Objectives - Thu 4/18/2019

- Quiz 6 → exercise
  - Full credit if you make a good faith effort
- Instruction-level execution
- Buffer overflow attacks

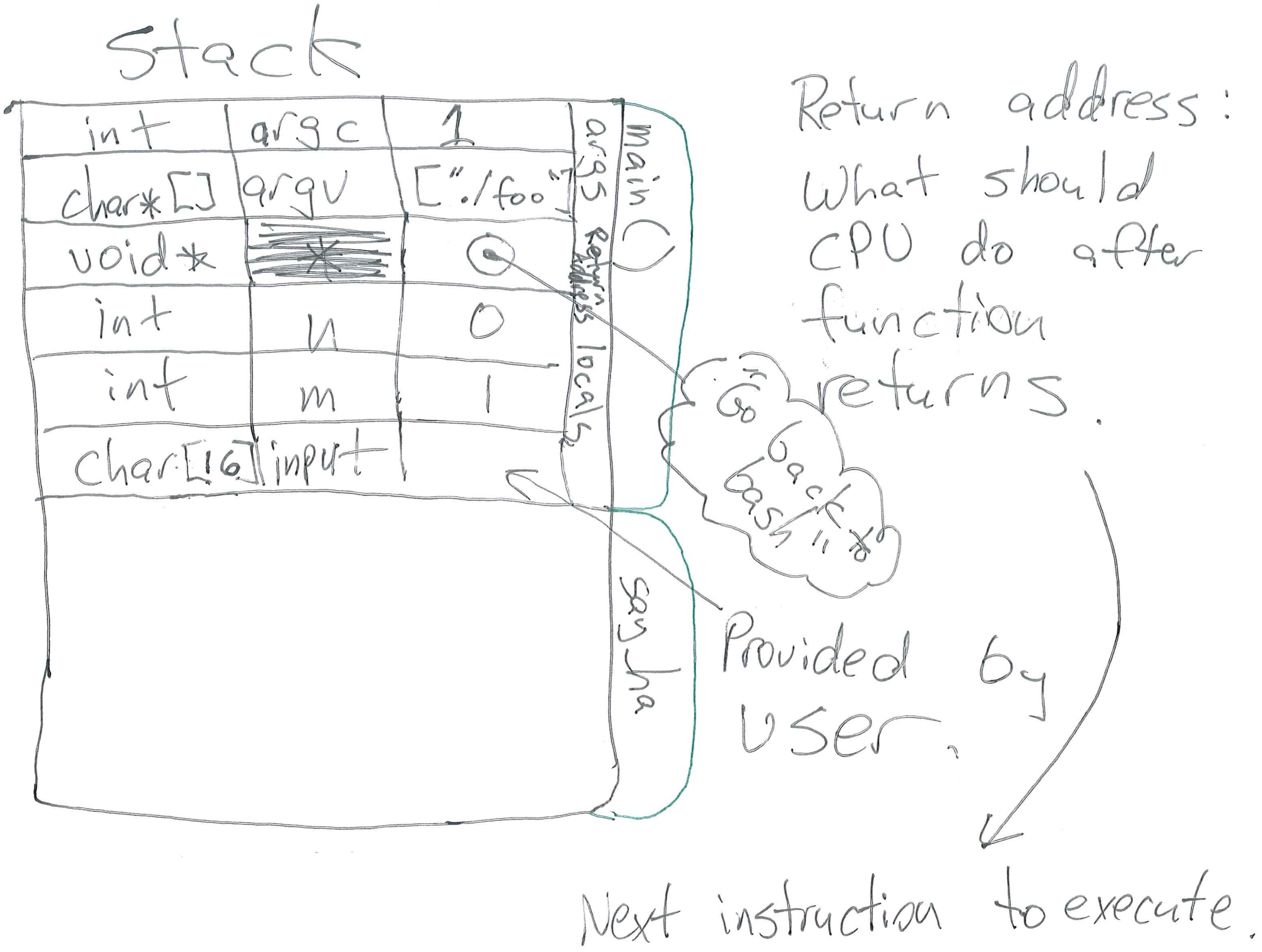
Buffer overflow attack

(extremely simple version)

