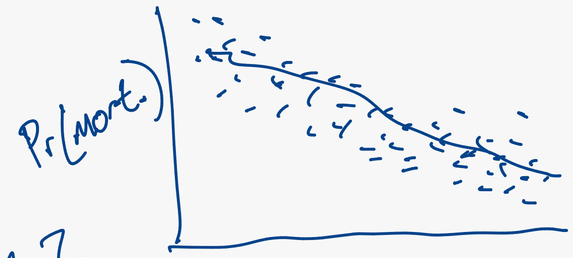
The problem and importance of scale in ecology

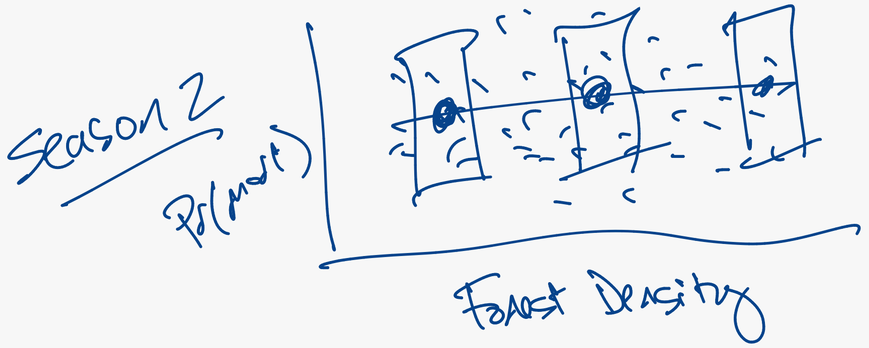
- Phenomenological vs. mechanistic understandings of nature

1)



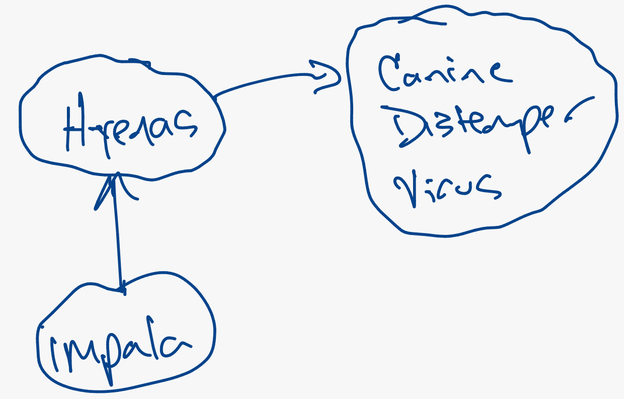
Season 1

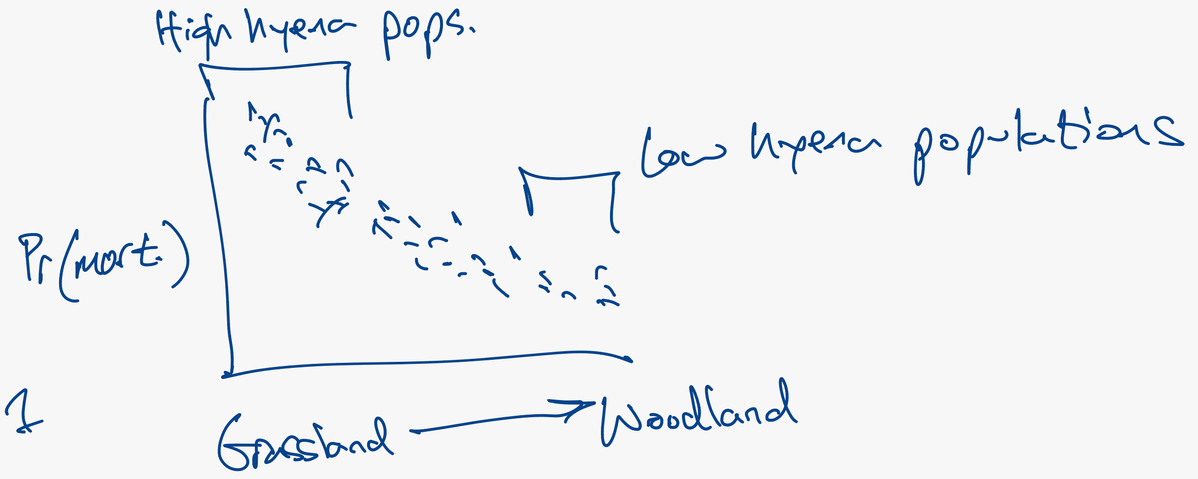
Obs: Something is killing impala in open environments but not closed environments



- We could not have made this prediction b/c we didn't know ~~that~~ the mechanism behind the relationship.

