Ph.D. in Information Technology
Thesis Defense

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Conference Room Emilio Gatti – building 20

Nico Catalano – XXXVII Cycle

Few Shot Segmentation: Combat Data Drought in Precision Agriculture

Supervisor: Prof. Matteo Matteucci

Abstract:

The ever-pressing need to increase efficiency and reduce the environmental impact of human activities involves many aspects of our society, including food production and the agricultural industry. Automation presents key solutions where vision systems capable of precise object detection and segmentation are crucial components.
Nevertheless, challenges such as limited labelled data and varying environmental conditions hinder the development of effective solutions. This thesis tackles these issues, leveraging Few Shot Segmentation techniques to improve adaptability and speed up the development of agricultural robotics.
This thesis begins by introducing the topic of agricultural robotics and then delves into Few Shot Segmentation methods.
These methods are categorized by their architectural design, focusing on the new opportunities presented by foundational models. A thorough review of the literature ranks these approaches based on their performance. The thesis also critically compares Few Shot Segmentation models with traditional Semantic Segmentation ones, highlighting the trade-offs between accuracy and the labour required for data collection and labelling in real-world agricultural scenarios. One significant finding is that existing models struggle with accurately detecting small weeds. To address this challenge, an enhanced model is proposed, incorporating specific modifications to improve the segmentation of small weeds in a few shot regime.
Further, this thesis explore the optimization of Few Shot Segmentation pipelines by analyzing the impact of different backbone architectures. We demonstrate that ensembling multiple backbones within a single model can significantly improve performance without additional data. The results present a novel approach that leverages the strengths of various backbone networks, offering a robust solution for segmentation tasks in data-scarce environments.

Finally, this thesis presents a method levereging from novel foundational models in solving the task of Few Shot Segmentation by combining and taking advantage of visual and texutual modalities.

PhD Committee

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