QUEEN'S UNIVERSITY BELFAST | IGFS THE INSTITUTE FOR GLOBAL FOOD SECURITY

Automated detection and quantification of ear biting in pigs

Anicetus Odo

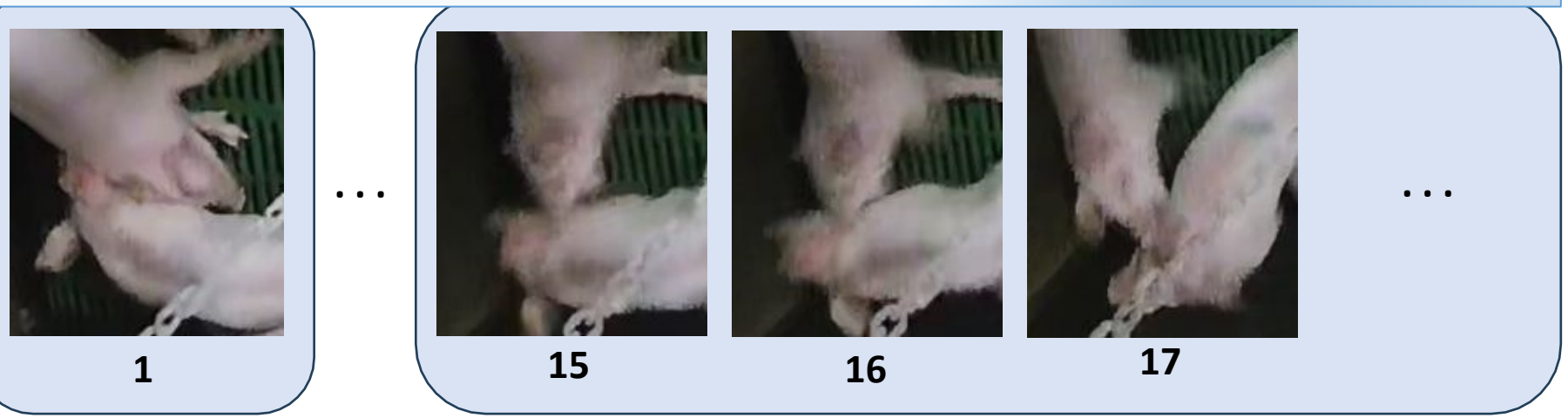
Wednesday 30 August 2023

Background

- Pigs reared in intensive farming systems develop damaging behaviours due to their difficulty in coping with the environment and their inability to perform natural behaviours.
- Most frequently, **ear injuries** are the most common indication that ear biting occurs within a pen, which may be too late for a remedial action.
- Due to large scale of modern farms, (early) detection through direct visual inspection is impractical.
- Automation will facilitate early intervention.

