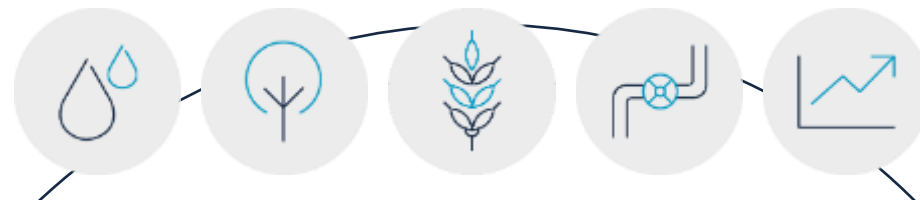




Rezatec
Analyzing Earth Data

Finding trees, water leaks and soybeans from space with Data Science



Dr Louise Lloyd



Agenda

- Rezatec
- Mapping soft commodities
- Pipeline risk assessments
- Mapping forests



About Rezatec

- + Geospatial Data Analytics Company:
Data as a Service
- + UK Based : Global Customers
- + World class team of PhD Data Scientists
& Earth Observation Experts
- + Established 2012 : Harwell Space Centre

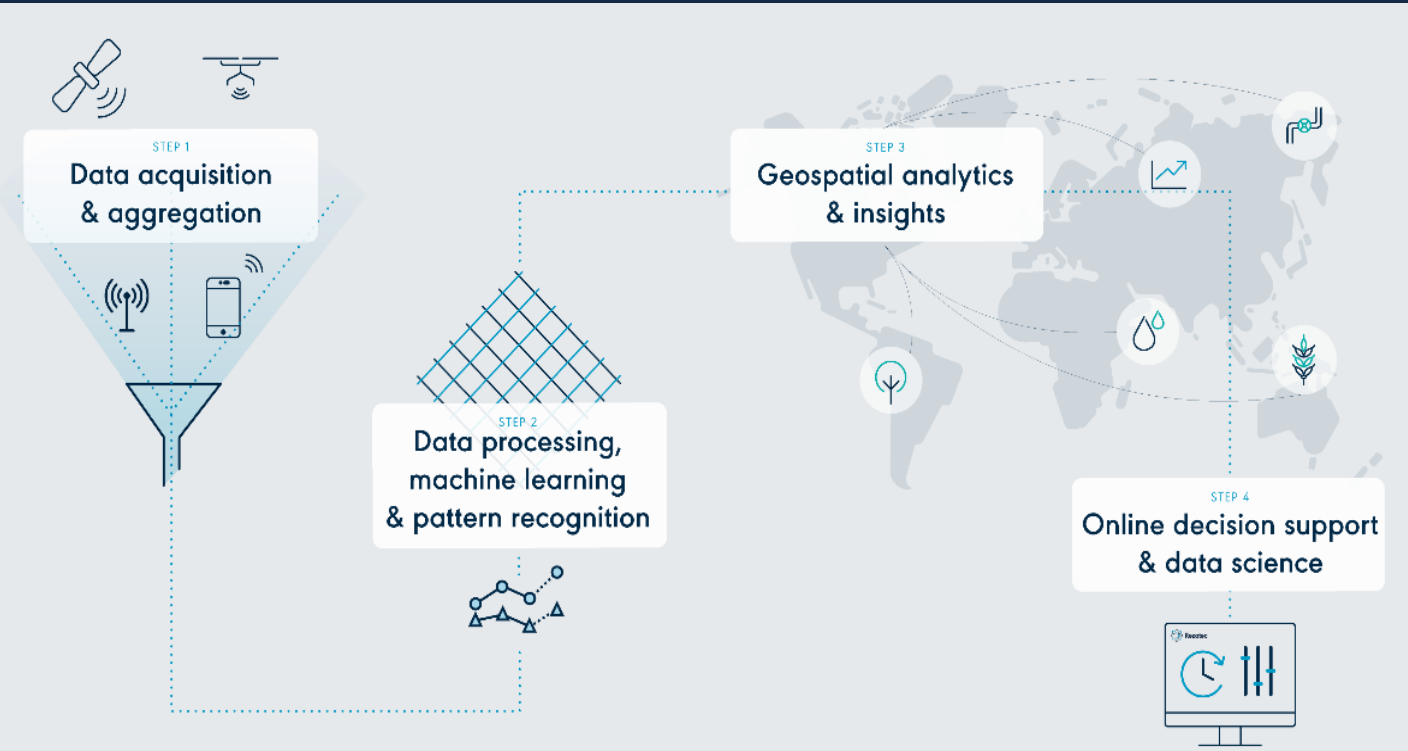
Most Innovative
Technology Winner

Utility Week Live
Isle's Big Water Pitch
May 2018

Sponsored by Eliquo Hydrok



Delivering Insights to Customers Worldwide





Team work

- Marketing
- Sales
- Delivery
- Development



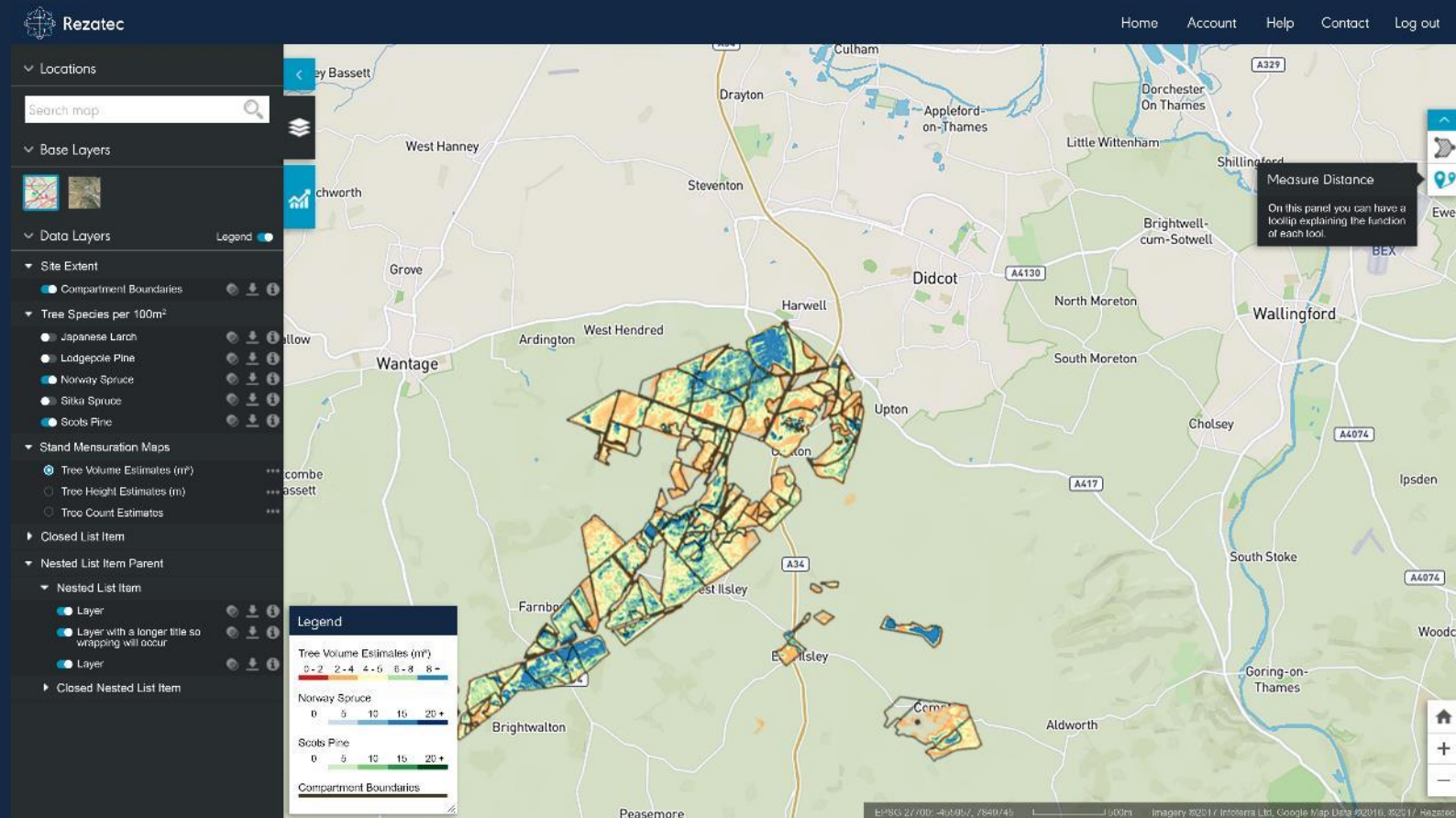


Input data





Output client view





Crop identification



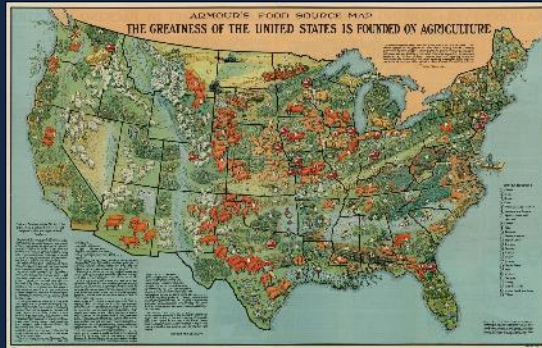
[Question 1](#)

[Question 2](#)





Crop Classification



ARMOUR'S FOOD SOURCE MAP

THE GREATNESS OF THE UNITED STATES IS FOUNDED ON AGRICULTURE



Live stock represent about one-third of the value of all farm products. They play an essential part in maintaining the fertility of the soil, also they consume crops which humans could not consume, and by turning these crops into meat they make them suitable. Successful agriculture is largely dependent on live stock and the growing of live stock is in turn dependent on successful marketing of the meat animals. Because nearly all industries depend on agriculture, the prosperity of the entire nation is inseparably linked with the marketing of meat and other animal products through the packing industry.

J. Edgar Armour

Packing Industry Links Farms With Cities And Enables Farmers to Get Highest Value for Agricultural Products.

Because of the many kinds of farm products raised in the United States, and because of the large amount of these products, the United States is the greatest self-sustaining nation in the world. Within its borders it can raise, and manufacture from its natural products, everything that is needed to keep every industry busy, to give employment to millions of people, to feed all of its own people, and still have much food left over to help feed other nations.

Agriculture is the most valuable of all industries. Of the agricultural products for which the United States is famous, live stock are the most important and the most valuable.

According to the census of 1920, the value of the live stock is greater than the value of any other farm product, and is one-third of the total farm production value in the United States. One of the principal by-products of live stock is fertilizer in the form of manure, which when put back upon the soil enriches it, makes it productive, and keeps it from becoming worn out. In fact, agriculture is largely dependent upon the live stock industry because the animals are necessary to keep the soil fertile so that all crops can be grown year after year.

If live stock were not raised on a large scale there would be a very limited use made of corn, hay and other crops that are used as feedstuffs. These crops are large and valuable, principally because they can be marketed through live stock. Ninety percent of the corn crop is marketed in that way, ninety-five percent of the oat crop and practically all of the hay crop.

