SLUCEII LMM Application Tutorial

For Version 2.0

Program/Documentation

Shipeng Sun, Qingxu Huang, Derek Robinson, Meghan Hutchinson, Rick Riolo

Project Supervisor

Dawn C. Parker, Daniel G. Brown

1. Introduction

SLUCEII-LMM is a theoretical, abstract agent-based model of land use change developed by the team of SLUCE2 project led by Professor Daniel G. Brown and Professor Dawn C. Parker. SLUCEII-LMM has a relatively complex land market mechanism with components of GIS and landscape. The more complete SLUCE2 model supporting both theoretical experiments and empirical investigations are under development and will be released later.

2. Installation and Removal

SLUCEII-LMM is a pure Java application based on Repast Simphony. The JDK/JRE 1.4 or above is required to run SLUCEII-LMM (for more on JDK and JRE, see http://www.oracle.com/technetwork/java/javase/downloads/index.html). Repast Simphony has compatibility issues with the latest Java 7 version. So, do NOT use Java 7 for SLUCEII-LMM. After installing JDK or JRE and setting environment variables such as Java command path, default Java classes path etc., please download the SLUCEII-LMM installer and run **`java -jar {installer_name}.jar`**. If you want to install the program without the GUI, use **`java -jar {installer_name}.jar -console.`** Simply follow instructions to complete the installation.

The SLUCEII-LMM installation package has included Repast Simphony components, so you do NOT need to install Repast Simphony separately. If you want to uninstall the model, go to the **`Uninstaller`** folder in your installation path and run **`java -jar uninstaller.jar`**. Uninstaller does not work if the program is installed using the console option. In that case, simply delete the installation folder. Additionally, SLUCEII_LMM can run on clusters that support DRMAA (Distributed Resource Management and Application API). Interested users can contact the team (Shipeng Sun) for more details.

3. Batch Mode

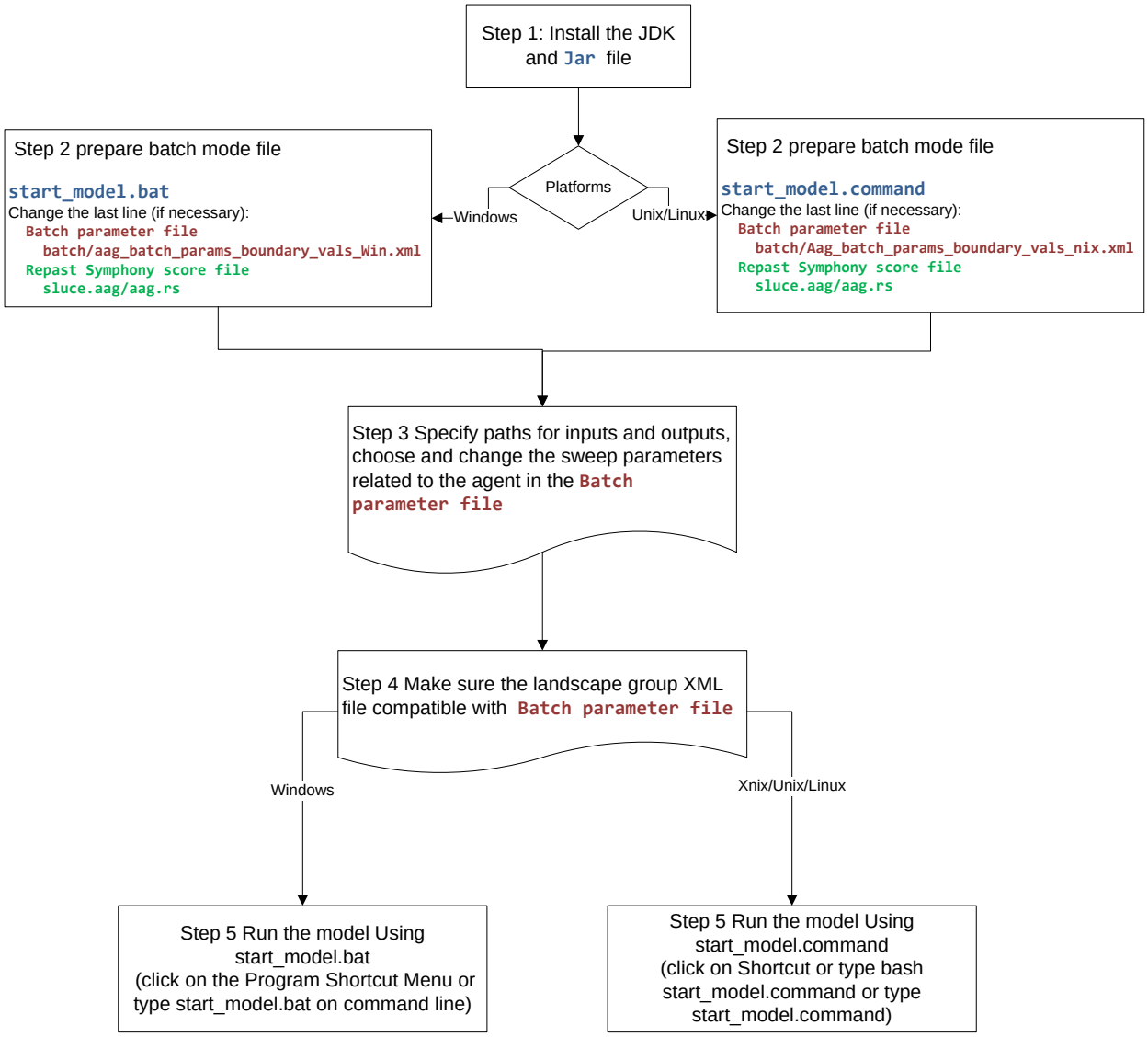
SLUCE_LMM model can run in standard Repast Simphony batch mode as well as GUI mode. Repast Simphony batch mode is mainly used to sweep parameter combinations set by users. Batch mode has no user interface. The model run is controlled by several parameter files and the model results will be saved automatically. To use batch mode, users must prepare several configuration files.

