Ship Identification: Ship Detection of Images by SSD with Dehazing

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Data

Original Images → Dehazing: $J(x) = \frac{I(x) - A}{\max(t(x), t_0)} + A$ → Resize → 300×300 → Split →

Using Dark Channel Prior

Reference: Single image haze removal using dark channel prior, K He et al., CVPR 2009.

- Images with Large Ships

- Images with Small Ships

Data Augmentation

Patch Sampling, then possibly:

- Horizontally Flip
- Photo-metric Distortions

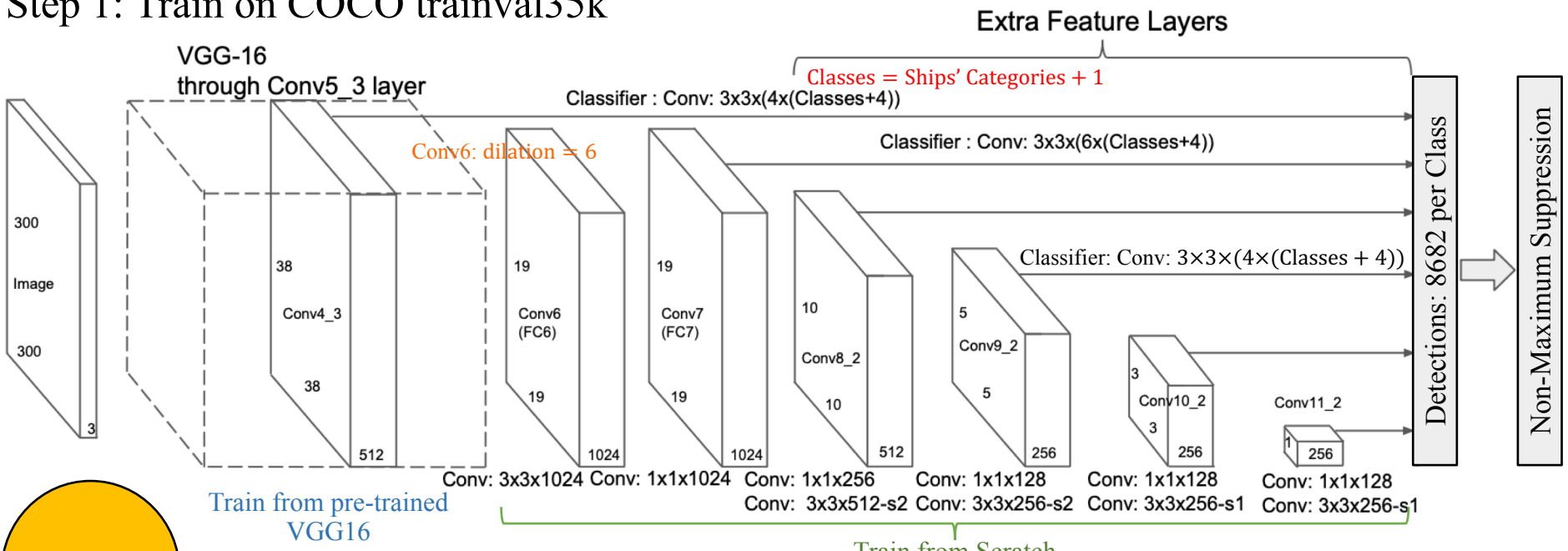
Image Clustering

Positive Augmentation:

Augmented images are only used for increasing positive default boxes, all negative boxes from these images are discarded.

Model

Step 1: Train on COCO trainval35k



Settings

	Aspect Ratios	For Detection?	Supplements
Conv4_3	$a_r \in \{1,2,\frac{1}{2},1'\}$	Yes	For $1'$, use $s'_k = \sqrt{s_k s_{k+1}}$
Conv7	$a_r \in \{1,2,3,\frac{1}{2},\frac{1}{3},1'\}$	Yes	
Conv8_2	$a_r \in \{1,2,3,\frac{1}{2},\frac{1}{3},1'\}$	Yes	
Conv9_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	Yes	Use aspect ratios more similar to ships' aspect rations
Conv10_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	Yes	
Conv11_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	Yes	

