1000 automatically generated exercises with n-gram grammars

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

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

SOLUTION TO EXERCISE 1.
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 TO EXERCISE 2.
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. bcccccca
4. bcaa

SOLUTION TO EXERCISE 3.
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 TO EXERCISE 4.
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 TO EXERCISE 5.
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^+:   {⋈   ⋈   ⋈b, ⋈   ⋈   ⋈d, ⋈   ⋈ bc, ⋈   ⋈ bd, ⋈   ⋈ da, ⋈da⋈, ⋈bdb, ⋈bcc, $accc$, $bcca$, $cacc$, $ccac$, $cccd$, $ccdb$, $cdbc$, bdb⋈, dbc⋈, db ⋈ ⋈, bc ⋈ ⋈, da ⋈ ⋈, c ⋈ ⋈⋈, a ⋈ ⋈⋈, b ⋈ ⋈⋈}

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

SOLUTION TO EXERCISE 6.
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 TO EXERCISE 7.
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 TO EXERCISE 8.
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^+: $\{\rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes \rtimes bb, \rtimes \rtimes b\ltimes, \rtimes \ltimes \ltimes \ltimes, \rtimes bbb, \rtimes b \rtimes \ltimes, aabb, abbb, baab, bbaa, bbba, bbbb, bbb\ltimes, bb \ltimes \ltimes, b \ltimes \ltimes \ltimes\}$

1. ε
2. aabb
3. b
4. aab

SOLUTION TO EXERCISE 9.
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 TO EXERCISE 10.
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 TO EXERCISE 11.
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 to Exercise 12.
1. No
2. No
3. Yes
4. No

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 to Exercise 13.
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 to Exercise 14.
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 TO EXERCISE 15.
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^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes b\ltimes, \rtimes ab, \rtimes ba, aba, abb, acb, bab, bac, bba, bbb, bbc, cbb, bc\ltimes, ba\ltimes, c\ltimes\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

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

SOLUTION TO EXERCISE 16.
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 TO EXERCISE 17.
1. Yes
2. Yes
3. Yes
4. Yes

EXERCISE 18.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes c, \rtimes c\ltimes, \rtimes\ltimes\ltimes, \rtimes cc, aba, acb, bab, bac, bba, bbb, bca, cbb, cbc, ccb, ca\ltimes, a\ltimes\ltimes, c\ltimes\ltimes\}$

1. ε
2. bacbccca
3. c
4. abcbcbccbb

SOLUTION TO EXERCISE 18.
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 TO EXERCISE 19.
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 TO EXERCISE 20.
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 TO EXERCISE 21.
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 to Exercise 22.
1. Yes
2. Yes
3. Yes
4. Yes

Exercise 23.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes dc, \rtimes \rtimes c\ltimes, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes cc, \rtimes \rtimes ad, \rtimes cca, \rtimes c \ltimes \ltimes, \rtimes dc\ltimes, \rtimes \ltimes\ltimes, \rtimes ada, aada, abdd, adab, caad, ccaa, dabd, bdd\ltimes, ada\ltimes, dc \ltimes \ltimes, dd \ltimes, da \ltimes \ltimes, c \ltimes \ltimes\ltimes, d \ltimes \ltimes\ltimes, a \ltimes \ltimes\ltimes\}$

1. cbccbad
2. ε
3. ccc
4. ba

Solution to Exercise 23.
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 TO EXERCISE 24.
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^+: $\{\rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes bb, aca, ada, bac, bba, bbb, cad, dad, ad\ltimes, d \ltimes \ltimes\}$

1. cbabbaba
2. bbbacad
3. ε
4. bbacad

SOLUTION TO EXERCISE 25.
1. No
2. Yes
3. Yes
4. Yes

EXERCISE 26.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{bacd, bbdd, cbba, ccbb, cccb, dabc, dbbc\}$

1. cd
2. dca
3. ε
4. a

SOLUTION TO EXERCISE 26.
1. Yes
2. Yes
3. Yes
4. Yes

Exercise 27.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aab, caa, cab, cba\}$

1. cbccaaa
2. c
3. cc
4. bcbcb

> **Solution to Exercise 27.**
> 1. No
> 2. Yes
> 3. Yes
> 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 to Exercise 28.**
> 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 TO EXERCISE 29.
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 TO EXERCISE 30.
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

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

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

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 TO EXERCISE 34.
1. Yes
2. Yes
3. Yes
4. Yes

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 TO EXERCISE 35.
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 TO EXERCISE 36.
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
4. baababa

SOLUTION TO EXERCISE 37.
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 TO EXERCISE 38.
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 TO EXERCISE 39.
1. Yes
2. Yes
3. No
4. Yes

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 TO EXERCISE 40.
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 TO EXERCISE 41.

    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
    4. bb

SOLUTION TO EXERCISE 42.

    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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes ac, \rtimes\rtimes a\ltimes, \rtimes a\ltimes\ltimes, \rtimes acb, aaab, acaa, acba, baca, caaa, cbac, aab\ltimes, ab\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

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

SOLUTION TO EXERCISE 43.

    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 TO EXERCISE 44.
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 TO EXERCISE 45.
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 TO EXERCISE 46.
    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 TO EXERCISE 47.
    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 TO EXERCISE 48.
    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^+: $\{$⋊ ⋊ e, ⋊ ⋊ c, ⋊ ⋊ ⋉, ⋊c⋉, ⋊ ⋉ ⋉, ⋊ee, aad, ada, dad, eaa, eea, ad⋉, d ⋉ ⋉, c ⋉ ⋉$\}$

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

Solution to Exercise 49.

1. No
2. No
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 to Exercise 50.

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 to Exercise 51.
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 to Exercise 52.
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^+: {⋊⋉, ⋊b, bc, cc, cd, db, b⋉}

1. ε
2. a
3. dacb
4. dadcaa

Solution to Exercise 53.
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^+: {⋊ ⋊ c, ⋊ ⋊ ⋊, ⋊ ⋊ d, ⋊ ⋊ b, ⋊cb, ⋊db, ⋊ ⋊ ⋉, ⋊b⋉, aba, bbd, bdb, bee, dbb, dbe, eab, eea, cb⋉, ba⋉, b⋉⋉, a⋉⋉}

1. cb
2. ε
3. dbddaee
4. b

SOLUTION TO EXERCISE 54.
1. Yes
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 TO EXERCISE 55.
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 TO EXERCISE 56.
    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^-: $\{aa, ab, ac, ba, bc, cb, cc\}$

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

SOLUTION TO EXERCISE 57.
    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^+: $\{ \rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes b, \rtimes \rtimes c\ltimes, \rtimes \rtimes cc, \rtimes \rtimes bc, \rtimes cca, \rtimes c \ltimes, \rtimes bcb, adcd, cadc, ccad, dcdc, cdc\ltimes, bcb\ltimes, dc \ltimes \ltimes, cb \ltimes \ltimes, c \ltimes \ltimes \ltimes, b \ltimes \ltimes \ltimes \}$

    1. d
    2. dcadb
    3. bcd
    4. ε

SOLUTION TO EXERCISE 58.
    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

SOLUTION TO EXERCISE 59.

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 TO EXERCISE 60.

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 TO EXERCISE 61.

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

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 TO EXERCISE 62.

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 to Exercise 63.
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^+: $\{\rtimes a, ab, ac, ba, bb, bc, ca, cb, cc, a\ltimes, b\ltimes\}$

1. ab
2. a
3. bbabbbbcca
4. acb

Solution to Exercise 64.
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 to Exercise 65.
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 TO EXERCISE 66.

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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes\ltimes, \rtimes\rtimes\ltimes\ltimes, \rtimes\rtimes\rtimes ab, \rtimes aba, \rtimes\rtimes\ltimes\ltimes, aaba, aabb, abaa, abab, baab, baba, aba\ltimes, abb\ltimes, ba\ltimes\ltimes, bb\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. ε
2. babbbbaba
3. bbbb
4. aba

SOLUTION TO EXERCISE 67.

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^+: $\{\rtimes\rtimes\rtimes b, \rtimes\rtimes ba, \rtimes\rtimes b\ltimes, \rtimes b\ltimes\ltimes, \rtimes baa, aaab, aabb, abbb, baaa, bbaa, bbba, baa\ltimes, aa\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. b

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2. aaabbbbbb
3. ε
4. babbbaaaa

SOLUTION TO EXERCISE 68.
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^+: $\{\rtimes \rtimes b, \rtimes b\ltimes, \rtimes bb, bac, bbc, bcb, cba, ac\ltimes, b \ltimes \ltimes, c \ltimes \ltimes\}$

1. bcca
2. cb
3. c
4. b

SOLUTION TO EXERCISE 69.
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 TO EXERCISE 70.
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 TO EXERCISE 71.
1. Yes
2. No
3. Yes
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 TO EXERCISE 72.
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 TO EXERCISE 73.

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 TO EXERCISE 74.

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^+: $\{\rtimes \rtimes \rtimes e, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes ea, \rtimes ead, \rtimes \rtimes \ltimes\ltimes, adbe, becc, ccea, cead, dbec, eadb, ecce, adb\ltimes, db \ltimes \ltimes, b \ltimes \ltimes\ltimes\}$

1. eabcc
2. e
3. adbabdaa

    4. ebaadcedae

SOLUTION TO EXERCISE 75.
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^+: $\{\rtimes c, ac, ca, cc, c\ltimes\}$

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

SOLUTION TO EXERCISE 76.
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 TO EXERCISE 77.
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 TO EXERCISE 78.
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 TO EXERCISE 79.
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 to Exercise 80.
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 to Exercise 81.
1. Yes
2. Yes
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 to Exercise 82.
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 TO EXERCISE 83.

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 TO EXERCISE 84.

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 TO EXERCISE 85.
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^+: {⋈⋈c, ⋈⋈a, ⋈⋈d, ⋈a⋈, ⋈dd, ⋈cc, aad, aca, adb, bac, cad, daa, dba, dda, ad⋈, cc⋈, d⋈⋈, c⋈⋈, a⋈⋈}

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

SOLUTION TO EXERCISE 86.
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 TO EXERCISE 87.
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. bacccca
3. aac
4. abcaabcb

SOLUTION TO EXERCISE 88.
1. No
2. No
3. No
4. No

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 TO EXERCISE 89.
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 TO EXERCISE 90.
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^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ b⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ aa, ⋊ ⋊ ba, ⋊aaa, ⋊baa, ⋊ba⋉, ⋊ ⋉ ⋉⋉, ⋊b ⋉ ⋉, $aaaa$, $aaab$, $aabb$, $abba$, baa⋉, bba⋉, ba⋉⋉, aa⋉⋉, a⋉⋉⋉, b⋉⋉⋉}

1. bbbaa
2. ε
3. baaa
4. a

SOLUTION TO EXERCISE 91.
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 to Exercise 92.
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 to Exercise 93.
1. Yes
2. Yes
3. Yes
4. Yes

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 to Exercise 94.
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 TO EXERCISE 95.
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
4. e

SOLUTION TO EXERCISE 96.
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 to Exercise 97.
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 to Exercise 98.
1. Yes
2. No
3. Yes
4. No

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

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

Solution to Exercise 99.
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 TO EXERCISE 100.

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 TO EXERCISE 101.

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 to Exercise 102.
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^+: {⋈⋈a, ⋈⋈b, ⋈⋈⋈, ⋈⋈⋈, ⋈b⋈, ⋈aa, aaa, aab, aba, abb, baa, bab, bba, aa⋈, b⋈⋈, a⋈⋈}

1. ε
2. b
3. baba
4. aa

Solution to Exercise 103.
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 to Exercise 104.
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^+:   {⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋉⋉, ⋊ ⋊ ba, ⋊ ⋊ ⋉⋉, ⋊baa, aabb, abba, baab, baba, bbab, aba⋉, ba ⋉ ⋉, a ⋉ ⋉⋉}

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

SOLUTION TO EXERCISE 105.
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^+: {⋊c, aa, ab, ac, ba, ca, cc, c⋉}

1. cbc
2. ε
3. abcaac
4. c

SOLUTION TO EXERCISE 106.
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 TO EXERCISE 107.
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 TO EXERCISE 108.
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 TO EXERCISE 109.
1. No
2. No
3. No
4. Yes

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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 TO EXERCISE 110.
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 TO EXERCISE 111.
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^+: $\{\rtimes\rtimes c, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes ba, \rtimes cd, abd, bab, bdc, cce, cde, cec, dcc, ecd, de\ltimes, cd\ltimes, e\ltimes\ltimes, d\ltimes\ltimes\}$

1. deebebab
2. d
3. dcddcdcee

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4. abcdecdbc

Solution to Exercise 112.
   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 to Exercise 113.
      1. No
      2. Yes
      3. Yes
      4. Yes

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 to Exercise 114.
      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 TO EXERCISE 115.
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

SOLUTION TO EXERCISE 116.
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^+: $\{\rtimes\rtimes\rtimes b, \rtimes\rtimes bb, \rtimes bba, \rtimes bb\ltimes, \rtimes bbb, babb, bbab, bbba, bbbb, bba\ltimes, abb\ltimes, ba\ltimes \ltimes, bb \ltimes \ltimes, a \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. b
2. bb
3. aaaa

4. bba

SOLUTION TO EXERCISE 117.
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 TO EXERCISE 118.
1. No
2. No
3. Yes
4. No

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 TO EXERCISE 119.
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 to Exercise 120.

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 to Exercise 121.

