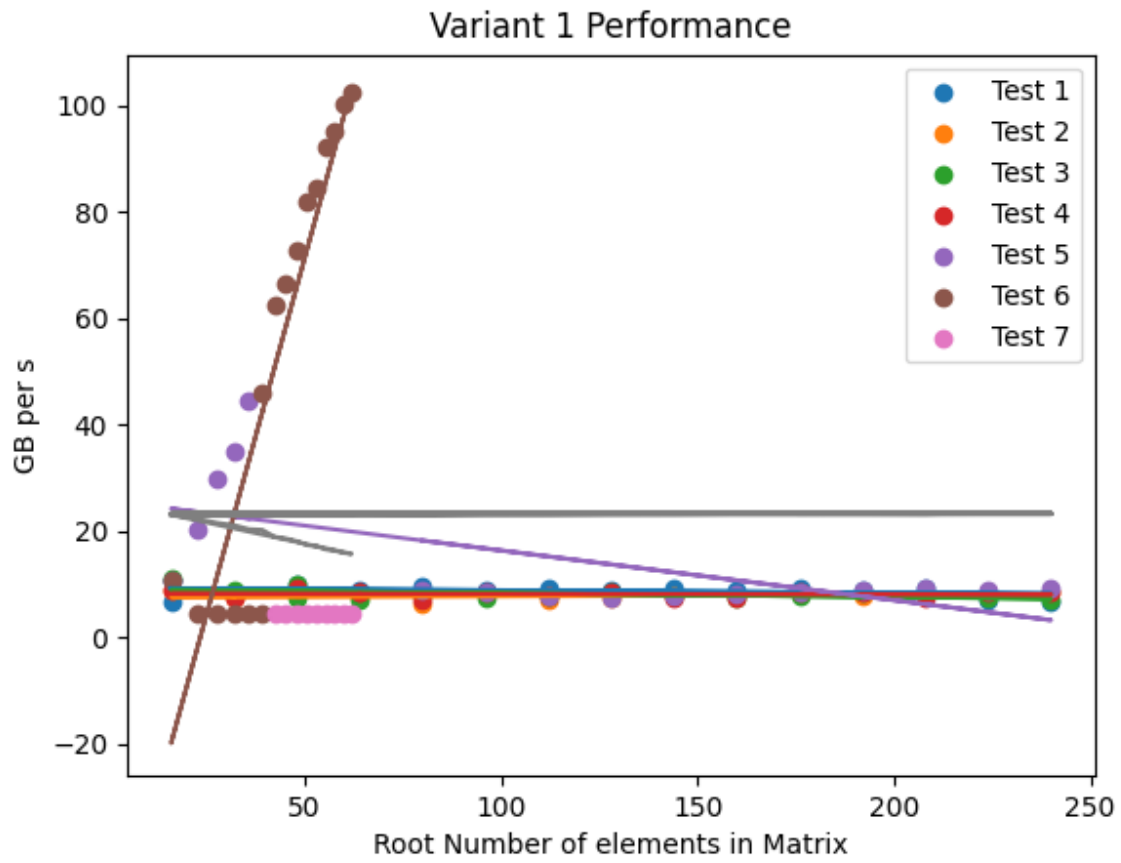
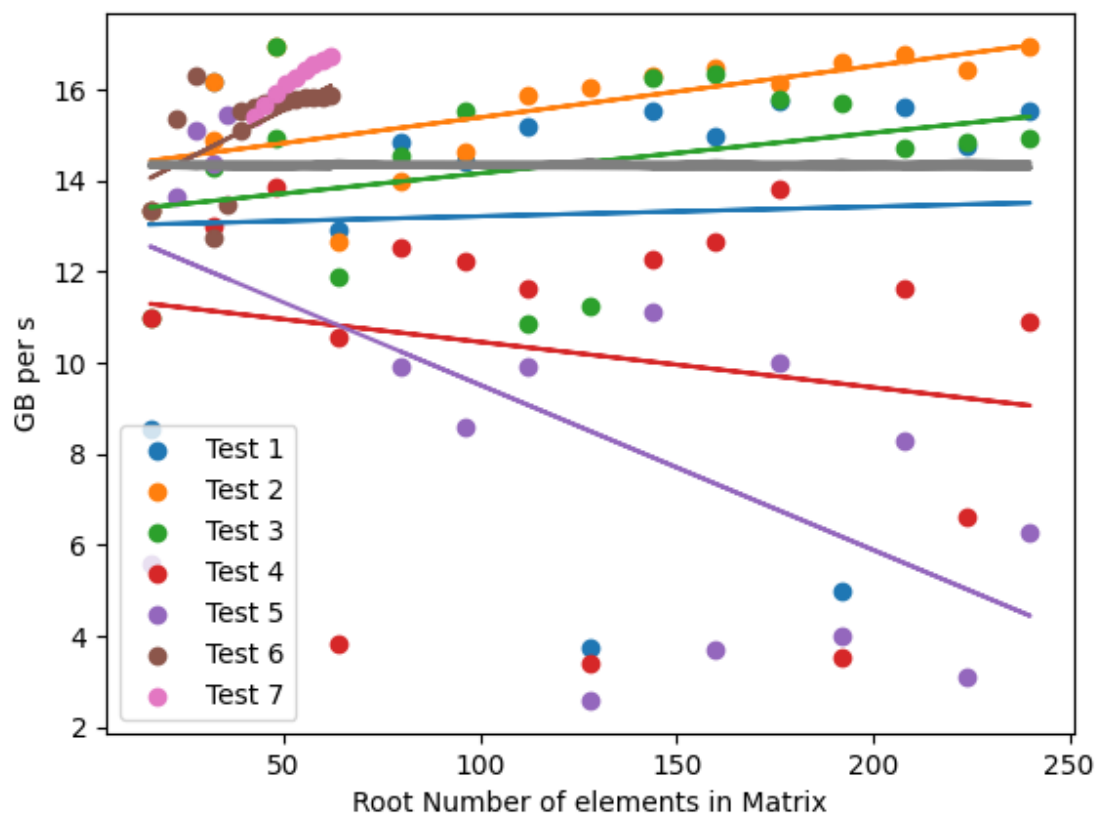
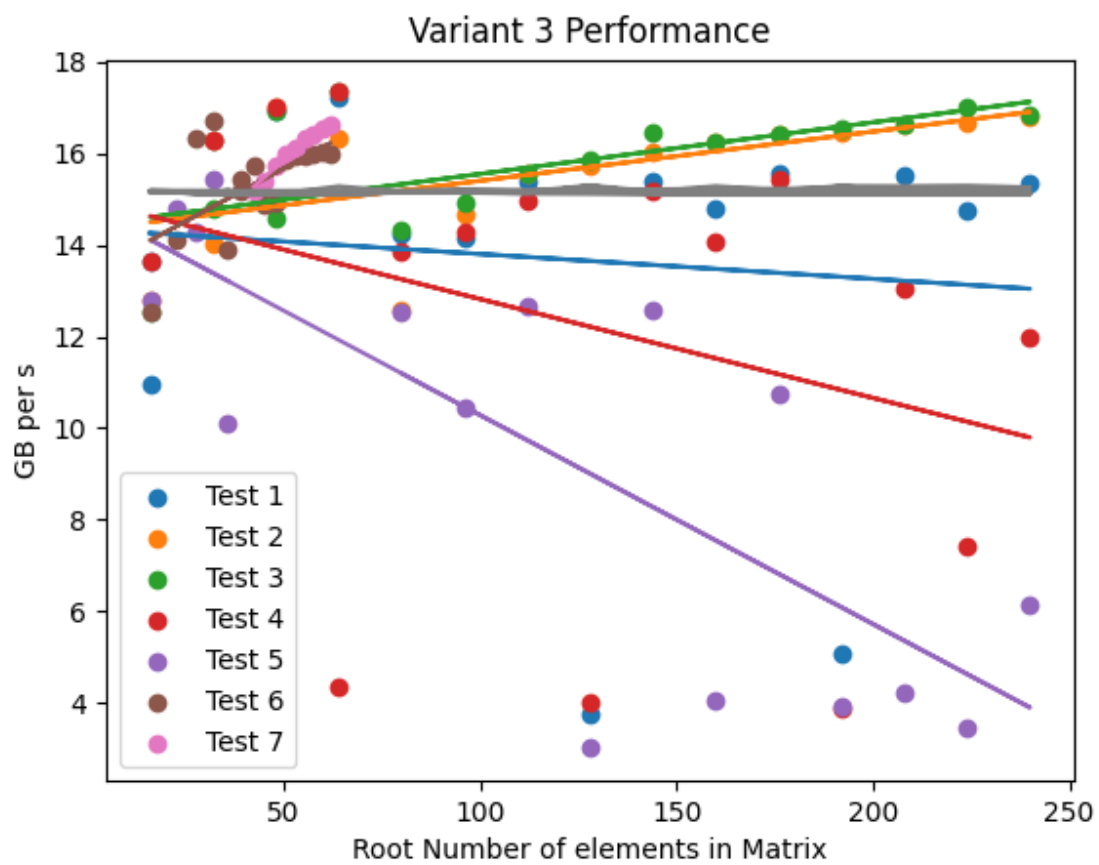


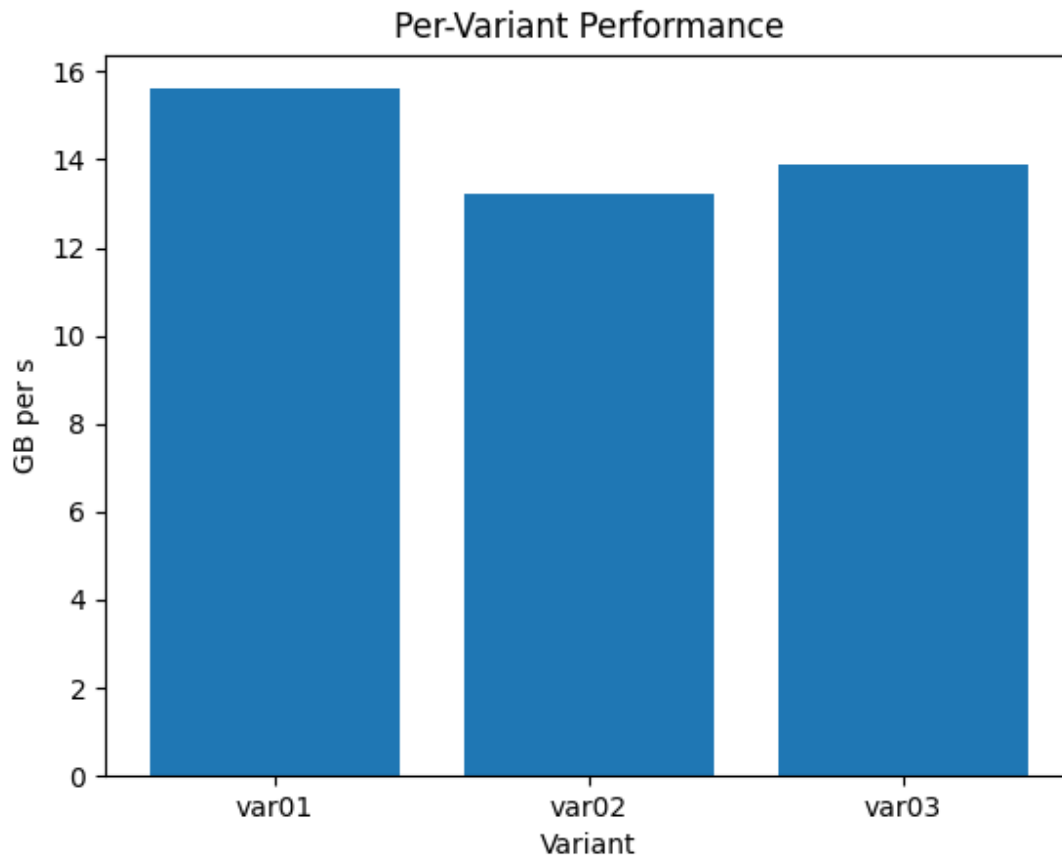
## Results



Variant 2 Performance







#### **Data**

```
awsomeandy911@LAPTOP-IFC4JBFG:~/cs4473-5473-lab/PROB01_TRANSPOSE$ make
```

```
./build_test_op2.sh
```

```
baseline_op_02.c
```

```
optimized_op_02_var_01.c
```

```
optimized_op_02_var_02.c
```

```
optimized_op_02_var_03.c
```

```
-std=c99 -O2 -mavx2 -mfma
```

```
touch result_verification_op2_var01.csv
```

```
./run_test_op2_var01.x 16 256 16 1 1 1 -1 1 -1 | tee -a
```

```
result_verification_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	16,	1,	PASS
32,	32,	32,	1,	32,	1,	PASS
48,	48,	48,	1,	48,	1,	PASS
64,	64,	64,	1,	64,	1,	PASS
80,	80,	80,	1,	80,	1,	PASS

