

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)

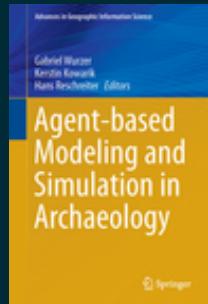
click on images to consult source



|

GAMING *SIMULATED* PASTS

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



Doug's Archaeology

Investigating the Profession and Research

Can you model that? Applications of complex systems simulation to explore the past

Posted on October 5, 2016

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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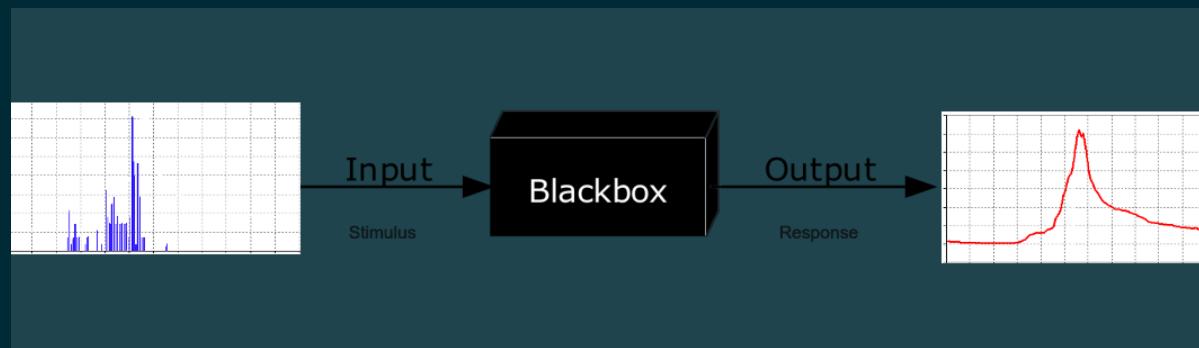
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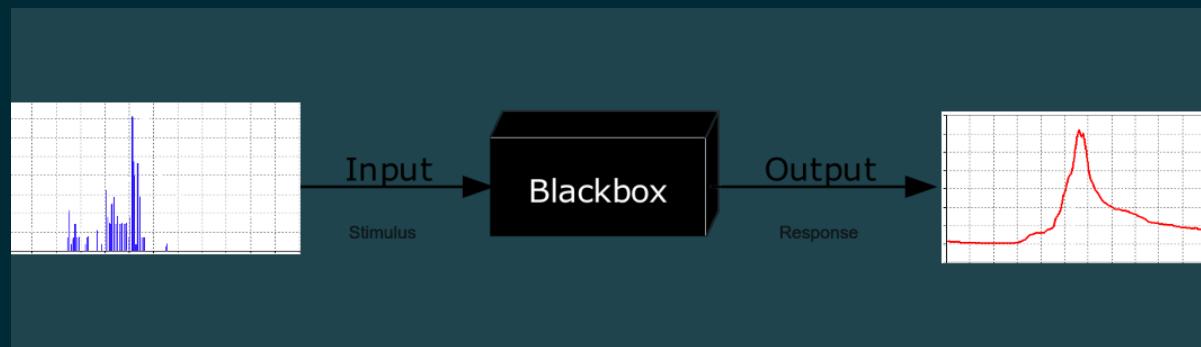
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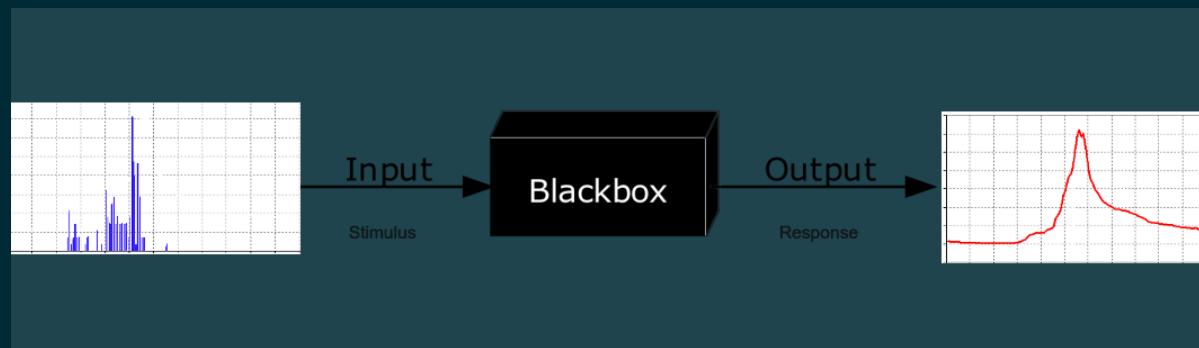


Articles are read, results interpreted

BIG CHALLENGE

Complicated designs + lack of documentation

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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?

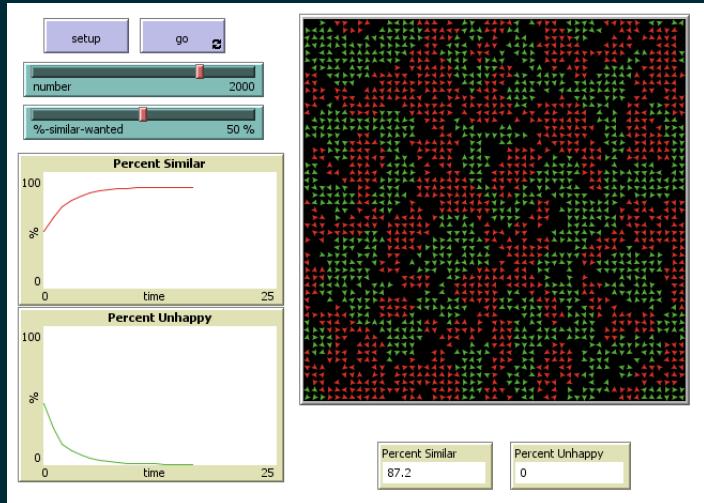
"games that play themselves"

What if...

people could *play* these ABM archaeological models?

Insert the human into the simulation!

An example:



PARABLE OF THE POLYGONS

A PLAYABLE POST ON THE SHAPE OF SOCIETY

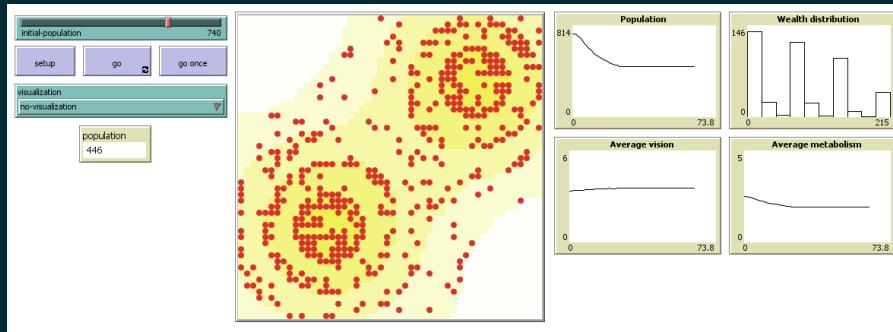
by [yi hart + nicky case](#)

[español](#) | [deutsch](#) | [français](#) | [português](#) | [日本語](#) | [中文](#) | [polski](#)
[italiano](#) | [magyar](#) | [nederlands](#) | [ਪੰਜਾਬੀ](#) | [čeština](#) | [Русский](#) | [فارسی](#) | [Українська](#)



Schelling's *Segregation model*

yet another *familiar* example:



