Legend

An actor based ground truth simulator

Ryan Stepanek

Legend - Summary

The goal of the Legend project is two-fold:

1) Empower Subject Matter Experts (SMEs) to build their own agent based simulations without the assistance, or with reduced assistance, from a modeling specialist or computer scientist.
    a) Legend achieves this by allowing flat file construction of complicated concepts through intuitive data structures.
2) It must be capable of scaling to meet the needs of the end user.
    a) Using actor based modelling, the Legend system is inherently distributed, allowing it share intensive workloads across different systems and processors.

Legend - Input Files

Each Legend simulation has 6 input files:

1. Sim.config - The config file for the simulation
2. Event List - A list of predetermined events set by the user
3. KML File - A KML file that holds a list of sites and areas of interest
4. Entity File - A file that holds the templates for entity types
5. States File - A file that holds the data for all states of all entities
6. Process File - A file that holds all process data (the graph relationships of states)

*The next planned improvement is to allow splitting of files 2,4,5,6 to load from multiple directories as this will allow for a better user experience

Legend - Input Files (Sim.Config - Part 1)

The Sim.Config file is the first file loaded in every sim run. It loads the following parameters:

start_date = A start date for the simulation. It can be specified down to the second i.e. 2017-05-05 17:21:00

end_date = An end date for the simulation. It can be specified down to the second i.e. 2017-05-08 17:23:01

out_file = The location of the INFO level log file, contains information on the overall system status and progression.

warn_file = The location of the WARN level log file, contains warning which could cause unexpected behavior.

error_file = The location of the ERROR level log file, contains errors which are usually fatal to the simulation.

event_file = The location of the EVENT level log file, contains most of the output of the sim.

kml_location = The location of the scenario kml file.

Legend - Input Files (Sim.Config - Part 2)

The Sim.Config file is the first file loaded in every sim run. It loads the following parameters:

entity_location = The location of the entity template file.

states_location = The location of the states file.

process_location =The location of the process file.

event_location = The location of the user-defined event file.

server_uri = The address of a server to stream EVENT level data. If this is not set, the system will not stream data.

Legend - Input Files (Event File)

Every Legend run must have at least one event (a “spawn” event) defined in an event file. A valid Event File has the following columns (tab delimited):

time - The time at which the event occurs, can be sim time (milliseconds since start) or real world time.

Event - The event to throw and its args.

Number - The number of times to insert an event of this type and args into the queue.

i.e.

```
time      event    number
1         Spawn(entity=test_tank,location=Hangar)          1
3         Spawn(entity=test_tank,location=Runway)          2
2017-05-05 17:23:00     Spawn(entity=test_tank,location=Military Airport) 1
```

*At the moment, only the Spawn event is supported. In the near future, a Destroy event will also be supported.

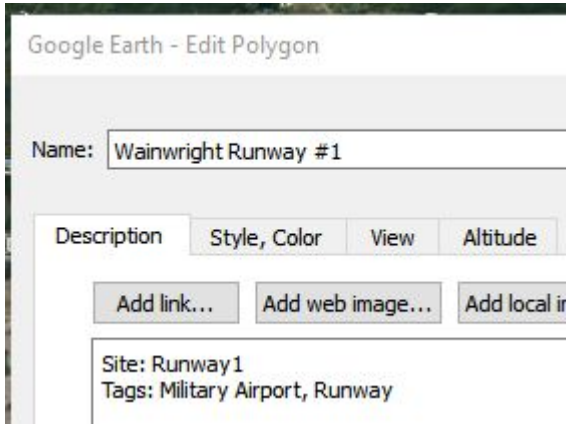
Legend - Input Files (KML File)

A KML file is a convenient way of storing geospatial information. It is highly recommended that you use a tool such as Google Earth to construct your KML file for input into the Legend system. Each entry in the KML should be a polygon which will be converted into a site.

A **site** is an area of interest where we can expect some event may occur i.e. Spawn, GoTo, etc… it is a way of instructing the internal system that a segment on earth, however large or small, is of interest to us and should be indexed and tagged.

In order for Legend to form a valid site from the KML the description property must be populated with at least one of the **site** or **area** parameters, the **tags** parameter is optional.

i.e.



*Currently sites are converted into rectangles equivalent to their bounding box to avoid expensive geometry computations at run time.

Legend - Input Files (Entity File)

The entity file holds all the templates for entities you wish to model in the sim i.e. B-52s, sedans, fire trucks, F-16s, etc… At the moment, an entity consists simply of name of the entity and its default process graph. When the Spawn event is issued, the system will check to make sure that “entity” argument matches the name of an existing entity type. All entity names must be unique.

i.e.

name = Firetruck

process = PutsOutFires

In the future, this will also contain the approximate dimensions and mass of the entity (used for modelling acceleration profiles) as well as any starting resources that it may have by default.

Legend - Input Files (States File)

The states file holds all possible states for all entities. A state represents an entity's state i.e. attributes such as speed for a certain duration. At present, all state names must be unique.

Duration (required) duration can be -1 to indicate an indefinite state, it can be a single value i.e. 4 hours, 3min,14sec, etc.. or it can be a range 1min-3days, 15s-3wks. It has a fairly intuitive parser for time units up to week lengths i.e. 52 weeks is OK, but 1 year or 12 Months is not.

