SCAMP User Manual
Chapter 4: Simulation Log Files

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This chapter explains each log file generated by SCAMP, organized by perspective (Table 1). The only required perspective is the CEG, and runs without other perspectives will not generate logs associated with those perspectives. Section 1 describes the contents of the first six logs, and how to use them to review a run for appropriate behavior. Section 2 describes how to visualize the movement of agents in the **agentTrack.csv** log. Section 3 describes the files that are not covered in the first two sections. The log files are in the SCAMP/logs directory, in a subdirectory named by the time of the run, e.g., `2021-01-27-09-59-02-345`.

Throughout this document, you will see the symbol ⚠ to indicate areas that in our experience merit particular attention.

Table 1. List of log files.

File Name	Perspective	Where Described
adjacencyMatrix.csv	CEG	Section 3
affs.csv	CEG	Section 1
agentGroup.csv	CEG, GEO, Social	Section 3
agentHistory.csv	CEG, GEO, Social	Section 1
agentMeetings.csv	CEG	Section 3
agents.csv	Social	Section 1
agentTrack.csv	GEO	Sections 1, 2
basePrefs.csv	CEG	Section 3
consoleLog.txt		Section 3
entropyLog.csv		Section 3
eventLog.csv	CEG	Section 3
features.csv	CEG	Section 3
fullPrefs.csv	CEG	Section 3
graphLog.txt	CEG	Section 1
groupChanges.csv	Social	Section 1
groupInfluencers.csv	Social	Section 3
groupNetwork.csv	Social	Section 3
hexmap.png	GEO	Section 2
implicitNetwork.csv	Social	Section 3
influences.csv	CEG	Section 3
meetings_ceg.csv	CEG	Section 3
meetings_geo.csv	GEO	Section 3
model.xml	CEG	Section 3
parameters.json		Section 3
realizedNetwork.csv	Social	Section 3
rouletteLog.csv	CEG	Section 3
satLog.csv	HGN	Section 3
snapshot.obj.gz		Section 3

In addition to the log files in Table 1, the first time you run SCAMP with a given **CEG.xml**, **<group>.hgn.xml, model.xlsx**, or **map.ora**, it generates a number of other files that you may find useful. The information in the xml files and **model.xlsx** is compiled into data/<modelName>/ **model.graphML.xml**, while the individual layers from GIMP in map.ora are extracted to separate png files in data/<modelName>/geo. And if you have a geospatial model (**map.ora**), you'll find three png files in your logs: **mapLayers.png** (a single view of all layers), **mapHexes.png** (the boundaries of the hexes into which the terrain is divided), and **mapCoordinates.png** (the coordinates of each hex).

1 Review the Run for Errors, Anomalies and Unexpected Behavior

1.1 Premature Termination

If the run ends too soon, it could be due to `transitTimes,` in the **delays** tab of **model.xlsx**.

1. Too many `transitTimes` equal to zero can cause agents to get caught in loops.

2. Too many long `transitTimes` can cause agents to visit only a small number of events before the sim time runs out.

Adjust the scores as needed and run the sim again.

1.2 graphLog.txt

The **graphLog.txt** file is used to check the structure of the CEG. It tracks three issues that can develop during construction of the CEG.

1. **<Group(n)> cycles detected:** Agents can get caught in a cycle and not continue to other events. This is more problematic among small sets of nodes. If three nodes form a cycle, add another event or additional edges to give the agent more choices when it selects its next event. If a cycle is composed of more than three nodes, make sure that each node has more than one outgoing edge. It may be necessary to add additional events.
2. **<Group(n)> can't reach the following # events from START:** This occurs if the incoming edges cannot be traced back to START. The events listed may not actually have this issue, but they still need to be checked. In addition, if an event id appears in the ToLoc column of the groupChanges tab of **model.xlsx**, it does not need to have any incoming agency edges, since agents can move to it via group changes.
3. **<Group(n)> can't complete path from the following # events:** This occurs when the outgoing edges do not reach the STOP node. The events listed may not actually have this issue, but they still need to be checked. In addition, if an event id appears in the FromLoc column of the groupChanges tab of **model.xlsx**, it does not need to have any outgoing agency edges, since agents can leave it via group changes.

Path enumeration in a large graph is computationally complex, and the heuristics we use may miss some anomalies, but you will want to examine the ones that it finds. Here is the process the modeling team uses to explore these issues:

1. Load **graphLog.txt** into the first column of a two-column table. The modeling team used Excel; Word would also work. The point is to allow you to supplement the information and explore its meaning.
2. Enter Events into the second column, next to the event ID numbers. Table 2 is an example from the sample model used in Ground Truth.[1]
3. Create subgraphs for each of the groups for which events need to be

Table 2. Example from the sample model used in Ground Truth: graphLog.txt file format after it is opened in MS Excel.

Graph Analysis for CEG data/SCAMP.CEG0073
Running graph analysis per group
At least 112218725 complete paths found for Government
Government cycles detected on:
E158 (govt improves its strategic military position)
E23 (government regains full control over functional aspects of governance & territorial rule)
E126 (government has tactical success)
Government can't reach the following 0 events from Start:
Government can't complete path from the following 14 events:
E129 (government rejects opposition's demands)
E132 (government thwarts military coup d'etat plan)
E224 (government seizes humanitarian aid)

[1] If you work in Excel, you can import event IDs and names from **model.xlsx** and use the xlookup() spreadsheet function to add the event descriptions automatically.

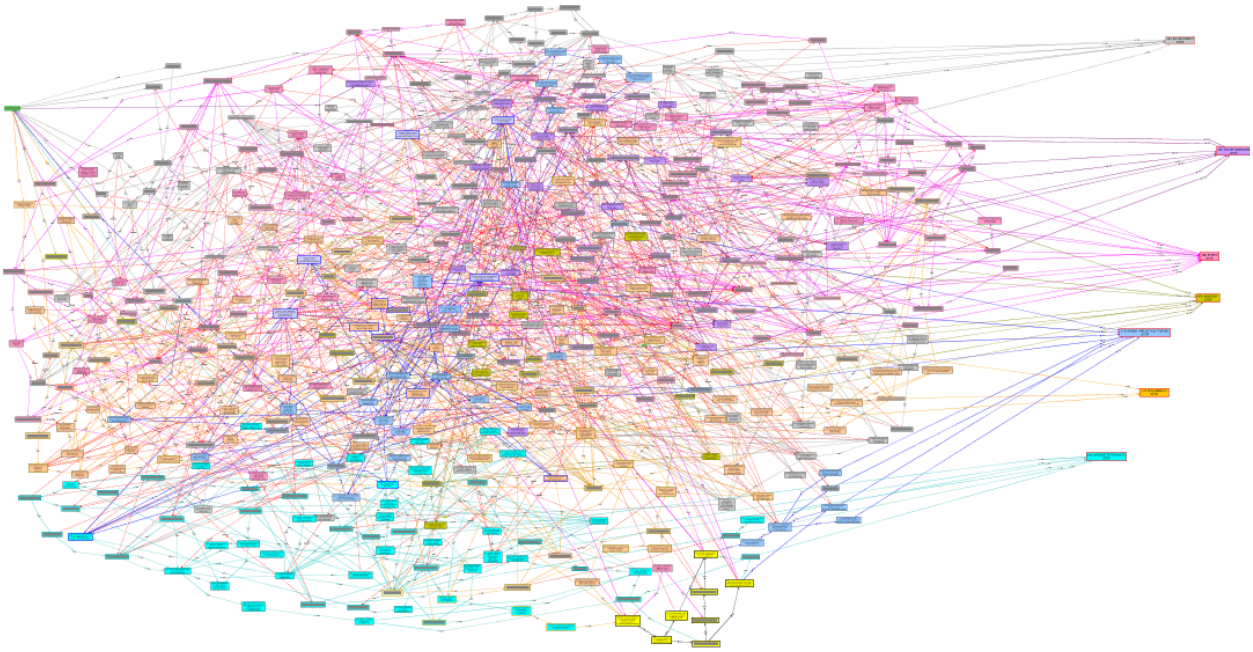

Figure 1. Example from the sample model from Ground Truth: The causal event graph consists of multiple subgraphs.

checked.[2]

a. Open **<modelName>.cmap**. Figure 1 is an example of a CEG from the sample model used in Ground Truth. It is too complex to be useful when reviewing **graphLog.txt**.
b. Save as CEG<version>.Group(n). CmapTools saves files automatically and will overwrite the original version with any changes.
c. Delete nodes that are not agented by that group(n), preserving nodes with shared agency between group(n) and other groups.
d. Save file.

4. For each group, check the CEG event(s) under each of the headings.

a. Cycles detected
   i. Highlight the events listed in **graphLog.txt** in each of the subgraphs.
   ii. Check for areas in the CEG that involve these events and that could result in an agent becoming stuck in a never-ending loop.
   iii. Cycles can involve any number of events.
   iv. Cycles that involve fewer events are more problematic and attempts should be made to fix them by editing edges.

⚠ For <Group(n)> cycles detected, focus on fixing cycles that are formed from a small number of events.

b. Can't complete path from the following # events. Nodes that don't have outgoing agency edges may be acceptable if group change rules can move agents from them (that is, if the event id appears in the FromLoc column of the groupChanges tab in model.xlsx). Otherwise, you've left the story hanging, and need to decide where it goes next (even if

[2] Another way to examine these subgraphs, without having to extract them manually, is to open data/<modelName>/model.graphML.xml (the compiled form of the input files that SCAMP actually processes) in CytoScape [1], an open-source network visualization tool. This file represents all of the input data in the form of graphs. One of these graphs is labeled "ceg," and the node information includes agency for each node. So you can select a subgraph based on agency and explore it through the CytoScape interface.

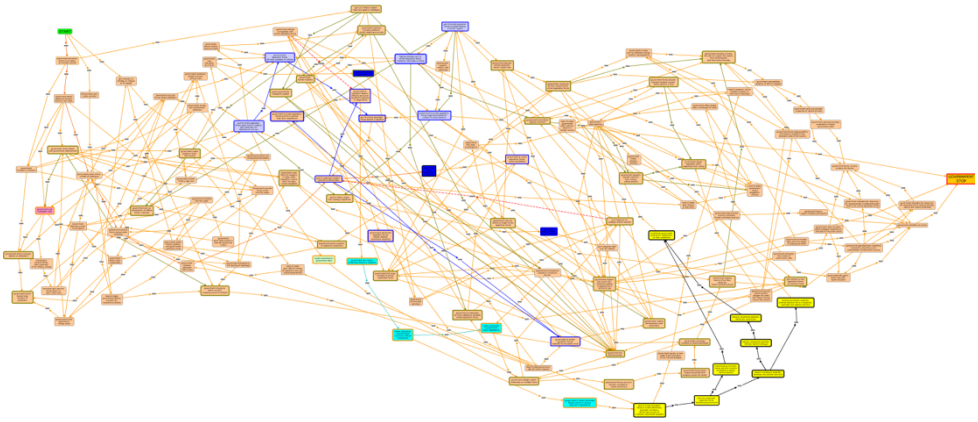

Figure 3: Subgraph with anomalous nodes marked

only to STOP).

i. Highlight the events listed in the **graphLog.txt** in each of the subgraphs. See Figure 2.

ii. Start with an incoming edge for one of the events and trace the pathway backwards to START, as shown in Figure 4.

iii. Next, start with an outgoing edge from that same event and follow the pathway to STOP, as shown in Figure 5.

iv. Add additional edges as appropriate.

v. For each event enter OK or FIXED into the second column of the two-column table.

vi. Save file.

c. Can't reach the following # events from START

i. Highlight the events listed in **graphLog.txt** in

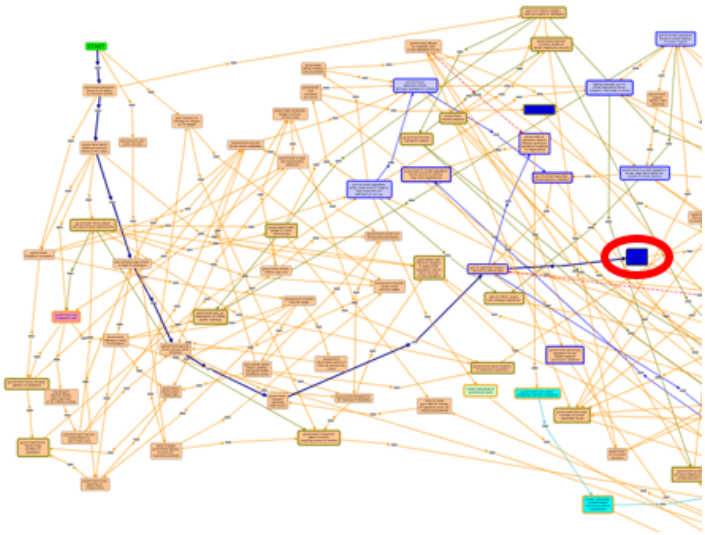

Figure 4. Example from the sample model used in Ground Truth: Path from START to the event circled in red is complete, as indicated by the bold blue edges

