Interactive Machine Learning Detection Assessment (IMLDA)

Recap, improved process, insights, future work

“Unlike other artificial intelligence techniques, **machine learning** uses specialized algorithms to make decisions by **learning from data**. It is a **subset** of artificial intelligence.”

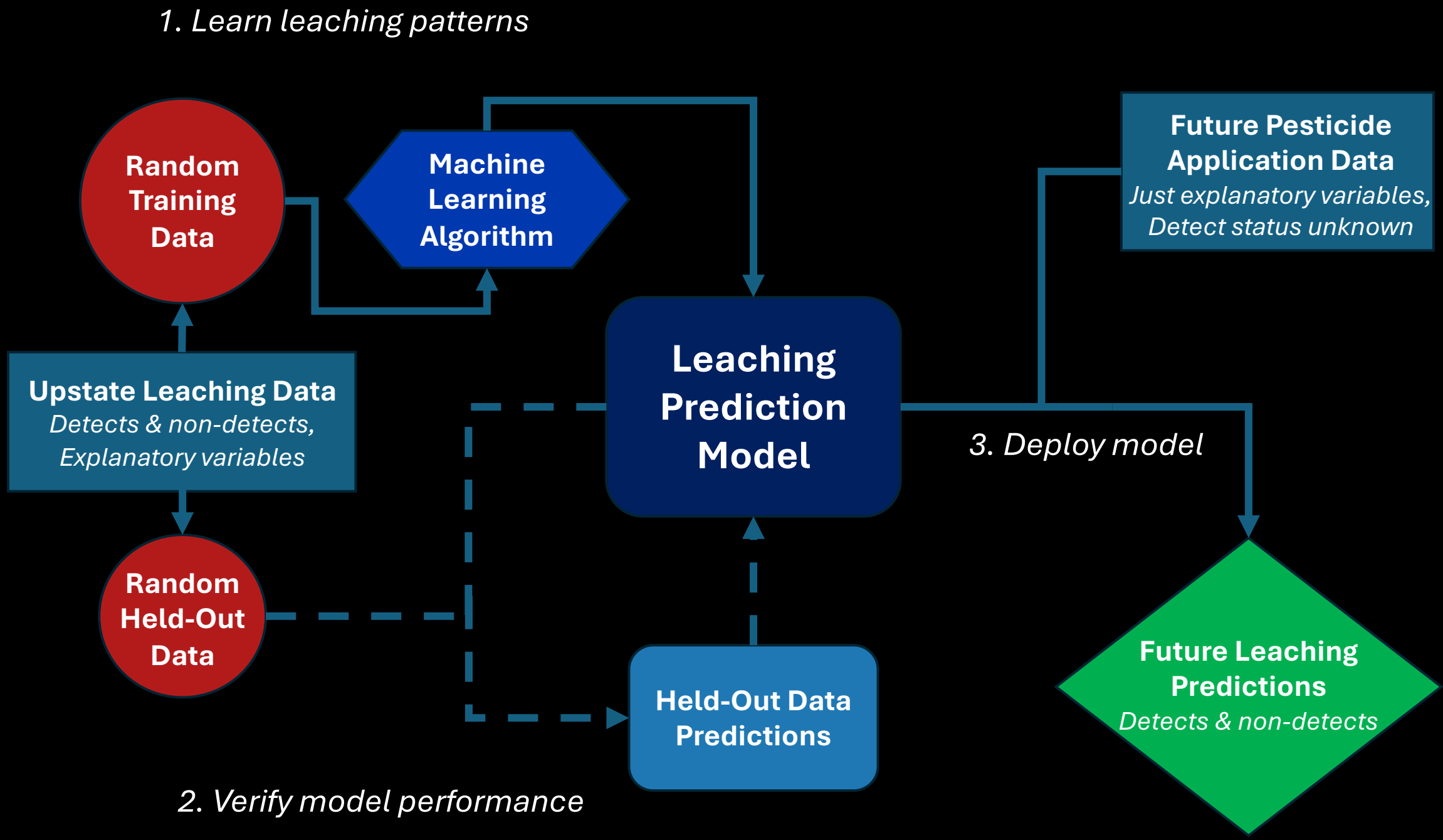
- Bea Stollnitz, Principal Cloud Advocate at Microsoft

