$L = \{ a^p b^q c^r d^s : p, q, r, s \geq 0, p+q = r+s \}$

1. Design a PDA that accepts L.

Hint: use four states, one for reading each different type of symbol.

2. Design a context-free grammar that generates L.

Assignment #3: Due Fri. Oct. 21.

For Oct. 18/19: Some practice questions for Tutorial #5 have been posted.

Old midterms are available on the CSC 320 web page.

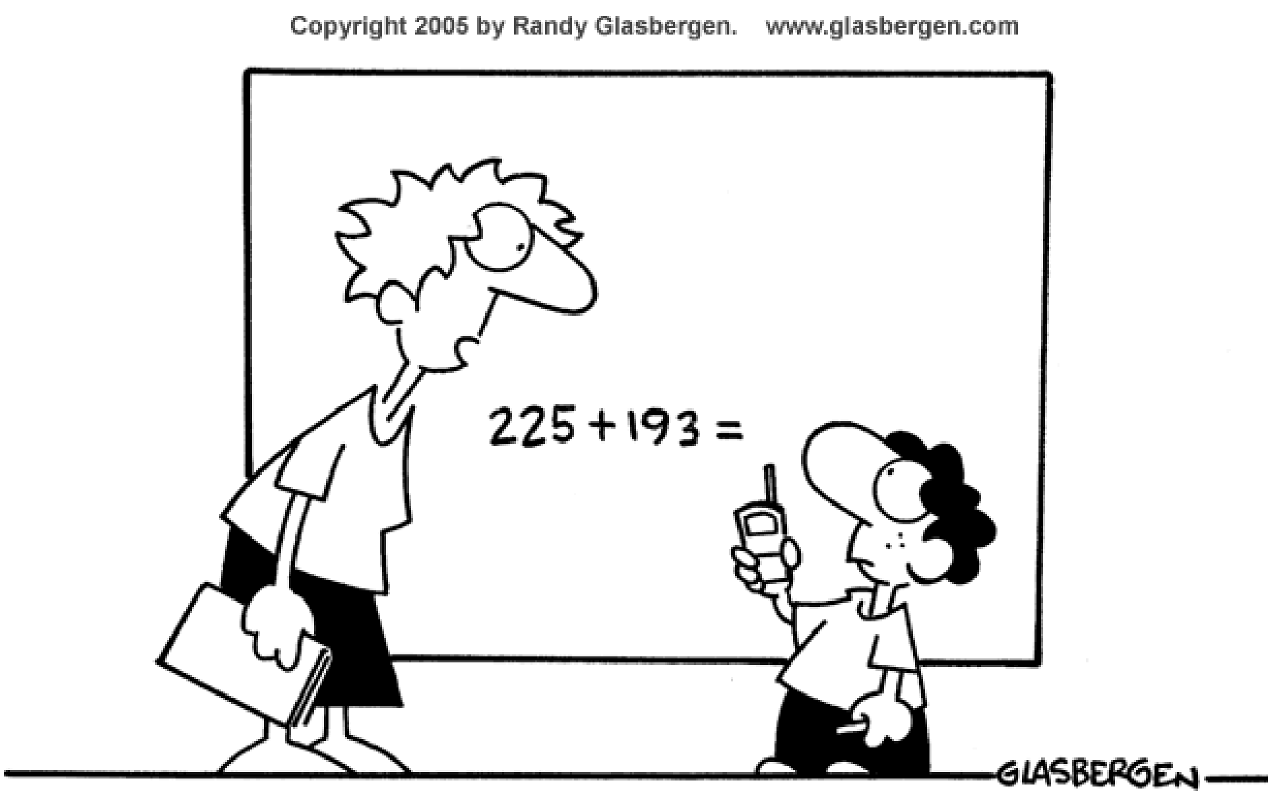
I'm away at a conference Oct. 19-21: No office hours. Ask assignment questions early.

Our midterm is **Wed. Oct. 26** in class.

Midterm tutorial: 6pm, Mon. Oct. 24, ECS 116.

Assignment solutions are in the connex resources.

To get maximum benefit from homework and old exams, solve problems yourself instead of doing a web search for solutions.



"You have to solve this problem by yourself. You can't call tech support."

A grammar for L_2:

$L = \{ a^p b^q c^r d^s : p, q, r, s \geq 0, p+q = r+s \}$

Meaning:

S: match a with d

T: match a with c

U: match b with d

V: match b with c

$$L = \{ a^p b^q c^r d^s : p, q, r, s \geq 0, p+q = r+s \}$$

Meaning:

S: match a with d

T: match a with c

U: match b with d

V: match b with c

Start symbol: S

$S \rightarrow a\,S\,d$

$S \rightarrow T$

$S \rightarrow U$

$S \rightarrow V$

$T \rightarrow a\,T\,c$

$T \rightarrow V$

$U \rightarrow b\,U\,d$

$U \rightarrow V$

$V \rightarrow b\,V\,c$

$V \rightarrow \varepsilon$

Design a PDA which accepts the language

$\{ u\, u^R\, v\, v^R : u, v \in \{a,b\}^+ \}$

Hint: A bottom of the stack symbol could prove useful in helping to ensure that u matches with u^R and v matches with v^R.

