



Artificial Intelligence for Sustainable Agriculture (AI4SA)

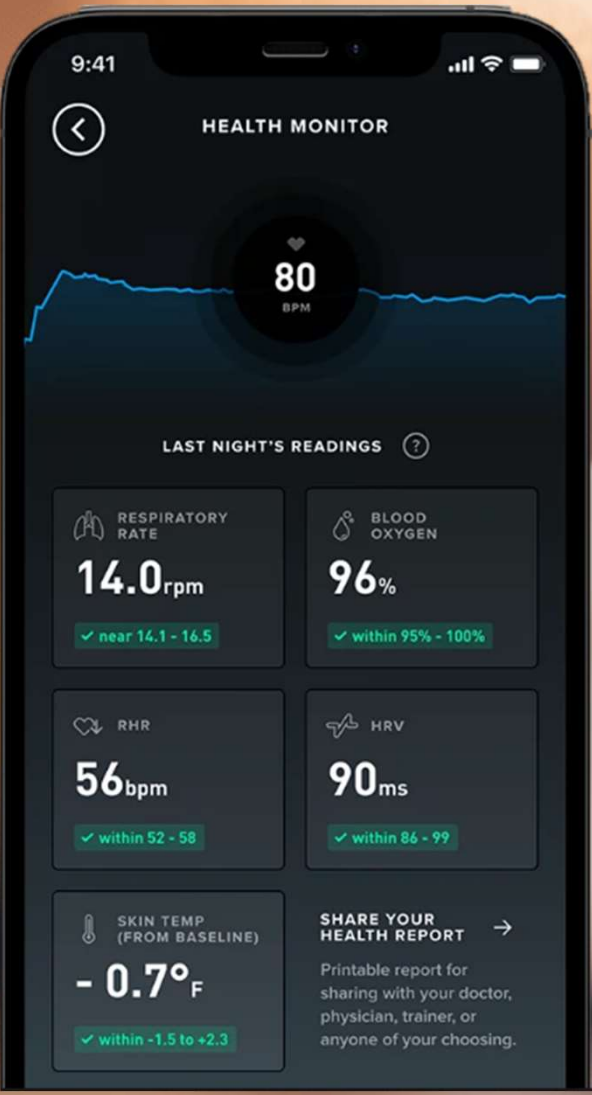
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- **'intelligence'** refers to the insights that can be gained from analyzing and interpreting data.
- It involves *identifying patterns, trends, and relationships in data* and using that information to make informed decisions or predictions.

Fitness tracker collects data

- daily activity levels,
- heart rate,
- Saturated O2
- sleep patterns

You can gain insights into how different factors impact your overall health and wellness



'Intelligence'

Human intelligence

Learning pattern with th
as we sense

Solving problems



Complex patterns!!



Artificial intelligence is the method by which a computer is able to act on data through statistical analysis, enabling it to understand, analyze, and learn from data through specifically designed algorithms.

Artificially intelligent machines can remember behavior patterns and adapt their responses to conform to those behaviors or encourage changes to them.



Human
intelligence



Artificial
intelligence

Examples of artificial intelligence that you're likely to come across daily

Maps and Navigation

Optimum and alternate routes based on Trained model (traffic, terrain etc)

Best travel modes

San Jose Mineta International Airport

Salinas, California

Add destination

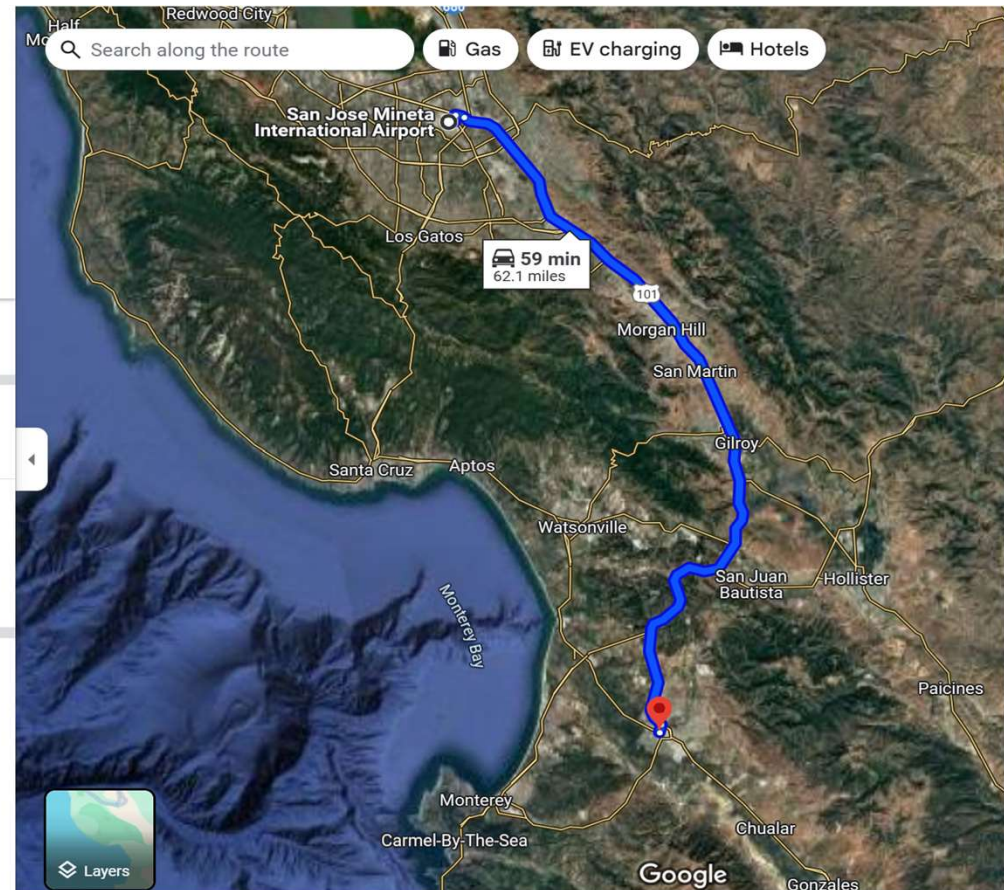
Leave now Options

Send directions to samsung SM-S926U Copy link

via US-101 S 59 min
Fastest route, the usual traffic 62.1 miles
[Details](#)

