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INTRODUCTION TO GPSS

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Summary information about key aspects of the simulation programming language GPSS is provided. The class of problems to which GPSS applies especially well is described; commentary on the semantics and syntax of the language is offered; the learning-oriented literature for GPSS is summarized; various GPSS implementations are commented on; the time-sharing networks offering GPSS are cited; and public courses on the language are listed. Finally, the source of a tutorial introduction to the fundamental semantics and syntax of GPSS is given. Copies of this tutorial material, excluded from reproduction here because of page-count limits, will be distributed at the session and provide the basis for the session itself.

1. A BRIEF PERSPECTIVE ON GPSS

GPSS (General Purpose Simulation System) is a simulation programming language whose use greatly eases the task of building computer models for certain types of discrete-event simulations. (A discrete-event simulation is one in which the state of the system being simulated changes at only a discrete, but possibly random, set of time points, called event times.) GPSS lends itself especially well to the modeling of queuing systems, but is generally applicable when it is of interest to determine how well a service organization will respond to the demands placed on it. For example, GPSS has been applied to the modeling of telephone companies, brokerage firms, computing centers, supermarkets, manufacturing shops, banks, steel mills, hotels, warehouse and distribution facilities, and general business.

2. THE SEMANTICS AND SYNTAX OF GPSS

GPSS offers a fairly rich set of semantics, and yet is sparse in its syntax. For example, only nine statements (excluding several control statements) are required to model a simple one-line, one-server queuing system in GPSS. These statements take such simple forms as "GENERATE 18,6" and "QUEUE LINE". No read, write, format, or test statements appear in the model. And yet when a simulation is performed with the model, fixed-form, fixed-content output is produced, providing statistics describing the server (number of times captured; average holding time per capture; and percent utilization) and the waiting line (average line content; average residence time in line; maximum line content; percent of arrivals who did not have to wait in line; and so on). This limited example is roughly suggestive of the character of GPSS.

The sparse syntax of GPSS, coupled with its block-diagram orientation, makes it possible for the beginner to learn a highly usable subset of the language quite quickly. This does not mean, however, that it is easy or straightforward to master the full set of GPSS capabilities. Considerable effort and study are needed to learn the language thoroughly.

The GPSS world view involves visualizing units of traffic ("transactions") which move along from block to block in a model as a simulation proceeds. This world view is so natural to the modeling of queuing systems that several other notable simulation languages now also offer a similar view. The effect of this cross-fertilization can be found in SIMSCRIPT (Russell 1982), SLAM (Pritsker and Pegden 1979), and SIMULA (Birtwistle 1979).

Disadvantages of traditional GPSS are that it has weak input/output capabilities, weak computational facilities, and a static control structure. (Each of these disadvantages has been remedied in GPSS/H, however; see Henriksen (1983b) and Henriksen and Crain (1983c). These disadvantages can be partially offset by interfacing a GPSS model with one or more FORTRAN subroutines, or with one or more PL/1 procedures. The GPSS HELP block is used for this purpose.

3. THE GPSS LEARNING-ORIENTED LITERATURE

There are several books devoted to GPSS (Bobillier, Kahan, and Probst 1976; Donovan 1976; Gordon 1975; Greenberg 1972; Schriber 1974; Sulzer, Bouteille, and Arquie 1970; Weber, Trzebiner, and Tempelmeier 1983). Brief introductions to GPSS can also be found in general simulation texts (e.g., Fishman 1978; Maisel and Gnugnoli 1972; McMillan and Gonzalez 1973).

Articles demonstrating use of advanced GPSS features also occasionally appear. For example, articles illustrating HELP block use are in Andrews and Schriber (1978); Degen and Schriber (1976); Lefkowits and Schriber (1971); Schriber and Andrews (1979). The GPSS user's manuals may also contain good learning-oriented material. For instance, a suggestive set of examples for HELP block use appears in Henriksen and Crain (1983c).

