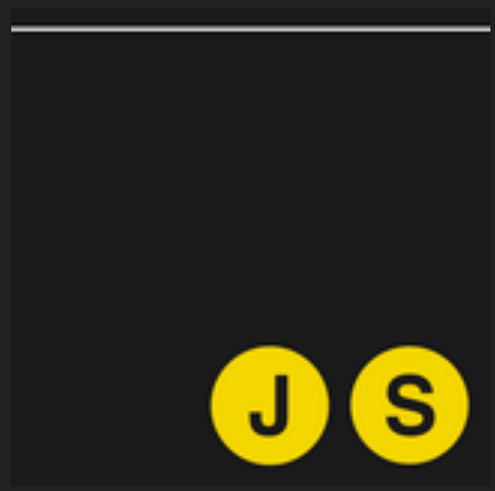
Parsing Parsers

Jenna Zeigen
JSConf Hawaii
2/5/2020

Senior Frontend Engineer
at Slack

Organizer of EmpireJS

Organizer of BrooklynJS



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1. abcs of language

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1. abcs of language
2. hmm, actually, let's just step through a (small) parser

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the abcs of language

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the abcs of language

"language" is a structured system of communication

https://en.wikipedia.org/wiki/Language

the abcs of language

"natural language" is a naturally evolved system that humans use to communicate with each other

https://en.wikipedia.org/wiki/Language

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the abcs of language

"formal languages" also have an alphabet and words, which can be combined correctly based on specific rules

https://en.wikipedia.org/wiki/Formal_language

grammar school

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grammar school

a language's grammar is the set of rules for that language, i.e. its syntax

https://en.wikipedia.org/wiki/Formal_grammar

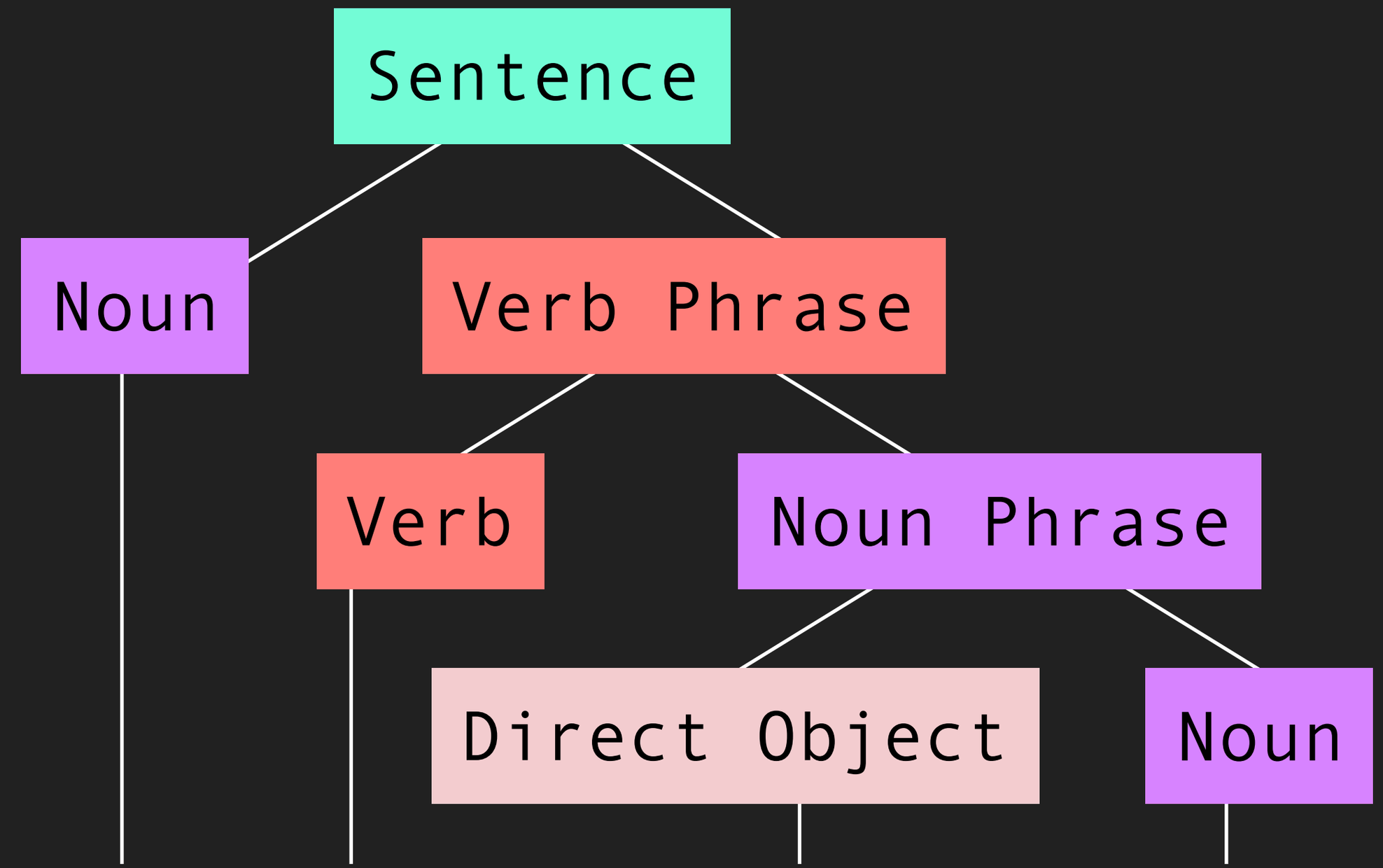
grammar school

"formal grammars" put these rules in terms of replacement

To the left, to the left
To the left, to the left (Mmm)
To the left, to the left
Non-terminals in the spot to the left
To the left, to the left
The grammar tells us for what symbols
They are replaceable
♪♪♪

Beyoncé - Irreplaceable
https://en.wikipedia.org/wiki/Formal_grammar

grammar school



Jenna gave the talk

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grammar school

Sentence = Noun + Verb Phrase

Verb Phrase = Verb + Noun Phrase

Noun Phrase = Direct Object + Noun

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grammar school

Programming language grammars are defined in their spec

https://www.ecma-international.org/ecma-262/10.0/index.html

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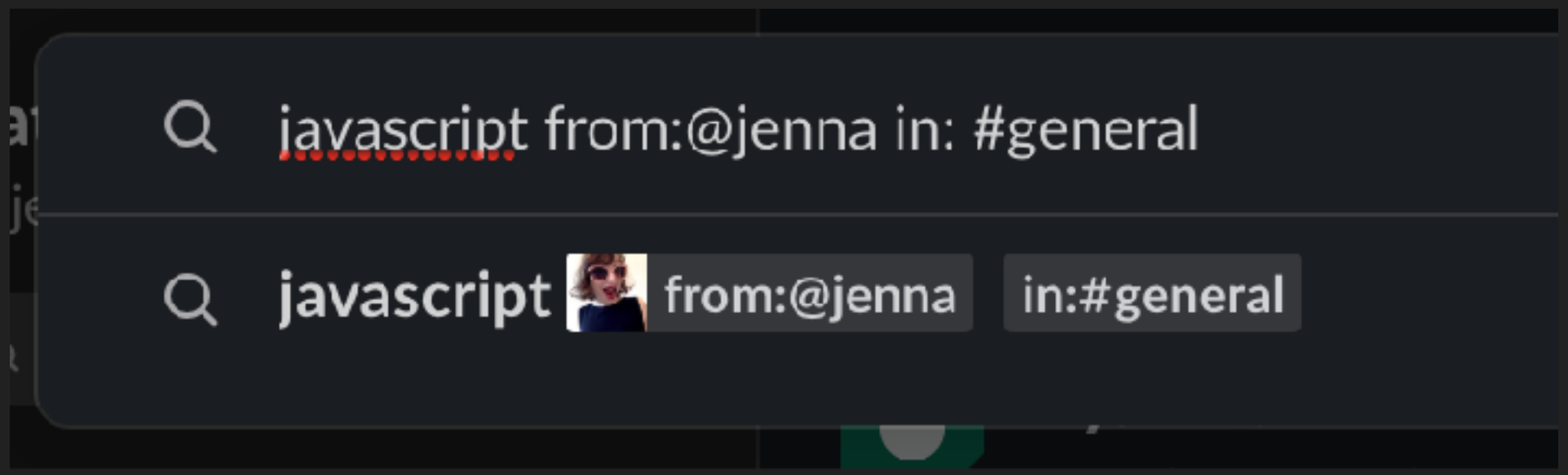
syntax city



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syntax city

javascript "front end"
in:#random in: #general
from:@jenna

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syntax city

javascript | "front end"

in:#random | in: #general

from:@jenna

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syntax city

javascript "front end" in:#random
in: #general from:@jenna

Query → Term

Query → Term Query

Query → Filter

Query → Filter Query

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ok, now parsers

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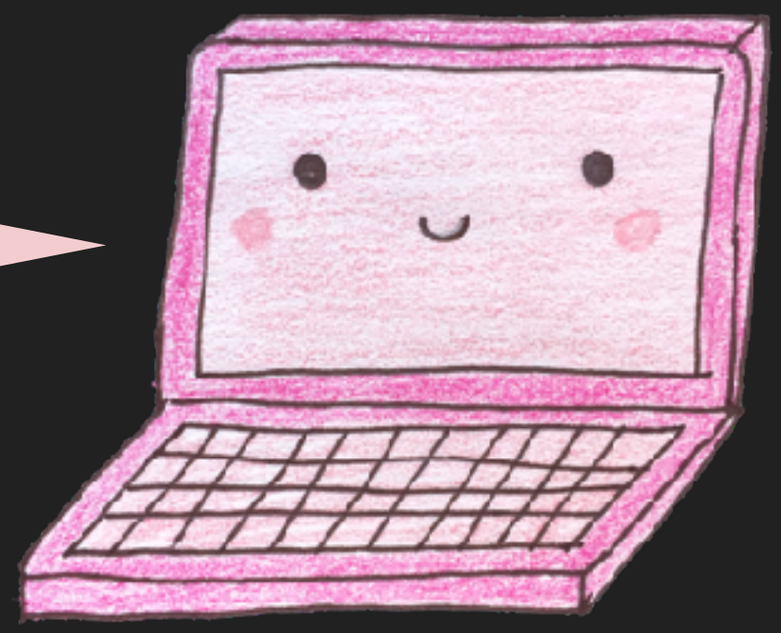
parsing

the process of analyzing language against the rules of its grammar

I got my rules up,
And a bit of language
Is its syntax okay?
Yeah we're parsing in the USA

