Chapter V
Simulation Languages

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computer simulation language

- A computer simulation language describes the operation of a simulation on a computer.
- There are two major types of simulation: **Continuous and discrete event** though more modern languages can handle combinations.
- Most languages also have a graphical interface and at least simple statistical gathering capability for the analysis of the results.
- An important part of discrete event languages is the ability to generate pseudo-random numbers and variates from different probability distributions.

Simulation Languages

- Discrete-event simulation languages, viewing the model as a sequence of random events each causing a change in state.
- AutoMod
- GASP
- GPSS
- SIMAN, a language with a very good GUI (Arena) developed by Rockwell Automation, Inc.
- SimPy, an open-source package based on Python
- SIMSCRIPT II.5, a well established commercial compiler
- Simula

Simulation Languages cont..d

- Continuous simulation languages, viewing the model essentially as a set of differential equations.
- Advanced Continuous Simulation Language (ACSL), which supports textual or graphical model specification
- Dynamo
- Simulation Language for Alternative Modeling (SLAM) (There used also be a Simulation Language for Analogue Modelling (SLAM))
- VisSim, a visually programmed block diagram language.

Simulation Languages cont..d

- Hybrid, and other.
- EcosimPro Language (EL) - Continuous modelling with discrete events
- Saber-Simulator - Continuous and discrete event capability. It simulates physical effects in different engineering domains (hydraulic, electronic, mechanical, thermal, etc.)
- Simulink - Continuous and discrete event capability
- SPICE - Analog circuit simulation
- Z simulation language
- Scilab contains a simulation package called Scicos
- XMLlab - simulations with XML
- Flexsim 4.0 powerful interative software for discrete event and continuous flow simulation.

Simulation Languages cont..d

- In the case of validation tools, several execution semantics have to be taken in consideration in order to perform global simulation:
- In Discrete Models (DM), the time represents a global notion for the overall system and advances discretely when passing by time stamps of events,
- In Continuous Models (CM), the time is a global variable involved in data computation and it advances by integration steps that may be variable.
- In discrete models, processes are sensitive to events while in continuous models processes are executed at each integration step.

Simulation Languages cont..d

- Currently, co-simulation is a popular validation technique for heterogeneous systems.
- This technique was successfully applied for discrete systems, but very few applied it for C/D systems.
- The cosimulation allows joint simulation of heterogeneous components

Simulation Languages cont..d

- The Advanced Continuous Simulation Language, or ACSL (pronounced "axle"), is a computer language designed for modelling and evaluating the performance of continuous systems described by time-dependent, nonlinear differential equations.
- It is a dialect of the Continuous System Simulation Language (CSSL), originally designed by the Simulations Council Inc (SCI) in 1967 in an attempt to unify the continuous simulations field

Discrete System Simulation

- Discrete Event Simulation (DES) concerns the modelling of a system as it evolves over time by representing the changes as separate events.
- In discrete-event simulation, the operation of a system is represented as a chronological sequence of events.
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Discrete System Simulation Languages

AutoMod

- AutoMod simulation software meets the needs of equally the casual, first-time user and the fulltime simulation model builder.
- easily and accurately simulate systems of any size or level of detail, from manual operations to fully automated facilities.
- AutoMod is a world leading software for simulation of production and logistics systems.
- The software is designed for detailed analysis of operations and flows.
- Although mainly used in manufacturing and material handling systems analysis, AutoMod's flexible architecture allows it to be used in a wide range of application areas, from airports to semiconductor industry

AutoMod cont..

- **Application/ Benefit**
- User-friendly, detailed 3D-animation, capable simulation and numerous analysis options are the keywords of AutoMod.
- AutoMod offers a variety of probable applications due to its very efficient simulation core.

Discrete System Simulation Languages

Arena

- Arena is a discrete event simulation software simulation and automation software developed by Systems Modeling and acquired by Rockwell Automation in 2000.
- It uses the SIMAN processor and simulation language. As of 2010, it is in version 13.0.
- It has been suggested that Arena may join other Rockwell software packages under the "FactoryTalk" brand.
- In Arena, the user builds an experiment model by placing modules (boxes of different shapes) that represent processes or logic.
- Connector lines are used to join these modules together and specifies the flow of entities.

