



Machine-Level Programming III: Procedures – stack base languages

These slides adapted from materials provided by the textbook

Stack-Based Languages

■ Languages that support recursion

- e.g., C, Pascal, Java
- Code must be “Reentrant”
 - Multiple simultaneous instantiations of single procedure
- Need some place to store state of each instantiation
 - Arguments
 - Local variables
 - Return pointer

■ Stack discipline

- State for given procedure needed for limited time
 - From when called to when return
- Callee returns before caller does

■ Stack allocated in **Frames**

- state for single procedure instantiation

Call Chain Example

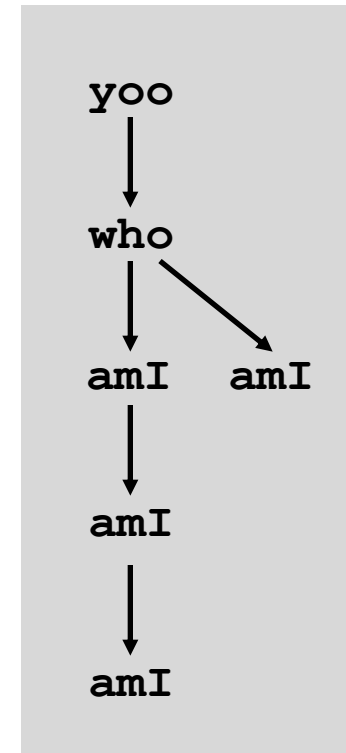
```
yoo (...)  
{  
  .  
  .  
  who ();  
  .  
  .  
}
```

```
who (...)  
{  
  . . .  
  amI ();  
  . . .  
  amI ();  
  . . .  
}
```

```
amI (...)  
{  
  .  
  .  
  amI ();  
  .  
  .  
}
```

Procedure **amI ()** is recursive

Example
Call Chain



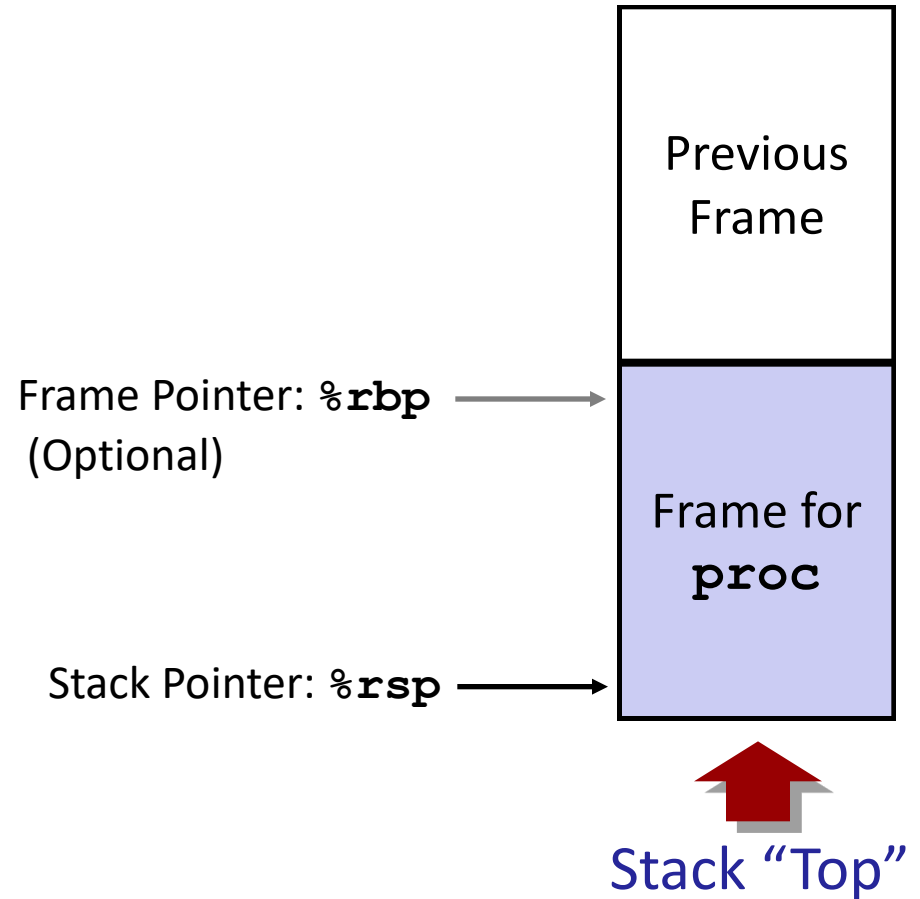
Stack Frames

■ Contents


- Return information
- Local storage (if needed)
- Temporary space (if needed)

