Intel®Xeon Phi™ Workshop
Convolutional Neural Network

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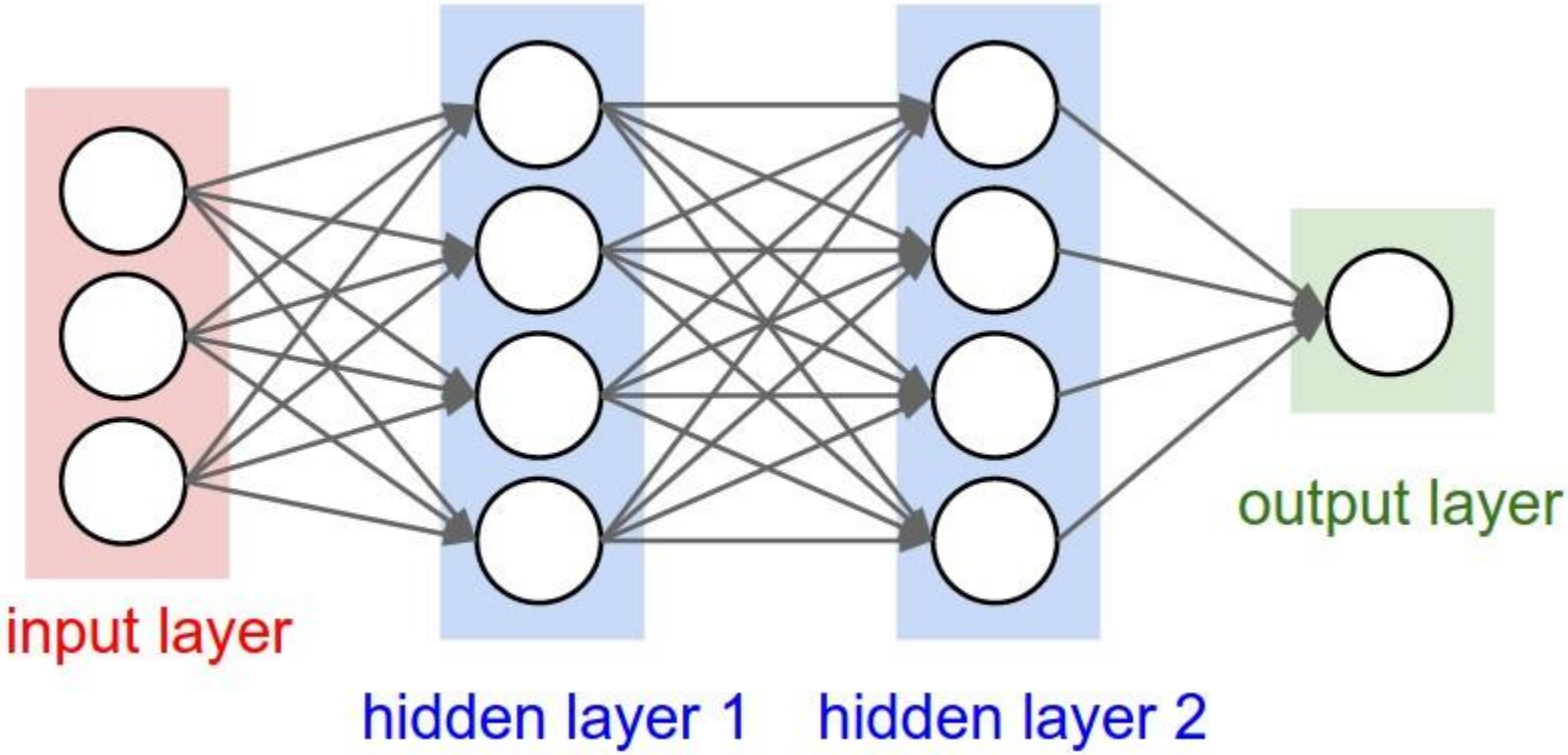
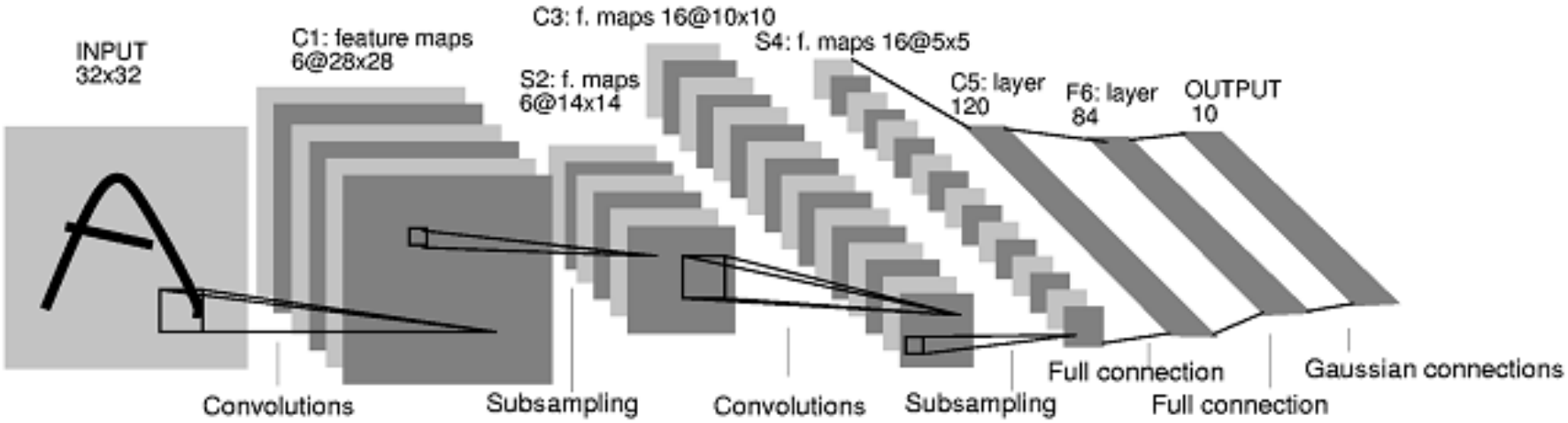
ANN



