



Kova PedSim Documentation

Network Simulation

Table of Contents



Introduction to Kova Pg. 3



Agent Type Components Pg. 5



Program Components Pg. 10



Environment Components Pg. 12



Compile Simulation Components Pg. 15

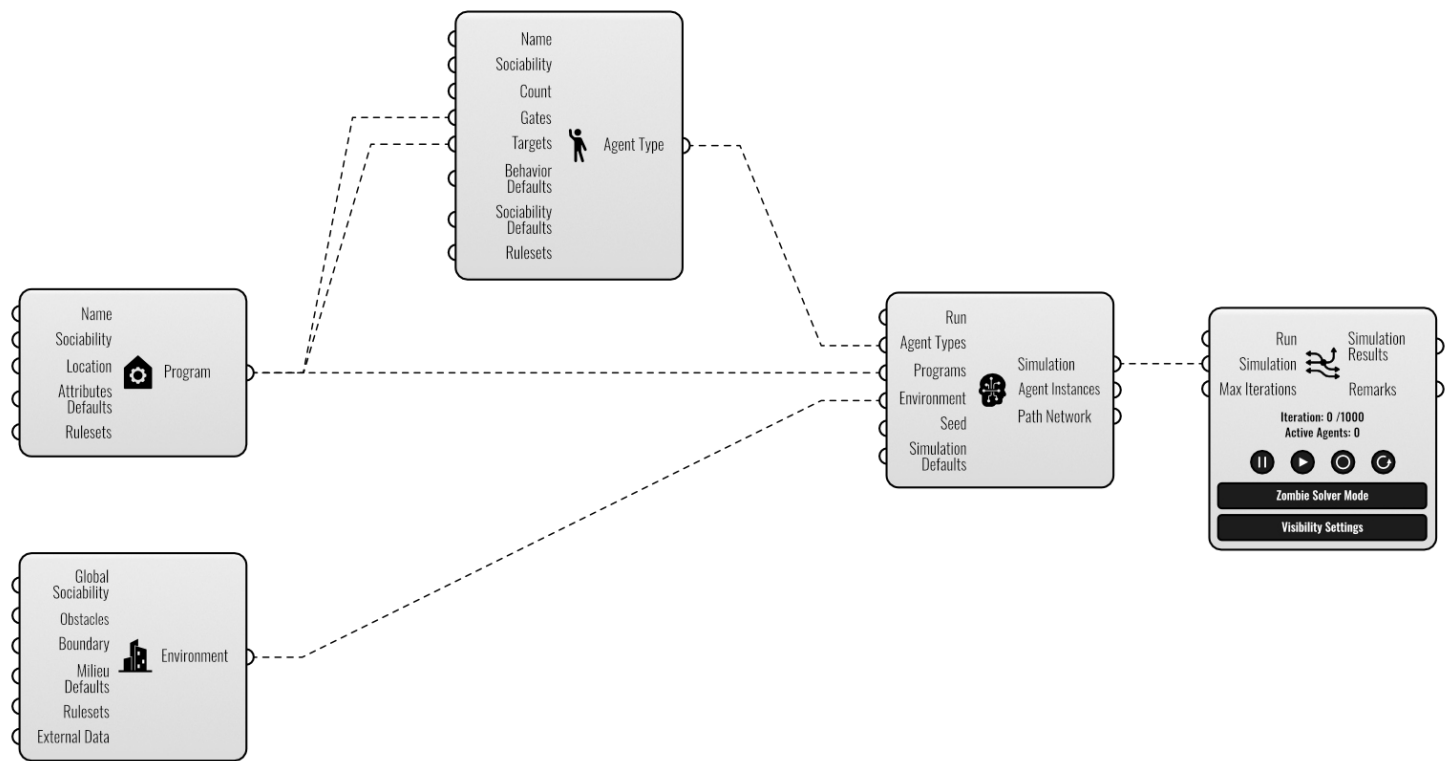


Run Simulation Components Pg. 17



Component Workflow

Kova uses a consistent workflow across the CA, Network, and Physics simulations. Constructor components define the agents, programs, and environment. The Compile Simulation component combines these elements into a simulation, and the Run Simulation component executes it.



Simulation Types

Cellular Automata Simulation

The Cellular Automata (CA) model divides a walkable surface into a grid of connected cells. Agents move from one cell to another based on destinations, surrounding conditions, social qualities, external data, and nearby agents. This model is well suited to testing movement patterns, occupancy, and spatial attraction across floors, plazas, and other open areas. Its discrete grid structure also makes it efficient for simulations with larger agent populations.

Network Simulation

The Network model moves agents along connected Rhino curves. These curves represent predefined routes such as streets, corridors, paths, or circulation networks. Agents select routes based on distance, turns, program sociability, external data, and their individual awareness. This model is useful when pedestrian movement should remain constrained to a known network rather than spread freely across a surface.

