TRACKING VIRAL OUTBREAKS IN REAL TIME

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WHY ARE WE HERE?

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- **Connect** the fields of programming and biology

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- **Use** real tools for computational biology

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- **Connect** the fields of programming and biology
- **Use** real tools for computational biology
- **Explore** patterns in virus evolution

WHO AM I?

- Ph.D. student in Molecular and Cellular Biology
- Studying influenza evolution in Trevor Bedford's lab at the Hutch
- Professional programmer for 8 years
- M.S. in computer science and biology

WHO ARE YOU?

- Rising 10th and 11th grade students
- Programmers?
- Scientists?

THE PLAN FOR TODAY

1. Introductions
2. Reconstructing the Ebola outbreak with freely available tools
3. Exploring the Ebola outbreak with Nextstrain

OUTCOMES FOR THIS WORKSHOP

At the end of this workshop you will know how to:

- Identify viral sequences from online databases
- Construct a multiple sequence alignment
- Build a phylogenetic tree
- Interpret ancestral relationships between organisms in a tree

ORIGINS OF AN OUTBREAK

QUESTIONS WE NEED TO ANSWER

- What is the infectious unit?
- Where is the outbreak?
- How is it transmitted geographically?
- How is it transmitted between people?
- How is it evolving?

WHERE IS THE OUTBREAK?

HOW IS THE VIRUS TRANSMITTED?