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 TO EXERCISE 122.
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 TO EXERCISE 123.
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^+: $\{\rtimes\ \rtimes\ \rtimes\ltimes, \rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ aa, \rtimes\ \rtimes\ \ltimes\ltimes, \rtimes\ \ltimes\ltimes, \rtimes aab, aabb, abba, baaa, bbaa, aaa\ltimes, aa\ltimes\ltimes, a\ltimes\ltimes\ltimes\}$

1. bbbaa
2. ab
3. ε
4. abbaba

SOLUTION TO EXERCISE 124.
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 to Exercise 125.
   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
3. abac
4. acac

   Solution to Exercise 126.
   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 to Exercise 127.
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 to Exercise 128.
1. No
2. No
3. No
4. Yes

Exercise 129.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: $\{\rtimes\rtimes a, \rtimes\rtimes d, \rtimes d\ltimes, \rtimes ac, aab, aac, abd, aca, acb, bcd, caa, cbc, cda, daa, bd\ltimes, d\ltimes\ltimes\}$

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

Solution to Exercise 129.
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 TO EXERCISE 130.
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^+: $\{\rtimes\rtimes c, \rtimes\rtimes a, \rtimes c\ltimes, \rtimes ac, abb, aca, bbb, bbc, bcb, cab, cbb, bb\ltimes, b\ltimes\ltimes, c\ltimes\ltimes\}$

1. bbb
2. ε
3. ca
4. abcc

SOLUTION TO EXERCISE 131.
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 to Exercise 132.
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 to Exercise 133.
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 to Exercise 134.
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 TO EXERCISE 135.
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

SOLUTION TO EXERCISE 136.
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 to Exercise 137.
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 to Exercise 138.
1. No
2. No
3. No
4. No

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 to Exercise 139.
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^+: {⋊⋊c, ⋊⋊d, ⋊ca, ⋊de, ⋊d⋉, aba, aec, bae, cab, ced, dec, eca, ece, edc, dc⋉, ca⋉, d⋉⋉, c⋉⋉, a⋉⋉}

1. ε
2. eadb
3. eadbaebeaa
4. dedb

Solution to Exercise 140.
   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^+: {⋊⋉, ⋊d, ac, bd, da, dd, de, eb, ee, c⋉}

1. ε
2. accebcbbc
3. eecdbbbebe
4. beedbebece

Solution to Exercise 141.
   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^+: {⋊c, cc, cd, dc, dd, c⋉}

1. ace
2. deeda
3. c

4. cc

Solution to Exercise 142.
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^+: {⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊aa, ⋊⋊ba, ⋊aab, ⋊baa, $aabb$, $abbb$, $baab$, $babb$, $bbab$, $bbba$, aab⋉, abb⋉, ab⋉⋉, bb⋉⋉, b⋉⋉⋉}

1. aabbbbb
2. ε
3. babb
4. b

Solution to Exercise 143.
1. No
2. No
3. No
4. No

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 to Exercise 144.
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^+: $\{\rtimes\ltimes, \rtimes b, ac, ad, ba, cd, da, dd, a\ltimes, b\ltimes\}$

1. ε
2. ababdabc
3. b
4. ddb

Solution to Exercise 145.
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
4. b

Solution to Exercise 146.
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 to Exercise 147.
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 to Exercise 148.
1. Yes
2. Yes
3. Yes
4. Yes

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 to Exercise 149.
    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^+: {⋈ ⋈ ⋈⋈, ⋈ ⋈ ⋈a, ⋈ ⋈ ⋈⋈, ⋈ ⋈ ac, ⋈ ⋈ a⋈, ⋈a ⋈ ⋈, ⋈acb, ⋈ ⋈ ⋈⋈, $acbd$, $bdca$, $cbdc$, acb⋈, dca⋈, cb ⋈ ⋈, ca ⋈ ⋈, a ⋈ ⋈⋈, b ⋈ ⋈⋈}

    1. ε
    2. cccdd
    3. b
    4. bacaab

    Solution to Exercise 150.
        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^+: {⋈⋈b, ⋈bc, ⋈bb, aac, aba, aca, baa, bab, bbb, bbc, bcc, cba, ccb, bc⋈, ca⋈, c⋈ ⋈, a ⋈ ⋈}

    1. bc
    2. bbbc
    3. bbc
    4. cbabaaaab

    Solution to Exercise 151.
        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 to Exercise 152.
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 to Exercise 153.
1. No
2. Yes
3. Yes
4. No

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

1. cd
2. ca
3. ε

   4. cad

   SOLUTION TO EXERCISE 154.
      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 TO EXERCISE 155.
      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 TO EXERCISE 156.
      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 TO EXERCISE 157.
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 TO EXERCISE 158.
1. No
2. No
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 to Exercise 159.
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 to Exercise 160.
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 to Exercise 161.
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 TO EXERCISE 162.
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 TO EXERCISE 163.
1. Yes
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^+: {⋊ ⋊ ⋉, ⋊ ⋊ a, ⋊ ⋉ ⋉, ⋊ac, acd, ace, cdd, cec, dac, dda, ecd, cd⋉, d ⋉ ⋉}

1. bbdccceab
2. acecd
3. ε

4. acd

Solution to Exercise 164.
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 to Exercise 165.
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 to Exercise 166.
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 TO EXERCISE 167.
      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 TO EXERCISE 168.
      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 to Exercise 169.
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 to Exercise 170.
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 to Exercise 171.
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 TO EXERCISE 172.
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 TO EXERCISE 173.
1. No
2. Yes
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

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Solution to Exercise 174.
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 to Exercise 175.
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}

1. cbeeccadca
2. e
3. b
4. ε

Solution to Exercise 176.
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 TO EXERCISE 177.
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 TO EXERCISE 178.
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 TO EXERCISE 179.

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 TO EXERCISE 180.

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:

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

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

SOLUTION TO EXERCISE 181.

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^+: {⋊ ⋊ d, ⋊da, acc, acd, bac, cba, ccb, dac, cd⋉, d ⋉ ⋉}

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

    SOLUTION TO EXERCISE 182.
       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^+: {⋊ ⋊ ⋉, ⋊ ⋊ c, ⋊ ⋉ ⋉, ⋊ca, abc, bcc, cab, cba, ccb, ba⋉, a ⋉ ⋉}

1. ac
2. accca
3. ε
4. acbbbc

    SOLUTION TO EXERCISE 183.
       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 TO EXERCISE 184.
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^+: {⋊ ⋉ ⋊a,⋊ ⋉ ⋊c,⋊ ⋉ ⋊⋉,⋊ ⋉ cb,⋊ ac,⋊ ⋉ ⋉⋉,⋊ ⋉ a⋉,⋊a ⋉ ⋉,⋊ac⋉,⋊cbb,⋊ ⋉ ⋉⋉, abca, babc, bbcb, bcab, bcba, cabc, cbab, cbbc, abc⋉, ac ⋊ ⋉, bc ⋊ ⋉, c ⋊ ⋉⋉, a ⋊ ⋉⋉}

1. ac
2. ε
3. cbbcba
4. ccbbcbabc

SOLUTION TO EXERCISE 185.
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 to Exercise 186.
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^+: $\{\rtimes \rtimes \rtimes e, \rtimes \rtimes ea, \rtimes eac, accc, ccca, cccc, eacc, cca \ltimes, ca \ltimes \ltimes, a \ltimes \ltimes \ltimes\}$

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

Solution to Exercise 187.
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

Solution to Exercise 188.
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 TO EXERCISE 189.
    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^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes a, \rtimes a\ltimes, \rtimes\ltimes\ltimes, \rtimes ac, aab, acb, baa, bba, cbb, ab\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. bba
2. c
3. a
4. ε

    SOLUTION TO EXERCISE 190.
    1. No
    2. No
    3. Yes
    4. Yes

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 to Exercise 191.
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 to Exercise 192.
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

Solution to Exercise 193.
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 TO EXERCISE 194.

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 TO EXERCISE 195.

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

EXERCISE 196.

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

G^+: {$\rtimes \rtimes d$, $\rtimes da$, aba, abb, bbe, bed, dab, eda, $ba\ltimes$, $a \ltimes \ltimes$}

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

Solution to Exercise 196.
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^+: $\{ \rtimes \rtimes a, \rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes ab, \rtimes b\ltimes, abb, bbb, bb\ltimes, b \ltimes \ltimes \}$

1. aaa
2. ε
3. aab
4. babaab

Solution to Exercise 197.
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^+: $\{ \rtimes\rtimes\rtimes e, \rtimes\rtimes eb, \rtimes\rtimes ed, \rtimes ebd, \rtimes eda, aace, aced, cedb, daac, dbda, edaa, edbd, ebd\ltimes, bda\ltimes, bd\ltimes \ltimes, da \ltimes \ltimes, a \ltimes \ltimes\ltimes, d \ltimes \ltimes\ltimes \}$

1. ceaee
2. aacccca
3. aedbb
4. beeede

Solution to Exercise 198.
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 TO EXERCISE 199.
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^+: $\{\rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes d \ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes \rtimes cc, \rtimes \rtimes cd, \rtimes cda, \rtimes d \ltimes \ltimes, \rtimes cc \ltimes, \rtimes \ltimes \ltimes \ltimes, abbe, cdab, dabb, bbe \ltimes, be \ltimes \ltimes, cc \ltimes \ltimes, c \ltimes \ltimes \ltimes, d \ltimes \ltimes \ltimes, e \ltimes \ltimes \ltimes\}$

1. d
2. ε
3. b
4. da

SOLUTION TO EXERCISE 200.
1. Yes
2. Yes
3. No
4. No

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 TO EXERCISE 201.
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 TO EXERCISE 202.
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

SOLUTION TO EXERCISE 203.
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^+: {⋈ ⋈ b, ⋈bc, aac, baa, bbc, bcb, bcd, cba, cbb, cdc, dcb, ac⋈, c ⋈ ⋈}

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

    SOLUTION TO EXERCISE 204.
    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 TO EXERCISE 205.
    1. No
    2. No
    3. No
    4. No

EXERCISE 206.

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, baa, bb⋈, ba⋈, b ⋈ ⋈, a ⋈ ⋈}

1. aba
2. bb
3. c
4. ε

SOLUTION TO EXERCISE 206.
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 TO EXERCISE 207.
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

SOLUTION TO EXERCISE 208.
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 TO EXERCISE 209.
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 TO EXERCISE 210.
1. Yes
2. No
3. Yes
4. Yes

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 TO EXERCISE 211.
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^+: {⋈⋈⋈a, ⋈⋈ab, ⋈⋈a⋈, ⋈a⋈⋈, ⋈abc, $abca$, $abcb$, $bcab$, $bcbb$, $cabc$, cbb⋈, bb⋈⋈, a⋈⋈⋈, b⋈⋈⋈}

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

    SOLUTION TO EXERCISE 212.
      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 TO EXERCISE 213.
      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 TO EXERCISE 214.
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 TO EXERCISE 215.
1. Yes
2. No
3. No
4. No

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 to Exercise 216.
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:
$G^+: \{⋊⋊a, ⋊⋊b, ⋊bb, ⋊ad, acb, bac, bba, bbd, bde, cbb, ad⋉, de⋉, e⋉⋉, d⋉⋉\}$

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

Solution to Exercise 217.
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 to Exercise 218.
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^+: {⋊⋊a, ⋊⋊b, ⋊b⋉, ⋊bb, ⋊aa, aab, aba, abb, baa, bab, bba, bbb, aa⋉, ba⋉, b⋉⋉, a⋉⋉}

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

SOLUTION TO EXERCISE 219.
    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 TO EXERCISE 220.
    1. Yes
    2. Yes
    3. Yes
    4. No

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 to Exercise 221.
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 to Exercise 222.
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 to Exercise 223.
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^+: {⋊$d, aa, bb, be, cb, cc, ce, dc, ea, ec, a$⋉$, d$⋉}

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

SOLUTION TO EXERCISE 224.
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 TO EXERCISE 225.
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 TO EXERCISE 226.
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^+: $\{\rtimes\ltimes, \rtimes d, ab, ac, ba, bb, be, ca, da, ea, a\ltimes\}$

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

SOLUTION TO EXERCISE 227.
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^+: $\{\rtimes b, aa, ac, bc, ca, cb, c\ltimes\}$

1. cbcc
2. a
3. bc
4. ccacbca

SOLUTION TO EXERCISE 228.
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 TO EXERCISE 229.
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 TO EXERCISE 230.
1. Yes
2. No
3. No
4. No

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 to Exercise 231.
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 to Exercise 232.
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 to Exercise 233.
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 TO EXERCISE 234.

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 TO EXERCISE 235.

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

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 TO EXERCISE 236.
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 TO EXERCISE 237.
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 TO EXERCISE 238.
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^+: {⋊⋉, ⋊b, aa, ab, ba, b⋉}

1. bbab
2. aabb
3. abbaa
4. ε

SOLUTION TO EXERCISE 239.
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 TO EXERCISE 240.
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 TO EXERCISE 241.
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 TO EXERCISE 242.
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

SOLUTION TO EXERCISE 243.
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^+: {⋊ ⋊ b, ⋊ ⋊ ⋉, ⋊ ⋉ ⋉, ⋊bb, aab, abd, baa, bba, bdd, daa, dda, ab⋉, b ⋉ ⋉}

1. deccae
2. ε
3. bbaab
4. bbdaedbe

SOLUTION TO EXERCISE 244.

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^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊a⋉, ⋊bd, aba, bab, bdb, dba, ba⋉, a ⋉ ⋉}

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

SOLUTION TO EXERCISE 245.

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

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 to Exercise 246.
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 to Exercise 247.
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

Solution to Exercise 248.
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 TO EXERCISE 249.

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 TO EXERCISE 250.

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 TO EXERCISE 251.
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 TO EXERCISE 252.
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 TO EXERCISE 253.
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 TO EXERCISE 254.**
> 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 TO EXERCISE 255.**
> 1. No
> 2. Yes
> 3. Yes
> 4. No

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 to Exercise 256.
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 to Exercise 257.
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

Solution to Exercise 258.
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^+: $\{\rtimes\rtimes e, \rtimes\rtimes c, \rtimes\rtimes\ltimes, \rtimes c\ltimes, \rtimes\ltimes\ltimes, \rtimes ec, ade, bad, cba, ecb, de\ltimes, e\ltimes\ltimes, c\ltimes\ltimes\}$

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

SOLUTION TO EXERCISE 259.
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^+: $\{\rtimes\ltimes, \rtimes b, ab, ba, b\ltimes\}$

1. ε
2. abbbb
3. aa
4. bb

SOLUTION TO EXERCISE 260.
1. Yes
2. No
3. No
4. No

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 TO EXERCISE 261.
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^+:   {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ac, ⋊ ⋊ ca, ⋊ ⋊ b⋉, ⋊ ⋊ ba, ⋊bac, ⋊acc, ⋊ca⋉, ⋊b ⋉ ⋉, $accc$, $ccca$, $cccc$, bac⋉, cca⋉, ac ⋉ ⋉, ca ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

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

SOLUTION TO EXERCISE 262.
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 TO EXERCISE 263.
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 TO EXERCISE 264.

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 TO EXERCISE 265.

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

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 to Exercise 266.
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^+: {⋈⋉, ⋈b, ab, ba, bb, b⋉}

1. ε
2. bbabba
3. bba
4. aab

Solution to Exercise 267.
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

Solution to Exercise 268.
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 to Exercise 269.
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 to Exercise 270.
1. Yes
2. No
3. No
4. No

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 TO EXERCISE 271.
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 TO EXERCISE 272.
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 TO EXERCISE 273.
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 to Exercise 274.
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 to Exercise 275.
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

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Solution to Exercise 276.
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 to Exercise 277.
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

Solution to Exercise 278.
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 TO EXERCISE 279.
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 TO EXERCISE 280.
1. No
2. No
3. Yes
4. No

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 TO EXERCISE 281.
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 TO EXERCISE 282.
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 to Exercise 283.
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 to Exercise 284.
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 to Exercise 285.
1. No
2. Yes
3. No
4. Yes

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 TO EXERCISE 286.

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 TO EXERCISE 287.

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 TO EXERCISE 288.

    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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes c, \rtimes\rtimes\rtimes\ltimes, \rtimes\rtimes ab, \rtimes\rtimes c\ltimes, \rtimes\rtimes ae, \rtimes\rtimes\rtimes\ltimes, \rtimes c\ltimes\ltimes, \rtimes ab\ltimes, \rtimes\rtimes\ltimes\ltimes, \rtimes aee, aeed, dded, edde, eedd, ded\ltimes, ab\ltimes\ltimes, ed\ltimes\ltimes, c\ltimes\ltimes\ltimes, d\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. babedee
2. cbcadbb
3. ε
4. cddbaa

SOLUTION TO EXERCISE 289.

