CS 536 Announcements for Monday, March 18, 2024

Midterm 2

- Thursday, March 21, 7:30 – 9 pm
- S429 Chemistry
- bring your student ID

Last Time

- static semantic analysis
- name analysis
  - symbol tables
  - scoping

Today

- name analysis
- exam review

Next Time

- type checking

Static Semantic Analysis

Two phases

- name analysis – P4
- type checking – P5

Name analysis

- for each scope
  - process declarations – add entries to symbol table
  - process statements – update IdNodes to point to appropriate symbol table entry
- each entry in symbol table keeps track of: kind, type, nesting level, runtime location
- identify errors
  - multiply-declared names
  - uses of undeclared variables
  - bad `tuple` accesses
  - bad declarations

Scoping

- **scope** = block of code in which a name is visible/valid
- kinds of scoping
  - **static** – correspondence between use & declaration made at compile time
  - **dynamic** – correspondence between use & declaration made at run time

Name analysis and `tuples`

Symbol tables and `tuples`

- Compiler needs to
  - for each field: determine type, size, and offset with the tuple
  - determine overall size of tuple
  - verify declarations and uses of something of a `tuple` type are valid
- Idea: each `tuple` type definition contains its own symbol table for its field declarations
  - associated with the main symbol table entry for that `tuple`'s name

Relevant base grammar rules

```
decl          ::= varDecl
                | fctnDecl
                | tupleDecl       // tuple defs only at top level
                ;

varDeclList   ::= varDeclList varDecl
                | /* epsilon */
                ;

varDecl       ::= type id DOT
                | TUPLE id id DOT
                ;
...
tupleDecl     ::= TUPLE id LCURLY tupleBody RCURLY DOT
                ;

tupleBody     ::= tupleBody varDecl
                | varDecl
                ;
...
type          ::= INTEGER
                | LOGICAL
                | VOID
                ;

loc           ::= id
                | loc COLON id

id            ::= ID
                ;
```

Definition of a `tuple` type

```
tuple Point {
    integer x.
    integer y.
}.

tuple Color {
    integer r.
    integer g.
    integer b.
}.

tuple ColorPoint {
    tuple Color color.
    tuple Point point.
}.
```

→ make sure not already in sym tab
- create a sym tab for this tuple & store in sym for tuple's name
- for each varDecl in body of tuple
  - if type is tuple, make sure tuple type is in global (main) sym tab
  - make sure field is not in tuple's sym tab (& then add it)

Declaring a variable of type `tuple`

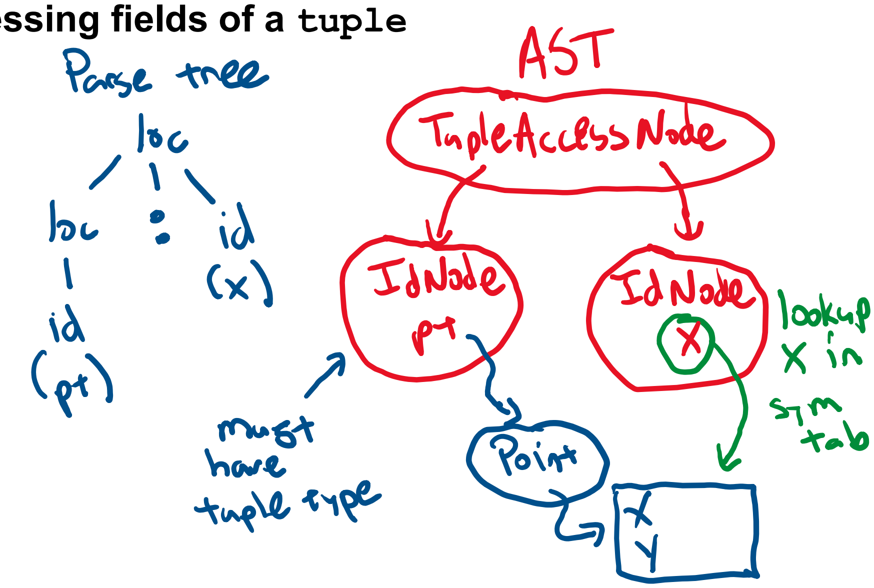
```
tuple Point pt.
tuple Color red.
tuple ColorPoint cpt.
```

