

Robust Multi-Task Learning from Multiple Remote Sensing Datasets

Master 2/Ecole d'Ingénieur Internship

Expected starting: February/March 2024 (6 months)

Keywords

Deep learning, multi-task learning, partial annotation, disjoint datasets, remote sensing

Context and objectives

In recent years, deep neural networks have been successfully adopted in almost every application domains of computer vision, including remote sensing for earth observation. The vast number of remote sensing images captured from frequent satellite passes or aerial acquisition, however, are not readily usable to train deep networks developed for generic vision problems due to the lack of task-specific annotations and possible domain gaps.

On the other hand, the individual development efforts of various research groups for their particular problems result in cluttered annotations and modalities: each dataset is typically annotated for a few tasks while many tasks may be related to one another and could be jointly learned to leverage complementary information and improve their performance. Coupling solving different but related tasks, or well-known in the ML community as multi-task learning, has also gained increasing attention in the remote sensing community. As multi-task learning aims to predict different targets from the same inputs, it typically requires annotations of all the target tasks for each input example to learn the interrelationship at the shared encoder by optimizing all tasks at the same time.

Obtaining extra annotations to maintain multi-task datasets, however, add extra burden to the development process. Recently, it has been shown in the vision community that that multi-task learning could be beneficial even when the tasks are partially annotated [2]. Training a network for multiple task while the training examples are annotated for a single task can improve the performance of both tasks. Such discovery could be of interest to explore for the benefit of remote sensing community.

This project is aimed to research the combination of different datasets annotated for different tasks which may follow different statistical distributions to benefit and improve performance of one another. To that end, we will focus on the object detection, i.e. bounding boxes prediction, and semantic segmentation tasks, which are closely related yet not trivial to combine due to differences in spatial structure and information granularity: object detection predicts bounding-box coordinates at object instance level while semantic segmentation provides per-pixel predictions of category including amorphous regions. A general scheme is shown in Figure 1. Another challenge of the project is to bridge possible domain gaps between the participating datasets with possible approaches including generative models (GANs, diffusion models, etc.)

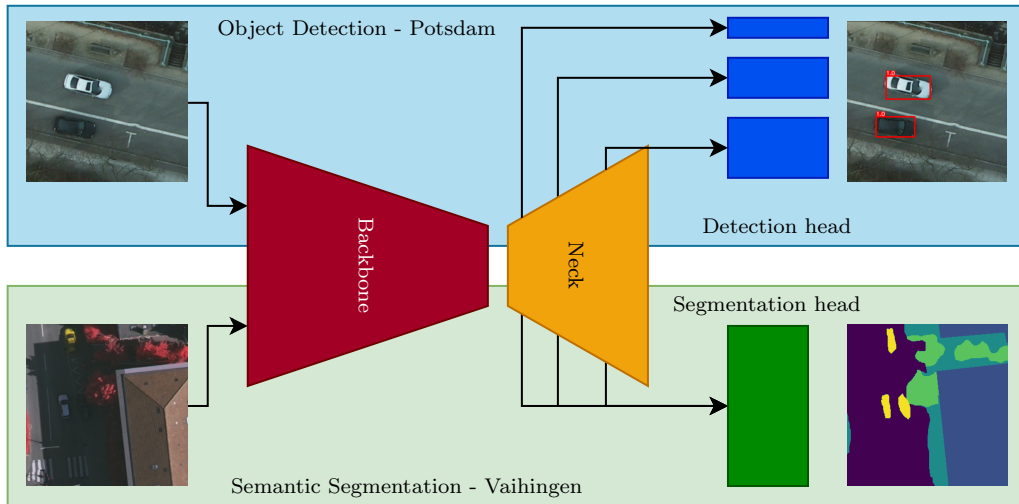


Figure 1: The general scheme of multi-task learning with partially annotated datasets simulated using the ISPRS benchmark [4]: the Potsdam subset is assumed to be annotated only with object detection thus can only train the detection subnet and Vaihingen subset semantic segmentation. The feature encoder (backbone and neck) is shared among the tasks.

Work program (expected)

In order to address the aforementioned objectives, a tentative work program is given below.

- Literature study and implement of state-of-the-art object detection and semantic segmentation as single task learning, e.g. DETR [1], FCOS [5], SegFormer [8], etc.
- Evaluation STL vs. MTL on benchmark datasets such as iSAID [6, 7], DIOR [3],
- Improvement of existing solutions and/or development of novel methods, starting with ISPRS data [4] and extended to other benchmark datasets.
- Dissemination: Master thesis, publication + source codes (highly recommended target).

Required background and skills

- Student in computer science and/or machine learning and/or signal & image processing;
- Python programming and familiarity with deep learning framework (Pytorch/Tensorflow);
- Highly motivated and passion in research.

Supervision

The expected intern will join the OBELIX research group (www.irisa.fr/obelix) from IRISA (UMR 6074) is located in the UBS (Université Bretagne Sud) campus in Vannes 56000, France. He/She will be jointly supervised by:

- Dr. Hoàng-Ân Lê¹, Postdoctoral researcher, IRISA/OBELIX
- Dr. Minh-Tan Pham², Assistant Professor (Maître de Conférences) at UBS, IRISA/OBELIX

¹<https://lhoangan.github.io/about>

²<https://sites.google.com/site/mtanpham89>

Application

Position to be filled as soon as possible (**call closed on December 15, 2023**). Send your detailed CV + Motivation letter + Master transcripts to `{hoang-an.le,minh-tan.pham}@irisa.fr`. Potential candidates will be contacted for interview.

References

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