Practical No. 2

Question-2

Design and Develop an Agent Based Model by:

- Adding word of mouth effect
- Considering product discards
- Considering delivery time

Agent-Based Model of Market Dynamics with Word-of-Mouth Effect, Product Discards, and Delivery Time.

Introduction:

Agent-based modelling (ABM) provides a powerful framework for simulating market dynamics. In this study, we develop an ABM to simulate a market model with the inclusion of word-of-mouth effects, product discards, and delivery time. The aim is to analyse the impact of these factors on market behaviour and product adoption. Understanding the dynamics of markets is essential for businesses to develop effective strategies. Word of mouth, product discards, and delivery time are critical factors that influence consumer behaviour and market outcomes. Agent-based modelling offers a bottom-up approach to modelling market behaviour, where individual agents, representing consumers and businesses, interact within an environment, leading to emergent market phenomena.

Aim:

The aim of this study is to develop an agent-based model to simulate market dynamics, considering word of mouth effects, product discards, and delivery time, and analyse their impact on market behaviour and product adoption.

Procedure:

1. Agent Population:

- Agent Attributes: Each consumer agent is characterized by attributes such as preferences, budget, social network, and word of mouth influence.

-Initialization: Consumers are randomly distributed in the market with initial preferences, budget, and social network connections.

-Interaction: Consumers interact with each other and businesses based on predefined rules governing purchasing behaviour, word of mouth influence, and product discards.

2. Agent Behaviour:

-Word of Mouth Effect:

- Agents influence each other through word of mouth based on their social network connections and satisfaction with products.

- Satisfied consumers are more likely to recommend the product to others, leading to increased adoption.

-Product Discards:

- Consumers may discard products based on factors such as dissatisfaction, product lifespan, and technological advancements.

- Delivery Time:

- Delivery time influences consumer purchasing decisions, with shorter delivery times leading to higher customer satisfaction and increased likelihood of purchase.

3. Model Output Visualization:

- Chart: Line charts and graphs are used to visualize various market metrics over time:

- Adoption rate of products.

- Word of mouth effect on product adoption.

- Product discards over time.

- Impact of delivery time on purchasing decisions.

4. Simulation Setup and Execution:

- Set simulation parameters such as product characteristics, word of mouth influence, product lifespan, and delivery times.

- Run the simulation to observe the impact of word-of-mouth effects, product discards, and delivery time on market dynamics and product adoption.

5. Analysis and Interpretation:

- Analyse the simulation results to gain insights into market dynamics:

- Evaluate the impact of word-of-mouth effects on product adoption and market share.

- Examine the influence of product discards on market saturation and consumer satisfaction.

- Assess the importance of delivery time in consumer purchasing decisions and market competitiveness.

6. Model Validation and Sensitivity Analysis:

- Validate the model by comparing simulation results with real-world market data.

- Perform sensitivity analysis to evaluate the robustness of the model to changes in parameter values and assumptions.

Steps:

1. Setting up the Agent Population:

- Open AnyLogic and create a new project.
- Create an Agent Population representing consumers:
- Define agent attributes such as preferences, budget, social network, and word of mouth influence.
- Initialize the agent population by randomly distributing consumers in the market with initial preferences, budget, and social network connections.
- Define interactions between consumers and businesses based on predefined rules governing purchasing behaviour, word of mouth influence, and product discards.

2. Agent Behaviour:

Word of Mouth Effect:

- Define how agents influence each other through word of mouth based on their social network connections and satisfaction with products.
- Implement algorithms to model the word-of-mouth effect on product adoption.
- Product Discards:
- Define rules for consumers to discard products based on factors such as dissatisfaction, product lifespan, and technological advancements.

Delivery Time:

- Model the impact of delivery time on consumer purchasing decisions:
- Define how delivery time influences consumer satisfaction and purchasing behaviour.
- Implement algorithms to calculate delivery times and incorporate them into the decision-making process.

3. Model Output Visualization:

- Create line charts and graphs to visualize various market metrics over time:
- Adoption rate of products.
- Word of mouth effect on product adoption.
- Product discards over time.
- Impact of delivery time on purchasing decisions.

4. Simulation Setup and Execution:

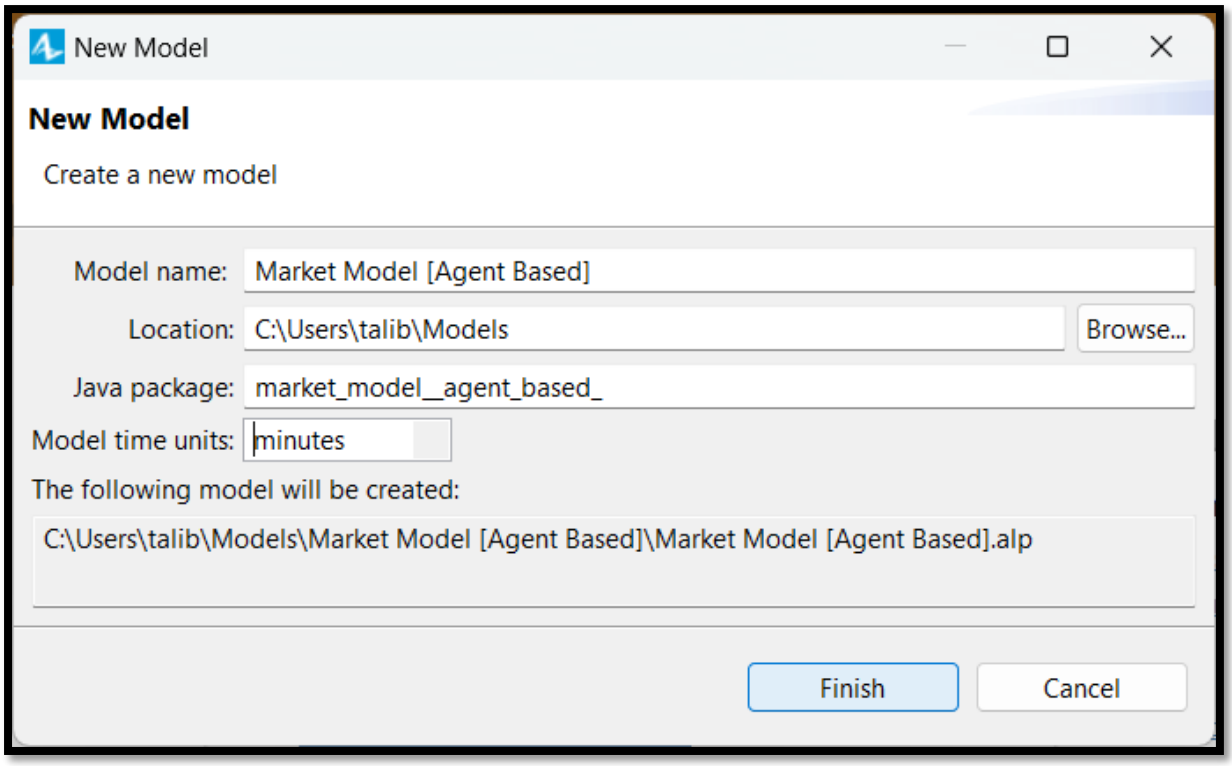
- Set simulation parameters such as product characteristics, word of mouth influence, product lifespan, and delivery times.
- Configure simulation experiments to explore different scenarios and parameter settings.
- Run the simulation to observe the impact of word-of-mouth effects, product discards, and delivery time on market dynamics and product adoption.

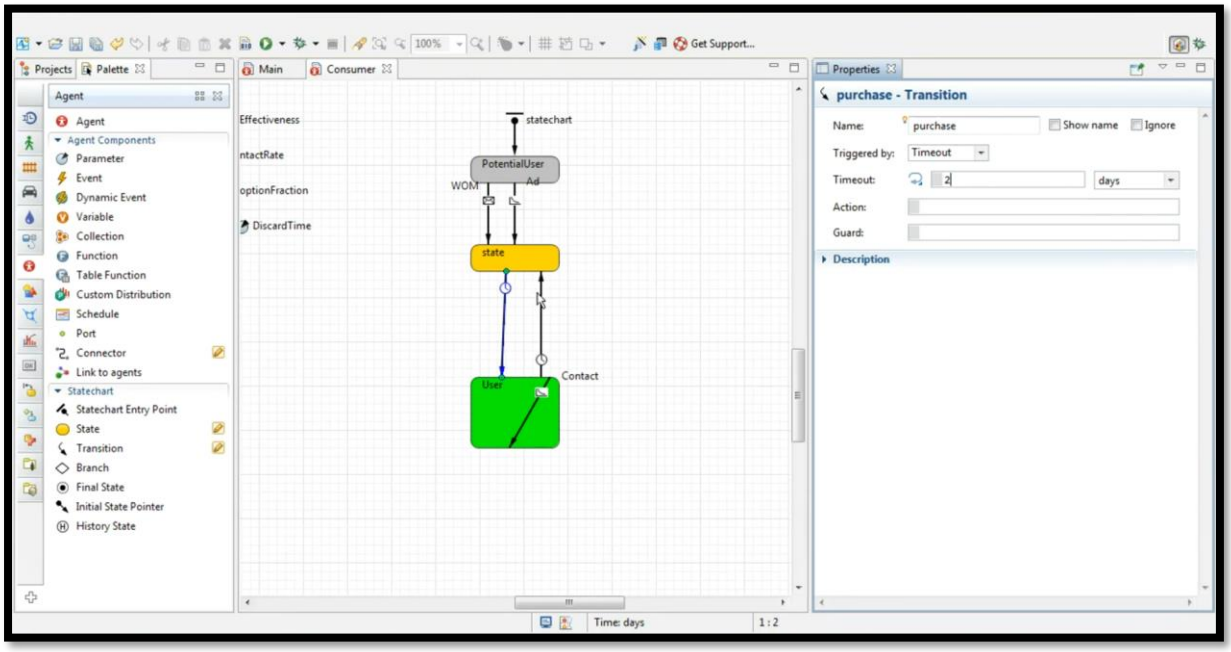
5. Analysis and Interpretation:

- Analyse the simulation results to gain insights into market dynamics:
- Evaluate the impact of word-of-mouth effects on product adoption and market share.
- Examine the influence of product discards on market saturation and consumer satisfaction.
- Assess the importance of delivery time in consumer purchasing decisions and market competitiveness.

