Interrupt Latency in Operating-System Kernels

Challenges and Benefits of Static Analysis

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and Operating Systems

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Technische Fakultät

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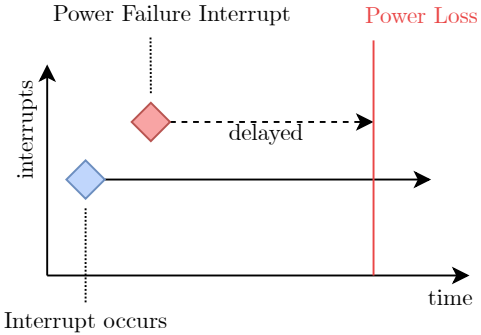

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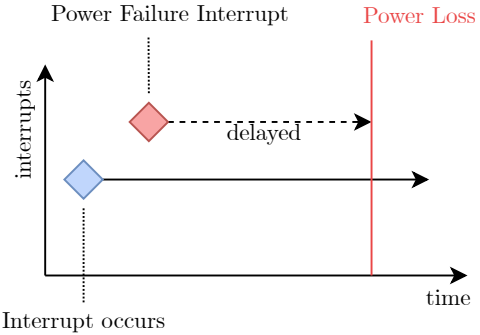

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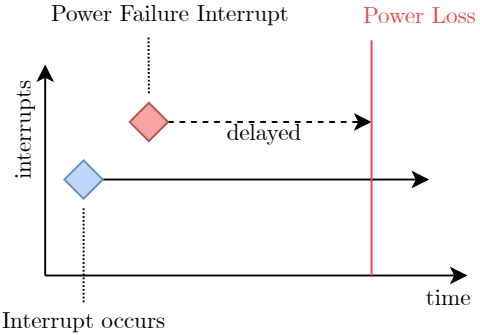

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$\Rightarrow$ Blocking time analysis on assembly level

Table of Contents

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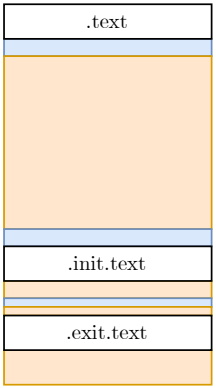
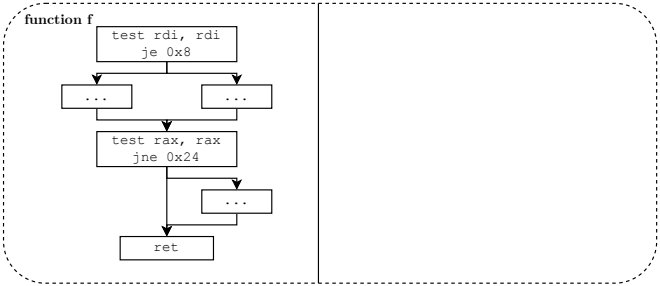



```
# 16/32 Bit
0x1000000: <startup>:
    mov ax, bx
    ...
# 64 Bit
0x1001000: <kernel_main>:
    sub rsp, 64
    ...
```

Control Flow

- Control Flow Graphs



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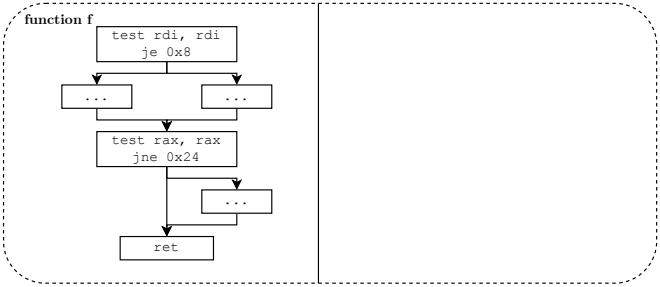

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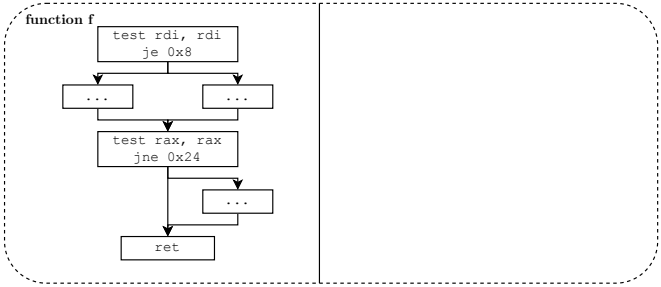

