Virtual Memory. The Stack

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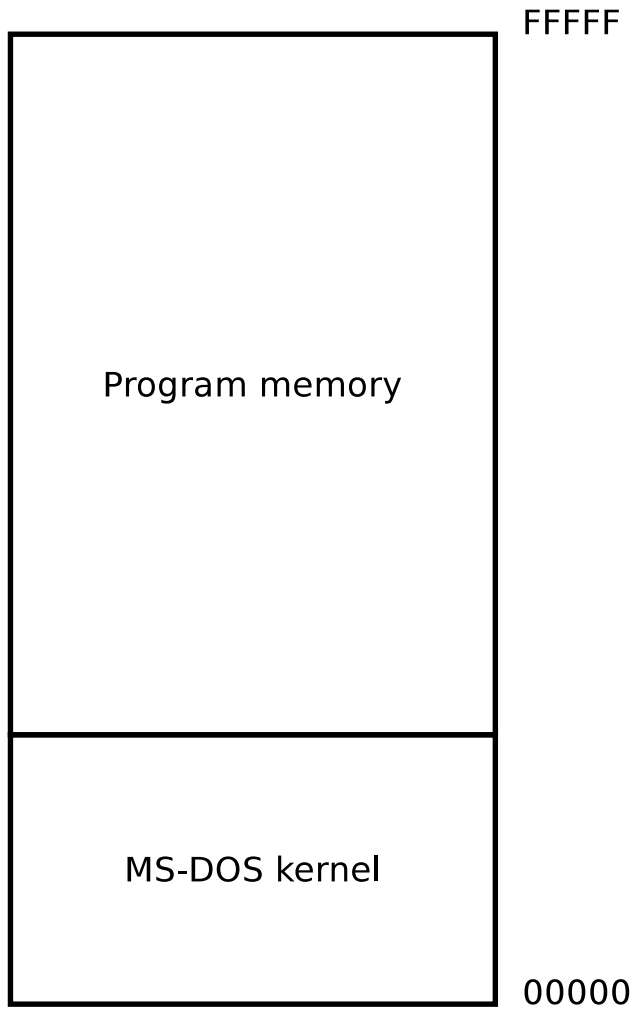
ROSEdu Summer Workshops

Overview

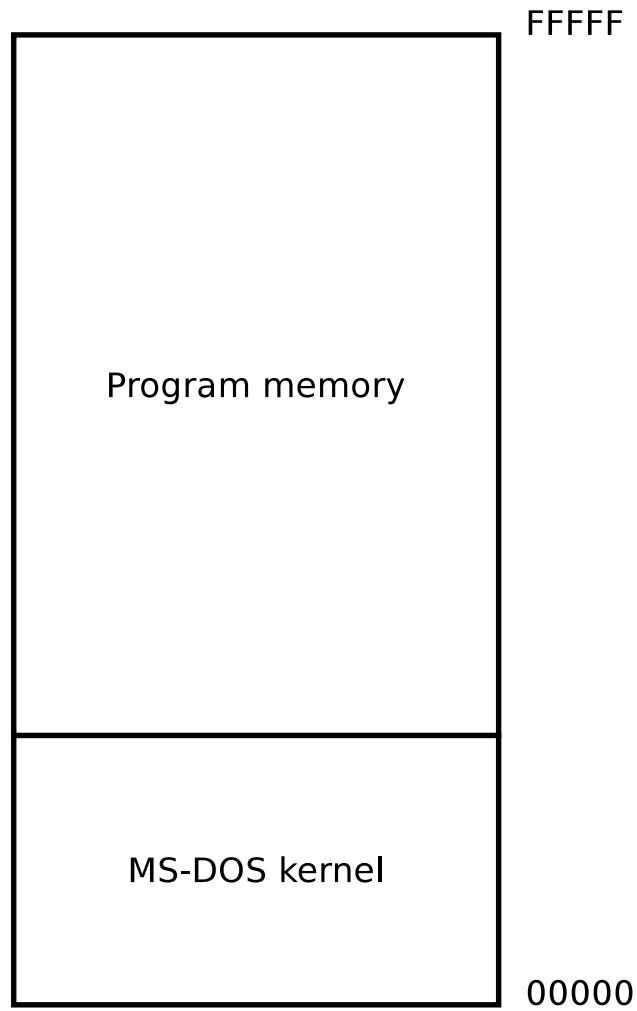
1. Virtual Memory
2. The Stack

8086 Days



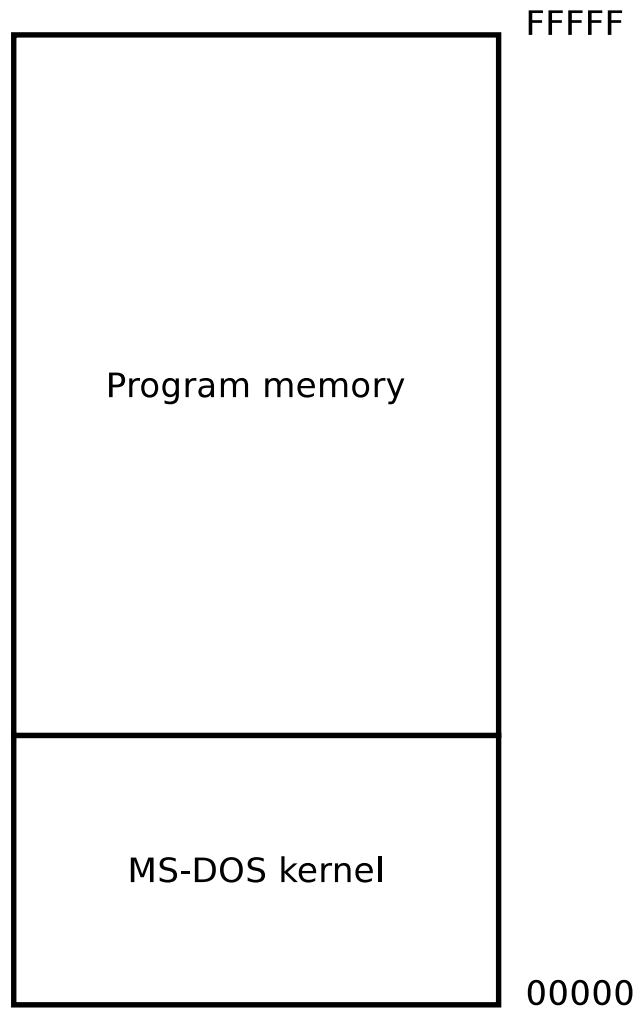
8086 Days

- A program can access the entire memory



8086 Days

- A program can access the entire memory
- A program can access the hardware directly



