

**Table S1.** The names and sample sizes of 20 insect species in the CPAF dataset

ID	Group	Full Name (abbreviation)	Sample Size
1	Fruit trees pests	Anomala corpulenta Motschulsky (ACM)	202
2		Papilio xuthus Linnaeus (PXL)	142
3		Papilio xuthus Linnaeus Larva (PXLL)	40
4		Gryllotalpa (Gryo)	178
5		Apriona germari (AG)	173
6		Papilio bianor Cramer (PBC)	521
7		Ctenuchidae (Cte)	85
8		Gongylus adiposus Brunner (GA)	332
9		Platylomia pieli Kato (PPK)	110
10		Stichophthalma louisa (SL)	118
11		Anoplophora chinensis (AC)	198
12	Cereals pests	Pieris rapae Crucivora (PR)	504
13		Parnara guttata Bremer et Grey (PGBG)	39
14		Gryllulus (Gryu)	426
15	Beneficial insects	Pergesa elpenorlewisi (PE)	156
16		Prosopocoilas Gracilis (Pro)	177
17		Coccinella Septempunctata (CS)	116
18		Paratenosera seu Hierodula (PH)	378
19		Dragonfly (Dra)	545
20		Tettigoniidae (Tet)	469
Total			4909

**Table S2.** Cross-validation accuracies of models using different dropout methods

Model	1	2	3	4	5	6	7	8	9
optiCPAFNet-2	88.23	88.09	88.67	88.51	89.05	89.17	89.15	88.96	88.79
optiCPAFNet-3	91.31	91.80	91.70	91.41	91.68	91.75	91.52	91.74	91.98
R-dropout	91.20	91.62	91.63	91.31	91.46	91.41	91.46	91.51	91.62
spatial-dropout	91.09	91.54	91.29	91.05	91.51	91.77	91.62	92.17	92.03
iGDnet-IP	91.89	92.20	92.39	92.32	92.39	92.86	92.41	92.56	92.69
GDnet-IP	91.99	91.99	92.27	92.08	92.08	91.99	92.00	92.20	92.43

Note: The optiCPAFNet-2 and optiCPAFNet-3 models used the ‘Dropout’ method; R-dropout and spatial-dropout were both applied to the optiCPAFNet-3 model; iGDnet-IP employed grouped dropout based on Inception modules; GDnet-IP utilized grouped dropout based on the WeDIV clustering algorithm. The last 9 epochs of training iterations were selected to represent the model’s accuracy, where each epoch is the average of 20 replicates under different runs with random seeds.

**Table S3.** Classification accuracy on Test Set 1 for models using different dropout methods

Model	1	2	3	4	5	6	7	8	9
optiCPAFNet-2	89.75	88.47	88.45	89.05	89.64	89.65	90.15	90.15	90.21
optiCPAFNet-3	91.15	91.44	91.37	91.59	91.77	91.68	91.72	91.89	91.76
R-dropout	91.42	91.38	91.51	91.41	91.54	91.59	91.82	91.87	91.73
spatial-dropout	91.18	91.27	91.35	91.61	91.65	91.80	91.58	91.43	91.66
iGDnet-IP	91.80	91.95	92.33	92.34	92.42	92.29	92.53	92.58	92.31
GDnet-IP	92.39	92.45	92.67	92.74	92.74	93.00	92.78	92.72	93.01

Note: The model and its parameters were saved when the current epoch was finished, then performing predictions on the test set.

**Table S4.** Classification accuracy on Test Set 2 for models using different dropout methods

Model	1	2	3	4	5	6	7	8	9
optiCPAFNet-2	89.71	89.97	88.97	89.64	90.40	91.19	90.95	91.01	91.10
optiCPAFNet-3	91.78	91.93	92.24	91.74	91.84	91.92	91.66	91.99	92.08
R-dropout	91.65	91.58	91.83	91.98	91.91	92.20	92.10	92.24	92.38
spatial-dropout	91.13	91.26	91.39	92.51	92.10	92.03	91.97	91.43	91.47
iGDnet-IP	92.87	92.84	92.98	91.89	92.11	91.91	92.55	92.72	92.37
GDnet-IP	93.25	92.97	93.12	92.62	93.12	93.02	92.26	92.62	92.95

**Table S5.** Cross-validation accuracies of different CNN models

Model	CV-1	CV-2	CV-3	Average
VGG11	85.67	89.77	88.63	88.02
VGG16	88.36	89.97	87.60	88.64
ResNet50	90.70	90.30	91.30	90.77
InceptionV3	89.80	86.10	88.65	88.18
optiCPAFNet-2	89.41	88.79	88.01	88.74
GDnet-IP	92.98	92.12	91.25	92.12

Note: Cross-validation accuracy of each fold is the average accuracy over multiple epochs with different random seeds.

**Table S6.** Classification accuracy on Test Set 1 for different CNN models

Model	1	2	3	4	5	6	7	8	9
VGG11	91.16	91.26	91.61	91.04	91.11	91.73	91.13	91.68	91.63
VGG16	90.66	90.92	90.35	90.96	91.09	91.58	91.20	90.96	91.48
ResNet50	91.47	90.83	90.36	91.13	91.55	91.08	91.71	91.83	91.82
InceptionV3	91.97	80.60	78.29	88.01	88.66	91.63	90.74	89.93	91.39
optiCPAFNet-2	89.75	88.47	88.45	89.05	89.64	89.65	90.15	90.15	90.21
GDnet-IP	92.39	92.45	92.67	92.74	92.74	93.00	92.78	92.72	93.01

**Table S7.** Classification accuracy on Test Set 2 for different CNN models

Model	1	2	3	4	5	6	7	8	9
VGG11	92.58	91.93	92.27	91.61	91.41	92.03	90.95	92.28	92.44
VGG16	90.81	91.80	91.89	91.78	91.78	92.59	92.99	91.85	93.24
ResNet50	92.28	91.91	90.97	91.20	92.57	92.31	92.61	92.60	92.38
InceptionV3	90.95	92.18	79.87	88.40	89.47	91.40	91.95	92.16	91.09
optiCPAFNet-2	89.71	89.97	88.97	89.64	90.40	91.19	90.95	91.01	91.10
GDnet-IP	93.25	92.97	93.12	92.62	93.12	93.02	92.26	92.62	92.95