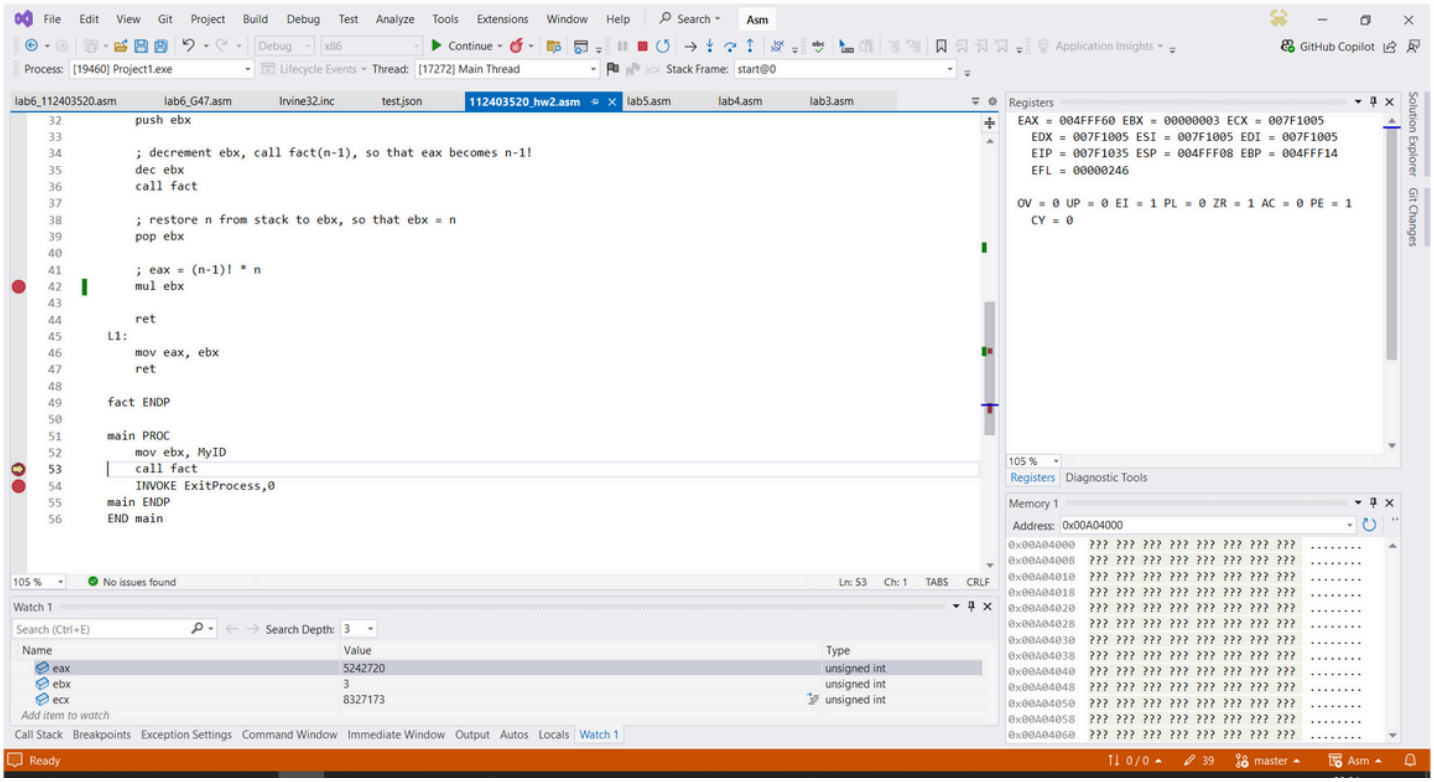
組合語言 作業一

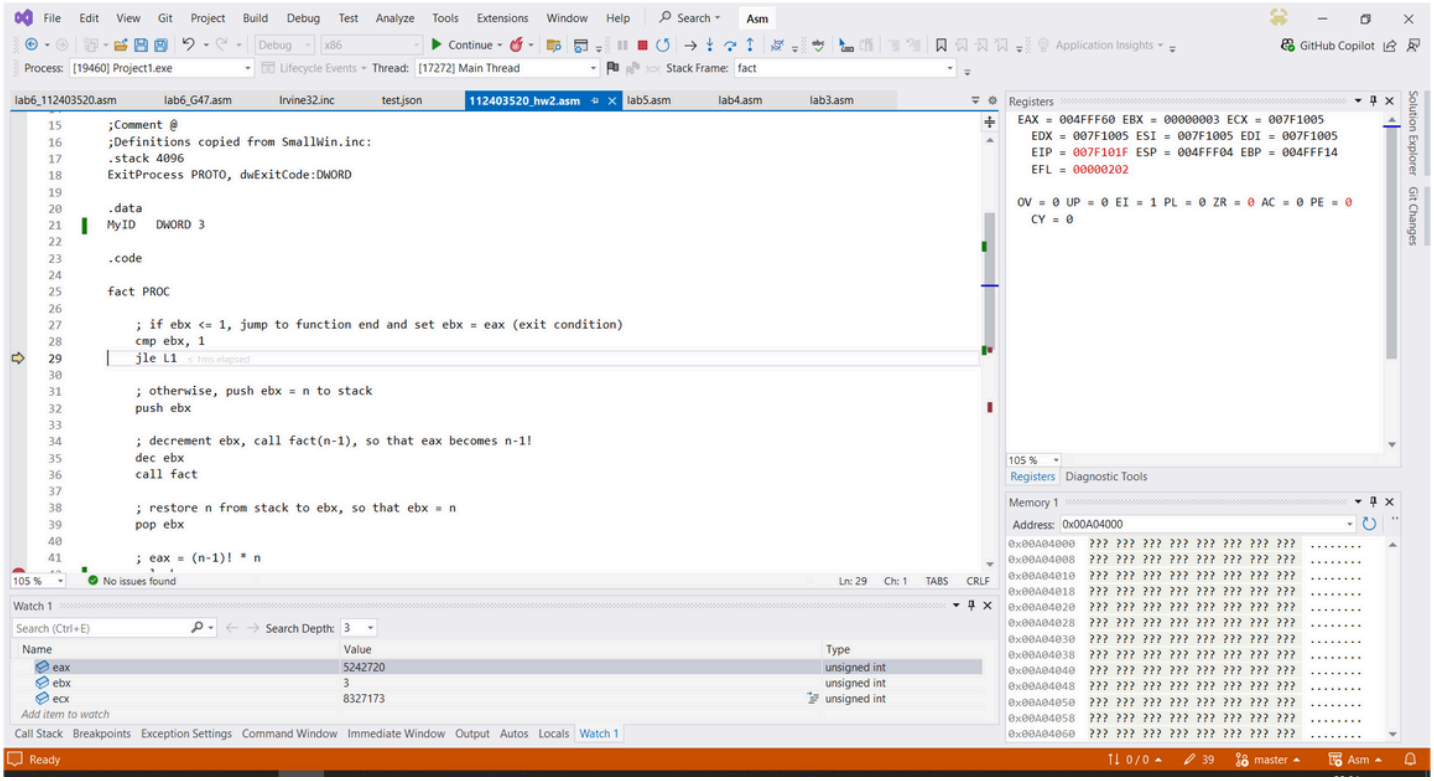
112403520李宥寬

