## DENOISING AUTOENCODER

Denoised text images (and black and white drawings) using three different types of architecture MLP and CNN based:

- 1. MLP
- 2. CNN + post process
- 3. CNN + 2 post process

#### Data

The train data has the same text with different damage and fonts.

There exist several methods elds to be filled in. For it surrounded by bounding boxe, by guiding rulers. These murite and, therefore, minimal overlapping with other parties can be located on a separat is located below the form rectly on the form. The use

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There exist several methods to desig filled in. For instance, fields may be boxes, by light rectangles or by guiding specify where to write and, therefookew and overlapping with other parties can be located on a separate stated below the form or they can be m. The use of guides on a separate method they are the point of view of the quality of the series of the ser

113.png

There are several classic spatial filter ting high frequency noise from imal median filter and the closing openind. The mean filter is a lowpass or laces the pixel values with the neighbor the image noise but blurs the image calculates the median of the pixel el, thereby reducing the blurring effects sing filter is a mathematical morphology.

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There are several classic spatial filters high frequency noise from images. The mean j and the closing opening filter are frequently is a lowpass or smoothing filter that replace with the neighborhood mean. It reduces the the image edges. The median filter calculate pixel neighborhood for each pixel, thereby reffect. Finally, the opening closing filter filter that combines the same number of erose operations in order to eliminate small objects

The main goal was to train a neural netword to obtain a clean image from a noisy one. In it was much easier to obtain a simulated noisy one than to clean a subset of noisy images. simulated noisy images follows this scheme:

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# Architecture 1: MLP (Multilayer perceptron)

- Not very effective Overfitting
- - - - - 37 class Autoncoder(nn.Module):

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- def init (self): 39 super(Autoncoder, self). init ()
  - self.encoder = Encoder() 40 self.Decoder = Decoder()
  - def forward(self, image): 43
  - z = self.encoder(image) 44 45 out = self.Decoder(z) 46 return out

def reiniciar(self):

super(Autoncoder, self). init ()

self.encoder = Encoder()

self.Decoder = Decoder()

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27 nn.Linear(180\*10,180\*80),

return out

def forward(self, z):

out = self.fl(z)

1 class Encoder(nn.Module): def init (self):

nn.ReLU()

nn.ReLU()

z = self.f2(out)

19 class Decoder(nn.Module):

def init (self):

return z

def forward(self, image): out = self.fl(image)

self.f2 = nn.Sequential(

super(Encoder, self). init () self.fl = nn.Sequential(

nn.Linear(180\*80,180\*10),

nn.Linear(180\*10,180\*10),

self.f5 = nn.Sequential(

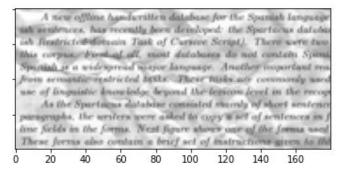
out = torch.tanh(self.f5(z))

- nn.ReLU()
- nn.Linear(180\*10,180\*10),
- super(Decoder, self). init () self.fl = nn.Sequential(

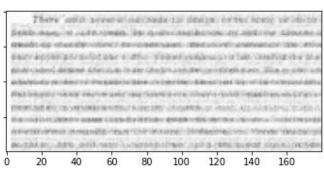
## Results

You may notice that there is a overfitting: The original image starts with "A new" but the output has a "There" at the beginning, that is the same text as the train data.

Original image:



The image after the autoencoder:



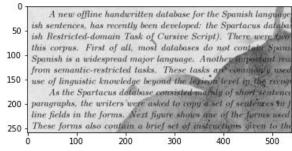
## Architecture 2: CNN (Convolutional neural network)

The architecture 2 is a CNN autoencoder that can denoising images, but the output does not look that great. That's why it is added another CNN, called Process, that makes the image aesthetic.

```
class Autoncoder(nn.Module):
 def init (self):
    super(Autoncoder, self). init ()
   self.encoder = Encoder()
   self.Decoder = Decoder()
    self.Process = Process()
 def forward(self, image):
   z = self.encoder(image)
   out = self.Decoder(z)
   out = self.Process(out)
    return out
 def reiniciar(self):
    super(Autoncoder, self). init ()
   self.encoder = Encoder()
   self.Decoder = Decoder()
   self.Process = Process()
```

