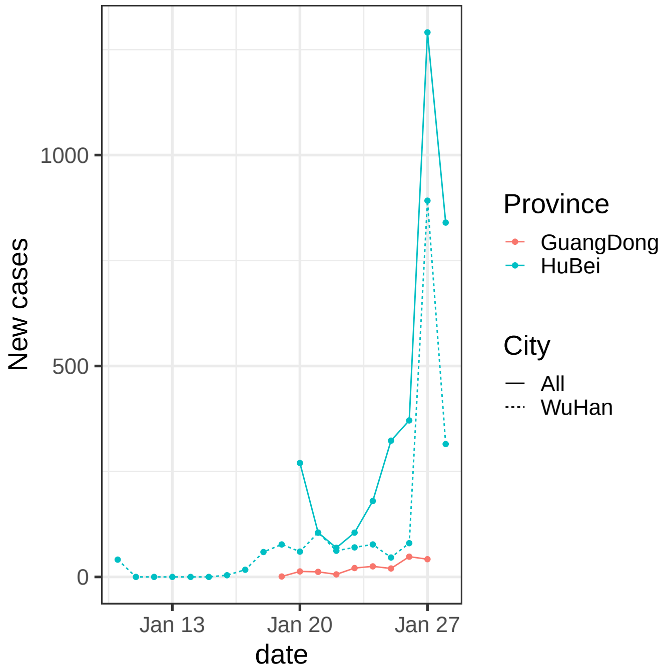
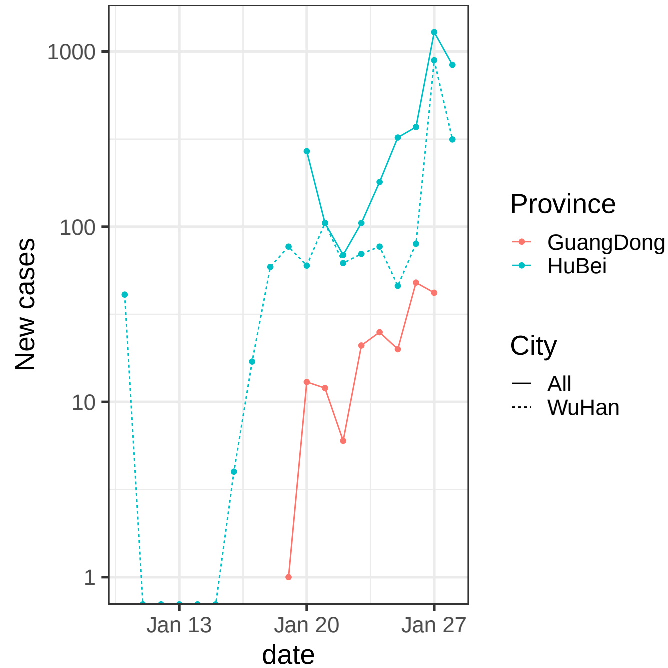
UNIT X Novel coronavirus





Scales

- Which scale should we look at?
  - **Answer:** Both, but the log scale is more relevant
    - **Answer:** Focus on what individual cases are doing
  - **Answer:** A slowdown on the log scale would be progress