Sugarscape series and *Evolving planet*

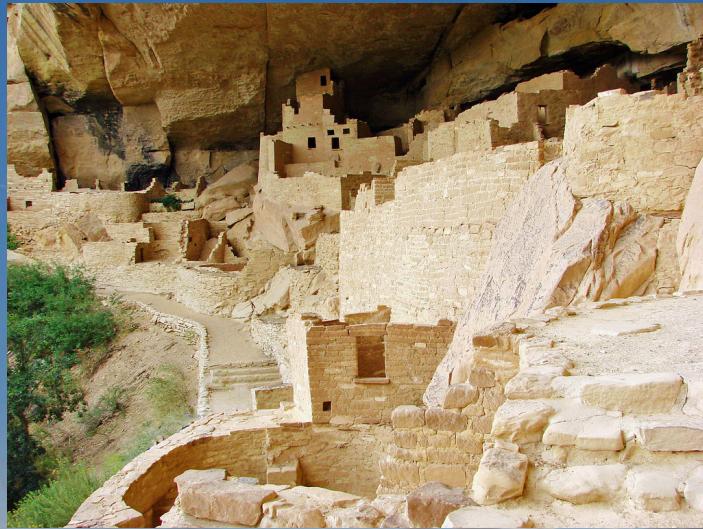
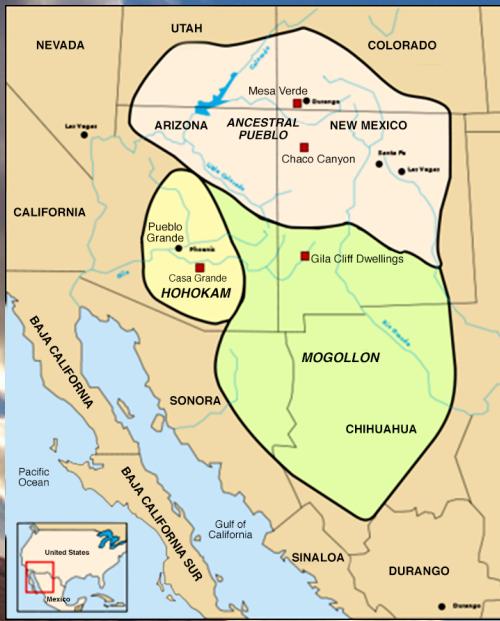
||

ARTIFICIAL ANASAZI

ANASAZI → ANCESTRAL PUEBLOANS



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



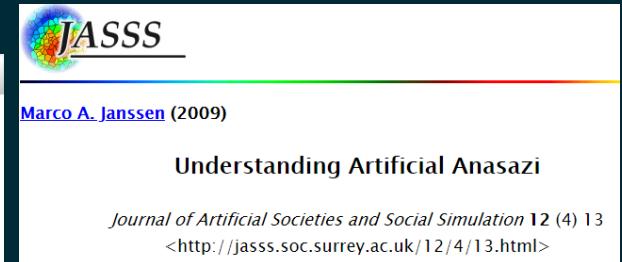
Calico Tanks Trail. Source: <https://www.flickr.com/photos/whsieh78/15763640429/>

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

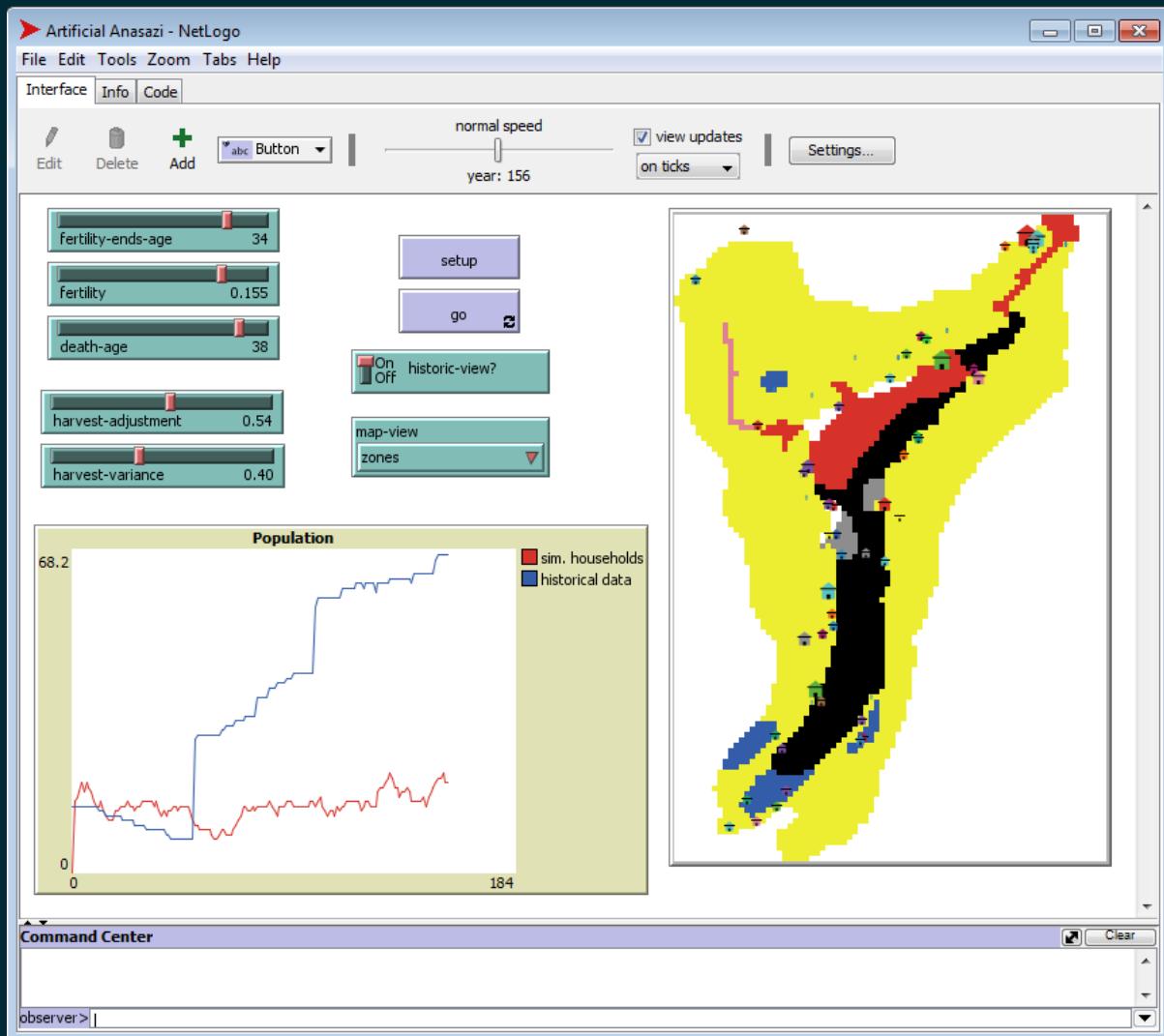


Population growth and collapse in a multiagent model of the Kayenta Anasazi in Long House Valley

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>



Long House Valley, NE Arizona





GAMING *IMMERSIVE* ABM

WHAT DO WE WANT?

WHAT DO WE WANT?

- Agent-based model as *game mechanics*

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- Agent-based model as *game mechanics*
- Turn the player into *an agent*

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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*
- 3D, first person, ideally VR-compatible
→ **immersive**, avoid god-like perspective
- A game, but also a tool for **communicating** the model

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

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- 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();

