



Geonomics Lab (Part 2)

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*Lab created by: Drew Terasaki Hart, Natalie Graham, Monica Wilkinson
and Keeley Takimoto*


Creating a GitHub account

1. Go to <https://github.com/>
2. Click Sign up
3. Sign up with your **berkeley email**
4. Follow the prompts to create your personal account.
5. Pick your username carefully, you will likely not want to change it (but you can). Some recommendations:
 - a. Use part of your real name so it is easier for people to know who you are
 - b. Try and keep it short, you may have to type it a lot
 - c. Keep everything lowercase. If you really want to separate words, use a hyphen (-) or an underscore (_)

GitHub Codespaces

1. Go to <https://github.com/TheWangLab/espm154>
2. Click the green "Code" button in the top right
3. Click "Open with Codespaces".
4. Wait for the codespace to load. This will take several minutes.
5. Open the "espm154_lab6" ipynb file
6. When you run a cell you will be prompted to pick a kernel: click "Python environment" and then the first item on the list which has a star next to it (conda)

Tips:

1. If you hover over the plots, you can copy the image by clicking this icon:  *This may be useful in answering the lab exercises and keeping track of the simulations.*
2. You can download your notebook by right clicking on the file and selecting "Download" (you may have to click "Accept" on a pop-up first)

Evolutionary Simulations in **Geonomics**

Geonomics: Forward-Time, Spatially Explicit, and Arbitrarily Complex Landscape Genomic Simulations

Drew E Terasaki Hart , Anusha P Bishop, Ian J Wang

Molecular Biology and Evolution, Volume 38, Issue 10, October 2021, Pages 4634–4646,
<https://doi.org/10.1093/molbev/msab175>

Published: 12 June 2021

*Simulation of **local adaptation** and **speciation** across realistic landscapes*

Parameters = Recipe

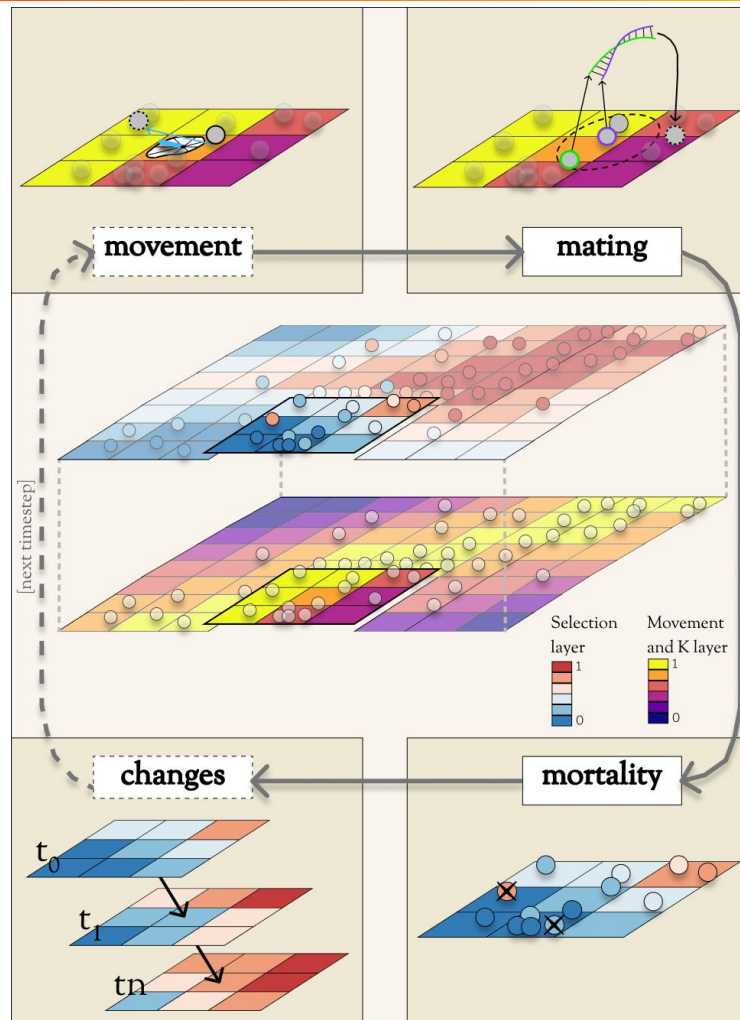


Brownie in a Mug

- 3 tablespoons sugar
- 3 tablespoons flour
- 1 ½ tablespoons cocoa powder
- 1 ½ tablespoons melted butter
- 3 tablespoons milk
- ¼ teaspoon vanilla extract

