GAMING ARTIFICIAL ANASAZI

Applying immersive game design and storytelling to an agent-based model in archaeology

Andreas **Angourakis** *@AndrosSpica* & Shawn **Graham** *@electricarchaeo*

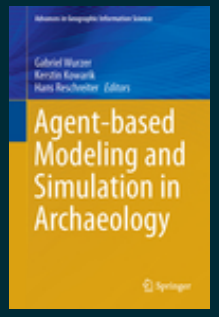
available at https://andros-spica.github.io/TIPC2-Angourakis-Graham-2018/
https://andros-spica.github.io/TIPC2-Angourakis-Graham-2018/index.html?print-pdf (printable version)

click on images to consult source

I

GAMING *SIMULATED* PASTS

Agent-based modelling (ABM) is a relatively extended practice in Archaeology



A few blogs with ABM & Archaeology contents:

- https://archaeologicalnetworks.wordpress.com
- https://simulatingcomplexity.wordpress.com
- https://electricarchaeology.ca

BIG CHALLENGE

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Complicated designs + lack of documentation

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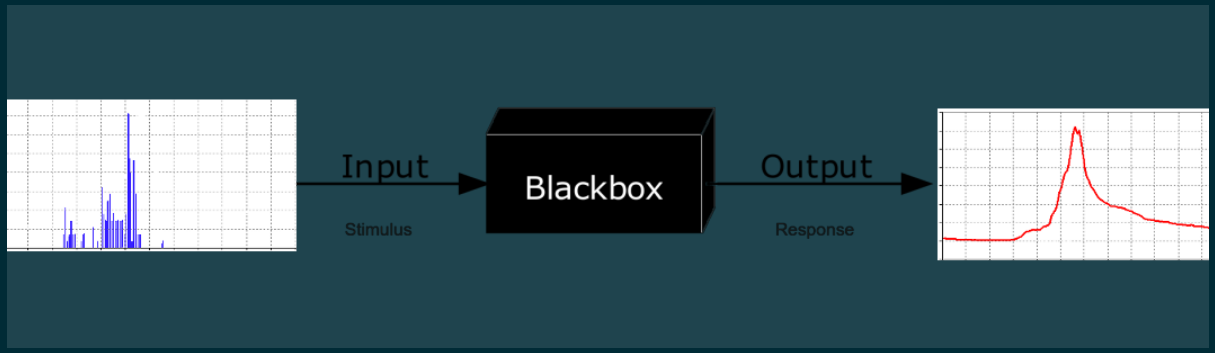
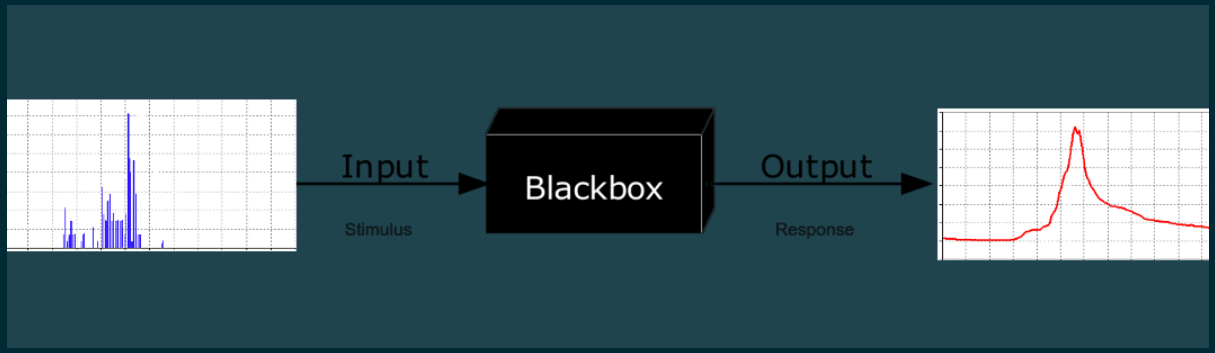
=



BIG CHALLENGE

Complicated designs + lack of documentation

=

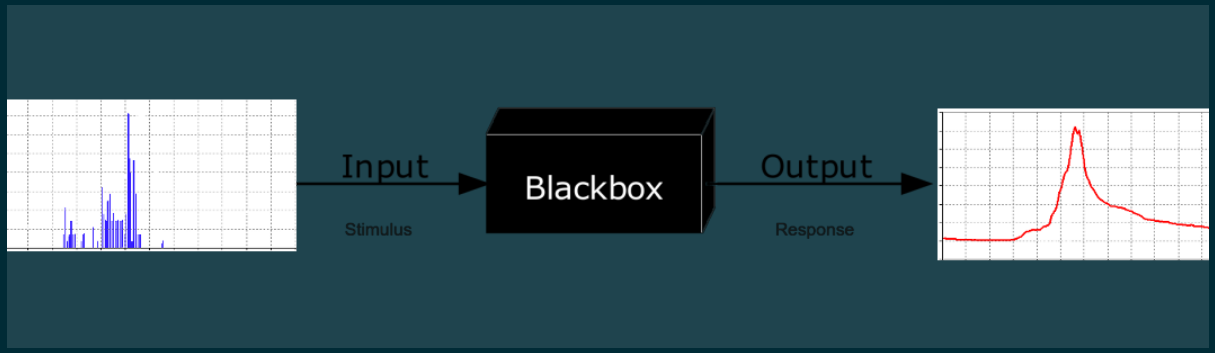


Articles are read, results interpreted

BIG CHALLENGE

Complicated designs + lack of documentation

=



Articles are read, results interpreted

but no one engages with the models

"games that play themselves"

"games that play themselves"

What if...

"games that play themselves"

What if...

people could *play* these ABM archaeological models?

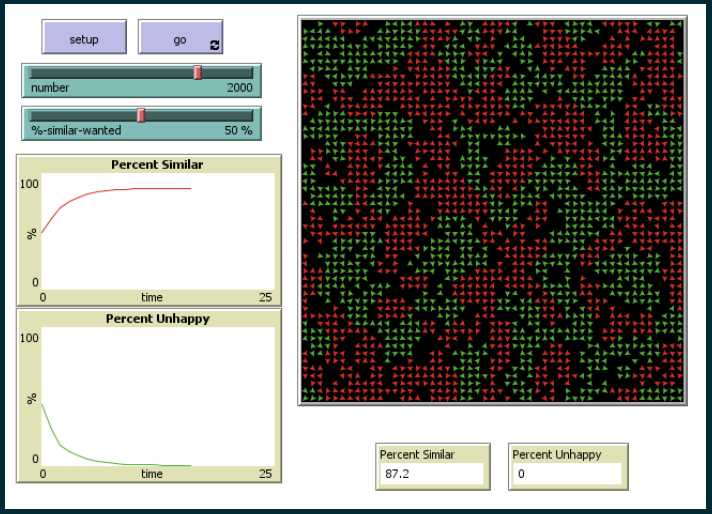
"games that play themselves"

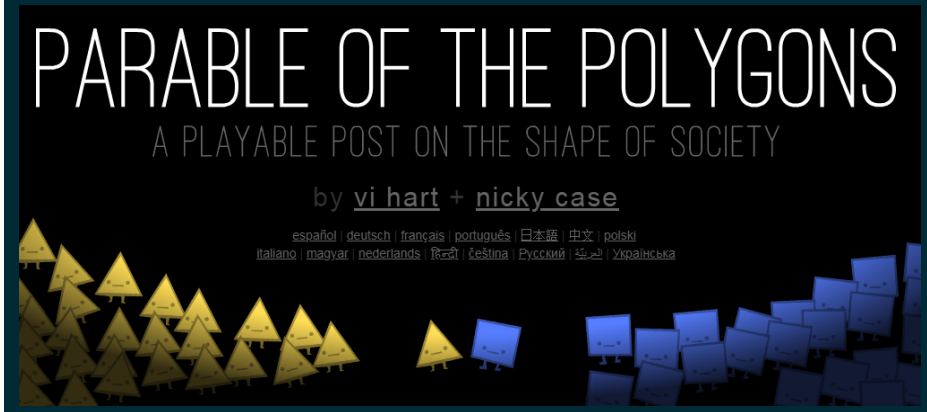
What if...

people could ***play*** these ABM archaeological models?

Insert the human into the simulation!

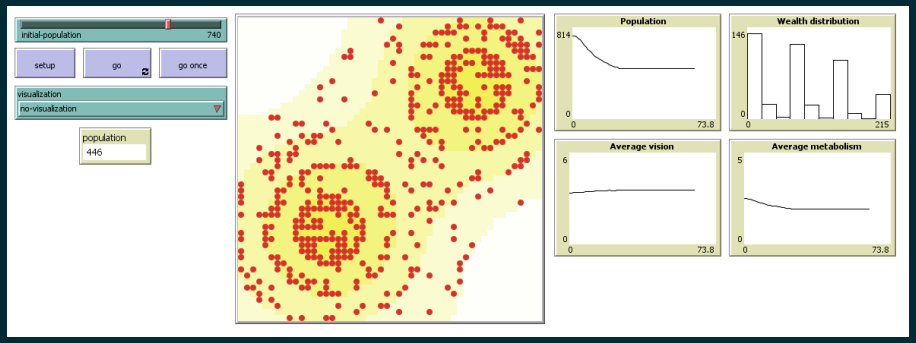
An example:

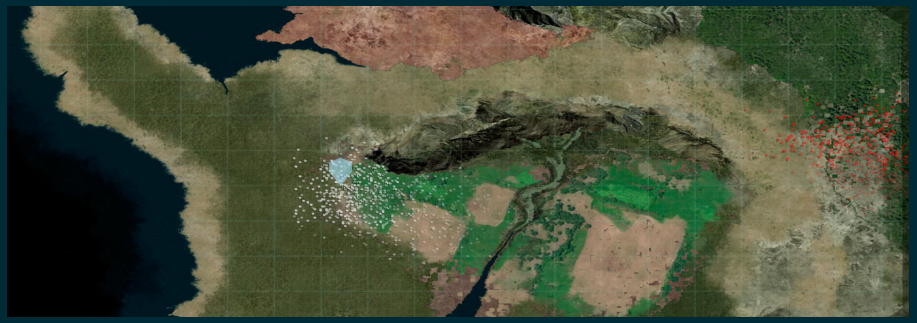




Schelling's *Segregation model*

yet another *familiar* example:





