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Dissertation Submitted to Hangzhou Dianzi University
for the Degree of Master

Computational Experiment Study on the Evolution of the Electronic Waste Recycling Processing Channel

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Supervisor: Prof.Yu Fumao

A.P.Wei Jie

March, 2016

( )

Agent

RePast Agent

1

2

Agent

[redacted]

government encourages the development of formal recycling enterprises, providing financial subsidies or technical supportand encouraging technology investment of formal recycling enterprises. It may be more favorable for the regulation of recycling channels when the government control and suppress the recycling of irregular small tradersand help them turn to d.

When the number of small vendors cut down, irregular recycling channels can not afford the convenience for citizens, then consumers will turn to formal recycling channelseventually.

Based on computational experiment results, It puts forward five policy recommendations for the government and other relevant management departments in order to accelerate the ecologicalization and regularization development of e-waste recycling and processing channels .

Key words: Electronic waste, Computational experiment, Channel evolution, Agent

1

1.1

1.1.1

electronic waste

2020

926.9×10^4t 11.4%[1]

[2]

1.1

1.1

Pb	
Hg	
Cr	DNA
Al	Alzheimer
Cd Y	

1.2

80%

[3]

1.2

1.1.2

1

2

1.2

1.2.1

[4]

Agent

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2

3

1.2.2

- - -

Agent

1

2

Agent

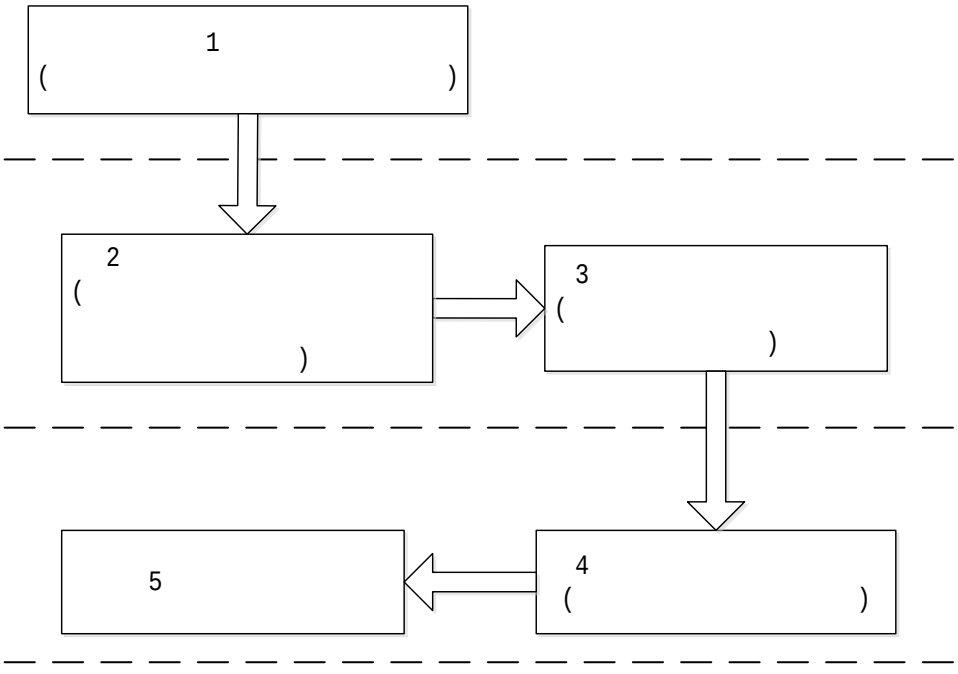
3 Agent

Agent

4 Agent

5

1.1



1.1

1.3

1.3.1

1

2

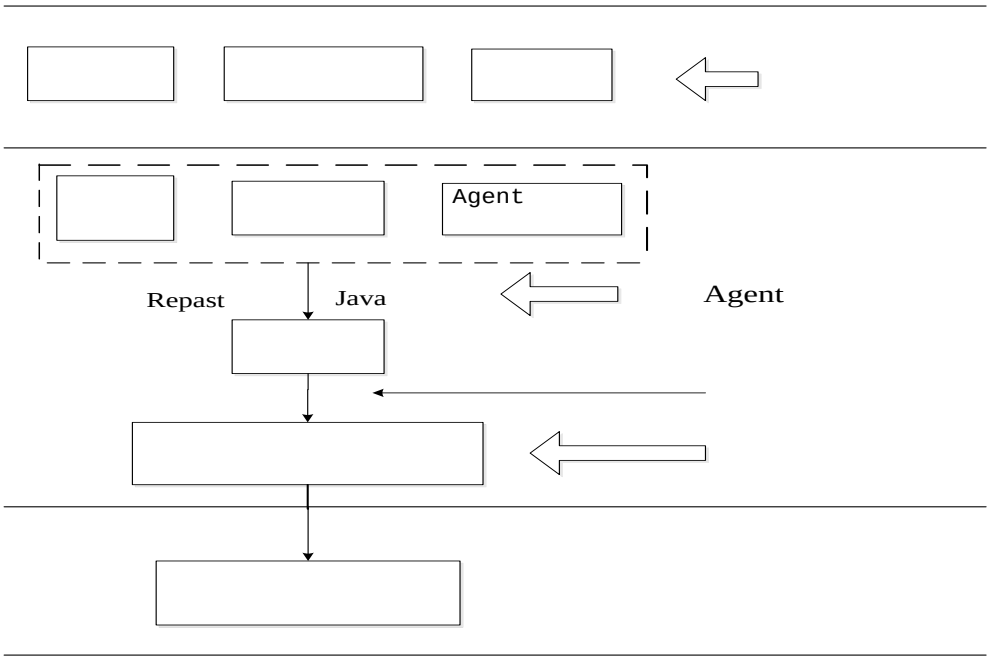
3 Agent

Agent

4

1.3.2

1.2



1.2

2012 7

[6]

