Lecture 2 : Compilers, Interpreters, and Racket.

Agenda:

- what is a programming language?
- how do we execute a program?
    - compilers vs. interpreters
- syntax + semantics
- Racket overview

What is a programming language?

way to specify algorithms?

HLL vs. low level?

unambiguous way of specifying logic

syntax + semantics

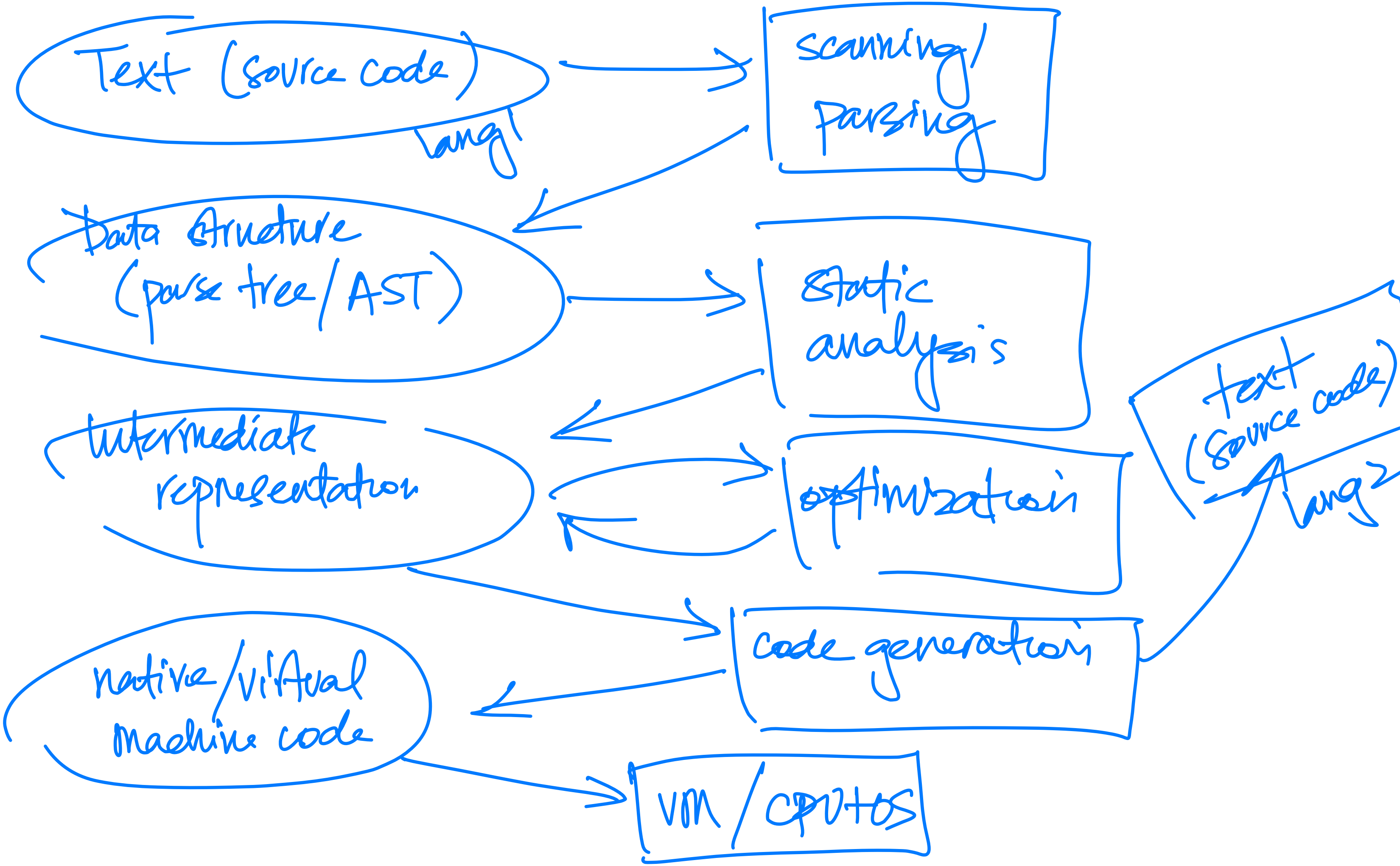
grammar

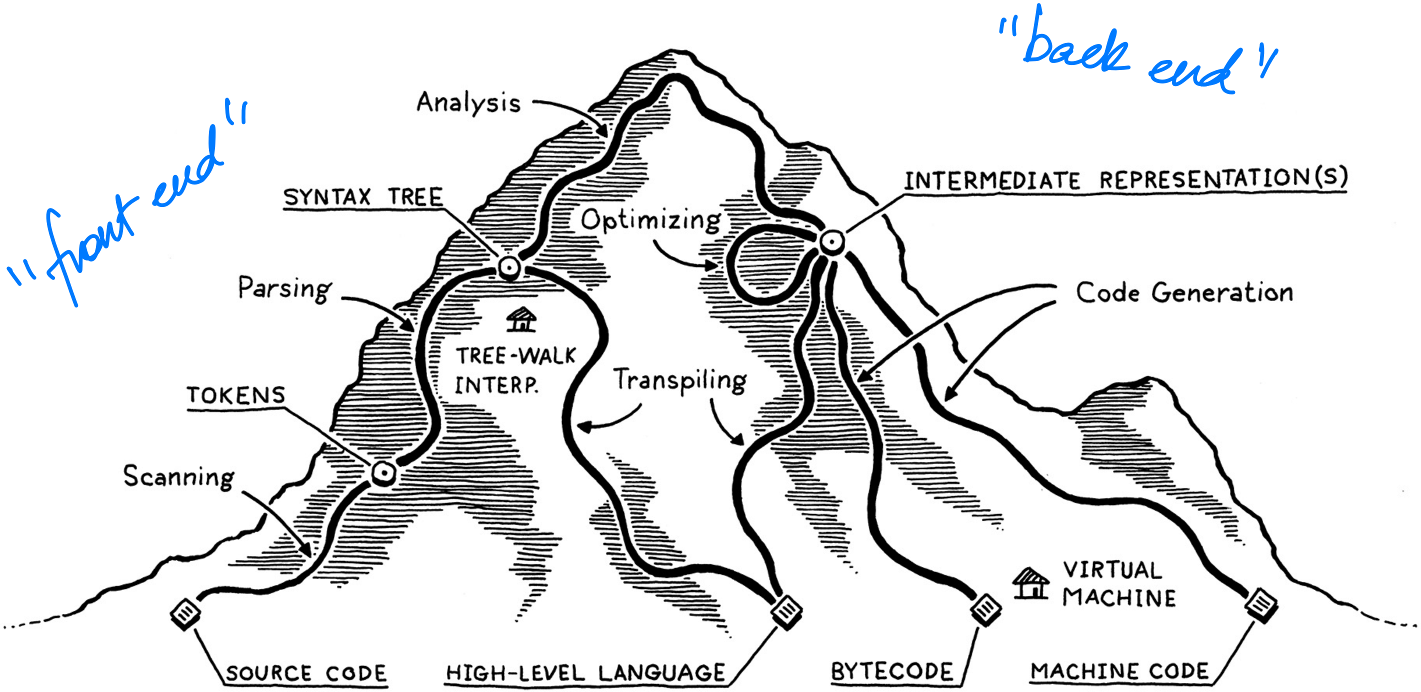
