Final Exam: April 30 at 8:00 am, Room NC 1313

Final Review: Sample Problems

1. Construct an indexed grammar generating the following language: $\{0^{n} \mid n$ is a power of $2\}$.

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2. Construct an attribute grammar G = ($V_{\mathbf{T}}$, $V_{\mathbf{N}}$, P, S)
with the following terminals

$$V_{\mathbf{T}} = \{c_{\mathbf{e}} , *, + , (,) , ANSWER_{\mathbf{d}}\},$$

nonterminals

$$V_{\mathbf{N}} = \{E_a, T_b, P_c, S \}$$

and generated attributes **a, b, c, d, e**,
which can compile the following expressions:

$$(c_{\mathbf{e1}} + c_{\mathbf{e2}})*(c_{\mathbf{e3}} + c_{\mathbf{e4}})$$

Compile the expression

$$(c_2+c_5)*(c_{11}+c_3)ANSWER_d,$$

show derivation tree, and find the value of attribute d.

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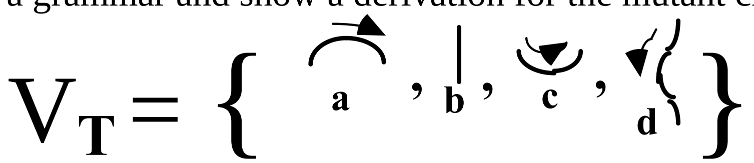
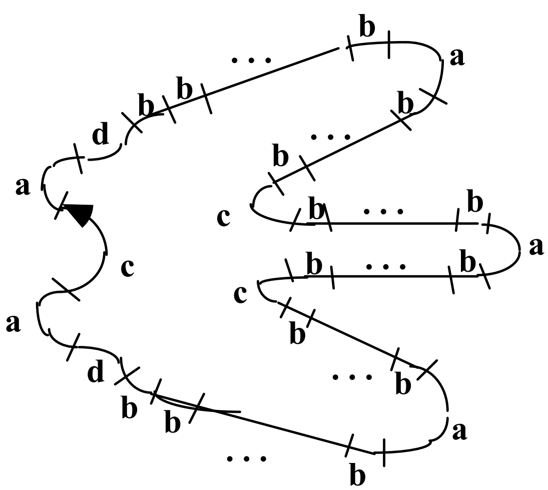
3. Construct a grammar and show a derivation for the mutant chromosome:





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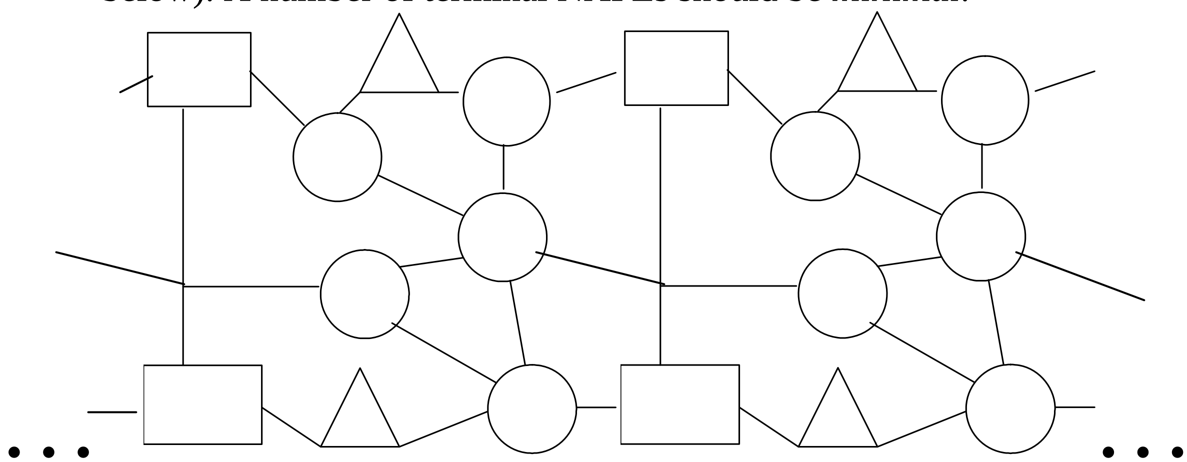
4. Construct <u>terminal</u> NAPEs for generating this kind of networks. They are called Chains of Data Flow Diagrams of arbitrary length. Construct a <u>Plex Grammar</u> generating the following Chain of Data Flow Diagrams (see below). A number of terminal NAPEs should be ***minimal***.



