University of Saskatchewan

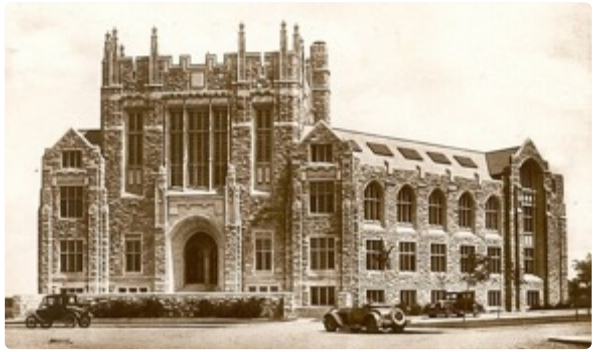
Computational Agriculture:
An Opportunity for Saskatchewan

Ian Stavness

Professor, Computer Science
University of Saskatchewan

Ian.Stavness@usask.ca

BIGLAB
Biological Imaging and Graphics Lab



College of Agriculture and Bioresources
Advancements in Agricultural Research Seminar Series
January 31, 2024

Computational Agriculture

People

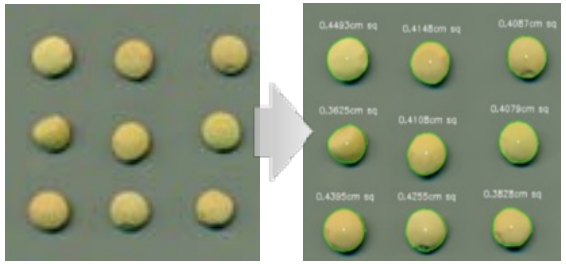
Data

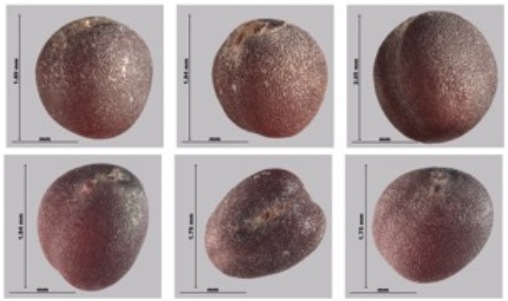
Opportunities

Computational Agriculture

Seed scale

seed phenotyping, provenance

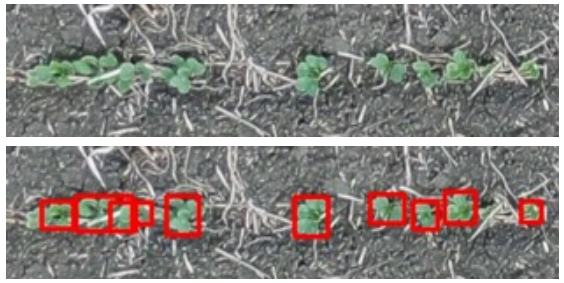




automated seed inspection, grading

Plant scale

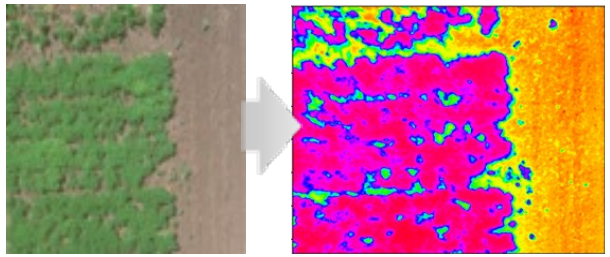
identifying plants, estimating traits

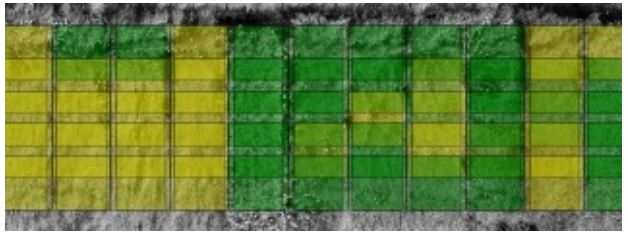


early disease detection

Field scale

crop health, precision management

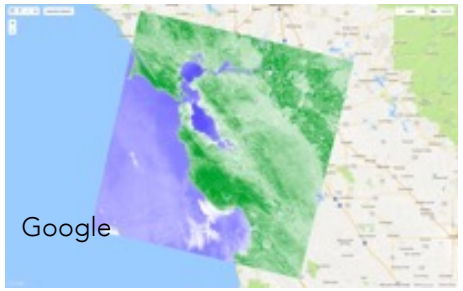


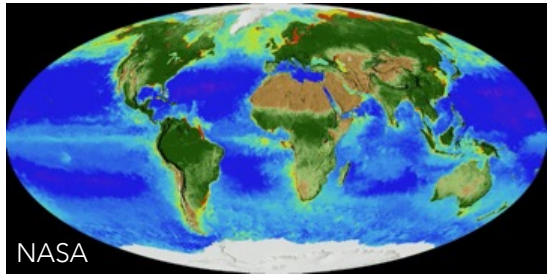


crop damage, crop insurance

Global scale

yield prediction, price forecasting





weather prediction, logistics

Plant Phenotyping and Imaging Research Centre (P^2IRC)

Flagship 1:
Breeding for Yield Stability

Flagship 2:
Mobilizing Root-Soil-Microbiome

Flagship 3:
Deep Learning for Phenomics

Flagship 4:
Field Imaging for Phenotyping

P²IRC Plant Phenotyping and Imaging Research Centre

CANADA FIRST RESEARCH EXCELLENCE FUND

GIFS | GLOBAL INSTITUTE FOR FOOD SECURITY

Growing science for life

Nutrien - a Founding Partner

CompAg in Saskatchewan

Comp Sci Researchers in Agriculture

Lingling Jin (Univ. Saskatchewan)

- Bioinformatics, Genomics, Plant imaging

Abdul Bais (Univ. Regina)

- Crop Imaging/Analysis

Jordan Ubbens (NRC, Saskatoon)

- Deep learning, Genomics/Phenomics

CompAg in the Prairies

Comp Sci Researchers in Agriculture

Chris Henry (Univ. Manitoba)

- Crop Imaging/Analysis

Farhad Maleki (Univ. Calgary)

- Artificial Intelligence in Ag

CompAg in Saskatchewan

Innovative Companies

- PrecisionAI
- Nutrien Ag Solutions
- Nuseed Canada
- Local tech companies (Siemens, Calian, Draganfly, etc.)

Supported by Saskatchewan's Agtech Growth Fund (AGF)

innovation SASKATCHEWAN

What do we need for CompAg?

People + Data

Introduction

People

Data

Discussion

We need *talented* people

Highly trained and qualified individuals and teams are the most important factor in a project's success

- For *Computational Agriculture*:
  - Specialized skills (Computer + Plant Science)
  - General skills (Communication, Data Management, IP)

We want *deadly* teams

From our experience with P^{2}IRC:

1. the best teams were diverse and open
2. matched Comp Sci and Plant Sci grad students
3. characteristics: enthusiasm, ok being uncomfortable

Example: **the *Canola Counter* team**

Canola Counter Team

Erik Andvaag
MSc Computer Science
eaa299@usask.ca

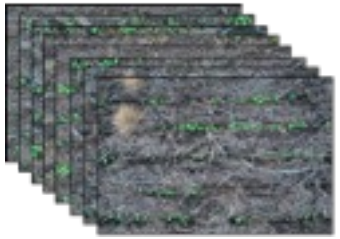
Kaylie Krys
MSc Plant Sciences
kmk806@usask.ca
@KaylieKrys

