Operating Systems

Limited Direct Execution + Memory Virtualisation

Nipun Batra

Direct Execution

OS

Program

Direct Execution

OS	Program
1. Create entry for process	

Direct Execution

OS	Program
1. Create entry for process 2. Allocate memory for process	

Direct Execution

OS	Program
1. Create entry for process 2. Allocate memory for process 3. Load program into memory	

Direct Execution

OS

Program

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2. Allocate memory for process
3. Load program into memory
4. Set up stack

Direct Execution

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Direct Execution

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Program

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OS

1. Free memory
2. Remove process from process list

Direct Execution Challenges

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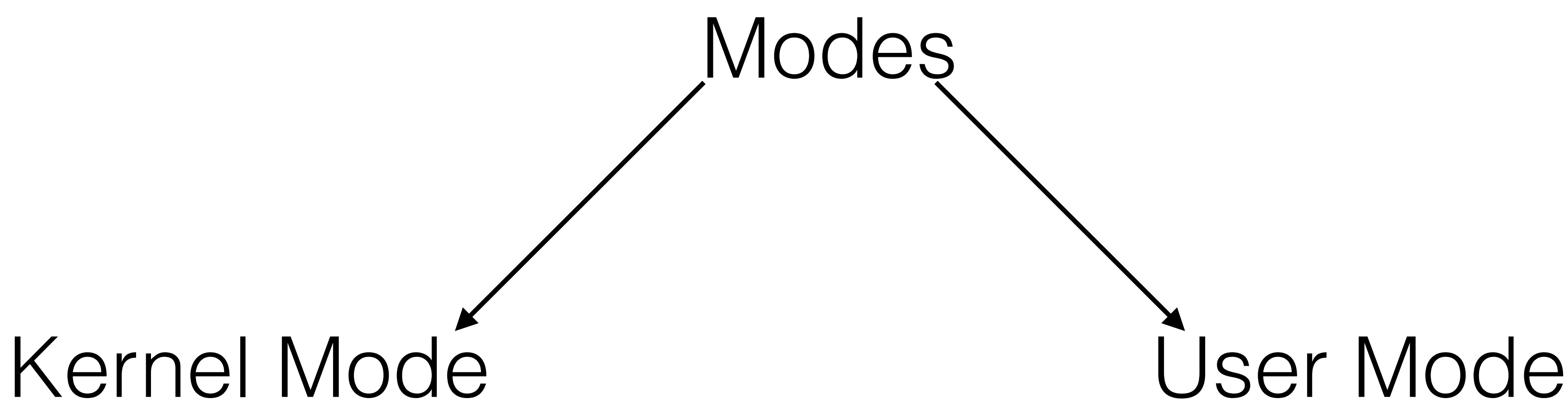
- Goal: A process must be able to perform I/O and some other restricted operations, but without giving the process complete control over the system.

Restricted Operations



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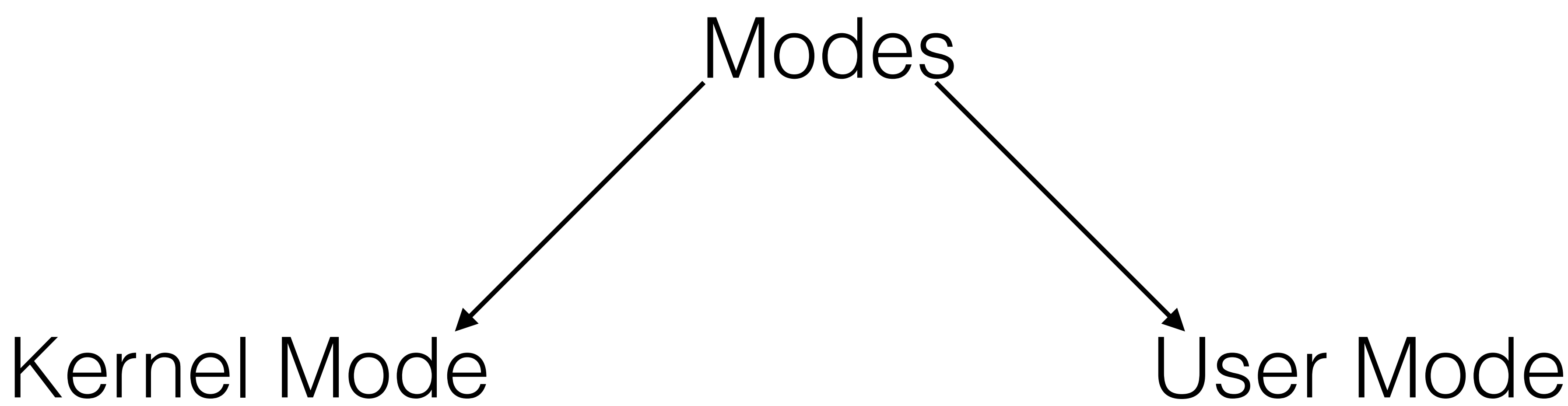

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Restricted Operations

Modes

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User Mode

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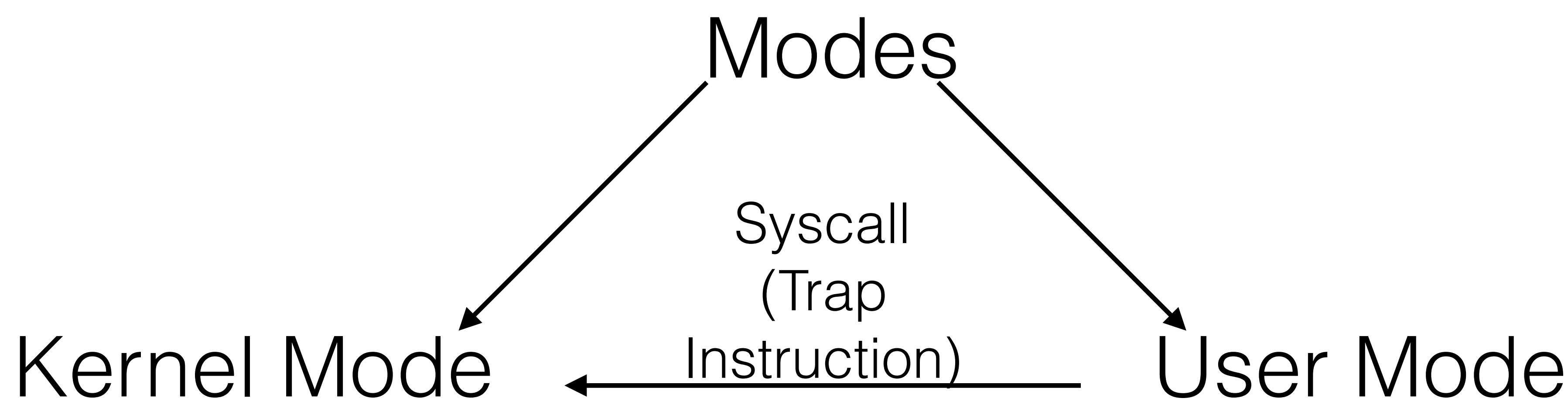

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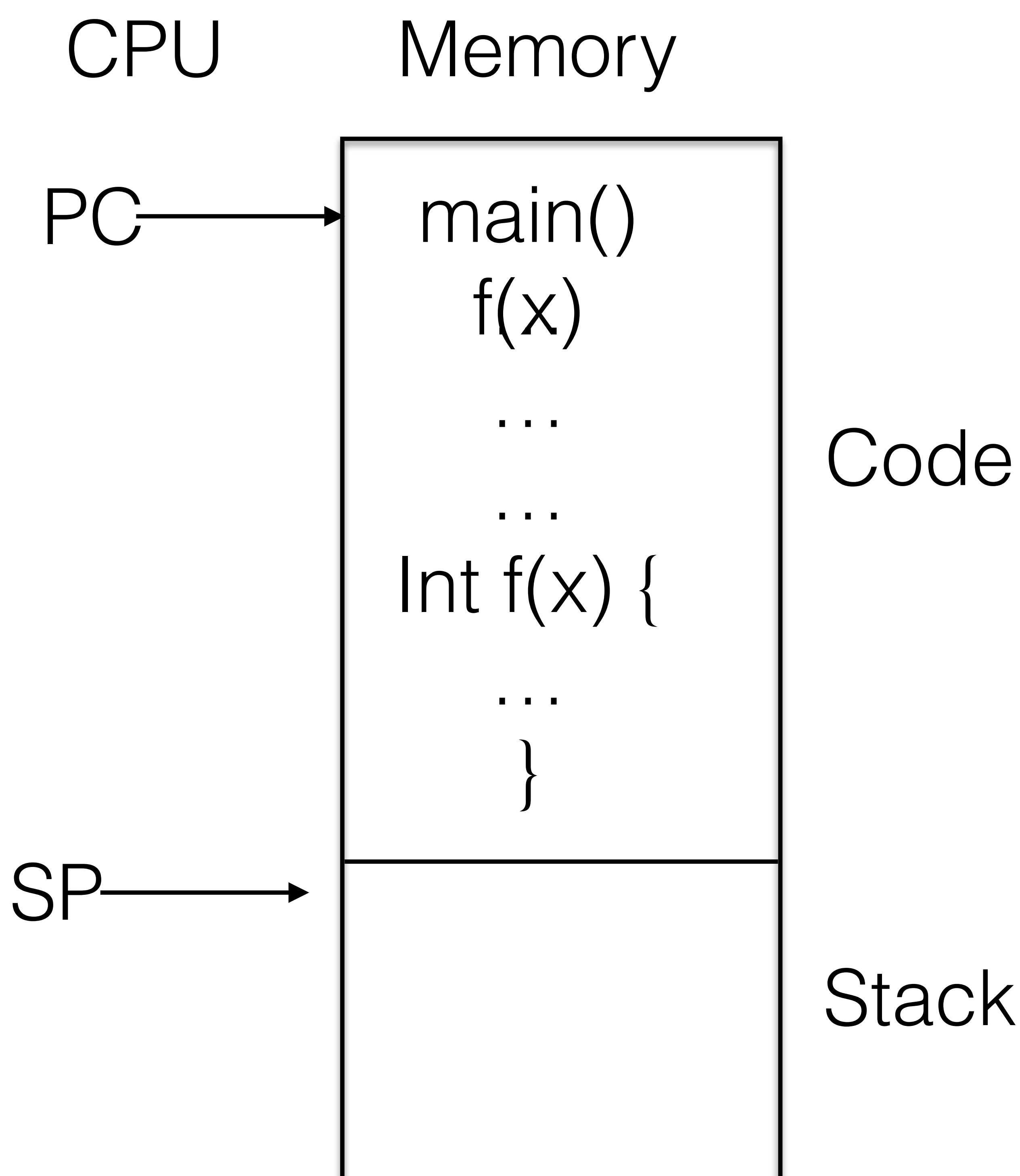
Traps v/s Function Calls

