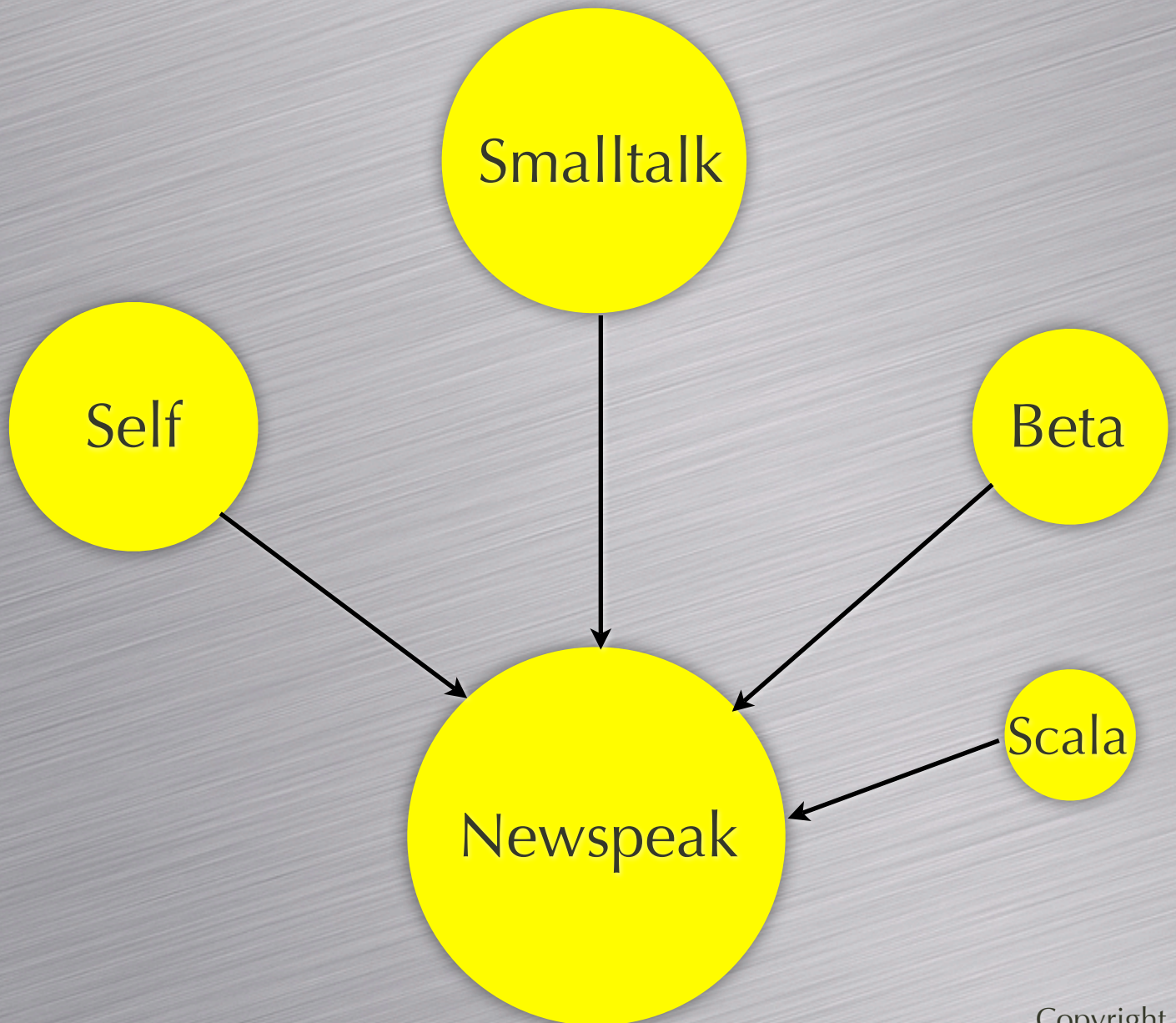
Newspeak

Gilad Bracha

Distinguished Engineer

Cadence Design Systems

A Noble Inheritance



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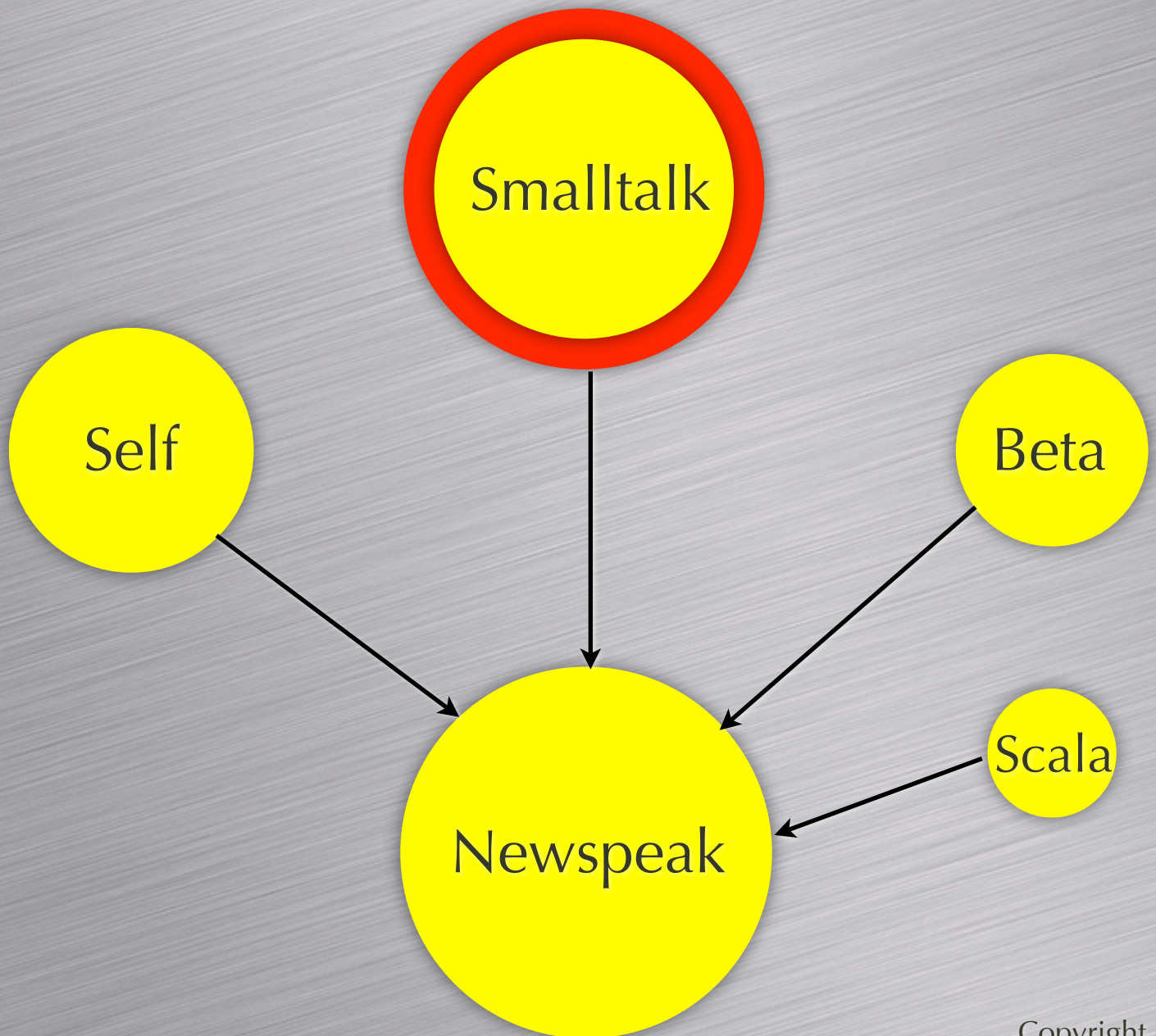
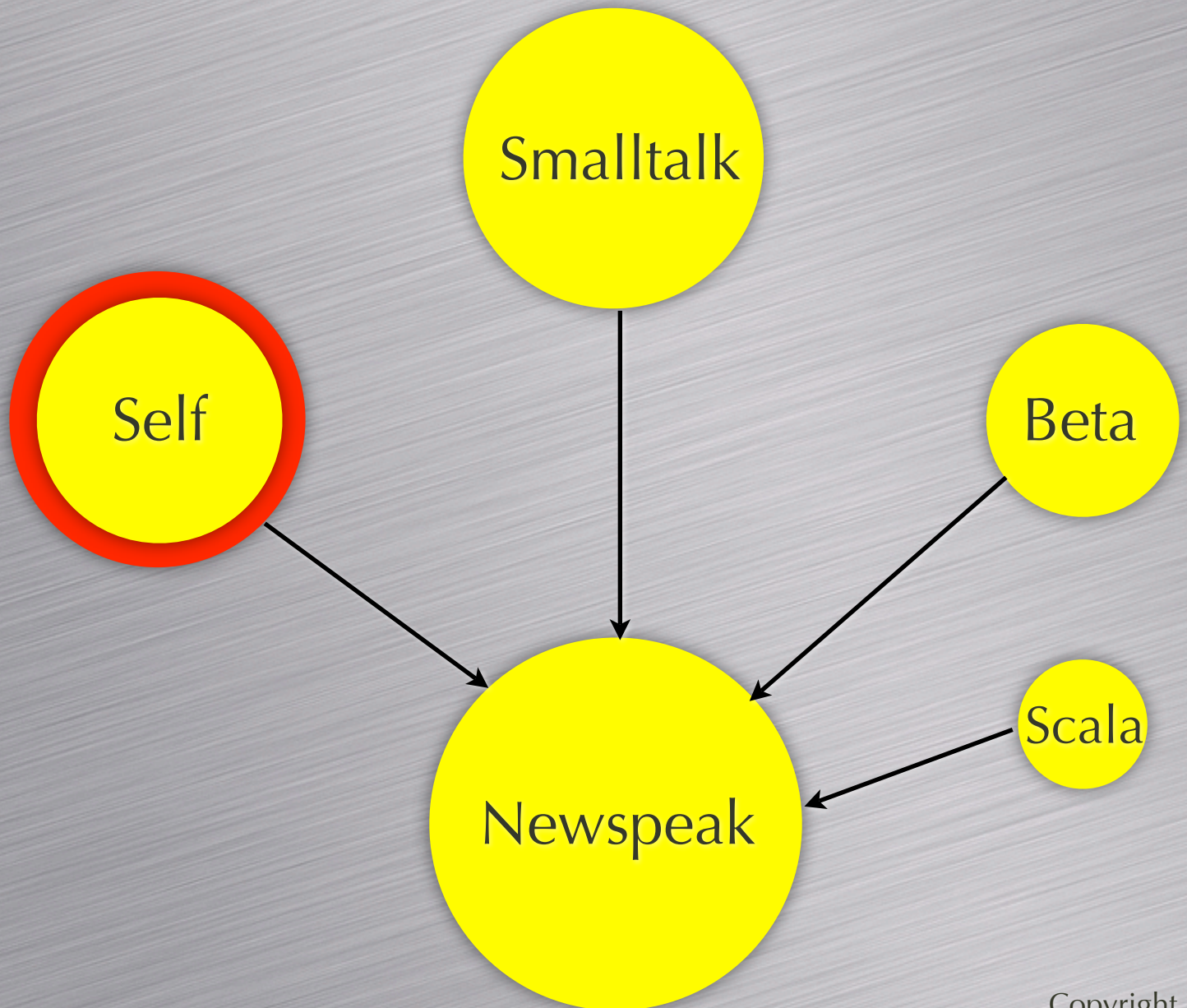


Influences of Smalltalk

- Class based
- Dynamically typed
- **Reflective**
  - Full hotswapping

A Noble Inheritance



Influences of Self

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  - Loose coupling, not necessarily asynchrony

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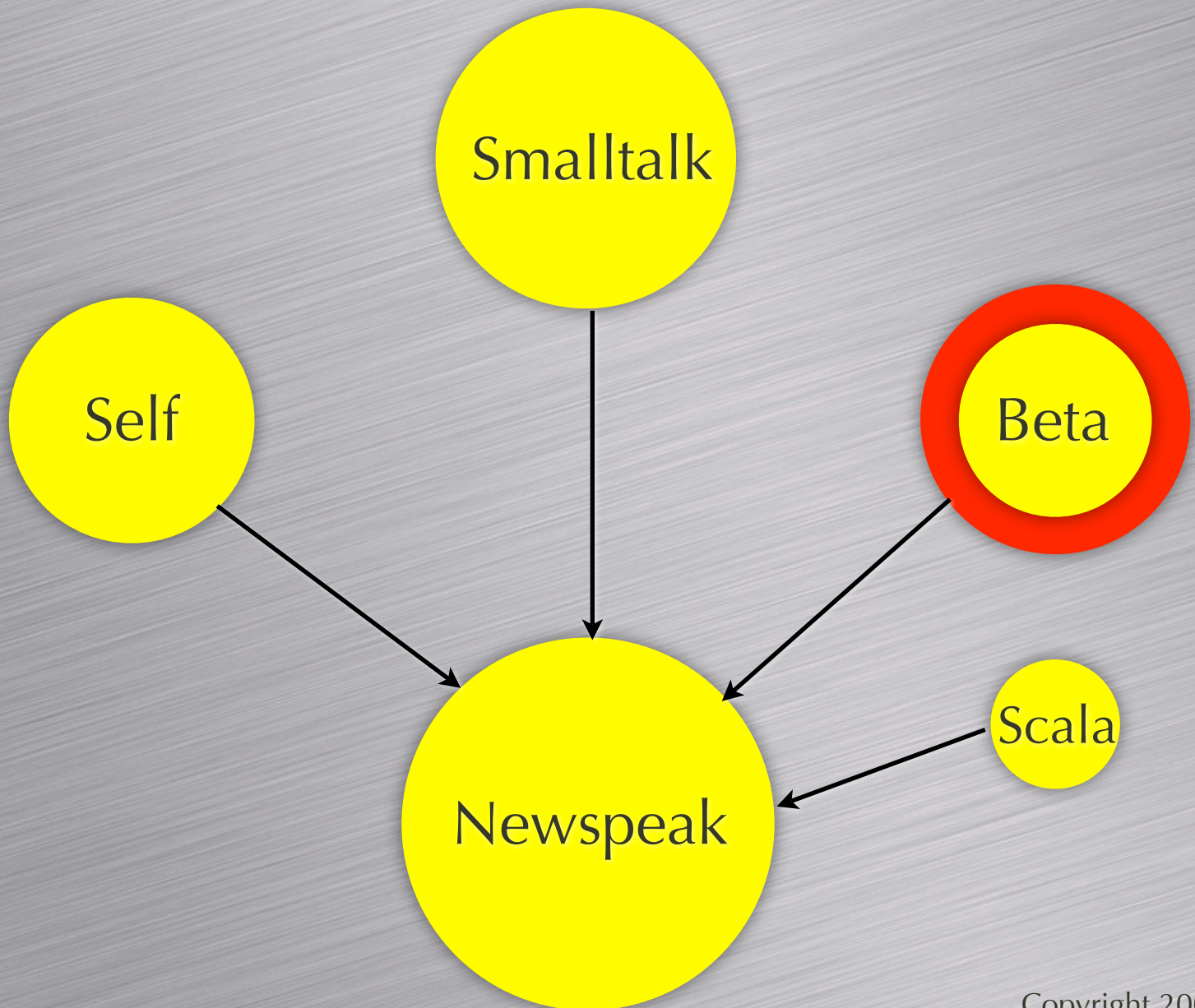
id ::= letter, (letter | digit) star.

