Automatic Detection of Ports For Map Generalisation

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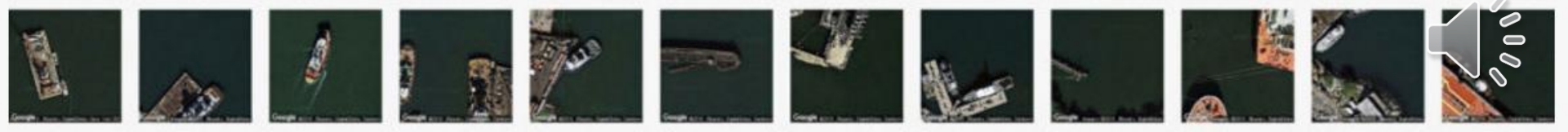
Automated generalisation for on-demand mapping, Helsinki, Finland, 14 June, 2016



Overview

- Ambition – to automatically detect higher order objects
  - Such as ‘farming region’, ‘mountainous regions’, ‘suburbs’, ‘ports’…
  - Derived from open source data
- OSM – entities recorded at a specific conceptual scale
  - → Therefore ‘entity constrained’
  - → Higher order objects not explicitly modelled
- Methodology
  - Detection of clusters of attributes of higher order objects
  - Use machine learning and neural nets to search for prototypical higher order objects

Derivation of very small scale mapping from large scale open source data

Major UK Ports

OSM
Common
The Avenue
Hill Lane
Anglesea Road
St James Road
Thomas Lewis Way
Tebourba Way
Shirley Road
Howard Road
Archers Road
Bevois Town
Millbrook Road West
Freemantle
Waterloo Road
Hill Lane
Onslow Road
Northam
Port of Southampton
Mountbatten Way
West Quay Road
St Mary Street
SOUTHAMPTON
New Forest
Southampton Hampshire
Bury Road
Normandy Way
Tavell's Lane
New Forest

OSM

- Physical features represented using tags attached to basic data structures (nodes, ways, relations).
- Each tag describes a geographic attribute of the feature being shown by that specific node, way or relation.
- ‘Free tagging’ allows the map to include an unlimited number of attributes describing each feature
- Scale dependent nature of entities

How is ‘Port’ defined within OSM?

1.13 Leisure

1.14 Man Made

1.15 Military

1.6 Building

- 1.6.1 Accommodation
- 1.6.2 Commercial
- 1.6.3 Civic/Amenity
- 1.6.4 Other Buildings
- 1.6.5 Additional Attributes

1.16 Natural

- 1.16.1 Veg/ surface related
- 1.16.2 Water related
- 1.16.3 Landform related

1.18 Places

- 1.18.1 Administratively declared plac
- 1.18.2 Populated settlements, urban
- 1.18.3 Pop. settlements, urban & rura
- 1.18.4 Other places
- 1.18.5 Additional attributes

1.26 Waterway

- 1.26.1 Natural watercourses
- 1.26.2 Man made waterways
- 1.26.3 Facilities

An Ontological Perspective

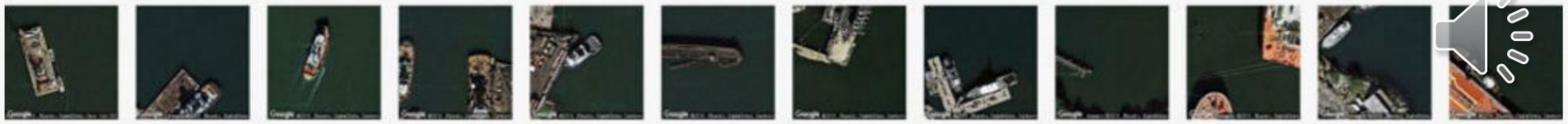
Port

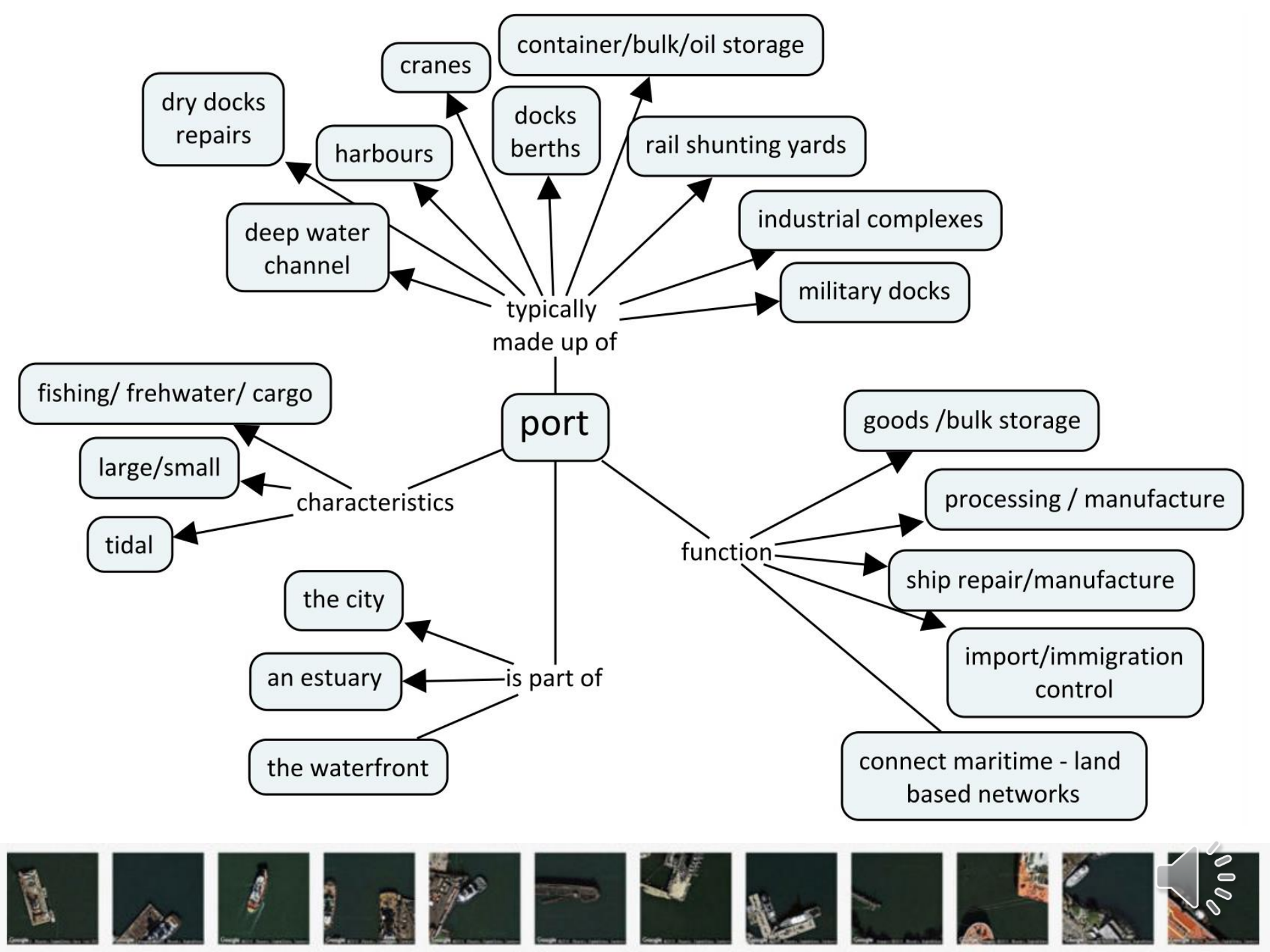
‘a location on a coast or shore containing one or more harbours where ships can dock and transfer people or cargo to or from land’

Ontology

An ontology is a shared conceptual description that facilitates machine-interpretable definitions of basic concepts in a domain and the relations among them

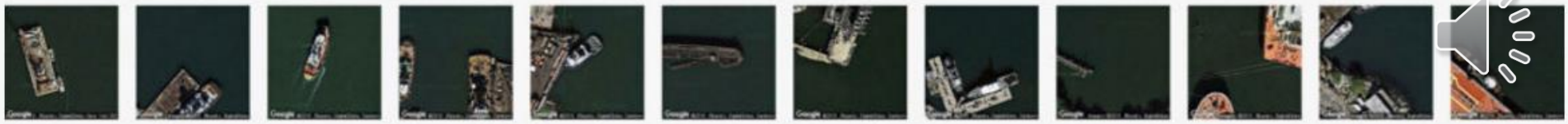
The role of the ontology: competency questions



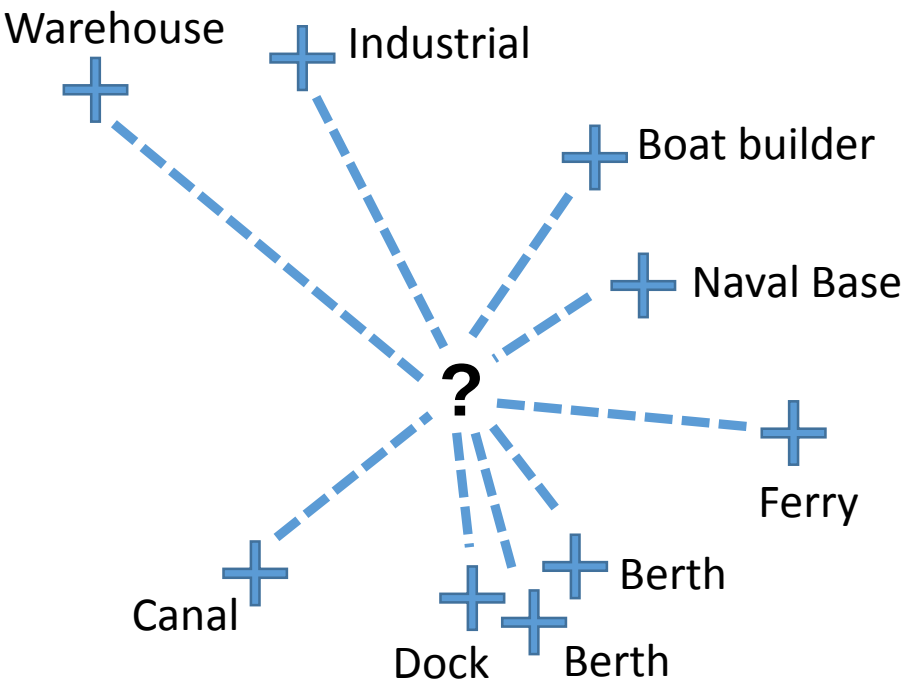

container/bulk/oil storage
cranes
dry docks
repairs
docks
berths
harbours
rail shunting yards
deep water
channel
industrial complexes
military docks
typically
made up of
fishing/ frehwater/ cargo
port
goods /bulk storage
large/small
characteristics
processing / manufacture
tidal
function
ship repair/manufacture
the city
import/immigration
control
an estuary
is part of
the waterfront
connect maritime - land
based networks

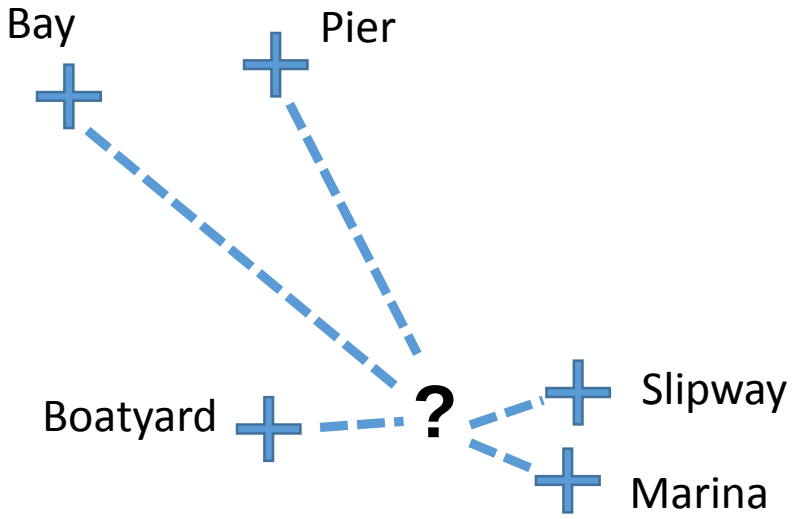
Variable	Contains the word
Amenity	boat
Amenity	ferry
Boundary	maritime
Building	industrial
Building	warehouse
Building	train station
Craft	boat builder
Craft	sail
Emergency	life
Historic	ship
Landuse	commercial
Landuse	industrial
Landuse	military
Landuse	port
leisure	marina
Leisure	slipway
Seamark	Berth
Seamark	Boatyard
Seamark	slipway