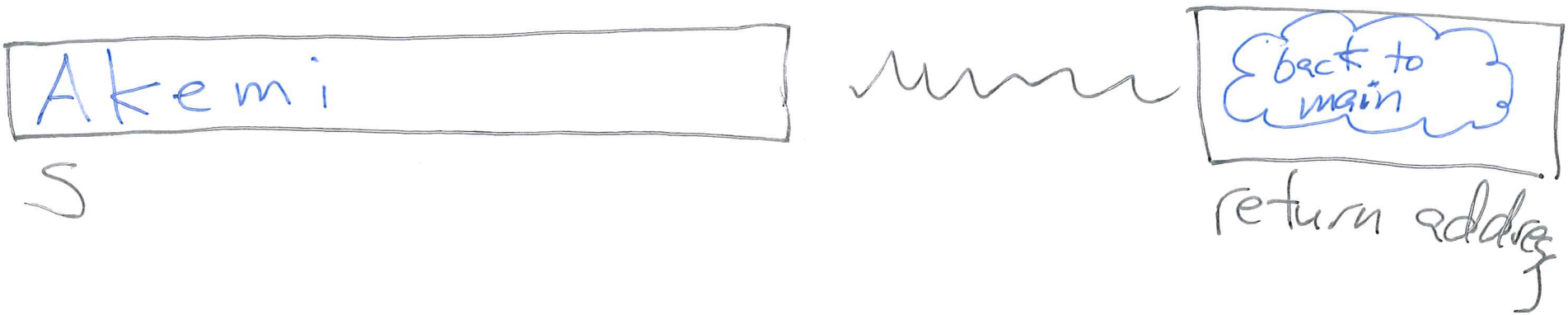
User gives input too big for a fixed-length buffer

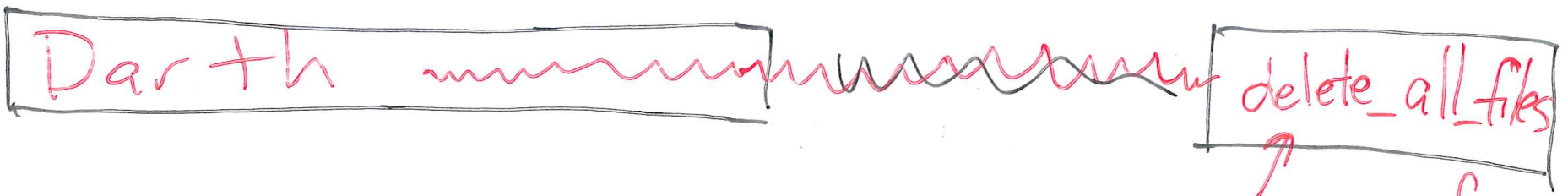
Overwrite the return address.

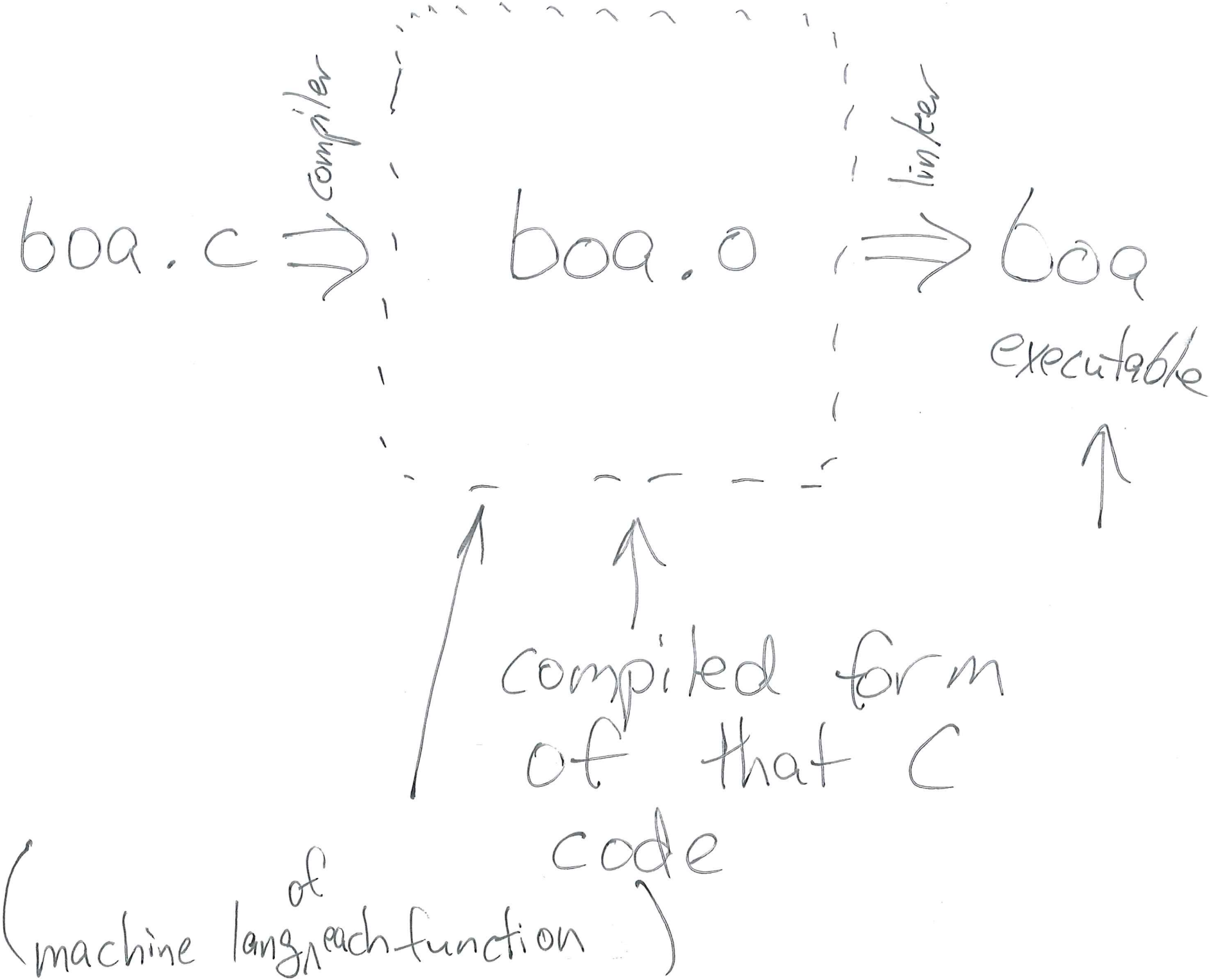
Victim is tricked into executing something else.


