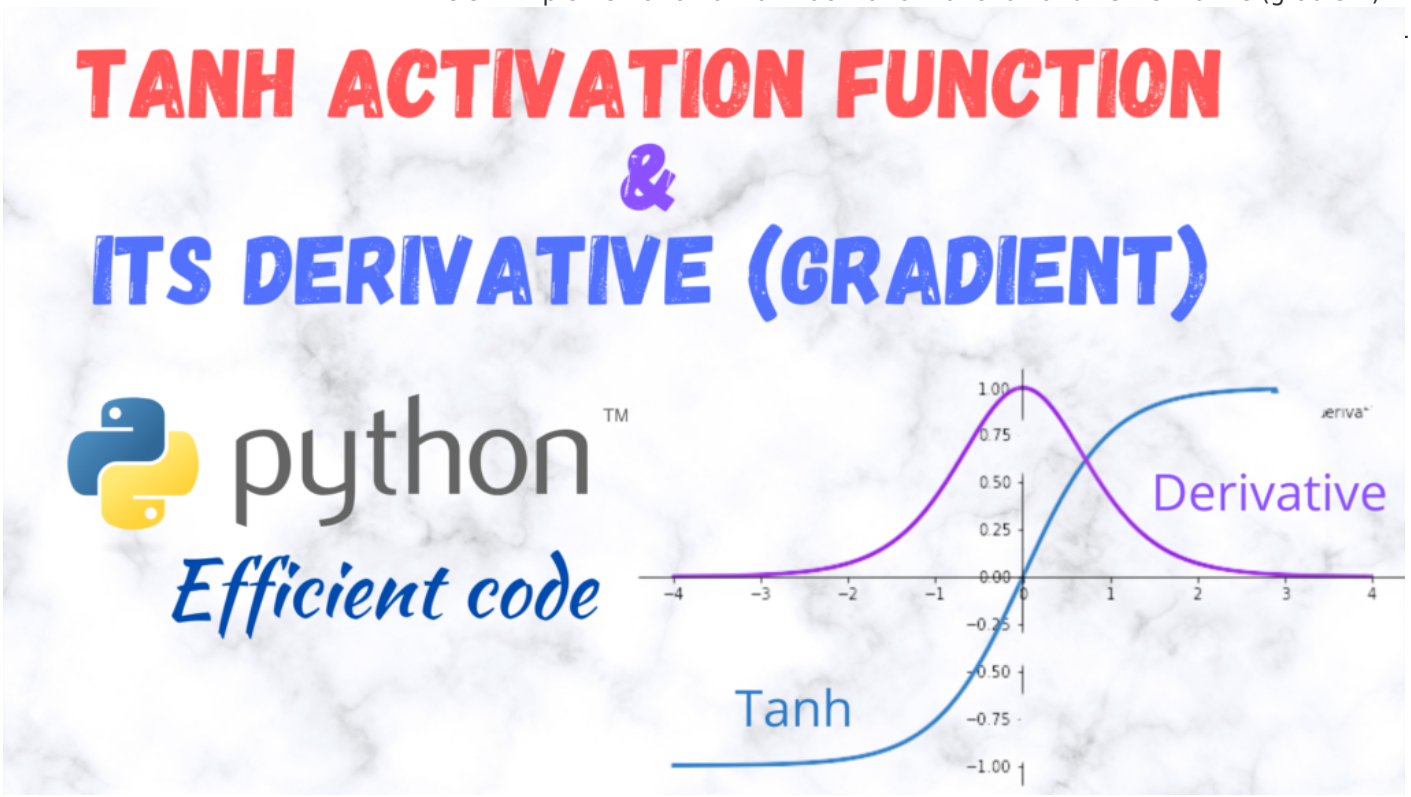
Efficient implementation of Tanh activation function and its Derivative (gradient) in



The mathematical definition of the Tanh activation function is

$$f(x) = \tanh(x)$$

and its derivative is defined as

$$f'(x) = 1 - \tanh^2(x)$$

The Tanh function and its derivative for a batch of inputs (a 2D array with nRows=nSamples and nColumns=nNodes) can be implemented in the following manner:
Tanh simplest implementation

```
import numpy as np
def Tanh(x):
    return np.tanh(x)
```

Tanh derivative simplest implementation

```
import numpy as np
def Tanh_grad(x):
    return 1.-np.tanh(x)**2 # sech^2{x}
```

However, these implementations can be further accelerated (sped-up) by using Numba (https://numba.pydata.org/). Numba is a Just-in-time (JIT) compiler that

> translates a subset of Python and NumPy code into fast machine code.

