IMPERIAL COLLEGE LONDON

MASTER OF RESEARCH PROJECT PROPOSAL

A new tool for quantifying the response of metabolic traits to climate change

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December 10, 2018

Keywords

Ecoinformatics; Metabolic theory; Climate change; Mathematical modelling; Temperature; Ecology.

Introduction

Temperature is fundamental to the rate at which energy and materials are reorganised in individuals, communities and ecosystems [Brown et al., 2004]. The intrinsic function of temperature in biological systems allows for insights to be made about how life might respond in the face of an ever changing thermal environment. In recent years, a wealth of research has been produced with the specific purpose of understanding biological responses to temperature [Dell et al., 2011] [Thomas et al., 2012]. However, far less research has been devoted to assessing the quantitative tools available to researchers striving to answer this complex question. Given the importance of this topic in the context of global climate change, it is imperative to approach data analysis with precision and care. For example, biogeographical estimates derived from the same data, with even the best-fitting models, have differed by the equivalent of a decade of predicted warming [Low-Décarie et al., 2017]. Significant fluctuation in results can also arise due to the quality of data used in fitting models. One key example of this, is the difference found in activation energy estimates due to variation in the range of temperatures measured [Pawar et al., 2016]. Thus, this project aims to unravel the mathematical architecture of the models available to metabolic theorists and reevaluate them given the data accessible today. In addition to this, I aim to construct an innovative tool to aid in the model fitting process and encourage overlap of practice between researchers in this field.

Methods

The data used in this project will be taken from the published BioTraits database [Dell et al., 2013]. Firstly, the scope of data quality will be investigated with two parameters; the range of temperature values taken and the frequency with which these values are recorded. Following this, the current mathematical models pertaining to metabolic theory will be implemented into Python modules. At this stage, it will be possible to compare the performance and precision of each model to various different levels of data quality using maximum likelihood and bayesian methods. In understanding the shortcomings of both data and models at this basal level, it will then be possible to make assessments of model robustness at higher level of realism. The python modules will undergo rigorous testing to ensure transparency and cross-platform compatibility. Eventually, these will be synthesised into a concise package as away of distributing a relevant collection of mathematical models for general use.

Anticipated outcomes and results

This project aims to provide a candid account of the flaws and shortcomings in the current quantitative tools used for analysing thermal responses. It will investigate the importance of precision, over generality and reality in the model fitting process. In the creation of a python package, I hope that this will inform decision making and efficiently contribute a robust set of computational methods to peers. In addition to this, the project will lay a statistical groundwork for elucidating higher level ecological questions such as population and coevolutionary dynamics.

Project feasibility

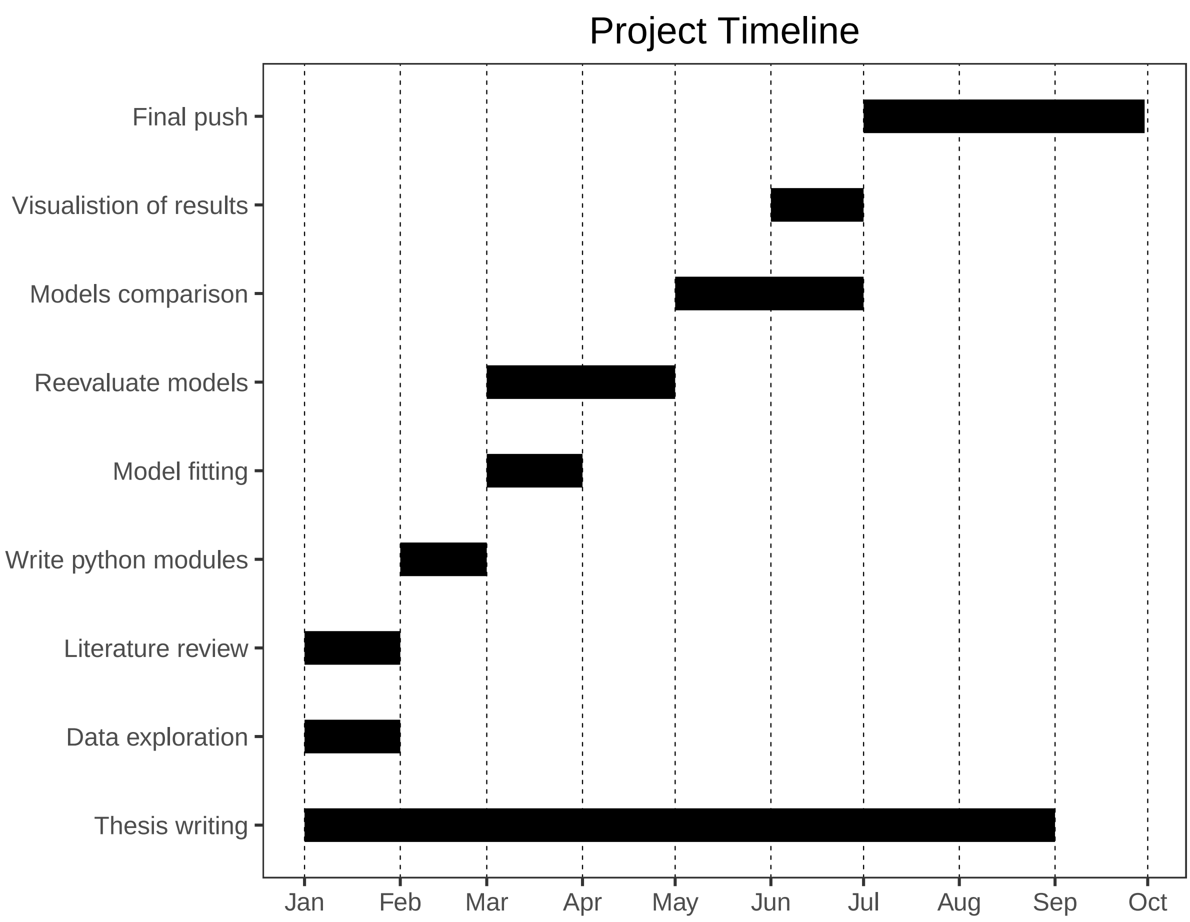

Figure 1: A Gantt chart outlining the approximate amount of time given to each main task between Januray 2019 and September 2019.

Budget

Activity	Justification	Cost
High Performance Computing Time	Running computationally intensive analyses	£200
Train fare	Visits to collaborators	£100
Miscellaneous conferences	Networking	£200
		£500

References

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I have seen and approved the proposal and budget:

Supervisor	Date