

# Large-Scale Open-Set Classification Protocols for ImageNet

## Supplemental Material

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### 1. Linear OSCR Curves

Depending on the application, different false positive values are of importance. In the main paper, we focus more on the low FPR regions since these are of more importance when a human needs to look into the positive cases and, hence, large numbers of false positives involve labor cost. When false positives are not of utmost importance, e.g., when handled by an automated system in low-security applications, the focus will be more on having high correct classification rate. Therefore, in Fig. 1 we provide the OSCR plots according to figure 2 of the main paper, but this time with linear FPR axis. These plots highlight even more that the Entropic Open-Set (EOS) and the SoftMax with Background class (BG) approaches fail when known and unknown classes are very similar, as provided in  $P_2$  and  $P_3$ .

### 2. Results Sorted by Protocol

Fig. 2 displays the same results as shown in Figure 2 of the main paper, but here we compare the results of the different protocols. This shows that the definition of our protocols follows our intuition. We can see that protocol  $P_1$  is easy in open-set, but difficult in closed-set operation, especially when looking to the performance of BG and EOS, which are designed for open-set classification. On the opposite, protocol  $P_3$  achieves higher closed-set recognition performance (at  $FPR = 1$ ) while dropping much faster for lower FPR values. Protocol  $P_2$  is difficult both in closed- and open-set evaluation, but open-set performance does not drop that drastically as in  $P_3$ , especially considering the unknown test data in the second row. Due to its relatively small size,  $P_2$  is optimal for hyperparameter optimization and hyperparameters should be able to be transferred to the other two protocols – unless the algorithm is critical w.r.t. hyperparameters. We leave hyperparameter optimization to future work.

### 3. Detailed Results

In Tab. 1 we include detailed numbers of the values seen in figures 2 and 3 of the main paper. We also include the cases where we use our confidence metric to select the best epoch of training.

When comparing Tab. 1(a) with Tab. 1(b) it can be seen that the selection of the best algorithm based on the confidence score provides better CCR values for BG in protocols  $P_1$  and  $P_2$ , and better or comparable numbers for EOS across all protocols. The advantage of S is not that expressed since S does not take into consideration negative samples and, thus, the confidence for unknown  $\gamma^-$  gets very low in Tab. 1(a). When using our validation metric, training stops early and does not provide a good overall, i.e., closed-set performance. Therefore, we propose to use our novel evaluation metric for training open-set classifiers, but not for closed-set classifiers such as S.

### 4. Detailed List of Classes

For reproducibility, we also provide the list of classes (ImageNet identifier and class name) that we used in our three protocols in Tables 2, 3 and 4. For known and negative classes, we used the samples of the original training partition for training and validation, and the samples from the validation partition for testing – since the test set labels of ILSVRC2012 are still not publicly available.