Context

Video sequence with evidence of ear biting

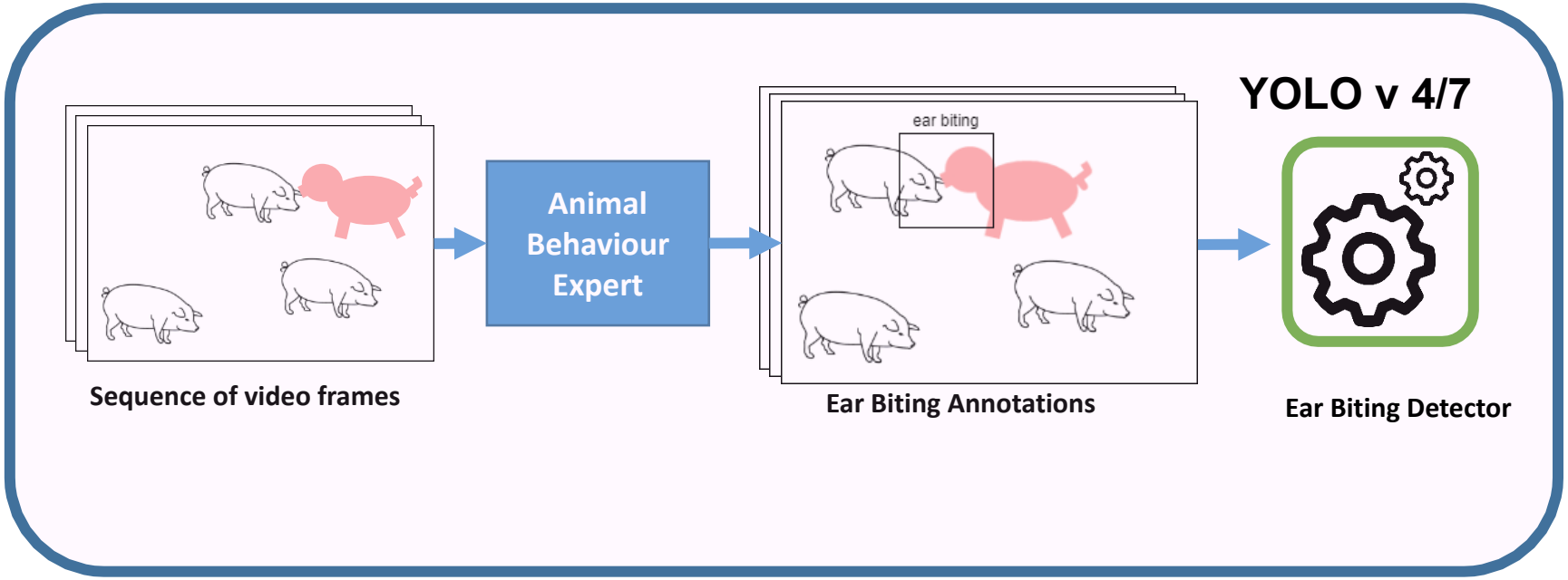


We aimed to:

- **Detect contact regions (i.e., location in image with snout-to-ear) using computer vision techniques**
- **As the basis for the development of an early warning system**
- **Improve the health and welfare of pigs.**