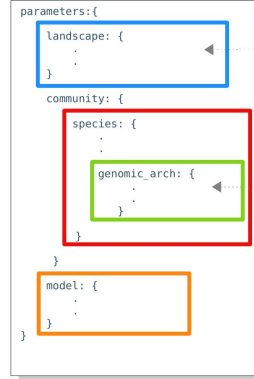
=

```
'mug_brownie': {  
  'sugar': 3  
  'flour': 3  
  'cocoa_powder': 1.5  
  'melted_butter': 1.5  
  'milk': 3,  
  'vanilla_extract': 0.25  
}
```



1.) Create and edit a parameters file

parameters file:



Optional: Include paths to raster files and/or directories of environmental-change rasters

raster file:



raster directory:

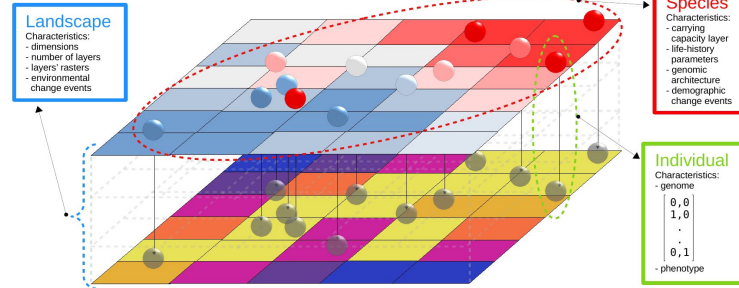


Optional: include path to a genomic architecture file (.csv)

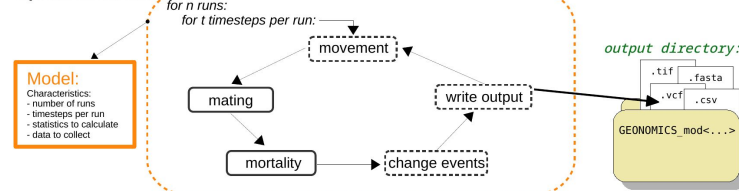
genomic architecture file:

loc,	p,	dom,	r,	trait,	alpha,
1,	0.5,	0,	0.5,	,	,
1,	0.5,	0,	0.5,	,	,
1,	0.5,	0,	0.01,	0,	0.5,
1,	0.5,	0,	0.01,	1,	0.5,
1,	0.5,	0,	0.01,	2,	0.5,
1,	0.5,	0,	0.5,	,	,
1,	0.5,	0,	0.5,	,	,
,	,	,	,	,	,
,	,	,	,	,	,

2.) Use the parameters file to create a model



3.) Run the model



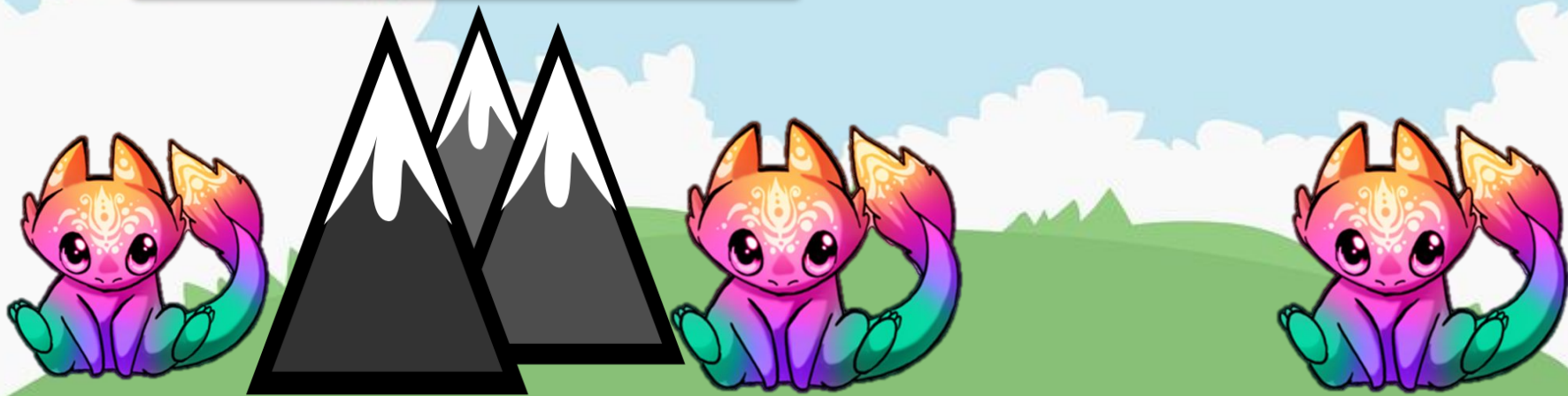
How does speciation occur?



