Environment Setting

```
[ ] from google.colab import drive
    drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

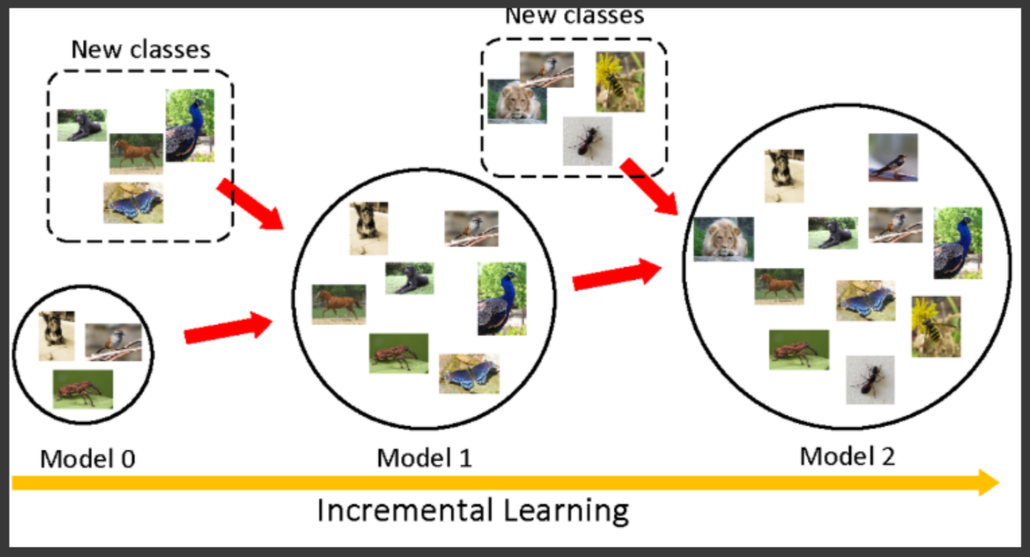
```
[ ] import os

    root = '/content/drive/MyDrive/ITM_AI/CD-DETR'
    os.chdir(root)
```

```
[ ] !chmod -R 777 .
    !pip install -r requirements.txt
```

숨겨진 출력 표시

Motivation



Project Motivation

- Overcome deep learning's inability to adapt to new, emerging classes not present in the initial dataset.
- Enhance real-world utility as data constantly evolves.

Problem Statement

- Implementing class incremental learning in object detection, a vital part of computer vision, presents unique challenges.
- Complexity of identifying multiple classes within a single image in object detection.

Project Aim

- Introduce a buffer training strategy optimized for object detection tasks.
- Improve replay methods to make incremental learning more suitable for real-world applicability.

A description of the data

COCO Dataset (Common Object in Context)

We choose the MS COCO 2017 (Microsoft Common Objects in Context) dataset

- One of the benchmark in Object Detection

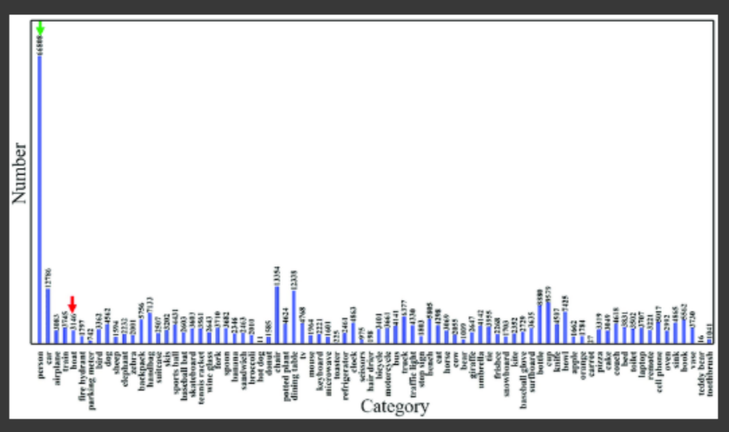
Why COCO 2017?

- Scale and diversity of categories reflect the complexity of real-world data
- Uneven distribution of images across classes mirrors real-world variety and imbalance.

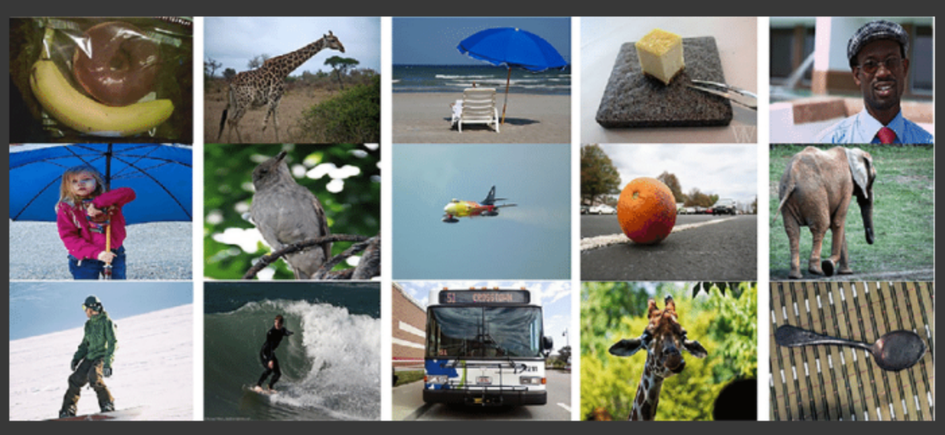
Dataset Details:

- Consists of over 200,000 images from various everyday scenes
- Annotated with object bounding boxes and class labels across 80 diverse object categories

Dataset Details



- Quite unbalanced class distribution
- This is normal in the context of Object Detection Task!



- Dataset Sample Image
- Configured to 'Common', life-related Objects


```
{
    "id": 125686,
    "category_id": 2,
    "iscrowd": 0,
    "segmentation": [[164.81, 417.51, 164.81, 4
    "image_id": 242287,
    "area": 42061.80340000001,
    "bbox": [19.23, 383.18, 314.5, 244.46]
},
{
    "id": 1409619,
```


- Annotation format of Object Detection
- Object Detection needs class(category) id & bbox coordinations *BOTH*!

We used coco.sh to download the overall dataset in local!

> Too large dataset size (~=30GB), We downloaded into local and moved to Google Drive.

```
mkdir COCODIR
cd COCODIR

wget -c http://images.cocodataset.org/zips/train2017.zip
echo "Extracting train2017.zip"
unzip -qq train2017.zip
rm train2017.zip

wget -c http://images.cocodataset.org/zips/val2017.zip
...(similar to upon)...

wget -c http://images.cocodataset.org/annotations/annotations_trainval2017.zip
...(similar to upon)...

cd annotations
find . -type f #
    -not -wholename ./instances_train2017.json #
    -not -wholename ./instances_val2017.json #
    -delete

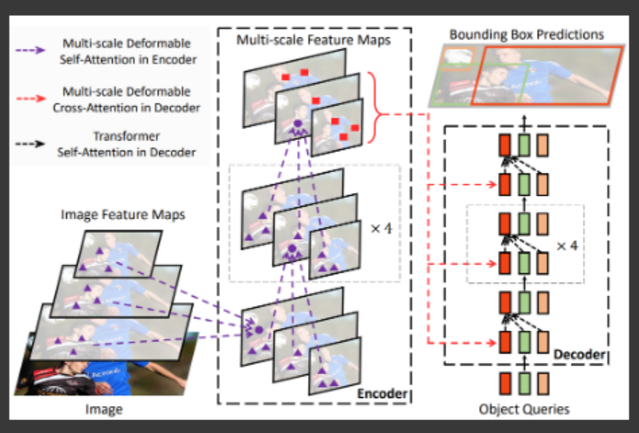
echo "DONE."
```

```
[ ]  # COCO Dataset - benchmark of Object Detection
     !bash /content/drive/MyDrive/ITM_AI/CD-DETR/coco.sh
```

숨겨진 출력 표시

Hyperparameter and architecture choices that were explored

Selected Baseline Architecture - Deformable DETR

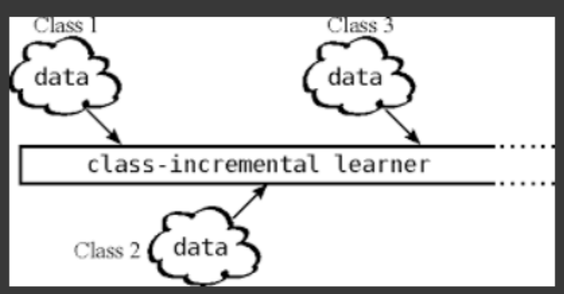


- **Object Detector exploiting *Transformer***
  - Previous object detection architecture was usually established on CNN

- **Deformable Attetion**
  - Enhancing spatial awareness and improve localization accuracy
  - particularly for deformed or irregular object shapes

- DETR(DEtection TRansformer) => Increase **Stability** and **Peformance**!
- We selected this due to its *clear structure and stability.*

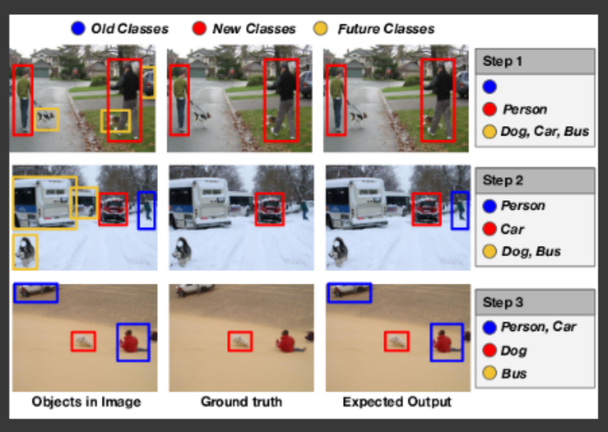
Replay Management - for Incremental Object Detection



ICaRL(Rebuffi et al. 2017)

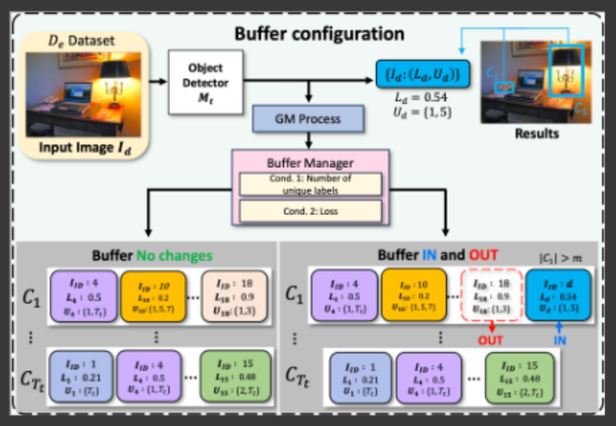
- Presented Replay method First
- Replay: collect some *sample* of respective class in the *buffer*
- Reuse the samples in the buffer when new dataset is trained
- Exploited mean-of-feature to collect the Replay Buffer
- **Targeted to Classification!**

Then, in Object Detection?



- Newly emerging classes(dataset)
- Multiple classes in one image => main difference between classification
- How to collect the buffer is main issue.

Effective & handling Class imbalance in Buffer Management Strategy



To tailoring the Replay method into Object Detection domain, We establisehd *two* criteria.

- **Number of unique labels** in a scene
- **Train-loss based strategy**; more efficient retrieving

Also, Consider the possibility that sparse classes will not be collected in the buffer

- **GM(Guarantee Mimimum)**
    - Determine the minimum number of images that should be included per class

Exploting Buffer in max!

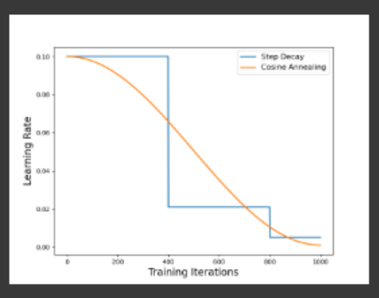
Buffer is relatevely too small than newly emerging dataset, So we devised how to fully use it.

- **CER (Circular Experience Replay) Training Strategy**
    - Repeatedly train buffer image into new training session.

> We combines Experience Replay (ER) training with circular training, where older samples are replaced over time to avoid fixation on outdated information and overfitting.

Selected Hyperparameters

1. **Task.**
   Current dataset + How many newly emerging dataset?
    - We selected 2
    - Simplest setting
2. **Guarantee Minimum.**
   Restricting number of images in buffer
    - limit image 1200
    - least image 12 (1%)
3. **Learning rate scheduler.**
   For effective learning.
    - Step LR
    - lr:2e-4

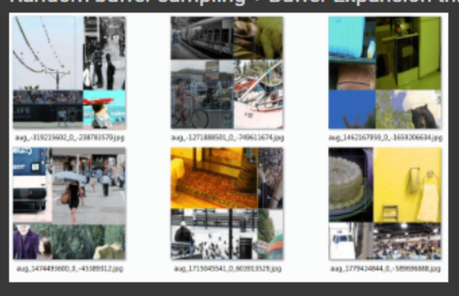


Results

BTW, We runned our code in owned server due to memory issue & assining GPU problem in GCP ... 🤯

We compared our results with

- Upper Bound
    - maximum potential performance achieved by joint training across all classes.
- Under Bound
    - Without the any incremental method, which experiences a significant forgetting.
- Mosaic
    - Random buffer sampling + Buffer Expansion through Mosaic Augmentation.



    - Large buffer capacity more than 10%.
- Ours
    - Small buffer limit but still performs well
    - 1% Buffer in regards to COCO Dataset (1200 images)

Method	T1+2					
	AP	AP.5	AP.75	AP_s	AP_m	AP_l
Upper Bound	**0.412**	**0.604**	**0.442**	**0.241**	**0.442**	**0.558**

UnderBound	**0.165**	**0.246**	**0.178**	**0.080**	**0.173**	**0.238**
Mosaic	**0.265**	**0.388**	**0.286**	**0.143**	**0.284**	**0.379**
eBTS (Ours)	**0.266**	**0.399**	**0.282**	**0.134**	**0.280**	**0.388**

Ours with Ablation Study

- Compare performance by adjusting the number of circular replay and normal replay epochs
  - (CER/ER)
  - 48/2
  - 47/3
  - 45/5

Phase		4040	
ER-CER Ratio		T(1+2)	
ER + CER		AP	AP.5
45	5	0.265	0.388
47	3	0.266	0.394
48	**2**	**0.266**	**0.399**

Our performance + Abiliation

더블클릭 또는 Enter 키를 눌러 수정

```
[ ]  !python main.py ₩
        --output_dir exps/deform ₩
        --coco_path ../COCODIR ₩
        --batch_size 12 ₩
        --resume ./pth/cd-detr-v3.pth ₩
        --with_box_refine ₩
        --eval
```

