CS 3110

Interpreters

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Today's music: *Step by Step* by New Kids on the Block

The Goal of 3110

Become a better programmer
though study of
programming languages

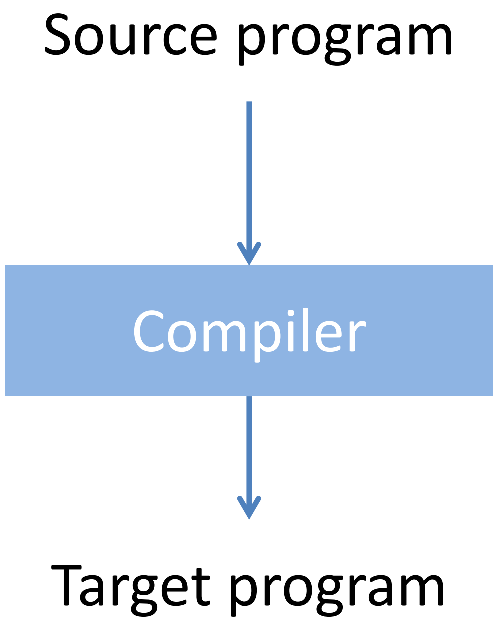
Review

Previously in 3110:

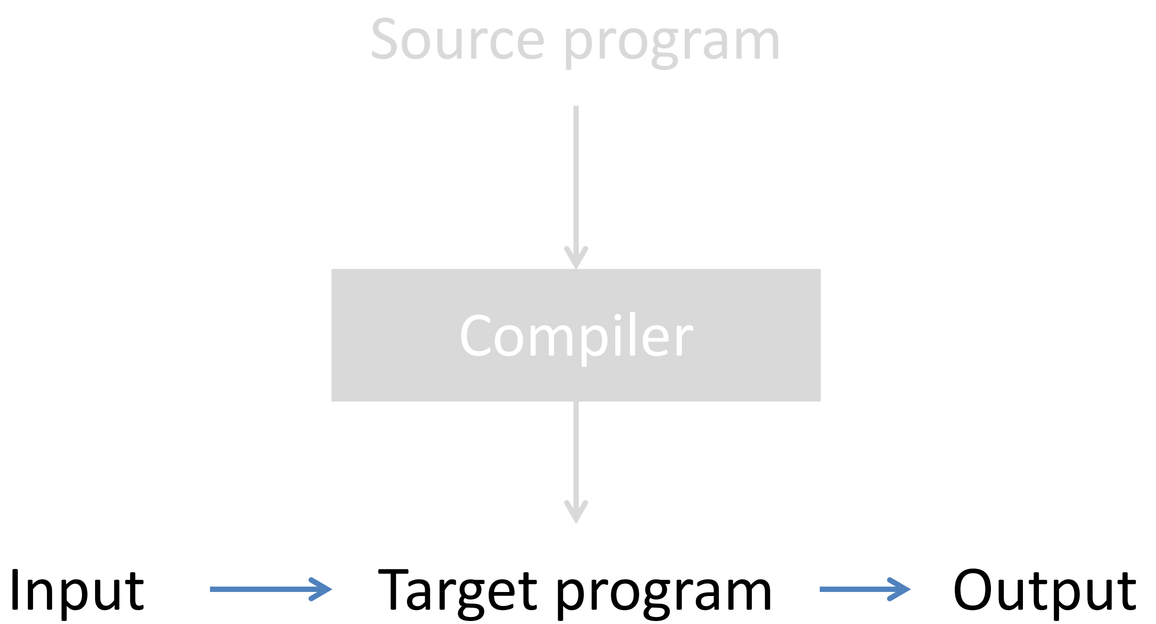
- functional programming
- modular programming
- data structures

Today:

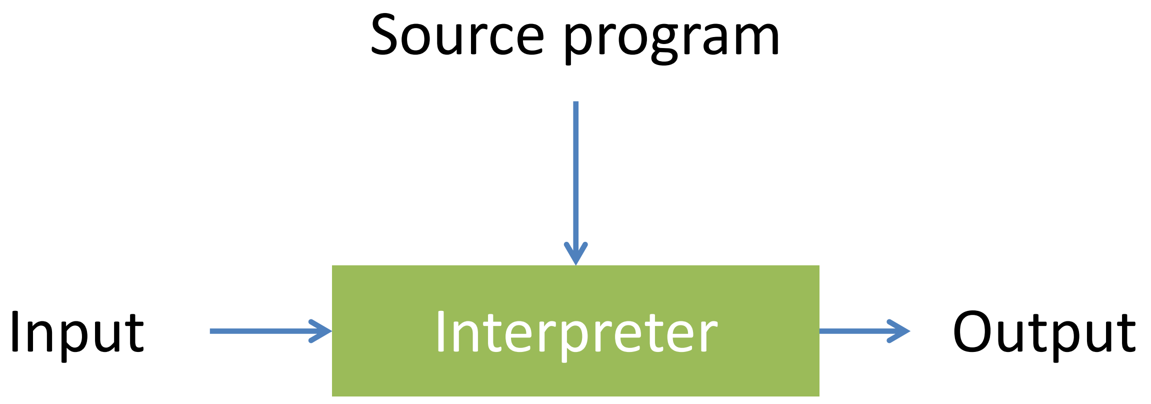
- new unit of course: interpreters



code as data: the compiler is code that operates on data; that data is itself code



the compiler goes away; not needed to run the program



the interpreter stays; needed to run the program

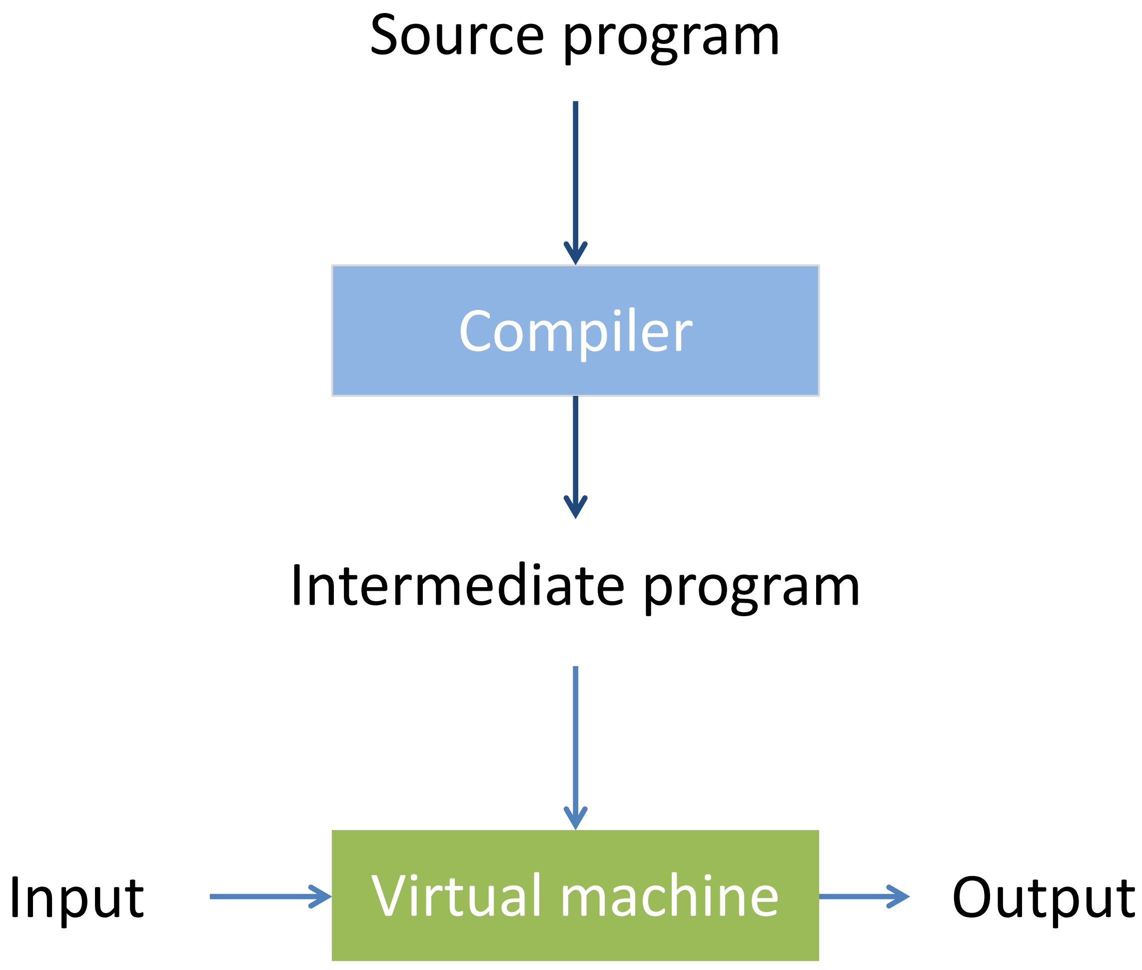
Compilers:

- primary job is *translation*
- better performance

vs.

Interpreters:

- primary job is *execution*
- easier implementation


Source program
Compiler
Intermediate program
Input
Virtual machine
Output

Architecture

Two phases:

- **Front end:** translate source code into *abstract syntax tree* (AST) then into *intermediate representation* (IR)
- **Back end:** translate AST into machine code

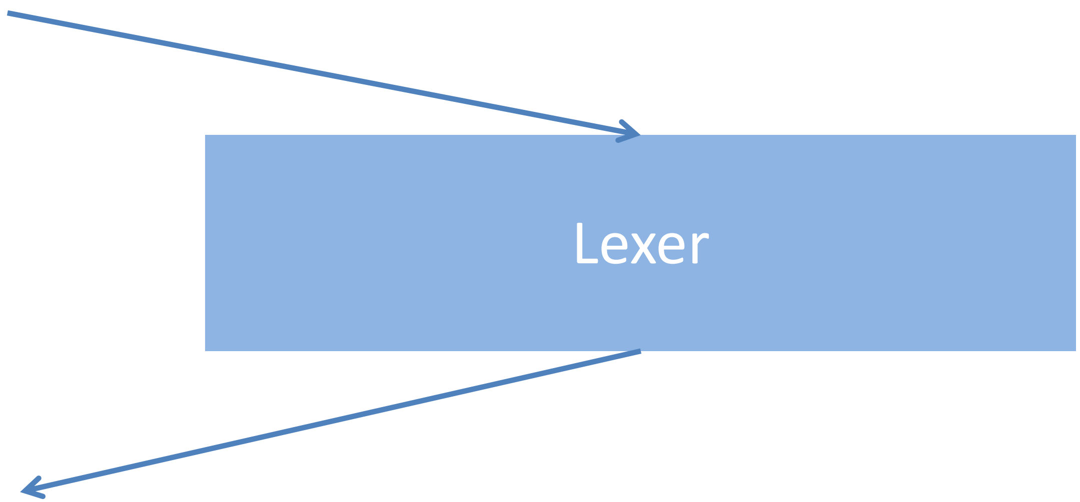
Front end of compilers and interpreters largely the same:

- *Lexical analysis* with lexer
- *Syntactic analysis* with parser
- *Semantic analysis*

