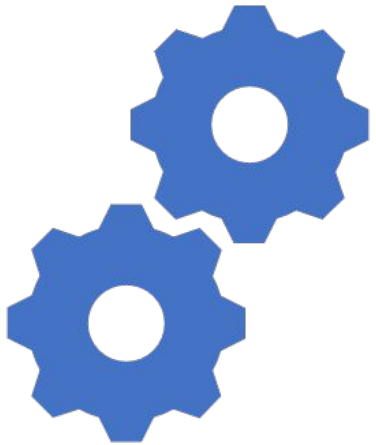
System Dynamics



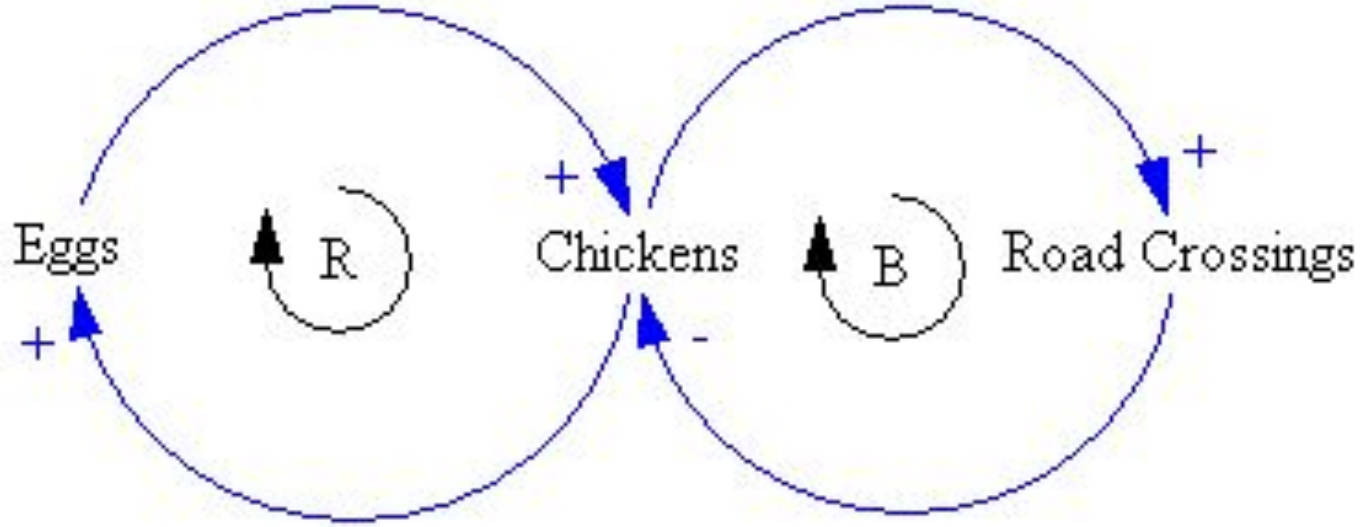
Dor Hirsh Bar Gai

What is systems dynamics?

- Feedback and delay processes
- Causal loop diagrams
- Stock and flow modeling
- Systems thinking

Causal loop diagrams

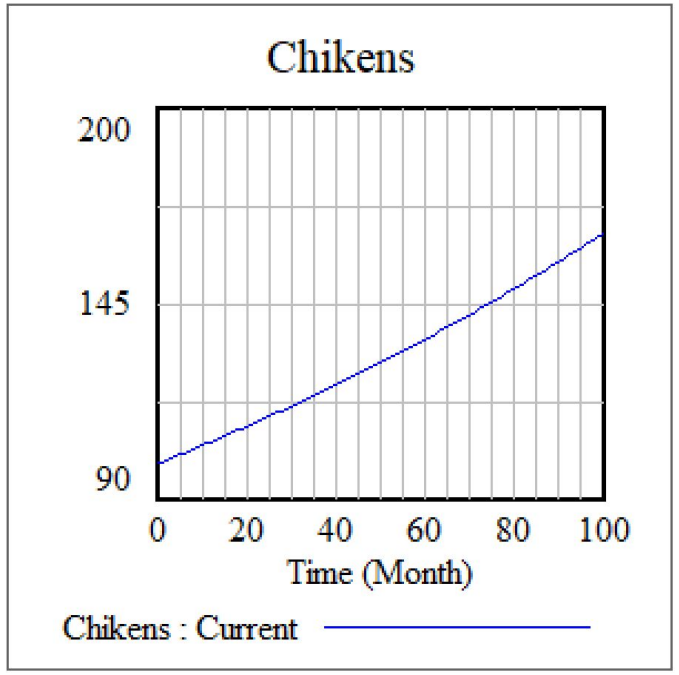
- Qualitative system relationship
- Reinforcing or balancing feedback
- Conceptual characteristics