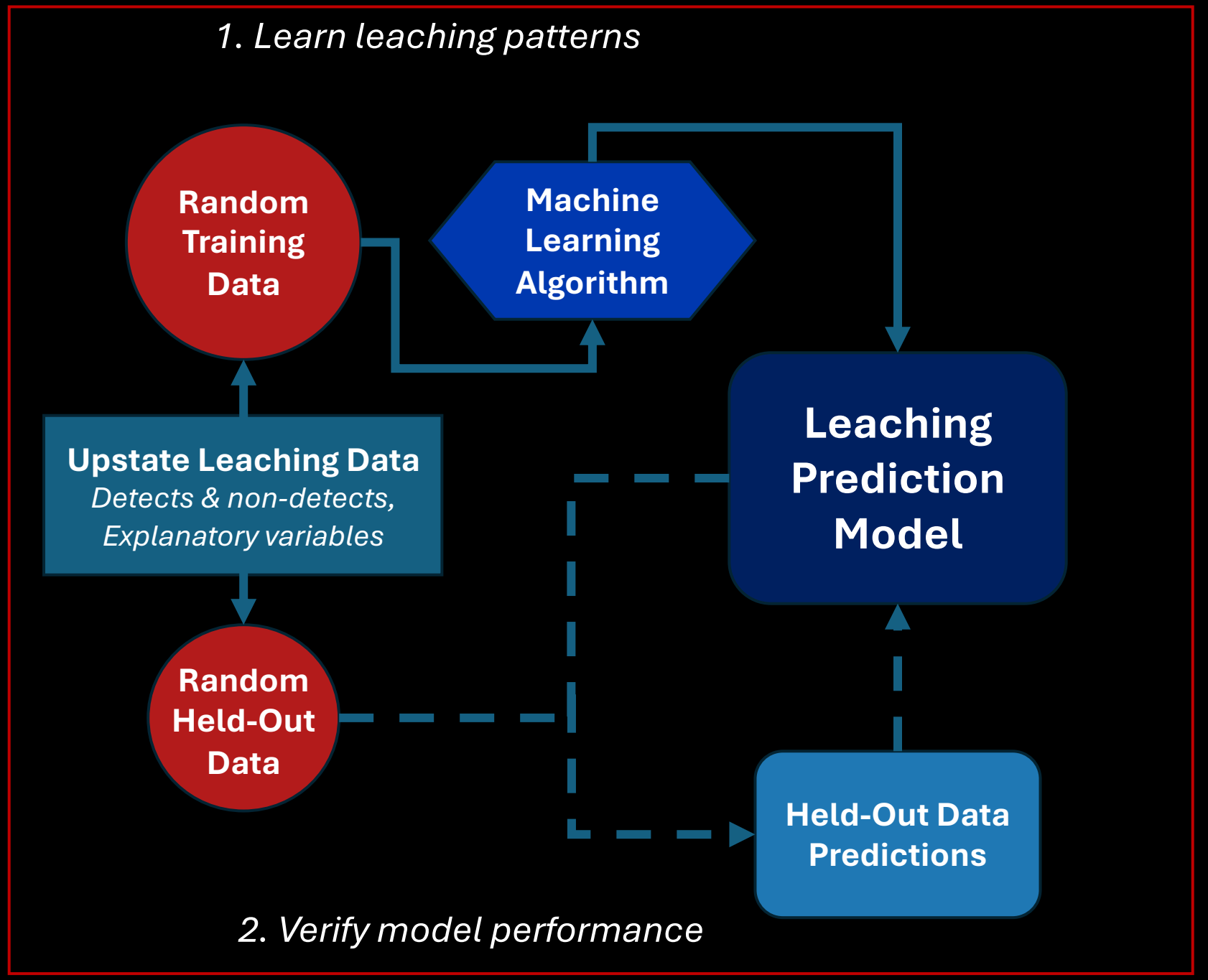
https://www.youtube.com/watch?v=6mSx_KJxcHI&t=64s

