Generators for Asynchronous Programming

User Manual

Benoit Viguier
@b_viguier

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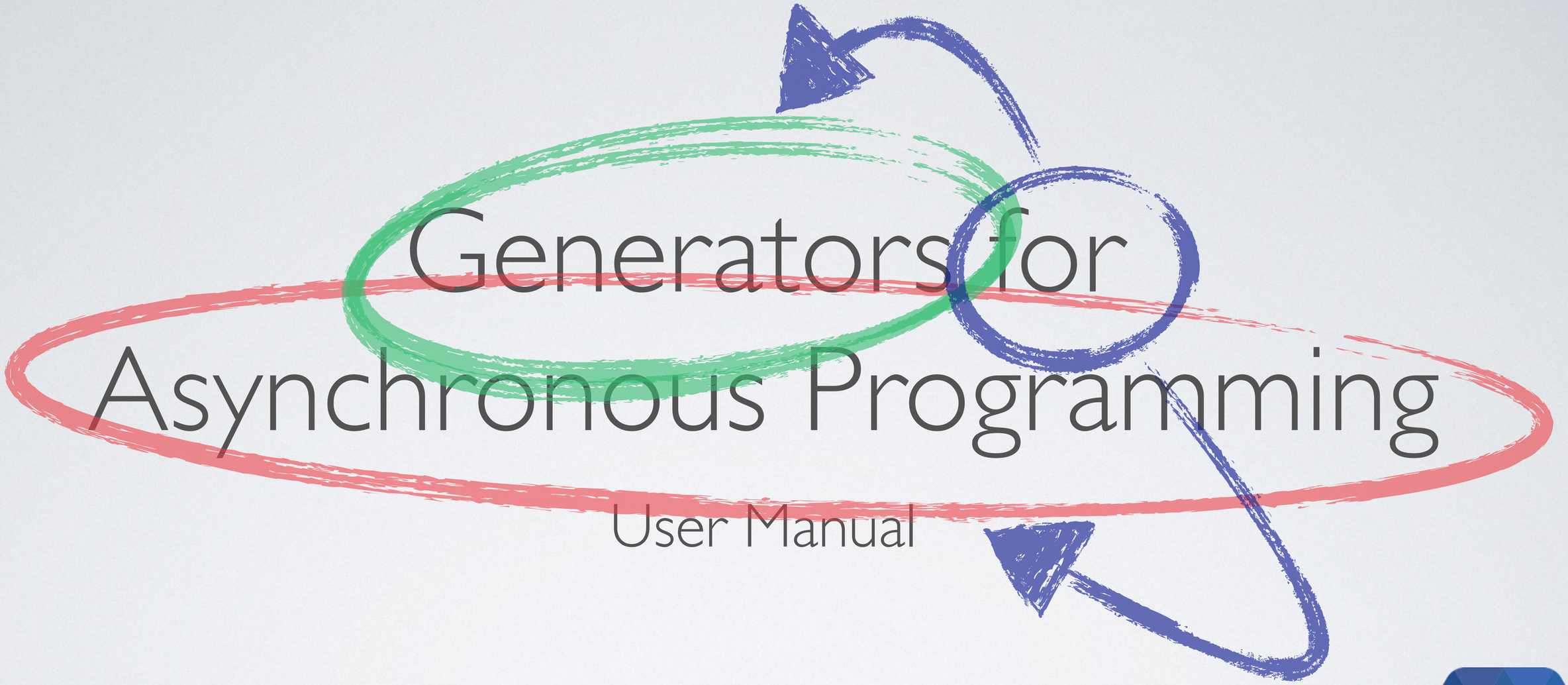

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PARIS2018

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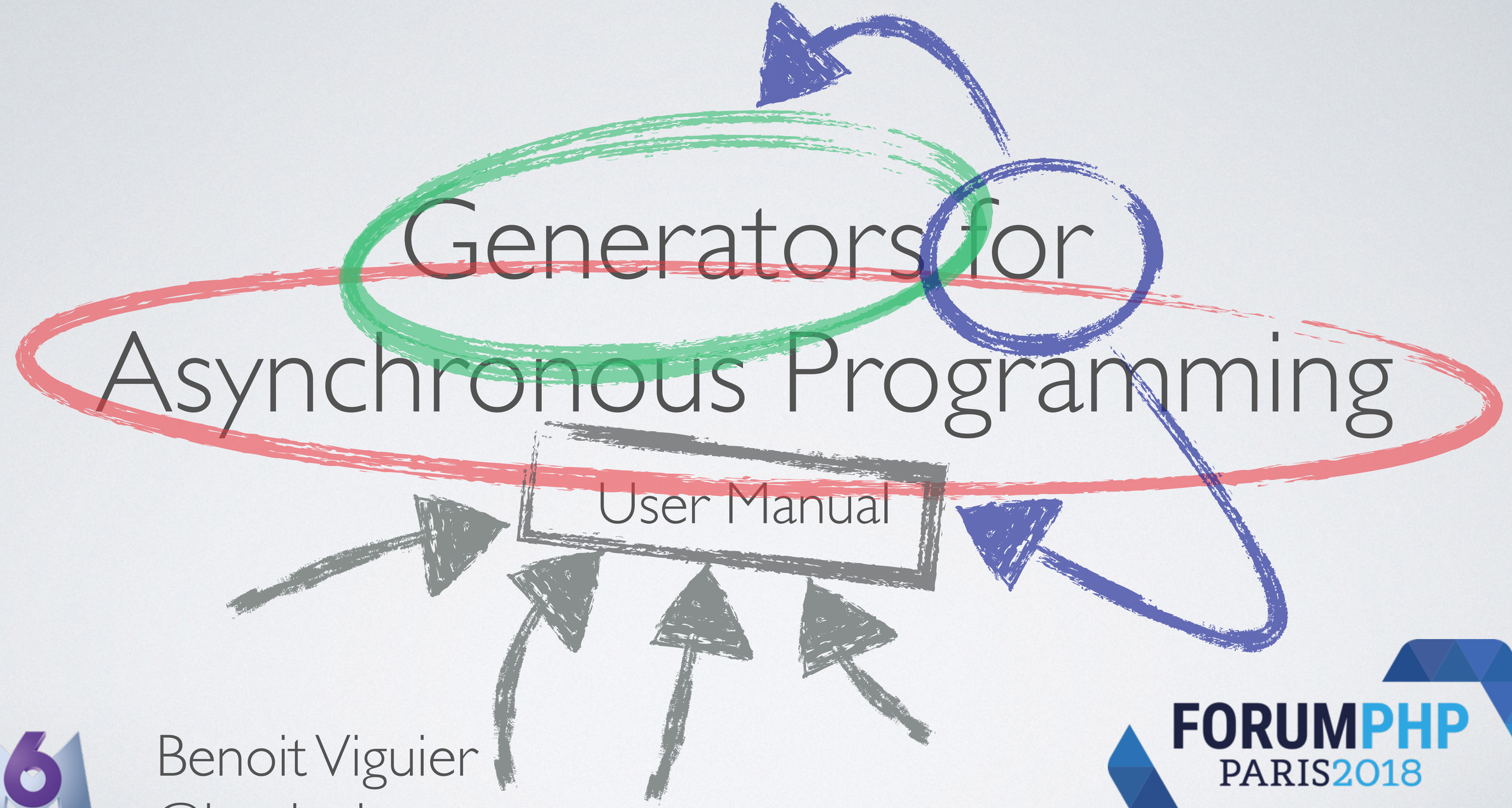

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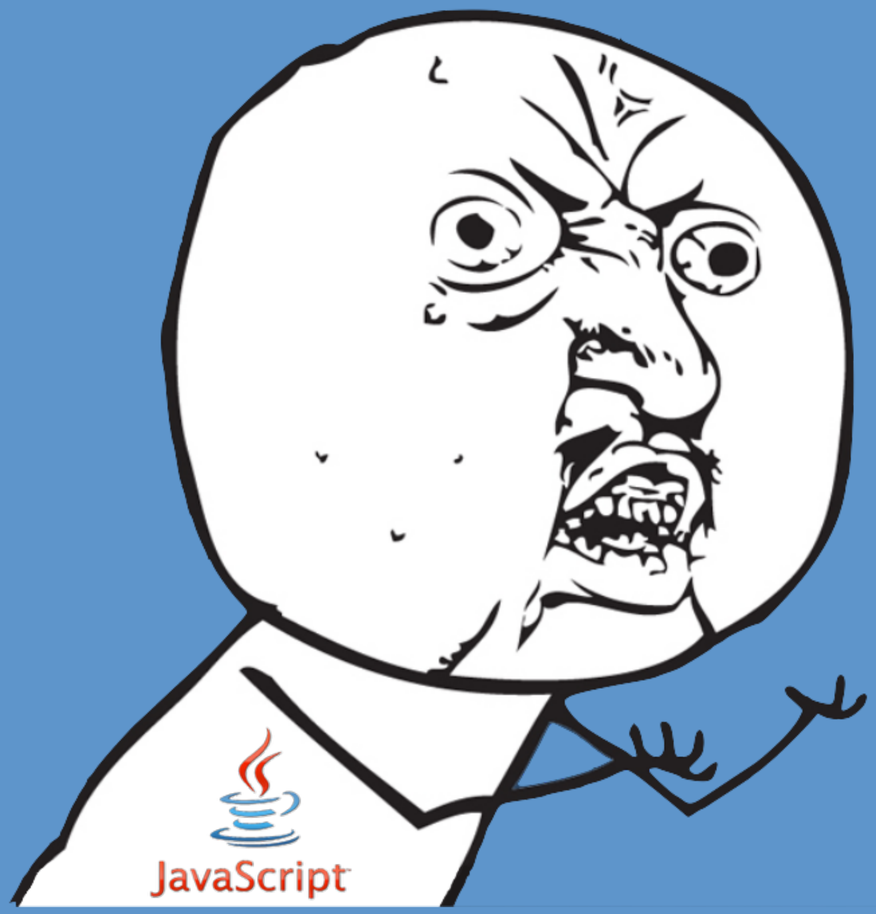
Asynchronous Programming

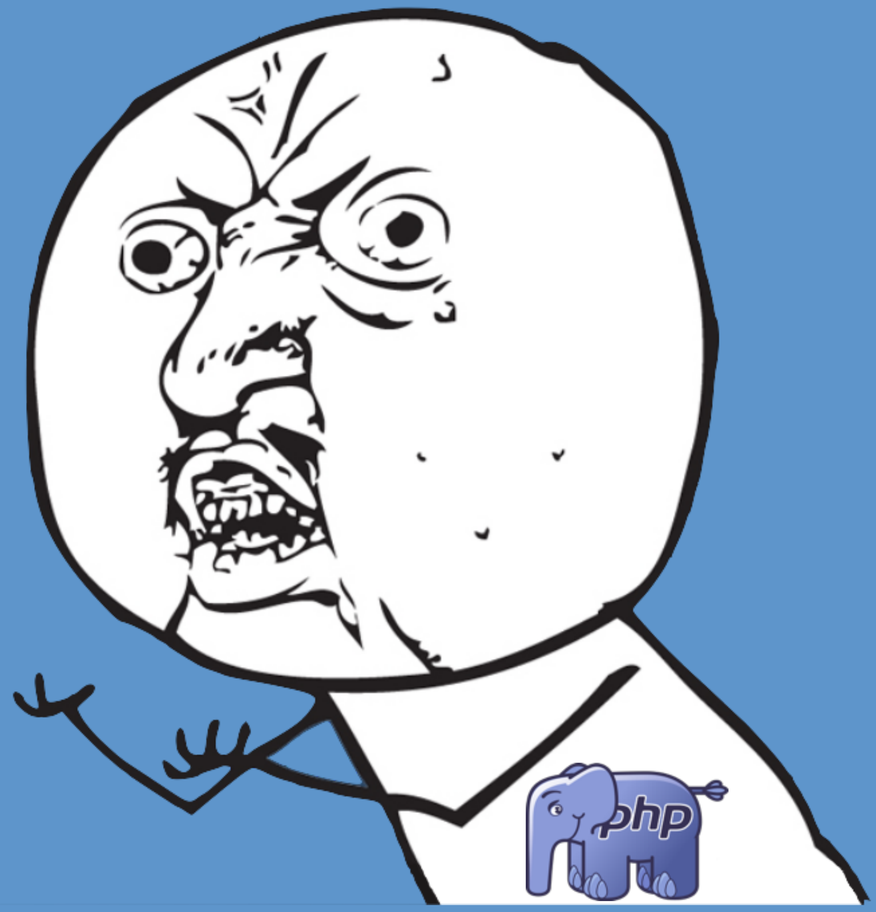


PHP DEV

Y U NO USE JAVASCRIPT

PHP DEV

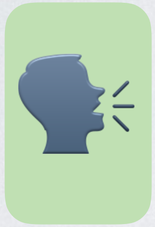
Y U NO USE PHP



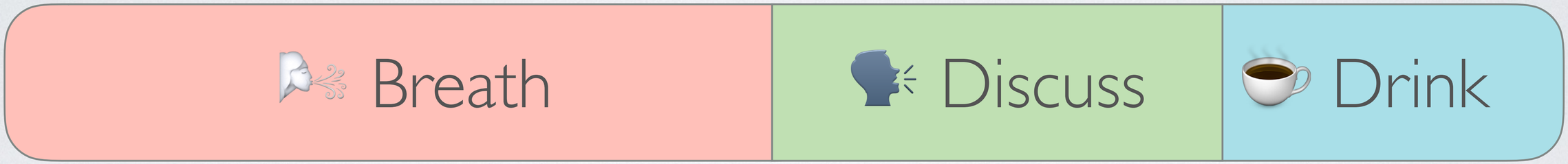
Tea for Two

An illustrated example

Tasks

-  **Drinking** Tea
-  **Discussing** with a friend
-  **Breathing** just… to live

Synchronous



Time

Concurrency

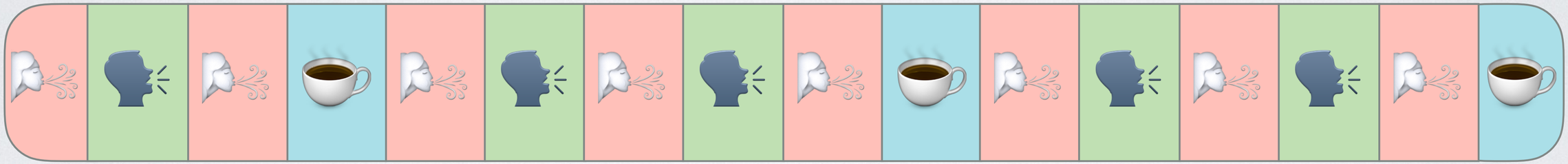
Starting next task before that current one ends

Parallel

Php is single threaded

… and it's a good thing

Asynchronous



Time

But… 🤔

Analyzing tasks

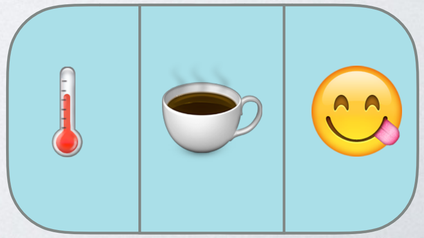
Internal/External operations

Drinking Tea

Waiting good temperature

Drinking (actually)

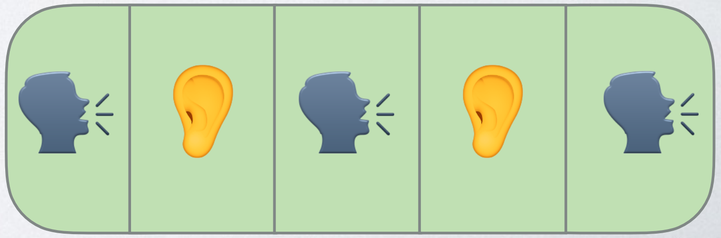
Enjoying



Discussing with a friend

Speaking, asking something

Listening

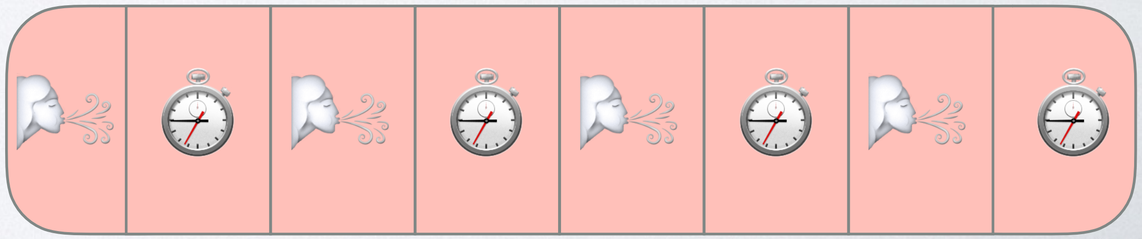


Breathing

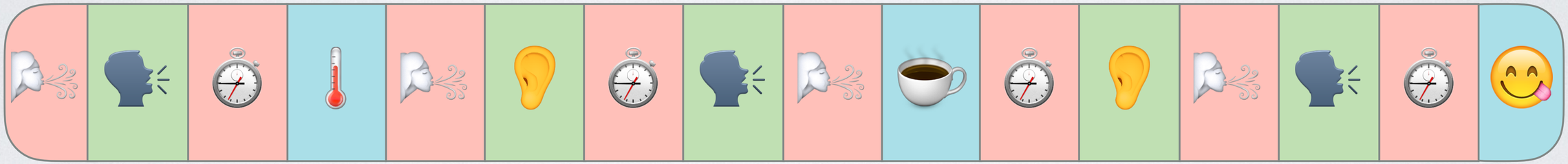
Breathing…

Waiting (a little)

