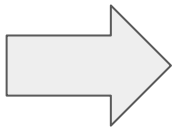
Runtime Stack

COMP201 Lab Session
Spring 2021

KOÇ
UNIVERSITY

Example Code

```
int foo1()
{
        int i = 2;
        return i;
}
int foo()
{
        int i = 5;
        return foo1();
}
```



```
0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $2, -0x4(rbp)
        movl -0x4(rbp), eax
        movq rbp, rsp
        pop rbp
        ret
0x0000000000400626 <foo>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $5,  -0x4(rbp)
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```

Execution Flow

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0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
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        ret
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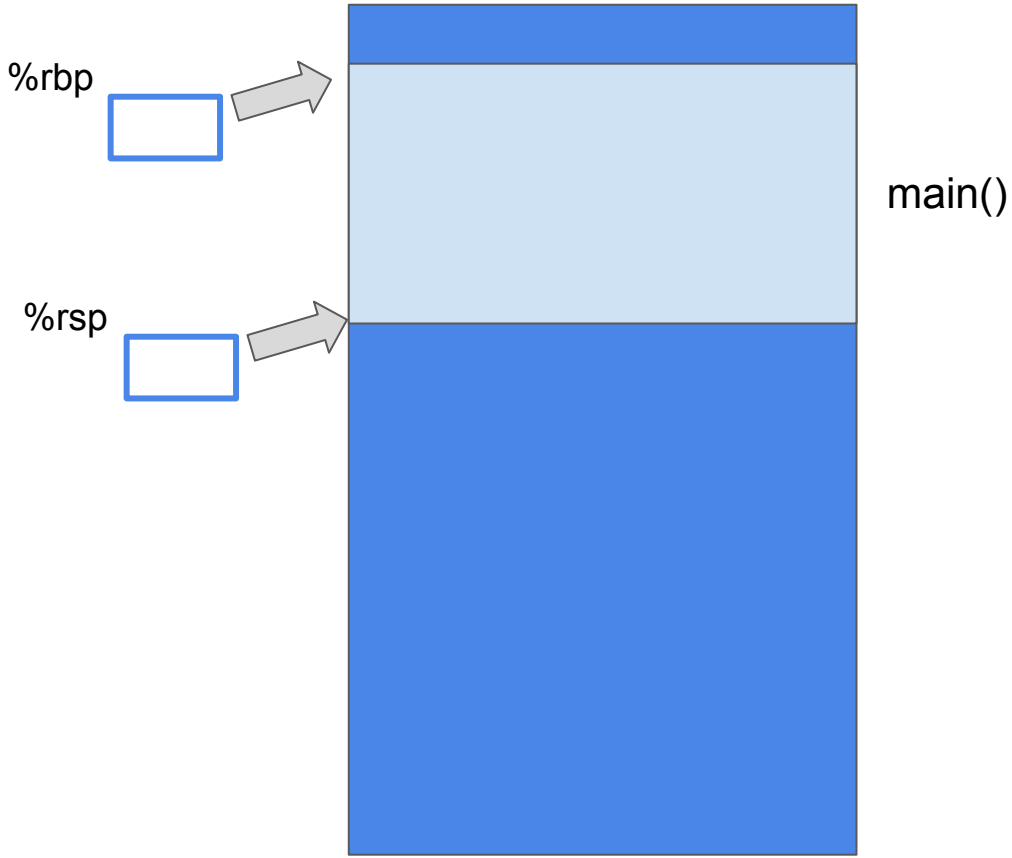

Execution Flow

```
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        push rbp
