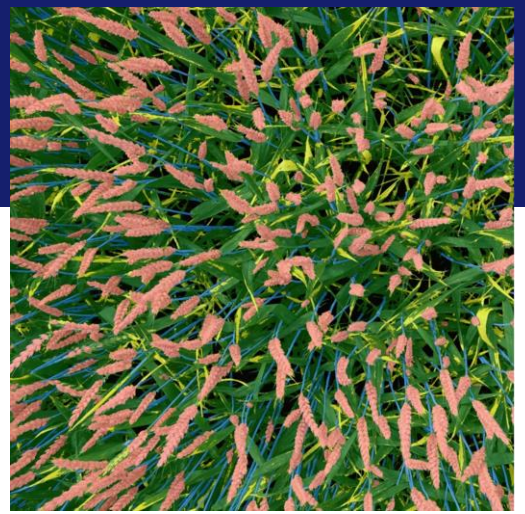
# The challenge of robust traits estimates with Deep Learning on high resolution RGB imagery



**Soutenance de thèse réalisée le 02/11/2021 par Etienne David**

**ED Agrosciences et Sciences 536 – Avignon Université**

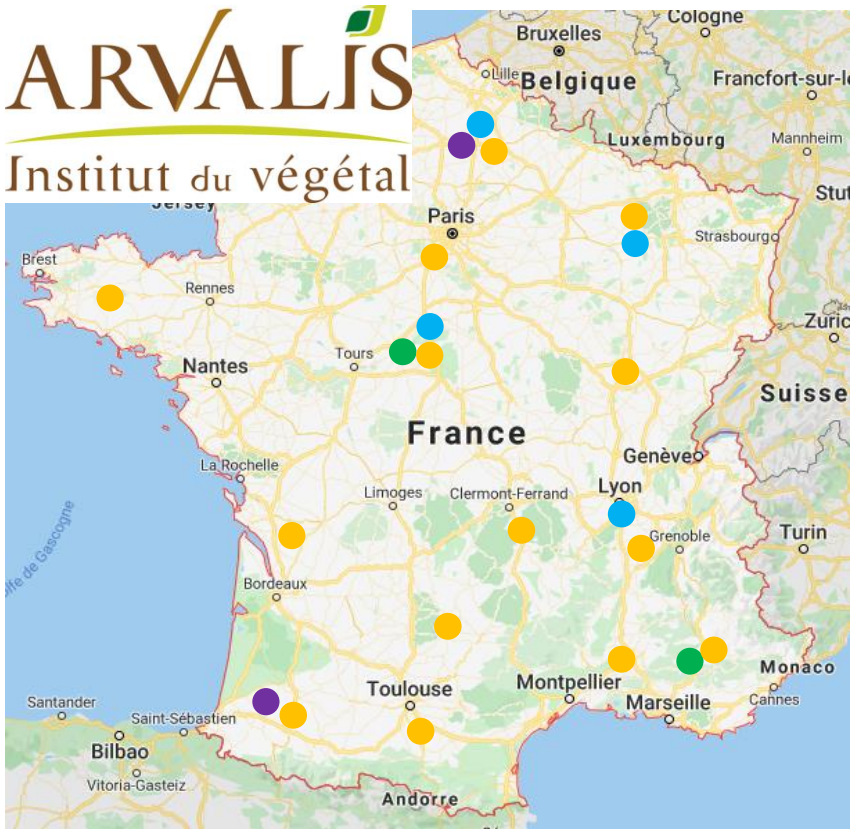
# Le phénotypage haut-débit accélère l'expérimentation