```
Test:  [ 30/417]  eta: 0:19:36  class_error: 39.44  loss: 13.9681 (14.6397)  loss_ce: 1.1353 (1.2078)  loss_bbox: 0.3595 (0.3884)  loss_giou: 0.7439 (0.7993)  loss_ce_0: 1.1447 (1.2244)  loss_bbox_0: 0.4305 (0.4524)  loss_giou_0: 0.8841 (0.9243)  loss_ce_
Test:  [ 40/417]  eta: 0:19:24  class_error: 40.34  loss: 13.9681 (14.5436)  loss_ce: 1.0749 (1.1955)  loss_bbox: 0.3595 (0.3913)  loss_giou: 0.7642 (0.7942)  loss_ce_0: 1.1305 (1.2119)  loss_bbox_0: 0.4178 (0.4593)  loss_giou_0: 0.9132 (0.9176)  loss_ce_
Test:  [ 50/417]  eta: 0:18:56  class_error: 37.78  loss: 15.7099 (14.8865)  loss_ce: 1.2224 (1.2287)  loss_bbox: 0.4215 (0.4020)  loss_giou: 0.8361 (0.8069)  loss_ce_0: 1.2423 (1.2380)  loss_bbox_0: 0.4929 (0.4695)  loss_giou_0: 0.9351 (0.9284)  loss_ce_
Test:  [ 60/417]  eta: 0:18:26  class_error: 35.23  loss: 16.3242 (15.0865)  loss_ce: 1.3312 (1.2469)  loss_bbox: 0.4338 (0.4061)  loss_giou: 0.8966 (0.8176)  loss_ce_0: 1.3311 (1.2554)  loss_bbox_0: 0.4929 (0.4732)  loss_giou_0: 1.0094 (0.9384)  loss_ce_
Test:  [ 70/417]  eta: 0:18:04  class_error: 39.78  loss: 15.1195 (14.9360)  loss_ce: 1.2625 (1.2329)  loss_bbox: 0.3913 (0.4022)  loss_giou: 0.7776 (0.8107)  loss_ce_0: 1.2631 (1.2427)  loss_bbox_0: 0.4805 (0.4714)  loss_giou_0: 0.9063 (0.9302)  loss_ce_
Test:  [ 80/417]  eta: 0:17:28  class_error: 58.59  loss: 14.2264 (14.8153)  loss_ce: 1.1731 (1.2277)  loss_bbox: 0.3689 (0.3987)  loss_giou: 0.7643 (0.7988)  loss_ce_0: 1.1838 (1.2379)  loss_bbox_0: 0.4608 (0.4703)  loss_giou_0: 0.8701 (0.9190)  loss_ce_
Test:  [ 90/417]  eta: 0:16:57  class_error: 25.00  loss: 14.2264 (14.8657)  loss_ce: 1.1731 (1.2295)  loss_bbox: 0.3744 (0.4014)  loss_giou: 0.7686 (0.8038)  loss_ce_0: 1.1881 (1.2385)  loss_bbox_0: 0.4703 (0.4722)  loss_giou_0: 0.8883 (0.9233)  loss_ce_
Test:  [100/417]  eta: 0:16:23  class_error: 54.93  loss: 15.0328 (14.9275)  loss_ce: 1.3422 (1.2379)  loss_bbox: 0.4187 (0.4024)  loss_giou: 0.7965 (0.8049)  loss_ce_0: 1.3094 (1.2473)  loss_bbox_0: 0.4780 (0.4716)  loss_giou_0: 0.9192 (0.9236)  loss_ce_
Test:  [110/417]  eta: 0:15:51  class_error: 51.43  loss: 16.1813 (15.0951)  loss_ce: 1.3422 (1.2521)  loss_bbox: 0.4503 (0.4098)  loss_giou: 0.8121 (0.8120)  loss_ce_0: 1.3346 (1.2611)  loss_bbox_0: 0.4824 (0.4773)  loss_giou_0: 0.9337 (0.9277)  loss_ce_
Test:  [120/417]  eta: 0:15:15  class_error: 38.18  loss: 14.7569 (15.0650)  loss_ce: 1.2158 (1.2460)  loss_bbox: 0.4342 (0.4094)  loss_giou: 0.8100 (0.8135)  loss_ce_0: 1.2589 (1.2573)  loss_bbox_0: 0.4758 (0.4757)  loss_giou_0: 0.9040 (0.9281)  loss_ce_
Test:  [130/417]  eta: 0:14:42  class_error: 49.18  loss: 14.6638 (15.0730)  loss_ce: 1.1872 (1.2475)  loss_bbox: 0.4053 (0.4108)  loss_giou: 0.8289 (0.8120)  loss_ce_0: 1.2221 (1.2598)  loss_bbox_0: 0.4594 (0.4776)  loss_giou_0: 0.9530 (0.9262)  loss_ce_
Test:  [140/417]  eta: 0:14:12  class_error: 65.00  loss: 16.2762 (15.1404)  loss_ce: 1.3745 (1.2587)  loss_bbox: 0.4136 (0.4103)  loss_giou: 0.8532 (0.8127)  loss_ce_0: 1.3565 (1.2701)  loss_bbox_0: 0.4876 (0.4771)  loss_giou_0: 0.9530 (0.9265)  loss_ce_
Test:  [150/417]  eta: 0:13:40  class_error: 44.00  loss: 14.7623 (15.0896)  loss_ce: 1.2771 (1.2525)  loss_bbox: 0.3889 (0.4098)  loss_giou: 0.8177 (0.8100)  loss_ce_0: 1.2552 (1.2668)  loss_bbox_0: 0.4850 (0.4767)  loss_giou_0: 0.8883 (0.9240)  loss_ce_
Test:  [160/417]  eta: 0:13:09  class_error: 28.00  loss: 14.7361 (15.0307)  loss_ce: 1.1937 (1.2486)  loss_bbox: 0.3621 (0.4068)  loss_giou: 0.7322 (0.8076)  loss_ce_0: 1.1954 (1.2607)  loss_bbox_0: 0.4293 (0.4738)  loss_giou_0: 0.8733 (0.9229)  loss_ce_
Test:  [170/417]  eta: 0:12:38  class_error: 52.81  loss: 15.6090 (15.0632)  loss_ce: 1.3117 (1.2510)  loss_bbox: 0.3930 (0.4086)  loss_giou: 0.7678 (0.8092)  loss_ce_0: 1.3069 (1.2625)  loss_bbox_0: 0.4197 (0.4748)  loss_giou_0: 0.8792 (0.9239)  loss_ce_
Test:  [180/417]  eta: 0:12:07  class_error: 40.32  loss: 14.1450 (14.9576)  loss_ce: 1.2925 (1.2415)  loss_bbox: 0.3990 (0.4069)  loss_giou: 0.7471 (0.8022)  loss_ce_0: 1.1918 (1.2540)  loss_bbox_0: 0.4433 (0.4730)  loss_giou_0: 0.8703 (0.9176)  loss_ce_
Test:  [190/417]  eta: 0:11:35  class_error: 37.50  loss: 14.0379 (15.0478)  loss_ce: 1.2083 (1.2535)  loss_bbox: 0.3897 (0.4085)  loss_giou: 0.7471 (0.8041)  loss_ce_0: 1.1903 (1.2651)  loss_bbox_0: 0.4446 (0.4745)  loss_giou_0: 0.8703 (0.9185)  loss_ce_
Test:  [200/417]  eta: 0:11:03  class_error: 43.64  loss: 15.5911 (15.0523)  loss_ce: 1.2357 (1.2516)  loss_bbox: 0.4209 (0.4100)  loss_giou: 0.7829 (0.8055)  loss_ce_0: 1.2685 (1.2635)  loss_bbox_0: 0.4756 (0.4751)  loss_giou_0: 0.8950 (0.9193)  loss_ce_
Test:  [210/417]  eta: 0:10:32  class_error: 41.89  loss: 15.1773 (15.1030)  loss_ce: 1.2409 (1.2561)  loss_bbox: 0.4209 (0.4107)  loss_giou: 0.7859 (0.8088)  loss_ce_0: 1.2361 (1.2686)  loss_bbox_0: 0.5138 (0.4752)  loss_giou_0: 0.9067 (0.9223)  loss_ce_
Test:  [220/417]  eta: 0:10:02  class_error: 36.45  loss: 15.6515 (15.1350)  loss_ce: 1.2618 (1.2569)  loss_bbox: 0.3908 (0.4110)  loss_giou: 0.8420 (0.8132)  loss_ce_0: 1.3280 (1.2698)  loss_bbox_0: 0.4632 (0.4745)  loss_giou_0: 0.9475 (0.9256)  loss_ce_
Test:  [230/417]  eta: 0:09:30  class_error: 36.25  loss: 14.4779 (15.1110)  loss_ce: 1.1845 (1.2546)  loss_bbox: 0.3754 (0.4095)  loss_giou: 0.8413 (0.8126)  loss_ce_0: 1.2423 (1.2681)  loss_bbox_0: 0.4324 (0.4735)  loss_giou_0: 0.9432 (0.9258)  loss_ce_
Test:  [240/417]  eta: 0:08:59  class_error: 43.69  loss: 14.4754 (15.0760)  loss_ce: 1.1356 (1.2503)  loss_bbox: 0.3810 (0.4094)  loss_giou: 0.7579 (0.8109)  loss_ce_0: 1.1642 (1.2641)  loss_bbox_0: 0.4656 (0.4737)  loss_giou_0: 0.9101 (0.9245)  loss_ce_
Test:  [250/417]  eta: 0:08:29  class_error: 33.96  loss: 13.9259 (15.0554)  loss_ce: 1.1148 (1.2487)  loss_bbox: 0.4011 (0.4084)  loss_giou: 0.7478 (0.8102)  loss_ce_0: 1.1642 (1.2623)  loss_bbox_0: 0.4792 (0.4727)  loss_giou_0: 0.8984 (0.9238)  loss_ce_
Test:  [260/417]  eta: 0:07:58  class_error: 65.00  loss: 14.5007 (15.0596)  loss_ce: 1.1577 (1.2486)  loss_bbox: 0.4098 (0.4092)  loss_giou: 0.7431 (0.8097)  loss_ce_0: 1.2082 (1.2642)  loss_bbox_0: 0.4782 (0.4735)  loss_giou_0: 0.8734 (0.9232)  loss_ce_
Test:  [270/417]  eta: 0:07:29  class_error: 30.77  loss: 14.5007 (15.0032)  loss_ce: 1.1577 (1.2436)  loss_bbox: 0.4098 (0.4081)  loss_giou: 0.7211 (0.8060)  loss_ce_0: 1.2131 (1.2601)  loss_bbox_0: 0.4782 (0.4726)  loss_giou_0: 0.8450 (0.9198)  loss_ce_
Test:  [280/417]  eta: 0:06:58  class_error: 45.52  loss: 14.7896 (15.0185)  loss_ce: 1.1820 (1.2430)  loss_bbox: 0.4294 (0.4089)  loss_giou: 0.8141 (0.8086)  loss_ce_0: 1.1920 (1.2593)  loss_bbox_0: 0.4775 (0.4726)  loss_giou_0: 0.9454 (0.9226)  loss_ce_
Test:  [290/417]  eta: 0:06:27  class_error: 30.30  loss: 15.4095 (15.0383)  loss_ce: 1.2142 (1.2442)  loss_bbox: 0.4294 (0.4102)  loss_giou: 0.8331 (0.8091)  loss_ce_0: 1.2673 (1.2610)  loss_bbox_0: 0.4770 (0.4739)  loss_giou_0: 0.9543 (0.9228)  loss_ce_
Test:  [300/417]  eta: 0:05:56  class_error: 45.19  loss: 15.3724 (15.0776)  loss_ce: 1.2653 (1.2471)  loss_bbox: 0.4230 (0.4111)  loss_giou: 0.8118 (0.8118)  loss_ce_0: 1.3169 (1.2637)  loss_bbox_0: 0.4770 (0.4749)  loss_giou_0: 0.9169 (0.9251)  loss_ce_
Test:  [310/417]  eta: 0:05:26  class_error: 56.52  loss: 15.1785 (15.0731)  loss_ce: 1.3153 (1.2474)  loss_bbox: 0.4038 (0.4106)  loss_giou: 0.8426 (0.8109)  loss_ce_0: 1.2917 (1.2648)  loss_bbox_0: 0.4920 (0.4748)  loss_giou_0: 0.9314 (0.9246)  loss_ce_
Test:  [320/417]  eta: 0:04:55  class_error: 28.36  loss: 14.6727 (15.0601)  loss_ce: 1.2593 (1.2467)  loss_bbox: 0.3775 (0.4097)  loss_giou: 0.7564 (0.8101)  loss_ce_0: 1.2917 (1.2642)  loss_bbox_0: 0.4657 (0.4741)  loss_giou_0: 0.9008 (0.9245)  loss_ce_
Test:  [330/417]  eta: 0:04:24  class_error: 48.15  loss: 15.3120 (15.0668)  loss_ce: 1.2593 (1.2465)  loss_bbox: 0.4031 (0.4114)  loss_giou: 0.7661 (0.8094)  loss_ce_0: 1.2845 (1.2642)  loss_bbox_0: 0.4774 (0.4760)  loss_giou_0: 0.9255 (0.9235)  loss_ce_
Test:  [340/417]  eta: 0:03:53  class_error: 23.85  loss: 15.1022 (15.0524)  loss_ce: 1.1597 (1.2444)  loss_bbox: 0.4383 (0.4115)  loss_giou: 0.8255 (0.8090)  loss_ce_0: 1.1763 (1.2626)  loss_bbox_0: 0.5006 (0.4759)  loss_giou_0: 0.9385 (0.9230)  loss_ce_
Test:  [350/417]  eta: 0:03:23  class_error: 31.58  loss: 13.2304 (15.0187)  loss_ce: 1.0754 (1.2394)  loss_bbox: 0.4215 (0.4113)  loss_giou: 0.7913 (0.8084)  loss_ce_0: 1.1310 (1.2583)  loss_bbox_0: 0.4602 (0.4754)  loss_giou_0: 0.9199 (0.9223)  loss_ce_
Test:  [360/417]  eta: 0:02:53  class_error: 52.08  loss: 13.7987 (15.0146)  loss_ce: 1.1061 (1.2388)  loss_bbox: 0.4057 (0.4113)  loss_giou: 0.7772 (0.8081)  loss_ce_0: 1.1732 (1.2587)  loss_bbox_0: 0.4593 (0.4754)  loss_giou_0: 0.9199 (0.9220)  loss_ce_
Test:  [370/417]  eta: 0:02:22  class_error: 34.72  loss: 15.0710 (15.0389)  loss_ce: 1.2661 (1.2409)  loss_bbox: 0.4057 (0.4121)  loss_giou: 0.8689 (0.8093)  loss_ce_0: 1.2954 (1.2611)  loss_bbox_0: 0.4590 (0.4758)  loss_giou_0: 0.9699 (0.9230)  loss_ce_
Test:  [380/417]  eta: 0:01:52  class_error: 25.17  loss: 15.1209 (15.0355)  loss_ce: 1.2661 (1.2402)  loss_bbox: 0.3979 (0.4122)  loss_giou: 0.8417 (0.8094)  loss_ce_0: 1.2954 (1.2608)  loss_bbox_0: 0.4590 (0.4755)  loss_giou_0: 0.9537 (0.9231)  loss_ce_
Test:  [390/417]  eta: 0:01:21  class_error: 42.53  loss: 14.2011 (15.0134)  loss_ce: 1.1316 (1.2377)  loss_bbox: 0.3903 (0.4113)  loss_giou: 0.8147 (0.8089)  loss_ce_0: 1.2005 (1.2588)  loss_bbox_0: 0.4493 (0.4748)  loss_giou_0: 0.9272 (0.9230)  loss_ce_
Test:  [400/417]  eta: 0:00:51  class_error: 47.92  loss: 14.3397 (15.0161)  loss_ce: 1.1405 (1.2380)  loss_bbox: 0.3930 (0.4115)  loss_giou: 0.8133 (0.8087)  loss_ce_0: 1.2194 (1.2586)  loss_bbox_0: 0.4640 (0.4754)  loss_giou_0: 0.9272 (0.9233)  loss_ce_
Test:  [410/417]  eta: 0:00:21  class_error: 49.17  loss: 15.8205 (15.0429)  loss_ce: 1.2847 (1.2404)  loss_bbox: 0.4029 (0.4117)  loss_giou: 0.8387 (0.8106)  loss_ce_0: 1.3052 (1.2610)  loss_bbox_0: 0.5012 (0.4755)  loss_giou_0: 0.9408 (0.9251)  loss_ce_
Test:  [416/417]  eta: 0:00:03  class_error: 29.27  loss: 15.3379 (15.0160)  loss_ce: 1.2148 (1.2384)  loss_bbox: 0.3997 (0.4108)  loss_giou: 0.7781 (0.8091)  loss_ce_0: 1.2420 (1.2592)  loss_bbox_0: 0.4868 (0.4748)  loss_giou_0: 0.8982 (0.9237)  loss_ce_
Test: Total time: 0:21:00 (3.0223 s / it)
Averaged stats: class_error: 29.27  loss: 15.3379 (15.0160)  loss_ce: 1.2148 (1.2384)  loss_bbox: 0.3997 (0.4108)  loss_giou: 0.7781 (0.8091)  loss_ce_0: 1.2420 (1.2592)  loss_bbox_0: 0.4868 (0.4748)  loss_giou_0: 0.8982 (0.9237)  loss_ce_1: 1.2308 (1.231
Accumulating evaluation results...
DONE (t=13.41s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.266
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.399
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.282
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.134
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.280
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.388
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.265
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.431
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.462
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.250
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.487
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.680
```