3.1 Settings

Besides the standard Repast Simphony initialization files (model.score and scenario.xml) included in the installation package, there are two major inputs for the model. The first one is a standard parameter file used by Repast Simphony, i.e., a controlling parameter file. These parameter files are saved in **`./batch`** folder. And you can check out several examples there.

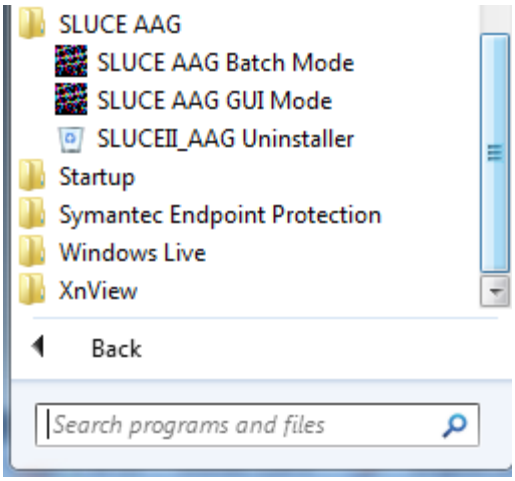
Another input for the model is landscape and log file setting. There are three constant parameters in the controlling parameter file that define the path to landscape and log settings. One is the path name, "**`dataFolderName`**". The second one is the file name of an xml file defining landscape, "**`landscapeGroupXMLFile`**". These two together will define an xml file pointing to other real raster files. Right now, the model will not read these raster files defined in this **`landscapeGroupXMLFile`** file, but you must define such entities because new output files depend on them. The last one is a log file, "**`logFileName`**". The main parameters and related output files will be saved in this log file in csv (comma separated) format. A separate **`paramOutputControlXML`** parameter specifies which parameters are included in the log file. Alternatively, A SQL Database option is undergoing development.

Now, we can go through the whole running process in the following order.



Start Command File:

If the model is installed correctly, a shortcut to a command file has been created. On Windows platform, the command file is **`start_model.bat`** and it is linked to the "**`SLUCE LMM Batch Mode`**" in the program menu. On Xnix (Unix/Linux) platform, the command file is **`start_model.command`**.



SLUCEII-LMM Model
Shortcut Menu, Windows 7

Users should check the paths specified in the file are correct. For example, "\" should not be used as path separator on Xnix platform. Most likely, users do not need to change anything but the last line.

```
START java -Xss32M -Xmx1024M -cp %CP% repast.simphony.batch.BatchMain -params
batch/aag_batch_params.xml -interactive sluce.aag/aag.rs
```

Users need to make sure the **batch parameter file** and the **Repast Symphony score file** exist at the specified locations. It is very likely that you have to create your own batch parameter file based on examples in **./batch** folder.