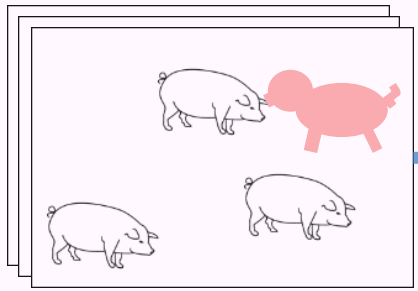
Methods

Training



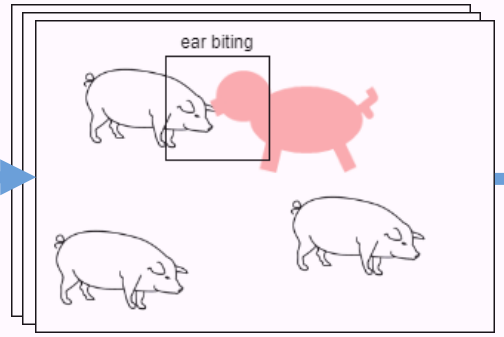
Methods

Training



Sequence of video frames

Animal Behaviour Expert

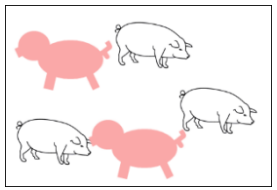


Ear Biting Annotations

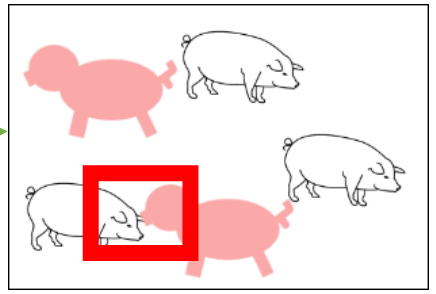
YOLO v 4/ 7

Ear Biting Detector

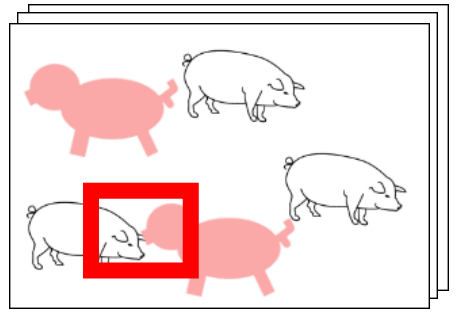
Deployment



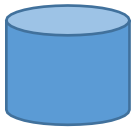
Video from pen



Detect Ear-Biting



Track detected region

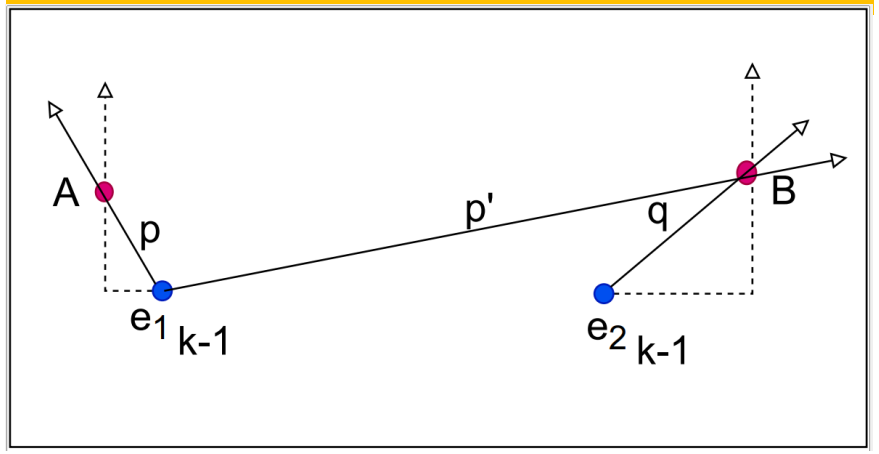


Frequency/Duration

Methods - tracking

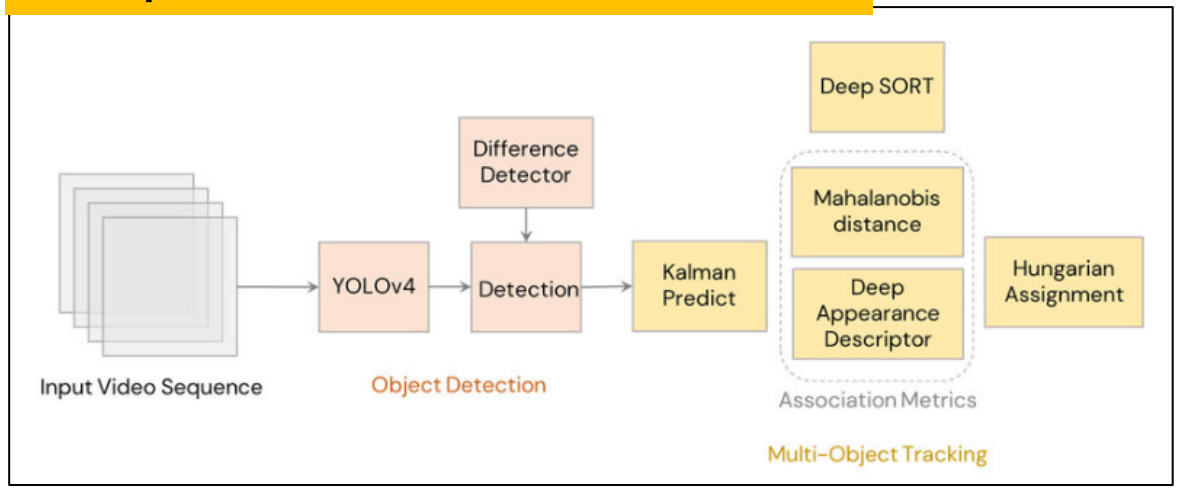
Tracking can help to cope with false positive detections and missing detections.

Centroid tracker



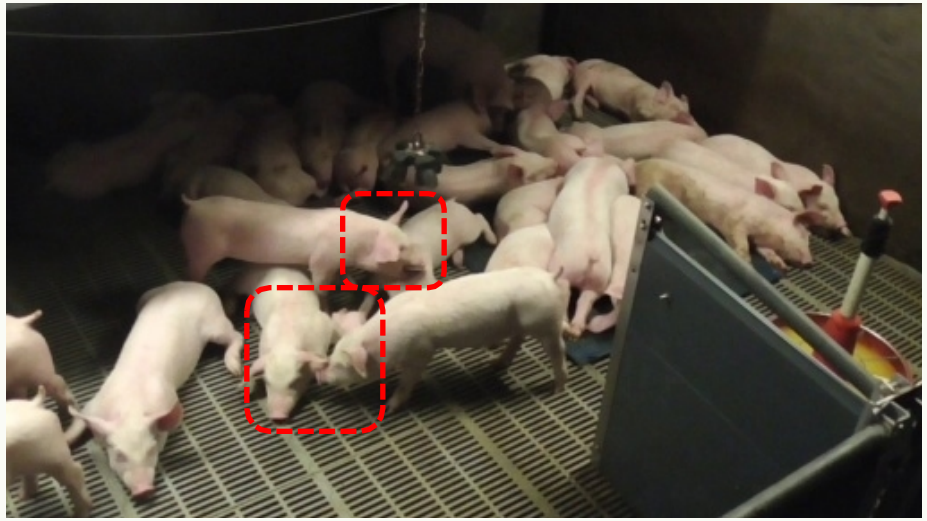
e1 and e2 are the centroids of the detected regions (BLUE). Two points were detected in the next frame: A and B (RED). The event trajectories from the current video frames, fk−1 to the next are e1A, e1B, e2A, e2B

Deep SORT tracker



Experiments – Pen configurations

Observation I: (i) perpendicular camera view (ii) low stocking density (iii) better lighting condition.