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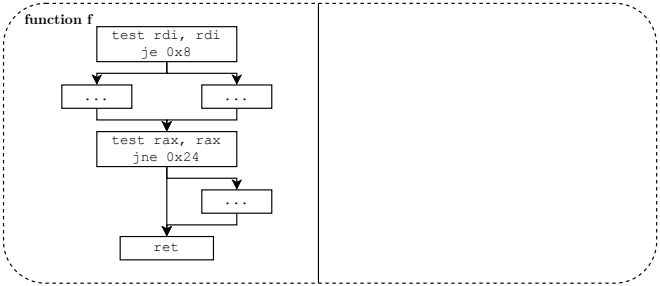

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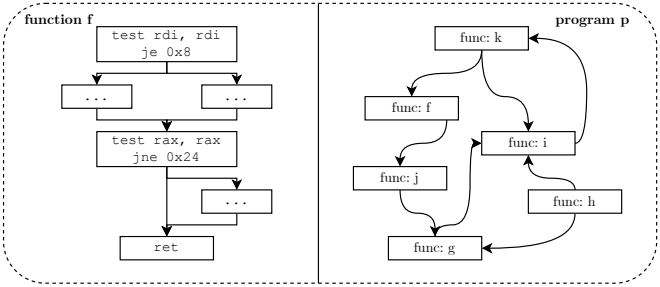

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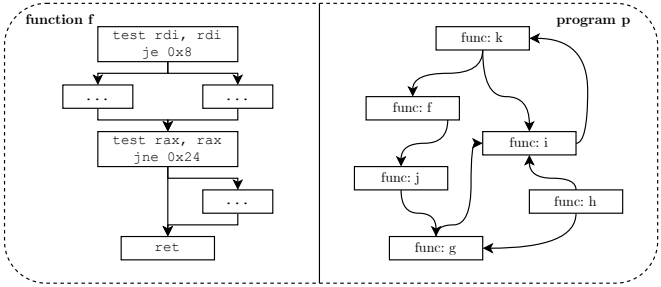

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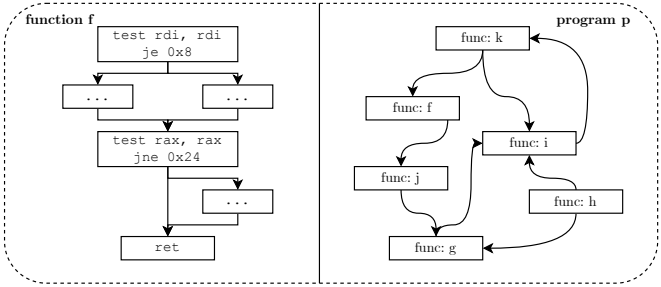

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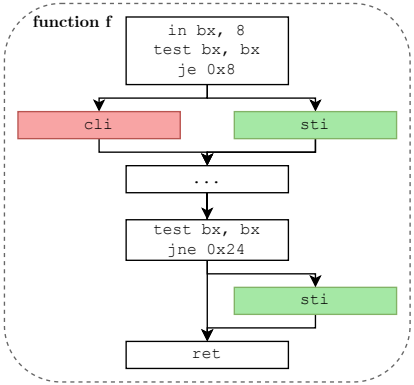

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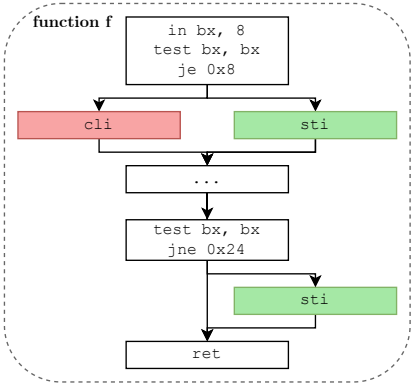