Training Data Augmentation

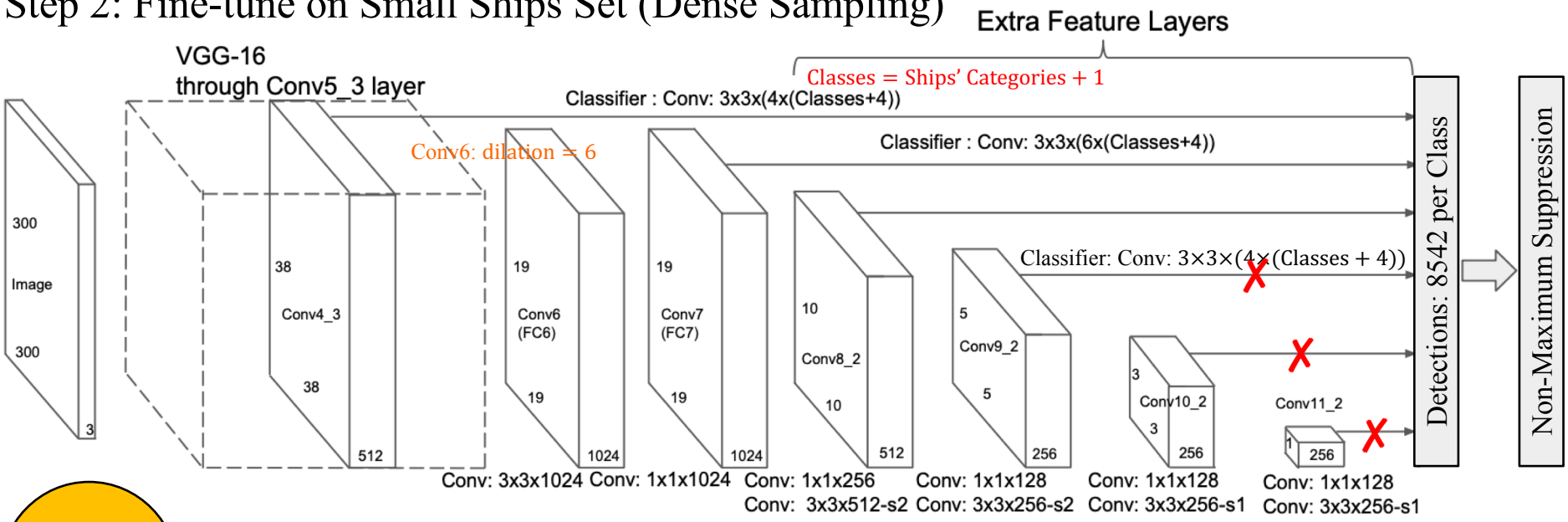
- Patch Sampling, then possibly:
  - Horizontally Flip
  - Photo-metric Distortions
- Random Expansion

Negative Sampling

- Hard Negative Mining

Model

Step 2: Fine-tune on Small Ships Set (Dense Sampling)



Settings

	Aspect Ratios	For Detection?
Conv4_3	$a_r \in \{1,2,\frac{1}{2},1'\}$	Yes
Conv7	$a_r \in \{1,2,3,\frac{1}{2},\frac{1}{3},1'\}$	Yes
Conv8_2	$a_r \in \{1,2,3,\frac{1}{2},\frac{1}{3},1'\}$	Yes
Conv9_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	No
Conv10_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	No
Conv11_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	No