Batch Parameter File:

Now, users need to check the batch parameter file specified above. The parameter file is a standard Repast Symphony batch parameter file (more at http://repast.sourceforge.net/docs/reference /SIM/Batch%20Parameters.html). Most parameters are related to agents. But there are several critical parameters that control how the model read and write external data. If not properly set, these parameters will create errors.

dataFolderName: a path name for both input and output data files

resutlsFolderName: reserved for cluster run. Keep this empty if you are not running on cluster.

landscapeGroupXMLFile: a configuration file for landscape. Make sure "dataFolderName+ landscapeGroupXMLFile" exists. The format of the landscape configuration file will be explained later.

logFileName: a log file (dataFolderName+logFileName) recording parameters and output files. Make sure the folder exists. The model will automatically create the log file if it does not exist. If the file does exist, new records will be added to the end of the file. NO INFORMATION IN THIS FILE WILL BE LOST DURING THE MODEL RUN.

paramOutputControlXML: an standard Java Properties XML file (dataFolderName+ paramOutputControlXML) that defines which parameters will be included in the log file specified above. A TRUE value will include the parameter in log file; a FALSE will

exclude. The values in the log file will in the same order as this control file.

XXX_LayerIndex: the index of raster layer in the landscape group. This will be explained with landscapeGroupXMLFile.

Landscape Group XML File

The model has two types of outputs in ESRI ASCII file format. Landscape Group XML file specifies how they are organized. As SLUCEII_LMM is a theoretical, abstract model, there are no input landscape data. What matters in the landscape group xml file is layer ID and data path. Scales of these layers are set inside the program and they are controlled by the worldSize parameter in the batch parameter file. MAKE SURE the file path exists. If not, create those folders.

Now, users can see there should be at least four layers that have been specified in batch parameter file. The reference layer could be any of them. Reference layer is used to extract the dimension and scale of the space. Make sure the layer ID in batch parameter file has a corresponding entry in the landscape group XML file.

```
<?xml version="1.0"?>
<sweep runs="1">
        <parameter name="randomSeed" type="constant" constant_type="number" value="1"/>
        <parameter name="runNumber" type="constant" constant_type="number" value="1"/>
        <parameter name="msgOutLevel" type="constant" constant_type="number" value="0"/>

        <parameter name="dataFolderName" type="constant" constant_type="string" value="../SLUCEII_AAG/sluce.aag/"/>
        <parameter name="resutlsFolderName" type="constant" constant_type="string" value="../SLUCEII_AAG/sluce.aag/data/"/>
        <parameter name="landscapeGroupXMLFile" type="constant" constant_type="string" value="config/aag.xml"/>
        <parameter name="logFileName" type="constant" constant_type="string" value="log/runLog_AAG.csv"/>
        <parameter name="paramOutputControlXML" type="constant" constant_type="string" value="param_control.xml"/>

        <parameter name="referenceLayerIndex" type="constant" constant_type="number" value="211"/>
        <parameter name="parcelIDLayerIndex" type="constant" constant_type="number" value="211"/>
        <parameter name="landUseTypeLayerIndex" type="constant" constant_type="number" value="212"/>
        <parameter name="distanceLayerIndex" type="constant" constant_type="number" value="111"/>
        <parameter name="finalPriceLayerIndex" type="constant" constant_type="number" value="213"/>
…….
</sweep>
```