4. VARIOUS GPSS IMPLEMENTATIONS

GPSS first became generally available when it was released by International Business Machines Corporation (IBM) in 1961. Since then, IBM GPSS implementations have evolved through several versions (GPSS II; GPSS III; GPSS/360, Versions I and II; GPSS V; APL GPSS; and PL/1 GPSS). The current de facto standard for the language is IBM's GPSS V, although GPSS/360, Version I, is still frequently used in colleges and universities (GPSS/360, Version I, was IBM's last pre-unbundled ("free") version of the language). There are also non-IBM implementations of GPSS for IBM hardware, e.g., GPSS/H (Henriksen and Crain 1983c) and GPSSTS (Computer Sciences Corporation 1973). Most GPSS implementations for non-IBM hardware are based either on IBM's GPSS V, or on GPSS/360. These versions include B7700 GPS and B6700 GPS (Burrough's 7700 and 6700 hardware); GPSS V/170 (Control Data 170 Series computer systems); GPSS/66 (Honeywell Series 60 Level 66 hardware); GPSS-10 (Digital Equipment Corporation's PDP-10 hardware); GPSS/UCC (University Computing Corporation's GPSS for Univac 1108 hardware); GPSSX8 (a high quality Univac 1100-series GPSS implementation maintained at Florida Atlantic University); GPDS (a GPSS implementation for Xerox Sigma 5-9 computers); and GPSS/VAX (a GPSS implementation for any hardware configuration supported by VAX/VMS; Martin 1981). GPSS/H is now also being implemented for VAX hardware, and for microcomputers based on the Motorola 68000 chip.

5. ALTERNATIVE LANGUAGES WITH GPSS EMBEDDED

The functions performed by the various GPSS blocks have been embedded in other languages on some occasions. Notable here are GPSS-FORTRAN (Schmidt 1980), APL GPSS (IBM 1977), and PL/1 GPSS (IBM 1981). Briefly, embedding takes the form of implementing the functions of the GPSS blocks and control statements in a host language as subroutines which augment the power of the existing language. Calling these subroutines then has the effect of simulating the behavior of the corresponding GPSS blocks and control statements. A paper on the embedding process has been given by Rubin (1981).

6. TIME-SHARING NETWORKS OFFERING GPSS

GPSS is available in the following networks: National CSS offers GPSS/H on IBM System 370 and 370-compatible hardware; Computer Sciences Corporation offers GPSSTS in its Infonet System; University Computing Corporation offers GPSS/UCC on the Univac 1108; ADP-Cyphernetics offers GPSS-10 on the PDP 10; Boeing Computer Services offers GPSS, as does McDonnell-Douglas Automation Company (McAuto); Control Data Corporation has GPSS in its Cybernet system, and American Management Systems (AMS) has a version of GPSS which can be accessed via Telenet. (This list is thought to be exhaustive, but may not be.)

7. SHORT COURSES

Intensive public short courses on GPSS are currently known to be available from three sources. A five-day course is offered each summer in The University of Michigan's Engineering Summer Conferences (contact Thomas J. Schriber). This course is also offered in October, February, and May in the Washington, D.C., area (contact James O. Henriksen, Wolverine Software, Inc., Annandale VA). A five-day course is also given each summer at The Ryerson Polytechnical Institute (contact R. Greer Lavery, Ryerson Polytechnical Institute, Toronto, Ontario, Canada). And a five-day course including GPSS modeling is offered periodically at Ohio State University (contact Edward J. Dudewicz, Syracuse University, Syracuse NY).

8. THE GPSS TUTORIAL

The GPSS tutorial will present a basic set of GPSS blocks, then illustrate their use in a series of three graduated examples:

(1) a one-line, one-server queuing system with uniformly distributed interarrival and service times, no customer balking, and simple stopping conditions (the simulation stops after eight simulated hours, whether or not there are customers in the system at that time);

(2) a one-line, multiple-server queuing system, modeled by simple extension of the one-line, one-server system; and

(3) the one-line, multiple-server queuing system extended to include nonuniform interarrival- and service-time distributions, a customer balking condition, and realistic stopping conditions (no new customers are permitted into the system after eight simulated hours, but the simulation is permitted to continue until there are no remaining customers in the system).

These examples, and supporting explanatory materials, are contained in a 77-page tutorial chapter on GPSS written by Thomas J. Schriber for McMillan and Gonzalez (1973). The Winter Simulation Conference GPSS tutorial will be based on transparencies taken from figures appearing in this source.

The chapter is too long to reproduce here, but copies of the chapter will be distributed to those in attendance at the tutorial. Those not attending the tutorial are referred to McMillan and Gonzalez (1973). Interested persons who do not have access to McMillan and Gonzalez (1973) can obtain single copies of the chapter on request by writing Thomas J. Schriber, Graduate School of Business, The University of Michigan, Ann Arbor MI 48109.

