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EXERCISE 1.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊ab, ⋊bb, aab, aba, abb, baa, bbb, bb⋉, b ⋉ ⋉}

1. aab
2. bb
3. abb
4. bbb

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 2.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {aab, abd, caa, cba, dad, dcc, ddc}

1. cba
2. dabcdbcd
3. dcdbacac
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 3.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$aaac$, $abaa$, $abba$, $abbb$, $cabb$, $cbab$}

1. ε
2. b
3. bccccca
4. bcaa

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 4.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaaa, acba, adac, beca, cbdb, cecb, dacd, ebcd\}$

1. d
2. deddbed
3. baeeedd
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 5.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes d, ba, cc, cd, db, dc, a\ltimes\}$

1. cabd
2. dba
3. edced
4. ε

Solution

1. No
2. Yes

3. No
4. Yes

EXERCISE 6.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes\rtimes\rtimes\rtimes b, \rtimes\rtimes\rtimes\rtimes d, \rtimes\rtimes\rtimes bc, \rtimes\rtimes\rtimes bd, \rtimes\rtimes da, \rtimes da\ltimes, \rtimes bdb, \rtimes bcc, accc, bcca, cacc, ccac, cccd, ccdb, cdbc, bdb\ltimes, dbc\ltimes, db\ltimes\ltimes, bc\ltimes\ltimes, da\ltimes\ltimes, c\ltimes\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. bdb
2. dd
3. da
4. cca

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 7.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{bab, ccb, dac, dba, dbd\}$

1. acab
2. bbbdcbba
3. d
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 8.

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{ab, ac, da, de, ed, ee\}$

1. ε
2. cbab
3. e
4. bebbec

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 9.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes \rtimes bb, \rtimes \rtimes b\ltimes, \rtimes \ltimes \ltimes \ltimes, \rtimes bbb, \rtimes b \ltimes \ltimes, aabb, abbb, baab, bbaa, bbba, bbbb, bbb\ltimes, bb \ltimes \ltimes, b \ltimes \ltimes \ltimes\}$

1. ε
2. aabb
3. b
4. aab

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 10.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{adc, bdb, bdd, cad\}$

1. baabdd
2. bca
3. bbaddcb
4. ε

Solution

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1. No
2. Yes
3. Yes
4. Yes

EXERCISE 11.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+:   {⋈   ⋈   ⋈c,⋈   ⋈   ⋈b,⋈   ⋈ c⋈,⋈   ⋈ bc,⋈c ⋈
⋈,⋈bcc, $bcbc$, $bccb$, $bcdc$, $bddb$, $cbcd$, $cbdd$, $ccbd$, $dbcb$, $ddbc$, cdc⋈, dc ⋈ ⋈,c ⋈
⋈⋈}

1. b
2. dbaddcdcaaa
3. cad
4. d

Solution

1. No
2. No
3. No
4. No

EXERCISE 12.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋈⋈a, ⋈⋈b, ⋈⋈⋈, ⋈a⋈, ⋈⋈⋈, ⋈ab, ⋈bb, aaa, aab, aba, baa, bab, bba, ab⋈, b⋈
⋈, a ⋈ ⋈}

1. bbabbab
2. aabaabbb
3. ε
4. baba

Solution

1. No
2. No
3. Yes
4. No

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EXERCISE 13.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aba, abb, bab, bba\}$

1. baabb
2. baa
3. ε
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 14.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ae, cc, cd, dd, ec\}$

1. daaaeb
2. dee
3. e
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 15.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aac, abc, acb, baa, bab, bca, cbb\}$

1. b
2. ε
3. bc
4. aac

Solution

1. Yes
2. Yes
3. Yes
4. No

Exercise 16.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊a, ⋊⋊b, ⋊b⋉, ⋊ab, ⋊ba, aba, abb, acb, bab, bac, bba, bbb, bbc, cbb, bc⋉, ba⋉, c⋉⋉, b⋉⋉, a⋉⋉}

1. cccc
2. baabbacab
3. b
4. cab

Solution

1. No
2. No
3. Yes
4. No

Exercise 17.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$acbd$, $bdbc$, $cadd$, $cbab$, $cbcc$, $ccca$, $cdcc$, $ddca$}

1. cdab
2. c
3. ε
4. bcc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 18.

For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:

G^+: {⋈⋈⋈, ⋈⋈c, ⋈c⋈, ⋈⋈⋈, ⋈cc, aba, acb, bab, bac, bba, bbb, bca, cbb, cbc, ccb, ca⋈, a⋈
⋈, c ⋈ ⋈}

1. ε
2. bacbccca
3. c
4. abcbcbccbb

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 19.

For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:

G^-: {abb, bad, bbd, bda, dca, dcb, dcd, dda}

1. dcccda
2. a
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 20.

For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:

G^-: {adaa, baaa, bbdc, caab, ddad}

1. ε
2. bbddada
3. cacccbad

4. abba

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 21.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{adab, cccb, cccc, dccc, dcdd\}$

1. ε
2. bbadbcd
3. b
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 22.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{bebb, cbce, cddb, ebaa\}$

1. bbbede
2. e
3. ε
4. dea

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 23.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+:   {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊d, ⋊ ⋊ dc, ⋊ ⋊ c⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ cc, ⋊ ⋊ ad, ⋊cca, ⋊c ⋉ ⋉, ⋊dc⋉, ⋊ ⋉ ⋉⋉, ⋊ada, $aada$, $abdd$, $adab$, $caad$, $ccaa$, $dabd$, bdd⋉, ada⋉, dc ⋉ ⋉, dd ⋉ ⋉, da ⋉ ⋉, c ⋉ ⋉⋉, d ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. cbccbad
2. ε
3. ccc
4. ba

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 24.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {abc, acc, bad, cac, ccd, daa, dbb, dda}

1. dcbddbdd
2. bdccab
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 25.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ b, ⋊ ⋊ ⋉, ⋊ ⋉ ⋉, ⋊bb, aca, ada, bac, bba, bbb, cad, dad, ad⋉, d ⋉ ⋉}

1. cbabbaba

4. Yes

EXERCISE 28.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊d, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ d⋉, ⋊ ⋊ ca, ⋊cab, ⋊d ⋉ ⋉, ⋊ ⋉ ⋉⋉, $abcd$, $bcdc$, $cabc$, $cdcc$, $dcca$, cca⋉, ca ⋉ ⋉, a ⋉ ⋉⋉, d ⋉ ⋉⋉}

1. abcb
2. aaacd
3. acdbcddb
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 29.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {ba, bc, cb, da, dc, eb}

1. acc
2. bd
3. dcbec
4. aecbdce

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 30.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+:   {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ bc, ⋊ ⋊ ac, ⋊ ⋊ ⋉⋉, ⋊ ⋊ aa, ⋊aaa, ⋊acc, ⋊bc⋉, ⋊⋉ ⋉⋉, $accb$, $bcbb$, $cbcb$, $ccbc$, aaa⋉, cbb⋉, aa⋉⋉, bc⋉

⋉, bb ⋊ ⋉, c ⋊ ⋉⋉, a ⋊ ⋉⋉, b ⋊ ⋉⋉}

1. bbac
2. aababc
3. cbbbc
4. ccc

Solution

1. No
2. No
3. No
4. No

EXERCISE 31.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {$ab, bd, cc, da, db, dc, dd$}

1. bdddcdcb
2. ε
3. acacbaab
4. ddb

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 32.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊d, ⋊ ⋊ db, ⋊ ⋊ bd, ⋊ ⋊ a⋉, ⋊db⋉, ⋊a ⋉, ⋊$bdb, acbd, bacb, bdba, bddb, cbdd, dbac, ddbb, dbb$⋉, db ⋊ ⋉, bb ⋊ ⋉, a ⋊ ⋉⋉, b ⋊ ⋉⋉}

1. abb
2. ddc
3. aacddddc
4. b

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Solution

1. No
2. No
3. No
4. No

EXERCISE 33.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{baaa, baba, bbaa, bbab, bbbb\}$

1. bbbabaabaaab
2. bbaa
3. bbaababbb
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 34.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaaa, abba, bbce, ddea, dded, ecde, edbd, eeee\}$

1. acbb
2. b
3. e
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 35.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊ac, ⋊⋊aa, ⋊aae, ⋊aca, $aaec$, $aeac$, $aece$, $cedd$, $daea$, $ddae$, $eced$, $edda$, aca⋉, eac⋉, ac⋉⋉, ca⋉⋉, c⋉⋉⋉, a⋉⋉⋉}

1. a
2. dd
3. aca
4. cbaabbccd

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 36.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$caae$, $cbdb$, $ccdb$, $cdce$, $dceb$}

1. b
2. d
3. ε
4. e

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 37.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: {aab, aba, abb, baa, bab, bba, bbb}

1. aaabbba
2. bbbbaab
3. ε

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4. baababa

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 38.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaaa, aaba, abaa, baaa, bbba, bbbb\}$

1. ε
2. babba
3. aa
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 39.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, aabb, abbb, baab, bbaa, bbab, bbbb\}$

1. ab
2. baba
3. bbbab
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

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EXERCISE 40.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{abaa, abab, abba, babb, bbab, bbbb\}$

1. a
2. abbaaaaa
3. ε
4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 41.

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{aa, ad, bb, bc, ca, cb, cc\}$

1. cb
2. bc
3. cabbabbba
4. bcbc

Solution

1. No
2. No
3. No
4. No

EXERCISE 42.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes\ \rtimes\ \rtimes d, \rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes b, \rtimes\ \rtimes\ be, \rtimes\ \rtimes\ ac, \rtimes\ \rtimes\ d\ltimes, \rtimes d\ \ltimes, \rtimes bec, \rtimes ac\ltimes, becd, cdce, ecdc, dce\ltimes, ce\ltimes\ltimes, ac\ltimes\ltimes, c\ltimes\ltimes\ltimes, e\ltimes\ltimes\ltimes, d\ltimes\ltimes\ltimes\}$

1. d
2. ab
3. abbbe

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4. bb

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 43.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋉⋉⋉a, ⋉⋉ac, ⋉⋉a⋉, ⋉a⋉⋉, ⋉acb, $aaab$, $acaa$, $acba$, $baca$, $caaa$, $cbac$, aab⋉, ab⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. cabcaa
2. a
3. cbbcccaa
4. bbaca

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 44.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋉⋉c, ⋉⋉b, ⋉⋉⋉, ⋉⋉⋉, ⋉b⋉, ⋉ca, aab, aba, abc, bab, bca, caa, cab, ba⋉, b⋉⋉, a⋉⋉}

1. ε
2. bbcacbb
3. b
4. bcbbbbc

Solution

1. Yes
2. No
3. Yes

   4. No

EXERCISE 45.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ c, ⋊ ⋊ a, ⋊a⋉, ⋊ca, abb, bbc, bca, cab, ab⋉, b ⋉ ⋉, a ⋉ ⋉}

1. a
2. cab
3. ccab
4. cbbca

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 46.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$abaa$, $bedd$, $cbbd$, $cbca$, $dbcb$, $eeec$}

1. ddadbda
2. ecc
3. eaebdea
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 47.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {aab, abb, bab, bba, bbb}

1. ε

2. ababa
3. a
4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 48.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{ \rtimes \rtimes a, \rtimes ab, abc, aca, bac, bcb, cba, ca \ltimes, a \ltimes \ltimes \}$

1. cabaca
2. bcbcb
3. ε
4. aabcabb

Solution

1. No
2. No
3. No
4. No

EXERCISE 49.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{ \rtimes \rtimes e, \rtimes \rtimes c, \rtimes \rtimes \ltimes, \rtimes c \ltimes, \rtimes \ltimes \ltimes, \rtimes ee, aad, ada, dad, eaa, eea, ad \ltimes, d \ltimes \ltimes, c \ltimes \ltimes \}$

1. dbdad
2. edad
3. daccac
4. adbe

Solution

1. No
2. No

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3. No
4. No

EXERCISE 50.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{bec, cab, cad, cdb, ceb, daa, ebb\}$

1. b
2. ed
3. e
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 51.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aec, bae, bcc, cee, eae, eba\}$

1. b
2. abee
3. cbcbddca
4. dbacc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 52.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{⋊⋊⋊c, ⋊⋊⋊⋉, ⋊⋊⋊e, ⋊⋊eb, ⋊⋊ce, ⋊⋊⋉⋉, ⋊cec, ⋊eb⋉, ⋊⋊$
$⋉⋉, bdce, cbdc, ccbd, cecc, ceee, dcee, eccb, eee⋉, eb⋉⋉, ee⋉⋉, e⋊⋉⋉, b⋊⋉⋉\}$

1. eb
2. ε
3. aaeaedabd
4. bee

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 53.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, bc, cc, cd, db, b\ltimes\}$

1. ε
2. a
3. dacb
4. dadcaa

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 54.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\ \rtimes\ c, \rtimes\ \rtimes\ \ltimes, \rtimes\ \rtimes\ d, \rtimes\ \rtimes\ b, \rtimes cb, \rtimes db, \rtimes\ \ltimes, \rtimes b\ltimes, aba, bbd, bdb, bee, dbb, dbe, eab, eea, cb\ltimes, ba\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. cb
2. ε
3. dbddaee
4. b

Solution

1. Yes

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2. Yes
3. No
4. Yes

EXERCISE 55.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊⋉, ⋊b, ⋊e, bd, ce, db, dc, ed, e⋉, b⋉}

1. b
2. eaa
3. ε
4. adaac

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 56.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {aaa, aca, bac, bca, cba, ccc}

1. ca
2. abcccaa
3. acbc
4. bcba

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 57.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {aa, ab, ac, ba, bc, cb, cc}

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1. ε
2. cccbcbac
3. abcbcabbbb
4. cbbbacacc

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 58.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ c⋉, ⋊ ⋊ cc, ⋊ ⋊ bc, ⋊cca, ⋊c ⋉, ⋊bcb, $adcd$, $cadc$, $ccad$, $dcdc$, cdc⋉, bcb⋉, dc ⋉ ⋉, cb ⋉ ⋉, c ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. d
2. dcadb
3. bcd
4. ε

Solution

1. No
2. No
3. No
4. No

EXERCISE 59.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ bc, ⋊ ⋊ ac, ⋊ ⋊ ca, ⋊ ⋊ b⋉, ⋊ ⋊ ⋉⋉, ⋊bcb, ⋊ca⋉, ⋊aca, ⋊ ⋉ ⋉⋉, ⋊b ⋉ ⋉, $acad$, $adad$, $adcc$, $cada$, $dadc$, dcc⋉, bcb⋉, cb ⋉ ⋉, cc ⋉ ⋉, ca ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. ε
2. aabacbdb
3. b
4. aca

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Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 60.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^{+}: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ab, ⋊b⋉, ⋊ba, aab, abc, baa, bca, bcc, caa, ccc, ab⋉, cc⋉, b⋉⋉, c⋉⋉}

1. abbbcca
2. bbab
3. acaacc
4. ccbbcca

Solution

1. No
2. No
3. No
4. No

EXERCISE 61.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^{-}: {aaac, babc, caaa, cbab, cbcc}

1. caacac
2. cab
3. ε
4. abcab

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 62.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ c, ⋊cb, ⋊ca, abb, aca, cab, cac, bb⋉, cb⋉, b ⋉ ⋉}

1. cb
2. cabb
3. abccb
4. bac

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 63.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊aa, ⋊⋊ab, ⋊aba, ⋊aaa, ⋊ab⋉, aaba, aabb, abaa, abba, baab, bbaa, baa⋉, aaa⋉, ab⋉⋉, aa ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. abaa
2. ε
3. aaa
4. ab

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 64.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊a, ab, ac, ba, bb, bc, ca, cb, cc, a⋉, b⋉}

1. ab
2. a
3. bbabbbbcca

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    4. acb

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 65.

For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:

G^-: $\{ab, cc, db, dc\}$

1. ddc
2. ddaa
3. dabdaa
4. aaacbcc

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 66.

For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:

G^+: $\{\rtimes a, \rtimes\ltimes, \rtimes c, aa, ab, bb, bc, ca, cb, a\ltimes, c\ltimes\}$

1. c
2. ε
3. a
4. cbcbb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 67.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+:   {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ ab, ⋊aba, ⋊ ⋊ ⋉⋉, $aaba$, $aabb$, $abaa$, $abab$, $baab$, $baba$, aba⋉, abb⋉, ba ⋉ ⋉, bb ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. ε
2. babbbbaba
3. bbbb
4. aba

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 68.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊⋊⋊b, ⋊⋊ba, ⋊⋊b⋉, ⋊b⋉⋉, ⋊baa, $aaab$, $aabb$, $abbb$, $baaa$, $bbaa$, $bbba$, baa⋉, aa⋉⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. b
2. aaabbbbb
3. ε
4. babbbaaaa

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 69.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊ ⋊ b, ⋊b⋉, ⋊bb, bac, bbc, bcb, cba, ac⋉, b ⋉ ⋉, c ⋉ ⋉}

1. bcca

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2. cb
3. c
4. b

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 70.

For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{bac, bcb, cab, cac, cca, ccb\}$

1. acaaaaa
2. baccab
3. ε
4. ab

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 71.

For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, abe, bcc, cab, dca, edb, eea\}$

1. dbbe
2. cebbbccebb
3. cbdbbee
4. e

Solution

1. Yes
2. No
3. Yes

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    4. Yes

EXERCISE 72.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abe, ada, adc, aed, cad, cea, deb\}$

    1. ε
    2. b
    3. ebbca
    4. daabeea

Solution

    1. Yes
    2. Yes
    3. Yes
    4. No

EXERCISE 73.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaaa, abab, abbb, baab, bbba, bbbb\}$

    1. ba
    2. ε
    3. b
    4. bb

Solution

    1. Yes
    2. Yes
    3. Yes
    4. Yes

EXERCISE 74.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{acb, bab, bbb, bbc, cac, cba, cbc\}$

    1. bccbbc

2. ε
3. b
4. cccbaaca

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 75.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊e, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ ea, ⋊ead, ⋊ ⋊ ⋉⋉, $adbe$, $becc$, $ccea$, $cead$, $dbec$, $eadb$, $ecce$, adb⋉, db ⋉ ⋉, b ⋉ ⋉⋉}

1. eabcc
2. e
3. adbabdaa
4. ebaadcedae

Solution

1. No
2. No
3. No
4. No

EXERCISE 76.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊c, ac, ca, cc, c⋉}

1. a
2. bbcb
3. caabaccc
4. c

Solution

1. No
2. No

3. No
4. Yes

EXERCISE 77.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aab, aba, baa, bba, bbb\}$

1. bba
2. ε
3. b
4. abbbab

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 78.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaaa, aabb, abab, abbb, baab, bbbb\}$

1. ε
2. abbbab
3. bbaaaaa
4. aaaaaaaa

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 79.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, bc, cc, cd, da, db, dc, dd\}$

1. bbc
2. abad
3. abbacab
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 80.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abb, abc, acc, bbc, cab, cbb, cbc, ccc\}$

1. cccc
2. ε
3. aaca
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 81.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aad, abc, bbd, bda, bdc, dad, dcb, dcc\}$

1. bacc
2. cd
3. aa
4. adcc

Solution

1. Yes
2. Yes

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3. Yes
4. No

EXERCISE 82.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes e, ad, ba, bb, bc, cb, de, eb, ec, b\ltimes\}$

1. eddcddce
2. eddcdab
3. abbcaeeaba
4. c

Solution

1. No
2. No
3. No
4. No

EXERCISE 83.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes d, ab, bc, cd, da, dd, d\ltimes\}$

1. ε
2. dc
3. cb
4. bbaada

Solution

1. No
2. No
3. No
4. No

EXERCISE 84.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, aa, ab, ac, ba, bc, ca, cb, cc, c\ltimes\}$

1. cabc
2. aa
3. bbb
4. aaabbaaa

Solution

1. No
2. No
3. No
4. No

EXERCISE 85.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{cabe, cdaa, cdca, cddc, cecc, dddd\}$

1. ade
2. dc
3. aeda
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 86.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes\rtimes a, \rtimes\rtimes d, \rtimes a\ltimes, \rtimes dd, \rtimes cc, aad, aca, adb, bac, cad, daa, dba, dda, ad\ltimes, cc\ltimes, d\ltimes\ltimes, c\ltimes\ltimes, a\ltimes\ltimes\}$

1. a
2. dbdbc
3. dcacbdbcdc
4. cc

Solution

1. Yes

2. No
3. No
4. Yes

EXERCISE 87.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊ ⋊ c, ⋊ ⋊ b, ⋊c⋉, ⋊ba, abc, aee, bae, dab, dda, edd, eed, bc⋉, c ⋉ ⋉}

1. dbcba
2. c
3. cdae
4. dded

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 88.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ bc, ⋊ ⋊ cb, ⋊ ⋊ ⋉⋉, ⋊bcb, ⋊cbc, ⋊ ⋊ ⋉⋉, babb, bbab, bbba, bbbb, bcbb, cbbb, cbc⋉, abb⋉, bc ⋉ ⋉, bb ⋉ ⋉, c ⋉ ⋉⋉, b ⋊ ⋉⋉}

1. cacb
2. bacccccca
3. aac
4. abcaabcb

Solution

1. No
2. No
3. No
4. No

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EXERCISE 89.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aca, bac, bba, bbd, bcd, dcb, dcc\}$

1. ε
2. b
3. cbddddd
4. dda

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 90.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aca, bbc, beb, ceb, cee, dde, ded\}$

1. e
2. ε
3. b
4. ec

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 91.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes b, \rtimes\rtimes\rtimes\ltimes, \rtimes\rtimes\rtimes\ltimes, b\ltimes, \rtimes\rtimes \ltimes\ltimes, \rtimes\rtimes aa, \rtimes\rtimes ba, \rtimes aaa, \rtimes baa, \rtimes ba\ltimes, \rtimes \ltimes \ltimes\ltimes, \rtimes b \ltimes \ltimes, aaaa, aaab, aabb, abba, baa\ltimes, bba\ltimes, ba\ltimes\ltimes, aa\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. bbbaa
2. ε

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3. baaa
4. a

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 92.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abca, bbbc, bbcc, bcca, caaa, cbbb, ccbc, ccca\}$

1. b
2. a
3. ε
4. abbbaabbbc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 93.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, abb, baa, bab, bbb\}$

1. bb
2. a
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 94.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊b⋉, ⋊bb, ⋊aa, aaa, aab, aba, baa, bb⋉, aa⋉, b⋉⋉, a⋉⋉}

1. abb
2. abababa
3. aaabb
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 95.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: {$aaba$, $abbb$, $baba$, $babb$, $bbba$}

1. baa
2. abaaaa
3. ε
4. abbbbaaab

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 96.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: {$abab$, $acce$, $cbae$, $ceee$, $dbba$, $ddcc$, $ecdd$, $edbc$}

1. eeaecb
2. aadaa
3. ε

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4. e

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 97.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aba, baa, bab, bba\}$

1. b
2. ε
3. bbabaabaa
4. aabbabaa

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 98.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ba, bb, cb, cc\}$

1. c
2. cabaaaa
3. ε
4. accbaaa

Solution

1. Yes
2. No
3. Yes
4. No

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EXERCISE 99.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊ba, ⋊aa, aab, abb, baa, bba, bbb, aa⋉, ba⋉, a ⋉ ⋉}

1. abbbab
2. aa
3. babaaa
4. ba

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 100.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$abab, abba, abbb, baba, babb, bbab, bbba$}

1. b
2. ε
3. a
4. baabbab

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 101.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {ab, bd, cc, dd}

1. ab
2. bcbddaba
3. acadb
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 102.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abe, bbb, ccb, ddb, dde, eca, eee\}$

1. ε
2. e
3. b
4. eb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 103.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\ltimes\ltimes a, \ltimes\ltimes b, \ltimes\ltimes\rtimes, \ltimes\rtimes\rtimes, \ltimes b\rtimes, \ltimes aa, aaa, aab, aba, abb, baa, bab, bba, aa\rtimes, b\rtimes\rtimes, a\rtimes\rtimes\}$

1. ε
2. b
3. baba
4. aa

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 104.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{adac, adcd, cbed, eaee, ebdc\}$

1. b
2. e
3. cdbada
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 105.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\ \rtimes\ \rtimes\ltimes, \rtimes\ \rtimes\ \rtimes b, \rtimes\ \rtimes\ \ltimes\ltimes, \rtimes\ \rtimes\ ba, \rtimes\ \rtimes\ \ltimes\ltimes, \rtimes baa, aabb, abba, baab, baba, bbab, aba\ltimes, ba\ltimes\ltimes, a\ltimes\ltimes\ltimes\}$

1. babaab
2. bbbba
3. ab
4. abaabb

Solution

1. No
2. No
3. No
4. No

EXERCISE 106.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes c, aa, ab, ac, ba, ca, cc, c\ltimes\}$

1. cbc
2. ε
3. abcaac

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  4. c

Solution

  1. No
  2. No
  3. No
  4. Yes

EXERCISE 107.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$cdec, dbea, dcba, eebb$}

  1. cd
  2. caedbdeeb
  3. ε
  4. aaedbaeec

Solution

  1. Yes
  2. Yes
  3. Yes
  4. Yes

EXERCISE 108.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: {$aaa, abb, caa, cba, cbb, cca, ccb$}

  1. b
  2. aac
  3. ε
  4. ba

Solution

  1. Yes
  2. Yes
  3. Yes
  4. Yes

EXERCISE 109.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋈⋈⋈c, ⋈⋈⋈b, ⋈⋈⋈⋈, ⋈⋈be, ⋈⋈c⋈, ⋈⋈bb, ⋈⋈⋈⋈, ⋈bb⋈, ⋈bed, ⋈c⋈⋈, ⋈⋈⋈⋈, $acdb$, $bede$, $deac$, $eacd$, $edea$, cdb⋈, db⋈⋈, bb⋈⋈, c⋈⋈⋈, b⋈⋈⋈}

1. eceab
2. dacacaab
3. daaeebd
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 110.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: {bcd, bdb, cba, cda, cdd, ced, dbb, eae}

1. ddaddcbda
2. cdbaaaed
3. ced
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 111.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: {aac, baa, bab, bdb, ccc, daa, dcc}

1. b
2. a
3. ε

4. cabbacbdbd

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 112.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊c, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ba, ⋊cd, abd, bab, bdc, cce, cde, cec, dcc, ecd, de⋉, cd⋉, e⋉⋉, d⋉⋉}

1. deebebab
2. d
3. dcddcdcee
4. abcdecdbc

Solution

1. No
2. No
3. No
4. No

EXERCISE 113.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: {abc, bcb, beb, cae, cbd, dcd, ebd}

1. ecebabce
2. dbaa
3. eb
4. ccac

Solution

1. No
2. Yes
3. Yes
4. Yes

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EXERCISE 114.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aeb, bce, bea, dbb\}$

1. ε
2. dddceed
3. e
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 115.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abbb, baaa, babb, bbbb\}$

1. b
2. ε
3. abbbbabbb
4. a

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 116.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes \rtimes b, \rtimes ab, \rtimes b\ltimes, aab, abb, baa, bba, bb\ltimes, ab\ltimes, b \ltimes \ltimes\}$

1. aabbab
2. b
3. abbbaa
4. aaaa

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Solution

1. No
2. Yes
3. No
4. No

Exercise 117.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊b, ⋊⋊bb, ⋊bba, ⋊bb⋉, ⋊bbb, $babb$, $bbab$, $bbba$, $bbbb$, bba⋉, abb⋉, ba⋉⋉, bb⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. b
2. bb
3. aaaa
4. bba

Solution

1. No
2. Yes
3. No
4. Yes

Exercise 118.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ba, aaa, aab, aba, baa, bab, ab⋉, b⋉⋉}

1. abaaabb
2. bbbabbba
3. ε
4. ababbbb

Solution

1. No
2. No
3. Yes
4. No

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EXERCISE 119.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{bcc, cad, ccd, cdc\}$

1. ε
2. d
3. dd
4. bacbadb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 120.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaca, accb, bacb, cccb\}$

1. acaccbcca
2. bcba
3. ε
4. bca

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 121.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ae, de, ea, ec\}$

1. badbbacc
2. bba
3. cdce
4. aaa

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 122.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abda, adcb, bccc, ccca, daab\}$

1. a
2. dcbb
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 123.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{adae, ccdc, cebd, dedc\}$

1. adedc
2. ε
3. b
4. e

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 124.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊a, ⋊ ⋊ aa, ⋊ ⋊ ⋉⋉, ⋊ ⋊ ⋉⋉, ⋊aab, $aabb$, $abba$, $baaa$, $bbaa$, aaa⋉, aa⋉⋉, a⋉⋉⋉}

1. bbbaa
2. ab
3. ε
4. abbaba

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 125.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊aa, ⋊⋊ba, ⋊aa⋉, ⋊aaa, ⋊baa, $aaab$, $aaba$, $abaa$, $baab$, baa⋉, aba⋉, aa⋉⋉, ba⋉⋉, a⋉⋉⋉}

