Parallel Programming Contest2018

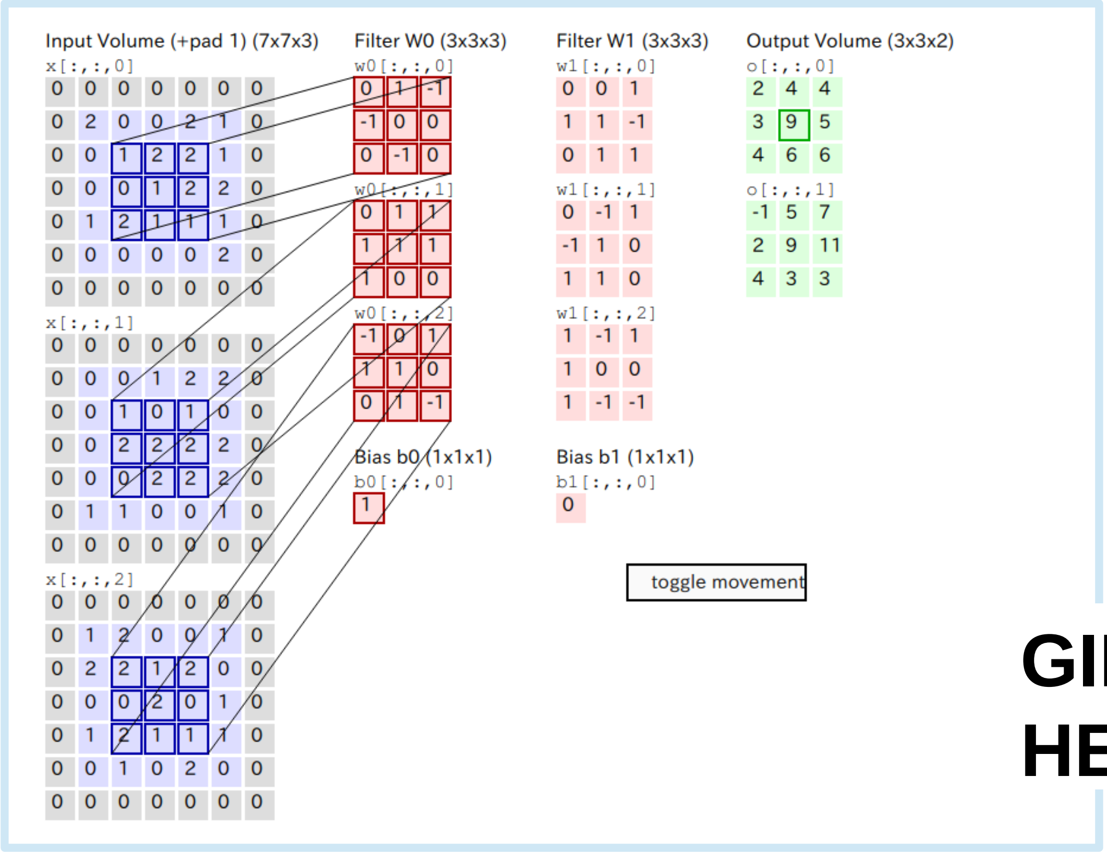
Convolution

It is a core computation in Deep Learning

Get conv.tar and transfer to comparc{01,02}.

Use nova for the final evaluation.

Convolution (in Deep Learning)



Input Volume (+pad 1) (7x7x3)

x[:,:,0]

0	0	0	0	0	0	0
0	2	0	0	2	1	0
0	0	1	2	2	1	0
0	0	0	1	2	2	0
0	1	2	1	1	1	0
0	0	0	0	0	2	0
0	0	0	0	0	0	0

x[:,:,1]

0	0	0	0	0	0	0
0	0	0	1	2	2	0
0	0	1	0	1	0	0
0	0	2	2	2	2	0
0	0	0	2	2	2	0
0	1	1	0	0	1	0
0	0	0	0	0	0	0

x[:,:,2]