REFERENCES

Andrews, RW, Schriber TJ (1978), Interactive analysis of output from GPSS-based simulations. In: H. J. Highland, N. R. Nielsen, and L. G. Hull (eds.), Proceedings of the 1978 Winter Simulation Conference, Association for Computing Machinery, New York, New York.

Birtwistle GM (1979), Discrete Event Modeling in Simula, McMillan and Company, London, England.

Bobillier PA, Kahan BC, Probst AR (1976), Simulation with GPSS and GPSS V, Prentice-Hall, Englewood Cliffs, New Jersey.

Computer Sciences Corporation (1973), GPSSTS: General Purpose Simulation System on CSTS, Computer Sciences Corporation, Los Angeles, California.

Degen RJ, Schriber TJ (1976), On the feasibility of using GPSS models in the simulation of hierarchical control systems. In: H. J. Highland, T. J. Schriber, and R. G. Sargent (eds.), Proceedings of the 1976 Winter Simulation Conference, Association for Computing Machinery, New York, New York.

Donovan TM (1976), GPSS Simulation Made Simple, Wiley-Interscience, Chichester, England.

Fishman GS (1978), Principles of Discrete Event Simulation, Wiley-Interscience, New York, New York.

Gordon G (1975), The Application of GPSS V to Discrete System Simulation, Prentice-Hall, Englewood Cliffs, New Jersey.

Greenberg S (1972), GPSS Primer, Wiley-Interscience, New York, New York.

Henriksen JO (1981a), GPSS - finding the appropriate world view. In: T. I. Oren, C. M. Delfosse, and C. M. Shub (eds.), Proceedings of the 1981 Winter Simulation Conference, Association for Computing Machinery, New York, New York.

Henriksen JO (1983b), State-of-the-art GPSS. In: Proceedings of the 1983 Summer Computer Simulation Conference, Society for Computer Simulation, LaJolla, CA, pp. 918-933.

Henriksen JO, Crain R (1983c), GPSS/H User's Manual, 2nd Ed., Wolverine Software, Inc., Annandale, Virginia.

IBM (1977), APL GPSS (Form Numbers G320-5745 and SH20-1942), International Business Machines, Inc., Armonk, New York.

IBM (1981), PL/1 GPSS (Form Number G320-6398), International Business Machines, Inc., Armonk, New York.

Lefkowits RM, Schriber TJ (1971), Use of an external optimizing algorithm with a GPSS model. In: L. Boelhouwer (ed.), Proceedings of the 1971 Winter Simulation Conference, Association for Computing Machinery, New York, New York.

Maisel H, Gnugnoli G (1972), Simulation of Discrete Stochastic Systems, Science Research Associates, Palo Alto, California.

Martin D (1981), GPSS/VAX Reference Manual, Simulation Software Design and Development Co., London, Ontario, Canada.

McMillan C, Gonzalez RF (1973), Systems Analysis, 3rd Ed., Richard D. Irwin, Homewood, Illinois.

Pritsker AAB, Pegden CD (1979), Introduction to Simulation and SLAM, Systems Publishing Corporation, West Lafayette, Indiana.

Rubin J (1981), Embedding GPSS in a general purpose language. In: T. I. Oren, C. M. Delfosse, and C. M. Shub (eds.), Proceedings of the 1981 Winter Simulation Conference, Association for Computing Machinery, New York, New York.

Russell EC (1982), Building Simulation Models with SIMSCRIPT II.5 (Preliminary Printing), CACI, Inc., Los Angeles, California.

Schmidt B (1980), GPSS-FORTRAN, John Wiley & Sons, Inc., New York, New York.

Schriber TJ (1974), Simulation Using GPSS, John Wiley & Sons, Inc., New York, New York. (Also published in 1980 in Russian by Mashinostroyenie Press, Moscow).

Schriber TJ, Andrews RW (1979), Interactive analysis of simulation output by the method of batch means. In: H. J. Highland, M. Spiegel, and R. Shannon (eds.), Proceedings of the 1979 Simulation Conference, Association for Computing Machinery, New York, New York.

Sulzer JR, Bouteille P, Arquie P, Bouchet JL, Durand PY (1970), La Simulation: Initiation Pratique au GPSS, Enterprise Moderne D'Edition, Paris.

Weber K, Trzebiner R, Tempelmeier H (1983), Simulation Mit GPSS, Verlag Paul Haupt, Stuttgart, West Germany.