1. aa
2. ε
3. ccc
4. aacc

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 126.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊a, ab, ac, ad, ba, ca, de, ea, c⋉}

1. a
2. ac

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3. abac
4. acac

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 127.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abb, acb, bbc, ccb, cce, edc\}$

1. eede
2. e
3. abaed
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 128.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, ac, ad, bc, ca, cb, cc, cd, da, db, c\ltimes\}$

1. aacd
2. bcadadbd
3. ccbbb
4. ac

Solution

1. No
2. No
3. No
4. Yes

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EXERCISE 129.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊a, ⋊⋊d, ⋊d⋉, ⋊ac, aab, aac, abd, aca, acb, bcd, caa, cbc, cda, daa, bd⋉, d⋉⋉}

1. d
2. acaabd
3. caac
4. cacacbba

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 130.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: {acd, bac, bda, cbb, daa, dab, dcc, ddb}

1. a
2. ε
3. adcac
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 131.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊c, ⋊⋊a, ⋊c⋉, ⋊ac, abb, aca, bbb, bbc, bcb, cab, cbb, bb⋉, b⋉⋉, c⋉⋉}

1. bbb
2. ε
3. ca

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4. abcc

Solution

1. No
2. No
3. No
4. No

EXERCISE 132.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ba, bb, bd, db, a\ltimes\}$

1. a
2. aa
3. dba
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 133.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abab, bacc, bccb, caaa, caba, cabb, cbcc\}$

1. ε
2. cabc
3. accb
4. bbbaa

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 134.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abab, abba, baaa, baab, baba\}$

1. ε
2. a
3. b
4. abbab

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 135.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{acdc, addb, bddd, cbbb, dbdc, ddca\}$

1. b
2. ε
3. da
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 136.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aab, aba, bab, bba, bbb\}$

1. abbabaaba
2. ε
3. baaabaab
4. bbbb

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Solution

1. No
2. Yes
3. No
4. No

Exercise 137.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, \rtimes c, bc, bd, cb, cc, cd, db, dc, dd, c\ltimes, d\ltimes\}$

1. dabbbca
2. c
3. ε
4. abdbc

Solution

1. No
2. Yes
3. Yes
4. No

Exercise 138.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aba, abb, bba, bbb\}$

1. abbbaabaa
2. baaba
3. bbab
4. bbb

Solution

1. No
2. No
3. No
4. No

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EXERCISE 139.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{babd, bcac, bcdb, cbbd, cdab, ddad, dddd\}$

1. adccca
2. ε
3. bdadcdaad
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 140.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\ltimes\ltimes c, \rtimes\rtimes d, \rtimes ca, \rtimes de, \rtimes d\ltimes, aba, aec, bae, cab, ced, dec, eca, ece, edc, dc\ltimes, ca\ltimes, d\ltimes\ltimes, c\ltimes\ltimes, a\ltimes\ltimes\}$

1. ε
2. eadb
3. eadbaebeaa
4. dedb

Solution

1. No
2. No
3. No
4. No

EXERCISE 141.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes d, ac, bd, da, dd, de, eb, ee, c\ltimes\}$

1. ε
2. accebcbbc
3. eecdbbbebe

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4. beedbebece

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 142.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
$G^+: \{\rtimes c, cc, cd, dc, dd, c\ltimes\}$

1. ace
2. deeda
3. c
4. cc

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 143.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
$G^+: \{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes b, \rtimes\rtimes aa, \rtimes\rtimes ba, \rtimes aab, \rtimes baa, aabb, abbb, baab, babb, bbab, bbba, aab\ltimes, abb\ltimes, ab\ltimes$
$\ltimes, bb\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. aabbbbb
2. ε
3. babb
4. b

Solution

1. No
2. No
3. No
4. No

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EXERCISE 144.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊e, ⋊⋊ea, ⋊ead, $adbb$, $bbee$, $beee$, $dbbe$, $eadb$, $eddb$, $eedd$, $eeed$, $eeee$, ddb⋉, db⋉⋉, b⋉⋉⋉}

1. ebeeacd
2. cbceced
3. eba
4. eadbbeeeddb

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 145.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊⋉, ⋊b, ac, ad, ba, cd, da, dd, a⋉, b⋉}

1. ε
2. ababdabc
3. b
4. ddb

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 146.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: {aaa, aab, abb, baa, bba}

1. ε
2. abaababa
3. a

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4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 147.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ba, bd, ca, dc\}$

1. cddbdcc
2. ddd
3. ε
4. bba

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 148.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, abb, bbc, cca, ccc\}$

1. cbacab
2. ε
3. aacacab
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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Exercise 149.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes b, ab, ba, bb, a\ltimes, b\ltimes\}$

1. b
2. ababbaaaa
3. aaba
4. bbabba

Solution

1. Yes
2. No
3. No
4. Yes

Exercise 150.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes \rtimes a, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes ac, \rtimes \rtimes a\ltimes, \rtimes a \ltimes \ltimes, \rtimes acb, \rtimes \rtimes \ltimes\ltimes, acbd, bdca, cbdc, acb\ltimes, dca\ltimes, cb \ltimes \ltimes, ca \ltimes \ltimes, a \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. ε
2. cccdd
3. b
4. bacaab

Solution

1. Yes
2. No
3. No
4. No

Exercise 151.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes b, \rtimes bc, \rtimes bb, aac, aba, aca, baa, bab, bbb, bbc, bcc, cba, ccb, bc\ltimes, ca\ltimes, c\ltimes \ltimes, a \ltimes \ltimes\}$

1. bc
2. bbbc

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3. bbc
4. cbabaaaab

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 152.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊c, ⋊⋊⋊b, ⋊⋊bc, ⋊⋊ca, ⋊bca, ⋊cab, $aaaa$, $aaab$, $aabc$, $abcd$, $bcaa$, $bcda$, $caaa$, $cdaa$, cab⋉, da⋉, aa⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. bcaaabcdaa
2. dcddcca
3. cab
4. cdddddcbdad

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 153.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊b, aa, ab, ba, bb, a⋉}

1. abaaaa
2. ba
3. bbbbbbbba
4. bbbbabbabb

Solution

1. No
2. Yes
3. Yes

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4. No

EXERCISE 154.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, aa, ac, ad, ca, cd, da, d\ltimes\}$

1. cd
2. ca
3. ε
4. cad

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 155.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaac, aabc, abbc, acaa, bbcb, bcbc, cabc, cbbc\}$

1. abc
2. acaccaaa
3. bbbacc
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 156.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes bb, \rtimes \rtimes a\ltimes, \rtimes bba, \rtimes a \ltimes, aaab, abba, baaa, babb, bbaa, bbab, aab\ltimes, ab\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. a
2. abbbbaa
3. baaba
4. babbbb

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 157.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, ba, bc, cb\}$

1. cbacc
2. b
3. ε
4. cba

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 158.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, bc, ca, cb, a\ltimes, b\ltimes\}$

1. bcabccacbabb
2. c
3. bbccabacaacb
4. bbabaa

Solution

1. No
2. No

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3. No
4. No

Exercise 159.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aab, aca, bbd, ccd\}$

1. adbd
2. abaa
3. d
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 160.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes c, aa, ac, bb, bc, cb, cc, c\ltimes\}$

1. babd
2. c
3. cc
4. ac

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 161.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ba, bd, cd, db, dc, dd\}$

1. ε
2. accaddc
3. bcac
4. ddacdbada

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 162.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^{+}: {⋊⋊⋉, ⋊⋊a, ⋊⋊b, ⋊⋉⋉, ⋊bc, ⋊aa, abc, bab, bba, bcb, cbb, bc⋉, aa⋉, a⋉⋉, c⋉⋉}

1. bc
2. bab
3. ε
4. aa

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 163.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^{-}: {aa, ba, bb, cb, cc}

1. ε
2. ccb
3. b
4. a

Solution

1. Yes

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2. No
3. Yes
4. Yes

EXERCISE 164.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes \ltimes, \rtimes \rtimes a, \rtimes \ltimes \ltimes, \rtimes ac, acd, ace, cdd, cec, dac, dda, ecd, cd\ltimes, d \ltimes \ltimes\}$

1. bbdccceab
2. acecd
3. ε
4. acd

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 165.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ad, ca, cc, db\}$

1. ea
2. ε
3. dbaea
4. abb

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 166.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{bbc, bcb, bda, bdb, cbd, ccc, dad, dcc\}$

1. bcac
2. ddaacaa
3. c
4. aca

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 167.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ba, bb, b\ltimes\}$

1. abbbab
2. ab
3. abbbbabbb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 168.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abcb, beba, cbdb, cddc, ceed, ceee, dcba, eadb\}$

1. e
2. b
3. dedc
4. ε

Solution

1. Yes
2. Yes

   3. Yes
   4. Yes

EXERCISE 169.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{acab, babb, bcbb, bcca, ccca\}$

1. a
2. b
3. bcb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 170.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abc, acb, dab, dad, ddb\}$

1. b
2. ccdaccdca
3. ε
4. aadcacba

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 171.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, \rtimes c, ad, bd, cb, da, a\ltimes, b\ltimes\}$

1. dcbbad
2. bccc
3. ε
4. dcab

Solution

1. No
2. No
3. Yes
4. No

Exercise 172.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes c, \rtimes d, aa, ab, bc, bd, cd, da, db, a\ltimes, c\ltimes\}$

1. ca
2. dbdc
3. ε
4. ddadcdbca

Solution

1. No
2. No
3. No
4. No

Exercise 173.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, aa, ab, ba, a\ltimes\}$

1. aaabbaba
2. a
3. bba
4. baaa

Solution

1. No
2. Yes

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    3. No

    4. No

EXERCISE 174.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aaaa, abaa, baab, bbaa\}$

1. bbbbb
2. aba
3. bbaa
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 175.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{⋊⋊a, ⋊ab, ⋊aa, aaa, aab, aba, baa, ab⋉, aa⋉, b⋉⋉, a⋉⋉\}$

1. abaabaaa
2. ab
3. bbbbaabaab
4. aa

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 176.

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{cb, ce, da, ea\}$

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1. cbeeccadca
2. e
3. b
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 177.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊e, ⋊ ⋊ e⋉, ⋊ ⋊ ca, ⋊ ⋊ ba, ⋊cac, ⋊e ⋉ ⋉, ⋊ba⋉, $acbb$, $bacb$, $bbac$, $bbdc$, $bdcb$, $cacb$, $cbba$, $cbbd$, dcb⋉, ba ⋉ ⋉, cb ⋉ ⋉, a ⋉ ⋉⋉, e ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. ba
2. cacbbdcb
3. e
4. cbbabaacdc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 178.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊⋉, ⋊b, aa, ab, ba, bb, b⋉}

1. baaaba
2. bb
3. baaab
4. abbaabaaa

Solution

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1. No
2. Yes
3. Yes
4. No

EXERCISE 179.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{bd, cb, cc, cd, da, dc\}$

1. cbcdad
2. ε
3. b
4. dcbccdabd

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 180.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, baa, bba, bbb\}$

1. ε
2. b
3. aabba
4. aaa

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 181.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:

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G^+: $\{\rtimes a, aa, ac, ca, cc, c\ltimes\}$

1. aac
2. acc
3. cbbc
4. ac

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 182.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes d, \rtimes da, acc, acd, bac, cba, ccb, dac, cd\ltimes, d \ltimes \ltimes\}$

1. acededeb
2. bbd
3. ddbecae
4. cca

Solution

1. No
2. No
3. No
4. No

EXERCISE 183.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes \ltimes, \rtimes \rtimes c, \rtimes \ltimes \ltimes, \rtimes ca, abc, bcc, cab, cba, ccb, ba\ltimes, a \ltimes \ltimes\}$

1. ac
2. accca
3. ε
4. acbbbc

Solution

1. No

2. No
3. Yes
4. No

EXERCISE 184.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{acd, bce, bda, cab, cad, ddb, deb\}$

1. b
2. e
3. ε
4. dee

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 185.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋊ \quad ⋊ \quad ⋊a, ⋊ \quad ⋊ \quad ⋊c, ⋊ \quad ⋊ \quad ⋊⋉, ⋊ \quad ⋊ \quad cb, ⋊ \quad ⋊$
$ac, ⋊ \quad ⋊ \quad ⋉⋉, ⋊ \quad ⋊ \quad a⋉, ⋊a \quad ⋉ \quad ⋉, ⋊ac⋉, ⋊cbb, ⋊ \quad ⋉$
$⋉⋉, abca, babc, bbcb, bcab, bcba, cabc, cbab, cbbc, abc⋉, ac ⋉ ⋉, bc ⋉ ⋉, c ⋉$
$⋉⋉, a ⋉ ⋉⋉\}$

1. ac
2. ε
3. cbbcba
4. ccbbcbabc

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 186.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{bcab, dabd, dacd, dbda, dcdc\}$

1. baadacbc
2. abdbccddcd
3. badddbdc
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 187.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\ltimes \ltimes \ltimes e, \ltimes \ltimes ea, \ltimes eac, accc, ccca, cccc, eacc, cca\rtimes, ca \rtimes \rtimes, a \rtimes \rtimes\rtimes\}$

1. eaccca
2. cdbcce
3. a
4. bdc

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 188.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ba, bb, db, dc, ec, ed\}$

1. dbced
2. daebcaeea
3. abdaccece
4. baebedaaac

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Solution

1. No
2. Yes
3. No
4. No

EXERCISE 189.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaaa, aaab, aabb, babb, bbaa, bbab, bbba\}$

1. aabbaa
2. ε
3. babaab
4. bbbb

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 190.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{⋈⋈⋉, ⋈⋈a, ⋈a⋉, ⋈⋉⋉, ⋈ac, aab, acb, baa, bba, cbb, ab⋉, b⋉⋉, a⋉⋉\}$

1. bba
2. c
3. a
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

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EXERCISE 191.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ba, bb, b\ltimes\}$

1. ε
2. bba
3. aaabaaba
4. a

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 192.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abaa, abbc, bbca, bcaa, cbac, cbbc, cccc\}$

1. b
2. ababcbca
3. cbbcac
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 193.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes ba, aaa, aab, aba, abb, baa, bab, bba, ab\ltimes, b \ltimes \ltimes\}$

1. baaba
2. bab
3. bbaaab
4. baab

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Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 194.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{ \rtimes\rtimes d, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes de, ace, ada, ced, dac, dda, dea, ead, edd, da\ltimes, a\ltimes\ltimes \}$

1. ebaeceda
2. daaaaaccac
3. ε
4. deada

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 195.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{ aadc, adde, bacc, bdea, cded, daea, ddcc \}$

1. bac
2. bdddb
3. e
4. abcc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 196.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ d, ⋊da, aba, abb, bbe, bed, dab, eda, ba⋉, a ⋉ ⋉}

1. cdccada
2. d
3. ab
4. daba

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 197.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊ ⋊ ⋉, ⋊ ⋉ ⋉, ⋊ab, ⋊b⋉, abb, bbb, bb⋉, b ⋉ ⋉}

1. aaa
2. ε
3. aab
4. babaab

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 198.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊e, ⋊⋊eb, ⋊⋊ed, ⋊ebd, ⋊eda, $aace$, $aced$, $cedb$, $daac$, $dbda$, $edaa$, $edbd$, ebd⋉, bda⋉, bd⋉ ⋉, da ⋉ ⋉, a ⋉ ⋉⋉, d ⋉ ⋉⋉}

1. ceaee
2. aacccca
3. aedbb

4. beeede

Solution

1. No
2. No
3. No
4. No

EXERCISE 199.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
$G^-: \{ab, ac, ad, bc, da\}$

1. ε
2. b
3. cddaa
4. a

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 200.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
$G^+: \{⋊⋊⋊c, ⋊⋊⋊⋉, ⋊⋊⋊d, ⋊⋊d⋉, ⋊⋊⋉⋉, ⋊⋊cc, ⋊⋊cd, ⋊cda, ⋊d⋉⋉, ⋊cc⋉, ⋊⋉⋉⋉, abbe, cdab, dabb, bbe⋉, be⋉⋉, cc⋉⋉, c⋉⋉⋉, d⋉⋉⋉, e⋉⋉⋉\}$

1. d
2. ε
3. b
4. da

Solution

1. Yes
2. Yes
3. No
4. No

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EXERCISE 201.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, bd, be, db, ea, ec, ed, ee\}$

1. e
2. ecbaece
3. b
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 202.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, aaba, abba, bbba\}$

1. ε
2. abababa
3. b
4. baaabb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 203.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aabd, acbd, baad, bbab, cbba, cddb, cddc, ddbb\}$

1. abbdacb
2. cd
3. bacdbaa
4. ε

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Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 204.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes bc, aac, baa, bbc, bcb, bcd, cba, cbb, cdc, dcb, ac\ltimes, c \ltimes \ltimes\}$

1. abdba
2. abdccca
3. cd
4. aa

Solution

1. No
2. No
3. No
4. No

EXERCISE 205.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ac, ba, bb\}$

1. cbcabbba
2. baccb
3. bbc
4. caccbbc

Solution

1. No
2. No
3. No
4. No

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EXERCISE 206.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes \rtimes b, \rtimes ab, \rtimes bb, aab, aba, baa, bb\ltimes, ba\ltimes, b \ltimes \ltimes, a \ltimes \ltimes\}$

1. aba
2. bb
3. c
4. ε

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 207.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaed, accb, baec, dcdd, deeb, eacc, ecac, eeac\}$

1. c
2. e
3. b
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 208.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaba, acba, bbba, cbaa\}$

1. aa
2. aabaac
3. cabba
4. bb

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Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 209.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abdb, baaa, bbbd, bcbb, cdbc, cddc, dbdb, dcad\}$

1. ε
2. a
3. b
4. dbbb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 210.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, aa, ab, ac, ba, bc, ca, cb, cc, a\ltimes\}$

1. aaa
2. ab
3. a
4. aa

Solution

1. Yes
2. No
3. Yes
4. Yes

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EXERCISE 211.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes b, \rtimes c, ac, ca, cc, a\ltimes, b\ltimes\}$

1. accb
2. bcbc
3. ε
4. caaac

Solution

1. No
2. No
3. No
4. No

EXERCISE 212.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes ab, \rtimes\rtimes a\ltimes, \rtimes a\ltimes\ltimes, \rtimes abc, abca, abcb, bcab, bcbb, cabc, cbb\ltimes, bb\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. cc
2. cabcba
3. a
4. abcbb

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 213.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ba, bd, ca, cd\}$

1. ε
2. b
3. a

4. daacbacccc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 214.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ac, ad, bd, dd\}$

1. ε
2. ababbbbccc
3. a
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 215.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes e, aa, ab, ad, ae, be, de, ea, e\ltimes\}$

1. ε
2. eabcccb
3. baddcabece
4. adbbcaad

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 216.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, abb, bcb, cbb, cbc\}$

1. acabca
2. cacacccaac
3. accbaacb
4. cccbb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 217.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes bb, \rtimes ad, acb, bac, bba, bbd, bde, cbb, ad\ltimes, de\ltimes, e\ltimes\ltimes, d\ltimes\ltimes\}$

1. caaeac
2. bbde
3. ad
4. abb

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 218.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ae, ba, ce, da\}$

1. e
2. acbaebe
3. ε
4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 219.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes b\ltimes, \rtimes bb, \rtimes aa, aab, aba, abb, baa, bab, bba, bbb, aa\ltimes, ba\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. b
2. aa
3. bba
4. aaa

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 220.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aab, aba, bba, bbb\}$

1. a
2. ε
3. b
4. abbb

Solution

1. Yes
2. Yes
3. Yes
4. No

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EXERCISE 221.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{adb, cac, dbd, ece, edb\}$

1. aacaaeda
2. eccaed
3. cddce
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 222.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{acd, bde, ccb, dea\}$

1. abbbcbecbabb
2. bedbcbadae
3. ε
4. abcaeeeb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 223.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aabb, abaa, abbb, babb, bbab, bbbb\}$

1. aa
2. ε
3. a
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 224.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes d, aa, bb, be, cb, cc, ce, dc, ea, ec, a\ltimes, d\ltimes\}$

1. dcea
2. d
3. dccea
4. adcad

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 225.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, aaba, abbb, baaa, babb, bbaa, bbbb\}$

1. ababa
2. bbaaab
3. ε
4. bbaaa

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 226.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊ ⋊ ⋉, ⋊ ⋊ a, ⋊ ⋊ b, ⋊ ⋊ d, ⋊ ⋊ ⋉, ⋊d⋉, ⋊aa, ⋊bd, bbc, bcc, bdb, cbd, ccb, dbb, aa⋉, bd⋉, d⋉⋉, a⋉⋉}

1. ε
2. ab
3. badbad
4. bd

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 227.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊⋉, ⋊d, ab, ac, ba, bb, be, ca, da, ea, a⋉}

1. beeee
2. aca
3. a
4. deebaeab

Solution

1. No
2. No
3. No
4. No

EXERCISE 228.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊b, aa, ac, bc, ca, cb, c⋉}

1. cbcc
2. a
3. bc

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4. ccacbca

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 229.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abab, abba, baaa, baab, babb\}$

1. bbbba
2. babbab
3. b
4. aababb

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 230.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes ba, aab, aba, abb, baa, bab, bb\ltimes, b \ltimes \ltimes\}$

1. ε
2. aa
3. ba
4. aab

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 231.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aac, aca, acb, ccc\}$

1. c
2. ε
3. b
4. ccb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 232.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, aabb, abaa, baba, babb, bbab, bbbb\}$

1. aabbba
2. ε
3. baa
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 233.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, ba, bb, bc, ca, cb\}$

1. a
2. cabb
3. ε
4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 234.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{baa, bab, bbd, bdc, cda, dbe, ddc, edc\}$

1. ba
2. a
3. adeaecadcaa
4. ceead

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 235.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{add, cab, cbc, dad, dbb, dbd, dcd\}$

1. bdacbc
2. b
3. ε
4. a

Solution

1. No
2. Yes
3. Yes
4. Yes

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EXERCISE 236.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊a⋉, ⋊⋊ab, ⋊aba, ⋊a⋉⋉, $aabb$, $abaa$, $baab$, abb⋉, bb⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. a
2. abbc
3. caab
4. b

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 237.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: {da, de, eb, ee}

1. ε
2. e
3. dcacdd
4. cbdedebc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 238.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: {aa, ab, ad, bb, cc, cd, da, dd}

1. ε
2. bcccd
3. b

4. dd

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 239.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, b\ltimes\}$

1. bbab
2. aabb
3. abbaa
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 240.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ac, ae, ba, ca\}$

1. b
2. ad
3. ε
4. ecac

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 241.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, bc, ca, cc\}$

1. ε
2. b
3. acbbcc
4. a

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 242.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{ \rtimes \rtimes c, \rtimes \rtimes a, \rtimes cb, \rtimes a\ltimes, acb, bac, bca, cac, cba, cbc, cb\ltimes, b \ltimes \ltimes, a \ltimes \ltimes \}$

1. ccacaa
2. baabbccc
3. bccac
4. cb

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 243.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, ad, ca, cc, da, db, dd\}$

1. ε
2. bdbdbadcb
3. dbca
4. db

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Solution

1. Yes
2. No
3. No
4. No

EXERCISE 244.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes bb, aab, abd, baa, bba, bdd, daa, dda, ab\ltimes, b \ltimes \ltimes\}$

1. deccae
2. ε
3. bbaab
4. bbdaedbe

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 245.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes \rtimes b, \rtimes a\ltimes, \rtimes bd, aba, bab, bdb, dba, ba\ltimes, a \ltimes \ltimes\}$

1. a
2. bdba
3. d
4. dabca

Solution

1. Yes
2. Yes
3. No
4. No

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EXERCISE 246.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ac, ba, bb, bc, ca, cb\}$

1. bbcaa
2. ε
3. bcbb
4. a

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 247.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, bd, cb, cc, dd\}$

1. da
2. d
3. ccda
4. a

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 248.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, ac, bd, ca, cd, db, dd\}$

1. dbaccabb
2. ca
3. cddbca
4. aaa

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Solution

1. No
2. No
3. No
4. Yes

EXERCISE 249.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aacb, abac, accb, baaa, bbac, bbbb, cacc, cbab\}$

1. b
2. abcc
3. ε
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 250.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes a\ltimes, \rtimes\ltimes\ltimes, \rtimes ba, \rtimes bb, aab, aba, abb, baa, bab, bba, ab\ltimes, bb\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. aab
2. ε
3. aaabbbbabbb
4. bbabbaa

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 251.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, ae, bc, ca, cd, de, eb, ec, ee, c\ltimes\}$

1. baccac
2. aec
3. ce
4. aeec

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 252.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abc, aca, bab, bcb, caa, cca\}$

1. b
2. caabbc
3. ε
4. cba

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 253.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ce, db, dc, ec\}$

1. caacbdbedab
2. ε
3. cbdacadd
4. a

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 254.

