

transfer_learning

April 5, 2022

1 Transfer Learning with ONNX

The notebooks retrieve the already converted onnx model for [SqueezeNet](#) and uses it in a pipeline created with [scikit-learn](#).

```
[1]: from jupyterhelper import add_notebook_menu
      add_notebook_menu()
```

```
[1]: <IPython.core.display.HTML object>
```

```
[2]: %matplotlib inline
```

1.1 Retrieve the ONNX model

```
[3]: import os
      from pyensae.datasource import download_data

      src = ("https://s3.amazonaws.com/onnx-model-zoo/mobilenet/"
            "mobilenetv2-1.0/")
      model_file = "mobilenetv2-1.0.onnx"
      src = "https://s3.amazonaws.com/onnx-model-zoo/squeezenet/squeezenet1.1/"
      model_file = "squeezenet1.1.onnx"

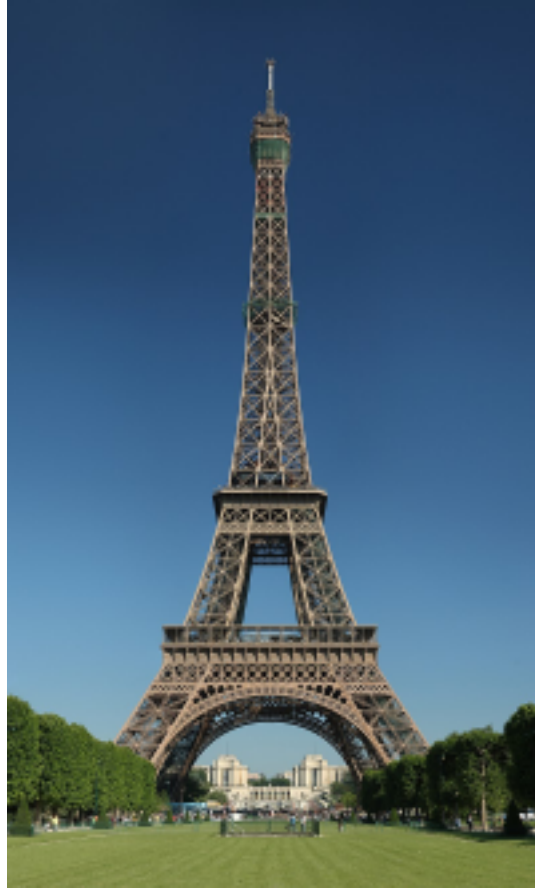
      if not os.path.exists(model_file):
          print("Download '{0}'...".format(model_file))
          download_data(model_file, website=src)
          print("Done.")
```

1.2 An image

```
[4]: from PIL import Image

      img_path = "800px-Tour_Eiffel_Wikimedia_Commons_(cropped).jpg"
      image = Image.open(img_path)
      image.reduce(4)
```

```
[4]:
```



1.3 ImageNet classes

Next cell is only about the list of class names associated to the *ImageNet* competition. Better to jump to the next part.

```
[5]: class_names = {
  0: 'tench, Tinca tinca',
  1: 'goldfish, Carassius auratus',
  2: 'great white shark, white shark, man-eater, man-eating shark, Carcharodon_
     ↪carcharias',
  3: 'tiger shark, Galeocerdo cuvieri',
  4: 'hammerhead, hammerhead shark',
  5: 'electric ray, crampfish, numbfish, torpedo',
  6: 'stingray',
  7: 'cock',
  8: 'hen',
  9: 'ostrich, Struthio camelus',
  10: 'brambling, Fringilla montifringilla',
  11: 'goldfinch, Carduelis carduelis',
  12: 'house finch, linnet, Carpodacus mexicanus',
  13: 'junco, snowbird',
  14: 'indigo bunting, indigo finch, indigo bird, Passerina cyanea',
  15: 'robin, American robin, Turdus migratorius',
```

16: 'bulbul',
17: 'jay',
18: 'magpie',
19: 'chickadee',
20: 'water ouzel, dipper',
21: 'kite',
22: 'bald eagle, American eagle, Haliaeetus leucocephalus',
23: 'vulture',
24: 'great grey owl, great gray owl, Strix nebulosa',
25: 'European fire salamander, Salamandra salamandra',
26: 'common newt, Triturus vulgaris',
27: 'eft',
28: 'spotted salamander, Ambystoma maculatum',
29: 'axolotl, mud puppy, Ambystoma mexicanum',
30: 'bullfrog, Rana catesbeiana',
31: 'tree frog, tree-frog',
32: 'tailed frog, bell toad, ribbed toad, tailed toad, Ascaphus trui',
33: 'loggerhead, loggerhead turtle, Caretta caretta',
34: 'leatherback turtle, leatherback, leathery turtle, Dermochelys coriacea',
35: 'mud turtle',
36: 'terrapin',
37: 'box turtle, box tortoise',
38: 'banded gecko',
39: 'common iguana, iguana, Iguana iguana',
40: 'American chameleon, anole, Anolis carolinensis',
41: 'whiptail, whiptail lizard',
42: 'agama',
43: 'frilled lizard, Chlamydosaurus kingi',
44: 'alligator lizard',
45: 'Gila monster, Heloderma suspectum',
46: 'green lizard, Lacerta viridis',
47: 'African chameleon, Chamaeleo chamaeleon',
48: 'Komodo dragon, Komodo lizard, dragon lizard, giant lizard, Varanus komodoensis',
49: 'African crocodile, Nile crocodile, Crocodylus niloticus',
50: 'American alligator, Alligator mississippiensis',
51: 'triceratops',
52: 'thunder snake, worm snake, Carphophis amoenus',
53: 'ringneck snake, ring-necked snake, ring snake',
54: 'hognose snake, puff adder, sand viper',
55: 'green snake, grass snake',
56: 'king snake, kingsnake',
57: 'garter snake, grass snake',
58: 'water snake',
59: 'vine snake',
60: 'night snake, Hypsiglena torquata',
61: 'boa constrictor, Constrictor constrictor',
62: 'rock python, rock snake, Python sebae',
63: 'Indian cobra, Naja naja',
64: 'green mamba',
65: 'sea snake',
66: 'horned viper, cerastes, sand viper, horned asp, Cerastes cornutus',
67: 'diamondback, diamondback rattlesnake, Crotalus adamanteus',
68: 'sidewinder, horned rattlesnake, Crotalus cerastes',