♪ ♪ ♪



Miley Cyrus - Party in the USA
https://en.wikipedia.org/wiki/Parsing

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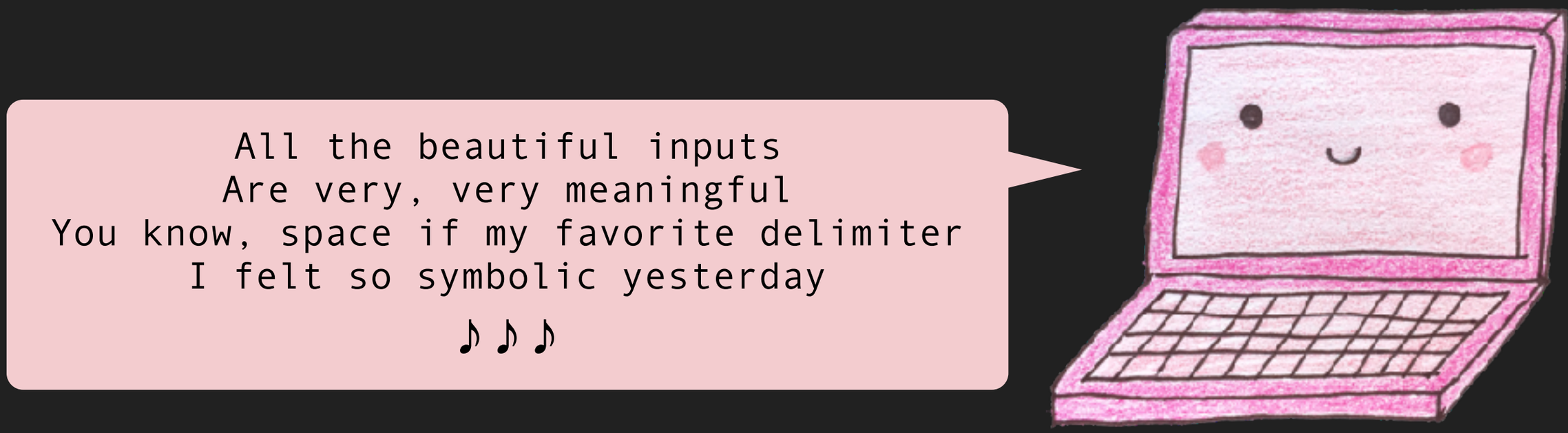
parser

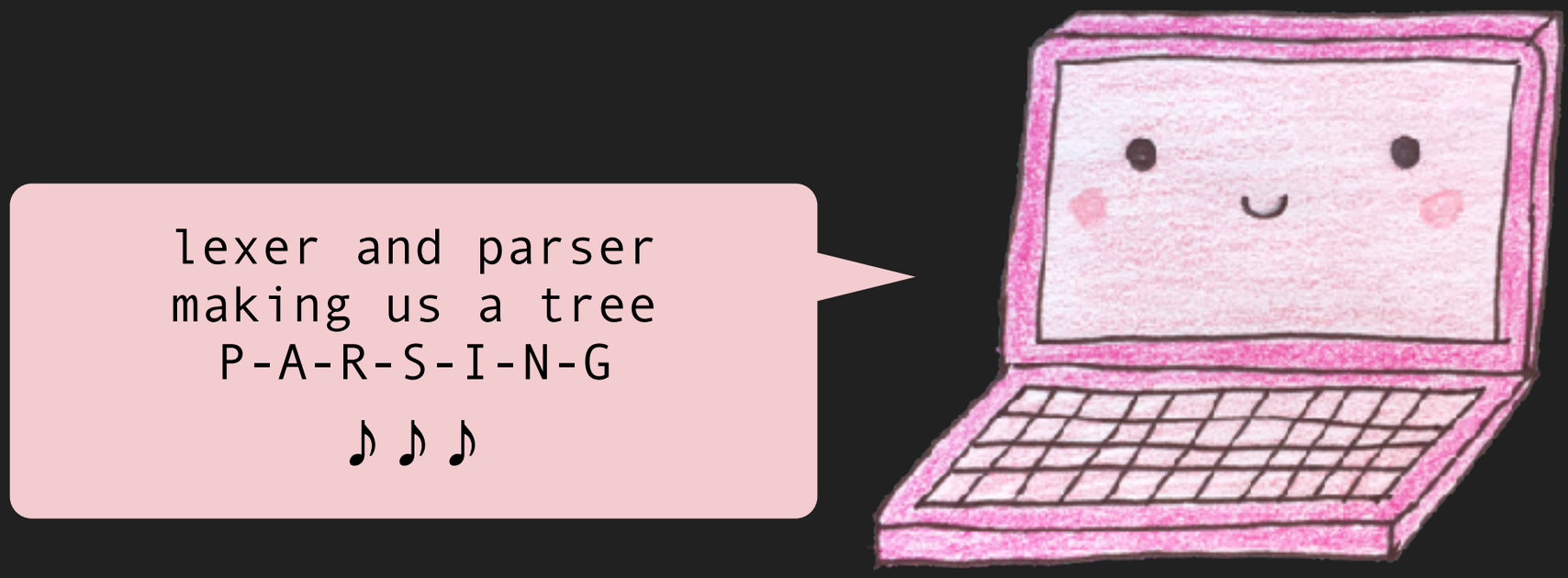
a function that takes raw input and returns meaningful data created from the input, or an error



Counting Crows - Mr. Jones
https://dev.to/yelouafi/a-gentle-introduction-to-parser-combinators-21a0

parsing

parsers usually have two parts: the lexer and the parser



https://en.wikipedia.org/wiki/Parsing

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lex go

the lexer takes the text and breaks it down into meaningful units, called "tokens"

Old Crow Medicine Show - Wagon Wheel
https://tomassetti.me/guide-parsing-algorithms-terminology/

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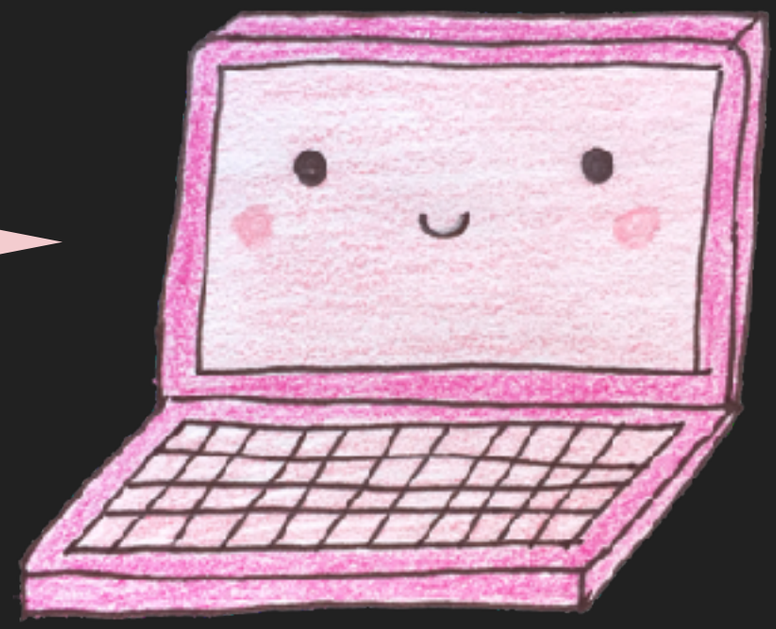
lex go

first, the "scanner"
goes through and breaks
the string of characters
into the proper chunks,
or "lexemes"

lex go

coding time
♪ ♪ ♪



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lex go

```
const lexemes =
'Jenna gave the
talk'.split(' ');
```

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lex go

```
const  lexemes  =
"Jenna gave the talk"
.  split
(  ' '  )
;
```

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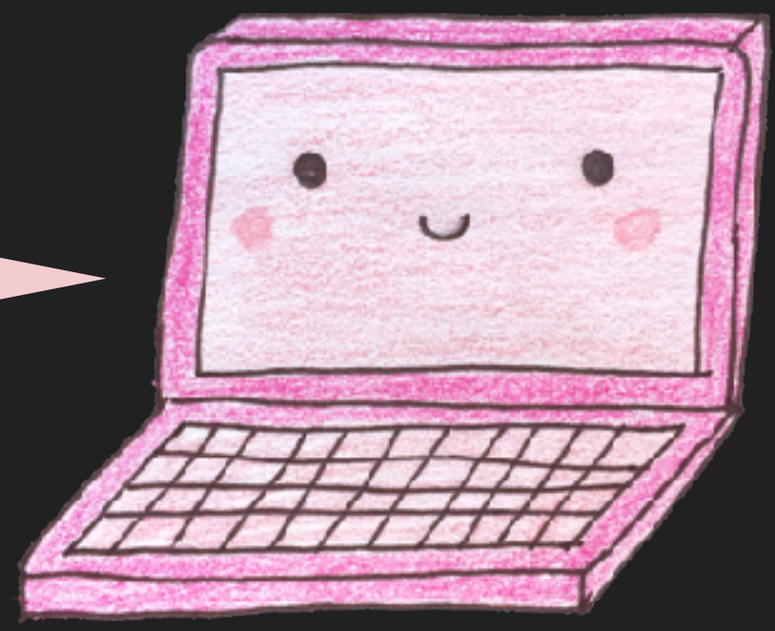
lex go

then, the "evaluator"
combines the lexeme's type
with its value to create a

"token"