106 1.27 / [6]
2013 4756 39.35
20
100 [7-8]

[8]

2.1.2

2010

[9]

[10]

Yang 2008

[11]

Savaskan 2006

[12] Webster

2007

[13]

Toyasaki 2010

[14] 2013 1

1

[15] 2014

[16]

2009

3

[17] 2012

[18]

Gu Qiaolun 2008

3

[19] 2010

[20] 2011

[21] 2012

[22] Hong 2012

[23]

2015

[24] 2015

3

3

3 [25] 2015

4

[26]

Wee 2011

[27] Dat

2012

[28]

4

2.2

2.2.1

Carter 1998 4

[29]

Mitra 2008 Lau Wang 2009 Aksen 2009 [30-32]

2008

[33] 2008

[34] 2009

[35]

2014

[36] 2014

5

[37]

EPR Extended Producter Responsibility

Klausner 2000 EPR

[38]

Nixon 2007

logistics

[46] 2009

Logistic

3

[47] Seunghae 2011

[48] Wang 2011 Logistic

[49] Saphores 2012 Logit 2136

[50] Song 2012 Logistic

[51] Li 2012 [52]

2009

[53]

2011

[54] 2012 317

[55] 2013

[56]

2.2.3

Lindhqvist 2003

[57] 2007

3

[58] Deniz Aksen 2009

[59] 2009

[60] Yabar

2013

[61] 2014

Stackelberg

[62] 2015

[63]

2013

EPR

[64]

Logistic

2.3

1

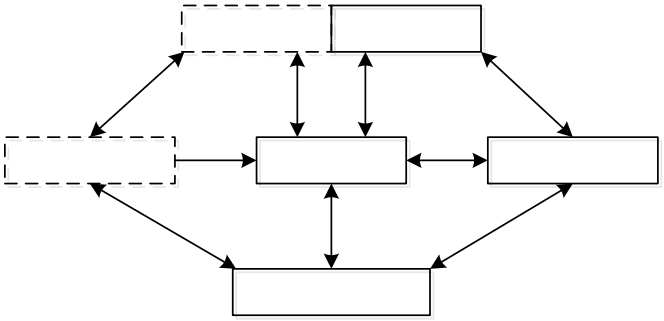
2

3

4

2.4

[65] 2.1



2.1

5

[66]

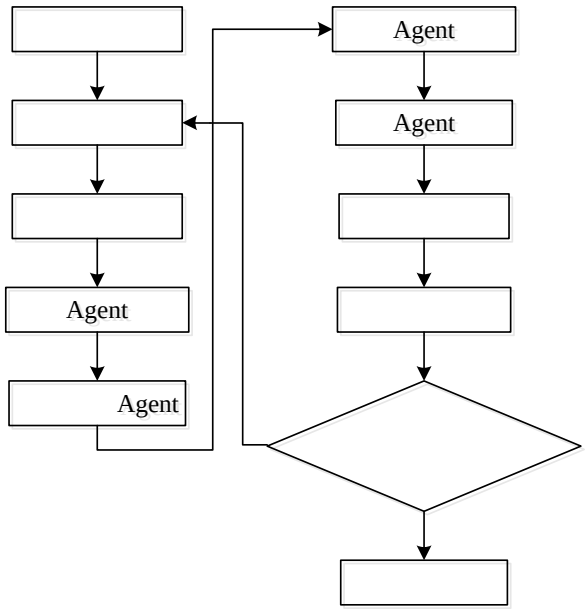
3 [66] 2.2

2.2

2.4.1

ABMS Agent-Based Modeling and Simulation Agent

2.3



2.3 ABMS

ABMS [73]

[74]

2.4

2.4 ABM

ABMS

Agent

Agent [75]

Agent

Agent Agent

ABMS

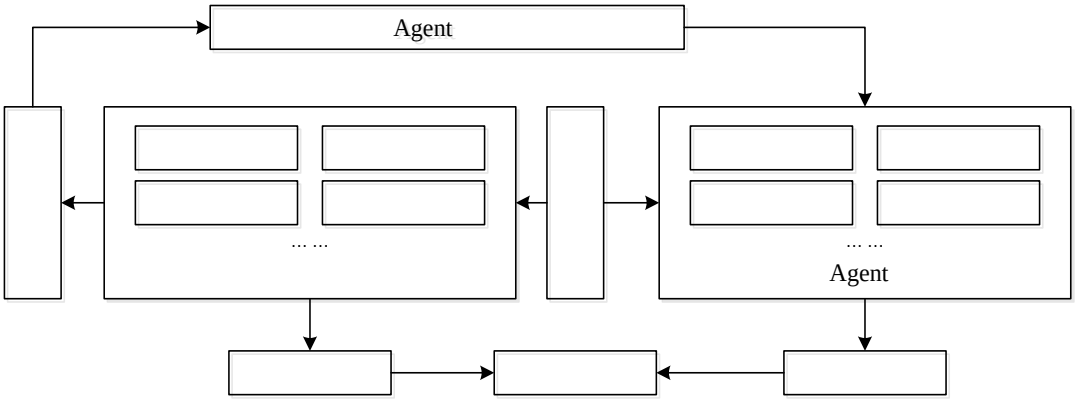
ABMS

Agent

Agent

Agent

2.4



2.4 Agent

2.4.3

Agent

[76]

2008 CAS ABMS

[77] 2008 Agent

[78] 2009

Agent

[79]

2010

[80]

2010 Agent

Agent

[81] 2010

[82] 2011

[83]

Zhang 2011

Netlogo [84] 2012

[85]