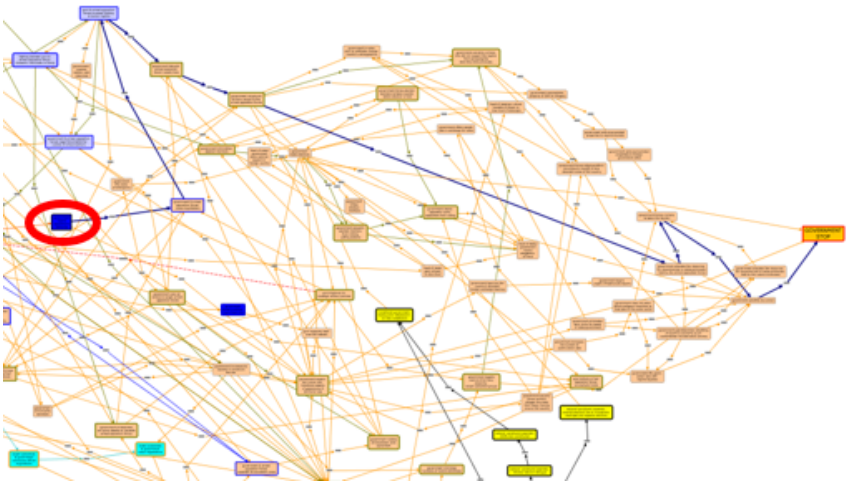

Figure 5. Example from the sample model used in Ground Truth: Path the event circled in red to STOP is complete, as indicated by the bold blue edges.

each of the subgraphs.

ii. Start with an incoming edge for one of the events and trace the pathway backwards to START. See 4.b, Can't complete path from the following # events.

5. Add edges, if needed.
6. For all of the events that were FIXED in the subgraph(s), make the same changes in the CEG. Then run the sim again before checking other files.
7. If the subgraphs do not have any changes, refer to the file created to avoid rechecking the same events in future sim runs.

Note that the sim run is not duplicated, so the list of events will not be the same, although there may be some overlap.

1.3 agentHistory.csv

⚠ agentHistory.csv records *when* avatars are moving to or from geospace. agentTrack.csv records *where* avatars are going in geospace.

SCAMP generates a line in this file each time an avatar makes a decision. **agentHistory.csv** only captures CEG event changes or when avatars are moving to or from geospace, but not where the avatars are going. The modeling team uses **agentHistory.csv**

1. To review the reasonableness of the CEG
   a. It contains details about the movement of each avatar in the run.
   b. It provides a time series of which agents participate in which events.
2. To identify which agents enter geospace and to visualize those agents' tracks in GIMP
3. To identify which events triggered a group change, as well as the type of group change that occurred

Table 2 lists the columns and definitions for this file. Here is additional information about `MsgType`:

Table 3. Columns and definitions for agentHistory.csv.

Column	Definition
Avatar	Identifies the agent described in each row
Group	The home group of the avatar
Tick	A measure used by the software team
TickInt	A measure used by the software team
DomainTime	The time at which the agent begins the event that leads to the MsgType
Dwell	The time an agent remains on an event in the number of days encoded as transitTime in delays tab of the model package file. The minimum value of Dwell is 0. It is computed at the start of the event or hex, and the log simply reports that cached value, whether the agent has reached it or not.
EventID	The number used to identify the event in the CEG
Event	The node in the CEG
MsgType	Describes the decision that the agent made while participating in the event
Location	The agent's location in the geospace hex lattice
Dest	The destination specified for a geospatial event in the dest tab of model.xlsx

1. Born means that record describes a new agent generated by the event. `Dwell` is 0 for Born records.
2. Dead means that the agent died during the event. The `DomainTime` for a `MsgType`. It also is the time that the agent entered the event that led to its death. `Dwell` on a Dead record is not meaningful.
3. FromGeo means that the agent has reached the geospatial goal of its current event, and is moving to its next event. ToGeo and FromGeo list the same event. `Dwell` on a FromGeo

record is not meaningful.
4. Moved means that an agent changed location. `Dwell` on a Moved record is not meaningful.
5. Proceed means that the agent has completed its participation in its current event, and is moving to its next event.
6. ToGeo means that the agent drops into geospace in order to complete the event. A subsequent line will report its return from geospace, with a `MsgType` FromGeo. The `Dwell` on a ToGeo record is not meaningful, but depends on how long it spends in geospace, and is recorded on the corresponding FromGeo record.
7. AbortGeo means that the agent did not reach its geospatial goal. In this case, its next event will be the same as its current one, and it will try again to reach its goal.
8. ChangedGroup means that the agent changed its home group, and thus its agency, based on this event.

1.3.1 Review the reasonableness of the CEG after a single sim run

1. Use Excel's data filtering capability to select a single agent of interest in **agentHistory.csv**
2. Be sure the remaining rows are sorted by `DomainTime`.
3. Examine the sequence of `Events` to be sure it makes sense.

1.3.2 Review reasonableness of the CEG after a multiple sim runs

If after several runs of the sim some events are never visited, do the following

1. Run the sim with zero determinism (see Chapter 3, Repast parameter Avatar Determinism) to see if the events are visited. Zero determinism means that agents move completely randomly, without regard to their preferences or the features of the events they choose. If all events are visited when determinism is zero, this means that the preferences you have specified exclude those events. If this result is not what you intend, adjust the preference score.
2. Run the sim with influence edges turned off (Chapter 3, Repast parameters Use Hard Influences and Use Soft Influences). It is possible to set up influence edges that make certain events inaccessible. For example, if two events *enable* each other, neither can be chosen by any agent until the other has been chosen, which means that neither one will ever be chosen. In this case, you may want to replace *enable* with *enhance*. *Prevent* influences can also cut off portions of the CEG, if the source events are always visited before any agents have a chance to consider the target events.

1.3.3 Identify which agents enter geospace and visualize those agents' tracks in GIMP

`MsgType` ToGeo indicates that an avatar entered geospace. `MsgType` FromGeo indicates that an avatar reached its destination in geospace and has returned to the CEG. Also see Section 2.

1.3.4 Identify which events triggered a group change, as well as the type of group change that occurred

Four `MsgTypes` indicate a group change (Table 4).

Table 4. MsgTypes that indicate a group change has occurred.

MsgType	Description
Born	An avatar has been created on that particular event
Died	An avatar was removed from that event and cannot return
ChangedGroup	An avatar has changed agency
Moved	An avatar has changed location

1.4 affs.csv

affs.csv lists the group(s) with which an agent affiliate(s). The modeling team uses this file to assess the reasonableness of the time series of CEG events listed in **agentHistory.csv**. See Section 1.3.

Table 5 lists the columns and definitions for this file.

Table 6 is a fragment of **agentHistory.csv** from the sample model used in Ground Truth, with the `Tick` and `TickInt` columns hidden. In the highlighted row, avatar A5433 is in the People group, but event E523, relief agencies perceive a need to provide adequate life sustaining aid to affected populations, is agented by the Relief Agencies group (refer to the agency (`Ag`) columns in the **events** tab of **model.xlsx** if necessary). Check the affiliations of A5433 in **affs.csv**. In Table 7, the highlighted row shows that the `Groups` are People and Relief Agencies, meaning the avatar is affiliated with the Relief Agencies group. This explains why a People avatar visits the event E523, which is agented by the Relief Agencies group.

Note: Neutral agents have no intrinsic preferences. They re-evaluate affiliation at each new event.

Table 5. Columns and definitions for affs.csv.

Column	Definition
GenNum	The number of ghost decision cycles that the avatar has conducted, used by the software team
Tick	A measure used by the software team
DomainTime	The time at which the agent enters an event
Dwell	The time an agent remains on an event in the number of days encoded as transitTime in the delays tab of model.xlsx.
EventID	The number used to identify the event in the CEG
CurEvent	The event on which the avatar is located at DomainTime (n)
Avatar	The identifier of the agent whose affiliations are being described
HomeGroupID	The group to which the avatar belongs
GroupIDs	HomeGroupID plus all group affiliation IDs
HomeGroup	The original group of the avatar, which can be identified in its ID number. Groups is HomeGroup name plus all group affiliation names. If HomeGroup and Group are the same, the avatar does not have any affiliations.
Weights	A measure of the strength of the affiliation(s)

Table 6. Example from the sample model used in Ground Truth: agentHistory.csv.

Avatar	Group	DomainTime	Dwell	EventID	Event	MsgType	Location	Dest
A9003	Government	12	43	E351	government sets up checkpoints at official border crossings	FromGeo	landscape _15x5	R013
A5433	People	1	22	E523	relief agencies perceive a need to provide adequate life sustaining aid to affected populations	Proceed	landscape _21x12	
A15112	Armed Opposition Forces	28	42	E56	armed opposition forces kill large numbers of govt forces	FromGeo	landscape _20x11	R023
A9003	Government	55	1	E24	govt & armed opposition forces increase fighting in border regions	FromGeo	landscape _15x5	R045
A1703	Government	61	1	E37	government arrests anti-government protesters	FromGeo	landscape _2x4	R038

Table 7. Example from the sample model used in Ground Truth: affs.csv.

Gen Num	DT	Dwell	EventID	CurEvent	Avatar	Home Group ID	Group IDs	Home Group	Groups	Weights	
0	1	22	E523	relief agencies perceive a need to provide adequate life sustaining aid to affected populations	A5433	G3	G3 G2	People	People Relief Agencies	1	0.84
1	23	1	E211	relief agencies send teams to affected areas to determine immediate needs	A5433	G3	G3 G2	People	People Relief Agencies	1	0.84
2	24	3	E211	relief agencies send teams to affected areas to determine immediate needs	A5433	G3	G3 G2	People	People Relief Agencies	1	0.84

1.5 groupChanges.csv

The modeling team uses **groupChanges.csv** to interpret the results of the changes encoded in the **groupChanges** tab of **model.xlsx**. These changes can include not only change in home group membership, but also agent birth, death, and change of location. These changes may be willing (joining another group or participating in a rescue mission) or unwilling (an abduction). This group change, like all moves in geospace, shows up in **agentTracking.csv**.

groupChanges.csv reports

1. The time at which the group change occurs
2. The avatar that is affected by the group change
3. The group to which the avatar belongs before and after the group change
4. The type of group change

Table 8 lists columns and definitions for this file.

For a full breakdown of `Id` in **groupChanges.csv**, see Chapter 2, Section 6.2, Group changes.

1.5.1 Actions

groupChanges.csv records four kinds of changes. Table 9 is a fragment of this table, illustrating the information produced.

1. **Births**. If `Action` is Born, then `BeforeGroup` will be blank.

In row 1, when an Armed Opposition Forces avatar visits event 297 (“Armed Opposition Forces use the internet to promote their political agenda”) and the conditions in `Id` are met, it triggers the birth of avatar A14112 at the event E295, armed opposition forces increase their numbers. In `Id`, the rule is located at E297. E297 is the same as event 297, so there is a single version of the rule.

2. **Deaths**. If `Action` is Died, then the `AfterGroup` will be blank.

In row 2, when any avatar is located in R016 (government security forces hq) and the conditions in `Id` are met, it triggers the death of avatar A3313, a member of the Armed Opposition Forces group. In `Id`, G8x17 is part of R016. If a region has multiple hexes, there is a version of the rule for every hex.

Table 8. Columns and definitions for groupChanges.csv

Column	Definition
Id	The rule information from the groupChanges tab of model.xlsx, plus the location of the rule
Tick	A measure used by the software team
Domain Time	The time at which the trigger occurs that results in the change.
Avatar	The agent whose change is recorded in the record
Before Group	The group name and number to which the avatar belonged before the group change occurred. If the change is a birth, this cell is blank
After Group	The group name and number to which the avatar belongs after implementation of the group change. If the change is a death, this cell is blank.
Action	The type of change Born: A new avatar is created from Gufe and placed in ToLoc listed in the Id Died: The avatar is removed from ToLoc listed in Id and sent to Gufe Group change: The avatar changes agency Location change: The avatar is moved to a new CEG event or region in geospace listed in the Id

3. **Group (agency) changes**. If `Action` is Group change, the `BeforeGroup` will be different than the `AfterGroup`.

Table 9. Example from the sample model used in Ground Truth: groupChanges.csv.