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[2] 17296
bffff77c
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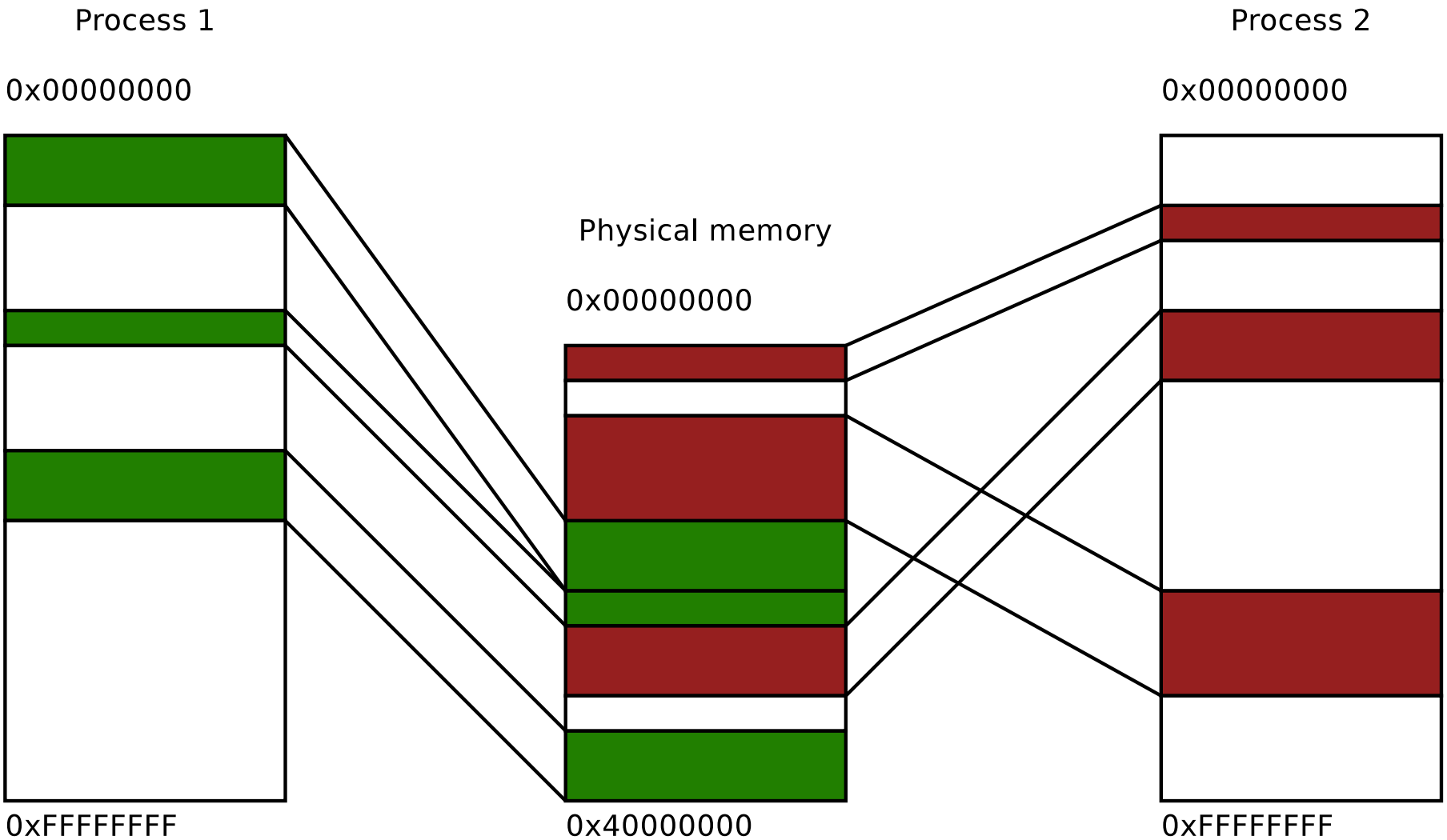
Virtual Memory



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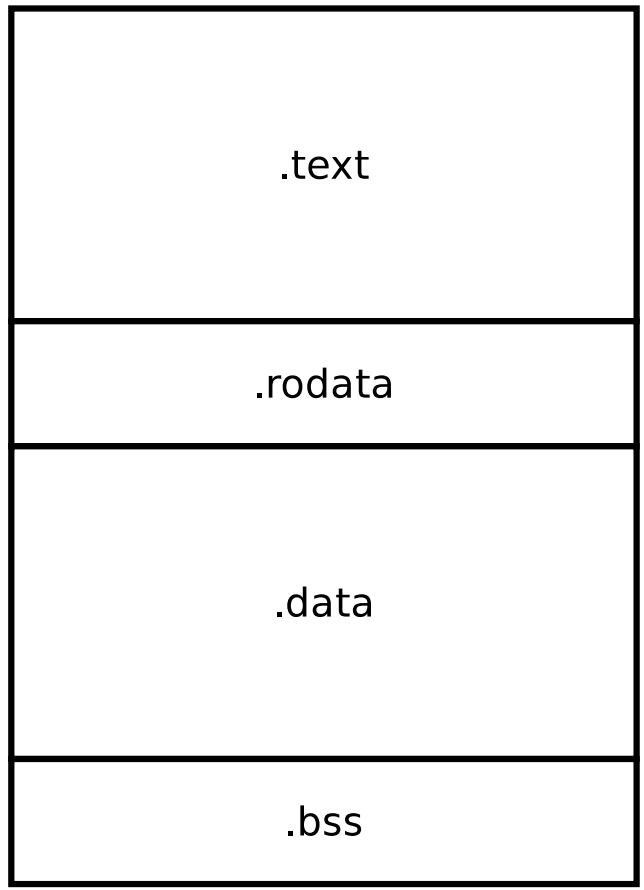
    - Swapping
    - Shared memory

ELF

- Executable and Linkable Format
- Divided in sections



ELF

- .text - program code

```c
#include <stdio.h>

const int x = 3;

int y = 10;
int v[] = { 0, 1, 2, 3 };

int z;
int w[100];

int f()
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        return 0;
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int main()
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        printf("Hello, World\n");

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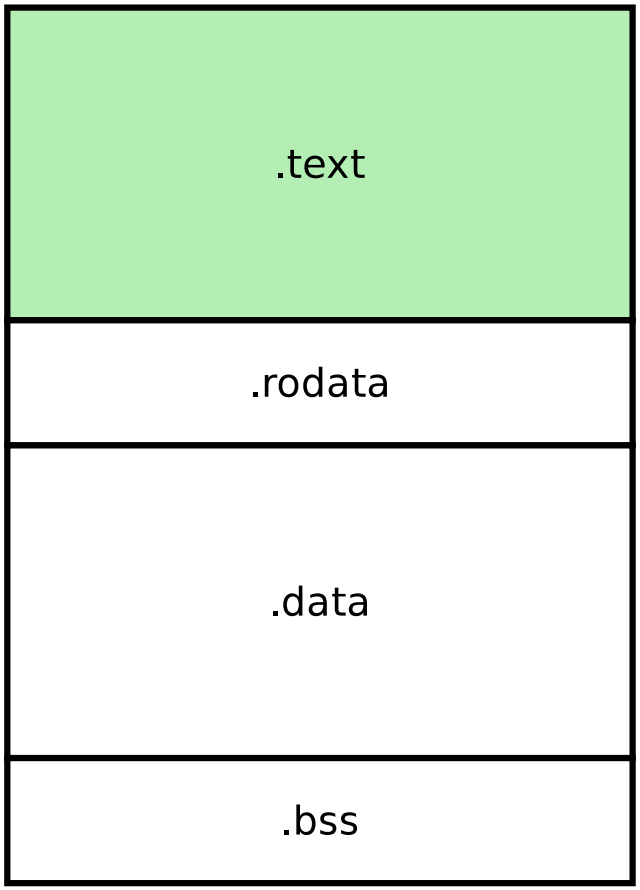
```



ELF

- .rodata - global constant data

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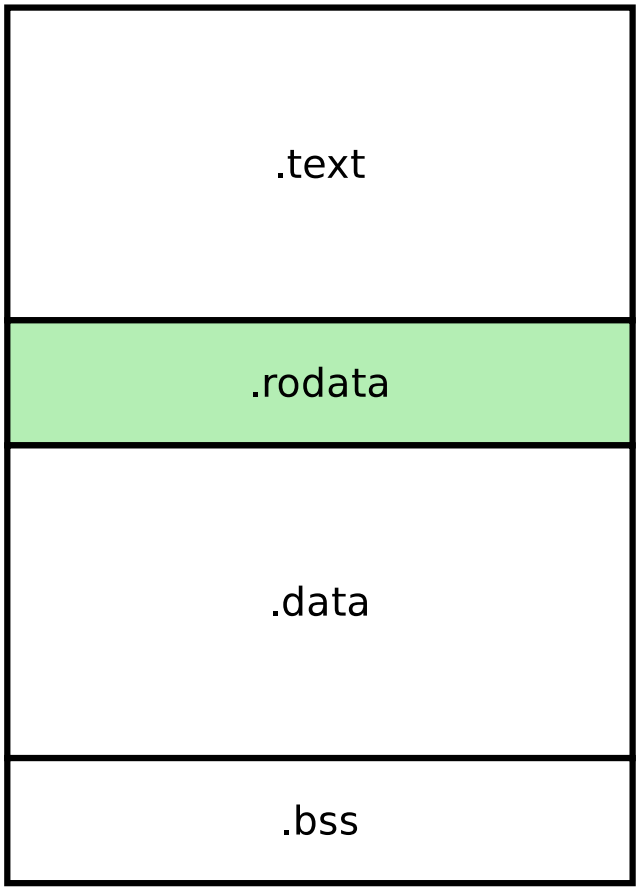