        movq rsp, rbp
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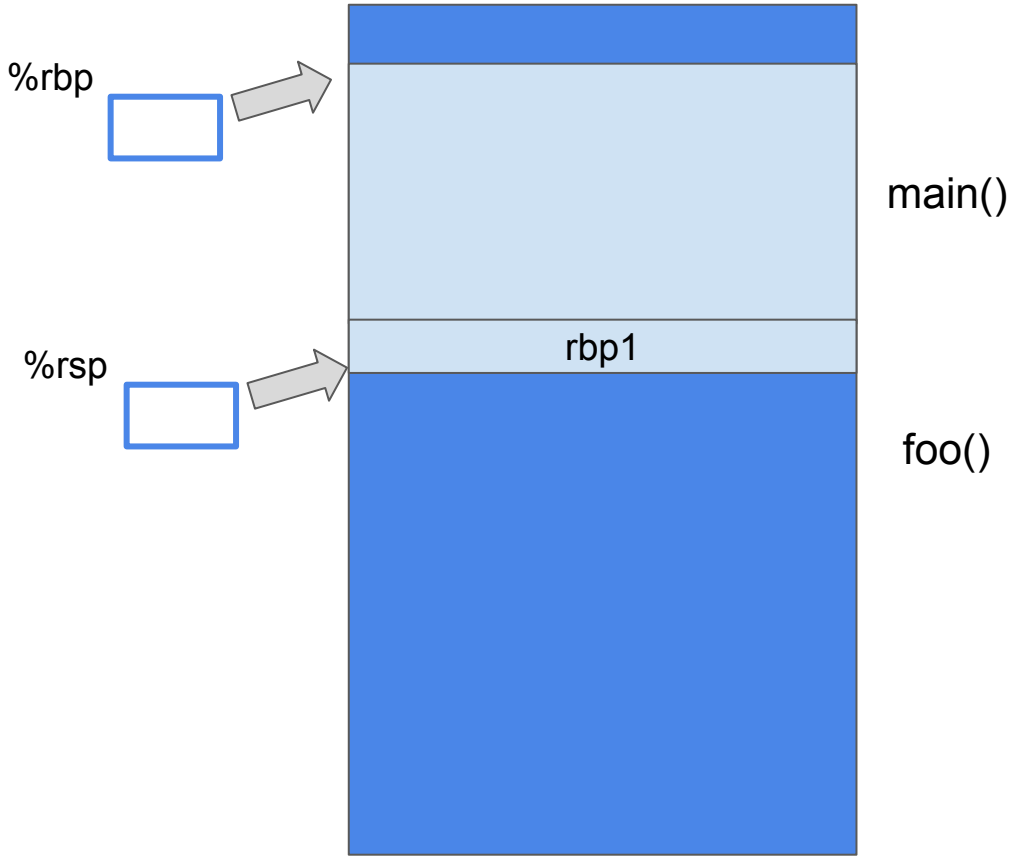
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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        push rbp
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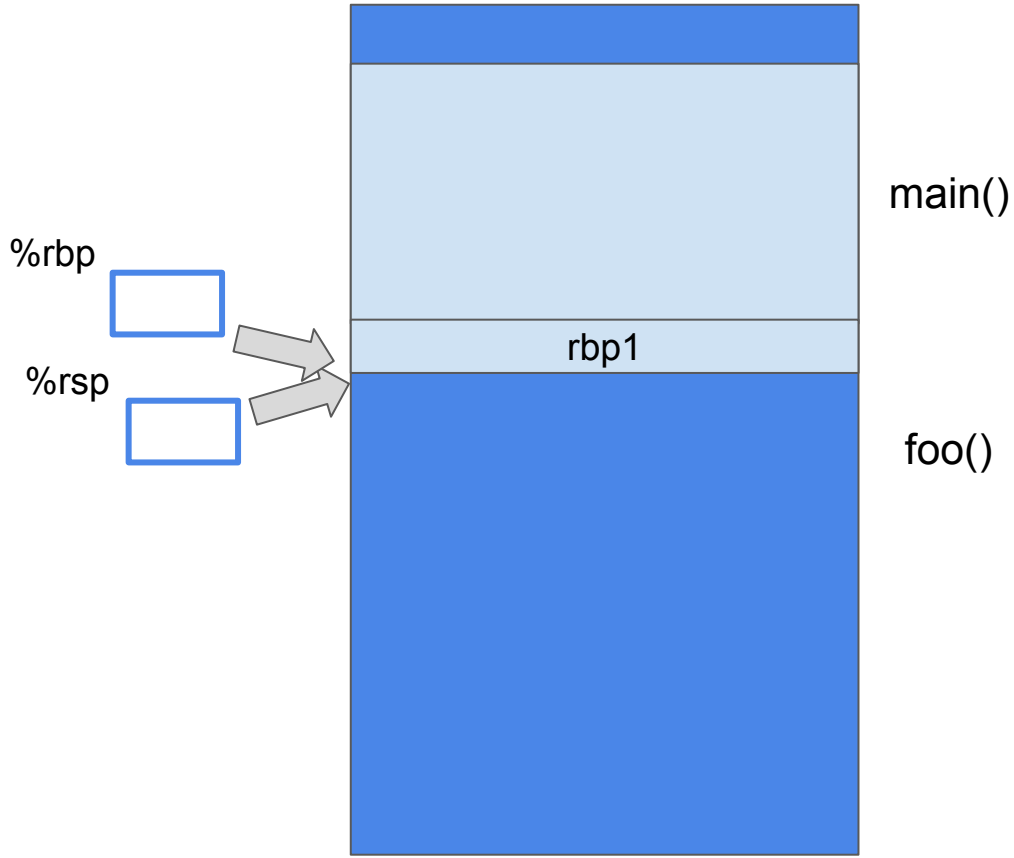
        sub 16, rsp
        movl $5,  -0x4(rbp)
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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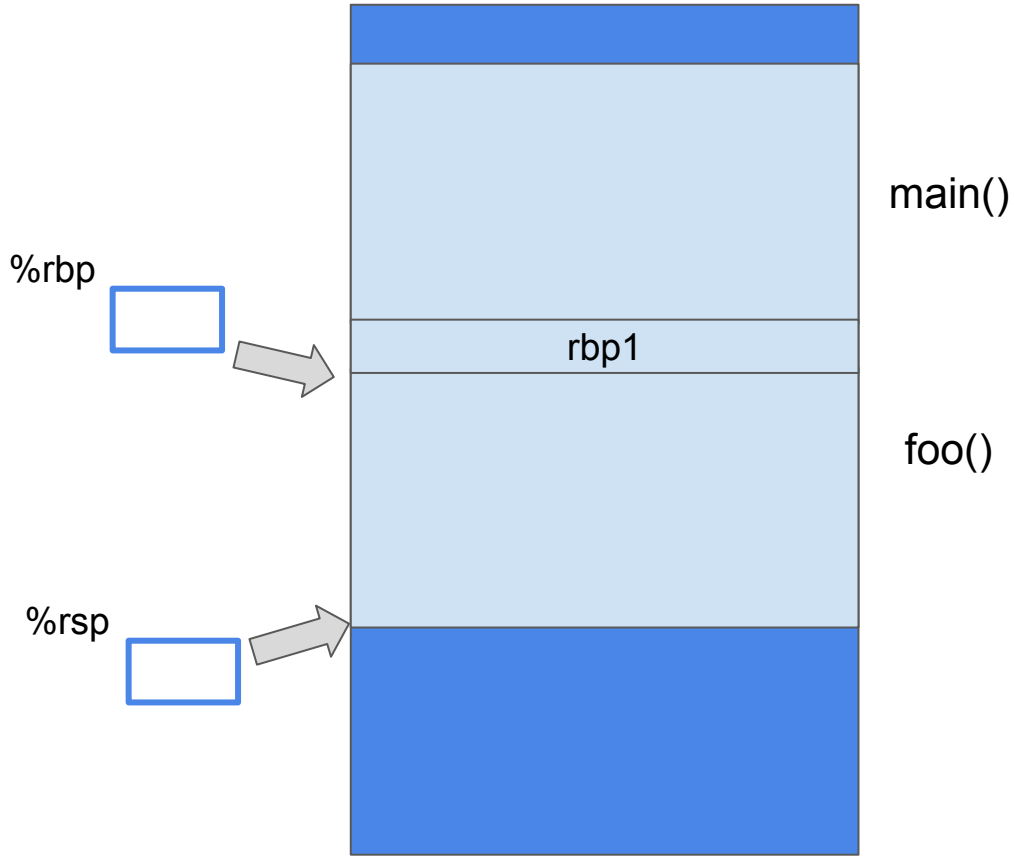
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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0x0000000000400546 <foo1>:
        push rbp
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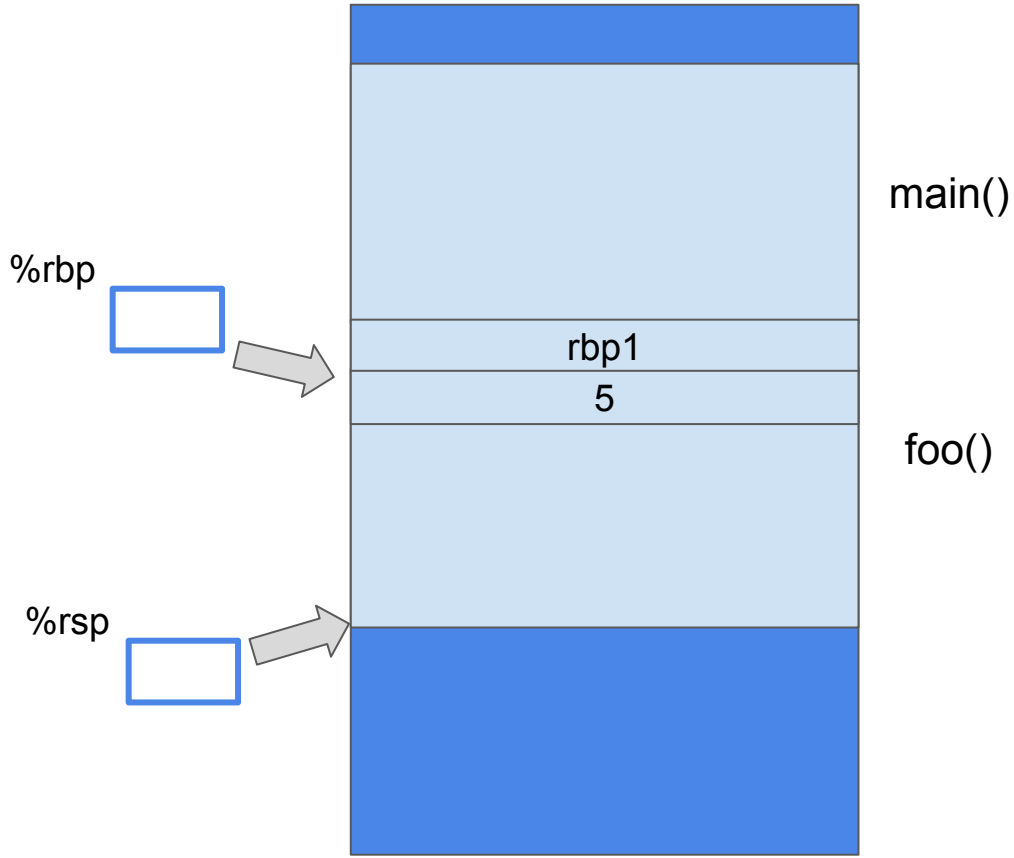
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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        call 0x400546 <foo1>