Sugarscape series and *Evolving planet*

II

ARTIFICIAL ANASAZI

~~ANASAZI~~ → *ANCESTRAL PUEBLOANS*

Calico Tanks Trail. Source: https://www.flickr.com/photos/whsieh78/15763640429/

Calico Tanks Trail. Source: https://www.flickr.com/photos/whsieh78/15763640429/

The *Artificial Anasazi model* was designed for exploring the relation of *climate change* and *cultural collapse*

Population growth and collapse in a multiagent model of the Kayenta Anasazi in Long House Valley

Robert L. Axtell, Joshua M. Epstein, Jeffrey S. Dean, George J. Gumerman, Alan C. Swedlund, Jason Harburger, Shubha Chakravarty, Ross Hammond, Jon Parker, and Miles Parker

PNAS May 14, 2002 99 (suppl 3) 7275-7279; https://doi.org/10.1073/pnas.092080799

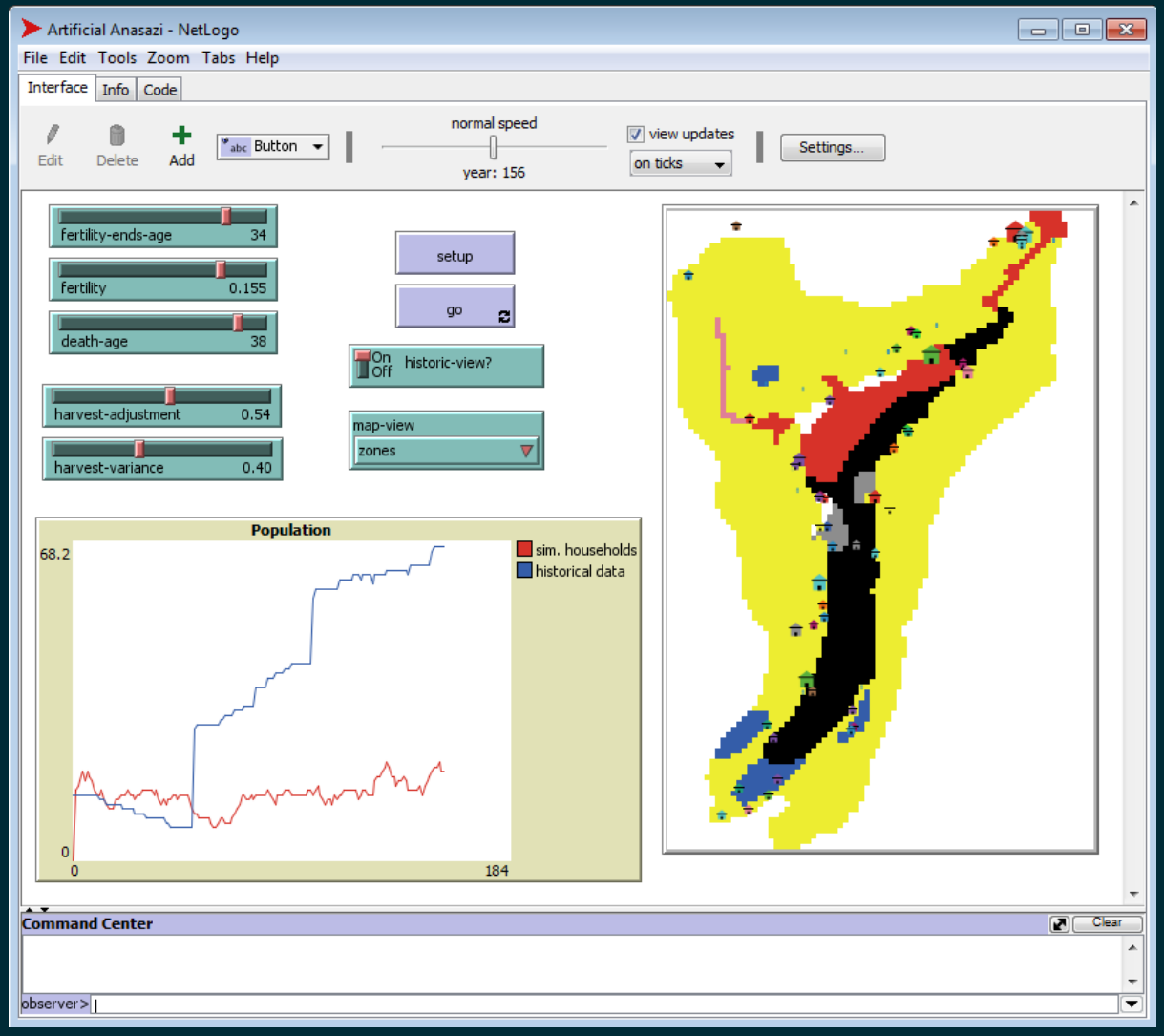
JASSS

Marco A. Janssen (2009)

Understanding Artificial Anasazi

Journal of Artificial Societies and Social Simulation **12** (4) 13
<http://jasss.soc.surrey.ac.uk/12/4/13.html>

Long House Valley, NE Arizona


Artificial Anasazi - NetLogo
File Edit Tools Zoom Tabs Help
Interface Info Code
Edit
Delete
Add
Button
normal speed
year: 156
view updates
on ticks
Settings...
fertility-ends-age 34
fertility 0.155
death-age 38
harvest-adjustment 0.54
harvest-variance 0.40
setup
go
On Off historic-view?
map-view
zones
Population
68.2
0
0
184
sim. households
historical data
Command Center
Clear
observer>

III

GAMING *IMMERSIVE* ABM

WHAT DO WE WANT?

WHAT DO WE WANT?

- Agent-based model as *game mechanics*

WHAT DO WE WANT?

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- Turn the player into *an agent* ("Agents lives matter!")

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- 3D, first person, ideally VR-compatible
  → *immersive*, avoid god-like perspective

WHAT DO WE WANT?

- Agent-based model as *game mechanics*
- Turn the player into *an agent* ("Agents lives matter!")
- 3D, first person, ideally VR-compatible
  → *immersive*, avoid god-like perspective
- A game, but also a tool for *communicating* the model

HOW CAN WE DO IT?

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- Bonus I: develop/import minimum art assets, including text

HOW CAN WE DO IT?

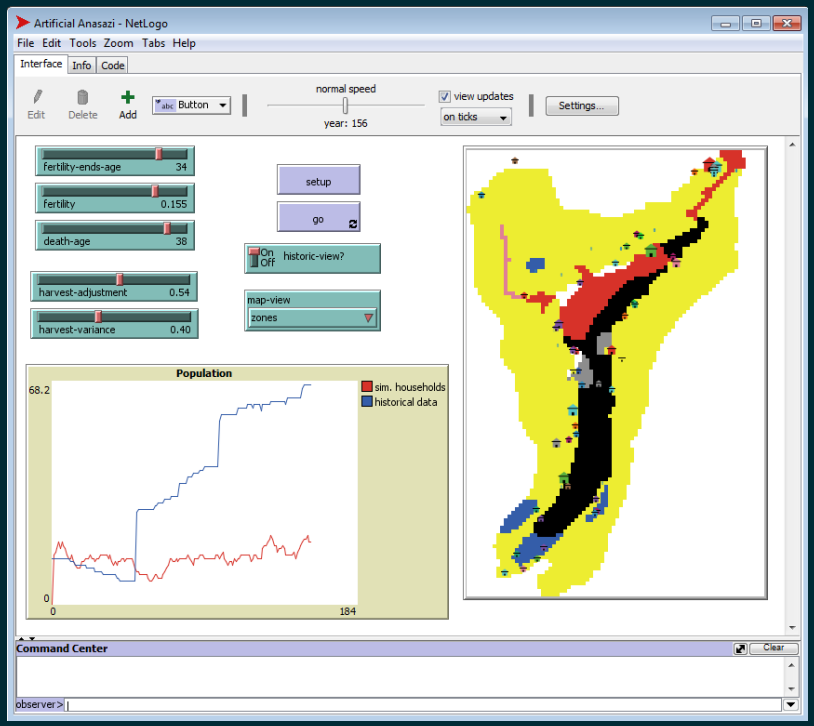
- *Translate* (replicate) the code from NetLogo to Unity (C#)
- Complement/expand the model to *fill gaps* (*e.g.*, have individuals instead of households)
- Define and implement *game mechanics*
- Bonus I: develop/import minimum art assets, including text
- Bonus II: proper UI, game save system, and a great etc.