Breathing…

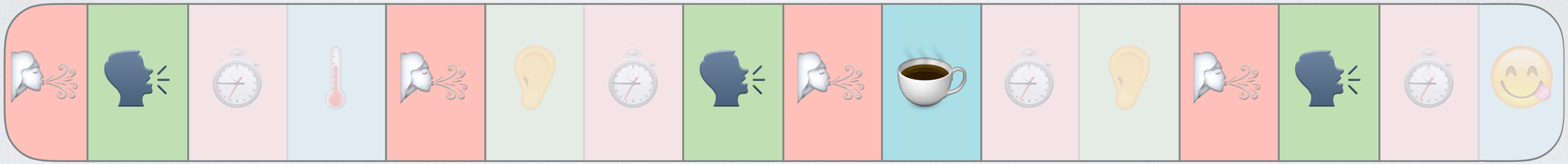


Asynchronous



Time

Internal operations



Time

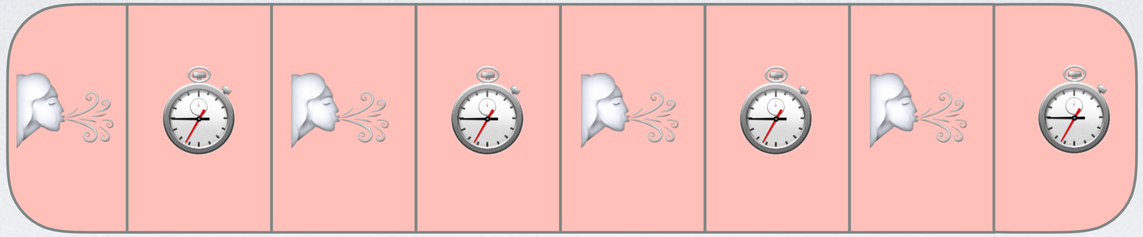
External operations

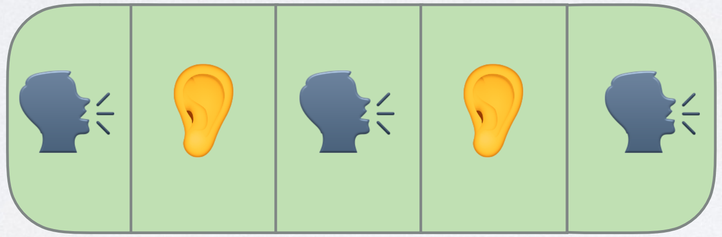
Time

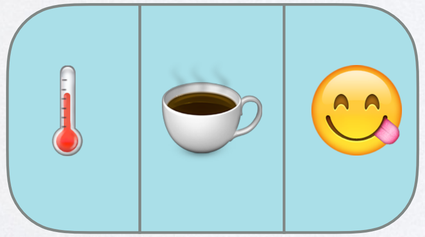
Dispatching execution

Event Loop

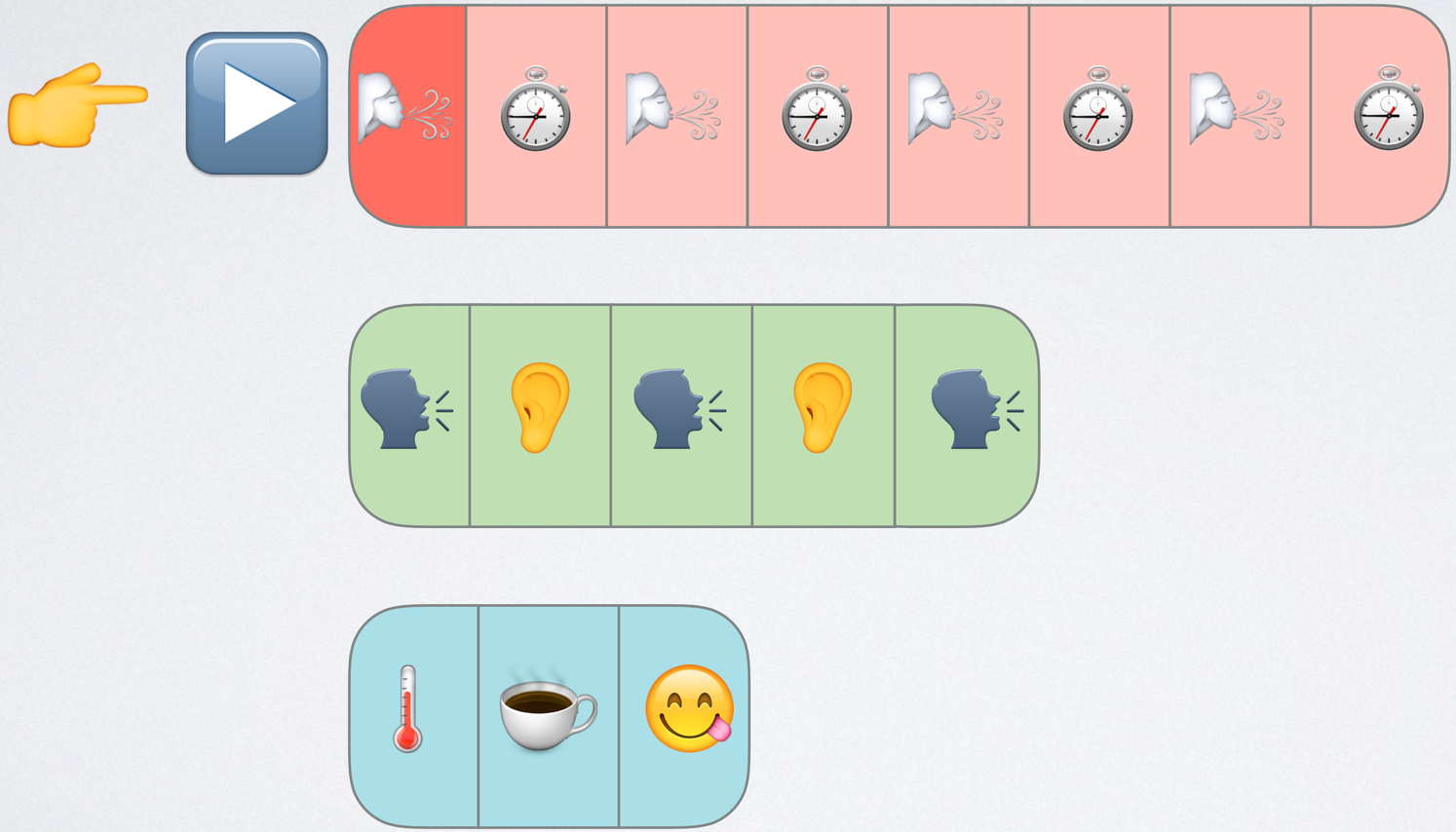
Event Loop



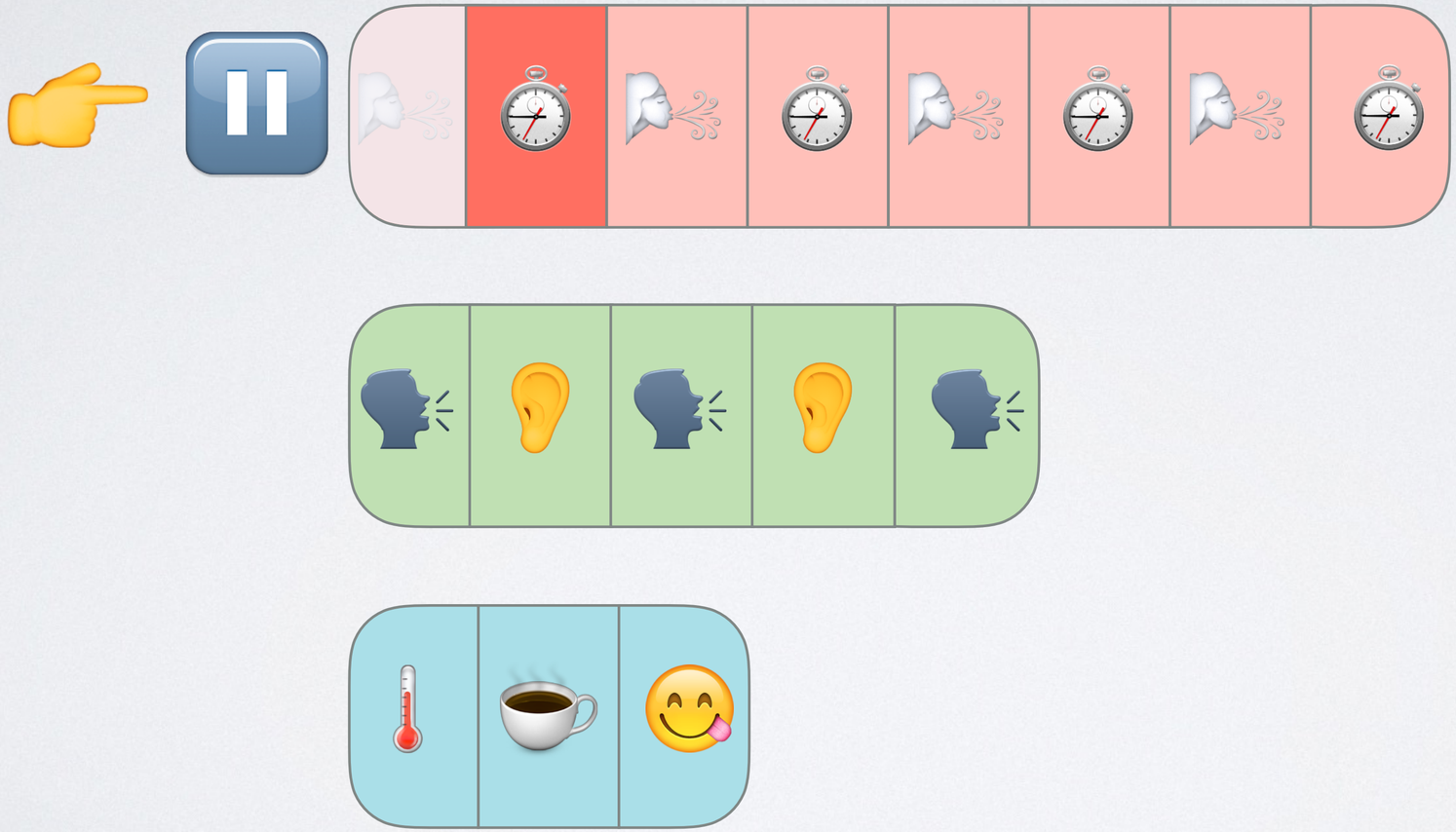




Event Loop

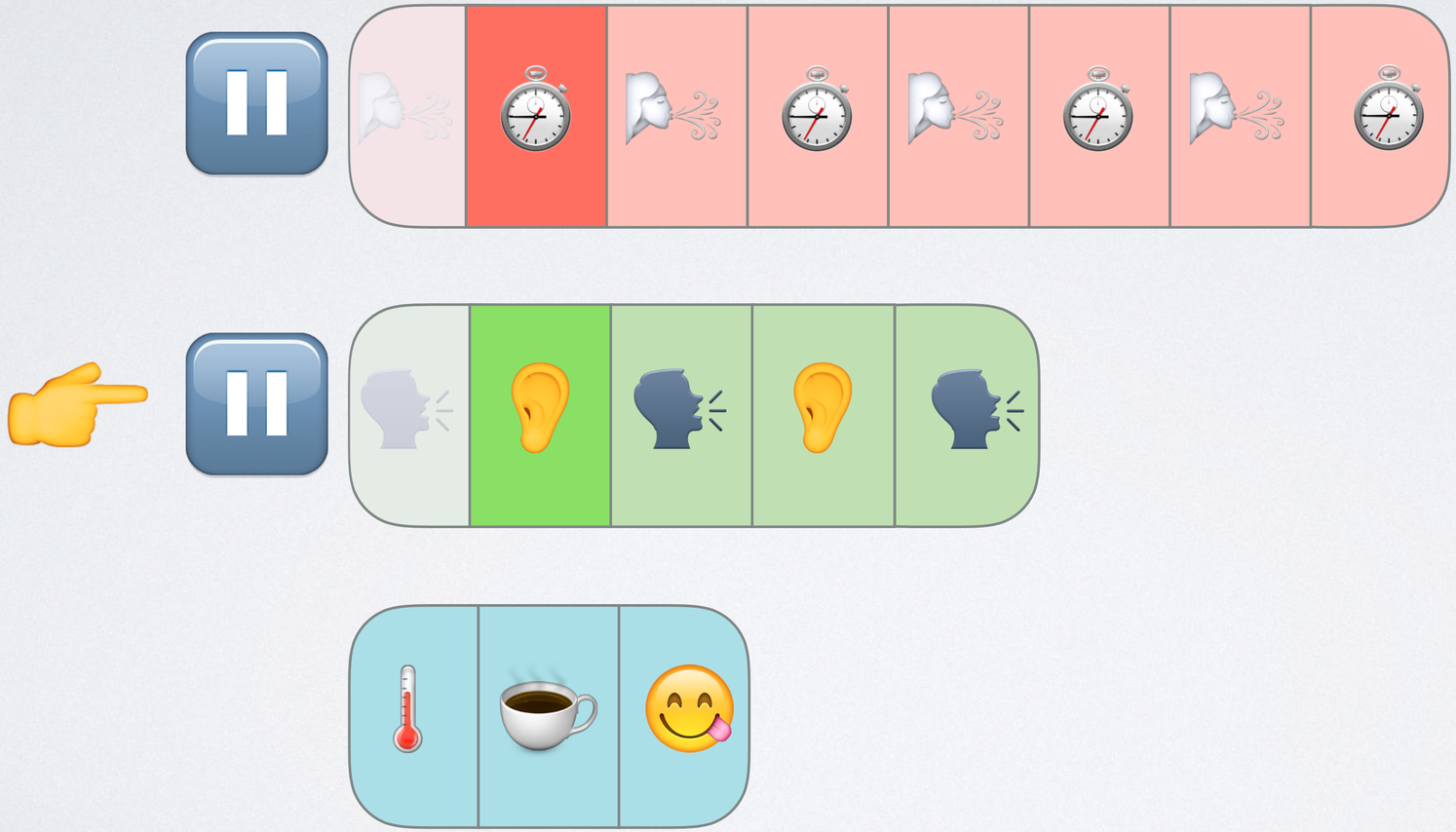


Event Loop

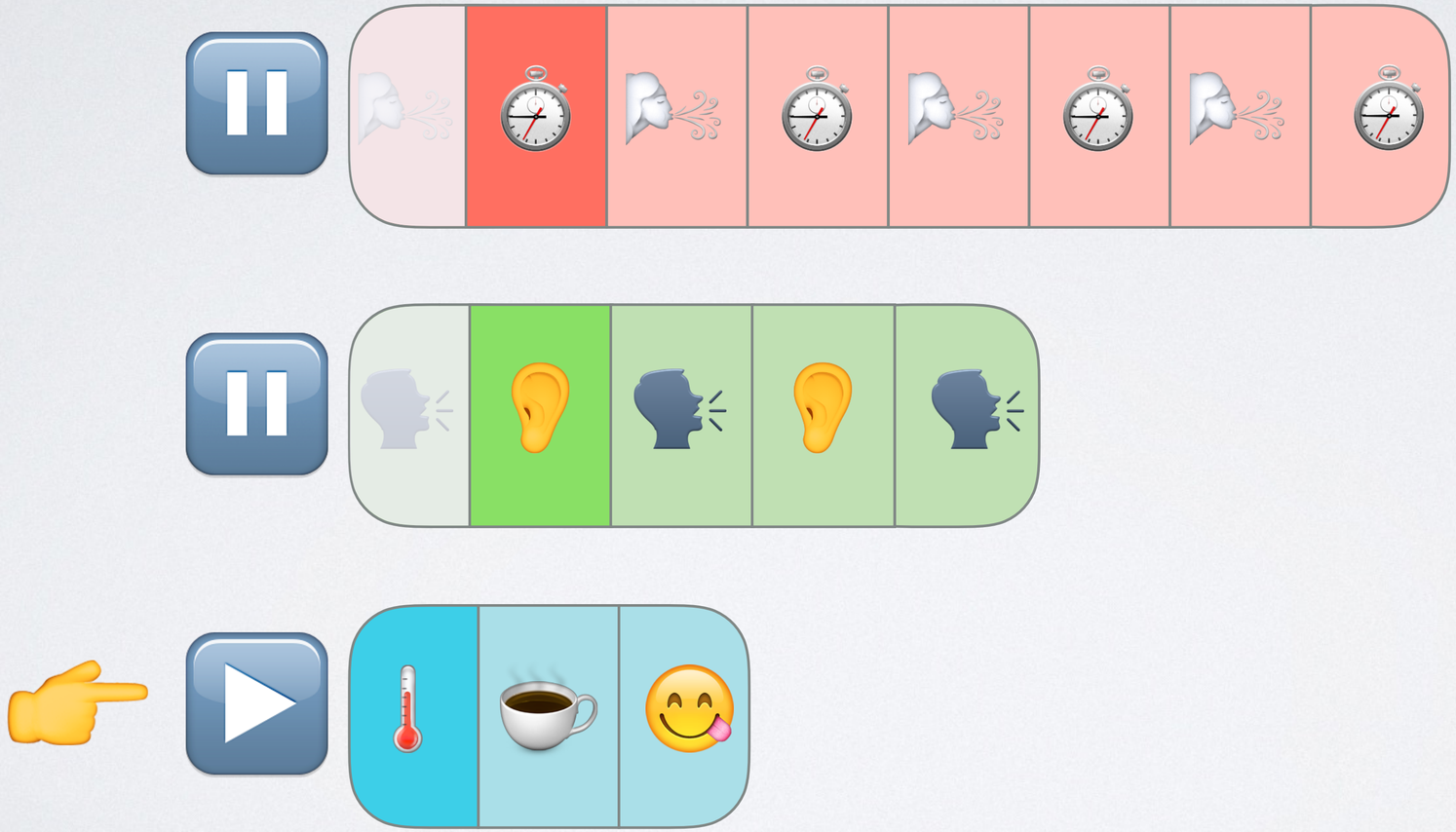