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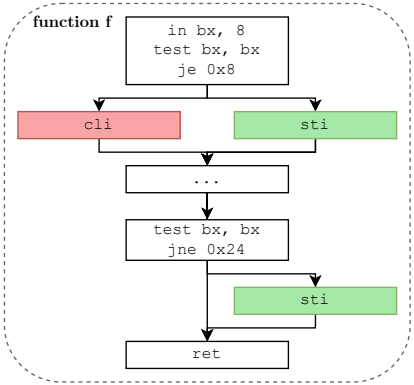

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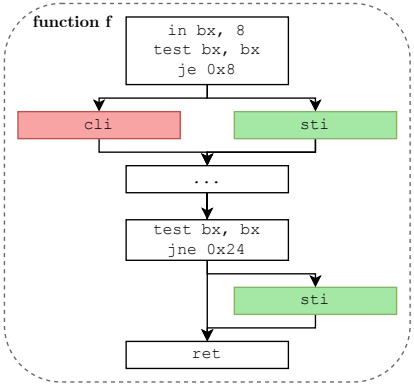

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⇒ **Propagate knowledge dynamically throughout the control flow graph**

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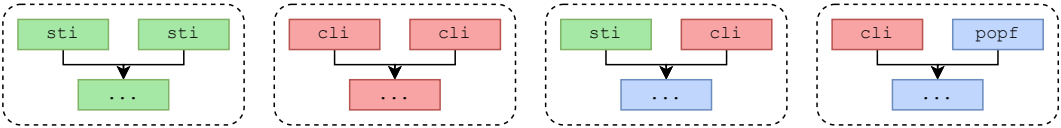

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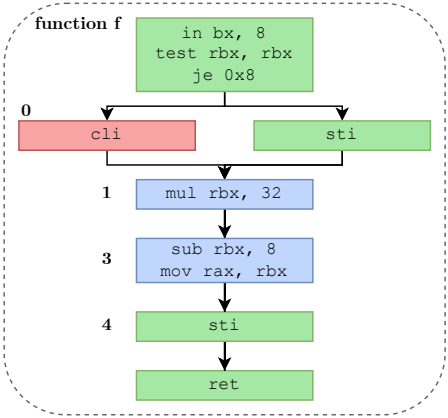

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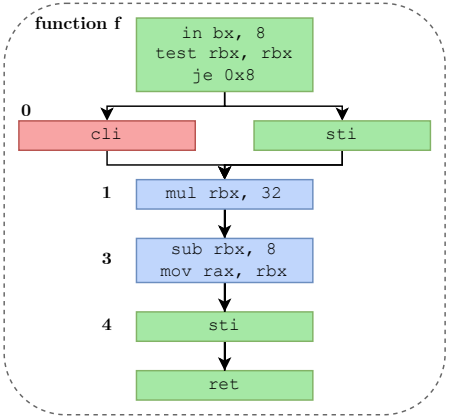

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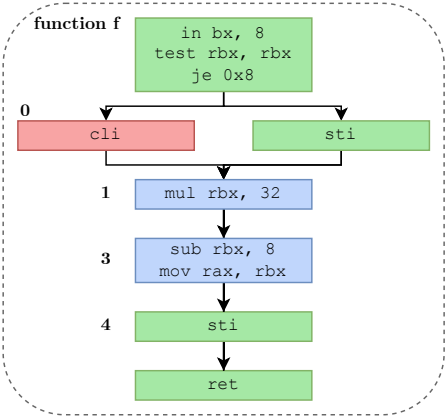

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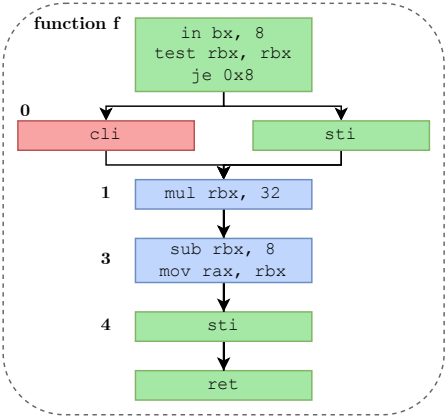