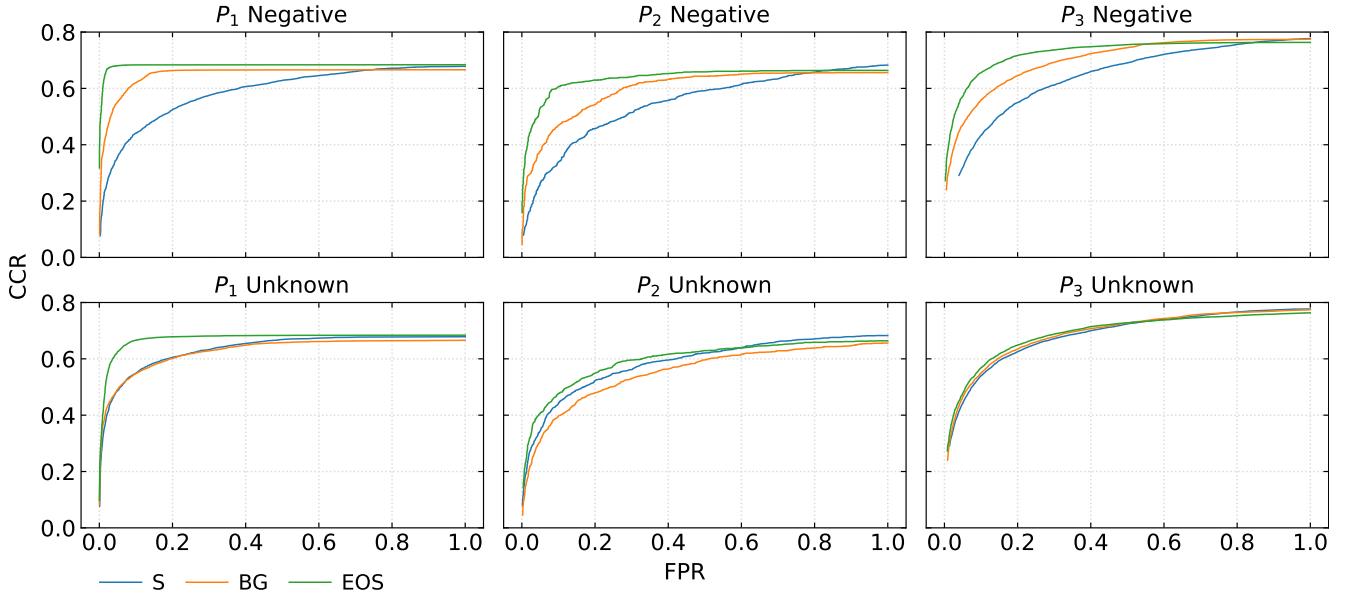


Figure 1: LINEAR OSCR CURVES. OSCR curves in linear scale for negative data (top tow) and unknown data (bottom row) of the test set for each protocol.

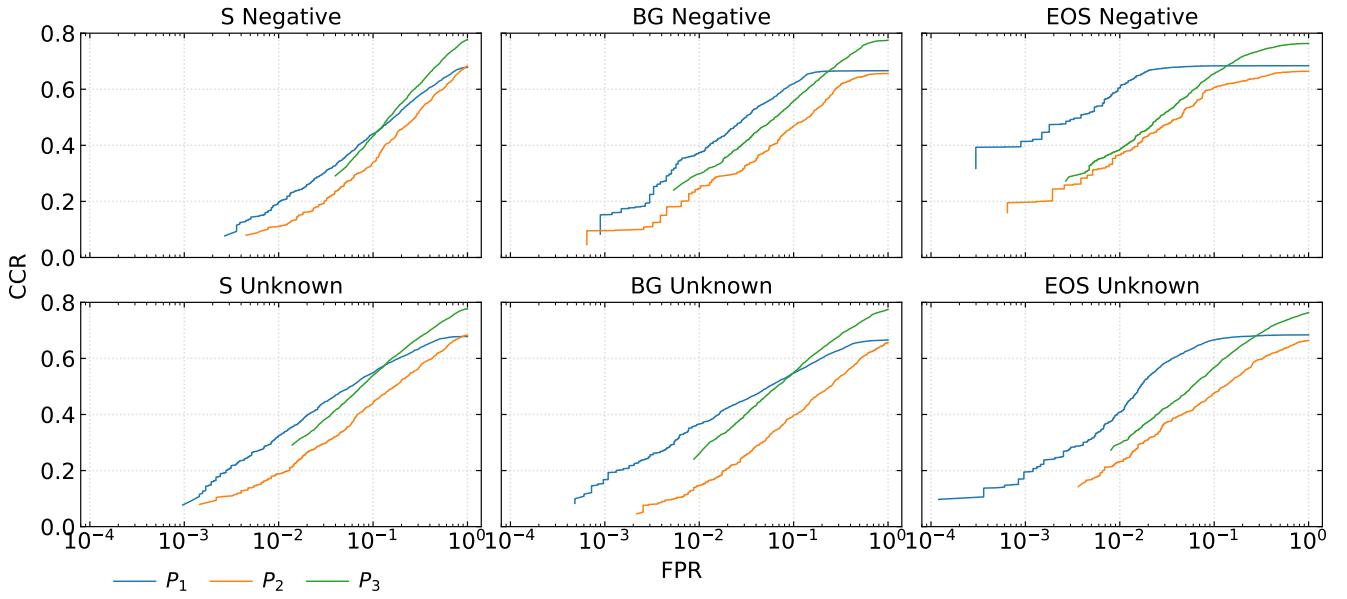


Figure 2: COMPARISON OF PROTOCOLS. OSCR curves are split by algorithm to allow a comparison across protocols. Results are shown for negative data (top row) and unknown data (bottom row).

Table 1: CLASSIFICATION RESULTS. Correct Classification Rates (CCR) are provided at some False Positive Rates (FPR) in the test set. The best CCR values are in bold.  $\gamma^+$  is calculated using known and  $\gamma^-$  using unknown classes.

(a) Using Last Epoch							
Epoch		Confidence		CCR at FPR of:			
		$\gamma^+$	$\gamma^-$	1e-3	1e-2	1e-1	1
$P_1$ - S	120	<b>0.665</b>	0.470	0.077	0.326	0.549	0.678
$P_1$ - BG	120	0.650	0.520	0.146	0.342	0.519	0.663
$P_1$ - EOS	120	0.663	<b>0.846</b>	<b>0.195</b>	<b>0.409</b>	<b>0.667</b>	<b>0.684</b>
$P_2$ - S	120	<b>0.665</b>	0.341	—	0.189	0.443	<b>0.683</b>
$P_2$ - BG	120	0.598	0.480	—	0.111	0.339	0.616
$P_2$ - EOS	120	0.592	<b>0.708</b>	—	<b>0.233</b>	<b>0.476</b>	0.664
$P_3$ - S	120	<b>0.767</b>	0.240	—	—	0.540	<b>0.777</b>
$P_3$ - BG	120	0.753	0.344	—	0.241	0.543	0.764
$P_3$ - EOS	120	0.684	<b>0.687</b>	—	<b>0.298</b>	<b>0.568</b>	0.763

