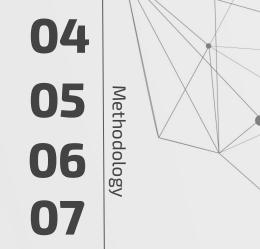# Generation and Simulation of Artificial Human Societies using Anthropologically modelled Learning Agents

Autor: Radu Galan
Mentor: Dr. Czibula Gabriela

TABLE OF CONTENTS

INTRODUCTION

01
ABSTRACT

What?

Abstract

The goal was building general **anthropological social simulations** using an **agent-based system**. Essential components are:

- High quality **modelling**
- A scalable and flexible **architecture**
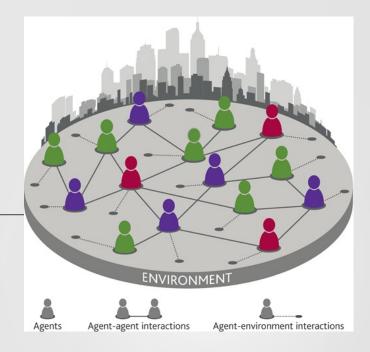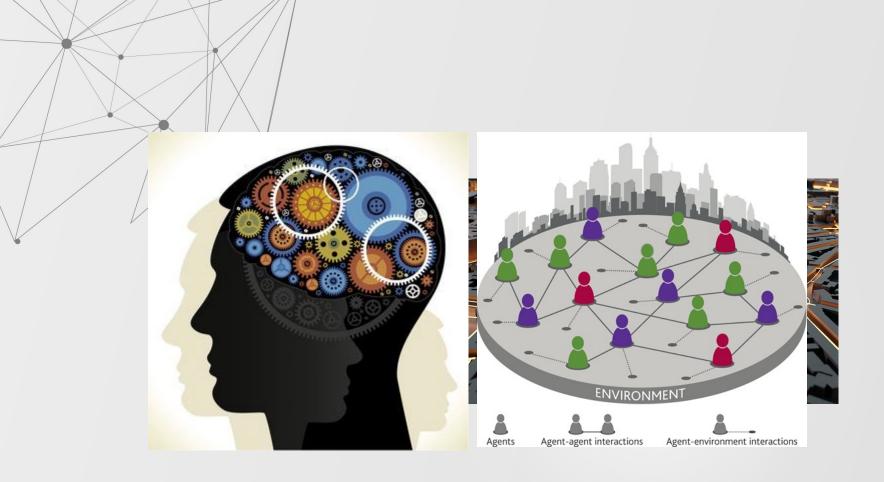- Means of **visualizing** and analysing

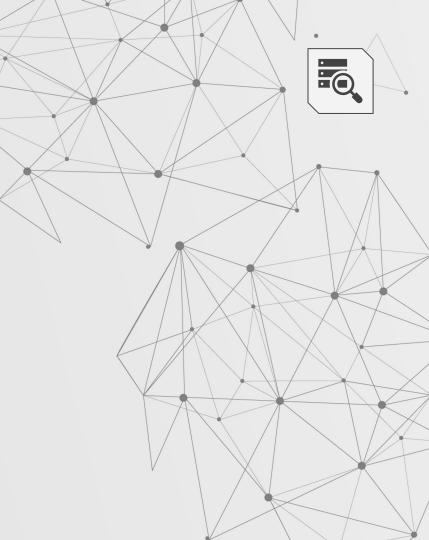# Anthropological model

Computational Model

Agent-based system

Interaction

Agents Agent-agent interactions Agent-environment interactions

ENVIRONMENT

02
MOTIVATION

Why?

Motivation

Sociological

Motivation

Ecological

(…) artificial societies offer "insight into the relationship between micro-level cognition and macro-level social behavior"

Drennan - JASSS vol. 8

Only by 'growing' a society in simulations we can declare that it is thoroughly understood
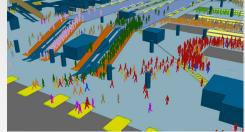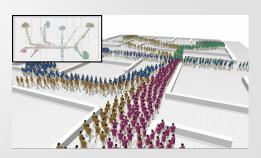
Joshua M. Epstein