Stack
int
argc
1
char*[]
argv
["./foo"]
void*
int
n
0
int
m
1
char[16]
input
argv
Return address
locals
main()
sayha
"Go back to bash"
Provided by user.
Return address: What should CPU do after function returns.
Next instruction to execute.

Buffer overflow attack






boa.c
compiler
boa.o
linker
boa
executable
compiled form of that C code
(machine lang. of each function)

When we run program (./bog):

Object code (compiled C) is copied from disk to memory.

Like fread() code in memory is same as on disk.

CPU sets its "instruction pointer" to the instruction to do next.

Name: [ ] Login: [ ] QUIZ 6 - SPECIAL

Stack memory and instruction-level execution

In the current execution frame…

1. What line of C code is about to be executed? line 10 in function greet_visitor
2. What is the value in the base pointer? 0x7fffffffde00
3. What is the value in the stack pointer? ? 0x7fffffffdde0
4. What is the return address? 0x400699 == line 22 in function main
5. What is address of the return address? 0x7fffffffde08

Upon return to the calling execution frame…

6. What line of C code will execute next? line 22
7. What will the value in the base pointer be? 0x7fffffffd___
8. What will the value in the stack pointer be? 0x7fffffffd___

In the memory dump below…

9. Label all 8 local variables, 2 parameters, 2 return addresses, and 2 saved base pointers. (Assignments/initializations and function calls will help.)

```
(gdb) info registers
                              [...]
rbp            0x7fffffffde00    0x7fffffffde00
rsp            0x7fffffffdde0    0x7fffffffdde0
                              [...]
rip            0x400638 0x400638 <greet_visitor+66>
                              [...]
```

```
(gdb) x/80bx $rsp
0x7fffffffdde0: 0x41  0x6c  0x65  0x78  0x61  0x6e  0x64  0x65
0x7fffffffdde8: 0x72  0x00  0x40  0x00  0x00  0x00  0x00  0x00
0x7fffffffddf0: 0x28  0xdf  0xff  0xff  0xff  0x7f  0x00  0x00
0x7fffffffddf8: 0xaa  0xbb  0xbb  0xaa  0xaa  0xaa  0xaa  0xaa
0x7fffffffde00: 0x30  0xde  0xff  0xff  0xff  0x7f  0x00  0x00
0x7fffffffde08: 0x99  0x06  0x40  0x00  0x00  0x00  0x00  0x00
0x7fffffffde10: 0x18  0xdf  0xff  0xff  0xff  0x7f  0x00  0x00
0x7fffffffde18: 0x90  0x04  0x40  0x00  0x01  0x00  0x00  0x00
0x7fffffffde20: 0x10  0xdf  0xff  0xff  0xff  0x7f  0x00  0x00
0x7fffffffde28: 0x00  0x00  0x00  0x00  0xaa  0xee  0xee  0xaa
0x7fffffffde30: 0x00  0x00  0x00  0x00  0x00  0x00  0x00  0x00
0x7fffffffde38: 0x1d  0xed  0x41  0x2f  0x38  0x00  0x00  0x00
```


```
(gdb) disas /s main
Dump of assembler code for function main:
boa.c:
19      int main(int argc, char *argv[]) {
   0x0000000000400679 <+0>:     push   %rbp
   0x000000000040067a <+1>:     mov    %rsp,%rbp
   0x000000000040067d <+4>:     sub    $0x20,%rsp
   0x0000000000400681 <+8>:     mov    %edi,-0x14(%rbp)
   0x0000000000400684 <+11>:    mov    %rsi,-0x20(%rbp)