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- .data - global initialized data

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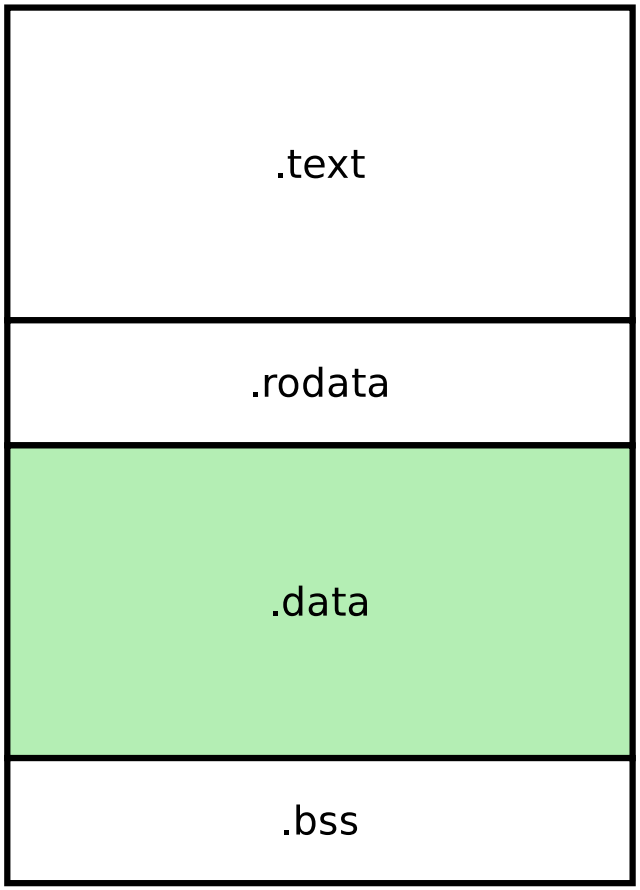

ELF

- .bss - global uninitialized data

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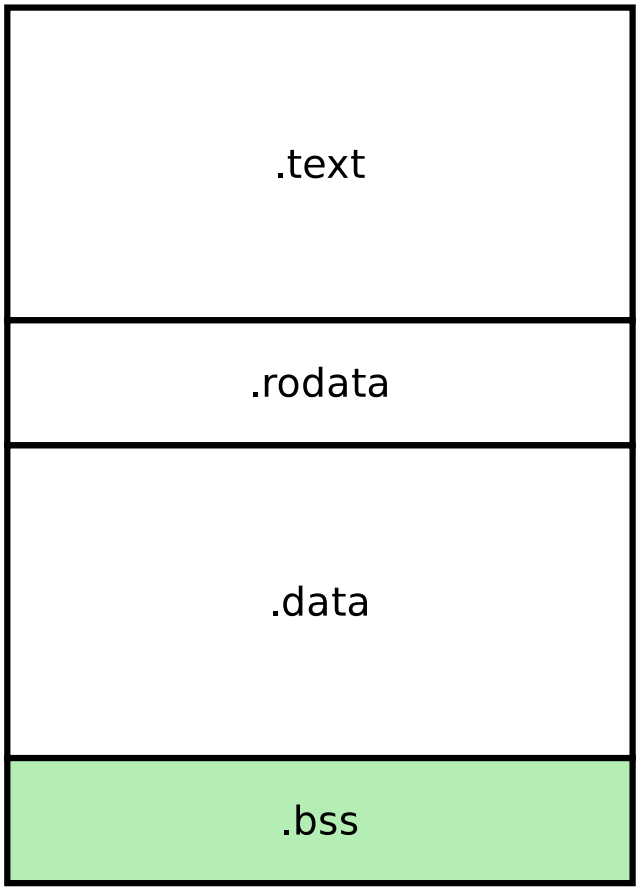