03
RELATED WORK

RELATED WORK

Specific simulations

aircraft evacuation
fire evacuation
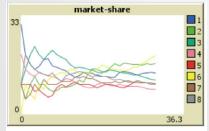crowd control
traffic flow optimization
Electronic market analysis

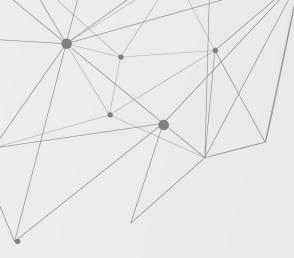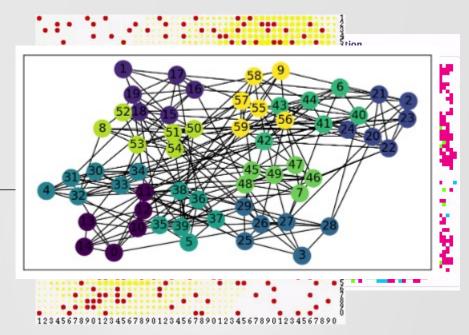market-share

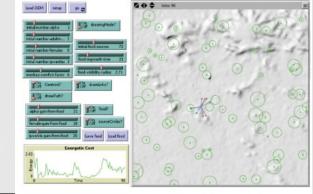Figure 3-a: GraphyOM effect on market share
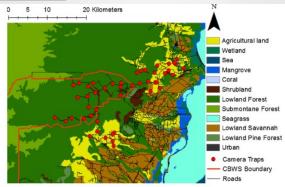
RELATED WORK

General simulations

Conway & Schelling
Sugarscape
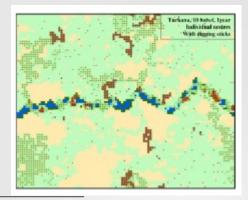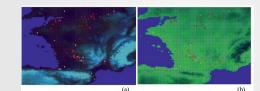Complex social networks

RELATED WORK

Spatially-explicit simulations
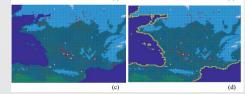
Wild-life simulations of jaguars
Wild-life simulations of capuchins

RELATED WORK

Social simulations (anthropological)
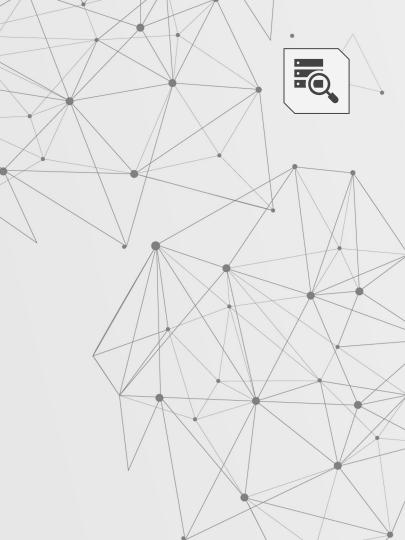
Hominids: ABS (Australopithecus boisei)
Virtual Neanderthals