I then begin to encounter with my parse,
To split the text apart
Break it down into sections
Tokens from the lexemes

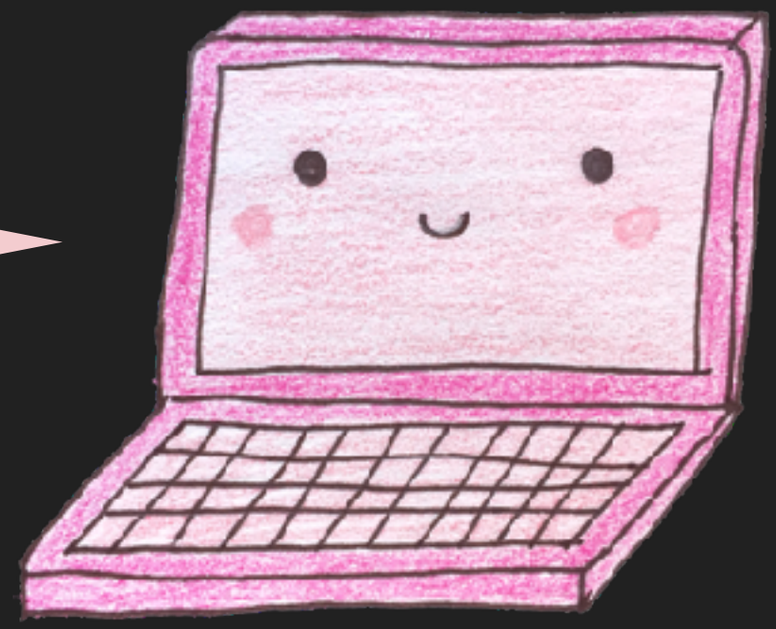
♪ ♪ ♪



The Notorious B.I.G. – Sky's The Limit
https://en.wikipedia.org/wiki/Lexical_analysis

lex go

coding time
♪ ♪ ♪



@zeigenvector
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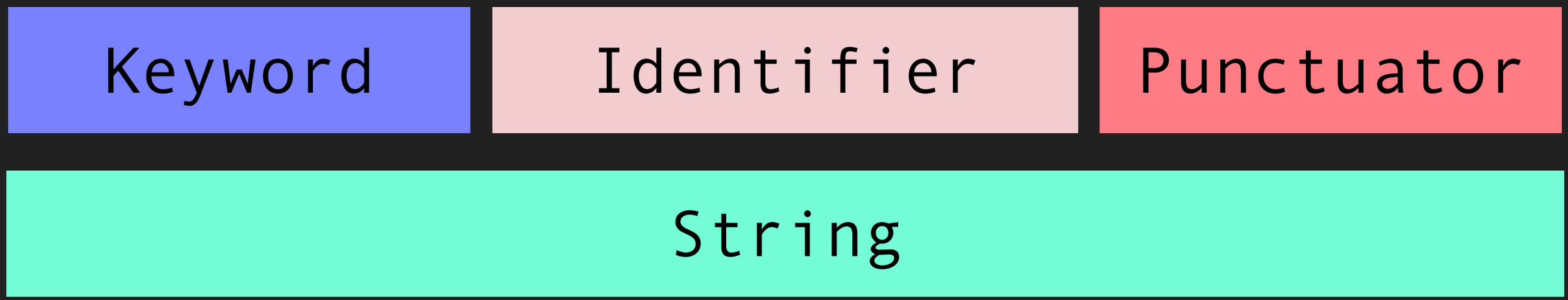
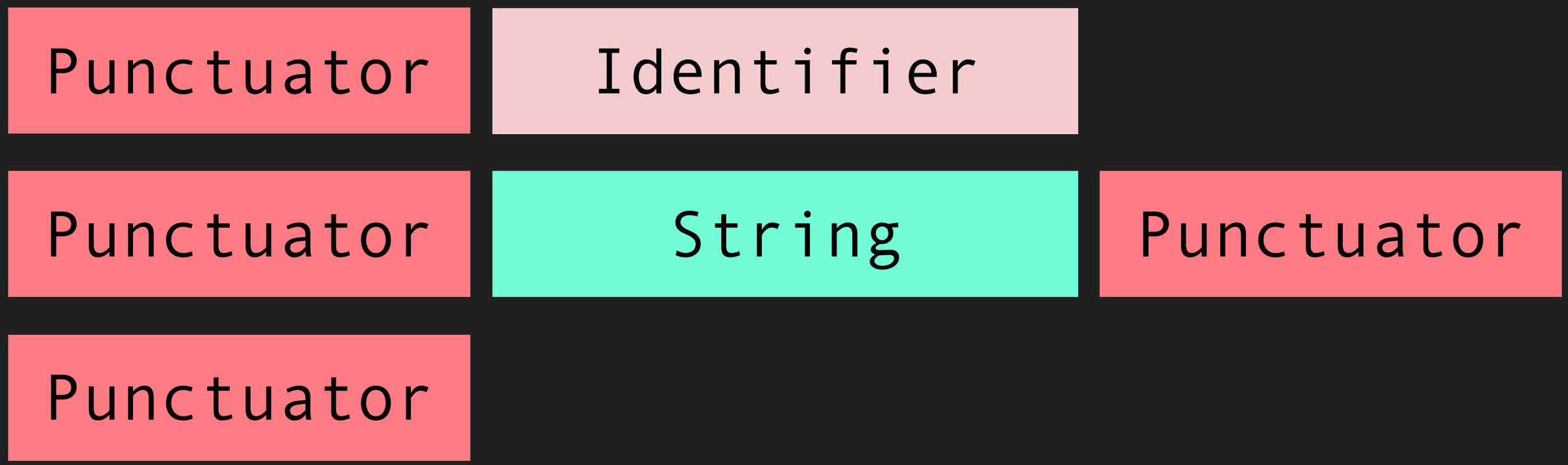
lex go

```
const  lexemes  =
"Jenna gave the talk"
.  split
(  ' '  )
;
```

@zeigenvector
jenna.is/at-jsconfhi

lex go





https://esprima.org/demo/parse.html#

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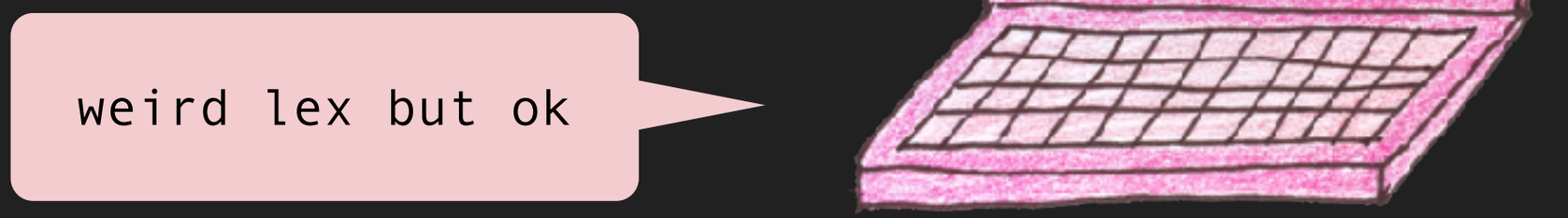
lex go


```
[
  { "type": "Keyword", "value": "const" },
  { "type": "Identifier", "value": "lexemes" },
  { "type": "Punctuator", "value": "=" },
  { "type": "String", "value": "'Jenna gave a talk'"
  { "type": "Punctuator", "value": "." },
  { "type": "Identifier", "value": "split" },
  { "type": "Punctuator", "value": "(" },
  { "type": "String", "value": "' '" },
  { "type": "Punctuator", "value": ")" },
  { "type": "Punctuator", "value": ";" }
]
```

https://esprima.org/demo/parse.html#

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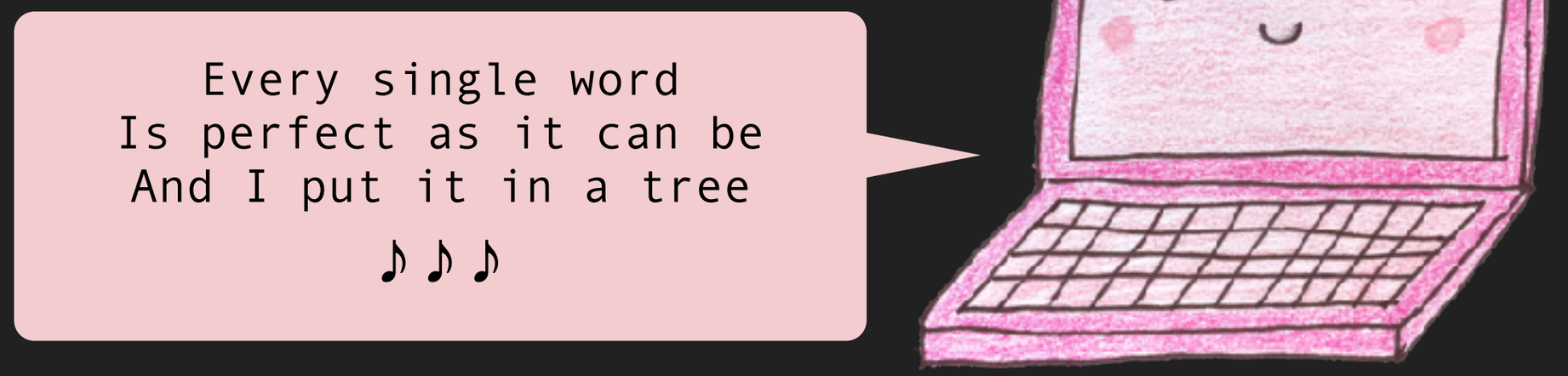
parse for the course