ColorPoint: lookup (globally)
- make sure it exists & is a tuple

cpt: lookup (locally)
- make sure it doesn't exist

Accessing fields of a `tuple`

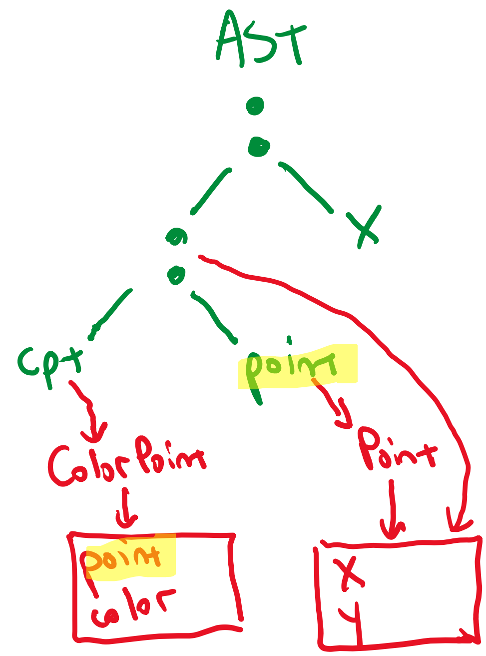
```
pt:x = 7.
pt:y = 8.
pt:z = 10.

red:r = 255.
red:g = 0.
red:b = 0.

cpt:point:x = pt.x.
cpt:color:r = red.r.
cpt:color:g = 34.
```



Recursively handle L child

If L child is an identifier

- check identifier has been declared of tuple type
- get symbol table for that tuple
- lookup R child in that sym tab



If L child is a colon-access

- recursively process L child
- if symbol table in : access is null

  then error

  else look up R child in sym tab

If R child is a tuple type

- then set ref in : access to tuple's sym tab

- else set ref to null

Name analysis: handling classes

Similar to handling aggregate data structures

- also need to be able to search the class hierarchy
  to see if uses are of inherited fields & methods

Idea:

Symbol table for each class with two nesting hierarchies

1) for lexical scoping within methods (ie, "regular" sym tab)
2) for inheritance hierarchy
   - not just a list of hashtable → hierarchy not necessarily linear

To resolve a name

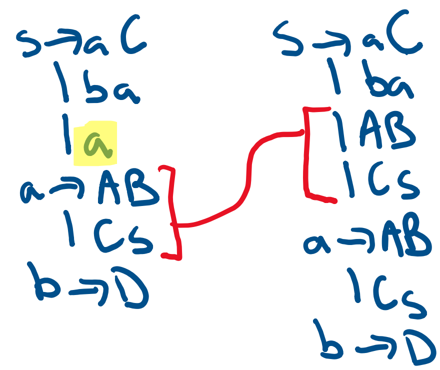
- first look in lexical scoping sym tab (ie "regular" one)
- then search inheritance hierarchy