6. Model Validation and Sensitivity Analysis:

- Validate the model by comparing simulation results with real-world market data.
- Perform sensitivity analysis to evaluate the robustness of the model to changes in parameter values and assumptions.
- By following these steps and using AnyLogic software, you can develop an agent-based model of market dynamics with word-of-mouth effect, product discards, and delivery time, and gain valuable insights into consumer behaviour and market outcomes.


New Model
New Model
Create a new model
Model name: Market Model [Agent Based]
Location: C:\Users\talib\Models
Browse...
Java package: market_model__agent_based_
Model time units: minutes
The following model will be created:
C:\Users\talib\Models\Market Model [Agent Based]\Market Model [Agent Based].alp
Finish
Cancel


Projects
Palette
Agent
Agent Components
Parameter
Event
Dynamic Event
Variable
Collection
Function
Table Function
Custom Distribution
Schedule
Port
Connector
Link to agents
Statechart
Statechart Entry Point
State
Transition
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Final State
Initial State Pointer
History State
Main
Consumer
Effectiveness
ntactRate
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DiscardTime
statechart
PotentialUser
WOM
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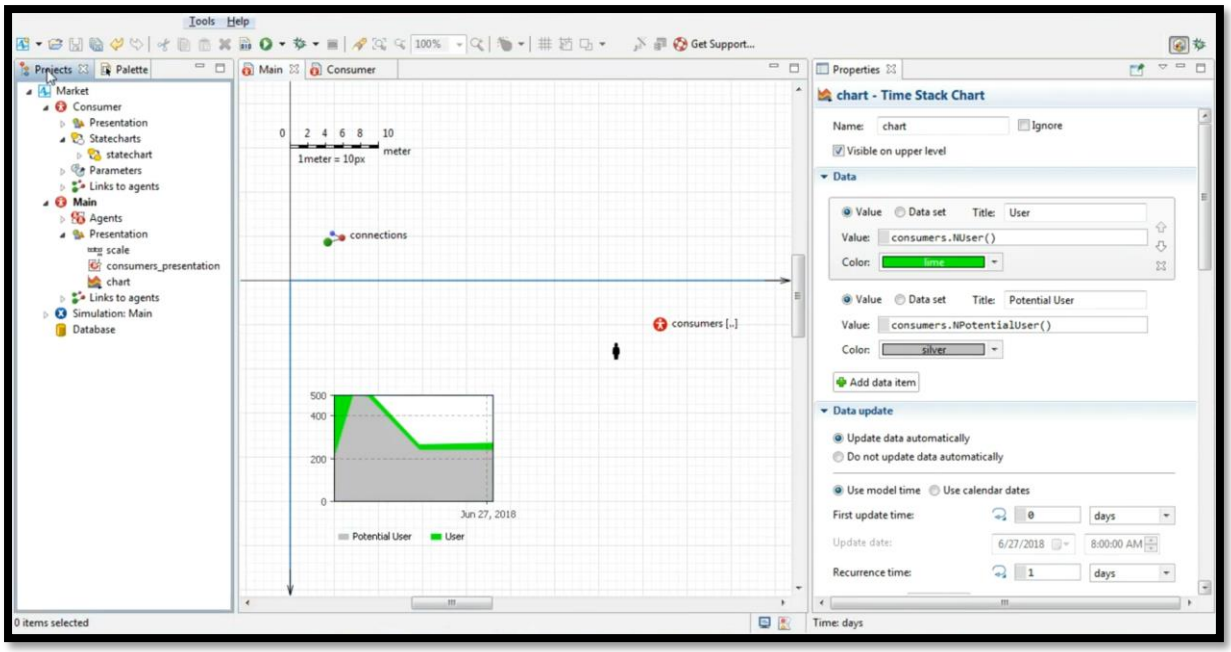
Contact
Properties
purchase - Transition
Name: purchase
Show name
Ignore
Triggered by: Timeout
Timeout: 2 days
Action:
Guard:
Description
Time: days
1 : 2


Tools Help
Get Support...
Projects
Palette
Market
Consumer
Presentation
Statecharts
statechart
Parameters
Links to agents
Main
Agents
Presentation
scale
consumers_presentation
chart
Links to agents
Simulation: Main
Database
Main
Consumer
0 2 4 6 8 10
1meter = 10px
meter
connections
consumers [..]
500
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200
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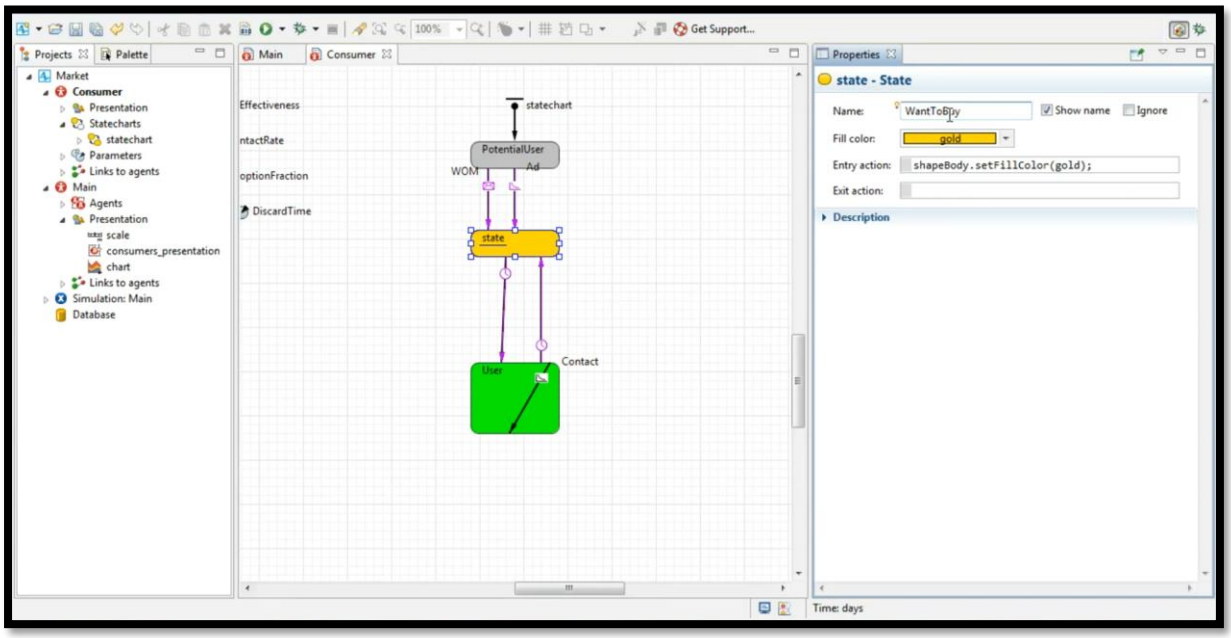
Jun 27, 2018
Potential User
User
0 items selected
Properties
chart - Time Stack Chart
Name: chart
Ignore
Visible on upper level
Data
Value
Data set
Title: User
Value: consumers.NUser()
Color: lime
Value
Data set
Title: Potential User
Value: consumers.NPotentialUser()
Color: silver
Add data item
Data update
Update data automatically
Do not update data automatically
Use model time
Use calendar dates
First update time: 0 days
Update date: 6/27/2018 8:00:00 AM
Recurrence time: 1 days
Time: days


Get Support...
Projects
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Simulation: Main
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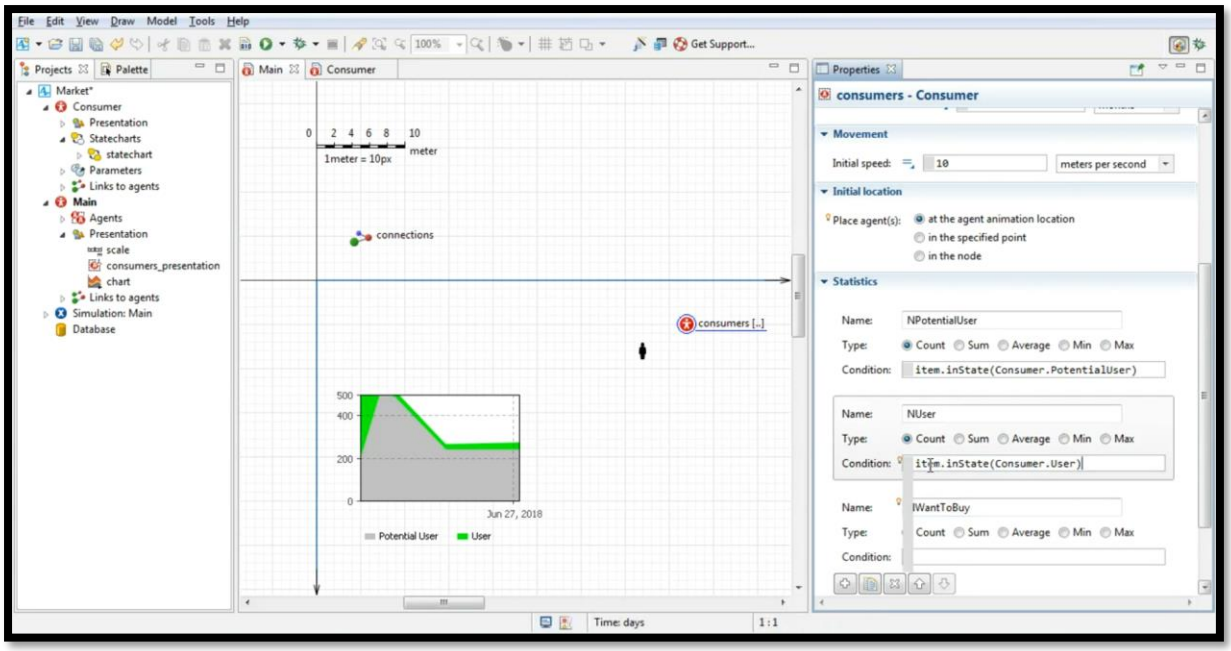
Properties
state - State
Name: WantToBuy
Show name
Ignore
Fill color: gold
Entry action: shapeBody.setFillColor(gold);
Exit action:
Description
Time: days