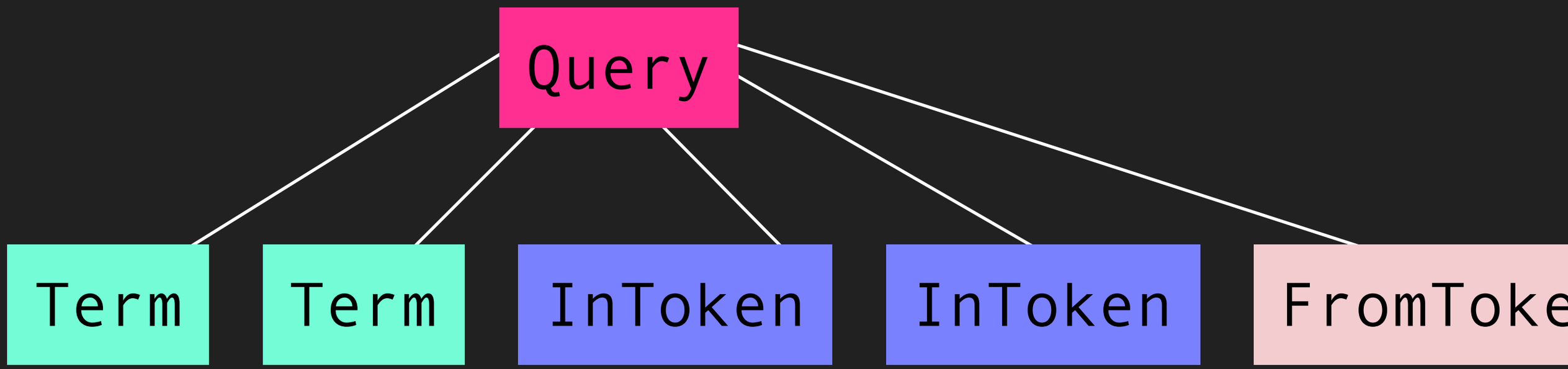
the parser will check that the syntax is correct while creating a structural representation



CHVRCHES ft. Marshmello - Here With Me
https://www.geeksforgeeks.org/introduction-of-parsing-ambiguity-and-parsers-set-1/

parse for the course

javascript "front end" in:#random
in: #general from:@jenna



@zeigenvector
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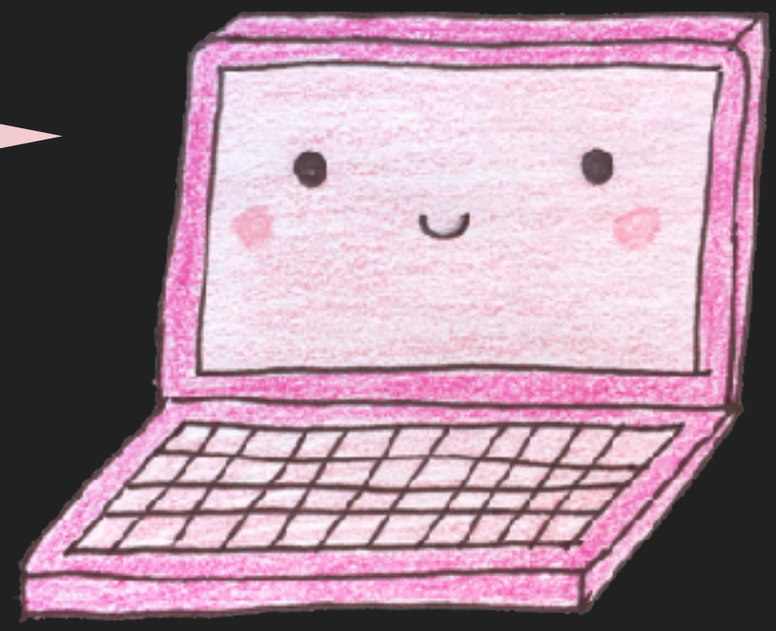
parse for the course

I know who I want
To read my code
(It's you!)

♪ ♪ ♪



Semisonic - Closing Time

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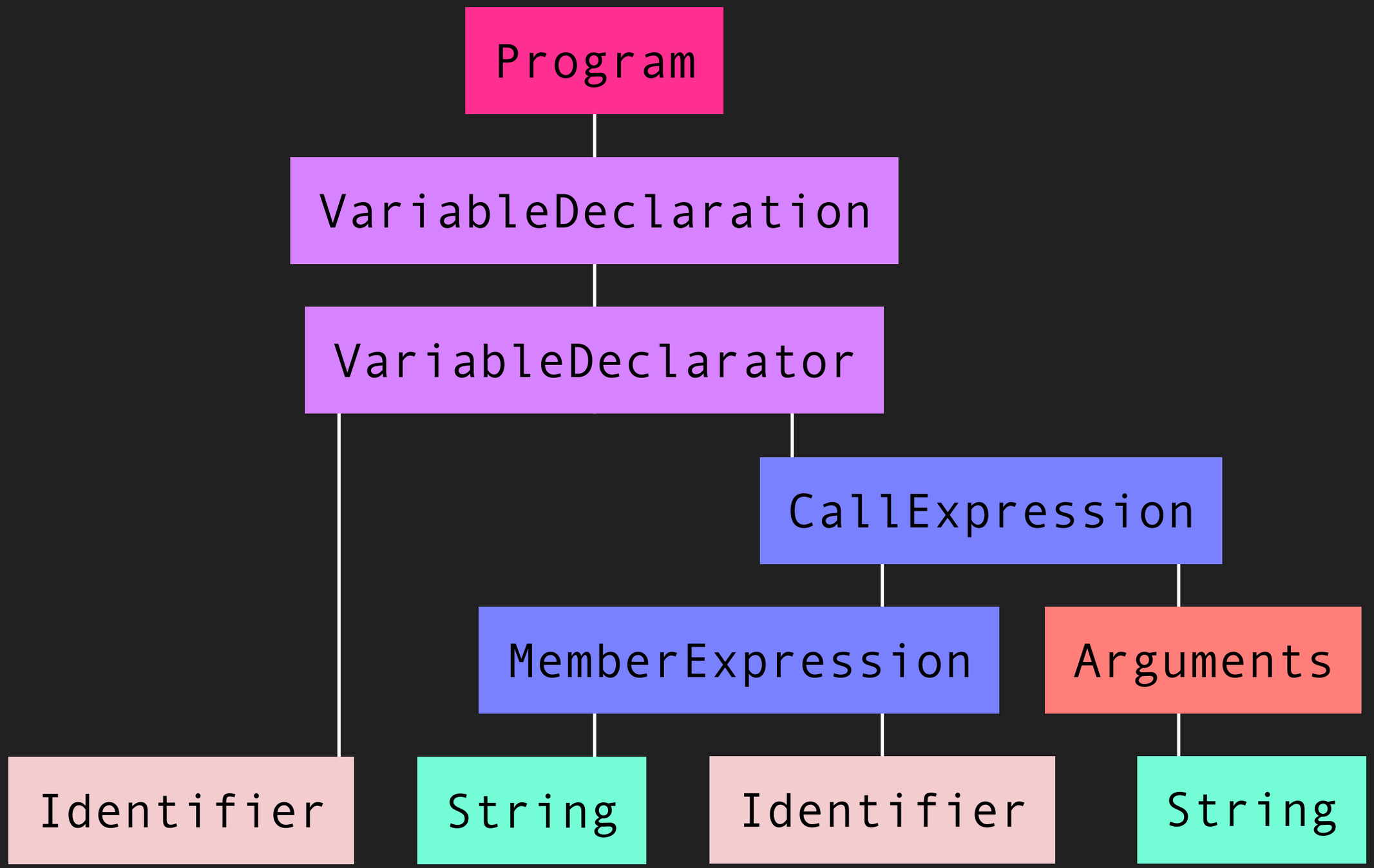
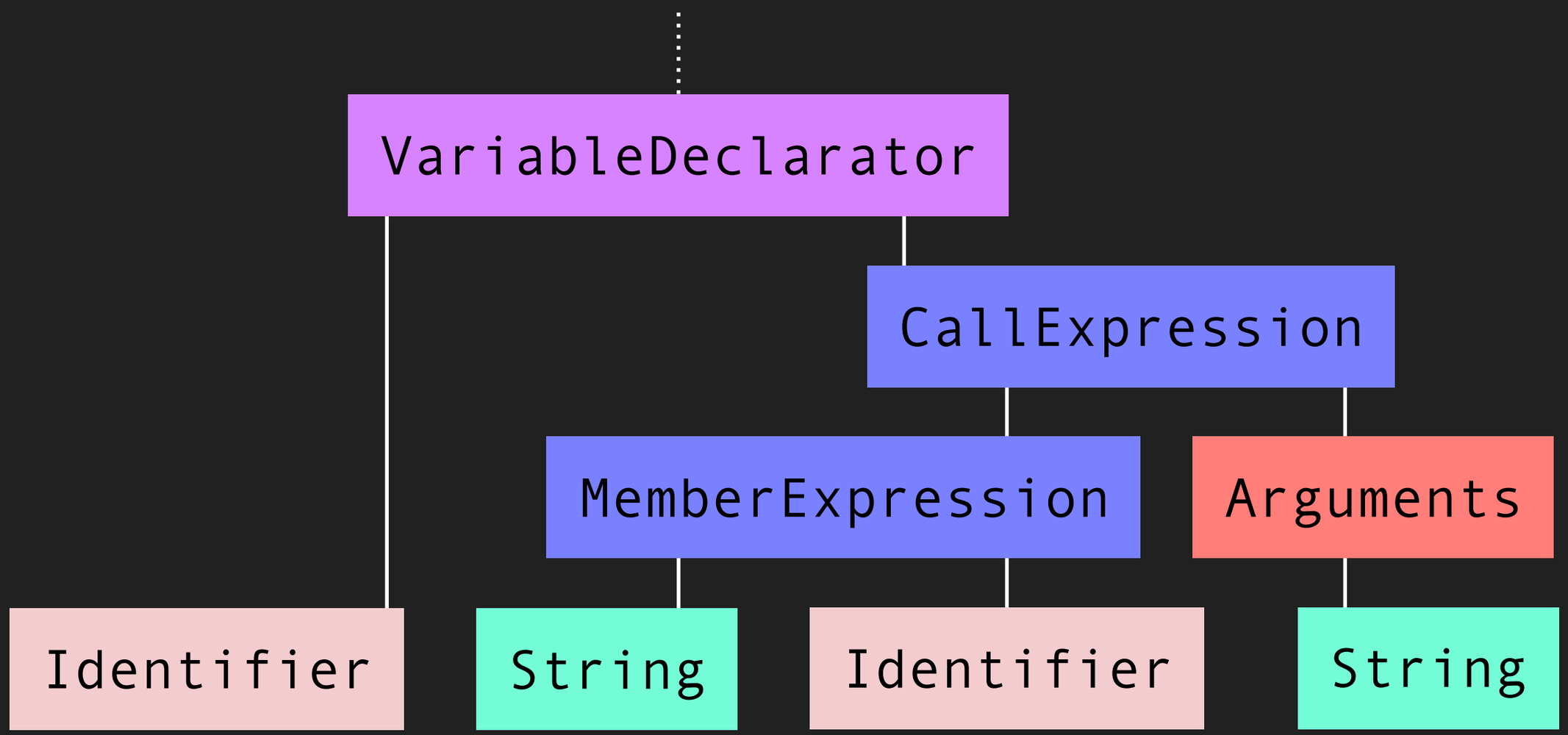
parse for the course