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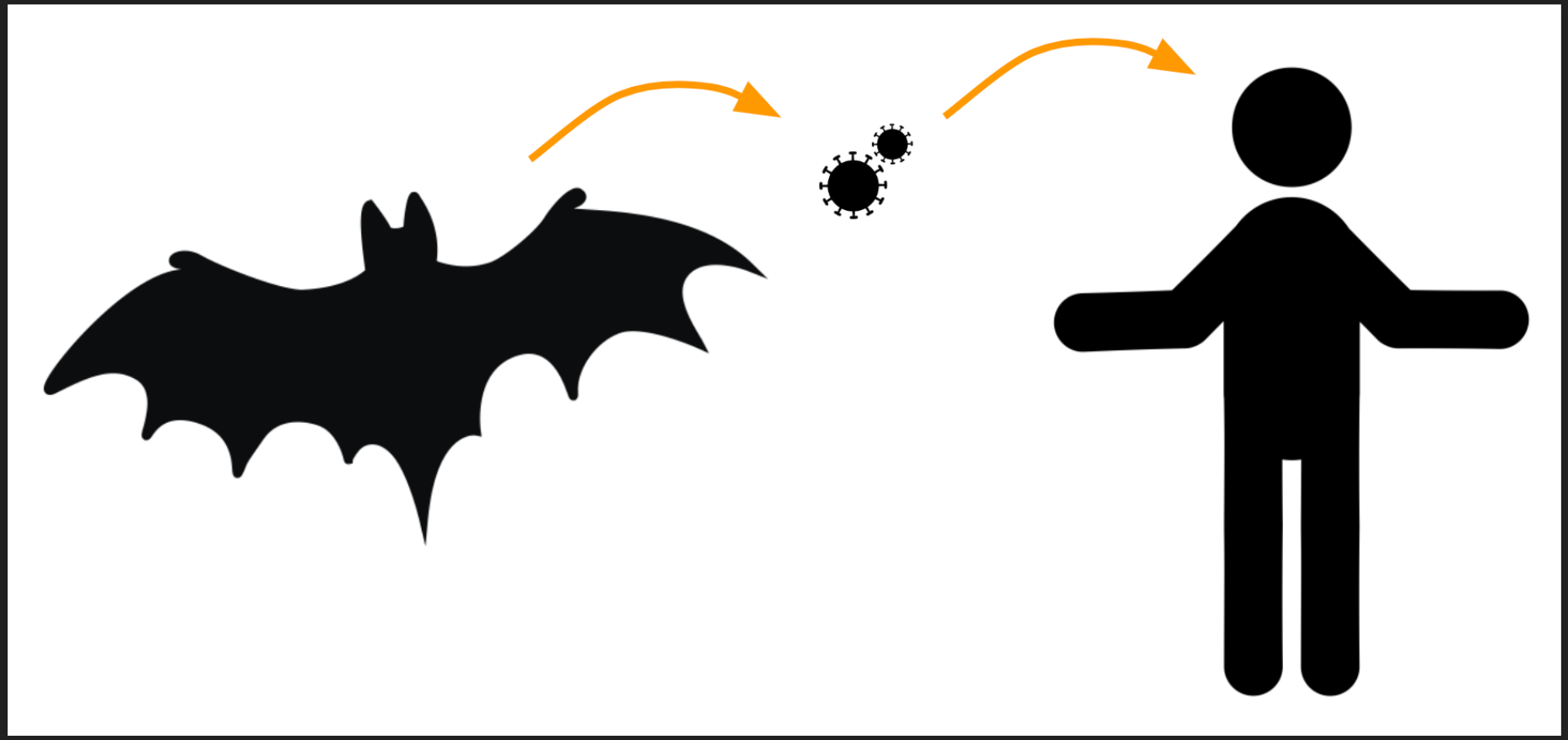