Variable	Contains the word
man-made	breakwater
man-made	crane
man-made	lighthouse
man-made	pier
man-made	silo
man-made	storage
military	naval base
natural	bay
natural coast	
power	plant
public transport	station
railway	rail
railway station	
service	siding
service	yard
route	ferry
waterway	canal
waterway	dock
waterway	boatyard



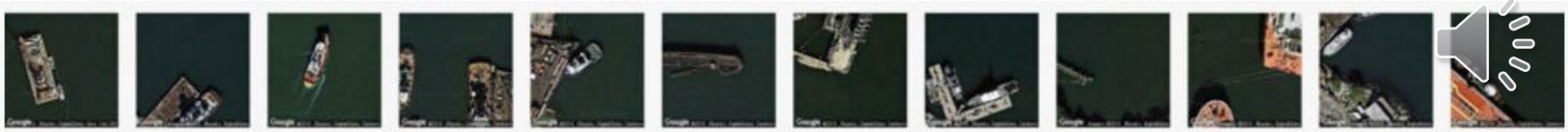
Major & Minor Ports?

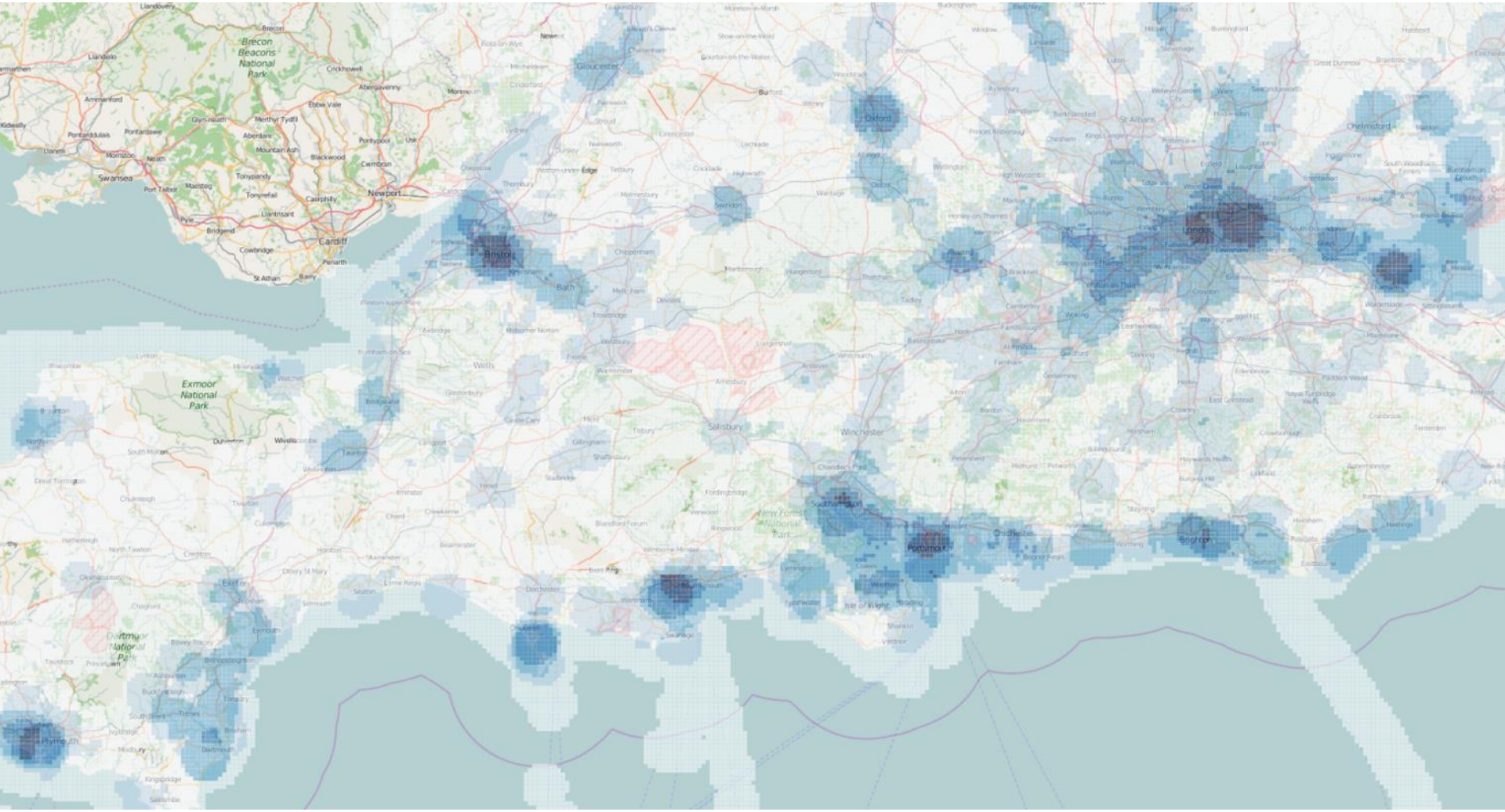




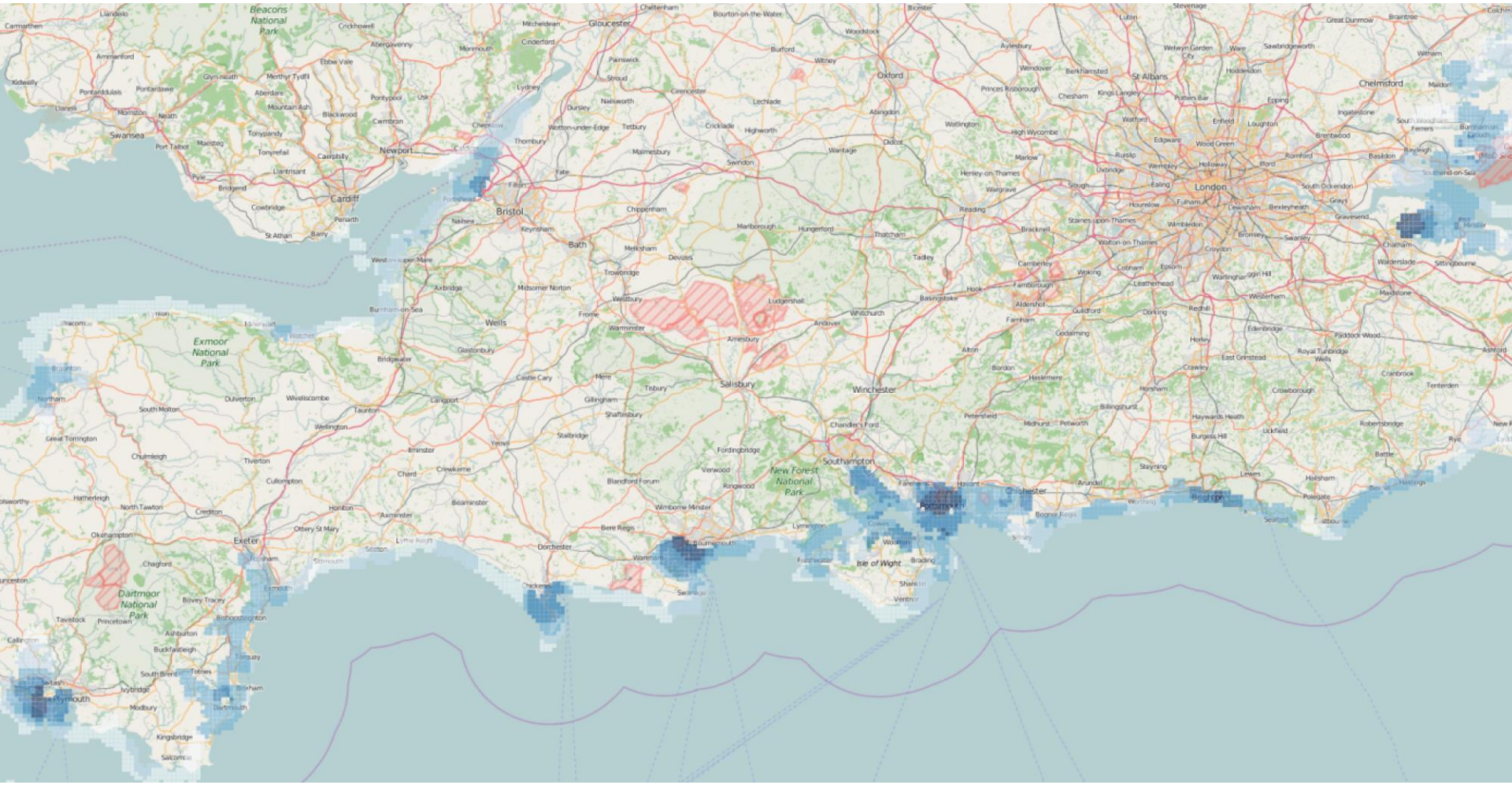
Methodology

- Create UK Fishnet
  - 1km by 1km square
  - 960,000 cells
  - Coastline modelling: Boolean: within 1km of coastline
- For each cell
  - calculated distance to nearest item from a list of 38 different features… (eg railway siding, marina, pier)
  - If feature not found within 5km: 999 score awarded
  - Calculate the mean of the sum of distances