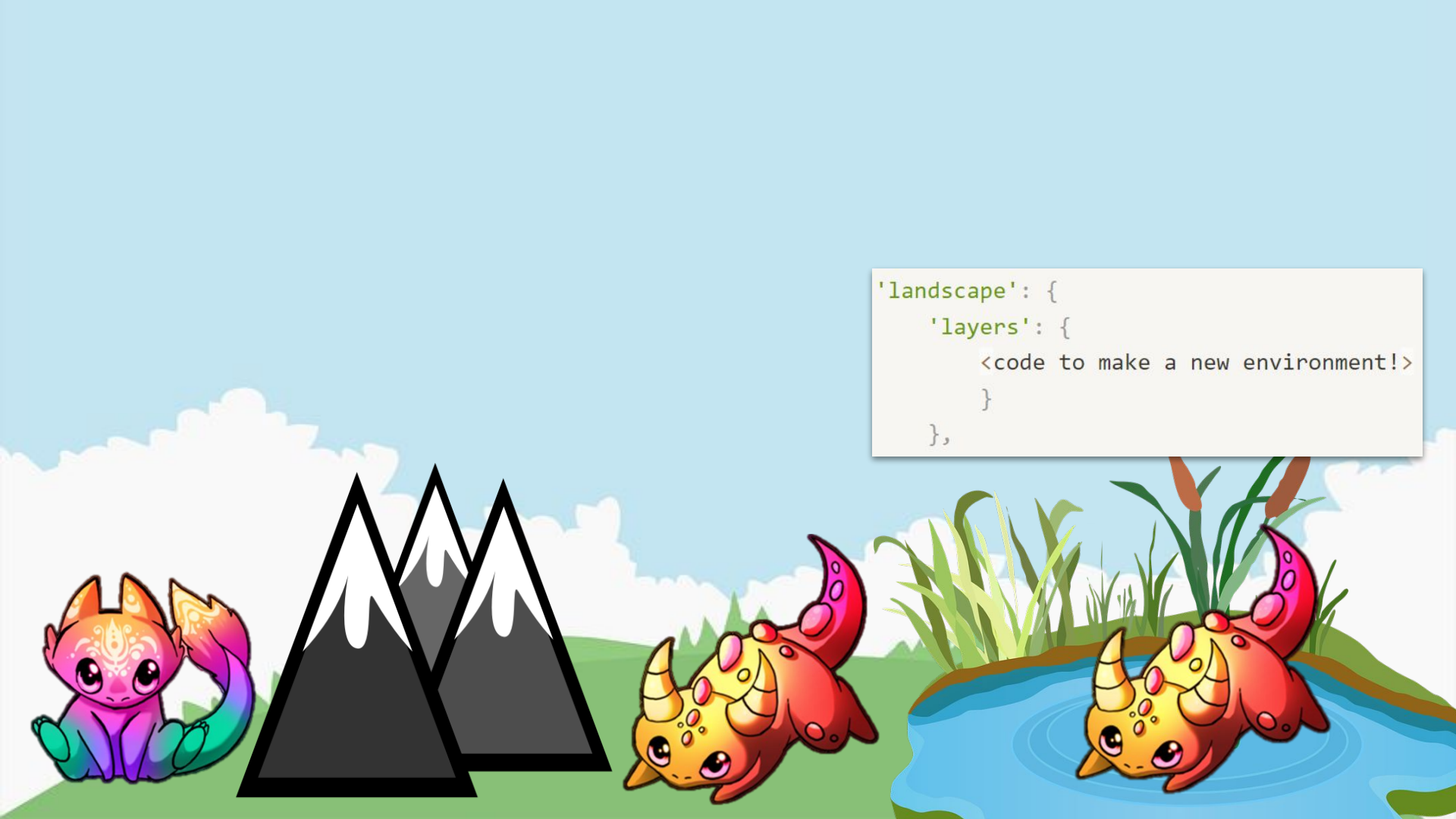
How does speciation occur?



```
'landscape': {  
  'layers': {  
    <code to make a barrier!>  
  }  
},
```



