Using Shiny for teaching

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What is Shiny?

- interactive web applications (R-backend, Pretty front-end)
    - If you can do it in R, you can put into an app
    - *Plus* pretty front-end & interactivity
    - Users don't need to worry about code
- many modes of delivery
    - Hosted online (free and pay options, or host your own)
    - On your own computer (i.e., locally)
    - Embedded in Rmarkdown documents (e.g., slides)

What's it good for?

- Anything where ***interaction*** improves learning or understanding…
  - working with data, model, map, etc.
- Research tools
  - Here's a model, what if I tweak these parameters?
    - (https://brunnerlab.shinyapps.io/Tick_Matrix_Model/ (https://brunnerlab.shinyapps.io/Tick_Matrix_Model/))
  - Here's a bit of a data set, what if I slice it this way or that?
    - (https://brunnerlab.shinyapps.io/GRRS_Interactive/ (https://brunnerlab.shinyapps.io/GRRS_Interactive/))
- Conveying information, data, predictions, etc. to a wider audience
  - Virtually every EEID grant I've read includes a Shiny module for outreach
- **Teaching tools** <– today's topic

Teaching Use cases

- **Illustrate a concept** or let students **play with an idea**
  - Pair with readings or lecture
  - Use for more **interactive homework**
    - e.g., play with simulations/data, then answer questions
- Use for **in-class exercises** (individually, in groups, as a class)
  - make predictions and see consequences
  - work with data (e.g., make plots, do calculations)
- Use **in labs**
  - **streamline analyses** / remove coding
    - e.g., do stats or calculations for students to get to the point faster
  - create **simulations** to see consequences, make decisions, answer questions
  - **work with real-world data** without having to worry about coding
- Create **learn-on-your-own interactive exercises**, especially for learning R.

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Example: playing with exponential growth

Exponential growth

Value of r (intrinsic growth rate):

0.05 0.25 0.5

0.05 0.14 0.23 0.32 0.41 0.5

Y axis

- (•) Linear
- ( ) Logarithmic (base 10)
- ( ) Logarithmic (natural log)

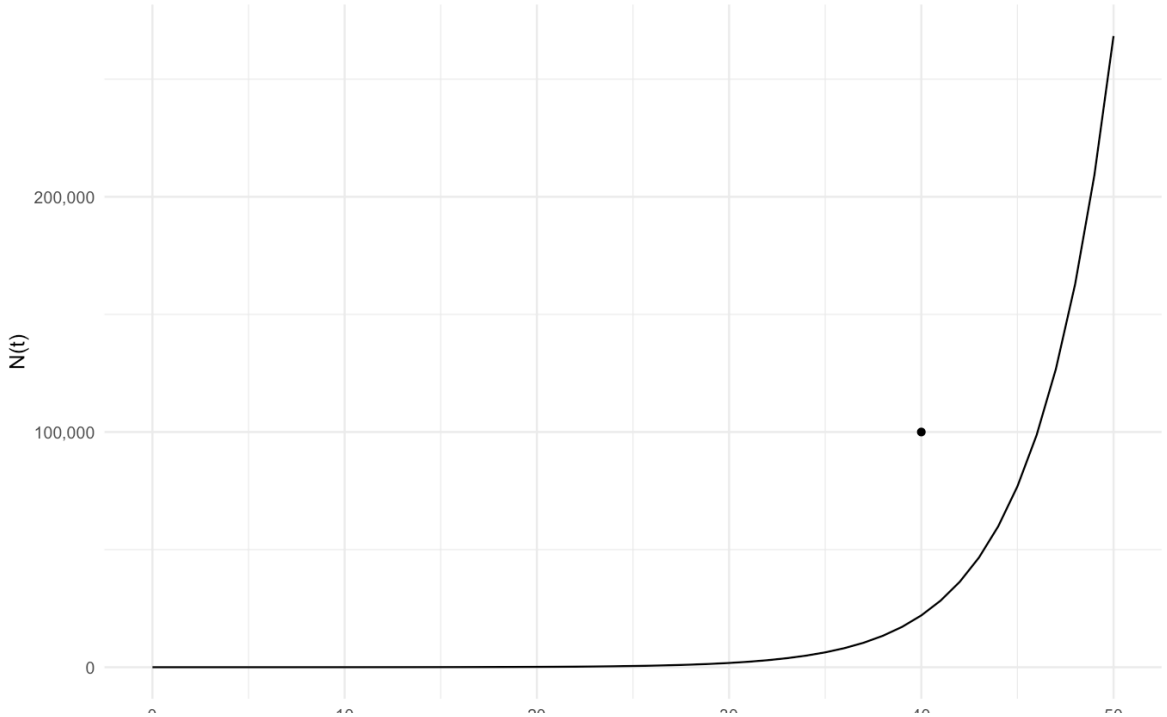
This graph shows the dynamics of exponential population growth over time. The underlying equestion is:

$$N(t) = N(0)e^{rt},$$

where r is the intrinsic growth rate and $N(0)$ is the initial population size

Exponential growth | Intervening | Ebola outbreaks

Try adjusting r so that the line hits the point.



https://brunnerlab.shinyapps.io/ExponentialGrowth/ (https://brunnerlab.shinyapps.io/ExponentialGrowth/)

Example: playing with logistic growth

Two models of population growth

Value of r (intrinsic growth rate):

0.05 0.25 0.5

0.05 0.14 0.23 0.32 0.41 0.5

Value of k ("carrying capacity"):

200 1,000 4,000

200 580 960 1,340 1,720 2,480 3,240 4,000

Initial population sizes (N0)

- [x] 1
- [ ] 100
- [ ] 500
- [ ] 1,000
- [ ] 5,000

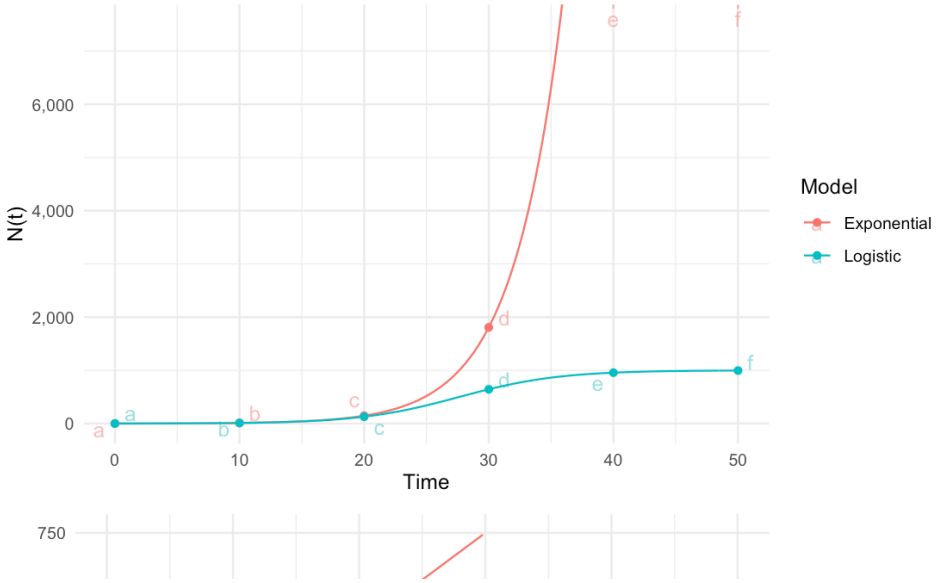
Time over which to run model:

20 50 200

Logistic vs. exponential | Ebola outbreaks

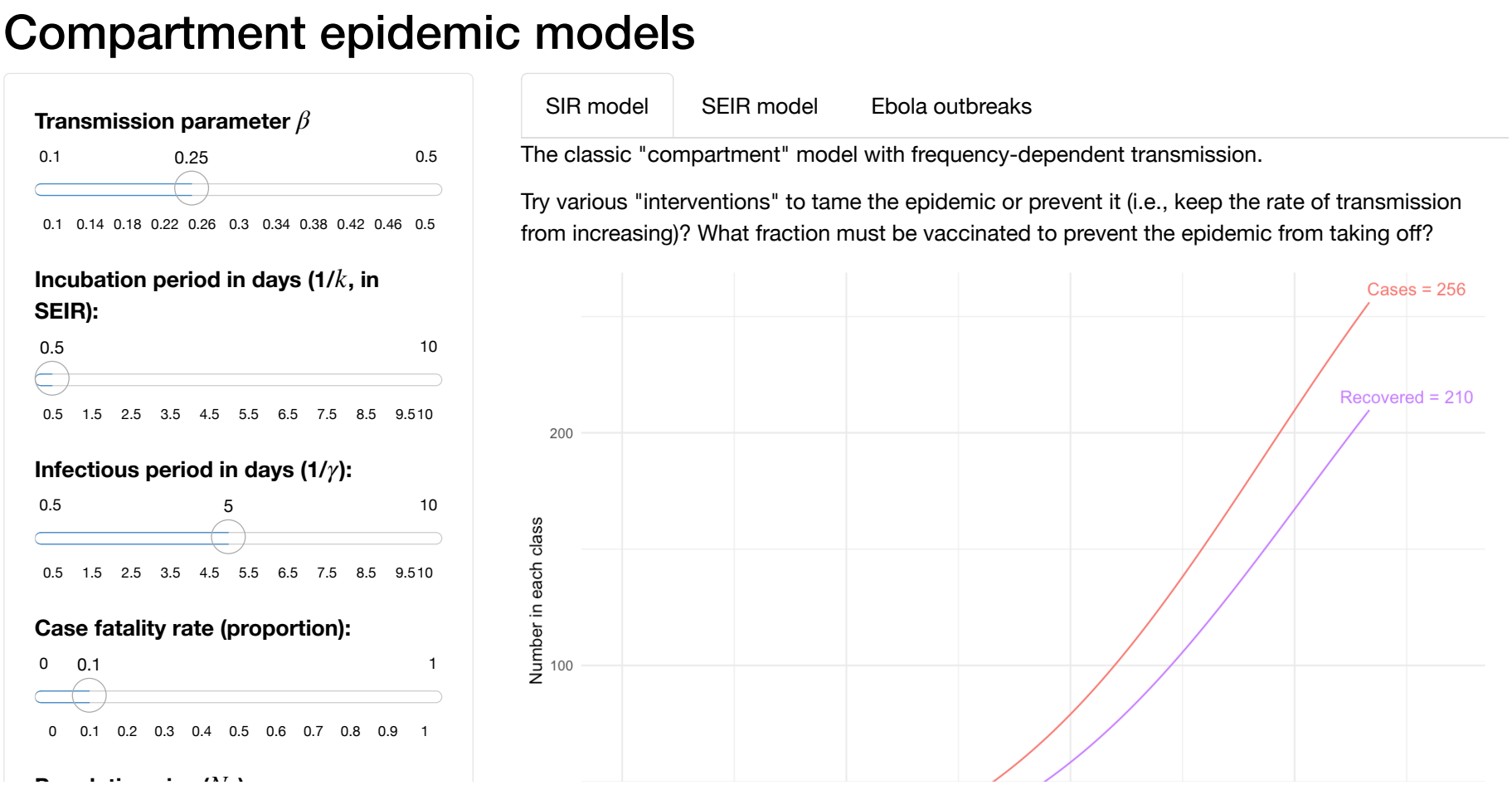
There are three plots. The first shows the population size through time while the second and third show population and per capita growth rates as a function of population size. Be sure to read the axes!