File Edit View Draw Model Tools Help
Get Support...
Projects Palette
Market*
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Links to agents
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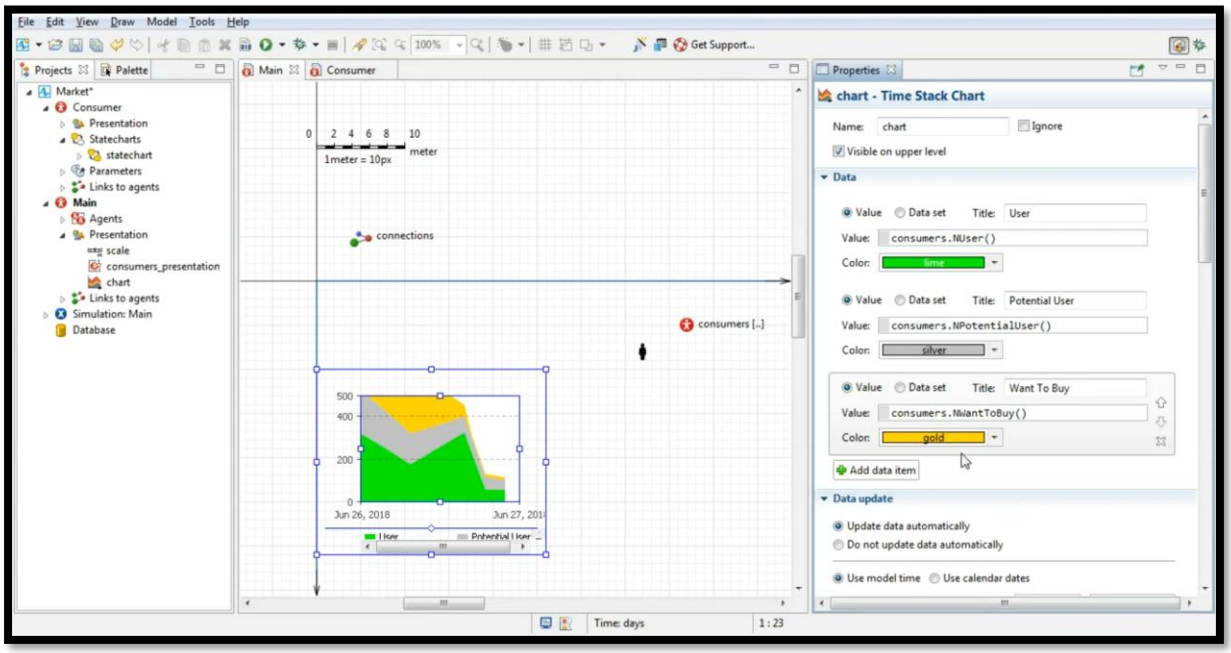
Links to agents
Simulation: Main
Database
Main Consumer
0 2 4 6 8 10
meter
1meter = 10px
connections
consumers [...]
500
400
200
0
Jun 27, 2018
Potential User
User
Properties
consumers - Consumer
Movement
Initial speed:
10
meters per second
Initial location
Place agent(s):
at the agent animation location
in the specified point
in the node
Statistics
Name:
NPotentialUser
Type:
Count Sum Average Min Max
Condition:
item.inState(Consumer.PotentialUser)
Name:
NUser
Type:
Count Sum Average Min Max
Condition:
item.inState(Consumer.User)
Name:
IWantToBuy
Type:
Count Sum Average Min Max
Condition:
Time: days
1 : 1


File Edit View Draw Model Tools Help
Get Support...
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Links to agents
Simulation: Main
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Main Consumer
0 2 4 6 8 10
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1meter = 10px
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consumers [...]
500
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Jun 26, 2018
Jun 27, 201
User
Potential User
Properties
chart - Time Stack Chart
Name:
chart
Ignore
Visible on upper level
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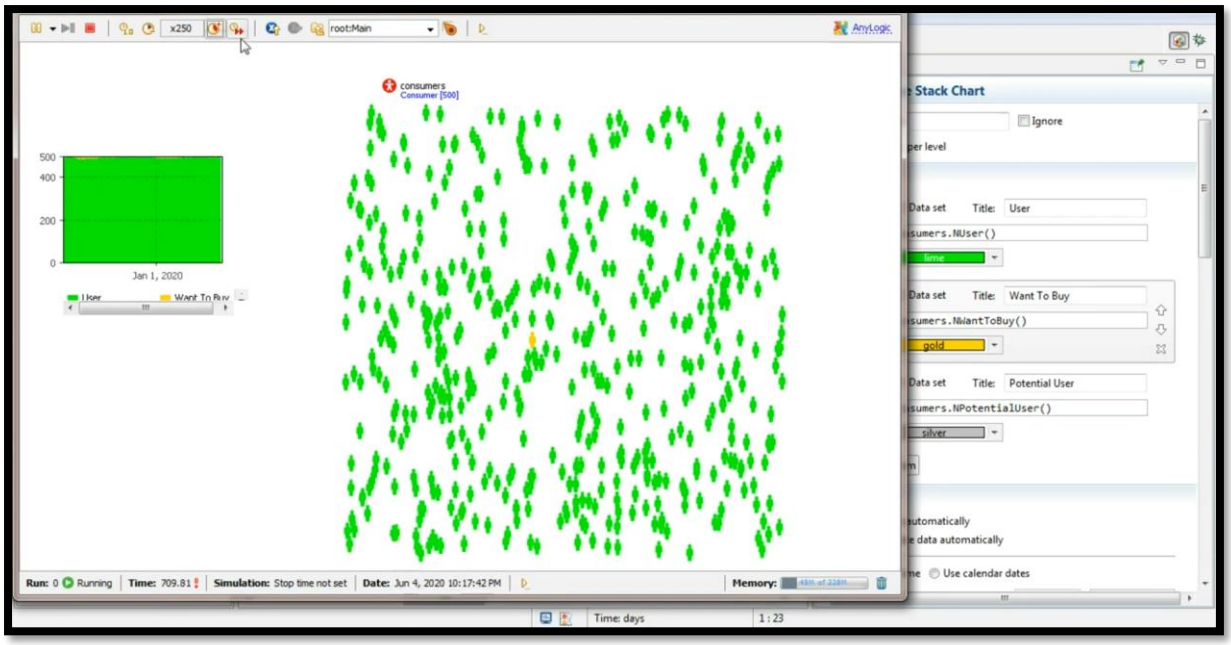
Value
Data set
Title:
User
Value:
consumers.NUser()
Color:
lime
Value
Data set
Title:
Potential User
Value:
consumers.NPotentialUser()
Color:
silver
Value
Data set
Title:
Want To Buy
Value:
consumers.NWantToBuy()
Color:
gold
Add data item
Data update
Update data automatically
Do not update data automatically
Use model time
Use calendar dates
Time: days
1 : 23


x250
root:Main
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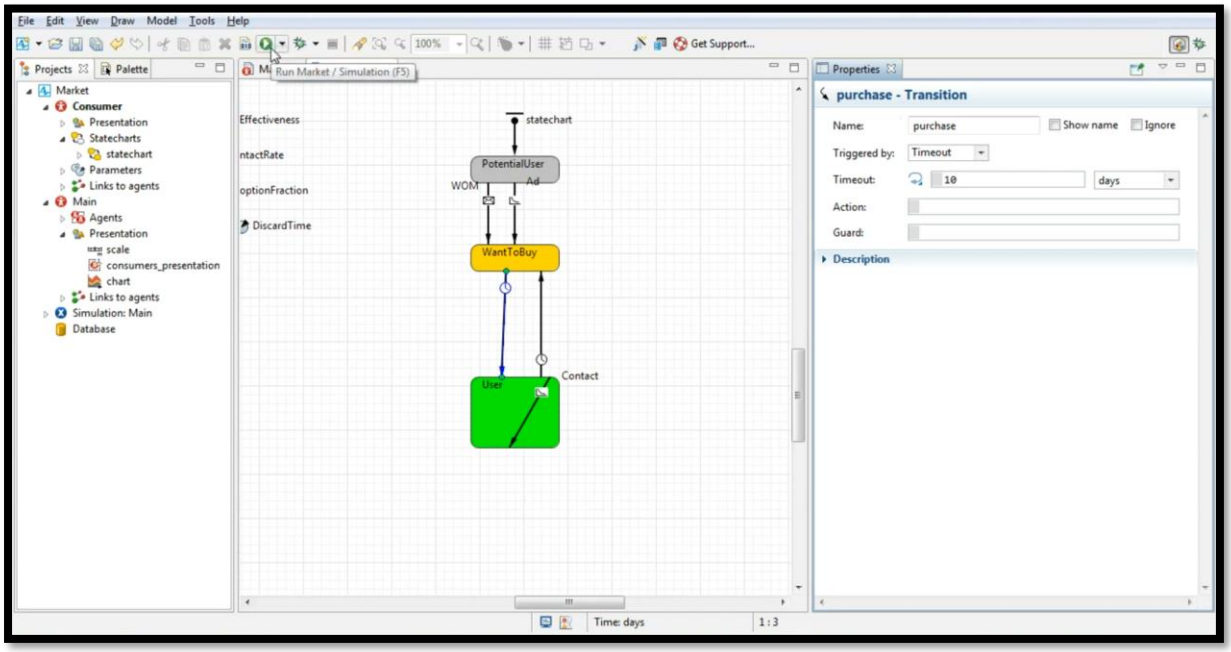
consumers
Consumer [500]
500
400
200
0
Jan 1, 2020
Stack Chart
Ignore
Data set
Title: User
Title: Want To Buy
Title: Potential User
Run: 0 Running
Time: 709.81
Simulation: Stop time not set
Date: Jun 4, 2020 10:17:42 PM
Memory:
Time: days
1 : 23