Convolutional Neural Networks



Convolution

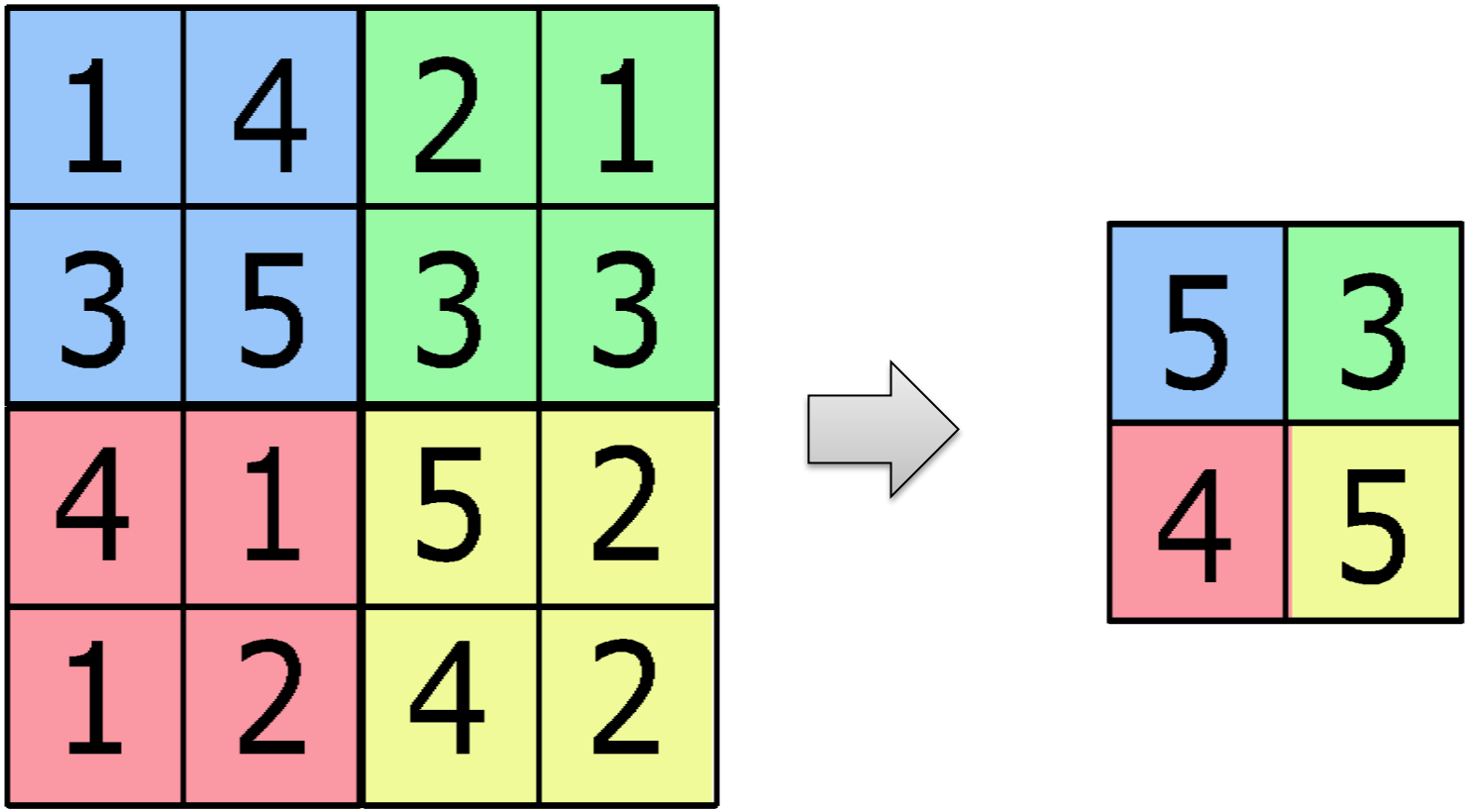
$$o(x, y) = \sum_{k,l} w(k, l) i(x - k, y - l)$$