Canola Counter

Canola Counter *workflow*

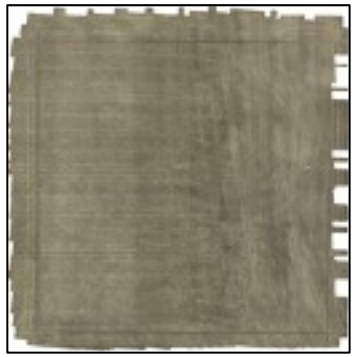
(1) Upload images

Set of Images

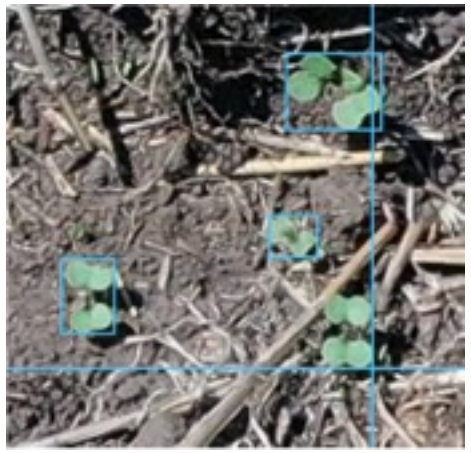


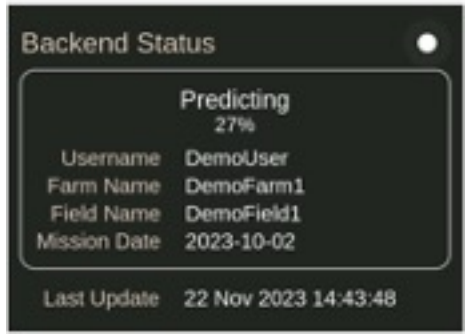
-- or --

Orthomosaic



(2) Annotate images, train models, apply models





(3) Inspect results and download counts

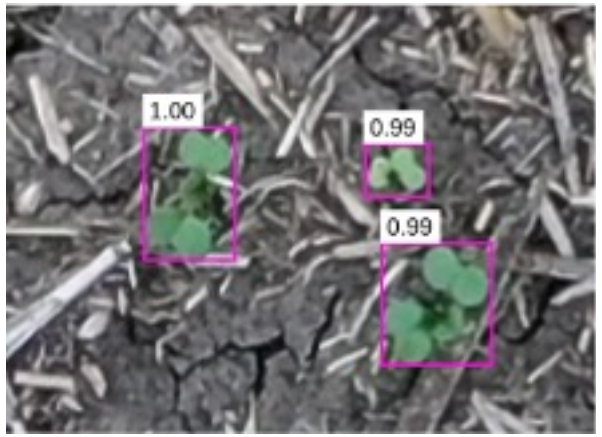
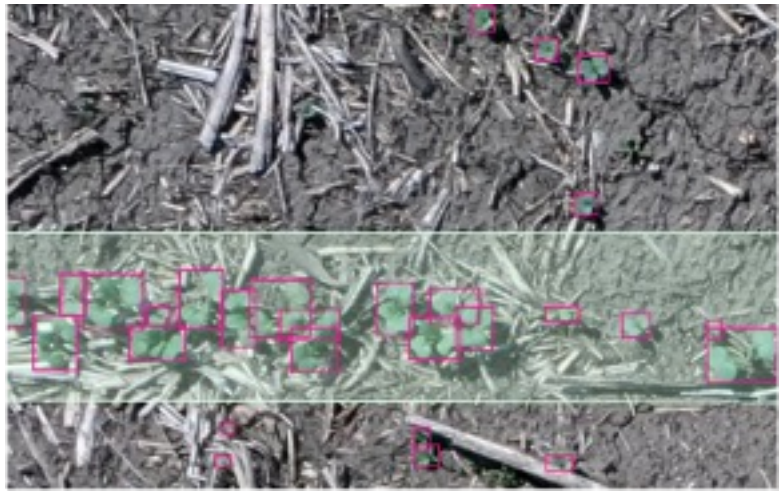


Image Name	Annotated Count	Predicted Count
1	329	332
2	6	7
3	559	555

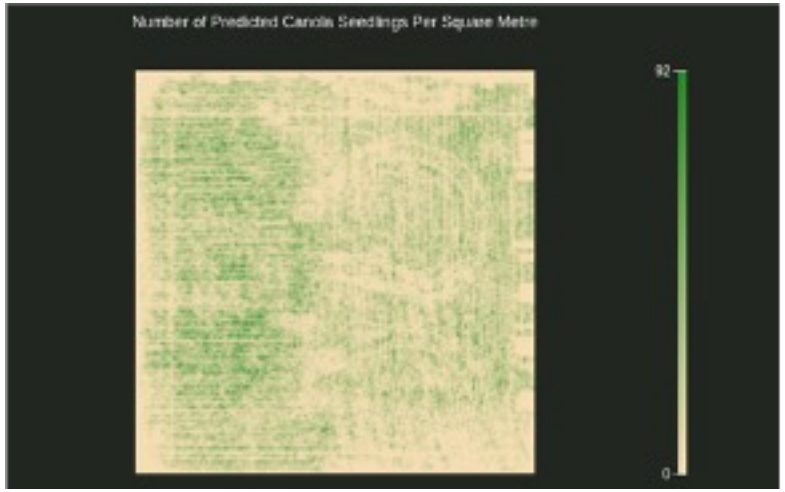
Canola Counter *visualizations*



Regions of Interest

Plant Spacing

Vegetation Coverage



Density Maps

Canola Counter Team

Erik Andvaag
MSc Computer Science
eaa299@usask.ca

Kaylie Krys
MSc Plant Sciences
kmk806@usask.ca
@KaylieKrys

Trainees want *Saskatchewan* experience

- Prioritize training for the needs of the *Saskatchewan* agriculture sector

- Emphasize hands-on experience:
  - get *CompSci* students in the *Field*
  - get *PlantSci* students on the *Cloud*

- Accelerate careers in academics, government and industry

NSERC CREATE in Computational Agriculture

Objective: Train graduate students at the intersection of Computer Science and Plant Sciences (2024 – 2029)

- New graduate course in Computational Agriculture
  - Cross-Training
  - Team Projects
  - Field Days, Cloud Days, Lab/Facility Tours
- New workshops:
  - AgTech Intellectual Property
  - Managing Agricultural Data
- Professional rotations & internships