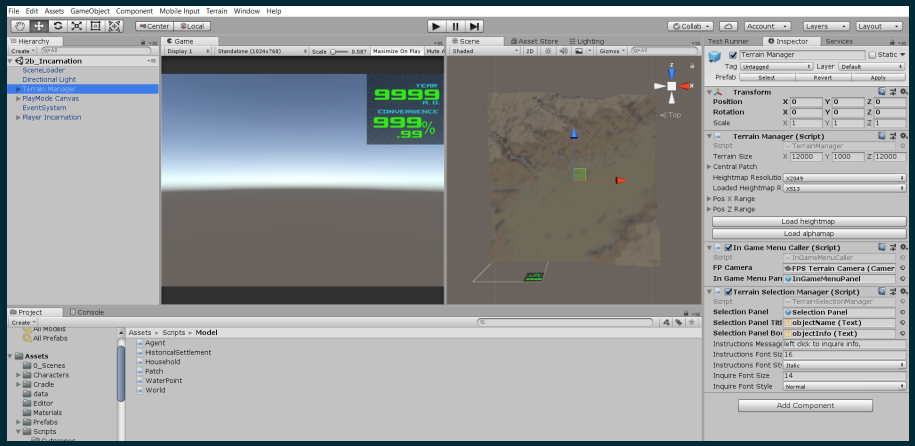
IV

FROM *NETLOGO* TO *UNITY*

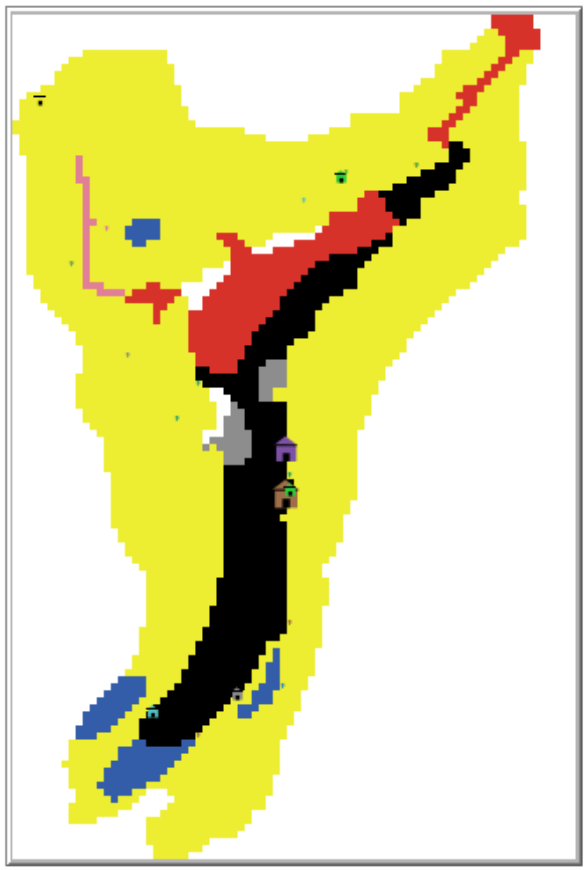

```
  reset-ticks
end

to go
  if year > 1350 [ stop ]
  set historical-total-households 0
  set total-households 0
  calculate-yield

  ; potential amount of households based on level of base-yield (dependent on PSDI and water availability)
  set potential count patches with [ base-yield >= household-min-nutrition-need ]

  if historic-view? [ show-historical-population ]
  calculate-harvest-consumption
  check-death
  estimate-harvest
  ask households [
    ; agents who expect not to have sufficient food next timestep move to a new spot
    ; (if available). If no spots are available, they leave the system.
    if estimate < nutrition-need [
      ; we have to check everytime whether locations are available for moving agents,
```

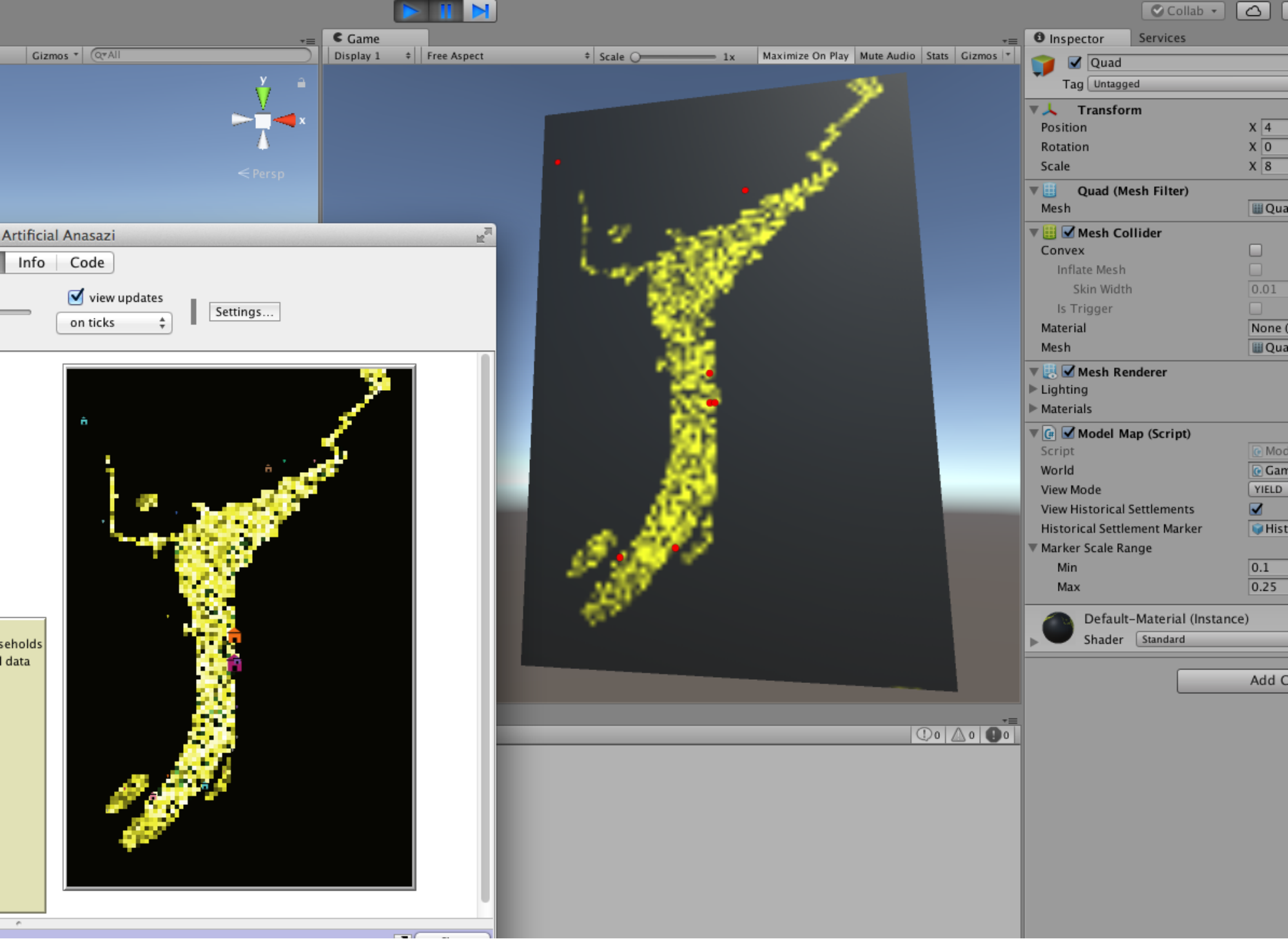
```
// <summary>Initialize a simulation</summary>
public static void SetUpNew()
{
    // get new set up data
    setUpData = new SetUpData();

    // override parameters
    setUpData.SEED = Environment.TickCount;

    // save set up data
    SaveSetUpData();

    year = setUpData.start_year;

    // set up procedures that are independent of new/load game states
    SetUp();

    // update input data
    DataReader.UpdateData();

    // set patch quality and water source condition
    SetupPatchQuality();

    // calculate patch yield
    UpdatePatchesYield(true); // with the set up configuration (i.e. not affected by harvest_adjustment)
```