Batch Parameter File

```
<?xml version="1.0" encoding="utf-8" ?>
<LandscapeLayerGroup ID="1" Name="LMM Landscape Layers">
	<LandscapeLayerGroup ID="11" Name="Environmental and Physical Layers">
		<LandscapeLayer ID="111" Type="Raster">
			<LayerName>Distance to Downtown</LayerName>
			<StoragePath>/users/sluce2/Release/SLUCEII_LMM/SLUCEII_AAG/sluce.aag/data/dist_c.txt</StoragePath>
			<Scale>
				<width>1024</width>
				<height>1024</height>
			</Scale>
			<DataType>Float</DataType>
		</LandscapeLayer>
	</LandscapeLayerGroup>

	<LandscapeLayerGroup ID="21" Name="Land Use Layers">
		<LandscapeLayer ID="211" Type="Raster">
			<LayerName>Parcel ID Layer</LayerName>
			<StoragePath>/users/sluce2/Release/SLUCEII_AAG/SLUCEII_AAG/sluce.aag/data/pin.txt</StoragePath>
			<Scale>
				<width>1024</width>
				<height>1024</height>
			</Scale>
			<DataType>Integer</DataType>
		</LandscapeLayer>

		<LandscapeLayer ID="212" Type="Raster">
```

```
                <LayerName>Land Use Type Layer</LayerName>
                <StoragePath>/users/sluce2/Release/SLUCEII_AAG/SLUCEII_AAG/sluce.aag/data/lu_s.asc</StoragePath>
                <Scale>
                        <width>1024</width>
                        <height>1024</height>
                </Scale>
                <DataType>Short</DataType>
        </LandscapeLayer>

        <LandscapeLayer ID="213" Type="Raster">
                <LayerName>Transaction Price Layer</LayerName>
                <StoragePath>/users/sluce2/Release/SLUCEII_AAG/SLUCEII_AAG/sluce.aag/data/tprice.asc</StoragePath>
                <Scale>
                        <width>1024</width>
                        <height>1024</height>
                </Scale>
                <DataType>Float</DataType>
        </LandscapeLayer>

    </LandscapeLayerGroup>
</LandscapeLayerGroup>
```

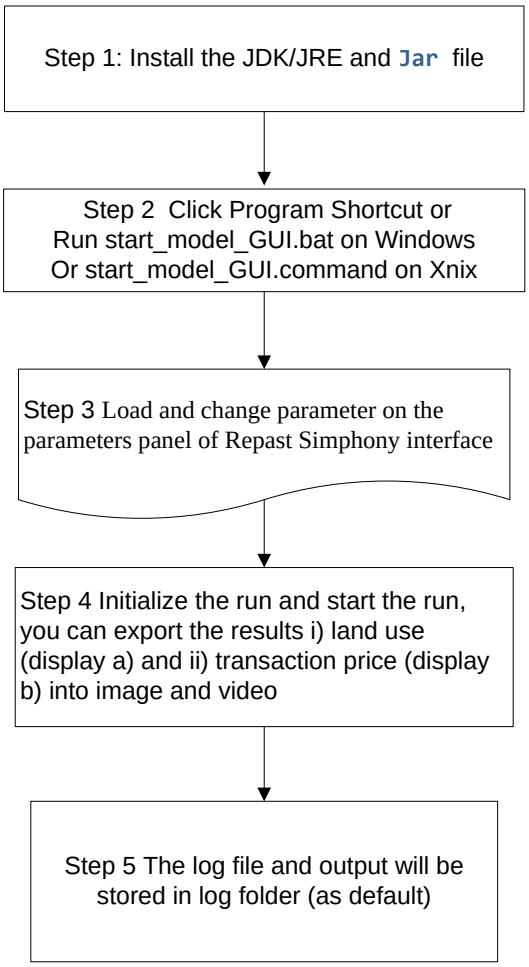
Landscape Group XML File

3.2 Run the Model

It does not need many words for running the model on Windows. Just double click the command file or run start_model.bat on command line (cmd.exe). For Linux/Unix/Mac OS, you need to run the model using "bash start_model.command ./". Depending on the type of your user account and the shell environment, you may not need to include "bash" in the command line. Accordingly, you might need to change 1 to 0 of the line `PWD="${0%/*} in` start_model.command file if no bash needed. The ./ means current folder. If you start the program from another location, replace ./ with the name of the folder that contains "SLUCEII_LMM" folder. For example, "`bash start_model.command /Users/Adam/Program/SLUCE2_LMM`". Another useful command for Linux/Unix/Mac OS is "nohup". When you run a time-consuming simulation, "nohup" will run the program in background. Even if you log out the system, the program is still running. Simply use "`nohup bash start_model.command ./ &`" to start the model in background.

4. GUI Mode

The Repast Simphony GUI mode has a standard user interface that allows users setting parameters and examining model output. As it is a little bit painful to input the parameters through the Repast Simphony interface, we recommend using the batch run to do large-scale experiments. If you do run the GUI version, some parameters are pre-defined in the program; but you can change others using the parameters panel.



