

USC Ground Truth Documentation

August 29, 2018

Contents

1 Background

We use influence diagrams as the underlying graph structure for our ground truth. Here is a simple influence diagram for a simulation of two actors, showing the three types of nodes and some possible links (always directed) among them:

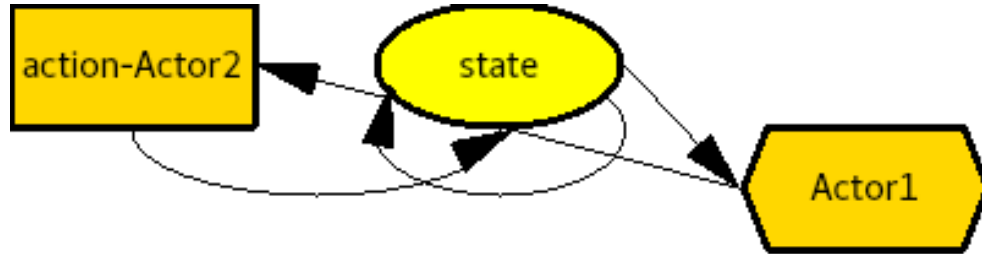


Figure 1: Simple influence diagram

- Rectangular nodes are possible actions for a particular agent (“Actor 1”, indicated by color) representing a potential behavior. They are labeled with a verb (“action”) and an optional object of the verb (“Actor2”). An action node has a binary value, indicating whether or not the action was chosen.
- Oval nodes are state variables. Their value is potentially a probability distribution over a domain of possible values. All true state variables will be certain (i.e., 100% probability for a single value), but agents’ perceptions of the true state will often be uncertain.
- Hexagonal nodes are utility or reward nodes. They represent an expected value computation by the agent (“Actor1”). The node’s value is a table with each row corresponding to a possible action choice and its expected utility.
- Links from action nodes to state nodes specify an effect that the action has on the value of the state.
- Links from one state node to another specify an influence that the value of the first state node has on the effect of at least one action on the second state node.
- Links from a state node to an agent’s utility node specify that the state node is an input to the expected value calculation performed by that agent. There is a real-valued weight from $(0,1]$ on each link specifying the priority of that variable’s influence on that agent’s reward calculation (higher values mean higher priority).
- Links from utility nodes to action nodes indicate that the expected value calculation then determines whether or not that action is chosen. In the simulations described here, we use a strict maximization, so that the action choice is deterministic (i.e., the action with the highest expected value is performed, with ties broken by a pre-determined fixed order).
- Therefore, in the above simple ground truth, whether or not “Actor1” chooses to do “action” to “Actor2” influences the subsequent value of the variable “state” (link from rectangle to oval). The subsequent value of “state” also depends on its prior value (link from oval to itself). “Actor1”’s expected value of doing “action” to “Actor2” is a function of the value of “state” (link from oval to hexagon), and this expected value influences whether or not “Actor1” chooses to do so (link from hexagon to rectangle).

Any real values (e.g., initial values of variables, conditional probability table values, reward weights) will be drawn from either a set $\{0, 0.5, 1\}$ or $\{0, 0.2, 0.4, 0.6, 0.8, 1\}$, depending on the appropriate granularity needed.

2 State

2.1 Actor's age

Type: Integer

2.2 Actor's alive

Type: Boolean

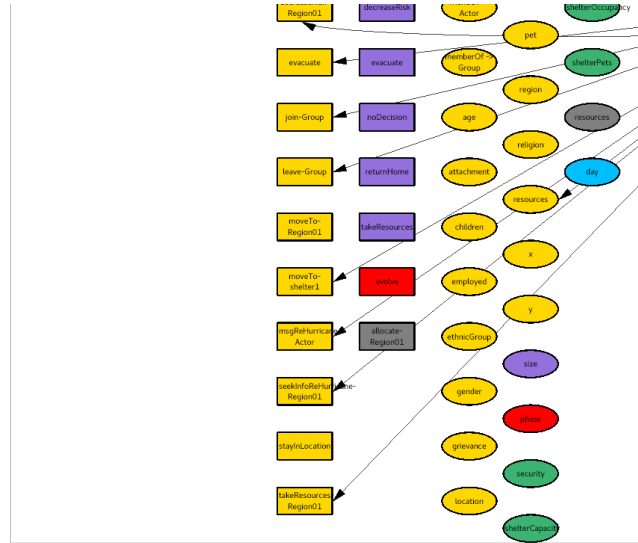


Figure 2: Ground Truth subgraph for Actor's alive

2.2.1 Default change in Actor's alive

IF Actor's alive

THEN IF Actor's health' > 0.01

THEN Actor's alive' ← true

ELSE Actor's alive' ← false

ELSE Actor's alive' ← Actor's alive

2.3 Actor's attachment

Attachment style

Type: String

Values: anxious, avoidant, secure

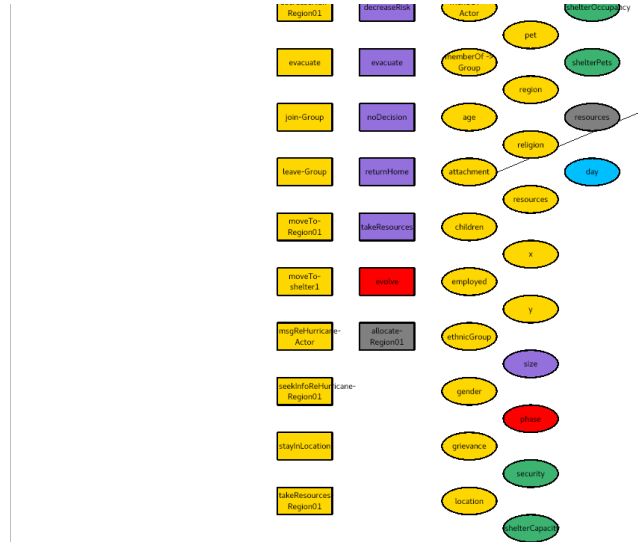


Figure 3: Ground Truth subgraph for Actor's attachment

2.4 Actor's category

Type: Integer

2.5 Actor's categoryData

Type: Integer

2.6 Actor's center

Type: String

Values: Region01, none

2.7 Actor's children

Number of children

Type: Real

2.8 Actor's childrenHealth

Current level of children's physical wellbeing

Type: Real

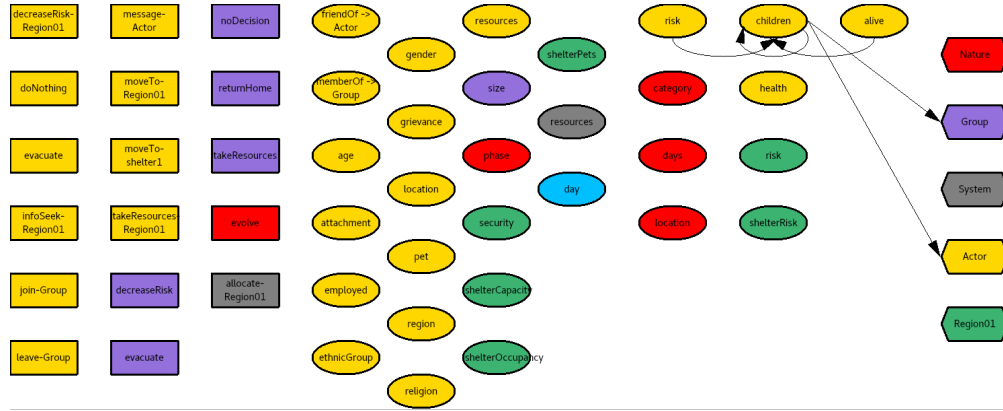


Figure 4: Ground Truth subgraph for Actor's children

2.8.1 Default change in Actor's childrenHealth

IF Actor's alive

THEN IF Actor's $\text{risk}' > 0.20$

THEN IF Actor's $\text{risk}' > 0.40$

THEN IF Actor's $\text{risk}' > 0.60$

THEN IF Actor's $\text{risk}' > 0.80$

THEN

80%: Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth}$

19%: Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth} + 0.24$

ELSE

60%: Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth}$

40%: Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth} + 0.24$

ELSE

40%: Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth}$

60%: Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth} + 0.24$

ELSE

20%: Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth}$

80%: Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth} + 0.24$

ELSE Actor's $\text{childrenHealth}' \leftarrow 60\% \cdot \text{Actor's childrenHealth} + 0.24$