Influences of Self

- Mirror based reflection

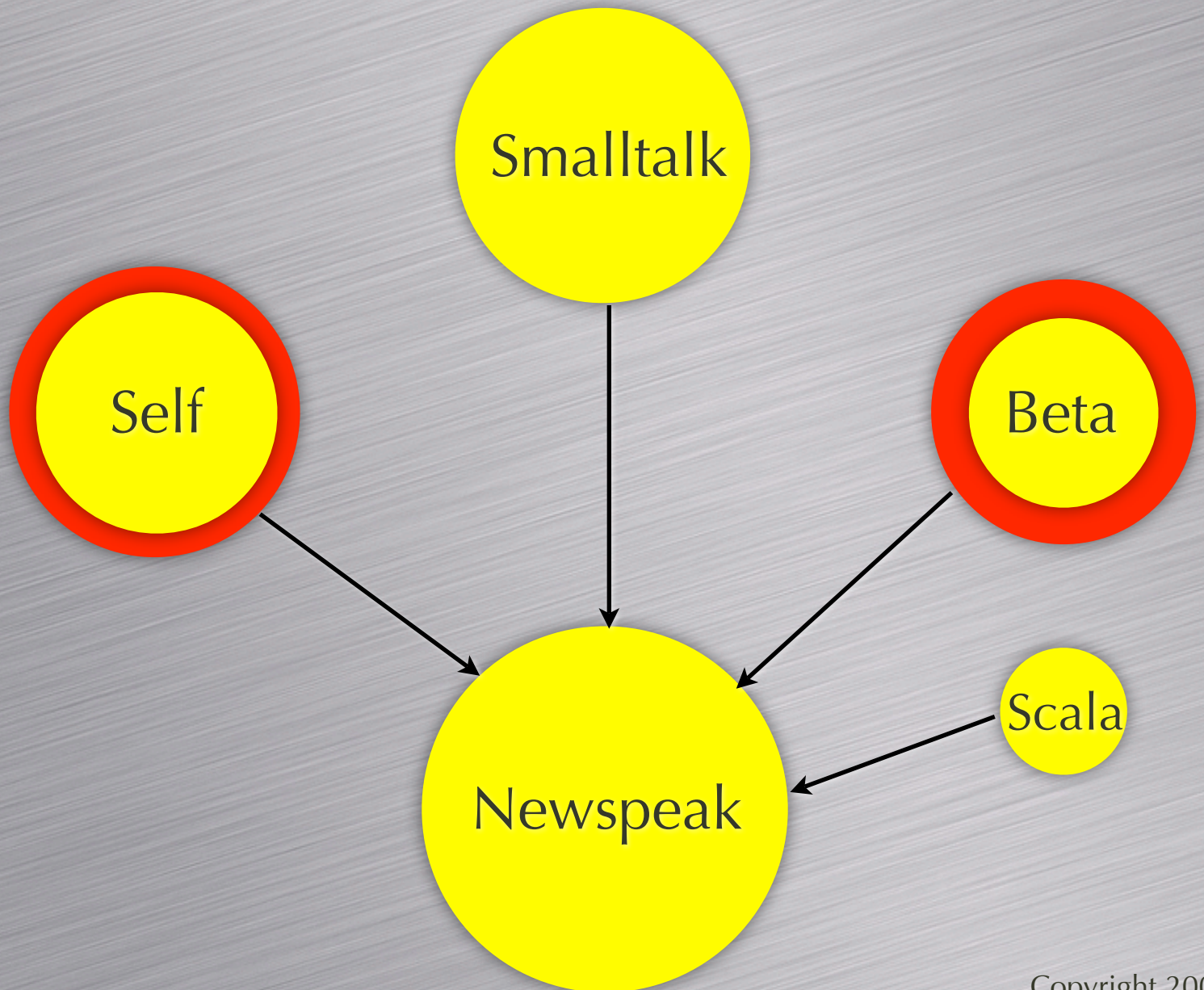
A Noble Inheritance



Influences of Beta

- Nested Classes

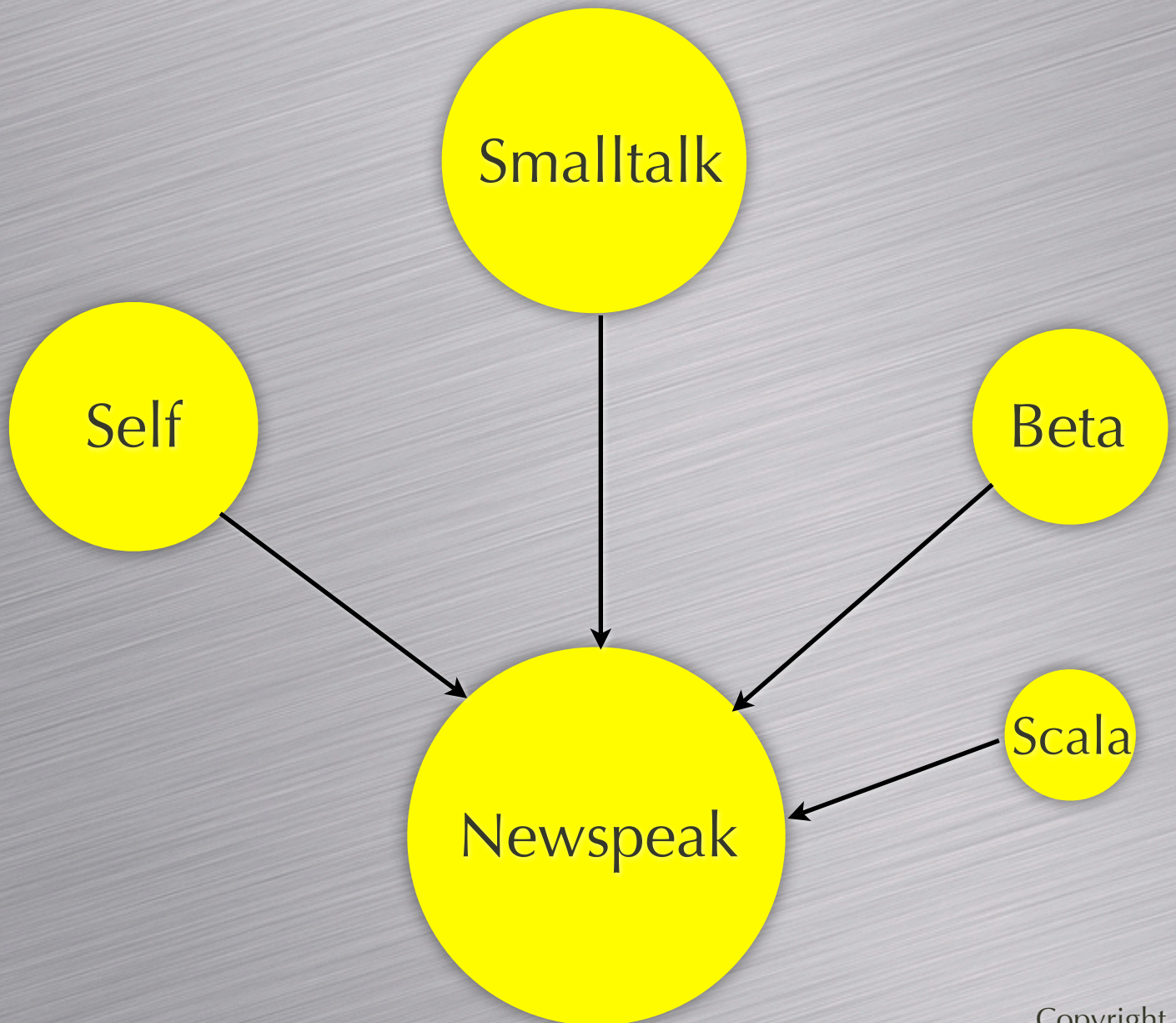
A Noble Inheritance



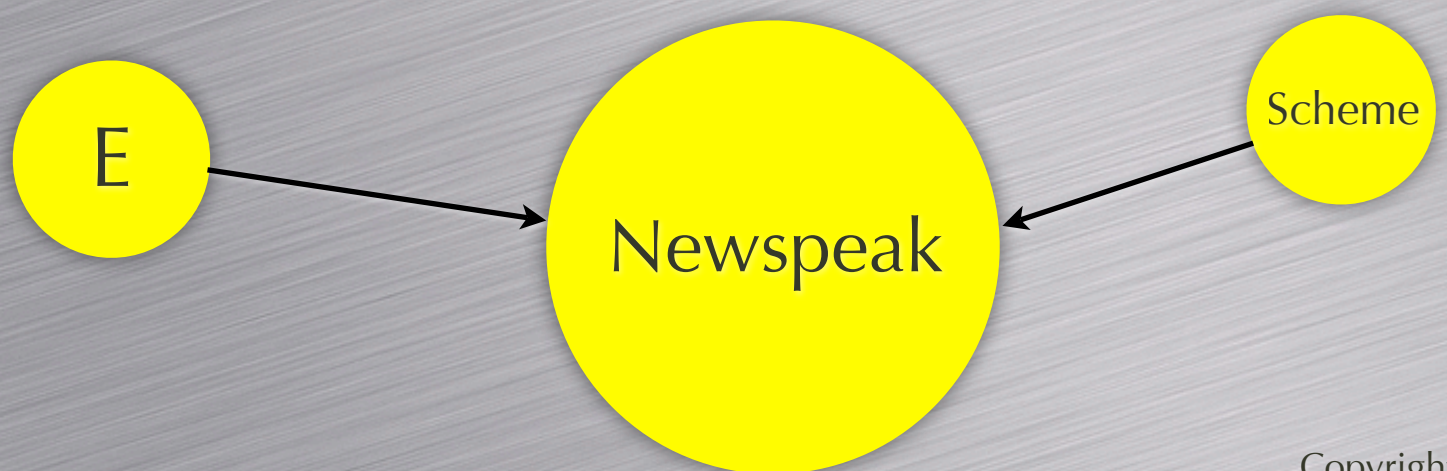
Class Nesting + Message based Programming

- All nested classes are virtual classes
- All classes are mixins
- Class Hierarchy inheritance

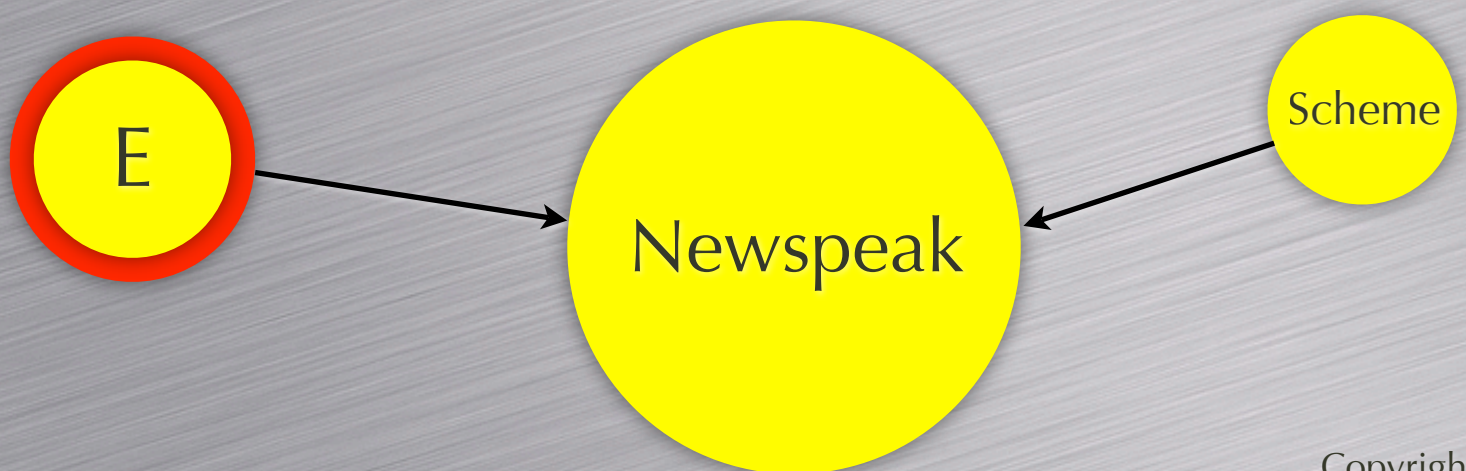
A Noble Inheritance



Commonalities



Commonalities



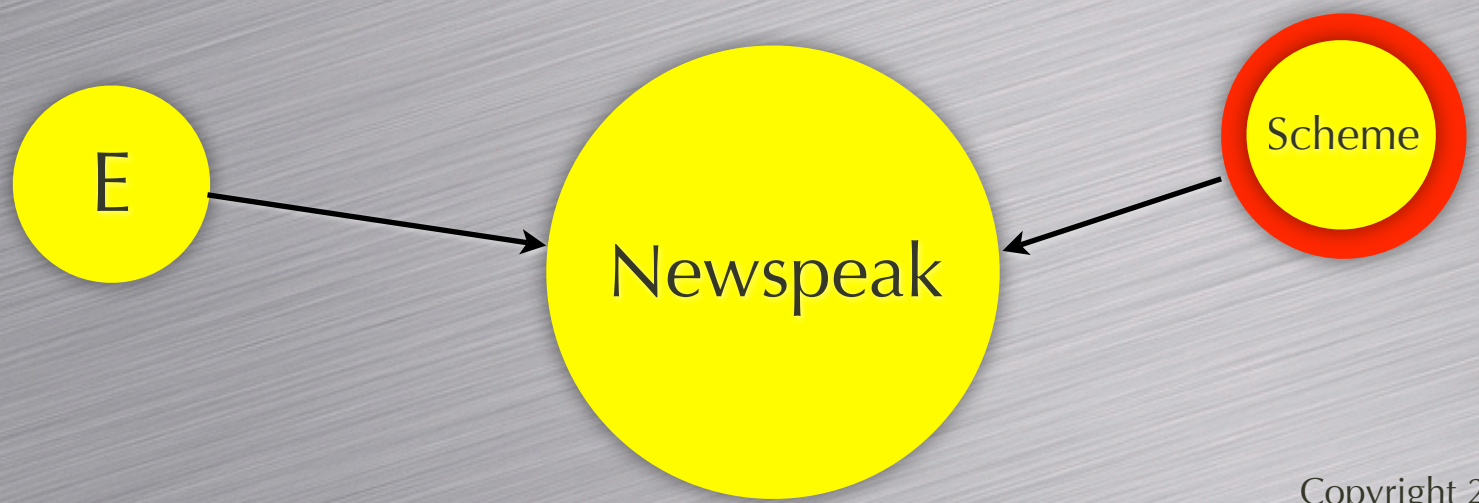
Commonalities with E

- **Security**
  - Object-capability model
    - public, protected and private messages
  - No static state

Uncommonalities with E

- Unlike E, Newspeak is reflective
  - Mirrors act as capabilities for reflection