Physics Simulation

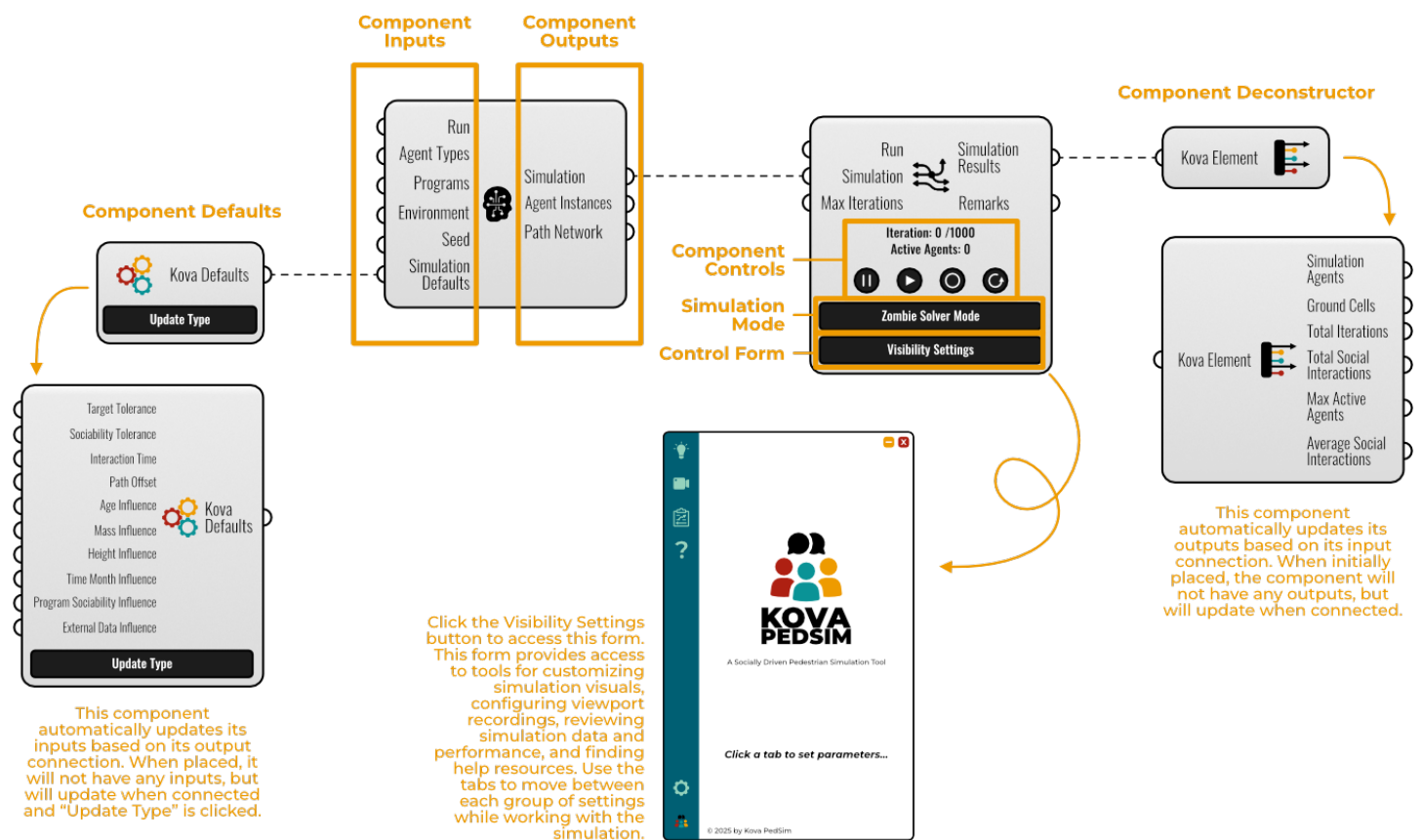
The Physics model moves agents continuously through a bounded environment using movement forces. Agents follow generated paths while responding to obstacles, nearby pedestrians, social spacing, programs, and random movement variation. This produces more detailed local movement than the other models. It is best suited to entrances, rooms, concourses, and other spaces where close-range pedestrian interactions are important, but generally requires more processing than CA or Network simulations.



Component Anatomy

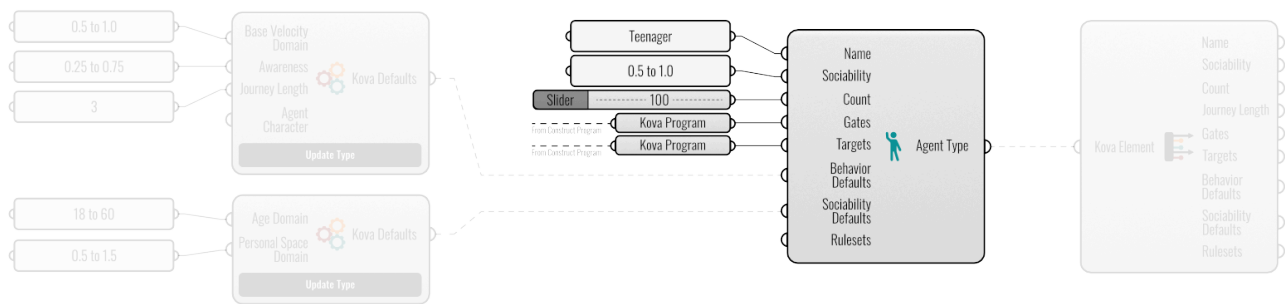
Kova components follow the standard Grasshopper structure, with inputs on the left and outputs on the right. Most components use fixed ports to construct or process simulation data, while several specialized components adapt to the connected workflow.

The Kova Defaults Override automatically generates inputs based on the Defaults input it is connected to; connect it first, then select Update Type. The Kova Deconstructor works in the opposite direction, automatically generating outputs based on the connected Kova element so its stored parameters and results can be inspected. The Run Simulation component adds controls for pausing, playing, stepping through, and resetting the simulation, along with controls for changing the solver mode and opening the Kova Settings form.



Construct Agent Type Component

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Name

A label for this type of agent. Use this to distinguish different populations, such as "Visitor", "Commuter", or "Staff". This value is only an identifier and does not influence the algorithm. Default: "Agent".

2 Sociability

The range of possible social levels assigned to this agent type. Each agent instance receives a randomly selected value within this interval. Values must stay between 0.0 and 1.0. During the simulation, two agents with similar social levels are more likely to socialize. Default: 0.25 to 0.75.

3 Count

The number of individual agents of this type to create for the simulation. Must be at least 1. Default: 100.

Outputs

1 Agent Type

A compiled Kova element representing the specified agent type in the simulation.

4 Gates

The Kova program(s) this agent type can spawn from during the simulation. If multiple gates are provided, the agents will pick their gates at random. Default: none; required input.

5 Targets

The Kova program(s) that define possible destinations for this agent type. If the number of targets is greater than the journey length, the agents will pick their targets at random. Default: none; required input.

6 Behavior Defaults

Optional movement and physical behavior settings. If left unconnected, Kova uses the built-in behavior defaults. Default: see Behavior Defaults.

7 Sociability Defaults

Optional social behavior settings. If left unconnected, Kova uses the built-in sociability defaults. Default: see Sociability Defaults.

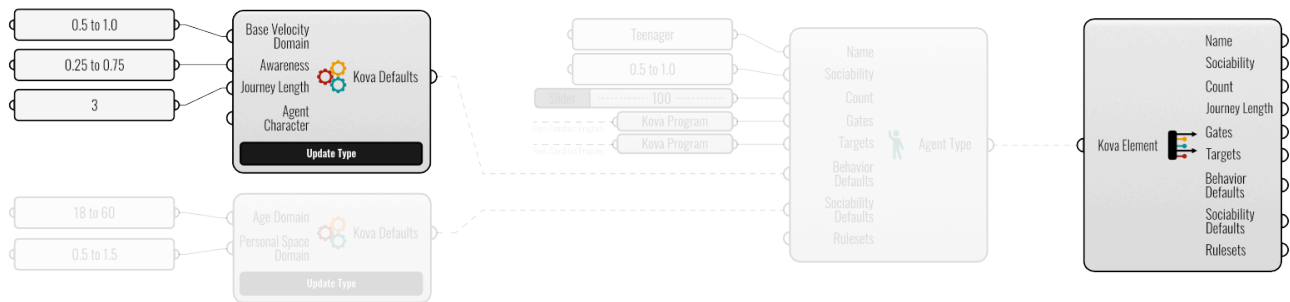
8 Rulesets

Optional rulesets to store with this agent type. These can be used to modify or constrain behavior during the simulation. Default: empty list.