ELSE Actor's $\text{childrenHealth}' \leftarrow 0.00$

2.9 Actor's employed

Has a full-time job

Type: Boolean

2.9.1 Effect of Actor-evacuate on Actor's employed

Actor's $\text{employed}' \leftarrow \text{Actor's employed}$

2.10 Actor's ethnicGroup

Ethnicity of actor

Type: String

Values: majority, minority

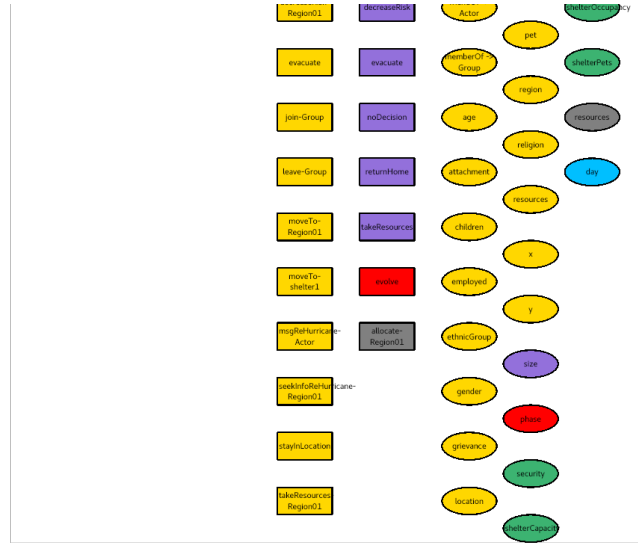


Figure 5: Ground Truth subgraph for Actor's childrenHealth

2.11 Actor's gender

Type: String

Values: female, male

2.12 Actor's grievance

Current level of grievance felt toward system

Type: Real

2.12.1 Effect of System-allocate-Region01 on Actor's grievance

IF Actor's region=Region01

THEN Actor's grievance' $\leftarrow 80\% \cdot \text{Actor's grievance}$

ELSE Actor's grievance' $\leftarrow 80\% \cdot \text{Actor's grievance} + 0.20$

2.13 Actor's health

Current level of physical wellbeing

Type: Real

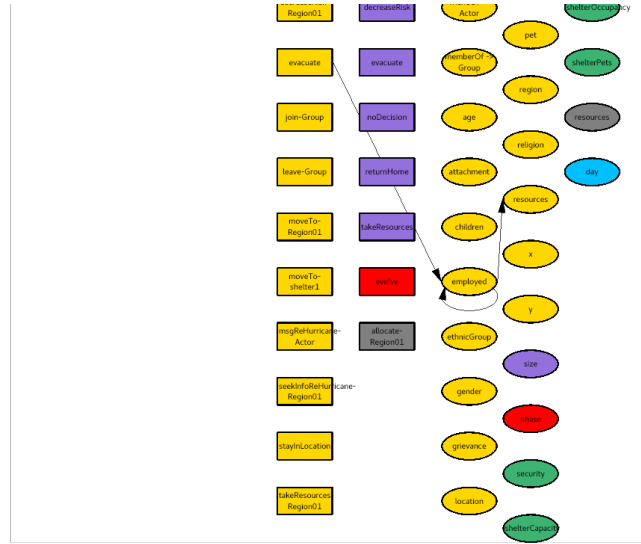


Figure 6: Ground Truth subgraph for Actor's employed

2.13.1 Default change in Actor's health

IF Actor's alive

THEN IF Actor's $\text{risk}' > 0.20$

THEN IF Actor's $\text{risk}' > 0.40$

THEN IF Actor's $\text{risk}' > 0.60$

THEN IF Actor's $\text{risk}' > 0.80$

THEN

80%: Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health}$

19%: Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health} + 0.24$

ELSE

60%: Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health}$

40%: Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health} + 0.24$

ELSE

40%: Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health}$

60%: Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health} + 0.24$

ELSE

20%: Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health}$

80%: Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health} + 0.24$

ELSE Actor's $\text{health}' \leftarrow 60\% \cdot \text{Actor's health} + 0.24$

ELSE Actor's $\text{health}' \leftarrow 0.00$

2.14 Actor's location

Current location

Type: String

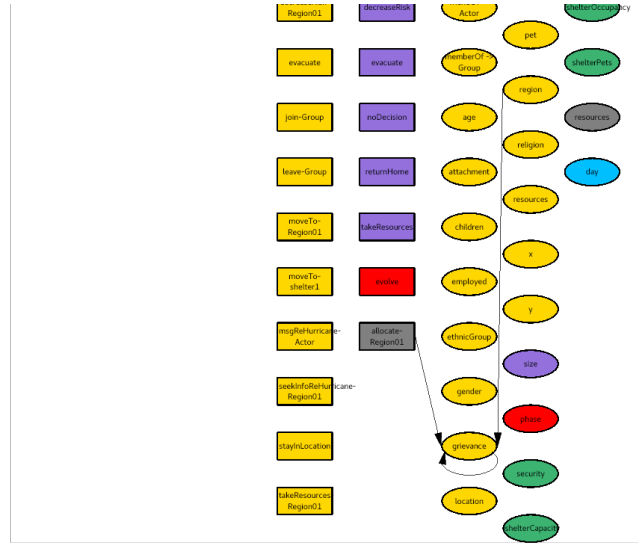


Figure 7: Ground Truth subgraph for Actor's grievance

Values: Region01, evacuated, shelter1

2.14.1 Effect of Actor-evacuate on Actor's location

Actor's location' \leftarrow evacuated

2.14.2 Effect of Actor-moveTo-Region01 on Actor's location

Actor's location' \leftarrow Region01

2.14.3 Effect of Actor-moveTo-shelter1 on Actor's location

Actor's location' \leftarrow shelter1

2.15 Actor's perceivedChildrenHealth

Type: Real

2.16 Actor's perceivedHealth

Type: Real

2.17 Actor's pet

Owns a pet

Type: Boolean

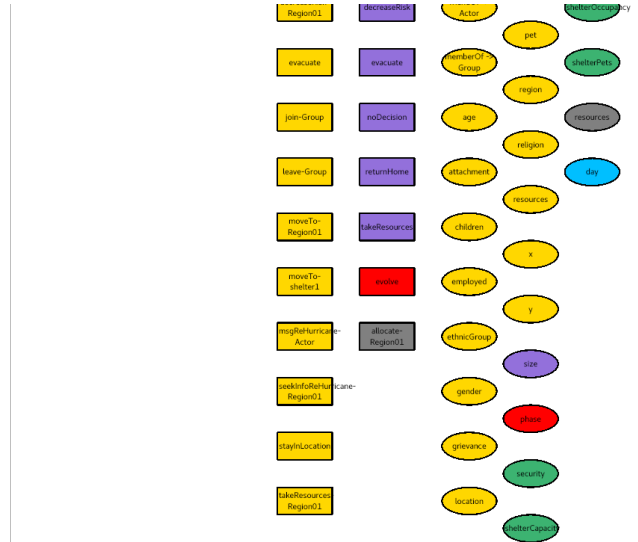


Figure 8: Ground Truth subgraph for Actor's health

2.18 Actor's phase

Type: String

Values: active, approaching, none

2.19 Actor's rcvdCategoryMsg

Type: Integer

2.20 Actor's region

Region of residence

Type: String

Values: Region01

2.21 Actor's religion

Religious affiliation of actor

Type: String

Values: majority, minority, none

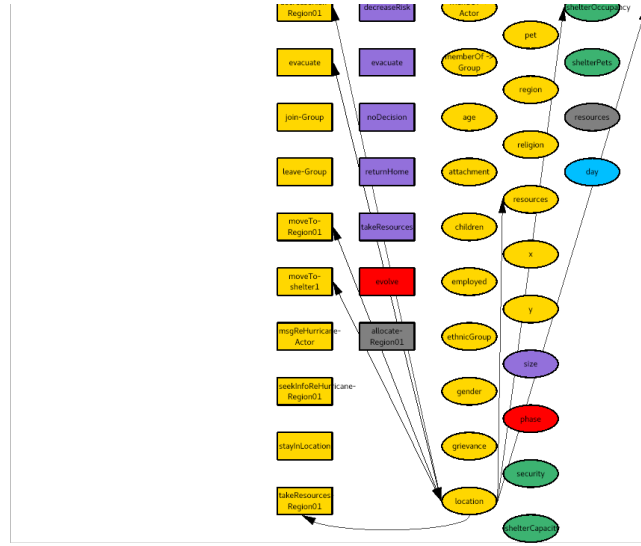


Figure 9: Ground Truth subgraph for Actor's location

2.22 Actor's resources

Material resources (wealth) currently owned

Type: Real

2.22.1 Effect of Actor-evacuate on Actor's resources

IF Actor's resources > 0.20
 THEN Actor's resources' \leftarrow Actor's resources $- 0.20$
 ELSE Actor's resources' $\leftarrow 0.00$

2.22.2 Effect of Actor-stayInLocation on Actor's resources

IF Actor's alive
 THEN IF Actor's employed
 THEN IF Actor's location = Region01 or evacuated
 THEN Actor's resources' $\leftarrow 80\% \cdot$ Actor's resources $+ 0.20$
 ELSE Actor's resources' \leftarrow Actor's resources
 ELSE Actor's resources' \leftarrow Actor's resources
 ELSE Actor's resources' \leftarrow Actor's resources

