WORKING NOTE AC71

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SIMULATION MADE EASY -

YOUR INTRODUCTION TO GHOLA.

(OR : things may be simpler than they seem.)

GHOLA FOR BEGINNERS.

In any simulation system, things of two different sorts may be happening. Some things go on for a long time : balls keep rolling, planets keep orbiting, voltages change continuously throughout the whole, or, at least, long stretches of, the simulation experiment. We call these things continuous. Other things take but an instant; they happen, perhaps from time to time, but do nothing between the instants of their happenings : balls bounce or collide, switches are opened or closed, people arrive or depart. We call these things events.

Some systems are completely continuous. Many mechanical or electrical systems can be represented by equations involving only continuous variables; so can populations, provided that they are big enough to make the effects of individual births and deaths insignificant. Other systems are composed entirely of events. Many simulations involving discrete objects moving between different places or states are of this sort : typically the simulations involve objects arriving in queues and waiting for service. The flow of traffic through a road system may be simulated in this way, as may the flow of jobs through an operating system.

In more complicated cases, both continuous variables and events may be needed to construct an accurate model of the real system. The event of opening or closing a switch may radically change the behaviour of an otherwise continuous electrical system. Events may arise from the continuous behaviour : two moving objects may collide, or a temperature may fall below freezing point. In Ghola, there is provision for both continuous and discrete behaviour. The terminology used is based on the model of events which happen in a context provided by the continuous components of the system. It is possible to have a context without events, or a set of events without a context, or both a context and a set of events : you can choose whichever is the more convenient form of description for each part of your system, and rely on Ghola to take care of the coordination. Whatever the details of the model, the Ghola system ensures that all the components are simulated by appropriate means, and that the whole system is properly coordinated so that each part depends on the others as described in the system definition.

MULTIPLE CONTEXTS : ADVANCED TOPIC.

For many systems, the facilities described so far will be adequate. This will usually be so if the events make no, or rather little, difference to the equations which govern the behaviour of the system (though even in this simple case you may need to be careful about identifying the precise moment of the event and handling its effects correctly). The effects of opening or closing a switch might be quite adequately represented by a conditional statement in the programme for the continuous part of the system, so that the transition is handled by the programme for the event simply as an assignment to the global variable switch-state. In other cases, though, an event may trigger a large change in the equations of motion of the continuous system. You can still handle that with the simple facilities if you like; but the result may well be a conditional with scope extending over a large part, or even the whole, of the programme. The behaviour of populations may be quite different at different seasons of the year; the behaviour of a chemical plant may be very different after gas escaping from a leak in a pipe has been ignited. In cases like this, it may be more convenient to think of a change from one context to another. In Ghola, you can define as many contexts as you wish, and switch them from active to dormant and back again as necessary.

It is instructive to consider how this context switching fits into the two examples. For the population, you may wish to define contexts for winter and summer, each containing the equations of motion appropriate to its season, and to switch beteen these contexts in events corresponding to the equinoxes. For the chemical plant, you may wish to retain a global context for most of the equipment which is not affected by the simulated accident, but to switch from a normal context for the affected part to a damaged context in the event representing the moment of ignition; then before the ignition the global and normal contexts would be active, while afterwards the global and damaged contexts would be active.