BEA: Revisiting anchor-based object detection DNN using Budding Ensemble Architecture

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Motivation

Deterministic object detection models and ensembles struggle with confidence score calibration and objects on corner.

Contributions

• Budding Ensemble Architecture (BEA) outperforms state of the art models in terms of accuracy.
• AP50-based retention curves are introduced to measure the quality of calibration for object detection models.
• Novel Tandem loss function is introduced to the BEA model which increases the overall accuracy by ~6% and OOD detection at least by ~300%.

BEA method

"Budding Ensemble Architecture" uses a common backbone to feed an ensemble of detectors trained with our novel tandem loss function.

Tandem loss function

\[ \mathcal{L}_{tandem} = \mathcal{L}_{tq} + \mathcal{L}_{ta} \]

\[ \mathcal{L}_{tq}(\phi) = \sum_{i=1}^{n} \sum_{j=1}^{P} y_{ij} \log\left(\frac{e^{\phi_{ij}}}{\sum_{k} e^{\phi_{kj}}}\right) \]

\[ \mathcal{L}_{ta}(\phi) = \sum_{i=1}^{n} \sum_{j=1}^{P} y_{ij} \frac{\left(\phi_{ij} - \phi^{*}_{ij}\right)^{2}}{2} \]

\[ \mathcal{L}_{\text{bea}} = \mathcal{L}_{\text{conv}} + \mathcal{L}_{\text{tandem}} \]

BEA results

The BEA shows better out-of-distribution image detection than the vanilla and ensemble models.

BEA applied to Validation dataset  BEA applied to shifted dataset

<table>
<thead>
<tr>
<th>Models</th>
<th>IAPPA (% T)</th>
<th>AP50 (%)</th>
<th>UE (%)</th>
<th>AP50-based Retention curve</th>
<th>Out-of-distribution detection (OOD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-YOLOv3</td>
<td>51.72</td>
<td>87.4</td>
<td>58.2</td>
<td>11.96</td>
<td>53.1</td>
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<tr>
<td>YOLOv3</td>
<td>54.58</td>
<td>89</td>
<td>82.94</td>
<td>9.25</td>
<td>57</td>
</tr>
<tr>
<td>YOLOv3 Ensemble</td>
<td>55.1</td>
<td>88.27</td>
<td>82.97</td>
<td>9.03</td>
<td>59.3</td>
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<tr>
<td>BEA-YOLOv3</td>
<td>55.1</td>
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</tbody>
</table>

NON-OOD

OOD

Example objects to compare base and BEA model performance