See how r and k affect each of these graphs. Do you see why?



https://brunnerlab.shinyapps.io/LogisticGrowth/ (https://brunnerlab.shinyapps.io/LogisticGrowth/)

Example: playing with compartment models



https://brunnerlab.shinyapps.io/SIRmodels/ (https://brunnerlab.shinyapps.io/SIRmodels/)

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Example: ranking odds of death in-class

Odds of death by...

Y axis

- (•) Linear
- ( ) Logarithmic

Choose the events to display

- [ ] Bear Attack
- [ ] Bee sting
- [ ] Bicyclist
- [ ] Cancer
- [ ] Cataclysmic storm
- [ ] Choking on food
- [ ] Chronic lower respiratory disease
- [ ] Cow Attack
- [ ] Deer Attack
- [ ] Dog attack
- [ ] Drowning
- [ ] Electrocution
- [ ] Electrocution, radiation, temperatures

Odds of each event per lifetime or per year in the U.S.A.

The odds are calculated over the entire population, rather than by group engaged in particular activities, age groups, etc. So if, for instance, you do not skydive, your odds of dying by skydiving are zero.

https://brunnerlab.shinyapps.io/Odds/ (https://brunnerlab.shinyapps.io/Odds/)

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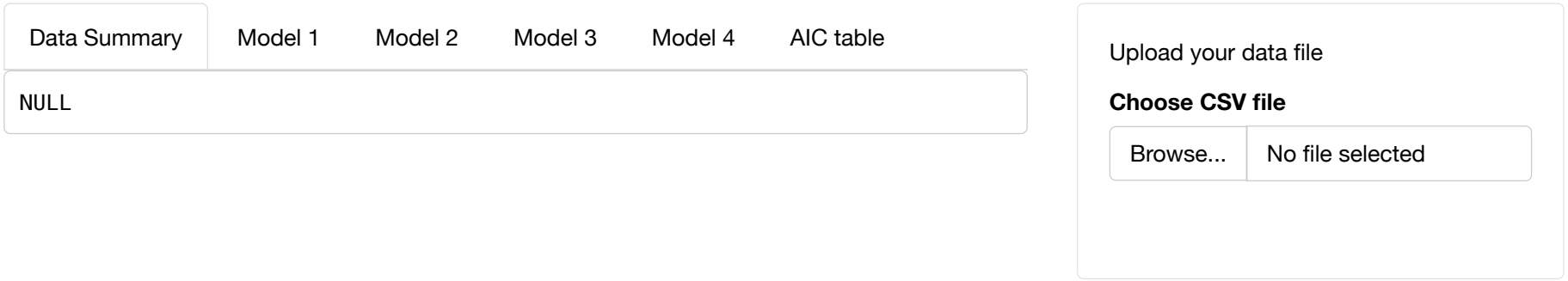
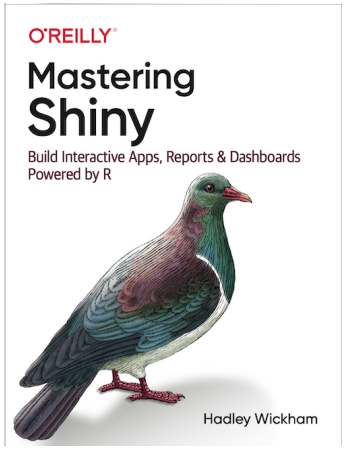
Example: occupancy lab calculations



https://brunnerlab.shinyapps.io/Occupancy/ (https://brunnerlab.shinyapps.io/Occupancy/)

I'm sold…how do I make my own?



- Comprehensive online book (https://mastering-shiny.org/ (https://mastering-shiny.org/))
- Online tutorials (https://shiny.rstudio.com/tutorial/ (https://shiny.rstudio.com/tutorial/))
- Seminars/talks (e.g., https://ecoforecast.org/workshops/r-shiny-seminar-series/ (https://ecoforecast.org/workshops/r-shiny-seminar-series/))
- Adapt existing apps <– *How I got started*
- lean on your R-savvy students & colleagues

I'm sold…but I don't code

Find existing apps

- Collections of apps available
  - e.g., ecology & evolution apps made by UCLA EEB grads (https://ecoevoapps.gitlab.io/ (https://ecoevoapps.gitlab.io/))
  - introductory statistical ideas (e.g., https://facweb.gvsu.edu/adriand1/happy_apps.html (https://facweb.gvsu.edu/adriand1/happy_apps.html) one of *many*)
- Creative googling & Twitter are your friends
- Consider contacting the creators…
  - In my experience, they often make changes I've asked for!

