Stuck macros

deterministically interleaving
macro-expansion and type-checking

presented at C◦mp◦se NYC 2019 by Samuel Gélineau

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Type-aware ~~Stuck~~ macros

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Type-aware ~~Stuck~~ macros

non-deterministically interleaving
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Type-aware Stuck macros

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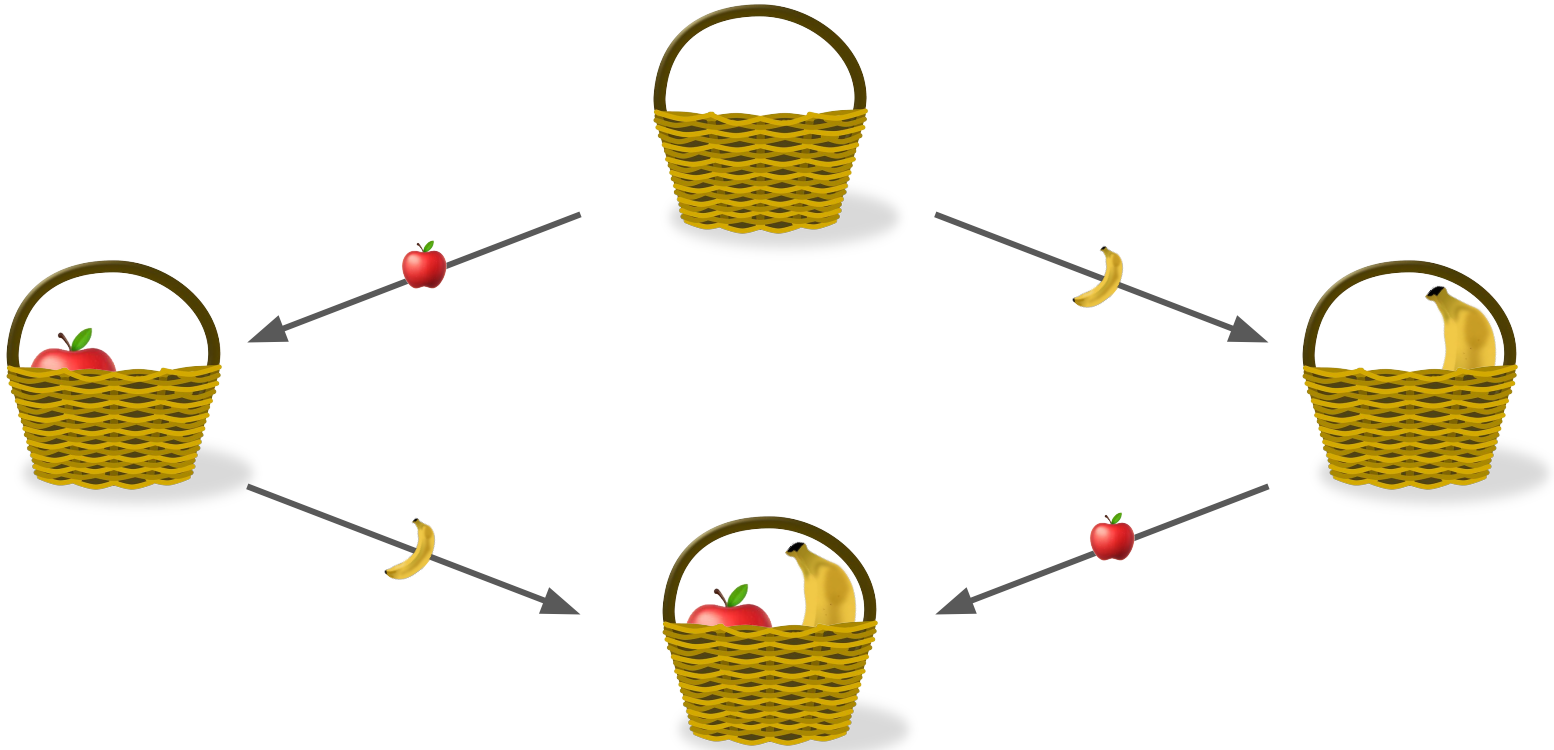
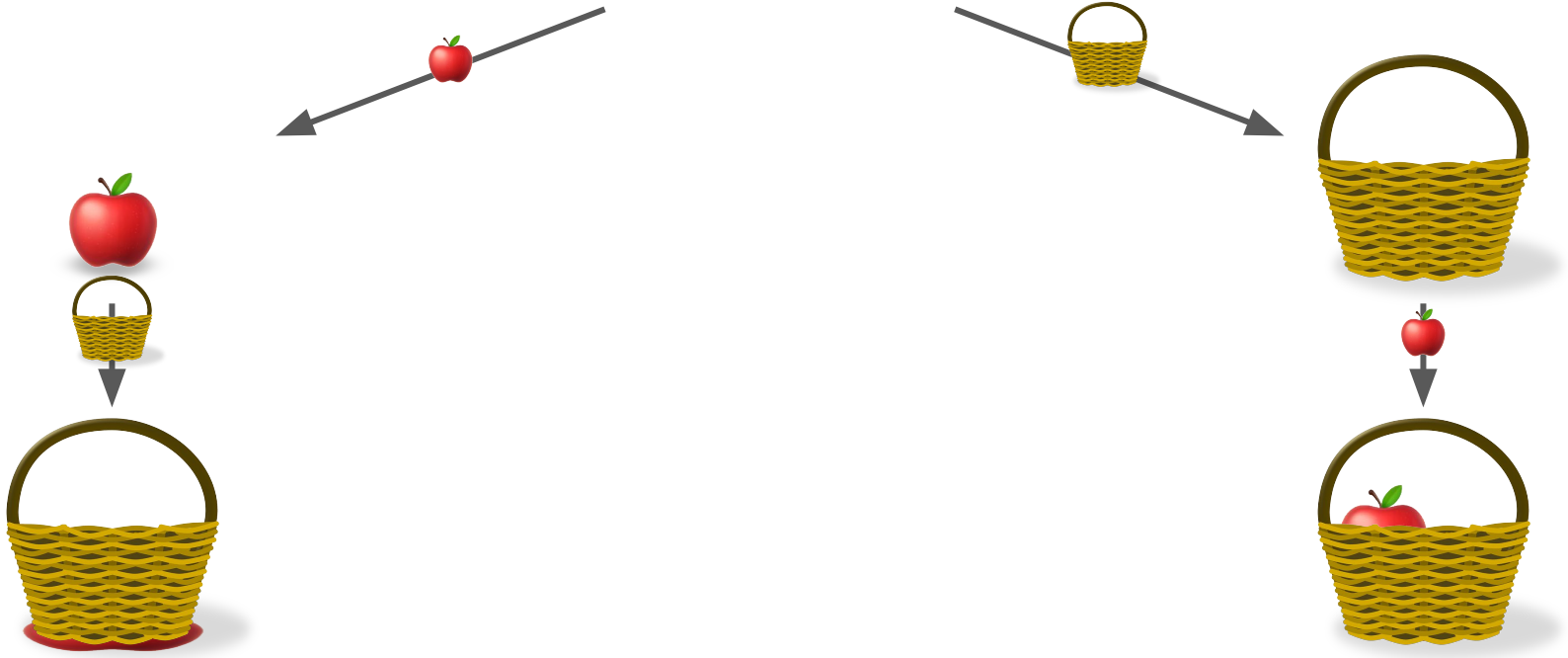
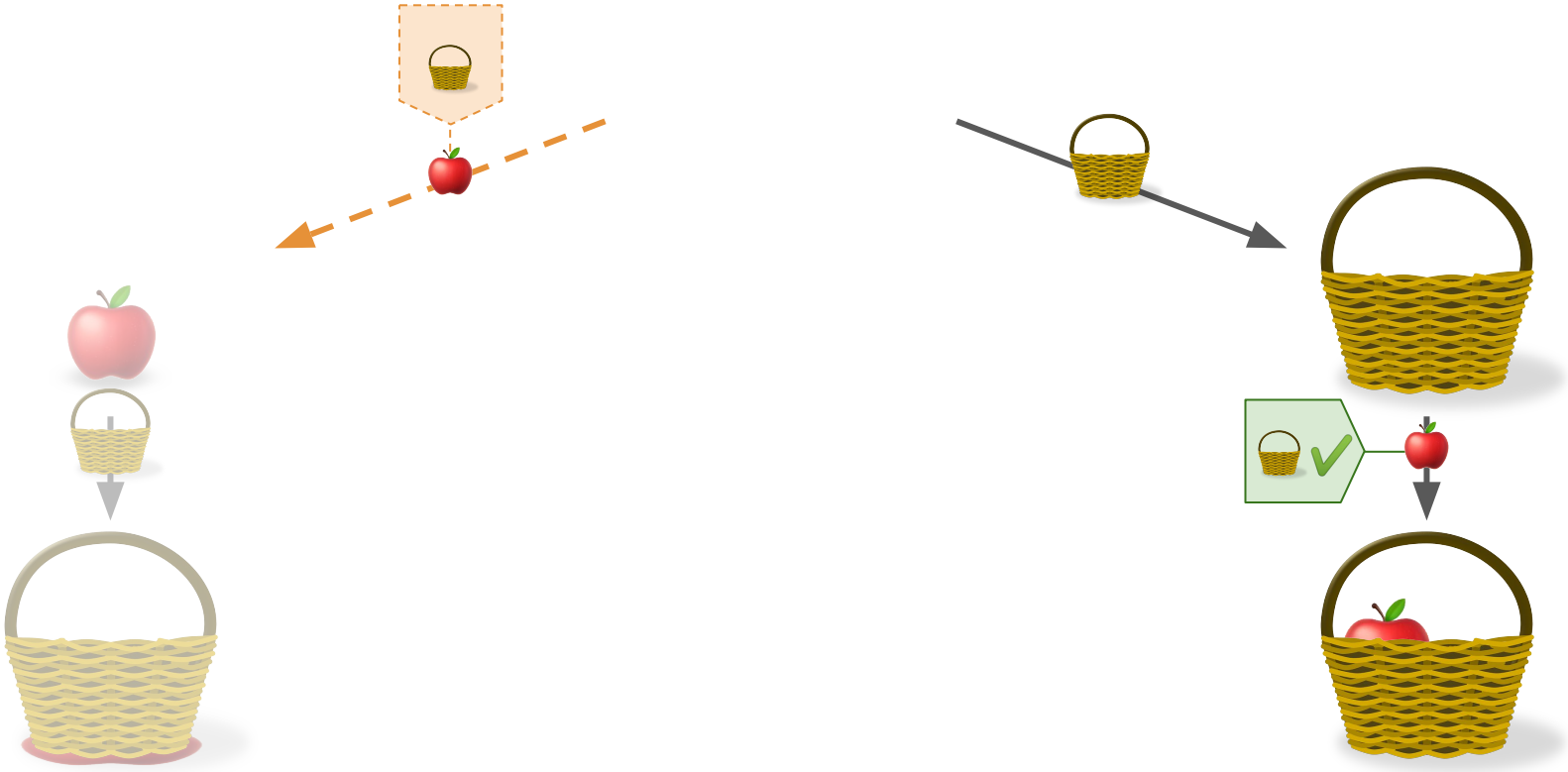
confluent



