COMPSCI 734 – Preview

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8 Mar 2019
13 Mar 2019

1. Kleisli fish

2. Other exotic beasts in our Zoo: asyncs, actors, channels

3. Assignment side-bar

Outline

1. Kleisli fish
2. Other exotic beasts in our Zoo: asyncs, actors, channels
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Function compositions and pipelines – high-order functions

- Consider

```
1 let f x = x + 1    // increment    f: int -> int
2 let g x = x + x    // double       g: int -> int
3
4 let a = [|10; 20; 30|]   // array
```

- Maps – high-order functions

```
1 let b = a |> Array.map f |> Array.map g
2
3 let b'' = Array.map g (Array.map f a)
4
5 let b' = a |> Array.map (f >> g)   // map fusion
6
7 // b = b' = [|22; 42; 62|]
```

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1 let b = a |> Array.map f
2 // b = [|11; 21; 31|]
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- Equivalent imperative code

```
1 let b' = Array.create a.Length 0
2 for i = 0 to a.Length-1 do
3     b'.[i] <- f a.[i]
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Function compositions – classical and Kleisli

- Software composability
- Classical composition `>>` `<<` $\circ$
- Limits of classical composition – e.g. what if function f may raise exceptions or doesn't exactly return an int?

```
1 let f x = 100 / x  // x = 0 ?
2
3 let f x = [|x+1|]      // singleton int array
```

- How do we compose this f with a g that takes just an int (and doesn't want to know about exceptions)?
- Kleisli composition (aka Kleisli "fish") `>=>` `<=<`

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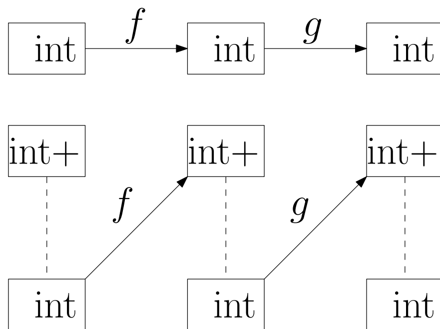
Classical vs Kleisli compositions



Kleisli compositions and pipelines

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let s x = [|x+1|]
let t x = [|x+x|]

let c = a |> Array.collect s |> Array.collect t

// c = [|22; 42; 62|]
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- Kleisli fish definition

```
let (>=>) f g =
  fun x -> x |> Array.collect f |> Array.collect g
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- Compact expression

```
let c' = a |> (s >=> t)

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Map vs Collect : High-order functions

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- Map – high-order function

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- Collect – high-order function – aka flatMap

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- Equivalent imperative code – home exercise

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Asyncs

- Basic scenario

```
1 async {
2     ... // thread#1
3     let! r = page_download_async () // await
4     ... // thread#1 or #2
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```

- For external time consuming tasks – only one thread is needed (JS)
- Also for parallel/concurrent processing (.NET)

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Actors

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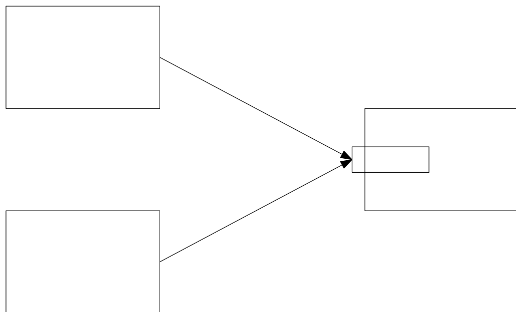

- Actors are named and each actor has its own potentially unbounded message queue, typically called mailbox
- Many-to-one messaging, but replies are often possible (ack)
- Simulating several queues often possible

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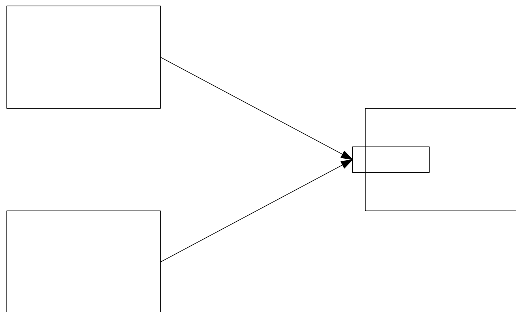

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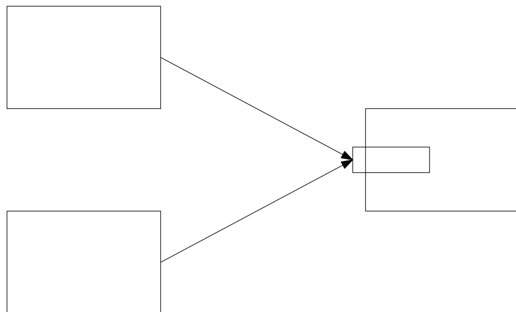