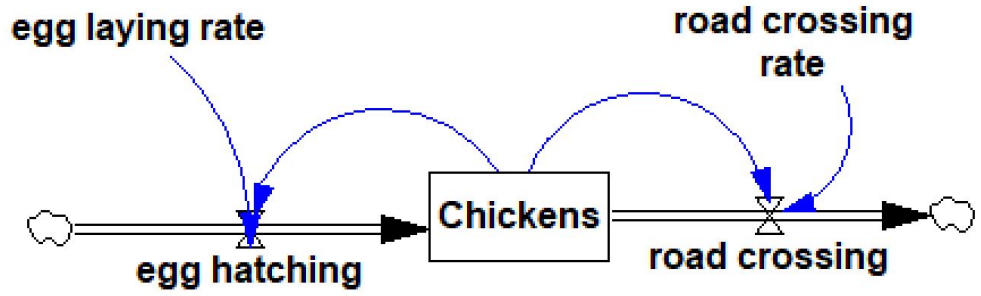


https://metasd.com/wp-content/uploads/2010/04/ChickenCLD.png

Stock and Flow

- Quantitative representation
- Reference mode
- Policy analysis





System thinking

System Dynamics Application

- Healthcare
- Energy
- Ecosystem management
- Climate change impacts
- Technology and information adoption

Disease Spread

- https://www.youtube.com/watch?v=WNYB_o8MpcA

- https://www.youtube.com/watch?v=9pVy8sRC440

Healthcare – Disease spread

- Types of Transmission:
  - Droplet
  - Contact
  - Aerosol
- Important periods:
  - Incubation
  - Latent
- Spread:
  - Imported case
  - Local
  - community