File Edit View Draw Model Tools Help
Get Support...
Projects
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Consumer
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Statecharts
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Links to agents
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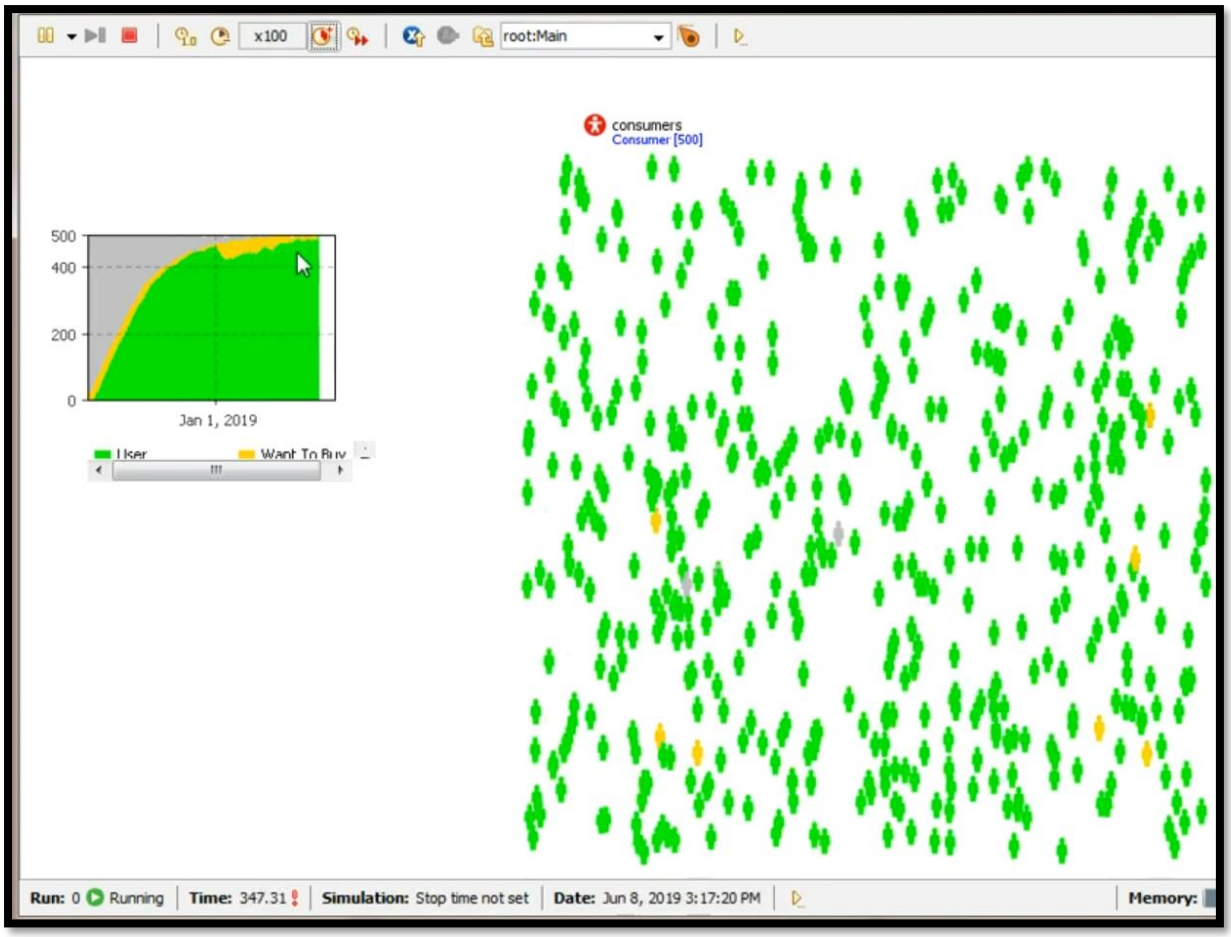
Links to agents
Simulation: Main
Database
Run Market / Simulation (F5)
Effectiveness
ntactRate
optionFraction
DiscardTime
statechart
PotentialUser
WOM
Ad
WantToBuy
User
Contact
Properties
purchase - Transition
Name: purchase
Show name
Ignore
Triggered by: Timeout
Timeout: 10
days
Action:
Guard:
Description
Time: days
1 : 3


x100
root:Main
consumers
Consumer [500]
500
400
200
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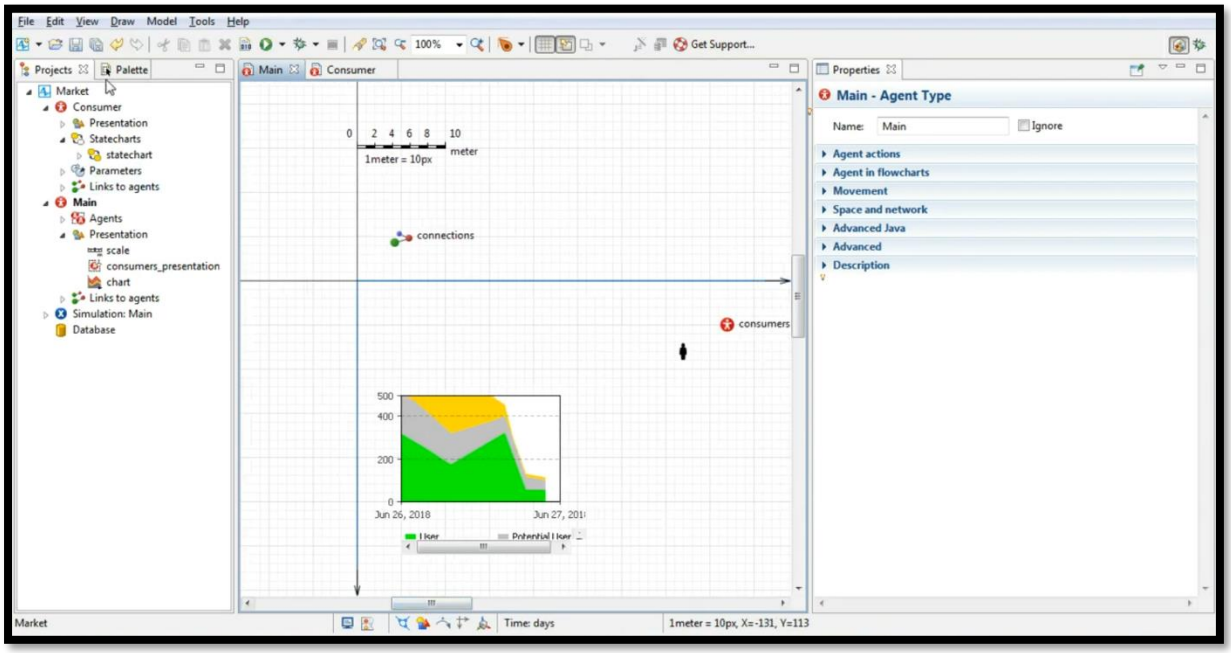
Jan 1, 2019
User
Want To Buy
Run: 0 Running
Time: 347.31
Simulation: Stop time not set
Date: Jun 8, 2019 3:17:20 PM
Memory: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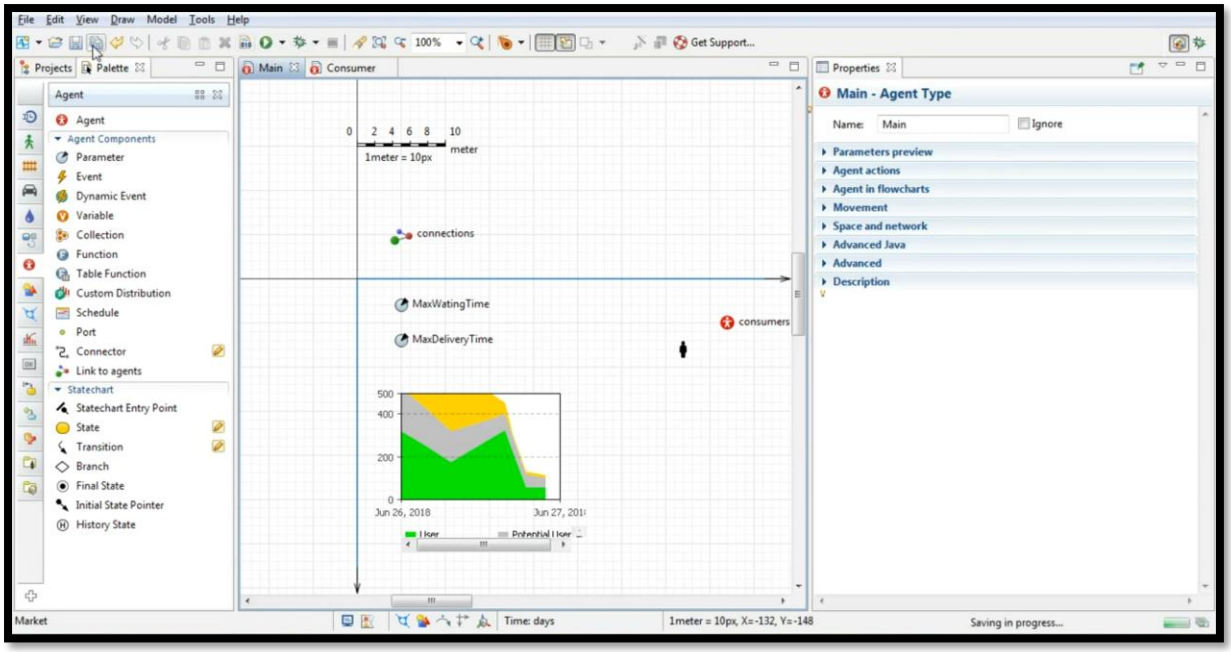
consumers_presentation
chart
Links to agents
Simulation: Main
Database
Main
Consumer
0 2 4 6 8 10
meter
1meter = 10px
connections
consumers
500
400
200
0
Jun 26, 2018
Jun 27, 2018
User
Potential User
Properties
Main - Agent Type
Name: Main
Ignore
Agent actions
Agent in flowcharts
Movement
Space and network
Advanced Java
Advanced
Description
Market
Time: days
1meter = 10px, X=-131, Y=113