2012 NetLogo

[86]

2015 Agent

[87]

Agent

[88] 2009 2010

[89-90]

Agent

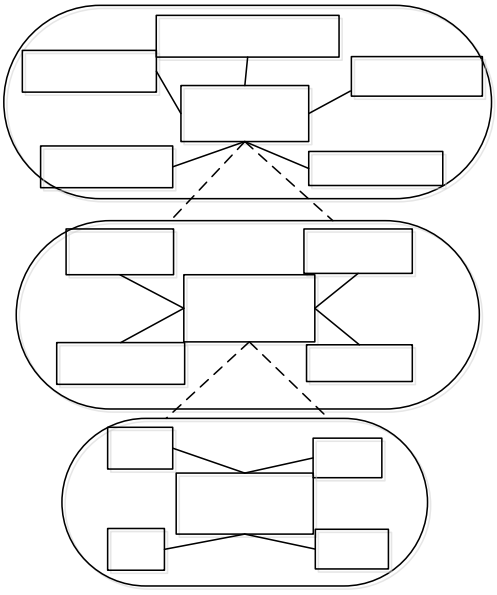
CAS

ABMS

3

3.1

3.1



3.1

3.1.1

[66,93]

[94]

3.1.3

[66]

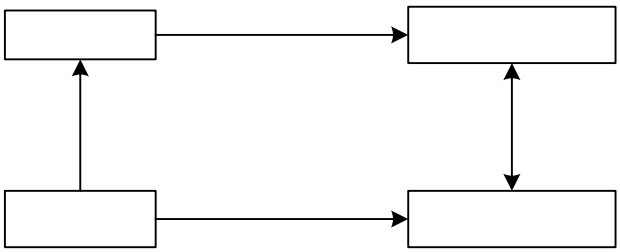
[95]

3.2

3.2.1

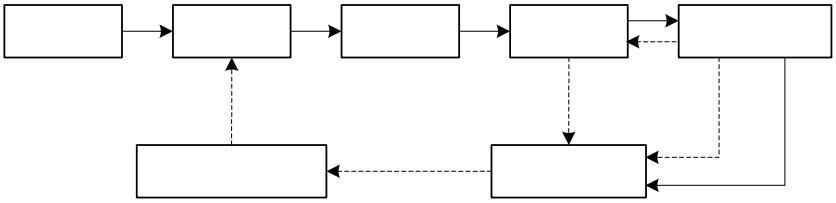
Agent

3.2



3.2

Agent Agent Agent
Agent Agent Agent Agent Agent
3.3



3.3

1 Agent
Agent

[96]

2 Agent
Agent

[92]

3 Agent

Agent

[92,97]

4 Agent

Agent

5 Agent

Agent

6 Agent

7 Agent

Agent

8 Agent

Agent

[98]

80%

3.2.2

Agent Agent

Agent Agent

1

8 r

Agent

Agent α Agent

Agent

2 Agent

3

4

5 $T=50$ t $t=1,2,...,50$

3.1

3.1

r	Agent
Cu_t	Custmer
P_t	
$1-P_t$	
α	
Pe_t	Pedlar
En	Enterprise

Q^p_t
Q^e_t
p^p_t
p^e_t
c^p_t
c^e_t
s^p_t
s^e_t
En_t
R^p_t
R^e_t
b_t
a_t

3.3

Agent

3.3.1 Agent

1 Agent

t Cu_t

P_t

$1-P_t$ 4

T

$$P_t = f(p_t, Pe_t, \alpha, h_{t-1}) \quad 3.1$$

5 3

Pe_t r Agent α

$0 < \alpha < 1$

h_{t-1} T

$P_t > 0.5$

2 Agent

/ / /

$$\pi_{Pe_t} = \frac{R^p{}_t}{(p^p{}_t + c^p{}_t) * Q^p{}_t} \times 100\% \quad 3.2$$