■ Management

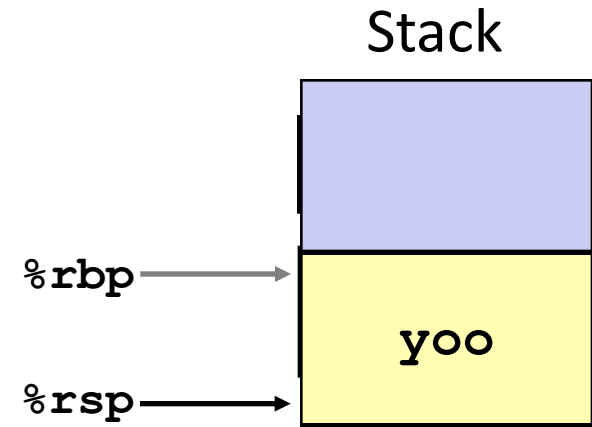
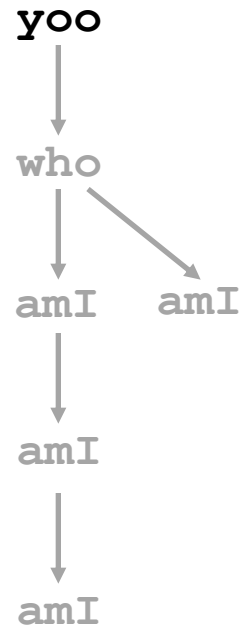
- Space allocated when enter procedure
 - “Set-up” code
 - Includes push by **call** instruction
- Deallocated when return
 - “Finish” code
 - Includes pop by **ret** instruction



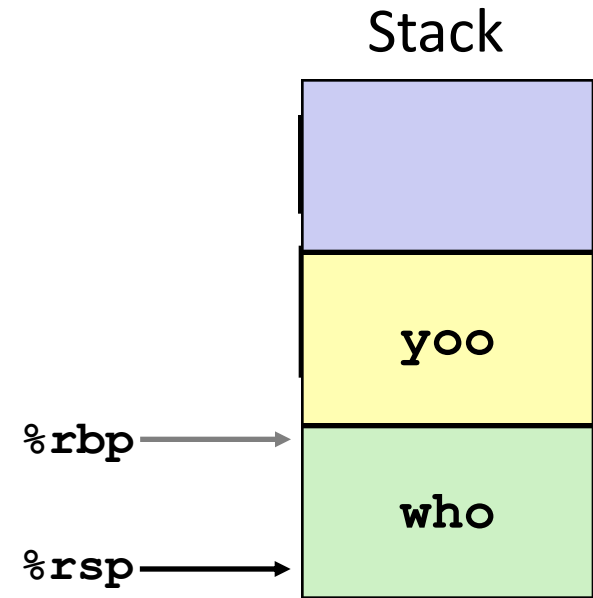
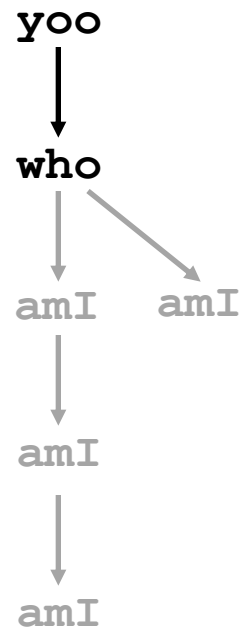
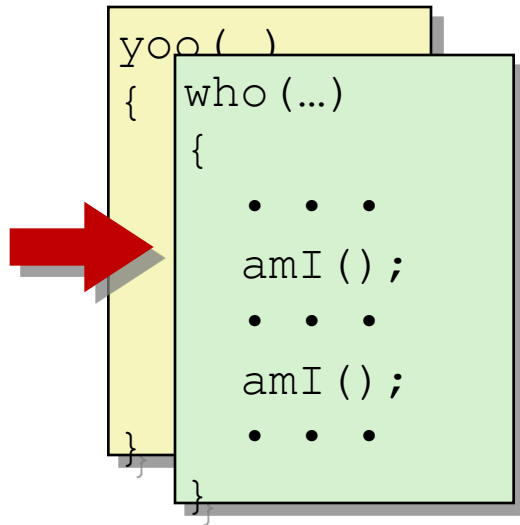
Example