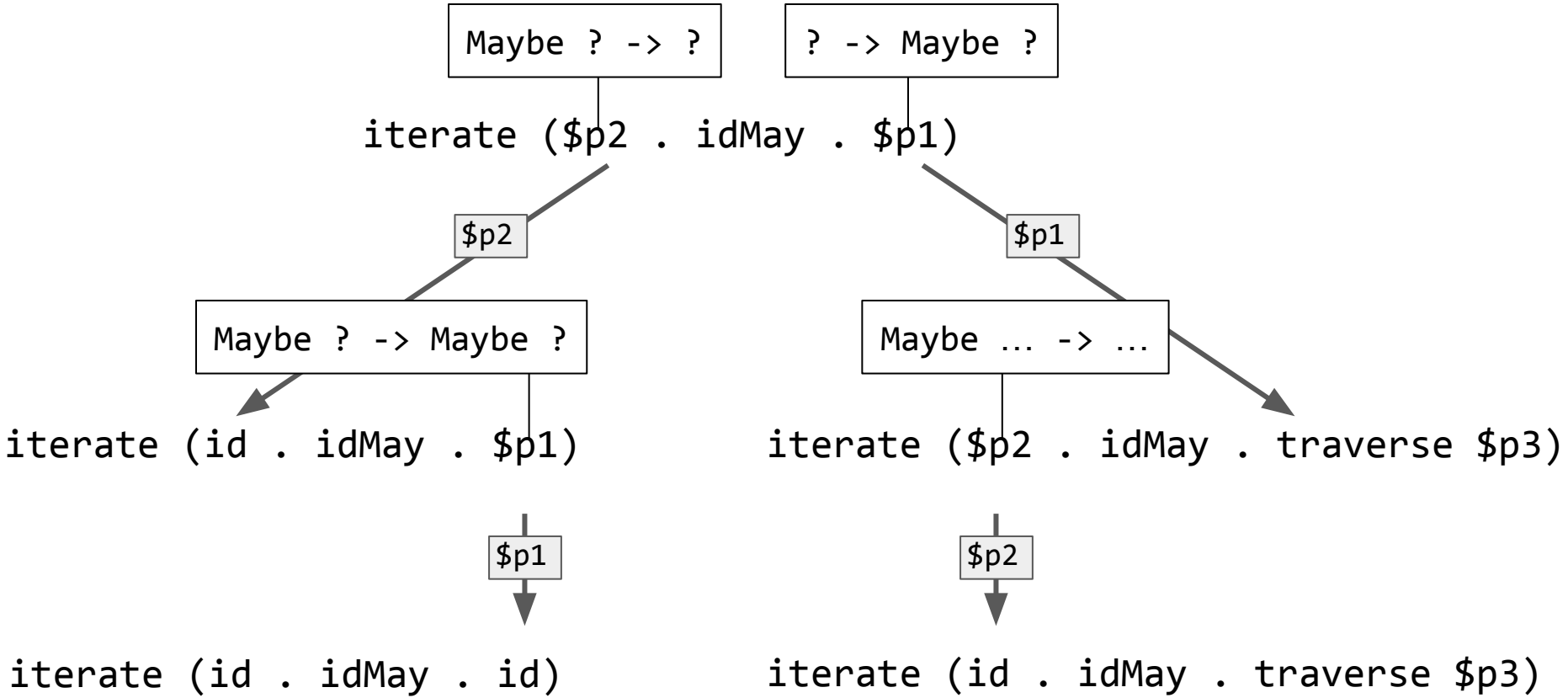
not confluent



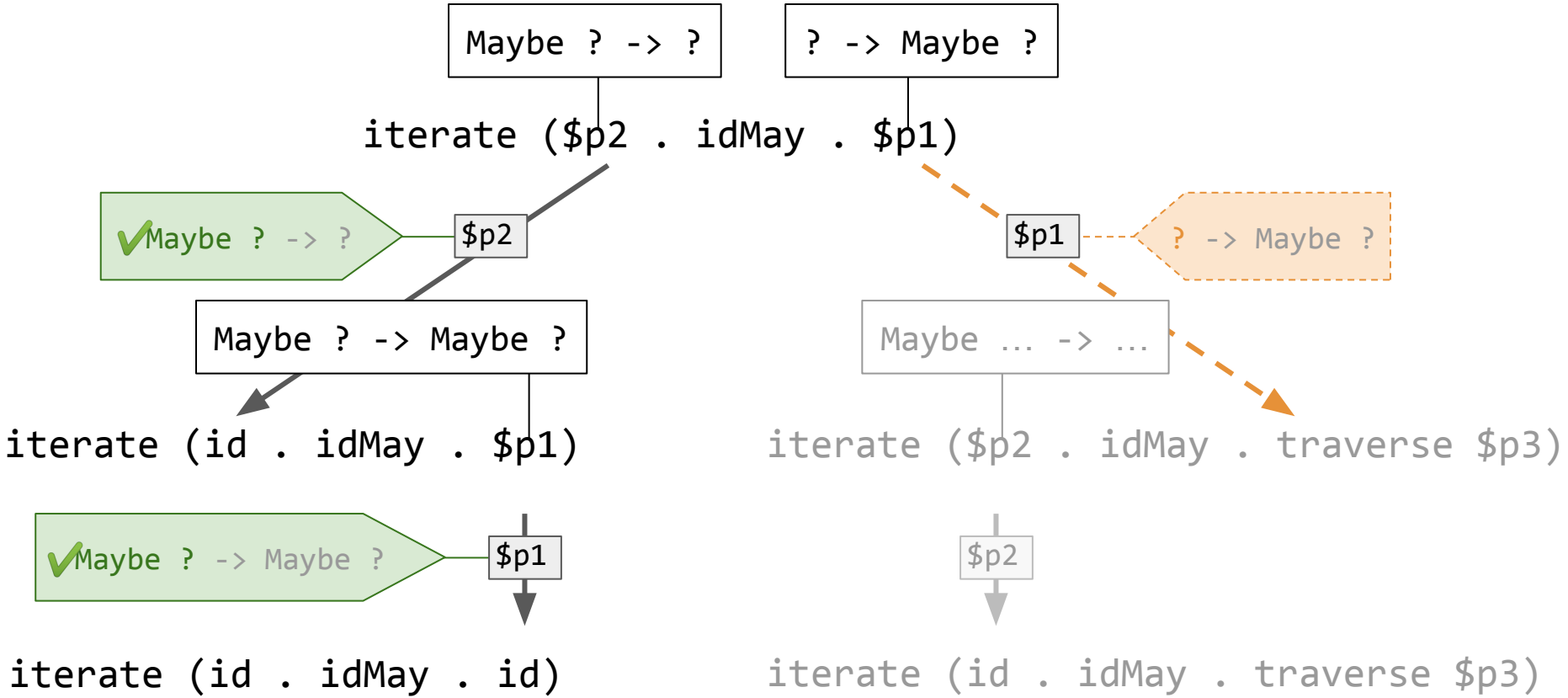
stuck fruits are confluent



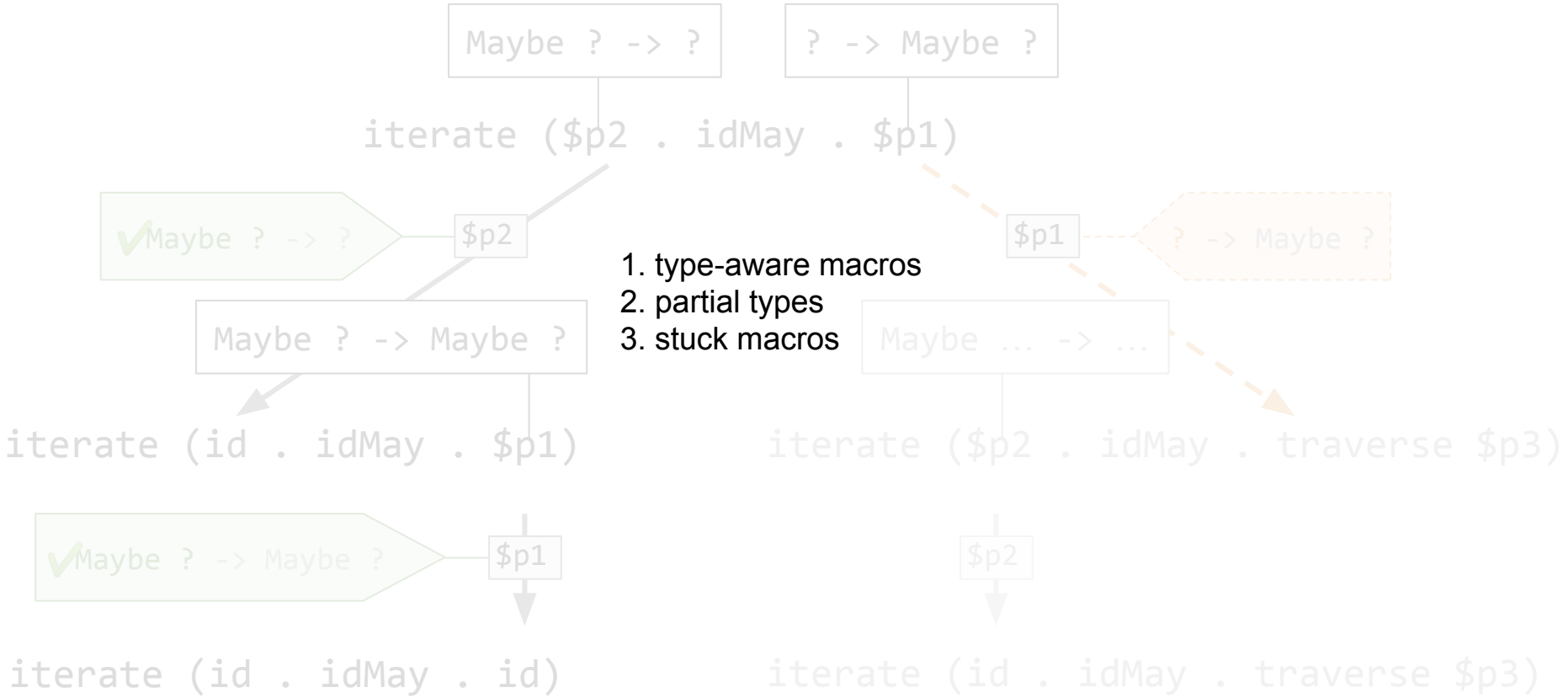
type-aware macros are not confluent



stuck macros are confluent



outline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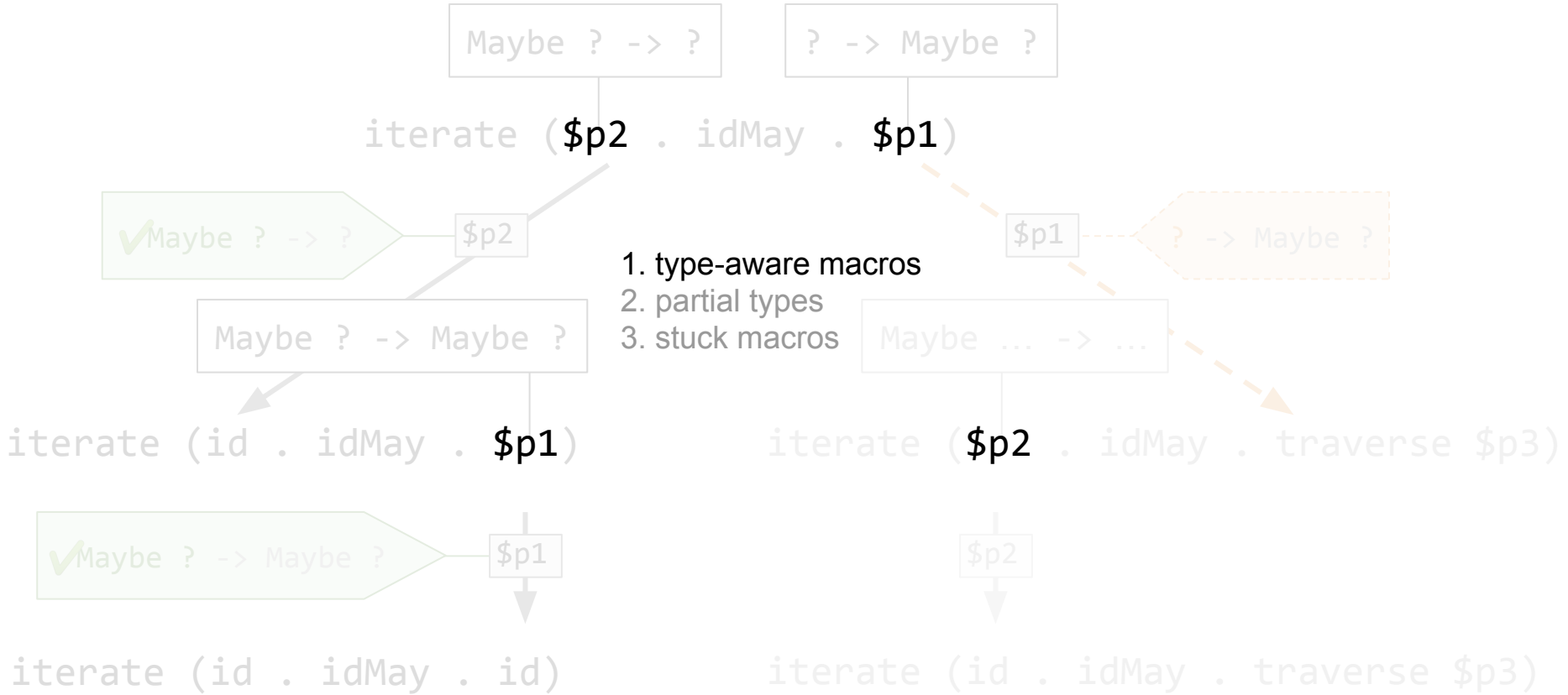
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type-aware macros

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pullMaybe :: Q Exp
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pullMaybe :: Q Exp
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if you only remember one thing!

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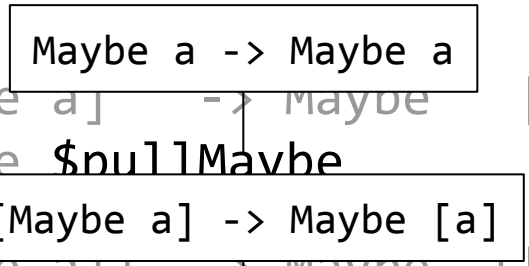


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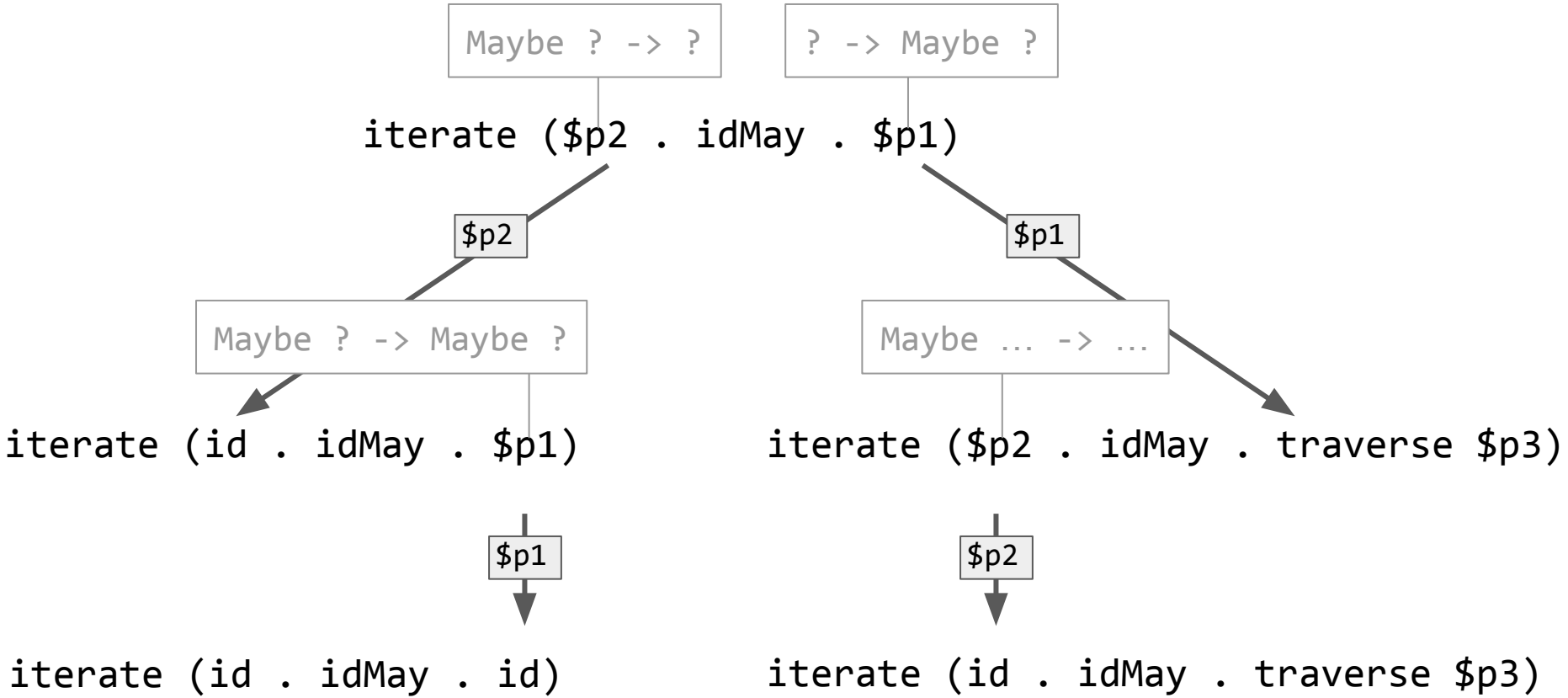
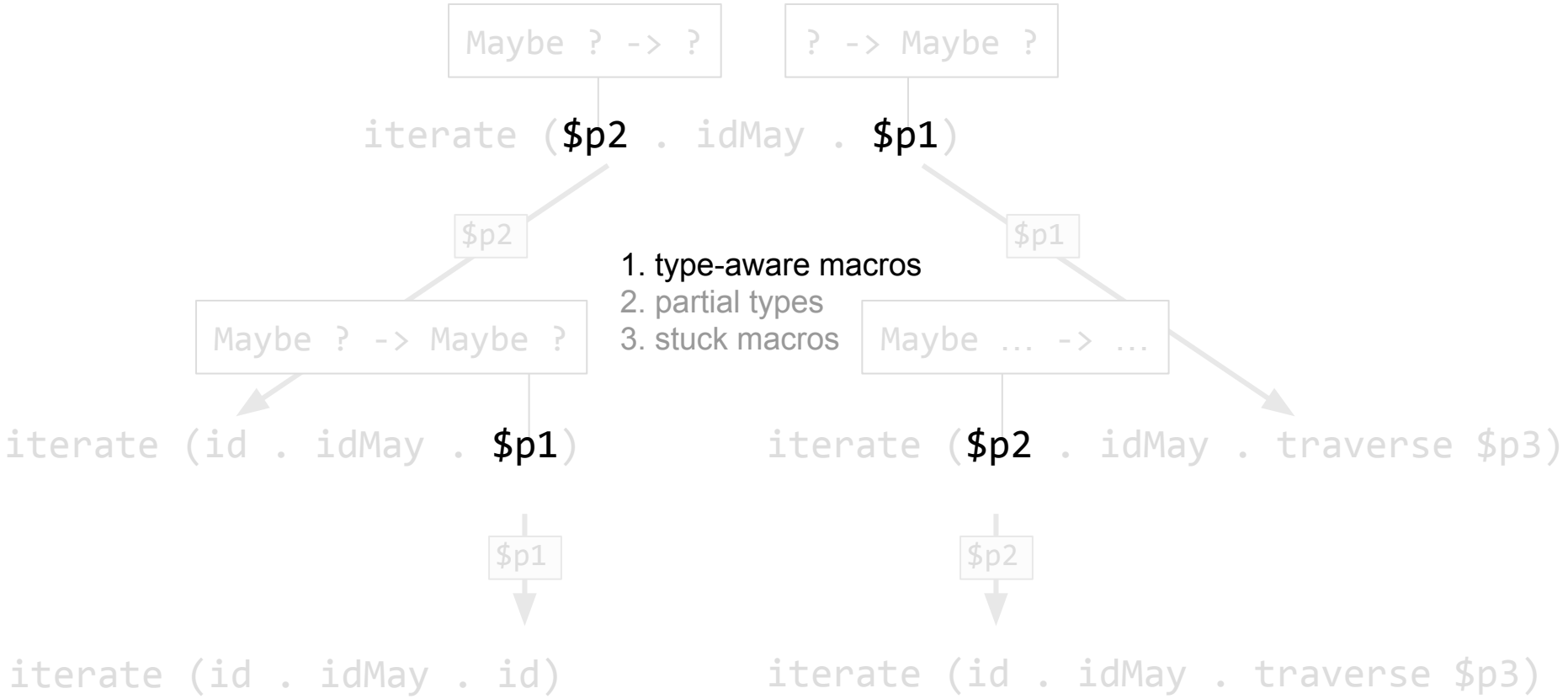