https://esprima.org/demo/parse.html#

parse for the course




```
const lexemes = 'Jenna gave
the talk'.split(' ');
```

https://esprima.org/demo/parse.html#

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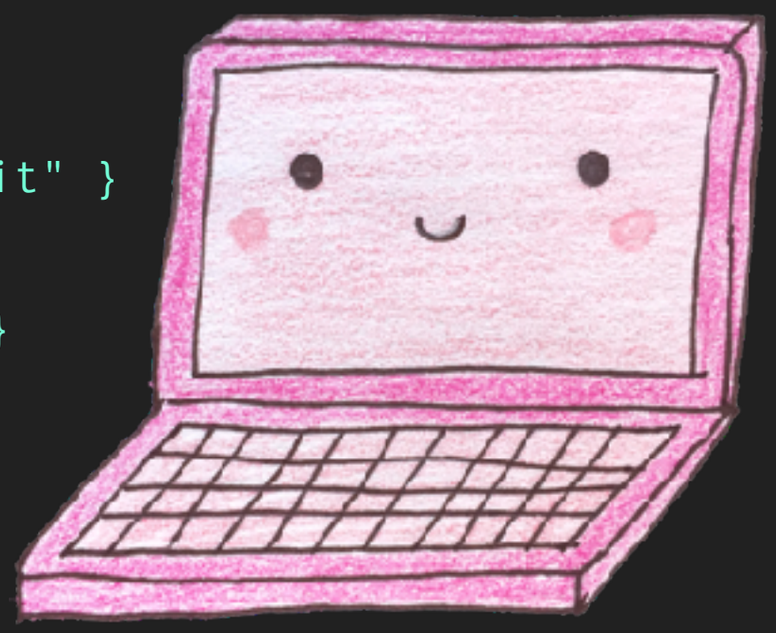
parse for the course


```
{
  "type": "Program",
  "body": [
    {
      "type": "VariableDeclaration",
      "declarations": [
        {
          "type": "VariableDeclarator",
          "id": { "type": "Identifier", "name": "lexemes" },
          "init": {
            "type": "CallExpression",
            "callee": {
              "type": "MemberExpression",
              "computed": false,
              "object": {
                "type": "Literal",
                "value": "Jenna gave the talk",
                "raw": "'Jenna gave a talk'"
              },
              "property": { "type": "Identifier", "name": "split" }
            },
            "arguments": [
              { "type": "Literal", "value": " ", "raw": "' '" }
            ]
          }
        }
      ],
      "kind": "const"
    }
```


Computers can have a little JavaScript, as a tree



https://esprima.org/demo/parse.html#

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syntax city

javascript	"front end"
in: #random	in: #general

from: @jenna

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syntax city

javascript "front end" in:#random
in: #general from:@jenna

Query → Term

Query → Term Query

Query → Filter

Query → Filter Query

Filter → Modifier Entity

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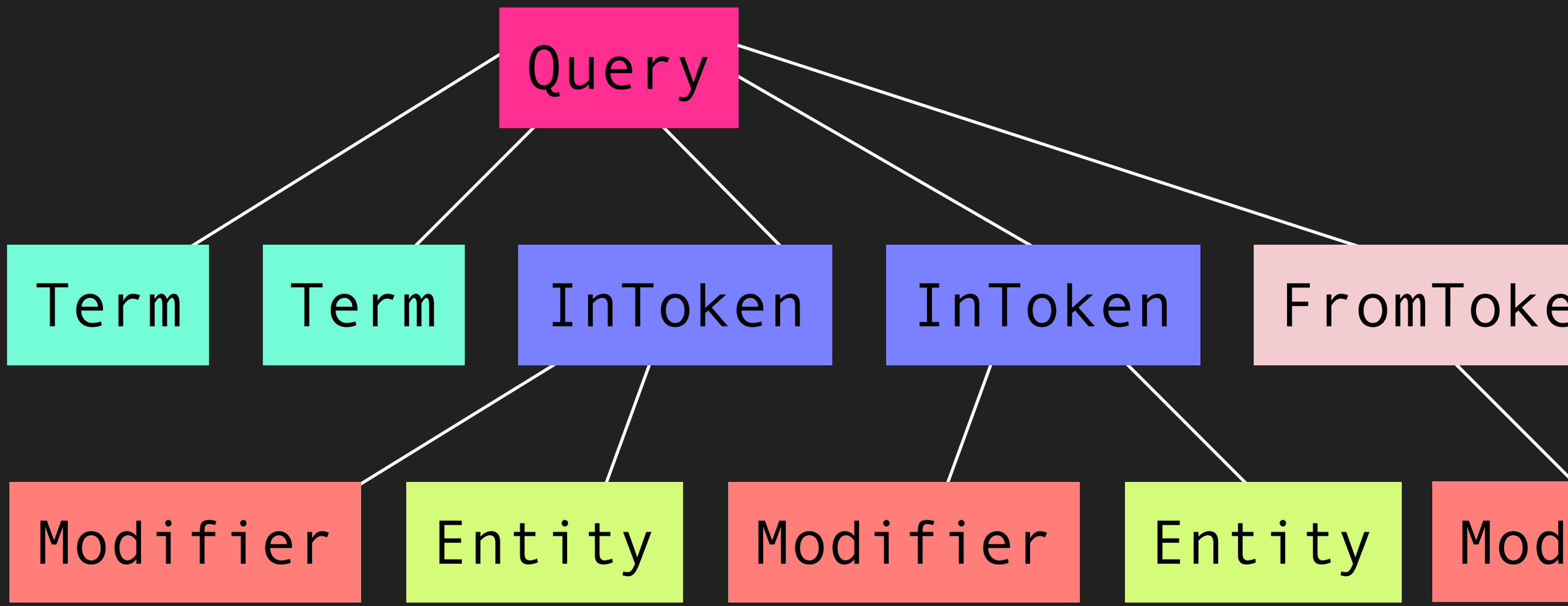
syntax city

javascript "front end" in:#random
in: #general from:@jenna



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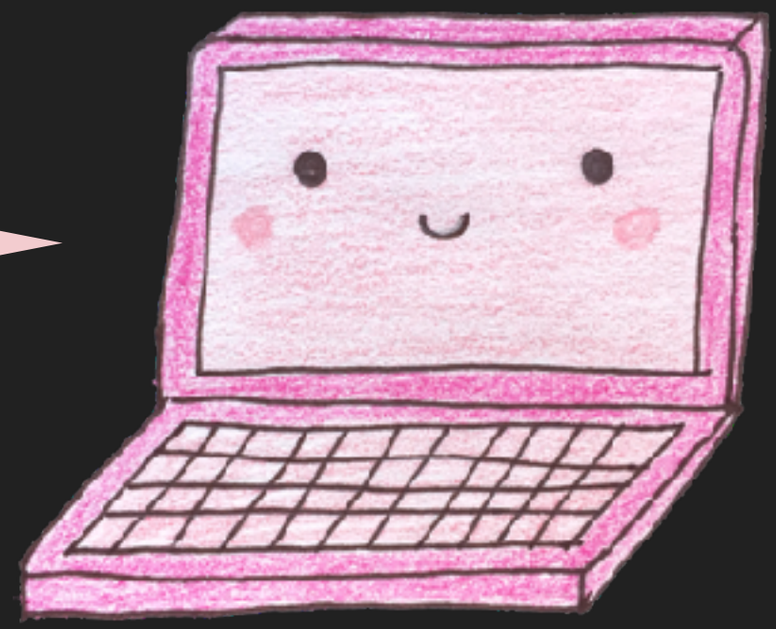
parse for the course

Read my co-odeeee
♪ ♪ ♪



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the more complicated stuff...