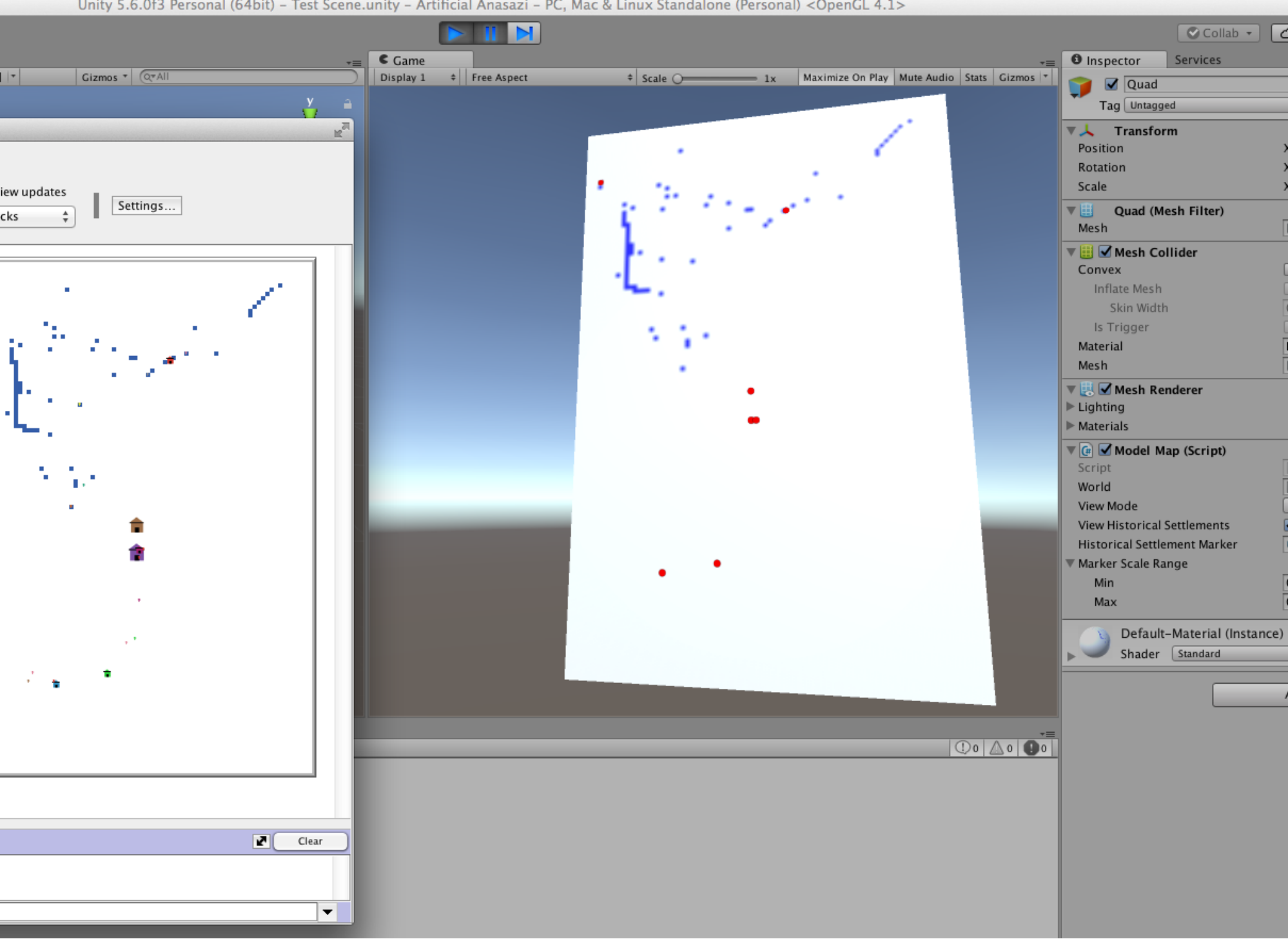

Artificial Anasazi - NetLogo
File Edit Tools Zoom Tabs Help
Interface Info Code
Edit
Delete
Add
Button
normal speed
year: 156
view updates
on ticks
Settings...
fertility-ends-age 34
fertility 0.155
death-age 38
harvest-adjustment 0.54
harvest-variance 0.40
setup
go
On Off historic-view?
map-view
zones
Population
68.2
0
0
184
sim. households
historical data
Command Center
Clear
observer>

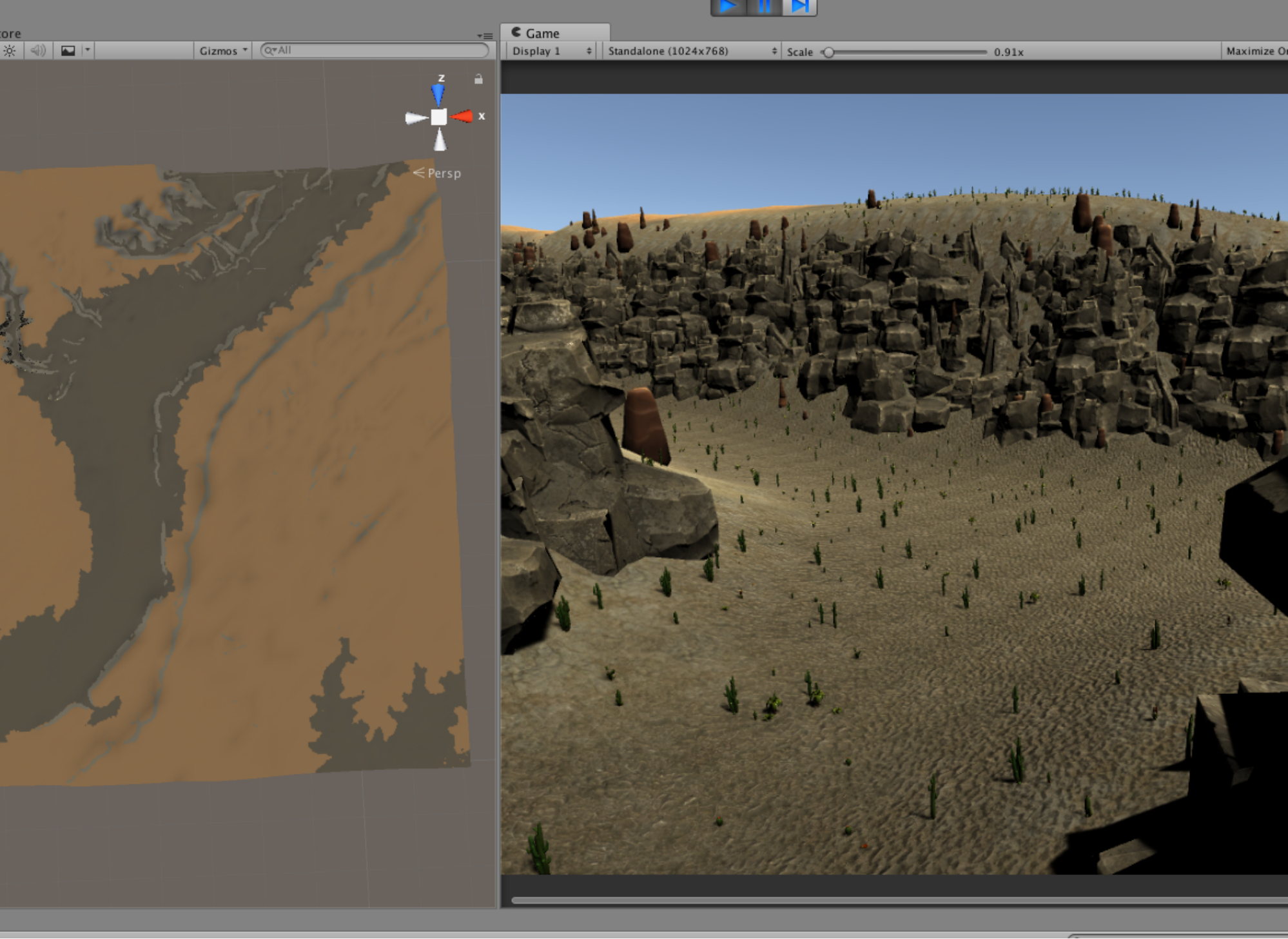

File Edit Assets GameObject Component Mobile Input Terrain Window Help
Hierarchy
Game
Scene
Asset Store
Lighting
Inspector
Terrain Manager (Script)
In Game Menu Caller (Script)
Terrain Selection Manager (Script)
Add Component

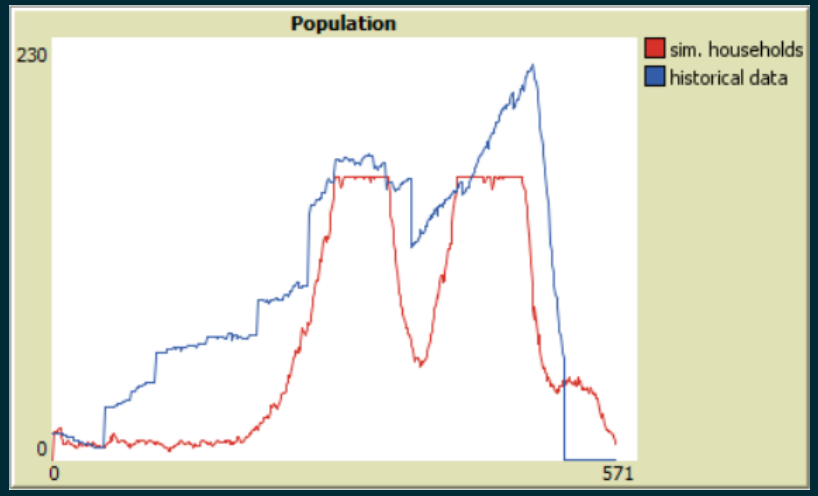
MODEL TRANSLATION

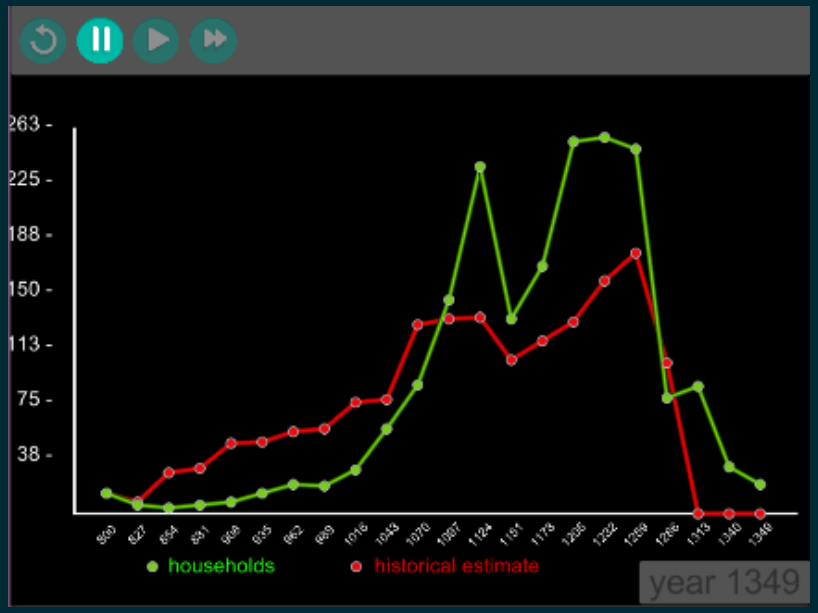



Gizmos
All
Persp
Game
Display 1
Free Aspect
Scale
1x
Maximize On Play
Mute Audio
Stats
Gizmos
Artificial Anasazi
Info
Code
view updates
on ticks
Settings...
Inspector
Services
Quad
Tag
Untagged
Transform
Position
Rotation
Scale
Quad (Mesh Filter)
Mesh
Mesh Collider
Convex
Inflate Mesh
Skin Width
Is Trigger
Material
Mesh
Mesh Renderer
Lighting
Materials
Model Map (Script)
Script
World
View Mode
YIELD
View Historical Settlements
Historical Settlement Marker
Marker Scale Range
Min
Max
Default-Material (Instance)
Shader
Standard
Add C


Unity 5.6.0f3 Personal (64bit) - Test Scene.unity - Artificial Anasazi - PC, Mac & Linux Standalone (Personal) <OpenGL 4.1>
Collab
Gizmos
All
iew updates
cks
Settings...
Clear
Game
Display 1
Free Aspect
Scale
1x
Maximize On Play
Mute Audio
Stats
Gizmos
Inspector
Services
Quad
Tag
Untagged
Transform
Position
Rotation
Scale
Quad (Mesh Filter)
Mesh
Mesh Collider
Convex
Inflate Mesh
Skin Width
Is Trigger
Material
Mesh
Mesh Renderer
Lighting
Materials
Model Map (Script)
Script
World
View Mode
View Historical Settlements
Historical Settlement Marker
Marker Scale Range
Min
Max
Default-Material (Instance)
Shader
Standard


