Call-de-stack

Version 1.1

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Dedication

In memory of Stack Overflow.

Environment

gcc

x86

Compilation

as --gstabs main.s -o main.o

ld main.o -o main

Execution

./main

OR

gdb main

Legend

804806f movl %ebp, %esp

Completed instruction

Value changed by completed instruction

Comment

Next IP

Stack pointer

Instruction pointer

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $0x2
    8048058:    call foo
    804805d:    addl $0x4, %esp
    8048060:    movl $0x1, %eax
    8048065:    int $0x80

                .type foo, @function
                foo:
    8048067:    pushl %ebp
    8048068:    movl %esp, %ebp
    804806a:    movl 8(%ebp), %eax
    804806d:    xorl %eax, %eax
    804806f:    movl %ebp, %esp
->  8048071:    popl %ebp
    8048072:    ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e674
ebp	0xbfc8e674
esi	0x0
edi	0x0
eip	0x8048071

Stack

```
    0xbfc8e68c:    0xbfc8fb38
    0xbfc8e688:    0x00000000
    0xbfc8e684:    0xbfc8fb12
    0xbfc8e680:    0x00000001
    0xbfc8e67c:    0x00000002
    0xbfc8e678:    0x0804805d
->  0xbfc8e674:    0x00000000
    0xbfc8e670:    0x00000000
```

Examples

1. Function call, without any arguments

2. Function call, with an argument

3. Recursive function

Function call, without any arguments

```
.section .data

.section .text

.globl _start
_start:
      nop
      nop
      call foo
      movl $1, %eax
      int $0x80

.type foo, @function
foo:
      pushl %ebp
      movl %esp, %ebp

      nop

      movl %ebp, %esp
      popl %ebp
      ret
```

Output of "objdump -d main"

```
main:     file format elf32-i386

Disassembly of section .text:
08048054 <_start>:
 8048054:   90                      nop
 8048055:   90                      nop
 8048056:   e8 07 00 00 00          call   8048062 <foo>
 804805b:   b8 01 00 00 00          mov    $0x1,%eax
 8048060:   cd 80                   int    $0x80

08048062 <foo>:
 8048062:   55                  push   %ebp
 8048063:   89 e5               mov    %esp,%ebp
 8048065:   90                  nop
 8048066:   89 ec               mov    %ebp,%esp
 8048068:   5d                  pop    %ebp
 8048069:   c3                  ret
```

8048054 nop

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:            nop
->  8048055:            nop
    8048056:            call foo
    804805b:            movl $1, %eax
    8048060:            int $0x80

                    .type foo, @function
                    foo:
    8048062:            pushl %ebp
    8048063:            movl %esp, %ebp
    8048065:            nop
    8048066:            movl %ebp, %esp
    8048068:            popl %ebp
    8048069:            ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbffa79a0
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048055

Stack

```
    0xbffa79ac:     0xbffa7b3e
    0xbffa79a8:     0x00000000
    0xbffa79a4:     0xbffa7b1c
->  0xbffa79a0:     0x00000001
    0xbffa799c:     0x00000000
    0xbffa7998      0x00000000
    0xbffa7994:     0x00000000
    0xbffa7990:     0x00000000
```

8048055 nop

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:            nop
    8048055:            nop
->  8048056:            call foo
    804805b:            movl $1, %eax
    8048060:            int $0x80

                    .type foo, @function
                    foo:
    8048062:            pushl %ebp
    8048063:            movl %esp, %ebp
    8048065:            nop
    8048066:            movl %ebp, %esp
    8048068:            popl %ebp
    8048069:            ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbffa79a0
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048056

Stack

```
    0xbffa79ac:     0xbffa7b3e
    0xbffa79a8:     0x00000000
    0xbffa79a4:     0xbffa7b1c
->  0xbffa79a0:     0x00000001
    0xbffa799c:     0x00000000
    0xbffa7998      0x00000000
    0xbffa7994:     0x00000000
    0xbffa7990:     0x00000000
```

8048056 call foo

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:        nop
    8048055:        nop
    8048056:        call foo
    804805b:        movl $1, %eax
    8048060:        int $0x80

                .type foo, @function
                foo:
->  8048062:        pushl %ebp
    8048063:        movl %esp, %ebp
    8048065:        nop
    8048066:        movl %ebp, %esp
    8048068:        popl %ebp
    8048069:        ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbffa799c
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048062

Stack

```
    0xbffa79ac:    0xbffa7b3e
    0xbffa79a8:    0x00000000
    0xbffa79a4:    0xbffa7b1c
    0xbffa79a0:    0x00000001
->  0xbffa799c:    0x0804805b
    0xbffa7998     0x00000000
    0xbffa7994:    0x00000000
    0xbffa7990:    0x00000000
```

Next IP

call pushes return address to stack

Stack grows downward

8048062 pushl %ebp

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:        nop
    8048055:        nop
    8048056:        call foo
    804805b:        movl $1, %eax
    8048060:        int $0x80

                .type foo, @function
                foo:
    8048062:        pushl %ebp
->  8048063:        movl %esp, %ebp
    8048065:        nop
    8048066:        movl %ebp, %esp
    8048068:        popl %ebp
    8048069:        ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbffa7998
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048063