Objectives

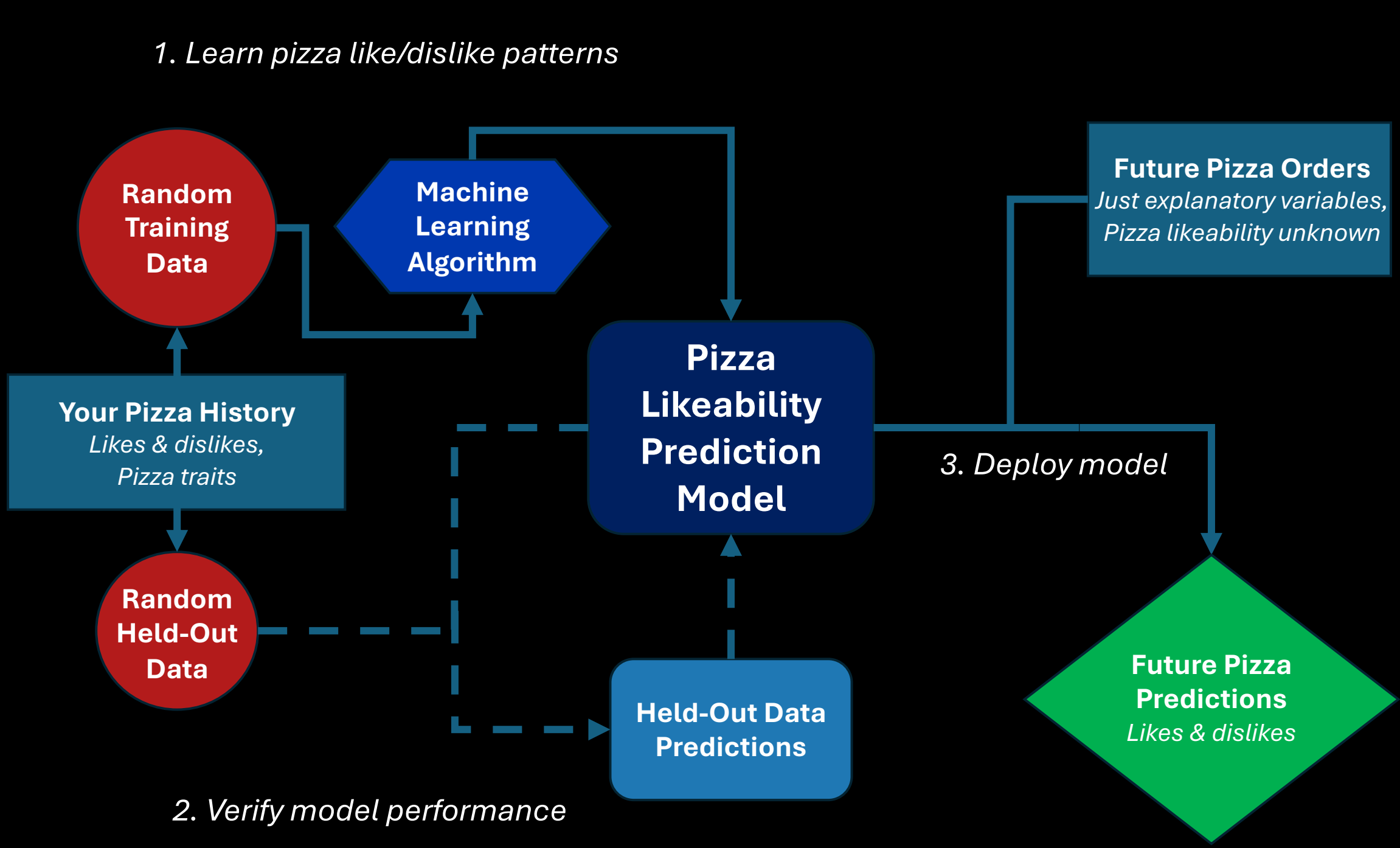
1. Build a machine learning model that **learns** to predict pesticide **detections & non-detections** from Upstate NY monitoring data