meaning

How do we "execute" a program?
(i.e., how do we go from HLL source code to
fetch-decode-execute on the CPU?)

compiler interpreter

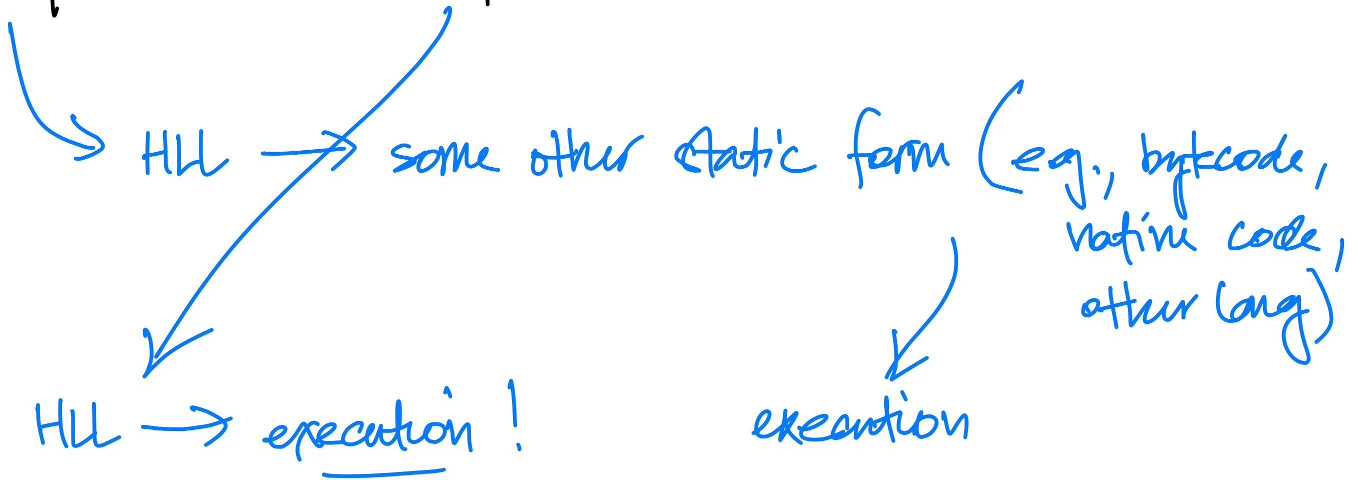
scanning / writing


Text (source code)
lang1
scanning/parsing
Data structure (parse tree/AST)
static analysis
intermediate representation
optimization
text (source code)
lang2
code generation
native/virtual machine code
vm / CPU+OS