Commonalities



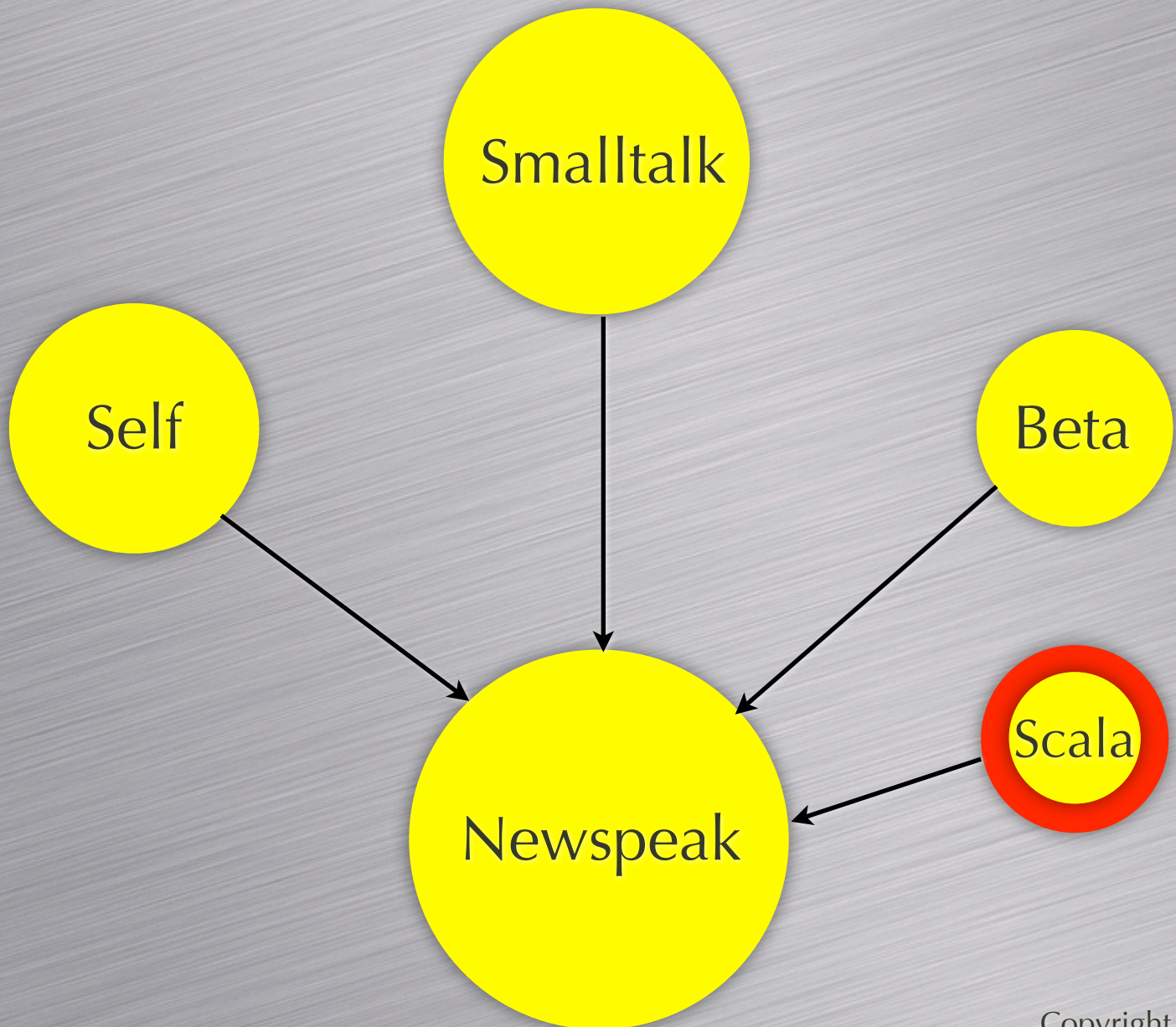
Commonalities with PLT Scheme

- **Modularity**
  - Component style modules

Module Definitions

- Classes not nested within another class
- Deeply Immutable
- Instantiated into stateful objects known as ***modules***
- No access to surrounding namespace
- Constructor parameters are objects/ capabilities that determine per-module sandbox

A Noble Inheritance



Influences of Scala

- Some details of object construction
- Pattern Matching via Extractors?

Parser Combinators

BNF

*id = letter (letter | digit) **

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Newspeak

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How it Works

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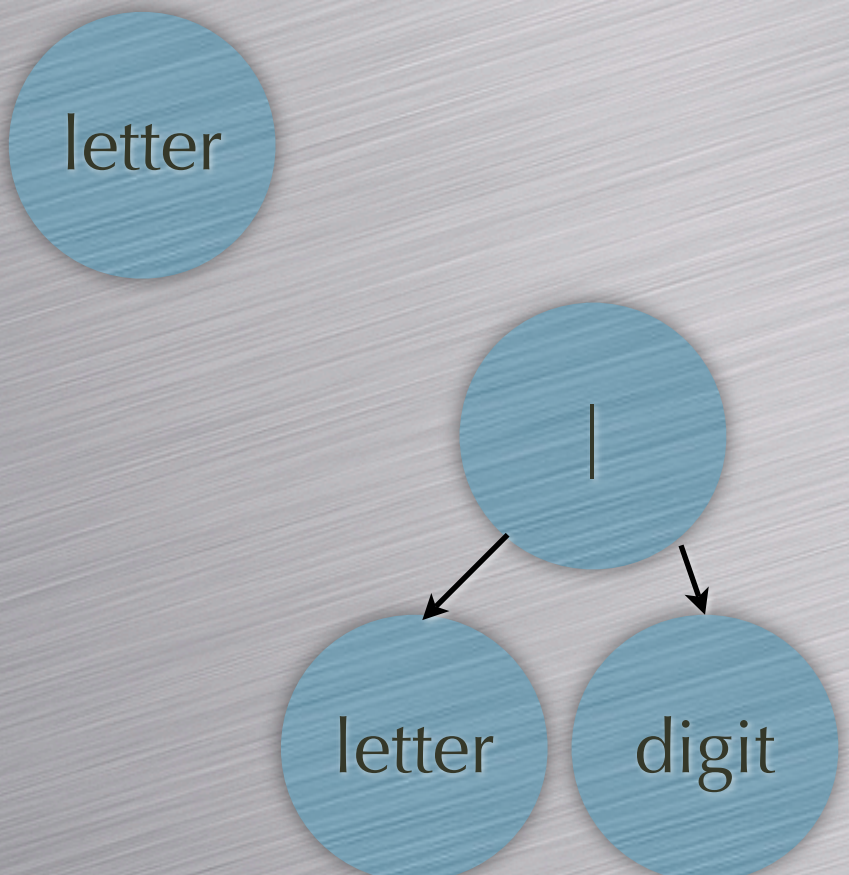

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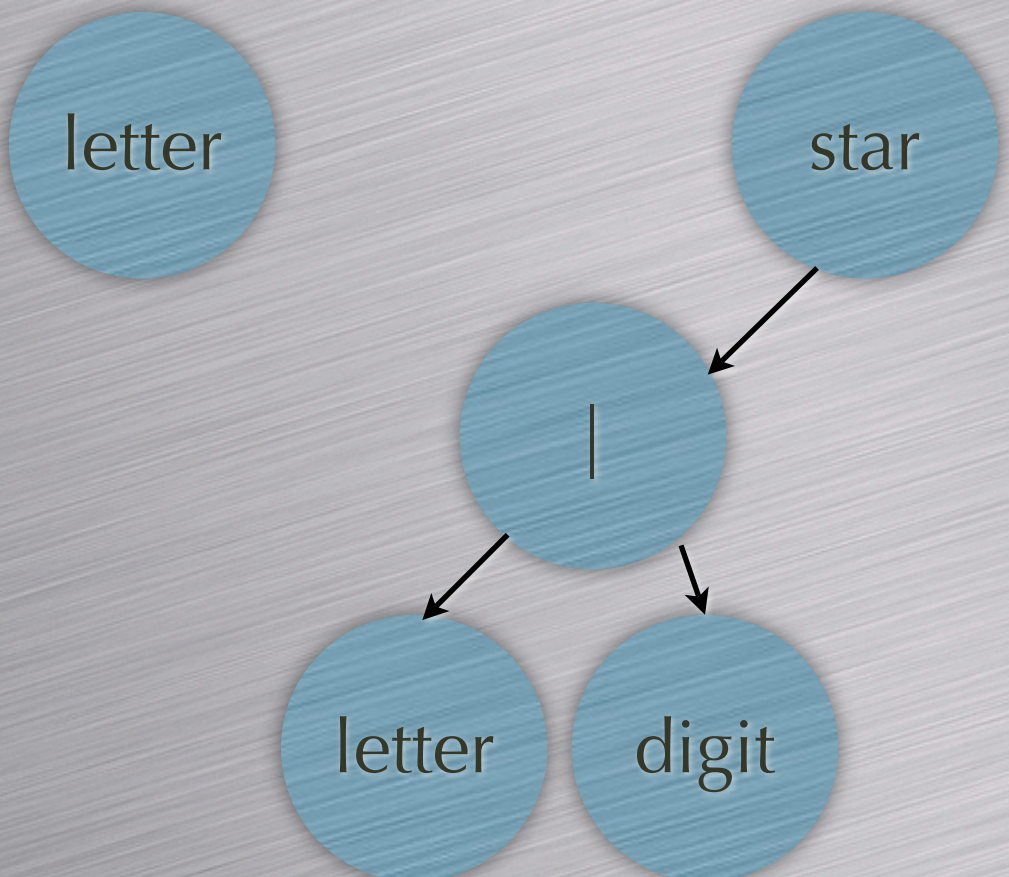

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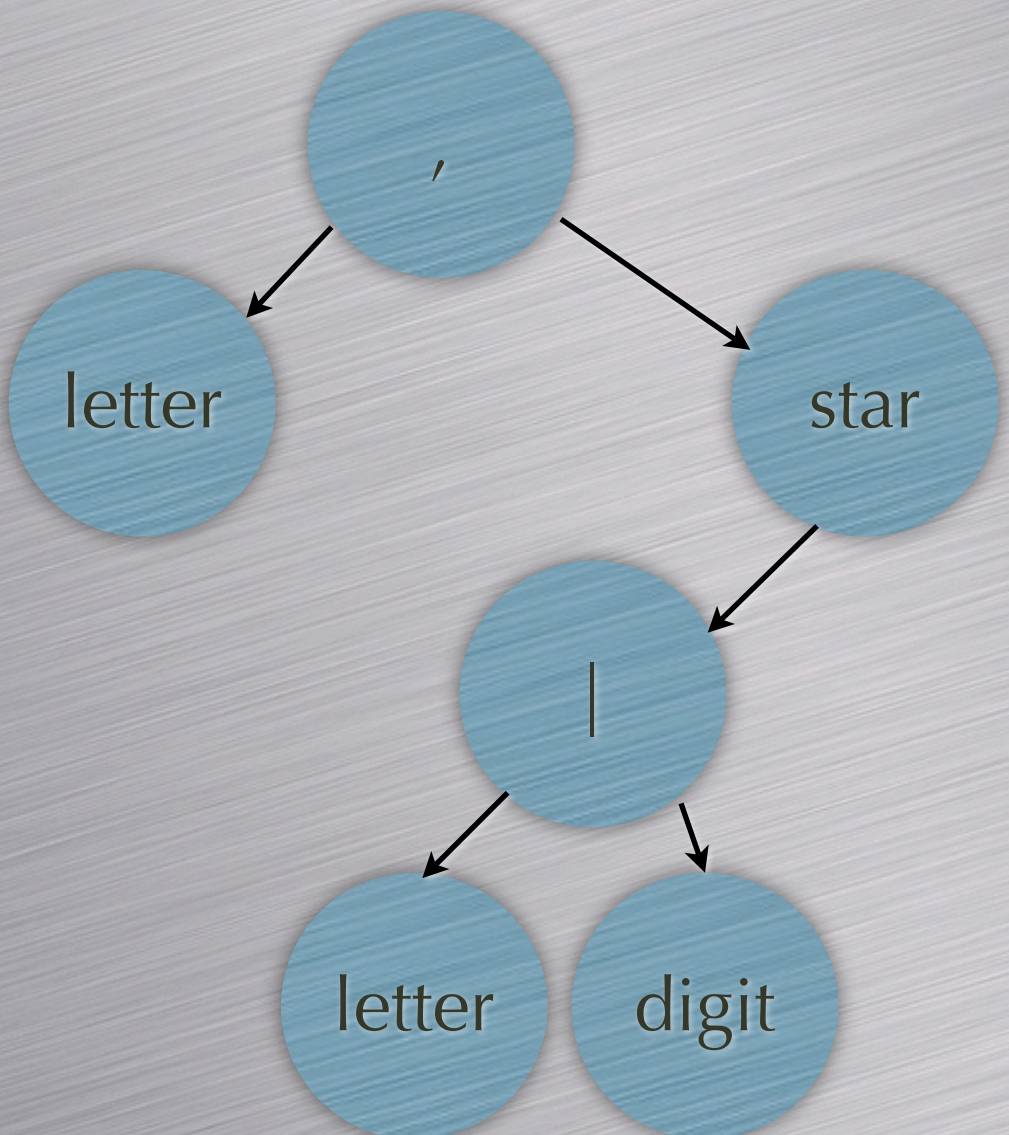

id = letter, (letter | digit) star.

Why is this Pretty?

id = letter, (letter | digit) star.

Why is this Ugly?

```
id = letter().seq(letter().or(digit()).star());
```

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*id = letter (letter | digit) **

vs.

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Why is this Ugly?

```
id = letter().seq(letter().or(digit()).star());
```

vs.

```
id = letter (letter | digit) *
```

vs.

```
id = letter, (letter | digit) star.
```

Why is it Ugly?

A programming language is low level when its programs require attention to the irrelevant

- Alan Perlis

A Complete Grammar

```
class ExampleGrammar1 = ExecutableGrammar (
|
digit = charBetween: $0 and: $9.
letter = (charBetween: $a and:$z) |
         (charBetween: $A and:$Z).
id = letter, (letter | digit) star.
identifier = tokenFor: id.
hat = tokenFromChar: $^.
expression = identifier.
returnStatement = hat, expression.
|
)()
```

Building an AST

```
returnStatement = hat, expression
                wrapper:[:r : e |
                        ReturnStatAST on: e
                ]
```

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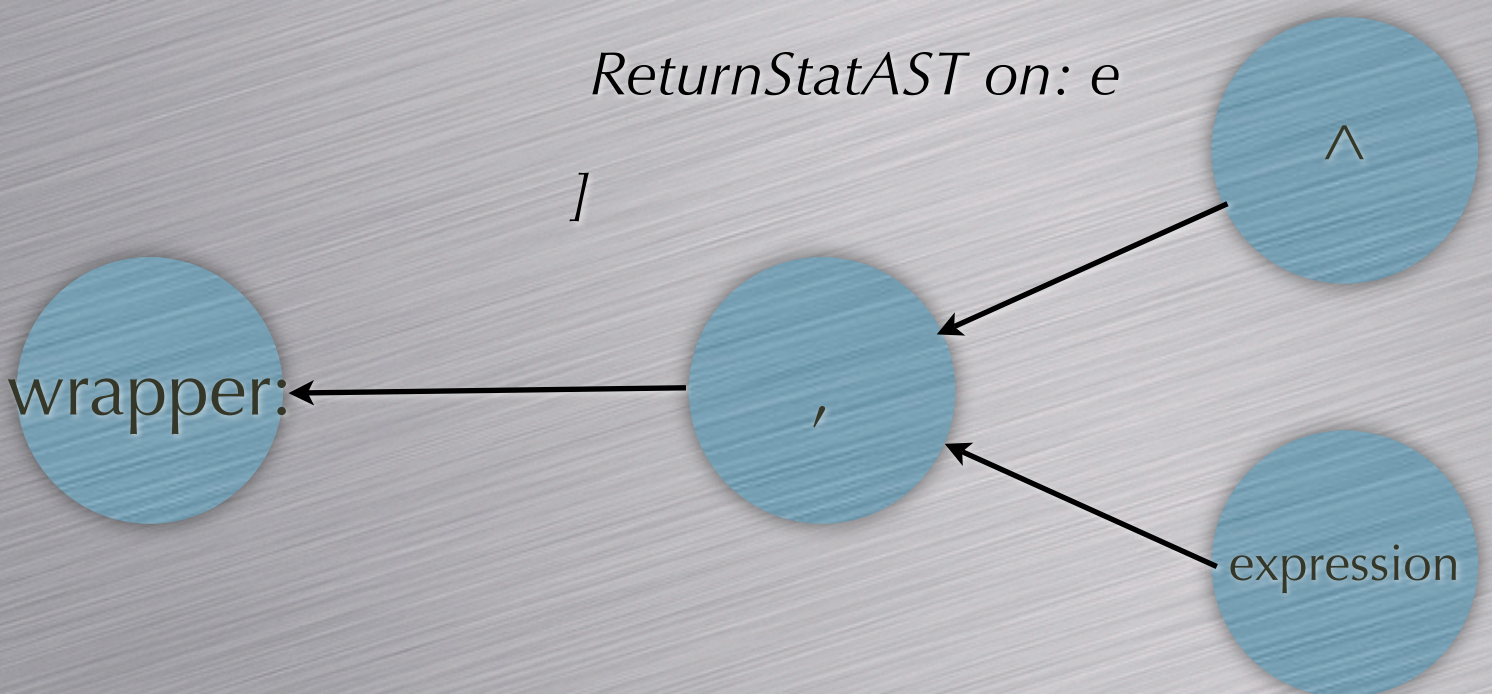


