A THEORETICAL APPROACH TO THE DESCRIPTION OF SHAPES OF THE GALAXIES

(Letter to the Editor)

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Abstract. A theoretical study to describe shapes of the galaxies is proposed. A syntactic approach to galaxy shape description as a method for recognition of galaxies is suggested. An attributed grammar is found.

What will be said below seems to justify our opinion that the knowledge of elementary linguistic concepts - initiated by N. Chomsky when the general theory was still little developed - are useful to describe shapes of galaxies. It is not our task here to point out all methods which might contribute to the problem. Our purpose is to propose only, by way of example, a new method, the syntactic approach to description of shapes of the galaxies. It explains the origin and destination of the letter.

In the syntactic approach the pattern is identified with its structure, i.e. the pattern is the system of elements and relations among primitives (see, e.g., Fu, 1974; You and Fu, 1979; Grabińska and Zabierowski, 1979). In theory of grammars a pattern is represented by a sequence of symbols from language (the theory of generative grammars is an important part of linguistic studies) generated by corresponding grammar. Let's propose an attributed grammar to describe a model disk such as in the case of the NGC 3115.

The NGC 3115-like contour may be divided into six curve segments (see Figure 1),

\[ n_1, n_2, e_1, e_2, e_3, e_4; \]

and only two angle primitives are decisive to settle that disk-like shape \( \beta_1, \beta_2 \).

Fig. 1.

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The sequence of the symbols
\[ e_1 n_1 e_2 \beta_1 e_3 n_2 e_4 \beta_2 \]
is one of the possible codes for the NGC 3115-like shape.

These isolated primitives are characterized by the following attributes:
\[
D(\beta_k) = \frac{\pi}{6}, \quad k = 1, 2;
\]
\[
D(e_i) = (C_{e_i}, L_{e_i}, 0, 0), \quad i = 1, 2, 3, 4;
\]
\[
D(n_j) = (C_{n_j}, L_{n_j}, \frac{3\pi}{2}, 0), \quad j = 1, 2.
\]

As usually any curve segments \( p \) is determined by attributes \( D(p) = (\vec{C}, L, A, S) \),
\( C \) is a vector pointing from \( X_1 \) to \( X_2 \) of a curve segment \( p \),
\[
\vec{C} = X_1X_2.
\]

A total length of curve is
\[
L = \int_0^L dl;
\]
\( A \) is a measure of the total angular change; and \( S \), a measure of symmetry (declination of a curve): i.e.,
\[
A = \int_0^L f(l) dl,
\]
\[
S = \int_0^L \left[ \int_0^S f(l) dl - A/2 \right] ds.
\]

The attributed grammar \( G_d \) is as follows:
\[
G_d = (V_d, T_d, P_d, S_d),
\]
\[
V_d = (S_d, N_{d_1}, N_{d_2}),
\]
\[
T_d = \{e_1\}_{i=1,...,4}, \{n_j\}_{j=1,2}, \{\beta_k\}_{k=1,2},
\]
\[
P_d: S_d \to N_{d_1} \beta_1 N_{d_2} \beta_2 ,
\]
\[
S_d \to N_{d_2} \beta_2 N_{d_1} \beta_1 ,
\]
\[
N_{d_1} \to e_1 n_1 e_2 ,
\]
\[
N_{d_2} \to e_3 n_2 e_4 ,
\]

\( S_d \) is the start symbol; \( d \) denotes a special attribute which is the label of the pattern;
\( V_d \) is the set of non-terminal symbols; \( T_d \) is the set of terminal symbols; \( P_d \) are production rules which generate the shape from segments.

Such a production rules as listed above make allowance for arbitrary order of pattern analysis. The NGC 3115-like shape can be taken, e.g., from Jeans (1929).

It seems that the attributed grammars are particularly useful to describe – and