一. 程式流程截圖、程式碼說明

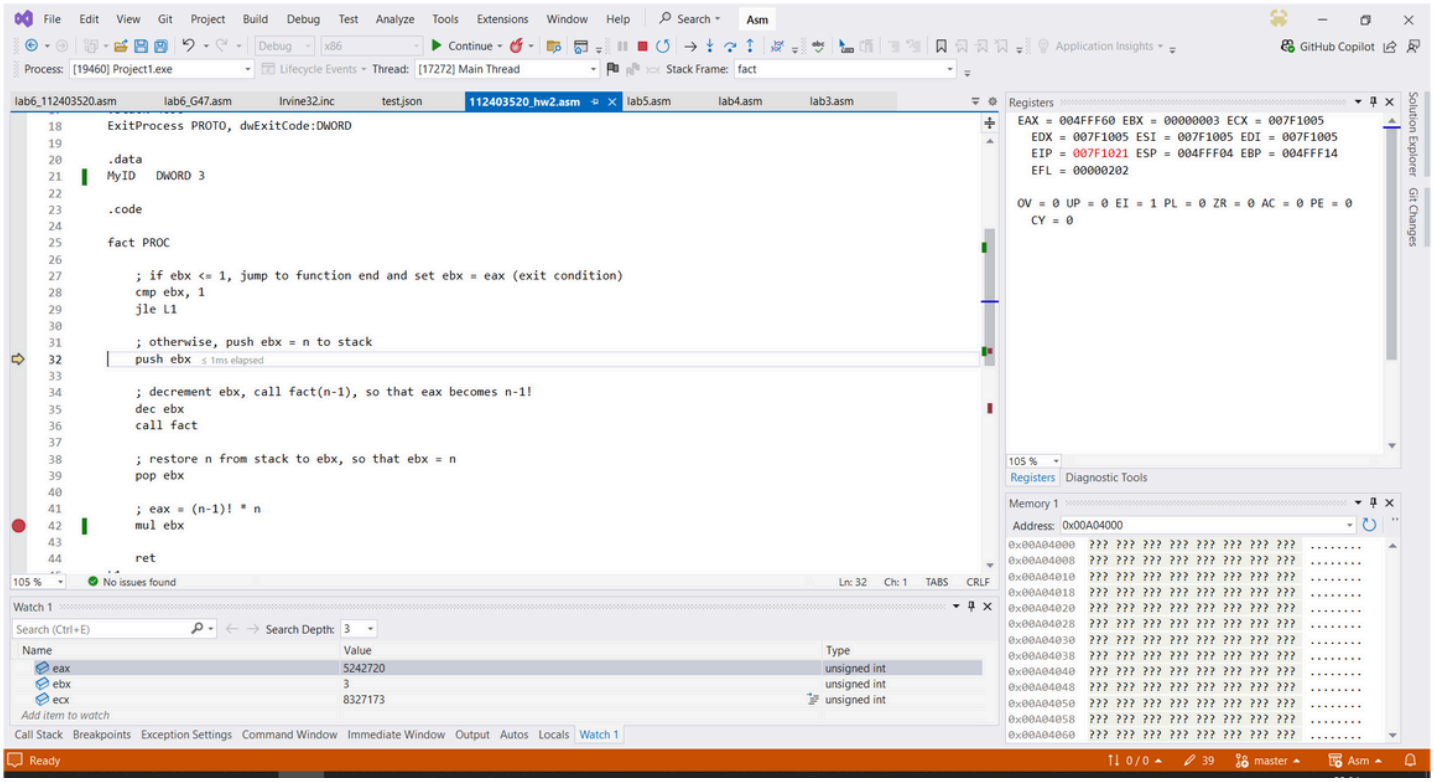


程式初始化，因為我的學號最後一碼是0，故使用MyID = 3來演示

