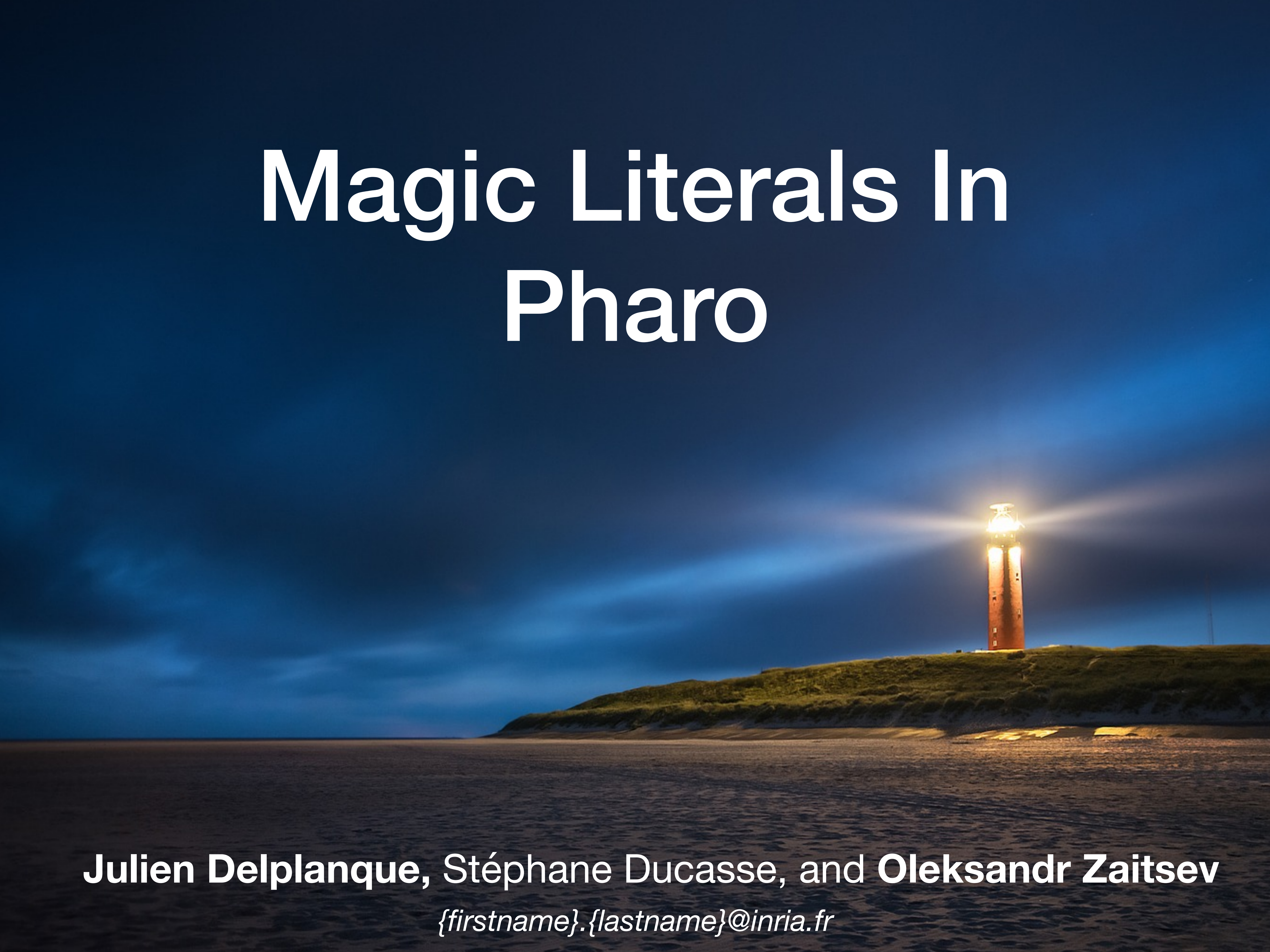
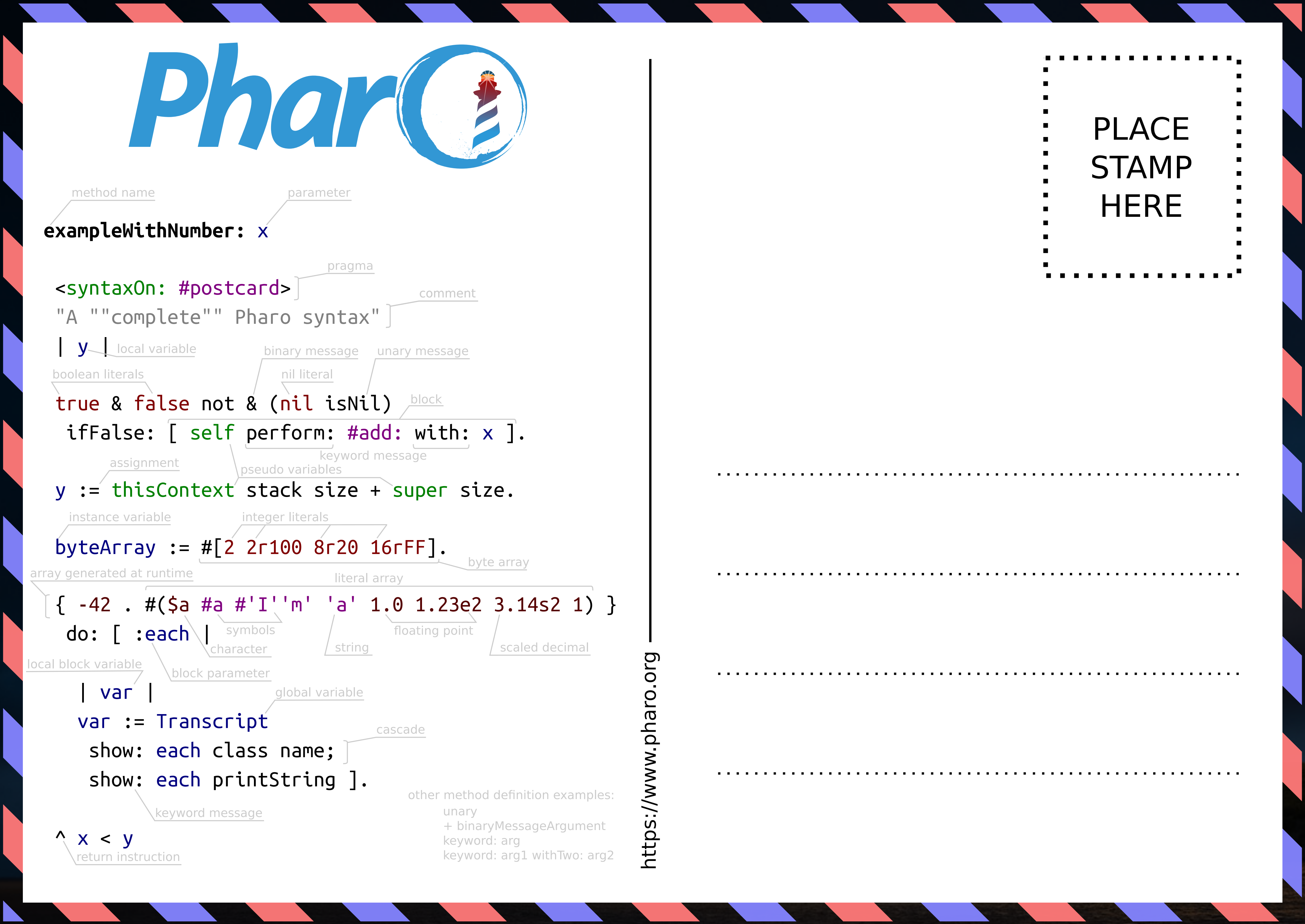


Magic Literals In Pharo

Julien Delplanque, Stéphane Ducasse, and **Oleksandr Zaitsev**

{firstname}.{lastname}@inria.fr



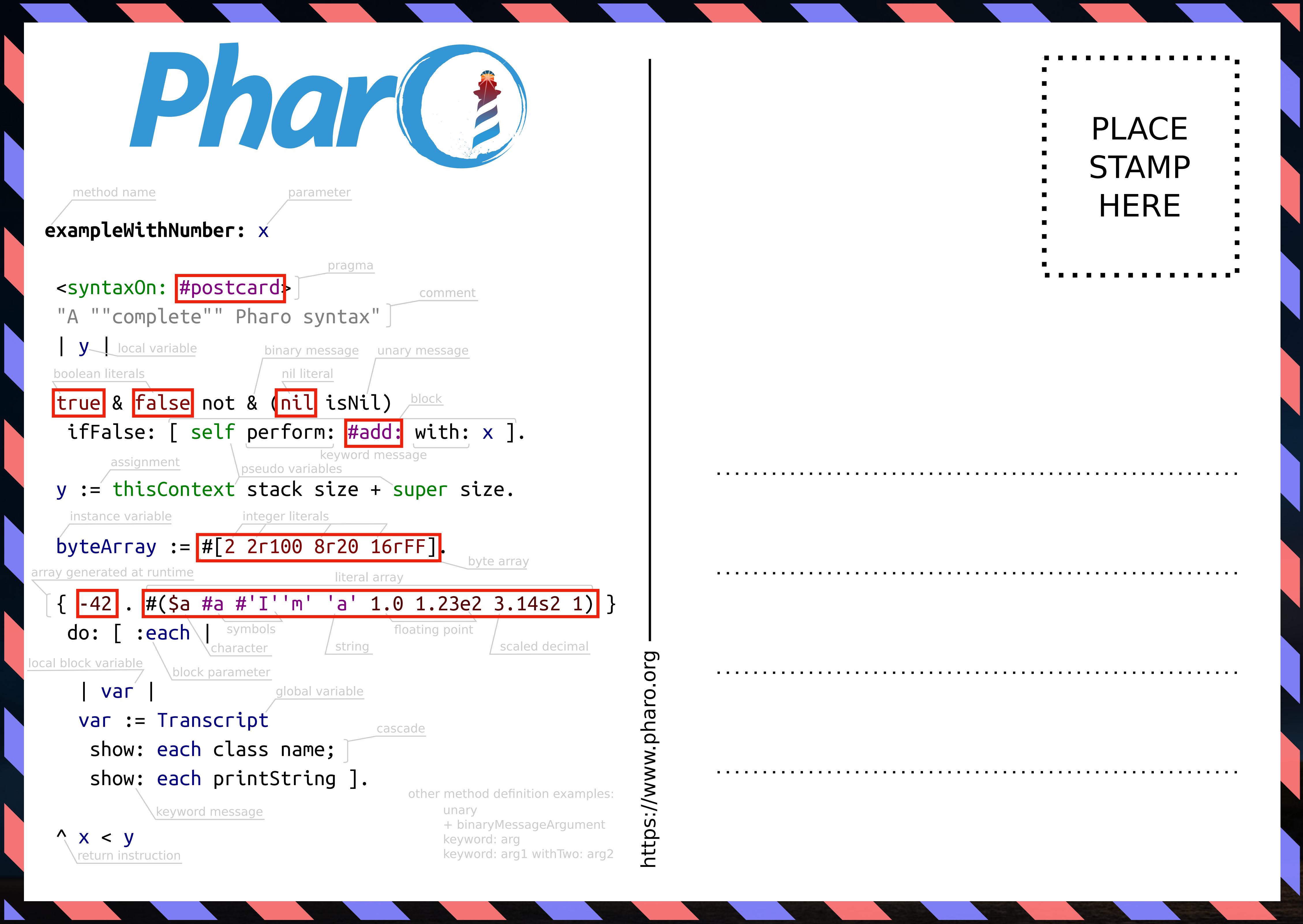
```
exampleWithNumber: x

 <syntaxOn: #postcard>
 "A ""complete"" Pharo syntax"
 | y |
 true & false not & (nil isNil)
  ifFalse: [ self perform: #add: with: x ].
 y := thisContext stack size + super size.
 byteArray := #[2 2r100 8r20 16rFF].
 { -42 . #($a #a #'I''m' 'a' 1.0 1.23e2 3.14s2 1) }
  do: [ :each |
    | var |
    var := Transcript
     show: each class name;
     show: each printString ].

 ^ x < y
```

Pharo
method name
parameter
pragma
comment
local variable
binary message
unary message
boolean literals
nil literal
block
keyword message
assignment
pseudo variables
instance variable
integer literals
byte array
array generated at runtime
literal array
symbols
character
floating point
string
scaled decimal
local block variable
block parameter
global variable
cascade
keyword message
return instruction
other method definition examples:
unary
+ binaryMessageArgument
keyword: arg
keyword: arg1 withTwo: arg2
https://www.pharo.org
PLACE STAMP HERE

Literals in Smalltalk


Pharo
method name
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PLACE STAMP HERE
https://www.pharo.org