You can run **start_model_GUI.bat** for Windows platform or **start_model_GUI.command** for Linux/Unix system. You can set your own experiment parameters in the Parameters panel. These parameters can be saved in a XML file using **Tools→Save Parameters**. To load predefined parameters from such a XML file, Click **Tools→Load Parameters** on the Parameters panel of Repast Simphony interface.

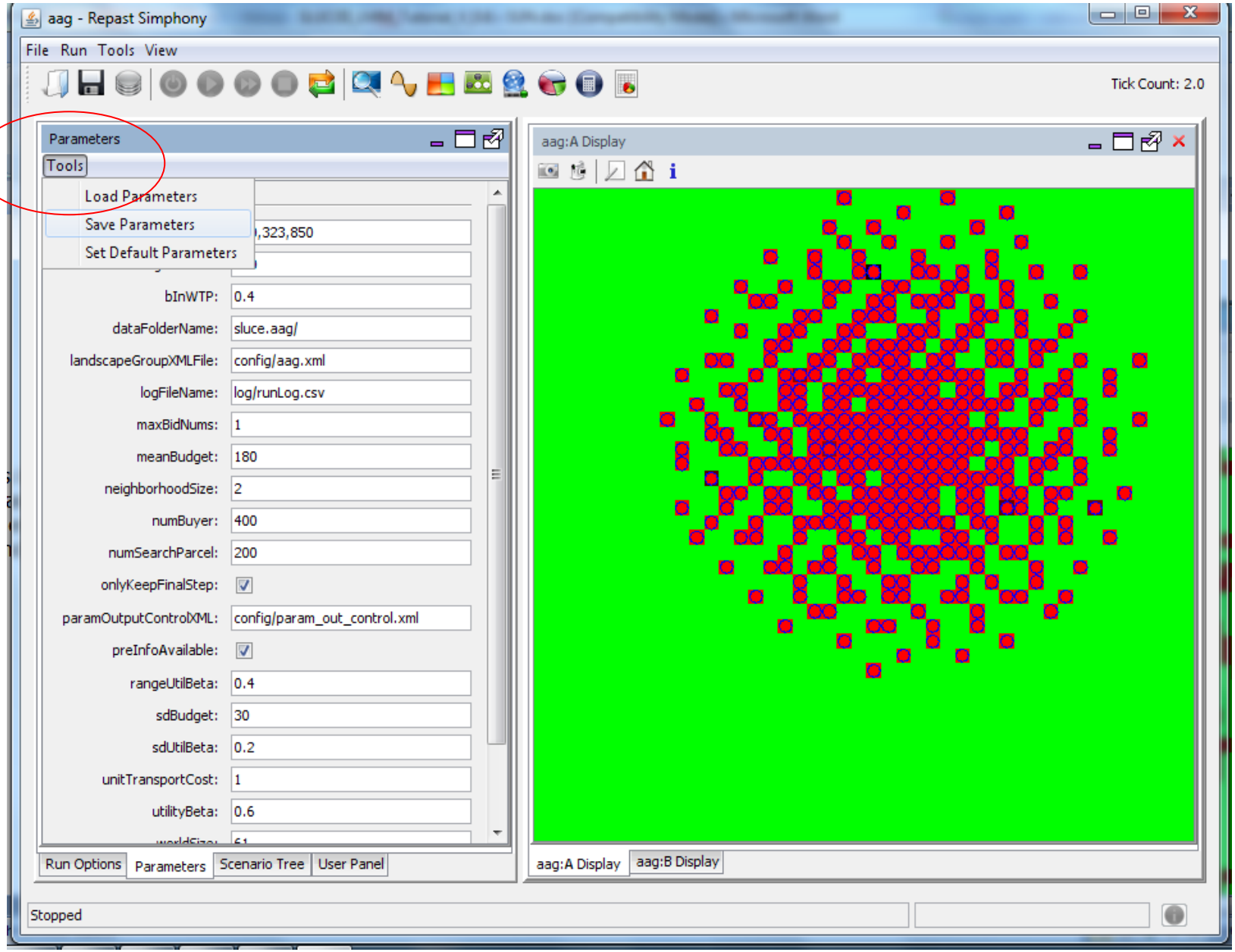
Parameter Setting*:* see section 3.1 and FAQ table 1. Make sure the folder "dataFolderName"/data exists and is writable. Similarly, make sure the folder "dataFolderName"+ "logFileName" exists and is writable too. For example, if you set the dataFolderName as "C:\Works\John\LMM", then you should have a folder "C:\Works\John\LMM\data" In addition, you must make the "C:\Works\John\LMM" folder writable because SLUCE_LMM will save output data there. One easy way to do this is to copy the whole "sluce.aag" folder to your own working folder, say C:\workspace and then change the dataFolderName to "C:/workspace/sluce.aag". In addition, update the StoragePath field in config/aag.xml to the new folder. For example, change "./sluce.aag/data/lu_s.asc" to "C:/workspace/sluce.aag/data/lu_s.asc". SLUCEII LMM will then save the output data in C:/workspace/sluce.aag/data folder