Event Loop

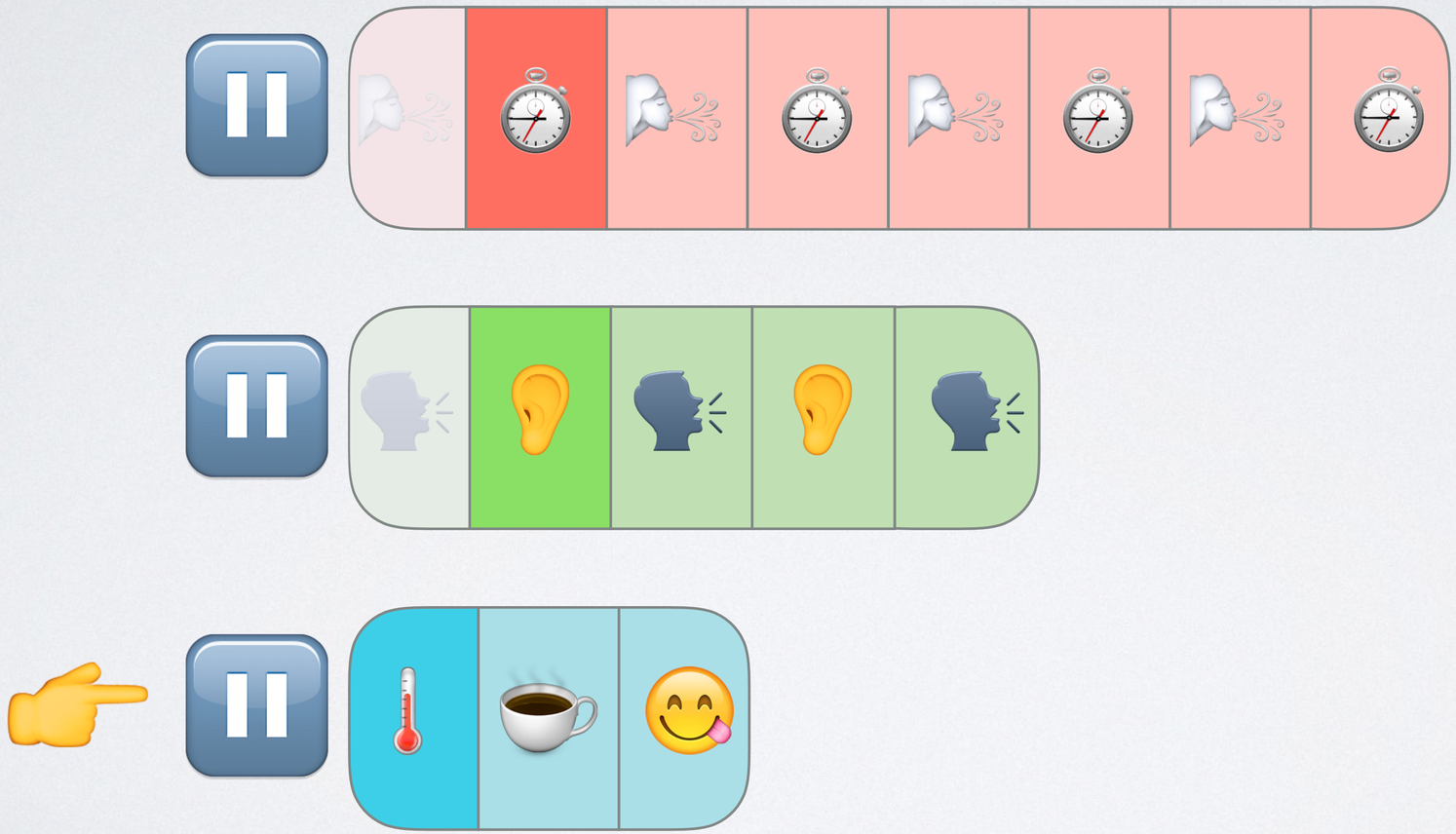
Event Loop



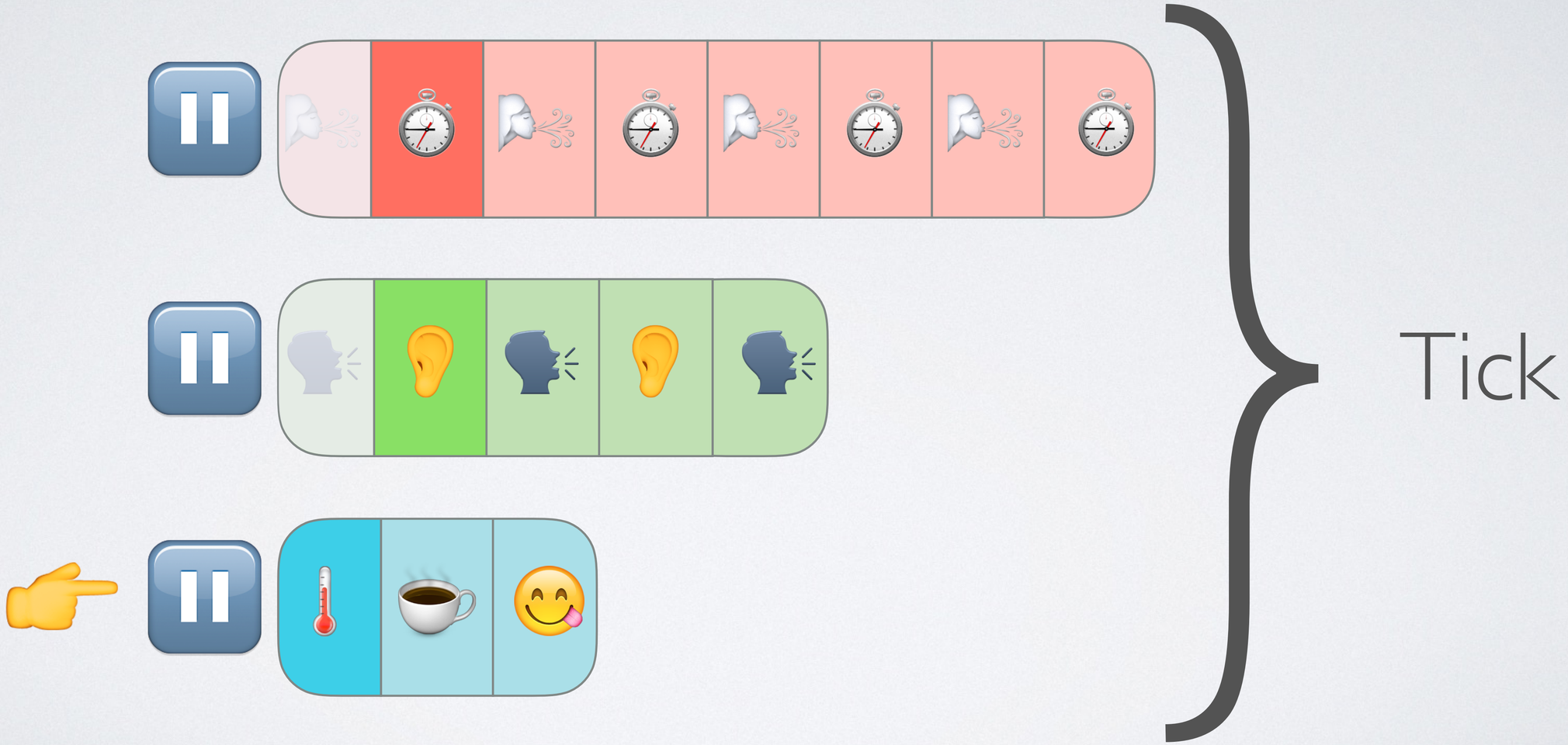
Event Loop



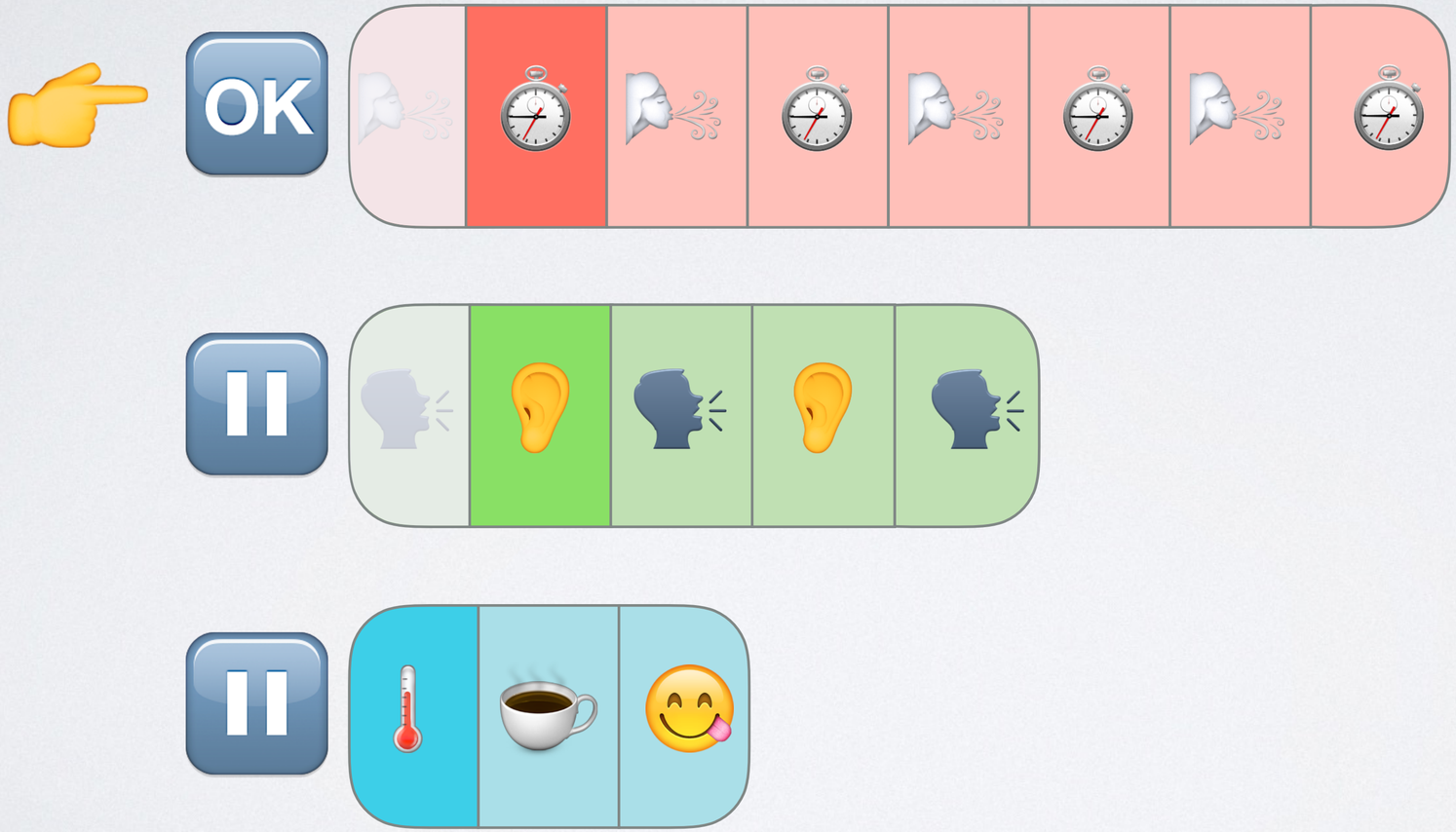
Event Loop



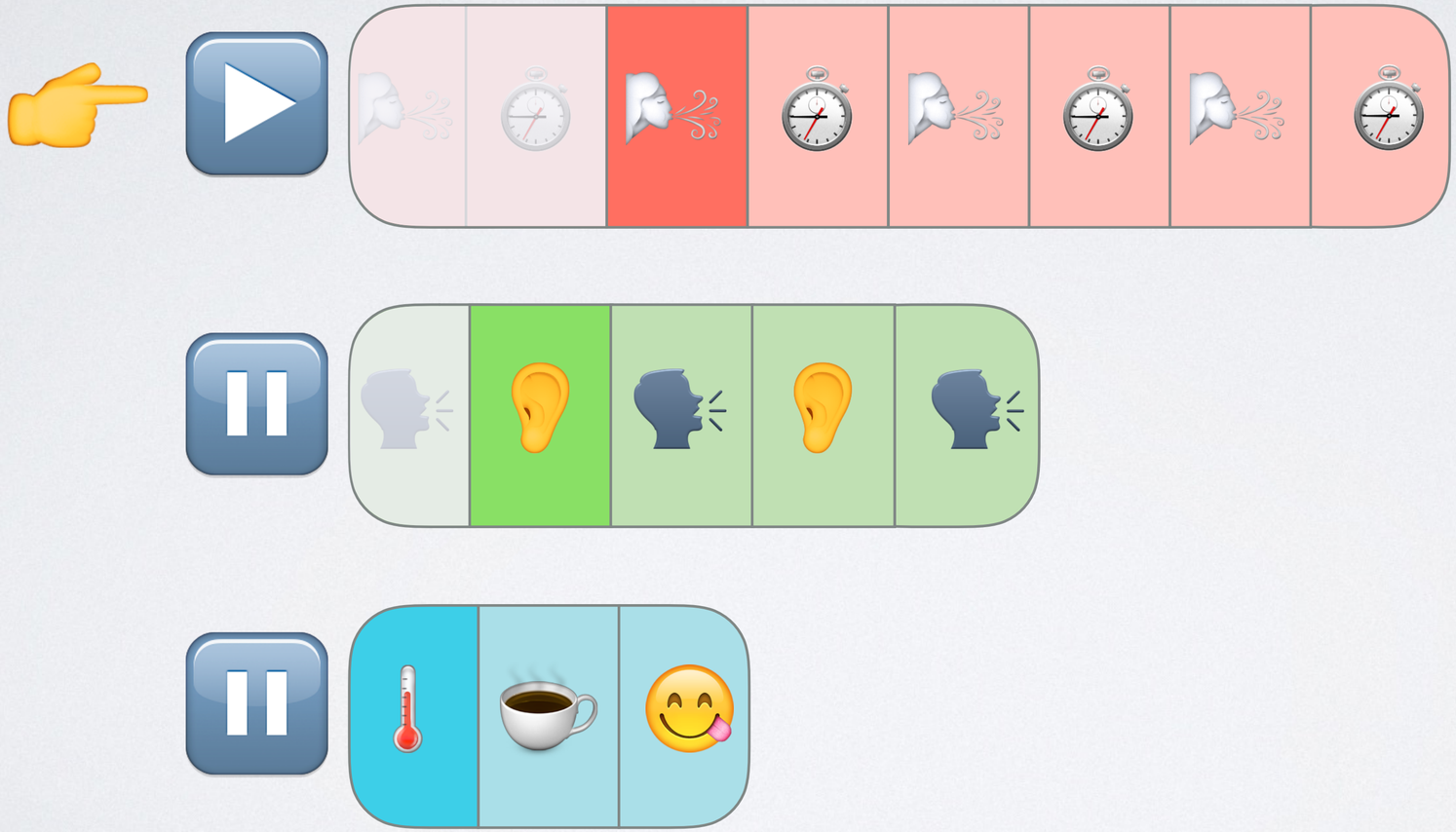
Event Loop



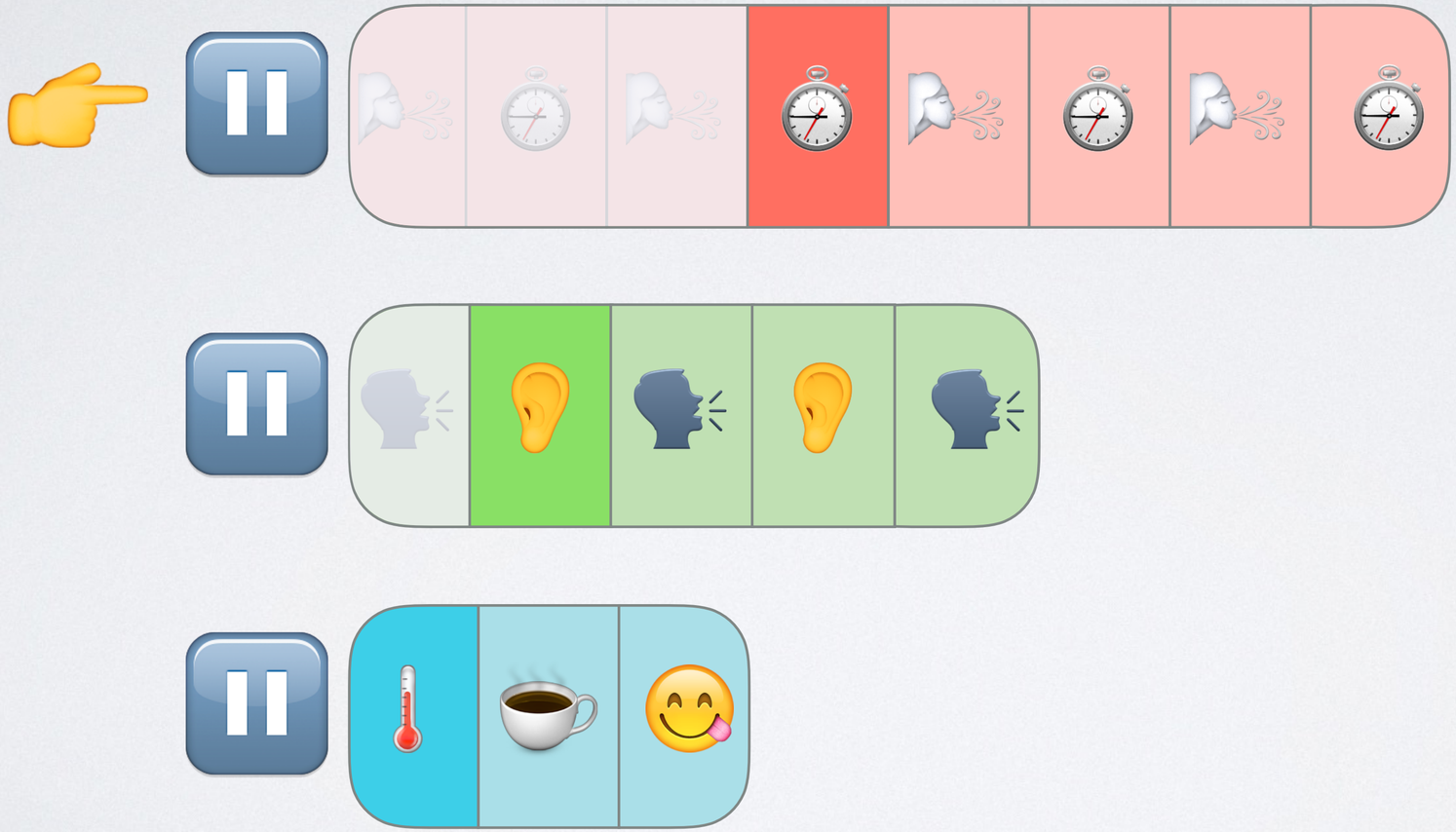
Event **Loop**



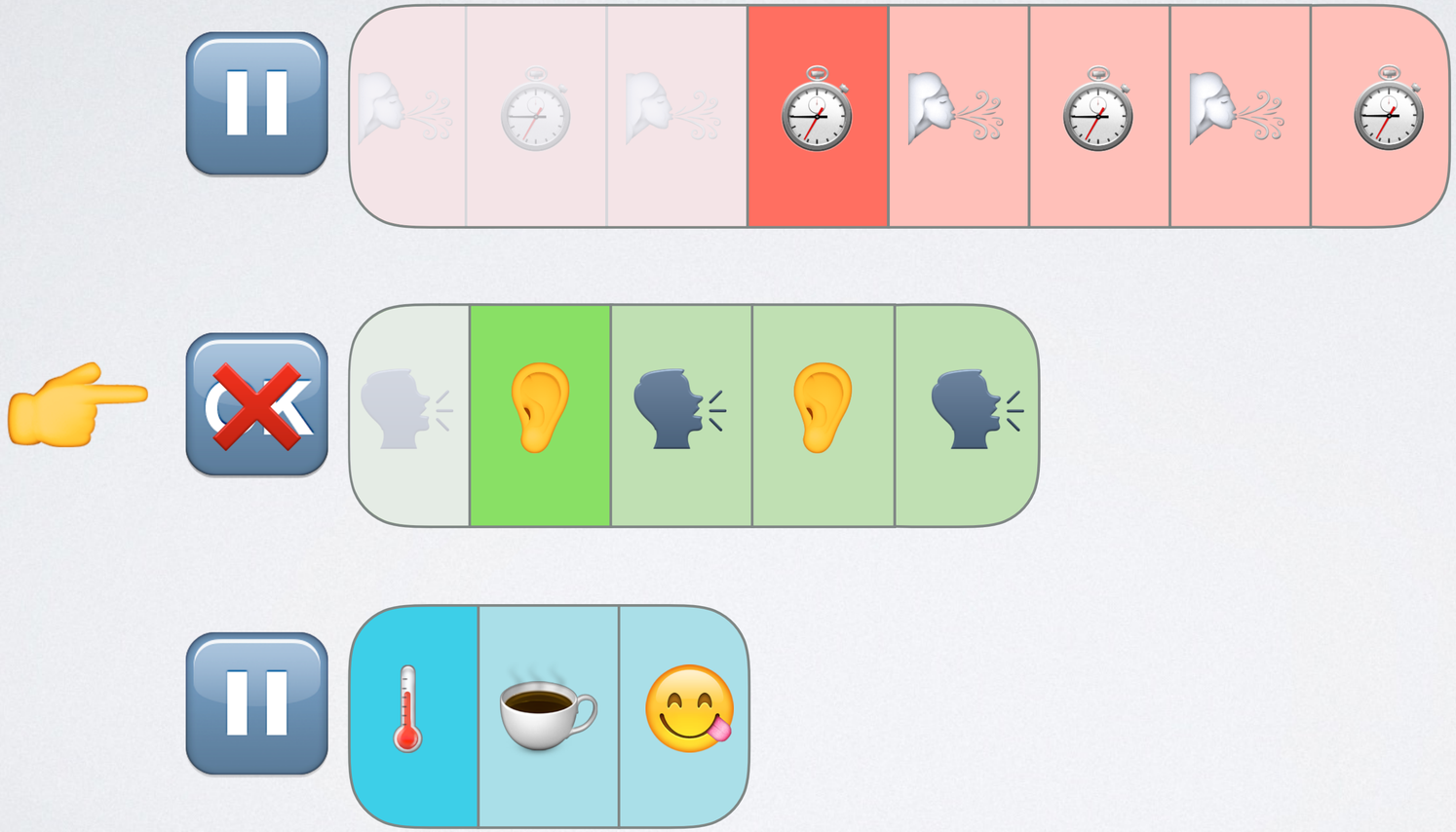
Event Loop



Event Loop



Event Loop



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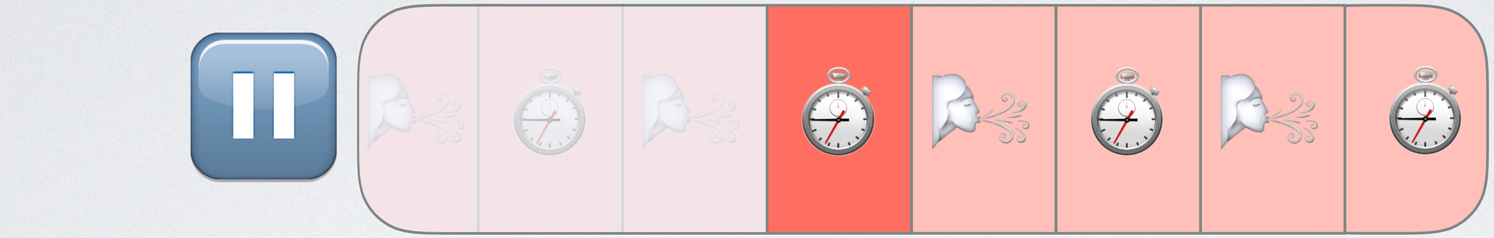

