

UC Santa Barbara

UC Santa Barbara Previously Published Works

Title

Deep learning for all: managing and analyzing underwater and remote sensing imagery on the web using BisQue

Permalink

<https://escholarship.org/uc/item/9z73t7hv>

Authors

Fedorov, Dmitry, V
Kvilekval, Kristian, G
Doheny, B
et al.

Publication Date

2017-03-01

Peer reviewed

Deep learning
for all

BisQue | Connoisseur

What is BisQue

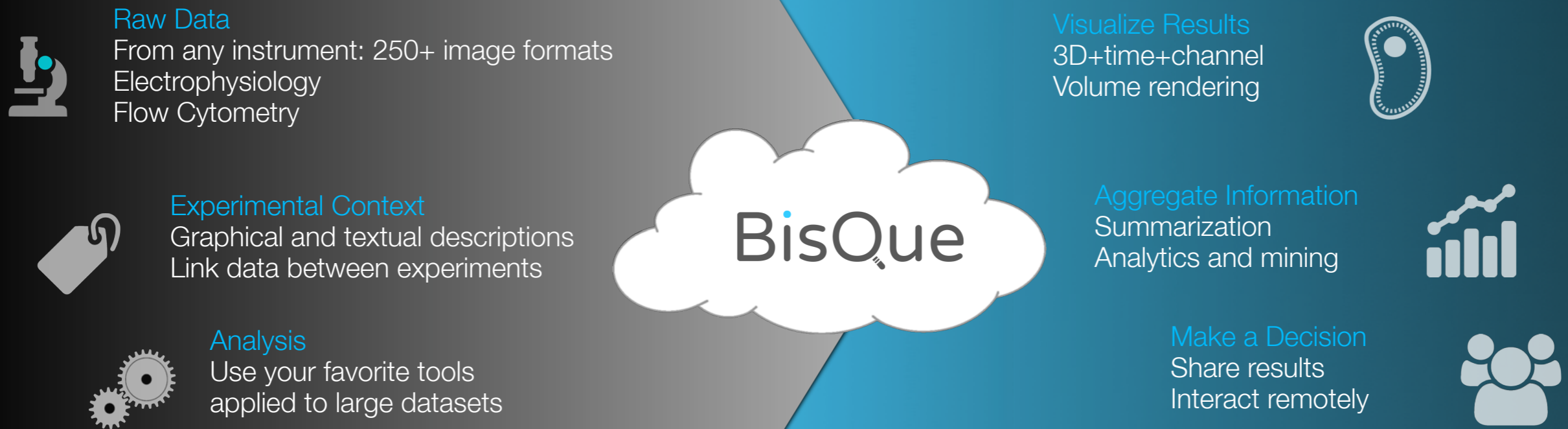
Management, annotation and analysis of complex scientific data:

- Any metadata schema in one system
- Very large 5D images in 250+ formats (videos, 3D, ...)
- Tables, charts, chemical, genetic data, ...
- Scalable analysis
- Multi-modal searching and mining
- Web based (access anywhere with web browser)
- Cloud-based and scalable (many users and analyses)
- Commercial version and support via

ViOQI

BisQue

Workflow

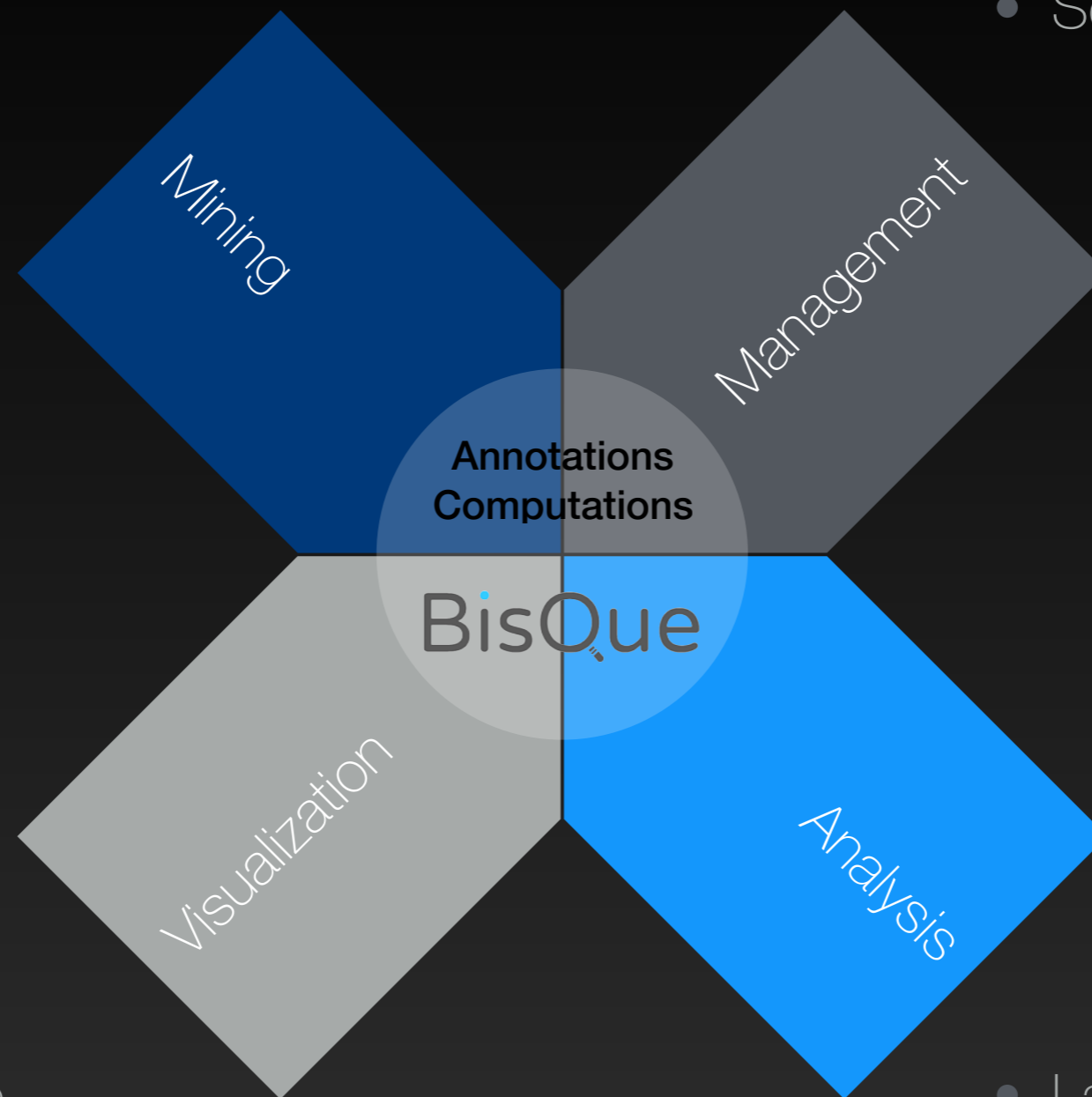


UCSB system supports labs working on:

Life sciences, Materials, GIS and ecology, Medical, Marine sciences

- Multimodal: Textual, 5D graphical, images, graph, geometry
- Semantic meaning

- 250+ image formats
- Everything on the web
- Searchable & organizable



- 5D images of any size
- WebGL volume viewer
- Many types: images, molecules, PDFs, etc...
- Plots and summaries

- Large-scale & extensible
- Automated UI
- Docker deployments
- Python, ITK, Matlab, CellProfiler, DREAM.3D, ...

BisQue | Architecture



XML, JSON, binary



Connoisseur services

Deep learning classification/training

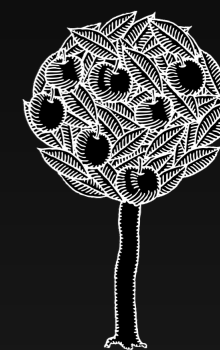


Index services

Content indexing: Full text, graph, geometry, image content

Full text

Graph



elastic

Image similarity

Geometry

Query services

Query dialects and extensions: XPath, BICKER,...