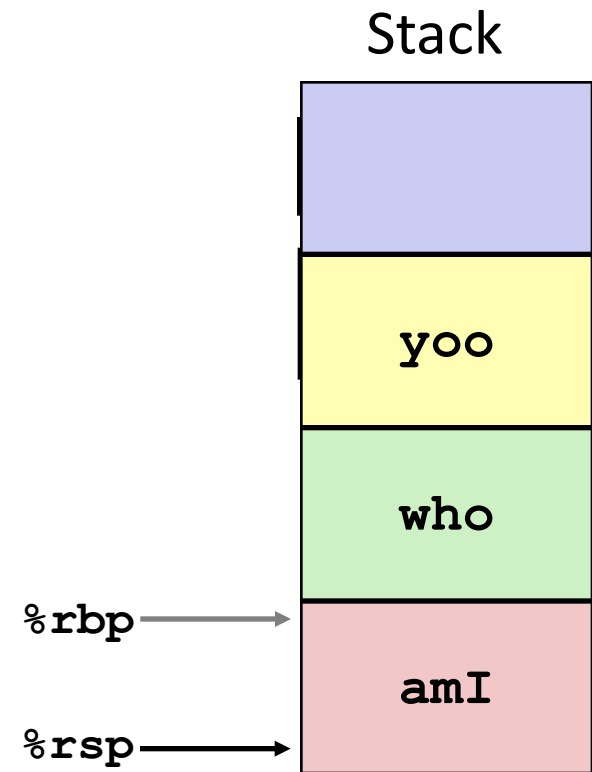
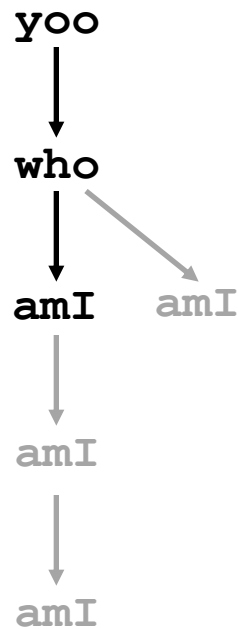
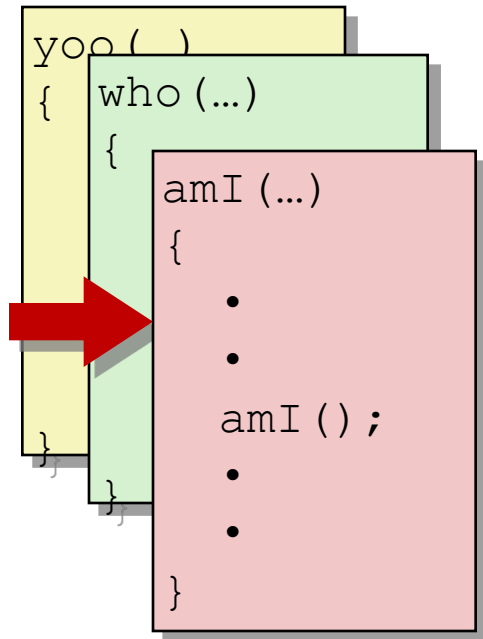
```
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{  
  .  
  .  
  who ();  
  .  
  .  
}
```



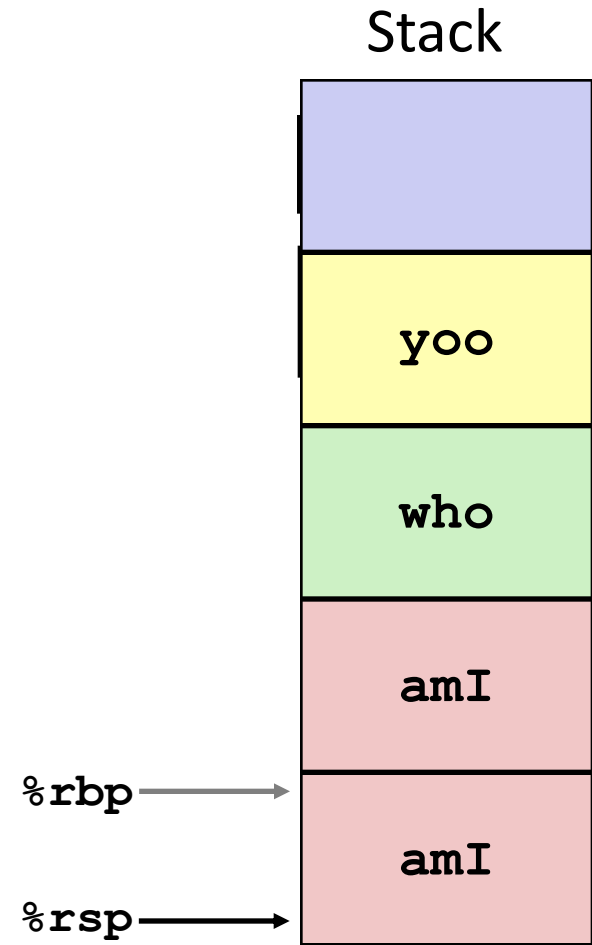
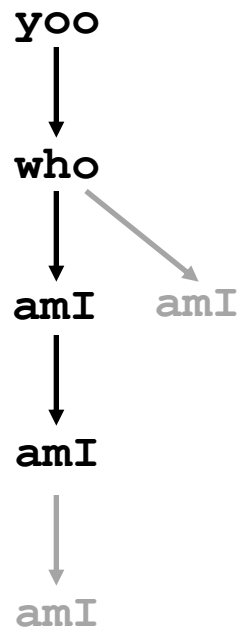
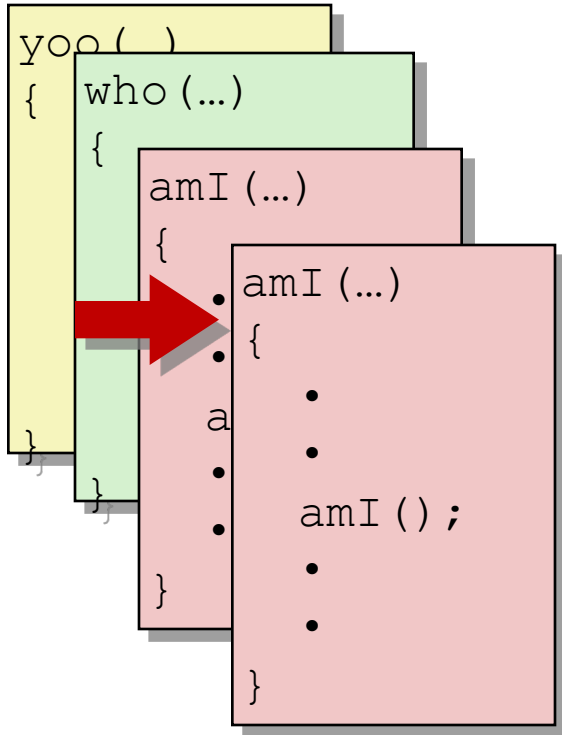
Example



