Course 6

Problem: Parsing (construct the parsee tree)

if the *source program is sintactically correct*

        then construct syntax tree

        else ”syntax error”

source program is sintactically correct = $w \in L(G) \Leftrightarrow S \overset{*}{\Rightarrow} w$

Descendent recursive parser

- Example

S -> aSbS | aS | c

Formal model

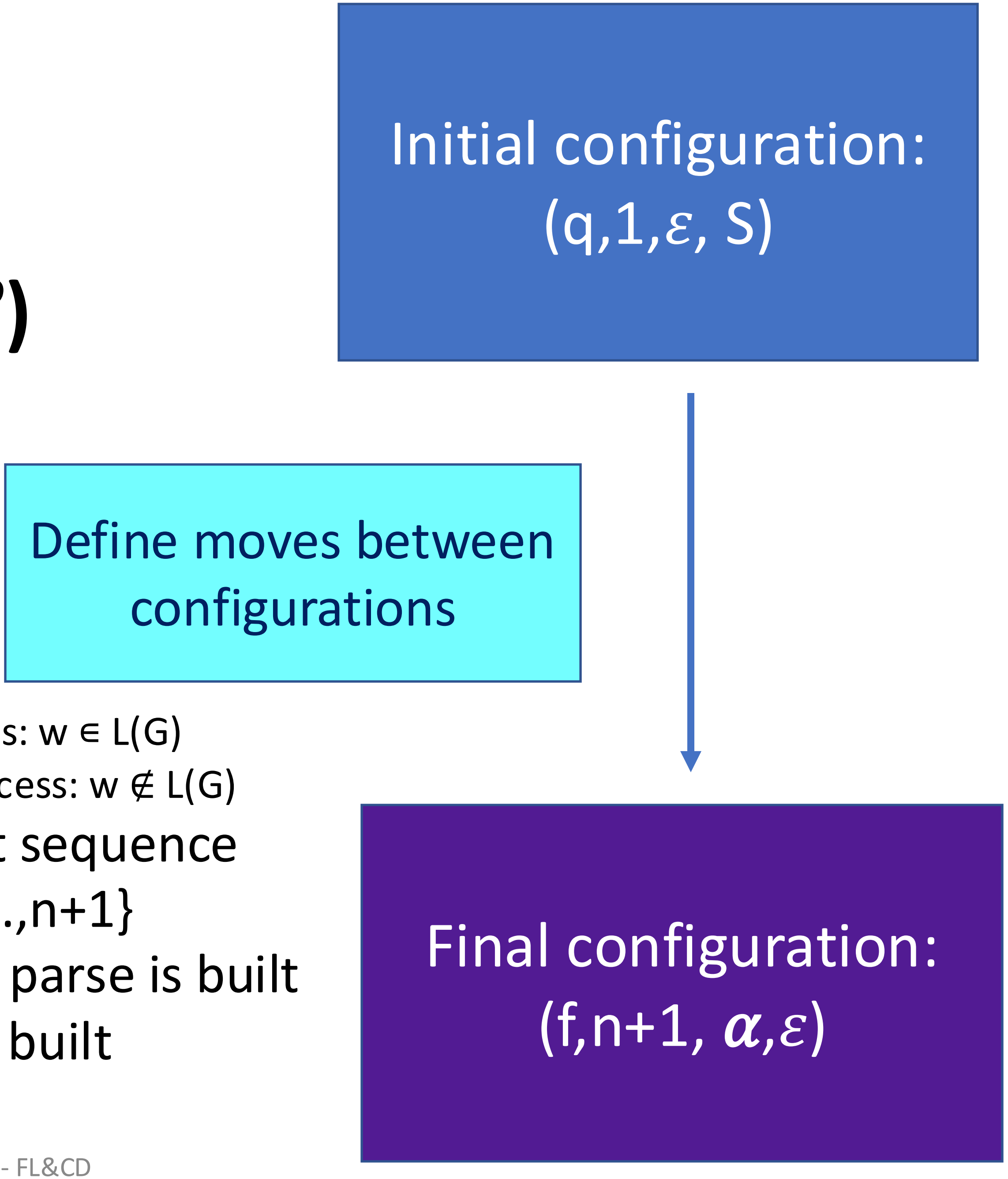
- Configuration

$$(\mathbf{s}, \mathbf{i}, \boldsymbol{\alpha}, \boldsymbol{\beta})$$

where:

- s = state of the parsing, can be:
  - q = normal state
  - b = back state
  - f = final state - corresponding to success: w ∊ L(G)
  - e = error state – corresponding to insuccess: w ∉ L(G)
- i – position of current symbol in input sequence

  $w = a_1a_2\ldots a_n$, $i \in \{1,\ldots,n+1\}$
- $\boldsymbol{\alpha}$ = working stack, stores the way the parse is built
- $\boldsymbol{\beta}$ = input stack, part of the tree to be built



Initial configuration: $(q,1,\varepsilon, S)$

Define moves between configurations

Final configuration: $(f,n+1, \boldsymbol{\alpha},\varepsilon)$

Expand

WHEN: head of input stack is a nonterminal

$(q,i, \boldsymbol{\alpha}, A\boldsymbol{\beta}) \vdash (q,i, \boldsymbol{\alpha}A_1, \boldsymbol{\gamma}_1\boldsymbol{\beta})$

where:

$A \rightarrow \boldsymbol{\gamma}_1 \mid \boldsymbol{\gamma}_2 \mid \ldots$ represents the productions corresponding to A

1 = first prod of A

Advance

WHEN: head of input stack is a terminal = current symbol from input

$(q,i, \boldsymbol{\alpha}, a_i\boldsymbol{\beta}) \vdash (q,i+1, \boldsymbol{\alpha}a_i, \boldsymbol{\beta})$

Momentary insuccess

WHEN: head of input stack is a terminal ≠ current symbol from input

$(q,i, \boldsymbol{\alpha}, a_i\boldsymbol{\beta}) \vdash (b,i, \boldsymbol{\alpha}, a_i\boldsymbol{\beta})$

Back

WHEN: head of working stack is a terminal

$(b,i, \boldsymbol{\alpha}a, \boldsymbol{\beta}) \vdash (b,i-1, \boldsymbol{\alpha}, a\boldsymbol{\beta})$

Another try

WHEN: head of working stack is a nonterminal

$(b,i,\boldsymbol{\alpha}\,A_j,\boldsymbol{\gamma}_j\,\boldsymbol{\beta}) \vdash$ $(q,i,\boldsymbol{\alpha}A_{j+1},\boldsymbol{\gamma}_{j+1}\boldsymbol{\beta})$, if $\exists\ A \rightarrow \boldsymbol{\gamma}_{j+1}$

$(b,i,\boldsymbol{\alpha},A\,\boldsymbol{\beta})$, otherwise with the exception

$(e,i,\boldsymbol{\alpha},\boldsymbol{\beta})$, if i=1, A =S, **ERROR**

Success

$(q, n+1, \boldsymbol{\alpha}, \varepsilon) \vdash (f, n+1, \boldsymbol{\alpha}, \varepsilon)$

Algorithm

Algorithm Descendent Recursive

INPUT: G, w =$a_1 a_2 \ldots a_n$

OUTPUT: string of productions and message

```
config = (q,1, $\varepsilon$,S);                                    //initial configuration (s,i,$\alpha$,$\beta$)
while (s $\neq$ f) and (s $\neq$ e) do
  if s = q
    then if (i=n+1) and IsEmpty($\beta$)
           then Success(config)
           else
             if Head($\beta$) = A
               then Expand(config)
               else
                 if  Head($\beta$) = $a_i$
                   then Advance(config)
                   else MomentaryInsuccess(config)
    else
      if s = b
        then
          if Head($\alpha$) = a
            then Back(config)
            else AnotherTry(config)
endWhile
if s = e  then message“Error”
       else message “Sequence accepted”;
            BuildStringOfProd($\alpha$)
```

w ∈ L(G) - HOW

- Process $\boldsymbol{\alpha}$:
  - From left to right (reverse if stored as stack)
  - Skip terminal symbols
  - Nonterminals – index of prod

- Example: $\boldsymbol{\alpha}$ = S_1 a S_2 a S_3 c b S_3 c

When the algorithm never stops?

- S->S**α** – expand infinitely (left recursive)