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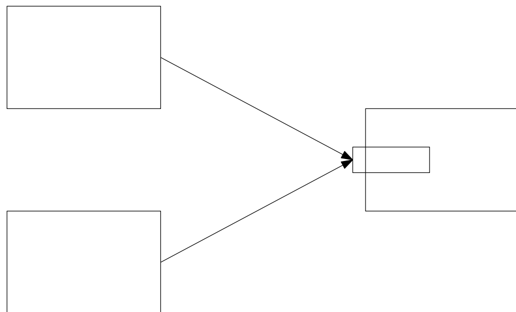

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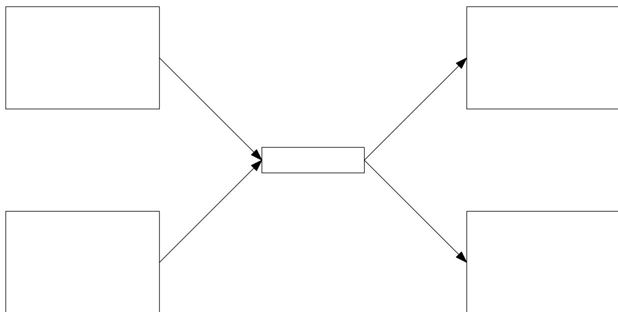

- Channels are named and typically have zero-size buffers (synchronous rendezvous)
- Many-to-many messaging, other configurations often possible, e.g non-zero buffer size
- Theoretically equivalence: actors vs channels

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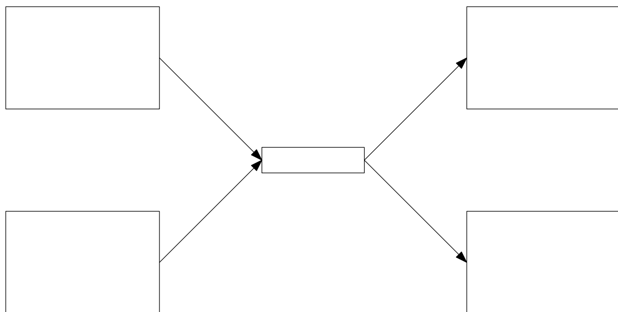

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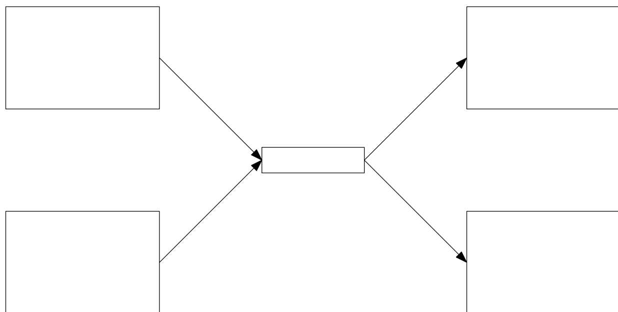

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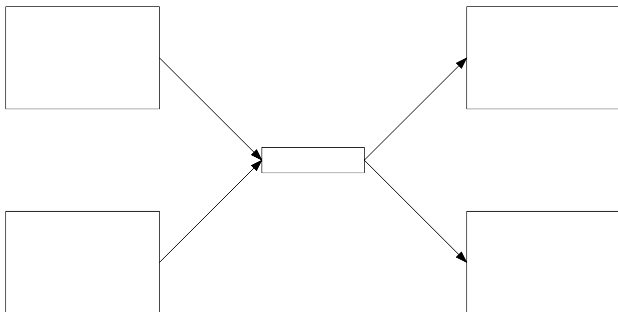

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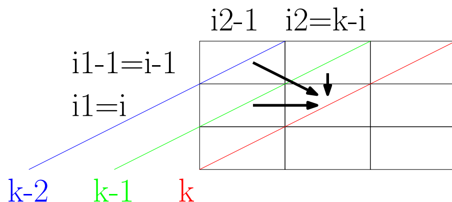
Assignment side-bar – rolling diag wave NW → SW

- Basic computation



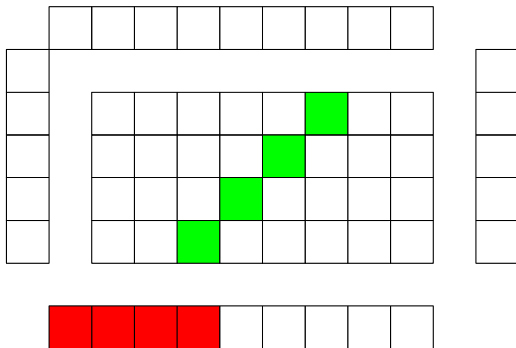
- Using one array, a:

```
1  a.[i1,i2] <- if s1.[i1-1] = s2.[i2-1]
2                then a.[i1-1,i2-1] + 1
3                else max a.[i1,i2-1] a.[i1-1,i2]
```

- Recycling three vectors, d0 (blue), d1 (green), d2 (red):

```
1  d2.[i] <- if s.[i-1] = s2.[k-i]
2             then d0.[i-1] + 1
3             else max d1.[i-1] d1.[i]
```