```

96, 96, 96, 1, 96, 1, PASS
112, 112, 112, 1, 112, 1, PASS
128, 128, 128, 1, 128, 1, PASS
144, 144, 144, 1, 144, 1, PASS
160, 160, 160, 1, 160, 1, PASS
176, 176, 176, 1, 176, 1, PASS
192, 192, 192, 1, 192, 1, PASS
208, 208, 208, 1, 208, 1, PASS
224, 224, 224, 1, 224, 1, PASS
240, 240, 240, 1, 240, 1, PASS
./run_test_op2_var01.x 16 256 16 1 1 -1 1 -1 1 | tee -a
result_verification_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,   1,   16,   1,   16,  PASS
32,  32,   1,   32,   1,   32,  PASS
48,  48,   1,   48,   1,   48,  PASS
64,  64,   1,   64,   1,   64,  PASS
80,  80,   1,   80,   1,   80,  PASS
96,  96,   1,   96,   1,   96,  PASS
112, 112,   1,  112,   1,  112,  PASS
128, 128,   1,  128,   1,  128,  PASS
144, 144,   1,  144,   1,  144,  PASS
160, 160,   1,  160,   1,  160,  PASS
176, 176,   1,  176,   1,  176,  PASS
192, 192,   1,  192,   1,  192,  PASS
208, 208,   1,  208,   1,  208,  PASS
224, 224,   1,  224,   1,  224,  PASS
240, 240,   1,  240,   1,  240,  PASS
./run_test_op2_var01.x 16 256 16 1 1 1 -1 -1 1 | tee -a
result_verification_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,  16,   1,   1,   16,  FAIL
32,  32,  32,   1,   1,   32,  FAIL
48,  48,  48,   1,   1,   48,  FAIL
64,  64,  64,   1,   1,   64,  FAIL
80,  80,  80,   1,   1,   80,  FAIL
96,  96,  96,   1,   1,   96,  FAIL
112, 112, 112,   1,   1,  112,  FAIL
128, 128, 128,   1,   1,  128,  FAIL
144, 144, 144,   1,   1,  144,  FAIL

```

```

160, 160, 160, 1, 1, 160, FAIL
176, 176, 176, 1, 1, 176, FAIL
192, 192, 192, 1, 1, 192, FAIL
208, 208, 208, 1, 1, 208, FAIL
224, 224, 224, 1, 1, 224, FAIL
240, 240, 240, 1, 1, 240, FAIL
./run_test_op2_var01.x 16 256 16 1 1 -1 1 1 -1 | tee -a
result_verification_op2_var01.csv
  m,    n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,   1,   16,   16,   1,  FAIL
32,  32,   1,   32,   32,   1,  FAIL
48,  48,   1,   48,   48,   1,  FAIL
64,  64,   1,   64,   64,   1,  FAIL
80,  80,   1,   80,   80,   1,  FAIL
96,  96,   1,   96,   96,   1,  FAIL
112, 112,   1,  112,  112,   1,  FAIL
128, 128,   1,  128,  128,   1,  FAIL
144, 144,   1,  144,  144,   1,  FAIL
160, 160,   1,  160,  160,   1,  FAIL
176, 176,   1,  176,  176,   1,  FAIL
192, 192,   1,  192,  192,   1,  FAIL
208, 208,   1,  208,  208,   1,  FAIL
224, 224,   1,  224,  224,   1,  FAIL
240, 240,   1,  240,  240,   1,  FAIL
./run_test_op2_var01.x 16 256 16 1 1 -2 2 2 -2 | tee -a
result_verification_op2_var01.csv
  m,    n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,   2,   32,   32,   2,  FAIL
32,  32,   2,   64,   64,   2,  FAIL
48,  48,   2,   96,   96,   2,  FAIL
64,  64,   2,  128,  128,   2,  FAIL
80,  80,   2,  160,  160,   2,  FAIL
96,  96,   2,  192,  192,   2,  FAIL
112, 112,   2,  224,  224,   2,  FAIL
128, 128,   2,  256,  256,   2,  FAIL
144, 144,   2,  288,  288,   2,  FAIL
160, 160,   2,  320,  320,   2,  FAIL
176, 176,   2,  352,  352,   2,  FAIL
192, 192,   2,  384,  384,   2,  FAIL
208, 208,   2,  416,  416,   2,  FAIL

```

```

224, 224, 2, 448, 448, 2, FAIL
240, 240, 2, 480, 480, 2, FAIL
./run_test_op2_var01.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
result_verification_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,  16,   1,   1,   16,  FAIL
32,  16,  16,   1,   1,   16,  FAIL
48,  16,  16,   1,   1,   16,  FAIL
64,  16,  16,   1,   1,   16,  FAIL
80,  16,  16,   1,   1,   16,  FAIL
96,  16,  16,   1,   1,   16,  FAIL
112, 16,  16,   1,   1,   16,  FAIL
128, 16,  16,   1,   1,   16,  FAIL
144, 16,  16,   1,   1,   16,  FAIL
160, 16,  16,   1,   1,   16,  FAIL
176, 16,  16,   1,   1,   16,  FAIL
192, 16,  16,   1,   1,   16,  FAIL
208, 16,  16,   1,   1,   16,  FAIL
224, 16,  16,   1,   1,   16,  FAIL
240, 16,  16,   1,   1,   16,  FAIL
./run_test_op2_var01.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
result_verification_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,  16,   1,   1,   16,  FAIL
16,  32,  32,   1,   1,   32,  FAIL
16,  48,  48,   1,   1,   48,  FAIL
16,  64,  64,   1,   1,   64,  FAIL
16,  80,  80,   1,   1,   80,  FAIL
16,  96,  96,   1,   1,   96,  FAIL
16, 112, 112,   1,   1,  112,  FAIL
16, 128, 128,   1,   1,  128,  FAIL
16, 144, 144,   1,   1,  144,  FAIL
16, 160, 160,   1,   1,  160,  FAIL
16, 176, 176,   1,   1,  176,  FAIL
16, 192, 192,   1,   1,  192,  FAIL
16, 208, 208,   1,   1,  208,  FAIL
16, 224, 224,   1,   1,  224,  FAIL
16, 240, 240,   1,   1,  240,  FAIL
grep -i "FAIL" result_verification_op2_var01.csv | wc -l
825

```

```
touch result_verification_op2_var02.csv
```

```
./run_test_op2_var02.x 16 256 16 1 1 1 -1 1 -1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	16,	1,	PASS
32,	32,	32,	1,	32,	1,	PASS
48,	48,	48,	1,	48,	1,	PASS
64,	64,	64,	1,	64,	1,	PASS
80,	80,	80,	1,	80,	1,	PASS
96,	96,	96,	1,	96,	1,	PASS
112,	112,	112,	1,	112,	1,	PASS
128,	128,	128,	1,	128,	1,	PASS
144,	144,	144,	1,	144,	1,	PASS
160,	160,	160,	1,	160,	1,	PASS
176,	176,	176,	1,	176,	1,	PASS
192,	192,	192,	1,	192,	1,	PASS
208,	208,	208,	1,	208,	1,	PASS
224,	224,	224,	1,	224,	1,	PASS
240,	240,	240,	1,	240,	1,	PASS

```
./run_test_op2_var02.x 16 256 16 1 1 -1 1 -1 1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	1,	16,	1,	16,	PASS
32,	32,	1,	32,	1,	32,	PASS
48,	48,	1,	48,	1,	48,	PASS
64,	64,	1,	64,	1,	64,	PASS
80,	80,	1,	80,	1,	80,	PASS
96,	96,	1,	96,	1,	96,	PASS
112,	112,	1,	112,	1,	112,	PASS
128,	128,	1,	128,	1,	128,	PASS
144,	144,	1,	144,	1,	144,	PASS
160,	160,	1,	160,	1,	160,	PASS
176,	176,	1,	176,	1,	176,	PASS
192,	192,	1,	192,	1,	192,	PASS
208,	208,	1,	208,	1,	208,	PASS
224,	224,	1,	224,	1,	224,	PASS
240,	240,	1,	240,	1,	240,	PASS

```
./run_test_op2_var02.x 16 256 16 1 1 1 -1 -1 1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
----	----	---------	---------	---------	---------	--------



```

16, 16, 16, 1, 1, 16, PASS
32, 32, 32, 1, 1, 32, PASS
48, 48, 48, 1, 1, 48, PASS
64, 64, 64, 1, 1, 64, PASS
80, 80, 80, 1, 1, 80, PASS
96, 96, 96, 1, 1, 96, PASS
112, 112, 112, 1, 1, 112, PASS
128, 128, 128, 1, 1, 128, PASS
144, 144, 144, 1, 1, 144, PASS
160, 160, 160, 1, 1, 160, PASS
176, 176, 176, 1, 1, 176, PASS
192, 192, 192, 1, 1, 192, PASS
208, 208, 208, 1, 1, 208, PASS
224, 224, 224, 1, 1, 224, PASS
240, 240, 240, 1, 1, 240, PASS
./run_test_op2_var02.x 16 256 16 1 1 -1 1 1 -1 | tee -a
result_verification_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16, 16,  1,  16,  16,  1, PASS
32, 32,  1,  32,  32,  1, PASS
48, 48,  1,  48,  48,  1, PASS
64, 64,  1,  64,  64,  1, PASS
80, 80,  1,  80,  80,  1, PASS
96, 96,  1,  96,  96,  1, PASS
112, 112,  1, 112, 112,  1, PASS
128, 128,  1, 128, 128,  1, PASS
144, 144,  1, 144, 144,  1, PASS
160, 160,  1, 160, 160,  1, PASS
176, 176,  1, 176, 176,  1, PASS
192, 192,  1, 192, 192,  1, PASS
208, 208,  1, 208, 208,  1, PASS
224, 224,  1, 224, 224,  1, PASS
240, 240,  1, 240, 240,  1, PASS
./run_test_op2_var02.x 16 256 16 1 1 -2 2 2 -2 | tee -a
result_verification_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16, 16,  2,  32,  32,  2, PASS
32, 32,  2,  64,  64,  2, PASS
48, 48,  2,  96,  96,  2, PASS
64, 64,  2, 128, 128,  2, PASS