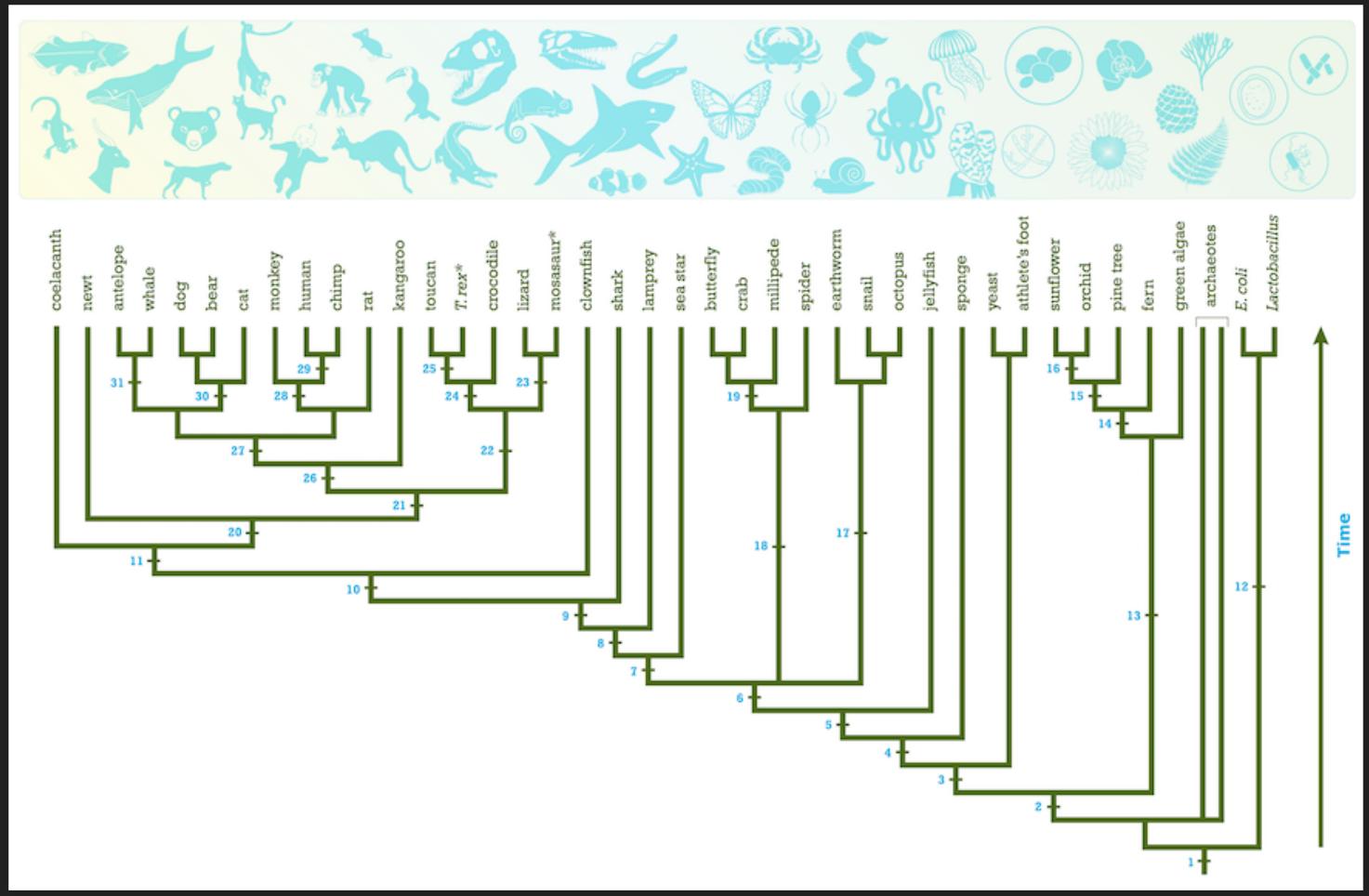
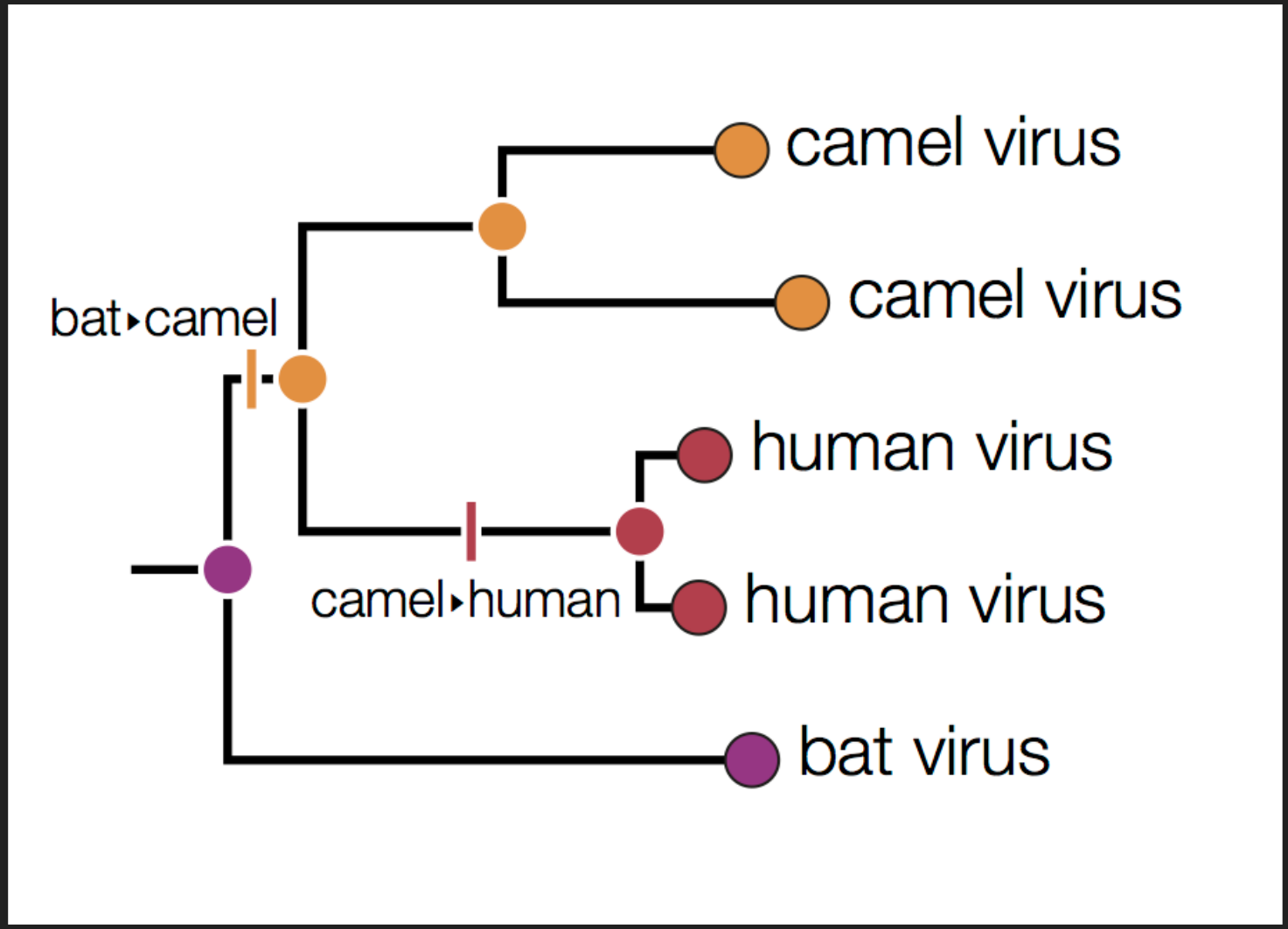


