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System/Software Requirements Specification

for

Cellular Automaton Simulator

**Version 1.0 approved**

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**USTH**

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**Revision History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Date** | **Reason For Changes** | **Version** |
| Tran Quy Ban | Feb, 5 | Created | 1.0 |
| Ha Vien Duong | Feb, 6 | Created UCs 2 -5 | 1.0 |
| Tran Thuy Kieu | Feb, 6 | Created UCs 6 - 7 | 1.0 |
| Tran Quy Ban | Feb, 7 | Reviewed and updated URD and UCs | 1.0 |

# Introduction

## Purpose

*<Describe the document purposes; what information this document will contain; who are readers that this document aims at…>*

## System Purpose

<*Identify the product whose system requirements are specified in this document, including the revision or release number. Describe the system objectives, scope of the product that is covered by this SRS, particularly if this SRS describes only part of the system or a single subsystem.*

## Definitions, Acronyms and Abbreviations

*<Describe all common business/technical definitions, acronyms, and abbreviations that are used in the whole document*

## Document Conventions

*<Describe any standards or typographical conventions that were followed when writing this SRS, such as fonts or highlighting that have special significance. For example, state whether priorities for higher-level requirements are assumed to be inherited by detailed requirements, or whether every requirement statement is to have its own priority.>*

## Intended Audience and Reading Suggestions

*<Describe the different types of reader that the document is intended for, such as developers, project managers, marketing staff, users, testers, and documentation writers. Describe what the rest of this SRS contains and how it is organized. Suggest a sequence for reading the document, beginning with the overview sections and proceeding through the sections that are most pertinent to each reader type.>*

## Project Scope

*<Provide a short description of the software being specified and its purpose, including relevant benefits, objectives, and goals. Relate the software to corporate goals or business strategies. If a separate vision and scope document is available, refer to it rather than duplicating its contents here. An SRS that specifies the next release of an evolving product should contain its own scope statement as a subset of the long-term strategic product vision.>*

## References

*<List any other documents or Web addresses to which this SRS refers. These may include user interface style guides, contracts, standards, system requirements specifications, use case documents, or a vision and scope document. Provide enough information so that the reader could access a copy of each reference, including title, author, version number, date, and source or location.>*

# Overall Description

## Product/System Perspective

*<Describe the context and origin of the product being specified in this SRS. For example, state whether this product is a follow-on member of a product family, a replacement for certain existing systems, or a new, self-contained product. If the SRS defines a component of a larger system, relate the requirements of the larger system to the functionality of this software and identify interfaces between the two. A simple diagram that shows the major components of the overall system, subsystem interconnections, and external interfaces can be helpful.>*

## System/Product Features

*<Summarize the major features the product contains or the significant functions that it performs or lets the user perform. Details will be provided in Section 3, so only a high level summary is needed here. Organize the functions to make them understandable to any reader of the SRS. A picture of the major groups of related requirements and how they relate, such as a top level data flow diagram or a class diagram, is often effective.>*

## User requirements

### Main Function

#### Main concept

* A cellular automaton is a model of a system of “cell” objects with the following characteristics.
* The cells live on a grid. A cellular automaton can exist in any finite number of dimensions.
* Each cell has a state. The number of state possibilities is typically finite. The simplest example has the two possibilities of 1 and 0 (otherwise referred to as “on” and “off” or “alive” and “dead”).
* Each cell has a neighborhood. This can be defined in any number of ways, but it is typically a list of adjacent cells.

#### Rule Notation

Each rule has three parts: Survival rule, Birth rule and number of generations (S/B/G).

* The Survival rule is a list of numbers 0 - 8 which specify how many neighboring cells must be alive in order for a given cell to survive.
* The Birth rule is also a list of numbers 0-8, which specify how many neighboring cells must be alive in order for a dead cell to come alive.
* The number of generations is a special rule used to create complex automata. This number may be 2 (corresponding with two states “alive” or “dead”) or greater such as 3, 4 or more (corresponding with three, four states “alive”, “dead”, “young” and “old”).

