Who am I

- Jared Pochtar
- TAed this class a few years ago
- Coauthored an unpublished paper with with Prof. Edwards
- Worked at 4 different kinds of compilers projects across as many companies
- Founded Pagedraw, a compilers startup

Compilers in Industry

Programming Language design is a very **unsolved** problem

n-stage **Compilers** are a very **well understood** way to approach software engineering problems

Open questions in Programming Languages

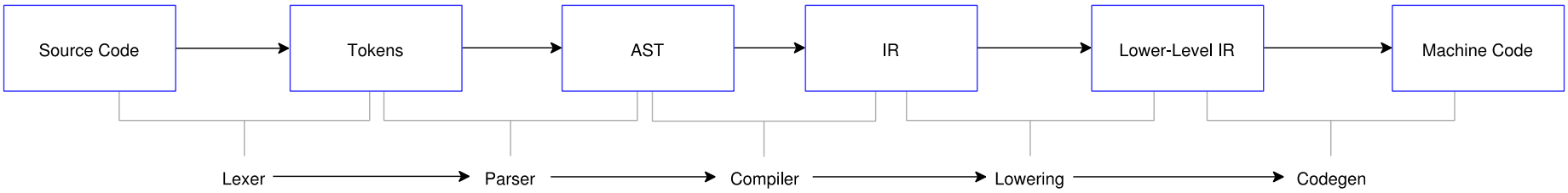
Nonlinear control flow

- Asynchrony and Distributed Computing
- Different from parallelization! That's a whole other topic of PL research
- Exception Handling

Devtools outside or adjacent to the code itself— IDEs+

- Coffeescript live compiler
- Autocomplete / inline type checking / debuggers

Programming in VR?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IR
Lower-Level IR
Machine Code
Lexer
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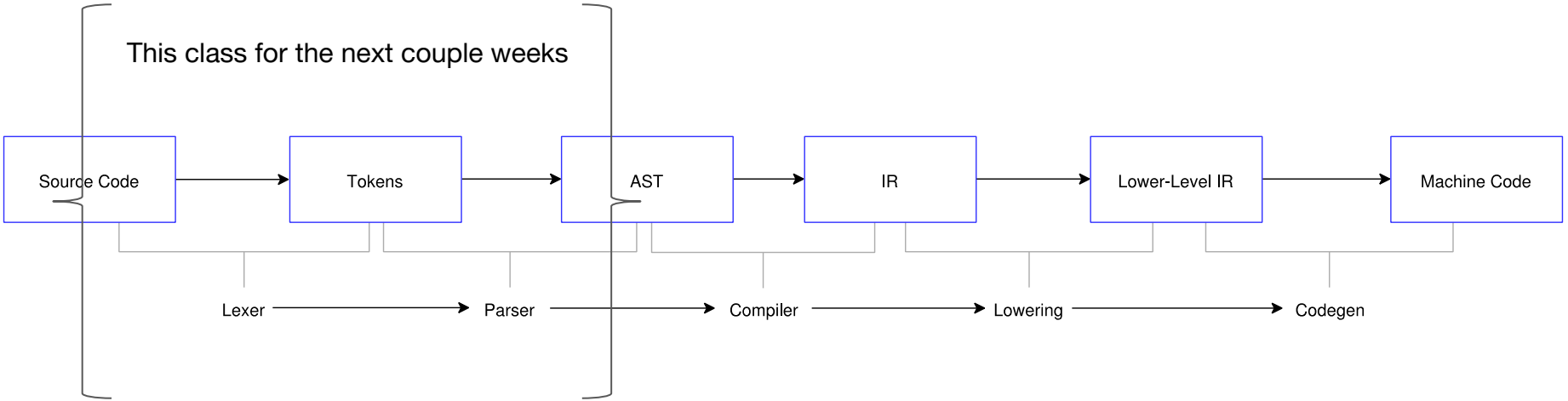
Codegen


This class for the next couple weeks
Source Code
Tokens
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Lower-Level IR
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Open questions in Programming Languages

that you could think about for your project!