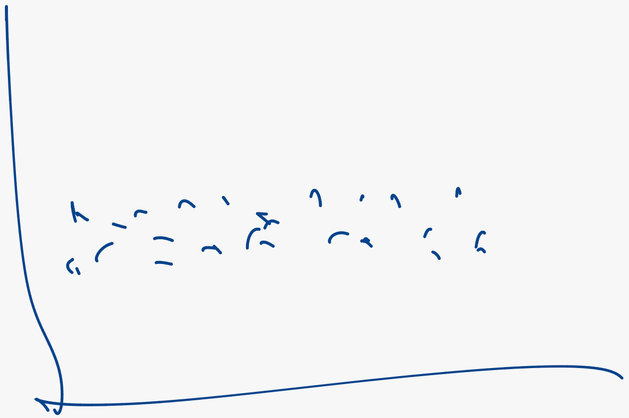
2) Mechanistic Understanding





Season 1 → Grassland → Woodland

Season 1 → outbreak → Season 2



Aldo Leopold
1887-1948

The Sand County Almanac
1949

Read the excerpts!

Big ideas:

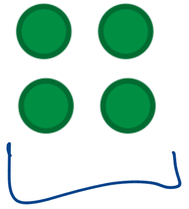
- Population cycles
- Mass mortality -> selection
- Energy transfer
- Extinction & invasion
- Organismal timescales
- Trophic cascades
- Trophic pyramids and food chains
- Ethics extended to ecology
- Ecological networks & stability
- Anthropogenic loss of predators

“It then occurred to me that these causes or their equivalents are continually acting in the case of animals also; and as animals usually breed much more quickly than does mankind, the destruction every year from these causes must be enormous in order to keep down the numbers of each species, since evidently they do not increase regularly from year to year, as otherwise the world would long ago have been crowded with those that breed most quickly. Vaguely thinking over the enormous and constant destruction which this implied, it occurred to me to ask the question, why do some die and some live? And the answer was clearly, on the whole the best fitted live ... and considering the amount of individual variation that my experience as a collector had shown me to exist, then it followed that all the changes necessary for the adaptation of the species to the changing conditions would be brought about ... In this way every part of an animals organization could be modified exactly as required, and in the very process of this modification the unmodified would die out, and thus the definite characters and the clear isolation of each new species would be explained.” -ARW