```
[ ]  !python main.py ₩
        --output_dir exps/deform ₩
        --coco_path ../COCODIR ₩
        --batch_size 12 ₩
        --resume ./pth/cd-detr-v1.pth ₩
        --with_box_refine ₩
        --eval
```

```
Test:  [ 30/417]  eta: 0:19:12  class_error: 54.93  loss: 15.9783 (17.8819)  loss_ce: 1.5439 (1.6805)  loss_bbox: 0.4018 (0.4495)  loss_giou: 0.7886 (0.8413)  loss_ce_0: 1.4692 (1.6544)  loss_bbox_0: 0.4467 (0.5031)  loss_giou_0: 0.9115 (0.9502)  loss_ce_
Test:  [ 40/417]  eta: 0:18:59  class_error: 65.55  loss: 17.0742 (17.7331)  loss_ce: 1.6458 (1.6815)  loss_bbox: 0.3799 (0.4420)  loss_giou: 0.7749 (0.8297)  loss_ce_0: 1.5084 (1.6391)  loss_bbox_0: 0.4370 (0.5018)  loss_giou_0: 0.9280 (0.9377)  loss_ce_
Test:  [ 50/417]  eta: 0:18:33  class_error: 47.78  loss: 17.9401 (18.0658)  loss_ce: 1.7301 (1.7115)  loss_bbox: 0.4477 (0.4549)  loss_giou: 0.7749 (0.8383)  loss_ce_0: 1.6515 (1.6736)  loss_bbox_0: 0.5189 (0.5121)  loss_giou_0: 0.9397 (0.9486)  loss_ce_
Test:  [ 60/417]  eta: 0:18:06  class_error: 47.73  loss: 18.7071 (18.2935)  loss_ce: 1.7946 (1.7347)  loss_bbox: 0.4867 (0.4597)  loss_giou: 0.9304 (0.8485)  loss_ce_0: 1.6944 (1.6929)  loss_bbox_0: 0.5407 (0.5181)  loss_giou_0: 1.0059 (0.9594)  loss_ce_
Test:  [ 70/417]  eta: 0:17:45  class_error: 60.22  loss: 18.4492 (18.1710)  loss_ce: 1.7734 (1.7197)  loss_bbox: 0.4837 (0.4578)  loss_giou: 0.8477 (0.8446)  loss_ce_0: 1.7110 (1.6813)  loss_bbox_0: 0.5296 (0.5168)  loss_giou_0: 0.9491 (0.9529)  loss_ce_
Test:  [ 80/417]  eta: 0:17:10  class_error: 67.19  loss: 18.4033 (18.1164)  loss_ce: 1.7668 (1.7200)  loss_bbox: 0.4408 (0.4566)  loss_giou: 0.7812 (0.8340)  loss_ce_0: 1.7110 (1.6873)  loss_bbox_0: 0.4923 (0.5156)  loss_giou_0: 0.8749 (0.9412)  loss_ce_
Test:  [ 90/417]  eta: 0:16:40  class_error: 44.64  loss: 16.7329 (18.1141)  loss_ce: 1.5764 (1.7188)  loss_bbox: 0.4484 (0.4533)  loss_giou: 0.8151 (0.8373)  loss_ce_0: 1.6524 (1.6872)  loss_bbox_0: 0.4814 (0.5131)  loss_giou_0: 0.9406 (0.9456)  loss_ce_
Test:  [100/417]  eta: 0:16:07  class_error: 71.13  loss: 19.1692 (18.2152)  loss_ce: 1.8840 (1.7320)  loss_bbox: 0.4484 (0.4554)  loss_giou: 0.8433 (0.8405)  loss_ce_0: 1.7773 (1.6952)  loss_bbox_0: 0.4830 (0.5136)  loss_giou_0: 0.9752 (0.9487)  loss_ce_
Test:  [110/417]  eta: 0:15:36  class_error: 54.29  loss: 20.1466 (18.4094)  loss_ce: 1.9100 (1.7479)  loss_bbox: 0.5195 (0.4630)  loss_giou: 0.9102 (0.8485)  loss_ce_0: 1.8498 (1.7103)  loss_bbox_0: 0.5782 (0.5216)  loss_giou_0: 1.0061 (0.9571)  loss_ce_
Test:  [120/417]  eta: 0:15:01  class_error: 54.55  loss: 19.0254 (18.4141)  loss_ce: 1.8625 (1.7522)  loss_bbox: 0.4434 (0.4623)  loss_giou: 0.9148 (0.8476)  loss_ce_0: 1.7416 (1.7105)  loss_bbox_0: 0.5139 (0.5193)  loss_giou_0: 1.0239 (0.9561)  loss_ce_
Test:  [130/417]  eta: 0:14:29  class_error: 55.74  loss: 18.9393 (18.4436)  loss_ce: 1.7843 (1.7542)  loss_bbox: 0.4480 (0.4656)  loss_giou: 0.8978 (0.8485)  loss_ce_0: 1.7416 (1.7120)  loss_bbox_0: 0.5095 (0.5220)  loss_giou_0: 0.9931 (0.9562)  loss_ce_
Test:  [140/417]  eta: 0:13:59  class_error: 68.00  loss: 19.3693 (18.4951)  loss_ce: 1.7843 (1.7617)  loss_bbox: 0.4706 (0.4653)  loss_giou: 0.8908 (0.8492)  loss_ce_0: 1.7900 (1.7224)  loss_bbox_0: 0.5245 (0.5209)  loss_giou_0: 0.9702 (0.9563)  loss_ce_
Test:  [150/417]  eta: 0:13:28  class_error: 51.00  loss: 18.5511 (18.4370)  loss_ce: 1.7420 (1.7558)  loss_bbox: 0.4683 (0.4649)  loss_giou: 0.8153 (0.8453)  loss_ce_0: 1.7290 (1.7165)  loss_bbox_0: 0.5097 (0.5208)  loss_giou_0: 0.9476 (0.9531)  loss_ce_
Test:  [160/417]  eta: 0:12:57  class_error: 42.00  loss: 18.5127 (18.3866)  loss_ce: 1.6327 (1.7502)  loss_bbox: 0.4484 (0.4631)  loss_giou: 0.7930 (0.8441)  loss_ce_0: 1.6080 (1.7085)  loss_bbox_0: 0.4845 (0.5194)  loss_giou_0: 0.9060 (0.9525)  loss_ce_
Test:  [170/417]  eta: 0:12:27  class_error: 58.43  loss: 18.9582 (18.3994)  loss_ce: 1.7925 (1.7499)  loss_bbox: 0.4479 (0.4638)  loss_giou: 0.8291 (0.8452)  loss_ce_0: 1.7451 (1.7101)  loss_bbox_0: 0.4932 (0.5201)  loss_giou_0: 0.9337 (0.9534)  loss_ce_
Test:  [180/417]  eta: 0:11:56  class_error: 43.55  loss: 16.5754 (18.2436)  loss_ce: 1.6543 (1.7335)  loss_bbox: 0.4147 (0.4609)  loss_giou: 0.7643 (0.8379)  loss_ce_0: 1.6219 (1.6944)  loss_bbox_0: 0.4858 (0.5180)  loss_giou_0: 0.8786 (0.9463)  loss_ce_
Test:  [190/417]  eta: 0:11:25  class_error: 67.50  loss: 16.5754 (18.3516)  loss_ce: 1.6749 (1.7479)  loss_bbox: 0.4265 (0.4633)  loss_giou: 0.7643 (0.8392)  loss_ce_0: 1.6398 (1.7079)  loss_bbox_0: 0.4863 (0.5205)  loss_giou_0: 0.8693 (0.9476)  loss_ce_
Test:  [200/417]  eta: 0:10:54  class_error: 71.82  loss: 18.3838 (18.3400)  loss_ce: 1.6749 (1.7435)  loss_bbox: 0.4794 (0.4654)  loss_giou: 0.8383 (0.8405)  loss_ce_0: 1.6911 (1.7011)  loss_bbox_0: 0.5317 (0.5228)  loss_giou_0: 0.9575 (0.9490)  loss_ce_
Test:  [210/417]  eta: 0:10:23  class_error: 63.51  loss: 19.2131 (18.4240)  loss_ce: 1.6436 (1.7512)  loss_bbox: 0.4794 (0.4668)  loss_giou: 0.8625 (0.8454)  loss_ce_0: 1.5150 (1.7090)  loss_bbox_0: 0.5317 (0.5236)  loss_giou_0: 0.9736 (0.9534)  loss_ce_
Test:  [220/417]  eta: 0:09:53  class_error: 52.34  loss: 19.9042 (18.4437)  loss_ce: 1.8289 (1.7495)  loss_bbox: 0.4665 (0.4678)  loss_giou: 0.9121 (0.8500)  loss_ce_0: 1.7991 (1.7070)  loss_bbox_0: 0.4899 (0.5233)  loss_giou_0: 0.9928 (0.9572)  loss_ce_
Test:  [230/417]  eta: 0:09:22  class_error: 57.50  loss: 18.0816 (18.4307)  loss_ce: 1.7085 (1.7498)  loss_bbox: 0.4413 (0.4656)  loss_giou: 0.9066 (0.8500)  loss_ce_0: 1.6404 (1.7062)  loss_bbox_0: 0.4864 (0.5217)  loss_giou_0: 0.9832 (0.9576)  loss_ce_
Test:  [240/417]  eta: 0:08:52  class_error: 64.08  loss: 17.3765 (18.3849)  loss_ce: 1.5643 (1.7437)  loss_bbox: 0.4437 (0.4655)  loss_giou: 0.8076 (0.8484)  loss_ce_0: 1.6150 (1.7010)  loss_bbox_0: 0.4938 (0.5214)  loss_giou_0: 0.8984 (0.9557)  loss_ce_
Test:  [250/417]  eta: 0:08:22  class_error: 28.30  loss: 16.7552 (18.3369)  loss_ce: 1.5302 (1.7403)  loss_bbox: 0.4522 (0.4630)  loss_giou: 0.8076 (0.8462)  loss_ce_0: 1.5311 (1.6974)  loss_bbox_0: 0.4992 (0.5194)  loss_giou_0: 0.8914 (0.9545)  loss_ce_
Test:  [260/417]  eta: 0:07:52  class_error: 82.14  loss: 17.2228 (18.3605)  loss_ce: 1.6429 (1.7423)  loss_bbox: 0.4591 (0.4642)  loss_giou: 0.8157 (0.8460)  loss_ce_0: 1.5993 (1.7010)  loss_bbox_0: 0.5011 (0.5208)  loss_giou_0: 0.9637 (0.9547)  loss_ce_
Test:  [270/417]  eta: 0:07:23  class_error: 39.74  loss: 17.1601 (18.2758)  loss_ce: 1.5825 (1.7339)  loss_bbox: 0.4855 (0.4626)  loss_giou: 0.7344 (0.8418)  loss_ce_0: 1.5704 (1.6935)  loss_bbox_0: 0.5265 (0.5189)  loss_giou_0: 0.8728 (0.9504)  loss_ce_
Test:  [280/417]  eta: 0:06:52  class_error: 62.69  loss: 17.1601 (18.2690)  loss_ce: 1.5644 (1.7314)  loss_bbox: 0.4480 (0.4625)  loss_giou: 0.8191 (0.8436)  loss_ce_0: 1.5097 (1.6912)  loss_bbox_0: 0.5023 (0.5184)  loss_giou_0: 0.9352 (0.9524)  loss_ce_
Test:  [290/417]  eta: 0:06:22  class_error: 51.52  loss: 17.7218 (18.2780)  loss_ce: 1.6462 (1.7331)  loss_bbox: 0.4480 (0.4630)  loss_giou: 0.8666 (0.8426)  loss_ce_0: 1.6145 (1.6941)  loss_bbox_0: 0.5023 (0.5189)  loss_giou_0: 0.9738 (0.9512)  loss_ce_
Test:  [300/417]  eta: 0:05:51  class_error: 50.96  loss: 18.2882 (18.3048)  loss_ce: 1.6958 (1.7356)  loss_bbox: 0.4491 (0.4636)  loss_giou: 0.8666 (0.8446)  loss_ce_0: 1.7225 (1.6957)  loss_bbox_0: 0.5008 (0.5194)  loss_giou_0: 0.9858 (0.9528)  loss_ce_
Test:  [310/417]  eta: 0:05:21  class_error: 81.52  loss: 18.0632 (18.2981)  loss_ce: 1.6900 (1.7356)  loss_bbox: 0.4434 (0.4630)  loss_giou: 0.8554 (0.8441)  loss_ce_0: 1.6459 (1.6958)  loss_bbox_0: 0.4888 (0.5190)  loss_giou_0: 0.9720 (0.9525)  loss_ce_
```

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Test:  [330/417]  eta: 0:04:20  class_error: 66.67  loss: 17.3426 (18.2775)  loss_ce: 1.5830 (1.7315)  loss_bbox: 0.4632 (0.4639)  loss_giou: 0.8204 (0.8429)  loss_ce_0: 1.6106 (1.6930)  loss_bbox_0: 0.5018 (0.5203)  loss_giou_0: 0.9280 (0.9518)  loss_ce_
Test:  [340/417]  eta: 0:03:50  class_error: 33.94  loss: 17.0886 (18.2379)  loss_ce: 1.4873 (1.7257)  loss_bbox: 0.4642 (0.4638)  loss_giou: 0.8550 (0.8419)  loss_ce_0: 1.4563 (1.6879)  loss_bbox_0: 0.5318 (0.5202)  loss_giou_0: 0.9760 (0.9510)  loss_ce_
Test:  [350/417]  eta: 0:03:20  class_error: 43.86  loss: 15.4329 (18.1778)  loss_ce: 1.4277 (1.7179)  loss_bbox: 0.4452 (0.4630)  loss_giou: 0.7940 (0.8405)  loss_ce_0: 1.3742 (1.6799)  loss_bbox_0: 0.4780 (0.5193)  loss_giou_0: 0.9465 (0.9497)  loss_ce_
Test:  [360/417]  eta: 0:02:50  class_error: 59.38  loss: 16.8915 (18.1710)  loss_ce: 1.5139 (1.7160)  loss_bbox: 0.4698 (0.4633)  loss_giou: 0.7940 (0.8407)  loss_ce_0: 1.5534 (1.6788)  loss_bbox_0: 0.4947 (0.5197)  loss_giou_0: 0.9064 (0.9501)  loss_ce_
Test:  [370/417]  eta: 0:02:20  class_error: 52.78  loss: 19.0330 (18.2156)  loss_ce: 1.7356 (1.7199)  loss_bbox: 0.4913 (0.4650)  loss_giou: 0.8811 (0.8425)  loss_ce_0: 1.7364 (1.6819)  loss_bbox_0: 0.5523 (0.5218)  loss_giou_0: 1.0097 (0.9519)  loss_ce_
Test:  [380/417]  eta: 0:01:50  class_error: 32.65  loss: 19.0330 (18.2140)  loss_ce: 1.8131 (1.7194)  loss_bbox: 0.4758 (0.4645)  loss_giou: 0.8967 (0.8433)  loss_ce_0: 1.7257 (1.6810)  loss_bbox_0: 0.5510 (0.5218)  loss_giou_0: 1.0097 (0.9528)  loss_ce_
Test:  [390/417]  eta: 0:01:20  class_error: 47.13  loss: 17.8356 (18.1973)  loss_ce: 1.6642 (1.7167)  loss_bbox: 0.4121 (0.4639)  loss_giou: 0.8555 (0.8433)  loss_ce_0: 1.6342 (1.6790)  loss_bbox_0: 0.4772 (0.5213)  loss_giou_0: 0.9422 (0.9531)  loss_ce_
Test:  [400/417]  eta: 0:00:50  class_error: 51.04  loss: 17.8356 (18.1973)  loss_ce: 1.6642 (1.7162)  loss_bbox: 0.4269 (0.4643)  loss_giou: 0.8366 (0.8436)  loss_ce_0: 1.6342 (1.6783)  loss_bbox_0: 0.4954 (0.5214)  loss_giou_0: 0.9494 (0.9534)  loss_ce_
Test:  [410/417]  eta: 0:00:20  class_error: 55.00  loss: 18.8608 (18.2279)  loss_ce: 1.7209 (1.7196)  loss_bbox: 0.4561 (0.4643)  loss_giou: 0.9022 (0.8455)  loss_ce_0: 1.6912 (1.6808)  loss_bbox_0: 0.4938 (0.5214)  loss_giou_0: 0.9952 (0.9551)  loss_ce_
Test:  [416/417]  eta: 0:00:02  class_error: 24.39  loss: 18.4857 (18.1943)  loss_ce: 1.6955 (1.7170)  loss_bbox: 0.4526 (0.4630)  loss_giou: 0.8259 (0.8437)  loss_ce_0: 1.6322 (1.6783)  loss_bbox_0: 0.4938 (0.5202)  loss_giou_0: 0.9576 (0.9535)  loss_ce_
Test: Total time: 0:20:44 (2.9846 s / it)
Averaged stats: class_error: 24.39  loss: 18.4857 (18.1943)  loss_ce: 1.6955 (1.7170)  loss_bbox: 0.4526 (0.4630)  loss_giou: 0.8259 (0.8437)  loss_ce_0: 1.6322 (1.6783)  loss_bbox_0: 0.4938 (0.5202)  loss_giou_0: 0.9576 (0.9535)  loss_ce_1: 1.6911 (1.692
Accumulating evaluation results...
DONE (t=13.18s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.266
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.394
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.284
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.114
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.280
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.405
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.245
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.389
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.416
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.206
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.432
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.608
```

```
[ ] !python main.py \
      --output_dir exps/deform \
      --coco_path ../COCODIR \