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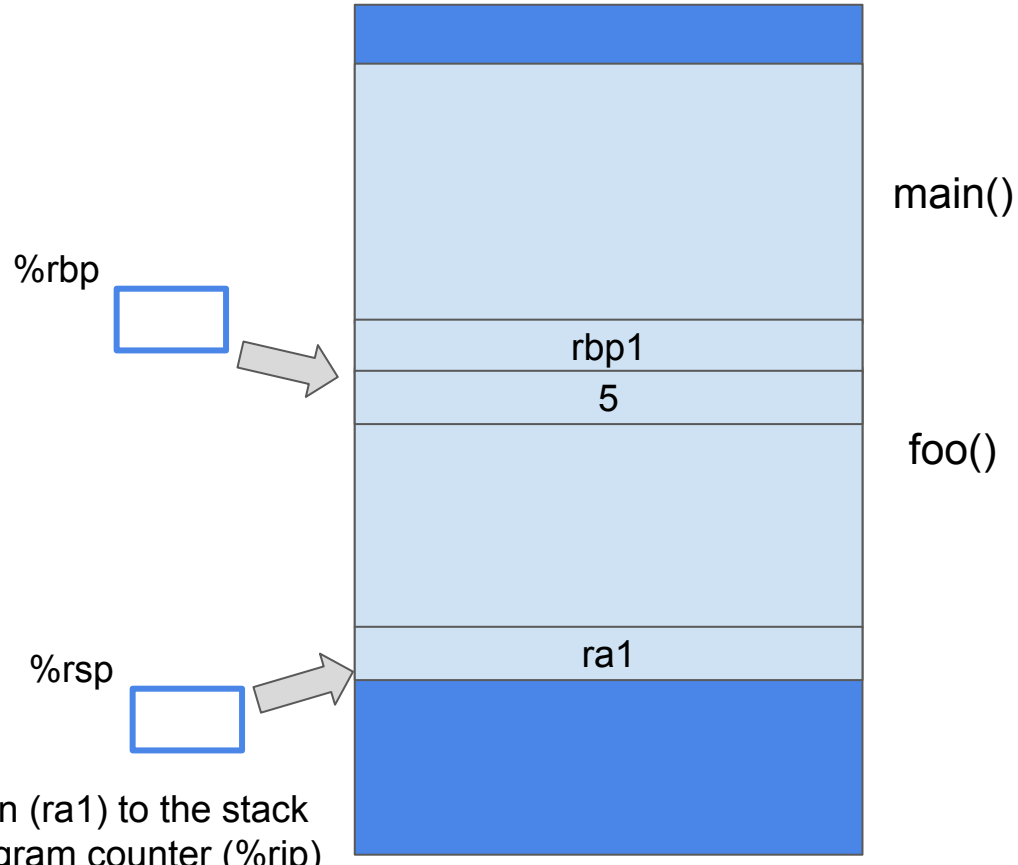
        pop rbp
        ret
```

ra1



call pushes the address of the next instruction (ra1) to the stack and puts the address of foo1 label to the program counter (%rip)

Execution Flow

```
0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $2, -0x4(rbp)
        movl -0x4(rbp), eax
        movq rbp, rsp
        pop rbp
        ret
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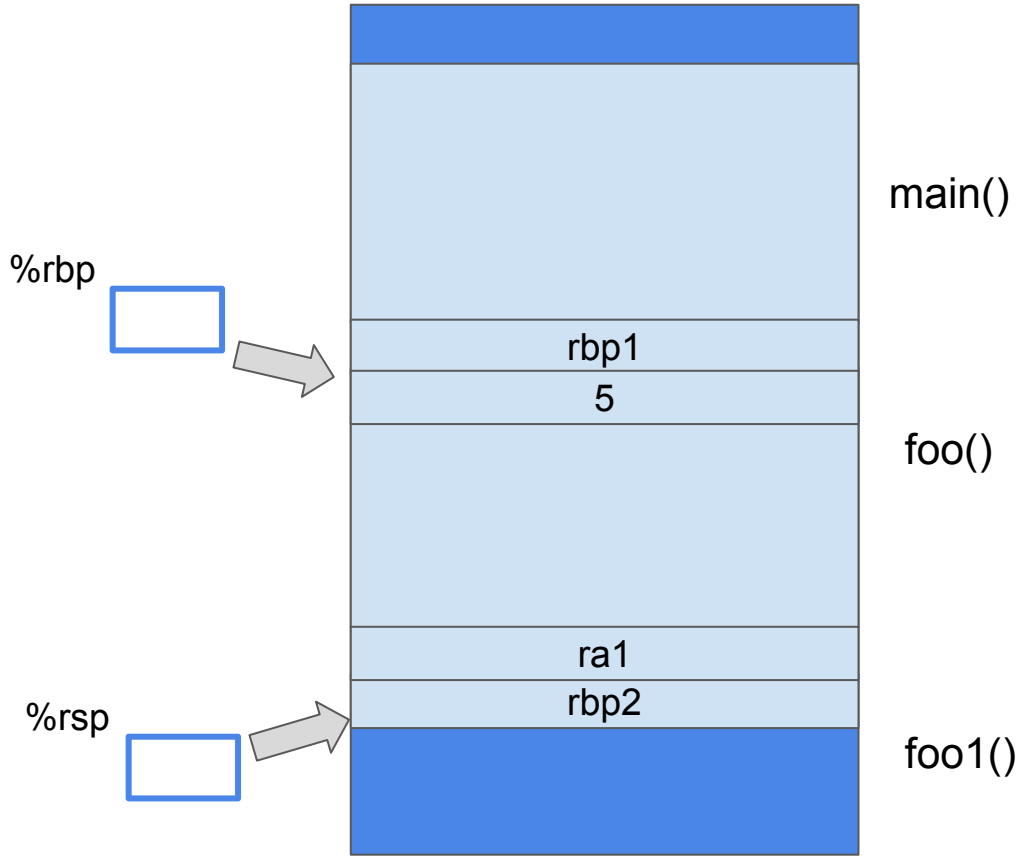
        movq rsp, rbp
        sub 16, rsp
        movl $5,  -0x4(rbp)
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
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        movq rbp, rsp
        pop rbp
        ret
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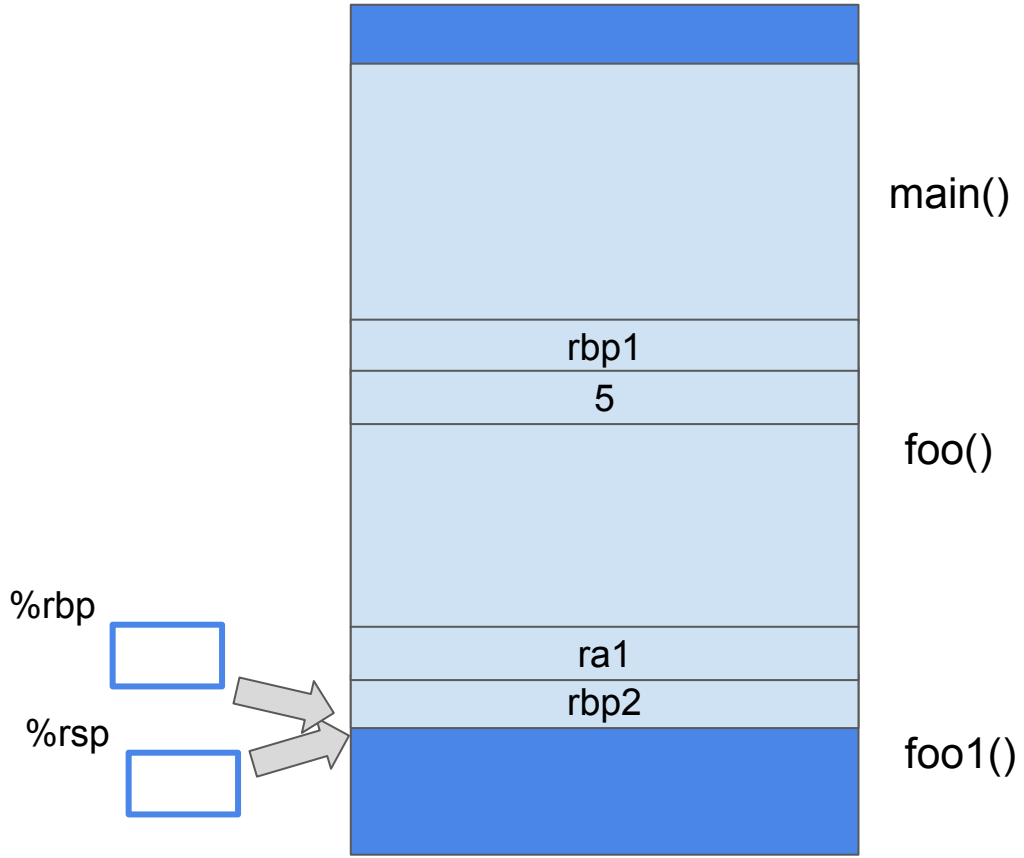