NSERC CRSNG

CREATE Team

Curtis Posniak

Adam Carter

Kirstin Bett

Ana Vargus

Maryse Bourgault

Steve Shirtliffe

Crop Breeding

Agronomy

Ian Stavness

Mrigank Rochan

Lingling Jin

Mark Eramian

Carl Gutwin

Deep Learning

Bioinformatics

Imaging & Visualization

CREATE Partners

GIFS | GLOBAL INSTITUTE FOR FOOD SECURITY

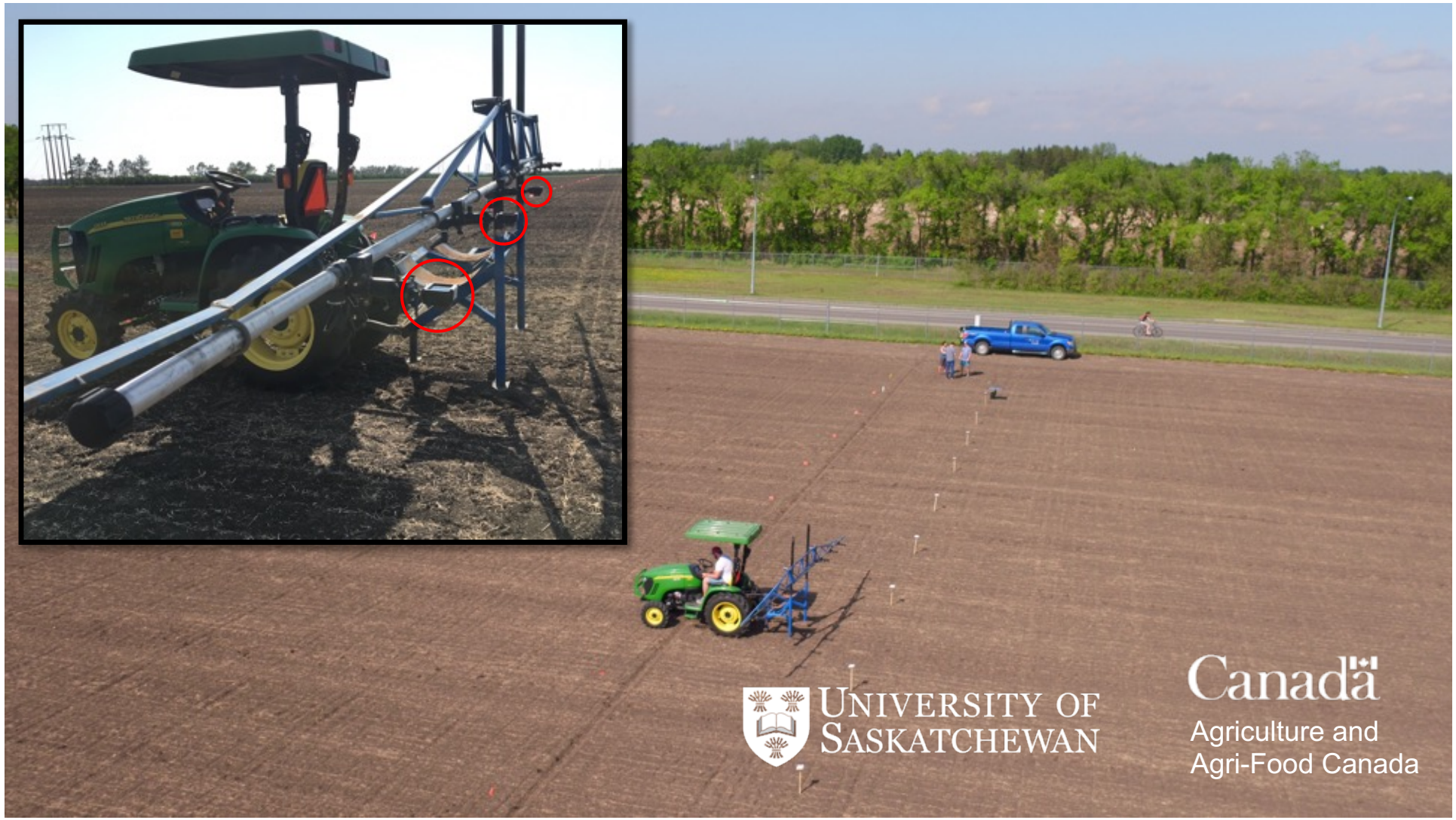
Growing science for life

Nutrien - a Founding Partner

Agriculture and Agri-Food Canada

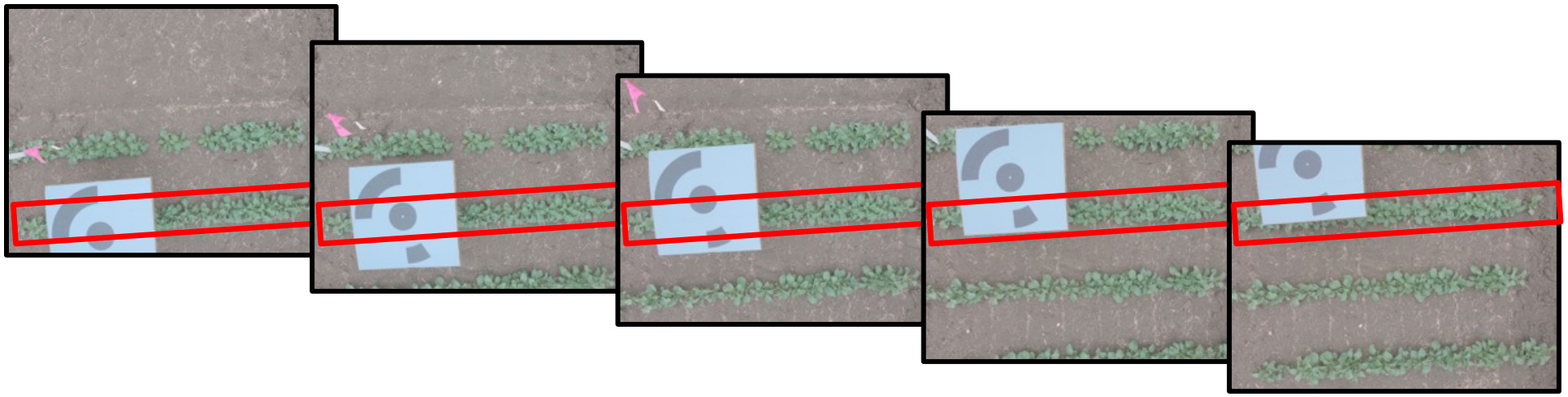
Saskatoon
Lethbridge
Brandon
Morden

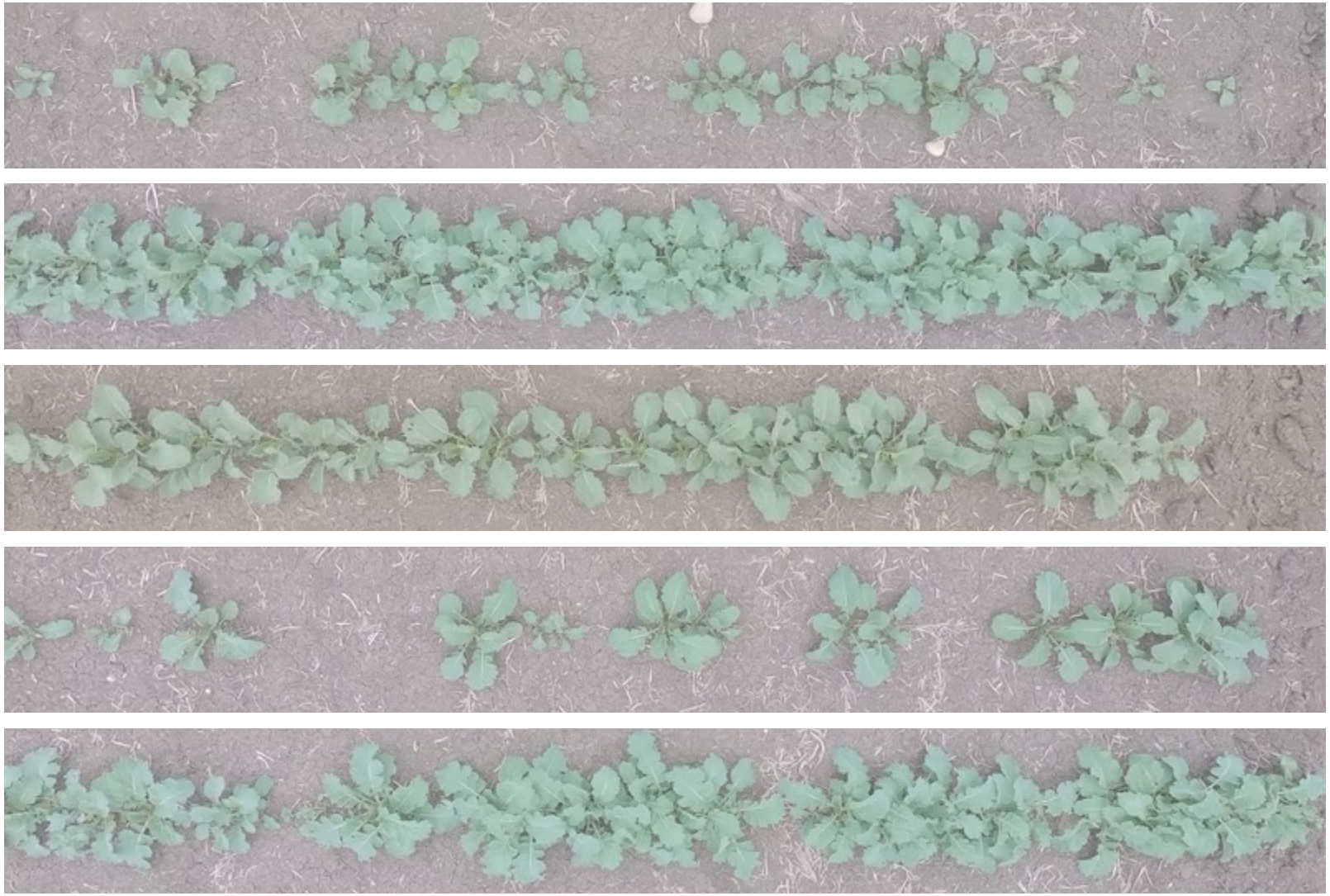