By far the greatest number of hogs are raised in the North Central States. Iowa ranks first of all the states in the production of hogs, Illinois second, and Missouri third.

The great cattle states are Texas, Iowa and Nebraska, which rank, so far as numbers of cattle produced are concerned, in the order they have been named.

The great sheep states are Montana, Wyoming, Texas, California and Idaho. Eggs and

poultry are becoming more and more important as food. They are produced in the states where corn and other grains grow most abundantly—principally in Iowa, Illinois and Missouri.

Veal calves are produced mainly in the dairy sections and in Texas. Dairy calves could not be brought to maturity without seriously cutting down the milk supply, and they do not make such good beef as do the breeds of cattle raised mainly for that purpose. Live stock would have a very small value if there were not a good way to get the meat, the hides and the wool to people in the United States and of the world, who have need for these things.

It is in the preparation of that meat and in the distribution of it that the meat packing industry performs its service. It becomes a connecting link between the man who produces live stock, and other forms of agriculture, and the millions of men and women and children who must be fed in the thickly populated manufacturing centers that cannot raise enough food for their own needs.

The New England states are not able to produce enough food to take care of their population, but because of their geographic location, they are especially suited to the great manufacturing centers. On the other hand, the states in the West and South are better suited to agriculture, and produce a great deal more than the people living there require. Both sections are able to exist as they do through an exchange of their chief products. Thus the manufacturing centers ship manufactured goods to the agricultural centers in exchange for food products and raw materials, and the things making possible this exchange are largely responsible for our national prosperity. The meat packing industry is one of the chief factors in making this exchange.

In order to work efficiently, the packers have had to build packing plants in those sections of the country where live stock are raised in the greatest number. Because the Central States market the greatest number of meat animals, most of the packing plants are located

there. It is a thousand miles or more from many of these big plants to the big cities in the East where most of the meat is sold. As meat is highly perishable, the packing companies have refrigerating cars for transporting the meat to the East, and in nearly every city and town of consequence, they have refrigerated branch houses in which the meat is kept until the retail dealer buys it. Dealers in towns which do not have branch houses can get their meat supplies direct from the refrigerator cars. Refrigeration makes it possible for consumers in all parts of the country to have an even supply of wholesome, fresh meat throughout the year.