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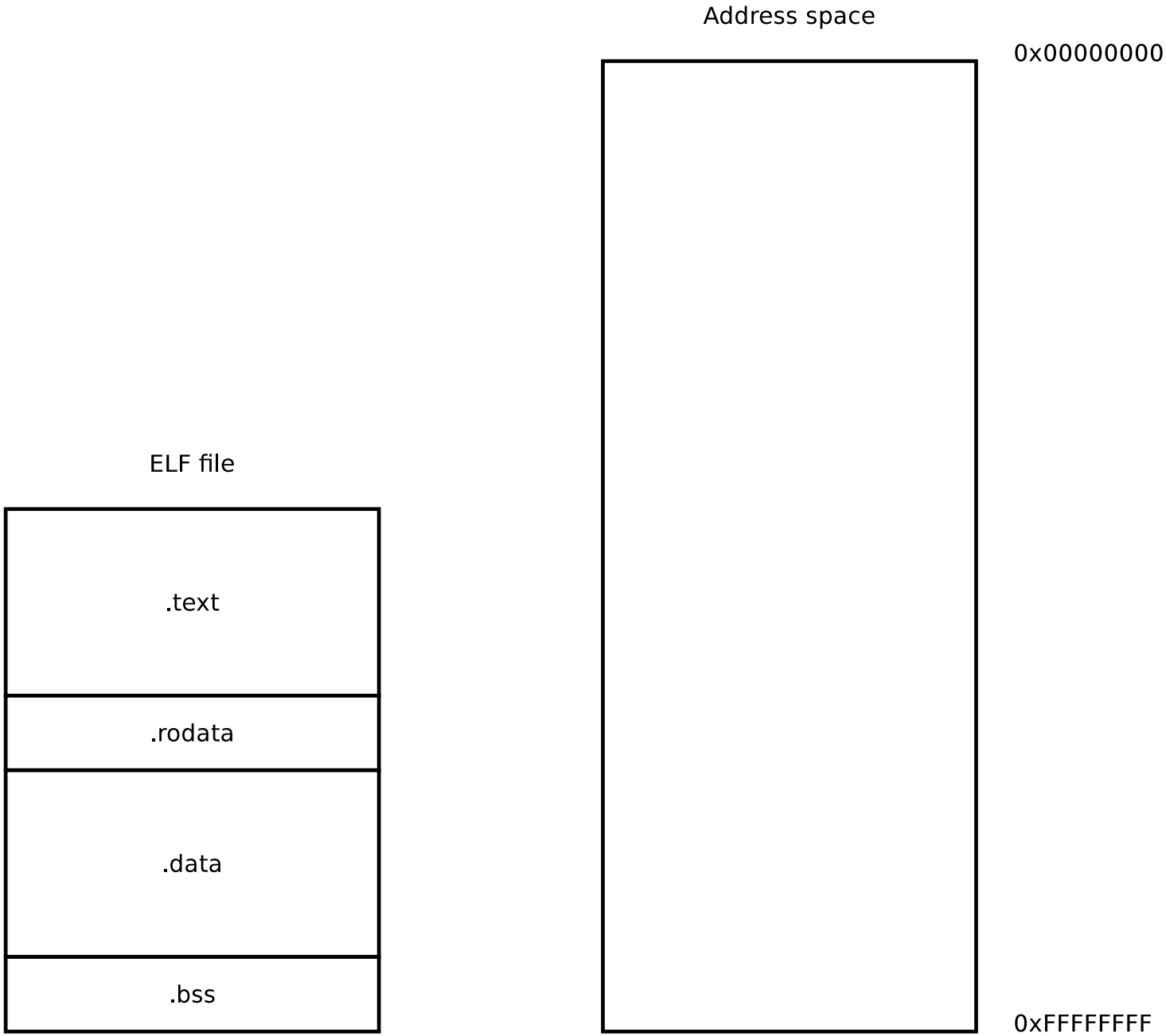
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0x00000000
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ELF file
.text
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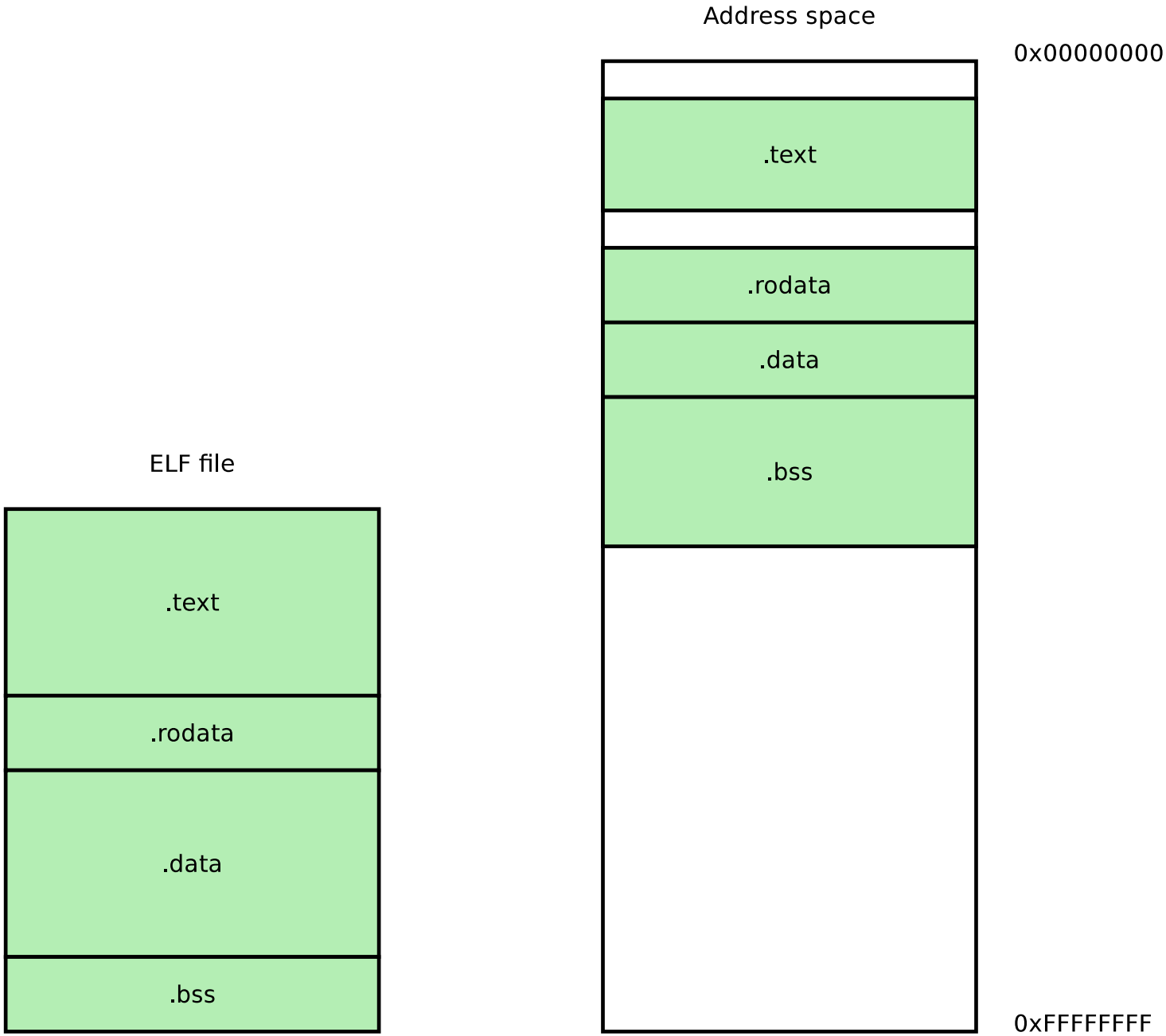
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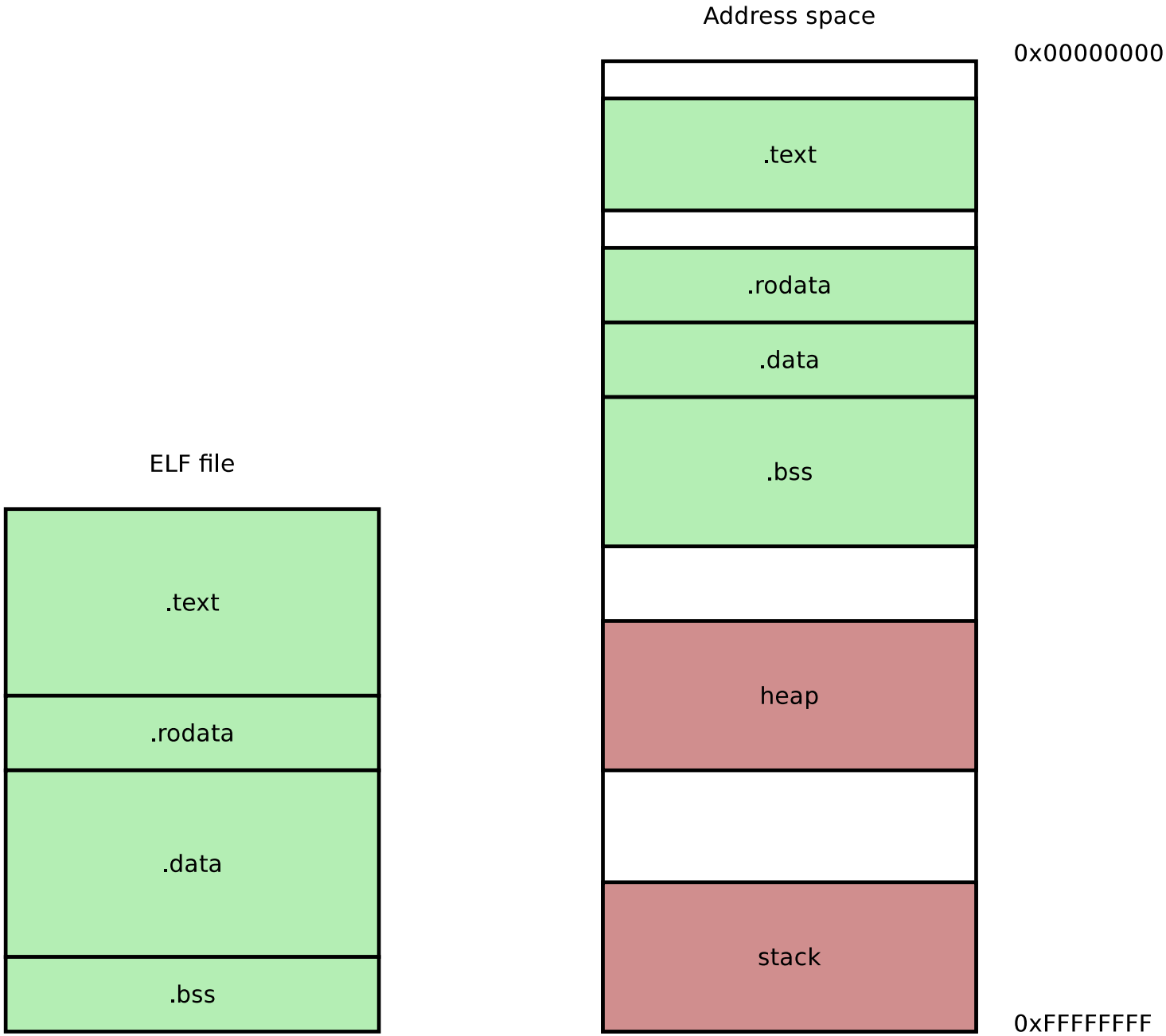
Address space
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  - Storing return addresses