Gizmos
All
z
x
Persp
Game
Display 1
Standalone (1024x768)
Scale
0.91x


Population
230
0
0
571
sim. households
historical data


263 -
225 -
188 -
150 -
113 -
75 -
38 -
households
historical estimate
year 1349

Replication:

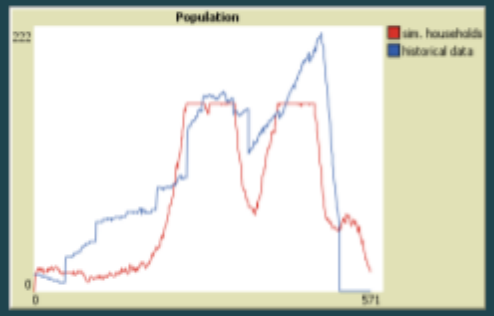
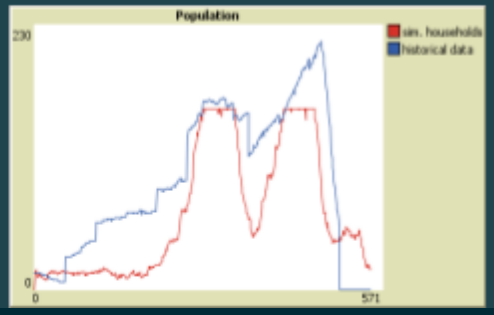
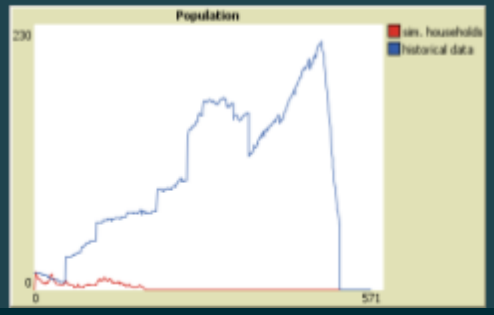
Replication:

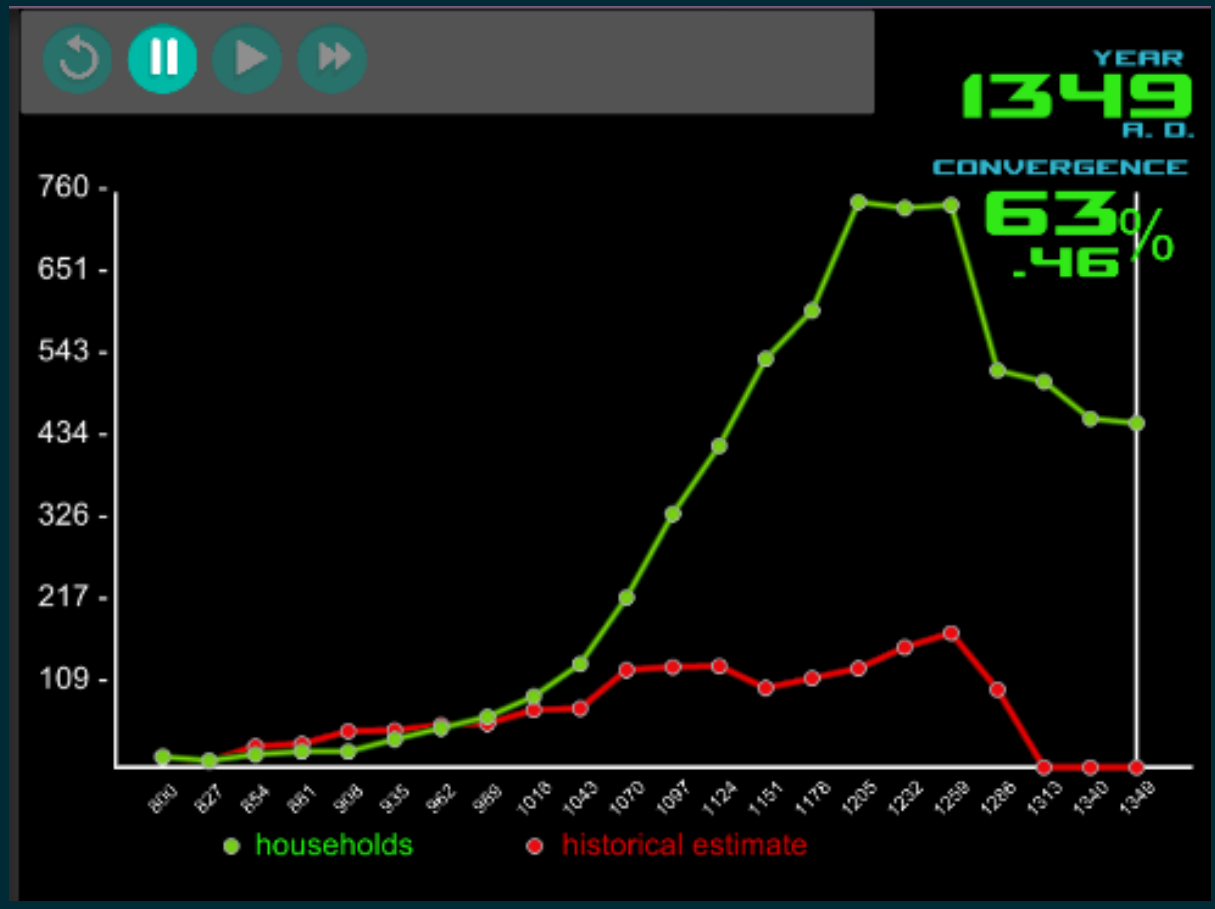
More profound understanding of the model

Replication:

More profound understanding of the model

Revealed problematic *assumptions*
and hard-to-spot *mistakes*.
$\longrightarrow$ a general problem in ABM

random-seed	*Original model*	*Corrected model*
0		
123		



corrected and accounting for *individuals* within households

V

THE *WORKING TITLE* GAME

GAME CONCEPT

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The point of the *model*:
to understand the factors behind the cultural collapse,
by running the model many times for different parameter settings

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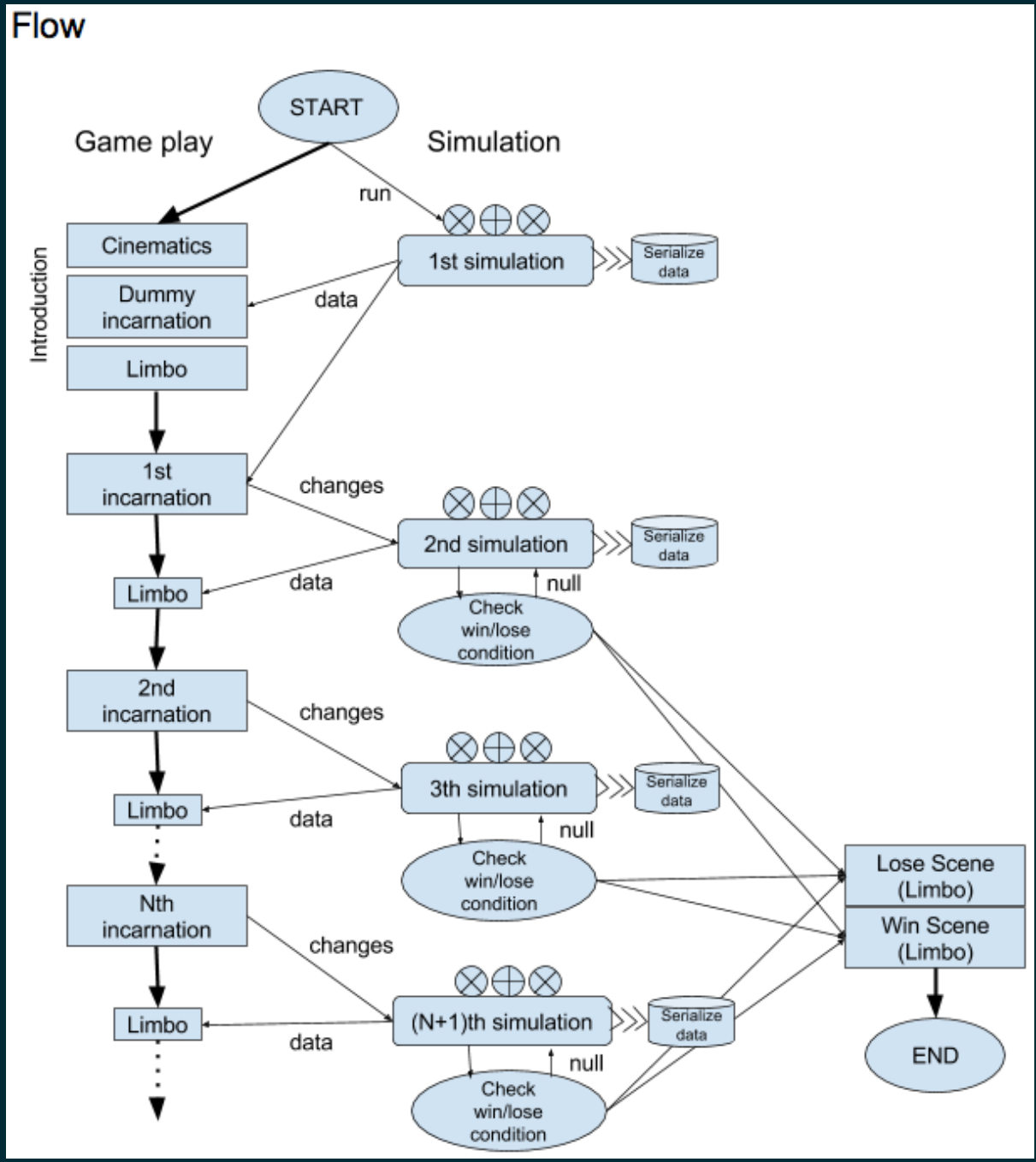
The point of the *model*:
to understand the factors behind the cultural collapse,
by running the model many times for different parameter settings