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{ac, ba, ca, cb, cd, db, dc, dd\}$

1. dcbc
2. ε
3. bbcbaaab
4. baabbb

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 255.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes\ltimes, \rtimes c, ab, bc, ca, cb, cc, a\ltimes\}$

1. cabcabba
2. ε
3. ca
4. ccacca

Solution

1. No
2. Yes
3. Yes
4. No

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EXERCISE 256.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, \rtimes d, aa, ab, ad, ba, bd, da, db, b\ltimes, d\ltimes\}$

1. b
2. ε
3. d
4. dcbb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 257.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, bb, bc, bd, cb, cc, dc, b\ltimes\}$

1. ε
2. b
3. bdbabac
4. dabd

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 258.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aadb, bacc, bcac, bdbd, dcca\}$

1. ε
2. dccccc
3. d
4. bbabaaad

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Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 259.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋈⋈e, ⋈⋈c, ⋈⋈⋈, ⋈c⋈, ⋈⋈⋈, ⋈ec, ade, bad, cba, ecb, de⋈, e⋈⋈, c⋈⋈}

1. e
2. bec
3. aaab
4. dbcdcc

Solution

1. No
2. No
3. No
4. No

EXERCISE 260.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋈⋈, ⋈b, ab, ba, b⋈}

1. ε
2. abbbb
3. aa
4. bb

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 261.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, bc, cb, cc\}$

1. ε
2. b
3. ccbccccc
4. bcbcbacaaa

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 262.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes b, \rtimes \rtimes \ ac, \rtimes \rtimes \ ca, \rtimes \rtimes \ b\ltimes, \rtimes \rtimes \ ba, \rtimes bac, \rtimes acc, \rtimes ca\ltimes, \rtimes b \ltimes \ltimes, accc, ccca, cccc, bac\ltimes, cca\ltimes, ac \ltimes \ltimes, ca \ltimes \ltimes, c \ltimes \ltimes \ltimes, a \ltimes \ltimes \ltimes, b \ltimes \ltimes \ltimes\}$

1. cac
2. b
3. cbc
4. ca

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 263.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, ba, bb, cb, cc\}$

1. bbb
2. a

3. ε
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 264.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{baaa, baab, baba, babb, bbaa, bbba, bbbb\}$

1. aa
2. ε
3. a
4. ab

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 265.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abcc, adad, bdaa, dacb, dbbc\}$

1. dcddcb
2. bdb
3. ε
4. c

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 266.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$abab, abba, baaa, baba, babb, bbaa$}

1. baabab
2. bb
3. ε
4. a

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 267.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {$\rtimes\ltimes, \rtimes b, ab, ba, bb, b\ltimes$}

1. ε
2. bbabba
3. bba
4. aab

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 268.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: {aaa, caa, dcc, dda}

1. ε
2. b
3. cdbca
4. ab

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Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 269.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊⋊c, ⋊⋊⋉, ⋊⋊b, ⋊c⋉, ⋊⋊⋉, ⋊bc, ⋊bd, aab, abc, acc, bca, bda, caa, cca, dac, ca⋉, bc⋉, c⋉⋉, a ⋉ ⋉}

1. dde
2. aebbdbbcdb
3. ε
4. cebbaebd

Solution

1. No
2. No
3. Yes
4. No

Exercise 270.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ a⋉, ⋊ ⋊ cd, ⋊a ⋉ ⋉, ⋊cdb, ⋊ ⋉ ⋉⋉, $aacd$, $acda$, $baac$, $cdaa$, $cdba$, $daac$, $dbaa$, acd⋉, cd ⋉ ⋉, d ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. ε
2. badddbbbdba
3. dcba
4. cddaaabbc

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 271.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aba, abb, bba\}$

1. ε
2. b
3. aabaa
4. a

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 272.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, acb, bba, cca\}$

1. a
2. ε
3. aaaa
4. b

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 273.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, aa, ab, ba, a\ltimes\}$

1. aa
2. b
3. bbaaaaab
4. a

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 274.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ba, bb, bc, bd, da, db, dc\}$

1. b
2. ε
3. bcaa
4. abdbcca

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 275.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes b, aa, ac, bc, ca, cb, cc, a\ltimes, b\ltimes\}$

1. ac
2. babcabb
3. cacabbc
4. bccaba

Solution

1. No
2. No
3. No
4. No

EXERCISE 276.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaaa, abaa, abba, baaa, babb, bbaa, bbba\}$

1. b
2. ε
3. aaaaa
4. a

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 277.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{baac, bbba, bcab, bcbc, bccc, cccc\}$

1. abca
2. ε
3. aababbbb
4. bcbbacba

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 278.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{bba, bdb, dde, edd\}$

1. e
2. cb
3. cbaeebccac
4. ε

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Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 279.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋈⋈⋈b, ⋈⋈bb, ⋈⋈ba, ⋈bab, ⋈bb⋈, ⋈baa, $abbb$, $babb$, $bbab$, $bbba$, $bbbb$, baa⋈, bab⋈, ab⋈⋈, aa⋈⋈, bb⋈⋈, a⋈⋈⋈, b⋈⋈⋈}

1. bab
2. baa
3. bb
4. a

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 280.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋈⋈e, ⋈⋈a, ⋈⋈⋈, ⋈⋈⋈, ⋈ae, ⋈ea, ade, deb, ead, eba, ae⋈, ba⋈, e⋈⋈, a⋈⋈}

1. ea
2. c
3. ε
4. abdde

Solution

1. No
2. No
3. Yes
4. No

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EXERCISE 281.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊bb, ⋊ad, ada, aec, cac, cda, dae, eca, ecd, bb⋉, ac⋉, b⋉⋉, c⋉⋉}

1. aaebcba
2. bb
3. ε
4. adaecac

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 282.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊⋊⋊e, ⋊⋊ee, ⋊eeb, ⋊ee⋉, $abba$, $bcdc$, $cdcd$, $cdda$, $dabb$, $dcdd$, $ddab$, $ebcd$, $eebc$, bba⋉, ee⋉⋉, ba⋉⋉, a⋉⋉⋉, e⋉⋉⋉}

1. ee
2. bccddedcbcee
3. bedbcb
4. eaddab

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 283.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊a, ⋊⋉, ⋊b, aa, ab, ba, bb, b⋉}

1. bab
2. ε

3. abbb
4. baaba

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 284.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ca, cb, cc, cd, da, dd\}$

1. e
2. aaedddc
3. ε
4. c

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 285.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, ac, bc, ca, cc, c\ltimes\}$

1. aab
2. bc
3. ba
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

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EXERCISE 286.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: ⋊⋊⋊a,⋊⋊⋊c,⋊⋊⋊⋉,⋊⋊⋊d,⋊⋊⋊e,⋊⋊ea,⋊⋊d⋉,⋊⋊⋉⋉,⋊⋊aa,⋊⋊cc,⋊cca,⋊aa⋉,⋊d⋉⋉,⋊⋊⋉⋉,⋊eac,$acac$,$acba$,$baca$,$cbac$,$eacb$,cca⋉,cac⋉,ac⋉⋉,aa⋉⋉,ca⋉⋉,c⋉⋉⋉,d⋉⋉⋉,a⋉⋉⋉}

1. aabd
2. bbdabed
3. d
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 287.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊a,⋊b,aa,ab,ba,bb,a⋉}

1. ε
2. abaaaaabab
3. baaaaabb
4. a

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 288.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$aaaa$,$aaba$,$abaa$,$bbaa$,$bbba$}

1. bbbbaa

2. ε
3. baababb
4. baa

Solution

1. No
2. Yes
3. No
4. Yes

Exercise 289.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊⋊c, ⋊⋊⋊⋉, ⋊⋊ab, ⋊⋊c⋉, ⋊⋊ae, ⋊⋊⋊⋉, ⋊c⋊⋉, ⋊ab⋉, ⋊⋊⋉⋉, ⋊aee, $aeed$, $dded$, $edde$, $eedd$, ded⋉, ab⋉⋉, ed⋊⋉, c⋊⋊⋉, d⋊⋊⋉, b⋊⋊⋉}

1. babedee
2. cbcadbb
3. ε
4. cddbaa

Solution

1. No
2. No
3. Yes
4. No

Exercise 290.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊c, ae, ba, cd, db, dd, ec, d⋉}

1. dabcbeca
2. eaaae
3. cbccdd
4. cd

Solution

1. No
2. No

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3. No
4. Yes

EXERCISE 291.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes\ltimes, \rtimes a\ltimes, \rtimes\ltimes\ltimes, \rtimes ab, aac, abb, acb, baa, bba, bca, cbc, ab\ltimes, ca\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. a
2. ε
3. abca
4. abccbaac

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 292.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes c, ab, ac, bc, bd, ca, cd, da, db, dd, a\ltimes\}$

1. bca
2. dcabdcbadd
3. bcdabc
4. baabbabaacc

Solution

1. No
2. No
3. No
4. No

EXERCISE 293.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes b, aa, ab, ba, bb, a\ltimes\}$

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1. baa
2. ba
3. bba
4. ababbb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 294.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊⋊c, ⋊⋊ca, ⋊⋊ab, ⋊abb, ⋊ca⋉, $abba$, $babc$, $bbab$, abc⋉, bc⋉⋉, ca⋉⋉, a⋉⋉⋉, c⋉⋉⋉}

1. aaabb
2. ccc
3. ca
4. ac

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 295.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ bb, ⋊ ⋊ ac, ⋊ ⋊ ⋉⋉, ⋊ ⋊ cc, ⋊bb⋉, ⋊acb, ⋊ccc, ⋊ ⋉⋉⋉, $abba$, $bbac$, $bbcc$, $bcca$, $cabb$, $cbbc$, $ccab$, $ccbb$, $cccb$, acb⋉, bac⋉, ac ⋉⋉, cb⋉⋉, bb⋉⋉, c⋉⋉⋉, b⋉⋉⋉}

1. b
2. ε
3. bbbbcbbcaca
4. bb

Solution

1. No
2. Yes
3. No
4. Yes

Exercise 296.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊⋉, ⋊⋊c, ⋊⋊b, ⋊⋉⋉, ⋊ba, ⋊cc, aad, adc, caa, cbd, cca, dcb, ba⋉, bd⋉, d⋉⋉, a⋉⋉}

1. bccdbbab
2. bbac
3. c
4. addb

Solution

1. No
2. No
3. No
4. No

Exercise 297.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊ab, ⋊⋊bb, ⋊bba, ⋊ab⋉, abab, baba, bbab, bab⋉, ab⋉⋉, b⋉⋉⋉}

1. aba
2. ε
3. ab
4. aa

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 298.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+:   {⋊⋊⋊a, ⋊⋊⋊c, ⋊⋊a⋉, ⋊⋊cd, ⋊a⋉⋉, ⋊cdb, abda, babd, bbab, bdad, cdbb, dadb, dbba, adb⋉, db⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. dcbcdcbbc
2. a
3. ddccacac
4. dbdda

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 299.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{ac, bb, bc, cb, cd, da, db, dd\}$

1. ε
2. aabc
3. bbbb
4. dbb

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 300.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{aa, ab, ba, bb, bc, ca, cb\}$

1. a
2. caabaaaabcba

3. ε
4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 301.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aba, ada, cab, cda, dca, ddb\}$

1. d
2. ε
3. ddd
4. cac

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 302.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, \rtimes b, aa, ab, ba, bb, a\ltimes, b\ltimes\}$

1. abbbabbb
2. b
3. abbbbb
4. aaaaaabaaab

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 303.

For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊d, ⋊ ⋊ ⋊e, ⋊ ⋊ ae, ⋊ ⋊ ec, ⋊ ⋊ d⋉, ⋊ ⋊ ba, ⋊bac, ⋊ecb, ⋊d⋉⋉, ⋊ae⋉, $acae$, $baca$, $caeb$, ecb⋉, aeb⋉, ae⋉⋉, cb⋉⋉, eb⋉⋉, d⋉⋉⋉, e⋉⋉⋉, b⋉⋉⋉}

1. ae
2. ε
3. b
4. d

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 304.

For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:

G^+: {⋊ ⋊ b, ⋊ ⋊ ⋉, ⋊ ⋉ ⋉, ⋊ba, aca, acb, bac, bdd, cac, cbd, dd⋉, d ⋉ ⋉}

1. bbc
2. bcdccb
3. cec
4. addded

Solution

1. No
2. No
3. No
4. No

EXERCISE 305.

For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:

G^+: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ba, ⋊aa, aab, aba, aca, bac, caa, ab⋉, ba⋉, b⋉⋉, a ⋉ ⋉}

1. ba

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2. ε
3. bb
4. ccbccacb

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 306.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abba, baab, bbab, bbbb\}$

1. a
2. aabb
3. b
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 307.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\ \rtimes\ \rtimes d, \rtimes\ \rtimes\ \rtimes e, \rtimes\ \rtimes\ db, \rtimes\ \rtimes\ ea, \rtimes\ \rtimes\ d\ltimes, \rtimes ead, \rtimes d\ \rtimes\ \ltimes, \rtimes dbd, abde, bdda, bded, dabd, dbdd, ddab, dedc, edc\ltimes, ead\ltimes, dc\ \ltimes\ \ltimes, ad\ \ltimes\ \ltimes, c\ \ltimes\ \ltimes\ltimes, d\ \ltimes\ \ltimes\ltimes\}$

1. cd
2. eeecc
3. aebceeaae
4. ε

Solution

1. No

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2. No
3. No
4. No

EXERCISE 308.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊b, ⋊bc, aac, acc, bcc, caa, cca, ca⋉, a⋉⋉}

1. acabcacb
2. a
3. bcca
4. bac

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 309.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊b, ⋊⋊d, ⋊db, ⋊bd, bbd, bdd, dbb, ddb, db⋉, bd⋉, b⋉⋉, d⋉⋉}

1. aaadda
2. ε
3. db
4. bd

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 310.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊a, ⋊⋉, aa, ab, ac, ba, bb, cc, cd, db, a⋉, b⋉}

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1. bdccc
2. bb
3. bbdadbccc
4. abaabbbda

Solution

1. No
2. No
3. No
4. No

EXERCISE 311.

For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ae, cc, da, dd, ed\}$

1. cbdeda
2. bddeae
3. dddeb
4. ecceecb

Solution

1. No
2. No
3. No
4. No

EXERCISE 312.

For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, ab, ac, bd, ca, cc, da, a\ltimes\}$

1. cca
2. ccaccbc
3. ca
4. ε

Solution

1. Yes
2. No

3. Yes
4. Yes

EXERCISE 313.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+:   {⋊ ⋊ ⋊a,⋊ ⋊ ⋊b,⋊ ⋊ ba,⋊ ⋊ bb,⋊ ⋊ a⋉,⋊a ⋉,⋊ba⋉, ⋊bbb, $aabb$, $abaa$, $abbb$, $baab$, $baba$, $bbab$, $bbba$, bba⋉, ba ⋉ ⋉,a ⋉ ⋉⋉}

1. a
2. ε
3. babaabbaa
4. aaaabab

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 314.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {$aa, ac, ad, bb, cc, da, db, dc$}

1. b
2. dbdbd
3. ε
4. a

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 315.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

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G^-: $\{abba, abca, bacb, cacc\}$

1. abbb
2. accbbbbbac
3. aac
4. accabbacc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 316.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ba, bb, ca\}$

1. ac
2. a
3. b
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 317.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abdb, acca, adea, ddbc, deac, eacb, ebdc\}$

1. ε
2. b
3. e
4. abeacb

Solution

1. Yes

2. Yes
3. Yes
4. No

EXERCISE 318.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊d, ⋊ ⋊ dc, ⋊ ⋊ c⋉, ⋊ ⋊ ca, ⋊ ⋊ ⋉⋉, ⋊ca⋉, ⋊c ⋉ ⋉, ⋊dcc, ⋊ ⋉ ⋉⋉, aaaa, caaa, ccdc, cdca, dcaa, dccd, aaa⋉, aa ⋉ ⋉, ca ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. ddcb
2. ccddacbbcb
3. aacbacd
4. abbbbdbc

Solution

1. No
2. No
3. No
4. No

EXERCISE 319.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊ ⋊ d, ⋊ ⋊ ⋉, ⋊ ⋉ ⋉, ⋊dd, aca, adb, bdd, caa, dac, dad, dbd, dda, aa⋉, a ⋉ ⋉}

1. acba
2. ε
3. caabdcaabd
4. addcbbbbd

Solution

1. No
2. Yes
3. No
4. No

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EXERCISE 320.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, bab, bbb\}$

1. aaba
2. a
3. ε
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 321.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{baad, bdae, edaa, edee\}$

1. e
2. cb
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 322.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abb, bbb, cab, cac, ccb\}$

1. b
2. ε
3. a
4. cb

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Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 323.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaac, bbaa, bbca, bbcc, caab, cdab, dbab\}$

1. b
2. a
3. dcbcbcabb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 324.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes c, \rtimes\rtimes\rtimes b, \rtimes\rtimes cb, \rtimes\rtimes bb, \rtimes bbb, \rtimes cb\ltimes, aaea, aeae, baae, bbaa, bbba, eaee, aee\ltimes, ee\ltimes \ltimes, cb\ltimes\ltimes, e\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. abeada
2. aaabdaae
3. dcdbea
4. ecda

Solution

1. No
2. No
3. No
4. No

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EXERCISE 325.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ac, bb, bc, cb\}$

1. bba
2. cbb
3. ε
4. c

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 326.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes \rtimes aa, \rtimes \rtimes bb, \rtimes aa\ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes bbb, aabb, abbb, baab, bbaa, bbba, baa\ltimes, aa \ltimes \ltimes, a \ltimes \ltimes \ltimes\}$

1. abab
2. abaaabbb
3. bbbbb
4. abbaabb

Solution

1. No
2. No
3. No
4. No

EXERCISE 327.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes c, \rtimes \rtimes a, \rtimes c\ltimes, \rtimes ac, aca, adc, cad, dcb, cb\ltimes, b \ltimes \ltimes, c \ltimes \ltimes\}$

1. ε
2. ccadaa
3. c

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4. cdbcb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 328.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aacb, aada, accd, addb, dacd, dbcc\}$

1. ε
2. b
3. ddcaaccccbd
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 329.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ba, bb, b\ltimes\}$

1. ab
2. aab
3. bbaab
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 330.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊d, ⋊ ⋊ da, ⋊ ⋊ ⋉⋉, ⋊ ⋊ aa, ⋊aaa, ⋊dac, ⋊ ⋊ ⋉⋉, $aaad$, $aada$, $acab$, $adac$, $daca$, cab⋉, dac⋉, ac⋉⋉, ab⋉⋉, c⋉⋉⋉, b⋉⋉⋉}

1. dacab
2. ε
3. dac
4. cacd

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 331.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: {$aaba$, $aabb$, $abaa$, $abba$, $baba$, $bbaa$}

1. b
2. bababaa
3. a
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 332.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊⋉, ⋊b, aa, ab, ba, bb, a⋉}

1. babbaabaaa
2. ba
3. aabaaba

   4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 333.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes b, ac, bb, bc, ca, c\ltimes, b\ltimes\}$

1. bb
2. b
3. ccbac
4. bbcbc

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 334.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes d, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes dd, acb, adc, cac, cad, cba, cca, dca, dcc, ddc, ba\ltimes, a\ltimes\ltimes\}$

1. ba
2. adcccbddbd
3. ddcacba
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

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EXERCISE 335.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, ab, ba, a\ltimes\}$

1. ababa
2. babab
3. a
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 336.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aab, acd, bab, bbb\}$

1. ε
2. ccdd
3. b
4. db

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 337.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, \rtimes d, aa, ac, ae, ba, be, cb, ea, ec, ee, c\ltimes, d\ltimes\}$

1. cacdeebde
2. ε
3. d
4. b

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Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 338.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, \rtimes b, aa, ab, ba, bb, a\ltimes\}$

1. ababaa
2. ε
3. abaaba
4. b

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 339.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes d, ab, bb, bc, ce, da, e\ltimes\}$

1. dabce
2. ae
3. ε
4. ce

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 340.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, abaa, abab, abbb, baaa, babb\}$

1. bba
2. aab
3. bb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 341.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aac, bab, bbb, caa, cbb, ccb\}$

1. b
2. ε
3. a
4. acbcacc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 342.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ac, ba, bb, bc, ca, cb, cc\}$

1. aaccaaac
2. aa
3. b
4. ccbbbcccaac

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 343.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aac, abc, baa, cac\}$

1. b
2. ε
3. bbbccc
4. aabbab

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 344.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abba, abca, acaa, bbaa, bbab, cabc, cccb\}$

1. bba
2. a
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 345.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abcd, aebc, bade, baec, beeb, cadd, cdcb, decc\}$

1. daddcba
2. b
3. ad
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 346.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\bowtie\bowtie a, \bowtie\bowtie b, \bowtie\bowtie\bowtie, \bowtie\bowtie\bowtie, \bowtie bb, \bowtie aa, aaa, aba, baa, bab, bba, bbb, aa\bowtie, a\bowtie\bowtie\}$

1. ε
2. bababbb
3. bbabab
4. bbb

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 347.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{adb, bcd, bda, bdb, cbb, cdb, dca, dcc\}$

1. ε
2. ba
3. b

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4. dbdd

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 348.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aac, abb, bca, bcb, bcc, caa, cca, ccb\}$

1. aacc
2. bcbabcaabcca
3. ccc
4. acaccbbacaa

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 349.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaaa, abbc, baab, cabb, caca, ccaa\}$

1. b
2. ε
3. aabcacbbbccb
4. acccaaabcb

Solution

1. Yes
2. Yes
3. Yes
4. No

Exercise 350.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, \rtimes e, bd, de, eb, ed, ee, e\ltimes, b\ltimes\}$

1. bcbbba
2. ε
3. e
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 351.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, ac, ca, cc, a\ltimes\}$

1. aaacc
2. bababcb
3. a
4. ε

Solution

1. No
2. No
3. Yes
4. No

Exercise 352.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes d, \rtimes \rtimes db, \rtimes \rtimes ab, \rtimes \rtimes b\ltimes, \rtimes dbb, \rtimes ab\ltimes, \rtimes b\ltimes \ltimes, aabd, abda, babd, bbab, bdaa, daab, dbba, abd\ltimes, ab\ltimes\ltimes, bd\ltimes\ltimes, d\ltimes\ltimes\ltimes, b\ltimes \ltimes\ltimes\}$

1. b
2. ddaa

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3. ab
4. ebaecacbbb

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 353.

For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aadd, bddd, dabb, dbbb, dcbb, ddda\}$

1. dbbdabdb
2. aadbada
3. db
4. cbdbcd

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 354.

For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ba, bc, db, dc, eb, ed, ee\}$

1. b
2. bc
3. ε
4. e

Solution

1. Yes
2. No
3. Yes
4. Yes

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EXERCISE 355.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊a, ⋊⋉, $aa, ab, ac, ba, bb, bc, ca, cb, cc, a$⋉$, b$⋉}

1. abcaab
2. accaaaacaca
3. aaa
4. bcb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 356.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊⋉, ⋊⋊d, ⋊⋊b, ⋊⋉⋉, ⋊be, ⋊$dc, aac, acc, caa, cba, cca, ccb, ccc, dcc, be$⋉$, ba$⋉$, e$⋉⋉$, a$⋉⋉}

1. be
2. eddbb
3. dccba
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 357.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊a, $aa, ab, ad, bd, da, dc, dd, c$⋉}

1. adc
2. aadc
3. abdc

4. ε

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 358.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \ bd, \rtimes \rtimes ce, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes \ aa, \rtimes \rtimes \ a\ltimes, \rtimes ceb, \rtimes a \ \ltimes \ \ltimes, \rtimes aa\ltimes, \rtimes bdd, \rtimes \ \ltimes\ltimes, aeec, bcea, cbdd, ceae, cebc, eaee, ebce, ecbd, eecb, bdd\ltimes, aa \ \ltimes \ \ltimes, dd \ \ltimes, d \ltimes \ltimes\ltimes, a \ltimes \ltimes\ltimes\}$

1. ebcdcddcba
2. ε
3. ba
4. aeeddeabddcb

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 359.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aaa, aba, abb, bba, bbc, cbb, cca, ccc\}$

1. bbbcbbaab
2. b
3. a
4. ε

Solution

1. No
2. Yes

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3. Yes
4. Yes

EXERCISE 360.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊⋊e, ⋊⋊b, ⋊b⋉, ⋊ea, aad, adc, ade, caa, dca, deb, ead, ebe, be⋉, e⋉⋉, b⋉⋉}

1. ad
2. adba
3. caede
4. b

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 361.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: {aaa, aab, acc, baa, bcc, cbb, cbc, cca}

1. b
2. abababab
3. ε
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 362.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊c, aa, ab, ac, ba, bd, cb, da, dd, c⋉}

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1. cbac
2. cbcbdccccb
3. ε
4. c

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 363.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aada, abac, abdb, bbac, cbbb, daca\}$

1. cbdaaadda
2. a
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 364.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{acb, bac, bbb, bbc, cbb\}$

1. ε
2. c
3. accabbc
4. cacca

Solution

1. Yes
2. Yes

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3. No
4. Yes

Exercise 365.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{acaa, addd, beec, cacc, cccd, dccd\}$

1. ddedea
2. ε
3. e
4. bacdbcaa

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 366.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes e, \rtimes d, ab, ba, be, cc, ce, dc, eb, ec, e\ltimes, c\ltimes\}$

1. e
2. ababadbb
3. aeceeab
4. ec

Solution

1. Yes
2. No
3. No
4. Yes

Exercise 367.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes$ $\rtimes$ $\rtimes\ltimes, \rtimes$ $\rtimes$ $\rtimes b, \rtimes$ $\rtimes$ $\rtimes d, \rtimes$ $\rtimes$ $bc, \rtimes$ $\rtimes$ $dd, \rtimes$ $\rtimes$
$de, \rtimes$ $\rtimes$ $d\ltimes, \rtimes$ $\rtimes$ $\ltimes\ltimes, \rtimes ddd, \rtimes d$ $\ltimes$ $\ltimes, \rtimes deb, \rtimes bc\ltimes, \rtimes$ $\ltimes$

⋈⋈, *abba*, *babb*, *bade*, *bbad*, *bceb*, *ceba*, *debc*, *ebab*, *ebce*, *ddd*⋈, *ade*⋈, *de* ⋈, ⋈, *bc*⋈⋈, *dd*⋈⋈, *c*⋈⋈⋈, *d*⋈⋈⋈, *e*⋈⋈⋈}

1. eaaadeceddc
2. ε
3. baaede
4. abc

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 368.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {*abab*, *aeae*, *bded*, *dbee*, *ddec*}

1. dbdeea
2. d
3. edaaa
4. cb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 369.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {*abba*, *abbc*, *acab*, *ccbc*}

1. aaccbac
2. cacaaabc
3. aaabb
4. c

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 370.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes a, \rtimes\ltimes, ab, ac, ad, ba, ce, ea, d\ltimes\}$

1. ebcc
2. eb
3. ε
4. eeeb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 371.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes b, \rtimes\ \rtimes\ \rtimes\ltimes, \rtimes\ \rtimes\ bb, \rtimes\ \rtimes\ \ltimes\ltimes, \rtimes\ \rtimes\ aa, \rtimes\ \rtimes\ a\ltimes, \rtimes\ \rtimes\ ba, \rtimes aaa, \rtimes a\ \ltimes\ \ltimes, \rtimes bbb, \rtimes ba\ltimes, \rtimes\ \ltimes\ \ltimes\ltimes, aaab, aaba, aabb, abaa, abba, baaa, bba\ltimes, bbb\ltimes, ba\ \ltimes\ \ltimes, bb\ \ltimes\ \ltimes, a\ \ltimes\ \ltimes\ltimes, b\ \ltimes\ \ltimes\ltimes\}$

1. ε
2. aaba
3. bbaba
4. bbbabb

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 372.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊⋉, ⋊b, ab, ba, bb, b⋉}

1. aaababb
2. bb
3. baabbaa
4. aabbba

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 373.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ b, ⋊b⋉, ⋊ba, aab, aba, abb, baa, bab, bba, bb⋉, b ⋉ ⋉}

1. bababa
2. ababa
3. baaaba
4. abbbbbbb

Solution

1. No
2. No
3. No
4. No

EXERCISE 374.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ c, ⋊ ⋊ b, ⋊ca, ⋊be, aba, abb, bab, bbe, bea, beb, eab, ebc, bc⋉, ca⋉, a ⋉ ⋉, c ⋉ ⋉}

1. bca
2. badb
3. bebc

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4. ca

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 375.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋈⋈⋈b, ⋈⋈⋈⋈, ⋈⋈⋈d, ⋈⋈bb, ⋈⋈da, ⋈⋈⋈⋈, ⋈da⋈, ⋈dab, ⋈bbe, ⋈⋈
⋈⋈, $acca$, $bbea$, $beac$, $cacd$, $ccac$, $eacc$, acd⋈, dab⋈, cd ⋈ ⋈, ab ⋈ ⋈, da ⋈ ⋈, d ⋈
⋈⋈, a ⋈ ⋈⋈, b ⋈ ⋈⋈}

1. e
2. abdded
3. cbdaddc
4. ecdbaaebc

Solution

1. No
2. No
3. No
4. No

EXERCISE 376.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$bdcc$, $bdcd$, $cacd$, $cdab$, $cddc$}

1. dbbbac
2. ε
3. a
4. ba

Solution

1. Yes
2. Yes
3. Yes

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4. Yes

EXERCISE 377.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, bd, ca, dc, ed, ee\}$

1. adddbe
2. ea
3. e
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 378.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ba, bb\}$

1. aabbabb
2. bba
3. abbbbab
4. aba

Solution

1. No
2. No
3. No
4. No

EXERCISE 379.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes c, \rtimes\rtimes aa, \rtimes\rtimes c\ltimes, \rtimes aad, \rtimes c\ltimes\ltimes, aadd, addc, ddcd, dcd\ltimes, cd\ltimes\ltimes, c\ltimes\ltimes\ltimes, d\ltimes\ltimes\ltimes\}$

1. b
2. bb
3. aabdb
4. ε

Solution

1. No
2. No
3. No
4. No

EXERCISE 380.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. bbbaababbb
2. aaaabbbbb
3. abaab
4. aaabbbaaa

Solution

1. No
2. No
3. No
4. No

EXERCISE 381.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋊ ⋊ ⋊d, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ db, ⋊ ⋊ ⋉⋉, ⋊dbb, bbdb, bdbd, dbbd, dbdb, bdb⋉, db ⋉ ⋉, b ⋉ ⋉⋉\}$

1. daddaa
2. ε
3. d
4. dcd

Solution

1. No

2. Yes
3. No
4. No

EXERCISE 382.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{ \rtimes \quad \rtimes \quad \rtimes a, \rtimes \quad \rtimes \quad \rtimes c, \rtimes \quad \rtimes \quad cb, \rtimes \quad \rtimes \quad cc, \rtimes \quad \rtimes$ $ad, \rtimes cbd, \rtimes cc \ltimes, \rtimes ada, acbd, bdac, cbda, cbdd, dacb, bdd \ltimes, ada \ltimes, cc \ltimes \ltimes, dd \ltimes$ $\ltimes, da \ltimes \ltimes, c \ltimes \ltimes \ltimes, d \ltimes \ltimes \ltimes, a \ltimes \ltimes \ltimes \}$

1. d
2. ε
3. cdc
4. ccaba

Solution

1. No
2. No
3. No
4. No

EXERCISE 383.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{ \rtimes c, ab, ba, bc, bd, cb, cd, db, b \ltimes \}$

1. bbbdca
2. cbadaacab
3. cb
4. cdddbdd

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 384.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ca, ⋊ ⋊ ⋉⋉, ⋊ ⋊ ba, ⋊bab, ⋊cab, ⋊ ⋊ ⋉⋉, $aacb$, $abba$, $abca$, $babb$, $babc$, $bbab$, $bcaa$, $caac$, acb⋉, cab⋉, ab ⋉ ⋉, cb ⋉ ⋉, b ⋉ ⋉⋉}

1. ε
2. babcaacb
3. bbbccb
4. cab

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 385.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: {$aabb$, $aadb$, $bbad$, $bbbb$, $dada$, $dbad$}

1. a
2. b
3. dddac
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 386.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊d, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊db, ⋊ba, acb, bac, bda, cbd, dba, da⋉, ba⋉, a⋉⋉}

1. ccdc

2. d
3. db
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 387.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes c, ac, bb, bc, bd, ca, cb, cc, cd, db, dc, c\ltimes\}$

1. cc
2. bdbbabda
3. ε
4. c

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 388.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes e, ac, ae, cd, da, ea, e\ltimes\}$

1. e
2. ba
3. edc
4. ε

Solution

1. Yes
2. No
3. No

4. No

EXERCISE 389.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: 				{⋊ ⋊ ⋉, ⋊ ⋊ d, ⋊ ⋊ b, ⋊ ⋊ e, ⋊ ⋉, ⋊d⋉, ⋊bc, ⋊ed, acc, bcb, cbc, ccb, dac, dda, ddd, edd, cb⋉, bc⋉, d ⋉ ⋉, c ⋉ ⋉, b ⋉ ⋉}

