

# Supplementary Material for CVPR2020 Submission#4904

## A. ADDITIONAL RESULTS

We visualize the results of our methods in the material. Note all the models in supplementary material are trained in *minitrain* and evaluated on *minival*.

### Concurrent Softmax

Table 1 shows the gain of mAP on some classes with co-occurrence phenomenon. Other results are listed in our supplementary logs. We provide 4 logs: *balance\_bsl\_sm.csv*, *balance\_bsl\_csmconf.csv*, *balance\_cs\_sm.csv* and *balance\_cs\_csmconf.csv*:

- *balance\_bsl\_sm.csv* shows the results of model trained with **vanilla softmax** and tested with **vanilla softmax**.
- *balance\_bsl\_csmconf.csv* shows the results of model trained with **vanilla softmax** and tested with **concurrent softmax**.
- *balance\_cs\_sm.csv* shows the results of model trained with **concurrent softmax** and tested with **vanilla softmax**.
- *balance\_cs\_csmconf.csv* shows the results of model trained with **concurrent softmax** and tested with **concurrent softmax**.

Figure 1 visualizes result of models with and without concurrent softmax during training and testing stage.

### Soft-Balance with Hybrid Training

Figure 2 visualizes the additional results of ground-truth, non-balance, class-aware balance, and soft-balance. It shows that the proposed soft-balance usually yields more detection bboxes than non-balance, and is more accurate than class-aware balance.

**Table 1.** We randomly pick some classes with co-occurrence phenomenon and show the performance gain.

Source Classes	Wood-burning stove	Flute	Blender	Brown bear	Snake	Sparrow	Tea	Cello	Teddy bear	Antelope
mAP w/o CSM	0.50	0.26	0.50	0.25	0.65	0.76	0.57	0.43	0.55	0.53
mAP w/ CSM	1.00	0.63	0.83	0.50	0.89	1.00	0.80	0.65	0.75	0.72
Gain	0.50	0.36	0.33	0.25	0.24	0.24	0.23	0.22	0.20	0.18

Source Classes	Digital clock	Sword	Pineapple	Brassiere	Sea turtle	Crab	Sandal	Boot	Handbag	Sea lion	Coffee
mAP w/o CSM	0.83	0.83	0.50	0.80	0.22	0.52	0.54	0.56	0.60	0.43	0.46
mAP w/ CSM	1.00	1.00	0.67	0.97	0.38	0.67	0.68	0.70	0.73	0.46	0.58
Gain	0.17	0.17	0.17	0.17	0.16	0.15	0.14	0.14	0.13	0.13	0.12

## B. IMPLICIT CONFUSION PAIR

Table 2 shows the detailed statistics of the confusion pairs explained in section 3 of the main paper. To obtain the confusion pairs, we first calculate the Intersection-over-Union(IoU) between each two instances. Then we mark those instances from different categories with a IoU higher than 0.9 as confusion bboxes. We define the confusion ratio as the number of the confusion bboxes divided by the source bboxes, and we list all 115 pairs of confusion categories whose confusion ratio is higher than 0.1.

**Table 2.** Statistics of the implicit confusion pairs. See the text in Section 3 for definitions of confusion pairs. The first two rows refer to the source and its confusion category. The third row refers to the total instances of source category, and the fourth row indicates how many instances from confused category are labeled as source.

Source Classes	Flashlight	Sea turtle	Bread	Hamster	Sombrero	Tiara	Antelope	Torch	Blender	Blender
Confusion Classes	Torch	Tortoise	Dessert	Mouse	Sun hat	Crown	Deer	Flashlight	Food processor	Mixer
#Source bboxes	71	1053	3691	522	618	383	1473	17	228	228
#Confusion bboxes	11	555	414	139	93	86	534	11	48	37

Source Classes	Billiard table	Tart	Fedora	Food processor	Food processor	Bookcase	Peach	Knife	Knife
Confusion Classes	Table	Dessert	Sun hat	Blender	Mixer	Shelf	Apple	Kitchen knife	Dagger
#Source bboxes	852	903	3447	184	184	4962	742	803	803
#Confusion bboxes	248	157	657	48	42	930	76	161	106