File Edit View Draw Model Tools Help
Projects Palette
Agent
Agent Components
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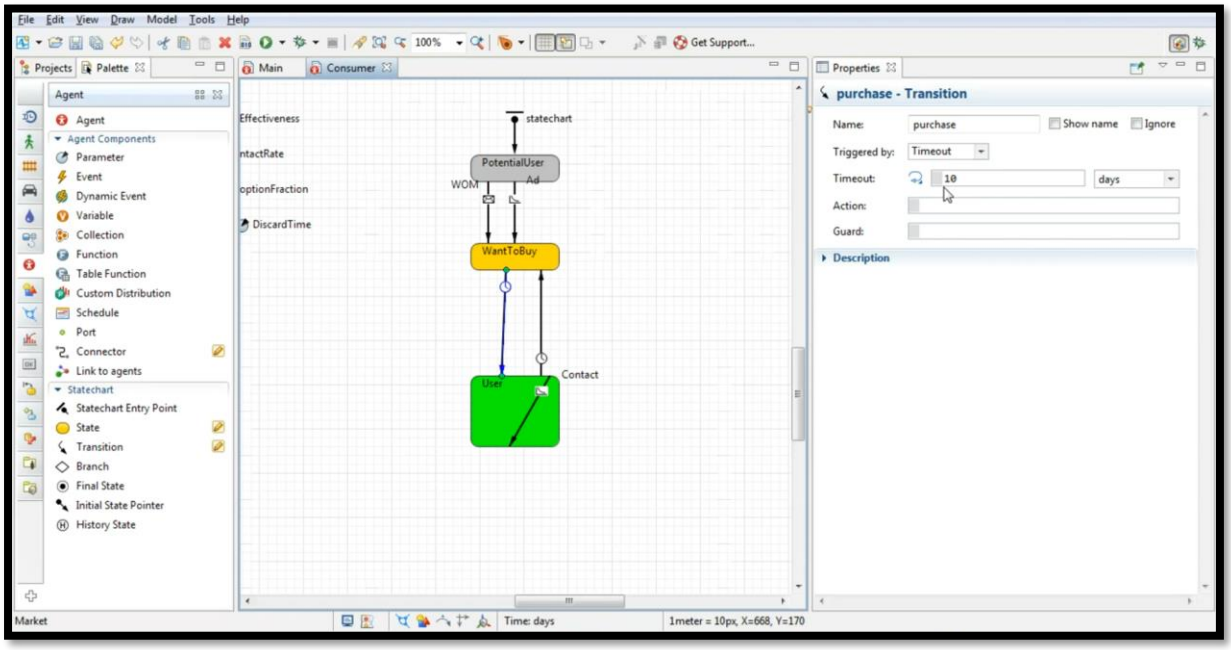
Event
Dynamic Event
Variable
Collection
Function
Table Function
Custom Distribution
Schedule
Port
Connector
Link to agents
Statechart
Statechart Entry Point
State
Transition
Branch
Final State
Initial State Pointer
History State
Main
Consumer
1meter = 10px
meter
connections
MaxWatingTime
MaxDeliveryTime
consumers
Jun 26, 2018
Properties
Main - Agent Type
Name: Main
Ignore
Parameters preview
Agent actions
Agent in flowcharts
Movement
Space and network
Advanced Java
Advanced
Description
Market
Time: days
1meter = 10px, X=-132, Y=-148
Saving in progress...