Front end

Character stream:

```
if x=0 then 1 else fact(x-1)
```



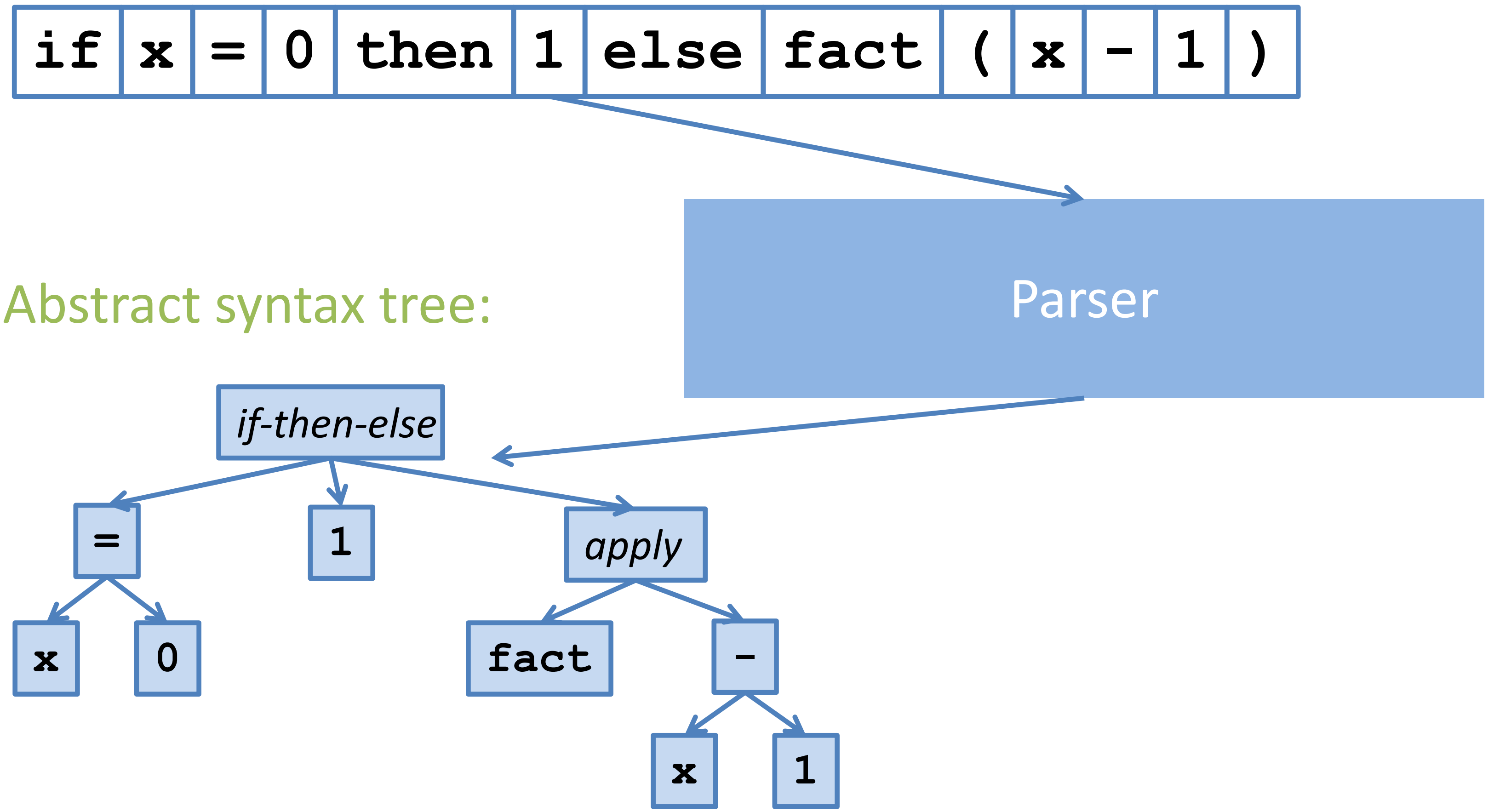
Token stream:

`if`	`x`	`=`	`0`	`then`	`1`	`else`	`fact`	`(`	`x`	`-`	`1`	`)`

Front end

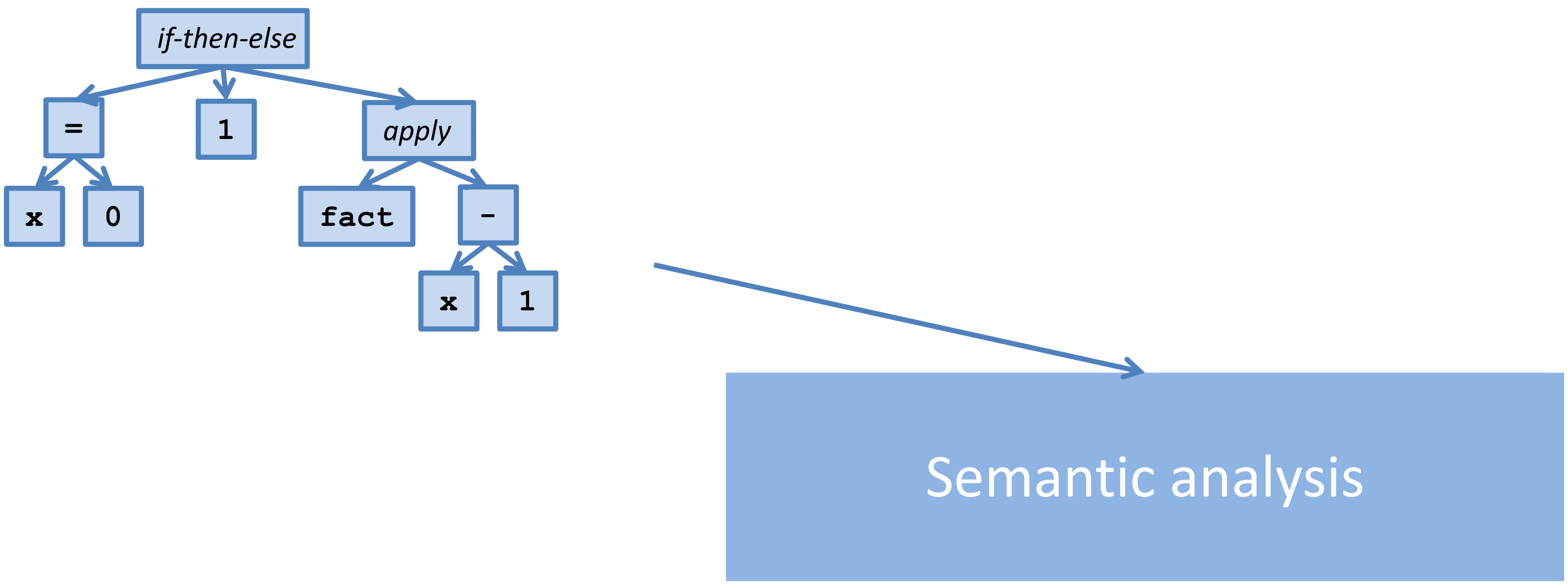
Token stream:

Abstract syntax tree:



Front end

Abstract syntax tree:



- accept or reject program
- create *symbol tables* mapping identifiers to types
- *decorate* AST with types
- etc.

Next

Might translate AST into a *intermediate representation* (IR) that is a kind of abstract machine code

Then:

- **Interpreter** executes AST or IR
- **Compiler** translates IR into machine code

Implementation

Functional languages are well-suited to implement compilers and interpreters

- **Code** easily represented by tree data types
- **Compilation/execution** easily defined by pattern matching on trees

EXPRESSION INTERPRETER

Arithmetic expressions

Goal: write an interpreter for expressions involving integers and addition

Path to solution:

- let's assume lexing and parsing is already done
- need to take in AST and interpret it
- intuition:
  - an expression e takes a single *step* to a new expression e'
  - expression keeps stepping until it reaches a *value*

Demo

Arithmetic expressions

Goal: extend interpreter to `let` expressions

Path to solution:

- extend AST with a variant for `let` and for variables
- add branches to `step` to handle those
- that requires *substitution*...

`let` expressions [from lec 2]

```
let x = e1 in e2
```

Evaluation:

- Evaluate **`e1`** to a value **`v1`**
- **Substitute** **`v1`** for **`x`** in **`e2`**, yielding a new expression **`e2'`**
- Evaluate **`e2'`** to **`v`**
- Result of evaluation is **`v`**

$$e\{v/x\}$$

means e with v substituted for x

Substitution

Instead of:

"Substitute **`v1`** for **`x`** in **`e2`**,

yielding a new expression **`e2'`**;

Evaluate **`e2'`** to **`v`**"

Write:

"Evaluate **`e2{v1/x}`** to **`v`**"

Demo

Upcoming events

- [Friday 11:59pm]: Team evals due

This is open to interpretation.

THIS IS 3110