# Foggy-DOTA: An Adverse weather Dataset for Object detection in Aerial images


Nguyen D. Vo, **Phuc Nguyen**, Thang Truong

Hoan C. Nguyen, Khang Nguyen

***University of Information Technology – VNU HCM, Vietnam***



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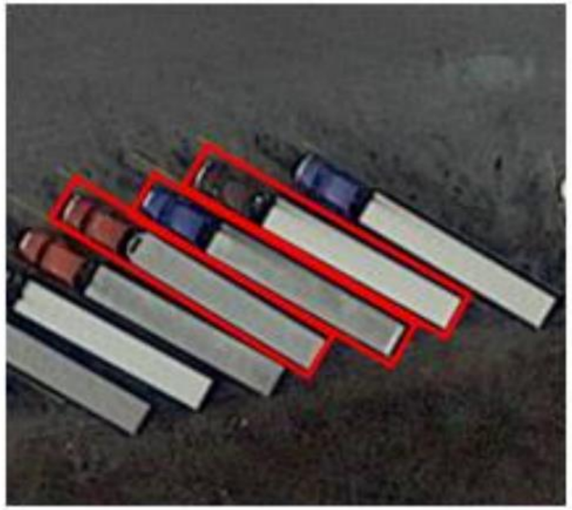
# Contents

# INTRODUCTION

# Introduction

(a) Horizontal object detector



(b) Oriented object detector

# Introduction

# Contributions

1. Introducing a well-designed Foggy-DOTA dataset.

2. Re-implementing three SOTA (S2ANet, ReDet, RoI Transformer) methods to give an in-depth analysis of this methods and dataset's challenge.

# FOGGY-DOTA DATASET

# Foggy-DOTA dataset

– **DOTA** is a large-scale aerial object detection dataset proposed in 2018.
  + **2,806** images
  + **15** classes: plane, baseball-diamond, bridge, ground-track-field, small-vehicle, large-vehicle, ship, tennis court, basketball court, storage tank, soccer-ball-field, roundabout, harbor, swimming pool, and helicopter.