Inference: dark blue → clustering of Port sub-entities



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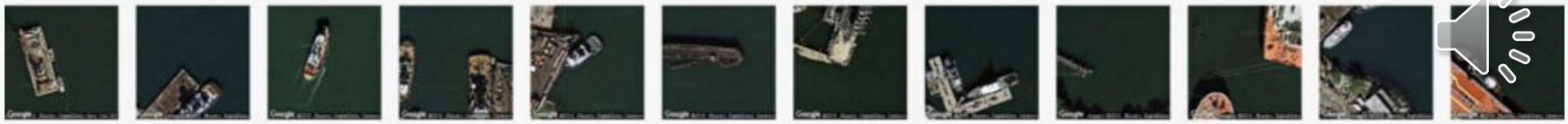
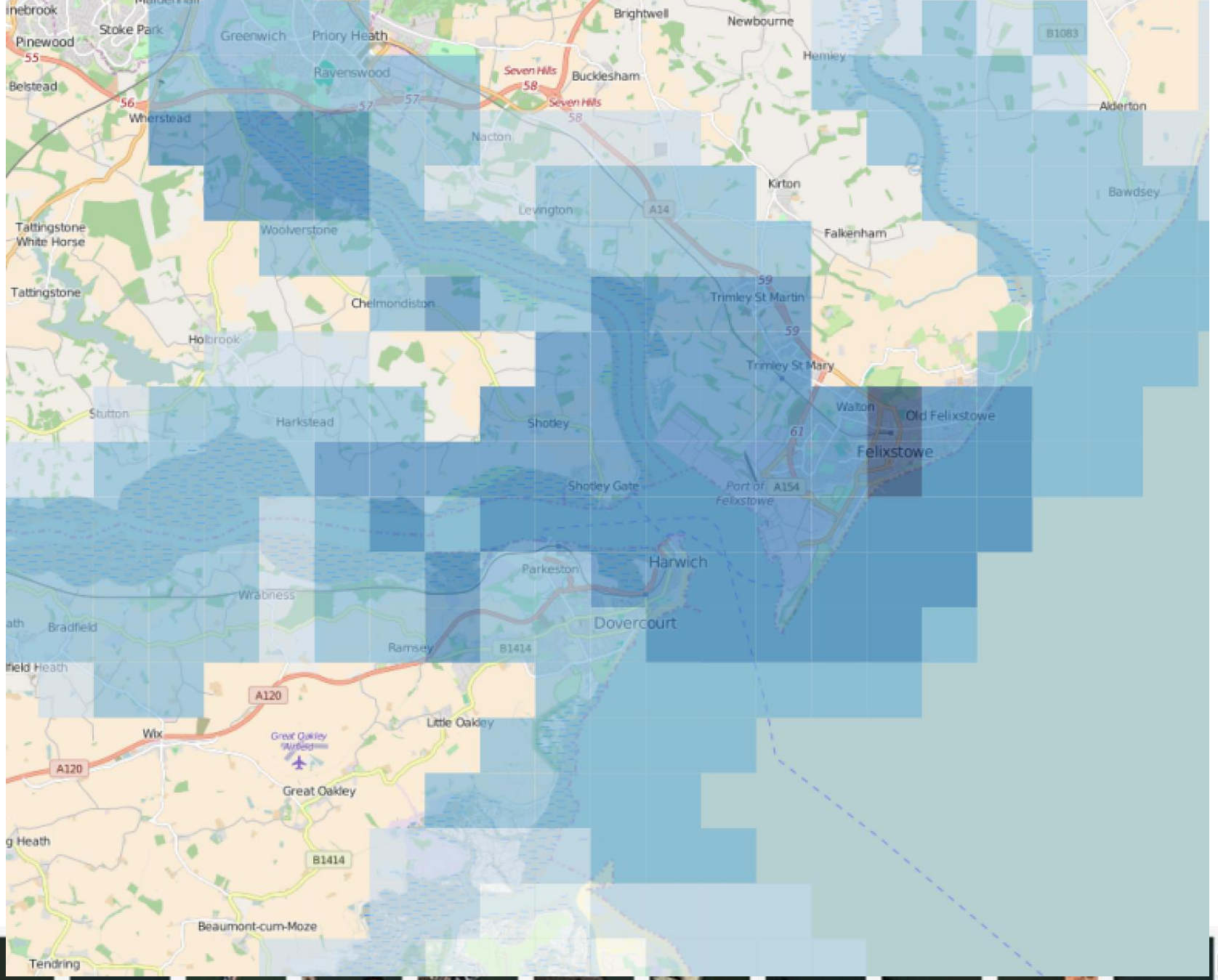
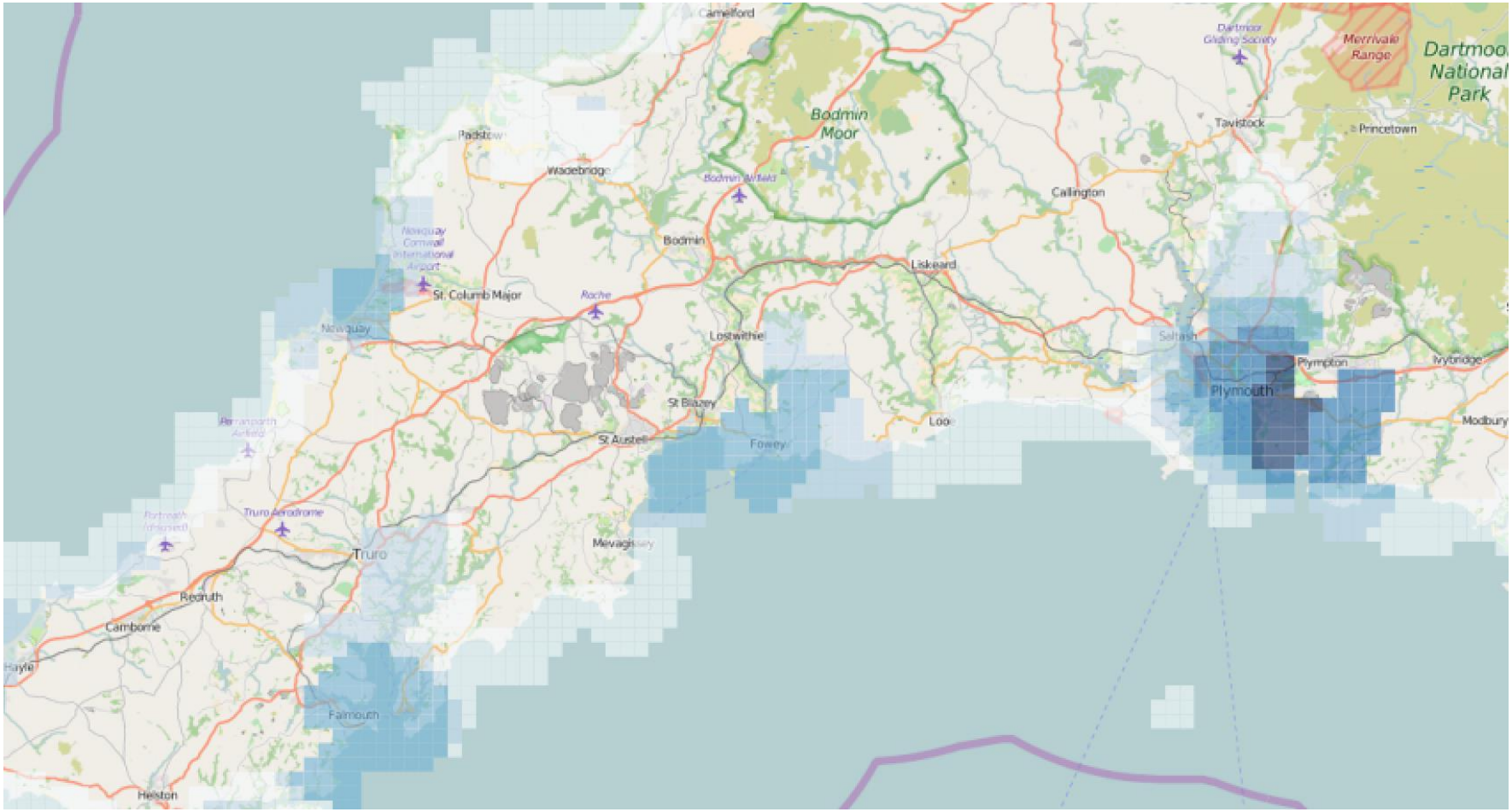
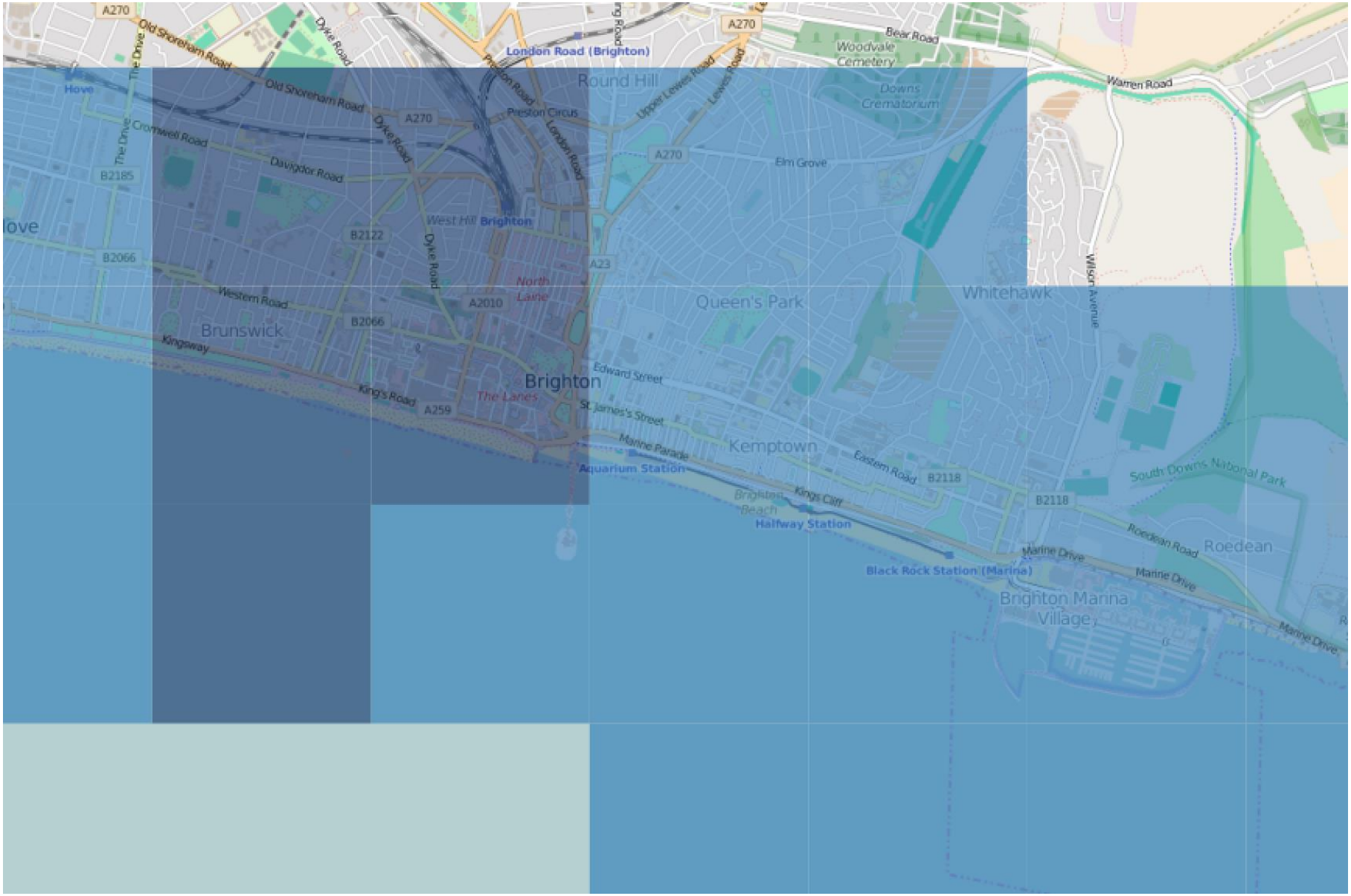



Stoke Park
Greenwich
Priory Heath
Brightwell
Newbourne
Pinewood
Ravenswood
Seven Hills
Bucklesham
Hemley
B1083
Belstead
Wherstead
Nacton
Alderton
Kirton
Bawdsey
Levington
A14
Tattingstone White Horse
Woolverstone
Falkenham
Tattingstone
Chelmondiston
Trimley St Martin
Holbrook
Trimley St Mary
Walton
Old Felixstowe
Stutton
Harkstead
Shotley
Felixstowe
Shotley Gate
Port of Felixstowe
A154
Harwich
Parkeston
Wrabness
Bradfield
Dovercourt
Ramsey
B1414
A120
Wix
Little Oakley
Great Oakley
Great Oakley
B1414
Beaumont-cum-Moze
Tendring