Speed defaults to 0 if not specified. If no units are provided for the the speed, then kph is assumed. Currently supported units are kph,mph, and knots.

Directives are special events only scheduled upon entering a state, at the moment, the only supported user provided directive is GoTo which will make an entity move to either a point or a site with matching tags and then stop when it arrives.

I.e.

Name = State:test2
Duration = 4hrs
Directives = GoTo(location=Runway)
Speed = 10

In the future, additional parameters such as visible/hidden, yields and cost (for modifying resource values), tags (selection of states during for run-time creation of processes), time frequencies for modelling PoL (Pattern of Life) behavior will be supported, and messaging will be supported.

Legend - Input Files (States File)

The process file holds all of the processes within the simulation. Each process must have a unique name. A process is a network graph of states (nodes) and transitions (edges). Note that while syntax for message based transitions exists, it is not yet implemented internally within the system.

A transition is a connection between two states with some probability. When a state has run its duration the process graph is checked to determine which state it should transition to next. At present you are allowed to enter probabilities for a state that do not sum to 1, this may cause unexpected behavior and is not recommended; it may be forbidden in future releases.

A transition may be of the form:
State1 -- 1.00 => State2

Or it may be an entrance transition i.e.

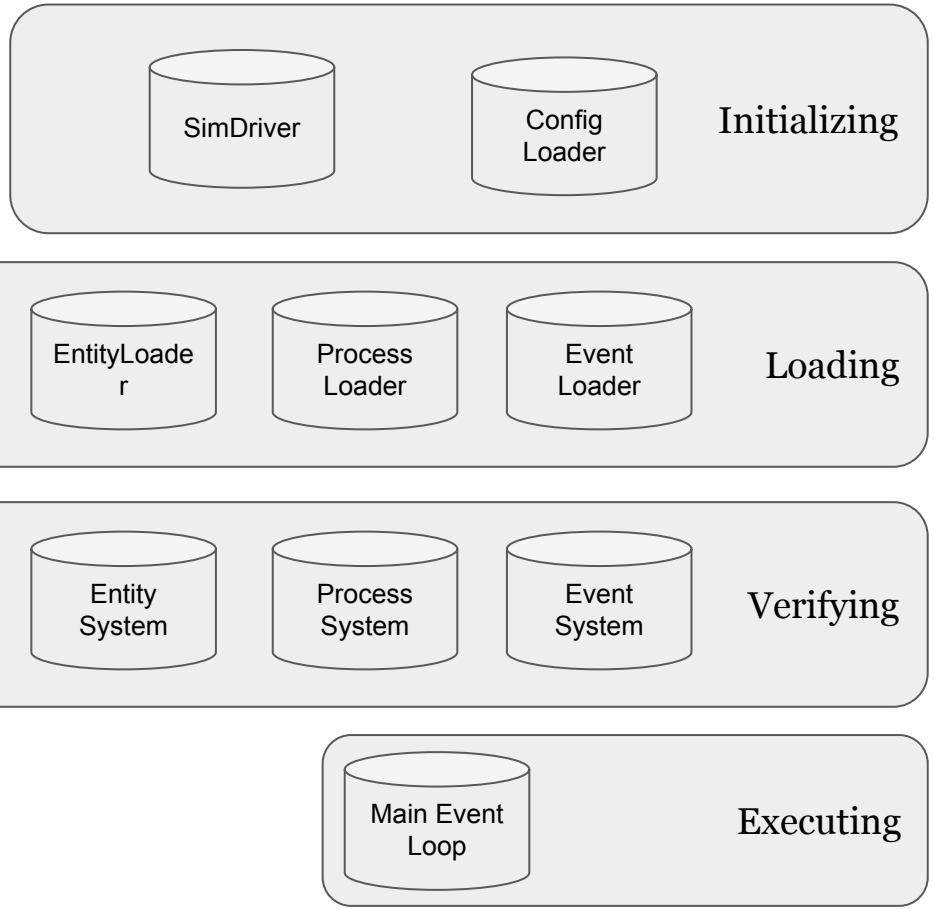
0.80 => State:test
0.20 => State:test2

(a transition upon entering the process graph)

Sample Process File entry

```
Name = Process:test
0.80 => State:test
0.20 => State:test2
State:test -- 1.00  => State:test2
State:test2 -- test_message -- 1.00 => State:test
State:test2 -- test_message1;test_message2 -- 1.00 => State:test2
State:test2 -- 0.30  => State:test
State:test2 -- 0.10  => State:test2
State:test2 -- 0.60  => State:test3
State:test3 -- 0.95  => State:test
State:test3 -- 0.05  => State:test2
```

Legend - Operating Phases



Loading is done in parallel using the config settings. Some minor verification is performed. Data is readied to be turned into sim objects.

Data is taken from the respective loaders and turned into real sim objects. This allows guaranteed verification of data before sim run.

SimEvents are processed and distributed to their respective systems until the SimEnd event it reached.

Note that the SimDriver is the only system to initialize other systems. In the future, the Geometry system will initialize subsystems called localities.