2.22.3 Effect of Actor-takeResources-Region01 on Actor's resources

Actor's resources' $\leftarrow 0\% \cdot$ Actor's resources $+ 1.00$

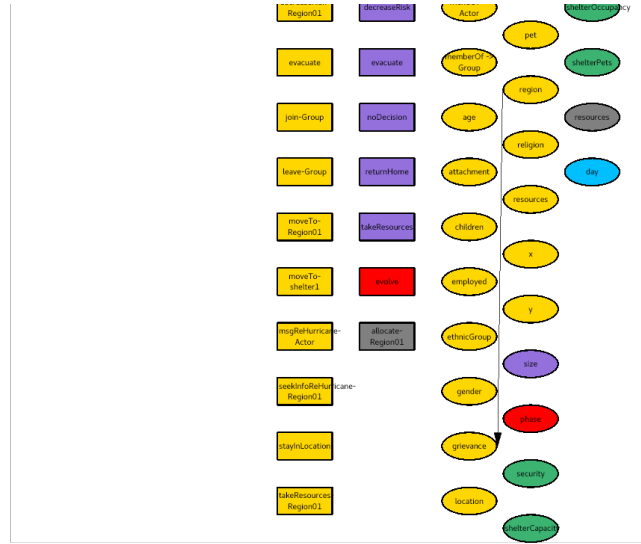


Figure 10: Ground Truth subgraph for Actor's region

2.23 Actor's risk

Current level of risk from hurricane

Type: Real

2.23.1 Effect of Actor-takeResources-Region01 on Actor's risk

IF Nature's phase=none

THEN Actor's risk' $\leftarrow 19\% \cdot \text{Actor's risk} + 0.80$

ELSE Actor's risk' $\leftarrow 80\% \cdot \text{Actor's risk} + 0.20$

2.23.2 Default change in Actor's risk

IF Actor's alive

THEN IF Actor's location'=shelter1

THEN Actor's risk' $\leftarrow \text{Region01's shelterRisk}$

ELSE IF Actor's location'=evacuated

THEN Actor's risk' $\leftarrow 9\% \cdot \text{Actor's risk}$

ELSE Actor's risk' $\leftarrow \text{Region01's risk}$

ELSE Actor's risk' $\leftarrow 0.00$

2.23.3 Effect of Actor-decreaseRisk-Region01 on Actor's risk

Actor's risk' $\leftarrow 80\% \cdot \text{Actor's risk} + 0.20$

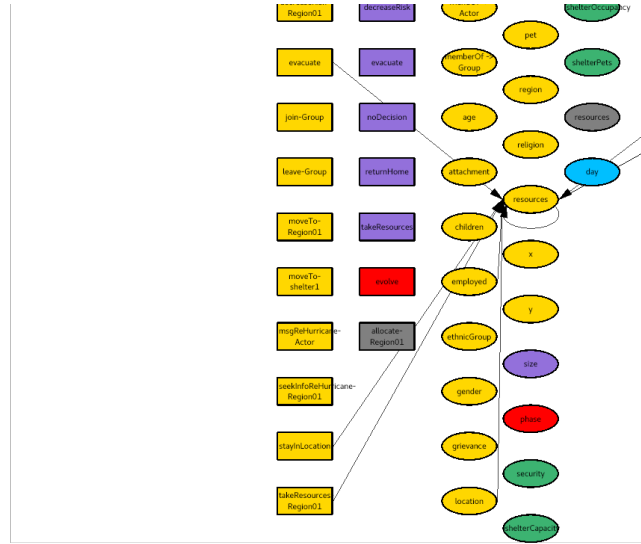


Figure 11: Ground Truth subgraph for Actor's resources

2.24 Actor's x

Representation of residence's longitude

Type: Real

2.25 Actor's y

Representation of residence's latitude

Type: Real

2.26 Group's size

Type: Integer

2.26.1 Effect of Actor-join-Group on Group's size

Group's size' \leftarrow Group's size+1

2.26.2 Effect of Actor-leave-Group on Group's size

Group's size' \leftarrow Group's size-1

2.27 Nature's category

Type: Integer

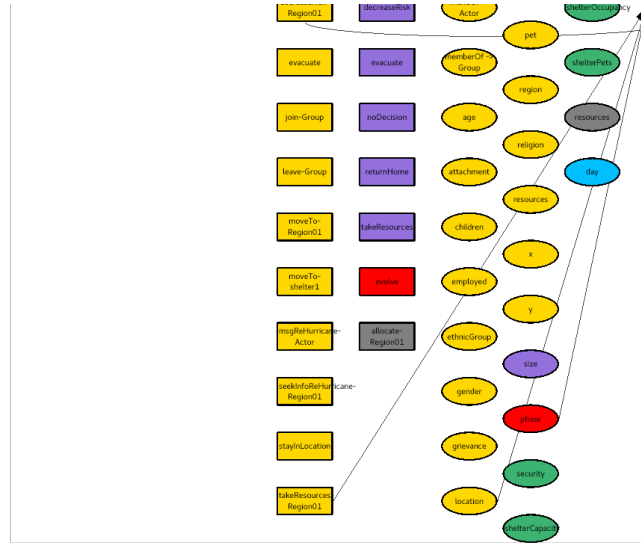


Figure 12: Ground Truth subgraph for Actor's risk

2.27.1 Effect of Nature-evolve on Nature's category

IF Nature's phase'=approaching

THEN IF Nature's category=0

THEN

20%: Nature's category' \leftarrow 1

20%: Nature's category' \leftarrow 2

20%: Nature's category' \leftarrow 5

20%: Nature's category' \leftarrow 3

20%: Nature's category' \leftarrow 4

ELSE IF Nature's category=1

THEN

80%: Nature's category' \leftarrow Nature's category

20%: Nature's category' \leftarrow 2

ELSE IF Nature's category=5

THEN

80%: Nature's category' \leftarrow Nature's category

20%: Nature's category' \leftarrow 4

ELSE

80%: Nature's category' \leftarrow Nature's category

10%: Nature's category' \leftarrow Nature's category - 1

10%: Nature's category' \leftarrow Nature's category + 1

ELSE IF Nature's phase'=active

THEN Nature's category' \leftarrow Nature's category

ELSE Nature's category' \leftarrow 0

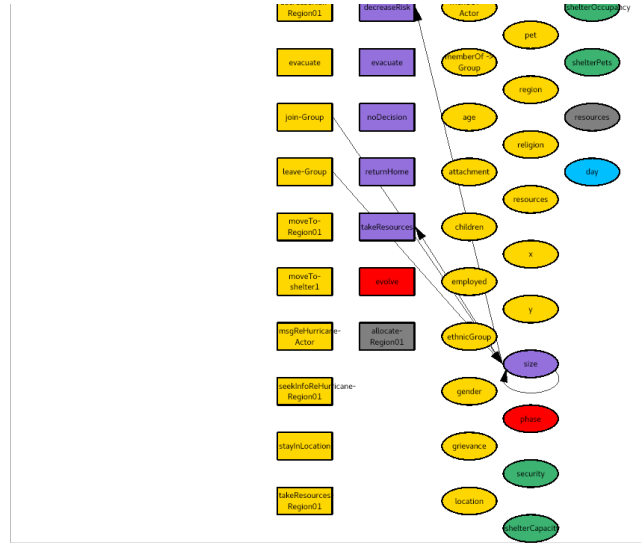


Figure 13: Ground Truth subgraph for Group's size

2.28 Nature's days

Type: Integer

2.28.1 Effect of Nature-evolve on Nature's days

```

IF Nature's phase=Nature's phase'
  THEN Nature's days' ← Nature's days+1
  ELSE Nature's days' ← 0

```

2.29 Nature's location

Type: String

Values: Region01, none

2.29.1 Effect of Nature-evolve on Nature's location

```

IF Nature's phase'=approaching
  THEN IF Nature's location=none
    THEN Nature's location' ← Region01
    ELSE Nature's location' ← Nature's location
  ELSE IF Nature's phase'=active
    THEN IF Nature's location=Region01
      THEN

```

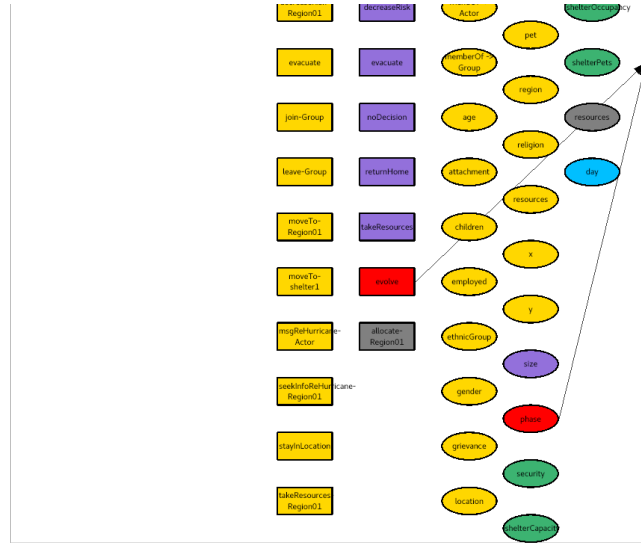


Figure 14: Ground Truth subgraph for Nature's category

40%: Nature's location' \leftarrow none
 20%: Nature's location' \leftarrow Region01
 ELSE Nature's location' \leftarrow Nature's location
 ELSE Nature's location' \leftarrow none

2.30 Nature's phase

Type: String

Values: active, approaching, none

2.30.1 Effect of Nature-evolve on Nature's phase

IF Nature's phase=none
 THEN IF Nature's days>5
 THEN
 60%: Nature's phase' \leftarrow Nature's phase
 40%: Nature's phase' \leftarrow approaching
 ELSE Nature's phase' \leftarrow Nature's phase
 ELSE IF Nature's phase=approaching
 THEN IF Nature's days>5
 THEN
 60%: Nature's phase' \leftarrow Nature's phase
 40%: Nature's phase' \leftarrow active
 ELSE Nature's phase' \leftarrow Nature's phase
 ELSE IF Nature's location=none