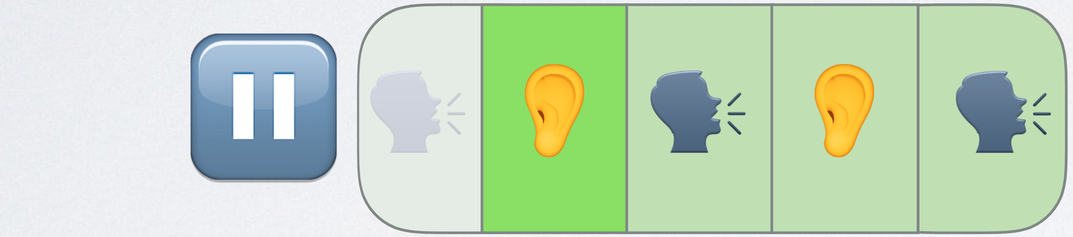

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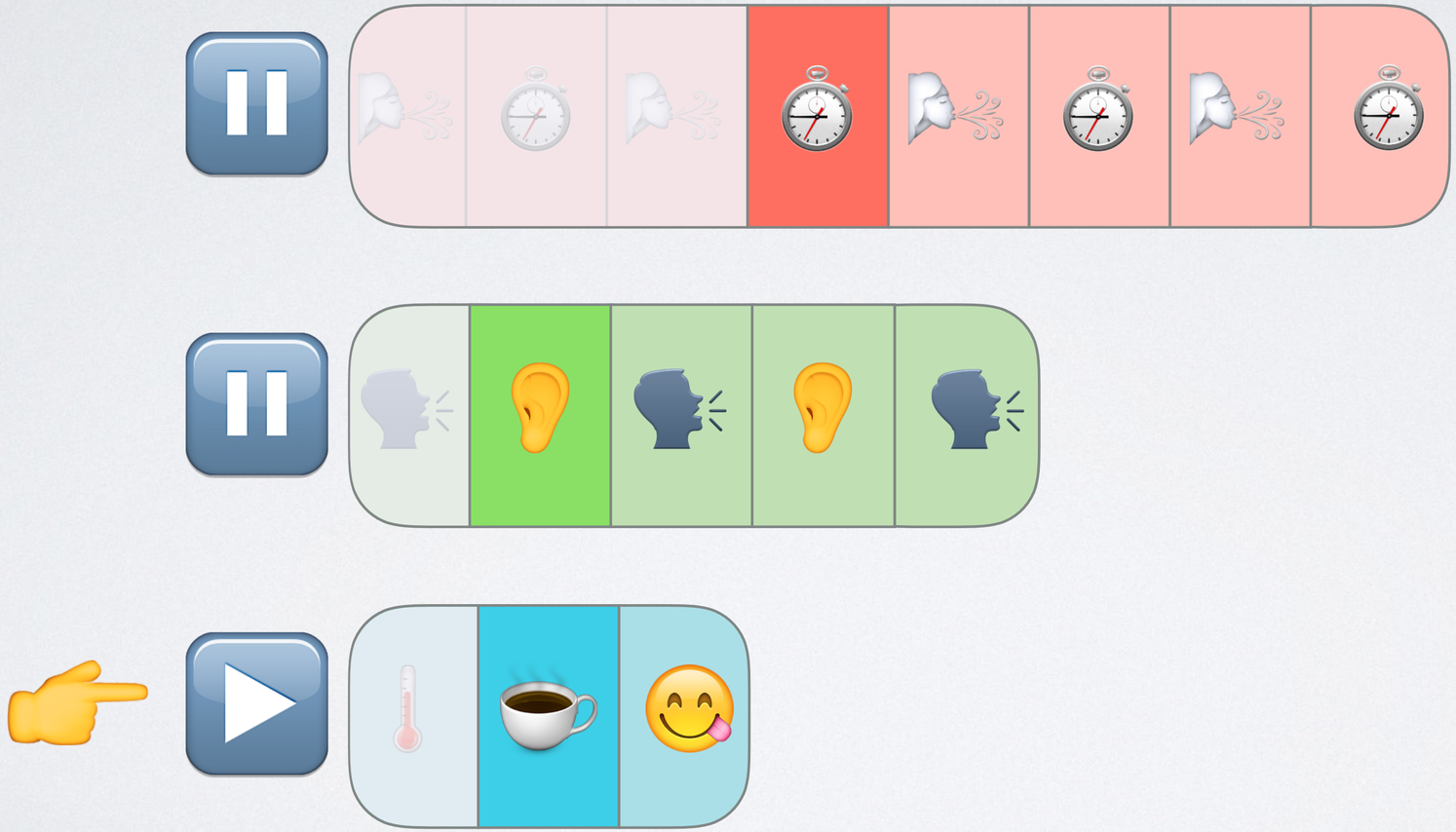

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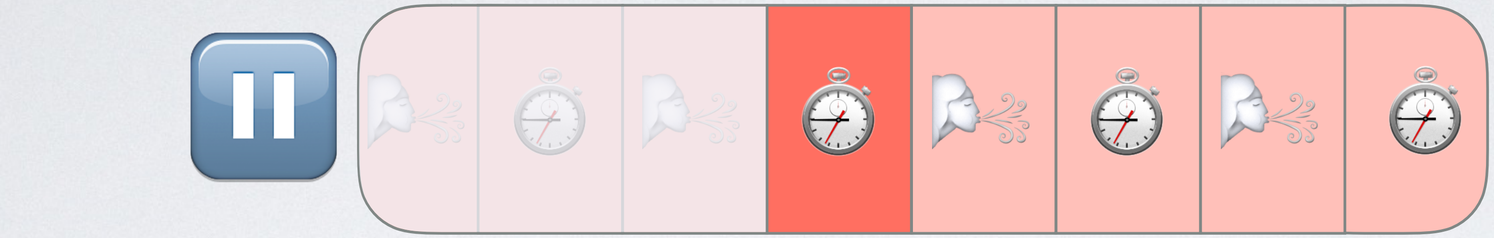

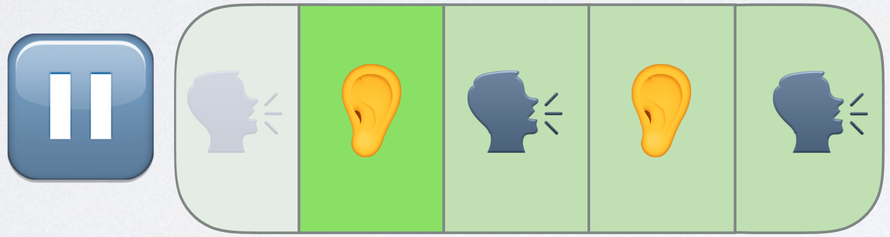

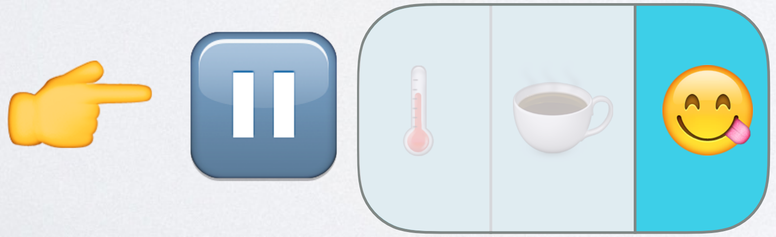

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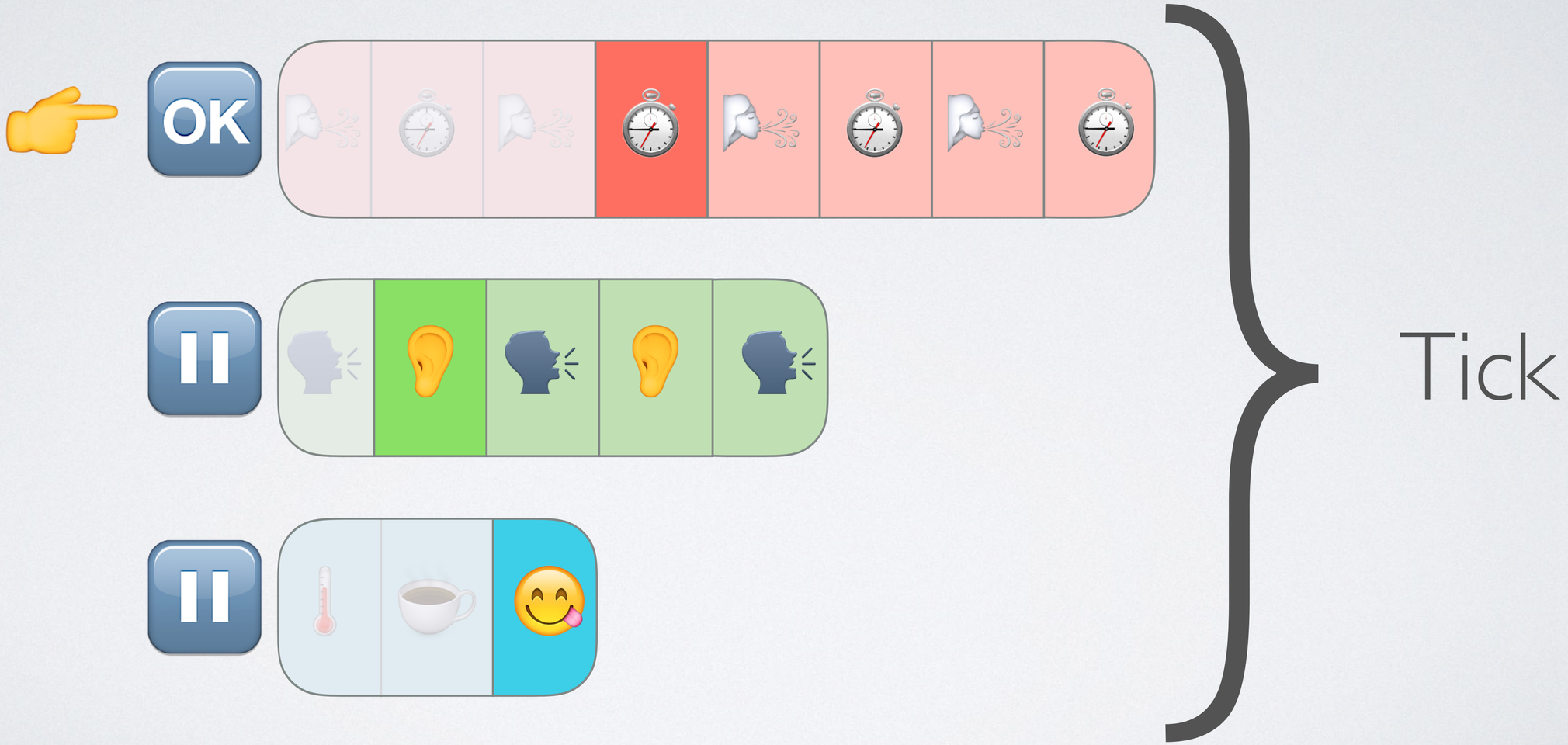

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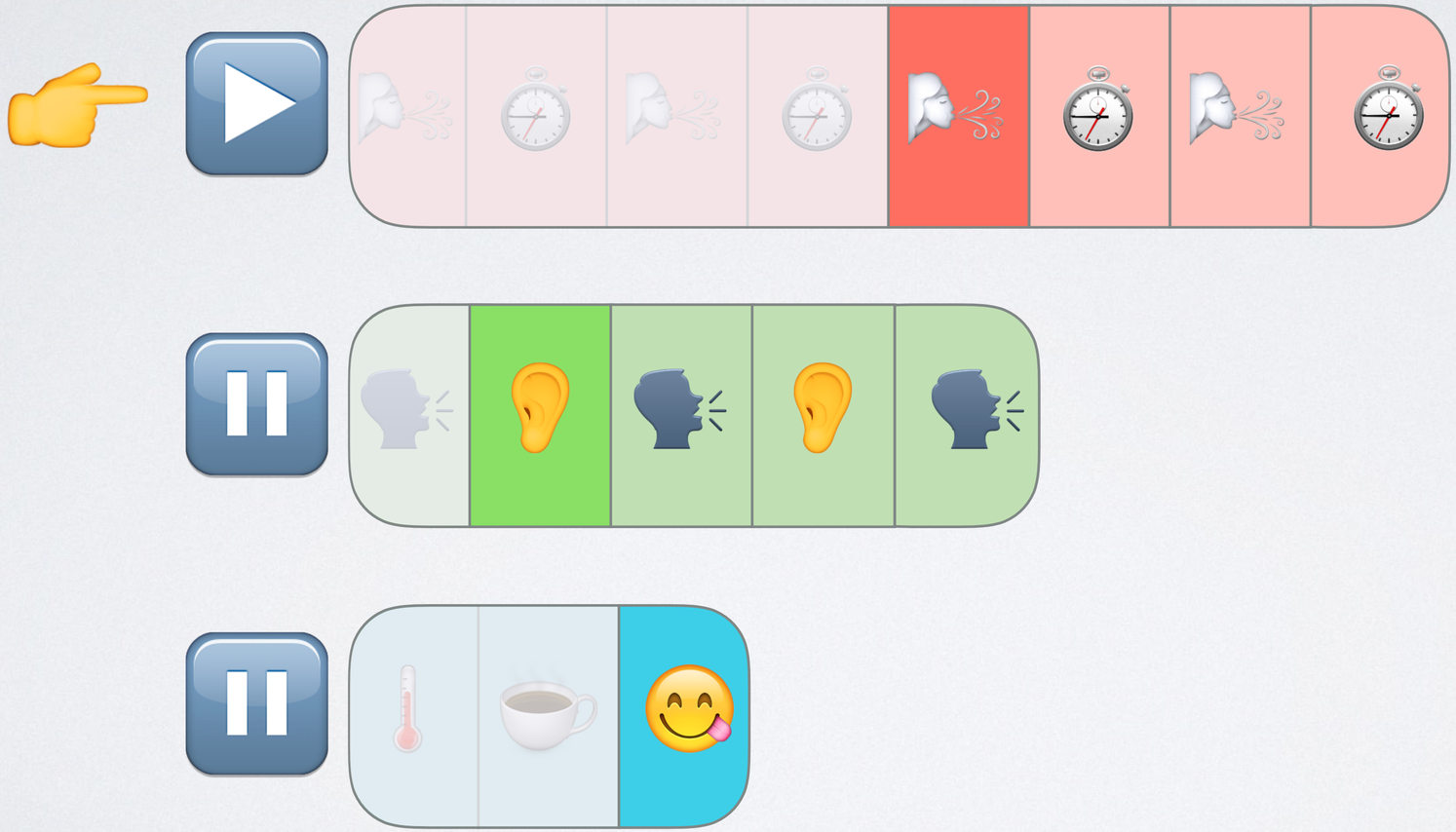

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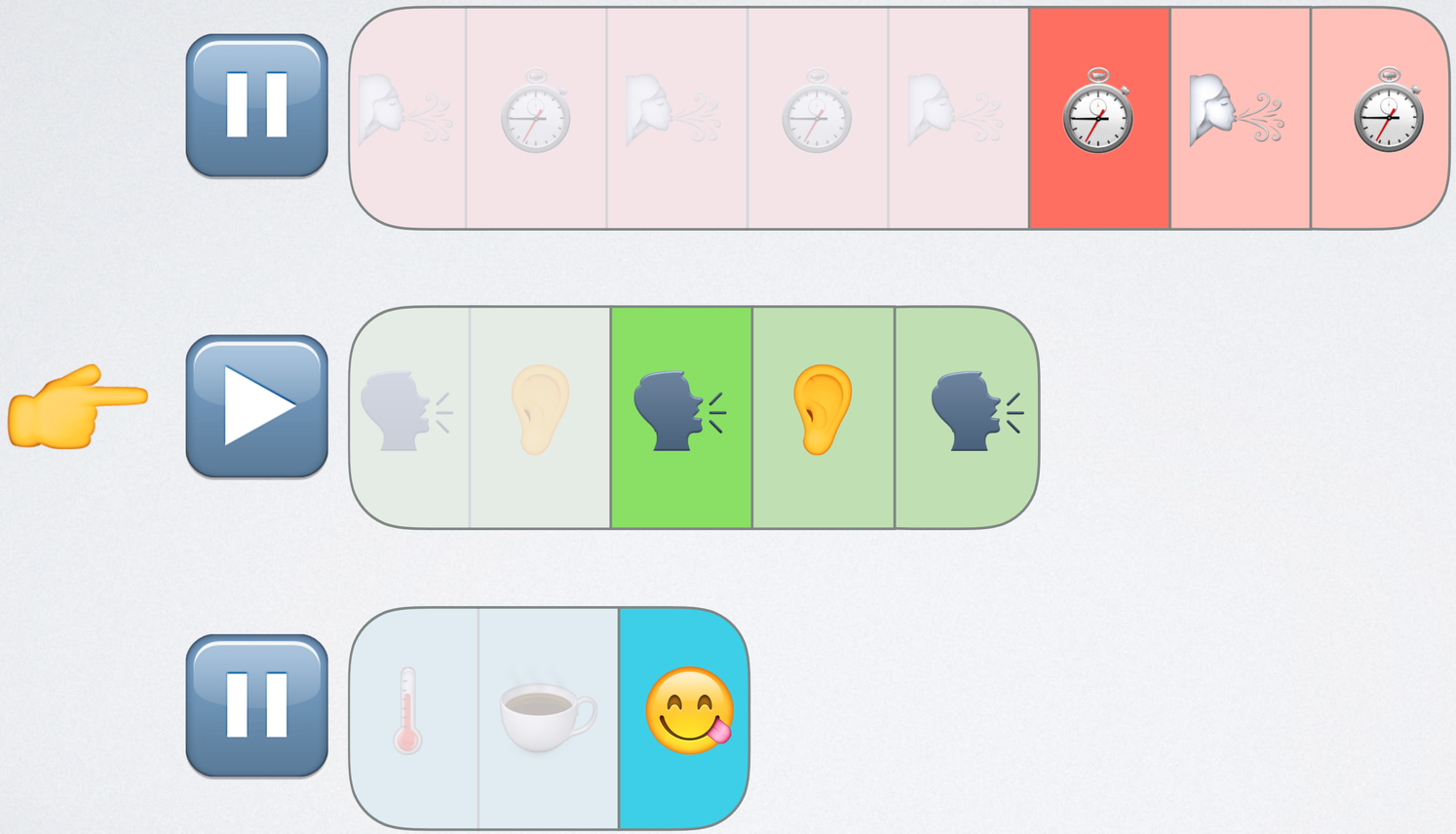

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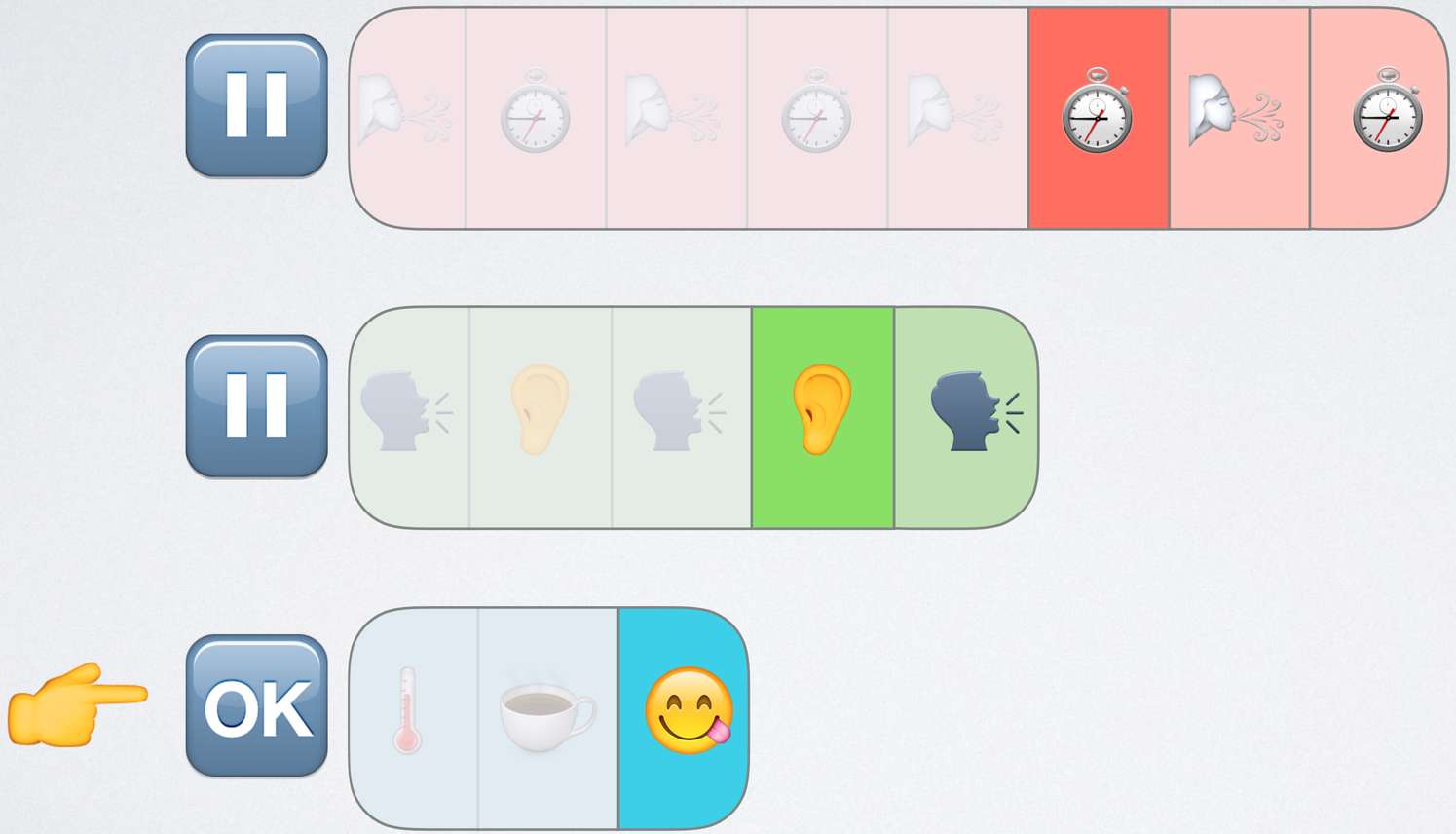

