**Epidemic Simulation** 

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## **Chapter 1**

## epidemic-simulation

### 1.1 Detailed description

The application is C# object-oritented implementation of the epidemic simulation employing make building system. WinForms and XNA (FNA) frameworks were used to created graphical user interface. The user can set up different initial parameters of simulation including disease lethality, communicability, duration and simulated population. There are three different scenarios enriching the user experience: 1) single community simulation, 2) shopping community simulation and 3) multigroup community simulation. The user is able to observe the spread of the germ in real time as well as follow graphs depicting progress of the disease. At the very end of simulation, the file containing detailed statistics is being generated. The project has been created and developed as university project for the 'Object-Oriented Programming' course. It contains unit tests and automatically generated documentation thanks to doxygen.

#### 1.2 Available commands

- make builds the entire project (application, tests and documentation)
- make run runs the application
- make test compiles and runs unit tests
- make compile\_tests compiles only unit tests
- make documentation updates the project documentation
- make clean cleans the project's auxiliary and temporary files

#### 1.3 Requirements:

- · C# implementation dotnet or mono
- · XNA or FNA framework
- · make command
- · doxygen command

2 epidemic-simulation

## Chapter 2

# Namespace Index

## 2.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

Charting	9
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## **Chapter 3**

## **Hierarchical Index**

## 3.1 Class Hierarchy

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## **Class Index**

## 4.1 Class List

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## **Chapter 5**

## **Namespace Documentation**

### 5.1 Charting Namespace Reference

#### **Classes**

· class Graph

### 5.2 EpidemicSimulation Namespace Reference

#### **Classes**

- · class ChartManager
- class Dead
- · class Disease
- · class Infectious
- interface ISimulation
- class MultigroupCommunitySimulation
- class Person
- class Recovered
- class Removed
- class ShoppingCommunitySimulation
- · class Simulation
- · class SingleCommunitySimulation
- class StatisticsPrinter
- · class Susceptible

#### 5.2.1 Detailed Description

Class manages the Graph class providing basic setup and letting easily update displayed statistics.

### 5.3 TestSuite Namespace Reference

#### **Classes**

- class PersonTest
- class SimulationTest
- class TestRunner

## **Chapter 6**

## **Class Documentation**

## 6.1 EpidemicSimulation.ChartManager Class Reference

#### **Public Member Functions**

- ChartManager (Vector2 position, Point size, Simulation simulation, GraphicsDevice graphicsDevice)
- void Update ()
- void Draw ()
- void LoadContent ()

#### 6.1.1 Constructor & Destructor Documentation

#### 6.1.1.1 ChartManager()

Constructor sets position of the the graph inside a window, size of the graph, instance of Simulation providing data for plotting and a graphics card object.

#### **Parameters**

position Position of the graph inside window	
size	Size of the graph in pixels
simulation	Instance of Simulation to dervive data from
graphicsDevice	A graphics card object

#### 6.1.2 Member Function Documentation

#### 6.1.2.1 Draw()

```
void EpidemicSimulation.ChartManager.Draw ( ) [inline]
```

Plots all data: infected in red, susceptible in blue, recovered in green and dead in gray.

#### 6.1.2.2 LoadContent()

```
void EpidemicSimulation.ChartManager.LoadContent ( ) [inline]
```

Initializes instance of Graph and configures it.

#### 6.1.2.3 Update()

```
void EpidemicSimulation.ChartManager.Update ( ) [inline]
```

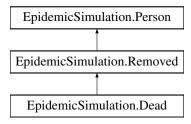
Updates the statistics culling them from provided instance of Simulation.

The documentation for this class was generated from the following file:

· src/ui/ChartManager.cs

### 6.2 EpidemicSimulation.Dead Class Reference

Inheritance diagram for EpidemicSimulation.Dead:



#### **Public Member Functions**

- Dead (Rectangle simulationRect, Point startPosition, Vector2 MovementVector, float? immunity=null, int? repulsionRate=null)
- override string Type ()

#### **Additional Inherited Members**

#### 6.2.1 Detailed Description

Class representing a person that have died due to the simulated epidemic.

#### 6.2.2 Constructor & Destructor Documentation

#### 6.2.2.1 Dead()

```
EpidemicSimulation.Dead.Dead (
    Rectangle simulationRect,
    Point startPosition,
    Vector2 MovementVector,
    float? immunity = null,
    int? repulsionRate = null ) [inline]
```

Constructor invoked during creation an instance of a concrete class representing a dead person.