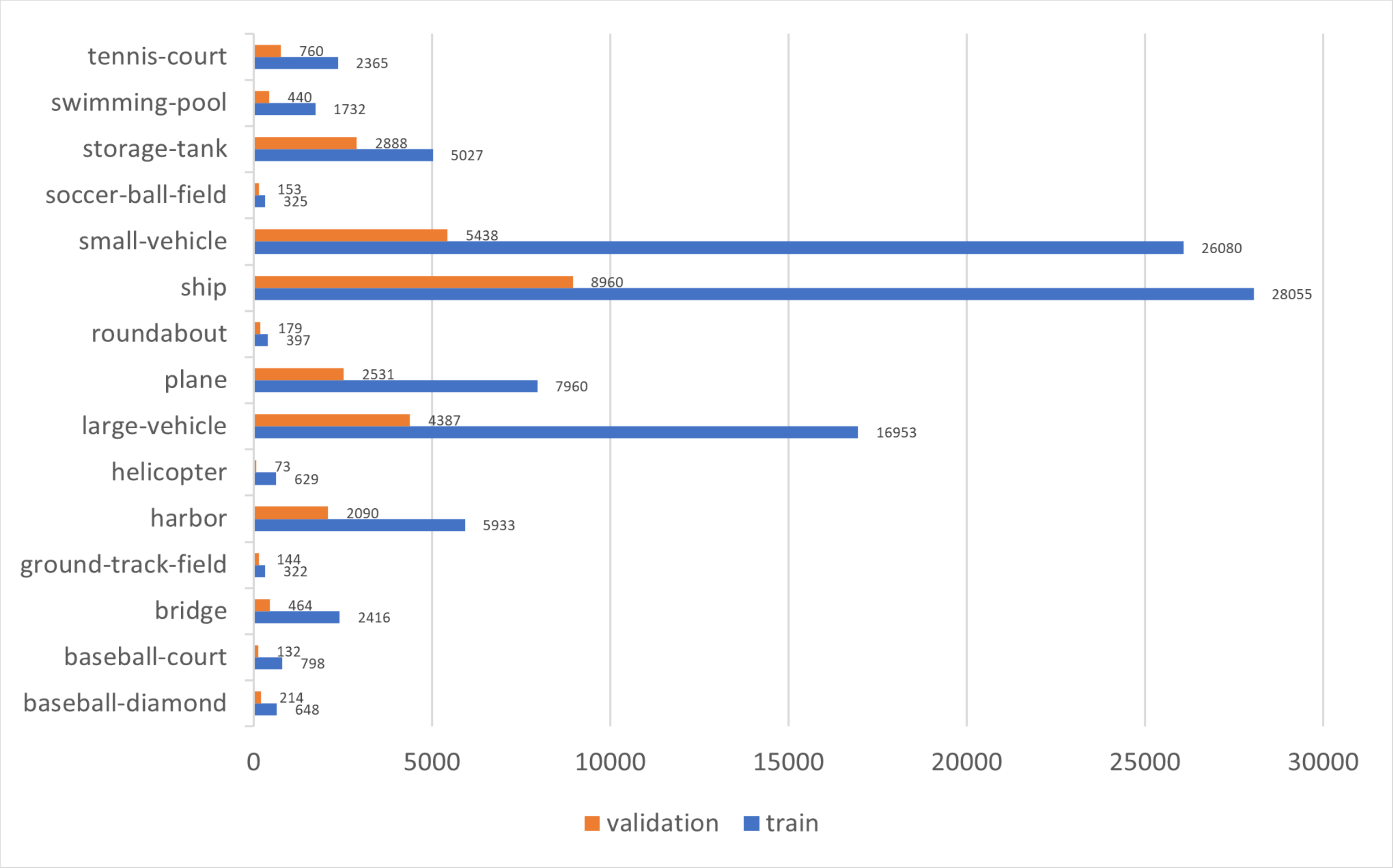
# Foggy-DOTA dataset

DOTA

Imagaug

Foggy - DOTA

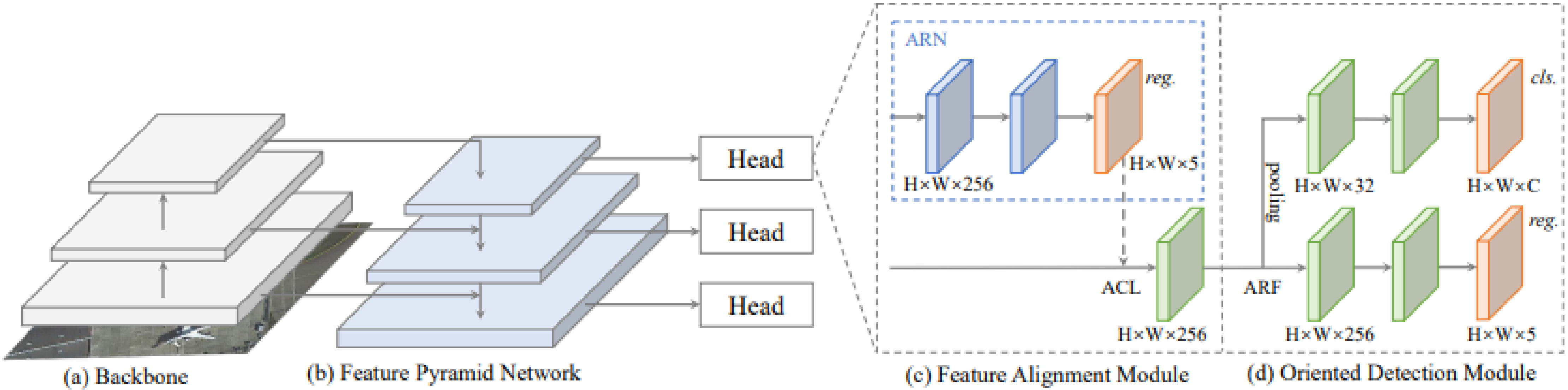
# Foggy-DOTA dataset



# COMPUTATIONAL MODELS

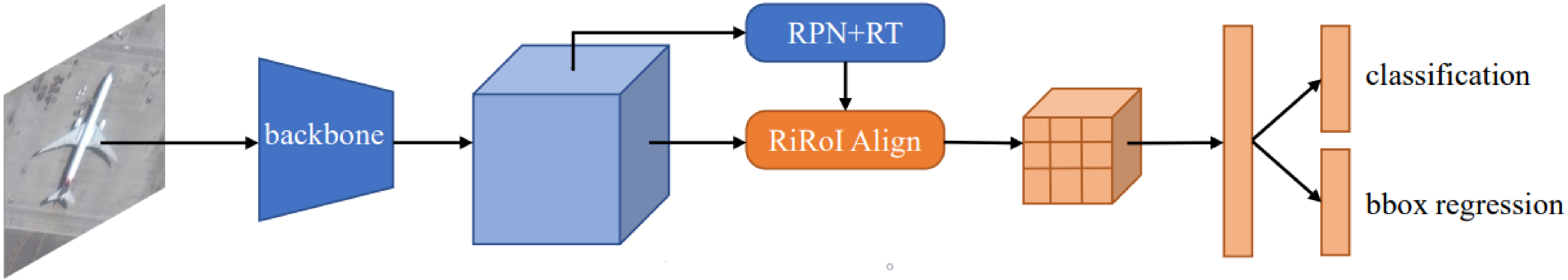
