

## 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

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. dabcdbed
3. dcdbacac
4.  $\varepsilon$

### Solution

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

### EXERCISE 3.

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

$G^- : \{aaac, abaa, abba, abbb, cabb, cbab\}$

1.  $\varepsilon$
2. b

3. bcccccca
4. bcaa

**Solution**

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

**EXERCISE 4.**

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

$G^-: \{aaaa, acba, adac, beca, cbdb, cecb, dacd, ebcd\}$

1. d
2. deddbed
3. baeeedd
4.  $\varepsilon$

**Solution**

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

**EXERCISE 5.**

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

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

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

**Solution**

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

**EXERCISE 6.**

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

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

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

**Solution**

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

**EXERCISE 7.**

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

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

1. acab
2. bbbdcbbba
3. d
4.  $\epsilon$

**Solution**

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

**EXERCISE 8.**

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

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

1.  $\epsilon$
2. cbab
3. e

4. bebbec

**Solution**

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

**EXERCISE 9.**

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

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

1.  $\varepsilon$
2. aabb
3. b
4. aab

**Solution**

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**

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:

$G^+$ :  $\{\epsilon, c, b, \epsilon, bc, cb, bcc, bcbc, bccb, bcdb, bddb, cbcd, cbdd, ccbd, dbcb, ddbc, cdc, dc, c, \epsilon\}$

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

**Solution**

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

**EXERCISE 12.**

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

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

1. bbabbab
2. aabaabbb
3.  $\epsilon$
4. baba

**Solution**

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**

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**

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**

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**

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**

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**

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**

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. bddada
3. caccbad
4. abba

**Solution**

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



**EXERCISE 21.**

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

$G^-: \{adab, cccb, cccc, dccc, dcdd\}$

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

**Solution**

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

**EXERCISE 22.**

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

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

1. bbbede
2. e
3.  $\varepsilon$
4. dea

**Solution**

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:

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

1. cbccbad
2.  $\varepsilon$

3. ccc
4. ba

**Solution**

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

**EXERCISE 24.**

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

$G^-: \{abc, acc, bad, cac, ccd, daa, dbb, dda\}$

1. dcbddbdd
2. bdccab
3.  $\varepsilon$
4. b

**Solution**

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

**EXERCISE 25.**

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

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

1. cbabbaba
2. bbbacad
3.  $\varepsilon$
4. bbacad

**Solution**

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:

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

1. cd
2. dca
3.  $\varepsilon$
4. a

**Solution**

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**

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:

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

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

**Solution**

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

**EXERCISE 29.**

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

$G^-: \{ba, bc, cb, da, dc, eb\}$

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

**Solution**

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

**EXERCISE 30.**

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

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

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

**Solution**

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**

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. aacdddc
4. b

**Solution**

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

**EXERCISE 33.**

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

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

1. bbbabaabaaab
2. bbaa
3. bbaababbb

4.  $\varepsilon$

**Solution**

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

**EXERCISE 34.**

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

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

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

**Solution**

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**

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**

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**

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**

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**

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**

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



**EXERCISE 41.**

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

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

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

**Solution**

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

**EXERCISE 42.**

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

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

1. d
2. ab
3. abbbe
4. bb

**Solution**

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**

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.  $\varepsilon$
2. bbcacbb
3. b
4. bcbbbbc

**Solution**

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

**EXERCISE 45.**

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

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

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

**Solution**

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

**EXERCISE 46.**

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

$G^-: \{abaa, bedd, cbbd, cbca, dbcb, eeec\}$

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

**Solution**

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

**EXERCISE 47.**

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

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

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

**Solution**

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

**EXERCISE 48.**

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

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

1. cabaca
2. bcbcb
3.  $\varepsilon$
4. aabcabb

**Solution**

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

**EXERCISE 49.**

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

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

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

**Solution**

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**

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

**EXERCISE 51.**

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

$G^-: \{aec, bae, bcc, cee, eae, eba\}$

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

**Solution**

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

**EXERCISE 52.**

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

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

1. eb
2.  $\epsilon$
3. aaeaedabd
4. bee

**Solution**

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

**EXERCISE 53.**

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

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

1.  $\epsilon$
2. a
3. dacb
4. dadcaa

**Solution**

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

**EXERCISE 54.**

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

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

1. cb
2.  $\epsilon$
3. dbddaee
4. b

**Solution**

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**

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

**EXERCISE 56.**

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

$G^-: \{aaa, aca, bac, bca, cba, ccc\}$

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

**Solution**

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

**EXERCISE 57.**

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

$G^-: \{aa, ab, ac, ba, bc, cb, cc\}$

1.  $\varepsilon$
2. cccbcbac
3. abcbcabbbb
4. cbbbacacc

**Solution**

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

**EXERCISE 58.**

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

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

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

**Solution**

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**

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**

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**

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**

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**

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:

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

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

**Solution**

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

**EXERCISE 65.**

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

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

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

**Solution**

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:

3.  $\varepsilon$
4. babbbaaaa

**Solution**

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

**EXERCISE 69.**

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

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

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

**Solution**

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**

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. cebbbcccebb
3. cbdbbee
4. e

**Solution**

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**

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

**EXERCISE 73.**

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

$G^-: \{aaaa, abab, abbb, baab, bbba, bbbb\}$

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

**Solution**

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

**EXERCISE 74.**

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

$G^-: \{acb, bab, bbb, bbc, cac, cba, cbc\}$

1. bccbbc
2.  $\varepsilon$
3. b
4. ccbaaca

**Solution**

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

**EXERCISE 75.**

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

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

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

**Solution**

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

**EXERCISE 76.**

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

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

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

**Solution**

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

**EXERCISE 77.**

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

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

1. bba
2.  $\varepsilon$
3. b
4. abbbab

**Solution**

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

**EXERCISE 78.**

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

$G^- : \{aaaa, aabb, abab, abbb, baab, bbbb\}$

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

**Solution**

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

**EXERCISE 79.**

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

$G^-: \{aa, bc, cc, cd, da, db, dc, dd\}$

1. bbc
2. abad
3. abbacab
4.  $\varepsilon$

**Solution**

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

**EXERCISE 80.**

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

$G^-: \{abb, abc, acc, bbc, cab, cbb, cbc, ccc\}$

1. cccc
2.  $\varepsilon$
3. aaca
4. b

**Solution**

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



**EXERCISE 81.**

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

$G^-: \{aad, abc, bbd, bda, bdc, dad, dcb, dcc\}$

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

**Solution**

1. Yes
2. Yes
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**

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**

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**

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

**EXERCISE 85.**

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

$G^- : \{cabe, cdaa, cdca, cddc, cecc, dddd\}$

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

**Solution**

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

**EXERCISE 86.**

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

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

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

**Solution**

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**

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:

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

1. cacb
2. bacccecca

3. aac
4. abcaabcb

**Solution**

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**

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**

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:

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

1. bbbbaa
2.  $\epsilon$
3. baaa
4. a

### Solution

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

**EXERCISE 92.**

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

$$G^-: \{abca, bbbc, bbcc, bcca, caaa, cbbb, ccbc, ccca\}$$

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

### Solution

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

**EXERCISE 93.**

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

$$G^-: \{aaa, aab, abb, baa, bab, bbb\}$$

1.  $\mathbf{bb}$
2.  $\mathbf{a}$
3.  $\mathbf{\varepsilon}$

4. b

**Solution**

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**

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**

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**

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**

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**

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:

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

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

**Solution**

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

**EXERCISE 100.**

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

$G^- : \{abab, abba, abbb, baba, babb, bbab, bbba\}$

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

**Solution**

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



**EXERCISE 101.**

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

$G^-: \{ab, bd, cc, dd\}$

1. ab
2. bcbddaba
3. acadb
4.  $\varepsilon$

**Solution**

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

**EXERCISE 102.**

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

$G^-: \{abe, bbb, ccb, ddb, dde, eca, eee\}$

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

**Solution**

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

**EXERCISE 103.**

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

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

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

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

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

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

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

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:

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

1. cbc
2.  $\varepsilon$
3. abcaac
4. c

**Solution**

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

**EXERCISE 107.**

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

$G^- : \{cdec, dbea, dcba, eebb\}$

1. cd
2. caedbdeeb
3.  $\varepsilon$
4. aaedbaeec

**Solution**

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

**EXERCISE 108.**

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

$G^- : \{aaa, abb, caa, cba, cbb, cca, ccb\}$

1. b
2. aac
3.  $\varepsilon$
4. ba

**Solution**

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

**EXERCISE 109.**

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

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

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

**Solution**

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**

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**

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. abcdecdbbc

**Solution**

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

**EXERCISE 113.**

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

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

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

**Solution**

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

**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**

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.  $\varepsilon$
3. abbbbabbb
4. a

**Solution**

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

**EXERCISE 116.**

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

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

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

**Solution**

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**

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:

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

1. abaaabb
2. bbbabbba
3.  $\varepsilon$
4. ababbbb

**Solution**

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**

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

**EXERCISE 120.**

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

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

1. acaccbcca
2. bcba
3.  $\varepsilon$
4. bca

**Solution**

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



**EXERCISE 121.**

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

$G^-: \{ae, de, ea, ec\}$

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

**Solution**

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

**EXERCISE 122.**

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

$G^-: \{abda, adcb, bccc, ccca, daab\}$

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

**Solution**

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

**EXERCISE 123.**

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

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

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

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

For each one of the strings below say whether it is generated by the following

positive 4-gram grammar:

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

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

For each one of the strings below say whether it is generated by the following

positive 4-gram grammar:

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

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**

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**

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:

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

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

**Solution**

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:

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

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

**Solution**

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

**EXERCISE 130.**

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

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

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

**Solution**

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

**EXERCISE 131.**

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

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

1. bbb
2.  $\varepsilon$
3. ca
4. abcc

**Solution**

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**

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.  $\varepsilon$
2. cabc
3. accb
4. bbbaa

**Solution**

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

**EXERCISE 134.**

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

$G^-: \{abab, abba, baaa, baab, baba\}$

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

**Solution**

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

**EXERCISE 135.**

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

$G^-: \{acdc, addb, bddd, cbbb, dbdc, ddca\}$

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

**Solution**

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

**EXERCISE 136.**

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

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

1. abbabaaba
2.  $\varepsilon$
3. baaabaab
4. bbbb

**Solution**

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

**EXERCISE 137.**

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

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

1. dabbbca
2. c
3.  $\varepsilon$
4. abdbc

**Solution**

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

**EXERCISE 138.**

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

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

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

**Solution**

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

**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.  $\varepsilon$
3. bdadcdaad
4. b

**Solution**

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

**EXERCISE 140.**

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

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

1.  $\varepsilon$
2. eadb
3. eadbaebeaa
4. dedb

**Solution**

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**

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**

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. aabbbbb
2.  $\varepsilon$
3. babb
4. b

**Solution**

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:

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

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

**Solution**

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

**EXERCISE 145.**

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

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

1.  $\varepsilon$
2. ababdabc
3. b
4. ddb

**Solution**

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

**EXERCISE 146.**

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

$G^-: \{aaa, aab, abb, baa, bba\}$

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

**Solution**

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

**EXERCISE 147.**

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

$G^-: \{aa, ba, bd, ca, dc\}$

1. cddbdc
2. ddd
3.  $\varepsilon$
4. bba

**Solution**

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

**EXERCISE 148.**

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

$G^-: \{aaa, abb, bbc, cca, ccc\}$

1. cbacab
2.  $\varepsilon$
3. aacacab
4. b

**Solution**

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**

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**

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**

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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times bc, \times \times ca, \times bca, \times cab, aaaa, aaab, aabc, abcd, bcaa, bcda, caaa, cdaa, cab\times, da\times\times, aa\times\times, a\times\times\times, b\times\times\times\}$

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

**Solution**

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

**EXERCISE 153.**

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

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

1. abaaaa
2. ba
3. bbbbbbba

4. bbbbababb

**Solution**

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:

$G^+ : \{\times\times, \times c, aa, ac, ad, ca, cd, da, d\times\}$

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

**Solution**

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

**EXERCISE 155.**

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

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

1. abc
2. acacaaa
3. bbbacc
4.  $\varepsilon$

**Solution**

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

**EXERCISE 156.**

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

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

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

### Solution

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

**EXERCISE 157.**

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

$$G^-: \{ab, ac, ba, bc, cb\}$$

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

### Solution

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

**EXERCISE 158.**

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

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

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

**Solution**

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**

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:

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

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

**Solution**

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



**EXERCISE 161.**

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

$G^-: \{aa, ba, bd, cd, db, dc, dd\}$

1.  $\varepsilon$
2. accaddc
3. bcac
4. ddacdbada

**Solution**

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

**EXERCISE 162.**

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

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

1. bc
2. bab
3.  $\varepsilon$
4. aa

**Solution**

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**

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.  $\epsilon$
4. acd

**Solution**

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

**EXERCISE 165.**

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

$G^- : \{ad, ca, cc, db\}$

1. ea
2.  $\epsilon$
3. dbaea
4. abb

**Solution**

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

**EXERCISE 166.**

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

$G^-: \{bbc, bcb, bda, bdb, cbd, ccc, dad, dcc\}$

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

**Solution**

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

**EXERCISE 167.**

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

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

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

**Solution**

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

**EXERCISE 168.**

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

$G^-: \{abcb, beba, cbdb, cddc, ceed, ceee, dcba, eadb\}$

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

**Solution**

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

**EXERCISE 169.**

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

$G^-: \{acab, babb, bcbb, bcca, ccca\}$

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

**Solution**

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

**EXERCISE 170.**

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

$G^-: \{abc, acb, dab, dad, ddb\}$

1. b
2. ccdaccdca
3.  $\varepsilon$
4. aadcacba

**Solution**

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

**EXERCISE 171.**

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

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

1. dcbbad
2. bccc
3.  $\varepsilon$
4. dcab

**Solution**

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

**EXERCISE 172.**

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

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

1. ca
2. dbdc
3.  $\varepsilon$
4. ddadcdbca

**Solution**

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

**EXERCISE 173.**

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

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

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

**Solution**

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:

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

1. bbbbb
2. aba
3. bbaa
4.  $\varepsilon$

**Solution**

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

**EXERCISE 175.**

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

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

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

**Solution**

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**

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:

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

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

**Solution**

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

**EXERCISE 178.**

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

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

1. baaaba
2. bb
3. baaab

4. abbaabaaa

**Solution**

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.  $\varepsilon$
3. b
4. dcbccdabd