1. cdbbadd
2. dcdeceab
3. acad
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 390.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aab, aba, bab\}$

1. b
2. abbaa
3. a
4. ba

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 391.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{⋊a, ⋊b, ab, ac, ba, bd, cb, b⋉, d⋉\}$

1. bcddcbad
2. b
3. ab
4. ccc

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 392.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{ \rtimes a, \rtimes \ltimes, ab, ba, bb, a \ltimes, b \ltimes \}$

1. ε
2. abbb
3. a
4. ab

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 393.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{ bda, dce, dee, eaa, ebc \}$

1. be
2. ε
3. bbabb
4. dcbdb

Solution

1. Yes
2. Yes

3. Yes
4. Yes

EXERCISE 394.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ac, bb, bc, ca, cc\}$

1. b
2. cbbb
3. a
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 395.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes \rtimes a \ltimes, \rtimes \rtimes ab, \rtimes aba, \rtimes a \ltimes \ltimes, \rtimes \rtimes \ltimes \ltimes, abab, abea, babe, bea \ltimes, ea \ltimes \ltimes, a \ltimes \ltimes \ltimes\}$

1. a
2. abe
3. c
4. ε

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 396.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes \ltimes, \rtimes d, aa, ad, ba, cd, db, dc, a \ltimes, d \ltimes\}$

1. ε
2. a
3. d
4. cbbb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 397.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaaa, acca, baab, bacb, bcca, cbba, cbcb\}$

1. ccbccc
2. b
3. ε
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 398.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes b, \rtimes\ \rtimes\ a\rtimes, \rtimes\ \rtimes\ bc, \rtimes a\ \rtimes\ \rtimes, \rtimes bcc, aacc, accc, bccc, caac, ccaa, ccca, cccc, ccc\rtimes, cc\rtimes\rtimes, a\rtimes\rtimes\rtimes, c\rtimes\rtimes\rtimes\}$

1. a
2. aabc
3. bbaa
4. bccc

Solution

1. Yes

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2. No
3. No
4. Yes

EXERCISE 399.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abab, babc, bcab, caab, ccbc\}$

1. abaca
2. ε
3. cbacca
4. aaabbcbc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 400.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes d, \rtimes \rtimes \rtimes e, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes \rtimes e \ltimes, \rtimes \rtimes da, \rtimes dae, \rtimes \ltimes \ltimes \ltimes, \rtimes e \ltimes \ltimes, aeaa, daea, eaad, aad \ltimes, ad \ltimes \ltimes, d \ltimes \ltimes \ltimes, e \ltimes \ltimes \ltimes\}$

1. ε
2. ddaebe
3. e
4. c

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 401.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:

G^-: $\{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. bbb
2. ε
3. bababab
4. baaabbbabb

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 402.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes b, \rtimes c, bb, bc, cb, cc, b\ltimes\}$

1. cb
2. bb
3. babbaa
4. b

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 403.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abdc, bbac, bccb, bccd, bcdc, ccbd, dbbc\}$

1. bdcadab
2. c
3. ca
4. ε

Solution

1. Yes

EXERCISE 406.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aac, aca, bbb, bbc, bca, cbb\}$

1. ε
2. aca
3. a
4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 407.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes bc, \rtimes \rtimes bd, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes a\ltimes, \rtimes a \ltimes \ltimes, \rtimes bde, \rtimes bc\ltimes, \rtimes\ltimes\ltimes\ltimes, bdee, deeb, ebac, eeba, bac\ltimes, ac\ltimes\ltimes, bc\ltimes\ltimes, c\ltimes\ltimes\ltimes, a\ltimes \ltimes\ltimes\}$

1. dceabe
2. ε
3. cabac
4. cececcd

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 408.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, bb, a\ltimes\}$

1. aaba
2. aba

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3. ε
4. b

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 409.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ba, cc, cd, ce, dd, eb, ec\}$

1. acdddeaa
2. ac
3. badbdedd
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 410.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes ba, aaa, aab, aba, abb, baa, bab, bba, ab\ltimes, b \ltimes \ltimes\}$

1. bbabaa
2. aabbabbbba
3. aaaa
4. aba

Solution

1. No
2. No
3. No
4. No

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EXERCISE 411.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abda, bddd, dadd, dbaa, dbca, ddda\}$

1. ε
2. b
3. ac
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 412.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{badd, beae, bebc, caca, ccad, dbce\}$

1. cc
2. cccb
3. adb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 413.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, bd, cc, cd, dc, dd\}$

1. ε
2. babababba
3. bbdacbc
4. b

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Solution

1. Yes
2. Yes
3. No
4. Yes

Exercise 414.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{accb, cabe, cada, ccec, dabb, dbdd\}$

1. ε
2. b
3. cbade
4. addbdcbb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 415.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes b, \rtimes\rtimes ba, \rtimes\rtimes b\ltimes, \rtimes b\ltimes\ltimes, \rtimes baa, \rtimes ba\ltimes, aaab, aabb, baaa, abb\ltimes, ba\ltimes\ltimes, bb\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. b
2. aabaa
3. ε
4. ab

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 416.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊⋊c, ⋊⋊d, ⋊⋊⋉, ⋊⋉⋉, ⋊d⋉, ⋊ce, acb, bac, bce, cbc, ceb, ced, dce, eba, edc, ed⋉, d⋉⋉}

1. dbdcd
2. aeeddbcaa
3. bcdebb
4. da

Solution

1. No
2. No
3. No
4. No

EXERCISE 417.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {aaae, adab, baca, bbca, bccb, bdbc, ddcc, ddcd}

1. ε
2. ccbedca
3. a
4. cceedd

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 418.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: {ba, bb, bc, ca, cc}

1. ba
2. babb
3. ac

4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 419.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, bb, bc, ca\}$

1. cbc
2. b
3. ε
4. aaca

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 420.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes c, \rtimes \rtimes d, \rtimes c\ltimes, \rtimes de, bec, ceb, dec, ebe, ece, ec\ltimes, c \ltimes \ltimes\}$

1. c
2. ecc
3. dccbdb
4. dec

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 421.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes\ltimes, \rtimes c, bb, bc, cb, cc, c\ltimes\}$

1. acac
2. cc
3. bcb
4. b

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 422.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aaaa, aabb, abaa, abab, abba, baaa, babb, bbaa\}$

1. b
2. a
3. ε
4. baab

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 423.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{bba, bbc, bcc, bdb, bdc, cdd, dad\}$

1. a
2. cbdacb
3. b
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 424.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊⋊⋊a, ⋊⋊⋊c, ⋊⋊⋊⋉, ⋊⋊ab, ⋊⋊c⋉, ⋊⋊⋉⋉, ⋊aba, ⋊c⋉⋉, ⋊abc, ⋊⋉⋉⋉, $aaaa$, $abab$, $abbc$, $acaa$, $babb$, $bbca$, $bcac$, $caaa$, $caca$, abc⋉, aaa⋉, aa ⋉ ⋉, bc⋉⋉, c⋉⋉⋉, a⋉⋉⋉}

1. ε
2. ccca
3. bbabcab
4. aba

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 425.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ cc, ⋊cca, $abbb$, $bbbb$, $bbbc$, $bbcc$, $cabb$, $ccab$, bcc⋉, cc ⋉ ⋉, c⋉⋉⋉}

1. ccabbbcc
2. ba
3. cababaccc
4. cabccaaaa

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 426.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abba, accb, accc, bcbb, bccc\}$

1. ε
2. caba
3. b
4. acabbabc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 427.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes b\ltimes, \rtimes ba, aaa, aab, aba, baa, bab, aa\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. ε
2. ba
3. bbabb
4. bbbabaabbbbb

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 428.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{acdb, badc, bcaa, cbda, cbdb, ddbc\}$

1. bbcd
2. a
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 429.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abe, acb, adc, cca, edb, eea, eed, eee\}$

1. ε
2. e
3. b
4. aac

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 430.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes c, \rtimes\ \rtimes\ \rtimes d, \rtimes\ \rtimes\ \rtimes e, \rtimes\ \rtimes\ ea, \rtimes\ \rtimes\ c\ltimes, \rtimes\ \rtimes\ ae, \rtimes\ \rtimes$
$da, \rtimes ea\ltimes, \rtimes aea, \rtimes c\ \ltimes\ \ltimes, \rtimes dae, aeae, aeec, eaee, ecdd, eecd, dae\ltimes, cdd\ltimes, ae\ \ltimes$
$\ltimes, ea\ltimes\ltimes, dd\ltimes\ltimes, c\ltimes\ltimes\ltimes, d\ltimes\ltimes\ltimes, a\ltimes\ltimes\ltimes, e\ltimes\ltimes\ltimes\}$

1. ea
2. cdbe
3. aaeabc
4. c

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 431.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, aabb, abab, baab, baba\}$

1. ε
2. ab
3. bbabbba
4. baabaaa

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 432.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋊⋊⋊c, ⋊⋊⋊d, ⋊⋊dd, ⋊⋊cb, ⋊⋊c⋉, ⋊ddd, ⋊c⋉⋉, ⋊cbb, bbdd, bddc, cbbd, cdda, daaa, dcdd, ddaa, ddcd, ddd⋉, aaa⋉, aa⋉⋉, dd⋉⋉, c⋉⋉⋉, d⋉⋉⋉, a⋉⋉⋉\}$

1. c
2. bcccddbbbab
3. aac
4. ddd

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 433.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊ab, ⋊⋊bb, ⋊⋊a⋉, ⋊a⋉⋉, ⋊abb, ⋊bbb, aaaa, aaab, baaa, bbaa, bbba, aab⋉, abb⋉, ab⋉⋉, bb⋉⋉, a⋉⋉⋉, b⋉⋉⋉\}$

1. a
2. ab
3. aaaabaaa
4. abb

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 434.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aab, acb, acc, bab, bac, cab, cbb, ccb\}$

1. ca
2. abc
3. bbbabbcba
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 435.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, aaba, aabb, abaa, abab, abba, baab, bbba\}$

1. b
2. bbb
3. aaab
4. ε

Solution

1. Yes
2. Yes

3. No
4. Yes

EXERCISE 436.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ bb, ⋊ ⋊ ⋉⋉, ⋊ ⋊ aa, ⋊aaa, ⋊bb⋉, ⋊ ⋊ ⋉⋉, $aaac$, $aacc$, $accb$, $adbd$, $badb$, $cbad$, $ccba$, $dbdd$, bdd⋉, dd ⋉ ⋉, bb ⋉ ⋉, d ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. dddaddbacd
2. bdbcdbcd
3. bb
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 437.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {$ab, ac, ba, bb, bc, ca, cb$}

1. bbaaba
2. a
3. ε
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 438.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

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G^+: $\{\ltimes\rtimes, \ltimes b, aa, ab, ba, bb, b\rtimes\}$

1. baaabaab
2. abb
3. ε
4. bababaaaa

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 439.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\ltimes\ltimes\ltimes a, \ltimes\ltimes\ltimes c, \ltimes\ltimes cb, \ltimes\ltimes ac, \ltimes acc, \ltimes aca, \ltimes cb\rtimes, abcb, acca, baac, bcba, cabc, cbaa, ccab, aca\rtimes, aa\ ⋯$
$\rtimes, cb\rtimes\rtimes, ca\rtimes\rtimes, c\rtimes\rtimes\rtimes, a\rtimes\rtimes\rtimes, b\rtimes\rtimes\rtimes\}$

1. ac
2. caccac
3. aacc
4. abbccc

Solution

1. No
2. No
3. No
4. No

EXERCISE 440.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abca, bbbc, bcac, cacb, cbbb, ccbc\}$

1. b
2. aab
3. ε
4. c

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 441.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes ac, aca, acb, bca, cac, cbc, ca\ltimes, a \ltimes \ltimes\}$

1. abcb
2. ac
3. bdca
4. ccdaabb

Solution

1. No
2. No
3. No
4. No

EXERCISE 442.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, aa, ac, ca, a\ltimes\}$

1. cbbb
2. c
3. ε
4. bccb

Solution

1. No
2. No
3. No
4. No

EXERCISE 443.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

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G^+: {⋊ ⋊ ⋊⋉,⋊ ⋊ ⋊a,⋊ ⋊ aa,⋊ ⋊ ⋊⋉,⋊ ⋉ ⋉⋉,⋊aaa,$aaab$,$aabb$,$abba$,$baaa$,$bbaa$,abb⋉,bb⋉⋉,b⋉⋊⋉}

1. aaabb
2. abbabbba
3. ε
4. bbaaabaaa

Solution

1. Yes
2. No
3. Yes
4. No

Exercise 444.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ c, ⋊ ⋊ b, ⋊c⋉, ⋊bb, bbc, bcb, cbb, bc⋉, c⋉⋉}

1. c
2. bbbcac
3. ε
4. bab

Solution

1. Yes
2. No
3. No
4. No

Exercise 445.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊⋉, ⋊b, aa, ab, ba, bb, b⋉}

1. a
2. bbbbabb
3. ε
4. b

Solution

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1. No
2. Yes
3. Yes
4. Yes

EXERCISE 446.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋊⋊⋊a, ⋊⋊ac, ⋊⋊ad, ⋊acc, ⋊ad⋉, accb, cbcd, ccbc, bcd⋉, cd⋉⋉, ad⋉⋉, d⋉⋉⋉\}$

1. b
2. ad
3. ε
4. a

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 447.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, ba, bb, bc, ca, cb, cc\}$

1. bcbbacb
2. accaaaacbc
3. b
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

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EXERCISE 448.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, baa, bab, bba\}$

1. baaba
2. ba
3. bbbab
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 449.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes\ltimes, \rtimes a\ltimes, \rtimes\ltimes\ltimes, \rtimes ab, \rtimes aa, aba, abb, bab, bba, aa\ltimes, ba\ltimes, a\ltimes\ltimes\}$

1. ε
2. a
3. b
4. baba

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 450.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes c, \rtimes\ \rtimes\ \rtimes e, \rtimes\ \rtimes\ e\ltimes, \rtimes\ \rtimes\ ab, \rtimes\ \rtimes\ ce, \rtimes\ \rtimes\ ad, \rtimes e\ \ltimes$
$\ltimes, \rtimes cee, \rtimes ab\ltimes, \rtimes adb, adbd, bddc, cade, dbdd, dcad, ddca, ade\ltimes, cee\ltimes, de\ \ \ltimes$
$\ltimes, ab\ltimes\ltimes, ee\ltimes\ltimes, e\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. eddade
2. abccbdece

3. bddaebbac
4. de

Solution

1. No
2. No
3. No
4. No

Exercise 451.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aaa, acb, adb, cdb, daa, dbd\}$

1. dbb
2. b
3. ε
4. cc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 452.

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{aa, ac, bc, ca, cb, cc\}$

1. ε
2. c
3. b
4. aa

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 453.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊b, ⋊ ⋊ bc, ⋊ ⋊ cb, ⋊ ⋊ ac, ⋊ ⋊ ⋉⋉, ⋊bcb, ⋊acd, ⋊cb⋉, ⋊ ⋉ ⋉⋉, $acda$, $adcd$, $cdad$, $dadc$, bcb⋉, dcd⋉, cd ⋉ ⋉, cb ⋉ ⋉, d ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. b
2. cb
3. ε
4. babca

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 454.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊⋉, ⋊⋊a, ⋊a⋉, ⋊⋉⋉, ⋊ad, aac, abd, acc, ada, bdd, ccd, daa, dab, dda, ddd, cd⋉, ad⋉, d⋉⋉, a ⋉ ⋉}

1. ε
2. ad
3. a
4. acdb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 455.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊a, ad, ba, bb, cb, cc, dc, dd, de, ec, c⋉}

1. abbb

2. adc
3. e
4. adec

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 456.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
$G^-: \{bb, ca, cd, dd\}$

1. dbbadbbcabd
2. b
3. dacbbaccda
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 457.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
$G^+: \{\rtimes\ltimes, \rtimes b, aa, ab, ba, a\ltimes\}$

1. aaaba
2. aa
3. ab
4. ε

Solution

1. No
2. No
3. No

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    4. Yes

EXERCISE 458.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaaa, aaab, abaa, abba, baab, bbbb\}$

    1. aaaaaa
    2. bbababbab
    3. bbba
    4. aaa

Solution

    1. No
    2. No
    3. Yes
    4. Yes

EXERCISE 459.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abaa, accb, bcae, bebe, ecdb\}$

    1. b
    2. dedbcacdceca
    3. bcc
    4. caeaabebb

Solution

    1. Yes
    2. Yes
    3. Yes
    4. Yes

EXERCISE 460.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, \rtimes d, bb, bc, cb, cc, cd, db, dc, c\ltimes, d\ltimes\}$

    1. c

2. ε
3. d
4. aabbddccaa

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 461.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aaa, aab, abb, baa, bab, bba\}$

1. b
2. bbbaa
3. ε
4. aa

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 462.

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{ac, ad, bb, bd, cb, cd\}$

1. d
2. dccbd
3. bdadaadab
4. cbad

Solution

1. Yes
2. No
3. No

4. No

Exercise 463.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes d, \rtimes \rtimes b, \rtimes dd, \rtimes bc, aca, cad, dac, dda, bc\ltimes, ad\ltimes, d \ltimes \ltimes, c \ltimes \ltimes\}$

1. dbdadb
2. badc
3. dc
4. abae

Solution

1. No
2. No
3. No
4. No

Exercise 464.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes db, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes aa, \rtimes aa\ltimes, \rtimes dbb, \rtimes \ltimes \ltimes\ltimes, acdc, bbca, bcac, cacd, cdcd, dbbb, dcd\ltimes, cd \ltimes \ltimes, aa \ltimes \ltimes, d \ltimes \ltimes\ltimes, a \ltimes \ltimes\ltimes\}$

1. aa
2. ε
3. cbdbabb
4. acbadcaa

Solution

1. Yes
2. Yes
3. No
4. No

Exercise 465.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes b, \rtimes \rtimes cc, \rtimes \rtimes b\ltimes, \rtimes ccb, \rtimes b \ltimes\ltimes, abea, aecd, babe, beae, cbab, ccba, eaec, ecda, cda\ltimes, da \ltimes \ltimes, a \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. aedaaadae
2. bbb
3. b
4. ecaccbacccd

Solution

1. No
2. No
3. Yes
4. No

Exercise 466.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaac, baab, cbba, cccb\}$

1. babba
2. cac
3. abacab
4. ca

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 467.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaaa, aaab, abaa, abba, baaa, baab, babb\}$

1. baa
2. aababaabaa
3. abaa
4. aababbb

Solution

1. Yes
2. No

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3. No
4. No

EXERCISE 468.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{cbda, ccda, cdcb, ecea\}$

1. acbabbce
2. de
3. ea
4. eaeaeda

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 469.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{⋊⋊⋊a, ⋊⋊⋊c, ⋊⋊⋊⋉, ⋊⋊c⋉, ⋊⋊cb, ⋊⋊ac, ⋊⋊⋉⋉, ⋊acb, ⋊c⋉⋉, ⋊cb⋉, ⋊⋉⋉⋉, acbb, bbcb, bcbc, cbbc, cbcb, bcb⋉, cb⋉⋉, c⋉⋉⋉, b⋉⋉⋉\}$

1. acaab
2. ε
3. cababa
4. acacac

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 470.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aac, acd, bab, bac, bca, cdb, dcd\}$

1. ε
2. a
3. abcddba
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 471.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ac, bc, cd, db\}$

1. adadaccd
2. ε
3. dadccddcbdad
4. bccdbd

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 472.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, abd, adc, bbb, cbd, cdd, dba, dca\}$

1. ε
2. a
3. cbc
4. b

Solution

1. Yes
2. Yes

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3. Yes
4. Yes

Exercise 473.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ba, bb\}$

1. abaab
2. a
3. baaa
4. aabab

Solution

1. No
2. Yes
3. No
4. No

Exercise 474.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abd, acc, bac, cdd, dab, dbc\}$

1. ddddbbbb
2. dbacabbdcdb
3. bacb
4. ε

Solution

1. Yes
2. No
3. No
4. Yes

Exercise 475.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{ace, adb, cab, cdd\}$

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1. dbdabaeaccca
2. dacaea
3. dcea
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 476.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes b, aa, ab, ba, bb, a\ltimes\}$

1. aaa
2. ε
3. aba
4. ba

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 477.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abd, baa, bac, bbc, cda\}$

1. cdcaaccc
2. ε
3. ccadcda
4. cbdcbabba

Solution

1. Yes
2. Yes

3. No
4. Yes

EXERCISE 478.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+:　　{⋈　⋈　⋈b,⋈　⋈　⋈d,⋈　⋈　db,⋈　⋈　bc,⋈　⋈　bb,⋈bbc,⋈bc⋈,⋈dbd,$bbcd$,$bcdc$,$bcdd$,$bddb$,$cddb$,$dbcd$,$dbdd$,$ddbc$,$ddbd$,cdc⋈,dbd⋈,dc⋈　⋈,bd ⋈ ⋈,bc ⋈ ⋈,c ⋈ ⋈⋈,d ⋈ ⋈⋈}

1. addbdbdddb
2. dbbcbcba
3. dabb
4. cadadda

Solution

1. No
2. No
3. No
4. No

EXERCISE 479.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {$aac, bcc, bda, bdd, cba, dab, ddb$}

1. b
2. bdbddddca
3. ε
4. dc

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 480.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aaaa, aaab, aaba, aabb, baab, baba, bbba\}$

1. baabab
2. bbaa
3. bab
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 481.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aac, abc, bca, cba, cbb\}$

1. cbac
2. ba
3. bab
4. babccbca

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 482.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, bb, ca, cb, cc\}$

1. ε
2. abcbccccacb
3. b
4. a

Solution

1. Yes

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2. No
3. Yes
4. Yes

Exercise 483.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ b, ⋊b⋉, ⋊ba, aab, aad, abd, add, baa, bda, daa, dd⋉, b ⋉ ⋉, d ⋉ ⋉}

1. bbd
2. ccadcbda
3. ε
4. aabab

Solution

1. No
2. No
3. No
4. No

Exercise 484.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ e, ⋊eb, bdb, bdd, dbc, dbd, ddb, ddd, ebd, bc⋉, c ⋉ ⋉}

1. aeed
2. ebdbc
3. ee
4. c

Solution

1. No
2. Yes
3. No
4. No

Exercise 485.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ e, ⋊ ⋊ b, ⋊e⋉, ⋊bb, add, bbc, bce, cea, ead, dd⋉, e ⋉ ⋉, d ⋉ ⋉}

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1. aba
2. cc
3. ε
4. c

Solution

1. No
2. No
3. No
4. No

Exercise 486.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ad, ba, bb, ca, db, dd\}$

1. bbca
2. abbdccddac
3. a
4. acabcaddbc

Solution

1. No
2. No
3. Yes
4. No

Exercise 487.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes\rtimes a, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes cc, \rtimes aa, aad, adc, ccc, ccd, cdd, dcc, dcd, ddc, cc\ltimes, cd\ltimes, d\ltimes\ltimes, c\ltimes\ltimes\}$

1. bbababdac
2. acdc
3. ε
4. caabab

Solution

1. No

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2. No
3. Yes
4. No

EXERCISE 488.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes e, ab, bd, ca, cc, ce, db, ec, b\ltimes\}$

1. bdde
2. cbdbbb
3. ecab
4. eee

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 489.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes aa, aac, acc, cbb, ccb, bb\ltimes, aa\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. aa
2. caaabc
3. acacc
4. aaca

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 490.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{acac, accb, bbcb, bcac, cbcb, cbcc, ccbc, cccc\}$

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1. ε
2. aaacbc
3. a
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 491.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaba, bbca, bbcc, bcbc, caaa, caba, cabb\}$

1. a
2. b
3. ε
4. acaaaaac

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 492.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ac, bc, ca, cb, a\ltimes, b\ltimes\}$

1. c
2. bca
3. ε
4. bc

Solution

1. No
2. No

3. Yes
4. No

EXERCISE 493.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊d, ⋊⋊dd, ⋊ddc, $bcbd$, $bdcd$, $cbcb$, $cbdc$, $dcbc$, $dcda$, $ddcb$, cda⋉, da⋉⋉, a⋉⋉⋉}

1. bbcdd
2. bdacb
3. ε
4. aca

Solution

1. No
2. No
3. No
4. No

EXERCISE 494.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$aaaa$, $aabb$, $abaa$, $abba$, $babb$, $bbab$, $bbba$, $bbbb$}

1. ε
2. abbbba
3. baabaabbb
4. bbbbabbabbaa

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 495.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {abd, adb, ceb, daa, dba}

1. cecaaadaab
2. cecdbbdebd
3. ecaecbbbab
4. ebc

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 496.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes b\ltimes, \rtimes ba, aab, aba, abb, baa, bab, bba, bbb, bb\ltimes, b\ltimes\ltimes\}$

1. babb
2. b
3. ε
4. abaaab

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 497.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes b, \rtimes ba, \rtimes bb, bac, bbc, bcc, cba, cbc, ccb, ccc, ac\ltimes, ba\ltimes, a\ltimes\ltimes, c\ltimes\ltimes\}$

1. cabac
2. ba
3. c
4. aacbcbcaacc

Solution

1. No

2. Yes
3. No
4. No

EXERCISE 498.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ c⋉, ⋊ ⋊ bb, ⋊ ⋊ ⋉⋉, ⋊bbb, ⋊c ⋉ ⋉, ⋊ ⋊ ⋉⋉, $acba$, $baca$, $bacb$, $bbbc$, $bbcb$, $bcba$, $cbac$, aca⋉, ca ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. ε
2. bcacccbaa
3. bbbcbaca
4. c

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 499.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊ab, ⋊b⋉, ⋊ba, aab, aba, abb, baa, bba, bbb, ba⋉, b ⋉ ⋉, a ⋉ ⋉}

1. baaaaaba
2. b
3. aabba
4. a

Solution

1. No
2. Yes
3. No
4. No

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EXERCISE 500.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{ \rtimes \rtimes a, \rtimes \rtimes b, \rtimes bb, \rtimes aa, aaa, aab, abb, baa, bba, bbb, ab\ltimes, bb\ltimes, b \ltimes \ltimes \}$

1. a
2. aababa
3. baabbb
4. aabbbaaa

Solution

1. No
2. No
3. No
4. No

EXERCISE 501.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{ \rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes ab, \rtimes \rtimes ba, \rtimes aba, \rtimes baa, aaba, abaa, abab, baaa, baab, baba, aba\ltimes, aaa\ltimes, aa\ltimes$
$\ltimes, ba \ltimes \ltimes, a \ltimes \ltimes \ltimes \}$

1. ab
2. bababaa
3. abbb
4. baabaaba

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 502.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{ \rtimes \rtimes c, \rtimes \rtimes a, \rtimes \rtimes b, \rtimes c\ltimes, \rtimes ac, \rtimes ba, aca, acb, bac, cac, cbc, bc\ltimes, ac\ltimes, c \ltimes \ltimes \}$

1. babc
2. abbcba
3. cca

4. c

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 503.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes ac, abd, acb, bab, bba, cbb, bd\ltimes, d \ltimes \ltimes\}$

1. ccacc
2. abbddae
3. ε
4. edeba

Solution

1. No
2. No
3. No
4. No

EXERCISE 504.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{acde, baab, bbdd, ceab, ebdc\}$

1. e
2. cbebdb
3. eeaccba
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 505.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abc, cbd, cce, ddb\}$

1. aacca
2. ec
3. eacac
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 506.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aba, abc, bca, caa, cab\}$

1. ccacccc
2. ε
3. a
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 507.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ aa, ⋊ ⋊ ba, ⋊aaa, ⋊ba⋉, ⋊ ⋊$
$⋉⋉, aaab, aaba, abab, abba, abbb, babb, bbab, bbbb, bbb⋉, ba ⋊ ⋉, bb ⋊ ⋉, a ⋊$
$⋉⋉, b ⋊ ⋉⋉\}$

1. aaaaababa
2. abbbabab

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3. abbbbaaa
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 508.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, aaba, abaa, abbb, bbbb\}$

1. ba
2. ε
3. bba
4. bb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 509.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{baa, bca, cab, cbc, cca\}$

1. ccbaab
2. acabbcccc
3. acc
4. bcaccaa

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 510.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊a⋉, ⋊ba, aaa, aab, aba, baa, bab, ab⋉, b ⋉ ⋉, a ⋉ ⋉}

1. babbaa
2. abbbab
3. ε
4. aaaaa

Solution

1. No
2. No
3. No
4. No

EXERCISE 511.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$abbc$, $adbc$, $cbab$, $cbad$, $dbbb$, $dddc$}