# Computational models

## 1. S2ANet



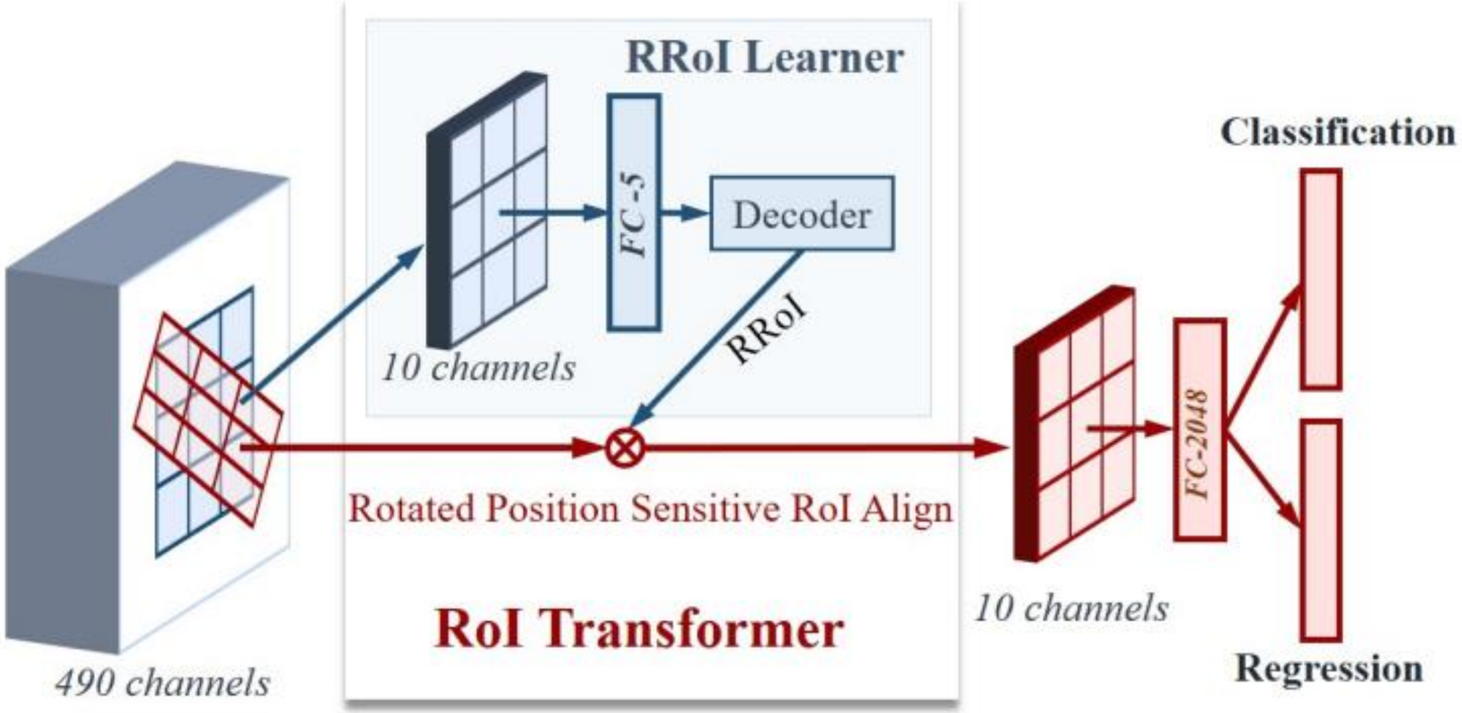
# Computational models

## 2. ReDet



# Computational models

## 3. RoI Transformer



# EVALUATION AND