(b) Using Best Epoch							
Epoch		Confidence		CCR at FPR of:			
		$\gamma^+$	$\gamma^-$	1e-3	1e-2	1e-1	1
$P_1$ - S	20	0.584	<b>0.906</b>	0.270	0.543	0.664	0.667
$P_1$ - BG	99	0.660	0.628	0.167	0.420	0.572	0.673
$P_1$ - EOS	105	<b>0.672</b>	0.877	<b>0.283</b>	<b>0.535</b>	<b>0.683</b>	<b>0.694</b>
$P_2$ - S	39	0.603	0.528	<b>0.031</b>	0.134	0.384	0.659
$P_2$ - BG	113	<b>0.638</b>	0.491	—	0.156	0.368	0.658
$P_2$ - EOS	101	0.599	<b>0.694</b>	—	<b>0.223</b>	<b>0.473</b>	<b>0.666</b>
$P_3$ - S	15	0.677	0.527	<b>0.083</b>	0.239	0.509	0.745
$P_3$ - BG	115	<b>0.747</b>	0.379	—	0.243	0.539	0.761
$P_3$ - EOS	114	0.696	<b>0.688</b>	—	<b>0.266</b>	<b>0.585</b>	<b>0.772</b>

Table 2: PROTOCOL 1 CLASSES: List of super-classes and leaf nodes of Protocol  $P_1$ .

Known		Negative		Unknown	
Id	Name	Id	Name	Id	Name
<i>n02084071</i>	<i>dog</i>	<i>n02118333</i>	<i>fox</i>	<i>n07555863</i>	<i>food</i>
n02085620	Chihuahua	n02119022	red fox	n07684084	French loaf
n02085782	Japanese spaniel	n02119789	kit fox	n07693725	bagel
n02085936	Maltese dog	n02120079	Arctic fox	n07695742	pretzel
n02086079	Pekinese	n02120505	grey fox	n07714571	head cabbage
n02086240	Shih-Tzu	<i>n02115335</i>	<i>wild dog</i>	n07714990	broccoli
n02086646	Blenheim spaniel	n02115641	dingo	n07715103	cauliflower
n02086910	papillon	n02115913	dhole	n07716358	zucchini
n02087046	toy terrier	n02116738	African hunting dog		n07716906
n02087394	Rhodesian ridgeback	<i>n02114100</i>	<i>wolf</i>	n07717410	spaghetti squash
n02088094	Afghan hound	n02114367	timber wolf	n07717556	acorn squash
n02088238	basset	n02114548	white wolf	n07718472	butternut squash
n02088364	beagle	n02114712	red wolf	n07718747	cucumber
n02088466	bloodhound	n02114855	coyote	n07720875	artichoke
n02088632	bluetick	<i>n02120997</i>	<i>feline</i>	n07730033	bell pepper
n02089078	black-and-tan coonho	n02125311	cougar	n07734744	cardoon
n02089867	Walker hound	n02127052	lynx	n07745940	mushroom
n02089973	English foxhound	n02128385	leopard	n07747607	strawberry
n02090379	redbone	n02128757	snow leopard	n07749582	orange
n02090622	borzoi	n02128925	jaguar	n07753113	lemon
n02090721	Irish wolfhound	n02129165	lion	n07753275	fig
n02091244	Ibizan hound	n02129604	tiger	n07753592	pineapple
n02091467	Norwegian elkhound	n02130308	cheetah	n07754684	banana
n02091635	otterhound	<i>n02131653</i>	<i>bear</i>	n07760859	jackfruit
n02091831	Saluki	n02132136	brown bear	n07768694	custard apple
n02092002	Scottish deerhound	n02133161	American black bear	<i>n03791235</i>	pomegranate
n02092339	Weimaraner	n02134084	ice bear	n02701002	<i>motor vehicle</i>
n02093256	Staffordshire bullter	n02134418	sloth bear	n02704792	ambulance
n02093428	American Staffordshi	<i>n02441326</i>	<i>musteline mammal</i>	n02814533	amphibian