Agent Behavior Defaults Override

User Input Data ■ Kova Output Data ■
Kova Input Data ■ Native Output Data ■



Inputs

1 Base Velocity Domain

The range of possible walking speeds assigned to this agent type. Each agent instance receives a randomly selected value within this interval. Values are measured in Rhino units per simulation iteration and are adjusted based on the agent's characteristics. Default: 0.5 to 1.0 m, 500 to 1000 mm, 1.65 to 3.3 ft, or 19.7 to 39.37 in, depending on Rhino units.

2 Awareness

The range of awareness values between 0.0 and 1.0 assigned to the agent type. Higher values make agents more aware of surrounding conditions when making movement decisions. Default: 0.25 to 0.75.

3 Journey Length

The number of destination programs each agent will try to visit during its journey. This cannot be greater than the number of connected targets. Default: 1.

4 Agent Character

Optional display geometry used to represent agents in the simulation preview. Default: no custom character. See Agent Character Constructor.

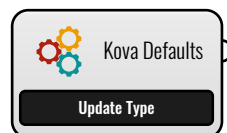
Outputs

1 Kova Defaults

A compiled set of behaviors which can be used for any agent type.

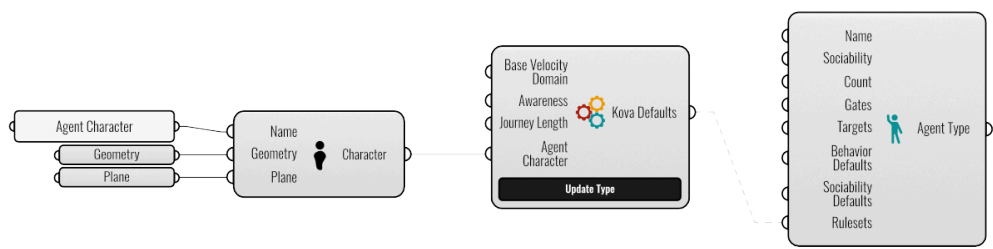
Note:

This component automatically updates its inputs based on its output connection. When placed, it will not have any inputs, but will update when connected and "Update Type" is clicked.



Agent Character Constructor

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

- 1 Name**
A label for this character. This value is only an identifier and does not influence the simulation. Default: "Default Character".
- 2 Geometry**
The Rhino geometry used to represent agents in the simulation preview. Meshes, breps, and SubDs are supported. Default: none; required input.
- 3 Plane**
The base plane used to position and orient the character geometry. Place the plane at the character's origin and align its axes with the intended forward and upright directions. Default: World XY.

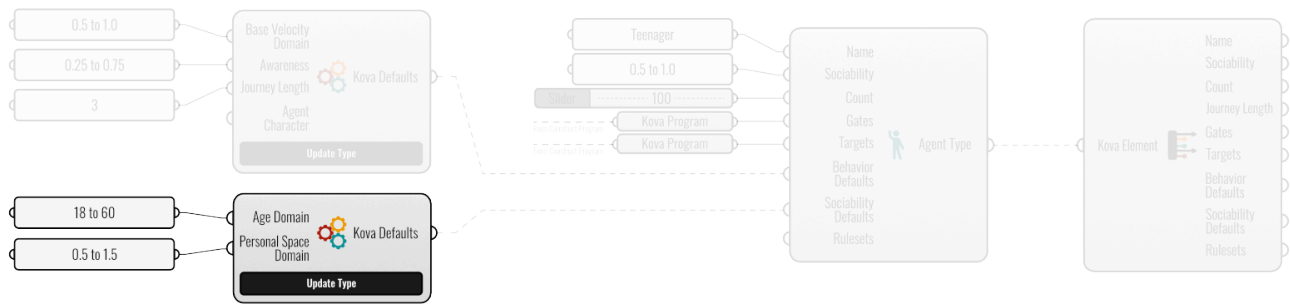
Outputs

- 1 Kova Defaults**
A compiled agent character which can be used for the environment.



Agent Sociability Defaults Override

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Age Domain

The range of possible ages assigned to this agent type. This will affect its movement patterns and social behaviors during the simulation. Default: 18 to 60.

2 Personal Space Range

The range of possible personal-space distances assigned to this agent type. Agents can detect and socialize with other agents inside this distance. Values are measured in Rhino units and must be greater than 0. Default: 0.5 to 1.5 m, 500 to 1500 mm, 1.6 to 4.9 ft, or 19.2 to 58.8 in, depending on Rhino units.

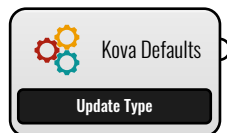
Outputs

1 Kova Defaults

A compiled set of social behaviors which can be used for any agent type.

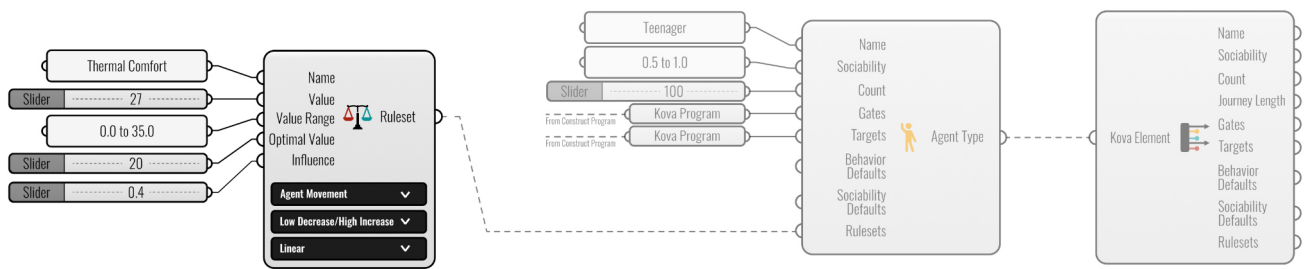
Note:

This component automatically updates its inputs based on its output connection. When placed, it will not have any inputs, but will update when connected and "Update Type" is clicked.



Agent Rulesets Constructor

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Name

A label used to identify this ruleset. This value is only an identifier and does not influence the simulation. Default: "Default Ruleset".

2 Value

The numeric value for this agent type evaluated by the ruleset. This value must fall within the supplied minimum and maximum range. Default: none; required input.

3 Value Range

The domain of the ruleset's evaluation range. This determines where the supplied value falls within the range. Default: none; required input.

4 Optimal Value

The natural value of the ruleset's evaluation range. This will determine the effect of the custom ruleset on the agent's movement or socialization. Default: none; required input.

5 Influence

The strength of the ruleset's effect. A value of 0.0 applies no influence, while 1.0 applies the full influence. Must remain between 0.0 and 1.0. Default: 0.3.

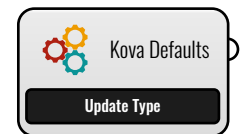
Outputs

1 Kova Ruleset

A compiled Kova element containing the ruleset's value range, influence, easing function, and intended simulation target. Connect this output to the Rulesets input of an agent type, program, or environment.

Note:

This component automatically updates its inputs based on its output connection. When placed, it will not have any inputs, but will update when connected and "Update Type" is clicked.