Explore Salinas

- Restaurants
- Hotels
- Gas stations
- Parking Lots
- More





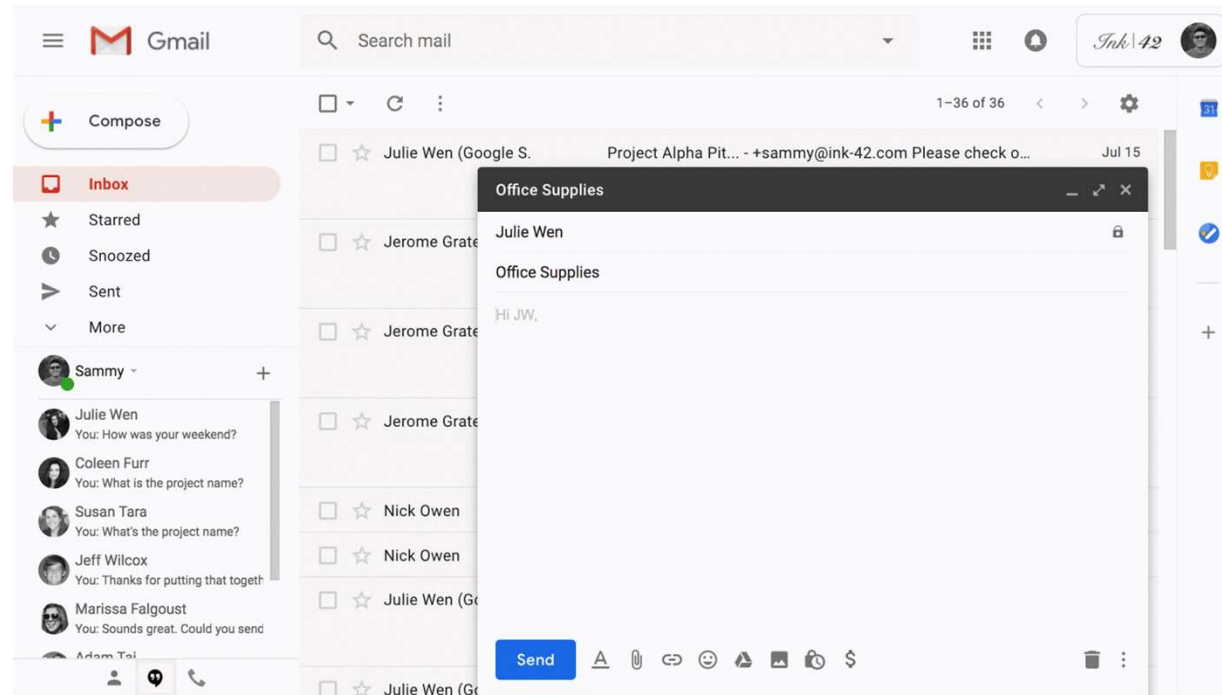
Email services (gmail/outlook etc.)

The spell check activate when you compose your email to help you draft messages free from errors.

Smart Compose, Quick Reply, and Grammar Check

It suggests complete sentences based on the preceding line that you have written. It uses Artificial Intelligence to quickly compose your email drafts with contextual accuracy and correct grammar.

These tools use artificial intelligence and natural language processing to autogenerate part of the sentences.





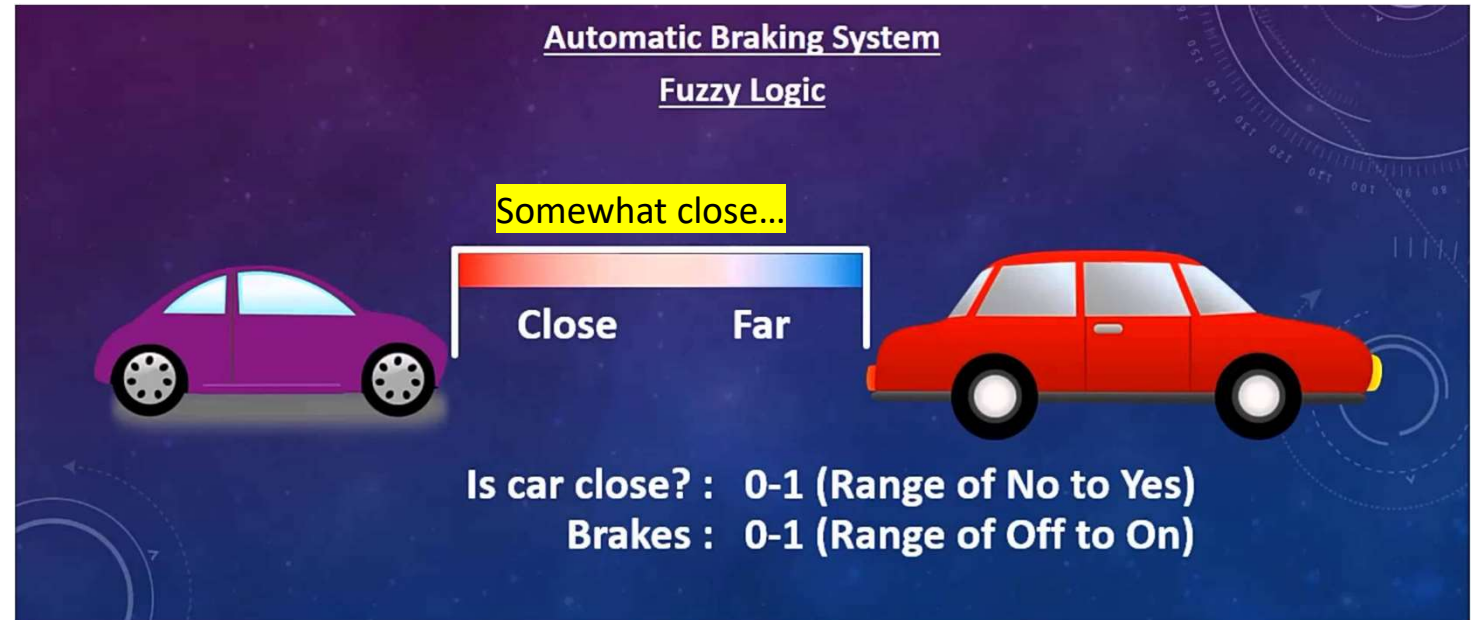
Daily weather forecasts

The accuracy of daily weather forecasts, as well as warnings of severe weather, depends on smart algorithms and supercomputers.