Nonlinear control flow

- Asynchrony and Synchronization.
- Different from parallelization! That's a whole other topic of PL research
- Exception Handling

Devtools outside or adjacent to the code itself— IDEs+

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Programming in VR?

New conventional uses of compilers

- Optimize database queries. Compile the SQL, optimize the query by rewriting it with cheaper operations, then Just-in-time compile it.
- JITting JS for v8, Sunspider, Nitro
- WASM and asm.js
- GPU, TPU languages and others targeting specialized hardware
- Cross-compile ML algorithms for different platforms (Tensorflow vs whatever the new thing is)
- Coffeescript2 just came out— we're still working on ways to improve Javascript, since we're stuck with it and it's pretty ugly, even though there's some real gold nuggets in there.
- Sourcemaps— correlating lines in the generated code with lines in the source code. Killer for debugging languages that compile to Javascript with the browser-based Chrome Web Inspector, which wants to work with Javascript even though you don't

Unconventional uses of compilers

Auto-add type annotations to code

- Python 3: Pinfer.py https://github.com/python/mypy/tree/master/pinfer
- Typescript/Flow: https://maierfelix.github.io/Iroh/

Migrate a codebase

- https://github.com/jaredp/coffeescript-to-typescript

Combine Python (CPython) and Javascript (v8)

Python

```
def fib(n):
    if n < 2:
        return 1
    else:
        return fib(n - 2) + fib(n - 1)

def loop(n):
    return [fib(i) for i in range(n)]

def log(line):
    print(line)

def mapInt2Str(nums):
    return [str(n) for n in nums]
```

Python3

```
def fib(n):
    if n < 2:
        return 1
    else:
        return fib(n - 2) + fib(n - 1)

def loop(n):
    return [fib(i) for i in range(n)]

def log(line):
    print(line)

def mapInt2Str(nums):
    return [str(n) for n in nums]
```

```
from typing import List, Dict, Set, Tuple,
Callable, Pattern, Match, Union, Optional

def fib(n: int) -> int:
    if n < 2:
        return 1
    else:
        return fib(n - 2) + fib(n - 1)

def loop(n: int) -> List[int]:
    return [fib(i) for i in range(n)]

def log(line: str) -> None:
    print(line)

def mapInt2Str(nums: List[int]) -> List[str]:
    return [str(n) for n in nums]
```

