PointRCNN with IoU Based Loss:

**1. Terminology & Metrics**

* **AP@X**: Average Precision at IoU threshold X (e.g. 0.5 for pedestrians/cyclists, 0.7 for cars). Higher is better.
* **AOS@X**: Average Orientation Similarity (combines detection + correct orientation) at the same IoU threshold.
* **bbox\_2d**: 2D bounding‐box AP in image space.
* **bbox\_bev**: Bird’s‐Eye View detection AP.
* **bbox\_3d**: Full 3D bounding‐box AP.

**Difficulty levels**

* **Easy**, **Moderate**, **Hard** correspond to increasing occlusion, truncation, distance, and smaller object sizes.

**2. Per‐Category Insights**

**Pedestrians (**[**AP@0.5**](mailto:AP@0.5)**)**

|  |  |  |  |
| --- | --- | --- | --- |
| **View / Metric** | **Easy** | **Moderate** | **Hard** |
| **2D bbox AP** | 73.54% | 65.83% | 62.27% |
| **AOS** | 71.29% | 63.17% | 59.48% |
| **BEV AP** | 67.51% | 60.27% | 54.09% |
| **3D AP** | 61.84% | 57.02% | 51.15% |

* **Lowest 3D AP**: Pedestrians are small with widely varied shapes compared to cars and bicycles. The model had the hardest time identifying them.

**Cyclists (**[**AP@0.5**](mailto:AP@0.5)**)**

|  |  |  |  |
| --- | --- | --- | --- |
| **View / Metric** | **Easy** | **Moderate** | **Hard** |
| **2D bbox AP** | 89.75% | 77.67% | 75.27% |
| **AOS** | 89.67% | 77.20% | 74.70% |
| **BEV AP** | 88.36% | 74.44% | 71.01% |
| **3D AP** | 87.72% | 72.57% | 69.94% |

* Tracks with other models.

**Cars (**[**AP@0.7**](mailto:AP@0.7)**)**

|  |  |  |  |
| --- | --- | --- | --- |
| **View / Metric** | **Easy** | **Moderate** | **Hard** |
| **2D bbox AP** | 90.52% | 89.23% | 88.94% |
| **AOS** | 90.52% | 89.13% | 88.78% |
| **BEV AP** | 89.81% | 87.12% | 85.84% |
| **3D AP** | 88.38% | 78.19% | 77.72% |

* **3D vs 2D**: While both 3D and 2D have very high precision in easy situations it is much harder to capture the location of an object in 3D space as conditions affect visibility of objects. There is a much larger drop for 3D AP than 2D AP.

**3. Overall Summary**

|  |  |  |  |
| --- | --- | --- | --- |
| **Metric** | **Easy** | **Moderate** | **Hard** |
| **2D bbox AP** | 84.60% | 77.58% | 75.49% |
| **AOS** | 83.83% | 76.50% | 74.32% |
| **BEV AP** | 81.89% | 73.94% | 70.31% |
| **3D AP** | 79.31% | 69.26% | 66.27% |