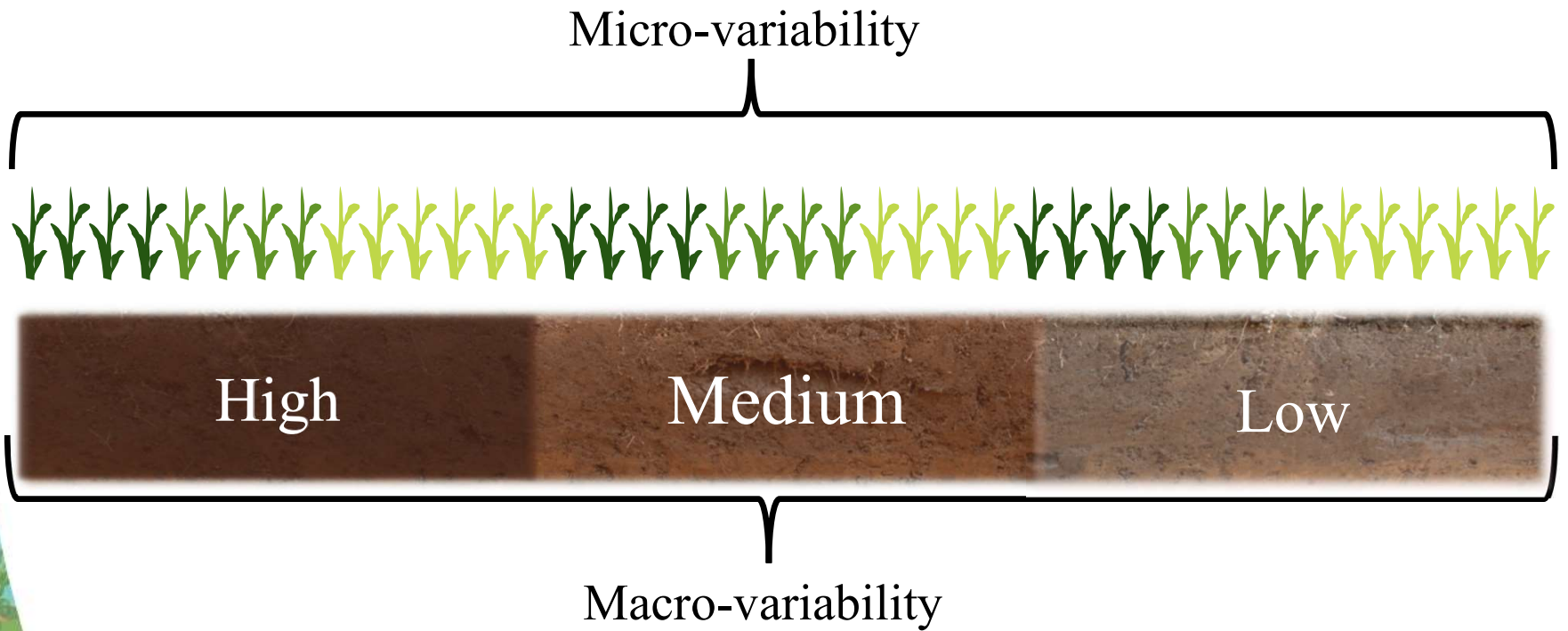
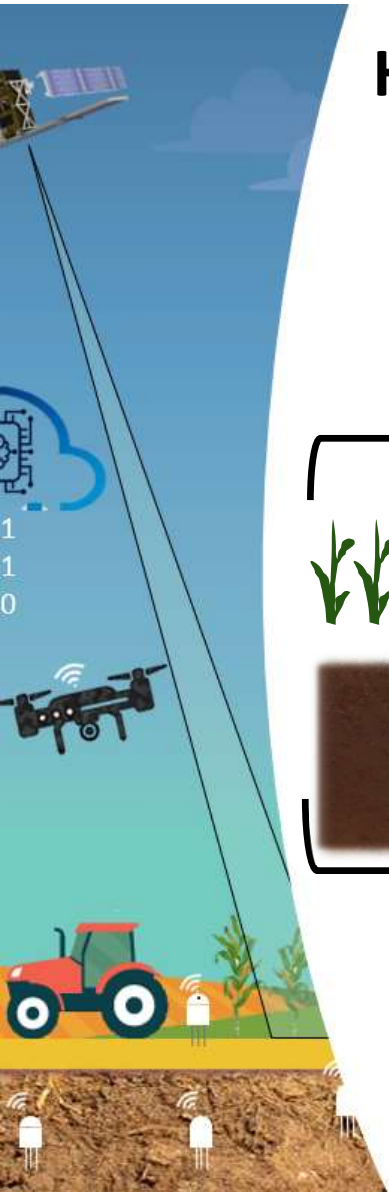
Weather forecasting, which involves managing, analyzing, and visualizing vast amounts of data, has depended on AI for years.