Grammar

```
returnStatement = hat, expression

        wrapper:[:r : e |

                ReturnStatAST on: e

        ]
```

Semantic action

```
returnStatement = hat, expression
                    wrapper:[:r : e |
                                ReturnStatAST on: e
                    ]
```

Factor out Grammar

Superclass (pure grammar specification):

returnStatement = hat, expression

Subclass (AST builder):

```
returnStatement = (

        super returnStatement

            wrapper:[:r : e |

                ReturnStatAST on: e

            ] )
```

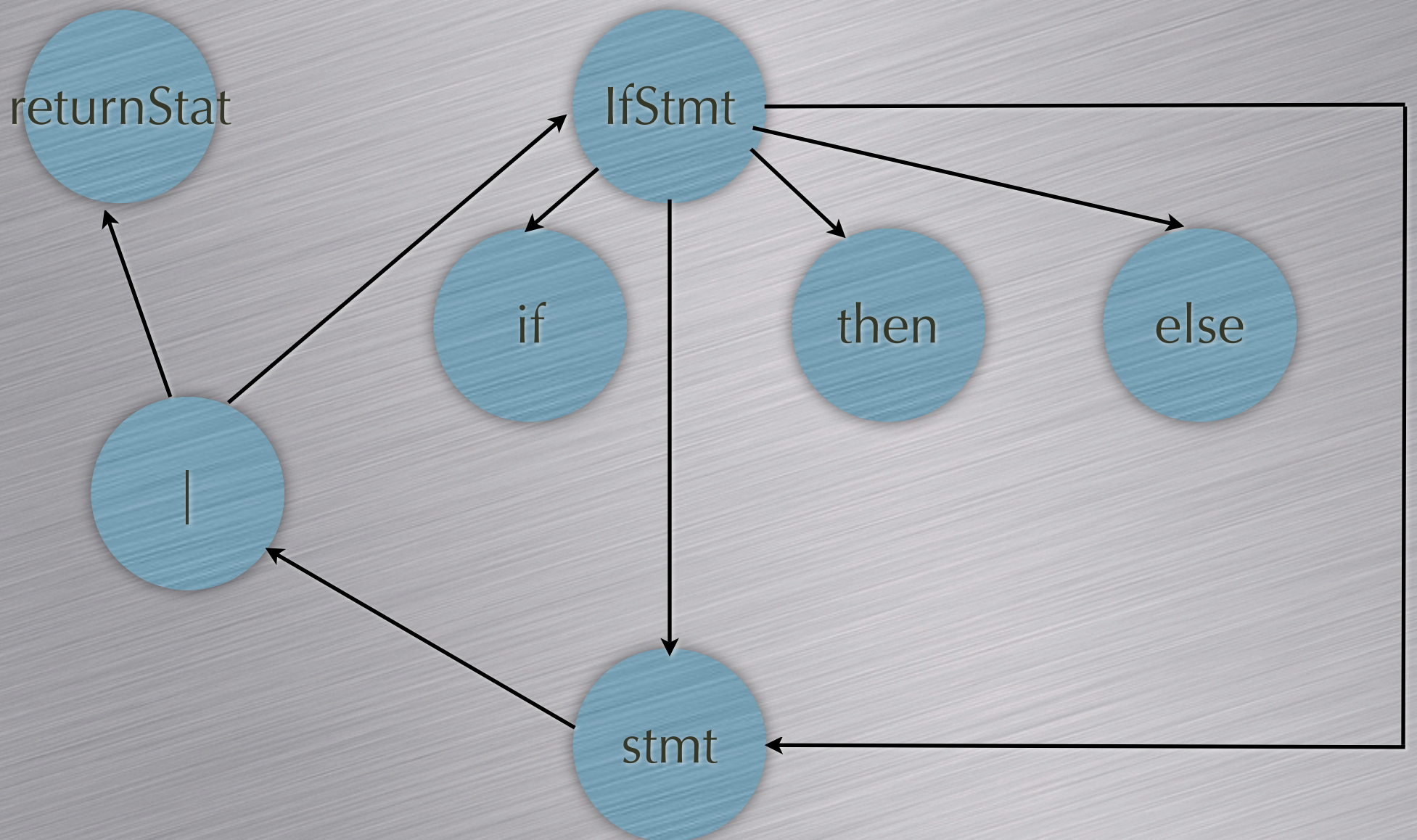
Modular Parser

```
class ExampleParser1= ExampleGrammar1 () (
  id = (
    ^super id
      wrapper:[:fst :snd | fst asString, (String withAll: snd)]
  )
  identifier = (
    ^super identifier
      wrapper:[:v |VariableAST new name: v token;
                                  start: v start; end: v end].
  )
  returnStatement = (
    ^super returnStatement
      wrapper:[:r :e | ReturnStatAST new expr:e;
                                  start: r start; end: e end].
)
```

Extending a Grammar

```
class ExampleGrammar2 = ExampleGrammar1 (
|
if = tokenFromSymbol:#if.
then = tokenFromSymbol:#then.
else = tokenFromSymbol:#else.
ifStatement = if, expression, then, statement, else, statement.
statement = ifStatement | returnStatement.
|
)()
```

Mutual Recursion



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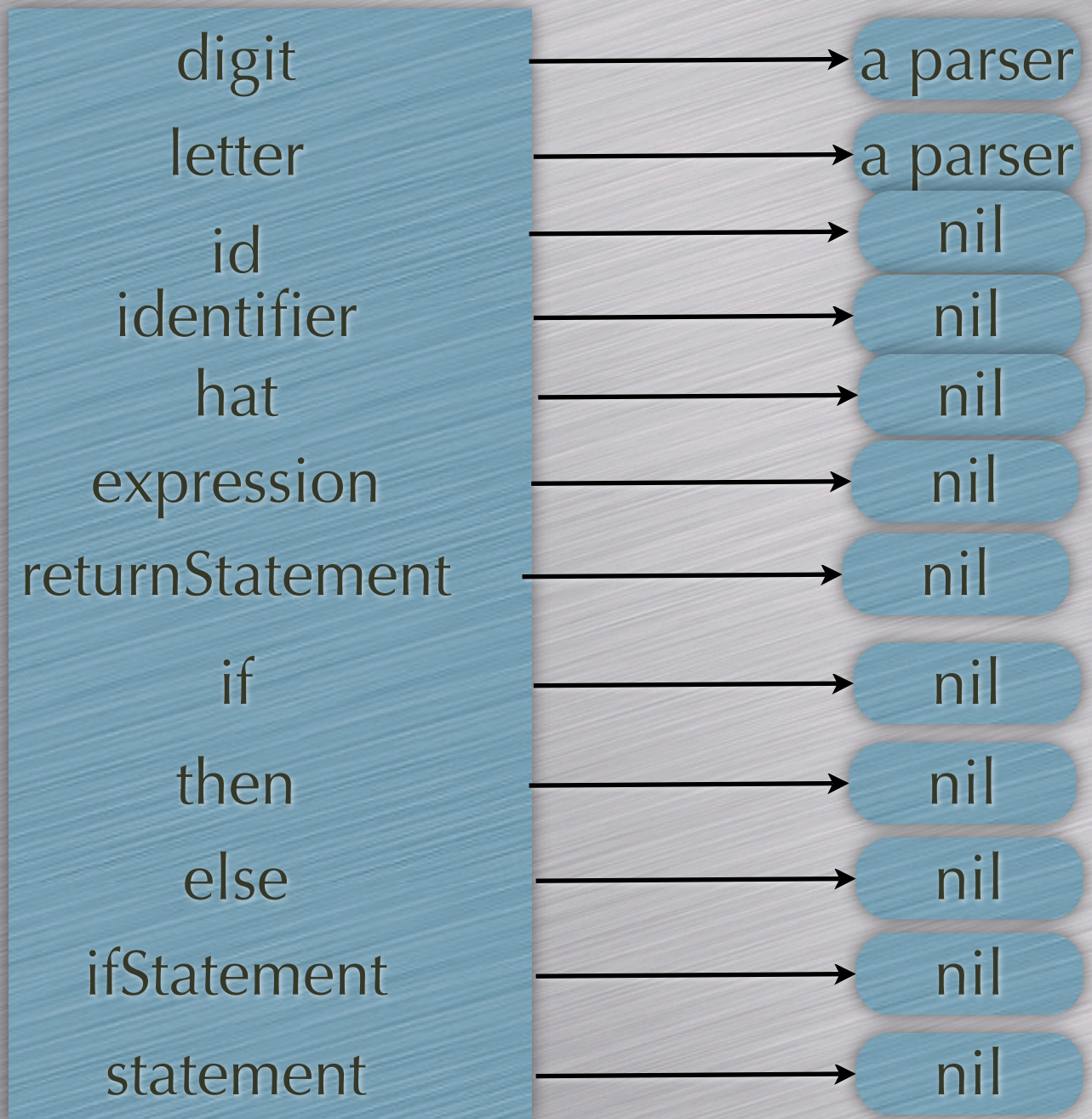

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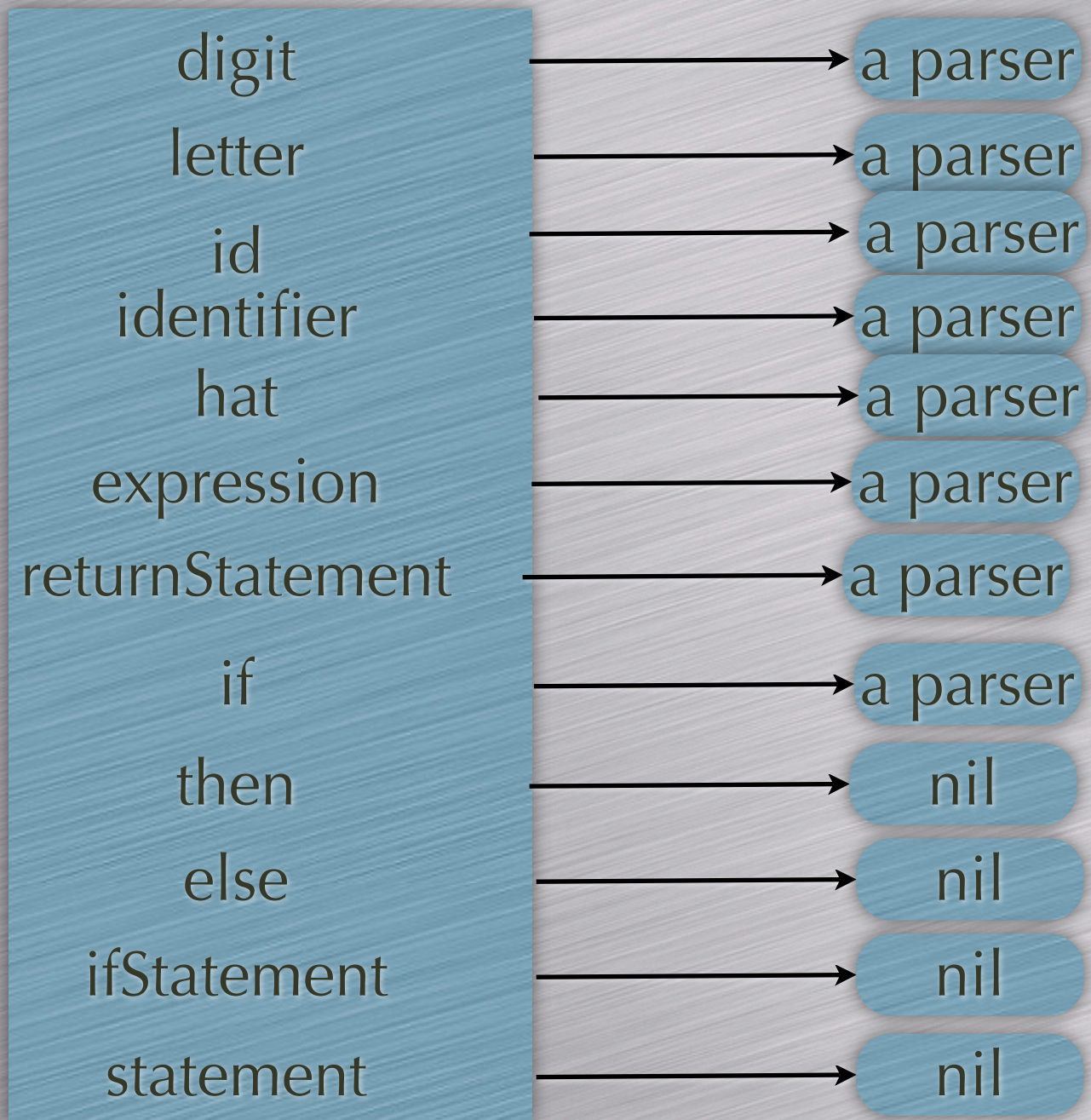

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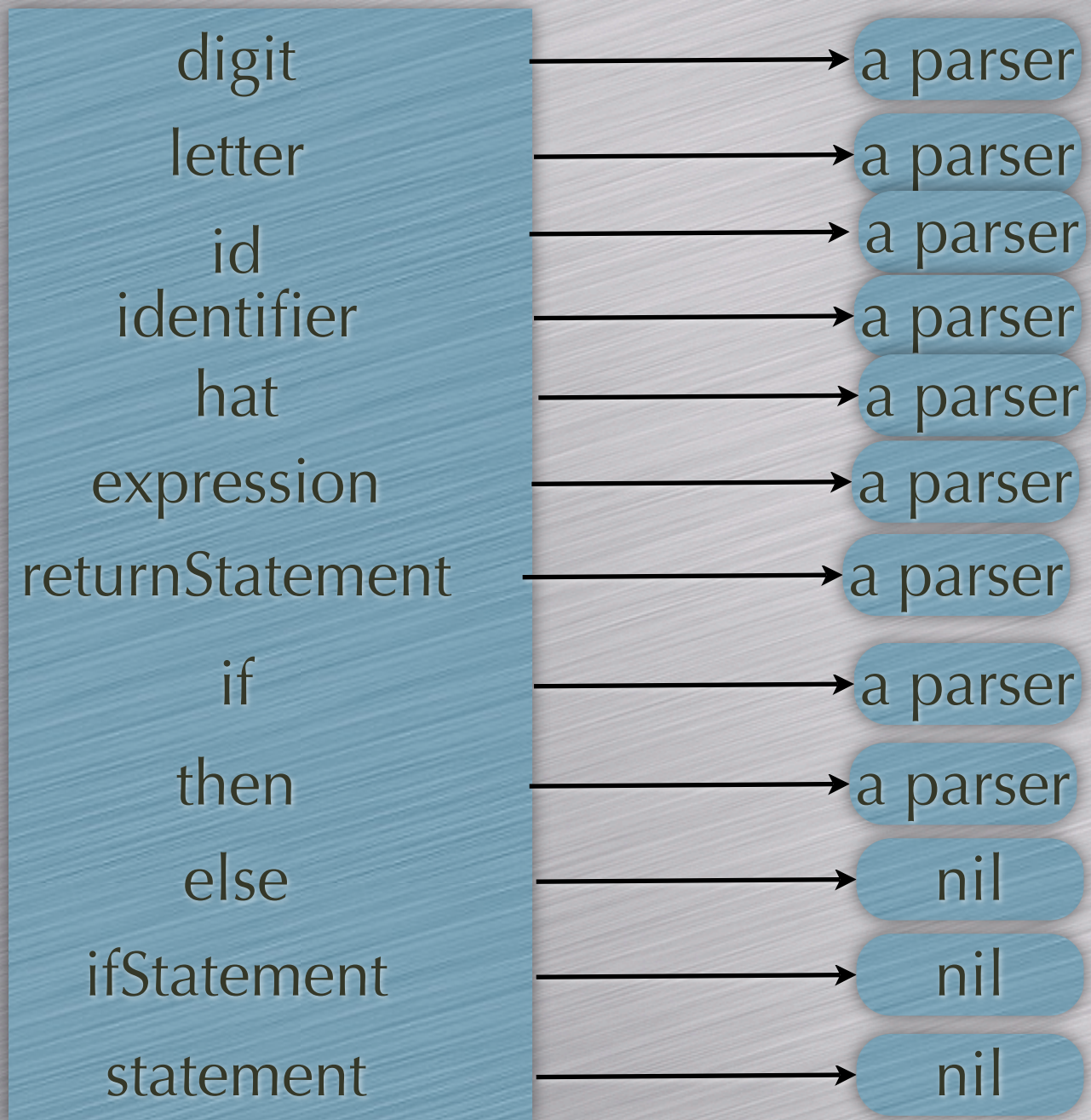