n02093647	Bedlington terrier	n02441942	weasel	n02930766	beach wagon
n02093754	Border terrier	n02442845	mink	n03100240	cab
n02093859	Kerry blue terrier	n02443114	polecat	n03345487	convertible
n02093991	Irish terrier	n02443484	black-footed ferret	n03417042	fire engine
n02094114	Norfolk terrier	n02444819	otter	n03444034	garbage truck
n02094258	Norwich terrier	n02445715	skunk	n03594945	go-kart
n02094433	Yorkshire terrier	n02447366	badger	n03670208	jeep
n02095314	wire-haired fox terr	<i>n02370806</i>	<i>ungulate</i>	n03770679	limousine
n02095570	Lakeland terrier	n02389026	sorrel	n03777568	minivan
n02095889	Sealyham terrier	n02391049	zebra	n03785016	Model T
n02096051	Airedale	n02395406	hog	n03796401	moped
n02096177	cairn	n02396427	wild boar	n03930630	moving van
n02096294	Australian terrier	n02397096	warthog	n03977966	pickup
n02096437	Dandie Dinnmont	n02398521	hippopotamus	n04037443	police van
n02096585	Boston bull	n02403003	ox	n04252225	racer
n02097047	miniature schnauzer	n02408429	water buffalo	n04285008	snowplow
n02097130	giant schnauzer	n02410509	bison	n04461696	sports car
n02097209	standard schnauzer	n02412080	ram	n04467665	tow truck
n02097298	Scotch terrier	n02415577	bighorn	<i>n03183080</i>	trailer truck
n02097474	Tibetan terrier	n02417914	ibex	device	device
n02097658	silky terrier	n02422106	hartebeest		abacus
n02098105	soft-coated wheaten	n02422699	impala	n02672831	accordion
n02098286	West Highland white	n02423022	gazelle	n02676566	acoustic guitar
n02098413	Lhasa	n02437312	Arabian camel	n02708093	analog clock
n02099267	flat-coated retriev	n02437616	llama	n02787622	assault rifle
n02099429	curly-coated retriev	<i>n02469914</i>	<i>primate</i>	n02794156	banjo
n02099601	golden retriever	n02480495	orangutan	n02804610	barometer
n02099712	Labrador retriever	n02480855	gorilla	n02841315	bassoon
n02099849	Chesapeake Bay retrie	n02481823	chimpanzee	n02879718	binoculars
n02100236	German short-haired	n02483362	gibbon	n02910353	bow
n02100583	vizsla	n02483708	siamang	n02948072	buckle
n02100735	English setter	n02484975	guenon	n02950826	candle
n02100877	Irish setter	n02486261	patas	n02965783	cannon
n02101006	Gordon setter	n02486410	baboon	n02966193	car mirror
n02101388	Brittany spaniel	n02487347	macaque	n02974003	carousel
n02101556	clumber	n02488291	langur	n02977058	car wheel
n02102040	English springer	n02488702	colobus	n02992211	cash machine
n02102177	Welsh springer spani	n02489166	proboscis monkey	n03000684	cello
n02102318	cocker spaniel	n02490219	marmoset	n03017168	chain saw
n02102480	Sussex spaniel	n02492035	capuchin	n03075370	chime
n02102973	Irish water spaniel	n02492660	howler monkey	n03110669	combination lock
n02104029	kuvasz	n02493509	titi	n03126707	cornet
					crane

