Architecture 1001: x86-64 Assembly GotoExample.c

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Control Flow

- Two forms of control flow
  - Conditional - go somewhere if a condition is met. Think “if”s, switches, loops
  - Unconditional - always go somewhere. Function calls, goto, exceptions, interrupts
- We’ve already seen function calls manifest themselves as call/ret, let’s see how goto manifests itself in asm

GotoExample.c

```c
#include <stdio.h>
int main(){
    goto mylabel;
    printf("skipped\n");
mylabel:
    printf("goto ftw!\n");
    return 0xb01dface;
}
```

```
main:
0000000140001000  sub   rsp,28h
0000000140001004  jmp   0000000140001012
0000000140001006  lea   rcx,[000000014000600h]
000000014000100D  call  0000000140001090
$mylabel:
0000000140001012  lea   rcx,[000000014000601h]
0000000140001019  call  0000000140001090
000000014000101E  mov   eax,0B01DFACEh
0000000140001023  add   rsp,28h
0000000140001027  ret
```

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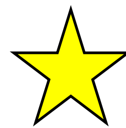

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main:
0000000140001000  sub   rsp,28h
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000000014000100D  call  0000000140001090
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0000000140001019  call  0000000140001090
000000014000101E  mov   eax,0B01DFACEh
0000000140001023  add   rsp,28h
0000000140001027  ret
```

JMP - Jump

- Unconditionally change RIP to given address