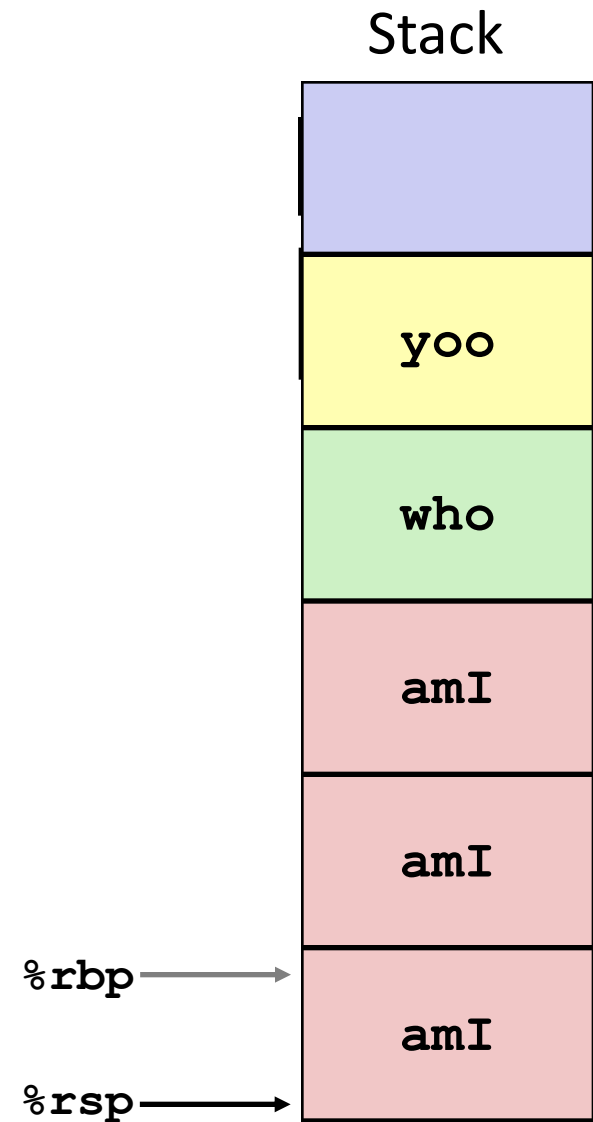
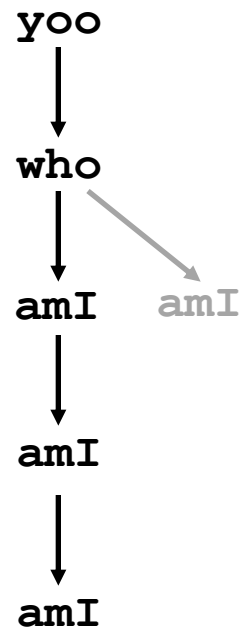
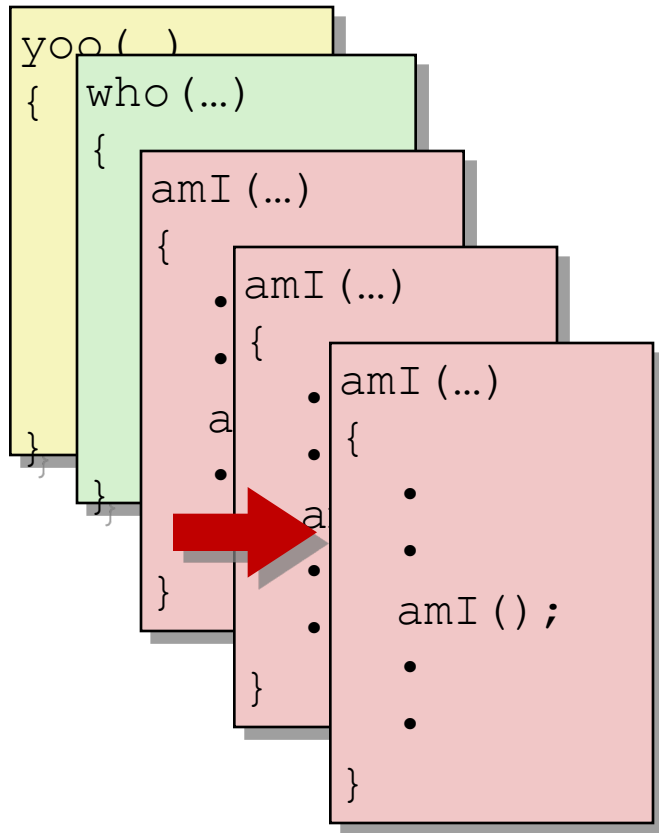
Example