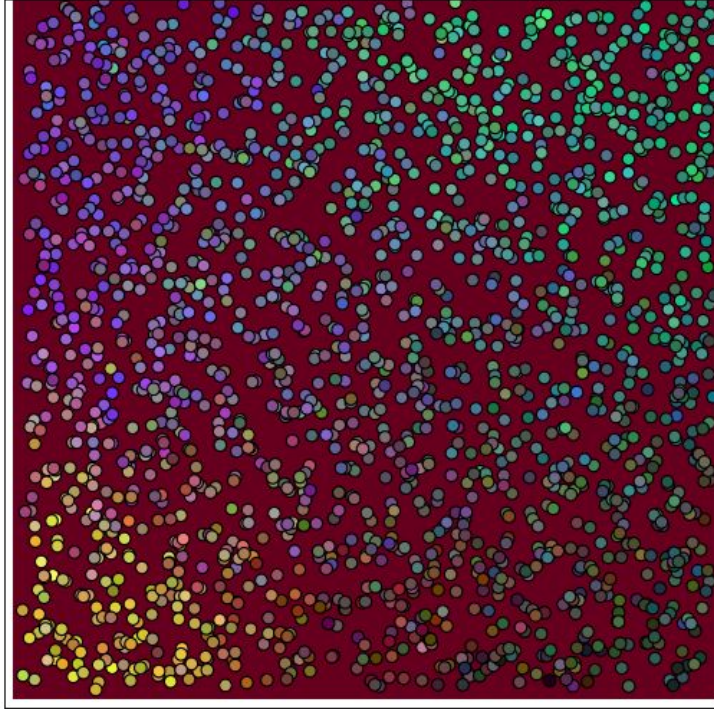




```
'landscape': {  
  'layers': {  
    <code to make a new environment!>  
  }  
},
```