DISCUSSION

# Evaluation Metrics

– Intersection over Union (IoU):

$$\text{IoU} = \frac{Area\ of\ Overlap}{Area\ of\ Union}$$

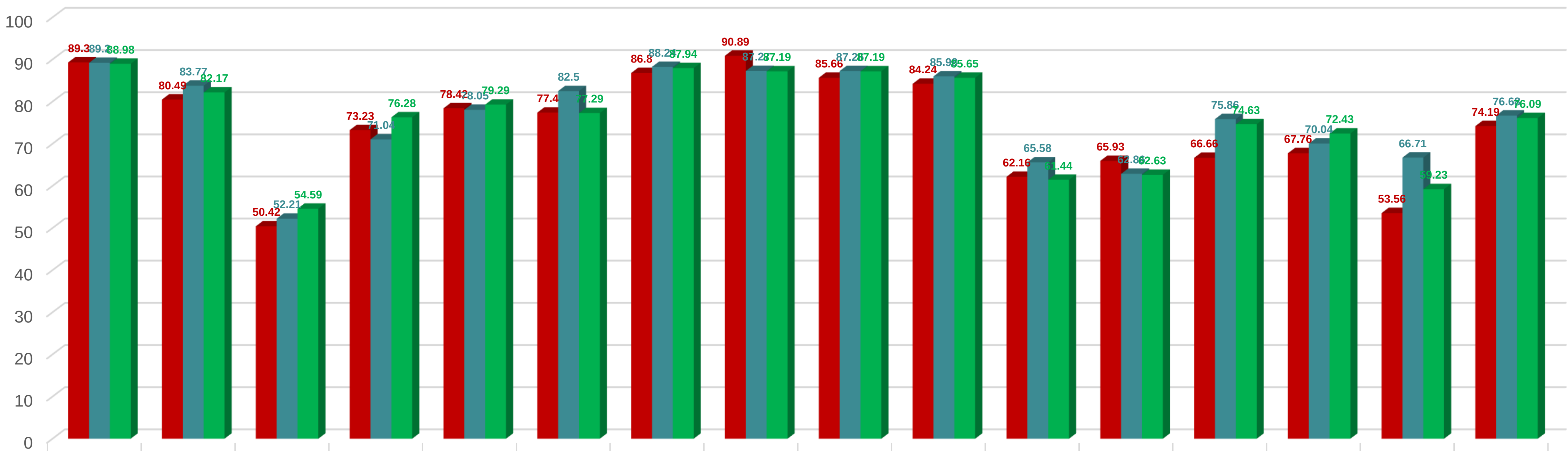
– Mean Average Precision (mAP) – MS COCO