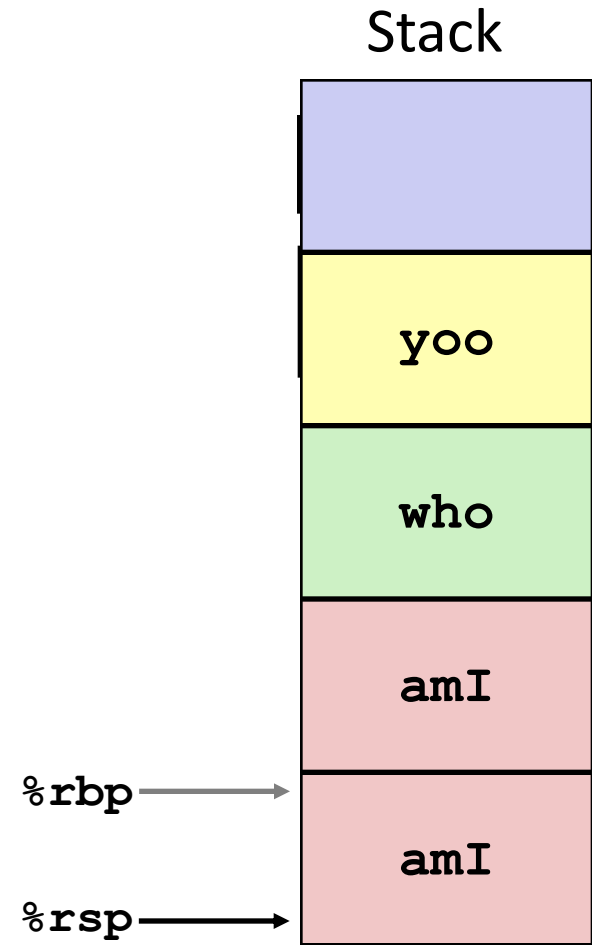
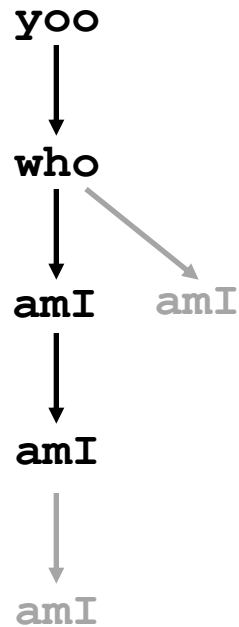
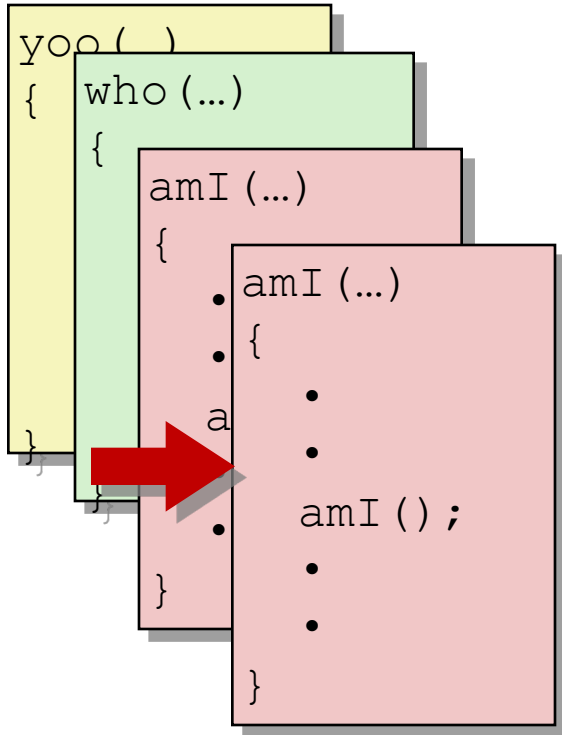
Example