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PROTOCOL 1 CLASSES: List of super-classes and leaf nodes of Protocol  $P_1$ .

Known		Negative		Unknown	
Id	Name	Id	Name	Id	Name
n02104365	schipperke	n02493793	spider monkey	n03180011	desktop computer
n02105056	groenendael	n02494079	squirrel monkey	n03196217	digital clock
n02105162	malinois	n02497673	Madagascar cat	n03197337	digital watch
n02105251	briard	n02500267	indri	n03208938	disk brake
n02105412	kelpie			n03249569	drum
n02105505	komondor			n03271574	electric fan
n02105641	Old English sheepdog			n03272010	electric guitar
n02105855	Shetland sheepdog			n03372029	flute
n02106030	collie			n03394916	French horn
n02106166	Border collie			n03425413	gas pump
n02106382	Bouvier des Flandres			n03447721	gong
n02106550	Rottweiler			n03452741	grand piano
n02106662	German shepherd			n03467068	guillotine
n02107142	Doberman			n03476684	hair slide
n02107312	miniature pinscher			n03485407	hand-held computer
n02107574	Greater Swiss Mounta			n03492542	hard disc
n02107683	Bernese mountain dog			n03494278	harmonica
n02107908	Appenzeller			n03495258	harp
n02108000	EntleBucher			n03496892	harvester
n02108089	boxer			n03532672	hook
n02108422	bull mastiff			n03544143	hourglass
n02108551	Tibetan mastiff			n03590841	jack-o'-lantern
n02108915	French bulldog			n03627232	knot
n02109047	Great Dane			n03642806	laptop
n02109525	Saint Bernard			n03666591	lighter
n02109961	Eskimo dog			n03691459	loudspeaker
n02110063	malamute			n03692522	loupe
n02110185	Siberian husky			n03706229	magnetic compass
n02110341	dalmatian			n03720891	maraca
n02110627	affenpinscher			n03721384	marimba
n02110806	basenji			n03733131	maypole
n02110958	pug			n03759954	microphone
n02111129	Leonberg			n03773504	missile
n02111277	Newfoundland			n03793489	mouse
n02111500	Great Pyrenees			n03794056	mousetrap
n02111889	Samoyed			n03803284	muzzle
n02112018	Pomeranian			n03804744	nail
n02112137	chow			n03814639	neck brace
n02112350	keeshond			n03832673	notebook
n02112706	Brabancion griffon			n03838899	oboe
n02113023	Pembroke			n03840681	ocarina
n02113186	Cardigan			n03841143	odometer
n02113624	toy poodle			n03843555	oil filter
n02113712	miniature poodle			n03854065	organ
n02113799	standard poodle			n03868863	oxygen mask
n02113978	Mexican hairless			n03874293	paddlewheel
				n03874599	padlock
				n03884397	panpipe
				n03891332	parking meter
				n03929660	pick
				n03933933	pier
				n03944341	pinwheel
				n03992509	potter's wheel
				n03995372	power drill
				n04008634	projectile
				n04009552	projector
				n04040759	radiator
				n04044716	radio telescope
				n04067472	reel
				n04074963	remote control
				n04086273	revolver
				n04090263	rifle
				n04118776	rule
				n04127249	safety pin
				n04141076	sax
				n04141975	scale
				n04152593	screen
				n04153751	screw
				n04228054	ski
				n04238763	slide rule
				n04243546	slot
				n04251144	snorkel