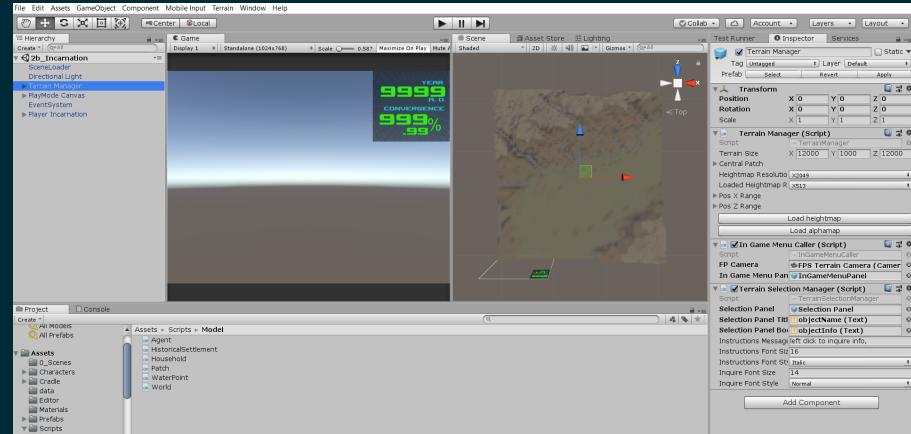
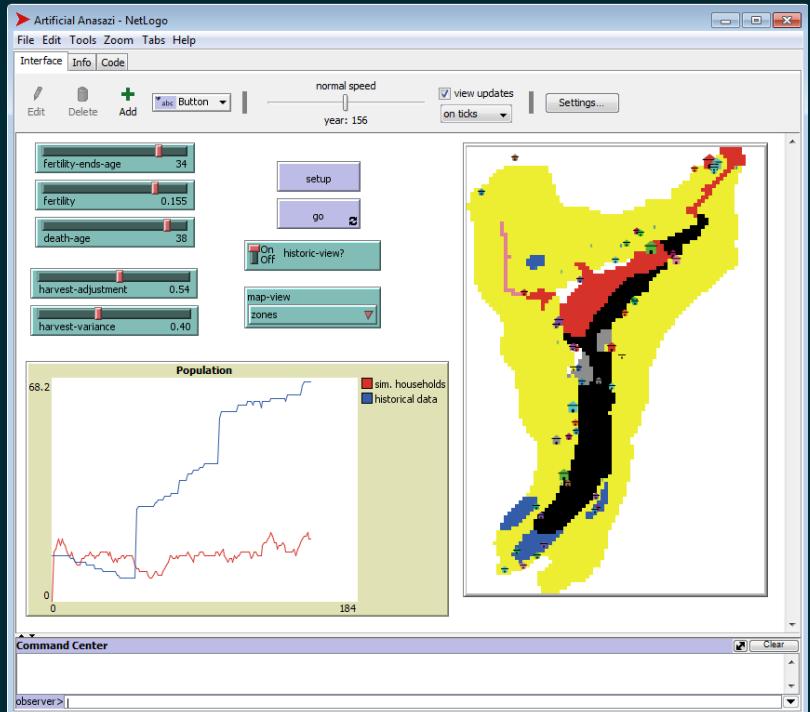
  year = setUpData.start_year;

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

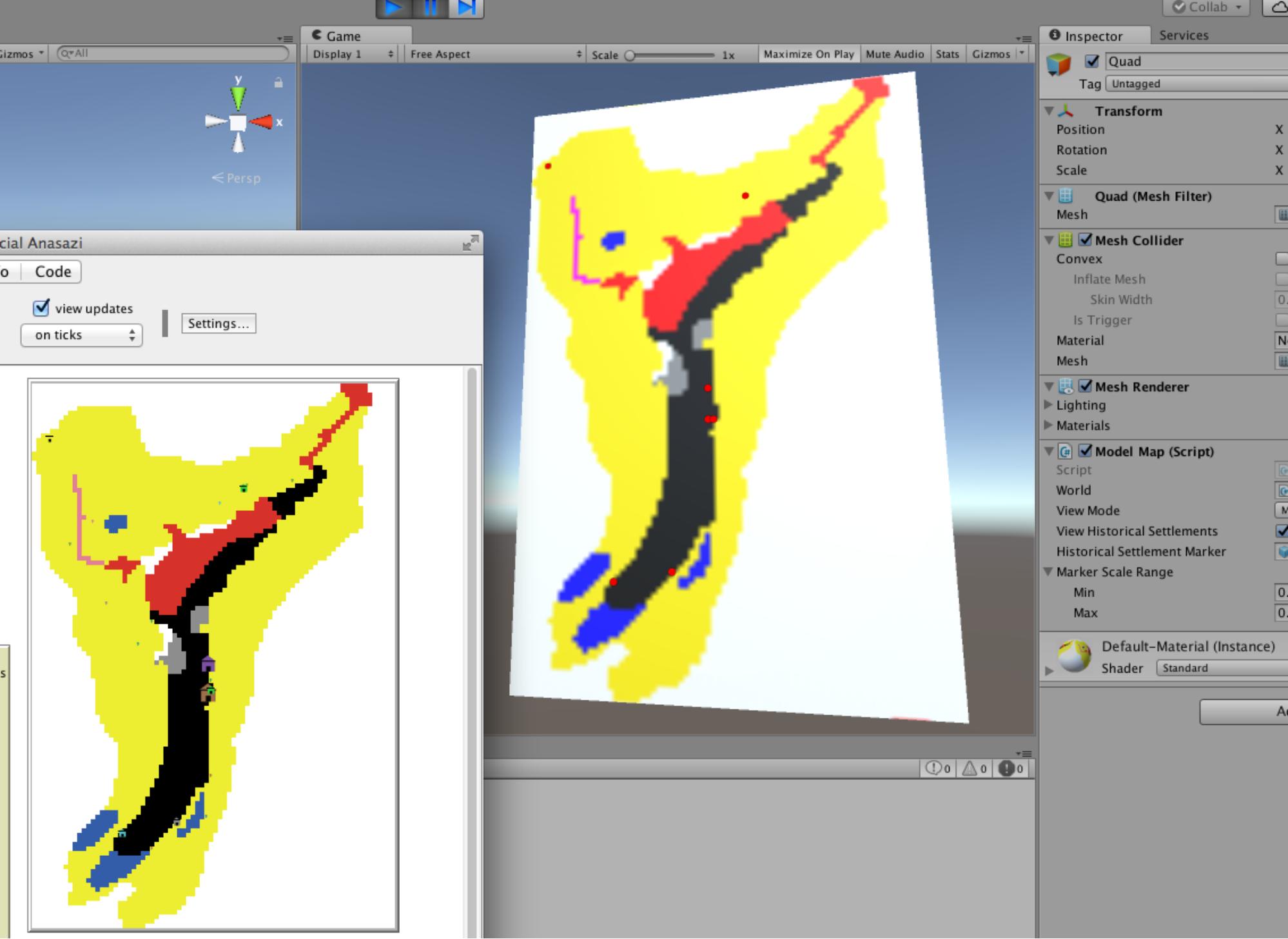
  // update input data
  DataReader.UpdateData();

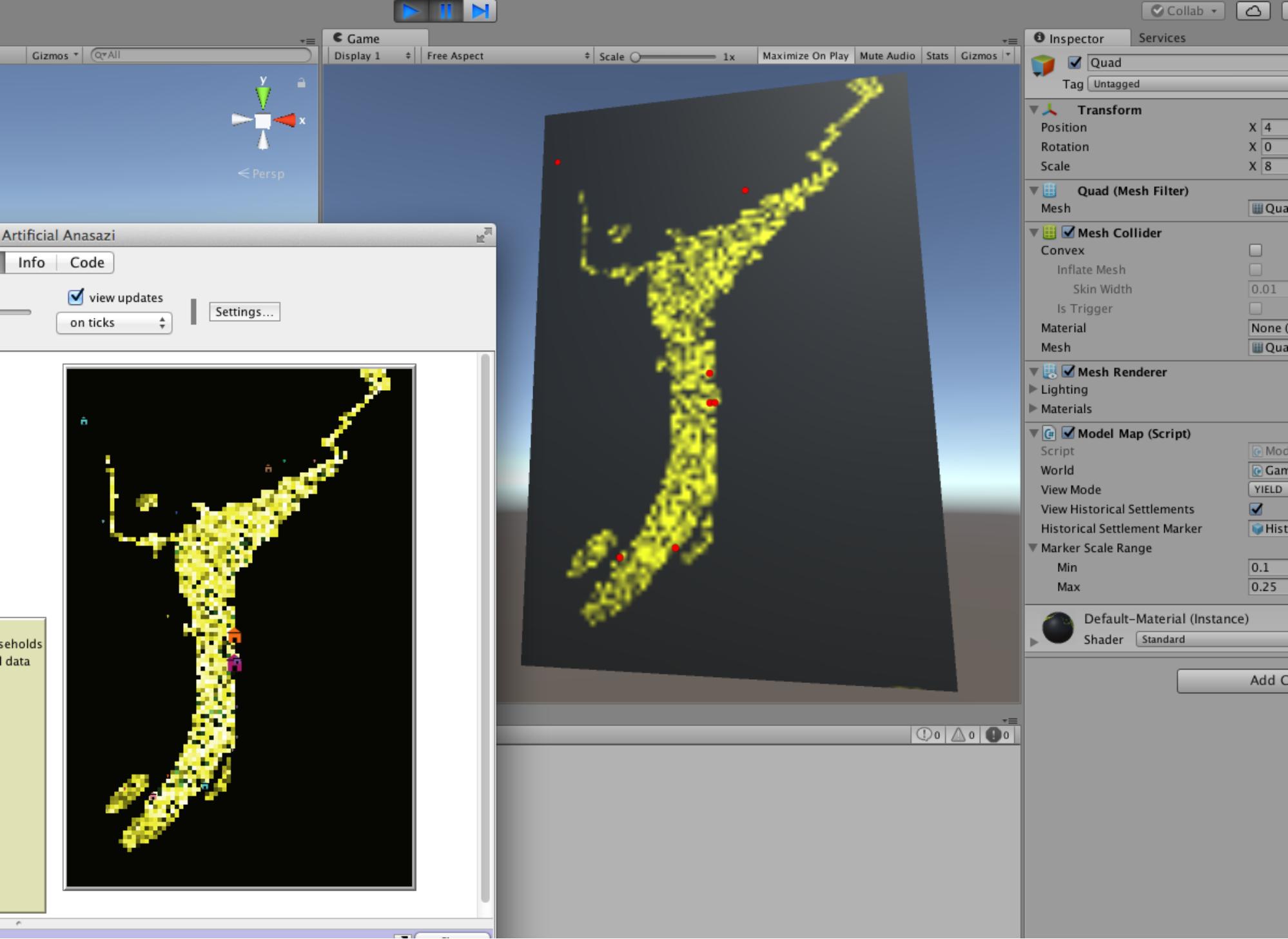
  // set patch quality and water source condition
  SetupPatchQuality();