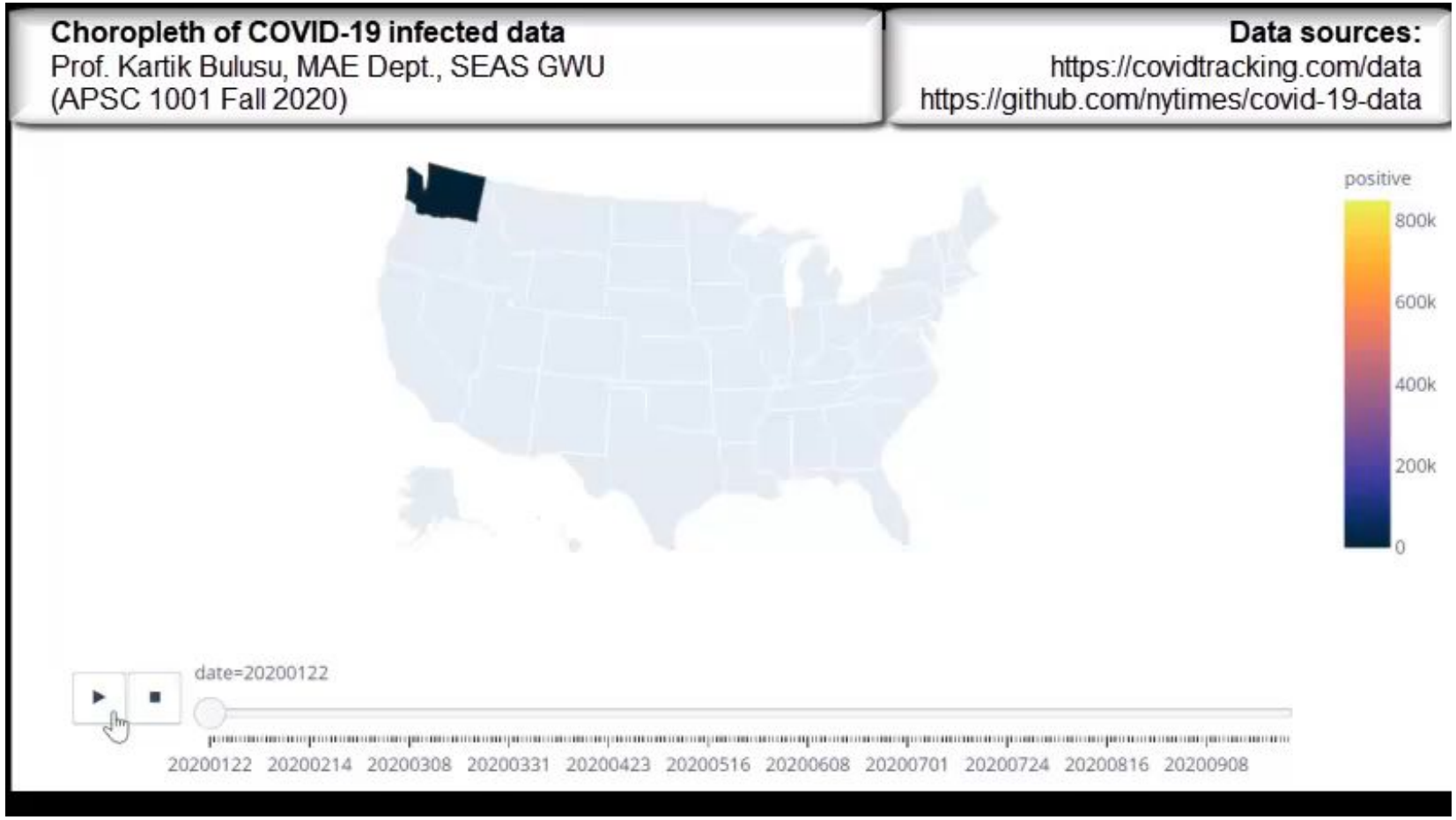
Parameters

- R0
  - Reproduction number
  - Basic reproduction number (maximum potential)
  - Effective Reproduction number (current vulnerability)
- Other important factors
  - Probability of infection
  - Number of people that are sick
  - Contact rates