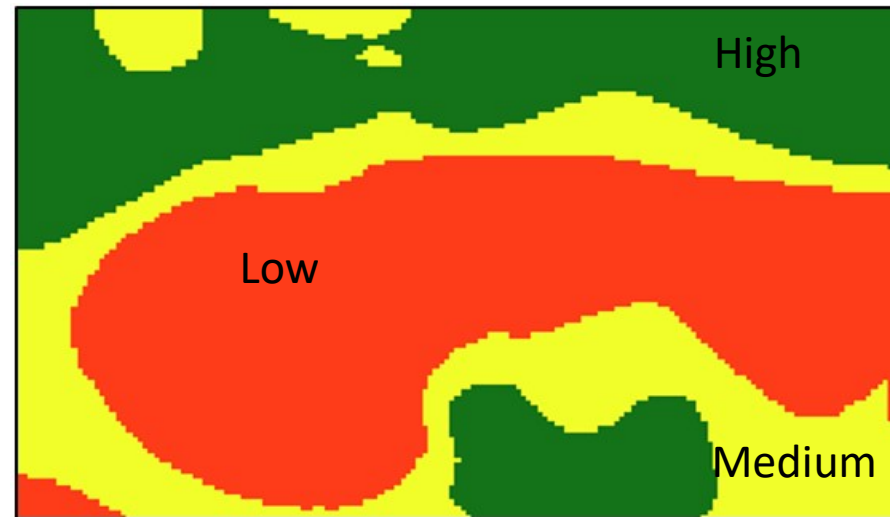
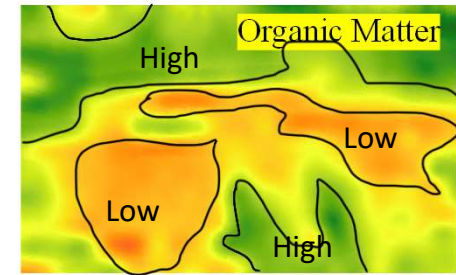
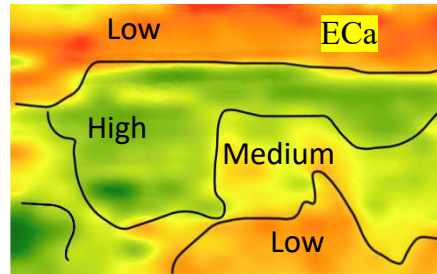
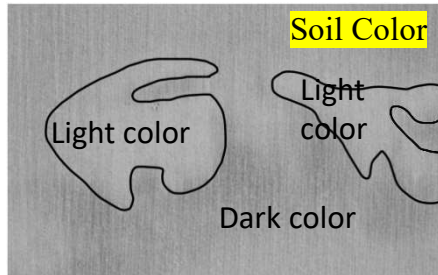
What is fuzzy logic system ?



How to apply fuzzy logic system to agriculture?



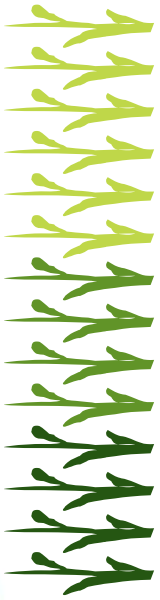
Macro-scale variability



Soil-based SSMZ-guided variable rate fertilizer applications were found to be efficient for areas with large-scale spatial variability of soil (Cordero et al., 2019).



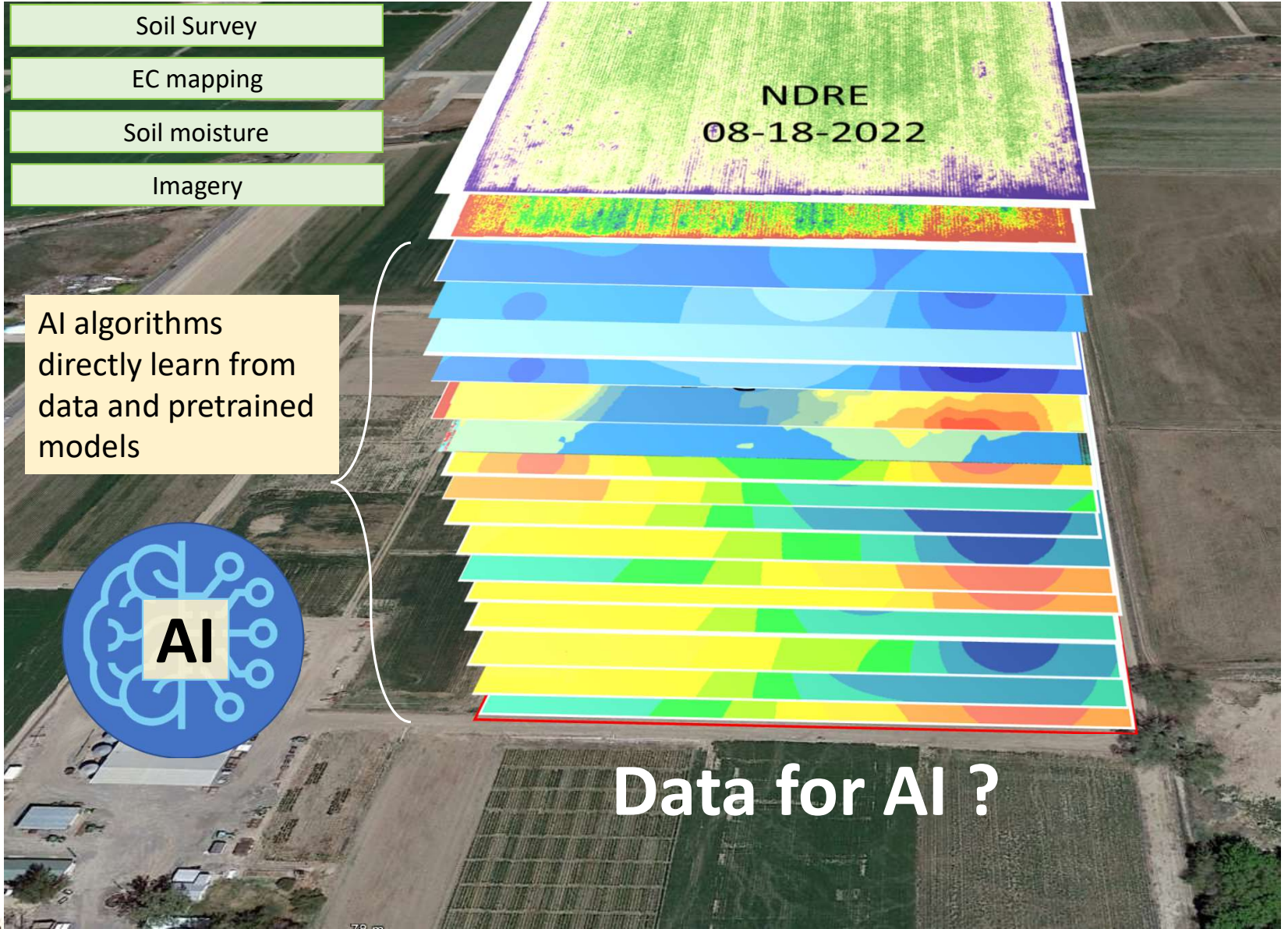
Micro-scale variability



GreenSeeker had effectively highlighted winter wheat N status variability (Cao et al., 2012).