1. dbd
2. abcdcaabc
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 512.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ab, ⋊ ⋊ b⋉, ⋊ ⋊ ⋉⋉, ⋊abb, ⋊ ⋉ ⋉⋉, ⋊b ⋉ ⋉, $abab$, $abba$, $abbb$, $baab$, $baba$, $babb$, $bbaa$, $bbab$, $bbba$, aab⋉, ab⋉⋉, b⋉⋉⋉}

1. ababbabaaab
2. ε
3. b

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4. abbaab

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 513.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ba, cb, cc\}$

1. aaaa
2. bcaca
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 514.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, ac, bb, bc, ca, cc\}$

1. b
2. ε
3. abaccacc
4. bbcaabbba

Solution

1. Yes
2. Yes
3. No
4. No

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EXERCISE 515.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, aaba, baab, baba, bbaa, bbba\}$

1. bbbaaa
2. baaabbab
3. a
4. aababbbb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 516.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, \rtimes c, ab, ac, bb, bc, ca, c\ltimes\}$

1. ε
2. baca
3. aaba
4. aaa

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 517.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes ac, abc, aca, acc, bca, cab, cac, cca, ac\ltimes, c \ltimes \ltimes\}$

1. bc
2. ε
3. b
4. babac

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Solution

1. No
2. No
3. No
4. No

EXERCISE 518.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. bbaaba
2. ε
3. baa
4. aaa

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 519.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{⋊⋊⋉, ⋊⋊a, ⋊⋊b, ⋊ac, ⋊⋉⋉, ⋊ba, abc, acb, bab, bba, bbb, bcc, cbb, cbc, ccb, bc⋉, ba⋉, c⋉⋉, a⋉⋉\}$

1. ε
2. ba
3. cccbcbbca
4. ac

Solution

1. Yes
2. Yes
3. No
4. No

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EXERCISE 520.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋈ ⋈ b, ⋈ ⋈ d, ⋈ ⋈ ⋈, ⋈ ⋈ ⋈, ⋈db, ⋈ba, adb, bad, bee, dbe, db⋈, ee⋈, e ⋈ ⋈, b ⋈ ⋈}

1. cab
2. ebca
3. abcd
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 521.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋈ ⋈ ⋈a, ⋈ ⋈ ⋈c, ⋈ ⋈ ⋈⋈, ⋈ ⋈ ⋈⋈, ⋈ ⋈ cc, ⋈ ⋈ a⋈, ⋈a ⋈ ⋈, ⋈ ⋈ ⋈⋈, ⋈ccb, $aaaa$, $baaa$, $bbaa$, $cbba$, $ccbb$, aaa⋈, aa ⋈ ⋈, a ⋈ ⋈⋈}

1. ε
2. cc
3. ccbbaaa
4. a

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 522.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: {aab, aac, bab, bbc, cac}

1. bacbbc
2. bbccababc

3. bbaaaabacc
4. bccbacaaaa

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 523.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{ \rtimes \rtimes b, \rtimes ba, abb, bab, bbc, bcc, ccc, cc\ltimes, c \ltimes \ltimes \}$

1. ca
2. babbcc
3. bacbbb
4. ε

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 524.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{ aab, adb, bbd, cdb, dba, dda \}$

1. a
2. ε
3. b
4. ba

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 525.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{bb, bd, be, cd, da, dd, eb\}$

1. ε
2. bb
3. ccabaeccabe
4. dbdeacbddaa

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 526.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aca, bcb, caa, cbc\}$

1. b
2. ε
3. a
4. ba

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 527.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{acb, bad, bcd, caa, dca, ddd\}$

1. aadbbc
2. ad
3. bcbaaa
4. cadcadb

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 528.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes\rtimes a, \rtimes a\ltimes, \rtimes cb, aad, adb, baa, bba, cbb, dba, ba\ltimes, cb\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. abaa
2. a
3. cb
4. adcdab

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 529.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes b\ltimes, \rtimes ba, \rtimes bb, aaa, aab, abb, baa, bba, bb\ltimes, ba\ltimes, b \ltimes \ltimes, a \ltimes \ltimes\}$

1. bb
2. bba
3. a
4. ba

Solution

1. Yes
2. Yes
3. No
4. Yes

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EXERCISE 530.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ac, ae, be, ea, eb\}$

1. ee
2. ea
3. aec
4. ε

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 531.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes e, ab, bd, be, ca, da, db, dd, ec, ed, b\ltimes\}$

1. a
2. aaee
3. dddeadebc
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 532.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes b, \rtimes ba, aaa, aab, abb, baa, bba, bbb, ab\ltimes, b\ltimes\ltimes\}$

1. a
2. b
3. bbbaaaaabba
4. baababbbb

Solution

1. No
2. No
3. No
4. No

Exercise 533.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ d, ⋊da, abe, bed, dab, dac, eda, ac⋉, c ⋉ ⋉}

1. eb
2. bbe
3. dac
4. a

Solution

1. No
2. No
3. Yes
4. No

Exercise 534.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ a, ⋊a⋉, ⋊aa, aaa, aab, abb, baa, bba, bbb, aa⋉, a ⋉ ⋉}

1. abbaaaabaaa
2. aaa
3. aa
4. a

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 535.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aad, abd, adb, caa, cca, dbd\}$

1. b
2. ε
3. bad
4. cddaacc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 536.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes b, ab, ba, bb, a\ltimes, b\ltimes\}$

1. abbaaab
2. a
3. b
4. ab

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 537.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes ab, \rtimes aa, aab, aba, abb, baa, bab, bba, ab\ltimes, b \ltimes \ltimes\}$

1. abbbbaaabba
2. bbb
3. babbbbb
4. bbbbbbbbbab

Solution

1. No
2. No
3. No
4. No

EXERCISE 538.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aab, bab, bba, caa, cab, cca, ccc\}$

1. b
2. ε
3. cb
4. aabcac

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 539.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes c, \rtimes\rtimes\rtimes b, \rtimes\rtimes bb, \rtimes\rtimes bd, \rtimes\rtimes ce, \rtimes bb\ltimes, \rtimes cee, \rtimes bdd, abde, bded, cabd, ceec, dabc, deda, ecab, edab, eeca, abc\ltimes, bdd\ltimes, bc\ltimes\ltimes, dd\ltimes\ltimes, bb\ltimes\ltimes, c\ltimes\ltimes\ltimes, d\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. bb
2. baaecd
3. acbca
4. edeebb

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 540.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$aabb, abbb, acbb, baca, bbba, cbcc, cccc$}

1. ε
2. a
3. b
4. acc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 541.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {adc, cba, cca, ddc}

1. accdbd
2. abbcc
3. dda
4. daddc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 542.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {$\ltimes\rtimes, \ltimes b, ab, ba, bd, da, b\rtimes$}

1. cdcbbc
2. b
3. ddddca
4. ε

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Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 543.

For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:

G^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes a, \rtimes\rtimes d, \rtimes\ltimes\ltimes, \rtimes d\ltimes, \rtimes ab, abd, aee, bdc, cae, cde, dca, dcd, dee, edc, eed, ee\ltimes, d\ltimes\ltimes, e\ltimes\ltimes\}$

1. ε
2. c
3. abdcdee
4. d

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 544.

For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:

G^-: $\{aaaa, aaab, aabb, abaa, abab, abba, baaa, bbab\}$

1. a
2. bbababbaaab
3. b
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 545.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aca, acb, bbb, cab, ccb\}$

1. b
2. aacaabca
3. a
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 546.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{bed, ccc, cce, dee, eaa\}$

1. dc
2. eddbae
3. bdcb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 547.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes b\ltimes, \rtimes bb, acc, bac, bba, cac, cca, ccb, ccc, cb\ltimes, b \ltimes \ltimes\}$

1. bbaccb
2. a
3. b
4. caaacac

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Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 548.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+:   {⋊ ⋊ ⋊⋊, ⋊ ⋊ ⋊a, ⋊ ⋊ aa, ⋊ ⋊ ⋊⋉, ⋊aaa, ⋊ ⋊ ⋉⋉, $aaab$, $aaba$, $aabb$, $abaa$, $abab$, $baaa$, $baba$, $abb⋉$, $bb⋉⋉$, $b⋉⋉⋉$}

1. abbbbbabaab
2. aaabbba
3. ε
4. aaabb

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 549.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$abca, acca, baaa, babb, bccc, cabb, cabc, ccbc$}

1. a
2. ε
3. caaca
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 550.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes c, bb, bc, ca, cb, a\ltimes\}$

1. aabaac
2. c
3. abacc
4. cba

Solution

1. No
2. No
3. No
4. No

EXERCISE 551.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{acbc, adab, cabd, cada, ceee\}$

1. cbaaedadcd
2. edbcbdac
3. d
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 552.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, ac, ba, bd, dd\}$

1. ε
2. b
3. a
4. dcdb

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Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 553.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, baa, bab, bba\}$

1. aabbbba
2. ε
3. bbabaabaab
4. b

Solution

1. No
2. Yes
3. No
4. Yes

Exercise 554.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes c, \rtimes\rtimes c\ltimes, \rtimes\rtimes cc, \rtimes c\ltimes\ltimes, \rtimes ccd, bccd, cbcc, ccda, ccdd, cdad, cddc, dcbc, ddcb, dad\ltimes, ad\ltimes$
$\ltimes, d\ltimes\ltimes\ltimes, c\ltimes\ltimes\ltimes\}$

1. c
2. ccdad
3. ddbaaaabcab
4. cdaba

Solution

1. Yes
2. Yes
3. No
4. No

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EXERCISE 555.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{bbeb, ddbe, dedb, ecbe, eeea\}$

1. beceaa
2. acdc
3. cdbaddc
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 556.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaba, abaa, abab, abbb\}$

1. ba
2. aabbb
3. baa
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 557.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{⋊⋊⋊a, ⋊⋊⋊c, ⋊⋊aa, ⋊⋊ce, ⋊aae, ⋊cee, aaeb, aebe, bedc, caee, dcae, ebed, edca, aee⋉, cee⋉, ee⋉⋉, e⋉⋉⋉\}$

1. ε
2. cee
3. be

   4. e

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 558.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aab, aba, abb, bab, bba\}$

1. b
2. bbbba
3. baabaabbbba
4. ε

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 559.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes c, \rtimes \rtimes b, \rtimes b\ltimes, \rtimes ca, aaa, aba, baa, cab, aa\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. b
2. aacaaa
3. cabaa
4. ε

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 560.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, da, dd, ec\}$

1. d
2. dabac
3. db
4. acb

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 561.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋊\,⋊\,⋊e, ⋊\,⋊\,e⋉, ⋊\,⋊\,eb, ⋊ebc, ⋊e\,⋉\,⋉, bccb, ccbc, ebcc, cbc⋉, bc\,⋉\,⋉, c\,⋉\,⋉⋉, e\,⋉\,⋉⋉\}$

1. edcc
2. ε
3. beeb
4. e

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 562.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{acaa, baba, bcbc, cbcc, ccab, ccac\}$

1. c
2. ε
3. a

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4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 563.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, \rtimes c, ad, bd, be, cc, db, dd, ec, c\ltimes\}$

1. aacdeeecee
2. c
3. ε
4. ccaeeccbeb

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 564.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes b\ltimes, \rtimes aa, \rtimes bc, aab, abb, baa, bab, bba, bcc, caa, cca, aa\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. b
2. ε
3. bbbc
4. cbacbbacab

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 565.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, be, cc, ed\}$

1. ea
2. bbacbcb
3. ε
4. bace

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 566.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ad, ba, ca, de, ed\}$

1. bbb
2. aa
3. a
4. dedbd

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 567.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes d, ad, da, dd, a\ltimes, d\ltimes\}$

1. b
2. aecee
3. d
4. a

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Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 568.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aada, abaa, abbc, abda, baba, bcda, dbca\}$

1. acab
2. ε
3. aaacccddbd
4. ada

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 569.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes\rtimes\rtimes e, \rtimes\rtimes\rtimes c, \rtimes\rtimes ee, \rtimes\rtimes ce, \rtimes ee\ltimes, \rtimes cea, aacc, abdb, acca, cabd, ccab, ceaa, eaac, bdb\ltimes, db\ltimes\ltimes, ee\ltimes\ltimes, e\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. c
2. ε
3. ee
4. abae

Solution

1. No
2. No
3. Yes
4. No

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Exercise 570.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ba, bb, a\ltimes\}$

1. baaabbbb
2. ε
3. abbaaaaa
4. aaaaaaba

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 571.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes ba, \rtimes \rtimes da, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes a\ltimes, \rtimes da\ltimes, \rtimes bab, \rtimes a \rtimes \ltimes, \rtimes \rtimes \ltimes\ltimes, aaab, aabc, abaa, abcd, baaa, baba, bcdc, cdcd, dcdc, cdc\ltimes, dc \rtimes \ltimes, da \rtimes \ltimes, c \rtimes \ltimes\ltimes, a \rtimes \ltimes\ltimes\}$

1. a
2. ba
3. cdcabccbd
4. ε

Solution

1. Yes
2. No
3. No
4. Yes

Exercise 572.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes ab, aab, aba, baa, ba\ltimes, a \ltimes \ltimes\}$

1. ccc

2. bb
3. bcabaa
4. aabca

Solution

1. No
2. No
3. No
4. No

EXERCISE 573.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{bdd, cab, dbd, dcd\}$

1. bdd
2. ad
3. dcccadc
4. adcac

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 574.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes b, ab, ba, bb, b\ltimes\}$

1. aa
2. bb
3. bbb
4. b

Solution

1. No
2. Yes
3. Yes

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4. Yes

EXERCISE 575.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ac, bc, ca, cb, cc, a\ltimes, c\ltimes\}$

1. aacaabaabc
2. ccaaaba
3. abbb
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 576.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaaa, aaab, abaa, abbb, baab, bbaa, bbab, bbbb\}$

1. babab
2. bba
3. ε
4. aabaa

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 577.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes a, \rtimes\ltimes\ltimes, \rtimes ad, abc, ada, bbc, bca, bcd, cad, cbb, cdc, dab, dcb, ad\ltimes, d\ltimes\ltimes\}$

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1. ε
2. bdbbbb
3. dcada
4. dacbddb

Solution

1. Yes
2. No
3. No
4. No

Exercise 578.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ ⋉, ⋊ ⋊ c, ⋊ ⋊ a, ⋊c⋉, ⋊cc, ⋊ ⋉, ⋊aa, acc, cac, cca, ccb, ccc, aa⋉, cb⋉, b ⋉ ⋉, a ⋉ ⋉, c ⋉ ⋉}

1. babcbc
2. ε
3. cbbccba
4. bc

Solution

1. No
2. Yes
3. No
4. No

Exercise 579.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊a, ⋊⋉, ⋊c, aa, ab, ac, ba, cc, cd, da, a⋉, d⋉}

1. cbccccbbd
2. aa
3. ε
4. a

Solution

1. No

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2. Yes
3. Yes
4. Yes

EXERCISE 580.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊⋉, ⋊d, aa, ab, ac, bb, bc, ca, cd, da, d⋉}

1. d
2. ccaad
3. ε
4. ccbb

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 581.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊⋊c, ⋊⋊ac, ⋊⋊ca, ⋊caa, ⋊ac⋉, aabc, abcc, bccc, caaa, caab, ccaa, ccca, aaa⋉, aa⋉⋉, ac⋉⋉, a⋉⋉⋉, c⋉⋉⋉}

1. ε
2. ac
3. bcacabcb
4. bbcbabccca

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 582.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

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G^-: $\{ab, ac, ca, cb\}$

1. c
2. babcccc
3. acaac
4. b

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 583.

For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes\rtimes a, \rtimes a\ltimes, \rtimes cb, adb, bad, bba, bbb, bbc, cbb, dbb, bc\ltimes, a\ltimes\ltimes, c\ltimes\ltimes\}$

1. ε
2. cddbd
3. aa
4. c

Solution

1. No
2. No
3. No
4. No

EXERCISE 584.

For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes cb, abc, bab, bcb, cba, ba\ltimes, a\ltimes\ltimes\}$

1. bac
2. cba
3. aa
4. bba

Solution

1. No

2. Yes
3. No
4. No

EXERCISE 585.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊c, ⋊⋊⋊⋉, ⋊⋊⋊e, ⋊⋊ea, ⋊⋊c⋉, ⋊⋊ce, ⋊⋊⋉⋉, ⋊ea⋉, ⋊cee, ⋊c⋉⋉, ⋊⋉⋉⋉, ceee, eeac, eeea, eac⋉, ac⋉⋉, ea⋉⋉, c⋉⋉⋉, a⋉⋉⋉}

1. cece
2. c
3. bdbac
4. cdca

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 586.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {ae, ba, bc, ca, dd, eb}

1. e
2. ε
3. daed
4. adbabb

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 587.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: $\{aa, ad, bd, cb, cd, da, dc\}$

1. aadcc
2. b
3. ε
4. adcbcbb

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 588.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{cba, cbd, cda, dcd\}$

1. b
2. ababddccacbc
3. ddbacdadbba
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 589.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊aa, ⋊⋊bb, ⋊aaa, ⋊bbb, aaab, baaa, bbaa, bbba, aab⋉, aaa⋉, ab⋉⋉, aa⋉⋉, a⋉⋉⋉, b⋉⋉⋉\}$

1. aaab
2. baaab
3. ba
4. aaa

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 590.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋉ a, ⋊a⋉, ⋊ab, ⋊aa, abc, bcc, cba, ccb, aa⋉, ba⋉, a ⋉ ⋉}

1. bbcbcc
2. caab
3. ε
4. cbcbbb

Solution

1. No
2. No
3. No
4. No

EXERCISE 591.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {bb, cb, de, ea, ec}

1. ce
2. ε
3. c
4. d

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 592.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

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G^-: $\{caba, ccaa, ccdc, cdad, ceeb, dbaa, ddea\}$

1. b
2. ε
3. e
4. cbc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 593.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaba, aabb, abab, abbb, baaa, baab, baba\}$

1. aaaba
2. abba
3. aaaa
4. aaaabbaabb

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 594.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes b, ac, bc, ca, cb, a \ltimes\}$

1. bca
2. ε
3. bcbca
4. bcbcbca

Solution

1. Yes

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2. No
3. Yes
4. Yes

EXERCISE 595.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abbc, abcb, bbab, bcac, caac, cbba, ccba\}$

1. b
2. a
3. abba
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 596.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aabc, abca, bcbb, bccb, cbac, dbac, dcba\}$

1. adbbcb
2. bc
3. caaaad
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 597.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abbb, accc, bcac, cbab, cdbb\}$

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1. bcdacad
2. b
3. a
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 598.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, bab, bba, bbb\}$

1. a
2. b
3. ε
4. bbbbba

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 599.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, aa, ae, bc, ce, ea, eb, ec, ee, e\ltimes\}$

1. ae
2. aee
3. cb
4. aae

Solution

1. Yes
2. Yes

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3. No
4. Yes

EXERCISE 600.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ aa, ⋊ ⋊ ⋉⋉, ⋊ ⋊ ba, ⋊ ⋉
⋉⋉, ⋊aaa, ⋊ba⋉, $aaaa$, $aaab$, $aabb$, abb⋉, ba ⋉ ⋉, bb ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. ba
2. ε
3. b
4. aaabb

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 601.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$aaaa, aaab, aaba, abba, baaa, baab, bbba$}

1. bbbbaaa
2. baaaabaaba
3. aaabbaab
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 602.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: {aaa, aab, abb, bab, bba}

1. baab
2. aabbabaa
3. bb
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 603.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaba, baac, babb, bbaa, bbbb, bcba\}$

1. a
2. ε
3. ccabcbaa
4. b

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 604.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{baae, bebc, ceac, eaac, eaec, ebcb, ebed\}$

1. b
2. ecceb
3. ad
4. eae

Solution

1. Yes
2. Yes

3. Yes
4. Yes

EXERCISE 605.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, cb, cd, db, dc, dd\}$

1. b
2. aaaa
3. ccddadd
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 606.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes c, \rtimes\rtimes cb, \rtimes\rtimes ae, \rtimes ae\ltimes, \rtimes cbb, addb, aead, bbca, bcae, caea, cbbc, ddbd, eadd, dbd\ltimes, ae\ltimes, bd\ltimes\ltimes, d\ltimes\ltimes\ltimes, e\ltimes\ltimes\ltimes\}$

1. a
2. deeaabc
3. bebebb
4. cdbcbabeed

Solution

1. No
2. No
3. No
4. No

EXERCISE 607.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes d, \rtimes\rtimes\rtimes c, \rtimes\rtimes c\ltimes, \rtimes\rtimes da, \rtimes dae, \rtimes c\ltimes\ltimes, aeeb, daee, eebe, ebe\ltimes, be\ltimes$

$\bowtie, c \bowtie \bowtie\bowtie, e \bowtie \bowtie\bowtie\}$

1. deeb
2. ε
3. dceaac
4. c

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 608.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{acc, ada, bbd, cba, ccb, dab, ddb, ddc\}$

1. cabca
2. c
3. ε
4. cadbc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 609.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\bowtie a, \bowtie\bowtie, aa, ac, ba, cb, a\bowtie\}$

1. aa
2. adaaac
3. ε
4. a

Solution

1. Yes

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2. No
3. Yes
4. Yes

EXERCISE 610.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aca, acb, bac, bca, cac, cba, cca\}$

1. c
2. bcaacc
3. bbbbcba
4. ε

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 611.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊⋊⋉, ⋊⋊⋉⋉, ⋊⋊aa, ⋊⋊ba, ⋊bab, ⋊aac, ⋊⋊$
$⋉⋉, abca, babc, bcac, cacb, acb⋉, aac⋉, ac⋉⋉, cb⋉⋉, c⋉⋉⋉, b⋉⋉⋉\}$

1. ε
2. aac
3. aca
4. a

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 612.
For each one of the strings below say whether it is generated by the following

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negative 3-gram grammar:
G^-: $\{abb, aca, baa, bcc, cba, cbc\}$

1. cb
2. cbcbca
3. cca
4. bb

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 613.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaba, aabb, bacb, bccb, bccc, caaa, cacb, cbca\}$

1. accbc
2. abbb
3. aab
4. bacbca

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 614.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aab, bba, bcb, caa, cba\}$

1. bcbcb
2. cb
3. ac
4. bbac

Solution

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1. No
2. Yes
3. Yes
4. No

EXERCISE 615.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, aa, ab, ac, ba, bc, ca, cb, c\ltimes\}$

1. baabaccabac
2. aac
3. abc
4. ac

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 616.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes\rtimes a, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes ac, \rtimes cd, aad, ada, cdd, daa, dad, dda, ac\ltimes, da\ltimes, a\ltimes\ltimes, c\ltimes\ltimes\}$

1. adbcccbaa
2. ac
3. cccbbbcd
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

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EXERCISE 617.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aac, abb, acb, bbb, bca, caa, cac, cbc\}$

1. cbbb
2. ε
3. acbccccb
4. abccb

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 618.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, ab, ba, bb, bc, cb, cc, a\ltimes\}$

1. aacbaba
2. bbb
3. bcaca
4. acbbabbb

Solution

1. No
2. No
3. No
4. No

EXERCISE 619.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes e, \rtimes \rtimes ea, \rtimes ead, adbc, dbcb, eadb, bcb\ltimes, cb \ltimes \ltimes, b \ltimes \ltimes\ltimes\}$

1. a
2. ε
3. c
4. dcdcbd

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Solution

1. No
2. No
3. No
4. No

EXERCISE 620.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{⋈⋈d, ⋈⋈⋊, ⋈⋊⋊, ⋈db, aea, aeb, bea, dbe, eae, eba, ba⋊, a⋊⋊\}$

1. ε
2. dadbbb
3. dbeaeba
4. c

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 621.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋈⋈⋈a, ⋈⋈⋈b, ⋈⋈b⋊, ⋈⋈ad, ⋈b⋊⋊, ⋈adc, adcd, cbdb, cdcb, dcbd, dcdc, bdb⋊, db⋊⋊, b⋊⋊⋊\}$

1. ε
2. bad
3. acbccb
4. c

Solution

1. No
2. No
3. No
4. No

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Exercise 622.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ad, ba, bc, cc, ec, ee\}$

1. ε
2. e
3. eaccb
4. bcba

Solution

1. Yes
2. Yes
3. No
4. No

Exercise 623.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes e, \rtimes\rtimes d, \rtimes\rtimes\ltimes, \rtimes eb, \rtimes\ltimes\ltimes, \rtimes d\ltimes, bed, cde, dcd, ebe, edc, de\ltimes, e\ltimes\ltimes, d\ltimes\ltimes\}$

1. acd
2. ccdc
3. eacbdab
4. dcebc

Solution

1. No
2. No
3. No
4. No

Exercise 624.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, ad, db, dd\}$

1. ε
2. dc
3. da

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4. caa

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 625.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊c, ⋊⋊⋊b, ⋊⋊cb, ⋊⋊bd, ⋊bde, ⋊cba, $aace$, $aced$, $bdec$, $cdda$, $cedb$, $daac$, $ddaa$, $decd$, $ecdd$, edb⋉, db⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. dbdeaab
2. ε
3. cba
4. ebeae

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 626.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ba, aab, abb, baa, bbc, bc⋉, c⋉⋉}

1. aaaac
2. bba
3. bbc
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 627.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aaaa, bebe, cbee, ddba, debe\}$

1. cbeeeb
2. ccdaa
3. e
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 628.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes a\ltimes, \rtimes\ltimes\ltimes, \rtimes bb, \rtimes aa, aaa, aab, aba, abb, baa, bab, bba, bb\ltimes, ba\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. ε
2. bb
3. abbaabbbaaa
4. bbaaaaba

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 629.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes c, \rtimes\rtimes\rtimes b, \rtimes\rtimes ca, \rtimes\rtimes b\ltimes, \rtimes\rtimes ad, \rtimes ad\ltimes, \rtimes caa, \rtimes b\ltimes\ltimes, aaac, aaca, acaa, caaa, caac, aac\ltimes, ac\ltimes\ltimes, ad\ltimes\ltimes, c\ltimes\ltimes\ltimes, d\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. baa
2. a

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   3. b
   4. ad

Solution

   1. No
   2. No
   3. Yes
   4. Yes

EXERCISE 630.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊b, ab, bc, ca, cb, cc, a⋉}

   1. ccabcaac
   2. ε
   3. baaaab
   4. abcaacbb

Solution

   1. No
   2. No
   3. No
   4. No

EXERCISE 631.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊⋊d, ⋊⋊dc, ⋊⋊ab, ⋊abb, ⋊dcc, $abbc, adee, bbca, bcad, becd, cade, deeb, ebec, eebe, ecd$⋉⋉, cc⋉⋉, c⋉⋉⋉, d⋉⋉⋉}

   1. dcc
   2. eceddede
   3. ceaadadb
   4. a

Solution

   1. Yes
   2. No
   3. No

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4. No

EXERCISE 632.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{adcb, bbcb, bcca, caaa, caad, cbbc, dbad, dbba\}$

1. a
2. dadcdc
3. dabccbabacc
4. dacbdbdbac

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 633.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, ad, bb, bc, cc, cd, db, dd\}$

1. adaa
2. d
3. abababac
4. bcad

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 634.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes b, \rtimes\ \rtimes\ aa, \rtimes\ \rtimes\ ab, \rtimes\ \rtimes$
$ba, \rtimes aba, \rtimes aab, \rtimes ba\ltimes, aaab, aabb, abbb, baaa, bbaa, bbba, aba\ltimes, bba\ltimes, ba\ \ltimes$
$\ltimes, a\ \ltimes\ \ltimes\ltimes\}$

1. aaaaabaaabab
2. bbabaaab
3. ba
4. bb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 635.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes d, \rtimes dd, abd, adb, bbc, bda, dab, dad, dbb, dda, ddd, bc\ltimes, c \ltimes \ltimes\}$

1. aabccbcebaa
2. ddadbbc
3. ddddadbbc
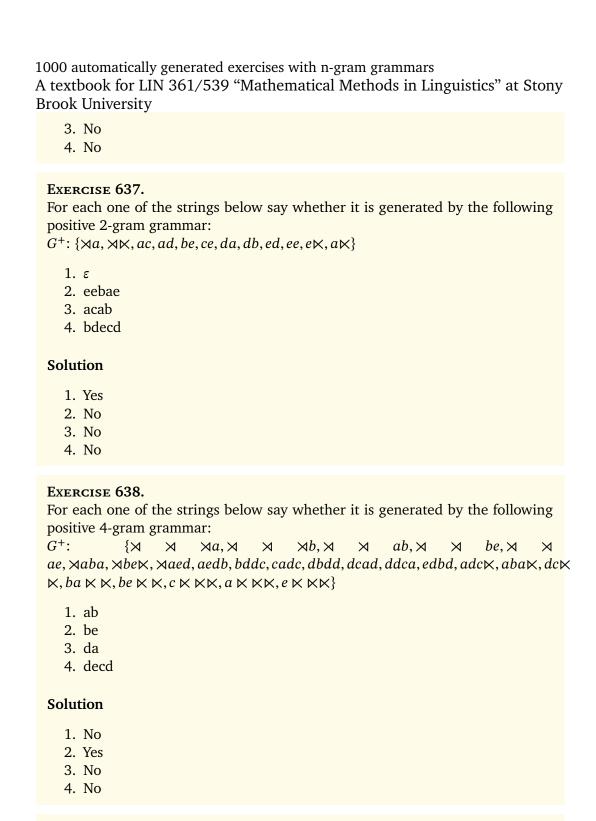4. dddadbbc