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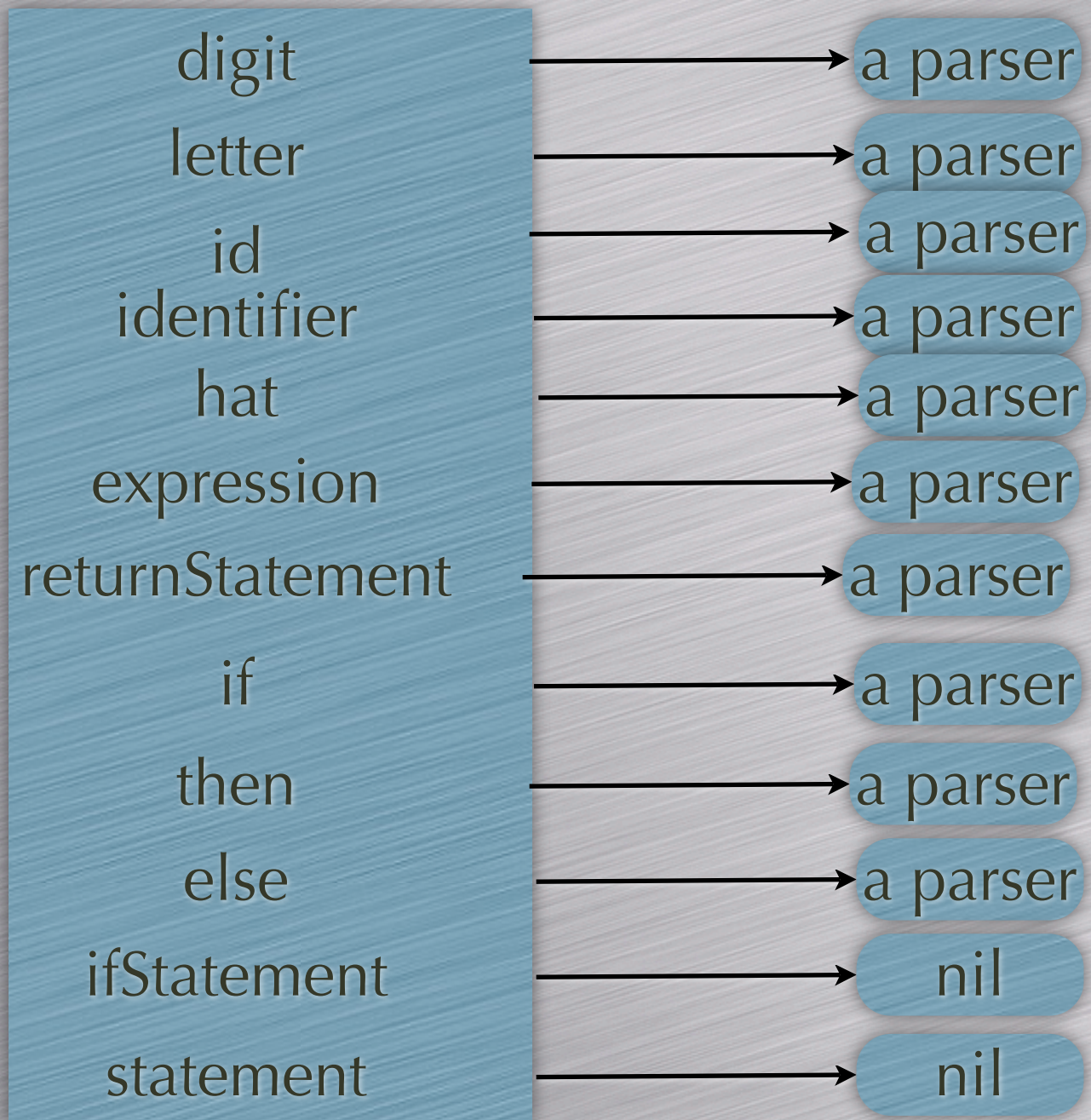

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- Addressed with laziness in Haskell
- Can be addressed with closures

ifStatement = if, [expression], [then], [statement],

[else], [statement].

statement = ifStatement | [returnStatement].

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Being Reflective rather than Lazy

Use Reflection instead of Laziness.

Framework initializes all slots to “stand-in” parsers which act as forward references

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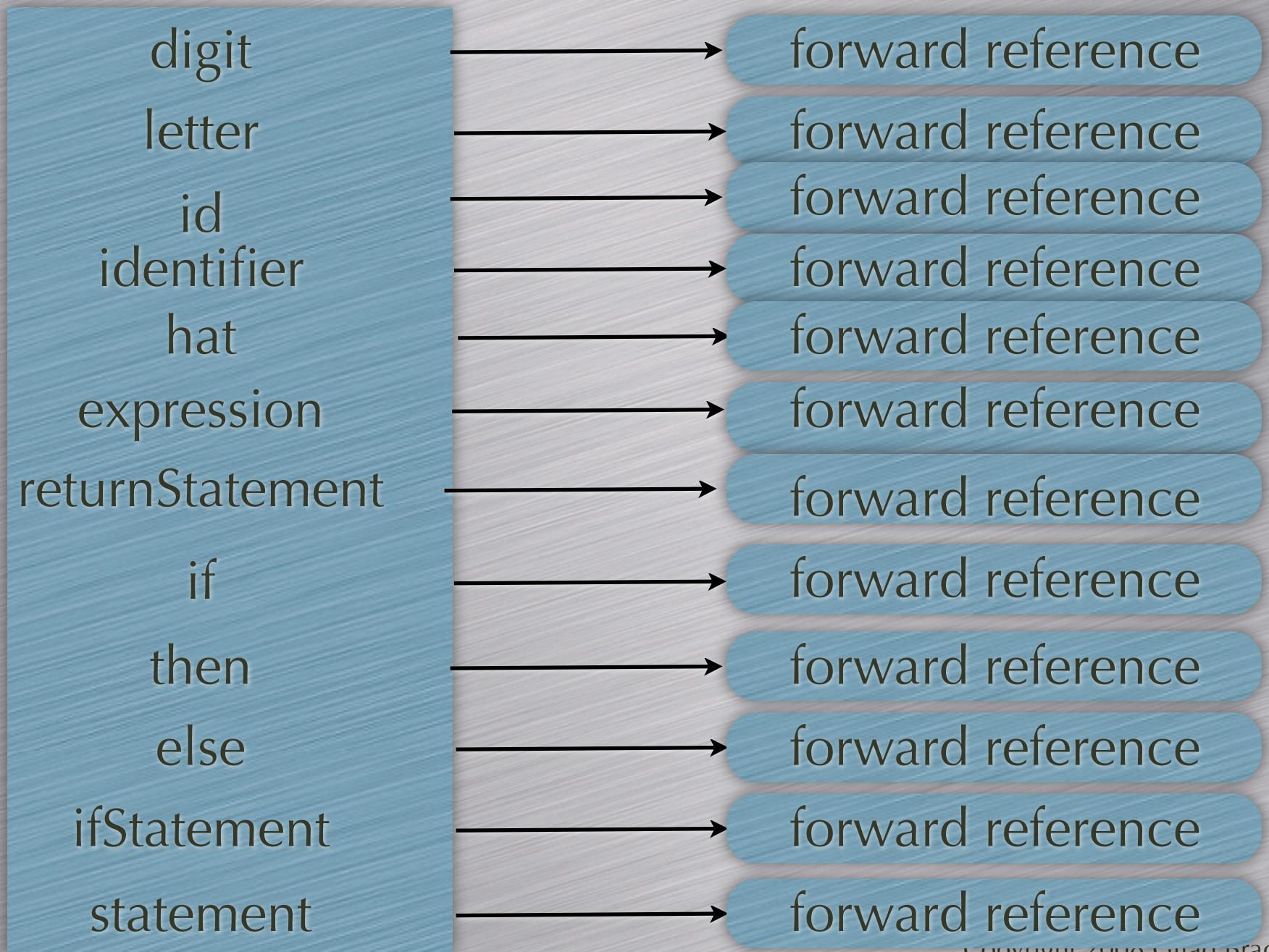

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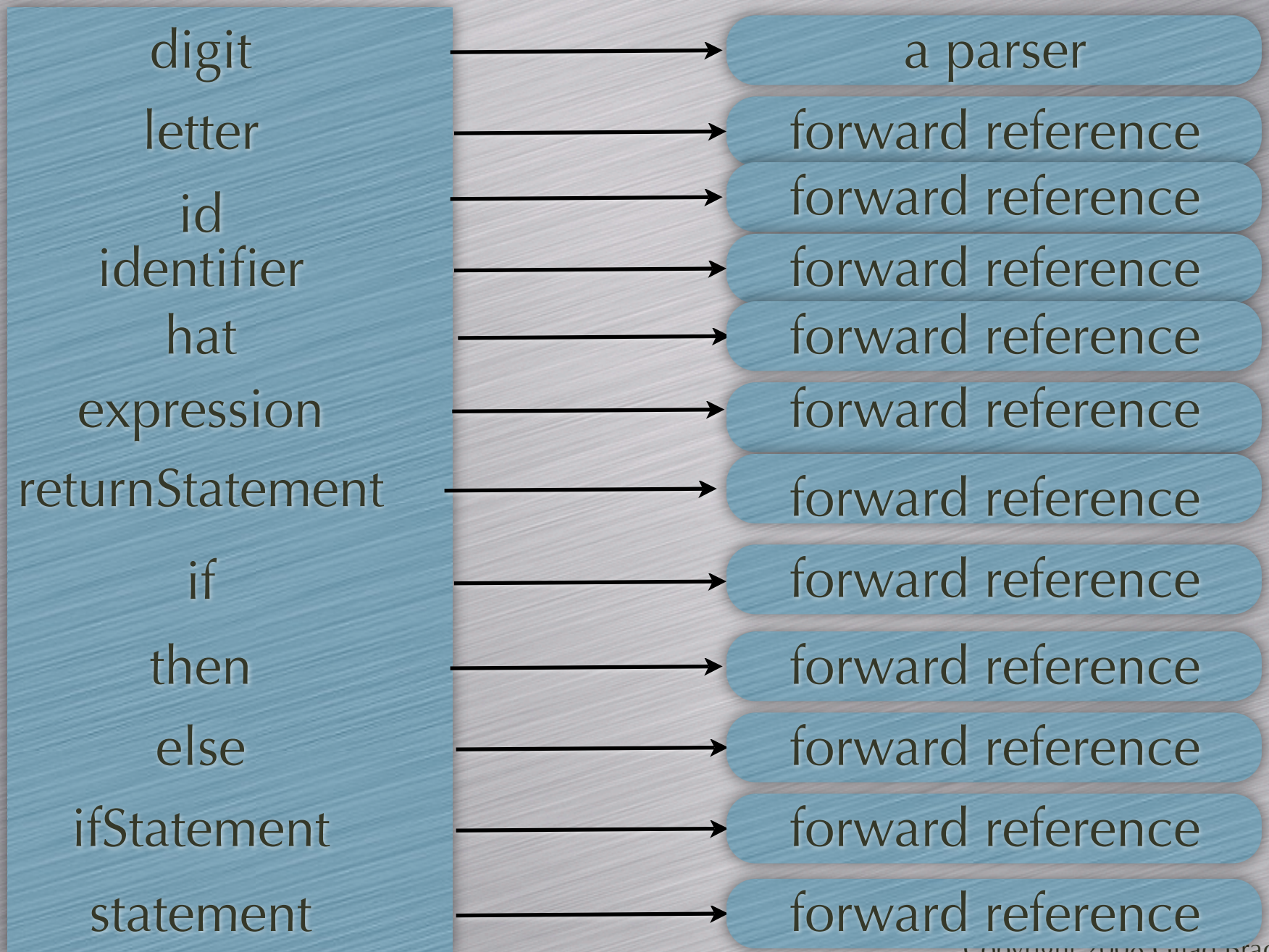

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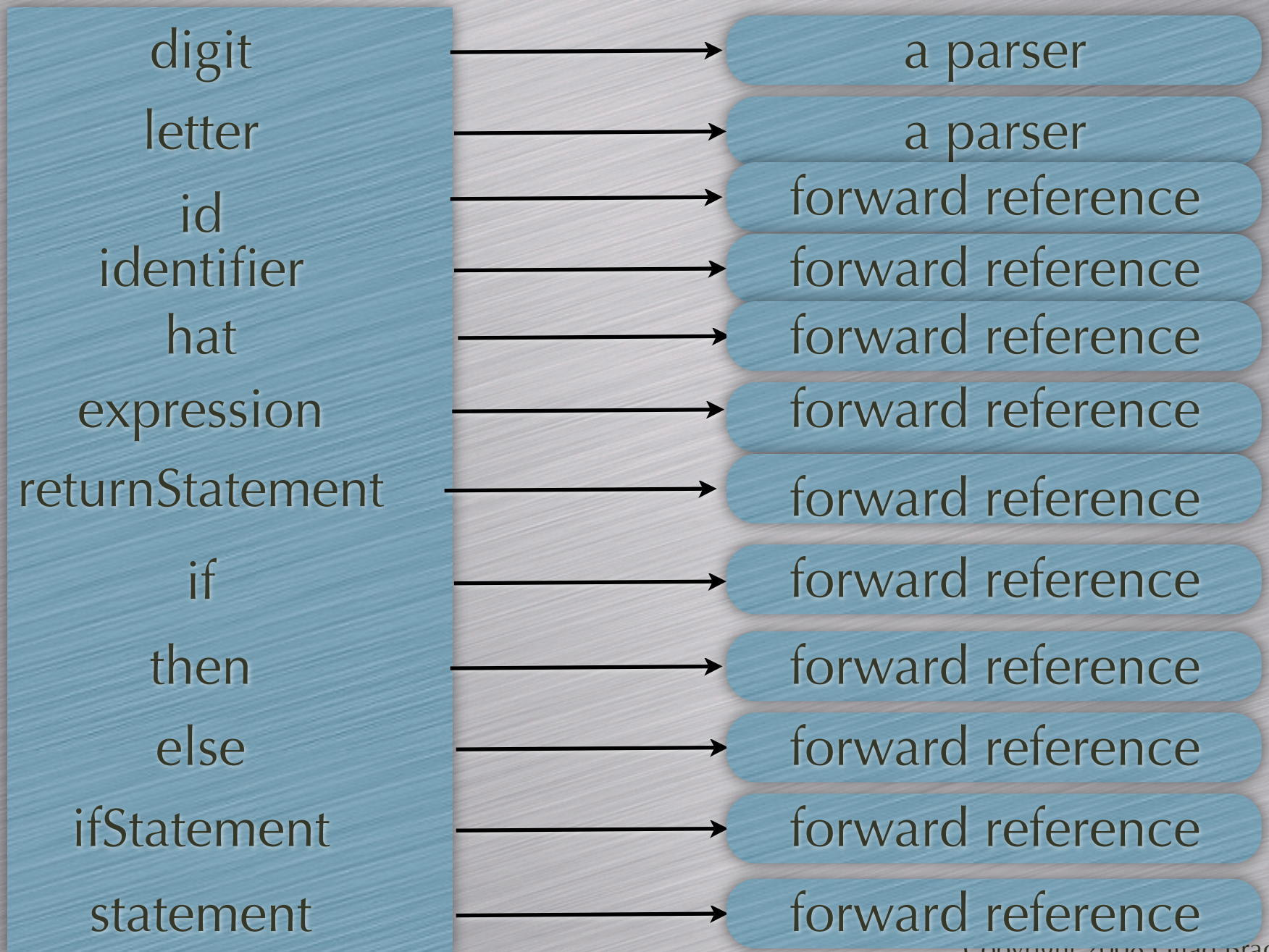