Population biology

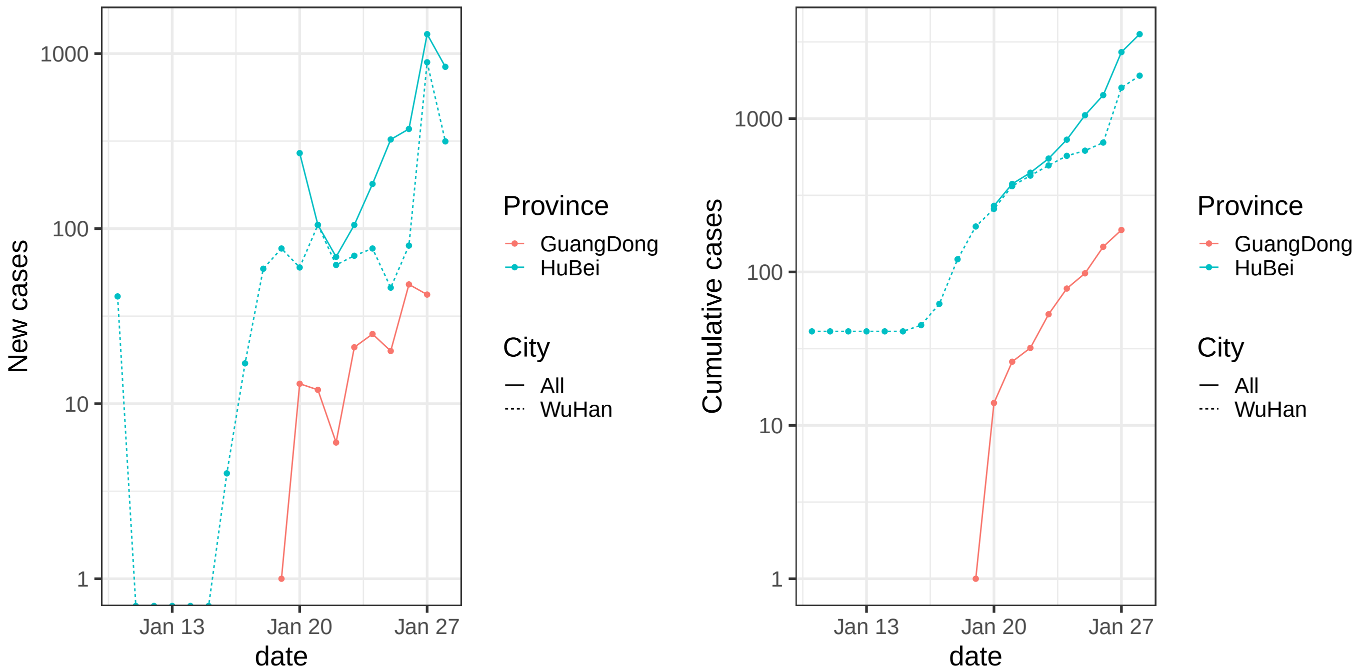
- What quantities do we want to look at?
  - **Answer:** Speed of exponential growth r
  - **Answer:** Finite rate of increase λ
  - **Answer:** Lifetime reproduction

Instantaneous rate of growth r

- What are the components?
  - **Answer:** Birth rate
    - **Answer:** Instantaneous rate of a case producing new cases
    - **Answer:** [case/(case · time]
  - **Answer:** Death rate
    - **Answer:** Virus-centered!
    - **Answer:** Rate of death, recovery, or effective quarantine

- How do you think we estimate?
    - **Answer:** People are estimating r right now from the population-level increase in disease
        - **Answer:** Then using that to estimate b
    - **Answer:** Models go both directions!

What's the difference?



Cumulative curves

- **Make process look smoother by counting the same cases over and over**
- **Can make communication clearer . . .**
    - **or lead to false confidence and over-simplfication**

Finite rate of growth λ

- Why do we want this?
    - **Answer:** to communicate with policy-makers or the public
    - **Answer:** maybe to make concrete predictions, though we could use r
- How do we calculate it?
    - **Answer:** Pick a time step (week? year?)
    - **Answer:** Use a formula $\lambda = \exp(r\Delta t)$

Example

- $r \approx 0.14/\,\text{day}$
- What is λ?
  - At a time scale of a day?
  - At a time scale of a week?

Reproductive number $\mathcal{R}$

- What is it?
  - **Answer:** Expected number of new cases per case over the lifetime of a case
- Why do we want this?
  - **Answer:** An important measure of how hard the epidemic will be to stop
- How do we calculate it?
  - **Answer:** $\mathcal{R} = b/d$; if we can estimate those

Example

- $r \approx 0.14/\,\text{day}$
- What is our estimate of $\mathcal{R}$?
  - When average length of infection $L = 5\,\text{day}$?
  - When average length of infection $L = 10\,\text{day}$?

Case fatality proportion

- If the disease spreads around the world, most of us will get it.
- How many will die?
  - This is a units question!
- What proportion of people with the disease are dying?
  - People are often not careful enough with the denominator of this proportion
  - People with (detected) severe disease; people with (detected) recognizable disease; people who develop antibodies

Population regulation

- What are some reasons the virus's reproductive number may go down as it spreads?
  - **Answer:** People react by changing behaviour
  - **Answer:** People die or become immune
  - **Answer:** Vaccination or treatment
- Are there any reasons it might go *up*?
  - **Answer:** Evolution
  - **Answer:** *One* way evolution sometimes increases $\mathcal{R}$ is by decreasing the fatality proportion

Other key questions

- How is the disease transmitted?
  - Probably air droplets and contaminated surfaces
- Can it be transmitted before symptoms start?
  - Probably
- What is the likely age distribution of serious cases?
  - Probably mostly elderly people