```

80,	80,	2,	160,	160,	2,	PASS
96,	96,	2,	192,	192,	2,	PASS
112,	112,	2,	224,	224,	2,	PASS
128,	128,	2,	256,	256,	2,	PASS
144,	144,	2,	288,	288,	2,	PASS
160,	160,	2,	320,	320,	2,	PASS
176,	176,	2,	352,	352,	2,	PASS
192,	192,	2,	384,	384,	2,	PASS
208,	208,	2,	416,	416,	2,	PASS
224,	224,	2,	448,	448,	2,	PASS
240,	240,	2,	480,	480,	2,	PASS

```
./run_test_op2_var02.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	PASS
32,	16,	16,	1,	1,	16,	PASS
48,	16,	16,	1,	1,	16,	PASS
64,	16,	16,	1,	1,	16,	PASS
80,	16,	16,	1,	1,	16,	PASS
96,	16,	16,	1,	1,	16,	PASS
112,	16,	16,	1,	1,	16,	PASS
128,	16,	16,	1,	1,	16,	PASS
144,	16,	16,	1,	1,	16,	PASS
160,	16,	16,	1,	1,	16,	PASS
176,	16,	16,	1,	1,	16,	PASS
192,	16,	16,	1,	1,	16,	PASS
208,	16,	16,	1,	1,	16,	PASS
224,	16,	16,	1,	1,	16,	PASS
240,	16,	16,	1,	1,	16,	PASS

```
./run_test_op2_var02.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	PASS
16,	32,	32,	1,	1,	32,	PASS
16,	48,	48,	1,	1,	48,	PASS
16,	64,	64,	1,	1,	64,	PASS
16,	80,	80,	1,	1,	80,	PASS
16,	96,	96,	1,	1,	96,	PASS
16,	112,	112,	1,	1,	112,	PASS
16,	128,	128,	1,	1,	128,	PASS

16,	144,	144,	1,	1,	144,	PASS
16,	160,	160,	1,	1,	160,	PASS
16,	176,	176,	1,	1,	176,	PASS
16,	192,	192,	1,	1,	192,	PASS
16,	208,	208,	1,	1,	208,	PASS
16,	224,	224,	1,	1,	224,	PASS
16,	240,	240,	1,	1,	240,	PASS

```
grep -i "FAIL" result_verification_op2_var02.csv | wc -l
```

```
0
```

```
touch result_verification_op2_var03.csv
```

```
./run_test_op2_var03.x 16 256 16 1 1 1 -1 1 -1 | tee -a
```

```
result_verification_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	16,	1,	PASS
32,	32,	32,	1,	32,	1,	PASS
48,	48,	48,	1,	48,	1,	PASS
64,	64,	64,	1,	64,	1,	PASS
80,	80,	80,	1,	80,	1,	PASS
96,	96,	96,	1,	96,	1,	PASS
112,	112,	112,	1,	112,	1,	PASS
128,	128,	128,	1,	128,	1,	PASS
144,	144,	144,	1,	144,	1,	PASS
160,	160,	160,	1,	160,	1,	PASS
176,	176,	176,	1,	176,	1,	PASS
192,	192,	192,	1,	192,	1,	PASS
208,	208,	208,	1,	208,	1,	PASS
224,	224,	224,	1,	224,	1,	PASS
240,	240,	240,	1,	240,	1,	PASS

```
./run_test_op2_var03.x 16 256 16 1 1 -1 1 -1 1 | tee -a
```

```
result_verification_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	1,	16,	1,	16,	PASS
32,	32,	1,	32,	1,	32,	PASS
48,	48,	1,	48,	1,	48,	PASS
64,	64,	1,	64,	1,	64,	PASS
80,	80,	1,	80,	1,	80,	PASS
96,	96,	1,	96,	1,	96,	PASS
112,	112,	1,	112,	1,	112,	PASS
128,	128,	1,	128,	1,	128,	PASS
144,	144,	1,	144,	1,	144,	PASS

```

160, 160, 1, 160, 1, 160, PASS
176, 176, 1, 176, 1, 176, PASS
192, 192, 1, 192, 1, 192, PASS
208, 208, 1, 208, 1, 208, PASS
224, 224, 1, 224, 1, 224, PASS
240, 240, 1, 240, 1, 240, PASS
./run_test_op2_var03.x 16 256 16 1 1 1 -1 -1 1 | tee -a
result_verification_op2_var03.csv
  m,    n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,  16,   1,   1,  16,  PASS
32,  32,  32,   1,   1,  32,  PASS
48,  48,  48,   1,   1,  48,  PASS
64,  64,  64,   1,   1,  64,  PASS
80,  80,  80,   1,   1,  80,  PASS
96,  96,  96,   1,   1,  96,  PASS
112, 112, 112,   1,   1, 112,  PASS
128, 128, 128,   1,   1, 128,  PASS
144, 144, 144,   1,   1, 144,  PASS
160, 160, 160,   1,   1, 160,  PASS
176, 176, 176,   1,   1, 176,  PASS
192, 192, 192,   1,   1, 192,  PASS
208, 208, 208,   1,   1, 208,  PASS
224, 224, 224,   1,   1, 224,  PASS
240, 240, 240,   1,   1, 240,  PASS
./run_test_op2_var03.x 16 256 16 1 1 -1 1 1 -1 | tee -a
result_verification_op2_var03.csv
  m,    n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,   1,  16,  16,   1,  PASS
32,  32,   1,  32,  32,   1,  PASS
48,  48,   1,  48,  48,   1,  PASS
64,  64,   1,  64,  64,   1,  PASS
80,  80,   1,  80,  80,   1,  PASS
96,  96,   1,  96,  96,   1,  PASS
112, 112,   1, 112, 112,   1,  PASS
128, 128,   1, 128, 128,   1,  PASS
144, 144,   1, 144, 144,   1,  PASS
160, 160,   1, 160, 160,   1,  PASS
176, 176,   1, 176, 176,   1,  PASS
192, 192,   1, 192, 192,   1,  PASS
208, 208,   1, 208, 208,   1,  PASS

```

```

224, 224, 1, 224, 224, 1, PASS
240, 240, 1, 240, 240, 1, PASS
./run_test_op2_var03.x 16 256 16 1 1 -2 2 2 -2 | tee -a
result_verification_op2_var03.csv
  m,    n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,  2,   32,   32,   2,  PASS
32,  32,  2,   64,   64,   2,  PASS
48,  48,  2,   96,   96,   2,  PASS
64,  64,  2,  128,  128,   2,  PASS
80,  80,  2,  160,  160,   2,  PASS
96,  96,  2,  192,  192,   2,  PASS
112, 112,  2,  224,  224,   2,  PASS
128, 128,  2,  256,  256,   2,  PASS
144, 144,  2,  288,  288,   2,  PASS
160, 160,  2,  320,  320,   2,  PASS
176, 176,  2,  352,  352,   2,  PASS
192, 192,  2,  384,  384,   2,  PASS
208, 208,  2,  416,  416,   2,  PASS
224, 224,  2,  448,  448,   2,  PASS
240, 240,  2,  480,  480,   2,  PASS
./run_test_op2_var03.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
result_verification_op2_var03.csv
  m,    n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,  16,   1,   1,   16,  PASS
32,  16,  16,   1,   1,   16,  PASS
48,  16,  16,   1,   1,   16,  PASS
64,  16,  16,   1,   1,   16,  PASS
80,  16,  16,   1,   1,   16,  PASS
96,  16,  16,   1,   1,   16,  PASS
112, 16,  16,   1,   1,   16,  PASS
128, 16,  16,   1,   1,   16,  PASS
144, 16,  16,   1,   1,   16,  PASS
160, 16,  16,   1,   1,   16,  PASS
176, 16,  16,   1,   1,   16,  PASS
192, 16,  16,   1,   1,   16,  PASS
208, 16,  16,   1,   1,   16,  PASS
224, 16,  16,   1,   1,   16,  PASS
240, 16,  16,   1,   1,   16,  PASS
./run_test_op2_var03.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
result_verification_op2_var03.csv

```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	PASS
16,	32,	32,	1,	1,	32,	PASS
16,	48,	48,	1,	1,	48,	PASS
16,	64,	64,	1,	1,	64,	PASS
16,	80,	80,	1,	1,	80,	PASS
16,	96,	96,	1,	1,	96,	PASS
16,	112,	112,	1,	1,	112,	PASS
16,	128,	128,	1,	1,	128,	PASS
16,	144,	144,	1,	1,	144,	PASS
16,	160,	160,	1,	1,	160,	PASS
16,	176,	176,	1,	1,	176,	PASS
16,	192,	192,	1,	1,	192,	PASS
16,	208,	208,	1,	1,	208,	PASS
16,	224,	224,	1,	1,	224,	PASS
16,	240,	240,	1,	1,	240,	PASS

```
grep -i "FAIL" result_verification_op2_var03.csv | wc -l
0
```

```
./build_bench_op2.sh
```

```
baseline_op_02.c
```

```
optimized_op_02_var_01.c
```

```
optimized_op_02_var_02.c
```

```
optimized_op_02_var_03.c
```

```
-std=c99 -O2 -mavx2 -mfma
```

```
touch result_bench_op2_var01.csv
```

```
./run_bench_op2_var01.x 16 256 16 1 1 1 -1 1 -1 | tee -a result_bench_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	16,	1,	19.200001
32,	32,	32,	1,	32,	1,	22.341818
48,	48,	48,	1,	48,	1,	22.030279
64,	64,	64,	1,	64,	1,	21.510721
80,	80,	80,	1,	80,	1,	22.358078
96,	96,	96,	1,	96,	1,	22.296774
112,	112,	112,	1,	112,	1,	21.926876
128,	128,	128,	1,	128,	1,	14.499115
144,	144,	144,	1,	144,	1,	22.138079
160,	160,	160,	1,	160,	1,	22.252808
176,	176,	176,	1,	176,	1,	22.112551
192,	192,	192,	1,	192,	1,	20.881189
208,	208,	208,	1,	208,	1,	22.139360

```

224, 224, 224, 1, 224, 1, 22.222254
240, 240, 240, 1, 240, 1, 21.974249
./run_bench_op2_var01.x 16 256 16 1 1 -1 1 -1 1 | tee -a result_bench_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,   1,   16,   1,   16, 19.200001
32,  32,   1,   32,   1,   32, 22.341818
48,  48,   1,   48,   1,   48, 22.030279
64,  64,   1,   64,   1,   64, 21.416994
80,  80,   1,   80,   1,   80, 22.100719
96,  96,   1,   96,   1,   96, 22.251911
112, 112,   1,  112,   1,  112, 21.910917
128, 128,   1,  128,   1,  128, 14.504463
144, 144,   1,  144,   1,  144, 22.207230
160, 160,   1,  160,   1,  160, 22.244749
176, 176,   1,  176,   1,  176, 22.132301
192, 192,   1,  192,   1,  192, 19.385101
208, 208,   1,  208,   1,  208, 22.134640
224, 224,   1,  224,   1,  224, 22.091799
240, 240,   1,  240,   1,  240, 21.974249
./run_bench_op2_var01.x 16 256 16 1 1 1 -1 -1 1 | tee -a result_bench_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,  16,   1,   1,   16, 19.200001
32,  32,  32,   1,   1,   32, 22.140541
48,  48,  48,   1,   1,   48, 22.030279
64,  64,  64,   1,   1,   64, 20.915745
80,  80,  80,   1,   1,   80, 22.260870
96,  96,  96,   1,   1,   96, 22.639099
112, 112, 112,   1,   1,  112, 22.450111
128, 128, 128,   1,   1,  128, 15.438398
144, 144, 144,   1,   1,  144, 22.610813
160, 160, 160,   1,   1,  160, 22.814705
176, 176, 176,   1,   1,  176, 22.706903
192, 192, 192,   1,   1,  192, 17.344362
208, 208, 208,   1,   1,  208, 22.671091
224, 224, 224,   1,   1,  224, 22.746960
240, 240, 240,   1,   1,  240, 22.710695
./run_bench_op2_var01.x 16 256 16 1 1 -1 1 1 -1 | tee -a result_bench_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,   1,   16,  16,   1, 18.070587
32,  32,   1,   32,  32,   1, 15.170370

```

48,	48,	1,	48,	48,	1,	21.684706
64,	64,	1,	64,	64,	1,	20.480000
80,	80,	1,	80,	80,	1,	22.228655
96,	96,	1,	96,	96,	1,	16.121283
112,	112,	1,	112,	112,	1,	18.910553
128,	128,	1,	128,	128,	1,	15.474853
144,	144,	1,	144,	144,	1,	16.258217
160,	160,	1,	160,	160,	1,	15.917098
176,	176,	1,	176,	176,	1,	16.008268
192,	192,	1,	192,	192,	1,	15.801679
208,	208,	1,	208,	208,	1,	15.227100
224,	224,	1,	224,	224,	1,	15.753846
240,	240,	1,	240,	240,	1,	14.623929