Blob/
Image
Services



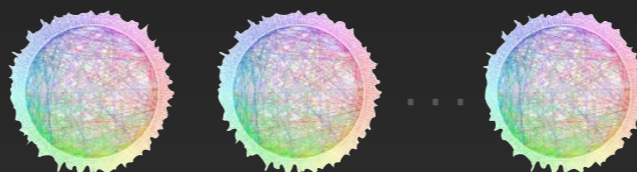
iRODS



amazon
web services™

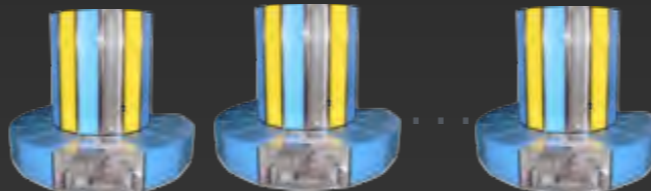


Data
Services



PostgreSQL

Analysis
Services



Spark



HTCCondor
High Throughput Computing

Users

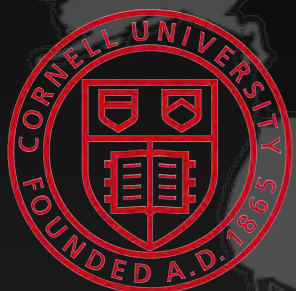


CYVERSE™

UCSB



ALLEN CELL EXPLORER



UCSF



THE UNIVERSITY OF ARIZONA



Cold Spring Harbor Laboratory



GILEAD

RARECYTE



EPIC SCIENCES™



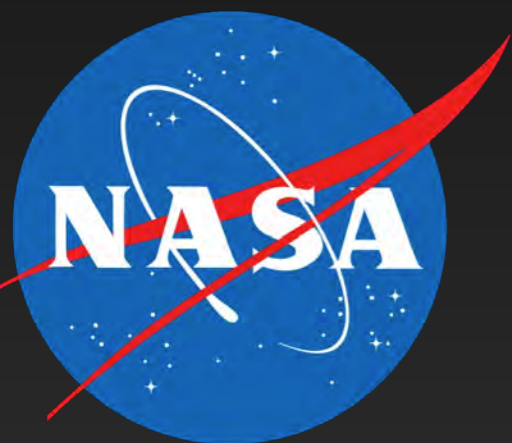
FEI™



Genesis Imaging Services

BisQue

Sponsors

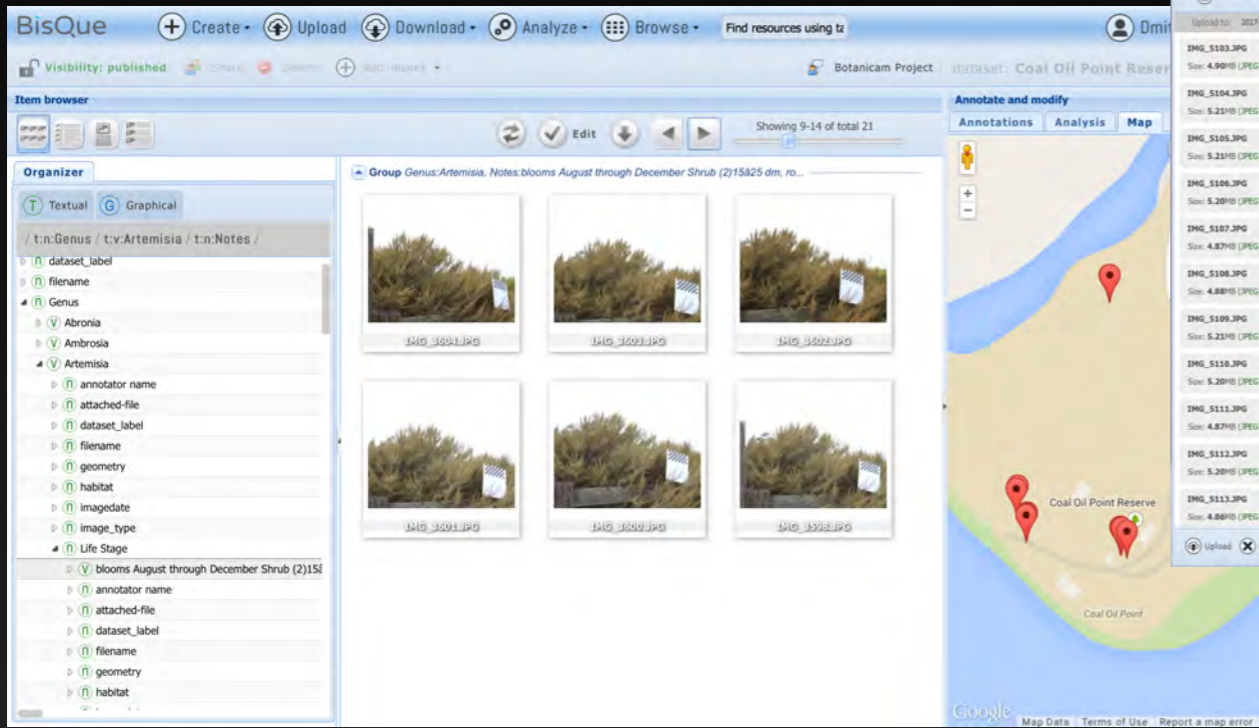


Features

BisQue | Connoisseur

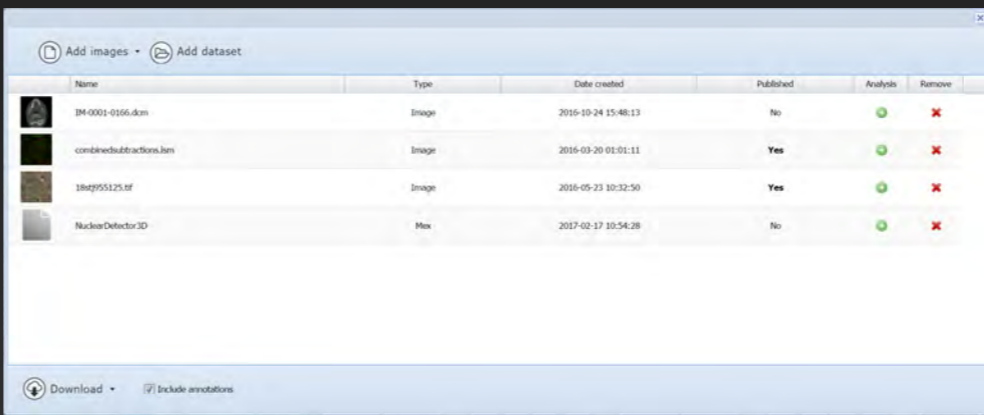
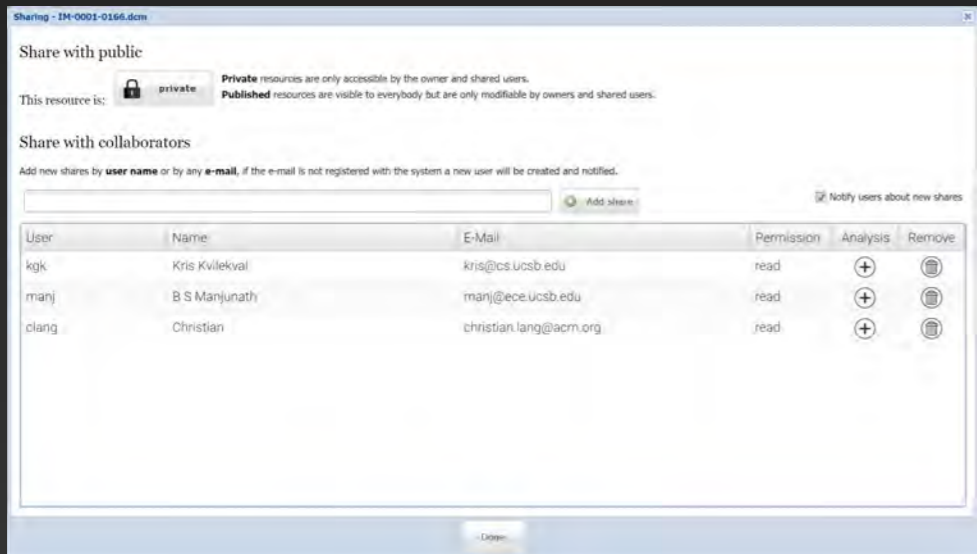
Features

