Non-ambiguous CFG for $\{a^n b^n \mid n \geq 0\}$

Write a **non-ambiguous** CFG generating the language over {a,b} where the first half of each word only contains a's and the second half only contains b's.

S -> aSb
S ->

Non-ambiguous CFG for $\{a^n c b^n \mid n > 0\}$

Write a **non-ambiguous** CFG generating the words over {a,b,c} such that there is an occurrence of c exactly at the middle, to its left there are only a's (and there is at least one a), and to its right there are only b's (and there is at least one b). Note that, since the only occurrence of c must be exactly at the middle, the number of a's must be equal to the number of b's.

S -> acb
S -> aSb

Non-ambiguous CFG for $\{a^i b^j \mid i \geq j\}$

Write a **non-ambiguous** CFG generating the words of the form $a^i b^j$ where the number of a's is at least the number of b's.

S -> aSb | X
X -> aX |

Non-ambiguous CFG for $\{a^i b^j \mid i \leq j\}$

Write a **non-ambiguous** CFG generating the words of the form $a^i b^j$ where the number of a's is at most the number of b's.

S -> aSb | X
X -> Xb |

o també es valid

S -> AB
B -> Bb |
A -> aAb|

Non-ambiguous CFG for $\{a^i b^j \mid 2i \le j\}$

Write a **non-ambiguous** CFG generating the words of the form $a^i b^j$ where the number of b’s is at least twice the number of a’s.

S -> S b | X
X -> aXbb |

CFG for $\{a^i b^j \mid 2i \ge j\}$

Write a CFG generating the words of the form $a^i b^j$ where the number of b’s is at most twice the number of a’s.

S -> aS | aSbb | ab |

Non-ambiguous CFG for $\{a^i b^j \mid 2i \ge j\}$

Write a **non-ambiguous** CFG generating the words of the form $a^i b^j$ where the number of b’s is at most twice the number of a’s.

S -> aS | X
X -> aXbb | ab |

Non-ambiguous CFG for $\{a^i b^j \mid j \le i \le 2j\}$

Write a non-ambiguous CFG generating the words of the form $a^i b^j$ where the number of a’s is at least the number of b’s, but at most twice the number of b’s.

S -> aaSb | A
A -> aAb |

Non-ambiguous CFG for $\{a^i b^j \mid i \ge j \vee i \le 2j\}$

Write a **non-ambiguous** CFG generating the words of the form $a^i b^j$ where the number of a’s is at least the number of b’s, or it is at most twice the number of b’s.

S -> AB
A -> aA |
B -> bB |

Non-ambiguous CFG for $\{ a^i b^j c^k \mid i=j+k \}$

Write a **non-ambiguous** CFG generating the words of the form $a^i b^j c^k$ such that the number of a’s coincides with the number of b’s plus the number of c’s.

K -> aKc | J
J -> aJb |

Non-ambiguous CFG for { $a^i b^j c^k$ | j=i+k }

Write a **non-ambiguous** CFG generating the words of the form $a^i b^j c^k$ such that the number of b's coincides with the number of a's plus the number of c's.

S -> X Y
X -> a X b |
Y -> b Y c |

CFG for { $a^i b^j c^k$ | i=j ∨ j=k ∨ i=k }

Write a CFG (**which will be ambiguous**) generating the words of the form $a^i b^j c^k$ where the number of aaa's equals the number of bbb's, or the number of bbb's equals the number of ccc's, or the number of ccc's equals the number of aaa's.

S -> AB | CD | E

A -> aAb |
B -> Bc |

C -> aC |
D -> bDc |

E -> aEc | F
F -> Fb |

CFG for $\{a^{n_0} b a^{n_1} b \ldots a^{n_{m-1}} b a^{n_m} \mid m \geq 1 \wedge \exists i \in \{1, \ldots, m\} : (n_0 = n_i)\}$

Write a CFG (**which will be ambiguous**) generating the words of the form $a^{n_0} b a^{n_1} b \ldots a^{n_{m-1}} b a^{n_m}$ for which there exists an i∈{1,…,m} such that $n_0=n_i$.