    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^+: $\{\rtimes c, ae, ba, cd, db, dd, ec, d\ltimes\}$

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

Solution to Exercise 290.
1. No
2. No
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 to Exercise 291.
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 to Exercise 292.
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^+: $\{\rtimes b, aa, ab, ba, bb, a\ltimes\}$

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

Solution to Exercise 293.
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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes c, \rtimes\rtimes ca, \rtimes\rtimes ab, \rtimes abb, \rtimes ca\ltimes, abba, babc, bbab, abc\ltimes, bc\ltimes\ltimes, ca\ltimes\ltimes, a\ltimes\ltimes\ltimes, c\ltimes\ltimes\ltimes\}$

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

Solution to Exercise 294.
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^+: $\{\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes c, \rtimes\ \rtimes\ \rtimes b, \rtimes\ \rtimes\ \rtimes\ltimes, \rtimes\ \rtimes\ bb, \rtimes\ \rtimes\ ac, \rtimes\ \rtimes\ \ltimes\ltimes, \rtimes\ \rtimes\ cc, \rtimes bb\ltimes, \rtimes acb, \rtimes ccc, \rtimes\ \ltimes\ltimes\ltimes, abba, bbac, bbcc, bcca, cabb, cbbc, ccab, ccbb, cccb, acb\ltimes, bac\ltimes, ac\ltimes\ltimes, cb\ltimes\ltimes, bb\ltimes\ltimes, c\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. b
2. ε
3. bbbbcbbcaca
4. bb

SOLUTION TO EXERCISE 295.
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 TO EXERCISE 296.
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 to Exercise 297.

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^+: $\{\rtimes\quad\rtimes\quad\rtimes a, \rtimes\quad\rtimes\quad\rtimes c, \rtimes\quad\rtimes\quad a\ltimes, \rtimes\quad\rtimes\quad cd, \rtimes a\quad\ltimes\ltimes, \rtimes cdb, abda, babd, bbab, bdad, cdbb, dadb, dbba, adb\ltimes, db\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

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

Solution to Exercise 298.

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 to Exercise 299.

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 to Exercise 300.**
> 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 to Exercise 301.**
> 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 to Exercise 302.

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

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 to Exercise 303.

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 to Exercise 304.

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
2. ε
3. bb
4. ccbccacb

Solution to Exercise 305.
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 to Exercise 306.
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^+: $\{⋈⋈⋈d, ⋈⋈⋈e, ⋈⋈db, ⋈⋈ea, ⋈⋈d⋉, ⋈ead, ⋈d⋉⋉, ⋈dbd, abde, bdda, bded, dabd, dbdd, ddab, dedc, edc⋉, ead⋉, dc⋉⋉, ad⋉⋉, c⋉⋉⋉, d⋉⋉⋉\}$

1. cd

2. eeecc
3. aebceeaae
4. ε

SOLUTION TO EXERCISE 307.
    1. No
    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^+: $\{ \rtimes \rtimes b, \rtimes bc, aac, acc, bcc, caa, cca, ca\ltimes, a \ltimes \ltimes \}$

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

SOLUTION TO EXERCISE 308.
    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^+: $\{ \rtimes \rtimes b, \rtimes \rtimes d, \rtimes db, \rtimes bd, bbd, bdd, dbb, ddb, db\ltimes, bd\ltimes, b \ltimes \ltimes, d \ltimes \ltimes \}$

1. aaadda
2. ε
3. db
4. bd

Solution to Exercise 309.

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^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ac, ba, bb, cc, cd, db, a\ltimes, b\ltimes\}$

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

Solution to Exercise 310.

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 to Exercise 311.

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^+: {⋈⋈, ⋈c, ab, ac, bd, ca, cc, da, a⋈}

1. cca
2. ccaccbc
3. ca
4. ε

SOLUTION TO EXERCISE 312.
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 TO EXERCISE 313.
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 TO EXERCISE 314.
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:
G^-: $\{abba, abca, bacb, cacc\}$

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

SOLUTION TO EXERCISE 315.
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 TO EXERCISE 316.
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 TO EXERCISE 317.
   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^+: $\{\rtimes\rtimes\rtimes c, \rtimes\rtimes\rtimes\ltimes, \rtimes\rtimes\rtimes d, \rtimes\rtimes dc, \rtimes\rtimes c\ltimes, \rtimes\rtimes ca, \rtimes\rtimes\ltimes\ltimes, \rtimes ca\ltimes, \rtimes c\ltimes\ltimes, \rtimes dcc, \rtimes\ltimes\ltimes\ltimes, aaaa, caaa, ccdc, cdca, dcaa, dccd, aaa\ltimes, aa\ltimes\ltimes, ca\ltimes\ltimes, c\ltimes\ltimes\ltimes, a\ltimes\ltimes\ltimes\}$

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

   SOLUTION TO EXERCISE 318.
   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^+: $\{\rtimes\rtimes d, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes dd, aca, adb, bdd, caa, dac, dad, dbd, dda, aa\ltimes, a\ltimes\ltimes\}$

1. acba

2. ε
3. caabdcaabd
4. addcbbbbd

SOLUTION TO EXERCISE 319.
1. No
2. Yes
3. No
4. No

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 TO EXERCISE 320.
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 to Exercise 321.
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

Solution to Exercise 322.
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 to Exercise 323.
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^+: {⋊⋊⋊c, ⋊⋊⋊b, ⋊⋊cb, ⋊⋊bb, ⋊bbb, ⋊cb⋉, aaea, aeae, baae, bbaa, bbba, eaee, aee⋉, ee⋉⋉, cb⋉⋉, e⋉⋉⋉, b⋉⋉⋉}

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

   SOLUTION TO EXERCISE 324.
   1. No
   2. No
   3. No
   4. No

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 TO EXERCISE 325.
   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^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ aa, ⋊ ⋊ bb, ⋊aa⋉, ⋊ ⋉ ⋉⋉, ⋊bbb, aabb, abbb, baab, bbaa, bbba, baa⋉, aa⋉⋉, a⋉⋉⋉}

1. abab
2. abaaabbb

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3. bbbbb
4. abbaabb

Solution to Exercise 326.

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
4. cdbcb

Solution to Exercise 327.

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. ddcaacccbd
4. a

Solution to Exercise 328.

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^+: {⋊a, ⋊⋉, aa, ab, ba, bb, b⋉}

1. ab
2. aab
3. bbaab
4. ε

SOLUTION TO EXERCISE 329.
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 TO EXERCISE 330.
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 TO EXERCISE 331.
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^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, bb, a\ltimes\}$

1. babbaabaaa
2. ba
3. aabaaba
4. ε

SOLUTION TO EXERCISE 332.
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 TO EXERCISE 333.
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^+: {⋊⋊d, ⋊⋊⋉, ⋊⋉⋉, ⋊dd, acb, adc, cac, cad, cba, cca, dca, dcc, ddc, ba⋉, a⋉⋉}

1. ba
2. adcccbddbd
3. ddcacba
4. ε

SOLUTION TO EXERCISE 334.
1. No
2. No
3. Yes
4. Yes

EXERCISE 335.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊⋉, ⋊b, ab, ba, a⋉}

1. ababa
2. babab
3. a
4. ε

SOLUTION TO EXERCISE 335.
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 TO EXERCISE 336.
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

SOLUTION TO EXERCISE 337.
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 TO EXERCISE 338.
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 TO EXERCISE 339.
1. Yes
2. No
3. No
4. No

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 TO EXERCISE 340.
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 TO EXERCISE 341.
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 TO EXERCISE 342.
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 TO EXERCISE 343.
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 TO EXERCISE 344.
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 TO EXERCISE 345.
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^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes bb, \rtimes aa, aaa, aba, baa, bab, bba, bbb, aa\ltimes, a\ltimes\ltimes\}$

1. ε
2. bababbb
3. bbabab

4. bbb

SOLUTION TO EXERCISE 346.
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
4. dbdd

SOLUTION TO EXERCISE 347.
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 TO EXERCISE 348.
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 TO EXERCISE 349.

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 TO EXERCISE 350.

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 to Exercise 351.
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^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊d, ⋊ ⋊ db, ⋊ ⋊ ab, ⋊ ⋊ b⋉, ⋊dbb, ⋊ab⋉, ⋊b ⋉ ⋉, $aabd$, $abda$, $babd$, $bbab$, $bdaa$, $daab$, $dbba$, abd⋉, ab⋉⋉, bd⋉⋉, d⋉⋉⋉, b⋉ ⋉⋉}

1. b
2. ddaa
3. ab
4. ebaecacbbb

Solution to Exercise 352.
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 to Exercise 353.
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 TO EXERCISE 354.**
> 1. Yes
> 2. No
> 3. Yes
> 4. Yes

EXERCISE 355.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, aa, ab, ac, ba, bb, bc, ca, cb, cc, a\ltimes, b\ltimes\}$

1. abcaab
2. accaaaacaca
3. aaa
4. bcb

> **SOLUTION TO EXERCISE 355.**
> 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^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes d, \rtimes\rtimes b, \rtimes\ltimes\ltimes, \rtimes be, \rtimes dc, aac, acc, caa, cba, cca, ccb, ccc, dcc, be\ltimes, ba\ltimes, e\ltimes\ltimes, a\ltimes\ltimes\}$

1. be
2. eddbb
3. dccba

    4. ε

Solution to Exercise 356.
    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^+: $\{\rtimes a, aa, ab, ad, bd, da, dc, dd, c\ltimes\}$

    1. adc
    2. aadc
    3. abdc
    4. ε

Solution to Exercise 357.
    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^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes bd, \rtimes \rtimes ce, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes aa, \rtimes \rtimes a\ltimes, \rtimes ceb, \rtimes a \ltimes \ltimes, \rtimes aa\ltimes, \rtimes bdd, \rtimes \ltimes \ltimes\ltimes, aeec, bcea, cbdd, ceae, cebc, eaee, ebce, ecbd, eecb, bdd\ltimes, aa \ltimes \ltimes, dd \ltimes, d\ltimes\ltimes\ltimes, a\ltimes\ltimes\ltimes\}$

    1. ebcdcddcba
    2. ε
    3. ba
    4. aeeddeabddcb

Solution to Exercise 358.
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 to Exercise 359.
1. No
2. Yes
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^+: $\{\rtimes\rtimes e, \rtimes\rtimes b, \rtimes b\ltimes, \rtimes ea, aad, adc, ade, caa, dca, deb, ead, ebe, be\ltimes, e\ltimes\ltimes, b\ltimes\ltimes\}$

1. ad
2. adba
3. caede
4. b

Solution to Exercise 360.
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 TO EXERCISE 361.
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^+: $\{\rtimes c, aa, ab, ac, ba, bd, cb, da, dd, c\ltimes\}$

1. cbac
2. cbcbdccccb
3. ε
4. c

SOLUTION TO EXERCISE 362.
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 TO EXERCISE 363.

    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 TO EXERCISE 364.

    1. Yes
    2. Yes
    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 TO EXERCISE 365.

    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^+: {⋊e, ⋊d, ab, ba, be, cc, ce, dc, eb, ec, e⋉, c⋉}

1. e
2. ababadbb
3. aeceeab
4. ec

SOLUTION TO EXERCISE 366.
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^+: {⋊ ⋊ ⋊⋉, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊d, ⋊ ⋊ bc, ⋊ ⋊ dd, ⋊ ⋊ de, ⋊ ⋊ d⋉, ⋊ ⋊ ⋉⋉, ⋊ddd, ⋊d ⋉ ⋉, ⋊deb, ⋊bc⋉, ⋊ ⋉ ⋉⋉, 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 TO EXERCISE 367.
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 TO EXERCISE 368.
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 TO EXERCISE 369.
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 to Exercise 370.
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^+:   {⋊ ⋊ ⋊a,⋊ ⋊ ⋊b,⋊ ⋊ ⋊⋉,⋊ ⋊ bb,⋊ ⋊ ⋊⋉,⋊ ⋊ aa,⋊ ⋊ a⋉,⋊ ⋊ ba,⋊aaa,⋊a ⋉ ⋉,⋊bbb,⋊ba⋉,⋊ ⋉ ⋉⋉,$aaab$,$aaba$,$aabb$,$abaa$,$abba$,$baaa$,bba⋉,bbb⋉,ba ⋉ ⋉,bb ⋉ ⋉,a ⋉ ⋉⋉,b ⋉ ⋉⋉}

1. ε
2. aaba
3. bbaba
4. bbbabb

Solution to Exercise 371.
1. Yes
2. No
3. No
4. No

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 to Exercise 372.
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 to Exercise 373.
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
4. ca

Solution to Exercise 374.
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 TO EXERCISE 375.
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 TO EXERCISE 376.
1. Yes
2. Yes
3. Yes
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

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3. e
4. ε

Solution to Exercise 377.
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 to Exercise 378.
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 to Exercise 379.

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 to Exercise 380.

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^+: $\{⋊ \quad ⋊ \quad ⋊d, ⋊ \quad ⋊ \quad ⋊⋉, ⋊ \quad ⋊ \quad ⋉⋉, ⋊ \quad ⋊ \quad db, ⋊ \quad ⋉$ $⋉⋉, ⋊dbb, bbdb, bdbd, dbbd, dbdb, bdb⋉, db ⋉ ⋉, b ⋉ ⋉⋉\}$

1. daddaa
2. ε
3. d
4. dcd

Solution to Exercise 381.

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

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EXERCISE 382.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ cb, ⋊ ⋊ cc, ⋊ ⋊ ad, ⋊cbd, ⋊cc⋉, ⋊ada, $acbd$, $bdac$, $cbda$, $cbdd$, $dacb$, bdd⋉, ada⋉, cc⋉⋉, dd⋉⋉, da⋉⋉, c⋉⋉⋉, d⋉⋉⋉, a⋉⋉⋉}

1. d
2. ε
3. cdc
4. ccaba

SOLUTION TO EXERCISE 382.
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^+: {⋊c, ab, ba, bc, bd, cb, cd, db, b⋉}

1. bbbdca
2. cbadaacab
3. cb
4. cdddbdd

SOLUTION TO EXERCISE 383.
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 ⋉ ⋉⋉}

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1. ε
2. babcaacb
3. bbbccb
4. cab

SOLUTION TO EXERCISE 384.

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 TO EXERCISE 385.