Dynamic organizer

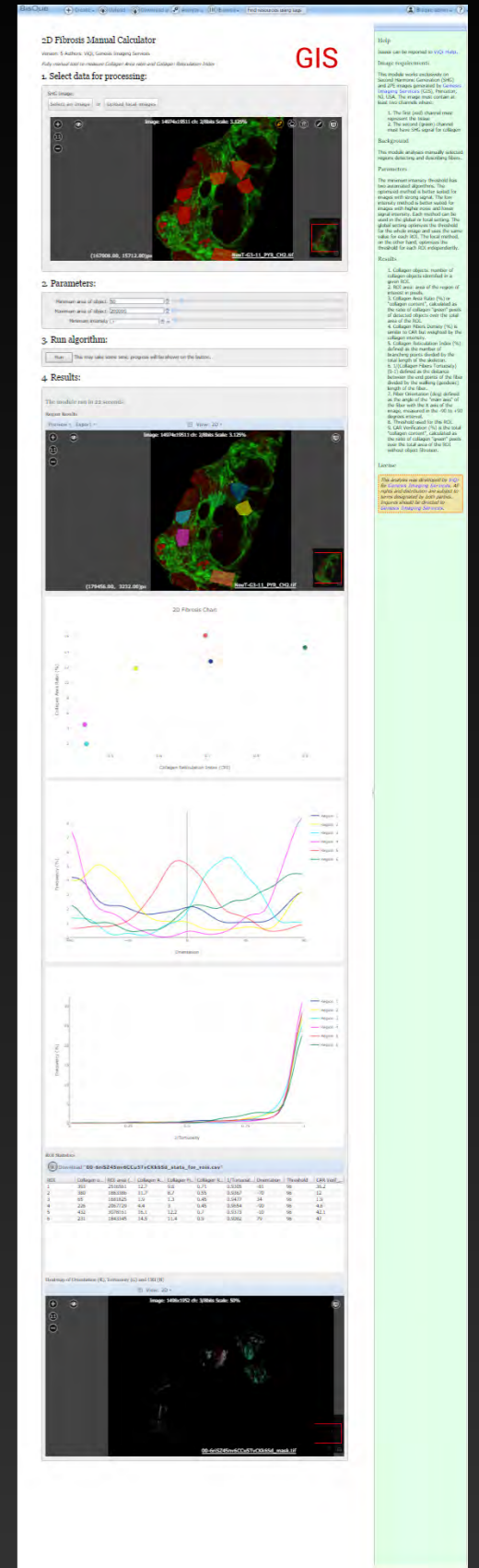


Import anything

Sharing

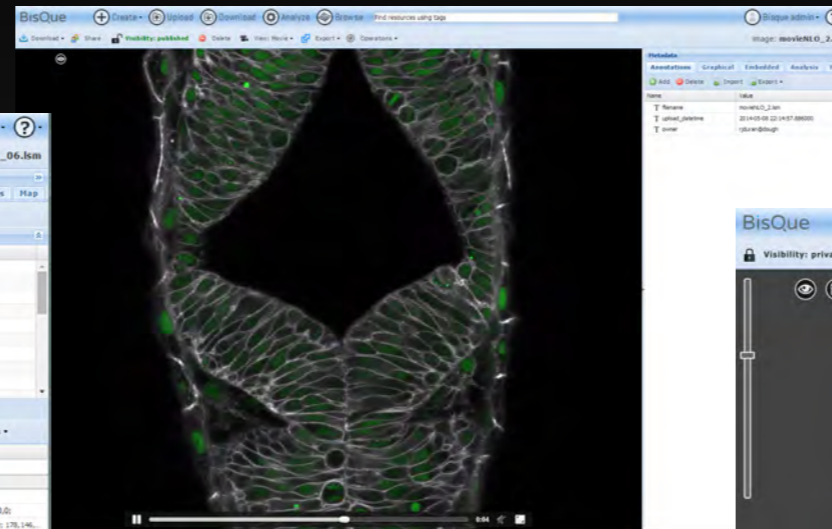
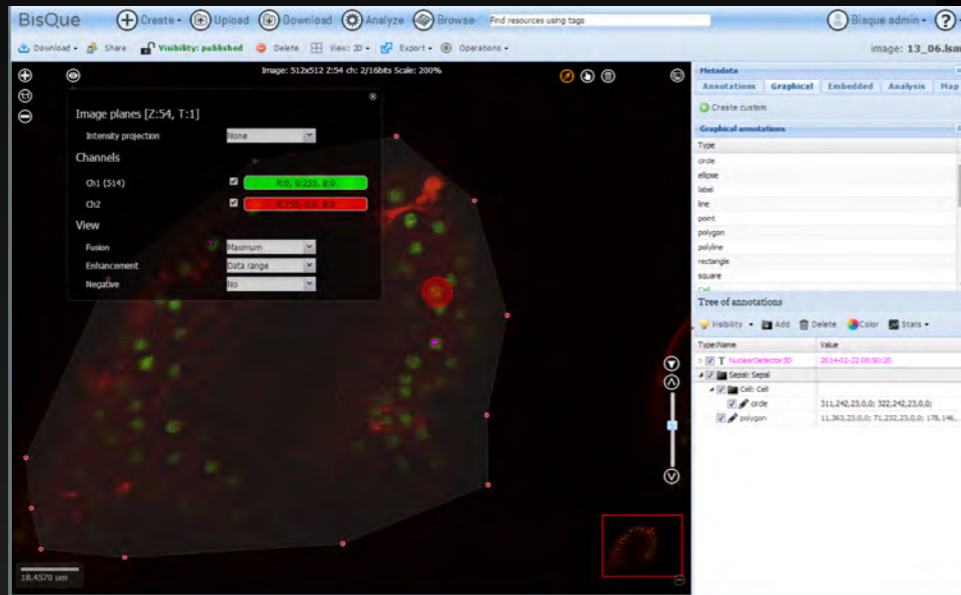


