Application of machine learning to automated image analysis

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Plankton:
How do we sample it?
In-situ Ichthyoplankton Imaging System (ISIIS)
- 13 cm x 13-cm field of view
- 45 cm depth of field
- 2048 pixel line-scan camera
- 66 μm pixel resolution
- 17 frames s⁻¹
- 180 L s⁻¹ imaged
5 kts = ~ 2.5 m s⁻¹

- Salinity
- Temperature
- Depth
- Fluorometry
- Diss. O₂
- PAR

Plankton Imaging
What does ISiIS see?
Now imagine that recording going on for several hours

Hundreds of millions to billions of single organisms imaged per cruise
Imaging pipeline - overview

a = segmentation
b = training + classification
- Unsupervised k-harmonic means clustering
- Bounding box; >= 250 pixels are retained
- CPU machines (100+ cores)
Convolutional neural networks (CNNs)

- Convolution (13x) = detect local combinations of features in images
- Pooling (12x) = merging similar features into one

SparseConvNet with Fractional Max-Pooling (Graham 2015)

Fully connected layer
- multinomial logistic regression
Extensive testing is part of the game ...

Current learning set: 161 classes

5.5h transect = 115M segments = 55h of processing
(8 parallel jobs on Nvidia P100 GPUs)
Efforts to make the pipeline more broadly available to the imaging community

- [www.PIC](http://www.PIC) funded by Belmont Forum

- Streamline steps to library generation

- Optimize CNNs for use across imaging systems (UVP, ISIIS…); transfer learning

- Make pipeline available to others
Three-dimensional cross-shelf zooplankton distributions off the Central Oregon Coast

NOAA ship Bell M. Shimada
• Newport Hydrographic Line, sampled since 1961
• June 2016

• What could be gained by adding an underwater plankton imager to more traditional deployments?
Oithona

All copepods

Larval Myctophids

Siphonophores

Longitude

Depth (m)

[Ind. m$^{-3}$]

Longitude
Questions?