```
./run_bench_op2_var01.x 16 256 16 1 1 -2 2 2 -2 | tee -a result_bench_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	2,	32,	32,	2,	19.819355
32,	32,	2,	64,	64,	2,	22.341818
48,	48,	2,	96,	96,	2,	22.030279
64,	64,	2,	128,	128,	2,	18.103867
80,	80,	2,	160,	160,	2,	22.196531
96,	96,	2,	192,	192,	2,	22.184956
112,	112,	2,	224,	224,	2,	22.023117
128,	128,	2,	256,	256,	2,	14.451158
144,	144,	2,	288,	288,	2,	22.266846
160,	160,	2,	320,	320,	2,	22.220613
176,	176,	2,	352,	352,	2,	22.258204
192,	192,	2,	384,	384,	2,	19.617207
208,	208,	2,	416,	416,	2,	22.267553
224,	224,	2,	448,	448,	2,	22.623032
240,	240,	2,	480,	480,	2,	22.246540

```
./run_bench_op2_var01.x 16 256 16 1 -16 1 -1 -1 1 | tee -a result_bench_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	19.200001
32,	16,	16,	1,	1,	16,	38.400002
48,	16,	16,	1,	1,	16,	52.662857
64,	16,	16,	1,	1,	16,	70.217148
80,	16,	16,	1,	1,	16,	78.769234
96,	16,	16,	1,	1,	16,	94.523079
112,	16,	16,	1,	1,	16,	100.018608



128,	16,	16,	1,	1,	16,	111.709084
144,	16,	16,	1,	1,	16,	115.199997
160,	16,	16,	1,	1,	16,	130.723404
176,	16,	16,	1,	1,	16,	127.516975
192,	16,	16,	1,	1,	16,	139.109436
208,	16,	16,	1,	1,	16,	142.628571
224,	16,	16,	1,	1,	16,	153.599991
240,	16,	16,	1,	1,	16,	156.203384

```
./run_bench_op2_var01.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
```

```
result_bench_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	19.200001
16,	32,	32,	1,	1,	32,	10.971428
16,	48,	48,	1,	1,	48,	11.307976
16,	64,	64,	1,	1,	64,	10.547639
16,	80,	80,	1,	1,	80,	11.420074
16,	96,	96,	1,	1,	96,	11.484112
16,	112,	112,	1,	1,	112,	11.499466
16,	128,	128,	1,	1,	128,	7.752682
16,	144,	144,	1,	1,	144,	10.374484
16,	160,	160,	1,	1,	160,	10.413560
16,	176,	176,	1,	1,	176,	10.318169
16,	192,	192,	1,	1,	192,	9.562646
16,	208,	208,	1,	1,	208,	10.440784
16,	224,	224,	1,	1,	224,	10.363373
16,	240,	240,	1,	1,	240,	10.605293

```
touch result_bench_op2_var02.csv
```

```
./run_bench_op2_var02.x 16 256 16 1 1 1 -1 1 -1 | tee -a result_bench_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	16,	1,	21.186207
32,	32,	32,	1,	32,	1,	23.405714
48,	48,	48,	1,	48,	1,	21.942858
64,	64,	64,	1,	64,	1,	22.090786
80,	80,	80,	1,	80,	1,	23.522203
96,	96,	96,	1,	96,	1,	19.926487
112,	112,	112,	1,	112,	1,	21.321247
128,	128,	128,	1,	128,	1,	8.769313
144,	144,	144,	1,	144,	1,	22.118401
160,	160,	160,	1,	160,	1,	21.982111
176,	176,	176,	1,	176,	1,	22.916893

```

192, 192, 192, 1, 192, 1, 12.114693
208, 208, 208, 1, 208, 1, 22.224657
224, 224, 224, 1, 224, 1, 22.395834
240, 240, 240, 1, 240, 1, 22.293179
./run_bench_op2_var02.x 16 256 16 1 1 -1 1 -1 1 | tee -a result_bench_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,   1,   16,   1,   16, 20.480000
32,  32,   1,   32,   1,   32, 21.748672
48,  48,   1,   48,   1,   48, 23.040001
64,  64,   1,   64,   1,   64, 22.090786
80,  80,   1,   80,   1,   80, 23.063063
96,  96,   1,   96,   1,   96, 16.743679
112, 112,   1,  112,   1,  112, 19.397938
128, 128,   1,  128,   1,  128, 12.775049
144, 144,   1,  144,   1,  144, 16.205275
160, 160,   1,  160,   1,  160, 16.062746
176, 176,   1,  176,   1,  176, 16.042814
192, 192,   1,  192,   1,  192, 15.776319
208, 208,   1,  208,   1,  208, 15.952312
224, 224,   1,  224,   1,  224, 15.905746
240, 240,   1,  240,   1,  240, 15.773619
./run_bench_op2_var02.x 16 256 16 1 1 1 -1 -1 1 | tee -a result_bench_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,  16,   1,   1,   16, 20.480000
32,  32,  32,   1,   1,   32, 23.184904
48,  48,  48,   1,   1,   48, 23.040001
64,  64,  64,   1,   1,   64, 23.517702
80,  80,  80,   1,   1,   80, 23.777090
96,  96,  96,   1,   1,   96, 21.065144
112, 112, 112,   1,   1,  112, 22.185408
128, 128, 128,   1,   1,  128, 22.456654
144, 144, 144,   1,   1,  144, 22.590286
160, 160, 160,   1,   1,  160, 22.959641
176, 176, 176,   1,   1,  176, 22.938107
192, 192, 192,   1,   1,  192, 23.239716
208, 208, 208,   1,   1,  208, 23.700891
224, 224, 224,   1,   1,  224, 23.252056
240, 240, 240,   1,   1,  240, 23.602526
./run_bench_op2_var02.x 16 256 16 1 1 -1 1 1 -1 | tee -a result_bench_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s

```

16,	16,	1,	16,	16,	1,	21.186207
32,	32,	1,	32,	32,	1,	22.755556
48,	48,	1,	48,	48,	1,	23.430508
64,	64,	1,	64,	64,	1,	22.090786
80,	80,	1,	80,	80,	1,	21.157024
96,	96,	1,	96,	96,	1,	16.655422
112,	112,	1,	112,	112,	1,	18.413212
128,	128,	1,	128,	128,	1,	6.262398
144,	144,	1,	144,	144,	1,	15.894730
160,	160,	1,	160,	160,	1,	14.278411
176,	176,	1,	176,	176,	1,	15.601763
192,	192,	1,	192,	192,	1,	6.959849
208,	208,	1,	208,	208,	1,	15.546279
224,	224,	1,	224,	224,	1,	8.126765
240,	240,	1,	240,	240,	1,	15.387356

```
./run_bench_op2_var02.x 16 256 16 1 1 -2 2 2 -2 | tee -a result_bench_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	2,	32,	32,	2,	21.186207
32,	32,	2,	64,	64,	2,	22.341818
48,	48,	2,	96,	96,	2,	22.849586
64,	64,	2,	128,	128,	2,	6.898526
80,	80,	2,	160,	160,	2,	15.073601
96,	96,	2,	192,	192,	2,	12.132968
112,	112,	2,	224,	224,	2,	14.370214
128,	128,	2,	256,	256,	2,	2.292537
144,	144,	2,	288,	288,	2,	13.824000
160,	160,	2,	320,	320,	2,	7.215502
176,	176,	2,	352,	352,	2,	10.533070
192,	192,	2,	384,	384,	2,	5.988466
208,	208,	2,	416,	416,	2,	8.715260
224,	224,	2,	448,	448,	2,	6.902975
240,	240,	2,	480,	480,	2,	7.705686

```
./run_bench_op2_var02.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
```

```
result_bench_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	21.186207
32,	16,	16,	1,	1,	16,	21.942856
48,	16,	16,	1,	1,	16,	22.755556
64,	16,	16,	1,	1,	16,	22.755556
80,	16,	16,	1,	1,	16,	22.755556

```

96, 16, 16, 1, 1, 16, 22.755556
112, 16, 16, 1, 1, 16, 22.876595
128, 16, 16, 1, 1, 16, 22.861395
144, 16, 16, 1, 1, 16, 22.944399
160, 16, 16, 1, 1, 16, 22.925373
176, 16, 16, 1, 1, 16, 21.871845
192, 16, 16, 1, 1, 16, 23.040001
208, 16, 16, 1, 1, 16, 23.084393
224, 16, 16, 1, 1, 16, 22.937599
240, 16, 16, 1, 1, 16, 22.925373
./run_bench_op2_var02.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
result_bench_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16, 16, 16, 1, 1, 16, 15.753846
16, 32, 32, 1, 1, 32, 21.557896
16, 48, 48, 1, 1, 48, 22.207230
16, 64, 64, 1, 1, 64, 22.755556
16, 80, 80, 1, 1, 80, 22.755556
16, 96, 96, 1, 1, 96, 21.186207
16, 112, 112, 1, 1, 112, 21.504000
16, 128, 128, 1, 1, 128, 21.748672
16, 144, 144, 1, 1, 144, 22.118401
16, 160, 160, 1, 1, 160, 22.588234
16, 176, 176, 1, 1, 176, 22.755556
16, 192, 192, 1, 1, 192, 22.896894
16, 208, 208, 1, 1, 208, 21.528841
16, 224, 224, 1, 1, 224, 23.122581
16, 240, 240, 1, 1, 240, 23.331646
touch result_bench_op2_var03.csv
./run_bench_op2_var03.x 16 256 16 1 1 1 -1 1 -1 | tee -a result_bench_op2_var03.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16, 16, 16, 1, 16, 1, 15.360001
32, 32, 32, 1, 32, 1, 16.384001
48, 48, 48, 1, 48, 1, 16.506269
64, 64, 64, 1, 64, 1, 16.493959
80, 80, 80, 1, 80, 1, 16.516129
96, 96, 96, 1, 96, 1, 16.530941
112, 112, 112, 1, 112, 1, 16.642122
128, 128, 128, 1, 128, 1, 16.647587
144, 144, 144, 1, 144, 1, 16.649851

```