$$R^p{}_t = (s^p{}_t - p^p{}_t - c^p{}_t) * Q^p{}_t \quad 3.3$$

π_{Pe_t} $R^p{}_t$ t

18% 3

25%

3.4

$$\begin{cases} \pi_{Pe_t} \le 25\% \\ \pi_{Pe_t} > 25\% \end{cases} \quad 3.5$$

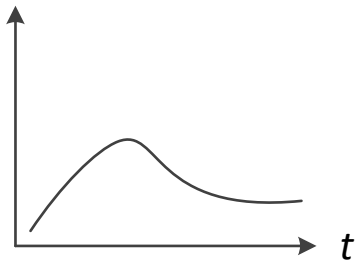
t Pe_t $t+1$

$$Pe_{t+1} = Pe_t + Pe^{-} - Pe \quad 3.6$$

3 Agent

$c^e{}_t > c^p{}_t$

3.4



3.4

$$t \quad \frac{R^e_t}{(p^e_t + c^e_t) * Q^e_t} \qquad 3.7$$

$$R^e_t = (s^e_t - p^e_t - c^e_t) * Q^e_t \qquad 3.8$$

π_{En_t} R^e_t t

20%

5%

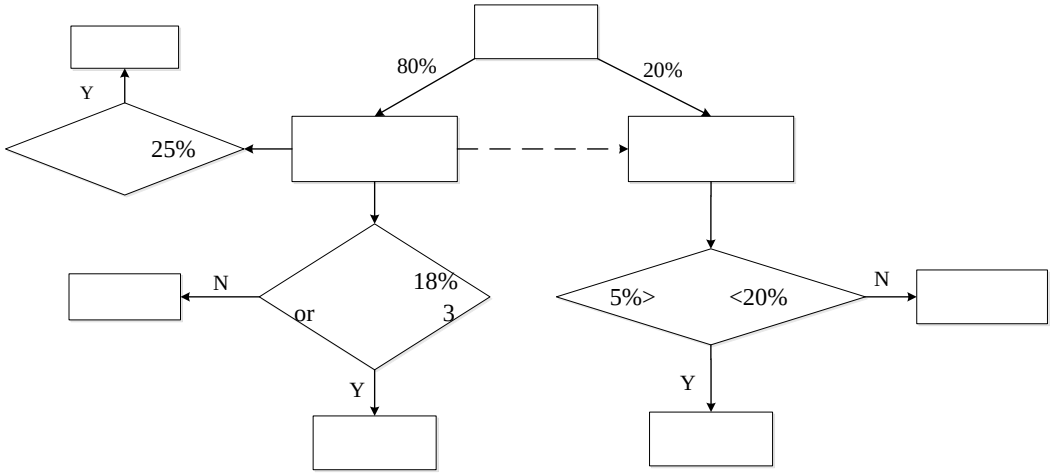
5%-20%

1.5%[98]

4 Agent

80% 20%

a_t



3.5 Agent

Agent

Agent Agent Agent Agent

Agent

Agent

Agent Agent

Agent

Agent

Agent

3.4

Agent Agent

$P_t > 0.5$

T

18%

3

25%

5%-20%

4

Agent Swarm NetLogo Ascape RePast

RePast Model Space Agent

4.1 Agent

4.1.1

Swarm NetLogo Ascape RePast

4.1

4.1 ABMS

	Swarm	NetLogo	Ascape	RePast
	SFI			
	Windows,Mac,Unix	Windows,Mac,Unix	Windows,Mac,Unix	Windows,Mac,Unix
	Java Objective C	Logo	Java	Java Python C#

Agent

Swarm SFI Swarm

Objective-C Swarm

Swarm

NetLogo 1999

Ascape The Brookings Institution

Java

Agent

Agent

Agent Agent Agent

RePast Recursive Porous Agent Simulation

Java [99]

RePast

Java C# Python

Eclipse Java

RePast Eclipse Agent

4.1.2 RePast

RePast uchicogo.src.sim Agent

[100] 4.2

4.2 RePast

engine	RePast RePast
analysis	1. 2.
network	Agent
space	Agent gui Agent RePast Multi2DGrid
gui	Agent RePast

Model RePast

4.3

4.3

main			RePast
setup	RePast	setup	
begin			

Agent Agent Agent Agent

Repast Eclipse Java Java

4.2.1

RePast [100] Model

Space Agent

Agent Space Agent

Eclipse Ewaste src demo demo 3 Java EwasteModel EwasteSpace EwasteAgent Model SimModelImpl getName 4.2

```
EwasteModel.java | EwasteSpace.java | EwasteAgent.java
package demo;

import uchicago.src.sim.engine.Schedule;
import uchicago.src.sim.engine.SimModelImpl;

public class EwasteModel extends SimModelImpl{

    public String getName(){
        return "Ewaste Recycling";
    }
```

4.2

begin begin buildModel buildSchedule buildDisplay 3 4.3

EwasteModel.java EwasteSpace.java EwasteAgent.java

```
    }
    public void begin(){
        buildModel();
        buildSchedule();
        buildDisplay();
    }
    public void buildModel(){

    }
    public void buildSchedule(){

    }
    public void buildDisplay(){

    }
```

4.3 begin

3

setup getSchedule() Schedule

getInitParam get set

4.4 4.5

EwasteModel.java EwasteSpace.java EwasteAgent.java

```
package demo;

import uchicago.src.sim.engine.Schedule;
import uchicago.src.sim.
```

4.4 setup

```
    public Schedule getSchedule(){
        return schedule;
    }
    public String[] getInitParam(){
```

4.5 getSchedule getInitParam

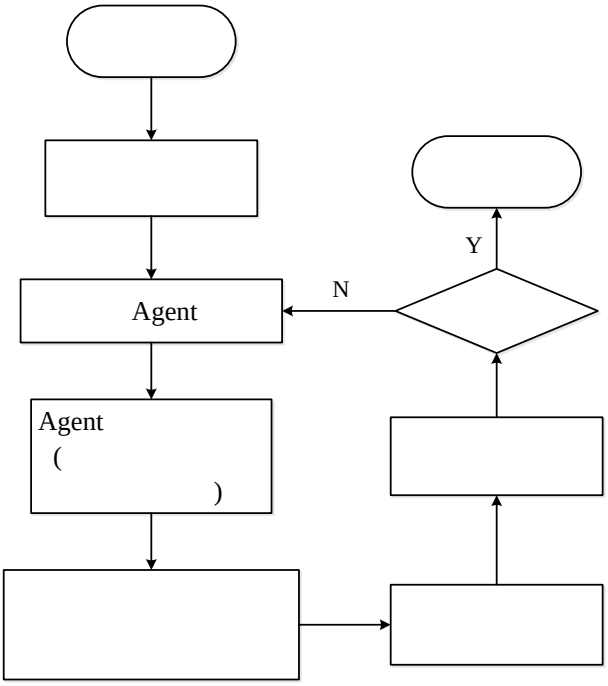
main SimInit

4.6

```
public static void main(String[] args) {
    SimInit init=new SimInit();
    EwasteModel model=new EwasteModel();
    init.loadModel(model, "", false);
}
```

4.6

4.7



4.7

4.2.2

2014 7 7 -2014 7 13

34

4.4

3-4 10-20

17

8100 /

4.4

	/
	16.864
	18.296
	13.465
	13.201
	15.929

20 /

3200 / 2013 1993-2010

Stanford 2015 613 [1]

80%

20% [84]