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advanced grammar school

```
/in: ?([^ ]+)|from: ?([^ ]+)'|"([^"]+)"|\'([^\']+)\'|([^ ]+)'/
```

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advanced grammar school

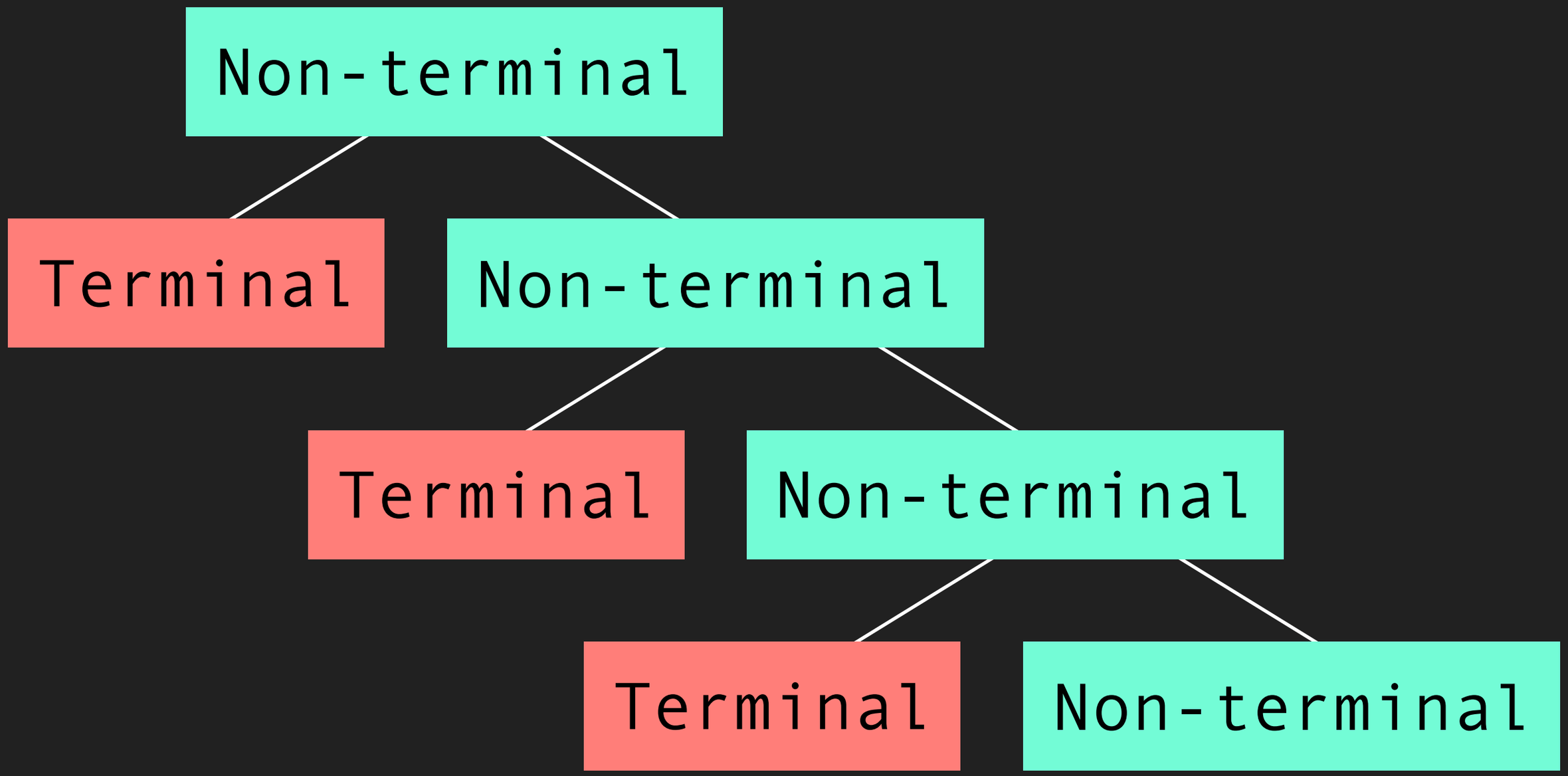
A "regular grammar" is one where all the production rules are one of the following:

$$A \rightarrow a$$

$$A \rightarrow Ba$$

https://en.wikipedia.org/wiki/Regular_grammar

advanced grammar school



https://en.wikipedia.org/wiki/Regular_grammar

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advanced grammar school

$$A \rightarrow a$$

$$A \rightarrow Ba$$

$$Query \rightarrow Term$$

$$Query \rightarrow Term\ Query$$

$$Query \rightarrow Filter$$

$$Query \rightarrow Query\ Filter$$

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advanced grammar school

A → a

A → Ba

Query → Query Filter

Filter → Modifier Entity

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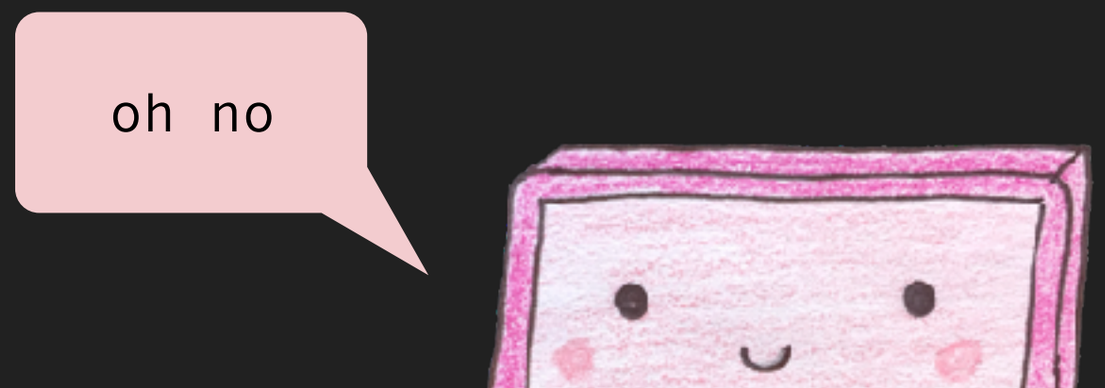
advanced grammar school

$$A \rightarrow a$$

$$A \rightarrow Ba$$

Query → Filter Query

Filter → Modifier Entity



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advanced grammar school

A "context-free grammar"
has rules that follow

$$A \rightarrow \alpha$$

where A is a non-terminal
and α is a combo of
terminal and non-terminal

https://en.wikipedia.org/wiki/Context-free_grammar

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advanced grammar school

$$S \rightarrow SS$$

$$S \rightarrow ()$$

$$S \rightarrow (S)$$

$$S \rightarrow []$$

$$S \rightarrow [S]$$

https://en.wikipedia.org/wiki/Context-free_grammar#Well-formed_parentheses

advanced grammar school

```
<div class="Wrapper">
  <input class="Input"/>
  <div class="Visualizer">
    <div class="Token">Grammars!</div>
  </div>
</div>
```

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real world parsing

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jenna.is/at-jsconfhi

real world: parsers

javascript "front end"

in: #random

in: #general

from: @jenna

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jenna.is/at-jsconfhi

real world: parsers

Term	Term
Modifier	Entity
Modifier	Entity
Modifier	Entity

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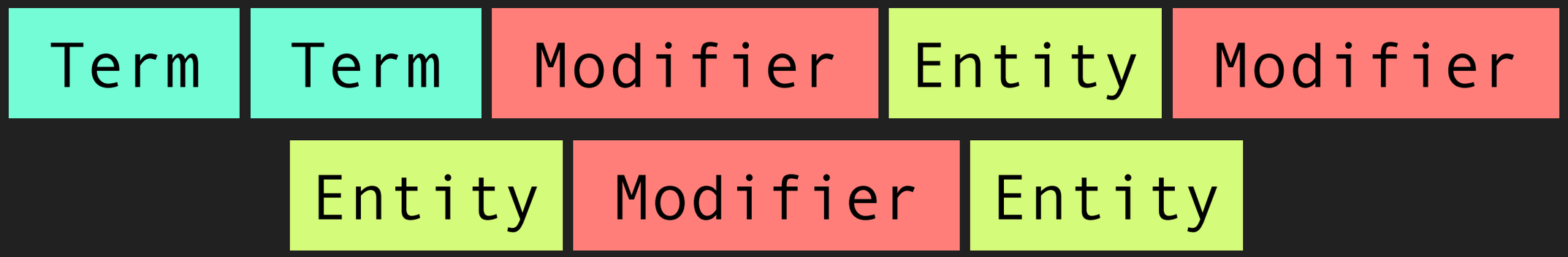
real world: parsers

then, the parser goes through and matches the tokens to production rules

https://www.cs.umd.edu/~mvz/cmsc430-s07/M08topdown.pdf

real world: parsers



https://www.cs.umd.edu/~mvz/cmsc430-s07/M08topdown.pdf

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real world: parsers

Term | Term | Modifier | Entity | Modifier

Entity | Modifier | Entity

Query

https://www.cs.umd.edu/~mvz/cmsc430-s07/M08topdown.pdf

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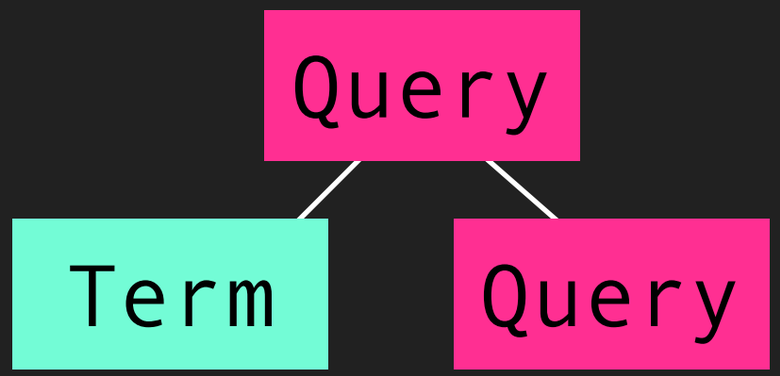
real world: parsers

