

# Team 4 : Population Dynamics

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# Outline

Lokta-Voletra!

Results

Real-World Factors

Explaining real world data

Implementation

Conclusion

## Predator-Prey “Relationship”<sup>1</sup>



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<sup>1</sup>[www.alaskapublic.org,en.wikipedia.org](http://www.alaskapublic.org/en.wikipedia.org)

# Predator-Prey Model

Coupled ODE's describing behavior of predator & prey populations.

$$\frac{dM}{dt} = br_M * M - df_M * M * W \quad | \quad \frac{dW}{dt} = br_W * W * M - df_W * W$$

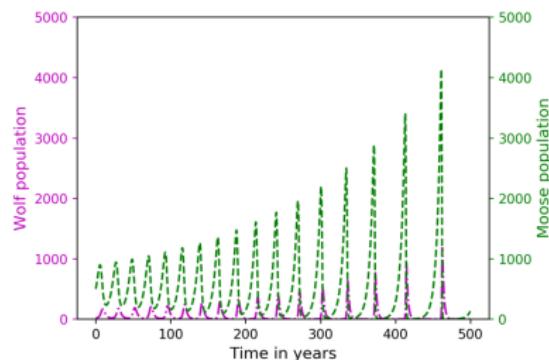
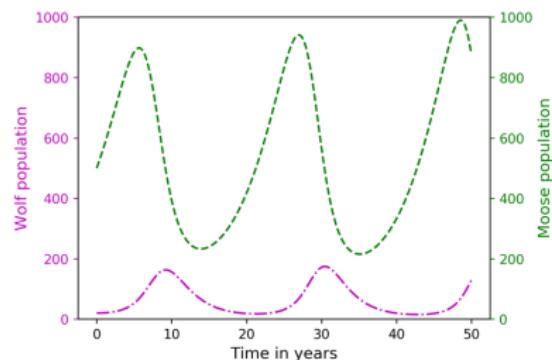
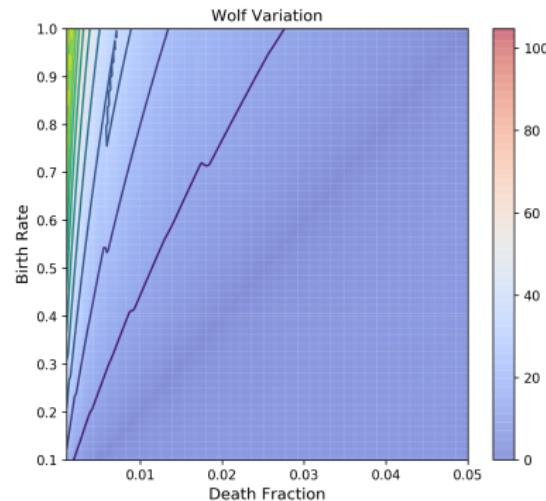
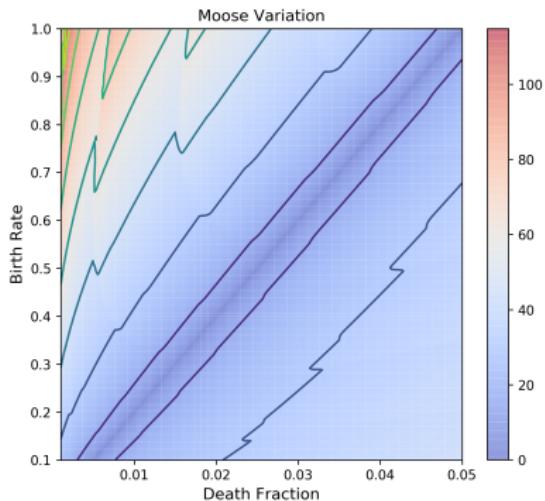


Figure: Stability analysis

# Sensitivity to Moose Birth and Death rates

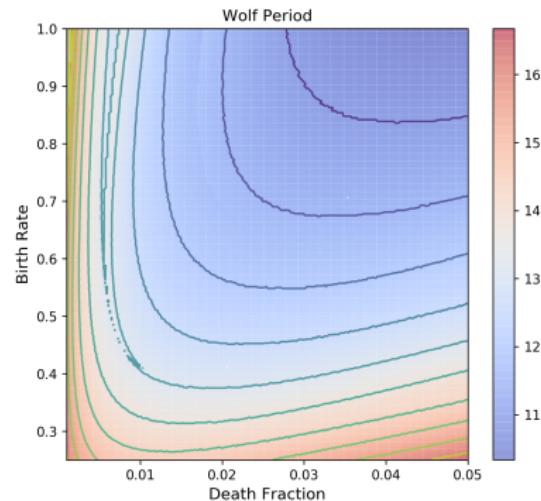
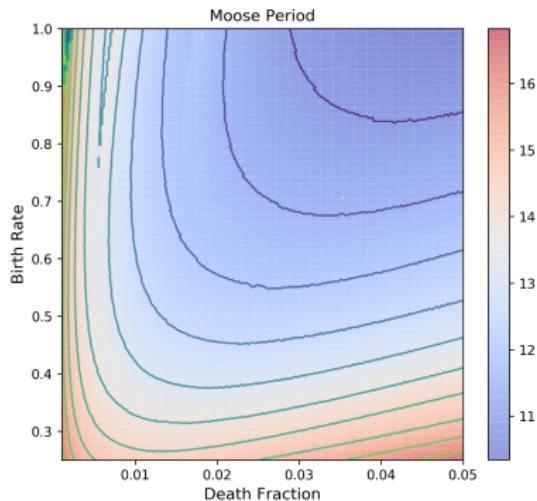
'Amplitude' plots for Moose and Wolf populations.<sup>2</sup>



