NASA's Jet Propulsion Laboratory
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Technical Support Package

Ship Classification Using Gnostic Fields

NASA Tech Briefs
NPO-49712

National Aeronautics and
Space Administration

Technical Support Package

for

Ship Classification Using Gnostic Fields

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NASA Tech Briefs

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Salient-Level & Fine-Grained Ship Classification

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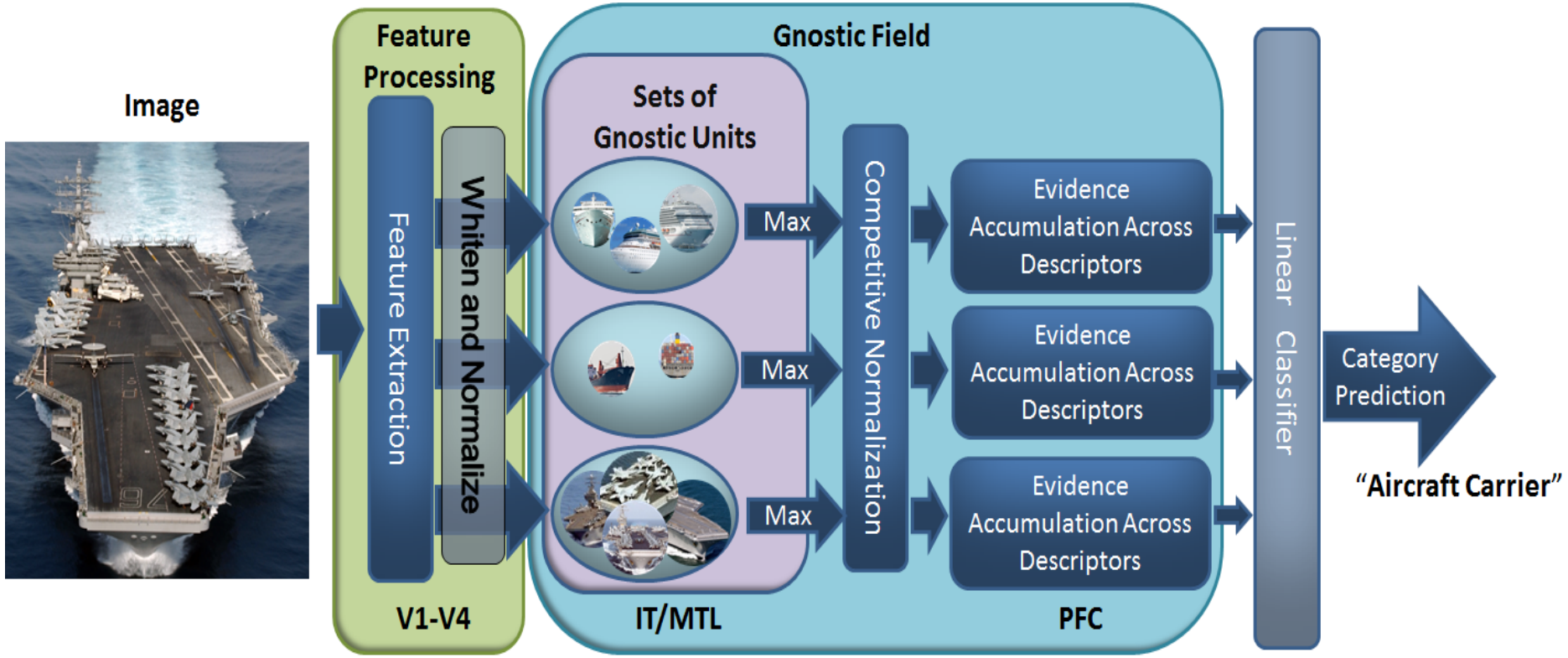
Why are ships challenging?

- We have large changes in scale and rotation.
- Large amount of intra-class variation
  - Variations in decoration and design
  - Backgrounds

Gnostic Fields for Fine-Grained Classification



Deploying Gnostic Fields for Autonomous Ships

- Classifying ships and other objects in the water.
- This is needed for two reasons:
  - Obeying COLREGs, the international traffic rules of the ocean.
  - Protecting the vessel.

JPL's Maritime Objects Dataset

- The JPL Maritime Objects Dataset.
  - Has bounding boxes for over 23,000 images.
  - 70 fine-grained categories have 100+ images each.
- Ships are challenging
  - Large changes in scale and rotation.
  - Large amount of intra-class variation
    - Variations in decoration and design
    - Backgrounds

7 Salient Classes

- Tugboat
- Sailing
- Fishing
- Military
- Other (small)
- Other (large)
- Obstacle