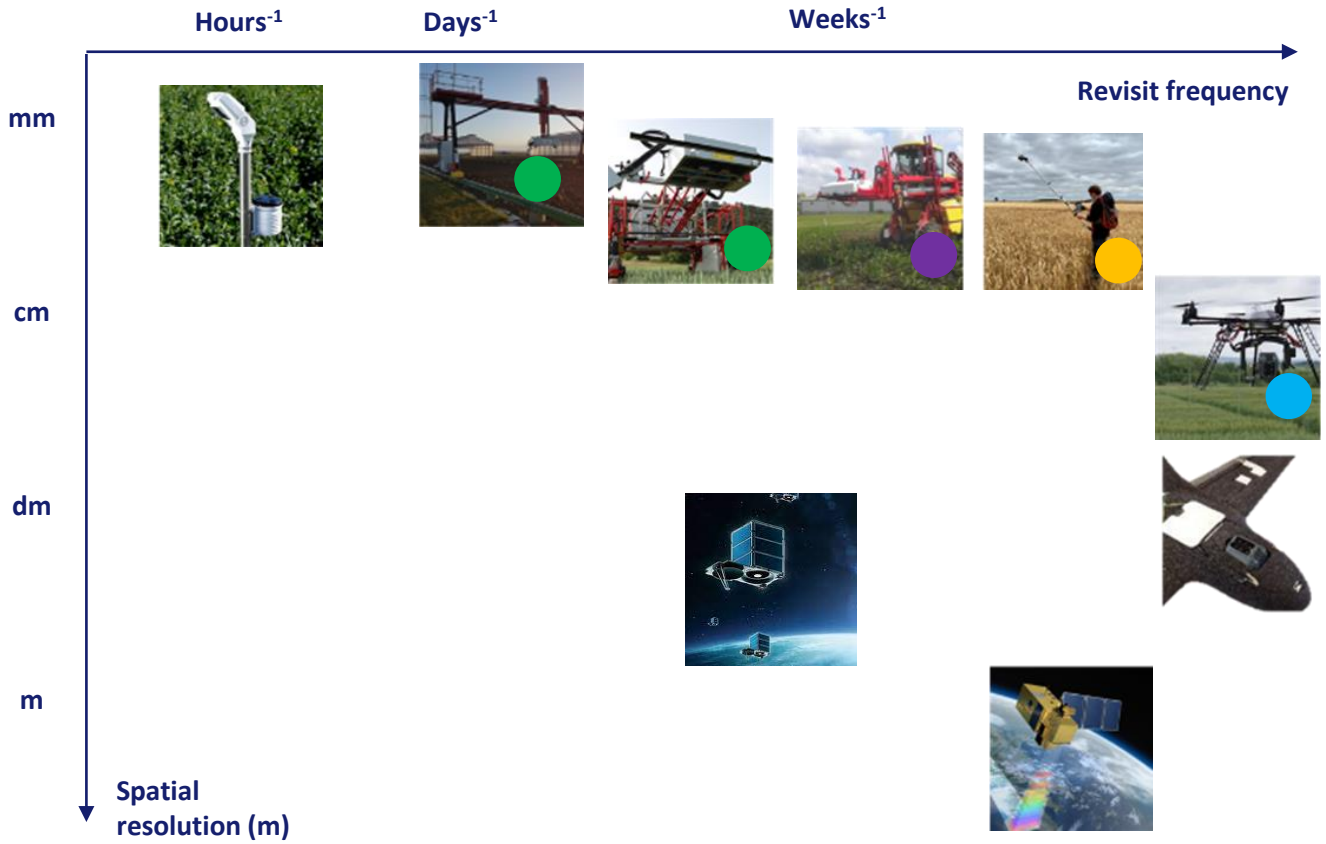
Mesures de plantes

Acquisition données brutes → Mesures de plantes

Des mesures plus rapides, plus fréquentes, revisitables

# Les plateformes de recherche française se digitalisent



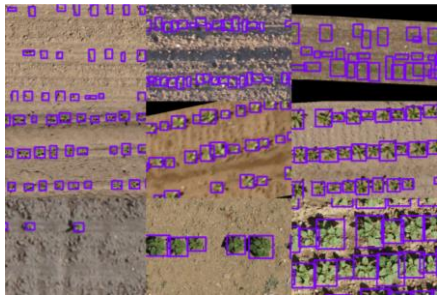




Les systèmes de phénotypage à haut débit (HTTP) se développent rapidement.