        movq rsp, rbp
        sub 16, rsp
        movl $5,  -0x4(rbp)
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $2, -0x4(rbp)
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        movq rbp, rsp
        pop rbp
        ret
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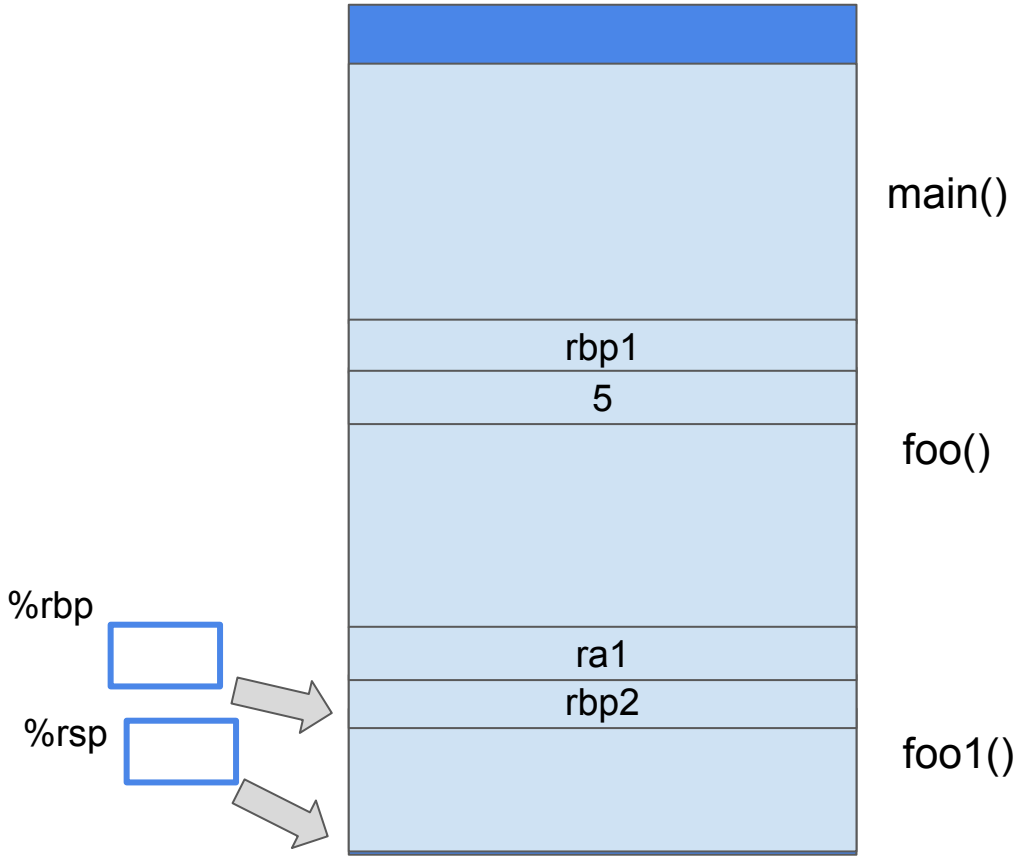
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
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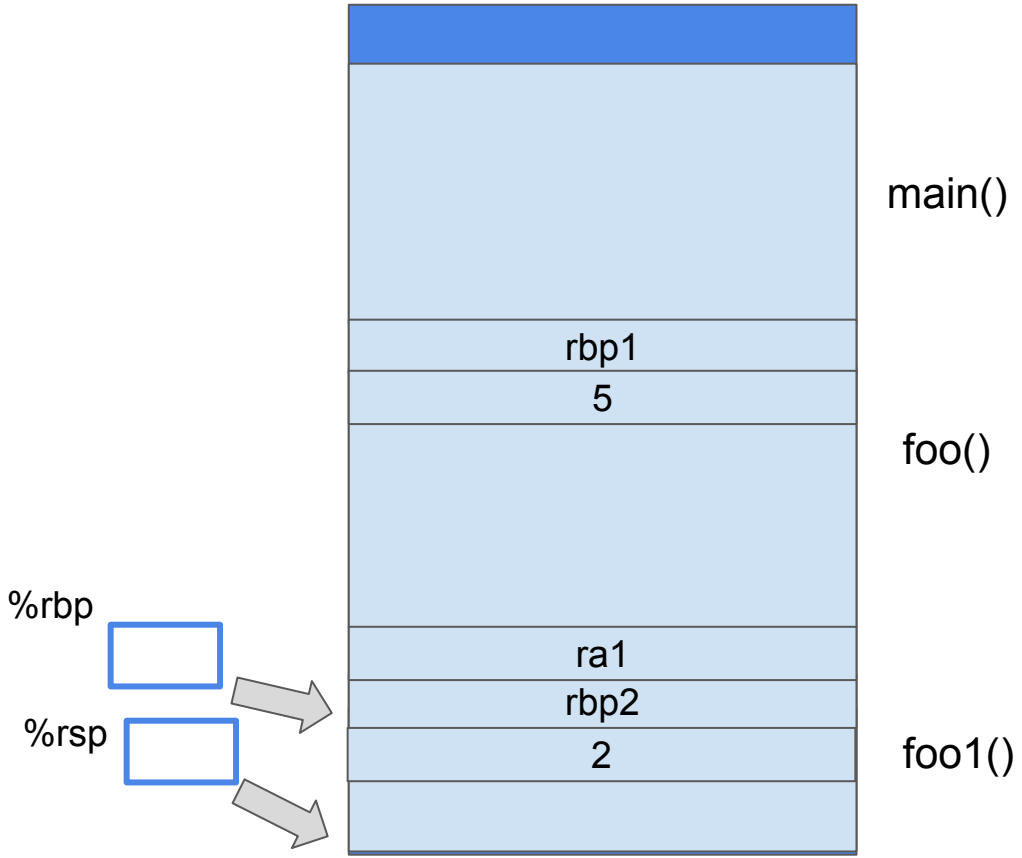
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $2, -0x4(rbp)
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        movq rbp, rsp
        pop rbp
        ret
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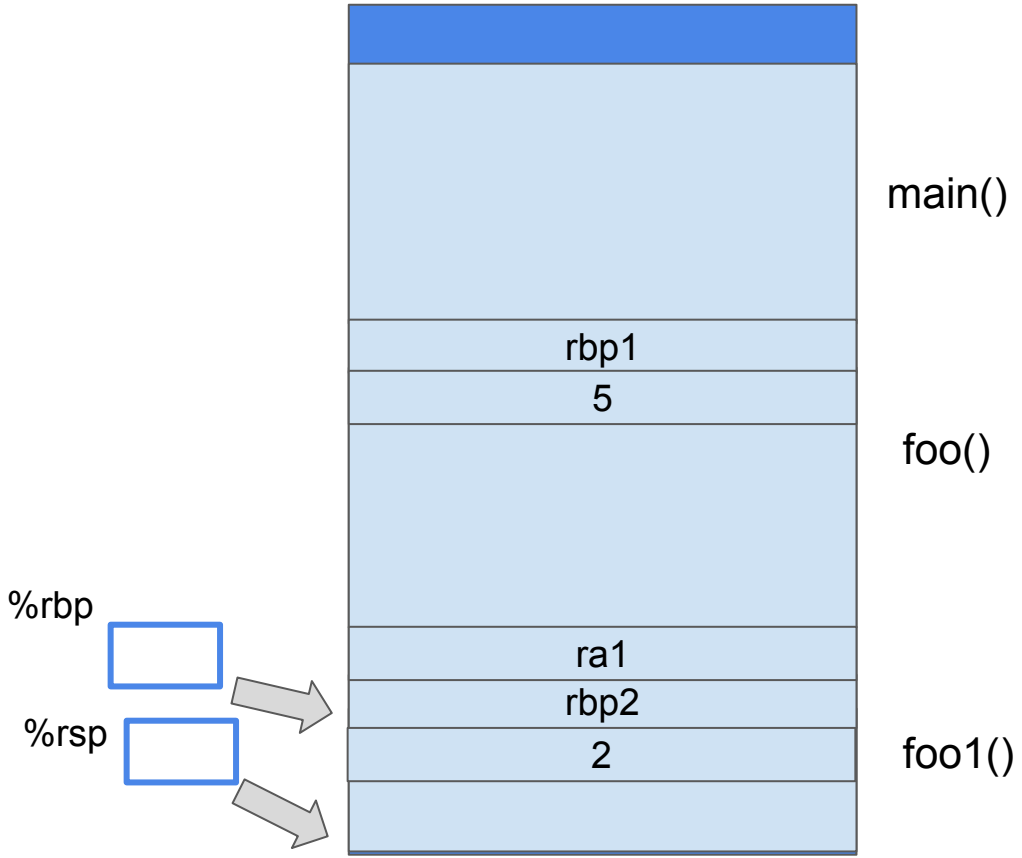
        movq rsp, rbp
        sub 16, rsp
        movl $5,  -0x4(rbp)
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $2, -0x4(rbp)