outline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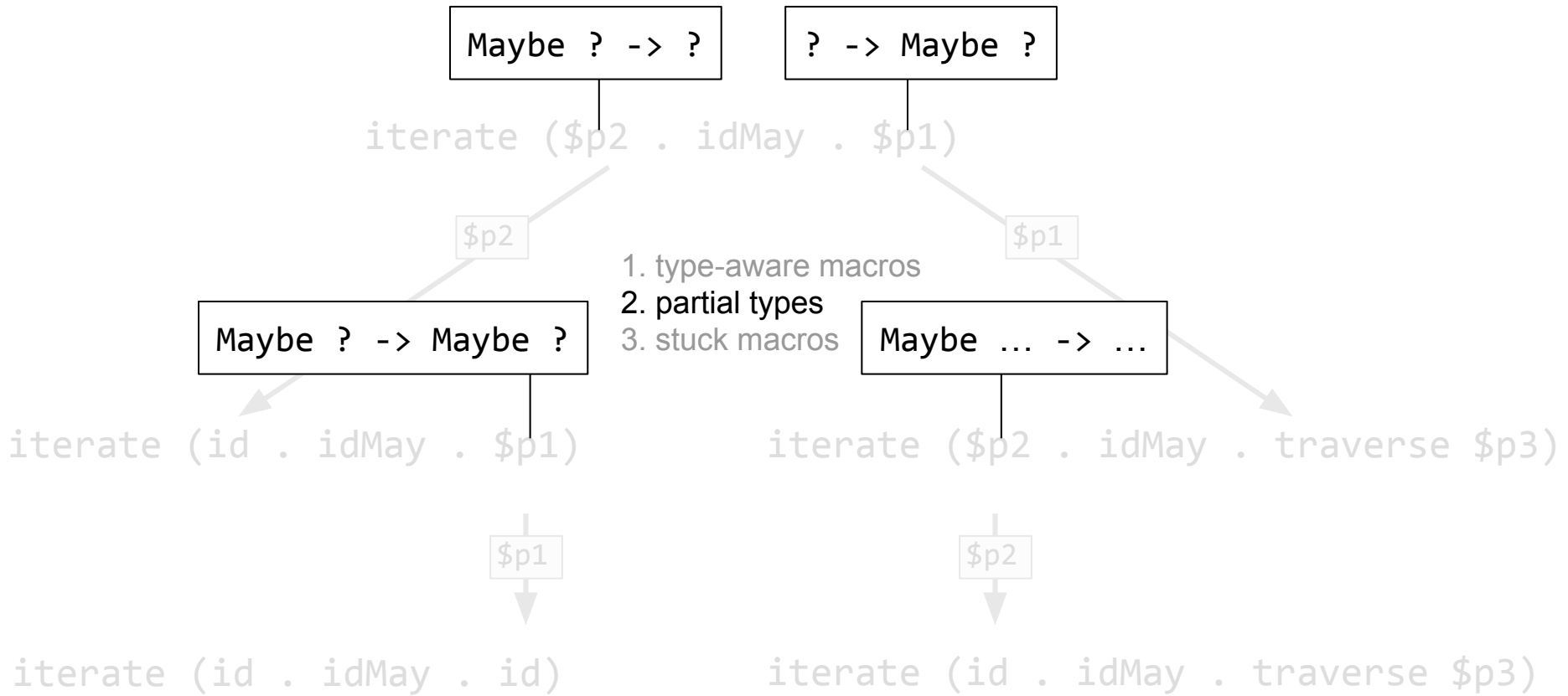
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A message from our non-sponsor:

Hackett

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our non-sponsor:

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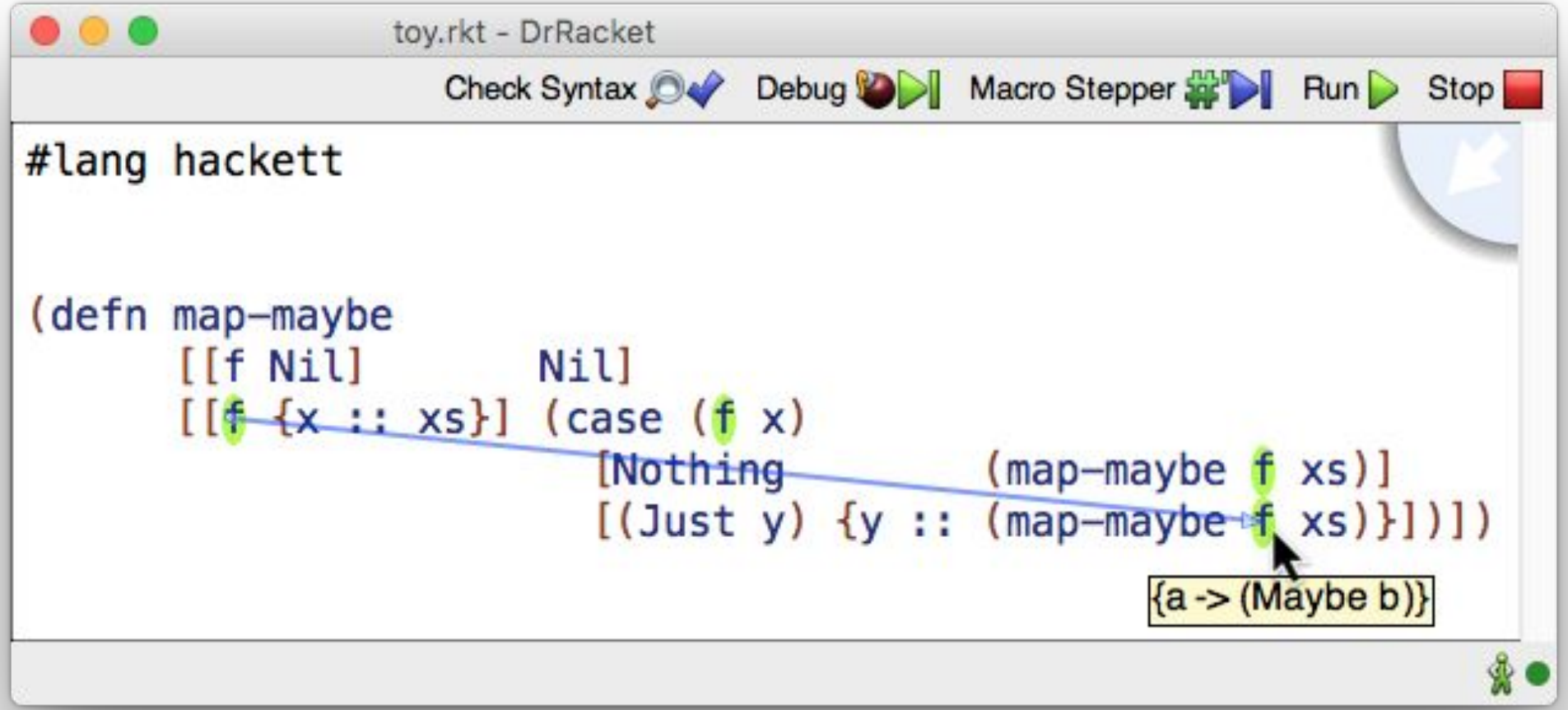
now with type-aware macros!

Hackett, a language by Alexis King (@lexi_lambda)

```
mapMaybe f []     = []
mapMaybe f (x:xs) = case f x of
                      Nothing ->     mapMaybe f xs
                      Just y  -> y : mapMaybe f xs
```

```
(defn map-maybe
  [[f Nil]       Nil]
  [[f {x :: xs}] (case (f x)
                   [Nothing        (map-maybe f xs)]
                   [(Just y) {y :: (map-maybe f xs)}])])
```

Hackett, a language by Alexis King (@lexi_lambda)

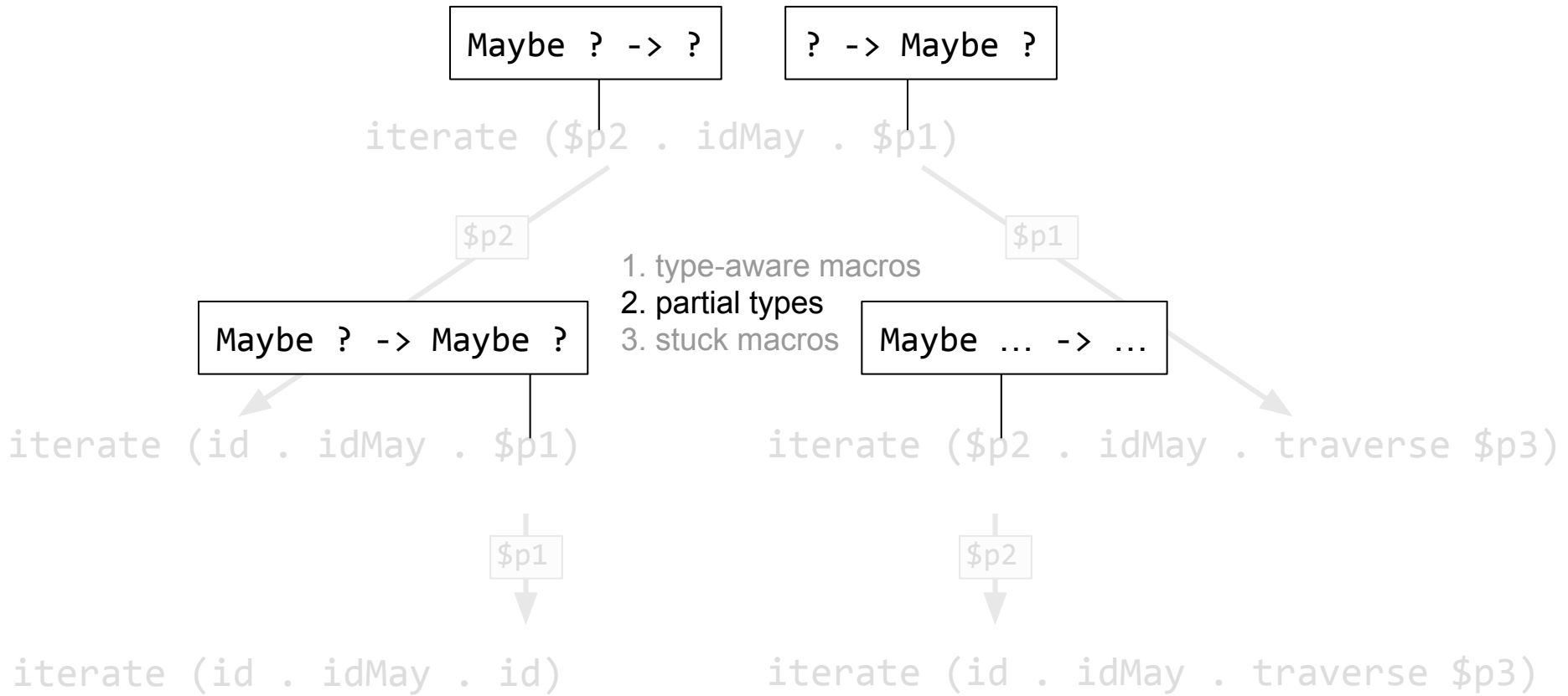


To learn more about

Hackett

visit `github.com/lexi-lambda/hackett` today!

outline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partial types

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```

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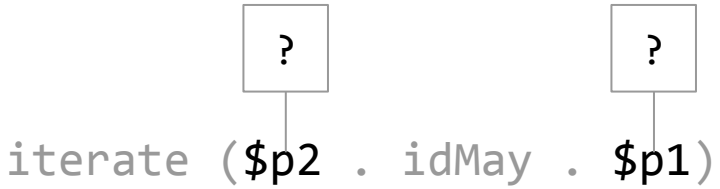

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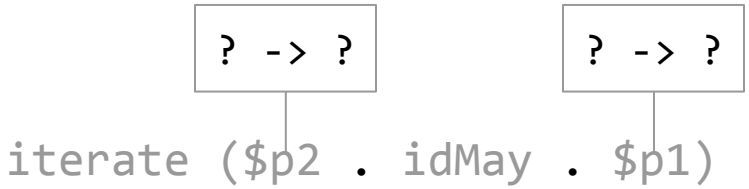

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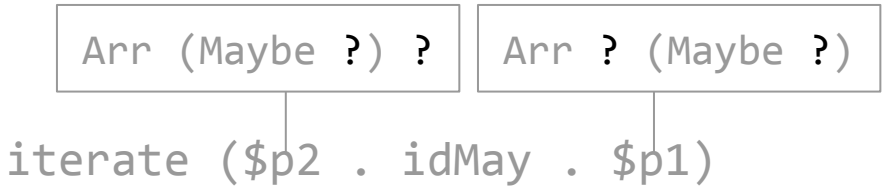