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



MODEL TRANSLATION







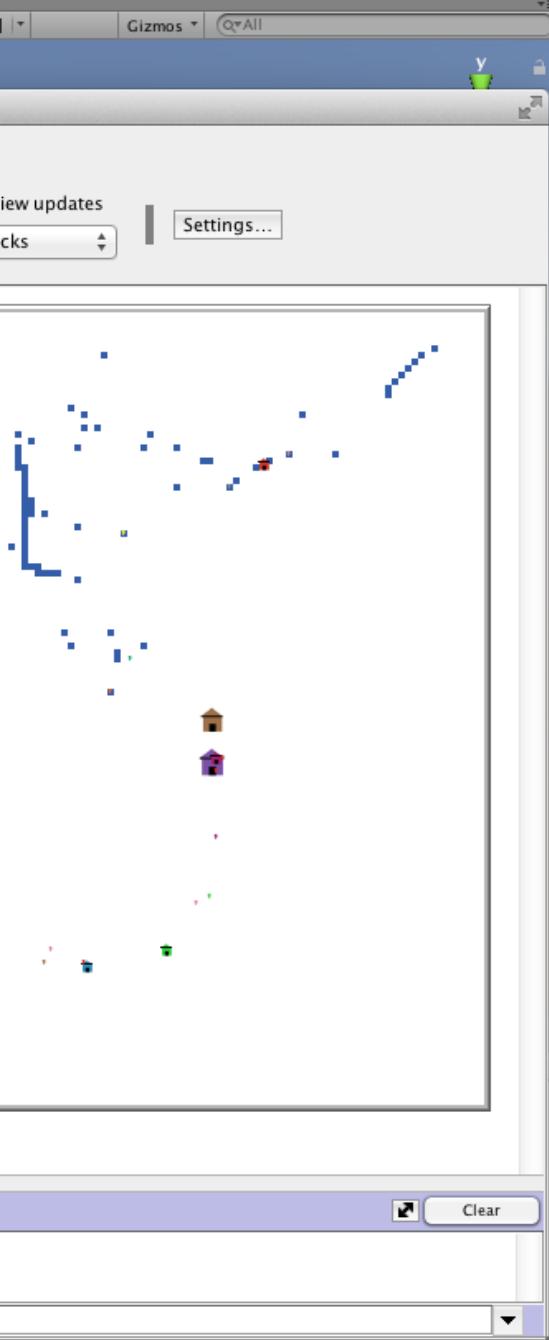
Game

Display 1 | Free Aspect

Scale

1x

Maximize On Play | Mute Audio | Stats | Gizmos



Quad
Tag Untagged

Transform
Position
Rotation
Scale

Quad (Mesh Filter)
Mesh

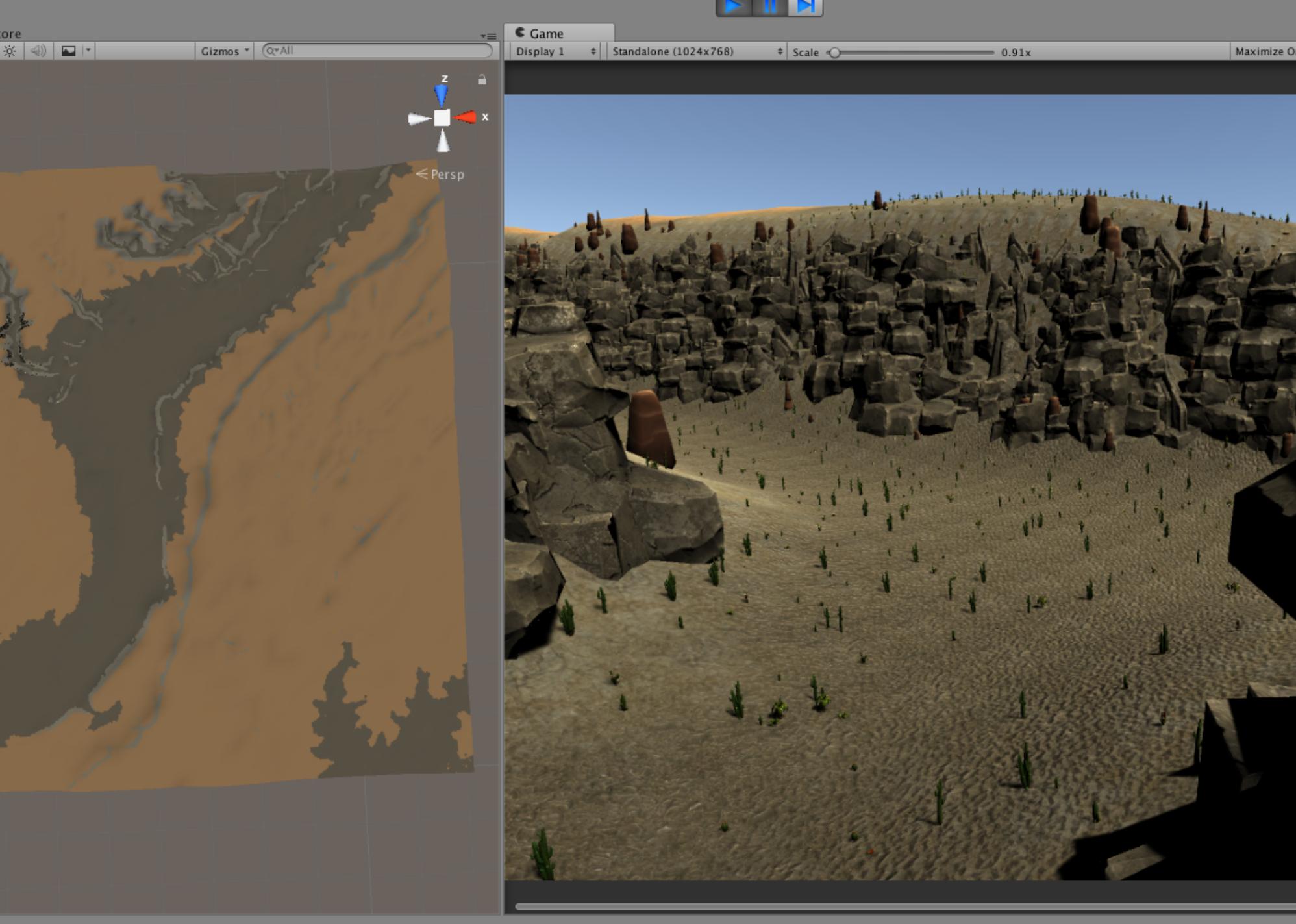
Mesh Collider
Convex
Inflate Mesh
Skin Width
Is Trigger
Material
Mesh