Export everything

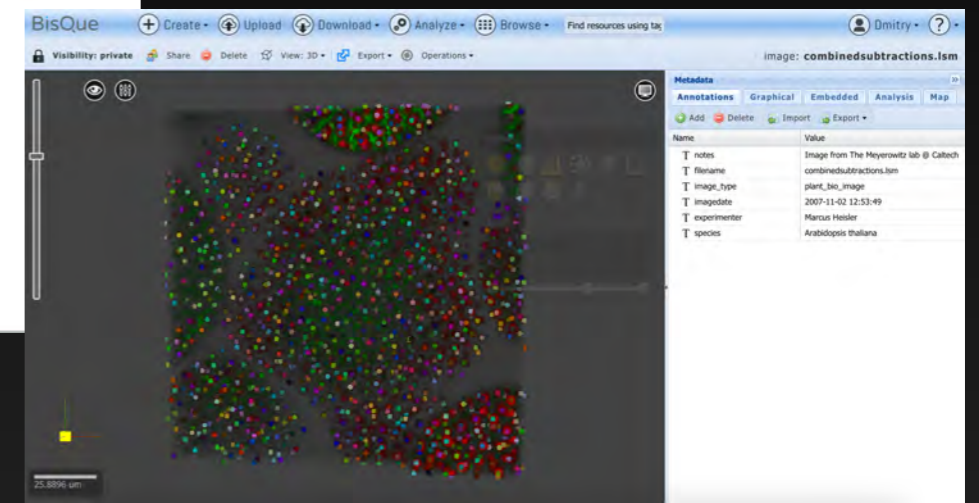


Features

Powerful image viewer and annotator

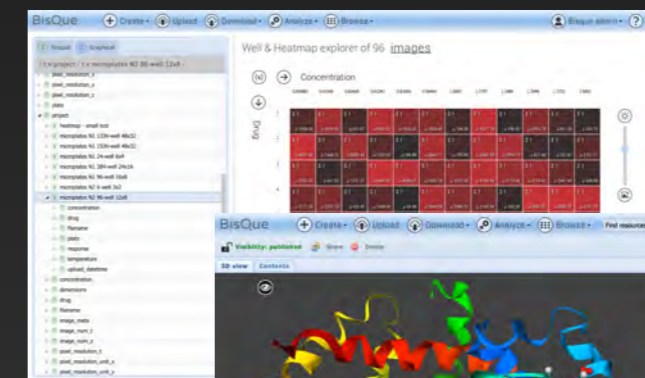
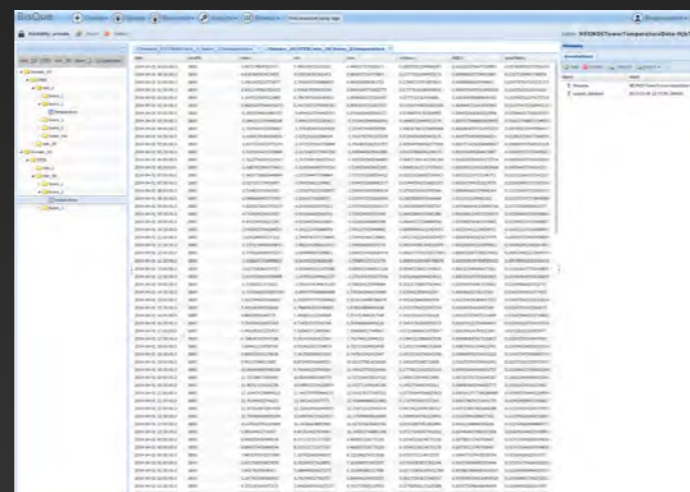


Volume rendering

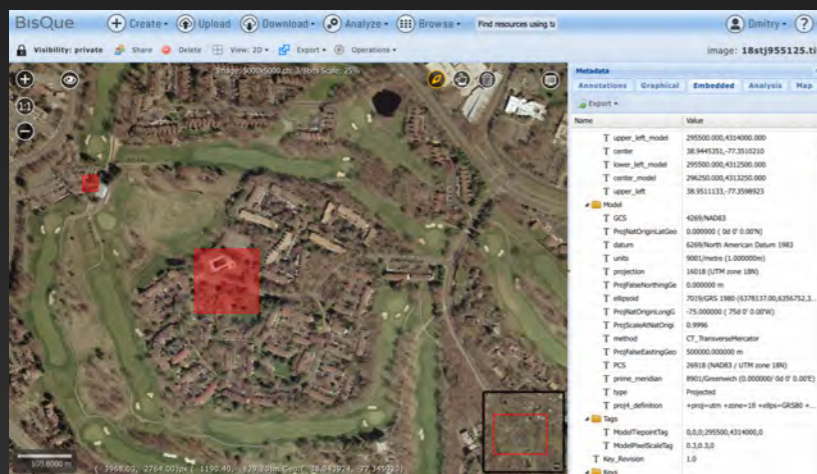


Movies

Tabular data



Custom data types



Geographic data

Deep learning
for all

BisQue | Connoisseur

Annotations by experts

The screenshot displays the BisQue web interface. At the top, the navigation bar includes options like 'Create', 'Upload', 'Download', 'Analyze', and 'Browse'. The main area shows a large image of a reef with a grid of red dots overlaid, indicating annotations. A ruler is visible at the bottom of the image. On the right side, there is a 'Metadata' panel with tabs for 'Annotations', 'Graphical', 'Embedded', 'Analysis', and 'Map'. The 'Annotations' tab is active, showing a list of 102 children with their types and names, such as 'Rhodophyta - Encrusting coralline spp.' and 'Substrate - Sand'. A small inset image is visible in the bottom right corner of the main image area.

Image: 5496x3670 ch: 3/16bits Scale: 25%

Image: IMG_2001.CR2

Metadata

Annotations Graphical Embedded Analysis Map

Current children: 102

Visibility Add Delete Color Stats

Type:Name

- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Substrate - Sand
- ✓ Substrate - amphipod tube complex
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Substrate - Bare Rock
- ✓ Substrate - Bare Rock
- ✓ Rhodophyta - Encrusting coralline spp. Substrate - Bare Rock
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Cnidaria - Plumularia spp.
- ✓ Substrate - Bare Rock
- ✓ Substrate - Hydroid/Bryozoan complex
- ✓ Substrate - Bare Rock
- ✓ Mollusca - Parapholas californica
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Substrate - Hydroid/Bryozoan complex
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Rhodymenia spp.
- ✓ Substrate - Sand
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Substrate - Bare Rock
- ✓ Substrate - Bare Rock
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Ectoprocta - Peach Bryozoan (Unknown)
- ✓ Ectoprocta - Peach Bryozoan (Unknown)
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Substrate - Bare Rock
- ✓ Substrate - Sediment (SCUM)
- ✓ Ectoprocta - Peach Bryozoan (Unknown)
- ✓ Substrate - Bare Rock
- ✓ Substrate - Bare Rock
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Rhodophyta - Encrusting coralline spp.
- ✓ Heterokontophyta - Macrocystis pyrifera
- ✓ Rhodophyta - Encrusting coralline spp.

(5768.00, 1344.00)px

Many images + Many annotators

Statistics of annotated data

BisQue + Create + Upload + Download + Analyze + Browse + Find resources using tag + Watersipora-Reef ?

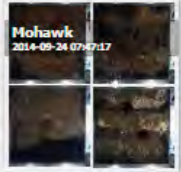
Histograms of graphical annotations

Version: 1 Authors: The Bisque team
This module summarises graphical annotations.

1. Select data for processing:

Dataset to extract metadata (Leave empty to process all available datasets):

Select a set of images



2. Parameters:

Use full annotation path:

3. Run algorithm:

Run This may take some time, progress will be shown on the button.