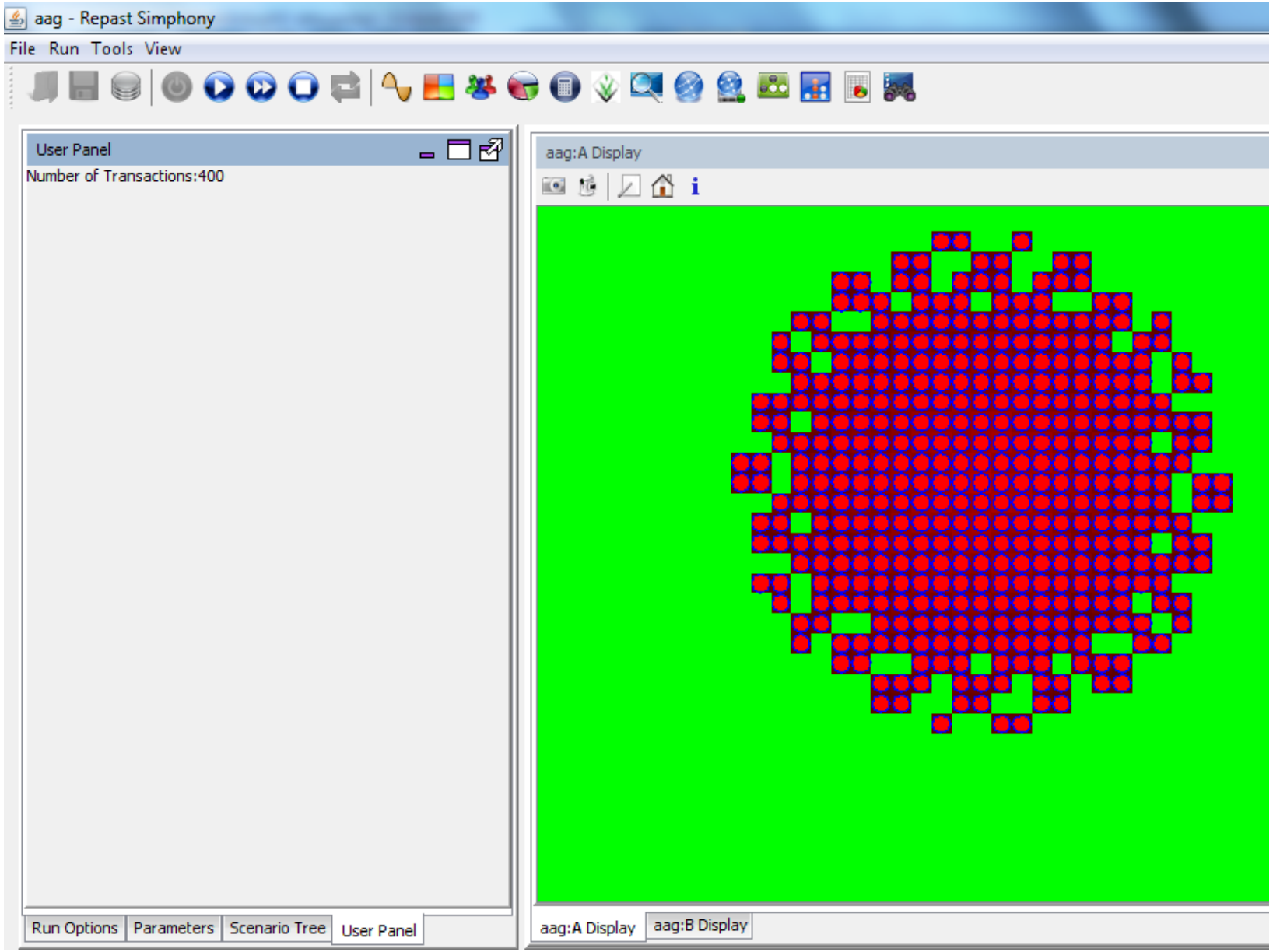
After setting the parameters, you should initialize the model first by clicking on "Initialize Run"  . Then you can either run the model step by step  or just let it run  .