MUTATIONS CAN ALTER PROTEINS

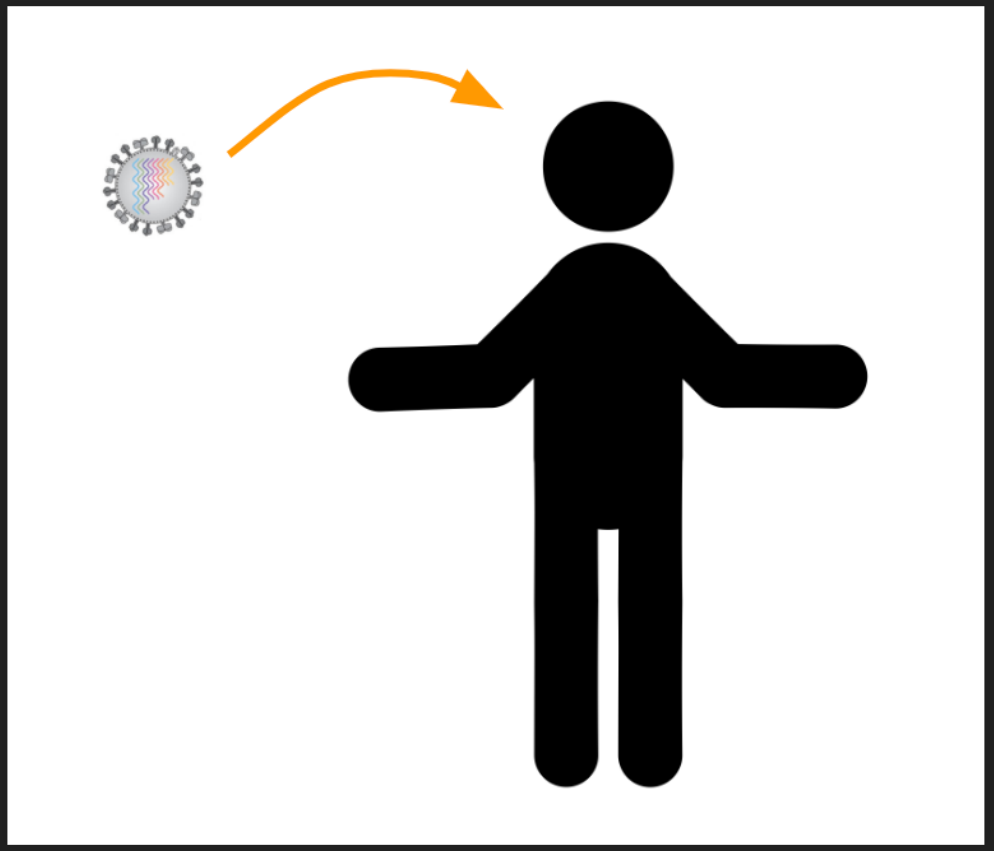
MUTATIONS INFORM ANCESTRAL RELATIONSHIPS

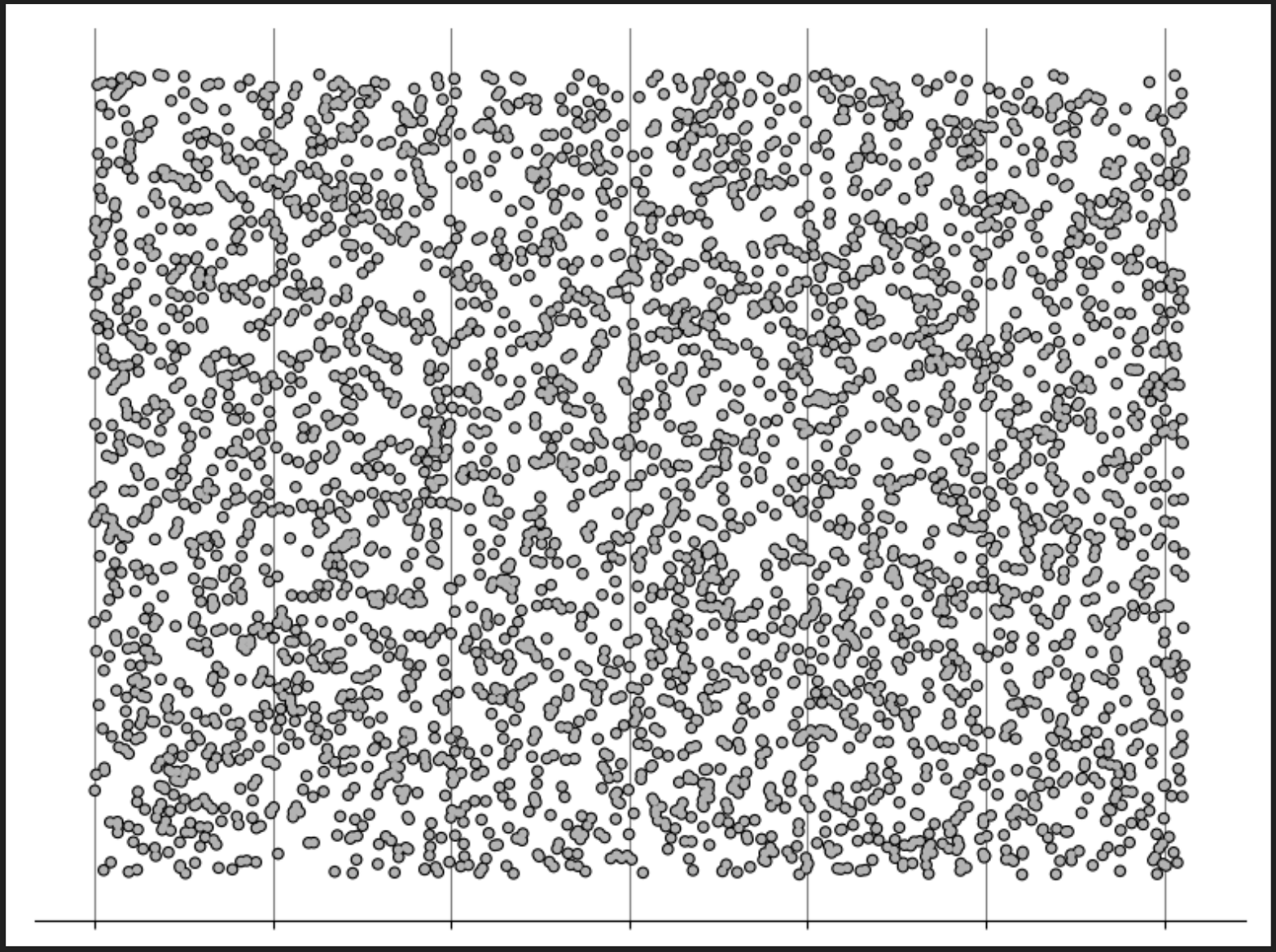