Id	Tick	DomainTime	Avatar	BeforeGroup	AfterGroup	Action
297_Gu_Gu_*_1_295_1_297_0.25_-_-_-_-_E297	145	10	A14112		Armed Opposition Forces[1]	Born
R016_1_89_*_Gu_Gu_01_R016_0.03_0_R016_-_-_G8x17	40	3	A3313	Armed Opposition Forces[1]		Died
113_3_18_*_1_295_1_295_0.25_0_113_-_-_E113	213	14	A6633	People[3]	Armed Opposition Forces[1]	Group change
113_3_18_*_1_295_1_295_0.25_0_113_-_-_E113	213	14	A6633	Armed Opposition Forces[1]	Armed Opposition Forces[1]	Location change E295
89_0_R016_*_=_R018_1_89_0.07_1_89_-_-_E89	67	5	A1503	Government[0]	Government[0]	Location change G0x8

In row 3, when a Government avatar visits event 113 ("govt imposes its ideology or religion on its people") and the conditions in `Id` are met, it triggers a group change for the People avatar located on event 18, people arm themselves. The avatar changes agency and becomes part of the Armed Opposition Forces group. In addition, row 4 shows the Location change for the new Armed Opposition Forces avatar to event 295, armed opposition forces increase their numbers. Note that `Id` is the same in rows 3 and 4, but the Group change and Location change are recorded in separate rows.

4. **Location changes**. If `Action` is Location change, identify the relevant regions or events in `Id`. To identify the names of the regions, refer to the `FromLoc`, `FromLocText`, `ToLoc`

and `ToLocText` in **groupChanges** tab of **model.xlsx**. To identify the events, refer to the `id` and `Event` in the **events** tab of **model.xlsx**.

In row 5, when an Armed Opposition Forces avatar visits event 89 ("armed opposition forces attack government security force HQs in key cities") and the conditions in `Id` are met, it triggers the Government avatar A1503 to move from the government security forces hq (R016) to the military airbase (R018).

Several files contain information relevant to group changes. Consider location change example in Table 9, row 5.

The location change recorded in **groupChanges.csv** also is recorded in **agentHistory.csv** as `MsgType` Moved and in **agentTrack.csv** as Location with the same landscape address that is listed as `Action` Location Change in **groupChanges.csv**.

1. At `DomainTime` 3, `MsgType` ToGeo, A1503 enters E146, government massacres ethnic minority including women & children.
   Files: **agentHistory.csv**, `id` and `Event` columns in the **events** tab of **model.xlsx**.
2. E146 is a geospatial event with the destination R035, which is the grouped region north peggytown, south peggytown, jonnyville.
   File: `dest` columns in **events** tab of **model.xlsx**.
3. A1503 drops down into GEO at location landscape_8x17. `Location` in **agentHistory.csv** and **agentTrack.csv** match.
   Files: **agentHistory.csv**, **agentTrack.csv**

Table 10 shows the relevant rows from **agentHistory.csv**.

Table 10. Example from the sample model used in Ground Truth: Row from agentHistory.csv.

Avatar	Group	Tick	TickInt	Domain Time	Dwell	EventID	Event	MsgType	Location	Dest
A1503	Govern-ment	39	13	3	0	E146	government massacres ethnic minority including women & children	ToGeo	landscape _8x17	R035
A1503	Govern-ment	67	13	5	1	E146	government massacres ethnic minority including women & children	Moved	landscape _0x8	R035

4. At `DomainTime` 4, A1503 then proceeds to landscape_8x18.
   Files: **agentTrack.csv, mapCoordinates.png**, **mapHexes.png**, **mapLayers.png**

Table 11 shows the relevant rows from **agentTrack.csv**.

Table 11. Example from the sample model used in Ground Truth: Fragment of agentTrack.csv with A2303's movement in geospace.

AgentID	GroupID	EventID	Tick	Domain Time	Dwell	XLoc	YLoc	Dest	Location
A1503	0	E146	39	3	1	379.303	930.71	R035	landscape_8x17
A1503	0	E146	52	4	2	379.303	985.458	R035	landscape_8x18
A1503	0	E146	67	5	1	0	437.981	R035	landscape_0x8

Figure 6 shows what is happening in geospace as a result of these changes.

5. At DomainTime = 4, A1503 is at landscape_8x18, which contains R016, government security forces hq.
6. At `DomainTime` = 5, Armed Opposition Forces avatar A4013 enters E89, armed opposition forces attack government security force HQs in key cities. Data not shown.
   Files: **agentHistory.csv**, `id` and `Event` columns in the **events** tab of **model.xlsx**.
7. E89 is the `Trigger` for the group change/Location change, when there is Government avatar at R016, government security forces hq.
   Files: **groupChanges.csv**, `id` and `Name` columns in the **regions** tab of **model.xlsx**
8. At `DomainTime` = 5 (the time the group change is triggered), A1503 is moved from R016 to R018, the military airbase. This is recorded in **agentHistory.csv** as `MsgType` Moved. See Table 9, row 2.
   Files: `MsgType` in **agentHistory.csv**, **groupChanges.csv**, `id` and `Name` columns in the **regions** tab of **model.xlsx**
9. R018, the military airbase, is located at landscape_0x8.
   Files: `id` and `Name` columns in the **regions** tab of **model.xlsx**, **mapCoordinates.png**, **mapHexes.png**, **mapLayers.png**
10. A1503 reaches landscape_0x8 at `DomainTime` 5.
    File: **agentTrack.csv**, **agentHistory.csv**.

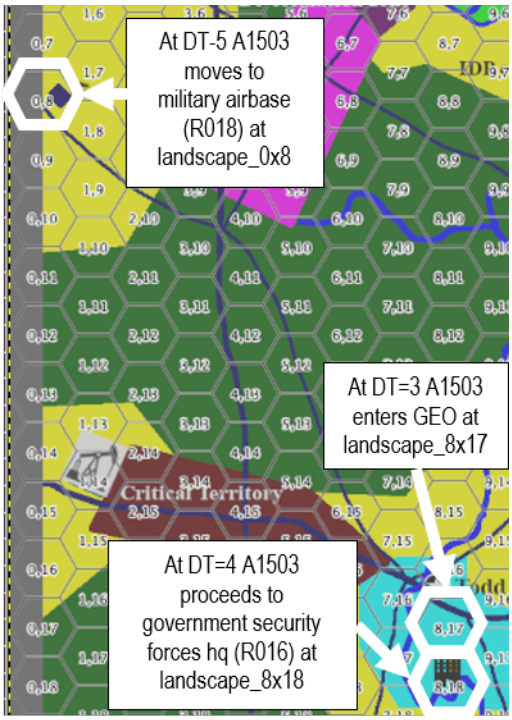

Figure 6. Example from the sample model used in Ground Truth: Fragment of mapLayers.png illustrating the FromLoc and ToLoc for a location change (group change).

Or, as a narrative:

> The Government decides to threaten protesters and heads south. While on the move, the Government encounters the Armed Opposition Forces, who are attacking the government security forces hq. The Government decides to move to the safety of its military airbase.

Group changes that result in location changes can be visualized in GIMP. Section 2.6.2 shows a visualization of this example.

1.5.2 Compare the number of avatars for each group at the beginning and end of the sim run

1. Get the number of avatars for each group at the start of the sim run from `Group` and `IndividualAvatars` in the **groups** tab of **model.xlsx.**
2. For each group tally the number of avatars with `Action` Born and Died.
3. For each group with `Action` Group Change, tally the number of `BeforeGroup` avatars and `AfterGroup` avatars.
4. Add the Born and `AfterGroup` numbers and subtract the Died and `BeforeGroup` numbers to the original numbers in **model.xlsx**.

1.5.3 Unexpected Behaviors

In our experience, two unexpected behaviors can arise.

1.5.3.1 Too many agents are born or too many agents die

1. If too many agents are born, check `Trigger` and `ToLoc` for the birth actions. If `Trigger` and `ToLoc` are the same, a loop can be created in which new agents are continually born.
2. If too many agents die
   a. Consider that if `Trigger` is frequently visited, the probabilities used for death actions may be too high.
   b. Consider that it may be the nature of the model, i.e., a war scenario.

1.5.3.2 An avatar does not appear to move after a location change

This can occur if an agent is already at `ToLoc` when the group change is triggered.

1. Check the `Id` to see if `ToLoc` is within `FromLoc`
2. Figure 7 is an example from the sample model used in Ground Truth that shows the location of the hospital in North Peggytown. North Peggytown spans multiple hexes.
3. The hospital is in a single hex, which also is one of the hexes that contains North Peggytown. The hospital appears to be located in more than one hex, but that is the hospital symbol in the labels layer. The hospital drawn on the geospatial map is located in a single hex. In addition, **mapHexes.png** shows the hex lattice used in the sim.
4. If an event triggers a location change to move an avatar from the hospital to North Peggytown, the avatar will not move because it is already at the `ToLoc`.
5. This can be verified by checking that there is a location change reported in **agentHistory.csv** as `MsgType` Moved and that the Location in **agentTrack.csv** has the same landscape address that is listed as `Action` Location Change in **groupChanges.csv**.

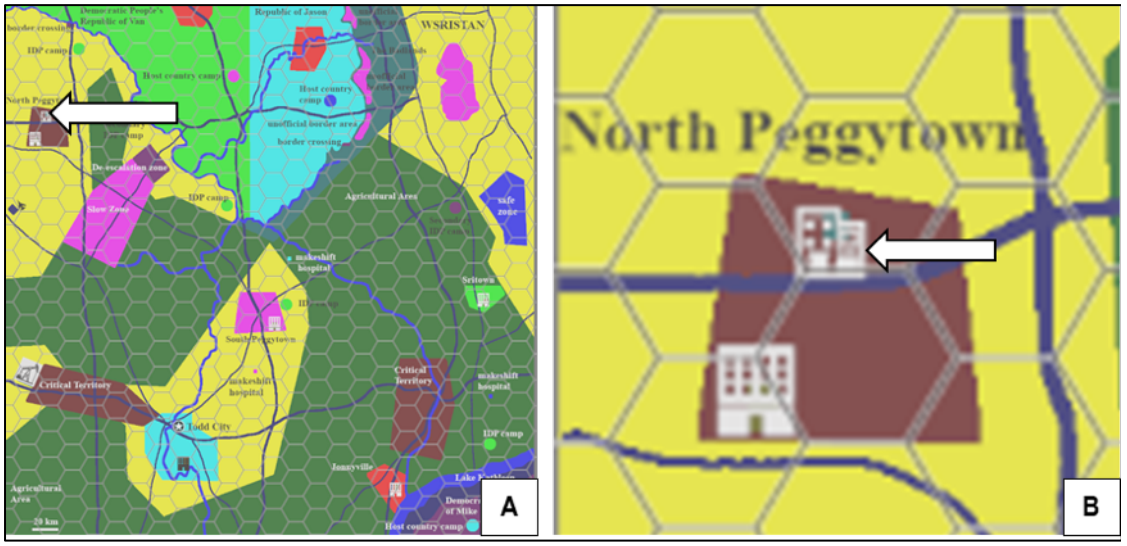

Figure 7. Example from the sample model used in Ground Truth: (A) the location of hospital in North Peggytown, indicated by the white arrow on the geospatial map and (B) a close-up image.

1.6 agents columns in the groups tab of model.xlsx

The **groups** tab of **model.xlsx** contains the settings used for the sim run, specifically the `IndependentAgency`, `ReceivesAffiliation`, `MakesAffiliation`,

`GhostsPerShift`. `ShiftsPerGen`, `MaxGhostSteps`, `GroupAvatars`, `IndividualAvatars`, `AffiliationThreshold`, `PrefVariation`, and `UseHGN`. Refer to Chapter 2, Section 3.6.3 for additional information.

1.7 agentTrack.csv

agentTrack.csv records all moves in geospace. It lists the locations of agents in geospace. Each time an agent moves, a new row is added to the file. The modeling team uses this file as part of the plot track visualization in GIMP. See Section 2.4.

Table 12 lists the columns and definitions for this file.

Table 12. Columns and definitions for agentTrack.csv.

Column	Definition
AgentID	Identifies the agent described in each row
GroupID	Ther home group of the agent
EventID	The number used to identify the event in the CEG
Tick	A measure used by the software team
DomainTime	The time at which the agent enters an event
Dwell	The time an agent remains on an event in the number of days encoded as transitTime in delays tab of model.xlsx
XLoc, YLoc	The pixel locations in GIMP of the center point of the hex cell at which the agent is located
Dest	The agent's current destination, in the Geo ID encoded in the regions tab of model.xlsx. AgentID identifies the agent described in each row.
Location	The hex location (X, Y) on the geospatial map

2 Visualizing Agents in Geospace

2.1 Install Plug-in and Scripts in GIMP

To examine the movement of agents through geospace, a plug-in and two scripts need to be installed in GIMP. The plug-in lets you import an **agentTrack.csv** log into layers in GIMP so you can see where the agents are over time. The scripts enable you to animate the layers. To find where they go, start GIMP, and open the Preferences dialog (accessible on a Mac from the program name, and on a Windows machine under the Edit menu). In Preferences, select Folders/Plugins to find the plugins directory, and Folders/Scripts to find the scripts directory. You may find two listings in each place, one under the program itself, and the other in Library/Application Support (on a Mac) or AppData/Roaming/GIMP. You want the directories that are *not* under the program folder.