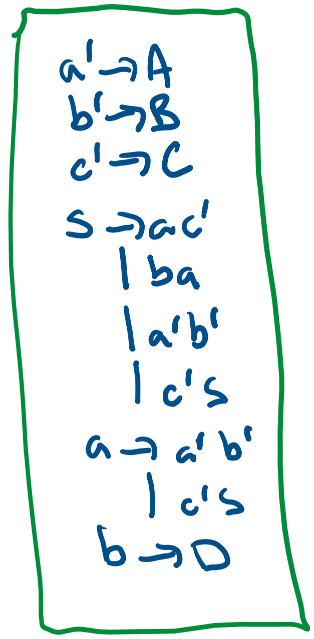
CYK example

CFG

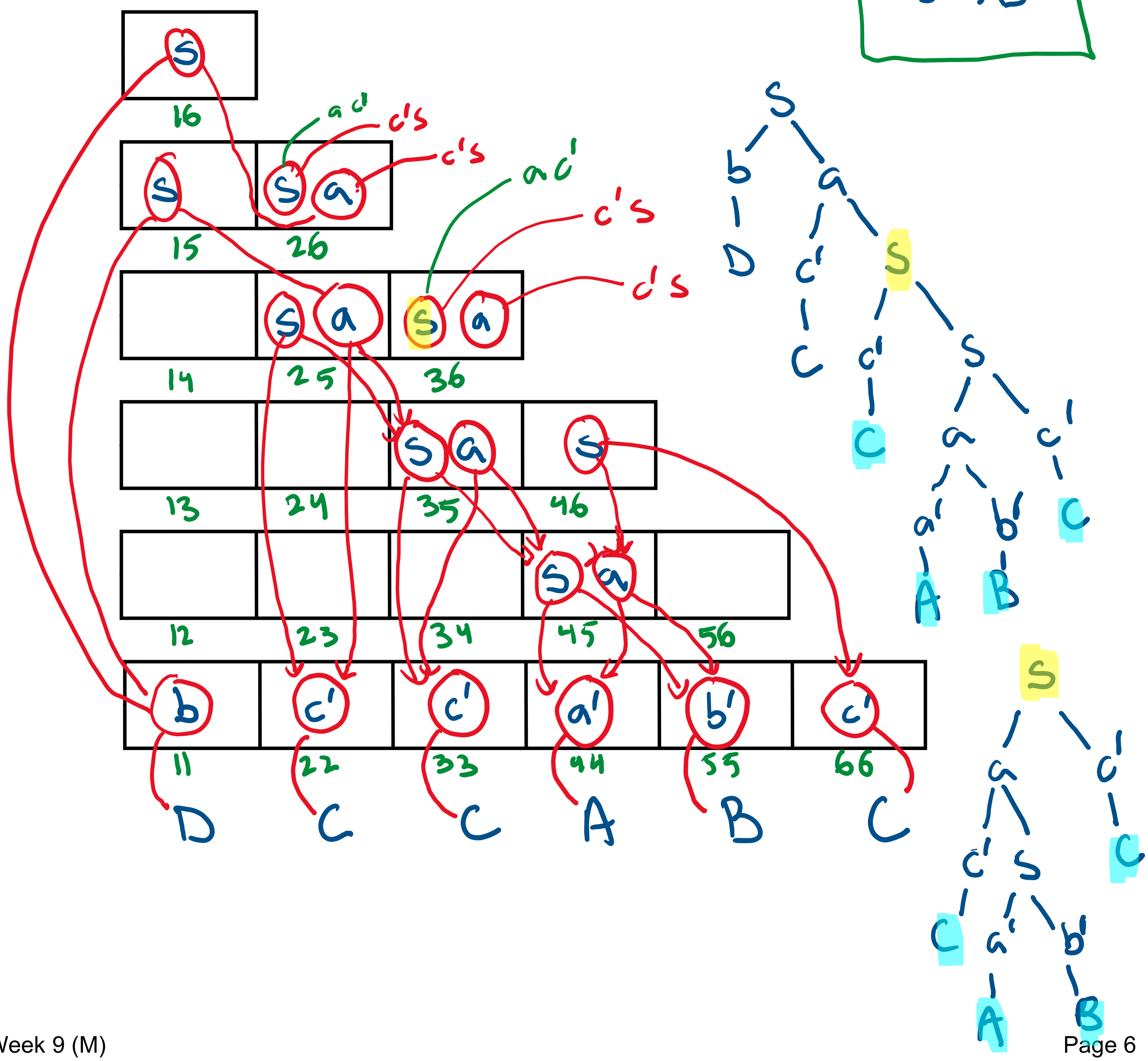
s → a C
  | b a
a → A B
  | C s
b → D
  | ε

Convert to CNF





Run the CYK algorithm to parse the input: `D C C A B C`



FIRST/FOLLOW Example

Original CFG

expr → expr + term
| term
term → term * factor
| factor
factor → INTLIT
| (expr)

Transformed CFG

expr → term expr'
expr' → + term expr' | ε
term → factor term'
term' → * factor term' | ε
factor → INTLIT | (expr)

	FIRST	FOLLOW
expr	INTLIT (	EOF)
expr'	+ ε	EOF)
term	INTLIT (	+ EOF)
term'	* ε	+ EOF)
factor	INTLIT (	* + EOF)

Parse table

	+	*	(	)	INTLIT	EOF
expr			term expr'		term expr'	
expr'	+ term expr'			ε		ε
term			factor term'		factor term'	
term'	ε	* factor term'		ε		ε
factor			(expr)		INTLIT	

Building the parse table

```
for each production x → α
    for each terminal T in FIRST(α)
        put α in table[x][T]

    if ε is in FIRST(α)
        for each terminal T in FOLLOW(x)
            put α in table[x][T]
```