

Evolution of emergence strategies

How organisms combine cues to make decisions

Collin Edwards Louie Yang

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Table of Contents

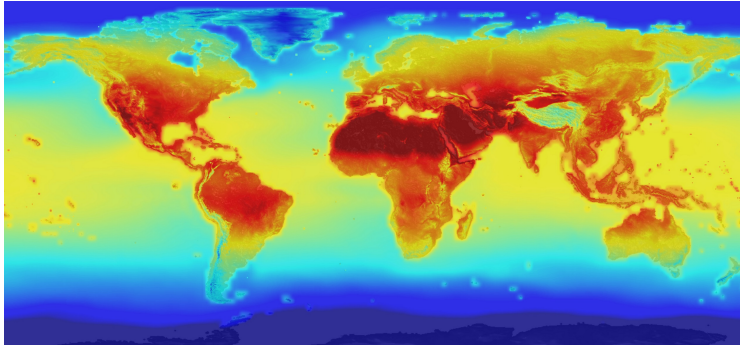
1 Introduction

2 Simulation

3 Predictive Framework







Goals

- Provide base-line model for multiple-cue decisions
- Develop predictions for the use of phenological cues

Table of Contents

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Basics

Let's start by imagining a very simplified system:

- Organisms decide when to emerge/germinate based on trait values and environmental cues

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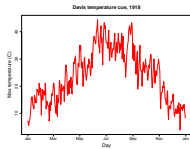
- Organisms decide when to emerge/germinate based on trait values and environmental cues
- Organisms collect resources (\sim fitness) based on abiotic conditions for a set duration after emerging (10 days)

Basics

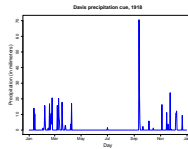
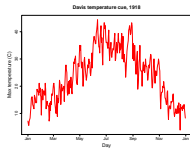
Let's start by imagining a very simplified system:

- Organisms decide when to emerge/germinate based on trait values and environmental cues
- Organisms collect resources (\sim fitness) based on abiotic conditions for a set duration after emerging (10 days)
- Lottery model reproduction: parents produce offspring proportional to resources gathered, each offspring has equal chance of filling one of the N 'slots' for adults in the next generation

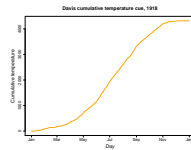
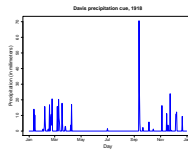
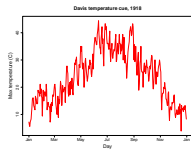
Emergence Cues



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Emergence

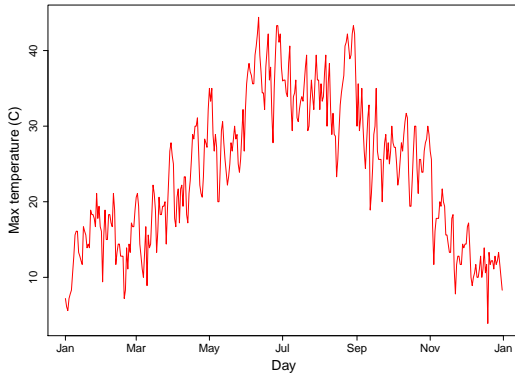
Every day, organisms combine environmental cues and traits to get an 'E' value:

$$E = \frac{\text{photoperiod cue}}{\text{photoperiod trait}} + \frac{\text{temperature cue}}{\text{temperature trait}} + \dots$$

If $E > 1$, organism decides to emerge!