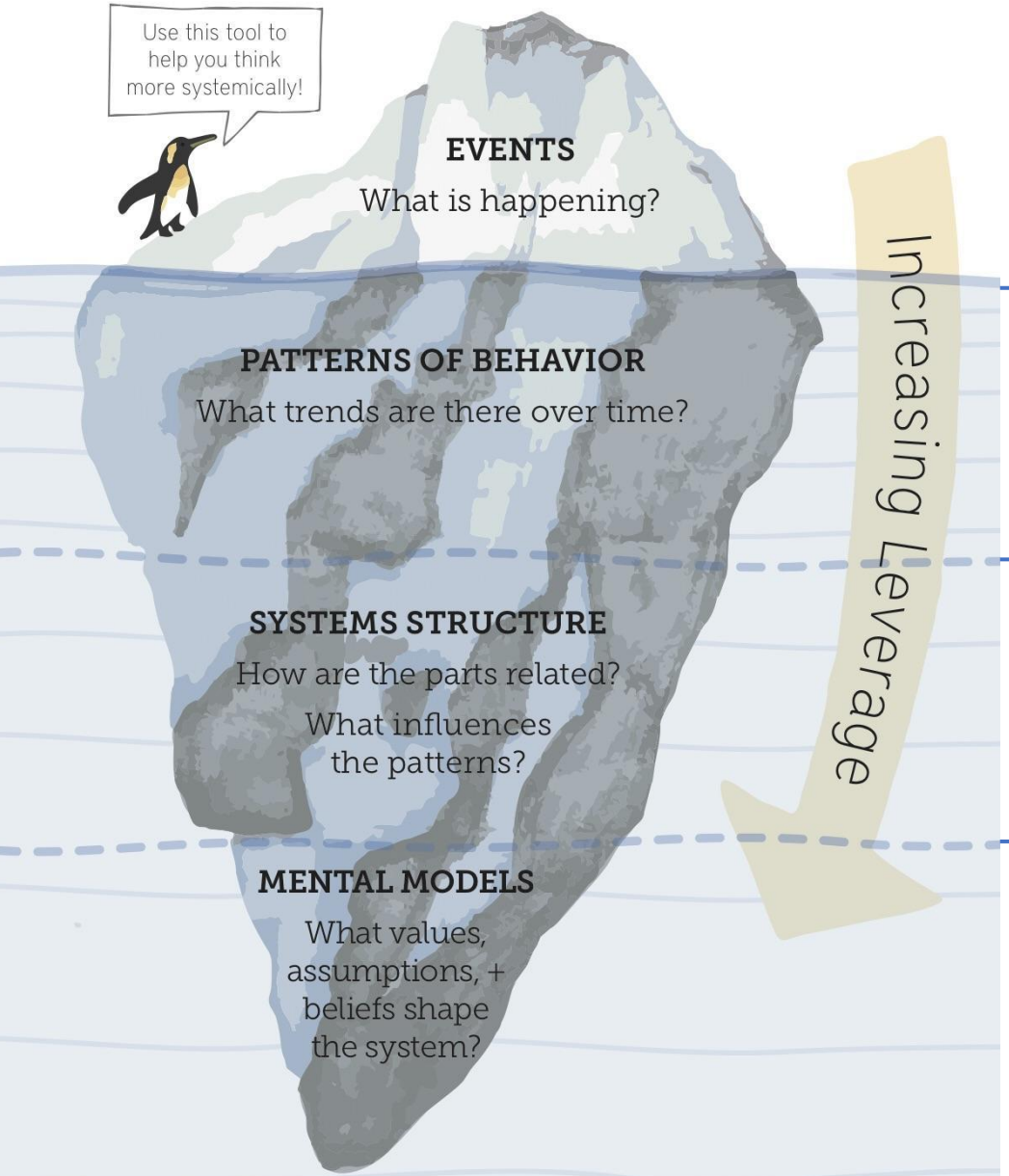
Activity 1

Covid-19 Iceberg Model

US Choropleth Animation of Covid-19 Infection



THE ICEBERG MODEL



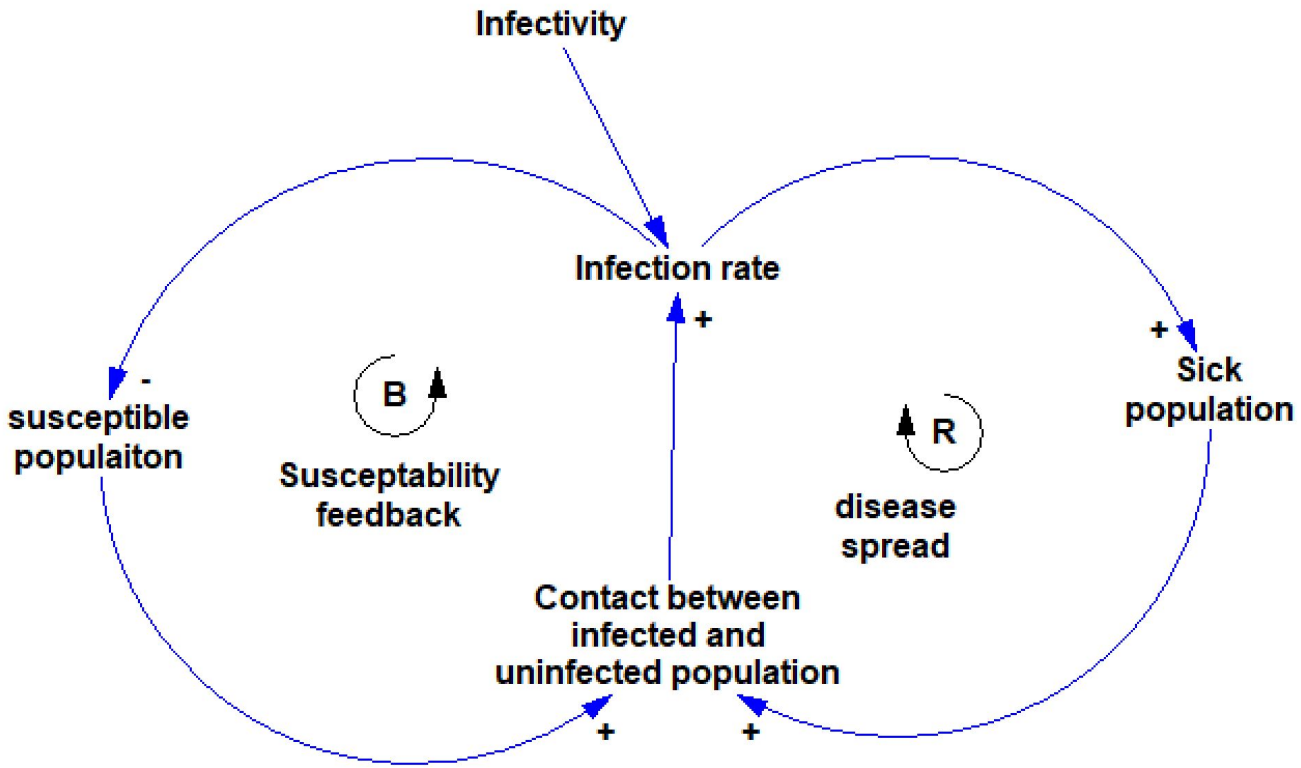
Increase in infection rate
no containment