Term | Modifier | Entity | Modifier

Entity | Modifier | Entity



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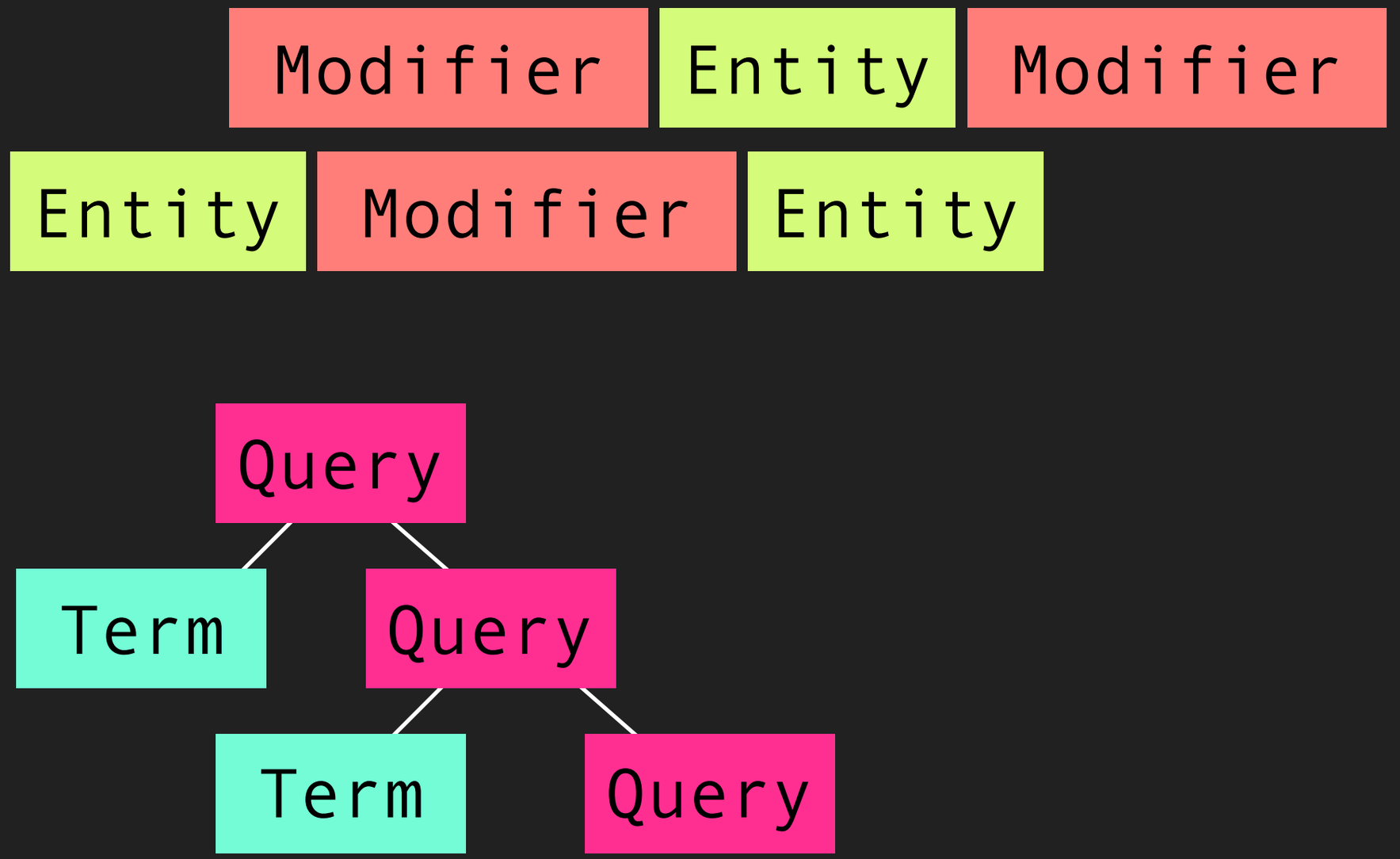
real world: parsers

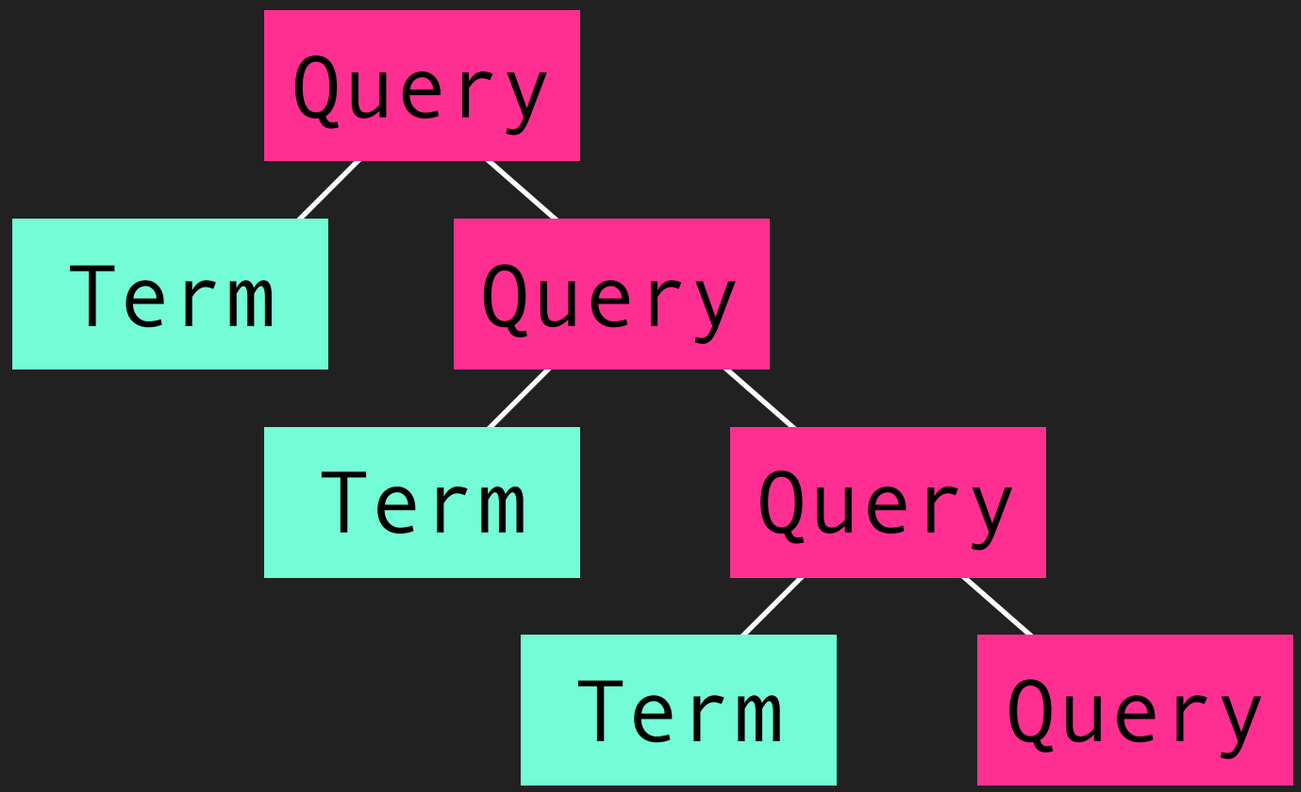


https://www.cs.umd.edu/~mvz/cmsc430-s07/M08topdown.pdf

real world: parsers

Entity | Modifier

Entity | Modifier | Entity



https://www.cs.umd.edu/~mvz/cmsc430-s07/M08topdown.pdf

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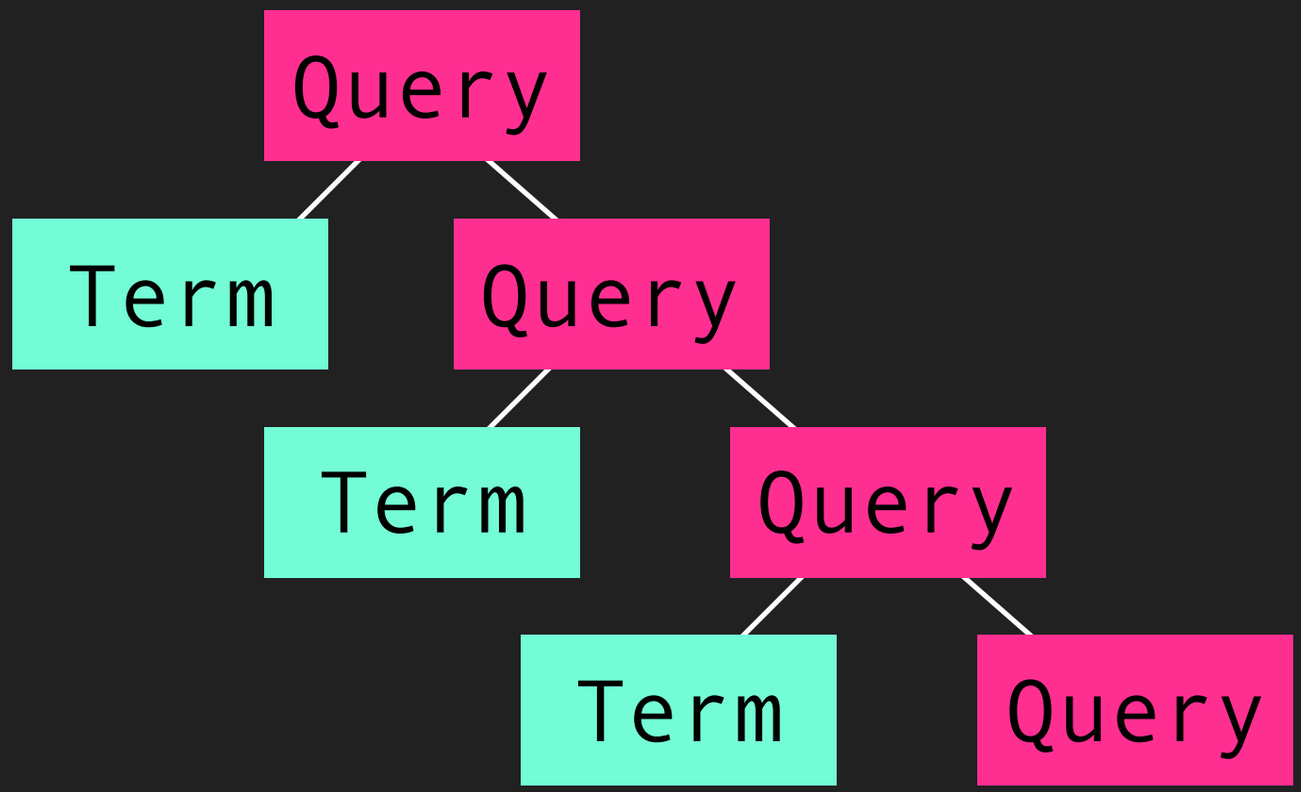
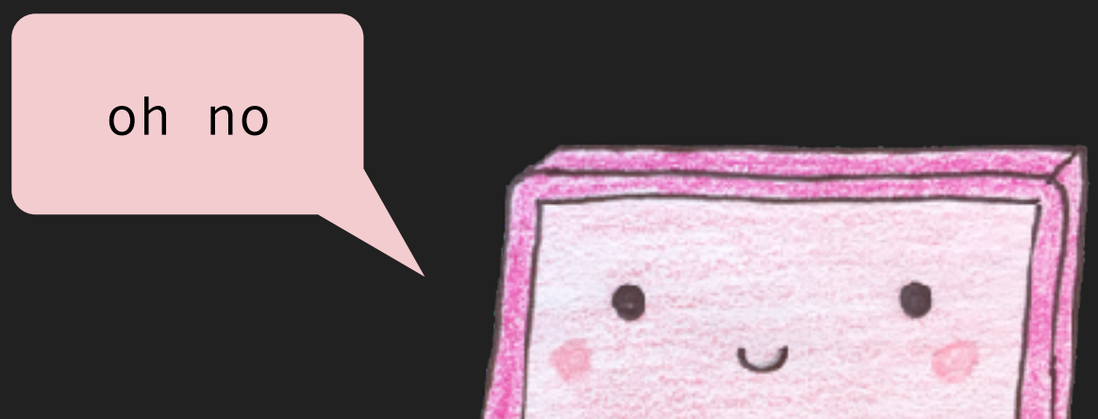
real world: parsers