0	0	0	0	0	0	0
0	1	2	0	0	1	0
0	2	2	1	2	0	0
0	0	0	2	0	1	0
0	1	2	1	1	1	0
0	0	1	0	2	0	0
0	0	0	0	0	0	0

Filter W0 (3x3x3)

w0[:,:,0]

0	1	-1
-1	0	0
0	-1	0

w0[:,:,1]

0	1	1
1	1	1
1	0	0

w0[:,:,2]

-1	0	1
1	1	0
0	1	-1

Bias b0 (1x1x1)

b0[:,:,0]

1

Filter W1 (3x3x3)

w1[:,:,0]

0	0	1
1	1	-1
0	1	1

w1[:,:,1]

0	-1	1
-1	1	0
1	1	0

w1[:,:,2]

1	-1	1
1	0	0
1	-1	-1

Bias b1 (1x1x1)

b1[:,:,0]

0

Output Volume (3x3x2)

o[:,:,0]

2	4	4
3	9	5
4	6	6

o[:,:,1]

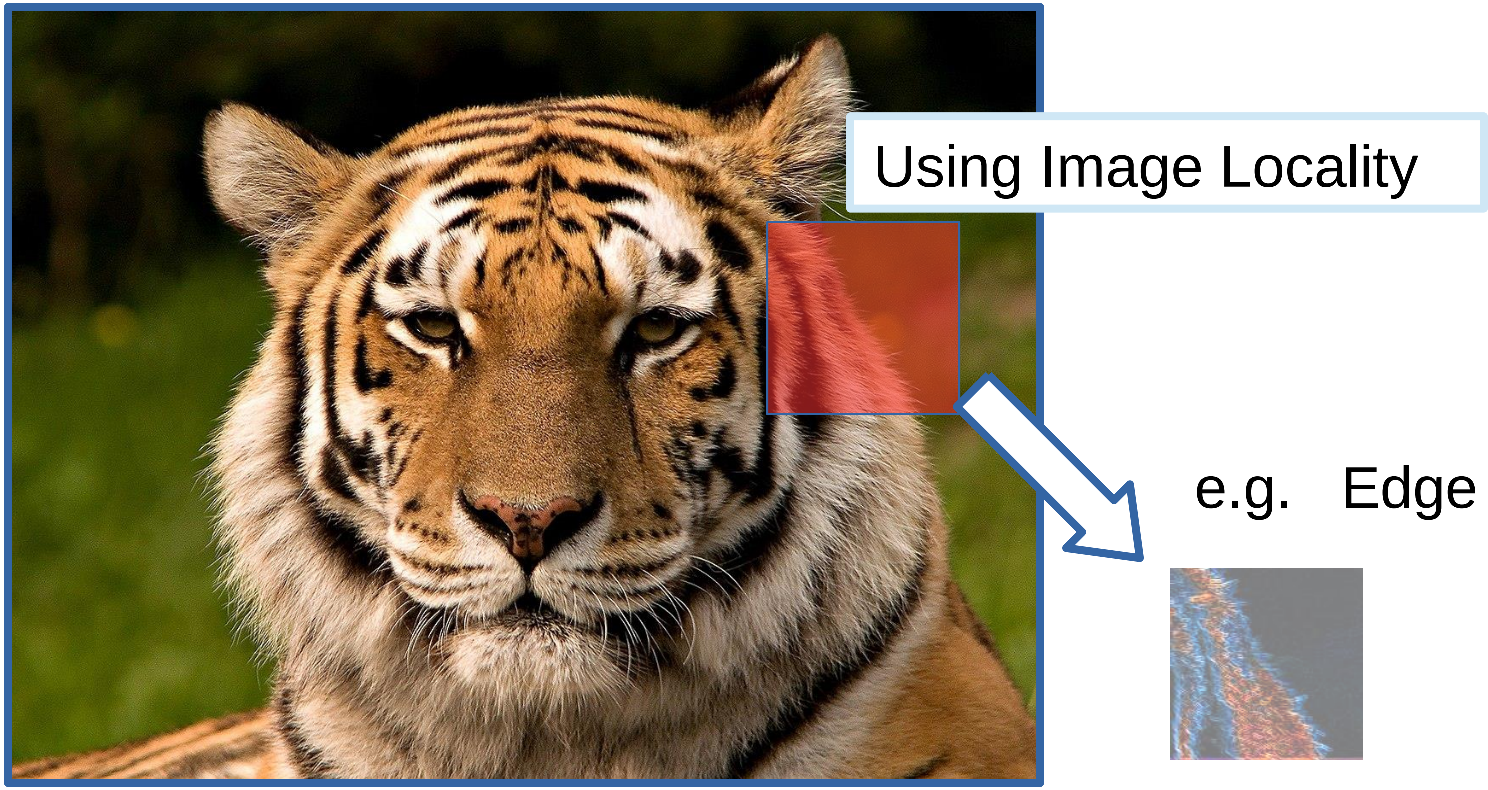
-1	5	7
2	9	11
4	3	3

GIF Animation HERE!

