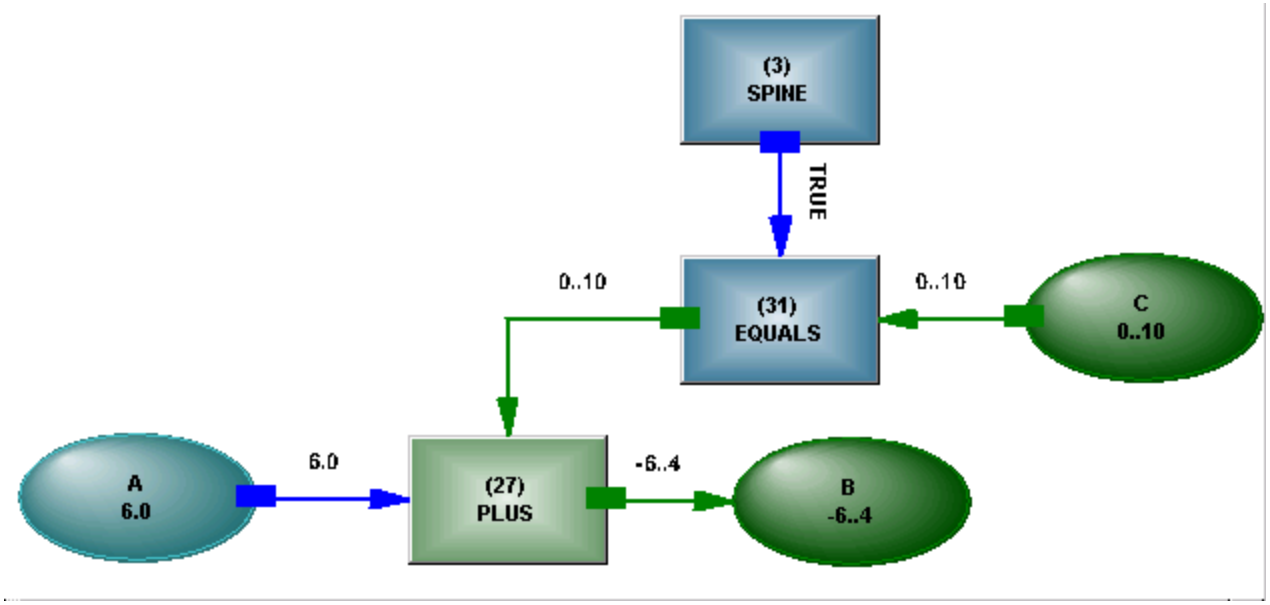
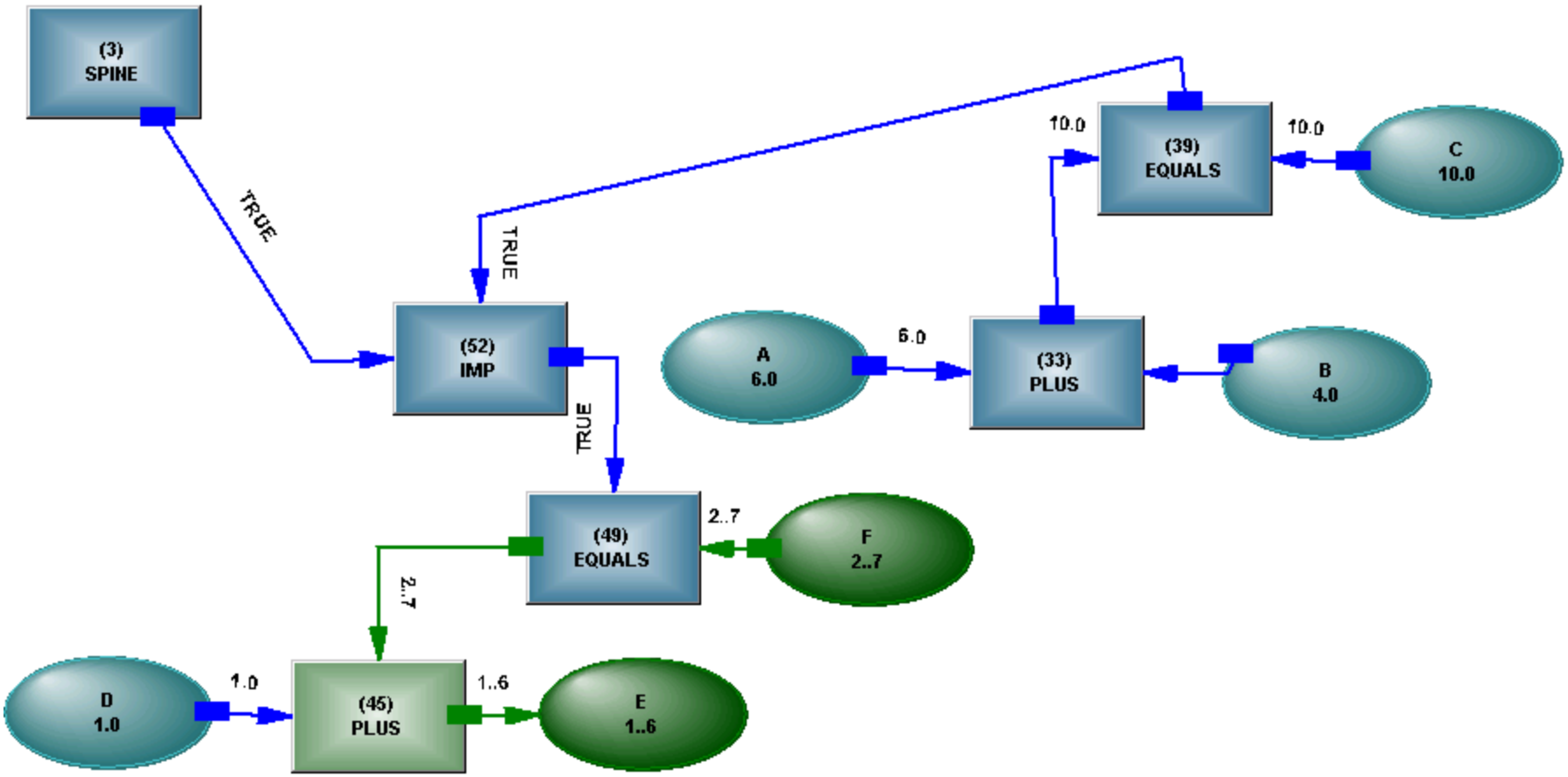
Active Structure