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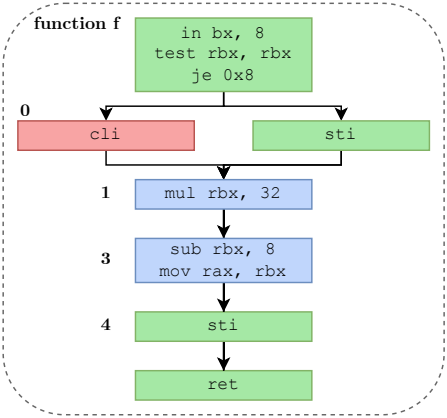

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Pitfalls and Limitations

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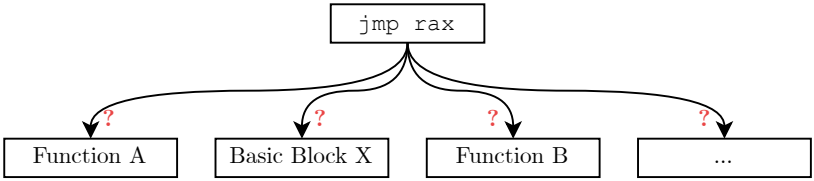

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1 dispatch:
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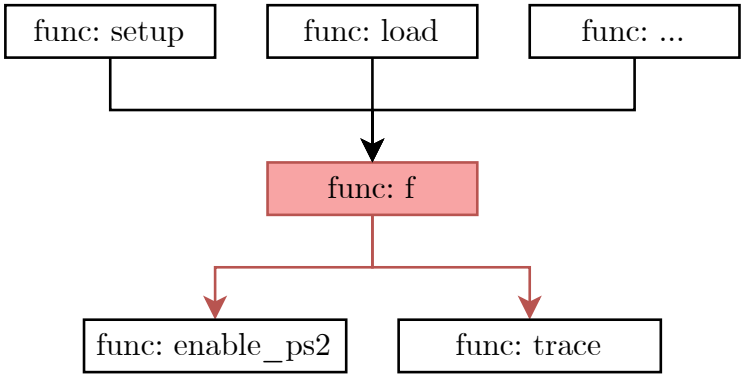

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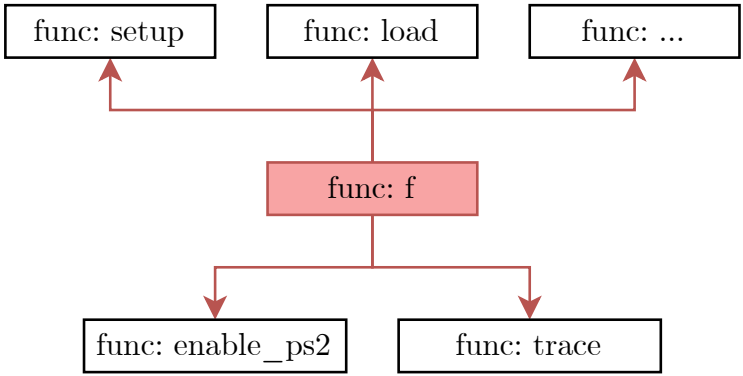

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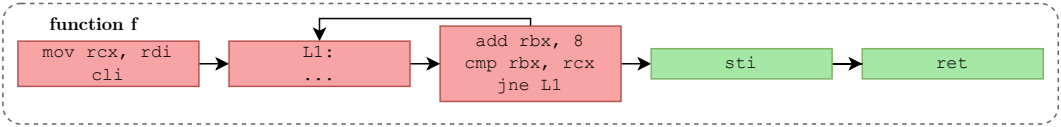

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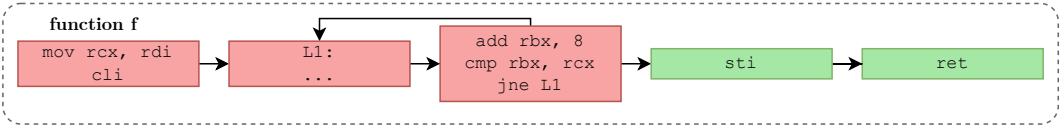