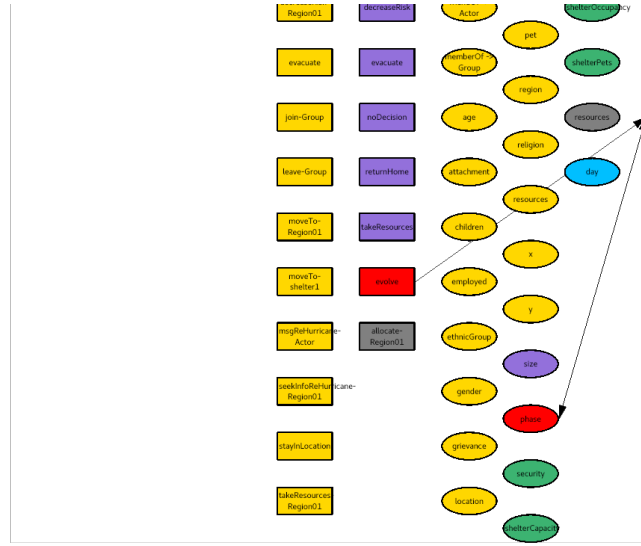


Figure 15: Ground Truth subgraph for Nature's days

THEN Nature's phase' \leftarrow none
ELSE Nature's phase' \leftarrow Nature's phase

2.31 Region01's risk

Type: Real

2.31.1 Effect of Actor-decreaseRisk-Region01 on Region01's risk

Region01's risk' \leftarrow 80% · Region01's risk

2.31.2 Effect of Nature-evolve on Region01's risk

IF Nature's phase' = active
 THEN IF Nature's location' = Region01
 THEN IF Nature's category = 4
 THEN Region01's risk' \leftarrow 60% · Region01's risk + 0.40
 ELSE IF Nature's category = 3
 THEN Region01's risk' \leftarrow 70% · Region01's risk + 0.30
 ELSE IF Nature's category = 2
 THEN Region01's risk' \leftarrow 80% · Region01's risk + 0.20
 ELSE IF Nature's category = 1
 THEN Region01's risk' \leftarrow 90% · Region01's risk + 0.10
 ELSE Region01's risk' \leftarrow 0% · Region01's risk + 1.00
 ELSE Region01's risk' \leftarrow Region01's risk
 ELSE Region01's risk' \leftarrow 80% · Region01's risk

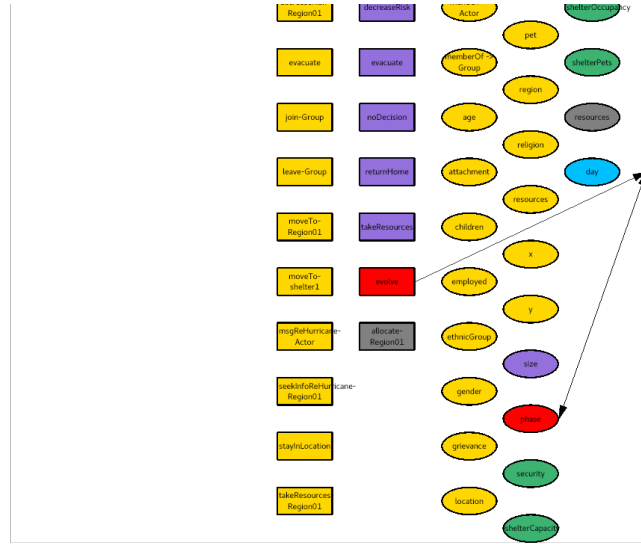


Figure 16: Ground Truth subgraph for Nature's location

2.31.3 Effect of System-allocate-Region01 on Region01's risk

Region01's risk' $\leftarrow 90\% \cdot \text{Region01's risk}$

2.32 Region01's security

Type: Real

2.33 Region01's shelterCapacity

Type: Integer

2.34 Region01's shelterOccupancy

Type: Integer

2.34.1 Effect of Actor-evacuate on Region01's shelterOccupancy

IF Actor's location=shelter1

THEN Region01's shelterOccupancy' \leftarrow Region01's shelterOccupancy-1

ELSE Region01's shelterOccupancy' \leftarrow Region01's shelterOccupancy

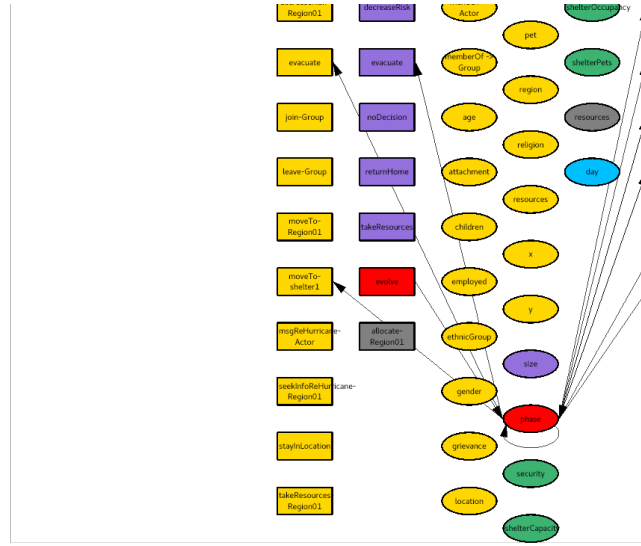


Figure 17: Ground Truth subgraph for Nature's phase

2.34.2 Effect of Actor-moveTo-Region01 on Region01's shelterOccupancy

IF Actor's location=shelter1

THEN Region01's shelterOccupancy' \leftarrow Region01's shelterOccupancy-1

ELSE Region01's shelterOccupancy' \leftarrow Region01's shelterOccupancy

2.34.3 Effect of Actor-moveTo-shelter1 on Region01's shelterOccupancy

Region01's shelterOccupancy' \leftarrow Region01's shelterOccupancy+1

2.35 Region01's shelterPets

Type: Boolean

2.36 Region01's shelterRisk

Type: Real

2.36.1 Effect of Nature-evolve on Region01's shelterRisk

IF Nature's phase'=active

THEN IF Nature's location'=Region01

THEN IF Nature's category=5

THEN Region01's shelterRisk' \leftarrow 19%·Region01's shelterRisk+0.80

ELSE IF Nature's category=4

THEN Region01's shelterRisk' \leftarrow 39%·Region01's shelterRisk+0.60

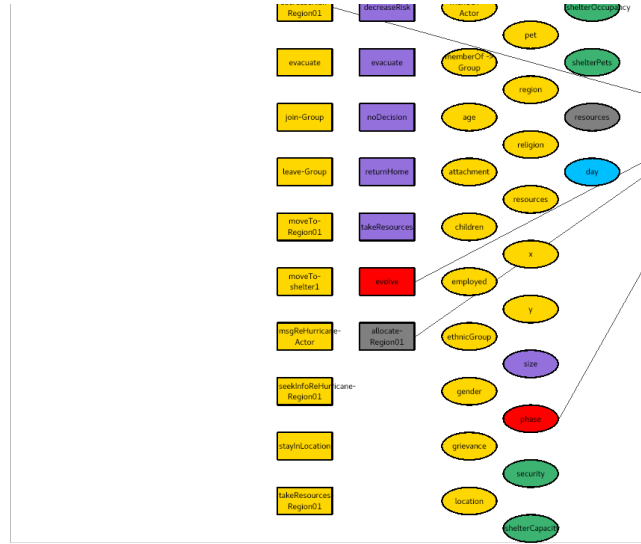


Figure 18: Ground Truth subgraph for Region01's risk

```

ELSE IF Nature's category=3
  THEN Region01's shelterRisk' ← 60% · Region01's shelterRisk + 0.40
ELSE IF Nature's category=2
  THEN Region01's shelterRisk' ← 80% · Region01's shelterRisk + 0.20
ELSE IF Nature's category=1
  THEN Region01's shelterRisk' ← Region01's shelterRisk
  ELSE Region01's shelterRisk' ← Region01's shelterRisk
ELSE Region01's shelterRisk' ← Region01's shelterRisk
ELSE Region01's shelterRisk' ← 80% · Region01's shelterRisk