將要計算的數字存入MyID後，呼叫fact

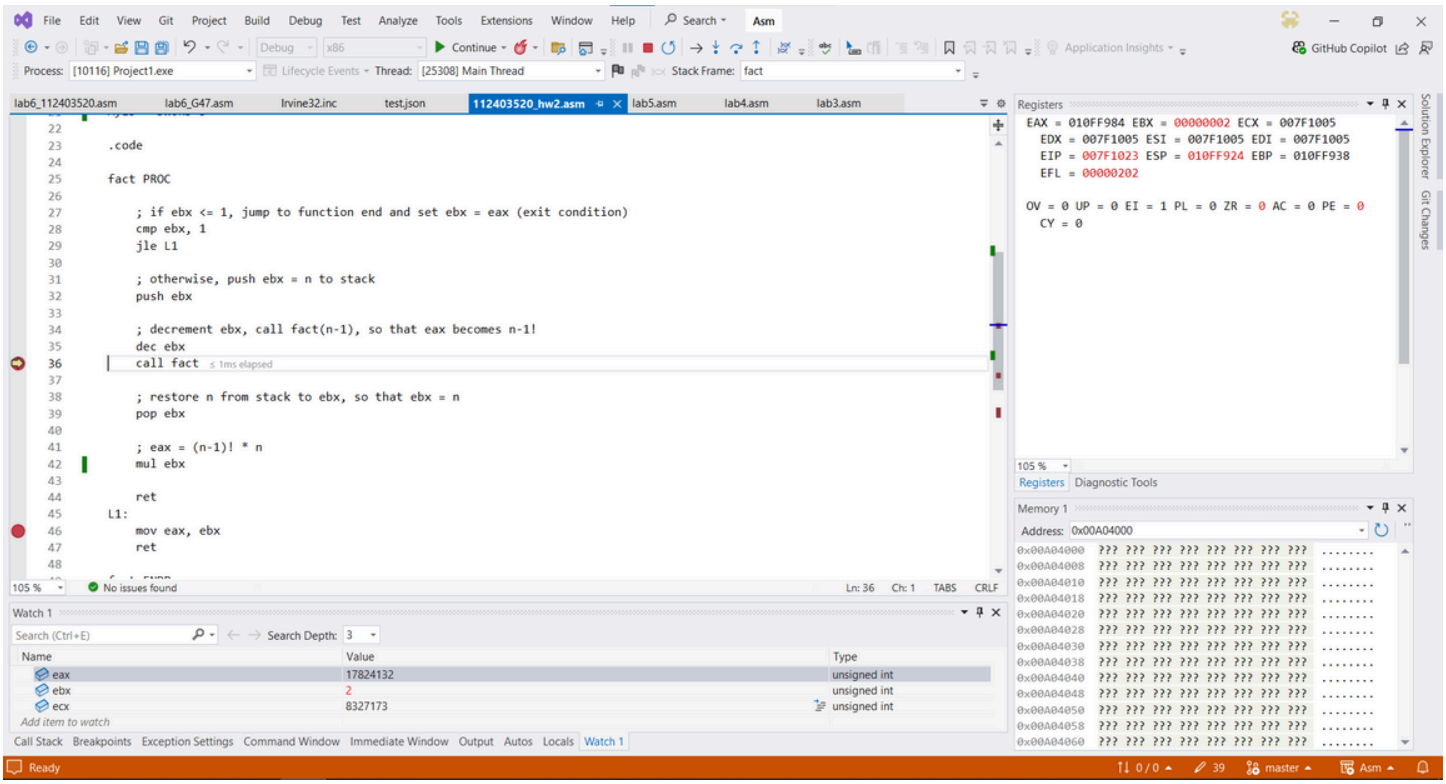


使用cmp比較ebx = n的值，若小於等於一則跳至L1