Assignment side-bar – rolling diag wave and sentinels



Assignment side-bar – sentinels and bands

0	0	0	0	0	0	0
0						
0						
0						
0						
0						
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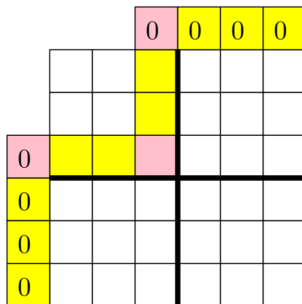

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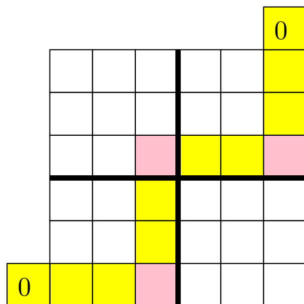

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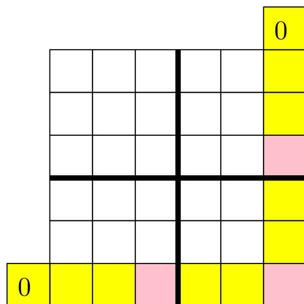
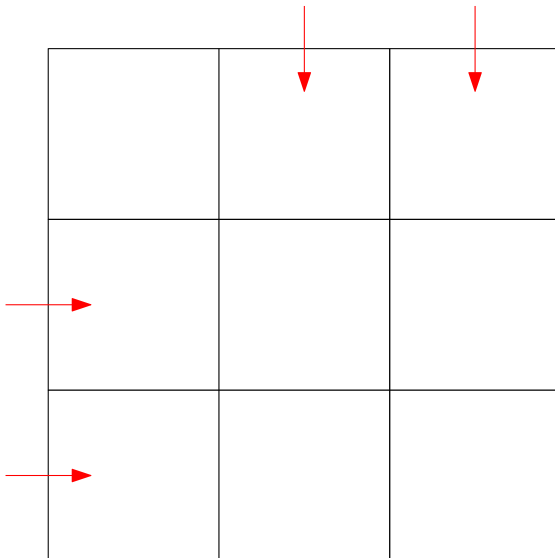


Assignment side-bar – actors



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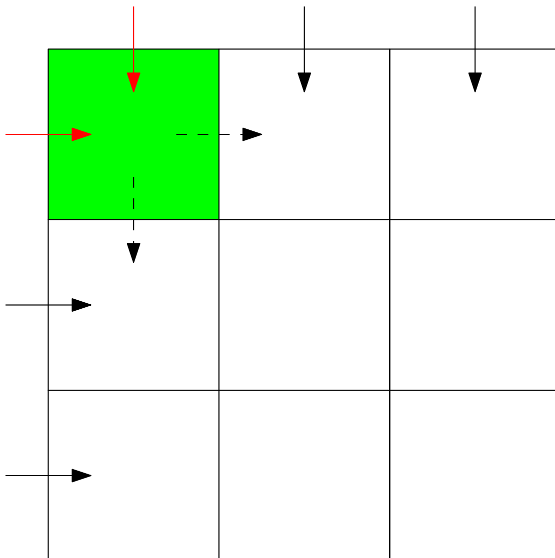

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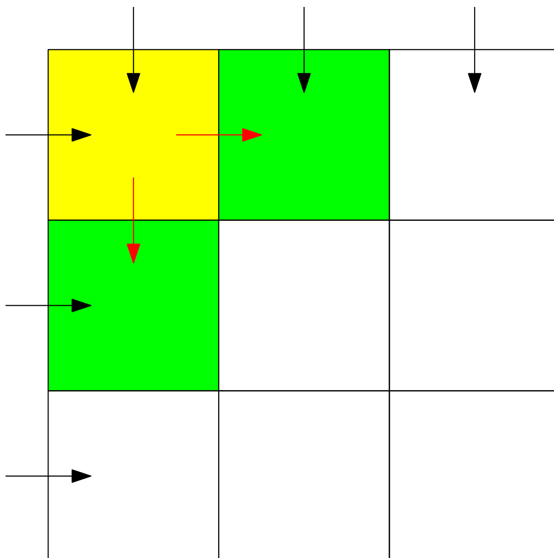

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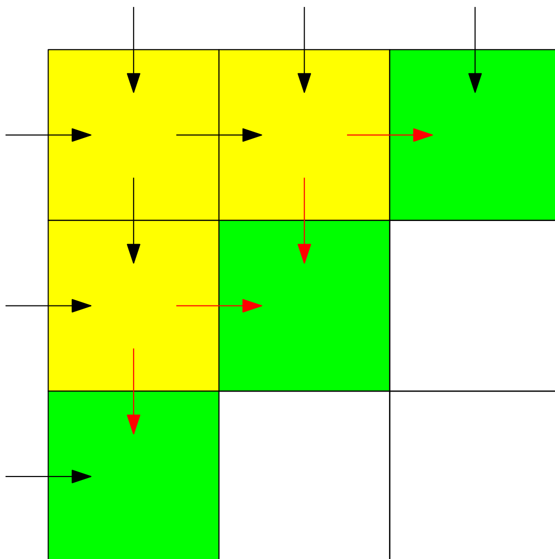

Assignment side-bar – challenges

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- Just one 1D vector of actors (not a 2D array)?

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