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 ^ x < y
```

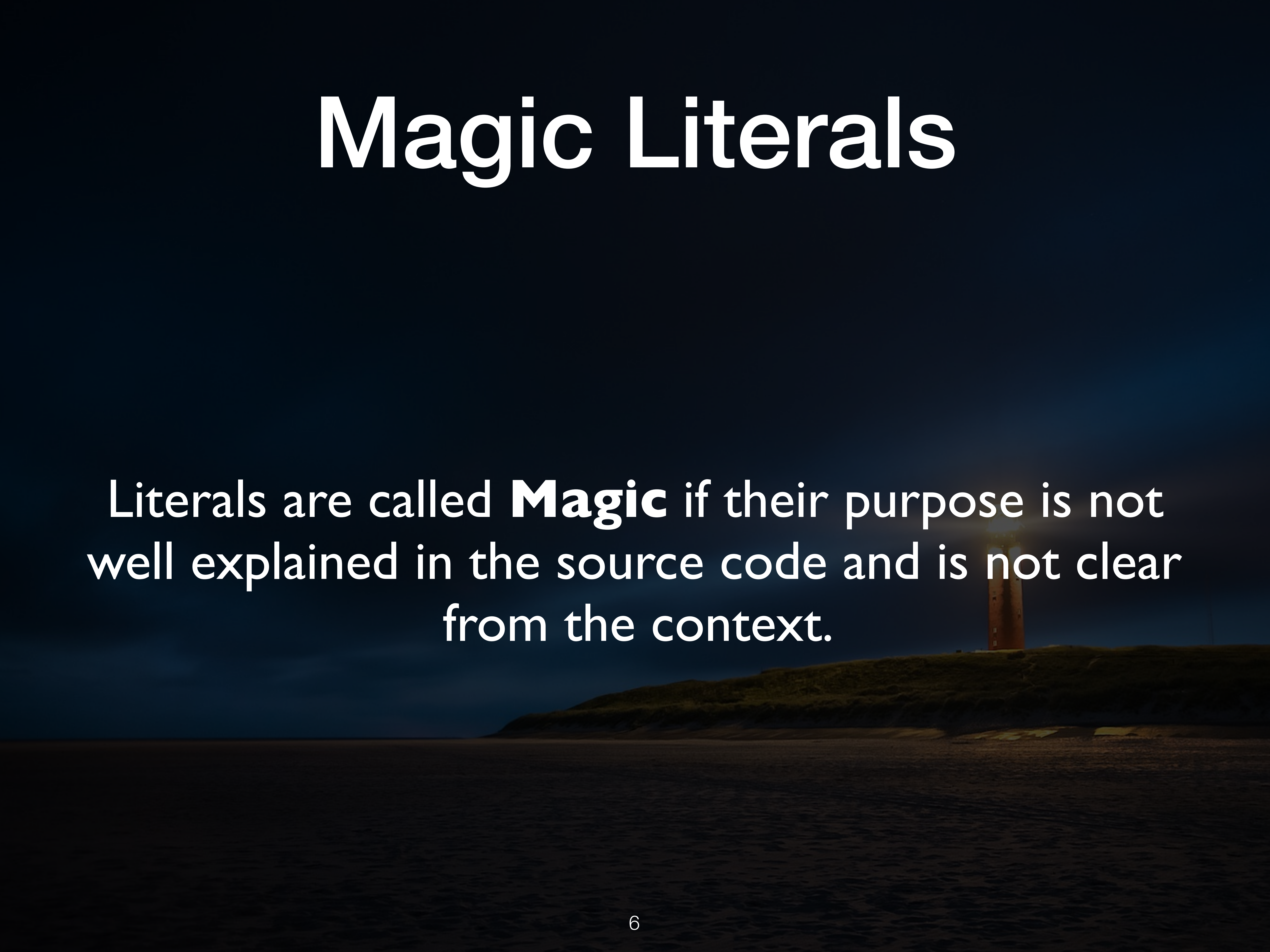
other method definition examples:
 unary
 + binaryMessageArgument
 keyword: arg
 keyword: arg1 withTwo: arg2

Literals in Smalltalk

Literals in Smalltalk

- **true** and **false**
- **nil**
- Numbers: 42, -42, 4.2, 4s2, 4e2, …
- Individual characters: $a
- Strings of characters: ‘foo’
- Symbols: #foo:bar:
- Arrays of other literal constants: #(1 2 4) and #[255 0]

What are Magic Literals?



Magic Literals

Literals are called **Magic** if their purpose is not well explained in the source code and is not clear from the context.

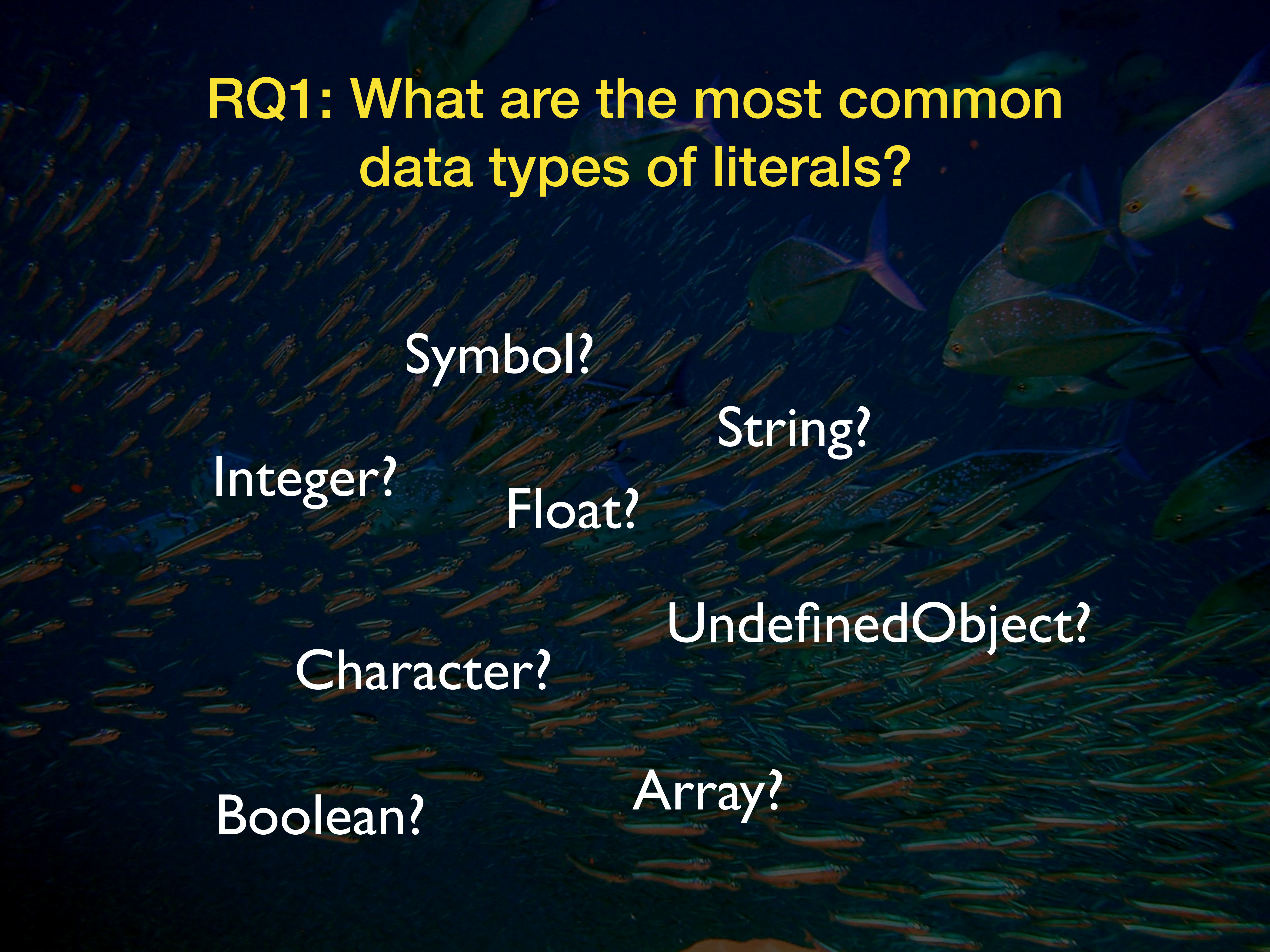
Exploring Literals in Pharo

We have identified

169,133

literals in Pharo 7

RQ1: What are the most common data types of literals?



Symbol?

String?

Integer?

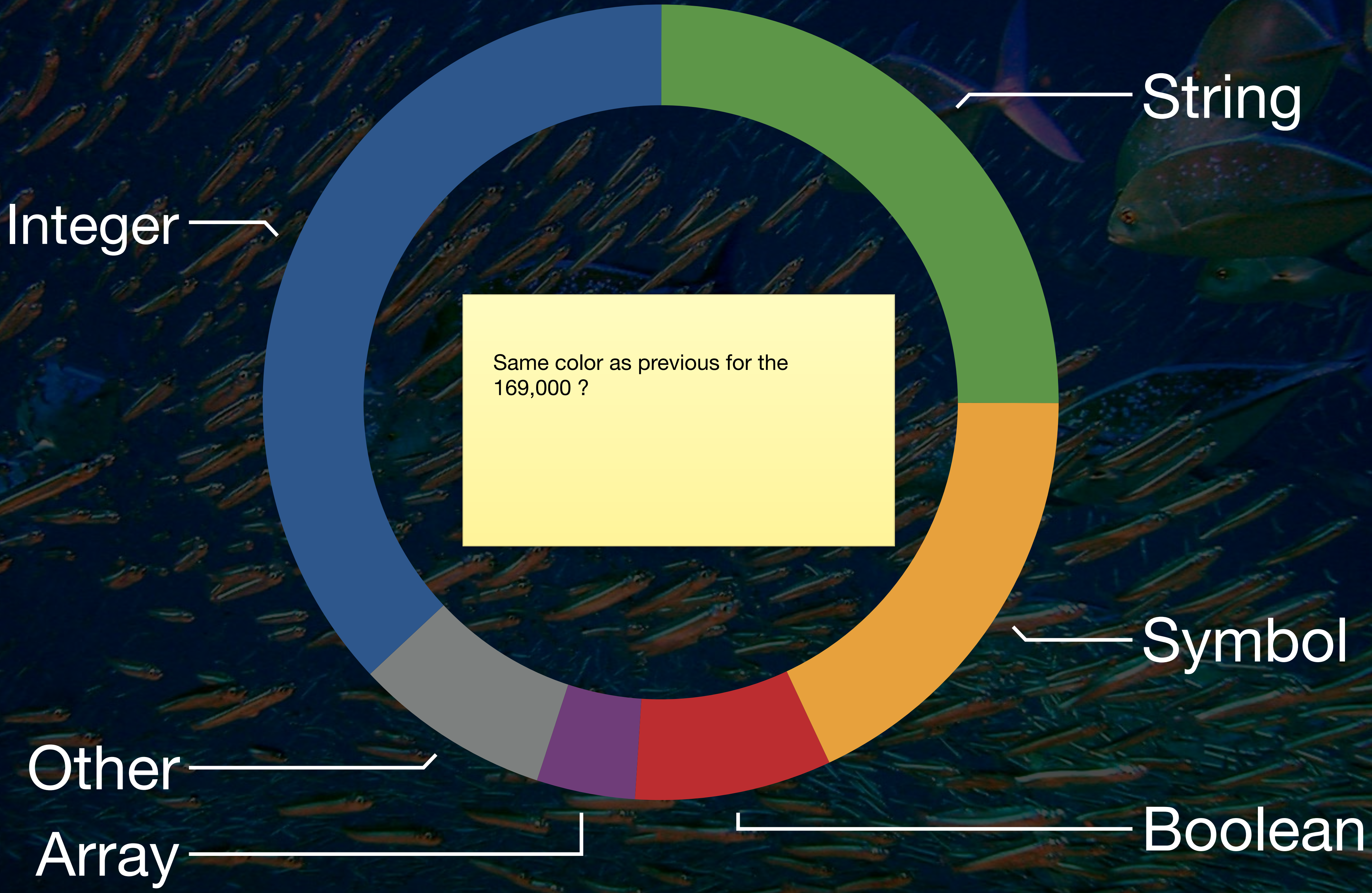
Float?

UndefinedObject?