$$o(x, y, f) = \sum_{k,l,d} w(k, l, d) i(x - k, y - l, d)$$

Convolution

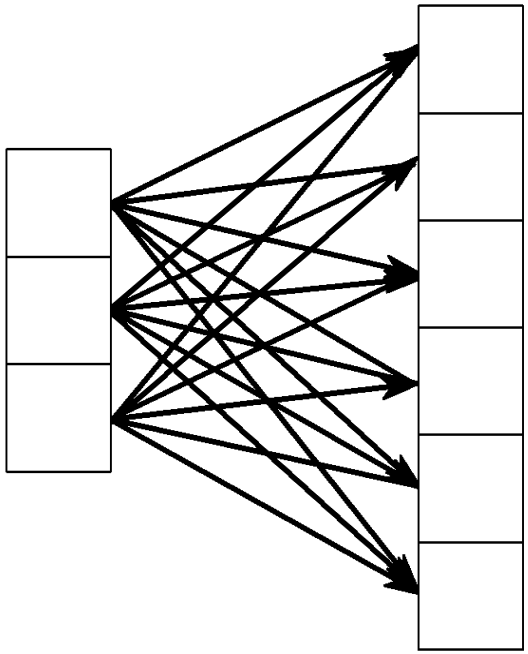
```
for ( od : out_depth )
  for ( id : in_depth )
    for ( y : out_height )
      for ( x : out_width )
        s[od,y,x] = 0
        for ( wy : conv_height )
          for ( wx : conv_width )
            s[od,y,x] += w[od,wy,wx] * in[id, y, x]
```

Subsamling (pooling)



input: 4x4 pool (2,2) out: 2x2

Fully Connected (Inner product)



