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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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

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 it 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 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]

2.1.1 Patriarch hypothesis

Proposed by [2] , Males having preference for younger females caused menopause

Deterministic model done in [3] but this has fixed age of end of reproduction – something not true now.

Stochastic model done in [4] – main focus of report. Fixes many of the flaws of [3] (including removing the fixed age of the end of reproduction) but still has problems.

2.1.2 Grandmother hypothesis

Grandmothers aid young through knowledge etc

2.1.3 Reproductive conflict

Grandmothers stop reproducing so that their offspring are not competing with their grandchildren for resources. [5]

2.1.4 Other hypotheses

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

2.2 Evolution

Overview [6]

2.2.1 Key concepts/terms

Selection
Description of selection

Mutation
Description of mutation

Crossover
Description of crossover

Coevolution
Description of co-evolution

2.2.2 Biological relevance to project

Project looking at evolution of long post-reproductive lifespans

2.2.3 Computational relevance to project

Genetic crossover and mutation computational models can be used for modelling actual evolution of genes.

2.3 Modelling in biology

2.3.1 Deterministic modelling

Populations often modelled with exponential growth/differential equations

2.3.2 Stochastic modelling

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

2.4 Conclusions from Literature

3 Problem Description

This should be about 1500 words long.

4 Design and Implemenation

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

[1] D. P. Croft, L. J. Brent, D. W. Franks, and M. A. Cant, "The evolution of prolonged life after reproduction," *Trends in Ecology & Evolution*, 2015. [Online]. Available: http://www.sciencedirect.com/science/article/pii/S0169534715001044

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[3] S. D. Tuljapurkar, C. O. Puleston, and M. D. Gurven, "Why men matter: Mating patterns drive evolution of human lifespan," *PLOS ONE*, 2007. [Online]. Available: http://dx.doi.org/10.1371%2Fjournal.pone.0000785

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[5] D. P. Croft, R. A. Johnstone, S. Ellis, S. Nattrass, D. W. Franks, L. J. N. Brent, S. Mazzi, K. C. Balcomb, J. K. B. Ford, and M. A. Cant, 2017.

[6] C. Darwin, *On the origin of species*. John Murray, 1859.