**Solution**

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

**EXERCISE 180.**

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

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

1.  $\varepsilon$
2. b
3. aabba
4. aaa

**Solution**

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



**EXERCISE 181.**

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

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

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

**Solution**

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

**EXERCISE 182.**

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

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

1. acedede b
2. bbd
3. ddbecae
4. cca

**Solution**

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

**EXERCISE 183.**

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

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

1. ac
2. accca
3.  $\varepsilon$
4. acbbbc

**Solution**

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

**EXERCISE 184.**

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

$G^-: \{acd, bce, bda, cab, cad, ddb, deb\}$

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

**Solution**

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

**EXERCISE 185.**

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

$G^+: \{\varepsilon, a, c, ac, ca, cb, acb, cba, abca, babc, bbcb, bcab, bcba, cabc, cbab, cbbc, abc, ac, bc, c, a\}$

1. ac
2.  $\varepsilon$
3. cbbcba
4. ccbbcbabc

**Solution**

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

**EXERCISE 186.**

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

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

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

**Solution**

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

**EXERCISE 187.**

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

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

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

**Solution**

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

**EXERCISE 188.**

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

$G^-: \{ab, ba, bb, db, dc, ec, ed\}$

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

**Solution**

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

**EXERCISE 189.**

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

$G^-: \{aaaa, aaab, aabb, babb, bbaa, bbab, bbba\}$

1. aabbaa
2.  $\varepsilon$
3. babaab
4. bbbb

**Solution**

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

**EXERCISE 190.**

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

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

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

**Solution**

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**

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**

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:

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

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

**Solution**

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

**EXERCISE 194.**

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

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

1. ebaeceda
2. daaaaaccac
3.  $\varepsilon$
4. deada

**Solution**

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

**EXERCISE 195.**

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

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

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

**Solution**

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

**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**

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.  $\epsilon$
3. aab
4. babaab

**Solution**

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

**EXERCISE 198.**

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

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

1. ceae
2. aaccca
3. aedbb
4. beeede

**Solution**

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

**EXERCISE 199.**

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

$G^-: \{ab, ac, ad, bc, da\}$

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

**Solution**

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

**EXERCISE 200.**

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

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

1. d
2.  $\varepsilon$
3. b
4. da

**Solution**

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**

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**

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**

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**

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

**EXERCISE 205.**

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

$G^- : \{aa, ab, ac, ba, bb\}$

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

**Solution**

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

**EXERCISE 206.**

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

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

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

**Solution**

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.  $\varepsilon$

**Solution**

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

**EXERCISE 208.**

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

$G^-$ :  $\{aaba, acba, bbba, cbba\}$

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

**Solution**

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

**EXERCISE 209.**

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

$G^-: \{abdb, baaa, bbbd, bcbb, cdbc, cddc, dbdb, dcad\}$

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

**Solution**

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

**EXERCISE 210.**

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

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

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

**Solution**

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. bc bc
3.  $\varepsilon$
4. caaac

**Solution**

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

**EXERCISE 212.**

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

$G^+ : \{\times \times \times a, \times \times ab, \times \times a \times, \times a \times \times, \times abc, abca, abcb, bcab, bcbb, cab c, cbb \times, bb \times \times, a \times \times \times, b \times \times \times\}$

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

**Solution**

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

**EXERCISE 213.**

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

$G^- : \{ba, bd, ca, cd\}$

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

**Solution**

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

**EXERCISE 214.**

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

$G^-: \{ac, ad, bd, dd\}$

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

**Solution**

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

**EXERCISE 215.**

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

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

1.  $\varepsilon$
2. eabcccb
3. baddcabece
4. adbbcaad

**Solution**

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**

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**

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**

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**

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.  $\varepsilon$
3. b
4. abbb

**Solution**

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**

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. abbbcbeebabb
2. bedbcbadae
3.  $\varepsilon$
4. abcaeeeb

**Solution**

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

**EXERCISE 223.**

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

$G^-: \{aabb, abaa, abbb, babb, bbab, bbbb\}$

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

**Solution**

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

**EXERCISE 224.**

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

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

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

**Solution**

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

**EXERCISE 225.**

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

$G^- : \{aaab, aaba, abbb, baaa, babb, bbaa, bbbb\}$

1. ababa
2. bbaaab
3.  $\varepsilon$
4. bbaaa

**Solution**

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

**EXERCISE 226.**

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

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

1.  $\epsilon$
2. ab
3. badbad
4. bd

**Solution**

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**

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**

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

**EXERCISE 229.**

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

$G^-: \{abab, abba, baaa, baab, babb\}$

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

**Solution**

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

**EXERCISE 230.**

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

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

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

**Solution**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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. bcbb
4. a

**Solution**

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

**EXERCISE 247.**

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

$G^-: \{ab, bd, cb, cc, dd\}$

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

**Solution**

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

**EXERCISE 248.**

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

$G^-: \{ab, ac, bd, ca, cd, db, dd\}$

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

**Solution**

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

**EXERCISE 249.**

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

$G^-: \{aacb, abac, accb, baaa, bbac, bbbb, cacc, cbab\}$

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

**Solution**

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

**EXERCISE 250.**

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

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

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

**Solution**

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

**EXERCISE 251.**

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

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

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

**Solution**

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

**EXERCISE 252.**

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

$G^- : \{abc, aca, bab, bcb, caa, cca\}$

1. b
2. caabbc
3.  $\varepsilon$
4. cba

**Solution**

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

**EXERCISE 253.**

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

$G^- : \{ce, db, dc, ec\}$

1. caacbdbedab
2.  $\varepsilon$
3. cbdacadd
4. a

**Solution**

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

**EXERCISE 254.**

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

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

1. dcbc
2.  $\varepsilon$
3. bbcbaaab
4. baabbb

**Solution**

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

**EXERCISE 255.**

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

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

1. cabcabba
2.  $\varepsilon$
3. ca
4. ccacca

**Solution**

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**

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:

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

1.  $\varepsilon$
2. b
3. bdbabac
4. dabd

**Solution**

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

**EXERCISE 258.**

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

$G^- : \{aadb, bacc, bcac, bdbd, dcca\}$

1.  $\varepsilon$
2. dcccc
3. d
4. bbabaaad

**Solution**

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

**EXERCISE 259.**

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

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

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

**Solution**

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

**EXERCISE 260.**

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

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

1.  $\varepsilon$
2. abbbb
3. aa
4. bb

**Solution**

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**

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:

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

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

**Solution**

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

**EXERCISE 263.**

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

$G^-: \{ab, ac, ba, bb, cb, cc\}$

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

4. b

**Solution**

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

**EXERCISE 264.**

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

$G^-: \{baaa, baab, baba, babb, bbaa, bbba, bbbb\}$

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

**Solution**

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

**EXERCISE 265.**

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

$G^-: \{abcc, adad, bdaa, dacb, dbbc\}$

1. dcddcb
2. bdb
3.  $\varepsilon$
4. c

**Solution**

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.  $\varepsilon$
4. a

**Solution**

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

**EXERCISE 267.**

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

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

1.  $\varepsilon$
2. bbabba
3. bba
4. aab

**Solution**

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

**EXERCISE 268.**

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

$G^-: \{aaa, caa, dcc, dda\}$

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

**Solution**

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

**EXERCISE 269.**

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

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

1. dde
2. aebdbbcbdb
3.  $\varepsilon$
4. cebbaebd

**Solution**

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

**EXERCISE 270.**

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

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

1.  $\varepsilon$
2. badddbbbdba
3. dcba
4. cddaaabbc

**Solution**

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**

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**

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:

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

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

**Solution**

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

**EXERCISE 274.**

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

$G^-: \{ba, bb, bc, bd, da, db, dc\}$

1. b
2.  $\varepsilon$
3. bcaa
4. abdbcca

**Solution**

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

**EXERCISE 275.**

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

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

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

**Solution**

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

**EXERCISE 276.**

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

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

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

**Solution**

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

**EXERCISE 277.**

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

$G^-: \{baac, bbba, bcab, bcba, bccc, cccc\}$

1. abca
2.  $\epsilon$
3. aababbbb
4. bcbabca

**Solution**

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

**EXERCISE 278.**

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

$G^-: \{bba, bdb, dde, edd\}$

1. e
2. cb
3. cbaeebccac
4.  $\epsilon$

**Solution**

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

**EXERCISE 279.**

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

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

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

**Solution**

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.  $\epsilon$
4. abdde

**Solution**

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.  $\epsilon$
4. adaecac

**Solution**

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

**EXERCISE 282.**

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

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

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

**Solution**

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.  $\epsilon$
3. abbb

4. baaba

**Solution**

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

**EXERCISE 284.**

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

$G^-: \{aa, ca, cb, cc, cd, da, dd\}$

1. e
2. aaedddc
3.  $\varepsilon$
4. c

**Solution**

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

**EXERCISE 285.**

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

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

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

**Solution**

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**

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**

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**

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:

$G^+ : \{\text{xxxa}, \text{xxxc}, \text{xxxx}, \text{xxab}, \text{xxcx}, \text{xxae}, \text{xxxx}, \text{xcxx}, \text{xabx}, \text{xx}\text{xx}, \text{x}aee, aeed, dded, edde, eedd, dedx, abxx, edxx, cxxx, dxxx, bxxx\}$

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

**Solution**

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

**EXERCISE 290.**

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

$G^+ : \{\text{xc}, ae, ba, cd, db, dd, ec, dx\}$

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

**Solution**

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**

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. dcabdcabdd
3. bcdabc
4. baabbabaacc

**Solution**

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

**EXERCISE 293.**

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

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

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

**Solution**

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

**EXERCISE 294.**

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

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

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

**Solution**

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

**EXERCISE 295.**

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

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

1. b
2.  $\epsilon$
3. bbbbcbbcac
4. bb

**Solution**

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

**EXERCISE 296.**

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

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

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

**Solution**

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

**EXERCISE 297.**

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

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

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

**Solution**

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. dcbbcdcbbc

2. a
3. ddccacac
4. dbdda

**Solution**

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

**EXERCISE 299.**

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

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

1.  $\varepsilon$
2. aabc
3. bbbb
4. dbb

**Solution**

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

**EXERCISE 300.**

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

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

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

**Solution**

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



**EXERCISE 301.**

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

$G^-: \{aba, ada, cab, cda, dca, ddb\}$

1. d
2.  $\varepsilon$
3. ddd
4. cac

**Solution**

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

**EXERCISE 302.**

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

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

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

**Solution**

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:

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

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

4. d

**Solution**

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

**EXERCISE 304.**

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

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

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

**Solution**

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**

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**

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**

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**

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**

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**

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

**EXERCISE 311.**

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

$G^-: \{aa, ab, ae, cc, da, dd, ed\}$

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

**Solution**

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

**EXERCISE 312.**

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

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

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

**Solution**

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

**EXERCISE 313.**

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

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

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

4. aaaabab

**Solution**

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

**EXERCISE 314.**

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

$G^-: \{aa, ac, ad, bb, cc, da, db, dc\}$

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

**Solution**

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

**EXERCISE 315.**

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

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

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

**Solution**

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

**EXERCISE 316.**

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

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

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

**Solution**

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

**EXERCISE 317.**

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

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

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

**Solution**

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

**EXERCISE 318.**

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

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

1. ddc b
2. ccddacbbcb
3. aacbacd

4. abbbdbbc

**Solution**

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:

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

1. acba
2.  $\varepsilon$
3. caabdcaabd
4. addcbbbbd

**Solution**

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**

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**

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**

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:

$G^-: \{aaac, bbba, bbca, bbcc, caab, cdab, dbab\}$

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

**Solution**

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

**EXERCISE 324.**

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

$G^+ : \{\times \times \times c, \times \times \times b, \times \times cb, \times \times bb, \times bbb, \times cb \times, aaea, aeae, baae, bbaa, bbba, eaee, aee \times, ee \times \times, cb \times \times, e \times \times \times, b \times \times \times\}$

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

**Solution**

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.  $\epsilon$
4. c

**Solution**

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

**EXERCISE 326.**

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

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

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

**Solution**

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

**EXERCISE 327.**

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

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

1.  $\epsilon$
2. ccadaa
3. c
4. cdbcb

**Solution**

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

**EXERCISE 328.**

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

$G^-$ :  $\{aacb, aada, accd, addb, dacd, dbcc\}$

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

**Solution**

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

**EXERCISE 329.**

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

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

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

**Solution**

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

**EXERCISE 330.**

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

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

1. dacab
2.  $\varepsilon$
3. dac
4. cacd

**Solution**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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.  $\varepsilon$
3. bbbccc
4. aabbab

**Solution**

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

**EXERCISE 344.**

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

$G^-: \{abba, abca, acaa, bbaa, bbab, cabc, cccb\}$

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

**Solution**

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

**EXERCISE 345.**

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

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

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

**Solution**

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

**EXERCISE 346.**

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

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

1.  $\epsilon$
2. bababbb
3. bbabab
4. bbb

**Solution**

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

**EXERCISE 347.**

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

$G^-$ :  $\{adb, bcd, bda, bdb, cbb, cdb, dca, dcc\}$

1.  $\epsilon$
2. ba
3. b
4. dbdd

**Solution**

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

**EXERCISE 348.**

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

$G^-$ :  $\{aac, abb, bca, bcb, bcc, caa, cca, ccb\}$

1. aacc
2. bcbabcaabcca
3. ccc
4. acaccbbacaa

**Solution**

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

**EXERCISE 349.**

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

$G^-: \{aaaa, abbc, baab, cabb, caca, ccaa\}$

1. b
2.  $\varepsilon$
3. aabcacbbcccb
4. acccaaabcb

**Solution**

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

**EXERCISE 350.**

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

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

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

**Solution**

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

**EXERCISE 351.**

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

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

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

**Solution**

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

**EXERCISE 352.**

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

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

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

**Solution**

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. cdbbcd

**Solution**

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

**EXERCISE 354.**

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

$G^-: \{ba, bc, db, dc, eb, ed, ee\}$

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

**Solution**

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**

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**

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**

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:

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

1. ebcdcdccba

2.  $\varepsilon$
3. ba
4. aeeddeabddcb

**Solution**

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

**EXERCISE 359.**

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

$G^-: \{aaa, aba, abb, bba, bbc, cbb, cca, ccc\}$

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

**Solution**

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**

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**

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. cbcdbccccb
3.  $\varepsilon$
4. c

**Solution**

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

**EXERCISE 363.**

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

$G^-: \{aada, abac, abdb, bbac, cbbb, daca\}$

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

**Solution**

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

**EXERCISE 364.**

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

$G^-: \{acb, bac, bbb, bbc, cbb\}$

1.  $\varepsilon$
2. c
3. accabbc
4. cacca

**Solution**

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:

$G^-: \{aca, add, beec, cacc, cccd, dccd\}$

1. ddedea
2.  $\varepsilon$
3. e
4. bacdbcaa

**Solution**

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

**EXERCISE 366.**

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

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

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

**Solution**

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:

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

1. eaaadeceddc
2.  $\varepsilon$
3. baaede
4. abc

**Solution**

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

**EXERCISE 368.**

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

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

1. dbdeea
2. d

3. edaaa
4. cb

**Solution**

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

**EXERCISE 369.**

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

$G^-: \{abba, abbc, acab, ccbc\}$

1. aaccbac
2. caciaabc
3. aaabb
4. c

**Solution**

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

**EXERCISE 370.**

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

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

1. ebcc
2. eb
3.  $\varepsilon$
4. eeeb

**Solution**

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

**EXERCISE 371.**

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

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

1.  $\varepsilon$
2. aaba
3. bbaba
4. bbbabb

**Solution**

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**

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**

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**

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**

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**

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**

1. Yes

2. Yes

3. Yes

4. Yes

**EXERCISE 378.**

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

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

1. aabbabb

2. bba
3. abbbbab
4. aba

**Solution**

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

**EXERCISE 379.**

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

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

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

**Solution**

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

**EXERCISE 380.**

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

$G^-$ :  $\{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. bbbaababbb
2. aaaabbbbb
3. abaab
4. aaabbbaaa

**Solution**

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



**EXERCISE 381.**

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

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

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

**Solution**

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

**EXERCISE 382.**

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

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

1. d
2.  $\epsilon$
3. cdc
4. ccaba

**Solution**

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

**EXERCISE 383.**

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

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

1. bbbdca
2. cbadaacab

3. cb
4. cdddbdd

**Solution**

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

**EXERCISE 384.**

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

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

1.  $\epsilon$
2. babcaacb
3. bbbccb
4. cab

**Solution**

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

**EXERCISE 385.**

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

$G^-$ :  $\{aabb, aadb, bbab, bbbb, dada, dbad\}$

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

**Solution**

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

**EXERCISE 386.**

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

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

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

**Solution**

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

**EXERCISE 387.**

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

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

1. cc
2. bdbbabda
3.  $\varepsilon$
4. c

**Solution**

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

**EXERCISE 388.**

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

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

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

**Solution**

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

**EXERCISE 389.**

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

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

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

**Solution**

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

**EXERCISE 390.**

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

$G^-$ :  $\{aaa, aab, aba, bab\}$

1. b
2. abbaa
3. a
4. ba

**Solution**

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

**EXERCISE 391.**

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

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

1. bcddcbad
2. b
3. ab
4. ccc

**Solution**

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

**EXERCISE 392.**

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

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

1.  $\varepsilon$
2. abbb
3. a
4. ab

**Solution**

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

**EXERCISE 393.**

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

$G^- : \{bda, dce, dee, eaa, ebc\}$

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

**Solution**

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

**EXERCISE 394.**

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

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

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

**Solution**

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

**EXERCISE 395.**

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

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

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

**Solution**

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.  $\epsilon$
2. a
3. d
4. cbbb

**Solution**

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

**EXERCISE 397.**

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

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

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

**Solution**

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

**EXERCISE 398.**

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

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

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

**Solution**

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**

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:

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

1.  $\varepsilon$
2. ddaebe
3. e
4. c

**Solution**

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



**EXERCISE 401.**

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

$G^-: \{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. bbb
2.  $\epsilon$
3. bababab
4. baaabbbabb

**Solution**

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

**EXERCISE 402.**

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

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

1. cb
2. bb
3. babbaa
4. b

**Solution**

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

**EXERCISE 403.**

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

$G^-: \{abdc, bbac, bccb, bccd, bcde, ccdb, dbbc\}$

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

**Solution**

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**

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**

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**

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:

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

1. dceabe
2.  $\varepsilon$
3. cabac
4. cececcd

**Solution**

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

**EXERCISE 408.**

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

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

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

4. b

**Solution**

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

**EXERCISE 409.**

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

$G^-: \{aa, ba, cc, cd, ce, dd, eb, ec\}$

1. acdddeaa
2. ac
3. badbdedd
4.  $\varepsilon$

**Solution**

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

**EXERCISE 410.**

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

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

1. bbabaa
2. aabbabbbba
3. aaaa
4. aba

**Solution**

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**

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**

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**

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**

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**

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**

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.  $\varepsilon$
2. ccbedca
3. a
4. cceedd

**Solution**

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

**EXERCISE 418.**

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

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

1. ba
2. babb
3. ac
4.  $\varepsilon$

**Solution**

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

**EXERCISE 419.**

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

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

1. cbc
2. b
3.  $\epsilon$
4. aaca

**Solution**

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

**EXERCISE 420.**

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

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

1. c
2. ecc
3. dccbdb
4. dec

**Solution**

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**

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**

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**

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.  $\epsilon$
2. ccca
3. bbabcab
4. aba

**Solution**

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

**EXERCISE 425.**

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

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

1. ccabbbcc
2. ba
3. cababaccc
4. cabccaaaa

**Solution**

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:

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

1.  $\varepsilon$
2. caba
3. b
4. acabbabc

**Solution**

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

**EXERCISE 427.**

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

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

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

**Solution**

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

**EXERCISE 428.**

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

$G^-: \{acdb, badc, bcaa, cbda, cbdb, ddbc\}$

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

**Solution**

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

**EXERCISE 429.**

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

$G^-: \{abe, acb, adc, cca, edb, eea, eed, eee\}$

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

**Solution**

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

**EXERCISE 430.**

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

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

1. ea
2. cdbe
3. aaeabc
4. c

**Solution**

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**

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:

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

1. c
2. bcccd dbbbab
3. aac
4. ddd

**Solution**

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

**EXERCISE 433.**

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

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

1. a

2. ab
3. aaaabaaa
4. abb

**Solution**

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

**EXERCISE 434.**

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

$G^-: \{aab, acb, acc, bab, bac, cab, cbb, ccb\}$

1. ca
2. abc
3. bbbabbcba
4.  $\varepsilon$

**Solution**

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

**EXERCISE 435.**

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

$G^-: \{aaab, aaba, aabb, abaa, abab, abba, baab, bbba\}$

1. b
2. bbb
3. aaab
4.  $\varepsilon$

**Solution**

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

**EXERCISE 436.**

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

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

1. dddaddbacd
2. bdbcd bcd
3. bb
4.  $\varepsilon$

**Solution**

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

**EXERCISE 437.**

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

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

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

**Solution**

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

**EXERCISE 438.**

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

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

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

4. bababaaaa

**Solution**

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

**EXERCISE 439.**

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

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

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

**Solution**

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.  $\epsilon$
4. c

**Solution**

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



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

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:

**Solution**

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

**EXERCISE 444.**

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

$G^+ : \{\epsilon \epsilon c, \epsilon \epsilon b, \epsilon c \epsilon, \epsilon bb, bbc, bcb, cbb, bc \epsilon, c \epsilon \epsilon\}$

1. c
2. bbbcac
3.  $\epsilon$
4. bab

**Solution**

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

**EXERCISE 445.**

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

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

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

**Solution**

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:

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

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

**Solution**

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**

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**

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**

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:

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

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

**Solution**

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.  $\varepsilon$
4. cc

**Solution**

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

**EXERCISE 452.**

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

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

1.  $\varepsilon$
2. c
3. b
4. aa

**Solution**

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

**EXERCISE 453.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+: \{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times \times b, \times \times bc, \times \times cb, \times \times ac, \times \times \times \times, \times bcb, \times acd, \times cb \times, \times \times \times \times, acda, adcd, cdad, dadc, bcb \times, dcd \times, cd \times \times, cb \times \times, d \times \times \times, b \times \times \times\}$

1. b
2. cb
3.  $\varepsilon$

4. babca

**Solution**

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**

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:

$G^+ : \{\times a, ad, ba, bb, cb, cc, dc, dd, de, ec, c \times\}$

1. abbb
2. adc
3. e
4. adec

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 456.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{bb, ca, cd, dd\}$

1. dbbadbbcabd
2. b
3. dacbbaccda
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 457.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times\times, \times b, aa, ab, ba, a\times\}$

1. aaaba
2. aa
3. ab
4.  $\varepsilon$

**Solution**

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**

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**

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. aabbddccaa

**Solution**

1. Yes
2. Yes
3. Yes
4. No



**EXERCISE 461.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, abb, baa, bab, bba\}$

1. b
2. bbbbaa
3.  $\varepsilon$
4. aa

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 462.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ac, ad, bb, bd, cb, cd\}$

1. d
2. dccbd
3. bdadaadab
4. cbad

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 463.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\bowtie \bowtie d, \bowtie \bowtie b, \bowtie dd, \bowtie bc, aca, cad, dac, dda, bc\bowtie, ad\bowtie, d \bowtie \bowtie, c \bowtie \bowtie\}$

1. dbdadab
2. badc
3. dc
4. abae

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 464.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times a, \times \times \times \times, \times \times \times d, \times \times db, \times \times \times \times, \times \times aa, \times aa \times, \times dbb, \times \times \times \times, acdc, bbca, bcac, cacd, cdcd, dbbc, dcd \times, cd \times \times, aa \times \times, d \times \times \times, a \times \times \times\}$

1. aa
2.  $\varepsilon$
3. cbdbabb
4. acbadcaa

**Solution**

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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times cc, \times \times b \times, \times ccb, \times b \times \times, \times, abea, aecd, babe, beae, cbab, ccba, eaec, ecda, cda \times, da \times \times, a \times \times \times, b \times \times \times\}$

1. aedaaadae
2. bbb
3. b
4. ecacbacccd

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 466.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaac, baab, cbba, cccb\}$

1. babba
2. cac
3. abacab
4. ca

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 467.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaaa, aaab, abaa, abba, baaa, baab, babb\}$

1. baa
2. aababaabaa
3. abaa
4. aababbb

**Solution**

1. Yes
2. No
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**

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:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times c \times, \times \times cb, \times \times ac, \times \times \times \times, \times acb, \times c \times \times, \times cb \times, \times \times \times \times, acbb, bbcb, bcbc, cbbc, cbc b, bcb \times, cb \times \times, c \times \times \times, b \times \times \times\}$

1. acaab
2.  $\epsilon$
3. cababa
4. acacac

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 470.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-$ :  $\{aac, acd, bab, bac, bca, cdb, dcd\}$

1.  $\epsilon$
2. a
3. abcd dba
4. b

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 471.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ac, bc, cd, db\}$

1. adadaccd
2.  $\varepsilon$
3. dadccddcbdad
4. bccdbd

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 472.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, abd, adc, bbb, cbd, cdd, dba, dca\}$

1.  $\varepsilon$
2. a
3. cbc
4. b

**Solution**

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**

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**

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**

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**

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**

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:

$G^+ : \{\times \times \times b, \times \times \times d, \times db, \times bc, \times bb, \times bbc, \times bc\times, \times dbd, bbcd, bcdd, bddb, cddb, dbcd, dbdd, ddbc, ddbd, cdc\times, dbd\times, dc\times, \times bd \times \times, bc \times \times, c \times \times \times, d \times \times \times\}$

1. addbdbdddb
2. dbbcbcba
3. dabb

4. cadadda

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 479.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aac, bcc, bda, bdd, cba, dab, ddb\}$

1. b
2. bdbddddca
3.  $\varepsilon$
4. dc

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 480.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaaa, aaab, aaba, aabb, baab, baba, bbba\}$

1. baabab
2. bbaa
3. bab
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. Yes
4. Yes



**EXERCISE 481.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aac, abc, bca, cba, cbb\}$

1. cbac
2. ba
3. bab
4. babccbca

**Solution**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 482.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ab, ac, bb, ca, cb, cc\}$

1.  $\varepsilon$
2. abcbccccacb
3. b
4. a

**Solution**

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:

$G^+: \{\times \times b, \times b \times, \times ba, aab, aad, abd, add, baa, bda, daa, dd \times, b \times \times, d \times \times\}$

1. bbd
2. ccadcbda
3.  $\varepsilon$
4. aabab

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 484.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times e, \times eb, bdb, bdd, dbc, dbd, ddb, ddd, ebd, bc\times, c \times \times\}$

1. aeed
2. ebdbc
3. ee
4. c

**Solution**

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**

1. No
2. No
3. No
4. No

**EXERCISE 486.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ad, ba, bb, ca, db, dd\}$

1. bbca
2. abbdccddac
3. a
4. acabcaddbc

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 487.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times c, \times \times a, \times \times \times, \times \times \times, \times cc, \times aa, aad, adc, ccc, ccd, cdd, dcc, dcd, ddc, cc \times, cd \times, d \times \times, c \times \times\}$

1. bbababdac
2. acdc
3.  $\varepsilon$
4. caabab

**Solution**

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**

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**

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**

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**

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**

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. bbcd d
2. bdac b
3.  $\varepsilon$
4. aca

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 494.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaaa, aabb, abaa, abba, babb, bbab, bbba, bbbb\}$

1.  $\varepsilon$
2. abbbbba
3. baabaabbb
4. bbbbababbbaa

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 495.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{abd, adb, ceb, daa, dba\}$

1. cecaaadaab
2. cecdbbdebd
3. ecaecbbbab
4. ebc

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 496.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times b, \times \times \times, \times \times \times, \times b \times, \times ba, aab, aba, abb, baa, bab, bba, bbb, bb \times, b \times \times\}$

1. babb
2. b
3.  $\varepsilon$
4. abaaab

**Solution**

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**

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. bcacccbaa
3. bbbcbaca

4. c

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 499.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times \times b, \times ab, \times b\times, \times ba, aab, aba, abb, baa, bba, bbb, ba\times, b\times\times, a\times\times\}$

1. baaaaaba
2. b
3. aabba
4. a

**Solution**

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**

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**

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**

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:

$G^+ : \{\times \times a, \times ac, abd, acb, bab, bba, cbb, bd \times, d \times \times\}$

1. ccacc
2. abbddae
3.  $\varepsilon$
4. edeba

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 504.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{acde, baab, bbdd, ceab, ebdc\}$

1. e
2. cbebdb
3. eeaccba
4.  $\varepsilon$

**Solution**

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**

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**

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**

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**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 509.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{baa, bca, cab, cbc, cca\}$

1. ccbaab
2. acabbcccc
3. acc
4. bcaccaa

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 510.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times a, \times \times b, \times a \times, \times ba, aaa, aab, aba, baa, bab, ab \times, b \times \times, a \times \times\}$

1. babbaa
2. abbbab
3.  $\varepsilon$
4. aaaaa

**Solution**

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**

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:

$G^+: \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ab, \times \times b \times, \times \times \times \times, \times abb, \times \times \times \times, \times b \times \times, abab, abba, abbb, baab, baba, babb, bbba, aab \times, ab \times \times, b \times \times \times\}$

1. ababbabaaaab
2.  $\varepsilon$
3. b
4. abbaab

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 513.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ab, ba, cb, cc\}$

1. aaaa
2. bcaca
3.  $\varepsilon$
4. b

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 514.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ab, ac, bb, bc, ca, cc\}$