2015

613×80%=490.4

613×20%=122.6

490.4 ÷3200 / =1532

122.6 ÷20 / =6

1532:6 250:1

8:1 5

3 2 4

18%

3

25%

20%

5%

5%-20%

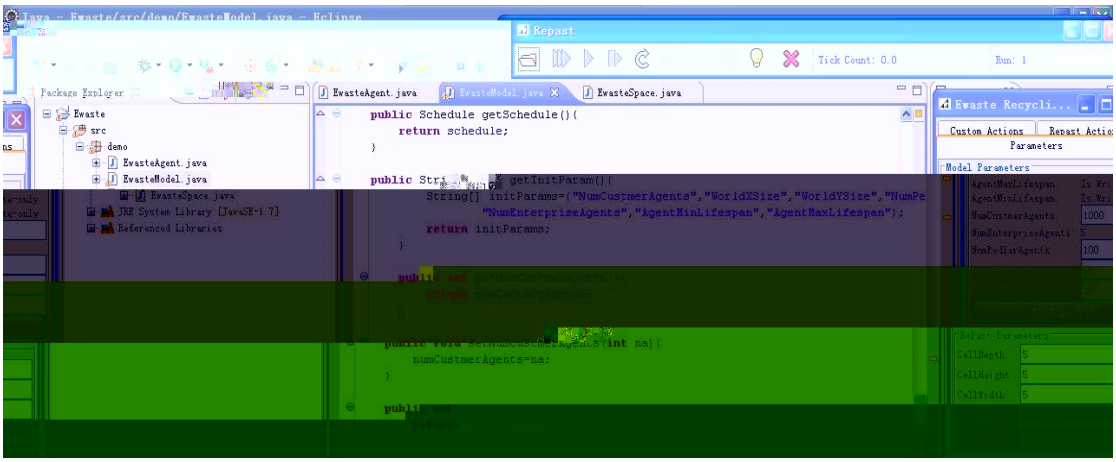
3

4.3

4.3.1

EwasteModel >Run As >Java Application

4.8



4.8

3

main()->setup()->begin()->buildModel()->buildSchedule()-> buildDisplay()->Step()

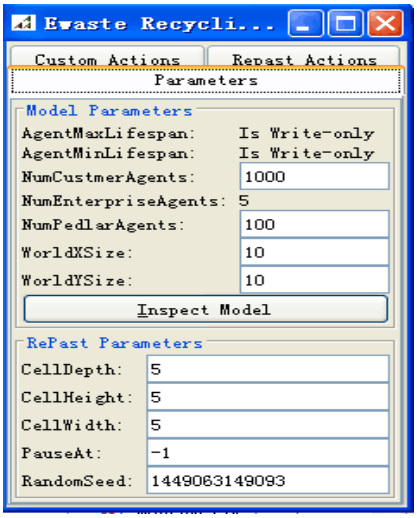
main() setup()

begin() bulldModel() buildschedule() buildDisplay()

Step() Step()

Step()