```

160, 160, 160, 1, 160, 1, 16.851345
176, 176, 176, 1, 176, 1, 16.842411
192, 192, 192, 1, 192, 1, 16.756363
208, 208, 208, 1, 208, 1, 16.853369
224, 224, 224, 1, 224, 1, 16.854080
240, 240, 240, 1, 240, 1, 16.953642
./run_bench_op2_var03.x 16 256 16 1 1 -1 1 -1 1 | tee -a result_bench_op2_var03.csv
awsomeandy911@LAPTOP-IFC4JBFG:~/cs4473-5473-lab/PROB01_TRANSPOSE$
16, 16, 1, 16, 1, 16, 2.292537
32, 32, 1, 32, 1, 32, 2.204125
48, 48, 1, 48, 1, 48, 2.154949
64, 64, 1, 64, 1, 64, 2.175349
80, 80, 1, 80, 1, 80, 2.111921
96, 96, 1, 96, 1, 96, 2.056760
112, 112, 1, 112, 1, 112, 2.046608
128, 128, 1, 128, 1, 128, 2.066295
144, 144, 1, 144, 1, 144, 2.055189
160, 160, 1, 160, 1, 160, 2.051762
176, 176, 1, 176, 1, 176, 2.027336
192, 192, 1, 192, 1, 192, 2.013326
208, 208, 1, 208, 1, 208, 2.003272
224, 224, 1, 224, 1, 224, 1.980338
240, 240, 1, 240, 1, 240, 1.959239
./run_bench_op2_var03.x 16 256 16 1 1 1 -1 -1 1 | tee -a result_bench_op2_var03.csv
m, n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16, 16, 16, 1, 1, 16, 15.753846
32, 32, 32, 1, 1, 32, 16.605406
48, 48, 48, 1, 1, 48, 16.807295
64, 64, 64, 1, 1, 64, 16.861750
80, 80, 80, 1, 1, 80, 16.805252
96, 96, 96, 1, 1, 96, 16.820076
112, 112, 112, 1, 1, 112, 16.932283
128, 128, 128, 1, 1, 128, 16.941664
144, 144, 144, 1, 1, 144, 16.950409
160, 160, 160, 1, 1, 160, 16.948965
176, 176, 176, 1, 1, 176, 16.953796
192, 192, 192, 1, 1, 192, 16.955462
208, 208, 208, 1, 1, 208, 16.988482
224, 224, 224, 1, 1, 224, 16.906134
240, 240, 240, 1, 1, 240, 16.838003

```

```
./run_bench_op2_var03.x 16 256 16 1 1 -1 1 1 -1 | tee -a result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	1,	16,	16,	1,	15.753846
32,	32,	1,	32,	32,	1,	16.605406
48,	48,	1,	48,	48,	1,	16.705740
64,	64,	1,	64,	64,	1,	16.775427
80,	80,	1,	80,	80,	1,	16.805252
96,	96,	1,	96,	96,	1,	16.923031
112,	112,	1,	112,	112,	1,	16.932283
128,	128,	1,	128,	128,	1,	16.941664
144,	144,	1,	144,	144,	1,	16.950409
160,	160,	1,	160,	160,	1,	16.948965
176,	176,	1,	176,	176,	1,	16.953796
192,	192,	1,	192,	192,	1,	16.855326
208,	208,	1,	208,	208,	1,	16.847898
224,	224,	1,	224,	224,	1,	16.771921
240,	240,	1,	240,	240,	1,	16.854425

```
./run_bench_op2_var03.x 16 256 16 1 1 -2 2 2 -2 | tee -a result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	2,	32,	32,	2,	22.755556
32,	32,	2,	64,	64,	2,	27.927271
48,	48,	2,	96,	96,	2,	28.356922
64,	64,	2,	128,	128,	2,	7.325186
80,	80,	2,	160,	160,	2,	14.898157
96,	96,	2,	192,	192,	2,	8.375010
112,	112,	2,	224,	224,	2,	14.714370
128,	128,	2,	256,	256,	2,	2.385296
144,	144,	2,	288,	288,	2,	13.082650
160,	160,	2,	320,	320,	2,	7.328244
176,	176,	2,	352,	352,	2,	12.632524
192,	192,	2,	384,	384,	2,	6.158541
208,	208,	2,	416,	416,	2,	9.649962
224,	224,	2,	448,	448,	2,	8.095079
240,	240,	2,	480,	480,	2,	7.923425

```
./run_bench_op2_var03.x 16 256 16 1 -16 1 -1 -1 1 | tee -a  
result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	15.753846
32,	16,	16,	1,	1,	16,	16.384001
48,	16,	16,	1,	1,	16,	16.605406

```

64, 16, 16, 1, 1, 16, 16.605406
80, 16, 16, 1, 1, 16, 16.695652
96, 16, 16, 1, 1, 16, 16.832876
112, 16, 16, 1, 1, 16, 16.734631
128, 16, 16, 1, 1, 16, 16.890722
144, 16, 16, 1, 1, 16, 16.807295
160, 16, 16, 1, 1, 16, 16.832878
176, 16, 16, 1, 1, 16, 16.811941
192, 16, 16, 1, 1, 16, 16.832876
208, 16, 16, 1, 1, 16, 16.850634
224, 16, 16, 1, 1, 16, 16.865883
240, 16, 16, 1, 1, 16, 16.879122
./run_bench_op2_var03.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
result_bench_op2_var03.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16, 16, 16, 1, 1, 16, 15.753846
16, 32, 32, 1, 1, 32, 16.384001
16, 48, 48, 1, 1, 48, 16.457142
16, 64, 64, 1, 1, 64, 16.493959
16, 80, 80, 1, 1, 80, 16.605406
16, 96, 96, 1, 1, 96, 16.605406
16, 112, 112, 1, 1, 112, 16.669767
16, 128, 128, 1, 1, 128, 16.661695
16, 144, 144, 1, 1, 144, 16.605406
16, 160, 160, 1, 1, 160, 16.741144
16, 176, 176, 1, 1, 176, 16.728714
16, 192, 192, 1, 1, 192, 16.642889
16, 208, 208, 1, 1, 208, 16.744654
16, 224, 224, 1, 1, 224, 16.865883
16, 240, 240, 1, 1, 240, 16.756363
awsomeandy911@LAPTOP-IFC4JBFG:~/cs4473-5473-lab/PROB01_TRANSPOSE$ make
./build_test_op2.sh
baseline_op_02.c
optimized_op_02_var_01.c
optimized_op_02_var_02.c
optimized_op_02_var_03.c
-std=c99 -O2 -mavx2 -mfma
touch result_verification_op2_var01.csv
./run_test_op2_var01.x 16 256 16 1 1 1 -1 1 -1 | tee -a
result_verification_op2_var01.csv

```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	16,	1,	PASS
32,	32,	32,	1,	32,	1,	PASS
48,	48,	48,	1,	48,	1,	PASS
64,	64,	64,	1,	64,	1,	PASS
80,	80,	80,	1,	80,	1,	PASS
96,	96,	96,	1,	96,	1,	PASS
112,	112,	112,	1,	112,	1,	PASS
128,	128,	128,	1,	128,	1,	PASS
144,	144,	144,	1,	144,	1,	PASS
160,	160,	160,	1,	160,	1,	PASS
176,	176,	176,	1,	176,	1,	PASS
192,	192,	192,	1,	192,	1,	PASS
208,	208,	208,	1,	208,	1,	PASS
224,	224,	224,	1,	224,	1,	PASS
240,	240,	240,	1,	240,	1,	PASS

```
./run_test_op2_var01.x 16 256 16 1 1 -1 1 -1 1 | tee -a
result_verification_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	1,	16,	1,	16,	PASS
32,	32,	1,	32,	1,	32,	PASS
48,	48,	1,	48,	1,	48,	PASS
64,	64,	1,	64,	1,	64,	PASS
80,	80,	1,	80,	1,	80,	PASS
96,	96,	1,	96,	1,	96,	PASS
112,	112,	1,	112,	1,	112,	PASS
128,	128,	1,	128,	1,	128,	PASS
144,	144,	1,	144,	1,	144,	PASS
160,	160,	1,	160,	1,	160,	PASS
176,	176,	1,	176,	1,	176,	PASS
192,	192,	1,	192,	1,	192,	PASS
208,	208,	1,	208,	1,	208,	PASS
224,	224,	1,	224,	1,	224,	PASS
240,	240,	1,	240,	1,	240,	PASS

```
./run_test_op2_var01.x 16 256 16 1 1 1 -1 -1 1 | tee -a
result_verification_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	FAIL
32,	32,	32,	1,	1,	32,	FAIL
48,	48,	48,	1,	1,	48,	FAIL



```

64, 64, 64, 1, 1, 64, FAIL
80, 80, 80, 1, 1, 80, FAIL
96, 96, 96, 1, 1, 96, FAIL
112, 112, 112, 1, 1, 112, FAIL
128, 128, 128, 1, 1, 128, FAIL
144, 144, 144, 1, 1, 144, FAIL
160, 160, 160, 1, 1, 160, FAIL
176, 176, 176, 1, 1, 176, FAIL
192, 192, 192, 1, 1, 192, FAIL
208, 208, 208, 1, 1, 208, FAIL
224, 224, 224, 1, 1, 224, FAIL
240, 240, 240, 1, 1, 240, FAIL
./run_test_op2_var01.x 16 256 16 1 1 -1 1 1 -1 | tee -a
result_verification_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16, 16, 1, 16, 16, 1, FAIL
32, 32, 1, 32, 32, 1, FAIL
48, 48, 1, 48, 48, 1, FAIL
64, 64, 1, 64, 64, 1, FAIL
80, 80, 1, 80, 80, 1, FAIL
96, 96, 1, 96, 96, 1, FAIL
112, 112, 1, 112, 112, 1, FAIL
128, 128, 1, 128, 128, 1, FAIL
awsomeandy911@LAPTOP-IFC4JBFG:~/cs4473-5473-lab/PROB01_TRANSPOSE$
160, 160, 1, 160, 160, 1, FAIL
176, 176, 1, 176, 176, 1, FAIL
192, 192, 1, 192, 192, 1, FAIL
208, 208, 1, 208, 208, 1, FAIL
224, 224, 1, 224, 224, 1, FAIL
240, 240, 1, 240, 240, 1, FAIL
./run_test_op2_var01.x 16 256 16 1 1 -2 2 2 -2 | tee -a
result_verification_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16, 16, 2, 32, 32, 2, FAIL
32, 32, 2, 64, 64, 2, FAIL
48, 48, 2, 96, 96, 2, FAIL
64, 64, 2, 128, 128, 2, FAIL
80, 80, 2, 160, 160, 2, FAIL
96, 96, 2, 192, 192, 2, FAIL
112, 112, 2, 224, 224, 2, FAIL

```

128,	128,	2,	256,	256,	2,	FAIL
144,	144,	2,	288,	288,	2,	FAIL
160,	160,	2,	320,	320,	2,	FAIL
176,	176,	2,	352,	352,	2,	FAIL
192,	192,	2,	384,	384,	2,	FAIL
208,	208,	2,	416,	416,	2,	FAIL
224,	224,	2,	448,	448,	2,	FAIL
240,	240,	2,	480,	480,	2,	FAIL

```
./run_test_op2_var01.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
```

```
result_verification_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	FAIL
32,	16,	16,	1,	1,	16,	FAIL
48,	16,	16,	1,	1,	16,	FAIL
64,	16,	16,	1,	1,	16,	FAIL
80,	16,	16,	1,	1,	16,	FAIL
96,	16,	16,	1,	1,	16,	FAIL
112,	16,	16,	1,	1,	16,	FAIL
128,	16,	16,	1,	1,	16,	FAIL
144,	16,	16,	1,	1,	16,	FAIL
160,	16,	16,	1,	1,	16,	FAIL
176,	16,	16,	1,	1,	16,	FAIL
192,	16,	16,	1,	1,	16,	FAIL
208,	16,	16,	1,	1,	16,	FAIL
224,	16,	16,	1,	1,	16,	FAIL
240,	16,	16,	1,	1,	16,	FAIL