http://cs231n.github.io/convolutional-networks/#MathJax-Element-42-Frame

Purpose of Convolution

(in Image Processing)

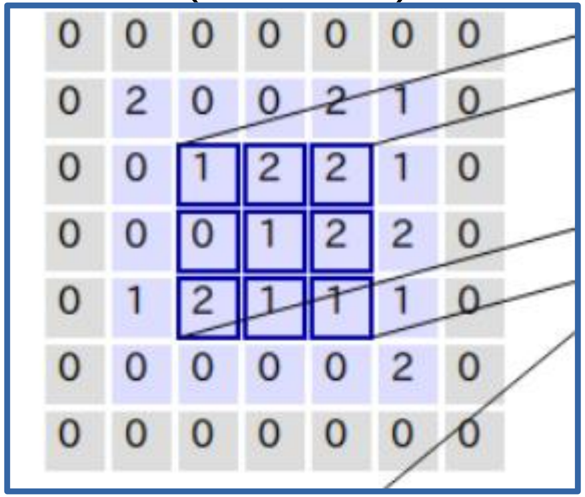


Using Image Locality

e.g. Edge Detection

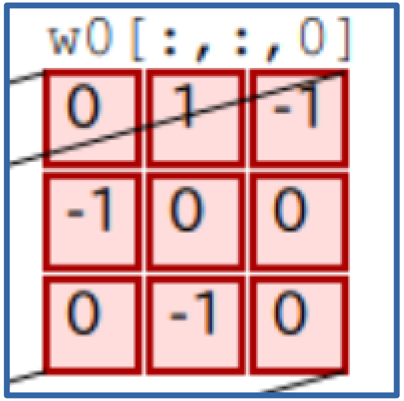
Terminology

Something like a Picture
(one color)



0	0	0	0	0	0	0
0	2	0	0	2	1	0
0	0	1	2	2	1	0
0	0	0	1	2	2	0
0	1	2	1	1	1	0
0	0	0	0	0	2	0
0	0	0	0	0	0	0

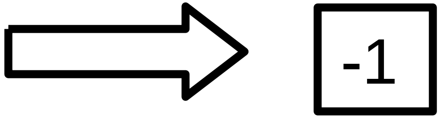
Convolution **Filter**
(or called **Weight**, **Kernel**)



w0[:,:,0]

0	1	-1
-1	0	0
0	-1	0

From these 9 x 2 values,
We got “-1”.



