Project 4: Campus Image-to-GPS Regression for Localization and Navigation.

Description:

In this project, you will build a model that predicts the GPS coordinates of the camera given a single image on the campus.You will collect images across a predefined area (that I will choose) using your smartphones. Modern phones automatically store GPS coordinates in the image metadata (EXIF), allowing you to use these coordinates as ground-truth labels. The goal is to train a regression model that maps the visual appearance of the scene to its geographical location, enabling coarse localization and navigation on campus.

You can see [an example here]() from an earlier project I conducted using classical computer vision methods only, where the task was to classify the building in the image and then provide a navigation map to the user (note: that older project performed classification, not regression).

Key Components:

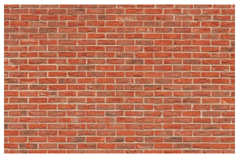
- **Collect your own dataset** of campus images with embedded GPS metadata in the predefined area.
- **Extracting latitude and longitude** labels from EXIF data (understand what is lat and lon, explain it)
- **Training a neural network** (you need to explore the models, loss functions, scale of data, augmentations etc.) to regress GPS coordinates from images.
- Evaluating the model by computing GPS prediction **error in meters**.
- Visualizing predicted vs. real locations on a map.
- **Robustness** to new images from different phones.
- Ensuring the **model remains robust under varying lighting conditions, <u>including daylight and nighttime images</u>.**

Example of a very small, predefined area.

Additional notes:

1. **You are not allowed** to share images with other teams (**I will check that, trust me**), that's all the point of the project and it can be fun to collect the data with your friends.
2. Your model **may unintentionally** rely on dynamic objects in the scene, such as people, cars, or other moving elements as cues for estimating location, which can harm generalization when these objects are absent. Be aware of this risk, but also ensure that your method remains robust even when such dynamic objects do appear in the images.
3. This project places a strong emphasis on **accuracy**, it is, in a sense, a competition for achieving the best performance. However, be thoughtful: simply collecting an enormous number of images to boost test accuracy is **not the goal**. While more data

might help you score higher on the leaderboard, <u>it may cost you points for originality and creativity if you don't find another way to justify the originality and creativity criterion.</u>
Explore and train different models, data-collection strategies, and smart techniques. If you achieve **strong accuracy** with **less data** compared to other groups, that can actually earn you **extra credit**.
4. Data collection is an integral part of the project. Analyze your process and clearly explain *how* and *why* you gathered the data you chose.
* Did randomly sampling images work surprisingly well?
* Did you design an algorithm or strategy that improved data collection for your model?
Show it. Include ablations describing what worked and what didn't and try to explain why.
4. The test data will not include completely empty walls like the example below. **However, it may contain images** with walls that include distinctive or unique features (such as a statue, artwork, or architectural element), as well as images with partial walls or otherwise visually unusual scenes.



5. I will not include images of the sky, rooftops, or the ground. You can assume that all test images are taken from approximately chest–head height, though some variation in angle may occur.
6. Some locations may be situated under buildings (for example, under Building 26), which can partially block or degrade the GPS signal. You should explore how this affects your approach. If you are able to capture images with usable GPS readings (even if they are noisy) and still perform successful regression, excellent. If it turns out to be infeasible, that is acceptable just document your findings.

<u>The predefined area</u> (in black overlay): (the orange is the library)

Good luck!