*Pro*Tractor


UNIVERSITY OF SASKATCHEWAN
Canada
Agriculture and Agri-Food Canada

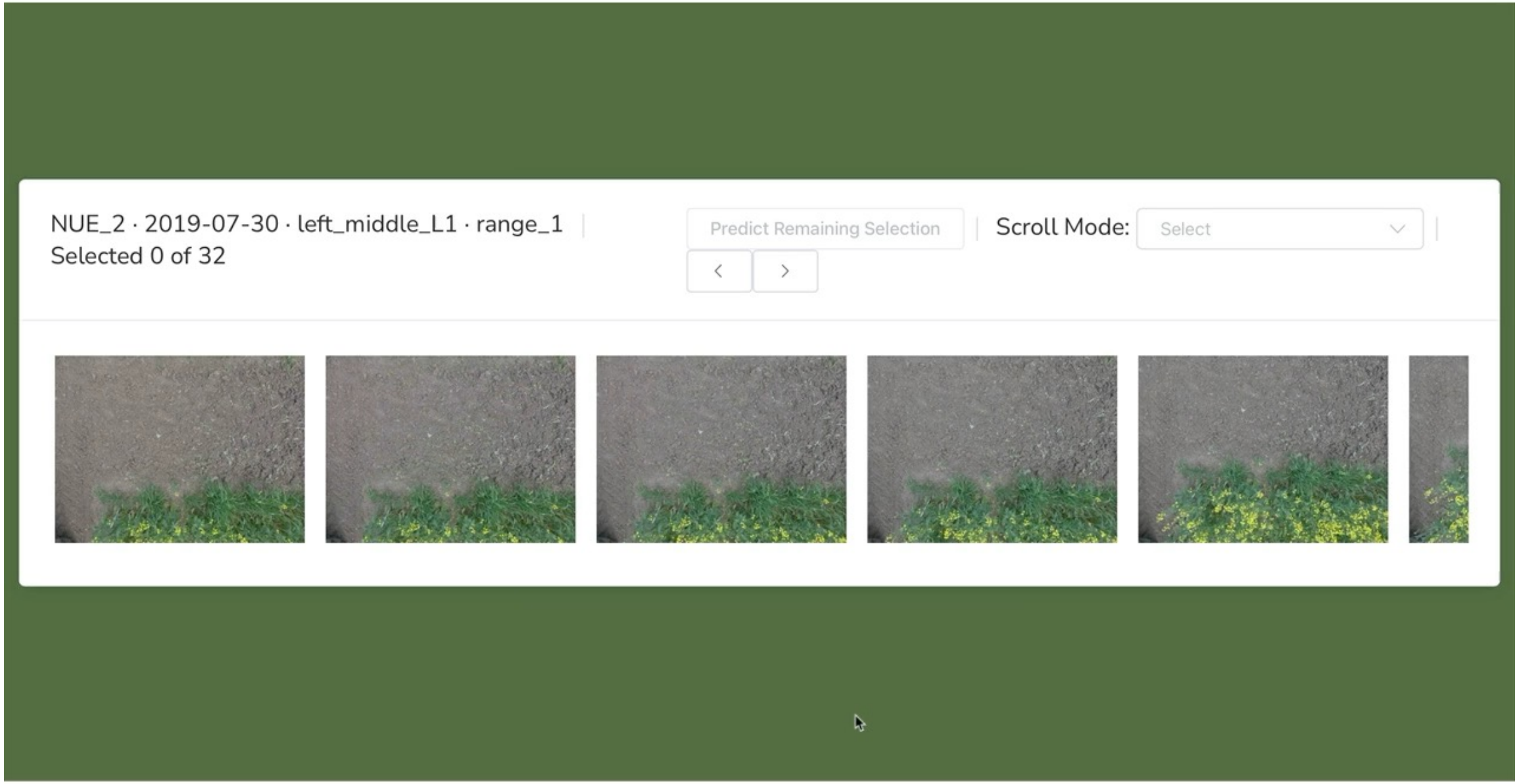
Higgs N, Leyeza B, Ubbens J, Kocur J, van der Kamp W, Cory T, ... Stavness, I. (2019). ProTractor: a lightweight ground imaging and analysis system for early-season field phenotyping. In Proceedings of the IEEE CVPR Workshops (pp. 1-10).

Row detection

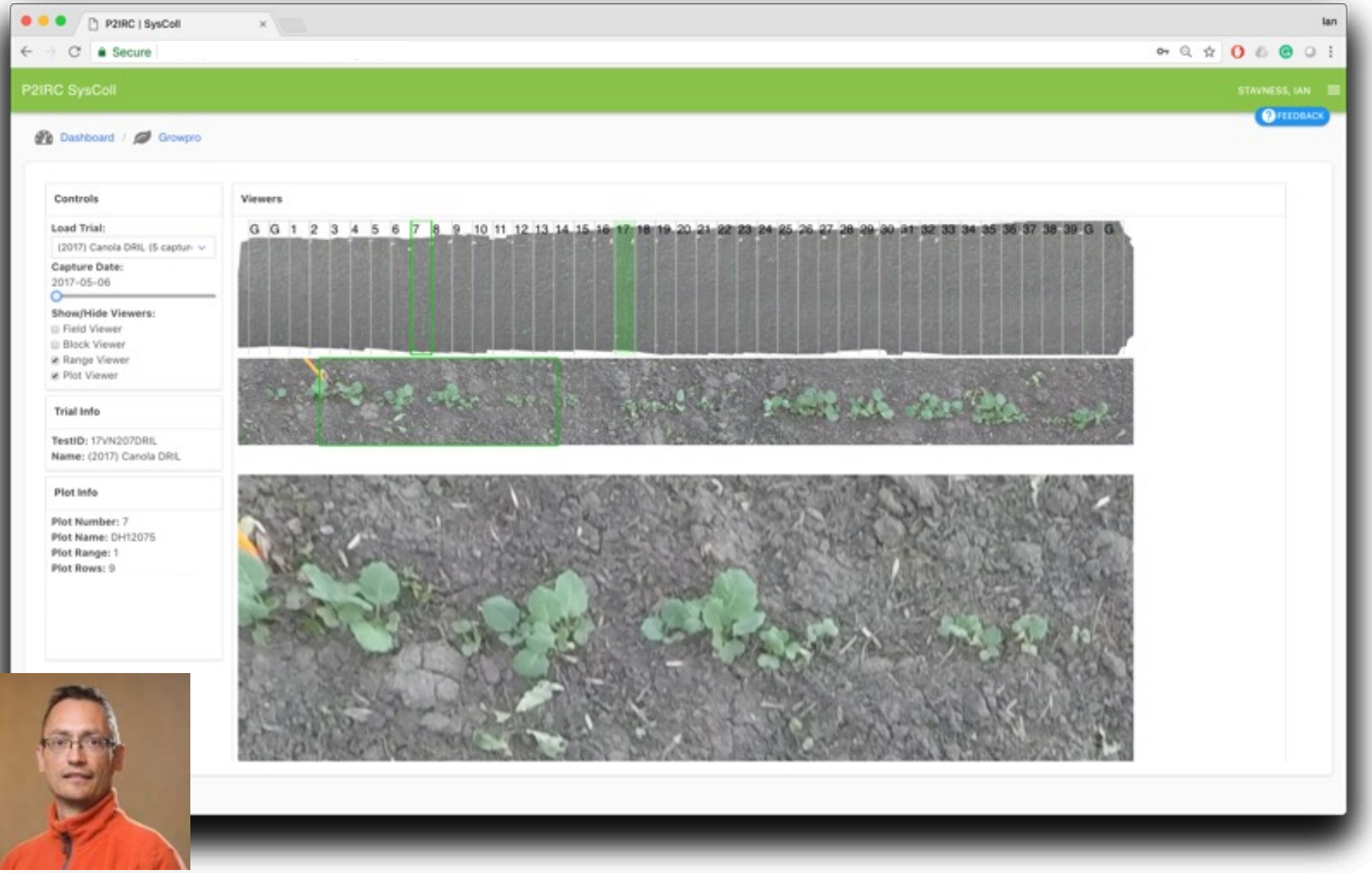




PlotReel


NUE_2 · 2019-07-30 · left_middle_L1 · range_1
Selected 0 of 32
Predict Remaining Selection
Scroll Mode:
Select