#### Example 1: Conway’s Game of Life - Rule 23/3/2

The system based on the following rules:

* Cell in the grid can either be ON or OFF. (Generation: 2)
* If a cell is OFF, and exactly 3 of its neighbors are ON, the cell turns ON in the next generation. (Birth rule: 3)
* If a cell is ON, and 2 or 3 of its neighbors are ON, it continues to survive. Otherwise, it dies in the next generation. (Survival rule: 23)

***Example 2: Star Wars - Rule 345/2/4***

The system based on the following rules:

* Cell in the grid can either be OFF, ON, or 2 other states between ON and OFF. (Generation: 4)
* If a cell is OFF, and exactly 2 of its neighbors are ON, the cell turns ON in the next generation. (Birth rule: 2)
* If a cell is ON and 3 or 4 or 5 of its neighbors are ON, it continues to survive. Otherwise, it increases the state. When the state is approached the state OFF, it turns to OFF.

#### Classification

The vast majority of elementary CA rulesets produce uninspiring results, while some result in wondrously complex patterns like those found in nature. Worlfram has divided up the range of outcomes into four classes:

Class 1: Uniformity. Class 1 CAs end up, after some number of generations, with every cell constant

Class 2: Repetition. Like class 1 CAs, class 2 CAs remain stable, but the cell states are not constant. Rather, they oscillate in some regular patterns back and forth from 0 to 1 to 0 to 1 and so on.

Class 3: Random. Class 3 CAs appear random and have no easily discernible pattern.

Class 4: Complexity. Class 4 CAs can be thought of as a mix between class 2 and class 3. One can find repetitive, oscillating patterns inside the CA, but where and when these patterns appear is unpredictable and seemingly random.

#### Normal User Function

##### Create/Edit parameter for the simulator

* User can change the dimension of the simulator. The default dimension of the simulator is 2.
* User can change the size of the grid. The cell lives on the grid. The grid has maximum and minimum value and if user do not change, the grid takes the default value.
* Each cell has a state and user can change the state of the cell. The minimum value of the state is 2 (on or off, dead or alive, etc…)
* User can change the rule of the simulator
* User can change the iteration of the simulator
* User can clear the graph to run a new rule.

##### View result of simulator

* User can view the result of the simulator on the graph.
* User can close the simulator.

## User Classes and Characteristics

*<Identify the various user classes that you anticipate will use this product. User classes may be differentiated based on frequency of use, subset of product functions used, technical expertise, security or privilege levels, educational level, or experience. Describe the pertinent characteristics of each user class. Certain requirements may pertain only to certain user classes. Distinguish the favored user classes from those who are less important to satisfy.>*

## Operating Environment

*<Describe the environment in which the software will operate, including the hardware platform, operating system and versions, and any other software components or applications with which it must peacefully coexist.>*

## Design and Implementation Constraints

*<Describe any items or issues that will limit the options available to the developers. These might include: corporate or regulatory policies; hardware limitations (timing requirements, memory requirements); interfaces to other applications; specific technologies, tools, and databases to be used; parallel operations; language requirements; communications protocols; security considerations; design conventions or programming standards (for example, if the customer’s organization will be responsible for maintaining the delivered software).>*

## User Documentation

*<List the user documentation components (such as user manuals, on-line help, and tutorials) that will be delivered along with the software. Identify any known user documentation delivery formats or standards.>*

## Assumptions and Dependencies

*<List any assumed factors (as opposed to known facts) that could affect the requirements stated in the SRS. These could include third-party or commercial components that you plan to use, issues around the development or operating environment, or constraints. The project could be affected if these assumptions are incorrect, are not shared, or change. Also identify any dependencies the project has on external factors, such as software components that you intend to reuse from another project, unless they are already documented elsewhere (for example, in the vision and scope document or the project plan).>*

## Apportioning of Requirements

<List of a*ll the requirements is optional. They can be deferred to the future or not necessary to implement* >