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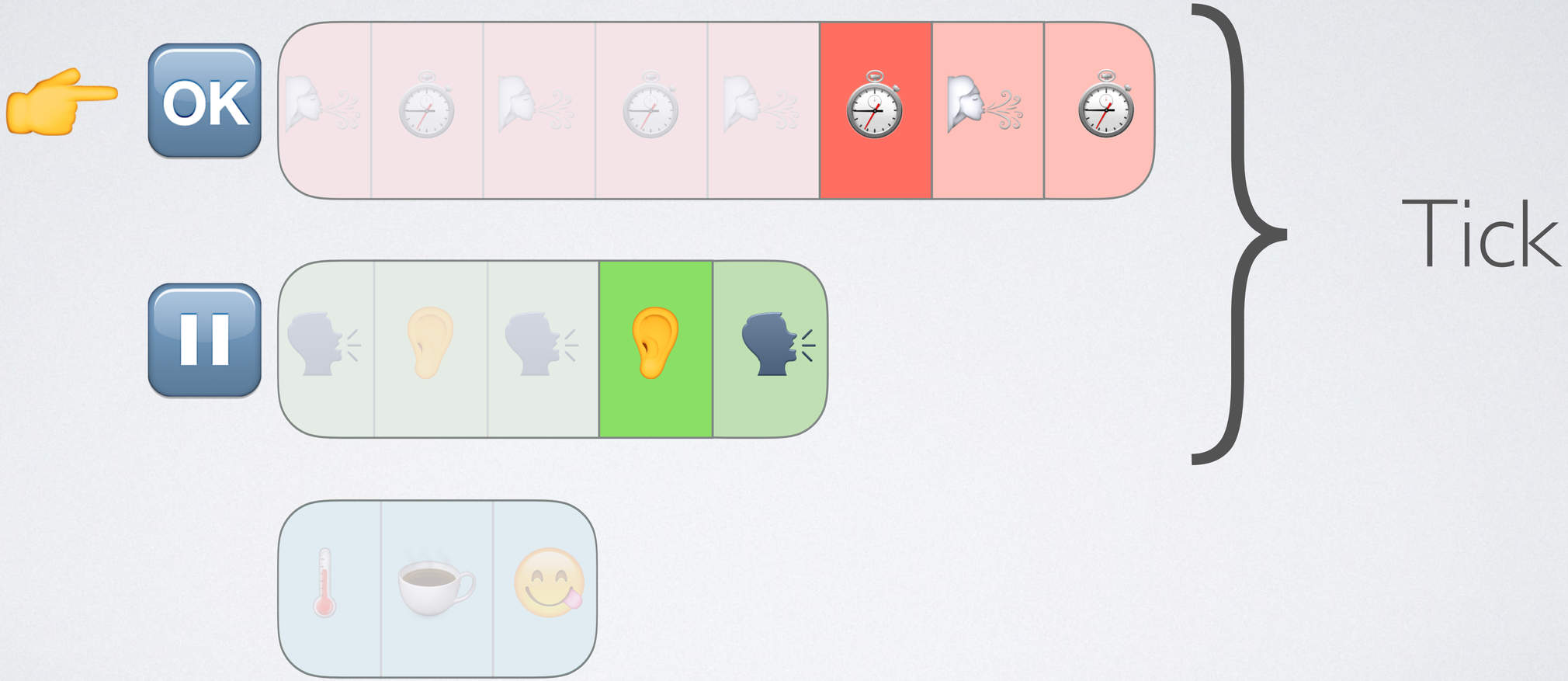

Event Loop

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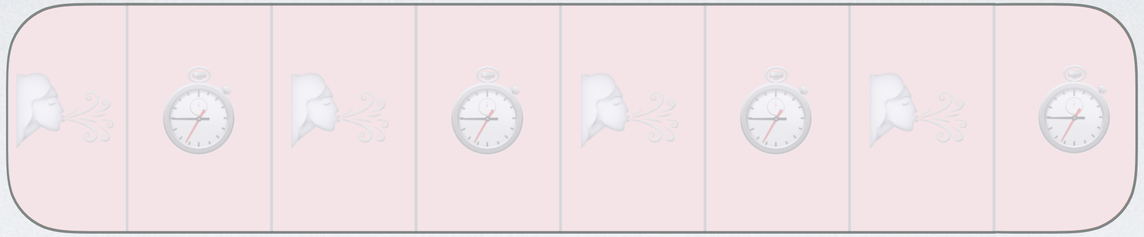
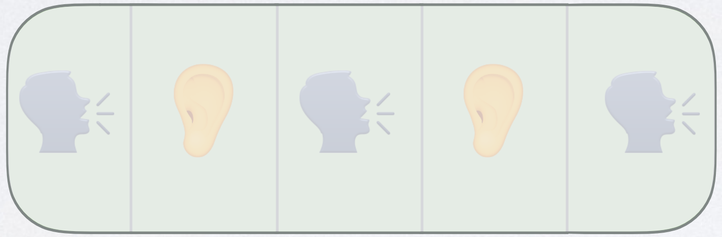
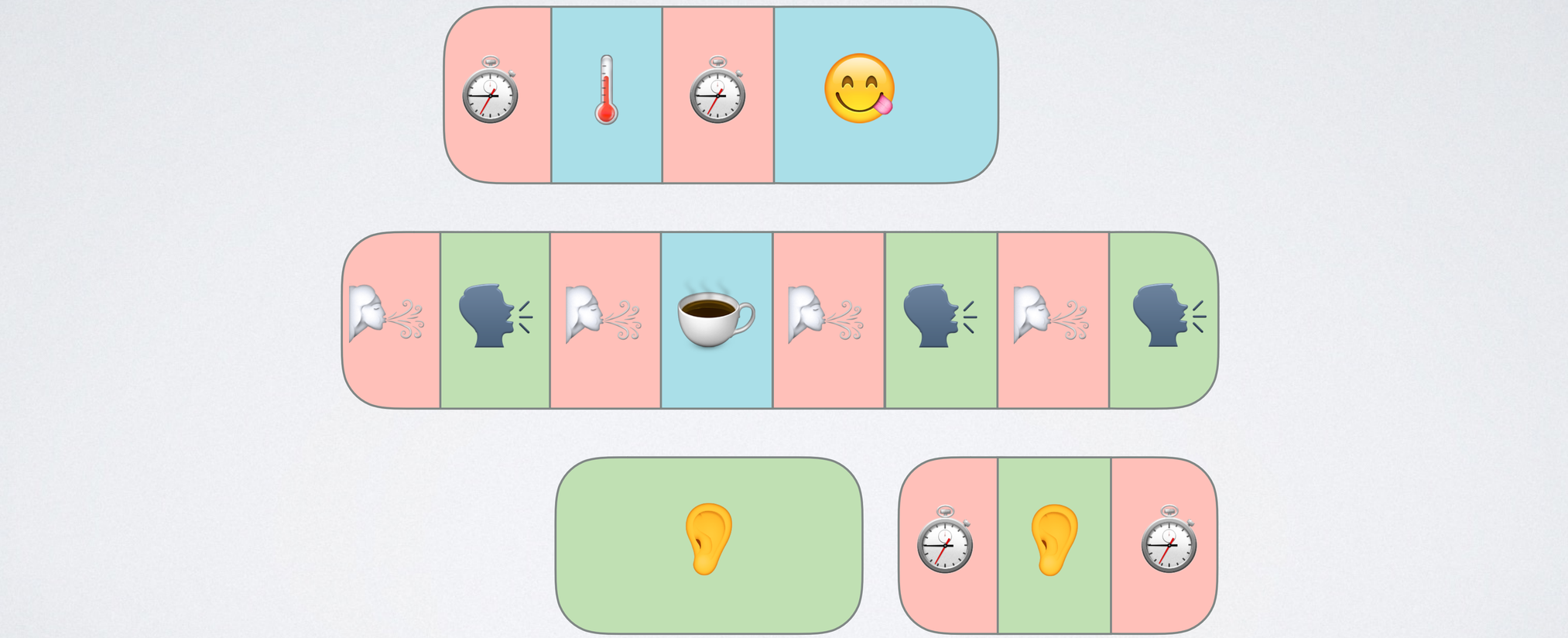


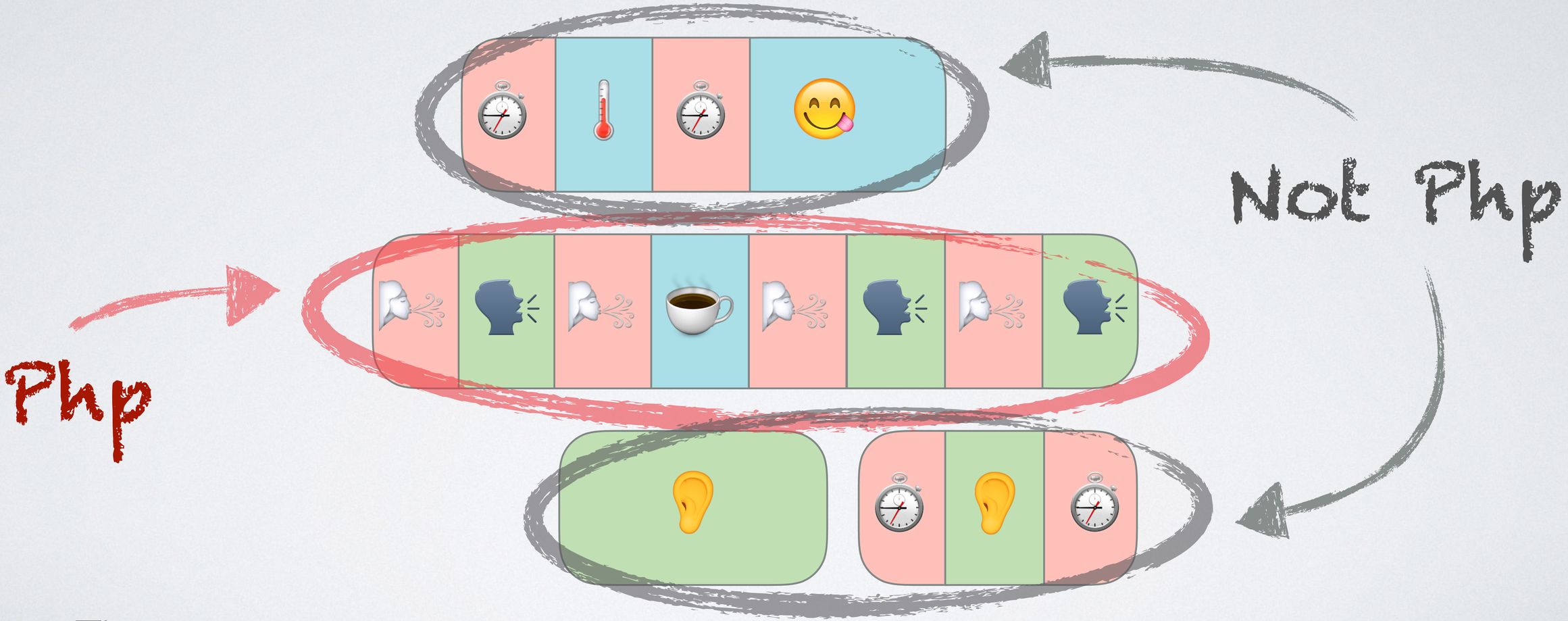


Asynchronous



Time

Asynchronous



How to dispatch code execution efficiently?


Generators
Subset of coroutines

Example

```php
function gen_one_to_three() {
    for ($i = 1; $i <= 3; $i++) {
        yield $i;
    }
}

$generator = gen_one_to_three();
foreach ($generator as $value) {
    echo "$value\n";
}
```

Starting with Generators

… by the weird part…

Creation

```
// ❌ Does NOT work
$generator = new \Generator;

// PHP Fatal error:  Uncaught Error:
// The "Generator" class is reserved
// for internal use
// and cannot be manually instantiated
```

Creation

```
function create(): \Generator
{
    yield;
}

$generator1 = create();
$generator2 = create();
```

Only `yield` matters

```php
function emptyGenerator(): \Generator
{
    return 1;
    yield; // Never reached…
}

$generator = emptyGenerator();
```

Execution start

```php
function dyingGenerator(): \Generator
{
    die('hard');
    yield;
}
// The function is not executed…
$generator = dyingGenerator();
// Will die ‘hard’
$generator->valid();
```

```
final class Generator implements Iterator {

    function rewind() {}
    function valid(): bool {}
    function current() {}
    function key() {}
    function next() {}

    function send($value) {}
    function throw(Throwable $exception) {}
    function getReturn() {}
}
```

Outside

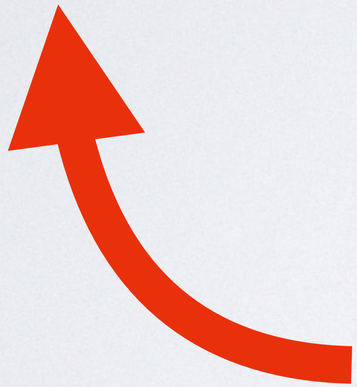
```php
$generator = createMyGenerator();
// Here, outside content
```

```php
function createMyGenerator():
\Generator
{
    // Here, inside content
}
```

Inside

Outside

```
$value = $generator->current();
$key = $generator->key();
```

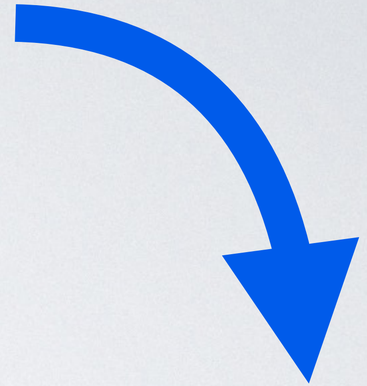


```
yield $key => $value;
```

Inside

Outside

```
$generator->send($value);
$generator->next();
```

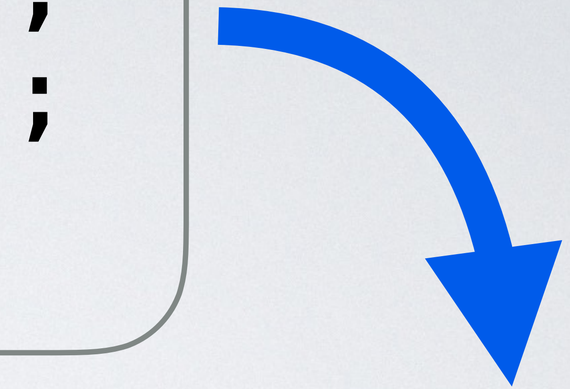


```
$value = yield;
$nullValue = yield;
```

Inside

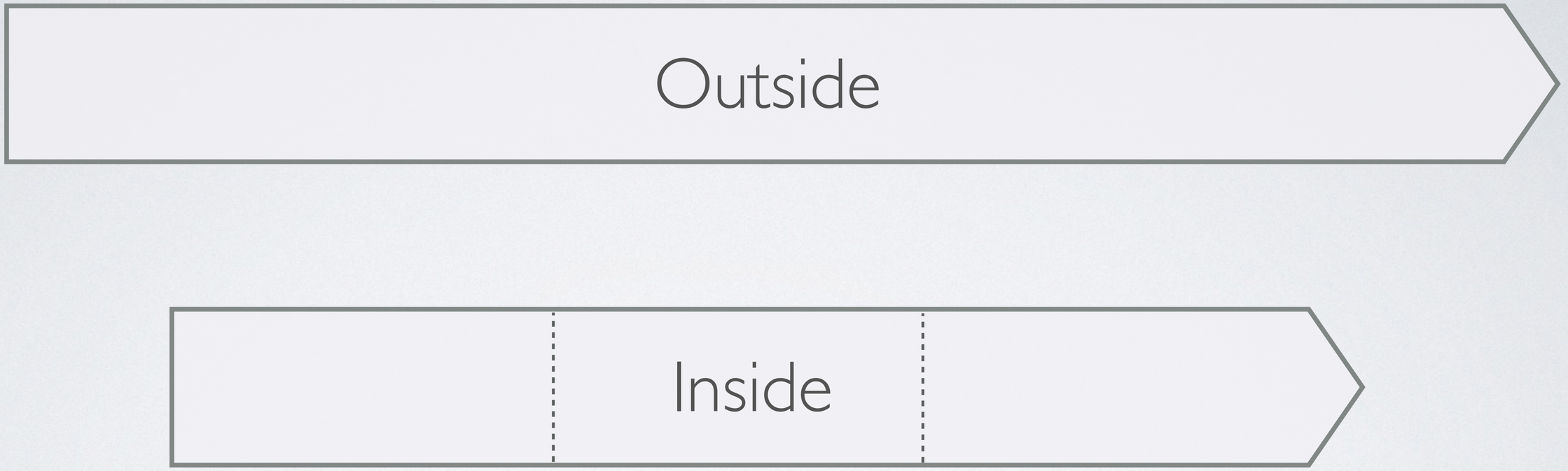
Outside

```
$v1 = $generator->current();
$v3 = $generator->send($v2);
```

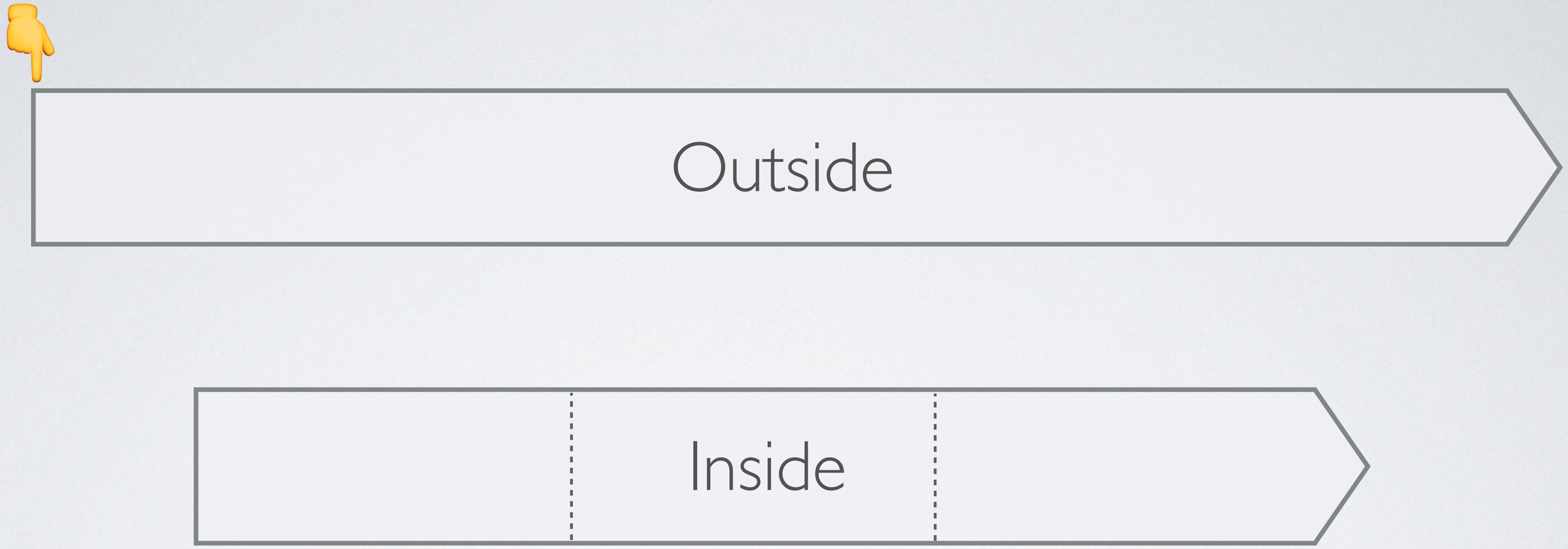


```
$v2 = yield $v1;
yield $v3;
```

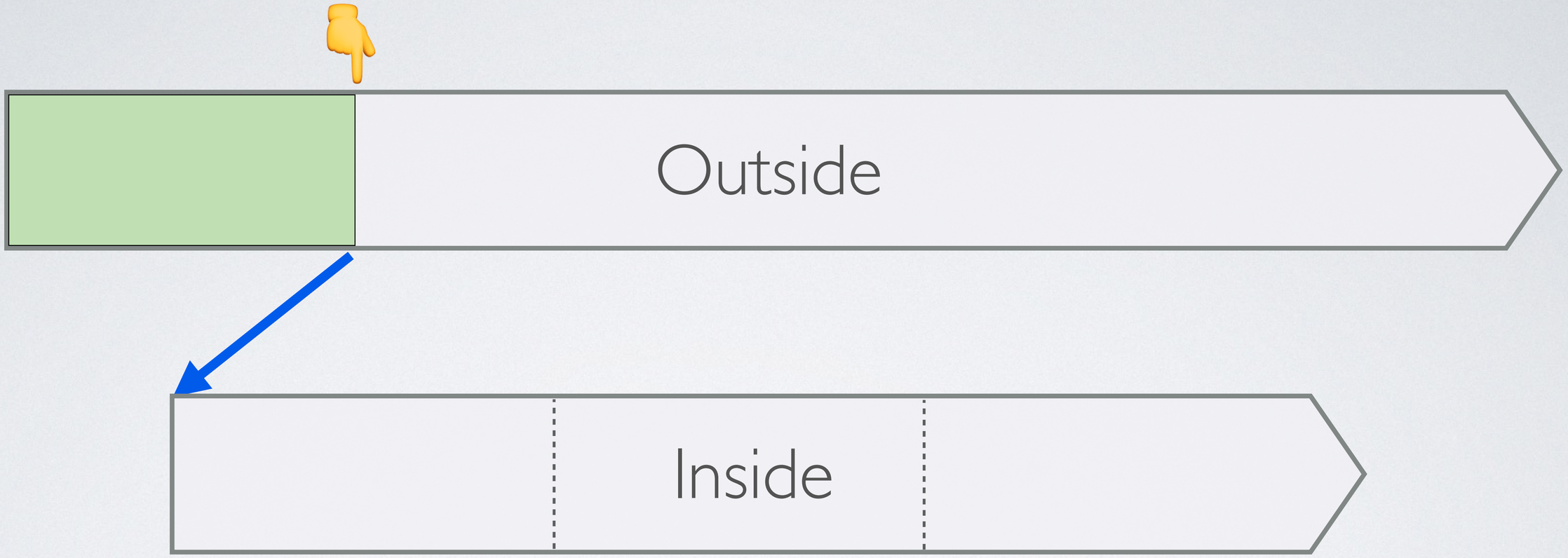
Inside


Outside
Inside

```
$generator = createMyGenerator()
```



```
$v1 = $generator->current()
```