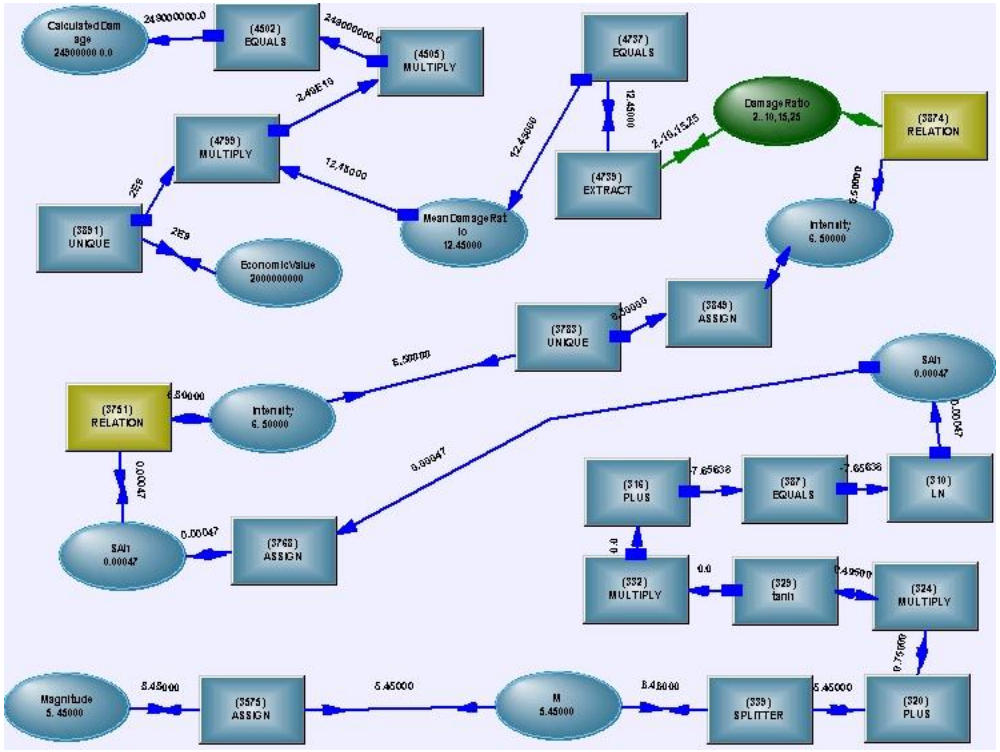
A + B = C

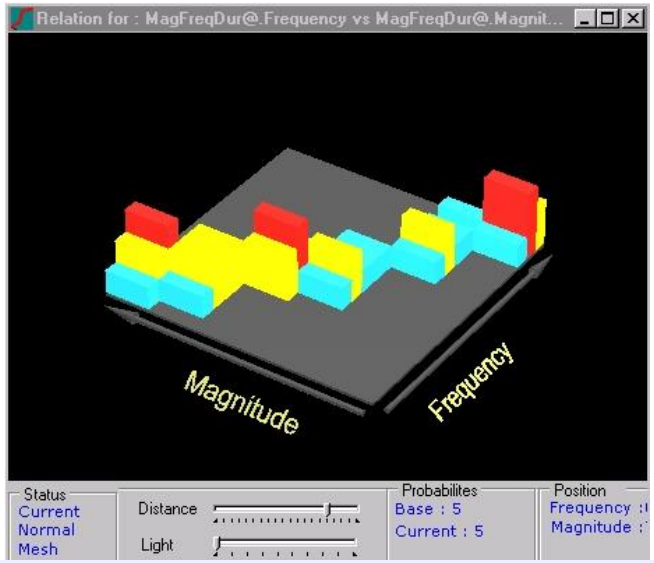
Logic and Numbers



IF A + B = C THEN D + E = F

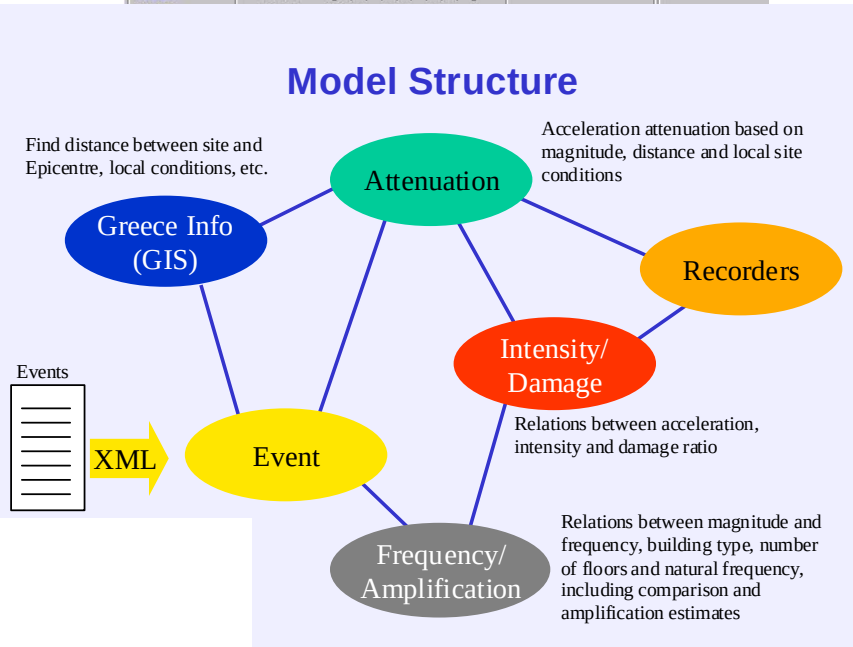
Earthquake Knowledge



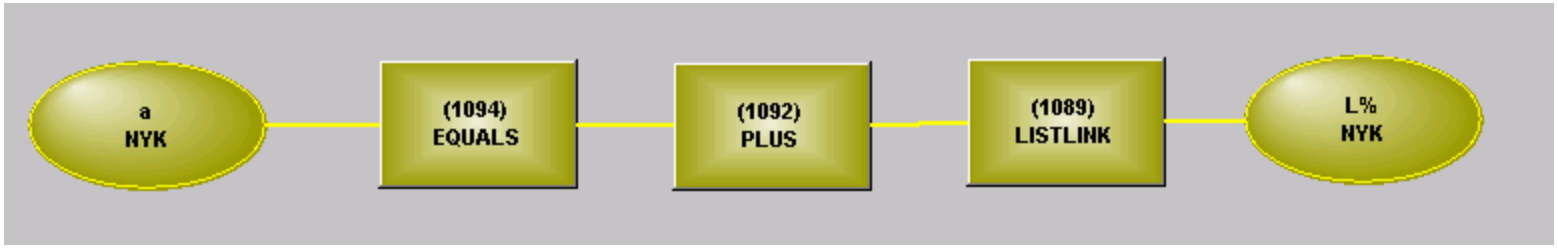


$$\ln(A_H) = -3.512 + 0.904M - 1.328\ln\sqrt{R_{SEIS}^2 + \left[0.149\exp(0.647M)\right]^2} + \left[1.125 - 0.112\ln(R_{SEIS}) - 0.0957M\right]F + \left[0.440 - 0.171\ln(R_{SEIS})\right]S_{SR} + \left[0.405 - 0.222\ln(R_{SEIS})\right]S_{HR} + \varepsilon \quad (3)$$

