Learned Data Augmentation

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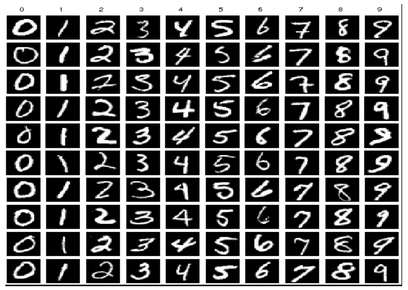
Introduction

Learned Data Augmentation is used to extend the existing dataset by modifying and comparing with the original data. The data that we have used in this project is the MNIST dataset.

The motivation of the project is to collect more data to create a model and receive data as much as we want. It also helps us to prevent overfitting of the data.



Key contributions:

- **Transformation** .
- Dreaming More Data paper.[1]
- Deep Diffeomorphic Transformation paper.[2]
- Spatial Transformation.

Model

Loss Function:

$$x_m \circ T^{\theta_{mn}} \approx x_n$$

$$\| x_n - x_m \circ T^{\theta_{mn}} \|$$

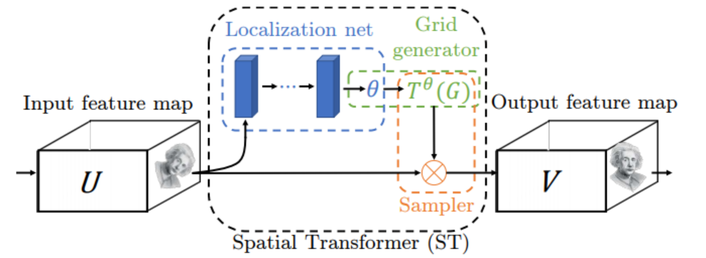
Statistical Model of Transformation [2]:

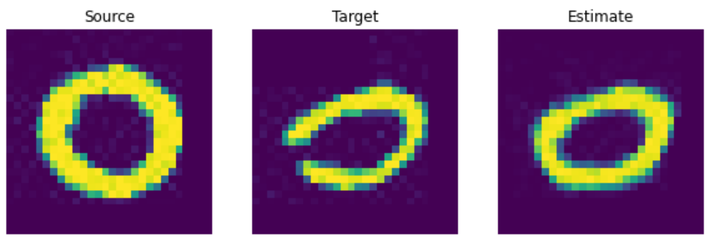
$$p(T^{\boldsymbol{\theta}}|y) \propto \exp\left(-\frac{1}{2}\operatorname{Log}_{T^0}(T^{\boldsymbol{\theta}})^\top \boldsymbol{\Sigma}_y^{-1} \operatorname{Log}_{T^0}(T^{\boldsymbol{\theta}})\right)$$

$$= \exp\left(-\frac{1}{2}(\boldsymbol{v}^{\boldsymbol{\theta}})^\top \boldsymbol{\Sigma}_y^{-1} \boldsymbol{v}^{\boldsymbol{\theta}}\right) .$$

Computation

Spatial Transformation [2] :





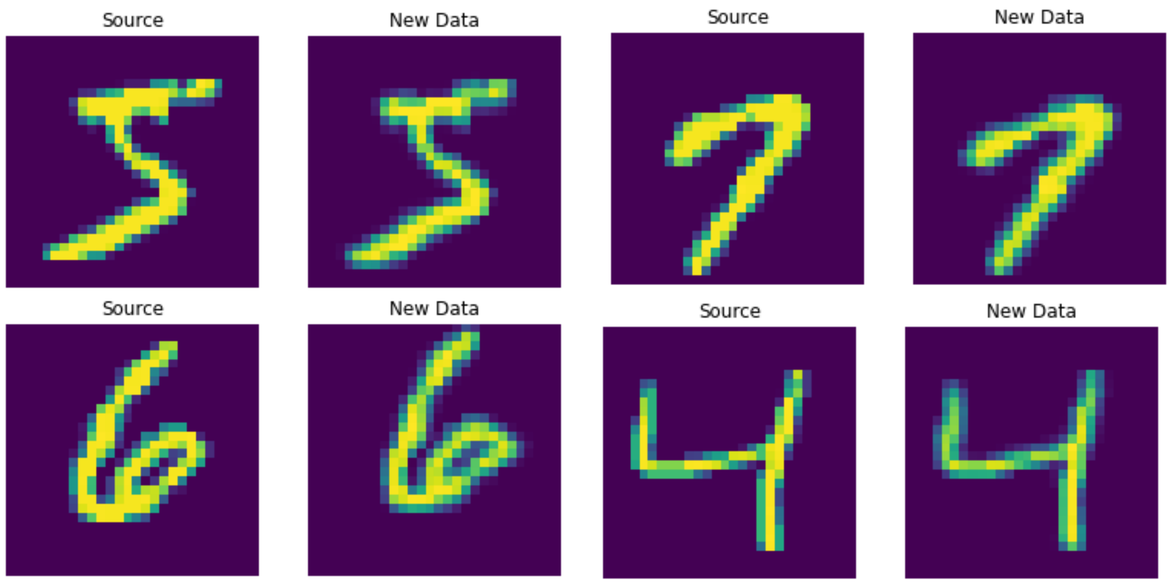
Algorithm

New data are generated by two steps. In the first step we have estimated transformer parameter, Θ then by using Θ we have generated new data.

```
# Algorithm for estimation of Θ
Require : I_1, I_2...I_N, N different images.
Initialize: Θ [ ]
Initialize: maxitter int
for m = 1,....,N do
    for n = 1,....,N do
      if n != m then
        Initialize: Spatial transformer T,θ_est
        Initialize: pytorch optimizer Adam[θ_est]
        for i = 1,....,maxitter do
          L := I_m * T * θ_est − I_n
          optimizer.step()
        end for
        Θ := [Θ, θ_est]
      end if
    end for
end for

# Algorithm for generating K new data
Require : I_1, I_2...I_K, K different images.
Initialize: Spatial transformer T
#Sample θ from Θ using Multivariate Gaussian Dis.
Θ_new := N(μ_Θ, σ²_Θ)
θ_true := sample(Θ_new)
for x=1,...,K do
    new_data = I_x * T * θ_true
end for
```

Results



References

[1] https://arxiv.org/pdf/1510.02795.pdf
[2] https://encyclopediaofmath.org/wiki/Diffeomorphism ,
[3]