Character?

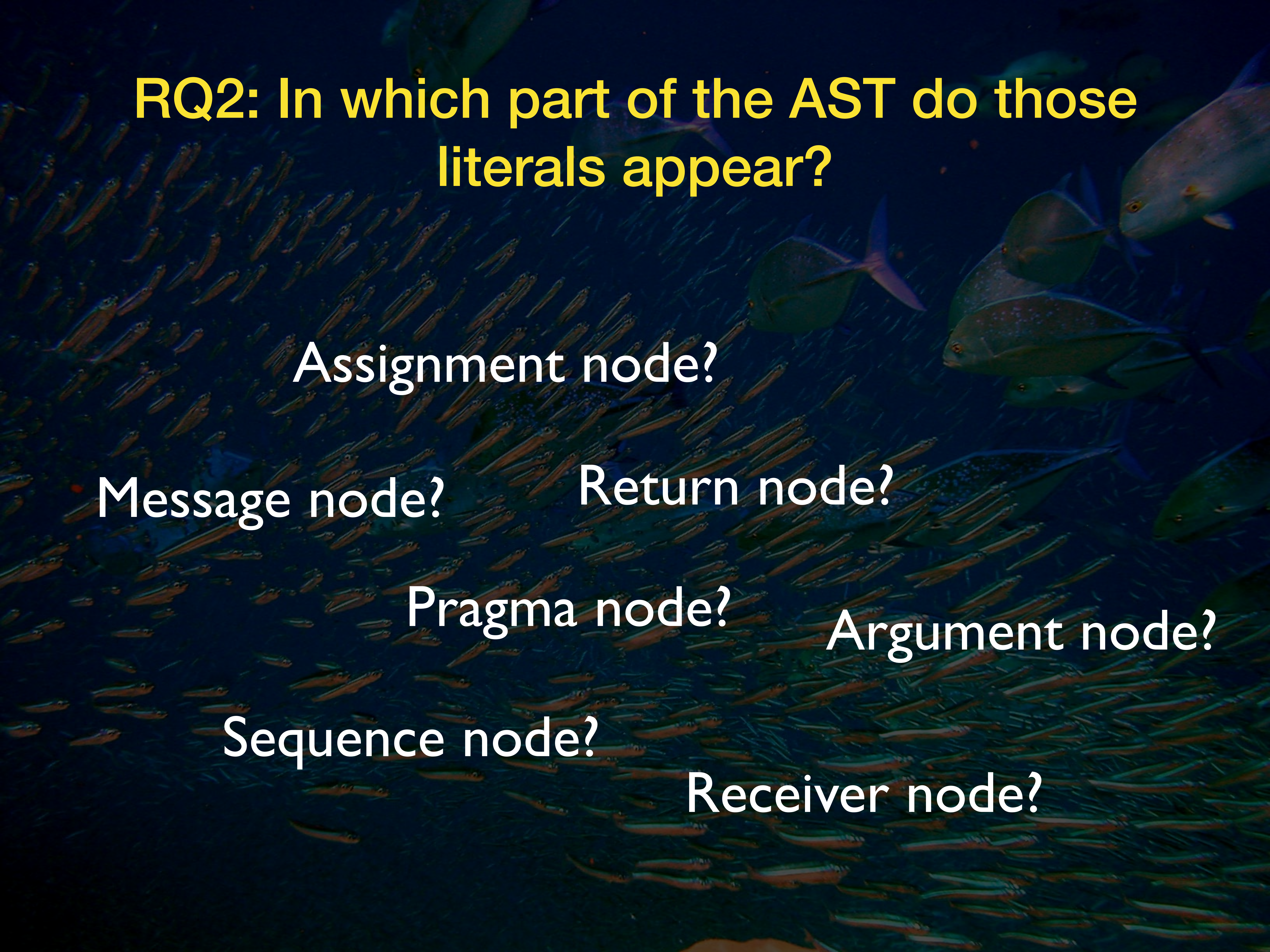
Boolean?

Array?



Same color as previous for the 169,000 ?

RQ2: In which part of the AST do those literals appear?



Assignment node?

Message node?

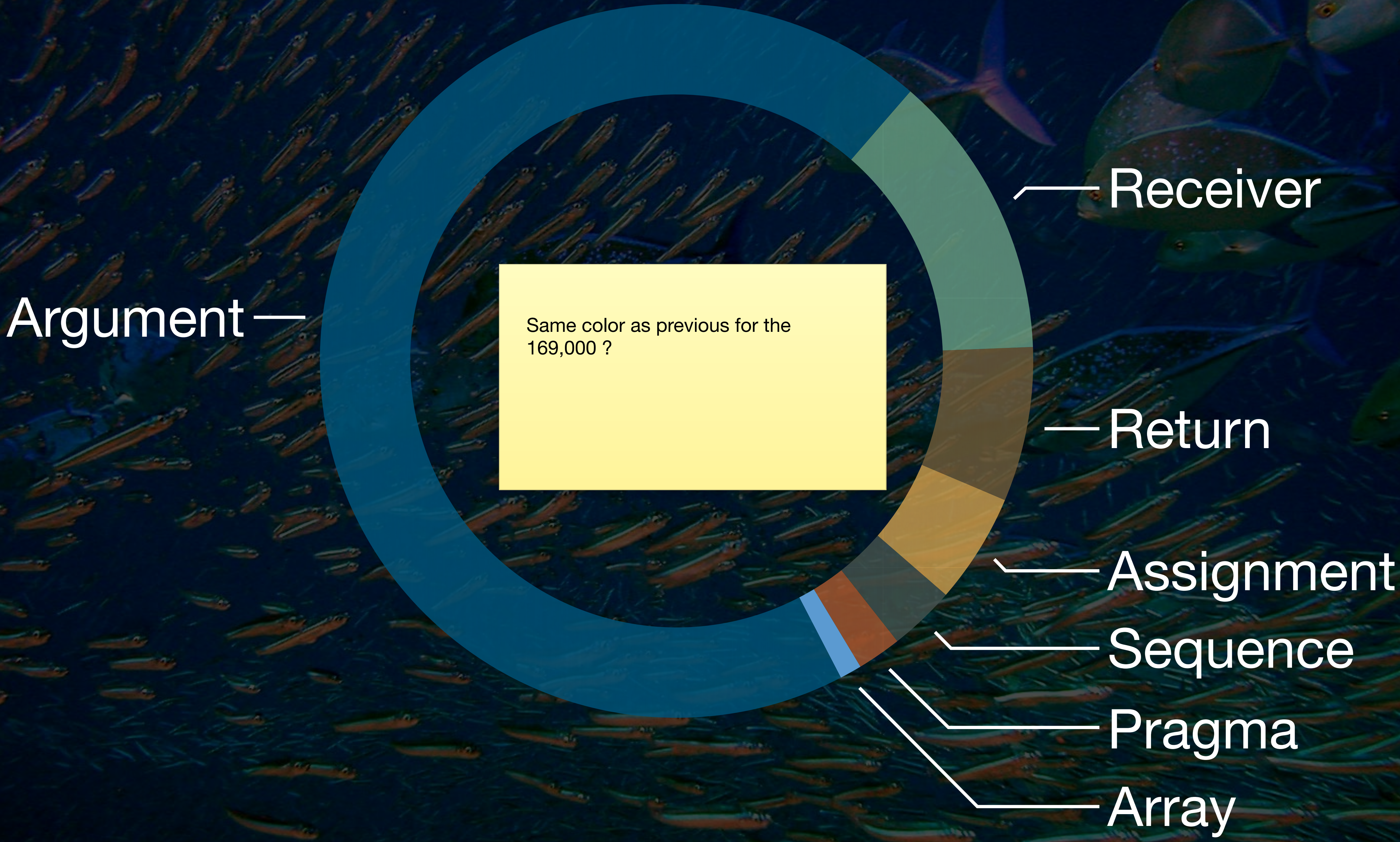
Return node?

Pragma node?

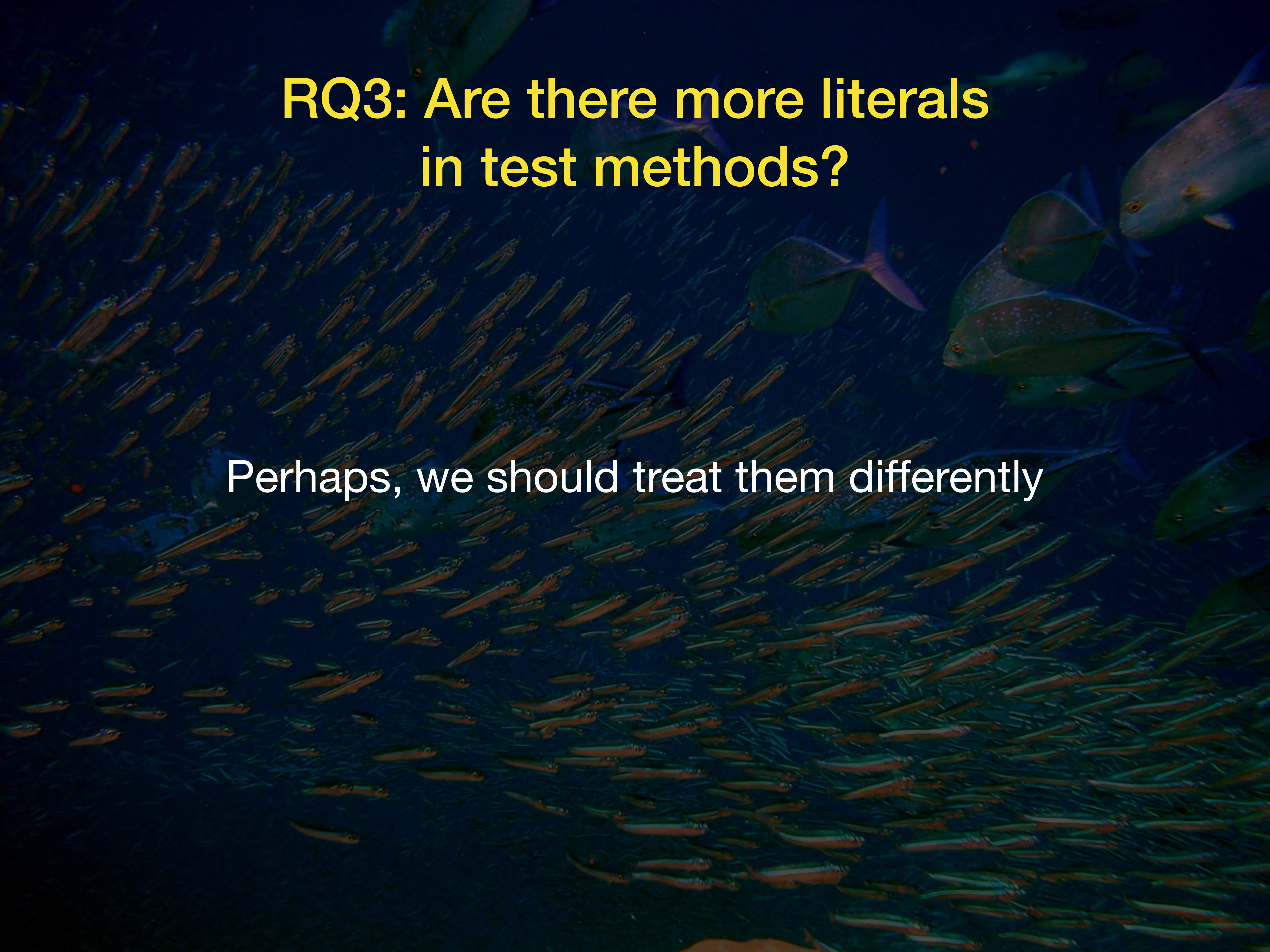
Argument node?

Sequence node?

Receiver node?



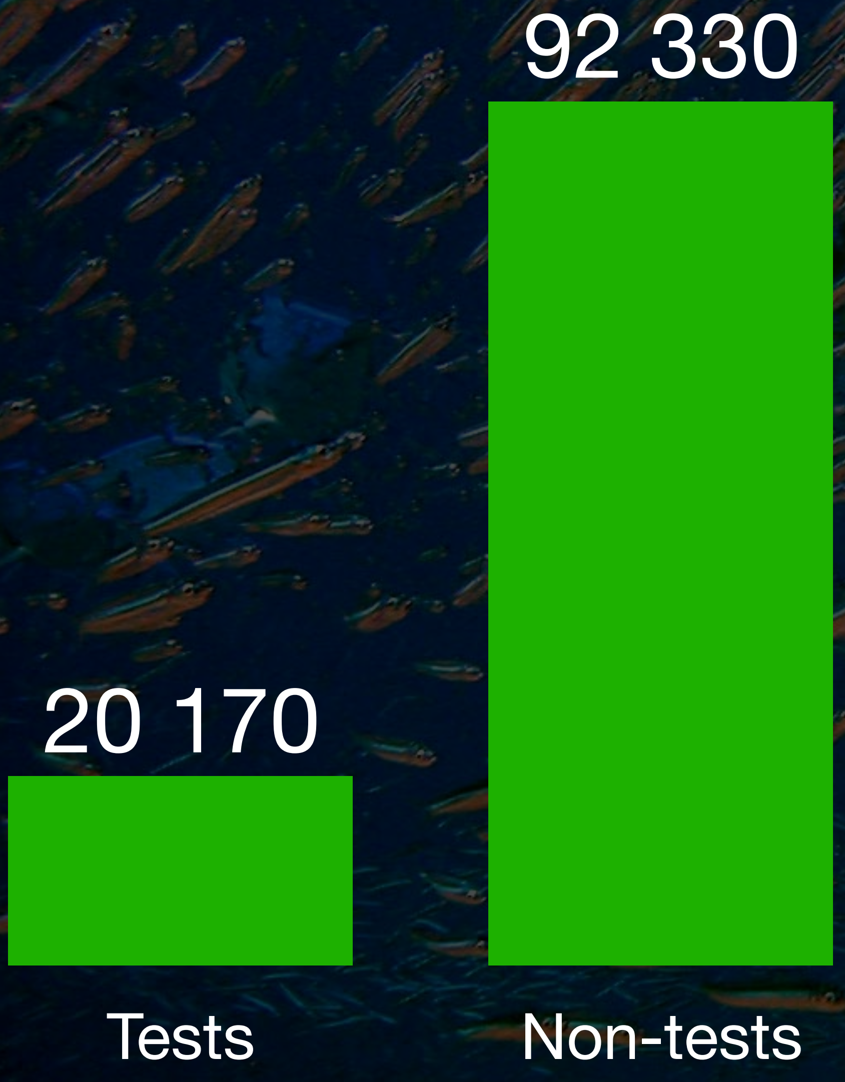
Same color as previous for the 169,000 ?

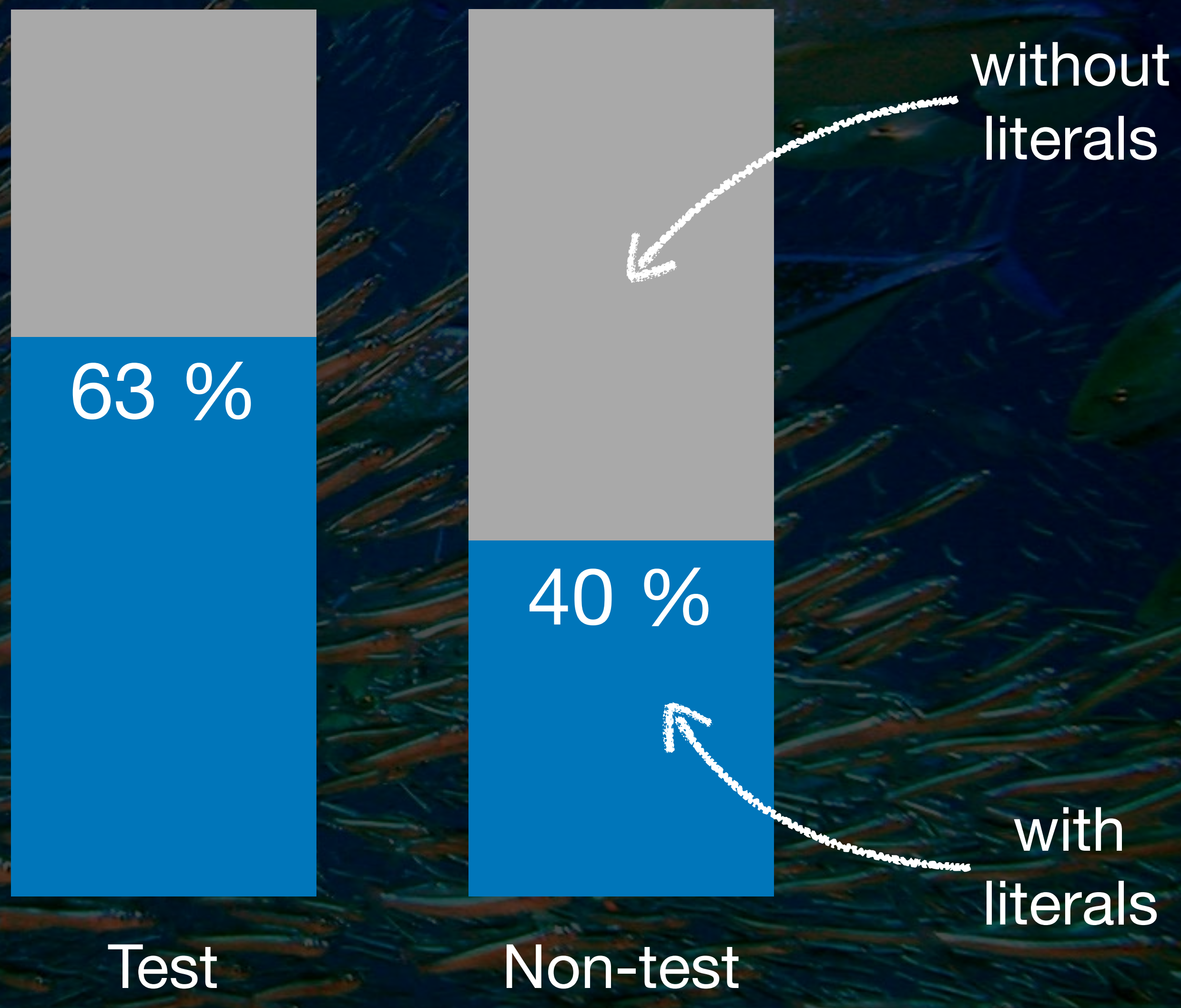


RQ3: Are there more literals in test methods?

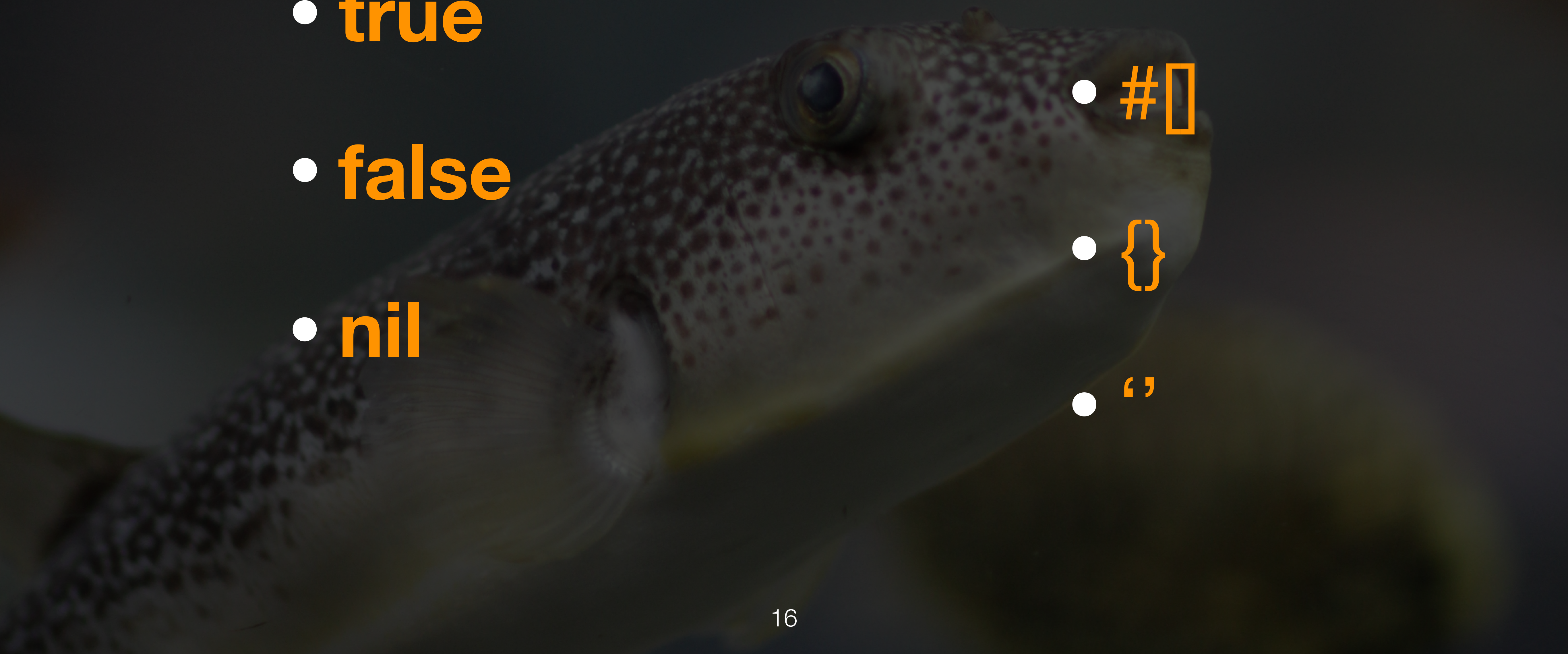
Perhaps, we should treat them differently

Distribution Over Test and Non-Test





Acceptable Literals



Acceptable literals

Literals self-describing their semantics

- **true**
- **false**
- **nil**

- #()
- #[]
- {}
- ‘’

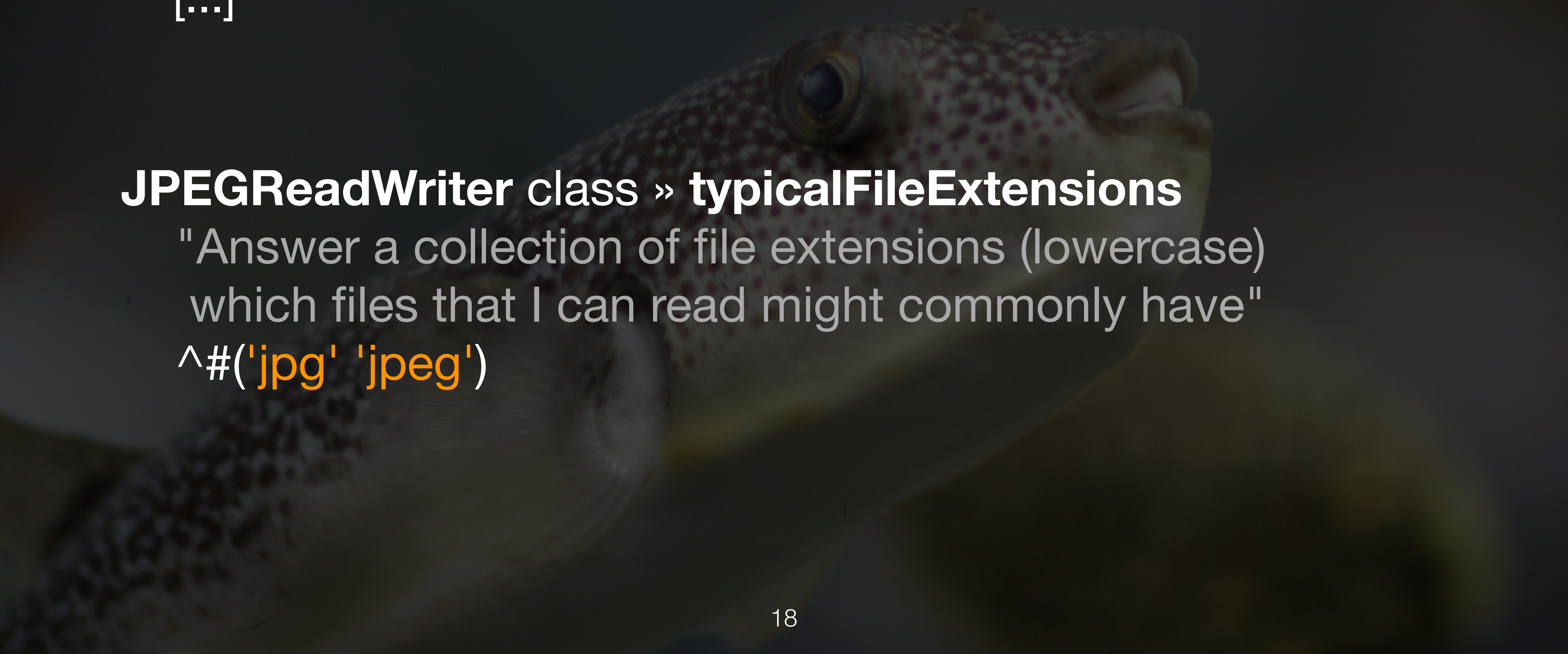
Acceptable literals

Literals that are part of API