Pinfer.py

mypy/pinfer/p.py simple test-main.py simple.py

```
# BEFORE: simple.py

def fib(n):
    if n < 2:
        return 1
    else:
        return fib(n - 2) + fib(n - 1)

def loop(n):
    return [fib(i) for i in range(n)]

def log(line):
    print(line)

def mapInt2Str(nums):
    return [str(n) for n in nums]
```

```
# AFTER: simple.py

from typing import List, Dict, Set, Tuple,
Callable, Pattern, Match, Union, Optional

def fib(n: int) -> int:
    if n < 2:
        return 1
    else:
        return fib(n - 2) + fib(n - 1)

def loop(n: int) -> List[int]:
    return [fib(i) for i in range(n)]

def log(line: str) -> None:
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Combine Python (CPython) and Javascript (v8)

Applying compilers to things that don’t look like source code

Jared Pochtar ▶ Stephen A. Edwards

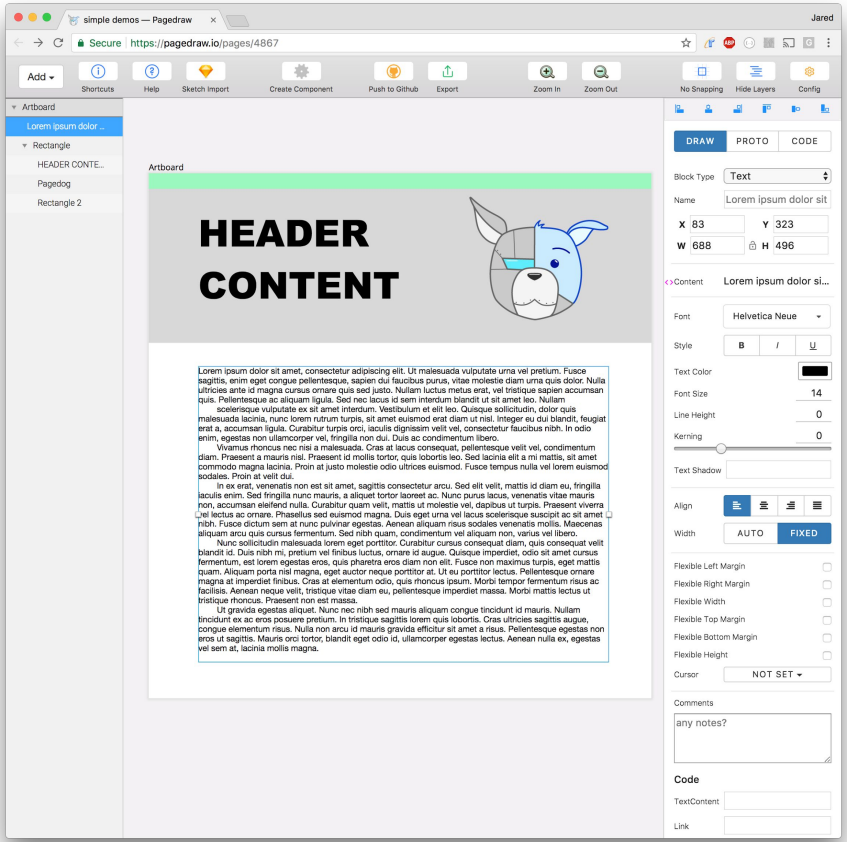
December 1, 2015 · Cambridge, MA ·

I know you've gotten to me when I go to Chipotle and think, hey, this is just a 5-stage pipeline English to burrito compiler