2. Use the machine learning model as a **companion analysis** with TGUS

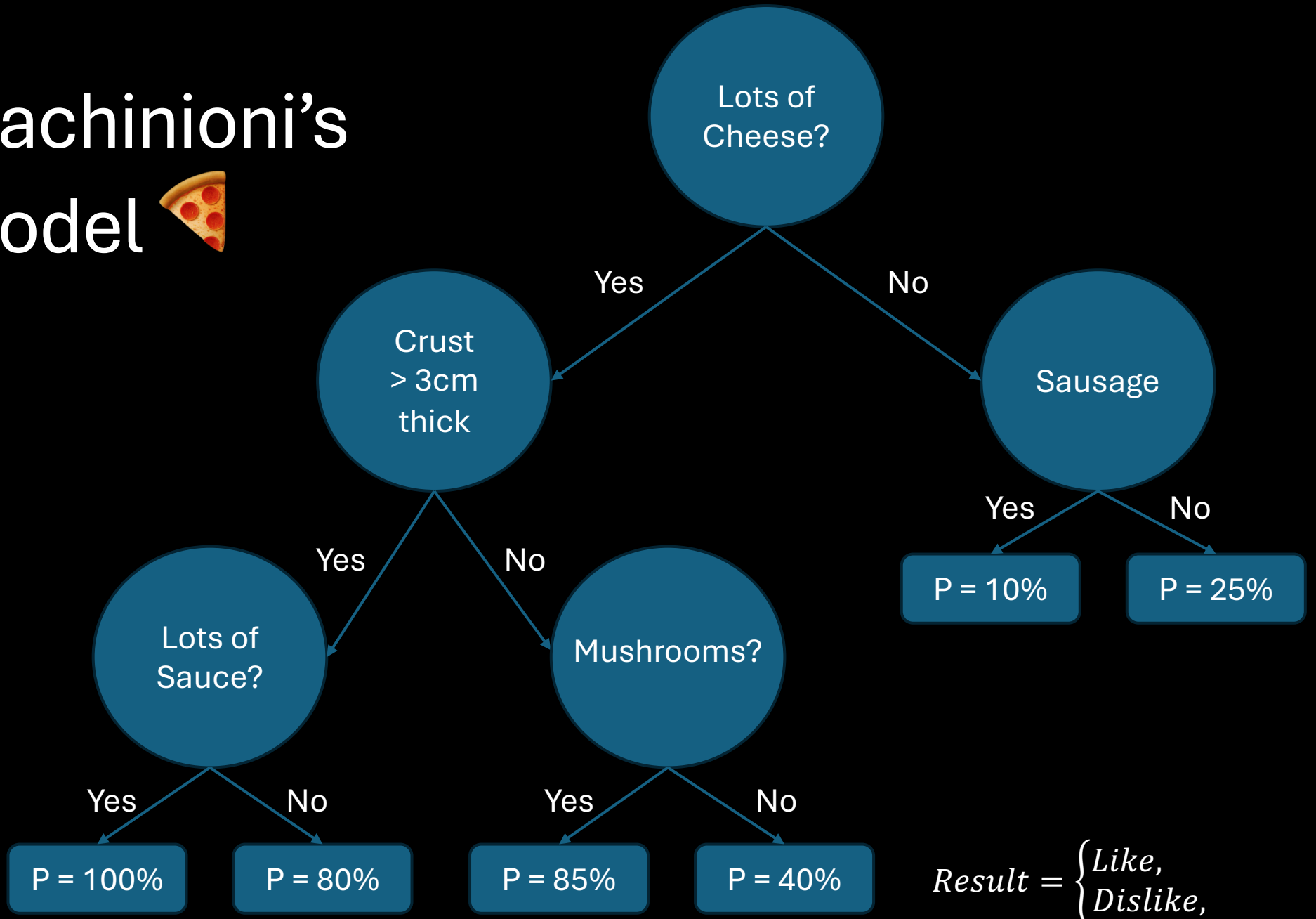

1. Learn leaching patterns
Random Training Data
Machine Learning Algorithm
Future Pesticide Application Data
Just explanatory variables, Detect status unknown
Upstate Leaching Data
Detects & non-detects, Explanatory variables
Leaching Prediction Model
3. Deploy model
Random Held-Out Data
Held-Out Data Predictions
Future Leaching Predictions
Detects & non-detects
2. Verify model performance


1. Learn leaching patterns
Random Training Data
Machine Learning Algorithm
Upstate Leaching Data
Detects & non-detects, Explanatory variables
Leaching Prediction Model
Random Held-Out Data
Held-Out Data Predictions
2. Verify model performance

We are here


1. Learn pizza like/dislike patterns
Random Training Data
Machine Learning Algorithm
Future Pizza Orders
Just explanatory variables, Pizza likeability unknown
Your Pizza History
Likes & dislikes, Pizza traits
Pizza Likeability Prediction Model
3. Deploy model
Random Held-Out Data
Held-Out Data Predictions
Future Pizza Predictions
Likes & dislikes
2. Verify model performance

Machinioni's Model 🍕