1. Install plug-in: When you install SCAMP as described in Chapter 2, you'll find track_plotter.py in the SCAMP/Misc directory. Copy this file to your GIMP plug-ins directory.
2. Install Scripts
   a. Go to https://chiselapp.com/user/saulgoode/repository/script-fu/wiki?name=sg-anim-settings
      i. Select sg-anim-settings.scm
      ii. Click on the Download button
   b. Go to https://chiselapp.com/user/saulgoode/repository/script-fu/wiki?name=sg-combine-bg
      i. Select sg-combine-bg.scm
      ii. Click on the download button.
   c. Copy both of these to your GIMP scripts directory.

2.2 Select Agent(s) to Visualize

Visualization is useful only for agents that move through geospace. Here's how to identify such agents.

1. Open **agentHistory.csv**.
2. Sort & Filter the columns.
3. In the `MsgType` column, Select All and select FromGeo.

The resulting list includes only agents that enter geospace and reach their destinations, and thus have tracks that you can visualize.

4. In the Avatar column, select one of the avatars listed that has a Dwell in its FromGeo column greater than 1. We'll follow agent A7233 as an example (Table 13)
5. In the `MsgType` column, Select All to see the agent's entire history.
   a. ToGeo is the event for which the agent to enter geospace.
   b. FromGeo is the event for which the agent leaves geospace, after reaching its destination.
   c. Proceed is the next event in the CEG to which the agent moves.
6. Select an event of interest. In this case, there is only one geospatial event for which the agent reaches its destination. Let's plot Agent A7233's track for the event E481, government and protesters clash. See the highlighted text in Table 13.
7. Now we need to find the period of time over which the agent is in geospace.

Table 13. Example from the sample model used in Ground Truth: agentHistory.csv with event of interest (A7233).

Avatar	Group	Tick	TickInt	Domain	Dwell	EventID	Event	MsgType	Location
A7233	People	13	13	1	2	E530	people perceive a threat to their personal wellbeing	Proceed	landscape_12x12
A7233	People	27	14	3	0	E94	large numbers of people protest throughout the country	ToGeo	landscape_12x12
A7233	People	40	13	3	1	E94	large numbers of people protest throughout the country	FromGeo	landscape_12x12
A7233	People	53	13	4	1	E31	Protesters share political news on social media	Proceed	landscape_12x12
A7233	People	66	13	5	26	E18	people arm themselves	Proceed	landscape_12x12
A7233	People	399	333	31	0	E481	government and protesters clash	ToGeo	landscape_12x12
A7233	People	560	56	31	11	E481	government and protesters clash	FromGeo	landscape_7x15
A7233	People	573	13	42	75	E299	civilians increase their support for armed opposition forces	Proceed	landscape_7x15

a. For `MsgType` ToGeo associated with E481, the `DomainTime`, which is the time at which the agent enters geospace for a particular event is 31.
b. For `MsgType` FromGeo, find `Dwell`, which is the time it took for the agent to reach its destination for this event. The unit of measure for time is the same as that used in the **delays** tab of **model.xlsx**. In this example, `Dwell` is 11.
c. To figure out how long the A7233 has spent on E481, look at its next event in and subtract the `DomainTime` of the first from the `DomainTime` of the second. If the second is a `MsgType` Proceed, then the `DomainTime` range will be the `DomainTime` of the first event plus `Dwell` of the first.
d. A7233's next event is E299, civilians increase their support for armed opposition forces, which occurs at `DomainTime` 42.
e. When plotting the track of an agent in GIMP, `DomainTime` and `Dwell` are used to create a `DomainTime` range.
    i. A7233 entered the E481 at `DomainTime` 31 and left the event at `DomainTime` 42.
    ii. A7233 remained at E481 for 11 days.
    iii. The `DomainTime` range can be entered into the Plot Agent Tracker as the Epoch to Plot.

2.3 Load mapLayers.png from the logs

The logs for your run will include the file **mapLayers.png**, which consists of the terrain in your **.xcf** file and the map labels.

1. Open **mapLayers.png** in GIMP. This is the bottom layer.
2. Open **mapHexes.png** using Open as Layers.
3. For better visualization, you may want to add a 20-30% white or gray layer.
    f. Add a new layer to GIMP, using Layer, then New Layer in the toolbar at the top of GIMP.
    g. Add a white or gray background and a low level of opacity (30% works for us).
4. **mapCoordinates.png** contains the x,y locations for each of the hexes. Open this file with Open as Layers, if using.

Figure 8 shows a region of this file, all with a 30% gray layer and (A) without hexes and coordinates, (B) with hexes and (C) with hexes and coordinates.

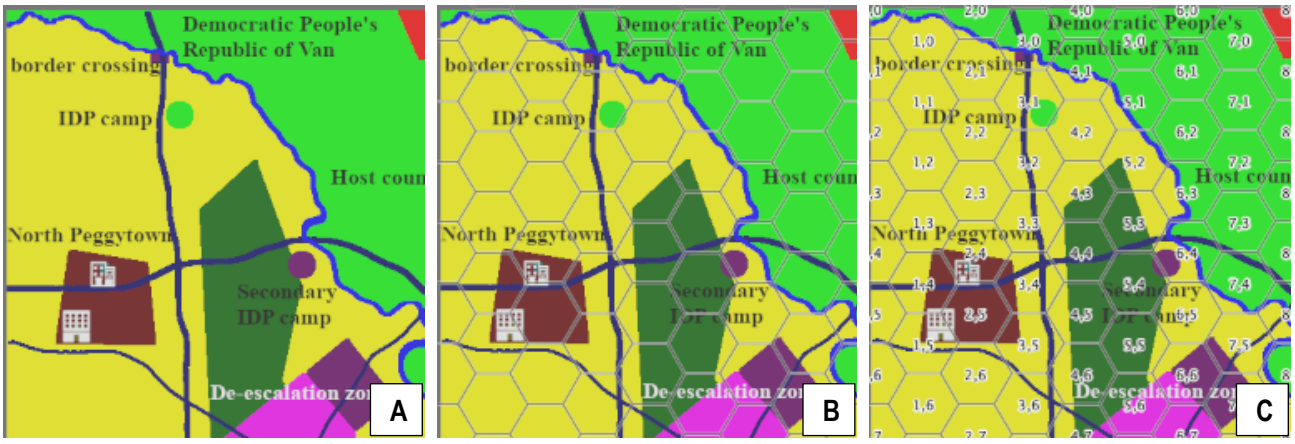

Figure 8. Section of mapLayer.png showing (A) without hexes and coordinates, (B) with hexes and (C) with hexes and coordinates.

2.4 Plot Track in GIMP

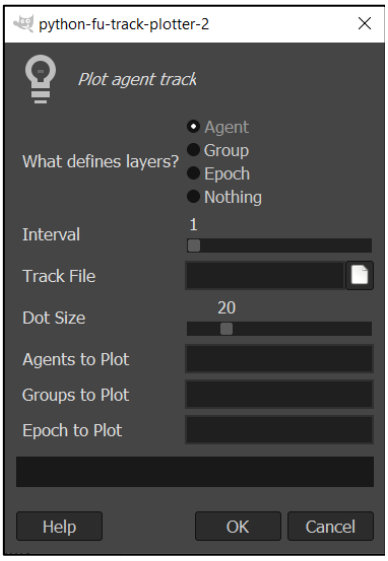

Figure 9. Example from the sample model used in Ground Truth: GIMP Plot agent track dialog box.

1. Select Layer, then Select Plot Track
2. The Plot agent track dialog box will open (Figure 9). Here are the options for each field.
   a. What defines layers? You can only select one option.
      i. Agent: a new layer is generated for each agent, showing all of its locations.
      ii. Group: a new layer is generated for each group, showing all of the locations for all agents in that group.
      iii. Epoch: a new layer is generated for each epoch, showing the locations of all agents during that epoch.
      iv. Nothing. If Selected, everything will be in a single layer.
   b. Interval: the number of domain days plotted on each layer of the visualization.
   c. Track File: Select the log files folder This field cannot be left blank
   d. Dot Size
      i. Dot colors correspond to Group colors in the CEG
      ii. Use the slider to adjust how big the plotting dot is
      iii. Less than 10 probably is too small
      iv. Greater than 30 probably is too large
   e. Agents to Plot
      i. Either the word "All", the ID of an individual agent (e.g., "A324"), or a comma separated list of agent IDs
      ii. For each agent listed, put that agent's group number in the Groups to Plot field
      iii. Either this field or Groups to Plot must contain a value. If both are completed, the track plotter will plot all rows that contain either the specified agents or the specified groups.
   f. Groups to Plot
      i. Either the word "All", or a comma separated list of groups to plot
      ii. Either this field or Agents to Plot must contain a value.
   g. Epoch to Plot
      i. Either the word "All", or a specific `DomainTime` range.
      ii. To specify a range, e.g., 230-1000, consult **agentHistory.csv**. The time range should start with `DomainTime` of the first event to plot, and extend to `DomainTime` + `Dwell` for the last event. For example, to plot the geomovements associated with the highlighted FromGeo row in Table 13, `DomainTime` is 31 and `Dwell` is 11, so the range is 31-42.
      iii. This field cannot be left blank.
3. Click OK.

2.4.1 Examples from the sample model used in Ground Truth

2.4.1.1 Plot the track of a single agent

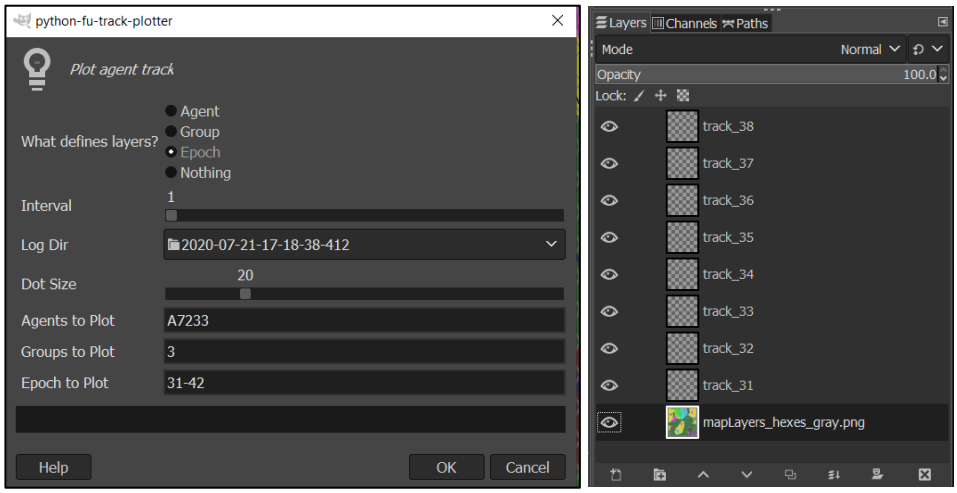

Figure 11. Example from the sample model used in Ground Truth: Track plotter for a single agent (L) and the Layers section of GIMP shows the list of tracks with agent ID (R).

1. Fill in the fields in the Plot agent track dialog box as shown in Figure 11(L).
2. Click OK.
3. In the Layers window, **mapLayers.png** will be at the bottom of the list and the track is labeled with the agent ID. See Figure 11 (R).
4. The GIMP image window will show the tracks of the agent for the specified epoch (Figure 10).
5. To animate an individual agent's movement and watch it develop over time, see Section 2.5.

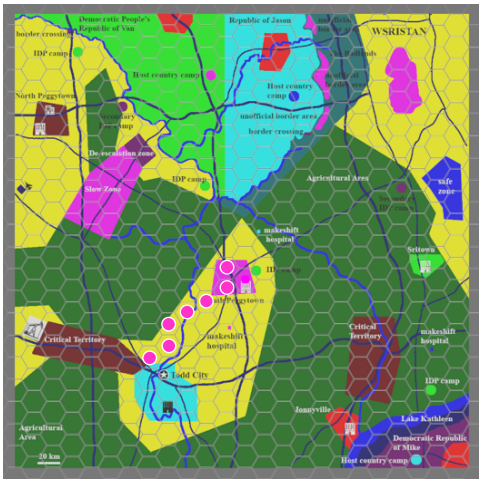

Figure 10. Example from the sample model used in Ground Truth: The resulting tracks for a single agent (A7233).