Function call



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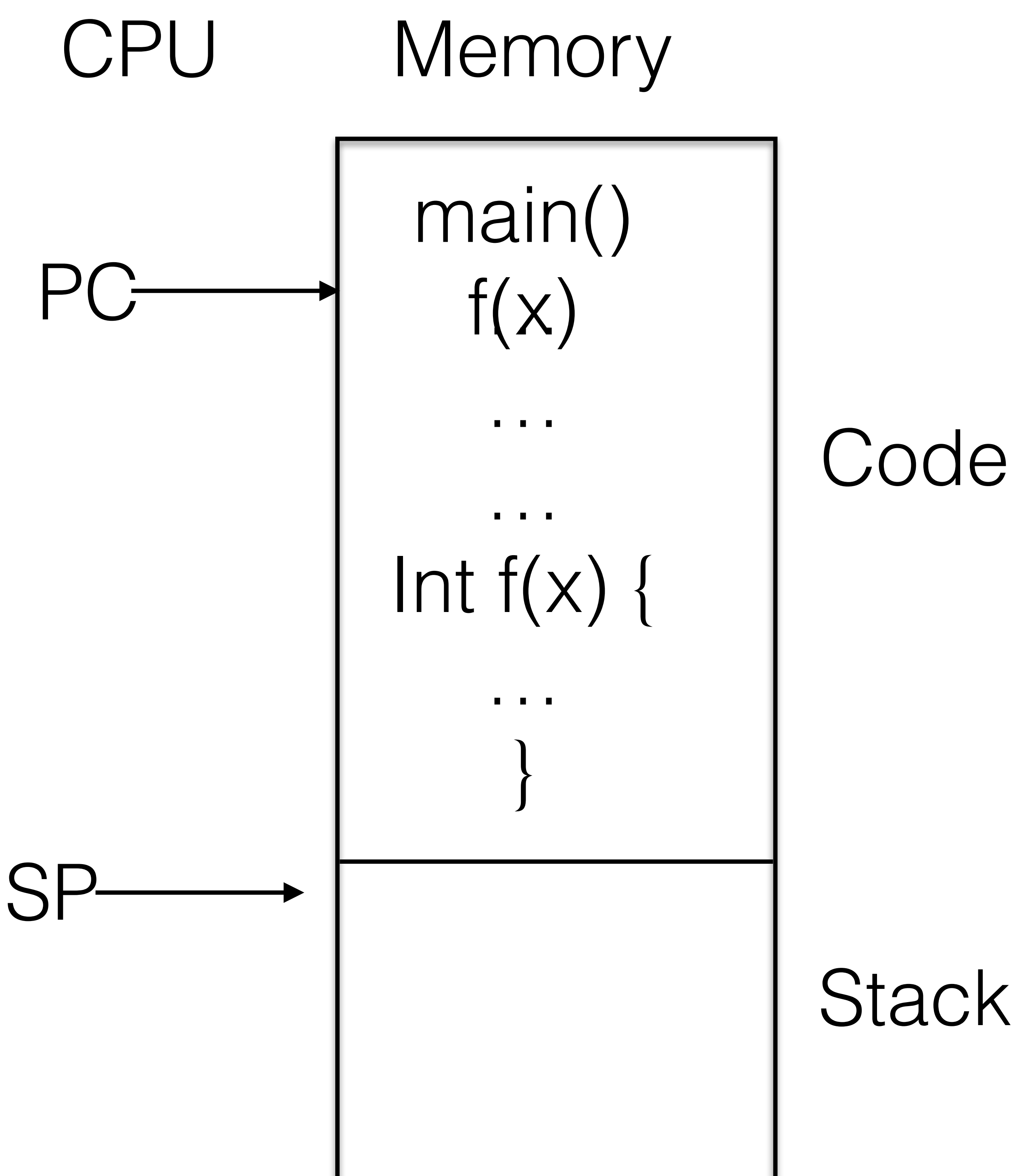

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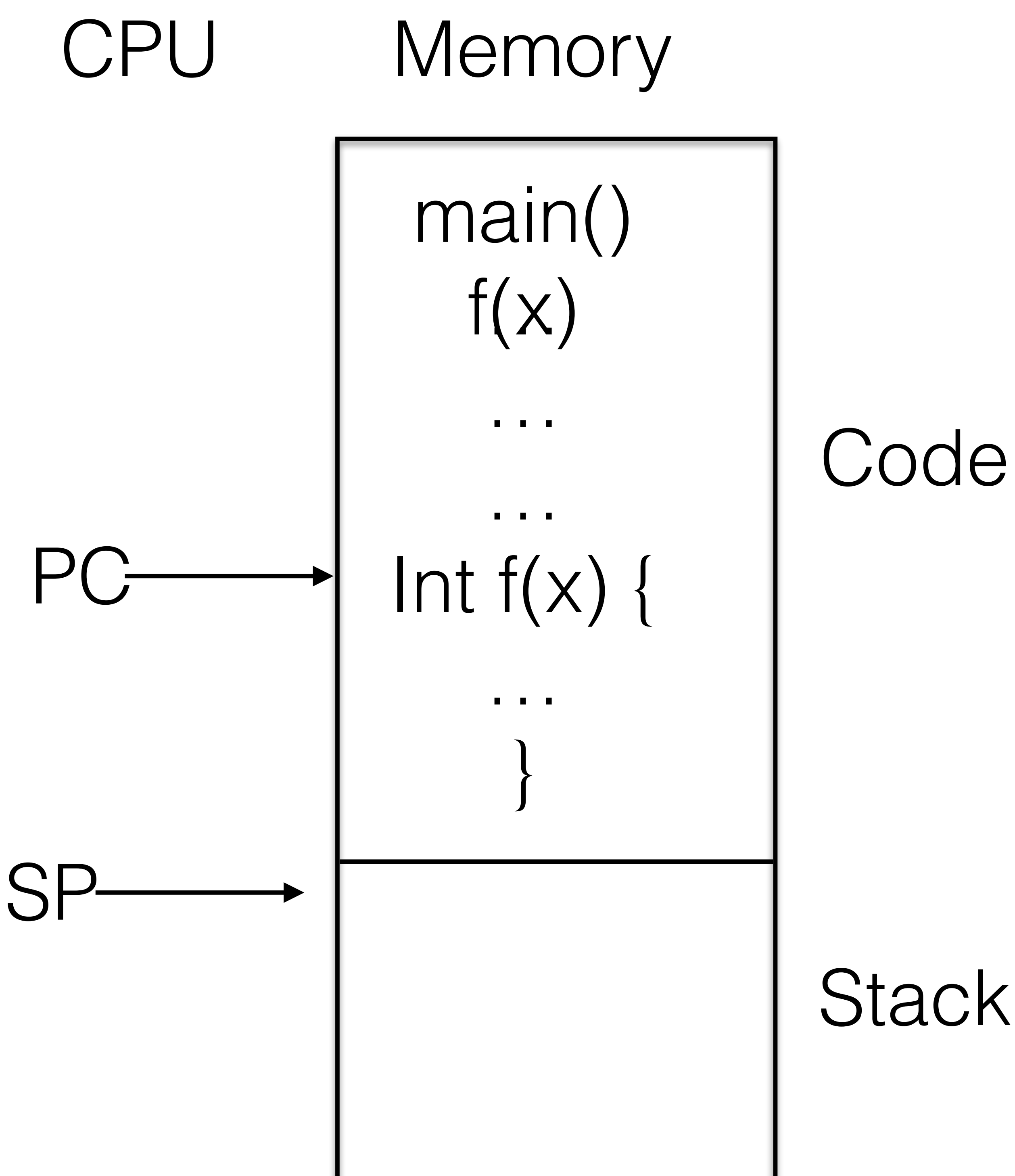