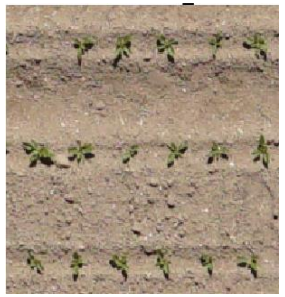
# Example of plant counting with UAV

## Phase 1: Entrainement

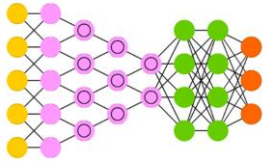
Jeu entrainement

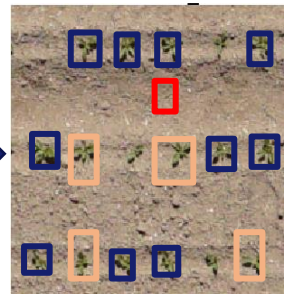


Fonction de coût



Algorithme Deep Learning

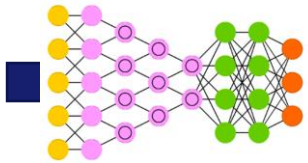


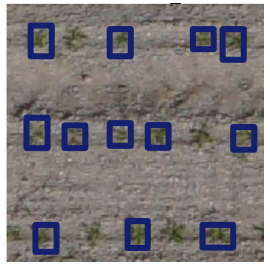


Modification des paramètres

## Phase 2: Prédiction

Données à prédire





Mais aussi classification et segmentation !

# Le changement de domaine

Un changement de domaine est une **modification** de la répartition des données entre l'ensemble de données d'apprentissage d'un algorithme et les images rencontrées lors du déploiement.

**Exemple : Un modèle de segmentation entraîné à détecter les tournesols ne détecte pas le maïs.**

Détecteur entrainé pour du tournesol

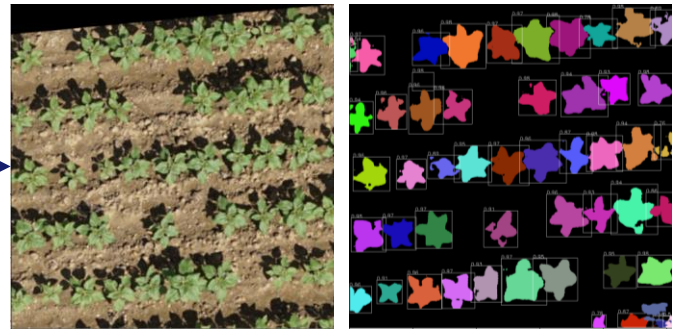
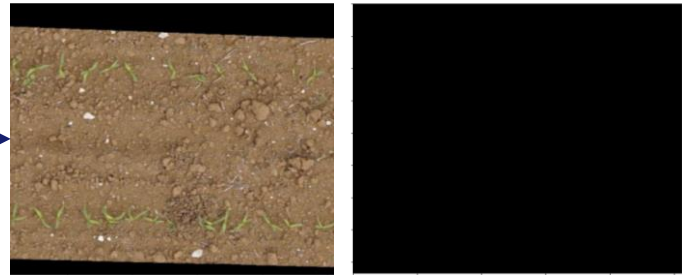


Image correspondant à l'entrainement



Différent

# Le domain shift influe t-il la mesure de phénotypage ?

# Les algorithmes sont évalués sur des données limitées

| Study | UAV | Crop | Sessions | Localization | Test independency |
|---|---|---|---|---|---|
| (Quan et al., 2019) | | Mais | 10 | ✓ | |
| (Ribera et al., 2017) | ✓ | Sorgho | 2 | | |
| (Valente et al., 2020) | ✓ | Epinard | 1 | | |
| (Liu et al., 2020) | ✓ | Mais | 2 | ✓ | |
| (Lin and Guo, 2020) | ✓ | Sorgho | 2 | ✓ | |
| (Madec et al., 2019) | | Blé | 2 | ✓ | ✓ |
| (Xiong et al., 2019) | ✓ | Blé | 10+ | | ✓ |

Seuls 2 articles sur 7 testent leurs algorithmes sur des données indépendantes.