- Ways to specify the address:
  - *Short, relative* (RIP = RIP of next instruction + 1 byte sign-extended-to-64-bits displacement)
    - Frequently used in small loops
    - Some disassemblers will indicate this with a mnemonic by writing it as “jmp short”
    - jmp -2 == infinite loop for short relative jmp :)
    - “jmp 0000000140001012” doesn’t have the number 0000000140001012 anywhere in it, it’s really “jmp 0x0C bytes forward”
  - *Far, absolute indirect* - We'll discuss in future class

JMP - Jump

- Ways to specify the address:
  - *Near, relative* (RIP = RIP of next instruction + 4 byte sign-extended-to-64-bits displacement)
  - *Near, absolute indirect* (address calculated with r/m64)

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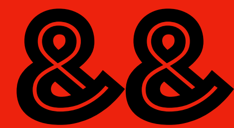
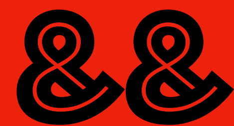
STOP



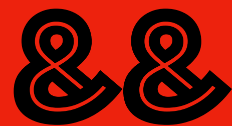
STEP THROUGH

THE ASSEMBLY

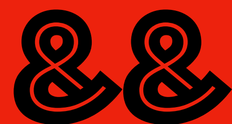


CHECK YOUR UNDERSTANDING

STOP



STEP THROUGH THE ASSEMBLY



CHECK YOUR UNDERSTANDING

GotoExample.c takeaways

- goto == jmp in asm :)

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```

Instructions we now know (13)

- NOP
- PUSH/POP
- CALL/RET
- MOV
- ADD/SUB
- IMUL
- MOVZX/MOVSX
- LEA
- **JMP**

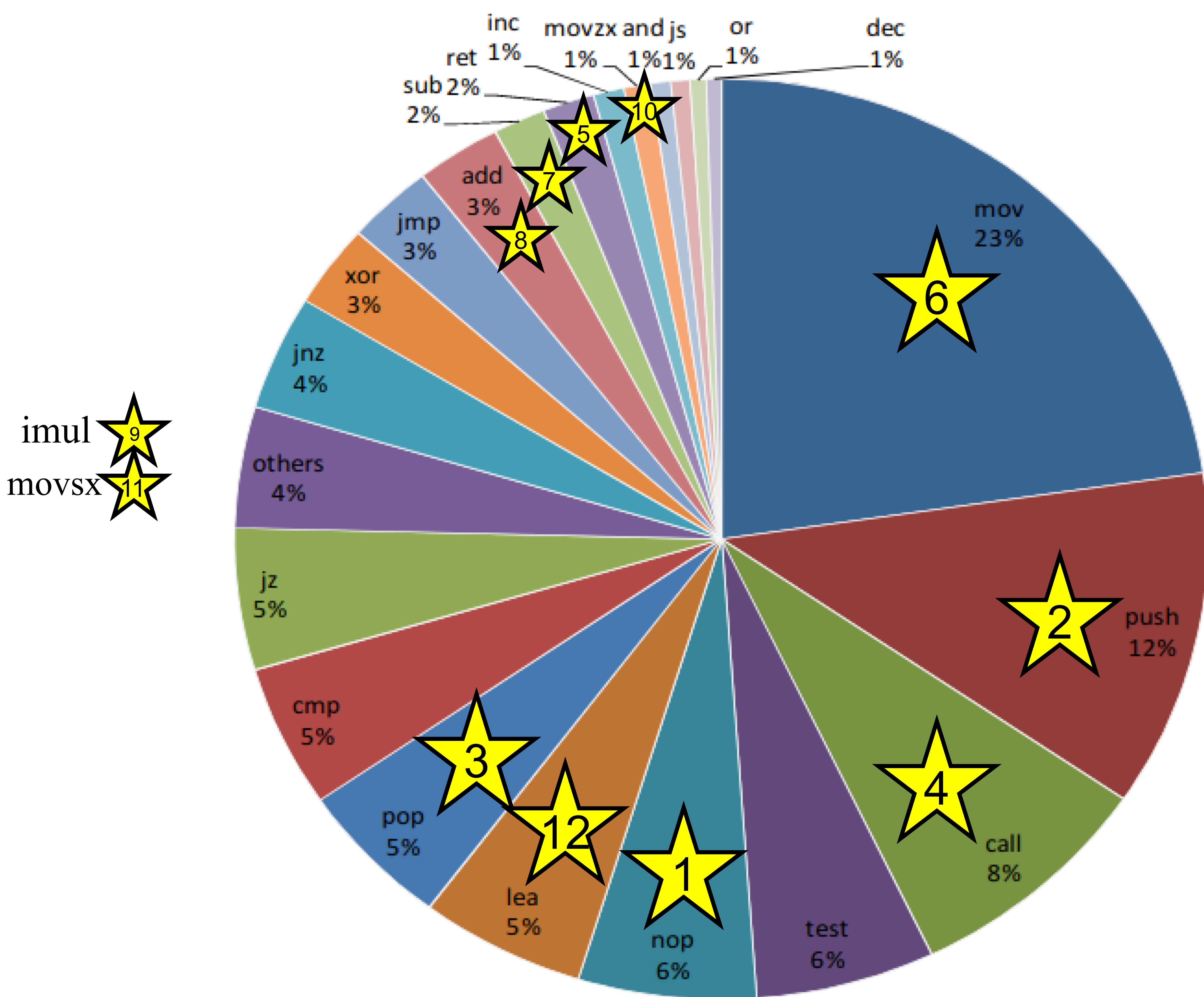

Fig. 2 Web browsers' instruction frequencies

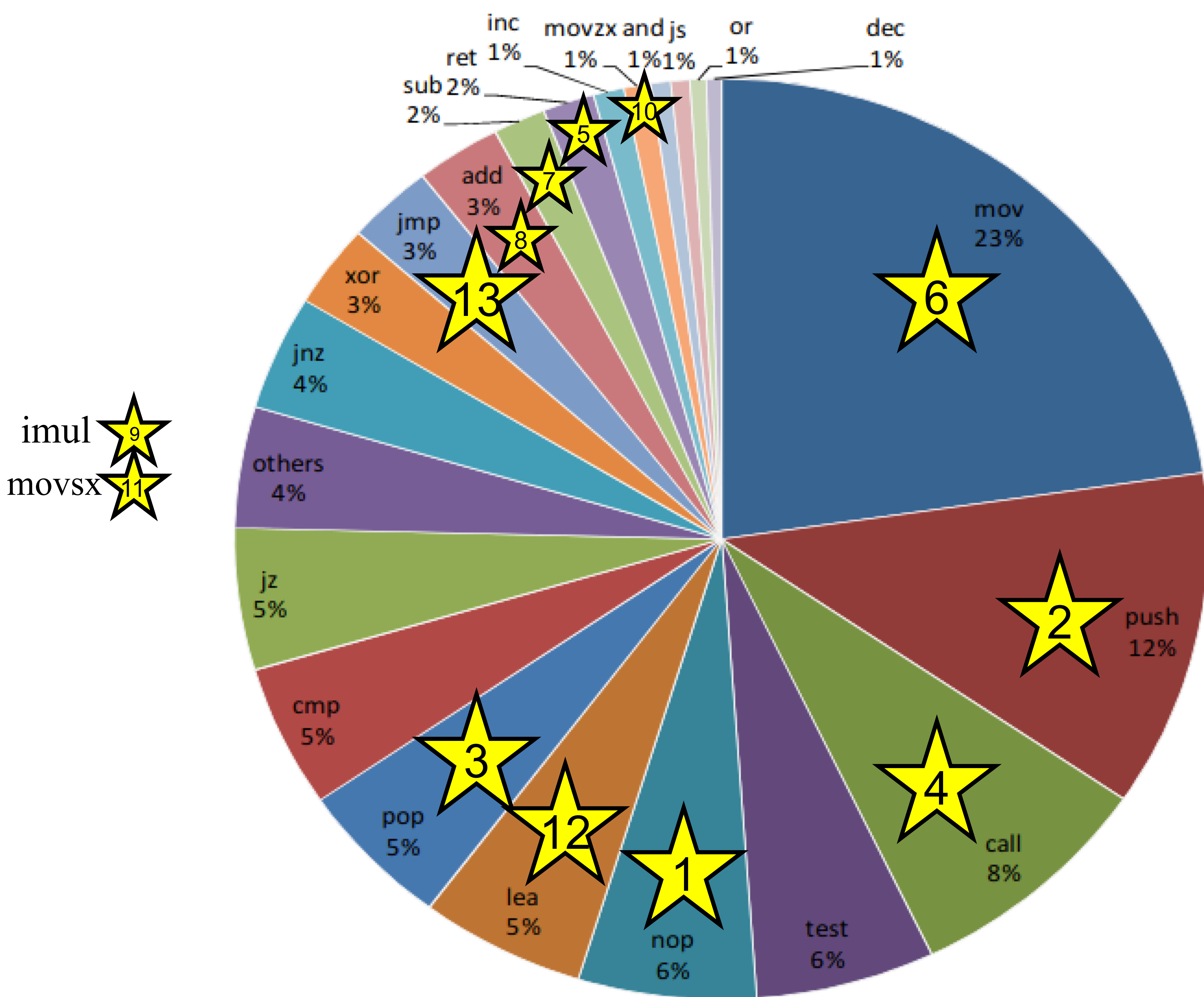

Fig. 2 Web browsers' instruction frequencies