Kova Tip!

Rulesets allow you to embed custom, scenario-specific behaviors to agents. Rulesets could capture agent scenarios surrounding **thermal comfort level, mobility requirements, luggage load, etc.** Each ruleset acts as a multiplier in Kova, allowing agents to respond to the selected condition.

Buttons

1 Agent Movement

The part of the simulation that this ruleset is intended to affect. Available options include Agent Movement, Path Network, Ground / Environment, and Program Sociability. Currently, only Agent Movement is available for use. Default: "Agent Movement".

3 Easing Function

Controls how the ruleset's effect changes as Value moves between Min Range and Max Range. Linear applies the effect proportionally, while the other easing options apply different rates of change. Default: "Linear".

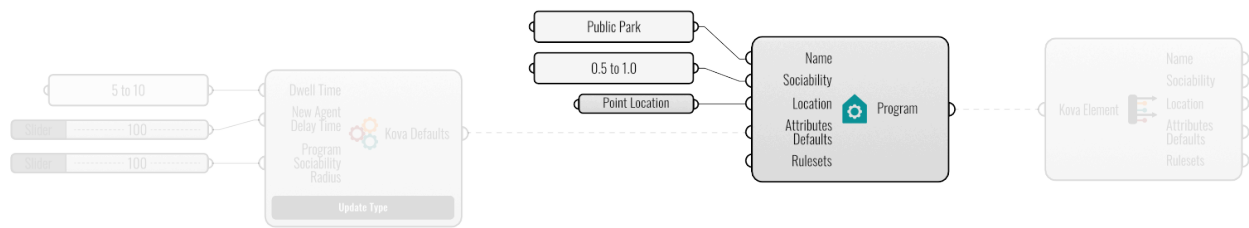
2 Range Extrema Behavior

Controls how the ruleset's effect changes as Value moves towards the Min Range and Max Range and away from the Optimal Value.



Construct Program Component

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Name

A label for this program. Use this to distinguish different spatial programs, such as "Entrance", "Cafe", "Gallery", or "Exit". This value is only an identifier and does not influence the algorithm. Default: "Program".

2 Sociability

The range of possible social levels assigned to this program. Each program receives a randomly selected value within this interval. Values must stay between 0.0 and 1.0. Program sociability contributes to the social weighting of nearby paths. Default: 0.25 to 0.75.

3 Location

The Rhino point that defines where this program exists in the simulation. Place the point on or near the connected path network so Kova can associate it with a valid route. Default: none; required input.

4 Attributes Defaults

Optional attribute settings stored with this program. If left unconnected, Kova uses the built-in attributes defaults. Default: see Attributes Defaults.

5 Rulesets

Optional rulesets to store with this program. These can be used to modify or constrain behavior during the simulation. Default: empty list.

Outputs

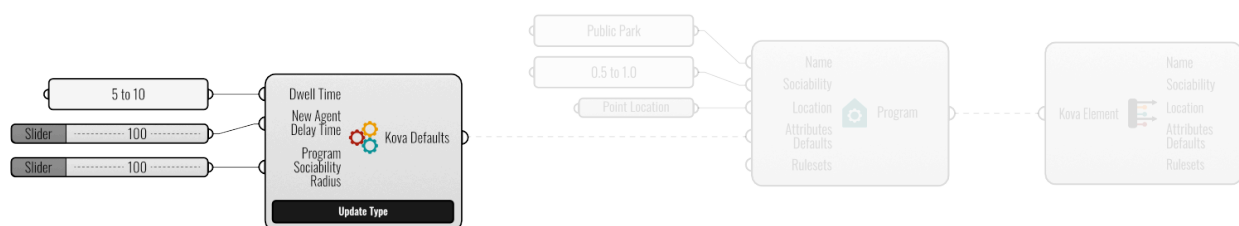
1 Program

A compiled Kova element representing the specified program in the simulation.



Program Attributes Defaults Override

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Dwell Time

The range of possible durations, in simulation iterations, that agents remain at this program after reaching it as a destination. Each visit receives a randomly selected duration within this interval. Default: 5 to 10

2 New Agent Delay Time

The number of simulation iterations between new agent releases from this program when it is used as a gate. Must be greater than 0 for gate programs. Default: 10 iterations.

3 Program Sociability Radius

The distance around this program where its sociability influences nearby network paths. Must be greater than 0. Default: 7 m, 7000 mm, 23 ft, or 275 in, depending on Rhino units.

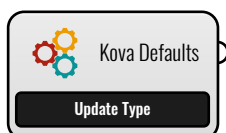
Outputs

1 Kova Defaults

A compiled set of attributes which can be used for any program.

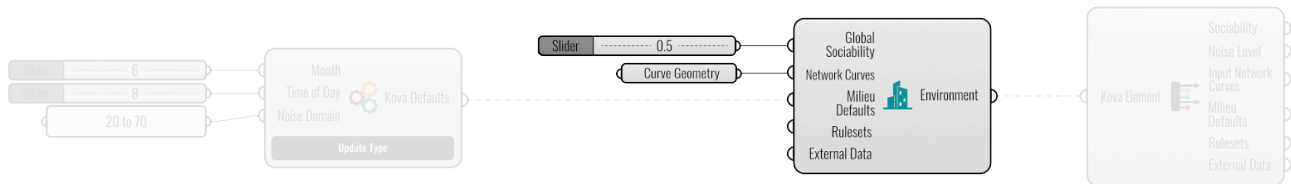
Note:

This component automatically updates its inputs based on its output connection. When placed, it will not have any inputs, but will update when connected and "Update Type" is clicked.



Construct Environment Component

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Global Sociability

The overall social level assigned to the environment. Values must stay between 0.0 and 1.0. A higher value will increase the likelihood of socialization, whereas a smaller value will minimize the likelihood. Default: 0.5.

2 Network Curves

The Rhino curves that define the paths agents can travel along. Kova splits curves at intersections, removes duplicate segments, and excludes isolated curves that are not connected to the main network. Default: none; required input.

3 Milieu Defaults

Optional environmental settings stored with this environment. If left unconnected, Kova uses the built-in milieu defaults. Default: see Milieu Defaults.

4 Rulesets

Optional rulesets to store with this environment. These can be used to modify or constrain behavior during the simulation. Default: empty list.

5 External Data

Optional external data to store with this environment. This can be used to influence path weighting during simulation compilation. See the external data page for more information. Default: empty list.

Outputs

1 Environment

A compiled Kova element representing the environment in the simulation.



Milieu Defaults Override

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Month

The month for the simulation. This will affect the agents' social and movement behaviors. This is a range from 1-12 where January = 1 and December = 12. Default: 6.

2 Time of Day

The time of day for the simulation. This will affect the agents' socialization and movement. This is a range from 0-23 where midnight = 0 and noon = 12. Default: 8.