# Specific Requirements

*<This template illustrates organizing the functional requirements for the product by system features, the major services provided by the product. You may prefer to organize this section by use case, mode of operation, user class, object class, functional hierarchy, or combinations of these, whatever makes the most logical sense for your product.>*

## Functional Requirements Specification

### Function1 /Use-case 1

|  |  |
| --- | --- |
| **Use Case ID** | UC-1 |
| **Use Case Name** | Initialize parameters |
| **Actors** | User |
| **Description** | The system allows user to create a new rule |
| **Pre-condition** | The simulator is started |
| **Post-condition** | N/A |
| **Trigger** | N/A |
| **Business Rules** | N/A |
| **Main flow** | |  |  |  | | --- | --- | --- | | **No.** | **Actor** | **Action** | | 1 | User | Tap on the rule combobox on the simulator screen | | 2 | System | Display a list of rules | | 3 | User | Choose a rule on the dropdown list of combobox | | 4 | System | Apply the rule and display the result of the rule | |
| **Alternative / Exception flow** | |  |  |  | | --- | --- | --- | | **No** | **Actor** | **Action** | |  | | | |  |  |  | |  |  |  | |  | | | |  |  |  | |  |  |  | |  | | | |  |  |  | |  |  |  | |
| **Uses** | N/A |
| **Extends** | N/A |
| **Frequency** | High |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Field Name** | **Description** | **Mandatory** | **Read only** | **Control type** | | **Data Type** | **Length** |
| **Main** | | | | | | | |
| Rule |  | - | - | combobox | - | | - |
|  |  | - | - |  | - | | - |
|  |  | - | - |  | - | | - |
|  |  | - | - |  | - | | - |
|  |  | - | - |  | - | | - |

### Function2 /Use-case 2

|  |  |
| --- | --- |
| **Use Case ID** | UC-2 |
| **Use Case Name** | Create new rule (advanced function) |
| **Actors** | User |
| **Description** | The system allows user to create a new rule |
| **Pre-condition** | N/A |
| **Post-condition** | N/A |
| **Trigger** | N/A |
| **Business Rules** | N/A |
| **Main flow** | |  |  |  | | --- | --- | --- | | **No.** | **Actor** | **Action** | | 1 | User | Click on “New” button on Rule Management screen | | 2 | System | Display a form to input name and values of ruleset (integer value). Each rule has three parts: Survival rule, Birth rule and # of generations (S/B/G) | | 3 | User | Enter name or Rule and value of ruleset (S/B/G values) and click “Save” button | | 4 | System | Insert new rule into XML file (configuration file) and back to display list rules | |
| **Alternative / Exception flow** | |  |  |  | | --- | --- | --- | | **No** | **Actor** | **Action** | |  | | | | 1 | User | After input name and values of rule, if user wants to reset all value input, user click “Reset” button to clear all information on the screen | |  |  |  | |  | | | |  |  |  | |  |  |  | |  | | | |  |  |  | |  |  |  | |
| **Uses** | N/A |
| **Extends** | N/A |
| **Frequency** | High |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Field Name** | **Description** | **Mandatory** | **Read only** | **Control type** | | **Data Type** | **Length** |
| **Main** | | | | | | | |
| Rule name | Name of rule | - | - | Textbox | String | | - |
| Survival rule (S) | The survival rule is a list of numbers 0-8 which specify how many neighboring cells must be alive in order for a given cell to survive | - | - | Textbox | Integer | | - |
| Birth rule (B) | The birth rule is also a list of numbers 0-8, which specify how many neighboring cells must be alive in order for a dead cell to come alive | - | - | Textbox | Integer | | - |
| # of generations (G) | The # of generations is a special rule used to create complex automata | - | - | Textbox | Integer | | - |
| Save |  | - | - | Button | - | | - |
| Reset |  |  |  | Button |  | |  |
| New |  |  |  | Button |  | |  |