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 636.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes e, bc, cd, db, ed, ee, d\ltimes\}$

1. bdc
2. eadbc
3. dedbbb
4. caaa

Solution

1. No
2. No

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3. No
4. No

EXERCISE 637.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, ac, ad, be, ce, da, db, ed, ee, e\ltimes, a\ltimes\}$

1. ε
2. eebae
3. acab
4. bdecd

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 638.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes ab, \rtimes \rtimes be, \rtimes \rtimes ae, \rtimes aba, \rtimes be\ltimes, \rtimes aed, aedb, bddc, cadc, dbdd, dcad, ddca, edbd, adc\ltimes, aba\ltimes, dc\ltimes\ltimes, ba\ltimes\ltimes, be\ltimes\ltimes, c\ltimes\ltimes\ltimes, a\ltimes\ltimes\ltimes, e\ltimes\ltimes\ltimes\}$

1. ab
2. be
3. da
4. decd

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 639.
For each one of the strings below say whether it is generated by the following

negative 3-gram grammar:
G^-: $\{aee, ced, dca, dda, dea, ded, ead\}$

1. dbccce
2. ε
3. b
4. e

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 640.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes cc, abc, acc, bca, cab, cac, cca, cc\ltimes, c\ltimes\ltimes\}$

1. ba
2. ccbc
3. ε
4. bccba

Solution

1. No
2. No
3. No
4. No

EXERCISE 641.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes c, \rtimes\rtimes cb, \rtimes\rtimes cc, \rtimes cca, \rtimes cbb, bbcc, bccc, cbbc, cccc, ccc\ltimes, cca\ltimes, cc\ltimes\ltimes, ca\ltimes\ltimes, a\ltimes\ltimes\ltimes, c\ltimes\ltimes\ltimes\}$

1. cca
2. ab
3. bac
4. cbbccc

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Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 642.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊e, ⋊ ⋊ ea, ⋊ ⋊ ed, ⋊ ⋊ ⋉⋉, ⋊ ⋊ a⋉, ⋊ead, ⋊a ⋉
⋉, ⋊⋉⋉⋉, ⋊ede, $decd$, $ecdd$, $edec$, cdd⋉, ead⋉, ad⋉⋉, dd⋉⋉, d⋉⋉⋉, a⋉⋉⋉}

1. e
2. a
3. dd
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 643.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$acaa$, $acca$, $baab$, $baac$, $bacb$, $bcac$, $caaa$, $cccc$}

1. b
2. a
3. baabcaacc
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 644.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaaa, aaba, abaa, abab, babb, bbaa, bbab, bbbb\}$

1. abbba
2. aba
3. ε
4. ba

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 645.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{acdc, adec, bbcd, bdda, ccbb, eaca, ecba, eeca\}$

1. e
2. bdecdbabdb
3. baeeeedae
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 646.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ba, bb, bd, ca, cc, da, dc\}$

1. caccab
2. cacacdccbcd
3. addbaccbb
4. dcabcdcdca

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Solution

1. No
2. No
3. No
4. No

EXERCISE 647.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aba, abb, baa, bab, bba, bbb\}$

1. b
2. aaaabbbbaaba
3. a
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 648.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes d, aa, ae, bd, db, de, ea, ed, ee, e\ltimes, d\ltimes\}$

1. eabdaab
2. cd
3. aa
4. aebbc

Solution

1. No
2. No
3. No
4. No

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EXERCISE 649.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{acd, baa, cba, dec, ece\}$

1. ε
2. e
3. ed
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 650.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ac, ae, bb, ca, cd, ec\}$

1. e
2. b
3. ε
4. aaea

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 651.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes\rtimes d, \rtimes\rtimes b, \rtimes cb, \rtimes db, \rtimes b\ltimes, aad, adb, adc, bdc, caa, cad, dbc, dbd, dca, cb\ltimes, bc\ltimes, c\ltimes\ltimes, b\ltimes\ltimes\}$

1. b
2. cb
3. dbc

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 4. cdacaadbc

Solution

 1. Yes
 2. Yes
 3. Yes
 4. No

EXERCISE 652.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊e, ⋊ ⋊ ea, ⋊ ⋊
c⋉, ⋊ ⋊ bd, ⋊ ⋊ ec, ⋊ece, ⋊ea⋉, ⋊bde, ⋊c ⋉
⋉, $aabd$, $abdc$, $bdcc$, $ccdb$, $ceaa$, $dccd$, $eaab$, $ecea$, cdb⋉, bde⋉, db ⋉ ⋉, de ⋊
⋉, ea ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉, e ⋉ ⋉⋉, b ⋉ ⋉⋉}

 1. c
 2. ebdede
 3. ecdccaeeebe
 4. ea

Solution

 1. Yes
 2. No
 3. No
 4. Yes

EXERCISE 653.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊⋉, ⋊b, ab, ba, bc, ca, cb, cc, a⋉}

 1. bca
 2. ε
 3. ccbaacacca
 4. ba

Solution

 1. Yes
 2. Yes

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3. No
4. Yes

Exercise 654.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{bacd, badd, bbda, cbcc, cdca, dbcd, ddac\}$

1. ε
2. bb
3. ddbbbccad
4. bcaaa

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 655.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abb, aca, bac, cba, cbb, cca, ccc\}$

1. bbcaaaabcb
2. cbbbcbbb
3. ca
4. bcccaaa

Solution

1. Yes
2. No
3. Yes
4. No

Exercise 656.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aab, abb, abc, aca, bbc, cac, ccc\}$

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1. b
2. accb
3. a
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 657.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ bc, ⋊ ⋊ ⋉⋉, ⋊ ⋊ cc, ⋊cca, ⋊bc⋉, ⋊ ⋊ ⋉⋉, aacc, accb, bbaa, caac, cbba, ccaa, ccbb, baa⋉, aa ⋉ ⋉, bc ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. c
2. accbcacb
3. aaaab
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 658.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:

G^-: {$aaab, abba, abbb, bbba$}

1. abbaa
2. ε
3. a
4. b

Solution

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1. No
2. Yes
3. Yes
4. Yes

EXERCISE 659.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, bab, bba, bbb\}$

1. aa
2. baa
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 660.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, bc, ca, cc, b\ltimes\}$

1. ε
2. ca
3. b
4. a

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 661.
For each one of the strings below say whether it is generated by the following

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positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, ab, bc, ca, cc, b\ltimes\}$

1. bbaccb
2. bc
3. acabc
4. bcab

Solution

1. No
2. No
3. No
4. No

Exercise 662.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes a\ltimes, \rtimes ab, aab, aba, abb, baa, bab, bb\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. aaaab
2. bbba
3. bbbabbbb
4. bbbbaa

Solution

1. No
2. No
3. No
4. No

Exercise 663.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. a
2. aaaa
3. ε
4. b

Solution

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1. Yes
2. No
3. Yes
4. Yes

EXERCISE 664.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, bc, ea, ec\}$

1. dcaccbece
2. ε
3. eebdcbdbbbec
4. ec

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 665.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{badb, bccc, bebc, cabe, deda, dedb, deed, eabd\}$

1. e
2. dd
3. ceaa
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 666.
For each one of the strings below say whether it is generated by the following

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negative 4-gram grammar:
G^-: $\{abcc, abcd, cdbd, ddbc\}$

1. b
2. ε
3. ccbddca
4. dbdbda

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 667.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{acbc, bbba, bbca, bcac, caab, cccb\}$

1. cba
2. b
3. ε
4. abb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 668.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \ltimes c, \rtimes \ltimes \ltimes, \rtimes \ltimes b, \rtimes cb, \rtimes c\ltimes, \rtimes \ltimes \ltimes, \rtimes ba, aac, abc, aca, bab, bcc, caa, cab, cca, cb\ltimes, ab\ltimes, c \ltimes \ltimes, b \ltimes \ltimes\}$

1. c
2. ε
3. abccbbcab
4. cb

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 669.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ c, ⋊ ⋊ a, ⋊a⋉, ⋊cc, acd, add, bad, cce, cdb, ceb, dac, dda, eba, db⋉, b ⋉ ⋉, a ⋉ ⋉}

1. ε
2. bccedcbb
3. eeecddc
4. d

Solution

1. No
2. No
3. No
4. No

EXERCISE 670.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$abbb$, $accb$, $cbbb$, $ccaa$, $ccba$, $cccc$}

1. b
2. a
3. bbab
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 671.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes b, \rtimes\rtimes d, \rtimes\ltimes\ltimes, \rtimes d\ltimes, \rtimes ba, aac, acc, baa, bcc, cbc, ccb, ccc, cb\ltimes, b\ltimes\ltimes, d\ltimes\ltimes\}$

1. bbca
2. d
3. ccbcd
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

Exercise 672.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes\ltimes, \rtimes c, ac, bb, bd, ca, cb, cc, d\ltimes\}$

1. cabbdbd
2. bad
3. ε
4. cbd

Solution

1. No
2. No
3. Yes
4. Yes

Exercise 673.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes b, aa, ac, bc, ca, a\ltimes\}$

1. bca
2. bcaa
3. bcaaa

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4. cbaa

Solution

1. Yes
2. Yes
3. Yes
4. No

Exercise 674.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aabd, aadc, adda, caaa, caba, cada, dbcb\}$

1. b
2. a
3. bcbdcdcd
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 675.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ba, bb, bc, cc\}$

1. accbabacb
2. baaa
3. accb
4. acbabbac

Solution

1. No
2. No
3. No
4. No

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EXERCISE 676.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{acac, babe, bdee, cabd, cacd, cbae, ccbe, edcb\}$

1. adce
2. de
3. bdbabe
4. cdbc

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 677.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ba, bb, bc, cc\}$

1. cbbaccc
2. bbaaccb
3. ε
4. ccbb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 678.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\ltimes\ltimes, \ltimes c, aa, ab, ac, ba, bb, bc, ca, a\rtimes\}$

1. caa
2. ε
3. cabac
4. ca

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 679.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ba, bb, b\ltimes\}$

1. ab
2. aaab
3. ε
4. aab

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 680.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aabd, adda, cdaa, cdba, cdca\}$

1. ε
2. aa
3. bdbbbcabcbbd
4. abbacc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 681.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊bb, abb, abc, bab, bba, bbb, bbc, bca, bcb, cab, cb⋉, b⋉⋉}

1. bbcb
2. b
3. accbbab
4. ε

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 682.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊a, ⋊⋉, ⋊d, ac, ad, cc, ce, dd, ea, d⋉}

1. cbad
2. ε
3. bdcaeac
4. d

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 683.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: {aaa, aba, abb, baa, bab}

1. aaa
2. ε
3. b

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4. a

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 684.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes ac, \rtimes aca, acac, acba, cacb, cba\ltimes, ba\ltimes\ltimes, a\ltimes\ltimes\ltimes\}$

1. c
2. cbccb
3. baa
4. acccab

Solution

1. No
2. No
3. No
4. No

EXERCISE 685.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aba, abb, baa, bab, bbb\}$

1. ε
2. baab
3. aa
4. abab

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 686.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {*aaba, abaa, abab, abbb, baaa, bbaa, bbba*}

1. bbaaababa
2. ε
3. b
4. bbbbbb

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 687.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {*aab, aba, abb, acb, bdc, cdb*}

1. bc
2. adcbb
3. abcd
4. dbdbac

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 688.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {*aaa, aab, aba, bab, bba, bbb*}

1. babaaab
2. ε
3. babababab
4. babbbabb

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Solution

1. No
2. Yes
3. No
4. No

EXERCISE 689.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{adab, bdca, dccb, eaec\}$

1. e
2. ε
3. ceaaecbccbea
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 690.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes e, ac, ae, ca, cd, da, ec, ee, c\ltimes\}$

1. ε
2. bbdbd
3. edbbded
4. acecdddbc

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 691.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aca, baa, bac, bbb, caa, ccb\}$

1. bacbb
2. bcaabbacabc
3. ε
4. ca

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 692.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ba, bb, b\ltimes\}$

1. abbaba
2. aab
3. ε
4. ab

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 693.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes b, \rtimes\rtimes ac, \rtimes\rtimes b\ltimes, \rtimes b\ltimes\ltimes, \rtimes acb, acbb, bbca, cbbc, bca\ltimes, ca\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. aa
2. b
3. bbb

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4. c

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 694.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aba, baa, bdd, cba, ddc\}$

1. b
2. cbdabbcdbbdc
3. dbdbacbaca
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 695.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abbb, bbee, cada, caea, dcda, ddec, dece, ebee\}$

1. e
2. ε
3. aeadeaa
4. ba

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 696.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abb, adc, add, bbc, cdd, dba, eed\}$

1. edeedd
2. ε
3. dac
4. cbbac

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 697.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{acbc, baad, bbcd, ccaa, ddad\}$

1. ε
2. bd
3. a
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 698.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\ltimes\ltimes e, \ltimes\ltimes a, \ltimes\ltimes\ltimes, \ltimes\ltimes\ltimes, \ltimes e\ltimes, \ltimes ab, abb, add, bad, bbd, bdb, beb, dbe, ddb, eba, db\ltimes, b\ltimes\ltimes, e\ltimes\ltimes\}$

1. eeebc
2. cbbeee
3. aabcbddbca

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4. cecd

Solution

1. No
2. No
3. No
4. No

EXERCISE 699.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, bb, b\ltimes\}$

1. ε
2. aabbbaa
3. bababbbaabab
4. aaabbabbab

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 700.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes d, \rtimes \rtimes db, \rtimes \rtimes dd, \rtimes \rtimes b\ltimes, \rtimes ddb, \rtimes db\ltimes, \rtimes dbb, \rtimes b \ltimes$
$\ltimes, aaab, aabd, abdc, baaa, bbaa, bbba, dbbb, ddbb, dbb\ltimes, bdc\ltimes, dc \ltimes \ltimes, db \ltimes$
$\ltimes, bb \ltimes \ltimes, c \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. ababcb
2. dcd
3. bbccbaddbc
4. dcdcccaadab

Solution

1. No
2. No
3. No

4. No

EXERCISE 701.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊⋊⋊a, ⋊⋊⋊c, ⋊⋊⋊⋉, ⋊⋊⋊d, ⋊⋊dc, ⋊⋊ca, ⋊⋊⋊⋉, ⋊⋊a⋉, ⋊dca, ⋊a⋉⋉, ⋊cad, ⋊ ⋉ ⋉⋉, $adcd$, $caaa$, $cadc$, $cdca$, $dcaa$, $dcad$, $dcdc$, aaa⋉, cad⋉, ad ⋉ ⋉, aa ⋉ ⋉, d ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. bbd
2. acbbabcb
3. cbcb
4. a

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 702.

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

G^-: {aa, ab, ba, bb}

1. bbabbaa
2. ba
3. abbbbab
4. aaaa

Solution

1. No
2. No
3. No
4. No

EXERCISE 703.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: {aaa, bba, bca, bcc, cac}

1. bb
2. ε
3. bbbbbbb
4. cccaba

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 704.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes be, ace, bac, beb, bee, eba, ebe, eeb, ce\ltimes, e \ltimes \ltimes\}$

1. cccabbd
2. ccaecbea
3. d
4. a

Solution

1. No
2. No
3. No
4. No

EXERCISE 705.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abcc, adad, badd, bbdb, bddb, ccda, dbcb\}$

1. dddb
2. dbbcb
3. dbd
4. ddbcbddba

Solution

1. Yes
2. Yes

3. Yes
4. No

EXERCISE 706.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes c, ab, ba, ca, cc, ce, ec, a\ltimes\}$

1. eada
2. dcbbda
3. cca
4. ca

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 707.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes\rtimes\rtimes d, \rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes b, \rtimes\rtimes dd, \rtimes\rtimes ab, \rtimes\rtimes b\ltimes, \rtimes ddb, \rtimes abd, \rtimes b\ltimes\ltimes, bbbb, dbbb, ddbb, abd\ltimes, bbb\ltimes, bd\ltimes\ltimes, bb\ltimes\ltimes, d\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. ε
2. bbca
3. cc
4. dcadbd

Solution

1. No
2. No
3. No
4. No

EXERCISE 708.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aba, baa, bab, bba\}$

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1. a
2. b
3. bb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 709.

For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes d, \rtimes d\ltimes, \rtimes da, acb, adc, bdd, cbd, dac, dad, dcd, dda, cd\ltimes, d \ltimes \ltimes\}$

1. d
2. baabad
3. dadcd
4. acbcacbcbd

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 710.

For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aace, abdd, cabe, cbdd, ccda, eddb, eecd\}$

1. ecaadd
2. e
3. ε
4. b

Solution

1. Yes
2. Yes

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3. Yes
4. Yes

EXERCISE 711.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊ab, ⋊⋊bb, ⋊⋊b⋉, ⋊⋊ba, ⋊baa, ⋊bba, ⋊ab⋉, ⋊b⋉⋉, $aaba$, $abab$, $abbb$, $baab$, $babb$, $bbaa$, $bbba$, baa⋉, bba⋉, ba⋉⋉, ab⋉⋉, aa⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. ab
2. baa
3. bba
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 712.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$bddd$, $bedc$, $cbea$, $cdce$, $ebca$, $ecab$}

1. ε
2. becaae
3. bcebadc
4. e

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 713.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:

G^-: $\{ab, ad, ca, cb, cd\}$

1. ddb
2. adaabdda
3. c
4. ε

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 714.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes e, \rtimes \rtimes e\ltimes, \rtimes \rtimes ea, \rtimes \rtimes be, \rtimes \rtimes ba, \rtimes e \ltimes, \rtimes bea, \rtimes eaa, \rtimes ba\ltimes, abac, aeab, beae, eaba, eaea, eaa\ltimes, bac\ltimes, ba \ltimes \ltimes, ac \ltimes \ltimes, aa \ltimes \ltimes, c \ltimes \ltimes\ltimes, a \ltimes \ltimes\ltimes, e \ltimes \ltimes\ltimes\}$

1. eaa
2. ba
3. e
4. accadead

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 715.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{bbba, bbbb, bcdd, cbac, dacb\}$

1. bacaaac
2. bcdcdba
3. cbcdaabc
4. ε

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Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 716.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes c, ca, ce, dc, ec, ed, ee, a\ltimes\}$

1. b
2. cdaa
3. ddd
4. ca

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 717.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes e, \rtimes \rtimes ae, \rtimes \rtimes e\ltimes, \rtimes aeb, \rtimes e \ltimes, aebb, bbeb, bebe, ebbe, ebe\ltimes, be \ltimes \ltimes, e \ltimes \ltimes\ltimes\}$

1. edadaea
2. a
3. edb
4. aa

Solution

1. No
2. No
3. No
4. No

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EXERCISE 718.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aadd, abba, addb, bacb, cbec, cdcb\}$

1. b
2. e
3. ε
4. ce

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 719.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes d, \rtimes\rtimes b, \rtimes dd, \rtimes ba, bac, cdb, dba, dcd, ddc, ac\ltimes, ba\ltimes, c\ltimes\ltimes, a\ltimes\ltimes\}$

1. ba
2. bbbadab
3. babdaab
4. bac

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 720.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ac, ba, bb, ca, cb, b\ltimes\}$

1. cabc
2. ε
3. ccaabbb
4. c

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Solution

1. No
2. Yes
3. No
4. No

EXERCISE 721.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, ca, cd, eb\}$

1. e
2. ddede
3. ε
4. eeecbad

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 722.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, bc, be, ca, cc, da, db, dc\}$

1. bdcaec
2. ε
3. bdabdb
4. cbccbc

Solution

1. No
2. Yes
3. No
4. No

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Exercise 723.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{bbb, bcb, bce, bed, cea, daa, dbc\}$

1. dcedc
2. ε
3. e
4. d

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 724.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, baa, bab, bbb\}$

1. ε
2. b
3. a
4. ababa

Solution

1. Yes
2. Yes
3. Yes
4. No

Exercise 725.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes ab, \rtimes b\ltimes, \rtimes ba, abb, bab, bba, ab\ltimes, b \ltimes \ltimes\}$

1. a
2. ε
3. abb
4. bbbaab

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 726.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. abaaa
2. aaaaa
3. aaaaabaaa
4. bbbbbb

Solution

1. No
2. No
3. No
4. No

EXERCISE 727.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aacd, abad, acbb, cade, cdee, ddad, edac\}$

1. ε
2. edceee
3. ce
4. acacae

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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Exercise 728.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊⋊c, ⋊⋊b, ⋊cd, ⋊bd, ace, bda, ced, dac, dcb, edc, cd⋉, cb⋉, b⋉⋉, d⋉⋉}

1. abadad
2. becba
3. dbdedca
4. dbb

Solution

1. No
2. No
3. No
4. No

Exercise 729.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊⋊⋊c, ⋊⋊⋊b, ⋊⋊⋊⋉, ⋊⋊bc, ⋊⋊c⋉, ⋊⋊⋉⋉, ⋊⋊ba, ⋊baa, ⋊bca, ⋊c⋉
⋉, ⋊⋉⋉⋉, $aabb$, $abbb$, $baab$, bca⋉, bbb⋉, ca⋉⋉, bb⋉⋉, c⋉⋉⋉, a⋉⋉⋉, b⋉
⋉⋉}

1. ε
2. aac
3. c
4. bca

Solution

1. Yes
2. No
3. Yes
4. Yes

Exercise 730.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$aaaa$, $aaab$, $abab$, $abba$, $abbb$, $baaa$, $babb$, $bbbb$}

1. b
2. ε

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3. a
4. abbb

Solution

1. Yes
2. Yes
3. Yes
4. No

Exercise 731.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, bb, b\ltimes\}$

1. ε
2. abbbaa
3. bbabaa
4. aabbbbbaaaaa

Solution

1. Yes
2. No
3. No
4. No

Exercise 732.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, bb, bc, cb, c\ltimes\}$

1. ε
2. b
3. a
4. ab

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 733.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{acc, bdc, cbd, ccc, daa, dab, dcd, ddc\}$

1. ε
2. bacbbc
3. b
4. dcaabda

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 734.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes d, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes d\ltimes, \rtimes dc, \rtimes bc, bcc, cce, ced, edb, dc\ltimes, db\ltimes, b\ltimes\ltimes, d\ltimes\ltimes, c\ltimes\ltimes\}$

1. ebd
2. dc
3. d
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 735.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes b\ltimes, \rtimes aa, aaa, aab, aba, abb, baa, bab, bb\ltimes, b\ltimes\ltimes\}$

1. ε
2. aaababab

3. bbbab
4. b

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 736.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, cb, cc\}$

1. b
2. ε
3. aba
4. bcacb

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 737.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes \rtimes b, \rtimes a \ltimes, \rtimes bb, aab, abb, baa, bab, bba, bb\ltimes, b \ltimes \ltimes, a \ltimes \ltimes\}$

1. bbbbba
2. aaba
3. a
4. bb

Solution

1. No
2. No
3. Yes
4. Yes

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EXERCISE 738.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ab, ac, ba, bb, da\}$

1. a
2. b
3. bcc
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 739.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes ab, \rtimes \rtimes b\ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes \rtimes aa, \rtimes aaa, \rtimes abb, \rtimes ab\ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes b \ltimes, aaaa, aaab, aaba, abaa, baaa, aaa\ltimes, abb\ltimes, ab \ltimes \ltimes, aa \ltimes \ltimes, bb \ltimes \ltimes, a \ltimes \ltimes \ltimes, b \ltimes \ltimes \ltimes\}$

1. b
2. ab
3. bab
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 740.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes \ltimes, \rtimes d, aa, ac, ae, bc, ca, cb, ce, dc, dd, ea, eb, b\ltimes\}$

1. eecbbdbdb

2. ccc
3. cbdbead
4. dcbebca

Solution

1. No
2. No
3. No
4. No

EXERCISE 741.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ a⋉, ⋊ ⋊ ba, ⋊a ⋉ ⋉, ⋊baa, $aabc$, $abcb$, $baab$, $bcba$, cba⋉, ba⋉⋉, a⋉⋉⋉}

1. ε
2. caaaba
3. a
4. bac

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 742.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊⋉, ⋊b, ⋊c, ad, bb, bc, ca, cd, db, dc, dd, c⋉}

1. ε
2. dbb
3. bdaabddcca
4. ccabbacbcd

Solution

1. Yes
2. No

  3. No
  4. No

Exercise 743.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊⋉, ⋊⋊c, ⋊⋊a, ⋊a⋉, ⋊cb, ⋊⋉⋉, ⋊ac, aca, bac, bba, cbb, ac⋉, ca⋉, a⋉⋉, c⋉⋉}

  1. ε
  2. ddcd
  3. daada
  4. ca

Solution

  1. Yes
  2. No
  3. No
  4. No

Exercise 744.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {baaa, bbcb, bccb, bdaa, cdab, cdcd, ddbd, dddc}

  1. dbcc
  2. ε
  3. cabda
  4. adcdda

Solution

  1. Yes
  2. Yes
  3. Yes
  4. Yes

Exercise 745.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊d, ⋊ ⋊ cb, ⋊ ⋊ da, ⋊ ⋊ b⋉, ⋊dad, ⋊cb⋉, ⋊b ⋉

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⋊, $aaab, aaba, abaa, adca, baaa, caab, dadc, dcaa, aab$⋉$, ab$ ⋉ ⋉$, cb$ ⋉ ⋉$, b$ ⋉
⋉⋉}

1. caaddaccada
2. cb
3. b
4. dadcaab

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 746.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$aabb, abba, baaa, bbbb$}

1. babab
2. b
3. bbb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 747.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊⋉, ⋊b, aa, ab, ba, b⋉}

1. b
2. abbabb
3. ababab
4. ε

Solution

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1. Yes
2. No
3. No
4. Yes

EXERCISE 748.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes\rtimes c, \rtimes\rtimes b, \rtimes c\ltimes, \rtimes bc, aac, acb, baa, bca, bcb, cba, cbc, bc\ltimes, ca\ltimes, c\ltimes\ltimes, a\ltimes\ltimes\}$

1. ca
2. aabbc
3. baa
4. ε

Solution

1. No
2. No
3. No
4. No

EXERCISE 749.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aaab, abba, baab, babb, bbaa, bbab, bbba\}$

1. baaaaaaaba
2. bababbbba
3. ba
4. aabbb

Solution

1. No
2. No
3. Yes
4. Yes

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EXERCISE 750.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes b, aa, ab, ba, bb, a\ltimes\}$

1. abab
2. aabbaba
3. bb
4. aa

Solution

1. No
2. No
3. No
4. No

EXERCISE 751.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes db, \rtimes \rtimes cb, \rtimes \rtimes \ltimes\ltimes, \rtimes dbc, \rtimes cb\ltimes, \rtimes \rtimes \ltimes\ltimes, abad, acab, adac, bada, bcda, cdab, daba, daca, dbcd, cab\ltimes, ab \ltimes \ltimes, cb \ltimes \ltimes, b \ltimes \ltimes\ltimes\}$

1. a
2. cb
3. ε
4. bc

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 752.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aacc, bbcc, cbac, cbcb\}$

1. aa
2. bc

3. ba
4. bbbac

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 753.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ac, ba, db, dc\}$

1. b
2. ε
3. aaaba
4. bdb

Solution

1. Yes
2. Yes
3. No
4. No

Exercise 754.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ac, ca, dd, ee\}$

1. cc
2. adaaeab
3. e
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

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EXERCISE 755.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋈$d, bc, bd, cd, db, de, ea, eb, ed, a$⋈}

1. dea
2. ecdbedacba
3. bedcdcdbdd
4. beecaceda

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 756.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋈ ⋈ e, ⋈ ⋈ a, ⋈eb, ⋈$aa, aac, acd, bba, cdb, dbb, eb$⋈$, ba$⋈$, b$ ⋈ ⋈$, a$ ⋈ ⋈}

1. c
2. eeeb
3. dddbb
4. ddeda

Solution

1. No
2. No
3. No
4. No

EXERCISE 757.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋈ ⋈ ⋈a, ⋈ ⋈ ⋈c, ⋈ ⋈ ⋈⋈, ⋈ ⋈ ab, ⋈ ⋈ c⋈, ⋈ ⋈ ⋈⋈, ⋈aba, ⋈c ⋈ ⋈, ⋈ ⋈ ⋈⋈, $aacc, abaa, accb, baac, bbca, bcab, cabc, cbbc, ccbb, abc$⋈$, bc$ ⋈ ⋈$, c$ ⋈ ⋈⋈}

1. aabcaab
2. c
3. ε

4. cabacaac

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 758.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, ac, ba, ca, cb\}$

1. acc
2. ε
3. a
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 759.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ac, ad, cb, db, dc, dd\}$