$$mAP@\alpha = \frac{1}{n}\sum_{i=1}^{n} AP_i \ \text{ for n classes}$$

+ mAP: AP at IoU = $.50{:}.05{:}.95$

# Discussion

EXPERIMENTAL RESULTS ON MODELS **TRAINED AND TESTED ON THE ORIGINAL DOTA DATASET**

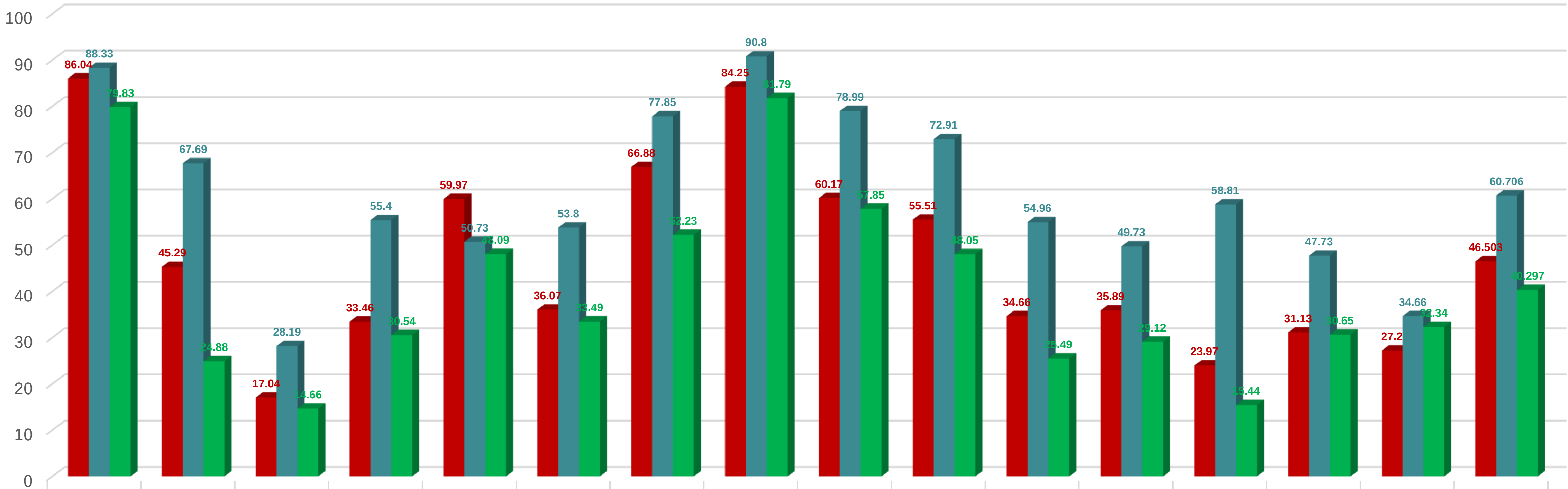



| | PL | BD | BR | GTF | SV | LV | SH | TC | BC | ST | SBF | RA | HA | SP | HC | mAP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S2ANet | 89.3 | 80.49 | 50.42 | 73.23 | 78.42 | 77.4 | 86.8 | 90.89 | 85.66 | 84.24 | 62.16 | 65.93 | 66.66 | 67.76 | 53.56 | 74.19 |
| ReDet | 89.2 | 83.77 | 52.21 | 71.04 | 78.05 | 82.5 | 88.24 | 87.27 | 87.26 | 85.98 | 65.58 | 62.86 | 75.86 | 70.04 | 66.71 | 76.68 |
| RoI Transformer | 88.98 | 82.17 | 54.59 | 76.28 | 79.29 | 77.29 | 87.94 | 87.19 | 87.19 | 85.65 | 61.44 | 62.63 | 74.63 | 72.43 | 59.23 | 76.09 |

S2ANet ReDet RoI Transformer

# Discussion

EXPERIMENTAL RESULTS ON MODELS **TRAINED ON THE ORIGINAL DOTA** AND **TESTED ON THE FOGGY-DOTA**



| | PL | BD | BR | GTF | SV | LV | SH | TC | BC | ST | SBF | RA | HA | SP | HC | mAP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S2ANet | 86.04 | 45.29 | 17.04 | 33.46 | 59.97 | 36.07 | 66.88 | 84.25 | 60.17 | 55.51 | 34.66 | 35.89 | 23.97 | 31.13 | 27.2 | 46.503 |
| ReDet | 88.33 | 67.69 | 28.19 | 55.4 | 50.73 | 53.8 | 77.85 | 90.8 | 78.99 | 72.91 | 54.96 | 49.73 | 58.81 | 47.73 | 34.66 | 60.706 |
| RoI Transformer | 79.83 | 24.88 | 14.66 | 30.54 | 48.09 | 33.49 | 52.23 | 81.79 | 57.85 | 48.05 | 25.49 | 29.12 | 15.44 | 30.65 | 32.34 | 40.297 |