### Function3 /Use-case 3

|  |  |
| --- | --- |
| **Use Case ID** | UC-3 |
| **Use Case Name** | Edit rule (advanced function) |
| **Actors** | User |
| **Description** | The system allows user to edit a rule |
| **Pre-condition** | N/A |
| **Post-condition** | N/A |
| **Trigger** | N/A |
| **Business Rules** | N/A |
| **Main flow** | |  |  |  | | --- | --- | --- | | **No.** | **Actor** | **Action** | | 1 | User | Click on “Edit” button on Rule Management screen to edit a specific rule | | 2 | System | Display a form with name (cannot be changed) and values of ruleset (integer value, can be changed). Each rule has three parts: Survival rule, Birth rule and # of generations (S/B/G) | | 3 | User | Enter new values of ruleset (S/B/G values) and click “Save” button | | 4 | System | Update new value of specific rule into XML file (configuration file) and back to display list rules | |
| **Alternative / Exception flow** | |  |  |  | | --- | --- | --- | | **No** | **Actor** | **Action** | |  | | | | 1 | User | After input new values of rule, if user wants to reset all value input, user click “Reset” button to clear all information on the screen | |  |  |  | |  | | | |  |  |  | |  |  |  | |  | | | |  |  |  | |  |  |  | |
| **Uses** | N/A |
| **Extends** | N/A |
| **Frequency** | High |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Field Name** | **Description** | **Mandatory** | **Read only** | **Control type** | | **Data Type** | **Length** |
| **Main** | | | | | | | |
| Rule name | Name of rule | - | - | Label | String | | - |
| Survival rule (S) | The survival rule is a list of numbers 0-8 which specify how many neighboring cells must be alive in order for a given cell to survive | - | - | Textbox | Integer | | - |
| Birth rule (B) | The birth rule is also a list of numbers 0-8, which specify how many neighboring cells must be alive in order for a dead cell to come alive | - | - | Textbox | Integer | | - |
| # of generations (G) | The # of generations is a special rule used to create complex automata | - | - | Textbox | Integer | | - |
| Save |  | - | - | Button | - | | - |
| Reset |  |  |  | Button |  | |  |
| Edit |  |  |  | Button |  | |  |

### Function4 /Use-case 4

|  |  |
| --- | --- |
| **Use Case ID** | UC-4 |
| **Use Case Name** | Delete rule (advanced function) |
| **Actors** | User |
| **Description** | The system allows user to delete a rule |
| **Pre-condition** | N/A |
| **Post-condition** | N/A |
| **Trigger** | N/A |
| **Business Rules** | N/A |
| **Main flow** | |  |  |  | | --- | --- | --- | | **No.** | **Actor** | **Action** | | 1 | User | Click on “Delete” button on Rule Management screen to remove a specific rule | | 2 | System | Ask user to confirm | | 3 | User | Decide to delete or not | | 4 | System | Remove specific rule from XML file (configuration file) if user decides to delete and back to display list rules | |
| **Alternative / Exception flow** | |  |  |  | | --- | --- | --- | | **No** | **Actor** | **Action** | |  | | | |  |  |  | |  |  |  | |  | | | |  |  |  | |  |  |  | |  | | | |  |  |  | |  |  |  | |
| **Uses** | N/A |
| **Extends** | N/A |
| **Frequency** | High |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Field Name** | **Description** | **Mandatory** | **Read only** | **Control type** | | **Data Type** | **Length** |
| **Main** | | | | | | | |
| Delete |  |  |  | Button |  | |  |
|  |  |  |  |  |  | |  |
|  |  |  |  |  |  | |  |
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### 

