

The University of York

Department of Computer Science

**Submitted in part fulfilment for the degree of BEng.**

# **Evolutionary agent-based simulation modelling of human life-history evolution**

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Version 0.01, 2016-November-15

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Number of words = 2001, as counted by `wc -w`.  
This includes the body of the report only.



### **Abstract**

This is an abstract. Should be about 500 words long.



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# 1 Introduction

## 1.1 Motivation

The cause and evolutionary benefits of menopause is an unsolved problem in biology.

Menopause unsolved problem in biology – many different hypotheses and the more research better can help provide evidence for or against each.

Replicating model can be used to check results found elsewhere

Model can be adapted for use for other hypotheses to do with menopause and/or population modelling.

## 1.2 Aims

To check validity of existing model by replicating it

To rewrite the model into an object oriented language (python)

Address some of its shortcomings (allowing preference to coevolve)

## 1.3 Thesis Outline

**Chapter Two Literature Review** reviewing past work relevant to the project

**Chapter Three Problem Description** looking at what the problem consists of

**Chapter Four Design and Implementation** designing a solution to the problem

**Chapter Five Results and Evaluation** presenting and analysing the results produced by the solution

**Chapter Six Conclusion** making judgement of the solution and the results, suggesting new work.

## **1.4 Statement of Ethics**

Model – no ethical concerns although eugenics is questionable at best.

## **2 Literature Review**

Project is covering computational models of populations to try and understand how menopause might be caused by evolution, therefore it is important to talk about them.

### **2.1 Agent Based Modelling**

#### **2.1.1 Explantion**

#### **2.1.2 Applications**

### **2.2 Genetic Algorithms**

#### **2.2.1 Explanation**

#### **2.2.2 Applications**

#### **2.2.3 Relationship to evolution**

## **2.3 Menopause**

What is menopause. Somatic vs reproductive senescence. Short vs long PRLS.

Which animals has it been show to occur in (Humans, Short Finned Pilot Whales, Orcas (Killer Whales)) Wild vs captive. Human vs Primates.

Possible reasons for menopause Patriarch Hypothesis, Grandmother, reproductive conflict. Overview in [1]

### 2.3.1 Patriarch Hypothesis

The Patriarch Hypothesis [2] hypothesises that menopause came about due to older, high status males having access to younger female mates allowing them to reproduce for much longer. This increased the proliferation of genes linked to longevity, increasing both the lifespan of males and females. This is reliant on several factors:

- That females have a limited number of oocytes (immature ova) which are depleted over time, and that reproduction naturally comes to an end when they run out. [3] In early females, before female longevity increased, most females died before their supply of oocytes had been completely depleted, and so did not experience menopause.
- That longevity causing mutations are on the X rather than the Y chromosome. If the gene were on the Y chromosome then the increase longevity would only be present in the males. The paper suggests that female longevity (and therefore have long post reproductive lifespans) is a result of females being "dragged along" by male longevity being passed on through the X chromosome.
- That older men continue to reproduce and pass on their longevity causing genes. High status males (normally those with a better reputation for hunting and gathering) would start a new family with a second, younger wife once their first wife had undergone menopause. Thus males carrying longevity causing genes would have greater opportunity to pass them on.

A deterministic model of the hypothesis was created [4], which models

. was created but this is not without its problems, the main problem being that model but this has fixed age of end of reproduction –

Stochastic model done in [5] – main focus of report. Fixes many of the flaws of [4] (including removing the fixed age of the end of reproduction) but still has problems.

### **2.3.2 Grandmother hypothesis**

Grandmothers aid young through knowledge etc

### **2.3.3 Reproductive conflict**

Grandmothers stop reproducing so that their offspring are not competing with their grandchildren for resources. [6]

### **2.3.4 Other hypotheses**

Follicular depletion, healthcare/lifespan improvements - not evolutionary but epiphenomenon, Risk from late age reproduction.

## **2.4 Evolution**

Overview [7]

### **2.4.1 Key concepts/terms**

#### **Selection**

Description of selection

#### **Mutation**

Description of mutation

#### **Crossover**

Description of crossover

#### **Coevolution**

Description of co-evolution

## **2.5 Modelling in biology**

### **2.5.1 Deterministic modelling**

Populations often modelled with exponential growth/differential equations

### **2.5.2 Stochastic modelling**

Multiagent systems, genetic algorithms, neural networks, machine learning to reduce dimensionality,

## **2.6 Conclusions from Literature**

### **3 Problem Description**

This should be about 1500 words long.



## **4 Design and Implementation**

This should be about 2500 words long.

## **5 Results and Evaluation**

This should be about 2500 words long.

## **6 Conclusion**

This should be about 1000 words long.

## Bibliography

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