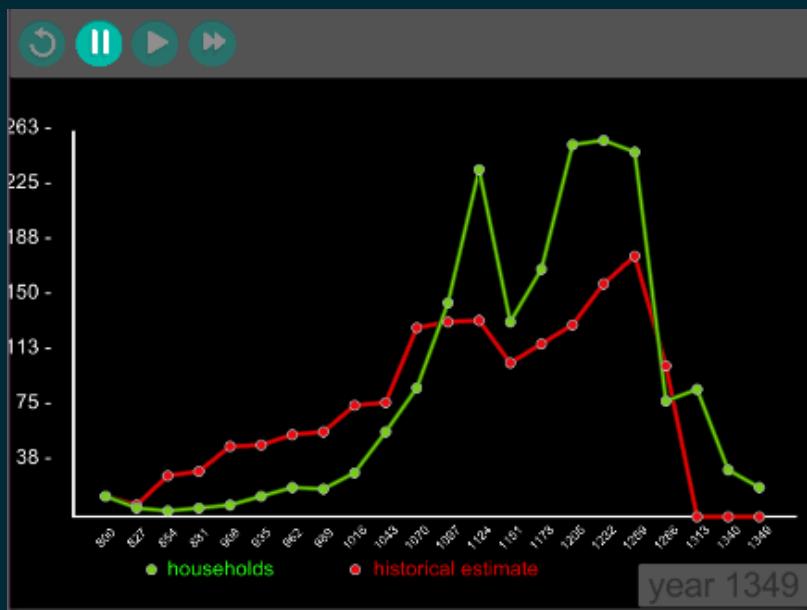
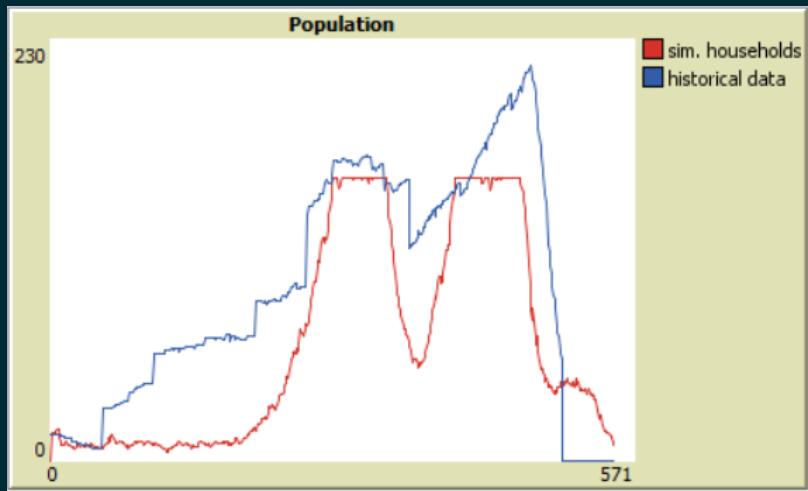
Mesh Renderer
Lighting
Materials

Model Map (Script)
Script
World
View Mode
View Historical Settlements
Historical Settlement Marker

Marker Scale Range
Min
Max

Default-Material (Instance)
Shader Standard





Replication:

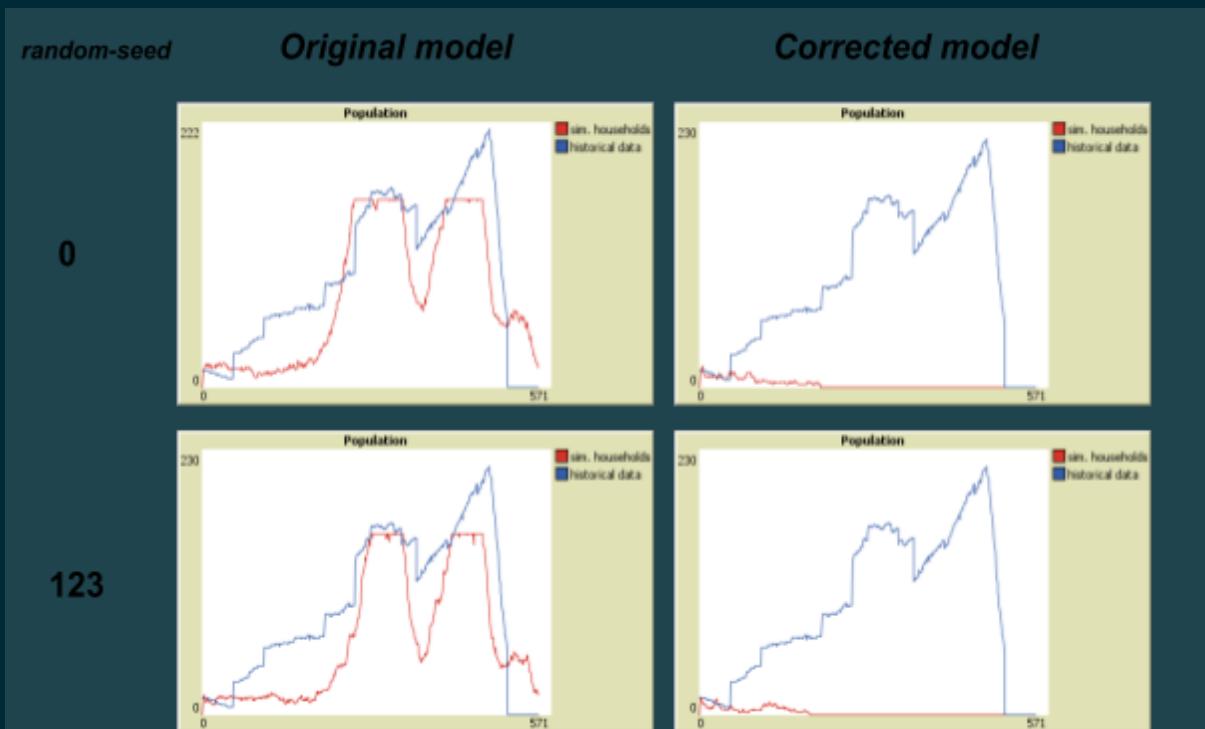
Replication:
More profound understanding of the model

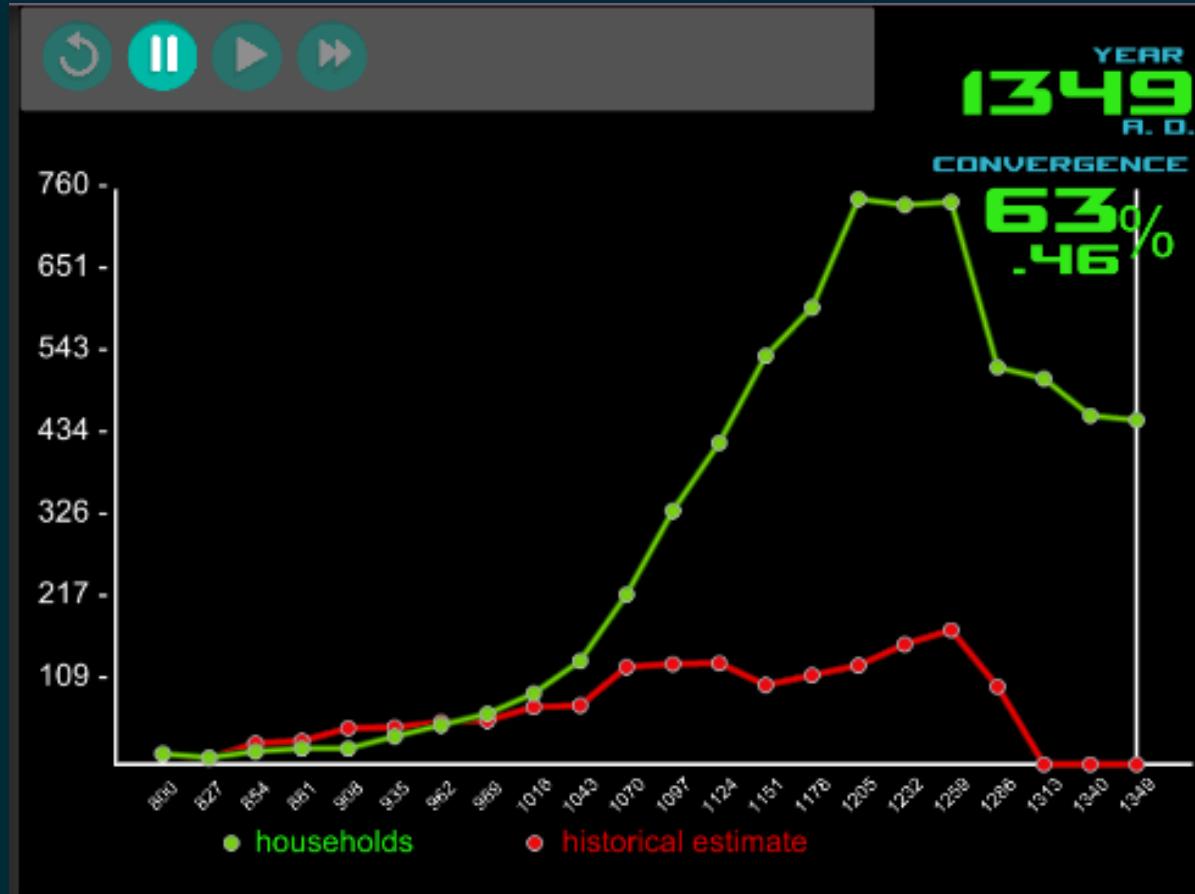
Replication:

More profound understanding of the model

Revealed problematic *assumptions*
and hard-to-spot *mistakes*.