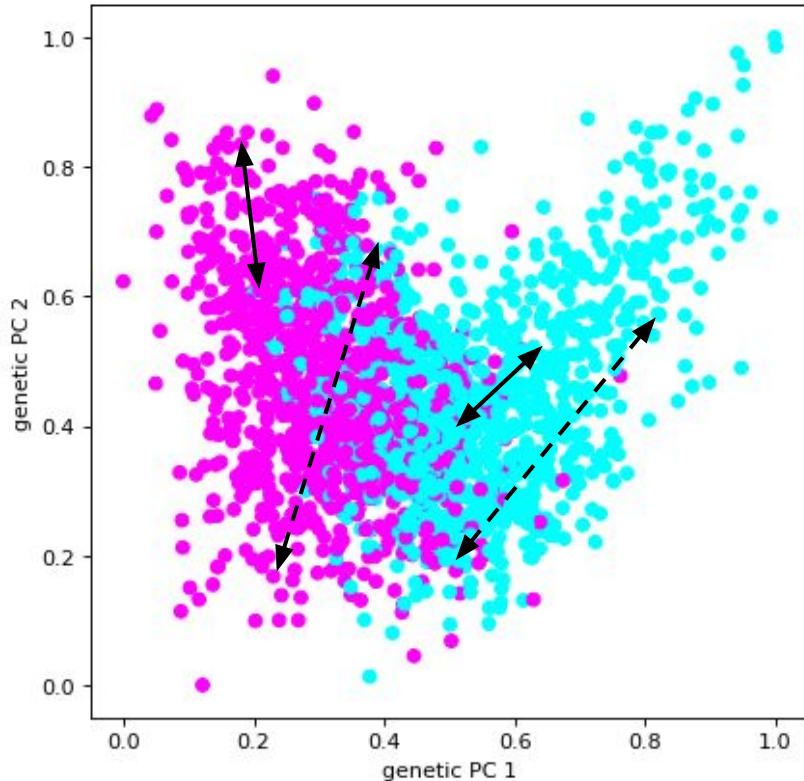


PCA plots



Individuals that have more similar colors are more similar

PCA plots



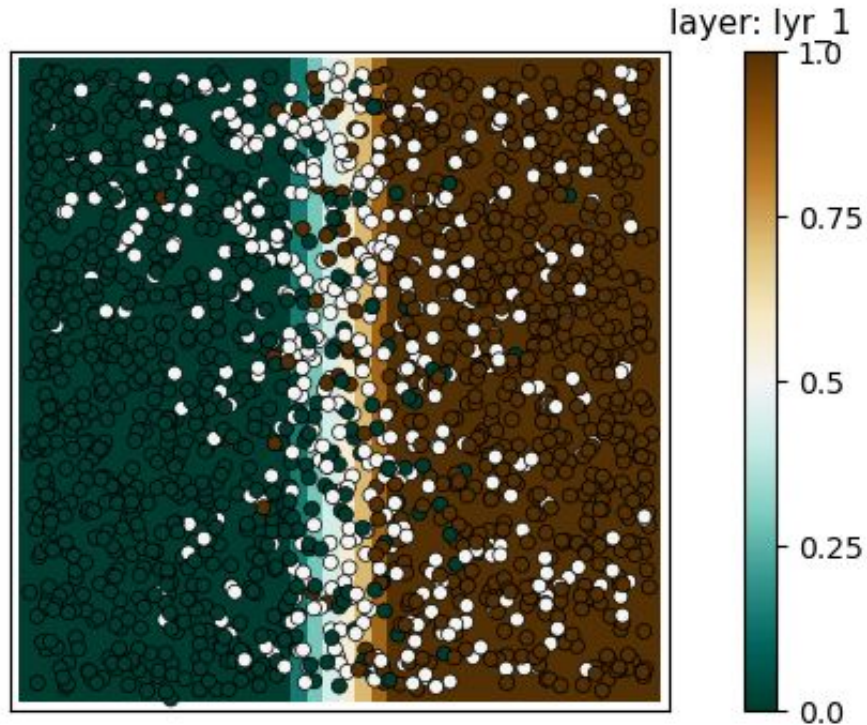
Individuals that are closer on the plot are more similar

Blue = individuals on right side of barrier
Pink = individuals on left side of barrier



Part 2: Natural Selection

Selection plots



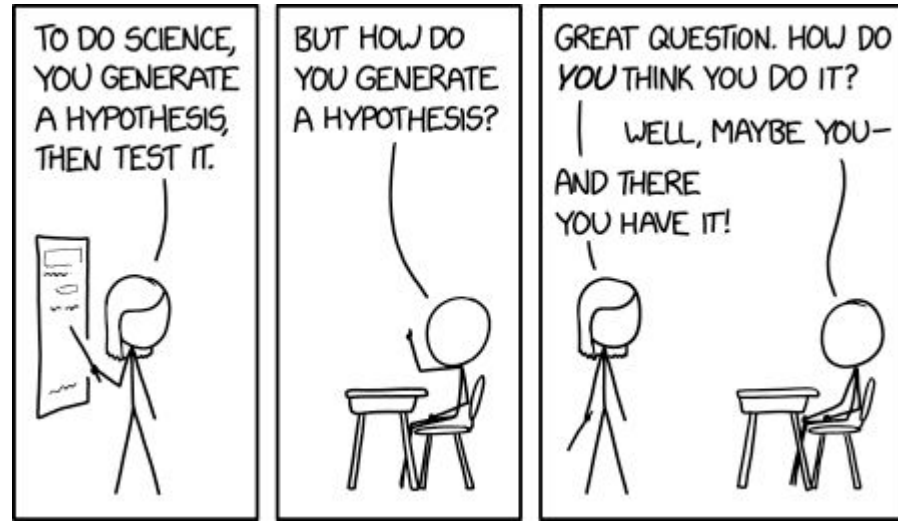
Individual color = trait
Landscape color = env

*Individual color matches the
background color = local
adaptation*



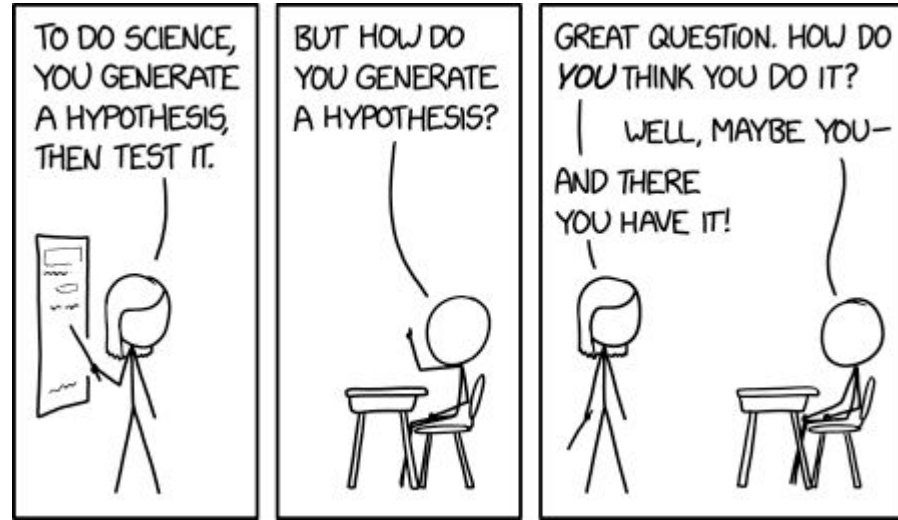
Part 3: Hypothesis Testing

Generating Hypotheses



If we [parameter change], then [outcome with evidence] because [justification]