To determine which groups are in the same area at the same time as A7233, plot the tracks of all agents from all groups using the epoch used to plot A7233. Keep in mind that A7233's own group may be affecting its movement.

1. Fill in the fields in the Plot agent track dialog box as shown in Figure 12 (L).
2. When plotting all agents from all groups for a specific epoch and using group to define the layers, the Layers window will show the map image at the bottom and the tracks listed in

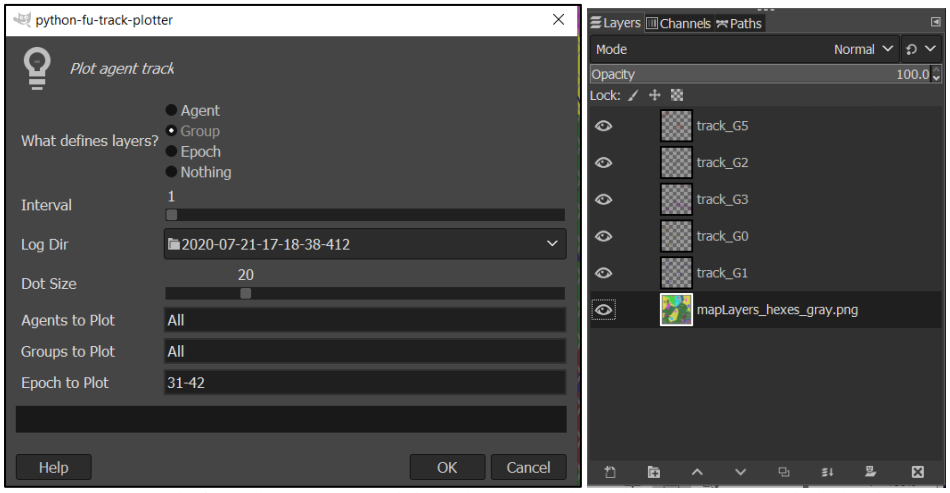

Figure 12. Example from the sample model used in Ground Truth: Plot agent track dialog box when plotting all agents from all groups for a specific epoch (L) and Layers window when plotting all agents from all groups for a specific epoch (R).

order from the bottom to the top. Each track is labeled with the group number. See Figure 12 (R).

3. The GIMP image window will show the tracks of the agents for the specified epoch. In Figure 13, a Relief Agencies avatar, represented by purple circles, and a Military group avatar, represented by green circles, are in the same area as A7233. Avatar A7233 is in the People group and is represented by pink circles. It is possible that the two avatars are overlapping.

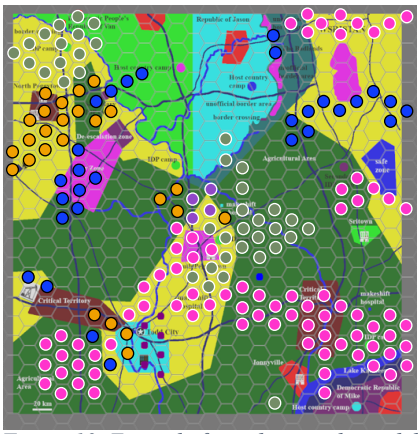

Figure 13. Example from the sample model used in Ground Truth: The resulting tracks for all agents from all groups.

2.4.1.2 Plot the tracks of all agents from two groups for a specific epoch

Plot all Government and People avatars for an epoch.

1. Fill in the fields in the Plot agent track dialog box as shown in Figure 14 (L).
2. When plotting all agents from two groups for a specific epoch and using agent to define the layers, the Layers window will show the map image at the bottom and the tracks listed in order from the bottom to the top. Each track is labeled with the avatar number. See Figure 14 (R).

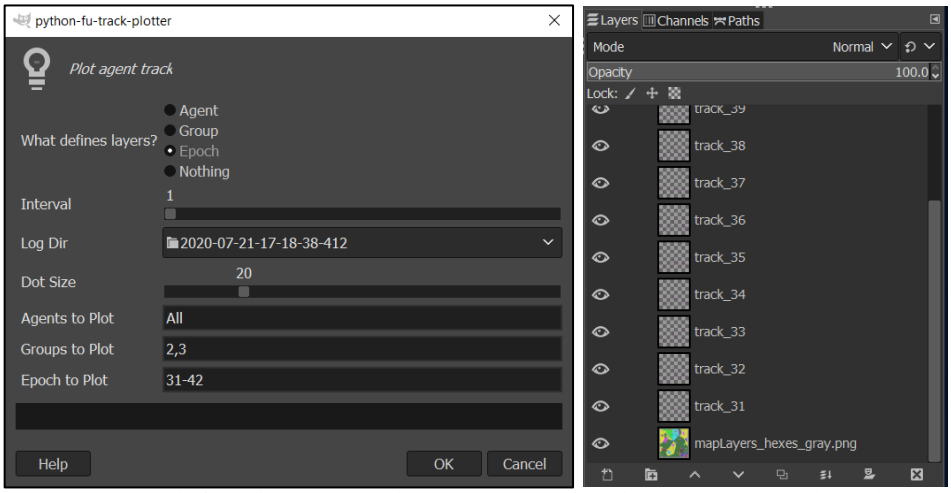

Figure 14. Example from the sample model used in Ground Truth: Plot agent track dialog box when plotting all agents from two groups for a specific epoch (L) and Layers window when plotting all agents from two groups for a specific epoch (R).

3. The GIMP image window will show the tracks of the People and Relief Agency avatars for the specified epoch. See Figure 15.

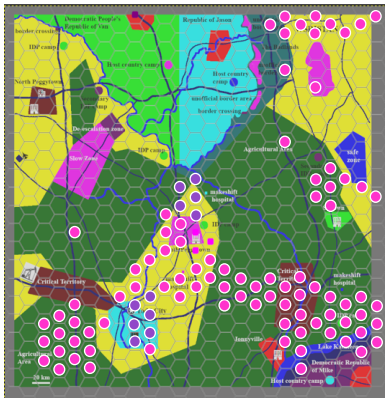

Figure 15. Example from the sample model used in Ground Truth: The resulting tracks for all agents from two groups.

2.4.1.3 Plot the tracks of two or more agents from the same or different groups for a specific epoch

1. Fill in the fields in the Plot agent track dialog box as shown in Figure 16 (L).
2. When plotting two or more agents from the same or different groups for a specific epoch and using agent to define the layers, the Layers window will show the map image at the bottom and the tracks listed in order from the bottom to the top. Each track is labeled with the avatar number. See Figure 16 (R).

3. The GIMP image window will show the tracks of the People and Relief Agency avatars for the specified epoch. See Figure 17.

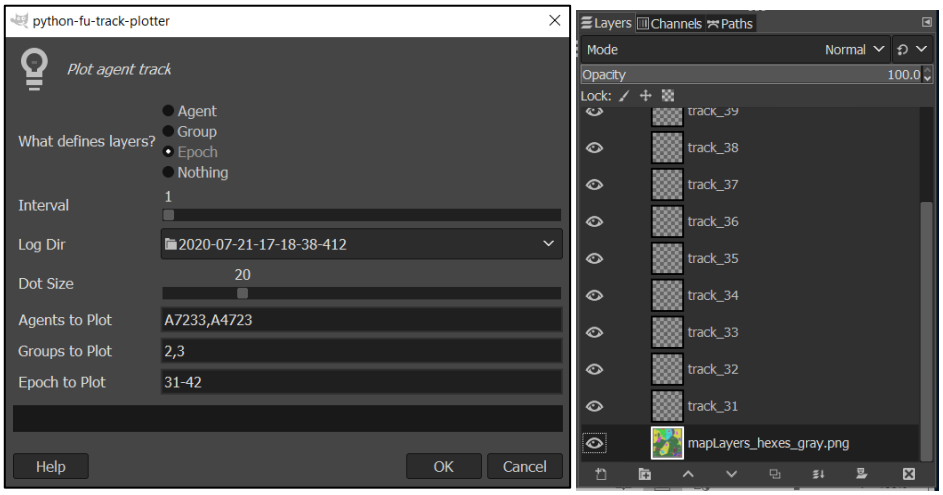

Figure 16. Example from the sample model used in Ground Truth: Plot agent track dialog box when plotting two or more agents from the same or different groups for a specific epoch (L) and Layers window when plotting two or more agents from the same or different groups for a specific epoch (R).

2.5 Animate Plot Track Results and Export GIFs in GIMP

The plot track results can be animated to aid the understanding of why an agent takes the path it does to get to a particular destination. Animations can be created for single agents or for multiple agents. Animations also can be created to visualize a location change triggered by the group change mechanism.

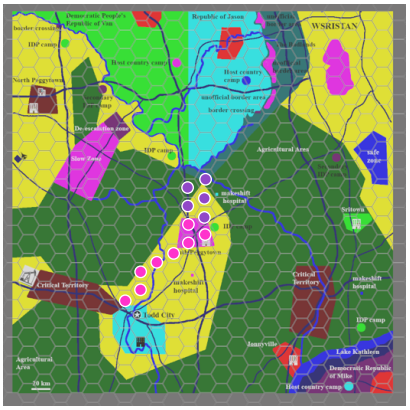

Figure 17. Example from the sample model used in Ground Truth: The resulting tracks for all agents from two or more agents from the same or different groups for a specific epoch.

To reach its destination, an agent has to be located in a hex that contains that region. If there is a single pixel of the target color in a hex (including the hex line), that region will be included in that hex. The hex overlay that is used as part of the visualization is accurate, but not as precise as the sim. In Figure 18, an agent wants to go to the pink trapezoid in the middle of the map (Figure 18-A). Figure 18-B is a close-up that shows the nine hexes that contain the destination. Figure 18-C shows all of the hexes that the agent can go to so that it reaches its destination. Example from the sample model used in Ground Truth: The resulting tracks for all agents from two or more agents from the same or different groups for a specific epoch.

To create an animation, you can have only one map layer in GIMP. If you want to include the 20% white layer, **map.Hexes.png** and/or **mapCoordinates.png** in the animation, you must use Merge Down to add them to **mapLayers.png**. Export it as a .png and save with a new name, so

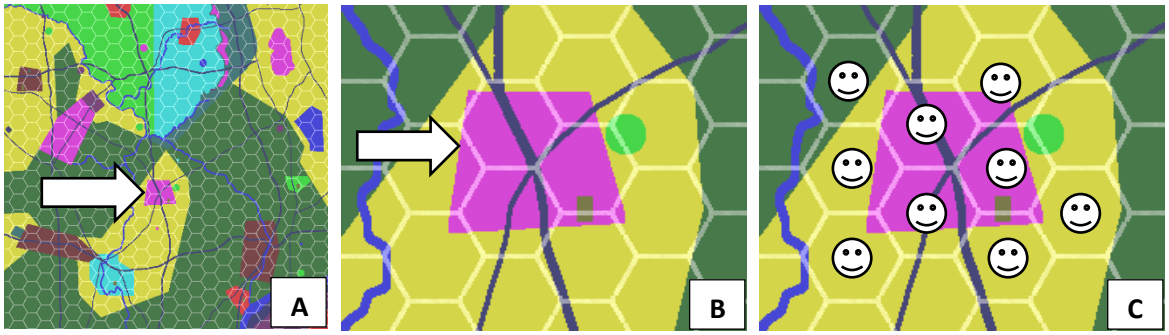

Figure 18. Several hexes can contain a region.

that you don't have to do it every time you want to create an animation. We suggest having one version with just the hexes and another with the hexes and coordinates.

There are two ways to create animations, once you have loaded your layers using the Plot agent track dialog.

1. One dot is plotted, then the next, then the next, etc. and all dots remain visible
2. One dot is plotted, then disappears, then the next dot is plotted, then disappears, etc.

In both cases, you can visualize the animation in GIMP, or save it as an animated gif file to include in presentations.

2.5.1 One dot is plotted, then the next, then the next, etc. and all dots remain visible

1. Fill in the fields in the Plot agent track dialog box as shown previously in Figure 11 (L).
2. When plotting an individual agent by epoch, tracks are labeled by number, as shown in Figure 11 (R).

To create animation (each dot remains as the next dot is plotted), go to Filters and select Animation, then Select Playback. A new window opens. At the bottom of the window

1. Select playback speed (0.25 is good)
2. Select fps (10 is good)
3. The percentage field may need to be adjusted to visualize the entire map

Click the play button at the top left portion of the window. The two buttons to the right of the play button, reverse or advance the video one frame at a time.