Extended examples / inspirations

- Statistical
  - Dice & Chi-square (https://mathisawesome.shinyapps.io/dice/ (https://mathisawesome.shinyapps.io/dice/))
  - Asymptotics & the behavior of large sample sizes (https://ukacz.shinyapps.io/asymptotics/ (https://ukacz.shinyapps.io/asymptotics/))
  - Linear regression diagnostics (https://gallery.shinyapps.io/slr_diag/ (https://gallery.shinyapps.io/slr_diag/))
  - *Interactive* lab exercise on categorical variables (https://kbodwin.shinyapps.io/Lab_Exercise_CatVars2/ (https://kbodwin.shinyapps.io/Lab_Exercise_CatVars2/))
- Graphing
  - Why bar plots are often nonsense (https://stekhoven.shinyapps.io/barplotNonsense/ (https://stekhoven.shinyapps.io/barplotNonsense/))
  - Interactive graphing in `ggplot` (https://fgeocomm.shinyapps.io/basics-vis/ (https://fgeocomm.shinyapps.io/basics-vis/))

Extended examples / inspirations

- Dynamic models
  - Changes in Allele frequency (https://cjbattey.shinyapps.io/adaptR/ (https://cjbattey.shinyapps.io/adaptR/))
  - Coalescence models (https://pyhatanja.shinyapps.io/CoalescenceContinuous/ (https://pyhatanja.shinyapps.io/CoalescenceContinuous/))
  - Within-host models (a whole class in one! https://shiny.ovpr.uga.edu/DSAIRM/ (https://shiny.ovpr.uga.edu/DSAIRM/))
  - Several of my own (https://github.com/JesseBrunner/EcoHealthDis_Interactive/wiki (https://github.com/JesseBrunner/EcoHealthDis_Interactive/wiki))
- Simulating data:
  - Simulate Cutthroat Trout populations in real streams (https://trout.shinyapps.io/lahontan/ (https://trout.shinyapps.io/lahontan/))

Extended examples / inspirations

- Using existing data:
  - What will climate feel like in 60 years? (https://fitzlab.shinyapps.io/cityapp/ (https://fitzlab.shinyapps.io/cityapp/))
  - Use CDC data for understanding trends (https://michaud.shinyapps.io/CDCPlot/ (https://michaud.shinyapps.io/CDCPlot/))
  - Compare COVID-19 with prior epidemics (https://vac-lshtm.shinyapps.io/ncov_tracker/ (https://vac-lshtm.shinyapps.io/ncov_tracker/))
  - Time series of marine fish abundance/biomass (https://james-thorson.shinyapps.io/FishViz/ (https://james-thorson.shinyapps.io/FishViz/))
  - Quiz for IDing UK plant species (https://gift.uni-goettingen.de/shiny/BotanizeR/ (https://gift.uni-goettingen.de/shiny/BotanizeR/))

Extended examples / inspirations

- Physiological
  - Estimate your Blood Alcohol Concentration (BAC) (https://rasmusab.shinyapps.io/drinkr/ (https://rasmusab.shinyapps.io/drinkr/) or https://irjerad.shinyapps.io/final/ (https://irjerad.shinyapps.io/final/))
  - Visualizing plant phenotypic space (https://shiny.cefe.cnrs.fr/PhenoSpace/ (https://shiny.cefe.cnrs.fr/PhenoSpace/))
  - Rat physiology simulation (impressive! http://physiol-seafile.uzh.ch:3939/entry_level/ (http://physiol-seafile.uzh.ch:3939/entry_level/))