The point of the *game*:
to understand the factors behind the cultural collapse,
by immersive exploration, discovery, and interaction with NPC and the 3D environment

Flow

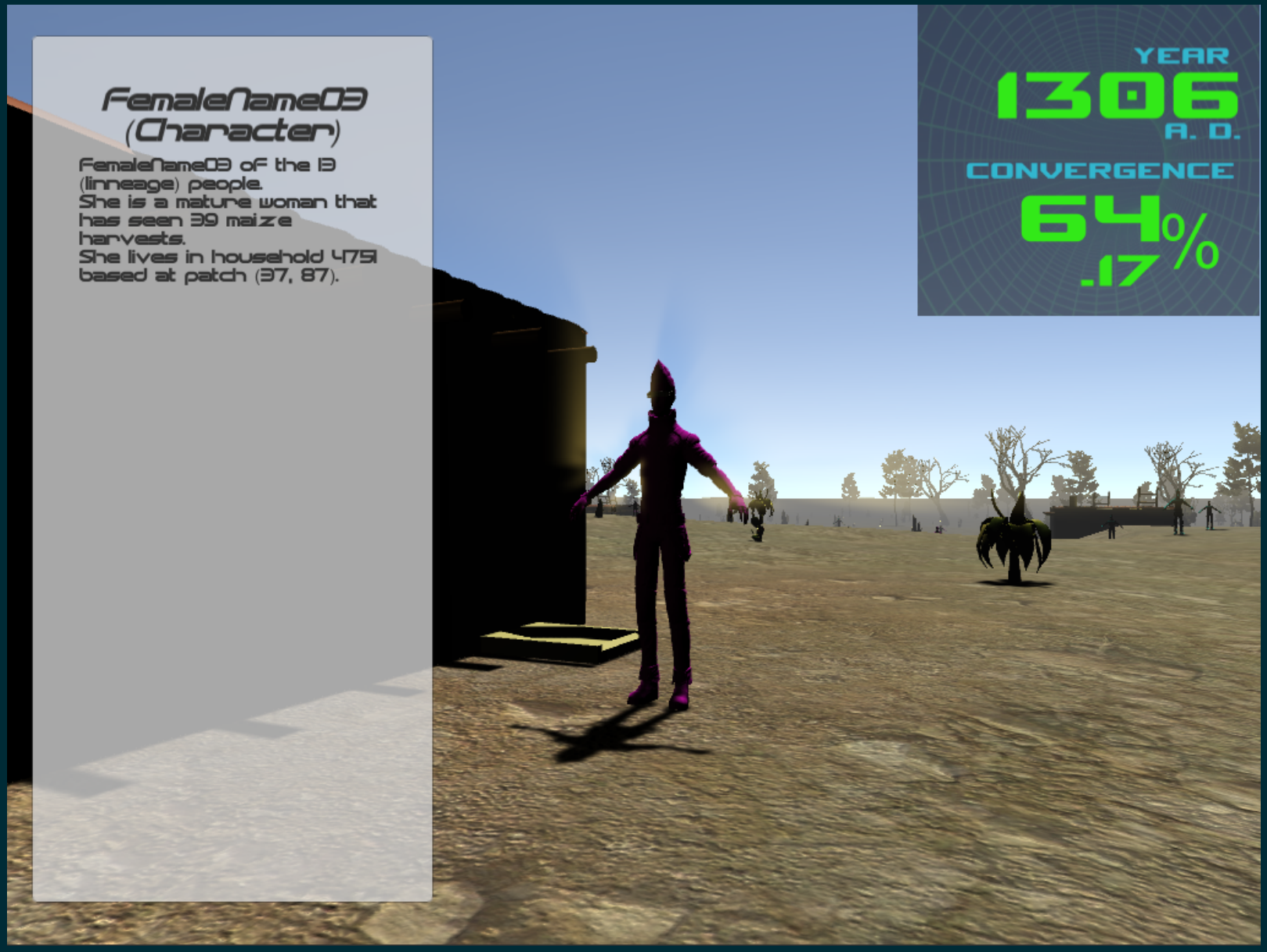

START
Game play
Simulation
run
Introduction
Cinematics
Dummy incarnation
Limbo
1st simulation
Serialize data
data
1st incarnation
changes
2nd simulation
Serialize data
Limbo
data
null
Check win/lose condition
2nd incarnation
changes
3th simulation
Serialize data
Limbo
data
null
Check win/lose condition
Nth incarnation
changes
(N+1)th simulation
Serialize data
Limbo
data
null
Check win/lose condition
Lose Scene (Limbo)
Win Scene (Limbo)
END