Next IP

Stack

```
    0xbffa79ac:    0xbffa7b3e
    0xbffa79a8:    0x00000000
    0xbffa79a4:    0xbffa7b1c
    0xbffa79a0:    0x00000001
    0xbffa799c:    0x0804805b
->  0xbffa7998     0x00000000
    0xbffa7994:    0x00000000
    0xbffa7990:    0x00000000
```

Save base pointer to stack

8048063 movl %esp, %ebp

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:            nop
    8048055:            nop
    8048056:            call foo
    804805b:            movl $1, %eax
    8048060:            int $0x80

                    .type foo, @function
                    foo:
    8048062:            pushl %ebp
    8048063:            movl %esp, %ebp
->  8048065:            nop
    8048066:            movl %ebp, %esp
    8048068:            popl %ebp
    8048069:            ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbffa7998
ebp	0xbffa7998
esi	0x0
edi	0x0
eip	0x8048065

Use base pointer as reference

Next IP

Stack

```
    0xbffa79ac:     0xbffa7b3e
    0xbffa79a8:     0x00000000
    0xbffa79a4:     0xbffa7b1c
    0xbffa79a0:     0x00000001
    0xbffa799c:     0x0804805b
->  0xbffa7998      0x00000000
    0xbffa7994:     0x00000000
    0xbffa7990:     0x00000000
```

8048065 nop

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:            nop
    8048055:            nop
    8048056:            call foo
    804805b:            movl $1, %eax
    8048060:            int $0x80

                    .type foo, @function
                    foo:
    8048062:            pushl %ebp
    8048063:            movl %esp, %ebp
    8048065:            nop
->  8048066:            movl %ebp, %esp
    8048068:            popl %ebp
    8048069:            ret
```

Registers

```
eax     0x0
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbffa7998
ebp     0xbffa7998
esi     0x0
edi     0x0
eip     0x8048066
```

Stack

```
    0xbffa79ac:     0xbffa7b3e
    0xbffa79a8:     0x00000000
    0xbffa79a4:     0xbffa7b1c
    0xbffa79a0:     0x00000001
    0xbffa799c:     0x0804805b
->  0xbffa7998      0x00000000
    0xbffa7994:     0x00000000
    0xbffa7990:     0x00000000
```

8048066 movl %ebp, %esp

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:        nop
    8048055:        nop
    8048056:        call foo
    804805b:        movl $1, %eax
    8048060:        int $0x80

                .type foo, @function
                foo:
    8048062:        pushl %ebp
    8048063:        movl %esp, %ebp
    8048065:        nop
    8048066:        movl %ebp, %esp
->  8048068:        popl %ebp
    8048069:        ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbffa7998
ebp	0xbffa7998
esi	0x0
edi	0x0
eip	0x8048068

Stack

```
    0xbffa79ac:    0xbffa7b3e
    0xbffa79a8:    0x00000000
    0xbffa79a4:    0xbffa7b1c
    0xbffa79a0:    0x00000001
    0xbffa799c:    0x0804805b
->  0xbffa7998     0x00000000
    0xbffa7994:    0x00000000
    0xbffa7990:    0x00000000
```

8048068 popl %ebp

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:            nop
    8048055:            nop
    8048056:            call foo
    804805b:            movl $1, %eax
    8048060:            int $0x80

                    .type foo, @function
                    foo:
    8048062:            pushl %ebp
    8048063:            movl %esp, %ebp
    8048065:            nop
    8048066:            movl %ebp, %esp
    8048068:            popl %ebp
->  8048069:            ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbffa799c
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048069

Restore old base pointer

Next IP

Stack

```
    0xbffa79ac:     0xbffa7b3e
    0xbffa79a8:     0x00000000
    0xbffa79a4:     0xbffa7b1c
    0xbffa79a0:     0x00000001
->  0xbffa799c:     0x0804805b
    0xbffa7998      0x00000000
    0xbffa7994:     0x00000000
    0xbffa7990:     0x00000000
```

8048069 ret

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:            nop
    8048055:            nop
    8048056:            call foo
->  804805b:            movl $1, %eax
    8048060:            int $0x80

                    .type foo, @function
                    foo:
    8048062:            pushl %ebp
    8048063:            movl %esp, %ebp
    8048065:            nop
    8048066:            movl %ebp, %esp
    8048068:            popl %ebp
    8048069:            ret
```

Registers

```
eax     0x0
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbffa79a0
ebp     0x0
esi     0x0
edi     0x0
eip     0x804805b
```

ret restores saved return address to ip

Stack

```
    0xbffa79ac:     0xbffa7b3e
    0xbffa79a8:     0x00000000
    0xbffa79a4:     0xbffa7b1c
->  0xbffa79a0:     0x00000001
    0xbffa799c:     0x0804805b
    0xbffa7998      0x00000000
    0xbffa7994:     0x00000000
    0xbffa7990:     0x00000000
```

804805b movl $1, %eax

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:            nop
    8048055:            nop
    8048056:            call foo
    804805b:            movl $1, %eax
->  8048060:            int $0x80

                    .type foo, @function
                    foo:
    8048062:            pushl %ebp
    8048063:            movl %esp, %ebp
    8048065:            nop
    8048066:            movl %ebp, %esp
    8048068:            popl %ebp
    8048069:            ret
```

Registers

```
eax     0x1
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbffa79a0
ebp     0x0
esi     0x0
edi     0x0
eip     0x8048060
```

Stack