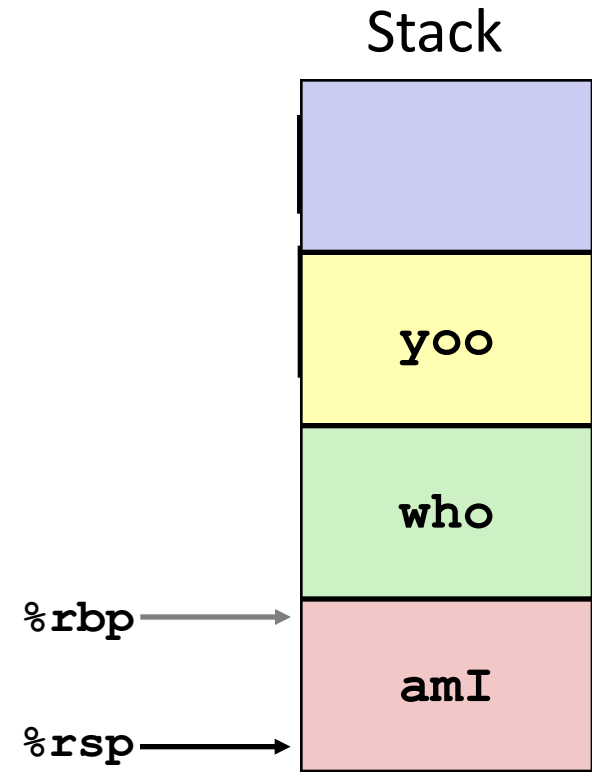
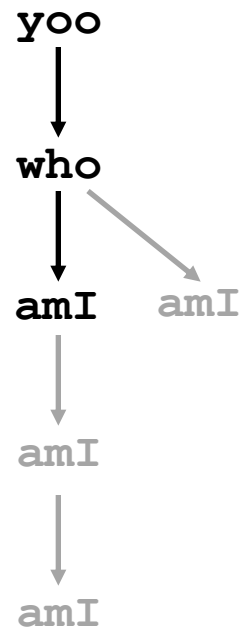
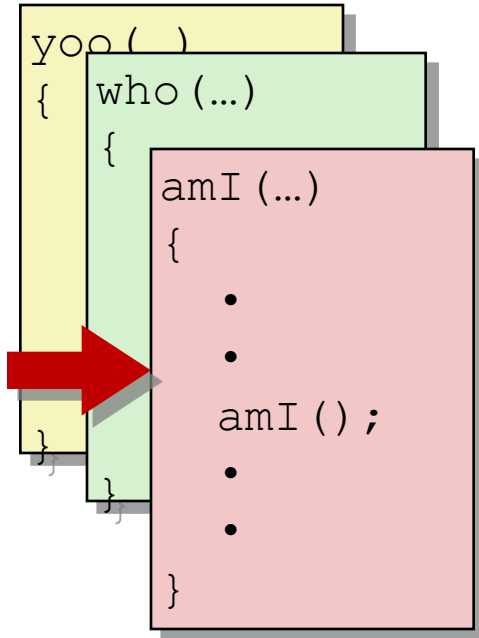
Example