METHODOLOGY

04
THE DESIGN

How?
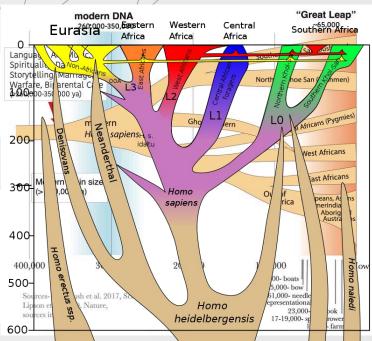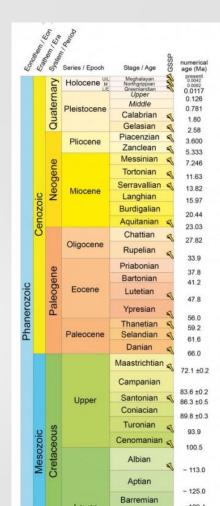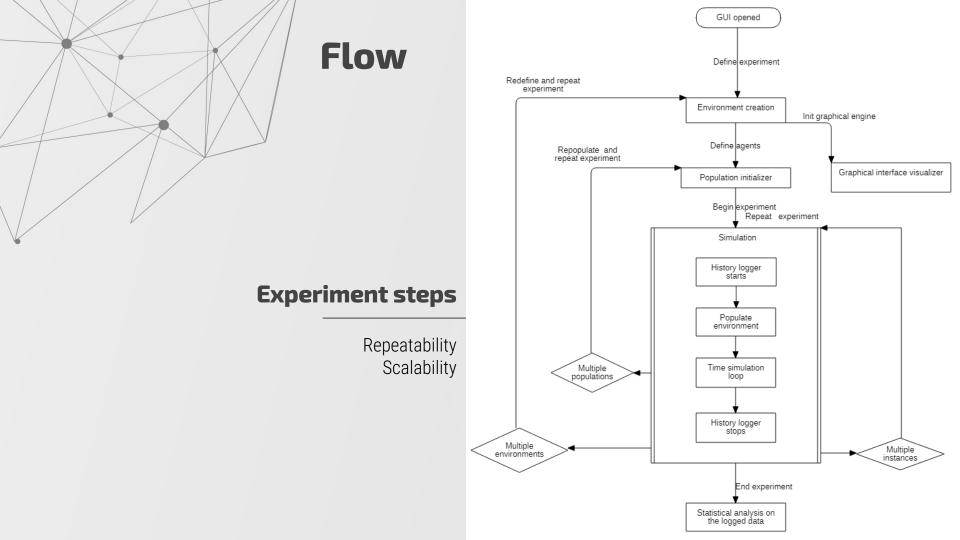
Agent-Based Social Simulation

Who?   Homo S Sapiens
Where?   EUROPE
What?   Hunter-Gatherer uncontested
When?   500'000 – 0
                    100'000 – 0
                    100'000 – 11'000
                      40'000 – 11'000
                    (Late Pleistocene)
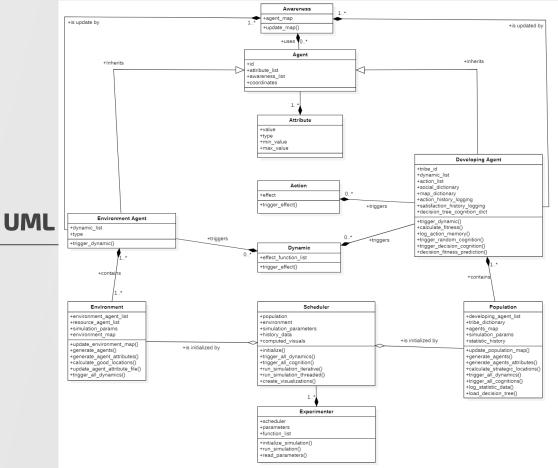
Compromises

The trade-offs

Causality vs Large scale
Generalization vs Performance
Low-level modelling vs Time

Architecture

UML
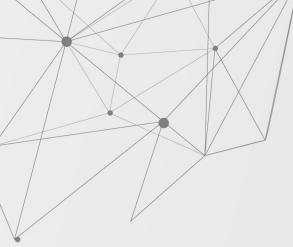
05
MODELLING & DATA

Modelling

Iterative

Statistical
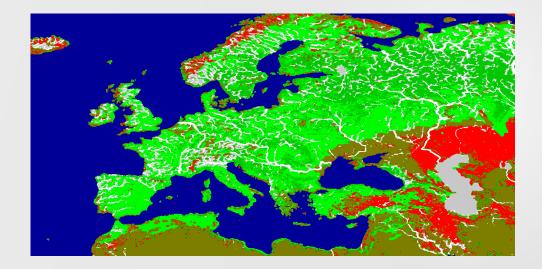
Context

- Homo S Sapiens
- EUROPE
- Hunter-Gatherer uncontested
- 40'000 – 11'000   (Late Pleistocene)

Environment

- -20° → 60° longitude; 30° → 70° latitude
- Cylindrical map projection

Environment
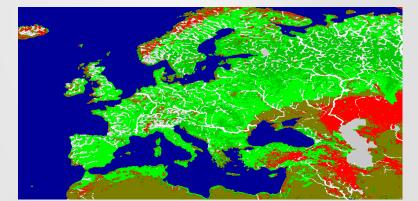
SPATIALLY EXPLICIT TERRAIN
- resolution 80x160: 1951 km2 in one cell
- resolution 160x320: 487.8 km2 in one cell
- resolution 320x640: 121.9 km2 in one cell
- resolution 480x960: 54.2 km2 in one cell
- resolution 800x1600: 19.5 km2 in one cell