To create a .gif, go to File and select Export as. The Export Image dialog box will open. Use Places to navigate to the location where the file will be saved, and enter the file name in the Name field.

In the Select File Type (By Extension), Select GIF Image. The Export Image as GIF dialog box will open. Select these options:

1. As animation
2. Animated GIF option
3. Loop forever
4. Delay between frames where unspecified: 1000
5. Frame disposal where unspecified: Cumulative layers (combine)
6. Use delay entered above for all frames
7. Use disposal entered above for all frames
8. Click Export

2.5.2 One dot is plotted, then disappears, then the next dot is plotted, then disappears, etc.

The procedure to generate a video in which each dot disappears before the next is plotted is almost the same, except first select all layers, then Filters/Animation/Combine background, and then proceed as above. This step merges the background into each image so that only the dots on that image appear in an animation frame.

The procedure for generating a gif is the same as before.

2.6 Understanding the movement of agents in geospace

Tracks can be turned on and off by clicking the eye icon in the Layers window. This will help you to identify which avatars are near A7233. For example, if A4623 is turned off, as shown in Figure 19, those tracks also will be removed from the map (Figure 20).

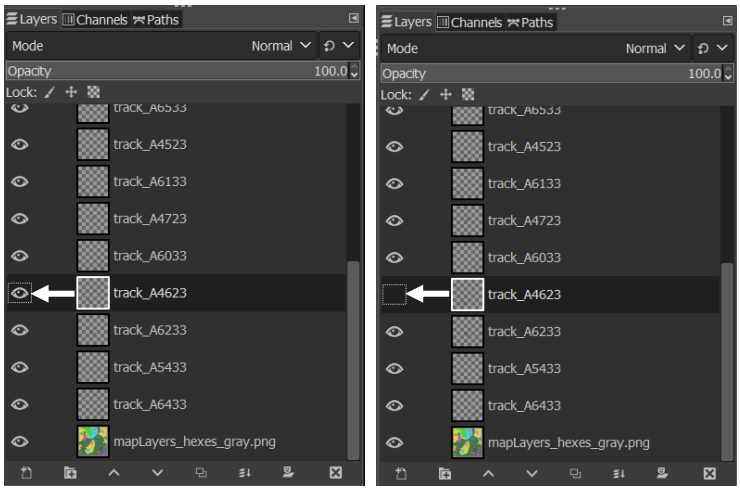

Figure 19. Tracks can be turned on and off in GIMP.

Using the list of avatars from the tracks in the Layers window, turn on and off the tracks to find which ones are not in the same area as A7233 and can be eliminated. In our example, that process eliminates all other avatars, except for A4723. Checking **agentHistory.csv**, A4723, which has a `DomainTime` equal to 10 and a `Dwell` equal to 25. It is in the same location as A7233 and their epochs overlap.

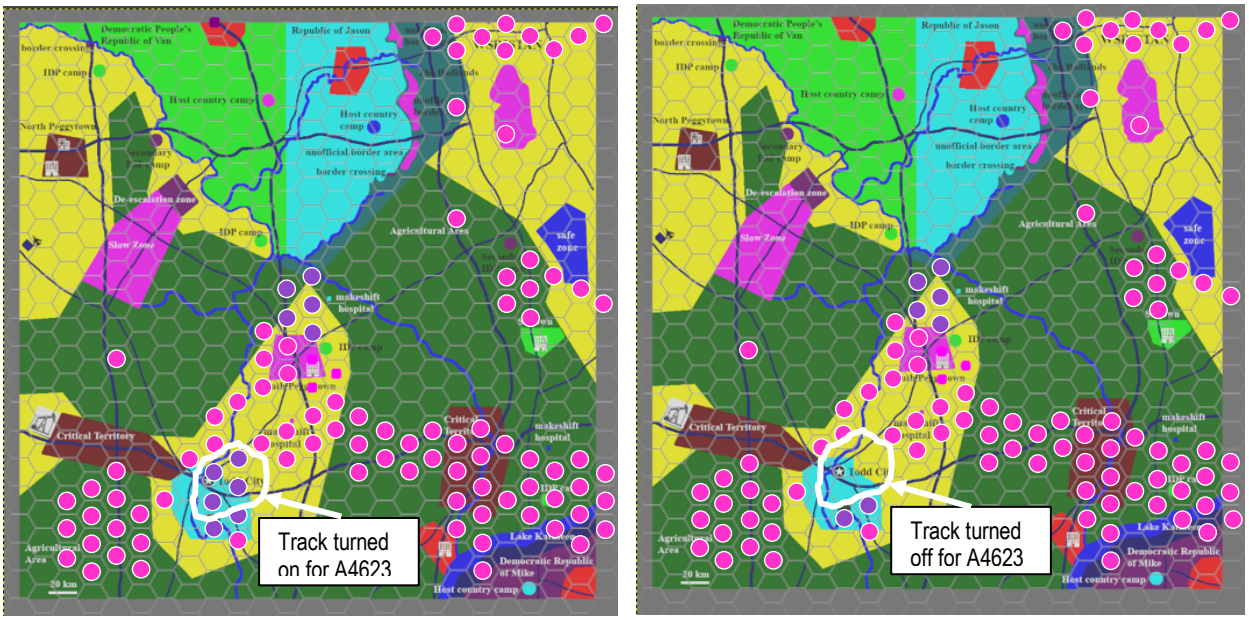

Figure 20. Example from the sample model used in Ground Truth: Tracks can be turned on and off and visualized in GIMP

Plot the two avatars. Figure 21-A shows the tracks of A7233. Figure 21-B shows the tracks of A4723. Figure 21-C shows the tracks of both agents.

Agents can travel along a direct path (Figure 22-A) or they can take a longer, circuitous path (Figure 22-B).

An agent can sense another agent's pheromones in any adjacent hex. Check the `PrefPresenceGroupAbbr(n)` scores in the **groups** tab of **model.xlsx** to determine which groups attract the agent and which groups repel it as it makes its journey. This can help to explain why the agent is moving away from its destination at certain points in its pathway.

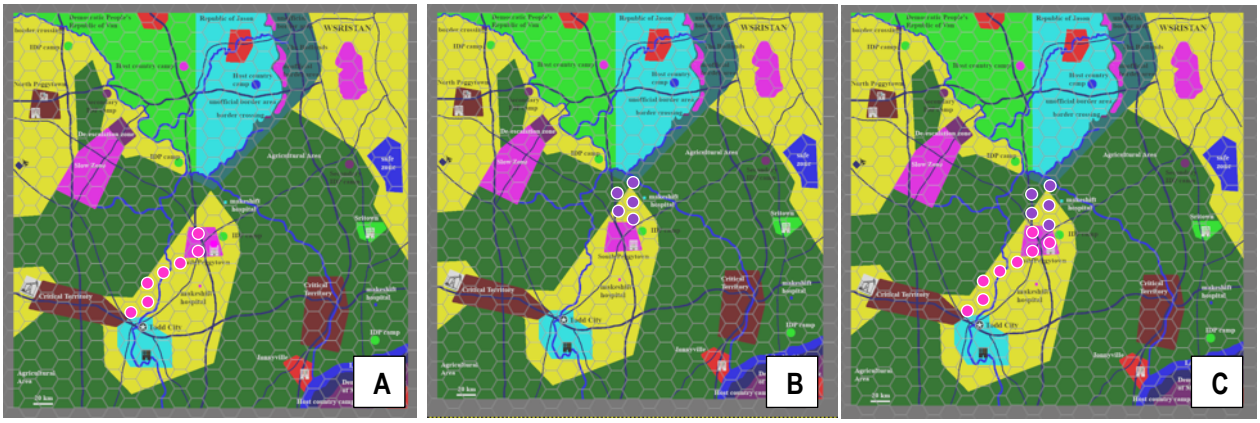

Figure 21. Example from the sample model used in Ground Truth: A7233's tracks (A), A4723's tracks (B), and both avatar's tracks (C).

In the example from the sample model used in Ground Truth, A7233 is in the People group and A4723 is in the Relief Agency group. To check whether homophily played a role in the paths of these agents, refer to their `PrefPresence` scores in the **group** tab of **model.xlsx** and consider that indirect paths may be explained by the pheromone field, which is not visualized, or by other avatars in the area at the same time.

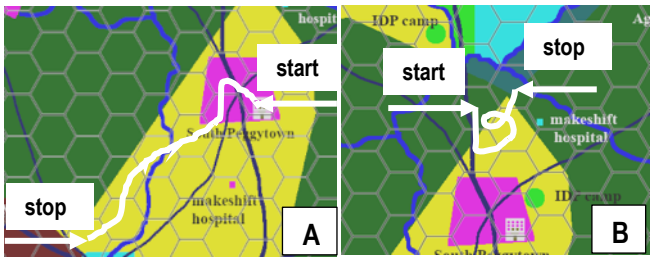

Figure 22. Example from the sample model used in Ground Truth: A7233's tracks (A) and A4723's tracks (B).

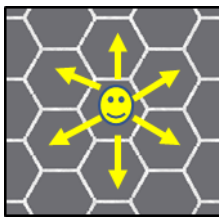

Figure 23. An agent can only move to an adjacent hex.

2.6.1 Tracks that appear to be missing in animations and GIFs

An agent always has a location in geospace. When an agent decides to move from its current location, it can only move to an adjacent hex. It cannot skip over hexes (unless it is moved by a group change action). See Figure 23.

Figure 24 and Figure 25 show the tracks of agent A4723 (pink) and A7233 (purple) for domain times 31-41, when plotted as described in Section 2.5.2.

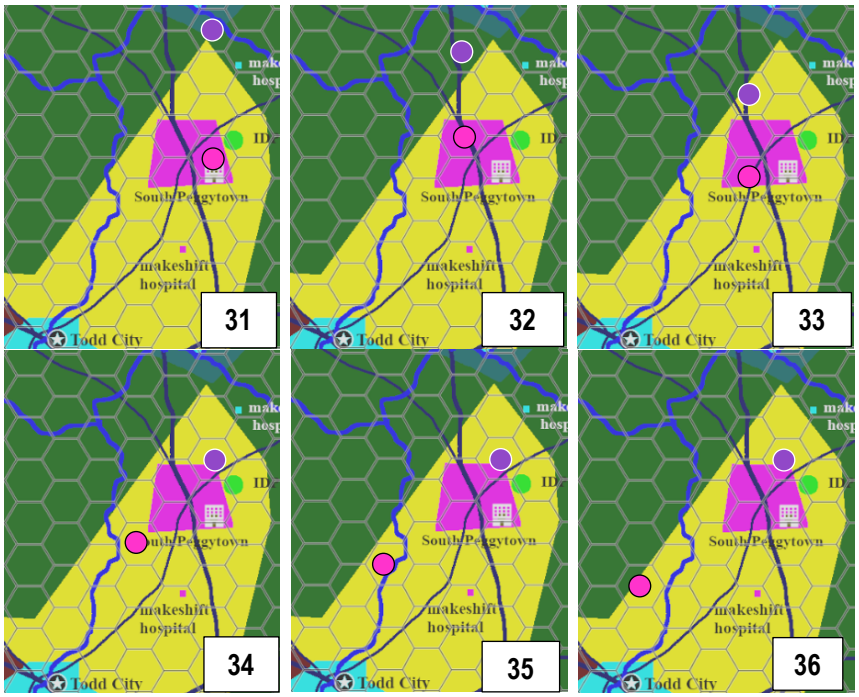

Figure 24: Example from the sample model used in Ground Truth: The track of A7233 (pink) and A4723 (purple) from DomainTime 31-36.

At `DomainTime` 36, A4723 has a `Dwell` of 2, meaning it remains at its location for 2 days. In Figure 25, A4723 is in the same location at `Dwell` 36 and 37. This information is recorded in **agentTrack.csv**. Table 14 shows a fragment of this file. Note that there is no `DomainTime` 37 listed for A4723.