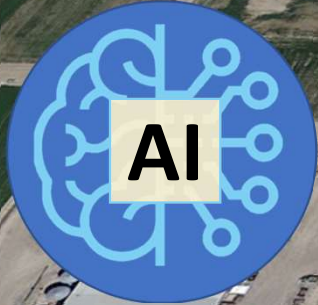
Why coupling macro-variability in soil and micro-variability in crop?





- Soil Survey
- EC mapping
- Soil moisture
- Imagery

AI algorithms directly learn from data and pretrained models



Data for AI ?

What data to use ?

Macro-scale variability in soil

- Apparent Electrical Conductivity (ECa) at shallow
- Apparent Electrical Conductivity (ECa) deep depth
- Organic Matter (OM)
- Cation Exchange Capacity (CEC)



Micro-scale variability in crop

Vegetation indices

Formula

Normalized difference vegetation index (NDVI)

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Soil Adjusted vegetation index (SAVI)

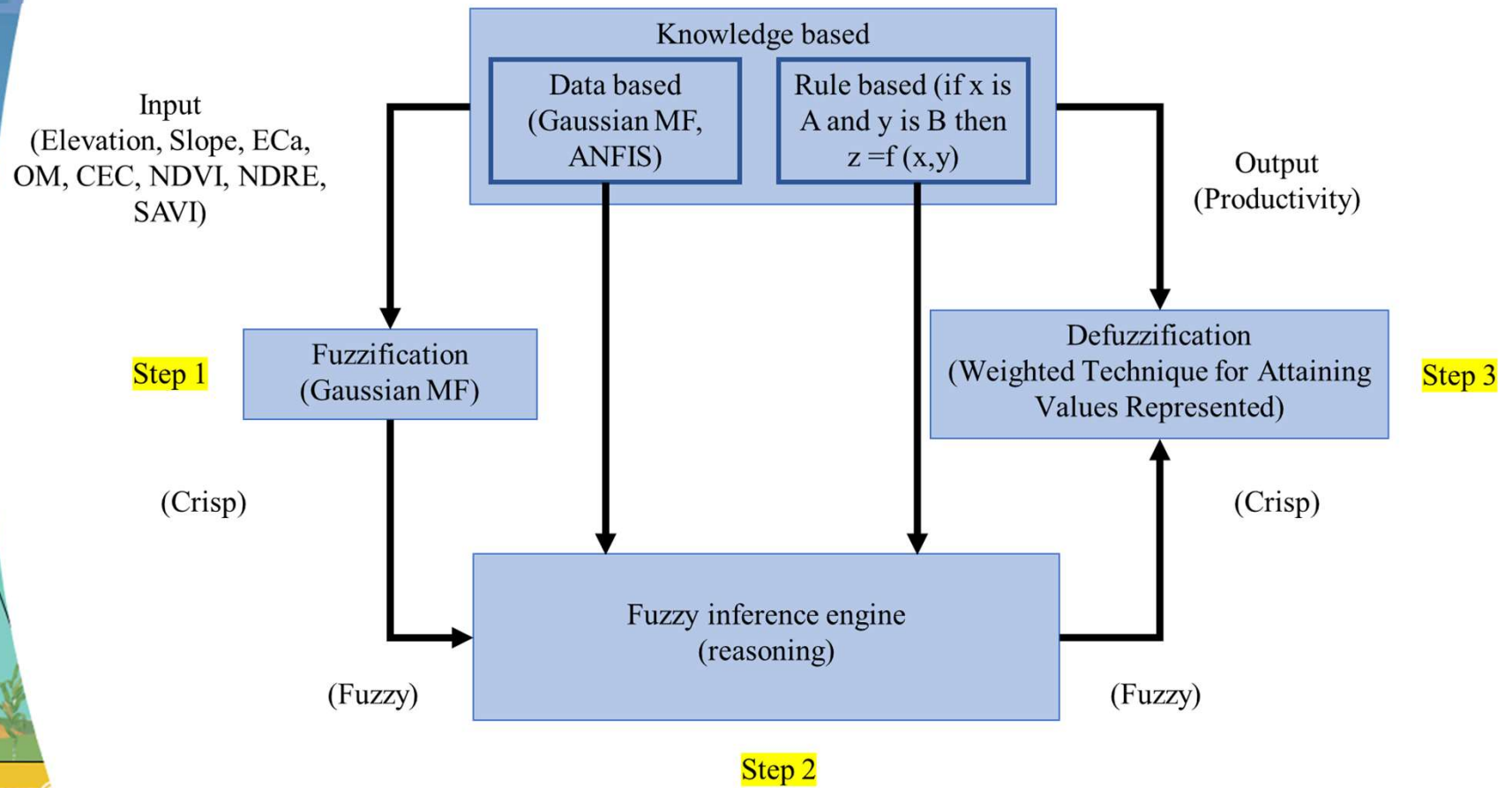
$$SAVI = \frac{NIR - Red}{NIR + Red} + L(1 + L)$$

Normalized Difference Red Edge (NDRE)