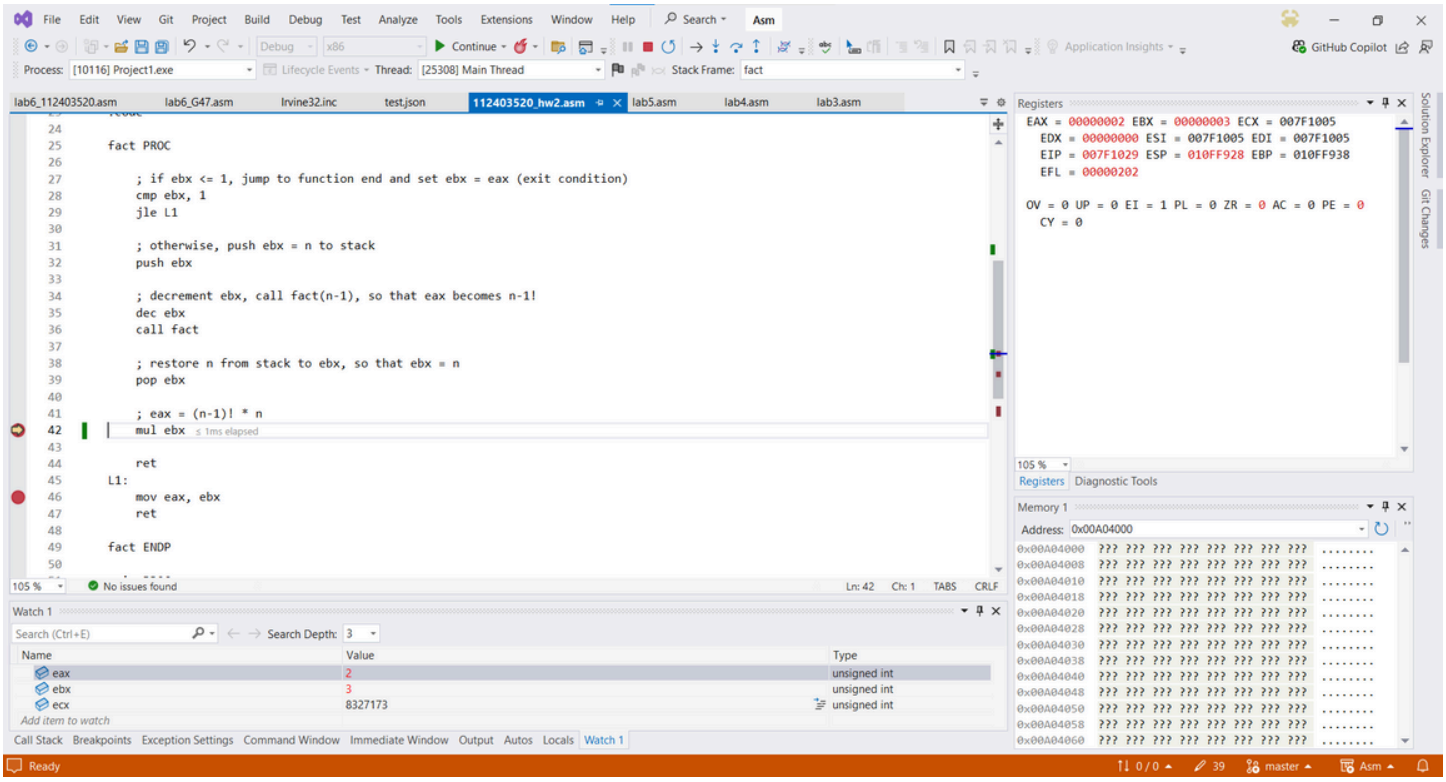
此時因為ebx還是3，程式繼續執行

因為等等會使用到ebx，將ebx先push到stack中儲存起來