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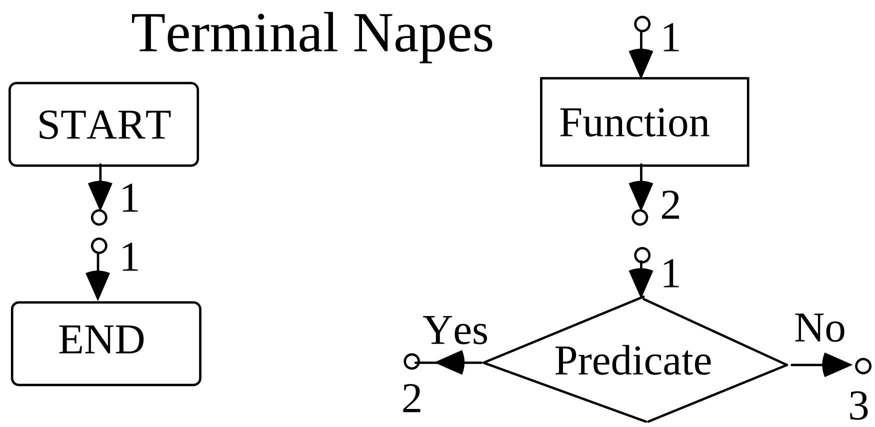
5. Show all the NAPEs which can be generated by the following plex grammar.



<P>(1,2) —> <FUNCT><FUNCT>(21)(10, 02)
<P>(1,2) —> <PRED><P>(21, 12)(21, 30)
<P>(1,2) —> <PRED><P><P>(210, 301, 022)(100, 022)
<PROGRAM> —> <START><P><END>(110, 021)

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6. Generate all the shortest trajectories for the robot called <u>Bishop</u> from **a1** to **b6** employing the Grammar of Shortest Trajectories. Show values of all the important functions and sets. (Table TAB15 for Bishop is shown below.)

1		2		2		2		2		2		2		1
	1		2		2		2		2		2		1	
2		1		2		2		2		2		1		2
	2		1		2		2		2		1		2	
2		2		1		2		2		1		2		2
	2		2		1		2		1		2		2	
2		2		2		1		1		2		2		2
	2		2		2		0		2		2		2	
2		2		2		1		1		2		2		2
	2		2		1		2		1		2		2	
2		2		1		2		2		1		2		2
	2		1		2		2		2		1		2	
2		1		2		2		2		2		1		2
	1		2		2		2		2		2		1	
1		2		2		2		2		2		2		1

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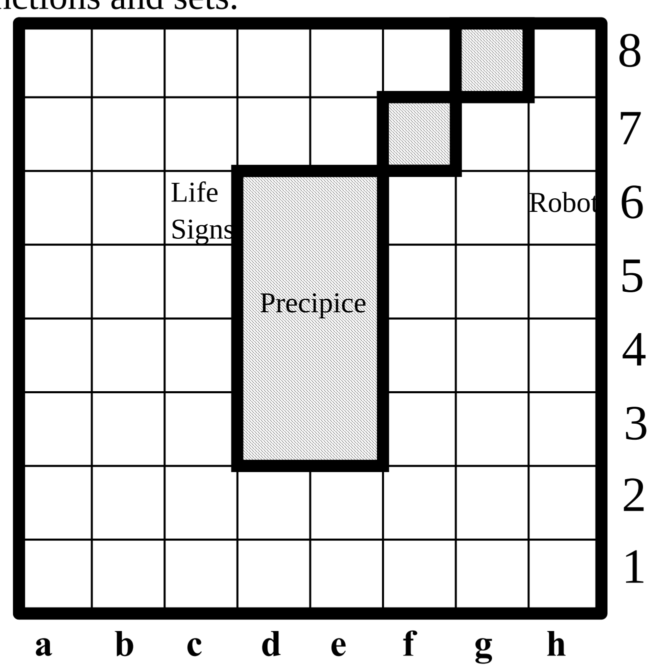
7. Assume that robot **Explorer** landed on Mars at the square **h6**. It has a map of Mars (shown below) taken from the orbit. It can reach any next square in one step (including diagonal moves). **Explorer** cannot move through the squares, which are in the precipice (shaded), but it can cross the edges of the precipice. The robot received a radio-message from the Earth to investigate <u>**all** the shortest paths</u> to the location of possible life signs (point **c6**). Its battery has limited capacity and it cannot recharge. Find **all** these paths employing Grammar of Shortest Trajectories. Show values of all the important functions and sets.



