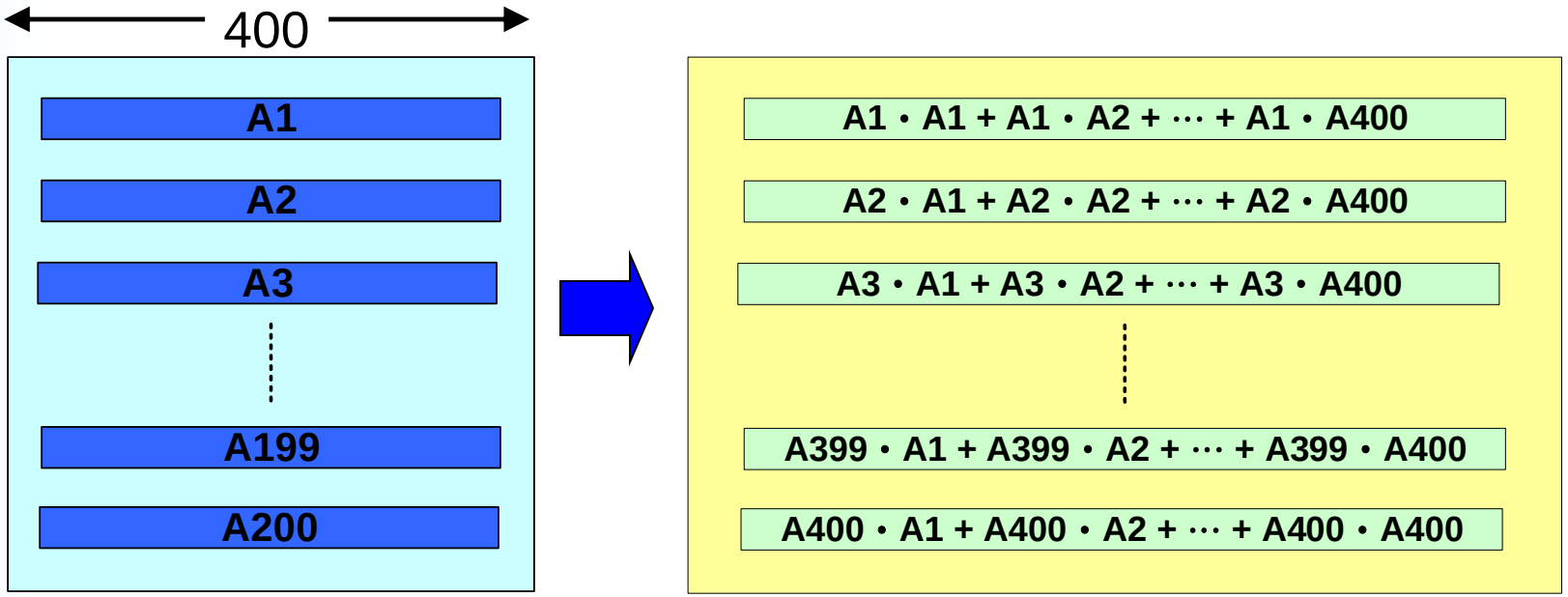
Homework #7 (1)

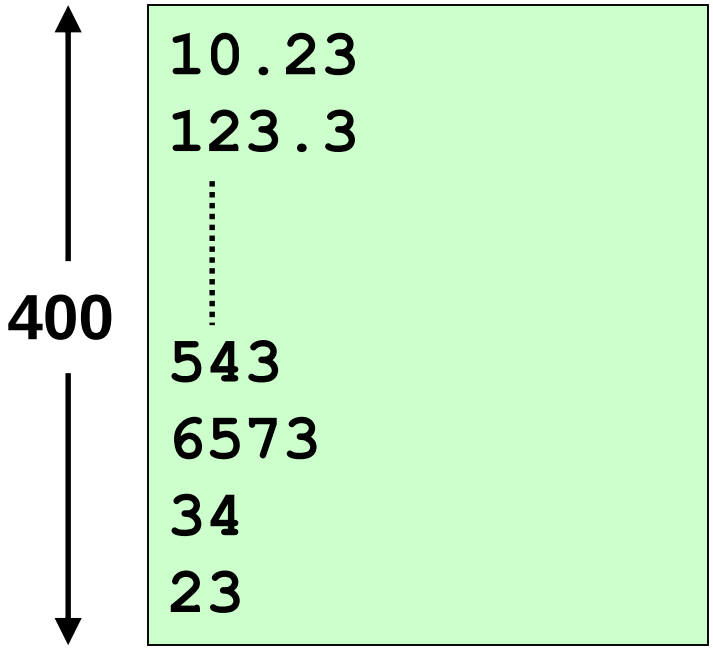
- Write a C program to perform:
  - Read a text file named "**data.txt**" (400x400 matrix, each element is a **float**)
  - Do following computation



