Concurrency Idioms and their Effect on Program Analysis

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Facilitating analysis by tailoring the programming model to the problem at hand

Concurrent Programming

- Concurrency is pervasive and useful
- But it adds complexity: deadlocks, race conditions, starvation
- A tradeoff…

Retaining "Just Enough" Concurrency

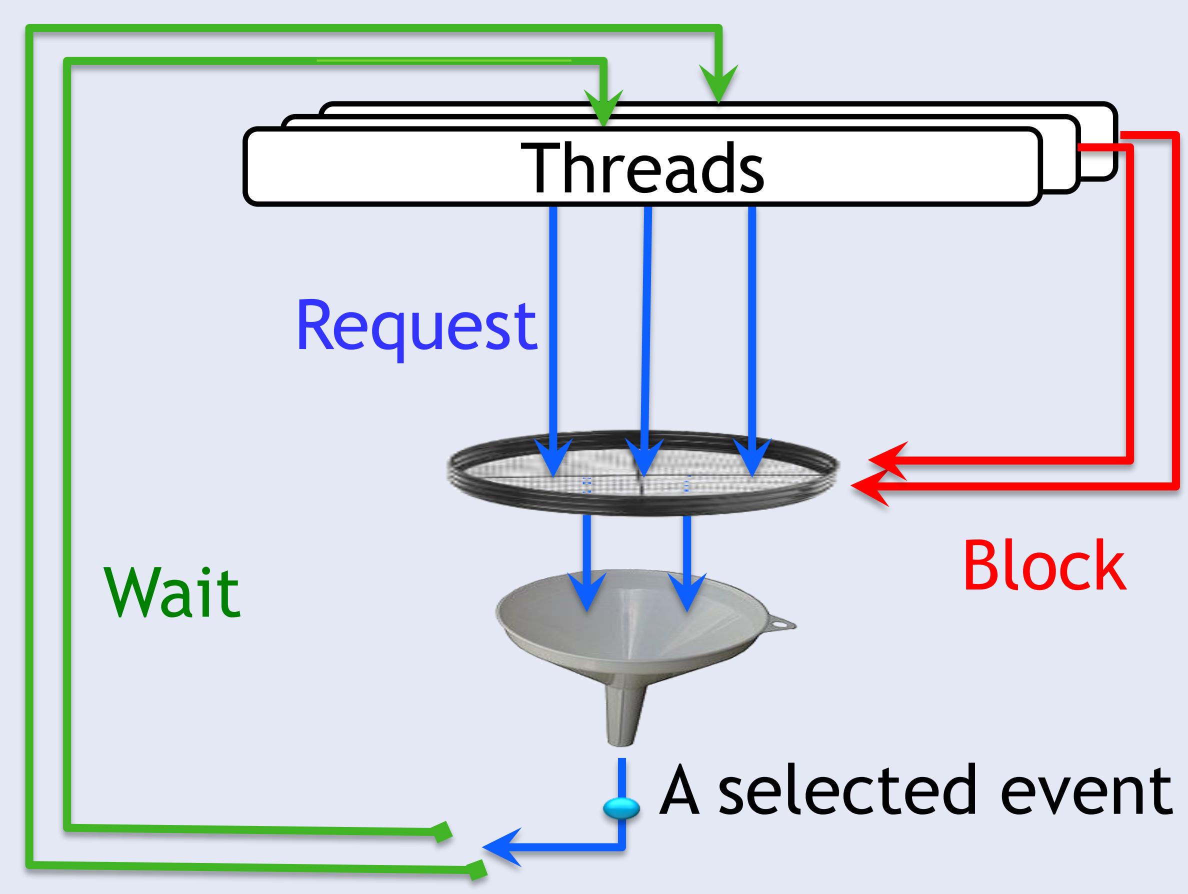
- Tailor the model to the task at hand
- Only pick the required concurrency idioms
- Solve the problem efficiently, while keeping the program simple

The Request / Wait / Block (*RWB*) Model

Interweaving parallel behavior threads

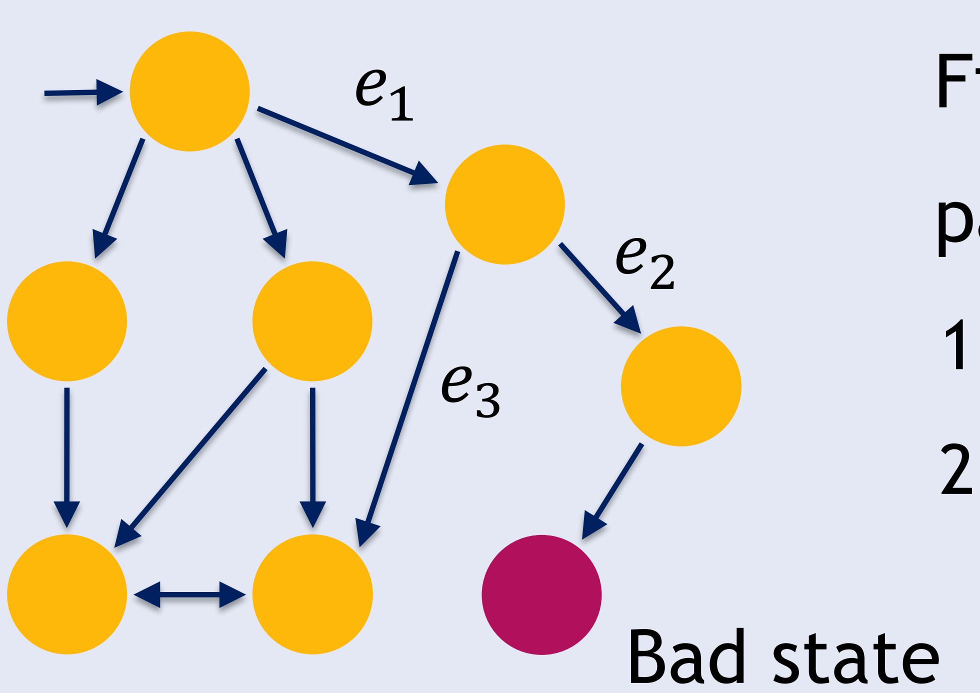
Declaration	Threads request, wait-for and block events
Event Selection	An event that is requested and not blocked is triggered
Notification	Resume threads that requested or waited-for the event

The *RWB* Execution Cycle



The Blocking Idiom Facilitates Program Repair

- Safety violation: a bad state is reachable
- A patch blocks bad transitions, without introducing deadlocks
- Incremental, non-intrusive repair



Fix violation by adding the patch thread:

1. wait-for e_1
2. wait-for e_3 while blocking e_2

Each Idiom Affords Unique Descriptive Succinctness and Makes Programs Smaller

- Smaller programs are easier to maintain and verify
- Each of requesting, waiting-for and blocking render some programs exponentially smaller
- Example: $L_n = \left(0^{n-1} \cdot (0+1)\right)^{\omega}$
- *RWB* implementation size: O$(\log^2 n \cdot \log\log n)$
- Size without blocking: $\Omega(n)$

RWB implementation for $\left(0^5 \cdot (0+1)\right)^{\omega}$