$$Result = \begin{cases} Like, & P \geq 50\% \\ Dislike, & P < 50\% \end{cases}$$

Possible outcomes

		Your Real Pizza Opinion	
		Like	**Don't Like**
Machinioni's Prediction	**Like**	True Positive (TP)	False Positive (FP)
	Don't Like	False Negative (FN)	True Negative (TN)

$$Result = \begin{cases} Like, & P \geq 50\% \\ Dislike, & P < 50\% \end{cases}$$

Possible outcomes

		Analytical Test Result	
		Detect	**Non-Detect**
Machine Learning Prediction	**Detect**	True Positive (TP)	False Positive (FP)
	Non-Detect	False Negative (FN)	True Negative (TN)

$$Result = \begin{cases} Detect, & P \geq threshold \\ Non\_Detect, & P < threshold \end{cases}$$

		Analytical Test Result	
		Detect	**Non-Detect**
TGUS Prediction	**Detect**	True Positive (TP)	False Positive (FP)
	Non-Detect	False Negative (FN)	True Negative (TN)

$$Result = \begin{cases} Detect, & LRP \geq threshold \\ Non\_Detect, & LRP < threshold \end{cases}$$

Machine learning findings - 2023

- Balanced performance on average
- High potential ceiling
- Ranked TGUS features

Improved process

- Extreme Gradient Boosting (XGB)
- General machine learning techniques
- Dataset doubled in size