S2ANet ReDet RoI Transformer

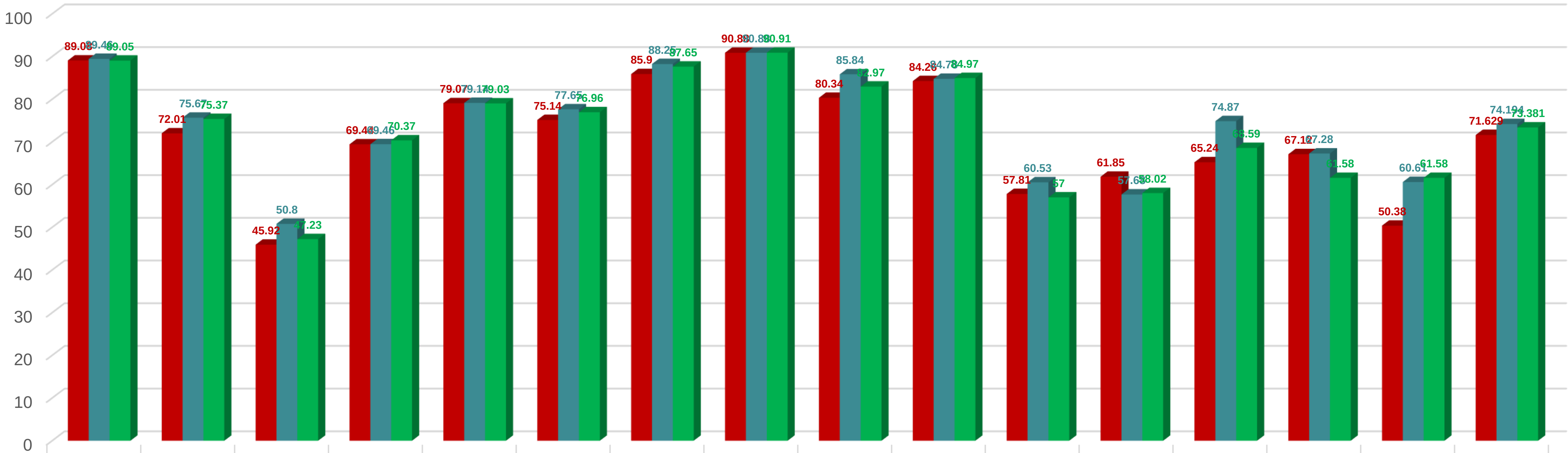
# Discussion

ReDet trained on the original DOTA

Left: test on original DOTA. Right: test on Foggy-DOTA

# Discussion

EXPERIMENTAL RESULTS ON MODELS **TRAINED AND TESTED ON THE FOGGY-DOTA DATASET**



| | PL | BD | BR | GTF | SV | LV | SH | TC | BC | ST | SBF | RA | HA | SP | HC | mAP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S2ANet | 89.08 | 72.01 | 45.92 | 69.44 | 79.07 | 75.14 | 85.9 | 90.88 | 80.34 | 84.26 | 57.81 | 61.85 | 65.24 | 67.12 | 50.38 | 71.629 |
| ReDet | 89.46 | 75.67 | 50.8 | 69.46 | 79.14 | 77.65 | 88.25 | 90.88 | 85.84 | 84.78 | 60.53 | 57.68 | 74.87 | 67.28 | 60.61 | 74.194 |
| RoI Transformer | 89.05 | 75.37 | 47.23 | 70.37 | 79.03 | 76.96 | 87.65 | 90.91 | 82.97 | 84.97 | 57 | 58.02 | 68.59 | 61.58 | 61.58 | 73.381 |