Like Comment Share

Margo Seltzer, Stephen A. Edwards and 7 others

Pagedraw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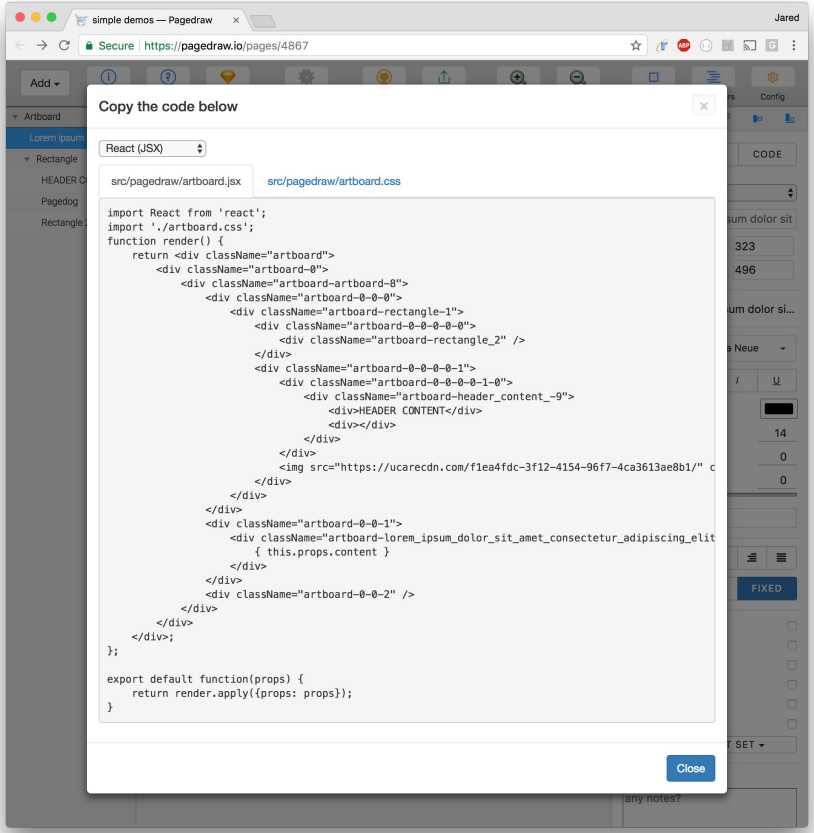
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Jared
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Copy the code below
React (JSX)
src/pagedraw/artboard.jsx
src/pagedraw/artboard.css
import React from 'react';
import './artboard.css';
function render() {
return

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<div className="artboard-lorem_ipsum_dolor_sit_amet_consectetur_adipiscing_elit
{ this.props.content }

;
};
export default function(props) {
return render.apply({props: props});
}
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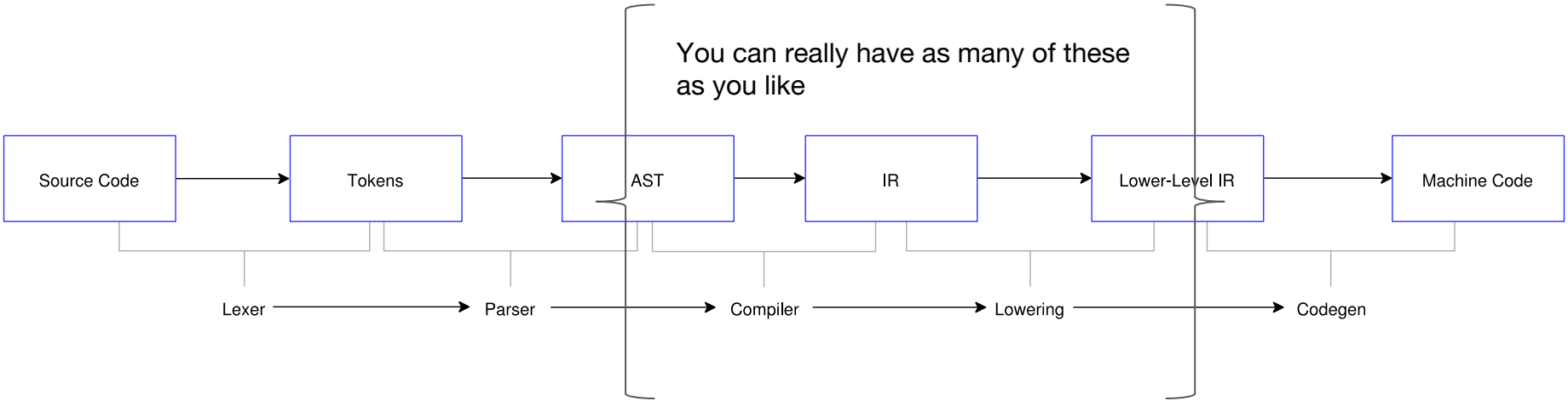
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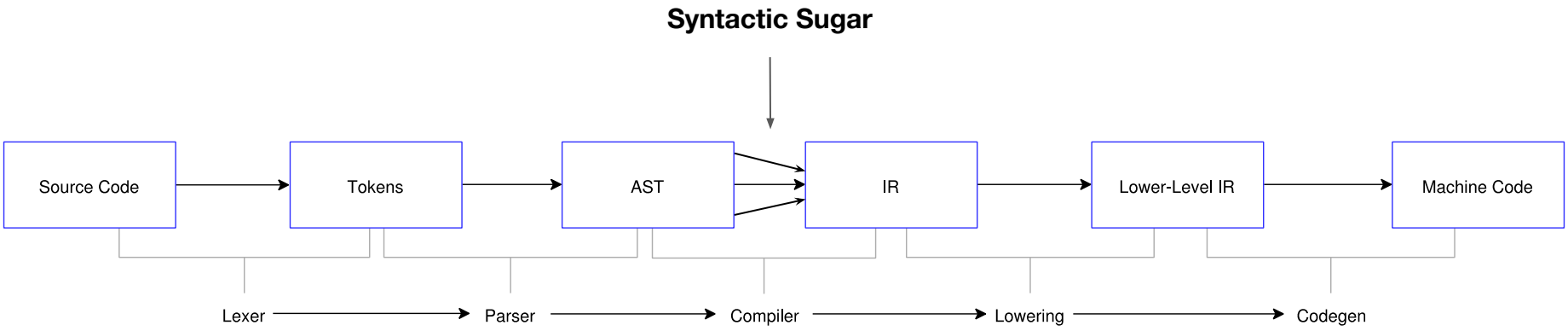
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Python