S -> A | AbC

A -> aAa | B
B -> b | bCb
C -> aC | bC |

Non-ambiguous CFG for $\{a^{n_0} b a^{n_1} b \ldots a^{n_{m-1}} b a^{n_m} \mid m \geq 1 \wedge (n_0 = \sum_{1 \leq i \leq m} n_i)\}$

Write a **non-ambiguous** CFG generating the words of the form $a^{n_0} b a^{n_1} b \ldots a^{n_{m-1}} b a^{n_m}$, with m ≥ 1, such that n_0 is equal to the sum $n_1+n_2+\ldots+n_m$.

S -> aSa | Sb | b

CFG for { $a^{n_0}ba^{n_1}b\ldots a^{n_{m-1}}ba^{n_m}$ $\mid$ $m \geq 1 \wedge \exists I \subseteq \{1,\ldots,m\} : (n_0 = \sum_{i \in I} n_i)$ }

Write a CFG (**which will be ambiguous**) generating the words of the form $a^{n_0}ba^{n_1}b\ldots a^{n_{m-1}}ba^{n_m}$, with $m \geq 1$, for which n_0 is equal to the sum of a selection of naturals from $n_1,n_2,\ldots,n_m$, i.e. $n_0=\sum_{i\in I}n_i$ where $I\subseteq \{1,\ldots,m\}$. Note that, in particular, the selection might be empty, and therefore a word where n_0 is 0 is necessarily correct.

S -> R | T
R -> a R a | S b | b
T -> T a | S b | b

Non-ambiguous CFG for { $w \in \{a,b\}^* \mid w = w^R$ }

Write a **non-ambiguous** CFG generating the palindromic words over {a,b}.

S -> a S a | b S b | a | b |

Non-ambiguous CFG for { $w \in \{a,b\}^* \mid w = w^R \wedge |w|_{aba}=0$ }

Write a **non-ambiguous** CFG generating the palindromic words over {a,b} with no occurrence of aba.

S -> a A a | b S b | a | b |
A -> b B b | a A a | a |
B -> b S b | b |

Non-ambiguous CFG for { $w \in \{a,b\}^* \mid w = w^R \wedge |w|_a > 0 \wedge |w|_b > 0$ }

S -> a B a | b A b
A -> a C a | b A b | a
B -> b C b | a B a | b
C -> a C a | b C b | a | b |

Non-ambiguous CFG for { $w \in \{a,b\}^* \mid w = w^R \wedge |w|_{aba} > 0$ }

S -> a A a | b S b
A -> a A a | b B b | b
B -> a R a | b S b | a
R -> a R a | b R b | a | b |

CFG for the well-parenthesized words over {(,)}

S -> (S) | () | SS |

CFG for the well-parenthesized words over {[,],(,)}

S -> (S) | () | SS | [S] | [] |

Non-ambiguous CFG for the well-parenthesized words over {(,)}

S -> (XS |
X -> (XX |)

Non-ambiguous CFG for the well-parenthesized words over {[,],(,)}

S -> (S) S | [S] S |

CFG for $\{w \in \{a,b\}* \mid |w|_a = |w|_b\}$

S -> a S b | b S a | SS |

CFG for $\{w \in \{a,b\}^* \mid |w|_a = |w|_b\}$

S -> a S b | b S a | SS | c |

CFG for $\{w \in \{a,b,c\}^* \mid |w|_a + |w|_b = |w|_c\}$

S -> c X | X c | SS |
X -> a S | b S | S a | S b

CFG for $\{w \in \{a,b\}^* \mid 2|w|_a = |w|_b\}$

S -> a S b S b | b S a S b | b S b S a | SS |

Non-ambiguous CFG for $\{w \in \{a,b\}^* \mid 2|w|_a = |w|_b\}$

S -> a B S | b A S |
A -> a | bAA
B -> b | aBB

Non-ambiguous CFG for $\{w \in \{a,b,c\}^* \mid 2|w|_a = |w|_b\}$

S -> a B S | b A S | c S |
A -> a | bAA | c A
B -> b | aBB | c B