69: 'trilobite',
70: 'harvestman, daddy longlegs, Phalangium opilio',
71: 'scorpion',
72: 'black and gold garden spider, Argiope aurantia',
73: 'barn spider, Araneus cavaticus',
74: 'garden spider, Aranea diademata',
75: 'black widow, Latrodectus mactans',
76: 'tarantula',
77: 'wolf spider, hunting spider',
78: 'tick',
79: 'centipede',
80: 'black grouse',
81: 'ptarmigan',
82: 'ruffed grouse, partridge, Bonasa umbellus',
83: 'prairie chicken, prairie grouse, prairie fowl',
84: 'peacock',
85: 'quail',
86: 'partridge',
87: 'African grey, African gray, Psittacus erithacus',
88: 'macaw',
89: 'sulphur-crested cockatoo, Kakatue galerita, Cacatua galerita',
90: 'lorikeet',
91: 'coucal',
92: 'bee eater',
93: 'hornbill',
94: 'hummingbird',
95: 'jacamar',
96: 'toucan',
97: 'drake',
98: 'red-breasted merganser, Mergus serrator',
99: 'goose',
100: 'black swan, Cygnus atratus',
101: 'tusker',
102: 'echidna, spiny anteater, anteater',
103: 'platypus, duckbill, duckbilled platypus, duck-billed platypus, Ornithorhynchus, anatinus',
104: 'wallaby, brush kangaroo',
105: 'koala, koala bear, kangaroo bear, native bear, Phascolarctos cinereus',
106: 'wombat',
107: 'jellyfish',
108: 'sea anemone, anemone',
109: 'brain coral',
110: 'flatworm, platyhelminth',
111: 'nematode, nematode worm, roundworm',
112: 'conch',
113: 'snail',
114: 'slug',
115: 'sea slug, nudibranch',
116: 'chiton, coat-of-mail shell, sea cradle, polyplacophore',
117: 'chambered nautilus, pearly nautilus, nautilus',
118: 'Dungeness crab, Cancer magister',
119: 'rock crab, Cancer irroratus',
120: 'fiddler crab',

121: 'king crab, Alaska crab, Alaskan king crab, Alaska king crab, Paralithodes┐
 ↪camtschatica',
 122: 'American lobster, Northern lobster, Maine lobster, Homarus americanus',
 123: 'spiny lobster, langouste, rock lobster, crawfish, crayfish, sea crawfish',
 124: 'crayfish, crawfish, crawdad, crawdaddy',
 125: 'hermit crab',
 126: 'isopod',
 127: 'white stork, Ciconia ciconia',
 128: 'black stork, Ciconia nigra',
 129: 'spoonbill',
 130: 'flamingo',
 131: 'little blue heron, Egretta caerulea',
 132: 'American egret, great white heron, Egretta albus',
 133: 'bittern',
 134: 'crane',
 135: 'limpkin, Aramus pictus',
 136: 'European gallinule, Porphyrio porphyrio',
 137: 'American coot, marsh hen, mud hen, water hen, Fulica americana',
 138: 'bustard',
 139: 'ruddy turnstone, Arenaria interpres',
 140: 'red-backed sandpiper, dunlin, Erolia alpina',
 141: 'redshank, Tringa totanus',
 142: 'dowitcher',
 143: 'oystercatcher, oyster catcher',
 144: 'pelican',
 145: 'king penguin, Aptenodytes patagonica',
 146: 'albatross, mollymawk',
 147: 'grey whale, gray whale, devilfish, Eschrichtius gibbosus, Eschrichtius┐
 ↪robustus',
 148: 'killer whale, killer, orca, grampus, sea wolf, Orcinus orca',
 149: 'dugong, Dugong dugon',
 150: 'sea lion',
 151: 'Chihuahua',
 152: 'Japanese spaniel',
 153: 'Maltese dog, Maltese terrier, Maltese',
 154: 'Pekinese, Pekingese, Peke',
 155: 'Shih-Tzu',
 156: 'Blenheim spaniel',
 157: 'papillon',
 158: 'toy terrier',
 159: 'Rhodesian ridgeback',
 160: 'Afghan hound, Afghan',
 161: 'basset, basset hound',
 162: 'beagle',
 163: 'bloodhound, sleuthhound',
 164: 'bluetick',
 165: 'black-and-tan coonhound',
 166: 'Walker hound, Walker foxhound',
 167: 'English foxhound',
 168: 'redbone',
 169: 'borzoi, Russian wolfhound',
 170: 'Irish wolfhound',
 171: 'Italian greyhound',