Inspecting plot images



Prof. Carl Gutwin

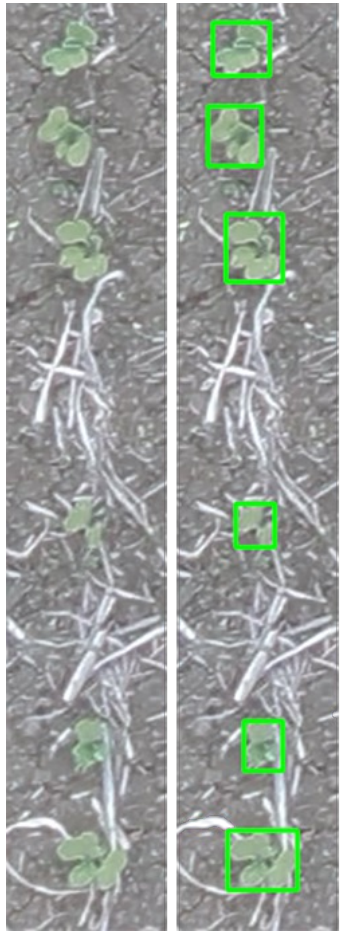
CompAg

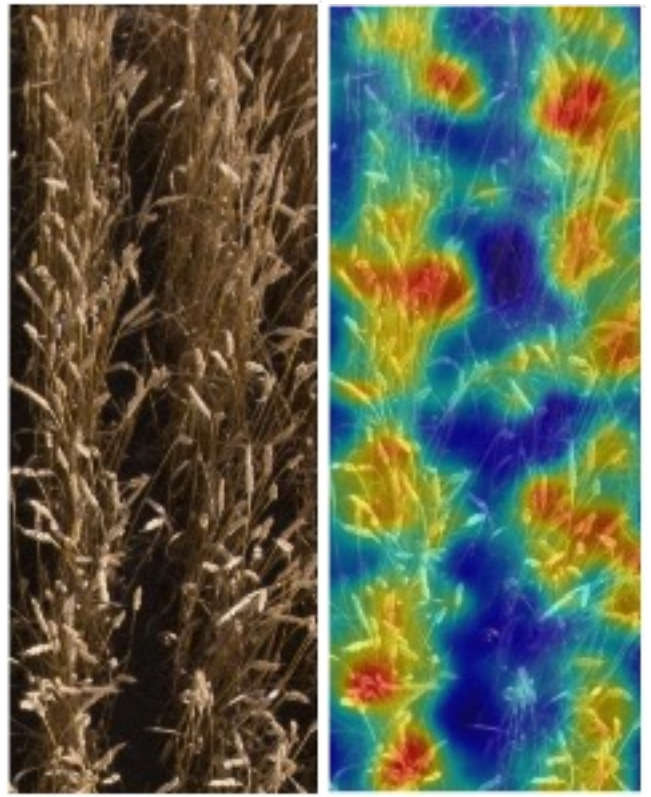
People

Data

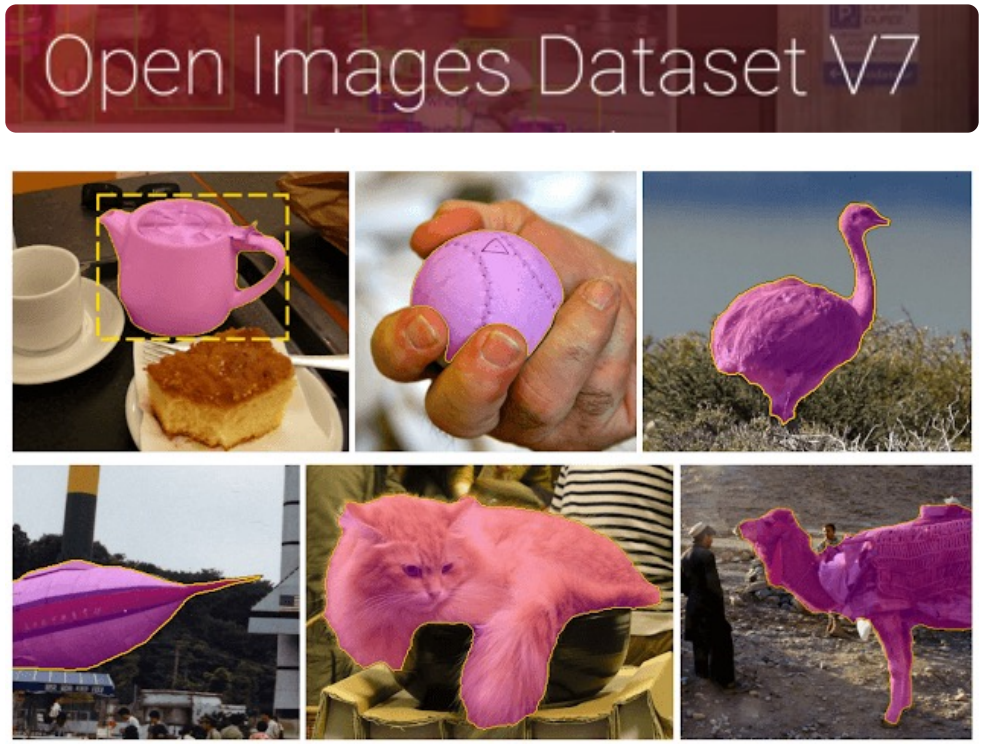
Opportunities

We want *models* that work



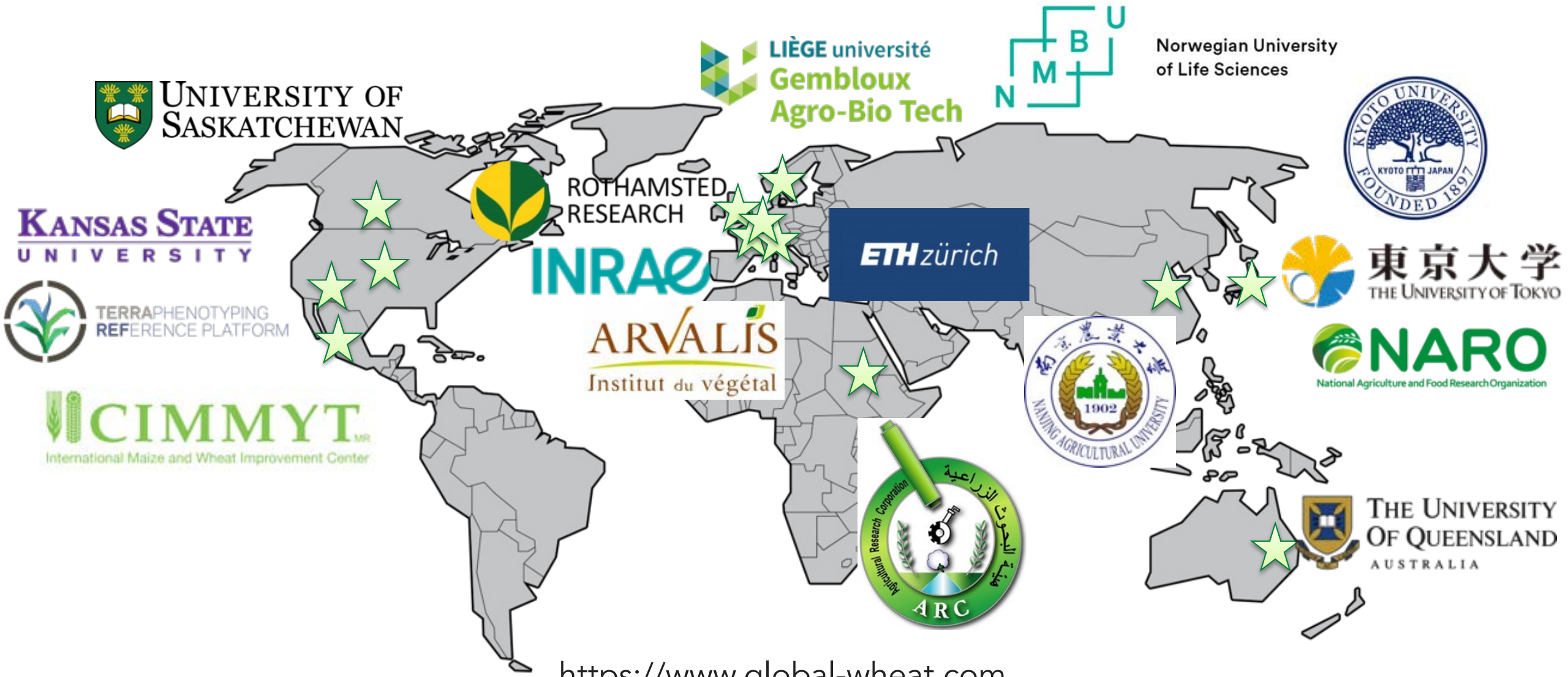


We need *large-scale* datasets



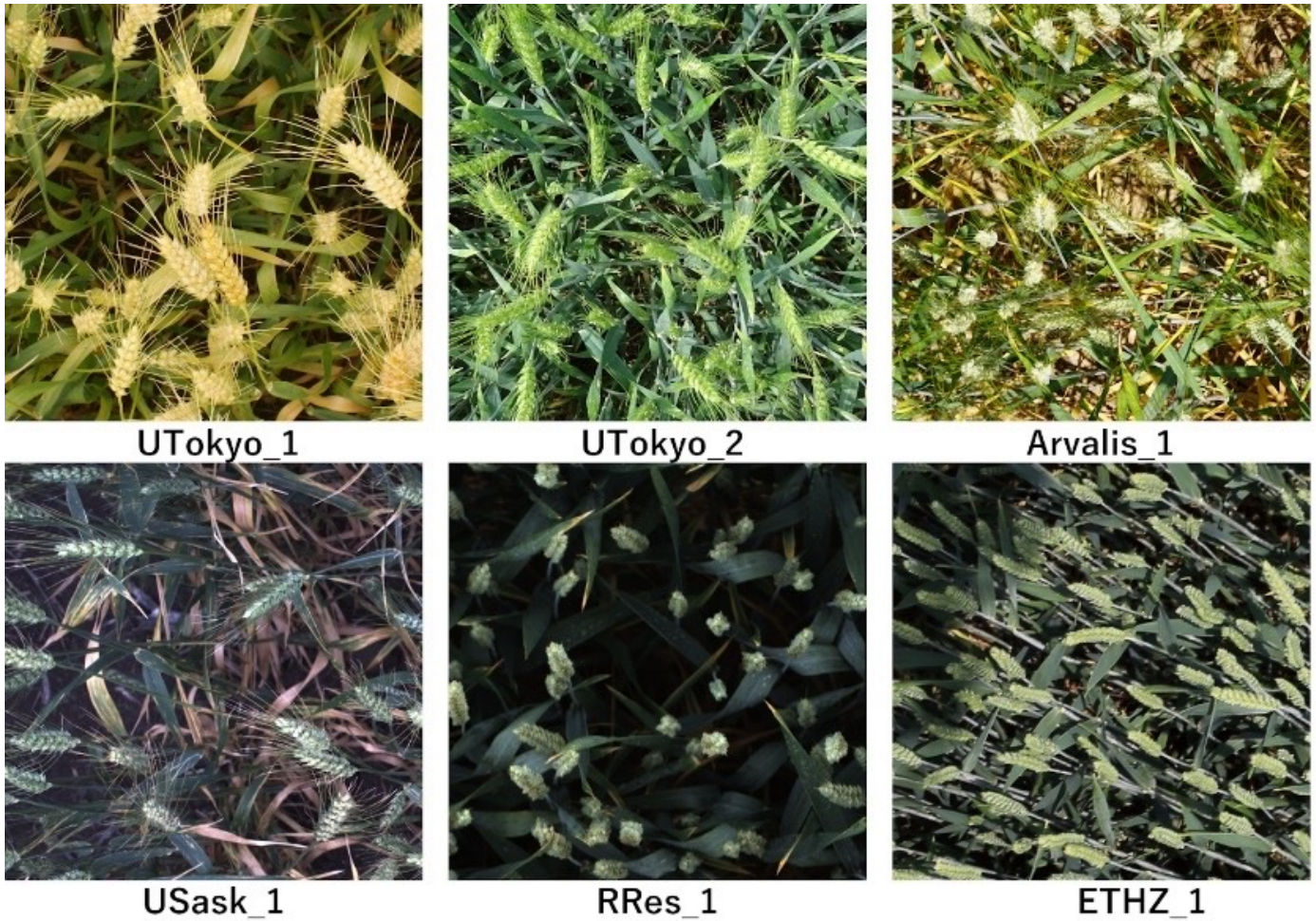
9 Million images
15 Million object boxes on 600 classes
3 Million segmentation masks on 350 classes

Global Wheat Head Dataset



https://www.global-wheat.com

Global Wheat Head Dataset



kaggle

Global Wheat Detection

Can you help identify wheat heads usi