→ a general problem in ABM





corrected and accounting for *individuals* within households

V

THE *WORKING TITLE* GAME

GAME CONCEPT

GAME CONCEPT

The point of the *model*:

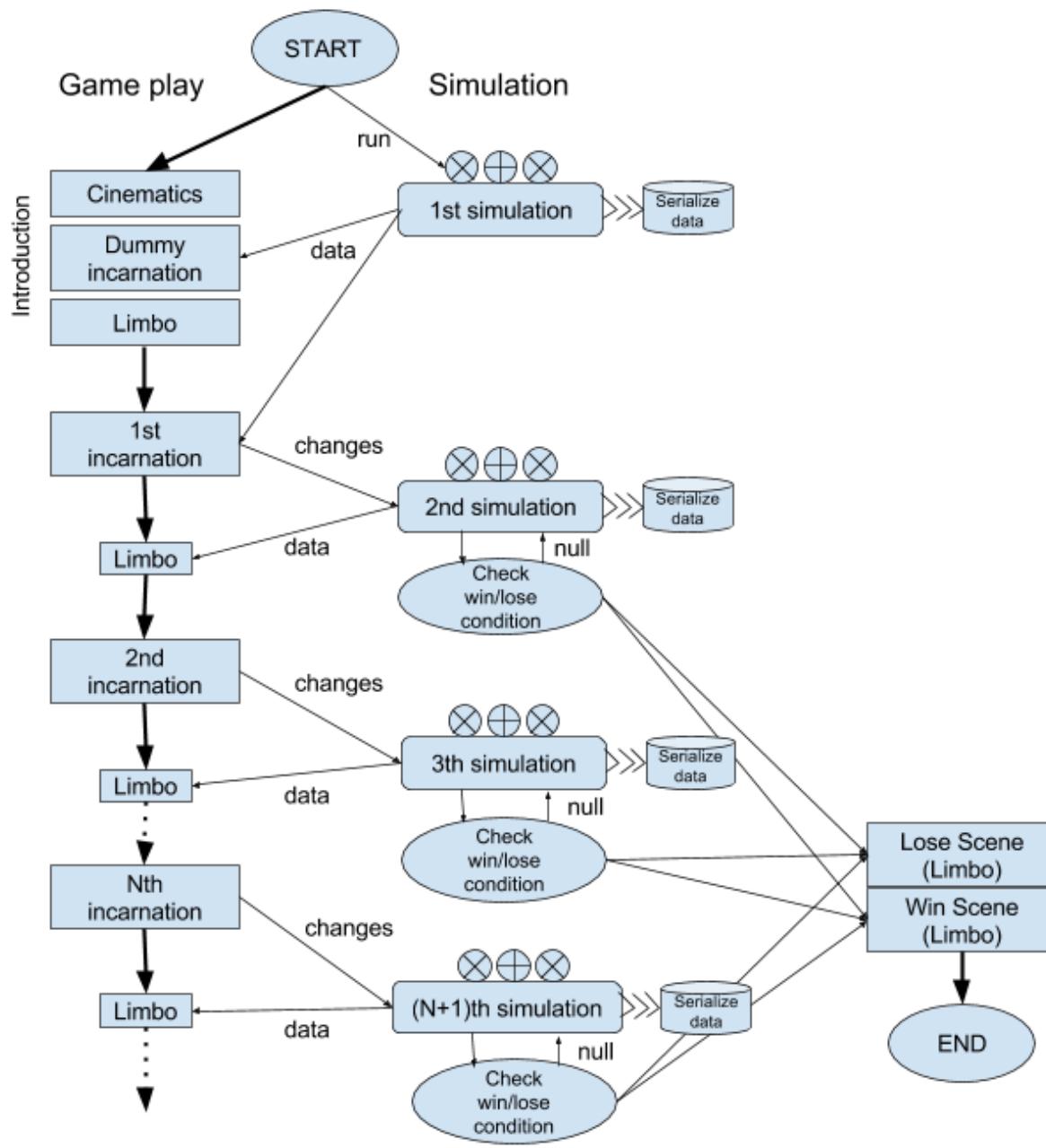
to understand the factors behind the cultural collapse,
*by running the model many times for different parameter
settings*