```
'abcdedfgh' copyFrom: 1 to: 5
```

Acceptable literals

Literals directly assigned to a variable / returned by a method

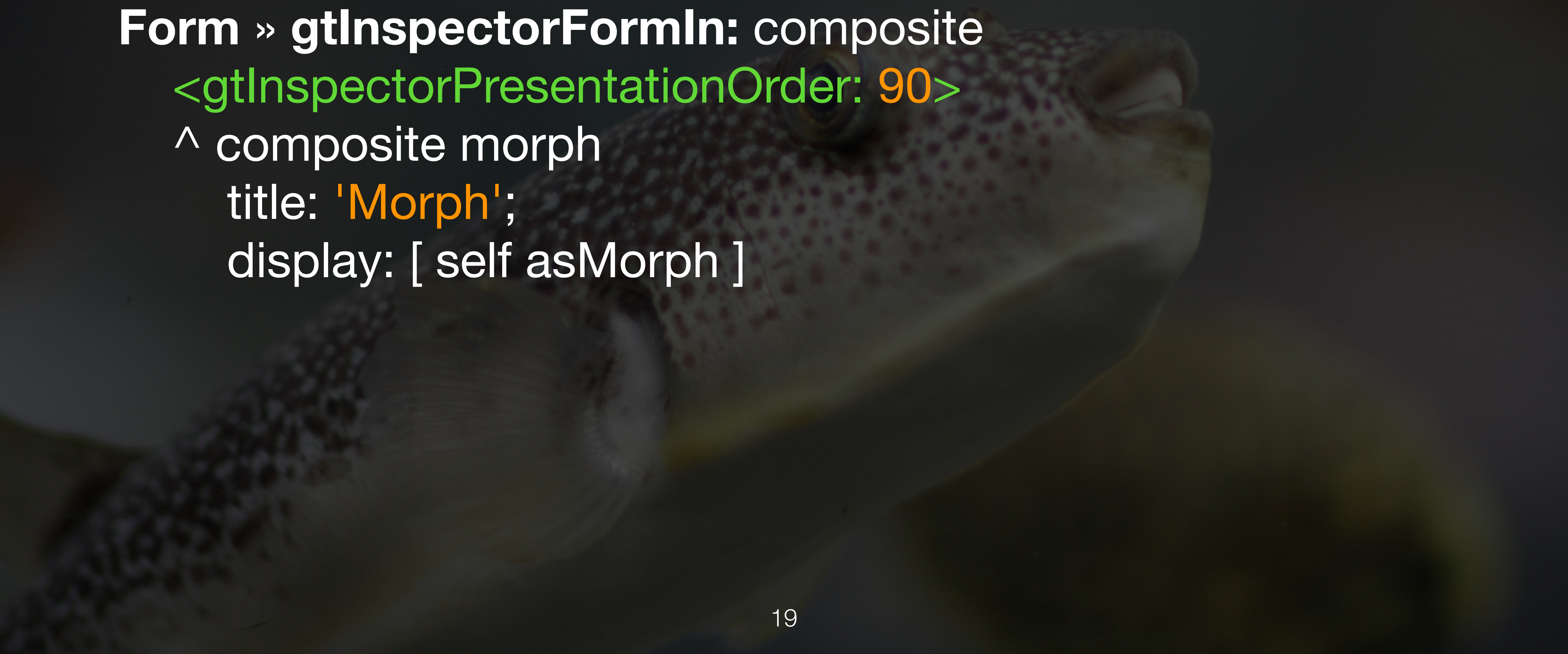