1. b
2.  $\varepsilon$
3. abaccacc
4. bbcaabbba

**Solution**

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**

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:

$G^+ : \{\times a, \times \times, \times c, ab, ac, bb, bc, ca, c \times\}$

1.  $\varepsilon$
2. baca
3. aaba
4. aaa

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 517.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times ac, abc, aca, acc, bca, cab, cac, cca, ac \times, c \times \times\}$

1. bc
2.  $\varepsilon$
3. b
4. babac

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 518.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. bbaaba
2.  $\varepsilon$
3. baa
4. aaa

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 519.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times \times, \times \times a, \times \times b, \times ac, \times \times \times, \times ba, abc, acb, bab, bba, bbb, bcc, cbb, cbc, ccb, bc \times, ba \times, c \times \times, a \times \times\}$

1.  $\varepsilon$
2. ba
3. cccbcbbca
4. ac

**Solution**

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:

$G^+ : \{\times \times b, \times \times d, \times \times \times, \times \times \times, \times db, \times ba, adb, bad, bee, db \times, ee \times, e \times \times, b \times \times\}$

1. cab
2. ebca
3. abcd
4.  $\varepsilon$

**Solution**

1. No
2. No
3. No
4. Yes



**EXERCISE 521.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\lambda \lambda \lambda a, \lambda \lambda \lambda c, \lambda \lambda \lambda \lambda, \lambda \lambda \lambda \lambda, \lambda \lambda cc, \lambda \lambda a\lambda, \lambda a \lambda \lambda, \lambda \lambda \lambda \lambda, \lambda ccb, aaaa, baaa, bbaa, cbba, cbb\lambda, a\lambda \lambda \lambda, a \lambda \lambda \lambda\}$

1.  $\epsilon$
2. cc
3. ccbbaaa
4. a

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 522.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-$ :  $\{aab, aac, bab, bbc, cac\}$

1. bacbbc
2. bbccababc
3. bbaaabacc
4. bccbacaana

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 523.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\lambda \lambda b, \lambda ba, abb, bab, bbc, bcc, ccc, cc\lambda, c \lambda \lambda\}$

1. ca
2. babbcc
3. bacbbb
4.  $\epsilon$

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 524.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aab, adb, bbd, cdb, dba, dda\}$

1. a
2.  $\varepsilon$
3. b
4. ba

**Solution**

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. dbdeacbdaa

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 526.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aca, bcb, caa, cbc\}$

1. b
2.  $\epsilon$
3. a
4. ba

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 527.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{acb, bad, bcd, caa, dca, ddd\}$

1. aadbbs
2. ad
3. bcbaaa
4. cadcadb

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 528.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times c, \times \times a, \times a \times, \times cb, aad, adb, baa, bba, cbb, dba, ba \times, cb \times, b \times \times, a \times \times\}$

1. abaa
2. a
3. cb
4. adcdab

**Solution**

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**

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**

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**

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:

$G^+ : \{\times \times b, \times ba, aaa, aab, abb, baa, bba, bbb, ab \times, b \times \times\}$

1. a
2. b
3. bbbaaaaabba
4. baababbbb

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 533.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times d, \times da, abe, bed, dab, dac, eda, ac \times, c \times \times\}$

1. eb
2. bbe
3. dac
4. a

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 534.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times a \times, \times aa, aaa, aab, abb, baa, bba, bbb, aa \times, a \times \times\}$

1. abbaaaabaaa
2. aaa
3. aa
4. a

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 535.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aad, abd, adb, caa, cca, dbd\}$

1. b
2.  $\varepsilon$
3. bad
4. cddaacc

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 536.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times a, \times b, ab, ba, bb, a \times, b \times\}$

1. abbaaab
2. a
3. b
4. ab

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 537.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times ab, \times aa, aab, aba, abb, baa, bab, bba, ab \times, b \times \times\}$

1. abbbbbaaabba
2. bbb
3. babbbbb
4. bbbbbbabbab

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 538.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aaa, aab, bab, bba, caa, cab, cca, ccc\}$

1. b
2.  $\varepsilon$
3. cb
4. aabcac

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 539.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\epsilon, c, b, bb, bd, ce, bb\epsilon, cee, bdd, abde, bded, cabd, ceec, dabc, deda, ecab, edab, eeca, abc\epsilon, bdd\epsilon, bc\epsilon, dd\epsilon\epsilon, bb\epsilon\epsilon, c\epsilon\epsilon\epsilon, d\epsilon\epsilon\epsilon, b\epsilon\epsilon\epsilon\}$

1. bb
2. baaecd
3. acbca
4. edeebb

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 540.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{aabb, abbb, acbb, baca, bbba, cbcc, cccc\}$

1.  $\epsilon$
2. a
3. b
4. acc

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes



**EXERCISE 541.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{adc, cba, cca, ddc\}$

1. accdbd
2. abbcc
3. dda
4. daddc

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 542.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times\times, \times b, ab, ba, bd, da, b\times\}$

1. cdcbbc
2. b
3. ddddca
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 543.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times\times\times, \times\times a, \times\times d, \times\times\times, \times d\times, \times ab, abd, aee, bdc, cae, cde, dca, dcd, dee, edc, eed, ee\times, d\times\times, e\times\times\}$

1.  $\varepsilon$
2. c
3. abdcdee
4. d

**Solution**

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. bbababbbaaab
3. b
4.  $\varepsilon$

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 545.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aca, acb, bbb, cab, ccb\}$

1. b
2. aacaabca
3. a
4.  $\varepsilon$

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 546.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{bed, ccc, cce, dee, eaa\}$

1. dc
2. eddbae
3. bdc b
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 547.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times b, \times b \times, \times bb, acc, bac, bba, cac, cca, ccb, ccc, cb \times, b \times \times\}$

1. bbac b
2. a
3. b
4. caaacac

**Solution**

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.  $\varepsilon$
4. aaabb

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 549.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{abca, acca, baaa, babb, bccc, cabb, cabc, ccbe\}$

1. a
2.  $\varepsilon$
3. caaca
4. b

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 550.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\bowtie c, bb, bc, ca, cb, a\bowtie\}$

1. aabaac
2. c
3. abacc
4. cba

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 551.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{acbc, adab, cabd, cada, ceee\}$

1. cbaaedaded
2. edbcbdac
3. d
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 552.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ab, ac, ba, bd, dd\}$

1.  $\varepsilon$
2. b
3. a
4. dcdb

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 553.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, aba, abb, baa, bab, bba\}$

1. aabbbba
2.  $\varepsilon$
3. bbabaabaab
4. b

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 554.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times c, \times \times c \times, \times \times cc, \times c \times \times, \times ccd, bccd, cbcc, ccda, ccdd, cdad, cddc, dc bc, ddc b, dad \times, ad \times, d \times \times \times, c \times \times \times\}$

1. c
2. cc dad
3. ddbaaaabcab
4. cdaba

**Solution**

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:

$G^- : \{bb eb, dd be, ded b, ec be, ee ea\}$

1. beceaa
2. acdc
3. cdbaddc
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 556.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaba, abaa, abab, abbb\}$

1. ba
2. aabbb
3. baa
4.  $\varepsilon$

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 557.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+: \{\times \times \times a, \times \times \times c, \times \times aa, \times \times ce, \times aae, \times cee, aae b, aebe, bedc, caee, dcae, ebed, edca, aee \times, cee \times, ee \times \times, e \times \times \times\}$

1.  $\varepsilon$
2. cee
3. be
4. e

**Solution**

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**

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**

1. Yes
2. No
3. Yes
4. No

**EXERCISE 560.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^- : \{ab, da, dd, ec\}$

1. d
2. dabac
3. db
4. acb

**Solution**

1. Yes
2. No
3. Yes
4. Yes



**EXERCISE 561.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times e, \times \times e \times, \times \times eb, \times ebc, \times e \times \times, bccb, cc bc, ebcc, cb c \times, bc \times \times, c \times \times \times, e \times \times \times\}$

1. edcc
2.  $\varepsilon$
3. beeb
4. e

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 562.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{acaa, baba, bc bc, cbcc, ccab, ccac\}$

1. c
2.  $\varepsilon$
3. a
4. b

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 563.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+$ :  $\{\times a, \times \times, \times c, ad, bd, be, cc, db, dd, ec, c \times\}$

1. aacdeeecee
2. c
3.  $\varepsilon$
4. ccaeecbeeb

**Solution**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 564.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times b \times, \times aa, \times bc, aab, abb, baa, bab, bba, bcc, caa, cca, aa \times, b \times \times, a \times \times\}$

1. b
2.  $\varepsilon$
3. bbbc
4. cbacbbacab

**Solution**

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. bbacbb
3.  $\varepsilon$
4. bace

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 566.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ad, ba, ca, de, ed\}$

1. bbb
2. aa
3. a
4. dedbd

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 567.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times a, \times d, ad, da, dd, a\times, d\times\}$

1. b
2. aecee
3. d
4. a

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 568.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aada, abaa, abbc, abda, baba, bcda, dbca\}$

1. acab
2.  $\varepsilon$
3. aaacccddbd
4. ada

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 569.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\lambda\lambda\lambda e, \lambda\lambda\lambda c, \lambda\lambda ee, \lambda\lambda ce, \lambda ee\lambda, \lambda cea, aacc, abdb, acca, cabd, ccab, ceaa, eaac, bdb\lambda, db\lambda\lambda, ee\lambda\lambda, e\lambda\lambda\lambda, b\lambda\lambda\lambda\}$

1. c
2.  $\epsilon$
3. ee
4. abae

**Solution**

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:

$G^+ : \{\lambda a, \lambda\lambda, aa, ab, ba, bb, a\lambda\}$

1. baaabbbb
2.  $\epsilon$
3. abbaaaaa
4. aaaaaaaba

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 571.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\epsilon, a, b, \epsilon\epsilon, d, \epsilon, ba, \epsilon da, \epsilon\epsilon, \epsilon a\epsilon, \epsilon da\epsilon, \epsilon bab, \epsilon a \epsilon \epsilon, \epsilon \epsilon\epsilon, aaab, aabc, abaa, abcd, baaa, baba, bcde, cdec, dcde, dc\epsilon, dc \epsilon \epsilon, da \epsilon \epsilon, c \epsilon \epsilon\epsilon, a \epsilon \epsilon\epsilon\}$

1. a
2. ba
3. cdcabccbd
4.  $\epsilon$

**Solution**

1. Yes
2. No
3. No
4. Yes

**EXERCISE 572.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\epsilon\epsilon a, \epsilon ab, aab, aba, baa, ba\epsilon, a \epsilon \epsilon\}$

1. ccc
2. bb
3. bcabaa
4. aabca

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 573.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-$ :  $\{bdd, cab, dbd, dcd\}$

1. bdd
2. ad

3. dcccadc
4. adcac

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 574.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\bowtie b, ab, ba, bb, b\bowtie\}$

1. aa
2. bb
3. bbb
4. b

**Solution**

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:

$G^+ : \{\bowtie a, \bowtie \bowtie, aa, ab, ac, bc, ca, cb, cc, a\bowtie, c\bowtie\}$

1. aacaabaabc
2. ccaaaba
3. abbb
4.  $\varepsilon$

**Solution**

1. No
2. No
3. No
4. Yes

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 positive 3-gram grammar:

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

4. bc

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 579.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times a, \times \times, \times c, aa, ab, ac, ba, cc, cd, da, a \times, d \times\}$

1. cbccccbbd
2. aa
3.  $\varepsilon$
4. a

**Solution**

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**

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.  $\epsilon$
2. ac
3. bcacabcb
4. bbcbabccca

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 582.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-$ :  $\{ab, ac, ca, cb\}$

1. c
2. babcccc
3. acaac
4. b

**Solution**

1. Yes
2. No
3. No
4. Yes

**EXERCISE 583.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times c, \times \times a, \times a \times, \times cb, adb, bad, bba, bbb, bbc, cbb, dbb, bc \times, a \times \times, c \times \times\}$

1.  $\epsilon$
2. cddbd
3. aa
4. c

**Solution**

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**

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**

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**

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**

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**

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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times aa, \times \times bb, \times aaa, \times bbb, aaab, baaa, bbba, aab\times, aaa\times, ab\times\times, aa\times\times, a\times\times\times, b\times\times\times\}$

1. aaab
2. baaab
3. ba
4. aaa

**Solution**

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.  $\epsilon$
4. cbcbbb

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 591.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{bb, cb, de, ea, ec\}$

1. ce
2.  $\varepsilon$
3. c
4. d

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 592.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{caba, ccaa, cc dc, cdad, ceeb, dbaa, ddea\}$

1. b
2.  $\varepsilon$
3. e
4. cbc

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 593.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaba, aabb, abab, abbb, baaa, baab, baba\}$

1. aaaba
2. abba
3. aaaa
4. aaaabbaabb

**Solution**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 594.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times b, ac, bc, ca, cb, a \times\}$

1. bca
2.  $\varepsilon$
3. bcbca
4. bcbcbca

**Solution**

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**

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**

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**

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**

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:

$G^+ : \{\bowtie a, aa, ae, bc, ce, ea, eb, ec, ee, e\bowtie\}$

1. ae
2. aee
3. cb
4. aae

**Solution**

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:

$G^+ : \{\bowtie \bowtie \bowtie a, \bowtie \bowtie \bowtie b, \bowtie \bowtie \bowtie \bowtie, \bowtie \bowtie aa, \bowtie \bowtie \bowtie \bowtie, \bowtie \bowtie ba, \bowtie \bowtie \bowtie \bowtie, \bowtie aaa, \bowtie ba\bowtie, aaaa, aaab, aabb, abb\bowtie, ba\bowtie\bowtie, bb\bowtie\bowtie, a\bowtie\bowtie\bowtie, b\bowtie\bowtie\bowtie\}$

1. ba
2.  $\varepsilon$
3. b
4. aaabb

**Solution**

1. Yes
2. Yes
3. No
4. Yes



**EXERCISE 601.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaaa, aaab, aaba, abba, baaa, baab, bbba\}$

1. bbbbaaa
2. baaaabaaba
3. aaabbaab
4.  $\varepsilon$

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 602.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, abb, bab, bba\}$

1. baab
2. aabbabaa
3. bb
4.  $\varepsilon$

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 603.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaba, baac, babb, bbba, bbbb, bcba\}$

1. a
2.  $\varepsilon$
3. ccabcbaa
4. b

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 604.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{baae, bebc, ceac, eaac, eaec, ebc b, ebed\}$

1. b
2. ecceb
3. ad
4. eae

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 605.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ab, ac, cb, cd, db, dc, dd\}$

1. b
2. aaaa
3. ccddadd
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 606.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times\times\times a, \times\times\times c, \times\times cb, \times\times ae, \times ae\times, \times cbb, addb, ae ad, bbca, bcae, caea, cbbc, ddbd, eadd, dbd\times, ae\times, bd\times\times, d\times\times\times, e\times\times\times\}$