```
./run_test_op2_var01.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
```

```
result_verification_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	FAIL
16,	32,	32,	1,	1,	32,	FAIL
16,	48,	48,	1,	1,	48,	FAIL
16,	64,	64,	1,	1,	64,	FAIL
16,	80,	80,	1,	1,	80,	FAIL
16,	96,	96,	1,	1,	96,	FAIL
16,	112,	112,	1,	1,	112,	FAIL
16,	128,	128,	1,	1,	128,	FAIL
16,	144,	144,	1,	1,	144,	FAIL
16,	160,	160,	1,	1,	160,	FAIL
16,	176,	176,	1,	1,	176,	FAIL

```
16, 192, 192, 1, 1, 192, FAIL
16, 208, 208, 1, 1, 208, FAIL
16, 224, 224, 1, 1, 224, FAIL
16, 240, 240, 1, 1, 240, FAIL
```

```
grep -i "FAIL" result_verification_op2_var01.csv | wc -l
```

```
900
```

```
touch result_verification_op2_var02.csv
```

```
./run_test_op2_var02.x 16 256 16 1 1 1 -1 1 -1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	16,	1,	PASS
32,	32,	32,	1,	32,	1,	PASS
48,	48,	48,	1,	48,	1,	PASS
64,	64,	64,	1,	64,	1,	PASS
80,	80,	80,	1,	80,	1,	PASS
96,	96,	96,	1,	96,	1,	PASS
112,	112,	112,	1,	112,	1,	PASS
128,	128,	128,	1,	128,	1,	PASS
144,	144,	144,	1,	144,	1,	PASS
160,	160,	160,	1,	160,	1,	PASS
176,	176,	176,	1,	176,	1,	PASS
192,	192,	192,	1,	192,	1,	PASS
208,	208,	208,	1,	208,	1,	PASS
224,	224,	224,	1,	224,	1,	PASS
240,	240,	240,	1,	240,	1,	PASS

```
./run_test_op2_var02.x 16 256 16 1 1 -1 1 -1 1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	1,	16,	1,	16,	PASS
32,	32,	1,	32,	1,	32,	PASS
48,	48,	1,	48,	1,	48,	PASS
64,	64,	1,	64,	1,	64,	PASS
80,	80,	1,	80,	1,	80,	PASS
96,	96,	1,	96,	1,	96,	PASS
112,	112,	1,	112,	1,	112,	PASS
128,	128,	1,	128,	1,	128,	PASS
144,	144,	1,	144,	1,	144,	PASS
160,	160,	1,	160,	1,	160,	PASS
176,	176,	1,	176,	1,	176,	PASS
192,	192,	1,	192,	1,	192,	PASS

```

208, 208, 1, 208, 1, 208, PASS
224, 224, 1, 224, 1, 224, PASS
240, 240, 1, 240, 1, 240, PASS
./run_test_op2_var02.x 16 256 16 1 1 1 -1 -1 1 | tee -a
result_verification_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,  16,   1,   1,  16,  PASS
32,  32,  32,   1,   1,  32,  PASS
48,  48,  48,   1,   1,  48,  PASS
64,  64,  64,   1,   1,  64,  PASS
80,  80,  80,   1,   1,  80,  PASS
96,  96,  96,   1,   1,  96,  PASS
112, 112, 112,   1,   1, 112,  PASS
128, 128, 128,   1,   1, 128,  PASS
144, 144, 144,   1,   1, 144,  PASS
160, 160, 160,   1,   1, 160,  PASS
176, 176, 176,   1,   1, 176,  PASS
192, 192, 192,   1,   1, 192,  PASS
208, 208, 208,   1,   1, 208,  PASS
224, 224, 224,   1,   1, 224,  PASS
240, 240, 240,   1,   1, 240,  PASS
./run_test_op2_var02.x 16 256 16 1 1 -1 1 1 -1 | tee -a
result_verification_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,   1,  16,  16,   1,  PASS
32,  32,   1,  32,  32,   1,  PASS
48,  48,   1,  48,  48,   1,  PASS
64,  64,   1,  64,  64,   1,  PASS
80,  80,   1,  80,  80,   1,  PASS
96,  96,   1,  96,  96,   1,  PASS
112, 112,   1, 112, 112,   1,  PASS
128, 128,   1, 128, 128,   1,  PASS
144, 144,   1, 144, 144,   1,  PASS
160, 160,   1, 160, 160,   1,  PASS
176, 176,   1, 176, 176,   1,  PASS
192, 192,   1, 192, 192,   1,  PASS
208, 208,   1, 208, 208,   1,  PASS
224, 224,   1, 224, 224,   1,  PASS
240, 240,   1, 240, 240,   1,  PASS

```

```
./run_test_op2_var02.x 16 256 16 1 1 -2 2 2 -2 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	2,	32,	32,	2,	PASS
32,	32,	2,	64,	64,	2,	PASS
48,	48,	2,	96,	96,	2,	PASS
64,	64,	2,	128,	128,	2,	PASS
80,	80,	2,	160,	160,	2,	PASS
96,	96,	2,	192,	192,	2,	PASS
112,	112,	2,	224,	224,	2,	PASS
128,	128,	2,	256,	256,	2,	PASS
144,	144,	2,	288,	288,	2,	PASS
160,	160,	2,	320,	320,	2,	PASS
176,	176,	2,	352,	352,	2,	PASS
192,	192,	2,	384,	384,	2,	PASS
208,	208,	2,	416,	416,	2,	PASS
224,	224,	2,	448,	448,	2,	PASS
240,	240,	2,	480,	480,	2,	PASS

```
./run_test_op2_var02.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	PASS
32,	16,	16,	1,	1,	16,	PASS
48,	16,	16,	1,	1,	16,	PASS
64,	16,	16,	1,	1,	16,	PASS
80,	16,	16,	1,	1,	16,	PASS
96,	16,	16,	1,	1,	16,	PASS
112,	16,	16,	1,	1,	16,	PASS
128,	16,	16,	1,	1,	16,	PASS
144,	16,	16,	1,	1,	16,	PASS
160,	16,	16,	1,	1,	16,	PASS
176,	16,	16,	1,	1,	16,	PASS
192,	16,	16,	1,	1,	16,	PASS
208,	16,	16,	1,	1,	16,	PASS
224,	16,	16,	1,	1,	16,	PASS
240,	16,	16,	1,	1,	16,	PASS

```
./run_test_op2_var02.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
```

```
result_verification_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	PASS

```

16, 32, 32, 1, 1, 32, PASS
16, 48, 48, 1, 1, 48, PASS
16, 64, 64, 1, 1, 64, PASS
16, 80, 80, 1, 1, 80, PASS
16, 96, 96, 1, 1, 96, PASS
16, 112, 112, 1, 1, 112, PASS
16, 128, 128, 1, 1, 128, PASS
16, 144, 144, 1, 1, 144, PASS
16, 160, 160, 1, 1, 160, PASS
16, 176, 176, 1, 1, 176, PASS
16, 192, 192, 1, 1, 192, PASS
16, 208, 208, 1, 1, 208, PASS
16, 224, 224, 1, 1, 224, PASS
16, 240, 240, 1, 1, 240, PASS

```

```
grep -i "FAIL" result_verification_op2_var02.csv | wc -l
```

```
0
```

```
touch result_verification_op2_var03.csv
```

```
./run_test_op2_var03.x 16 256 16 1 1 1 -1 1 -1 | tee -a
```

```
result_verification_op2_var03.csv
```

```

m,    n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,  16,   1,   16,   1,  PASS
32,  32,  32,   1,   32,   1,  PASS
48,  48,  48,   1,   48,   1,  PASS
64,  64,  64,   1,   64,   1,  PASS
80,  80,  80,   1,   80,   1,  PASS
96,  96,  96,   1,   96,   1,  PASS
112, 112, 112,   1,  112,   1,  PASS
128, 128, 128,   1,  128,   1,  PASS
144, 144, 144,   1,  144,   1,  PASS
160, 160, 160,   1,  160,   1,  PASS
176, 176, 176,   1,  176,   1,  PASS
192, 192, 192,   1,  192,   1,  PASS
208, 208, 208,   1,  208,   1,  PASS
224, 224, 224,   1,  224,   1,  PASS
240, 240, 240,   1,  240,   1,  PASS

```

```
./run_test_op2_var03.x 16 256 16 1 1 -1 1 -1 1 | tee -a
```

```
result_verification_op2_var03.csv
```

```

m,    n, rs_src, cs_src, rs_dst, cs_dst, result
16,  16,   1,   16,   1,   16,  PASS
32,  32,   1,   32,   1,   32,  PASS

```

```

48, 48, 1, 48, 1, 48, PASS
64, 64, 1, 64, 1, 64, PASS
80, 80, 1, 80, 1, 80, PASS
96, 96, 1, 96, 1, 96, PASS
112, 112, 1, 112, 1, 112, PASS
128, 128, 1, 128, 1, 128, PASS
144, 144, 1, 144, 1, 144, PASS
160, 160, 1, 160, 1, 160, PASS
176, 176, 1, 176, 1, 176, PASS
192, 192, 1, 192, 1, 192, PASS
208, 208, 1, 208, 1, 208, PASS
224, 224, 1, 224, 1, 224, PASS
240, 240, 1, 240, 1, 240, PASS
./run_test_op2_var03.x 16 256 16 1 1 1 -1 -1 1 | tee -a
result_verification_op2_var03.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16, 16, 16, 1, 1, 16, PASS
32, 32, 32, 1, 1, 32, PASS
48, 48, 48, 1, 1, 48, PASS
64, 64, 64, 1, 1, 64, PASS
80, 80, 80, 1, 1, 80, PASS
96, 96, 96, 1, 1, 96, PASS
112, 112, 112, 1, 1, 112, PASS
128, 128, 128, 1, 1, 128, PASS
144, 144, 144, 1, 1, 144, PASS
160, 160, 160, 1, 1, 160, PASS
176, 176, 176, 1, 1, 176, PASS
192, 192, 192, 1, 1, 192, PASS
208, 208, 208, 1, 1, 208, PASS
224, 224, 224, 1, 1, 224, PASS
240, 240, 240, 1, 1, 240, PASS
./run_test_op2_var03.x 16 256 16 1 1 -1 1 1 -1 | tee -a
result_verification_op2_var03.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16, 16, 1, 16, 16, 1, PASS
32, 32, 1, 32, 32, 1, PASS
48, 48, 1, 48, 48, 1, PASS
64, 64, 1, 64, 64, 1, PASS
80, 80, 1, 80, 80, 1, PASS
96, 96, 1, 96, 96, 1, PASS

```

112,	112,	1,	112,	112,	1,	PASS
128,	128,	1,	128,	128,	1,	PASS
144,	144,	1,	144,	144,	1,	PASS
160,	160,	1,	160,	160,	1,	PASS
176,	176,	1,	176,	176,	1,	PASS
192,	192,	1,	192,	192,	1,	PASS
208,	208,	1,	208,	208,	1,	PASS
224,	224,	1,	224,	224,	1,	PASS
240,	240,	1,	240,	240,	1,	PASS