```
    0xbffa79ac:     0xbffa7b3e
    0xbffa79a8:     0x00000000
    0xbffa79a4:     0xbffa7b1c
->  0xbffa79a0:     0x00000001
    0xbffa799c:     0x0804805b
    0xbffa7998      0x00000000
    0xbffa7994:     0x00000000
    0xbffa7990:     0x00000000
```

Program exited normally.

Function call, with an argument

```
.section .data
.section .text
.globl _start
_start:
      nop
      nop
      push $2
      call foo
      add $4, %esp
      movl $1, %eax
      int $0x80

.type foo, @function
foo:
      pushl %ebp
      movl %esp, %ebp

      movl 8(%ebp), %eax
      xorl %eax, %eax

      movl %ebp, %esp
      popl %ebp
      ret
```

Output of "objdump -d main"

```
main:     file format elf32-i386

Disassembly of section .text:

08048054 <_start>:
 8048054:   90                      nop
 8048055:   90                      nop
 8048056:   6a 02                   push   $0x2
 8048058:   e8 0a 00 00 00 call   8048067 <foo>
 804805d:   83 c4 04                add    $0x4,%esp
 8048060:   b8 01 00 00 00 mov    $0x1,%eax
 8048065:   cd 80                   int    $0x80

08048067 <foo>:
 8048067:   55                      push   %ebp
 8048068:   89 e5                   mov    %esp,%ebp
 804806a:   8b 45 08                mov    0x8(%ebp),%eax
 804806d:   31 c0                   xor    %eax,%eax
 804806f:   89 ec                   mov    %ebp,%esp
 8048071:   5d                      pop    %ebp
 8048072:   c3                      ret
```

8048054 nop

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:        nop
->  8048055:        nop
    8048056:        pushl $0x2
    8048058:        call foo
    804805d:        addl $0x4, %esp
    8048060:        movl $0x1, %eax
    8048065:        int $0x80

                    .type foo, @function
                    foo:
    8048067:        pushl %ebp
    8048068:        movl %esp, %ebp
    804806a:        movl 8(%ebp), %eax
    804806d:        xorl %eax, %eax
    804806f:        movl %ebp, %esp
    8048071:        popl %ebp
    8048072:        ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e680
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048055

Stack

```
    0xbfc8e68c:     0xbfc8fb38
    0xbfc8e688:     0x00000000
    0xbfc8e684:     0xbfc8fb12
->  0xbfc8e680:     0x00000001
    0xbfc8e67c:     0x00000000
    0xbfc8e678:     0x00000000
    0xbfc8e674:     0x00000000
    0xbfc8e670:     0x00000000
```

8048055 nop

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:        nop
    8048055:        nop
->  8048056:        pushl $0x2
    8048058:        call foo
    804805d:        addl $0x4, %esp
    8048060:        movl $0x1, %eax
    8048065:        int $0x80

                    .type foo, @function
                    foo:
    8048067:        pushl %ebp
    8048068:        movl %esp, %ebp
    804806a:        movl 8(%ebp), %eax
    804806d:        xorl %eax, %eax
    804806f:        movl %ebp, %esp
    8048071:        popl %ebp
    8048072:        ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e680
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048056

Stack

```
    0xbfc8e68c:     0xbfc8fb38
    0xbfc8e688:     0x00000000
    0xbfc8e684:     0xbfc8fb12
->  0xbfc8e680:     0x00000001
    0xbfc8e67c:     0x00000000
    0xbfc8e678:     0x00000000
    0xbfc8e674:     0x00000000
    0xbfc8e670:     0x00000000
```

8048056 pushl $0x2

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:        nop
    8048055:        nop
    8048056:        pushl $0x2
->  8048058:        call foo
    804805d:        addl $0x4, %esp
    8048060:        movl $0x1, %eax
    8048065:        int $0x80

                    .type foo, @function
                    foo:
    8048067:        pushl %ebp
    8048068:        movl %esp, %ebp
    804806a:        movl 8(%ebp), %eax
    804806d:        xorl %eax, %eax
    804806f:        movl %ebp, %esp
    8048071:        popl %ebp
    8048072:        ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e67c
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048058

Stack

```
    0xbfc8e68c:     0xbfc8fb38
    0xbfc8e688:     0x00000000
    0xbfc8e684:     0xbfc8fb12
    0xbfc8e680:     0x00000001
->  0xbfc8e67c:     0x00000002
    0xbfc8e678:     0x00000000
    0xbfc8e674:     0x00000000
    0xbfc8e670:     0x00000000
```

Next IP

Push argument to stack

Stack grows downward

8048058 call foo

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:        nop
    8048055:        nop
    8048056:        pushl $0x2
    8048058:        call foo
    804805d:        addl $0x4, %esp
    8048060:        movl $0x1, %eax
    8048065:        int $0x80

                    .type foo, @function
                    foo:
->  8048067:        pushl %ebp
    8048068:        movl %esp, %ebp
    804806a:        movl 8(%ebp), %eax
    804806d:        xorl %eax, %eax
    804806f:        movl %ebp, %esp
    8048071:        popl %ebp
    8048072:        ret
```