Trait interpretation, simple example

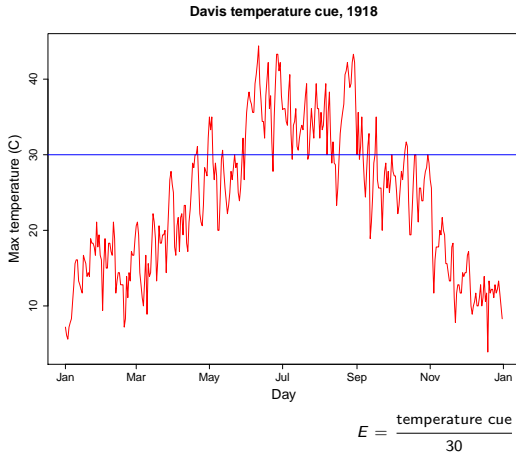
Davis temperature cue, 1918



$$E = \frac{\text{temperature cue}}{30}$$

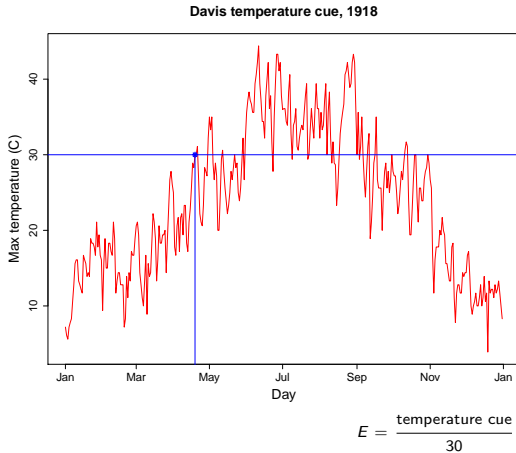
Temp trait = 30,
other cues not in
use.

Trait interpretation, simple example



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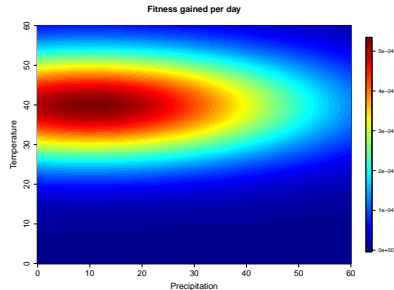
Temp trait = 30,
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Fitness

- After emergence, collect resources each day (for 10 days)
- Daily resources based on temp and precip

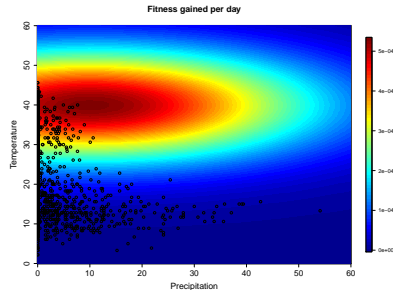
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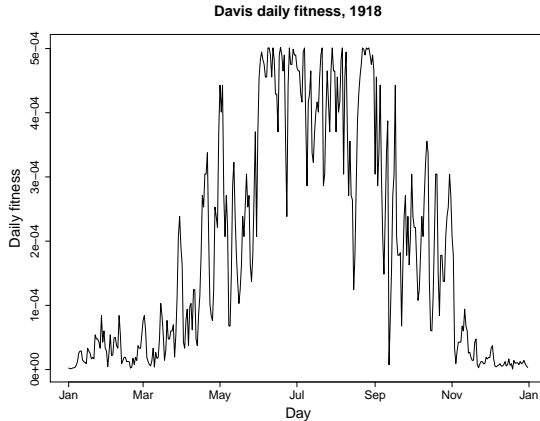


Fitness

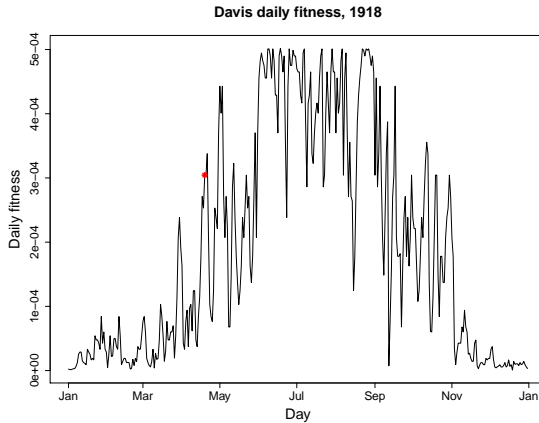
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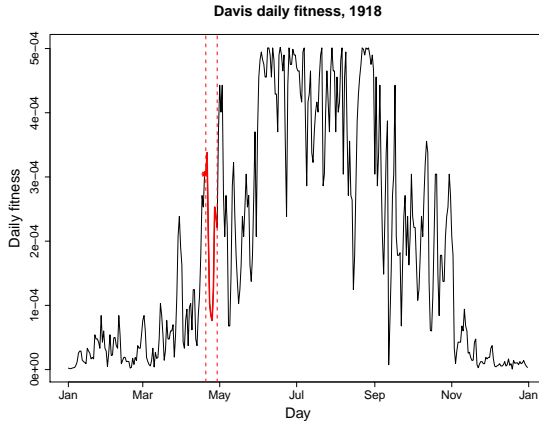
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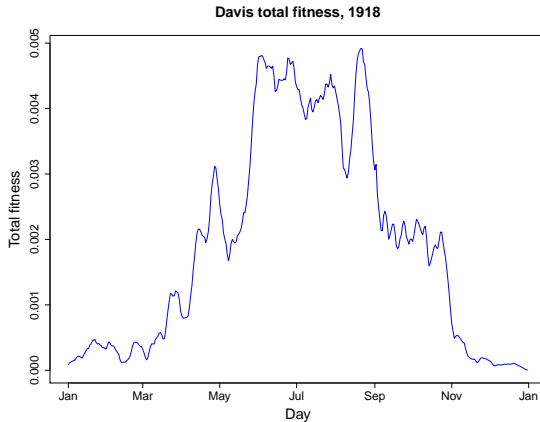
Fitness