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data Type = Arr Type Type
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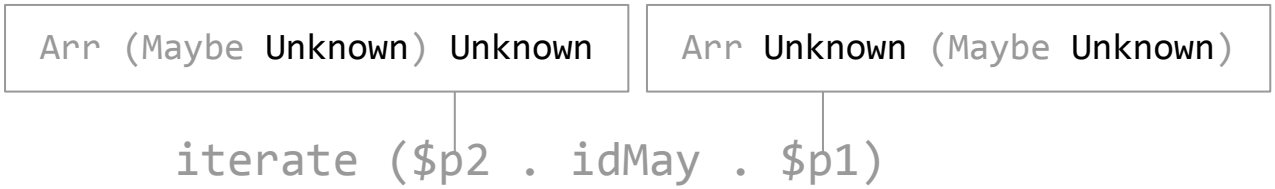


```
data PartialType = Arr PartialType PartialType
                 | Maybe PartialType
                 | ...
                 | Unknown
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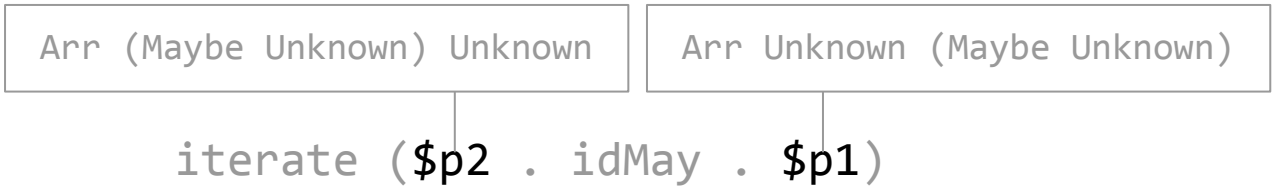


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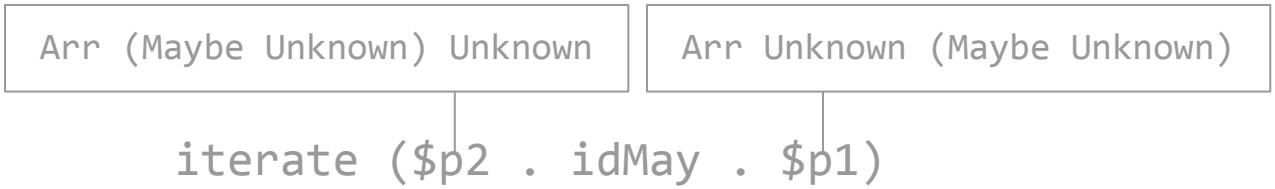


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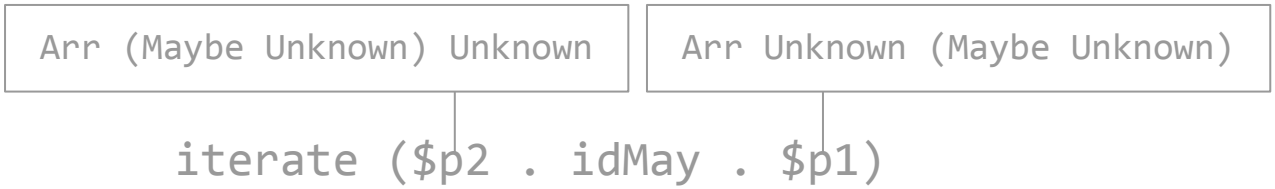


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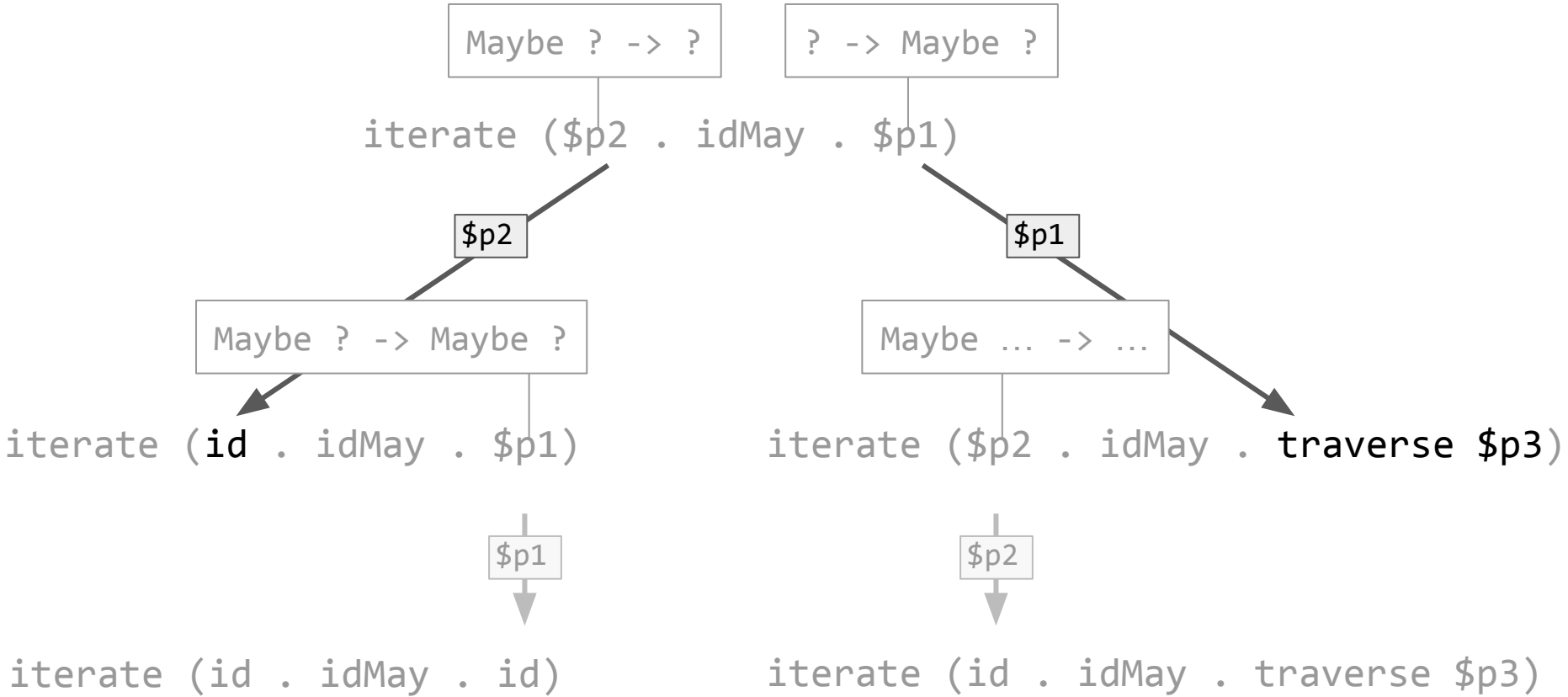

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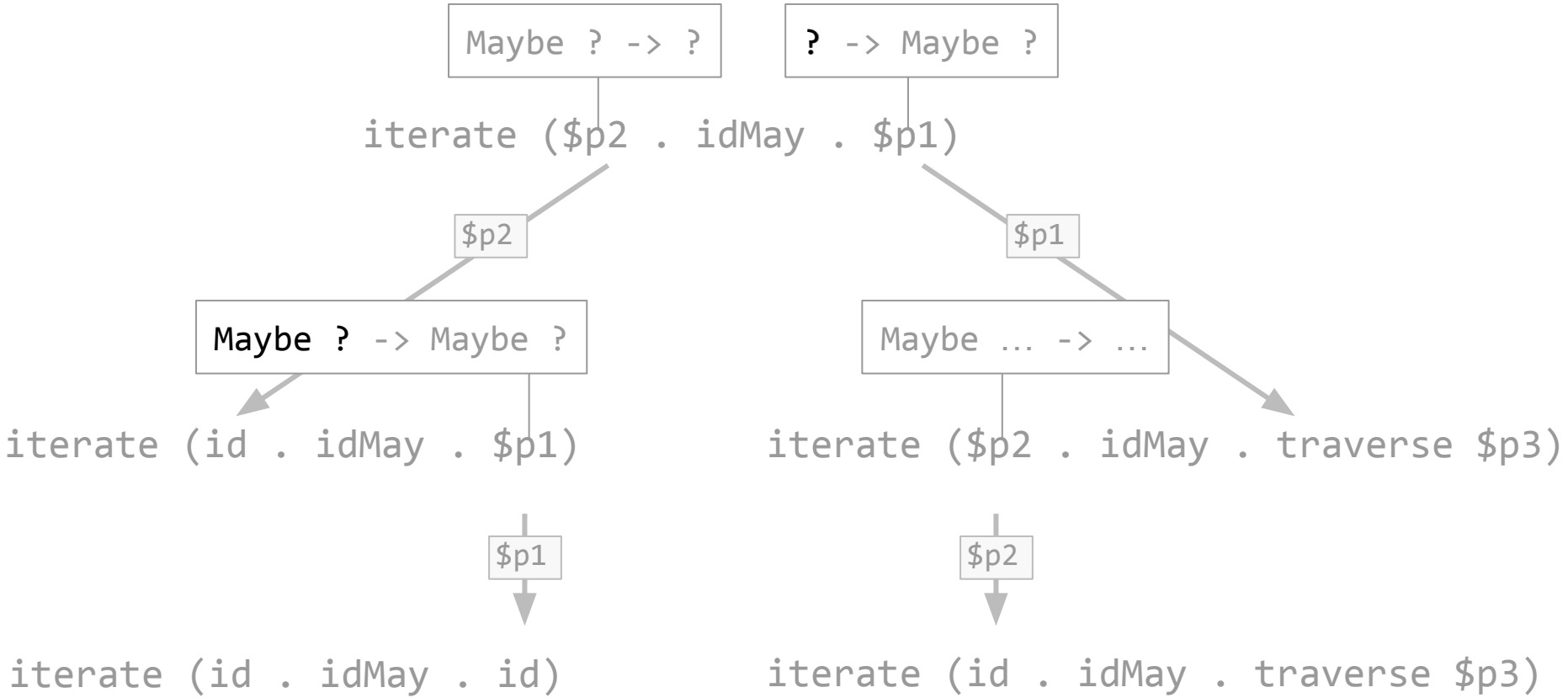

type-aware macros are not confluent

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p1 = p2 = p3 = pullMaybe
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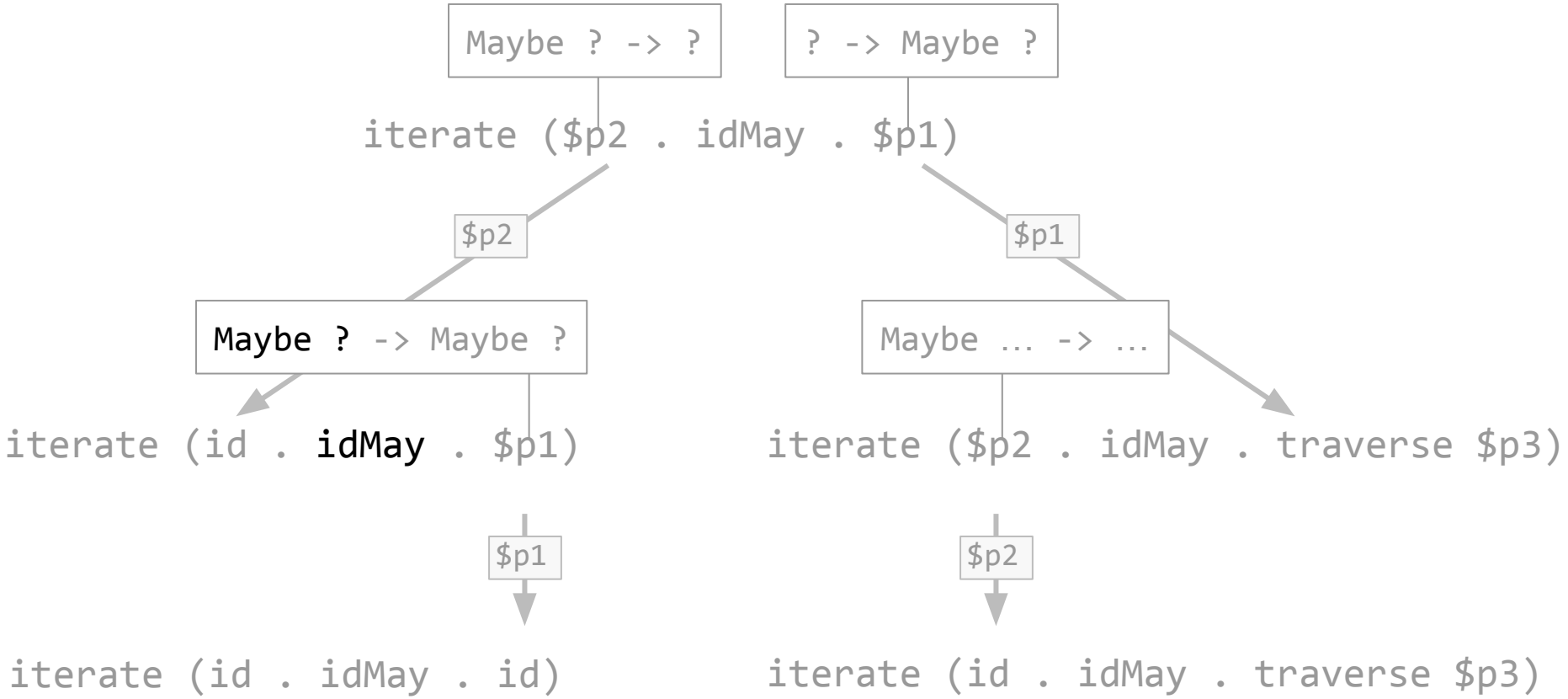