Politicization of science
Distrust in government
“pandemic fatigue”

Economic pressure
Political dynamics
Mental health

Civil Rights vs public health
State vs. Federal enforcement

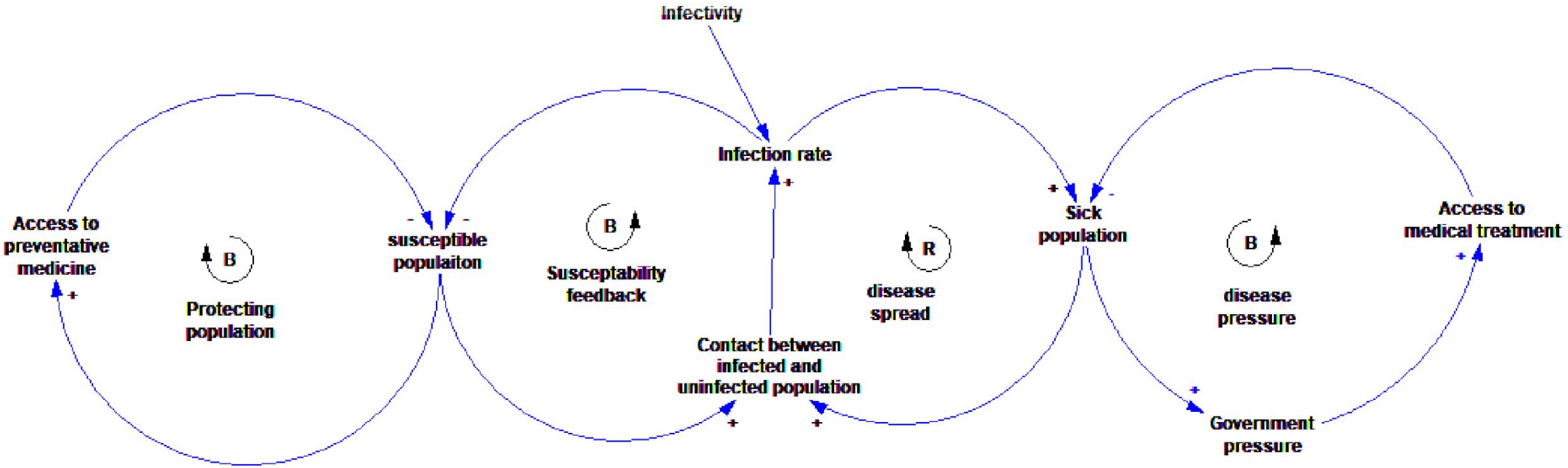
Causal Loop Diagrams



Model the problem NOT the system

Activity 2

Infection CLD



Interventions

Stock & Flow

Activity 3

Infection stock & flow

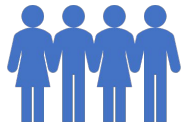
Key parameters

- How can you mitigate disease risks?
  - Transmission
  - Treatment
- Explore the impact of individual parameters (assuming no vaccine)
  - Contact rate
  - Infectivity
  - Recovery rate
  - Loss rate
  - Death rate
- Explore impact of multiple changes

To conclude

- Conceptualization of causal relationships
- Powerful tool for observing accumulation and feedback impacts
- Meaningful platform for scenario analysis

Future considerations - COGS



What challenges influence our ability to model disease spread?

Which opportunities exist in public health to enhance mitigation efforts?

What are potential gaps and how do they impact us?

What surprises could the future hold, and how should we prepare for them?

Questions?