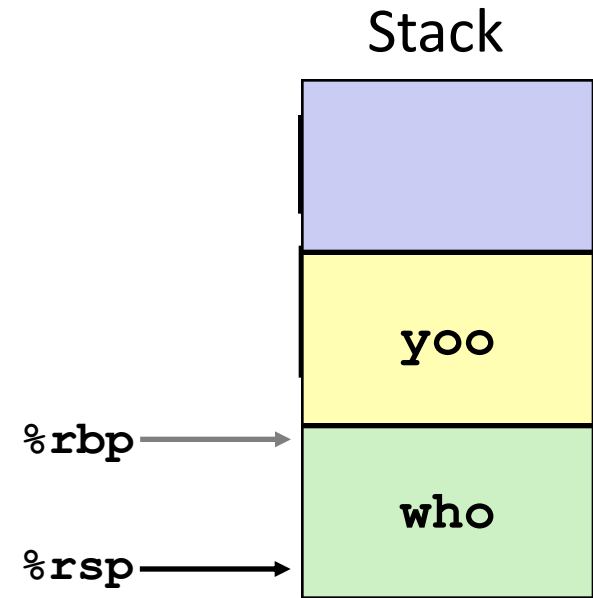
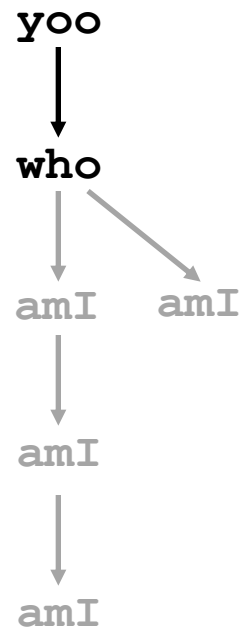
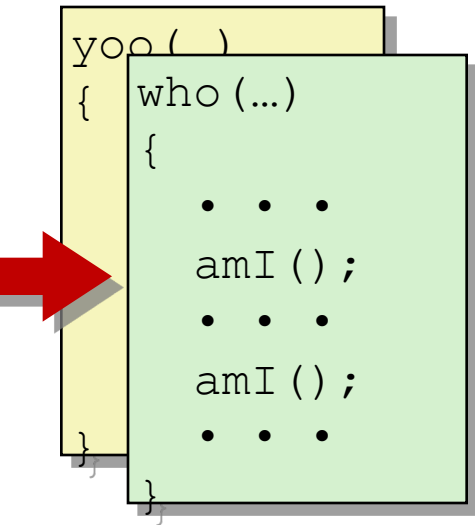
Example



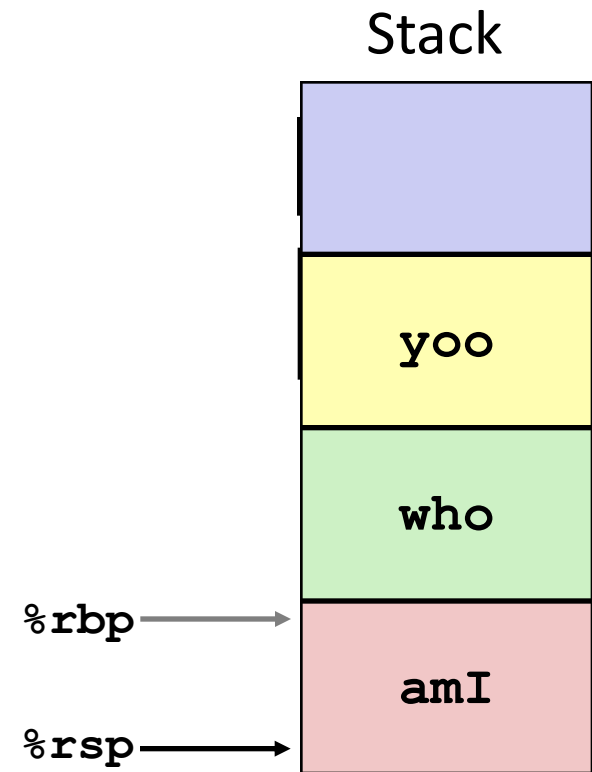
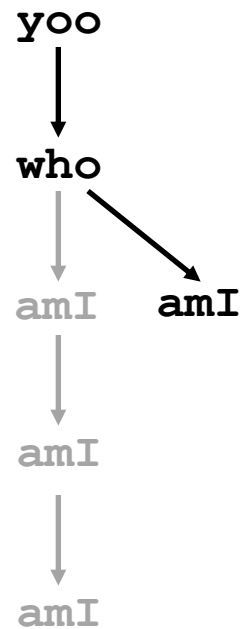
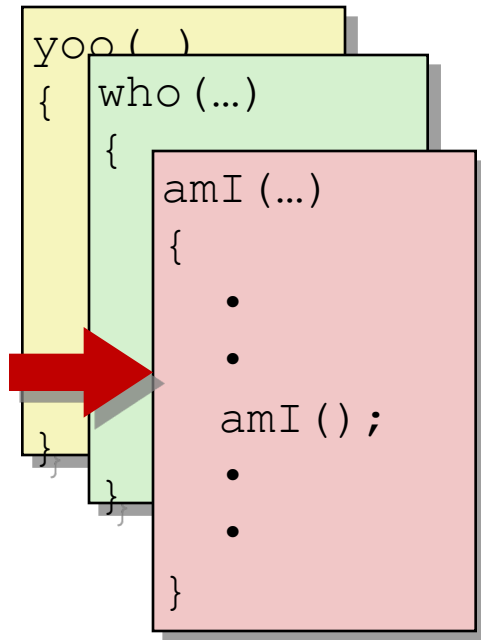
Example