        movl -0x4(rbp), eax
        movq rbp, rsp
        pop rbp
        ret
0x0000000000400626 <foo>:
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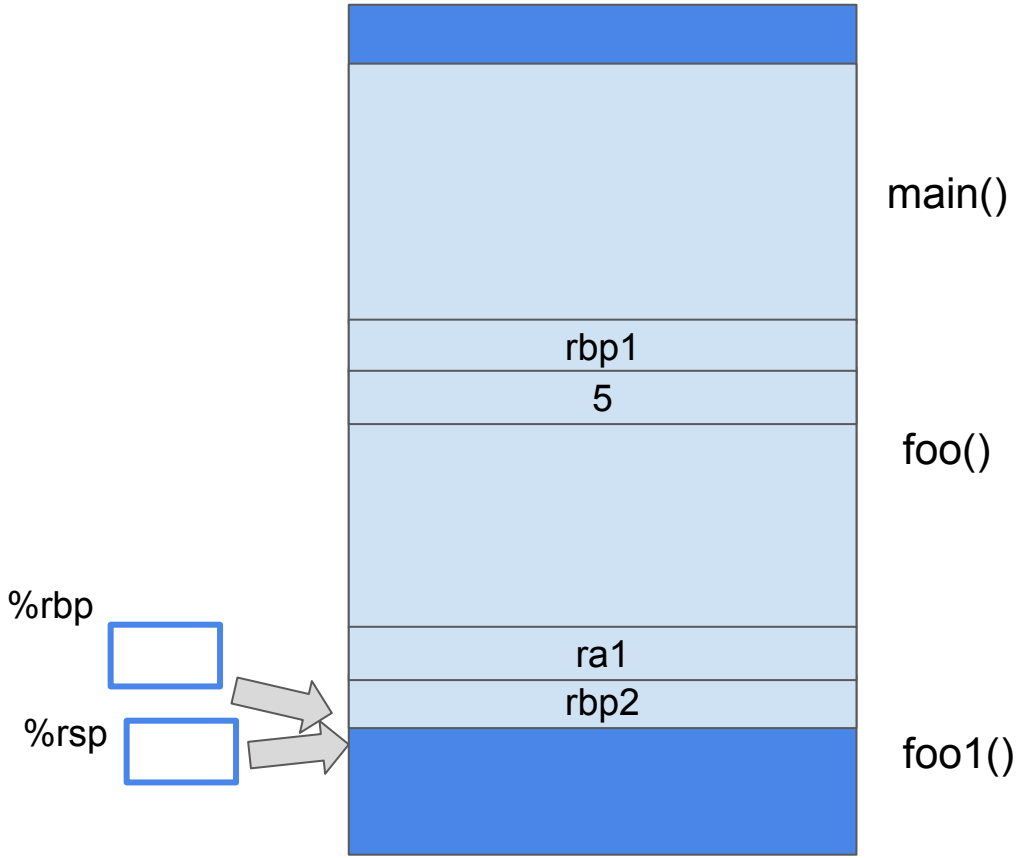
        movq rsp, rbp
        sub 16, rsp
        movl $5,  -0x4(rbp)
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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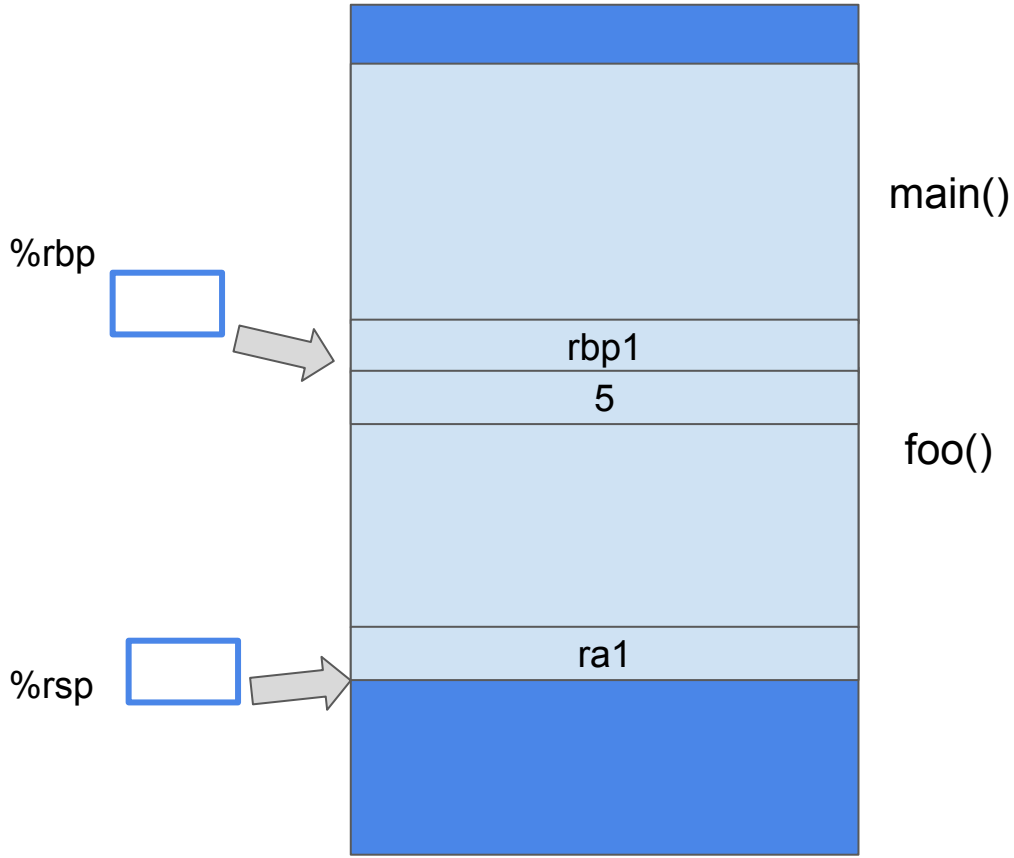
0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $2, -0x4(rbp)
        movl -0x4(rbp), eax
        movq rbp, rsp
        pop rbp
        ret
0x0000000000400626 <foo>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $5,  -0x4(rbp)
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
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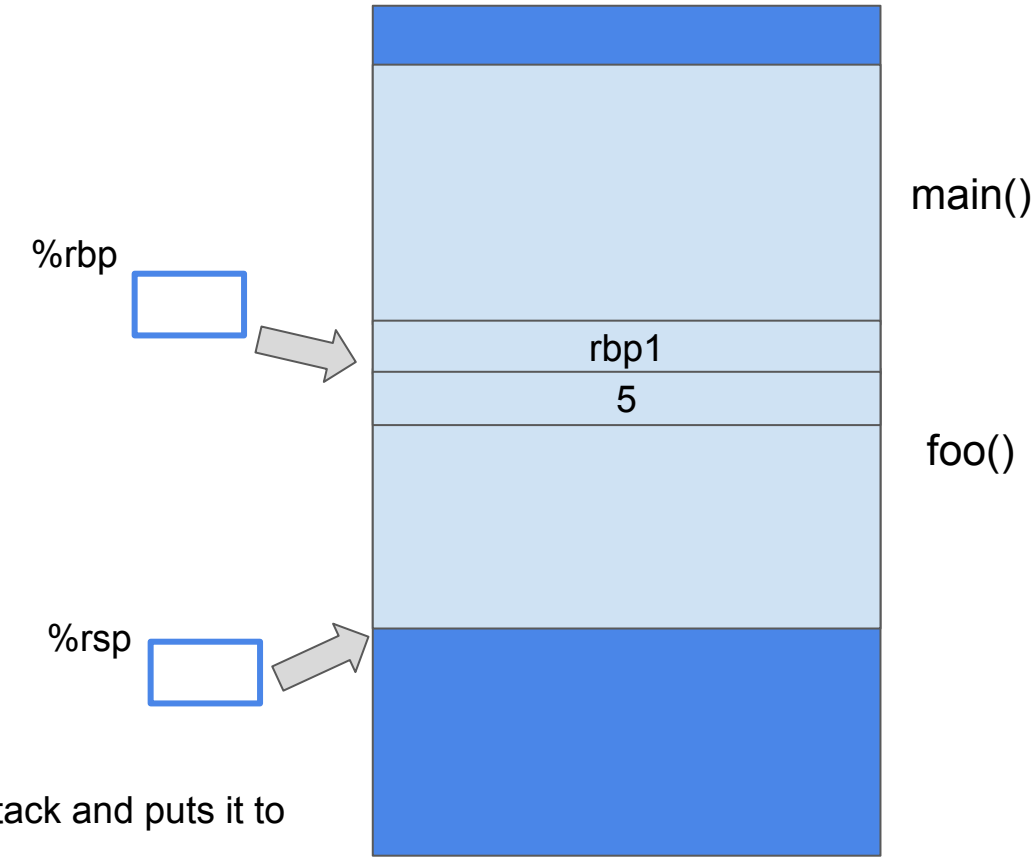
        movq rbp, rsp
        pop rbp
        ret