1. a
2. deeaabc
3. bebebb
4. cdbcbabeed

**Solution**

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:

$G^+$ :  $\{\times\times\times d, \times\times\times c, \times\times c\times, \times\times da, \times dae, \times c\times\times, ae eb, daee, eebe, ebe\times, be\times\times, c\times\times\times, e\times\times\times\}$

1. deeb
2.  $\varepsilon$
3. dceaac
4. c

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 608.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-$ :  $\{acc, ada, bbd, cba, ccb, dab, ddb, ddc\}$

1. cabca
2. c
3.  $\varepsilon$

4. cadbc

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 609.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times a, \times \times, aa, ac, ba, cb, a \times\}$

1. aa
2. adaaac
3.  $\varepsilon$
4. a

**Solution**

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**

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:

$G^+$ :  $\{\epsilon, a, b, c, aa, ab, ac, ba, bab, aac, \epsilon\epsilon, abca, babc, bcac, cacb, acb\epsilon, aac\epsilon, ac\epsilon\epsilon, cb\epsilon\epsilon, c\epsilon\epsilon\epsilon, b\epsilon\epsilon\epsilon\}$

1.  $\epsilon$
2. aac
3. aca
4. a

**Solution**

1. Yes
2. Yes
3. No
4. No

**EXERCISE 612.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-$ :  $\{abb, aca, baa, bcc, cba, cbc\}$

1. cb
2. cbcba
3. cca
4. bb

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 613.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{aaba, aabb, bach, bccb, bccc, caaa, cacb, cbca\}$

1. accbc
2. abbb
3. aab
4. bacbca

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 614.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aab, bba, bcb, caa, cba\}$

1. bcbcb
2. cb
3. ac
4. bbac

**Solution**

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:

$G^+: \{\bowtie a, aa, ab, ac, ba, bc, ca, cb, c\bowtie\}$

1. baabaccabac
2. aac
3. abc
4. ac

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 616.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times c, \times \times a, \times \times \times, \times \times \times, \times ac, \times cd, aad, ada, cdd, daa, dad, dda, ac \times, da \times, a \times \times, c \times \times\}$

1. adbcccbaa
2. ac
3. cccbbbcd
4.  $\epsilon$

**Solution**

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**

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**

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:

$G^+ : \{\epsilon \epsilon \epsilon e, \epsilon \epsilon ea, \epsilon ead, adbc, dbcb, eadb, bcb\epsilon, cb \epsilon \epsilon, b \epsilon \epsilon \epsilon\}$

1. a
2.  $\epsilon$
3. c
4. dcdcbd

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 620.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\epsilon \epsilon d, \epsilon \epsilon \epsilon, \epsilon \epsilon \epsilon, \epsilon db, aea, aeb, bea, db\epsilon, eae, eba, ba\epsilon, a \epsilon \epsilon\}$

1.  $\epsilon$
2. dadbbb
3. dbeaeba
4. c

**Solution**

1. Yes
2. No
3. Yes
4. No





4. dcebc

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 624.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ab, ad, db, dd\}$

1.  $\varepsilon$
2. dc
3. da
4. caa

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 625.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+: \{\times \times \times c, \times \times \times b, \times \times cb, \times \times bd, \times bde, \times cba, aace, aced, bdec, cdda, cedb, daac, ddaa, decd, ecdd, edb \times, \times, db \times \times, a \times \times \times, b \times \times \times\}$

1. dbdeaab
2.  $\varepsilon$
3. cba
4. ebeae

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 626.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times b, \times \times \times, \times \times \times, \times ba, aab, abb, baa, bbc, bc\times, c \times \times\}$

1. aaaac
2. bba
3. bbc
4.  $\varepsilon$

**Solution**

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**

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.  $\varepsilon$
2. bb
3. abbaabbbaaa
4. bbaaaaba

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 629.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times b, \times \times ca, \times \times b\times, \times \times ad, \times ad\times, \times caa, \times b\times\times, aaac, aaca, acaa, caaa, caac, aac\times, ac\times\times, ad\times\times, c\times\times\times, d\times\times\times, b\times\times\times\}$

1. baa
2. a
3. b
4. ad

**Solution**

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**

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**

1. Yes
2. No
3. No
4. No

**EXERCISE 632.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{adcb, bbcb, bcca, caaa, caad, cbbc, dbad, dbba\}$

1. a
2. dadcdc
3. dabccbabacc
4. dacbdbdbac

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 633.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-$ :  $\{ab, ad, bb, bc, cc, cd, db, dd\}$

1. adaa
2. d
3. abababac
4. bcad

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 634.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\epsilon \epsilon \epsilon a, \epsilon \epsilon \epsilon b, \epsilon \epsilon aa, \epsilon \epsilon ab, \epsilon \epsilon ba, \epsilon aba, \epsilon aab, \epsilon ba\epsilon, aaab, aabb, abbb, baaa, bbba, bbba, aba\epsilon, bba\epsilon, ba \epsilon \epsilon, a \epsilon \epsilon \epsilon\}$

1. aaaaabaaabab
2. bbabaaab
3. ba
4. bb

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 635.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\epsilon \epsilon d, \epsilon dd, abd, adb, bbc, bda, dab, dad, dbb, dda, ddd, bc\epsilon, c \epsilon \epsilon\}$

1. aabccbcebaa
2. ddadbcb
3. ddddadbbc
4. dddadbcb

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 636.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times e, bc, cd, db, ed, ee, d\times\}$

1. bdc
2. eadbc
3. dedbbb
4. caaa

**Solution**

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.  $\varepsilon$
2. eebae
3. acab
4. bdec d

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 638.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times ab, \times \times be, \times \times ae, \times aba, \times be\times, \times aed, aedb, bddc, cadc, dbdd, dcad, ddca, edbd, adc\times, aba\times, dc\times\times, ba\times\times, be\times\times, c\times\times\times, a\times\times\times, e\times\times\times\}$

1. ab
2. be
3. da

4. decd

**Solution**

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**

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:

$G^+: \{\bowtie \bowtie c, \bowtie cc, abc, acc, bca, cab, cac, cca, cc\bowtie, c \bowtie \bowtie\}$

1. ba
2. ccbc
3.  $\varepsilon$
4. bccba

**Solution**

1. No
2. No
3. No
4. No



**EXERCISE 641.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times c, \times \times cb, \times \times cc, \times cca, \times cbb, bbcc, bccc, cbbc, cccc, ccc\times, cca\times, cc \times \times, ca \times \times, a \times \times \times, c \times \times \times\}$

1. cca
2. ab
3. bac
4. cbbccc

**Solution**

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.  $\epsilon$

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 643.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{acaa, acca, baab, baac, bacb, bcac, caaa, cccc\}$

1. b
2. a
3. baabcaacc

4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 644.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaaa, aaba, abaa, abab, babb, bbaa, bbab, bbbb\}$

1. abbba
2. aba
3.  $\varepsilon$
4. ba

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 645.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{acdc, adec, bbcd, bdda, ccbb, eaca, echa, eeca\}$

1. e
2. bdecdbabdb
3. baeeeedae
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 646.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ba, bb, bd, ca, cc, da, dc\}$

1. caccab
2. cacacdccbcd
3. addbacbb
4. dcabdcddca

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 647.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aba, abb, baa, bab, bba, bbb\}$

1. b
2. aaaabbbbbaaba
3. a
4.  $\varepsilon$

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 648.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times a, \times d, aa, ae, bd, db, de, ea, ed, ee, e\times, d\times\}$

1. eabdaab
2. cd
3. aa
4. aebbc

**Solution**

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**

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**

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. cdacaadbc

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 652.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times \times e, \times \times \times ea, \times \times \times c \times, \times \times \times bd, \times \times \times ec, \times ece, \times ea \times, \times bde, \times c \times \times, aabd, abdc, bdcc, cddb, ceaa, dccd, eaab, ecea, cdb \times, bde \times, db \times \times, de \times \times, ea \times \times, c \times \times \times, a \times \times \times, e \times \times \times, b \times \times \times\}$

1. c
2. ebdede
3. ecdcaeebe
4. ea

**Solution**

1. Yes
2. No
3. No
4. Yes

**EXERCISE 653.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+$ :  $\{\times \times, \times b, ab, ba, bc, ca, cb, cc, a \times\}$

1. bca

2.  $\varepsilon$
3. ccbaacacca
4. ba

**Solution**

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.  $\varepsilon$
2. bb
3. ddbbbccad
4. bcaaa

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 655.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{abb, aca, bac, cba, cbb, cca, ccc\}$

1. bbcaaaabcb
2. cbbbcbbb
3. ca
4. bcccaa

**Solution**

1. Yes
2. No
3. Yes
4. No

**EXERCISE 656.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aab, abb, abc, aca, bbc, cac, ccc\}$

1. b
2. accb
3. a
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 657.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+: \{\times \times \times c, \times \times \times b, \times \times \times \times, \times \times bc, \times \times \times \times, \times \times cc, \times cca, \times bc \times, \times \times \times \times, aacc, accb, bbaa, caac, cbba, ccaa, cccb, baa \times, aa \times \times, bc \times \times, c \times \times \times, a \times \times \times\}$

1. c
2. accbcacb
3. aaaab
4.  $\varepsilon$

**Solution**

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**

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**

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**

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**

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**

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.  $\epsilon$
4. b

**Solution**

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**

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**

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.  $\epsilon$
3. ccbddca
4. dbdbda

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 667.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{acbc, bbba, bbca, bcac, caab, cccb\}$

1. cba
2. b
3.  $\epsilon$
4. abb

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 668.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times c, \times \times \times, \times \times b, \times cb, \times c \times, \times \times \times, \times \times ba, aac, abc, aca, bab, bcc, caa, cab, cca, cb \times, ab \times, c \times \times, b \times \times\}$

1. c
2.  $\epsilon$
3. abccbbcab
4. cb

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 669.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times c, \times \times a, \times a \times, \times cc, acd, add, bad, cce, cdb, ceb, dac, dda, eba, db \times, b \times \times, a \times \times\}$

1.  $\varepsilon$
2. bccedcbb
3. eecddc
4. d

**Solution**

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**

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. ccbcd
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 672.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+$ :  $\{\times\times, \times c, ac, bb, bd, ca, cb, cc, d\times\}$

1. cabbdbd
2. bad
3.  $\varepsilon$
4. cbd

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 673.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+$ :  $\{\times b, aa, ac, bc, ca, a\times\}$

1. bca
2. bcaa
3. bcaaa
4. cbaa

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 674.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aabd, aadc, adda, caaa, caba, cada, dbcb\}$

1. b
2. a
3. bcbdcdd
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 675.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ba, bb, bc, cc\}$

1. accbabacb
2. baaa
3. accb
4. acbabbac

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 676.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{acac, babe, bdee, cabd, cacd, cbae, ccbe, edcb\}$

1. adce
2. de
3. bdbabe
4. cdbc

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 677.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ab, ba, bb, bc, cc\}$

1. cbbaccc
2. bbaaccb
3.  $\epsilon$
4. ccbb

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 678.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times\times, \times c, aa, ab, ac, ba, bb, bc, ca, a\times\}$

1. caa
2.  $\epsilon$
3. cabac
4. ca

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 679.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times a, \times \times, aa, ab, ba, bb, b \times\}$

1. ab
2. aaab
3.  $\varepsilon$
4. aab

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 680.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^- : \{aabd, adda, cdaa, cdba, cdca\}$

1.  $\varepsilon$
2. aa
3. bdbbbcabcbbd
4. abbacc

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes



**EXERCISE 681.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times b, \times \times \times, \times \times \times, \times bb, abb, abc, bab, bba, bbb, bbc, bca, bcb, cab, cb \times, b \times \times\}$

1. bbcb
2. b
3. accbbab
4.  $\epsilon$

**Solution**

1. Yes
2. No
3. No
4. Yes

**EXERCISE 682.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+$ :  $\{\times a, \times \times, \times d, ac, ad, cc, ce, dd, ea, d \times\}$

1. cbad
2.  $\epsilon$
3. bdcaeac
4. d

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 683.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-$ :  $\{aaa, aba, abb, baa, bab\}$

1. aaa
2.  $\epsilon$
3. b
4. a

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 684.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times a, \times \times ac, \times aca, acac, acba, cacb, cba\times, ba \times \times, a \times \times \times\}$

1. c
2. cbccb
3. baa
4. acccab

**Solution**

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.  $\varepsilon$
2. baab
3. aa
4. abab

**Solution**

1. Yes
2. No
3. Yes
4. No

**EXERCISE 686.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaba, abaa, abab, abbb, baaa, bbaa, bbba\}$

1. bbaaababa
2.  $\varepsilon$
3. b
4. bbbbbb

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 687.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aab, aba, abb, acb, bdc, cdb\}$

1. bc
2. adcb
3. abcd
4. dbdbac

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 688.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, aba, bab, bba, bbb\}$

1. babaaab
2.  $\varepsilon$
3. babababab
4. babbbabb

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 689.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{adab, bdca, dccb, eaec\}$

1. e
2.  $\varepsilon$
3. ceaaecbccbea
4. b

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 690.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\bowtie\bowtie, \bowtie e, ac, ae, ca, cd, da, ec, ee, c\bowtie\}$

1.  $\varepsilon$
2. bbdbd
3. edbbded
4. acecdddbc

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 691.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aca, baa, bac, bbb, caa, ccb\}$

1. bacbb
2. bcaabbacabc
3.  $\varepsilon$
4. ca

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 692.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times a, \times \times, aa, ab, ba, bb, b \times\}$

1. abbaba
2. aab
3.  $\varepsilon$
4. ab

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 693.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+: \{\times \times \times a, \times \times \times b, \times \times ac, \times \times b \times, \times b \times \times, \times acb, acbb, bbca, cbbc, bca \times, ca \times \times, a \times \times \times, b \times \times \times\}$

1. aa
2. b
3. bbb
4. c

**Solution**

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**

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**

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**

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**

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. aabcbddbca
4. cecd

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 699.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\epsilon, ab, aa, ab, ba, bb, b\}$

1.  $\epsilon$
2. aabbbbaa
3. bababbbaabab
4. aaabbabbab

**Solution**

1. Yes
2. No
3. Yes
4. No

**EXERCISE 700.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\epsilon, ab, ad, db, dd, b, ddb, dbb, b \epsilon, \epsilon, aab, aabd, abdc, baaa, bbba, dbbb, ddbb, dbb, bdc, dc \epsilon, db \epsilon, bb \epsilon, c \epsilon \epsilon, b \epsilon \epsilon\}$