To use numba, install it as:

```
pip install numba
```

Also, make sure that your numpy is compatible with Numba or not, although usually pip takes care of that. You can get the info here: https://pypi.org/project/numba/

Accelerating the above functions using Numba is quite simple. Just modify them in the following manner:

Tanh NUMBA implementation

```
from numba import njit
@njit(cache=True,fastmath=True)
def Tanh(x):
    return np.tanh(x)
```

Tanh derivative NUMBA implementation

```
from numba import njit
@njit(cache=True,fastmath=True)
def Tanh_grad(x):
    return 1.-np.tanh(x)**2 # sech^2{x}
```

This is quite fast and competitive with Tensorflow and PyTorch (https://github.com/manassharma07/crysx_nn/blob/main/benchmarks_tests/Performance_Activation_Functions_CPU.ipynb).

It is in fact also used in the CrysX-Neural Network library (crysx_nn)

Furthermore, the above implementations can be further accelerated using Cupy (CUDA), if using single precision (float32) is not a problem.

> CuPy is an open-source array library for GPU-accelerated computing with Python. CuPy utilizes CUDA Toolkit libraries to make full use of the GPU architecture.

The Cupy implementations look as follows:

```
import cupy as cp
def Tanh_cupy(x):
    return cp.tanh(x)
```

```
def Tanh_grad_cupy(x):
    return 1.-cp.tanh(x)**2 # sech^2{x}
```

The above code is also used in the crysx_nn library.
To see how the crysx_nn implementations of Tanh compare with TensorFlow and PyTorch, click here.

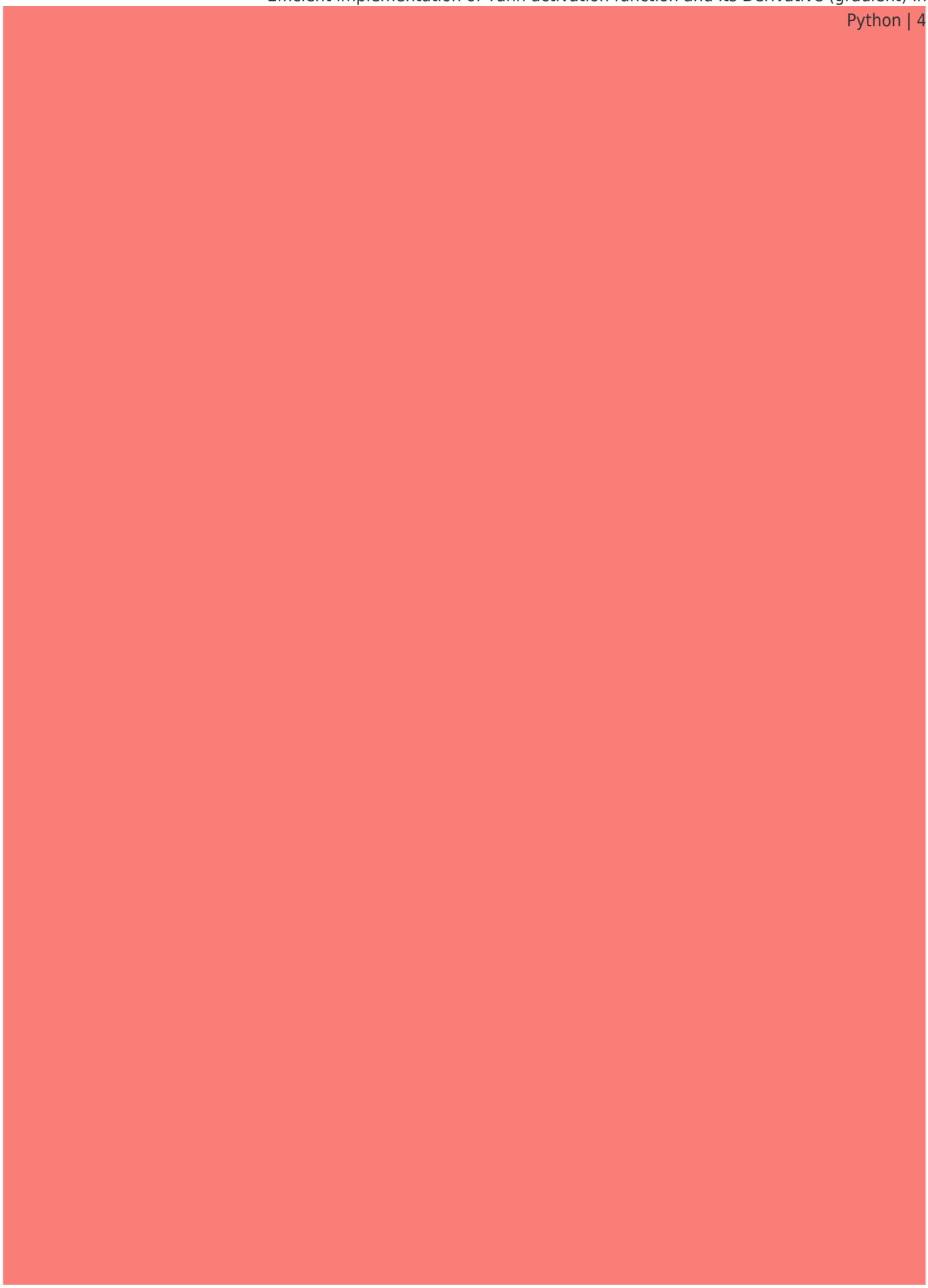
I hope you found this information useful.

