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| **Project title:** | The Augmented Agronomist: Synthesis of Privacy-Preserving Neural Networks and Robotics to Assist Decision Support |
| **Project number:** | SF/TF 170 |
| **Project leader:** | Marc Hanheide, University of Lincoln<br>Georgios Leontidis, University of Aberdeen |
| **Report:** | Annual report, 2020 |
| **Previous report:** | Annual report, 2019 |
| **Key staff:** | - |
| **Location of project:** | University of Lincoln |
| **Industry Representative:** | Richard Harnden, Berry Gardens |
| **Date project commenced:** | 30 November 2018 |

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## AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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# GROWER SUMMARY

## Headline

To provide automated agronomy support for agronomists at scale using machine/ deep learning techniques for yield prediction, from high dimensional spatio-temporal data.

This approach will reduce costs whilst maximizing specialist human time in areas that require the most attention.

## Background

This work on the augmented agronomist has been undertaken to help focus human time to the most vital areas, and act as an arm for agronomists to help locate problem areas in the crop, and improve yield prediction earlier than possible before. This system is also being created to improve trust, and security around the usually enigmatised deep learning models, and ensure data owner's privacy.

## Summary

Over the course of this project we intend to complete the following key objectives:

- **Provide agronomists and agriculturalists with yield predictions.** This is the primary advantage provided by the augmented agronomist system which will provide alerts to the operator of deviations from forecasts, and highlight areas where predicted yield potential is not on target. This information will enable the operator to focus efforts in areas which require most attention in order to maximise yield potential.
- **Create an autonomous data collection system**. Hand collecting data at scale would be infeasible due to both time and cost investments being too high while also providing inconsistent results. We will develop a repeatable and autonomous data collection platform so that we can collect spacio-temporal data for yield consistently and at scale.
- **Create a data aggregation and utilization pipeline.** This pipeline will be designed to be able to handle distributed autonomous data collections, which is the most likely scenario faced in practice, such as multiple robots operating and feeding in their data simultaneously across multiple sites.
- **Deploy an agronomy assistive neural network to predict plant yield ahead of harvest.** Ultimately this project will culminate with several other concurrent projects to develop an autonomous data collection, and actuation platform (Thorvald), to collect, process, and act on the data.

## Financial Benefits

According to Berry Gardens Growers (BGG) in 2018 they over estimated crop yield by 17.7% for 14 weeks of the 30-week growing period and underestimated the remaining 16 weeks by 10%, giving them an average absolute error (MAE) of 13.6% for the whole season. Underestimates cause surpluses, yield devalue, and subsequently costs by additional disposal of the yield. Additionally, over-estimates mean to meet demand, and contracts, growers will need to resort to expensive imported fruit, to cover the shortfall. In 2018 this cost BGG roughly 8 million pounds, whereas losses to the rest of the industry (70%) are estimated to cost 18 million pounds.

Current literature of deep learning enabled yield prediction expects an error (MAE) of roughly 15% (Konstantinos et al 2018; Maimaitijiang et al 2020). We can already match this and roughly the MAE of BGG using purely environmental data. We hope with the additional layers of image data, and more granular time series data that we can further improve upon this error, preventing further losses. We also hope to reduce the spread of inaccuracy, compared to purely human predictions, since human inaccuracy can vary wildly from person to person, and day to day, even if overall it gives a cumulative error of 13.6%.

## Action Points

- There are no action points at this time.

 