```
./run_test_op2_var03.x 16 256 16 1 1 -2 2 2 -2 | tee -a
result_verification_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	2,	32,	32,	2,	PASS
32,	32,	2,	64,	64,	2,	PASS
48,	48,	2,	96,	96,	2,	PASS
64,	64,	2,	128,	128,	2,	PASS
80,	80,	2,	160,	160,	2,	PASS
96,	96,	2,	192,	192,	2,	PASS
112,	112,	2,	224,	224,	2,	PASS
128,	128,	2,	256,	256,	2,	PASS
144,	144,	2,	288,	288,	2,	PASS
160,	160,	2,	320,	320,	2,	PASS
176,	176,	2,	352,	352,	2,	PASS
192,	192,	2,	384,	384,	2,	PASS
208,	208,	2,	416,	416,	2,	PASS
224,	224,	2,	448,	448,	2,	PASS
240,	240,	2,	480,	480,	2,	PASS

```
./run_test_op2_var03.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
result_verification_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	result
16,	16,	16,	1,	1,	16,	PASS
32,	16,	16,	1,	1,	16,	PASS
48,	16,	16,	1,	1,	16,	PASS
64,	16,	16,	1,	1,	16,	PASS
80,	16,	16,	1,	1,	16,	PASS
96,	16,	16,	1,	1,	16,	PASS
112,	16,	16,	1,	1,	16,	PASS
128,	16,	16,	1,	1,	16,	PASS
144,	16,	16,	1,	1,	16,	PASS
160,	16,	16,	1,	1,	16,	PASS



```

176, 16, 16, 1, 1, 16, PASS
192, 16, 16, 1, 1, 16, PASS
208, 16, 16, 1, 1, 16, PASS
224, 16, 16, 1, 1, 16, PASS
240, 16, 16, 1, 1, 16, PASS
./run_test_op2_var03.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
result_verification_op2_var03.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, result
16, 16, 16, 1, 1, 16, PASS
16, 32, 32, 1, 1, 32, PASS
16, 48, 48, 1, 1, 48, PASS
16, 64, 64, 1, 1, 64, PASS
16, 80, 80, 1, 1, 80, PASS
16, 96, 96, 1, 1, 96, PASS
16, 112, 112, 1, 1, 112, PASS
16, 128, 128, 1, 1, 128, PASS
16, 144, 144, 1, 1, 144, PASS
16, 160, 160, 1, 1, 160, PASS
16, 176, 176, 1, 1, 176, PASS
16, 192, 192, 1, 1, 192, PASS
16, 208, 208, 1, 1, 208, PASS
16, 224, 224, 1, 1, 224, PASS
16, 240, 240, 1, 1, 240, PASS
grep -i "FAIL" result_verification_op2_var03.csv | wc -l
0
./build_bench_op2.sh
baseline_op_02.c
optimized_op_02_var_01.c
optimized_op_02_var_02.c
optimized_op_02_var_03.c
-std=c99 -O2 -mavx2 -mfma
touch result_bench_op2_var01.csv
./run_bench_op2_var01.x 16 256 16 1 1 1 -1 1 -1 | tee -a result_bench_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16, 16, 16, 1, 16, 1, 19.200001
32, 32, 32, 1, 32, 1, 22.546789
48, 48, 48, 1, 48, 1, 22.207230
64, 64, 64, 1, 64, 1, 21.510721
80, 80, 80, 1, 80, 1, 22.228655
96, 96, 96, 1, 96, 1, 22.364408

```

112,	112,	112,	1,	112,	1,	22.007017
128,	128,	128,	1,	128,	1,	14.477762
144,	144,	144,	1,	144,	1,	22.138079
160,	160,	160,	1,	160,	1,	22.228655
176,	176,	176,	1,	176,	1,	22.514355
192,	192,	192,	1,	192,	1,	19.617207
208,	208,	208,	1,	208,	1,	22.134640
224,	224,	224,	1,	224,	1,	22.185408
240,	240,	240,	1,	240,	1,	22.037302

```
./run_bench_op2_var01.x 16 256 16 1 1 -1 1 -1 1 | tee -a result_bench_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	1,	16,	1,	16,	18.618181
32,	32,	1,	32,	1,	32,	22.341818
48,	48,	1,	48,	1,	48,	22.207230
64,	64,	1,	64,	1,	64,	21.416994
80,	80,	1,	80,	1,	80,	22.325583
96,	96,	1,	96,	1,	96,	22.409727
112,	112,	1,	112,	1,	112,	22.055384
128,	128,	1,	128,	1,	128,	14.579755
144,	144,	1,	144,	1,	144,	22.256887
160,	160,	1,	160,	1,	160,	22.358078
176,	176,	1,	176,	1,	176,	22.264870
192,	192,	1,	192,	1,	192,	19.552177
208,	208,	1,	208,	1,	208,	22.125208
224,	224,	1,	224,	1,	224,	22.095854
240,	240,	1,	240,	1,	240,	21.953312

```
./run_bench_op2_var01.x 16 256 16 1 1 1 -1 -1 1 | tee -a result_bench_op2_var01.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	19.200001
32,	32,	32,	1,	1,	32,	18.904615
48,	48,	48,	1,	1,	48,	21.942858
64,	64,	64,	1,	1,	64,	20.960340
80,	80,	80,	1,	1,	80,	22.260870
96,	96,	96,	1,	1,	96,	22.755556
112,	112,	112,	1,	1,	112,	22.567917
128,	128,	128,	1,	1,	128,	15.474853
144,	144,	144,	1,	1,	144,	22.672621
160,	160,	160,	1,	1,	160,	22.797775
176,	176,	176,	1,	1,	176,	22.860518
192,	192,	192,	1,	1,	192,	20.783087

```

208, 208, 208, 1, 1, 208, 22.484539
224, 224, 224, 1, 1, 224, 22.597559
240, 240, 240, 1, 1, 240, 22.343622
./run_bench_op2_var01.x 16 256 16 1 1 -1 1 1 -1 | tee -a result_bench_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,   1,   16,   16,   1, 17.554287
32,  32,   1,   32,   32,   1, 14.804820
48,  48,   1,   48,   48,   1, 20.945454
64,  64,   1,   64,   64,   1, 20.310743
80,  80,   1,   80,   80,   1, 21.911554
96,  96,   1,   96,   96,   1, 15.923974
112, 112,   1,  112,  112,   1, 18.641237
128, 128,   1,  128,  128,   1, 15.223228
144, 144,   1,  144,  144,   1, 16.064041
160, 160,   1,  160,  160,   1, 15.709537
176, 176,   1,  176,  176,   1, 16.080986
192, 192,   1,  192,  192,   1, 15.706303
208, 208,   1,  208,  208,   1, 15.200352
224, 224,   1,  224,  224,   1, 15.745606
240, 240,   1,  240,  240,   1, 14.550047
./run_bench_op2_var01.x 16 256 16 1 1 -2 2 2 -2 | tee -a result_bench_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,   2,   32,   32,   2, 19.200001
32,  32,   2,   64,   64,   2, 22.140541
48,  48,   2,   96,   96,   2, 21.942858
64,  64,   2,  128,  128,   2, 19.051163
80,  80,   2,  160,  160,   2, 22.293179
96,  96,   2,  192,  192,   2, 22.296774
112, 112,   2,  224,  224,   2, 22.316977
128, 128,   2,  256,  256,   2, 14.612263
144, 144,   2,  288,  288,   2, 22.397120
160, 160,   2,  320,  320,   2, 22.366217
176, 176,   2,  352,  352,   2, 22.258204
192, 192,   2,  384,  384,   2, 19.621557
208, 208,   2,  416,  416,   2, 22.248468
224, 224,   2,  448,  448,   2, 22.027143
240, 240,   2,  480,  480,   2, 22.200096
./run_bench_op2_var01.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
result_bench_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s

```

```

16, 16, 16, 1, 1, 16, 19.200001
32, 16, 16, 1, 1, 16, 38.400002
48, 16, 16, 1, 1, 16, 49.816216
64, 16, 16, 1, 1, 16, 68.266670
80, 16, 16, 1, 1, 16, 65.361702
96, 16, 16, 1, 1, 16, 94.523079
112, 16, 16, 1, 1, 16, 100.018608
128, 16, 16, 1, 1, 16, 114.306984
144, 16, 16, 1, 1, 16, 120.208702
160, 16, 16, 1, 1, 16, 133.565216
176, 16, 16, 1, 1, 16, 140.800003
192, 16, 16, 1, 1, 16, 150.465317
208, 16, 16, 1, 1, 16, 142.628571
224, 16, 16, 1, 1, 16, 153.599991
240, 16, 16, 1, 1, 16, 153.600006
./run_bench_op2_var01.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
result_bench_op2_var01.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16, 16, 16, 1, 1, 16, 19.200001
16, 32, 32, 1, 1, 32, 9.675591
16, 48, 48, 1, 1, 48, 11.377778
16, 64, 64, 1, 1, 64, 10.638961
16, 80, 80, 1, 1, 80, 11.462687
16, 96, 96, 1, 1, 96, 11.484112
16, 112, 112, 1, 1, 112, 11.499466
16, 128, 128, 1, 1, 128, 7.777215
16, 144, 144, 1, 1, 144, 11.520000
16, 160, 160, 1, 1, 160, 11.548872
16, 176, 176, 1, 1, 176, 11.474363
16, 192, 192, 1, 1, 192, 10.577906
16, 208, 208, 1, 1, 208, 11.492373
16, 224, 224, 1, 1, 224, 11.561291
16, 240, 240, 1, 1, 240, 11.505618
touch result_bench_op2_var02.csv
./run_bench_op2_var02.x 16 256 16 1 1 1 -1 1 -1 | tee -a result_bench_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16, 16, 16, 1, 16, 1, 17.066668
32, 32, 32, 1, 32, 1, 22.968225
48, 48, 48, 1, 48, 1, 23.233614
64, 64, 64, 1, 64, 1, 23.461576

```

80,	80,	80,	1,	80,	1,	23.850931
96,	96,	96,	1,	96,	1,	19.419140
112,	112,	112,	1,	112,	1,	20.648560
128,	128,	128,	1,	128,	1,	8.674520
144,	144,	144,	1,	144,	1,	21.875340
160,	160,	160,	1,	160,	1,	21.982111
176,	176,	176,	1,	176,	1,	22.224934
192,	192,	192,	1,	192,	1,	12.137961
208,	208,	208,	1,	208,	1,	22.661196
224,	224,	224,	1,	224,	1,	22.275694
240,	240,	240,	1,	240,	1,	22.503664

```
./run_bench_op2_var02.x 16 256 16 1 1 -1 1 -1 1 | tee -a result_bench_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	1,	16,	1,	16,	20.480000
32,	32,	1,	32,	1,	32,	21.942856
48,	48,	1,	48,	1,	48,	23.331646
64,	64,	1,	64,	1,	64,	22.392710
80,	80,	1,	80,	1,	80,	23.132530
96,	96,	1,	96,	1,	96,	17.106264
112,	112,	1,	112,	1,	112,	19.236805
128,	128,	1,	128,	1,	128,	12.926232
144,	144,	1,	144,	1,	144,	16.386698
160,	160,	1,	160,	1,	160,	16.253969
176,	176,	1,	176,	1,	176,	16.122837
192,	192,	1,	192,	1,	192,	15.949811
208,	208,	1,	208,	1,	208,	16.055916
224,	224,	1,	224,	1,	224,	15.916257
240,	240,	1,	240,	1,	240,	18.375648

```
./run_bench_op2_var02.x 16 256 16 1 1 1 -1 -1 1 | tee -a result_bench_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	21.186207
32,	32,	32,	1,	1,	32,	23.630770
48,	48,	48,	1,	1,	48,	23.530214
64,	64,	64,	1,	1,	64,	23.630770
80,	80,	80,	1,	1,	80,	24.497608
96,	96,	96,	1,	1,	96,	21.308670
112,	112,	112,	1,	1,	112,	22.618784
128,	128,	128,	1,	1,	128,	22.928047
144,	144,	144,	1,	1,	144,	23.136402
160,	160,	160,	1,	1,	160,	23.405714