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# De nombreux facteurs influent l'apparence d'une photo

**Protocole d'acquisition ?**

**Stade de développement ?**

**Distance interrang ?**

**Capteur utilisé ?**

**Génétique ?**

# Global Wheat Head Dataset 2021

275,187 wheat heads

6515 images

16 institutions

Collaborative labelling

Global WHEAT Dataset

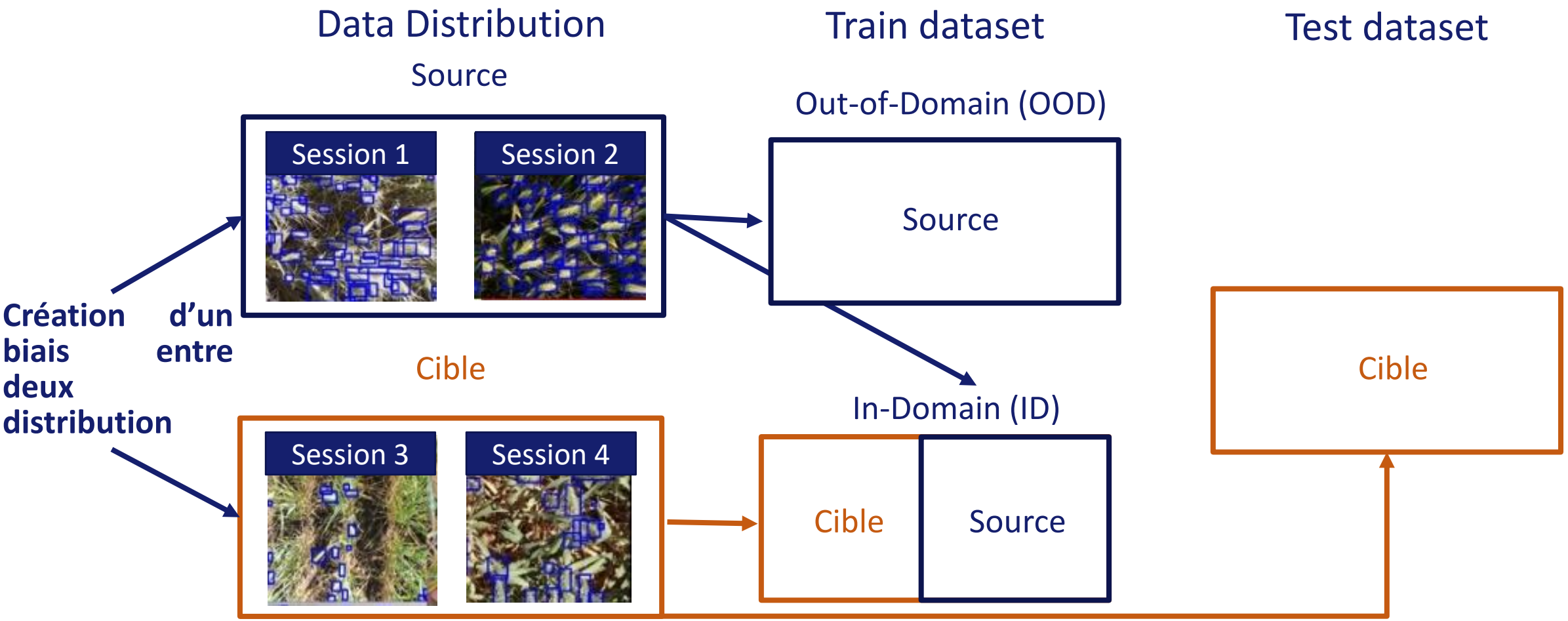
*Research Article*

**Global Wheat Head Detection (GWHD) Dataset: A Large and Diverse Dataset of High-Resolution RGB-Labelled Images to Develop and Benchmark Wheat Head Detection Methods**