4. Results:

The module ran in 19 seconds

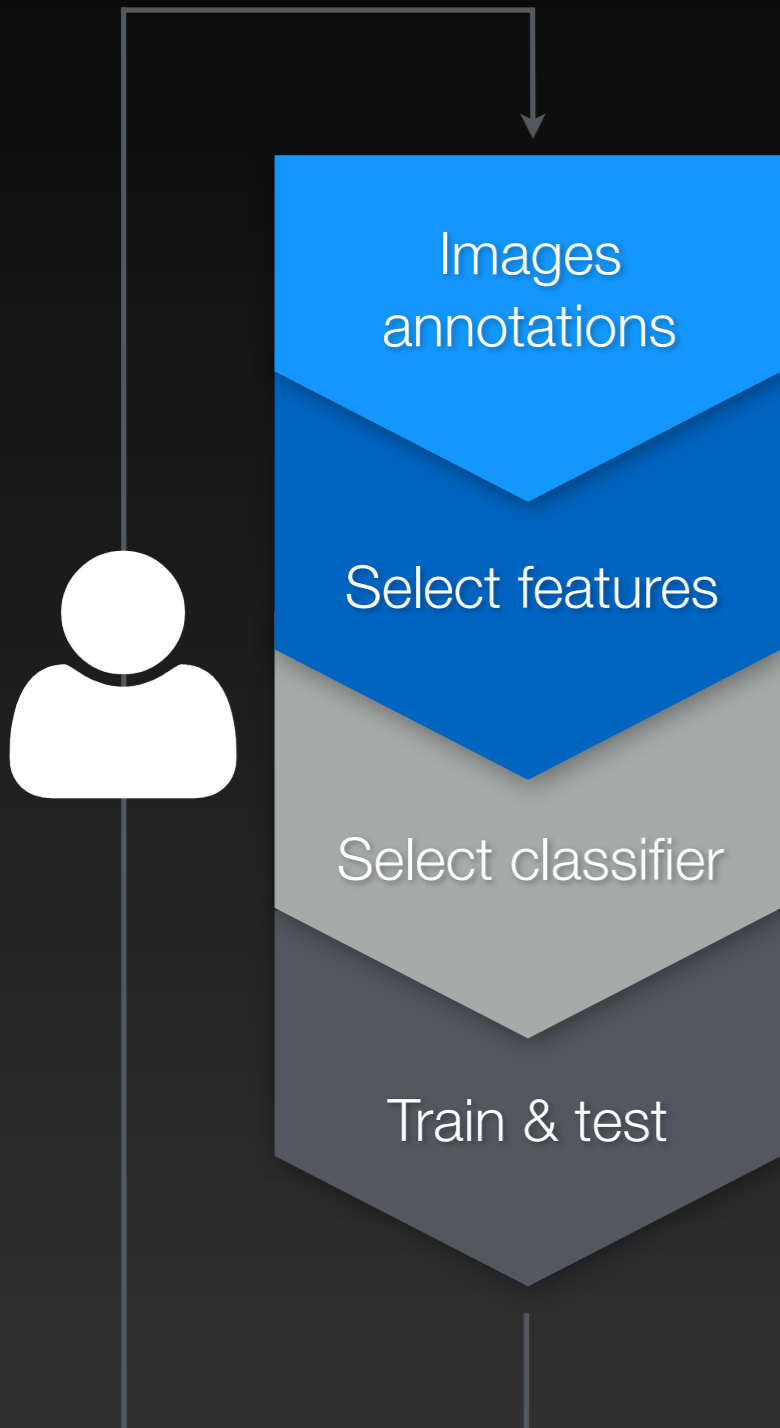
Histogram of annotations

Download "histograms_one_layer_20160509T152754_00-4aDK4TQrTqNqvYUJLQ2Wid.csv"

dataset	filename	Meter #	Transect #	With Algae?	annotation_	Annelid	Annelid	Annelid	Annelid	Annelid	Annelid	Annelid	Annelid	Annelid	Annelid	Annelid	Annelid	Arthro	Arthro	Arthro	Arthro	Arthro	Arthro	Arthro	Arthro	Chloro	Chloro	Chloro	Chloro	Chloro
Mohawk	IMG_1689.CR2	40	1	yes	validated	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1690.CR2	40	1	yes	validated	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
Mohawk	IMG_1692.CR2	42	1	yes	validated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1694.CR2	42	1	yes	validated	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1695.CR2	44	1	yes	validated	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1696.CR2	44	1	yes	validated	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1697.CR2	44	1	no	validated	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1698.CR2	46	1	yes	validated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1699.CR2	46	1	yes	validated	0	0	0	0	1	1	0	0	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1701.CR2	48	1	yes	validated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1702.CR2	48	1	no	validated	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1703.CR2	48	1	yes	validated	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1704.CR2	50	1	yes	validated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mohawk	IMG_1705.CR2	50	1	yes	validated	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Dynamic export into desired forms

Typical machine learning



Engineer required throughout

Time consuming (3 months)

Only works on specific type of data

Best example for marine sciences

CORALNET ALPHA
A WEB SOLUTION FOR CORAL REEF ANALYSIS

Upload coral reef images, organize and annotate images, and view annotation statistics.

[Sign In](#) [Sign Up](#) [What is CoralNet?](#)

Visit data sources from around the world by clicking on public sources to explore images, labels, and coverage statistics.

There are currently 329 sources on CoralNet, with a combined total of 195753 images. Out of all the annotations on the site, 5187441 are human annotated, 5750550 are machine annotated, with a total of 10937991 annotations.

[About](#) [Contact Us](#)

Powered by [Django](#)
Site theme adapted from [Django-Userena](#)

Features: Color and Texture
Classifier: SVM

Goals for Connoisseur

Automate annotations

without engineer

in reduced time

for specific datasets

Continuously improve classifier



Deep learning made easy

Benefits

Generalizes to your data

Fully automated - no feature selection

High accuracy

Convolutional Neural Network (CNN)

Leverages

Big data

Scalable services

Annotation system

Multimodal queries

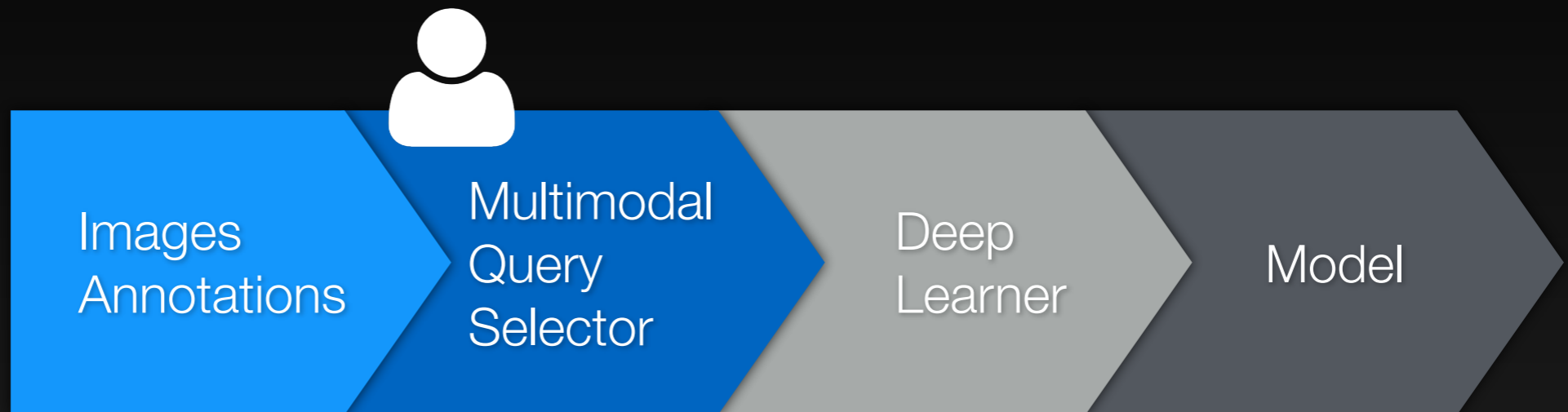
Cluster processing

Fast classification on GPUs



Deep learning made easy

Learning pipeline



BisQue services



GPU cluster

Recognition pipeline



Model building

BisQue Create Upload Download Analyze Browse Find resources using tags Bisque admin

Connoisseur | Sea fruits

Author: Dmitry Fedorov
License: unrestricted
© UCSB
Model designed for natural image recognition

Dataset: Watersipora-Reef (13 images)

73 Minimum number of samples 20% Minimum class accuracy 95% Minimum sample goodness

Available classes		Model performance	
ID	Samples	Label	
29	176	Cnidaria - Corynactis californica	
105	154	Rhodophyta - Encrusting coralline spp.	
10	113	Arthropoda - Barnacles (Unidentifiable)	
9	56	Arthropoda - Barnacle (DEAD)	
114	53	Rhodophyta - Rhodomenia spp.	
68	34	Ectoprocta - Thalamoporella californica	
118	33	Substrate - Hydroid/Bryozoan complex	
83	30	No Data - Shells	
103	28	Rhodophyta - Chondracanthus spp.	
20	27	Chordata - Trididemnum spp.	
49	27	Echinodermata - Strongylocentrotus franciscanus	
69	27	Ectoprocta - Watersipora subota	
3	19	Annelida - Solmocina tritrichiata	
26	19	Cnidaria - Aequorea victoria	
63	18	Ectoprocta - Peach Bryozoan (Unknown)	
107	18	Rhodophyta - Filamentous red spp. (Unidentifiable)	
119	18	Substrate - Sand	
58	17	Ectoprocta - Crisia A	
113	17	Rhodophyta - Red Tuff spp. (Unidentifiable)	
59	16	Ectoprocta - Diaperofoma californica	
120	16	Substrate - amphipod-tube-complex	
116	15	Substrate - Bare Rock	
8	14	Arthropoda - Balanus spp.	
51	14	Ectoprocta - Bugula californica	
82	14	No Data - Shadow	

Plot

BisQue Create Upload Download Analyze Browse Find resources using tags Bisque admin

Connoisseur: automated image annotation

Version: 1 Authors: Dmitry Fedorov
This module automatically annotates selected images.