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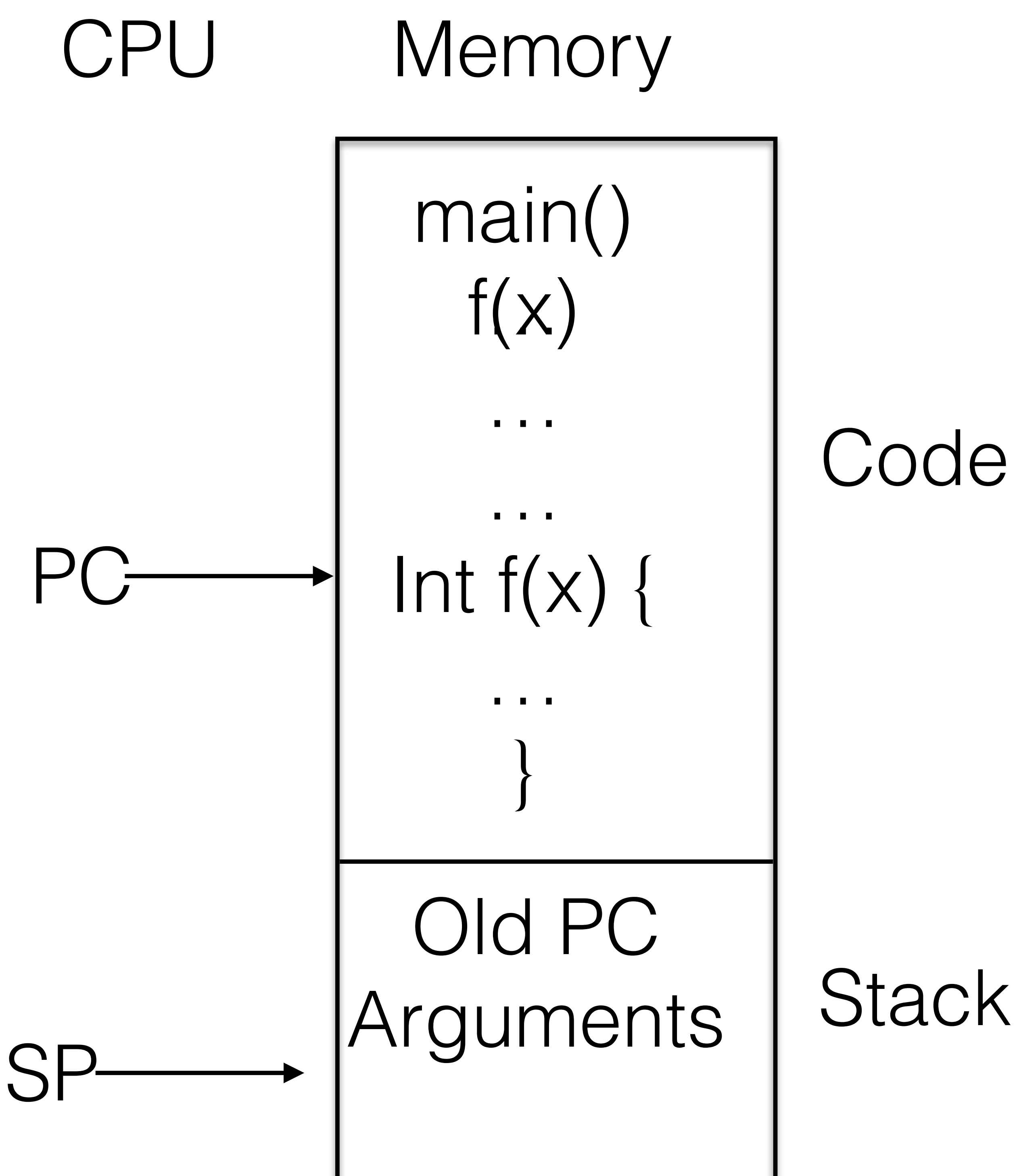

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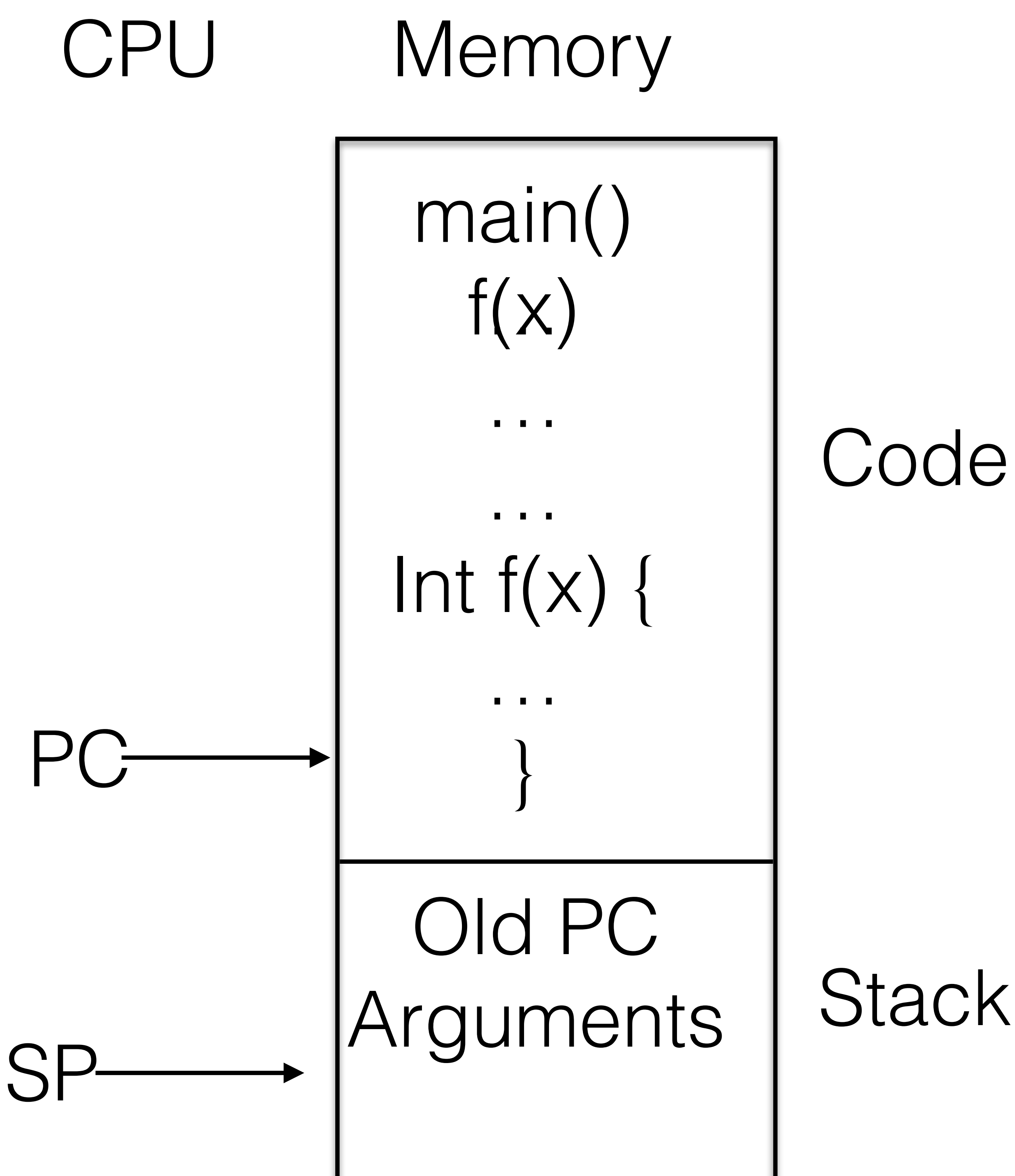
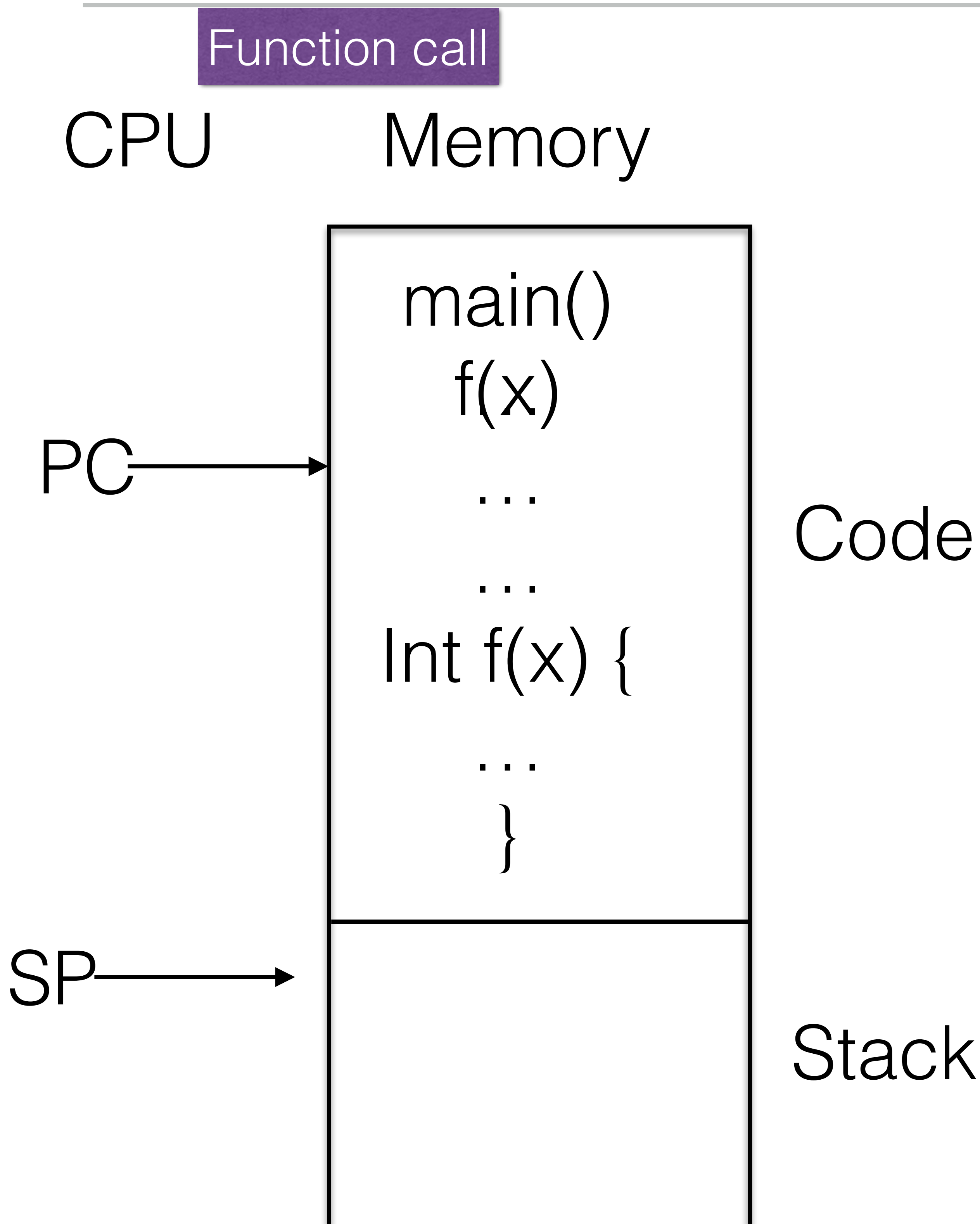
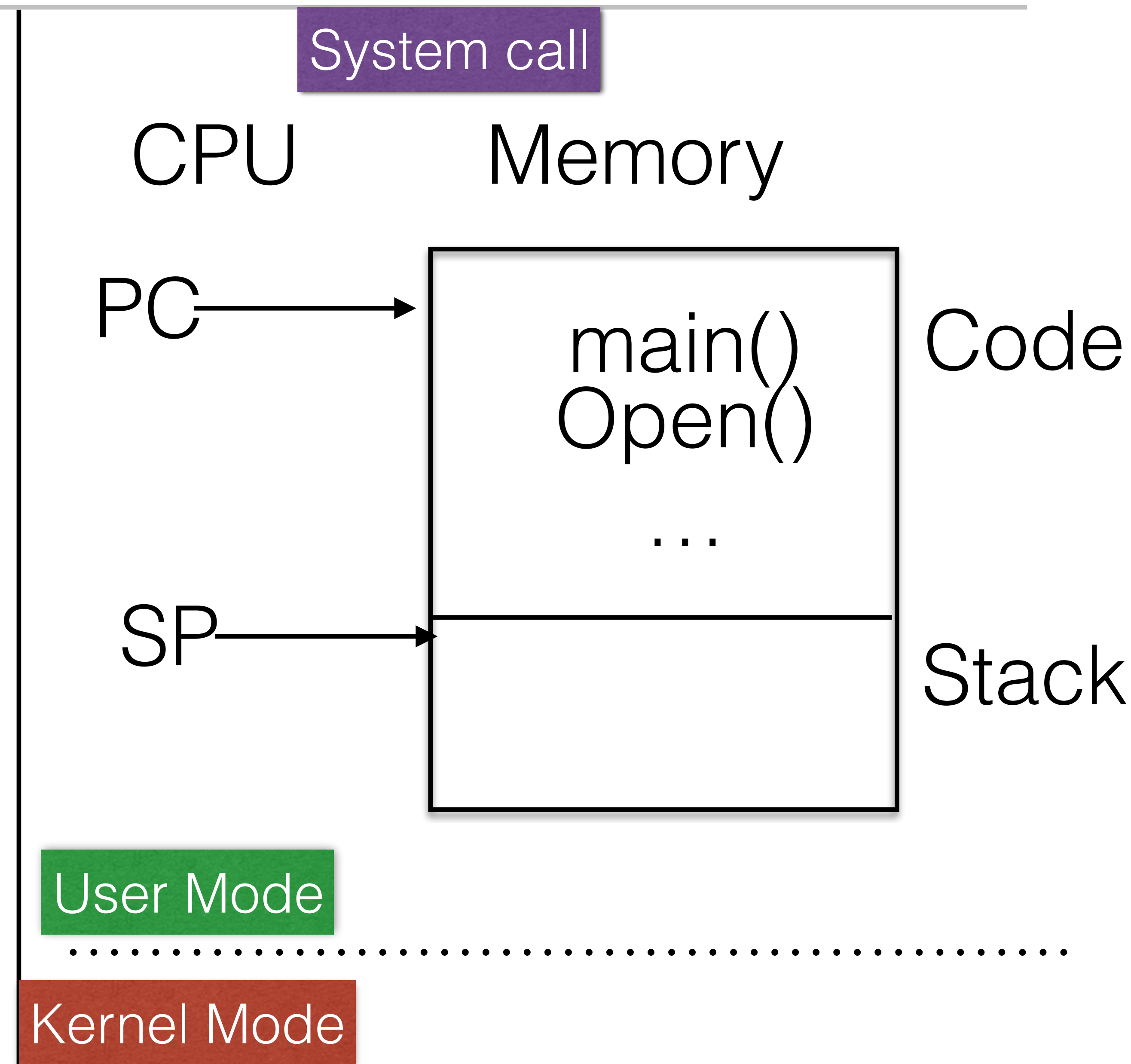