```
# code you write

def loop(n):
    return [fib(i) for i in range(n)]
```

```
# code the bytecode interpreter sees

def loop(n):
    _list = []
    for i in range(n):
        _list.append(n)
    _temp = _list
    return _temp
```

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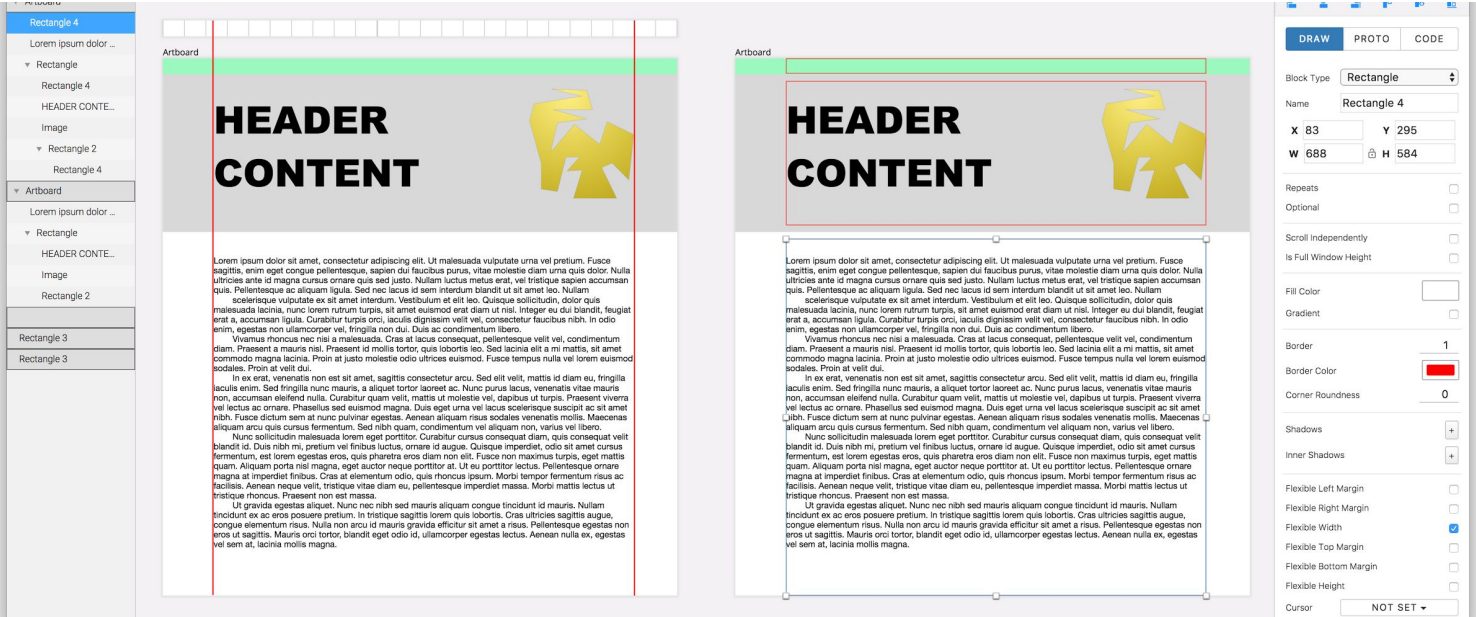

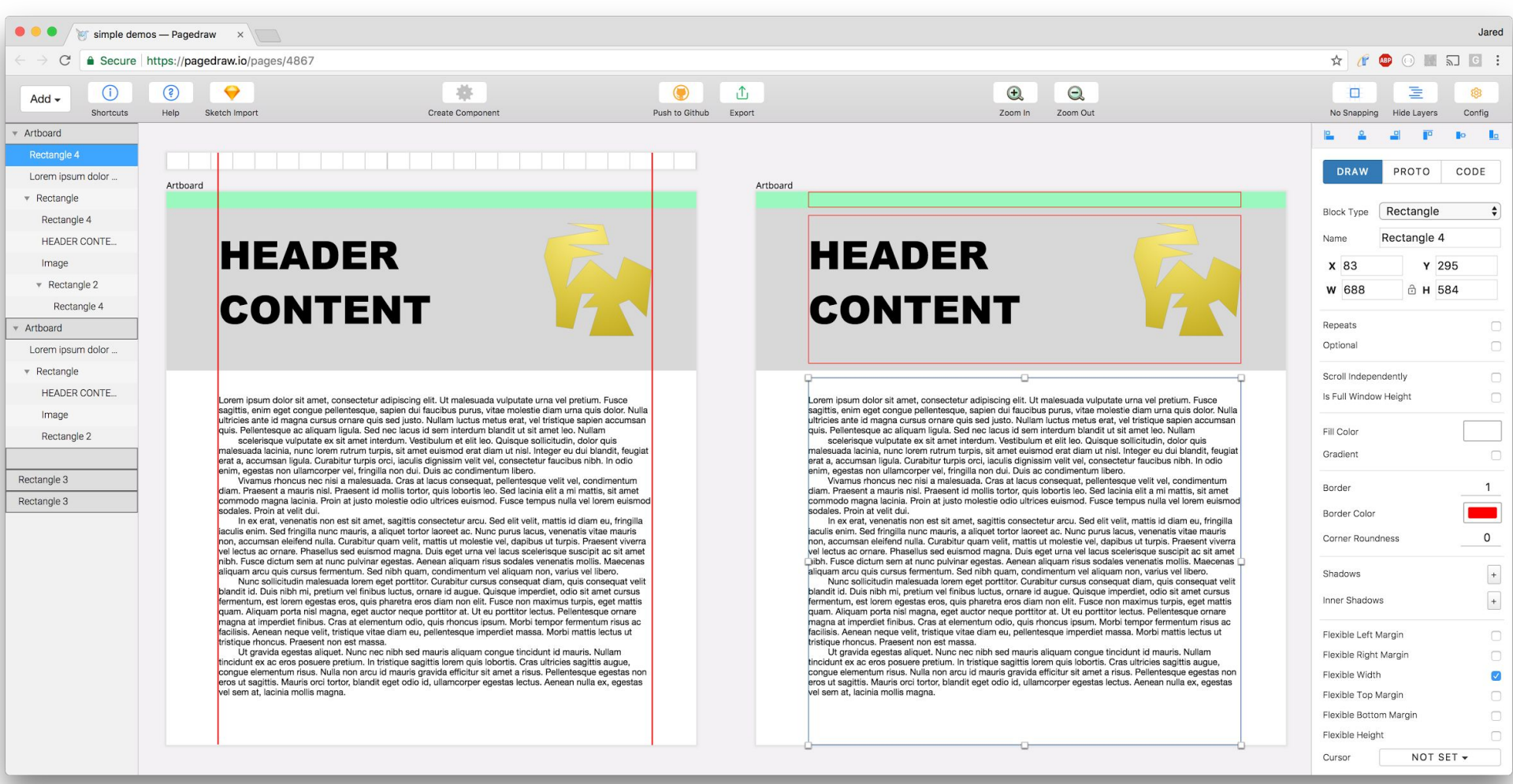