```

2.37 System's resources

Type: Integer

2.37.1 Effect of System-allocate-Region01 on System's resources

System's resources' ← System's resources − 5

2.38 day

Type: Integer

2.38.1 Effect of Nature-evolve on day

day' ← day + 1

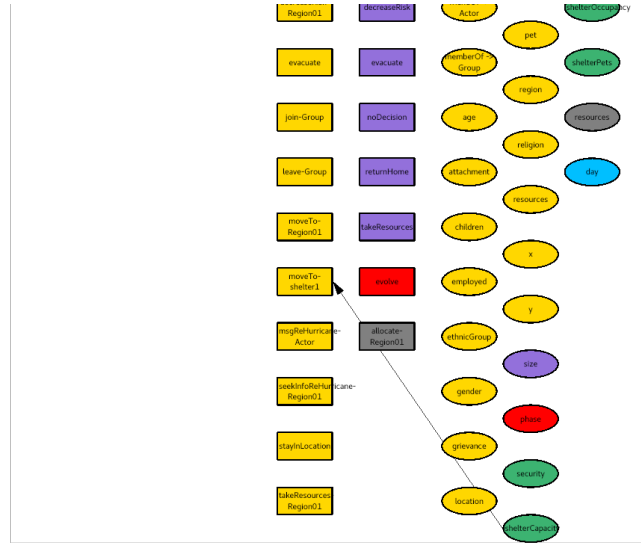


Figure 19: Ground Truth subgraph for Region01's shelterCapacity

3 Relations

3.1 Actor friendOf Actor

Type: Boolean

3.2 Actor memberOf Group

Type: Boolean

3.2.1 Effect of Actor-join-Group on Actor memberOf Group

Actor memberOf Group' \leftarrow true

3.2.2 Effect of Actor-leave-Group on Actor memberOf Group

Actor memberOf Group' \leftarrow false

4 Actions

4.1 System allocate Region01

4.1.1 Applicability of System allocate Region01

IF System's resources > 5
THEN true

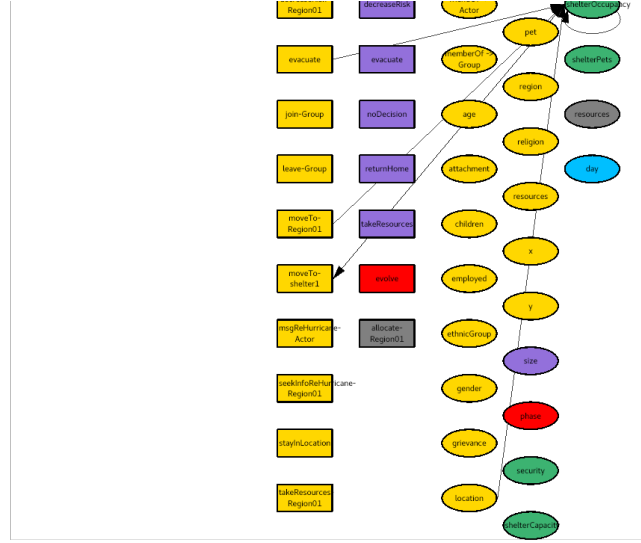


Figure 20: Ground Truth subgraph for Region01's shelterOccupancy

ELSE false

4.1.2 Effect on Actor's grievance of System allocate Region01

IF Actor's region=Region01

THEN Actor's grievance' $\leftarrow 80\% \cdot \text{Actor's grievance}$

ELSE Actor's grievance' $\leftarrow 80\% \cdot \text{Actor's grievance} + 0.20$

4.1.3 Effect on Region01's risk of System allocate Region01

Region01's risk' $\leftarrow 90\% \cdot \text{Region01's risk}$

4.1.4 Effect on System's resources of System allocate Region01

System's resources' $\leftarrow \text{System's resources} - 5$

4.2 Group decreaseRisk

4.2.1 Applicability of Group decreaseRisk

IF Group's size > 0

THEN true

ELSE false

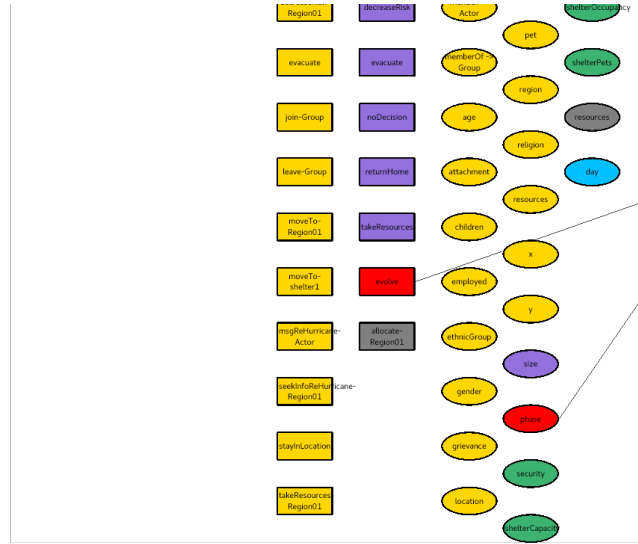


Figure 21: Ground Truth subgraph for Region01's shelterRisk

4.3 Group evacuate

4.3.1 Applicability of Group evacuate

```

IF Nature's phase=none
  THEN false
  ELSE true

```

4.4 Group noDecision

4.5 Group returnHome

4.6 Group takeResources

4.6.1 Applicability of Group takeResources

```

IF Group's size>0
  THEN true
  ELSE false

```

4.7 Actor decreaseRisk Region01

4.7.1 Applicability of Actor decreaseRisk Region01

```

IF Actor's location=Region01
  THEN IF Actor's alive
    THEN true

```

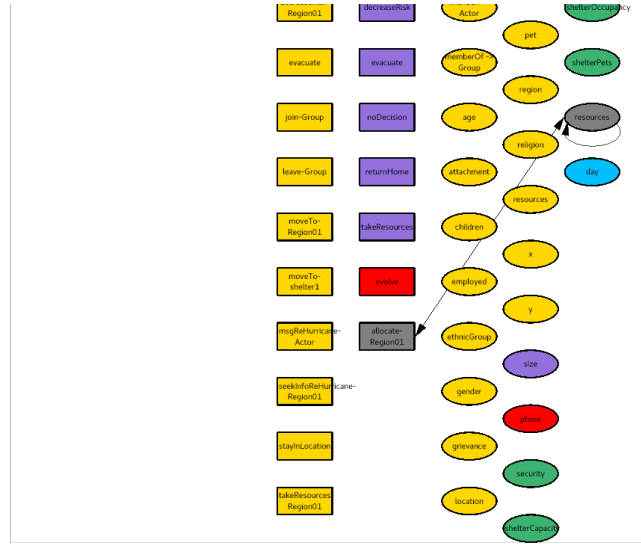


Figure 22: Ground Truth subgraph for System's resources

ELSE false
ELSE false

4.7.2 Effect on Actor's risk of Actor decreaseRisk Region01

$\text{Actor's risk}' \leftarrow 80\% \cdot \text{Actor's risk} + 0.20$

4.7.3 Effect on Region01's risk of Actor decreaseRisk Region01

$\text{Region01's risk}' \leftarrow 80\% \cdot \text{Region01's risk}$

4.8 Actor evacuate

4.8.1 Applicability of Actor evacuate

IF Nature's phase=none
THEN false
ELSE IF Actor's location=evacuated
THEN false
ELSE IF Actor's alive
THEN true
ELSE false

4.8.2 Effect on Actor's employed of Actor evacuate

$\text{Actor's employed}' \leftarrow \text{Actor's employed}$

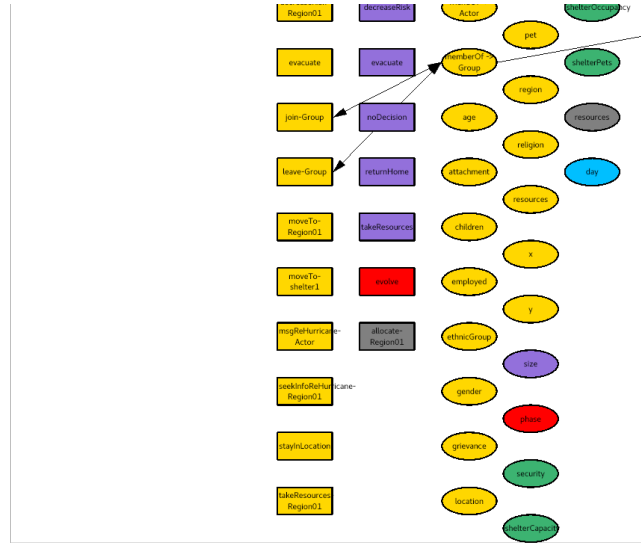


Figure 24: Ground Truth subgraph for Actor memberOf -> Group

4.9.2 Effect on Actor memberOf Group of Actor join Group

Actor memberOf Group' \leftarrow true

4.9.3 Effect on Group's size of Actor join Group

Group's size' \leftarrow Group's size + 1

4.10 Actor leave Group

4.10.1 Applicability of Actor leave Group

IF Actor's alive

THEN IF Actor memberOf Group

THEN true

ELSE false

ELSE false

4.10.2 Effect on Actor memberOf Group of Actor leave Group

Actor memberOf Group' \leftarrow false

4.10.3 Effect on Group's size of Actor leave Group

Group's size' \leftarrow Group's size - 1

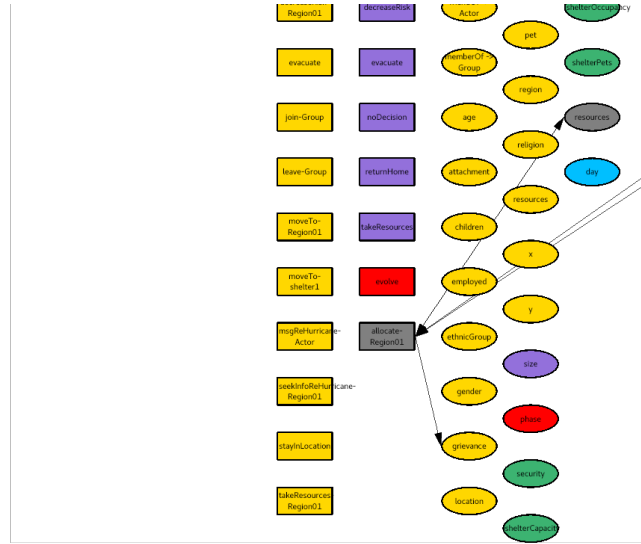


Figure 25: Ground Truth subgraph for System-allocate-Region01

4.11 Actor moveTo Region01

4.11.1 Applicability of Actor moveTo Region01

IF Actor's location=evacuatedor shelter1
 THEN true
 ELSE false

4.11.2 Effect on Actor's location of Actor moveTo Region01

Actor's location' \leftarrow Region01

4.11.3 Effect on Region01's shelterOccupancy of Actor moveTo Region01

IF Actor's location=shelter1
 THEN Region01's shelterOccupancy' \leftarrow Region01's shelterOccupancy-1
 ELSE Region01's shelterOccupancy' \leftarrow Region01's shelterOccupancy