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^+: $\{\rtimes\rtimes d, \rtimes\rtimes b, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes db, \rtimes ba, acb, bac, bda, cbd, dba, da\ltimes, ba\ltimes, a\ltimes\ltimes\}$

1. ccdc
2. d
3. db
4. ε

Solution to Exercise 386.
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 to Exercise 387.
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 to Exercise 388.
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 to Exercise 389.
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 to Exercise 390.
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 TO EXERCISE 391.
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^+: {⋊a, ⋊⋉, ab, ba, bb, a⋉, b⋉}

1. ε
2. abbb
3. a
4. ab

SOLUTION TO EXERCISE 392.
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 TO EXERCISE 393.
1. Yes
2. Yes
3. Yes
4. Yes

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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 to Exercise 394.
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 to Exercise 395.
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

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4. cbbb

Solution to Exercise 396.
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 to Exercise 397.
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^+: $\{\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes b, \rtimes\ \rtimes\ a\ltimes, \rtimes\ \rtimes\ bc, \rtimes a\ \rtimes\ \ltimes, \rtimes bcc, aacc, accc, bccc, caac, ccaa, ccca, cccc, ccc\ltimes, cc\ltimes\ltimes, a\ltimes\ltimes\ltimes, c\ltimes\ltimes\ltimes\}$

1. a
2. aabc
3. bbaa
4. bccc

Solution to Exercise 398.
1. Yes
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 to Exercise 399.
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^+: $\{⋊⋊⋊d, ⋊⋊⋊e, ⋊⋊⋊⋉, ⋊⋊⋉⋉, ⋊⋊e⋉, ⋊⋊da, ⋊dae, ⋊⋉⋉⋉, ⋊e⋉⋉, aeaa, daea, eaad, aad⋉, ad⋉⋉, d⋉⋉⋉, e⋉⋉⋉\}$

1. ε
2. ddaebe
3. e
4. c

Solution to Exercise 400.
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 TO EXERCISE 401.
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 TO EXERCISE 402.
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 TO EXERCISE 403.
1. Yes
2. Yes
3. Yes
4. Yes

Exercise 404.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+: {⋈ ⋈ ⋈a, ⋈ ⋈ ⋈b, ⋈ ⋈ ⋈⋈, ⋈ ⋈ ⋈e, ⋈ ⋈ bb, ⋈ ⋈ ec, ⋈ ⋈⋈⋈, ⋈ ⋈ a⋈, ⋈a ⋈⋈, ⋈bbb, ⋈ecc, ⋈ ⋈ ⋈⋈, $cccb$, $cccc$, $eccc$, ccb⋈, bbb⋈, cb ⋈ ⋈, bb ⋈ ⋈, a ⋈ ⋈⋈, b ⋈ ⋈⋈}

  1. eeee
  2. ecba
  3. ea
  4. badc

   Solution to Exercise 404.
     1. No
     2. No
     3. No
     4. No

Exercise 405.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {$ac, ae, bb, be, ca, dd, ed$}

  1. b
  2. ε
  3. d
  4. e

   Solution to Exercise 405.
     1. Yes
     2. Yes
     3. Yes
     4. 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 TO EXERCISE 406.

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^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ bc, ⋊ ⋊ bd, ⋊ ⋊ ⋉⋉, ⋊ ⋊ a⋉, ⋊a ⋊ ⋉, ⋊bde, ⋊bc⋉, ⋊⋉⋉⋉, $bdee$, $deeb$, $ebac$, $eeba$, bac⋉, ac⋉⋉, bc⋉⋉, c⋉⋉⋉, a⋉ ⋉⋉}

1. dceabe
2. ε
3. cabac
4. cececcd

SOLUTION TO EXERCISE 407.

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^+: {⋊⋉, ⋊b, aa, ab, ba, bb, a⋉}

1. aaba
2. aba
3. ε
4. b

Solution to Exercise 408.
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 to Exercise 409.
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 to Exercise 410.
1. No
2. No
3. No
4. No

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 TO EXERCISE 411.
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 TO EXERCISE 412.
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. bababba
3. bbdacbc
4. b

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Solution to Exercise 413.
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 to Exercise 414.
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^+: $\{⋊⋊⋊b, ⋊⋊ba, ⋊⋊b⋊, ⋊b⋊⋊, ⋊baa, ⋊ba⋊, aaab, aabb, baaa, abb⋊, ba⋊⋊, bb⋊⋊, a⋊⋊⋊, b⋊⋊⋊\}$

1. b
2. aabaa
3. ε
4. ab

Solution to Exercise 415.
1. Yes
2. No
3. No
4. No

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 TO EXERCISE 416.
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 TO EXERCISE 417.
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 TO EXERCISE 418.
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 TO EXERCISE 419.
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 TO EXERCISE 420.
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 TO EXERCISE 421.
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 TO EXERCISE 422.
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 to Exercise 423.
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 to Exercise 424.
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 TO EXERCISE 425.
   1. Yes
   2. No
   3. No
   4. No

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 TO EXERCISE 426.
   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 TO EXERCISE 427.
   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 TO EXERCISE 428.
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 TO EXERCISE 429.
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^+: $\{⋈\ ⋈\ ⋈a, ⋈\ ⋈\ ⋈c, ⋈\ ⋈\ ⋈d, ⋈\ ⋈\ ⋈e, ⋈\ ⋈\ ea, ⋈\ ⋈\ c⋈, ⋈\ ⋈\ ae, ⋈\ ⋈\ da, ⋈ea⋈, ⋈aea, ⋈c\ ⋈\ ⋈, ⋈dae, aeae, aeec, eaee, ecdd, eecd, dae⋈, cdd⋈, ae\ ⋈\ ⋈, ea\ ⋈\ ⋈, dd\ ⋈\ ⋈, c\ ⋈\ ⋈⋈, d\ ⋈\ ⋈⋈, a\ ⋈\ ⋈⋈, e\ ⋈\ ⋈⋈\}$

1. ea
2. cdbe

3. aaeabc
4. c

Solution to Exercise 430.
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 to Exercise 431.
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^+: $\{\rtimes\ \rtimes\ \rtimes c, \rtimes\ \rtimes\ \rtimes d, \rtimes\ \rtimes\ dd, \rtimes\ \rtimes\ cb, \rtimes\ \rtimes\ c\ltimes, \rtimes ddd, \rtimes c\ \ltimes\ \ltimes, \rtimes cbb, bbdd, bddc, cbbd, cdda, daaa, dcdd, ddaa, ddcd, ddd\ltimes, aaa\ltimes, aa\ \ \ltimes\ \ltimes, dd\ \ltimes\ \ltimes, c\ \ltimes\ \ltimes\ \ltimes, d\ \ltimes\ \ltimes\ \ltimes, a\ \ltimes\ \ltimes\ \ltimes\}$

1. c
2. bcccddbbbab
3. aac
4. ddd

Solution to Exercise 432.
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 to Exercise 433.
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 to Exercise 434.
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 to Exercise 435.
       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 to Exercise 436.
       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 TO EXERCISE 437.
   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:
G^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, bb, b\ltimes\}$

1. baaabaab
2. abb
3. ε
4. bababaaaa

SOLUTION TO EXERCISE 438.
   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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes c, \rtimes\rtimes cb, \rtimes\rtimes ac, \rtimes acc, \rtimes aca, \rtimes cb\ltimes, abcb, acca, baac, bcba, cabc, cbaa, ccab, aca\ltimes, aa$
$\ltimes, cb\ltimes\ltimes, ca\ltimes\ltimes, c\ltimes\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. ac
2. caccac
3. aacc
4. abbccc

SOLUTION TO EXERCISE 439.
  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 TO EXERCISE 440.
  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^+: $\{\bowtie \bowtie a, \bowtie ac, aca, acb, bca, cac, cbc, ca\bowtie, a \bowtie \bowtie\}$

  1. abcb
  2. ac
  3. bdca
  4. ccdaabb

SOLUTION TO EXERCISE 441.
  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 to Exercise 442.
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:
G^+: $\{\rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes \rtimes a, \rtimes \rtimes aa, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes \ltimes\ltimes, \rtimes aaa, aaab, aabb, abba, baaa, bbaa, abb\ltimes, bb\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. aaabb
2. abbabbba
3. ε
4. bbaaabaaa

Solution to Exercise 443.
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^+: $\{\rtimes \rtimes c, \rtimes \rtimes b, \rtimes c\ltimes, \rtimes bb, bbc, bcb, cbb, bc\ltimes, c\ltimes\ltimes\}$

1. c
2. bbbcac
3. ε

4. bab

Solution to Exercise 444.
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^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, bb, b\ltimes\}$

1. a
2. bbbbabb
3. ε
4. b

Solution to Exercise 445.
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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes ac, \rtimes\rtimes ad, \rtimes acc, \rtimes ad\ltimes, accb, cbcd, ccbc, bcd\ltimes, cd\ltimes\ltimes, ad\ltimes\ltimes, d\ltimes\ltimes\ltimes\}$

1. b
2. ad
3. ε
4. a

Solution to Exercise 446.
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 to Exercise 447.
1. No
2. No
3. Yes
4. Yes

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 to Exercise 448.
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

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Solution to Exercise 449.
 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^+: {⋈ ⋈ ⋈a, ⋈ ⋈ ⋈c, ⋈ ⋈ ⋈e, ⋈ ⋈ e⋈, ⋈ ⋈ ab, ⋈ ⋈ ce, ⋈ ⋈ ad, ⋈e ⋈ ⋈, ⋈cee, ⋈ab⋈, ⋈adb, $adbd$, $bddc$, $cade$, $dbdd$, $dcad$, $ddca$, ade⋈, cee⋈, de ⋈ ⋈, ab ⋈ ⋈, ee ⋈ ⋈, e ⋈ ⋈⋈, b ⋈ ⋈⋈}

 1. eddade
 2. abccbdece
 3. bddaebbac
 4. de

Solution to Exercise 450.
 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 to Exercise 451.
 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 TO EXERCISE 452.
   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 TO EXERCISE 453.
   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 TO EXERCISE 454.

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^+: $\{ \rtimes a, ad, ba, bb, cb, cc, dc, dd, de, ec, c\ltimes \}$

1. abbb
2. adc
3. e
4. adec

SOLUTION TO EXERCISE 455.

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 to Exercise 456.
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 to Exercise 457.
1. No
2. No
3. No
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 to Exercise 458.
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 TO EXERCISE 459.
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 TO EXERCISE 460.
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

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Solution to Exercise 461.
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 to Exercise 462.
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 to Exercise 463.
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^+: $\{ \rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes db, \rtimes \rtimes \ltimes \ltimes, \rtimes \rtimes aa, \rtimes aa \ltimes, \rtimes dbb, \rtimes \rtimes \ltimes \ltimes, acdc, bbca, bcac, cacd, cdcd, dbbc, dcd \ltimes, cd \ltimes \ltimes, aa \ltimes \ltimes, d \ltimes \ltimes \ltimes, a \ltimes \ltimes \ltimes \}$

1. aa
2. ε
3. cbdbabb
4. acbadcaa

SOLUTION TO EXERCISE 464.

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 TO EXERCISE 465.

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 TO EXERCISE 466.
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 TO EXERCISE 467.
1. Yes
2. No
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 to Exercise 468.
 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 to Exercise 469.
    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 to Exercise 470.
    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 TO EXERCISE 471.
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 TO EXERCISE 472.
1. Yes
2. Yes
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 to Exercise 473.
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. ddddbbb
2. dbacabbdcdb
3. bacb
4. ε

Solution to Exercise 474.
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^-: $\{ace, adb, cab, cdd\}$

1. dbdabaeaccca
2. dacaea
3. dcea
4. ε

Solution to Exercise 475.
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^+: {⋈b, aa, ab, ba, bb, a⋈}

  1. aaa
  2. ε
  3. aba
  4. ba

   Solution to Exercise 476.
     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 to Exercise 477.
     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 to Exercise 478.
   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 to Exercise 479.
   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 to Exercise 480.
   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 TO EXERCISE 481.
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 TO EXERCISE 482.
1. Yes
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^+: $\{\rtimes \rtimes b, \rtimes b\ltimes, \rtimes ba, aab, aad, abd, add, baa, bda, daa, dd\ltimes, b \ltimes \ltimes, d \ltimes \ltimes\}$

1. bbd
2. ccadcbda
3. ε
4. aabab

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Solution to Exercise 483.
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 to Exercise 484.
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 ⋈ ⋈}

1. aba
2. cc
3. ε
4. c

Solution to Exercise 485.
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 TO EXERCISE 486.
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 TO EXERCISE 487.
1. No
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 TO EXERCISE 488.
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 TO EXERCISE 489.
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^-: $\{acac, accb, bbcb, bcac, cbcb, cbcc, ccbc, cccc\}$

1. ε
2. aaacbc
3. a
4. b

SOLUTION TO EXERCISE 490.
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 TO EXERCISE 491.
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 TO EXERCISE 492.
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^+: $\{\rtimes\rtimes\rtimes d, \rtimes\rtimes dd, \rtimes ddc, bcbd, bdcd, cbcb, cbdc, dcbc, dcda, ddcb, cda\ltimes, da\ltimes\ltimes, a\ltimes\ltimes\ltimes\}$

1. bbcdd
2. bdacb
3. ε

4. aca

SOLUTION TO EXERCISE 493.
   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 TO EXERCISE 494.
   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 TO EXERCISE 495.
   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^+: {⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊b⋉, ⋊ba, aab, aba, abb, baa, bab, bba, bbb, bb⋉, b⋉⋉}

1. babb
2. b
3. ε
4. abaaab

SOLUTION TO EXERCISE 496.
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^+: {⋊⋊b, ⋊ba, ⋊bb, bac, bbc, bcc, cba, cbc, ccb, ccc, ac⋉, ba⋉, a⋉⋉, c⋉⋉}

1. cabac
2. ba
3. c
4. aacbcbcaacc

SOLUTION TO EXERCISE 497.
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

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3. bbbcbaca
4. c

SOLUTION TO EXERCISE 498.
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^+: $\{\rtimes \rtimes a, \rtimes \rtimes b, \rtimes ab, \rtimes b\ltimes, \rtimes ba, aab, aba, abb, baa, bba, bbb, ba\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. baaaaaba
2. b
3. aabba
4. a

SOLUTION TO EXERCISE 499.
1. No
2. Yes
3. No
4. No

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 to Exercise 500.
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^+: $\{⋊⋊⋊a, ⋊⋊⋊b, ⋊⋊ab, ⋊⋊ba, ⋊aba, ⋊baa, aaba, abaa, abab, baaa, baab, baba, aba⋉, aaa⋉, aa⋉⋉, ba⋉⋉, a⋉⋉⋉\}$

1. ab
2. bababaa
3. abbb
4. baabaaba

Solution to Exercise 501.
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^+: $\{⋊⋊c, ⋊⋊a, ⋊⋊b, ⋊c⋉, ⋊ac, ⋊ba, aca, acb, bac, cac, cbc, bc⋉, ac⋉, c⋉⋉\}$

1. babc
2. abbcba
3. cca
4. c

Solution to Exercise 502.
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 to Exercise 503.
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 to Exercise 504.
1. Yes
2. Yes
3. Yes
4. Yes

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 to Exercise 505.
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 to Exercise 506.
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^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes aa, \rtimes \rtimes ba, \rtimes aaa, \rtimes ba\ltimes, \rtimes \rtimes \ltimes\ltimes, aaab, aaba, abab, abba, abbb, babb, bbab, bbbb, bbb\ltimes, ba \ltimes \ltimes, bb \ltimes \ltimes, a \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. aaaaababa
2. abbbabab
3. abbbbaaa
4. ε