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- A dedicated CPU register holds the current stack pointer
  - `esp` on i386
  - `rsp` on x86_64
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- A dedicated CPU register holds the current stack pointer
  - `esp` on i386
  - `rsp` on x86_64
  - `sp` on ARM
- Grows downwards on most architectures
  - When pushing a value the stack pointer decreases

Calling Conventions

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  - What registers are caller saved, what registers are callee saved
  - Who cleans the stack after the callee ends

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  - Parameters passed on the stack, pushed in reverse order
  - EAX, ECX, EDX caller saved, rest callee-saved
  - Result in EAX
  - The caller cleans the parameters from the stack
- `stdcall` - Win32

Stack Frames

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#include <stdio.h>

int g(int x, int y)
{
        int s;

        s = x+y;

        return s;
}

void f(void)
{
        g(10, 11);
}

int main(void)
{
        f();
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```

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        push   %ebp
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        leave
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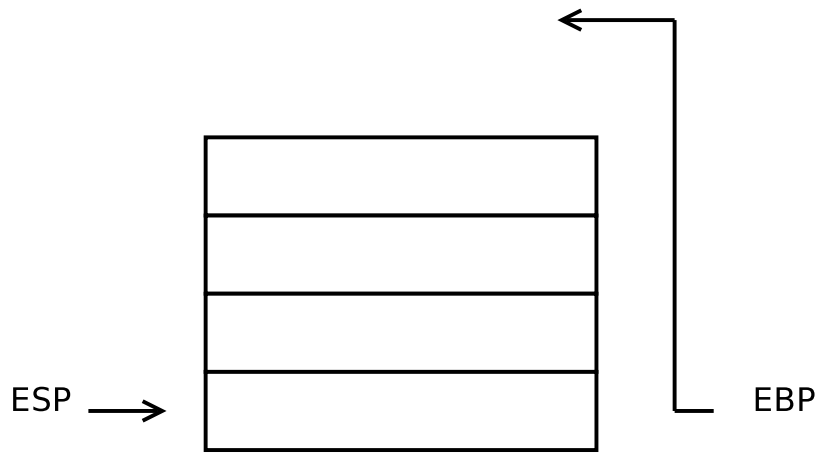

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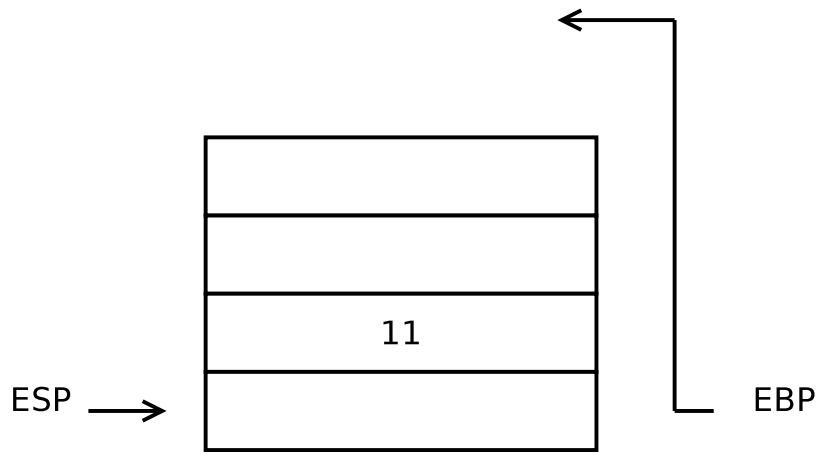

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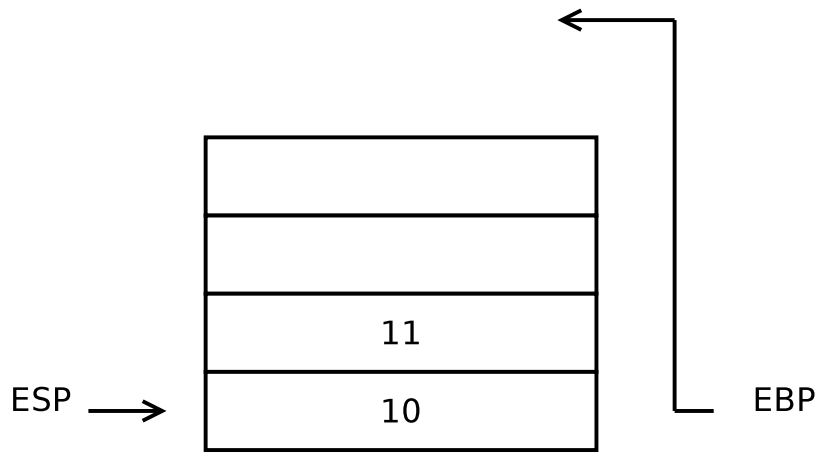

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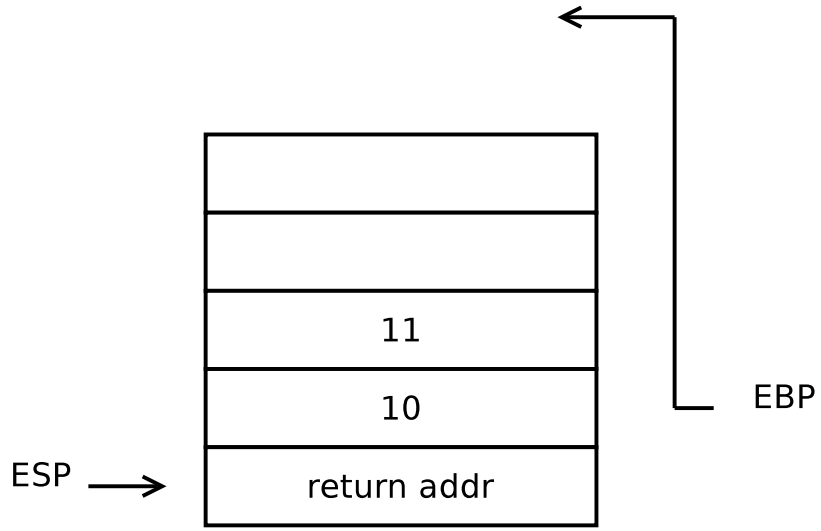

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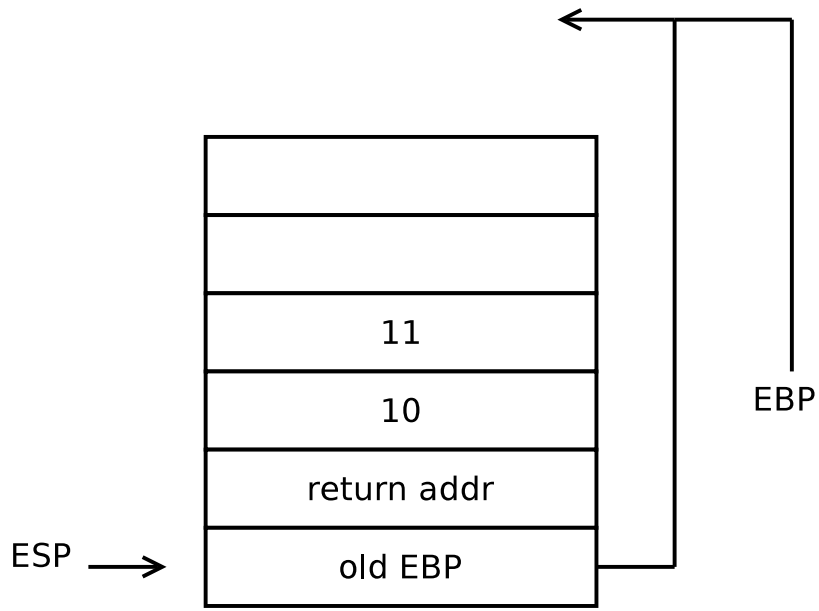