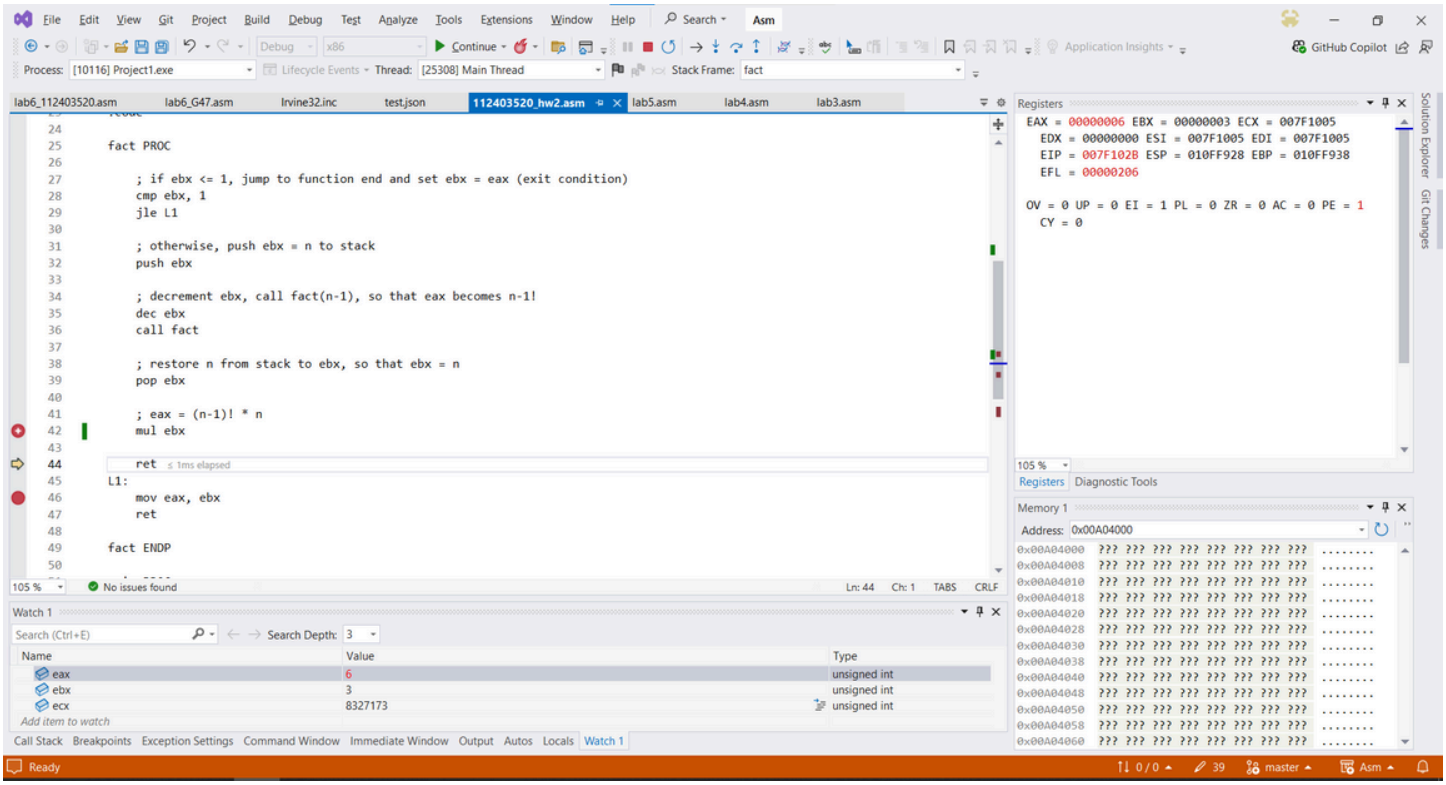
此時將ebx減一變成n-1，再call fact

得到(n - 1)!的值，並儲存在eax上



這時候再pop ebx，將剛剛儲存起來n的值放回ebx

所以此時eax = (n - 1)! , ebx = n



將eax乘以ebx，即得到(n - 1)! * n = n!

所以程式的call stack可以視為:

fact(3)

fact(2)