4.12 Actor moveTo shelter1

4.12.1 Applicability of Actor moveTo shelter1

IF Region01's shelterCapacity-Region01's shelterOccupancy>0
 THEN IF Nature's phase=none
 THEN false
 ELSE IF Actor's alive
 THEN IF Actor's location=shelter1

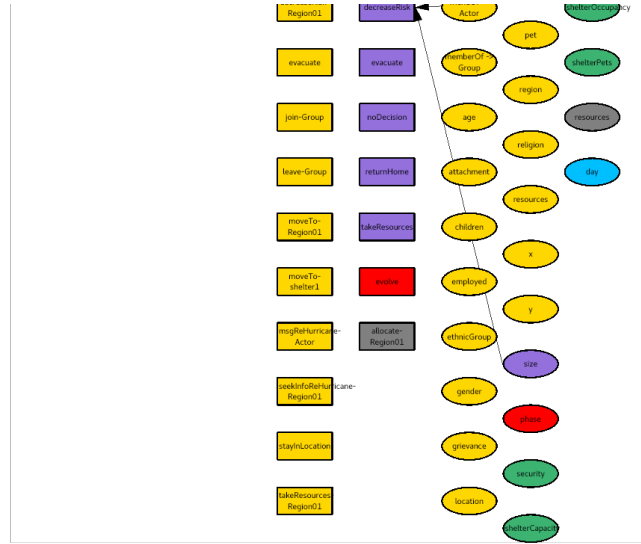


Figure 26: Ground Truth subgraph for Group-decreaseRisk

THEN false
 ELSE true
 ELSE false
 ELSE false

4.12.2 Effect on Actor's location of Actor moveTo shelter1

Actor's location' \leftarrow shelter1

4.12.3 Effect on Region01's shelterOccupancy of Actor moveTo shelter1

Region01's shelterOccupancy' \leftarrow Region01's shelterOccupancy+1

4.13 Actor msgReHurricane Actor

4.13.1 Applicability of Actor msgReHurricane Actor

IF Actor's alive
 THEN true
 ELSE false

4.14 Actor seekInfoReHurricane Region01

4.14.1 Applicability of Actor seekInfoReHurricane Region01

IF Actor's alive
 THEN true

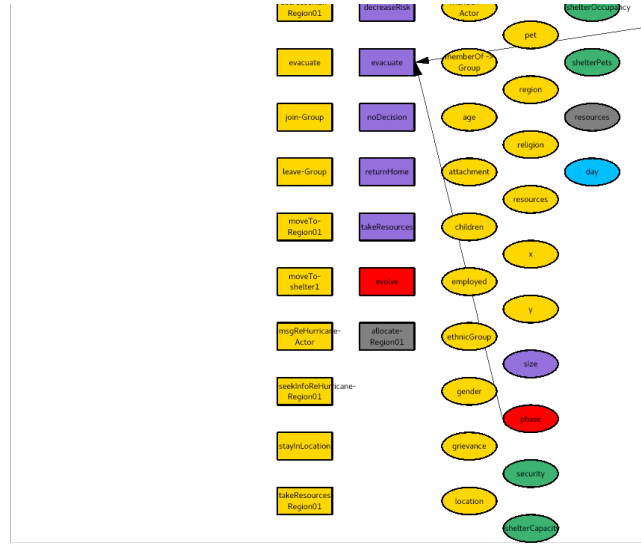


Figure 27: Ground Truth subgraph for Group-evacuate

ELSE false

4.15 Actor stayInLocation

4.15.1 Effect on Actor's resources of Actor stayInLocation

IF Actor's alive

THEN IF Actor's employed

THEN IF Actor's location=Region01or evacuated

THEN Actor's resources' $\leftarrow 80\% \cdot \text{Actor's resources} + 0.20$

ELSE Actor's resources' $\leftarrow \text{Actor's resources}$

ELSE Actor's resources' $\leftarrow \text{Actor's resources}$

ELSE Actor's resources' $\leftarrow \text{Actor's resources}$

4.16 Actor takeResources Region01

4.16.1 Applicability of Actor takeResources Region01

IF Actor's location=Region01

THEN IF Actor's alive

THEN true

ELSE false

ELSE false

4.16.2 Effect on Actor's resources of Actor takeResources Region01

Actor's resources' $\leftarrow 0\% \cdot \text{Actor's resources} + 1.00$

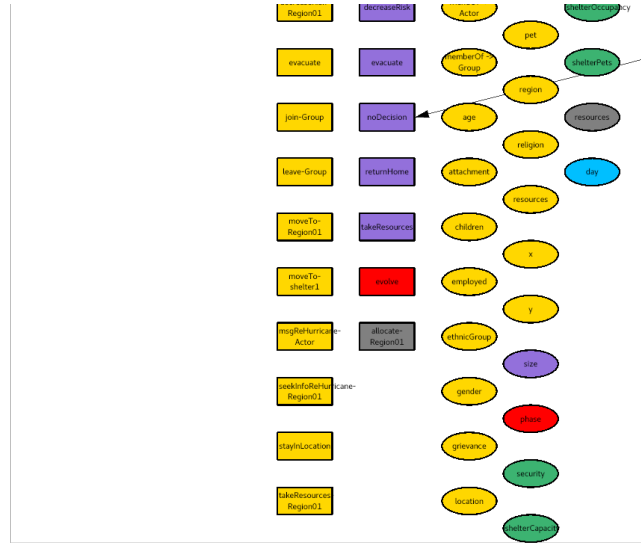


Figure 28: Ground Truth subgraph for Group-noDecision

4.16.3 Effect on Actor's risk of Actor takeResources Region01

IF Nature's phase=none

THEN Actor's risk' $\leftarrow 19\% \cdot \text{Actor's risk} + 0.80$

ELSE Actor's risk' $\leftarrow 80\% \cdot \text{Actor's risk} + 0.20$

4.17 Nature evolve

4.17.1 Effect on Nature's category of Nature evolve

IF Nature's phase'=approaching

THEN IF Nature's category=0

THEN

20%: Nature's category' $\leftarrow 1$

20%: Nature's category' $\leftarrow 2$

20%: Nature's category' $\leftarrow 5$

20%: Nature's category' $\leftarrow 3$

20%: Nature's category' $\leftarrow 4$

ELSE IF Nature's category=1

THEN

80%: Nature's category' $\leftarrow \text{Nature's category}$

20%: Nature's category' $\leftarrow 2$

ELSE IF Nature's category=5

THEN

80%: Nature's category' $\leftarrow \text{Nature's category}$

20%: Nature's category' $\leftarrow 4$

ELSE

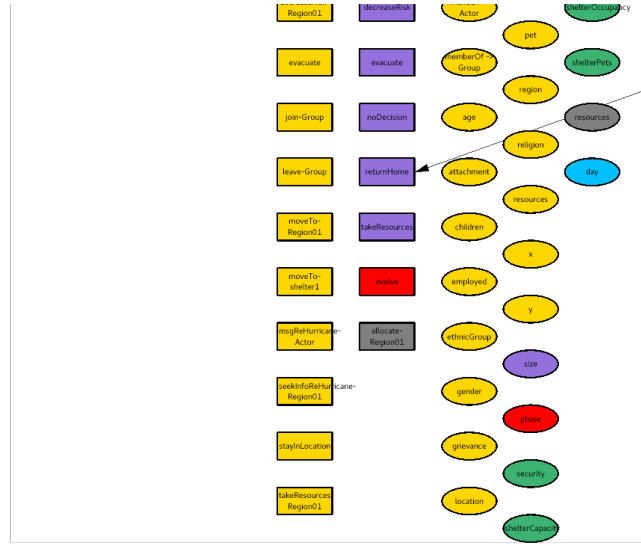


Figure 29: Ground Truth subgraph for Group-returnHome

80%: $\text{Nature's category}' \leftarrow \text{Nature's category}$
 10%: $\text{Nature's category}' \leftarrow \text{Nature's category} - 1$
 10%: $\text{Nature's category}' \leftarrow \text{Nature's category} + 1$
 ELSE IF $\text{Nature's phase}' = \text{active}$
 THEN $\text{Nature's category}' \leftarrow \text{Nature's category}$
 ELSE $\text{Nature's category}' \leftarrow 0$

4.17.2 Effect on Nature's days of Nature evolve

IF $\text{Nature's phase} = \text{Nature's phase}'$
 THEN $\text{Nature's days}' \leftarrow \text{Nature's days} + 1$
 ELSE $\text{Nature's days}' \leftarrow 0$

4.17.3 Effect on Nature's location of Nature evolve

IF $\text{Nature's phase}' = \text{approaching}$
 THEN IF $\text{Nature's location} = \text{none}$
 THEN $\text{Nature's location}' \leftarrow \text{Region01}$
 ELSE $\text{Nature's location}' \leftarrow \text{Nature's location}$
 ELSE IF $\text{Nature's phase}' = \text{active}$
 THEN IF $\text{Nature's location} = \text{Region01}$
 THEN
 40%: $\text{Nature's location}' \leftarrow \text{none}$
 20%: $\text{Nature's location}' \leftarrow \text{Region01}$
 ELSE $\text{Nature's location}' \leftarrow \text{Nature's location}$
 ELSE $\text{Nature's location}' \leftarrow \text{none}$