172: 'whippet',
173: 'Ibizan hound, Ibizan Podenco',
174: 'Norwegian elkhound, elkhound',
175: 'otterhound, otter hound',
176: 'Saluki, gazelle hound',
177: 'Scottish deerhound, deerhound',
178: 'Weimaraner',
179: 'Staffordshire bullterrier, Staffordshire bull terrier',
180: 'American Staffordshire terrier, Staffordshire terrier, American pit bull, terrier, pit bull terrier',
181: 'Bedlington terrier',
182: 'Border terrier',
183: 'Kerry blue terrier',
184: 'Irish terrier',
185: 'Norfolk terrier',
186: 'Norwich terrier',
187: 'Yorkshire terrier',
188: 'wire-haired fox terrier',
189: 'Lakeland terrier',
190: 'Sealyham terrier, Sealyham',
191: 'Airedale, Airedale terrier',
192: 'cairn, cairn terrier',
193: 'Australian terrier',
194: 'Dandie Dinmont, Dandie Dinmont terrier',
195: 'Boston bull, Boston terrier',
196: 'miniature schnauzer',
197: 'giant schnauzer',
198: 'standard schnauzer',
199: 'Scotch terrier, Scottish terrier, Scottie',
200: 'Tibetan terrier, chrysanthemum dog',
201: 'silky terrier, Sydney silky',
202: 'soft-coated wheaten terrier',
203: 'West Highland white terrier',
204: 'Lhasa, Lhasa apso',
205: 'flat-coated retriever',
206: 'curly-coated retriever',
207: 'golden retriever',
208: 'Labrador retriever',
209: 'Chesapeake Bay retriever',
210: 'German short-haired pointer',
211: 'vizsla, Hungarian pointer',
212: 'English setter',
213: 'Irish setter, red setter',
214: 'Gordon setter',
215: 'Brittany spaniel',
216: 'clumber, clumber spaniel',
217: 'English springer, English springer spaniel',
218: 'Welsh springer spaniel',
219: 'cocker spaniel, English cocker spaniel, cocker',
220: 'Sussex spaniel',
221: 'Irish water spaniel',
222: 'kuvasz',
223: 'schipperke',

224: 'groenendael',
225: 'malinois',
226: 'briard',
227: 'kelpie',
228: 'komondor',
229: 'Old English sheepdog, bobtail',
230: 'Shetland sheepdog, Shetland sheep dog, Shetland',
231: 'collie',
232: 'Border collie',
233: 'Bouvier des Flandres, Bouviers des Flandres',
234: 'Rottweiler',
235: 'German shepherd, German shepherd dog, German police dog, alsatian',
236: 'Doberman, Doberman pinscher',
237: 'miniature pinscher',
238: 'Greater Swiss Mountain dog',
239: 'Bernese mountain dog',
240: 'Appenzeller',
241: 'EntleBucher',
242: 'boxer',
243: 'bull mastiff',
244: 'Tibetan mastiff',
245: 'French bulldog',
246: 'Great Dane',
247: 'Saint Bernard, St Bernard',
248: 'Eskimo dog, husky',
249: 'malamute, malemute, Alaskan malamute',
250: 'Siberian husky',
251: 'dalmatian, coach dog, carriage dog',
252: 'affenpinscher, monkey pinscher, monkey dog',
253: 'basenji',
254: 'pug, pug-dog',
255: 'Leonberg',
256: 'Newfoundland, Newfoundland dog',
257: 'Great Pyrenees',
258: 'Samoyed, Samoyede',
259: 'Pomeranian',
260: 'chow, chow chow',
261: 'keeshond',
262: 'Brabancon griffon',
263: 'Pembroke, Pembroke Welsh corgi',
264: 'Cardigan, Cardigan Welsh corgi',
265: 'toy poodle',
266: 'miniature poodle',
267: 'standard poodle',
268: 'Mexican hairless',
269: 'timber wolf, grey wolf, gray wolf, Canis lupus',
270: 'white wolf, Arctic wolf, Canis lupus tundrarum',
271: 'red wolf, maned wolf, Canis rufus, Canis niger',
272: 'coyote, prairie wolf, brush wolf, Canis latrans',
273: 'dingo, warrigal, warragal, Canis dingo',
274: 'dhole, Cuon alpinus',
275: 'African hunting dog, hyena dog, Cape hunting dog, Lycaon pictus',
276: 'hyena, hyaena',

277: 'red fox, *Vulpes vulpes*',
 278: 'kit fox, *Vulpes macrotis*',
 279: 'Arctic fox, white fox, *Alopex lagopus*',
 280: 'grey fox, gray fox, *Urocyon cinereoargenteus*',
 281: 'tabby, tabby cat',
 282: 'tiger cat',
 283: 'Persian cat',
 284: 'Siamese cat, Siamese',
 285: 'Egyptian cat',
 286: 'cougar, puma, catamount, mountain lion, painter, panther, *Felis concolor*',
 287: 'lynx, catamount',
 288: 'leopard, *Panthera pardus*',
 289: 'snow leopard, ounce, *Panthera uncia*',
 290: 'jaguar, panther, *Panthera onca*, *Felis onca*',
 291: 'lion, king of beasts, *Panthera leo*',
 292: 'tiger, *Panthera tigris*',
 293: 'cheetah, chetah, *Acinonyx jubatus*',
 294: 'brown bear, bruin, *Ursus arctos*',
 295: 'American black bear, black bear, *Ursus americanus*, *Euarctos americanus*',
 296: 'ice bear, polar bear, *Ursus Maritimus*, *Thalarctos maritimus*',
 297: 'sloth bear, *Melursus ursinus*, *Ursus ursinus*',
 298: 'mongoose',
 299: 'meerkat, mierkat',
 300: 'tiger beetle',
 301: 'ladybug, ladybeetle, lady beetle, ladybird, ladybird beetle',
 302: 'ground beetle, carabid beetle',
 303: 'long-horned beetle, longicorn, longicorn beetle',
 304: 'leaf beetle, chrysomelid',
 305: 'dung beetle',
 306: 'rhinoceros beetle',
 307: 'weevil',
 308: 'fly',
 309: 'bee',
 310: 'ant, emmet, pismire',
 311: 'grasshopper, hopper',
 312: 'cricket',
 313: 'walking stick, walkingstick, stick insect',
 314: 'cockroach, roach',
 315: 'mantis, mantid',
 316: 'cicada, cicala',
 317: 'leafhopper',
 318: 'lacewing, lacewing fly',
 319: "dragonfly, darnig needle, devil's darnig needle, sewing needle, snake feeder, ↵
 ↵snake doctor, mosquito hawk, skeeter hawk",
 320: 'damselfly',
 321: 'admiral',
 322: 'ringlet, ringlet butterfly',
 323: 'monarch, monarch butterfly, milkweed butterfly, *Danaus plexippus*',
 324: 'cabbage butterfly',
 325: 'sulphur butterfly, sulfur butterfly',
 326: 'lycaenid, lycaenid butterfly',
 327: 'starfish, sea star',
 328: 'sea urchin',