The service of the packing house brings a great part of the farmers' products to the door of the person who wants to buy them. It has made the best of food available to every person in any part of the United States, thereby enabling many of those persons to spend their time in making useful articles, or in doing other work that is of value to the progress and the culture of the nation.

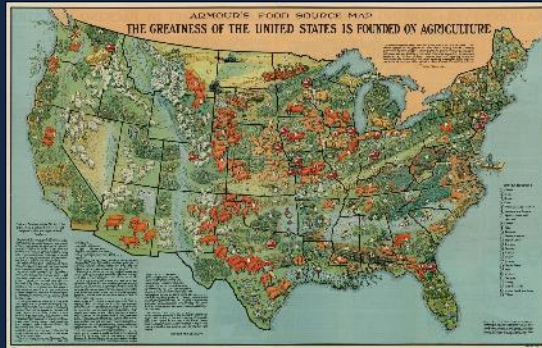
ARMOUR AND COMPANY.

KEY TO NUMBERS

- 1 Cattle
- 2 Swine
- 3 Sheep
- 4 Corn
- 5 Wheat, oats, rye, barley
- 6 Oranges and lemons
- 7 Apples, pears and peaches
- 8 Cotton
- 9 Rice
- 10 Tobacco
- 11 Sweet potatoes
- 12 Sugar Cane
- 13 Turkeys
- 14 Poultry
- 15 Celery
- 16 Dairy
- 17 Grapes
- 18 Sugar Beets
- 19 Fish
- 20 Oysters
- 21 Peanuts
- 22 Honey
- 23 Irish Potatoes
- 24 Grape Fruit and limes
- 25 Olives

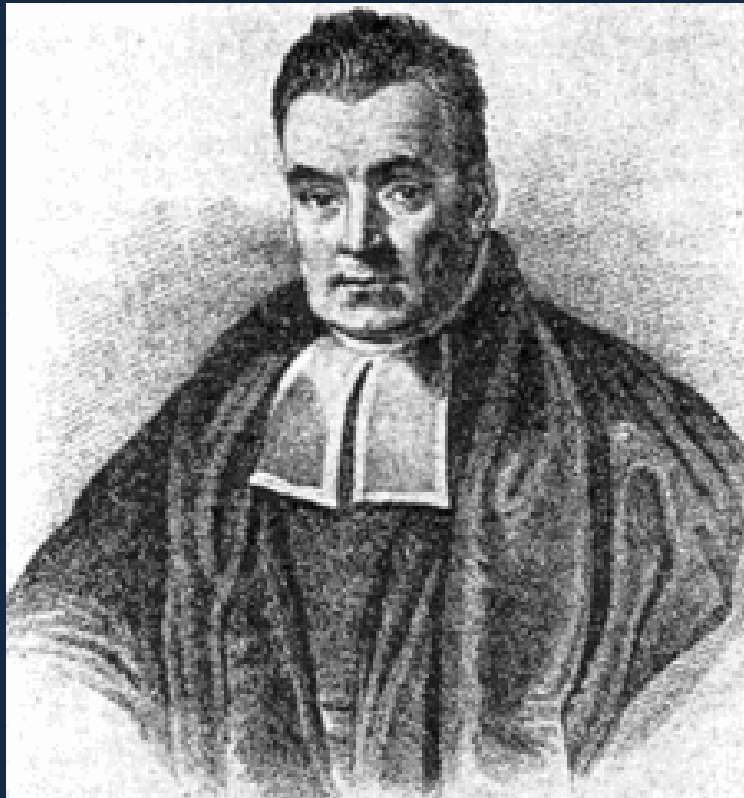
Note—It has been impossible to locate with geographic accuracy within state lines, all of the principal products of some of the states. Nevertheless, the principal products of each state are indicated, and the geographic location of the principal products in the divisions of the United States have been affected with a fair degree of accuracy.

Crop Classification





Agriculture development



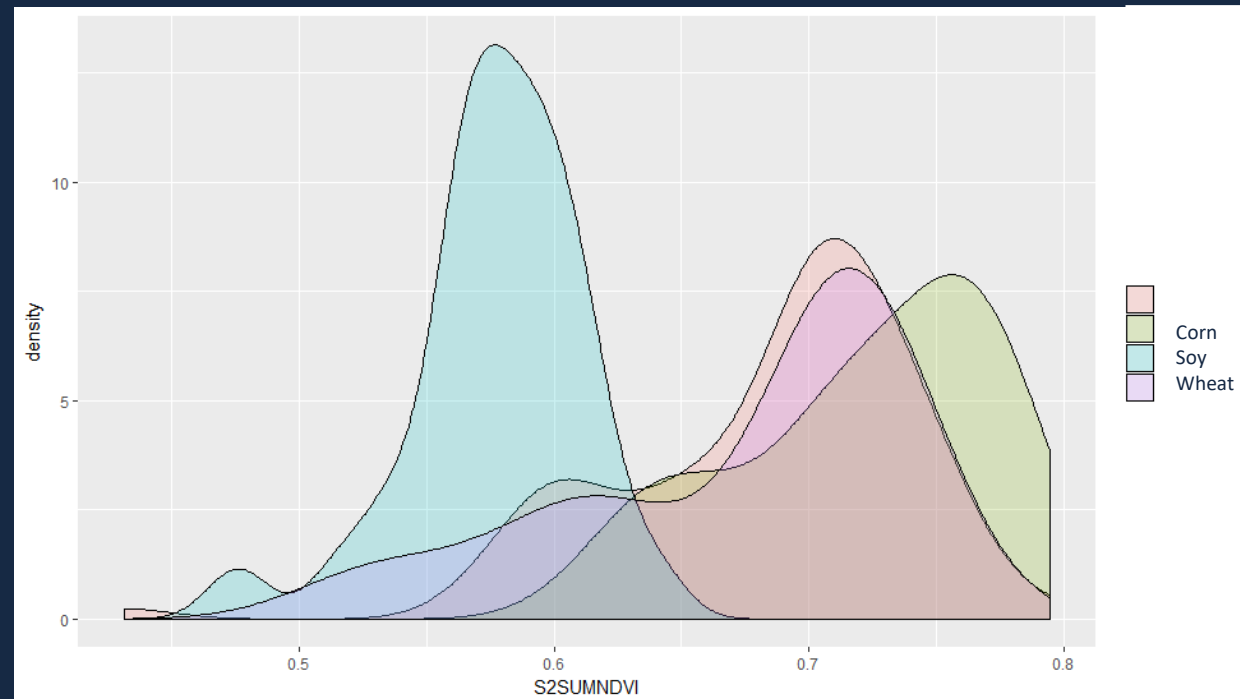
$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$