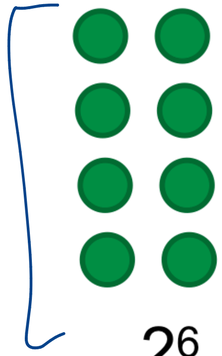
Exponential population growth

2^1
2

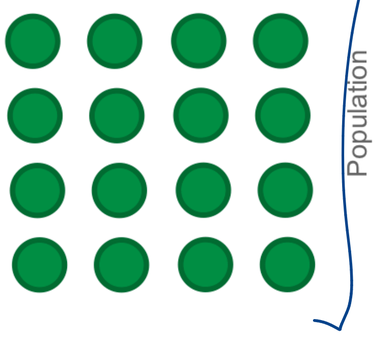
2^2
4

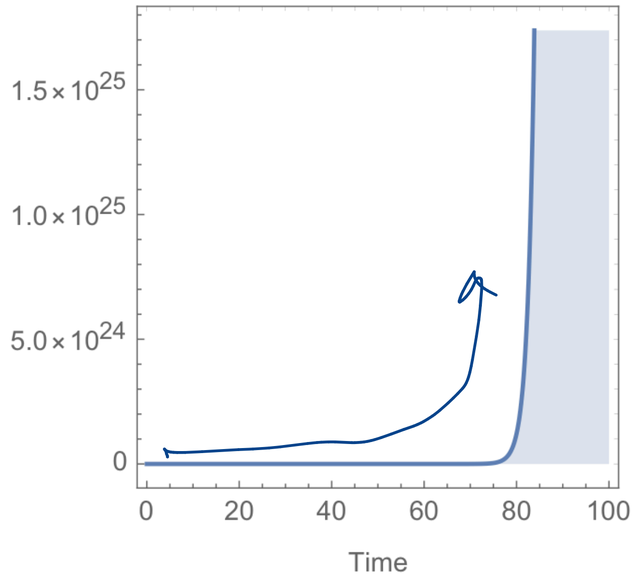


2^3
8

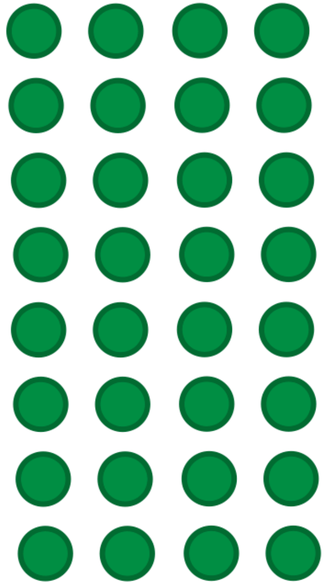


2^4
16

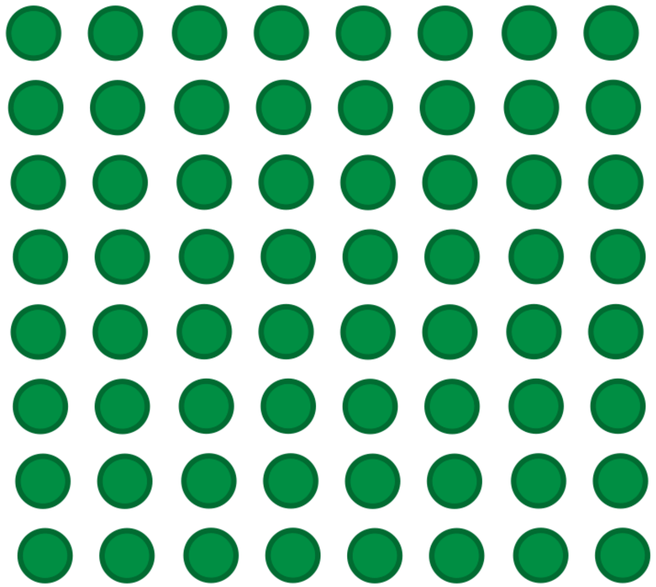




2^5
32



2^6
64



2^t

t=100?

$N = 1.2 \times 10^{30}$

Where is everybody?

Exponential population growth

2^1
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2^2
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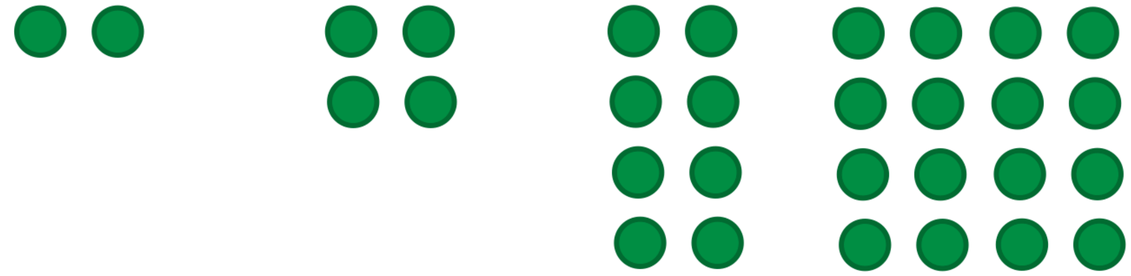
8

