

**2020-21AY Undergraduate Final Year Project**

**Project Proposal Form**

Please refer to the **Project Handbook Section 4** when completing this form

Degree Title:  Computing	Student's Name:  Ryan Syme
	Supervisor's Name:  Dr Vegard Engen
	Project Title/Area:  What's wrong with my crop? Using convolutional neural networks to detect crop defects.

**Section 1: Project Overview**

**1.1 Problem definition - use one sentence to summarise the problem:**

Crop defects threatening food security in the developing world and food supplementation in the developed world.

**1.2 Project description - briefly explain your project:**

Creating a REST (representational state transfer) API (application programming interface) to allow crop pictures to be uploaded and analysed by a CNN (convolutional neural network). Which will feed back percentage likelihood of each kind of crop defect and images that the network sees as a good match to the input.

**1.3 Background - please provide brief background information, e.g., client, problem domain:**

This web service could be of aid to small scale gardeners/farmers for identifying problems that may arise with their crop. For example, diseases, pest infestation, lack of water, lack of nitrogen, too hot/cold, humid/dry. With global food security still a major concern in both the developing and developed world, diseases and pests become an ever more prevalent threat. In the context of a developing country, communities are reliant on the crop produced by smallholders for survival as "Smallholders manage over 80 per cent of the world's estimated 500 million small farms and provide over 80 per cent of the food consumed in a large part of the developing world" (Walpole et al., 2013). In the developed world namely

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the US, more people that are not expert horticulturalists are taking to producing food. Especially in recent times (2020), there has been a huge increase in interest for home food production (Google Trends, 2021). Therefore, having a quick way to get an idea of what is causing crop failure/defects and information on what is appropriate recourse, will allow producers to act against the problem and as a result, improve their yield. Current examples of research into image classification for aiding crop production include, crop disease identification of 3 different diseases in paddy fields (Anthonys and Wickramarachchi, 2009) whereby they obtained over 70% classification accuracy. And a research project in 2016 produced a model that achieved 99.35% accuracy at identifying 26 diseases (or lack thereof) on over 14 different crop species on a held-out test set (Mohanty, Hughes and Salathé, 2016)

#### 1.4 Aims and objectives – what are the aims and objectives of your project?

Aims and Objectives:

- have a working REST API. The API will provide information regarding the likelihood of each kind of crop defect, when served an image via a link to a relational database. In addition to other metrics such as similar images and time to compute. The API will be robust enough to handle the receipt of erroneous requests.
- A python backend that will handle image classification using a CNN.
- A UI that will allow the user to upload an image to be analysed.
- The UI will display information regarding the likelihood of each kind of possible defect.
- To display the relevant images that fit the description of the most likely defects
- To display recourse information to rectify the defect
- Collecting, cleaning and pre-processing the image data
- Artificially growing the dataset by performing translations/rotations/adding noise to the images to make the training data more comprehensive.
- Include regularisation techniques to the NN to prevent overfitting.

The focus of the project will be building and optimising the CNN that will perform the image classification. A stretch goal will be to include features may that will enable the analysis of the NN's decision making process, perhaps leveraging open source libraries such as lucid (tensorflow/lucid, 2021)

## Section 2: Artefact

### 2.1 What is the artefact that you intend to produce?

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The artefact will consist of two main parts. Firstly, a REST API integrated with a CNN (convolutional neural network) that I will build largely from scratch and will perform image classification of crop defects. Secondly, a web interface that sends/receives relevant parameters from the user/client in the form of a RESTful API and a front end that visualises the returned data with the help of JavaScript.

**2.2 How is your artefact actionable (i.e., routes to exploitation in the technology domain)?**

With “90.7% of U.S. residents age 15–44 having Internet access” (Couper et al., 2018) and the number of people with internet access from all backgrounds steadily increasing year on year (Internet users per 100 inhabitants ITU.svg, 2021) with this number set to continue to increase due to the proliferation of satellite based internet access. With a single company claiming an Africa-wide satellite internet coverage (ArabSat 5C - Internet by Satellite in Africa, 2021). Therefore, services that can be accessed via the internet are becoming an ever more viable solution for the majority of people around the world. Hence, the web service will also continue to become more available to those in developing countries where it will be most impactful when aiding the identification of crop defect. And at present will be easily accessible to those in developed countries. Additional requirements will be a method of taking pictures and a device to access the internet. Smartphone use is increasing around the world (Smartphone users 2020 | Statista, 2021) which satisfies both these requirements. Furthermore, digital cameras have reached a market value of 14.7 billion (Digital Camera Market: Global Industry Trends, 2021) and home computer access has reached 49.7% of the world’s population in 2019 (How many people have access to a computer 2018 | Statista, 2021) a statistic that has been increasing year on year.

**Section 3: Evaluation**

**3.1 How are you going to evaluate your work?**

Firstly, were the aims and objectives met? This can be evaluated through observation of a working and stable artefact that has the features mentioned in the proposal. This will be formalised by comparing the final software artefact with a list of requirements that will be iteratively created during the SDL, ensuring inclusion the features mentioned in my initial proposal.