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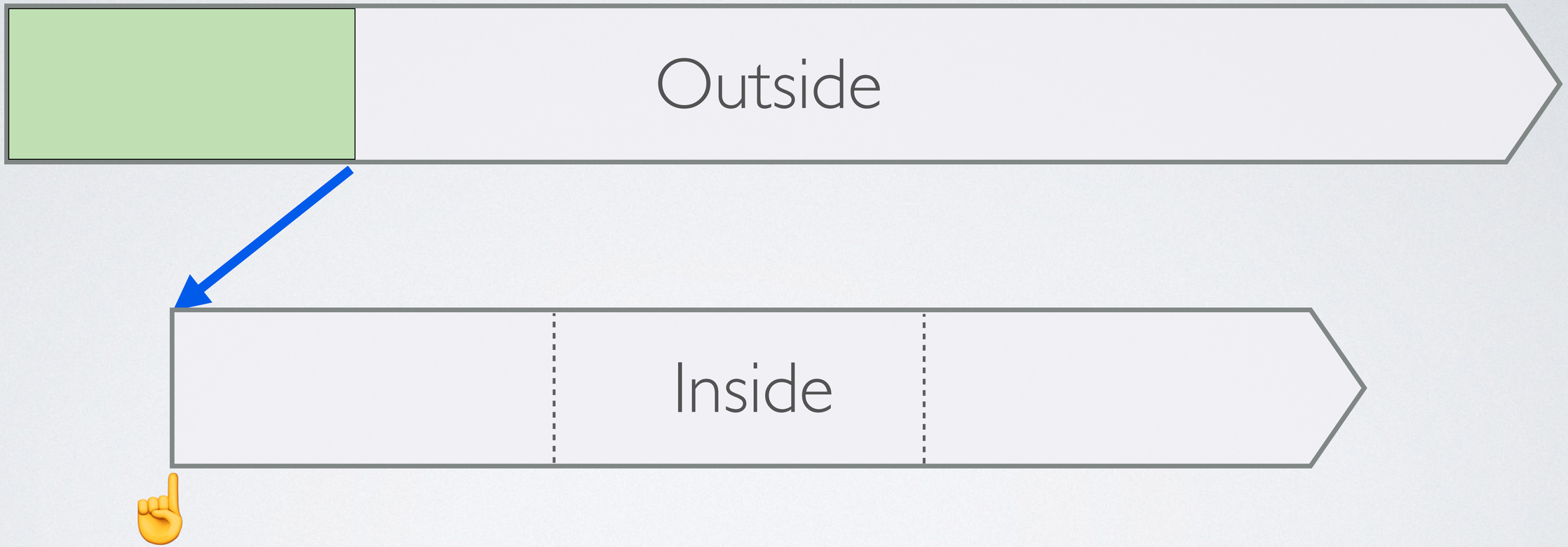
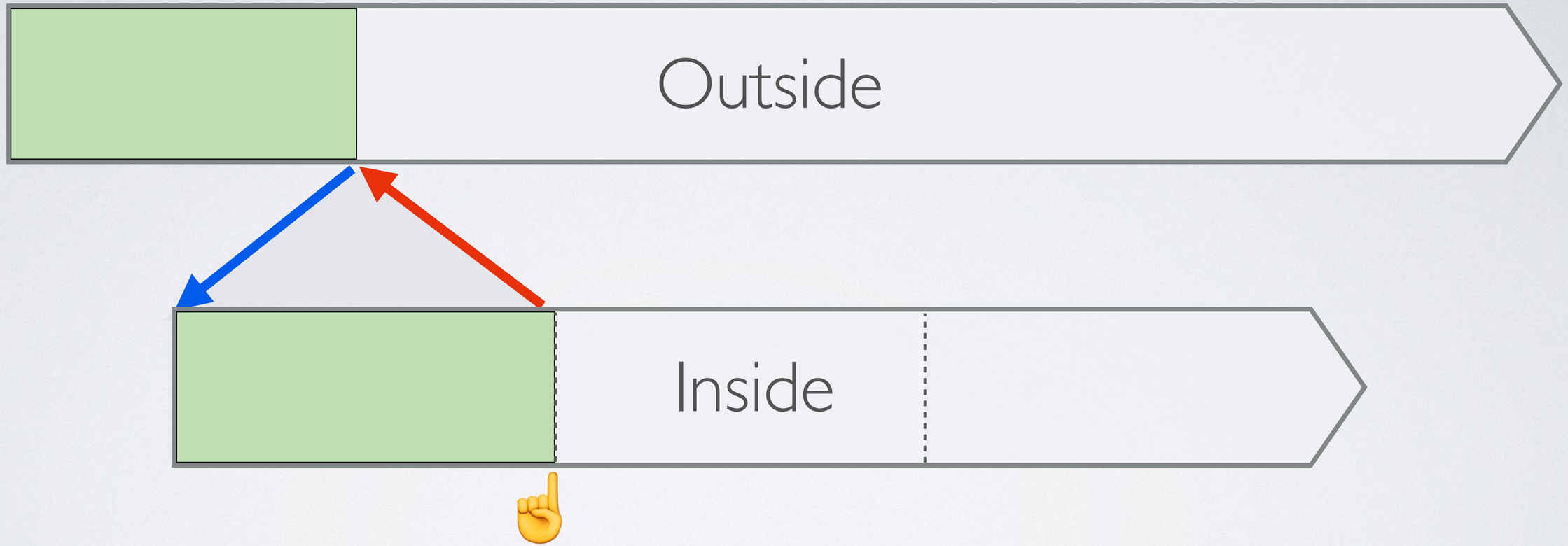
$v1 = $generator->current()
```

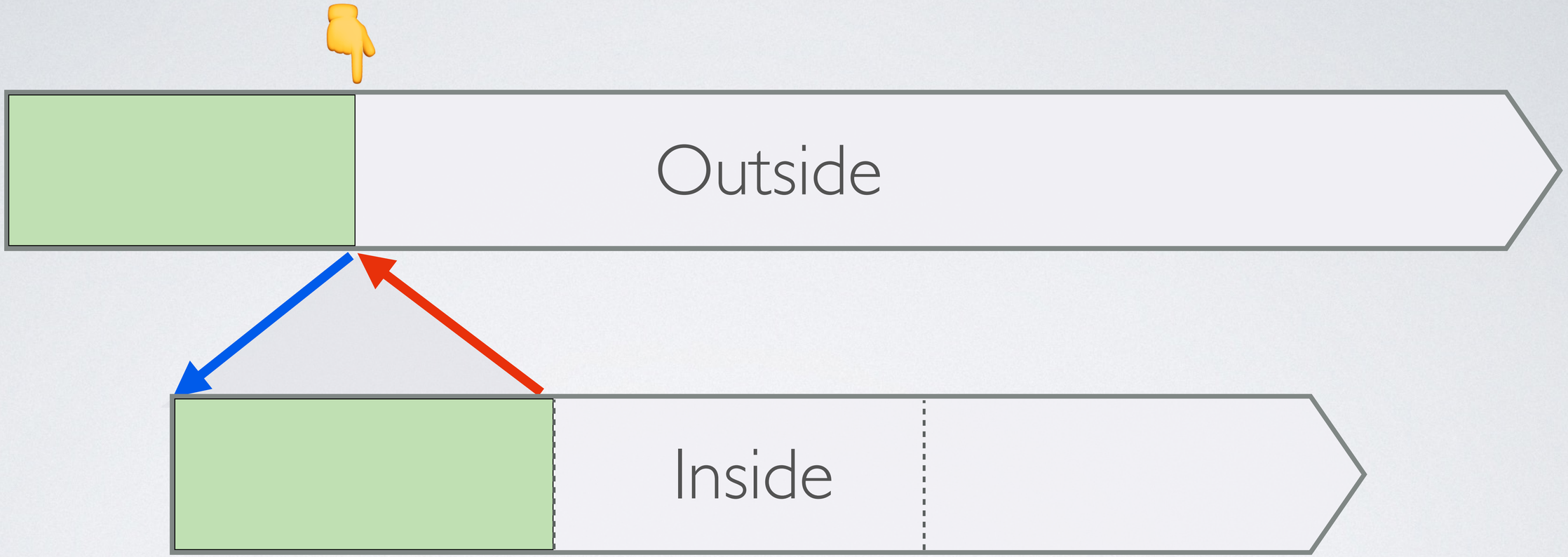


```
$v1 = $generator->current()
```



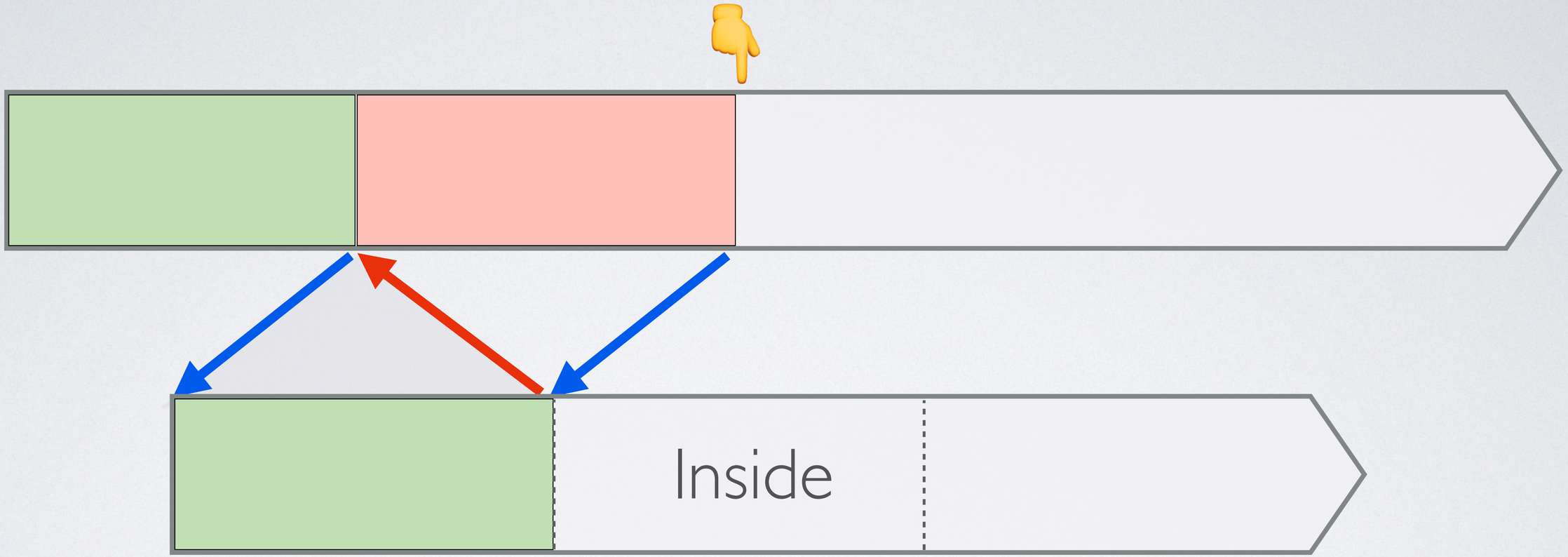

```
$v2 = yield $v1
```

```
$v1 = $generator->current()
```



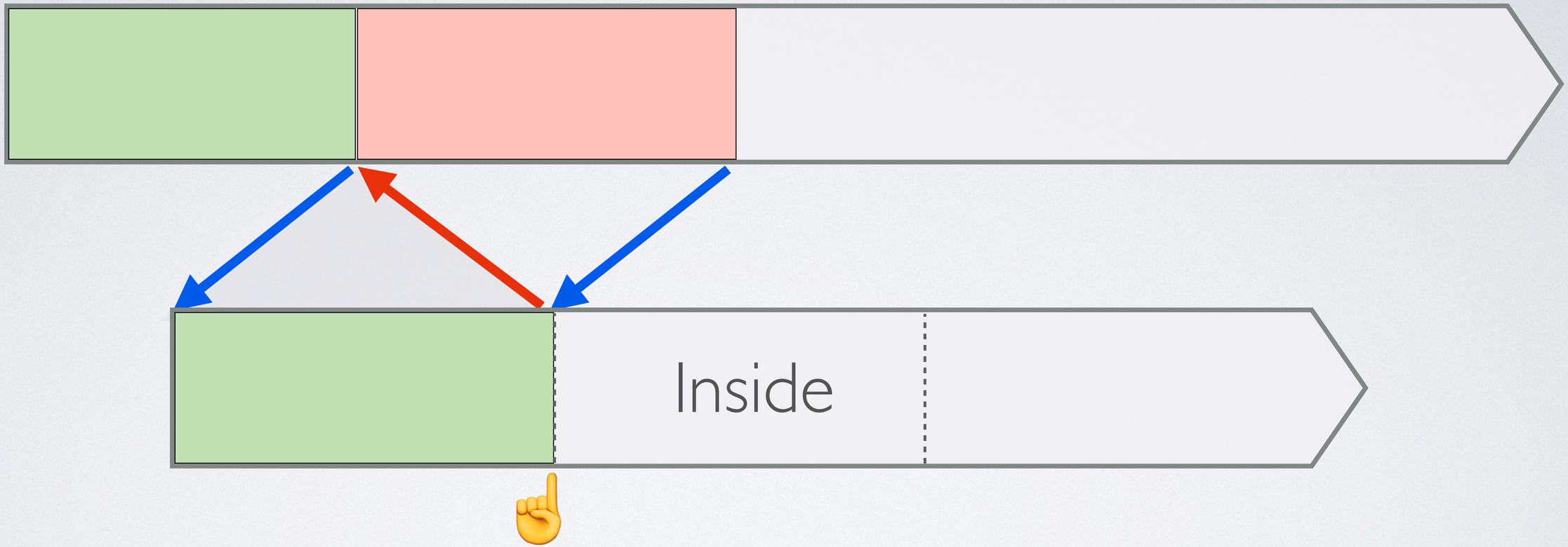

```
$v2 = yield $v1
```

```
$v3 = $generator->send($v2)
```



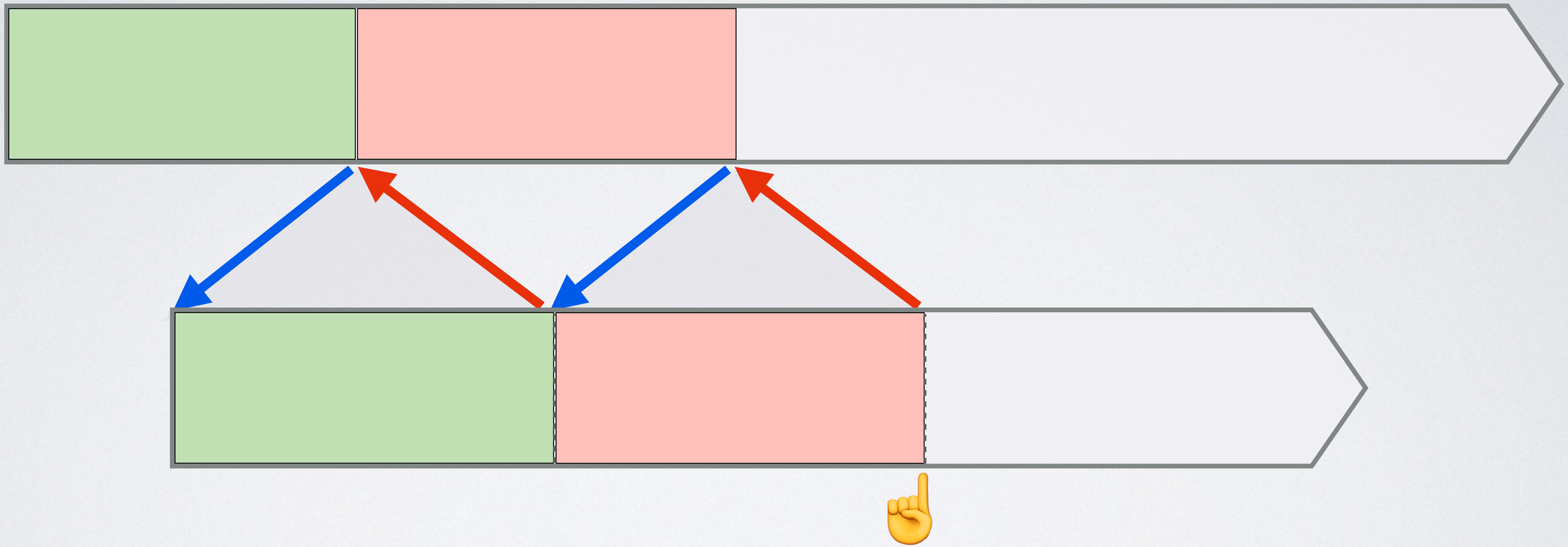

```
$v2 = yield $v1
```

```
$v3 = $generator->send($v2)
```



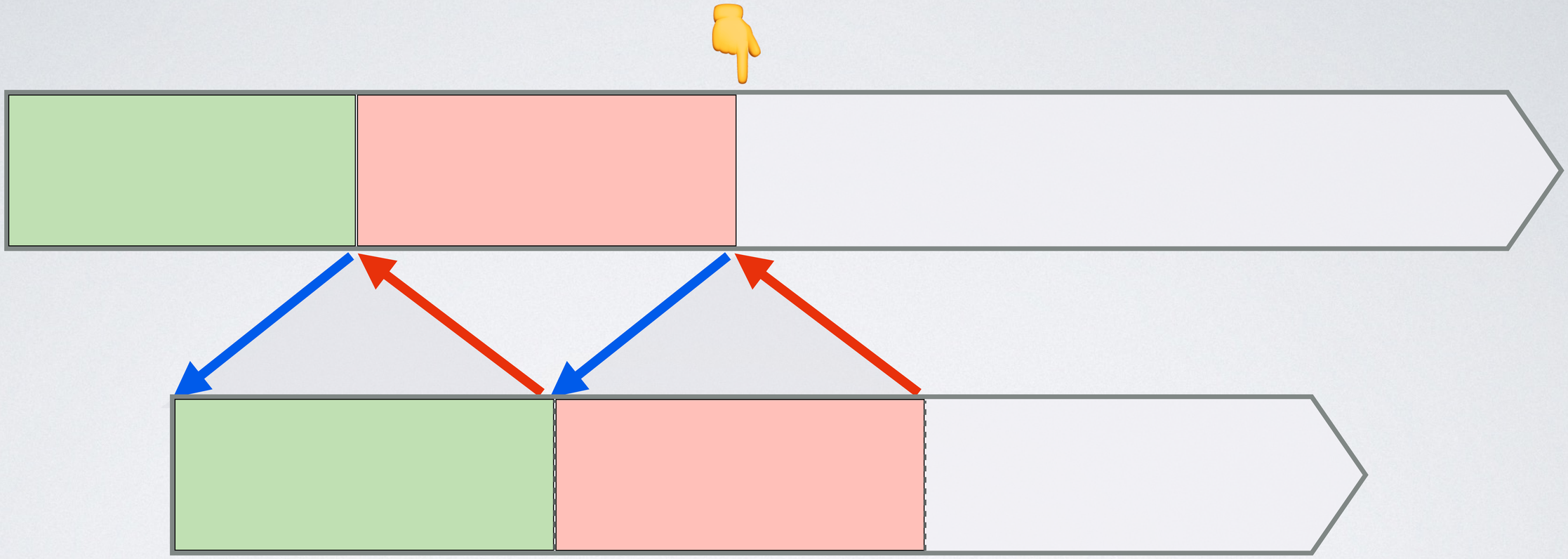

```
$v2 = yield $v1
```

```
$v3 = $generator->send($v2)
```



```
yield $v3
```

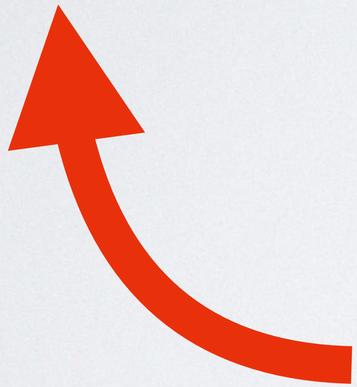
```
$v3 = $generator->send($v2)
```