```
EventSensorConstants class » initializeEventTypeConstants
    "Types of events"
    EventTypeNone := 0.
    [...]
```

```
JPEGReadWriter class » typicalFileExtensions
    "Answer a collection of file extensions (lowercase)
     which files that I can read might commonly have"
    ^#('jpg' 'jpeg')
```

Acceptable literals

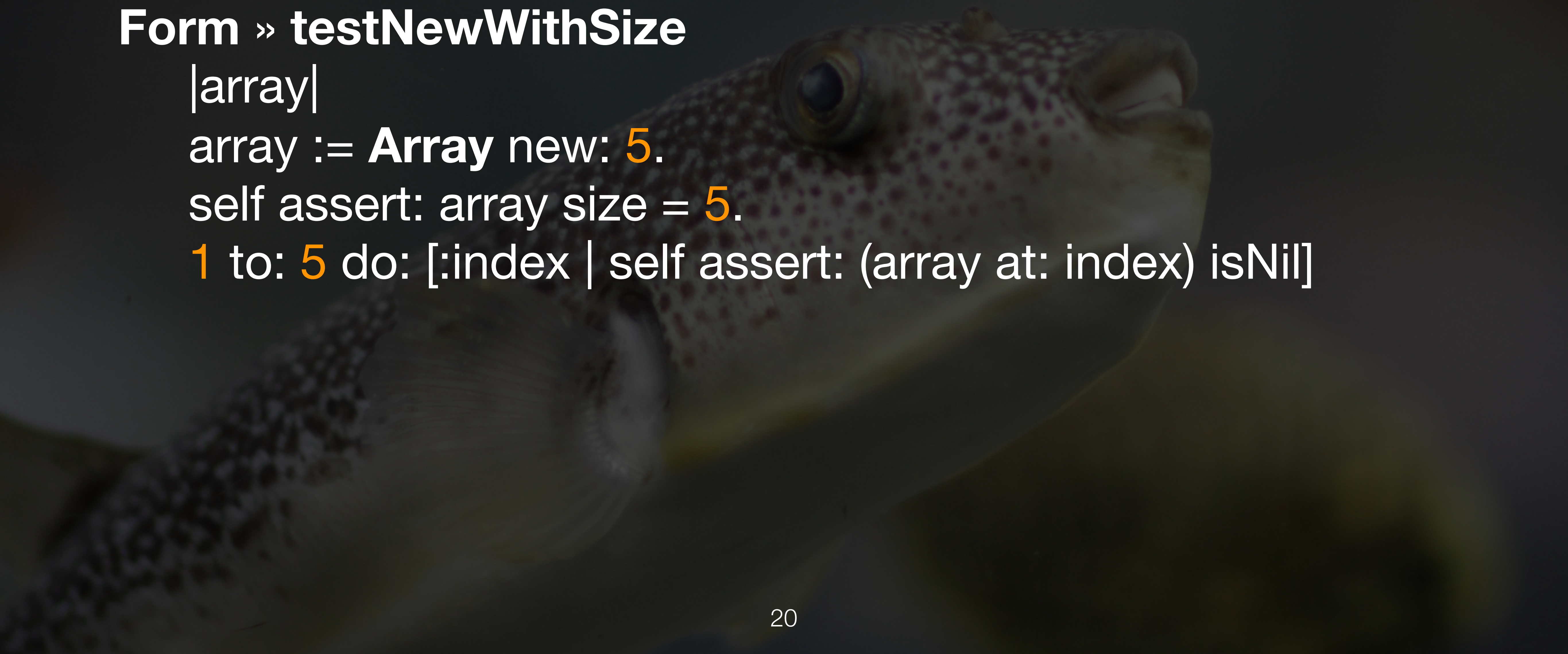
Literals located in a method annotation arguments