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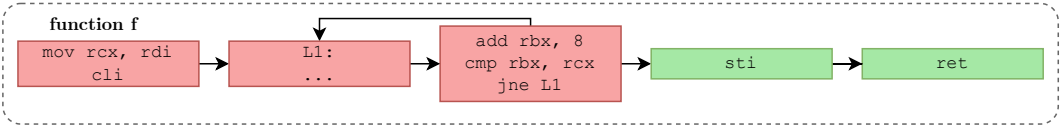

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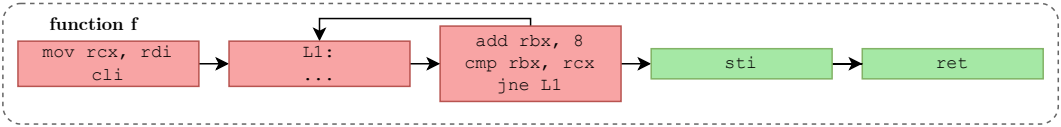

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→ Only possible for trivial cases

Evaluation

Analysis Environment

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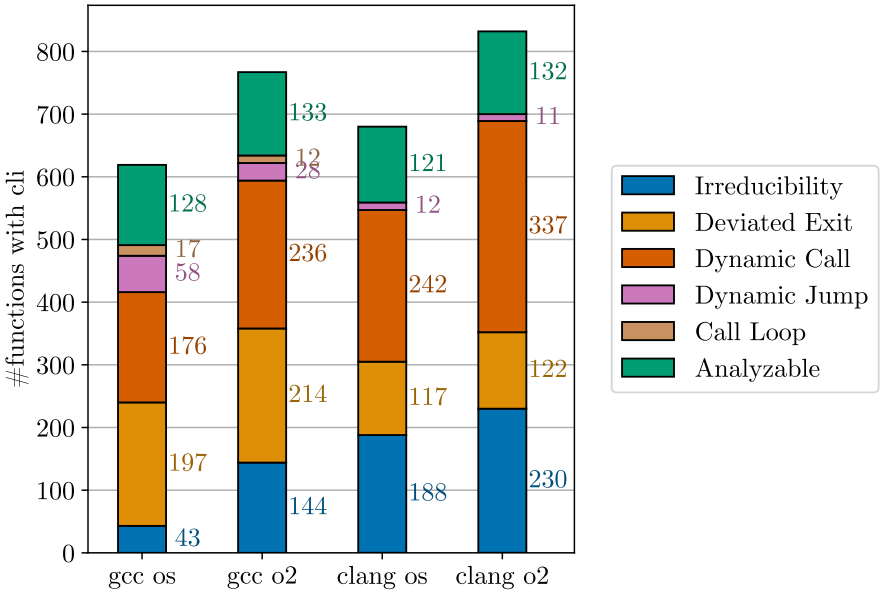
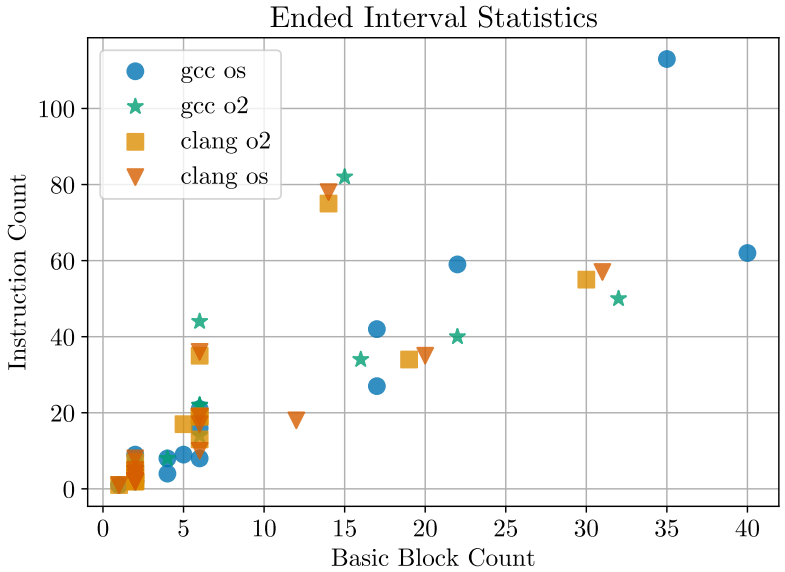
Operating Systems:

	Version	Notable Options
Linux	6.5.7	tinyconfig, readable asm, ...
BSD	13.1	GENERIC*
StuBs	-	-
RuStuBs	-	-

Error Kinds


#functions with cli
0
100
200
300
400
500
600
700
800
gcc os
gcc o2
clang os
clang o2
128
17
58
176
197
43
133
12
28
236
214
144
121
12
242
117
188
132
11
337
122
230
Irreducibility
Deviated Exit
Dynamic Call
Dynamic Jump
Call Loop
Analyzable

Intervals


Ended Interval Statistics
gcc os
gcc o2
clang o2
clang os
Instruction Count
Basic Block Count
0
20
40
60
80
100
0
5
10
15
20
25
30
35
40

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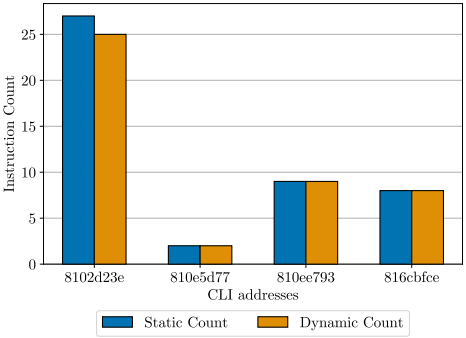

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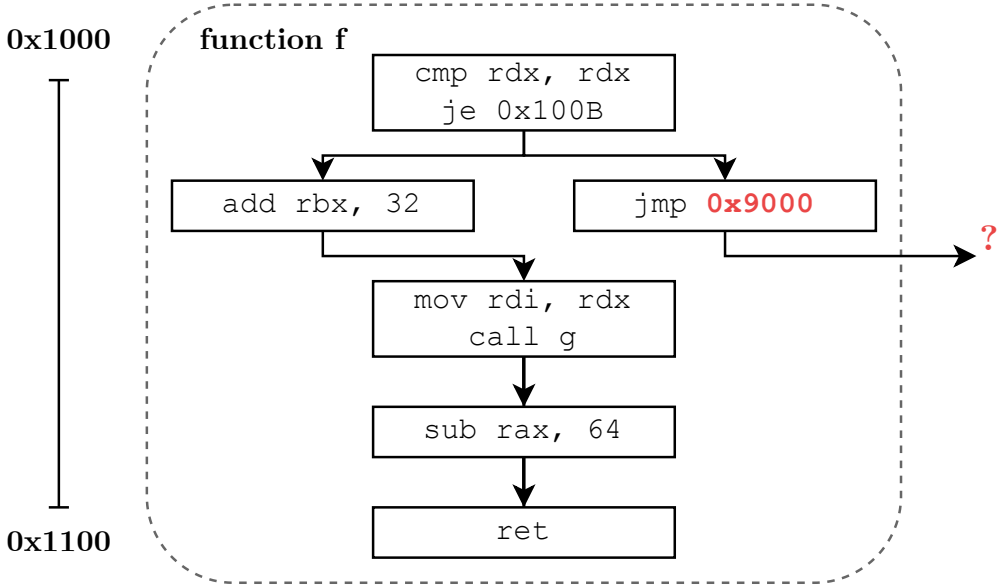
Questions?


0x1000
function f
cmp rdx, rdx
je 0x100B
add rbx, 32
jmp 0x9000
?
mov rdi, rdx
call g
sub rax, 64
ret
0x1100

```
1  int measure(Sensor* s) {
2    int total = 0, limit;
3    if (s->kind == 0x0) {
4      limit = 16;
5    } else {
6      limit = 32;
7    }
8    for(int i = 0; i < limit; ++i) {
9      total += sense(s);
10   }
11   return total;
12 }
```

statically obtainable
run-time dependency