Generating Hypotheses



If we [parameter change], then [outcome with evidence] because [justification]

If we *add a barrier to our landscape*, then we will observe *differentiation of the populations on either side of the barrier in our PCA plot* because of *drift*

Think-pair-share

1. THINK [5 minutes]: Pick one of the parameters listed in the lab to change and generate a hypothesis.

For ex: if we [*increase/decrease parameter X*] then we will observe that [*mismatch increase/decreases*] because [*justification*]

2. PAIR [5 minutes]: Share your hypothesis with the person next to you. See if you agree with each others expected outcomes.
3. SHARE: Be prepared to share one of your hypotheses with the class.

(Before you start running you simulations, answer Question 2)

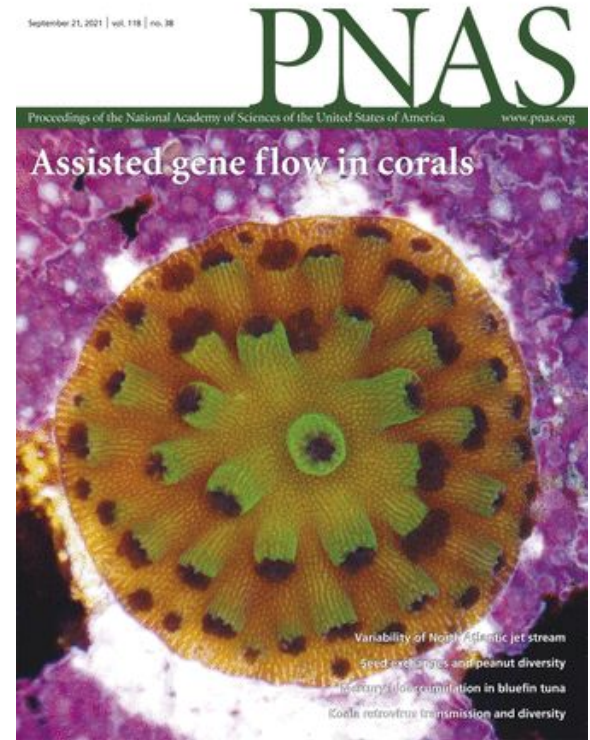


Why does this matter?

Real world conservation question:
Is gene flow always good?

Testable question:
What is the effect of movement distance on phenotype-environment mismatch?

CLASSROOM POLL: Do you hypothesize that increasing movement distance will increase or decrease phenotype-environment mismatch in our simulations?



<https://www.pnas.org/doi/full/10.1073/pnas.2110559118>

Why does this matter?

A real world conservation question: **Is gene flow always good?**

Testable question: **What is the effect of movement distance on phenotype-environment mismatch?**

Hypothesis A: If we have more movement, then adaptive alleles can spread more easily through the population, increasing fitness/decreasing mismatch

Hypothesis B: If we have more movement, then alleles that are not adapted to the local environment (i.e., maladaptive alleles) can spread more easily, decreasing fitness/increasing mismatch

I HAVE A QUESTION.

WELL, LESS OF A QUESTION
AND MORE OF A COMMENT.

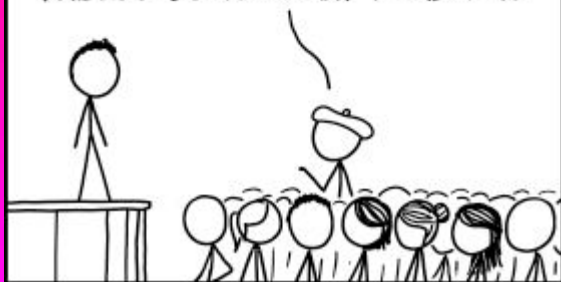
I GUESS IT'S LESS OF A COMMENT
AND MORE OF AN UTTERANCE

REALLY IT'S LESS AN UTTERANCE,
MORE AN AIR PRESSURE WAVE.

IT'S LESS AN AIR PRESSURE WAVE
AND MORE A FRIENDLY HAND WAVE.