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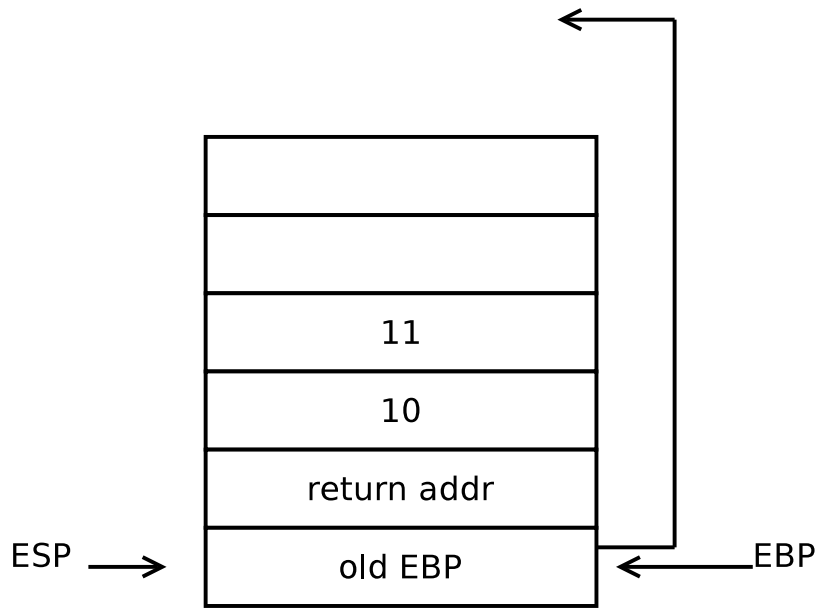

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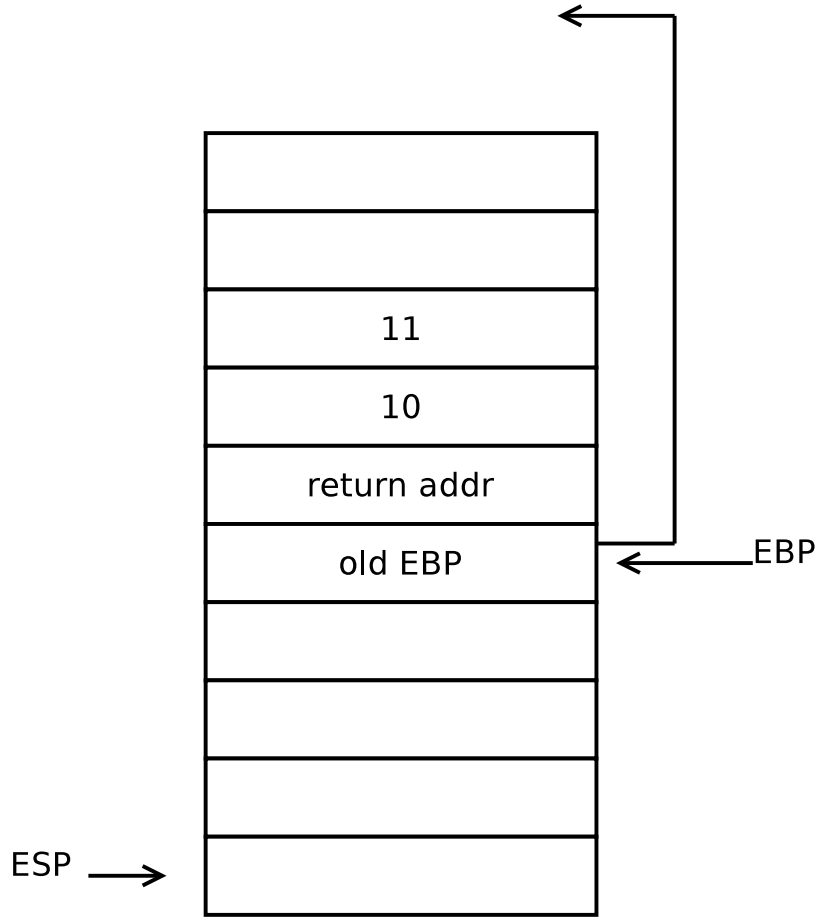

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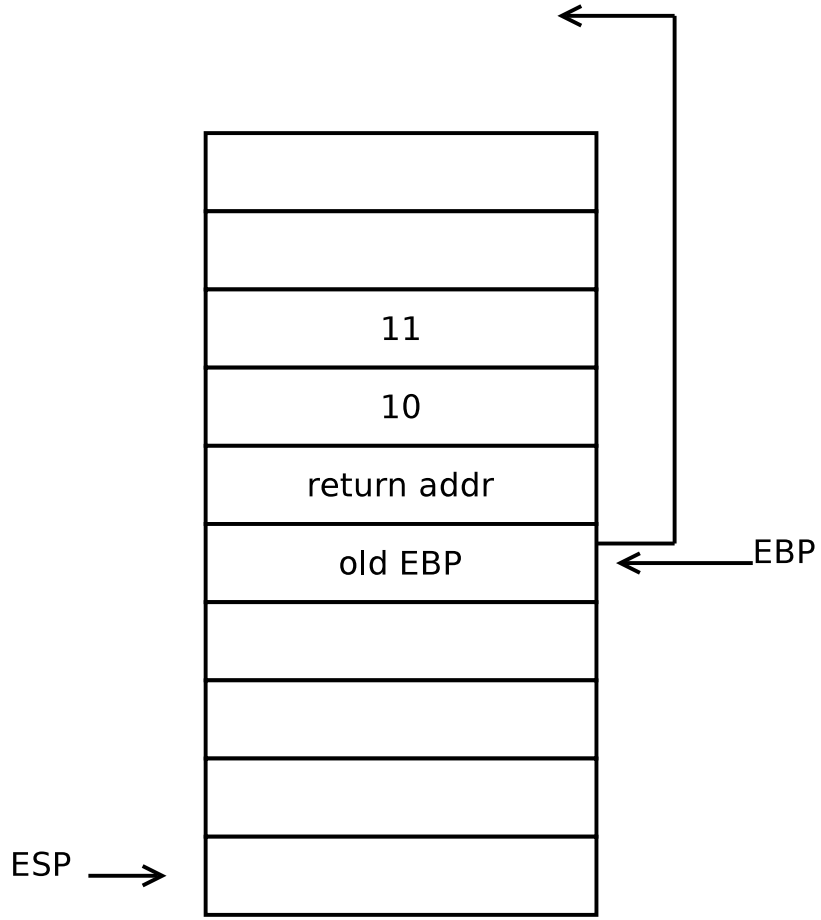

