

lab04-segnet-meanshift

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Abstract

Here is the report for the lab04-segnet-meanshift.

For this exercise, Copilot was used to help with the syntax. The written report was checked with Grammarly.

1 Mean-Shift

The core of the mean-shift is implemented in several functions. The distance one calculates the Euclidean distance between a point \mathbf{x} and a set of points \mathbf{X} using the torch norm. The distance_batch, as it immediately calculates the distance of all the points simultaneously, uses the cdist function. The gaussian kernel, to smooth the result was implemented using this formula [1].

$$K(\mathbf{x}, \mathbf{x}') = \exp\left(-\frac{\|\mathbf{x} - \mathbf{x}'\|^2}{2\sigma^2}\right),$$

where:

- $\mathbf{x}, \mathbf{x}' \in \mathbb{R}^n$ are input vectors in the feature space.
- $\|\mathbf{x} - \mathbf{x}'\|^2$ is the squared Euclidean distance between the vectors \mathbf{x} and \mathbf{x}' .
- $\sigma > 0$ is a free parameter that controls the width of the Gaussian kernel.

So this is how the Gaussian was implemented.

The update point function is, as the name already tells, updating the position of a point or a batch of points by computing a weighted average of neighboring points.

The meanshift_step function performs one iteration of the Mean-Shift algorithm for each point separately, while meanshift_step_batch does this for all points in a batch, making it more efficient. The meanshift function iteratively applies the Mean-Shift steps for a fixed number of iterations (20 in this case). The values that were achieved were:

Table 1: Elapsed times for mean-shift algorithm on CPU and GPU implementations.

Platform	Implementation	Elapsed Time (seconds)
CPU	Loop	20.491
CPU	Vectorize	1.750
GPU	Loop	3.348
GPU	Vectorize	0.670

It can be seen that the looping over all the points separately is an expensive operation and vectorising is important. I had the biggest problems in understanding the dimensions. The loop function was intuitive and easy to understand but I needed some time to understand the different dimensions and how to update the points then.

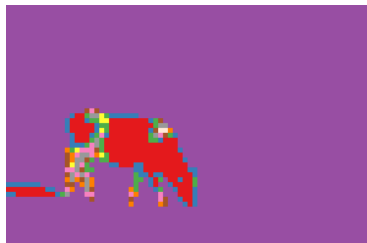


Figure 1: Result of mean-shift of the cow.

References

- [1] Wikipedia contributors, Radial Basis Function Kernel, Accessed: 2024-11-20, **2024**, https://en.wikipedia.org/wiki/Radial_basis_function_kernel (visited on 11/20/2024).