#### **Parameters**

simulationRect	Rectangle determining an area where this person can move	
startPosition	Position where the person is located at the very beginning of the simulation or after being	
	added to the simulation	
MovementVector	Vector defining movement of this person	
immunity	Number representing personal immunity	
repulsionRate	Rate at which a person is repulsed from other. It hinders a risk of getting infected.	

#### 6.2.3 Member Function Documentation

#### 6.2.3.1 Type()

```
override string EpidemicSimulation.Dead.Type ( ) [inline], [virtual]
```

Returns a type of person as a text label.

Implements EpidemicSimulation.Person.

The documentation for this class was generated from the following file:

· src/backend/Dead.cs

### 6.3 EpidemicSimulation.Disease Class Reference

#### **Static Public Member Functions**

static void s\_SetUpParams (float? lethality=null, float? duration=null, float? Communicability=null, float? requiredFieldIntersetion=null)

#### **Static Public Attributes**

- static float Lethality = 0.1f
- static float Duration = 2000f
- static float Communicability = 0.03f
- static float RequiredFieldIntersetion = 0.3f

The documentation for this class was generated from the following file:

src/backend/Disease.cs

### 6.4 Charting.Graph Class Reference

### **Public Types**

enum GraphType { Line , Fill }

#### **Public Member Functions**

- Graph (GraphicsDevice graphicsDevice, Point size)
- void Draw (List< Tuple< float, Color > > values)

Draws the values in given order, with specific color for each value

void Draw (List< float > values, Color color)

Draws the values in given order, in specified color

#### **Properties**

• GraphType Type [get, set]

Determines whether the drawn graph will be line only, or filled

Vector2 Position [get, set]

The bottom left position of the graph

• Point Size [get, set]

The size of the graph. The graph values will be scaled horizontally to fill width (Size.X) Vertically, the values will be scaled based on MaxValue property, where the position of the value that is equal to MaxValue will be Size.Y

• float MaxValue [get, set]

Determines the vertical scaling of the graph. The value that is equal to MaxValue will be displayed at the top of the graph (at point Size.Y)

#### 6.4.1 Member Function Documentation

#### 6.4.1.1 Draw() [1/2]

Draws the values in given order, in specified color

#### **Parameters**

values	Values to draw, in order from left to right
color	Color of the entire graph

### 6.4.1.2 Draw() [2/2]

```
void Charting.Graph.Draw ( \label{eq:color} {\it List}{<}~{\it Tuple}{<}~{\it float,}~{\it Color}~>>{\it values}~{\it )}~{\it [inline]}
```

Draws the values in given order, with specific color for each value

#### **Parameters**

values	Value/color pairs to draw, in order from left to right
--------	--

The documentation for this class was generated from the following file:

· vendor/Graph.cs

## 6.5 EpidemicSimulation.Infectious Class Reference

Inheritance diagram for EpidemicSimulation.Infectious:



#### **Public Member Functions**

- Infectious (Rectangle simulationRect, float? immunity=null, int? repulsionRate=null)
- Infectious (Rectangle simulationRect, Point startPosition, Vector2 MovementVector, float? immunity=null, int? repulsionRate=null)
- override string Type ()

#### **Public Attributes**

• new float InfectionDuration = 0

#### **Additional Inherited Members**

#### 6.5.1 Detailed Description

Class representing a person that got infected and spreads the germs.

#### 6.5.2 Constructor & Destructor Documentation

#### 6.5.2.1 Infectious() [1/2]

Constructor creating a concrete instance of a infectious person.

#### **Parameters**

simulationRect	Rectangle determining an area where this person can move
immunity	Number representing personal immunity
repulsionRate	Rate at which a person is repulsed from other. It hinders a risk of getting infected.

#### 6.5.2.2 Infectious() [2/2]

Constructor creating a concrete instance of a infectious person.

#### **Parameters**

simulationRect	Rectangle determining an area where this person can move	
startPosition	Position where the person is located at the very beginning of the simulation or after being added to the simulation	
MovementVector	Vector defining movement of this person	
immunity	Number representing personal immunity	
repulsionRate	Rate at which a person is repulsed from other. It hinders a risk of getting infected.	

#### 6.5.3 Member Function Documentation

#### 6.5.3.1 Type()

```
override string EpidemicSimulation.Infectious.Type ( ) [inline], [virtual]
```

Returns a type of person as a text label.