*Database/Software Article*

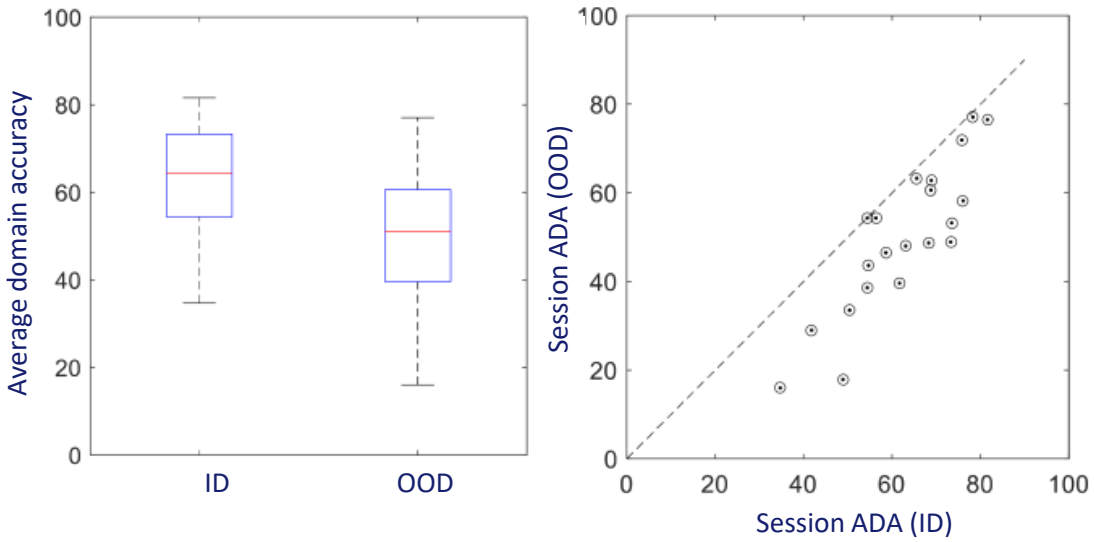
**Global Wheat Head Detection 2021: An Improved Dataset for Benchmarking Wheat Head Detection Methods**

# Comment mesurer le domain shift ?



# Les biais induisent une perte de performance réelle

Global WHEAT Dataset




Les meilleures performances sont obtenues avec des données provenant de la même distribution.

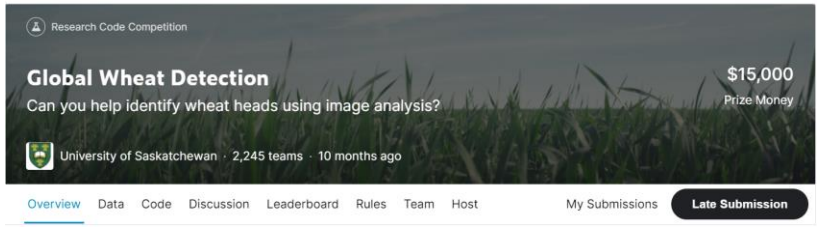
Comment entrainer des modèles robustes aux variations ?

1 – Le crowdsourcing de modèle par des compétitions de données

2- La mise à disposition des données aux autres domaines de la recherche

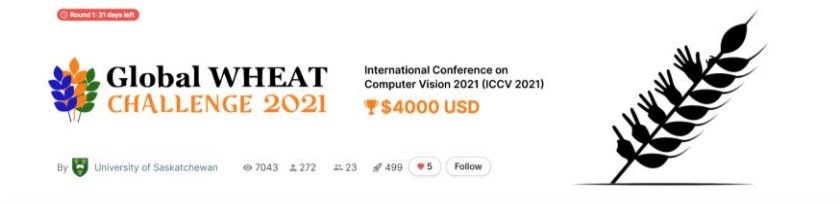
# Global Wheat Head Challenges

**2020** kaggle




**2200+**

**2021** AIcrowd




**400+**

GIFS | GLOBAL INSTITUTE FOR FOOD SECURITY
Growing science for life
Nutrien - a Founding Partner
Kubota
#DigitAg
hiphen
Plant Phenomics
A SCIENCE PARTNER JOURNAL
Quantomics
Navigator for Future Agriculture