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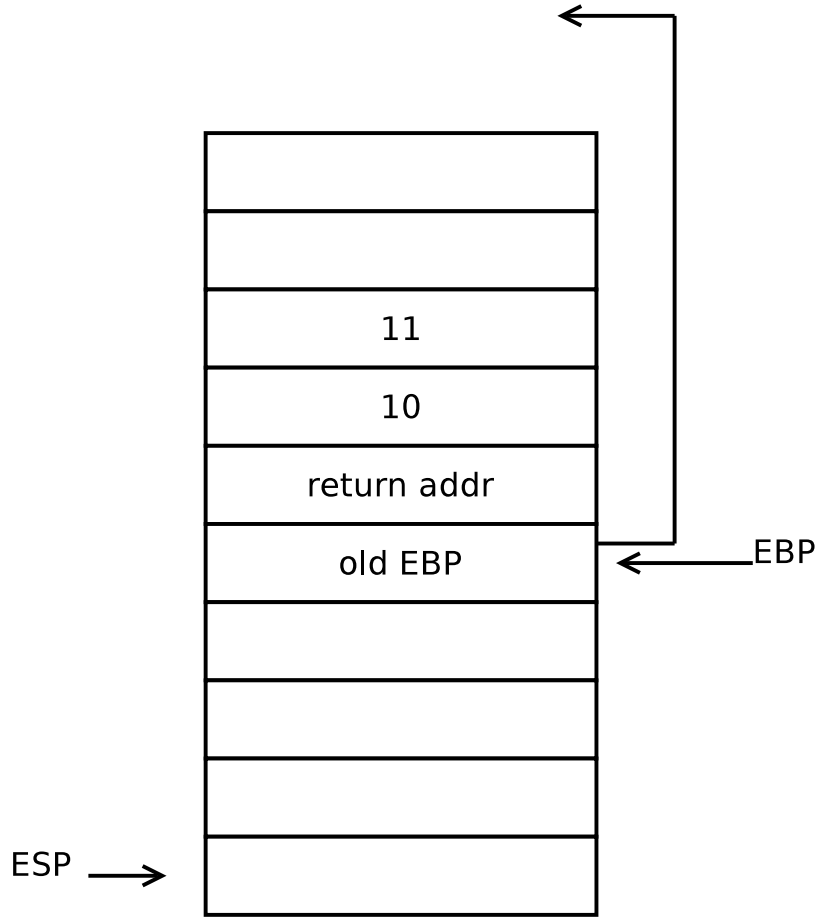

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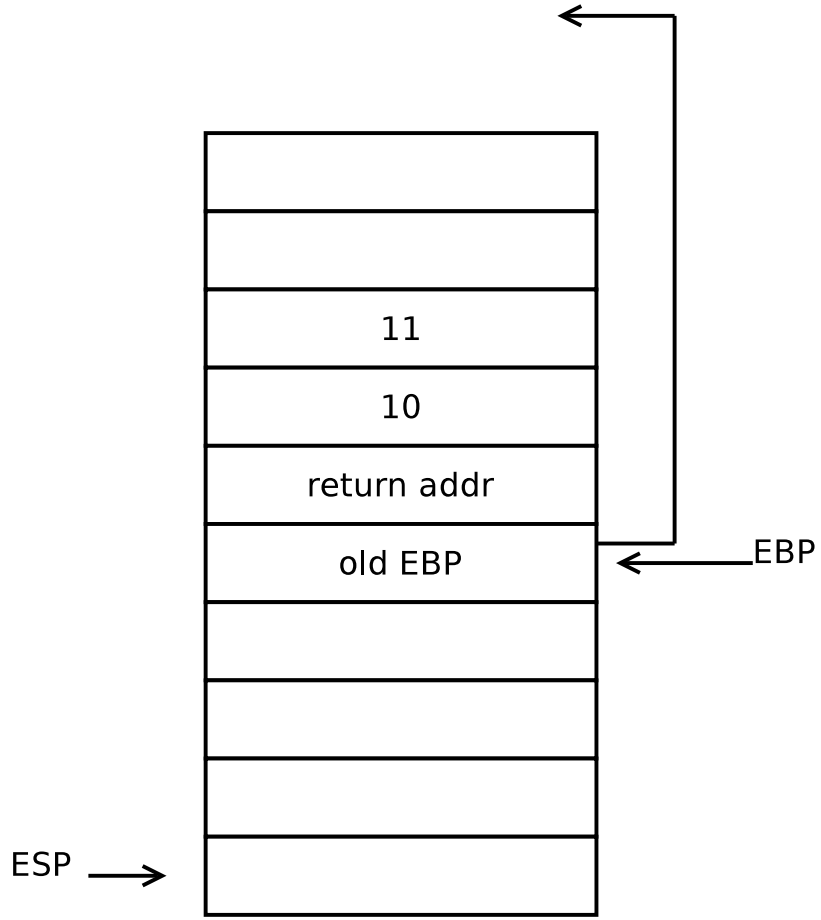

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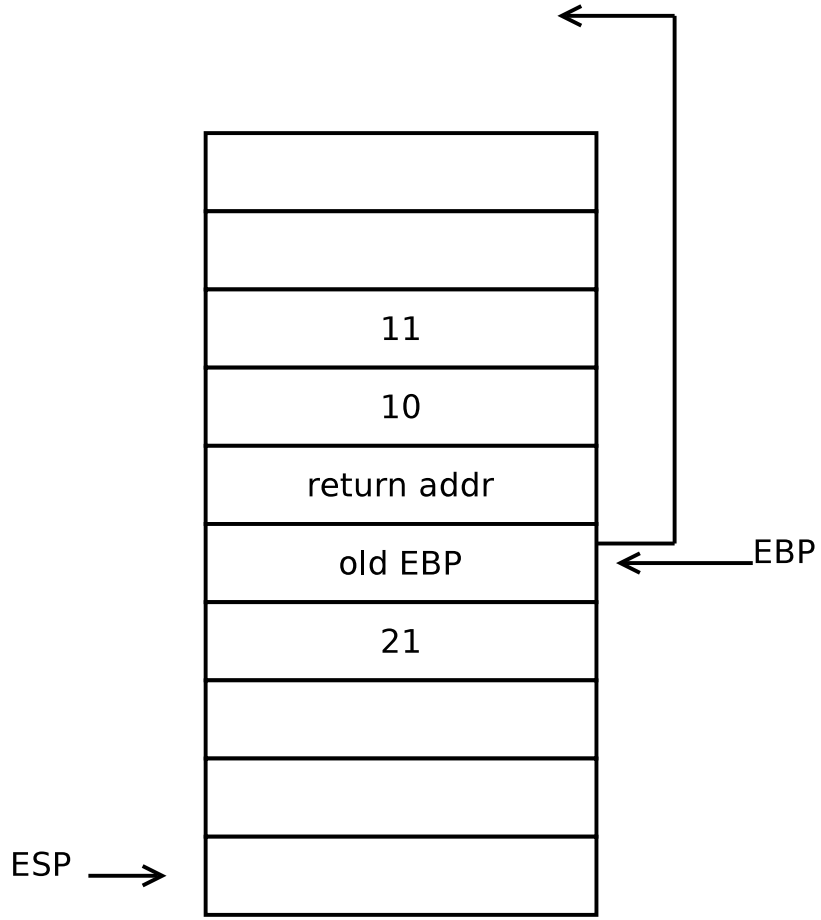

Stack Frames

```c
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int g(int x, int y)
{
        int s;

        s = x+y;

        return s;
}

void f(void)
{
        g(10, 11);
}

int main(void)
{
        f();
}
```
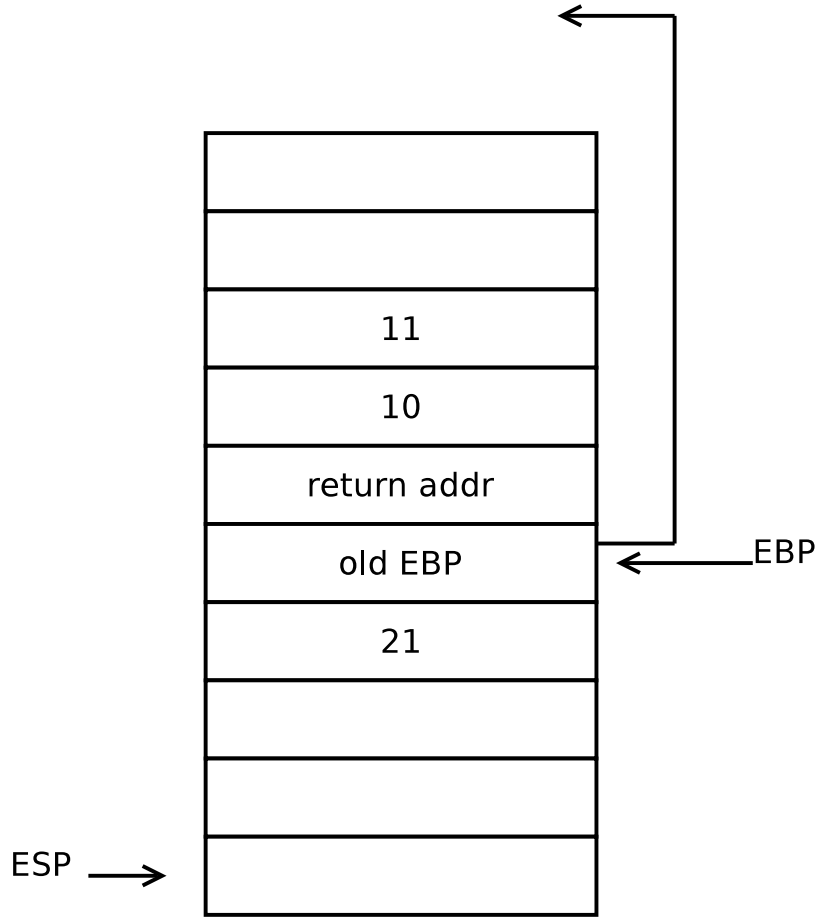

```
g:
        push   %ebp
        mov    %esp,%ebp
        sub    $0x10,%esp
        mov    0xc(%ebp),%eax
        mov    0x8(%ebp),%edx
        add    %edx,%eax
        mov    %eax,-0x4(%ebp)
        mov    -0x4(%ebp),%eax
        leave
        ret

f:
        push   %ebp
        mov    %esp,%ebp
        sub    $0x8,%esp
        movl   $0xb,0x4(%esp)
        movl   $0xa,(%esp)
        call   80483d4 <g>
        leave
        ret
```



