LUMEN Data Science

BMW

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# The Problem

Computer vision is an area of research that has seen the most growth from the advent of deep learning. Over the past decade, it grew from a niche research area to one of the most widely applicable fields within machine learning. In computer vision, we need to use neural networks to somehow analize a large number of images, extract some potentially useful information from them, and use that inforamtion to classify those images into predefined classes.

The problem we were tasked with solving in this competition falls neatly into this category. Specifically, we were given a list of Google Street View images taken on Croatian roads, 4 for each location and each facing a cardinal direction (north, south, west, east) from the Street View car, and our task is to infer the location where these images were taken, as each image has its coordinates speciffied. Error is measured using the *haversine* distance measure, which measures the distance between two points over a curved surface, i. e. the surface of the Earth. For every coodinate we infer from the data, the haversine distance to the real coordinate of the image is measured and summed up for all locations. This gives us a total error which will be used to determine how succesful our model is compared to others.

On paper, this sounds fairly simple and not unlike many other computer vision tasks. However, this is also a very difficult task, as a country can look very similar over large swathes of land from a car’s perspective and almost feel impossible, even to a human (just think of playing GeoGuesser and teeling the difference in which corner of Russia you are). There is a silver lining to this though. Croatia, although small, is very geologically and culturaly diverse. Mountains, houses, forests and even fields can look different depending on in which part of the country you are located, giving precedence to the idea that a convolutional neural network could catch these differences. That being said, it is still a difficult problem to solve and requires clever feature engineering and careful network setups in order to work, which we will talk about in the coming chapters.

# Data and Feature Engineering

This problem can be approached from two perspectives. We can either try regressing the image coordinates (a continuous output from the network that will be restricted by the minimum and maximum possible coordinates of the images) or classifying them (assigning areas of the map to different classes). We have here chosen the second approach.

## Classification approach

The way we did this is by dividng a map of Croatia made out of polygons into distinct squares and asigning all images in a square to the corresponding class. We can specify the number of classes and thereby create more or less dense latices that divide the map into classes. By setting this to a high number, we can alsmost simulate a regression, as we have to assign out output into one of many possible, similar to regression, where we have a theoretical infinity of classes. This has its problems though. There simply aren’t enough images per class for us to effectively train our network with a large number of classes. Another problems arises because of Croatia’s weird shape. A lot of the squares mostly end up in other countries, with only a side of the square touching th teritory of Croatia. Because of this, we will have squares that won’t contain any classes and we will face situations where images are assigned to coordinates that our not within the boundaries of Croatia. We solved these problems in the following way. In order to solve the first problem, we simply created a “blacklist” of classes that don’t have any images within them and removed them from the possible class assignments our network could do. We solved the second problem by assigning all images that were classified outside of Croatia to the nearest point that is still within Croatia, and also within the same class. Fortunately, this doesn’t happen too often as the images are very evenly distributed both on the Coratian mainland and its numerous islands.

# Model

There are numerous approaches that are state-of-the-art right now

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