Next IP

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e678
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048067

call pushes return address to stack

Stack

```
    0xbfc8e68c:     0xbfc8fb38
    0xbfc8e688:     0x00000000
    0xbfc8e684:     0xbfc8fb12
    0xbfc8e680:     0x00000001
    0xbfc8e67c:     0x00000002
->  0xbfc8e678:     0x0804805d
    0xbfc8e674:     0x00000000
    0xbfc8e670:     0x00000000
```

8048067 pushl %ebp

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:        nop
    8048055:        nop
    8048056:        pushl $0x2
    8048058:        call foo
    804805d:        addl $0x4, %esp
    8048060:        movl $0x1, %eax
    8048065:        int $0x80

                    .type foo, @function
                    foo:
    8048067:        pushl %ebp
->  8048068:        movl %esp, %ebp
    804806a:        movl 8(%ebp), %eax
    804806d:        xorl %eax, %eax
    804806f:        movl %ebp, %esp
    8048071:        popl %ebp
    8048072:        ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e674
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048068

Next IP

Stack

```
    0xbfc8e68c:     0xbfc8fb38
    0xbfc8e688:     0x00000000
    0xbfc8e684:     0xbfc8fb12
    0xbfc8e680:     0x00000001
    0xbfc8e67c:     0x00000002
    0xbfc8e678:     0x0804805d
->  0xbfc8e674:     0x00000000
    0xbfc8e670:     0x00000000
```

Save base pointer to stack

8048068 movl %esp, %ebp

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $0x2
    8048058:    call foo
    804805d:    addl $0x4, %esp
    8048060:    movl $0x1, %eax
    8048065:    int $0x80

                .type foo, @function
                foo:
    8048067:    pushl %ebp
    8048068:    movl %esp, %ebp
->  804806a:    movl 8(%ebp), %eax
    804806d:    xorl %eax, %eax
    804806f:    movl %ebp, %esp
    8048071:    popl %ebp
    8048072:    ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e674
ebp	0xbfc8e674
esi	0x0
edi	0x0
eip	0x804806a

Next IP

Stack

```
    0xbfc8e68c:    0xbfc8fb38
    0xbfc8e688:    0x00000000
    0xbfc8e684:    0xbfc8fb12
    0xbfc8e680:    0x00000001
    0xbfc8e67c:    0x00000002
    0xbfc8e678:    0x0804805d
->  0xbfc8e674:    0x00000000
    0xbfc8e670:    0x00000000
```

Use base pointer as reference

804806a movl 8(%ebp), %eax

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $0x2
    8048058:    call foo
    804805d:    addl $0x4, %esp
    8048060:    movl $0x1, %eax
    8048065:    int $0x80

                .type foo, @function
                foo:
    8048067:    pushl %ebp
    8048068:    movl %esp, %ebp
    804806a:    movl 8(%ebp), %eax
->  804806d:    xorl %eax, %eax
    804806f:    movl %ebp, %esp
    8048071:    popl %ebp
    8048072:    ret
```

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e674
ebp	0xbfc8e674
esi	0x0
edi	0x0
eip	0x804806d

Use the argument

Next IP

Stack

```
    0xbfc8e68c:    0xbfc8fb38
    0xbfc8e688:    0x00000000
    0xbfc8e684:    0xbfc8fb12
    0xbfc8e680:    0x00000001
    0xbfc8e67c:    0x00000002
    0xbfc8e678:    0x0804805d
->  0xbfc8e674:    0x00000000
    0xbfc8e670:    0x00000000
```

804806d xorl %eax, %eax

an operation on the argument

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $0x2
    8048058:    call foo
    804805d:    addl $0x4, %esp
    8048060:    movl $0x1, %eax
    8048065:    int $0x80

                .type foo, @function
                foo:
    8048067:    pushl %ebp
    8048068:    movl %esp, %ebp
    804806a:    movl 8(%ebp), %eax
    804806d:    xorl %eax, %eax
->  804806f:    movl %ebp, %esp
    8048071:    popl %ebp
    8048072:    ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e674
ebp	0xbfc8e674
esi	0x0
edi	0x0
eip	0x804806f

Next IP

Stack

```
    0xbfc8e68c:    0xbfc8fb38
    0xbfc8e688:    0x00000000
    0xbfc8e684:    0xbfc8fb12
    0xbfc8e680:    0x00000001
    0xbfc8e67c:    0x00000002
    0xbfc8e678:    0x0804805d
->  0xbfc8e674:    0x00000000
    0xbfc8e670:    0x00000000
```

804806f movl %ebp, %esp

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $0x2
    8048058:    call foo
    804805d:    addl $0x4, %esp
    8048060:    movl $0x1, %eax
    8048065:    int $0x80

                .type foo, @function
                foo:
    8048067:    pushl %ebp
    8048068:    movl %esp, %ebp
    804806a:    movl 8(%ebp), %eax
    804806d:    xorl %eax, %eax
    804806f:    movl %ebp, %esp
->  8048071:    popl %ebp
    8048072:    ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e674
ebp	0xbfc8e674
esi	0x0
edi	0x0
eip	0x8048071

Next IP

Stack