File Edit View Draw Model Tools Help
Projects Palette
Agent
Agent Components
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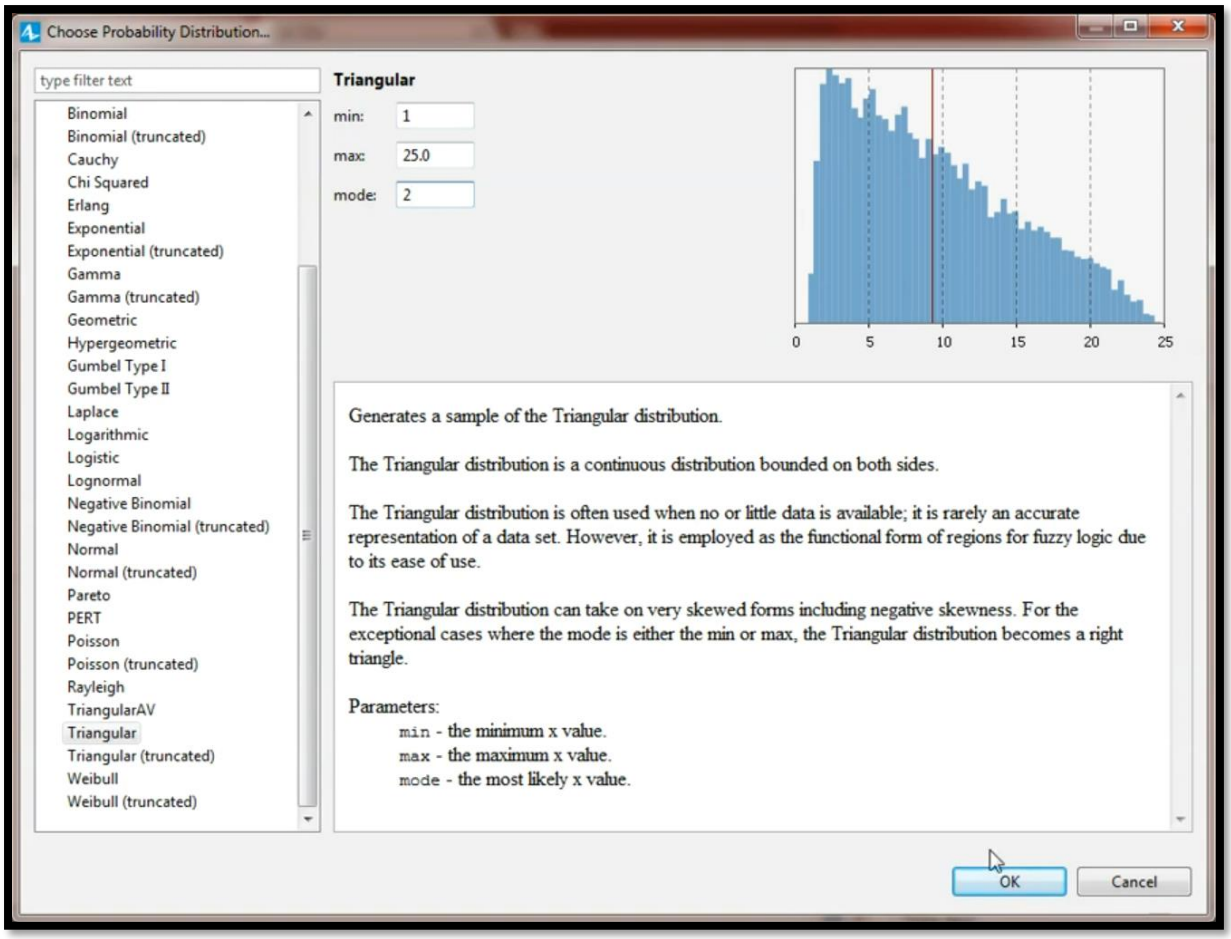
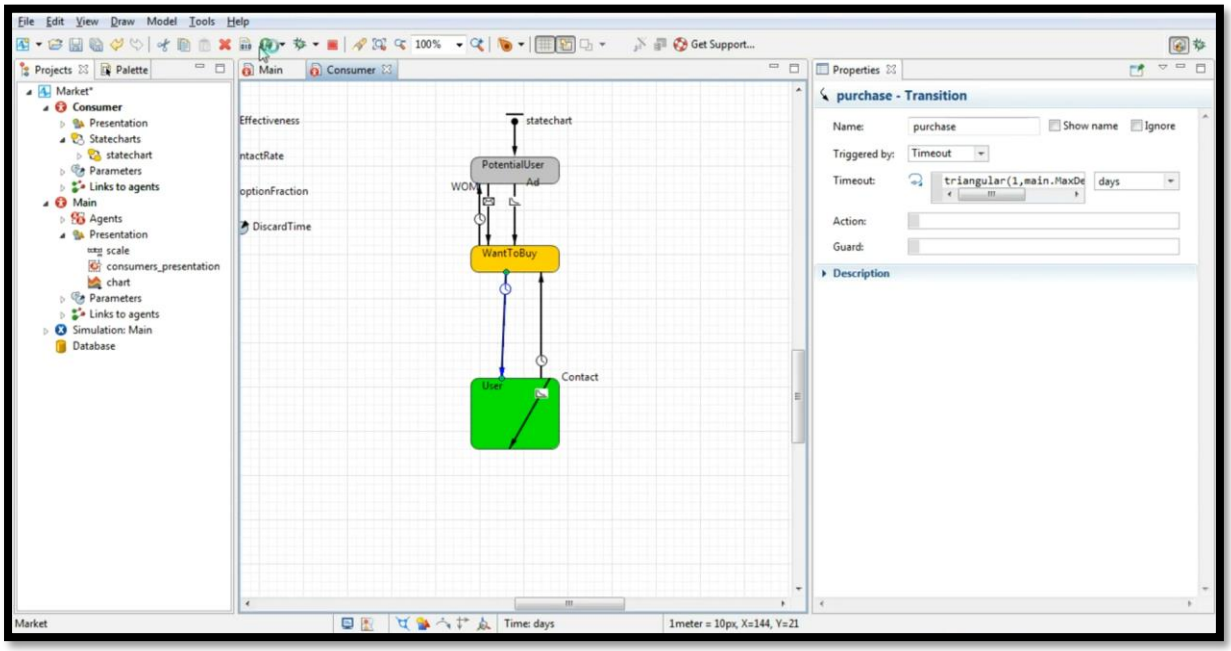
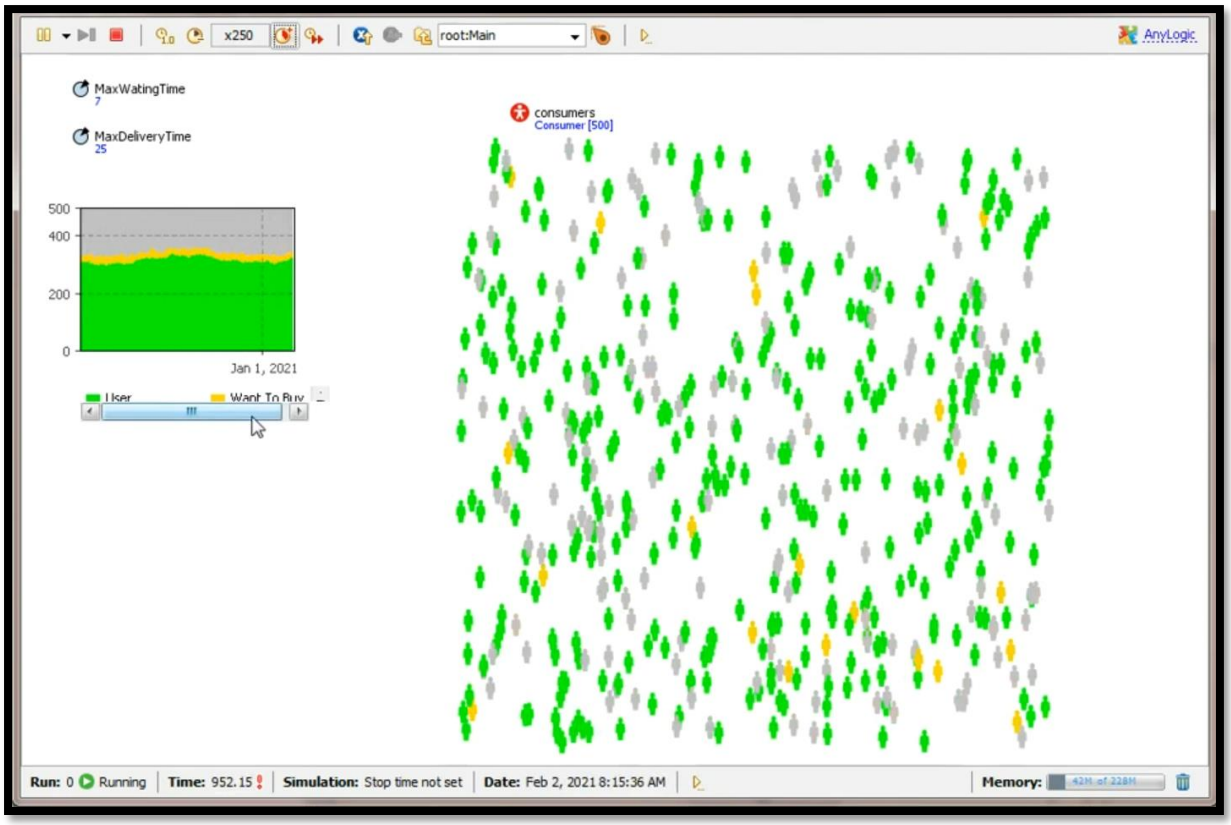
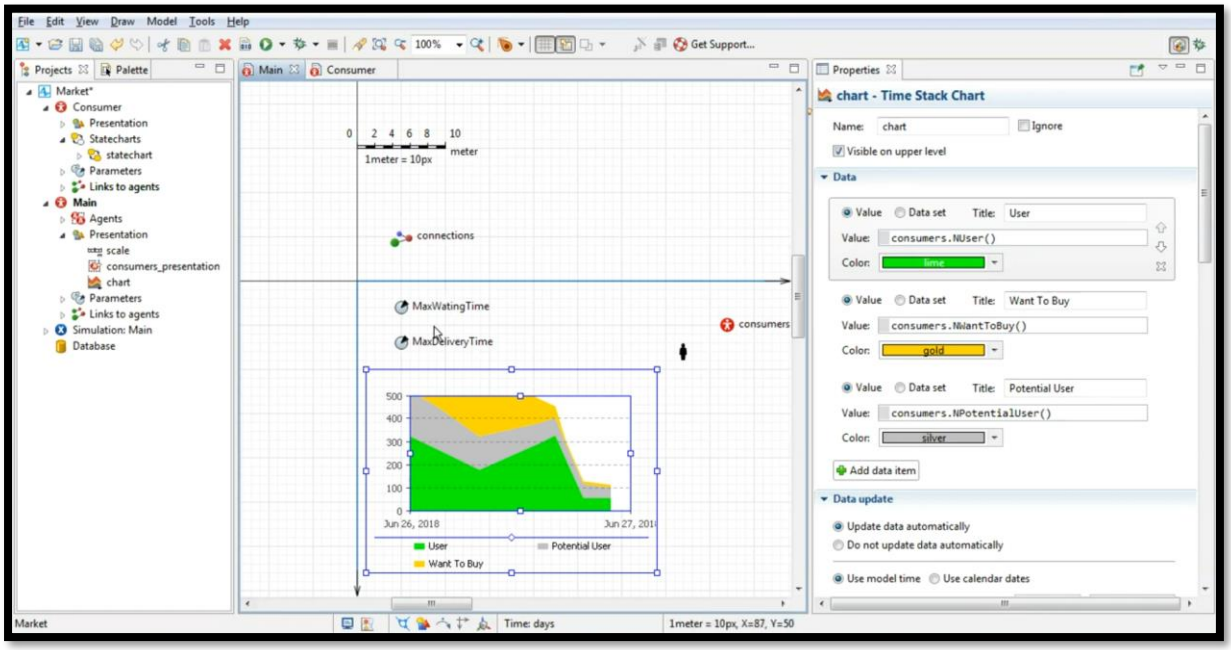
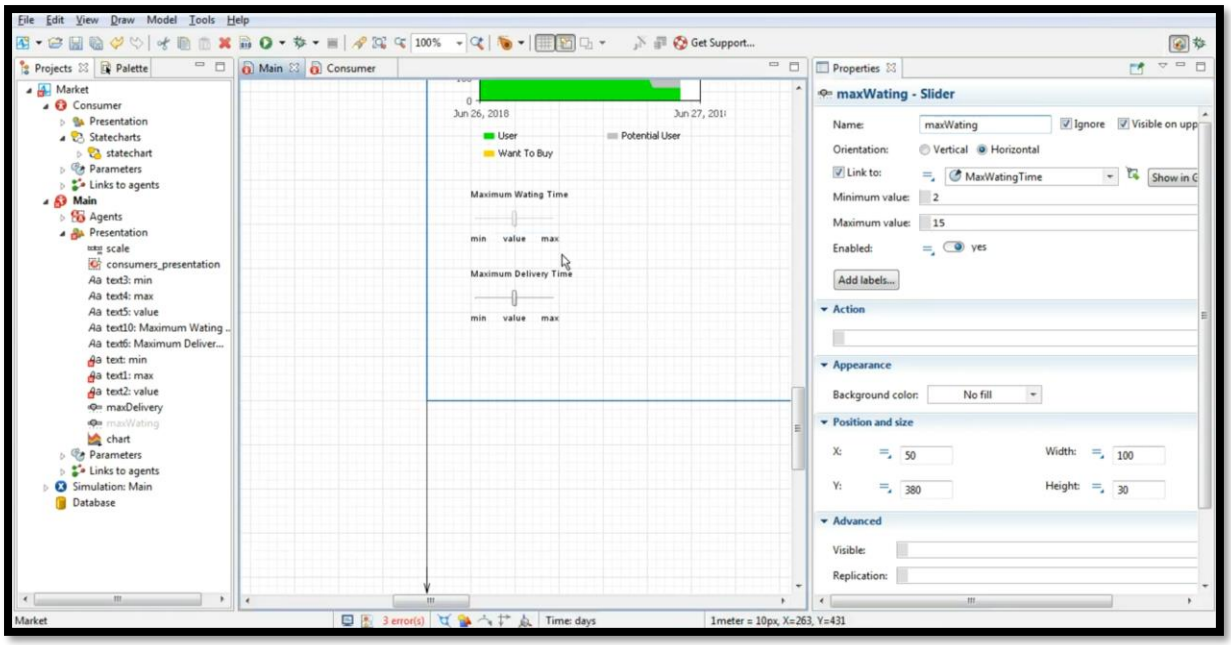
Dynamic Event
Variable
Collection
Function
Table Function
Custom Distribution
Schedule
Port
Connector
Link to agents
Statechart
Statechart Entry Point
State
Transition
Branch
Final State
Initial State Pointer
History State
Main
Consumer
Effectiveness
ntactRate
optionFraction
DiscardTime
statechart
PotentialUser
WOM
Ad
WantToBuy
User
Contact
Properties
purchase - Transition
Name: purchase
Show name
Ignore
Triggered by: Timeout
Timeout: 10
days
Action:
Guard:
Description
Market
Time: days
1meter = 10px, X=668, Y=170