Solution to Exercise 507.
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 TO EXERCISE 508.
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 TO EXERCISE 509.
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^+: $\{\rtimes \rtimes a, \rtimes \rtimes b, \rtimes a\ltimes, \rtimes ba, aaa, aab, aba, baa, bab, ab\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. babbaa
2. abbbab
3. ε
4. aaaaa

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SOLUTION TO EXERCISE 510.
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 TO EXERCISE 511.
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^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes ab, \rtimes \rtimes b\ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes abb, \rtimes \ltimes \ltimes \ltimes, \rtimes b \ltimes \ltimes, abab, abba, abbb, baab, baba, babb, bbaa, bbab, bbba, aab\ltimes, ab\ltimes \ltimes, b\ltimes \ltimes \ltimes\}$

1. ababbabaaab
2. ε
3. b
4. abbaab

SOLUTION TO EXERCISE 512.
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 TO EXERCISE 513.
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 TO EXERCISE 514.
1. Yes
2. Yes
3. No
4. No

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 to Exercise 515.
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 to Exercise 516.
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

Solution to Exercise 517.
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 to Exercise 518.
   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 to Exercise 519.
   1. Yes
   2. Yes
   3. No
   4. No

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 to Exercise 520.
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 to Exercise 521.
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 TO EXERCISE 522.
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^+: $\{⋈⋈b, ⋈ba, abb, bab, bbc, bcc, ccc, cc⋈, c⋈⋈\}$

1. ca
2. babbcc
3. bacbbb
4. ε

SOLUTION TO EXERCISE 523.
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 TO EXERCISE 524.
1. Yes
2. Yes
3. Yes
4. Yes

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 to Exercise 525.
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 to Exercise 526.
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 to Exercise 527.
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^+: {⋊⋊c, ⋊⋊a, ⋊a⋉, ⋊cb, aad, adb, baa, bba, cbb, dba, ba⋉, cb⋉, b⋉⋉, a⋉⋉}

1. abaa
2. a
3. cb
4. adcdab

Solution to Exercise 528.
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^+: {⋊ ⋊ b, ⋊b⋉, ⋊ba, ⋊bb, aaa, aab, abb, baa, bba, bb⋉, ba⋉, b ⋉ ⋉, a ⋉ ⋉}

1. bb
2. bba
3. a
4. ba

Solution to Exercise 529.
1. Yes
2. Yes
3. No
4. Yes

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 TO EXERCISE 530.
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 TO EXERCISE 531.
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 to Exercise 532.
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^+: $\{\rtimes \rtimes d, \rtimes da, abe, bed, dab, dac, eda, ac\ltimes, c \ltimes \ltimes\}$

1. eb
2. bbe
3. dac
4. a

Solution to Exercise 533.
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^+: $\{\rtimes \rtimes a, \rtimes a\ltimes, \rtimes aa, aaa, aab, abb, baa, bba, bbb, aa\ltimes, a \ltimes \ltimes\}$

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

Solution to Exercise 534.
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 TO EXERCISE 535.
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 TO EXERCISE 536.
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 to Exercise 537.
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 to Exercise 538.
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 to Exercise 539.
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 TO EXERCISE 540.
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 TO EXERCISE 541.
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^+: $\{\rtimes\ltimes, \rtimes b, ab, ba, bd, da, b\ltimes\}$

1. cdcbbc
2. b
3. ddddca
4. ε

SOLUTION TO EXERCISE 542.
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^+: {⋊⋊⋉, ⋊⋊a, ⋊⋊d, ⋊⋉⋉, ⋊d⋉, ⋊ab, abd, aee, bdc, cae, cde, dca, dcd, dee, edc, eed, ee⋉, d⋉ ⋉, e ⋉ ⋉}

1. ε
2. c
3. abdcdee
4. d

SOLUTION TO EXERCISE 543.
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 TO EXERCISE 544.
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 TO EXERCISE 545.
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 TO EXERCISE 546.
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

Solution to Exercise 547.
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 to Exercise 548.
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 to Exercise 549.
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 TO EXERCISE 550.
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 TO EXERCISE 551.
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

Solution to Exercise 552.
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 to Exercise 553.
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^+: $\{⋊⋊⋊c, ⋊⋊c⋉, ⋊⋊cc, ⋊c⋉⋉, ⋊ccd, bccd, cbcc, ccda, ccdd, cdad, cddc, dcbc, ddcb, dad⋉, ad⋉⋉, d⋉⋉⋉, c⋉⋉⋉\}$

1. c
2. ccdad
3. ddbaaaabcab
4. cdaba

Solution to Exercise 554.
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 TO EXERCISE 555.
    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 TO EXERCISE 556.
    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 TO EXERCISE 557.
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 TO EXERCISE 558.
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 TO EXERCISE 559.
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 to Exercise 560.

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 to Exercise 561.

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 to Exercise 562.
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 to Exercise 563.
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 to Exercise 564.

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 to Exercise 565.

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 to Exercise 566.

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

SOLUTION TO EXERCISE 567.
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 TO EXERCISE 568.
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

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    4. abae

SOLUTION TO EXERCISE 569.
1. No
2. No
3. Yes
4. No

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. aaaaaaaba

    SOLUTION TO EXERCISE 570.
    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^+: {$\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes b, \rtimes\ \rtimes\ \rtimes\ltimes, \rtimes\ \rtimes\ \rtimes d, \rtimes\ \rtimes\ ba, \rtimes\ \rtimes\ da, \rtimes\ \rtimes\ \ltimes\ltimes, \rtimes\ \rtimes\ a\ltimes, \rtimes da\ltimes, \rtimes bab, \rtimes a\ \ltimes\ \ltimes, \rtimes\ \ltimes\ \ltimes\ltimes, aaab, aabc, abaa, abcd, baaa, baba, bcdc, cdcd, dcdc, cdc\ltimes, dc\ \ltimes\ \ltimes, da\ \ltimes\ \ltimes, c\ \ltimes\ \ltimes\ltimes, a\ \ltimes\ \ltimes\ltimes$}

1. a
2. ba
3. cdcabccbd
4. ε

SOLUTION TO EXERCISE 571.
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 TO EXERCISE 572.
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 TO EXERCISE 573.
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 TO EXERCISE 574.
1. No
2. Yes
3. Yes
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 TO EXERCISE 575.
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 TO EXERCISE 576.
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^+: {⋈⋈⋈, ⋈⋈a, ⋈⋈⋈, ⋈ad, abc, ada, bbc, bca, bcd, cad, cbb, cdc, dab, dcb, ad⋈, d⋈⋈}

1. ε
2. bdbbbb
3. dcada
4. dacbddb

SOLUTION TO EXERCISE 577.
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 TO EXERCISE 578.
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^+: $\{\rtimes a, \rtimes\ltimes, \rtimes c, aa, ab, ac, ba, cc, cd, da, a\ltimes, d\ltimes\}$

1. cbccccbbd
2. aa
3. ε
4. a

    SOLUTION TO EXERCISE 579.
      1. No
      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^+: $\{\rtimes\ltimes, \rtimes d, aa, ab, ac, bb, bc, ca, cd, da, d\ltimes\}$

1. d
2. ccaad
3. ε
4. ccbb

    SOLUTION TO EXERCISE 580.
      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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes c, \rtimes\rtimes ac, \rtimes\rtimes ca, \rtimes caa, \rtimes ac\ltimes, aabc, abcc, bccc, caaa, caab, ccaa, ccca, aaa\ltimes, aa\ltimes\ltimes, ac\ltimes\ltimes, a\ltimes\ltimes\ltimes, c\ltimes\ltimes\ltimes\}$

1. ε
2. ac
3. bcacabcb

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4. bbcbabccca

SOLUTION TO EXERCISE 581.
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:
G^-: $\{ab, ac, ca, cb\}$

1. c
2. babcccc
3. acaac
4. b

SOLUTION TO EXERCISE 582.
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 TO EXERCISE 583.
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^+: {⋊ ⋊ c, ⋊cb, abc, bab, bcb, cba, ba⋉, a ⋉ ⋉}

1. bac
2. cba
3. aa
4. bba

SOLUTION TO EXERCISE 584.
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 TO EXERCISE 585.
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 TO EXERCISE 586.
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 TO EXERCISE 587.
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 TO EXERCISE 588.
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 TO EXERCISE 589.
   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 TO EXERCISE 590.
   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 TO EXERCISE 591.
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:
G^-: $\{caba, ccaa, ccdc, cdad, ceeb, dbaa, ddea\}$

1. b
2. ε
3. e
4. cbc

SOLUTION TO EXERCISE 592.
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 TO EXERCISE 593.
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 TO EXERCISE 594.
1. Yes
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 TO EXERCISE 595.
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 to Exercise 596.
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^-: $\{abbb, accc, bcac, cbab, cdbb\}$

1. bcdacad
2. b
3. a
4. ε

Solution to Exercise 597.
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 to Exercise 598.
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^+: {⋊a, aa, ae, bc, ce, ea, eb, ec, ee, e⋉}

  1. ae
  2. aee
  3. cb
  4. aae

   SOLUTION TO EXERCISE 599.
    1. Yes
    2. Yes
    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 TO EXERCISE 600.
    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 TO EXERCISE 601.

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 TO EXERCISE 602.

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 TO EXERCISE 603.

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 TO EXERCISE 604.
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 TO EXERCISE 605.
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 to Exercise 606.
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^+: {⋊⋊⋊d, ⋊⋊⋊c, ⋊⋊c⋉, ⋊⋊da, ⋊dae, ⋊c⋉⋉, $aeeb$, $daee$, $eebe$, ebe⋉, be⋉⋉, c⋉⋉⋉, e⋉⋉⋉}

1. deeb
2. ε
3. dceaac
4. c

Solution to Exercise 607.
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 to Exercise 608.
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^+: $\{\rtimes a, \rtimes\ltimes, aa, ac, ba, cb, a\ltimes\}$

1. aa
2. adaaac
3. ε
4. a

Solution to Exercise 609.
1. Yes
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 to Exercise 610.
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 to Exercise 611.
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 negative 3-gram grammar:
G^-: {$abb, aca, baa, bcc, cba, cbc$}

1. cb
2. cbcbca
3. cca
4. bb

Solution to Exercise 612.
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 TO EXERCISE 613.
   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 TO EXERCISE 614.
   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 TO EXERCISE 615.
   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 TO EXERCISE 616.
1. No
2. Yes
3. No
4. Yes

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. acbcccb
4. abccb

SOLUTION TO EXERCISE 617.
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

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4. acbbabbb

Solution to Exercise 618.
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^+: {⋊⋊⋊e, ⋊⋊ea, ⋊ead, $adbc$, $dbcb$, $eadb$, bcb⋉, cb⋉⋉, b⋉⋊⋉}

1. a
2. ε
3. c
4. dcdcbd

Solution to Exercise 619.
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 to Exercise 620.
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 to Exercise 621.
1. No
2. No
3. No
4. No

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 to Exercise 622.
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^+: {⋊⋊e, ⋊⋊d, ⋊⋊⋉, ⋊eb, ⋊⋉⋉, ⋊d⋉, bed, cde, dcd, ebe, edc, de⋉, e⋉⋉, d⋉⋉}

1. acd
2. ccdc

3. eacbdab
4. dcebc

SOLUTION TO EXERCISE 623.

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
4. caa

SOLUTION TO EXERCISE 624.

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 to Exercise 625.
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 to Exercise 626.
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 to Exercise 627.
1. No
2. Yes
3. Yes
4. Yes

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EXERCISE 628.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊a⋉, ⋊⋉⋉, ⋊bb, ⋊aa, aaa, aab, aba, abb, baa, bab, bba, bb⋉, ba⋉, b⋉⋉, a⋉⋉}

1. ε
2. bb
3. abbaabbbaaa
4. bbaaaaba

SOLUTION TO EXERCISE 628.
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^+: {⋊ ⋊ ⋊a, ⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ ca, ⋊ ⋊ b⋉, ⋊ ⋊ ad, ⋊ad⋉, ⋊caa, ⋊b⋉⋉, $aaac$, $aaca$, $acaa$, $caaa$, $caac$, aac⋉, ac⋉⋉, ad⋉⋉, c⋉⋉⋉, d⋉⋉⋉, b⋉⋉⋉}

1. baa
2. a
3. b
4. ad

SOLUTION TO EXERCISE 629.
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 TO EXERCISE 630.
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 TO EXERCISE 631.
1. Yes
2. No
3. No
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 to Exercise 632.
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 to Exercise 633.
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^+: $\{\rtimes \quad \rtimes \quad \rtimes a, \rtimes \quad \rtimes \quad \rtimes b, \rtimes \quad \rtimes \quad aa, \rtimes \quad \rtimes \quad ab, \rtimes \quad \rtimes ba, \rtimes aba, \rtimes aab, \rtimes ba\ltimes, aaab, aabb, abbb, baaa, bbaa, bbba, aba\ltimes, bba\ltimes, ba \ltimes, a \ltimes \ltimes\ltimes\}$

1. aaaaabaaabab
2. bbabaaab
3. ba
4. bb

Solution to Exercise 634.
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^+: $\{⋈ ⋈ d, ⋈dd, abd, adb, bbc, bda, dab, dad, dbb, dda, ddd, bc⋈, c ⋈ ⋈\}$

1. aabccbcebaa
2. ddadbbc
3. ddddadbbc
4. dddadbbc

SOLUTION TO EXERCISE 635.
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^+: $\{⋈e, bc, cd, db, ed, ee, d⋈\}$

1. bdc
2. eadbc
3. dedbbb
4. caaa

SOLUTION TO EXERCISE 636.
1. No
2. No
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^+: $\{⋈a, ⋈⋈, ac, ad, be, ce, da, db, ed, ee, e⋈, a⋈\}$

1. ε
2. eebae
3. acab
4. bdecd

Solution to Exercise 637.

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^+: $\{\rtimes \quad \rtimes \quad \rtimes a, \rtimes \quad \rtimes \quad \rtimes b, \rtimes \quad \rtimes \quad ab, \rtimes \quad \rtimes \quad be, \rtimes \quad \rtimes$ $ae, \rtimes aba, \rtimes be\ltimes, \rtimes aed, aedb, bddc, cadc, dbdd, dcad, ddca, edbd, adc\ltimes, aba\ltimes, dc\ltimes$ $\ltimes, ba \ltimes \ltimes, be \ltimes \ltimes, c \ltimes \ltimes\ltimes, a \ltimes \ltimes\ltimes, e \ltimes \ltimes\ltimes\}$

1. ab
2. be
3. da
4. decd

Solution to Exercise 638.

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 to Exercise 639.