Controlled grammar of shortest trajectories $G_t^{(1)}$

L	Q	Kernel	F_T	F_F
1	Q_1	$S(x,y,l) \rightarrow A(x,y,l)$	*two*	ø
2_i	Q_2	$A(x,y,l) \rightarrow a(x)A(next_i(x,l), y, f(l))$	*two*	3
3	Q_3	$A(x,y,l) \rightarrow a(y)$	øø	

$V_T = \{a\}$

$V_N = \{S, A\}$

V_{PR}

Pred $= \{Q_1, Q_2, Q_3\}$,

$Q_1(x, y, l) = (MAP_{x,p}(y) = l)$ $(0 < l < n)$

$Q_2(l) = (l \geq 1)$

$Q_3 = T$

Var $= \{x, y, l\}$

$F = \{f, next_1, ..., next_n\}$ $(n = |X|)$,

$f(l) = l - 1$, $D(f) = \mathbf{Z}_+ - \{0\}$, $next_i$ is defined below;

$E = \mathbf{Z}_+ \cup X \cup P$

Parm: $S \rightarrow Var$, $A \rightarrow Var$, $a \rightarrow \{x\}$

$L = \{1,3\} \cup two$, $two = \{2_1, 2_2, ..., 2_n\}$

At the beginning of derivation:

$x = x_0$, $y = y_0$, $l = l_0$, $x_0 \in X$, $y_0 \in X$, $l_0 \in \mathbf{Z}_+$, $p \in P$

Function $next_i$ is defined as follows: $D(next_i) = X \times \mathbf{Z}_+ \times X^2 \times \mathbf{Z}_+ \times P$

$MOVE_l(x)$ is the intersection of the following sets:

$ST_1(x)$, $ST_{l_0-l+1}(x_0)$ and SUM, where

$SUM = \{v \mid v \text{ from } X, MAP_{x_0,p}(v) + MAP_{y_0,p}(v) = l_0\}$,

$ST_k(x) = \{v \mid v \text{ from } X, MAP_{x,p}(v) = k\}$,

If

$MOVE_l(x) = \{m_1, m_2, ..., m_r\} \neq \emptyset$

then

$next_i(x, l) = m_i$ for $i \leq r$;

$next_i(x, l) = m_r$ for $r < i \leq n$,

otherwise

$next_i(x, l) = x$.

Sample Solutions

1. $G = \{V_T, V_N, F, P, S\}$

   $V_T = \{\mathbf{0}\}$, $V_N = \{S, A, B\}$

   $F = \{\mathbf{a}, \mathbf{b}\}$

   P: 1. $S \longrightarrow A\mathbf{b}$

   2. $A \longrightarrow A\mathbf{a}$

   $\mathbf{a} = \{A \longrightarrow BB,\ B \longrightarrow BB\}$

   $\mathbf{b} = \{A \longrightarrow \mathbf{0},\ B \longrightarrow \mathbf{0}\}$

Derivation

n = 0 $S \overset{1}{\Rightarrow} Ab \overset{b_1}{\Rightarrow} 0$

n = 1 $S \overset{1}{\Rightarrow} Ab \overset{2}{\Rightarrow} Aab \overset{a_1}{\Rightarrow} BbBb \overset{b_2 \times 2}{\Rightarrow} 0^2$

n > 1 $S \overset{1}{\Rightarrow} Ab$

n times:

$\overset{2}{\Rightarrow} Aab$

$\overset{2}{\Rightarrow} Aa^2b$

…….

$\overset{2}{\Rightarrow} Aa^nb$

n times:

$\overset{a_1}{\Rightarrow} Ba^{n-1}bBa^{n-1}b$

$\overset{a_2 \times 2}{\Rightarrow} \underline{Ba^{n-2}bB\,a^{n-2}b}\ \ \underline{Ba^{n-2}bB\,a^{n-2}b}$

$\overset{a_2 \times 2^2}{\Rightarrow}$ ….

…….

$\overset{a_2 \times 2^{n-1}}{\Rightarrow} (Bb)^{2^n}$

2^n times:

$\overset{b_2}{\Rightarrow} 0(Bb)^{2^n-1}$

………

$\overset{b_2}{\Rightarrow} \mathbf{0}^{2^n}$

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2. 1) $S \longrightarrow E_a$ $ANSWER_b$ $b := a$
2) $E_d \longrightarrow E_a + T_f$ $d := e + f$
3) $E_g \longrightarrow T_h$ $g := h$
4) $T_i \longrightarrow T_j * P_k$ $i := j * k$
5) $T_m \longrightarrow P_n$ $m := n$
6) $P_p \longrightarrow (E_q)$ $p := q$
7) $P_r \longrightarrow c_s$ $r := s$