GAME CONCEPT

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



GAMEPLAY SHOTS

WORKING TITLE



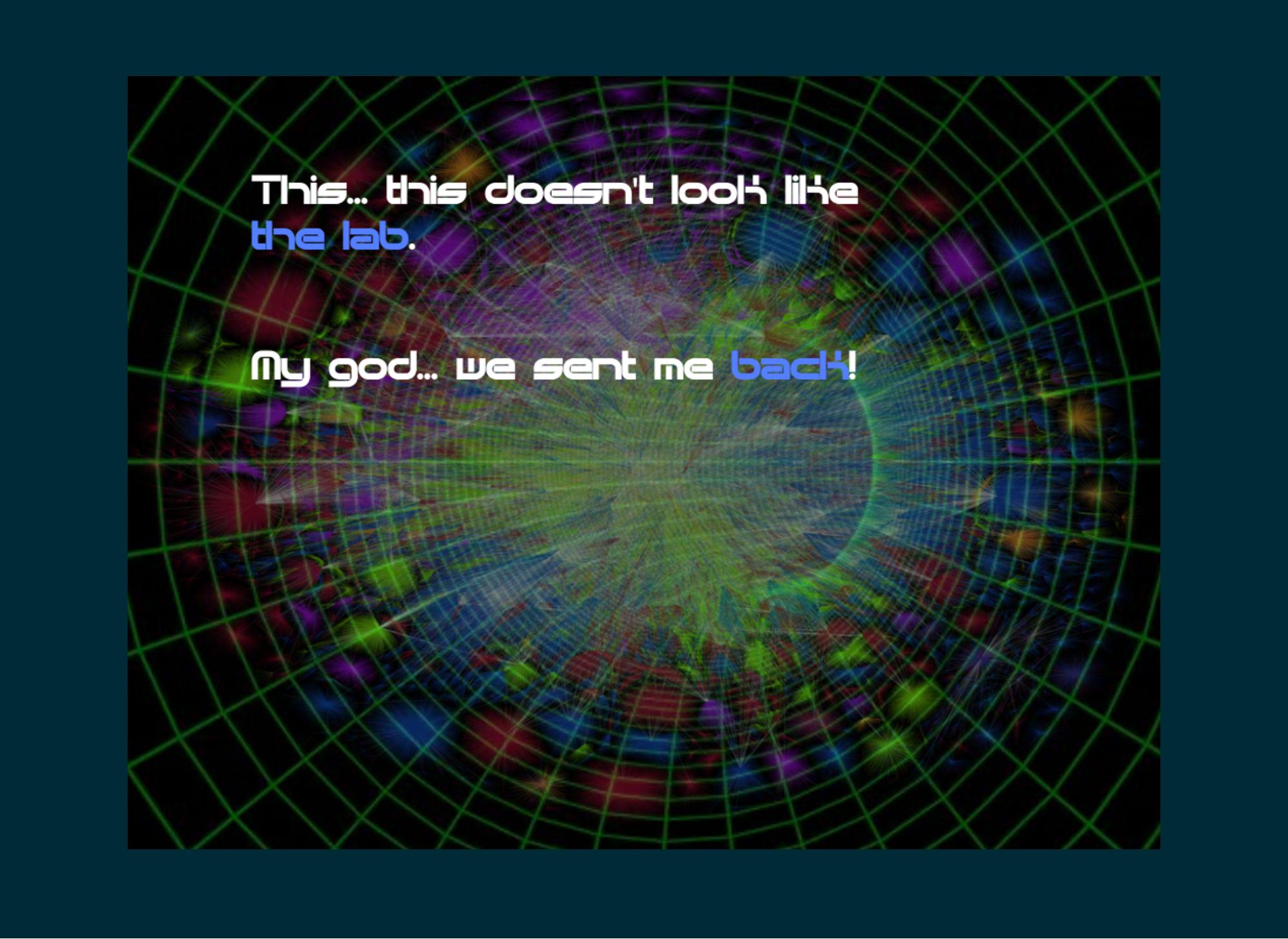
CONTINUE

NEW
GAME

LOAD
GAME

OPTIONS

QUIT



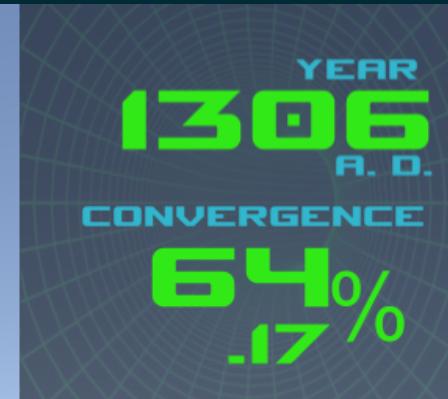
**This... this doesn't look like
the lab.**

My god... we sent me back!



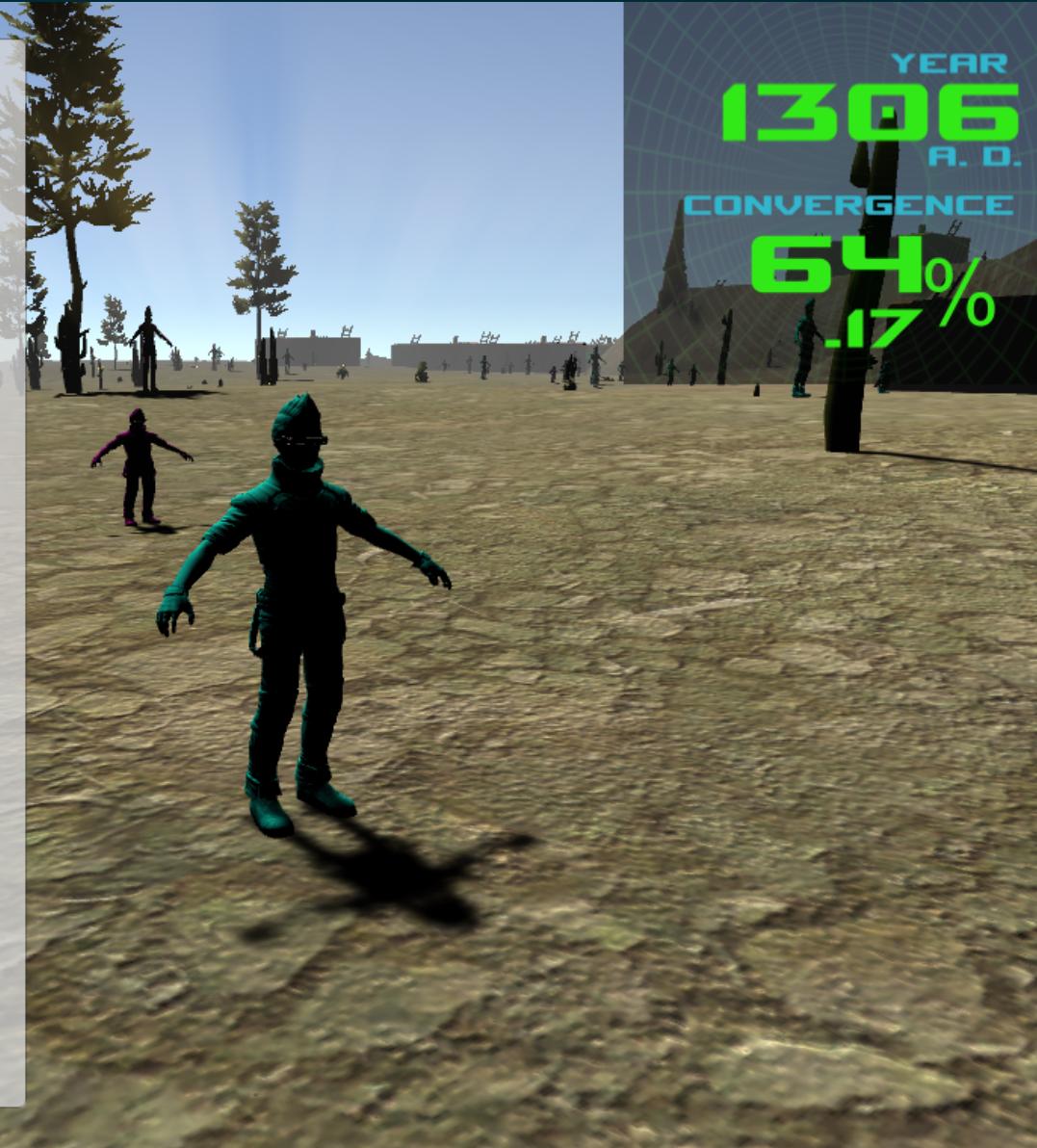
FemaleName09 (Character)

FemaleName09 of the 19
(lineage) people.
She is a mature woman that
has seen 39 maize
harvests.
She lives in household 4791
based at patch (97, 87).



maleName06 (Character)

maleName06 of the B
(lineage) people.
He is a boy that has seen
12 maize harvests.
He lives in household 479
based at patch (37, 87).

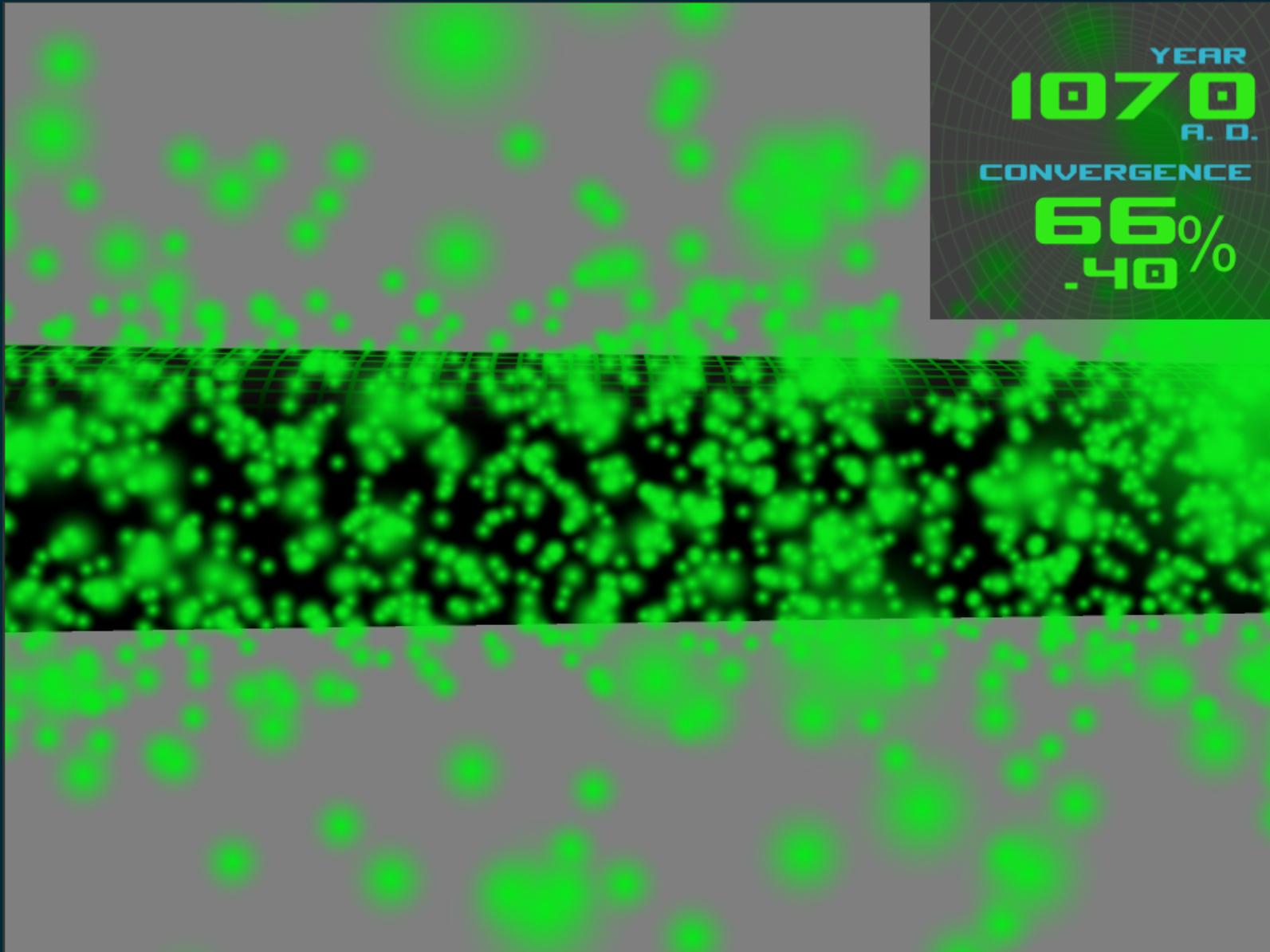
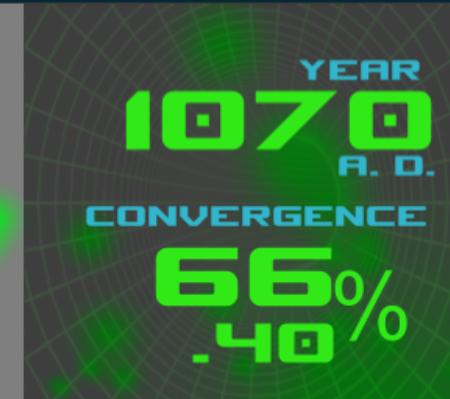