Entity | Modifier

Entity | Modifier | Entity





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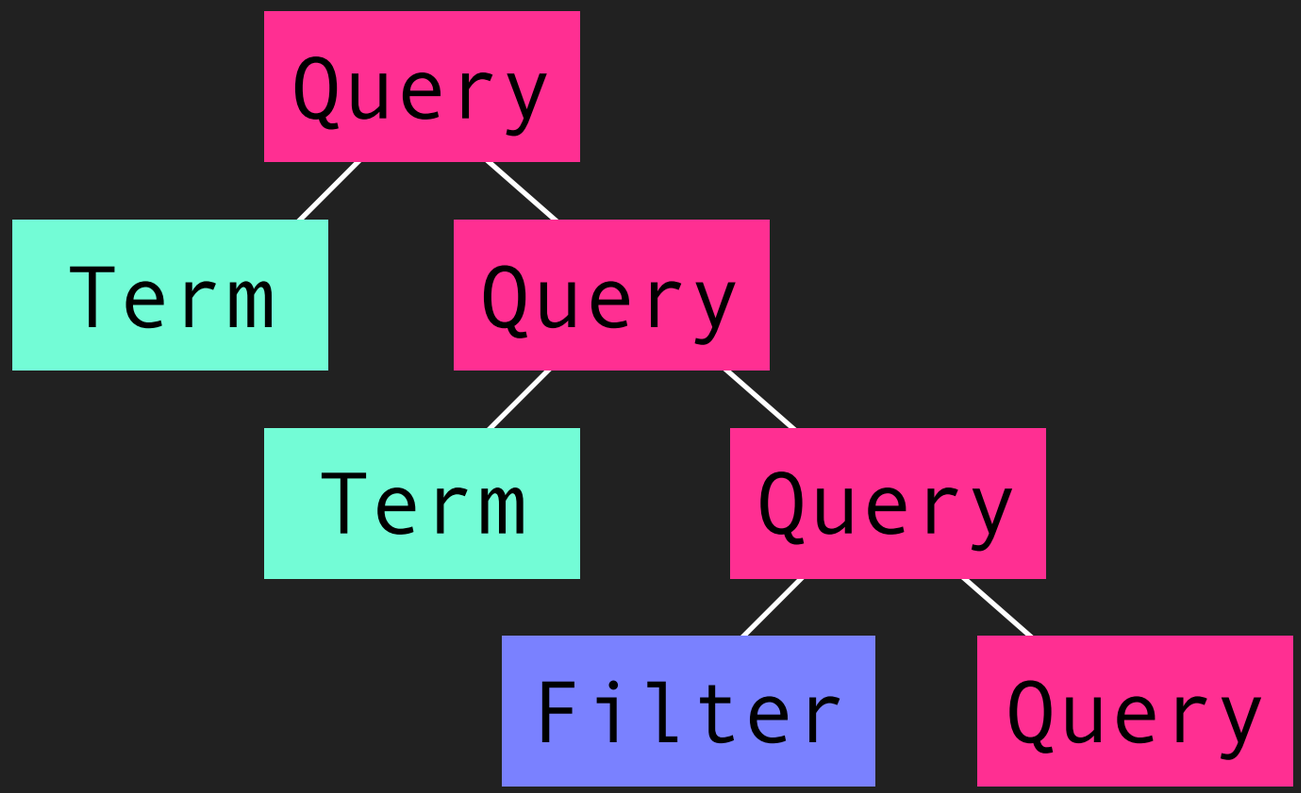
real world: parsers

Entity Modifier

Entity Modifier Entity



https://www.cs.umd.edu/~mvz/cmsc430-s07/M08topdown.pdf

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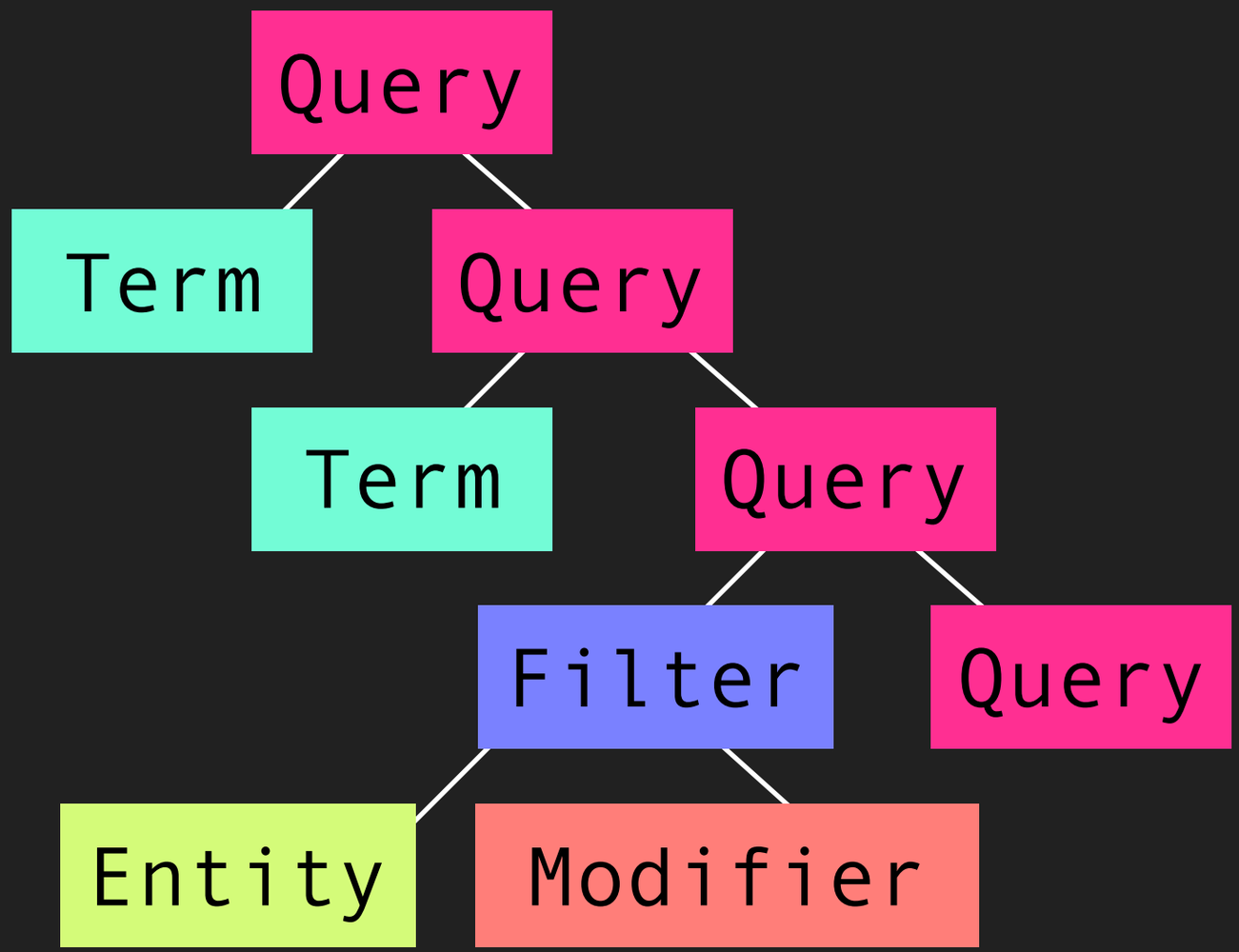
real world: parsers

Entity | Modifier | Entity



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Grammars!

Lexers!

Tokens!

Parsers!

Trees!

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"thank you"

"JSConf Hawaii"

from:@zeigenvector

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