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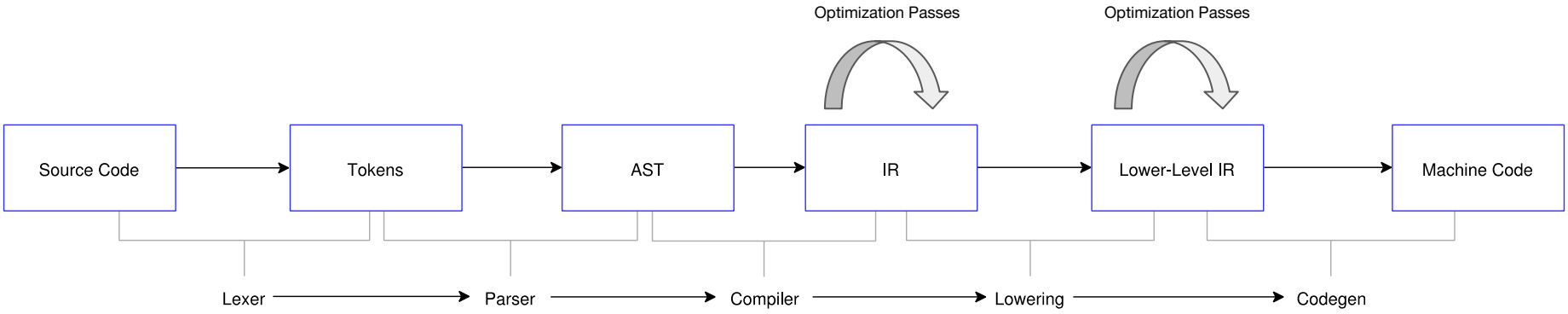
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Optimization Passes
Source Code
Tokens
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IR
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Lexer
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X to Java (hypothetical)