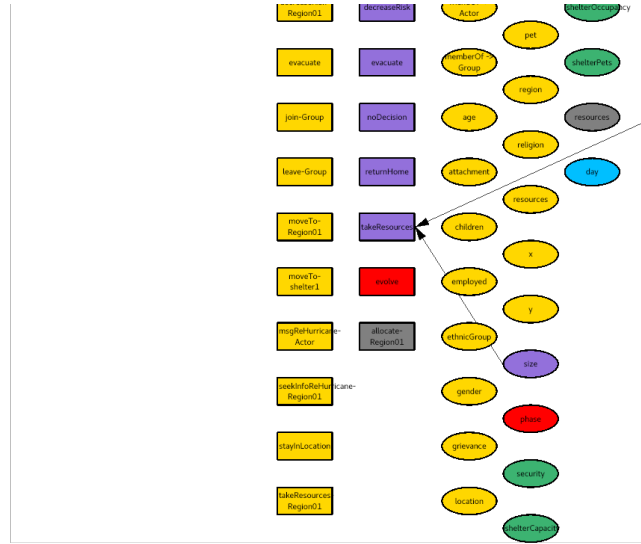


Figure 30: Ground Truth subgraph for Group-takeResources

4.17.4 Effect on Nature's phase of Nature evolve

IF Nature's phase=none

THEN IF Nature's days>5

THEN

60%: Nature's phase' ← Nature's phase

40%: Nature's phase' ← approaching

ELSE Nature's phase' ← Nature's phase

ELSE IF Nature's phase=approaching

THEN IF Nature's days>5

THEN

60%: Nature's phase' ← Nature's phase

40%: Nature's phase' ← active

ELSE Nature's phase' ← Nature's phase

ELSE IF Nature's location=none

THEN Nature's phase' ← none

ELSE Nature's phase' ← Nature's phase

4.17.5 Effect on Region01's risk of Nature evolve

IF Nature's phase'=active

THEN IF Nature's location'=Region01

THEN IF Nature's category=4

THEN Region01's risk' ← 60%·Region01's risk+0.40

ELSE IF Nature's category=3

THEN Region01's risk' ← 70%·Region01's risk+0.30

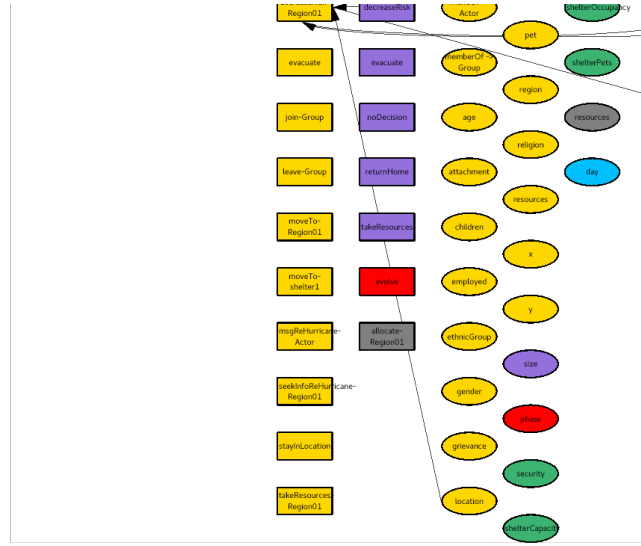


Figure 31: Ground Truth subgraph for Actor-decreaseRisk-Region01

```

ELSE IF Nature's category=2
  THEN Region01's risk' ← 80% · Region01's risk + 0.20
ELSE IF Nature's category=1
  THEN Region01's risk' ← 90% · Region01's risk + 0.10
  ELSE Region01's risk' ← 0% · Region01's risk + 1.00
ELSE Region01's risk' ← Region01's risk
ELSE Region01's risk' ← 80% · Region01's risk

```

4.17.6 Effect on Region01's shelterRisk of Nature evolve

```

IF Nature's phase'=active
  THEN IF Nature's location'=Region01
    THEN IF Nature's category=5
      THEN Region01's shelterRisk' ← 19% · Region01's shelterRisk + 0.80
    ELSE IF Nature's category=4
      THEN Region01's shelterRisk' ← 39% · Region01's shelterRisk + 0.60
    ELSE IF Nature's category=3
      THEN Region01's shelterRisk' ← 60% · Region01's shelterRisk + 0.40
    ELSE IF Nature's category=2
      THEN Region01's shelterRisk' ← 80% · Region01's shelterRisk + 0.20
    ELSE IF Nature's category=1
      THEN Region01's shelterRisk' ← Region01's shelterRisk
      ELSE Region01's shelterRisk' ← Region01's shelterRisk
    ELSE Region01's shelterRisk' ← Region01's shelterRisk
  ELSE Region01's shelterRisk' ← 80% · Region01's shelterRisk

```

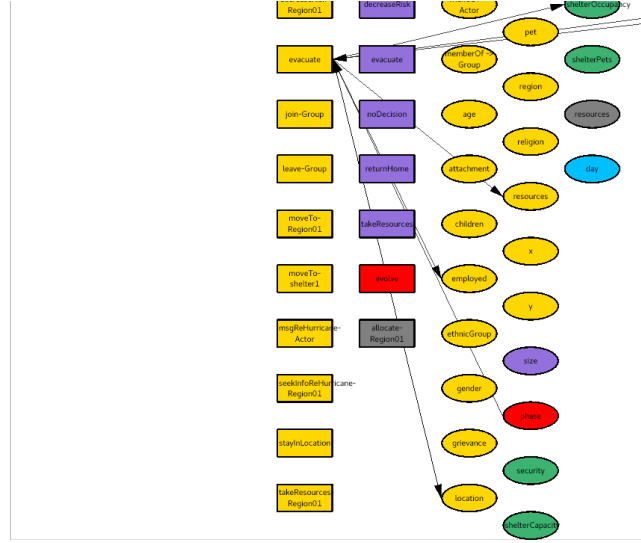


Figure 32: Ground Truth subgraph for Actor-evacuate

4.17.7 Effect on day of Nature evolve

$\text{day}' \leftarrow \text{day} + 1$

5 Expected Reward

5.1 Group's Reward

IF Actor's risk > 0.60

THEN IF Actor's attachment = anxious

THEN $R \leftarrow 10\% \cdot \text{Actor memberOf Group} + 40\% \cdot \text{Actor's childrenHealth} + \text{Actor's health} + 40\% \cdot \text{Actor's resources}$

ELSE IF Actor's attachment = avoidant

THEN $R \leftarrow -10\% \cdot \text{Actor memberOf Group} + 40\% \cdot \text{Actor's childrenHealth} + \text{Actor's health} + 40\% \cdot \text{Actor's resources}$

ELSE $R \leftarrow 40\% \cdot \text{Actor's childrenHealth} + \text{Actor's health} + 40\% \cdot \text{Actor's resources}$

ELSE $R \leftarrow -40\% \cdot \text{Actor's childrenHealth} + \text{Actor's health} + 40\% \cdot \text{Actor's resources}$

5.2 Actor's Reward

IF Actor's risk > 0.60

THEN IF Actor's attachment = anxious

THEN $R \leftarrow 10\% \cdot \text{Actor memberOf Group} + 40\% \cdot \text{Actor's childrenHealth} + \text{Actor's health} + 40\% \cdot \text{Actor's resources}$

ELSE IF Actor's attachment = avoidant

THEN $R \leftarrow -10\% \cdot \text{Actor memberOf Group} + 40\% \cdot \text{Actor's childrenHealth} + \text{Actor's health} + 40\% \cdot \text{Actor's resources}$

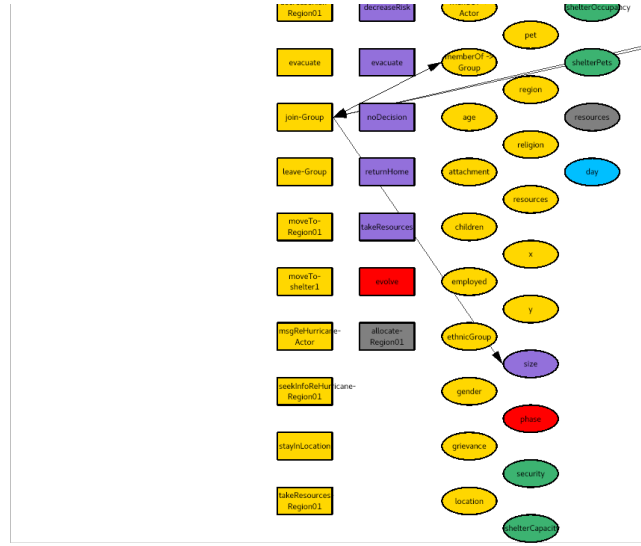


Figure 33: Ground Truth subgraph for Actor-join-Group

health+40%·Actor's resources

ELSE $R \leftarrow 40\% \cdot \text{Actor's childrenHealth} + \text{Actor's health} + 40\% \cdot \text{Actor's resources}$

ELSE $R \leftarrow 40\% \cdot \text{Actor's childrenHealth} + \text{Actor's health} + 40\% \cdot \text{Actor's resources}$