$$NDRE = \frac{NIR - RE}{NIR + RE}$$



Fuzzy logic system to delineate SSMGs



Fuzzification

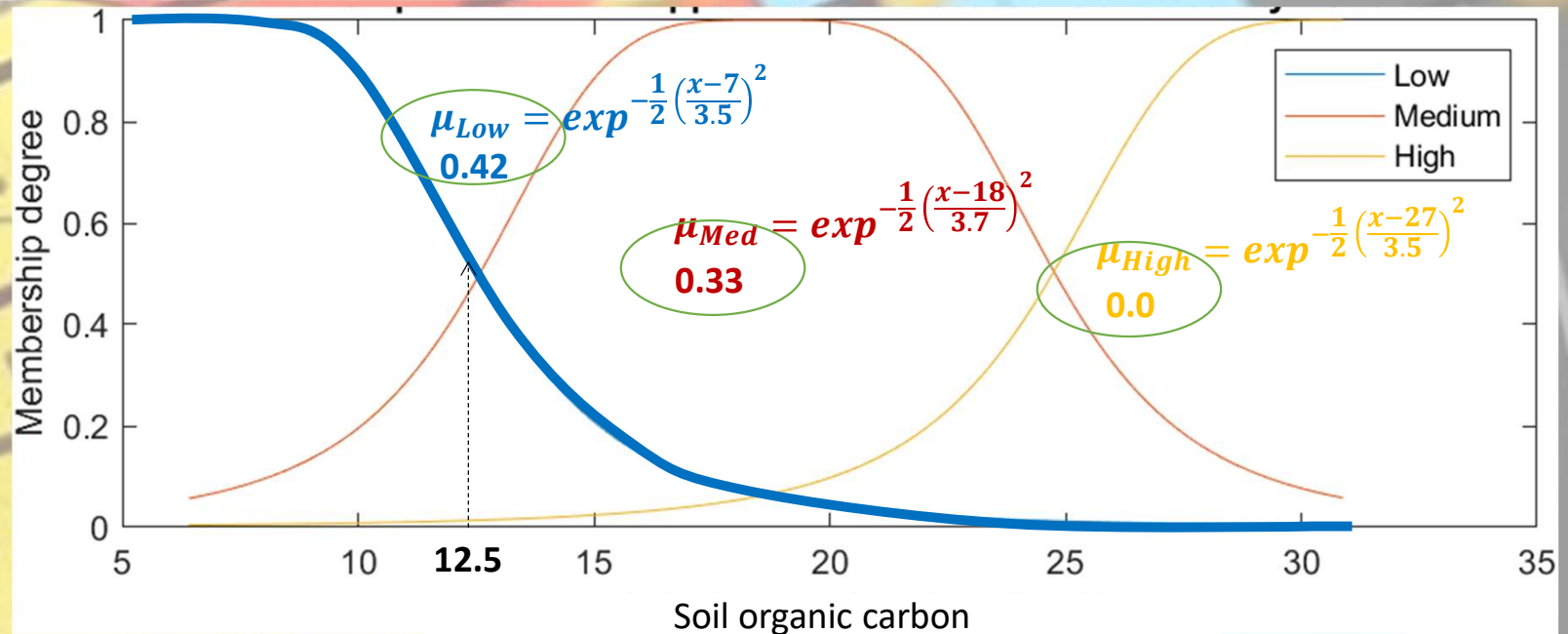
The word “fuzzy” means “vagueness (ambiguity)”.

Fuzziness occurs when the boundary of a piece of information is not well-defined

For example, words like high, medium, low are fuzzy.

There is no single quantitative value which defines the term high → no clean boundary

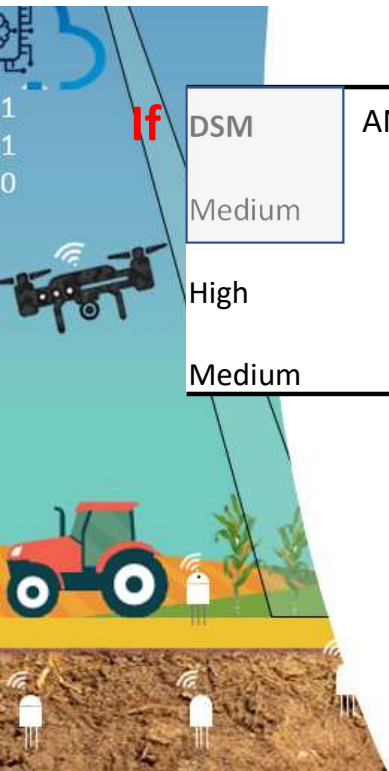
Fuzzy set theory is an extension of classical set theory where elements have degree of membership between 0 and 1.