```
// function call syntax

add(
  subtract(4, n),
  times(5,
    add(a, b)
  )
)
```

```
// Java (without optimizations)

(((4) - (n)) + ((5) * ((a) + (b))))


// Java (incorrectly without parens)
// 4 - n + 5 * a + b
```

```
// Java (with optimizations)

4 - n + 5 * (a + b)
```

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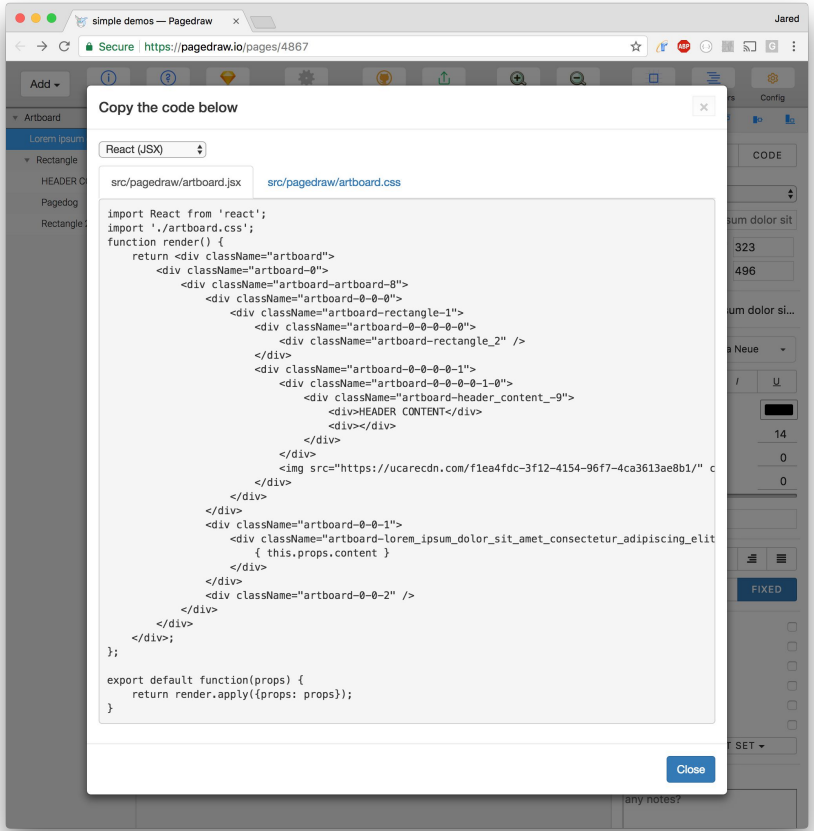
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React (JSX)
src/pagedraw/artboard.jsx
src/pagedraw/artboard.css
import React from 'react';
import './artboard.css';
function render() {
return

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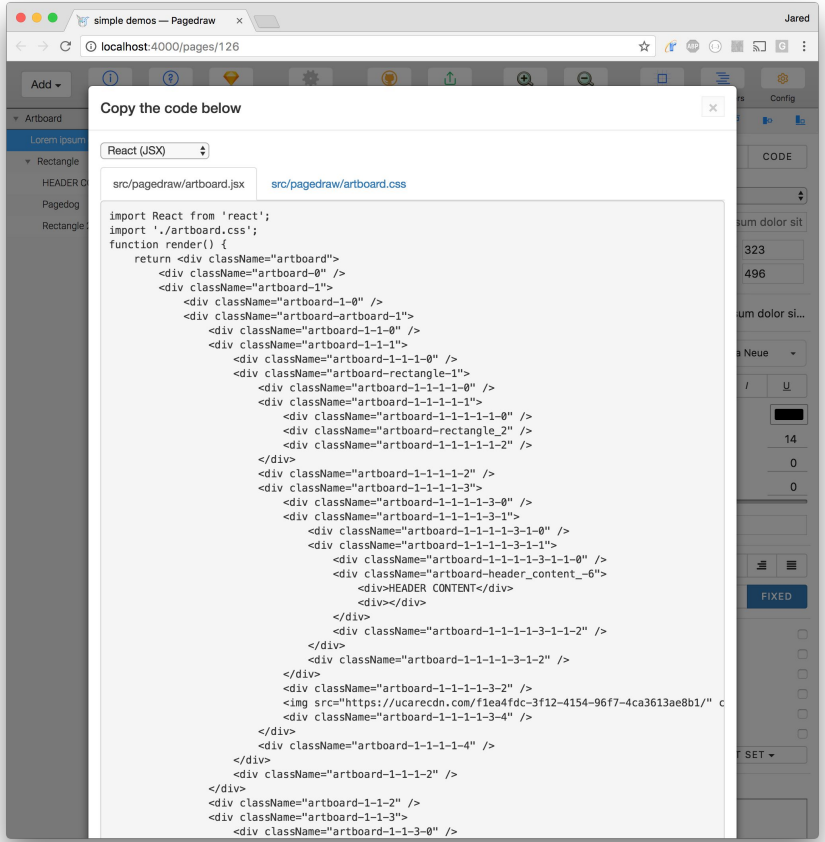