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^+: {⋊ ⋊ c, ⋊cc, abc, acc, bca, cab, cac, cca, cc⋉, c ⋉ ⋉}

1. ba
2. ccbc
3. ε
4. bccba

   Solution to Exercise 640.
   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^+: {⋊ ⋊ ⋊c, ⋊ ⋊ cb, ⋊ ⋊ cc, ⋊cca, ⋊cbb, $bbcc$, $bccc$, $cbbc$, $cccc$, ccc⋉, cca⋉, cc ⋉ ⋉, ca ⋉ ⋉, a ⋉ ⋉⋉, c ⋉ ⋉⋉}

1. cca
2. ab
3. bac
4. cbbccc

   Solution to Exercise 641.
   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 TO EXERCISE 642.
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 TO EXERCISE 643.
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 to Exercise 644.
   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 to Exercise 645.
      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

   Solution to Exercise 646.
      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 TO EXERCISE 647.
      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 TO EXERCISE 648.
      1. No
      2. No
      3. No
      4. No

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 to Exercise 649.
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 to Exercise 650.
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
4. cdacaadbc

Solution to Exercise 651.
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 TO EXERCISE 652.
      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 TO EXERCISE 653.
      1. Yes
      2. Yes
      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 TO EXERCISE 654.
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 TO EXERCISE 655.
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^-: $\{aab, abb, abc, aca, bbc, cac, ccc\}$

1. b
2. accb
3. a
4. ε

Solution to Exercise 656.
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 to Exercise 657.
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 to Exercise 658.
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 TO EXERCISE 659.
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 TO EXERCISE 660.
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 positive 2-gram grammar:
G^+: $\{\rtimes\ltimes, \rtimes c, ab, bc, ca, cc, b\ltimes\}$

1. bbaccb
2. bc
3. acabc
4. bcab

Solution to Exercise 661.
   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^+: {⋈ ⋈ a, ⋈a⋈, ⋈ab, aab, aba, abb, baa, bab, bb⋈, b ⋈ ⋈, a ⋈ ⋈}

   1. aaaab
   2. bbba
   3. bbbabbbb
   4. bbbbaa

Solution to Exercise 662.
   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 to Exercise 663.
   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 TO EXERCISE 664.
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 TO EXERCISE 665.
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 negative 4-gram grammar:
G^-: $\{abcc, abcd, cdbd, ddbc\}$

1. b
2. ε
3. ccbddca
4. dbdbda

Solution to Exercise 666.
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 to Exercise 667.
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^+: $\{\rtimes \rtimes c, \rtimes \rtimes \ltimes, \rtimes \rtimes b, \rtimes cb, \rtimes c\ltimes, \rtimes \rtimes \ltimes, \rtimes ba, aac, abc, aca, bab, bcc, caa, cab, cca, cb\ltimes, ab\ltimes, c \ltimes \ltimes, b \ltimes \ltimes\}$

1. c
2. ε
3. abccbbcab
4. cb

Solution to Exercise 668.
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 to Exercise 669.
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 to Exercise 670.
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^+: {⋊⋊⋉, ⋊⋊b, ⋊⋊d, ⋊⋉⋉, ⋊d⋉, ⋊ba, aac, acc, baa, bcc, cbc, ccb, ccc, cb⋉, b⋉⋉, d⋉⋉}

1. bbca
2. d

3. ccbcd
4. ε

SOLUTION TO EXERCISE 671.
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^+: $\{\bowtie\bowtie, \bowtie c, ac, bb, bd, ca, cb, cc, d\bowtie\}$

1. cabbdbd
2. bad
3. ε
4. cbd

SOLUTION TO EXERCISE 672.
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^+: $\{\bowtie b, aa, ac, bc, ca, a\bowtie\}$

1. bca
2. bcaa
3. bcaaa
4. cbaa

Solution to Exercise 673.
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 to Exercise 674.
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 to Exercise 675.
1. No
2. No
3. No
4. No

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 TO EXERCISE 676.
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 TO EXERCISE 677.
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^+: {$\rtimes\ltimes, \rtimes c, aa, ab, ac, ba, bb, bc, ca, a\ltimes$}

1. caa
2. ε
3. cabac
4. ca

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

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

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 to Exercise 681.
      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 to Exercise 682.
      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

4. a

Solution to Exercise 683.
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 to Exercise 684.
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 to Exercise 685.
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 TO EXERCISE 686.
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 TO EXERCISE 687.
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

Solution to Exercise 688.
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 to Exercise 689.
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 to Exercise 690.
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 to Exercise 691.
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 to Exercise 692.
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

4. c

SOLUTION TO EXERCISE 693.
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 TO EXERCISE 694.
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 TO EXERCISE 695.
1. Yes
2. Yes
3. Yes
4. Yes

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 TO EXERCISE 696.
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 TO EXERCISE 697.
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^+: $\{\rtimes\rtimes e, \rtimes\rtimes a, \rtimes\rtimes\ltimes, \rtimes\ltimes\ltimes, \rtimes e\ltimes, \rtimes ab, abb, add, bad, bbd, bdb, beb, dbe, ddb, eba, db\ltimes, b\ltimes\ltimes, e\ltimes\ltimes\}$

1. eeebc
2. cbbeee
3. aabcbddbca

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    4. cecd

SOLUTION TO EXERCISE 698.
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 TO EXERCISE 699.
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 to Exercise 700.
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 to Exercise 701.
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 to Exercise 702.
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 TO EXERCISE 703.
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 TO EXERCISE 704.
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 TO EXERCISE 705.
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 TO EXERCISE 706.
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 TO EXERCISE 707.
1. No
2. No
3. No
4. No

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EXERCISE 708.
For each one of the strings below say whether it is generated by the following negative 3-gram grammar:
G^-: $\{aba, baa, bab, bba\}$

1. a
2. b
3. bb
4. ε

SOLUTION TO EXERCISE 708.
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 TO EXERCISE 709.
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

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SOLUTION TO EXERCISE 710.
1. Yes
2. Yes
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 TO EXERCISE 711.
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 TO EXERCISE 712.
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 TO EXERCISE 713.
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^+: $\{⋊ ⋊ ⋊b, ⋊ ⋊ ⋊e, ⋊ ⋊ e⋉, ⋊ ⋊ ea, ⋊ ⋊ be, ⋊ ⋊ ba, ⋊e ⋊ ⋉, ⋊bea, ⋊eaa, ⋊ba⋉, abac, aeab, beae, eaba, eaea, eaa⋉, bac⋉, ba ⋉ ⋉, ac ⋉ ⋉, aa ⋉ ⋉, c ⋉ ⋉⋉, a ⋉ ⋉⋉, e ⋉ ⋉⋉\}$

1. eaa
2. ba
3. e
4. accadead

SOLUTION TO EXERCISE 714.
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

SOLUTION TO EXERCISE 715.
   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 TO EXERCISE 716.
   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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes e, \rtimes\rtimes ae, \rtimes\rtimes e\ltimes, \rtimes aeb, \rtimes e\rtimes\ltimes, aebb, bbeb, bebe, ebbe, ebe\ltimes, be\ltimes\ltimes, e\ltimes\ltimes\ltimes\}$

1. edadaea
2. a
3. edb
4. aa

SOLUTION TO EXERCISE 717.
1. No
2. No
3. No
4. No

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 TO EXERCISE 718.
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^+: $\{\bowtie \bowtie d, \bowtie \bowtie b, \bowtie dd, \bowtie ba, bac, cdb, dba, dcd, ddc, ac\bowtie, ba\bowtie, c \bowtie \bowtie, a \bowtie \bowtie\}$

1. ba
2. bbbadab
3. babdaab
4. bac

SOLUTION TO EXERCISE 719.
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^+: {⋈⋉, ⋊b, aa, ab, ac, ba, bb, ca, cb, b⋉}

1. cabc
2. ε
3. ccaabbb
4. c

SOLUTION TO EXERCISE 720.
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 TO EXERCISE 721.
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 to Exercise 722.
   1. No
   2. Yes
   3. No
   4. No

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 to Exercise 723.
   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 to Exercise 724.
   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^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊ ⋊ ⋉, ⋊ ⋉ ⋉, ⋊ab, ⋊b⋉, ⋊ba, abb, bab, bba, ab⋉, b ⋉ ⋉}

1. a
2. ε
3. abb
4. bbbaab

SOLUTION TO EXERCISE 725.
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 TO EXERCISE 726.
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 to Exercise 727.
1. Yes
2. Yes
3. Yes
4. Yes

Exercise 728.
For each one of the strings below say whether it is generated by the following positive 3-gram grammar:
G^+: {$\rtimes \rtimes c, \rtimes \rtimes b, \rtimes cd, \rtimes bd, ace, bda, ced, dac, dcb, edc, cd\ltimes, cb\ltimes, b\ltimes\ltimes, d\ltimes\ltimes$}

1. abadad
2. becba
3. dbdedca
4. dbb

Solution to Exercise 728.
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^+: {$\rtimes\rtimes\rtimes c, \rtimes\rtimes\rtimes b, \rtimes\rtimes\rtimes\ltimes, \rtimes\rtimes bc, \rtimes\rtimes c\ltimes, \rtimes\rtimes\ltimes\ltimes, \rtimes\rtimes ba, \rtimes baa, \rtimes bca, \rtimes c\ltimes \ltimes, \rtimes\ltimes\ltimes\ltimes, aabb, abbb, baab, bca\ltimes, bbb\ltimes, ca\ltimes\ltimes, bb\ltimes\ltimes, c\ltimes\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes$}

1. ε
2. aac
3. c
4. bca

Solution to Exercise 729.
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
3. a
4. abbb

SOLUTION TO EXERCISE 730.
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^+: $\{\bowtie\bowtie, \bowtie b, aa, ab, ba, bb, b\bowtie\}$

1. ε
2. abbbaa
3. bbabaa
4. aabbbbbaaaaa

SOLUTION TO EXERCISE 731.
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^+: $\{\bowtie a, \bowtie\bowtie, aa, ab, bb, bc, cb, c\bowtie\}$

1. ε
2. b
3. a
4. ab

Solution to Exercise 732.
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 to Exercise 733.
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 to Exercise 734.
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^+: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊b⋉, ⋊aa, aaa, aab, aba, abb, baa, bab, bb⋉, b⋉⋉}

1. ε
2. aaababab
3. bbbab
4. b

Solution to Exercise 735.
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 to Exercise 736.
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^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊a⋉, ⋊bb, aab, abb, baa, bab, bba, bb⋉, b ⋉ ⋉, a ⋉ ⋉}

1. bbbbba
2. aaba
3. a

4. bb

Solution to Exercise 737.
1. No
2. No
3. Yes
4. Yes

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 to Exercise 738.
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^+: $\{$⋊ ⋊ ⋊a, ⋊ ⋊ ⋊b, ⋊ ⋊ ⋊⋉, ⋊ ⋊ ab, ⋊ ⋊ b⋉, ⋊ ⋊ ⋉⋉, ⋊ ⋊ aa, ⋊aaa, ⋊abb, ⋊ab⋉, ⋊ ⋉ ⋉⋉, ⋊b ⋉ ⋉, $aaaa, aaab, aaba, abaa, baaa, aaa$⋉$, abb$⋉$, ab$ ⋉ ⋉$, aa$ ⋉ ⋉$, bb$ ⋉ ⋉$, a$ ⋉ ⋉⋉$, b$ ⋉ ⋉⋉$\}$

1. b
2. ab
3. bab
4. ε

Solution to Exercise 739.
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 to Exercise 740.
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^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes a\ltimes, \rtimes \rtimes ba, \rtimes a \rtimes \ltimes, \rtimes baa, aabc, abcb, baab, bcba, cba\ltimes, ba\ltimes\ltimes, a\ltimes\ltimes\ltimes\}$

1. ε
2. caaaba
3. a
4. bac

Solution to Exercise 741.
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^+: $\{\rtimes\ltimes, \rtimes b, \rtimes c, ad, bb, bc, ca, cd, db, dc, dd, c\ltimes\}$

1. ε
2. dbb
3. bdaabddcca
4. ccabbacbcd

Solution to Exercise 742.
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^+: $\{\rtimes\rtimes\ltimes, \rtimes\rtimes c, \rtimes\rtimes a, \rtimes a\ltimes, \rtimes cb, \rtimes\ltimes\ltimes, \rtimes ac, aca, bac, bba, cbb, ac\ltimes, ca\ltimes, a\ltimes\ltimes, c\ltimes\ltimes\}$

1. ε
2. ddcd
3. daada
4. ca

Solution to Exercise 743.
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 to Exercise 744.
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 ⋉ ⋉, $aaab$, $aaba$, $abaa$, $adca$, $baaa$, $caab$, $dadc$, $dcaa$, aab⋉, ab ⋉ ⋉, cb ⋉ ⋉, b ⋉ ⋉⋉}

1. caaddaccada
2. cb
3. b
4. dadcaab

Solution to Exercise 745.
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 to Exercise 746.
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^+: $\{\rtimes\ltimes, \rtimes b, aa, ab, ba, b\ltimes\}$

1. b
2. abbabb
3. ababab
4. ε

Solution to Exercise 747.
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 to Exercise 748.
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 TO EXERCISE 749.

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

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 TO EXERCISE 750.

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

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3. ε
4. bc

Solution to Exercise 751.
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 to Exercise 752.
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 to Exercise 753.
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 TO EXERCISE 754.
   1. Yes
   2. Yes
   3. Yes
   4. Yes

EXERCISE 755.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes d, bc, bd, cd, db, de, ea, eb, ed, a\ltimes\}$

1. dea
2. ecdbedacba
3. bedcdcdbdd
4. beecaceda

   SOLUTION TO EXERCISE 755.
   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^+: $\{\rtimes \rtimes e, \rtimes \rtimes a, \rtimes eb, \rtimes aa, aac, acd, bba, cdb, dbb, eb\ltimes, ba\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. c
2. eeeb
3. dddbb
4. ddeda

SOLUTION TO EXERCISE 756.

   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 TO EXERCISE 757.

   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 TO EXERCISE 758.

   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 TO EXERCISE 759.

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^+: $\{\rtimes\rtimes c, \rtimes\rtimes a, \rtimes c\ltimes, \rtimes ac, ace, ade, bad, ceb, ded, eba, eda, da\ltimes, a\ltimes\ltimes, c\ltimes\ltimes\}$

1. beee
2. c
3. ecbbbab
4. b

SOLUTION TO EXERCISE 760.