1. bdaad
2. ε
3. b
4. a

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 760.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊c, ⋊⋊a, ⋊c⋉, ⋊ac, ace, ade, bad, ceb, ded, eba, eda, da⋉, a⋉⋉, c⋉⋉}

1. beee
2. c
3. ecbbbab
4. b

Solution

1. No
2. Yes
3. No
4. No

Exercise 761.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊c, ⋊cb, bbc, bcc, cbb, cca, ca⋉, a⋉⋉}

1. cbbc
2. c
3. b
4. a

Solution

1. No
2. No
3. No
4. No

Exercise 762.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {ac, ad, ba, bb, bc, db, dd}

1. bccabbbd
2. a
3. ε
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 763.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊d, ⋊ ⋊ ⋊db, ⋊ ⋊ ⋉⋉, ⋊ ⋊ cc, ⋊ ⋊ a⋉, ⋊a ⋉ ⋉, ⋊dbb, ⋊cc⋉, ⋊ ⋊ ⋉⋉, $aaba$, $acaa$, $bbdc$, $bdca$, $caab$, $caca$, $dbbd$, $dcac$, aba⋉, ba ⋉ ⋉, cc ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. ε
2. abaddeddc
3. dbabdebbbe
4. edcaccde

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 764.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$abaa, baba, bbaa, bbba$}

1. ε
2. ababaaa
3. bbabbb
4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

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EXERCISE 765.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊a, ⋊⋉, ⋊b, ab, ac, ba, cb, cc, a⋉, b⋉}

1. ε
2. cab
3. cc
4. cacab

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 766.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: {ab, ac, ba, bb, bc, ca, cb, cc}

1. ε
2. bbba
3. a
4. b

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 767.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ba, ⋊aa, acb, bac, bcc, cbc, ccc, ccd, cda, da⋉, aa⋉, a⋉⋉}

1. c
2. bacbccda
3. ε

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    4. aa

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 768.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊ ⋊ b, ⋊ ⋊ ⋉, ⋊ ⋉ ⋉, ⋊bb, aab, baa, bba, bbb, ab⋉, b ⋉ ⋉}

1. ε
2. ba
3. abba
4. bbaab

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 769.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊bb, ⋊ ⋊b⋉, ⋊ ⋊aa, ⋊ ⋊ba, ⋊aaa, ⋊bb⋉, ⋊bab, ⋊b ⋉ ⋉, $abba$, $babb$, $bbab$, bab⋉, aaa⋉, ab ⋉ ⋉, aa ⋉ ⋉, bb ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. b
2. bb
3. aaa
4. aaaaaaaa

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 770.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ac, bb, cc, cd, da, dc, dd\}$

1. aacdccb
2. ε
3. ccaabdcd
4. b

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 771.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ad, bd, cd, dc, dd\}$

1. b
2. ε
3. dcccaca
4. a

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 772.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, baa, bab, bbb\}$

1. abba
2. b
3. bba
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 773.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aba, baa, bbb\}$

1. aa
2. baaabb
3. baabbbaba
4. aab

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 774.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes c, \rtimes\rtimes b, \rtimes cd, \rtimes bd, aab, abc, acd, aea, bca, cae, cda, daa, dac, ea\ltimes, bd\ltimes, d\ltimes\ltimes, a\ltimes\ltimes\}$

1. cdaabcaea
2. daedeeabad
3. bebcdbbbd
4. bd

Solution

1. Yes
2. No
3. No
4. Yes

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EXERCISE 775.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊⋉, ⋊b, ab, ad, bc, bd, ca, db, dc, dd, c⋉}

1. aada
2. cdccdaad
3. ε
4. bdcb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 776.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ac, ⋊ ⋊ ⋉⋉, ⋊ ⋊ cc, ⋊ ⋊ ba, ⋊acc, ⋊baa, ⋊cc⋉, ⋊ ⋉ ⋉⋉, $aabc$, $abcc$, $baab$, $bccb$, $ccba$, acc⋉, cba⋉, ba ⋉ ⋉, cc ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. acc
2. ε
3. cabacc
4. cc

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 777.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+:   {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ bb, ⋊ ⋊ a⋉, ⋊ ⋊ ba, ⋊bab, ⋊a ⋉ ⋉, ⋊bb⋉, $abba$, $abbb$, $babb$, $bbab$, $bbbb$, bbb⋉, bb ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. a

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   2. abbaaa

   3. ε

   4. babbaabb

Solution

   1. Yes

   2. No

   3. No

   4. No

EXERCISE 778.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊⋊a, ⋊⋊b, ⋊b⋉, ⋊ba, ⋊aa, aab, aba, abb, bab, bbc, bcb, cbc, bc⋉, ba⋉, b⋉⋉, a⋉⋉, c⋉⋉}

   1. b

   2. bc

   3. ba

   4. cab

Solution

   1. Yes

   2. No

   3. Yes

   4. No

EXERCISE 779.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: {aa, ab, ac, bb, bc}

   1. ε

   2. acccb

   3. ba

   4. b

Solution

   1. Yes

   2. No

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3. Yes
4. Yes

EXERCISE 780.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abc, acd, baa, bdc, dac, dcd\}$

1. b
2. ε
3. bdabddbbd
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 781.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{bd, cb, eb, ec, ee\}$

1. eecde
2. ε
3. eadaab
4. eaebdebbd

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 782.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ac, ba, bc, ca, cb\}$

1. ccca
2. acca
3. c
4. acbcb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 783.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ad, bc, bd, cd, da, dd\}$

1. ddcaddaa
2. cbdadad
3. ε
4. daccacbacd

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 784.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, aadb, abbb, adbd, cdac, dcac, dcdb\}$

1. a
2. b
3. ε
4. cadcb

Solution

1. Yes
2. Yes

3. Yes
4. Yes

EXERCISE 785.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, ac, ba, bb, bc, ca, cb\}$

1. cacbba
2. cb
3. ccbbac
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 786.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes c, \rtimes \rtimes a, \rtimes a \ltimes, \rtimes cb, \rtimes aa, bcc, bdb, cbd, dbc, cc\ltimes, aa\ltimes, a \ltimes \ltimes, c \ltimes \ltimes\}$

1. aa
2. acc
3. a
4. bcc

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 787.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes b, \rtimes \rtimes cc, \rtimes \rtimes b\ltimes, \rtimes ccb, \rtimes b \ltimes \ltimes, bccb, bccc, cbcc, ccbc, cccb, cccc, ccb\ltimes, cb \ltimes \ltimes, b \ltimes \ltimes \ltimes\}$

1. ccb
2. b
3. acbccacbbbc
4. ccbccb

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 788.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ cb, ⋊ ⋊ ba, ⋊cbd, ⋊ ⋊ ⋉⋉, ⋊baa, $aaba$, $abab$, $baab$, cbd⋉, bab⋉, ab ⋉ ⋉, bd ⋉ ⋉, d ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. cbbcbc
2. aac
3. cbd
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 789.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊d, aa, ad, da, dd, d⋉}

1. d
2. ddd
3. bd
4. dd

Solution

1. Yes

2. Yes
3. No
4. Yes

EXERCISE 790.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊e, ⋊⋊c, ⋊⋊⋉, ⋊⋉⋉, ⋊e⋉, ⋊ca, aab, abb, abc, baa, bba, bca, cab, cac, ac⋉, e⋉⋉, c⋉⋉}

1. bbabea
2. cbeccbcad
3. aceaae
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 791.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊⋊⋉, ⋊⋊ab, ⋊⋊b⋉, ⋊⋊⋉⋉, ⋊aba, ⋊⋉⋉⋉, ⋊b⋉⋉, $aaab$, $aabb$, $abaa$, $abbb$, $baaa$, $bbaa$, $bbba$, baa⋉, aa⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. abaa
2. b
3. ε
4. aabaa

Solution

1. Yes
2. Yes
3. Yes
4. No

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Exercise 792.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ab, ⋊ ⋊ bb, ⋊ ⋊ ⋉⋉, ⋊ ⋊ a⋉, ⋊aba, ⋊a ⋉ ⋉, ⋊bba, ⋊ ⋉ ⋉⋉, $aaac$, $aaca$, $acaa$, $acca$, $bacc$, $bbac$, $caaa$, $caca$, $ccac$, aca⋉, aba⋉, ba ⋉ ⋉, ca ⋉ ⋉, a ⋉ ⋉⋉}

1. bbaccabca
2. acbccbccbcb
3. ε
4. a

Solution

1. No
2. No
3. Yes
4. Yes

Exercise 793.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ac, ⋊ ⋊ ⋉⋉, ⋊ ⋊ ba, ⋊aca, ⋊ba⋉, ⋊ ⋉ ⋉⋉, $aacc$, $acaa$, $accc$, $caac$, $cccc$, ccc⋉, ba ⋉ ⋉, cc ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. baaaa
2. ccaa
3. bccac
4. cab

Solution

1. No
2. No
3. No
4. No

Exercise 794.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:

G^+: {⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊aa, ⋊⋊bb, ⋊aab, ⋊bbb, $aaba$, $abaa$, $baab$, bbb⋉, aba⋉, ba⋉

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⋈, bb ⋈ ⋈, a ⋈ ⋈⋈, b ⋈ ⋈⋈}

1. a
2. abbbaa
3. abbabba
4. aaabb

Solution

1. No
2. No
3. No
4. No

EXERCISE 795.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: {aa, ab, ba, bb}

1. ε
2. a
3. bbbabb
4. abb

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 796.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊d, ⋊ ⋊ bc, ⋊ ⋊ da, ⋊ ⋊ ⋉⋉, ⋊dad, ⋊bc⋉, ⋊ ⋊ ⋉⋉, $adad, adbc, bcda, cdad, dada, dadb, dbcd, dad$⋉, ad⋉⋉, bc⋉⋉, c⋉⋉⋉, d⋉ ⋉⋉}

1. badcc
2. bc
3. ε
4. cbcdad

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Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 797.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aabc, abab, abba, acab, cabb\}$

1. acacccbab
2. ε
3. cc
4. bacbbccccc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 798.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ac, ba, bb, ca, cc, ce, db, eb\}$

1. bebecda
2. ε
3. b
4. e

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 799.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, ac, ba, bb, ca, cd, db, a\ltimes\}$

1. ddda
2. dbad
3. ε
4. ca

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 800.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes aa, \rtimes aab, aaab, aabb, abba, baaa, bbaa, aab\ltimes, ab\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. aab
2. baa
3. abbbaab
4. abbb

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 801.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{bb, bc, be, ca, cb, ea, eb, ee\}$

1. ε
2. a
3. bacacbc
4. dbcae

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Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 802.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aaca, aacb, abba, abbb, abca, abcb, babc, ccaa\}$

1. ε
2. ac
3. b
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 803.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aad, ada, baa, bcb, bcc, cab, ccd, dcd\}$

1. aaabddabd
2. ε
3. dbaaa
4. abacd

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 804.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aac, abc, aca, baa, cac, cbb, cbc\}$

1. ε
2. acbcbcbaccb
3. ab
4. bbcca

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 805.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes \rtimes c, \rtimes \rtimes d, \rtimes cb, \rtimes dc, add, bca, cad, cbc, dcc, ddc, ddd, dc\ltimes, cc\ltimes, c \ltimes \ltimes\}$

1. ddccc
2. dc
3. bbbaaa
4. dcc

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 806.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aab, bac, bcd, bdc, cca, cdb\}$

1. b
2. ε
3. cadc
4. acacdd

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 807.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes e, \rtimes d, be, de, eb, ed, ee, e\ltimes, d\ltimes\}$

1. ed
2. a
3. d
4. e

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 808.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, \rtimes d, ab, ad, ba, bb, bc, cb, da, db, dd, c\ltimes, b\ltimes\}$

1. accaacd
2. cccbbcab
3. b
4. caddad

Solution

1. No
2. No
3. No
4. No

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EXERCISE 809.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, aabb, abba, baab\}$

1. bbababbbabab
2. ba
3. ε
4. aaababaaa

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 810.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{baaa, baeb, bcaa, ccce, ebea\}$

1. bcdddbe
2. de
3. a
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 811.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes d, ac, bc, cb, cd, da, dc, dd, b\ltimes\}$

1. bdbdaaa
2. dbbba
3. adddc
4. cca

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Solution

1. No
2. No
3. No
4. No

Exercise 812.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, bba\}$

1. aaababaabb
2. bb
3. bba
4. aaaab

Solution

1. No
2. Yes
3. No
4. No

Exercise 813.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{acbb, acec, bcaa, cbad, cead, ebee\}$

1. ε
2. cdebcbb
3. dad
4. eed

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 814.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ab, ⋊ ⋊ b⋉, ⋊ ⋊ ⋉⋉, ⋊aba, ⋊abb, ⋊ ⋊ ⋉⋉, ⋊b⋉⋉, $aabb$, $abba$, $abbb$, $baab$, $bbaa$, $bbba$, $bbbb$, aba⋉, bba⋉, ba⋉⋉, a⋉ ⋉⋉, b ⋉ ⋉⋉}

1. b
2. ε
3. aaa
4. aba

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 815.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+:   {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ cb, ⋊ ⋊ bb, ⋊ ⋊ b⋉, ⋊bbc, ⋊cba, ⋊b ⋉ ⋉, $aacb$, $acba$, $bbca$, $bcaa$, $caac$, $cbab$, bab⋉, cba⋉, ba ⋉ ⋉, ab ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. ε
2. abc
3. acaccb
4. caaaaca

Solution

1. No
2. No
3. No
4. No

EXERCISE 816.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: {$cabd, cbbc, daeb, eccc$}

1. deeaaab
2. ε
3. adba
4. ddadbced

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 817.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{adac, cbcd, dacb, dacc, dcaa\}$

1. abcbbbdaad
2. b
3. dbcdddda
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 818.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\ltimes \ltimes d, \ltimes \ltimes \rtimes, \ltimes \rtimes \rtimes, \ltimes da, abc, aca, bcb, bda, cab, cbd, dac, ac\rtimes, c \rtimes \rtimes\}$

1. bdbb
2. bddeecacce
3. ε
4. dac

Solution

1. No
2. No

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3. Yes
4. Yes

Exercise 819.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, bb, cc, cd, da, dc\}$

1. bbda
2. a
3. ε
4. b

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 820.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aeed, baae, baea, bdec, caad, ecbd\}$

1. eddc
2. ε
3. deacdaa
4. deddcbdd

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 821.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes a, \rtimes aa, aab, aba, abb, baa, bab, bba, aa\ltimes, a \ltimes \ltimes\}$

1. a
2. abbbaaaabb
3. bbbbbaaaa
4. ε

Solution

1. No
2. No
3. No
4. No

EXERCISE 822.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊⋊⋉, ⋊⋊ab, ⋊⋊⋊⋉, ⋊⋊a⋉, ⋊⋊ba, ⋊baa, ⋊aba, ⋊a⋉ ⋉, ⋊ ⋉ ⋉⋉, $aaba$, $abaa$, $abab$, $baab$, baa⋉, bab⋉, ab ⋉ ⋉, aa ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. ε
2. baaa
3. bbaaab
4. aaabaaa

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 823.

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: {$aaa, aab, aba, abb, baa, bab, bba, bbb$}

1. ababa
2. ab
3. abbbaa
4. b

Solution

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1. No
2. Yes
3. No
4. Yes

EXERCISE 824.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, bb, b\ltimes\}$

1. babbb
2. b
3. aaaabb
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 825.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aed, bea, cee, dbe, dcd, ded, edd\}$

1. cee
2. baceaa
3. ε
4. ce

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 826.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:

G^-: $\{abba, abcb, acaa, acab\}$

1. b
2. ε
3. a
4. c

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 827.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, ab, bb, bc, ca, cb, cc, b\ltimes\}$

1. ε
2. aacbbbcb
3. abbbcb
4. cabbabbb

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 828.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, abab, baba, bbab, bbbb\}$

1. ε
2. bb
3. abaab
4. bbaaaa

Solution

1. Yes

2. Yes
3. Yes
4. Yes

EXERCISE 829.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊⋉, ⋊ ⋊ cb, ⋊ ⋊ ⋉⋉, ⋊ ⋊ aa, ⋊aaa, ⋊cbc, ⋊ ⋉ ⋉⋉, $aaac$, $aaba$, $aacb$, $abaa$, $acbc$, $baab$, $bcaa$, $caab$, $cbca$, aab⋉, cbc⋉, ab ⋉ ⋉, bc ⋉ ⋉, c ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. ε
2. cbc
3. ccbccb
4. aaa

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 830.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊ ⋊ ⋉, ⋊ ⋊ c, ⋊c⋉, ⋊ ⋉ ⋉, ⋊cc, cab, cca, ccc, ab⋉, b ⋉ ⋉, c ⋉ ⋉}

1. acbbaacacaa
2. ε
3. ca
4. c

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 831.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊d, ⋊ ⋊ db, ⋊ ⋊ bb, ⋊ ⋊ d⋉, ⋊ ⋊ ⋉⋉, ⋊db⋉, ⋊d ⋉ ⋉, ⋊bba, ⋊ ⋉ ⋉⋉, ⋊bbd, $acac$, $bbdc$, $bdca$, $caca$, $cacc$, $dcac$, acc⋉, bba⋉, ba ⋉ ⋉, db ⋉ ⋉, cc ⋉ ⋉, c ⋉ ⋉⋉, d ⋉ ⋉⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. dcbaadd
2. db
3. ε
4. d

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 832.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊b, aa, ab, ba, bb, a⋉}

1. bbb
2. ba
3. bba
4. baaab

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 833.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: {$aaba$, $acbd$, $cbad$, $cbcb$, $ddbc$}

1. dbcabcdcda
2. ca

3. ccbaabdbd
4. abccbada

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 834.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, \rtimes b, aa, bb, bc, ca, cc, a\ltimes\}$

1. ε
2. bbbca
3. abb
4. cbbaba

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 835.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, ba, bc, cb, db, dd, ee\}$

1. ε
2. bcdcb
3. eeecdedc
4. becb

Solution

1. Yes
2. No
3. No
4. No

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EXERCISE 836.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes b, aa, ab, ba, b\ltimes\}$

1. b
2. aba
3. aaab
4. aaabbabaa

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 837.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abbb, cbcd, ccbb, dccc\}$

1. c
2. a
3. b
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 838.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes ab, \rtimes \rtimes da, \rtimes \rtimes \ltimes\ltimes, \rtimes aba, \rtimes dac, \rtimes \rtimes$
$\ltimes\ltimes, abac, acac, acdb, baca, cacd, cdb\ltimes, dac\ltimes, db \ltimes \ltimes, ac \ltimes \ltimes, c \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. addd
2. ε
3. dac

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    4. bdcbbcbd

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 839.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaba, acac, cbaa, cbcb, ccaa, ccca\}$

1. ccac
2. ccbbc
3. b
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 840.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{⋊⋊⋊d, ⋊⋊da, ⋊dad, abec, adda, adea, beca, cade, dabe, dadd, ddab, ecad, dea⋉, ea⋉⋉, a⋉⋉⋉\}$

1. bbdeb
2. ebcac
3. aee
4. cbada

Solution

1. No
2. No
3. No
4. No

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Exercise 841.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊⋊c, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊bc, ⋊ca, adb, bcc, bda, cad, cca, daa, dbd, aa⋉, ca⋉, a⋉⋉}

1. abb
2. ε
3. bcca
4. ca

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 842.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: {⋊⋉, ⋊b, ⋊d, ac, bb, bc, ca, cb, b⋉, d⋉}

1. da
2. bca
3. ca
4. dbadc

Solution

1. No
2. No
3. No
4. No

Exercise 843.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊ ⋊ a, ⋊aa, aaa, aab, abb, bbb, bb⋉, aa⋉, b ⋉ ⋉, a ⋉ ⋉}

1. aa
2. aaa
3. abaaaa

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4. ba

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 844.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ bc, ⋊ ⋊ c⋉, ⋊ ⋊ bb, ⋊ ⋊ cd, ⋊cdd, ⋊bbb, ⋊c ⋉
⋉, ⋊bc⋉, $cdda$, $daca$, $ddac$, aca⋉, bbb⋉, bc ⋉ ⋉, ca ⋉ ⋉, bb ⋉ ⋉, c ⋉ ⋉⋉, a ⋉
⋉⋉, b ⋉ ⋉⋉}

1. c
2. abba
3. bb
4. dba

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 845.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊c, aa, ab, ba, bb, bc, ca, cb, cc, b⋉}

1. dcaaba
2. cb
3. ccb
4. cbb

Solution

1. No
2. Yes
3. Yes

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4. Yes

EXERCISE 846.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes bb, aaa, abb, baa, bab, bba, bbb, aa\ltimes, a \ltimes \ltimes\}$

1. bbaa
2. b
3. bbaaa
4. bbbaa

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 847.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes b, aa, ab, ba, bb, bd, db, d\ltimes\}$

1. bd
2. ε
3. cdacaa
4. bbd

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 848.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, bba, bca, bcb, cbb\}$

1. bbac

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2. bbc
3. bbccb
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 849.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes d, bb, bc, bd, cd, db, dc, dd, c\ltimes\}$

1. cbaaa
2. ε
3. cacda
4. ddcbccdbd

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 850.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes b, aa, ab, ba, a\ltimes, b\ltimes\}$

1. babb
2. a
3. b
4. aa

Solution

1. No
2. Yes
3. Yes

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4. Yes

EXERCISE 851.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes e, aa, bd, be, db, dd, ea, eb, e\ltimes, a\ltimes\}$

1. ε
2. e
3. ea
4. ddd

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 852.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\ \rtimes\ \rtimes\ltimes, \rtimes\ \rtimes\ \rtimes d, \rtimes\ \rtimes\ \ltimes\ltimes, \rtimes\ \rtimes\ d\ltimes, \rtimes\ \rtimes\ da, \rtimes d\ \ltimes\ \ltimes, \rtimes\ \ltimes\ \ltimes\ltimes, \rtimes dad, adcb, adcd, bcad, cadc, cbca, dadc, dcbc, dcd\ltimes, cd\ltimes\ltimes, d\ltimes\ \ltimes\ltimes\}$

1. ccaddcbcc
2. a
3. d
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 853.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes a, \rtimes\rtimes b, \rtimes aa, \rtimes\ltimes\ltimes, \rtimes b\ltimes, aaa, aac, ace, adb, bae, bda, ceb, dad, dba, ebd, ae\ltimes, e\ltimes\ltimes, b\ltimes\ltimes\}$

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1. daad
2. dcaa
3. ε
4. b

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 854.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes d, \rtimes\rtimes e, \rtimes db, \rtimes\ltimes\ltimes, \rtimes ed, bbd, bdc, bee, cde, ceb, dbe, dcd, ebb, ece, eec, ed\ltimes, de\ltimes, d\ltimes\ltimes, e\ltimes\ltimes\}$

1. ed
2. ε
3. badde
4. eaccecaed

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 855.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes ba, abb, bab, bba, bbb, bb\ltimes, b\ltimes\ltimes\}$

1. babb
2. ε
3. babbb
4. aa

Solution

1. Yes

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2. Yes
3. Yes
4. No

EXERCISE 856.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ae, bc, bd, cb, dc\}$

1. bcbcdba
2. d
3. bceecaabbee
4. ab

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 857.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. bbbaba
2. bbabbba
3. b
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 858.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{abd, dae, dbc, eab\}$

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1. ε
2. eaaccb
3. bacaecec
4. dabedb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 859.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{bed, cce, cdb, cdd\}$

1. ε
2. be
3. abbaddd
4. cdcd

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 860.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{adbd, badd, bdbd, ccba, dbdb, deab, eacb\}$

1. aa
2. ebce
3. dead
4. ε

Solution

1. Yes
2. Yes

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3. Yes
4. Yes

EXERCISE 861.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, aaba, baaa, baba, bbaa, bbab, bbba, bbbb\}$

1. babbb
2. ε
3. aaaabbab
4. b

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 862.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes ba, aaa, abc, bab, bca, caa, aa\ltimes, a \ltimes \ltimes\}$

1. aabbaa
2. ccbcaabc
3. bcbbcca
4. ccbab

Solution

1. No
2. No
3. No
4. No

EXERCISE 863.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes \ltimes, \rtimes \rtimes c, \rtimes \rtimes d, \rtimes \ltimes \ltimes, \rtimes dc, \rtimes cc, bda, cbd, ccb, ccc, dac, dc\ltimes, ac\ltimes, c\ltimes \ltimes\}$

1. cbabdca
2. dc
3. abdd
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 864.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes d, ab, ba, bc, cb, cc, b\ltimes, d\ltimes\}$

1. dbbbabdc
2. d
3. abbbdd
4. ddab

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 865.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aac, ada, cad, dad\}$

1. a
2. baabbaba
3. ε
4. b

Solution

1. Yes
2. Yes

3. Yes
4. Yes

EXERCISE 866.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ aa, ⋊aad, $aadb$, $abdd$, $adba$, $babd$, $dbab$, bdd⋉, dd ⋉ ⋉, d ⋉ ⋉⋉}

1. cb
2. aad
3. bbc
4. adcb

Solution

1. No
2. No
3. No
4. No

EXERCISE 867.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {aeb, bbe, bdb, cad, cba, dcb, eac, edc}

1. dabcecbbccbe
2. ε
3. e
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 868.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {ac, ba, bc, ca}

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1. cbb
2. bb
3. cccbabb
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 869.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aab, abb, baa, bbb\}$

1. bbb
2. aaaaaabba
3. ababaaba
4. bba

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 870.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aba, abb, bba\}$

1. aaaaa
2. b
3. ε
4. babba

Solution

1. No
2. Yes

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3. Yes
4. No

EXERCISE 871.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aab, abb, bab, bba\}$

1. bb
2. b
3. a
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 872.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ba, bb, bd, db, dc, dd\}$

1. abca
2. ε
3. b
4. badbab

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 873.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes \rtimes \ltimes, \rtimes \rtimes c, \rtimes \ltimes \ltimes, \rtimes cc, cbd, ccb, ccc, bd\ltimes, d \ltimes \ltimes\}$

1. a
2. c
3. ccbd
4. ε

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 874.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aaab, aabb, abaa, abab, abbb, baba, babb, bbba\}$

1. bbbab
2. ε
3. abbbb
4. b

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 875.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes \rtimes c, \rtimes cc, aba, abb, bab, bbc, bcc, cab, cba, cca, ccb, ccc, ba\ltimes, a \ltimes \ltimes\}$

1. ccbabccbc
2. ccba
3. ccccabbaaaba
4. cccba

Solution

1. No
2. Yes

3. No
4. Yes

EXERCISE 876.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abb, ada, add, bdc, cba, dad, dcb\}$

1. ε
2. dbddc
3. b
4. ddc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 877.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes d, aa, ab, ba, bc, cb, cc, cd, da, a\ltimes\}$

1. ε
2. dbabdcc
3. a
4. aa

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 878.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, aaba, abba, baaa, baba, bbab, bbba\}$

1. ε
2. aaab
3. bbbab
4. ababbb

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 879.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes ab, \rtimes bb, aab, aba, abb, baa, bab, bba, bbb, bb\ltimes, ba\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. baabaa
2. ε
3. bbb
4. aabbab

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 880.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes ac, \rtimes ba, aba, abc, bab, bcc, ac\ltimes, cc\ltimes, c\ltimes\ltimes\}$

1. ac
2. bb
3. babcc
4. acbacb

Solution

1. Yes

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2. No
3. Yes
4. No

EXERCISE 881.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: {⋊⋊c, ⋊⋊b, ⋊c⋉, ⋊bc, ⋊ca, aac, acc, bbb, caa, cbb, ccb, bb⋉, bc⋉, b⋉⋉, c⋉
⋉}

1. caabcbc
2. c
3. bc
4. aacba

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 882.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: {aab, aba, bba, bbb}

1. babba
2. ε
3. abaababaa
4. baabbb

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 883.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:

G^-: $\{ad, ca, cc, cd, ed\}$

1. bd
2. cecd
3. abcaeb
4. abdbadad

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 884.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{acc, aeb, aed, bba, cde, ded, edd\}$

1. bdc
2. ε
3. aa
4. e

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 885.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, abcb, acbc, bcac, bcba, cabb, cbbc, ccaa\}$

1. a
2. ac
3. ε
4. b

Solution

1. Yes

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2. Yes
3. Yes
4. Yes

EXERCISE 886.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, abab, abba, bbbb, caab, cbac, ccac, ccba\}$

1. bcbbcaccbbcb
2. ab
3. abbbacbbaaa
4. aacbacbbab

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 887.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ab, ac, ba, bb, bc, cb, cc\}$

1. aca
2. ε
3. b
4. a

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 888.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, ad, bb, bc, cb, cd, db, dd\}$

1. aabc
2. bdd
3. ε
4. ccbb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 889.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaac, aaba, babb, bbba, bcac, bcbc, caaa, ccba\}$