### Function5 /Use-case 5

|  |  |
| --- | --- |
| **Use Case ID** | UC-5 |
| **Use Case Name** | View rule (advanced function) |
| **Actors** | User |
| **Description** | The system allows user to view content of a specific rule |
| **Pre-condition** | N/A |
| **Post-condition** | N/A |
| **Trigger** | N/A |
| **Business Rules** | N/A |
| **Main flow** | |  |  |  | | --- | --- | --- | | **No.** | **Actor** | **Action** | | 1 | User | Click on “View” button on Rule Management screen to view a specific rule | | 2 | System | Display a form with name (cannot be changed) and values of ruleset (integer value, cannot be changed). Each rule has three parts: Survival rule, Birth rule and # of generations (S/B/G) | |  |  |  | |  |  |  | |
| **Alternative / Exception flow** | |  |  |  | | --- | --- | --- | | **No** | **Actor** | **Action** | |  | | | |  |  |  | |  |  |  | |  | | | |  |  |  | |  |  |  | |  | | | |  |  |  | |  |  |  | |
| **Uses** | N/A |
| **Extends** | N/A |
| **Frequency** | High |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Field Name** | **Description** | **Mandatory** | **Read only** | **Control type** | | **Data Type** | **Length** |
| **Main** | | | | | | | |
| Rule name | Name of rule | - | - | Label | String | | - |
| Survival rule (S) | The survival rule is a list of numbers 0-8 which specify how many neighboring cells must be alive in order for a given cell to survive | - | - | Label | Integer | | - |
| Birth rule (B) | The birth rule is also a list of numbers 0-8, which specify how many neighboring cells must be alive in order for a dead cell to come alive | - | - | Label | Integer | | - |
| # of generations (G) | The # of generations is a special rule used to create complex automata | - | - | Label | Integer | | - |
| View |  |  |  | Button |  | |  |
|  |  |  |  |  |  | |  |
|  |  |  |  |  |  | |  |

* + 1. **Function6 /Use-case 6**

|  |  |
| --- | --- |
| **Use Case ID** | UC-6 |
| **Use Case Name** | Start evolution progress |
| **Actors** | User |
| **Description** | The system allows user to start the evolution process in the first visit or continue the pausing simulator |
| **Pre-condition** | First visit or the simulator are pausing |
| **Post-condition** | N/A |
| **Trigger** | N/A |
| **Business Rules** | N/A |
| **Main flow** | |  |  |  | | --- | --- | --- | | **No.** | **Actor** | **Action** | | 1 | User | Click on “Start” button on the simulator screen | | 2 | System | Start or continue the evolution process and display the result on the screen | |  |  |  | |  |  |  | |
| **Alternative / Exception flow** | |  |  |  | | --- | --- | --- | | **No** | **Actor** | **Action** | |  | | | |  |  |  | |  |  |  | |
| **Uses** | N/A |
| **Extends** | N/A |
| **Frequency** | High |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Field Name** | **Description** | **Mandatory** | **Read only** | **Control type** | | **Data Type** | **Length** |
| **Main** | | | | | | | |
| Start |  |  |  | Button |  | |  |

* + 1. **Function7 /Use-case 7**

|  |  |
| --- | --- |
| **Use Case ID** | UC-7 |
| **Use Case Name** | Stop evolution progress |
| **Actors** | User |
| **Description** | The system allows user to stop the running evolution process |
| **Pre-condition** | The simulator is running |
| **Post-condition** | N/A |
| **Trigger** | N/A |
| **Business Rules** | N/A |
| **Main flow** | |  |  |  | | --- | --- | --- | | **No.** | **Actor** | **Action** | | 1 | User | Click on “Stop” button on the simulator screen | | 2 | System | Stop the evolution process and display the result at current clicking time on the screen | |
| **Alternative / Exception flow** | |  |  |  | | --- | --- | --- | | **No** | **Actor** | **Action** | |  | | | |  |  |  | |  |  |  | |
| **Uses** | N/A |
| **Extends** | N/A |
| **Frequency** | High |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Field Name** | **Description** | **Mandatory** | **Read only** | **Control type** | | **Data Type** | **Length** |
| **Main** | | | | | | | |
| Stop |  |  |  | Button |  | |  |