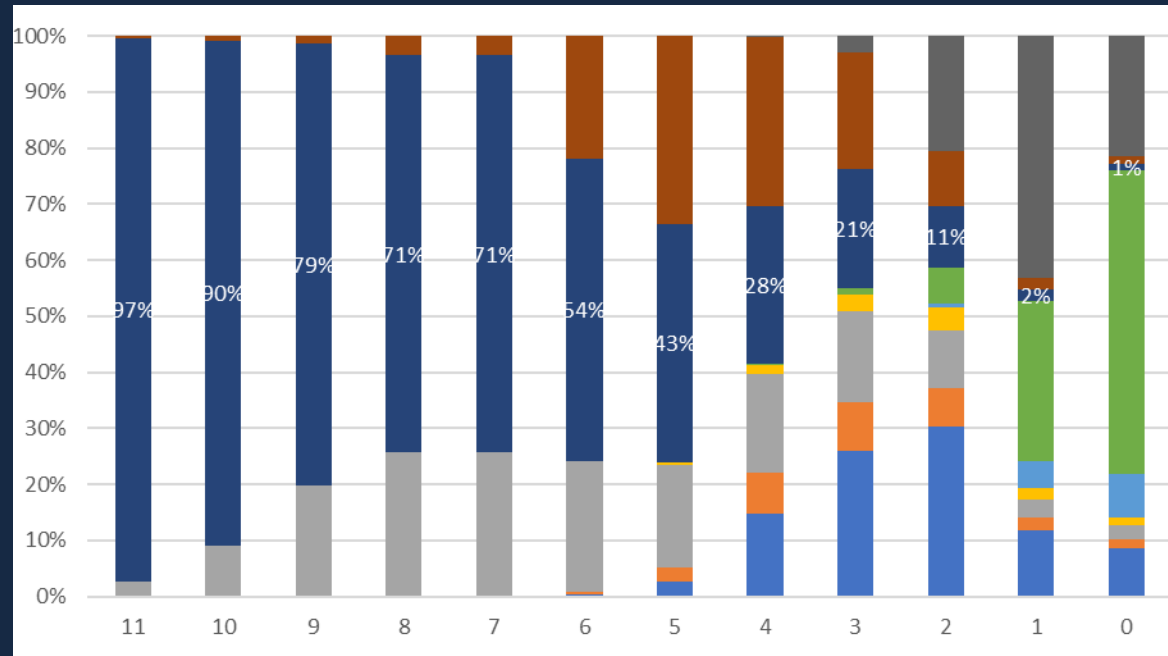
Machine Learning algorithms

- Indices identify individual species with certain probability





A single pixel (sugar beet)



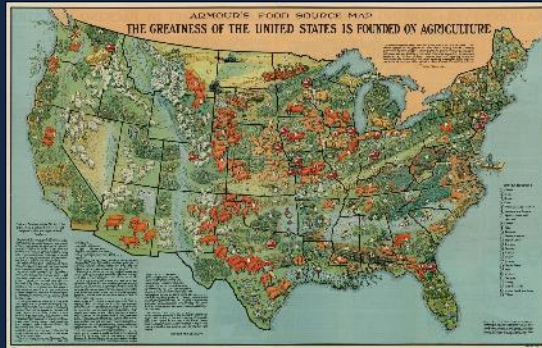
Probability outcome: 97%

Data:

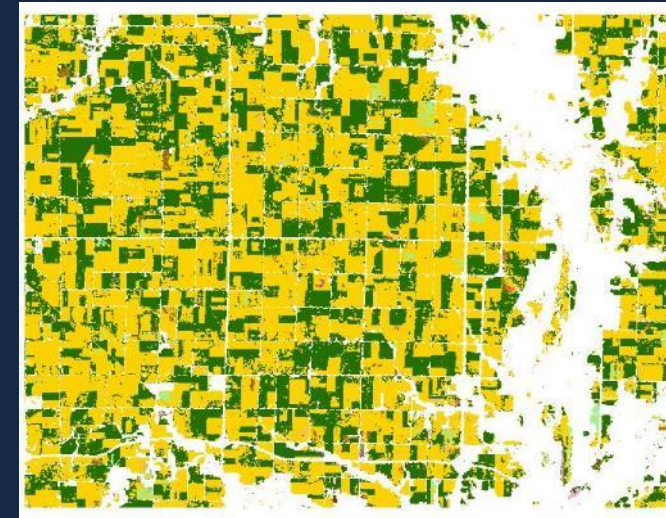
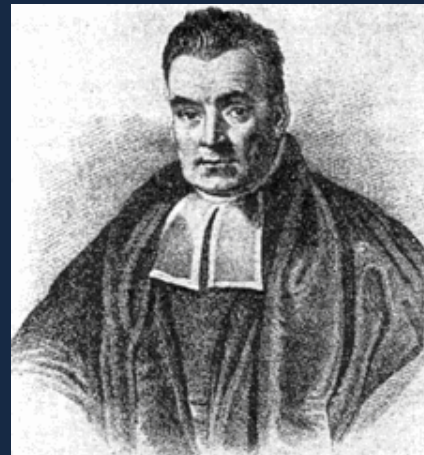
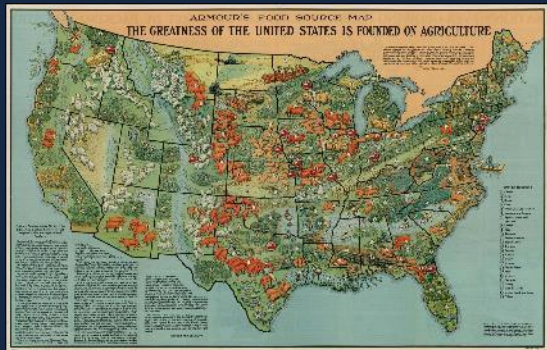
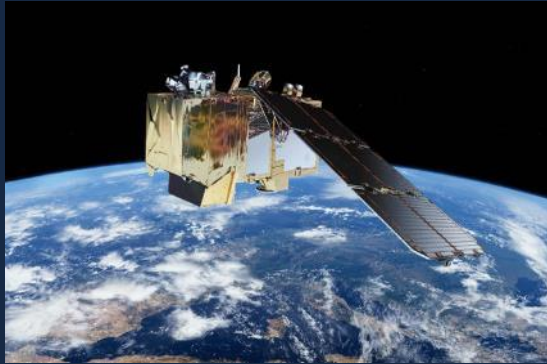
Prior: 1%