20          int mn_top = 0xAAEEEEAA;
   0x0000000000400688 <+15>:    movl   $0xaaeeeeaa,-0x4(%rbp)
21          greet_visitor();
   0x000000000040068f <+22>:    mov    $0x0,%eax
   0x0000000000400694 <+27>:    callq  0x4005f6 <greet_visitor>
22          int mn_btm = 0xAAFFFFAA;
   0x0000000000400699 <+32>:    movl   $0xaaffffaa,-0x8(%rbp)
23          return 0;
   0x00000000004006a0 <+39>:    mov    $0x0,%eax
24      }
   0x00000000004006a5 <+44>:    leaveq
   0x00000000004006a6 <+45>:    retq
```

```
(gdb) disas /s greet_visitor
Dump of assembler code for function greet_visitor:
boa.c:
3       void greet_visitor() {
   0x00000000004005f6 <+0>:     push   %rbp
   0x00000000004005f7 <+1>:     mov    %rsp,%rbp
   0x00000000004005fa <+4>:     sub    $0x20,%rsp
4           int gt_top = 0xAAAAAAAA;
   0x00000000004005fe <+8>:     movl   $0xaaaaaaaa,-0x4(%rbp)
5           char name[10]; // BAD!!!
6           printf("Hello.  What is your name?\n");
   0x0000000000400605 <+15>:    mov    $0x40079c,%edi
   0x000000000040060a <+20>:    callq  0x400450 <puts@plt>
7           gets(name);     // VERY, VERY, VERY BAD!!!
   0x000000000040060f <+25>:    lea    -0x20(%rbp),%rax
   0x0000000000400613 <+29>:    mov    %rax,%rdi
   0x0000000000400616 <+32>:    callq  0x400480 <gets@plt>
8           printf("Hello, %s.", name);
   0x000000000040061b <+37>:    lea    -0x20(%rbp),%rax
   0x000000000040061f <+41>:    mov    %rax,%rsi
   0x0000000000400622 <+44>:    mov    $0x4007b7,%edi
   0x0000000000400627 <+49>:    mov    $0x0,%eax
   0x000000000040062c <+54>:    callq  0x400460 <printf@plt>
9           int gt_btm = 0xAABBBBAA;
   0x0000000000400631 <+59>:    movl   $0xaabbbbaa,-0x8(%rbp)
10      }
   0x0000000000400638 <+66>:    nop
   0x0000000000400639 <+67>:    leaveq
   0x000000000040063a <+68>:    retq
```

```
(gdb) disas /s scare_visitor
Dump of assembler code for function scare_visitor:
boa.c:
12      void scare_visitor() {
   0x000000000040063b <+0>:     push   %rbp
   0x000000000040063c <+1>:     mov    %rsp,%rbp
   0x000000000040063f <+4>:     sub    $0x20,%rsp
13          int sv_top = 0xAACCCCAA;
   0x0000000000400643 <+8>:     movl   $0xaaccccaa,-0x4(%rbp)
14          char message[10] = "BRAH!!!\n"; // OKAY
   0x000000000040064a <+15>:    movabs $0xa21212148415242,%rax
   0x0000000000400654 <+25>:    mov    %rax,-0x20(%rbp)
   0x0000000000400658 <+29>:    movw   $0x0,-0x18(%rbp)
15          printf(message);
   0x000000000040065e <+35>:    lea    -0x20(%rbp),%rax
   0x0000000000400662 <+39>:    mov    %rax,%rdi
   0x0000000000400665 <+42>:    mov    $0x0,%eax
   0x000000000040066a <+47>:    callq  0x400460 <printf@plt>
16          int sv_btm = 0xAADDDDAA;
   0x000000000040066f <+52>:    movl   $0xaaddddaa,-0x8(%rbp)
17      }
   0x0000000000400676 <+59>:    nop
   0x0000000000400677 <+60>:    leaveq
   0x0000000000400678 <+61>:    retq
```