Fitness



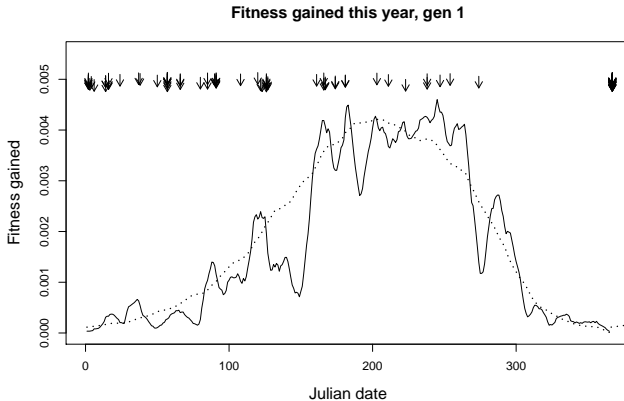
Fitness



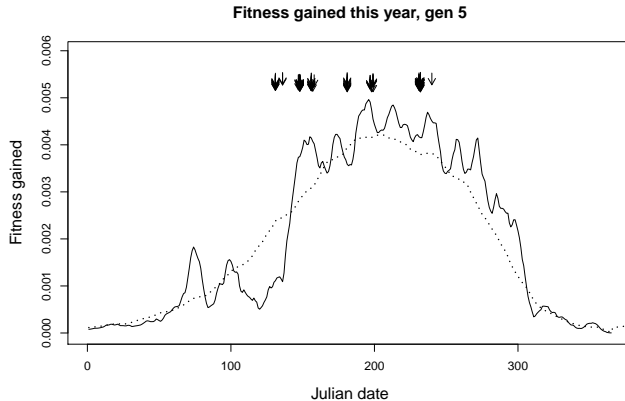
Reproduction: Lottery Model

- Fixed population size for all generations
- Assign offspring randomly proportional to fitness
- Offspring traits = parent + mutation (asexual)