Observation II: (i) lateral camera view (ii) high stocking density (iii) high occlusion (iv) poor illumination.

Experiments - Datasets

We used videos derived from commercial pig settings:

Dataset I:

- Training - 8 videos x 2 Hours:
- Validation – 2 videos x 2 Hours

✓ At 25 FPS, there are 180,000 images per video
✓ To facilitate labelling, we sampled 3 FPS from each video (averaging 21,600).

Dataset II:

- Training – 19 video x 22 minutes
- Validation – 3 videos x 22 minutes

✓ 29,040 images analyzed

Summary of images and labels used for development.

Dataset	Data Split	Video frame	Ground truth
I	Training	4672	5,087
	Validation	525	524
II	Training	6,984	7,066
	Validation	844	844

Results

Summary of detection performance on the validation set

Dataset I:

Metrics	YOLOv4	YOLOv7
↑ Precision	0.7	0.92
↑ Recall	0.99	0.95
↑ Average Precision	0.98	0.98
↓ Speed (ms)	13.4	8

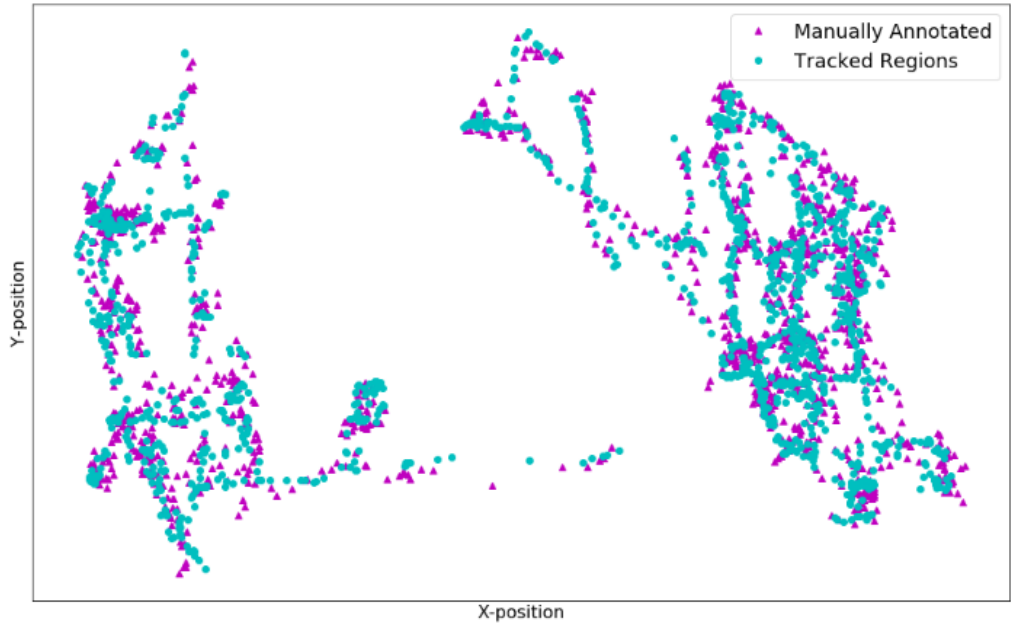
Dataset II:

Metrics	YOLOv4	YOLOv7
↑ Precision	0.75	0.77
↑ Recall	0.82	0.75
↑ Average Precision	0.86	0.81
↓ Speed (ms)	13.4	8

Results - Tracking

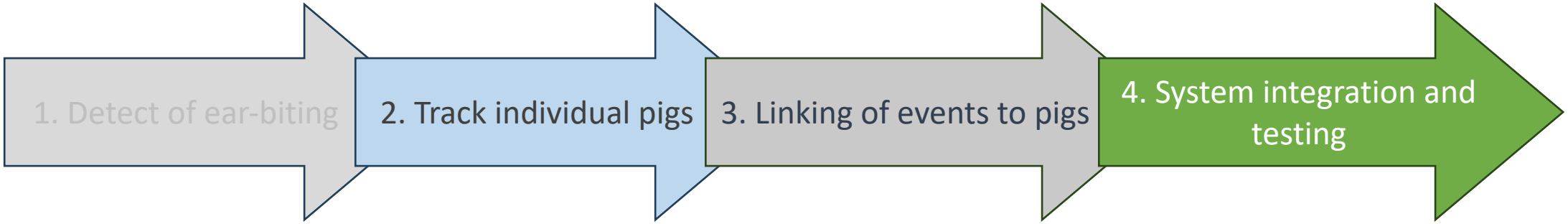
Ear biting was detected in 2,113 frames (ground truth) in the test video.