Environment

Environment

ELEVATION

Climate

10 Meter Wind Vectors,   Valid: 2100 UTC Thu 04 Jun 2009 (dx=1.5 km)

Climate

DAY

NIGHT
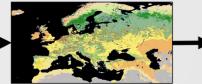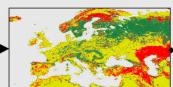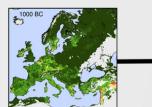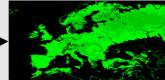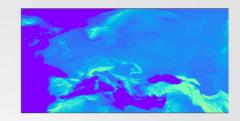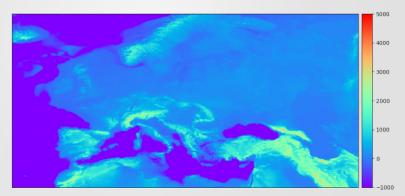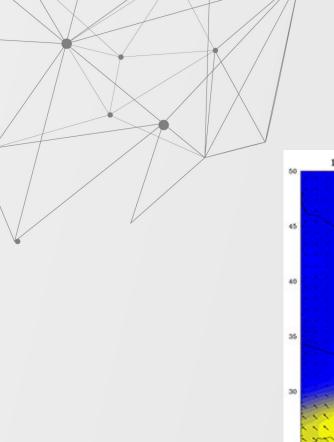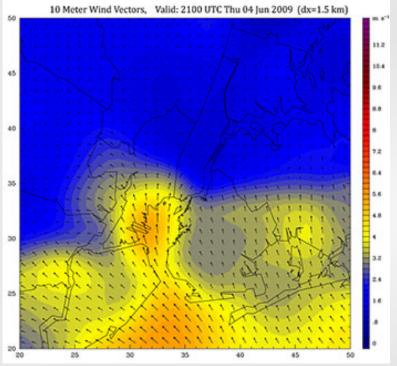
TEMPERATURE
20 years modern dataset
8 days time step

Resources

Food source:
- Plant population:
  EnvironmentAgent->ResourceAgent

3 types of plants:
- high cal. Fruits
- mid cal. Roots/Vegetables
- herbs and spices (health benefits)

Resources

Plant attributes:
- color {1,2,3}
- energy (0,700] – calories per 100g
- heal [0,3] – health points
- quantity [1,100] – multiple of 100g
- population [100,1000] * avg. area of cell
- probability for each terrain [0,100], …, [0,100]
- probability preferred temperature for ripping[-30,70]
- probability referred month for ripping [1,12]
- spread ability [0,100]
- Sensibility [0,100]
- current food

Plant dynamics:
- Population fluctuation
- Food production

Humans

Memory:
- Human social status
- Places fondness

Dynamics:
- Aging
- Needs changing
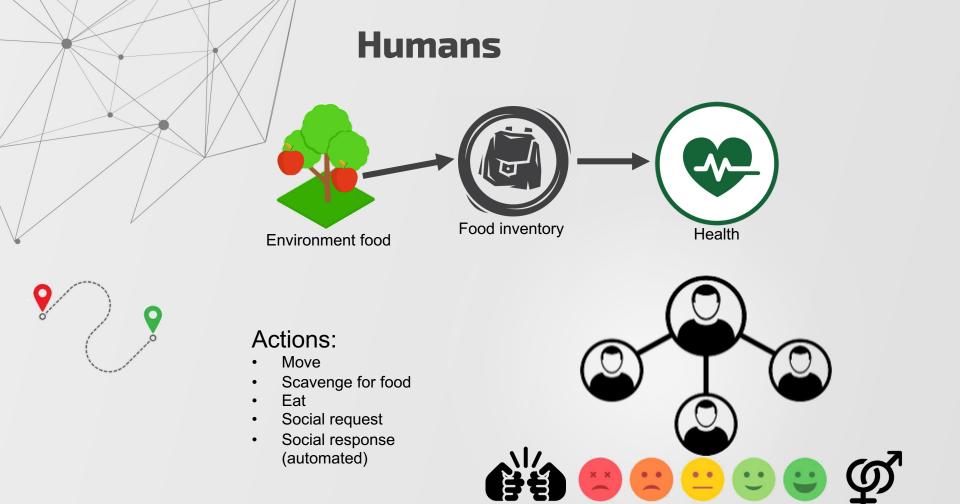
Actions:
- Move
- Eat
- Scavenge for food
- Social request
- Social response (automated)
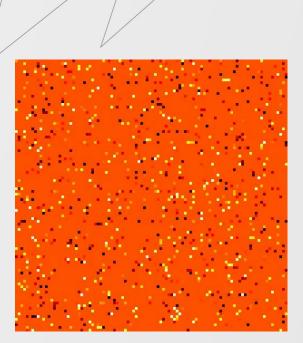
Attributes:
- age (0,100)
- sex {0,1}
- health [1,100] – health points
- fitness [1,100]
- Hunger need [0,100]
- Thirst need [0,100]
- Reproductive need [0,100]
- Safety need [0,100]
- Emotional State [0,100]
- Plant find ability [0,100]
- Social interaction ability [0,100]
- Food Inventory
- Character
- Offspring