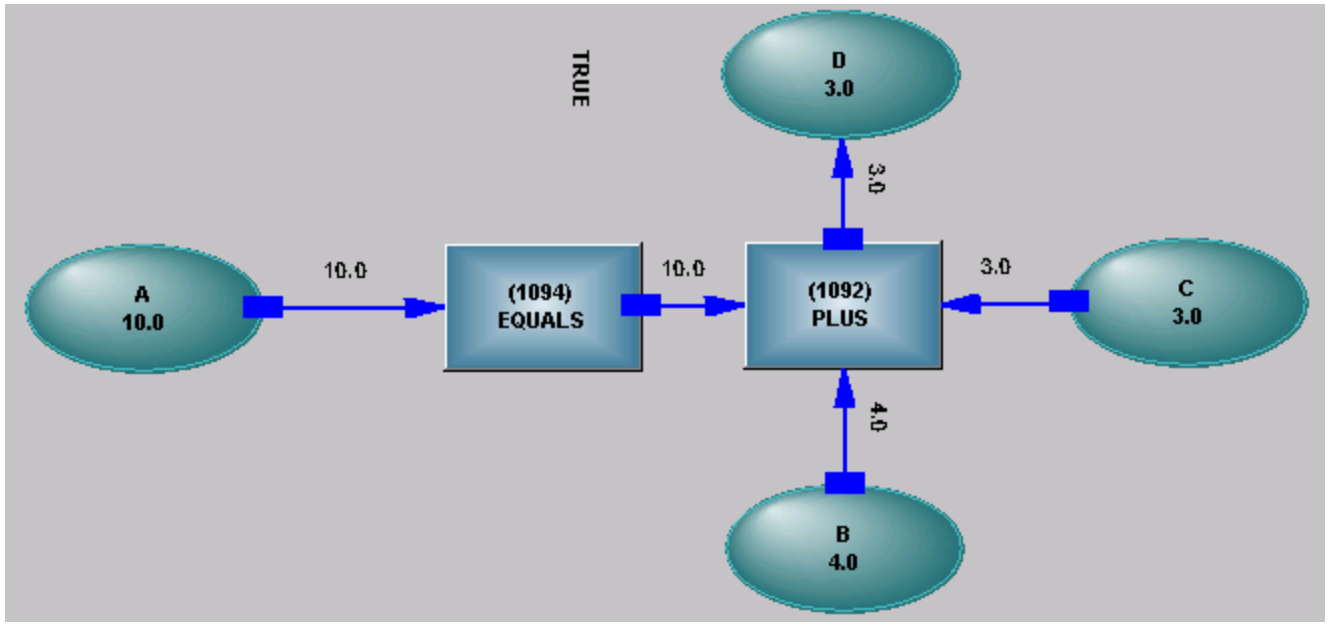
Model Structure



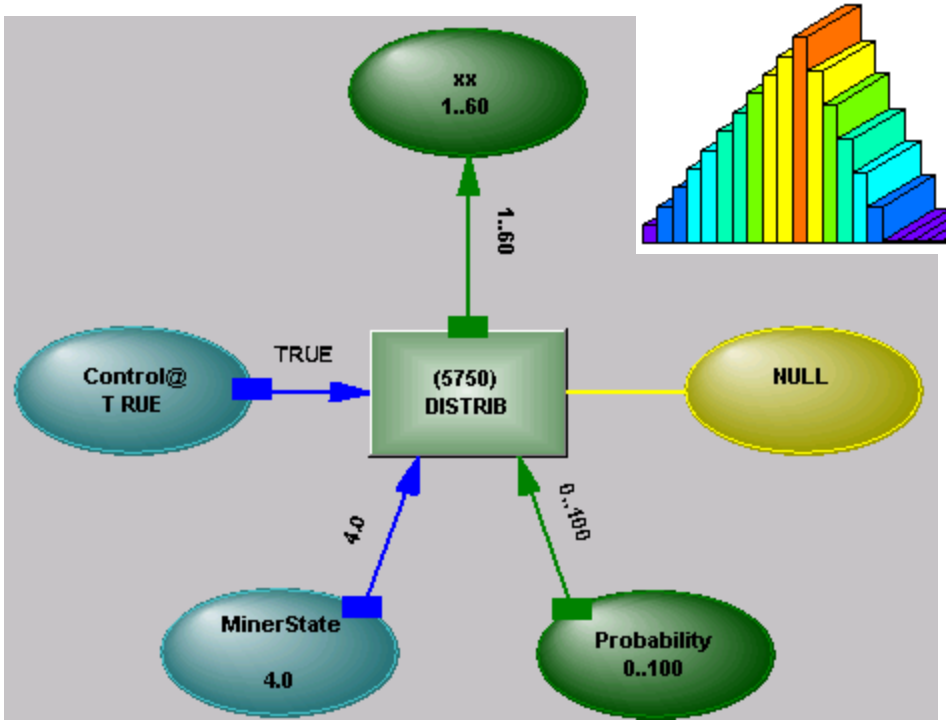
Self-Modification

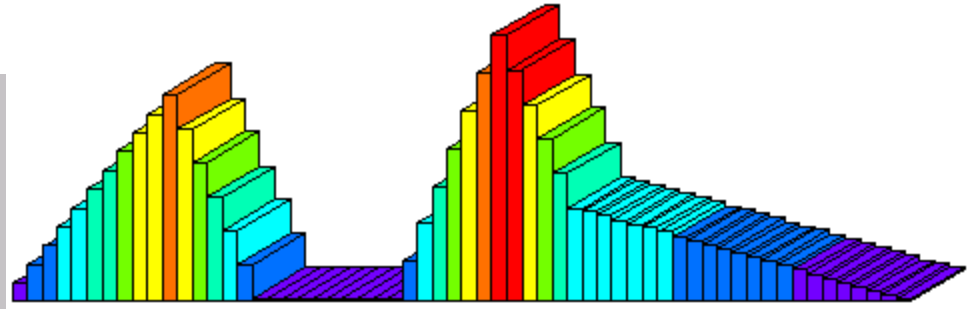


A = SUM(List)

