

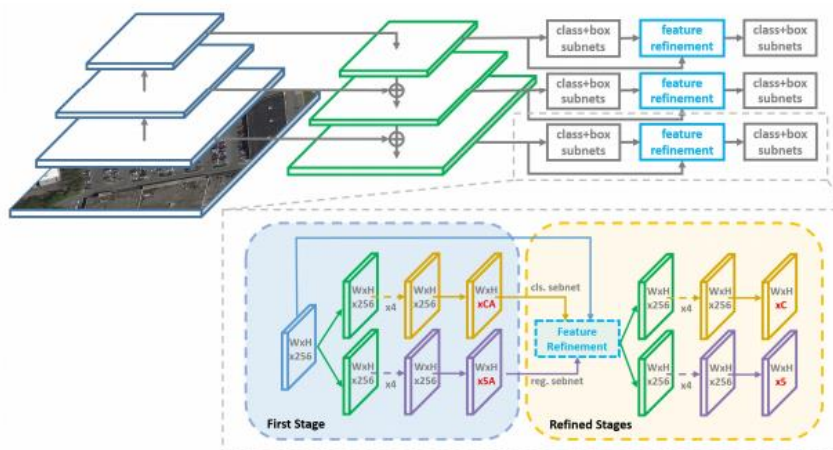
## "R 3Det: Refined Single-Stage Detector with Feature Refinement for Rotating Object".

Link: <https://arxiv.org/pdf/1908.05612.pdf>

Based on RetinaNet, adding another value " $\theta$ " to represent the acute angle of each bounding box to the x-axis. The reasoning behind adding  $\theta$  is that they found that rotating anchors can perform better in dense scenes, while horizontal anchors can achieve higher recalls in fewer quantities. So, they adopt a combination strategy of the two types of anchors. First, they use horizontal anchors to for the faster speed and higher recall, then they use rotating anchors for the refinement stages.

In addition, they found that existing refined single-stage detectors suffer from feature misalignment, which limits the reliability of classification and regression during the refinement stages. To address this problem, the refining stage, that can be repeated many times, is added to refine the bounding box and the introduced "Feature Refinement Module" (FRM) is used during the refinement stage for feature map reconstruction.

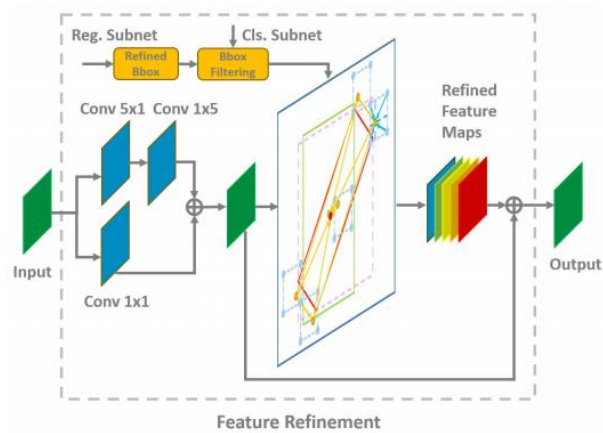
To improve the IoU score for large scale object, and densely arranged small objects multiple refinement stages are joined with different IoU thresholds. In addition to using the foreground IoU threshold 0.5 and background IoU threshold 0.4 in the first stage, the thresholds of first refinement stage are set 0.6 and 0.5, respectively. If there are multiple refinement stages, the remaining thresholds are 0.7 and 0.6.



### The bounding box:

Now, each bounding box is represented using 5 parameters  $(x, y, w, h, \theta)$ .  $(x, y)$  is the middle point of the bounding box,  $w$  is width,  $h$  is height.  $\theta$  denotes the acute angle to the x-axis. Therefore, it calls for predicting an additional angular offset in the regression subnet.

### Feature Refinement Module:



To solve the feature misalignment problem, FRN is introduced. Using feature interpolation to obtain the position information of the refined anchor and reconstructing the feature map to achieve feature alignment. FRM can also reduce the number of refined bounding box after the first stage, thus speeding up the model. Only the bounding box with the highest score of each feature point is preserved in the refinement stage to increase the speed.