Performance metrics

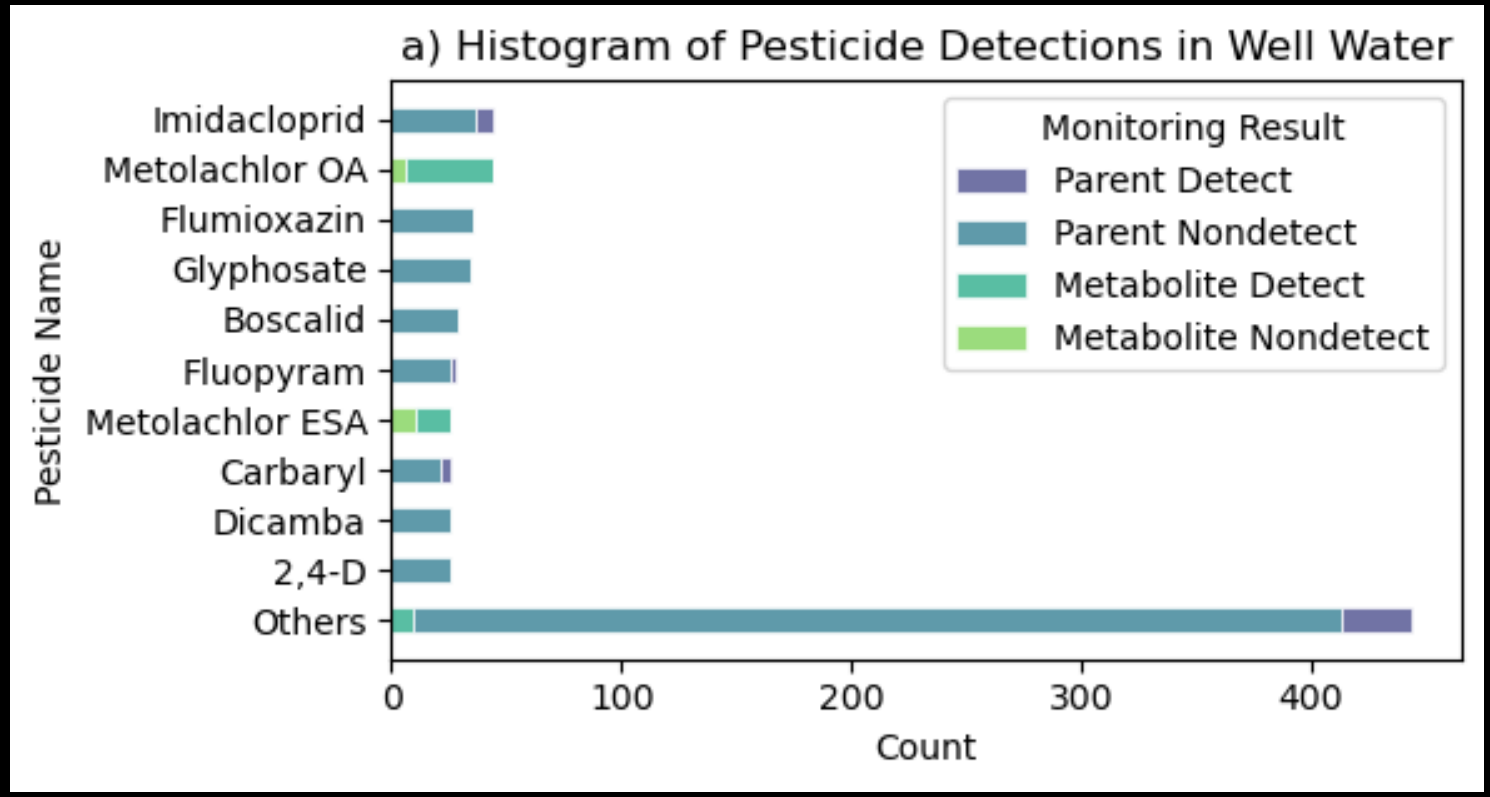
- $Accuracy\ (Acc) = \frac{TP+TN}{TP+TN+FP+FN}$
- $Precision\ (Pr) = \frac{TP}{TP+FP}$
- $Recall\ (Re) = \frac{TP}{TP+FN}$
- $\boldsymbol{Harmonic\ Mean\ (F_\beta) = \frac{(1+\beta^2)*Pr*Re}{\beta^2*Pr+Re}}$
  - $\boldsymbol{\beta}$ *is weight of Re vs Pr*

		Analytical Test Result	
		Detect	**Non-Detect**
Prediction	**Detect**	True Positive (TP)	False Positive (FP)
	Non-Detect	False Negative (FN)	True Negative (TN)

$$Result = \begin{cases} Detect, & P \geq threshold \\ Non\_Detect, & P < threshold \end{cases}$$

Upstate monitoring data for machine learning

- 107 detects
  - 21 unique pesticides
  - 24 unique sites
- 654 non-detects
  - 46 unique pesticides
  - 11 unique sites