```
Form » gtInspectorFormIn: composite
    <gtInspectorPresentationOrder: 90>
    ^ composite morph
        title: 'Morph';
        display: [ self asMorph ]
```

Acceptable literals

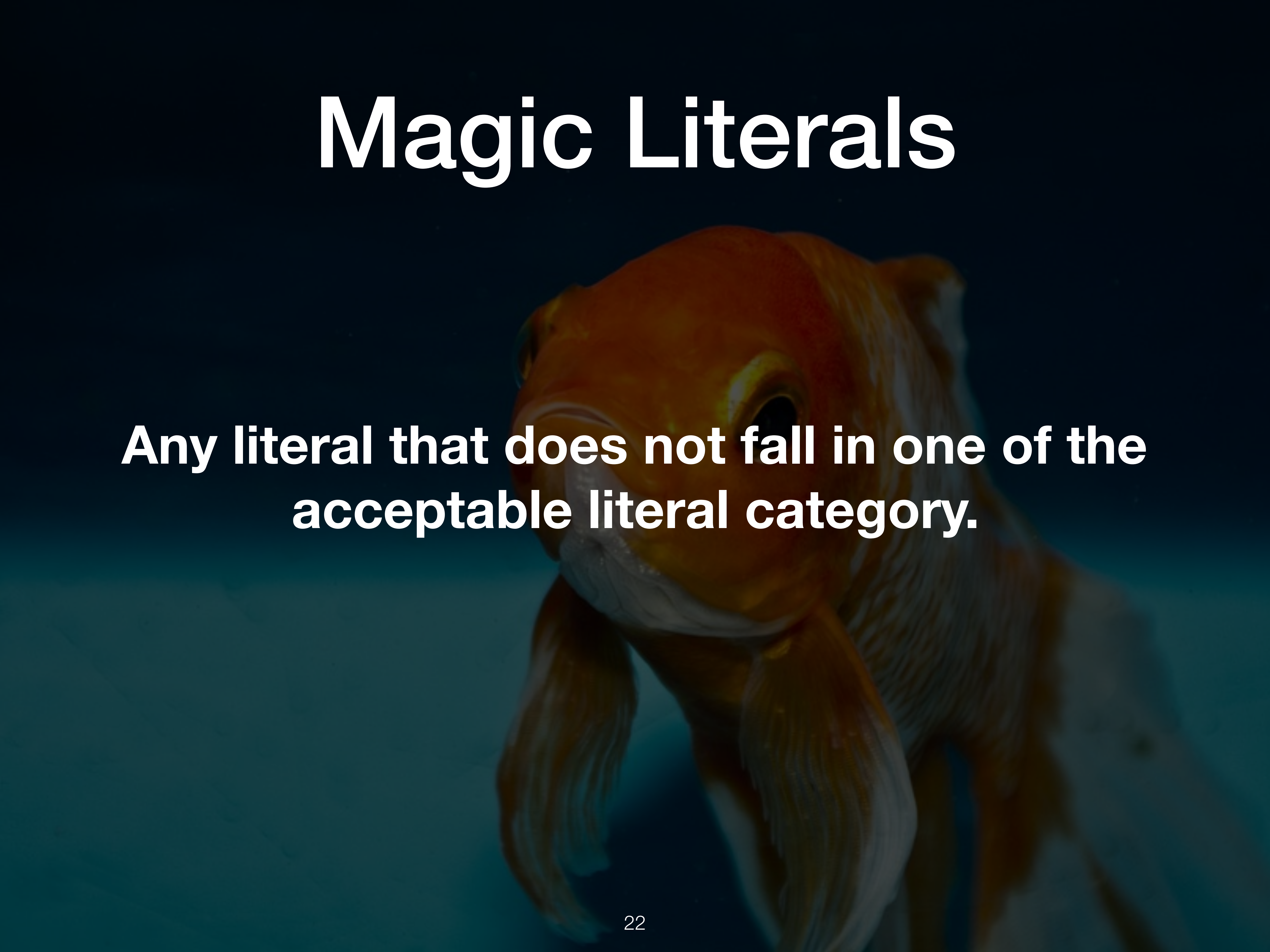
Literals located in a test and example methods



Form » testNewWithSize

```
    |array|
    array := Array new: 5.
    self assert: array size = 5.
    1 to: 5 do: [:index | self assert: (array at: index) isNil]
```

Magic Literals



Magic Literals

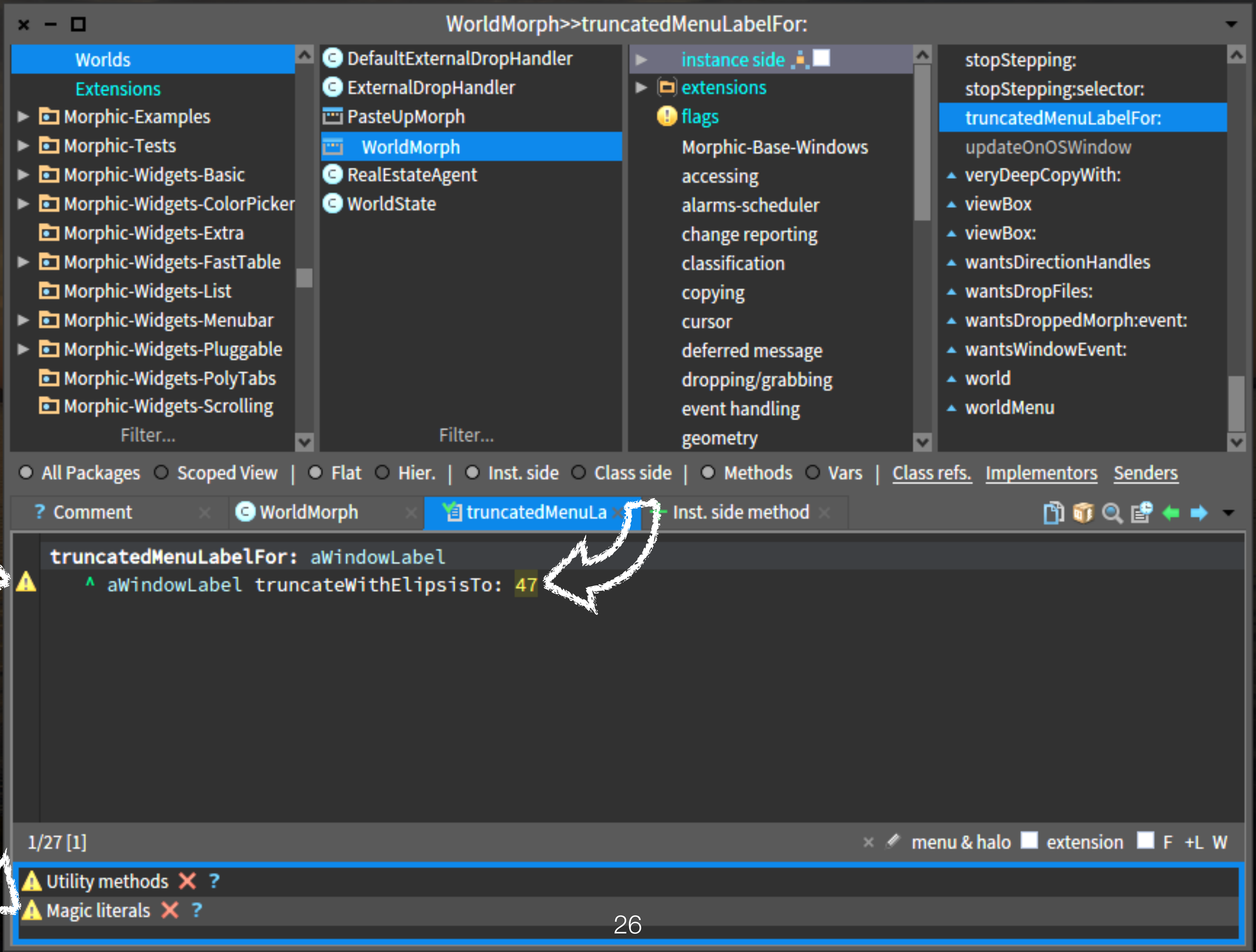
Any literal that does not fall in one of the acceptable literal category.

But… why are they bad?

1. Readability
2. Logic duplication
3. Modularity

Detecting Magic Literals

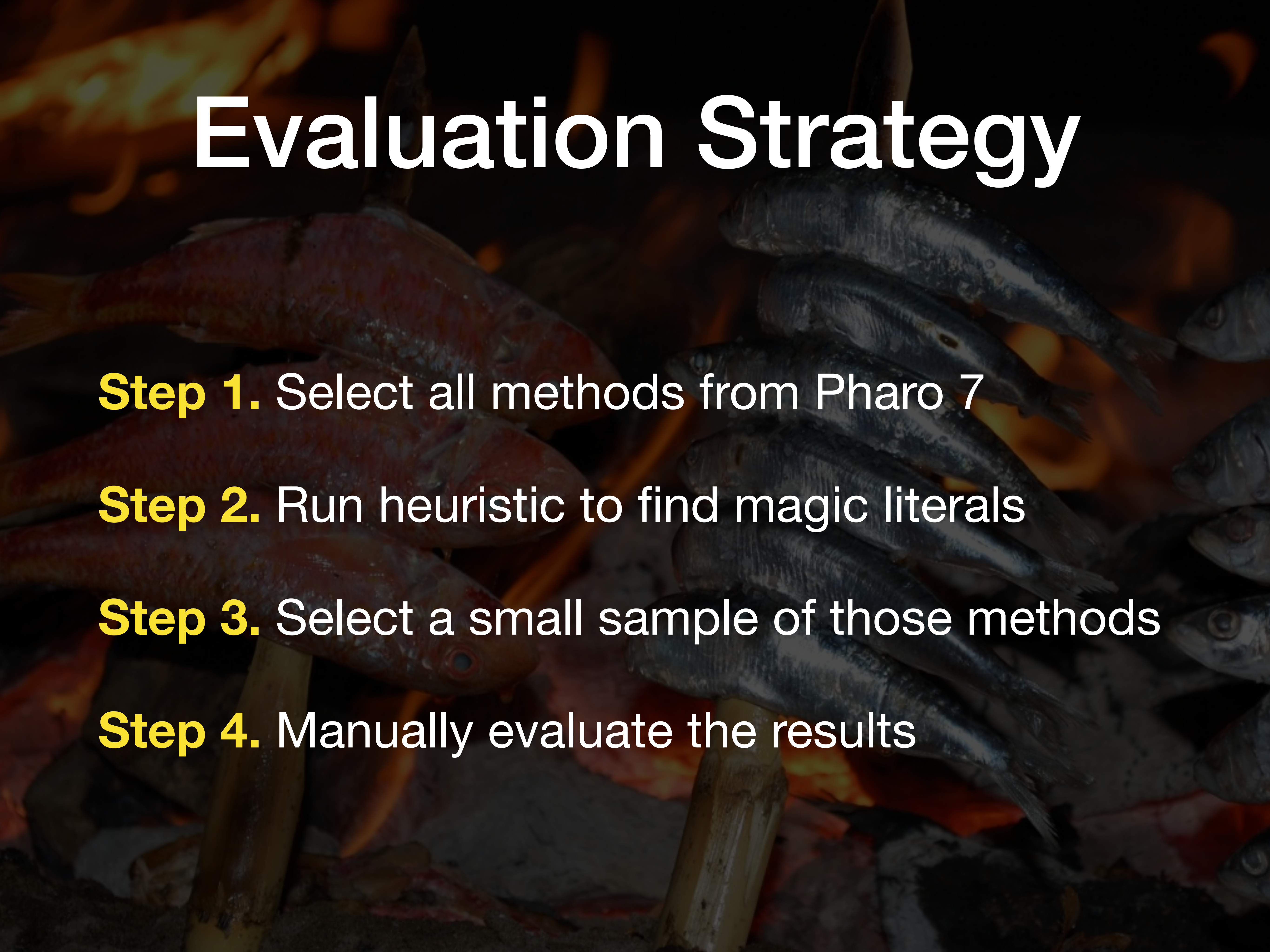
Heuristic implemented as a CodeCritic rule