1. Select data for processing:

Images to classify:
Select an image or Select a set of images or even Upload local images

Classification model:
Select connoisseur
Sea fruits

2. Parameters:

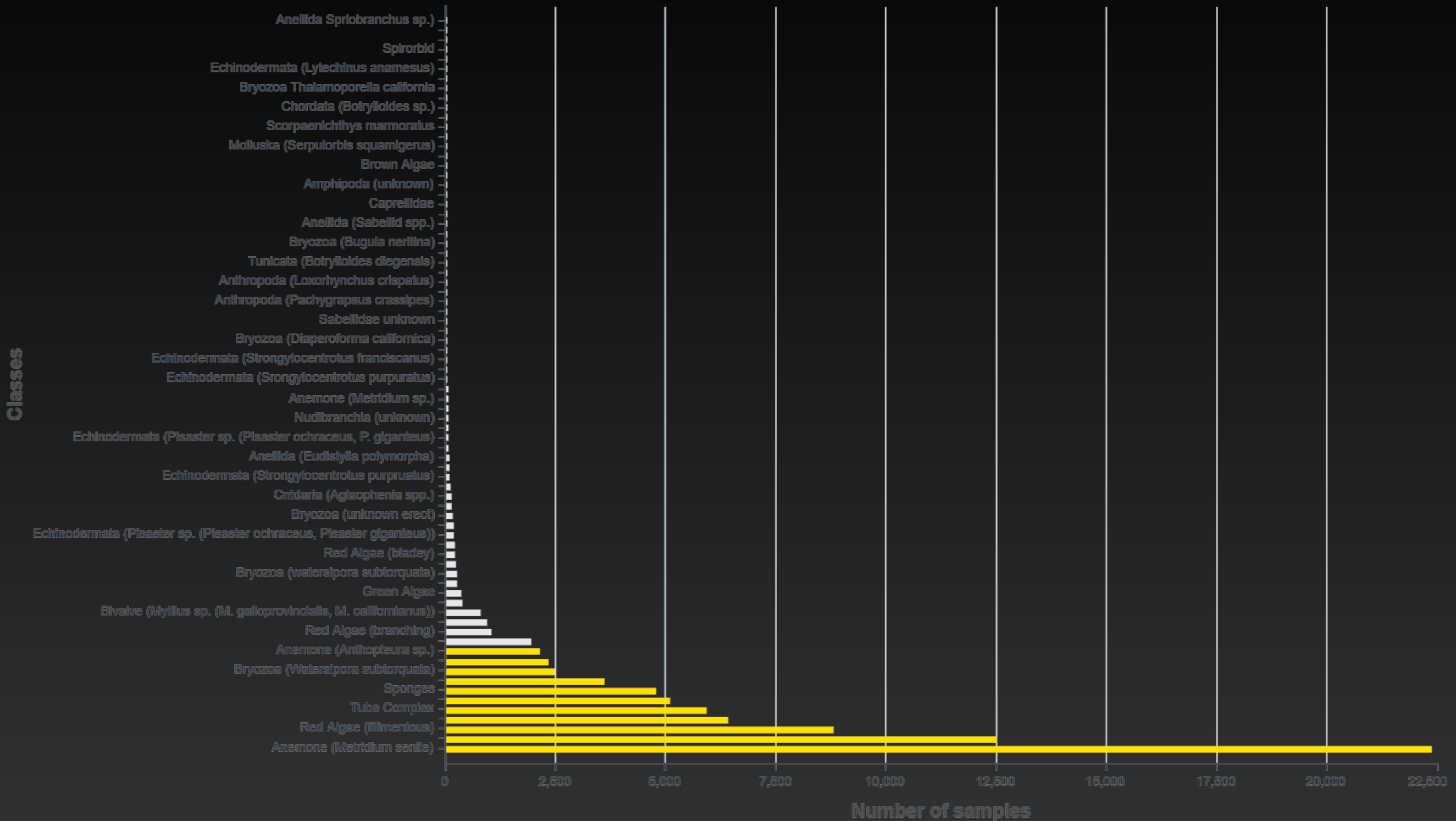
The classification method: Uniformly distributed points
Number of points to classify: 100
Minimum confidence: 0%
Margin: 10%
Store annotations on the image:

3. Run algorithm:
Run This may take some time, progress will be shown on the button.

4. Results:
The module ran in 40 seconds

Classified image
View: 2D

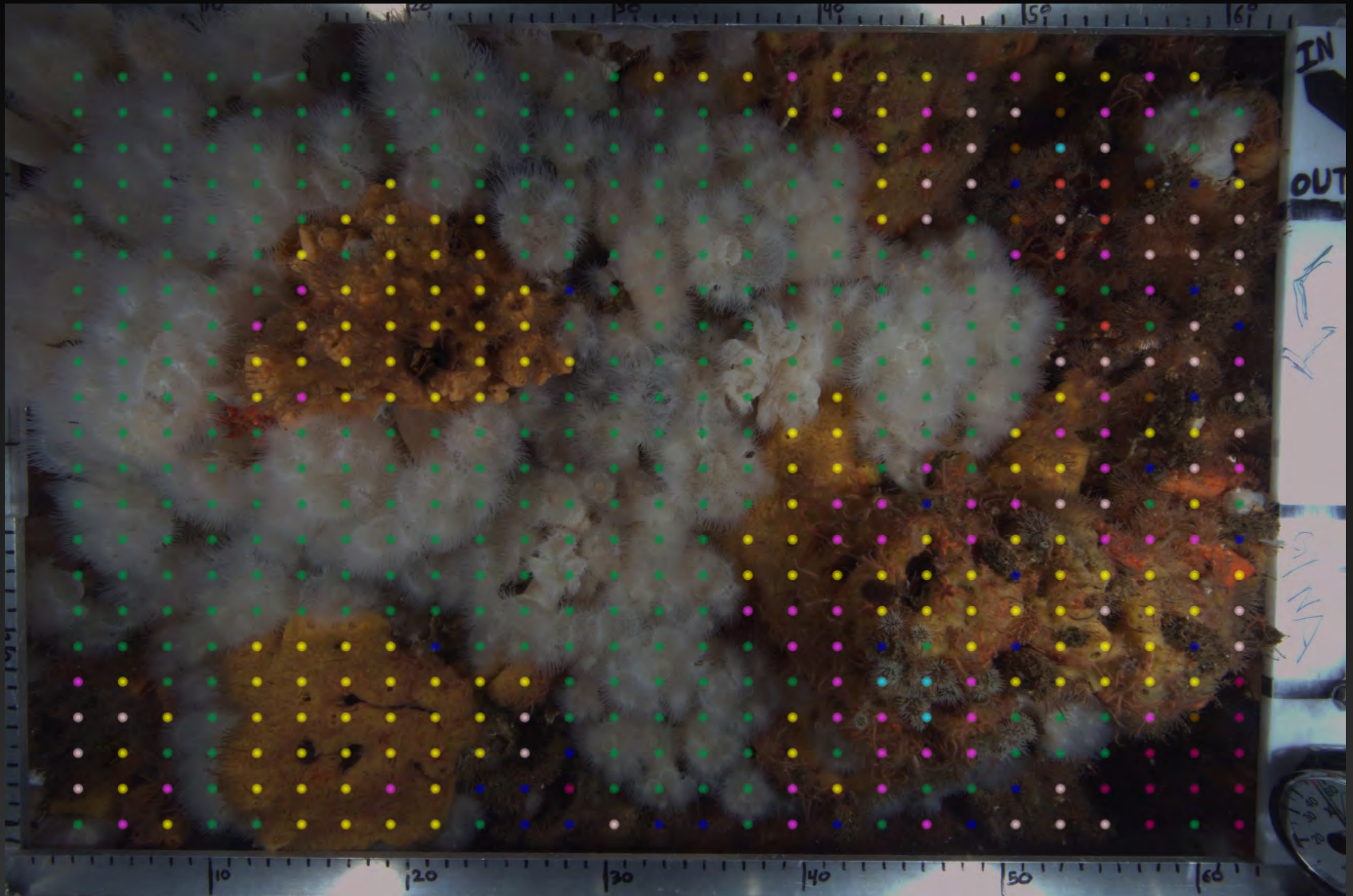
Results



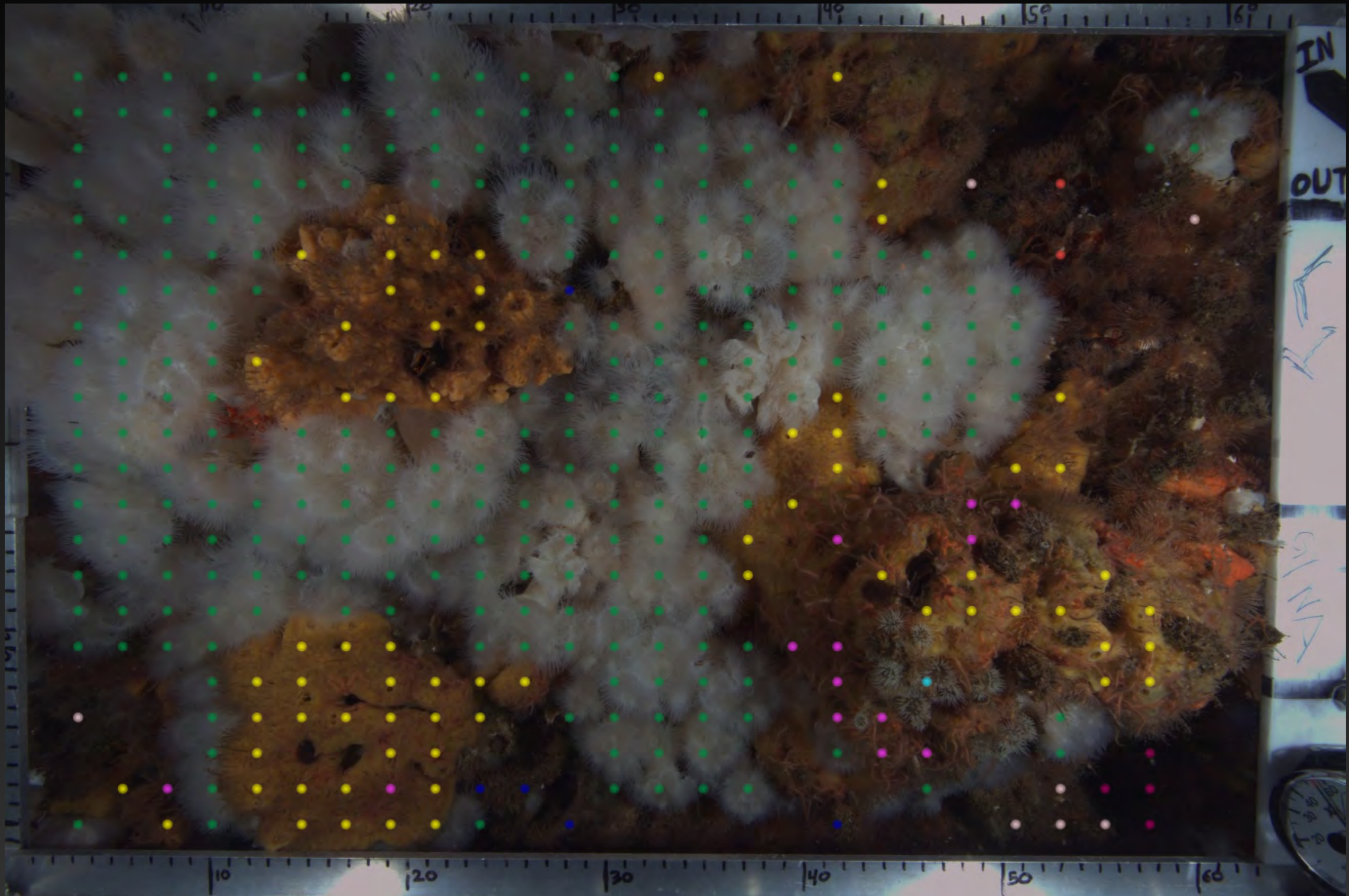
Results

	Samples	Accuracy	Error	F1
Barnacle (<i>Megabalanus californicus</i>)	460	87%	1.50%	0.8
Sponges	946	91%	2.30%	0.84
Anemone (<i>Anthopleura</i> sp.)	421	98%	0.70%	0.97
Echinodermata (Ophiuroid)	1011	99%	3.20%	0.94
Bryozoa (<i>Watersipora subatra</i>)	489	98%	1.50%	0.95
Anemone (<i>Metridium senile</i>)	4465	100%	8.20%	0.91
Anemone (<i>Corynactis californica</i>)	2496	100%	4.70%	0.94
No Data (water)	1272	99%	2.80%	0.95
Hydroid	710	80%	1.00%	0.76
Red Algae (filimentous)	1752	98%	12.10%	0.81
Tube Complex	1175	92%	2.20%	0.84