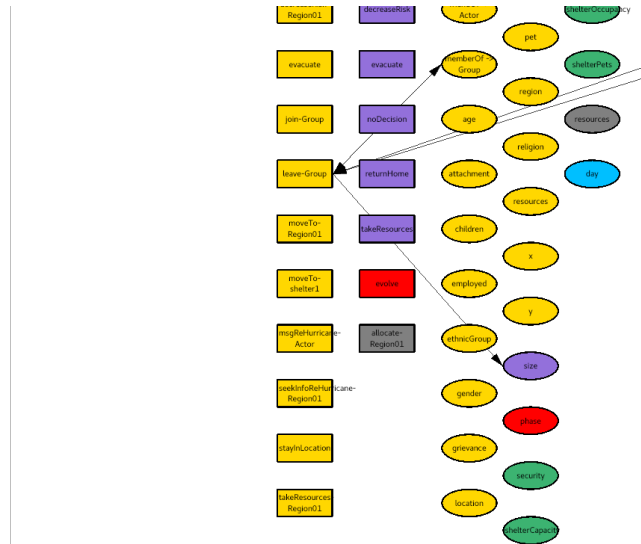


Figure 34: Ground Truth subgraph for Actor-leave-Group

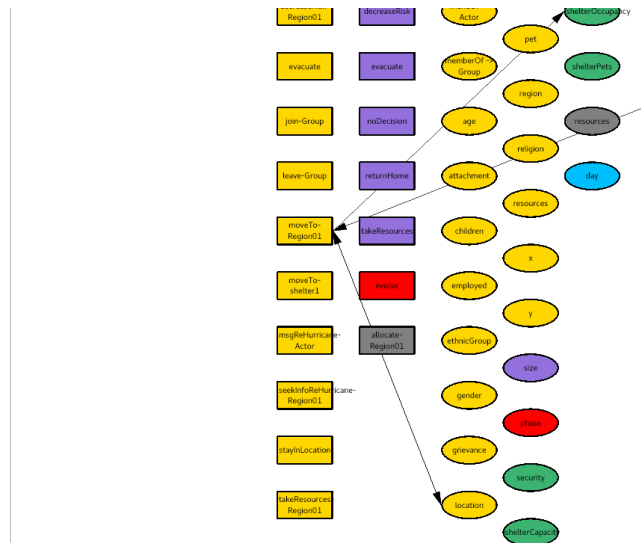


Figure 35: Ground Truth subgraph for Actor-moveTo-Region01

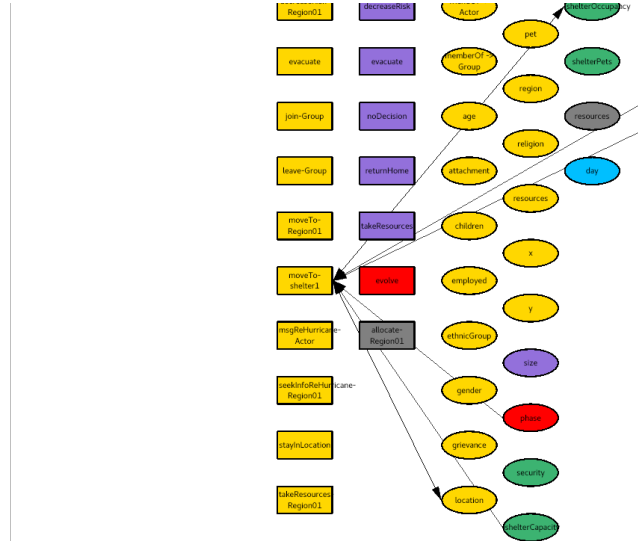


Figure 36: Ground Truth subgraph for Actor-moveTo-shelter1

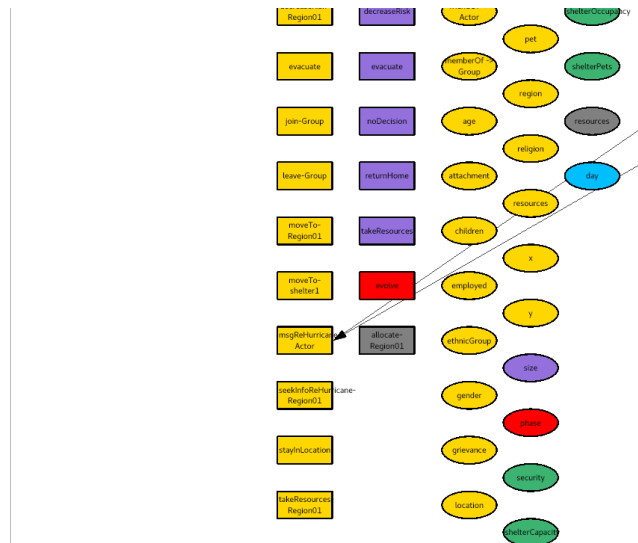


Figure 37: Ground Truth subgraph for Actor-msgReHurricane-Actor

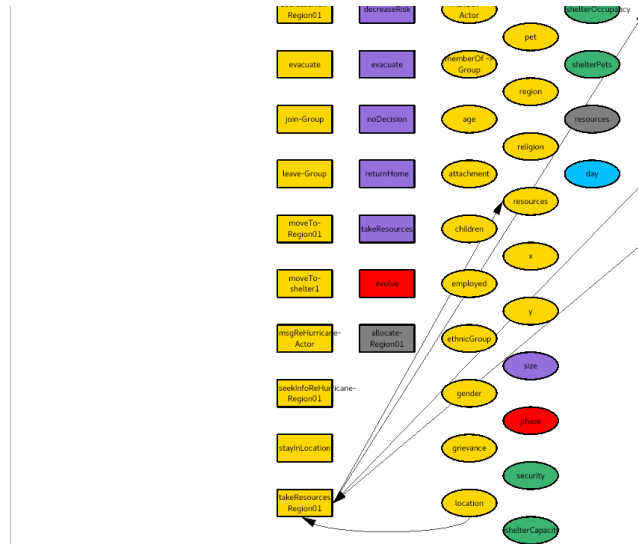


Figure 40: Ground Truth subgraph for Actor-takeResources-Region01

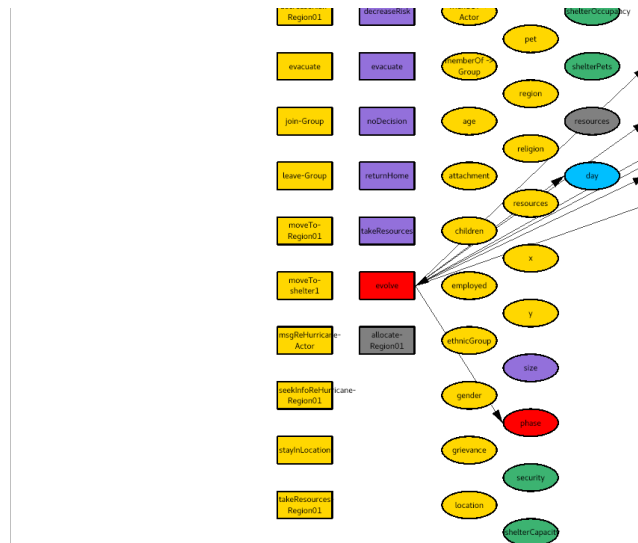


Figure 41: Ground Truth subgraph for Nature-evolve

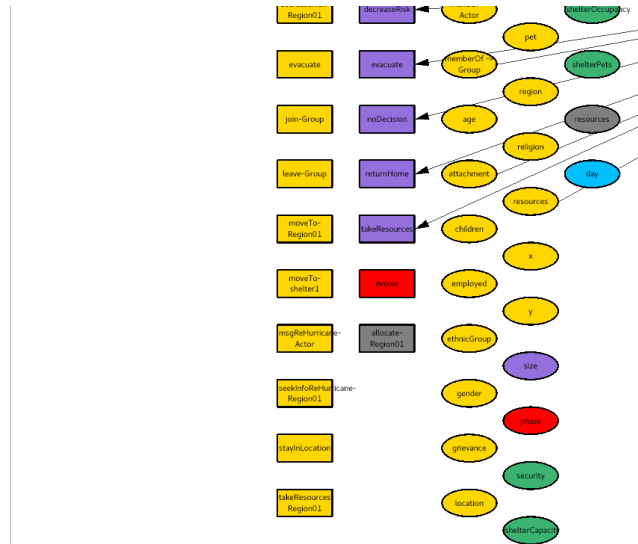


Figure 42: Ground Truth subgraph for Group

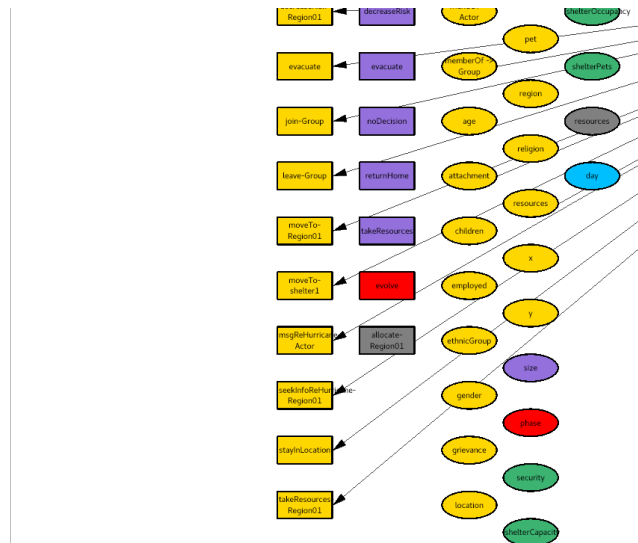


Figure 43: Ground Truth subgraph for Actor