(from "Crafting Interpreters")

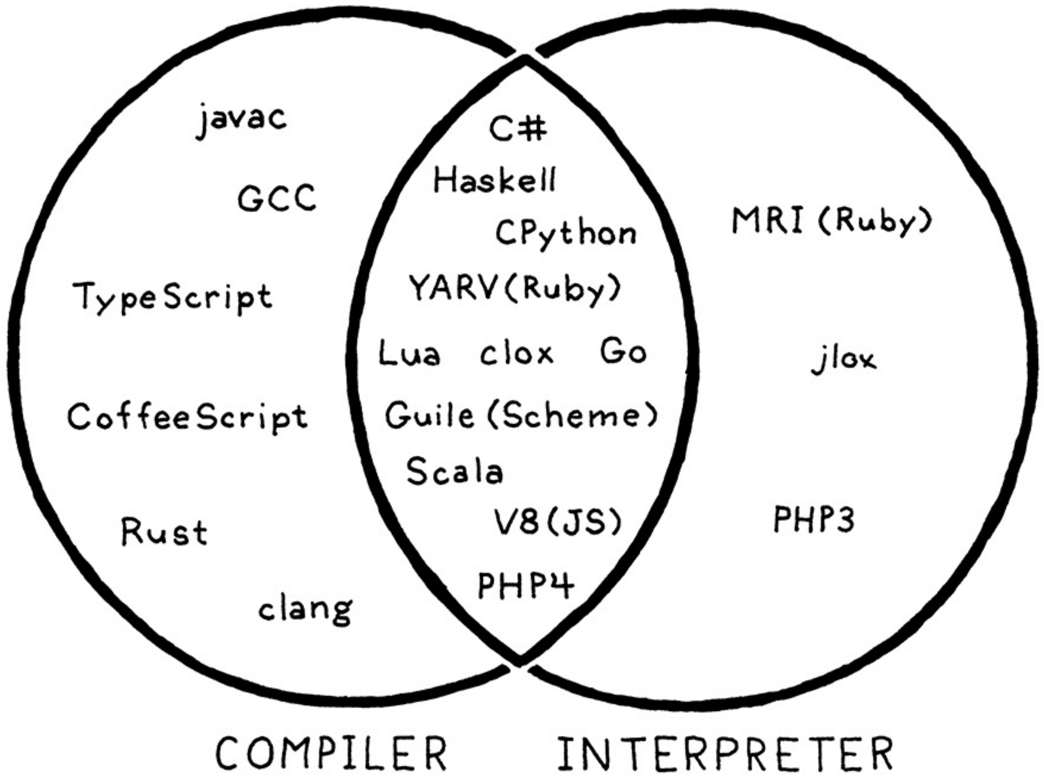
"compiler" vs. "interpreter"



HLL → some other static form (e.g., bytecode, native code, other lang) → execution

HLL → execution!

lots of middle ground!



(from "Crafting Interpreters")

Syntax + Semantics

- rules for writing a valid (legal) program
- <u>GRAMMAR</u>

- what does a program (or some language construct) <u>mean</u> ?
- how will a program behave (what will it compute) when run ?
  - result value / type / eventuality
- operational semantics : formal, logical reasoning about a program
  - mathematical foundations

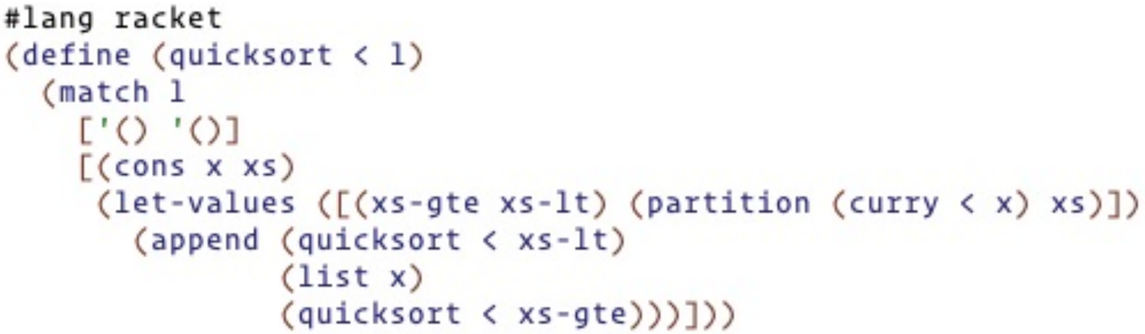
Racket

(a decendant of Scheme,
and a member of the LISP family of languages)