```
truncatedMenuLabelFor: aWindowLabel
	^ aWindowLabel truncateWithElipsisTo: 47
```

⚠ Utility methods ✕ ?
⚠ Magic literals ✕ ?

Evaluation



Evaluation Strategy

Step 1. Select all methods from Pharo 7

Step 2. Run heuristic to find magic literals

Step 3. Select a small sample of those methods

Step 4. Manually evaluate the results

Evaluation. Step 1

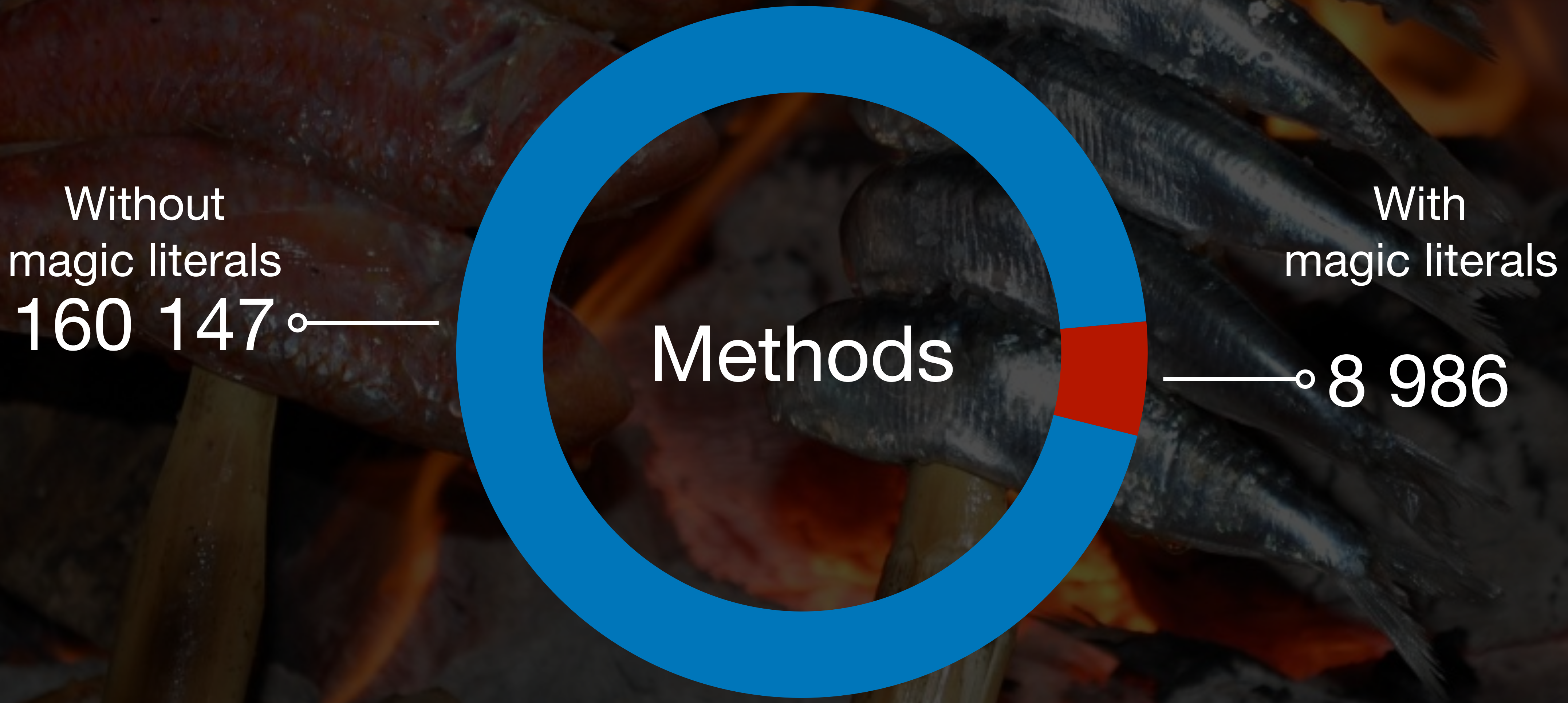
We have collected

112,500 methods

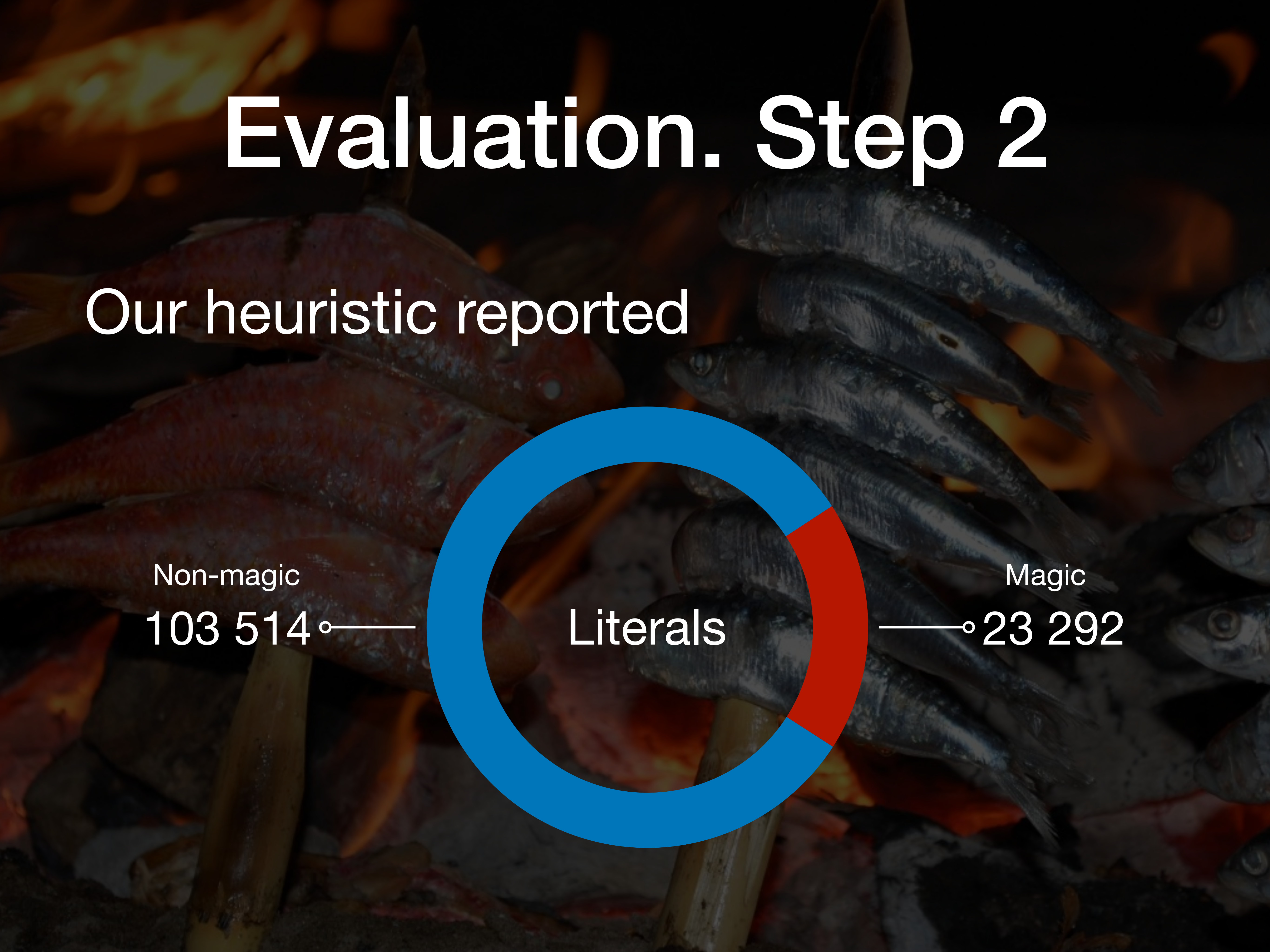
from Pharo 7 image

Evaluation. Step 2

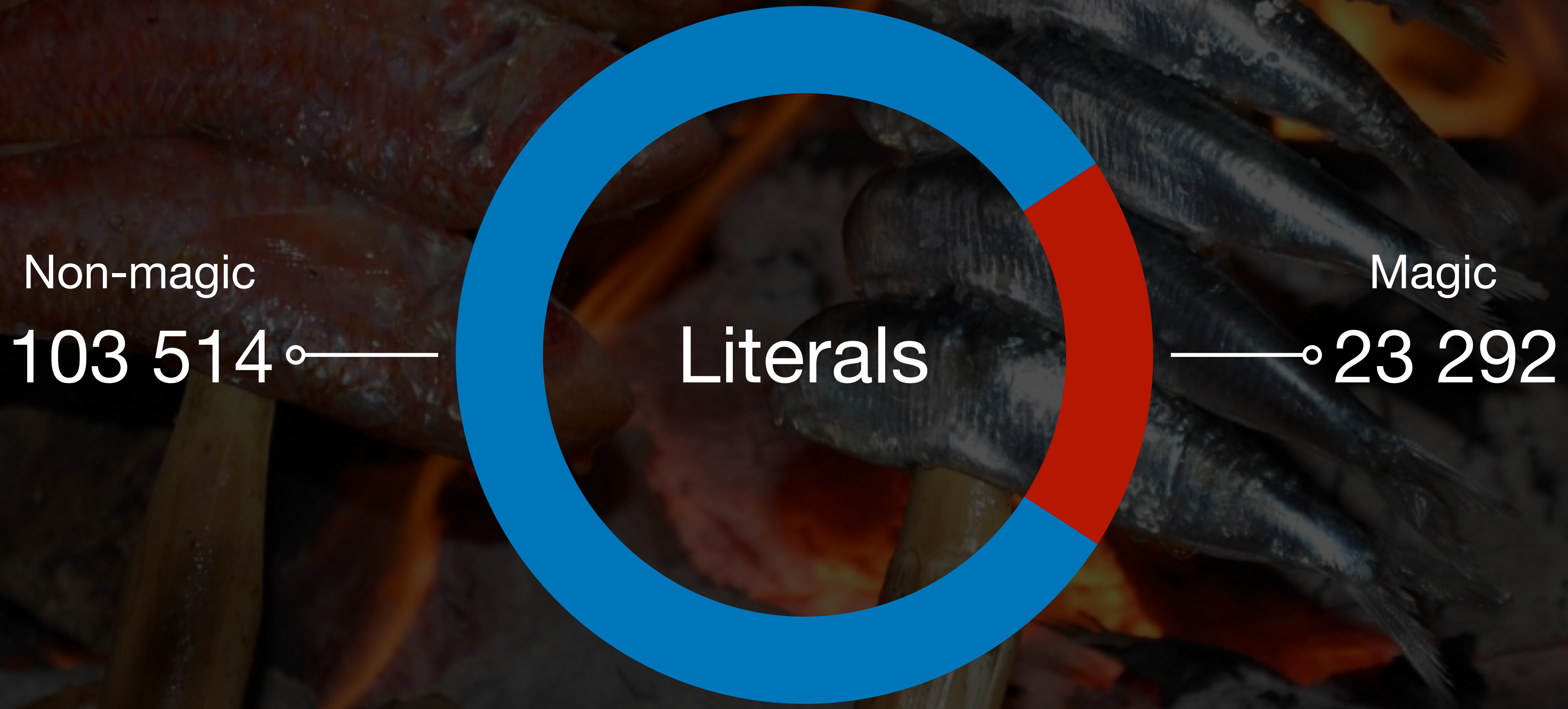
Our heuristic reported

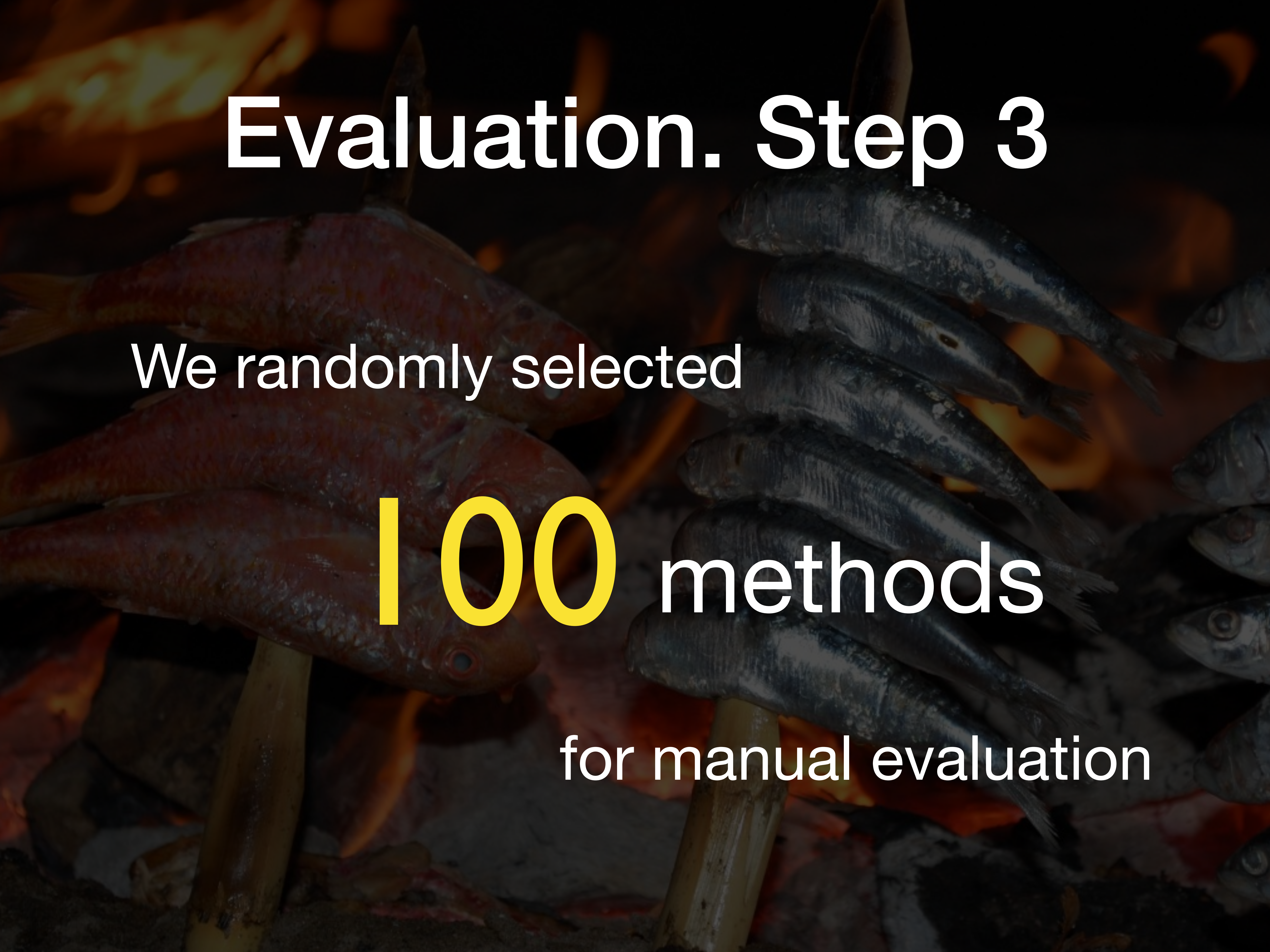


Evaluation. Step 2



Our heuristic reported



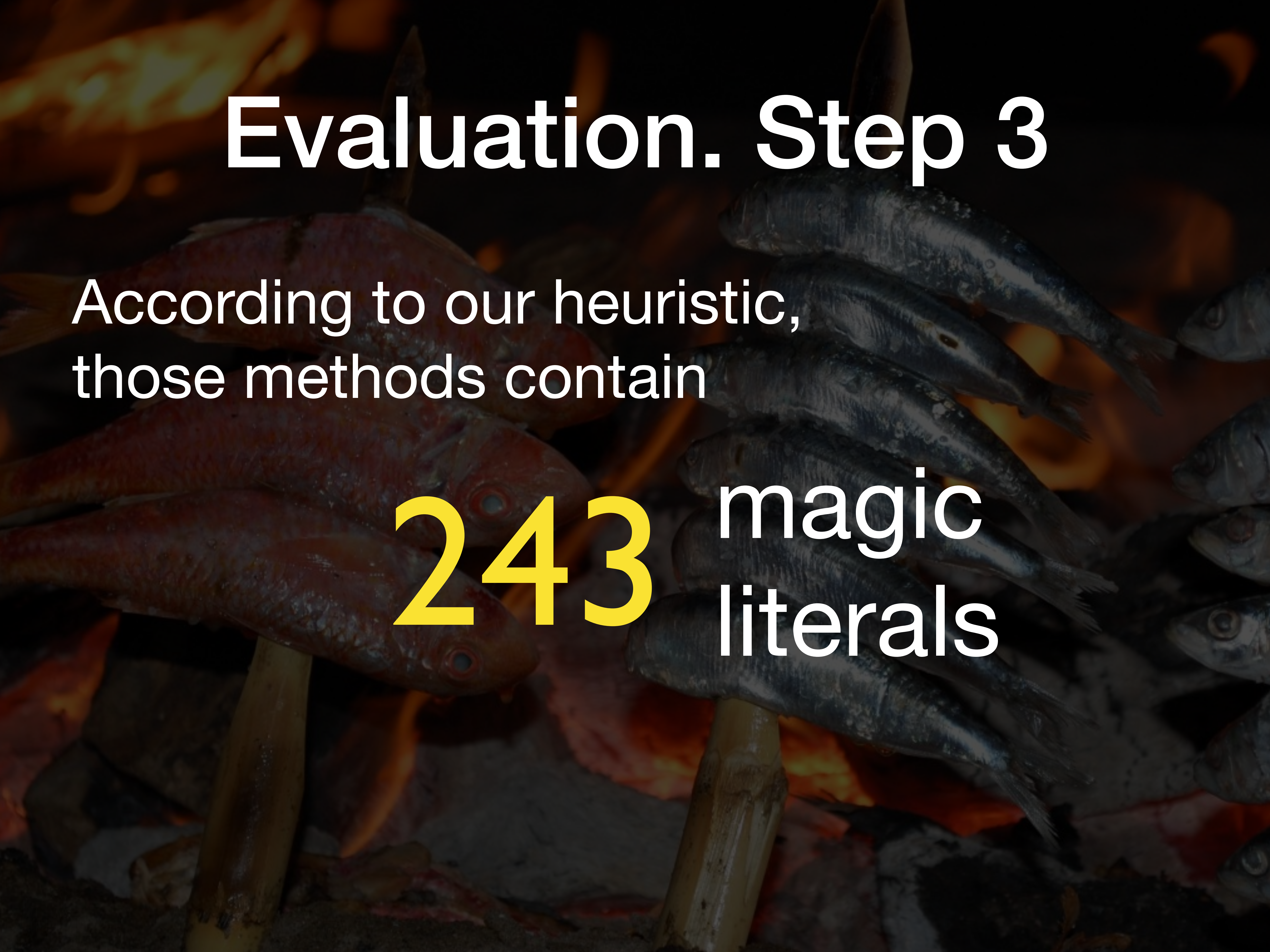


Evaluation. Step 3

We randomly selected

100 methods

for manual evaluation

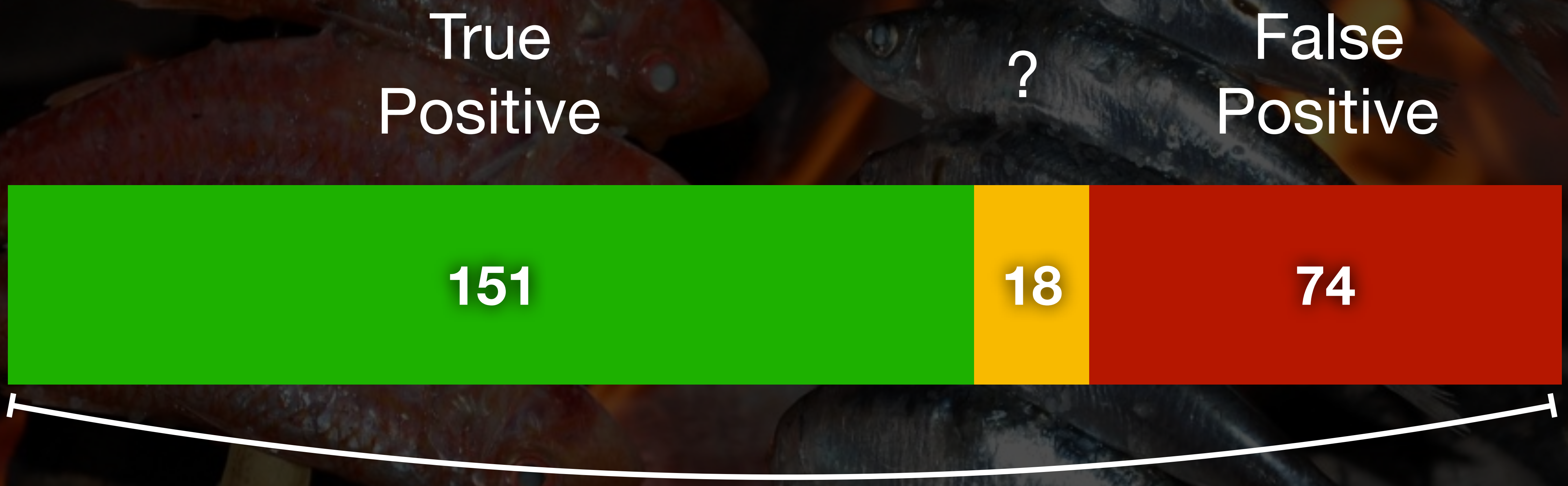


Evaluation. Step 3

According to our heuristic, those methods contain

243 magic literals

Evaluation. Step 4

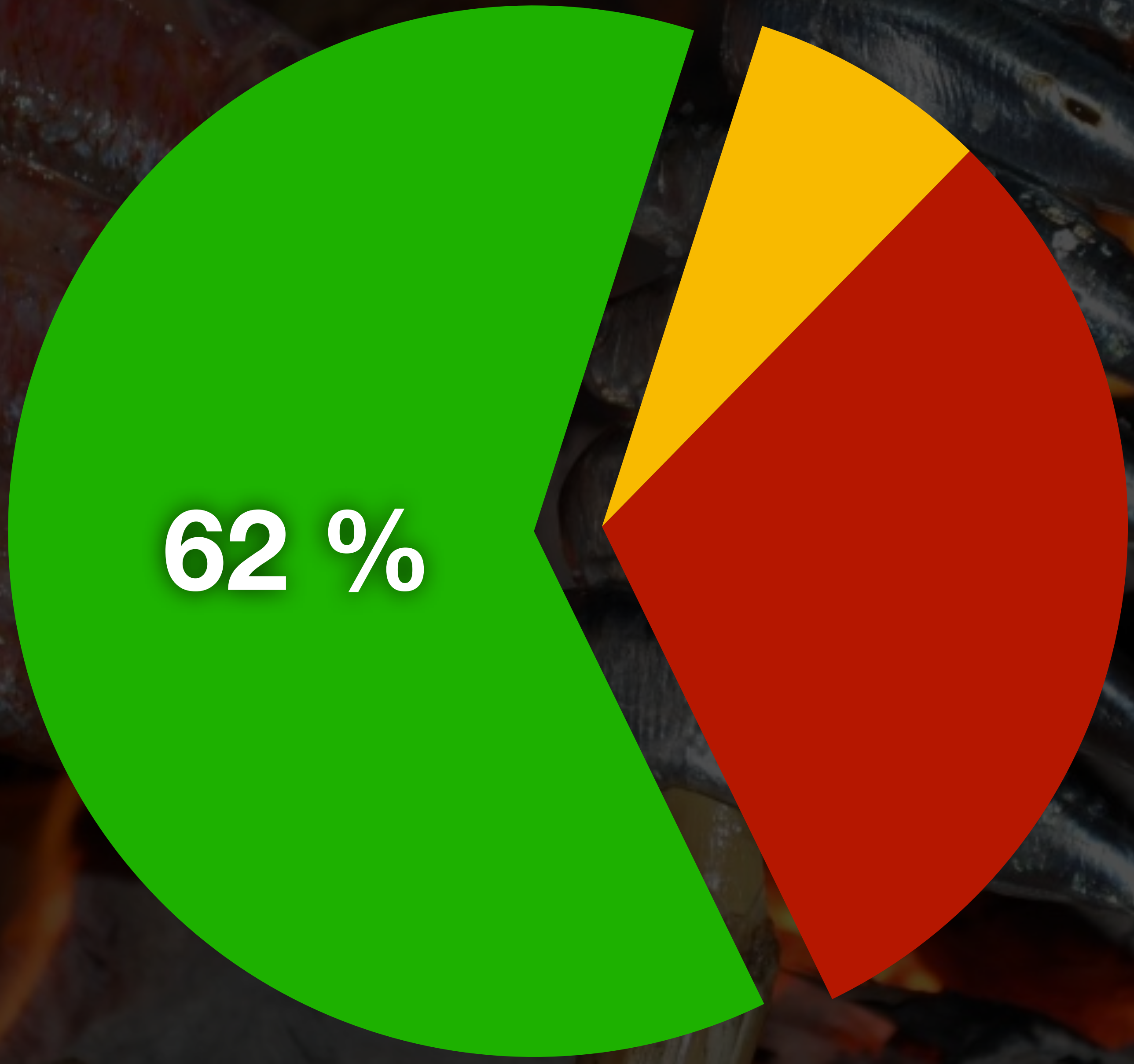


Same color as previous slide for 243 ?

rals

magic

Estimated Precision

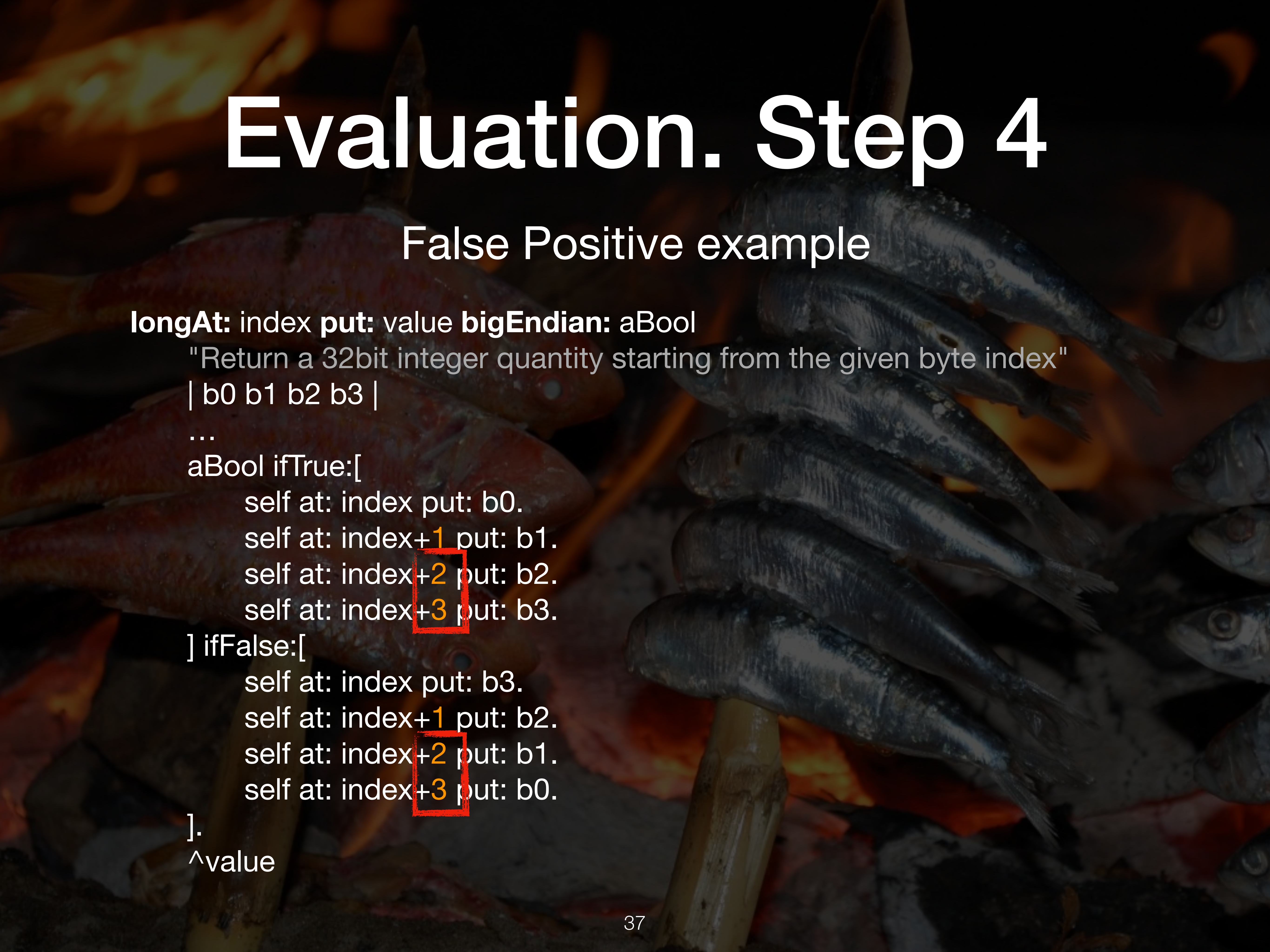


Evaluation. Step 4

True Positive example