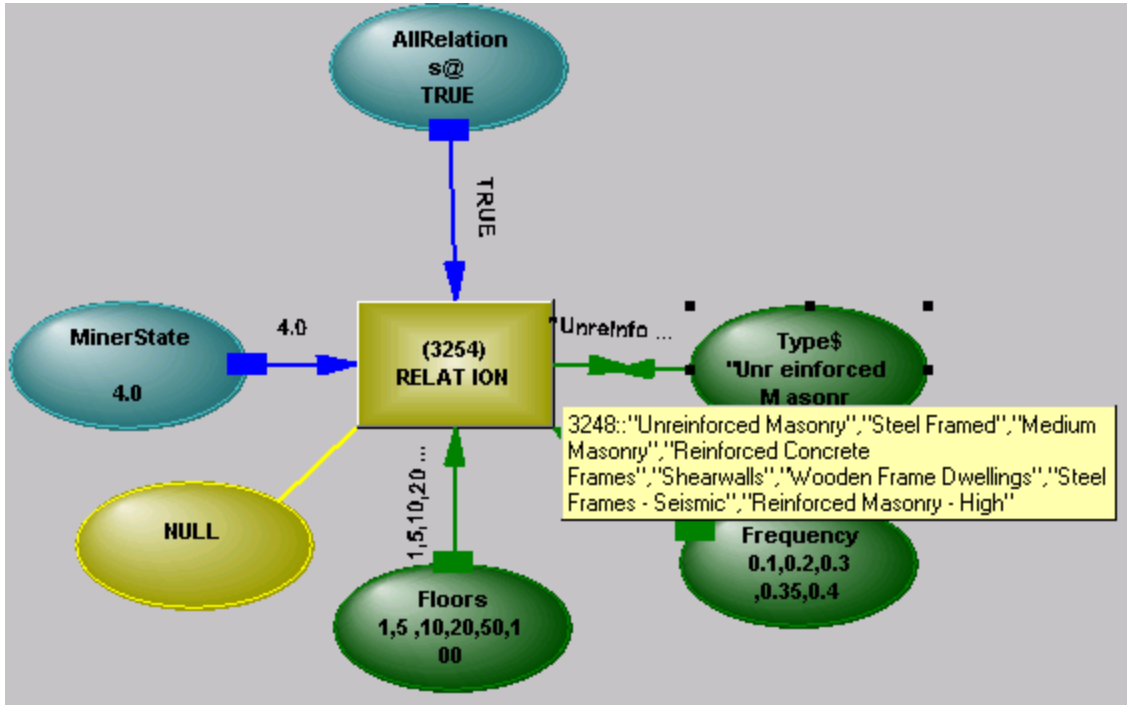


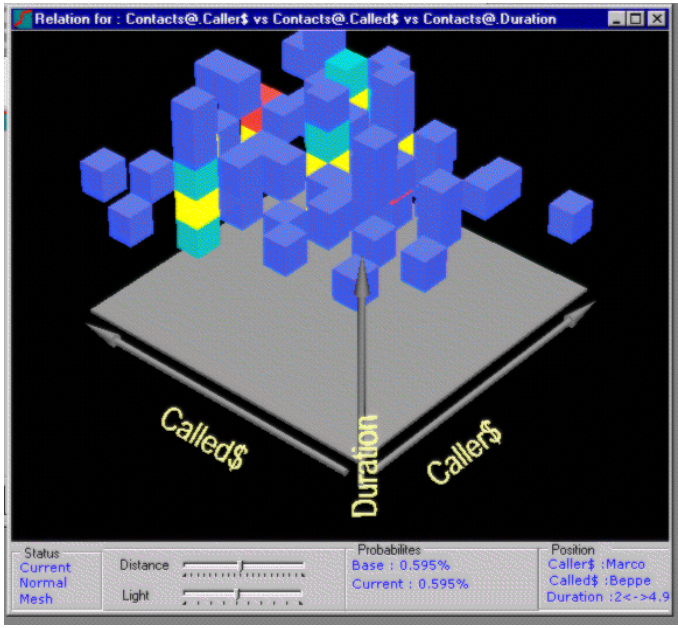
Controllable Distributions





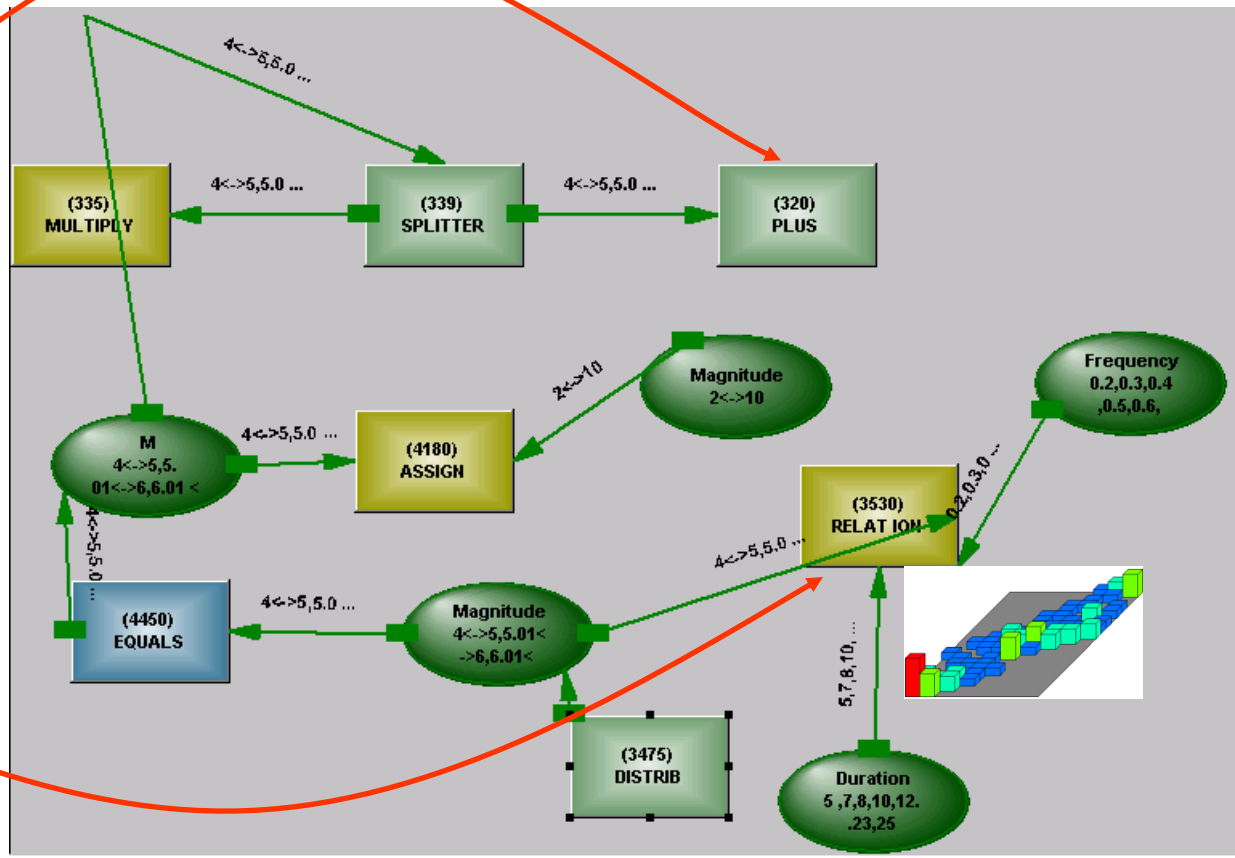
Controllable Correlations





Analytic and Experiential Structure

A variable can have a PLUS operator on one side and a RELATION on the other.



Structural Analogs

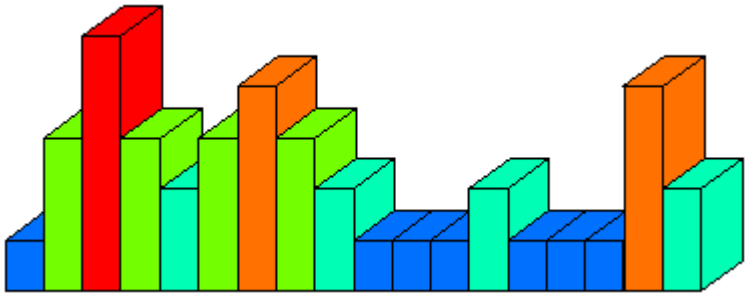
A structural method needs analogs of all instruction-based operations:

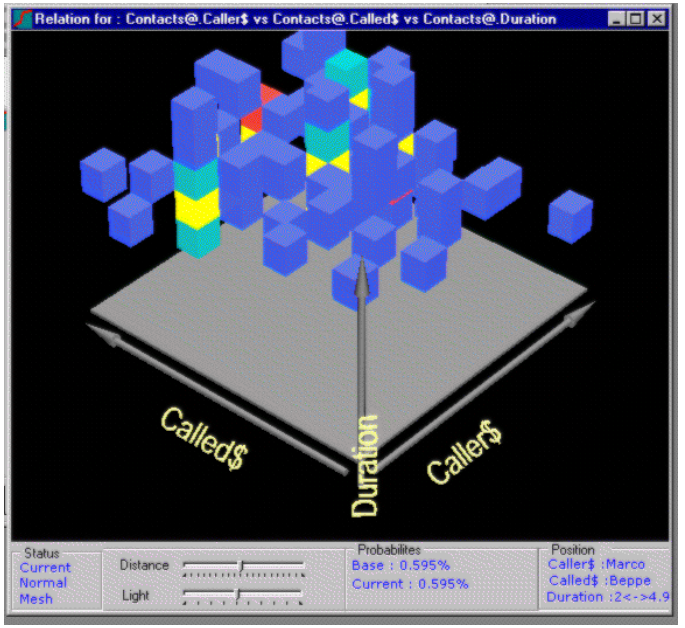
- FOR Loop
- Sequencing
- Creation and Destruction of Objects