Global WHEAT Dataset

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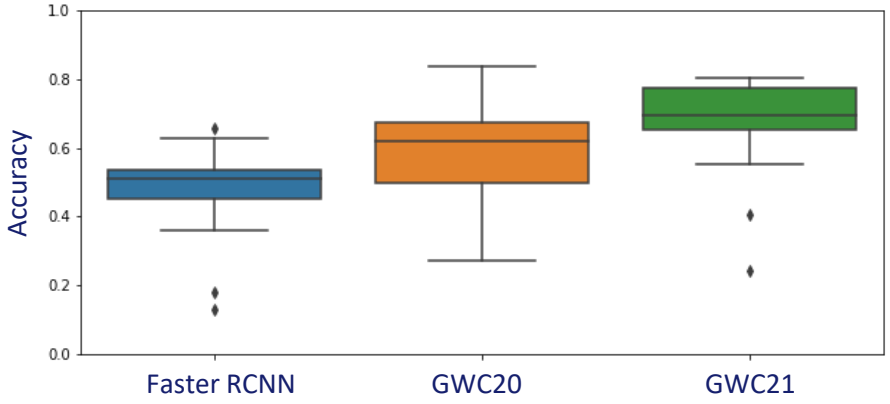
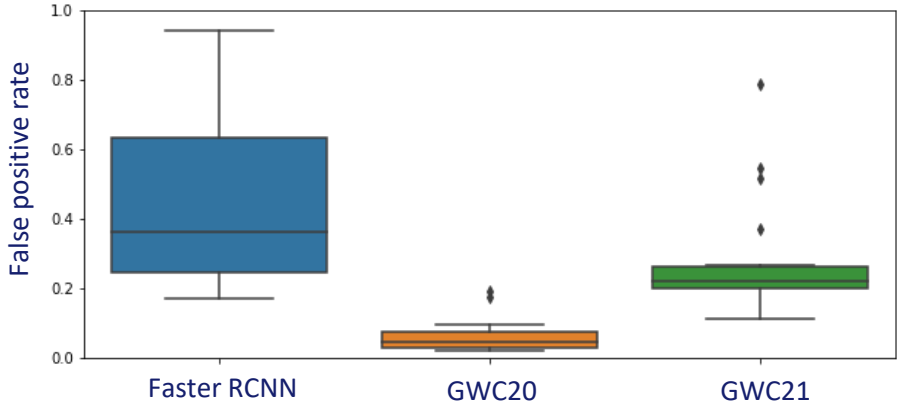
# Comparaison des performances sur GWC 21

## Les solutions proposées dépassent l'état de l'art en phénotypage

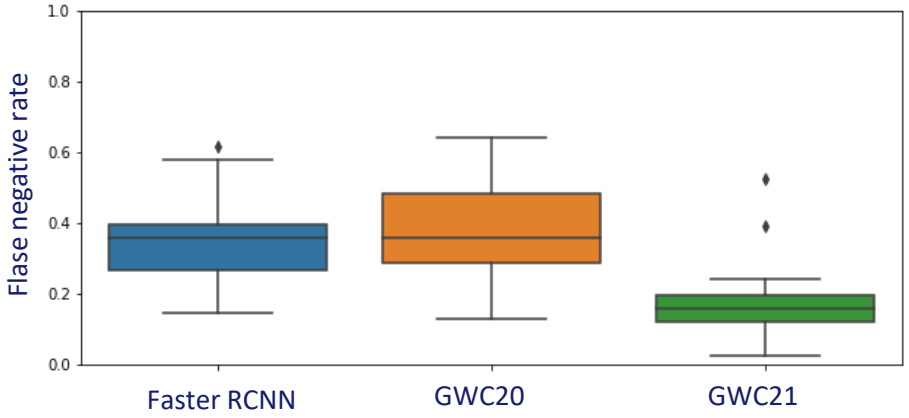
Précision




Faux positif




Faux négatif




Global WHEAT Dataset

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# Impact du Global Wheat Head Dataset

La moitié des 90+ citations sont de nouveaux modèles pour détecter et/ou compter les épis de blé dans les images RVB !

Open Access Article

**Rapid Detection and Counting of Wheat Ears in the Field Using YOLOv4 with Attention Module**

by Baohua Yang [1,2,*], Zhiwei Gao [1], Yuan Gao [1] and Yue Zhu [1]

[1] School of Information and Computer, Anhui Agricultural University, Hefei 230036, China
[2] Smart Agriculture Research Institute, Anhui Agricultural University, Hefei 230036, China
[*] Author to whom correspondence should be addressed.

