

## 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:

$G^+$ :  $\{\times \times a, \times \times b, \times ab, \times bb, aab, aba, abb, baa, bbb, bb\times, b \times \times\}$

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.  $\varepsilon$

### 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.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+: \{\bowtie\bowtie, \bowtie d, ba, cc, cd, db, dc, a\bowtie\}$

1. cabd
2. dba
3. edced
4.  $\varepsilon$

**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:

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

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. bbbdcbbba
3. d
4.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\times \times \times b, \times \times \times \times, \times \times \times \times, \times \times bb, \times \times b \times, \times \times \times \times, \times bbb, \times b \times \times, aabb, abbb, baab, bbaa, bbba, bbbb, bbb \times, bb \times \times, b \times \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times c \times, \times \times bc, \times c \times \times, \times \times bcc, bc bc, bccb, bc dc, bddb, cbcd, cbdd, cc bd, dbcb, ddbc, cd c \times, dc \times \times, c \times \times \times\}$

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:

$G^+$ :  $\{\times \times a, \times \times b, \times \times \times, \times a \times, \times \times \times, \times ab, \times bb, aaa, aab, aba, baa, bab, bba, ab \times, b \times \times, a \times \times\}$

1. bbabbab
2. aabaabbb
3.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\times \times a, \times \times b, \times b \times, \times ab, \times ba, aba, abb, acb, bab, bac, bba, bbb, bbc, cbb, bc \times, ba \times, c \times \times, b \times \times, a \times \times\}$

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.  $\varepsilon$

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:

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

1.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
2. bbddada
3. caccbad
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.  $\varepsilon$
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:

$G^-: \{bebb, cbce, cddb, eb aa\}$

1. bbbede
2. e
3.  $\varepsilon$
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:

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

1. cbccbad
2.  $\epsilon$
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.  $\epsilon$
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:

$G^+$ :  $\{\times \times b, \times \times \times, \times \times \times, \times bb, aca, ada, bac, bba, bbb, cad, dad, ad\times, d \times \times\}$

1. cbabbaba
2. bbbacad
3.  $\varepsilon$
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:

$G^-$ :  $\{bacd, bbdd, cbba, cccb, cccb, dabc, dbbc\}$

1. cd
2. dca
3.  $\varepsilon$
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:

$G^+: \{\times \times \times d, \times \times \times c, \times \times \times \times, \times \times \times \times, \times \times d \times, \times \times ca, \times cab, \times d \times \times, \times \times \times \times, abcd, bcde, cabd, cdcc, dcca, cca \times, ca \times \times, a \times \times \times, d \times \times \times\}$

1. abcb
2. aaacd
3. acdbcd db
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times bc, \times \times ac, \times \times \times \times, \times \times aa, \times aaa, \times acc, \times bc \times, \times \times \times \times, accb, bcbb, cbcb, cc bc, aaa \times, cbb \times, aa \times \times, bc \times \times, bb \times \times, c \times \times \times, a \times \times \times, b \times \times \times\}$

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. bdddcdb
2.  $\varepsilon$
3. acacbaab
4. ddb

**SOLUTION TO EXERCISE 31.**

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

**EXERCISE 32.**

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

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times d, \times \times db, \times \times bd, \times \times a\times, \times db\times, \times a \times \times, \times bdb, acbd, bacb, bdba, bddb, cbdd, dbac, ddbb, dbb\times, db \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

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

**SOLUTION TO EXERCISE 32.**

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

**EXERCISE 33.**

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

$G^-$ :  $\{baaa, baba, bbaa, bbab, bbbb\}$

1. bbbabaabaaab
2. bbaa
3. bbaababbb
4.  $\varepsilon$

**SOLUTION TO EXERCISE 33.**

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

**EXERCISE 34.**

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

$G^-: \{aaaa, abba, bbce, ddea, dded, ecde, edbd, eeee\}$

1. acbb
2. b
3. e
4.  $\varepsilon$

**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:

$G^+: \{\times \times \times a, \times \times ac, \times \times aa, \times aae, \times aca, aaec, aeac, aece, cedd, daea, ddae, eced, edda, aca \times, eac \times, ac \times \times, ca \times \times, c \times \times \times, a \times \times \times\}$

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.  $\varepsilon$

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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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. bc bc

**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:

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

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:

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

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:

$G^+ : \{\times \times c, \times \times b, \times \times \times, \times \times \times, \times b \times, \times ca, aab, aba, abc, bab, bca, caa, cab, ba \times, b \times \times, a \times \times\}$

1.  $\epsilon$
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:

$G^+ : \{\times \times c, \times \times a, \times a \times, \times ca, abb, bbc, bca, cab, ab \times, b \times \times, a \times \times\}$

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:

$G^- : \{abaa, bedd, cbdd, cbca, dbcb, eec\}$

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.  $\varepsilon$
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:

$G^+: \{\bowtie \bowtie a, \bowtie ab, abc, aca, bac, bcb, cba, ca\bowtie, a \bowtie \bowtie\}$

1. cabaca
2. bcbcb
3.  $\varepsilon$
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:

$G^+$ :  $\{\times \times e, \times \times c, \times \times \times, \times c \times, \times \times \times, \times ee, aad, ada, dad, eaa, eea, ad \times, d \times \times, c \times \times\}$

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.  $\varepsilon$

**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. cbcddca

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:

$G^+$ :  $\{\times \times \times c, \times \times \times \times, \times \times \times e, \times \times eb, \times \times ce, \times \times \times \times, \times cec, \times eb \times, \times \times \times \times, bdce, cbdc, ccbd, cecc, ceee, dcee, eccb, eee \times, eb \times \times, ee \times \times, e \times \times \times, b \times \times \times\}$

1. eb
2.  $\varepsilon$
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:

$G^+$ :  $\{\times \times, \times b, bc, cc, cd, db, b \times\}$

1.  $\varepsilon$
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:

$G^+$ :  $\{\epsilon, c, \epsilon, \epsilon, d, \epsilon, b, \epsilon cb, \epsilon db, \epsilon \epsilon, \epsilon b \epsilon, aba, bbd, bdb, bee, dbb, dbe, eab, eea, cb \epsilon, ba \epsilon, b \epsilon \epsilon, a \epsilon \epsilon\}$

1. cb
2.  $\epsilon$
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:

$G^+$ :  $\{\epsilon \epsilon, \epsilon b, \epsilon e, bd, ce, db, dc, ed, e \epsilon, b \epsilon\}$

1. b
2. eaa
3.  $\epsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times \times c, \times \times \times b, \times \times \times c, \times \times \times cc, \times \times \times bc, \times cca, \times c \times \times, \times bcb, adcd, cadc, ccad, dcde, cdc \times, bcb \times, dc \times \times, cb \times \times, c \times \times \times, b \times \times \times\}$

1. d
2. dcadb
3. bcd
4.  $\varepsilon$

**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:

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

1.  $\epsilon$
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:

$G^+$ :  $\{\epsilon\epsilon a, \epsilon\epsilon b, \epsilon\epsilon\epsilon, \epsilon\epsilon\epsilon, \epsilon ab, \epsilon b\epsilon, \epsilon ba, aab, abc, baa, bca, bcc, caa, ccc, ab\epsilon, cc\epsilon, b\epsilon\epsilon, c \epsilon \epsilon\}$

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.  $\varepsilon$
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:

$G^+ : \{\times \times c, \times cb, \times ca, abb, aca, cab, cac, bb\times, cb\times, b \times \times\}$

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:

$G^+ : \{\times \times \times a, \times \times aa, \times \times ab, \times aba, \times aaa, \times ab\times, aaba, aabb, abaa, abba, baab, bbaa, baa\times, aaa\times, ab\times\times, aa\times\times, a\times\times\times, b\times\times\times\}$

1. abaa
2.  $\varepsilon$
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:

$G^+ : \{\times a, ab, ac, ba, bb, bc, ca, cb, cc, a\times, b\times\}$

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. aaacbcca

**SOLUTION TO EXERCISE 65.**

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

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

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

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

2. aaabbbbbb
3.  $\varepsilon$
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:

$G^+ : \{\times \times b, \times b \times, \times bb, bac, bbc, bcb, cba, ac \times, b \times \times, c \times \times\}$

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.  $\varepsilon$
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. cebbbcebb
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.  $\varepsilon$
2. b
3. ebbca
4. daabeea

**SOLUTION TO EXERCISE 72.**

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

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

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

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

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:

$G^+ : \{\times c, ac, ca, cc, c\times\}$

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.  $\varepsilon$
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.  $\varepsilon$
2. abbbab
3. bbaaaaa
4. aaaaaaaaa

**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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\times e, ad, ba, bb, bc, cb, de, eb, ec, b\times\}$

1. eddcddce
2. eddc dab
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:

$G^+ : \{\times d, ab, bc, cd, da, dd, d\times\}$

1.  $\varepsilon$
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:

$G^+ : \{\times a, aa, ab, ac, ba, bc, ca, cb, cc, c\times\}$

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:

$G^+ : \{\times \times c, \times \times a, \times \times d, \times a \times, \times dd, \times cc, aad, aca, adb, bac, cad, daa, dba, dda, ad \times, cc \times, d \times \times, c \times \times, a \times \times\}$

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:

$G^+ : \{\times \times c, \times \times b, \times c \times, \times ba, abc, aee, bae, dab, dda, edd, eed, bc \times, c \times \times\}$

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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times \times \times, \times \times bc, \times \times cb, \times \times \times \times, \times bcb, \times cbc, \times \times \times \times, babb, bbab, bbba, bbbb, bcb b, cbb b, cbc \times, abb \times, bc \times \times, bb \times \times, c \times \times \times, b \times \times \times\}$

1. cacb
2. baccacca
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.  $\varepsilon$
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.  $\varepsilon$

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:

$$G^+: \{ \times \times \times a, \times \times \times b, \times \times \times \times, \times \times \times b \times, \times \times \times \times \times, \times \times \times a a, \times \times \times b a, \times a a a, \times b a a, \times b a \times, \times \times \times \times, \times b \times \times, \times a a a a, a a a b, a a b b, a b b a, b a a \times, b b a \times, b a \times \times, a a \times \times, a \times \times \times, b \times \times \times \}$$

1. bbbbaa
2.  $\epsilon$
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.  $\epsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times b \times, \times bb, \times aa, aaa, aab, aba, baa, bb \times, aa \times, b \times \times, a \times \times\}$

1. abb
2. abababa
3. aaabb
4.  $\varepsilon$

**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.  $\varepsilon$
4. abbbbbaaab

**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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\bowtie \bowtie a, \bowtie \bowtie b, \bowtie ba, \bowtie aa, aab, abb, baa, bba, bbb, aa\bowtie, ba\bowtie, a\bowtie\bowtie\}$

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.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+ : \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times b \times, \times aa, aaa, aab, aba, abb, baa, bab, bba, aa \times, b \times \times, a \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+$ :  $\{\lambda, \lambda, \lambda\lambda, \lambda, \lambda, \lambda b, \lambda, \lambda, \lambda\lambda, \lambda, \lambda, ba, \lambda, \lambda, \lambda\lambda, \lambda baa, aabb, abba, baab, baba, bbab, aba\lambda, ba\lambda\lambda, a\lambda\lambda\lambda\}$

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:

$G^+$ :  $\{\lambda c, aa, ab, ac, ba, ca, cc, c\lambda\}$

1. cbc
2.  $\epsilon$
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.  $\epsilon$

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.  $\varepsilon$
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:

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

1. eceab
2. dacacaab
3. daaeabd
4.  $\varepsilon$

**SOLUTION TO EXERCISE 109.**

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

**EXERCISE 110.**

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

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

1. ddaddcbda
2. cdbaaaed
3. ced
4.  $\varepsilon$

**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.  $\varepsilon$
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:

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

1. deebebab
2. d
3. dcddcdcee

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.  $\varepsilon$
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.  $\epsilon$
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:

$G^+: \{\times \times a, \times \times b, \times ab, \times b\times, aab, abb, baa, bba, bb\times, ab\times, b\times\times\}$

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:

$G^+: \{\times \times \times b, \times \times bb, \times bba, \times bb\times, \times bbb, babb, bbab, bbba, bbbb, bba\times, abb\times, ba\times\times, bb\times\times, a\times\times\times, b\times\times\times\}$

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:

$G^+ : \{\bowtie \bowtie b, \bowtie \bowtie \bowtie, \bowtie \bowtie \bowtie, \bowtie ba, aaa, aab, aba, baa, bab, ab\bowtie, b \bowtie \bowtie\}$

1. abaaabb
2. bbbabbba
3.  $\varepsilon$
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.  $\varepsilon$
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:

$G^-: \{aaca, accb, bach, cccb\}$

1. acaccbcca
2. bcba
3.  $\varepsilon$
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.  $\varepsilon$
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:

$G^-: \{adae, ccde, cebd, dedc\}$

1. adedc
2.  $\varepsilon$
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:

$G^+: \{\times \times \times \times, \times \times \times a, \times \times aa, \times \times \times \times, \times \times \times \times, \times \times \times a, \times \times ab, \times \times bb, \times \times ba, \times \times aa, \times \times \times \times, \times \times \times a, \times \times \times b, \times \times \times \times\}$

1. bbbbaa
2. ab
3.  $\varepsilon$
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:

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

1. aa
2.  $\varepsilon$
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:

$G^+ : \{\times a, ab, ac, ad, ba, ca, de, ea, c \times\}$

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.  $\varepsilon$

**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:

$G^+ : \{\bowtie a, ac, ad, bc, ca, cb, cc, cd, da, db, c\bowtie\}$

1. aacd
2. bcadadb
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:

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

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.  $\varepsilon$
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:

$G^+: \{\times \times c, \times \times a, \times c \times, \times ac, abb, aca, bbb, bbc, bcb, cab, cbb, bb \times, b \times \times, c \times \times\}$

1. bbb
2.  $\varepsilon$
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:

$G^+: \{\times a, \times \times, aa, ab, ba, bb, bd, db, a \times\}$

1. a
2. aa
3. dba
4.  $\varepsilon$

**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.  $\epsilon$
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.  $\epsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, \times c, bc, bd, cb, cc, cd, db, dc, dd, c\times, d\times\}$

1. dabbca
2. c
3.  $\varepsilon$
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.  $\epsilon$
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:

$G^+ : \{\times \times c, \times \times d, \times ca, \times de, \times d \times, aba, aec, bae, cab, ced, dec, eca, ece, edc, dc \times, ca \times, d \times \times, c \times \times, a \times \times\}$

1.  $\varepsilon$
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:

$G^+ : \{\times \times, \times d, ac, bd, da, dd, de, eb, ee, c \times\}$

1.  $\varepsilon$
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:

$G^+ : \{\times c, cc, cd, dc, dd, c \times\}$

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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times aa, \times \times ba, \times aab, \times baa, aabb, abbb, baab, babb, bbab, bbba, aab\times, abb\times, ab\times\times, bb\times\times, b\times\times\times\}$

1. aabbbbbb
2.  $\varepsilon$
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:

$G^+ : \{\times \times \times e, \times \times ea, \times ead, adbb, bbee, beee, dbbe, eadb, eddb, eedd, eeed, eeee, ddb\times, db\times\times, b\times\times\times\}$

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

**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:

$G^+ : \{\times\times, \times b, ac, ad, ba, cd, da, dd, a\times, b\times\}$

1.  $\epsilon$
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.  $\epsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times b, ab, ba, bb, a\times, b\times\}$

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:

$G^+$ :  $\{\times \times \times \times, \times \times \times a, \times \times \times \times, \times \times ac, \times \times a \times, \times a \times \times, \times acb, \times \times \times \times, acbd, bdca, cbdc, acb \times, dca \times, cb \times \times, ca \times \times, a \times \times \times, b \times \times \times\}$

1.  $\varepsilon$
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:

$G^+$ :  $\{\times \times b, \times bc, \times bb, aac, aba, aca, baa, bab, bbb, bbc, bcc, cba, ccb, bc \times, ca \times, c \times \times, a \times \times\}$

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:

$G^+ : \{\text{XXXXc}, \text{XXXXb}, \text{XXbc}, \text{XXca}, \text{Xbca}, \text{Xcab}, \text{aaaa}, \text{aaab}, \text{aabc}, \text{abcd}, \text{bcaa}, \text{bcda}, \text{caaa}, \text{cdaa}, \text{cabX}, \text{daX}, \text{aaX}, \text{aXX}, \text{bXX}\}$

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

**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:

$G^+ : \{\text{Xb}, \text{aa}, \text{ab}, \text{ba}, \text{bb}, \text{aX}\}$

1. abaaaa
2. ba
3. bbbbbbba
4. bbbabbabb

**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:

$G^+ : \{\text{XX}, \text{Xc}, \text{aa}, \text{ac}, \text{ad}, \text{ca}, \text{cd}, \text{da}, \text{dX}\}$

1. cd
2. ca
3.  $\varepsilon$

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:

$G^-: \{aaac, aabc, abbc, acaa, bbcb, bc bc, cabc, cbbc\}$

1. abc
2. acaccaaa
3. bbbacc
4.  $\epsilon$

**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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times bb, \times \times a \times, \times bba, \times a \times \times, aaab, abba, baaa, babb, bbaa, bbab, aab \times, ab \times \times, a \times \times \times, b \times \times \times\}$

1. a
2. abbbbbaa
3. baaba
4. babbba

**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.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, aa, ab, ba, bc, ca, cb, a\times, b\times\}$

1. bcabccacbabbb
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.  $\varepsilon$

**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:

$G^+ : \{\times a, \times c, aa, ac, bb, bc, cb, cc, c\times\}$

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.  $\epsilon$
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:

$G^+ : \{\times \times \times, \times \times a, \times \times b, \times \times \times, \times bc, \times aa, abc, bab, bba, bcb, cbb, bc \times, aa \times, a \times \times, c \times \times\}$

1. bc
2. bab
3.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times \times \times, \times \times a, \times \times \times, \times ac, acd, ace, cdd, cec, dac, dda, ecd, cd \times, d \times \times\}$

1. bbdccceab
2. acecd
3.  $\varepsilon$

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.  $\varepsilon$
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:

$G^+ : \{\times a, \times \times, aa, ab, ba, bb, b \times\}$

1. abbbab
2. ab
3. abbbbabbb
4.  $\varepsilon$

**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.  $\varepsilon$

**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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, \times c, ad, bd, cb, da, a\times, b\times\}$

1. dcbbad
2. bccc
3.  $\varepsilon$
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:

$G^+ : \{\times c, \times d, aa, ab, bc, bd, cd, da, db, a \times, c \times\}$

1. ca
2. dbdc
3.  $\varepsilon$
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:

$G^+ : \{\times a, aa, ab, ba, a \times\}$

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. bbbbbb
2. aba
3. bbaa
4.  $\varepsilon$

**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:

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

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.  $\varepsilon$

**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:

$G^+$ :  $\{\epsilon\epsilon\epsilon c, \epsilon\epsilon\epsilon b, \epsilon\epsilon\epsilon e, \epsilon\epsilon\epsilon\epsilon, \epsilon\epsilon ca, \epsilon\epsilon ba, \epsilon cac, \epsilon e\epsilon\epsilon, \epsilon ba\epsilon, \epsilon cbb, \epsilon acb, \epsilon bbac, \epsilon bdc, \epsilon bdc\epsilon, \epsilon acb, \epsilon cbba, \epsilon cbbd, \epsilon dcb\epsilon, \epsilon ba\epsilon\epsilon\epsilon, \epsilon cb\epsilon\epsilon\epsilon, \epsilon a\epsilon\epsilon\epsilon, \epsilon\epsilon\epsilon\epsilon, \epsilon\epsilon\epsilon\epsilon\}$

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:

$G^+$ :  $\{\epsilon\epsilon, \epsilon b, aa, ab, ba, bb, b\epsilon\}$

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.  $\epsilon$

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.  $\varepsilon$
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:

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

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:

$G^+ : \{\times \times d, \times da, acc, acd, bac, cba, ccb, dac, cd\times, d \times \times\}$

1. acedede**b**
2. bbd
3. ddbeca**e**
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:

$G^+ : \{\times \times \times, \times \times c, \times \times \times, \times ca, abc, bcc, cab, cba, ccb, ba\times, a \times \times\}$

1. ac
2. accca
3.  $\epsilon$
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.  $\epsilon$
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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times \times cb, \times \times \times ac, \times \times \times \times \times, \times \times \times a \times, \times \times \times \times, \times \times \times ac \times, \times \times \times cbb, \times \times \times \times \times, abca, babc, bbcb, bcab, bcba, cabc, cbab, cbbc, abc \times, ac \times \times, bc \times \times, c \times \times \times, a \times \times \times\}$

1. ac
2.  $\varepsilon$
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:

$G^-$ :  $\{bcab, dabd, dacd, dbda, dcde\}$

1. baadacbc
2. abdbccddcd
3. badddbdc
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times e, \times \times ea, \times eac, acce, ccca, cccc, eacc, cca\times, ca \times \times, a \times \times \times\}$

1. eaccce
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.  $\varepsilon$
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:

$G^+: \{\times \times \times, \times \times a, \times a \times, \times \times \times, \times ac, aab, acb, baa, bba, cbb, ab \times, b \times \times, a \times \times\}$

1. bba
2. c
3. a
4.  $\varepsilon$

**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:

$G^+: \{\times a, \times \times, aa, ab, ba, bb, b \times\}$

1.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+: \{\bowtie \bowtie b, \bowtie ba, aaa, aab, aba, abb, baa, bab, bba, ab\bowtie, b \bowtie \bowtie\}$

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:

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

1. ebaeceda
2. daaaaaccac
3.  $\varepsilon$
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:

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

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:

$G^+ : \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times ab, \times b \times, abb, bbb, bb \times, b \times \times\}$

1. aaa
2.  $\varepsilon$
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:

$G^+ : \{\times \times \times e, \times \times eb, \times \times ed, \times ebd, \times eda, aace, aced, cedb, daac, dbda, edaa, edbd, ebd \times, bda \times, bd \times \times, da \times \times, a \times \times \times, d \times \times \times\}$

1. ceace
2. aaccca
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.  $\varepsilon$
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:

$G^+: \{\times \times \times c, \times \times \times \times, \times \times \times d, \times \times d \times, \times \times \times \times, \times \times cc, \times \times cd, \times cda, \times d \times \times, \times cc \times, \times \times \times \times, abbe, cdab, dabb, bbe \times, be \times \times, cc \times \times, c \times \times \times, d \times \times \times, e \times \times \times\}$

1. d
2.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+ : \{\times \times b, \times bc, aac, baa, bbc, bcb, bcd, cba, cbb, cdc, dcb, ac\times, c \times \times\}$

1. abdba
2. abdcca
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:

$G^+ : \{\times \times a, a \times \times b, \times ab, \times bb, aab, aba, baa, bb\times, ba\times, b \times \times, a \times \times\}$

1. aba
2. bb
3. c
4.  $\varepsilon$

**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.  $\epsilon$

**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.  $\varepsilon$
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:

$G^+: \{\times a, aa, ab, ac, ba, bc, ca, cb, cc, a\times\}$

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:

$G^+: \{\times b, \times c, ac, ca, cc, a\times, b\times\}$

1. accb
2. bcbc
3.  $\varepsilon$
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:

$G^+ : \{\times \times \times a, \times \times ab, \times \times a \times, \times a \times \times, \times abc, abca, abcb, bcab, bcb b, cabc, cbb \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. cc
2. cabcba
3. a
4. abcb b

**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.  $\epsilon$
2. b
3. a
4. daacbacc c c c c

**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.  $\varepsilon$
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:

$G^+: \{\times\times, \times e, aa, ab, ad, ae, be, de, ea, e\times\}$

1.  $\varepsilon$
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. cacaccaac
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:

$G^+$ :  $\{\times \times a, \times \times b, \times bb, \times ad, acb, bac, bba, bbd, bde, cbb, ad\times, de\times, e\times\times, d\times\times\}$

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.  $\varepsilon$
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:

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

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.  $\epsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times d, aa, bb, be, cb, cc, ce, dc, ea, ec, a \times, d \times\}$

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.  $\epsilon$
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:

$G^+ : \{\times \times \times, \times \times \times, a, \times \times \times, b, \times \times \times, d, \times \times \times, \times \times, \times d \times, \times aa, \times bd, bbc, bcc, bdb, cbd, ccb, dbb, aa \times, bd \times, d \times \times, a \times \times\}$

1.  $\epsilon$
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:

$G^+ : \{\times \times, \times d, ab, ac, ba, bb, be, ca, da, ea, a \times\}$

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:

$G^+ : \{\times b, aa, ac, bc, ca, cb, c \times\}$

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:

$G^+: \{\times \times b, \times \times \times, \times \times \times, \times ba, aab, aba, abb, baa, bab, bb\times, b \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^-: \{baa, bab, bbd, bdc, cda, dba, ddc, edc\}$

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.  $\epsilon$
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:

$G^+: \{\times \times \times a, \times \times a \times, \times \times ab, \times aba, \times a \times \times, aabb, abaa, baab, abb \times, bb \times \times, a \times \times \times, b \times \times \times\}$

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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times\times, \times b, aa, ab, ba, b\times\}$

1. bbab
2. aabb
3. abbaa
4.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times \times c, \times \times a, \times cb, \times a \times, acb, bac, bca, cac, cba, cbc, cb \times, b \times \times, a \times \times\}$

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.  $\varepsilon$
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:

$G^+ : \{\times \times b, \times \times \times, \times \times \times, \times bb, aab, abd, baa, bba, bdd, daa, dda, ab\times, b \times \times\}$

1. deccae
2.  $\varepsilon$
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:

$G^+ : \{\times \times a, \times \times b, \times a\times, \times bd, aba, bab, bdb, dba, ba\times, a \times \times\}$

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.  $\varepsilon$
3. bcb
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.  $\varepsilon$
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:

$G^+: \{\times \times a, \times \times b, \times \times \times, \times a \times, \times \times \times, \times ba, \times bb, aab, aba, abb, baa, bab, bba, ab \times, bb \times, b \times \times, a \times \times\}$

1. aab
2.  $\varepsilon$
3. aaabbbbabbb
4. bbabbbaa

**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:

$G^+: \{\times a, ae, bc, ca, cd, de, eb, ec, ee, c \times\}$

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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

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

1. cabcabba
2.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, \times d, aa, ab, ad, ba, bd, da, db, b\times, d\times\}$

1. b
2.  $\varepsilon$
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:

$G^+$ :  $\{\bowtie\bowtie, \bowtie b, bb, bc, bd, cb, cc, dc, b\bowtie\}$

1.  $\varepsilon$
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.  $\varepsilon$
2. dcccc
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:

$G^+ : \{\times \times e, \times \times c, \times \times \times, \times c \times, \times \times \times, \times ec, ade, bad, cba, ecb, de \times, e \times \times, c \times \times\}$

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:

$G^+ : \{\times \times, \times b, ab, ba, b \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times b, \times \times ac, \times \times ca, \times \times b\times, \times \times ba, \times bac, \times acc, \times ca\times, \times b\times\times, \times accc, \times ccca, \times cccc, \times bac\times, \times cca\times, \times ac\times\times, \times ca\times\times, \times c\times\times\times, \times a\times\times\times, \times b\times\times\times\}$

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.  $\epsilon$
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.  $\epsilon$
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.  $\epsilon$
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.  $\epsilon$
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:

$G^+ : \{\times\times, \times b, ab, ba, bb, b\times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+$ :  $\{\times \times c, \times \times \times, \times \times b, \times c \times, \times \times \times, \times bc, \times bd, aab, abc, acc, bca, bda, caa, cca, dac, ca \times, bc \times, c \times \times, a \times \times\}$

1. dde
2. ae b b d b b c d b
3.  $\varepsilon$
4. ce b b a e b d

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times \times \times, \times \times a \times, \times \times cd, \times a \times \times, \times cdb, \times \times \times \times, aacd, acda, baac, cdaa, cdba, daac, dbaa, acd \times, cd \times \times, d \times \times \times, a \times \times \times\}$

1.  $\varepsilon$
2. ba d d d b b b d b a
3. dcba
4. cd da a a b b c

**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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times a, aa, ab, ba, a\times\}$

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.  $\epsilon$
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:

$G^+: \{\times a, \times b, aa, ac, bc, ca, cb, cc, a\times, b\times\}$

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:

$G^-: \{aaaa, abaa, abba, baaa, babb, bbba, bbba\}$

1. b
2.  $\epsilon$
3. aaaaa
4. a



**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.  $\varepsilon$
3. aababbbb
4. bcbbaaba

**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.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times b, \times \times bb, \times \times ba, \times bab, \times bb \times, \times baa, abbb, babb, bbab, bbba, bbbb, baa \times, bab \times, ab \times \times, aa \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

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:

$G^+$ :  $\{\times \times e, \times \times a, \times \times \times, \times \times \times, \times ae, \times ea, ade, deb, ead, eba, ae \times, ba \times, e \times \times, a \times \times\}$

1. ea
2. c
3.  $\varepsilon$
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:

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

1. aaebcba

2. bb
3.  $\varepsilon$
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:

$G^+$ :  $\{\times\times\times e, \times\times ee, \times eeb, \times ee\times, abba, bcdd, cdcd, cdda, dabb, dcdd, ddab, ebcd, eebc, bba\times, ee\times\times, ba\times\times, a\times\times\times, e\times\times\times\}$

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:

$G^+$ :  $\{\times a, \times\times, \times b, aa, ab, ba, bb, b\times\}$

1. bab
2.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, ac, bc, ca, cc, c\times\}$

1. aab
2. bc
3. ba
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times \times d, \times \times \times e, \times \times \times ea, \times \times \times d\times, \times \times \times \times\times, \times \times \times aa, \times \times \times cc, \times cca, \times aa\times, \times d \times \times, \times \times \times \times\times, \times eac, acac, acba, baca, cbac, eacb, cca\times, cac\times, ac \times \times, aa \times \times, ca \times \times, c \times \times\times, d \times \times\times, a \times \times\times\}$

1. aabd
2. bbdabed
3. d
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times a, \times b, aa, ab, ba, bb, a\times\}$

1.  $\varepsilon$
2. abaaaaabab
3. baaaaaabb
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.  $\varepsilon$
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:

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

1. babedee
2. cbcadbb
3.  $\varepsilon$
4. cddbba

**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:

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

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:

$G^+ : \{\times \times a, \times \times \times, \times a \times, \times \times \times, \times ab, aac, abb, acb, baa, bba, bca, cbc, ab \times, ca \times, b \times \times, a \times \times\}$

1. a
2.  $\varepsilon$
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:

$G^+ : \{\times c, ab, ac, bc, bd, ca, cd, da, db, dd, a \times\}$

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:

$$G^+ : \{\bowtie b, aa, ab, ba, bb, a\bowtie\}$$

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:

$$G^+: \{\bowtie \bowtie \bowtie a, \bowtie \bowtie \bowtie c, \bowtie \bowtie ca, \bowtie \bowtie ab, \bowtie abb, \bowtie ca \bowtie, abba, babc, bbab, abc \bowtie, bc \bowtie \bowtie, ca \bowtie \bowtie, a \bowtie \bowtie \bowtie, c \bowtie \bowtie \bowtie\}$$

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:

$$G^+: \{ \times \times \times a, \times \times \times c, \times \times \times b, \times \times \times \times, \times \times \times \times \times ac, \times \times \times \times \times cc, \times \times \times \times \times bb \times, \times \times \times \times \times acb, \times \times \times \times \times ccc, \times \times \times \times \times abba, \times \times \times \times \times bbac, \times \times \times \times \times bbcc, \times \times \times \times \times bcca, \times \times \times \times \times cabb, \times \times \times \times \times cbbc, \times \times \times \times \times ccab, \times \times \times \times \times ccbb, \times \times \times \times \times cccb, \times \times \times \times \times acb \times, \times \times \times \times \times bac \times, \times \times \times \times \times cb \times \times, \times \times \times \times \times bb \times \times, \times \times \times \times \times c \times \times \times, \times \times \times \times \times b \times \times \times \times \}$$



1. b
2.  $\varepsilon$
3. bbbbcbbcac
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:

$G^+ : \{\times \times \times, \times \times c, \times \times b, \times \times \times, \times ba, \times cc, aad, adc, caa, cbd, cca, dc b, ba \times, bd \times, d \times \times, a \times \times\}$

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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times ab, \times \times bb, \times bba, \times ab \times, abab, baba, bbab, bab \times, ab \times \times, b \times \times \times\}$

1. aba
2.  $\varepsilon$
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:

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

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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\bowtie a, \bowtie \bowtie, \bowtie b, aa, ab, ba, bb, a\bowtie, b\bowtie\}$

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:

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

1. ae
2.  $\varepsilon$
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:

$G^+$ :  $\{\times \times b, \times \times \times, \times \times \times, \times ba, aca, acb, bac, bdd, cac, cbd, dd\times, d\times\times\}$

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

**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:

$G^+$ :  $\{\times \times a, \times \times b, \times \times \times, \times \times \times, \times ba, \times aa, aab, aba, aca, bac, caa, ab \times, ba \times, b \times \times, a \times \times\}$

1. ba
2.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times d, \times \times \times e, \times \times db, \times \times ea, \times \times d \times, \times ead, \times d \times \times, \times dbd, abde, bdda, bded, dabd, dbdd, ddab, dedc, edc \times, ead \times, dc \times \times, ad \times \times, c \times \times \times, d \times \times \times\}$

1. cd

2. eecc
3. aebceaae
4.  $\varepsilon$

**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:

$G^+ : \{\times \times b, \times bc, aac, acc, bcc, caa, cca, ca\times, a \times \times\}$

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:

$G^+ : \{\times \times b, \times \times d, \times db, \times bd, bbd, bdd, dbb, ddb, db\times, bd\times, b \times \times, d \times \times\}$

1. aaadda
2.  $\varepsilon$
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:

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

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:

$G^+ : \{\times \times, \times c, ab, ac, bd, ca, cc, da, a \times\}$

1. cca
2. ccaccbc
3. ca
4.  $\varepsilon$

**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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times ba, \times \times bb, \times \times a \times, \times a \times \times, \times ba \times, \times bbb, aabb, abaa, abbb, baab, baba, bbab, bbba, bba \times, ba \times \times, a \times \times \times\}$

1. a
2.  $\varepsilon$
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.  $\varepsilon$
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. accbbsbbac
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.  $\varepsilon$

**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:

$G^-: \{abdb, acca, adea, ddbc, deac, each, ebdc\}$

1.  $\varepsilon$
2. b
3. e
4. abeach

**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:

$G^+: \{\times \times \times c, \times \times \times \times, \times \times \times d, \times \times dc, \times \times c \times, \times \times ca, \times \times \times \times, \times ca \times, \times c \times \times, \times dcc, \times \times \times \times, aaaa, caaa, cc dc, cdca, dcaa, dccd, aaa \times, aa \times \times, ca \times \times, c \times \times \times, a \times \times \times\}$

1. ddc b
2. ccddacbbcb
3. aacbacd
4. abbbdbbc

**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:

$G^+: \{\times \times d, \times \times \times, \times \times \times, \times dd, aca, adb, bdd, caa, dac, dad, dbd, dda, aa \times, a \times \times\}$

1. acba

2.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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. dcbcbabb
4.  $\varepsilon$

**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:

$G^+$ :  $\{\text{xxxc}, \text{xxx}b, \text{xxcb}, \text{xxbb}, \text{xbbb}, \text{xcbx}, \text{aaea}, \text{aeae}, \text{baae}, \text{bbaa}, \text{bbba}, \text{eae}, \text{aex}, \text{ee}, \text{cb}, \text{e}, \text{b}\}$

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.  $\varepsilon$
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:

$G^+$ :  $\{\text{xxxa}, \text{xxxb}, \text{xxx}, \text{xx}, \text{xxaa}, \text{xxbb}, \text{xaa}, \text{xb}, \text{xxx}, \text{bbb}, \text{aabb}, \text{abbb}, \text{baab}, \text{bbaa}, \text{bbba}, \text{baa}, \text{aa}, \text{a}\}$

1. abab
2. abaaabbb

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:

$G^+ : \{\times \times c, \times \times a, \times c \times, \times ac, aca, adc, cad, dcb, cb \times, b \times \times, c \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times a, \times \times, aa, ab, ba, bb, b \times\}$

1. ab
2. aab
3. bbaab
4.  $\varepsilon$

**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:

$G^+ : \{\times \times \times a, \times \times \times \times, \times \times \times d, \times \times da, \times \times \times \times, \times \times aa, \times aaa, \times dac, \times \times \times \times, aaad, aada, acab, adac, daca, cab \times, dac \times, ac \times \times, ab \times \times, c \times \times \times, b \times \times \times\}$

1. dacab
2.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+ : \{\times\times, \times b, aa, ab, ba, bb, a\times\}$

1. babbaabaaa
2. ba
3. aabaaba
4.  $\varepsilon$

**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:

$G^+ : \{\times b, ac, bb, bc, ca, c\times, b\times\}$

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:

$G^+ : \{\times \times d, \times \times \times, \times \times \times, \times dd, acb, adc, cac, cad, cba, cca, dca, dcc, ddc, ba \times, a \times \times\}$

1. ba
2. adcccbddbd
3. ddcacba
4.  $\varepsilon$

**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:

$G^+ : \{\times \times, \times b, ab, ba, a \times\}$

1. ababa
2. babab
3. a
4.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+ : \{\times\times, \times b, \times d, aa, ac, ae, ba, be, cb, ea, ec, ee, c\times, d\times\}$

1. cacdeebde
2.  $\varepsilon$
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:

$G^+ : \{\times a, \times\times, \times b, aa, ab, ba, bb, a\times\}$

1. ababaa
2.  $\varepsilon$
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:

$G^+ : \{\times d, ab, bb, bc, ce, da, e \times\}$

1. dabce
2. ae
3.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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. ccbbbccaac

**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.  $\epsilon$
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.  $\varepsilon$
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:

$G^-: \{abcd, aebc, bade, baec, beeb, cadd, cdc b, decc\}$

1. daddcba
2. b
3. ad
4.  $\varepsilon$

**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:

$G^+: \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times bb, \times aa, aaa, aba, baa, bab, bba, bbb, aa \times, a \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, \times e, bd, de, eb, ed, ee, e\times, b\times\}$

1. bcbba
2.  $\varepsilon$
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:

$G^+: \{\times a, ac, ca, cc, a\times\}$

1. aaacc
2. bababcb
3. a
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times d, \times \times db, \times \times ab, \times \times b\times, \times dbb, \times ab\times, \times b \times \times, aabd, abda, babd, bbab, bdaa, daab, dbba, abd\times, ab\times\times, bd\times\times, d\times\times\times, b\times\times\times\}$

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.  $\varepsilon$
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:

$G^+: \{\times a, \times \times, aa, ab, ac, ba, bb, bc, ca, cb, cc, a \times, b \times\}$

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:

$G^+: \{\times \times \times, \times \times d, \times \times b, \times \times \times, \times be, \times dc, aac, acc, caa, cba, cca, ccb, ccc, dcc, be \times, ba \times, e \times \times, a \times \times\}$

1. be
2. eddbb
3. dccba

4.  $\varepsilon$

**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:

$G^+ : \{\times a, aa, ab, ad, bd, da, dc, dd, c\times\}$

1. adc
2. aadc
3. abdc
4.  $\varepsilon$

**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:

$G^+ : \{\times \times \times a, \times \times \times c, \times \times \times b, \times \times \times \times, \times \times bd, \times \times ce, \times \times \times \times, \times \times aa, \times \times a\times, \times ceb, \times a \times \times, \times aa\times, \times bdd, \times \times \times \times, aeec, bcea, cbdd, ceae, cebc, eaee, ebce, ecdb, eecb, bdd\times, aa \times \times, dd \times \times, d \times \times \times, a \times \times \times\}$

1. ebcddcddcba
2.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+: \{\times \times e, \times \times b, \times b \times, \times ea, aad, adc, ade, caa, dca, deb, ead, ebe, be \times, e \times \times, b \times \times\}$

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.  $\varepsilon$
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:

$G^+: \{\times c, aa, ab, ac, ba, bd, cb, da, dd, c\times\}$

1. cbac
2. cbcbdccccb
3.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times e, \times d, ab, ba, be, cc, ce, dc, eb, ec, e \times, c \times\}$

1. e
2. ababadbb
3. aececab
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:

$G^+ : \{\times \times \times \times, \times \times \times b, \times \times \times d, \times \times bc, \times \times dd, \times \times de, \times \times d \times, \times \times \times \times, \times ddd, \times d \times \times, \times deb, \times bc \times, \times \times \times \times, abba, babb, bade, bbad, bceb, ceba, debc, ebab, ebce, ddd \times, ade \times, de \times \times, bc \times \times, dd \times \times, c \times \times \times, d \times \times \times, e \times \times \times\}$

1. eaaadeceddc
2.  $\varepsilon$
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:

$G^- : \{abab, aeae, bded, dbec, ddec\}$

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:

$G^+: \{\times a, \times \times, ab, ac, ad, ba, ce, ea, d \times\}$

1. ebcc
2. eb
3.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times bb, \times \times \times \times, \times \times aa, \times \times a \times, \times \times ba, \times aaa, \times a \times \times, \times bbb, \times ba \times, \times \times \times, aaab, aaba, aabb, abaa, abba, baaa, bba \times, bbb \times, ba \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1.  $\varepsilon$
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:

$G^+$ :  $\{\times \times, \times b, ab, ba, bb, b \times\}$

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:

$G^+$ :  $\{\times \times b, \times b \times, \times ba, aab, aba, abb, baa, bab, bba, bb \times, b \times \times\}$

1. bababa
2. ababa
3. baaaba
4. abbbbbbbb

**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:

$G^+$ :  $\{\times \times c, \times \times b, \times ca, \times be, aba, abb, bab, bbe, bea, beb, eab, ebc, bc \times, ca \times, a \times \times, c \times \times\}$

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:

$G^+$ :  $\{\times \times \times b, \times \times \times \times, \times \times \times d, \times \times bb, \times \times da, \times \times \times \times, \times da \times, \times dab, \times bbe, \times \times \times \times, acca, bbea, beac, cacd, ccac, eacc, acd \times, dab \times, cd \times \times, ab \times \times, da \times \times, d \times \times \times, a \times \times \times, b \times \times \times\}$

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.  $\varepsilon$
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

3. e

4.  $\varepsilon$

**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:

$G^+: \{\times \times \times a, \times \times \times c, \times \times aa, \times \times c \times, \times aad, \times c \times \times, aadd, addc, ddcd, dcd \times, cd \times \times, c \times \times \times, d \times \times \times\}$

1. b

2. bb

3. aabdb

4.  $\varepsilon$

**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. aaaabbbbbb
3. abaab
4. aaabbbbaaa

**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:

$G^+: \{\times \times \times d, \times \times \times \times, \times \times \times \times, \times \times \times \times, \times db, \times \times \times \times, \times ddb, bddb, bdbd, dbbd, dbdb, bdb \times, db \times \times, b \times \times \times\}$

1. daddda
2.  $\varepsilon$
3. d
4. dcd

**SOLUTION TO EXERCISE 381.**

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

**EXERCISE 382.**

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

$G^+$ :  $\{\epsilon, a, c, cb, cc, ad, acbd, \epsilon, ada, acbd, bdac, cbda, cbdd, dach, bdd, ada, cc, dd, da, c, d, a\}$

1. d
2.  $\epsilon$
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:

$G^+$ :  $\{\epsilon, ab, ba, bc, bd, cb, cd, db, b\}$

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:

$G^+$ :  $\{\epsilon, b, ca, ba, bab, cab, aacb, abba, abca, babb, babc, bbab, bcaa, caac, acb, cab, ab, cb, b\}$

1.  $\varepsilon$
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.  $\varepsilon$

**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:

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

1. ccde
2. d
3. db
4.  $\varepsilon$

**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:

$G^+ : \{\times c, ac, bb, bc, bd, ca, cb, cc, cd, db, dc, c \times\}$

1. cc
2. bdbbabda
3.  $\varepsilon$
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:

$G^+ : \{\times e, ac, ae, cd, da, ea, e \times\}$

1. e
2. ba
3. edc
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times, \times \times d, \times \times b, \times \times e, \times \times \times, \times d \times, \times bc, \times ed, acc, bcb, cbc, ccb, dac, dda, ddd, edd, cb \times, bc \times, d \times \times, c \times \times, b \times \times\}$

1. cdbbadd
2. dcdeceab
3. acad
4.  $\epsilon$

**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:

$G^+$ :  $\{\times a, \times b, ab, ac, ba, bd, cb, b \times, d \times\}$

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:

$G^+ : \{\times a, \times \times, ab, ba, bb, a \times, b \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
3. bbabb
4. dcbdb

**SOLUTION TO EXERCISE 393.**

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

**EXERCISE 394.**

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

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

1. b
2. cbbb
3. a
4.  $\varepsilon$

**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:

$G^+: \{\times \times \times a, \times \times \times \times, \times \times \times \times, \times \times a \times, \times \times ab, \times aba, \times a \times \times, \times \times \times \times, abab, abea, babe, bea \times, ea \times \times, a \times \times \times\}$

1. a
2. abe
3. c
4.  $\varepsilon$

**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:

$G^+: \{\times a, \times \times, \times d, aa, ad, ba, cd, db, dc, a \times, d \times\}$

1.  $\varepsilon$
2. a
3. d

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:

$G^-: \{aaaa, acca, baab, bach, bcca, cbba, cbc b\}$

1. cbc bcc
2. b
3.  $\varepsilon$
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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times \times a \times, \times \times \times bc, \times a \times \times, \times \times bcc, aacc, accc, bccc, caac, ccaa, ccca, cccc, ccc \times, cc \times \times, a \times \times \times, c \times \times \times\}$

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.  $\varepsilon$
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:

$G^+: \{\times \times \times d, \times \times \times e, \times \times \times \times, \times \times \times \times, \times \times e \times, \times \times da, \times dae, \times \times \times \times, \times e \times \times, aaaa, daea, eaad, aad \times, ad \times \times, d \times \times \times, e \times \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times b, \times c, bb, bc, cb, cc, b\times\}$