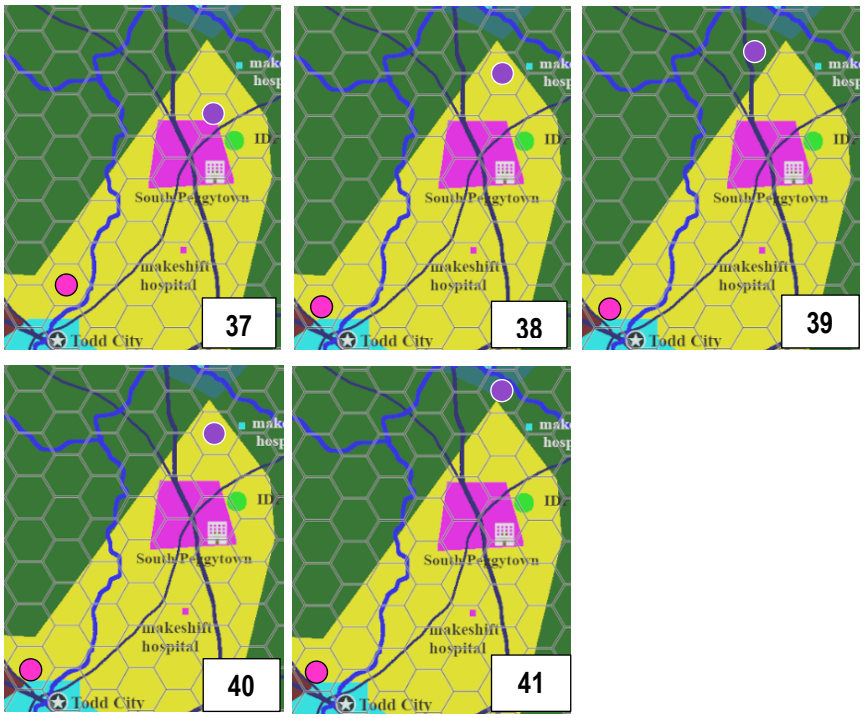

Figure 25. Example from the sample model used in Ground Truth: The track of A7233 (pink) and A4723 (purple) from DomainTime 37-41.

Note: Location changes encoded in the **groupChanges** tab of **model.xlsx**, if triggered, allow for agents to be picked up and moved anywhere on the map. This is a different dynamic than that of agents choosing their next hex. See Section 1.5.1.

2.6.2 Visualization of group changes

Agency changes do not result in an avatar's color changing when plotted in GIMP. But GIMP can visualize changes in geospatial locations listed in **groupChanges.csv**. Table 15 is an

Table 14. Example from the sample model used in Ground Truth: agentTrack.csv with Dwells greater than 0.

AgentID	GroupID	EventID	Tick	DomainTime	Dwell	XLoc	YLoc	Dest	Location
A7233	3	E481	399	31	1	568.9542	656.9717	R038	landscape_12x12
A4723	2	E211	411	32	1	521.5414	520.1026	R019	landscape_11x9
A7233	3	E481	412	32	1	521.5414	629.5979	R038	landscape_11x11
A4723	2	E211	424	33	1	521.5414	574.8503	R019	landscape_11x10
A7233	3	E481	425	33	1	521.5414	684.3456	R038	landscape_11x12
A4723	2	E211	437	34	1	568.9542	602.2241	R019	landscape_12x11
A7233	3	E481	438	34	1	474.1285	711.7194	R038	landscape_10x13
A7233	3	E481	451	35	1	426.7157	739.0932	R038	landscape_9x13
A4723	2	E193	463	35	1	568.9542	602.2241	R049	landscape_12x11
A7233	3	E481	464	36	1	379.3028	766.467	R038	landscape_8x14
A4723	2	E538	489	36	2	568.9542	602.2241	R022	landscape_12x11
A7233	3	E481	490	37	1	379.3028	821.2147	R038	landscape_8x15
A4723	2	E538	504	38	1	568.9542	547.4764	R022	landscape_12x10
A7233	3	E481	504	38	4	331.89	848.5885	R038	landscape_7x15
A4723	2	E538	518	39	1	521.5414	520.1026	R022	landscape_11x9
A4723	2	E538	532	40	2	568.9542	547.4764	R022	landscape_12x10
A4723	2	E538	560	42	1	568.9542	492.7288	R022	landscape_12x9

Table 15. Example from the sample model used in Ground Truth: groupChanges.csv with an example of a location change.

Id	Domain Time	Avatar	BeforeGroup	AfterGroup	Action
76_3_R020_*_=_R058_5_76_0.12_5_76_-_-_E76	29	A80333	People[3]	People[3]	Location change G11x14
89_0_R016_*_=_R018_1_89_0.07_1_89_-_-_E89	29	A2303	Government[0]	Government[0]	Location change G0x8
1_3_R017_*_=_R058_0_R017_0.03_0_R017_-_-_E1	38	A7233	People[3]	People[3]	Location change G11x14

example of **groupChanges.csv** from the sample model used in Ground Truth. In row 2, at `DomainTime` 29, the event 89, armed opposition forces attack government security force HQs in key cities, triggers the Government group avatar A2303 to move from the government security forces hq (R016) to the military airbase (R018).

Table 16 is **agentTrack.csv**. It shows that at `DomainTime` 29, A2303 moves to landscape_0x8, which matches the location listed in the `Action` column of **groupChanges.csv** in Table 15.

Table 16. Example from the sample model used in Ground Truth: agentTrack.csv with location listed. This location corresponds to the location change listed in the groupChanges.csv log file shown in Table 15.

AgentID	GroupID	EventID	Tick	DomainTime	Dwell	XLoc	YLoc	Dest	Location
A2303	0	E52	372	29	1	568.9542	656.9717	R049	landscape_12x12
A2303	0	E52	385	29	1	0	437.9812	R049	landscape_0x8
A2303	0	E52	397	30	1	0	383.2335	R049	landscape_0x7
A2303	0	E52	410	31	1	0	437.9812	R049	landscape_0x8

Figure 26 visualizes this change.

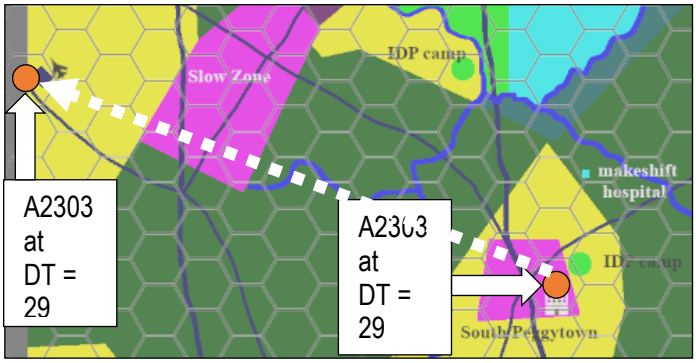

Figure 26. Example from the sample model used in Ground Truth: A location change that is listed in the groupChanges.csv log file. The agent did not traverse the hexes, but moved instantly at DomainTime 29.

3 Other Log Files

SCAMP has some other logs.

3.1 adjacencyMatrix.csv

This file (which is tab-separated rather than comma-separated) contains one row and one column for each event in the CEG. If a cell in the file is not empty, it specifies the relation from the row event to the column event, one of {then, thenGroup, enable, enhance, inhibit, prevent}.

3.2 agentGroup.csv

This log records the home group of each agent over time. Table 17 lists its columns and definitions.

Table 17. Columns and definitions for agentGroup.csv.

Column	Definition
Agent	Agent ID, in the form Annn
DomainTime	Current domain time
Group	Name of agent's home group

3.3 agentMeetings.csv

For each agent and each domain time, this file records the other agents who are participating on the same event or located on the same geospatial hex. Table 18 lists its columns and definitions.

Table 18. Columns and definitions for agentMeetings.csv.

Column	Definition
Agent	The agent whose meetings are recorded
DomainTime	The time of the meetings
Agent…	A list of agents (one per column) whom Agent met at DomainTime

3.4 basePrefs.csv

This file records the preferences assigned to each agent when it is initialized. These differ from those specified in `Pref*` columns of the **groups** tab of **model.xlsx** because they are sampled from a region around those base preferences, using the `PrefVariation` column of the **groups** tab. Table 19 lists its columns and definitions.

Table 19. Columns and definitions for basePrefs.csv

Column	Definition
Avatar	The agent ID
Group	The group name of the agent's home group
Preferences	A list of the base preferences (one per column)

3.5 consoleLog.txt

This file collects a variety of status information generated during a simulation run, including:

1. The pairwise similarity among the groups at the start of the run,
2. The number of avatars assigned to each group at initialization;
3. A list of the number of avatars in each group at each change (caused by the group change mechanism).

3.6 entropyLog.csv

This log records, as a function of simulation tick, the entropy and participation levels of the different groups over the nodes of the CEG, as well as some performance information. Table 20 lists its columns and definitions.

The pheromone and count information reflect how widely the different groups are exploring the CEG. Low entropy and high zero counts indicate that the run is more deterministic.

3.7 eventLog.csv

This log provides a summary of the participation in each event at the end of the run. Table 21 lists its columns and definitions.

Table 20. Columns and definitions for entropyLog.csv.

Column	Definition
Tick	The Repast simulation tick (not the domainTime)
TotalPhEnt	Entropy of the total pheromone on each node
<groupName>Ent	One column for each group; entropy of that group's pheromone on each node
TotalPh	Total pheromone over the entire CEG
TotalZeroCounts	Number of nodes with 0 participation
<groupName>TotalPh	One column for each group; total pheromone of that group over the entire CEG
<groupName>ZeroCounts	One column for each group; total nodes in the CEG with no participation by that group
ms	Elapsed processor time
freeMem	Free memory in the Java VM

Comparison of `numGhosts` and `numAvatars` is helpful in evaluating how widely the CEG has been sampled. Since avatars follow the pheromones left by their ghosts, it will always be the case that `numGhosts` ≤ `numAvatars`. If `numGhosts` = 0 for a node, that means that the preferences and node features during the run were such that other nodes were always more attractive than this node. If `numGhosts` > 0 but `numAvatars` = 0, that means that the node was at least considered by the avatar, but other nodes always won out. Review of this information may lead modelers to revise their preferences or node features.

Table 21. Columns and definitions for eventLog.csv.

Column	Definition
EventID	The event identifier
Event	Full name of the event
numGhosts	Total number of ghosts that visited the event
numAvatars	Total number of avatars that visited the event

3.8 features.csv

This log records the features of each CEG event or hex tile that some agent is considering visiting over time, including the pheromone and urgency levels for each group. Table 22 lists its columns and definitions.

Table 22. Columns and definitions for features.csv.

Column	Definition
Tick	The Repast tick
DomainTime	The current domain time
NominalDwell	The nominal dwell associated with the event. This is only a nominal value, since in the case of a geospatial event, the actual dwell will depend on the agent's experience in geospace
EventID	The event's identifier
NextEvent	The full name of the event, or the location if the agent is in geospace
NumSupZips	The number of supporting zips between this event and an HGN
NumBlockZips	The number of blocking zips between this event and an HGN
Avatar	The avatar whose options are listed
Group	The name of the avatar's home group
Features	The current values of the features, one for each feature

For example, Table 23 is an excerpt for agent A10450 at domain times 15 and 16. Several columns and most of the features are omitted for clarity. The **agentHistory** log shows that this agent moved to E536 at domain time 7 and stayed there for 8 days, so at domain time 15 it is

Table 23. Example from the sample model used in Ground Truth: Excerpt from the features log.

DomainTime	EventID	NextEvent	Avatar	Features		
15	E76	government forces attack anti-government communities	A10450	-0.2	0.5	0.5
15	E485	govt & military argue over strategic objectives	A10450	0	0	-0.2
15	E502	govt and military leaders meet and agree on strategies	A10450	0	0.5	0.5
15	E351	government sets up checkpoints at official border crossings	A10450	-0.2	0.2	0.2
16	E0	landscape_11x11	A10450	0.882	0.882	0.882
16	E0	landscape_11x12	A10450	0.9	0.9	0.9
16	E0	landscape_12x11	A10450	0.891	0.891	0.891
16	E0	landscape_12x13	A10450	0.914	0.914	0.914
16	E0	landscape_13x11	A10450	0.894	0.894	0.894
16	E0	landscape_13x12	A10450	0.876	0.876	0.876

ready to choose a successor to E536. The first four rows show that, the agent is considering four events: E76, E485, E502, and E351. By combining the feature information from this log and the preference information from the **fullPrefs** log, we could manually compute the relative attractiveness of each alternative. The **agentHistory** log shows that the agent in fact chose E76 and moved to geospace, with a current location of landscape_12x12. The next six rows record the six geospatial hexes surrounding this location; when the agent is in geospace, the `EventID` column defaults to E0 (but in fact the agent is in the process of completing E76). By consulting the features for these hexes and the preferences of the agent at this time, we could again replicate SCAMP's assessment of the alternatives. The **agentTrack** log shows that in fact it chooses landscape_12x11.

Even though avatars attend only to the pheromones of their group's ghosts, the ghosts inherit the preferences of their avatars. Thus, the preferences recorded in this table reflect the features used by that avatar's ghosts at the particular decision point.

3.9 fullPrefs.csv

This log records the full time-varying preferences of each avatar. Table 24 lists its columns and definitions.

As with features, though the information is reported per avatar, the preferences are those used by the ghosts of that avatar at the decision point in question. In combination with the information in the features log, this log allows us to reconstruct the roulette used by the ghosts at each decision.