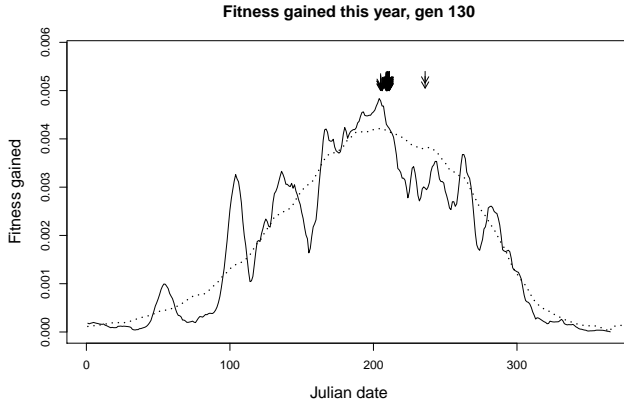
Simulation results



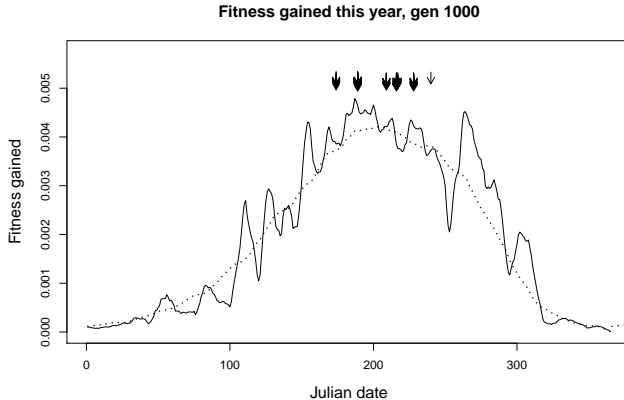
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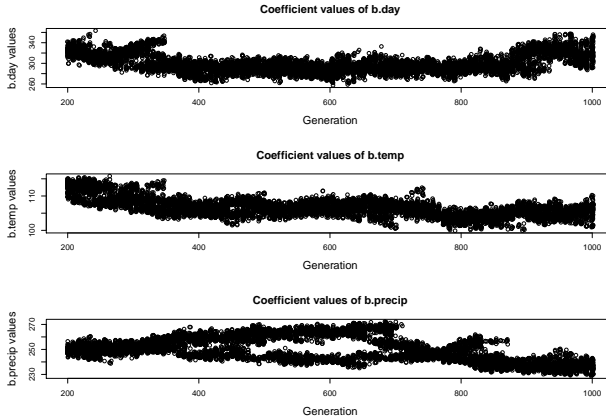
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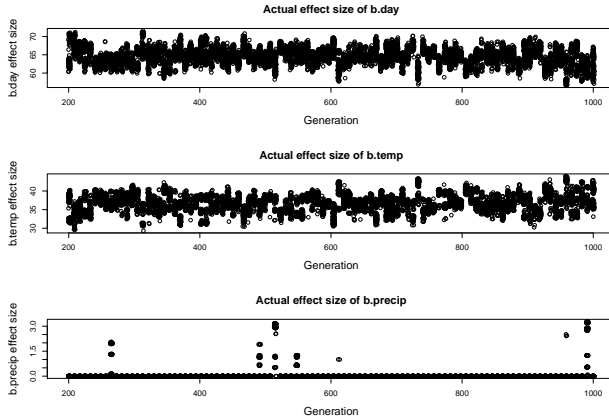
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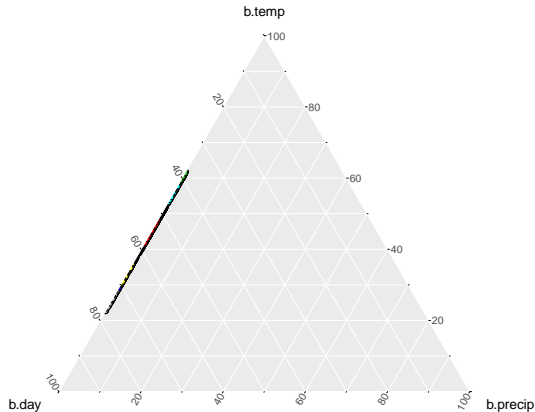


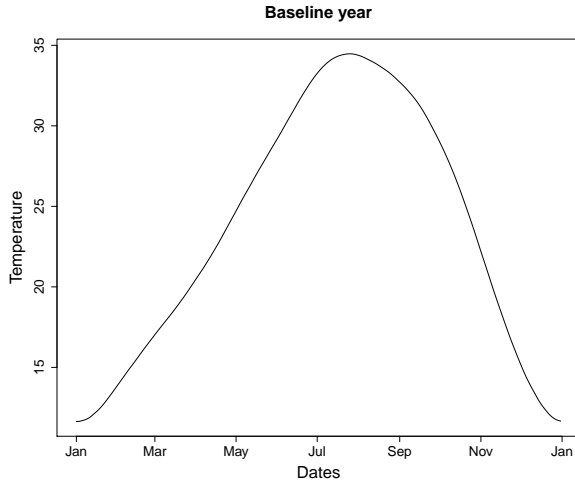
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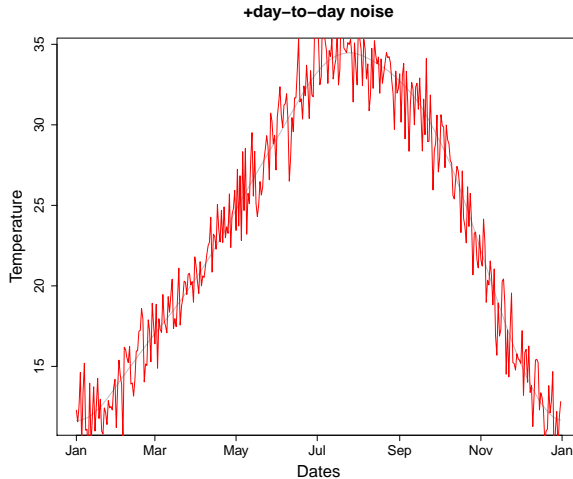
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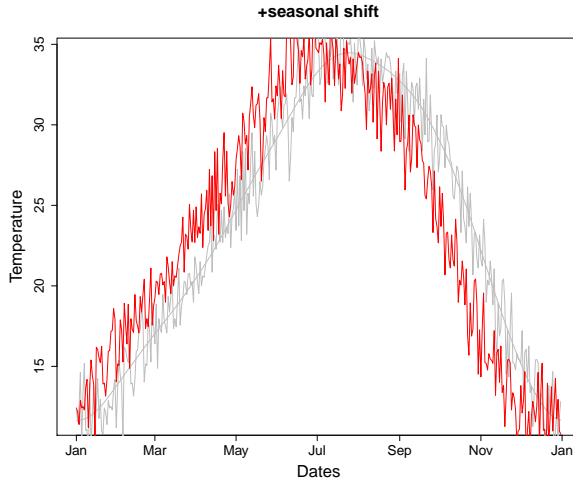
Baseline year