Metrics	Centroid Tracker	DeepSORT
↓ Tracking Error	20.40%	16.80%
↓ False-Alarm Rate	0.34	0.14
↓ False-Negative Rate	0.03	0.34
↑ True-Positive Rate	0.97	0.66



A plot showing the degree of overlap between events detected manually on the test set (ground truth) and those detected using the automated system.

Next steps


1. Detect of ear-biting
2. Track individual pigs
3. Linking of events to pigs
4. System integration and testing

IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received 21 April 2023, accepted 2 June 2023, date of publication 12 June 2023, date of current version 20 June 2023.

Digital Object Identifier 10.1109/ACCESS.2023.3285144

RESEARCH ARTICLE

Video Analysis Using Deep Learning for Automated Quantification of Ear Biting in Pigs

ANICETUS ODO[1], (Member, IEEE), RAMON MUNS[2], LAURA BOYLE[3], AND ILIAS KYRIAZAKIS[1]

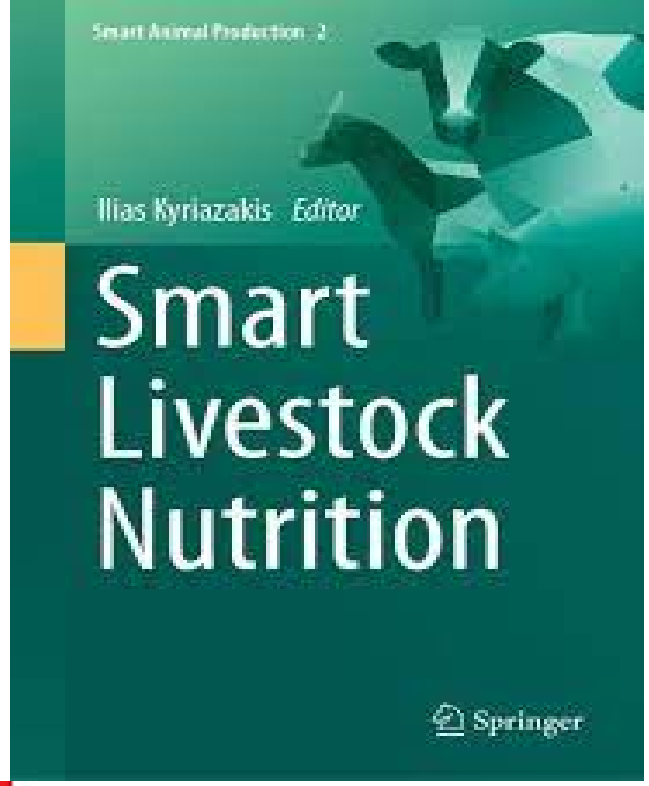
[1]Institute for Global Food Security, School of Biological Sciences, Queen's University Belfast, BT9 5DL Belfast, U.K.
[2]Sustainable Agri-Food Science Division, Livestock Production Science Branch, Agri-Food and Biosciences Institute, BT26 6DR Hillsborough, U.K.
[3]Animal & Grassland Research and Innovation Centre, Teagasc Pig Development, Moorepark, Fermoy, P61 C996 Ireland

Corresponding author: Anicetus Odo (A.odo@qub.ac.uk)

This research was part of the European Union (EU)-China HealthyLivestock project. The authors wish to acknowledge that HealthyLivestock is funded by the EU H2020 research and innovation program under grant agreement number 773436.

This work involved animals in its research. Ethics approval for the experiments conducted at Teagasc was granted by the Teagasc Animal Ethics Committee under Approval Number TAEC 40/2013. Similarly, experiments at the Agri-Food Bioscience Institute (AFBI) were carried out under the Project Licence Number PPL2851 as approved by the Animal Welfare Ethical Review Body and in accordance with the Animals Scientific Act (1986).

ABSTRACT Ear biting is a welfare challenge in commercial pig farming. Pigs sustain injuries at the



Thank You!

QUEEN'S UNIVERSITY BELFAST

SCHOOL OF BIOLOGICAL SCIENCES

INSTITUTE FOR GLOBAL FOOD SECURITY

1ST IN THE UK AGRICULTURE, FOOD AND VETERINARY SCIENCES *(REF2021)

1ST IN THE UK AGRICULTURE *(Complete University Guide 2023)

4TH IN THE UK FOOD SCIENCE *(Complete University Guide 2023)

9TH IN THE UK BIOLOGICAL SCIENCES *(Complete University Guide 2023)

Royal Society of Biology Advanced Accredited Degree

Royal Society of Biology Accredited Degree

Institute of Food Science + Technology ifst

RICS Accredited Course

Athena Swan Gold Award

Gender Charter