1. ababcb
2. dcd
3. bbccbaddbc
4. dcdcccaadab

**Solution**

1. No
2. No
3. No
4. No



**EXERCISE 701.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\text{XXXXa}, \text{XXXXc}, \text{XXXXX}, \text{XXXXd}, \text{XXdc}, \text{XXca}, \text{XXXX}, \text{XXaX}, \text{Xdca}, \text{XaX}, \text{Xcad}, \text{X} \text{ X} \text{ XX}, \text{adcd}, \text{caaa}, \text{cadc}, \text{cdca}, \text{dcaa}, \text{dcad}, \text{dcdc}, \text{aaaX}, \text{cadX}, \text{ad} \text{ X}, \text{aa} \text{ X} \text{ X}, \text{d} \text{ X} \text{ XX}, \text{a} \text{ X} \text{ XX}\}$

1. bbd
2. acbbabcb
3. cbc
4. a

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 702.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-$ :  $\{aa, ab, ba, bb\}$

1. bbabbaa
2. ba
3. abbbbab
4. aaaa

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 703.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-$ :  $\{aaa, bba, bca, bcc, cac\}$

1. bb
2.  $\epsilon$
3. bbbbbb

4. cccaba

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 704.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times b, \times be, ace, bac, beb, bee, eba, ebe, eeb, ce\times, e \times \times\}$

1. cccabbd
2. ccaecbea
3. d
4. a

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 705.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{abcc, adad, badd, bbdb, bddb, ccda, dbcb\}$

1. dddb
2. dbbcdb
3. dbd
4. ddbcbddba

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 706.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times c, ab, ba, ca, cc, ce, ec, a \times\}$

1. eada
2. dcbbda
3. cca
4. ca

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 707.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times d, \times \times \times a, \times \times \times b, \times \times dd, \times \times ab, \times \times b \times, \times ddb, \times abd, \times b \times \times, bbbb, dbbb, ddbb, abd \times, bbb \times, bd \times \times, bb \times \times, d \times \times \times, b \times \times \times\}$

1.  $\varepsilon$
2. bbca
3. cc
4. dcadbd

**Solution**

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**

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:

$G^+ : \{\times \times d, \times d \times, \times da, acb, adc, bdd, cbd, dac, dad, dcd, dda, cd \times, d \times \times\}$

1. d
2. baabad
3. dadcd
4. acbcacbcdb

**Solution**

1. Yes
2. No
3. Yes
4. No

**EXERCISE 710.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^- : \{aace, abdd, cabe, cbdd, ccda, eddb, eecd\}$

1. ecaadd
2. e
3.  $\varepsilon$
4. b

**Solution**

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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times ab, \times \times bb, \times \times b \times, \times \times ba, \times baa, \times bba, \times ab \times, \times b \times \times, aaba, abab, abbb, baab, babb, bbaa, bbba, baa \times, bba \times, ba \times \times, ab \times \times, aa \times \times, a \times \times \times, b \times \times \times\}$

1. ab
2. baa
3. bba
4. b

**Solution**

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.  $\epsilon$
2. becaae
3. bcebadc
4. e

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 713.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-$ :  $\{ab, ad, ca, cb, cd\}$

1. ddb
2. adaabdda
3. c

4.  $\varepsilon$

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 714.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times b, \times \times \times e, \times \times e \times, \times \times ea, \times \times be, \times \times ba, \times e \times \times, \times bea, \times eaa, \times ba \times, abac, aeab, beae, eaba, eaea, eaa \times, bac \times, ba \times \times, ac \times \times, aa \times \times, c \times \times \times, a \times \times \times, e \times \times \times\}$

1. eaa
2. ba
3. e
4. accadead

**Solution**

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. cbcd aabc
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 716.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times c, ca, ce, dc, ec, ed, ee, a \times\}$

1. b
2. cdaa
3. ddd
4. ca

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 717.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times a, \times \times \times e, \times \times ae, \times \times e \times, \times aeb, \times e \times \times, aebb, bbeb, bebe, ebbe, ebe \times, be \times \times, e \times \times \times\}$

1. edadaea
2. a
3. edb
4. aa

**Solution**

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**

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**

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**

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**

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. cbcabc

**Solution**

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**

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**

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.  $\varepsilon$
3. abb
4. bbbaab

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 726.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. abaaa
2. aaaaa
3. aaaaabaaa
4. bbbbbb

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 727.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aacd, abad, acbb, cade, cdee, ddad, edac\}$

1.  $\varepsilon$
2. edceee
3. ce
4. acacae

**Solution**

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**

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.  $\epsilon$
2. aac
3. c
4. bca

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 730.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{aaaa, aaab, abab, abba, abbb, baaa, babb, bbbb\}$

1. b
2.  $\epsilon$
3. a
4. abbb

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 731.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times\times, \times b, aa, ab, ba, bb, b\times\}$

1.  $\varepsilon$
2. abbbbaa
3. bbabaa
4. aabbbbbaaaaa

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 732.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times a, \times\times, aa, ab, bb, bc, cb, c\times\}$

1.  $\varepsilon$
2. b
3. a
4. ab

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 733.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{acc, bdc, cbd, ccc, daa, dab, dcd, ddc\}$

1.  $\varepsilon$
2. bacbbc
3. b
4. dcaabda

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 734.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times d, \times \times b, \times \times \times, \times \times \times, \times d \times, \times dc, \times bc, bcc, cce, ced, edb, dc \times, db \times, b \times \times, d \times \times, c \times \times\}$

1. ebd
2. dc
3. d
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 735.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times a, \times \times b, \times \times \times, \times \times \times, \times b \times, \times aa, aaa, aab, aba, abb, baa, bab, bb \times, b \times \times\}$

1.  $\varepsilon$
2. aaababab
3. bbbab
4. b

**Solution**

1. Yes
2. No
3. No
4. Yes

**EXERCISE 736.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ab, cb, cc\}$

1. b
2.  $\varepsilon$
3. aba
4. bcacb

**Solution**

1. Yes
2. Yes
3. No
4. No

**EXERCISE 737.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\bowtie \bowtie a, \bowtie \bowtie b, \bowtie a \bowtie, \bowtie bb, aab, abb, baa, bab, bba, bb \bowtie, b \bowtie \bowtie, a \bowtie \bowtie\}$

1. bbbba
2. aaba
3. a
4. bb

**Solution**

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.  $\varepsilon$

1. Yes
2. Yes
3. Yes
4. Yes

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

1.  $b$
2.  $ab$
3.  $bab$
4.  $\varepsilon$

1. Yes
2. Yes
3. No
4. Yes

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

1. eecbbdbdb
2. ccc
3. cbdbead
4. dcbebc

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:

$G^+$ :  $\{\epsilon, a, \epsilon a, \epsilon b, a\epsilon, \epsilon\epsilon, ba, \epsilon a, \epsilon\epsilon, \epsilon baa, aabc, abcb, baab, bcba, cba\epsilon, ba\epsilon\epsilon, a\epsilon\epsilon\epsilon\}$

1.  $\epsilon$
2. caaaba
3. a
4. bac

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 742.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+$ :  $\{\epsilon\epsilon, \epsilon b, \epsilon c, ad, bb, bc, ca, cd, db, dc, dd, c\epsilon\}$

1.  $\epsilon$
2. dbb
3. bdaabddcca
4. ccabbacbcd

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 743.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\epsilon\epsilon\epsilon, \epsilon\epsilon c, \epsilon\epsilon a, \epsilon a\epsilon, \epsilon cb, \epsilon\epsilon\epsilon, \epsilon ac, aca, bac, bba, cbb, ac\epsilon, ca\epsilon, a\epsilon\epsilon, c\epsilon\epsilon\}$

1.  $\epsilon$
2. ddc
3. daada

4. ca

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 744.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{baaa, bbcb, bccb, bdaa, cdab, cdcd, ddbd, dddc\}$

1. dbcc
2.  $\varepsilon$
3. cabda
4. adcdda

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 745.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+: \{\times \times \times c, \times \times \times b, \times \times \times d, \times \times cb, \times \times da, \times \times b\times, \times dad, \times cb\times, \times b \times \times, aaab, aaba, abaa, adca, baaa, caab, dadc, dcaa, aab\times, ab \times \times, cb \times \times, b \times \times \times\}$

1. caaddaccada
2. cb
3. b
4. dadcaab

**Solution**

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**

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**

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**

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**

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**

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.  $\varepsilon$
4. bc

**Solution**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 752.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{aacc, bbcc, cbac, cbcb\}$

1. aa
2. bc
3. ba
4. bbbac

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 753.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-$ :  $\{aa, ac, ba, db, dc\}$

1. b
2.  $\varepsilon$
3. aaaba

4. bdb

**Solution**

1. Yes
2. Yes
3. No
4. No

**EXERCISE 754.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ac, ca, dd, ee\}$

1. cc
2. adaaeab
3. e
4.  $\varepsilon$

**Solution**

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:

$G^+: \{\times d, bc, bd, cd, db, de, ea, eb, ed, a \times\}$

1. dea
2. ecdbedacba
3. bedcdcbdd
4. beecaceda

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 756.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times e, \times \times a, \times eb, \times aa, aac, acd, bba, cdb, dbb, eb\times, ba\times, b \times \times, a \times \times\}$

1. c
2. eeeb
3. dddbb
4. ddeda

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 757.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times ab, \times \times c\times, \times \times \times \times, \times aba, \times c \times \times, \times \times \times \times, aacc, abaa, accb, baac, bbca, bcab, cabc, cbbc, ccbb, abc\times, bc \times \times, c \times \times \times\}$

1. aabcaab
2. c
3.  $\varepsilon$
4. cabacaac

**Solution**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 758.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^- : \{aa, ab, ac, ba, ca, cb\}$

1. acc
2.  $\varepsilon$
3. a
4. b

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 759.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ac, ad, cb, db, dc, dd\}$

1. bdaad
2.  $\varepsilon$
3. b
4. a

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 760.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times c, \times \times a, \times c \times, \times ac, ace, ade, bad, ceb, ded, eba, eda, da \times, a \times \times, c \times \times\}$

1. beee
2. c
3. ecbbbab
4. b

**Solution**

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**

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**

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:

$G^+ : \{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times \times d, \times \times db, \times \times \times \times, \times \times cc, \times \times a\times, \times a \times \times, \times dbb, \times cc\times, \times \times \times \times, aaba, acaa, bbdc, bdca, caab, caca, dbbd, dcac, aba\times, ba \times \times, cc \times \times, c \times \times \times, a \times \times \times\}$

1.  $\varepsilon$
2. abaddeddc

3. dbabdebbbe
4. edcaccd

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 764.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{abaa, baba, bbaa, bbba\}$

1.  $\varepsilon$
2. ababaaa
3. bbabbb
4. b

**Solution**

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:

$G^+: \{\times a, \times \times, \times b, ab, ac, ba, cb, cc, a \times, b \times\}$

1.  $\varepsilon$
2. cab
3. cc
4. cacab

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 766.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ab, ac, ba, bb, bc, ca, cb, cc\}$

1.  $\varepsilon$
2. bbba
3. a
4. b

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 767.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times ba, \times aa, acb, bac, bcc, cbc, ccc, ccd, cda, da \times, aa \times, a \times \times\}$

1. c
2. bacbccda
3.  $\varepsilon$
4. aa

**Solution**

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**

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**

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**

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. dccccaca
4. a

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 772.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, aba, abb, baa, bab, bbb\}$

1. abba
2. b
3. bba
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 773.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aba, baa, bbb\}$

1. aa
2. baaabb
3. baabbbaba
4. aab

**Solution**

1. Yes
2. No
3. No
4. Yes

**EXERCISE 774.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times c, \times \times b, \times cd, \times bd, aab, abc, acd, aea, bca, cae, cda, daa, dac, ea \times, bd \times, d \times \times, a \times \times\}$

1. cdaabcaea
2. daedeeabad
3. bebcdbbbd
4. bd

**Solution**

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.  $\epsilon$
4. bdc b

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 776.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times b, \times \times \times \times, \times \times ac, \times \times \times \times, \times \times cc, \times \times ba, \times acc, \times baa, \times cc \times, \times \times \times \times, aabc, abcc, baab, bccb, ccba, acc \times, cba \times, ba \times \times, cc \times \times, c \times \times \times, a \times \times \times\}$

1. acc
2.  $\varepsilon$
3. cabacc
4. cc

**Solution**

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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times bb, \times \times a \times, \times \times ba, \times bab, \times a \times \times, \times bb \times, abba, abbb, babb, bbab, bbbb, bbb \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. a
2. abbaaa
3.  $\varepsilon$
4. babbaabb

**Solution**

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**

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**

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**

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**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 782.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ab, ac, ba, bc, ca, cb\}$

1. ccca
2. acca
3. c
4. acbcb

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 783.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ad, bc, bd, cd, da, dd\}$

1. ddcaddaa
2. cbdadad
3.  $\varepsilon$
4. daccacbacd

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 784.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaab, aadb, abbb, adbd, cdac, dcac, dcdb\}$

1. a
2. b
3.  $\varepsilon$
4. cadcb

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 785.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ab, ac, ba, bb, bc, ca, cb\}$

1. cacbba
2. cb
3. ccbbac
4.  $\varepsilon$

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 786.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times c, \times \times a, \times a \times, \times cb, \times aa, bcc, bdb, cbd, dbc, cc \times, aa \times, a \times \times, c \times \times\}$

1. aa
2. acc
3. a
4. bcc

**Solution**

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:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times cc, \times \times b \times, \times ccb, \times b \times \times, bccb, bccc, cbcc, cccb, cccc, ccb \times, cb \times \times, b \times \times \times\}$

1. ccb
2. b
3. acbccacbbbc
4. ccbccb

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 788.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times \times \times, \times \times \times \times, \times \times cb, \times \times ba, \times cbd, \times \times \times \times, \times baa, aaba, abab, baab, cbd \times, bab \times, ab \times \times, bd \times \times, d \times \times \times, b \times \times \times\}$

1. cbbcbc
2. aac
3. cbd

4.  $\varepsilon$

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 789.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times d, aa, ad, da, dd, d\times\}$

1. d
2. ddd
3. bd
4. dd

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 790.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times e, \times \times c, \times \times \times, \times \times \times, \times e \times, \times ca, aab, abb, abc, baa, bba, bca, cab, cac, ac \times, e \times \times, c \times \times\}$

1. bbabea
2. cbecbcbad
3. aceaae
4.  $\varepsilon$

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 791.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ab, \times \times b \times, \times \times \times \times, \times aba, \times \times \times \times, \times b \times \times, aaab, aabb, abaa, abbb, baaa, bbaa, bbba, baa \times, aa \times \times, a \times \times \times, b \times \times \times\}$

1. abaa
2. b
3.  $\varepsilon$
4. aabaa

**Solution**

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**

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:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ac, \times \times \times \times, \times \times ba, \times aca, \times ba \times, \times \times \times \times, aacc, acaa, accc, caac, cccc, ccc \times, ba \times \times, cc \times \times, c \times \times \times, a \times \times \times\}$