```
    0xbfc8e68c:    0xbfc8fb38
    0xbfc8e688:    0x00000000
    0xbfc8e684:    0xbfc8fb12
    0xbfc8e680:    0x00000001
    0xbfc8e67c:    0x00000002
    0xbfc8e678:    0x0804805d
->  0xbfc8e674:    0x00000000
    0xbfc8e670:    0x00000000
```

8048071 popl %ebp

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $0x2
    8048058:    call foo
    804805d:    addl $0x4, %esp
    8048060:    movl $0x1, %eax
    8048065:    int $0x80

                .type foo, @function
                foo:
    8048067:    pushl %ebp
    8048068:    movl %esp, %ebp
    804806a:    movl 8(%ebp), %eax
    804806d:    xorl %eax, %eax
    804806f:    movl %ebp, %esp
    8048071:    popl %ebp
->  8048072:    ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e678
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048072

Restore old base pointer

Next IP

Stack

```
    0xbfc8e68c:    0xbfc8fb38
    0xbfc8e688:    0x00000000
    0xbfc8e684:    0xbfc8fb12
    0xbfc8e680:    0x00000001
    0xbfc8e67c:    0x00000002
->  0xbfc8e678:    0x0804805d
    0xbfc8e674:    0x00000000
    0xbfc8e670:    0x00000000
```

8048072 ret

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:        nop
    8048055:        nop
    8048056:        pushl $0x2
    8048058:        call foo
->  804805d:        addl $0x4, %esp
    8048060:        movl $0x1, %eax
    8048065:        int $0x80

                    .type foo, @function
                    foo:
    8048067:        pushl %ebp
    8048068:        movl %esp, %ebp
    804806a:        movl 8(%ebp), %eax
    804806d:        xorl %eax, %eax
    804806f:        movl %ebp, %esp
    8048071:        popl %ebp
    8048072:        ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e67c
ebp	0x0
esi	0x0
edi	0x0
eip	0x804805d

ret restores saved return address to ip

Stack

```
    0xbfc8e68c:     0xbfc8fb38
    0xbfc8e688:     0x00000000
    0xbfc8e684:     0xbfc8fb12
    0xbfc8e680:     0x00000001
->  0xbfc8e67c:     0x00000002
    0xbfc8e678:     0x0804805d
    0xbfc8e674:     0x00000000
    0xbfc8e670:     0x00000000
```

804805d addl $0x4, %esp

Assembly

```
                    .section .text
                    .globl _start
                    _start:
    8048054:        nop
    8048055:        nop
    8048056:        pushl $0x2
    8048058:        call foo
    804805d:        addl $0x4, %esp
->  8048060:        movl $0x1, %eax
    8048065:        int $0x80

                    .type foo, @function
                    foo:
    8048067:        pushl %ebp
    8048068:        movl %esp, %ebp
    804806a:        movl 8(%ebp), %eax
    804806d:        xorl %eax, %eax
    804806f:        movl %ebp, %esp
    8048071:        popl %ebp
    8048072:        ret
```

Next IP

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e680
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048060

restore stack pointer for pushed argument

Stack

```
    0xbfc8e68c:     0xbfc8fb38
    0xbfc8e688:     0x00000000
    0xbfc8e684:     0xbfc8fb12
->  0xbfc8e680:     0x00000001
    0xbfc8e67c:     0x00000002
    0xbfc8e678:     0x0804805d
    0xbfc8e674:     0x00000000
    0xbfc8e670:     0x00000000
```

8048060 movl $0x1, %eax

Assembly

```
                .section .text
                .globl _start
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $0x2
    8048058:    call foo
    804805d:    addl $0x4, %esp
    8048060:    movl $0x1, %eax
->  8048065:    int $0x80

                .type foo, @function
                foo:
    8048067:    pushl %ebp
    8048068:    movl %esp, %ebp
    804806a:    movl 8(%ebp), %eax
    804806d:    xorl %eax, %eax
    804806f:    movl %ebp, %esp
    8048071:    popl %ebp
    8048072:    ret
```

Registers

eax	0x1
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbfc8e680
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048065

Stack

```
    0xbfc8e68c:    0xbfc8fb38
    0xbfc8e688:    0x00000000
    0xbfc8e684:    0xbfc8fb12
->  0xbfc8e680:    0x00000001
    0xbfc8e67c:    0x00000002
    0xbfc8e678:    0x0804805d
    0xbfc8e674:    0x00000000
    0xbfc8e670:    0x00000000
```

Program exited normally.

Recursive function - factorial

```
.section .data
.section .text
.globl _start
_start:
	nop
	nop
	push $3

	call factorial

	addl $4, %esp
	movl %eax, %ebx

	movl $1, %eax
	int $0x80
```

```
.type factorial, @function
factorial:
	pushl %ebp
	movl %esp, %ebp

	movl 8(%ebp), %eax
	cmpl $1, %eax
	je end_factorial

	decl %eax
	pushl %eax

	call factorial

	movl 8(%ebp), %ebx
	imull %ebx, %eax

end_factorial:
	movl %ebp, %esp
	popl %ebp
	ret
```

8048054 nop

Assembly

```
            _start:
    8048054:    nop
->  8048055:    nop
    8048056:    pushl $0x3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
          end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879260
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048055

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
->  0xbf879260:    0x00000001
    0xbf87925c:    0x00000000
    0xbf879258:    0x00000000
    0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048055 nop

Assembly

```
                _start:
    8048054:    nop
    8048055:    nop
->  8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

                factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
                end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879260
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048056

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
->  0xbf879260:    0x00000001
    0xbf87925c:    0x00000000
    0xbf879258:    0x00000000
    0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048056 pushl $3

Assembly