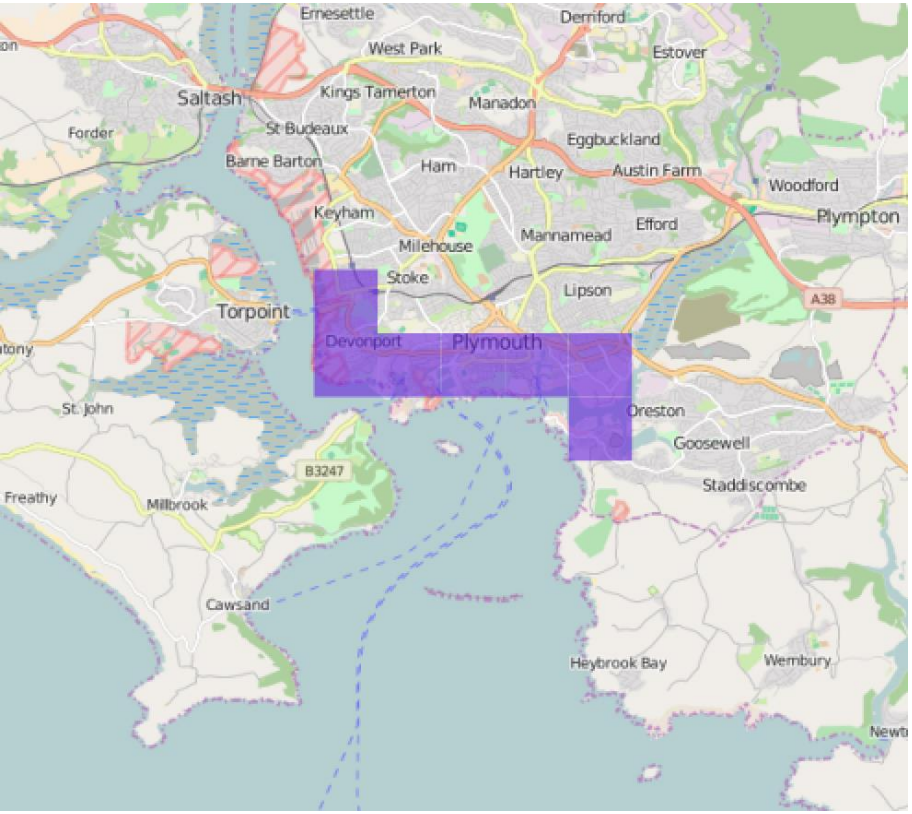

Camelford
Dartmoor Gliding Society
Merrivale Range
Dartmoor National Park
Bodmin Moor
Padstow
Tavistock
Princetown
Wadebridge
Bodmin Airfield
Callington
Newquay Cornwall International Airport
Bodmin
Liskeard
St. Columb Major
Roche
Newquay
Lostwithiel
Saltash
Plympton
Ivybridge
Plymouth
St Blazey
Looe
Modbury
Perranporth Airfield
St Austell
Fowey
Truro Aerodrome
Truro
Redruth
Camborne
Hayle
Falmouth
Helston

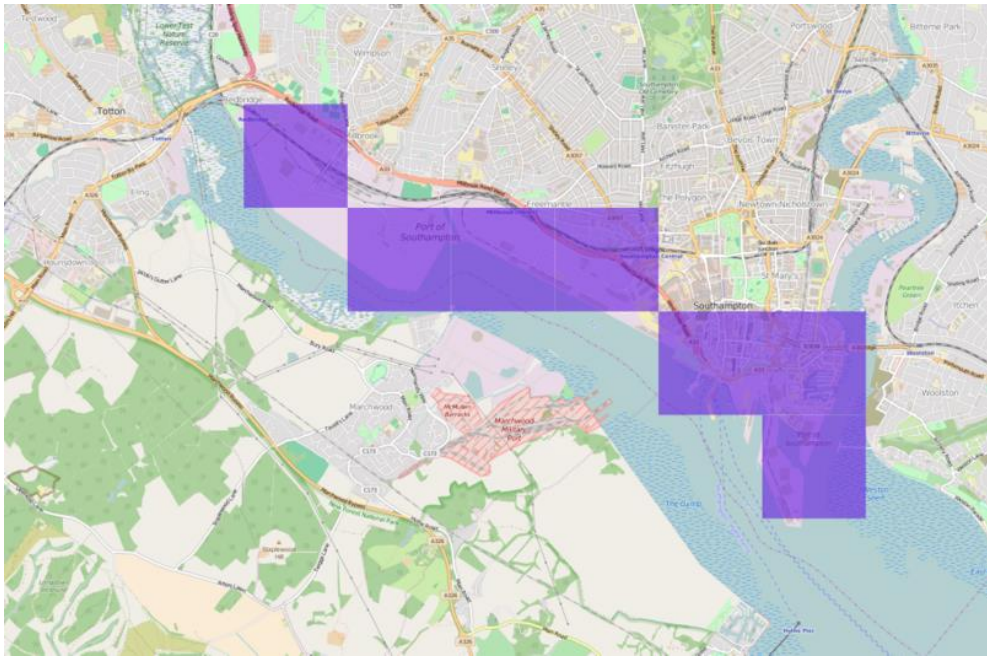

A270
Old Shoreham Road
Dyke Road
London Road (Brighton)
Round Hill
Preston Road
Preston Circus
Upper Lewes Road
Lewes Road
Bear Road
Woodvale Cemetery
Downs Crematorium
Warren Road
Hove
The Drive
Cromwell Road
Dyke Road
Davigdor Road
B2185
A270
Elm Grove
London Road
B2122
West Hill
Brighton
B2066
A23
North Laine
Western Road
A2010
Queen's Park
Whitehawk
Wilson Avenue
Brunswick
B2066
Kingsway
Edward Street
Brighton
The Lanes
King's Road
A259
St James's Street
Marine Parade
Aquarium Station
Kemptown
Eastern Road
B2118
South Downs National Park
Brighton Beach
Kings Cliff
Halfway Station
Roedean Road
Roedean
Marine Drive
Black Rock Station (Marina)
Brighton Marina Village
Marine Drive

Machine Learning?

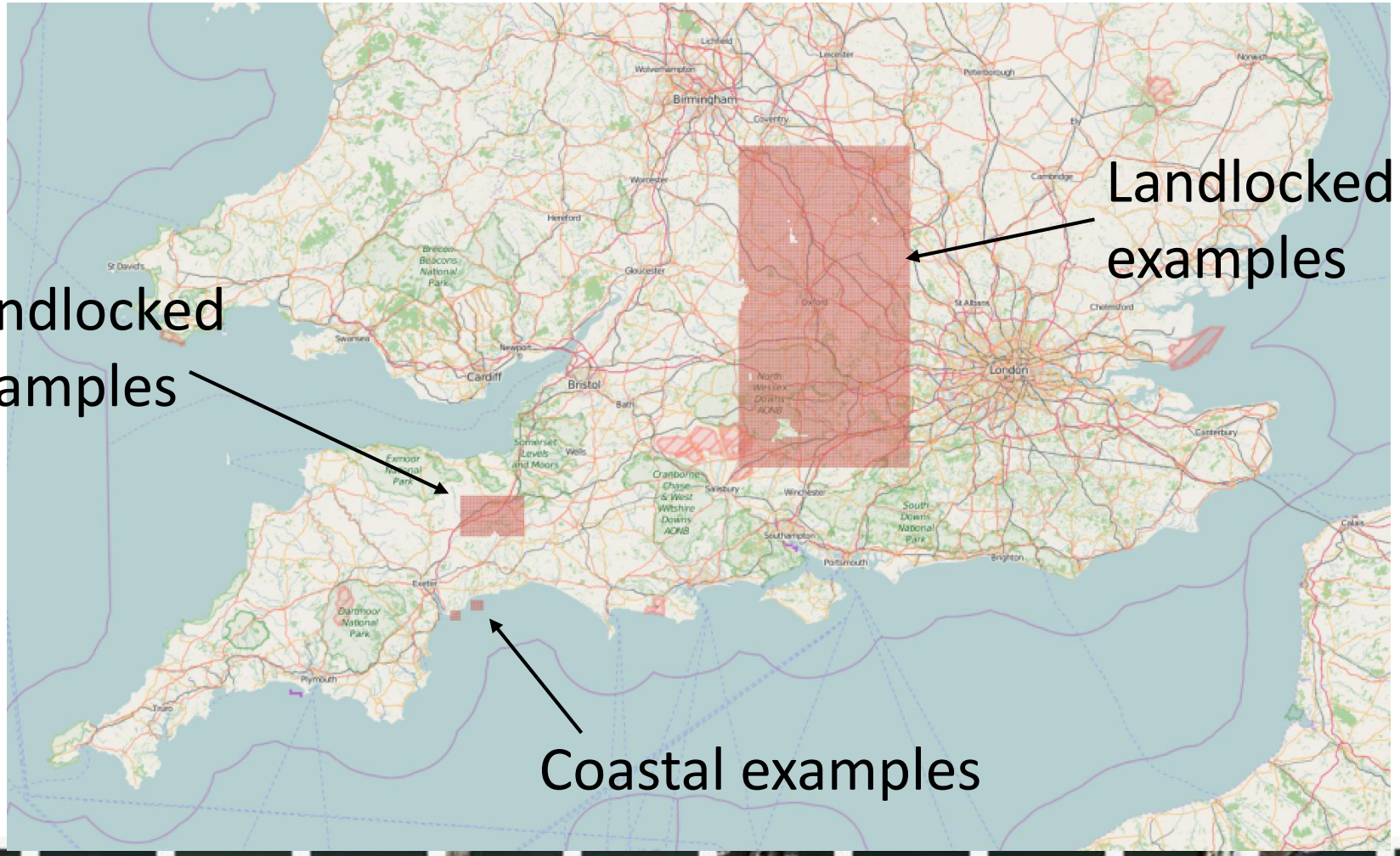
- evolved from the study of pattern recognition and computational learning theory in AI
- Field of study that gives computers the ability to learn without being explicitly programmed.
- 3 Approaches
  - Decision Trees
  - Bayes Classifier
  - Neural Net