0x0000000000400626 <foo>:
        push rbp
        movq rsp, rbp
        sub 16, rsp
        movl $5,  -0x4(rbp)
        call 0x400546 <foo1>
        movq rbp, rsp   <-- ra1
        pop rbp
        ret
```



ret pops the return address (ra1) from the stack and puts it to %rip.

Execution Flow

```
0x0000000000400546 <foo1>:
        push rbp
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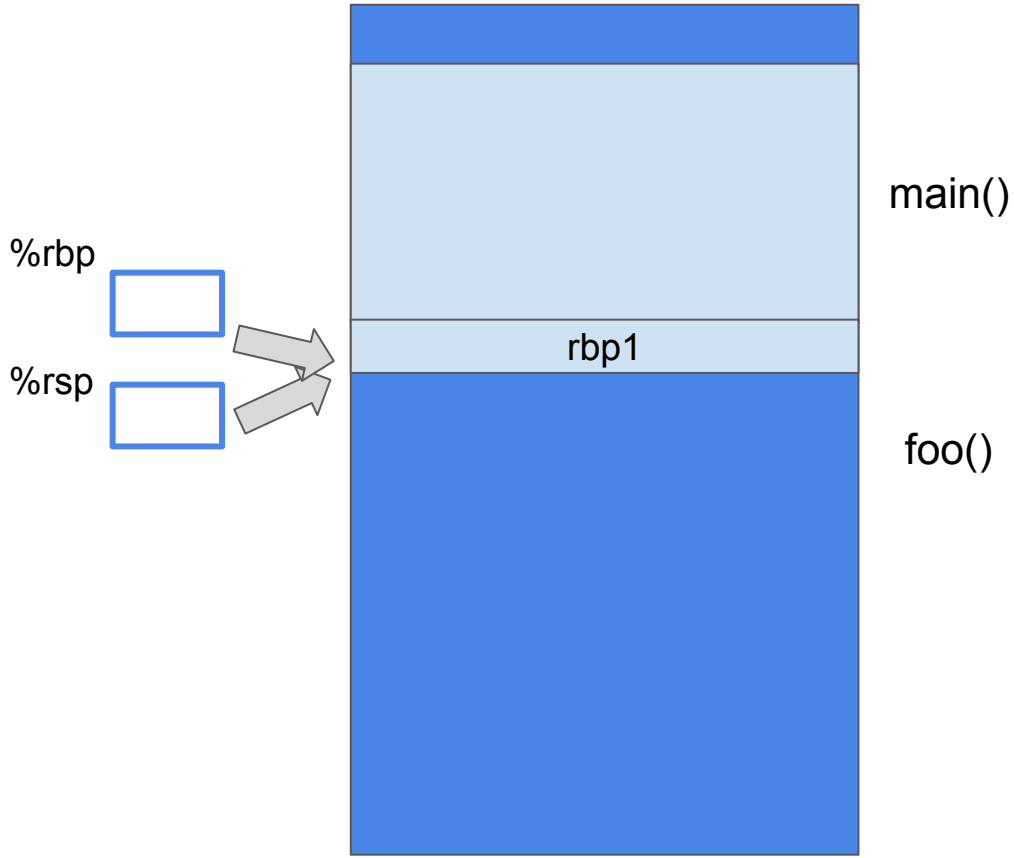
        movq rbp, rsp
        pop rbp
        ret
```



Execution Flow

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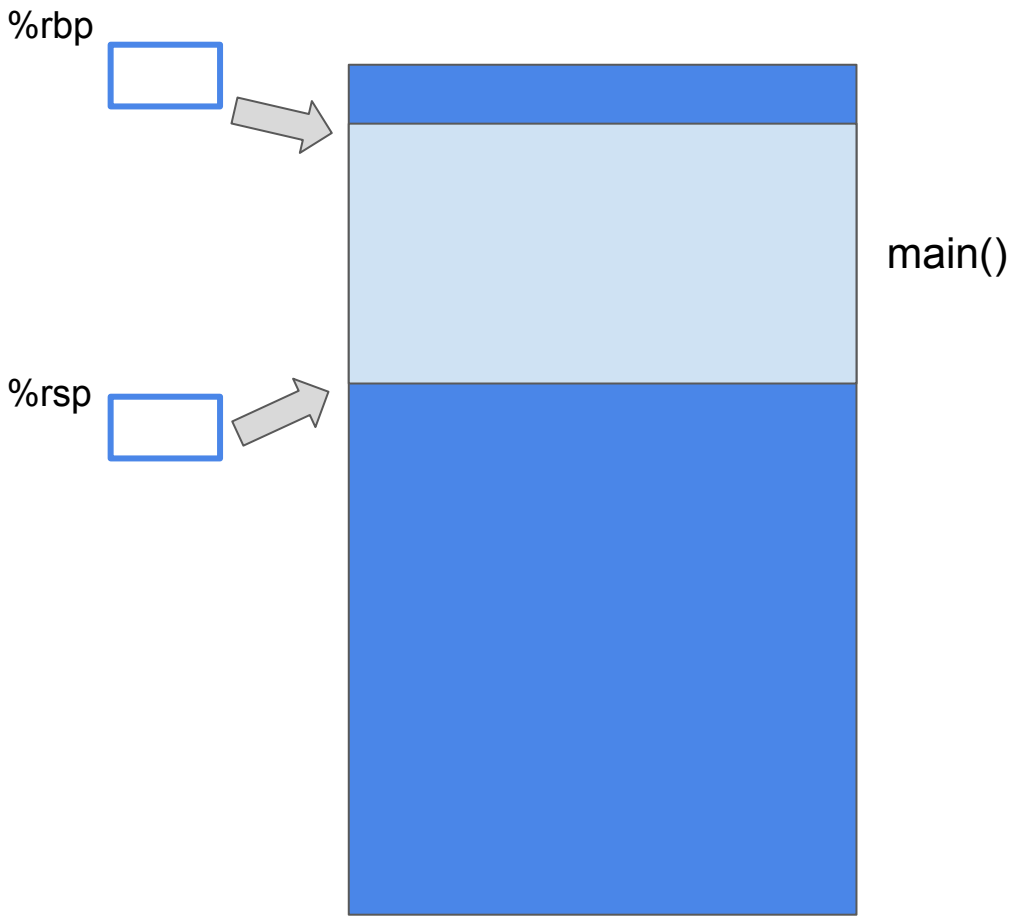
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



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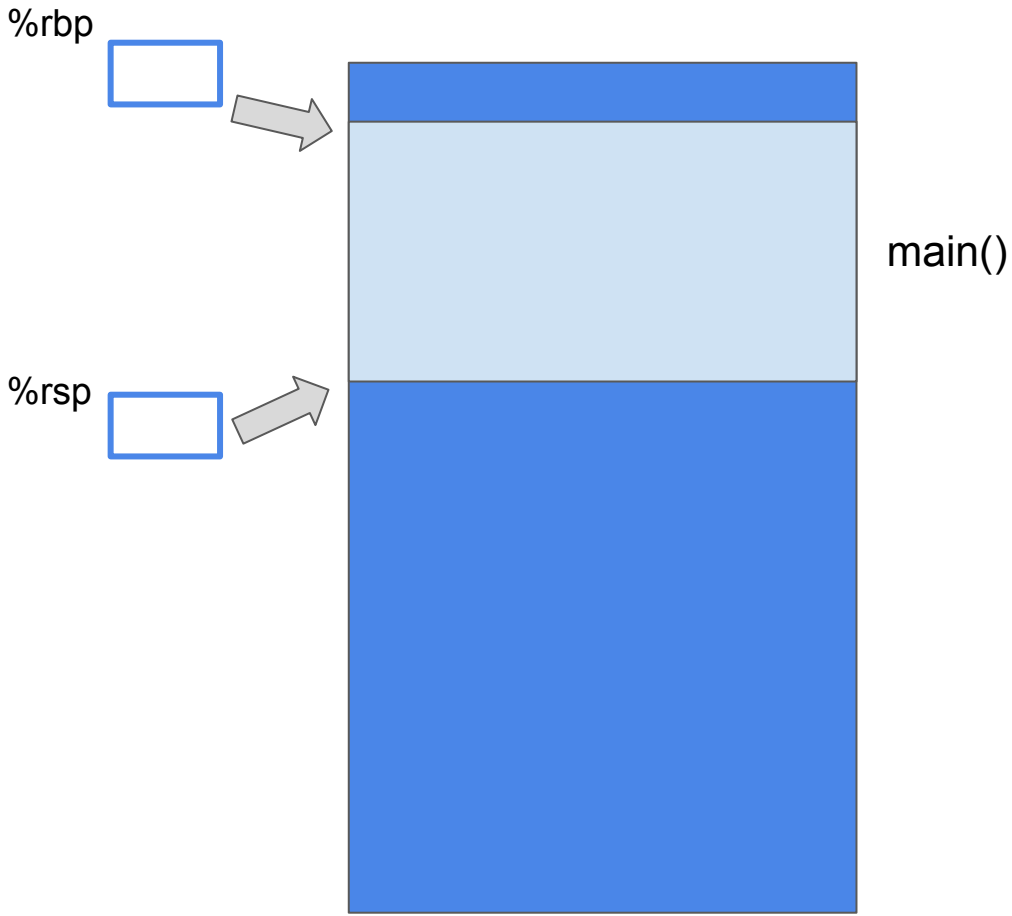
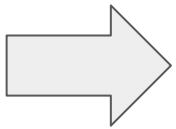
        call 0x400546 <foo1>
        movq rbp, rsp
        pop rbp
        ret