Traps (System) v/s Function Calls





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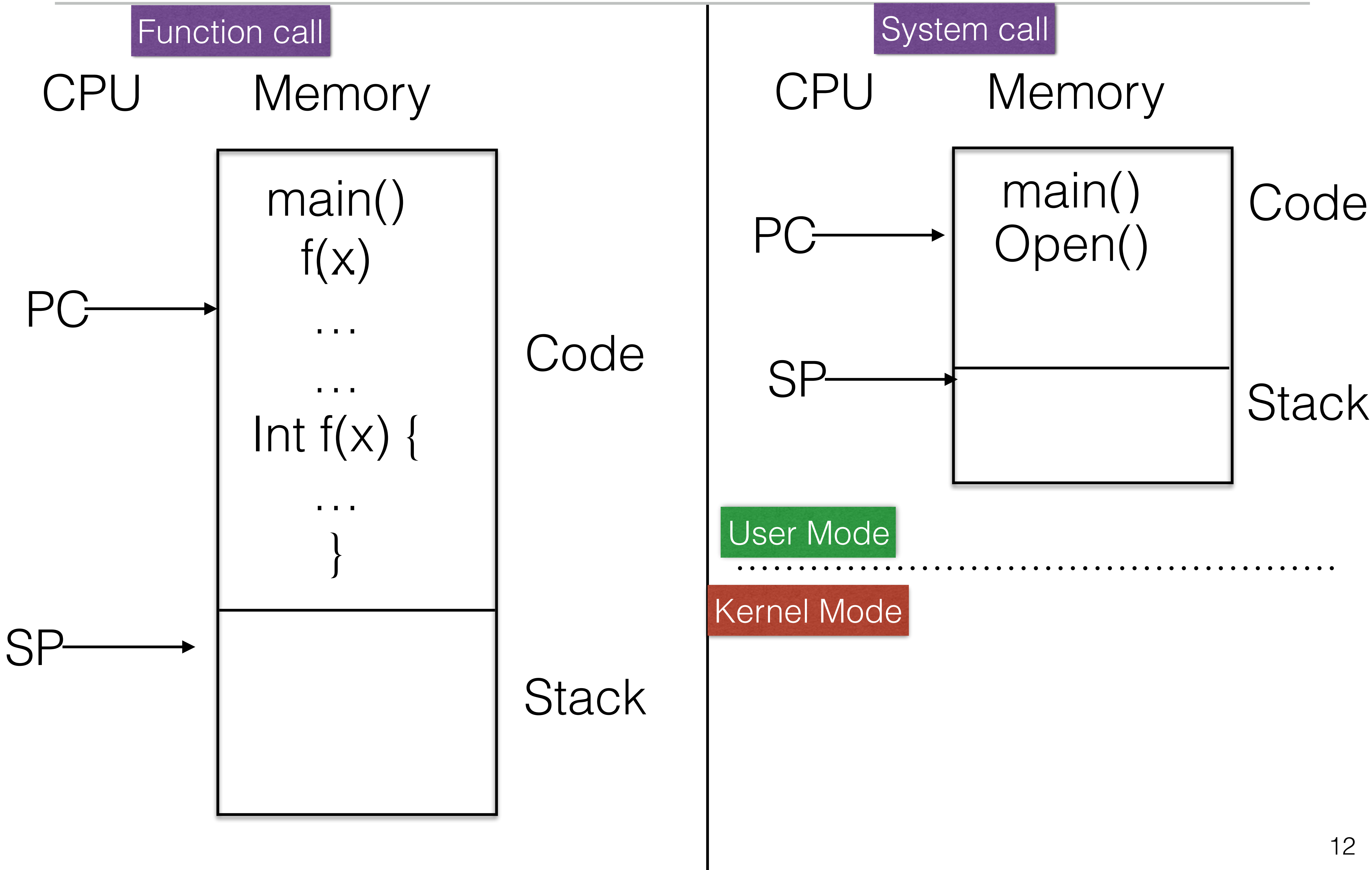