3 Noise Domain

A domain in decibels which represents the level of noise the environment. An environment which is too noisy or too quiet will reduce agent socialization. Default: 20 to 70.

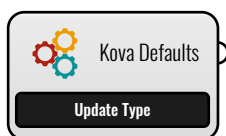
Outputs

1 Kova Defaults

A compiled set of environment parameters which can be used for the environment.

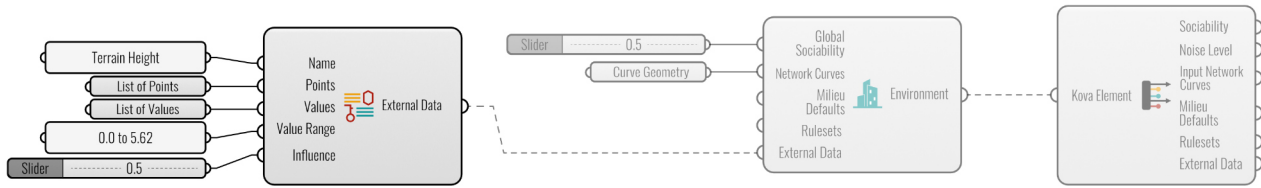
Note:

This component automatically updates its inputs based on its output connection. When placed, it will not have any inputs, but will update when connected and "Update Type" is clicked.



External Data Constructor

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Name

A label for this external dataset. Use this to distinguish different datasets, such as "Noise", "Temperature", or "Air Quality". This value is only an identifier and does not influence the algorithm. Default: "External Data".

2 Points

The Rhino points where the external data was measured or sampled. During simulation compilation, each point is associated with the nearest ground cell. At least one point must be provided. Default: none; required input.

3 Values

The external data values corresponding to the provided points. Each point must have one value, and the Points and Values lists must contain the same number of items. Kova normalizes these values between 0.0 and 1.0 using the Best and Worst inputs. Default: none; required input.

4 Value Range

The data range that Kova will normalize to 0.0 to 1.0. In the workflow, values closer to the max make their associated ground cells more attractive to agents and values closer to minimum make their associated ground cells less attractive to agents. Default: none; required input.

5 Influence

The strength of this dataset's effect on the simulation. Values must stay between 0.0 and 1.0, where 0.0 disables its effect and 1.0 applies its full weighting. Default: 1.0.

Outputs

1 Kova External Data

A compiled Kova element containing the external data points, normalized values, and weighting settings.

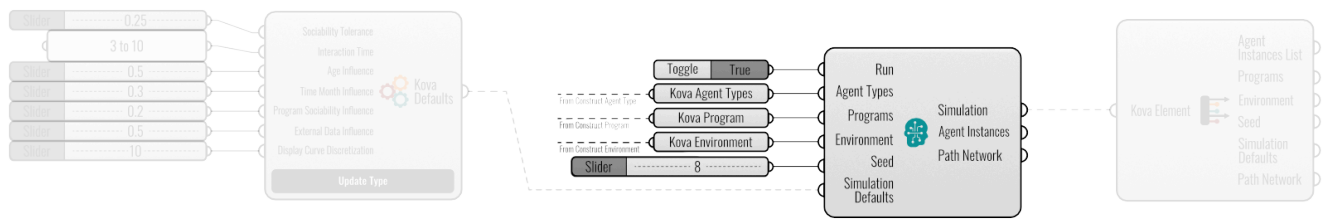
Kova Tip!

External data can represent any spatial condition that makes an area more or less attractive to pedestrians. Examples include **daylight, temperature, shade, air quality, visibility, greenery, terrain slope or even safety conditions**. Use Best and Worst to tell Kova which values are more desirable. Best does not need to be the highest number. For conditions such as pollution, lower values may be preferable.



Compile Simulation Component

User Input Data ■ Kova Output Data ■
Kova Input Data ■ Native Output Data ■



Inputs

1 Run

A boolean that tells Kova whether to compile the simulation. Set this to true to generate the simulation, agent instances, and standardized paths. Default: false.

2 Agent Types

The Kova agent(s) which are part of this simulation. One or more agent types can be connected from the Construct Agent Type component. Default: none; required input.

3 Programs

The Kova program(s) which are part of this simulation. One or more programs can be connected from the Construct Program component. Default: none; required input.

4 Environment

The Kova environment for this simulation. Only one environment can be defined using the Construct Environment component. Default: none; required input.

5 Seed

An integer that controls randomization during compilation. Using the same seed with the same inputs will produce consistent results, while changing the seed will create a different variation. Must be greater than 0. Default: 57.

6 Simulation Defaults

Optional simulation settings used to control movement and socialization behavior. If left unconnected, Kova uses the built-in simulation defaults. Default: see Simulation Defaults.

Outputs

1 Simulation

A compiled Kova element representing the entire simulation, including its parameters and defined members.

2 Agent Instances

The individual agents generated from the connected agent types. Each instance receives unique characteristics based on the agent type ranges and the simulation seed.

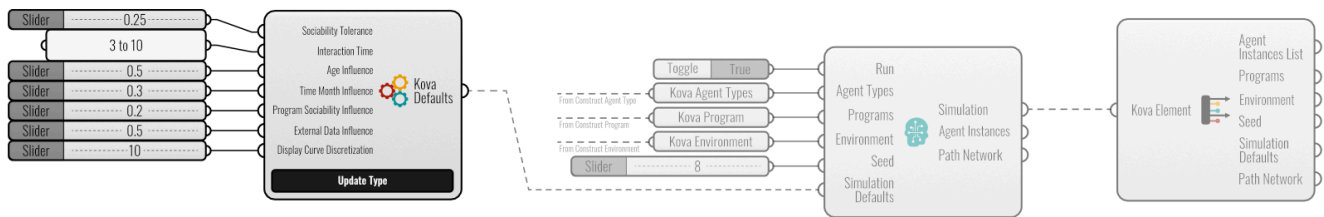
3 Path Network

The final compiled and weighted path network used by agents to travel through the simulation.



Simulation Defaults Override

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

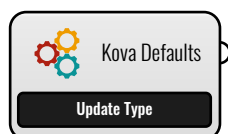
- 1 Sociability Tolerance**
The maximum difference between two agents' social levels for them to be eligible to socialize. Values must stay between 0.0 and 1.0. Default: 0.25.
- 2 Interaction Time**
The range of possible durations, in simulation iterations, that agents spend socializing once an interaction begins. Values must be zero or greater. Default: 3 to 10.
- 3 Age Influence**
The amount that agent age affects movement and socialization behavior. Values must stay between 0.0 and 1.0. Default: 0.5.
- 4 Time Month Influence**
The amount that the time of day and month affect socialization behavior. Values must stay between 0.0 and 1.0. Default: 0.3.
- 5 Program Sociability Influence**
The intended strength of program sociability when weighting nearby network paths. Values must stay between 0.0 and 1.0. Default: 0.2.
- 6 External Data Influence**
The amount that connected external data affects weighting during simulation compilation. Values must stay between 0.0 and 1.0. Default: 0.5.
- 7 Display Curve Discretization**
The target segment length used to divide network curves for simulation display. Smaller values create a more detailed display but require more processing. Default: 10 m, 10,000 mm, 35 ft, or 400 in, depending on Rhino units.