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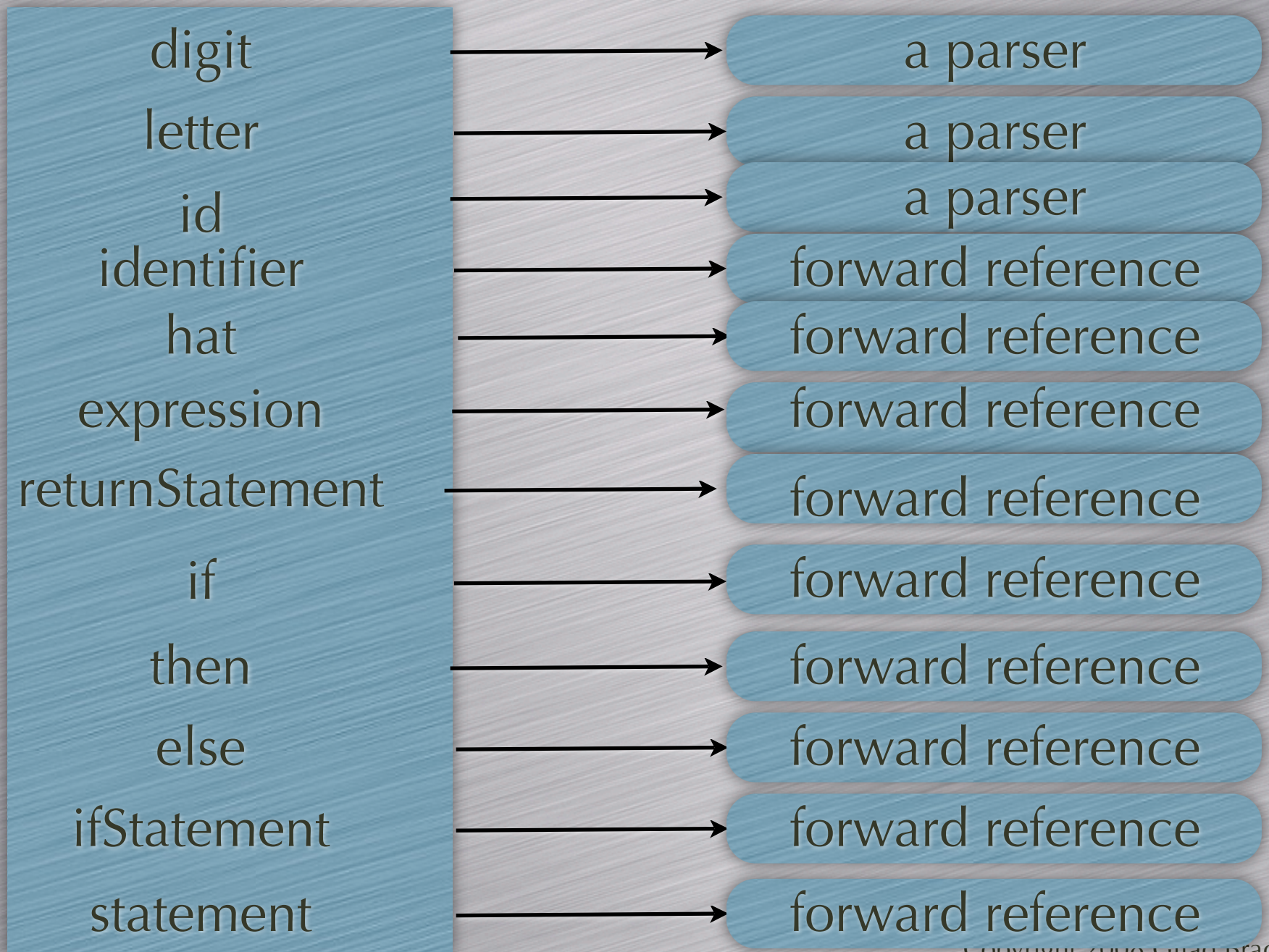

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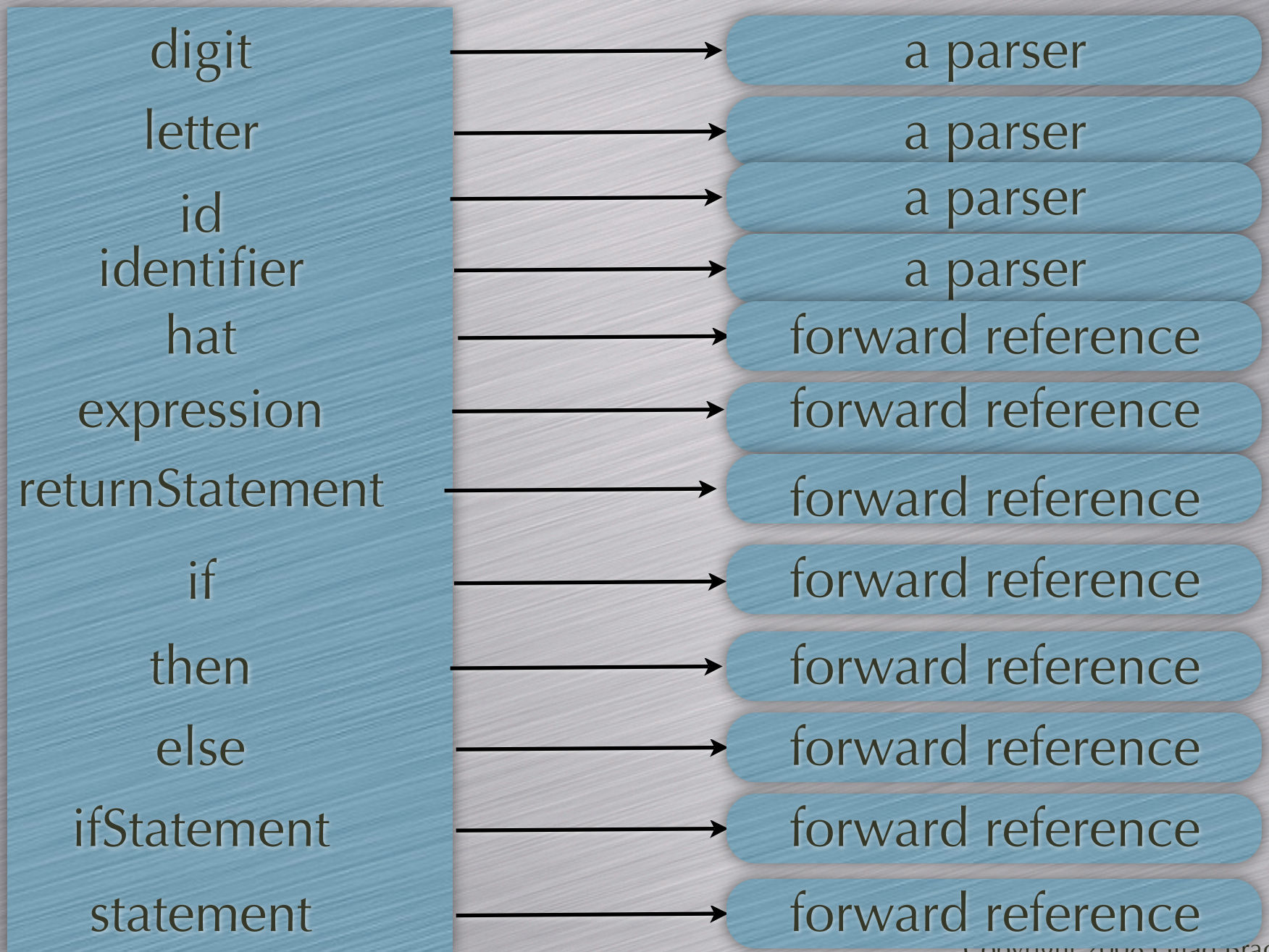

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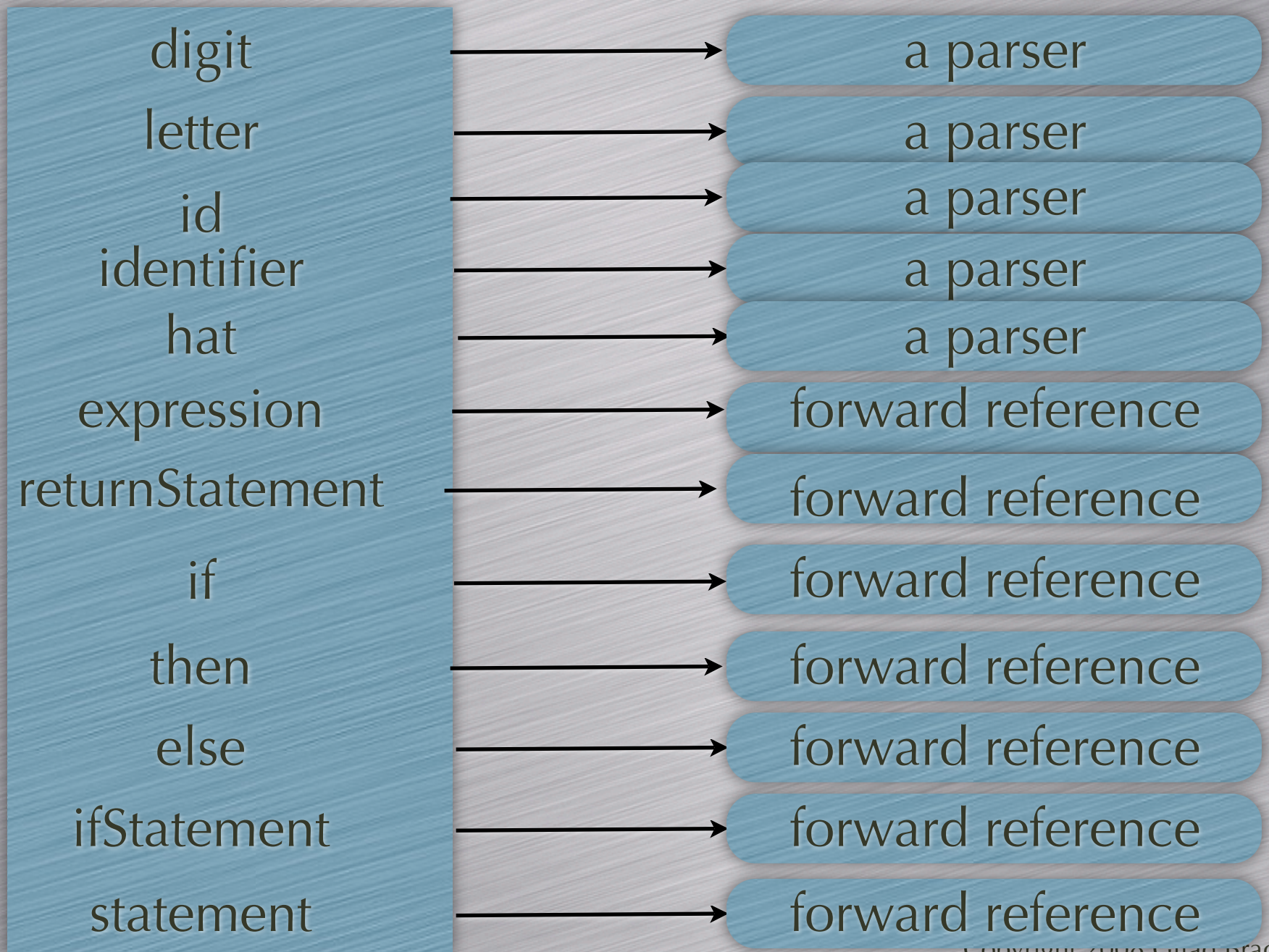

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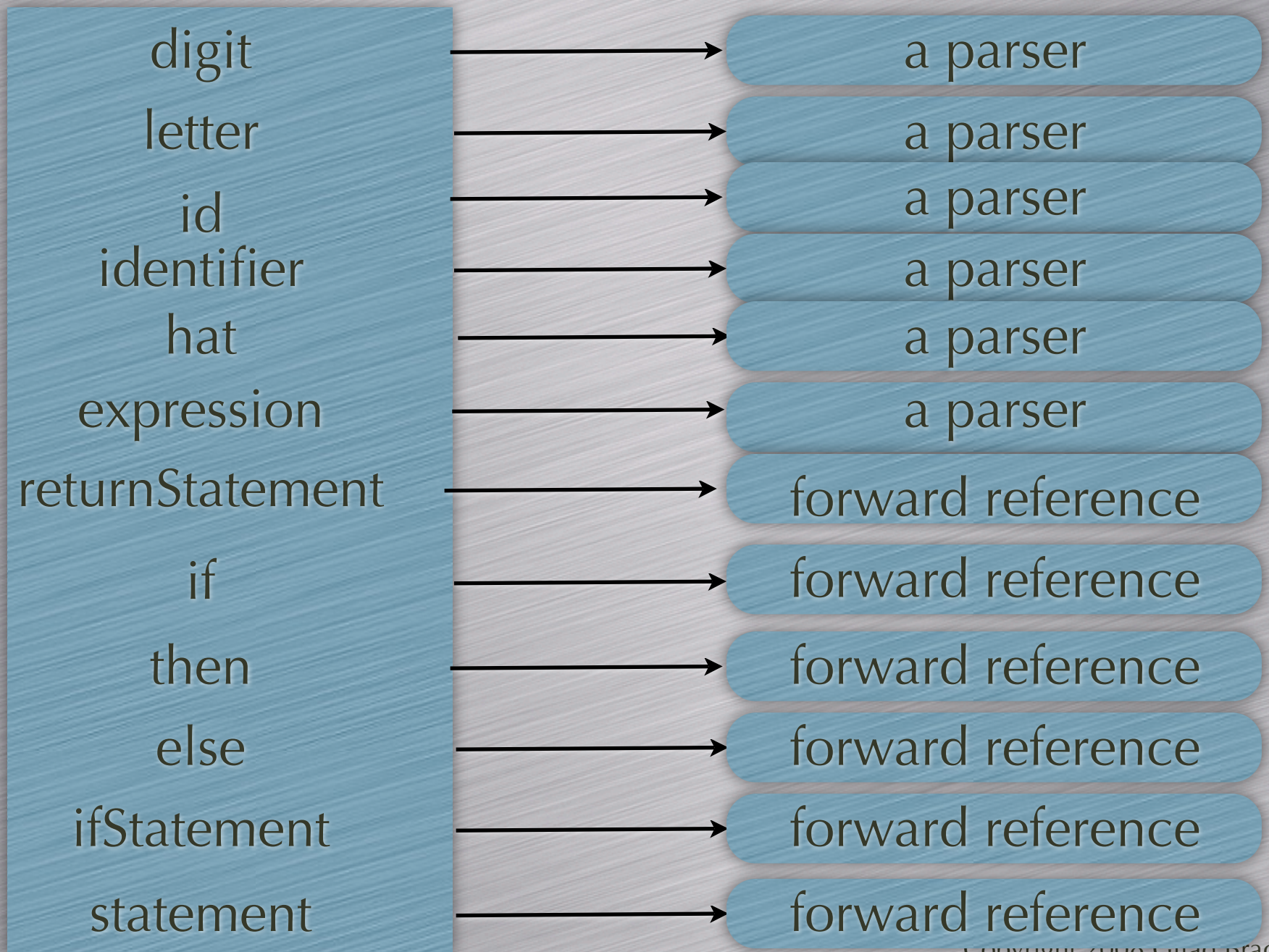