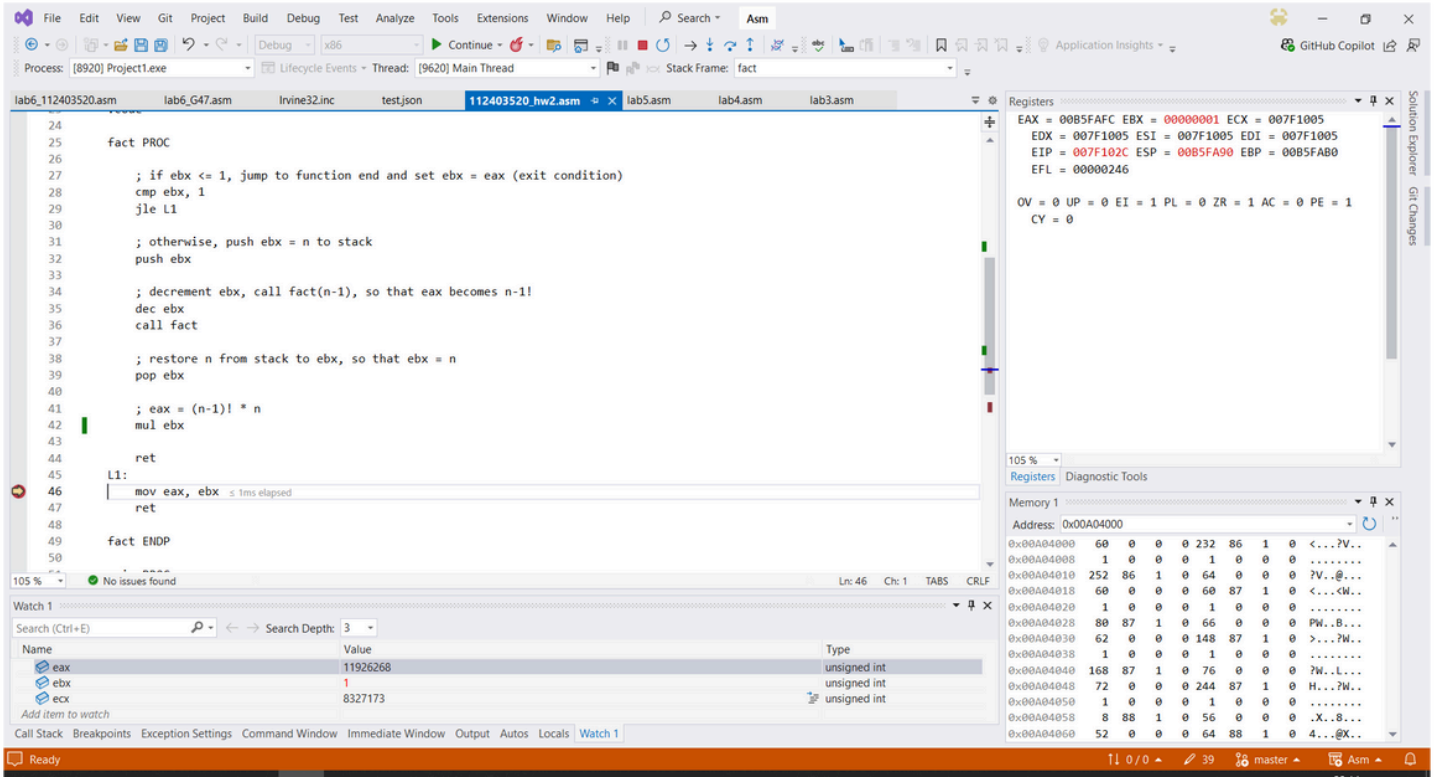
fact(1)