1. baaaa
2. ccaa
3. bccac
4. cab

**Solution**

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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times aa, \times \times bb, \times aab, \times bbb, aaba, abaa, baab, bbb \times, aba \times, ba \times \times, bb \times \times, a \times \times \times, b \times \times \times\}$

1. a
2. abbbbaa
3. abbabba
4. aaabb

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 795.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^- : \{aa, ab, ba, bb\}$

1.  $\epsilon$
2. a
3. bbbabb
4. abb

**Solution**

1. Yes
2. Yes

3. No

4. No

**EXERCISE 796.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times b, \times \times \times \times, \times \times \times d, \times \times bc, \times \times da, \times \times \times \times, \times dad, \times bc \times, \times \times \times \times, adad, adbc, bcda, cdad, dada, dadb, dbcd, dad \times, ad \times \times, bc \times \times, c \times \times \times, d \times \times \times\}$

1. badcc

2. bc

3.  $\varepsilon$

4. cbcdad

**Solution**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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:

$G^+ : \{\times d, ac, bc, cb, cd, da, dc, dd, b\times\}$

1. bdbdaaa
2. dbbba
3. adddc
4. cca

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 812.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aaa, aab, aba, abb, bba\}$

1. aaababaabb
2. bb
3. bba
4. aaaab

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 813.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^- : \{acbb, acec, bcaa, cbad, cead, ebee\}$

1.  $\varepsilon$
2. cdebcbb
3. dad
4. eed

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 814.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ab, \times \times b\times, \times \times \times\times, \times aba, \times abb, \times \times \times\times, \times b\times\times, aabb, abba, abbb, baab, bbaa, bbba, bbbb, aba\times, bba\times, ba\times\times, a\times \times\times, b\times \times\times\}$

1. b
2.  $\varepsilon$
3. aaa
4. aba

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 815.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times cb, \times \times bb, \times \times b\times, \times bbc, \times cba, \times b \times \times, aacb, acba, bbca, bcaa, caac, cbab, bab\times, cba\times, ba \times \times, ab \times \times, a \times \times\times, b \times \times\times\}$

1.  $\varepsilon$
2. abc
3. acaccb
4. caaaaca

**Solution**

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**

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. dbcddddd
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 818.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\bowtie \bowtie d, \bowtie \bowtie \bowtie, \bowtie \bowtie \bowtie, \bowtie da, abc, aca, bcb, bda, cab, cbd, dac, ac\bowtie, c \bowtie \bowtie\}$

1. bdbb
2. bddeecacce
3.  $\varepsilon$
4. dac

**Solution**

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**

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:

$G^-: \{aeed, baae, baea, bdec, caad, ecba\}$

1. eddc
2.  $\varepsilon$
3. deacdaa
4. deddcbdd

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes



**EXERCISE 821.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times aa, aab, aba, abb, baa, bab, bba, aa\times, a \times \times\}$

1. a
2. abbbbaaabb
3. bbbbaaaa
4.  $\varepsilon$

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 822.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ab, \times \times \times \times, \times \times a \times, \times \times ba, \times baa, \times aba, \times a \times \times, \times \times \times \times, aaba, abaa, abab, baab, baa \times, bab \times, ab \times \times, aa \times \times, a \times \times \times, b \times \times \times\}$

1.  $\varepsilon$
2. baaa
3. bbbaab
4. aaabaaa

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 823.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aaa, aab, aba, abb, baa, bab, bba, bbb\}$

1. ababa
2. ab
3. abbbbaa

4. b

**Solution**

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**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 825.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aed, bea, cee, dbe, dcd, ded, edd\}$

1. cee
2. baceaa
3.  $\varepsilon$
4. ce

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 826.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{abba, abcb, acaa, acab\}$

1. b
2.  $\varepsilon$
3. a
4. c

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 827.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times\times, \times c, ab, bb, bc, ca, cb, cc, b\times\}$

1.  $\varepsilon$
2. aacbbcb
3. abbbcb
4. cabbabbb

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 828.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaab, abab, baba, bbab, bbbb\}$

1.  $\varepsilon$
2. bb
3. abaab
4. bbaaaa

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 829.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times a, \times \times \times c, \times \times \times \times, \times \times cb, \times \times \times \times, \times \times aa, \times aaa, \times cbc, \times \times \times \times, aaac, aaba, aacb, abaa, acbc, baab, bcaa, caab, cbca, aab\times, cbc\times, ab\times\times, bc\times\times, c\times\times\times, b\times\times\times\}$

1.  $\epsilon$
2. cbc
3. ccbccb
4. aaa

**Solution**

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:

$G^+$ :  $\{\times \times \times, \times \times c, \times c\times, \times \times \times, \times cc, cab, cca, ccc, ab\times, b\times\times, c\times\times\}$

1. acbbaacacaa
2.  $\epsilon$
3. ca
4. c

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 831.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times b, \times \times \times \times, \times \times \times d, \times \times db, \times \times bb, \times \times d \times, \times \times \times \times, \times db \times, \times d \times \times, \times bba, \times \times \times \times, \times bbd, acac, bdbc, bdca, caca, cacc, dcac, acc \times, bba \times, ba \times \times, db \times \times, cc \times \times, c \times \times \times, d \times \times \times, a \times \times \times, b \times \times \times\}$

1. dcbaadd
2. db
3.  $\varepsilon$
4. d

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 832.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+$ :  $\{\times b, aa, ab, ba, bb, a \times\}$

1. bbb
2. ba
3. bba
4. baaab

**Solution**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 833.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{aaba, acbd, cbad, cbc b, ddbc\}$

1. dbcabdcda
2. ca
3. ccbaabdbd

4. abccbada

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 834.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\bowtie a, \bowtie \bowtie, \bowtie b, aa, bb, bc, ca, cc, a\bowtie\}$

1.  $\varepsilon$
2. bbbca
3. abb
4. cbbaba

**Solution**

1. Yes
2. Yes
3. No
4. No

**EXERCISE 835.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^- : \{aa, ab, ba, bc, cb, db, dd, ee\}$

1.  $\varepsilon$
2. bcdcb
3. eecededc
4. becb

**Solution**

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:

$G^+ : \{\times a, \times b, aa, ab, ba, b \times\}$

1. b
2. aba
3. aaab
4. aaabbabaa

**Solution**

1. Yes
2. No
3. Yes
4. No

**EXERCISE 837.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^- : \{abbb, cbcd, ccbb, dccc\}$

1. c
2. a
3. b
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 838.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times a, \times \times \times \times, \times \times \times d, \times \times ab, \times \times da, \times \times \times \times, \times aba, \times dac, \times \times \times \times, abac, acac, acdb, baca, cacd, cdb \times, dac \times, db \times \times, ac \times \times, c \times \times \times, b \times \times \times\}$

1. addd
2.  $\varepsilon$
3. dac
4. bdcbbcbd

**Solution**

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. ccbbc
3. b
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 840.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+: \{\times \times \times d, \times \times da, \times dad, abec, adda, adea, beca, cade, dabe, dadd, ddab, ecad, dea \times, ea \times \times, a \times \times \times\}$

1. bbdeb
2. ebcac
3. aee
4. cbada

**Solution**

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**

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**

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. aba aaa
4. ba

**Solution**

1. Yes
2. Yes
3. No
4. No

**EXERCISE 844.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times c, \times \times \times b, \times \times bc, \times \times c\times, \times \times bb, \times \times cd, \times cdd, \times bbb, \times c \times \times, \times bc\times, cdda, daca, ddac, aca\times, bbb\times, bc \times \times, ca \times \times, bb \times \times, c \times \times \times, a \times \times \times, b \times \times \times\}$

1. c
2. abba
3. bb
4. dba

**Solution**

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**

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**

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**

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**

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**

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**

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**

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:

$G^+ : \{\times \times \times \times, \times \times \times d, \times \times \times \times, \times \times d \times, \times \times da, \times d \times \times, \times \times \times \times, \times \times \times \times, \times dad, adcb, adcd, bcad, cadc, cbca, dadc, dc bc, dcd \times, cd \times \times, d \times \times \times\}$

1. ccaddcbcc
2. a
3. d
4.  $\varepsilon$

**Solution**

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**

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:

$G^+$ :  $\{\times \times \times, \times \times d, \times \times e, \times db, \times \times \times, \times ed, bbd, bdc, bee, cde, ceb, dbe, dcd, ebb, ece, eec, ed \times, de \times, d \times \times, e \times \times\}$

1. ed
2.  $\varepsilon$
3. badde
4. eaccecaed

**Solution**

1. Yes
2. Yes
3. No
4. No

**EXERCISE 855.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times b, \times \times \times, \times \times \times, \times ba, abb, bab, bba, bbb, bb \times, b \times \times\}$

1. babb
2.  $\varepsilon$
3. babbb
4. aa

**Solution**

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**

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**

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. eaaccb
3. bacaecec
4. dabedb

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 859.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{bed, cce, cdb, cdd\}$

1.  $\varepsilon$
2. be
3. abbadd
4. cdcd

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 860.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{adbd, badd, bdbd, ccba, dbdb, deab, each\}$

1. aa
2. ebce
3. dead
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes



**EXERCISE 861.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaab, aaba, baaa, baba, bbaa, bbab, bbba, bbbb\}$

1. babbb
2.  $\varepsilon$
3. aaaabbab
4. b

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 862.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times b, \times ba, aaa, abc, bab, bca, caa, aa\times, a \times \times\}$

1. aabbaa
2. ccbcaabc
3. bcbcca
4. ccbab

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 863.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times \times, \times \times c, \times \times d, \times \times \times, \times dc, \times cc, bda, cbd, ccb, ccc, dac, dc\times, ac\times, c\times \times\}$

1. cbabdca
2. dc
3. abdd
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 864.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times a, \times d, ab, ba, bc, cb, cc, b\times, d\times\}$

1. dbbbabdc
2. d
3. abbbdd
4. ddab

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 865.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aac, ada, cad, dad\}$

1. a
2. baabbaba
3.  $\varepsilon$
4. b

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 866.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times a, \times \times aa, \times aad, aadb, abdd, adba, babd, dbab, bdd\times, dd \times \times, d \times \times \times\}$

1. cb
2. aad
3. bbc
4. adcb

**Solution**

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. dabcecbbbcbe
2.  $\epsilon$
3. e
4. b

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 868.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-$ :  $\{ac, ba, bc, ca\}$

1. cbb
2. bb
3. cccbabb
4.  $\epsilon$

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 869.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, abb, baa, bbb\}$

1. bbb
2. aaaaaabba
3. ababaaba
4. bba

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 870.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aba, abb, bba\}$

1. aaaaa
2. b
3.  $\epsilon$
4. babba

**Solution**

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**

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**

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. ccbd
4.  $\varepsilon$

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 874.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaab, aabb, abaa, abab, abbb, baba, babb, bbba\}$

1. bbbab
2.  $\varepsilon$
3. abbbb
4. b

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 875.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times c, \times cc, aba, abb, bab, bbc, bcc, cab, cba, cca, ccb, ccc, ba\times, a \times \times\}$

1. ccbabccbc
2. ccba
3. cccabbbaaaba
4. ccba

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 876.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{abb, ada, add, bdc, cba, dad, dcb\}$

1.  $\varepsilon$
2. dbddc
3. b
4. ddc

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 877.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times a, \times d, aa, ab, ba, bc, cb, cc, cd, da, a \times\}$

1.  $\varepsilon$
2. dbabdcc
3. a
4. aa

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 878.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaab, aaba, abba, baaa, baba, bbab, bbba\}$

1.  $\varepsilon$
2. aaab
3. bbbab
4. ababbb

**Solution**

1. Yes
2. No
3. No
4. Yes

**EXERCISE 879.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times ab, \times bb, aab, aba, abb, baa, bab, bba, bbb, bb\times, ba\times, b\times\times, a\times\times\}$

1. baabaa
2.  $\varepsilon$
3. bbb
4. aabbab

**Solution**

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**

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:

$G^+ : \{\text{Xc}, \text{Xb}, \text{cX}, \text{bc}, \text{ca}, \text{aac}, \text{acc}, \text{bbb}, \text{caa}, \text{cbb}, \text{ccb}, \text{bbX}, \text{bcX}, \text{bXX}, \text{cX}\}$

1. caabcbc
2. c
3. bc
4. aacba

**Solution**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 882.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aab, aba, bba, bbb\}$

1. babba
2.  $\epsilon$
3. abaababaa
4. baabbb

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 883.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^- : \{ad, ca, cc, cd, ed\}$

1. bd
2. cecd
3. abcaeb
4. abdbadad

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 884.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{acc, aeb, aed, bba, cde, ded, edd\}$

1. bdc
2.  $\varepsilon$
3. aa
4. e

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 885.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaab, abcb, acbc, bcac, bcba, cabb, cbbc, ccaa\}$

1. a
2. ac
3.  $\varepsilon$
4. b

**Solution**

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. bcbbcacbbcb
2. ab
3. abbbacbbaaa
4. aacbaccbbab

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 887.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ab, ac, ba, bb, bc, cb, cc\}$

1. aca
2.  $\varepsilon$
3. b
4. a

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 888.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ab, ad, bb, bc, cb, cd, db, dd\}$

1. aabc
2. bdd
3.  $\varepsilon$
4. ccbb

1. No
2. No
3. Yes
4. No

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

1. Yes
2. Yes
3. No
4. Yes

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

1. No
2. Yes
3. No
4. No

**EXERCISE 891.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaaa, aaba, abba, baaa, baba, babb\}$

1. babba
2. b
3. baaabb
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 892.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times\times, \times d, cc, cd, ce, da, dc, dd, ec, a\times\}$

1. abdb
2. dd
3.  $\varepsilon$
4. eccdcaadca

**Solution**

1. No
2. No
3. Yes
4. No

**EXERCISE 893.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaab, accb, bbbb, cadc, cbcd, ccbb, ddcb, dddb\}$

1. cbbb
2. ddcca
3. acb
4. ccdbbcd

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 894.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{abc, aca, acb, bab, bbb, bcc, cba, ccb\}$

1. bbcbabcb
2. cbbcabaaca
3. bb
4. baaabb

**Solution**

1. No
2. No
3. Yes
4. Yes

**EXERCISE 895.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times\times, \times b, \times c, ab, ac, ba, bb, bc, cb, cc, c\times, b\times\}$

1. aacbabbccab
2. bbacbcbbbaa
3. acaaaccabbca
4. bcabcbcc

**Solution**

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**

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:

$G^+: \{\times \times \times c, \times \times \times b, \times \times bd, \times \times c \times, \times bdb, \times c \times \times, aaab, aaba, baaa, bbaa, bdbb, dbba, aba \times, ba \times \times, a \times \times \times, c \times \times \times\}$