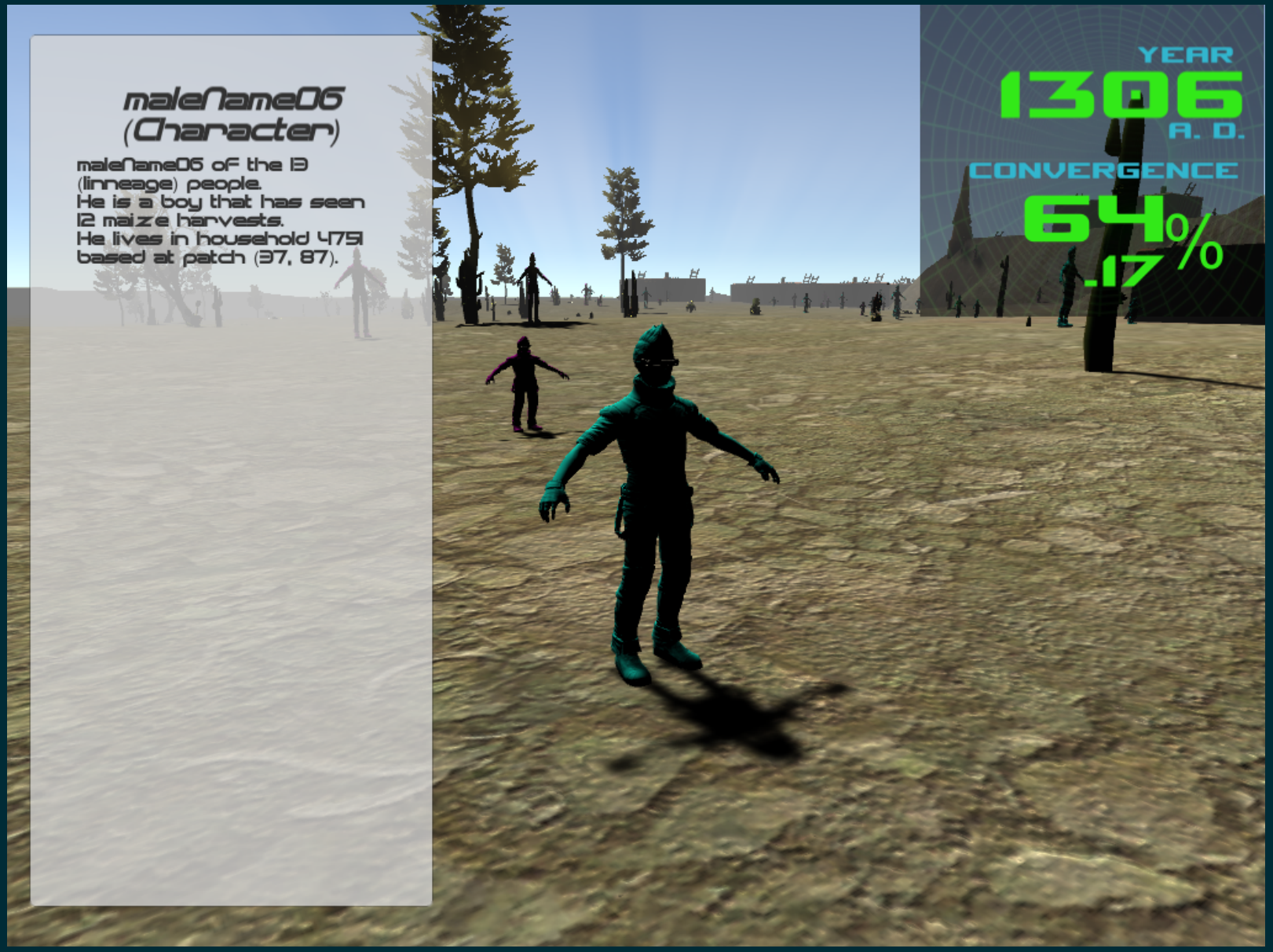
GAMEPLAY SHOTS

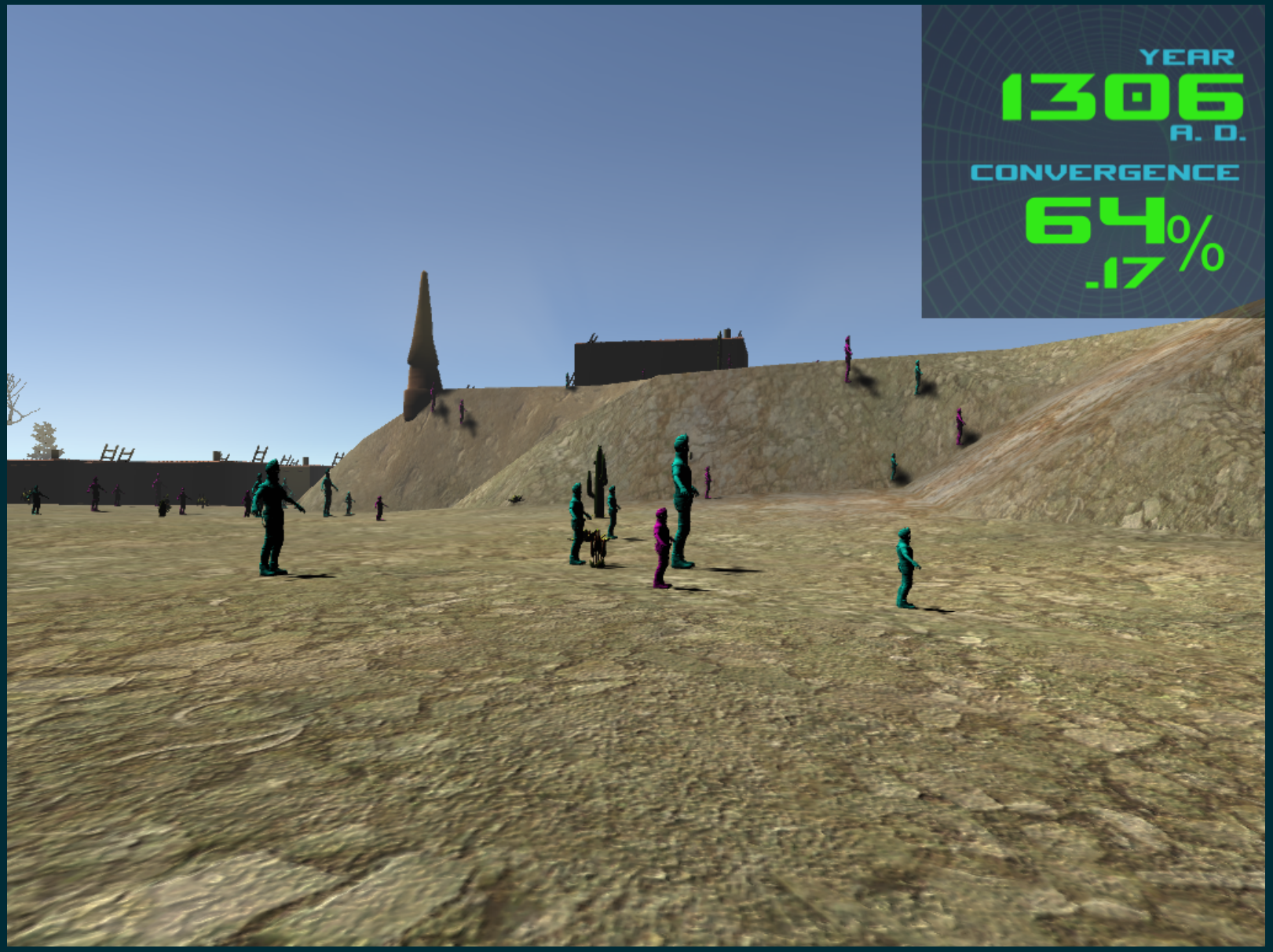

WORKING
TITLE
NEW
GAME
LOAD
GAME
OPTIONS
CONTINUE
QUIT


This... this doesn't look like
the lab.
My god... we sent me back!

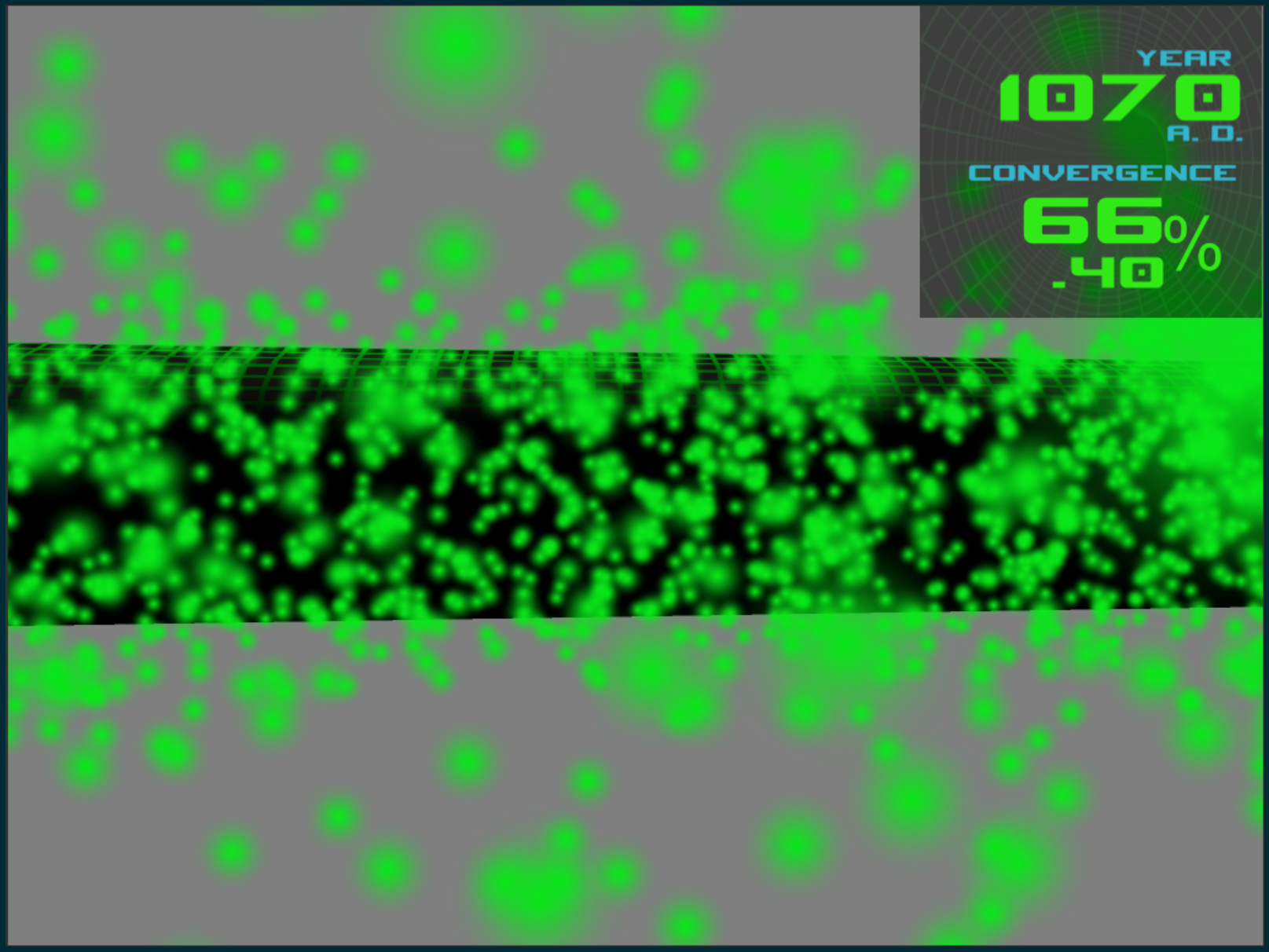

LOADING ..
14.83%

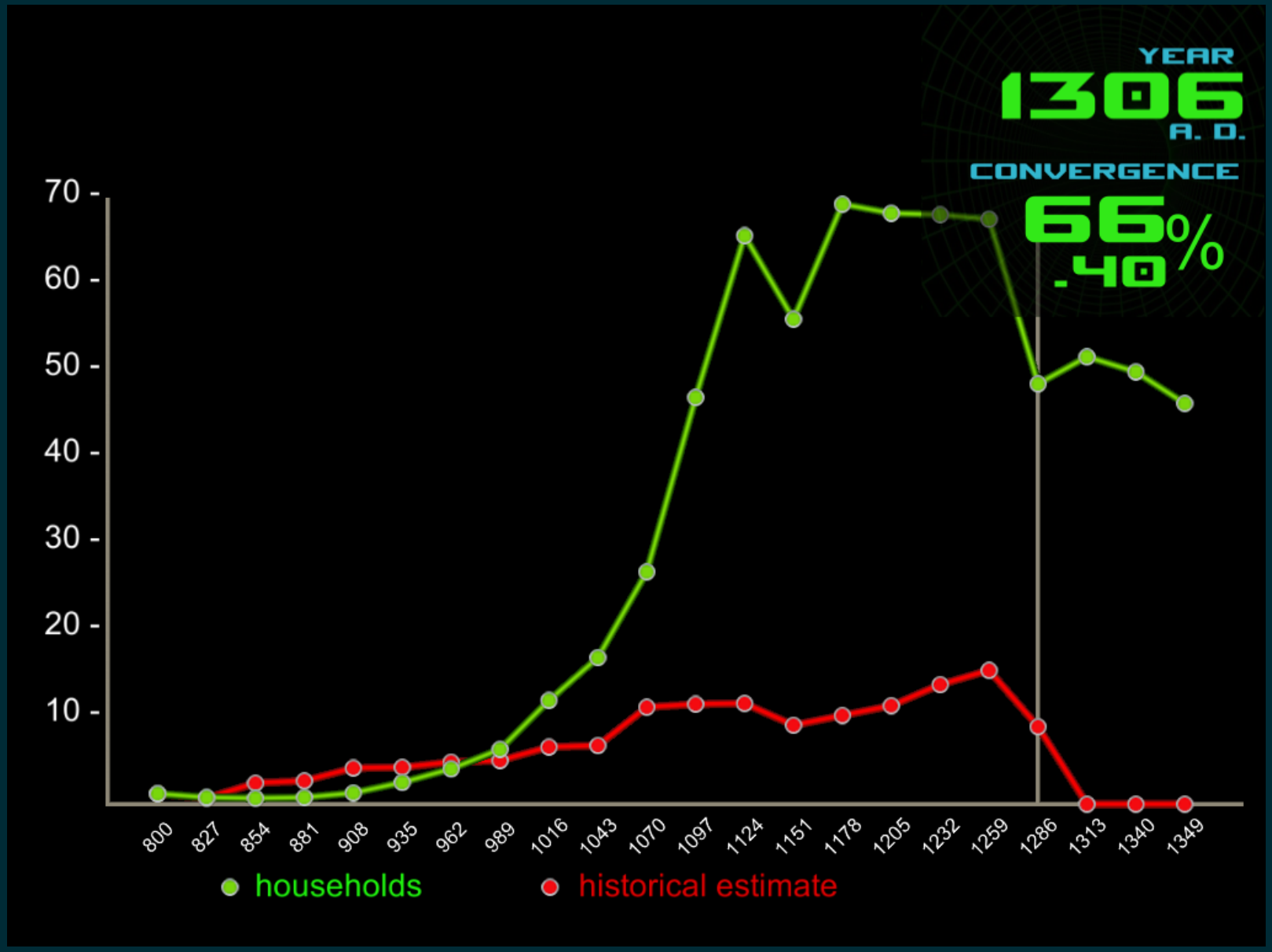

FemaleName03
(Character)
FemaleName03 of the 13 (lineage) people.
She is a mature woman that has seen 39 maize harvests.
She lives in household 4751 based at patch (37, 87).
YEAR
1306
A. D.
CONVERGENCE
64%
.17%