human_sex

human_age

human_health

Humans

Environment food → Food inventory → Health

Actions:
- Move
- Scavenge for food
- Eat
- Social request
- Social response (automated)

06
EXPERIMENTS

Architecture Testing

An environment
One environment agent in each square
One attribute: temperature
One dynamic: convection
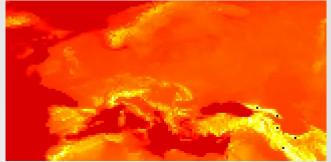
Environment
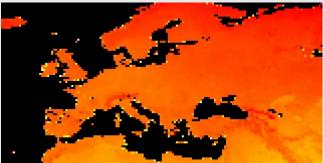
Surface day temperature

Surface elevation
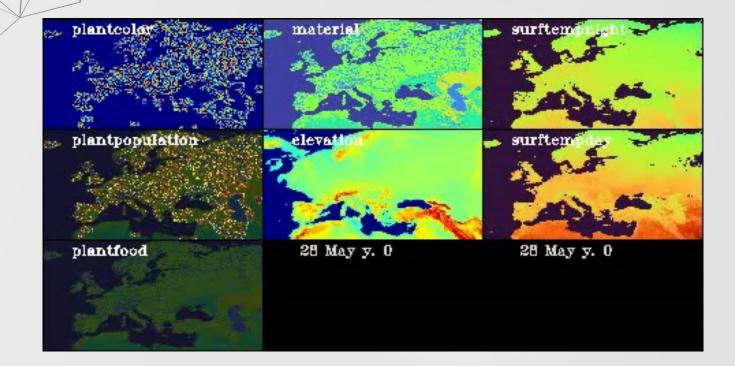
Surface night temperature

Surface terrain
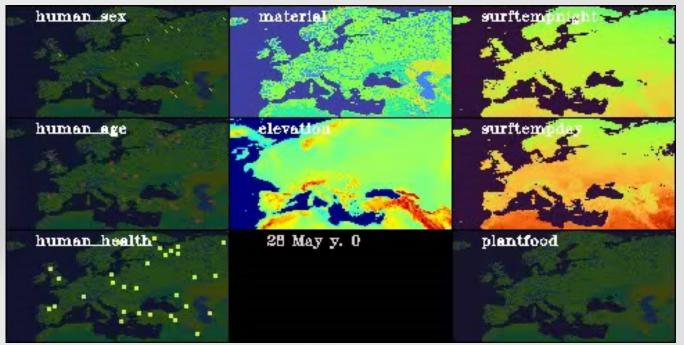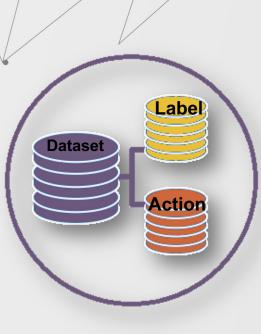
Environment with resources