Fuzzy rules: Expert knowledge/from data driven

Fuzzy rule formulation

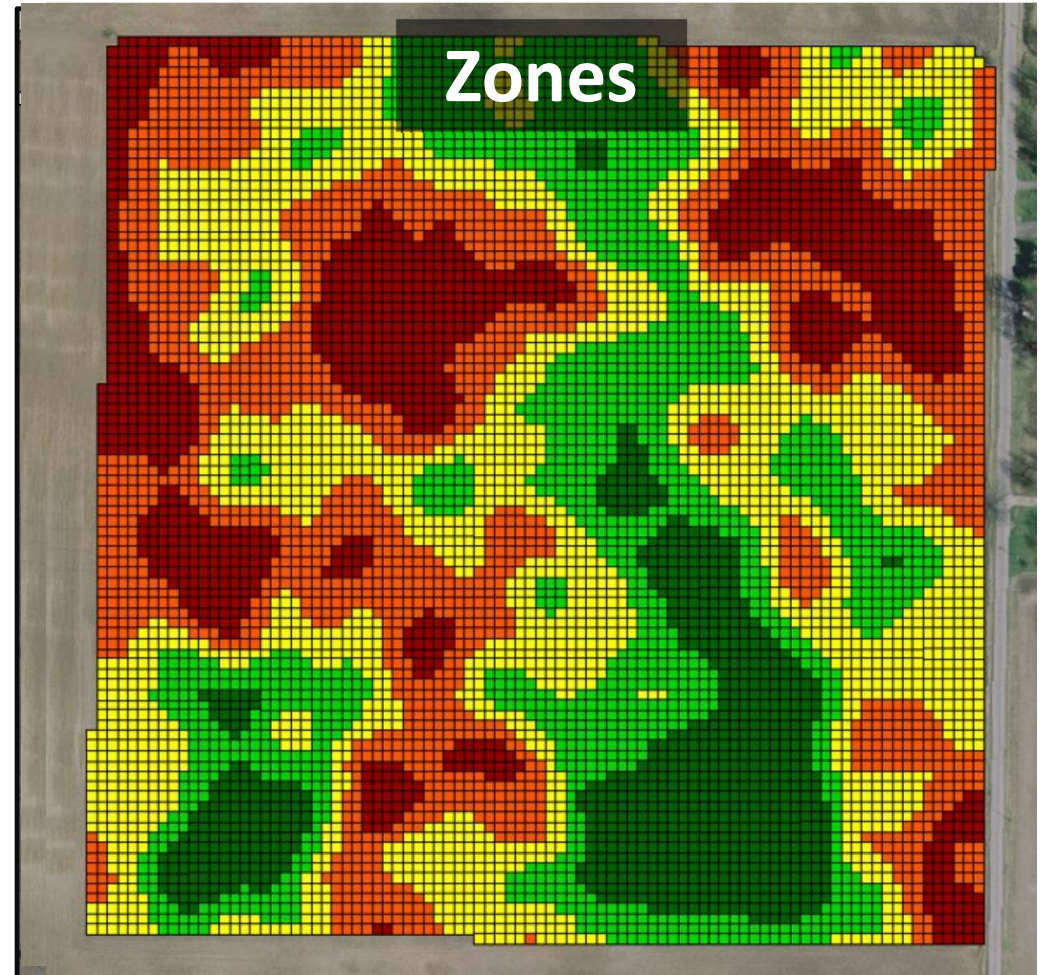
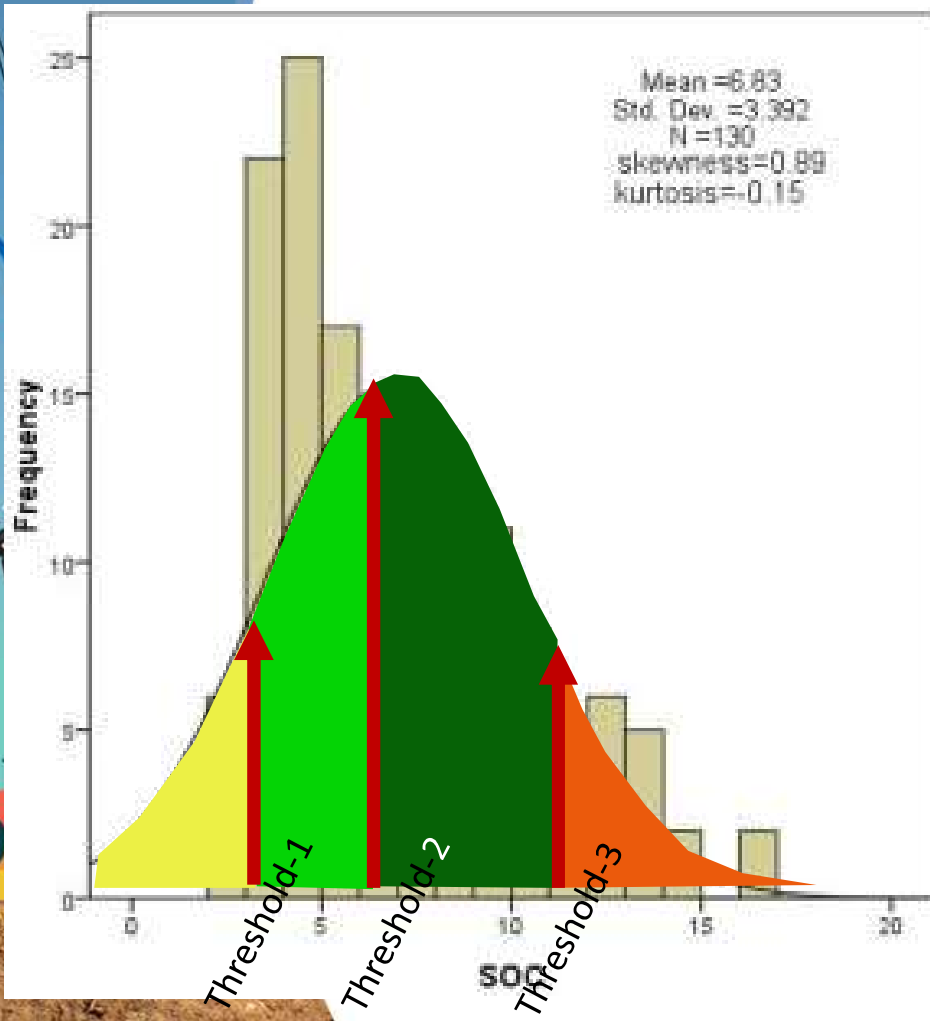
IF Input1 is Medium AND/OR Input2 is Medium AND/OR Input3 is Medium AND/OR Input4 is Medium AND/OR Input5 is Low **THEN** Productivity is Low.



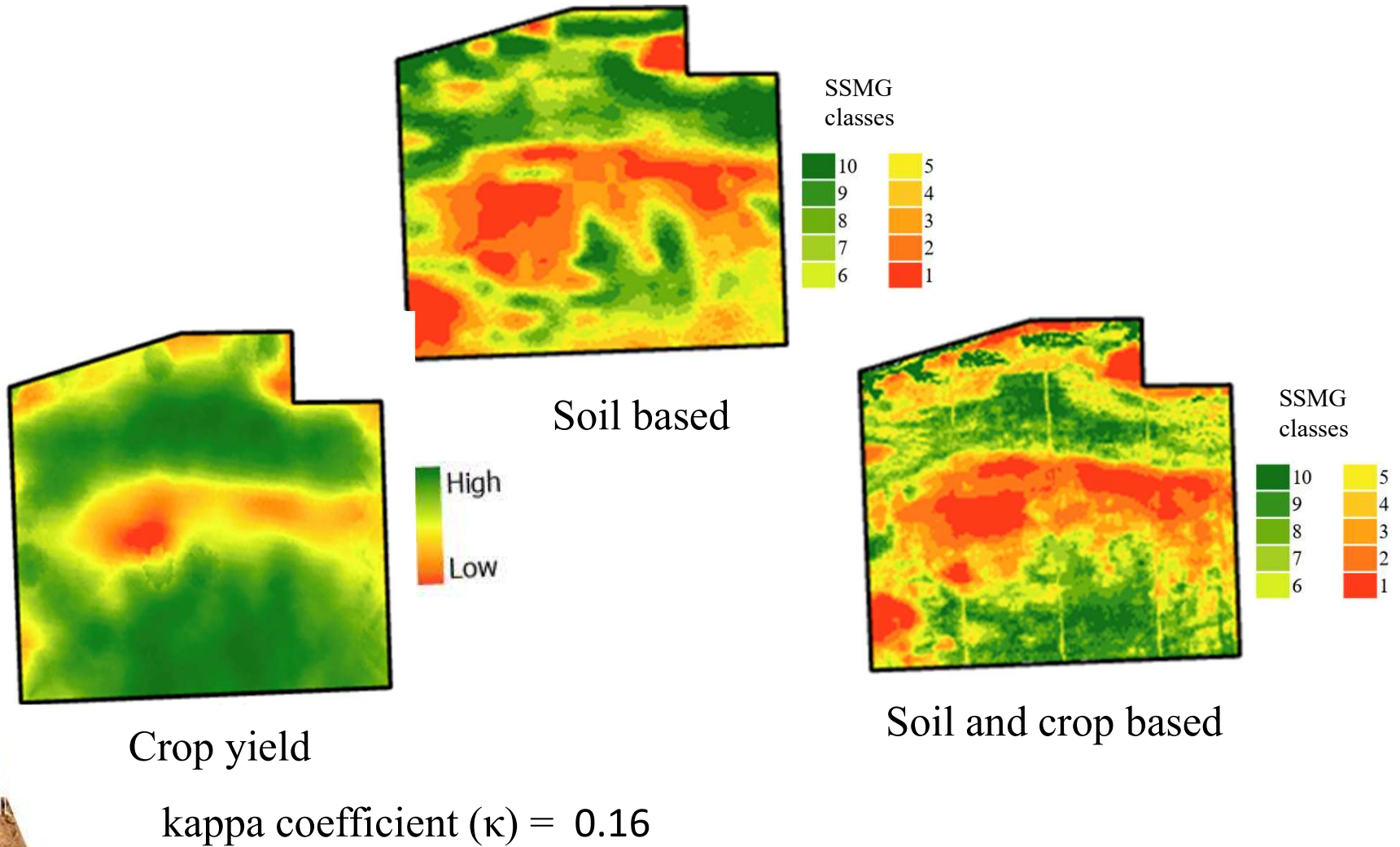
If	DSM	AND	Slope	AND	ECa- Shallow	AND	ECa-Deep	AND	NDRE	Then	Productivity Zone
	Medium		Medium		Low		Low		Medium		Low
	High		Medium		Low		Low		Medium		Medium
	Medium		Low		Medium		Medium		High		High