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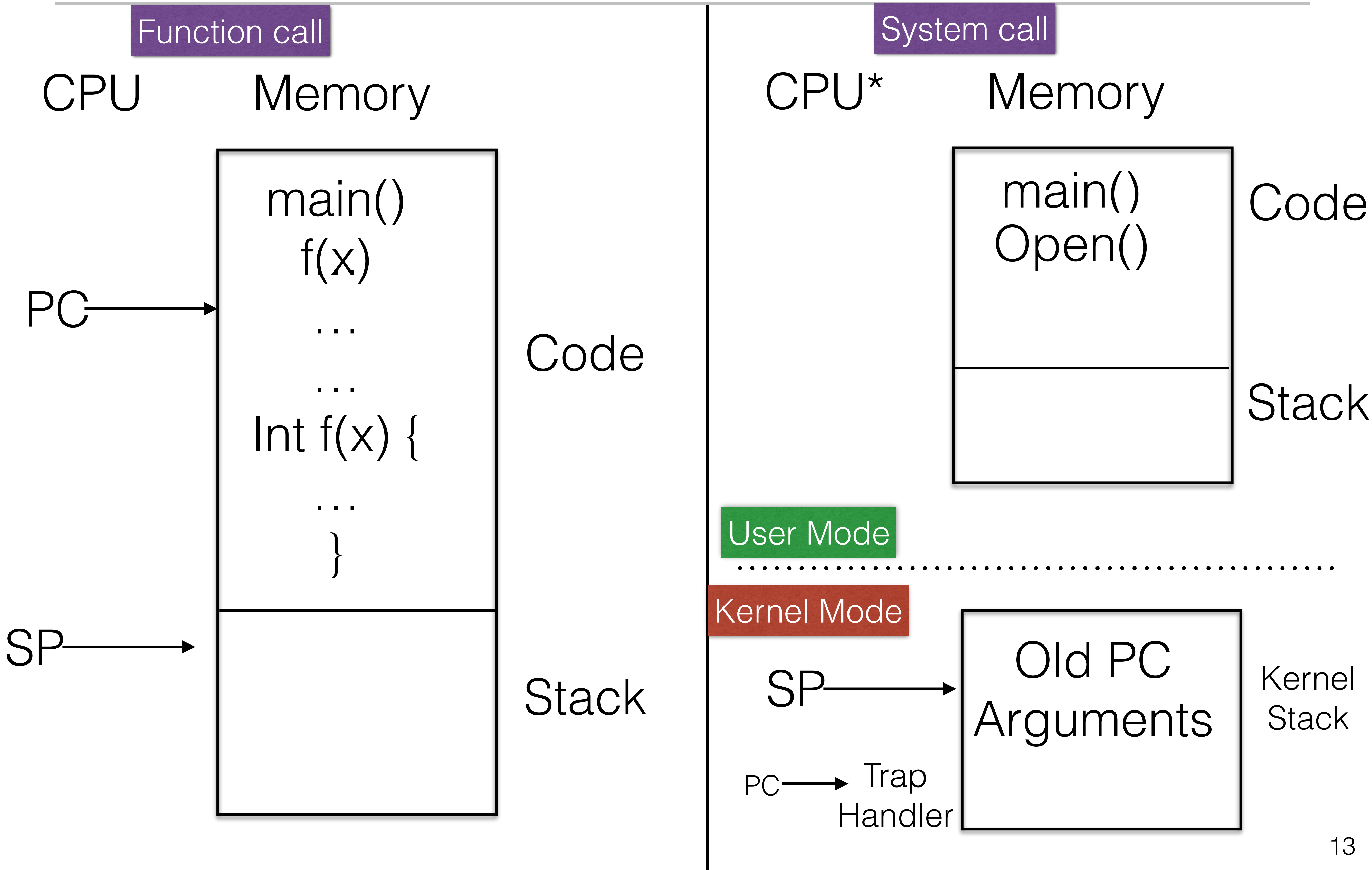

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	restore regs from kernel stack move to user mode jump to main	

Load program into memory Setup user stack with argv Fill kernel stack with reg/PC **return-from-trap**		
	restore regs from kernel stack move to user mode jump to main	
		Run main() ... Call system call **trap** into OS
	save regs to kernel stack move to kernel mode jump to trap handler	
Handle trap Do work of syscall **return-from-trap**		
	restore regs from kernel stack move to user mode jump to PC after trap	
		... return from main **trap** (via `exit()`)
Free memory of process Remove from process list		

Summary

https://minnie.tuhs.org/CompArch/Lectures/week05.html

Switching Between Processes

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- Is the OS running on CPU when program is running?
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- How does OS get back in control?

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    - Restart!

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OS @ run (kernel mode)	**Hardware**	**Program (user mode)**
		Process A ...
	timer interrupt save regs(A) to k-stack(A) move to kernel mode jump to trap handler	
Handle the trap Call `switch()` routine save regs(A) to proc-struct(A) restore regs(B) from proc-struct(B) switch to k-stack(B) **return-from-trap (into B)**		

System Call handling (save regs(A) to k-stack(A))

User mode registers (save regs(A) to proc-struct(A), restore regs(B) from proc-struct(B))

System Call handling (switch to k-stack(B))

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  restore regs(B) from proc-struct(B)
  switch to k-stack(B)
return-from-trap (into B)		

	restore regs(B) from k-stack(B) move to user mode jump to B's PC	
		Process B ...

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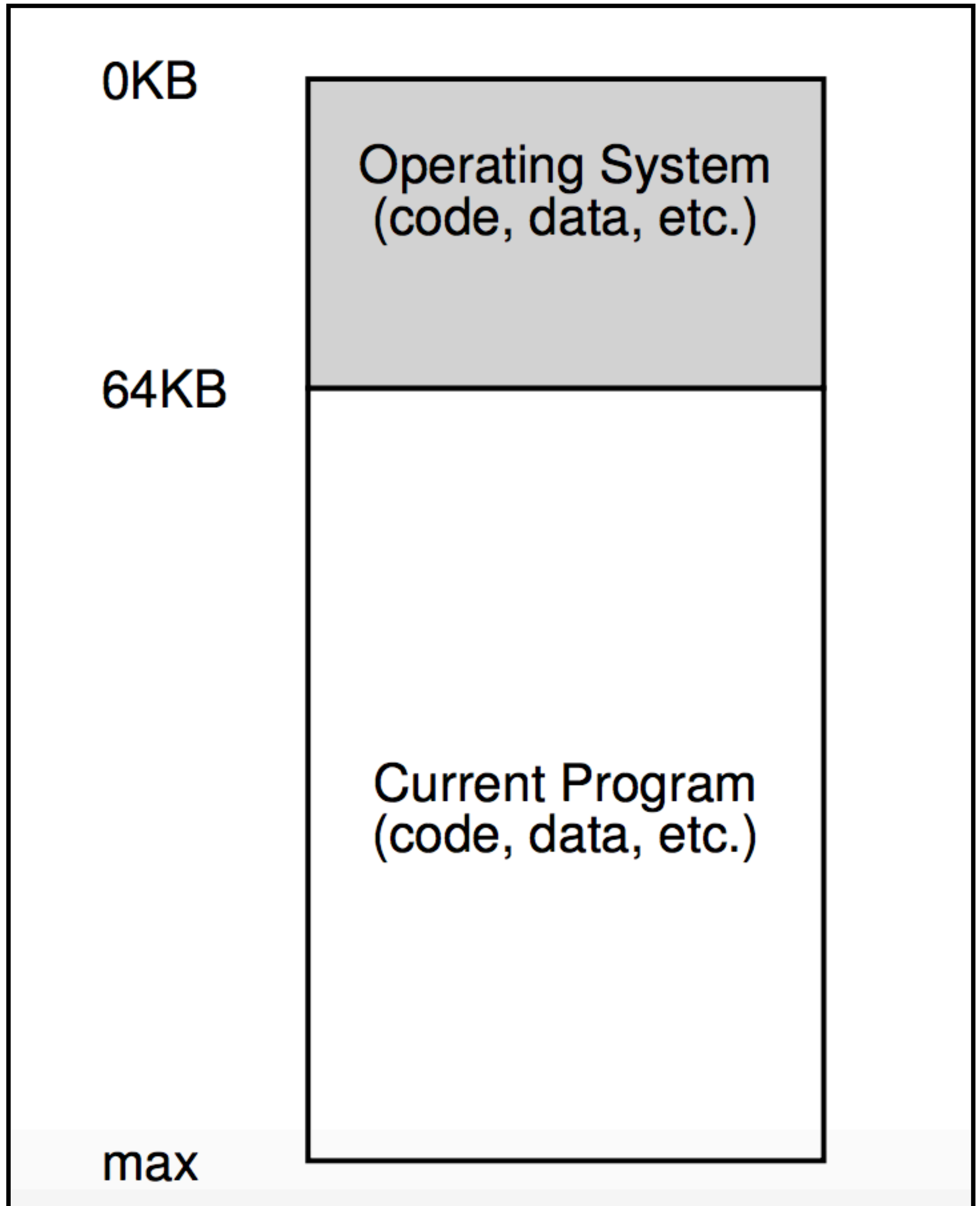
- More on it when we study concurrency!