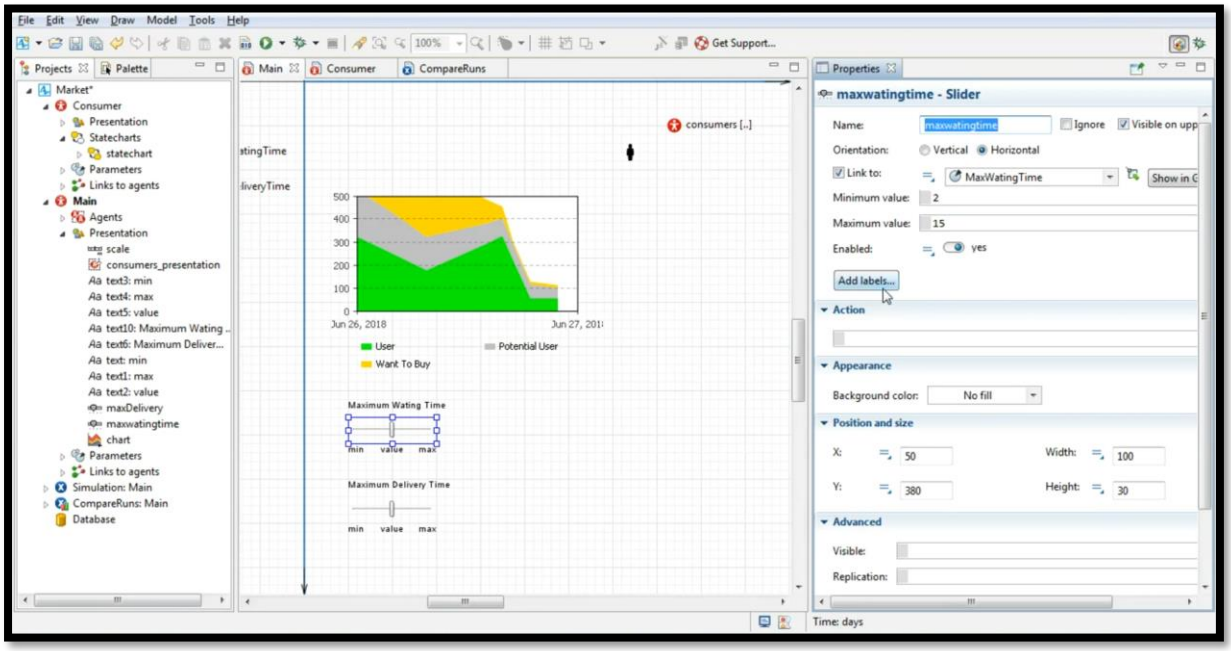

Choose Probability Distribution...
type filter text
Binomial
Binomial (truncated)
Cauchy
Chi Squared
Erlang
Exponential
Exponential (truncated)
Gamma
Gamma (truncated)
Geometric
Hypergeometric
Gumbel Type I
Gumbel Type II
Laplace
Logarithmic
Logistic
Lognormal
Negative Binomial
Negative Binomial (truncated)
Normal
Normal (truncated)
Pareto
PERT
Poisson
Poisson (truncated)
Rayleigh
TriangularAV
Triangular
Triangular (truncated)
Weibull
Weibull (truncated)
Triangular
min: 1
max: 25.0
mode: 2
0 5 10 15 20 25
Generates a sample of the Triangular distribution.
The Triangular distribution is a continuous distribution bounded on both sides.
The Triangular distribution is often used when no or little data is available; it is rarely an accurate representation of a data set. However, it is employed as the functional form of regions for fuzzy logic due to its ease of use.
The Triangular distribution can take on very skewed forms including negative skewness. For the exceptional cases where the mode is either the min or max, the Triangular distribution becomes a right triangle.
Parameters:
min - the minimum x value.
max - the maximum x value.
mode - the most likely x value.
OK
Cancel


File Edit View Draw Model Tools Help
Projects
Palette
Market*
Consumer
Presentation
Statecharts
statechart
Parameters
Links to agents
Main
Agents
Presentation
scale
consumers_presentation
chart
Parameters
Links to agents
Simulation: Main
Database
Main
Consumer
Effectiveness
ntactRate
optionFraction
DiscardTime
statechart
PotentialUser
Ad
WOM
WantToBuy
User
Contact
Properties
purchase - Transition
Name: purchase
Show name
Ignore
Triggered by: Timeout
Timeout: triangular(1,main.MaxDe
days
Action:
Guard:
Description
Market
Time: days
1meter = 10px, X=144, Y=21


x250
root:Main
AnyLogic
MaxWatingTime
7
MaxDeliveryTime
25
consumers
Consumer [500]
500
400
200
0
Jan 1, 2021
User
Want To Buy
Run: 0 Running
Time: 952.15
Simulation: Stop time not set
Date: Feb 2, 2021 8:15:36 AM
Memory:


File Edit View Draw Model Tools Help
Get Support...
Projects
Palette
Main
Consumer
Properties
Market*
Consumer
Presentation
Statecharts
statechart
Parameters
Links to agents
Main
Agents
Presentation
scale
consumers_presentation
chart
Parameters
Links to agents
Simulation: Main
Database
0 2 4 6 8 10
meter
1meter = 10px
connections
MaxWatingTime
MaxDeliveryTime
consumers
500
400
300
200
100
0
Jun 26, 2018
Jun 27, 201
User
Potential User
Want To Buy
chart - Time Stack Chart
Name: chart
Ignore
Visible on upper level
Data
Value
Data set
Title: User
Value: consumers.NUser()
Color: lime
Title: Want To Buy
Value: consumers.NWantToBuy()
Color: gold
Title: Potential User
Value: consumers.NPotentialUser()
Color: silver
Add data item
Data update
Update data automatically
Do not update data automatically
Use model time
Use calendar dates
Market
Time: days
1meter = 10px, X=87, Y=50


File Edit View Draw Model Tools Help
Projects Palette
Main Consumer
Properties
maxWating - Slider
Market
Consumer
Presentation
Statecharts
statechart
Parameters
Links to agents
Main
Agents
Presentation
scale
consumers_presentation
text3: min
text4: max
text5: value
text10: Maximum Wating ...
text6: Maximum Deliver...
text: min
text1: max
text2: value
maxDelivery
maxWating
chart
Parameters
Links to agents
Simulation: Main
Database
User
Potential User
Want To Buy
Maximum Wating Time
min value max
Maximum Delivery Time
min value max
Name: maxWating
Ignore
Orientation: Vertical Horizontal
Link to: MaxWatingTime
Minimum value: 2
Maximum value: 15
Enabled: yes
Add labels...
Action
Appearance
Background color: No fill
Position and size
X: 50
Width: 100
Y: 380
Height: 30
Advanced
Visible:
Replication:
Market
3 error(s)
Time: days
1meter = 10px, X=263, Y=431


