Image Geolocation Using Deep Learning

- **Image geolocation** is the task of defining the geographical location where an image was taken.
- **Image metadata (EXIF)** as other Internet geolocation information can be manipulated. Therefore, it can be worthwhile defining the location from the image pixels as a computer vision problem.
- Application area in open-source intelligence (OSINT), geospatial intelligence (GEOINT), and imagery intelligence (IMINT)
- Challenging problem due to the variety of images

- **Research problem**: How to geolocate outdoor street-view images using computer vision?
- **RQ1**: How to geolocate a street-view image using deep learning?
- **RQ2**: How to utilize satellite imagery/maps for street-view image geolocation?

Implementation of Outdoor Image Geolocation in Finland:

1. Geocell partitioning
2. Predict geolocation
3. Shapley Additive exPlanations (SHAP)
4. Utilizing satellite imagery

**Figure 1: Geocells.** Partitioning of the selected rectangular area of Finland into geocells of 40x30.

**Figure 2: Trained model predicting geolocation for a sample outdoor image.** Black dot indicates the true location, geocells from dark to light indicate probabilities that the image was taken there.

**Figure 3: Explainable AI (XAI).** Why was the image located like that? SHAP values show the positive and negative impacts on the prediction.

**Figure 4: Cross-view image geolocation (CVIG).** Are the street-view and satellite-view images from the same location?

**Conclusions**
- Using deep learning, street-view image geolocation can be solved as a classification problem (RQ1).
- Utilizing satellite imagery/maps for street-view image geolocation can be solved as a binary classification/similarity problem (RQ2).