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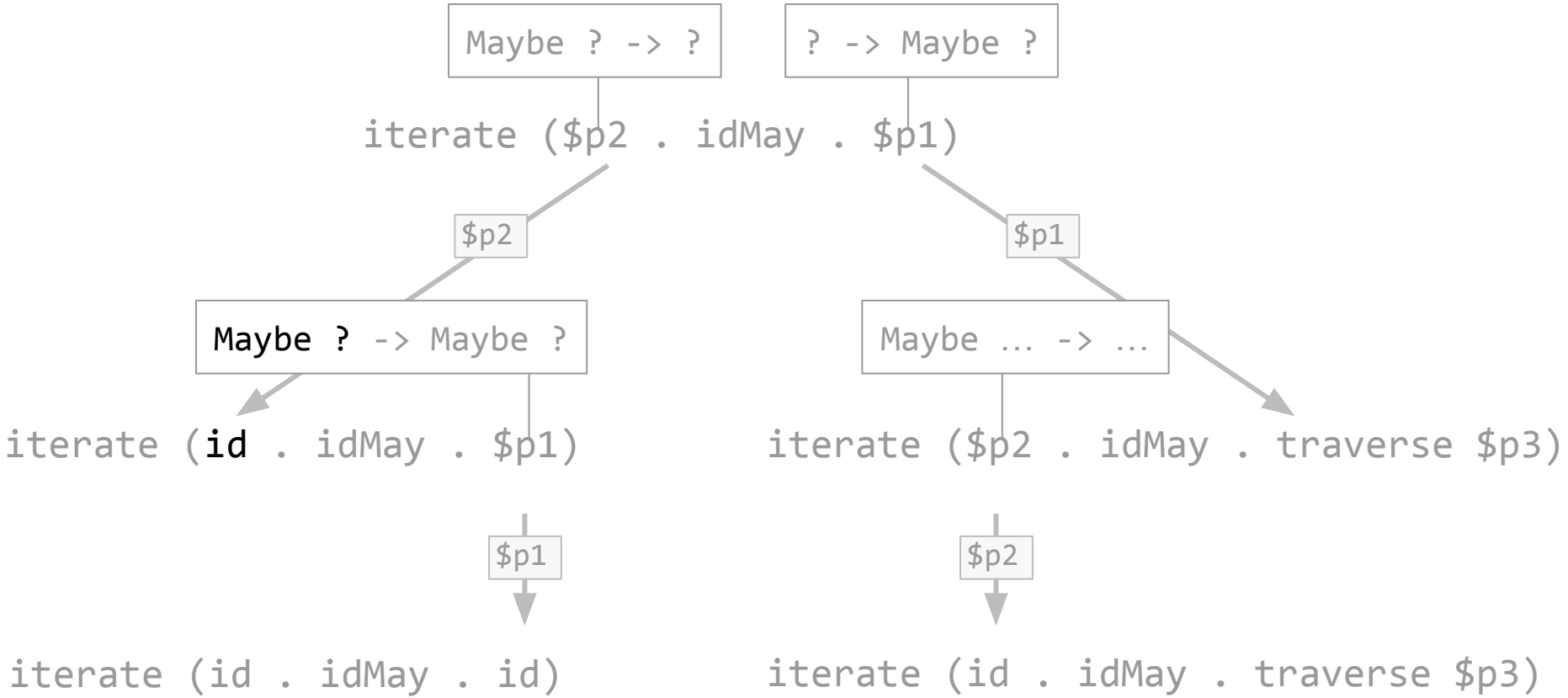

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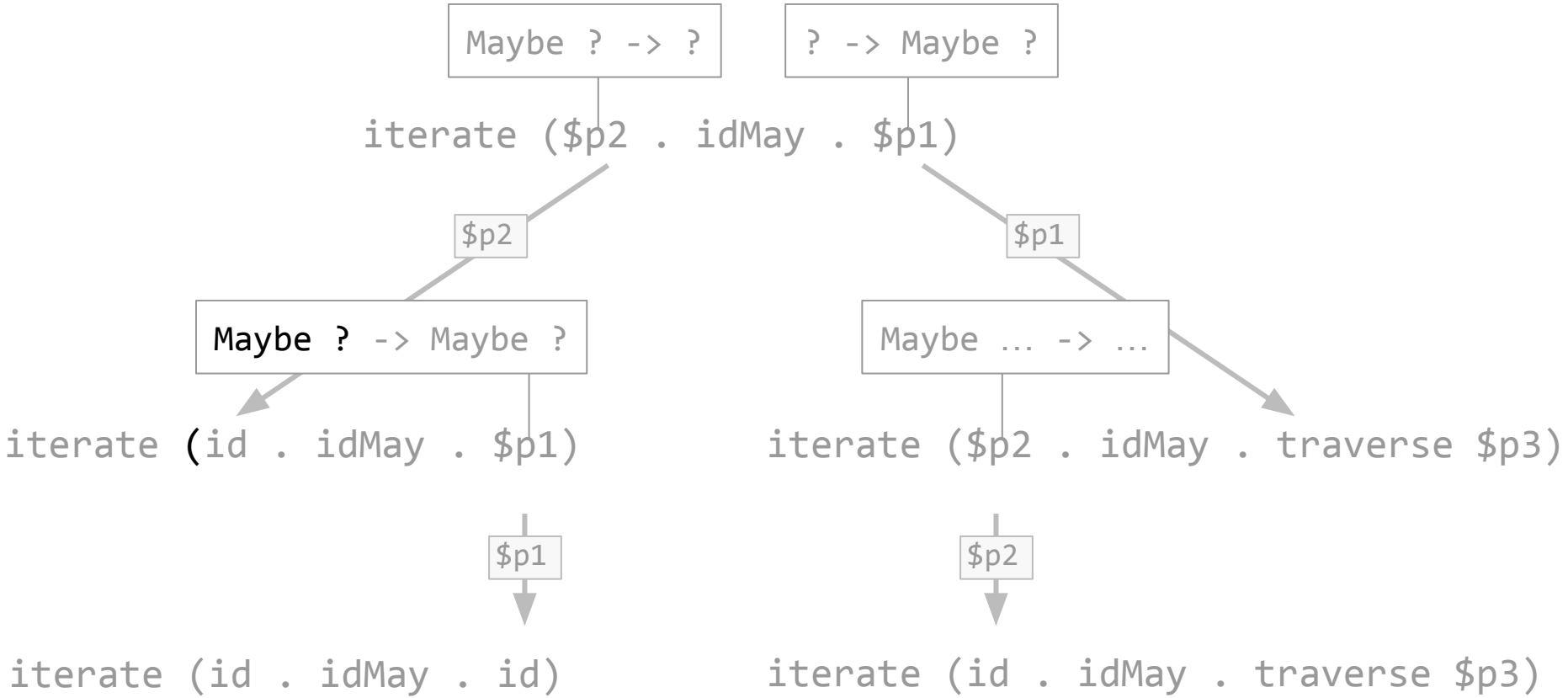

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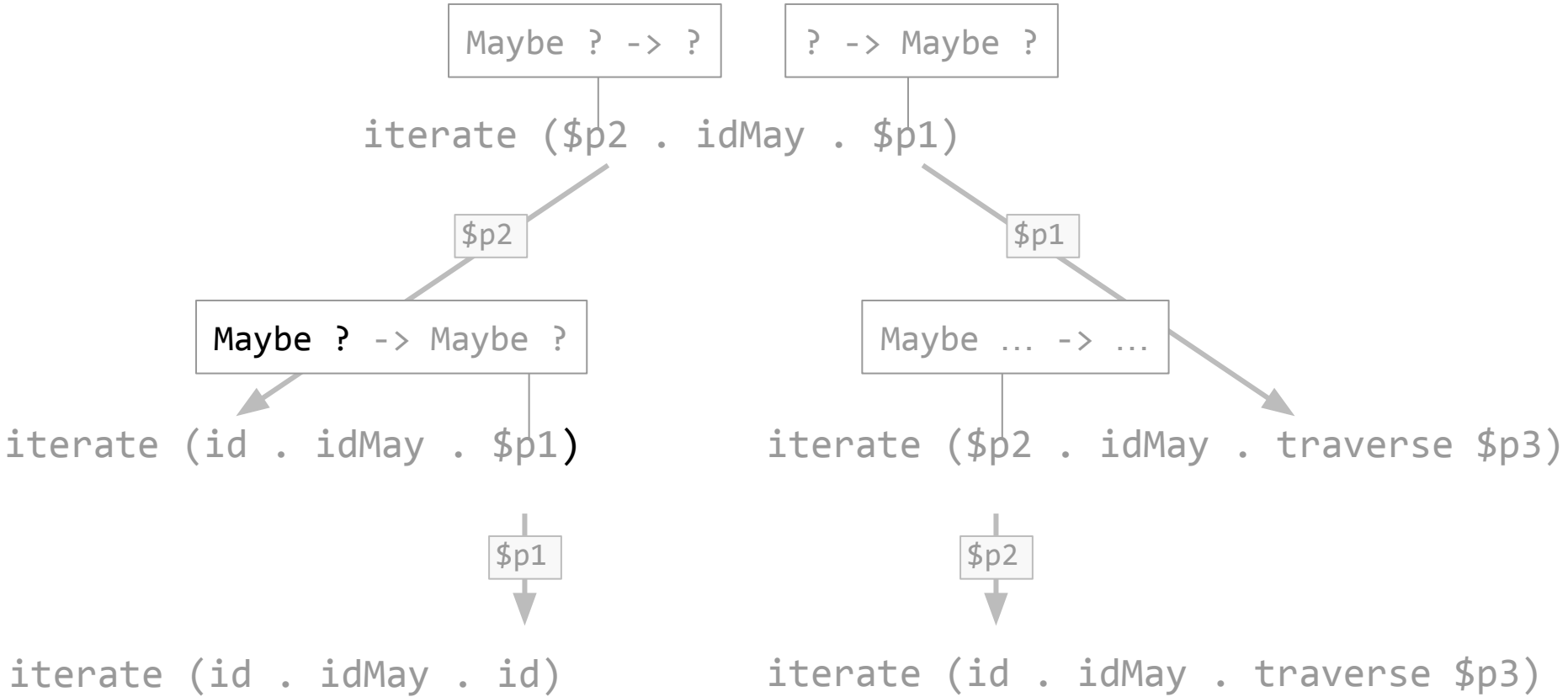

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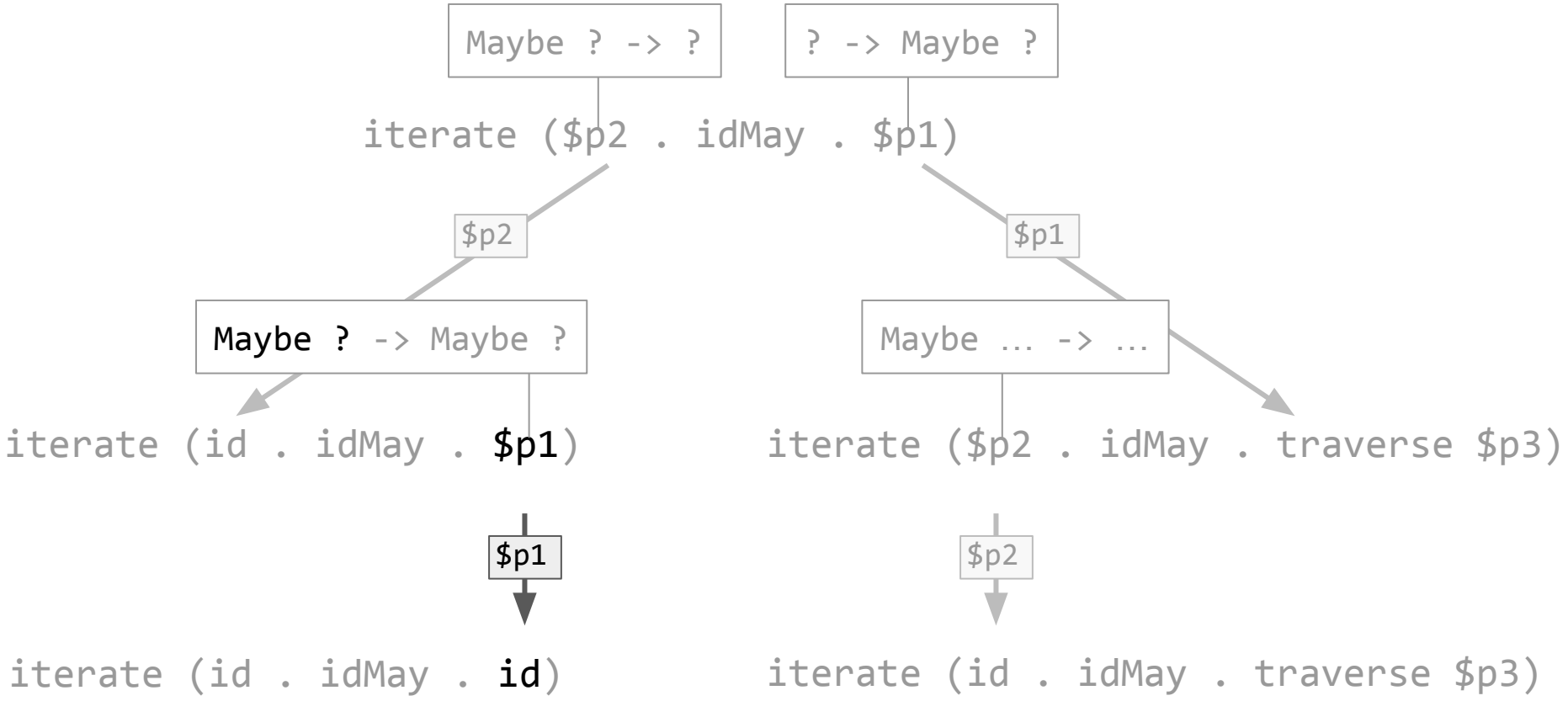

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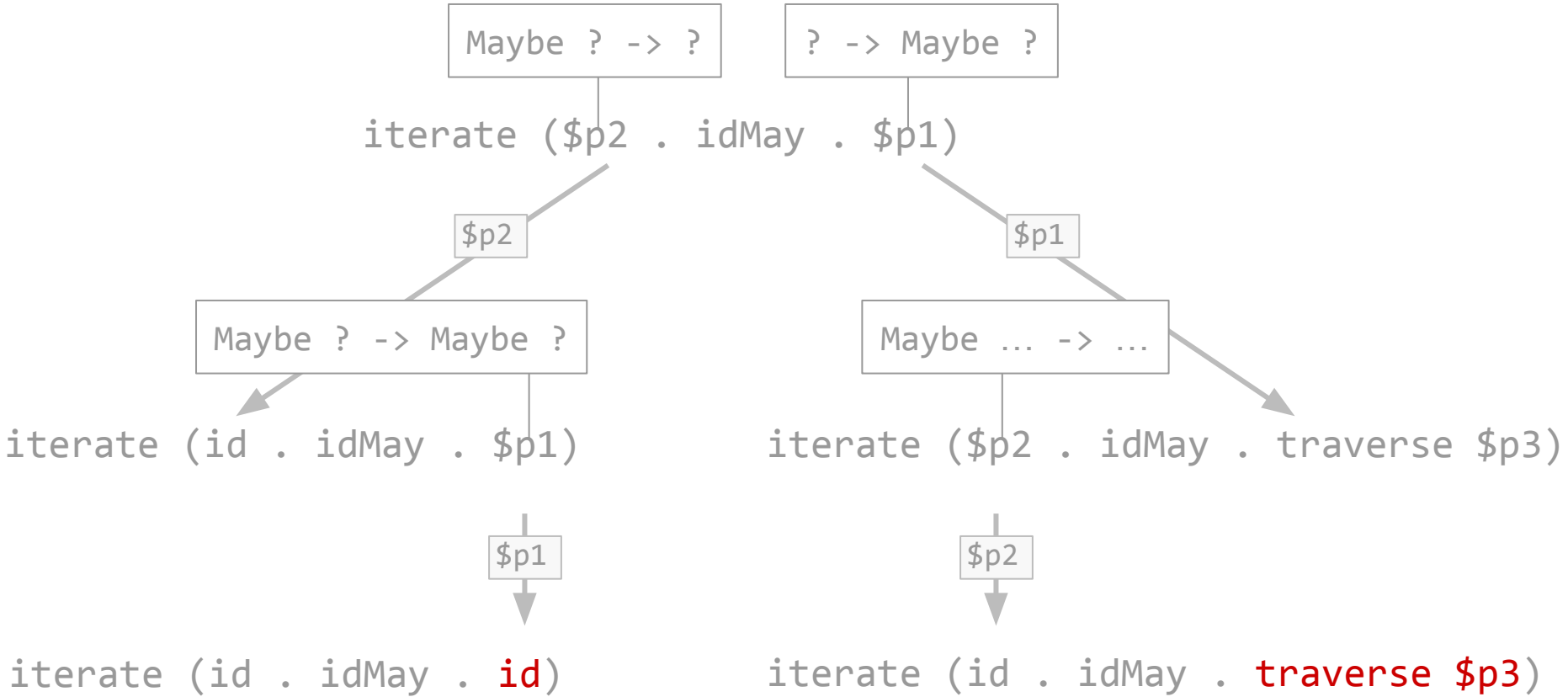
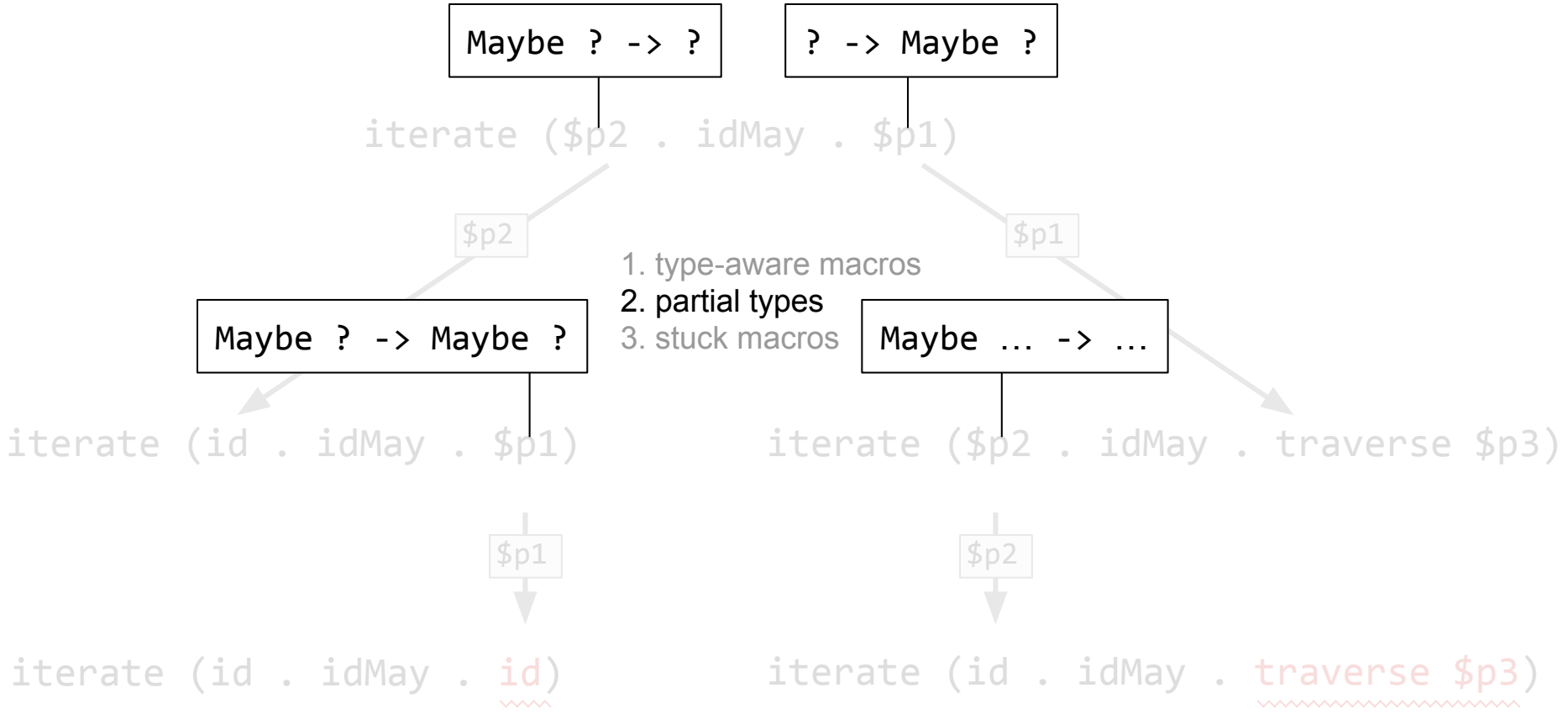
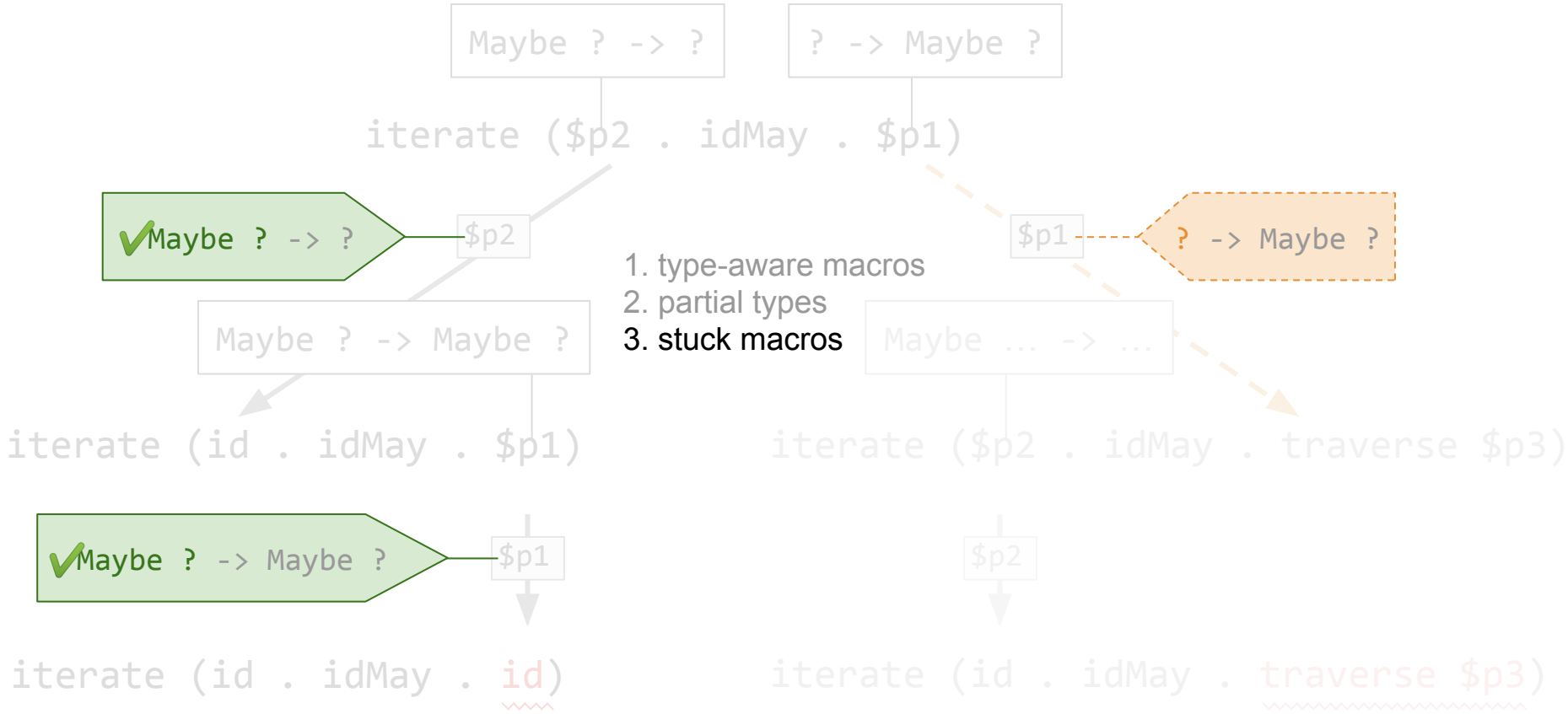


outline


Maybe ? -> ?
? -> Maybe ?
iterate ($p2 . idMay . $p1)
$p2
$p1
1. type-aware macros
2. partial types
3. stuck macros
Maybe ? -> Maybe ?
Maybe ... -> ...
iterate (id . idMay . $p1)
iterate ($p2 . idMay . traverse $p3)
$p1
$p2
iterate (id . idMay . id)
iterate (id . idMay . traverse $p3)

outline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A message from our non-sponsor:

Typer

A message from our non-sponsor:

Typer

coming soon: stuck macros!

Typer, a language by Stefan Monnier (Université de Montréal)

