PSP: A NEW POISSON SERIES PROCESSOR

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Abstract. A specialized Poisson Series Processor (PSP) is proposed. It is designed for manipulating long Poisson series. The Keplerian Processor and analytical generator of special celestial mechanics functions based on the PSP are proposed as well.

The PSP (Poisson Series Processor) is a typical software for the implementation of analytical algorithms of Celestial Mechanics. It is a new realization and development of Universal Poisson Processor (Babaev et al., 1980). All the procedures of the PSP are general and may be used in other fields of science. It manipulates the Poisson series of the form:

$$S = \sum C_j^i x^i \begin{matrix} sin \\ cos \end{matrix} (jy)$$

Here $x = (x_1, \ldots, x_n)$, $y = (y_1, \ldots, y_m)$ are vectors of power and angular variables respectively; $i = (i_1, \ldots, i_n)$, $j = (j_1, \ldots, j_m)$ are vectors of integer components. Coefficients C_j^i are rational or floating-point numbers. Summation is performed over all integer values of indices i and j.

The most important characteristics of the PSP are as follows:

• The PSP is written in standard FORTRAN-77 language and runs under MS-DOS on IBM PC and under UNIX on a Sun workstation.

• There are two versions of the PSP depending on the representation of the coefficients of Poisson series as rational or floating-point numbers. The range of the representation of the rational coefficients was increased by approximately 7 decimal orders in comparison with the range of the standard representation of computer integer number due to using the double precision floating-point numbers for correct operations on integer numbers.

• The PSP has no restrictions on the number of power and angular variables and on the ranges of the associated indices.

S. Ferraz-Mello et al. (eds.), Dynamics, Ephemerides and Astrometry of the Solar System, 283–284.

• Each term of the series is characterized by the analytical order of smallness which is defined as the sum of the power indices multiplied by the weight functions of the corresponding variables.
• All the computer operations on the series are formal. The criterion for rejecting a term is its smallness which is determined by the analytical order of the term, the numerical estimation of its coefficient and the values of indices if they fall outside the preassigned limits.
• The PSP allows the user to write his own procedures.
• The hierarchical architecture of the PSP allows rather easily to adapt the system on other computers and to modify it for the objects slightly different from standard Poisson series (for instance, for manipulating the exponents instead of the trigonometric functions or for changing the type of coefficients), or in case of using other storage technique for series.
• The list of basic operations of the PSP includes the standard arithmetic operations on series, the partial differentiation and integration with respect to polynomial and trigonometric variables, the total differentiation and integration with respect to time under the assumption that all the trigonometric variables are linear functions of the time with numerical values for the frequencies, raising to any power, binomial and Taylor expanding up to prescribed order, substituting other series in place of any set of the variables, fast evaluating of the series in fixing values of some variables, converting of the series, different sortings and selectings, etc. The PSP allows to input and output the series in any format or unformatted mode and to type them in the natural mathematical form. An effective algorithm for the most crucial operations of binary searching and inserting of terms into the series was worked out. It takes into account the advantages of table and linked representation of series. The searching of any term demands at most $\ln(N) + 2$ operations of terms comparison and N fast numeric assignment operations (N – the number of terms in the series).

The Keplerian Processor and analytical generator of special celestial mechanics functions based on the PSP are proposed as well. These systems are designed for implementing the expansions of the most important mathematical functions for celestial mechanics, for constructing the expansions of the elliptic motion functions of the unperturbed two-body problem and the expansions of the typical celestial mechanics functions.

The PSP is available on request by electronic address: 1197@ita.spb.su.

References

Babaev, I. O., Brumberg, V. A., Ivanova, T. V., Skripnichenko, V. I., Tarasevich, S. V. and Vasiliev N. N.: 1980, "Universal Poissonian Processor (UPP)", *Internat. Conf. on Systems and Techniques of Analytical Computing and their Applications in Theoretical Physics*, Dubna, 80.