```

176, 176, 176, 1, 1, 176, 23.518633
192, 192, 192, 1, 1, 192, 23.719465
208, 208, 208, 1, 1, 208, 23.550373
224, 224, 224, 1, 1, 224, 23.879120
240, 240, 240, 1, 1, 240, 23.801653
./run_bench_op2_var02.x 16 256 16 1 1 -1 1 1 -1 | tee -a result_bench_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,   1,   16,   16,   1, 20.480000
32,  32,   1,   32,   32,   1, 22.968225
48,  48,   1,   48,   48,   1, 23.630770
64,  64,   1,   64,   64,   1, 22.392710
80,  80,   1,   80,   80,   1, 22.789316
96,  96,   1,   96,   96,   1, 16.731014
112, 112,   1,  112,  112,   1, 18.664352
128, 128,   1,  128,  128,   1,  6.247474
144, 144,   1,  144,  144,   1, 16.074419
160, 160,   1,  160,  160,   1, 14.490566
176, 176,   1,  176,  176,   1, 15.794009
192, 192,   1,  192,  192,   1,  7.147072
208, 208,   1,  208,  208,   1, 15.658814
224, 224,   1,  224,  224,   1,  8.203161
240, 240,   1,  240,  240,   1, 15.581605
./run_bench_op2_var02.x 16 256 16 1 1 -2 2 2 -2 | tee -a result_bench_op2_var02.csv
  m,   n, rs_src, cs_src, rs_dst, cs_dst, GB_per_s
16,  16,   2,   32,   32,   2, 21.186207
32,  32,   2,   64,   64,   2, 20.310743
48,  48,   2,   96,   96,   2, 23.136400
64,  64,   2,  128,  128,   2,  7.801905
80,  80,   2,  160,  160,   2, 15.452717
96,  96,   2,  192,  192,   2, 12.220110
112, 112,   2,  224,  224,   2, 14.714370
128, 128,   2,  256,  256,   2,  1.599219
144, 144,   2,  288,  288,   2, 14.086159
160, 160,   2,  320,  320,   2,  7.346646
176, 176,   2,  352,  352,   2, 12.585475
192, 192,   2,  384,  384,   2,  3.636848
208, 208,   2,  416,  416,   2,  9.569917
224, 224,   2,  448,  448,   2,  7.089926
240, 240,   2,  480,  480,   2,  7.871541

```

```
./run_bench_op2_var02.x 16 256 16 1 -16 1 -1 -1 1 | tee -a  
result_bench_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	18.618181
32,	16,	16,	1,	1,	16,	19.200001
48,	16,	16,	1,	1,	16,	19.608509
64,	16,	16,	1,	1,	16,	19.819355
80,	16,	16,	1,	1,	16,	19.819355
96,	16,	16,	1,	1,	16,	20.144262
112,	16,	16,	1,	1,	16,	21.612061
128,	16,	16,	1,	1,	16,	20.915745
144,	16,	16,	1,	1,	16,	19.962456
160,	16,	16,	1,	1,	16,	19.883495
176,	16,	16,	1,	1,	16,	20.604877
192,	16,	16,	1,	1,	16,	20.537048
208,	16,	16,	1,	1,	16,	23.630770
224,	16,	16,	1,	1,	16,	23.761326
240,	16,	16,	1,	1,	16,	23.813953

```
./run_bench_op2_var02.x 16 256 16 -16 1 1 -1 -1 1 | tee -a  
result_bench_op2_var02.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	21.186207
16,	32,	32,	1,	1,	32,	18.618181
16,	48,	48,	1,	1,	48,	22.755556
16,	64,	64,	1,	1,	64,	23.405714
16,	80,	80,	1,	1,	80,	23.272728
16,	96,	96,	1,	1,	96,	20.594412
16,	112,	112,	1,	1,	112,	22.283939
16,	128,	128,	1,	1,	128,	22.650692
16,	144,	144,	1,	1,	144,	23.040001
16,	160,	160,	1,	1,	160,	23.450382
16,	176,	176,	1,	1,	176,	23.304827
16,	192,	192,	1,	1,	192,	23.258045
16,	208,	208,	1,	1,	208,	21.882740
16,	224,	224,	1,	1,	224,	23.437601
16,	240,	240,	1,	1,	240,	23.450382

```
touch result_bench_op2_var03.csv
```

```
./run_bench_op2_var03.x 16 256 16 1 1 1 -1 1 -1 | tee -a result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	16,	1,	15.753846

32,	32,	32,	1,	32,	1,	16.718367
48,	48,	48,	1,	48,	1,	16.910091
64,	64,	64,	1,	64,	1,	16.861750
80,	80,	80,	1,	80,	1,	17.009966
96,	96,	96,	1,	96,	1,	16.923031
112,	112,	112,	1,	112,	1,	16.932283
128,	128,	128,	1,	128,	1,	16.941664
144,	144,	144,	1,	144,	1,	16.944637
160,	160,	160,	1,	160,	1,	16.953642
176,	176,	176,	1,	176,	1,	16.953796
192,	192,	192,	1,	192,	1,	16.955462
208,	208,	208,	1,	208,	1,	16.946890
224,	224,	224,	1,	224,	1,	16.910883
240,	240,	240,	1,	240,	1,	16.852371

```
./run_bench_op2_var03.x 16 256 16 1 1 -1 1 -1 1 | tee -a result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	1,	16,	1,	16,	2.292537
32,	32,	1,	32,	1,	32,	2.204125
48,	48,	1,	48,	1,	48,	2.154949
64,	64,	1,	64,	1,	64,	2.162429
80,	80,	1,	80,	1,	80,	2.111630
96,	96,	1,	96,	1,	96,	2.060209
112,	112,	1,	112,	1,	112,	2.054289
128,	128,	1,	128,	1,	128,	2.085695
144,	144,	1,	144,	1,	144,	2.067999
160,	160,	1,	160,	1,	160,	2.049845
176,	176,	1,	176,	1,	176,	2.046365
192,	192,	1,	192,	1,	192,	2.020130
208,	208,	1,	208,	1,	208,	1.995074
224,	224,	1,	224,	1,	224,	1.978191
240,	240,	1,	240,	1,	240,	1.967661

```
./run_bench_op2_var03.x 16 256 16 1 1 1 -1 -1 1 | tee -a result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	15.753846
32,	32,	32,	1,	1,	32,	16.832876
48,	48,	48,	1,	1,	48,	17.014153
64,	64,	64,	1,	1,	64,	17.066668
80,	80,	80,	1,	1,	80,	17.009966
96,	96,	96,	1,	1,	96,	17.119505
112,	112,	112,	1,	1,	112,	17.037691



128,	128,	128,	1,	1,	128,	17.044474
144,	144,	144,	1,	1,	144,	17.049126
160,	160,	160,	1,	1,	160,	17.052456
176,	176,	176,	1,	1,	176,	17.054920
192,	192,	192,	1,	1,	192,	17.056795
208,	208,	208,	1,	1,	208,	17.055452
224,	224,	224,	1,	1,	224,	17.059414
240,	240,	240,	1,	1,	240,	16.959883

```
./run_bench_op2_var03.x 16 256 16 1 1 -1 1 1 -1 | tee -a result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	1,	16,	16,	1,	15.753846
32,	32,	1,	32,	32,	1,	16.605406
48,	48,	1,	48,	48,	1,	16.910091
64,	64,	1,	64,	64,	1,	16.978239
80,	80,	1,	80,	80,	1,	17.009966
96,	96,	1,	96,	96,	1,	16.923031
112,	112,	1,	112,	112,	1,	16.941813
128,	128,	1,	128,	128,	1,	16.847301
144,	144,	1,	144,	144,	1,	16.944637
160,	160,	1,	160,	160,	1,	16.948965
176,	176,	1,	176,	176,	1,	16.853867
192,	192,	1,	192,	192,	1,	16.858536
208,	208,	1,	208,	208,	1,	16.856104
224,	224,	1,	224,	224,	1,	16.858799
240,	240,	1,	240,	240,	1,	16.858536

```
./run_bench_op2_var03.x 16 256 16 1 1 -2 2 2 -2 | tee -a result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	2,	32,	32,	2,	24.575998
32,	32,	2,	64,	64,	2,	22.755556
48,	48,	2,	96,	96,	2,	27.374258
64,	64,	2,	128,	128,	2,	6.908222
80,	80,	2,	160,	160,	2,	15.088409
96,	96,	2,	192,	192,	2,	13.165714
112,	112,	2,	224,	224,	2,	22.152760
128,	128,	2,	256,	256,	2,	2.358824
144,	144,	2,	288,	288,	2,	13.901230
160,	160,	2,	320,	320,	2,	7.360728
176,	176,	2,	352,	352,	2,	12.775804
192,	192,	2,	384,	384,	2,	6.181777
208,	208,	2,	416,	416,	2,	9.596451

```
224, 224, 2, 448, 448, 2, 7.994052
240, 240, 2, 480, 480, 2, 7.939808
./run_bench_op2_var03.x 16 256 16 1 -16 1 -1 -1 1 | tee -a
result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	15.753846
32,	16,	16,	1,	1,	16,	16.384001
48,	16,	16,	1,	1,	16,	16.457142
64,	16,	16,	1,	1,	16,	16.605406
80,	16,	16,	1,	1,	16,	16.695652
96,	16,	16,	1,	1,	16,	16.756365
112,	16,	16,	1,	1,	16,	16.734631
128,	16,	16,	1,	1,	16,	16.661695
144,	16,	16,	1,	1,	16,	16.807295
160,	16,	16,	1,	1,	16,	16.832878
176,	16,	16,	1,	1,	16,	16.853867
192,	16,	16,	1,	1,	16,	16.832876
208,	16,	16,	1,	1,	16,	16.850634
224,	16,	16,	1,	1,	16,	16.865883
240,	16,	16,	1,	1,	16,	16.756363

```
./run_bench_op2_var03.x 16 256 16 -16 1 1 -1 -1 1 | tee -a
result_bench_op2_var03.csv
```

m,	n,	rs_src,	cs_src,	rs_dst,	cs_dst,	GB_per_s
16,	16,	16,	1,	1,	16,	15.753846
16,	32,	32,	1,	1,	32,	16.384001
16,	48,	48,	1,	1,	48,	16.605406
16,	64,	64,	1,	1,	64,	16.605406
16,	80,	80,	1,	1,	80,	16.695652
16,	96,	96,	1,	1,	96,	16.832876
16,	112,	112,	1,	1,	112,	16.734631
16,	128,	128,	1,	1,	128,	16.775427
16,	144,	144,	1,	1,	144,	16.910091
16,	160,	160,	1,	1,	160,	16.925619
16,	176,	176,	1,	1,	176,	16.853867
16,	192,	192,	1,	1,	192,	16.832876
16,	208,	208,	1,	1,	208,	16.850634
16,	224,	224,	1,	1,	224,	16.865883
16,	240,	240,	1,	1,	240,	16.879122

```
awsomeandy911@LAPTOP-IFC4JBFG:~/cs4473-5473-lab/PROB01_TRANSPOSE$
```