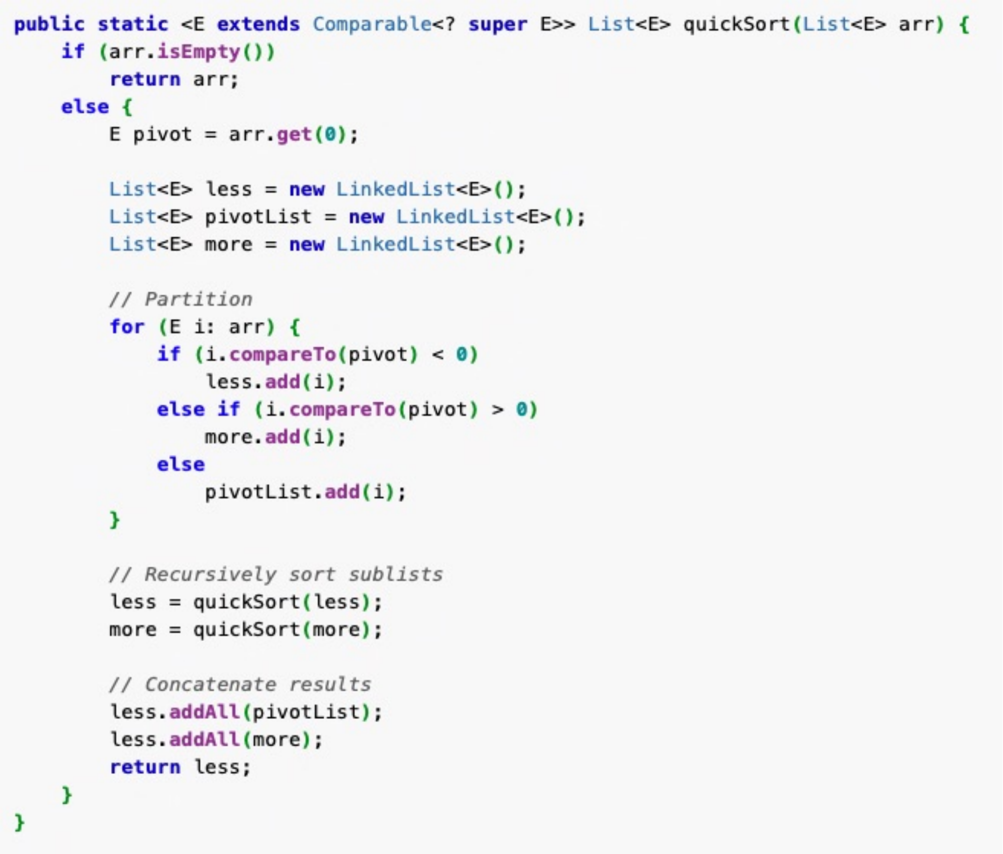
"List processing"

"Lots of Insidious, Silly Parentheses"

"Lost In a Sea of Parentheses"



```
#lang racket
(define (quicksort < l)
  (match l
    ['() '()]
    [(cons x xs)
     (let-values ([(xs-gte xs-lt) (partition (curry < x) xs)])
       (append (quicksort < xs-lt)
               (list x)
               (quicksort < xs-gte)))]))
```



```
public static <E extends Comparable<? super E>> List<E> quickSort(List<E> arr) {
    if (arr.isEmpty())
        return arr;
    else {
        E pivot = arr.get(0);

        List<E> less = new LinkedList<E>();
        List<E> pivotList = new LinkedList<E>();
        List<E> more = new LinkedList<E>();

        // Partition
        for (E i: arr) {
            if (i.compareTo(pivot) < 0)
                less.add(i);
            else if (i.compareTo(pivot) > 0)
                more.add(i);
            else
                pivotList.add(i);
        }

        // Recursively sort sublists
        less = quickSort(less);
        more = quickSort(more);

        // Concatenate results
        less.addAll(pivotList);
        less.addAll(more);
        return less;
    }
}
```

(it's too easy to pick on Java)

"S-expressions"

- atoms : numbers, strings, or "symbols" (identifiers)
- parenthesized list of space-delineated S-expressions

e.g., 1 , 2, "hello world", apple, really? , a-b/c,

( ), (2 3 4), (a b 1), ("hello"), (+ 1 2),

(foo 1 2 (bar 3))

* special characters: ( ) [ ] { } " ' ` , ; # | \

```
(foo 1 2 (bar 4
              (baz)
              (bat 8)))

(define (foo x y)
  (+ x
     (* 2 y)))
```