<sup>2</sup>Square root of quantities visualized for enhanced contrast

# Sensitivity to Moose Birth and Death rates

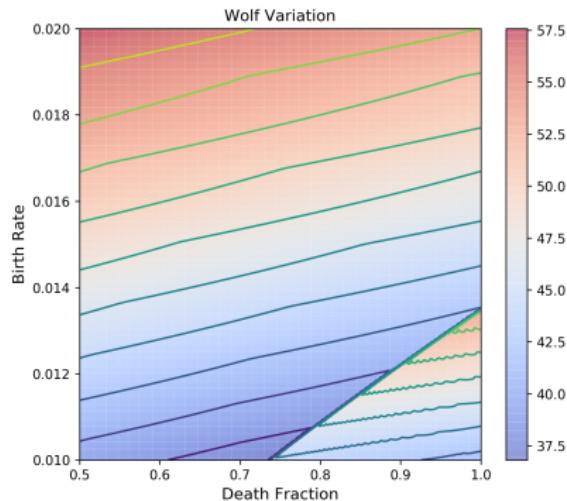
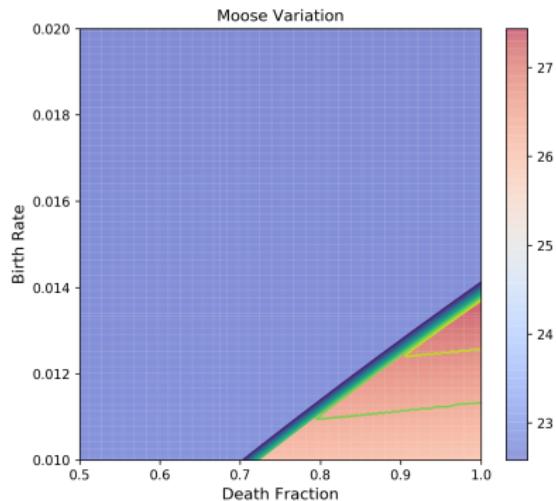
'Period' plots for Moose and Wolf populations.<sup>3</sup>



<sup>3</sup> Square root of quantities visualized for enhanced contrast

# Sensitivity to Wolf Birth and Death rates

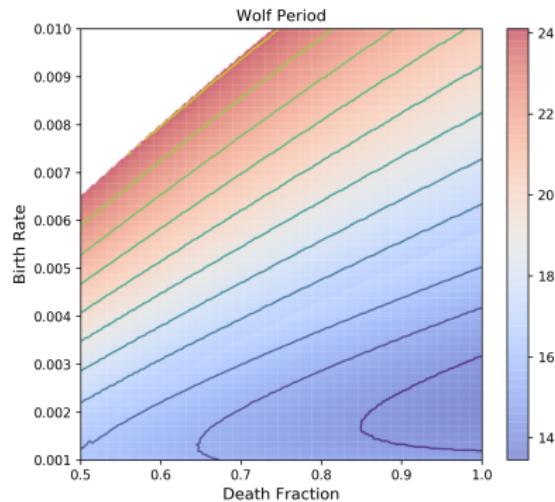
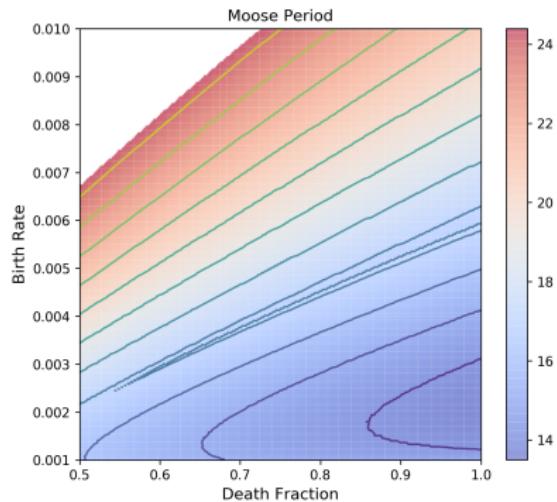
'Amplitude' plots for Moose and Wolf populations.<sup>4</sup>