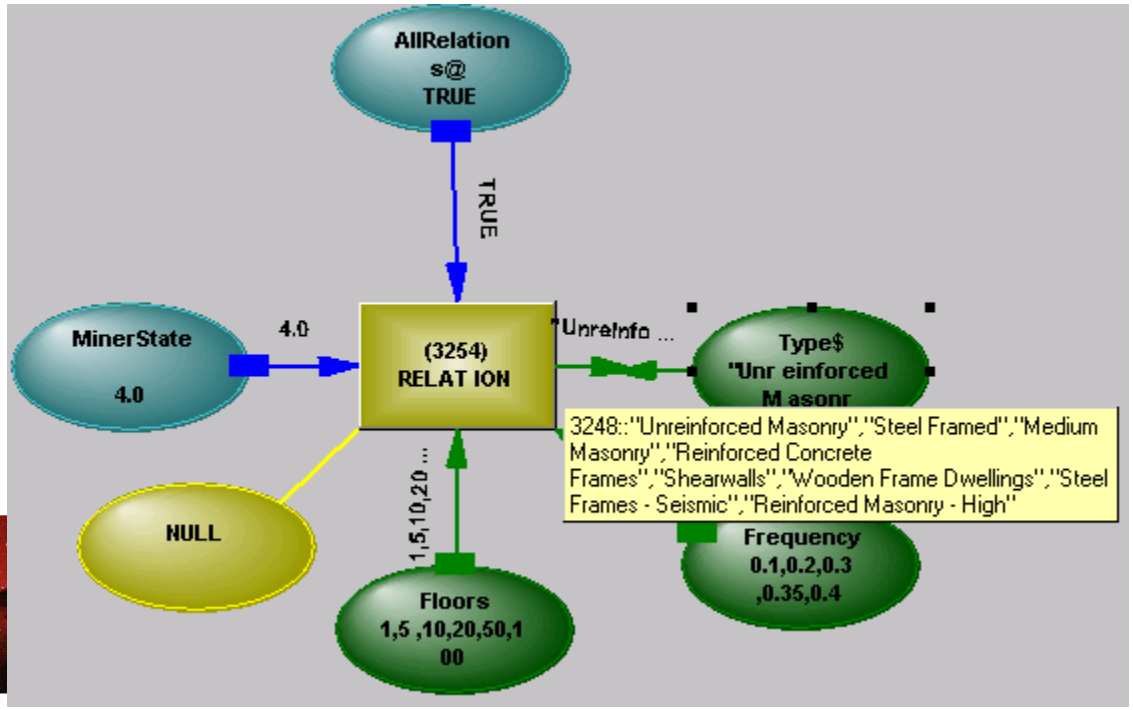
States are contained in a structure, rather than a stream of instructions is executed.

The Active Structure is visible and auditable, yet more flexible than the equivalent instruction stream.

A Learning Structure



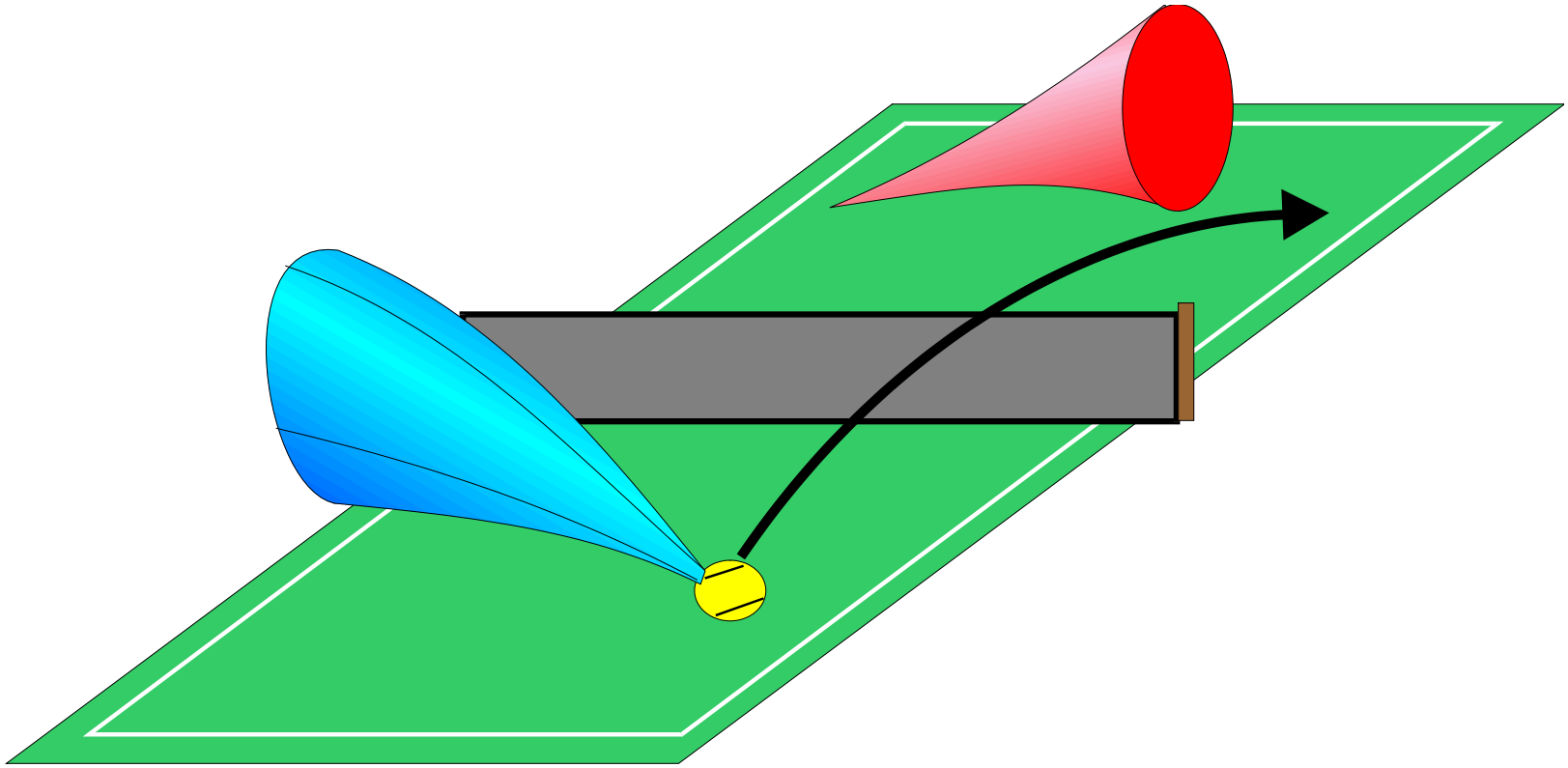




A Strategy

The tennis player uses a complex predictive strategy in what looks like a simple game

Bringing to a Point



A decision must be made, but every factor should play its part in the decision process, including what will happen soon

The Tennis Analogy

The analogy is very close - we have a complex system moving through time in an environment it does not fully control.

- There are severe local and global energy constraints.
- Striving too hard to reach an immediate goal may cause it to be out of position for the next cycle.
- The most desirable position is changing over time.
- The system needs to continuously observe the current state and predict future events before making decisions.

Playing at Another Level

The tennis analogy only works so far.

In comparison, you are playing on a field that is changing its shape, and the rules of engagement keep changing as well.

Even more reason to bring more information into focus before making decisions.