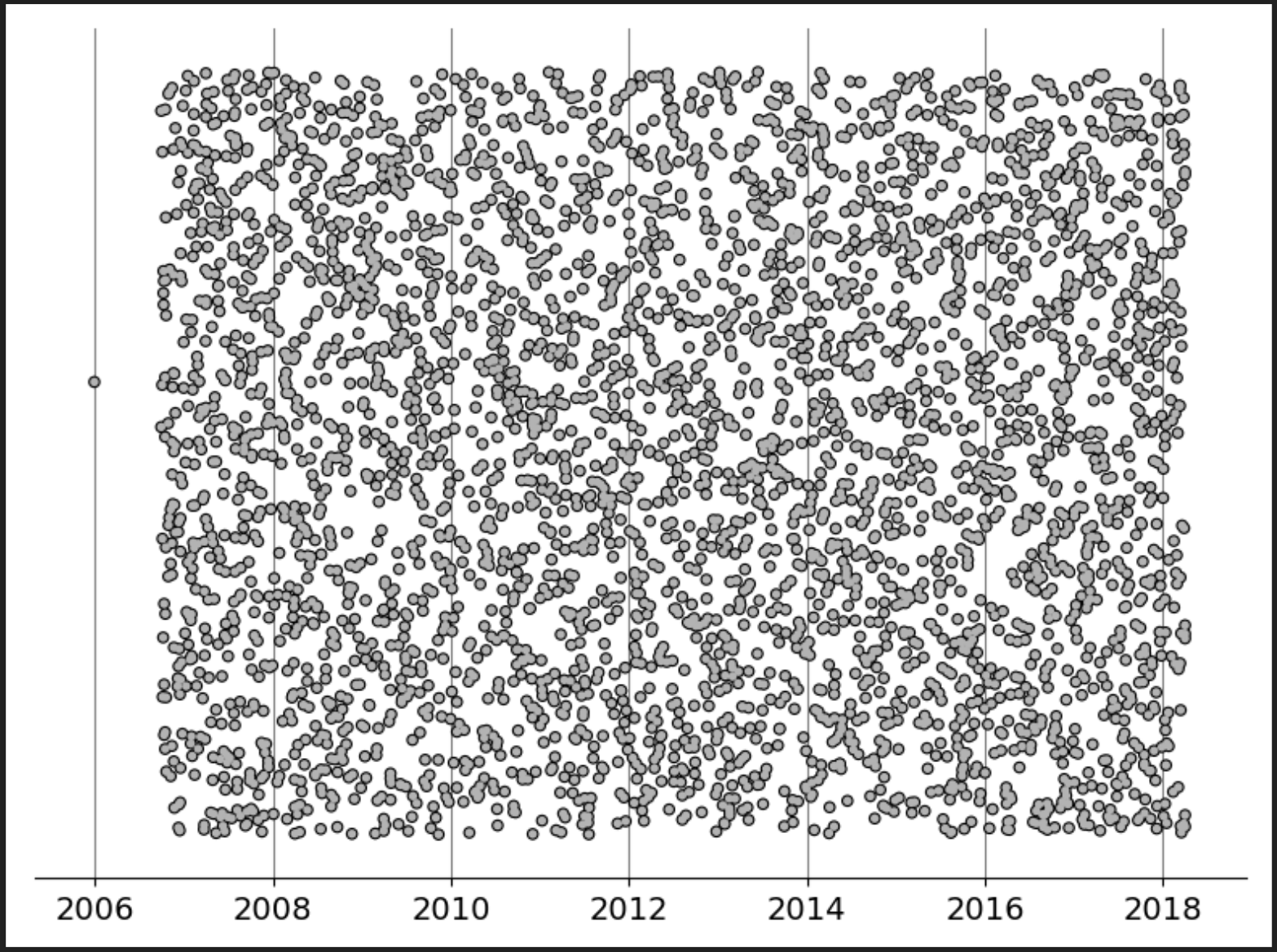
HOW TO READ A TREE



AN EXAMPLE FROM INFLUENZA



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