      --batch_size 12 \
      --resume ./pth/cd-detr-v2.pth \
      --with_box_refine \
      --eval
```

```
Test:  [ 30/417]  eta: 0:18:56  class_error: 59.15  loss: 17.8572 (18.4410)  loss_ce: 1.6185 (1.7456)  loss_bbox: 0.4295 (0.4592)  loss_giou: 0.7928 (0.8354)  loss_ce_0: 1.6271 (1.7612)  loss_bbox_0: 0.4669 (0.5185)  loss_giou_0: 0.9226 (0.9604)  loss_ce_
Test:  [ 40/417]  eta: 0:18:55  class_error: 70.59  loss: 17.8757 (18.4328)  loss_ce: 1.8363 (1.7600)  loss_bbox: 0.3995 (0.4541)  loss_giou: 0.7928 (0.8246)  loss_ce_0: 1.6616 (1.7697)  loss_bbox_0: 0.4586 (0.5197)  loss_giou_0: 0.9277 (0.9488)  loss_ce_
Test:  [ 50/417]  eta: 0:18:31  class_error: 48.89  loss: 19.1471 (18.6961)  loss_ce: 1.8705 (1.7822)  loss_bbox: 0.4621 (0.4612)  loss_giou: 0.8106 (0.8344)  loss_ce_0: 1.8736 (1.8000)  loss_bbox_0: 0.5397 (0.5265)  loss_giou_0: 0.9460 (0.9587)  loss_ce_
Test:  [ 60/417]  eta: 0:18:06  class_error: 48.86  loss: 19.1316 (18.9674)  loss_ce: 1.8392 (1.8162)  loss_bbox: 0.4652 (0.4651)  loss_giou: 0.8736 (0.8418)  loss_ce_0: 1.8191 (1.8340)  loss_bbox_0: 0.5397 (0.5285)  loss_giou_0: 0.9982 (0.9660)  loss_ce_
Test:  [ 70/417]  eta: 0:17:46  class_error: 59.14  loss: 18.9374 (18.7895)  loss_ce: 1.8672 (1.7965)  loss_bbox: 0.4480 (0.4620)  loss_giou: 0.8265 (0.8358)  loss_ce_0: 1.8782 (1.8144)  loss_bbox_0: 0.5059 (0.5250)  loss_giou_0: 0.9554 (0.9604)  loss_ce_
Test:  [ 80/417]  eta: 0:17:12  class_error: 67.19  loss: 17.6181 (18.6865)  loss_ce: 1.7917 (1.7921)  loss_bbox: 0.4409 (0.4584)  loss_giou: 0.7597 (0.8236)  loss_ce_0: 1.8122 (1.8140)  loss_bbox_0: 0.4970 (0.5236)  loss_giou_0: 0.8926 (0.9485)  loss_ce_
Test:  [ 90/417]  eta: 0:16:43  class_error: 43.75  loss: 17.4817 (18.6852)  loss_ce: 1.7310 (1.7895)  loss_bbox: 0.4409 (0.4573)  loss_giou: 0.8118 (0.8275)  loss_ce_0: 1.7860 (1.8116)  loss_bbox_0: 0.4955 (0.5216)  loss_giou_0: 0.9224 (0.9518)  loss_ce_
Test:  [100/417]  eta: 0:16:10  class_error: 70.42  loss: 19.2659 (18.7600)  loss_ce: 1.8464 (1.7998)  loss_bbox: 0.4707 (0.4585)  loss_giou: 0.8181 (0.8276)  loss_ce_0: 1.9372 (1.8205)  loss_bbox_0: 0.5014 (0.5226)  loss_giou_0: 0.9740 (0.9527)  loss_ce_
Test:  [110/417]  eta: 0:15:39  class_error: 54.29  loss: 20.4027 (18.9487)  loss_ce: 1.9564 (1.8131)  loss_bbox: 0.5096 (0.4666)  loss_giou: 0.8523 (0.8370)  loss_ce_0: 1.9729 (1.8376)  loss_bbox_0: 0.5691 (0.5301)  loss_giou_0: 0.9945 (0.9611)  loss_ce_
Test:  [120/417]  eta: 0:15:05  class_error: 60.00  loss: 20.4027 (18.9689)  loss_ce: 1.9564 (1.8189)  loss_bbox: 0.4776 (0.4667)  loss_giou: 0.8508 (0.8371)  loss_ce_0: 1.9867 (1.8390)  loss_bbox_0: 0.5283 (0.5288)  loss_giou_0: 0.9883 (0.9609)  loss_ce_
Test:  [130/417]  eta: 0:14:32  class_error: 59.02  loss: 19.0142 (19.0001)  loss_ce: 1.8656 (1.8187)  loss_bbox: 0.4730 (0.4704)  loss_giou: 0.8506 (0.8396)  loss_ce_0: 1.7576 (1.8404)  loss_bbox_0: 0.5276 (0.5316)  loss_giou_0: 0.9629 (0.9611)  loss_ce_
Test:  [140/417]  eta: 0:14:03  class_error: 67.00  loss: 19.3652 (19.0532)  loss_ce: 1.8453 (1.8243)  loss_bbox: 0.4932 (0.4711)  loss_giou: 0.8618 (0.8413)  loss_ce_0: 1.9216 (1.8489)  loss_bbox_0: 0.5630 (0.5314)  loss_giou_0: 0.9875 (0.9626)  loss_ce_
Test:  [150/417]  eta: 0:13:32  class_error: 53.00  loss: 19.3652 (19.9908)  loss_ce: 1.7231 (1.8189)  loss_bbox: 0.4656 (0.4702)  loss_giou: 0.8228 (0.8381)  loss_ce_0: 1.8164 (1.8415)  loss_bbox_0: 0.5437 (0.5308)  loss_giou_0: 0.9647 (0.9599)  loss_ce_
Test:  [160/417]  eta: 0:13:01  class_error: 44.00  loss: 18.4829 (18.9085)  loss_ce: 1.6192 (1.8124)  loss_bbox: 0.4579 (0.4665)  loss_giou: 0.7740 (0.8351)  loss_ce_0: 1.6697 (1.8323)  loss_bbox_0: 0.4841 (0.5278)  loss_giou_0: 0.9121 (0.9578)  loss_ce_
Test:  [170/417]  eta: 0:12:31  class_error: 59.55  loss: 19.5324 (18.9171)  loss_ce: 1.8060 (1.8128)  loss_bbox: 0.4066 (0.4663)  loss_giou: 0.8481 (0.8360)  loss_ce_0: 1.7957 (1.8330)  loss_bbox_0: 0.4841 (0.5281)  loss_giou_0: 0.9262 (0.9590)  loss_ce_
Test:  [180/417]  eta: 0:12:00  class_error: 51.61  loss: 17.2211 (18.7563)  loss_ce: 1.7450 (1.7960)  loss_bbox: 0.4236 (0.4638)  loss_giou: 0.7794 (0.8294)  loss_ce_0: 1.6771 (1.8146)  loss_bbox_0: 0.4801 (0.5262)  loss_giou_0: 0.8895 (0.9524)  loss_ce_
Test:  [190/417]  eta: 0:11:29  class_error: 75.00  loss: 17.2211 (18.8808)  loss_ce: 1.7913 (1.8121)  loss_bbox: 0.4382 (0.4659)  loss_giou: 0.7738 (0.8315)  loss_ce_0: 1.7222 (1.8314)  loss_bbox_0: 0.4981 (0.5285)  loss_giou_0: 0.8804 (0.9535)  loss_ce_
Test:  [200/417]  eta: 0:10:58  class_error: 73.64  loss: 19.3447 (18.8624)  loss_ce: 1.8809 (1.8077)  loss_bbox: 0.4826 (0.4675)  loss_giou: 0.8472 (0.8319)  loss_ce_0: 1.8614 (1.8252)  loss_bbox_0: 0.5627 (0.5300)  loss_giou_0: 0.9749 (0.9544)  loss_ce_
Test:  [210/417]  eta: 0:10:27  class_error: 63.51  loss: 18.3800 (18.9448)  loss_ce: 1.7812 (1.8148)  loss_bbox: 0.4931 (0.4688)  loss_giou: 0.8472 (0.8368)  loss_ce_0: 1.7463 (1.8334)  loss_bbox_0: 0.5433 (0.5312)  loss_giou_0: 0.9749 (0.9593)  loss_ce_
Test:  [220/417]  eta: 0:09:57  class_error: 54.21  loss: 19.9145 (18.9534)  loss_ce: 1.8272 (1.8122)  loss_bbox: 0.4919 (0.4688)  loss_giou: 0.8789 (0.8408)  loss_ce_0: 1.7824 (1.8301)  loss_bbox_0: 0.5377 (0.5311)  loss_giou_0: 1.0031 (0.9638)  loss_ce_
Test:  [230/417]  eta: 0:09:26  class_error: 60.00  loss: 18.4736 (18.9353)  loss_ce: 1.6583 (1.8108)  loss_bbox: 0.4368 (0.4667)  loss_giou: 0.8591 (0.8409)  loss_ce_0: 1.7182 (1.8296)  loss_bbox_0: 0.5012 (0.5295)  loss_giou_0: 1.0033 (0.9640)  loss_ce_
Test:  [240/417]  eta: 0:08:56  class_error: 71.84  loss: 17.9049 (18.8955)  loss_ce: 1.7539 (1.8049)  loss_bbox: 0.4419 (0.4674)  loss_giou: 0.7762 (0.8395)  loss_ce_0: 1.7730 (1.8239)  loss_bbox_0: 0.5001 (0.5294)  loss_giou_0: 0.9286 (0.9626)  loss_ce_
Test:  [250/417]  eta: 0:08:26  class_error: 33.96  loss: 17.0285 (18.8351)  loss_ce: 1.6352 (1.7995)  loss_bbox: 0.4208 (0.4646)  loss_giou: 0.7762 (0.8377)  loss_ce_0: 1.6405 (1.8177)  loss_bbox_0: 0.4913 (0.5269)  loss_giou_0: 0.9286 (0.9609)  loss_ce_
Test:  [260/417]  eta: 0:07:55  class_error: 82.14  loss: 17.2415 (18.8565)  loss_ce: 1.8009 (1.8019)  loss_bbox: 0.4208 (0.4652)  loss_giou: 0.7376 (0.8368)  loss_ce_0: 1.8831 (1.8230)  loss_bbox_0: 0.4927 (0.5280)  loss_giou_0: 0.8935 (0.9602)  loss_ce_
Test:  [270/417]  eta: 0:07:26  class_error: 42.31  loss: 17.2415 (18.7770)  loss_ce: 1.7523 (1.7933)  loss_bbox: 0.4602 (0.4642)  loss_giou: 0.7255 (0.8329)  loss_ce_0: 1.7271 (1.8150)  loss_bbox_0: 0.5311 (0.5269)  loss_giou_0: 0.8187 (0.9566)  loss_ce_
Test:  [280/417]  eta: 0:06:55  class_error: 61.19  loss: 17.0275 (18.7695)  loss_ce: 1.5247 (1.7899)  loss_bbox: 0.4547 (0.4645)  loss_giou: 0.8034 (0.8350)  loss_ce_0: 1.5460 (1.8117)  loss_bbox_0: 0.5083 (0.5265)  loss_giou_0: 0.9539 (0.9584)  loss_ce_
Test:  [290/417]  eta: 0:06:25  class_error: 45.45  loss: 18.3193 (18.7973)  loss_ce: 1.7660 (1.7924)  loss_bbox: 0.4539 (0.4657)  loss_giou: 0.8632 (0.8355)  loss_ce_0: 1.7526 (1.8156)  loss_bbox_0: 0.5142 (0.5278)  loss_giou_0: 0.9814 (0.9586)  loss_ce_
Test:  [300/417]  eta: 0:05:54  class_error: 51.92  loss: 18.5625 (18.8181)  loss_ce: 1.8015 (1.7939)  loss_bbox: 0.4539 (0.4661)  loss_giou: 0.8457 (0.8375)  loss_ce_0: 1.8750 (1.8175)  loss_bbox_0: 0.5142 (0.5277)  loss_giou_0: 0.9814 (0.9597)  loss_ce_
Test:  [310/417]  eta: 0:05:24  class_error: 83.70  loss: 18.4772 (18.8069)  loss_ce: 1.7786 (1.7933)  loss_bbox: 0.4494 (0.4652)  loss_giou: 0.8303 (0.8369)  loss_ce_0: 1.7999 (1.8174)  loss_bbox_0: 0.4997 (0.5268)  loss_giou_0: 0.9760 (0.9592)  loss_ce_
Test:  [320/417]  eta: 0:04:53  class_error: 40.30  loss: 18.2360 (18.7961)  loss_ce: 1.7451 (1.7929)  loss_bbox: 0.4372 (0.4644)  loss_giou: 0.8303 (0.8364)  loss_ce_0: 1.7841 (1.8166)  loss_bbox_0: 0.5063 (0.5260)  loss_giou_0: 0.9760 (0.9593)  loss_ce_
Test:  [330/417]  eta: 0:04:22  class_error: 64.20  loss: 18.5989 (18.7900)  loss_ce: 1.7451 (1.7907)  loss_bbox: 0.4603 (0.4659)  loss_giou: 0.8345 (0.8355)  loss_ce_0: 1.7841 (1.8149)  loss_bbox_0: 0.5114 (0.5279)  loss_giou_0: 0.9807 (0.9582)  loss_ce_
Test:  [340/417]  eta: 0:03:52  class_error: 32.11  loss: 17.5147 (18.7516)  loss_ce: 1.5764 (1.7851)  loss_bbox: 0.4743 (0.4660)  loss_giou: 0.8642 (0.8347)  loss_ce_0: 1.5535 (1.8095)  loss_bbox_0: 0.5767 (0.5282)  loss_giou_0: 0.9807 (0.9577)  loss_ce_
Test:  [350/417]  eta: 0:03:22  class_error: 40.35  loss: 15.9770 (18.6910)  loss_ce: 1.4435 (1.7773)  loss_bbox: 0.4245 (0.4650)  loss_giou: 0.8414 (0.8335)  loss_ce_0: 1.4414 (1.8008)  loss_bbox_0: 0.4849 (0.5272)  loss_giou_0: 0.9607 (0.9571)  loss_ce_
Test:  [360/417]  eta: 0:02:52  class_error: 63.54  loss: 16.9795 (18.6786)  loss_ce: 1.5913 (1.7743)  loss_bbox: 0.4505 (0.4654)  loss_giou: 0.8414 (0.8336)  loss_ce_0: 1.5830 (1.7986)  loss_bbox_0: 0.4966 (0.5276)  loss_giou_0: 0.9607 (0.9572)  loss_ce_
Test:  [370/417]  eta: 0:02:21  class_error: 55.56  loss: 18.8425 (18.7101)  loss_ce: 1.7523 (1.7786)  loss_bbox: 0.4663 (0.4661)  loss_giou: 0.8558 (0.8341)  loss_ce_0: 1.7688 (1.8019)  loss_bbox_0: 0.5393 (0.5285)  loss_giou_0: 0.9947 (0.9578)  loss_ce_
Test:  [380/417]  eta: 0:01:51  class_error: 29.25  loss: 18.8425 (18.6982)  loss_ce: 1.7837 (1.7772)  loss_bbox: 0.4190 (0.4652)  loss_giou: 0.8328 (0.8346)  loss_ce_0: 1.7713 (1.8003)  loss_bbox_0: 0.5014 (0.5276)  loss_giou_0: 0.9537 (0.9580)  loss_ce_
Test:  [390/417]  eta: 0:01:21  class_error: 49.43  loss: 18.0527 (18.6786)  loss_ce: 1.6711 (1.7742)  loss_bbox: 0.4028 (0.4649)  loss_giou: 0.8013 (0.8345)  loss_ce_0: 1.6603 (1.7972)  loss_bbox_0: 0.4672 (0.5274)  loss_giou_0: 0.9295 (0.9580)  loss_ce_
Test:  [400/417]  eta: 0:00:51  class_error: 47.92  loss: 18.0527 (18.6717)  loss_ce: 1.6657 (1.7728)  loss_bbox: 0.4326 (0.4653)  loss_giou: 0.8013 (0.8346)  loss_ce_0: 1.6603 (1.7955)  loss_bbox_0: 0.4675 (0.5276)  loss_giou_0: 0.9629 (0.9580)  loss_ce_
Test:  [410/417]  eta: 0:00:21  class_error: 51.67  loss: 18.6826 (18.6958)  loss_ce: 1.7369 (1.7749)  loss_bbox: 0.4705 (0.4654)  loss_giou: 0.8877 (0.8365)  loss_ce_0: 1.7814 (1.7969)  loss_bbox_0: 0.5414 (0.5276)  loss_giou_0: 0.9818 (0.9603)  loss_ce_
Test:  [416/417]  eta: 0:00:03  class_error: 43.90  loss: 18.6397 (18.6679)  loss_ce: 1.7128 (1.7728)  loss_bbox: 0.4598 (0.4645)  loss_giou: 0.8419 (0.8350)  loss_ce_0: 1.7354 (1.7951)  loss_bbox_0: 0.5401 (0.5265)  loss_giou_0: 0.9381 (0.9585)  loss_ce_
Test: Total time: 0:20:54 (3.0087 s / it)
Averaged stats: class_error: 43.90  loss: 18.6397 (18.6679)  loss_ce: 1.7128 (1.7728)  loss_bbox: 0.4598 (0.4645)  loss_giou: 0.8419 (0.8350)  loss_ce_0: 1.7354 (1.7951)  loss_bbox_0: 0.5401 (0.5265)  loss_giou_0: 0.9381 (0.9585)  loss_ce_1: 1.6933 (1.765
Accumulating evaluation results...
DONE (t=12.82s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.261
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.387
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.279
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.117
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.270
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.395
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.238
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.379
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.404
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.216
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.418
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.591
```