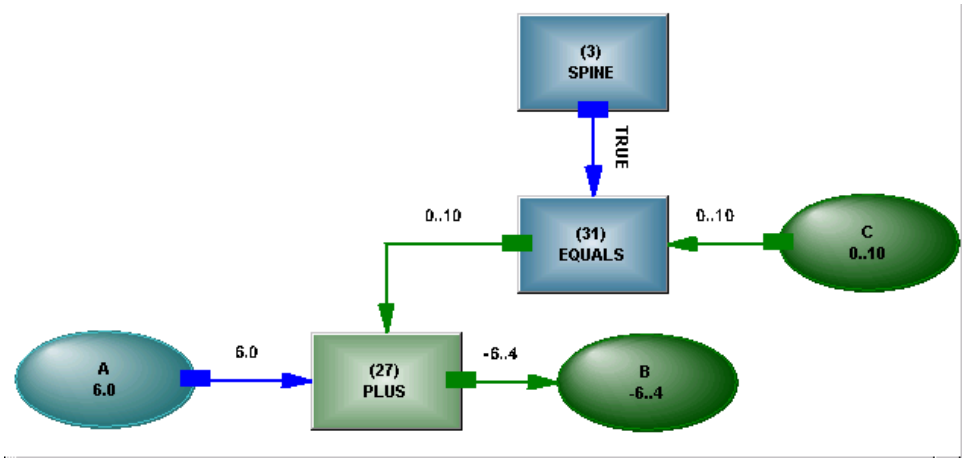
The Single Value Method

Single value methods may be fine for historical analysis, except that we are never sure exactly what happened in the past.
They are not appropriate for complex systems moving through time - decisions are made too early and too little information can be brought into focus.

Complex Messages

If we increase the complexity of the messages being transmitted, we can delay any decision until more information is available at a focus

Deciding on a single value before we need to seems to be simpler, but we are limiting the complexity of our decision-making if we do that - we are solving an artificial problem, not the real problem



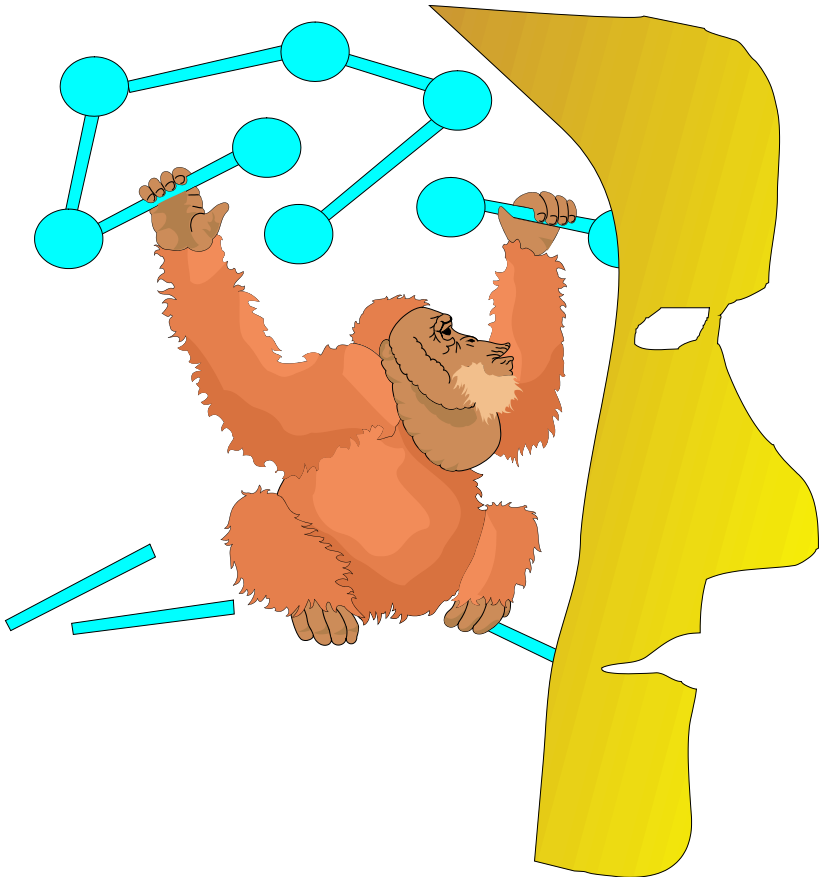
Interacting Influences

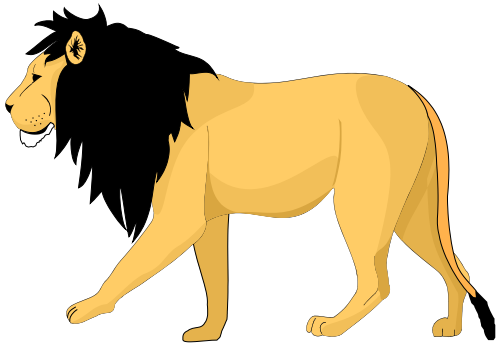
Consider the tennis player.

- A ball with partially known trajectory and spin
- The position of the opposing player
- A choice of stroke - volley, lob, drop shot
- A collision course with the racquet is plotted, based on the player's position, speed and physical limits

All brought together and processed on the run, with increasing precision until the moment of impact, and then accuracy at the 99.9% level. A single number in a register or using static states in a resistor network (ANN) sound slightly inadequate in comparison.