{ this.props.content }

;
};
export default function(props) {
return render.apply({props: props});
}
Close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React (JSX)
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src/pagedraw/artboard.css
import React from 'react';
import './artboard.css';
function render() {
return

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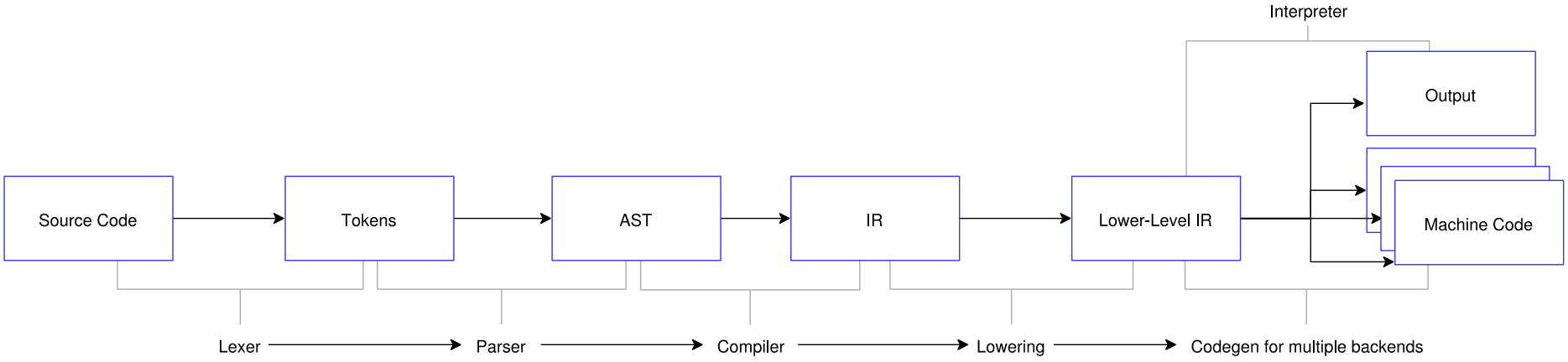
Interpreter
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Tokens
AST
IR
Lower-Level IR
Machine Code
Lexer
Parser
Compiler
Lowering
Codegen for multiple backends