Outputs

- 1 Kova Defaults**
A compiled set of parameters which can be used for the simulation.

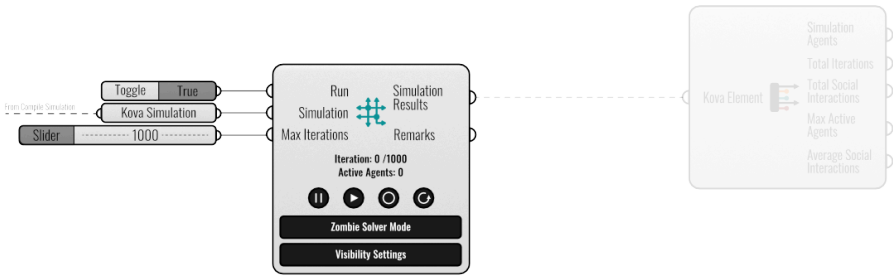
Note:

This component automatically updates its inputs based on its output connection. When placed, it will not have any inputs, but will update when connected and "Update Type" is clicked.



Run Simulation Component

User Input Data Kova Output Data
Kova Input Data Native Output Data



Inputs

1 Run

A boolean which defines if the simulation is currently running or active. Toggle to true to activate the simulation.

2 Simulation

The Kova compiled simulation. Connect this from the Compile Simulation component.

3 Max Iterations

The maximum number of iterations the simulation will run for. The simulation may terminate early if all agents have completed their journeys.

Outputs

1 Simulation Results

A compiled Kova element representing the final results of the simulation, including the final agents and some simulation data.

2 Remarks

Notes about the progression of the simulation and abnormalities it encountered, if any.

Buttons

1 Iteration

"Iteration" indicates which step of the simulation is currently being processed and displayed.

2 Active Agents

"Active Agents" displays a live count of all agent instances that are currently engaged in simulation behavior.

3 Pause / Play / Step / Reset Icons

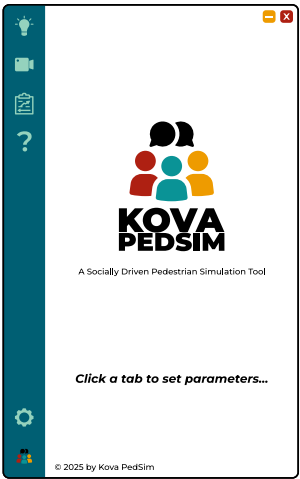
These set of four buttons controls the live simulation if the simulation is in "Step-Solver" mode. Pause and Play temporarily stop or start the simulation, Step increments the simulation by one iteration, and Reset will restart the simulation from the beginning.

4 Zombie-Solver / Step-Solver Mode

This button toggles between Zombie and Step Solver mode. Step solver mode runs and displays each iteration, while zombie mode runs the entire simulation at once without displaying the intermediate steps.

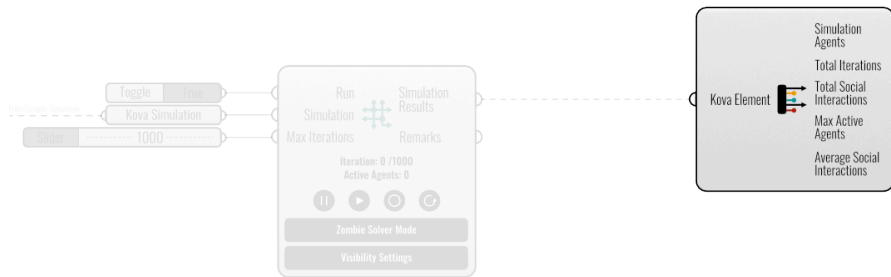
5 Visibility Settings

Click this button to open up a panel of settings for the simulation. For more information, please continue reading.



Simulation Results Deconstructor

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Kova Element

The compiled Kova simulation class to deconstruct.

Note:

This component automatically updates its outputs based on its input connection. When initially placed, the component will not have any outputs, but will update when connected.



Outputs

1 Simulation Agents

The agent instances that were activated during the simulation. Please attach another Kova Deconstructor to this output to view each agent's characteristics, state, and history.

2 Total Iterations

The total number of iterations completed by the simulation. If the simulation converged before reaching the maximum iteration count, this will show the iteration where it stopped.

3 Total Social Interactions

The total number of successful social interactions recorded during the simulation.

4 Max Active Agents

The highest number of agents active in the simulation at the same time.

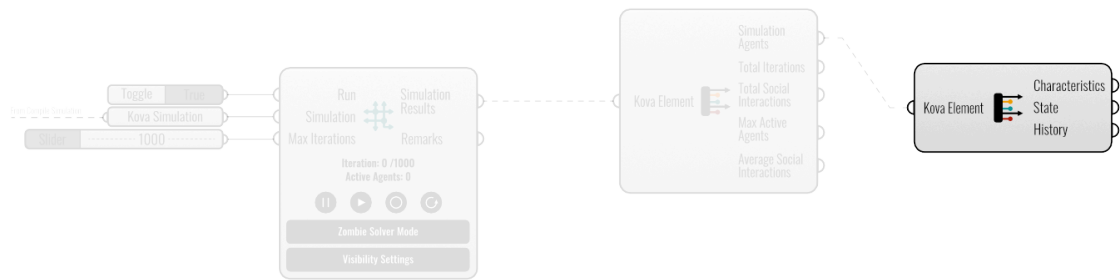
5 Average Social Interactions

The average number of social interactions relative to the number of active agents during the simulation.



Agent Instance Deconstructor

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Kova Element

The compiled Kova agent instance class to deconstruct.

Note:

This component automatically updates its outputs based on its input connection. When initially placed, the component will not have any outputs, but will update when connected.



Outputs

1 Characteristics

A compiled element which holds all of the characteristics for this agent. Please attach another Kova Deconstructor to this output to obtain the data for this element.

2 State

A compiled element which describes the agent's state at the current iteration. Please attach another Kova Deconstructor to obtain the data for this element.