University of Saskatchewan · 2,245 teams

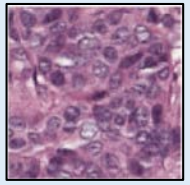
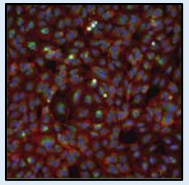
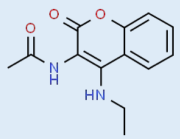
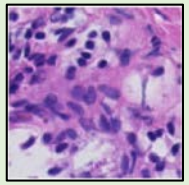
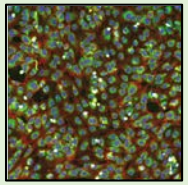
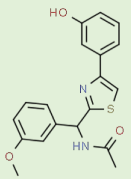
AIcrowd

Global WHEAT CHALLENGE 2021

David E, … Stavness I, Guo W, (2020). 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. Plant Phenomics, Volume 2020, Article ID 3521852.

WILDS Dataset

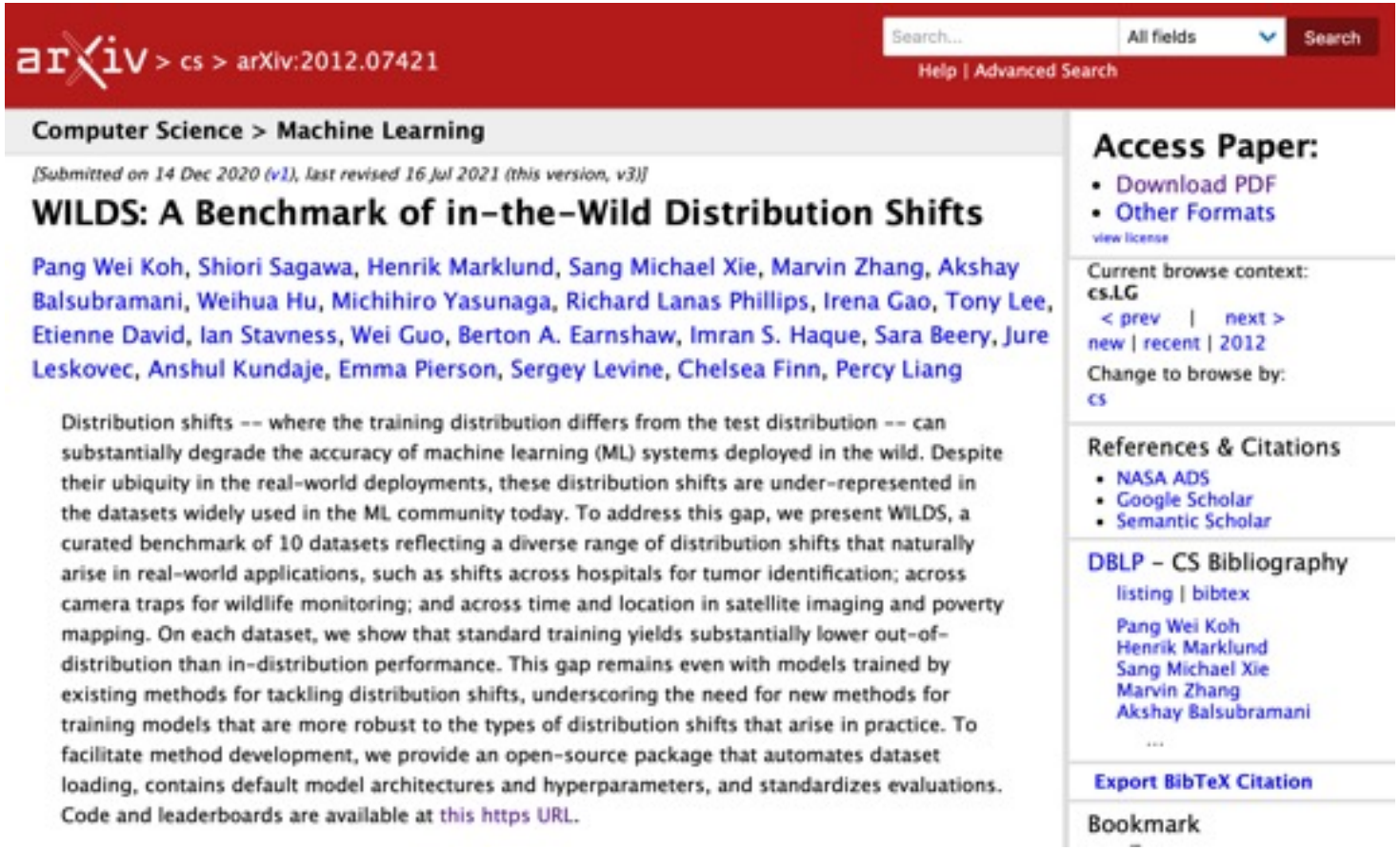
in-the-wild distribution shifts spanning diverse data