## Results

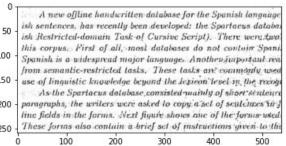




The image after the autoencoder:

A new offline handwritten database for the Spanish language
ish sentences, has recently been developed: the Spaniacus database
ish Restricted domain Task of Curvive Script). There were two
this corpus. First of all, most databases do not contain Spani
100 Spanish is a widespread major language. Another important rea
from semantic restricted tasks. These tasks are commodify used
use of linguistic knowledge beyond the lexicon level in the recog
As the Spaniacus database consisted mainly of short sentence
paragraphs, the writers were asked to copy a set of sentences in I
line fields in the forms. Next figure shows are of the forms used
These forms also contain a brief set of instructions given to the

The image after Process:



El panda, oso panda o panda gigante (Ailuropoda melanoleuca mamifero del orden de los carnivoros. El estudio de su ADN lo o miembros de la familia de los osos (Ursidae),2 siendo el oso de más cercano, que pertenece a la subfamilia de los tremarctinos panda rojo pertenece a una familia propia e independiente, Ailu muy localizada. Nativo de China central, el panda gigante habit montañosas, principalmente las de Sichuan, hasta una altura del 2017 se estimó que la población total superaba los dos mil ej 1864 viven en libertad, 4 lo que demuestra que la cifra de panda va en aumento. Desde 1961 el panda es el simbolo de WWF (Fo Naturaleza). El principal alimento del panda es el bambú (en tor dieta), aunque también se alimenta de frutos, pequeños mamife

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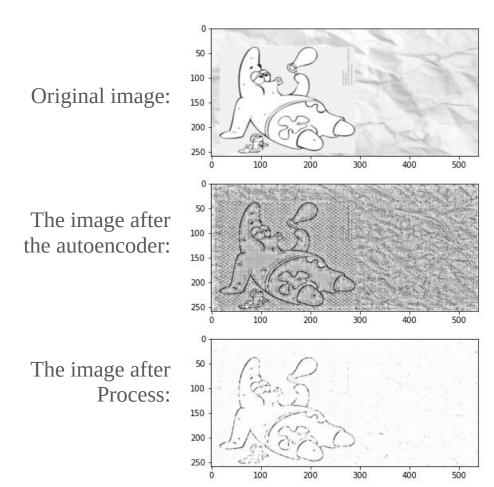
100

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montañosas, principalmente las de Sichuan; hasta una altura de 
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ve en aumento. Desde 1951 el panda es el almbolo de WWF (Fo 
Naturaleza). El principal alimento del panda es el bambolo de de 
250 deta), aunque también se alimenta de frutos, pequeños mamife

You may observe that the autoencoder makes the image background homogeneous, and highlights the text (and the lines of the drawings). After the autoencoder, Process clear up the background.



## Architecture 3: CNN (Convolutional neural network)

Architecture 3 follow the same idea of architecture 2, but has two Process to improve the results. And it works.

Keep in mind that both Process are CNN and they get trained as a whole to archive clearing the background, so the result images after each Process will be different that the previous one.

```
class Autoncoder(nn.Module):
 def init (self):
    super(Autoncoder, self). init ()
    self.encoder = Encoder()
    self.Decoder = Decoder()
    self.Process = Process()
    self.Process2 = Process()
 def forward(self, image):
    z = self.encoder(image)
   out = self.Decoder(z)
   out = self.Process(out)
   out = self.Process2(out)
    return out
 def reiniciar(self):
    super(Autoncoder, self). init ()
    self.encoder = Encoder()
    self.Decoder = Decoder()
    self.Process = Process()
    self.Process2 = Process()
```

## **Results**

Original image:

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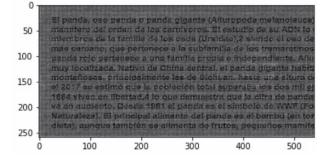
400

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200

100

Image after the autoencoder:





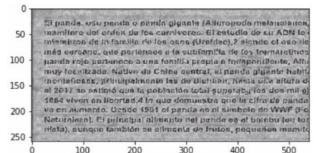
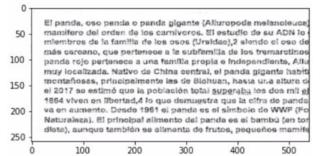


Image after the second process:



Original image:

Image after the

autoencoder:

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250 -

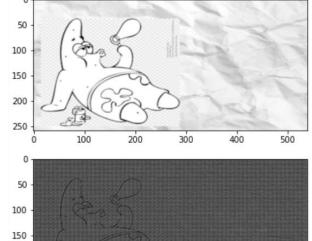
100

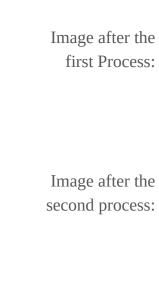
200

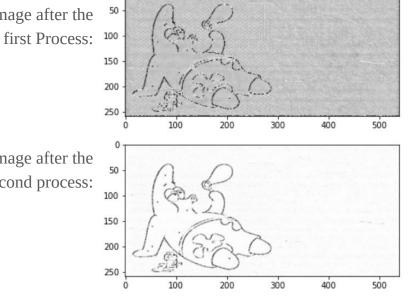
300

400

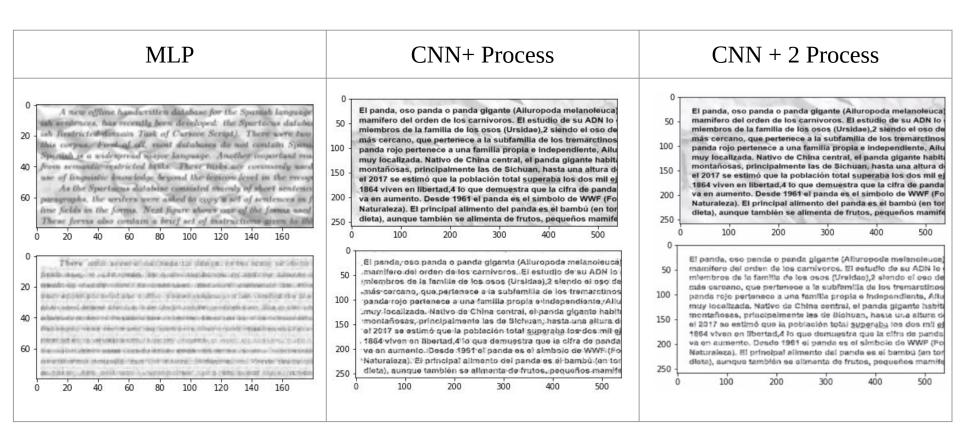
500



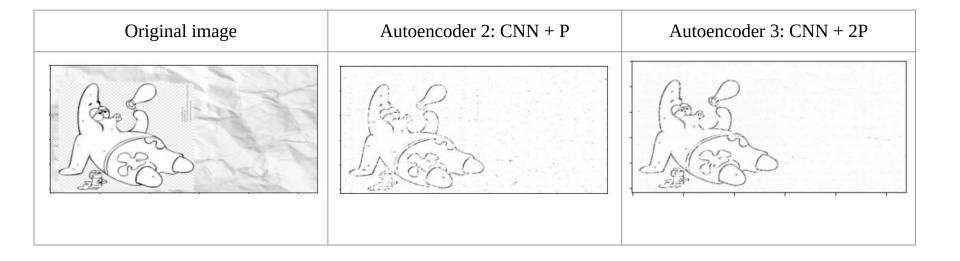




## Comparison



## Comparison



## Notes

- For the encoders, dimensional reduction strongly affect the training time and results. It was observed that the better options were dimension reduction (only 10 dimensions for the encoder output)
- For the decoders, error is important for better results as it is common that a CNN get stuck between values and so not get a good performance. This situation can be recognized when the output is a complete white image. As a error function compare each pixel of the image, a complete white image will has low error because we look to clear the background.

#### Future work

• For upgrade the autoencoders, it is need to explore another types of error functions that give more importance to little differences between predictions and expected outputs. Because, as mentioned earlier, the neural network could get stuck and produce empty images.