Comparision with Others

```
[ ] !python main.py \
      --output_dir exps/deform \
      --coco_path ../COCODIR \
      --batch_size 12 \
      --resume ./pth/underbound.pth \
      --with_box_refine \
      --eval
```

```
Test:  [ 30/417]  eta: 0:19:02  class_error: 67.61  loss: 24.7281 (25.4804)  loss_ce: 2.4608 (2.5989)  loss_bbox: 0.5680 (0.5891)  loss_giou: 0.9914 (1.0379)  loss_ce_0: 2.4828 (2.6343)  loss_bbox_0: 0.5894 (0.6292)  loss_giou_0: 1.0954 (1.1184)  loss_ce_
Test:  [ 40/417]  eta: 0:18:52  class_error: 71.43  loss: 26.8264 (26.0432)  loss_ce: 2.6915 (2.6594)  loss_bbox: 0.5992 (0.6086)  loss_giou: 1.0317 (1.0482)  loss_ce_0: 2.7344 (2.6994)  loss_bbox_0: 0.6018 (0.6483)  loss_giou_0: 1.1349 (1.1251)  loss_ce_
Test:  [ 50/417]  eta: 0:18:27  class_error: 61.11  loss: 27.2822 (26.0732)  loss_ce: 2.8055 (2.6542)  loss_bbox: 0.6498 (0.6168)  loss_giou: 1.0723 (1.0531)  loss_ce_0: 2.8546 (2.6909)  loss_bbox_0: 0.6825 (0.6537)  loss_giou_0: 1.1382 (1.1292)  loss_ce_
Test:  [ 60/417]  eta: 0:18:00  class_error: 69.32  loss: 27.1924 (26.3881)  loss_ce: 2.7432 (2.6889)  loss_bbox: 0.6378 (0.6213)  loss_giou: 1.1203 (1.0664)  loss_ce_0: 2.8011 (2.7269)  loss_bbox_0: 0.6523 (0.6549)  loss_giou_0: 1.1626 (1.1393)  loss_ce_
Test:  [ 70/417]  eta: 0:17:31  class_error: 62.37  loss: 27.3798 (26.3248)  loss_ce: 2.7134 (2.6809)  loss_bbox: 0.6264 (0.6200)  loss_giou: 1.1203 (1.0650)  loss_ce_0: 2.7873 (2.7188)  loss_bbox_0: 0.6523 (0.6532)  loss_giou_0: 1.1602 (1.1365)  loss_ce_
Test:  [ 80/417]  eta: 0:17:06  class_error: 71.88  loss: 27.0573 (26.2579)  loss_ce: 2.6826 (2.6772)  loss_bbox: 0.6382 (0.6202)  loss_giou: 1.0598 (1.0552)  loss_ce_0: 2.6952 (2.7163)  loss_bbox_0: 0.6729 (0.6551)  loss_giou_0: 1.1118 (1.1272)  loss_ce_
Test:  [ 90/417]  eta: 0:16:36  class_error: 67.86  loss: 27.1562 (26.3414)  loss_ce: 2.7427 (2.6821)  loss_bbox: 0.5772 (0.6208)  loss_giou: 1.0858 (1.0647)  loss_ce_0: 2.8045 (2.7214)  loss_bbox_0: 0.6550 (0.6553)  loss_giou_0: 1.1366 (1.1339)  loss_ce_
Test:  [100/417]  eta: 0:16:03  class_error: 71.83  loss: 27.4582 (26.5163)  loss_ce: 2.7888 (2.7062)  loss_bbox: 0.6224 (0.6225)  loss_giou: 1.1251 (1.0681)  loss_ce_0: 2.8354 (2.7456)  loss_bbox_0: 0.6534 (0.6557)  loss_giou_0: 1.1749 (1.1358)  loss_ce_
Test:  [110/417]  eta: 0:15:32  class_error: 74.29  loss: 27.8465 (26.7059)  loss_ce: 2.8580 (2.7216)  loss_bbox: 0.6777 (0.6326)  loss_giou: 1.1237 (1.0754)  loss_ce_0: 2.8774 (2.7603)  loss_bbox_0: 0.7175 (0.6647)  loss_giou_0: 1.1699 (1.1427)  loss_ce_
Test:  [120/417]  eta: 0:14:57  class_error: 70.91  loss: 28.8873 (26.7967)  loss_ce: 2.8702 (2.7311)  loss_bbox: 0.6630 (0.6322)  loss_giou: 1.1879 (1.0813)  loss_ce_0: 2.9128 (2.7709)  loss_bbox_0: 0.6897 (0.6646)  loss_giou_0: 1.2421 (1.1467)  loss_ce_
Test:  [130/417]  eta: 0:14:25  class_error: 59.02  loss: 24.8350 (26.6472)  loss_ce: 2.5031 (2.7130)  loss_bbox: 0.6303 (0.6307)  loss_giou: 1.0807 (1.0762)  loss_ce_0: 2.6047 (2.7519)  loss_bbox_0: 0.6631 (0.6632)  loss_giou_0: 1.1460 (1.1417)  loss_ce_
Test:  [140/417]  eta: 0:13:56  class_error: 77.00  loss: 25.6447 (26.7099)  loss_ce: 2.5404 (2.7198)  loss_bbox: 0.6371 (0.6319)  loss_giou: 1.0807 (1.0792)  loss_ce_0: 2.5943 (2.7582)  loss_bbox_0: 0.6647 (0.6636)  loss_giou_0: 1.1312 (1.1438)  loss_ce_
Test:  [150/417]  eta: 0:13:25  class_error: 60.00  loss: 27.5283 (26.7386)  loss_ce: 2.8597 (2.7240)  loss_bbox: 0.6345 (0.6330)  loss_giou: 1.0926 (1.0783)  loss_ce_0: 2.9393 (2.7632)  loss_bbox_0: 0.6647 (0.6657)  loss_giou_0: 1.1066 (1.1428)  loss_ce_
Test:  [160/417]  eta: 0:12:54  class_error: 74.00  loss: 26.8990 (26.7551)  loss_ce: 2.7950 (2.7266)  loss_bbox: 0.6244 (0.6319)  loss_giou: 1.0658 (1.0791)  loss_ce_0: 2.8191 (2.7653)  loss_bbox_0: 0.6704 (0.6647)  loss_giou_0: 1.1080 (1.1436)  loss_ce_
Test:  [170/417]  eta: 0:12:22  class_error: 71.91  loss: 26.9772 (26.7457)  loss_ce: 2.7776 (2.7251)  loss_bbox: 0.5746 (0.6318)  loss_giou: 1.1296 (1.0786)  loss_ce_0: 2.8079 (2.7643)  loss_bbox_0: 0.6141 (0.6650)  loss_giou_0: 1.1697 (1.1439)  loss_ce_
Test:  [180/417]  eta: 0:11:54  class_error: 56.45  loss: 26.5801 (26.5751)  loss_ce: 2.6462 (2.7077)  loss_bbox: 0.5644 (0.6285)  loss_giou: 0.9667 (1.0707)  loss_ce_0: 2.7069 (2.7464)  loss_bbox_0: 0.6039 (0.6628)  loss_giou_0: 1.0256 (1.1374)  loss_ce_
Test:  [190/417]  eta: 0:11:23  class_error: 85.00  loss: 26.8202 (26.7001)  loss_ce: 2.7445 (2.7243)  loss_bbox: 0.6021 (0.6314)  loss_giou: 0.9672 (1.0729)  loss_ce_0: 2.8118 (2.7626)  loss_bbox_0: 0.6176 (0.6653)  loss_giou_0: 1.0613 (1.1388)  loss_ce_
Test:  [200/417]  eta: 0:10:52  class_error: 76.36  loss: 28.5221 (26.7596)  loss_ce: 2.9322 (2.7297)  loss_bbox: 0.6509 (0.6338)  loss_giou: 1.1262 (1.0745)  loss_ce_0: 3.0001 (2.7685)  loss_bbox_0: 0.7000 (0.6680)  loss_giou_0: 1.1526 (1.1406)  loss_ce_
Test:  [210/417]  eta: 0:10:21  class_error: 70.27  loss: 27.0917 (26.7678)  loss_ce: 2.8374 (2.7314)  loss_bbox: 0.6433 (0.6316)  loss_giou: 1.1005 (1.0764)  loss_ce_0: 2.8370 (2.7698)  loss_bbox_0: 0.6802 (0.6659)  loss_giou_0: 1.1742 (1.1425)  loss_ce_
Test:  [220/417]  eta: 0:09:51  class_error: 75.70  loss: 27.0917 (26.7662)  loss_ce: 2.7322 (2.7293)  loss_bbox: 0.5935 (0.6300)  loss_giou: 1.1186 (1.0804)  loss_ce_0: 2.8058 (2.7670)  loss_bbox_0: 0.6020 (0.6637)  loss_giou_0: 1.1870 (1.1453)  loss_ce_
Test:  [230/417]  eta: 0:09:20  class_error: 76.25  loss: 27.4291 (26.8096)  loss_ce: 2.7613 (2.7365)  loss_bbox: 0.5783 (0.6280)  loss_giou: 1.1174 (1.0821)  loss_ce_0: 2.8372 (2.7744)  loss_bbox_0: 0.6020 (0.6623)  loss_giou_0: 1.1669 (1.1469)  loss_ce_
Test:  [240/417]  eta: 0:08:50  class_error: 80.58  loss: 25.7241 (26.7497)  loss_ce: 2.7613 (2.7280)  loss_bbox: 0.5783 (0.6280)  loss_giou: 1.0339 (1.0804)  loss_ce_0: 2.8034 (2.7658)  loss_bbox_0: 0.6029 (0.6623)  loss_giou_0: 1.1407 (1.1455)  loss_ce_
Test:  [250/417]  eta: 0:08:21  class_error: 60.38  loss: 25.2501 (26.7072)  loss_ce: 2.7002 (2.7270)  loss_bbox: 0.5702 (0.6249)  loss_giou: 0.9929 (1.0769)  loss_ce_0: 2.7119 (2.7650)  loss_bbox_0: 0.5996 (0.6596)  loss_giou_0: 1.0964 (1.1439)  loss_ce_
Test:  [260/417]  eta: 0:07:50  class_error: 85.00  loss: 25.2140 (26.6784)  loss_ce: 2.7002 (2.7247)  loss_bbox: 0.5863 (0.6241)  loss_giou: 1.0075 (1.0747)  loss_ce_0: 2.7119 (2.7627)  loss_bbox_0: 0.6219 (0.6597)  loss_giou_0: 1.0964 (1.1418)  loss_ce_
Test:  [270/417]  eta: 0:07:21  class_error: 69.23  loss: 25.1142 (26.6011)  loss_ce: 2.6748 (2.7178)  loss_bbox: 0.6036 (0.6222)  loss_giou: 0.9461 (1.0705)  loss_ce_0: 2.6805 (2.7555)  loss_bbox_0: 0.6339 (0.6581)  loss_giou_0: 1.0463 (1.1386)  loss_ce_
Test:  [280/417]  eta: 0:06:51  class_error: 73.13  loss: 24.9037 (26.5714)  loss_ce: 2.5143 (2.7123)  loss_bbox: 0.5935 (0.6213)  loss_giou: 1.0437 (1.0724)  loss_ce_0: 2.5671 (2.7494)  loss_bbox_0: 0.6283 (0.6568)  loss_giou_0: 1.1222 (1.1400)  loss_ce_
Test:  [290/417]  eta: 0:06:21  class_error: 75.76  loss: 27.4330 (26.6023)  loss_ce: 2.7882 (2.7150)  loss_bbox: 0.5965 (0.6236)  loss_giou: 1.0807 (1.0723)  loss_ce_0: 2.8485 (2.7522)  loss_bbox_0: 0.6473 (0.6594)  loss_giou_0: 1.1234 (1.1401)  loss_ce_
Test:  [300/417]  eta: 0:05:50  class_error: 59.62  loss: 27.7320 (26.6143)  loss_ce: 2.8595 (2.7152)  loss_bbox: 0.6179 (0.6238)  loss_giou: 1.0598 (1.0743)  loss_ce_0: 2.8976 (2.7523)  loss_bbox_0: 0.6585 (0.6593)  loss_giou_0: 1.1380 (1.1418)  loss_ce_
Test:  [310/417]  eta: 0:05:20  class_error: 88.04  loss: 25.5160 (26.6032)  loss_ce: 2.6315 (2.7162)  loss_bbox: 0.6092 (0.6227)  loss_giou: 1.0242 (1.0727)  loss_ce_0: 2.6728 (2.7531)  loss_bbox_0: 0.6310 (0.6583)  loss_giou_0: 1.0937 (1.1399)  loss_ce_
Test:  [320/417]  eta: 0:04:50  class_error: 77.61  loss: 25.5826 (26.5960)  loss_ce: 2.5790 (2.7135)  loss_bbox: 0.6092 (0.6230)  loss_giou: 1.0565 (1.0738)  loss_ce_0: 2.6426 (2.7507)  loss_bbox_0: 0.6252 (0.6581)  loss_giou_0: 1.1324 (1.1411)  loss_ce_
Test:  [330/417]  eta: 0:04:20  class_error: 87.65  loss: 26.0246 (26.5717)  loss_ce: 2.5790 (2.7097)  loss_bbox: 0.6455 (0.6247)  loss_giou: 1.1095 (1.0714)  loss_ce_0: 2.6295 (2.7475)  loss_bbox_0: 0.6587 (0.6595)  loss_giou_0: 1.1714 (1.1389)  loss_ce_
Test:  [340/417]  eta: 0:03:49  class_error: 42.20  loss: 23.7386 (26.5029)  loss_ce: 2.4520 (2.7007)  loss_bbox: 0.6229 (0.6242)  loss_giou: 1.0070 (1.0697)  loss_ce_0: 2.4937 (2.7381)  loss_bbox_0: 0.6436 (0.6589)  loss_giou_0: 1.1380 (1.1376)  loss_ce_
Test:  [350/417]  eta: 0:03:19  class_error: 63.16  loss: 23.3714 (26.4561)  loss_ce: 2.3423 (2.6944)  loss_bbox: 0.6041 (0.6235)  loss_giou: 0.9442 (1.0687)  loss_ce_0: 2.4093 (2.7313)  loss_bbox_0: 0.6326 (0.6586)  loss_giou_0: 1.0991 (1.1372)  loss_ce_
Test:  [360/417]  eta: 0:02:50  class_error: 72.92  loss: 25.0261 (26.4312)  loss_ce: 2.5173 (2.6923)  loss_bbox: 0.6161 (0.6225)  loss_giou: 0.9535 (1.0675)  loss_ce_0: 2.5770 (2.7292)  loss_bbox_0: 0.6326 (0.6577)  loss_giou_0: 1.0991 (1.1363)  loss_ce_