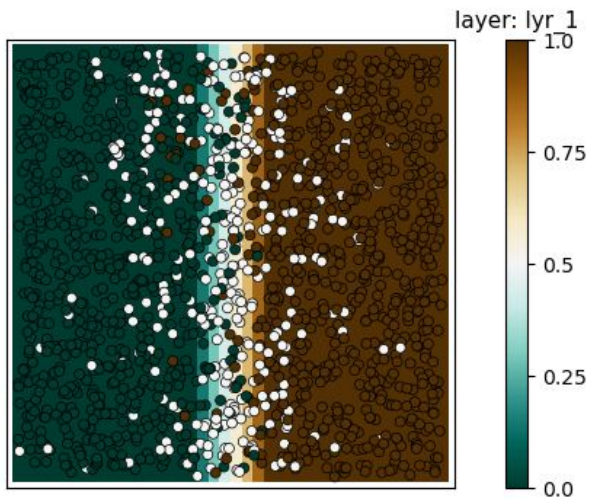
I GUESS IT'S LESS A FRIENDLY
WAVE THAN IT IS A FRIENDLY BUG.

I FOUND THIS BUG AND NOW WE'RE
FRIENDS. DO YOU WANT TO MEET IT?

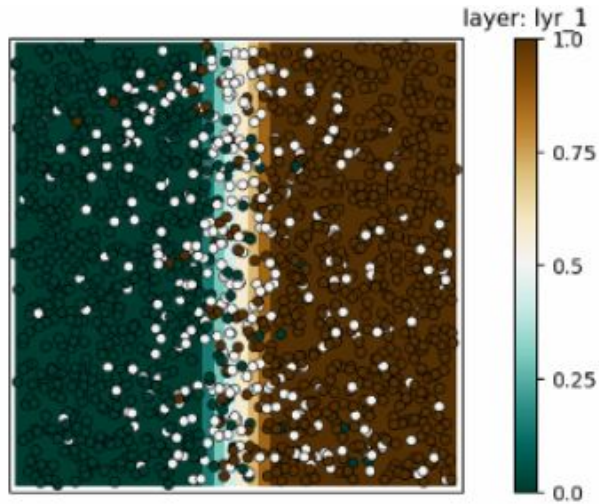


Thanks! Questions?

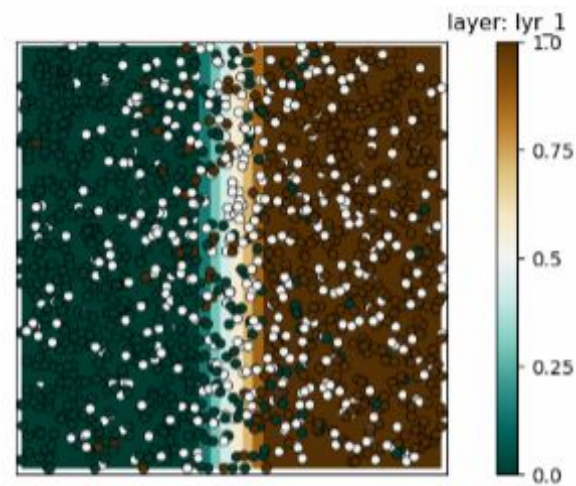
Original (move distance = 0.5)



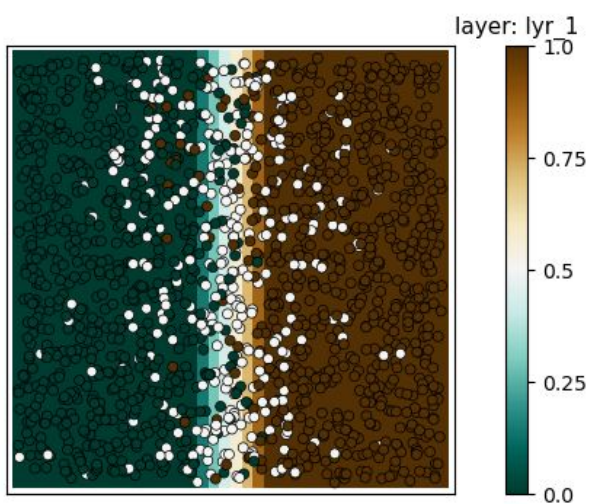
Morgan (new value = 1)