Implements EpidemicSimulation.Person.

The documentation for this class was generated from the following file:

· src/backend/Infectious.cs

### 6.6 EpidemicSimulation.ISimulation Interface Reference

Inheritance diagram for EpidemicSimulation. ISimulation:



#### **Public Member Functions**

- void Start ()
- void Close ()
- void Pause ()
- Dictionary< string, int > GetSimulationData ()

#### 6.6.1 Detailed Description

Interface constituting abstraction of epidemic scenario.

#### 6.6.2 Member Function Documentation

#### 6.6.2.1 Close()

```
void EpidemicSimulation.ISimulation.Close ( )
```

 $Implemented \ in \ Epidemic Simulation. Shopping Community Simulation, \ and \ Epidemic Simulation. Single Community Simulation.$ 

#### 6.6.2.2 GetSimulationData()

```
Dictionary<br/>< string, int > EpidemicSimulation.ISimulation.GetSimulationData ( )
```

Implemented in EpidemicSimulation.ShoppingCommunitySimulation, and EpidemicSimulation.SingleCommunitySimulation.

#### 6.6.2.3 Pause()

```
void EpidemicSimulation.ISimulation.Pause ( )
```

 $Implemented \ in \ Epidemic Simulation. Shopping Community Simulation, \ and \ Epidemic Simulation. Single Community Simulation.$ 

#### 6.6.2.4 Start()

```
void EpidemicSimulation.ISimulation.Start ( )
```

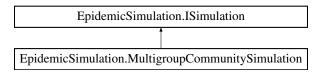
Implemented in EpidemicSimulation.ShoppingCommunitySimulation, and EpidemicSimulation.SingleCommunitySimulation.

The documentation for this interface was generated from the following file:

· src/backend/ISimulation.cs

# 6.7 EpidemicSimulation.MultigroupCommunitySimulation Class Reference

Inheritance diagram for EpidemicSimulation.MultigroupCommunitySimulation:



#### **Public Member Functions**

- · MultigroupCommunitySimulation (uint population, uint infected)
- Dictionary< string, int > GetSimulationData ()
- void Start ()
- void Close ()

#### **Protected Member Functions**

- override void **Update** (GameTime gameTime)
- override void **Draw** (GameTime gameTime)

#### 6.7.1 Detailed Description

This class constitues the multigroup community scenario, handling high-level events of simulation such as pausing, closing, starting a simulation, providing data and providing a simplified constructor.

#### 6.7.2 Member Function Documentation

#### 6.7.2.1 Close()

void EpidemicSimulation.MultigroupCommunitySimulation.Close () [inline]

Implements EpidemicSimulation. ISimulation.

#### 6.7.2.2 GetSimulationData()

Dictionary< string, int > EpidemicSimulation.MultigroupCommunitySimulation.GetSimulationData (
) [inline]

Implements EpidemicSimulation. ISimulation.

#### 6.7.2.3 Start()

 $\verb"void Epidemic Simulation.Multigroup Community Simulation.Start () \\ [inline]$ 

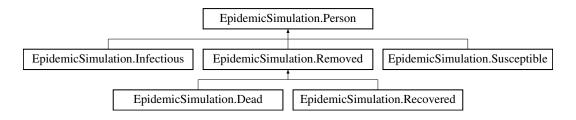
Implements EpidemicSimulation. ISimulation.

The documentation for this class was generated from the following file:

• src/backend/MultigroupCommunitySimulation.cs

### 6.8 EpidemicSimulation.Person Class Reference

Inheritance diagram for EpidemicSimulation.Person:



#### **Public Member Functions**

- abstract string Type ()
- Person (Rectangle SimulationRect, float? immunity=null, int? repulsionRate=null)
- **Person** (Rectangle SimulationRect, Point startPosition, Vector2 MovementVector, float? immunity=null, int? repulsionRate=null)
- virtual void UpdateSelf ()
- void **GoToPoint** (Point? centerPoint=null, float probability=0)
- float FieldIntersectionPrecentege (Rectangle obj1, Rectangle obj2)

#### **Static Public Member Functions**

- static bool s\_CheckCollision (Rectangle obj1, Rectangle obj2)
- static float s\_FieldIntersectionPrecentege (Rectangle obj1, Rectangle obj2)