Table 24. Columns and definitions for fullPrefs.csv.

Column	Defintion
Tick	The tick in the Repast framework
DomainTime	The current domain time
Dwell	How long the agent spends on the event
EventID	The ID of the current event
CurEvent	The full name of the current event
Avatar	The avatar whose preferences are recorded
Group	The avatar's home group
Preferences	One column for each Pref* column in the groups tab of model.xlsx, giving the current value of that preference
Wellbeing	One column for each dimension of wellbeing defined in the fixedFeatures tab of model.xlsx, giving the current value of that dimension for the agent
GroupPrefs	One column for each group other than Neutral, giving the strength of the agent's desire to change to that group

3.10 groupInfluencers.csv

The social network model allows each group to have a designated leader and a set of influential members, or "influencers," specified in advance in the **namedAgents** tab of **model.xlsx**. Since agents can be killed during the course of the simulation run, this tab also allows specification of a number of backups to be specified for each named agent. Thus, the actual influential agents may change over time as initial incumbents are removed and new agents take their places. This file logs the actual influencers active in each group at each point in time. Table 25 lists its columns and definitions.

Table 25. Columns and definitions for groupInfluencers.csv.

Column	Definition
Group	The group whose influencers are being reported
DomainTime	The time at which these influencers are active
Leader	The current leader of the group
Influencer...	One or more columns listing the group's active influencers

3.11 groupNetwork.csv

This log records the group wellbeing and strength of inter-group ties over time. Table 26 lists its columns and definitions

The last eight columns reflect the groups in the default scenario, and will change if you define a model with different groups.

Table 26. Columns and definitions for groupNetwork.csv.

Column	Definition
Group	The group from whose perspective the values are being reported (the "ego" groupo)
DomainTime	The time at which these values are current
Wellbeing	The wellbeing of the group, one column for each dimension of wellbeing
Government	The affiliation of Group with Government
ArmedOppositionForces	The affiliation of Group with Armed Opposition Forces
ReliefAgencies	The affiliation of Group with Relief Agencies
People	The affiliation of Group with People
ViolentExtremists	The affiliation of Group with Violent Extremists
Military	The affiliation of Group with Military
Environment	The affiliation of Group with Environment
Neutral	The affiliation of Group with Neutral

3.12 implicitNetwork.csv

An agent's implicit social network defines its proximity with other agents based not on their direct interaction with one another, but on other forms of similarity, e.g., their participation in similar activities, membership in similar clubs, or (in our case) similar preferences. An agent need not know who is in its implicit network--if it did, the link would be explicit rather than implicit.

An agent's implicit network includes all agents in three sets:

- its realized network (the agents it has met, described below),
- the influencers in the agent's own group (which includes the group's leaders)
- an idealized agent for each group with which it is affiliated, to represent agents that it has not met

The preference vectors that ego associates with each of these are the actual preference vectors in the first two cases. In the third case, it uses the notional group preference vector defined on initialization from the **groups** tab in **model.xlsx** and then maintained by the Group Social Influence Process, defined in the SCAMP Design for Social networks. The weight of each edge is the cosine similarity between the preference vectors of the agents involved, times the strength of the defining agent's affiliation with the group of the other agent.

The weights in the implicit network are not necessarily symmetrical. Imagine that A and B are in different groups, and that A is affiliated with B's group, but B is not affiliated with A's. Then B is in A's implicit NW, but A is not in B's at all. And when each is affiliated with the other, the strengths of affiliation may be different.

Table 27 lists the columns and definitions in this log.

Table 27. Columns and definitions for implicitNetwork.csv

Column	Definition
Agent	The agent whose implicit network is being logged
DomainTime	The time at which it is logged
Other	This column and the next are repeated (alternately) for each agent in the implicit network. This column records the avatar that is in the network.
Weight...	This column reports the weight between Agent and Other.

3.13 influences.csv

This file logs the strength of each influence edge in the CEG, over time. Table 29 lists its columns and definitions.

Table 29. Columns and definitions for influences.csv

Column	Definition
Tick	Simulator tick at which the strength is recorded. Tick is useful as well as domain time because pheromone strength can change within a given domain day at different ticks, so exact registration of information across different logs depends on the tick information
Time	Domain time at which the strength is recorded
Type	Type of edge (enable, enhance, inhibit, prevent)
Source	Event identifier (Ennn) of the event causing the influence
Dest	Event identifier of the event being influenced
Pher	Current total pheromone strength on the Source

3.14 meetings_ceg.csv

This file is a cumulative log of the total number and length of meetings between each pair of avatars in the CEG (that is, participating in the same event for an overlapping period of time). Table 28 lists its columns and definitions.

Table 28. Columns and definitions for meetings_ceg.csv

Column	Definition
AvatarA	ID of the first avatar in the pair
GroupA	Avatar A's group number
AvatarB	ID of the second avatar in the pair
GroupB	Avatar B's group number
Count	Total number of meetings between the avatars in the run
Length	Total length of those meetings (sum of overlapping times, in domain days)

3.15 meetings_geo.csv

This file is a cumulative log of the total number and length of meetings between each pair of avatars in geospace (that is, being present on the same hex tile for an overlapping period of time). The columns are the same as for **meetings_ceg**.

3.16 model.xml

This file, in graphml format, contains all the data provided by modelers in the **model.xlsx** workbook and the CEG and HGN xml files. If you open it in a graph visualization tool such as Cytoscape, you will find six "graphs." One, labeled "ceg", shows the events of the CEG, the goals of the HGNs, and all connections among them. The other five, "symbols", "groups", "namedAgents", "regions", and "groupChanges", are disconnected graphs.

3.17 parameters.json

This file contains the values of all the Repast parameters at the conclusion of the run

3.18 realizedNetwork.csv

An agent's realized network is the set of other agents that it has encountered, each with a connection weight in [0, 1] proportional to the frequency and duration of interaction (being on the same event or the same geospace tile at the same time). Each agent weights its interactions with other agents by the total number and duration of all of its interactions. Since these totals will in general differ for different agents, the weights in the realized network are not symmetrical: AgentA may feel that it interacts more highly with AgentB than AgentB feels about AgentA, because each of them is comparing their interactions with different sets of other interactions. These connection weights evaporate over time.

The columns are the same as for **implicitNetwork.csv**.

3.19 rouletteLogs.csv

This log records the raw values of the roulette used by agents to choose their next moves (the dot products of the agent's preferences with the feature vector of each alternative, without exponentiation or application of determinism). Each option being considered has one row in this log. Table 30 lists its columns.

Table 30. Columns and definitions for rouletteLog.csv

Column	Definition
Tick	Tick number at which the line was recorded
DomainTime	Current domain time for the agent
EventID	Agent's current event
NextEvent	Alternative for which the dot product is reported
AgentID	Agent doing the computation
Value	Value of the dot product
Features	Current features for NextEvent
Prefs	Current preferences for agent

3.20 satLog.csv

This log records the satisfaction level at the root of the HGNs for each group over time. Table 31 lists its columns in the conflict model that ships with SCAMP, and will change if you define news groups in **model.xlsx**. In particular, in the latest version of SCAMP, a group may have multiple HGNs, and the general form for the column labels other than Tick is <Group><Root>, where <Group> is the group name (without spaces) and <Root> is the unique goal number of the root of the HGN. Thus a single group may have multiple columns in **satLog.csv**.

Table 31. Columns and definitions for satLog.csv

Column	Definition
Tick	Tick number at which the line was recorded
Government	Root satisfaction for the Government HGN
ArmedOppositionForces	Root satisfaction for the Armed Opposition HGN
ReliefAgencies	Root satisfaction for the Relief Agencies HGN satisfaction
People	Root satisfaction for the People HGN
ViolentExtremists	Root satisfaction for the Violent Extremist HGN
Military	Root satisfaction for the Military HGN

3.21 snapshot.obj.gz

SCAMP generates this file at the end of every run, capturing the state of the simulation to allow you to restart at that point without repeating everything that has already been done. If you copy this file to data/<modelName> (the same directory as the model.graphML.xml file) and start the sim, the new run will pick up where the old one left off, with one exception: the tick counter will start over. In this case, the runLen parameter defines the number of *additional* ticks that the sim will run. For example, if the initial run was for 2000 ticks, then setting the runLen to 2000 for the subsequent run will run from 2001 to 4000. The UI will still show the tick as 1 to 2000, but all of the console output, logs, internal counts, etc. will show 2001 to 4000. The original runDur parameter still applies; if the original run terminated because the sim exceeded runDur, no further extension can be run.

This file can easily be as large as all the other logs combined, so if you do not expect to extend a run, you may want to delete it before archiving your logs.

Acknowledgements

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References

[1]Cytoscape Consortium. Cytoscape: Network Data Integration, Analysis, and Visualization in a Box. 2020. https://cytoscape.org.

Appendix: Files, columns and definitions for log files

File	Column	Definition
affs	Avatar	Identifies the agent described in each row
	Group	The home group of the avatar
	Tick	A measure used by the software team
	TickInt	A measure used by the software team
	DomainTime	The time at which the agent enters an event that leads to the MsgType
	Dwell	The time an agent remains on an event in the number of days encoded as transitTime in delays tab of the model package file. The minimum value of Dwell is 0.
	EventID	The number used to identify the event in the CEG
	Event	The node in the CEG
	MsgType	Describes the decision that the agent made while participating in the event
	Location	The agent's location in the geospace hex lattice
	Dest	The destination specified for a geospatial event in the dest tab of model.xlsx
agentHistory	Avatar	Identifies the agent described in each row
	Group	The home group of the avatar
	Tick	A measure used by the software team
	TickInt	A measure used by the software team
	DomainTime	The time at which the agent enters an event that leads to the MsgType
	Dwell	The time an agent remains on an event in the number of days encoded as transitTime in delays tab of the model package file. The minimum value of Dwell is 0.
	EventID	The number used to identify the event in the CEG
	Event	The node in the CEG
	MsgType	Describes the decision that the agent made while participating in the event
	Location	The agent's location in the geospace hex lattice
	Dest	The destination specified for a geospatial event in the dest tab of model.xlsx
agents	Group	
	IndependentAgency	
	ReceivesAffiliation	
	MakesAffiliation	
	GhostsPerShift	
	ShiftsPerGen	
	MaxGhostSteps	
	GroupAvatars	
	IndividualAvatars	
	AffiliationThreshold	

File	Column	Definition
	PrefVariation	
	UseHGN	
groupChanges	Id	The row information from the groupChanges tab of model.xlsx
	DomainTime	The time at which the agent takes the action that results in the change. Avatar is the agent whose change is recorded in the record
	Avatar	The agent whose change is recorded in the record
File	**Column**	**Definition**
	BeforeGroup	The group name and number to which the avatar belonged before the group change occurred. If the change is a birth, this cell is blank
	AfterGroup	The group name and number to which the avatar belongs after implementation of the group change. If the change is a death, this cell is blank.
	Action	The type of change Born: A new avatar is created from Guf and placed in ToLoc listed in the Id Died: The avatar is removed from ToLoc listed in Id and sent to Guf Group change: The avatar changes agency Location change: The avatar is moved to a new CEG event or region in geospace listed in the Id
adjacencyMatrix.csv		
agentGroup	Agent	Agent ID, in the form Annn
	DomainTime	Current domain time
	Group	Name of agent's home group
agentMeetings	Agent	The agent whose meetings are recorded
	DomainTime	The time of the meetings
	Agent…	A list of agents (one per column) whom Agent met at DomainTime
agentTrack	AgentID	Identifies the agent described in each row
	GroupID	The home group of the agent
	EventID	The number used to identify the event in the CEG
	Tick	A measure used by the software team
	DomainTime	The time at which the agent enters an event
	Dwell	The time an agent remains on an event in the number of days encoded as transitTime in delays tab of model.xlsx
	XLoc, YLoc	The pixel locations in GIMP of the center point of the hex cell at which the agent is located
	Dest	The agent's current destination, in the Geo ID encoded in the regions tab of model.xlsx. AgentID identifies the agent described in each row.
	Location	The hex location (X, Y) on the geospatial map
basePrefs	Avatar	The agent ID
	Group	The group name of the agent's home group
	Preferences	A list of the base preferences (one per column)
entropyLog	Tick	The Repast simulation tick (not the domainTime)
	TotalPhEnt	Entropy of the total pheromone on each node
	<groupName>Ent	One column for each group; entropy of that group's pheromone on each node
	TotalPh	Total pheromone over the entire CEG
	TotalZeroCounts	Number of nodes with 0 participation

File	Column	Definition
	<groupName>ZeroCounts	One column for each group; total nodes in the CEG with no participation by that group