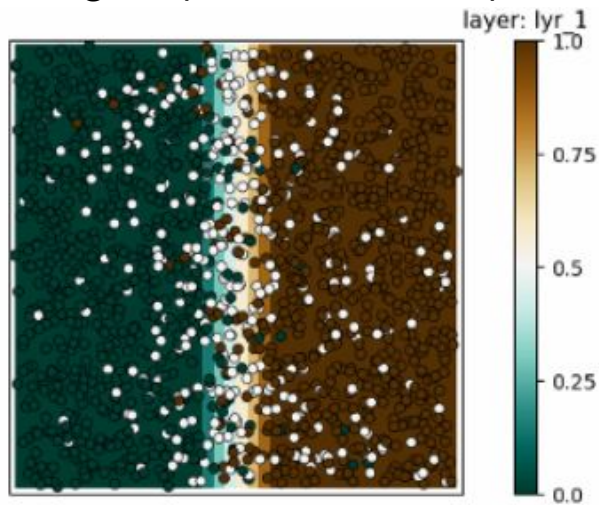
Nathan (new value = 2)



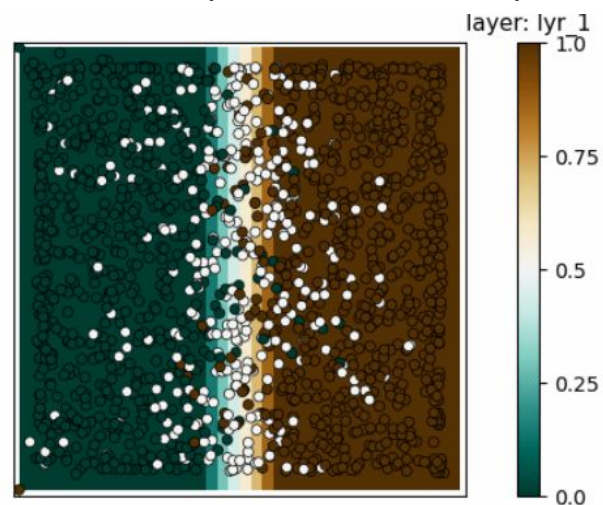
Original (move distance = 0.5)



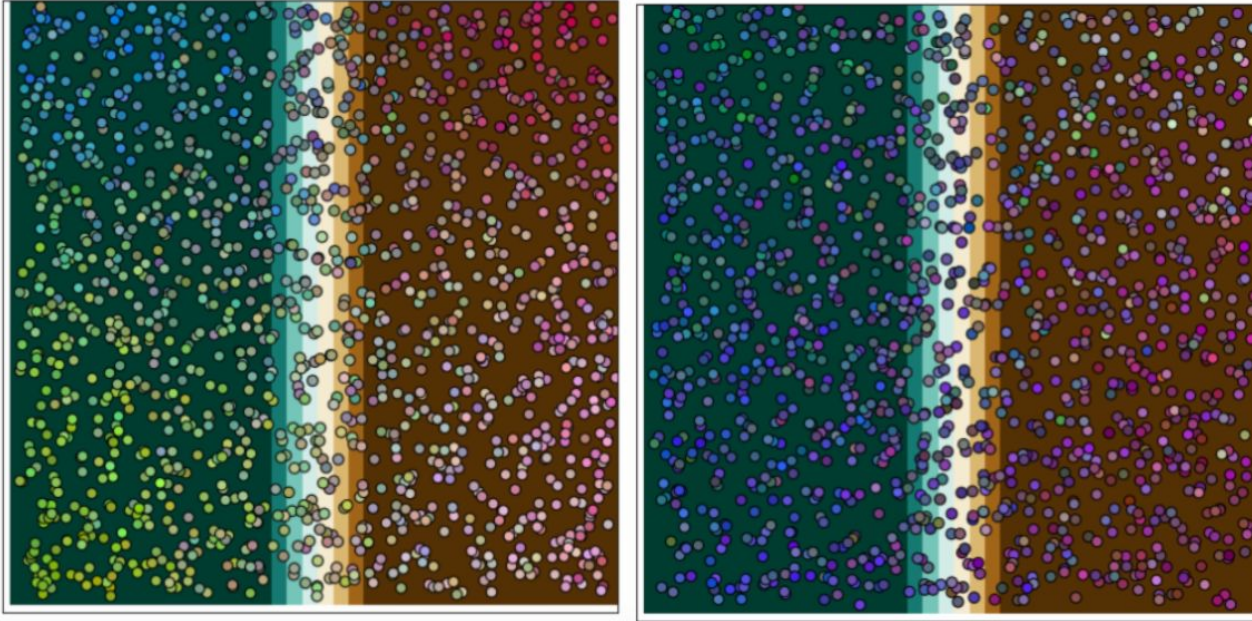
Morgan (new value = 1)



Nathan (new value = 0)



Namrita



mating radius 10 vs 100