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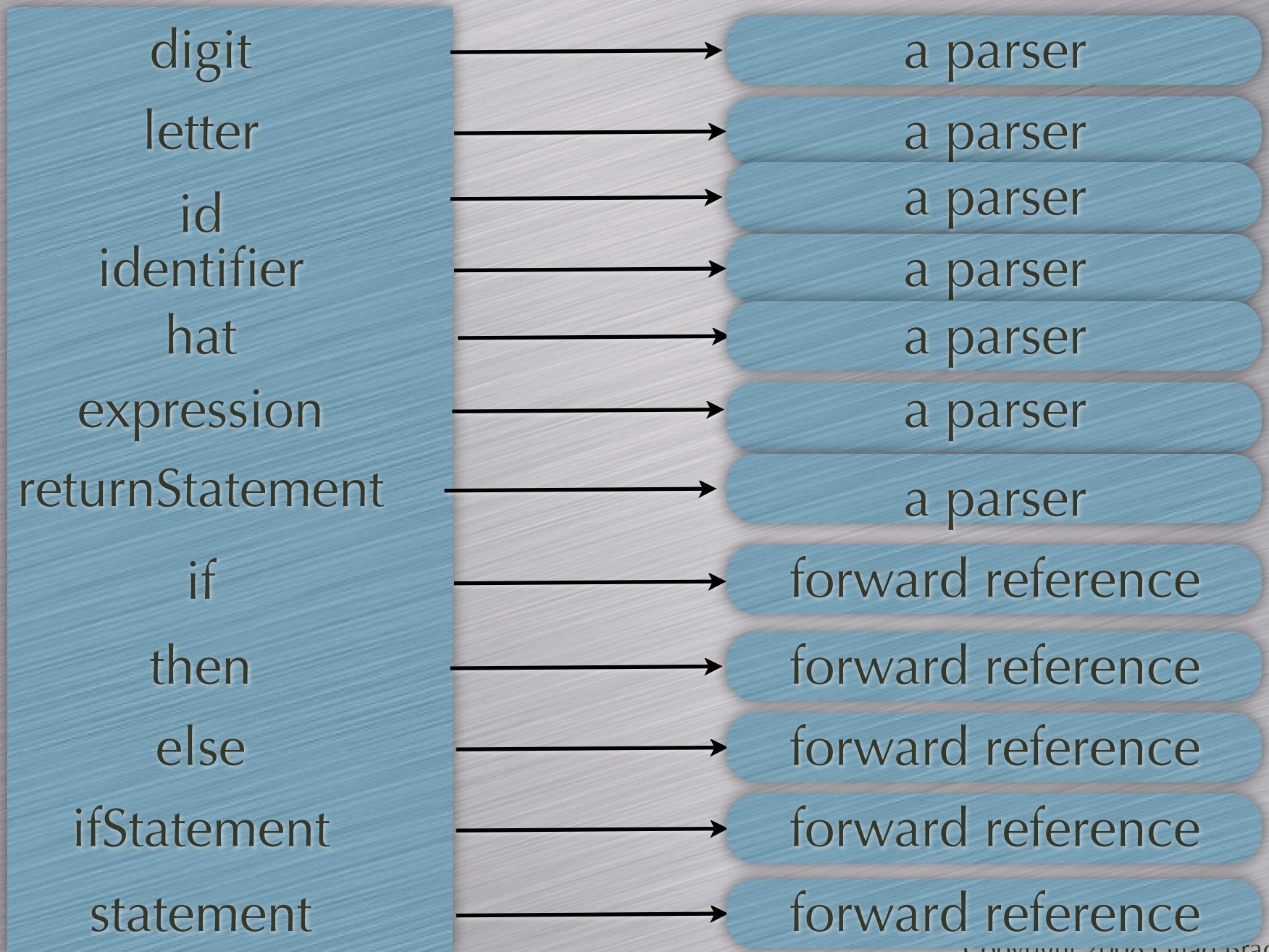

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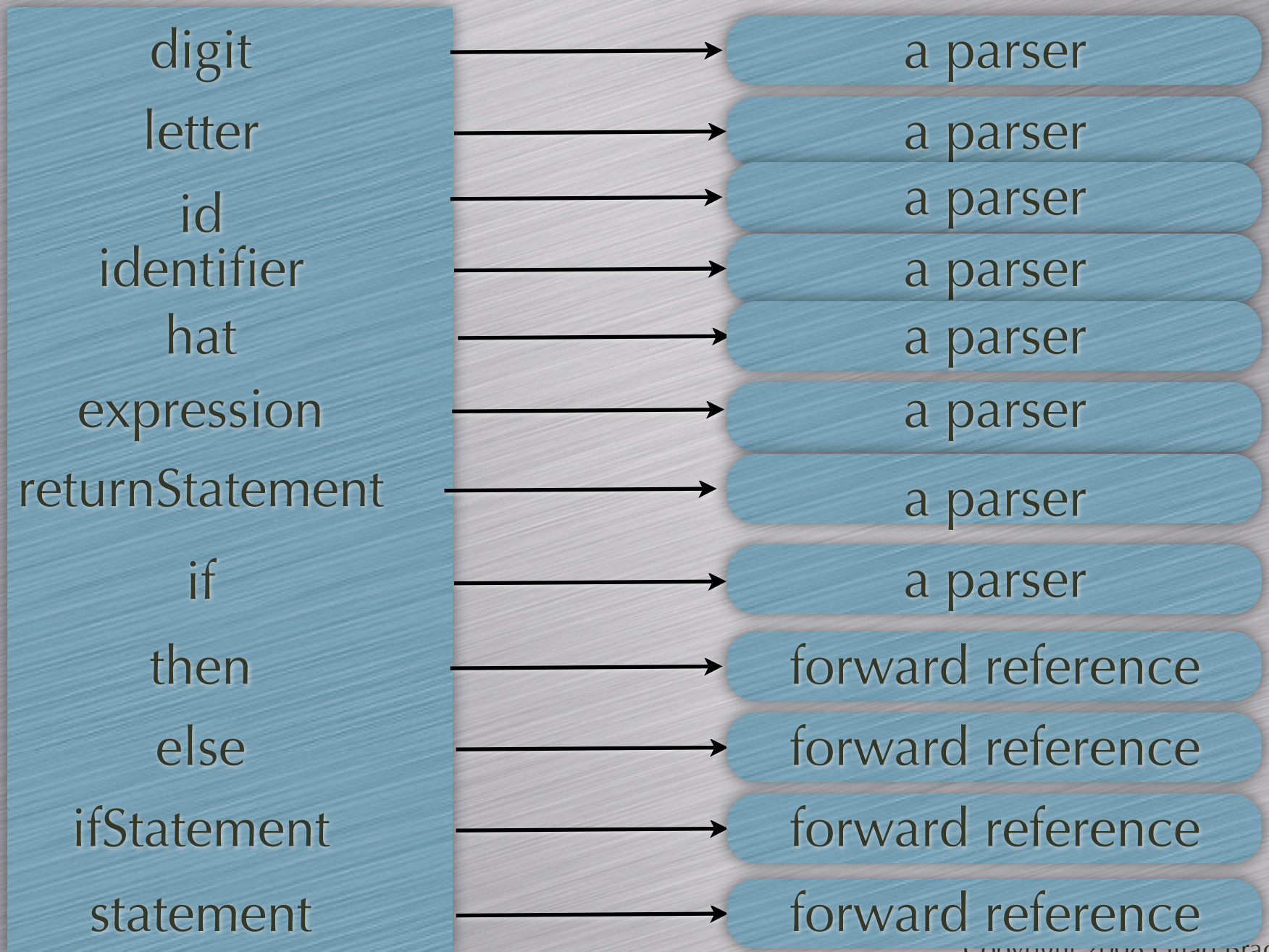

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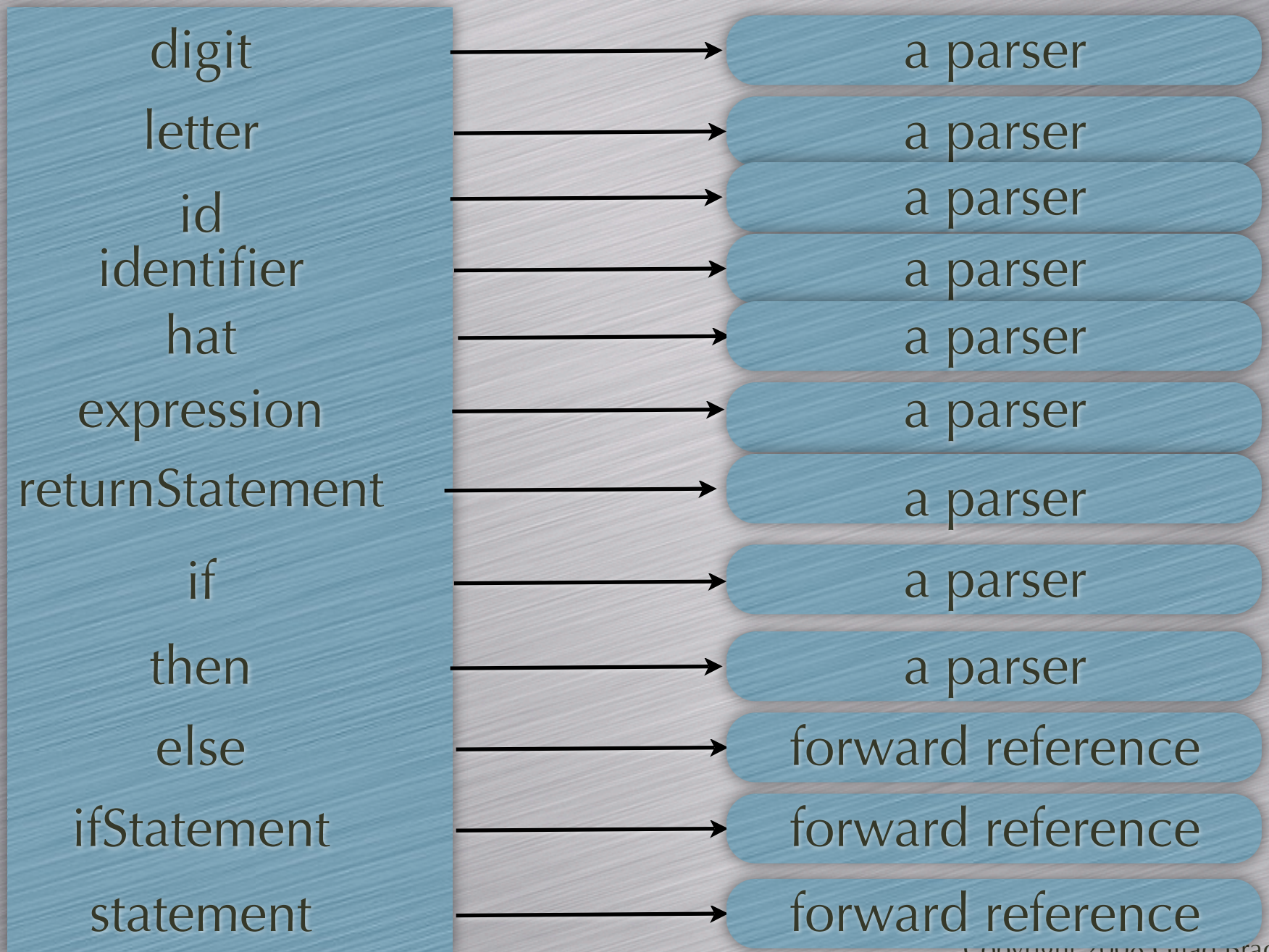

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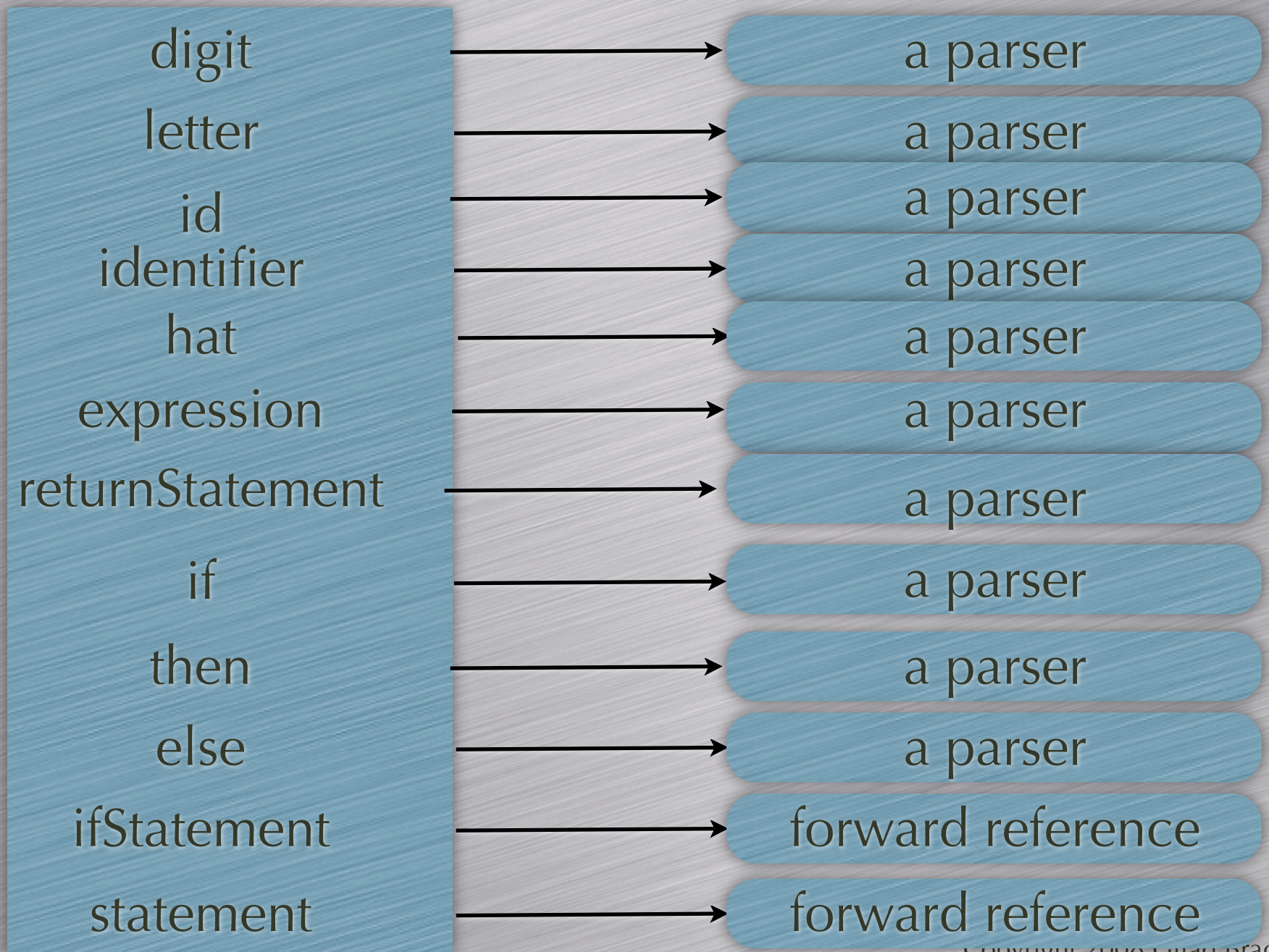