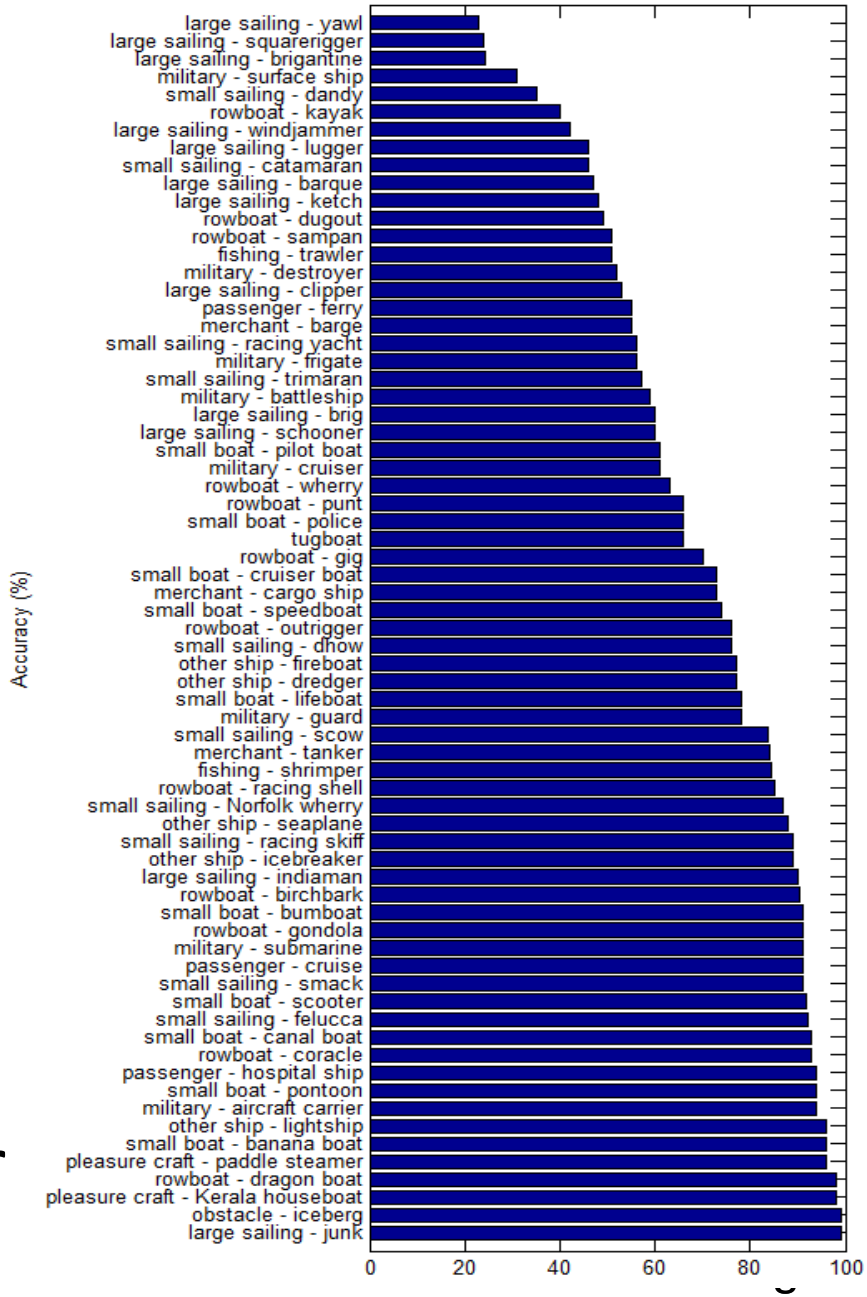
- These are especially important for COLREGs and control.

Fine-Grained → Salient

- We train on fine-grained categories.
- To get a classifier for salient categories, we combine together the output of fine-grained gnostic set groupings.
  - Submarine + Aircraft Carrier + … → Military
  - Shrimper + Fishing Trawler → Fishing
  - Tugboat → Tugboat
- This approach gives us results at both levels, without needing to train two classifiers.

Fine-Grained

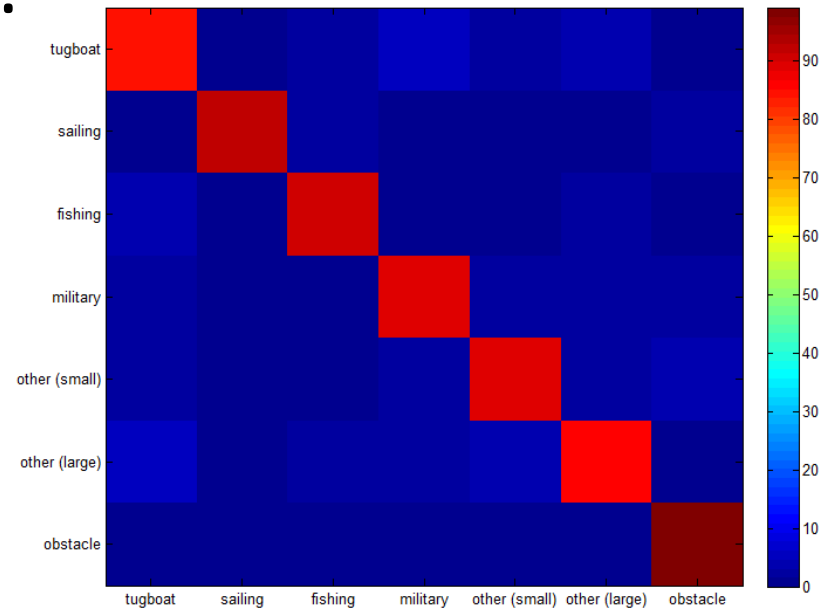
- Gnostic Field Mean Per Class Accuracy:
  - Color: 70.2%
  - Gray: 68.3%
  - Chance is 1.45%
- VLAD Mean Per Class Accuracy:
  - Color: 64.26%
  - Gray: 57.1%
- Trained on 100 images per fine-grained category.



Salient-Level

Categories needed for COLREGs and control

- Mean Per Class Accuracy:
  - Gnostic Field
    - Gray: 88.7%
    - Chance is 14.3%
  - VLAD
    - Gray: 79.6%



- These results are from fusing fine-grained results to create salient predictions.

Ship Classification Summary

- Gnostic Fields work quite well at the problem.
  - Over 90% accuracy at the salient level.
- Color provides a small benefit at both fine-grained and salient levels.
- Still need to assess how well the system works on imagery from our ship.
  - Preliminary results indicate that we can easily identify cargo ships, but we have very little data from any other categories.