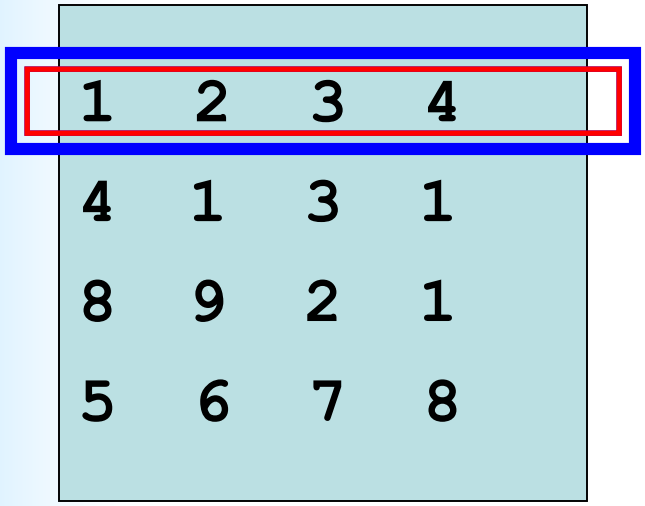
Homework #7 (2)

- Output the result to a file named “output.txt”

- Output file needs to follow the form:



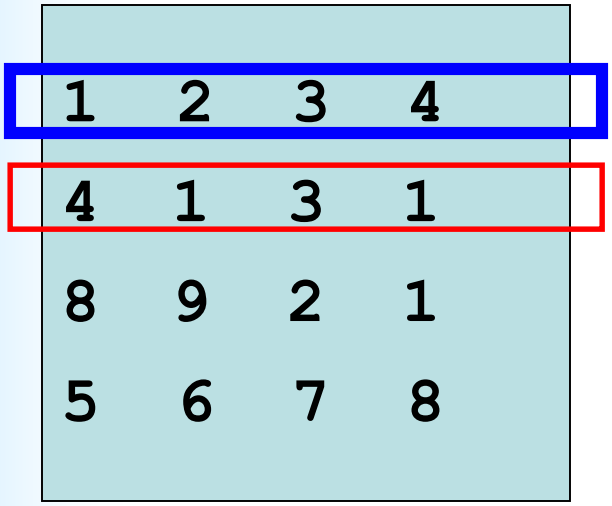
Homework #7 (3)



30

$$1x1 + 2x2 + 3x3 + 4x4 = 1 + 4 + 9 + 16 = 30$$

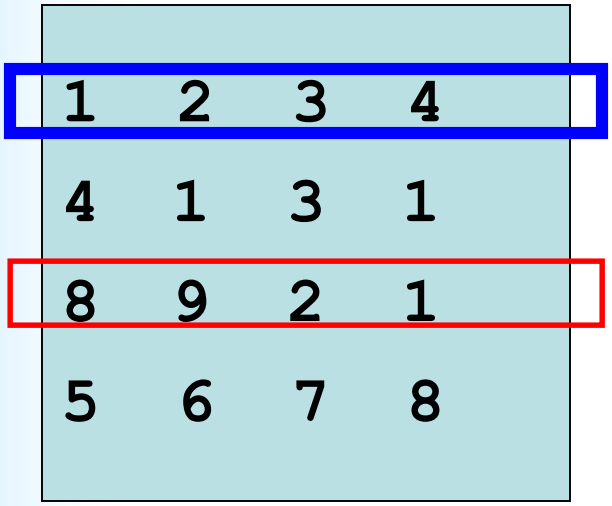
Homework #7 (3)