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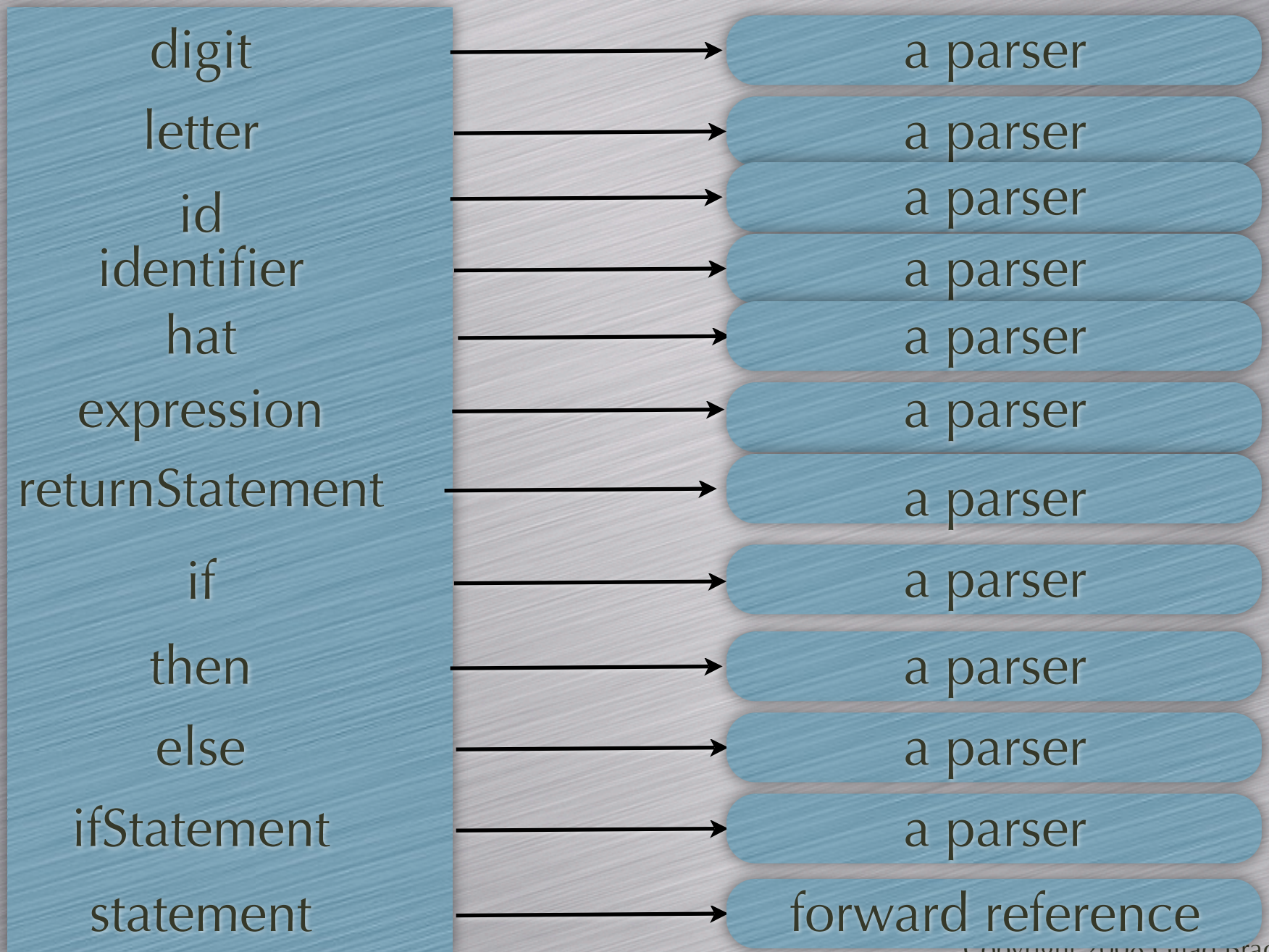

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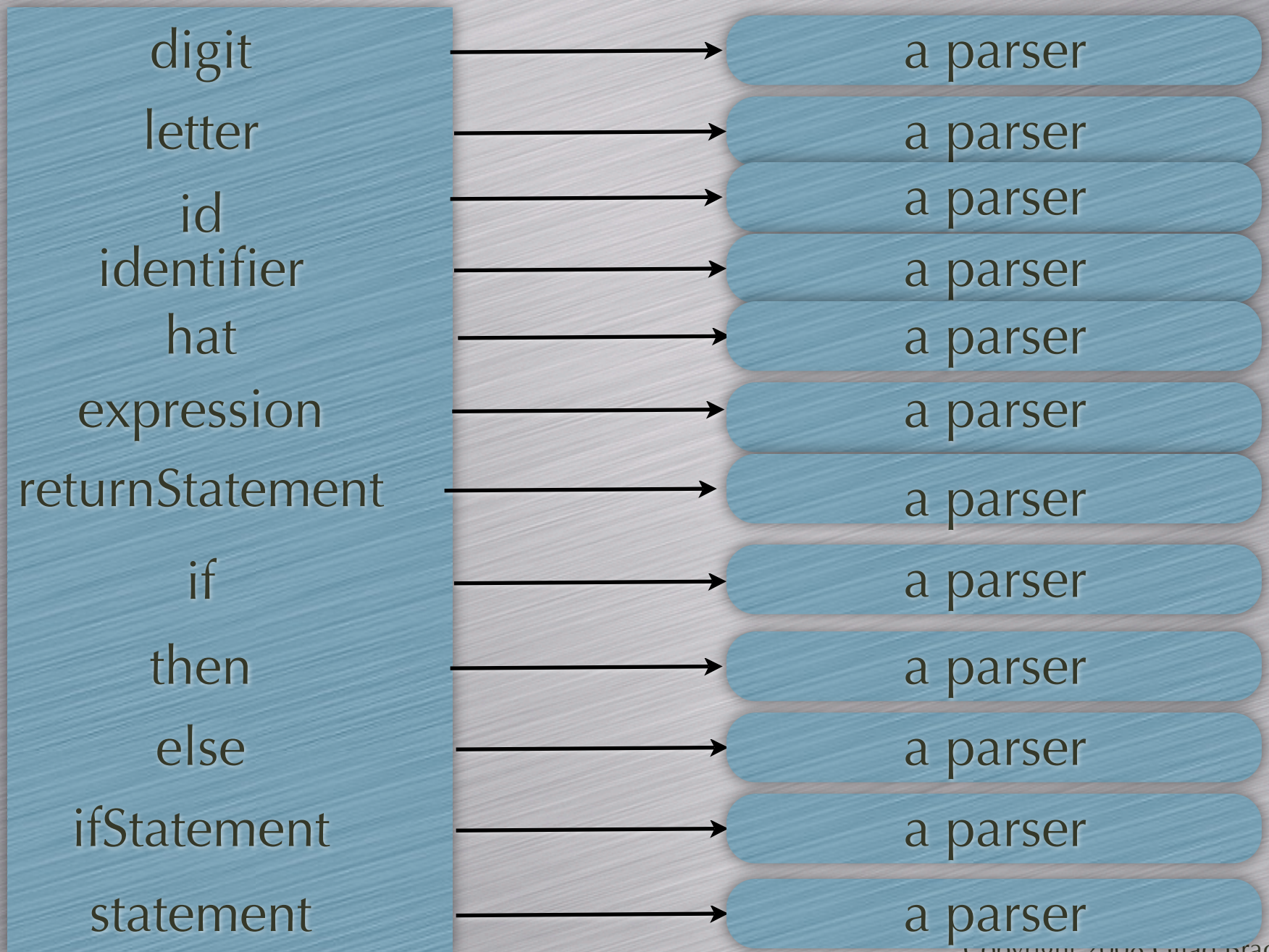

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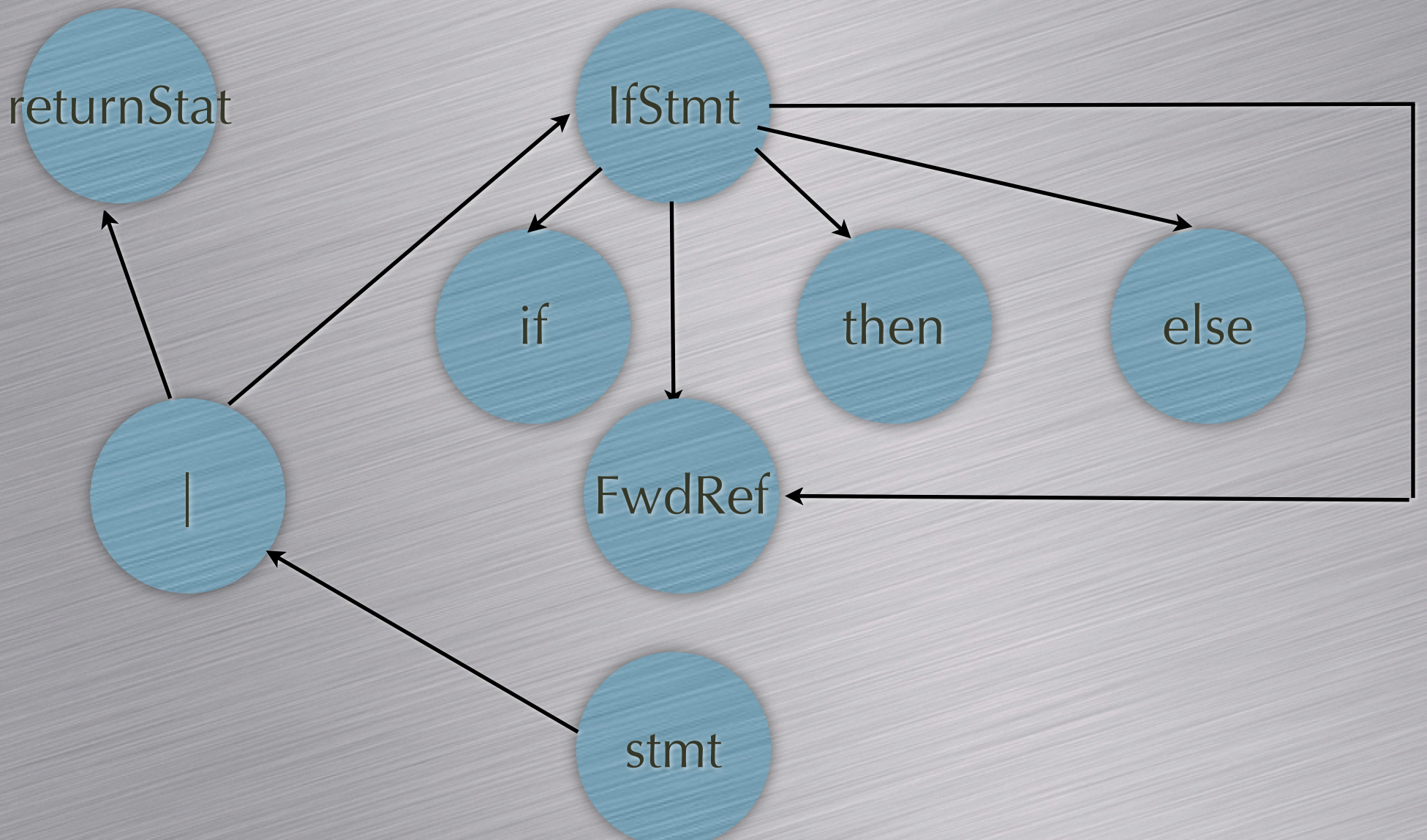


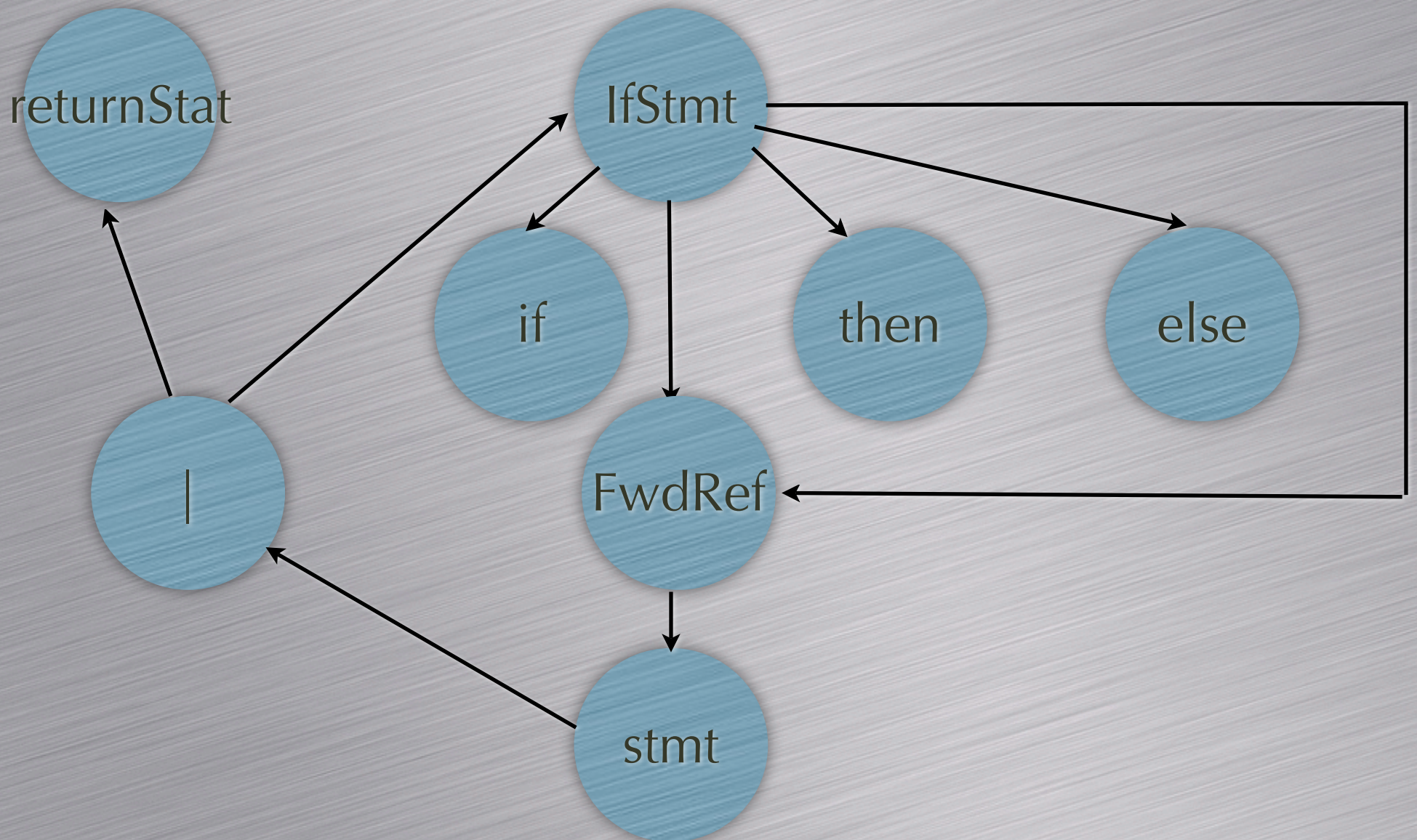
Being Reflective rather than Lazy

Use Reflection instead of Laziness.

Framework initializes all slots to “stand-in” parsers which act as forward references

When grammar is completely initialized, stand-ins are connected to originals and forward calls to them

Mutual Recursion



Composing Parsers

```
class ExampleParser2 = ExampleParser1 mixin |>
                                        ExampleGrammar2 ()
(
  ifStatement = (
    ^super ifStatement
      wrapper:[:ifKw :e :thenKw :s1 :elseKw :s2 |
                  IfStatAST new cond: e;
                                  trueBranch: s1;
                                  falseBranch: s2;
                                  start: ifKw start;
                                  end: s2 end
                ]
  )
)
```

Grammar is shared executable specification

- Shareable among several IDEs/ compilers that require distinct ASTs
- Shareable among other language tools: syntax colorizers, postprocessing tools

Connections

- Mirrors
  - Self
  - Strongtalk, JDI, APT ... See OOPSLA 04
- No static
  - Scala
  - E

Connections

- Security
  - E (Miller 06)
  - Java
- Modules
  - Jigsaw, 1991
  - Units
  - ML
  - Fortress

Connections

- Message-based programming
  - Emerald, Trellis/Owl
  - Smalltalk
  - Self
- Virtual Types
  - Beta
  - gBeta
  - Scala, ...
- Hierarchy inheritance: Ossher & Harrisson 92, Cook 89

Connections

- Parser Combinators.
  - Too much to survey; some highlights:
    - Parsec (Haskell parser combinator library)
    - Swierstra et al.
    - Sparsec (Scala parser combinator library)
    - PEGs (Ford, POPL04, ICFP)
    - Tedir (Plesner-Hansen's masters thesis)
    - Ometa (OOPLA 07 DLS)

Conclusions

- Natural and powerful synergy between:
  - Message-based programming
  - Component style modularity
  - Virtual classes, mixins, class hierarchy inheritance
  - Object capability model and security
  - Mirror based reflection
  - Actor style concurrency
  - Pluggable types