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:

$G^- : \{abdc, bbac, bccb, bccd, bc dc, cc bd, db bc\}$

1. bdcadab
2. c
3. ca
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times \times e, \times \times bb, \times \times ec, \times \times \times \times, \times \times a \times, \times a \times \times, \times bbb, \times ecc, \times \times \times \times, cccb, cccc, eccc, ccb \times, bbb \times, cb \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+$ :  $\{\epsilon \epsilon \epsilon a, \epsilon \epsilon \epsilon b, \epsilon \epsilon \epsilon \epsilon, \epsilon \epsilon bc, \epsilon \epsilon bd, \epsilon \epsilon \epsilon \epsilon, \epsilon \epsilon a \epsilon, \epsilon a \epsilon \epsilon, \epsilon bde, \epsilon bc \epsilon, \epsilon \epsilon \epsilon \epsilon, bdee, deeb, ebac, ee ba, bac \epsilon, ac \epsilon \epsilon, bc \epsilon \epsilon, c \epsilon \epsilon \epsilon, a \epsilon \epsilon \epsilon\}$

1. dceabe
2.  $\epsilon$
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:

$G^+$ :  $\{\epsilon \epsilon, \epsilon b, aa, ab, ba, bb, a \epsilon\}$

1. aaba
2. aba
3.  $\epsilon$
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.  $\varepsilon$

**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:

$G^+: \{\bowtie \bowtie b, \bowtie \bowtie \bowtie, \bowtie \bowtie \bowtie, \bowtie ba, aaa, aab, aba, abb, baa, bab, bba, ab\bowtie, b \bowtie \bowtie\}$

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.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
2. bababba
3. bbdacbc
4. b

**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.  $\varepsilon$
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:

$G^+: \{\times \times \times b, \times \times ba, \times \times b \times, \times b \times \times, \times baa, \times ba \times, aaab, aabb, baaa, abb \times, ba \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. b
2. aabaa
3.  $\varepsilon$
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:

$G^+ : \{\times \times c, \times \times d, \times \times \times, \times \times \times, \times d \times, \times ce, acb, bac, bce, cbc, ceb, ced, dce, eba, edc, ed \times, d \times \times\}$

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.  $\epsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\bowtie \bowtie c, \bowtie \bowtie d, \bowtie c \bowtie, \bowtie de, bec, ceb, dec, ebe, ece, ec \bowtie, c \bowtie \bowtie\}$

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:

$G^+ : \{\times\times, \times c, bb, bc, cb, cc, c\times\}$

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.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times ab, \times \times c \times, \times \times \times \times, \times aba, \times c \times \times, \times abc, \times \times \times \times, aaaa, abab, abbc, acaa, babb, bbca, bcac, caaa, caca, abc \times, aaa \times, aa \times \times, bc \times \times, c \times \times \times, a \times \times \times\}$

1.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times c, \times \times cc, \times cca, abbb, bbbb, bbbc, bbcc, cabb, ccab, bcc \times, cc \times \times, c \times \times \times\}$

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:

$G^-: \{abba, accb, acce, bcb, bccc\}$

1.  $\epsilon$
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:

$G^+: \{\times \times b, \times \times \times, \times \times \times, \times b \times, \times ba, aaa, aab, aba, baa, bab, aa \times, b \times \times, a \times \times\}$

1.  $\epsilon$
2. ba
3. bbabb
4. bbbabaabbbbbb

**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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times \times a, \times \times \times c, \times \times \times d, \times \times \times e, \times \times ea, \times \times c\times, \times \times ae, \times \times da, \times ea\times, \times aea, \times c \times \times, \times dae, aeae, aeec, eae, ecdd, eecd, dae\times, cdd\times, ae \times \times, ea \times \times, dd \times \times, c \times \times \times, d \times \times \times, a \times \times \times, e \times \times \times\}$

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.  $\varepsilon$
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:

$G^+: \{\times \times \times c, \times \times \times d, \times \times dd, \times \times cb, \times \times c\times, \times ddd, \times c \times \times, \times cbb, bbdd, bddc, cbbd, cdda, daaa, dcdd, ddaa, ddc d, ddd\times, aaa\times, aa \times \times, dd \times \times, c \times \times \times, d \times \times \times, a \times \times \times\}$

1. c
2. bccddbbbab
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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times ab, \times \times bb, \times \times a\times, \times a \times \times, \times abb, \times bbb, aaaa, aaab, baaa, bbaa, bbba, aab\times, abb\times, ab \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

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. bbbabbcbba
4.  $\varepsilon$

**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.  $\varepsilon$

**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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times bb, \times \times \times \times, \times \times aa, \times aaa, \times bb \times, \times \times \times \times, aaac, aacc, accb, adbd, badb, cbad, ccba, dbdd, bdd \times, dd \times \times, bb \times \times, d \times \times \times, b \times \times \times\}$

1. dddaddbacd
2. bdbcdabcd
3. bb
4.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+ : \{\times\times, \times b, aa, ab, ba, bb, b\times\}$

1. baaabaab
2. abb
3.  $\varepsilon$
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:

$G^+ : \{\times\times\times a, \times\times\times c, \times\times cb, \times\times ac, \times acc, \times aca, \times cb\times, abcb, acca, baac, bcba, cabc, cbaa, ccab, aca\times, aa\times\times, cb\times\times, ca\times\times, c\times\times\times, a\times\times\times, b\times\times\times\}$

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.  $\varepsilon$
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

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

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

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

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:

$G^+ : \{\times \times, \times b, aa, ab, ba, bb, b \times\}$

1. a
2. bbbbabbb
3.  $\varepsilon$
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:

$G^+ : \{\times \times \times a, \times \times ac, \times \times ad, \times acc, \times ad \times, accb, cbcd, ccbc, bcd \times, cd \times \times, ad \times \times, d \times \times \times\}$

1. b
2. ad
3.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$

**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:

$G^+: \{\times \times a, \times \times \times, \times a \times, \times \times \times, \times ab, \times aa, aba, abb, bab, bba, aa \times, ba \times, a \times \times\}$

1.  $\varepsilon$
2. a
3. b
4. baba



**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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times e, \times \times e \times, \times \times ab, \times \times ce, \times \times ad, \times e \times \times, \times cee, \times ab \times, \times adb, adbd, bddc, cade, dbdd, dcad, ddca, ade \times, cee \times, de \times \times, ab \times \times, ee \times \times, e \times \times \times, b \times \times \times\}$

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.  $\epsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times \times b, \times \times bc, \times \times cb, \times \times ac, \times \times \times \times, \times bcb, \times acd, \times cb \times, \times \times \times \times, acda, adcd, cdad, dadc, bcb \times, dcd \times, cd \times \times, cb \times \times, d \times \times \times, b \times \times \times\}$

1. b
2. cb
3.  $\varepsilon$
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:

$G^+: \{\times \times \times, \times \times a, \times a \times, \times \times \times, \times ad, aac, abd, acc, ada, bdd, ccd, daa, dab, dda, ddd, cd \times, ad \times, d \times \times, a \times \times\}$

1.  $\varepsilon$

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:

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

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.  $\varepsilon$

**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:

$G^+ : \{\times\times, \times b, aa, ab, ba, a\times\}$

1. aaaba
2. aa
3. ab
4.  $\varepsilon$

**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. caeaabebbb

**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:

$G^+: \{\times\times, \times c, \times d, bb, bc, cb, cc, cd, db, dc, c\times, d\times\}$

1. c
2.  $\varepsilon$
3. d
4. aabddccaa

**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.  $\varepsilon$
4. aa

**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:

$G^+: \{\times \times d, \times \times b, \times dd, \times bc, aca, cad, dac, dda, bc\times, ad\times, d \times \times, c \times \times\}$

1. dbdaddb
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:

$G^+$ :  $\{\times \times \times a, \times \times \times \times, \times \times \times d, \times \times db, \times \times \times \times, \times \times aa, \times aa \times, \times dbb, \times \times \times \times, acdc, bbca, bcac, cacd, cdcd, dbbc, dcd \times, cd \times \times, aa \times \times, d \times \times \times, a \times \times \times\}$

1. aa
2.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times cc, \times \times b \times, \times ccb, \times b \times \times, abea, aecd, babe, beae, cbab, ccba, eaec, ecda, cda \times, da \times \times, a \times \times \times, b \times \times \times\}$

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:

$G^-: \{cbda, ccda, cdc b, ecea\}$

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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times c \times, \times \times cb, \times \times ac, \times \times \times \times, \times acb, \times c \times \times, \times cb \times, \times \times \times \times, acbb, bbcb, bcb \times, cbbc, cbcb, bcb \times, cb \times \times, c \times \times \times, b \times \times \times\}$

1. acaab
2.  $\varepsilon$
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.  $\varepsilon$
2. a
3. abcd dba
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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$

**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. dbdabaeacca
2. dcaaea
3. dcea
4.  $\varepsilon$

**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:

$G^+ : \{\times b, aa, ab, ba, bb, a\times\}$

1. aaa
2.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times \times \times b, \times \times \times d, \times db, \times bc, \times bb, \times bbc, \times bc\times, \times dbd, bbcd, bcdd, bcdd, bddb, cddb, dbcd, dbdd, ddbc, ddbd, cdc\times, dbd\times, dc\times, \times bd \times \times, bc \times \times, c \times \times \times, d \times \times \times\}$

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. bdbdddca
3.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\bowtie \bowtie b, \bowtie b \bowtie, \bowtie ba, aab, aad, abd, add, baa, bda, daa, dd \bowtie, b \bowtie \bowtie, d \bowtie \bowtie\}$

1. bbd
2. ccadcbda
3.  $\varepsilon$
4. aabab

**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:

$G^+$ :  $\{\times \times e, \times eb, bdb, bdd, dbc, dbd, ddb, ddd, ebd, bc\times, c \times \times\}$

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:

$G^+$ :  $\{\times \times e, \times \times b, \times e\times, \times bb, add, bbc, bce, cea, ead, dd\times, e \times \times, d \times \times\}$

1. aba
2. cc
3.  $\varepsilon$
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:

$G^+: \{\times \times c, \times \times a, \times \times \times, \times \times \times, \times cc, \times aa, aad, adc, ccc, ccd, cdd, dcc, dcd, ddc, cc \times, cd \times, d \times \times, c \times \times\}$

1. bbababdac
2. acdc
3.  $\varepsilon$
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:

$G^+: \{\times e, ab, bd, ca, cc, ce, db, ec, b \times\}$

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:

$G^+$ :  $\{\times \times a, \times aa, aac, acc, cbb, ccb, bb\times, aa\times, b \times \times, a \times \times\}$

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:

$G^-$ :  $\{acac, accb, bbcb, bcac, cbc b, cbcc, cc bc, cccc\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times a, \times \times, aa, ab, ac, bc, ca, cb, a \times, b \times\}$

1. c
2. bca
3.  $\varepsilon$
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:

$G^+: \{\times \times \times d, \times \times dd, \times ddc, bcbd, bdc d, cbcb, cbdc, dc bc, dc da, ddcb, cda \times, da \times \times, a \times \times \times\}$

1. bbcdd
2. bdacb
3.  $\varepsilon$

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.  $\epsilon$
2. abbbba
3. baabaabbb
4. bbbbababbbaa

**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:

$G^+ : \{\times \times b, \times \times \times, \times \times \times, \times b \times, \times ba, aab, aba, abb, baa, bab, bba, bbb, bb \times, b \times \times\}$

1. babb
2. b
3.  $\varepsilon$
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:

$G^+ : \{\times \times b, \times ba, \times bb, bac, bbc, bcc, cba, cbc, ccb, ccc, ac \times, ba \times, a \times \times, c \times \times\}$

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

**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:

$G^+ : \{\times \times \times c, \times \times \times b, \times \times \times \times, \times \times c \times, \times \times bb, \times \times \times \times, \times bbb, \times c \times \times, \times \times \times \times, acba, baca, bacb, bbcb, bbcb, bcba, cbac, aca \times, ca \times \times, c \times \times \times, a \times \times \times\}$

1.  $\varepsilon$
2. bcaccbaa

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:

$G^+ : \{\times \times a, \times \times b, \times ab, \times b \times, \times ba, aab, aba, abb, baa, bba, bbb, ba \times, b \times \times, a \times \times\}$

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:

$G^+ : \{\times \times a, \times \times b, \times bb, \times aa, aaa, aab, abb, baa, bba, bbb, ab \times, bb \times, b \times \times\}$

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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times ab, \times \times ba, \times aba, \times baa, aaba, abaa, abab, baaa, baab, baba, aba\times, aaa\times, aa\times\times, ba\times\times, a\times\times\times\}$

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:

$G^+ : \{\times \times c, \times \times a, \times \times b, \times c\times, \times ac, \times ba, aca, acb, bac, cac, cbc, bc\times, ac\times, c\times\times\}$

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:

$G^+ : \{\bowtie \bowtie a, \bowtie ac, abd, acb, bab, bba, cbb, bd\bowtie, d \bowtie \bowtie\}$

1. ccacc
2. abbddae
3.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times \times \times, \times \times aa, \times \times ba, \times aaa, \times ba \times, \times \times \times \times, aaab, aaba, abab, abba, abbb, babb, bbab, bbbb, bbb \times, ba \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. aaaaababa
2. abbbabab
3. abbbbbaaa
4.  $\varepsilon$

**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.  $\varepsilon$
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. acabbccccc
3. acc
4. bcacca

**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:

$G^+: \{\times a \times a, \times \times b, \times a \times, \times ba, aaa, aab, aba, baa, bab, ab \times, b \times \times, a \times \times\}$

1. babbaa
2. abbbab
3.  $\varepsilon$
4. aaaaa

**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.  $\varepsilon$
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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ab, \times \times b \times, \times \times \times \times, \times abb, \times \times \times \times, \times b \times \times, abab, abba, abbb, baab, baba, babb, bbaa, bbab, bbba, aab \times, ab \times \times, b \times \times \times\}$

1. ababbabaaab
2.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\bowtie a, \bowtie \bowtie, \bowtie c, ab, ac, bb, bc, ca, c\bowtie\}$

1.  $\varepsilon$
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:

$G^+ : \{\bowtie \bowtie a, \bowtie ac, abc, aca, acc, bca, cab, cac, cca, ac\bowtie, c \bowtie \bowtie\}$

1. bc
2.  $\varepsilon$
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.  $\epsilon$
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:

$G^+: \{\times \times \times, \times \times a, \times \times b, \times ac, \times \times \times, \times ba, abc, acb, bab, bba, bbb, bcc, cbb, cbc, ccb, bc \times, ba \times, c \times \times, a \times \times\}$

1.  $\epsilon$
2. ba
3. cccbcbba
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:

$G^+: \{\times \times b, \times \times d, \times \times \times, \times \times \times, \times db, \times ba, adb, bad, bee, dbe, db \times, ee \times, e \times \times, b \times \times\}$

1. cab
2. ebca

3. abcd
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times \times \times, \times \times cc, \times \times a \times, \times a \times \times, \times \times \times \times, \times ccb, aaaa, baaa, bbaa, cbba, ccbb, aaa \times, aa \times \times, a \times \times \times\}$

1.  $\varepsilon$
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. bbaaabacc
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:

$G^+ : \{\bowtie \bowtie b, \bowtie ba, abb, bab, bbc, bcc, ccc, cc\bowtie, c \bowtie \bowtie\}$

1. ca
2. babbcc
3. bacbbb
4.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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. aadbbsc
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:

$G^+$ :  $\{\times \times c, \times \times a, \times a \times, \times cb, aad, adb, baa, bba, cbb, dba, ba \times, cb \times, b \times \times, a \times \times\}$

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:

$G^+$ :  $\{\times \times b, \times b \times, \times ba, \times bb, aaa, aab, abb, baa, bba, bb \times, ba \times, b \times \times, a \times \times\}$

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.  $\varepsilon$

**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:

$G^+: \{\times\times, \times e, ab, bd, be, ca, da, db, dd, ec, ed, b\times\}$

1. a
2. aaee
3. dddeadebc
4.  $\varepsilon$

**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:

$G^+: \{\times\times\times b, \times ba, aaa, aab, abb, baa, bba, bbb, ab\times, b\times\times\}$

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:

$G^+ : \{\times \times d, \times da, abe, bed, dab, dac, eda, ac\times, c \times \times\}$

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:

$G^+ : \{\times \times a, \times a\times, \times aa, aaa, aab, abb, baa, bba, bbb, aa\times, a \times \times\}$

1. abbbaaabaaa
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.  $\epsilon$
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:

$G^+: \{\bowtie a, \bowtie b, ab, ba, bb, a\bowtie, b\bowtie\}$

1. abbbaaab
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:

$G^+: \{\bowtie \bowtie a, \bowtie ab, \bowtie aa, aab, aba, abb, baa, bab, bba, ab\bowtie, b\bowtie \bowtie\}$

1. abbbbbaaabba
2. bbb
3. babbbbb
4. bbbbbbabbab

**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.  $\varepsilon$
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:

$G^+: \{\times \times \times c, \times \times \times b, \times \times bb, \times \times bd, \times \times ce, \times bb \times, \times cee, \times bdd, abde, bded, cabd, ceec, dabc, deda, ecab, edab, eeca, abc \times, bdd \times, bc \times \times, dd \times \times, bb \times \times, c \times \times \times, d \times \times \times, b \times \times \times\}$

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.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, ab, ba, bd, da, b\times\}$

1. cdcbbc
2. b
3. ddddca
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times\times\times, \times\times a, \times\times d, \times\times\times, \times d\times, \times ab, abd, aee, bdc, cae, cde, dca, dcd, dee, edc, eed, ee\times, d\times\times, e\times\times\}$

1.  $\varepsilon$
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. bbababbbaab
3. b
4.  $\varepsilon$

**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.  $\varepsilon$

**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. bdc b
4.  $\varepsilon$

**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:

$G^+: \{\times \times b, \times b \times, \times bb, acc, bac, bba, cac, cca, ccb, ccc, cb \times, b \times \times\}$

1. bbac b
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:

$G^+$ :  $\{\times \times \times \times, \times \times \times a, \times \times aa, \times \times \times \times, \times aaa, \times \times \times \times, aaab, aaba, aabb, abaa, abab, baaa, baba, abb \times, bb \times \times, b \times \times \times\}$

1. abbbbbbabaab
2. aaabbba
3.  $\epsilon$
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:

$G^-$ :  $\{abca, acca, baaa, babb, bccc, cabb, cabc, ccba\}$

1. a
2.  $\epsilon$
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:

$G^+ : \{\times c, bb, bc, ca, cb, a \times\}$

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.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times\times\times c, \times\times c\times, \times\times cc, \times c\times\times, \times ccd, bccd, cbcc, ccda, ccdd, cdad, cddc, dc bc, ddc b, dad\times, ad\times, \times, d\times\times\times, c\times\times\times\}$

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

**SOLUTION TO EXERCISE 554.**

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

**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.  $\varepsilon$

**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.  $\varepsilon$

**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:

$G^+: \{\times \times \times a, \times \times \times c, \times \times aa, \times \times ce, \times aae, \times cee, aaeb, aebe, bedc, caee, dcae, ebed, edca, aee \times, cee \times, ee \times \times, e \times \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+: \{\times \times c, \times \times b, \times b \times, \times ca, aaa, aba, baa, cab, aa \times, b \times \times, a \times \times\}$

1. b
2. aacaaa
3. cabaa
4.  $\varepsilon$

**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:

$G^+: \{\times \times \times e, \times \times e \times, \times \times eb, \times ebc, \times e \times \times, bccb, cc bc, ebcc, bc \times \times, c \times \times \times, e \times \times \times\}$

1. edcc
2.  $\varepsilon$
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:

$G^-: \{acaa, baba, bc bc, cbcc, ccab, ccac\}$

1. c
2.  $\varepsilon$
3. a

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:

$G^+ : \{\times a, \times \times, \times c, ad, bd, be, cc, db, dd, ec, c \times\}$

1. aacdeeecee
2. c
3.  $\varepsilon$
4. ccaeecbeeb

**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:

$G^+ : \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times b \times, \times aa, \times bc, aab, abb, baa, bab, bba, bcc, caa, cca, aa \times, b \times \times, a \times \times\}$

1. b
2.  $\varepsilon$
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. bbacbc
3.  $\varepsilon$
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:

$G^+ : \{\times a, \times d, ad, da, dd, a \times, d \times\}$

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.  $\varepsilon$
3. aaaccddbd
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:

$G^+ : \{\times \times \times e, \times \times \times c, \times \times ee, \times \times ce, \times ee \times, \times cea, aacc, abdb, acca, cabd, ccab, ceaa, eaac, bdb \times, db \times \times, ee \times \times, e \times \times \times, b \times \times \times\}$

1. c
2.  $\varepsilon$
3. ee

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:

$G^+ : \{\times a, \times \times, aa, ab, ba, bb, a \times\}$

1. baaabbbb
2.  $\varepsilon$
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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times d, \times \times ba, \times \times da, \times \times \times \times, \times a \times, \times da \times, \times bab, \times a \times \times, \times \times \times \times, aaab, aabc, abaa, abcd, baaa, baba, bcde, cdcd, dcde, dc \times, da \times \times, c \times \times \times, a \times \times \times\}$

1. a
2. ba
3. cdcabccbd
4.  $\varepsilon$

**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:

$G^+ : \{\times \times a, \times ab, aab, aba, baa, ba\times, a \times \times\}$

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:

$G^+ : \{\times b, ab, ba, bb, b\times\}$

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:

$G^+ : \{\times a, \times\times, aa, ab, ac, bc, ca, cb, cc, a\times, c\times\}$

1. aacaabaabc
2. ccaaaba
3. abbb
4.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times, \times \times a, \times \times \times, \times ad, abc, ada, bbc, bca, bcd, cad, cbb, cdc, dab, dcb, ad \times, d \times \times\}$

1.  $\varepsilon$
2. bdbbbb
3. dcada
4. dacbdb

**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:

$G^+$ :  $\{\times \times \times, \times \times \times, c, \times \times \times, a, \times c \times, \times cc, \times \times \times, \times \times aa, acc, cac, cca, ccb, ccc, aa \times, cb \times, b \times \times, a \times \times, c \times \times\}$

1. babcbc
2.  $\varepsilon$
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:

$G^+ : \{\times a, \times \times, \times c, aa, ab, ac, ba, cc, cd, da, a \times, d \times\}$

1. cbccccbbd
2. aa
3.  $\varepsilon$
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:

$G^+ : \{\times \times, \times d, aa, ab, ac, bb, bc, ca, cd, da, d \times\}$

1. d
2. ccaad
3.  $\varepsilon$
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:

$G^+ : \{\times \times \times a, \times \times \times c, \times \times ac, \times \times ca, \times caa, \times ac \times, aabc, abcc, bccc, caaa, caab, ccaa, ccca, aaa \times, aa \times \times, ac \times \times, a \times \times \times, c \times \times \times\}$

1.  $\varepsilon$
2. ac
3. bcacabcb

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. babccccc
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:

$G^+: \{\times \times c, \times \times a, \times a \times, \times cb, adb, bad, bba, bbb, bbc, cbb, dbb, bc \times, a \times \times, c \times \times\}$

1.  $\epsilon$
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:

$G^+ : \{\times \times c, \times cb, abc, bab, bcb, cba, ba\times, a \times \times\}$

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:

$G^+ : \{\times \times \times c, \times \times \times \times, \times \times \times e, \times \times ea, \times \times c\times, \times \times ce, \times \times \times \times, \times ea\times, \times cee, \times c\times\times, \times \times \times \times, ceee, eeac, eeea, eac\times, ac \times \times, ea \times \times, c \times \times \times, a \times \times \times\}$

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.  $\varepsilon$
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.  $\varepsilon$
4. adcbccb

**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.  $\varepsilon$

**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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times aa, \times \times bb, \times aaa, \times bbb, aaab, baaa, bbaa, bbba, aab \times, aaa \times, ab \times \times, aa \times \times, a \times \times \times, b \times \times \times\}$

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:

$G^+ : \{\times \times a, \times a \times, \times ab, \times aa, abc, bcc, cba, ccb, aa \times, ba \times, a \times \times\}$

1. bbcbcc
2. caab
3.  $\varepsilon$
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.  $\varepsilon$
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:

$G^-: \{caba, ccaa, ccde, cdad, ceeb, dbaa, ddea\}$

1. b
2.  $\varepsilon$
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:

$G^+ : \{\times b, ac, bc, ca, cb, a \times\}$

1. bca
2.  $\varepsilon$
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.  $\varepsilon$

**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. caaad
4.  $\varepsilon$

**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.  $\varepsilon$

**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.  $\varepsilon$
4. bbbba

**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:

$G^+ : \{\times a, aa, ae, bc, ce, ea, eb, ec, ee, e\times\}$

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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times aa, \times \times \times \times, \times \times ba, \times \times \times \times, \times aaa, \times ba \times, aaaa, aaab, aabb, abb \times, ba \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. ba
2.  $\epsilon$
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.  $\varepsilon$

**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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^-: \{baae, bebc, ceac, eaac, eaec, ebc b, ebed\}$

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.  $\varepsilon$

**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:

$G^+: \{\times \times \times a, \times \times \times c, \times \times cb, \times \times ae, \times ae \times, \times cbb, addb, aead, bbca, bcae, caea, cbbc, ddbd, eadd, dbd \times, ae \times, bd \times \times, d \times \times \times, e \times \times \times\}$

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:

$G^+ : \{\times \times \times d, \times \times \times c, \times \times c \times, \times \times da, \times dae, \times c \times \times, ae eb, da ee, ee be, e be \times, be \times \times, c \times \times \times, e \times \times \times\}$

1. deeb
2.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times a, \times \times, aa, ac, ba, cb, a \times\}$

1. aa
2. adaaac
3.  $\varepsilon$
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. bbbcbca
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times \times \times, \times \times aa, \times \times ba, \times bab, \times aac, \times \times \times \times, abca, babc, bcac, cacb, acb \times, aac \times, ac \times \times, cb \times \times, c \times \times \times, b \times \times \times\}$

1.  $\epsilon$
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. cbc bca
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:

$G^-$ :  $\{aaba, aabb, bach, bccb, bccc, caaa, cacb, cbca\}$

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:

$G^+: \{\times a, aa, ab, ac, ba, bc, ca, cb, c\times\}$

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:

$G^+ : \{\times \times c, \times \times a, \times \times \times, \times \times \times, \times ac, \times cd, aad, ada, cdd, daa, dad, dda, ac \times, da \times, a \times \times, c \times \times\}$

1. adbcccbaa
2. ac
3. cccbbbcd
4.  $\epsilon$

**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.  $\epsilon$
3. acbccccb
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:

$G^+ : \{\times a, ab, ba, bb, bc, cb, cc, a \times\}$

1. aacbaba
2. bbb
3. bcaca

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:

$G^+ : \{\times \times \times e, \times \times ea, \times ead, adbc, dbcb, eadb, bcb\times, cb \times \times, b \times \times \times\}$

1. a
2.  $\varepsilon$
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:

$G^+ : \{\times \times d, \times \times \times, \times \times \times, \times db, aea, aeb, bea, dbe, eae, eba, ba\times, a \times \times\}$

1.  $\varepsilon$
2. dadbbb
3. dbeaeba
4. c

**SOLUTION TO EXERCISE 620.**

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



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.  $\varepsilon$
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:

$G^+: \{\times\times\times c, \times\times\times b, \times\times cb, \times\times bd, \times bde, \times cba, aace, aced, bdec, cdda, cedb, daac, ddaa, decd, ecdd, edbd, db\times\times, a\times\times\times, b\times\times\times\}$

1. dbdeaab
2.  $\varepsilon$
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:

$G^+ : \{\times \times b, \times \times \times, \times \times \times, \times ba, aab, abb, baa, bbc, bc\times, c \times \times\}$

1. aaaac
2. bba
3. bbc
4.  $\varepsilon$

**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. cbееeb
2. ccdaa
3. e
4.  $\varepsilon$

**SOLUTION TO EXERCISE 627.**

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

**EXERCISE 628.**

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

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

1.  $\epsilon$
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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times b, \times \times ca, \times \times b \times, \times \times ad, \times ad \times, \times caa, \times b \times \times, aaac, aaca, acaa, caaa, caac, aac \times, ac \times \times, ad \times \times, c \times \times \times, d \times \times \times, b \times \times \times\}$

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:

$G^+$ :  $\{\times b, ab, bc, ca, cb, cc, a \times\}$

1. ccabcaac
2.  $\epsilon$

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:

$G^+$ :  $\{\times\times\times a, \times\times\times d, \times\times dc, \times\times ab, \times abb, \times dcc, abbc, adee, bbca, bcad, becd, cade, deeb, ebec, eebe, ecd\times, \times, cc\times\times, c\times\times\times, d\times\times\times\}$

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. dacbdbbac

**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:

$G^+: \{\text{⌘} \text{⌘} \text{⌘}a, \text{⌘} \text{⌘} \text{⌘}b, \text{⌘} \text{⌘} \text{⌘}aa, \text{⌘} \text{⌘} \text{⌘}ab, \text{⌘} \text{⌘} \text{⌘}ba, \text{⌘}aba, \text{⌘}aab, \text{⌘}ba\text{⌘}, aaab, aabb, abbb, baaa, bbba, bbba, aba\text{⌘}, bba\text{⌘}, ba \text{⌘} \text{⌘}, a \text{⌘} \text{⌘} \text{⌘}\}$

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:

$G^+ : \{\times \times d, \times dd, abd, adb, bbc, bda, dab, dad, dbb, dda, ddd, bc\times, c \times \times\}$

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:

$G^+ : \{\times e, bc, cd, db, ed, ee, d\times\}$

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:

$G^+ : \{\times a, \times \times, ac, ad, be, ce, da, db, ed, ee, e\times, a\times\}$

1.  $\epsilon$
2. eebae
3. acab
4. bdec d

**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:

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

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.  $\varepsilon$
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:

$G^+ : \{\times \times c, \times cc, abc, acc, bca, cab, cac, cca, cc\times, c \times \times\}$

1. ba
2. ccbc
3.  $\varepsilon$
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:

$G^+ : \{\times \times \times c, \times \times cb, \times \times cc, \times cca, \times cbb, bbcc, bccc, cbbc, cccc, ccc\times, cca\times, cc \times \times, ca \times \times, a \times \times \times, c \times \times \times\}$

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:

$G^+ : \{\times \times \times a, \times \times \times \times, \times \times \times e, \times \times ea, \times \times ed, \times \times \times \times, \times \times a \times, \times ead, \times a \times \times, \times \times \times \times, \times ede, decd, ecdd, edec, cdd\times, ead\times, ad \times \times, dd \times \times, d \times \times \times, a \times \times \times\}$