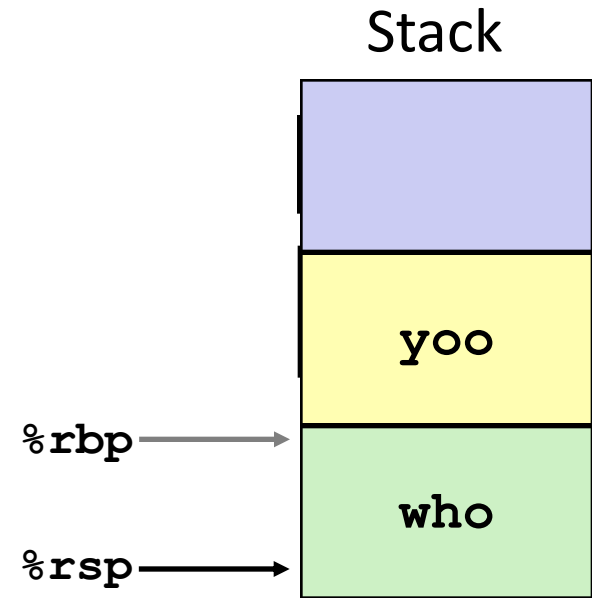
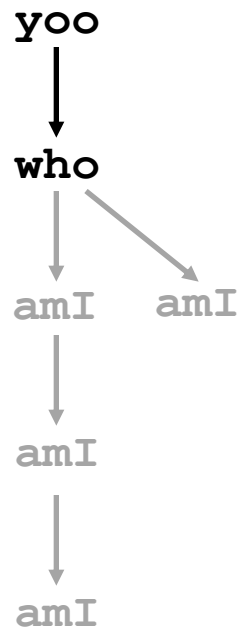
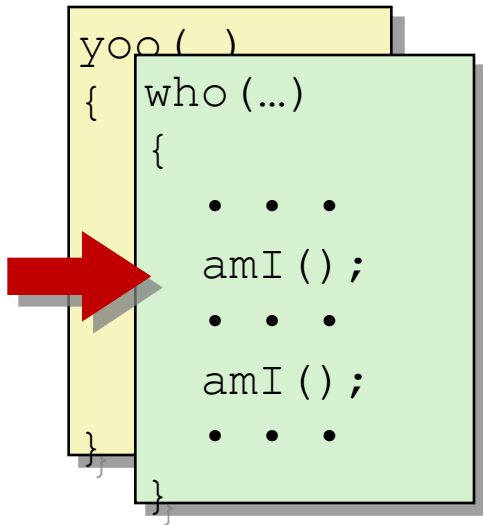
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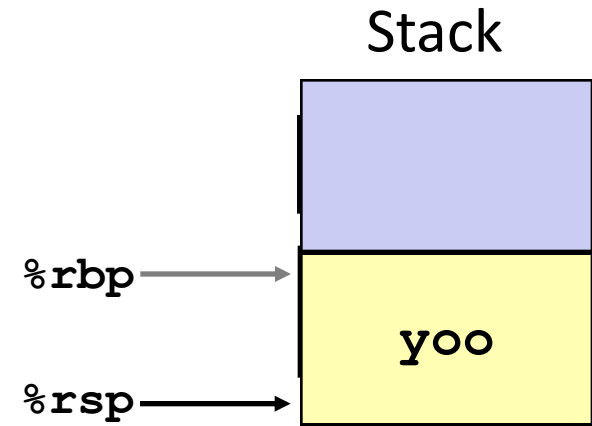
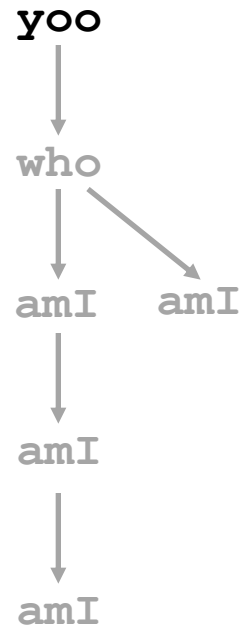
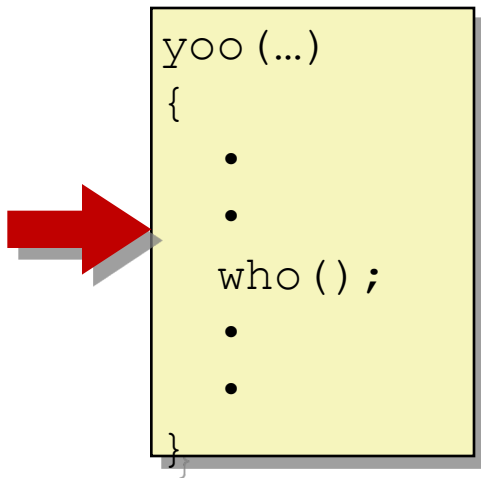
Example



Example



Example



x86-64/Linux Stack Frame

■ Current Stack Frame (“Top” to Bottom)

- “Argument build:”
Parameters for function about to call
- Local variables
If can’t keep in registers
- Saved register context
- Old frame pointer (optional)

■ Caller Stack Frame

- Return address
 - Pushed by **call** instruction
- Arguments for this call