Arena cont..

- Arena is used by many large companies engaged in simulating business processes.
- Some of these firms include General Motors, UPS, IBM, Nike, Xerox, Lufthansa, Ford Motor Company, and others.

Implementation for Bank system

Simulation Engine Logic

The main loop of a discrete-event simulation is something like this:

Start

Initialize Ending Condition to FALSE.

Initialize system state variables.

Initialize Clock (usually starts at simulation time zero).

Schedule an initial event (i.e., put some initial event into the Events List).

"Do loop" or "While loop"

While (Ending Condition is FALSE) then do the following:

Set clock to next event time.

Do next event and remove from the Events List.

Update statistics.

End

Generate statistical report.

Block oriented simulation languages

- Block oriented simulation languages are based on the method of analogue computers.
- The system must be expressed as a block diagram that defines the interconnection of functional units and their quantitative parameters.
- "Programming" means entering the interconnection of the blocks and their description.
- Then the user adds statements and/or directives that control the simulation.
- The typical blocks available in most continuous block oriented languages are integrators, limiters, delays, multipliers, hysteresis, constant values, adders, holders, gain (coefficient) and other.

Block oriented simulation languages

- The alternative to a block structured language is an algebraic language, such as SIMSCRIPT or FORTRAN.
- It would be desirable to have a language which combines the advantages of both types of language without some of the disadvantages.
- QUIKSIM represents an attempt to produce.

GPSS (General Purpose Simulation Languages)

- General Purpose Simulation System (GPSS) (originally Gordon's Programmable Simulation System after creator Geoffrey Gordon.
- The name was changed when it was decided to release it as a product) is a discrete time simulation language, where a simulation clock advances in discrete steps.
- GPSS is less flexible than simulation languages such as Simula and SIMSCRIPT II.5.

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- GPSS is less flexible than simulation languages such as Simula and SIMSCRIPT II.5.
- These languages do not include some of the useful but more specialized features of previous languages (GPSS, CSL, SOL) especially interrogative sequencing statements such as “SEIZE (facility)” or “WAIT UNTIL (Boolean expression)”;

Advantages of Special Purpose Languages

- Simulation languages offer most (if not all) of the features needed in programming a simulation model resulting in a decrease in programming time which can often be significant.
  - Generating random numbers, that is U (0,1) random variables.
  - Generating random variables from a specified distribution.
  - Advancing simulated time.
  - Determining the next event from the event list (e) Adding records to, or deleting records from, a list.
  - Collecting and analyzing data.
  - Reporting the results.
  - Detecting error conditions.
- Simulation models are usually easier to change when written in a simulation language.
- They provide better error detection because many potential types of errors have been recognized and are checked for automatically. Since fewer lines of code have to be written, the chance of making an error will probably be smaller.

Advantages of General Purpose Languages

- Most modelers already know a general purpose language, but this is often not the case with a simulation language.
- General purpose languages are obtainable on virtually every computer, but a particular simulation language may not be accessible on the computer that the analyst wants to use.
- An competently written general purpose program may require less execution time than the corresponding program written in a simulation language.
- General purpose languages allow greater programming flexibility than certain simulation languages.

General Purpose Simulation Packages

AweSim

- AweSim is a completely new general-purpose simulation system.
- AweSim takes advantage of the latest in Windows technology to integrate programs and provide componentware.

GPSS/SLX

- GPSS/H is a very powerful simulation tool.
- It has a illustrious 20-year track record, and it has been used for a vast array of applications.
- We anticipate that it will be used for many more.
- While SLX is not a replacement for GPSS/H, it contains a lot of its spirit. For example, SLX's"zero tolerance" policy for errors was derived from a similar policy in GPSS/H.

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SIMPLE++

SimpSim is a simulator/assembler for the machine language as proposed in "Computer Science: An Overview" by J. Glenn Brookshear.