Open Access Article

**Real-Time Detection for Wheat Head Applying Deep Neural Network**

by Bo Gong, Daji Ergu [*], Ying Cai and Bo Ma

Key Laboratory of Electronic and Information Engineering (Southwest Minzu University), State Ethnic Affairs Commission, Chengdu 610041, China
[*] Author to whom correspondence should be addressed.

WheatNet-Lite: A Novel Light Weight Network for Wheat Head Detection

***Sandesh Bhagat, Manesh Kokare, Vineet Haswani, Praful Hambarde, Ravi Kamble***; Proceedings of the IEEE/CVF International Conference on Computer Vision (ICCV) Workshops, 2021, pp. 1332-1341

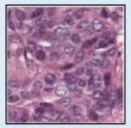
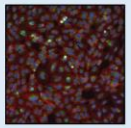
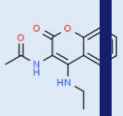
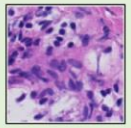
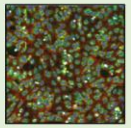
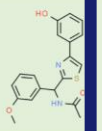
# Le Global Wheat Head Dataset est aussi utilisé en recherche en informatique

WILDS

**WILDS: A Benchmark of in-the-Wild Distribution Shifts**

Pang Wei Koh [*1] Shiori Sagawa [*1] Henrik Marklund [1] Sang Michael Xie [1] Marvin Zhang [2]
Akshay Balsubramani [1] Weihua Hu [1] Michihiro Yasunaga [1] Richard Lanas Phillips [3] Irena Gao [1] Tony Lee [1]
Etienne David [4] Ian Stavness [5] Wei Guo [6] Berton A. Earnshaw [7] Imran S. Haque [7] Sara Beery [8]
Jure Leskovec [1] Anshul Kundaje [1] Emma Pierson [3 9] Sergey Levine [2] Chelsea Finn [1] Percy Liang [1]

Accepted at ICML 2021
(Responsible for the object detection part)

| | Domain generalization | | | | | Subpopulation shift | Domain generalization + subpopulation shift | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dataset | iWildCam | Camelyon17 | RxRx1 | OGB-MolPCBA | GlobalWheat | CivilComments | FMoW | PovertyMap | Amazon | Py150 |
| Input (x) | camera trap photo | tissue slide | cell image | molecular graph | wheat image | online comment | satellite image | satellite image | product review | code |
| Prediction (y) | animal species | tumor | perturbed gene | bioassays | wheat head bbox | toxicity | land use | asset wealth | sentiment | autocomplete |
| Domain (d) | camera | hospital | batch | scaffold | location, time | demographic | time, region | country, rural-urban | user | git repository |
| # domains | 323 | 5 | 51 | 120,084 | 47 | 16 | 16 x 5 | 23 x 2 | 2,586 | 8,421 |
| # examples | 203,029 | 455,954 | 125,510 | 437,929 | 6,515 | 448,000 | 523,846 | 19,669 | 539,502 | 150,000 |
| Train example | |  |  |  | | What do Black and LGBT people have to do with bicycle licensing? | | | Overall a solid package that has a good quality of construction for the price. | import numpy as np … norm=np.___ |
| Test example | |  |  |  | | As a Christian, I will not be patronizing any of those businesses. | | | I *loved* my French press, it's so perfect and came with all this fun stuff! | import subprocess as sp p=sp.Popen() stdout=p.___ |
| Adapted from | Beery et al. 2020 | Bandi et al. 2018 | Taylor et al. 2019 | Hu et al. 2020 | David et al. 2021 | Borkan et al. 2019 | Christie et al. 2018 | Yeh et al. 2020 | Ni et al. 2019 | Raychev et al. 2016 |

Combler le fossé entre la recherche en informatique et le monde réel

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# Agricola moderna

AGRICOLA
MODERNA

Merci de votre attention !