Memory Virtualisation

Early days
Single program



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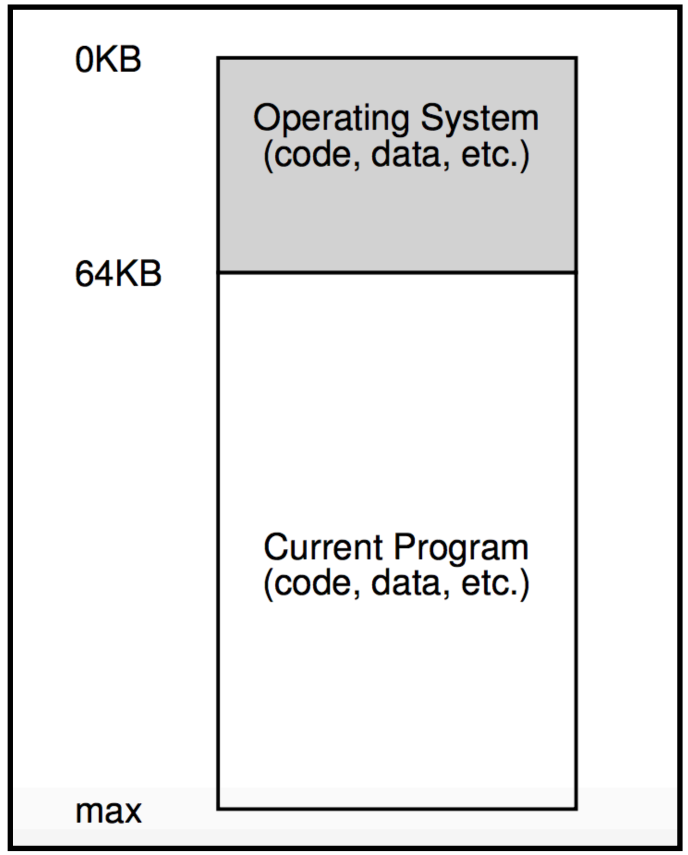
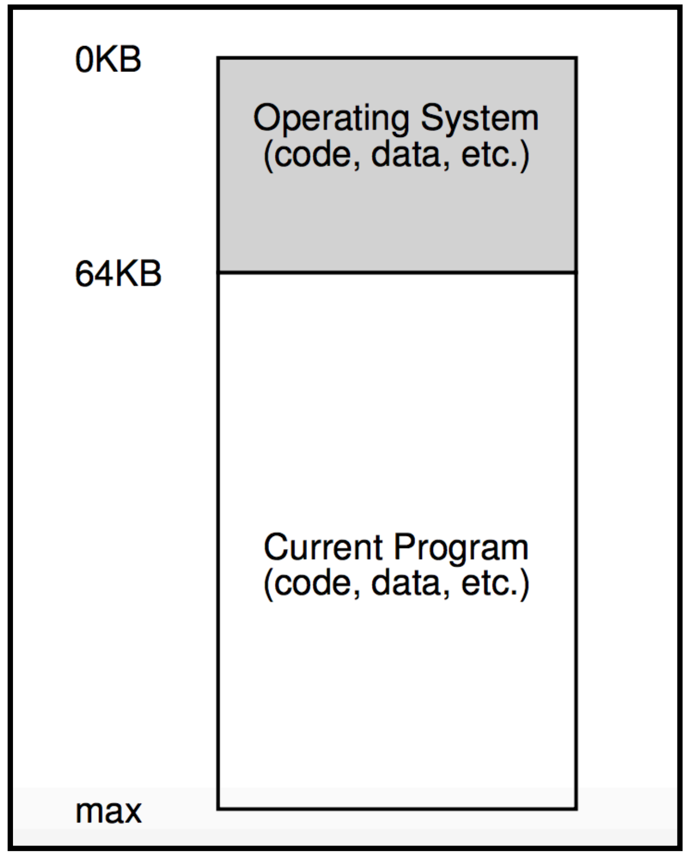


Early days
Multiprogamming

Memory Virtualisation



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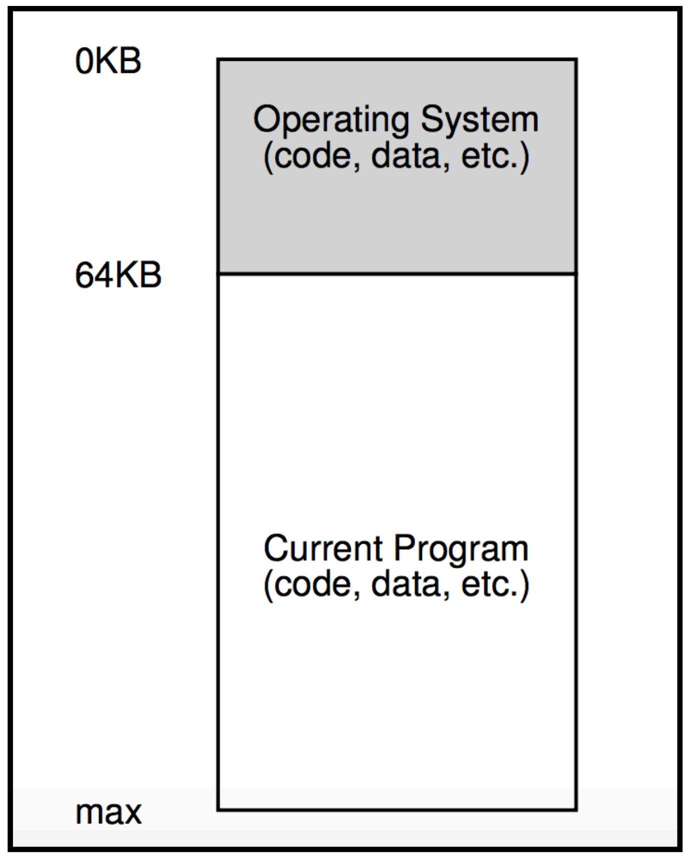

Early days
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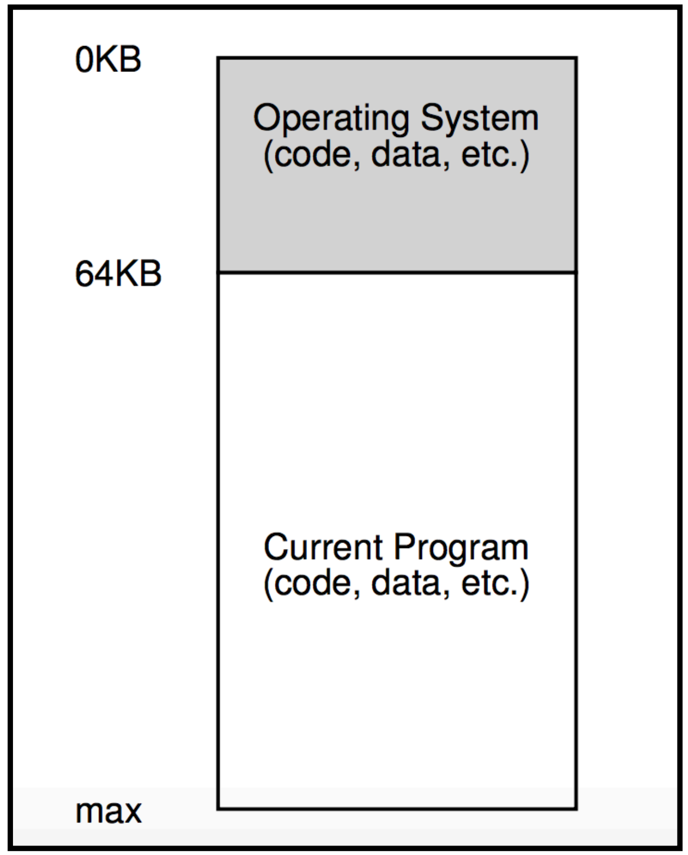
- Single program takes total memory
- Load another process?

Memory Virtualisation



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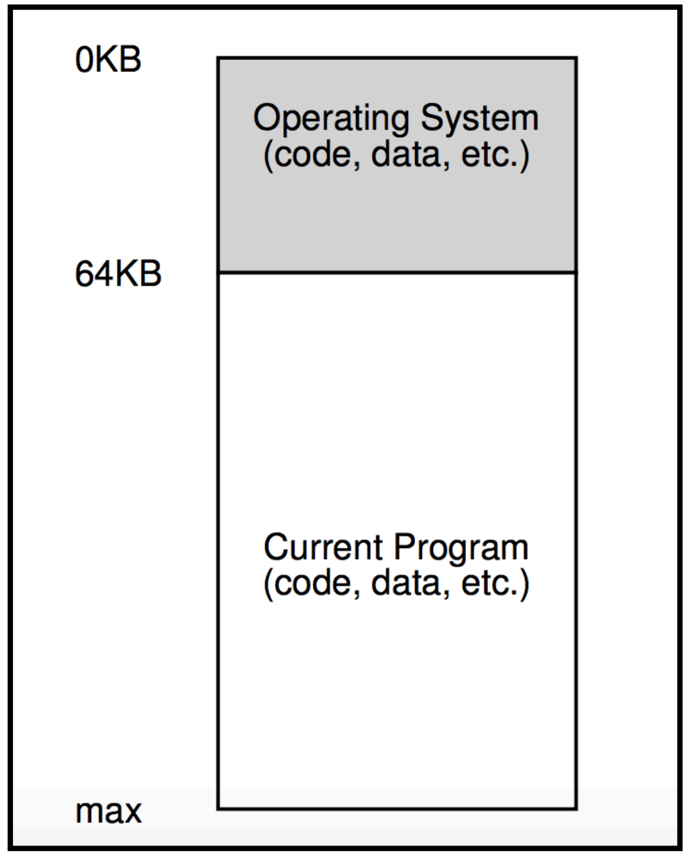