```
if 2 + 2 == 4
  then "sane"
  else "crazy"
```

```
(if_then_else_ (_==_ (_+_ 2 2) 4)
  "sane"
  "crazy")
```

```
define-macro (infix-replicate n op arg) = ...
```

```
triple x = infix-replicate 3 _*_ x
```

```
triple x = x * x * x
```

```
macro : (List Sexp -> Sexp) -> Macro;
```

```
macro : (List Sexp -> Sexp) -> Macro;
infix-replicate : Int -> Macro;

    triple x = infix-replicate 3 _*_ x
```

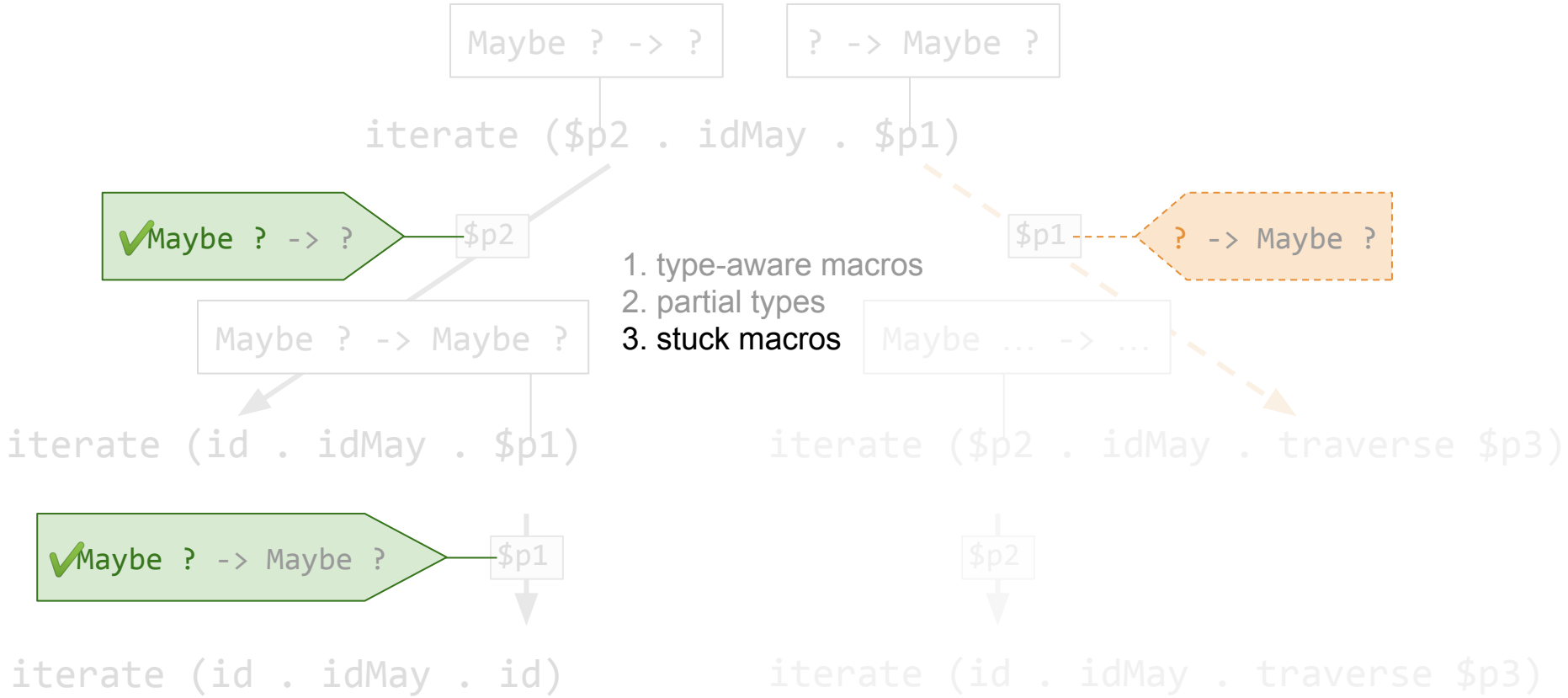
```
    triple x = x * x * x
```

To learn more about

Typer

visit gitlab.com/monnier/typer today!

outline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$p2
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iterate (id . idMay . traverse $p3)

stuck macros

```
p1 = p2 = p3 = pullMaybe
iterate :: (a -> a) -> (a -> a)
  idMay :: Maybe a -> Maybe a
```

`Arr (Maybe Unknown) Unknown`	`Arr Unknown (Maybe Unknown)`

```
iterate ($p2 . idMay . $p1)
```

```
getExpectedType :: Q PartialType

data PartialType = Arr PartialType PartialType
                 | Maybe PartialType
                 | ...
                 | Unknown
```

```
data Type = Arr Type Type
          | Maybe Type
          | ...
```

```
pullMaybe :: Q Exp
pullMaybe = getExpectedType >>= \case
  Arr (Maybe _) _ -> [| id |]
  _               -> [| traverse $pullMaybe |]
```

`$p1`

stuck macros

```
p1 = p2 = p3 = pullMaybe
iterate :: (a -> a) -> (a -> a)
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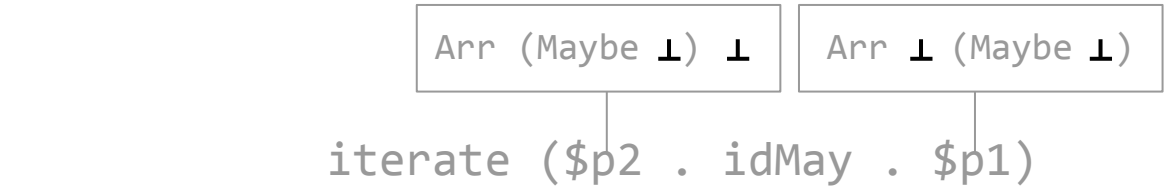

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data PartialType = Arr PartialType PartialType
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                 | Unknown
```

```
getExpectedType :: Q Type

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pullMaybe :: Q Exp
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stuck macros

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iterate :: (a -> a) -> (a -> a)
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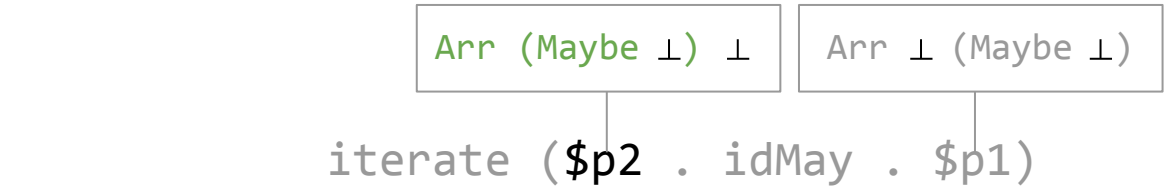