S2ANet ReDet RoI Transformer

# Discussion

**ReDet trained and test on Foggy-DOTA**

# Discussion

TABLE I

EXPERIMENTAL RESULTS ON MODELS TRAINED AND TESTED ON THE ORIGINAL **DOTA** DATASET

| Computational Models | PL | BD | BR | GTF | SV | LV | SH | TC | BC | ST | SBF | RA | HA | SP | HC | mAP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S2ANet** | 89.3 | 80.49 | 50.42 | 73.23 | 78.42 | 77.4 | 86.8 | 90.89 | 85.66 | 84.24 | 62.16 | 65.93 | 66.66 | 67.76 | 53.56 | 74.19 |
| **ReDet** | 89.2 | 83.77 | 52.21 | 71.04 | 78.05 | 82.5 | 88.24 | 90.86 | 87.26 | 85.98 | 65.58 | 62.86 | 75.86 | 70.04 | 66.71 | 76.68 |
| **RoI Transformer** | 88.98 | 82.17 | 54.59 | 76.28 | 79.29 | 77.96 | 87.94 | 90.91 | 87.19 | 85.65 | 61.44 | 62.63 | 74.63 | 72.43 | 59.23 | 76.09 |

TABLE II

EXPERIMENTAL RESULTS ON MODELS TRAINED ON THE ORIGINAL **DOTA** AND TESTED ON THE **FOGGY-DOTA** DATASET

| Computational Models | PL | BD | BR | GTF | SV | LV | SH | TC | BC | ST | SBF | RA | HA | SP | HC | mAP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S2ANet** | 86.04 | 45.29 | 17.04 | 33.46 | 59.97 | 36.07 | 66.88 | 84.25 | 60.17 | 55.51 | 34.66 | 35.89 | 23.97 | 31.13 | 27.20 | 46.503 |
| **ReDet** | 88.33 | 67.69 | 28.19 | 55.4 | 50.73 | 53.80 | 77.85 | 90.80 | 78.99 | 72.91 | 54.96 | 49.73 | 58.81 | 47.73 | 34.66 | 60.706 |
| **RoI Transformer** | 79.83 | 24.88 | 14.66 | 30.54 | 48.09 | 33.49 | 52.23 | 81.79 | 57.85 | 48.05 | 25.49 | 29.12 | 15.44 | 30.65 | 32.34 | 40.297 |

TABLE III

EXPERIMENTAL RESULTS ON MODELS TRAINED AND TESTED ON THE **FOGGY-DOTA** DATASET

| Computational Models | PL | BD | BR | GTF | SV | LV | SH | TC | BC | ST | SBF | RA | HA | SP | HC | mAP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S2ANet** | 89.08 | 72.01 | 45.92 | 69.44 | 79.07 | 75.14 | 85.9 | 90.88 | 80.34 | 84.26 | 57.81 | 61.85 | 65.24 | 67.12 | 50.38 | 71.629 |
| **ReDet** | 89.46 | 75.67 | 50.80 | 69.46 | 79.14 | 77.65 | 88.25 | 90.88 | 85.84 | 84.78 | 60.53 | 57.68 | 74.87 | 67.28 | 60.61 | 74.194 |
| **RoI Transformer** | 89.05 | 75.37 | 47.23 | 70.37 | 79.03 | 76.96 | 87.65 | 90.91 | 82.97 | 84.95 | 57.00 | 58.02 | 68.59 | 71.04 | 61.58 | 73.381 |

# CONCLUSION AND FUTURE WORK

# Conclusion

1. We introduced the fine Foggy-DOTA dataset for adverse weather oriented/horizontal object detection in aerial images.

2. We experiment extensively with many oriented object detection methods to provide an in-depth analysis of dataset challenges and model structures.

# Future work

1. In the future, we’re opening our scope more to aerial image object detection as well as image adaptive for adverse weather conditions.

# References

[1] Han, J., Ding, J., Xue, N., & Xia, G. S. (2021). Redet: A rotation-equivariant detector for aerial object detection. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 2786-2795).

[2] Ding, J., Xue, N., Long, Y., Xia, G. S., & Lu, Q. (2019). Learning RoI transformer for oriented object detection in aerial images. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 2849-2858).

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[3] Han, J., Ding, J., Li, J., & Xia, G. S. (2021). Align deep features for oriented object detection. IEEE Transactions on Geoscience and Remote Sensing, 60, 1-11.

# THANK YOU FOR YOUR ATTENTION!

**Group of authors:**

Nguyen D. Vo, Phuc Nguyen, Thang Truong

Hoan C. Nguyen, Khang Nguyen