How to Calculate

Picture
(Feature map)

2	0	0	2	1
0	1	2	2	1
0	0	1	2	2
1	2	1	1	1
0	0	0	0	2

Kernel
(Filter)

0	1	-1
-1	0	0
0	-1	0

Result

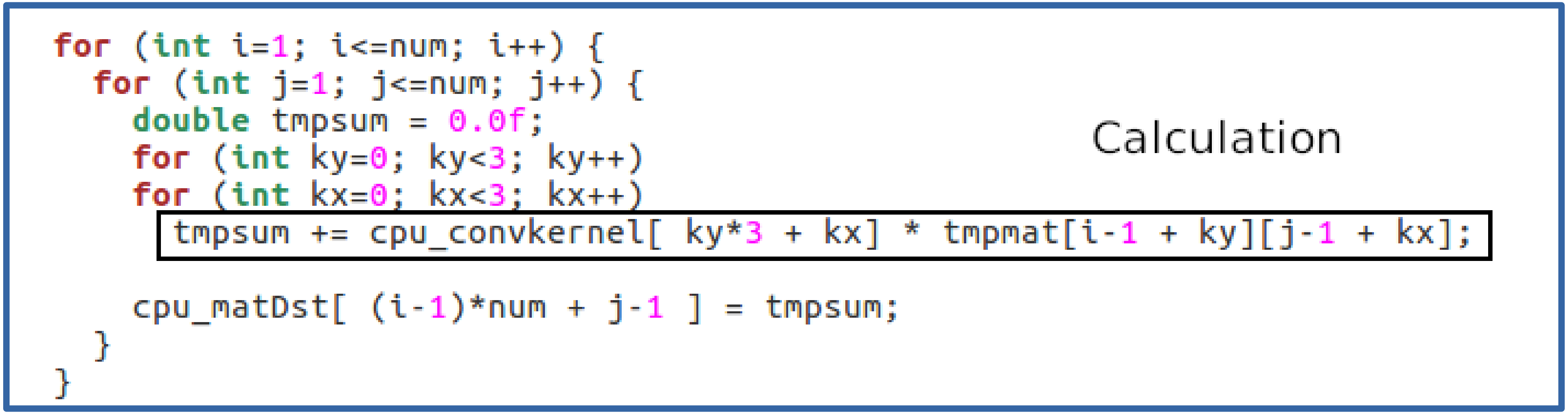
-1

How to calculate

1 × 0
2 × 1
2 × -1
0 × -1
1 × 0
2 × 0
2 × 0
1 × -1
+ 1 × 0

-1

Source Code

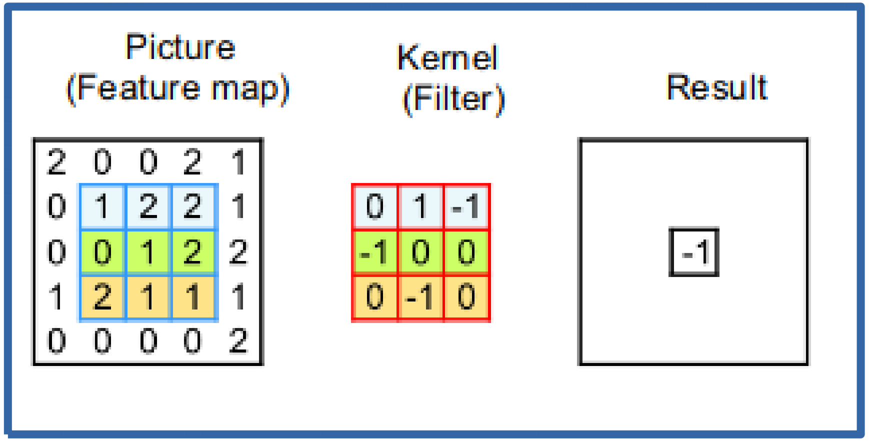


```
for (int i=1; i<=num; i++) {
  for (int j=1; j<=num; j++) {
    double tmpsum = 0.0f;
    for (int ky=0; ky<3; ky++)
    for (int kx=0; kx<3; kx++)
      tmpsum += cpu_convkernel[ ky*3 + kx] * tmpmat[i-1 + ky][j-1 + kx];

    cpu_matDst[ (i-1)*num + j-1 ] = tmpsum;
  }
}
```

Zero Padding

If we slide the kernel inside the feature map, we would get a smaller window result.