GUI control:

- ✓ to zoom in/out, scroll mouse wheel;
- ✓ to pan the display, hold down the right button of mouse and drag;
- ✓ to show values of agents and layers, double-click on them.

In addition, using "Color Setting" parameter in the parameter setting panel, you can choose colors for the simulated land use maps. 0 is grey scale, 1 is blue to red, 2 is red to blue, and 3 (default) is a variant of blue to red.


aag - Repast Simphony
File Run Tools View
Tick Count: 2.0
Parameters
Tools
Load Parameters
Save Parameters
Set Default Parameters
,323,850
bInWTP: 0.4
dataFolderName: sluce.aag/
landscapeGroupXMLFile: config/aag.xml
logFileName: log/runLog.csv
maxBidNums: 1
meanBudget: 180
neighborhoodSize: 2
numBuyer: 400
numSearchParcel: 200
onlyKeepFinalStep:
paramOutputControlXML: config/param_out_control.xml
preInfoAvailable:
rangeUtilBeta: 0.4
sdBudget: 30
sdUtilBeta: 0.2
unitTransportCost: 1
utilityBeta: 0.6
Run Options
Parameters
Scenario Tree
User Panel
aag:A Display
aag:A Display
aag:B Display
Stopped


aag - Repast Simphony
File Run Tools View
User Panel
Number of Transactions:400
Run Options
Parameters
Scenario Tree
User Panel
aag:A Display
aag:A Display
aag:B Display

5. Run the Model on a Cluster

SLUCE2-LMM has created a generic RepastSimphony adaptor for GridSweeper developed by XXX at the University of Michigan. We also created bash scripts that can start the GridSweeper on Linux/Unix. There are several key steps that are required to run SLUCEII LMM on a cluster.

First, make sure the cluster is based on DRMAA. Currently, SLUCEII LMM only supports DRMAA (http://drmaa.org/). Additionally, install GridSweeper and the RepastSimphony adaptor. GridSweeper is created by Ed Baskerville (gridsweeper@umich.edu) and RepastSimphonyAdapter is implemented by Shipeng Sun.

Then, create a GridSweeper experiment file. Several example files are available in the 'batch' folder of the SLUCEII LMM package.

Third, set values for parameters in the experiment file. Particularly important are ResultsDirectory, RepastSimphonyJarPath, ScorePath, and ParameterTemplate.

Fourth, create the parameter template file. This file is a standard batch parameter file for Repast Simphony, but with all parameters be constants. Make sure the parameter names in the GridSweeper experiment file are exactly same as those in the template file. Values in the experiment file will replace values in the batch parameter file. This is where GridSweeper hooks up with Repast Simphony.

Last, run the experiment using "`gsrepast [path/]experiment_file.gsexp`".

6. Model Output

The model will keep updating the land use type file (output file name starting with "lu_s_") and the final transaction price file (file name starting with "tprice_"), all in ESRI ASCII raster format. The file names will add date/time (year_month_day_hour_minute_second_millisecond) and model step stamped (_step number). All information is saved in the log file specified in the parameter file. For GUI mode, the model also exports transactions records (file name starting with "trans").

7. Output Analysis

Some R programs have been developed to analyze model outputs. For more details, please contact team members (Shipeng Sun and Qingxu Huang).

8. FAQ

8.1 What does the parameters in the batch xml stand for?

See Table 1 SLUCEII-LMM Model Parameters.

8.2 Do we need to install Repast Simphony or Java to run the model?

To run SLUCEII-LMM, Java SDK or JRE 1.4 or above is required. Repast Simphony components have been included in the installation package. You do NOT need separate Repast Simphony installed. See part 2.