```
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
->  8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

                factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
                end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Calculate factorial of 3

Registers

```
eax     0x0
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbf87925c
ebp     0x0
esi     0x0
edi     0x0
eip     0x8048058
```

Stack grows downward

Stack

```
    0xbf87926c:     0xbf879b36
    0xbf879268:     0x00000000
    0xbf879264:     0xbf879b0f
    0xbf879260:     0x00000001
->  0xbf87925c:     0x00000003
    0xbf879258:     0x00000000
    0xbf879254:     0x00000000
    0xbf879250:     0x00000000
    0xbf87924c:     0x00000000
    0xbf879248:     0x00000000
    0xbf879244:     0x00000000
    0xbf879240:     0x00000000
    0xbf87923c:     0x00000000
```

8048058 call factorial

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
->  8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879258
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048069

call pushes return address to stack

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
->  0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048069 pushl %ebp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

          factorial:
    8048069:    pushl %ebp
->  804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879254
ebp	0x0
esi	0x0
edi	0x0
eip	0x804806a

Save base pointer to stack

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
->  0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

804806a movl %esp, %ebp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
->  804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x0
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879254
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x804806c

Use base pointer as reference

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
->  0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

804806c movl 8(%ebp), %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
->  804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
          end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

Use the argument

eax	0x3
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879254
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x804806f

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
->  0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

804806f cmpl $1, %eax

Assembly

```
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

                factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
->  8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
             end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

1 != 3

```
eax     0x3
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbf879254
ebp     0xbf879254
esi     0x0
edi     0x0
eip     0x8048072
```

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
->  0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048072 je end_factorial

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
->  8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

Flag not set

eax	0x3
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879254
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x8048074

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
->  0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048074 decl %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
->  8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879254
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x8048075

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
->  0xbf879254:    0x00000000
    0xbf879250:    0x00000000
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048075 pushl %eax

Assembly

```
            _start:
8048054:    nop
8048055:    nop
8048056:    pushl $3
8048058:    call factorial
804805d:    addl $0x4, %esp
9048060:    movl %eax, %ebx
8048062:    movl $0x1, %eax
8048067:    int $0x80

            factorial:
8048069:    pushl %ebp
804806a:    movl %esp, %ebp
804806c:    movl 8(%ebp), %eax
804806f:    cmpl $1, %eax
8048072:    je end_factorial
8048074:    decl %eax
8048075:    pushl %eax
->  8048076:    call factorial
804807b:    movl 8(%ebp), %ebx
804807e:    imull %ebx, %eax
        end_factorial:
8048081:    movl %ebp, %esp
8048083:    popl %ebp
8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879250
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x8048076

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
->  0xbf879250:    0x00000002
    0xbf87924c:    0x00000000
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048076 call factorial

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
->  8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf87924c
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x8048069

call pushes return address to stack

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
->  0xbf87924c:    0x0804807b
    0xbf879248:    0x00000000
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048069 pushl %ebp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
->  804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879248
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x804806a

Save base pointer to stack

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
->  0xbf879248:    0xbf879254
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

804806a movl %esp, %ebp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
->  804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879248
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x804806c

Use base pointer as reference

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
->  0xbf879248:    0xbf879254
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

804806c movl 8(%ebp), %eax

Assembly

```
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

              factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
->  804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
            end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

Use the argument

eax	0x2
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879248
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x804806f

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
->  0xbf879248:    0xbf879254
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

804806f cmpl $1, %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
->  8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

1 != 2

```
eax     0x2
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbf879248
ebp     0xbf879248
esi     0x0
edi     0x0
eip     0x8048072
```

Stack

```
    0xbf87926c:     0xbf879b36
    0xbf879268:     0x00000000
    0xbf879264:     0xbf879b0f
    0xbf879260:     0x00000001
    0xbf87925c:     0x00000003
    0xbf879258:     0x0804805d
    0xbf879254:     0x00000000
    0xbf879250:     0x00000002
    0xbf87924c:     0x0804807b
->  0xbf879248:     0xbf879254
    0xbf879244:     0x00000000
    0xbf879240:     0x00000000
    0xbf87923c:     0x00000000
```

8048072 je end_factorial

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
->  8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

Flag not set

eax	0x2
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879248
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x8048074

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
->  0xbf879248:    0xbf879254
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048074 decl %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
->  8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x1
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879248
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x8048075

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
->  0xbf879248:    0xbf879254
    0xbf879244:    0x00000000
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048075 pushl %eax

Assembly

```
            _start:
8048054:    nop
8048055:    nop
8048056:    pushl $3
8048058:    call factorial
804805d:    addl $0x4, %esp
9048060:    movl %eax, %ebx
8048062:    movl $0x1, %eax
8048067:    int $0x80

          factorial:
8048069:    pushl %ebp
804806a:    movl %esp, %ebp
804806c:    movl 8(%ebp), %eax
804806f:    cmpl $1, %eax
8048072:    je end_factorial
8048074:    decl %eax
8048075:    pushl %eax
->  8048076:    call factorial
804807b:    movl 8(%ebp), %ebx
804807e:    imull %ebx, %eax
        end_factorial:
8048081:    movl %ebp, %esp
8048083:    popl %ebp
8048084:    ret
```

Next IP

Registers

eax	0x1
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879244
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x8048076

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
->  0xbf879244:    0x00000001
    0xbf879240:    0x00000000
    0xbf87923c:    0x00000000
```