Test:  [370/417]  eta: 0:02:20  class_error: 73.61  loss: 27.8076 (26.5237)  loss_ce: 2.8292 (2.7026)  loss_bbox: 0.6453 (0.6248)  loss_giou: 1.1451 (1.0701)  loss_ce_0: 2.8731 (2.7401)  loss_bbox_0: 0.6902 (0.6597)  loss_giou_0: 1.1784 (1.1384)  loss_ce_
Test:  [380/417]  eta: 0:01:50  class_error: 39.46  loss: 28.5692 (26.5156)  loss_ce: 2.9716 (2.7009)  loss_bbox: 0.6423 (0.6242)  loss_giou: 1.1451 (1.0708)  loss_ce_0: 3.0255 (2.7388)  loss_bbox_0: 0.6851 (0.6589)  loss_giou_0: 1.1784 (1.1388)  loss_ce_
Test:  [390/417]  eta: 0:01:20  class_error: 70.11  loss: 26.1591 (26.4902)  loss_ce: 2.7195 (2.6994)  loss_bbox: 0.5855 (0.6228)  loss_giou: 1.0300 (1.0692)  loss_ce_0: 2.8012 (2.7377)  loss_bbox_0: 0.6133 (0.6575)  loss_giou_0: 1.1198 (1.1379)  loss_ce_
Test:  [400/417]  eta: 0:00:50  class_error: 55.21  loss: 25.6012 (26.4764)  loss_ce: 2.6473 (2.6980)  loss_bbox: 0.5545 (0.6229)  loss_giou: 1.0622 (1.0685)  loss_ce_0: 2.6926 (2.7360)  loss_bbox_0: 0.6170 (0.6575)  loss_giou_0: 1.1247 (1.1371)  loss_ce_
Test:  [410/417]  eta: 0:00:20  class_error: 69.17  loss: 27.2634 (26.5068)  loss_ce: 2.6786 (2.6996)  loss_bbox: 0.5914 (0.6235)  loss_giou: 1.1098 (1.0714)  loss_ce_0: 2.7857 (2.7374)  loss_bbox_0: 0.6170 (0.6578)  loss_giou_0: 1.1411 (1.1395)  loss_ce_
Test:  [416/417]  eta: 0:00:02  class_error: 53.66  loss: 25.3530 (26.4784)  loss_ce: 2.4914 (2.6964)  loss_bbox: 0.6032 (0.6227)  loss_giou: 1.0567 (1.0702)  loss_ce_0: 2.5725 (2.7343)  loss_bbox_0: 0.6079 (0.6573)  loss_giou_0: 1.1288 (1.1387)  loss_ce_
Test: Total time: 0:20:40 (2.9750 s / it)
Averaged stats: class_error: 53.66  loss: 25.3530 (26.4784)  loss_ce: 2.4914 (2.6964)  loss_bbox: 0.6032 (0.6227)  loss_giou: 1.0567 (1.0702)  loss_ce_0: 2.5725 (2.7343)  loss_bbox_0: 0.6079 (0.6573)  loss_giou_0: 1.1288 (1.1387)  loss_ce_1: 2.5929 (2.708
Accumulating evaluation results...
DONE (t=12.02s).
IoU metric: bbox
```

```
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.165
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.246
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.178
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.080
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.173
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.238
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.159
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.260
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.282
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.148
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.294
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.387
```

```
!python main.py \
    --output_dir exps/deform \
    --coco_path ../COCODIR \
    --batch_size 12 \
    --resume ./pth/upperbound.pth \
    --with_box_refine \
    --eval
```

```
Test:  [ 30/417]  eta: 0:26:47  class_error: 4.23  loss: 7.3548 (7.3347)  loss_ce: 0.4123 (0.4242)  loss_bbox: 0.2212 (0.2170)  loss_giou: 0.5482 (0.5254)  loss_ce_0: 0.4817 (0.4858)  loss_bbox_0: 0.2658 (0.2808)  loss_giou_0: 0.6634 (0.6608)  loss_ce_1:
Test:  [ 40/417]  eta: 0:24:45  class_error: 12.61  loss: 7.1631 (7.3126)  loss_ce: 0.3974 (0.4182)  loss_bbox: 0.2107 (0.2192)  loss_giou: 0.5290 (0.5264)  loss_ce_0: 0.4543 (0.4807)  loss_bbox_0: 0.2631 (0.2808)  loss_giou_0: 0.6542 (0.6566)  loss_ce_1:
Test:  [ 50/417]  eta: 0:23:08  class_error: 2.22  loss: 7.3042 (7.4070)  loss_ce: 0.4129 (0.4214)  loss_bbox: 0.2218 (0.2257)  loss_giou: 0.5327 (0.5335)  loss_ce_0: 0.4881 (0.4836)  loss_bbox_0: 0.2744 (0.2864)  loss_giou_0: 0.6229 (0.6607)  loss_ce_1:
Test:  [ 60/417]  eta: 0:21:52  class_error: 17.05  loss: 7.5569 (7.4048)  loss_ce: 0.4307 (0.4232)  loss_bbox: 0.2175 (0.2249)  loss_giou: 0.5327 (0.5326)  loss_ce_0: 0.4881 (0.4837)  loss_bbox_0: 0.2798 (0.2860)  loss_giou_0: 0.6414 (0.6605)  loss_ce_1:
Test:  [ 70/417]  eta: 0:20:49  class_error: 15.05  loss: 6.9459 (7.3451)  loss_ce: 0.4194 (0.4220)  loss_bbox: 0.2108 (0.2224)  loss_giou: 0.4863 (0.5262)  loss_ce_0: 0.4742 (0.4820)  loss_bbox_0: 0.2787 (0.2855)  loss_giou_0: 0.6414 (0.6559)  loss_ce_1:
Test:  [ 80/417]  eta: 0:19:55  class_error: 12.50  loss: 6.8671 (7.2891)  loss_ce: 0.4285 (0.4241)  loss_bbox: 0.2083 (0.2197)  loss_giou: 0.4646 (0.5170)  loss_ce_0: 0.4818 (0.4829)  loss_bbox_0: 0.2768 (0.2851)  loss_giou_0: 0.5945 (0.6481)  loss_ce_1:
Test:  [ 90/417]  eta: 0:19:04  class_error: 9.82  loss: 7.2061 (7.3243)  loss_ce: 0.4428 (0.4261)  loss_bbox: 0.2137 (0.2210)  loss_giou: 0.4802 (0.5197)  loss_ce_0: 0.4916 (0.4860)  loss_bbox_0: 0.2660 (0.2846)  loss_giou_0: 0.6387 (0.6504)  loss_ce_1:
Test:  [100/417]  eta: 0:18:16  class_error: 7.04  loss: 7.2653 (7.2989)  loss_ce: 0.4126 (0.4229)  loss_bbox: 0.2172 (0.2210)  loss_giou: 0.5351 (0.5186)  loss_ce_0: 0.4621 (0.4830)  loss_bbox_0: 0.2701 (0.2838)  loss_giou_0: 0.6635 (0.6485)  loss_ce_1:
Test:  [110/417]  eta: 0:17:30  class_error: 17.14  loss: 6.9708 (7.3200)  loss_ce: 0.3917 (0.4250)  loss_bbox: 0.2200 (0.2215)  loss_giou: 0.4801 (0.5191)  loss_ce_0: 0.4760 (0.4863)  loss_bbox_0: 0.2701 (0.2841)  loss_giou_0: 0.6371 (0.6490)  loss_ce_1:
Test:  [120/417]  eta: 0:16:44  class_error: 12.73  loss: 7.4238 (7.3041)  loss_ce: 0.4204 (0.4227)  loss_bbox: 0.2114 (0.2213)  loss_giou: 0.4768 (0.5190)  loss_ce_0: 0.4864 (0.4853)  loss_bbox_0: 0.2555 (0.2824)  loss_giou_0: 0.6238 (0.6489)  loss_ce_1:
Test:  [130/417]  eta: 0:16:02  class_error: 19.67  loss: 7.1454 (7.2830)  loss_ce: 0.4040 (0.4212)  loss_bbox: 0.2114 (0.2214)  loss_giou: 0.4861 (0.5173)  loss_ce_0: 0.4605 (0.4841)  loss_bbox_0: 0.2555 (0.2822)  loss_giou_0: 0.6249 (0.6465)  loss_ce_1:
Test:  [140/417]  eta: 0:15:24  class_error: 17.00  loss: 7.2400 (7.2904)  loss_ce: 0.4040 (0.4222)  loss_bbox: 0.2082 (0.2213)  loss_giou: 0.5151 (0.5175)  loss_ce_0: 0.4678 (0.4843)  loss_bbox_0: 0.2790 (0.2821)  loss_giou_0: 0.6396 (0.6468)  loss_ce_1:
Test:  [150/417]  eta: 0:14:46  class_error: 6.00  loss: 7.2462 (7.2869)  loss_ce: 0.4147 (0.4224)  loss_bbox: 0.2082 (0.2213)  loss_giou: 0.5148 (0.5165)  loss_ce_0: 0.4678 (0.4842)  loss_bbox_0: 0.2788 (0.2827)  loss_giou_0: 0.6396 (0.6459)  loss_ce_1:
Test:  [160/417]  eta: 0:14:08  class_error: 11.00  loss: 7.0579 (7.2868)  loss_ce: 0.4070 (0.4224)  loss_bbox: 0.2105 (0.2211)  loss_giou: 0.5044 (0.5168)  loss_ce_0: 0.4573 (0.4834)  loss_bbox_0: 0.2826 (0.2820)  loss_giou_0: 0.6359 (0.6459)  loss_ce_1:
Test:  [170/417]  eta: 0:13:29  class_error: 10.11  loss: 7.4181 (7.3146)  loss_ce: 0.4070 (0.4229)  loss_bbox: 0.2265 (0.2230)  loss_giou: 0.5130 (0.5189)  loss_ce_0: 0.4685 (0.4847)  loss_bbox_0: 0.2759 (0.2832)  loss_giou_0: 0.6464 (0.6476)  loss_ce_1:
Test:  [180/417]  eta: 0:12:55  class_error: 14.52  loss: 7.7497 (7.3097)  loss_ce: 0.4090 (0.4224)  loss_bbox: 0.2317 (0.2244)  loss_giou: 0.5144 (0.5177)  loss_ce_0: 0.4835 (0.4828)  loss_bbox_0: 0.2892 (0.2849)  loss_giou_0: 0.6073 (0.6452)  loss_ce_1:
Test:  [190/417]  eta: 0:12:20  class_error: 10.00  loss: 7.1472 (7.3218)  loss_ce: 0.4342 (0.4252)  loss_bbox: 0.2472 (0.2247)  loss_giou: 0.4896 (0.5168)  loss_ce_0: 0.4723 (0.4850)  loss_bbox_0: 0.3021 (0.2854)  loss_giou_0: 0.5927 (0.6441)  loss_ce_1:
Test:  [200/417]  eta: 0:11:44  class_error: 3.64  loss: 7.1126 (7.3097)  loss_ce: 0.4245 (0.4237)  loss_bbox: 0.2323 (0.2246)  loss_giou: 0.4897 (0.5163)  loss_ce_0: 0.4616 (0.4825)  loss_bbox_0: 0.2852 (0.2855)  loss_giou_0: 0.6010 (0.6444)  loss_ce_1:
Test:  [210/417]  eta: 0:11:09  class_error: 5.41  loss: 7.1943 (7.3194)  loss_ce: 0.3974 (0.4231)  loss_bbox: 0.2198 (0.2243)  loss_giou: 0.5144 (0.5188)  loss_ce_0: 0.4395 (0.4815)  loss_bbox_0: 0.2852 (0.2850)  loss_giou_0: 0.6500 (0.6468)  loss_ce_1:
Test:  [220/417]  eta: 0:10:36  class_error: 14.02  loss: 7.6906 (7.3470)  loss_ce: 0.4306 (0.4246)  loss_bbox: 0.2203 (0.2245)  loss_giou: 0.5516 (0.5217)  loss_ce_0: 0.5091 (0.4834)  loss_bbox_0: 0.2764 (0.2847)  loss_giou_0: 0.6686 (0.6495)  loss_ce_1:
Test:  [230/417]  eta: 0:10:01  class_error: 6.25  loss: 7.5074 (7.3516)  loss_ce: 0.4085 (0.4244)  loss_bbox: 0.2203 (0.2244)  loss_giou: 0.5516 (0.5227)  loss_ce_0: 0.5091 (0.4834)  loss_bbox_0: 0.2764 (0.2850)  loss_giou_0: 0.6779 (0.6505)  loss_ce_1:
Test:  [240/417]  eta: 0:09:28  class_error: 5.83  loss: 7.0140 (7.3389)  loss_ce: 0.3681 (0.4231)  loss_bbox: 0.2147 (0.2244)  loss_giou: 0.4984 (0.5219)  loss_ce_0: 0.4215 (0.4820)  loss_bbox_0: 0.2923 (0.2851)  loss_giou_0: 0.6591 (0.6505)  loss_ce_1:
Test:  [250/417]  eta: 0:08:55  class_error: 18.87  loss: 7.2356 (7.3341)  loss_ce: 0.3884 (0.4226)  loss_bbox: 0.2147 (0.2240)  loss_giou: 0.5060 (0.5219)  loss_ce_0: 0.4649 (0.4818)  loss_bbox_0: 0.2899 (0.2849)  loss_giou_0: 0.6591 (0.6506)  loss_ce_1:
Test:  [260/417]  eta: 0:08:22  class_error: 6.43  loss: 7.3784 (7.3430)  loss_ce: 0.3971 (0.4227)  loss_bbox: 0.2366 (0.2253)  loss_giou: 0.5123 (0.5220)  loss_ce_0: 0.4806 (0.4817)  loss_bbox_0: 0.2921 (0.2863)  loss_giou_0: 0.6441 (0.6510)  loss_ce_1:
Test:  [270/417]  eta: 0:07:49  class_error: 6.41  loss: 7.0974 (7.3336)  loss_ce: 0.4248 (0.4232)  loss_bbox: 0.2330 (0.2248)  loss_giou: 0.4847 (0.5203)  loss_ce_0: 0.4889 (0.4825)  loss_bbox_0: 0.2921 (0.2859)  loss_giou_0: 0.6238 (0.6492)  loss_ce_1:
Test:  [280/417]  eta: 0:07:16  class_error: 8.21  loss: 7.2612 (7.3503)  loss_ce: 0.4541 (0.4241)  loss_bbox: 0.2246 (0.2251)  loss_giou: 0.5186 (0.5220)  loss_ce_0: 0.4905 (0.4831)  loss_bbox_0: 0.2723 (0.2859)  loss_giou_0: 0.6531 (0.6509)  loss_ce_1:
Test:  [290/417]  eta: 0:06:44  class_error: 6.06  loss: 7.2848 (7.3370)  loss_ce: 0.4251 (0.4235)  loss_bbox: 0.2227 (0.2247)  loss_giou: 0.5284 (0.5208)  loss_ce_0: 0.4619 (0.4822)  loss_bbox_0: 0.2774 (0.2857)  loss_giou_0: 0.6551 (0.6497)  loss_ce_1:
Test:  [300/417]  eta: 0:06:11  class_error: 13.46  loss: 6.9349 (7.3414)  loss_ce: 0.4139 (0.4230)  loss_bbox: 0.2062 (0.2250)  loss_giou: 0.4932 (0.5219)  loss_ce_0: 0.4385 (0.4820)  loss_bbox_0: 0.2538 (0.2853)  loss_giou_0: 0.6275 (0.6499)  loss_ce_1:
Test:  [310/417]  eta: 0:05:39  class_error: 10.87  loss: 7.5768 (7.3557)  loss_ce: 0.4396 (0.4247)  loss_bbox: 0.2155 (0.2253)  loss_giou: 0.5087 (0.5225)  loss_ce_0: 0.4961 (0.4836)  loss_bbox_0: 0.2549 (0.2853)  loss_giou_0: 0.6275 (0.6502)  loss_ce_1:
Test:  [320/417]  eta: 0:05:07  class_error: 8.96  loss: 7.1754 (7.3515)  loss_ce: 0.4386 (0.4248)  loss_bbox: 0.2127 (0.2247)  loss_giou: 0.5103 (0.5220)  loss_ce_0: 0.4911 (0.4838)  loss_bbox_0: 0.2711 (0.2848)  loss_giou_0: 0.6573 (0.6505)  loss_ce_1:
Test:  [330/417]  eta: 0:04:34  class_error: 16.05  loss: 7.6028 (7.3710)  loss_ce: 0.4575 (0.4265)  loss_bbox: 0.2200 (0.2261)  loss_giou: 0.5131 (0.5222)  loss_ce_0: 0.5132 (0.4857)  loss_bbox_0: 0.2823 (0.2865)  loss_giou_0: 0.6431 (0.6502)  loss_ce_1:
Test:  [340/417]  eta: 0:04:02  class_error: 10.09  loss: 7.6634 (7.3773)  loss_ce: 0.4719 (0.4272)  loss_bbox: 0.2498 (0.2264)  loss_giou: 0.5449 (0.5223)  loss_ce_0: 0.5132 (0.4861)  loss_bbox_0: 0.3069 (0.2867)  loss_giou_0: 0.6465 (0.6505)  loss_ce_1:
Test:  [350/417]  eta: 0:03:30  class_error: 10.53  loss: 7.5059 (7.3811)  loss_ce: 0.4350 (0.4274)  loss_bbox: 0.2230 (0.2265)  loss_giou: 0.5200 (0.5226)  loss_ce_0: 0.4996 (0.4864)  loss_bbox_0: 0.2847 (0.2868)  loss_giou_0: 0.6629 (0.6508)  loss_ce_1:
Test:  [360/417]  eta: 0:02:59  class_error: 6.25  loss: 7.2050 (7.3758)  loss_ce: 0.4179 (0.4266)  loss_bbox: 0.2167 (0.2264)  loss_giou: 0.5058 (0.5225)  loss_ce_0: 0.4550 (0.4854)  loss_bbox_0: 0.2770 (0.2868)  loss_giou_0: 0.6629 (0.6513)  loss_ce_1:
Test:  [370/417]  eta: 0:02:27  class_error: 4.17  loss: 7.1783 (7.3735)  loss_ce: 0.4116 (0.4263)  loss_bbox: 0.2213 (0.2266)  loss_giou: 0.4939 (0.5222)  loss_ce_0: 0.4631 (0.4851)  loss_bbox_0: 0.2806 (0.2868)  loss_giou_0: 0.6333 (0.6509)  loss_ce_1:
Test:  [380/417]  eta: 0:01:56  class_error: 13.61  loss: 7.4789 (7.3865)  loss_ce: 0.4193 (0.4270)  loss_bbox: 0.2282 (0.2266)  loss_giou: 0.5150 (0.5239)  loss_ce_0: 0.4710 (0.4856)  loss_bbox_0: 0.2921 (0.2867)  loss_giou_0: 0.6393 (0.6519)  loss_ce_1:
Test:  [390/417]  eta: 0:01:24  class_error: 12.64  loss: 7.7141 (7.3906)  loss_ce: 0.4274 (0.4272)  loss_bbox: 0.2232 (0.2264)  loss_giou: 0.5638 (0.5244)  loss_ce_0: 0.4959 (0.4863)  loss_bbox_0: 0.2953 (0.2864)  loss_giou_0: 0.6743 (0.6524)  loss_ce_1:
Test:  [400/417]  eta: 0:00:53  class_error: 14.58  loss: 7.7823 (7.3924)  loss_ce: 0.4220 (0.4278)  loss_bbox: 0.2037 (0.2261)  loss_giou: 0.5366 (0.5242)  loss_ce_0: 0.4836 (0.4867)  loss_bbox_0: 0.2789 (0.2863)  loss_giou_0: 0.6743 (0.6524)  loss_ce_1:
Test:  [410/417]  eta: 0:00:21  class_error: 24.17  loss: 8.1189 (7.4151)  loss_ce: 0.4610 (0.4293)  loss_bbox: 0.2254 (0.2265)  loss_giou: 0.5510 (0.5261)  loss_ce_0: 0.5234 (0.4882)  loss_bbox_0: 0.2828 (0.2866)  loss_giou_0: 0.6748 (0.6543)  loss_ce_1:
Test:  [416/417]  eta: 0:00:03  class_error: 7.32  loss: 7.9235 (7.4134)  loss_ce: 0.4384 (0.4290)  loss_bbox: 0.2265 (0.2265)  loss_giou: 0.5550 (0.5261)  loss_ce_0: 0.5234 (0.4883)  loss_bbox_0: 0.2789 (0.2866)  loss_giou_0: 0.6637 (0.6542)  loss_ce_1:
Test: Total time: 0:21:41 (3.1222 s / it)
Averaged stats: class_error: 7.32  loss: 7.9235 (7.4134)  loss_ce: 0.4384 (0.4290)  loss_bbox: 0.2265 (0.2265)  loss_giou: 0.5550 (0.5261)  loss_ce_0: 0.5234 (0.4883)  loss_bbox_0: 0.2789 (0.2866)  loss_giou_0: 0.6637 (0.6542)  loss_ce_1: 0.4881 (0.4606)
Accumulating evaluation results...
DONE (t=12.30s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.412
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.604
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.442
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.241
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.442
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.558
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.341
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.560
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.602
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.383
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.646
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.809
```

```
!python main.py \
    --output_dir exps/deform \
    --coco_path ../COCODIR \
    --batch_size 12 \
    --resume ./pth/mosaic.pth \
    --with_box_refine \
    --eval
```

```
Test:  [ 30/417]  eta: 0:19:21  class_error: 52.11  loss: 16.6947 (17.5377)  loss_ce: 1.4463 (1.4948)  loss_bbox: 0.4544 (0.4921)  loss_giou: 0.7776 (0.8753)  loss_ce_0: 1.5202 (1.5829)  loss_bbox_0: 0.4814 (0.5316)  loss_giou_0: 0.9336 (0.9729)  loss_ce_
Test:  [ 40/417]  eta: 0:19:07  class_error: 57.14  loss: 16.6723 (17.6311)  loss_ce: 1.4518 (1.4944)  loss_bbox: 0.4544 (0.5046)  loss_giou: 0.8380 (0.8774)  loss_ce_0: 1.5928 (1.5901)  loss_bbox_0: 0.4814 (0.5474)  loss_giou_0: 0.9686 (0.9741)  loss_ce_
Test:  [ 50/417]  eta: 0:18:40  class_error: 52.22  loss: 19.1002 (17.9364)  loss_ce: 1.5792 (1.5148)  loss_bbox: 0.5805 (0.5205)  loss_giou: 0.9578 (0.8958)  loss_ce_0: 1.6685 (1.6133)  loss_bbox_0: 0.5860 (0.5572)  loss_giou_0: 1.0316 (0.9837)  loss_ce_
Test:  [ 60/417]  eta: 0:18:11  class_error: 61.36  loss: 18.6373 (18.1809)  loss_ce: 1.5214 (1.5387)  loss_bbox: 0.5340 (0.5241)  loss_giou: 0.9835 (0.9099)  loss_ce_0: 1.5905 (1.6334)  loss_bbox_0: 0.5860 (0.5639)  loss_giou_0: 1.0526 (0.9969)  loss_ce_
Test:  [ 70/417]  eta: 0:17:49  class_error: 53.76  loss: 17.5596 (18.0163)  loss_ce: 1.5214 (1.5210)  loss_bbox: 0.5015 (0.5203)  loss_giou: 0.9052 (0.9017)  loss_ce_0: 1.5809 (1.6173)  loss_bbox_0: 0.5573 (0.5608)  loss_giou_0: 1.0025 (0.9904)  loss_ce_
Test:  [ 80/417]  eta: 0:17:14  class_error: 67.19  loss: 17.3967 (17.9145)  loss_ce: 1.4557 (1.5184)  loss_bbox: 0.4818 (0.5178)  loss_giou: 0.8353 (0.8879)  loss_ce_0: 1.5323 (1.6135)  loss_bbox_0: 0.5467 (0.5610)  loss_giou_0: 0.9474 (0.9810)  loss_ce_
Test:  [ 90/417]  eta: 0:16:43  class_error: 38.39  loss: 17.3086 (17.9179)  loss_ce: 1.5258 (1.5209)  loss_bbox: 0.4856 (0.5140)  loss_giou: 0.8473 (0.8903)  loss_ce_0: 1.5610 (1.6137)  loss_bbox_0: 0.5408 (0.5579)  loss_giou_0: 0.9504 (0.9839)  loss_ce_
Test:  [100/417]  eta: 0:16:10  class_error: 67.61  loss: 18.4932 (18.0468)  loss_ce: 1.6454 (1.5345)  loss_bbox: 0.4856 (0.5175)  loss_giou: 0.8716 (0.8933)  loss_ce_0: 1.6717 (1.6294)  loss_bbox_0: 0.5408 (0.5607)  loss_giou_0: 0.9876 (0.9879)  loss_ce_
Test:  [110/417]  eta: 0:15:38  class_error: 41.90  loss: 19.7275 (18.2508)  loss_ce: 1.7557 (1.5471)  loss_bbox: 0.5551 (0.5280)  loss_giou: 0.9384 (0.9046)  loss_ce_0: 1.8427 (1.6421)  loss_bbox_0: 0.6356 (0.5705)  loss_giou_0: 1.0856 (0.9979)  loss_ce_
Test:  [120/417]  eta: 0:15:03  class_error: 54.55  loss: 19.8305 (18.2694)  loss_ce: 1.7538 (1.5508)  loss_bbox: 0.5075 (0.5268)  loss_giou: 1.0084 (0.9067)  loss_ce_0: 1.8205 (1.6423)  loss_bbox_0: 0.5515 (0.5687)  loss_giou_0: 1.0855 (0.9989)  loss_ce_
Test:  [130/417]  eta: 0:14:31  class_error: 55.74  loss: 18.8918 (18.2487)  loss_ce: 1.6247 (1.5509)  loss_bbox: 0.4901 (0.5256)  loss_giou: 0.9402 (0.9052)  loss_ce_0: 1.6364 (1.6413)  loss_bbox_0: 0.5419 (0.5679)  loss_giou_0: 1.0018 (0.9972)  loss_ce_
Test:  [140/417]  eta: 0:14:01  class_error: 66.00  loss: 18.8918 (18.3063)  loss_ce: 1.5821 (1.5574)  loss_bbox: 0.5309 (0.5261)  loss_giou: 0.8957 (0.9082)  loss_ce_0: 1.6412 (1.6477)  loss_bbox_0: 0.5876 (0.5681)  loss_giou_0: 0.9917 (1.0000)  loss_ce_
Test:  [150/417]  eta: 0:13:30  class_error: 50.00  loss: 19.0236 (18.2596)  loss_ce: 1.4978 (1.5528)  loss_bbox: 0.5556 (0.5254)  loss_giou: 0.9011 (0.9054)  loss_ce_0: 1.6340 (1.6423)  loss_bbox_0: 0.5884 (0.5692)  loss_giou_0: 0.9906 (0.9977)  loss_ce_
Test:  [160/417]  eta: 0:12:59  class_error: 44.00  loss: 18.3500 (18.1760)  loss_ce: 1.4435 (1.5464)  loss_bbox: 0.4749 (0.5212)  loss_giou: 0.8912 (0.9021)  loss_ce_0: 1.5336 (1.6351)  loss_bbox_0: 0.5279 (0.5647)  loss_giou_0: 0.9692 (0.9947)  loss_ce_