329: 'sea cucumber, holothurian',
 330: 'wood rabbit, cottontail, cottontail rabbit',
 331: 'hare',
 332: 'Angora, Angora rabbit',
 333: 'hamster',
 334: 'porcupine, hedgehog',
 335: 'fox squirrel, eastern fox squirrel, *Sciurus niger*',
 336: 'marmot',
 337: 'beaver',
 338: 'guinea pig, *Cavia cobaya*',
 339: 'sorrel',
 340: 'zebra',
 341: 'hog, pig, grunter, squealer, *Sus scrofa*',
 342: 'wild boar, boar, *Sus scrofa*',
 343: 'warthog',
 344: 'hippopotamus, hippo, river horse, *Hippopotamus amphibius*',
 345: 'ox',
 346: 'water buffalo, water ox, Asiatic buffalo, *Bubalus bubalis*',
 347: 'bison',
 348: 'ram, tup',
 349: 'bighorn, bighorn sheep, cimarron, Rocky Mountain bighorn, Rocky Mountain sheep, *Ovis canadensis*',
 350: 'ibex, *Capra ibex*',
 351: 'hartebeest',
 352: 'impala, *Aepyceros melampus*',
 353: 'gazelle',
 354: 'Arabian camel, dromedary, *Camelus dromedarius*',
 355: 'llama',
 356: 'weasel',
 357: 'mink',
 358: 'polecat, fitch, foulmart, fougart, *Mustela putorius*',
 359: 'black-footed ferret, ferret, *Mustela nigripes*',
 360: 'otter',
 361: 'skunk, polecat, wood pussy',
 362: 'badger',
 363: 'armadillo',
 364: 'three-toed sloth, ai, *Bradypus tridactylus*',
 365: 'orangutan, orang, orangutang, *Pongo pygmaeus*',
 366: 'gorilla, *Gorilla gorilla*',
 367: 'chimpanzee, chimp, *Pan troglodytes*',
 368: 'gibbon, *Hylobates lar*',
 369: 'siamang, *Hylobates syndactylus*, *Symphalangus syndactylus*',
 370: 'guenon, guenon monkey',
 371: 'patas, hussar monkey, *Erythrocebus patas*',
 372: 'baboon',
 373: 'macaque',
 374: 'langur',
 375: 'colobus, colobus monkey',
 376: 'proboscis monkey, *Nasalis larvatus*',
 377: 'marmoset',
 378: 'capuchin, ringtail, *Cebus capucinus*',
 379: 'howler monkey, howler',
 380: 'titi, titi monkey',

381: 'spider monkey, Ateles geoffroyi',
382: 'squirrel monkey, Saimiri sciureus',
383: 'Madagascar cat, ring-tailed lemur, Lemur catta',
384: 'indri, indris, Indri indri, Indri brevicaudatus',
385: 'Indian elephant, Elephas maximus',
386: 'African elephant, Loxodonta africana',
387: 'lesser panda, red panda, panda, bear cat, cat bear, Ailurus fulgens',
388: 'giant panda, panda, panda bear, coon bear, Ailuropoda melanoleuca',
389: 'barracouta, snoek',
390: 'eel',
391: 'coho, cohoe, coho salmon, blue jack, silver salmon, Oncorhynchus kisutch',
392: 'rock beauty, Holocanthus tricolor',
393: 'anemone fish',
394: 'sturgeon',
395: 'gar, garfish, garpike, billfish, Lepisosteus osseus',
396: 'lionfish',
397: 'puffer, pufferfish, blowfish, globefish',
398: 'abacus',
399: 'abaya',
400: "academic gown, academic robe, judge's robe",
401: 'accordion, piano accordion, squeeze box',
402: 'acoustic guitar',
403: 'aircraft carrier, carrier, flattop, attack aircraft carrier',
404: 'airliner',
405: 'airship, dirigible',
406: 'altar',
407: 'ambulance',
408: 'amphibian, amphibious vehicle',
409: 'analog clock',
410: 'apiary, bee house',
411: 'apron',
412: 'ashcan, trash can, garbage can, wastebin, ash bin, ash-bin, ashbin, dustbin, □
↳trash barrel, trash bin',
413: 'assault rifle, assault gun',
414: 'backpack, back pack, knapsack, packsack, rucksack, haversack',
415: 'bakery, bakeshop, bakehouse',
416: 'balance beam, beam',
417: 'balloon',
418: 'ballpoint, ballpoint pen, ballpen, Biro',
419: 'Band Aid',
420: 'banjo',
421: 'bannister, banister, balustrade, balusters, handrail',
422: 'barbell',
423: 'barber chair',
424: 'barbershop',
425: 'barn',
426: 'barometer',
427: 'barrel, cask',
428: 'barrow, garden cart, lawn cart, wheelbarrow',
429: 'baseball',
430: 'basketball',
431: 'bassinet',
432: 'bassoon',