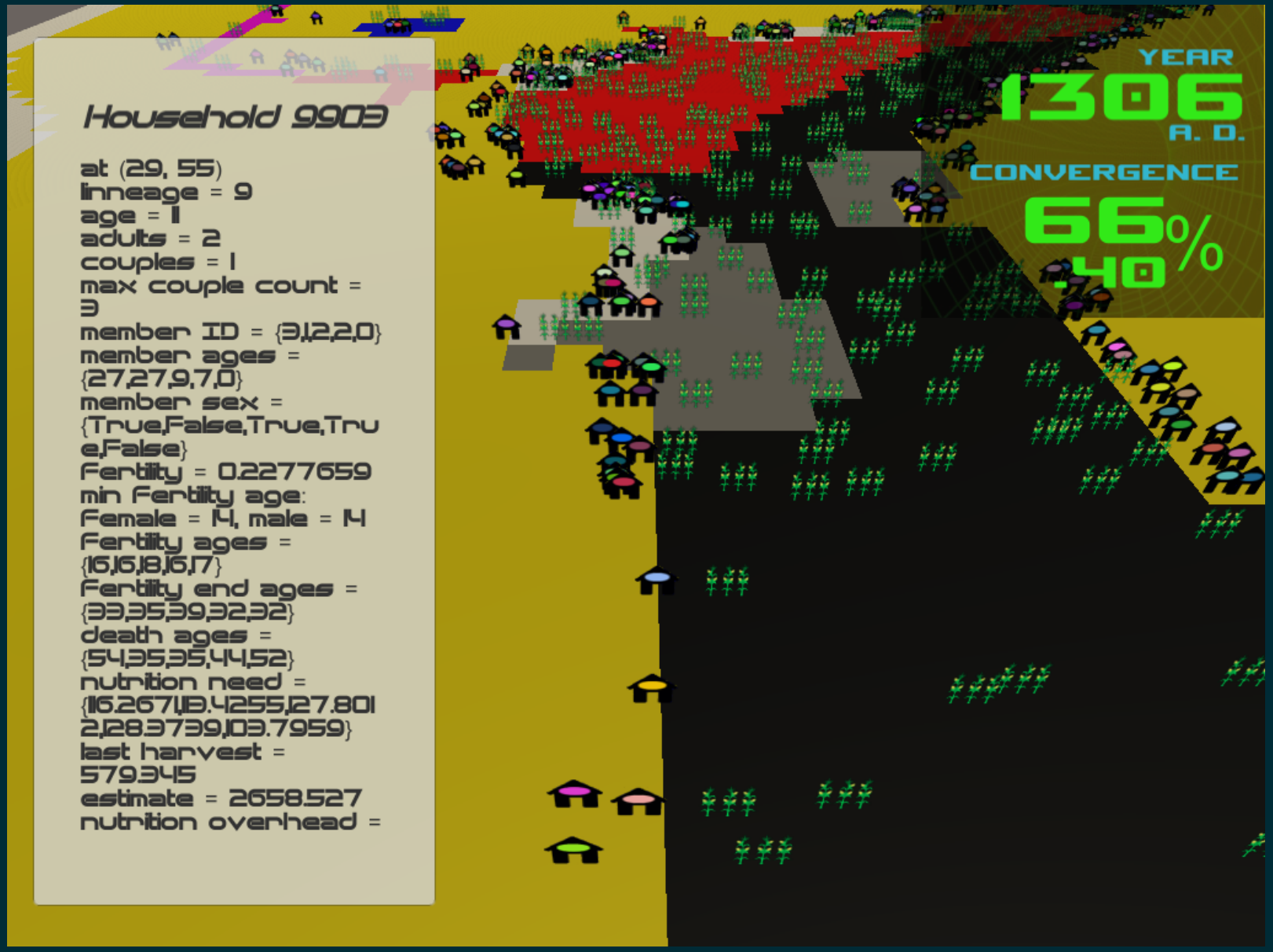

maleName06
(Character)
maleName06 of the 13 (linneage) people.
He is a boy that has seen 12 maize harvests.
He lives in household 4751 based at patch (37, 87).
YEAR
1306
A. D.
CONVERGENCE
64%
-.17%


YEAR
1306
A. D.
CONVERGENCE
64%
.17%


House of the household 321
The household 321 has 29 people.
It descends from household 3 and survived for 249 years.
YEAR
1306
A. D.
CONVERGENCE
64%
.17%

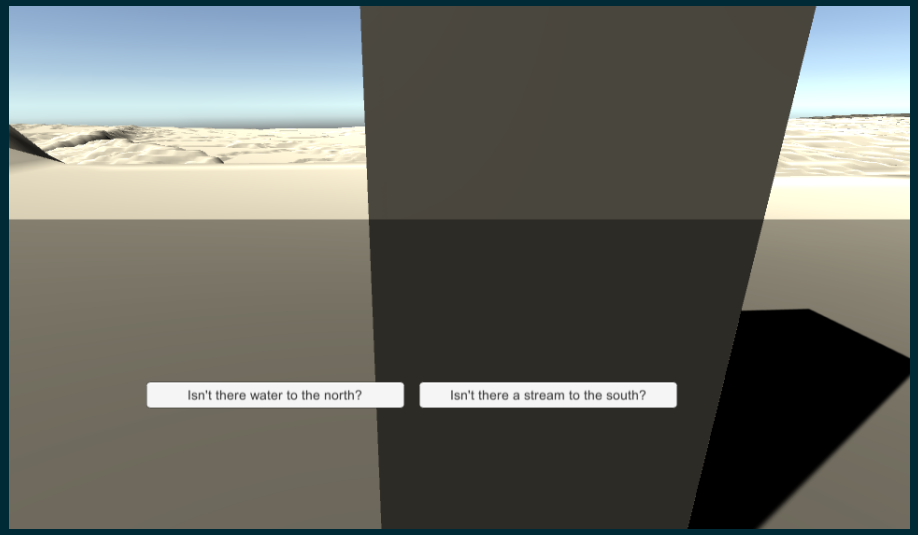

YEAR
1070
A. D.
CONVERGENCE
66%
.40%

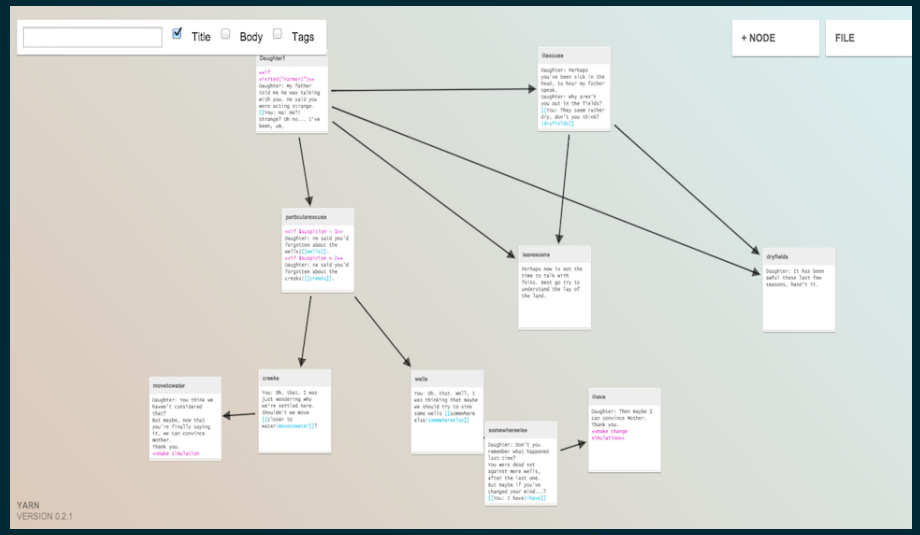

YEAR
1306
A. D.
CONVERGENCE
66%
.40%
70
60
50
40
30
20
10
800
827
854
881
908
935
962
989
1016
1043
1070
1097
1124
1151
1178
1205
1232
1259
1286
1313
1340
1349
households
historical estimate


Household 9903
at (29, 55)
lineage = 9
age = 11
adults = 2
couples = 1
max couple count = 3
member ID = {3,1,2,2,0}
member ages = {27,27,9,7,0}
member sex = {True,False,True,True,False}
Fertility = 0.2277659
min Fertility age:
Female = 14, male = 14
Fertility ages = {16,16,18,16,17}
Fertility end ages = {33,35,39,32,32}
death ages = {54,35,35,44,52}
nutrition need = {116.2671,13.4255,27.8012,28.3739,103.7959}
last harvest = 579.345
estimate = 2658.527
nutrition overhead =
YEAR
1306
A. D.
CONVERGENCE
66%
40

KEY MECHANISM STILL PENDING...

Dialog with NPCs → changing the model's parameters and variables





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available at https://andros-spica.github.io/TIPC2-Angourakis-Graham-2018/
https://andros-spica.github.io/TIPC2-Angourakis-Graham-2018/index.html?print-pdf (printable version)

THANK YOU!

Check our youtube playlist