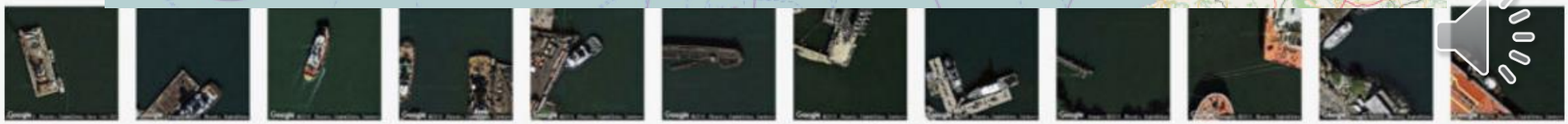
Training set





Training set

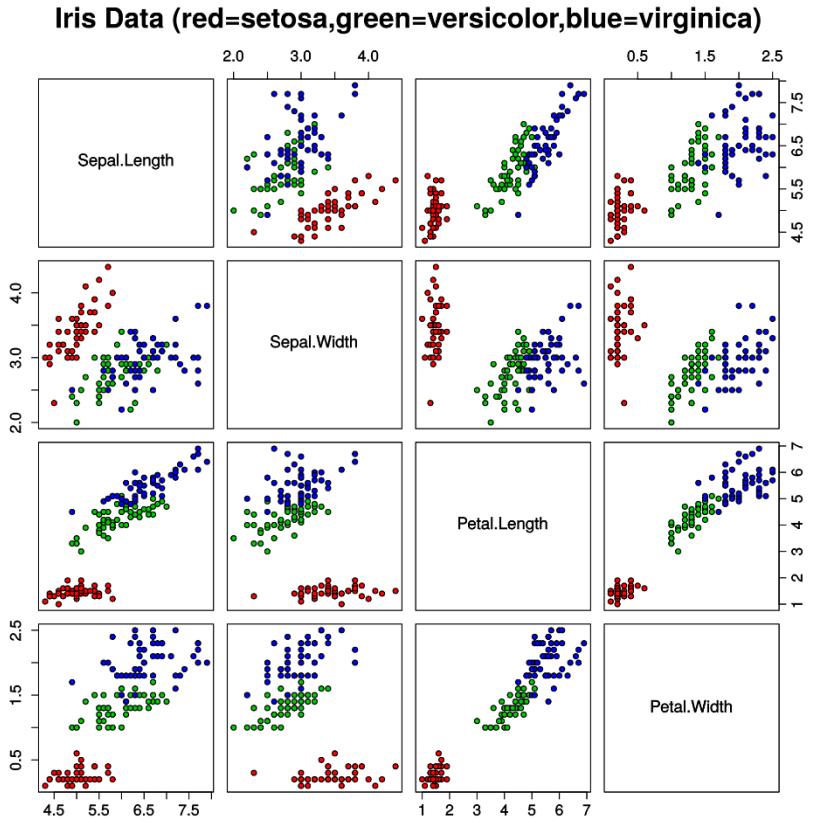


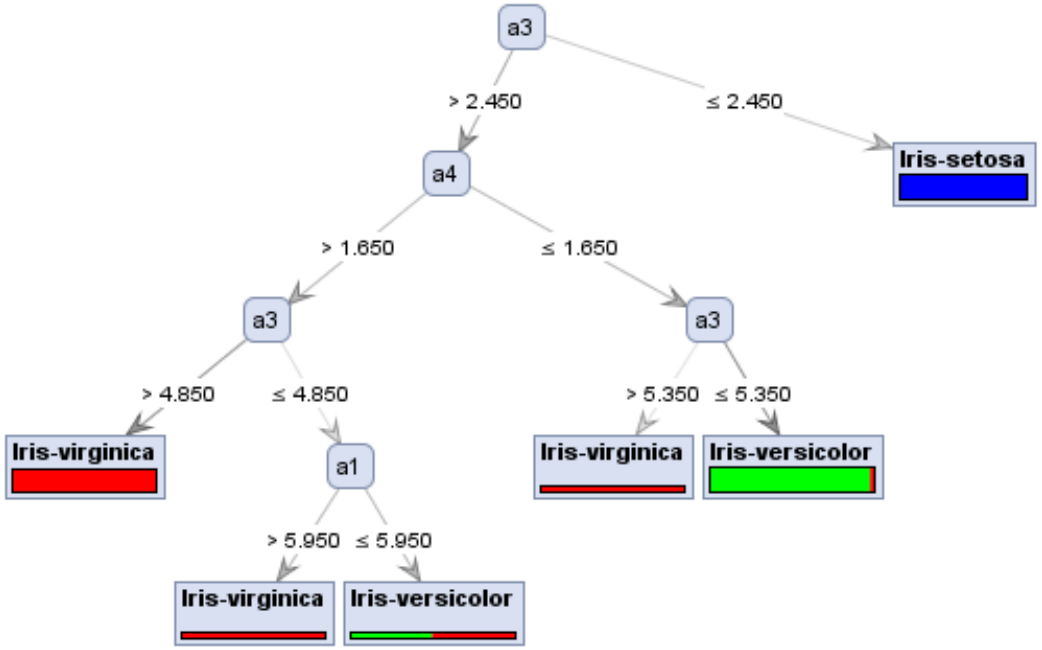


Decision Trees

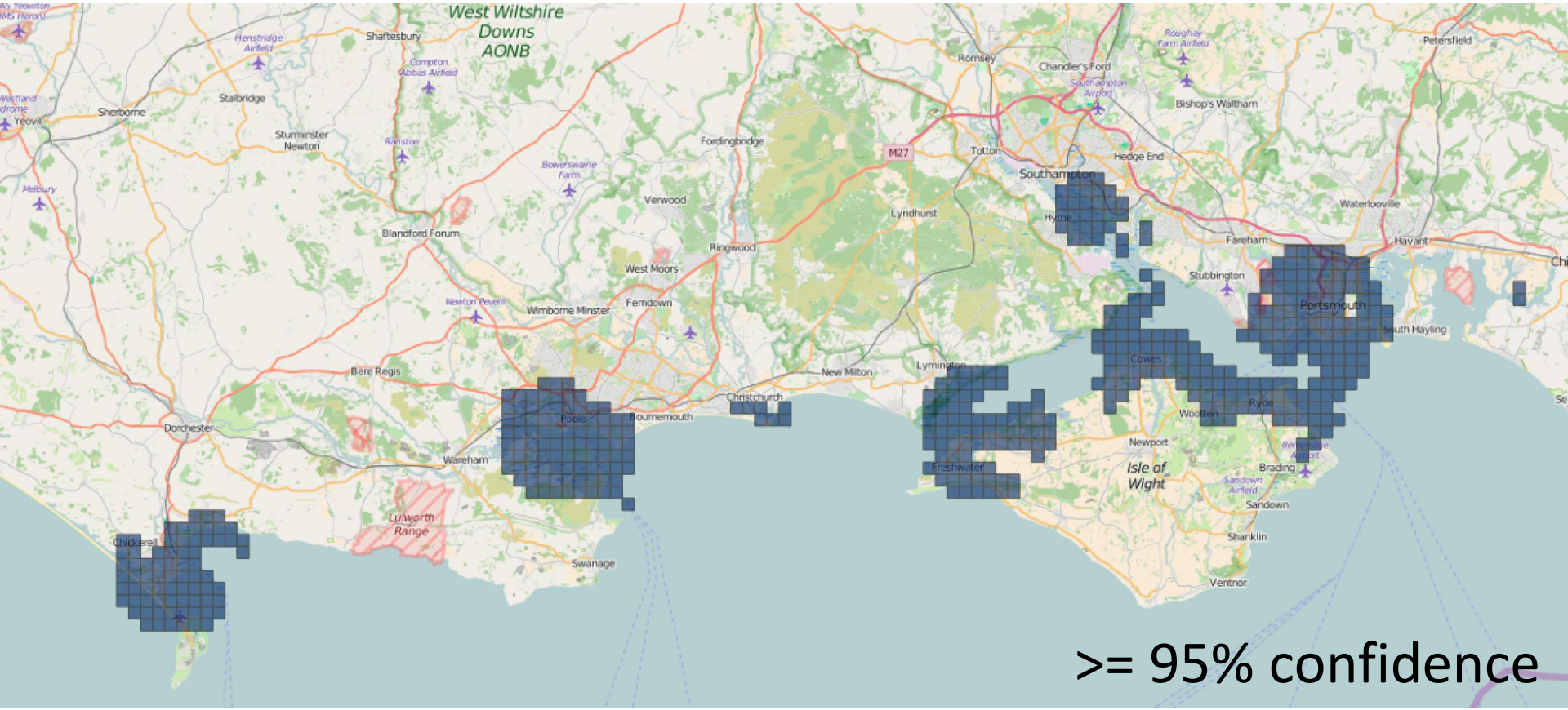
- Uses a decision tree as a predictive model which maps observations about an item to conclusions about the item's target value
- Tree structure denotes decision pathways
  - Comprises decision nodes & leaf nodes
- Topmost decision node corresponds to best predictor – root node
- Handle both categorical & numerical data

Decision tree: classification Iris Data

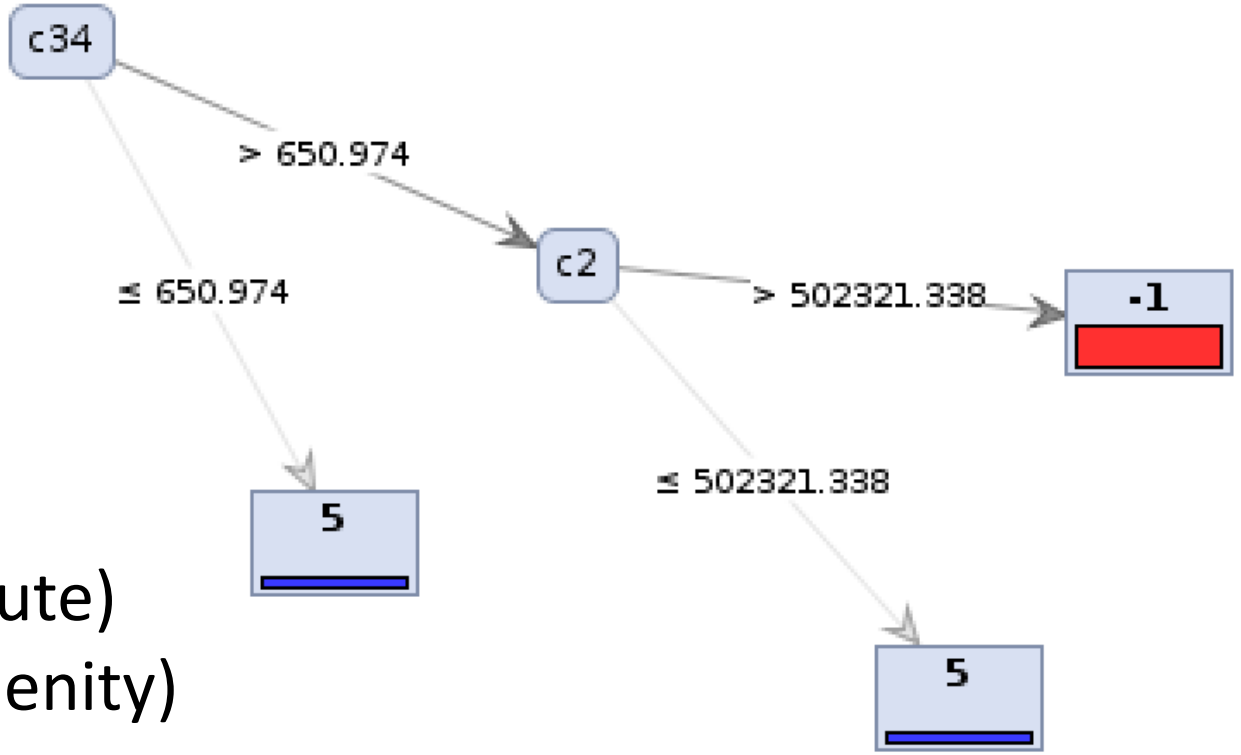




Decision Tree



Decision Tree

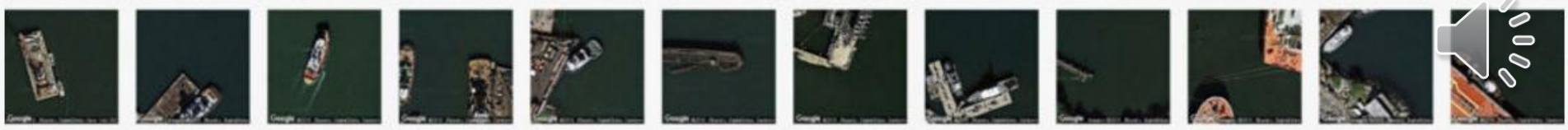


C34 = FERRY (route)

C2 = FERRY (amenity)