30 + 19

1x4 + 2x1 + 3x3 + 4x1 = 4 + 2 + 9 + 4 = 19

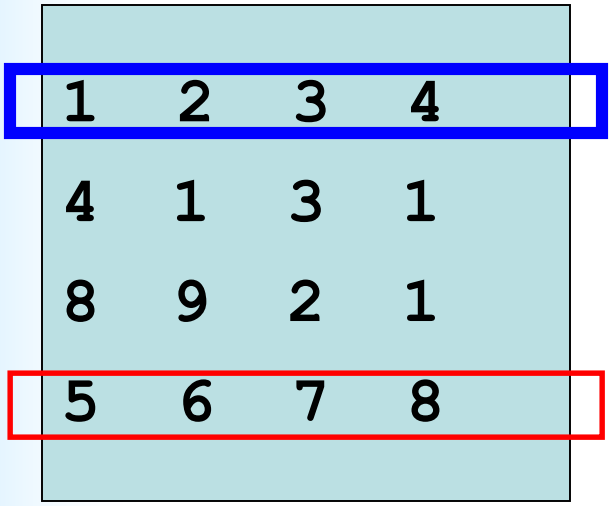
Homework #7 (3)



30 + 19 + 36

1x8 + 2x9 + 3x2 + 4x1 = 8 + 18 + 6 + 4 = 36

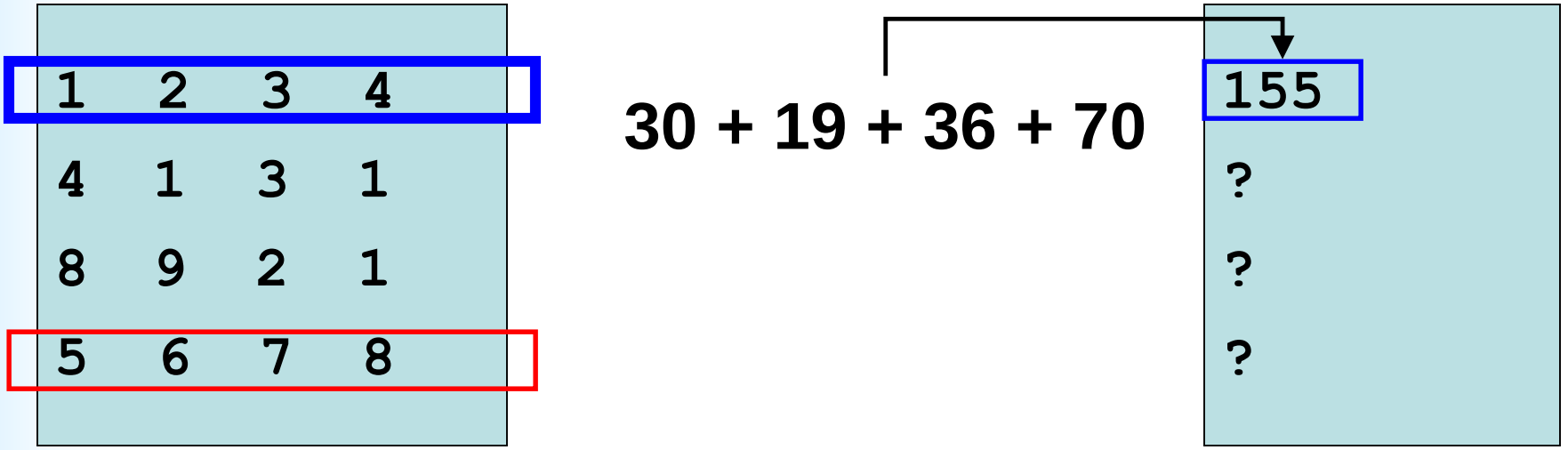
Homework #8 (3)