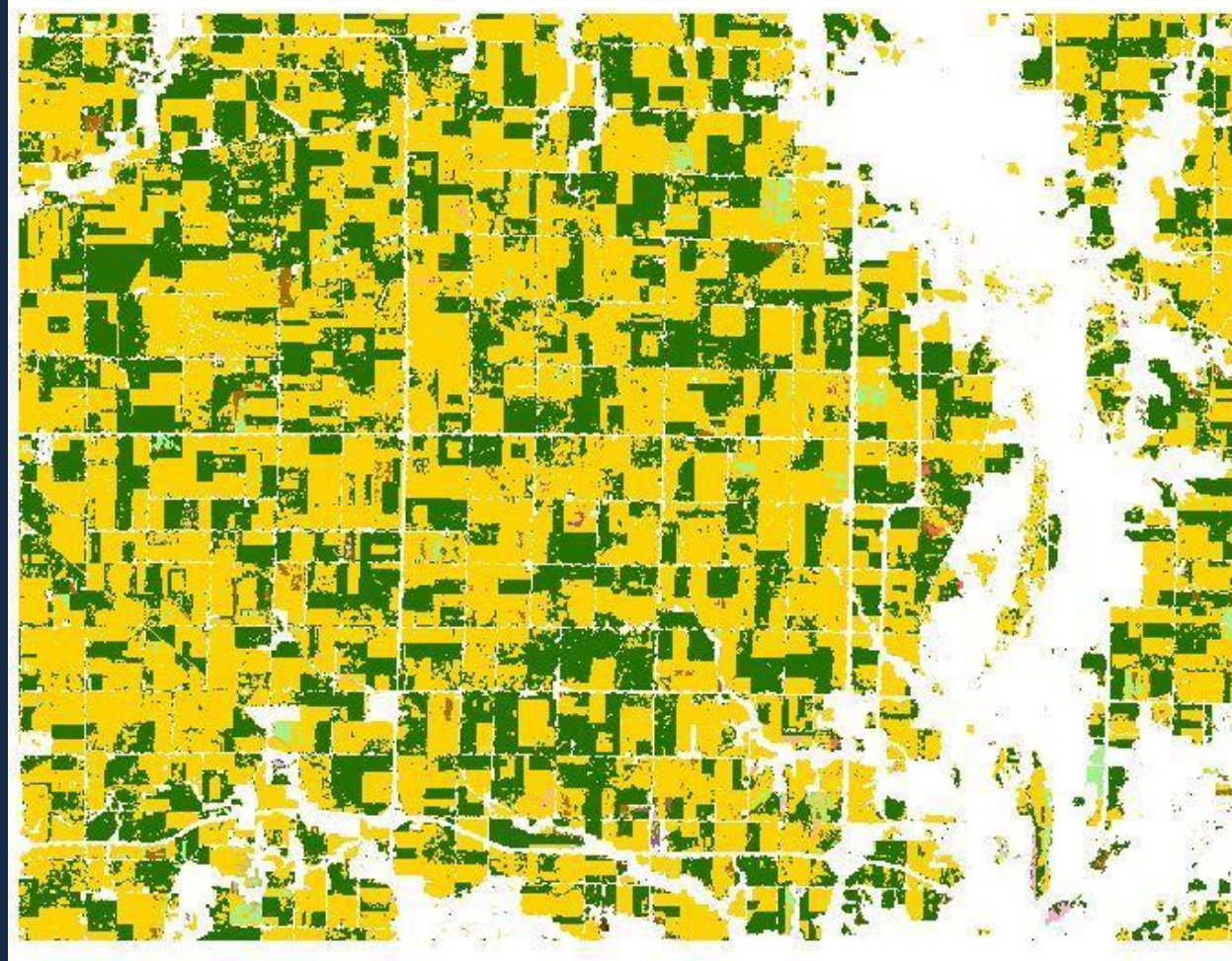
Crop Classification



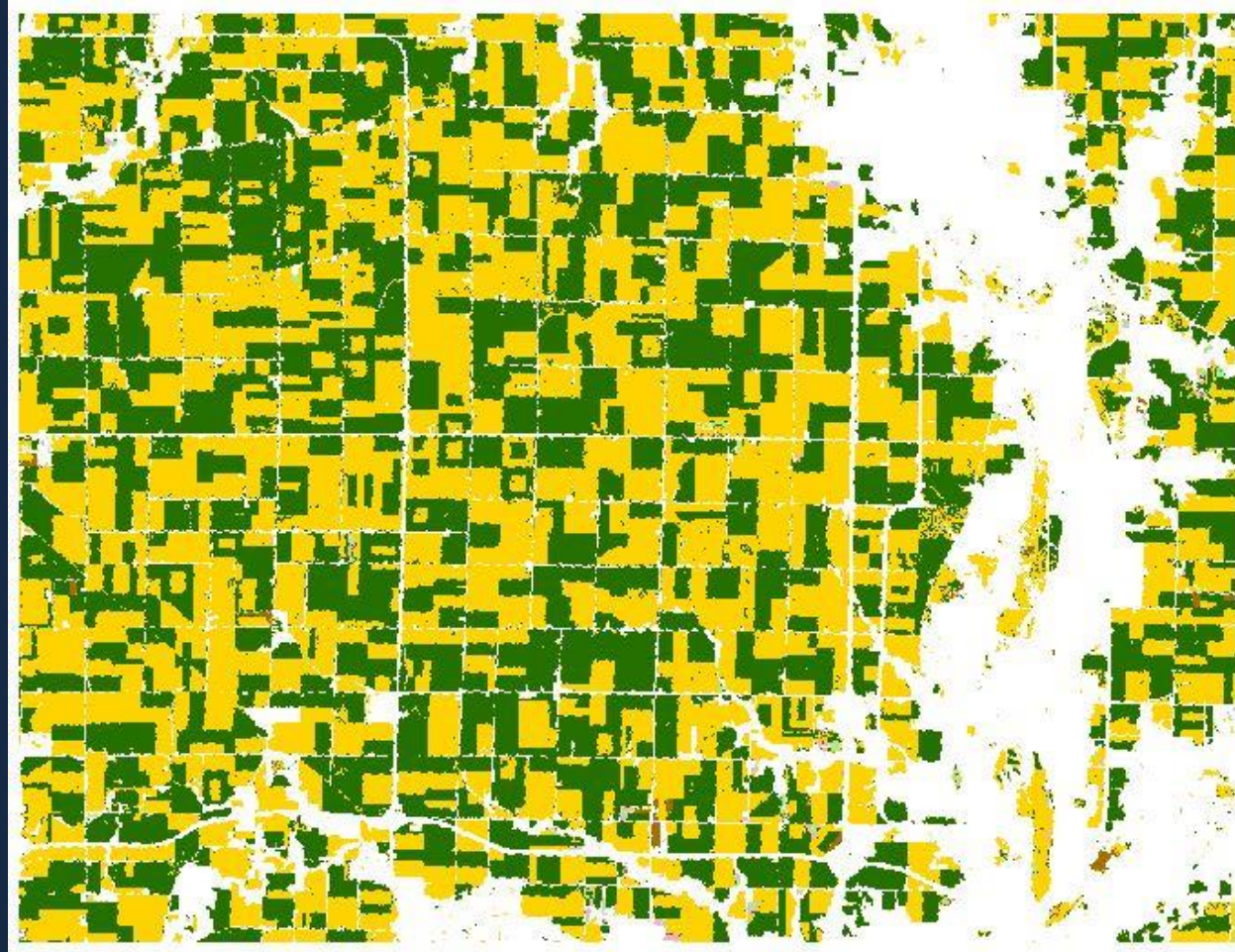
Crop Classification



Soybean Classification



Soybean Classification



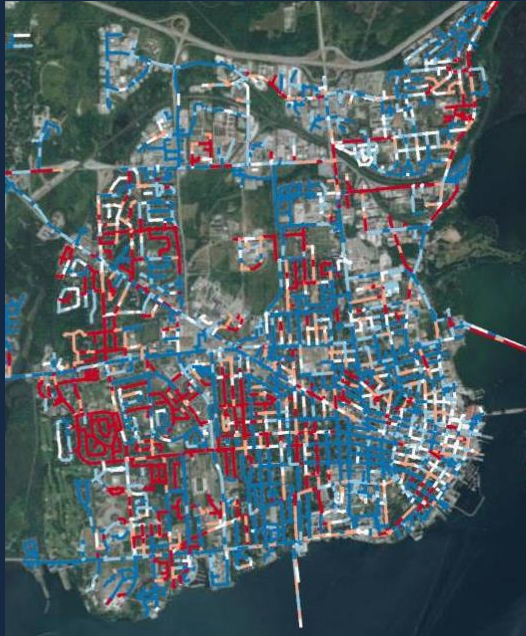
Water leaks



- England and Wales lost 3.1 billion litres of water every day from leakage in 2017
- Thames Water is the worst offender as it loses around 179 litres of water per household per day (2 baths)
- Each person consumes 140 litres of water per day