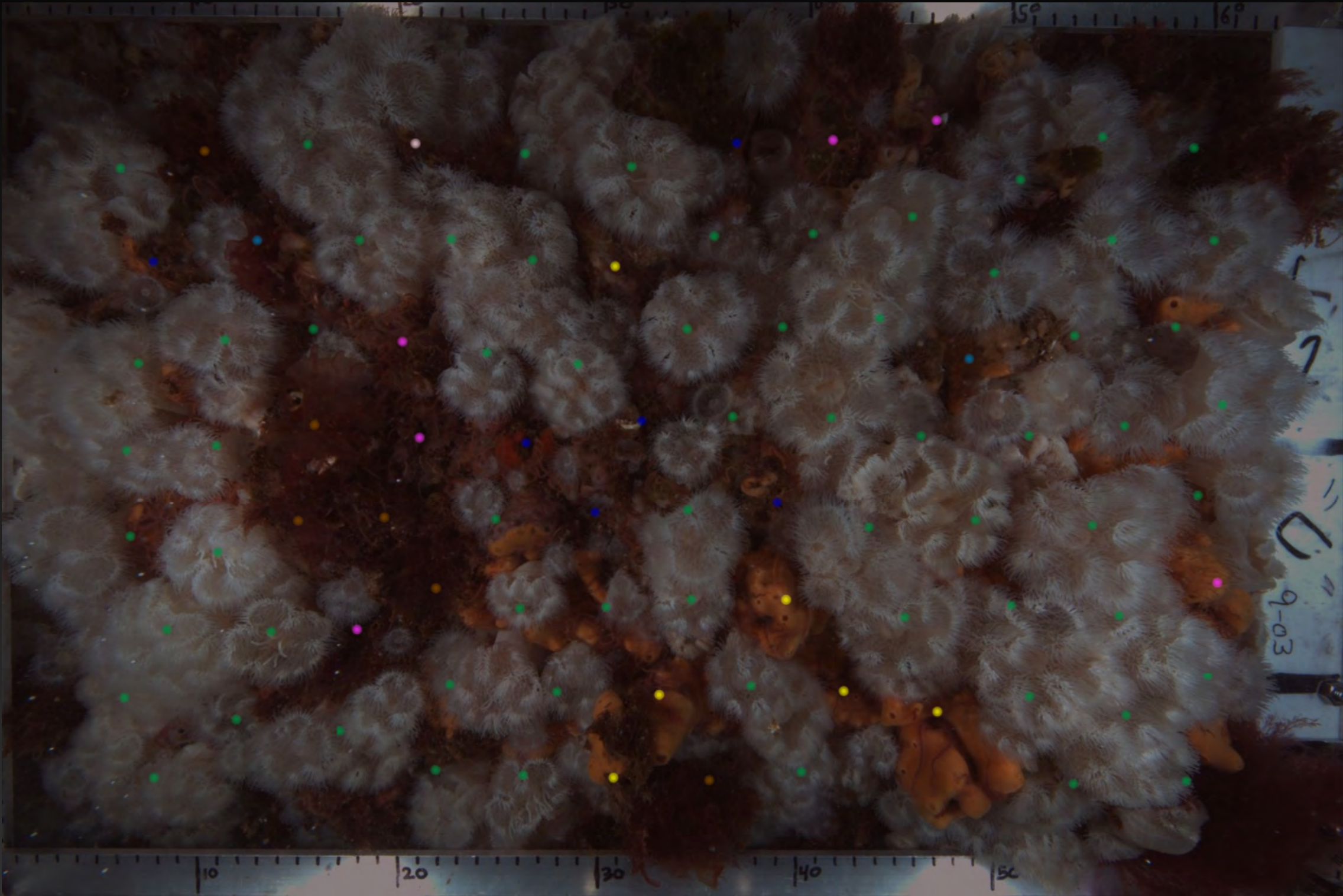
Percent cover at 0% confidence



Percent cover at 95% confidence



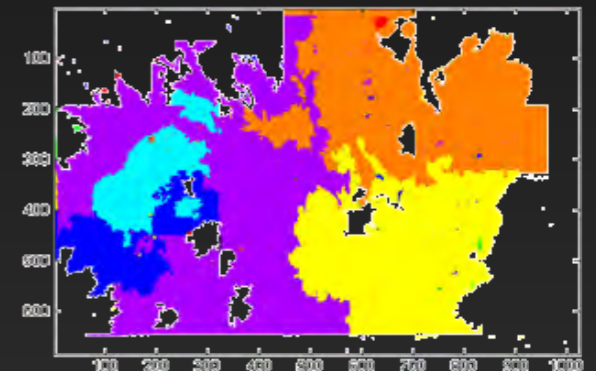
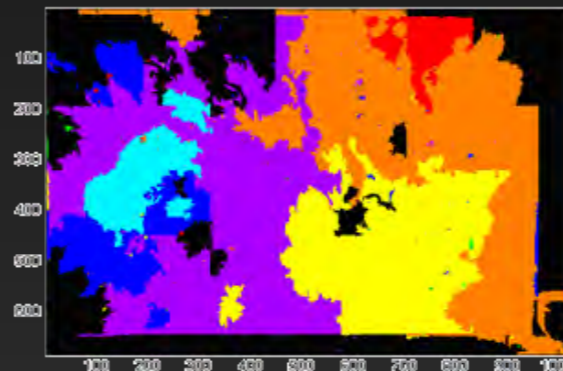
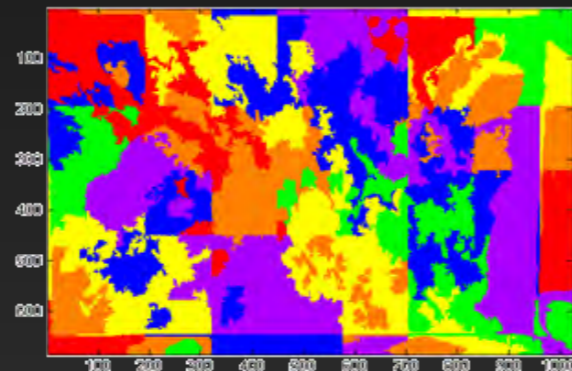
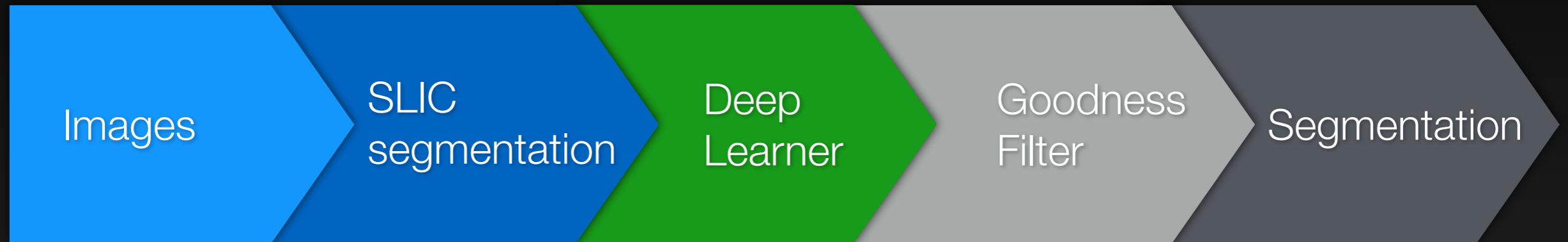
Centroids



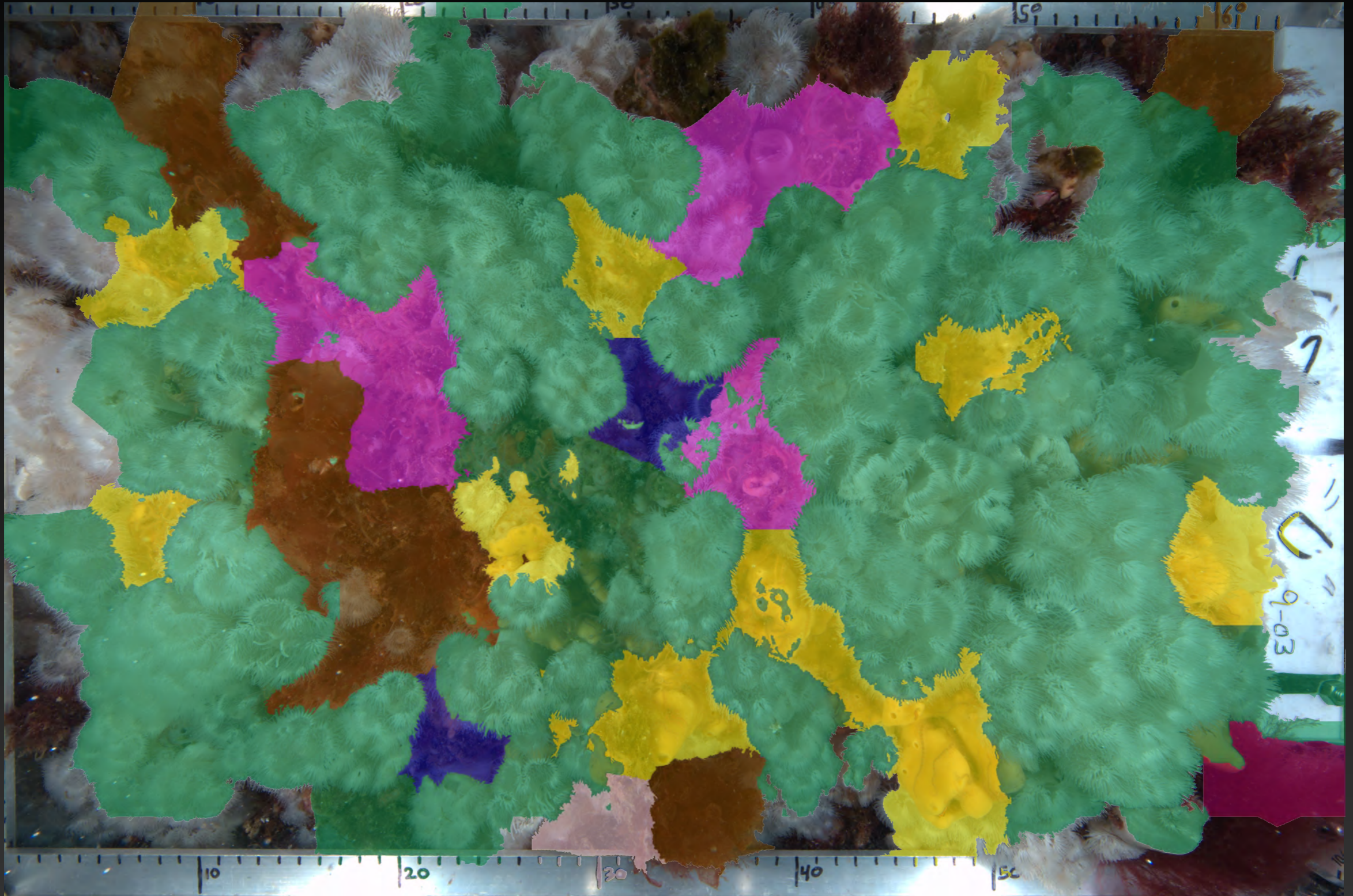
Regions (Substrate partitioning)



Semantic segmentation



Segmentation at 0% confidence



Work in progress

Hierarchical models

- Taxonomic: Genus -> Species
- Ontological: Substrate -> Exact object

Detection workflow

Fully convolutional segmentation

Scalable deployment



BisQue | Connoisseur

ViQI | Software we offer

Open-source BisQue (BSD)

ViQI - BisQue

- Optimized code base
- Fully licensed and GPL-free stack
- Early access to new features

ViQI SaaS service

- Scalable data and image analytics