8048076 call factorial

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
->  8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

```
eax     0x1
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbf879240
ebp     0xbf879248
esi     0x0
edi     0x0
eip     0x8048069
```

call pushes return address to stack

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
->  0xbf879240:    0x0804807b
    0xbf87923c:    0x00000000
```

8048069 pushl %ebp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
->  804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

```
eax     0x1
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbf87923c
ebp     0xbf879248
esi     0x0
edi     0x0
eip     0x804806a
```

Save base pointer to stack

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
->  0xbf87923c:    0xbf879248
```

804806a movl %esp, %ebp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

          factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
->  804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

```
eax     0x1
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbf87923c
ebp     0xbf87923c
esi     0x0
edi     0x0
eip     0x804806c
```

Use base pointer as reference

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
->  0xbf87923c:    0xbf879248
```

804806c movl 8(%ebp), %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
->  804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
          end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

Use the argument

eax	0x1
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf87923c
ebp	0xbf87923c
esi	0x0
edi	0x0
eip	0x804806f

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
->  0xbf87923c:    0xbf879248
```

804806f cmpl $1, %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
->  8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

1 == 1

```
eax     0x1
ecx     0x0
edx     0x0
ebx     0x0
esp     0xbf87923c
ebp     0xbf87923c
esi     0x0
edi     0x0
eip     0x8048072
```

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
->  0xbf87923c:    0xbf879248
```

8048072 je end_factorial

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
->  8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x1
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf87923c
ebp	0xbf87923c
esi	0x0
edi	0x0
eip	0x8048081

Flag is set

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
->  0xbf87923c:    0xbf879248
```

8048081 movl %ebp, %esp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
->  8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x1
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf87923c
ebp	0xbf87923c
esi	0x0
edi	0x0
eip	0x8048083

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
->  0xbf87923c:    0xbf879248
```

8048083 popl %ebp

Assembly

```
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

                factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
                end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
->  8048084:    ret
```

Next IP

Registers

eax	0x1
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879240
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x8048084

Restore old base pointer

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
->  0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048084 ret

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
->  804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x1
ecx	0x0
edx	0x0
ebx	0x0
esp	0xbf879244
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x804807b

ret restores saved return address to ip

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
->  0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

804807b movl 8(%ebp), %ebx

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
->  804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x1
ecx	0x0
edx	0x0
ebx	0x2
esp	0xbf879244
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x804807e

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
->  0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

804807e imull %ebx, %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
->  8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x2
esp	0xbf879244
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x8048081

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
->  0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048081 movl %ebp, %esp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
->  8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x2
esp	0xbf879248
ebp	0xbf879248
esi	0x0
edi	0x0
eip	0x8048083

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
->  0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048083 pop %ebp

Assembly

```
                _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

                factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
                end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
->  8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x2
esp	0xbf87924c
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x8048084

Restore old base pointer

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
->  0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048084 ret

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
->  804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x2
esp	0xbf879250
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x804807b

ret restores saved return address to ip

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
->  0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

804807b movl 8(%ebp), %ebx

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
->  804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x2
ecx	0x0
edx	0x0
ebx	0x3
esp	0xbf879250
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x804807e

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
->  0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

804807e imull %ebx, %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
->  8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x6
ecx	0x0
edx	0x0
ebx	0x3
esp	0xbf879250
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x8048081

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
->  0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048081 movl %ebp, %esp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
->  8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x6
ecx	0x0
edx	0x0
ebx	0x3
esp	0xbf879254
ebp	0xbf879254
esi	0x0
edi	0x0
eip	0x8048083

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
->  0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048083 popl %ebp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
->  8048084:    ret
```

Next IP

Registers

eax	0x6
ecx	0x0
edx	0x0
ebx	0x3
esp	0xbf879258
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048084

Restore old base pointer

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
->  0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048084 ret

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
->  804805d:    addl $0x4, %esp
    9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
          end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

```
eax     0x6
ecx     0x0
edx     0x0
ebx     0x3
esp     0xbf87925c
ebp     0x0
esi     0x0
edi     0x0
eip     0x804805d
```

ret restores saved return address to ip

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
    0xbf879260:    0x00000001
->  0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

804805d addl $0x4, %esp

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
->  9048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x6
ecx	0x0
edx	0x0
ebx	0x3
esp	0xbf879260
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048060

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
->  0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048060 movl %eax, %ebx

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    8048060:    movl %eax, %ebx
->  8048062:    movl $0x1, %eax
    8048067:    int $0x80

            factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
          end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

eax	0x6
ecx	0x0
edx	0x0
ebx	0x6
esp	0xbf879260
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048062

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
->  0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

8048062 movl $0x1, %eax

Assembly

