Programming Paradigms

Control Abstraction (Part 4)

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Overview

- Calling Sequences
- Parameter Passing
- Exception Handling
- Coroutines 
- Events

Coroutines

- **Control abstraction that allows for**
  - suspending execution
  - resuming where it was suspended
- **For implementing non-preemptive multi-tasking**

Coroutines (pseudo code)

```
us, cfs : coroutine

coroutine check_file_system()
    detach  // create coroutine &
            // return reference to caller

    for all files:
        ...
        transfer (us)
        ...
            .

main:
    us := new update_screen ()
    cfs := new check_file_system ()
    transfer (us)
```

```
coroutine update_screen()
    detach

    loop
        ...
        transfer (cfs)
```

Coroutines vs. Threads

- Explicit transfer of control (non-preemptive)
- Only one coroutines runs at a time

- Control flow transfered implicitly and preemptively
- Multiple threads may run concurrently

Coroutines vs. Continuations

- Changes every time it runs
- Old program counter saved when transfering to another coroutines
- When transfering back, continue where we left off

- Once created, doesn't change
- When invoking, old program counter is lost
- Multiple jumps to same continuation always start at some position

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Both: Represented by a closure
(= code address + referencing environment)

Stack Allocation

- **Coroutines may call subroutines and create other coroutines**
- **Each coroutine has its own function stack**
  - Second stack created when a routine creates a coroutine
- **Repeated creation of coroutines: "Cactus stack"**

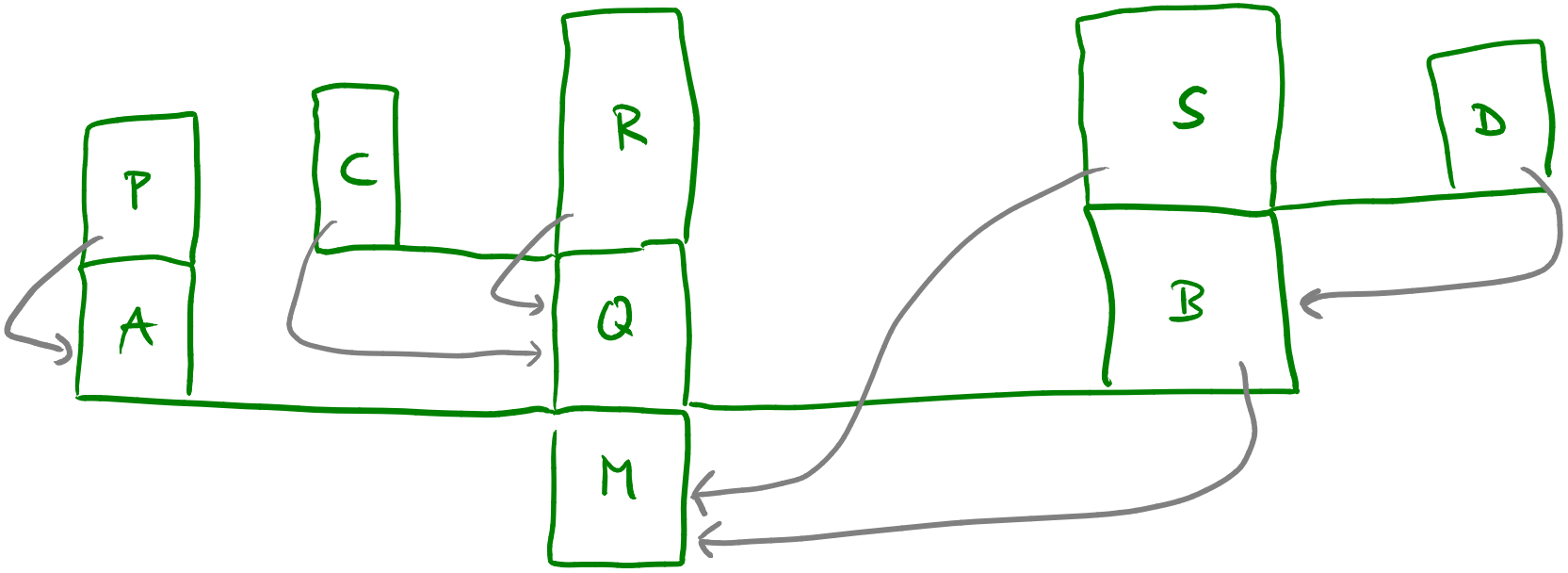
Example: Cactus Stack

Nesting of routine declarations:

A
- P

Π
- B
- D
- S

Q
- C
- R



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Coroutines in Popular PLs

- **Natively** supported, e.g., in Ruby and Go
- Available as **libraries**, e.g., for Java, C#, JavaScript, Kotlin
- **Specialized variants**, e.g., in Python (generators)