Active Structure

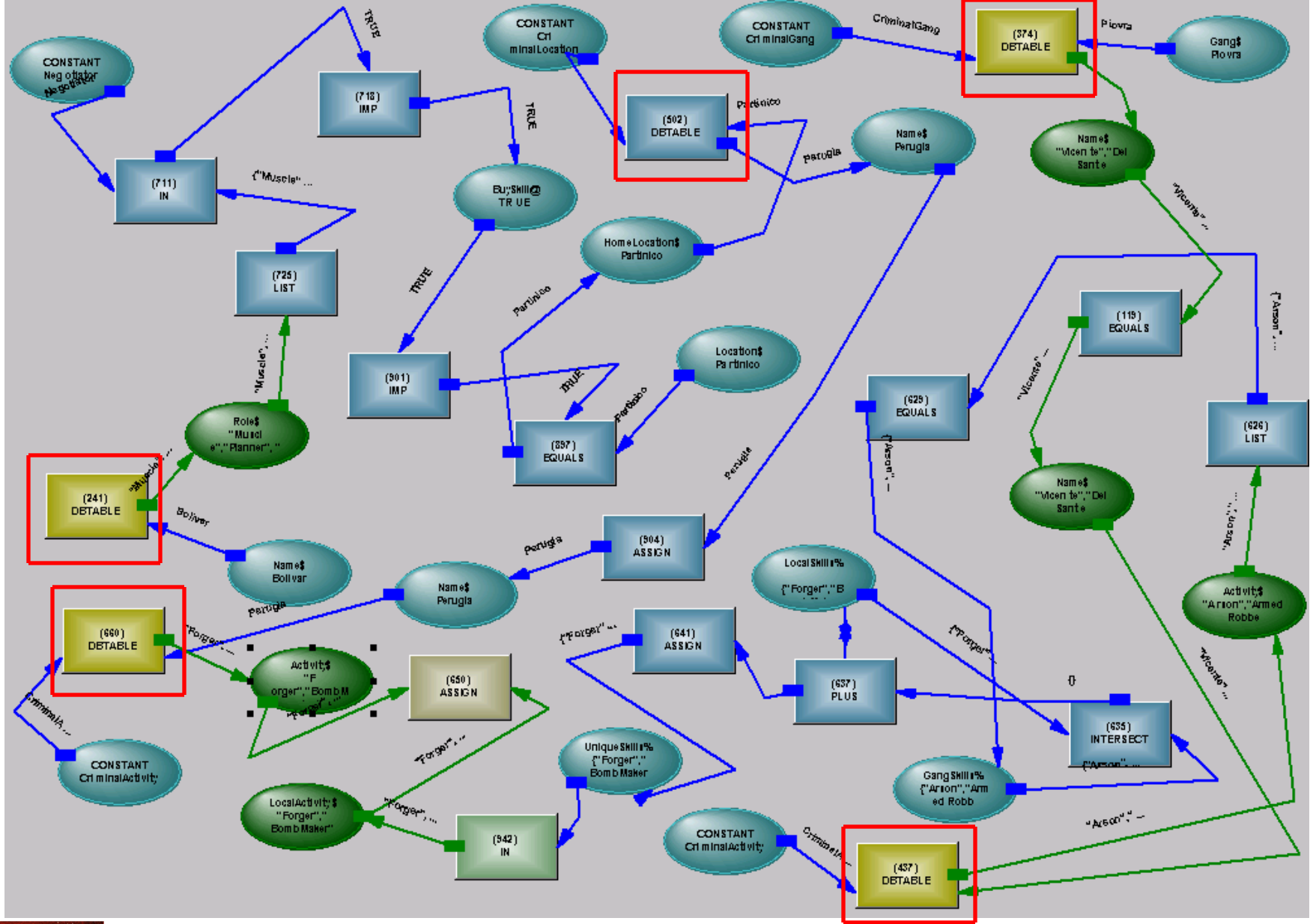




We build an internal model of the world, so we can predict future behavior - we make the model out of structure so we can combine it with other structure - we pass complex messages through the structure

Risk Analysis based on Coincidence of Real and Potential Events

"Don Marcello arrested"
"Bolivar seen in Teracino"



One event may cause analysis and generation of other events, which may provide a link to a catastrophic event

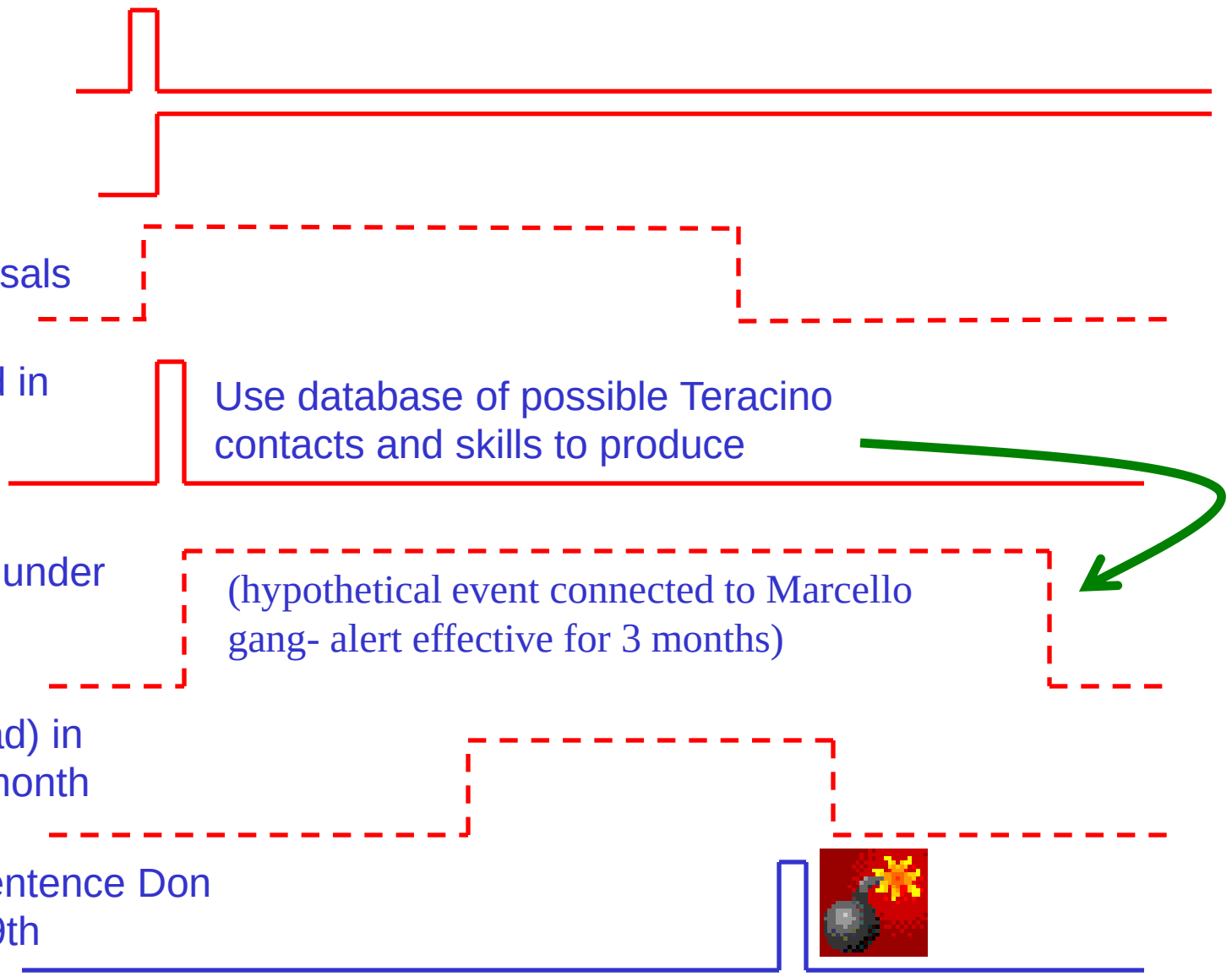
The red and blue indicate criminal and police events.

Criminal humint says “something will happen”, so we assume something bad.

The importance of handling time intervals such as “this month” or “next week” should be emphasised.

The system handles alternatives for people, places, times, actions - so it can easily see where events may collide.

Events Colliding



Compromise

When you build a model, most of it is straightforward.

But there will come a point where you need to do something subtle, something the toolbuilder didn't allow for.