433: 'bathing cap, swimming cap',
434: 'bath towel',
435: 'bathtub, bathing tub, bath, tub',
436: 'beach wagon, station wagon, wagon, estate car, beach waggon, station waggon, ↵
↪waggon',
437: 'beacon, lighthouse, beacon light, pharos',
438: 'beaker',
439: 'bearskin, busby, shako',
440: 'beer bottle',
441: 'beer glass',
442: 'bell cote, bell cot',
443: 'bib',
444: 'bicycle-built-for-two, tandem bicycle, tandem',
445: 'bikini, two-piece',
446: 'binder, ring-binder',
447: 'binoculars, field glasses, opera glasses',
448: 'birdhouse',
449: 'boathouse',
450: 'bobsled, bobsleigh, bob',
451: 'bolo tie, bolo, bola tie, bola',
452: 'bonnet, poke bonnet',
453: 'bookcase',
454: 'bookshop, bookstore, bookstall',
455: 'bottlecap',
456: 'bow',
457: 'bow tie, bow-tie, bowtie',
458: 'brass, memorial tablet, plaque',
459: 'brassiere, bra, bandeau',
460: 'breakwater, groin, groyne, mole, bulwark, seawall, jetty',
461: 'breastplate, aegis, egis',
462: 'broom',
463: 'bucket, pail',
464: 'buckle',
465: 'bulletproof vest',
466: 'bullet train, bullet',
467: 'butcher shop, meat market',
468: 'cab, hack, taxi, taxicab',
469: 'caldron, cauldron',
470: 'candle, taper, wax light',
471: 'cannon',
472: 'canoe',
473: 'can opener, tin opener',
474: 'cardigan',
475: 'car mirror',
476: 'carousel, carrousel, merry-go-round, roundabout, whirligig',
477: "carpenter's kit, tool kit",
478: 'carton',
479: 'car wheel',
480: 'cash machine, cash dispenser, automated teller machine, automatic teller ↵
↪machine, automated teller, automatic teller, ATM',
481: 'cassette',
482: 'cassette player',
483: 'castle',

484: 'catamaran',
485: 'CD player',
486: 'cello, violoncello',
487: 'cellular telephone, cellular phone, cellphone, cell, mobile phone',
488: 'chain',
489: 'chainlink fence',
490: 'chain mail, ring mail, mail, chain armor, chain armour, ring armor, ring_ armour',
491: 'chain saw, chainsaw',
492: 'chest',
493: 'chiffonier, commode',
494: 'chime, bell, gong',
495: 'china cabinet, china closet',
496: 'Christmas stocking',
497: 'church, church building',
498: 'cinema, movie theater, movie theatre, movie house, picture palace',
499: 'cleaver, meat cleaver, chopper',
500: 'cliff dwelling',
501: 'cloak',
502: 'clog, geta, patten, sabot',
503: 'cocktail shaker',
504: 'coffee mug',
505: 'coffeepot',
506: 'coil, spiral, volute, whorl, helix',
507: 'combination lock',
508: 'computer keyboard, keypad',
509: 'confectionery, confectionary, candy store',
510: 'container ship, containership, container vessel',
511: 'convertible',
512: 'corkscrew, bottle screw',
513: 'cornet, horn, trumpet, trump',
514: 'cowboy boot',
515: 'cowboy hat, ten-gallon hat',
516: 'cradle',
517: 'crane',
518: 'crash helmet',
519: 'crate',
520: 'crib, cot',
521: 'Crock Pot',
522: 'croquet ball',
523: 'crutch',
524: 'cuirass',
525: 'dam, dike, dyke',
526: 'desk',
527: 'desktop computer',
528: 'dial telephone, dial phone',
529: 'diaper, nappy, napkin',
530: 'digital clock',
531: 'digital watch',
532: 'dining table, board',
533: 'dishrag, dishcloth',
534: 'dishwasher, dish washer, dishwashing machine',
535: 'disk brake, disc brake',

536: 'dock, dockage, docking facility',
537: 'dogsled, dog sled, dog sleigh',
538: 'dome',
539: 'doormat, welcome mat',
540: 'drilling platform, offshore rig',
541: 'drum, membranophone, tympan',
542: 'drumstick',
543: 'dumbbell',
544: 'Dutch oven',
545: 'electric fan, blower',
546: 'electric guitar',
547: 'electric locomotive',
548: 'entertainment center',
549: 'envelope',
550: 'espresso maker',
551: 'face powder',
552: 'feather boa, boa',
553: 'file, file cabinet, filing cabinet',
554: 'fireboat',
555: 'fire engine, fire truck',
556: 'fire screen, fireguard',
557: 'flagpole, flagstaff',
558: 'flute, transverse flute',
559: 'folding chair',
560: 'football helmet',
561: 'forklift',
562: 'fountain',
563: 'fountain pen',
564: 'four-poster',
565: 'freight car',
566: 'French horn, horn',
567: 'frying pan, frypan, skillet',
568: 'fur coat',
569: 'garbage truck, dustcart',
570: 'gasmask, respirator, gas helmet',
571: 'gas pump, gasoline pump, petrol pump, island dispenser',
572: 'goblet',
573: 'go-kart',
574: 'golf ball',
575: 'golfcart, golf cart',
576: 'gondola',
577: 'gong, tam-tam',
578: 'gown',
579: 'grand piano, grand',
580: 'greenhouse, nursery, glasshouse',
581: 'grille, radiator grille',
582: 'grocery store, grocery, food market, market',
583: 'guillotine',
584: 'hair slide',
585: 'hair spray',
586: 'half track',
587: 'hammer',
588: 'hamper',

589: 'hand blower, blow dryer, blow drier, hair dryer, hair drier',
590: 'hand-held computer, hand-held microcomputer',
591: 'handkerchief, hankie, hanky, hankey',
592: 'hard disc, hard disk, fixed disk',
593: 'harmonica, mouth organ, harp, mouth harp',
594: 'harp',
595: 'harvester, reaper',
596: 'hatchet',
597: 'holster',
598: 'home theater, home theatre',
599: 'honeycomb',
600: 'hook, claw',
601: 'hoopskirt, crinoline',
602: 'horizontal bar, high bar',
603: 'horse cart, horse-cart',
604: 'hourglass',
605: 'iPod',
606: 'iron, smoothing iron',
607: "jack-o'-lantern",
608: 'jean, blue jean, denim',
609: 'jeep, landrover',
610: 'jersey, T-shirt, tee shirt',
611: 'jigsaw puzzle',
612: 'jinrikisha, ricksha, rickshaw',
613: 'joystick',
614: 'kimono',
615: 'knee pad',
616: 'knot',
617: 'lab coat, laboratory coat',
618: 'ladle',
619: 'lampshade, lamp shade',
620: 'laptop, laptop computer',
621: 'lawn mower, mower',
622: 'lens cap, lens cover',
623: 'letter opener, paper knife, paperknife',
624: 'library',
625: 'lifeboat',
626: 'lighter, light, igniter, ignitor',
627: 'limousine, limo',
628: 'liner, ocean liner',
629: 'lipstick, lip rouge',
630: 'Loafer',
631: 'lotion',
632: 'loudspeaker, speaker, speaker unit, loudspeaker system, speaker system',
633: "loupe, jeweler's loupe",
634: 'lumbermill, sawmill',
635: 'magnetic compass',
636: 'mailbag, postbag',
637: 'mailbox, letter box',
638: 'maillot',
639: 'maillot, tank suit',
640: 'manhole cover',
641: 'maraca',