1. e
2. a

3. dd
4.  $\varepsilon$

**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.  $\varepsilon$

**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:

$G^-: \{aaaa, aaba, abaa, abab, babb, bbba, bbab, bbbb\}$

1. abbba
2. aba
3.  $\varepsilon$
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:

$G^-: \{acdc, aded, bbcd, bdda, ccbb, eaca, ecba, eeca\}$

1. e
2. bdecdbabdb
3. baeeeedae
4.  $\varepsilon$

**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. addbacbb
4. dcabdcddca

**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. aaaabbbbbaaba
3. a
4.  $\varepsilon$

**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:

$G^+: \{\times a, \times d, aa, ae, bd, db, de, ea, ed, ee, e\times, d\times\}$

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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times c, \times \times d, \times \times b, \times cb, \times db, \times b \times, aad, adb, adc, bdc, caa, cad, dbc, dbd, dca, cb \times, bc \times, c \times \times, b \times \times\}$

1. b
2. cb
3. dbc
4. cdacaadb

**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:

$G^+$ :  $\{\epsilon, c, b, e, ea, c\epsilon, bd, ec, ece, eae, bde, c\epsilon, aabd, abdc, bdcc, ccdb, ceaa, dccd, eaab, ecea, cdb\epsilon, bde\epsilon, db\epsilon, de\epsilon, ea\epsilon, c\epsilon\epsilon, a\epsilon\epsilon, e\epsilon\epsilon, b\epsilon\epsilon\}$

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:

$G^+$ :  $\{\epsilon, b, ab, ba, bc, ca, cb, cc, a\epsilon\}$

1. bca
2.  $\epsilon$
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.  $\epsilon$

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.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times \times \times, \times \times bc, \times \times \times \times, \times \times cc, \times cca, \times bc \times, \times \times \times \times, aacc, accb, bbaa, caac, cbba, ccaa, ccbb, baa \times, aa \times \times, bc \times \times, c \times \times \times, a \times \times \times\}$

1. c
2. accbcacb
3. aaaab
4.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, aa, ab, bc, ca, cc, b\times\}$

1.  $\varepsilon$
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:

$G^+: \{\times\times, \times c, ab, bc, ca, cc, b\times\}$

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:

$G^+$ :  $\{\times \times a, \times a \times, \times ab, aab, aba, abb, baa, bab, bb\times, b \times \times, a \times \times\}$

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

**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.  $\varepsilon$
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.  $\varepsilon$
3. eebdcdbbbec
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.  $\varepsilon$

**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.  $\varepsilon$
3. ccbddca
4. dbdbda

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

1. cba
2. b
3.  $\epsilon$
4. abb

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

1. c
2.  $\epsilon$
3. abccbcbcab
4. cb

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:

$G^+ : \{\times \times c, \times \times a, \times a \times, \times cc, acd, add, bad, cce, cdb, ceb, dac, dda, eba, db \times, b \times \times, a \times \times\}$

1.  $\varepsilon$
2. bccedcbb
3. eecddc
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.  $\varepsilon$

**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:

$G^+ : \{\times \times \times, \times \times b, \times \times d, \times \times \times, \times d \times, \times ba, aac, acc, baa, bcc, cbc, ccb, ccc, cb \times, b \times \times, d \times \times\}$

1. bbca
2. d

3. ccbed
4.  $\varepsilon$

**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. cabdbdbd
2. bad
3.  $\varepsilon$
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. bcbdcdd
4.  $\epsilon$

**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.  $\epsilon$
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:

$G^+: \{\times\times, \times c, aa, ab, ac, ba, bb, bc, ca, a\times\}$

1. caa
2.  $\epsilon$
3. cabac
4. ca

**SOLUTION TO EXERCISE 678.**

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

**EXERCISE 679.**

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

$G^+ : \{\bowtie a, \bowtie \bowtie, aa, ab, ba, bb, b\bowtie\}$

1. ab
2. aaab
3.  $\varepsilon$
4. aab

**SOLUTION TO EXERCISE 679.**

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

**EXERCISE 680.**

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

$G^- : \{aabd, adda, cdaa, cdba, cdca\}$

1.  $\varepsilon$
2. aa
3. bdbbbcabcbbd
4. abbacc

**SOLUTION TO EXERCISE 680.**

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

**EXERCISE 681.**

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

$G^+ : \{\times \times b, \times \times \times, \times \times \times, \times bb, abb, abc, bab, bba, bbb, bbc, bca, bcb, cab, cb \times, b \times \times\}$

1. bbcb
2. b
3. accbbab
4.  $\varepsilon$

**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:

$G^+ : \{\times a, \times \times, \times d, ac, ad, cc, ce, dd, ea, d \times\}$

1. cbad
2.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times a, \times \times ac, \times aca, acac, acba, cacb, cba\times, ba \times \times, a \times \times \times\}$

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.  $\epsilon$
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.  $\epsilon$
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. adcb
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.  $\epsilon$
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.  $\varepsilon$
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:

$G^+: \{\bowtie\bowtie, \bowtie e, ac, ae, ca, cd, da, ec, ee, c\bowtie\}$

1.  $\varepsilon$
2. bdbdb
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.  $\varepsilon$
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:

$G^+: \{\times a, \times \times, aa, ab, ba, bb, b \times\}$

1. abbaba
2. aab
3.  $\varepsilon$
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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times ac, \times \times b \times, \times b \times \times, \times acb, acbb, bbca, cbbc, bca \times, ca \times \times, a \times \times \times, b \times \times \times\}$

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.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times e, \times \times a, \times \times \times, \times \times \times, \times e \times, \times ab, abb, add, bad, bbd, bdb, beb, db e, ddb, eba, db \times, b \times \times, e \times \times\}$

1. eeebc
2. cbbeee
3. aabcdbdbca

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:

$G^+ : \{\times \times, \times b, aa, ab, ba, bb, b \times\}$

1.  $\varepsilon$
2. aabbbbaa
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:

$G^+ : \{\times \times \times b, \times \times \times d, \times \times db, \times \times dd, \times \times b \times, \times ddb, \times db \times, \times dbb, \times b \times \times, aaab, aabd, abdc, baaa, bbaa, bbba, dbbb, ddbb, dbb \times, bdc \times, dc \times \times, db \times \times, bb \times \times, c \times \times \times, b \times \times \times\}$

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:

$G^+$ :  $\{\times\times\times a, \times\times\times c, \times\times\times\times, \times\times\times d, \times\times dc, \times\times ca, \times\times\times\times, \times\times a\times, \times dca, \times a\times\times, \times cad, \times\times\times\times, adcd, caaa, cadc, cdca, dcaa, dcad, dcde, aaa\times, cad\times, ad\times\times, aa\times\times, d\times\times\times, a\times\times\times\}$

1. bbd
2. acbbabcb
3. cbc b
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.  $\varepsilon$
3. bbbbbb
4. ccaba

**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:

$G^+: \{\bowtie \bowtie b, \bowtie be, ace, bac, beb, bee, eba, ebe, eeb, ce\bowtie, e \bowtie \bowtie\}$

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:

$G^-: \{abcc, adad, badd, bddb, bddb, ccda, dbcb\}$

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:

$G^+ : \{\times c, ab, ba, ca, cc, ce, ec, a \times\}$

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:

$G^+ : \{\times \times \times d, \times \times \times a, \times \times \times b, \times \times dd, \times \times ab, \times \times b \times, \times ddb, \times abd, \times b \times \times, bbbb, dbbb, ddbb, abd \times, bbb \times, bd \times \times, bb \times \times, d \times \times \times, b \times \times \times\}$

1.  $\varepsilon$
2. bbca
3. cc
4. dcadbd

**SOLUTION TO EXERCISE 707.**

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

**EXERCISE 708.**

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

$G^-: \{aba, baa, bab, bba\}$

1. a
2. b
3. bb
4.  $\varepsilon$

**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:

$G^+: \{\bowtie \bowtie d, \bowtie d \bowtie, \bowtie da, acb, adc, bdd, cbd, dac, dad, dcd, dda, cd \bowtie, d \bowtie \bowtie\}$

1. d
2. baabad
3. dadcd
4. acbcacbcdb

**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.  $\varepsilon$
4. b

**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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times ab, \times \times bb, \times \times b \times, \times \times ba, \times baa, \times bba, \times ab \times, \times b \times \times, aaba, abab, abbb, baab, babb, bbba, bbaa, bba \times, bba \times, ba \times \times, ab \times \times, aa \times \times, a \times \times \times, b \times \times \times\}$

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.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+: \{\times \times \times b, \times \times \times e, \times \times e \times, \times \times ea, \times \times be, \times \times ba, \times e \times \times, \times bea, \times eaa, \times ba \times, abac, aeab, beae, eaba, eaea, eaa \times, bac \times, ba \times \times, ac \times \times, aa \times \times, c \times \times \times, a \times \times \times, e \times \times \times\}$

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.  $\varepsilon$

**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:

$G^+ : \{\times c, ca, ce, dc, ec, ed, ee, a \times\}$

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:

$G^+ : \{\times \times \times a, \times \times \times e, \times \times ae, \times \times e \times, \times aeb, \times e \times \times, aebb, bbeb, bebe, ebbe, ebe \times, be \times \times, e \times \times \times\}$

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:

$G^-: \{aadd, abba, addb, bacb, cbec, cdc b\}$

1. b
2. e
3.  $\varepsilon$
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:

$G^+: \{\times \times d, \times \times b, \times dd, \times ba, bac, cdb, dba, dcd, ddc, ac\times, ba\times, c \times \times, a \times \times\}$

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:

$G^+ : \{\times\times, \times b, aa, ab, ac, ba, bb, ca, cb, b\times\}$

1. cabc
2.  $\varepsilon$
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.  $\varepsilon$
4. eeebad

**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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times ab, \times b \times, \times ba, abb, bab, bba, ab \times, b \times \times\}$

1. a
2.  $\epsilon$
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.  $\epsilon$
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:

$G^+ : \{\times \times c, \times \times b, \times cd, \times bd, ace, bda, ced, dac, dcb, edc, cd\times, cb\times, b\times\times, d\times\times\}$

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:

$G^+ : \{\times \times \times c, \times \times \times b, \times \times \times \times, \times \times bc, \times \times c\times, \times \times \times \times, \times \times ba, \times baa, \times bca, \times c\times\times, \times \times \times \times, aabb, abbb, baab, bca\times, bbb\times, ca\times\times, bb\times\times, c\times\times\times, a\times\times\times, b\times\times\times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times\times, \times b, aa, ab, ba, bb, b\times\}$

1.  $\varepsilon$
2. abbbbaa
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:

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

1.  $\varepsilon$
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.  $\epsilon$
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:

$G^+: \{\times \times d, \times \times b, \times \times \times, \times \times \times, \times d \times, \times dc, \times bc, bcc, cce, ced, edb, dc \times, db \times, b \times \times, d \times \times, c \times \times\}$

1. ebd
2. dc
3. d
4.  $\epsilon$

**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:

$G^+$ :  $\{\times \times a, \times \times b, \times \times \times, \times \times \times, \times b \times, \times aa, aaa, aab, aba, abb, baa, bab, bb \times, b \times \times\}$

1.  $\epsilon$
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.  $\epsilon$
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:

$G^+$ :  $\{\times \times a, \times \times b, \times a \times, \times bb, aab, abb, baa, bab, bba, bb \times, b \times \times, a \times \times\}$

1. bbbba
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.  $\varepsilon$

**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:

$G^+: \{\text{ } \times \text{ } \times \text{ } \times a, \times \text{ } \times \text{ } \times b, \times \text{ } \times \text{ } \times \times, \times \text{ } \times \text{ } ab, \times \text{ } \times \text{ } b \times, \times \text{ } \times \text{ } \times \times, \times \text{ } \times \text{ } aa, \times aaa, \times abb, \times ab \times, \times \text{ } \times \text{ } \times \times, \times b \text{ } \times \text{ } \times, \times aaa, \times aab, \times aba, \times aba, \times baaa, \times aaa \times, \times abb \times, \times ab \text{ } \times \text{ } \times, \times aa \text{ } \times \text{ } \times, \times bb \text{ } \times \text{ } \times, \times a \text{ } \times \text{ } \times \times, \times b \text{ } \times \text{ } \times \times\}$

1. b
2. ab
3. bab
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times\times, \times d, aa, ac, ae, bc, ca, cb, ce, dc, dd, ea, eb, b\times\}$

1. eecbbdbdb
2. ccc
3. cbdbead
4. dcbebc

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times a \times, \times \times ba, \times a \times \times, \times \times baa, aabc, abcb, baab, bcba, cba \times, ba \times \times, a \times \times \times\}$

1.  $\epsilon$
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:

$G^+ : \{\times\times, \times b, \times c, ad, bb, bc, ca, cd, db, dc, dd, c\times\}$

1.  $\varepsilon$
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:

$G^+ : \{\times\times\times, \times\times c, \times\times a, \times a\times, \times cb, \times\times\times, \times ac, aca, bac, bba, cbb, ac\times, ca\times, a\times\times, c\times\times\}$

1.  $\varepsilon$
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.  $\varepsilon$
3. cabda

4. adcdada

**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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times \times d, \times \times cb, \times \times da, \times \times b\times, \times dad, \times cb\times, \times b \times \times, aaab, aaba, abaa, adca, baaa, caab, dadc, dcaa, aab\times, ab \times \times, cb \times \times, b \times \times \times\}$

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.  $\varepsilon$

**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:

$G^+ : \{\times\times, \times b, aa, ab, ba, b\times\}$

1. b
2. abbabb
3. ababab
4.  $\varepsilon$

**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:

$G^+ : \{\times\times c, \times\times b, \times c\times, \times bc, aac, acb, baa, bca, bcb, cba, cbc, bc\times, ca\times, c\times\times, a\times\times\}$

1. ca
2. aabbc
3. baa
4.  $\varepsilon$

**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. baaaaaaba
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:

$G^+: \{\times b, aa, ab, ba, bb, a\times\}$

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:

$G^+: \{\times \times \times c, \times \times \times \times, \times \times \times d, \times \times db, \times \times cb, \times \times \times \times, \times dbc, \times cb \times, \times \times \times \times, abad, acab, adac, bada, bcda, cdab, daba, daca, dbcd, cab \times, ab \times \times, cb \times \times, b \times \times \times\}$

1. a
2. cb

3.  $\epsilon$
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:

$G^-: \{aacc, bbcc, cbac, cbc b\}$

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.  $\epsilon$
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.  $\varepsilon$

**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:

$G^+: \{\bowtie d, bc, bd, cd, db, de, ea, eb, ed, a\bowtie\}$

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:

$G^+: \{\bowtie \bowtie e, \bowtie \bowtie a, \bowtie eb, \bowtie aa, aac, acd, bba, cdb, dbb, eb\bowtie, ba\bowtie, b \bowtie \bowtie, a \bowtie \bowtie\}$

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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times ab, \times \times c\times, \times \times \times\times, \times aba, \times c\times\times, \times \times \times\times, aacc, abaa, accb, baac, bbca, bcab, cabc, cbbc, cbbb, abc\times, bc\times\times, c\times\times\times\}$

1. aabcaab
2. c
3.  $\varepsilon$
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.  $\varepsilon$
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.  $\epsilon$
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:

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

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:

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

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.  $\varepsilon$
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:

$G^+: \{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times \times d, \times \times db, \times \times \times \times, \times \times cc, \times \times a \times, \times \times \times dbb, \times \times cc \times, \times \times \times \times, aaba, acaa, bbdc, bdca, caab, caca, dbbd, dcac, aba \times, ba \times \times, cc \times \times, c \times \times \times, a \times \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\bowtie a, \bowtie \bowtie, \bowtie b, ab, ac, ba, cb, cc, a\bowtie, b\bowtie\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times ba, \times aa, acb, bac, bcc, cbc, ccc, ccd, cda, da \times, aa \times, a \times \times\}$

1. c
2. bacbccda
3.  $\varepsilon$
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:

$G^+: \{\times \times b, \times \times \times, \times \times \times, \times bb, aab, baa, bba, bbb, ab \times, b \times \times\}$

1.  $\varepsilon$
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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times bb, \times \times b \times, \times \times aa, \times \times ba, \times aaa, \times bb \times, \times bab, \times b \times \times, abba, babb, bbab, bab \times, aaa \times, ab \times \times, aa \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. b
2. bb
3. aaa
4. aaaaaaaaa

**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.  $\epsilon$
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.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+ : \{\times \times c, \times \times b, \times cd, \times bd, aab, abc, acd, aea, bca, cae, cda, daa, dac, ea \times, bd \times, d \times \times, a \times \times\}$

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:

$G^+ : \{\times \times, \times b, ab, ad, bc, bd, ca, db, dc, dd, c \times\}$

1. aada
2. cdccdaad
3.  $\varepsilon$
4. bdc b

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times b, \times \times \times \times, \times \times ac, \times \times \times \times, \times \times cc, \times \times ba, \times acc, \times baa, \times cc \times, \times \times \times \times, aabc, abcc, baab, bccb, ccba, acc \times, cba \times, ba \times \times, cc \times \times, c \times \times \times, a \times \times \times\}$

1. acc
2.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times bb, \times \times a \times, \times \times ba, \times bab, \times a \times \times, \times bbb \times, abba, abbb, babb, bbab, bbbb, bbb \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. a
2. abbaaa
3.  $\varepsilon$
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:

$G^+$ :  $\{\times \times a, \times \times b, \times b \times, \times ba, \times aa, aab, aba, abb, bab, bbc, bcb, cbc, bc \times, ba \times, b \times \times, a \times \times, c \times \times\}$

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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times c, \times \times a, \times a \times, \times cb, \times aa, bcc, bdb, cbd, dbc, cc \times, aa \times, a \times \times, c \times \times\}$

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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times cc, \times \times b \times, \times ccb, \times b \times \times, bccb, bccc, cbcc, cc bc, cccb, cccc, ccb \times, cb \times \times, b \times \times \times\}$

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:

$G^+$ :  $\{\text{⌘ ⌘ ⌘ c}, \text{⌘ ⌘ ⌘ b}, \text{⌘ ⌘ ⌘ ⌘}, \text{⌘ ⌘ ⌘ ⌘}, \text{⌘ ⌘ cb}, \text{⌘ ⌘ ba}, \text{⌘ cbd}, \text{⌘ ⌘ ⌘ ⌘}, \text{⌘ baa}, \text{aaba}, \text{abab}, \text{baab}, \text{cbd ⌘}, \text{bab ⌘}, \text{ab ⌘ ⌘}, \text{bd ⌘ ⌘}, \text{d ⌘ ⌘ ⌘}, \text{b ⌘ ⌘ ⌘}\}$

1. cbbcbc
2. aac
3. cbd
4.  $\varepsilon$

**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:

$G^+$ :  $\{\text{⌘ d}, \text{aa}, \text{ad}, \text{da}, \text{dd}, \text{d ⌘}\}$

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:

$G^+$ :  $\{\text{⌘ ⌘ e}, \text{⌘ ⌘ c}, \text{⌘ ⌘ ⌘}, \text{⌘ ⌘ ⌘}, \text{⌘ e ⌘}, \text{⌘ ca}, \text{aab}, \text{abb}, \text{abc}, \text{baa}, \text{bba}, \text{bca}, \text{cab}, \text{cac}, \text{ac ⌘}, \text{e ⌘ ⌘}, \text{c ⌘ ⌘}\}$

1. bbabea
2. cbeccbcad

3. aceaae

4.  $\varepsilon$

**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:

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

1. abaa

2. b

3.  $\varepsilon$

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:

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

1. bbaccabca

2. acbccbccbcb

3.  $\varepsilon$

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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ac, \times \times \times \times, \times \times ba, \times \times \times aca, \times \times \times \times ba \times, \times \times \times \times \times \times, aacc, acaa, acce, caac, cccc, ccc \times, ba \times \times, cc \times \times, c \times \times \times, a \times \times \times\}$

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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times a, \times \times \times b, \times \times \times a, \times \times \times b, aaba, abaa, baab, bbb \times, aba \times, ba \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. a
2. abbbba
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.  $\varepsilon$
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:

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

1. badcc
2. bc
3.  $\varepsilon$
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.  $\varepsilon$

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.  $\varepsilon$
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:

$G^+: \{\times\times, \times c, ac, ba, bb, ca, cd, db, a\times\}$

1. ddda
2. dbad
3.  $\varepsilon$
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:

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

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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+ : \{\times \times c, \times \times d, \times cb, \times dc, add, bca, cad, cbc, dcc, ddc, ddd, dc\times, cc\times, c \times \times\}$

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.  $\varepsilon$
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:

$G^+ : \{\times e, \times d, be, de, eb, ed, ee, e\times, d\times\}$

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:

$G^+ : \{\times\times, \times c, \times d, ab, ad, ba, bb, bc, cb, da, db, dd, c\times, b\times\}$

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.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+: \{\bowtie d, ac, bc, cb, cd, da, dc, dd, b\bowtie\}$

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

**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.  $\epsilon$
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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ab, \times \times b \times, \times \times \times \times, \times aba, \times abb, \times \times \times \times, \times b \times \times, aabb, abba, abbb, baab, bbaa, bbba, bbbb, aba \times, bba \times, ba \times \times, a \times \times \times, b \times \times \times\}$

1. b
2.  $\epsilon$
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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times cb, \times \times bb, \times \times b\times, \times bbc, \times cba, \times b \times, \times, aacb, acba, bbca, bcaa, caac, cbab, bab\times, cba\times, ba \times \times, ab \times \times, a \times \times \times, b \times \times \times\}$

1.  $\varepsilon$
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. deaaaab
2.  $\varepsilon$
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. dbcdddda
4.  $\varepsilon$

**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:

$G^+ : \{\times \times d, \times \times \times, \times \times \times, \times da, abc, aca, bcb, bda, cab, cbd, dac, ac\times, c \times \times\}$

1. bdbb
2. bddeecacce
3.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times a, \times aa, aab, aba, abb, baa, bab, bba, aa\times, a \times \times\}$

1. a
2. abbbaaaabb
3. bbbbaaaaa
4.  $\varepsilon$

**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:

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

1.  $\varepsilon$
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. abbbbaa
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:

$G^+: \{\times\times, \times b, aa, ab, ba, bb, b\times\}$

1. babbb
2. b
3. aaaabb
4.  $\varepsilon$

**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:

$G^-: \{aed, bea, cee, dba, dcd, ded, edd\}$

1. cee
2. baceaa
3.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times\times, \times c, ab, bb, bc, ca, cb, cc, b\times\}$

1.  $\varepsilon$
2. aacbbcb
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.  $\epsilon$
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:

$G^+: \{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times cb, \times \times \times \times, \times \times aa, \times aaa, \times cbc, \times \times \times \times, aaac, aaba, aacb, abaa, acbc, baab, bcaa, caab, cbca, aab \times, cbc \times, ab \times \times, bc \times \times, c \times \times \times, b \times \times \times\}$

1.  $\epsilon$
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:

$G^+ : \{\epsilon \epsilon \epsilon, \epsilon \epsilon c, \epsilon c \epsilon, \epsilon \epsilon \epsilon, \epsilon cc, cab, cca, ccc, ab\epsilon, b \epsilon \epsilon, c \epsilon \epsilon\}$

1. acbbaacacaa
2.  $\epsilon$
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:

$G^+ : \{\epsilon \epsilon \epsilon b, \epsilon \epsilon \epsilon \epsilon, \epsilon \epsilon \epsilon d, \epsilon \epsilon db, \epsilon \epsilon bb, \epsilon \epsilon d\epsilon, \epsilon \epsilon \epsilon \epsilon, \epsilon db\epsilon, \epsilon d \epsilon \epsilon, \epsilon bba, \epsilon \epsilon \epsilon \epsilon, \epsilon bbd, acac, bbdc, bdca, caca, cacc, dcac, acc\epsilon, bba\epsilon, ba \epsilon \epsilon, db \epsilon \epsilon, cc \epsilon \epsilon, c \epsilon \epsilon \epsilon, d \epsilon \epsilon \epsilon, a \epsilon \epsilon \epsilon, b \epsilon \epsilon \epsilon\}$

1. dcbaadd
2. db
3.  $\epsilon$
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:

$G^+ : \{\epsilon b, aa, ab, ba, bb, a\epsilon\}$

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:

$G^-: \{aaba, acbd, cbad, cbc b, ddbc\}$

1. dbcabdcda
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:

$G^+: \{\bowtie a, \bowtie \bowtie, \bowtie b, aa, bb, bc, ca, cc, a\bowtie\}$

1.  $\varepsilon$
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.  $\varepsilon$
2. bcdcb
3. eeecdcdc
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:

$G^+: \{\bowtie a, \bowtie b, aa, ab, ba, b\bowtie\}$

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.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times a, \times \times \times \times, \times \times \times d, \times \times ab, \times \times da, \times \times \times \times, \times aba, \times dac, \times \times \times \times, abac, acac, acdb, baca, cacd, cdb \times, dac \times, db \times \times, ac \times \times, c \times \times \times, b \times \times \times\}$

1. addd
2.  $\varepsilon$
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:

$G^-$ :  $\{aaba, acac, cbaa, cbc b, ccaa, ccca\}$

1. ccac
2. cbbbc
3. b
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times\times\times d, \times\times da, \times dad, abec, adda, adea, beca, cade, dabe, dadd, ddab, ecad, dea\times, ea\times, a\times\times\times\}$

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:

$G^+$ :  $\{\times\times c, \times\times b, \times\times\times, \times\times\times, \times bc, \times ca, adb, bcc, bda, cad, cca, daa, dbd, aa\times, ca\times, a\times\times\}$

1. abb
2.  $\varepsilon$
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:

$G^+$ :  $\{\times\times, \times b, \times d, ac, bb, bc, ca, cb, b\times, d\times\}$

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:

$G^+ : \{\times \times a, \times aa, aaa, aab, abb, bbb, bb\times, aa\times, b \times \times, a \times \times\}$

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:

$G^+ : \{\times \times \times c, \times \times \times b, \times \times bc, \times \times c\times, \times \times bb, \times \times cd, \times cdd, \times bbb, \times c \times \times, \times bc\times, cdda, daca, ddac, aca\times, bbb\times, bc \times \times, ca \times \times, bb \times \times, c \times \times \times, a \times \times \times, b \times \times \times\}$

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:

$G^+ : \{\times c, aa, ab, ba, bb, bc, ca, cb, cc, b\times\}$

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:

$G^+ : \{\times \times b, \times bb, aaa, abb, baa, bab, bba, bbb, aa\times, a \times \times\}$

1. bbaa
2. b
3. bbaaa
4. bbbaa

**SOLUTION TO EXERCISE 846.**

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

**EXERCISE 847.**

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

$G^+ : \{\times b, aa, ab, ba, bb, bd, db, d\times\}$

1. bd
2.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+ : \{\times\times, \times d, bb, bc, bd, cd, db, dc, dd, c\times\}$

1. cbaaa
2.  $\varepsilon$
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:

$G^+ : \{\times a, \times b, aa, ab, ba, a\times, b\times\}$

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:

$G^+ : \{\times\times, \times e, aa, bd, be, db, dd, ea, eb, e\times, a\times\}$

1.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times \times, \times \times \times d, \times \times \times \times, \times \times d \times, \times \times da, \times d \times \times, \times \times \times \times, \times dad, adcb, adcd, bcad, cadc, cbca, dadc, dc bc, dcd \times, cd \times \times, d \times \times \times\}$

1. ccaddcbcc
2. a
3. d
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times \times, \times \times a, \times \times b, \times aa, \times \times \times, \times b \times, aaa, aac, ace, adb, bae, bda, ceb, dad, dba, ebd, ae \times, e \times \times, b \times \times\}$

1. daad
2. dcaa
3.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times, \times \times d, \times \times e, \times db, \times \times \times, \times ed, bbd, bdc, bee, cde, ceb, db e, dcd, ebb, ece, eec, ed \times, de \times, d \times \times, e \times \times\}$

1. ed

2.  $\varepsilon$
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:

$G^+ : \{\bowtie \bowtie b, \bowtie \bowtie \bowtie, \bowtie \bowtie \bowtie, \bowtie ba, abb, bab, bba, bbb, bb\bowtie, b \bowtie \bowtie\}$

1. babb
2.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
2. eaacbb
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.  $\varepsilon$
2. be
3. abbadd
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:

$G^-: \{adbd, badd, bdbd, ccba, dbdb, deab, each\}$

1. aa
2. ebce
3. dead
4.  $\varepsilon$

**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:

$G^-: \{aaab, aaba, baaa, baba, bbba, bbab, bbba, bbbb\}$

1. babbb
2.  $\varepsilon$
3. aaaabbab
4. b

**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:

$G^+ : \{\times \times b, \times ba, aaa, abc, bab, bca, caa, aa\times, a \times \times\}$

1. aabbaa
2. ccbcaabc
3. bcbbecca
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:

$G^+ : \{\times \times \times, \times \times c, \times \times d, \times \times \times, \times dc, \times cc, bda, cbd, ccb, ccc, dac, dc\times, ac\times, c\times \times\}$

1. cbadca
2. dc
3. abdd
4.  $\varepsilon$

**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:

$G^+ : \{\times a, \times d, ab, ba, bc, cb, cc, b\times, d\times\}$

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.  $\varepsilon$
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:

$G^+ : \{\times \times \times a, \times \times aa, \times aad, aadb, abdd, adba, babd, dbab, bdd\times, dd \times \times, d \times \times \times\}$

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.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\times \times \times, \times \times c, \times \times \times, \times cc, cbd, ccb, ccc, bd\times, d \times \times\}$

1. a
2. c
3. ccdb
4.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+: \{\times \times c, \times cc, aba, abb, bab, bbc, bcc, cab, cba, cca, ccb, ccc, ba\times, a \times \times\}$

1. ccbabccbc
2. ccba
3. cccabbaaaba
4. ccba

**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.  $\varepsilon$
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:

$G^+ : \{\times a, \times d, aa, ab, ba, bc, cb, cc, cd, da, a \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

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

1. baabaa
2.  $\varepsilon$
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:

$G^+ : \{\times \times a, \times \times b, \times ac, \times ba, aba, abc, bab, bcc, ac\times, cc\times, c\times\times\}$

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:

$G^+ : \{\times \times c, \times \times b, \times c\times, \times bc, \times ca, aac, acc, bbb, caa, cbb, ccb, bb\times, bc\times, b\times\times, c\times\times\}$

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.  $\varepsilon$
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.  $\epsilon$
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.  $\epsilon$
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. aacbaccbbab

**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.  $\varepsilon$
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.  $\varepsilon$
4. ccbb

**SOLUTION TO EXERCISE 888.**

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



4.  $\varepsilon$

**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:

$G^+ : \{\times \times, \times d, cc, cd, ce, da, dc, dd, ec, a \times\}$

1. abdb
2. dd
3.  $\varepsilon$
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:

$G^- : \{aaab, accb, bbbb, cadc, cbcd, ccbb, ddc b, dddb\}$

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:

$G^+: \{\bowtie\bowtie, \bowtie b, \bowtie c, ab, ac, ba, bb, bc, cb, cc, c\bowtie, b\bowtie\}$

1. aacbabbccab
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.  $\varepsilon$
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:

$G^+$ :  $\{\epsilon \epsilon \epsilon c, \epsilon \epsilon \epsilon b, \epsilon \epsilon bd, \epsilon \epsilon c\epsilon, \epsilon bdb, \epsilon c \epsilon \epsilon, aaab, aaba, baaa, bbaa, bdbb, dbba, aba\epsilon, ba \epsilon \epsilon, a \epsilon \epsilon \epsilon, c \epsilon \epsilon \epsilon\}$

1. ddcbaaac
2. dbbabc
3.  $\epsilon$
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.  $\epsilon$
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:

$G^+$ :  $\{\epsilon \epsilon \epsilon a, \epsilon \epsilon \epsilon c, \epsilon \epsilon \epsilon e, \epsilon \epsilon ab, \epsilon \epsilon c\epsilon, \epsilon \epsilon ee, \epsilon ee\epsilon, \epsilon aba, \epsilon c \epsilon \epsilon, abac, abdc, acab, baca, bdce, cabd, ceeb, dcee, eeb\epsilon, eb\epsilon\epsilon, ee\epsilon\epsilon, c\epsilon\epsilon\epsilon, e\epsilon\epsilon\epsilon, b\epsilon\epsilon\epsilon\}$

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:

$G^+$ :  $\{\epsilon \epsilon c, \epsilon \epsilon \epsilon, \epsilon \epsilon a, \epsilon \epsilon b, \epsilon cb, \epsilon \epsilon \epsilon, \epsilon b\epsilon, \epsilon ab, aab, abb, aca, bbc, bca, bcb, caa, cac, cba, cbc, ab\epsilon, ba\epsilon, b \epsilon \epsilon, a \epsilon \epsilon\}$

1. acc
2. cabccacbbcba
3.  $\epsilon$
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.  $\varepsilon$
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:

$G^+$ :  $\{\times \times b, \times bd, aec, bca, bde, cae, cbc, dcb, ded, ecc, edc, cc\times, c \times \times\}$

1. aaa
2. d
3.  $\varepsilon$
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:

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

1. c
2.  $\varepsilon$
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:

$G^+ : \{\times a, \times \times, \times b, ab, ba, bb, a \times\}$

1. a
2. aaabbabb
3.  $\varepsilon$
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:

$G^- : \{aaba, addb, aebe, ddcc\}$

1. e
2.  $\varepsilon$
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:

$G^+ : \{\times a, \times e, ae, ba, ce, de, eb, ec, ed, ee, c\times, a\times\}$

1.  $\varepsilon$
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:

$G^+ : \{\times \times e, \times \times d, \times de, \times ee, \times d\times, adb, bdc, ceb, dbd, dce, dea, ead, eb\times, ee\times, b\times\times, e\times\times, d\times\times\}$

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:

$G^+ : \{\times \times b, \times \times \times, \times \times \times, \times b\times, \times bc, aaa, aab, aba, aca, bac, bca, caa, bc\times, aa\times, b\times\times, c\times\times, a\times\times\}$

1.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times \times d, \times \times bc, \times \times c\times, \times \times da, \times \times ce, \times ced, \times c\times, \times bc\times, \times dac, abcb, acdc, bcbd, cbdb, cdab, cdcd, dabc, dacd, dcda, ced\times, bdb\times, db\times, bc\times\times, ed\times\times, c\times\times\times, d\times\times\times, b\times\times\times\}$

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:

$G^+$ :  $\{\times \times \times d, \times \times \times e, \times \times eb, \times \times dc, \times \times ed, \times ebe, \times dc\times, \times edd, bccd, bedb, ccde, cdce, cebe, dbcc, dceb, ebed, edbc, eba\times, edd\times, dc\times, ba\times\times, dd\times\times, c\times\times\times, d\times\times\times, a\times\times\times\}$

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.  $\varepsilon$
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:

$G^+: \{\times \times \times c, \times \times \times e, \times \times e \times, \times \times eb, \times \times ec, \times \times cd, \times eca, \times cda, \times e \times \times, \times eb \times, aede, cdae, daed, deae, eaed, edea, eca \times, aed \times, eb \times \times, ed \times \times, ca \times \times, d \times \times \times, a \times \times \times, e \times \times \times, b \times \times \times\}$

1. cbccbbba
2. ddaca
3.  $\varepsilon$
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. caaacdcababa
3. cccbaac
4.  $\varepsilon$

**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.  $\varepsilon$
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:

$G^+ : \{\times b, bb, bc, cb, cc, c\times\}$

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:

$G^+ : \{\times\times\times a, \times\times aa, \times\times ab, \times aaa, \times abc, aaac, aaca, acac, cacb, abc\times, acb\times, bc\times, \times, cb\times\times, c\times\times\times, b\times\times\times\}$

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:

$G^+ : \{\times a, \times \times, \times c, aa, ab, ac, ba, bc, ca, cb, a \times, c \times\}$

1. bcabc
2.  $\varepsilon$
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.  $\varepsilon$

**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:

$G^+ : \{\times \times \times, \times \times b, \times ba, \times ca, abb, aca, bbb, bbc, bcc, cab, cac, cca, bb \times, ba \times, b \times \times, a \times \times\}$

1. bbcbaaa
2. bacbabaa
3. bbcc

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.  $\varepsilon$

**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:

$G^+: \{\times\times, \times c, aa, ab, ac, ba, ca, cb, b\times\}$

1. cbbab
2. c
3.  $\varepsilon$
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:

$G^+$ :  $\{\times \times b, \times \times \times, \times \times \times, \times ba, aaa, aab, aba, abb, baa, bab, bba, ab\times, b \times \times\}$

1. abab
2. bbaaaaaba
3.  $\varepsilon$
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:

$G^+$ :  $\{\times a, aa, ab, ac, ba, bb, ca, cc, a\times\}$

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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ba, \times \times b\times, \times \times \times \times, \times \times aa, \times aaa, \times bab, \times \times \times \times, \times b \times \times, aaab, aaba, abab, abba, baba, babb, bbab, bab\times, abb\times, ab \times \times, bb \times \times, b \times \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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:

$G^-: \{abaa, abba, acab, bccb, cbcb, cccc\}$

1. bababc
2. baccacaab
3.  $\varepsilon$
4. aaabbabcb

**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.  $\varepsilon$
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:

$G^+: \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times ac, \times ba, acb, adc, bca, cad, cbc, dc \times, ba \times, a \times \times, c \times \times\}$

1. cc
2. ba
3. dcacdbb
4.  $\varepsilon$

**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:

$G^+: \{\times \times \times b, \times \times \times \times, \times \times \times \times, \times \times bb, \times \times ba, \times \times b \times, \times b \times \times, \times bba, \times bab, \times \times \times \times, abbb, babb, bbba, bba \times, ba \times \times, a \times \times \times, b \times \times \times\}$

1. b
2. bba

3. abbab
4.  $\varepsilon$

**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:

$G^+ : \{\times d, bb, bc, cd, db, dc, c\times\}$

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.  $\varepsilon$
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:

$G^+: \{\bowtie a, \bowtie \bowtie, aa, ab, ba, bb, b\bowtie\}$

1. b
2.  $\varepsilon$
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. dcbbdbbc
4.  $\varepsilon$

**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:

$G^+ : \{\times b, aa, ab, ba, bb, b\times\}$

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:

$G^+ : \{\times a, \times\times, aa, ab, ba, bb, a\times\}$

1. bbab
2. a
3. aa
4.  $\varepsilon$

**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:

$G^+ : \{\text{XXXXc}, \text{XXXXb}, \text{XXcb}, \text{XXba}, \text{Xbaa}, \text{Xcbc}, \text{XbaX}, \text{aaab}, \text{aaba}, \text{abaa}, \text{baaa}, \text{bcaa}, \text{caaa}, \text{cbca}, \text{baaX}, \text{X}, \text{aaX}, \text{aXX}\}$

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:

$G^+ : \{\text{XXa}, \text{XXb}, \text{XX}, \text{XX}, \text{Xa}, \text{Xb}, \text{Xbab}, \text{Xa}, \text{X}, \text{X}, \text{X}, \text{abcb}, \text{bab}, \text{bacc}, \text{bcba}, \text{cbac}, \text{acc}, \text{cc}, \text{a}, \text{c}\}$

1. bcbc
2. ababcc
3. c
4.  $\varepsilon$

**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:

$G^+ : \{\text{Xa}, \text{ab}, \text{ba}, \text{bb}, \text{bX}\}$

1. baa
2. ab

3. babbbb
4.  $\varepsilon$

**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:

$G^+$ :  $\{\times \times a, \times \times b, \times b \times, \times ba, \times aa, aab, abb, baa, bab, bba, ab \times, aa \times, b \times \times, a \times \times\}$

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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times ba, \times \times ca, \times \times b \times, \times cac, \times bab, \times ba \times, \times b \times \times, aaca, abaa, baac, baba, aca \times, cac \times, ba \times \times, ac \times \times, ca \times \times, c \times \times \times, a \times \times \times, b \times \times \times\}$

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:

$G^+ : \{\times \times e, \times \times b, \times e \times, \times b d, aad, aba, add, baa, bde, cda, dab, ddb, dec, ecd, db \times, b \times \times, e \times \times\}$

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.  $\varepsilon$
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:

$G^+ : \{\times a, \times b, aa, ac, ba, bb, bc, cb, cc, a\times, b\times\}$

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:

$G^+ : \{\times \times \times b, \times \times \times \times, \times \times d, \times \times \times e, \times \times bb, \times \times ed, \times \times d\times, \times \times \times \times, \times ed\times, \times d \times \times, \times bbc, \times \times \times \times, addb, bbca, bcad, beea, cadd, dbee, ddbe, eea\times, ea \times \times, ed \times \times, d \times \times \times, a \times \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times c, \times \times a, \times \times b, \times \times \times, \times c \times, \times \times \times, \times bb, \times aa, aab, abb, baa, bba, bb \times, aa \times, b \times \times, a \times \times, c \times \times\}$

1. abbb
2.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times \times \times, \times \times \times \times, \times \times cc, \times \times ba, \times baa, \times cc \times, \times \times \times \times, aacc, abbc, acca, baac, bbca, bcaa, cabb, ccab, caa \times, cc \times \times, aa \times \times, c \times \times \times, a \times \times \times\}$

1.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times d, aa, ac, ad, ae, ca, ce, da, dc, ed, e \times\}$

1. cddecac
2. aeaccccedbda
3. ddcedbaceae
4. ebedbdcceadc

**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.  $\varepsilon$

**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:

$G^+ : \{\times \times e, \times \times c, \times cb, \times ee, adb, dad, eda, eed, db\times, cb\times, b \times \times\}$

1. cc
2.  $\varepsilon$
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.  $\varepsilon$

**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.  $\varepsilon$

**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:

$G^+ : \{\times \times a, \times \times c, \times \times \times, \times c \times, \times \times \times, \times ac, \times ab, aca, acb, bca, cab, cac, cbc, ab \times, b \times \times, c \times \times\}$

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

**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.  $\varepsilon$
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.  $\varepsilon$
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. abbbba
2. abbbbaabbabba
3. aaaaabaabab
4. bbaaaba

**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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times aa, \times \times ab, \times \times b\times, \times b \times \times, \times aaa, \times abb, aaaa, aaab, aaba, abb\times, aba\times, ba\times\times, bb\times\times, a\times\times\times, b\times\times\times\}$

1. bbaaba
2. b
3.  $\varepsilon$

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.  $\varepsilon$
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.  $\varepsilon$
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.  $\varepsilon$

**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. ccddb
3.  $\varepsilon$
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:

$G^+: \{\times \times a, \times \times b, \times a \times, \times bb, acc, bac, bba, cab, cca, ab \times, b \times \times, a \times \times\}$

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

**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:

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

1. dbbaccbcbbaac
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:

$G^+ : \{\times b, ac, ae, ba, bb, ca, ec, ee, c\times\}$

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:

$G^+ : \{\times a, ab, ba, bb, a\times\}$

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. eabcbdcbase
3. ddbceccce
4.  $\varepsilon$

**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:

$G^+ : \{\times\times, \times b, \times c, aa, ac, ba, cb, c\times, b\times\}$

1. acac
2.  $\varepsilon$
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:

$G^+ : \{\times\times a, \times\times d, \times dc, \times ac, acb, bcb, bdc, cbc, cbd, dca, dc\times, ca\times, a\times\times, c\times\times\}$

1. cddaa
2. ba
3.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+: \{\times \times \times a, \times \times a \times, \times \times ad, \times a \times \times, \times ade, aade, adea, deaa, eaad, ade \times, de \times \times, a \times \times \times, e \times \times \times\}$

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:

$G^+: \{\times b, aa, ab, ba, bb, b \times\}$

1. bab
2.  $\varepsilon$
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:

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

1. bbbbbb
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:

$G^+ : \{\times \times \times, \times \times a, \times \times b, \times ac, \times \times \times, \times bc, abb, acb, baa, bab, bba, bbb, bca, cac, cba, aa \times, ac \times, c \times \times, a \times \times\}$

1. bcac
2. ac
3.  $\varepsilon$
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:

$G^+$ :  $\{\times \times c, \times \times a, \times a \times, \times ca, ade, bbc, bcc, cad, ccb, dbb, ded, edb, cb \times, b \times \times, a \times \times\}$

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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times aa, \times \times \times \times, \times \times bb, \times aab, \times \times \times \times, \times bb \times, aaba, abaa, baab, aab \times, ab \times \times, bb \times \times, b \times \times \times\}$

1. bb
2.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times a, \times \times \times \times, \times \times \times d, \times \times dd, \times \times \times \times, \times \times a \times, \times a \times \times, \times ddc, \times \times \times \times, bada, bddb, cbdd, ccbd, dbad, dccb, ddba, ddcc, ada \times, da \times \times, a \times \times \times\}$

1. abdcbbab
2. a
3. abcc
4.  $\varepsilon$

**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.  $\varepsilon$
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.  $\varepsilon$

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.  $\varepsilon$
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.  $\varepsilon$
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:

$G^+$ :  $\{\times \times \times b, \times \times \times \times, \times \times b \times, \times \times \times \times, \times \times ba, \times bab, \times ba \times, \times \times \times \times, \times b \times \times, aaaa, abba, baaa, babb, bbaa, aaa \times, ba \times \times, aa \times \times, a \times \times \times, b \times \times \times\}$

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:

$G^+$ :  $\{\times \times c, \times \times b, \times b \times, \times ca, aab, aba, bac, caa, ac \times, ca \times, b \times \times, a \times \times, c \times \times\}$

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:

$G^+$ :  $\{\times d, ac, ad, bd, cb, da, db, dc, dd, c \times\}$

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:

$G^+ : \{\times \times a, \times \times b, \times \times \times, \times a \times, \times \times \times, \times ba, \times bb, aba, abb, baa, bab, bba, aa \times, ba \times, a \times \times\}$

1. bbbaaaa
2. aababb
3. bbbbbbba
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.  $\varepsilon$
2. bcc
3. cbcdbeac
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.  $\varepsilon$
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. bdc d
4. dbd

**SOLUTION TO EXERCISE 1000.**

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