Environment with resources and non-intelligent humans

Random decision-making

Environment with resources and intelligent humans

Fitness label: health, emotional-state, hunger, thirst, reproductive

Circumstances:
Relation to another human attr. (4)
Target environment attr.(8)
Resource attributes(Plants Color)
Personal State attr. (8)
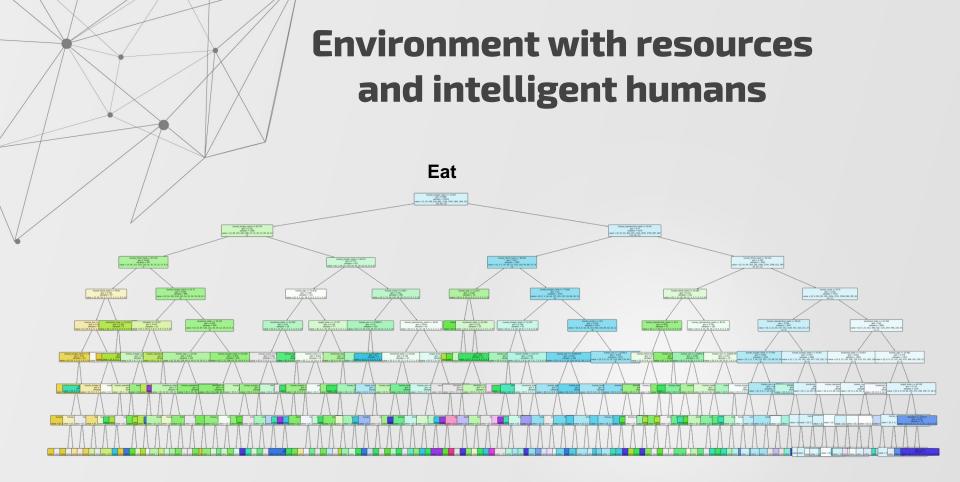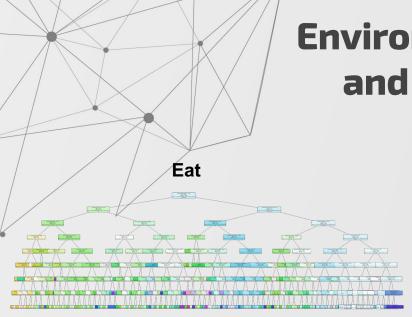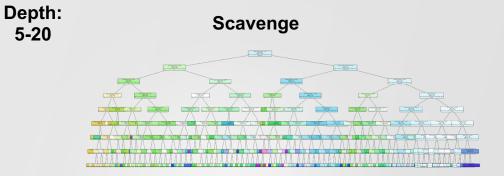
Environment with resources and intelligent humans