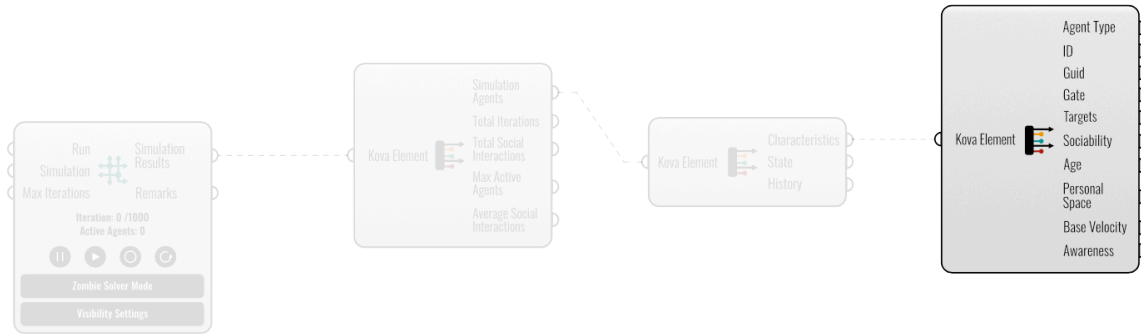
3 History

A compiled element which holds the simulation history for this agent. Please attach another Kova Deconstructor to this output to obtain the data for this element.



Agent Characteristics Deconstructor

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Kova Element

The compiled Kova characteristics class to deconstruct.

Note:

This component automatically updates its outputs based on its input connection. When initially placed, the component will not have any outputs, but will update when connected.



Outputs

1 Agent Type

The identifier of the agent type this instance was created from, such as "Visitor", "Commuter", or "Staff". This value is only an identifier and does not influence the algorithm.

2 ID

A two-part index key: the first digit denotes agent type, the second identifies the specific instance.

3 Guid

A globally unique identifier assigned to each agent instance for consistent tracking throughout the simulation.

4 Gate

The Kova program this agent instance spawned from during the simulation.

5 Targets

The Kova compiled program(s) this agent instance visited during the simulation.

5 Sociability

The agent's sociability value, which determines its interaction behavior with other agents. This is derived from its agent type's sociability domain.

6 Age

The agent's age, which affects its movement and social behaviors during the simulation. This is derived from its agent type's age domain.

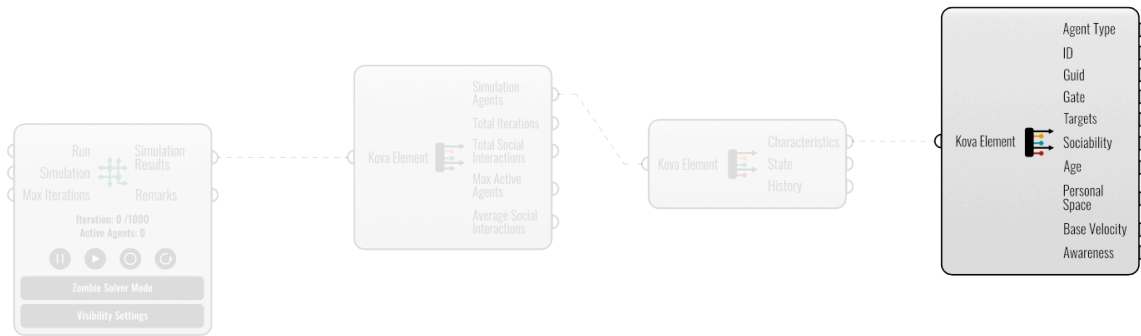
7 Personal Space

The agent's personal radius. If another agent enters this radius, there is a chance the two will socialize. This is derived from its agent type's personal space domain.



Agent Characteristics Deconstructor

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Kova Element

The compiled Kova characteristics class to deconstruct.

Note:

This component automatically updates its outputs based on its input connection. When initially placed, the component will not have any outputs, but will update when connected.



Outputs

8 Base Velocity

The base movement speed assigned to this agent instance, measured in Rhino units per simulation iteration. Kova adjusts this speed based on the agent's characteristics.

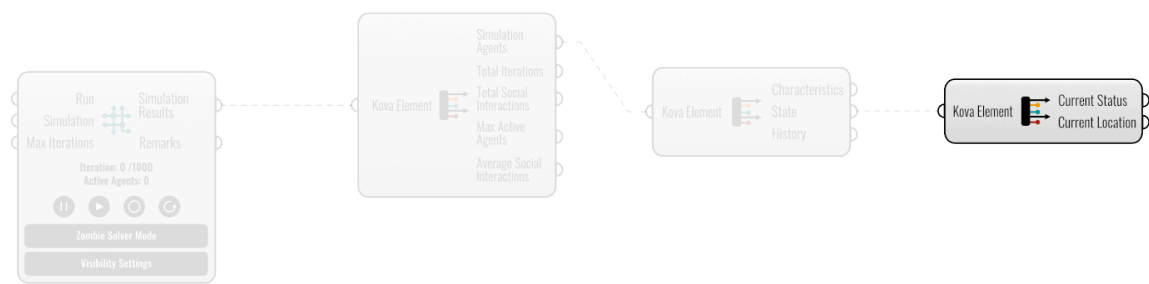
9 Awareness

A number between 0.0 and 1.0 specifying how familiar the agent is with their surroundings.



Agent State Deconstructor

User Input Data Kova Output Data Kova Input Data Native Output Data



Inputs

- 1 Kova Element
The compiled Kova agent state class to deconstruct.

Note:

This component automatically updates its outputs based on its input connection. When initially placed, the component will not have any outputs, but will update when connected.



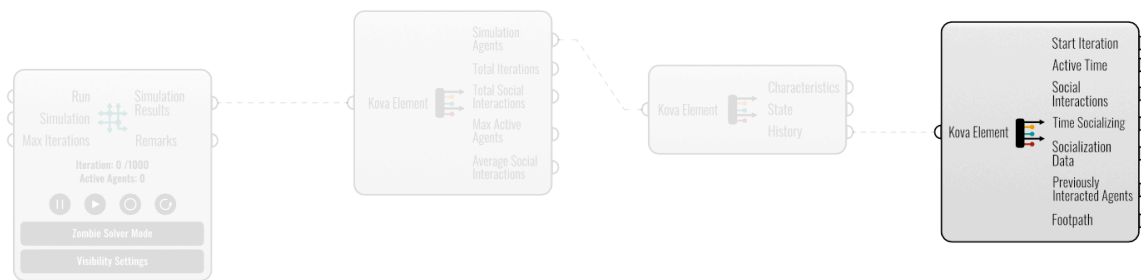
Outputs

- 1 Current Status
The agent's current status at the active iteration, such as "Moving" or "Socializing".
- 2 Current Location
The agent's current x,y,z location at the active iteration.



Agent History Deconstructor

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 



Inputs

1 Kova Element

The compiled Kova agent history class to deconstruct.

Note:

This component automatically updates its outputs based on its input connection. When initially placed, the component will not have any outputs, but will update when connected.



Outputs

1 Start Iteration

The iteration which this agent was instantiated.

2 Active Time

The total number of iterations during which this agent was actively involved in the simulation.

3 Social Interactions

The total number of social interactions this agent instance had during the simulation.

4 Time Socializing

The number of iterations this agent instance spent socializing during the simulation.

5 Socialization Data

A time-ordered record of the agent's status during each simulation iteration, such as moving or socializing. Iterations before the agent entered the simulation are marked as not initialized.