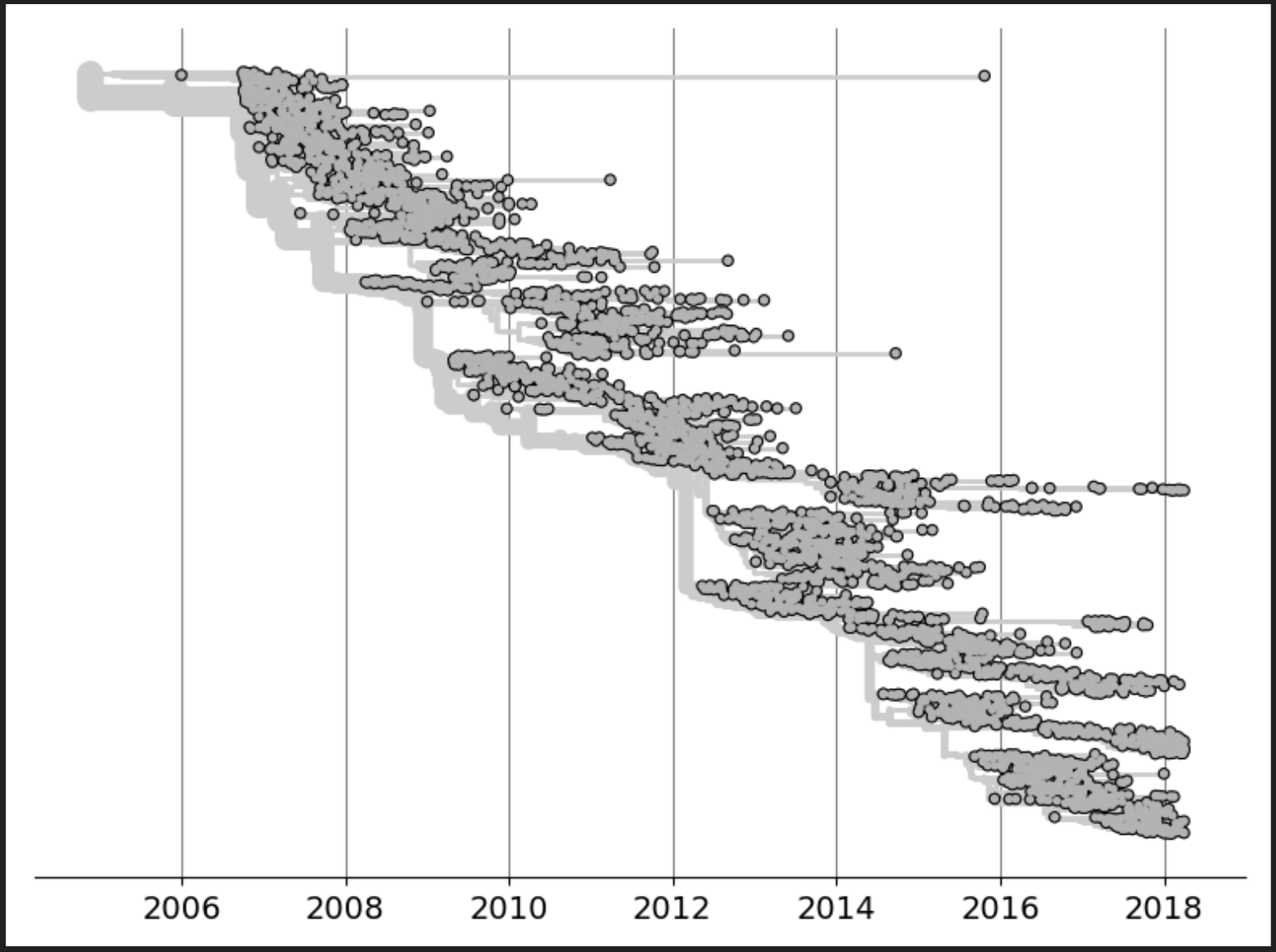
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