Picture
(Feature map)

2	0	0	2	1
0	1	2	2	1
0	0	1	2	2
1	2	1	1	1
0	0	0	0	2

Kernel
(Filter)

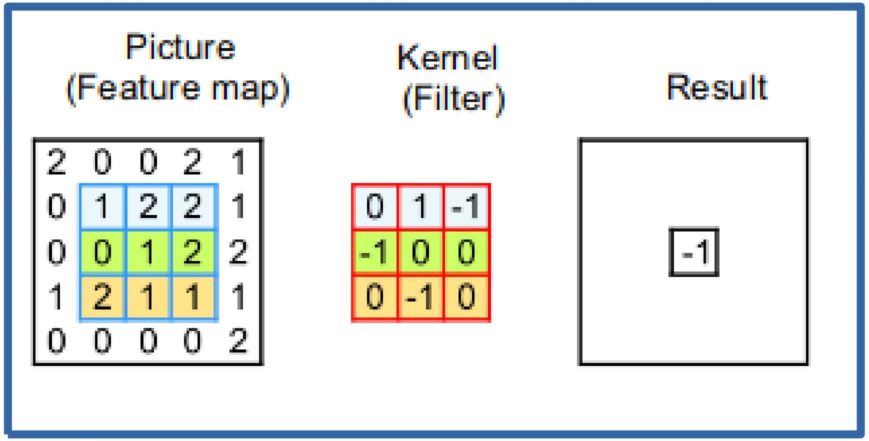
0	1	-1
-1	0	0
0	-1	0

Result

-1

Zero Padding

If we slide the kernel inside the feature map, we would get a smaller window result.



Picture (Feature map)

2	0	0	2	1
0	1	2	2	1
0	0	1	2	2
1	2	1	1	1
0	0	0	0	2

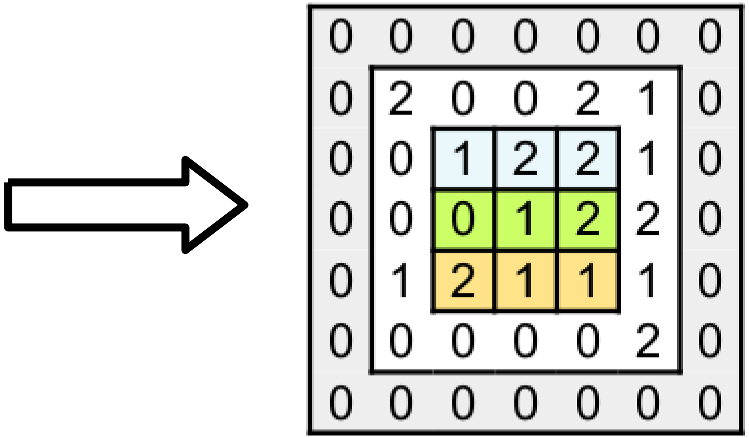
Kernel (Filter)