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PROTOCOL 1 CLASSES: List of super-classes and leaf nodes of Protocol  $P_1$ .

Known		Negative		Unknown	
Id	Name	Id	Name	Id	Name
		n04258138	solar dish		
		n04265275	space heater		
		n04275548	spider web		
		n04286575	spotlight		
		n04311174	steel drum		
		n04317175	stethoscope		
		n04328186	stopwatch		
		n04330267	stove		
		n04332243	strainer		
		n04355338	sundial		
		n04355933	sunglass		
		n04356056	sunglasses		
		n04372370	switch		
		n04376876	syringe		
		n04428191	thresher		
		n04456115	torch		
		n04485082	tripod		
		n04487394	trombone		
		n04505470	typewriter keyboard		
		n04515003	upright		
		n04525305	vending machine		
		n04536866	violin		
		n04548280	wall clock		
		n04579432	whistle		
		n04592741	wing		
		n06359193	web site		

End of table Protocol 1

Table 3: PROTOCOL 2 CLASSES: List of super-classes and leaf nodes of Protocol  $P_2$ .

Known		Negative		Unknown	
Id	Name	Id	Name	Id	Name
<i>n02087122</i>	<i>hunting dog</i>	<i>n02087122</i>	<i>hunting dog</i>	<i>n02085374</i>	<i>toy dog</i>
n02087394	Rhodesian ridgeback	n02096051	Airedale	n02085620	Chihuahua
n02088094	Afghan hound	n02096177	cairn	n02085782	Japanese spaniel
n02088238	basset	n02096294	Australian terrier	n02085936	Maltese dog
n02088364	beagle	n02096437	Dandie Dinmont	n02086079	Pekinese
n02088466	bloodhound	n02096585	Boston bull	n02086240	Shih-Tzu
n02088632	bluetick	n02097047	miniature schnauzer	n02086646	Blenheim spaniel
n02089078	black-and-tan coonho	n02097130	giant schnauzer	n02086910	papillon
n02089867	Walker hound	n02097209	standard schnauzer	n02087046	toy terrier
n02089973	English foxhound	n02097298	Scotch terrier	<i>n02118333</i>	<i>fox</i>
n02090379	redbone	n02097474	Tibetan terrier	n02119022	red fox
n02090622	borzoi	n02097658	silky terrier	n02119789	kit fox
n02090721	Irish wolfhound	n02098105	soft-coated wheaten	n02120079	Arctic fox
n02091244	Ibizan hound	n02098286	West Highland white	n02120505	grey fox
n02091467	Norwegian elkhound	n02098413	Lhasa	<i>n02115335</i>	<i>wild dog</i>
n02091635	otterhound	n02099267	flat-coated retrieve	n02115641	dingo
n02091831	Saluki	n02099429	curly-coated retriev	n02115913	dhole
n02092002	Scottish deerhound	n02099601	golden retriever	n02116738	African hunting dog
n02092339	Weimaraner	n02099712	Labrador retriever	<i>n02114100</i>	<i>wolf</i>
n02093256	Staffordshire bultte	n02099849	Chesapeake Bay retr	n02114367	timber wolf
n02093428	American Staffordshi	n02100236	German short-haired	n02114548	white wolf
n02093647	Bedlington terrier	n02100583	vizsla	n02114712	red wolf
n02093754	Border terrier	n02100735	English setter	n02114855	coyote
n02093859	Kerry blue terrier	n02100877	Irish setter	<i>n02120997</i>	<i>feline</i>
n02093991	Irish terrier	n02101006	Gordon setter	n02125311	cougar
n02094114	Norfolk terrier	n02101388	Brittany spaniel	n02127052	lynx
n02094258	Norwich terrier	n02101556	clumber	n02128385	leopard
n02094433	Yorkshire terrier	n02102040	English springer	n02128757	snow leopard
n02095314	wire-haired fox terr	n02102177	Welsh springer spani	n02128925	jaguar
n02095570	Lakeland terrier	n02102318	cocker spaniel	n02129165	lion
n02095889	Sealyham terrier	n02102480	Sussex spaniel	n02129604	tiger
		n02102973	Irish water spaniel	n02130308	cheetah
				<i>n02131653</i>	<i>bear</i>
				n02132136	brown bear
				n02133161	American black bear
				n02134084	ice bear
				n02134418	sloth bear
				<i>n02441326</i>	<i>musteline mammal</i>
				n02441942	weasel
				n02442845	mink
				n02443114	polecat
				n02443484	black-footed ferret
				n02444819	otter
				n02445715	skunk
				n02447366	badger
				<i>n02370806</i>	<i>ungulate</i>
				n02389026	sorrel
				n02391049	zebra
				n02395406	hog
				n02396427	wild boar
				n02397096	warthog
				n02398521	hippopotamus
				n02403003	ox
				n02408429	water buffalo
				n02410509	bison
				n02412080	ram
				n02415577	bighorn
				n02417914	ibex
				n02422106	hartebeest
				n02422699	impala
				n02423022	gazelle
				n02437312	Arabian camel
				n02437616	llama