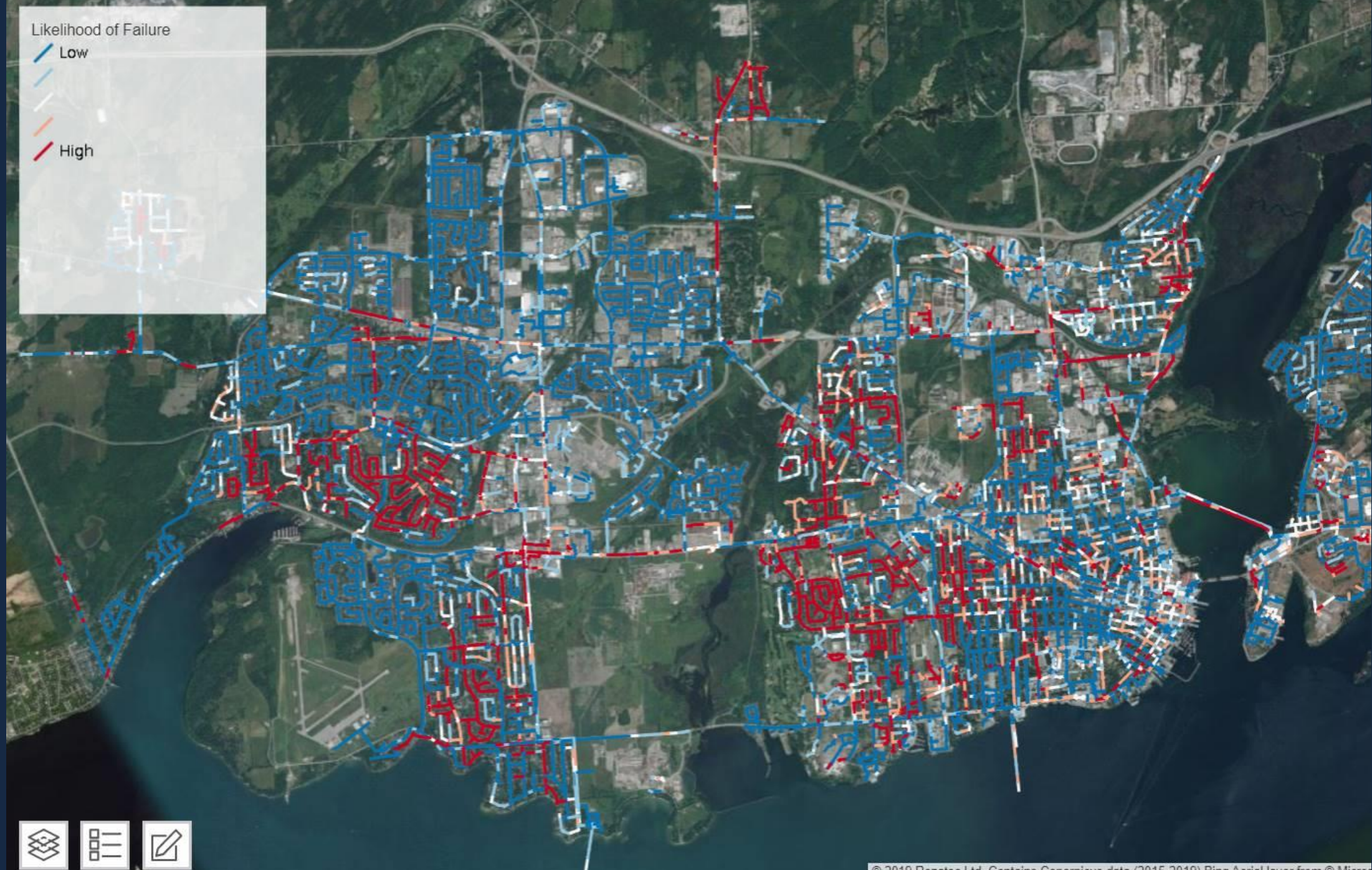
Pipeline failure risk



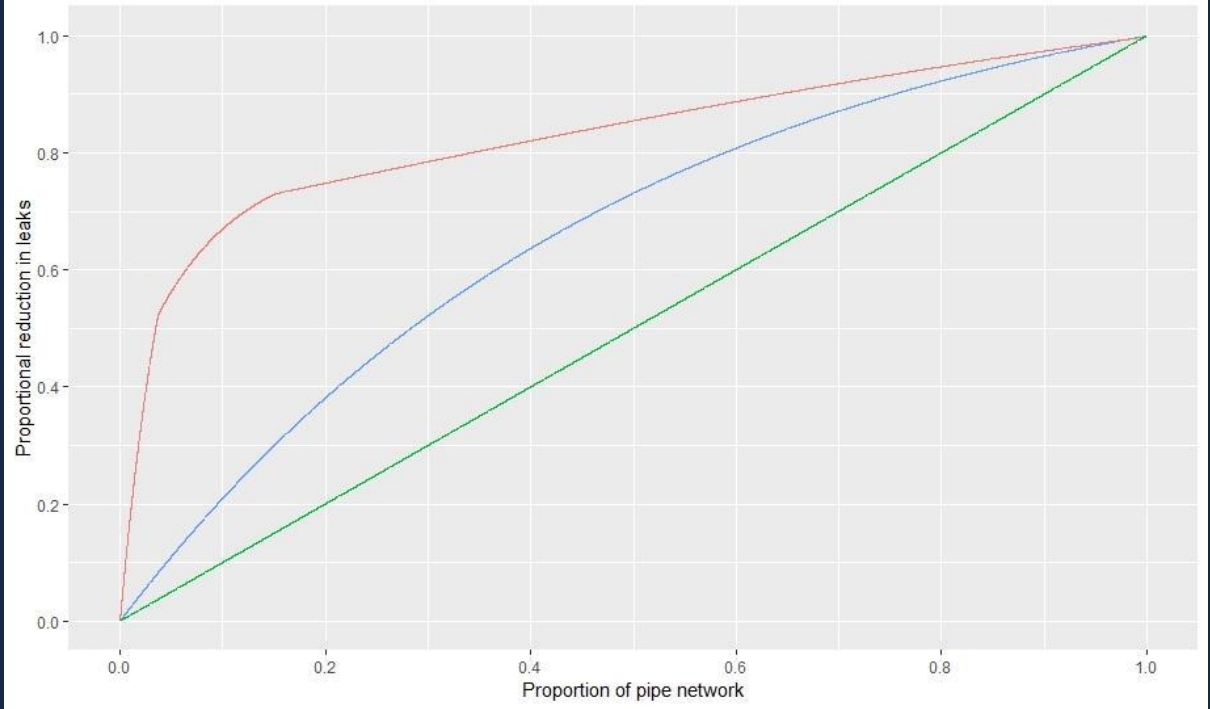


Likelihood of Failure

- Low
- High



Pipeline failure risk



Forestry applications



Question 3



Forestry



Accuracy