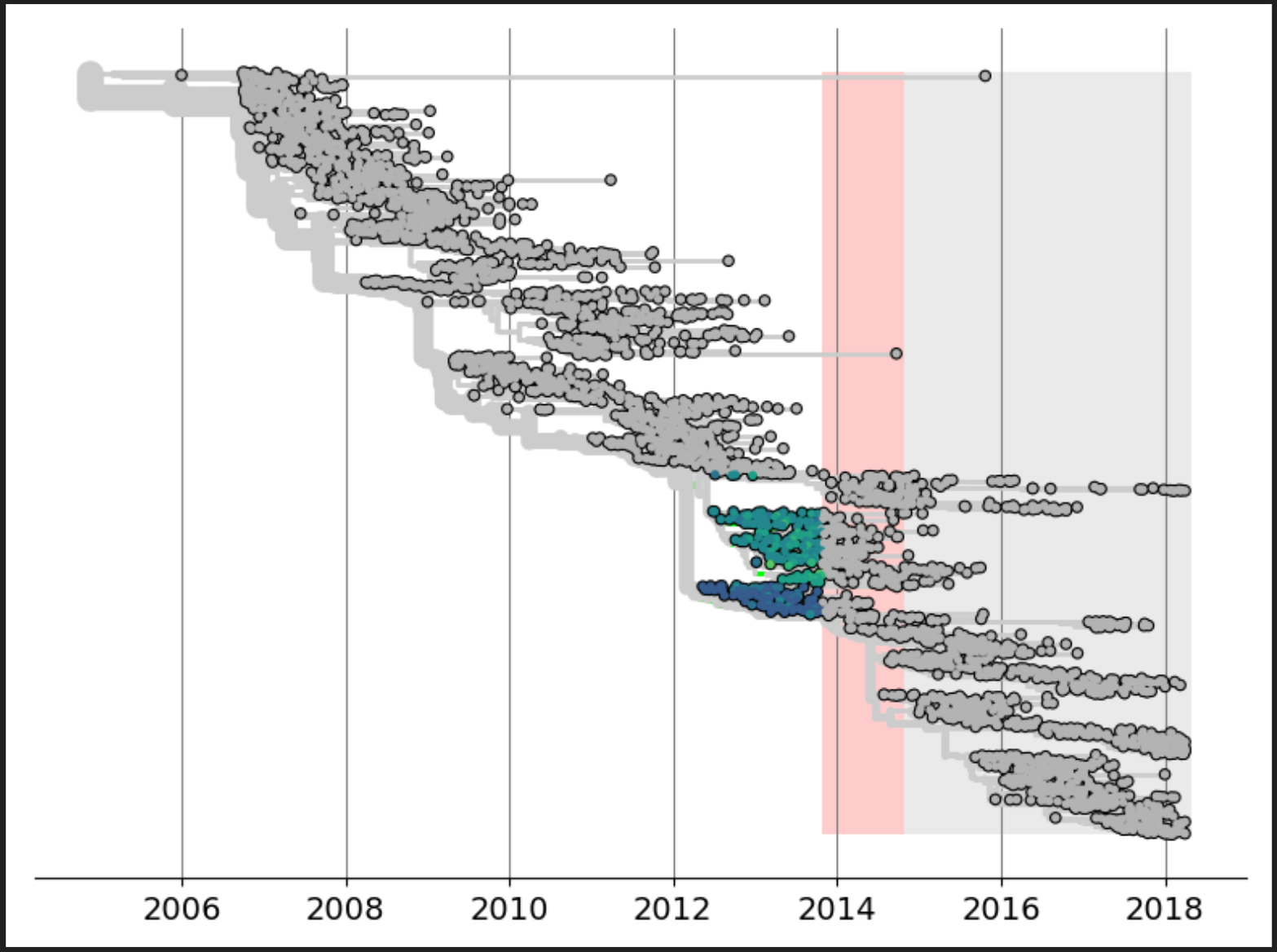
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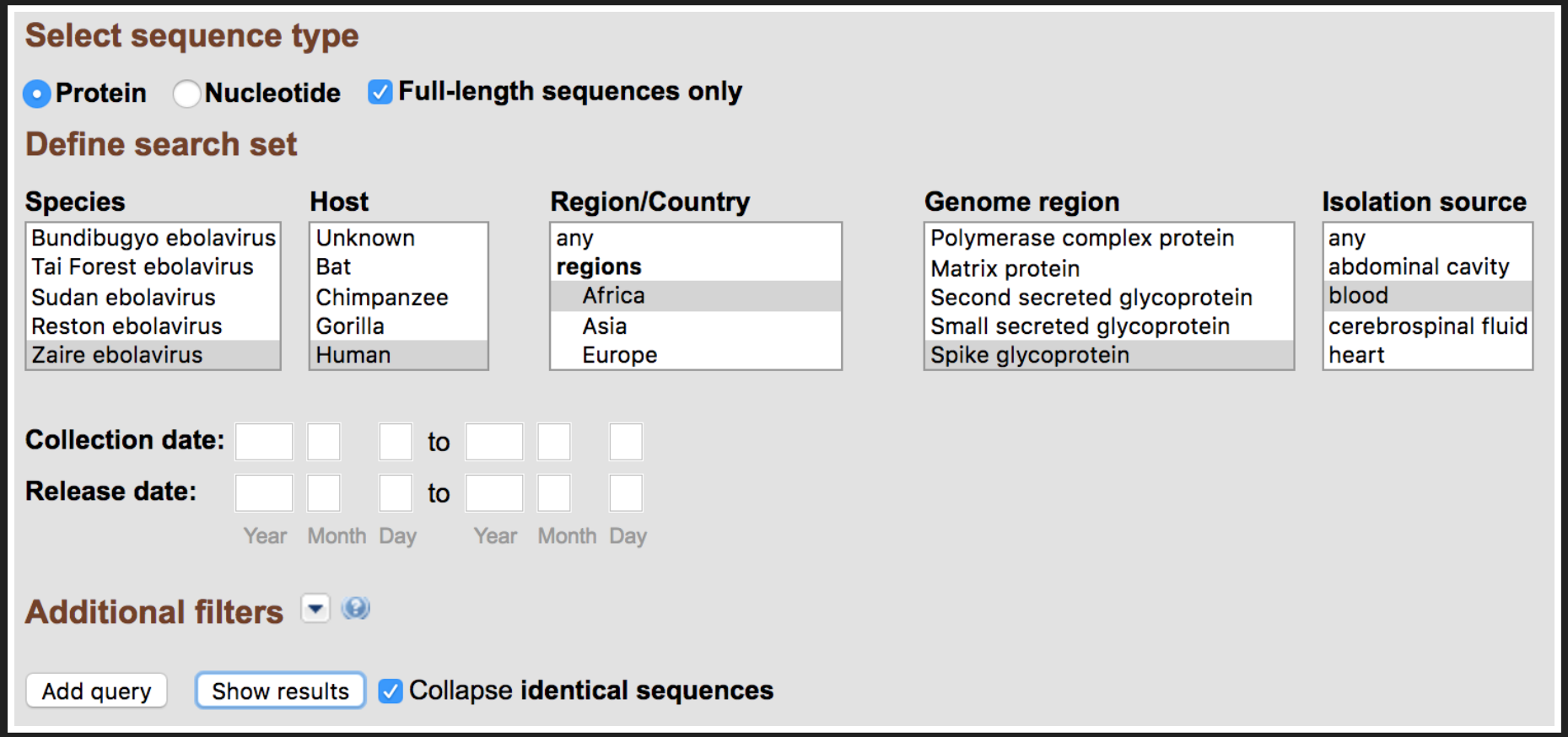
EXPLORE ONLINE TOOLS