```
Socket>>receiveSomeData
	"Receive currently available data (if any). Do not wait."

	| buffer bytesRead |
	buffer := String new: 2000.
	bytesRead := self receiveSomeDataInto: buffer.
	^buffer copyFrom: 1 to: bytesRead
```



Evaluation. Step 4

False Positive example

```
longAt: index put: value bigEndian: aBool
	"Return a 32bit integer quantity starting from the given byte index"
	| b0 b1 b2 b3 |
	…
	aBool ifTrue:[
		self at: index put: b0.
		self at: index+1 put: b1.
		self at: index+2 put: b2.
		self at: index+3 put: b3.
	] ifFalse:[
		self at: index put: b3.
		self at: index+1 put: b2.
		self at: index+2 put: b1.
		self at: index+3 put: b0.
	].
	^value
```

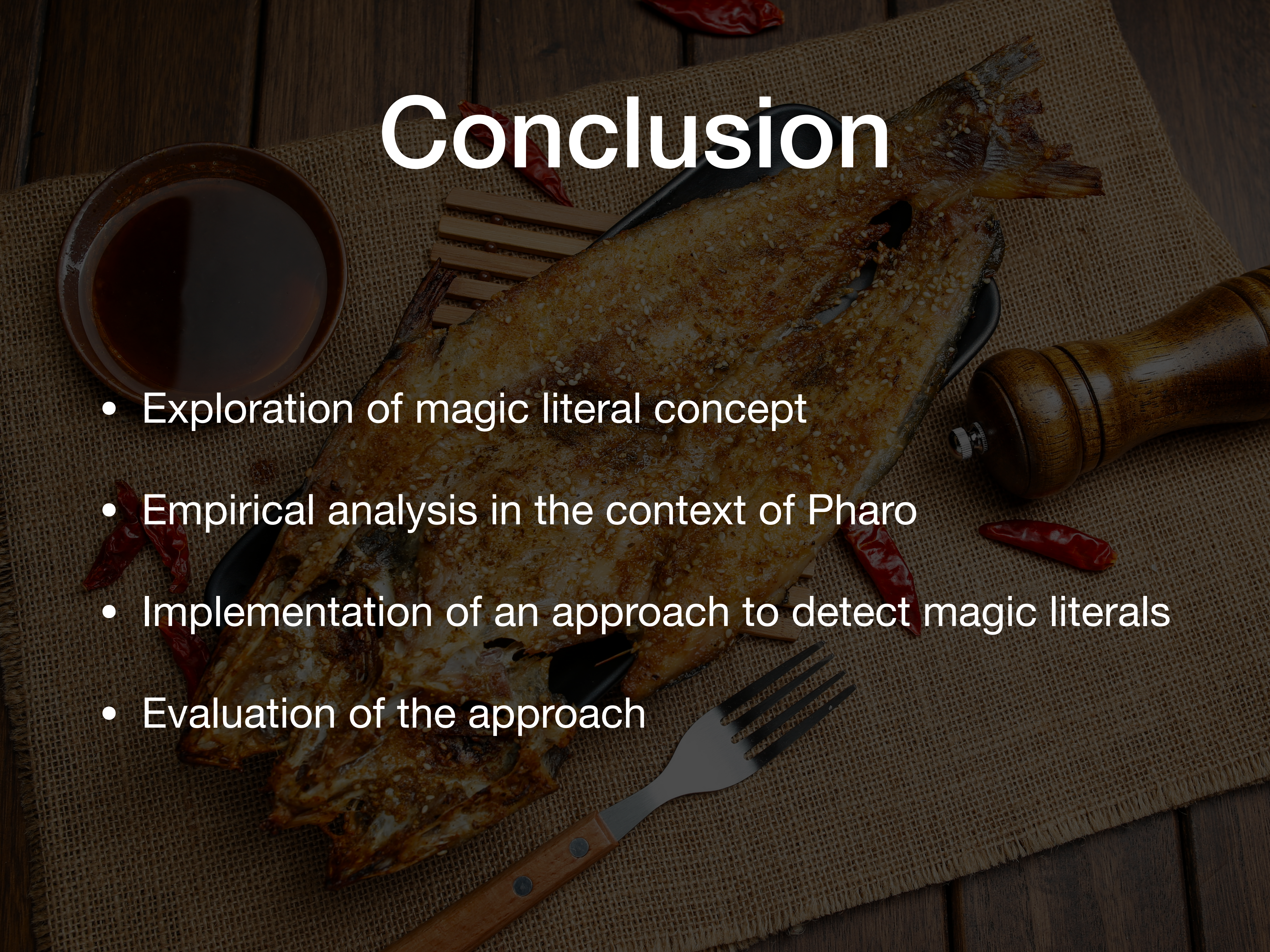
Evaluation. Step 4

Not sure of category example

Put example with number instead

```
IceGitSshRemote>>httpsUrl
        ^ 'https://{1}/{2}.git' format: { self host . self projectPath }
```

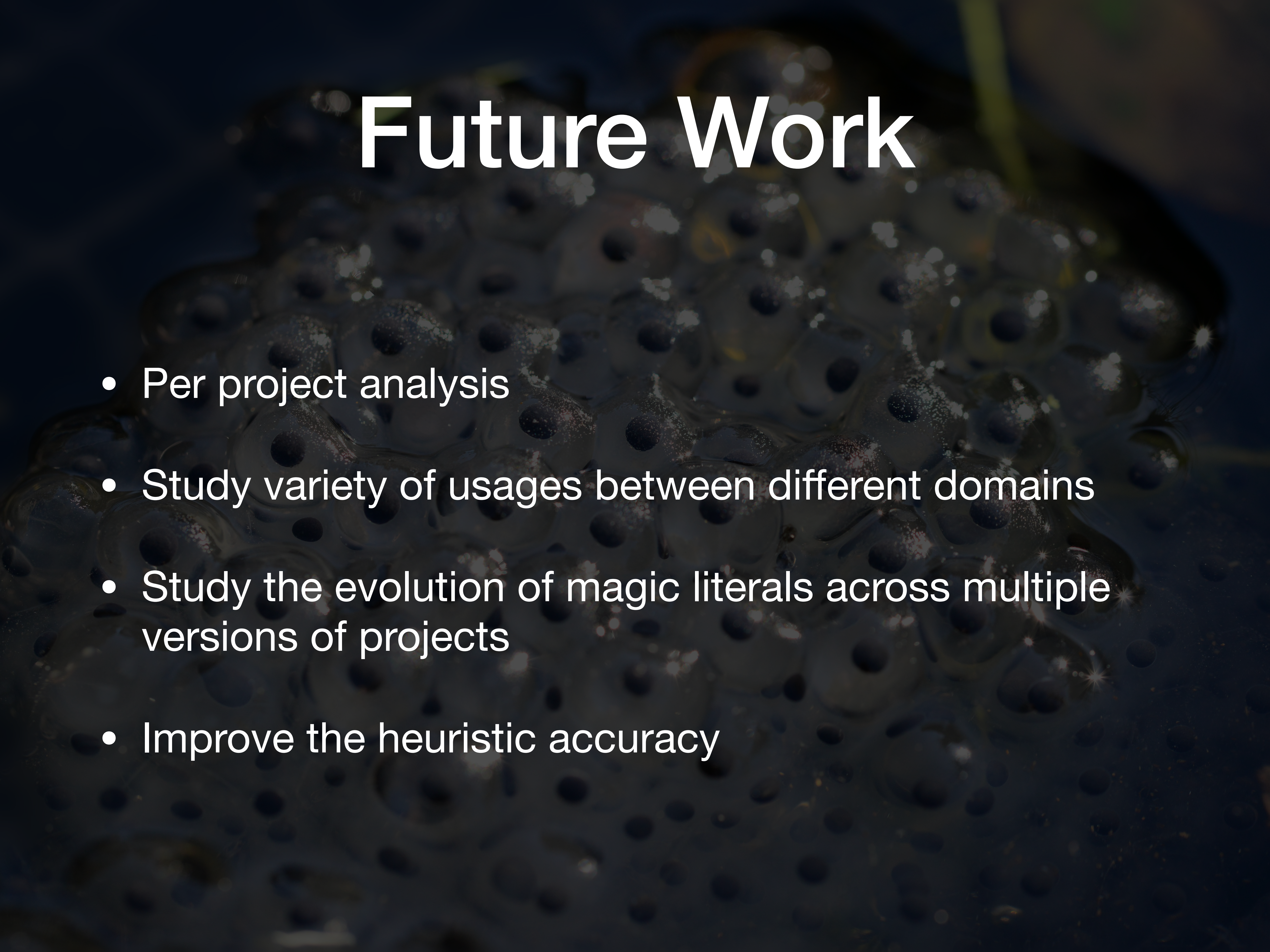
Conclusion



Conclusion

- Exploration of magic literal concept
- Empirical analysis in the context of Pharo
- Implementation of an approach to detect magic literals
- Evaluation of the approach

Future Work

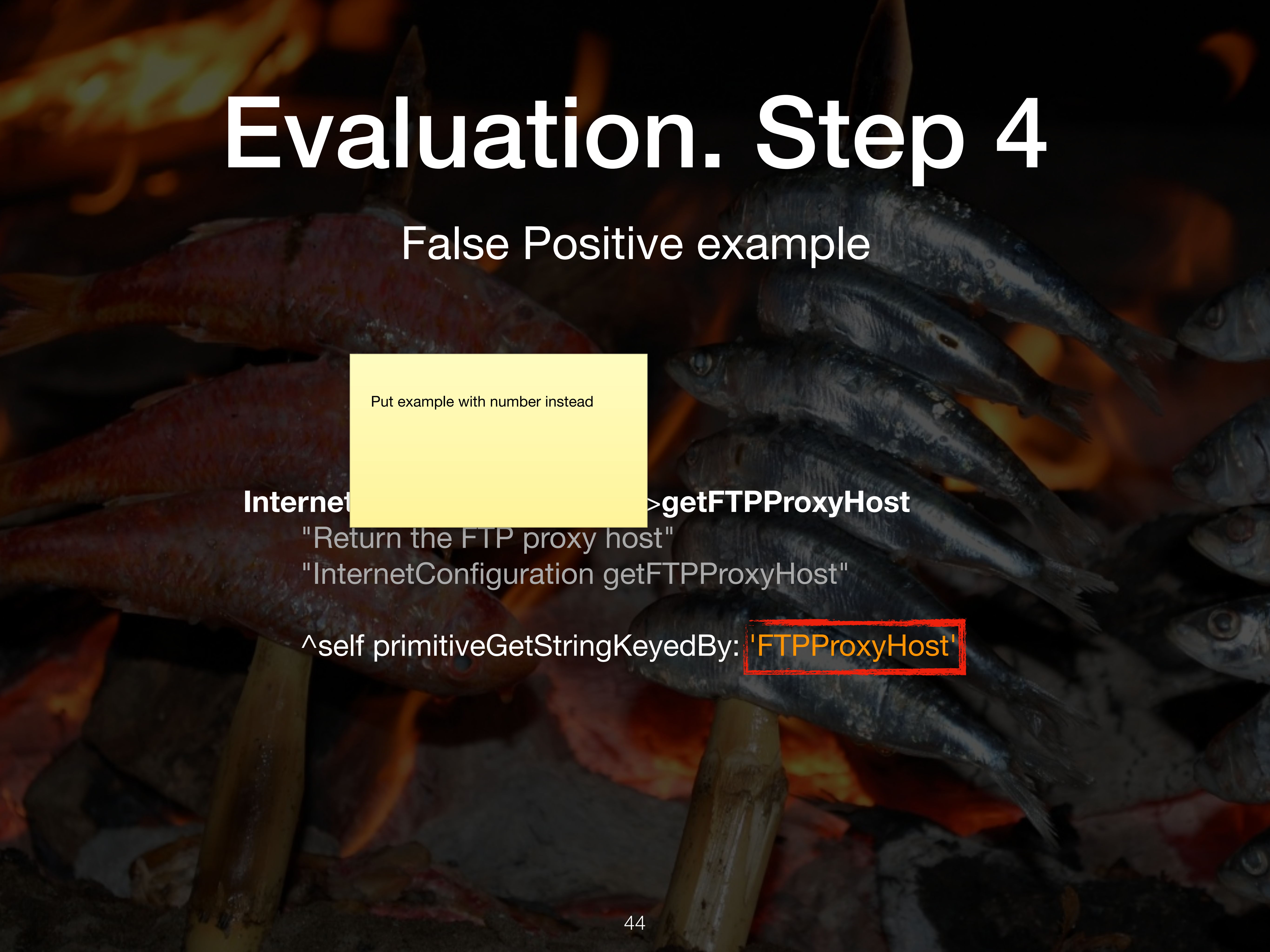


Future Work

- Per project analysis
- Study variety of usages between different domains
- Study the evolution of magic literals across multiple versions of projects
- Improve the heuristic accuracy

Takeaways

- First heuristic for identifying magic literals
- Implemented as code critics (lint) rule
- 62% of reported literals were actually magic (and should be fixed)



Evaluation. Step 4

False Positive example

Put example with number instead

```
Internet                    >getFTPProxyHost
    "Return the FTP proxy host"
    "InternetConfiguration getFTPProxyHost"

    ^self primitiveGetStringKeyedBy: 'FTPProxyHost'
```