```
yield $v3
```

Outside

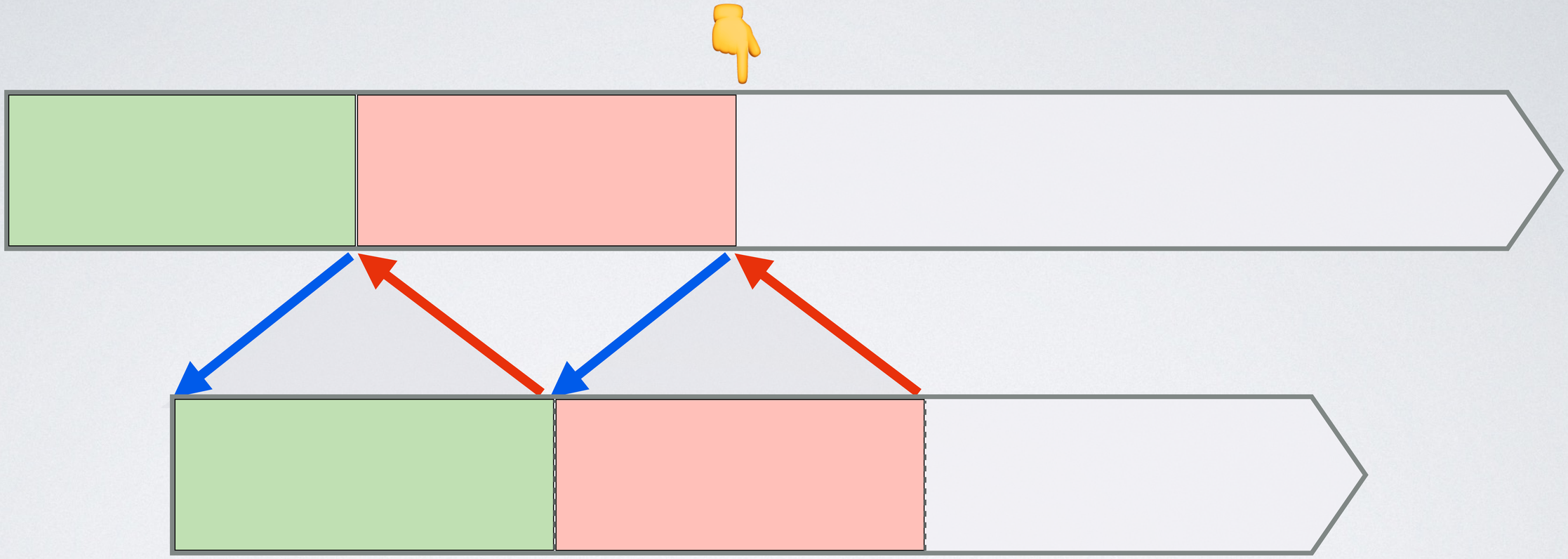
```php
if (!$generator->valid()) {
    $value = $generator->getReturn();
}
```



```php
return $value;
```

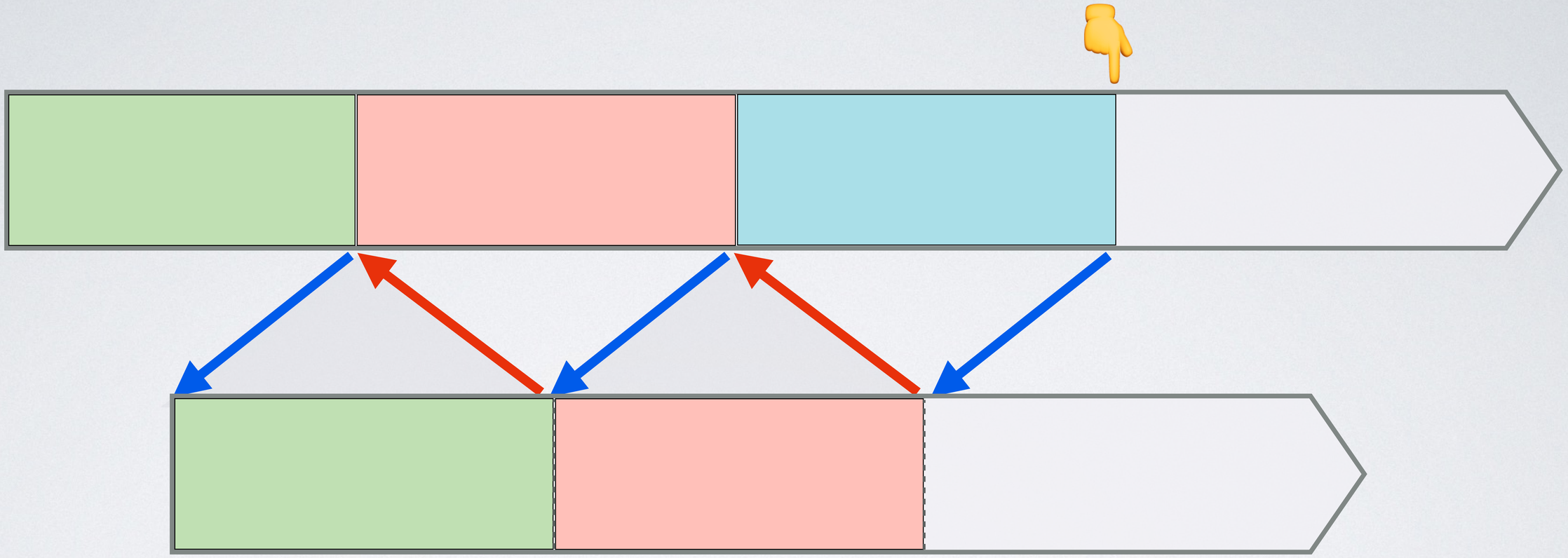
Inside

```
$v3 = $generator->send($v2)
```



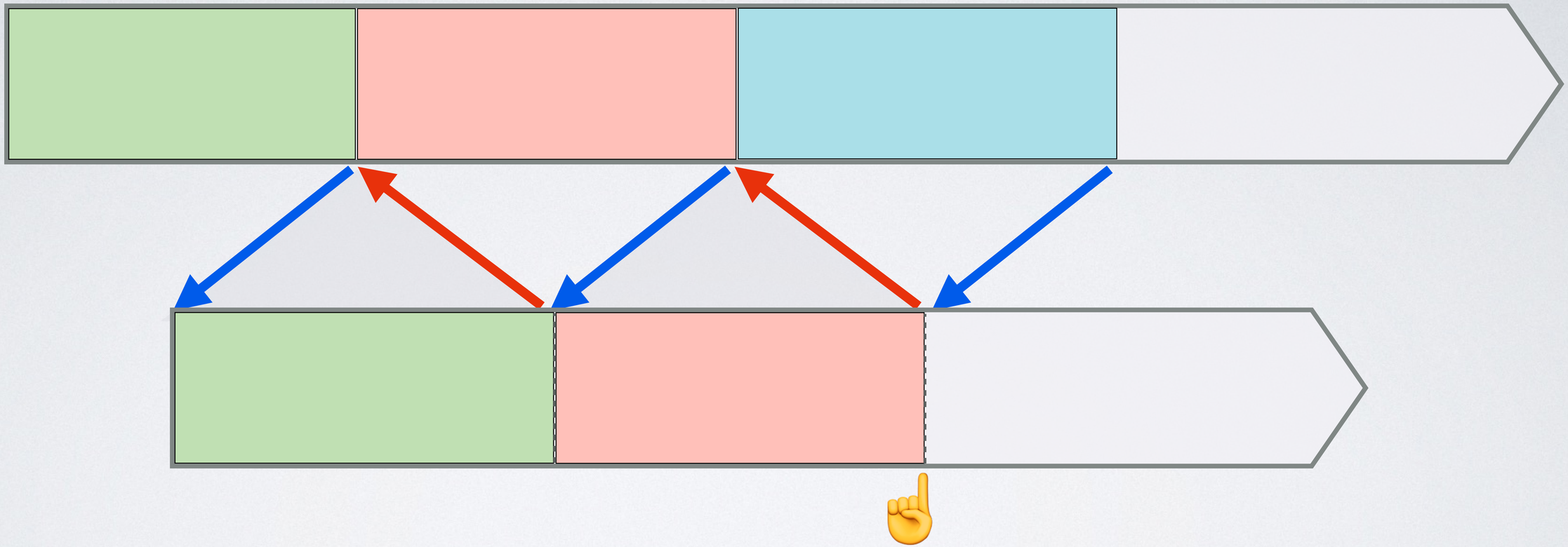
```
yield $v3
```

```
$generator->next()
```



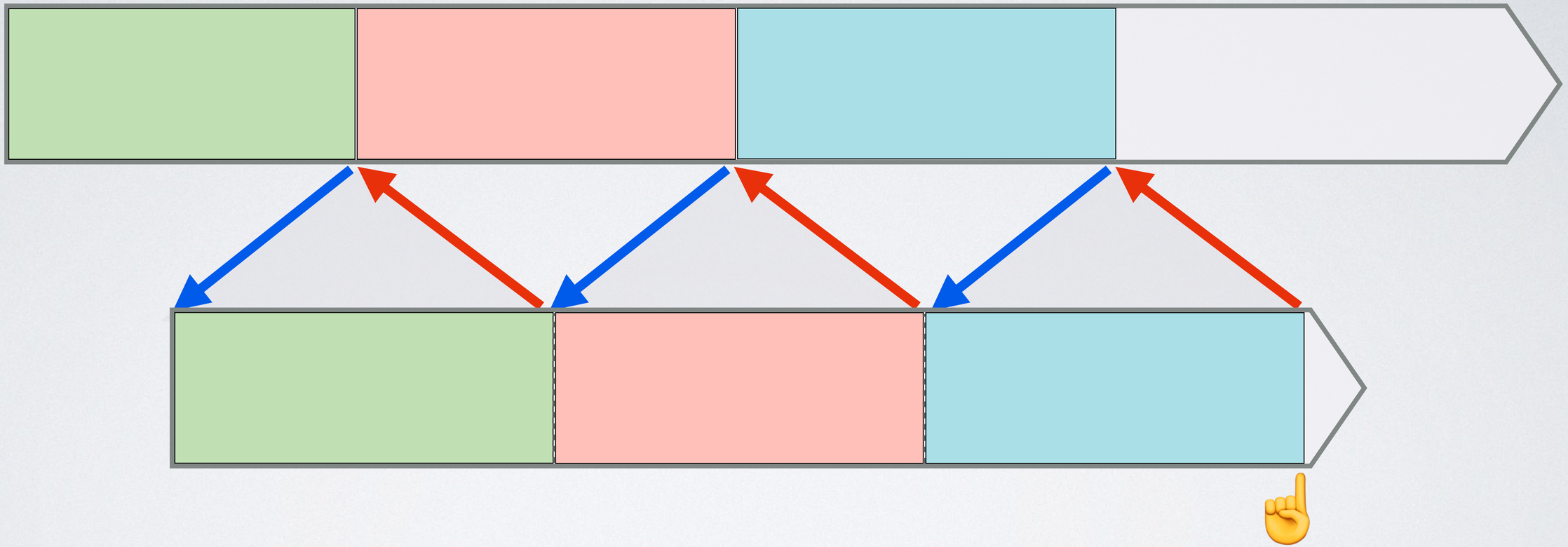
```
yield $v3
```

```
$generator->next()
```



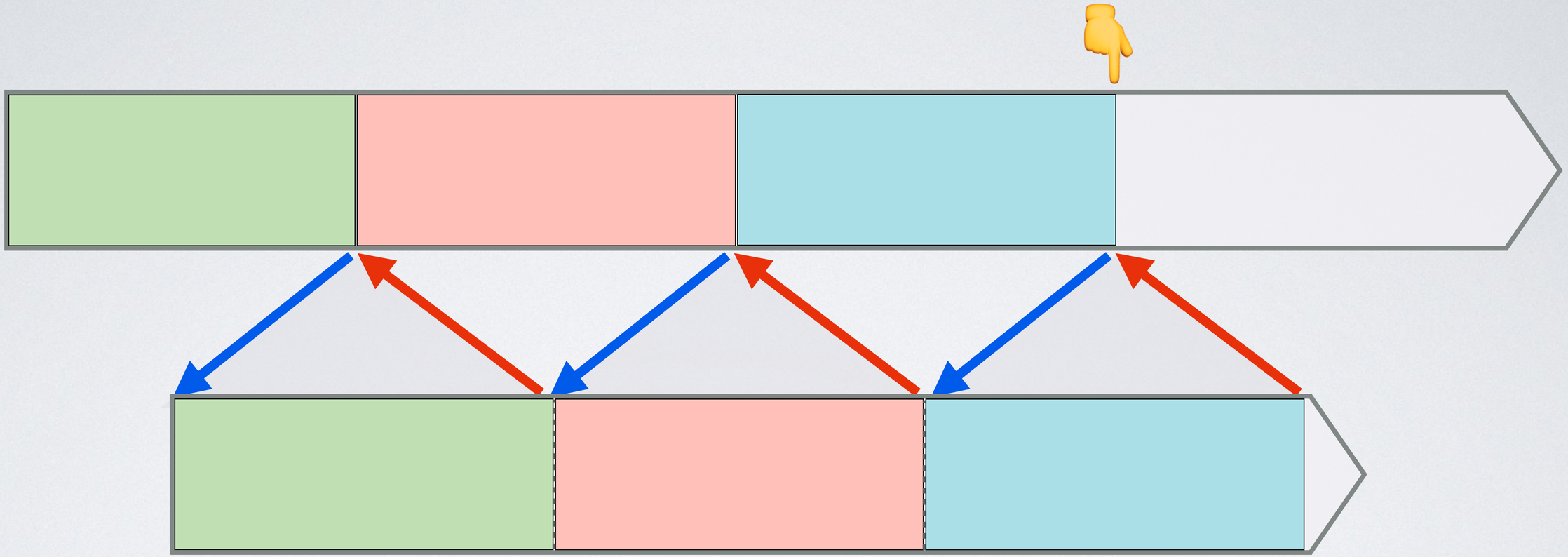
```
yield $v3
```

```
$generator->next()
```



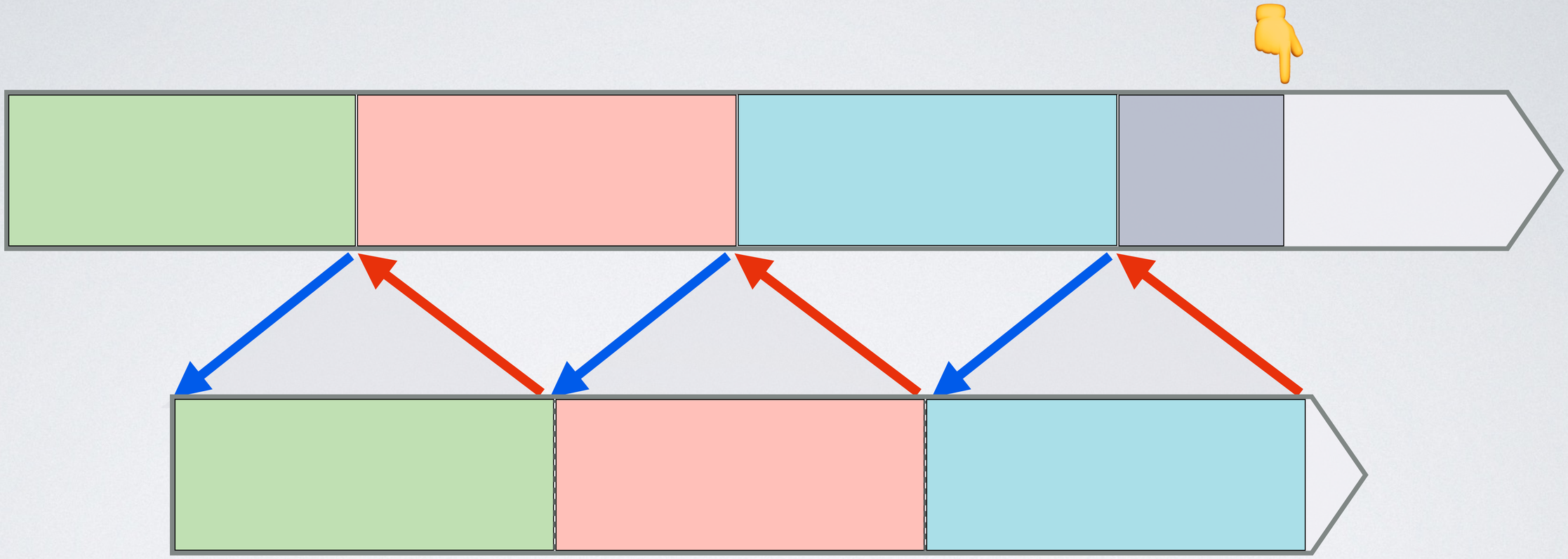
```
return $value;
```

```
$generator->next()
```



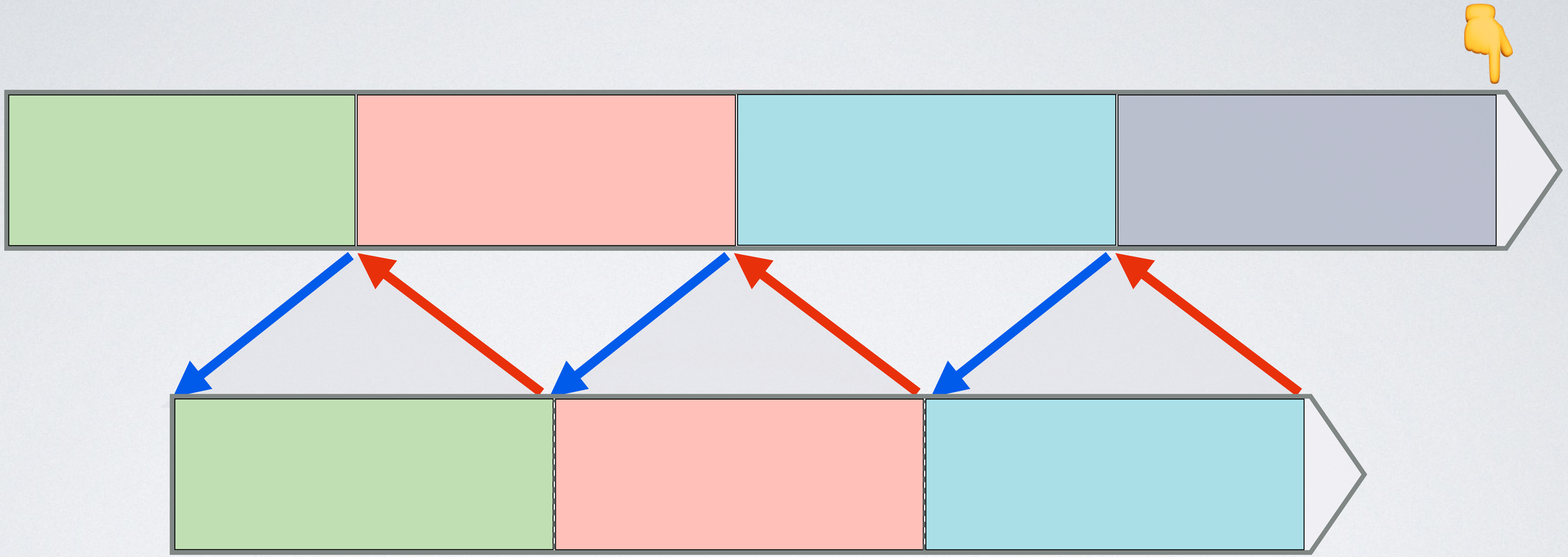
```
return $value;
```