#### **Public Attributes**

- Vector2 MovementVector
- bool IsColliding = false
- · Rectangle AnticipadedPositon
- float InfectionDuration
- bool IgnoreColision = false

#### **Static Public Attributes**

• static List< Rectangle > **Obsticles** = new List<Rectangle>()

#### **Protected Member Functions**

- virtual void Move ()
- void MoveRadiusField ()
- int DrawDirection ()

#### **Static Protected Member Functions**

• static float **RectSurface** (Rectangle obj)

#### **Properties**

- Point Position [get]
- static int \_size [get]
- static float s\_MovementSpeed [get, set]
- Rectangle Rect [get, set]
- float ImmunityRate [get]
- int RepulsionRate [get]
- bool RepulsionExpand [get]
- Rectangle RadiusRect [get]

#### 6.8.1 Member Function Documentation

#### 6.8.1.1 Type()

```
abstract string EpidemicSimulation.Person.Type ( ) [pure virtual]
```

Implemented in EpidemicSimulation.Dead, EpidemicSimulation.Infectious, EpidemicSimulation.Recovered, and EpidemicSimulation.Susceptible.

The documentation for this class was generated from the following file:

· src/backend/Person.cs

#### 6.9 TestSuite.PersonTest Class Reference

#### **Static Public Member Functions**

- static void TestCheckCollisionWhileTheyAreIntersectingWithOnePoint ()
- static void TestCheckCollisionWhileIntersectingWithSomeArea ()
- static void TestCheckCollisionWhileOneContainsTheOther ()
- static void TestCheckCollisionWhileTheyNotShareAnyArea ()
- static void TestFieldIntersectionPrecentegeWith1Percent ()
- static void TestFieldIntersectionPrecentegeWith0Percent ()
- static void TestFieldIntersectionPrecentegeWith100Percent ()

The documentation for this class was generated from the following file:

· test/PersonTest.cs

### 6.10 Program Class Reference

Inheritance diagram for Program:



#### **Public Member Functions**

• Program ()

#### **Static Public Member Functions**

· static void Main ()

#### 6.10.1 Constructor & Destructor Documentation

#### 6.10.1.1 Program()

```
Program.Program ( ) [inline]
```

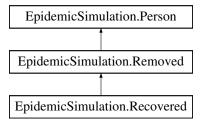
Constructor setting up the postions of all user interface components such as buttons, radio boxes, sliders, and the size of the main window.

The documentation for this class was generated from the following file:

· src/ui/Program.cs

## 6.11 EpidemicSimulation.Recovered Class Reference

Inheritance diagram for EpidemicSimulation.Recovered:



#### **Public Member Functions**

- Recovered (Rectangle simulationRect, Point startPosition, Vector2 MovementVector, float? immunity=null, int? repulsionRate=null)
- override string Type ()

#### **Additional Inherited Members**

#### 6.11.1 Detailed Description

Class representing a person that had been ill due to the simulated epidemic but has managed to recover.

#### 6.11.2 Constructor & Destructor Documentation

#### 6.11.2.1 Recovered()

```
EpidemicSimulation.Recovered.Recovered (
    Rectangle simulationRect,
    Point startPosition,
    Vector2 MovementVector,
    float? immunity = null,
    int? repulsionRate = null ) [inline]
```

Constructor creating a concrete instance of a recovered person.

#### **Parameters**

simulationRect	Rectangle determining an area where this person can move	
startPosition	Position where the person is located at the very beginning of the simulation or after being	
	added to the simulation  Vector defining movement of this person  Number representing personal immunity  Rate at which a person is repulsed from other. It hinders a risk of getting infected.	
MovementVector		
immunity		
repulsionRate		

#### **6.11.3** Member Function Documentation

#### 6.11.3.1 Type()

```
override string EpidemicSimulation.Recovered.Type ( ) [inline], [virtual]
```

Returns a type of person as a text label.

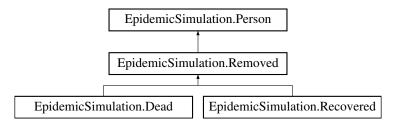
Implements EpidemicSimulation.Person.

The documentation for this class was generated from the following file:

• src/backend/Recovered.cs

## 6.12 EpidemicSimulation.Removed Class Reference

Inheritance diagram for EpidemicSimulation.Removed:



#### **Public Member Functions**

 Removed (Rectangle simulationRect, Point startPosition, Vector2 MovementVector, float? immunity=null, int? repulsionRate=null)

#### **Additional Inherited Members**

#### 6.12.1 Detailed Description

Abstract class representing a person that have either died or recovered.