8.3 How to set up an experiment?

Step 1: Prepare your parameter setting file and put it into the batch folder.

You can make your own batch parameter file which determine the parameters setting. For explanation of every parameter included in the batch parameter file, you can check the appendix table. First of all, you can specify folder names and paths for input data and output data. Then you can set your parameter combinations for sweeping. If the parameter is constant in your setting, you can use the constant type, for example <parameter name="xxxx" type="constant" constant_type="number" value="1.0f"/> or <parameter name="xxxx" type="constant" constant_type="boolean" value="true"/>. If the parameter is non-constant, you can either use the list type, for example, a three components list <parameter name="xxxx" type="list" value_type="float" values="1.0f 2.0f 3.0f"> ….other non-constant parameters </parameter>, or the step list type, for example, a 100 steps list <parameter name="xxxx" type="number" start="1.0f" end="100.0f" step="1.0f">..... other non-constant parameters </parameter>.

- You need to make sure that the parameters inside list or step list are also non-constant even though it can be a list with only constant one value. For instance, you can add <parameter name="xxxx" type="list" value_type="int" values="1"></parameter> inside the list and it works as a constant parameter.
- Another thing you need to be cautious is that the randomSeed parameter can just be set as int values, the float values may cause the batch runs failed

Step 2: Change the last line of start_model.bat file to point to your own batch xml file

Step 3: Run the start_model.bat and check the log file and output data folder for results.

8.4 Where can I get history and the latest news on SLUCEII model?

Table 1 SLUCEII-LMM Model Parameters

Name	Role	Domain	Type
randomSeed	The seed used to generate a series of random numbers.		Integer
runNumber	(only for cluster) the run number on a specific node		Integer
msgOutLevel	Level of verbosity of messages. Higher number will allow more messages.		Positive Integer
dataFolderName	Input data folder path		String
resutlsFolderName	(only for cluster) Output data folder path		String
landscapeGroupXMLFile	Path for landscape group XML file		String
logFileName	Log file path		String
paramOutputControlXML	An XML file controlling which parameters will be included in log file		String
exportTransactionRecords	If export transaction records for each run		Boolean
referenceLayerIndex	Extract the dimension and scale of the space		Integer
parcelIDLayerIndex	Record the parcel ID		Integer
landUseTypeLayerIndex	Record land use type (0 agricultural/not developed; 1 urban/developed)		Integer
distanceLayerIndex	Distance to CBD		Integer
finalPriceLayerIndex	Final transaction price layer		Integer
worldSize	The size of abstract world	Input	Integer
worldXCenter	The index of the landscape center	Input	Integer
worldYCenter	The index of the landscape center	Input	Integer
numBuyer	Number of buyers	Input	Integer
numSeller	Number of sellers	Input	Integer
sellDecisionUpperBound	How many sellers will participate in market	Input	Double

buyDecisionUpperBound	How many buyers will participate in market	Input	Double
maxBidding Tries	How many times a buyer try to bid	Input	Integer
onlyKeepFinalStep	Control if the intermediate results will be kept or only final step.	Input	Boolean
unitTransportCost	Transport cost for each unit	Input	Constant
neighborhoodSize	The neighborhood size	Input	Constant
preInfoAvailable	Agent has preference	Input	Boolean
excludeCenterInNeighborhood	Exclude the center in neighborhood calculation	Input	Boolean
bInWTP	The constant b in WTP calculation	Input	Float
meanBudget	Average budget of buyers	Input	Float
sdBudget	Standard deviation of budget distribution	Input	Float
numSearchParcel	Number of parcels searched by buyers	Input	Integer
maxBidNums	Maximum bid numbers a seller accepts	Input	Integer
agResPrice	Price for agriculture land	Input	Integer
utilityBeta	The preference parameter beta in utility calculation	Input	Float
sdUtilBeta	Standard deviation of preference (beta) distribution	Input	Float
rangeUtilBeta	The range preference parameter beta can vary	Input	Constant
Output			
	Transaction price map	Output	Raster
	Land use map	Output	Raster
	Statistics of transaction price (mean, maximum, minimum)	Output	Numeric
	Statistics of transportation cost	Output	Numeric
	Transaction records (seller, buyer, parcel ID etc.)	Output	File
	Landscape metrics (patch number, edges, edge density, fractal dimension)	Output	Numeric