	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

https://wilds.stanford.edu/

WILDS Paper

1000+ citations since 2021



arXiv > cs > arXiv:2012.07421

Search... All fields Search

Help | Advanced Search

Computer Science > Machine Learning

[Submitted on 14 Dec 2020 (v1), last revised 16 Jul 2021 (this version, v3)]

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

Pang Wei Koh, Shiori Sagawa, Henrik Marklund, Sang Michael Xie, Marvin Zhang, Akshay Balsubramani, Weihua Hu, Michihiro Yasunaga, Richard Lanas Phillips, Irena Gao, Tony Lee, Etienne David, Ian Stavness, Wei Guo, Berton A. Earnshaw, Imran S. Haque, Sara Beery, Jure Leskovec, Anshul Kundaje, Emma Pierson, Sergey Levine, Chelsea Finn, Percy Liang

Distribution shifts -- where the training distribution differs from the test distribution -- can substantially degrade the accuracy of machine learning (ML) systems deployed in the wild. Despite their ubiquity in the real-world deployments, these distribution shifts are under-represented in the datasets widely used in the ML community today. To address this gap, we present WILDS, a curated benchmark of 10 datasets reflecting a diverse range of distribution shifts that naturally arise in real-world applications, such as shifts across hospitals for tumor identification; across camera traps for wildlife monitoring; and across time and location in satellite imaging and poverty mapping. On each dataset, we show that standard training yields substantially lower out-of-distribution than in-distribution performance. This gap remains even with models trained by existing methods for tackling distribution shifts, underscoring the need for new methods for training models that are more robust to the types of distribution shifts that arise in practice. To facilitate method development, we provide an open-source package that automates dataset loading, contains default model architectures and hyperparameters, and standardizes evaluations. Code and leaderboards are available at this https URL.

Access Paper:
- Download PDF
- Other Formats

view license

Current browse context: cs.LG

< prev | next >

new | recent | 2012

Change to browse by: cs

References & Citations
- NASA ADS
- Google Scholar
- Semantic Scholar

DBLP - CS Bibliography

listing | bibtex

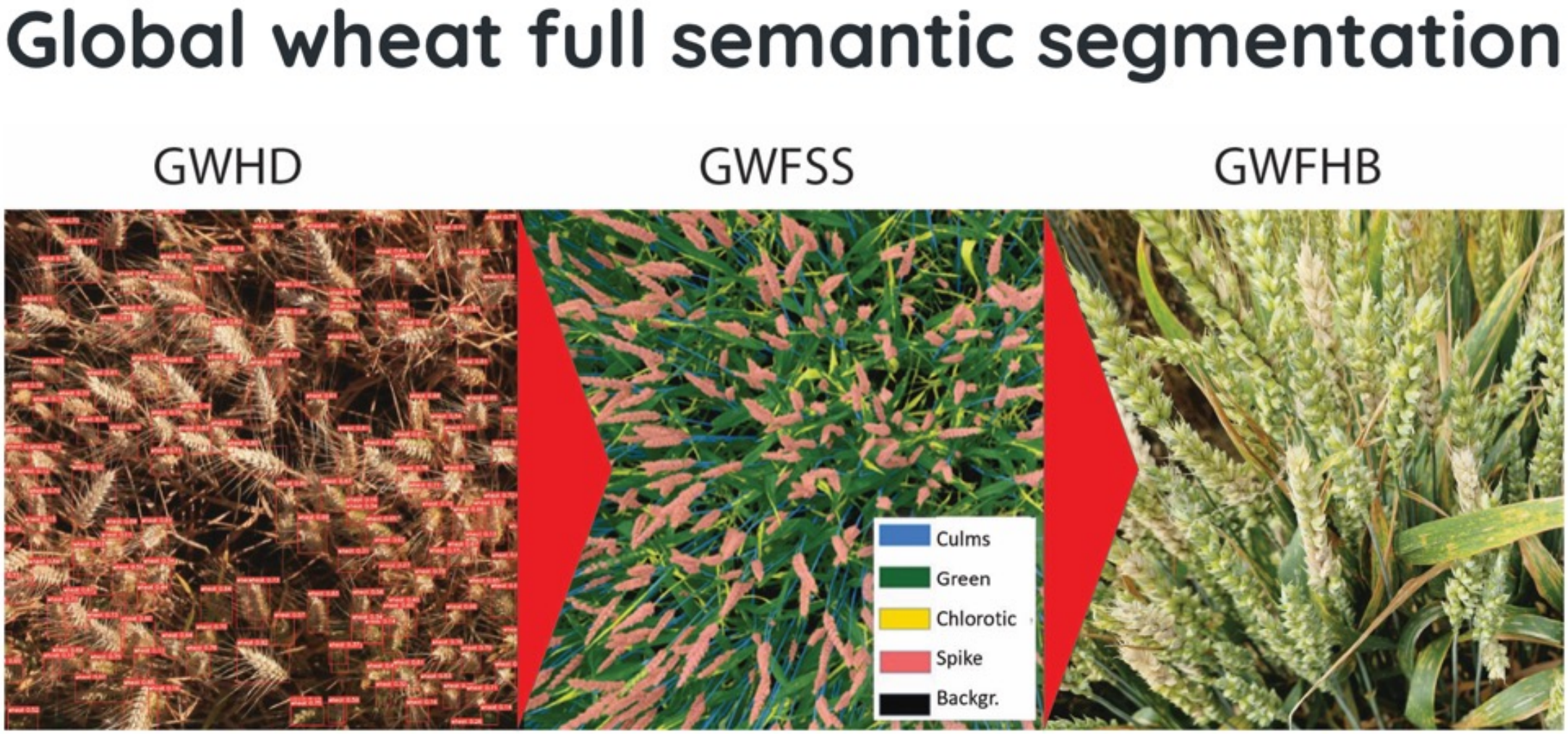
Pang Wei Koh
Henrik Marklund
Sang Michael Xie
Marvin Zhang
Akshay Balsubramani
...

Export BibTeX Citation

Bookmark

https://wilds.stanford.edu/

Future *Global Wheat Datasets*



Saskatchewan is collecting data

(Noble, UFPS)

(Shirtliffe, Drones)

(Stavness & Vail, Protractor)

(Jin, Smartphones)

Saskatchewan needs an Ag data strategy

We want farm data

- Ensure data privacy and intended-use
- Flow benefits to data generators (growers)
- Reduce costs to store, update, and utilize data
- Elevate the entire Saskatchewan ag-tech sector