#### 6.12.2 Constructor & Destructor Documentation

#### 6.12.2.1 Removed()

```
EpidemicSimulation.Removed.Removed (
    Rectangle simulationRect,
    Point startPosition,
    Vector2 MovementVector,
    float? immunity = null,
    int? repulsionRate = null ) [inline]
```

Constructor delegating assigning parameters to higher-level abstract constructor (Person).

#### **Parameters**

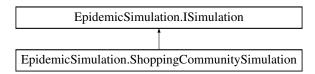
simulationRect	Rectangle determining an area where this person can move  Position where the person is located at the very beginning of the simulation or after being	
startPosition		
	added to the simulation	
MovementVector	Vector defining movement of this person	
immunity	Number representing personal immunity	
repulsionRate	Rate at which a person is repulsed from other. It hinders a risk of getting infected.	

The documentation for this class was generated from the following file:

src/backend/Removed.cs

# 6.13 EpidemicSimulation.ShoppingCommunitySimulation Class Reference

Inheritance diagram for EpidemicSimulation. ShoppingCommunitySimulation:



#### **Public Member Functions**

- ShoppingCommunitySimulation (uint population, Point? centerPoint=null)
- Dictionary< string, int > GetSimulationData ()
- void Start ()
- void Pause ()
- void Close ()

#### 6.13.1 Detailed Description

This class constitues the shopping community scenario, handling high-level events of simulation such as pausing, closing, starting a simulation, providing data and providing a simplified constructor.

#### 6.13.2 Constructor & Destructor Documentation

#### 6.13.2.1 ShoppingCommunitySimulation()

Constructor sets the population and center point.

#### **Parameters**

population	Number of people to be simulated
centerPoint	Location of the central point (like shopping mal). It can be null

#### 6.13.3 Member Function Documentation

#### 6.13.3.1 Close()

void EpidemicSimulation.ShoppingCommunitySimulation.Close ( ) [inline]

Closes the simulation.

Implements EpidemicSimulation. ISimulation.

#### 6.13.3.2 GetSimulationData()

Dictionary< string, int > EpidemicSimulation.ShoppingCommunitySimulation.GetSimulationData ( )
[inline]

Returns numbers of infected, susceptible, recovered and dead people.

Implements EpidemicSimulation. ISimulation.

#### 6.13.3.3 Pause()

void EpidemicSimulation.ShoppingCommunitySimulation.Pause ( ) [inline]

Pauses and unpauses the simulation.

Implements EpidemicSimulation. ISimulation.

#### 6.13.3.4 Start()

void EpidemicSimulation.ShoppingCommunitySimulation.Start ( ) [inline]

Starts the simulation.

Implements EpidemicSimulation. ISimulation.

The documentation for this class was generated from the following file:

• src/backend/ShoppingCommunitySimulation.cs

#### 6.14 TestSuite.SimulationTest Class Reference

#### **Static Public Member Functions**

• static void TestGenerateOutputLists ()

The documentation for this class was generated from the following file:

· test/SimulationTest.cs

### 6.15 EpidemicSimulation.SingleCommunitySimulation Class Reference

Inheritance diagram for EpidemicSimulation.SingleCommunitySimulation:



#### **Public Member Functions**

- SingleCommunitySimulation (uint population)
- Dictionary< string, int > GetSimulationData ()
- void Start ()
- void Pause ()
- void Close ()

#### 6.15.1 Detailed Description

This class constitues the single community scenario, handling high-level events of simulation such as pausing, closing, starting a simulation, providing data and providing a simplified constructor.

#### 6.15.2 Constructor & Destructor Documentation

#### 6.15.2.1 SingleCommunitySimulation()

```
\label{thm:community} Epidemic Simulation. Single Community Simulation. Single Community Simulation ( \\ uint population ) [inline]
```

Constructor creating an instance of Simulation class taking as a parameter the desired population size.

#### **Parameters**

population The desired population size expressed in the number of people.

#### 6.15.3 Member Function Documentation

#### 6.15.3.1 Close()

 $\verb"void Epidemic Simulation.Single Community Simulation.Close () \\ [inline]$ 

Closes the simulation.

Implements EpidemicSimulation. ISimulation.