L= {w in {a, b}* : w has the same number of a's and b's}

Start state: s

Final states: {s}

State	Input	Pop	Next state	Push
s	a	ε	s	B
s	a	A	s	ε
s	b	ε	s	A
s	b	B	s	ε

L= {w in {a, b}* : w has the same number of a's and b's}

State state: s, Final states: {f}

State	Input	Pop	Next state	Push
s	ε	ε	t	X
t	a	X	t	BX
t	a	A	t	ε
t	a	B	t	BB
t	b	X	t	AX
t	b	A	t	AA
t	b	B	t	ε
t	ε	X	f	ε

A more deterministic solution:

Stack will never contain both A's and B's.

X- bottom of stack marker.

Languages which are context-free.

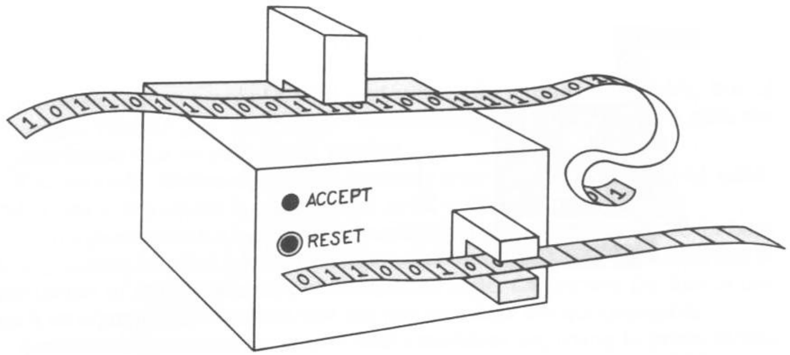
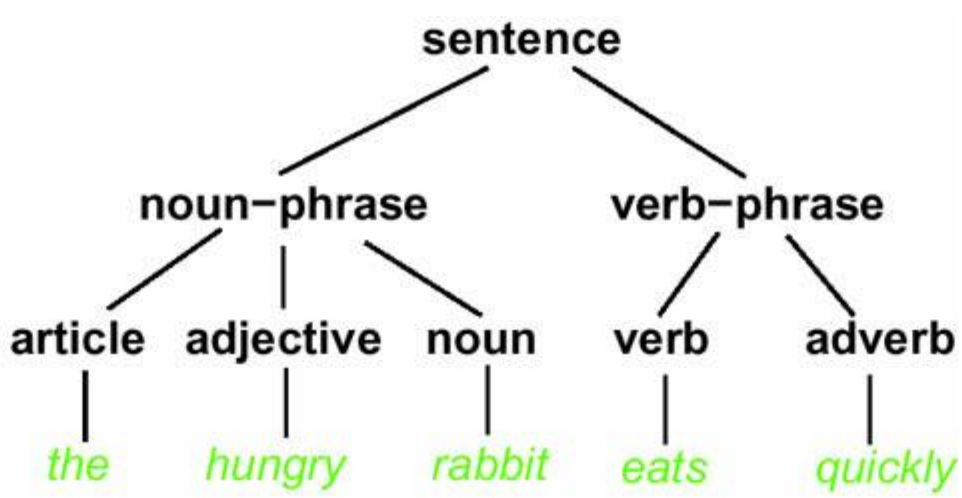
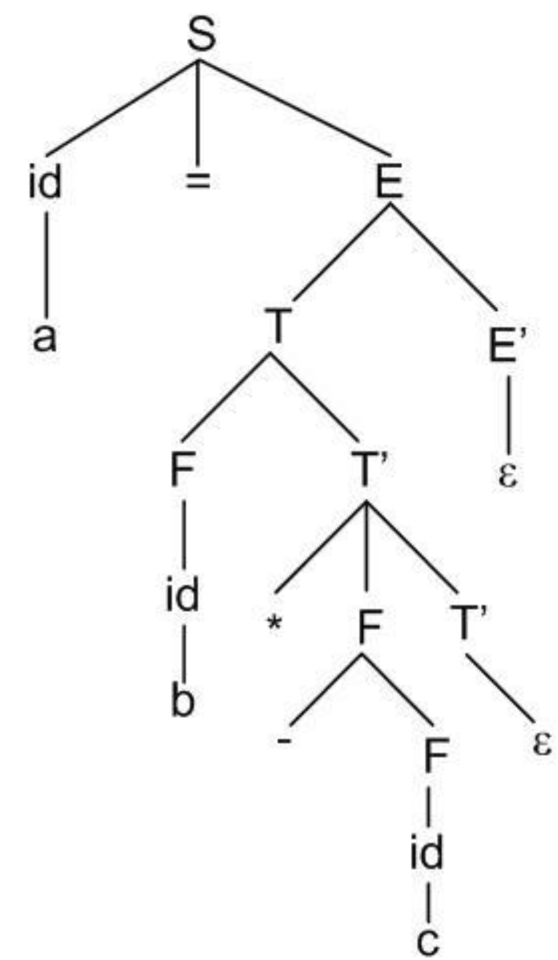


Figure 7.4 A push-down automaton



A Derivation Tree



Theorem:

If L is L(G) for some context-free grammar G, then there is a PDA M which accepts L.

Proof: By construction of a PDA which mimics derivations in the grammar.

A context-free grammar, start symbol S:

$S \rightarrow \varepsilon$

$S \rightarrow A\ B\ A$

$A \rightarrow aa$

$B \rightarrow b\ S\ a$

Apply construction to get a PDA.