End of table Protocol 2

Table 4: PROTOCOL 3 CLASSES: List of super-classes and leaf nodes of Protocol  $P_3$ .

Known			Negative		Unknown	
Id	Name	Id	Name	Id	Name	
<i>n02084071</i>	<i>dog</i>	<i>n02084071</i>	<i>dog</i>	<i>n02084071</i>	<i>dog</i>	
n02085620	Chihuahua	n02085782	Japanese spaniel	n02086079	Pekinese	
n02085936	Maltese dog	n02086646	Blenheim spaniel	n02088094	Afghan hound	
n02086240	Shih-Tzu	n02087046	toy terrier	n02089867	Walker hound	
n02086910	papillon	n02088364	beagle	n02091467	Norwegian elkhound	
n02087394	Rhodesian ridgeback	n02088632	bluetick	n02093428	American Staffordshire terrier	
n02088238	basset	n02090379	redbone	n02094258	Norwich terrier	
n02088466	bloodhound	n02090721	Irish wolfhound	n02096177	cairn	
n02089078	black-and-tan coonhound	n02091831	Saluki	n02097209	standard schnauzer	
n02089973	English foxhound	n02092339	Weimaraner	n02098413	Lhasa	
n02090622	borzoi	n02093754	Border terrier	n02100236	German short-haired pointer	
n02091244	Ibizan hound	n02093991	Irish terrier	n02101556	clumber	
n02091635	otterhound	n02095314	wire-haired fox terrier	n02104029	kuvasz	
n02092002	Scottish deerhound	n02095889	Sealyham terrier	n02105505	komondor	
n02093256	Staffordshire bullterrier	n02096437	Dandie Dinmont	n02106550	Rottweiler	
n02093647	Bedlington terrier	n02097047	miniature schnauzer	n02107908	Appenzeller	
n02093859	Kerry blue terrier	n02097474	Tibetan terrier	n02109047	Great Dane	
n02094114	Norfolk terrier	n02098105	soft-coated wheaten	n02110627	affenpinscher	
n02094433	Yorkshire terrier	n02099429	curly-coated retriever	n02111889	Samoyed	
n02095570	Lakeland terrier	n02099712	Labrador retriever	n02113186	Cardigan	
n02096051	Airedale	n02100735	English setter	<i>n01503061</i>	<i>bird</i>	
n02096294	Australian terrier	n02101006	Gordon setter	n01530575	brambling	
n02096585	Boston bull	n02102177	Welsh springer spaniel	n01560419	bulbul	
n02097130	giant schnauzer	n02102480	Sussex spaniel	n01614925	bald eagle	
n02097298	Scotch terrier	n02105056	groenendael	n01820546	lorikeet	
n02097658	silky terrier	n02105251	briard	n01843383	toucan	
n02098286	West Highland white terrier	n02105855	Shetland sheepdog	n02002724	black stork	
n02099267	flat-coated retriever	n02106166	Border collie	n02012849	crane	
n02099601	golden retriever	n02107142	Doberman	n02027492	red-backed sandpiper	
n02099849	Chesapeake Bay retriever	n02107574	Greater Swiss Mountain dog	n02058221	albatross	
n02100583	vizsla	n02108089	boxer	<i>n02159955</i>	<i>insect</i>	
n02100877	Irish setter	n02108551	Tibetan mastiff	n02168699	long-horned beetle	
n02101388	Brittany spaniel	n02109961	Eskimo dog	n02206856	bee	
n02102040	English springer	n02110185	Siberian husky	n02236044	mantis	
n02102318	cocker spaniel	n02110958	pug	n02276258	admiral	
n02102973	Irish water spaniel	n02111277	Newfoundland	<i>n03405725</i>	<i>furniture</i>	
n02104365	schipperke	n02112137	chow	n03016953	chiffonier	
n02105162	malinois	n02112706	Brabancon griffon	n03290653	entertainment center	
n02105412	kelpie	n02113712	miniature poodle	n04099969	rocking chair	
n02105641	Old English sheepdog	n02113978	Mexican hairless	<i>n02512053</i>	<i>fish</i>	
n02106030	collie	<i>n01503061</i>	<i>bird</i>	n01491361	tiger shark	
n02106382	Bouvier des Flandres	n01514859	hen	n02536864	coho	
n02106662	German shepherd	n01532829	house finch	n02655020	puffer	
n02107312	miniature pinscher	n01537544	indigo bunting	<i>n02484322</i>	<i>monkey</i>	
n02107683	Bernese mountain dog	n01582220	magpie	n02487347	macaque	
n02108000	EntleBucher	n01601694	water ouzel	n02492660	howler monkey	
n02108422	bulld mastiff	n01622779	great grey owl	<i>n02958343</i>	<i>car</i>	
n02108915	French bulldog	n01818515	macaw	n03100240	convertible	
n02109525	Saint Bernard	n01828970	bee eater	n04285008	sports car	
n02110063	malamute	n01833805	hummingbird	<i>n02120997</i>	<i>feline</i>	
n02110341	dalmatian	n01855032	red-breasted merganser	n02128757	snow leopard	
n02110806	basenji	n01860187	black swan	<i>n04490091</i>	<i>truck</i>	
n02111129	Leonberg	n02007558	flamingo	n03930630	pickup	
n02111500	Great Pyrenees	n02009912	American egret	<i>n13134947</i>	<i>fruit</i>	
n02112018	Pomeranian	n02017213	European gallinule	n12267677	acorn	
n02112350	keeshond	n02018795	bustard	<i>n12992868</i>	<i>fungus</i>	
n02113023	Pembroke	n02033041	dowitcher	n13040303	stinkhorn	
n02113624	toy poodle	n02051845	pelican	<i>n02858304</i>	<i>boat</i>	
n02113799	standard poodle	<i>n02159955</i>	<i>insect</i>	n03662601	lifeboat	
<i>n01503061</i>	<i>bird</i>	n02165456	ladybug	<i>n03082979</i>	<i>computer</i>	
n01514668	cock	n02172182	dung beetle	n03832673	notebook	
n01518878	ostrich	n02177972	weevil	<i>n01661091</i>	<i>reptile</i>	
n01531178	goldfinch	n02226429	grasshopper	n01664065	loggerhead	
n01534433	juncos	n02231487	walking stick	n01665541	leatherback turtle	
n01558993	robin	n02259212	leafhopper	n01667114	mud turtle	
n01580077	jay	n02268443	dragonfly	n01667778	terrapin	
n01592084	chickadee	n02279972	monarch	n01669191	box turtle	
n01608432	kite	n02281406	sulphur butterfly	n01675722	banded gecko	
n01616318	vulture	<i>n03405725</i>	<i>furniture</i>	n01677366	common iguana	
n01817953	African grey	n02804414	bassinet	n01682714	American chameleon	
n01819313	sulphur-crested cockatoo	n03125729	cradle	n01685808	whiptail	

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PROTOCOL 3 CLASSES: List of super-classes and leaf nodes of Protocol  $P_3$ .