642: 'marimba, xylophone',
643: 'mask',
644: 'matchstick',
645: 'maypole',
646: 'maze, labyrinth',
647: 'measuring cup',
648: 'medicine chest, medicine cabinet',
649: 'megalith, megalithic structure',
650: 'microphone, mike',
651: 'microwave, microwave oven',
652: 'military uniform',
653: 'milk can',
654: 'minibus',
655: 'miniskirt, mini',
656: 'minivan',
657: 'missile',
658: 'mitten',
659: 'mixing bowl',
660: 'mobile home, manufactured home',
661: 'Model T',
662: 'modem',
663: 'monastery',
664: 'monitor',
665: 'moped',
666: 'mortar',
667: 'mortarboard',
668: 'mosque',
669: 'mosquito net',
670: 'motor scooter, scooter',
671: 'mountain bike, all-terrain bike, off-roader',
672: 'mountain tent',
673: 'mouse, computer mouse',
674: 'mousetrap',
675: 'moving van',
676: 'muzzle',
677: 'nail',
678: 'neck brace',
679: 'necklace',
680: 'nipple',
681: 'notebook, notebook computer',
682: 'obelisk',
683: 'oboe, hautboy, hautbois',
684: 'ocarina, sweet potato',
685: 'odometer, hodometer, mileometer, milometer',
686: 'oil filter',
687: 'organ, pipe organ',
688: 'oscilloscope, scope, cathode-ray oscilloscope, CRO',
689: 'overskirt',
690: 'oxcart',
691: 'oxygen mask',
692: 'packet',
693: 'paddle, boat paddle',
694: 'paddlewheel, paddle wheel',

695: 'padlock',
696: 'paintbrush',
697: "pajama, pyjama, pj's, jammies",
698: 'palace',
699: 'panpipe, pandean pipe, syrinx',
700: 'paper towel',
701: 'parachute, chute',
702: 'parallel bars, bars',
703: 'park bench',
704: 'parking meter',
705: 'passenger car, coach, carriage',
706: 'patio, terrace',
707: 'pay-phone, pay-station',
708: 'pedestal, plinth, footstall',
709: 'pencil box, pencil case',
710: 'pencil sharpener',
711: 'perfume, essence',
712: 'Petri dish',
713: 'photocopier',
714: 'pick, plectrum, plectron',
715: 'pickelhaube',
716: 'picket fence, paling',
717: 'pickup, pickup truck',
718: 'pier',
719: 'piggy bank, penny bank',
720: 'pill bottle',
721: 'pillow',
722: 'ping-pong ball',
723: 'pinwheel',
724: 'pirate, pirate ship',
725: 'pitcher, ewer',
726: "plane, carpenter's plane, woodworking plane",
727: 'planetarium',
728: 'plastic bag',
729: 'plate rack',
730: 'plow, plough',
731: "plunger, plumber's helper",
732: 'Polaroid camera, Polaroid Land camera',
733: 'pole',
734: 'police van, police wagon, paddy wagon, patrol wagon, wagon, black Maria',
735: 'poncho',
736: 'pool table, billiard table, snooker table',
737: 'pop bottle, soda bottle',
738: 'pot, flowerpot',
739: "potter's wheel",
740: 'power drill',
741: 'prayer rug, prayer mat',
742: 'printer',
743: 'prison, prison house',
744: 'projectile, missile',
745: 'projector',
746: 'puck, hockey puck',
747: 'punching bag, punch bag, punching ball, punchball',

748: 'purse',
749: 'quill, quill pen',
750: 'quilt, comforter, comfort, puff',
751: 'racer, race car, racing car',
752: 'racket, racquet',
753: 'radiator',
754: 'radio, wireless',
755: 'radio telescope, radio reflector',
756: 'rain barrel',
757: 'recreational vehicle, RV, R.V.',
758: 'reel',
759: 'reflex camera',
760: 'refrigerator, icebox',
761: 'remote control, remote',
762: 'restaurant, eating house, eating place, eatery',
763: 'revolver, six-gun, six-shooter',
764: 'rifle',
765: 'rocking chair, rocker',
766: 'rotisserie',
767: 'rubber eraser, rubber, pencil eraser',
768: 'rugby ball',
769: 'rule, ruler',
770: 'running shoe',
771: 'safe',
772: 'safety pin',
773: 'saltshaker, salt shaker',
774: 'sandal',
775: 'sarong',
776: 'sax, saxophone',
777: 'scabbard',
778: 'scale, weighing machine',
779: 'school bus',
780: 'schooner',
781: 'scoreboard',
782: 'screen, CRT screen',
783: 'screw',
784: 'screwdriver',
785: 'seat belt, seatbelt',
786: 'sewing machine',
787: 'shield, buckler',
788: 'shoe shop, shoe-shop, shoe store',
789: 'shoji',
790: 'shopping basket',
791: 'shopping cart',
792: 'shovel',
793: 'shower cap',
794: 'shower curtain',
795: 'ski',
796: 'ski mask',
797: 'sleeping bag',
798: 'slide rule, slipstick',
799: 'sliding door',
800: 'slot, one-armed bandit',