Tree

Volume

Assess the volume of each species across our forest aggregated up to stand level with an accuracy greater than 80%

Species

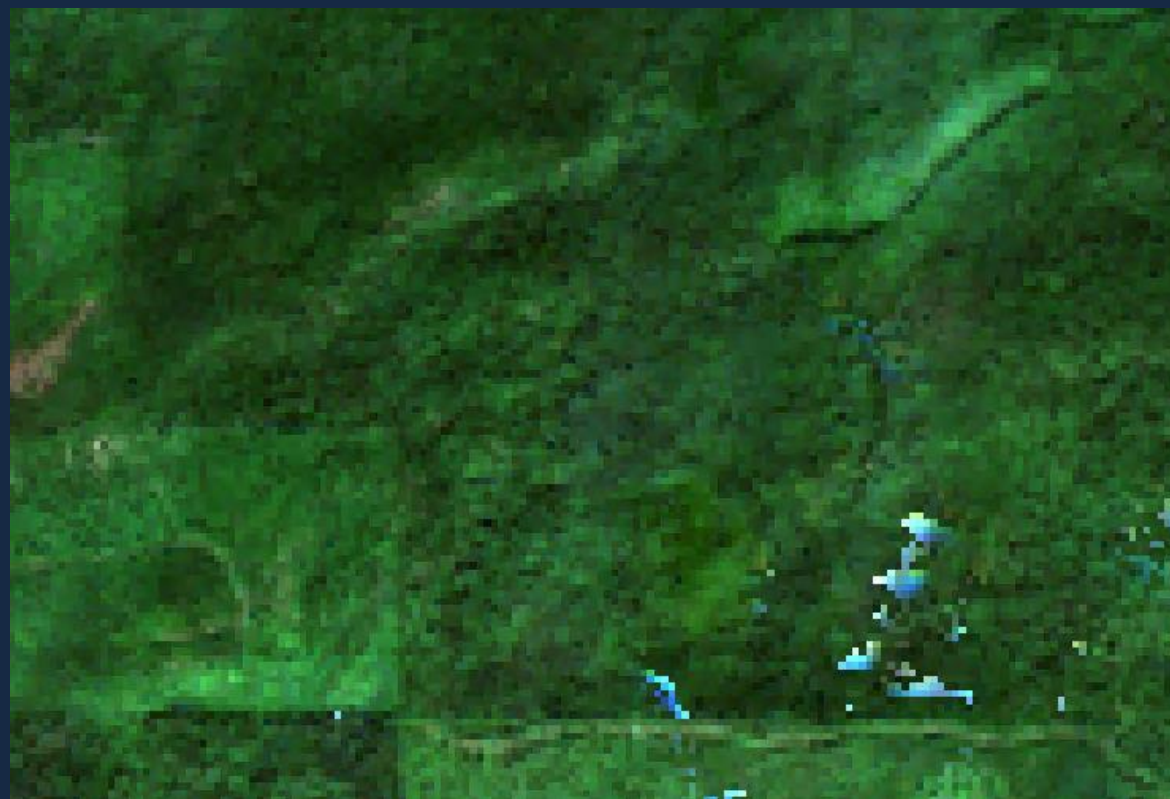
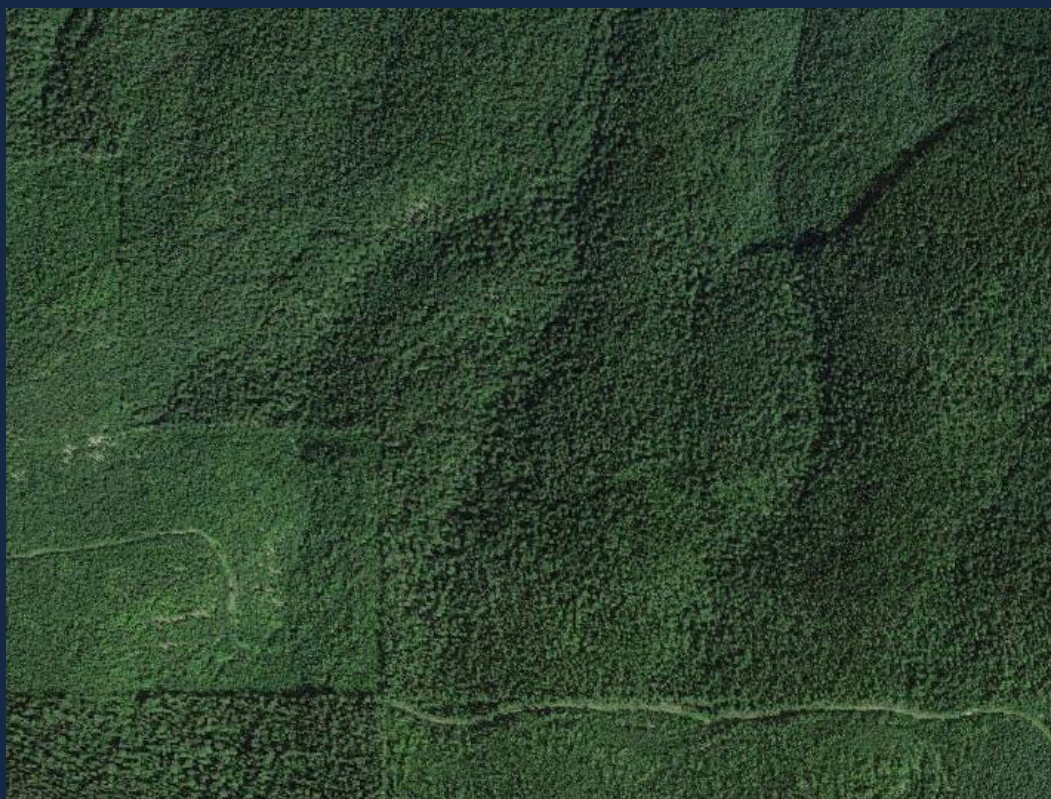
Stand