Parameters 4.9



4.9 Parameters

4.3.2

4.2.2

1 1

1 numCustmerAgents=2000 numPedlarAgents=250 numEnterpriseAgents=1

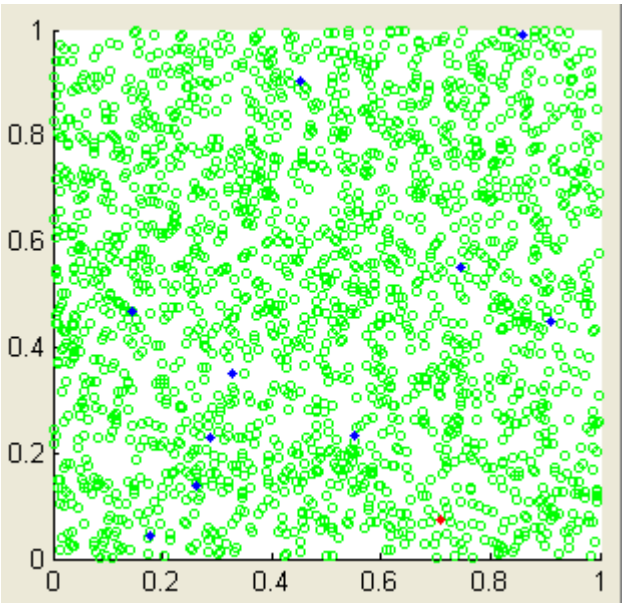
4.10a

4.10b 4.10c Agent Agent

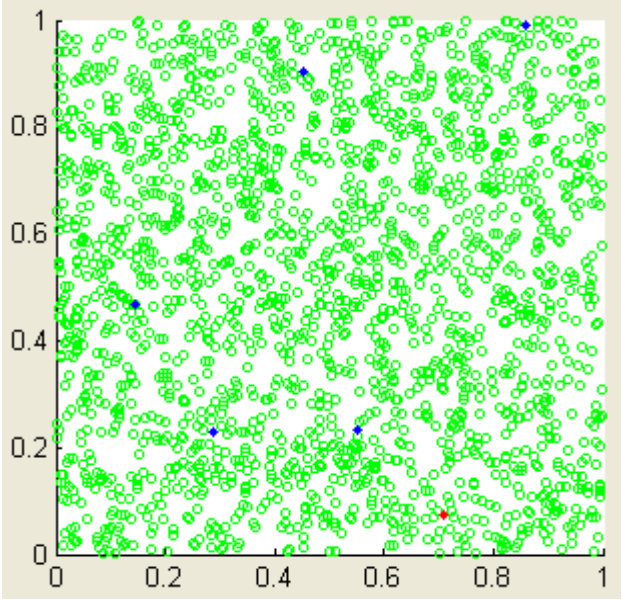
Agent

3

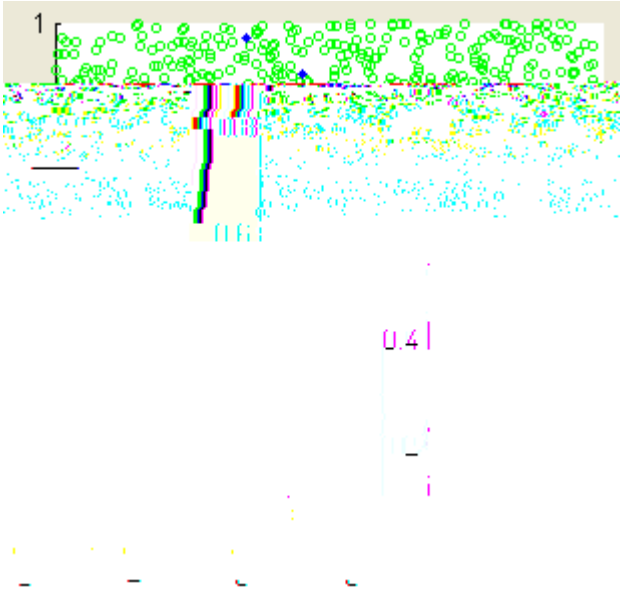
4.10d



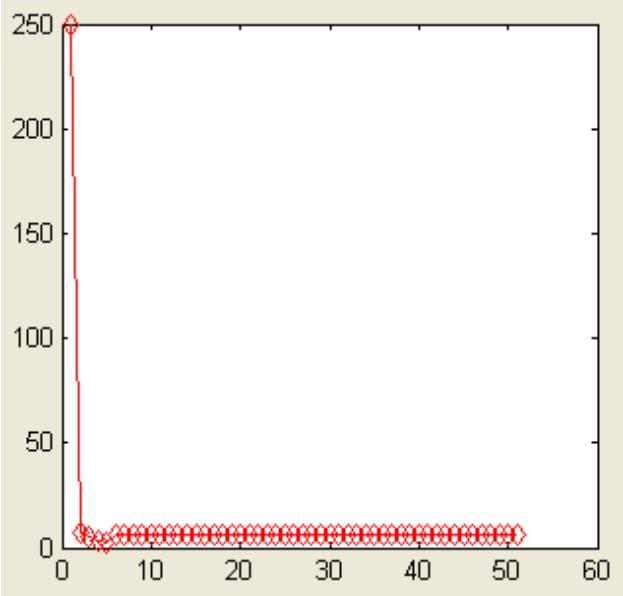
4.10a



4.10b

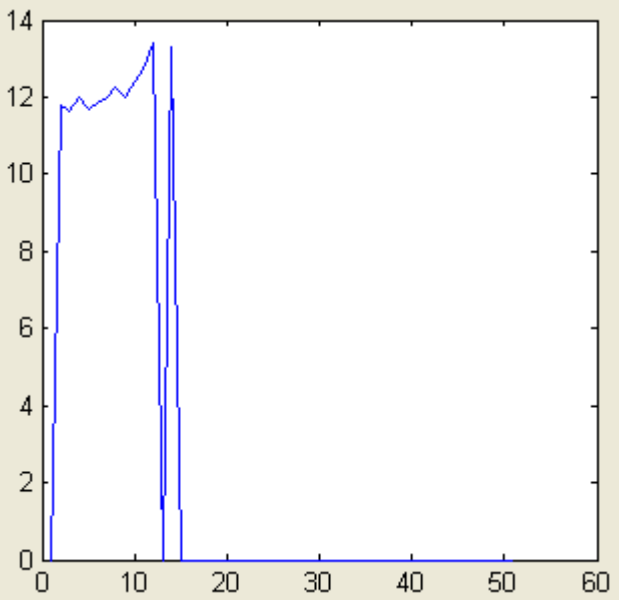


4.10c



4.10d

4.11



4.11

2 2