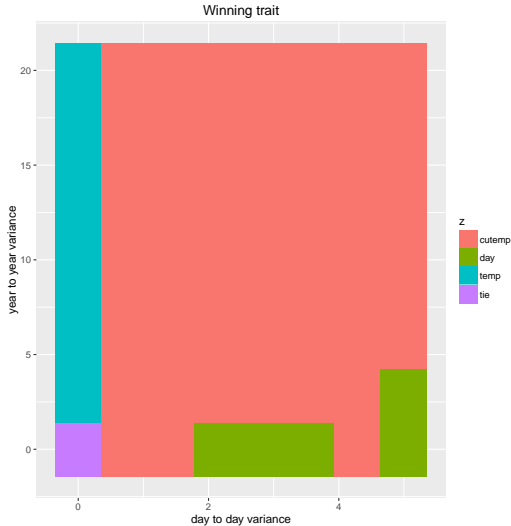
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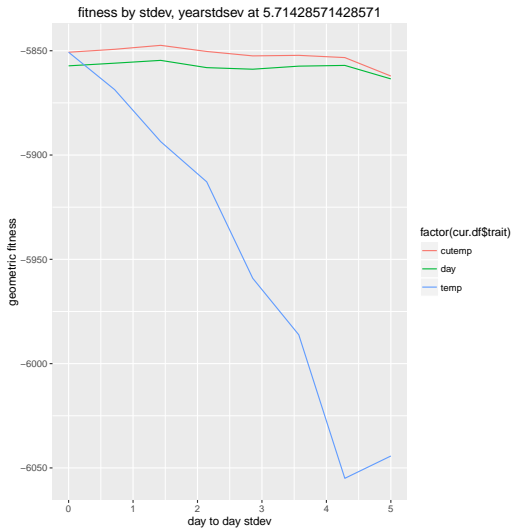
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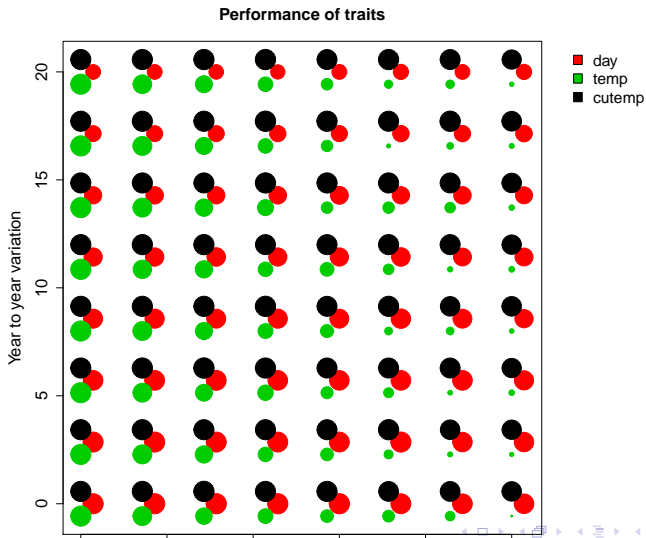
Optimal traits



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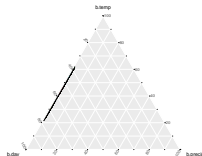


Conclusion

$$E = \frac{\text{photoperiod cue}}{\text{photoperiod trait}} + \frac{\text{temperature cue}}{\text{temperature trait}} + \dots$$

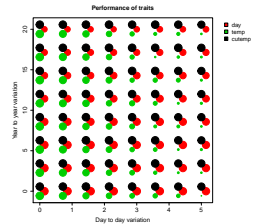
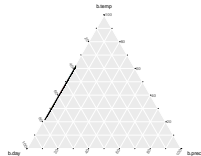
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Questions or suggestions?