It features the following:

- Windows 95/98/NT/XP/Vista, no installation required
- Simulator with run, step and break functions
- Built-in assembler editor with syntax highlighting
- Built-in assembler
- Loading and saving of files (assembler and machine coded (byte code))
- Built-in assembler examples

Cont..

- Context sensitive helppages about virtually all items
- Extra www infopage (this can be set by the teacher of a particular course to point to a page, used for that course, with the latest information, hints and so on)
- Disassembler/trace window for stepping
- Output window to output text from a machine language program.
- No password or registration needed, so everyone can use it

SIMUL8

- SIMUL8 simulation software is a creation of the SIMUL8 Corporation used for simulating systems that involve processing of discrete entities at discrete times.
- This program is a tool for planning, design, optimization and reengineering of real production, manufacturing, logistic or service provision systems.
- SIMUL8 allows its user to create a computer model, which takes into account real life constraints, capacities, failure rates, shift patterns, and other factors affecting the total performance and efficiency of production.

SIMUL8 cont..

- A common feature of problems solved in SIMUL8 is that they are concerned with cost, time and inventory.
- SIMUL8 uses dynamic discrete simulation, which makes it possible to provide unambiguous and concrete results and proofs.
- The outputs of SIMUL8 simulation are “hard data”, values and statistics of performance parameters and metrics of the production system.

SIMUL8 cont..

Typical Inputs and Outputs

- These are the most regular parameters of a SIMUL8 model, which are set by the user to influence the conditions of simulated environment:
  - Cycle times
  - Production rate
  - Capacity of production equipment
  - Arrival/order rates
  - Production rates of production equipment

SIMUL8 cont.

- Statistics of production equipment failures
- The outputs of the simulation offer information about:
- Utilization of production equipment
- Identification of bottlenecks
- Production system performance
- Inventory levels

SIMUL8
cont..

Areas of Use

- to model any procedure where there is a flow of work, however the main areas of use are in manufacturing, health care, contact centers and supply chain.
- SIMUL8 can be used to simulate different kinds of:
- Manufacturing systems such as assembly line models or models of material flow during production.
- Logic systems such as model of manipulation with material between storage, manufacturing and expedition, models of storage expeditionary systems or models of logistic services for distribution centers.
- Administrative workflows such as model of received orders.
- Client service systems or service delivery such as model of customer attendance at banks, models of call center customer attendance or models of customer attendance at hypermarket cash desks.

Taylor

- Taylor II is a menu driven simulation package mainly used in manufacturing and logistics.
- It is developed for the analysis and quantitative evaluation of complex processes especially of those with a dynamic character.

Expression based Languages

- Expression oriented continuous languages are based on writing expressions (equations) that represent the mathematical model.
- The system simulated must be expressed by a set of equations.

Continues and Discrete Systems Simulation Languages

- In models for discrete event dynamic systems (i.e., DEDS models) state changes occur at particular points in time whose values are not known a priori.
- As a direct consequence, (simulated) time advances in discrete 'jumps' that have unequal length.
- continuous time dynamic systems (i.e., CTDS models), state changes occur continuously (at least in principle) as time advances in a continuous fashion over the length of the observation interval.

Selection of simulation Software

- Advice when evaluating and selecting simulation software
- Beware of “checklists” with “yes” and “no” as the entries, e.g. many packages claim to have a conveyor entity, however, implementations have considerable variation and level of fidelity.
- Determine whether the simulation package and language are sufficiently powerful to avoid having to write logic in any external language.
- Beware of “no programming required,” unless either the package is a near-perfect fit to your problem domain, or programming is possible with the supplied blocks, nodes, or process-flow diagram.

Simulation in Java

Java is widely used programming language that has been used extensively in simulation.

- It does not provide any facilities directly aimed at aiding the simulation analyst.
- The runtime library provides a random-number generator.
- It supports modular construction of large models.
- Simulation libraries such as SSG alleviate the development burden.
- Provides access to standardized simulation functionality and hide low-level scheduling minutiae.

Do…more