Source Classes	Ambulance	Eagle	Mixer	Mixer	Wood-burning stove	Beaker	Beehive	Cupboard
Confusion Classes	Van	Falcon	Blender	Food processor	Fireplace	Measuring cup	Honeycomb	Cabinetry
#Source bboxes	429	1599	203	203	289	162	492	1269
#Confusion bboxes	171	562	37	42	67	26	147	153

Source Classes	Grapefruit	Mechanical fan	Shotgun	Tire	Sandal	Harpsichord	Violin	Leopard	Leopard	Harbor seal
Confusion Classes	Orange	Ceiling fan	Rifle	Wheel	High heels	Piano	Cello	Jaguar	Cheetah	Sea lion
#Source bboxes	1211	646	539	115719	2738	197	2613	768	768	2003
#Confusion bboxes	285	153	136	17117	351	57	275	347	370	457

Source Classes	Goose	Coffee cup	Microwave oven	Serving tray	Serving tray	Beer	Toilet paper	Kitchen knife	Lynx
Confusion Classes	Duck	Mug	Oven	Platter	Plate	Bottle	Paper towel	Knife	Cat
#Source bboxes	7948	5018	458	111	111	9065	356	333	222
#Confusion bboxes	1077	1146	89	30	17	920	81	161	76

Source Classes	Platter	Snowplow	Saucer	Insect	Ceiling fan	Jaguar	Jaguar	Taxi	Pitcher	High heels	Bust
Confusion Classes	Plate	Land vehicle	Plate	Spider	Mechanical fan	Leopard	Cheetah	Car	Jug	Sandal	Man
#Source bboxes	3317	293	2681	8457	446	553	553	3984	329	2950	986
#Confusion bboxes	983	34	282	1007	153	347	218	412	121	351	113

Source Classes	Bust	Trombone	Bidet	Falcon	Fox	Sofa bed	Desk	Tick	Tick	Filing cabinet	Mouse
Confusion Classes	Person	Trumpet	Toilet	Eagle	Dog	studio couch	Table	Beetle	Insect	Chest of drawers	Hamster
#Source bboxes	986	904	411	1624	528	1417	11015	138	138	343	810
#Confusion bboxes	169	95	51	562	66	480	1516	14	18	69	139

Source Classes	Wine	Honeycomb	Doughnut	Doughnut	Chest of drawers	Dagger	Dagger	Mug	Pressure cooker
Confusion Classes	Bottle	Beehive	Dessert	Bagel	Cabinetry	Knife	Sword	Coffee cup	Slow cooker
#Source bboxes	14458	366	870	870	1431	350	350	2140	11
#Confusion bboxes	1540	147	110	197	159	106	132	1146	4

Source Classes	Tortoise	Sword	Girl	Seafood	Sea lion	Tea	Mule	Doll	Goggles	Organ	Cocktail
Confusion Classes	Sea turtle	Dagger	Woman	Fish	Harbor seal	Coffee	Horse	Girl	Sunglasses	Piano	Wine glass
#Source bboxes	1885	532	185837	2894	1747	1266	1068	6046	9087	376	4199
#Confusion bboxes	555	132	34772	292	457	160	196	623	970	40	446