801: 'snorkel',
802: 'snowmobile',
803: 'snowplow, snowplough',
804: 'soap dispenser',
805: 'soccer ball',
806: 'sock',
807: 'solar dish, solar collector, solar furnace',
808: 'sombrero',
809: 'soup bowl',
810: 'space bar',
811: 'space heater',
812: 'space shuttle',
813: 'spatula',
814: 'speedboat',
815: "spider web, spider's web",
816: 'spindle',
817: 'sports car, sport car',
818: 'spotlight, spot',
819: 'stage',
820: 'steam locomotive',
821: 'steel arch bridge',
822: 'steel drum',
823: 'stethoscope',
824: 'stole',
825: 'stone wall',
826: 'stopwatch, stop watch',
827: 'stove',
828: 'strainer',
829: 'streetcar, tram, tramcar, trolley, trolley car',
830: 'stretcher',
831: 'studio couch, day bed',
832: 'stupa, tope',
833: 'submarine, pigboat, sub, U-boat',
834: 'suit, suit of clothes',
835: 'sundial',
836: 'sunglass',
837: 'sunglasses, dark glasses, shades',
838: 'sunscreen, sunblock, sun blocker',
839: 'suspension bridge',
840: 'swab, swob, mop',
841: 'sweatshirt',
842: 'swimming trunks, bathing trunks',
843: 'swing',
844: 'switch, electric switch, electrical switch',
845: 'syringe',
846: 'table lamp',
847: 'tank, army tank, armored combat vehicle, armoured combat vehicle',
848: 'tape player',
849: 'teapot',
850: 'teddy, teddy bear',
851: 'television, television system',
852: 'tennis ball',
853: 'thatch, thatched roof',

854: 'theater curtain, theatre curtain',
855: 'thimble',
856: 'thresher, thrasher, threshing machine',
857: 'throne',
858: 'tile roof',
859: 'toaster',
860: 'tobacco shop, tobacconist shop, tobacconist',
861: 'toilet seat',
862: 'torch',
863: 'totem pole',
864: 'tow truck, tow car, wrecker',
865: 'toyshop',
866: 'tractor',
867: 'trailer truck, tractor trailer, trucking rig, rig, articulated lorry, semi',
868: 'tray',
869: 'trench coat',
870: 'tricycle, trike, velocipede',
871: 'trimaran',
872: 'tripod',
873: 'triumphal arch',
874: 'trolleybus, trolley coach, trackless trolley',
875: 'trombone',
876: 'tub, vat',
877: 'turnstile',
878: 'typewriter keyboard',
879: 'umbrella',
880: 'unicycle, monocycle',
881: 'upright, upright piano',
882: 'vacuum, vacuum cleaner',
883: 'vase',
884: 'vault',
885: 'velvet',
886: 'vending machine',
887: 'vestment',
888: 'viaduct',
889: 'violin, fiddle',
890: 'volleyball',
891: 'waffle iron',
892: 'wall clock',
893: 'wallet, billfold, notecase, pocketbook',
894: 'wardrobe, closet, press',
895: 'warplane, military plane',
896: 'washbasin, handbasin, washbowl, lavabo, wash-hand basin',
897: 'washer, automatic washer, washing machine',
898: 'water bottle',
899: 'water jug',
900: 'water tower',
901: 'whiskey jug',
902: 'whistle',
903: 'wig',
904: 'window screen',
905: 'window shade',
906: 'Windsor tie',

907: 'wine bottle',
908: 'wing',
909: 'wok',
910: 'wooden spoon',
911: 'wool, woolen, woollen',
912: 'worm fence, snake fence, snake-rail fence, Virginia fence',
913: 'wreck',
914: 'yawl',
915: 'yurt',
916: 'web site, website, internet site, site',
917: 'comic book',
918: 'crossword puzzle, crossword',
919: 'street sign',
920: 'traffic light, traffic signal, stoplight',
921: 'book jacket, dust cover, dust jacket, dust wrapper',
922: 'menu',
923: 'plate',
924: 'guacamole',
925: 'consomme',
926: 'hot pot, hotpot',
927: 'trifle',
928: 'ice cream, icecream',
929: 'ice lolly, lolly, lollipop, popsicle',
930: 'French loaf',
931: 'bagel, beigel',
932: 'pretzel',
933: 'cheeseburger',
934: 'hotdog, hot dog, red hot',
935: 'mashed potato',
936: 'head cabbage',
937: 'broccoli',
938: 'cauliflower',
939: 'zucchini, courgette',
940: 'spaghetti squash',
941: 'acorn squash',
942: 'butternut squash',
943: 'cucumber, cuke',
944: 'artichoke, globe artichoke',
945: 'bell pepper',
946: 'cardoon',
947: 'mushroom',
948: 'Granny Smith',
949: 'strawberry',
950: 'orange',
951: 'lemon',
952: 'fig',
953: 'pineapple, ananas',
954: 'banana',
955: 'jackfruit, jak, jack',
956: 'custard apple',
957: 'pomegranate',
958: 'hay',
959: 'carbonara',

```

960: 'chocolate sauce, chocolate syrup',
961: 'dough',
962: 'meat loaf, meatloaf',
963: 'pizza, pizza pie',
964: 'potpie',
965: 'burrito',
966: 'red wine',
967: 'espresso',
968: 'cup',
969: 'eggnog',
970: 'alp',
971: 'bubble',
972: 'cliff, drop, drop-off',
973: 'coral reef',
974: 'geyser',
975: 'lakeside, lakeshore',
976: 'promontory, headland, head, foreland',
977: 'sandbar, sand bar',
978: 'seashore, coast, seacoast, sea-coast',
979: 'valley, vale',
980: 'volcano',
981: 'ballplayer, baseball player',
982: 'groom, bridegroom',
983: 'scuba diver',
984: 'rapeseed',
985: 'daisy',
986: "yellow lady's slipper, yellow lady-slipper, Cypripedium calceolus, Cypripedium_
↳parviflorum",
987: 'corn',
988: 'acorn',
989: 'hip, rose hip, rosehip',
990: 'buckeye, horse chestnut, conker',
991: 'coral fungus',
992: 'agaric',
993: 'gyromitra',
994: 'stinkhorn, carrion fungus',
995: 'earthstar',
996: 'hen-of-the-woods, hen of the woods, Polyporus frondosus, Grifola frondosa',
997: 'bolete',
998: 'ear, spike, capitulum',
999: 'toilet tissue, toilet paper, bathroom tissue'}