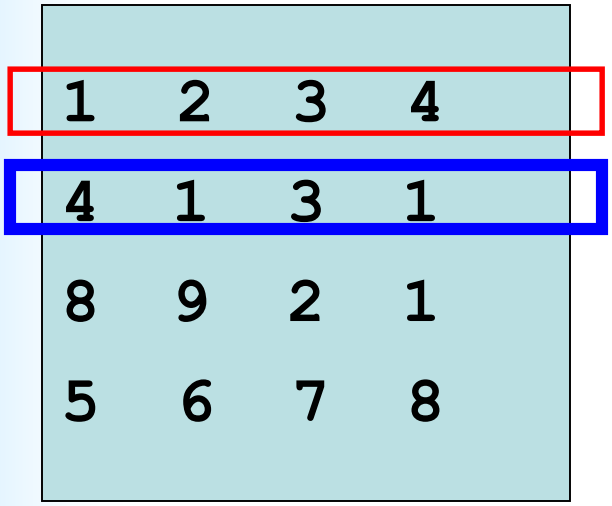
30 + 19 + 36 + 70

1x5 + 2x6 + 3x7 + 4x8 = 5 + 12 + 21 + 32 = 70

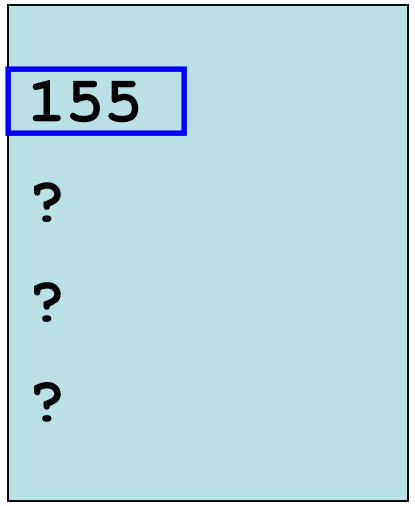
Homework #7 (3)



Homework #7 (3)

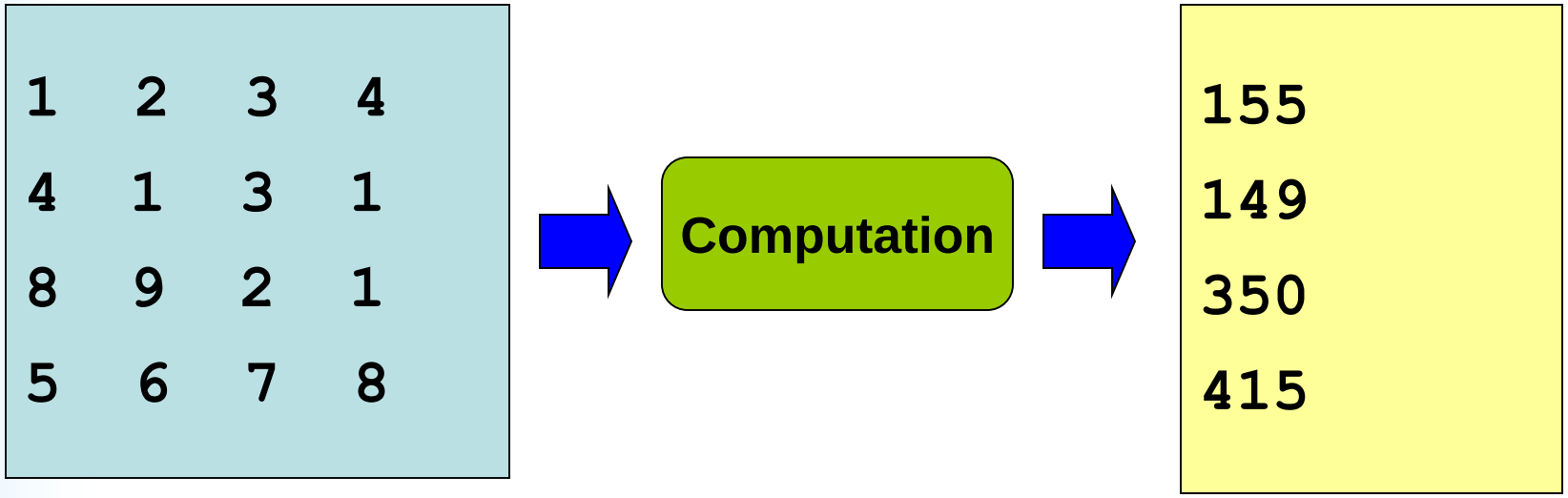


19



4x1 + 1x2 + 3x3 + 1x4 = 4 + 2 + 9 + 4 = 19

Homework #7 (3)