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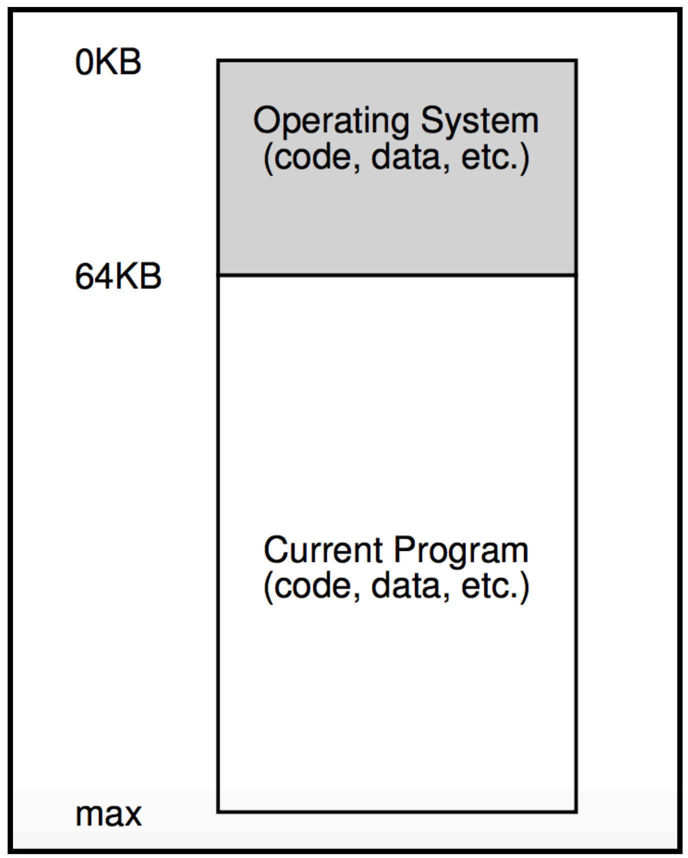

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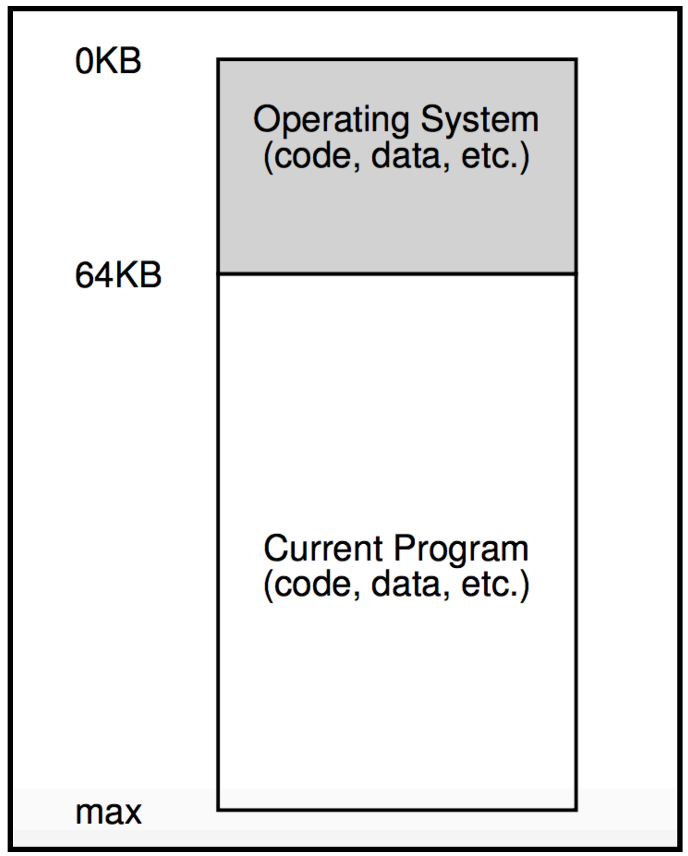

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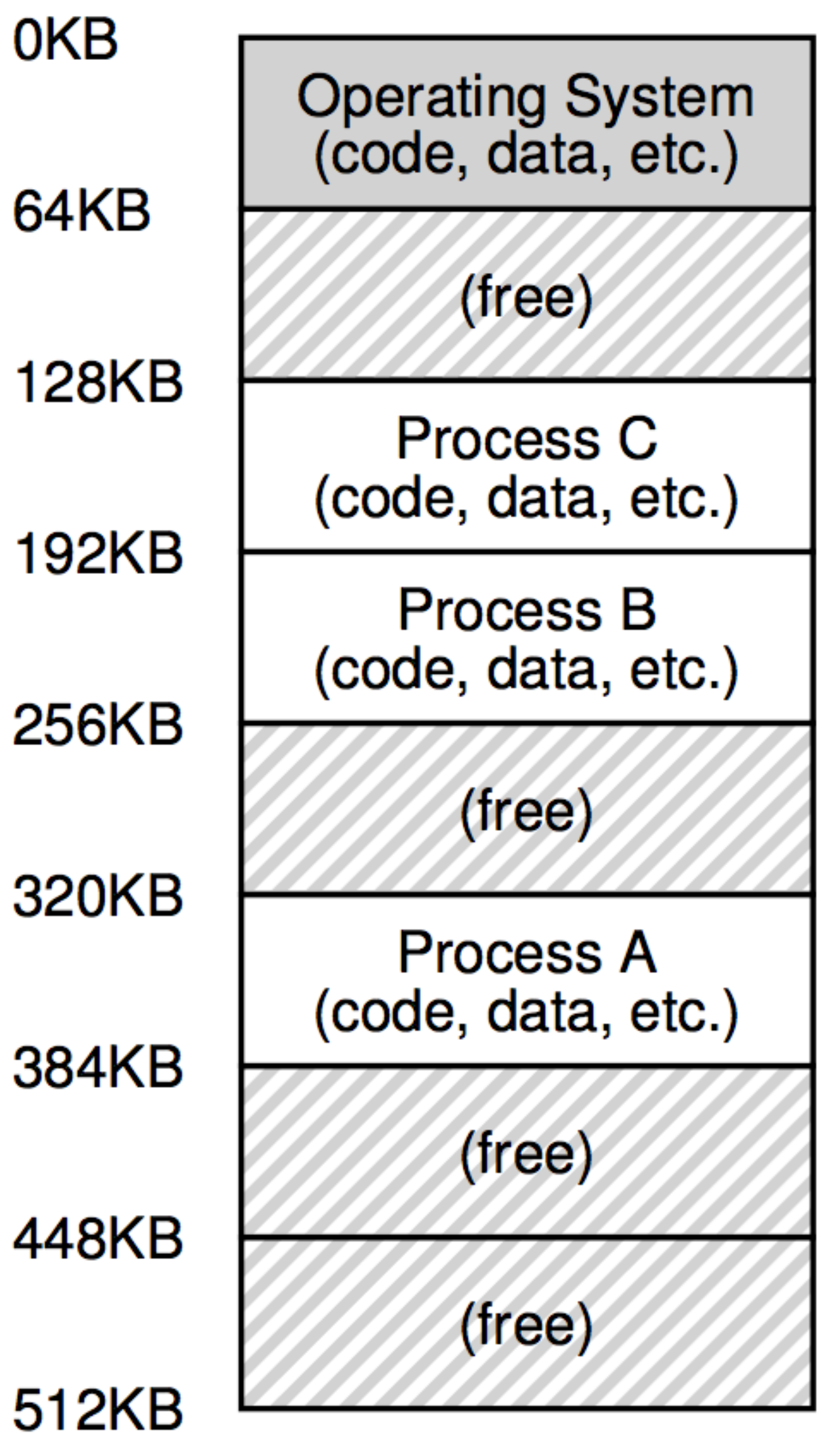
Shared Memory