Data strategy & data sharing

1. Trusted entities

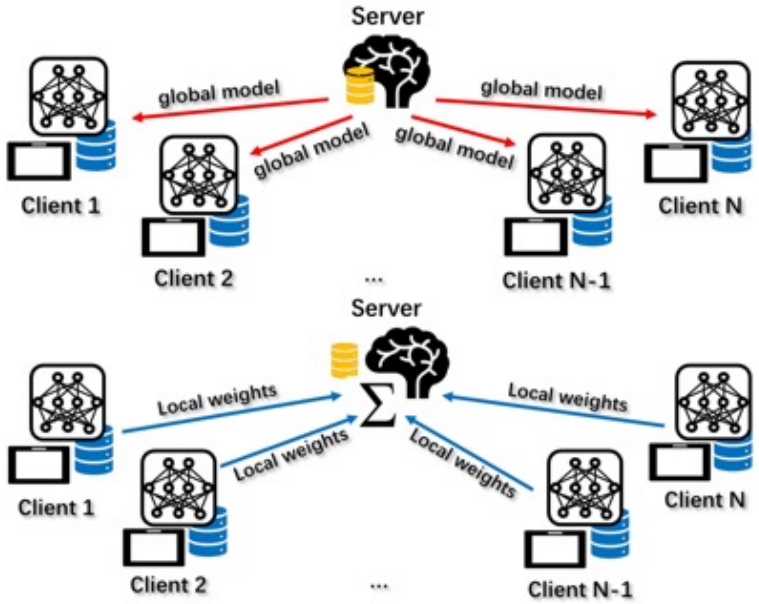
EMILI / Data Initiative

GIFS | GLOBAL INSTITUTE FOR FOOD SECURITY

Growing science for life

Nutrien - a Founding Partner

2. Privacy-preserving technology
   e.g. federated-learning



CompAg

People

Data

Compute

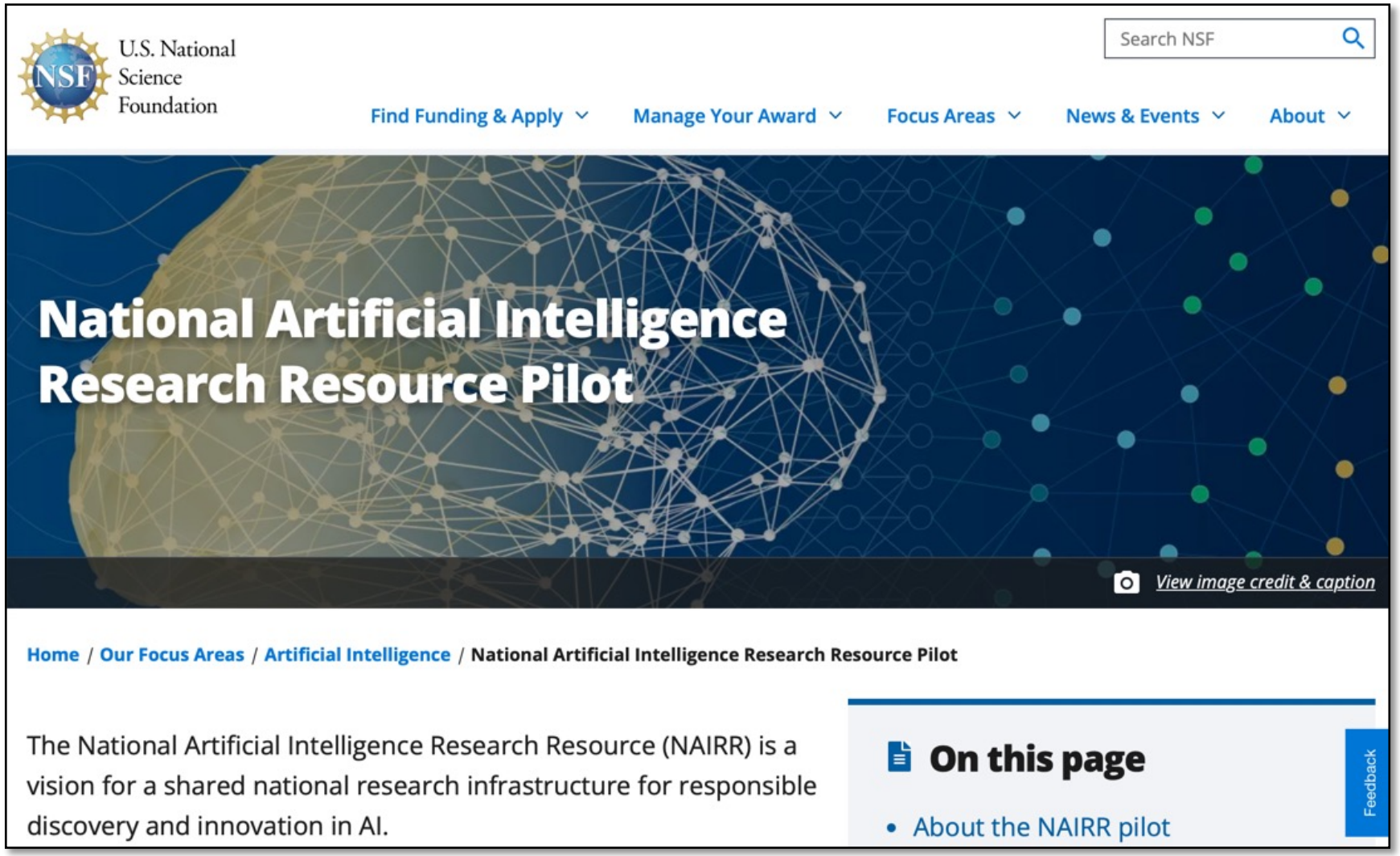
Opportunities

We need *large-scale* compute

(Niagara Cluster, Digital Research Alliance of Canada)

We need *large-scale* compute

We need *large-scale* compute



We need *large-scale* compute

Digital Research Alliance of Canada | Alliance de recherche numérique du Canada

Home / Funding Opportunities

Funding Opportunities

Update as of October 26, 2022: Funding opportunities are currently being reviewed and prioritized. Sign up to our newsletter to be alerted when a funding opportunity is launched and continue to visit this webpage for updates.

The Alliance is now recruiting volunteer experts for its Merit Review Committees in preparation for the Alliance's upcoming funding opportunities. For more information and to submit your application, refer to the Call for Volunteer Experts to sit on the Alliance's Merit Review Committee(s).

CompAg

People

Data

Compute

Opportunities

CompAg

People

Data

Compute

Opportunities

CREATE Opportunities

https://CompAg.usask.ca

Ian.Stavness@usask.ca

Future Directions

Large-scale crop imaging & analysis

(NASA)

Future Directions

Large-scale crop imaging & analysis

(Phil McLoughlin, USask Biology)

Future Directions

Radiance field rendering of plant structures

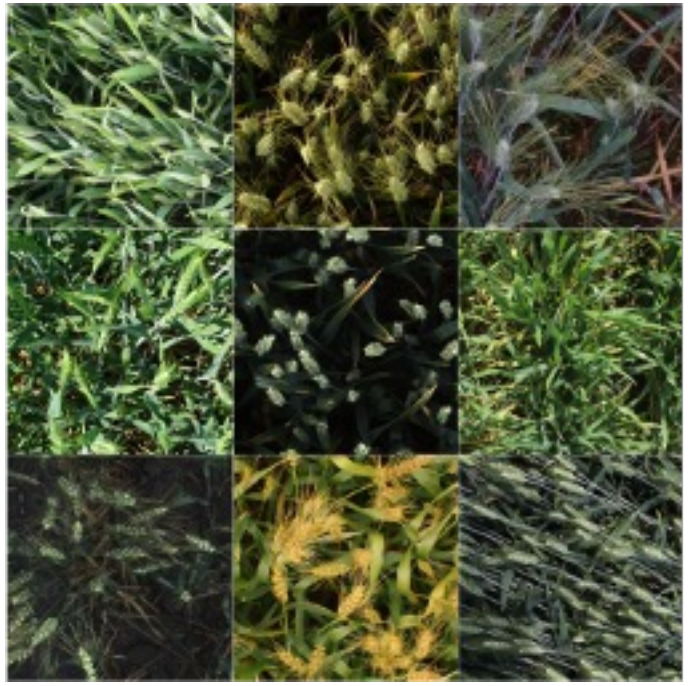
(https://www.matthewtancik.com/nerf)

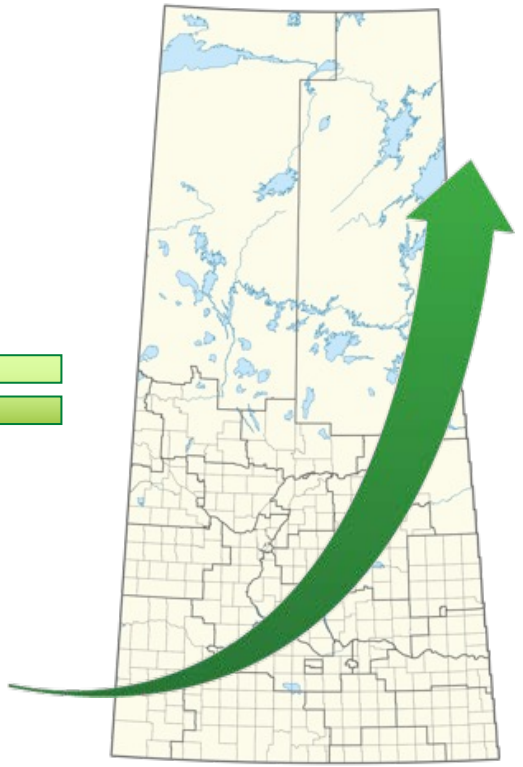
Future Directions

Plant and crop digital twins

(Mik Cieslak, University of Calgary)

Summary





We are recruiting Undergrad, MSc and PhD for the CREATE in Computational Agriculture

https://CompAg.usask.ca

Ian.Stavness@usask.ca