, in color or not
- freely accessible: [github.com/HugoSchtr/Gallicalbum](https://github.com/HugoSchtr/Gallicalbum)
- useful to artificially colorize text images
- useful for other tasks like Layout Detection (no layout)



# Enhanced IAM-Dataset

A MOVE to stop Mr. Gaitskell from A MOVE to stop Mr. Gaitskell from

a01-000u-00.png - A MOVE to stop Mr Gaitskell from

appeal to "prop up" an out-dated institution. appeal to "prop up" an out-dated institution.

a01-003x-08.png - appear to "pop up" an out-date institution

The film version of Miss Shelagh Delaney's play The film version of Miss Shelagh Delaney's play

c03-000c-00.png - The film version of Miss Shelagh Delaney's play

the great advantages to be derived from this the great advantages to be derived from this

c03-000c-05.png - the great advantages to be derived from this

The journey has been against me, as there has The journey has been against me, as there has

g06-018a-05.png - The journey has been against me, as there has

objects of beauty or interest- Vittoria, on the objects of beauty or interest- Vittoria, on the

k04-022-04.png - objects of beauty or interest. Vittoria, on the

fringe of the party, caught snatches of this fringe of the party, caught snatches of this

k04-022-05.png - fringe of the party, caught snatches of this

# Testing on real historical data

- 2 historical datasets in English covering a period from 1850 to 1950
- listed in the HTR-United catalog and reusable (licence)
- annotation rules compatible with IAM's

I am disappointed at not  
being your name in the list, which I  
Smith he believed to be - It is only  
declared, that is very sure, & with in  
my day I feel very sure

Joseph Hooker HTR (1850-1911)

she was a good and  
hard working girl while  
she was healthy. —  
now I am so thankful  
and really don't know

Univ. of Denver Jewish Consumptives Relief Society  
Medical Records (1900-1950)

# Experimentation set-up

- Kraken v 4.3.0
- default training architecture
  - 120 pixels resize, 3 CNNs + 3Bi-LSTM + 1 linear layer
- learning rate of  $1e-4$  and batch size of 1
- two configs for the number of training epochs:
  - fixed (100)
  - early stopping (stops when learning curves reaches a plateau)
- train / validation / test follows the official IAM split
- test different combinations of original/enhanced train set and validation sets



Set	N text lines	N writers
train	6161	283
val 1	900	46
val 2	940	43
test	1861	128
<b>Total</b>	<b>9862</b>	<b>500</b>

Train set	Validation set	N epochs	IAM grayscale test set	IAM enhanced test set	Historical test set	Training time
IAM grayscale	IAM grayscale	100	69,8	29,7	4,1	01:14:33
IAM grayscale	IAM grayscale	87	70,1	30,6	7,6	01:10:19
IAM grayscale	IAM Enhanced	100	69,4	26,5	0,3	01:14:58
IAM grayscale	IAM Enhanced	62	66,4	27,9	11,1	00:51:30
IAM Enhanced	IAM grayscale	100	47,8	60,2	-4,9	01:16:52
IAM Enhanced	IAM grayscale	72	44,1	58,7	11,0	01:04:54
IAM Enhanced	IAM Enhanced	100	51,0	62,1	8,3	01:15:30
IAM Enhanced	IAM Enhanced	194	52,0	64,9	7,1	02:40:32
Manu McFrench Model V1		/	65,6	52,4	59,6	/
Manu McFondue		/	63,5	54,9	60,4	/

accuracy scale

0%

50%

100%

# Our results

# Discussions of the results

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- probably not enough data to train an efficient model out of domain with the chosen architecture
- Manu McFrench and Manu McFondue are much better, but not good enough in zero-shot scenario on the historical testset
- models trained only on the original dataset = significant loss of accuracy on colored images (-40pts)
- models trained on colored images = minor loss of accuracy on original dataset (-10pts)
- colorful background seem to have an impact during prediction and not during training
- adding a colored background might augment the minimum amount of training data required

# Perspectives to push the experiment further

- increase the quantity of data
- control the quality of the annotation in the historical test sets
- test with other historical datasets
- increase the batch size during training
- mix grayscale data and enhanced data in the train and validation sets

- Could we reach more stable scores when playing on these parameters?
- Can we reach 90% of accuracy on the IAM test set?

# Final discussion on the environmental costs

- artificially enhancing IAM dataset increased its size by a factor of 6
  - Train set: 325 Mb → 1960 Mb
  - Validation set: 52 Mb → 287 Mb
  - Test set: 107 Mb → 611 Mb
- minor impact on compilation time but not on training time (fixed epoch)
- estimations from Green Algorithms' Calculator ([calculator.green-algorithms.org](https://calculator.green-algorithms.org)):

	Compilation time	Training time	Total time	Carbon footprint (CO2e)	Energy needed (kWh)
All grayscale	1m27s	1h14m33s	1h16m0s	109,17	2,13
All enhanced	2m14s	1h15m30s	1h17m44s	112,04	2,18

# Key takeaways

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- we created a dataset of blank pages
- we successfully applied our enhancement technique to the IAM dataset
- we need to push our experimentations further to get more meaningful results
- we can already find that colorful background add noise during prediction but not during really training
- enhancing the dataset has a limited impact on the environmental cost of training a transcription model on the IAM Dataset



## Dataset references:

- U.-V. Marti, H. Bunke, *The IAM-database: An English sentence database for offline handwriting recognition*, International Journal on Document Analysis and Recognition 5 (2002) 39–46. doi:10.1007/s100320200071.
- K. Pham, *University of Denver Collections as Data - HTR Train and Validation Set JCRS\_2020\_5\_27*, 2020. doi:10.5281/zenodo.4243023.
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# Thank you!

And many thanks to Jennifer Carrow for her feedback on this presentation!