<sup>4</sup> Square root of quantities visualized for enhanced contrast

# Sensitivity to Wolf Birth and Death rates

'Period' plots for Moose and Wolf populations.<sup>5</sup>

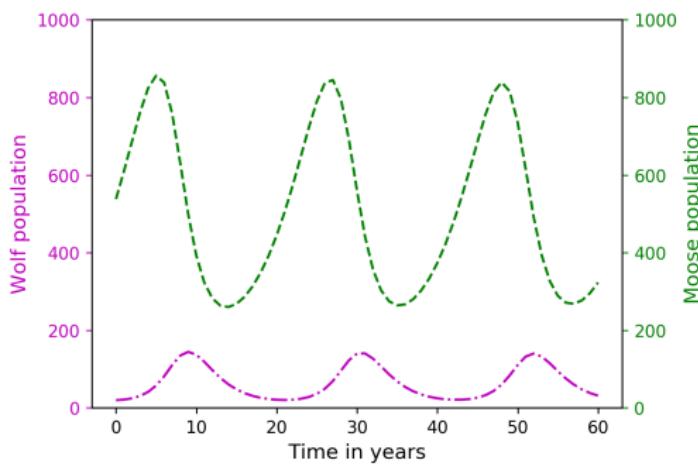


<sup>5</sup> Square root of quantities visualized for enhanced contrast

## Model Carrying Capacity

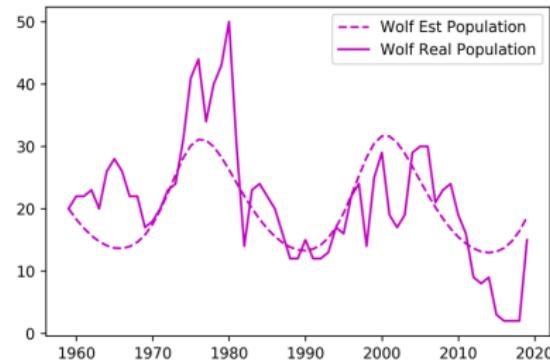
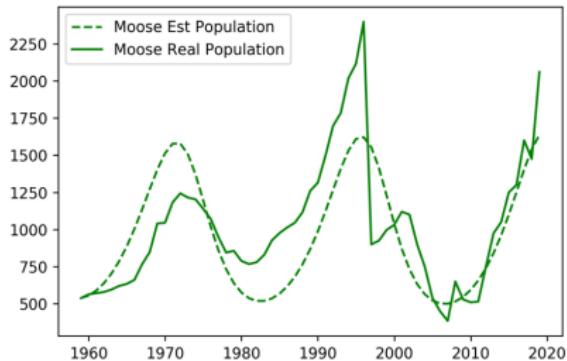
- ▶ Restorative term that inhibits exponential growth

- ▶  $\frac{dM}{dt} = br_M * M * \left(1 - \frac{M}{M_C}\right) - df_M * M * W$



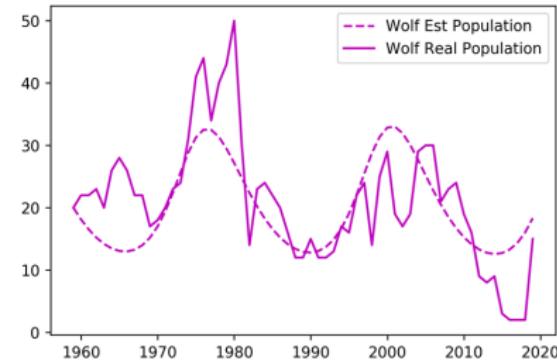
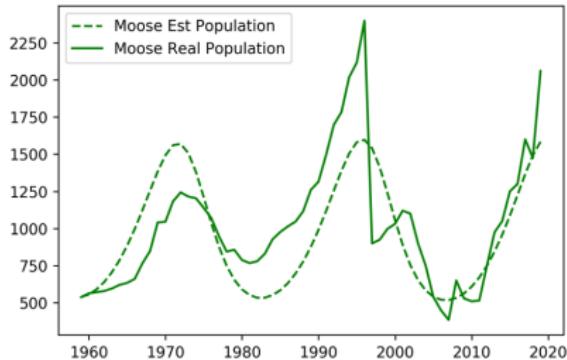
# Explaining real world data I

- ▶ Fitting our model to real world data
- ▶ Carrying capacity model



## Explaining real world data II

- ▶ Carrying capacity model with inbreeding correction
- ▶  $df_W$  becomes linearly dependent on time.



# Language & Libraries!

- ▶ Libraries :
  - ▶ Numpy/Scipy : Arrays and Fit functions
  - ▶ Matplotlib : Visualization
  - ▶ Pandas : Dataframes
- ▶ How to HPC ?
  - ▶ Numexpr : Fast expression evaluation, to optimize code
  - ▶ Joblib : Parallel execution module
  - ▶ HDF5 : Structured I/O for scalable performance.
  - ▶ More science! ?

# Conclusion

- ▶ Model could be improved by:
  - ▶ Winter shock to moose population
  - ▶ Parvovirus shock to wolf population
  - ▶ Weather/tick effect on moose population
- ▶ Thank you to the organizers of PEARC19!