Test:  [170/417]  eta: 0:12:28  class_error: 56.18  loss: 18.3707 (18.1971)  loss_ce: 1.5317 (1.5455)  loss_bbox: 0.4770 (0.5231)  loss_giou: 0.9126 (0.9051)  loss_ce_0: 1.5908 (1.6335)  loss_bbox_0: 0.5112 (0.5669)  loss_giou_0: 1.0004 (0.9971)  loss_ce_
Test:  [180/417]  eta: 0:11:57  class_error: 45.16  loss: 16.4874 (18.0646)  loss_ce: 1.4120 (1.5336)  loss_bbox: 0.4772 (0.5198)  loss_giou: 0.8187 (0.8975)  loss_ce_0: 1.4795 (1.6227)  loss_bbox_0: 0.5112 (0.5641)  loss_giou_0: 0.9398 (0.9900)  loss_ce_
Test:  [190/417]  eta: 0:11:26  class_error: 52.50  loss: 16.9914 (18.1730)  loss_ce: 1.5668 (1.5437)  loss_bbox: 0.4838 (0.5238)  loss_giou: 0.8187 (0.9018)  loss_ce_0: 1.6314 (1.6335)  loss_bbox_0: 0.5190 (0.5682)  loss_giou_0: 0.9398 (0.9932)  loss_ce_
Test:  [200/417]  eta: 0:10:55  class_error: 72.73  loss: 19.2592 (18.1483)  loss_ce: 1.5719 (1.5393)  loss_bbox: 0.5725 (0.5252)  loss_giou: 0.8899 (0.9012)  loss_ce_0: 1.7444 (1.6292)  loss_bbox_0: 0.6010 (0.5691)  loss_giou_0: 0.9549 (0.9921)  loss_ce_
Test:  [210/417]  eta: 0:10:24  class_error: 60.81  loss: 19.7134 (18.1980)  loss_ce: 1.5160 (1.5433)  loss_bbox: 0.5103 (0.5250)  loss_giou: 0.9020 (0.9055)  loss_ce_0: 1.6035 (1.6330)  loss_bbox_0: 0.5509 (0.5694)  loss_giou_0: 0.9996 (0.9965)  loss_ce_
Test:  [220/417]  eta: 0:09:54  class_error: 55.14  loss: 19.7810 (18.2104)  loss_ce: 1.5944 (1.5434)  loss_bbox: 0.5088 (0.5247)  loss_giou: 0.9497 (0.9082)  loss_ce_0: 1.7601 (1.6325)  loss_bbox_0: 0.5239 (0.5689)  loss_giou_0: 1.0149 (0.9988)  loss_ce_
Test:  [230/417]  eta: 0:09:23  class_error: 58.75  loss: 17.7575 (18.2005)  loss_ce: 1.4793 (1.5440)  loss_bbox: 0.4371 (0.5219)  loss_giou: 0.8971 (0.9082)  loss_ce_0: 1.5909 (1.6340)  loss_bbox_0: 0.4864 (0.5669)  loss_giou_0: 1.0006 (0.9991)  loss_ce_
Test:  [240/417]  eta: 0:08:53  class_error: 63.11  loss: 16.9357 (18.1552)  loss_ce: 1.4276 (1.5390)  loss_bbox: 0.4417 (0.5217)  loss_giou: 0.8522 (0.9054)  loss_ce_0: 1.5909 (1.6287)  loss_bbox_0: 0.5225 (0.5671)  loss_giou_0: 0.9618 (0.9974)  loss_ce_
Test:  [250/417]  eta: 0:08:23  class_error: 33.96  loss: 16.2998 (18.1070)  loss_ce: 1.3884 (1.5356)  loss_bbox: 0.4534 (0.5196)  loss_giou: 0.8012 (0.9029)  loss_ce_0: 1.4636 (1.6249)  loss_bbox_0: 0.5225 (0.5650)  loss_giou_0: 0.9046 (0.9953)  loss_ce_
Test:  [260/417]  eta: 0:07:52  class_error: 77.14  loss: 17.1382 (18.1216)  loss_ce: 1.5474 (1.5373)  loss_bbox: 0.5098 (0.5206)  loss_giou: 0.8455 (0.9022)  loss_ce_0: 1.6673 (1.6267)  loss_bbox_0: 0.5610 (0.5664)  loss_giou_0: 0.9246 (0.9949)  loss_ce_
Test:  [270/417]  eta: 0:07:23  class_error: 39.74  loss: 17.1382 (18.0484)  loss_ce: 1.5290 (1.5315)  loss_bbox: 0.5113 (0.5185)  loss_giou: 0.7770 (0.8978)  loss_ce_0: 1.6465 (1.6211)  loss_bbox_0: 0.5385 (0.5641)  loss_giou_0: 0.8515 (0.9907)  loss_ce_
Test:  [280/417]  eta: 0:06:53  class_error: 58.96  loss: 17.1328 (18.0541)  loss_ce: 1.4115 (1.5310)  loss_bbox: 0.5014 (0.5181)  loss_giou: 0.8813 (0.9000)  loss_ce_0: 1.4744 (1.6200)  loss_bbox_0: 0.5304 (0.5633)  loss_giou_0: 1.0010 (0.9930)  loss_ce_
Test:  [290/417]  eta: 0:06:22  class_error: 36.36  loss: 18.1308 (18.0819)  loss_ce: 1.4115 (1.5327)  loss_bbox: 0.5114 (0.5209)  loss_giou: 0.9606 (0.9003)  loss_ce_0: 1.5166 (1.6226)  loss_bbox_0: 0.5500 (0.5654)  loss_giou_0: 1.0165 (0.9929)  loss_ce_
Test:  [300/417]  eta: 0:05:52  class_error: 48.08  loss: 18.1818 (18.1115)  loss_ce: 1.6391 (1.5342)  loss_bbox: 0.4895 (0.5219)  loss_giou: 0.9341 (0.9030)  loss_ce_0: 1.6865 (1.6235)  loss_bbox_0: 0.5548 (0.5664)  loss_giou_0: 0.9997 (0.9950)  loss_ce_
Test:  [310/417]  eta: 0:05:22  class_error: 78.26  loss: 17.4478 (18.1082)  loss_ce: 1.6096 (1.5367)  loss_bbox: 0.4416 (0.5204)  loss_giou: 0.8577 (0.9014)  loss_ce_0: 1.6367 (1.6256)  loss_bbox_0: 0.5390 (0.5655)  loss_giou_0: 0.9802 (0.9940)  loss_ce_
Test:  [320/417]  eta: 0:04:51  class_error: 40.30  loss: 17.0192 (18.0982)  loss_ce: 1.5227 (1.5352)  loss_bbox: 0.4402 (0.5202)  loss_giou: 0.8504 (0.9013)  loss_ce_0: 1.6162 (1.6245)  loss_bbox_0: 0.5064 (0.5652)  loss_giou_0: 0.9561 (0.9941)  loss_ce_
Test:  [330/417]  eta: 0:04:21  class_error: 69.14  loss: 17.3326 (18.1036)  loss_ce: 1.3917 (1.5337)  loss_bbox: 0.5370 (0.5226)  loss_giou: 0.8677 (0.9009)  loss_ce_0: 1.4625 (1.6228)  loss_bbox_0: 0.5907 (0.5681)  loss_giou_0: 0.9853 (0.9941)  loss_ce_
Test:  [340/417]  eta: 0:03:50  class_error: 35.78  loss: 16.8152 (18.0670)  loss_ce: 1.3219 (1.5291)  loss_bbox: 0.5411 (0.5227)  loss_giou: 0.8677 (0.8994)  loss_ce_0: 1.4100 (1.6180)  loss_bbox_0: 0.5904 (0.5680)  loss_giou_0: 0.9853 (0.9930)  loss_ce_
Test:  [350/417]  eta: 0:03:20  class_error: 38.60  loss: 16.1010 (18.0268)  loss_ce: 1.3025 (1.5237)  loss_bbox: 0.5013 (0.5222)  loss_giou: 0.8649 (0.8988)  loss_ce_0: 1.3539 (1.6120)  loss_bbox_0: 0.5291 (0.5674)  loss_giou_0: 0.9198 (0.9926)  loss_ce_
Test:  [360/417]  eta: 0:02:50  class_error: 62.50  loss: 16.4587 (18.0081)  loss_ce: 1.3859 (1.5212)  loss_bbox: 0.4933 (0.5218)  loss_giou: 0.8779 (0.8986)  loss_ce_0: 1.4844 (1.6097)  loss_bbox_0: 0.5333 (0.5669)  loss_giou_0: 0.9482 (0.9925)  loss_ce_
Test:  [370/417]  eta: 0:02:20  class_error: 52.78  loss: 18.2926 (18.0478)  loss_ce: 1.5071 (1.5254)  loss_bbox: 0.5221 (0.5233)  loss_giou: 0.9224 (0.8994)  loss_ce_0: 1.5980 (1.6133)  loss_bbox_0: 0.5847 (0.5689)  loss_giou_0: 1.0120 (0.9937)  loss_ce_
Test:  [380/417]  eta: 0:01:50  class_error: 30.61  loss: 18.6433 (18.0462)  loss_ce: 1.5525 (1.5250)  loss_bbox: 0.4936 (0.5229)  loss_giou: 0.9224 (0.9001)  loss_ce_0: 1.6092 (1.6126)  loss_bbox_0: 0.5851 (0.5682)  loss_giou_0: 1.0147 (0.9942)  loss_ce_
Test:  [390/417]  eta: 0:01:20  class_error: 49.43  loss: 16.7399 (18.0264)  loss_ce: 1.4837 (1.5236)  loss_bbox: 0.4801 (0.5214)  loss_giou: 0.8750 (0.8996)  loss_ce_0: 1.5399 (1.6111)  loss_bbox_0: 0.5095 (0.5669)  loss_giou_0: 0.9647 (0.9942)  loss_ce_
Test:  [400/417]  eta: 0:00:50  class_error: 55.21  loss: 16.7399 (18.0198)  loss_ce: 1.5073 (1.5236)  loss_bbox: 0.4654 (0.5211)  loss_giou: 0.8750 (0.8989)  loss_ce_0: 1.5399 (1.6108)  loss_bbox_0: 0.5127 (0.5667)  loss_giou_0: 0.9647 (0.9937)  loss_ce_
Test:  [410/417]  eta: 0:00:20  class_error: 50.83  loss: 18.2719 (18.0519)  loss_ce: 1.5572 (1.5262)  loss_bbox: 0.5035 (0.5214)  loss_giou: 0.9351 (0.9016)  loss_ce_0: 1.6496 (1.6124)  loss_bbox_0: 0.5606 (0.5672)  loss_giou_0: 1.0303 (0.9961)  loss_ce_
Test:  [416/417]  eta: 0:00:02  class_error: 36.59  loss: 17.8883 (18.0211)  loss_ce: 1.4936 (1.5238)  loss_bbox: 0.4875 (0.5203)  loss_giou: 0.9137 (0.8999)  loss_ce_0: 1.5606 (1.6103)  loss_bbox_0: 0.5430 (0.5663)  loss_giou_0: 0.9972 (0.9944)  loss_ce_
Test: Total time: 0:20:45 (2.9867 s / it)
Averaged stats: class_error: 36.59  loss: 17.8883 (18.0211)  loss_ce: 1.4936 (1.5238)  loss_bbox: 0.4875 (0.5203)  loss_giou: 0.9137 (0.8999)  loss_ce_0: 1.5606 (1.6103)  loss_bbox_0: 0.5430 (0.5663)  loss_giou_0: 0.9972 (0.9944)  loss_ce_1: 1.5652 (1.578
Accumulating evaluation results...
DONE (t=13.35s).
IoU metric: bbox
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.265
 Average Precision  (AP) @[ IoU=0.50      | area=   all | maxDets=100 ] = 0.388
 Average Precision  (AP) @[ IoU=0.75      | area=   all | maxDets=100 ] = 0.286
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.143
 Average Precision  (AP) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.284
 Average Precision  (AP) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.379
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=  1 ] = 0.255
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets= 10 ] = 0.414
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=   all | maxDets=100 ] = 0.443
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= small | maxDets=100 ] = 0.266
 Average Recall     (AR) @[ IoU=0.50:0.95 | area=medium | maxDets=100 ] = 0.463
 Average Recall     (AR) @[ IoU=0.50:0.95 | area= large | maxDets=100 ] = 0.641
```

Insights and discussions

Contribution

- The project pioneers a replay scheme in class-incremental learning, specifically tailored for object detection, filling a significant gap in current research.
- Our project arranges the replay buffer based on training loss, enhancing the efficiency of knowledge retrieval and potentially inspiring future machine learning developments.
- The proposed circular training strategy addresses the data quantity asymmetry between new samples and the replay buffer, offering a solution to class imbalance.

Limitation

- More Detailed experiement can be performed.
  - For example, Task1-70, Task2-10

Future Research

- Implement this approach in *open-world settings*
  - Not divided datset, Add some samples subsequently.
  - can give a substantial impact in areas like autonomous driving and robotics.

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