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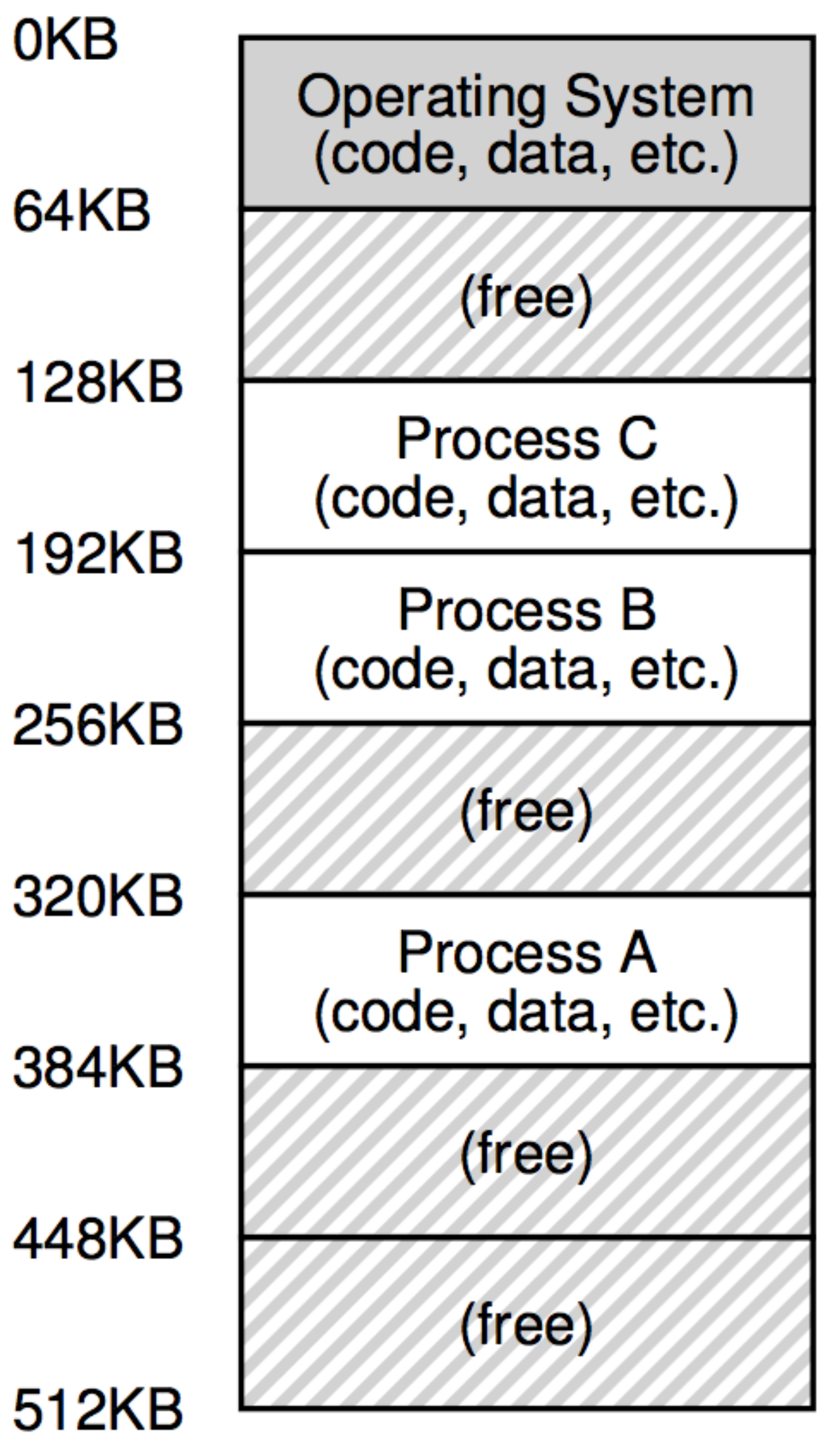
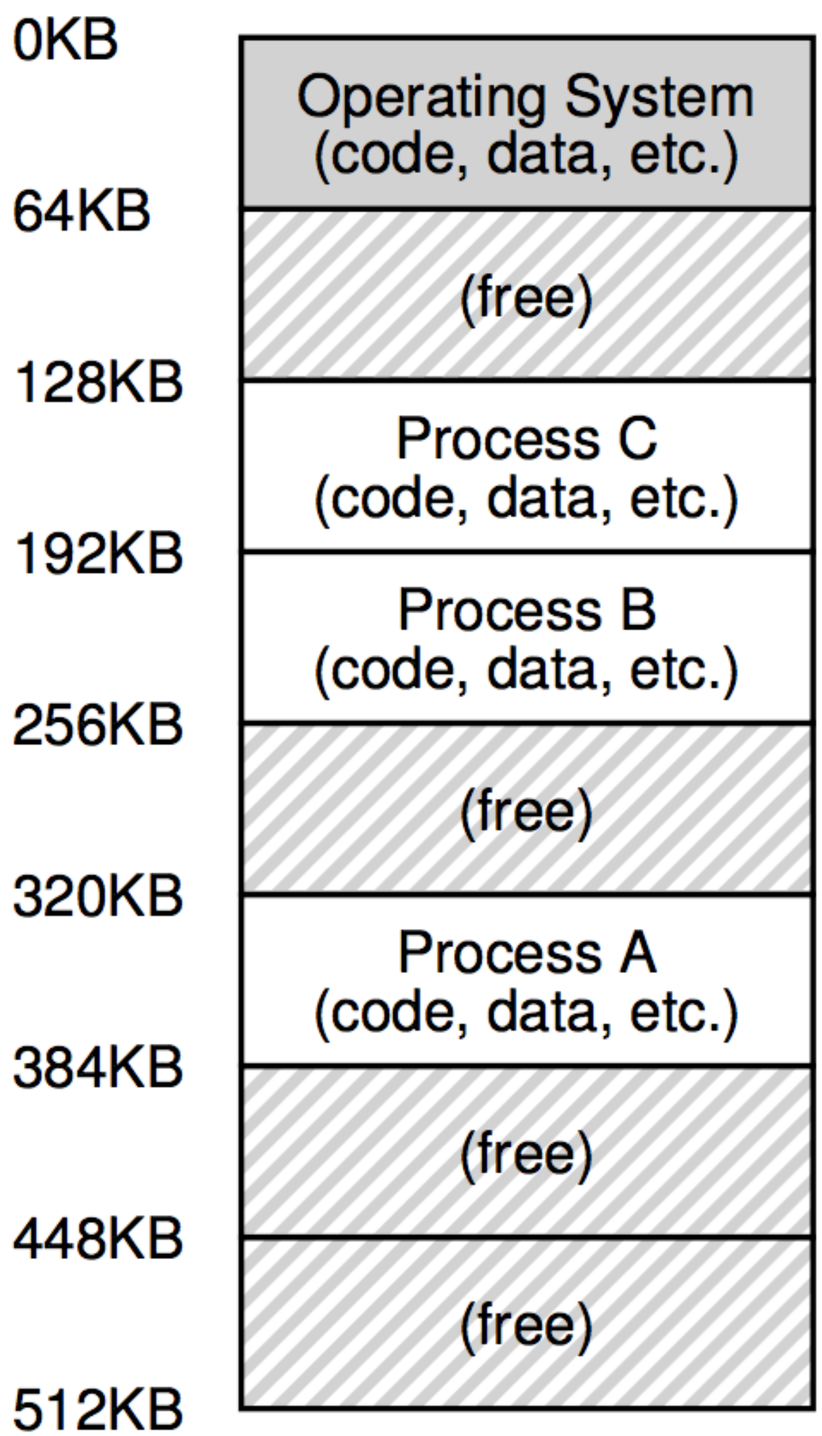


Risk

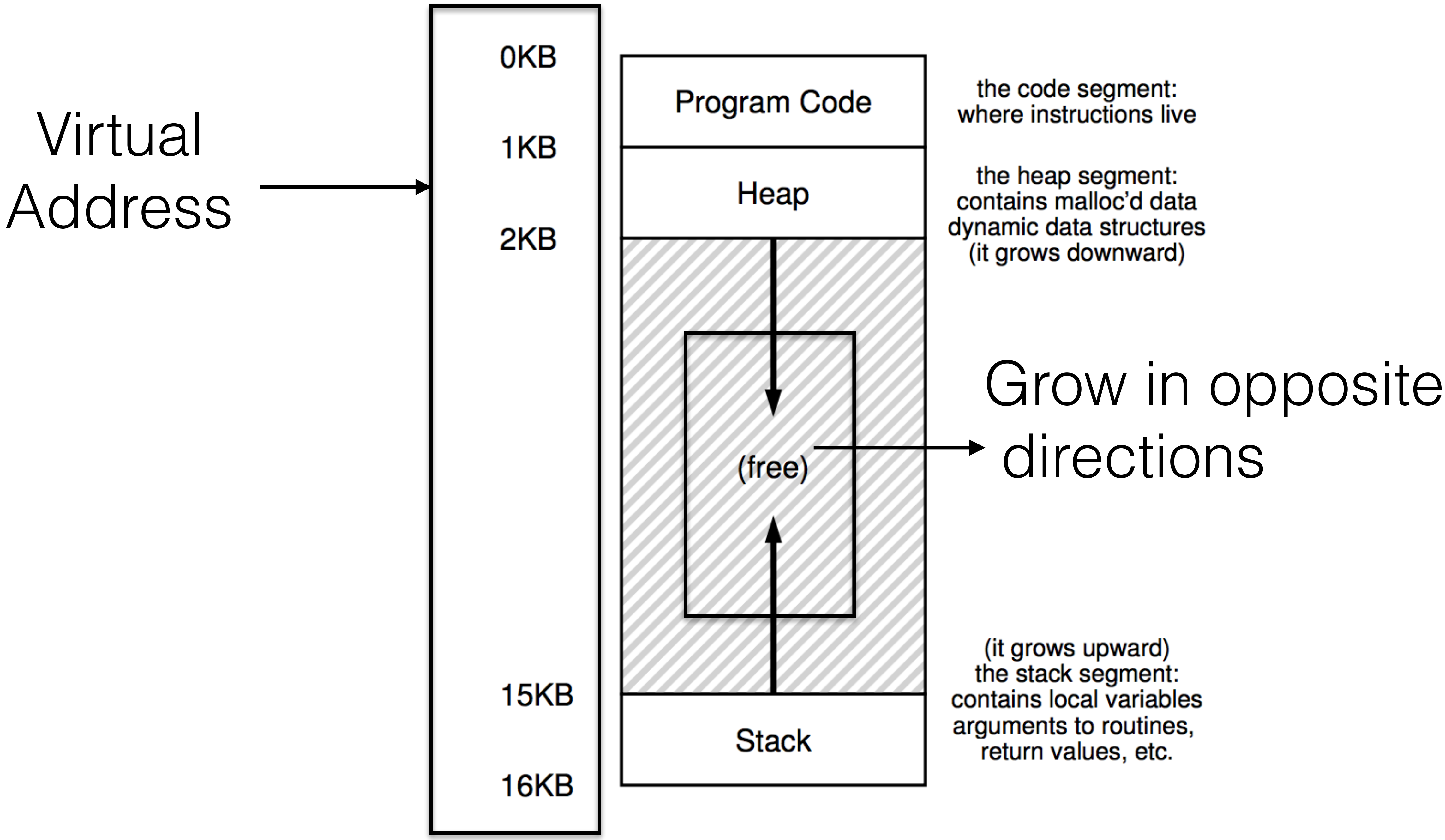
Shared Memory



Risk

- Programs accessing others' memory

Address Space



Goals of OS for Memory Virtualisation

1. Transparency
   1. Virtual memory is invisible to user program
   2. Program thinks it has own private large memory
2. Efficiency
   1. Not taking very long
   2. Not taking too much space
3. Protection/Isolation
   1. Protect processes from each other