## Non-Functional Requirements Specification

### External Interface Requirements

#### User Interfaces

*<Describe the logical characteristics of each interface between the software product and the users. This may include sample screen images, any GUI standards or product family style guides that are to be followed, screen layout constraints, standard buttons and functions (e.g., help) that will appear on every screen, keyboard shortcuts, error message display standards, and so on. Define the software components for which a user interface is needed. Details of the user interface design should be documented in a separate user interface specification.>*

#### Hardware Interfaces

*<Describe the logical and physical characteristics of each interface between the software product and the hardware components of the system. This may include the supported device types, the nature of the data and control interactions between the software and the hardware, and communication protocols to be used.>*

#### Software Interfaces

*<Describe the connections between this product and other specific software components (name and version), including databases, operating systems, tools, libraries, and integrated commercial components. Identify the data items or messages coming into the system and going out and describe the purpose of each. Describe the services needed and the nature of communications. Refer to documents that describe detailed application programming interface protocols. Identify data that will be shared across software components. If the data sharing mechanism must be implemented in a specific way (for example, use of a global data area in a multitasking operating system), specify this as an implementation constraint.>*

#### Communications Interfaces

*<Describe the requirements associated with any communications functions required by this product, including e-mail, web browser, network server communications protocols, electronic forms, and so on. Define any pertinent message formatting. Identify any communication standards that will be used, such as FTP or HTTP. Specify any communication security or encryption issues, data transfer rates, and synchronization mechanisms.>*

### Other Nonfunctional Requirements

#### Performance Requirements

*<If there are performance requirements for the product under various circumstances, state them here and explain their rationale, to help the developers understand the intent and make suitable design choices. Specify the timing relationships for real time systems. Make such requirements as specific as possible. You may need to state performance requirements for individual functional requirements or features.*

*This* section lists all requirements whose ***Category*** has been stated in the goal model to be ‘**performance’***>*

#### Design constraints

*<This section lists all requirements whose* **Category** *has been stated in the goal model to be ‘****development’*** *or ‘****architecture’*** *(see Figure 7.5)*

#### Safety Requirements

*<Specify those requirements that are concerned with possible loss, damage, or harm that could result from the use of the product. Define any safeguards or actions that must be taken, as well as actions that must be prevented. Refer to any external policies or regulations that state safety issues that affect the product’s design or use. Define any safety certifications that must be satisfied.*

*This section* lists all requirements whose ***Category*** has another value e.g. ‘**safety’**

*>*

#### Security Requirements

*<Specify any requirements regarding security or privacy issues surrounding use of the product or protection of the data used or created by the product. Define any user identity authentication requirements. Refer to any external policies or regulations containing security issues that affect the product. Define any security or privacy certifications that must be satisfied.>*

#### Software Quality Attributes

*<Specify any additional quality characteristics for the product that will be important to either the customers or the developers. Some to consider are: adaptability, availability, correctness, flexibility, interoperability, maintainability, portability, reliability, reusability, robustness, testability, and usability. Write these to be specific, quantitative, and verifiable when possible. At the least, clarify the relative preferences for various attributes, such as ease of use over ease of learning.*

*This section* lists all requirements whose ***Category*** has another value e.g. **‘accuracy**’ *>*

# Other Requirements

*<Define any other requirements not covered elsewhere in the SRS. This might include database requirements, internationalization requirements, legal requirements, reuse objectives for the project, and so on. Add any new sections that are pertinent to the project.>*

**Appendix A: Glossary**

*<Define all the terms necessary to properly interpret the SRS, including acronyms and abbreviations. You may wish to build a separate glossary that spans multiple projects or the entire organization, and just include terms specific to a single project in each SRS.>*

**Appendix B: Analysis Models**

*<Optionally, include any pertinent analysis models, such as data flow diagrams, class diagrams, state-transition diagrams, or entity-relationship diagrams*.>

**Appendix C: Issues List**

*< This is a dynamic list of the open requirements issues that remain to be resolved, including TBDs, pending decisions, information that is needed, conflicts awaiting resolution, and the like.>*