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^+: $\{\rtimes\rtimes c, \rtimes cb, bbc, bcc, cbb, cca, ca\ltimes, a\ltimes\ltimes\}$

1. cbbc
2. c
3. b
4. a

Solution to Exercise 761.
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 to Exercise 762.
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^+: $\{\rtimes \quad \rtimes \quad \rtimes a, \rtimes \quad \rtimes \quad \rtimes c, \rtimes \quad \rtimes \quad \rtimes\ltimes, \rtimes \quad \rtimes \quad \rtimes d, \rtimes \quad \rtimes\ db, \rtimes \quad \rtimes \quad \rtimes\ltimes, \rtimes \quad \rtimes \quad cc, \rtimes \quad \rtimes \quad a\ltimes, \rtimes a \quad \ltimes \quad \ltimes, \rtimes dbb, \rtimes cc\ltimes, \rtimes \quad \ltimes \ltimes, aaba, acaa, bbdc, bdca, caab, caca, dbbd, dcac, aba\ltimes, ba \ltimes \ltimes, cc \ltimes \ltimes, c \ltimes \ltimes\ltimes, a \ltimes \ltimes\ltimes\}$

1. ε
2. abaddeddc
3. dbabdebbbe
4. edcaccde

Solution to Exercise 763.
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 to Exercise 764.
1. Yes
2. No
3. Yes
4. Yes

Exercise 765.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: $\{\rtimes a, \rtimes\ltimes, \rtimes b, ab, ac, ba, cb, cc, a\ltimes, b\ltimes\}$

1. ε
2. cab
3. cc
4. cacab

Solution to Exercise 765.
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 to Exercise 766.
       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^+: $\{ \rtimes \rtimes a, \rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes ba, \rtimes aa, acb, bac, bcc, cbc, ccc, ccd, cda, da\ltimes, aa\ltimes, a\ltimes \ltimes \}$

1. c
2. bacbccda
3. ε
4. aa

    Solution to Exercise 767.
       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^+: $\{ \rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes bb, aab, baa, bba, bbb, ab\ltimes, b\ltimes \ltimes \}$

1. ε
2. ba
3. abba

4. bbaab

Solution to Exercise 768.
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 to Exercise 769.
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 to Exercise 770.
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 TO EXERCISE 771.
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 TO EXERCISE 772.
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 to Exercise 773.
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^+: {⋊⋊c, ⋊⋊b, ⋊cd, ⋊bd, aab, abc, acd, aea, bca, cae, cda, daa, dac, ea⋉, bd⋉, d⋉⋉, a⋉⋉}

1. cdaabcaea
2. daedeeabad
3. bebcdbbbd
4. bd

Solution to Exercise 774.
1. Yes
2. No
3. No
4. Yes

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 to Exercise 775.
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 to Exercise 776.
   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
2. abbaaa
3. ε
4. babbaabb

   Solution to Exercise 777.
   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^+: $\{⋊⋊a, ⋊⋊b, ⋊b⋉, ⋊ba, ⋊aa, aab, aba, abb, bab, bbc, bcb, cbc, bc⋉, ba⋉, b⋉⋉, a\ ⋉\ ⋉, c\ ⋉\ ⋉\}$

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1. b
2. bc
3. ba
4. cab

SOLUTION TO EXERCISE 778.

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 TO EXERCISE 779.

1. Yes
2. No
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 to Exercise 780.
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 to Exercise 781.
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 to Exercise 782.
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 TO EXERCISE 783.
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 TO EXERCISE 784.
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 to Exercise 785.
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 to Exercise 786.
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 to Exercise 787.
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 TO EXERCISE 788.
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 TO EXERCISE 789.
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 to Exercise 790.

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^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes ab, \rtimes \rtimes b\ltimes, \rtimes \rtimes \ltimes\ltimes, \rtimes aba, \rtimes \ltimes \ltimes\ltimes, \rtimes b\ltimes \ltimes, aaab, aabb, abaa, abbb, baaa, bbaa, bbba, baa\ltimes, aa \ltimes \ltimes, a \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. abaa
2. b
3. ε
4. aabaa

Solution to Exercise 791.

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

Exercise 792.

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

G^+: $\{\rtimes \quad \rtimes \quad \rtimes a, \rtimes \quad \rtimes \quad \rtimes b, \rtimes \quad \rtimes \quad \rtimes\ltimes, \rtimes \quad \rtimes \quad ab, \rtimes \quad \rtimes$
$bb, \rtimes \quad \rtimes \quad \ltimes\ltimes, \rtimes \quad \rtimes \quad a\ltimes, \rtimes aba, \rtimes a \quad \ltimes \quad \ltimes, \rtimes bba, \rtimes \quad \ltimes$
$\ltimes\ltimes, aaac, aaca, acaa, acca, bacc, bbac, caaa, caca, ccac, aca\ltimes, aba\ltimes, ba \quad \ltimes$
$\ltimes, ca \ltimes \ltimes, a \ltimes \ltimes\ltimes\}$

1. bbaccabca
2. acbccbccbcb
3. ε
4. a

Solution to Exercise 792.
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 to Exercise 793.
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⋉ ⋉, bb ⋉ ⋉, a ⋉ ⋉⋉, b ⋉ ⋉⋉}

1. a
2. abbbaa
3. abbabba
4. aaabb

Solution to Exercise 794.
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 TO EXERCISE 795.

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^+: $\{\rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes bc, \rtimes \rtimes da, \rtimes \rtimes \ltimes\ltimes, \rtimes dad, \rtimes bc\ltimes, \rtimes \rtimes \ltimes\ltimes, adad, adbc, bcda, cdad, dada, dadb, dbcd, dad\ltimes, ad\ltimes\ltimes, bc\ltimes\ltimes, c\ltimes\ltimes\ltimes, d\ltimes \ltimes\ltimes\}$

1. badcc
2. bc
3. ε
4. cbcdad

SOLUTION TO EXERCISE 796.

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 TO EXERCISE 797.

    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 TO EXERCISE 798.

    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 TO EXERCISE 799.

    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^+: $\{⋈⋈⋈a, ⋈⋈aa, ⋈aab, aaab, aabb, abba, baaa, bbaa, aab⋈, ab⋈⋈, b⋈⋈⋈\}$

1. aab
2. baa
3. abbbaab
4. abbb

SOLUTION TO EXERCISE 800.
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

SOLUTION TO EXERCISE 801.
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 to Exercise 802.
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 to Exercise 803.
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 to Exercise 804.
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 TO EXERCISE 805.
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 TO EXERCISE 806.
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 to Exercise 807.
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 to Exercise 808.
1. No
2. No
3. No
4. No

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 to Exercise 809.
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 TO EXERCISE 810.
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

SOLUTION TO EXERCISE 811.
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

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Solution to Exercise 812.
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 to Exercise 813.
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^+: {$\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes ab, \rtimes \rtimes b\ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes aba, \rtimes abb, \rtimes \rtimes \ltimes \ltimes, \rtimes b \ltimes \ltimes, aabb, abba, abbb, baab, bbaa, bbba, bbbb, aba\ltimes, bba\ltimes, ba\ltimes \ltimes, a\ltimes \ltimes \ltimes, b \ltimes \ltimes \ltimes$}

1. b
2. ε
3. aaa
4. aba

Solution to Exercise 814.
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 TO EXERCISE 815.
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 TO EXERCISE 816.
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. dbcddddda
4. ε

Solution to Exercise 817.
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^+: $\{\rtimes \rtimes d, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes da, abc, aca, bcb, bda, cab, cbd, dac, ac\ltimes, c \ltimes \ltimes\}$

1. bdbb
2. bddeecacce
3. ε
4. dac

Solution to Exercise 818.
1. No
2. No
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 to Exercise 819.
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 TO EXERCISE 820.

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 TO EXERCISE 821.

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^+: {$\rtimes\rtimes\rtimes a, \rtimes\rtimes\rtimes b, \rtimes\rtimes\rtimes\rtimes, \rtimes\rtimes ab, \rtimes\rtimes\rtimes\ltimes, \rtimes\rtimes a\ltimes, \rtimes\rtimes ba, \rtimes baa, \rtimes aba, \rtimes a\ltimes \ltimes, \rtimes \ltimes \ltimes\ltimes, aaba, abaa, abab, baab, baa\ltimes, bab\ltimes, ab \ltimes \ltimes, aa \ltimes \ltimes, a \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes$}

1. ε
2. baaa

3. bbaaab
4. aaabaaa

SOLUTION TO EXERCISE 822.
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 TO EXERCISE 823.
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^+: $\{\bowtie\bowtie, \bowtie b, aa, ab, ba, bb, b\bowtie\}$

1. babbb
2. b
3. aaaabb
4. ε

SOLUTION TO EXERCISE 824.
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 TO EXERCISE 825.
      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 TO EXERCISE 826.
      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 to Exercise 827.
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 to Exercise 828.
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^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes\ltimes, \rtimes \rtimes cb, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes aa, \rtimes aaa, \rtimes cbc, \rtimes \rtimes \ltimes\ltimes, aaac, aaba, aacb, abaa, acbc, baab, bcaa, caab, cbca, aab\ltimes, cbc\ltimes, ab \ltimes, bc \ltimes \ltimes, c \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. ε
2. cbc
3. ccbccb
4. aaa

Solution to Exercise 829.
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 TO EXERCISE 830.

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 TO EXERCISE 831.

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 to Exercise 832.
      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 to Exercise 833.
      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 to Exercise 834.
      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 to Exercise 835.
1. Yes
2. No
3. No
4. No

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 to Exercise 836.
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 to Exercise 837.
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
4. bdcbbcbd

Solution to Exercise 838.
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 to Exercise 839.
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 to Exercise 840.
1. No
2. No
3. No
4. No

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 to Exercise 841.
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 to Exercise 842.
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^+: $\{ \rtimes \rtimes a, \rtimes aa, aaa, aab, abb, bbb, bb\ltimes, aa\ltimes, b \ltimes \ltimes, a \ltimes \ltimes \}$

1. aa
2. aaa
3. abaaaa
4. ba

Solution to Exercise 843.
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^+: $\{ \rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes b, \rtimes \rtimes bc, \rtimes \rtimes c\ltimes, \rtimes \rtimes bb, \rtimes \rtimes cd, \rtimes cdd, \rtimes bbb, \rtimes c \ltimes \ltimes, \rtimes bc\ltimes, cdda, daca, ddac, aca\ltimes, bbb\ltimes, bc \ltimes \ltimes, ca \ltimes \ltimes, bb \ltimes \ltimes, c \ltimes \ltimes\ltimes, a \ltimes \ltimes\ltimes, b \ltimes \ltimes\ltimes \}$

1. c
2. abba
3. bb
4. dba

Solution to Exercise 844.
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^+: $\{\rtimes c, aa, ab, ba, bb, bc, ca, cb, cc, b\ltimes\}$

1. dcaaba
2. cb
3. ccb
4. cbb

Solution to Exercise 845.
1. No
2. Yes
3. Yes
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 to Exercise 846.
1. Yes
2. No
3. Yes
4. Yes

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EXERCISE 847.
For each one of the strings below say whether it is generated by the following positive 2-gram grammar:
G^+: {⋊$b, aa, ab, ba, bb, bd, db, d$⋉}

1. bd
2. ε
3. cdacaa
4. bbd

SOLUTION TO EXERCISE 847.
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
2. bbc
3. bbccb
4. ε

SOLUTION TO EXERCISE 848.
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^+: {⋊⋉, ⋊$d, bb, bc, bd, cd, db, dc, dd, c$⋉}

1. cbaaa
2. ε
3. cacda
4. ddcbccdbd

Solution to Exercise 849.
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 to Exercise 850.
1. No
2. Yes
3. Yes
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 to Exercise 851.
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^+: {⋈ ⋈ ⋈⋉, ⋈ ⋈ ⋈d, ⋈ ⋈ ⋈⋉, ⋈ ⋈ d⋉, ⋈ ⋈ da, ⋈d ⋉ ⋉, ⋈ ⋈ ⋉⋉, ⋈dad, adcb, adcd, bcad, cadc, cbca, dadc, dcbc, dcd⋉, cd ⋉ ⋉, d ⋉ ⋉⋉}

1. ccaddcbcc
2. a
3. d
4. ε

SOLUTION TO EXERCISE 852.
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^+: {⋈⋈⋉, ⋈⋈a, ⋈⋈b, ⋈aa, ⋈⋉⋉, ⋈b⋉, aaa, aac, ace, adb, bae, bda, ceb, dad, dba, ebd, ae⋉, e⋉ ⋉, b ⋉ ⋉}

1. daad
2. dcaa
3. ε
4. b

SOLUTION TO EXERCISE 853.
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^+: {⋈⋈⋉, ⋈⋈d, ⋈⋈e, ⋈db, ⋈⋉⋉, ⋈ed, bbd, bdc, bee, cde, ceb, dbe, dcd, ebb, ece, eec, ed⋉, de⋉, d⋉ ⋉, e ⋉ ⋉}

1. ed

2. ε
3. badde
4. eaccecaed

Solution to Exercise 854.

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 to Exercise 855.

1. Yes
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 to Exercise 856.

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 to Exercise 857.

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^-: $\{abd, dae, dbc, eab\}$

1. ε
2. eaaccb
3. bacaecec
4. dabedb

Solution to Exercise 858.

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 TO EXERCISE 859.
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 TO EXERCISE 860.
1. Yes
2. Yes
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

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SOLUTION TO EXERCISE 861.
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^+: {⋈ ⋈ b, ⋈ba, aaa, abc, bab, bca, caa, aa⋈, a ⋈ ⋈}

1. aabbaa
2. ccbcaabc
3. bcbbcca
4. ccbab

SOLUTION TO EXERCISE 862.
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^+: {⋈⋈⋈, ⋈⋈c, ⋈⋈d, ⋈⋈⋈, ⋈dc, ⋈cc, bda, cbd, ccb, ccc, dac, dc⋈, ac⋈, c⋈⋈}

1. cbabdca
2. dc
3. abdd
4. ε

SOLUTION TO EXERCISE 863.
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 TO EXERCISE 864.
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 TO EXERCISE 865.
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^+: {$\rtimes \rtimes \rtimes a, \rtimes \rtimes aa, \rtimes aad, aadb, abdd, adba, babd, dbab, bdd\ltimes, dd\ltimes\ltimes, d\ltimes\ltimes\ltimes$}

1. cb
2. aad
3. bbc

4. adcb

SOLUTION TO EXERCISE 866.
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 TO EXERCISE 867.
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^-: $\{ac, ba, bc, ca\}$

1. cbb
2. bb
3. cccbabb
4. ε

SOLUTION TO EXERCISE 868.
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 TO EXERCISE 869.
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 TO EXERCISE 870.
1. No
2. Yes
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 to Exercise 871.

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 to Exercise 872.

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 to Exercise 873.