Training Data Augmentation

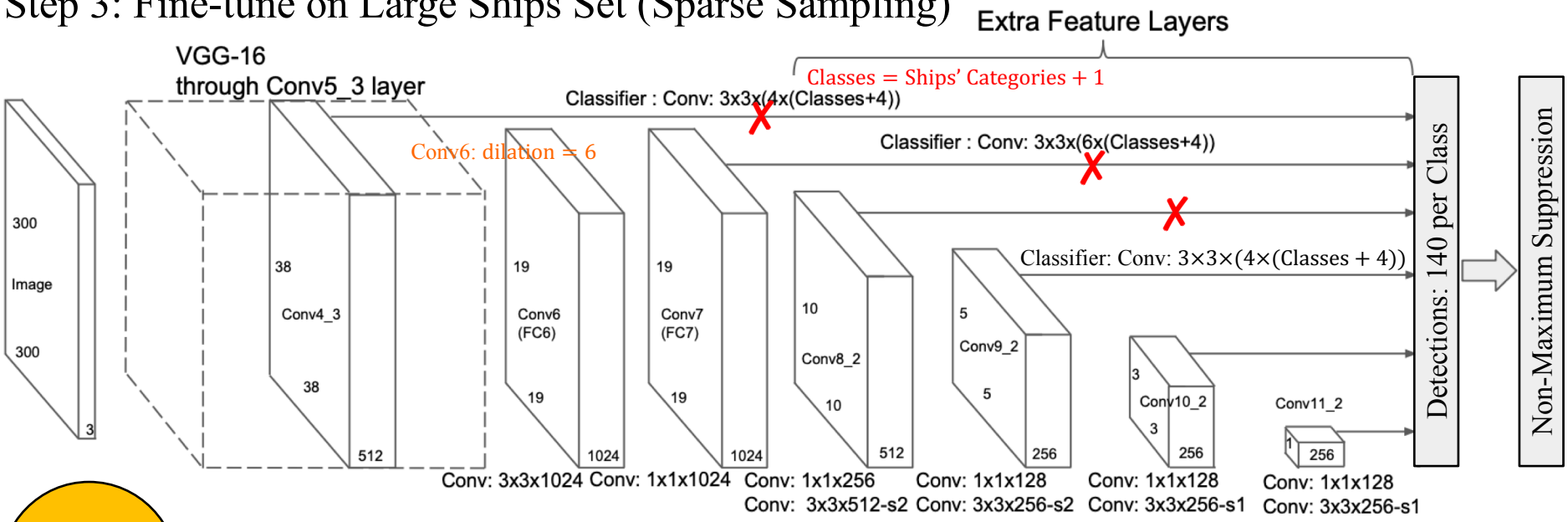
- Patch Sampling, then possibly:
  - Horizontally Flip
  - Photo-metric Distortions
- Image Clustering (Pos Aug)

Negative Sampling

- Hard Negative Mining (non clusterings)
- Discard all Negative Default Boxes (clusteirng)

Model

Step 3: Fine-tune on Large Ships Set (Sparse Sampling)



Settings

	Aspect Ratios	For Detection?
Conv4_3	$a_r \in \{1,2,\frac{1}{2},1'\}$	No
Conv7	$a_r \in \{1,2,3,\frac{1}{2},\frac{1}{3},1'\}$	No
Conv8_2	$a_r \in \{1,2,3,\frac{1}{2},\frac{1}{3},1'\}$	No
Conv9_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	Yes
Conv10_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	Yes
Conv11_2	$a_r \in \{2,4,\frac{1}{2},\frac{1}{4}\}$	Yes

Training Data Augmentation

- Patch Sampling, then possibly:
  - Horizontally Flip
  - Photo-metric Distortions
- Image Clustering (Pos Aug)

Negative Sampling

- Hard Negative Mining (non clusterings)
- Discard all Negative Default Boxes (clusteirng)

Innovation and Discussion

Improvements and Innovations

- In Data Augmentation:
  - Image clustering for positive augmentation
- In Model Structure:
  - Change aspect ratios of default boxes at layers (locations near output) which are responsible for large scale detection more similar to ships' aspect ratios.
- In Training Strategies:
  - 3 Stages: Train + Fine-tune on Small Ships Set (Dense Sampling) + Fine-tune on Large Ships Set (Sparse Sampling)
  - We use layers near input to produce predictions in the stage of fine-tuning on small ships set (stage 2), because there is no need to update parameters of layers for large items detection when training for small items detection.
  - In the same way, we use layers near output to produce predictions in the stage of fine-tuning on large ships set (stage 3).

Discussions and To Improve

- More effective data augmentation for improving effect of small ships detection
  - eg. Format ship to relative "big" goal
- More effective data augmentation to introduce randomness
- More effective negative sampling