#### 6.15.3.2 GetSimulationData()

```
Dictionary< string, int > EpidemicSimulation.SingleCommunitySimulation.GetSimulationData ( )
[inline]
```

Returns numbers of infected, susceptible, recovered and dead people.

Implements EpidemicSimulation.ISimulation.

#### 6.15.3.3 Pause()

```
void EpidemicSimulation.SingleCommunitySimulation.Pause ( ) [inline]
```

Pauses and unpauses the simulation.

Implements EpidemicSimulation. ISimulation.

#### 6.15.3.4 Start()

```
void EpidemicSimulation.SingleCommunitySimulation.Start ( ) [inline]
```

Starts the simulation.

Implements EpidemicSimulation. ISimulation.

The documentation for this class was generated from the following file:

src/backend/SingleCommunitySimulation.cs

### 6.16 EpidemicSimulation.StatisticsPrinter Class Reference

#### **Public Member Functions**

- StatisticsPrinter (ISimulation simulation)
- void Print ()

#### 6.16.1 Detailed Description

Class saves statistics to an external text file.

#### 6.16.2 Constructor & Destructor Documentation

#### 6.16.2.1 StatisticsPrinter()

Constructor takes an instance of ISimulation and assigns its reference to class's private property.

#### **Parameters**

simulation An instance of ISimulation where the data will be culled from.

#### 6.16.3 Member Function Documentation

#### 6.16.3.1 Print()

```
void EpidemicSimulation.StatisticsPrinter.Print ( ) [inline]
```

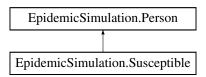
Creates a new file if none exists, otherwise, doesn't create or override anything. Saves information including date, time, chosen lethality, disease duration, communicability, overall population and the final number of infected, uninfected, recovered and dead people to the file. Closes that file.

The documentation for this class was generated from the following file:

• src/backend/StatisticsPrinter.cs

### 6.17 EpidemicSimulation.Susceptible Class Reference

Inheritance diagram for EpidemicSimulation.Susceptible:



#### **Public Member Functions**

- Susceptible (Rectangle simulationRect, float? immunity=null, int? repulsionRate=null)
- Susceptible (Rectangle simulationRect, Point startPosition, Vector2 MovementVector, float? immunity=null, int? repulsionRate=null)
- override string Type ()

#### **Additional Inherited Members**

#### 6.17.1 Detailed Description

Class representing a person that is still healthy but prone to get infected.

#### 6.17.2 Constructor & Destructor Documentation

#### 6.17.2.1 Susceptible() [1/2]

Constructor invoked during creation an instance of a concrete class representing a healthy but suscetible person.

#### **Parameters**

simulationRect	Rectangle determining an area where this person can move  Position where the person is located at the very beginning of the simulation or after being added to the simulation	
startPosition		
MovementVector	Vector defining movement of this person	
immunity	Number representing personal immunity	
repulsionRate	Rate at which a person is repulsed from other. It hinders a risk of getting infected.	

#### 6.17.2.2 Susceptible() [2/2]

```
EpidemicSimulation.Susceptible.Susceptible (
    Rectangle simulationRect,
    Point startPosition,
    Vector2 MovementVector,
    float? immunity = null,
    int? repulsionRate = null ) [inline]
```

Constructor invoked during creation an instance of a concrete class representing a healthy but suscetible person.

#### **Parameters**

simulationRect	Rectangle determining an area where this person can move	
immunity	Number representing personal immunity. If it's null, a random value will be assigned	
repulsionRate	Rate at which a person is repulsed from other. It hinders a risk of getting infected. If it's null, a random value will be assigned	

#### 6.17.3 Member Function Documentation

#### 6.17.3.1 Type()

override string EpidemicSimulation.Susceptible.Type ( ) [inline], [virtual]

Returns a type of person as a text label.

Implements EpidemicSimulation.Person.

The documentation for this class was generated from the following file:

• src/backend/Susceptible.cs

#### 6.18 TestSuite.TestRunner Class Reference

#### **Static Public Member Functions**

- static void Main (string[] args)
- static void AssertTrue (bool value)
- static void AssertFalse (bool value)
- static void AssertEquals (dynamic expected, dynamic actual)
- static void PrintSummary ()

#### **Static Public Attributes**

- static int failedTests = 0
- static int numberOfTests = 0

The documentation for this class was generated from the following file:

• test/TestRunner.cs

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