1. aabc
2. b
3. bbbaccaca
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 890.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{⋊\ ⋊\ ⋊a, ⋊\ ⋊\ ⋊⋊, ⋊\ ⋊\ ⋊⋊, ⋊\ ⋊\ ab, ⋊aba, ⋊\ ⋊\ ⋊⋊, abac, acde, bacd, cdec, decc, eccc, ccc⋊, cc ⋊ ⋊, c ⋊ ⋊⋊\}$

1. adbaebec
2. ε
3. edcedaae
4. b

Solution

1. No

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2. Yes
3. No
4. No

EXERCISE 891.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaaa, aaba, abba, baaa, baba, babb\}$

1. babba
2. b
3. baaabb
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 892.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes d, cc, cd, ce, da, dc, dd, ec, a\ltimes\}$

1. abdb
2. dd
3. ε
4. eccdcaadca

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 893.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, accb, bbbb, cadc, cbcd, ccbb, ddcb, dddb\}$

1. cbbb
2. ddcca
3. acb
4. ccdbbcd

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 894.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abc, aca, acb, bab, bbb, bcc, cba, ccb\}$

1. bbcbabcb
2. cbbcabaaca
3. bb
4. baaabb

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 895.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes b, \rtimes c, ab, ac, ba, bb, bc, cb, cc, c\ltimes, b\ltimes\}$

1. aacbabbbccab
2. bbacbcbbbaa
3. acaaaccabbca
4. bcabcbcc

Solution

1. No
2. No

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1. b
2. e
3. ε
4. c

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 899.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊e, ⋊ ⋊ ab, ⋊ ⋊ c⋉, ⋊ ⋊ ee, ⋊ee⋉, ⋊aba, ⋊c ⋉ ⋉, $abac$, $abdc$, $acab$, $baca$, $bdce$, $cabd$, $ceeb$, $dcee$, eeb⋉, eb⋉⋉, ee⋉⋉, c⋉⋉⋉, e⋉⋉⋉, b ⋉ ⋉⋉}

1. dbdbc
2. c
3. beba
4. ee

Solution

1. No
2. Yes
3. No
4. Yes

Exercise 900.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: {⋊ ⋊ c, ⋊ ⋊ ⋉, ⋊ ⋊ a, ⋊ ⋊ b, ⋊cb, ⋊ ⋉, ⋊b⋉, ⋊ab, aab, abb, aca, bbc, bca, bcb, caa, cac, cba, cbc, ab⋉, ba⋉, b ⋉, a ⋉ ⋉}

1. acc
2. cabccacbbcba
3. ε
4. baaabaabaabb

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 901.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ac, bc, bd, cb, da\}$

1. ε
2. aaa
3. cbad
4. cdbcc

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 902.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes b, \rtimes bd, aec, bca, bde, cae, cbc, dcb, ded, ecc, edc, cc\ltimes, c \ltimes \ltimes\}$

1. aaa
2. d
3. ε
4. aebdc

Solution

1. No
2. No
3. No
4. No

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EXERCISE 903.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+:   {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ab, ⋊ ⋊
c⋉, ⋊ ⋊ bb, ⋊ ⋊ ⋉⋉, ⋊ ⋊ cc, ⋊ccb, ⋊bbb, ⋊c ⋉ ⋉, ⋊ab⋉, ⋊ ⋊
⋉⋉, $accb$, $bacc$, $cbac$, $cbcc$, $ccba$, $ccbc$, bcc⋉, bbb⋉, ab ⋉ ⋉, cc ⋉ ⋉, bb ⋉ ⋉, c ⋉
⋉⋉, b ⋉ ⋉⋉}

1. c
2. ε
3. cbacaacab
4. ab

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 904.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {⋊a, ⋊⋉, ⋊b, ab, ba, bb, a⋉}

1. a
2. aaabbabb
3. ε
4. bbbb

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 905.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$aaba$, $addb$, $aeba$, $ddcc$}

1. e

  2. ε
  3. b
  4. a

Solution

  1. Yes
  2. Yes
  3. Yes
  4. Yes

Exercise 906.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes e, ae, ba, ce, de, eb, ec, ed, ee, c\ltimes, a\ltimes\}$

  1. ε
  2. bbadbed
  3. a
  4. beaadcec

Solution

  1. No
  2. No
  3. Yes
  4. No

Exercise 907.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes e, \rtimes\rtimes d, \rtimes de, \rtimes ee, \rtimes d\ltimes, adb, bdc, ceb, dbd, dce, dea, ead, eb\ltimes, ee\ltimes, b\ltimes\ltimes, e\ltimes\ltimes, d\ltimes\ltimes\}$

  1. eec
  2. bdcad
  3. deddaaae
  4. d

Solution

  1. No
  2. No

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3. No
4. Yes

EXERCISE 908.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊b⋉, ⋊bc, aaa, aab, aba, aca, bac, bca, caa, bc⋉, aa⋉, b⋉⋉, c⋉⋉, a⋉⋉}

1. ε
2. baaacabaac
3. b
4. bc

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 909.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊c, ⋊⋊⋊b, ⋊⋊⋊d, ⋊⋊bc, ⋊⋊c⋉, ⋊⋊da, ⋊⋊ce, ⋊ced, ⋊c⋉⋉, ⋊bc⋉, ⋊dac, $abcb$, $acdc$, $bcbd$, $cbdb$, $cdab$, $cdcd$, $dabc$, $dacd$, $dcda$, ced⋉, bdb⋉, db⋉⋉, bc⋉⋉, ed⋉⋉, c⋉⋉⋉, d⋉⋉⋉, b⋉⋉⋉}

1. a
2. beeddbbaecb
3. dcc
4. bbcc

Solution

1. No
2. No
3. No
4. No

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EXERCISE 910.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊d, ⋊ ⋊ ⋊e, ⋊ ⋊ eb, ⋊ ⋊ dc, ⋊ ⋊ ed, ⋊ebe, ⋊dc⋉, ⋊edd, $bccd$, $bedb$, $ccdc$, $cdce$, $ceba$, $dbcc$, $dceb$, $ebed$, $edbc$, eba⋉, edd⋉, dc⋉⋉, ba ⋉ ⋉, dd ⋉ ⋉, c ⋉ ⋉⋉, d ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. adcaedeeea
2. dc
3. abbccb
4. edd

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 911.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: {$aaab$, $bbcb$, $cacb$, $cbab$, $ccbb$}

1. ca
2. ababcab
3. ε
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 912.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊e, ⋊ ⋊ e⋉, ⋊ ⋊ eb, ⋊ ⋊ ec, ⋊ ⋊ cd, ⋊eca, ⋊cda, ⋊e ⋉, ⋊eb⋉, $aede$, $cdae$, $daed$, $deae$, $eaed$, $edea$, eca⋉, aed⋉, eb ⋉ ⋉, ed ⋉ ⋉, ca ⋉ ⋉, d ⋉ ⋉⋉, a ⋉ ⋉⋉, e ⋉ ⋉⋉, b ⋉ ⋉⋉}

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1. cbcccbbba
2. ddaca
3. ε
4. eadab

Solution

1. No
2. No
3. No
4. No

EXERCISE 913.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aabd, abdc, acbb, acbc, adda, ddab\}$

1. baac
2. caaacdcbaba
3. cccbaac
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 914.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaca, abad, abca, bacd, daaa\}$

1. dadbdac
2. ε
3. b
4. cbcdc

Solution

1. Yes
2. Yes

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3. Yes
4. Yes

EXERCISE 915.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, ae, cb, cc, ce, da\}$

1. cbae
2. bda
3. dcbbeea
4. dba

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 916.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes b, bb, bc, cb, cc, c\ltimes\}$

1. bc
2. bbc
3. bca
4. c

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 917.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes aa, \rtimes\rtimes ab, \rtimes aaa, \rtimes abc, aaac, aaca, acac, cacb, abc\ltimes, acb\ltimes, bc\ltimes\ltimes, cb\ltimes\ltimes, c\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

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1. aac
2. acac
3. cbc
4. abc

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 918.

For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, \rtimes c, aa, ab, ac, ba, bc, ca, cb, a\ltimes, c\ltimes\}$

1. bcabc
2. ε
3. baaaa
4. ccaabc

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 919.

For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaba, aabb, baba, bbba\}$

1. ab
2. bbaaab
3. b
4. ε

Solution

1. Yes
2. Yes

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3. Yes
4. Yes

EXERCISE 920.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes c, \rtimes \rtimes b, \rtimes ba, \rtimes ca, abb, aca, bbb, bbc, bcc, cab, cac, cca, bb\ltimes, ba\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. bbcbaaa
2. bacbabaa
3. bbcc
4. baacabc

Solution

1. No
2. No
3. No
4. No

EXERCISE 921.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aba, baa, bab, bba, bbb\}$

1. aababab
2. bab
3. baab
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 922.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, aa, ab, ac, ba, ca, cb, b\ltimes\}$

1. cbbab
2. c
3. ε
4. a

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 923.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes ba, aaa, aab, aba, abb, baa, bab, bba, ab\ltimes, b \ltimes \ltimes\}$

1. abab
2. bbaaaaaba
3. ε
4. baabba

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 924.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes a, aa, ab, ac, ba, bb, ca, cc, a\ltimes\}$

1. cacc
2. babb
3. acaacabba
4. cc

Solution

1. No
2. No

  3. Yes
  4. No

EXERCISE 925.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊⋊⋉, ⋊⋊ba, ⋊⋊b⋉, ⋊⋊⋉⋉, ⋊⋊aa, ⋊aaa, ⋊bab, ⋊⋉⋉⋉, ⋊b ⋉ ⋉, $aaab$, $aaba$, $abab$, $abba$, $baba$, $babb$, $bbab$, bab⋉, abb⋉, ab ⋉ ⋉, bb⋉⋉, b⋉⋉⋉}

  1. ε
  2. b
  3. bab
  4. bbaabab

Solution

  1. Yes
  2. Yes
  3. Yes
  4. No

EXERCISE 926.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {$ac, ba, bb, cc, cd, eb, ee$}

  1. dbaa
  2. ε
  3. dd
  4. a

Solution

  1. No
  2. Yes
  3. Yes
  4. Yes

EXERCISE 927.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

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G^-: $\{abaa, abba, acab, bccb, cbbb, cbcb, cccc\}$

1. bababc
2. baccacaab
3. ε
4. aaabbabcab

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 928.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aba, abb, baa, bab, bba, bbb\}$

1. a
2. ε
3. abaaa
4. b

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 929.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes ac, \rtimes ba, acb, adc, bca, cad, cbc, dc\ltimes, ba\ltimes, a\ltimes\ltimes, c\ltimes\ltimes\}$

1. cc
2. ba
3. dcacdbb
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 930.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{⋊⋊⋊b, ⋊⋊⋊⋉, ⋊⋊⋉⋉, ⋊⋊bb, ⋊⋊ba, ⋊⋊b⋉, ⋊b⋉⋉, ⋊bba, ⋊bab, ⋊⋉⋉⋉, abbb, babb, bbba, bba⋉, ba⋉⋉, a⋉⋉⋉, b⋉⋉⋉\}$

1. b
2. bba
3. abbab
4. ε

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 931.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{⋊d, bb, bc, cd, db, dc, c⋉\}$

1. ca
2. dc
3. dbc
4. bcbbad

Solution

1. No
2. Yes
3. Yes
4. No

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EXERCISE 932.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$abac, abbb, acba, baba, babc, bcaa, ccab, ccac$}

1. ε
2. ccabaac
3. b
4. a

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 933.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: {$daca, dbeb, ebbc, ebed, ecda$}

1. cebeee
2. abebdebe
3. eaadd
4. beeeccc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 934.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: {$\rtimes a, \rtimes \ltimes, aa, ab, ba, bb, b\ltimes$}

1. b
2. ε
3. aab
4. ab

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 935.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{ba, bc, ca, dd\}$

1. bbacacaba
2. cd
3. dcbbbdbbc
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 936.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes b, aa, ab, ba, bb, b\ltimes\}$

1. baa
2. aaaa
3. bbabaaaabaa
4. babaaa

Solution

1. No
2. No
3. No
4. No

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Exercise 937.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊a, ⋊⋉, aa, ab, ba, bb, a⋉}

1. bbab
2. a
3. aa
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 938.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊⋊⋊c, ⋊⋊⋊b, ⋊⋊cb, ⋊⋊ba, ⋊baa, ⋊cbc, ⋊ba⋉, $aaab$, $aaba$, $abaa$, $baaa$, $bcaa$, $caaa$, $cbca$, baa⋉, ⋉, aa⋉⋉, a⋉⋉⋉}

1. baaa
2. baa
3. ba
4. aabb

Solution

1. Yes
2. Yes
3. Yes
4. No

Exercise 939.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ a⋉, ⋊ ⋊ ba, ⋊bab, ⋊a⋉⋉, ⋊ ⋊ ⋉⋉, $abcb$, $babc$, $bacc$, $bcba$, $cbac$, acc⋉, cc⋉⋉, a⋉⋉⋉, c⋉⋉⋉}

1. bcbc
2. ababcc

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3. c
4. ε

Solution

1. No
2. No
3. No
4. Yes

EXERCISE 940.
For each one of the strings below say whether it is generated by the following
positive 2-gram grammar:
G^+: $\{\rtimes a, ab, ba, bb, b\ltimes\}$

1. baa
2. ab
3. babbbb
4. ε

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 941.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes b\ltimes, \rtimes ba, \rtimes aa, aab, abb, baa, bab, bba, ab\ltimes, aa\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. bbabba
2. aab
3. b
4. aa

Solution

1. No
2. Yes
3. Yes

4. Yes

EXERCISE 942.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ba, ⋊ ⋊ ca, ⋊ ⋊ b⋉, ⋊cac, ⋊bab, ⋊ba⋉, ⋊b ⋉ ⋉, $aaca$, $abaa$, $baac$, $baba$, aca⋉, cac⋉, ba ⋉ ⋉, ac ⋉ ⋉, ca ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. b
2. acbc
3. caaca
4. bbac

Solution

1. Yes
2. No
3. No
4. No

EXERCISE 943.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊e, ⋊⋊b, ⋊e⋉, ⋊bd, aad, aba, add, baa, bde, cda, dab, ddb, dec, ecd, db⋉, b⋉, e ⋉ ⋉}

1. a
2. e
3. ebecaeeedab
4. dceacaaaa

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 944.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^-: $\{aca, bda, cbb, daa, dcb\}$

1. daa
2. ε
3. cbb
4. b

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 945.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes b, aa, ac, ba, bb, bc, cb, cc, a\ltimes, b\ltimes\}$

1. bbccacabbb
2. cabba
3. bbca
4. ccb

Solution

1. No
2. No
3. No
4. No

EXERCISE 946.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes \; \rtimes \; \rtimes b, \rtimes \; \rtimes \; \rtimes \ltimes, \rtimes \; \rtimes \; \rtimes d, \rtimes \; \rtimes \; \rtimes e, \rtimes \; \rtimes \; bb, \rtimes \; \rtimes \; ed, \rtimes \; \rtimes \; d\ltimes, \rtimes \; \rtimes \; \ltimes\ltimes, \rtimes ed\ltimes, \rtimes d \; \ltimes \; \ltimes, \rtimes bbc, \rtimes \; \ltimes \; \ltimes\ltimes, addb, bbca, bcad, beea, cadd, dbee, ddbe, eea\ltimes, ea \; \ltimes \; \ltimes, ed \; \ltimes \; \ltimes, d \; \ltimes \; \ltimes\ltimes, a \ltimes \; \ltimes\ltimes\}$

1. ε
2. eabecdd
3. cacba
4. dddaa

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Solution

1. Yes
2. No
3. No
4. No

EXERCISE 947.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aab, aba, acb, bba, cbb\}$

1. cca
2. aabba
3. ε
4. a

Solution

1. Yes
2. No
3. Yes
4. Yes

EXERCISE 948.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaaa, aaba, aabb, abba, baab, baba, bbab, bbbb\}$

1. bbabb
2. bbaa
3. bbbbbb
4. a

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 949.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ac, bb, ca, cc, cd\}$

1. cddcbccddd
2. ab
3. bdc
4. bdcbacbacdc

Solution

1. No
2. Yes
3. Yes
4. No

EXERCISE 950.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aaab, accb, baca, bcba, caca, cacc, ccbc\}$

1. bc
2. ε
3. cac
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 951.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes \rtimes c, \rtimes \rtimes a, \rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes c \ltimes, \rtimes \ltimes, \rtimes bb, \rtimes aa, aab, abb, baa, bba, bb\ltimes, aa\ltimes, b \ltimes \ltimes, a \ltimes \ltimes, c \ltimes \ltimes\}$

1. abbb
2. ε
3. ab

4. babcc

Solution

1. No
2. Yes
3. No
4. No

Exercise 952.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ cc, ⋊ ⋊ ba, ⋊baa, ⋊cc⋉, ⋊ ⋊ ⋉⋉, $aacc, abbc, acca, baac, bbca, bcaa, cabb, ccab, caa$⋉, cc ⋉ ⋉, aa ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉}

1. ε
2. b
3. cbbc
4. abbbaaaa

Solution

1. Yes
2. No
3. No
4. No

Exercise 953.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$aaab, aabb, abaa, abab, abba, baaa, baab, babb$}

1. aaaba
2. b
3. aaababb
4. baba

Solution

1. No
2. Yes
3. No

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4. Yes

Exercise 954.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{adc, bdc, ccb, dbd\}$

1. ε
2. abdab
3. cdcdb
4. dcadacad

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 955.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{ab, bb, bc, ca, cb, da, dd\}$

1. cbbbbd
2. b
3. dbac
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

Exercise 956.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa, aac, abb, abc, aca, acb, bca, cca\}$

1. ε

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2. cc
3. bbaaabcb
4. bbcabbcc

Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 957.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{bd, ca, cb, cc, da\}$

1. b
2. ac
3. ε
4. cbc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 958.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ac, ba, bb, ca, cc\}$

1. ε
2. cc
3. c
4. b

Solution

1. Yes
2. No
3. Yes

4. Yes

EXERCISE 959.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {$\rtimes d, aa, ac, ad, ae, ca, ce, da, dc, ed, e\ltimes$}

1. cddecac
2. aeaccccedbda
3. ddcedbaceae
4. ebedbdcceadc

Solution

1. No
2. No
3. No
4. No

EXERCISE 960.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {aed, bce, cea, ced}

1. e
2. eabddb
3. eeae
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 961.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: {$aaa, aab, bba, bbc, bca, bcb, cba, cbc$}

1. ccc

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2. aa
3. ccbbaccaa
4. cb

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 962.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^{+}: $\{\rtimes \rtimes e, \rtimes \rtimes c, \rtimes cb, \rtimes ee, adb, dad, eda, eed, db\ltimes, cb\ltimes, b \ltimes \ltimes\}$

1. cc
2. ε
3. ee
4. bd

Solution

1. No
2. No
3. No
4. No

EXERCISE 963.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^{-}: $\{aa, ba, bc, bd, cd, db\}$

1. cadccd
2. cdcbdcadb
3. b
4. ε

Solution

1. No
2. No
3. Yes

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4. Yes

EXERCISE 964.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{aaab, aaba, abab, baab\}$

1. aaab
2. a
3. b
4. ε

Solution

1. No
2. Yes
3. Yes
4. Yes

EXERCISE 965.
For each one of the strings below say whether it is generated by the following
positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes c, \rtimes\rtimes\ltimes, \rtimes c\ltimes, \rtimes\ltimes\ltimes, \rtimes ac, \rtimes ab, aca, acb, bca, cab, cac, cbc, ab\ltimes, b\ltimes\ltimes, c\ltimes\ltimes\}$

1. cc
2. bb
3. cabac
4. abbcb

Solution

1. No
2. No
3. No
4. No

EXERCISE 966.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa, ad, bc, bd, da, db, dd\}$

1. b
2. ε
3. ccd
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 967.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aec, cac, cce, dad\}$

1. a
2. ε
3. d
4. b

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 968.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aaa, aab, aba, abb\}$

1. abbbbba
2. abbbaabbabba
3. aaaaabaabab
4. bbbaaabaa

Solution

1. No
2. No

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3. No
4. No

EXERCISE 969.
For each one of the strings below say whether it is generated by the following
positive 4-gram grammar:
G^+:　　$\{\ltimes\quad\ltimes\quad\ltimes a,\ltimes\quad\ltimes\quad\ltimes b,\ltimes\quad\ltimes\quad aa,\ltimes\quad\ltimes\quad ab,\ltimes\quad\ltimes\quad b\ltimes,\ltimes b\quad\ltimes$
$\ltimes,\ltimes aaa,\ltimes abb,aaaa,aaab,aaba,abb\ltimes,aba\ltimes,ba\ltimes\ltimes,bb\ltimes\ltimes,a\ltimes\ltimes\ltimes,b\ltimes\ltimes\ltimes\}$

1. bbaaba
2. b
3. ε
4. a

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 970.
For each one of the strings below say whether it is generated by the following
negative 2-gram grammar:
G^-: $\{aa,ab,ac,bb,ca,cb\}$

1. cbcbb
2. ε
3. bb
4. abcab

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 971.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{aaa,aab,aca,acc,cab\}$

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1. bac
2. ε
3. b
4. bc

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 972.
For each one of the strings below say whether it is generated by the following
negative 3-gram grammar:
G^-: $\{bbd, ccd, dcc, dda, ddb, ddc\}$

1. b
2. adcacab
3. abcbccb
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 973.
For each one of the strings below say whether it is generated by the following
negative 4-gram grammar:
G^-: $\{abcd, bbdd, bddc, ccac, ddbc\}$

1. bab
2. ccddbb
3. ε
4. dbacbaa

Solution

1. Yes
2. Yes

3. Yes
4. Yes

EXERCISE 974.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊a⋉, ⋊bb, acc, bac, bba, cab, cca, ab⋉, b ⋉ ⋉, a ⋉ ⋉}

1. cba
2. a
3. bcccbbb
4. bcaacba

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 975.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊a, ⋊⋉, ab, ac, bc, bd, cb, cd, da, db, dc, c⋉}

1. dbbaccbcbaac
2. cbcd
3. addaa
4. ccdbd

Solution

1. No
2. No
3. No
4. No

EXERCISE 976.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: {$aaaa$, $accc$, $babb$, $bbbc$, $bcab$, $cacc$}

1. aac
2. cbcaac
3. abcaac
4. cb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 977.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{ \rtimes b, ac, ae, ba, bb, ca, ec, ee, c \ltimes \}$

1. bbac
2. bac
3. baec
4. d

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 978.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{ \rtimes a, ab, ba, bb, a \ltimes \}$

1. abaab
2. b
3. aba
4. a

Solution

1. No
2. No

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   3. Yes

   4. Yes

EXERCISE 979.

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

G^-: $\{aaed, adba, beae, ccdb, cddb, ceab\}$

1. d
2. eabcbdcbace
3. ddbceccce
4. ε

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 980.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes\ltimes, \rtimes b, \rtimes c, aa, ac, ba, cb, c\ltimes, b\ltimes\}$

1. acac
2. ε
3. bbbb
4. cbba

Solution

1. No
2. Yes
3. No
4. No

EXERCISE 981.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes \rtimes a, \rtimes \rtimes d, \rtimes dc, \rtimes ac, acb, bcb, bdc, cbc, cbd, dca, dc\ltimes, ca\ltimes, a \ltimes \ltimes, c \ltimes \ltimes\}$

1. cddaa
2. ba
3. ε
4. dabbbb

Solution

1. No
2. No
3. No
4. No

EXERCISE 982.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, ac, bb, bc, cb, cc\}$

1. a
2. b
3. ε
4. abba

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 983.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes a\ltimes, \rtimes\rtimes ad, \rtimes a\ltimes\ltimes, \rtimes ade, aade, adea, deaa, eaad, ade\ltimes, de\ltimes\ltimes, a\ltimes\ltimes\ltimes, e\ltimes\ltimes\ltimes\}$

1. ade
2. becccdc
3. a
4. cdee

Solution

1. Yes

   2. No

   3. Yes

   4. No

EXERCISE 984.

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

G^+: $\{\rtimes b, aa, ab, ba, bb, b\ltimes\}$

   1. bab

   2. ε

   3. bb

   4. b

Solution

   1. Yes

   2. No

   3. Yes

   4. Yes

EXERCISE 985.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

G^+: $\{\rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes ba, \rtimes bb, aab, aba, abb, baa, bab, bba, bbb, bb\ltimes, aa\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

   1. bbbbbbbb

   2. b

   3. bbaabaaaba

   4. bbbbababaa

Solution

   1. Yes

   2. No

   3. No

   4. Yes

EXERCISE 986.

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

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G^+: {⋊⋊⋉, ⋊⋊a, ⋊⋊b, ⋊ac, ⋊⋉⋉, ⋊bc, abb, acb, baa, bab, bba, bbb, bca, cac, cba, aa⋉, ac⋉, c⋉⋉, a ⋉ ⋉}

1. bcac
2. ac
3. ε
4. bcbccabc

Solution

1. Yes
2. Yes
3. Yes
4. No

EXERCISE 987.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊c, ⋊⋊a, ⋊a⋉, ⋊ca, ade, bbc, bcc, cad, ccb, dbb, ded, edb, cb⋉, b⋉⋉, a⋉⋉}

1. bb
2. eadda
3. a
4. aaaacd

Solution

1. No
2. No
3. Yes
4. No

EXERCISE 988.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ aa, ⋊ ⋊ ⋉⋉, ⋊ ⋊ bb, ⋊aab, ⋊ ⋊ ⋉⋉, ⋊bb⋉, aaba, abaa, baab, aab⋉, ab ⋉ ⋉, bb ⋉ ⋉, b ⋉ ⋉⋉}

1. bb
2. ε
3. aabaa
4. bbba

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Solution

1. Yes
2. Yes
3. No
4. No

EXERCISE 989.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^{+}: {⋊⋊⋊a, ⋊⋊⋊⋉, ⋊⋊⋊d, ⋊⋊dd, ⋊⋊⋉⋉, ⋊⋊a⋉, ⋊a⋉⋉, ⋊ddc, ⋊⋊⋉⋉, $bada$, $bddb$, $cbdd$, $ccbd$, $dbad$, $dccb$, $ddba$, $ddcc$, ada⋉, da⋉⋉, a⋉⋉⋉}

1. abdcbbab
2. a
3. abcc
4. ε

Solution

1. No
2. Yes
3. No
4. Yes

EXERCISE 990.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

G^{-}: {aab, abb, abc, acb, baa, bab, bcb, cba}

1. ε
2. aacba
3. b
4. ccba

Solution

1. Yes
2. No
3. Yes
4. No

EXERCISE 991.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: $\{aa, ab, ba, bb\}$

1. babba
2. ab
3. ε
4. b

Solution

1. No
2. No
3. Yes
4. Yes

EXERCISE 992.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{abc, ace, ade, bee, eba, ecc\}$

1. ε
2. eedb
3. b
4. dcbdda

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 993.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{babb, bacc, bbaa, bcab, bcbc, ccab\}$

1. b
2. ε
3. ab
4. a

Solution

1. Yes
2. Yes
3. Yes
4. Yes

Exercise 994.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ b⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ ba, ⋊bab, ⋊ba⋉, ⋊ ⋉ ⋉⋉, ⋊b ⋉ ⋉, $aaaa$, $abba$, $baaa$, $babb$, $bbaa$, aaa⋉, ba ⋉ ⋉, aa ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. b
2. ba
3. bbba
4. a

Solution

1. Yes
2. Yes
3. No
4. No

Exercise 995.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊ ⋊ c, ⋊ ⋊ b, ⋊b⋉, ⋊ca, aab, aba, bac, caa, ac⋉, ca⋉, b ⋉ ⋉, a ⋉ ⋉, c ⋉ ⋉}

1. b
2. c
3. cabcbc
4. ca

Solution

1. Yes
2. No
3. No
4. Yes

EXERCISE 996.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes d, ac, ad, bd, cb, da, db, dc, dd, c\ltimes\}$

1. dc
2. ddc
3. adcbdaacdc
4. dac

Solution

1. Yes
2. Yes
3. No
4. Yes

EXERCISE 997.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes a\ltimes, \rtimes\ltimes\ltimes, \rtimes ba, \rtimes bb, aba, abb, baa, bab, bba, aa\ltimes, ba\ltimes, a\ltimes\ltimes\}$

1. bbbaaaa
2. aababb
3. bbbbbba
4. aaaab

Solution

1. No
2. No
3. No
4. No

EXERCISE 998.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{adaa, bceb, ccab, cebb\}$

1. ε
2. bcc
3. cbcdcbeac

4. addedb

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 999.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abcc, adaa, cdcc, daad, dccd\}$

1. ε
2. cddbb
3. cadadaba
4. dbdbd

Solution

1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 1000.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{abbc, cbbb, cccc, cdba\}$

1. ca
2. dddd
3. bdcd
4. dbd

Solution

1. Yes
2. Yes
3. Yes
4. Yes