~~getExpectedType :: Q PartialType~~

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data PartialType = Arr PartialType PartialType
                 | Maybe PartialType
                 | ...
                 | Unknown
```

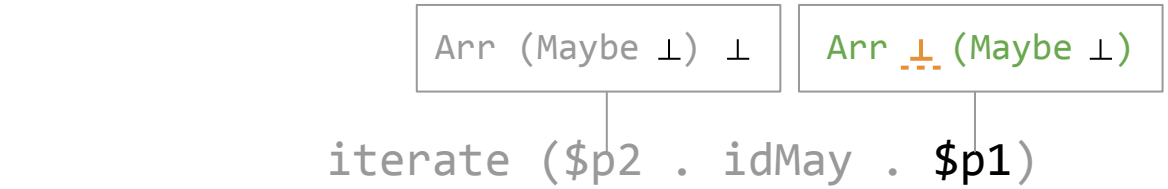
```
getExpectedType :: Q Type

data Type = Arr Type Type
          | Maybe Type
          | ...
```

```
pullMaybe :: Q Exp
pullMaybe = getExpectedType >>= \case
  Arr (Maybe _) _ -> [| id |] $p2
  _               -> [| traverse $pullMaybe |]
```

stuck macros

```
p1 = p2 = p3 = pullMaybe
iterate :: (a -> a) -> (a -> a)
  idMay :: Maybe a -> Maybe a
```



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```
pullMaybe :: Q Exp
pullMaybe = getExpectedType >>= \case
  Arr (Maybe _) _ -> [| id |] ~~$p1~~
  _               -> [| traverse $pullMaybe |] ~~$p1~~
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stuck macros

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p1 = p2 = p3 = pullMaybe
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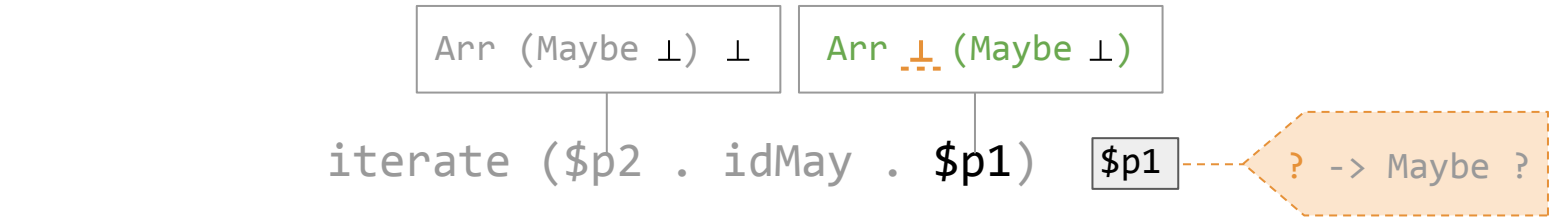

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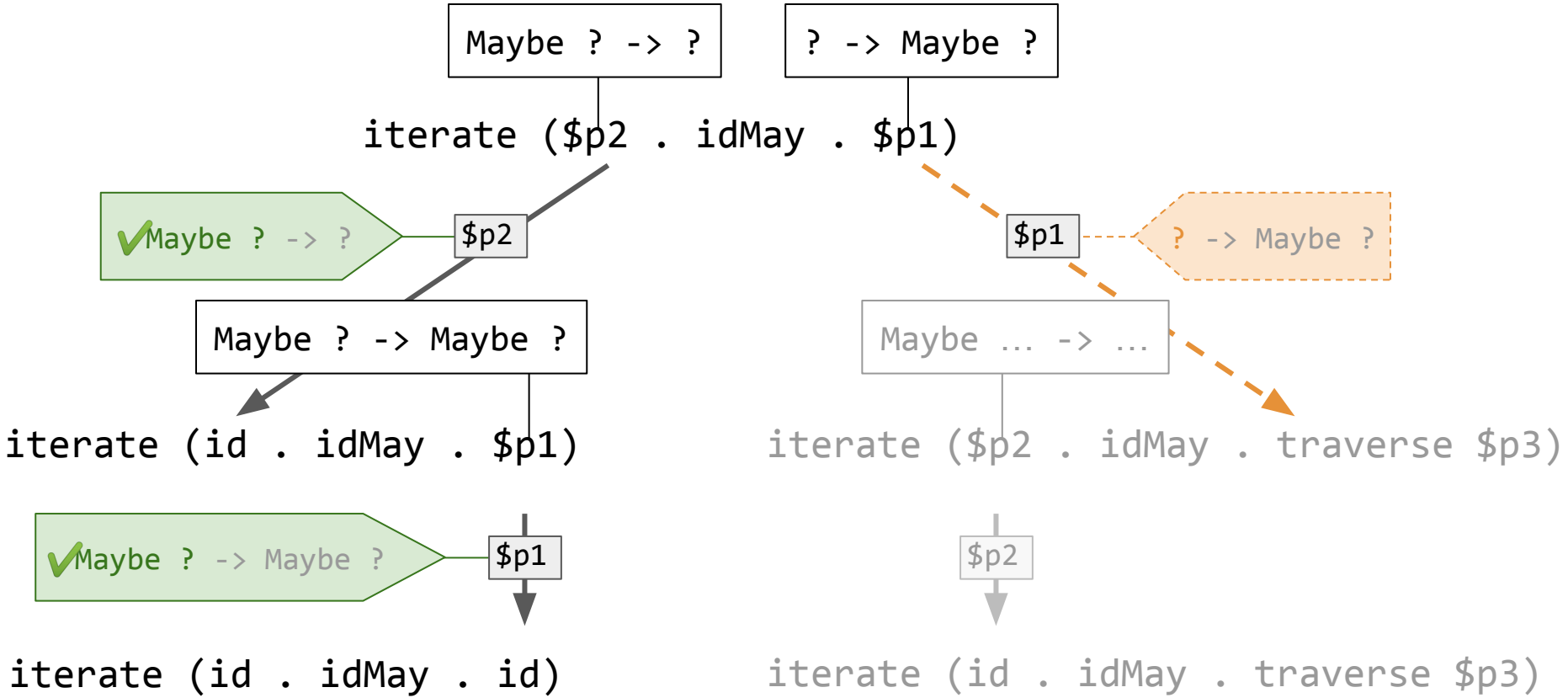
```
pullMaybe :: Q Exp
pullMaybe = getExpectedType >>= \case
  Arr (Maybe _) _ -> [| id |] $p1
  _               -> [| traverse $pullMaybe |] $p1
```

stuck macros are confluent



these slides: gelisam.com/files/stuck-macros.pdf

Haskell jobs:  remote! (work from anywhere in 🇺🇸 or 🇨🇦

Questions?

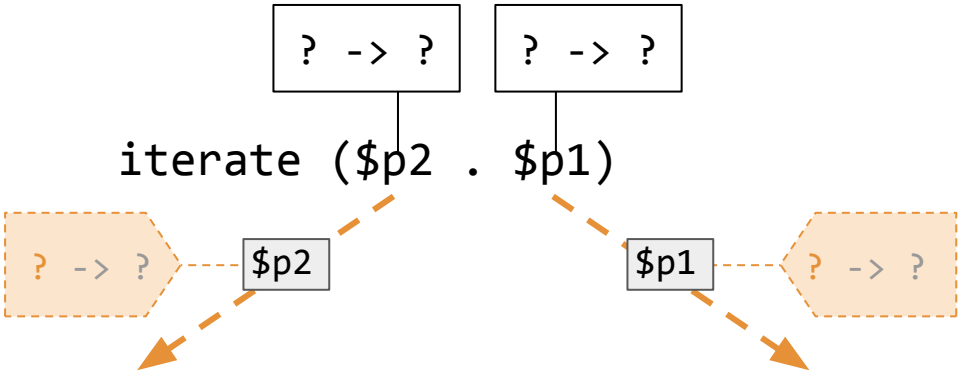
recommended questions (I have bonus slides) :

- can two macros get stuck on each other?
- why is this confluent in general?

presented at C◦mp◦se NYC 2019 by Samuel Gélineau

selfish macros

```
p1 = p2 = p3 = pullMaybe
iterate :: (a -> a) -> (a -> a)
  idMay :: Maybe a -> Maybe a
```



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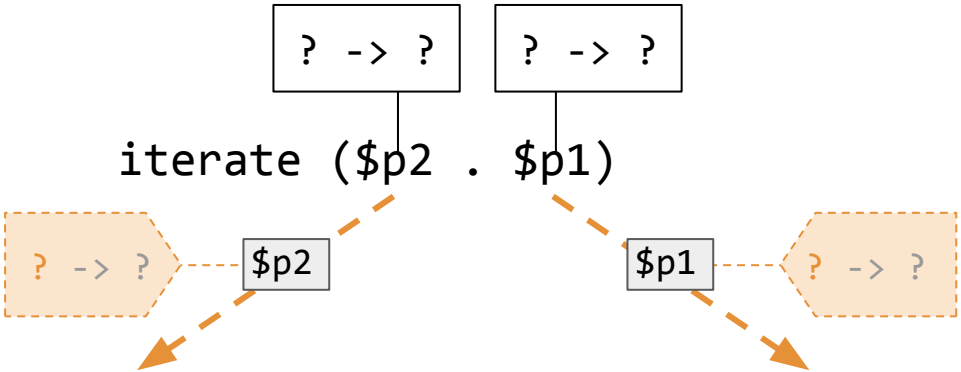


```
type ambiguity error:
please add a type annotation
```

selfish macros

```
p1 = p2 = p3 = pullMaybe
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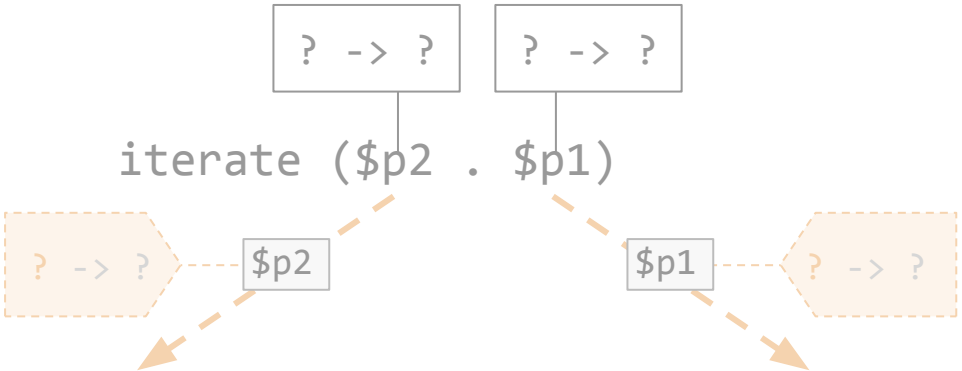
```




```
$pullMaybe ::   Maybe a    -> Maybe    a
$pullMaybe ::  [Maybe a]   -> Maybe   [a]
$pullMaybe :: [[Maybe a]]  -> Maybe  [[a]]
```

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p1 = p2 = p3 = pullMaybe
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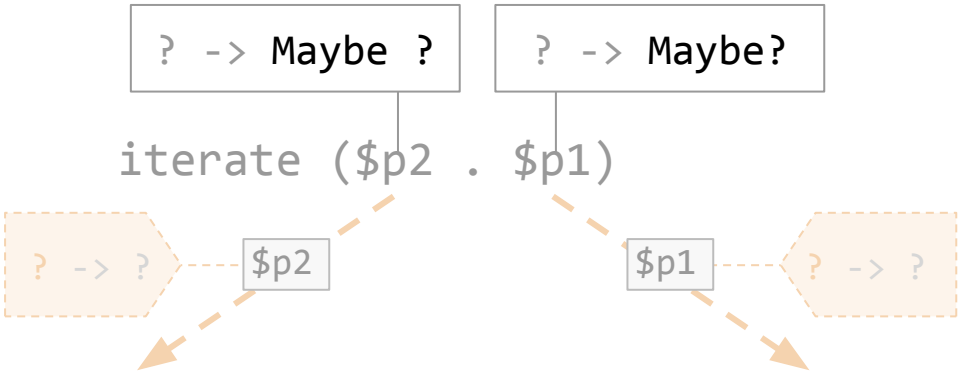


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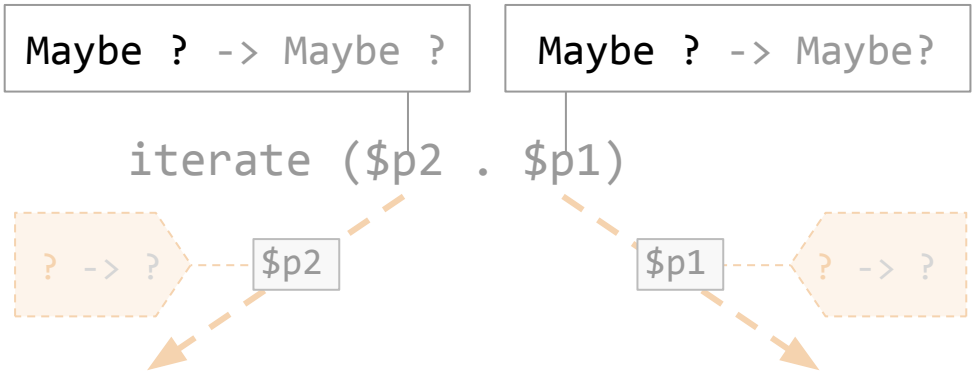


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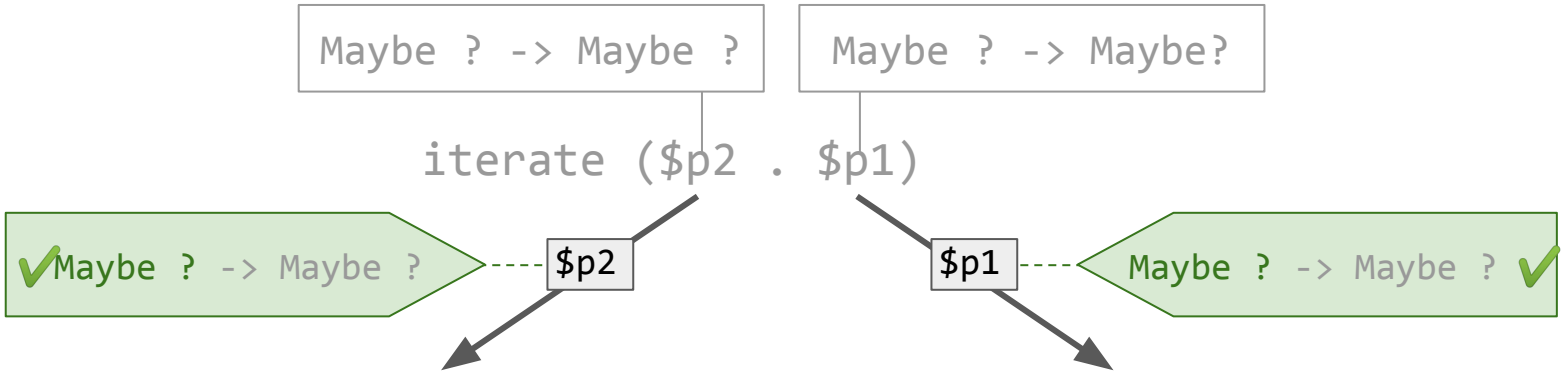


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```
pullMaybe :: Q Exp
pullMaybe = do
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    _               -> [| traverse $pullMaybe |]
```

preliminary output

```
pullMaybe :: Q Exp
pullMaybe = do
  setPartialType [| Maybe _ -> Maybe _ |]
  getExpectedType >>= \case
    Arr (Maybe _) _ -> [| id |]
    _               -> [| traverse $pullMaybe |]
```

preliminary output

```
pullMaybe :: Q Exp
pullMaybe = do
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```

preliminary output