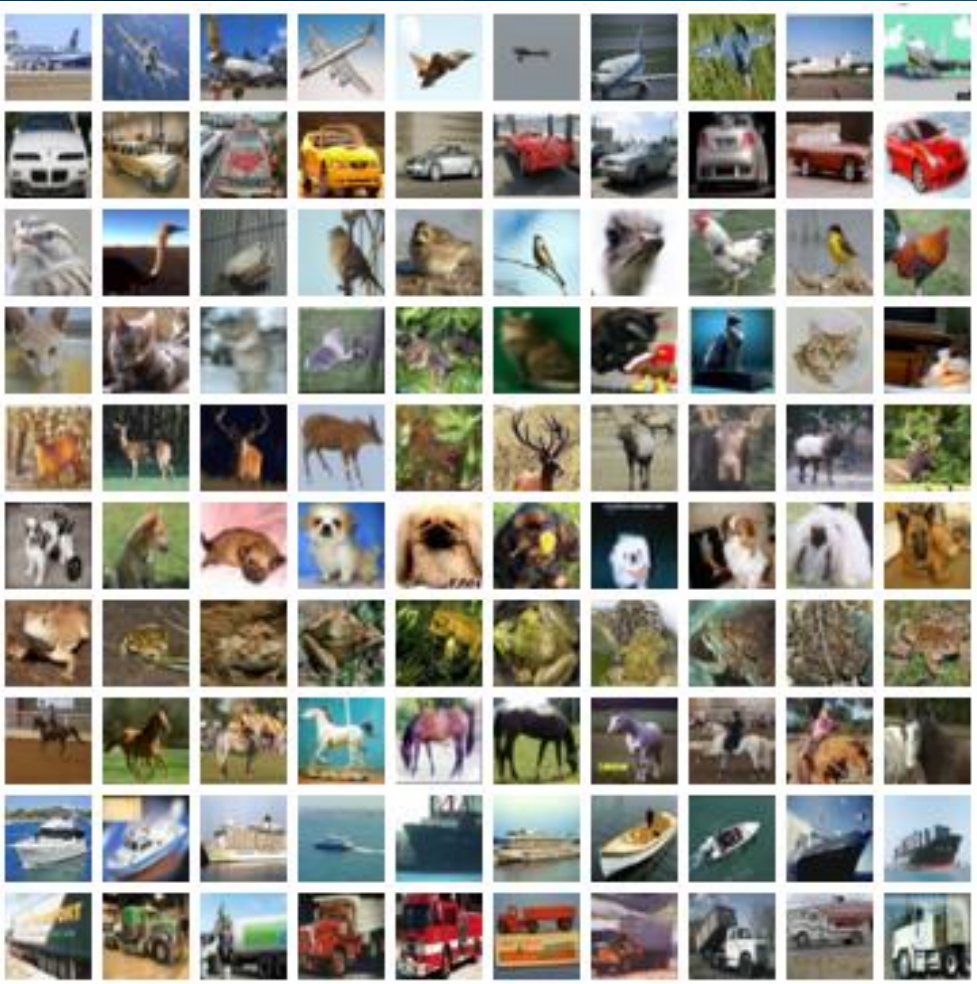
input: 3 fc (6) out: 6

CNN Frameworks

Theano
Torch
Caffe
Pylearn2
Tensorflow
MXNet
Lasagne
Keras
Chainer
DeepLearnToolbox
Cuda-Convnet
RNNLM
… (over 9000)

CIFAR 10 Dataset

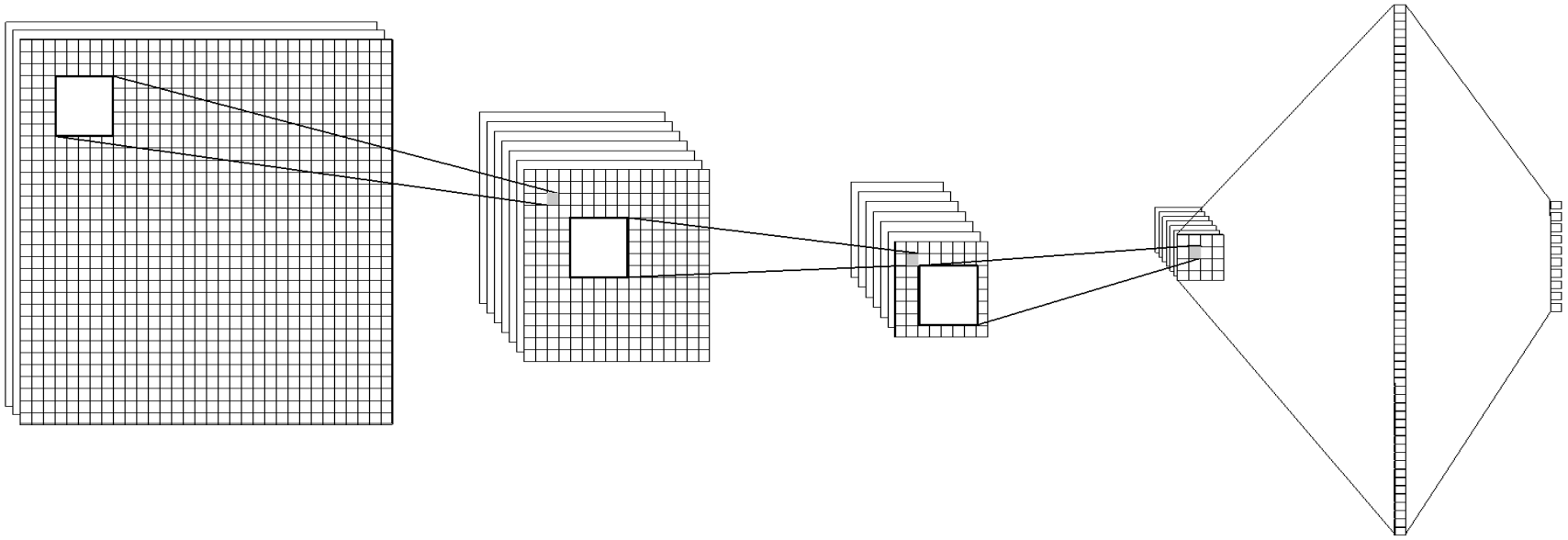
Airplane
Automobile
Bird
Cat
Deer
Dog
Frog
Horse
Ship
Truck