2 numCustmerAgents=4000 numPedlarAgents=500 numEnterpriseAgents=2

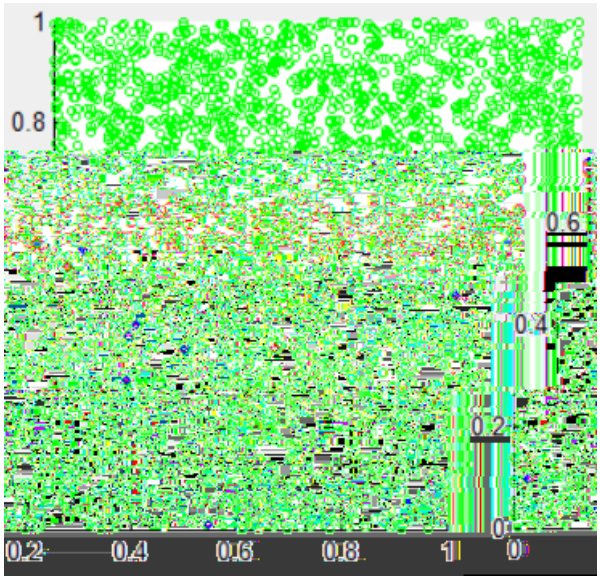
4.12a 4.12b

4.12c 2 1 3

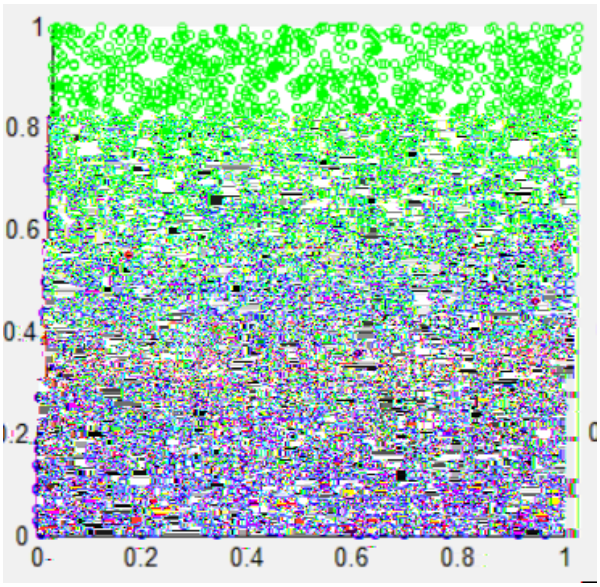
2000

4.12d

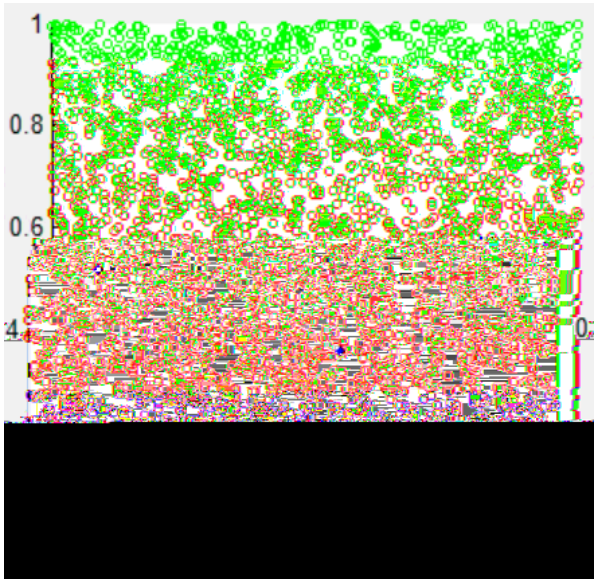
4

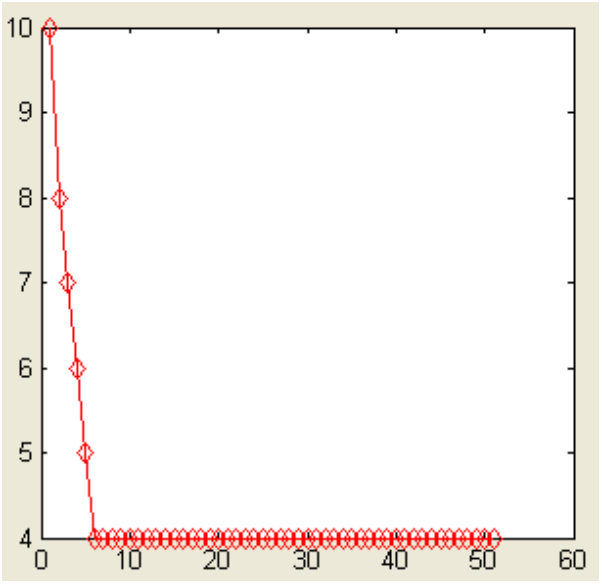


4.12a



4.12b



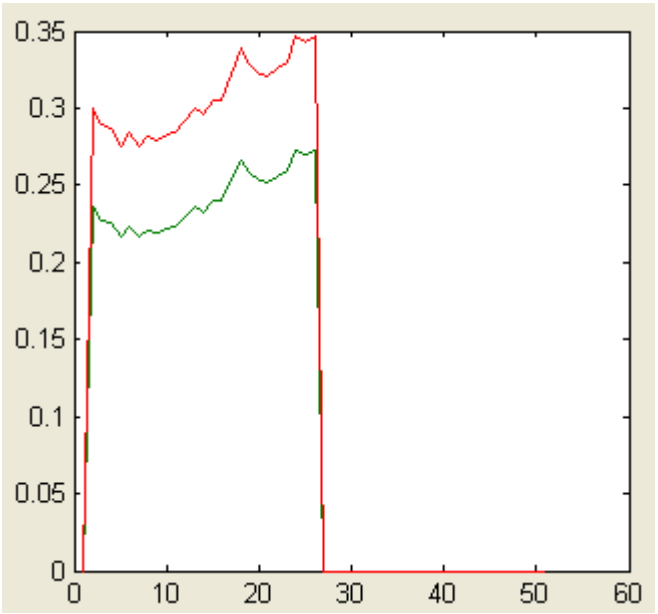


4.12c 4.12d

4.13

3 3~25

25



4.13

3 3

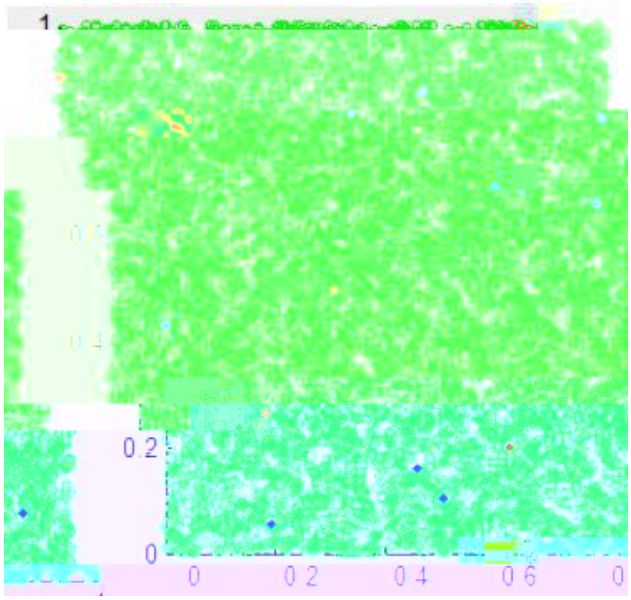
3 numCustmerAgents=9000 numPedlarAgents=1250 numEnterpriseAgents=5