```
pullMaybe :: Q Exp
pullMaybe = do
  [setPartialType| Maybe s -> Maybe t |]
  case s of
    Arr (Maybe _) _ -> [| id |]
    _               -> [| traverse $pullMaybe |]
```

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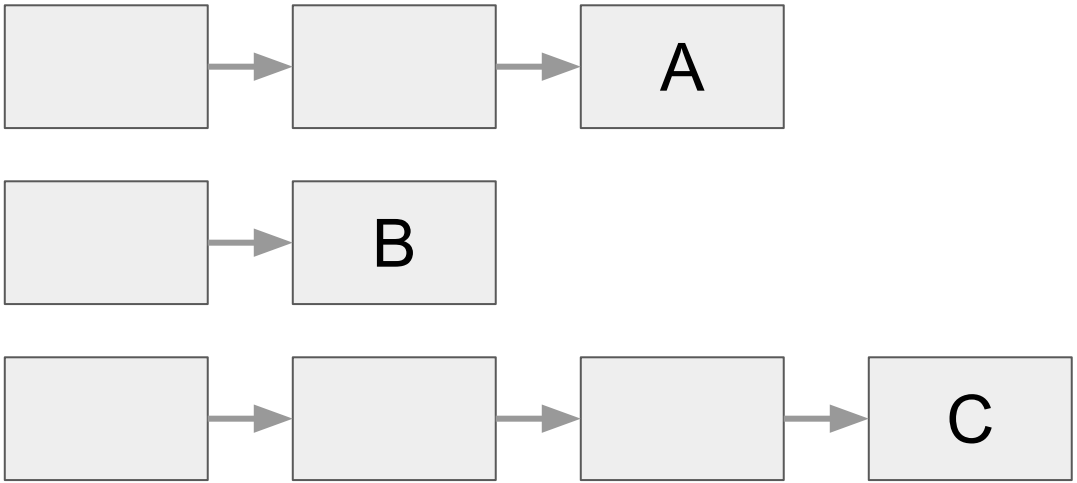
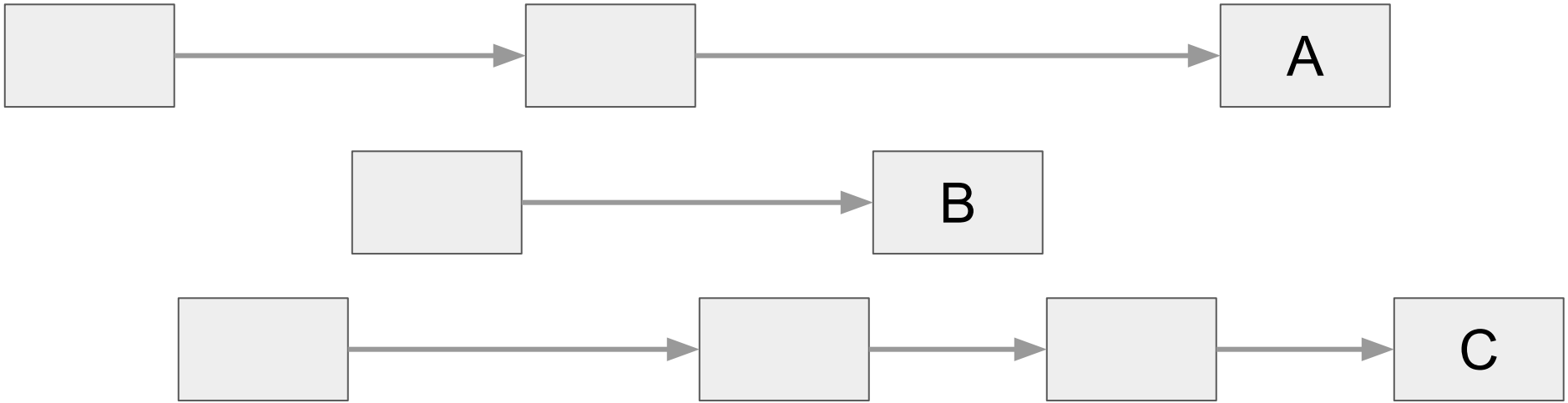
`N independent processes`



proof sketch

N independent processes:
same results regardless of interleaving



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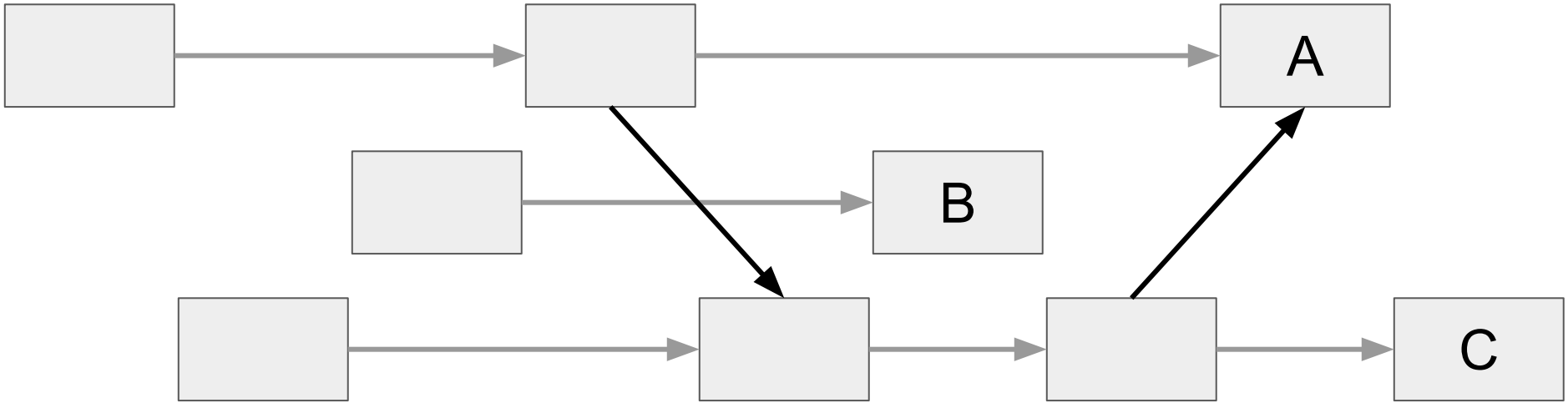
N independent processes with ordering constraints:
same results regardless of interleaving



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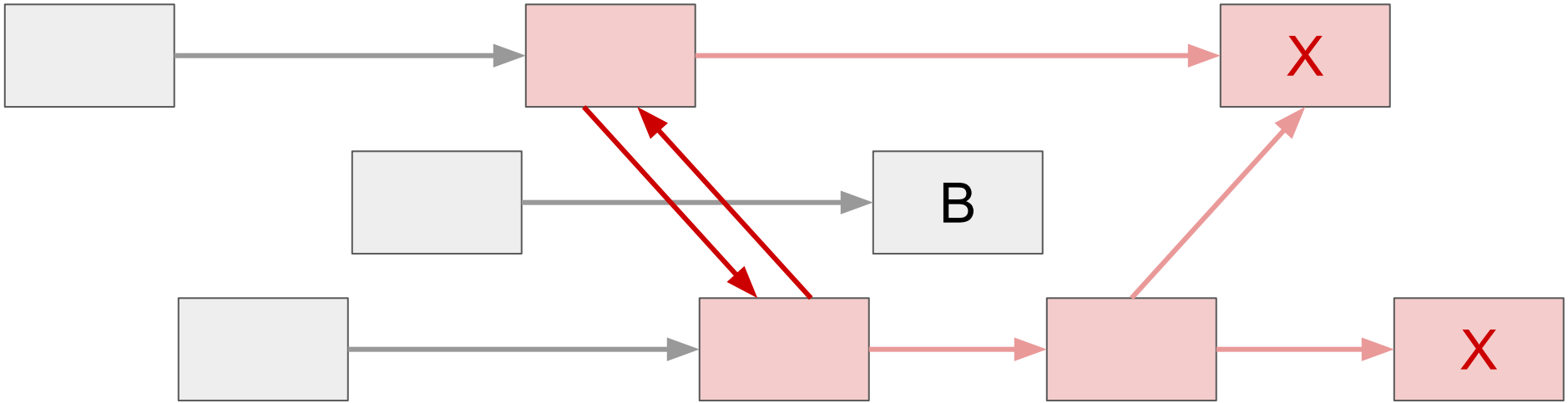

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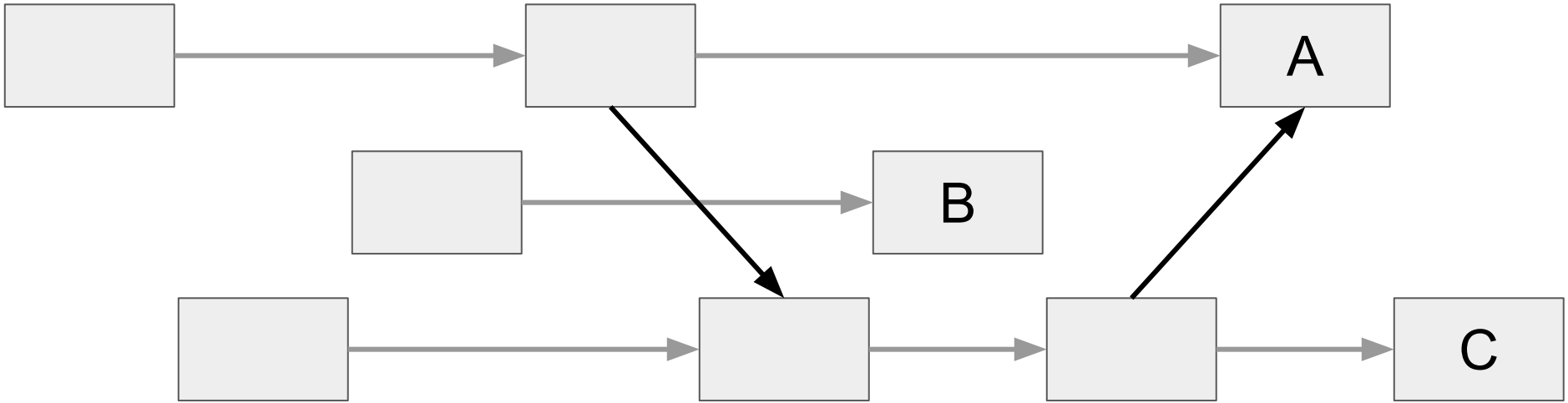
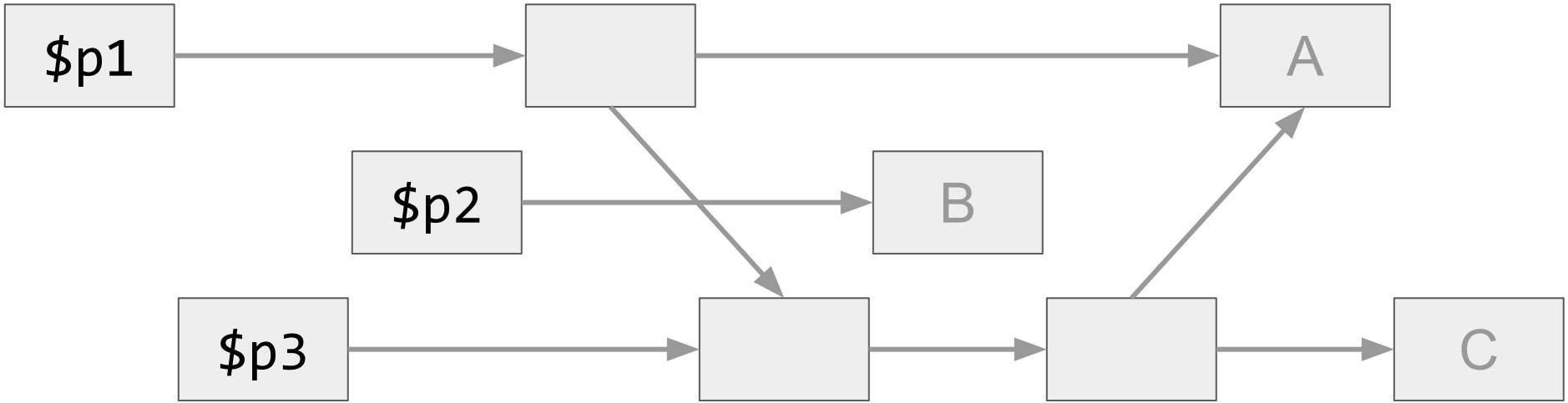


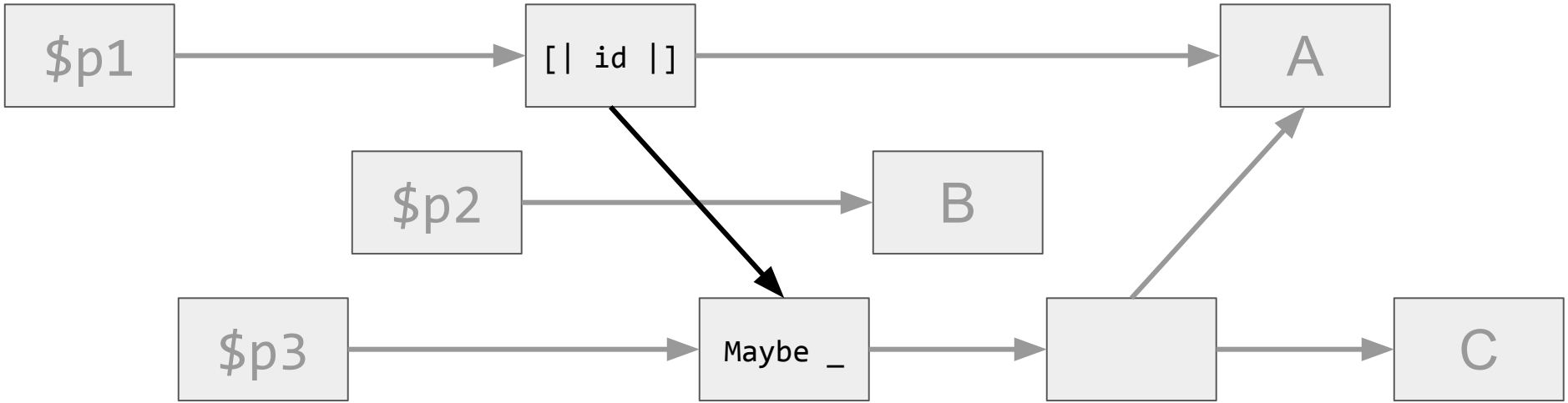
proof sketch

N independent macro expansions with ordering constraints:
same results regardless of interleaving



proof sketch

N independent macro expansions which sometimes get stuck:
same results regardless of interleaving



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