**Goal:** train 3D recognition framework with class tags

**Novelties:**
1) multi-task joint learning
2) unsupervised proposal generation

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**Training objectives:**
- Multiple instance learning (MIL)
- Self-training
- Cross-task consistency
- Cross-transformation consistency
- Local smoothness

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**Results**

**Segmentation**

<table>
<thead>
<tr>
<th>Methods</th>
<th>Split</th>
<th>mIoU</th>
</tr>
</thead>
<tbody>
<tr>
<td>PointNet++ (Qi 2017)</td>
<td>256</td>
<td>73.6</td>
</tr>
<tr>
<td>VoteNet</td>
<td>256</td>
<td>73.6</td>
</tr>
<tr>
<td>VoteNet</td>
<td>1k</td>
<td>88.1</td>
</tr>
</tbody>
</table>

**Proposal & Detection**

<table>
<thead>
<tr>
<th>Methods</th>
<th>#boxes</th>
<th>MABO</th>
<th>AR</th>
<th>mAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCAM (Wei 2020)</td>
<td>train</td>
<td>22.1</td>
<td>N/A</td>
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</tr>
<tr>
<td>MPRM (Wei 2020)</td>
<td>train</td>
<td>24.4</td>
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<tr>
<td>WyPR</td>
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<td>30.7</td>
<td>N/A</td>
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<tr>
<td>MIL-Seg</td>
<td>val</td>
<td>20.7</td>
<td>9.6</td>
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<tr>
<td>WyPR</td>
<td>val</td>
<td>29.6</td>
<td>18.3</td>
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<tr>
<td>WyPR+prior</td>
<td>val</td>
<td>31.1</td>
<td>19.7</td>
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<tr>
<td>PointNet+</td>
<td>val</td>
<td>55.7</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>SparseConv</td>
<td>val</td>
<td>73.6</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

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**WyPR: Weakly-supervised Point Cloud Recognition**

- **Backbone**
- **Geometric features**
- **Seg. head**
- **Pseudo labels**
- **Post-processing**

**Proposals**

- **GSS**
- **Post-processing**

**Detection**

- **GSS proposals**
- **HAC**
- **GT detection**
- **Pred detection**
- **GT segmentation**
- **Pred segmentation**

---

**Prior work**

- **Strong**
  - 2D instance label
  - 2D bounding box
  - Non-parametric
- **Weak**
  - No supervision
  - Sparse label
  - Parametric

**Class tags**

- floor, wall, chair, table
- desk, sofa, door, bed, window

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**Geometric Selective Search (GSS)**

- **Forecasted proposals**
- **Pred labels**
- **Ground-truth labels**