```
            _start:
    8048054:    nop
    8048055:    nop
    8048056:    pushl $3
    8048058:    call factorial
    804805d:    addl $0x4, %esp
    8048060:    movl %eax, %ebx
    8048062:    movl $0x1, %eax
->  8048067:    int $0x80

          factorial:
    8048069:    pushl %ebp
    804806a:    movl %esp, %ebp
    804806c:    movl 8(%ebp), %eax
    804806f:    cmpl $1, %eax
    8048072:    je end_factorial
    8048074:    decl %eax
    8048075:    pushl %eax
    8048076:    call factorial
    804807b:    movl 8(%ebp), %ebx
    804807e:    imull %ebx, %eax
        end_factorial:
    8048081:    movl %ebp, %esp
    8048083:    popl %ebp
    8048084:    ret
```

Next IP

Registers

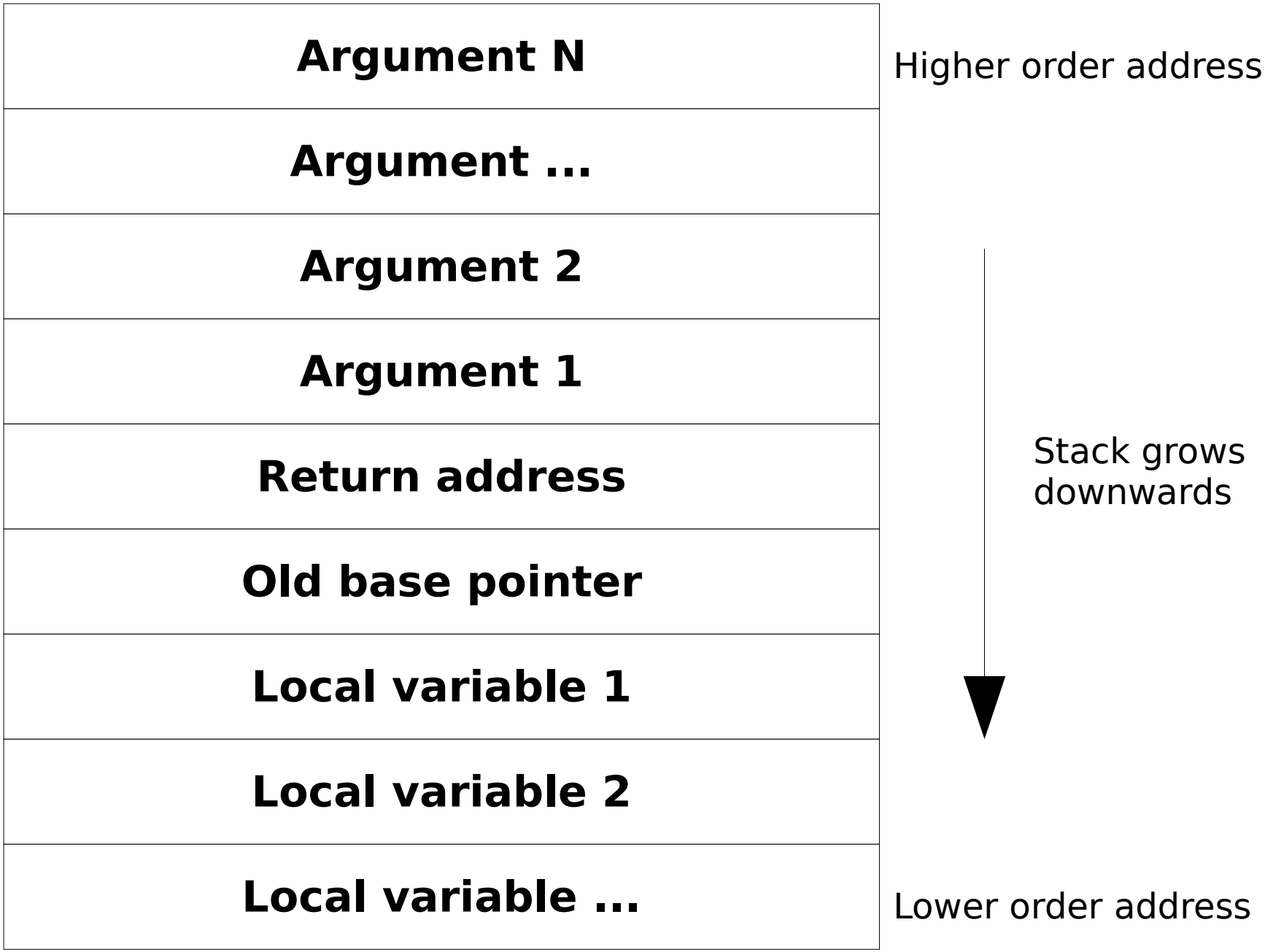
eax	0x1
ecx	0x0
edx	0x0
ebx	0x6
esp	0xbf879260
ebp	0x0
esi	0x0
edi	0x0
eip	0x8048067

Stack

```
    0xbf87926c:    0xbf879b36
    0xbf879268:    0x00000000
    0xbf879264:    0xbf879b0f
->  0xbf879260:    0x00000001
    0xbf87925c:    0x00000003
    0xbf879258:    0x0804805d
    0xbf879254:    0x00000000
    0xbf879250:    0x00000002
    0xbf87924c:    0x0804807b
    0xbf879248:    0xbf879254
    0xbf879244:    0x00000001
    0xbf879240:    0x0804807b
    0xbf87923c:    0xbf879248
```

Program exited normally.

Stack Summary



References

- Richard Blum. 2005. *Professional Assembly Language*. Wrox.
- Jonathan Bartlett. 2003. *Programming from the Ground Up*.