5 = Port

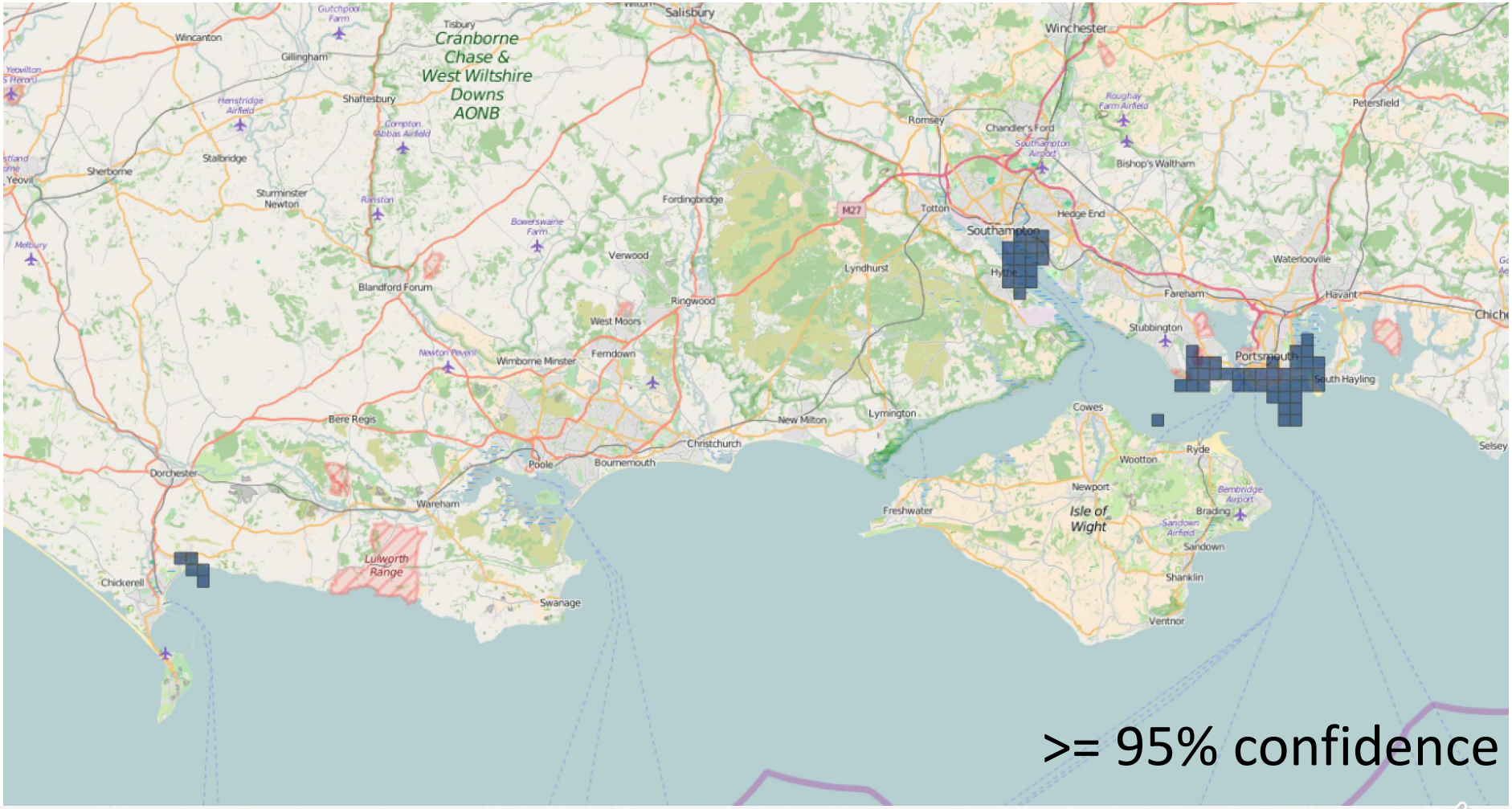
-1 = Not a port

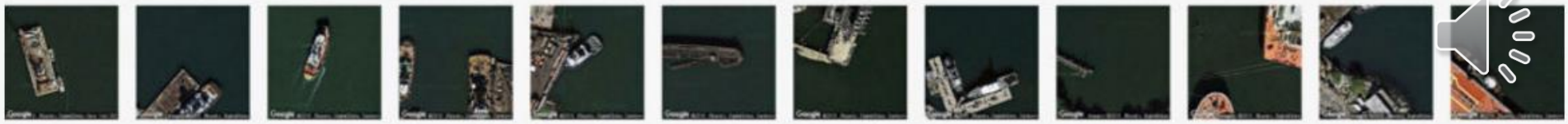


Baye's Classifier

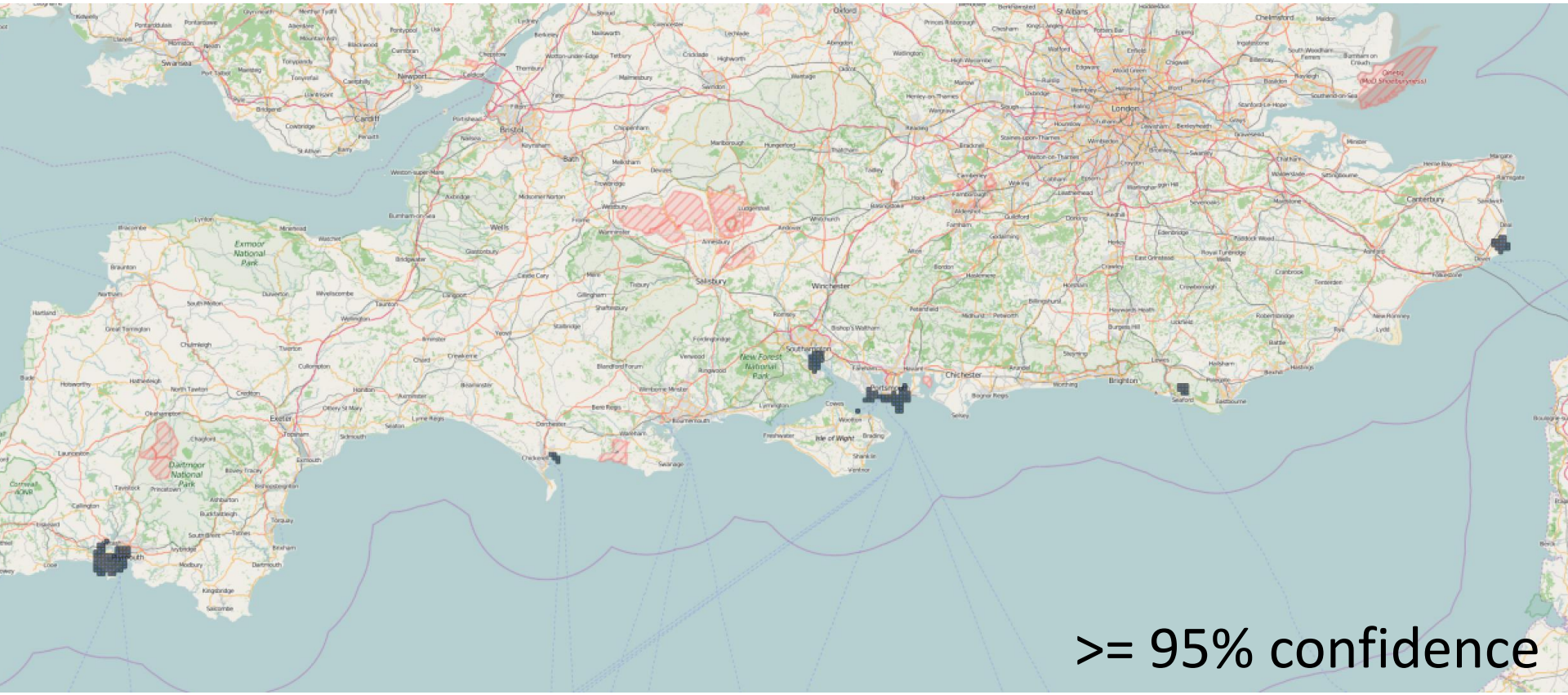
- is a probabilistic graphical model (a type of statistical model) that represents a set of random variables and their conditional dependencies via a directed acyclic graph (DAG).

Bayes Classifier

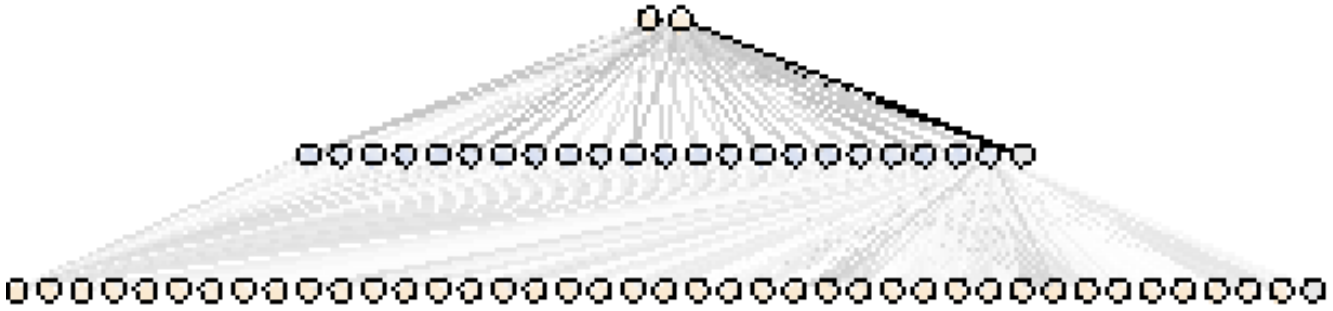




Bayes Classifier



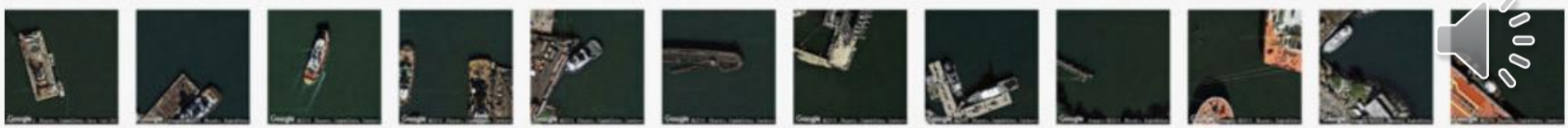
Artificial Neural Network



2 output classes
(port or not port)