Forest

Plot



Data





Data

PLOT_SEQ_N	Slope	Elev	NDVI_ Sm17	NDWI_ Sm17	GRE_ Sm17	WET_ Sm17	NDVI_ Sp16	NDWI_ Sp16	...
A_2	10.1	627	0.895	-0.798	1269	-131.8	0.834	-0.692	
A_17	12.3	628	0.892	-0.753	1565	97.5	0.848	-0.724	
A_39	5.6	643	0.867	-0.779	1048	-34.3	0.832	-0.792	
C_39	12.7	959	0.834	-0.749	2279	395.2	0.844	-0.738	
D_5	21.7	653	0.858	-0.763	1151	49.7	0.857	-0.773	



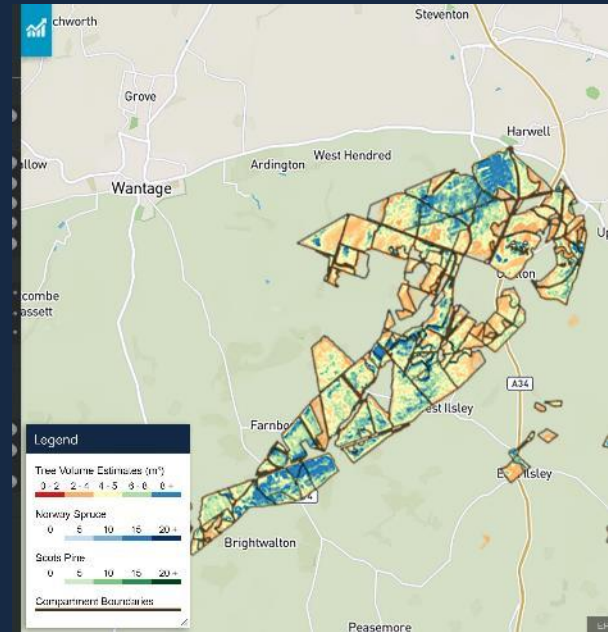


Ground data

PLOT NO.	Diameter			Height			Tree count				
	Min	Max	Ave	Min	Max	Ave	B (Fir)	P (Pine)	S (Spruce)	OHW	OSW
A_2	27.0	55.0	43.2	16.3	21.5	18.9	0	0	0	4	0
A_17	25.1	64.7	39.5	14.2	14.2	14.2	0	0	0	1	1
A_39	18.0	69.8	41.5	20.4	20.4	20.4	2	0	0	1	2
C_39	22.3	38.9	32.7	13.9	22.0	18.9	0	0	1	11	0
D_5	23.7	107.7	63.1	13.8	36.6	25.2	1	0	2	1	3



Forestry mensuration

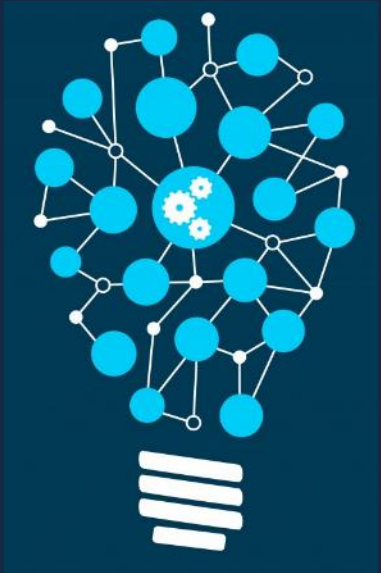


PLOT NO.	Diameter			Ht
	Min	Max	Ave	
A_2	27.0	55.0	43.2	M
A_17	25.1	64.7	39.5	M
A_39	18.0	69.8	41.5	M
C_39	22.3	38.9	32.7	M
D_5	23.7	107.7	63.1	M





Model structure



- Need to model volume by species
- Calculate volume
- Consider contents of 1 pixel
- Consider validation size
- Model approximate proportion of tree species using Dominant Species
- Model total volume





Validation

- TDI aim:
 - 80% of our estimates are within 10% of ground data for each species.

		Ground data Dominant Species					
		Mixed	B	OHW	OSW	P	S
Predicted Dominant Species	B	74	33	3	0	0	39
	OHW	5	0	1	0	0	3
	OSW	39	13	0	0	0	23
	P	11	0	2	0	12	1
	S	180	43	0	0	1	161





Summary

- You were at predicting soft commodities than we are from space
- You were at predicting tree species than we are from space
- I am looking for interesting people to join Rezatec!

Dr Louise Lloyd
Head of Data Science
louise.lloyd@rezatec.com
01865 817500