Known		Negative		Unknown	
Id	Name	Id	Name	Id	Name
n01824575	coucal	n03179701	desk	n01687978	agama
n01829413	hornbill	n03376595	folding chair	n01688243	frilled lizard
n01843065	jacamar	n03742115	medicine chest	n01689811	alligator lizard
n01847000	drake	n04380533	table lamp	n01692333	Gila monster
n01855672	goose	n04447861	toilet seat	n01693334	green lizard
n02002556	white stork	n02512053	<i>fish</i>	n01694178	African chameleon
n02006656	spoonbill	n01443537	goldfish	n01695060	Komodo dragon
n02009229	little blue heron	n01496331	electric ray	n01697457	African crocodile
n02011460	bittern	n02514041	barracouta	n01698640	American alligator
n02013706	limpkin	n02607072	anemone fish	n01704323	triceratops
n02018207	American coot	n02641379	gar	n01728572	thunder snake
n02025239	ruddy turnstone	n02484322	<i>monkey</i>	n01728920	ringneck snake
n02028035	redshank	n02486261	patas	n01729322	hognose snake
n02037110	oystercatcher	n02488702	colobus	n01729977	green snake
n02056570	king penguin	n02490219	marmoset	n01734418	king snake
<i>insect</i>		n02493793	spider monkey	n01735189	garter snake
	tiger beetle	n02958343	<i>car</i>	n01737021	water snake
	ground beetle	n02814533	beach wagon	n01739381	vine snake
	leaf beetle	n03670208	limousine	n01740131	night snake
	rhinoceros beetle	n03777568	Model T	n01742172	boa constrictor
	fly	n02120997	<i>feline</i>	n01744401	rock python
	ant	n02127052	lynx	n01748264	Indian cobra
	cricket	n02129165	lion	n01749939	green mamba
	cockroach	n02130308	cheetah	n01751748	sea snake
	cicada	n04490091	<i>truck</i>	n01753488	horned viper
n02219486	lacewing	n03417042	garbage truck	n01755581	diamondback
n02268853	damselfly	n04461696	tow truck	n01756291	sidewinder
n02277742	ringlet	n13134947	<i>fruit</i>	n03051540	<i>clothing</i>
n02280649	cabbage butterfly	n11879895	rapeseed	n02667093	abaya
n02281787	lycaenid	n12768682	buckeye	n02669723	academic gown
<i>furniture</i>		n12992868	<i>fungus</i>	n02730930	apron
	barber chair	n12998815	agaric	n02807133	bathing cap
	bookcase	n13052670	hen-of-the-woods	n02817516	bearskin
	china cabinet	n02858304	<i>boat</i>	n02837789	bikini
	crib	n03344393	fireboat	n02865351	bole tie
	dining table	n04612504	yawl	n02869837	bonnet
	file	n03082979	<i>computer</i>	n02883205	bow tie
	four-poster	n03485407	hand-held computer	n02892767	brassiere
	park bench	n06359193	web site	n02963159	cardigan
	studio couch			n03026506	Christmas stocking
n04344873	throne			n03124170	cowboy hat
n04429376	wardrobe			n03127747	crash helmet
<i>fish</i>				n03188531	diaper
	tench			n03325584	feather boa
	great white shark			n03379051	football helmet
	hammerhead			n03404251	fur coat
	stingray			n03450230	gown
	eel			n03534580	hoop skirt
	rock beauty			n03594734	jean
	sturgeon			n03595614	jersey
	lionfish			n03617480	kimono
				n03623198	knee pad
<i>monkey</i>				n03630383	lab coat
	guenon			n03710637	maillot
	baboon			n03710721	mask
	langur			n03724870	military uniform
	proboscis monkey			n03763968	miniskirt
	capuchin			n03770439	mittens
	titi			n03775071	mitten
	squirrel monkey			n03787032	mortarboard
				n03866082	overskirt
				n03877472	pajama
<i>car</i>				n03980874	poncho
	ambulance			n04136333	sarong
	cab			n04162706	seat belt
	jeep			n04209133	shower cap
	minivan			n04254777	sock
	racer			n04259630	sombrero
				n04325704	stole
				n04350905	suit
				n04370456	sweatshirt
				n04371430	swimming trunks

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PROTOCOL 3 CLASSES: List of super-classes and leaf nodes of Protocol  $P_3$ .

Known		Negative		Unknown	
Id	Name	Id	Name	Id	Name
n03796401	moving van			n04479046	trench coat
n03977966	police van			n04532106	vestment
n04467665	trailer truck			n04584207	wig
<i>n13134947</i>	<i>fruit</i>			n04591157	Windsor tie
n07742313	Granny Smith			<i>n02370806</i>	<i>ungulate</i>
n12144580	corn			n02389026	sorrel
n12620546	hip			n02391049	zebra
n13133613	ear			n02395406	hog
<i>n12992868</i>	<i>fungus</i>			n02396427	wild boar
n12985857	coral fungus			n02397096	warthog
n13037406	gyromitra			n02398521	hippopotamus
n13044778	earthstar			n02403003	ox
n13054560	bolete			n02408429	water buffalo
<i>n02858304</i>	<i>boat</i>			n02410509	bison
n02951358	canoe			n02412080	ram
n03447447	gondola			n02415577	bighorn
n04273569	speedboat			n02417914	ibex
<i>n03082979</i>	<i>computer</i>			n02422106	hartebeest
n03180011	desktop computer			n02422699	impala
n03642806	laptop			n02423022	gazelle
n04238763	slide rule			n02437312	Arabian camel
				n02437616	llama
				<i>n07707451</i>	<i>vegetable</i>
				n07714571	head cabbage
				n07714990	broccoli
				n07715103	cauliflower
				n07716358	zucchini
				n07716906	spaghetti squash
				n07717410	acorn squash
				n07717556	butternut squash
				n07718472	cucumber
				n07718747	artichoke
				n07720875	bell pepper
				n07730033	cardoon
				n07734744	mushroom
				<i>n02686568</i>	<i>aircraft</i>
				n02690373	airliner
				n02692877	airship
				n02782093	balloon

End of table Protocol 3