*Does not include lakes

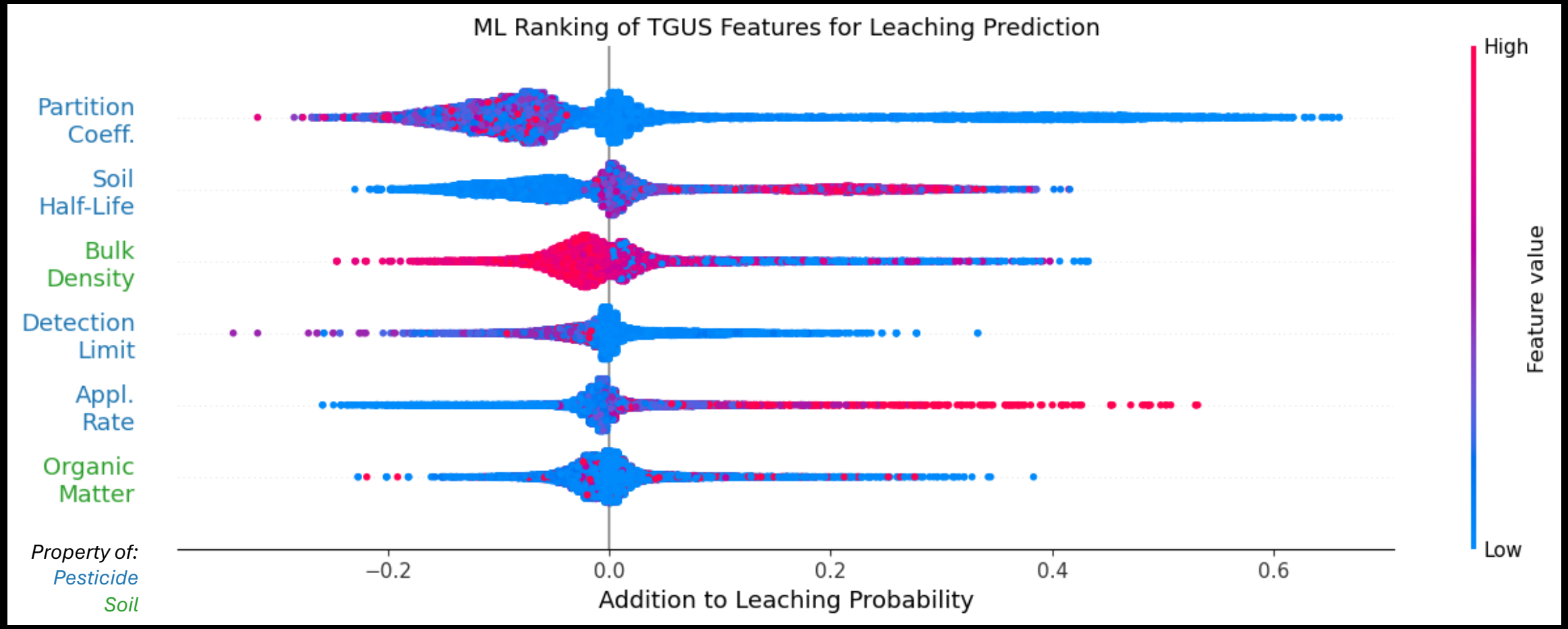
Results for Upstate monitoring data

Models	Performance Metrics			
	Accuracy [%]	Precision [%]	Recall [%]	F_β [%]
TGUS LRP > 100 *Protective, β=4*	45.6	20.4	**99.1**	80.8
ML avg *Protective, β=4*	88.8	61.6	87.1	**84.4**
ML avg *Balanced, β=1*	**93.0**	**77.8**	74.5	74.6

High ceiling for machine learning

Models	Performance Metrics			
	Accuracy [%]	Precision [%]	Recall [%]	F_β [%]

Insights into feature (variable) importance



- ML learns TGUS theory
- Sub-patterns available

Future work

- Paper
- Ethics assessment
- Additional data/features
- Hybrid-ML
- Suggestions?