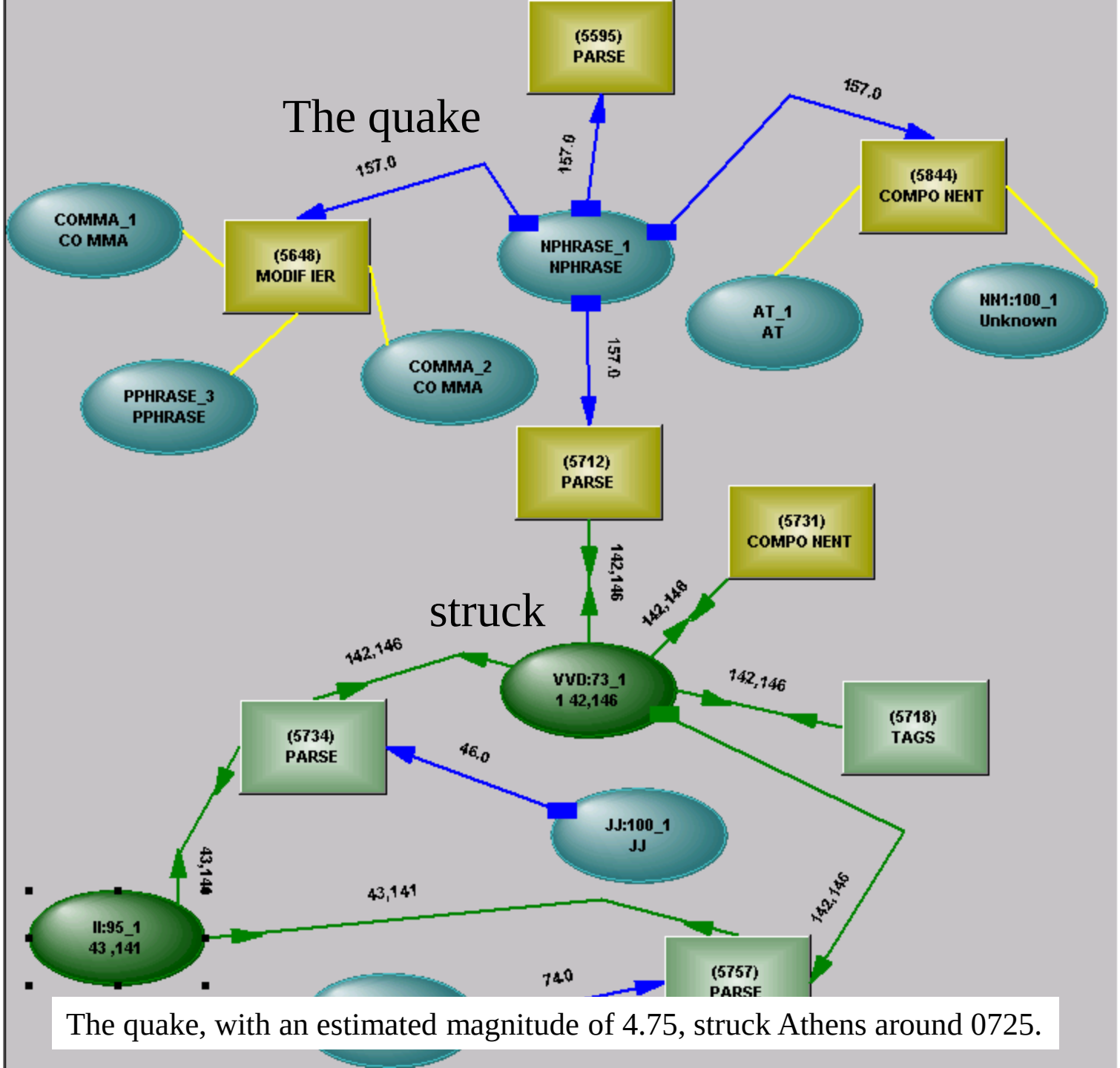
Then you have to twist the problem to suit the tool - you are constrained by the concepts embodied in it - how it works.

Very soon you are trying to solve someone else's problem, not your own.

Are you using a $100 algorithm to run a billion dollar business?

A network of operators linking parts of speech is being used to disambiguate the sentence before integrating it into knowledge about earthquakes.

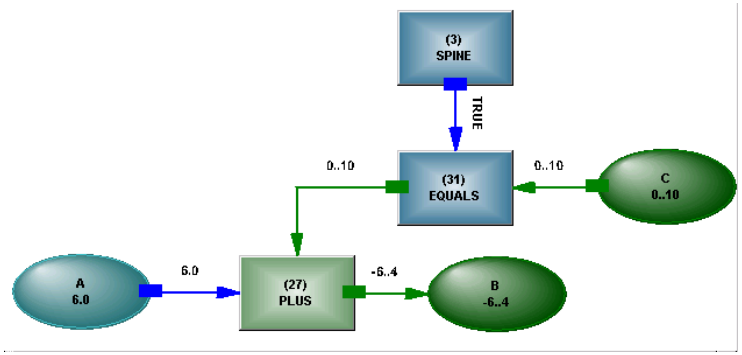
This part of the network is dynamic, and will disappear on completion.

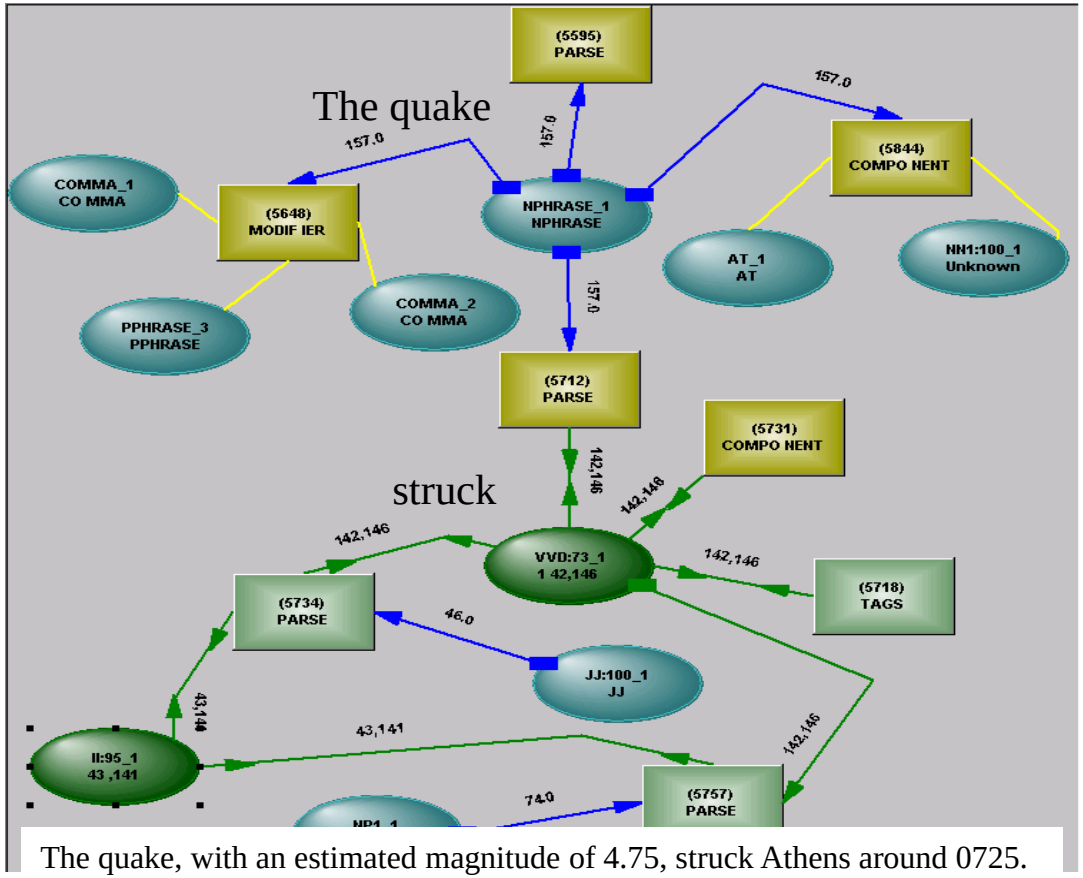


The quake, with an estimated magnitude of 4.75, struck Athens around 0725.

From Static to Dynamic

The Active Structure formalism spans from static formulae to the most demanding dynamic analysis - in other words, no compromise needed





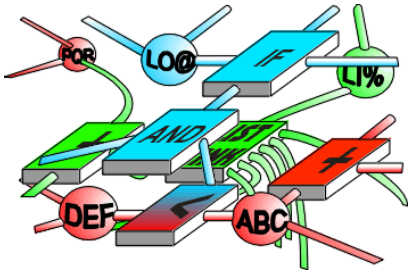
The quake, with an estimated magnitude of 4.75, struck Athens around 0725.

What's the Point?

We need to build structure to handle every state transition - we can't use the crutches of 'directed dataflow' or 'natural order of calculation'.

If we do this, we can handle complex and dynamic interactions beyond the reach of programming

The structure can be modified on the run, it can see itself and can adapt and extend itself, it can backtrack out of a scenario it has constructed and analyzed.



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