→ ret 1

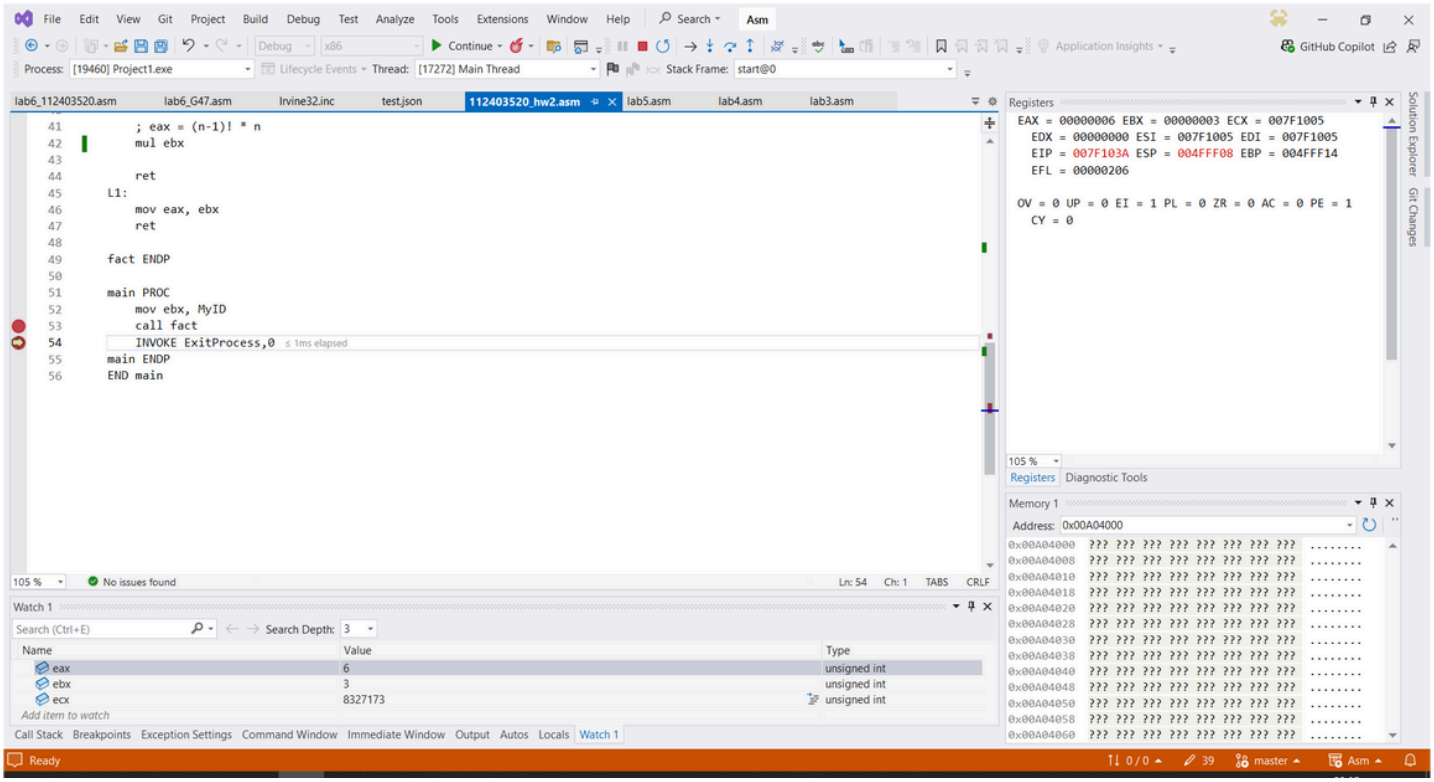
→ ret 2 * 1

→ ret 3 * 2 * 1

當執行到fact(1)時，會直接執行L1區段程式碼，回傳1，如下:



L1區段將ebx的值複製到eax作為結果傳回



得到最終結果eax = 3! = 6

二. 完成的程式畫面截圖

```
20          .data
21          MyID    DWORD 0
```

data 區段，將MyID設為學號最後一碼0

程式區段

```
23      .code
24
25      fact PROC
26
27          ; if ebx <= 1, jump to function end and set ebx = eax (exit condition)
28          cmp ebx, 1
29          jle L1
30
31          ; otherwise, push ebx = n to stack
32          push ebx
33
34          ; decrement ebx, call fact(n-1), so that eax becomes n-1!
35          dec ebx
36          call fact
37
38          ; restore n from stack to ebx, so that ebx = n
39          pop ebx
40
41          ; eax = (n-1)! * n
42          mul ebx
43
44          ret
45      L1:
46          mov eax, ebx
47          ret
48
49      fact ENDP
```

25~49 計算階乘的函式

```
51        main PROC
52            mov ebx, MyID
53            call fact
54            INVOKE ExitProcess,0
55        main ENDP
```

51~55 程式進入點

三. 學習心得

學習收穫:

- **組合語言的細節:**
  - **這次作業讓我更加深入地了解組合語言的指令集和記憶體操作，還有函數呼叫真正的意義。**
- **遞迴的原理:**
  - **透過這個例子，我對遞迴的原理和應用有了更深刻的認識。**
- **函數呼叫和堆疊:**
  - **遞迴的實現離不開函數呼叫和堆疊的使用，這部分的知識也是非常重要的。**
- **演算法效率:**
  - **遞迴雖然寫法簡潔，但效率可能不是最佳的。在實際應用中，需要根據具體情況選擇合適的演算法。**

遞迴的優缺點

- **優點:**
  - **程式結構清晰: 遞迴的寫法通常比較直觀，符合數學上的遞迴定義。**
  - **代碼簡潔: 相較於其他的方法，遞迴的程式碼往往更簡潔。**
- **缺點:**
  - **程式可讀性: 相較於線性或迴圈程式，遞迴較難分析及除錯**
  - **容易發生堆疊溢位(stack overflow): 可以注意到每次呼叫下個遞迴，都要先把變數除存在stack，並將return address也push到stack上。如果遞迴層次過深，可能會導致堆疊溢位。**