```
!$generator->valid()
```



```
return $value;
```

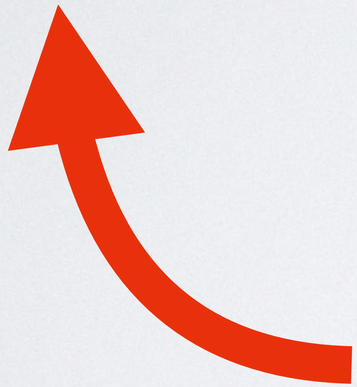
```
$value = $generator->getReturn()
```



```
return $value;
```

Outside

```php
try {
    $generator->next();
} catch (\Exception $exception)
{}
```

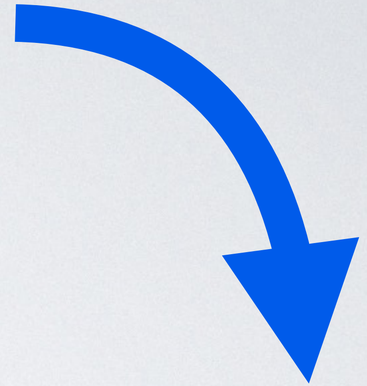


```php
yield;
throw new \Exception();
```

Inside

Outside

```
$generator->throw($exception);
```

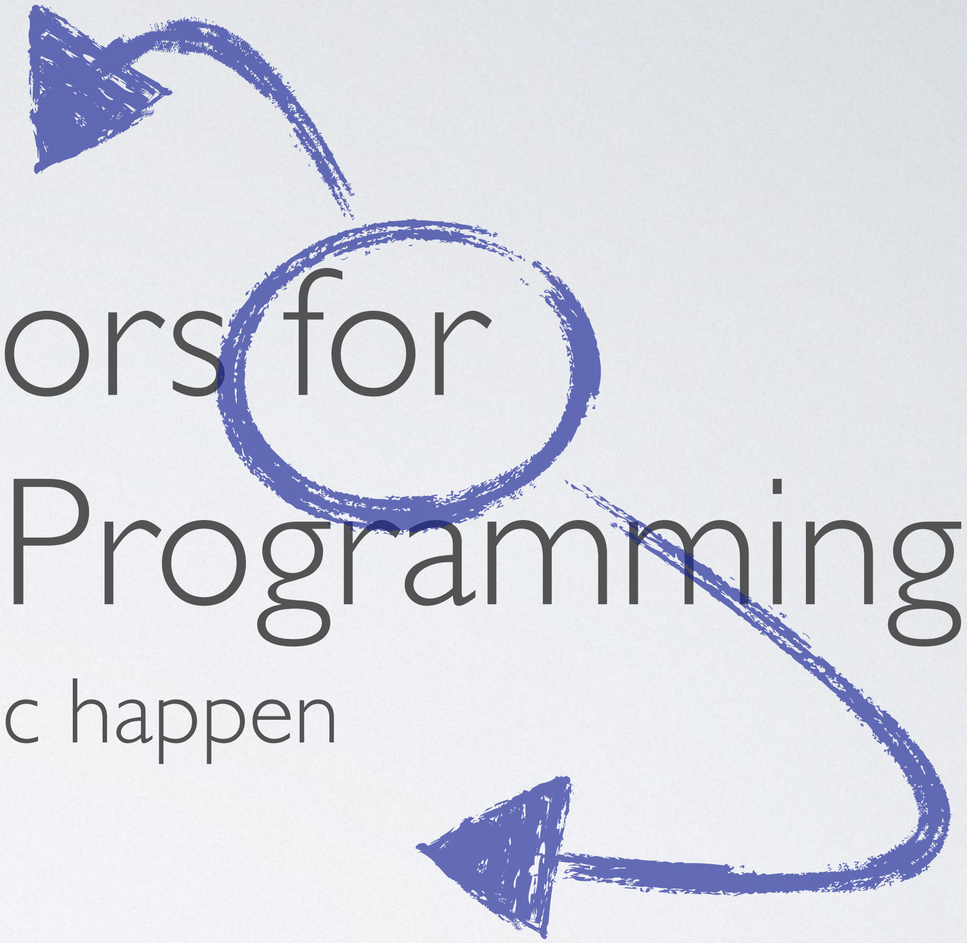


```
try {
    yield;
} catch (\Exception $exception)
{}
```

Inside

Generators for Asynchronous Programming

Let the magic happen



Promises

Synchronous

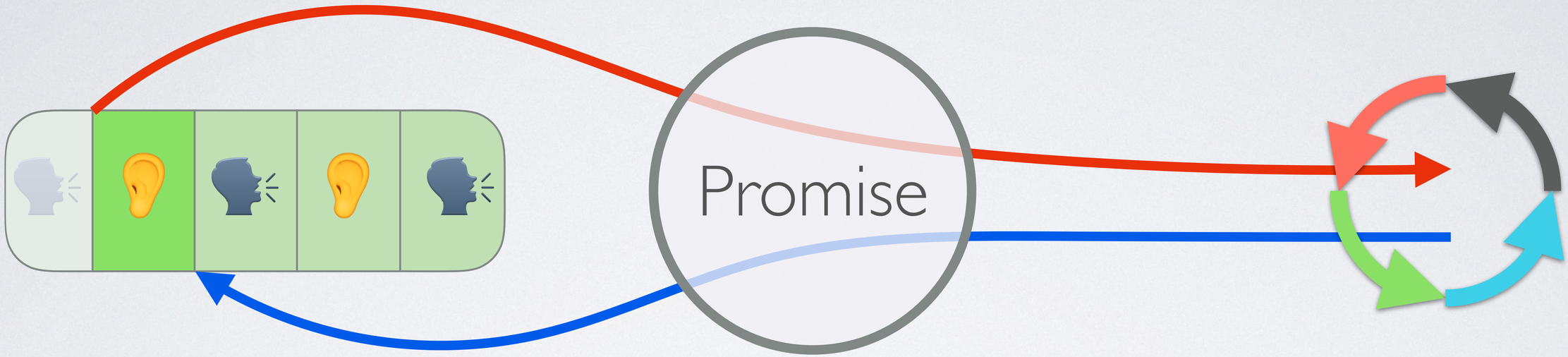
```
function discuss(string $question1, string $question2)
{
    /** @var string $response */
    $response = askQuestion($question1);
    echo $response;

    /** @var string $response */
    $response = askQuestion($question2);
    echo $response;
}
```

Synchronous

```
function askQuestion(string $question): string
{
    // …
}
```

Waiting for a result…



Here your result!

Asynchronous

```
function askQuestion(string $question): Promise
{
    // …
}
```

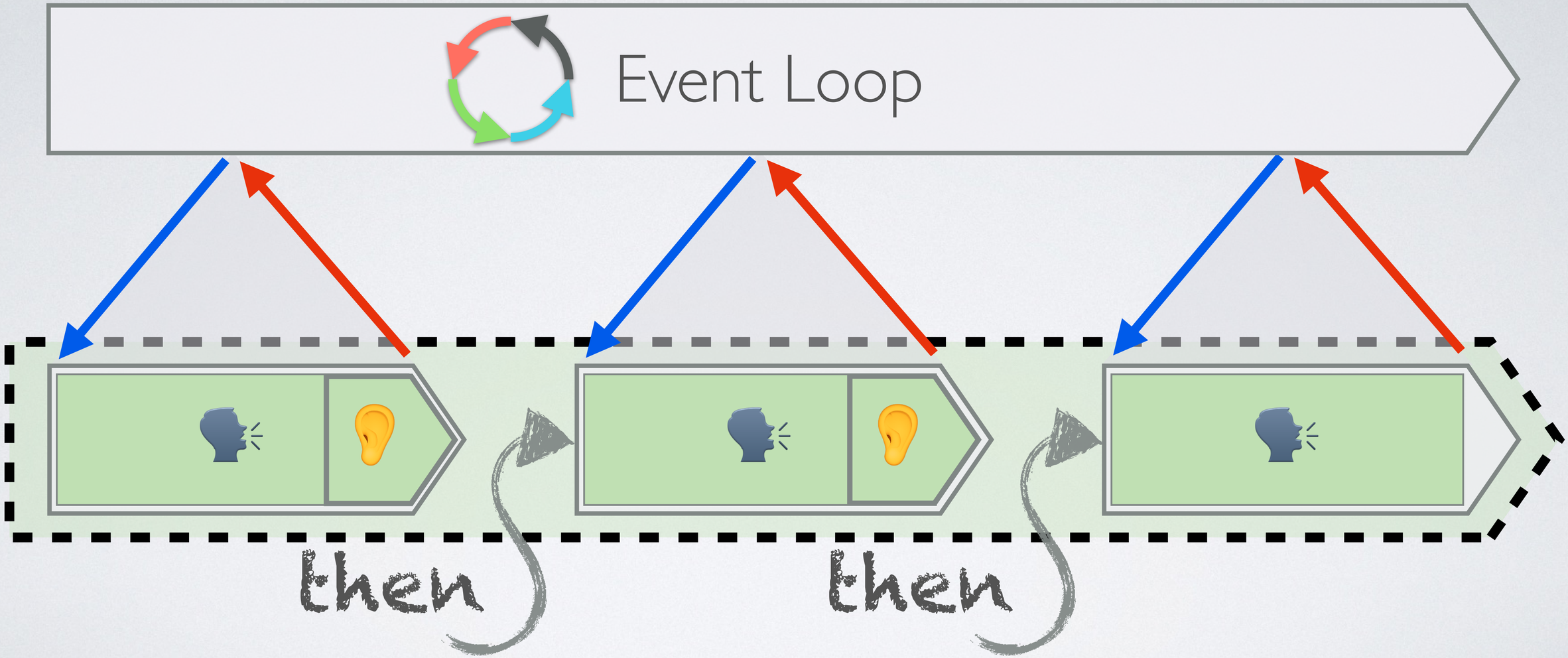
Asynchronous

```
function discuss(string $question1, string $question2)
{
    /** @var Promise $promise */
    $promise = askQuestion($question1);
    // !? echo $response;

    /** @var Promise $promise */
    $promise = askQuestion($question2);
    // !? echo $response;
}
```

Promises A+

Thenable Promises


Event Loop
then
then

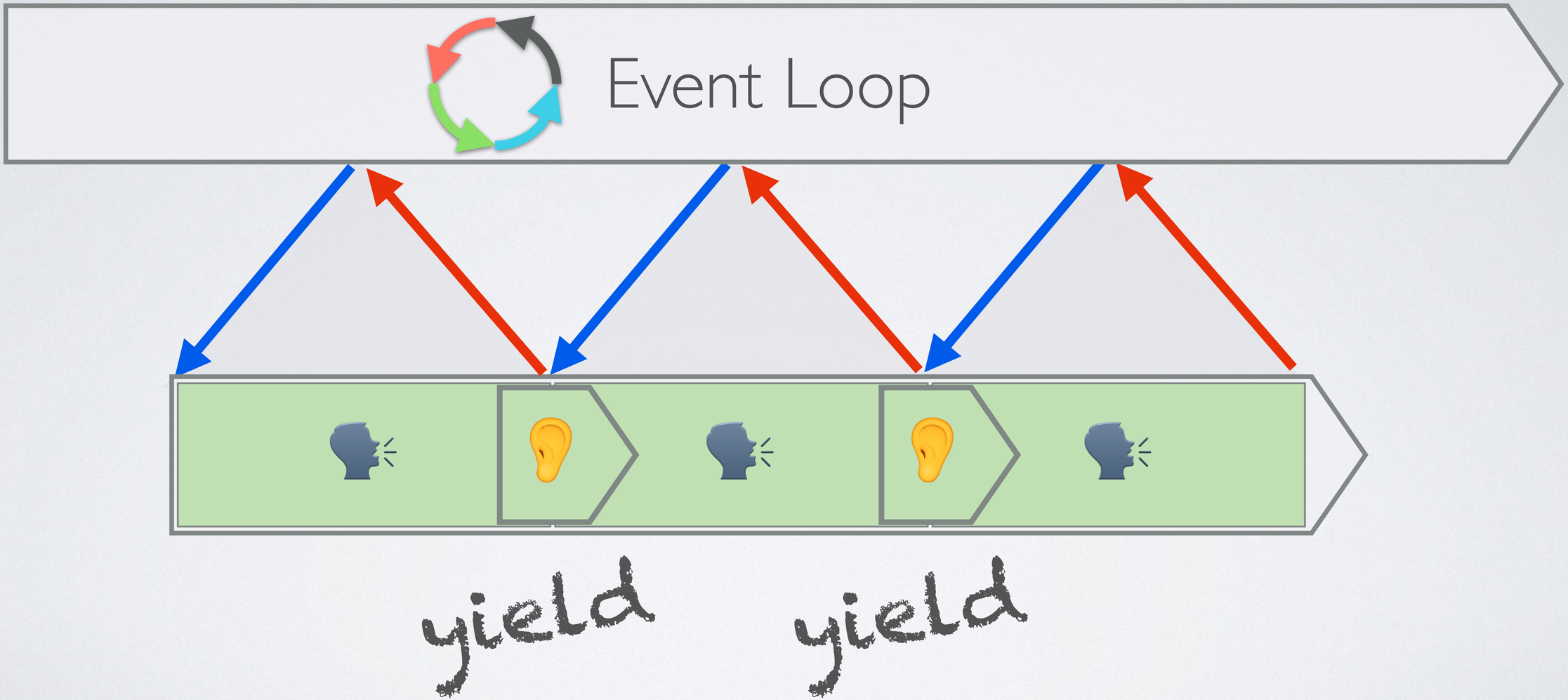
```php
function discuss(string $question1, string $question2)
{
    $promise = askQuestion($question1);
    $promise->then(
        function(string $response) use($question2) {
            echo $response;

            return askQuestion($question2);
        }
    )->then(
        function(string $response) {
            echo $response;
        }
    );
}
```

🔥Callback Hell🔥

```
$promise
    ->then(function ($x) {
        return $x + 1;
    })
    ->then(function ($x) {
        throw new \Exception($x + 1);
    })
    ->otherwise(function (\Exception $x) {
        return $x->getMessage() + 1;
    })
    ->then(function ($x) {
        echo 'Mixed '.$x;
    });
```

Generator Promises


Event Loop
yield
yield

Synchronous

```php
function discuss(string $question1, string $question2)
{

    /** @var string $response */
    $response = askQuestion($question1);
    echo $response;



    /** @var string $response */
    $response = askQuestion($question2);
    echo $response;
}
```

Asynchronous

```
function discuss(string $question1, string $question2)
{

    /** @var string $response */
    $response = yield askQuestion($question1);
    echo $response;



    /** @var string $response */
    $response = yield askQuestion($question2);
    echo $response;
}
```

Asynchronous

```
function discuss(string $question1, string $question2)
{
    $promise = askQuestion($question1);
    /** @var string $response */
    $response = yield $promise;
    echo $response;

    $promise = askQuestion($question2);
    /** @var string $response */
    $response = yield $promise;
    echo $response;
}
```

To asynchronously *wait* the value of a **promise**, use **`yield`**.

Asynchronous Function:

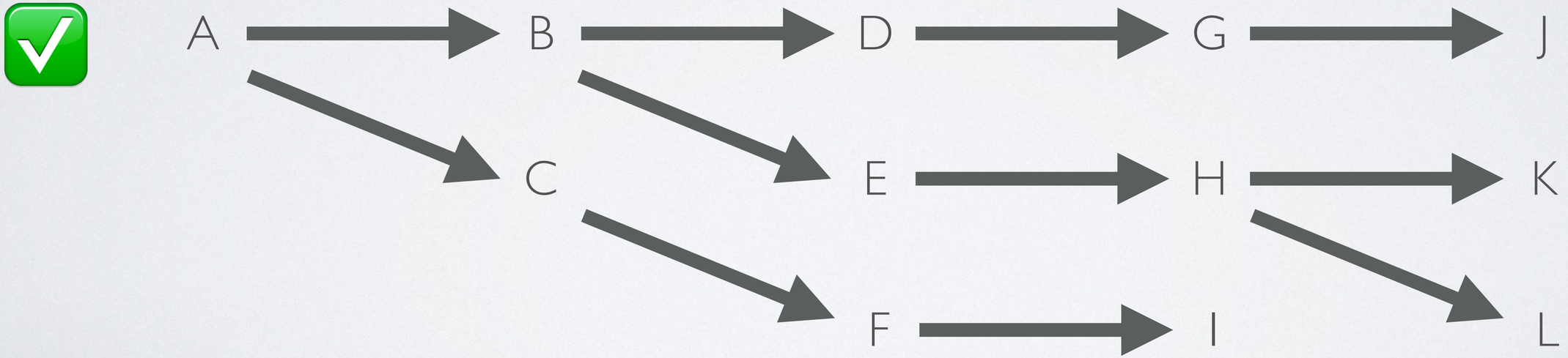
a **generator**

yielding only *promises*.


Getting started!

Finding the good use case


A
B
C
D
E


A
B
D
G
J
C
E
H
K
F
I
L

Choose your Event Loop

reactphp/react

👍 Community

😩 *Thenable* Promises

amphp/amp

👍 Generators

🤔 Coupling ?

m6web/tornado

👍 Generators

😘 Interfaces / Adapters

🤔 M6Web

Tea for Two

Let's code it!

Discussing with a friend

```php
function discuss(string $question1, string $question2)
: \Generator
{
    /** @var string $response */
    $response = yield askQuestion($question1);
    echo $response;

    /** @var string $response */
    $response = yield askQuestion($question2);
    echo $response;
}
```

Breathing

```
function breath(EventLoop $eventLoop, int $count)
: \Generator
{
    while (--$count >= 0) {
        echo "Breathing\n";
        yield $eventLoop->idle();
    }
}
```

Drinking Tea

```
function tMax(EventLoop $eventLoop, int $maximum)
: \Generator
{
    do {
        yield $eventLoop->idle();
        $current = rand(20, 40);
    } while ($current > $maximum);

    return $current;
}
```

Drinking Tea

```
function drink(EventLoop $eventLoop): \Generator
{
    $generator = tMax($eventLoop, 35);
    $promise = $eventLoop->async($generator);
    $temperature = yield $promise;

    echo "Drinking [$temperature °]\n";

    yield $eventLoop->delay(1000/*ms*/);
}
```

Drinking Tea

```
function drink(EventLoop $eventLoop): \Generator
{
    $generator = tMax($eventLoop, 35);
    $promise = $eventLoop->async($generator);
    $temperature = yield $promise;

    echo "Drinking [$temperature °]\n";

    yield $eventLoop->delay(1000/*ms*/);
}
```

Drinking Tea

```
function drink(EventLoop $eventLoop): \Generator
{
    $generator = tMax($eventLoop, 35);
    $promise = $eventLoop->async($generator);
    $temperature = yield $promise;

    echo "Drinking [$temperature °]\n";

    yield $eventLoop->delay(1000/*ms*/);
}
```

Drinking Tea

```
function drink(EventLoop $eventLoop): \Generator
{
    $generator = tMax($eventLoop, 35);
    $promise = $eventLoop->async($generator);
    $temperature = yield $promise;

    echo "Drinking [$temperature °]\n";

    yield $eventLoop->delay(1000/*ms*/);
}
```

Wait for it…

```
$concurrentPromise = $eventLoop->promiseAll(

    $eventLoop->async( breath($eventLoop, 10)       ),
    $eventLoop->async( discuss('Where?', ‘What?') ),
    $eventLoop->async( drink($eventLoop)            )

);

$eventLoop->wait($concurrentPromise);
```

Wait for it…

```
$concurrentPromise = $eventLoop->promiseAll(

    $eventLoop->async( breath($eventLoop, 10)       ),
    $eventLoop->async( discuss('Where?', ‘What?') ),
    $eventLoop->async( drink($eventLoop)            )

);

$eventLoop->wait($concurrentPromise);
```

Wait for it…

```
$concurrentPromise = $eventLoop->promiseAll(

    $eventLoop->async( breath($eventLoop, 10)       ),
    $eventLoop->async( discuss('Where?', ‘What?') ),
    $eventLoop->async( drink($eventLoop)            )

);

$eventLoop->wait($concurrentPromise);
```

So…

Asynchronous Programming

doesn't require…


Http Server


Threads


JavaScript™

Asynchronous Programming

requires…

Event Loop

Interruptible Tasks

Generators:
Powerful tool for Asynchronous Programming


PRACTICE

Generators for Asynchronous Programming

User Manual

Benoit Viguier
@b_viguier

Thanks !

```
$answer = yield $you->ask($me);
```

Benoit Viguier
@b_viguier