0	1	-1
-1	0	0
0	-1	0

Result

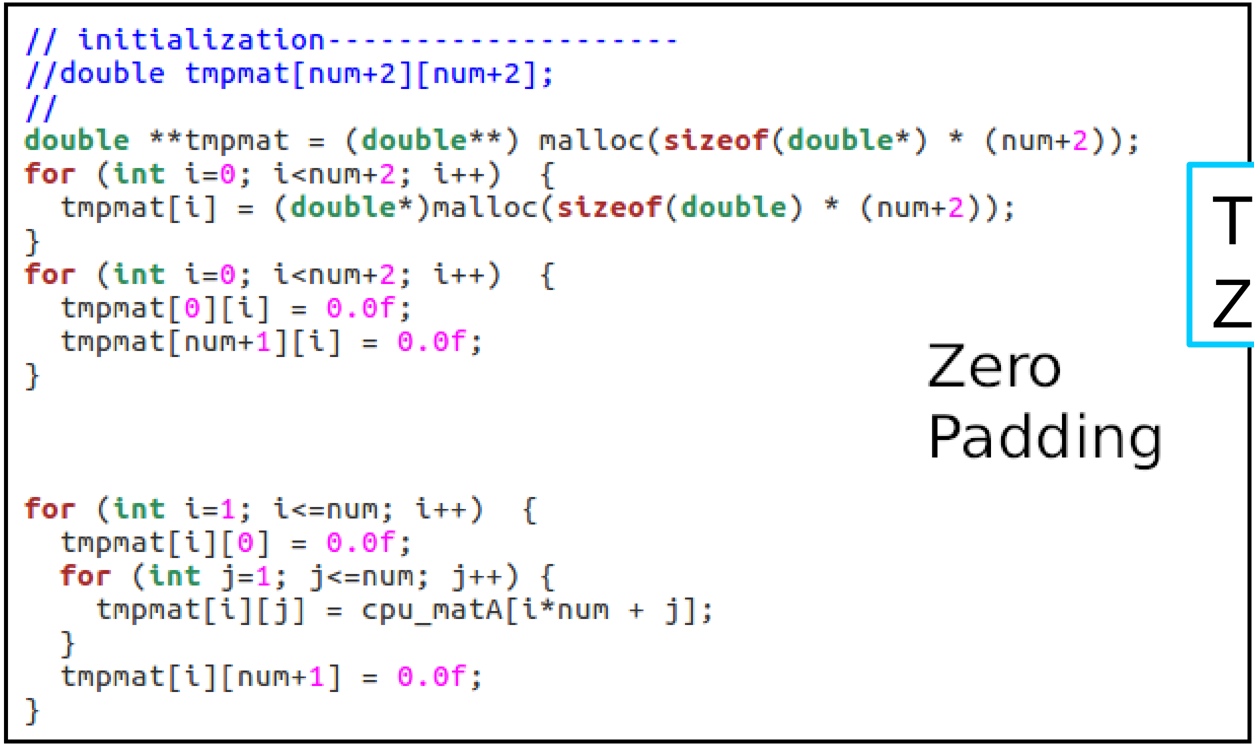
-1

So we zero-pad feature maps.



0	0	0	0	0	0	0
0	2	0	0	2	1	0
0	0	1	2	2	1	0
0	0	0	1	2	2	0
0	1	2	1	1	1	0
0	0	0	0	0	2	0
0	0	0	0	0	0	0

Zero Padding



```
// initialization--------------------
//double tmpmat[num+2][num+2];
//
double **tmpmat = (double**) malloc(sizeof(double*) * (num+2));
for (int i=0; i<num+2; i++)  {
  tmpmat[i] = (double*)malloc(sizeof(double) * (num+2));
}
for (int i=0; i<num+2; i++)  {
  tmpmat[0][i] = 0.0f;
  tmpmat[num+1][i] = 0.0f;
}


for (int i=1; i<=num; i++)  {
  tmpmat[i][0] = 0.0f;
  for (int j=1; j<=num; j++) {
    tmpmat[i][j] = cpu_matA[i*num + j];
  }
  tmpmat[i][num+1] = 0.0f;
}
```

Zero
Padding

The first part of the code Zero-pads feature maps.

Programming contest

- Accelerate this calculation with GPU!
  - We can use lots of cells to calculate each pixel.

- There are a lot of acceleration techniques.
  - See https://media.nips.cc/Conferences/2015/tutorialslides/Dally-NIPS-Tutorial-2015.pdf

Report

- Leave your design in “conv_contest” directory in your home directory.
- Send the mail to hunga4125@gmail.com with a report and your account number.
- The report must include:
- the generated message by the program. The answer must be correct.
- a simple description on techniques you used for acceleration.
- The deadline is 8/2 24:00. Never delayed.
- The ranking will appear on the web site.
- If you have any question, mail to kazami@am.ics.keio.ac.jp.