3 4.14a

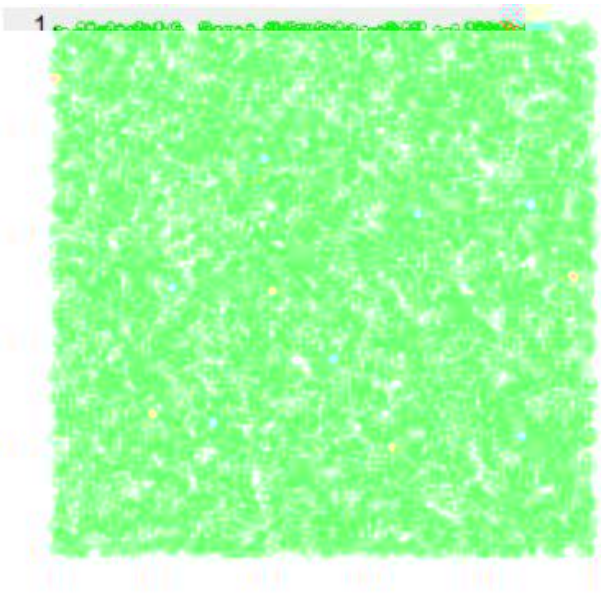
4.14b 4.14c 2 Agent 5000 Agent

750

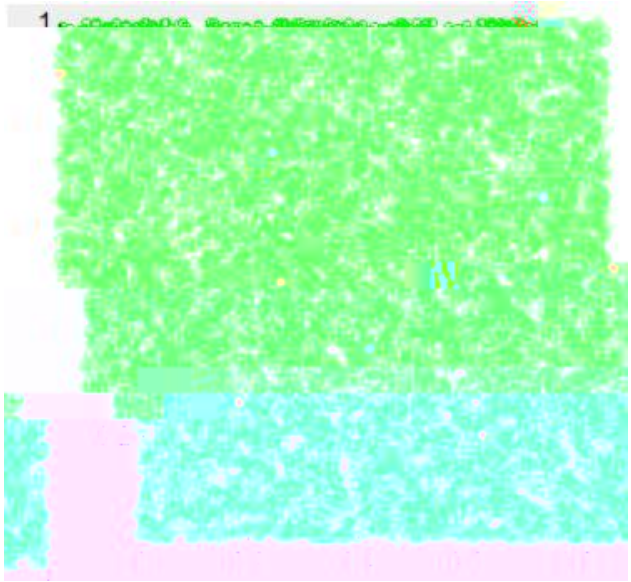
4.14d



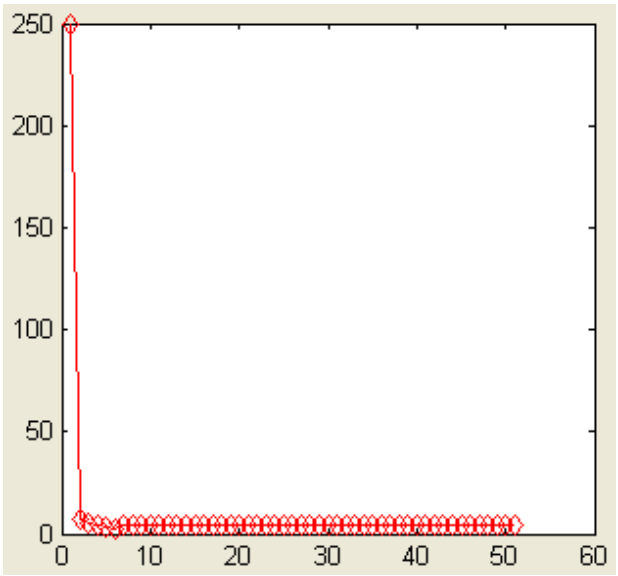
4.14a



4.14b

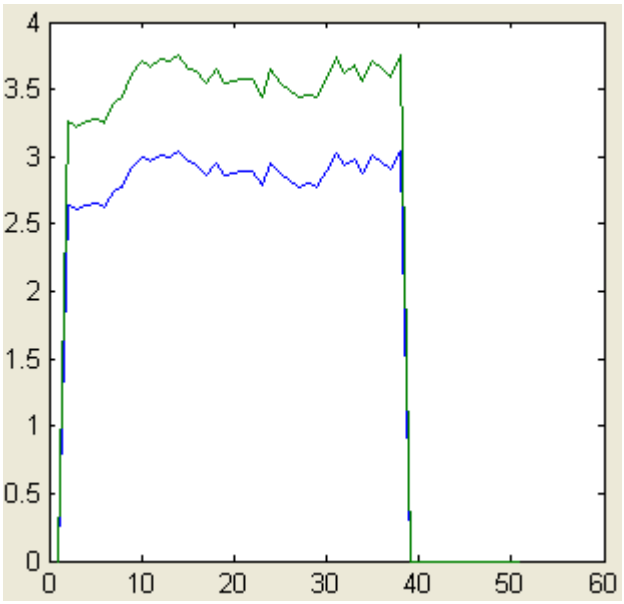


4.14c



4.14d

4.15



4.15

3

4.3.3

1

2

3

4

5

4.4

Eclipse Java

5

5.1

CAS

ABMS

1

2 CAS

3

Agent

3 RePast Agent Eclipse Java

5.2

Agent

1 Agent

Agent

2

9000 1250 5

3

13

[1] , , . [J]. , 2013, 06:195-199.

[2] . [D]. , 2012.

[3] , , . [J]. , 2012, 06:33-36.

[4] , . [J]. , 2014, 10:189-194.

[5] . [D]. , 2013.

[6] , . [J]. , 2014, 03:21-24.

[7] . [J]. , 2014, 12:12.

[8] , , . [J]. , 2014, 04:17-20.

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