```

```

[6]: names_list = list(range(max(class_names) + 1))
for k, v in class_names.items():
    names_list[k] = v

```

1.4 Preprocessing, zooming, predicting

```

[7]: import numpy

def preprocess(img):

```

```

img2 = img.resize((224, 224))
X = numpy.asarray(img2).transpose((2, 0, 1))
X = X[numpy.newaxis, :, :, :] / 255.0
return X.astype(numpy.float32)

```

```

image_data = preprocess(image)
image_data.shape, image_data.min(), image_data.max()

```

```
[7]: ((1, 3, 224, 224), 0.0, 0.9843137)
```

```
[8]: from onnxruntime import InferenceSession
sess = InferenceSession("squeezenet1.1.onnx")
```

```
[9]: ([_name for _ in sess.get_inputs()],
      [_name for _ in sess.get_outputs()])
```

```
[9]: (['data'], ['squeezenet0_flatten0_reshape0'])
```

```
[10]: pred = sess.run(None, {'data': image_data})
pred[0].shape, list(zip(pred[0][0, :5], names_list))
```

```
[10]: ((1, 1000),
      [(3.0617495, 'tench, Tinca tinca'),
       (2.026736, 'goldfish, Carassius auratus'),
       (3.3874047,
        'great white shark, white shark, man-eater, man-eating shark, Carcharodon
        carcharias'),
       (4.0234704, 'tiger shark, Galeocerdo cuvieri'),
       (3.2848926, 'hammerhead, hammerhead shark')])
```

```
[11]: named_pred = list(zip(pred[0][0, :], names_list))
named_pred.sort()
named_pred[-5:]
```

```
[11]: [(18.077364, 'monastery'),
      (18.1407, 'mosque'),
      (18.739332, 'church, church building'),
      (18.902193, 'bell cote, bell cot'),
      (19.789839, 'stupa, tope')]
```

1.5 Transfer Learning

The class `OnnxTransformer` wraps a runtime into a class which follows scikit-learn API.

```
[12]: from onnxruntime import InferenceSession
sess = InferenceSession("squeezenet1.1.onnx")
```

```
[13]: list(sess.get_inputs())
```

```
[13]: [<onnxruntime.capi.onnxruntime_pybind11_state.NodeArg at 0x197f9735c00>]
```

```
[14]: image_data.shape
```

```
[14]: (1, 3, 224, 224)
```

```
[15]:
```

```
[16]:
```

```
[17]: from mlproduct.sklapi import OnnxTransformer

with open(model_file, 'rb') as f:
    content = f.read()

tr = OnnxTransformer(content, runtime='onnxruntime1')
tr.fit(None)
onx_pred = tr.transform(image_data)
named_onx_red = list(zip(onx_pred[0, :], names_list))
named_onx_red.sort()
named_onx_red[-5:]
```

```
[17]: [(18.077364, 'monastery'),
      (18.1407, 'mosque'),
      (18.739332, 'church, church building'),
      (18.902193, 'bell cote, bell cot'),
      (19.789839, 'stupa, tope')]
```

Let's normalize the probabilities within a pipeline.

```
[18]: from sklearn.pipeline import Pipeline
      from sklearn.preprocessing import Normalizer

pipe = Pipeline([
    ('squeeze', tr),
    ('scaler', Normalizer(norm='l1'))
])

pipe.fit(image_data);
```

```
[19]: onx_pred = pipe.transform(image_data)
      named_onx_pred = list(zip(onx_pred[0, :], names_list))
      named_onx_pred.sort()
      named_onx_pred[-5:]
```

```
[19]: [(0.003157723, 'monastery'),
      (0.0031687862, 'mosque'),
      (0.0032733544, 'church, church building'),
      (0.0033018026, 'bell cote, bell cot'),
      (0.0034568552, 'stupa, tope')]
```

1.6 Merge ONNX graphs in a pipeline

The output probabilities are now normalized. What if we want to merge the ONNX got from the model zoo and the added normalizer...

```
[20]:
```

```
[21]: from mlproduct.onnx_conv import to_onnx
new_onnx = to_onnx(pipe, image_data)
```

```
[22]: from mlproduct.onnxrt import OnnxInference

try:
    oinf_merged = OnnxInference(new_onnx, runtime="onnxruntime1")
except RuntimeError as e:
    print(e)
```

The previous error is due to the fact the downloaded ONNX file was saved in a different opset. We need to reuse this one for the conversion of the whole pipeline.

```
[23]: tr.opsets
```

```
[23]: {'': 7}
```

We convert again.

```
[24]: new_onnx = to_onnx(pipe, image_data, target_opset=12)
```

```
[25]: oinf_merged = OnnxInference(new_onnx, runtime="onnxruntime1")
res = oinf_merged.run({'X': image_data})
pred_prob = res["variable"]
```

```
[26]: tr.opsets
```

```
[26]: {'': 7}
```

```
[27]: named_onx_pred_prob = list(zip(pred_prob[0, :], names_list))
named_onx_pred_prob.sort()
named_onx_pred_prob[-5:]
```

```
[27]: [(0.0031577228, 'monastery'),
(0.003168786, 'mosque'),
(0.0032733541, 'church, church building'),
(0.0033018023, 'bell cote, bell cot'),
(0.0034568547, 'stupa, tope)']
```

```
[28]: # oinf_merged.to_sequence() # Conv, Relu, Dropout, MaxPool, AveragePool
```

```
[29]: # oinfpy = OnnxInference(new_onnx, runtime="python")
# res = oinfpy.run({'X': image_data})
# pred_prob = res["variable"]
```

```
[30]:
```