1. ddcbaaac
2. dbbabc
3.  $\varepsilon$
4. c

**Solution**

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.  $\varepsilon$
4. c

### Solution

1. Yes
2. Yes
3. Yes
4. Yes

### EXERCISE 899.

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\epsilon \epsilon \epsilon a, \epsilon \epsilon \epsilon c, \epsilon \epsilon \epsilon e, \epsilon \epsilon ab, \epsilon \epsilon c\epsilon, \epsilon \epsilon ee, \epsilon ee\epsilon, \epsilon aba, \epsilon c \epsilon \epsilon, abac, abdc, acab, baca, bdce, cabd, ceeb, dcee, eeb\epsilon, eb\epsilon\epsilon, ee\epsilon\epsilon, c\epsilon\epsilon\epsilon, e\epsilon\epsilon\epsilon, b\epsilon\epsilon\epsilon\}$

1. dbdbc
2. c
3. beba
4. ee

### Solution

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

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**

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**

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**

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:

$G^+ : \{\bowtie a, \bowtie \bowtie, \bowtie b, ab, ba, bb, a\bowtie\}$

1. a

2. aaabbabb

3.  $\varepsilon$

4. bbbb

**Solution**

1. Yes

2. No

3. Yes

4. No

**EXERCISE 905.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^- : \{aaba, addb, aebe, ddcc\}$

1. e

2.  $\varepsilon$

3. b

4. a

**Solution**

1. Yes

2. Yes

3. Yes

4. Yes

**EXERCISE 906.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times a, \times e, ae, ba, ce, de, eb, ec, ed, ee, c\times, a\times\}$

1.  $\varepsilon$
2. bbadbed
3. a
4. beaadcec

**Solution**

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**

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**

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**

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**

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**

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:

$G^+: \{\times \times \times c, \times \times \times e, \times \times \times e \times, \times \times \times eb, \times \times \times ec, \times \times \times cd, \times eca, \times cda, \times e \times \times, \times eb \times, aede, cdae, daed, deae, eaed, edea, eca \times, aed \times, eb \times \times, ed \times \times, ca \times \times, d \times \times \times, a \times \times \times, e \times \times \times, b \times \times \times\}$

1. cbccbbba
2. ddaca
3.  $\varepsilon$
4. eadab

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 913.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aabd, abdc, acbb, acbc, adda, ddab\}$

1. baac
2. caaacdcbaba
3. cccbaac
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 914.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaca, abad, abca, bacd, daaa\}$

1. dadbdac
2.  $\varepsilon$
3. b
4. cbcdc

**Solution**

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**

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**

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**

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**

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**

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:

$G^+ : \{\times \times c, \times \times b, \times ba, \times ca, abb, aca, bbb, bbc, bcc, cab, cac, cca, bb \times, ba \times, b \times \times, a \times \times\}$

1. bbcbaaa
2. bacbabaa
3. bbcc
4. baacabc

**Solution**

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**

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**

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**

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**

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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times ba, \times \times b \times, \times \times \times \times, \times \times aa, \times aaa, \times bab, \times \times \times \times, \times b \quad \times \quad \times, aaab, aaba, abab, abba, baba, babb, bbab, bab \times, abb \times, ab \quad \times \times, bb \times \times \times, b \times \times \times\}$

1.  $\varepsilon$
2. b
3. bab
4. bbaabab

**Solution**

1. Yes

2. Yes
3. Yes
4. No

**EXERCISE 926.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{ac, ba, bb, cc, cd, eb, ee\}$

1. dbaa
2.  $\varepsilon$
3. dd
4. a

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 927.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{abaa, abba, acab, bccb, cbbb, cbcb, cccc\}$

1. bababc
2. baccacaab
3.  $\varepsilon$
4. aaabbabcb

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 928.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aba, abb, baa, bab, bba, bbb\}$

1. a
2.  $\varepsilon$
3. abaaa
4. b

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 929.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times \times b, \times \times \times, \times \times \times, \times ac, \times ba, acb, adc, bca, cad, cbc, dc\times, ba\times, a\times\times, c\times\times\}$

1. cc
2. ba
3. dcacdbb
4.  $\varepsilon$

**Solution**

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**

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:

$G^+ : \{\bowtie d, bb, bc, cd, db, dc, c\bowtie\}$

1. ca
2. dc
3. dbc
4. bcbbad

**Solution**

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**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 933.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^- : \{daca, dbeb, ebbc, ebed, ecda\}$

1. cebeee
2. abebdebe
3. eaadd
4. beeeccc

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 934.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\bowtie a, \bowtie \bowtie, aa, ab, ba, bb, b\bowtie\}$

1. b
2.  $\varepsilon$
3. aab
4. ab

**Solution**

1. No
2. Yes
3. Yes
4. Yes

**EXERCISE 935.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^- : \{ba, bc, ca, dd\}$

1. bbacacaba
2. cd
3. dcbbdbbc
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 936.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times b, aa, ab, ba, bb, b\times\}$

1. baa
2. aaaa
3. bbabaaaabaa
4. babaaa

**Solution**

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**

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:

$G^+ : \{\times\times\times c, \times\times\times b, \times\times cb, \times\times ba, \times baa, \times cbc, \times ba\times, aaab, aaba, abaa, baaa, bcaa, caaa, cbca, baa\times, \times, aa\times\times, a\times\times\times\}$

1. baaa
2. baa
3. ba
4. aabb

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 939.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times \times \times, \times \times a \times, \times \times ba, \times bab, \times a \times \times, \times \times \times \times, abcb, babc, bacc, bcba, cbac, acc \times, cc \times \times, a \times \times \times, c \times \times \times\}$

1. bc bc
2. ababcc
3. c
4.  $\varepsilon$

**Solution**

1. No
2. No
3. No
4. Yes

**EXERCISE 940.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times a, ab, ba, bb, b \times\}$

1. baa
2. ab
3. babb bb
4.  $\varepsilon$

**Solution**

1. No
2. Yes
3. No
4. No



**EXERCISE 941.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\times \times a, \times \times b, \times b \times, \times ba, \times aa, aab, abb, baa, bab, bba, ab \times, aa \times, b \times \times, a \times \times\}$

1. bbabba
2. aab
3. b
4. aa

**Solution**

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**

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:

$G^+$ :  $\{\times \times e, \times \times b, \times e \times, \times bd, aad, aba, add, baa, bde, cda, dab, ddb, dec, ecd, db \times, b \times \times, e \times \times\}$

1. a

2. e
3. ebecaeedab
4. dceacaaaa

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 944.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aca, bda, cbb, daa, dcb\}$

1. daa
2.  $\varepsilon$
3. cbb
4. b

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 945.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times a, \times b, aa, ac, ba, bb, bc, cb, cc, a\times, b\times\}$

1. bbccacabbb
2. cabba
3. bbca
4. ccb

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 946.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\epsilon, b, bb, ed, d, dd, e, be, bc, addb, bbca, bcad, beea, cadd, dbee, ddbe, eea, ea, ed, d, a, a\}$

1.  $\epsilon$
2. eabecdd
3. cacba
4. dddaa

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 947.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-$ :  $\{aab, aba, acb, bba, cbb\}$

1. cca
2. aabba
3.  $\epsilon$
4. a

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 948.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{aaaa, aaba, aabb, abba, baab, baba, bbab, bbbb\}$

1. bbabb
2. bbaa

3. bbbbbb
4. a

**Solution**

1. No
2. Yes
3. No
4. Yes

**EXERCISE 949.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ac, bb, ca, cc, cd\}$

1. cddcbccddd
2. ab
3. bdc
4. bdcbacbacdc

**Solution**

1. No
2. Yes
3. Yes
4. No

**EXERCISE 950.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaab, accb, baca, bcba, caca, cacc, ccbc\}$

1. bc
2.  $\varepsilon$
3. cac
4. b

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 951.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+$ :  $\{\epsilon, c, a, b, \epsilon, \epsilon c \epsilon, \epsilon \epsilon, \epsilon \epsilon b b, \epsilon a a, a a b, a b b, b a a, b b a, b b \epsilon, a a \epsilon, b \epsilon \epsilon, a \epsilon \epsilon, c \epsilon \epsilon\}$

1. abbb
2.  $\epsilon$
3. ab
4. babcc

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 952.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\epsilon \epsilon \epsilon c, \epsilon \epsilon \epsilon b, \epsilon \epsilon \epsilon \epsilon, \epsilon \epsilon \epsilon \epsilon, \epsilon \epsilon c c, \epsilon \epsilon b a, \epsilon b a a, \epsilon c c \epsilon, \epsilon \epsilon \epsilon \epsilon, a a c c, a b b c, a c c a, b a a c, b b c a, b c a a, c a b b, c c a b, c a a \epsilon, c c \epsilon \epsilon, a a \epsilon \epsilon, c \epsilon \epsilon \epsilon, a \epsilon \epsilon \epsilon\}$

1.  $\epsilon$
2. b
3. cbbc
4. abbbaaaa

**Solution**

1. Yes
2. No
3. No
4. No

**EXERCISE 953.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-$ :  $\{a a a b, a a b b, a b a a, a b a b, a b b a, b a a a, b a a b, b a b b\}$

1. aaaba
2. b

3. aaababb
4. baba

**Solution**

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**

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**

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. bb aa abcb
4. bbcabbcc

**Solution**

1. Yes
2. Yes
3. No
4. No

**EXERCISE 957.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{bd, ca, cb, cc, da\}$

1. b
2. ac
3.  $\varepsilon$
4. cbc

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 958.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-: \{aa, ac, ba, bb, ca, cc\}$

1.  $\varepsilon$
2. cc
3. c
4. b

**Solution**

1. Yes
2. No
3. Yes
4. Yes

**EXERCISE 959.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+ : \{\times d, aa, ac, ad, ae, ca, ce, da, dc, ed, e\times\}$

1. cddecac
2. aeaccccedbda
3. ddcedbaceae
4. ebedbdcceadc

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 960.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^- : \{aed, bce, cea, ced\}$

1. e
2. eabddb
3. eeae
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes



**EXERCISE 961.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, bba, bbc, bca, bcb, cba, cbc\}$

1. ccc
2. aa
3. ccbbaccaa
4. cb

**Solution**

1. Yes
2. Yes
3. No
4. Yes

**EXERCISE 962.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+: \{\times \times e, \times \times c, \times cb, \times ee, adb, dad, eda, eed, db\times, cb\times, b\times\times\}$

1. cc
2.  $\varepsilon$
3. ee
4. bd

**Solution**

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. cdcdbcadb
3. b
4.  $\varepsilon$

**Solution**

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**

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**

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**

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**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 968.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, aba, abb\}$

1. abbbbba
2. abbbaabbabba
3. aaaaabaabab
4. bbbaaabaa

**Solution**

1. No
2. No
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:

$G^+$ :  $\{\epsilon, a, b, aa, ab, ba, bb, aaa, aabb, aaaa, aaab, aaba, abb, aba, baa, bbb, abba, baab, abbb, bbaa, babb, baab, baab, baab, baab\}$

1. bbaaba
2. b
3.  $\epsilon$
4. a

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 970.**

For each one of the strings below say whether it is generated by the following negative 2-gram grammar:

$G^-$ :  $\{aa, ab, ac, bb, ca, cb\}$

1. cbcbb
2.  $\epsilon$
3. bb
4. abcab

**Solution**

1. No
2. Yes
3. No
4. No

**EXERCISE 971.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{aaa, aab, aca, acc, cab\}$

1. bac
2.  $\varepsilon$
3. b
4. bc

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 972.**

For each one of the strings below say whether it is generated by the following negative 3-gram grammar:

$G^-: \{bbd, ccd, dcc, dda, ddb, ddc\}$

1. b
2. adcacab
3. abcbccb
4.  $\varepsilon$

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 973.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{abcd, bbdd, bddc, ccac, ddbc\}$

1. bab
2. ccddbb
3.  $\varepsilon$
4. dbacbaa

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 974.**

For each one of the strings below say whether it is generated by the following positive 3-gram grammar:

$G^+ : \{\times \times a, \times \times b, \times a \times, \times bb, acc, bac, bba, cab, cca, ab \times, b \times \times, a \times \times\}$

1. cba
2. a
3. bccbbb
4. bcaacba

**Solution**

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:

$G^+ : \{\times a, \times \times, ab, ac, bc, bd, cb, cd, da, db, dc, c \times\}$

1. dbbaccbcbbaac
2. cbcd
3. addaa
4. ccdbd

**Solution**

1. No
2. No
3. No
4. No

**EXERCISE 976.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{aaaa, accc, babb, bbbc, bcab, cacc\}$

1. aac
2. cbcaac
3. abcaac
4. cb

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 977.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times b, ac, ae, ba, bb, ca, ec, ee, c\times\}$

1. bbac
2. bac
3. baec
4. d

**Solution**

1. Yes
2. Yes
3. Yes
4. No

**EXERCISE 978.**

For each one of the strings below say whether it is generated by the following positive 2-gram grammar:

$G^+: \{\times a, ab, ba, bb, a\times\}$

1. abaab
2. b
3. aba
4. a

**Solution**

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**

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**

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**

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**

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**

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**

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**

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**

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**

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:

$G^+ : \{\times \times \times a, \times \times \times b, \times \times \times \times, \times \times aa, \times \times \times \times, \times \times bb, \times aab, \times \times \times \times, \times bbb, aaba, abaa, baab, aab \times, ab \times \times, bb \times \times, b \times \times \times\}$

1. bb
2.  $\varepsilon$

3. aabaa
4. bbba

**Solution**

1. Yes
2. Yes
3. No
4. No

**EXERCISE 989.**

For each one of the strings below say whether it is generated by the following positive 4-gram grammar:

$G^+$ :  $\{\times \times \times a, \times \times \times \times, \times \times \times d, \times \times dd, \times \times \times \times, \times \times a \times, \times a \times \times, \times ddc, \times \times \times \times, bada, bddb, cbdd, ccbd, dbad, dccb, ddba, ddcc, ada \times, da \times \times, a \times \times \times\}$

1. abdcbbab
2. a
3. abcc
4.  $\varepsilon$

**Solution**

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**

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**

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**

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**

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**

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**

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**

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**

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. cbcdcbeac
4. addedb

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 999.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{abcc, adaa, cdcc, daad, dccd\}$

1.  $\varepsilon$
2. cddbb
3. cadadaba
4. dbdbd

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes

**EXERCISE 1000.**

For each one of the strings below say whether it is generated by the following negative 4-gram grammar:

$G^-: \{abbc, cbbb, cccc, cdba\}$

1. ca
2. dddd
3. bdcd
4. dbd

**Solution**

1. Yes
2. Yes
3. Yes
4. Yes