2^4
16



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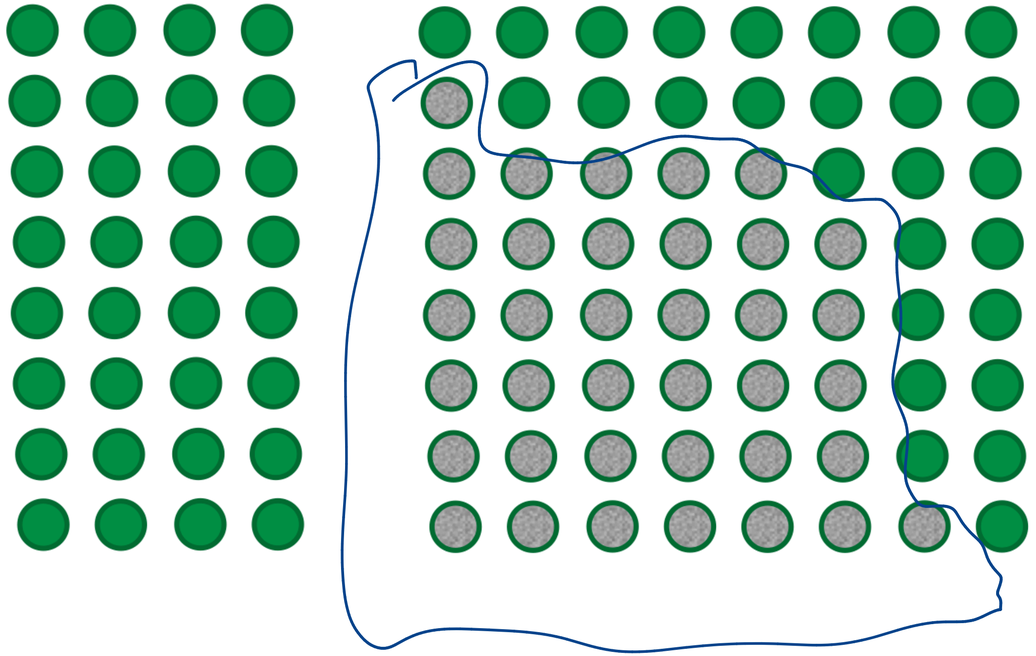


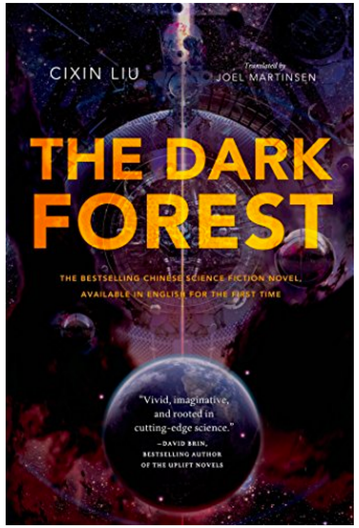
t=100?

$N = 1.2 \times 10^{30}$

Where is everybody?

Cixin Liu's Axiomatic Perspective of Ecology

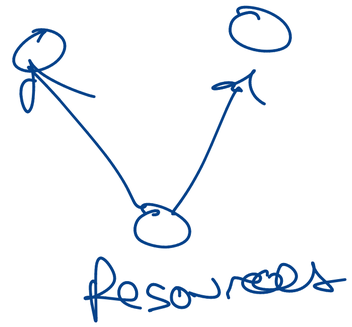
The Three Body Problem



Axiom 1:
Life Grows Exponentially

Axiom 2:
Resources Are Finite

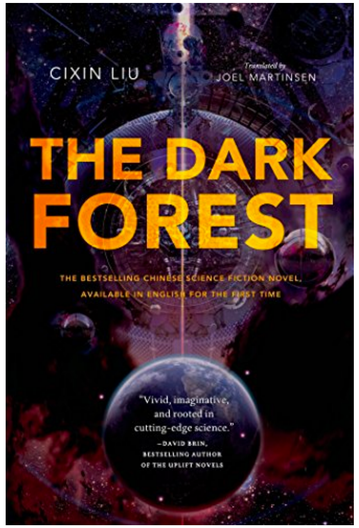
Individuals
Species



- Competition is inevitable

- Fitness ~ competitive edge

Cixin Liu's Axiomatic Perspective of Ecology



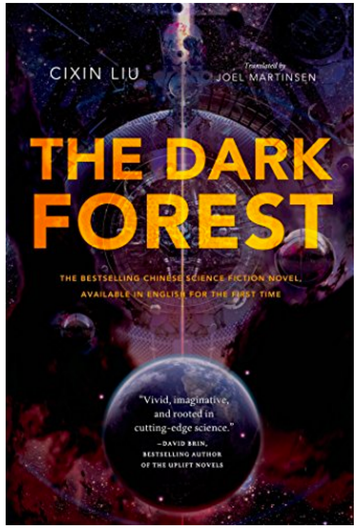
Axiom 1:
Life Grows Exponentially

$$\frac{d}{dt}N = rN$$

$$N(t) = N_0 e^{rt}$$

Axiom 2:
Resources Are Finite

Cixin Liu's Axiomatic Perspective of Ecology



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Axiom 2:
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Competition leads to ⇩ per-capita birth rates and ⇧ per-capita death rates with increasing population size

$$\frac{d}{dt}N = rN\left(1 - \frac{N}{K}\right)$$

Competition across the universe