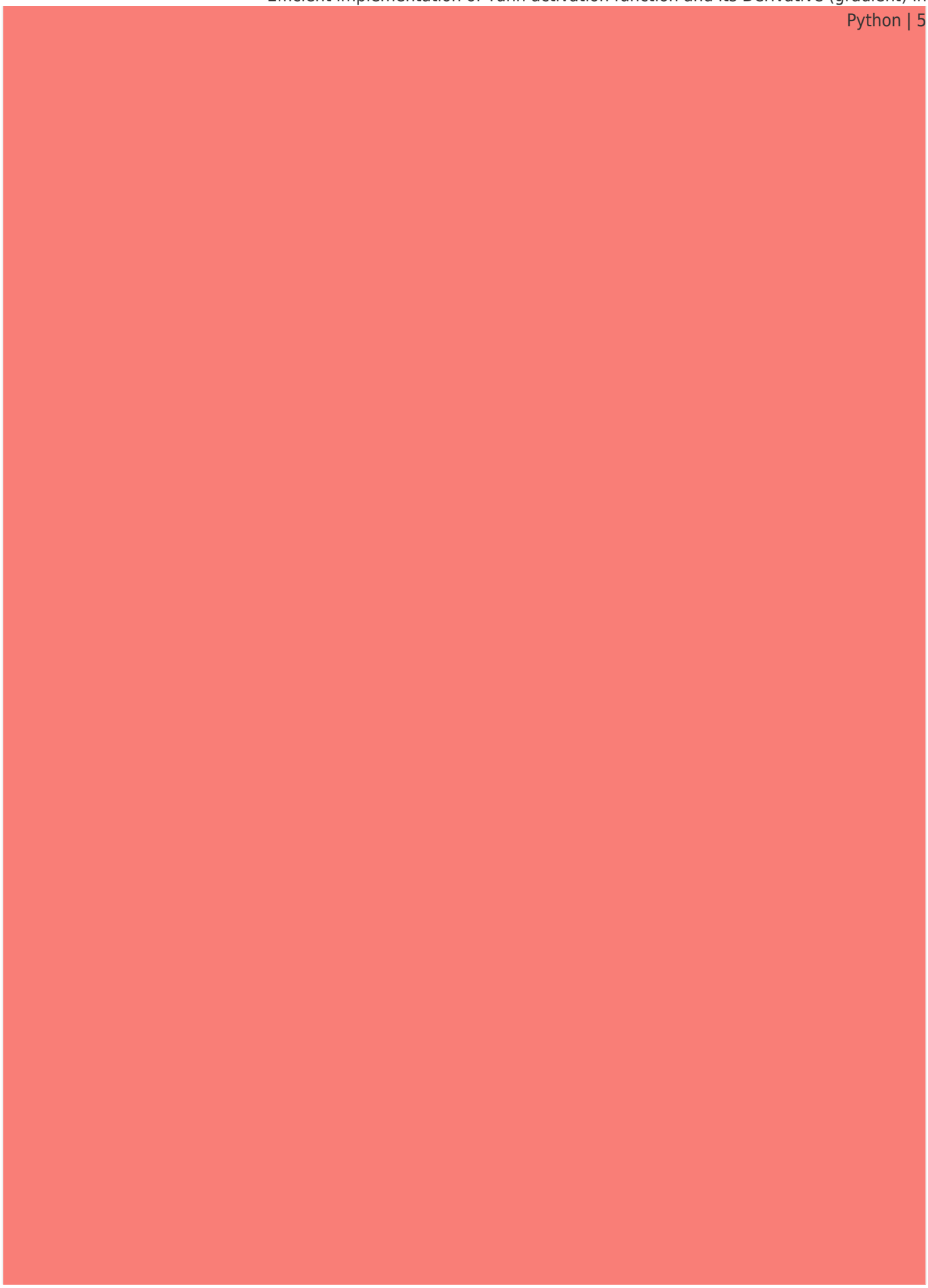
If you did, then don't forget to check out my other posts on Machine Learning and efficient implementations of

Manas Sharma

I'm a physicist specializing in computational material science with a PhD in Physics from Friedrich-Schiller University Jena, Germany. I write efficient codes for simulating light-matter interactions at atomic scales. I like to develop Physics, DFT, and Machine Learning related apps and software from time to time. Can code in most of the popular languages. I like to share my knowledge in Physics and applications using this Blog and a YouTube channel.

manas.bragitoff.com/





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