Overview

1. With this work, we present a method to detect objects that are not randomly positioned in images, but spatially organized. We focus on plants in crop fields as a case study.

2. We relied on synthetic datasets to overcome the lack of public labelled datasets of crop fields. We built a crop field generator with the game engine Unity. We use synthetic datasets both to design our strategy and to test its performances in the case of plant overlapping.

3. Our method proceeds in TWO STEPS to detect spatially organized objects. In the first one the spatial organization is approximated using unsupervised learning. In the second step a multi-agent system is initialized based on the approximation and refines the detection of the objects.

4. Our method yields a counting accuracy equivalent to state-of-the-art methods in easy cases; and it is much better on hard cases.

Datasets

Public labelled datasets of crop fields are rare. We generate different synthetic datasets both for training and testing. Made with Unity, a professional game engine, State-of-the-art methods struggle against plant overlapping. For testing, we generate different synthetic datasets.

The Multi-Agent System is a corporate hierarchy with 4 layers: Director Agent (DA), Row Agents (RAs), Plant Agents (PAs), and Pixel Agents (PXAs).

Counting Accuracy (CA) on Synthetic & Real Datasets

Plant 1
- Plants are well separated
- EASY
0.97 ± 0.07

Plant 2
- Plants are at the limit of overlapping
- MEDIUM
1.00 ± 0.04

Plants are overlapping
- HARD
1.03 ± 0.07

OTHER METHODS

State-of-the-art methods rely on supervised learning. Example of studies tackling the issue of plant counting with various plant overlapping conditions:

- García-Martínez et al. (2020)
- Gnädiger & Schmidhalter (2017)
- Ribera et al. (2017)

= 5% error in EASY-like datasets
= 20% error in HARD-like datasets