Secondly, providing the application to potential users with an attached questionnaire to gather feedback. My questionnaire feedback will be evaluated against the System Usability Scale (SUS) which will include the generic questions and method of interpreting scores outlined on (System Usability Scale (SUS) | Usability.gov, 2021)

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**3.2 Why is this project honours worthy?**

The project is honours worthy as it will be a clear demonstration of one's ability to carry out the production of a piece of software, start to finish, back-end and UI. Which will show one's planning and problem-solving skills as well as the domain knowledge one has acquired during their years of academic study and additional year in industry. The project will be an addition to a growing body of research into image classification and how its usefulness can be incorporated into the domain of food production.

**3.3 How does this project relate to your degree title outcomes?**

With the degree title being Computing, the main degree title outcomes that will be covered are computer algorithms, software development and some amount of creating a web application. The project will also be strongly building upon one's final year units, being; machine intelligence, deep learning and data mining. With the creation of a CNN being a direct extension of the deep learning module and an example of employing complex computer algorithms. The need to pre-process data being an extension of the data mining module. Creating a REST API will further build upon the web development skills of Ivl5. The coupling and design of the front/back end will be a demonstration of one's software development ability.

**3.4 How does your project meet the BCS Undergraduate Project Requirements?**

The project builds upon one's final year modules, it contains objectives for the creation of a relevant software artefact, it will highlight one's main skills under the computing remit. Furthermore, the project will be created using current technologies and methodologies to show current best practice as determined by existing successful software applications and literature.

**3.5 What are the risks in this project and how are you going to manage them?**

- Improper time management – this mitigated by staying on track to the Gantt chart
- HDD/storage failure – any work done for the project will be backed up to cloud storage such as GitHub and Google Drive.
- Illness/injury – Should the need arise I will apply for an extension to the due date.

## Section 4: References

### 4.1 Please provide references if you have used any.

[1] [https://www.ifad.org/documents/38714170/39135645/smallholders\\_report.pdf/133e8903-0204-4e7d-a780-bca847933f2e](https://www.ifad.org/documents/38714170/39135645/smallholders_report.pdf/133e8903-0204-4e7d-a780-bca847933f2e) (p6)

Anthony, G. and Wickramarachchi, N., 2009. An image recognition system for crop disease identification of paddy fields in Sri Lanka. 2009 International Conference on Industrial and Information Systems (ICIIS),. Globaltt.com. 2021. ArabSat 5C - Internet by Satellite in Africa. [online] Available at: <[https://www.globaltt.com/en/coverages-Arabsat%205C\\_C.html](https://www.globaltt.com/en/coverages-Arabsat%205C_C.html)> [Accessed 1 February 2021].

Couper, M., Gremel, G., Axinn, W., Guyer, H., Wagner, J. and West, B., 2018. New options for national population surveys: The implications of internet and smartphone coverage. Social Science Research, 73, pp.221-235.

Digital Camera Market: Global Industry Trends, O., 2021. Digital Camera Market Share, Size, Trends and Forecast 2020-2025. [online] Imarcgroup.com. Available at: <<https://www.imarcgroup.com/digital-camera-market#:~:text=The%20global%20digital%20camera%20market,viewfinder%20or%20live%20preview%20screen.>> [Accessed 1 February 2021].

Google Trends. 2021. Google Trends. [online] Available at: <<https://trends.google.com/trends/explore?q=best%20vegetables%20to%20grow&date=all&geo=US>> [Accessed 1 February 2021].

Statista. 2021. How many people have access to a computer 2018 | Statista. [online] Available at: <<https://www.statista.com/statistics/748551/worldwide-households-with-computer/>> [Accessed 1 February 2021].

En.wikipedia.org. 2021. Internet users per 100 inhabitants ITU.svg. [online] Available at: <[https://en.wikipedia.org/wiki/File:Internet\\_users\\_per\\_100\\_inhabitants\\_ITU.svg](https://en.wikipedia.org/wiki/File:Internet_users_per_100_inhabitants_ITU.svg)> [Accessed 1 February 2021].

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<<https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/>> [Accessed 1 February 2021].

GitHub. 2021. tensorflow/lucid. [online] Available at: <<https://github.com/tensorflow/lucid>> [Accessed 1 February 2021].

Walpole, M., Smith, J., Rosser, A., Brown, C., Schulte-Herbruggen, B., Booth, H., Sassen, M., Mapendembe, A., Fancourt, M., Bieri, M., Glaser, S., Corrigan, C., Narloch, U., Runsten, L., Jenkins, M., Gomera, M. and Hutton, J., 2013. Smallholders, food security, and the environment. [ebook] Available at: <[https://www.ifad.org/documents/38714170/39135645/smallholders\\_report.pdf/133e8903-0204-4e7d-a780-bca847933f2e](https://www.ifad.org/documents/38714170/39135645/smallholders_report.pdf/133e8903-0204-4e7d-a780-bca847933f2e)> [Accessed 1 February 2021].

Usability.gov. 2021. *System Usability Scale (SUS)* | Usability.gov. [online] Available at: <<https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html>> [Accessed 1 February 2021].

**Section 5: Ethics (please delete as appropriate)**

5.1 Have you submitted online ethics checklist to your supervisor?

Yes / **No**

5.2 Has the checklist been approved by your supervisor?

Yes / **No**

**Section 6: Proposed Plan (please attach your Gantt chart below)**

## Project Planner

Select a period to highlight at right. A legend describing the symbols is provided below.