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 TO EXERCISE 874.
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^+: $\{\bowtie \bowtie c, \bowtie cc, aba, abb, bab, bbc, bcc, cab, cba, cca, ccb, ccc, ba\bowtie, a \bowtie \bowtie\}$

1. ccbabccbc
2. ccba
3. ccccabbaaaba
4. cccba

SOLUTION TO EXERCISE 875.
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 to Exercise 876.
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^+: $\{⋊a, ⋊d, aa, ab, ba, bc, cb, cc, cd, da, a⋉\}$

1. ε
2. dbabdcc
3. a
4. aa

Solution to Exercise 877.
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 to Exercise 878.
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^+: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ab, ⋊bb, aab, aba, abb, baa, bab, bba, bbb, bb⋉, ba⋉, b⋉⋉, a⋉⋉}

1. baabaa
2. ε
3. bbb
4. aabbab

SOLUTION TO EXERCISE 879.
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^+: {⋊ ⋊ a, ⋊ ⋊ b, ⋊ac, ⋊ba, aba, abc, bab, bcc, ac⋉, cc⋉, c ⋉ ⋉}

1. ac
2. bb
3. babcc
4. acbacb

SOLUTION TO EXERCISE 880.
1. Yes
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 TO EXERCISE 881.
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 TO EXERCISE 882.
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 TO EXERCISE 883.
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 TO EXERCISE 884.
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 TO EXERCISE 885.
1. Yes
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 to Exercise 886.
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 to Exercise 887.
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 to Exercise 888.
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 TO EXERCISE 889.
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^+: $\{\rtimes\ \rtimes\ \rtimes a, \rtimes\ \rtimes\ \rtimes\ltimes, \rtimes\ \rtimes\ \ltimes\ltimes, \rtimes\ \rtimes\ ab, \rtimes aba, \rtimes\ \rtimes\ \ltimes\ltimes, abac, acde, bacd, cdec, decc, eccc, ccc\ltimes, cc\ltimes\ltimes, c\ltimes\ltimes\ltimes\}$

1. adbaebec
2. ε
3. edcedaae
4. b

SOLUTION TO EXERCISE 890.
1. No
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 to Exercise 891.
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 to Exercise 892.
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 to Exercise 893.
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 TO EXERCISE 894.
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 TO EXERCISE 895.
1. No
2. No
3. No
4. No

EXERCISE 896.
For each one of the strings below say whether it is generated by the following negative 4-gram grammar:
G^-: $\{aabb, abaa, abba, baaa, baab, baba, bbaa, bbab\}$

1. ε
2. aaaaba
3. abb
4. abbba

Solution to Exercise 896.
1. Yes
2. Yes
3. Yes
4. Yes

Exercise 897.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:
G^+:   {⋊ ⋊ ⋊c, ⋊ ⋊ ⋊b, ⋊ ⋊ bd, ⋊ ⋊ c⋉, ⋊bdb, ⋊c ⋉, $aaab$, $aaba$, $baaa$, $bbaa$, $bdbb$, $dbba$, aba⋉, ba ⋉ ⋉, a ⋉ ⋉⋉, c ⋉ ⋉⋉}

1. ddcbaaac
2. dbbabc
3. ε
4. c

Solution to Exercise 897.
1. No
2. No
3. No
4. Yes

Exercise 898.
For each one of the strings below say whether it is generated by the following negative 2-gram grammar:
G^-: {$aa, ac, ad, bb, bd, ca, ee$}

1. b
2. e
3. ε
4. c

Solution to Exercise 898.
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 to Exercise 899.
    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 to Exercise 900.
    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 TO EXERCISE 901.
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 TO EXERCISE 902.
1. No
2. No
3. No
4. No

EXERCISE 903.
For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

G^+: $\{\rtimes \rtimes \rtimes a, \rtimes \rtimes \rtimes c, \rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes ab, \rtimes \rtimes c\ltimes, \rtimes \rtimes bb, \rtimes \rtimes \ltimes\ltimes, \rtimes \rtimes cc, \rtimes ccb, \rtimes bbb, \rtimes c \ltimes \ltimes, \rtimes ab\ltimes, \rtimes \rtimes \ltimes\ltimes, accb, bacc, cbac, cbcc, ccba, ccbc, bcc\ltimes, bbb\ltimes, ab \ltimes \ltimes, cc \ltimes \ltimes, bb \ltimes \ltimes, c \ltimes\ltimes, b \ltimes \ltimes\ltimes\}$

1. c
2. ε
3. cbacaacab
4. ab

Solution to Exercise 903.
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^+: $\{\rtimes a, \rtimes\ltimes, \rtimes b, ab, ba, bb, a\ltimes\}$

1. a
2. aaabbabb
3. ε
4. bbbb

Solution to Exercise 904.
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 to Exercise 905.
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 TO EXERCISE 906.
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 TO EXERCISE 907.
1. No
2. No
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^+: $\{\rtimes \rtimes b, \rtimes \rtimes \ltimes, \rtimes \ltimes \ltimes, \rtimes b\ltimes, \rtimes bc, aaa, aab, aba, aca, bac, bca, caa, bc\ltimes, aa\ltimes, b\ltimes \ltimes, c\ltimes \ltimes, a\ltimes \ltimes\}$

1. ε
2. baaacabaac

3. b
4. bc

SOLUTION TO EXERCISE 908.
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 TO EXERCISE 909.
1. No
2. No
3. No
4. No

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 to Exercise 910.
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 to Exercise 911.
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^+: $\{\rtimes\ \rtimes\ \rtimes c, \rtimes\ \rtimes\ \rtimes e, \rtimes\ \rtimes\ e\ltimes, \rtimes\ \rtimes\ eb, \rtimes\ \rtimes\ ec, \rtimes\ \rtimes\ cd, \rtimes eca, \rtimes cda, \rtimes e\ \ltimes, \rtimes eb\ltimes, aede, cdae, daed, deae, eaed, edea, eca\ltimes, aed\ltimes, eb\ \ltimes\ \ltimes, ed\ \ltimes\ \ltimes, ca\ \ltimes, d\ \ltimes\ \ltimes\ltimes, a\ \ltimes\ \ltimes\ltimes, e\ \ltimes\ \ltimes\ltimes, b\ \ltimes\ \ltimes\ltimes\}$

1. cbcccbbba
2. ddaca
3. ε
4. eadab

Solution to Exercise 912.
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 TO EXERCISE 913.
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 TO EXERCISE 914.
1. Yes
2. Yes
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 to Exercise 915.
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 to Exercise 916.
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^+: $\{\rtimes\rtimes\rtimes a, \rtimes\rtimes aa, \rtimes\rtimes ab, \rtimes aaa, \rtimes abc, aaac, aaca, acac, cacb, abc\ltimes, acb\ltimes, bc\ltimes \ltimes, cb\ltimes\ltimes, c\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. aac
2. acac
3. cbc
4. abc

Solution to Exercise 917.
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^+: {⋊a, ⋊⋉, ⋊c, aa, ab, ac, ba, bc, ca, cb, a⋉, c⋉}

1. bcabc
2. ε
3. baaaa
4. ccaabc

SOLUTION TO EXERCISE 918.
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 TO EXERCISE 919.
1. Yes
2. Yes
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^+: {⋊⋊c, ⋊⋊b, ⋊ba, ⋊ca, abb, aca, bbb, bbc, bcc, cab, cac, cca, bb⋉, ba⋉, b⋉⋉, a⋉⋉}

1. bbcbaaa
2. bacbabaa
3. bbcc

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4. baacabc

SOLUTION TO EXERCISE 920.
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. aabababa
2. bab
3. baab
4. ε

SOLUTION TO EXERCISE 921.
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 TO EXERCISE 922.
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^+: {⋊ ⋊ b, ⋊ ⋊ ⋉, ⋊ ⋉ ⋉, ⋊ba, aaa, aab, aba, abb, baa, bab, bba, ab⋉, b ⋉ ⋉}

1. abab
2. bbaaaaaba
3. ε
4. baabba

Solution to Exercise 923.
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^+: {⋊a, aa, ab, ac, ba, bb, ca, cc, a⋉}

1. cacc
2. babb
3. acaacabba
4. cc

Solution to Exercise 924.
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 to Exercise 925.
   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 to Exercise 926.
   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:
G^-: $\{abaa, abba, acab, bccb, cbbb, cbcb, cccc\}$

1. bababc
2. baccacaab
3. ε
4. aaabbabcab

Solution to Exercise 927.
   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 TO EXERCISE 928.
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^+: $\{⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ac, ⋊ba, acb, adc, bca, cad, cbc, dc⋉, ba⋉, a⋉⋉, c⋉⋉\}$

1. cc
2. ba
3. dcacdbb
4. ε

SOLUTION TO EXERCISE 929.
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 TO EXERCISE 930.
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^+: $\{\rtimes d, bb, bc, cd, db, dc, c\ltimes\}$

1. ca
2. dc
3. dbc
4. bcbbad

SOLUTION TO EXERCISE 931.
1. No
2. Yes
3. Yes
4. No

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 TO EXERCISE 932.
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 TO EXERCISE 933.
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 TO EXERCISE 934.
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 to Exercise 935.
 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 to Exercise 936.
 1. No
 2. No
 3. No
 4. No

Exercise 937.
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. bbab
 2. a
 3. aa
 4. ε

Solution to Exercise 937.
 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 to Exercise 938.
     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
3. c
4. ε

   Solution to Exercise 939.
     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^+: {⋊a, ab, ba, bb, b⋉}

1. baa
2. ab

3. babbbb
4. ε

SOLUTION TO EXERCISE 940.
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^+: {⋊⋊a, ⋊⋊b, ⋊b⋉, ⋊ba, ⋊aa, aab, abb, baa, bab, bba, ab⋉, aa⋉, b⋉⋉, a⋉⋉}

1. bbabba
2. aab
3. b
4. aa

SOLUTION TO EXERCISE 941.
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 to Exercise 942.
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^+: $\{ \rtimes\rtimes e, \rtimes\rtimes b, \rtimes e\ltimes, \rtimes bd, aad, aba, add, baa, bde, cda, dab, ddb, dec, ecd, db\ltimes, b\ltimes \ltimes, e\ltimes \ltimes \}$

1. a
2. e
3. ebecaeeedab
4. dceacaaaa

Solution to Exercise 943.
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 to Exercise 944.
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 TO EXERCISE 945.
   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^+: $\{\rtimes \rtimes \rtimes b, \rtimes \rtimes \rtimes \ltimes, \rtimes \rtimes \rtimes d, \rtimes \rtimes \rtimes e, \rtimes \rtimes bb, \rtimes \rtimes ed, \rtimes \rtimes d\ltimes, \rtimes \rtimes \ltimes \ltimes, \rtimes ed\ltimes, \rtimes d \ltimes \ltimes, \rtimes bbc, \rtimes \rtimes \ltimes \ltimes, addb, bbca, bcad, beea, cadd, dbee, ddbe, eea\ltimes, ea \ltimes \ltimes, ed \ltimes \ltimes, d \ltimes \ltimes \ltimes, a \ltimes \ltimes \ltimes\}$

1. ε
2. eabecdd
3. cacba
4. dddaa

SOLUTION TO EXERCISE 946.
   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 to Exercise 947.
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 to Exercise 948.
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 to Exercise 949.
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 to Exercise 950.
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^+: $\{\rtimes\quad\rtimes\quad c, \rtimes\quad\rtimes\quad a, \rtimes\quad\rtimes\quad b, \rtimes\quad\rtimes\quad\ltimes, \rtimes c\ltimes, \rtimes\quad\ltimes, \rtimes bb, \rtimes aa, aab, abb, baa, bba, bb\ltimes, aa\ltimes, b\ltimes\ltimes, a\ltimes\ltimes, c\ltimes\ltimes\}$

1. abbb
2. ε
3. ab
4. babcc

Solution to Exercise 951.
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 to Exercise 952.

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 to Exercise 953.

1. No
2. Yes
3. No
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 to Exercise 954.
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 to Exercise 955.
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
2. cc
3. bbaaabcb
4. bbcabbcc

Solution to Exercise 956.
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 TO EXERCISE 957.
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 TO EXERCISE 958.
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

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Solution to Exercise 959.
   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 to Exercise 960.
   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
   2. aa
   3. ccbbaccaa
   4. cb

Solution to Exercise 961.
   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^+: $\{⋈⋈e, ⋈⋈c, ⋈cb, ⋈ee, adb, dad, eda, eed, db⋈, cb⋈, b⋈⋈\}$

1. cc
2. ε
3. ee
4. bd

   SOLUTION TO EXERCISE 962.
   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 TO EXERCISE 963.
   1. No
   2. No
   3. Yes
   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 to Exercise 964.
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^+: $\{⋈⋈a, ⋈⋈c, ⋈⋈⋈, ⋈c⋈, ⋈⋈⋈, ⋈ac, ⋈ab, aca, acb, bca, cab, cac, cbc, ab⋈, b⋈⋈, c⋈⋈\}$

1. cc
2. bb
3. cabac
4. abbcb

Solution to Exercise 965.
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 to Exercise 966.
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 TO EXERCISE 967.**
> 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 TO EXERCISE 968.**
> 1. No
> 2. No
> 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^+: $\{\rtimes \ \rtimes \ \rtimes a, \rtimes \ \rtimes \ \rtimes b, \rtimes \ \rtimes \ aa, \rtimes \ \rtimes \ ab, \rtimes \ \rtimes \ b\ltimes, \rtimes b \ \ltimes, \rtimes aaa, \rtimes abb, aaaa, aaab, aaba, abb\ltimes, aba\ltimes, ba\ltimes\ltimes, bb\ltimes\ltimes, a\ltimes\ltimes\ltimes, b\ltimes\ltimes\ltimes\}$

1. bbaaba
2. b
3. ε

4. a

SOLUTION TO EXERCISE 969.
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 TO EXERCISE 970.
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^-: $\{aaa, aab, aca, acc, cab\}$

1. bac
2. ε
3. b
4. bc

SOLUTION TO EXERCISE 971.
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 to Exercise 972.
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 to Exercise 973.
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^+: $\{\rtimes\rtimes a, \rtimes\rtimes b, \rtimes a\ltimes, \rtimes bb, acc, bac, bba, cab, cca, ab\ltimes, b\ltimes\ltimes, a\ltimes\ltimes\}$

1. cba
2. a
3. bcccbbb
4. bcaacba

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Solution to Exercise 974.

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^+: $\{\rtimes a, \rtimes\ltimes, ab, ac, bc, bd, cb, cd, da, db, dc, c\ltimes\}$

1. dbbaccbcbaac
2. cbcd
3. addaa
4. ccdbd

Solution to Exercise 975.

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 to Exercise 976.

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 to Exercise 977.

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 to Exercise 978.

1. No
2. No
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 to Exercise 979.
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 to Exercise 980.
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 to Exercise 981.
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 to Exercise 982.
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 to Exercise 983.
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 TO EXERCISE 984.
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^+: {⋊⋊b, ⋊⋊⋉, ⋊⋉⋉, ⋊ba, ⋊bb, aab, aba, abb, baa, bab, bba, bbb, bb⋉, aa⋉, b⋉⋉, a⋉⋉}

1. bbbbbbbb
2. b
3. bbaabaaaba
4. bbbbababaa

SOLUTION TO EXERCISE 985.
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:
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 to Exercise 986.
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 to Exercise 987.
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

Solution to Exercise 988.
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 TO EXERCISE 989.
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 TO EXERCISE 990.
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 TO EXERCISE 991.
   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 TO EXERCISE 992.
   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 TO EXERCISE 993.
   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 TO EXERCISE 994.**
> 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 TO EXERCISE 995.**
> 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^+: {⋊d, ac, ad, bd, cb, da, db, dc, dd, c⋉}

1. dc
2. ddc
3. adcbdaacdc

4. dac

Solution to Exercise 996.

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^+: {⋊⋊a, ⋊⋊b, ⋊⋊⋉, ⋊a⋉, ⋊⋉⋉, ⋊ba, ⋊bb, aba, abb, baa, bab, bba, aa⋉, ba⋉, a⋉⋉}

1. bbbaaaa
2. aababb
3. bbbbbba
4. aaaab

Solution to Exercise 997.

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 to Exercise 998.

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 to Exercise 999.
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 to Exercise 1000.
1. Yes
2. Yes
3. Yes
4. Yes