What's going on inside Fuzzy 'AND'/'OR'?

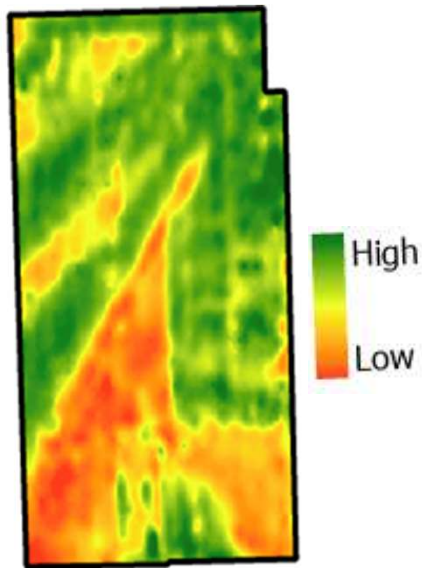
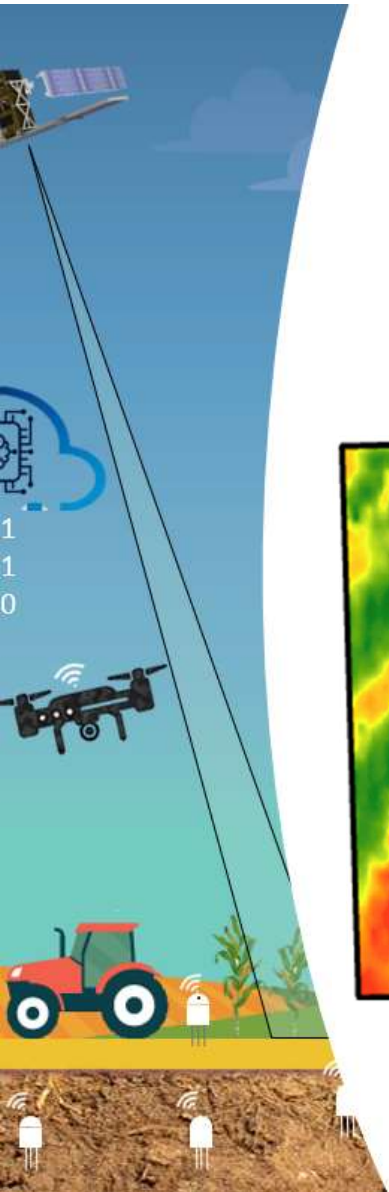
Defuzzification: How do we decide thresholds/bins?



Fuzzy inference system (FIS) based SSMGs

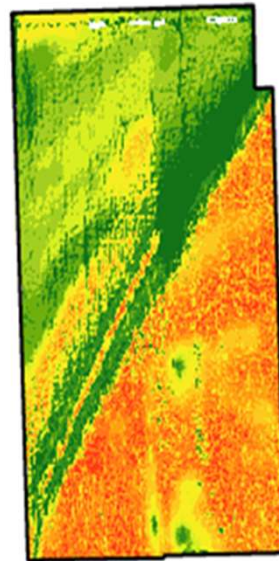


Fuzzy inference system (FIS) based SSMGs



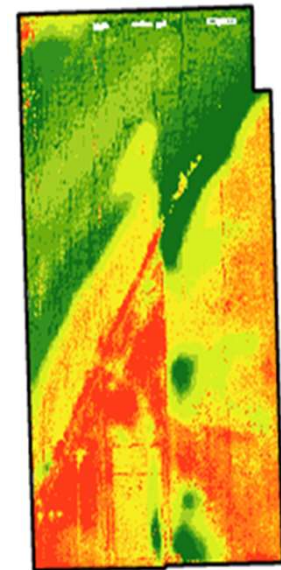
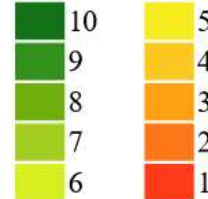
Crop yield

kappa coefficient (κ) = 0.09



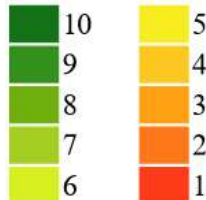
Soil based

SSMG
classes



Soil and crop based

SSMG
classes



Findings ...

- Fuzzy inference system (FIS) based SSMGs capture both macro-scale and micro-scale variability.
- H-FIS generated SSMGs with cluster ID (productivity zones).
- Introduced artificial intelligence (AI), a hybrid fuzzy system to delineate SSMGs.





Thank You !!!

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