https://www.ncbi.nlm.nih.gov/genomes/VirusVariation/Database

Or, Google:

`ncbi virus variation database`

FILTER EBOLA SEQUENCES



ALIGN SEQUENCES

1. Build sequence alignment
2. Browse alignment
3. Download alignment ("Fasta plus gaps")
4. View alignment at http://msa.biojs.net/app/

BUILD A PHYLOGENETIC TREE

1. Build phylogenetic tree
2. Collapse view to "viewport"
3. Explore patterns

EXPLORE EBOLA OUTBREAK WITH NEXTSTRAIN

https://nextstrain.org/ebola

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- Where did Ebola emerge? Where did it expand most rapidly?
- When did the outbreak start?
- What mutations were associated with the outbreak?
- How does the mutation rate of Ebola compare to other viruses?

BEHIND THE SCENES OF NEXTSTRAIN

https://github.com/nextstrain

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You can contribute to the tools and/or the science

CONTINUE TO EXPLORE NEXTSTRAIN

https://nextstrain.org/

- Where did the recent mumps outbreaks originate?
- How has Zika virus migrated globally?
- Which viruses have the fastest mutation rate? The longest genome?
- How do trees for different influenza genome segments differ from each other?

THANK YOU!

More at https://github.com/huddlej/workshop-2018-hutch-explorers