File Edit View Draw Model Tools Help
Projects Palette
Main Consumer CompareRuns
Properties
maxwatingtime - Slider
Market*
Consumer
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Statecharts
statechart
Parameters
Links to agents
Main
Agents
Presentation
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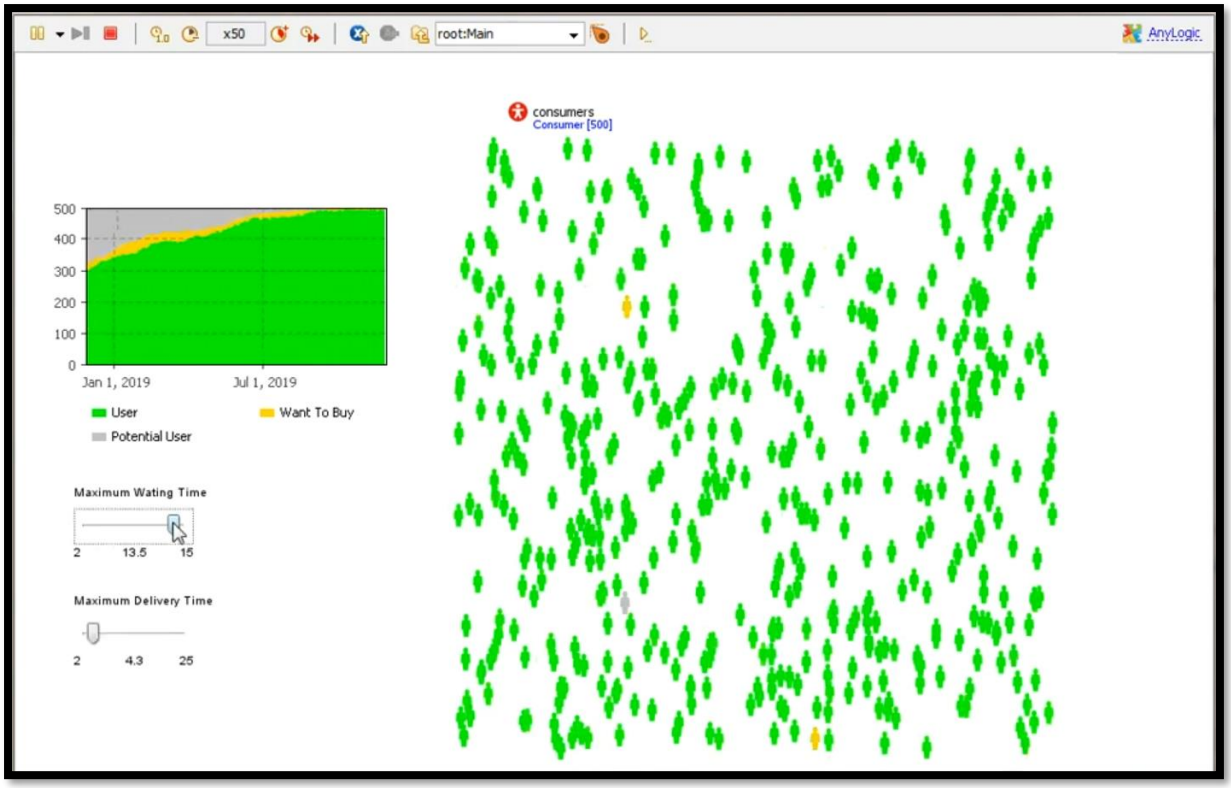
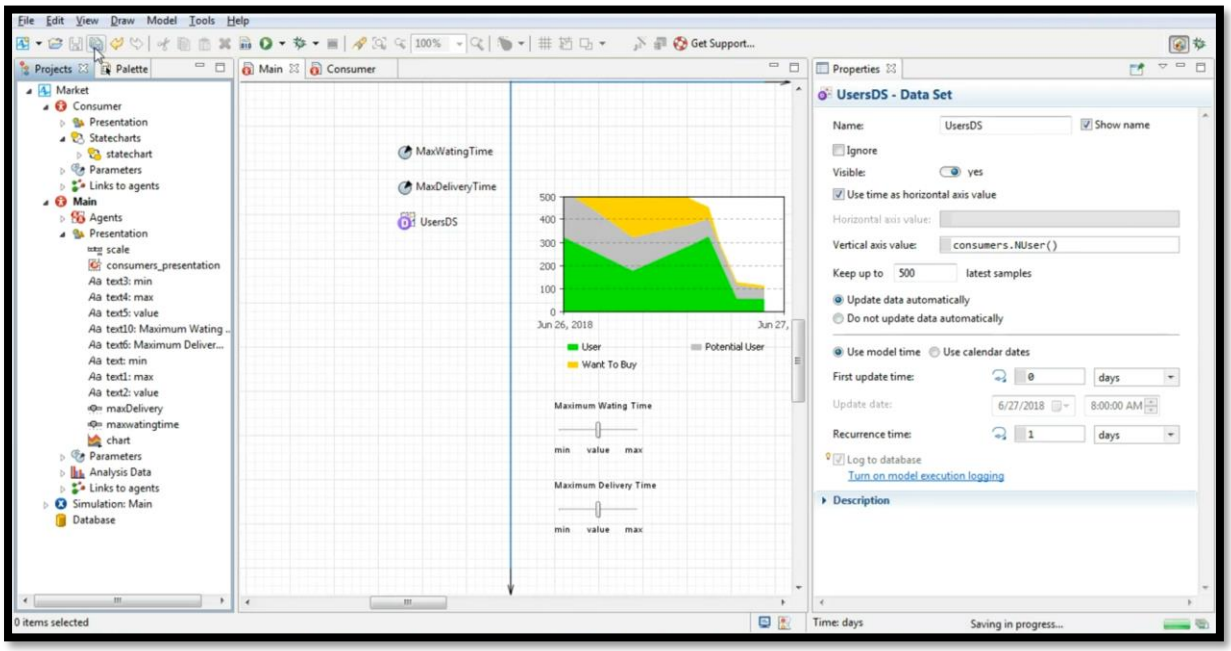
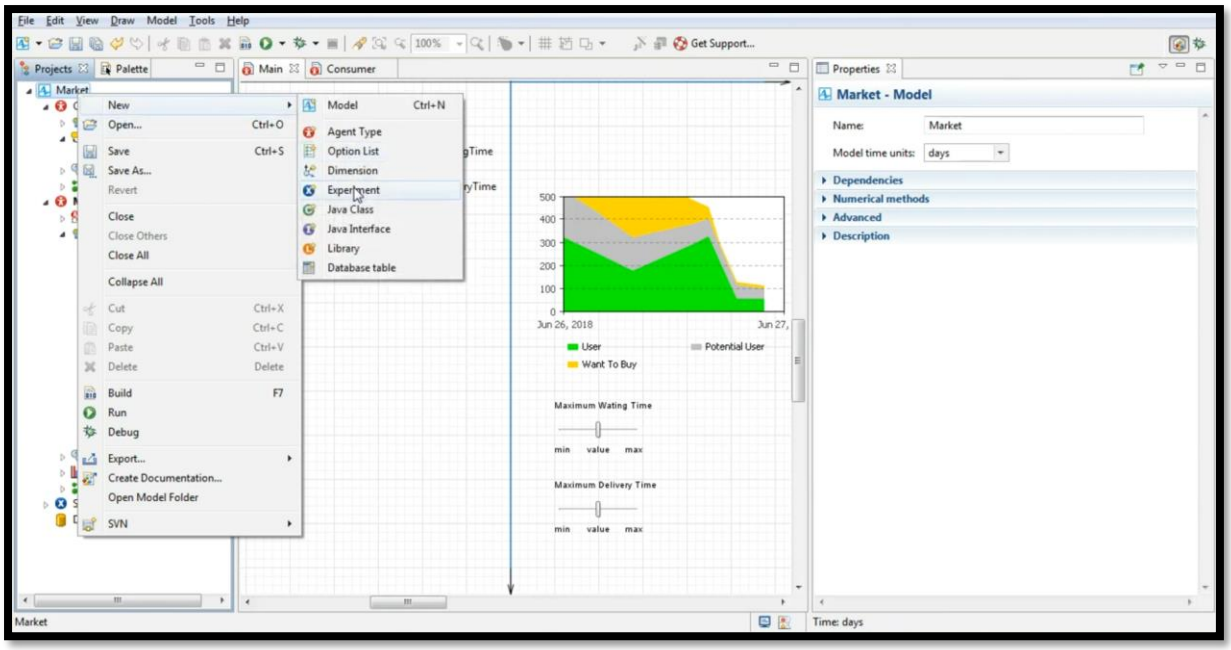
consumers_presentation
text3: min
text4: max
text5: value
text10: Maximum Wating ...
text6: Maximum Deliver...
text: min
text1: max
text2: value
maxDelivery
maxwatingtime
chart
Parameters
Links to agents
Simulation: Main
CompareRuns: Main
Database
consumers [..]
500
400
300
200
100
0
Jun 26, 2018
Jun 27, 201
User
Potential User
Want To Buy
Maximum Wating Time
min value max
Maximum Delivery Time
min value max
Name: maxwatingtime
Ignore
Orientation: Vertical Horizontal
Link to: MaxWatingTime
Minimum value: 2
Maximum value: 15
Enabled: yes
Add labels...
Action
Appearance
Background color: No fill
Position and size
X: 50
Width: 100
Y: 380
Height: 30
Advanced
Visible:
Replication:
Time: days


x50
root:Main
AnyLogic
consumers
Consumer [500]
500
400
300
200
100
0
Jan 1, 2019
Jul 1, 2019
User
Want To Buy
Potential User
Maximum Wating Time
2
13.5
15
Maximum Delivery Time
2
4.3
25


File Edit View Draw Model Tools Help
Get Support...
Projects
Palette
Main
Consumer
Properties
Market
Consumer
Presentation
Statecharts
statechart
Parameters
Links to agents
Main
Agents
Presentation
scale
consumers_presentation
text3: min
text4: max
text5: value
text10: Maximum Wating ...
text6: Maximum Deliver...
text: min
text1: max
text2: value
maxDelivery
maxwatingtime
chart
Parameters
Analysis Data
Links to agents
Simulation: Main
Database
MaxWatingTime
MaxDeliveryTime
UsersDS
500
400
300
200
100
0
Jun 26, 2018
Jun 27,
User
Potential User
Want To Buy
Maximum Wating Time
min value max
Maximum Delivery Time
min value max
UsersDS - Data Set
Name: UsersDS
Show name
Ignore
Visible: yes
Use time as horizontal axis value
Horizontal axis value:
Vertical axis value: consumers.NUser()
Keep up to 500 latest samples
Update data automatically
Do not update data automatically
Use model time
Use calendar dates
First update time: 0 days
Update date: 6/27/2018 8:00:00 AM
Recurrence time: 1 days
Log to database
Turn on model execution logging
Description
0 items selected
Time: days
Saving in progress...



Conclusion:

The agent-based model developed in this study successfully simulates market dynamics, considering word of mouth effects, product discards, and delivery time. By capturing the behaviour of individual consumers and businesses, the model provides insights into the complex dynamics of markets and product adoption, which can inform business strategies and decision-making processes.