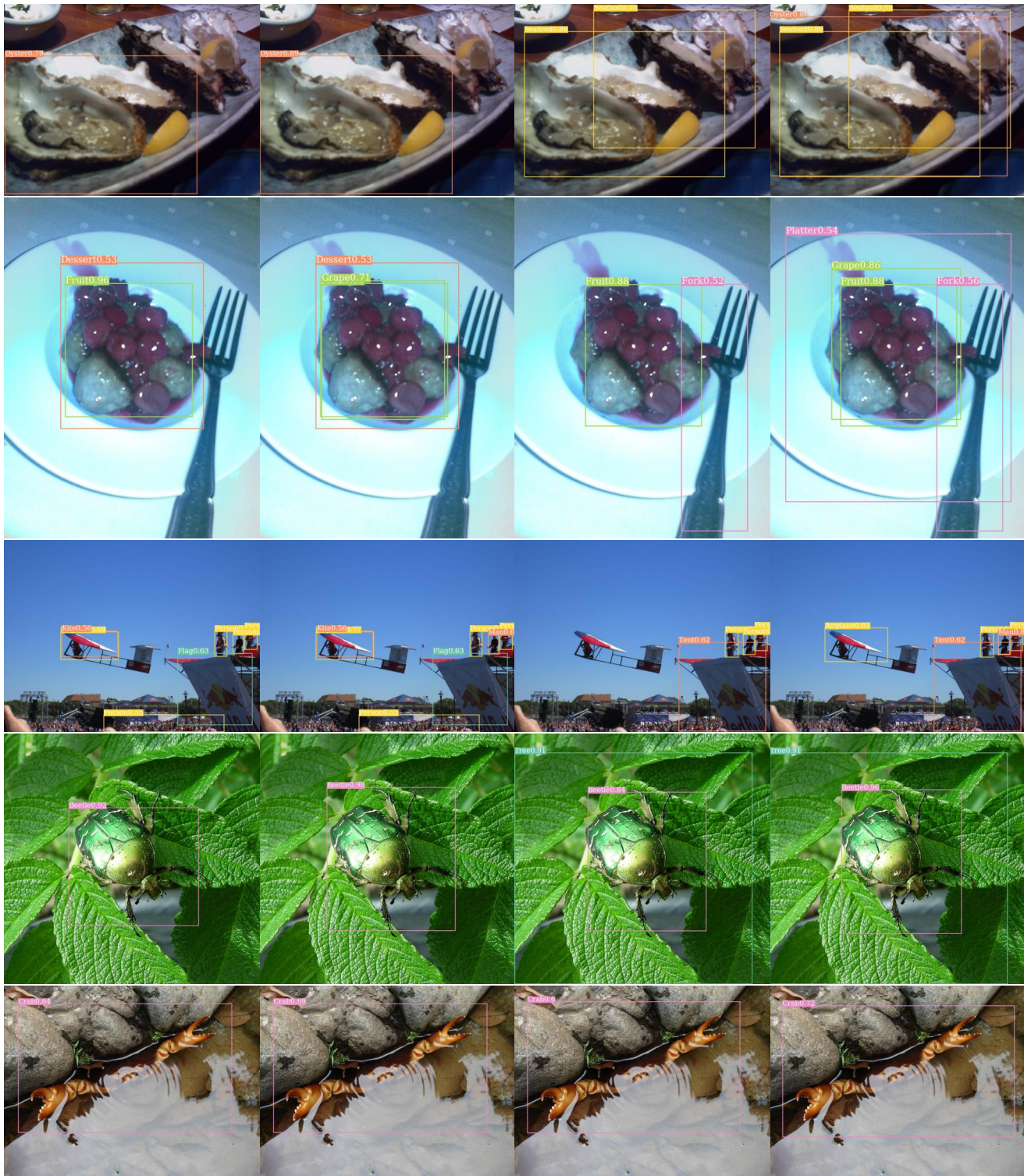
Source Classes	Winter melon	Winter melon	Deer	Briefcase	Briefcase	Cello	Bull	Whale	Crown	Cheetah
Confusion Classes	Watermelon	Cucumber	Antelope	Handbag	Suitcase	Violin	Cattle	Dolphin	Tiara	Leopard
#Source bboxes	40	40	3658	145	145	1894	1610	937	656	677
#Confusion bboxes	6	4	534	19	19	275	266	180	86	370

Source Classes	Cheetah	Oven	Measuring cup	Loveseat	Loveseat	Teapot	Kettle	Spider	Plate	Bagel
Confusion Classes	Jaguar	Microwave oven	Beaker	Sofa bed	studio couch	Kettle	Teapot	Insect	Platter	Dessert
#Source bboxes	677	597	70	600	600	604	630	1876	5118	589
#Confusion bboxes	218	89	26	90	135	185	185	1007	983	100

Source Classes	Bagel	Brassiere	studio couch	Dolphin	Jug	Paper towel	Bicycle wheel
Confusion Classes	Doughnut	Swimwear	Sofa bed	Whale	Pitcher	Toilet paper	Wheel
#Source bboxes	589	1613	1797	1428	542	196	56138
#Confusion bboxes	197	241	480	180	121	81	11066



**Figure 1.** Examples of detection results on Open Images dataset. We abbreviate softmax as *sm* and concurrent softmax as *csm* here. From left to right: *sm-train+sm-test*, *sm-train+csm-test*, *csm-train+sm-test*, *csm-train+csm-test*. We set the score threshold to 0.5 for visualization.





**Figure 2.** Examples of detection results on Open Images dataset. From left to right: ground truth, non-balance, class-aware balance, soft-balance. We set the score threshold to 0.5 for visualization.