6 Previously Interacted Agents

The complete list of other Kova agent instances that this agent instance interacted with during the simulation.

7 Footpath

The time-ordered points recording the agent's location throughout the simulation. Iterations before the agent entered the simulation contain unset points so the list remains aligned with the global simulation timeline.



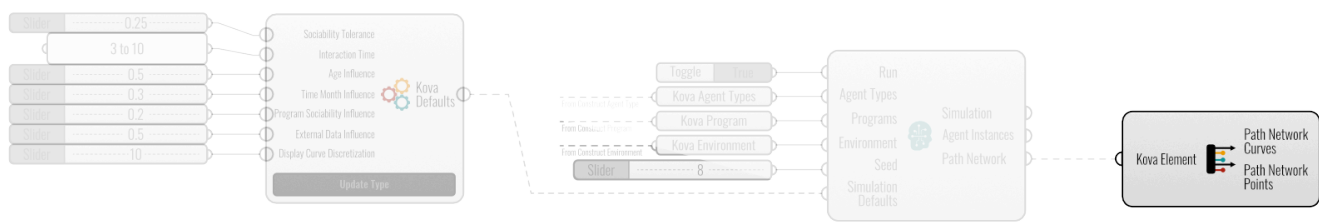
Path Network Deconstructor

User Input Data

Kova Output Data

Kova Input Data

Native Output Data



Inputs

- 1 Kova Element
- The compiled Kova path network class to deconstruct.

Note:

This component automatically updates its outputs based on its input connection. When initially placed, the component will not have any outputs, but will update when connected.



Outputs

- 1 Path Network Curves
- The curve segments representing the edges of the compiled travel network. Kova uses these connections when calculating routes between programs. Program sociability and external data may affect their internal travel weights.
- 2 Path Network Points
- The unique nodes in the compiled path network. These occur at curve endpoints, intersections, and connected program locations and are used by Kova's route-finding algorithm.



Settings

User Input Data  Kova Output Data 
Kova Input Data  Native Output Data 

Visualization Settings

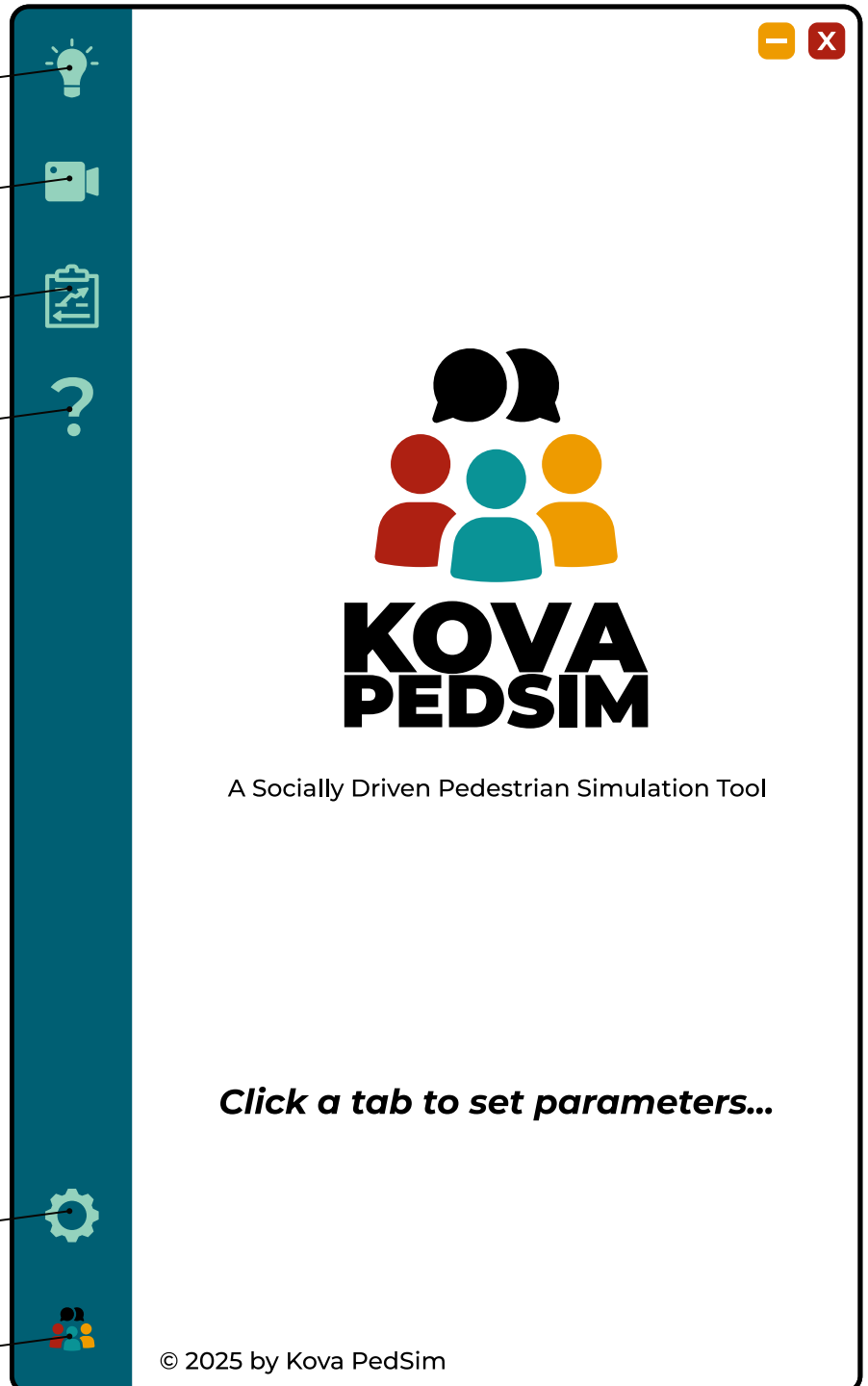
Recording Settings

Simulation Data

Help

Utilities

Kova PedSim Website



26 | Network Simulation

Simulation Data

Monitor the current run and review its latest results. Iterations are abstract simulation steps; elapsed time is active application runtime.

Overview

Engine

Solver Mode

Random Seed

Model Units

Programs

Cellular Automata

Zombie-Solver

57

Meters

22

Progress

Iteration

Progress

Active Elapsed

700 / 1000

70%

00:00:00

Agent Behavior

Configured

Waiting

Active

Model Units

Exited

1000

243

629

Meters

128

Current Behavior

Moving

Socializing

391

238

Run Summary

Social Interactions

Peak Active Agents

1250

639

© 2025 by Kova PedSim

General data about the simulation, including the current engine, simulation mode, and units

Data about the current active simulation, including its progress percentage and iteration

Data about the agent behaviors, including the number of agents who are currently active or completed

Data about the current status of every agent, such as number of moving or socializing agents

Overall summary information about the simulation run