1 hidden layer

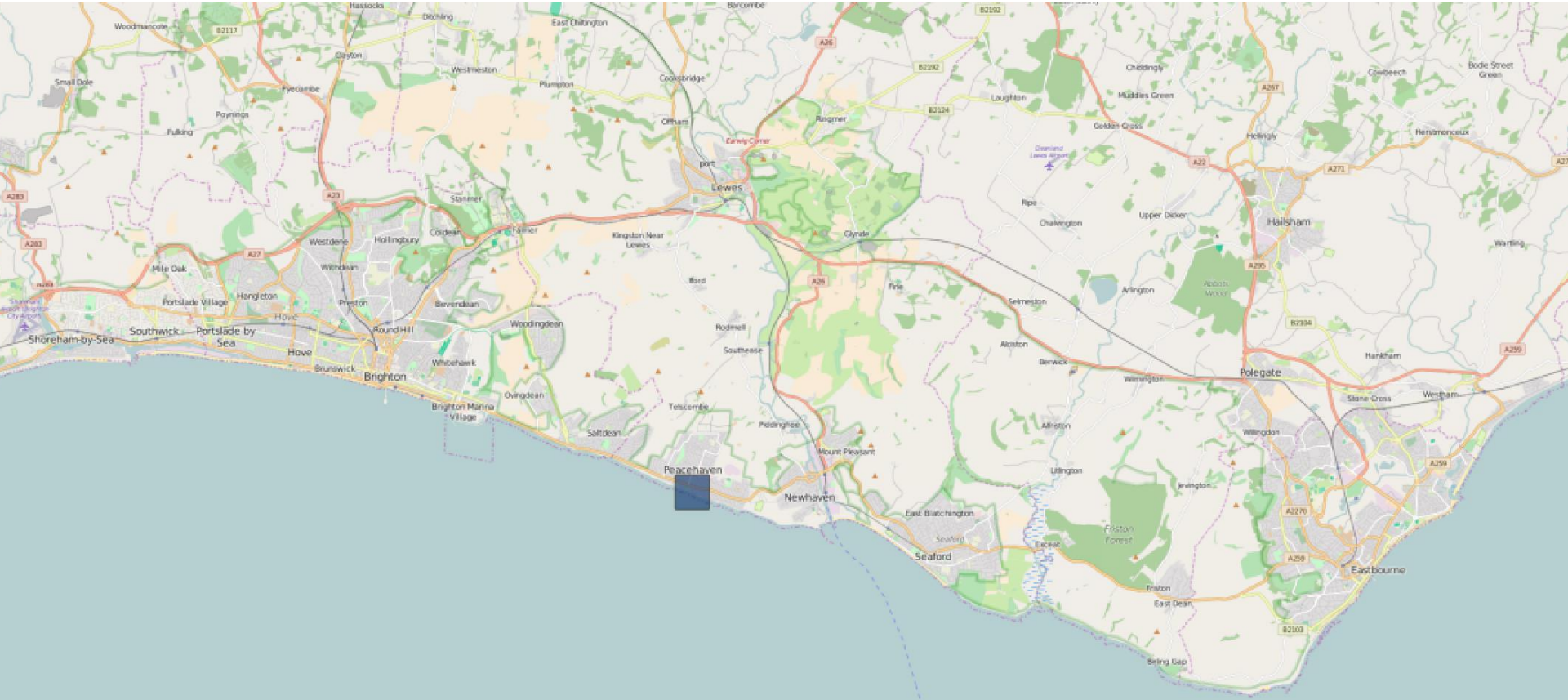
38 inputs



Artificial Neural Network: outputs

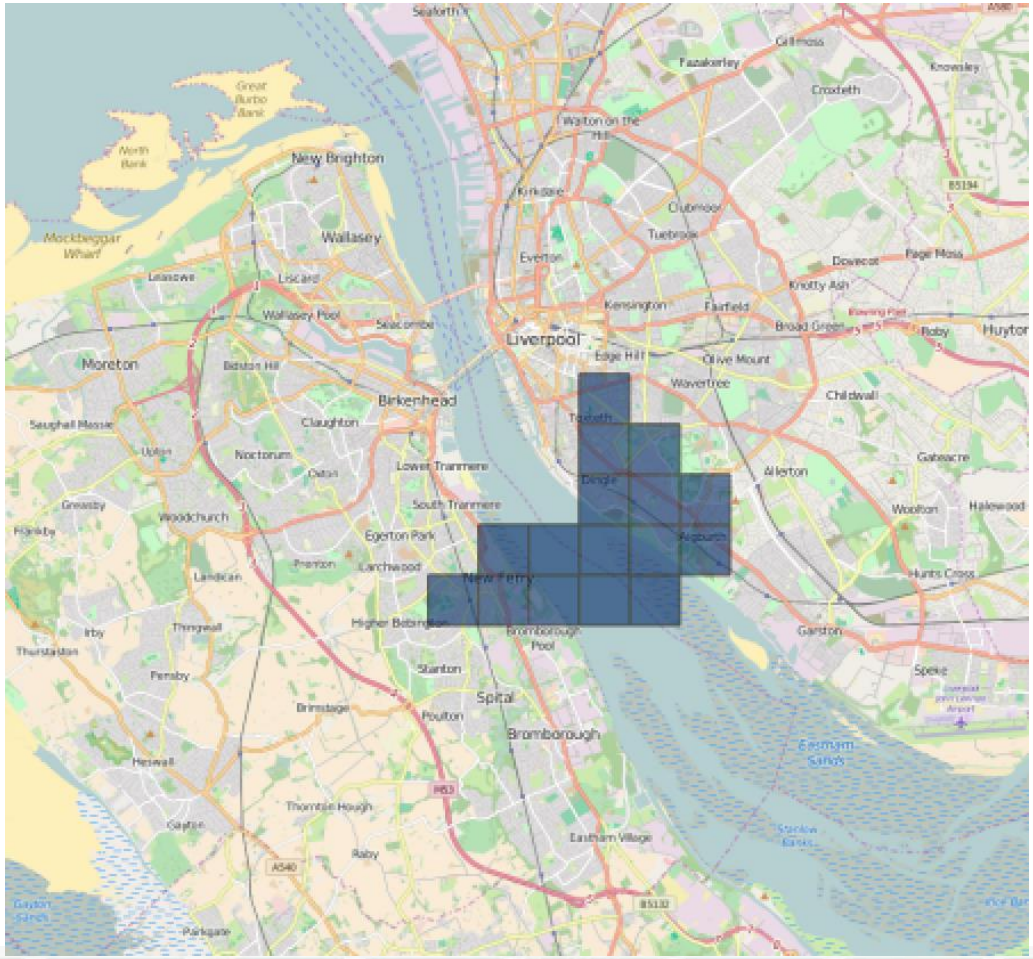
>= 95% confidence

Artificial Neural Network: outputs

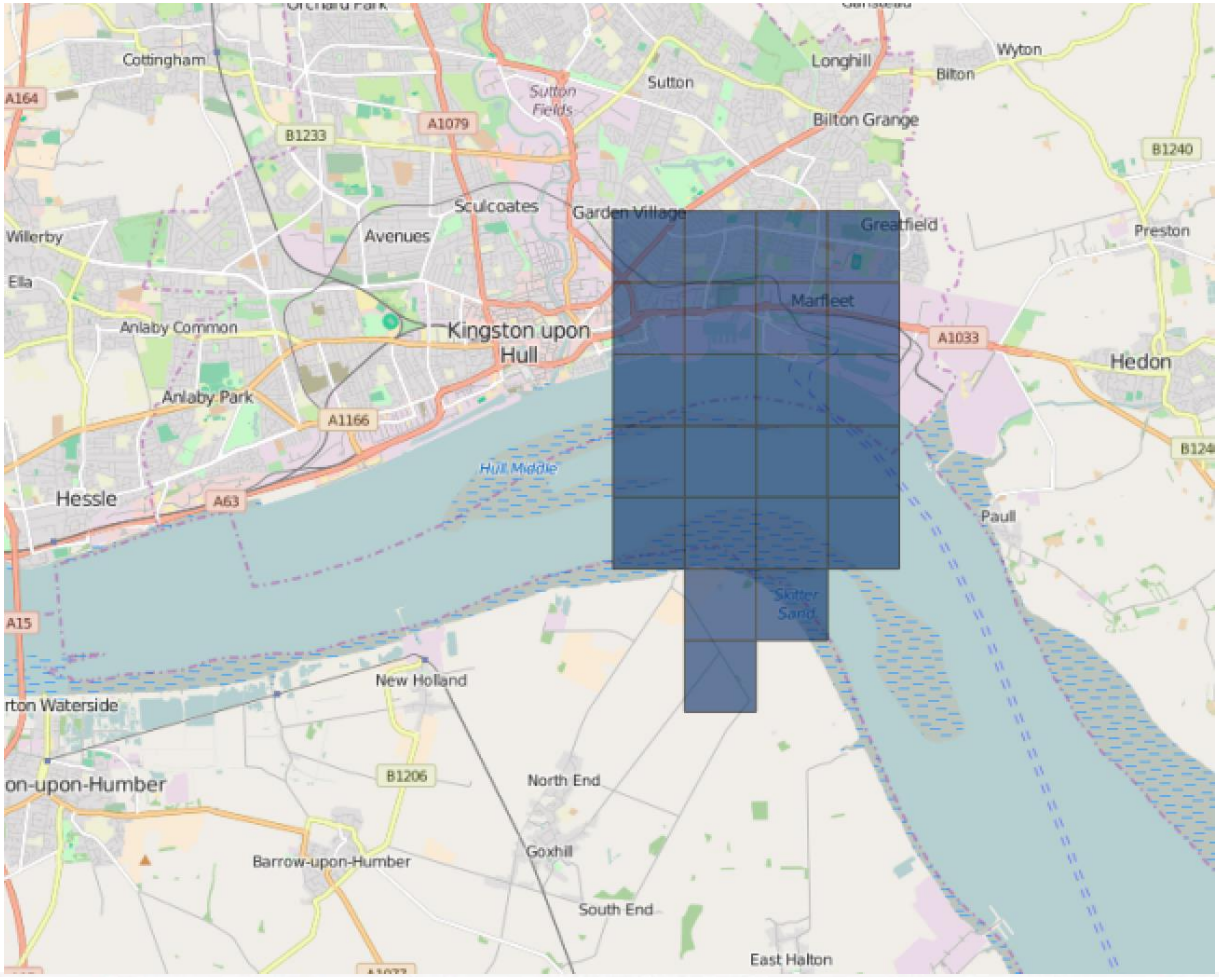


>= 95% confidence

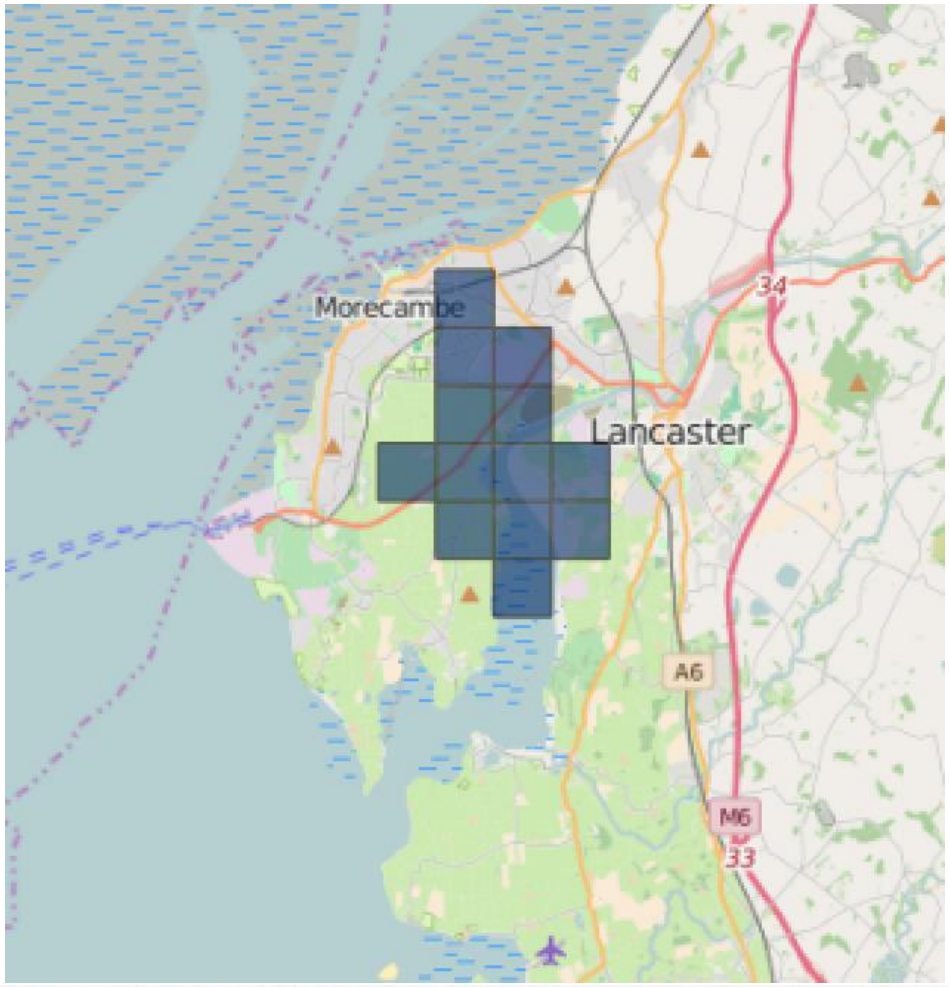
Artificial Neural Network: outputs

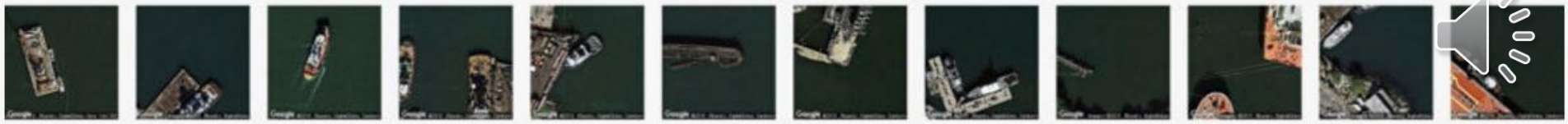


Artificial Neural Network: outputs



Artificial Neural Network: outputs



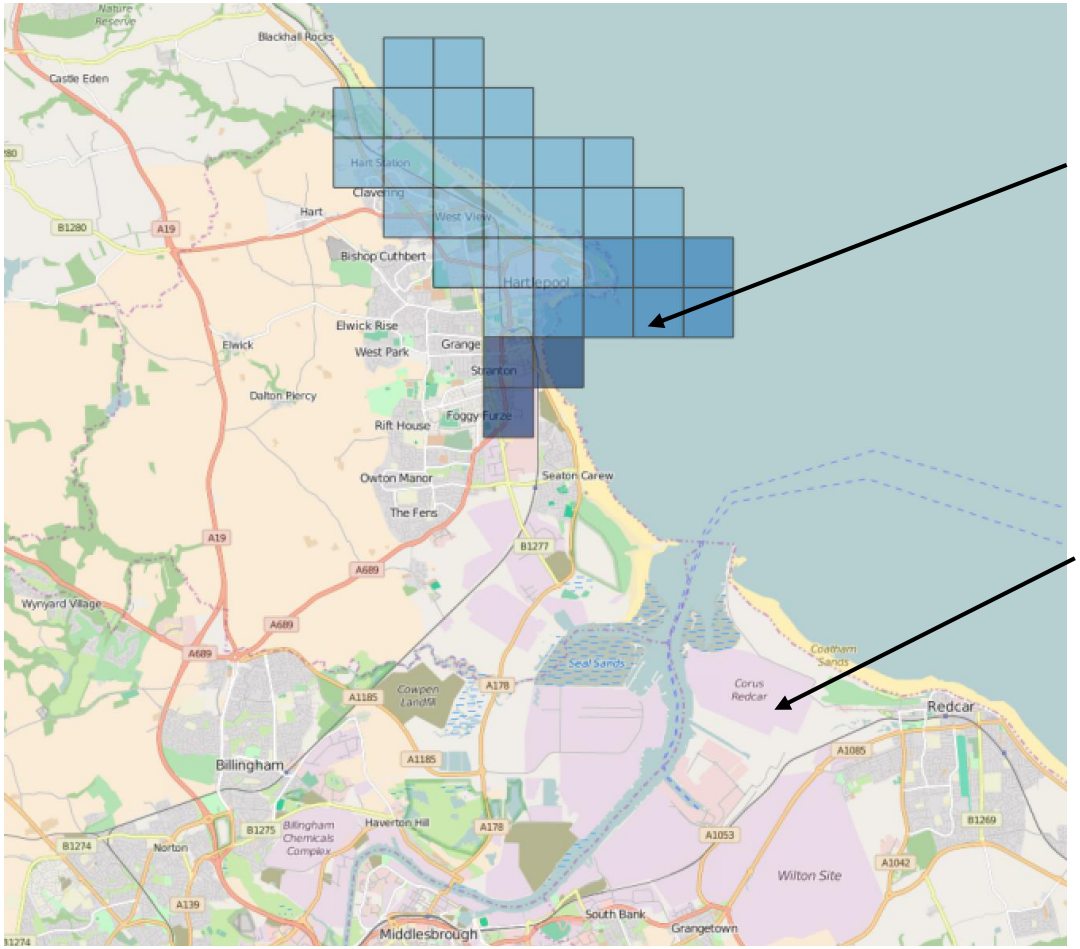


Artificial Neural Network: outputs

Evaluation

Confidence

- 40 - 80%
- 80 - 95%
- 95%+