```



How to pass parameters to a called function??

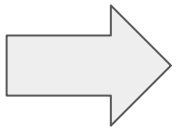
```
int foo1(int a, int b, int c)
{
        return a+b+c;
}
int foo()
{
        return foo1(1,2,3);
}
```



```
0x0000000000400546 <foo1>:
        push rbp
        movq rsp, rbp
        movl edi, -0x4(rbp)
        movl esi, -0x8(rbp)
        movl edx, -0xc(rbp)
        movl -0x4(rbp), edx
        mov -0x8(rbp), eax
        add eax, edx
        mov -0xc(rbp), eax
        add edx, eax
        pop rbp
        ret
0x0000000000400626 <foo>:
        push rbp
        movq rsp, rbp
        movl $3, edx
        movl $2, esi
        movl $1, edi
        call 0x400546 <foo1>
        pop rbp
        ret
```

How to pass parameters to a called function??

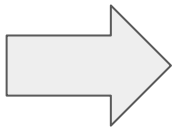
```
int foo1(int a, int b, int c, int d, int e,
int f)
{
        ……..
}
int foo()
{
        return foo1(1,2,3,4,5,6);
}
```



```
0x0000000000400546 <foo1>:
        ……..
0x0000000000400626 <foo>:
        push rbp
        mov rsp, rbp
        movl $6, r9d
        movl $5, r8d
        movl $4, ecx
        movl $3, edx
        movl $2, esi
        movl $1, edi
        call 0x400546 <foo1>:
        pop rbp
        ret
```

How to pass parameters to a called function??

```
int foo1(int a, int b, int c, int d, int e,
int f, int g, int h)
{
        ……..
}
int foo()
{
        return foo1(1,2,3,4,5,6,7,8);
}
```



```
0x0000000000400546 <foo1>:
        ……..
0x0000000000400626 <foo>:
        push rbp
        mov rsp, rbp
        sub 16, rsp
        push 8
        push 7
        mov $6, r9d
        mov $5, r8d
        mov $4, ecx
        mov $3, edx
        mov $2, esi
        mov $1, edi
        call 0x400546 <foo1>
        add 16, rsp
        leave
        ret
```