32x32 color images
10 classes
60000 images
50000 training,
10000 testing

*Learning Multiple Layers of Features from Tiny Images, Alex Krizhevsky, 2009

Network architecture



data:	input:	feature 1:	feature 2:	feature 3:	inner:	out:
	32x32x3	16x16x32	8x8x32	4x4x64	64	10

operation:	conv 5x5x32	conv 5x5x32	conv 5x5x64	fc 64	fc 10
	pool 2x2	pool 2x2	pool 2x2		softmax

Tiny-cnn

A header only, dependency-free deep learning framework in C++11

- tbb, openmp
- simple code
- SSE/AVX with C++ templates
- CMake

https://github.com/nyanp/tiny-cnn

Changes to repo code

- xeon_toolchain.cmake and phi_toolchain.cmake
- removed dependency on OpenCV
- fixed errors with C++11
- in config.h change float_t to float

phi-toolchain.cmake

```
SET(CMAKE_SYSTEM_NAME Linux)
SET(CMAKE_SYSTEM_PROCESSOR k1om)
SET(CMAKE_SYSTEM_VERSION 1)

# where is the target environment
SET(CMAKE_FIND_ROOT_PATH /opt/software/intel/lib/mic/)

# search for programs in the build host directories
set(CMAKE_FIND_ROOT_PATH_MODE_PROGRAM NEVER)
# for libraries and headers in the target directories
set(CMAKE_FIND_ROOT_PATH_MODE_LIBRARY ONLY)
set(CMAKE_FIND_ROOT_PATH_MODE_INCLUDE ONLY)

# specify the cross compiler
SET(CMAKE_C_COMPILER icc)
SET(CMAKE_CXX_COMPILER icpc)
SET(CMAKE_C_FLAGS "-mmic " CACHE STRING "" FORCE)
SET(CMAKE_CXX_FLAGS "-mmic " CACHE STRING "" FORCE)
```

cmake, make, run!

```
$ cd tiny-cnn
$ mkdir build-xeon
$ cd build-xeon
$ cmake -DUSE_AVX=ON -DCMAKE_TOOLCHAIN_FILE=../xeon_toolchain.cmake ..
$ make
$ ssh <xeon-node>
$ ./example_cifar_train ../../data/ 0.01    ← Do not try on login!!!
learning rate:0.01
load models...
start learning

0%   10   20   30   40   50   60   70   80   90   100%
|----|----|----|----|----|----|----|----|----|----|
**************************************************33.8093s elapsed.
392/1000
```

cmake, make, run!

```
$ cd tiny-cnn
$ mkdir build-phi
$ cd build-phi
$ cmake -DCMAKE_TOOLCHAIN_FILE=../phi_toolchain.cmake ..
$ make
$ ssh <phi-node>
$ cnn/tiny-cnn/build-phi/example_cifar_train cnn/data/ 0.01
learning rate:0.01
load models...
start learning

0%   10   20   30   40   50   60   70   80   90   100%
|----|----|----|----|----|----|----|----|----|----|
**************************************************244.4s elapsed.
393/1000
```

First run

xeon	phi
14 cores, up to 56 threads + AVX	60 cores, up to 240 threads
33.8s	244.4

Disable automatic vectorization

xeon	phi
14 cores, up to 56 threads + AVX	60 cores, up to 240 threads, -no-vec
--	145.2s

Modify phi-toolchain.cmake:

```
SET(CMAKE_C_FLAGS "-mmic -no-vec" CACHE STRING "" FORCE)
SET(CMAKE_CXX_FLAGS "-mmic -no-vec" CACHE STRING "" FORCE)
```

with KNC (AVX512)

xeon	phi
14 cores, up to 56 threads + AVX	60 cores, up to 240 threads, -no-vec
--	123.1s

Add `-DUSE_AVX=ON` to cmake.
Look into modified product.h for details.

Thanks for attention!

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