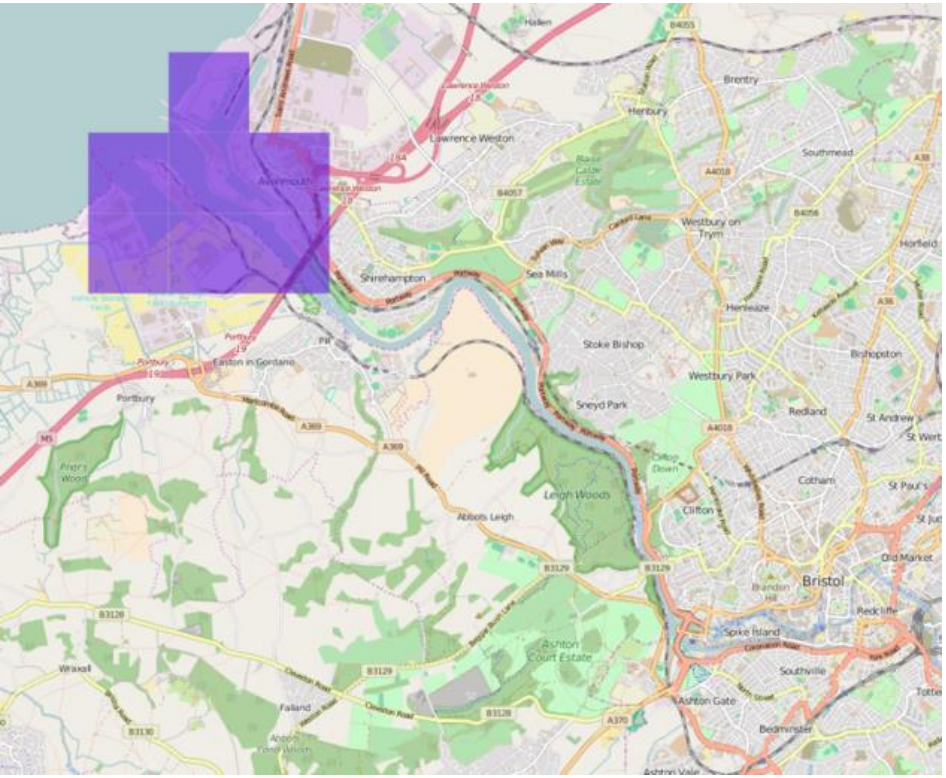


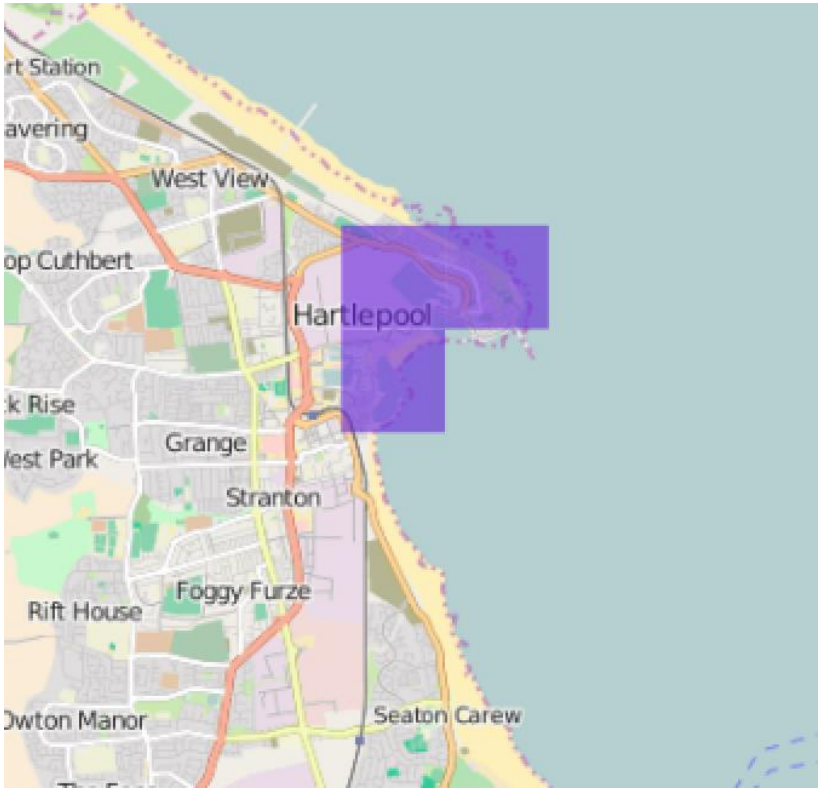
Suggests this is a port

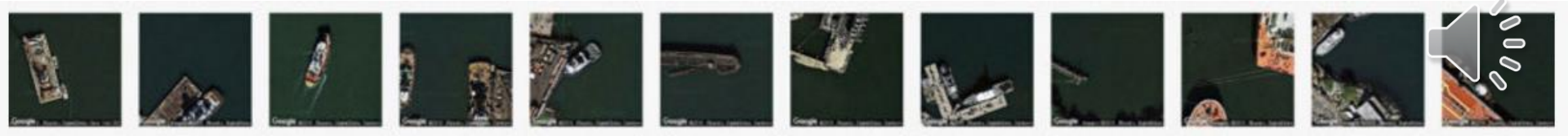
Suggests this is not a port

Additional training?

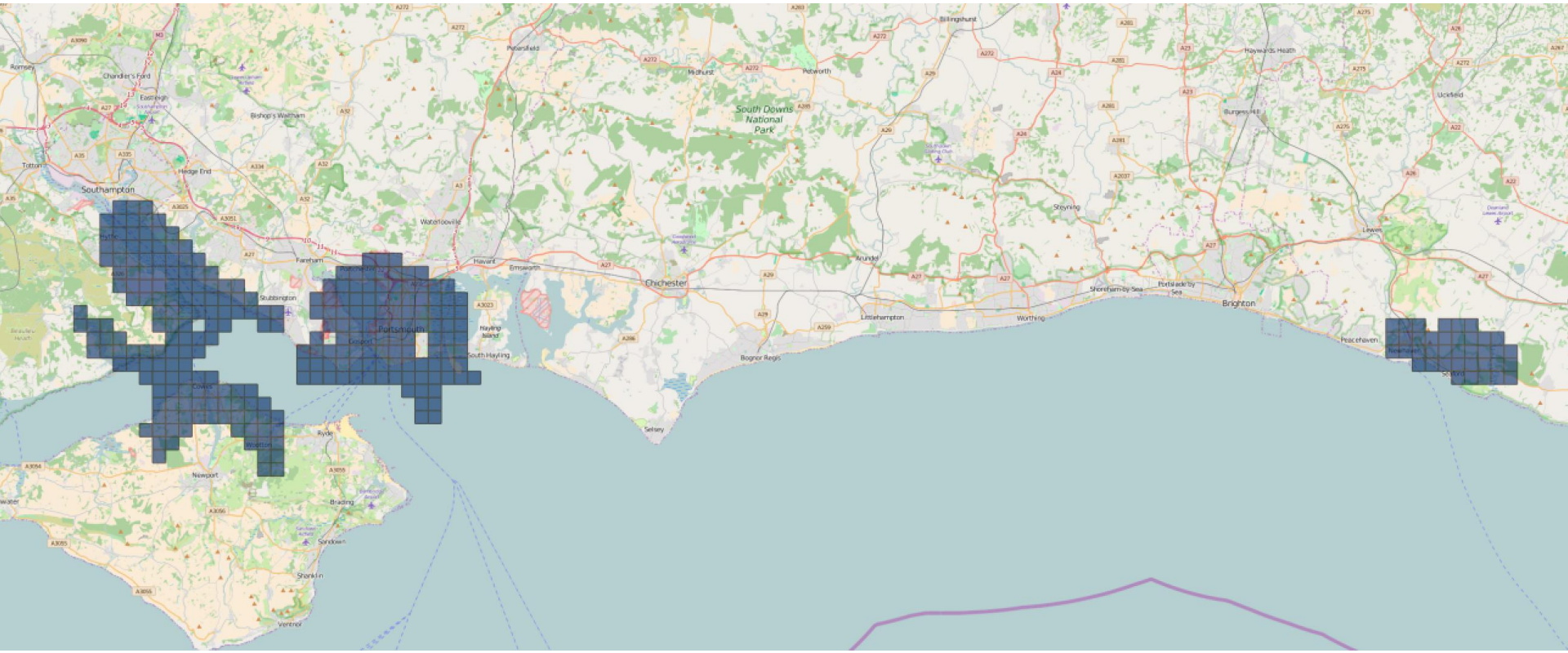
- Bristol and Hartlepool







Artificial Neural Network: outputs



Conclusion

- Simple distance measures produce some meaningful results
- Machine learning approaches show great promise
- Refinement in the training and classification of ports required
- Further evaluation required
- Research ongoing (as they say)

References

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