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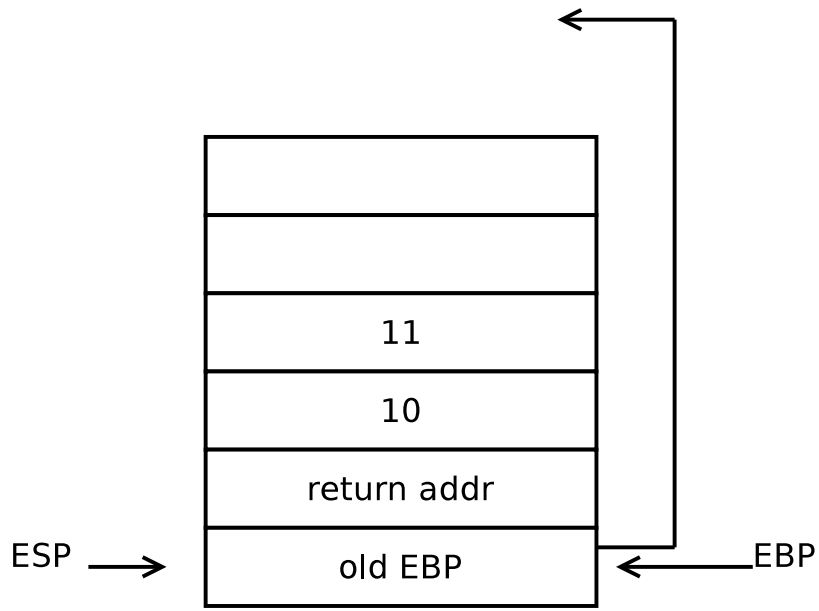

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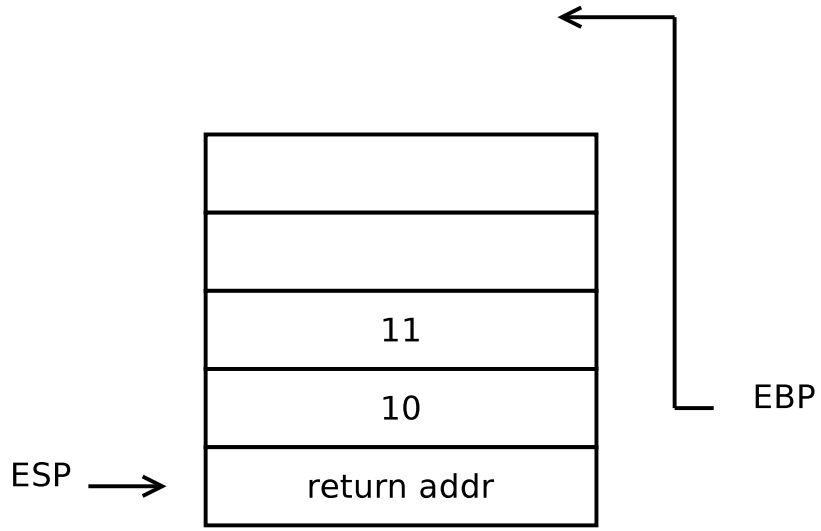

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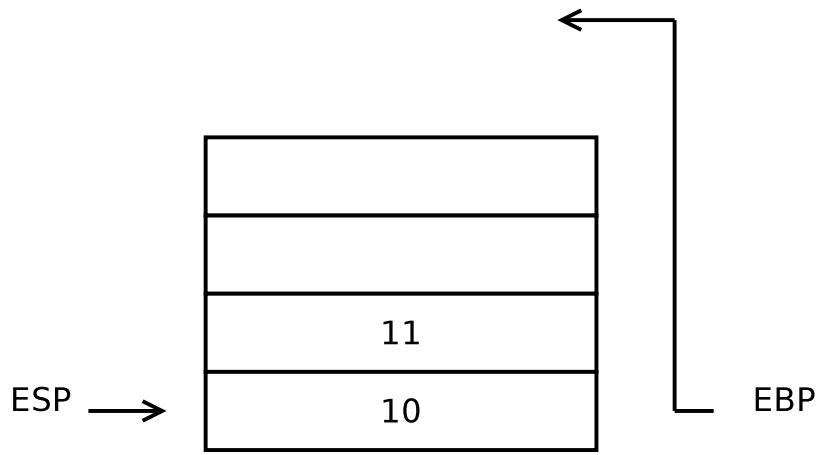
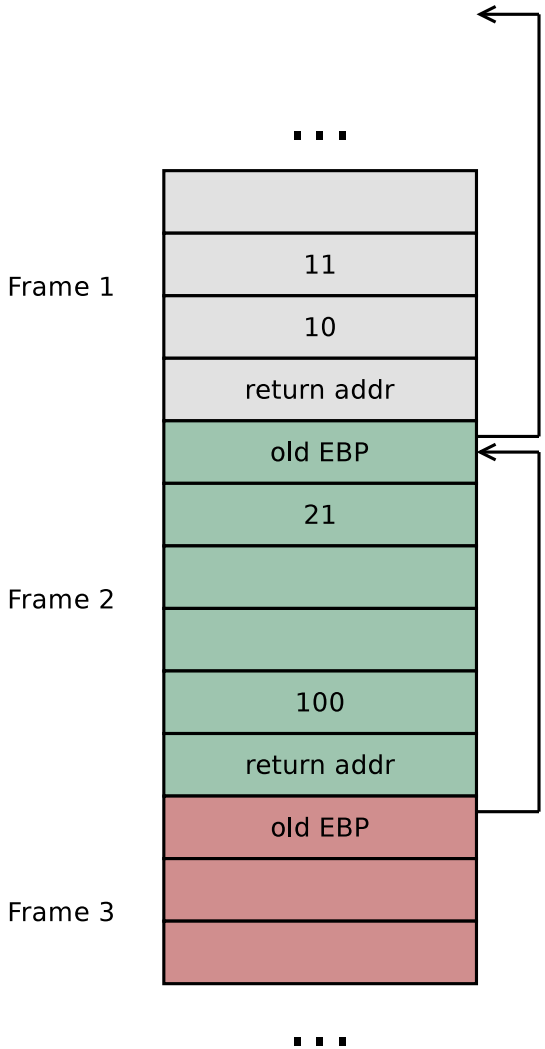


Stack Frames



Stack Corruption

```
int x = 100;
int v[5] = { 0, 10, 20, 30, 40 };

v[5] = ...;
v[7] = ...;
```