Move Action

Scavenge

Eat

Request

Environment with resources and intelligent humans

Eat

Environment with resources and intelligent humans

Eat

Depth: 5-20

Scavenge

Move
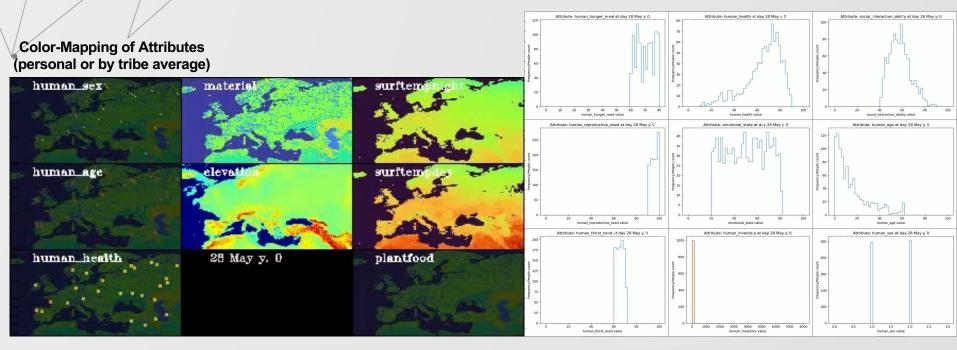
Social request

Environment with resources and intelligent humans

Imagine – Think – Decide
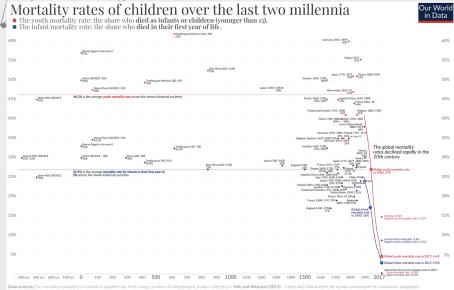
Global Attribute Histogram
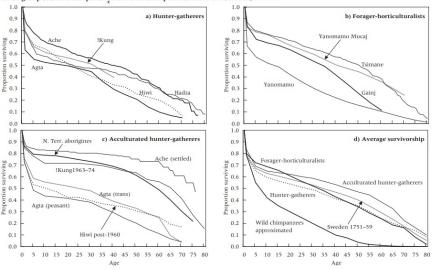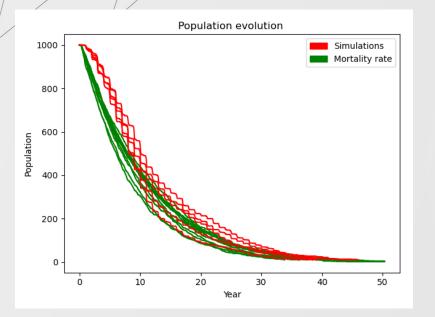
Color-Mapping of Attributes (personal or by tribe average)

07
VALIDATION

Mortality

Mortality rates of children over the last two millennia

- The youth mortality rate: the share who **died as infants or children** (younger than 15).
- The infant mortality rate: the share who **died in their first year of life.**

Our World in Data

FIGURE 1 Survivorship (l_x) for (a) hunter-gatherers, (b) forager-horiculturalists, and (c) acculturated hunter-gatherers using the Siler competing hazards model to estimate mortality. Panel (d) illustrates average l_x for each of these group sets and compares l_x from wild chimpanzees and from Sweden, 1751–59

Metrics

Population evolution
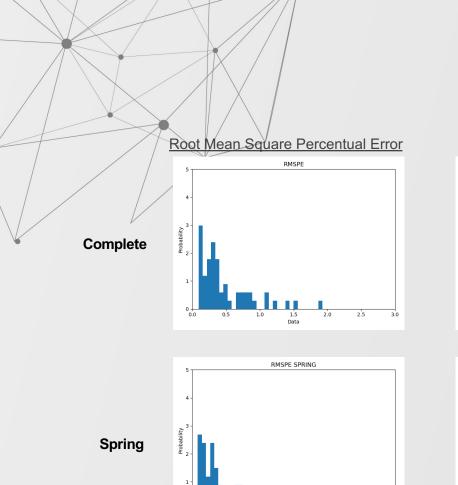
AVG:
MAPE 40.25 min: 7.67   and max: 132.46
RMSPE 0.47 min: 0.095 and max: 1.92

SPRING AVG:
MAPE 37.50 min: 6.93 and max: 123.86
RMSPE 0.44 min: 0.082 and max: 1.91

Metrics
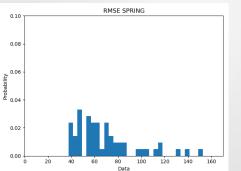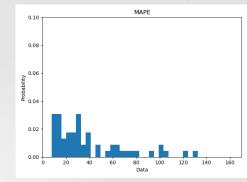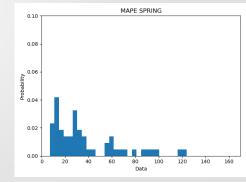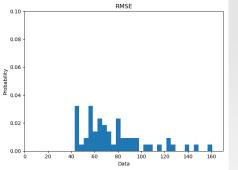
Root Mean Square Percentual Error   Root Mean Square Error   Mean absolute percentage error

Complete

Spring

CONCLUSION

08
CONSIDERATIONS

Considerations

Personal contribution

- One of the few (if not only) Spatially Explicit Social Simulation of early Homo Sapiens
- Unique Data Gathering Results
- SOTA validation process
- Accurately modelled sapiens

Limitations

- Simulation of society from inside a society
- Computational power
- Current social research might have low accuracy

Philosophical

- Social implication of implementation
- Great knowledge, Great responsibility
- Subjective interpretations

09
FUTURE WORK

Future work

Optimization

More parallelization, Better memory allocation, Cloud computing

Extended modelling

Animals, More actions, Settlement study, More specific plant species,
Technologies, Cultural habits, Changing geography, Other hominins

Better visualization

3D animation, More statistical analysis, correlation analysis

More Experiments

Longer experiments with offspring enabled, validation on population growth
or range areas or migration trends

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THANK YOU!