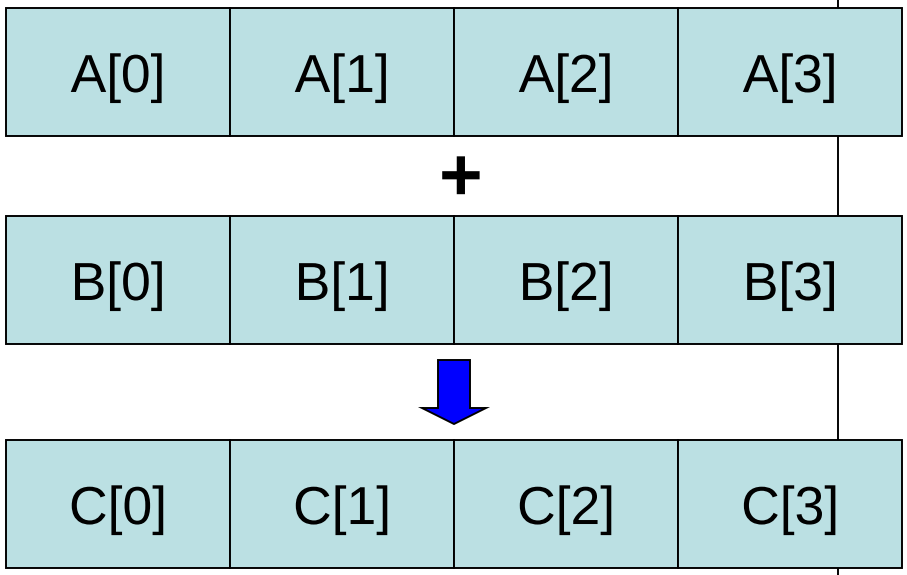
Homework #7 (4)

- 輸入檔檔名 data.txt (自行產生/參考網站)
  - 包含400 row的資料
  - 每一row有400個floating point數字，數字與數字間用一個空白隔開
- 輸出檔檔名 output.txt (計算結果)
  - 包含400 row的資料

Example

```
#include <xmmintrin.h>
#include <stdio.h>

int main(void)
{
  float A[4] __attribute__ ((aligned(16)));
  float B[4] __attribute__ ((aligned(16)));
  float C[4] __attribute__ ((aligned(16)));
  __m128 *a, *b, *c;

  a = (__m128*) A;
  b = (__m128*) B;
  c = (__m128*) C;

  *c = _mm_add_ps(*a, *b);

  printf("%f  %f  %f  %f\n", C[0], C[1], C[2], C[3]);

  return 0;
}
```

請特別留意資料對齊的問題



GCC Options

- These switches enable or disable the use of built-in functions that allow direct access to the MMX, SSE, SSE2, SSE3, SSE4, AVX, and 3Dnow extensions of the instruction set
  - `-mavx`
  - `-mavx2`
  - `-msse`
  - `-msse2`
  - `-msse3`
  - `-msse4`
  - `-m3dnow`

```
gcc -msse4 test.c
```

Intrinsic Functions

- 你可以使用 SSE, SSE2, SSE3, SSE4 相關的 intrinsic functions (請參閱cref_cls.pdf文件裡 page 88, 124, 168裡面的函式說明)
- 或請至下面的網站查詢有哪些intrinsic functions (建議由下面網站查詢)
  - https://software.intel.com/sites/landingpage/IntrinsicsGuide/#

Homework #7 (5)

- 使用SIMD intrinsic function來做計算
  - **請使用GCC 3.4以上的版本編譯你的程式**
  - **主要評分標準：**
    - **是否使用大量的SIMD intrinsic function？**
    - **程式執行速度？**
- 在Linux上進行編譯與測試
  - 請多利用系上工作站
- 程式中應有適當的說明（註解）

計算誤差

- 關於作業7的誤差問題: 在這個作業裡，因為浮點數運算順序的緣故，很小的誤差是可以接受的。
- 作業也讓我們了解到浮點數的運算與精確度的問題，不同的領域對於精確度的要求各有不同。

程式正確性的驗證

- 我建議有幾個方式驗證程式的正確性:
  - 先嘗試小矩陣的計算，比較容易驗證正確性。
  - 縮小400x400矩陣裡每個元素的值，使他們在1~10之間，如此，應該可以大量減輕因為幅點數極大、極小值**運算順序不同**造成的誤差，看看結果是否很接近。
  - 嘗試改成整數的版本，每個元素的值也不要太大，避免overflow，如此應該SIMD version與一般的版本答案是一樣的。

Homework #7 (6)

- You should turn in to **ECOURSE2**
  - "**README.txt**" file: 文字檔，描述你程式的內容、如何編譯程式 (編譯時所下的參數)、如何執行你的程式、**在哪個型號的CPU上執行成功**等等。
  - 一個可以執行成功的input檔案"data.txt"與相對應的結果檔案"output.txt"
  - A C program without SIMD intrinsic functions: hw7.c
  - A C program with SIMD intrinsic functions: hw7simd.c
  - Any file needed in your work (ex: Makefile)
    - 請將欲繳交的檔案壓縮成 <hw7_學號.tar.bz2>，上傳壓縮檔。
- **Deadline: January 9 (Thursday), 24:00, 2020**

這次作業，無法補交。