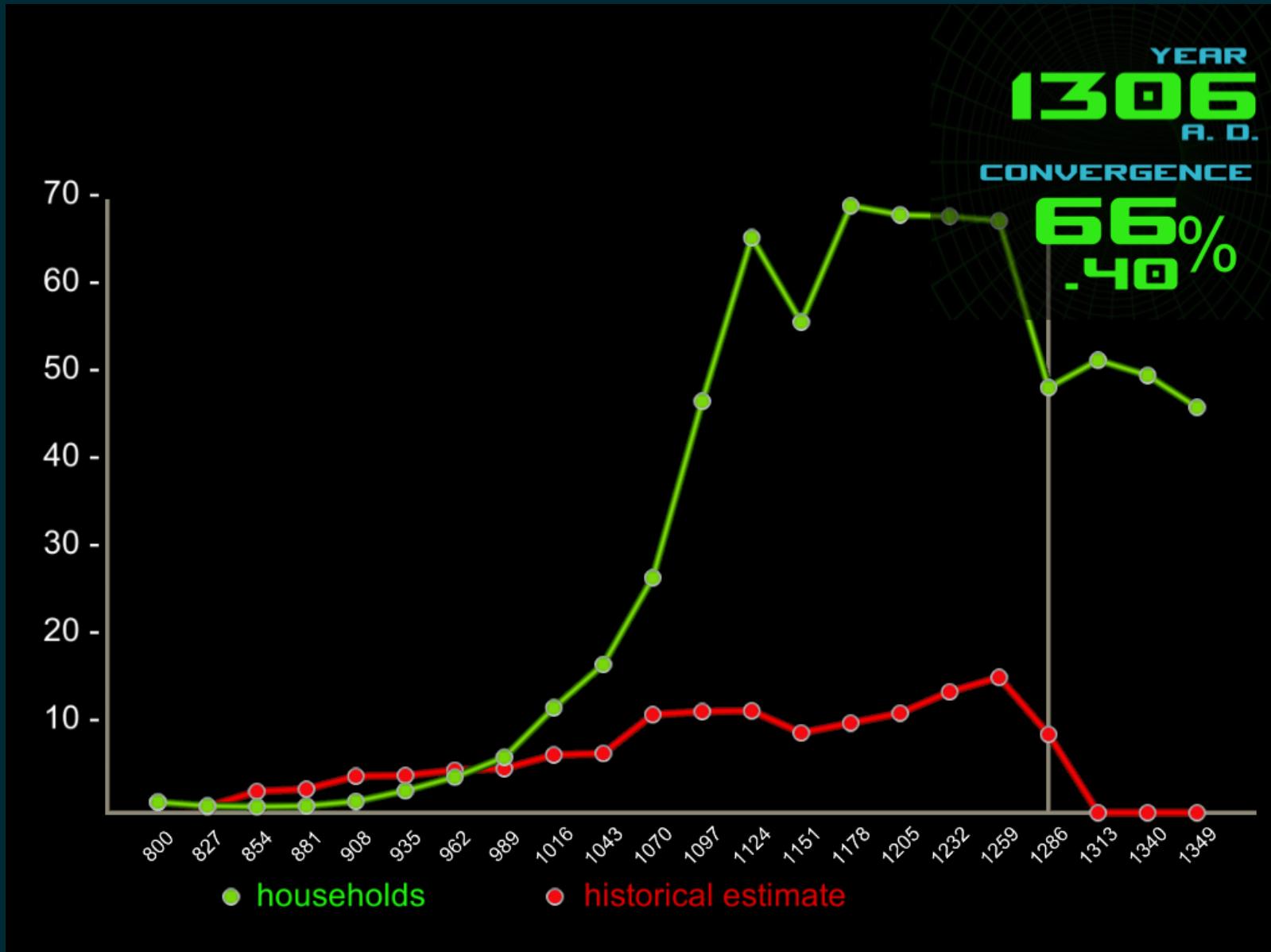


House of the household 321

The household 321 has 23 people.
It descends from household 3 and survived
for 249 years.







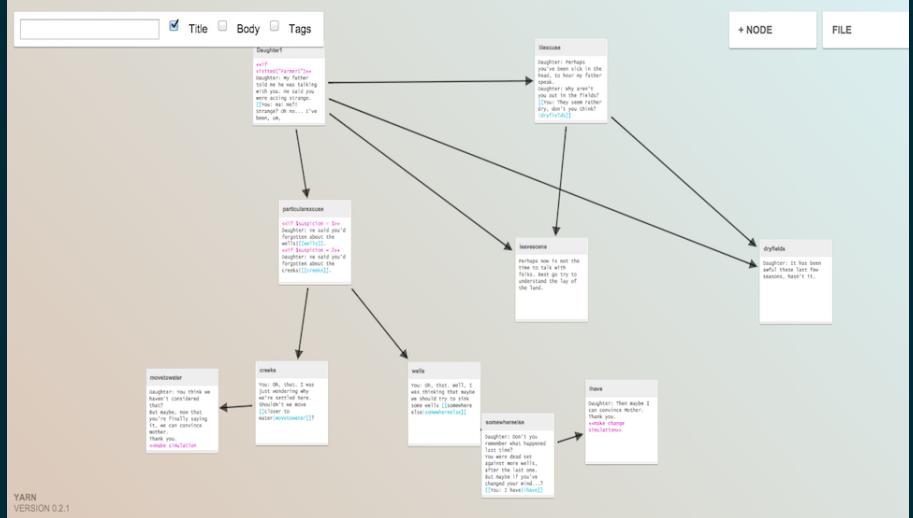
Household 9909

at (29, 55)
lineage = 9
age = 1
adults = 2
couples = 1
max couple count = 3
member ID = {3122,0}
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 = {39,35,39,32,32}
death ages = {54,35,35,44,52}
nutrition need = {16,26748,4255,27,801,2,283739,103,7959}
last harvest = 579345
estimate = 2658527
nutrition overhead =



KEY MECHANISM STILL PENDING...

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



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THANK YOU!

Check our youtube playlist



UNIVERSITAT DE
BARCELONA



THE INTERACTIVE
PASTS
CONFERENCE 2
8-10 October 2018 | the Netherlands Institute for Sound and Vision