Solution for Exercise 4

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The Splitter Object

- Only one operation: *splitter*
- Returns: *stop*, *left* or *right*
- If a single process executes *splitter*, then this process gets *stop*.
- If two or more processes invoke *splitter*, then not all get the same output.
- At most one process gets *stop*.

An Implementation of a Splitter

We use two registers:

- P (multi-valued), and
- S (binary, initialized to *false*)

upon $splitter_i$

- $P \leftarrow i$
- **if** S **then return** *"right"*
- $S \leftarrow true$
- **if** $P = i$ **then return** *"stop"*
- **return** *"left"*

An Implementation of a Splitter

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upon $splitter_i$

- $P \leftarrow i$
- **if** S **then return** *"right"*
- $S \leftarrow true$
- **if** $P = i$ **then return** *"stop"*
- **return** *"left"*

Non-adaptive Snapshot

```
upon scan_i
    t_1 ← collect(), t_2 ← t_1
    while true do
        t_3 ← collect()
        if t_3 = t_2 then return ⟨ t_3[1].val, ..., t_3[N].val ⟩
        for k ← 1 to N do
            if t_3[k].ts ≥ t_1[k].ts + 2 then return t_3[k].snapshot
        t_2 ← t_3

procedure collect()
    for k ← 1 to N do
        x[k] ← R[k]
    return x
```

Non-adaptive Snapshot (2)

procedure $update_i(v)$
    $ts \leftarrow ts + 1$
    $snapshot \leftarrow scan()$
    $R[i] \leftarrow \langle ts, v, snapshot \rangle$

Adaptive Update

procedure *update*(v)
    if $myreg = \perp$ **then**
        $myreg \leftarrow obtain()$
    $ts \leftarrow ts + 1$
    $snapshot \leftarrow scan()$
    $R[myreg] \leftarrow \langle ts, v, snapshot \rangle$

Adaptive Scan

upon $scan_i$
- $t_1 \leftarrow collect()$, $t_2 \leftarrow t_1$
- **while** *true* **do**
  - $t_3 \leftarrow collect()$
  - **if** $t_3 = t_2$ **then return** $\langle t_3[1].val, \ldots, t_3[t_3.length].val \rangle$
  - **for** $k \leftarrow 1$ **to** $t_3.length$ **do**
    - **if** $t_3[k].ts \geq t_1[k].ts + 2$ **then return** $t_3[k].snapshot$
  - $t_2 \leftarrow t_3$

A Disallowed Solution

```
procedure obtain()
    myreg ← C.fetch&inc()

procedure collect()
    for k ← 1 to C.read() do
        x[k] ← R[k]
    return x
```

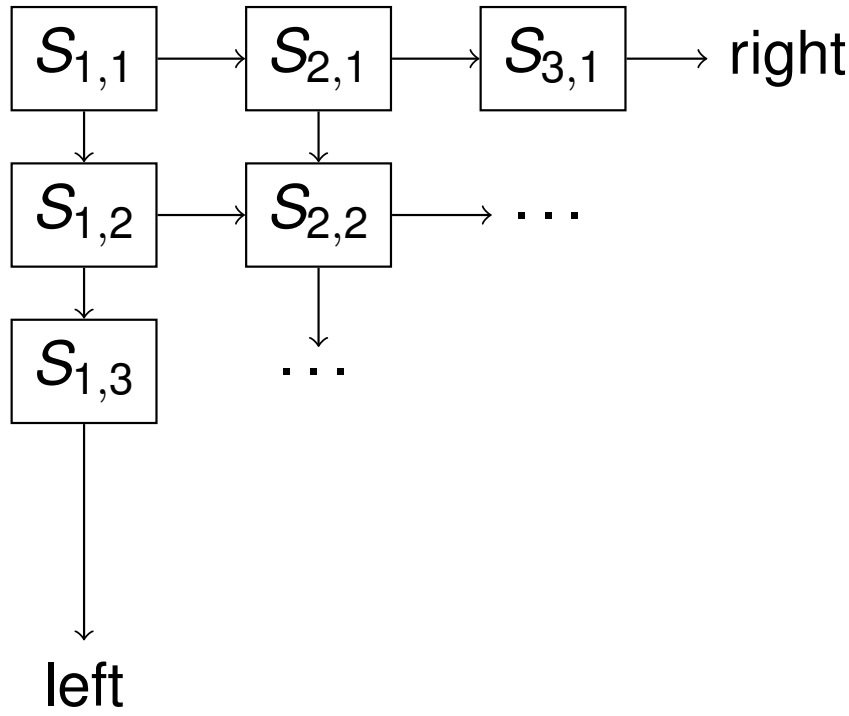
But we can use only registers!

The Splitter Object

- One operation: *splitter*
- Returns: *stop*, *left* or *right*
- If a single process executes *splitter*, then *stop* is returned.
- If two or more processes invoke *splitter*, then not all get the same output.
- At most one process gets *stop*.

Main Idea of Adaptive Snapshot

- Matrix of registers and splitters
- To obtain a register, a process must find a splitter that returns *stop*.
- Process starts from left top corner and follows the output of splitters.



The Obtain Operation

```
procedure obtain()
    x ← 1, y ← 1
    while true do
        s ← S[x, y].splitter()
        if s ="stop" then myreg ← ⟨ x, y ⟩
        else if s ="left" then y ← y + 1
        else x ← x + 1
```

The Collect Operation

procedure *collect*
- $C \leftarrow \langle\,\rangle$
- $d \leftarrow 1$
- **while** *diagonal d has a splitter that has been traversed* **do**
  - $C \leftarrow C \cdot \langle$ values of all non-$\perp$ registers on diagonal $d\,\rangle$
  - $d \leftarrow d + 1$
- **return** C