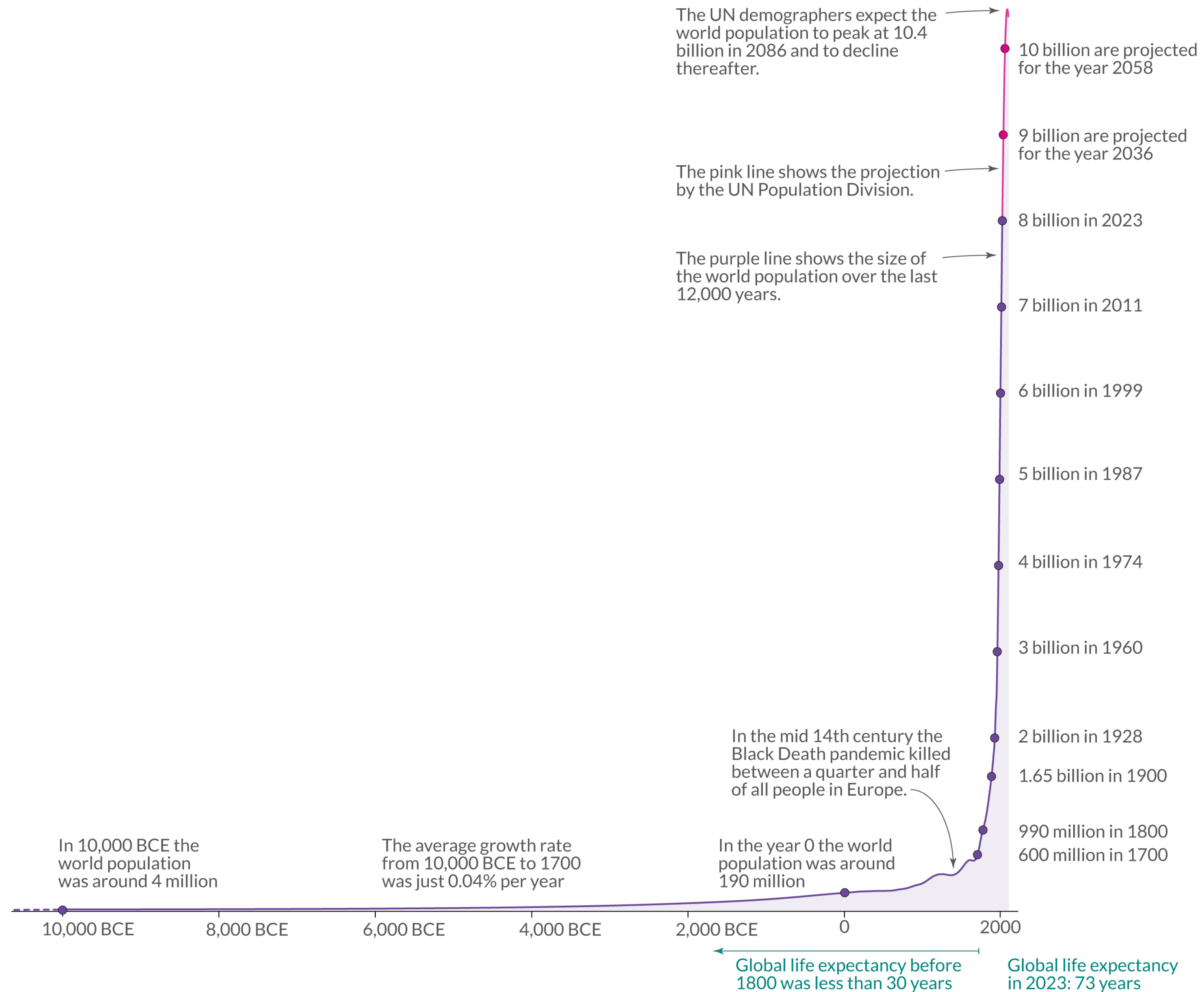


# **Exponential growth**

**Evolution & Ecology**

**Jacopo Grilli, Ciudad de Guatemala, 26/11/2025**

# The size of the world population over the long-run



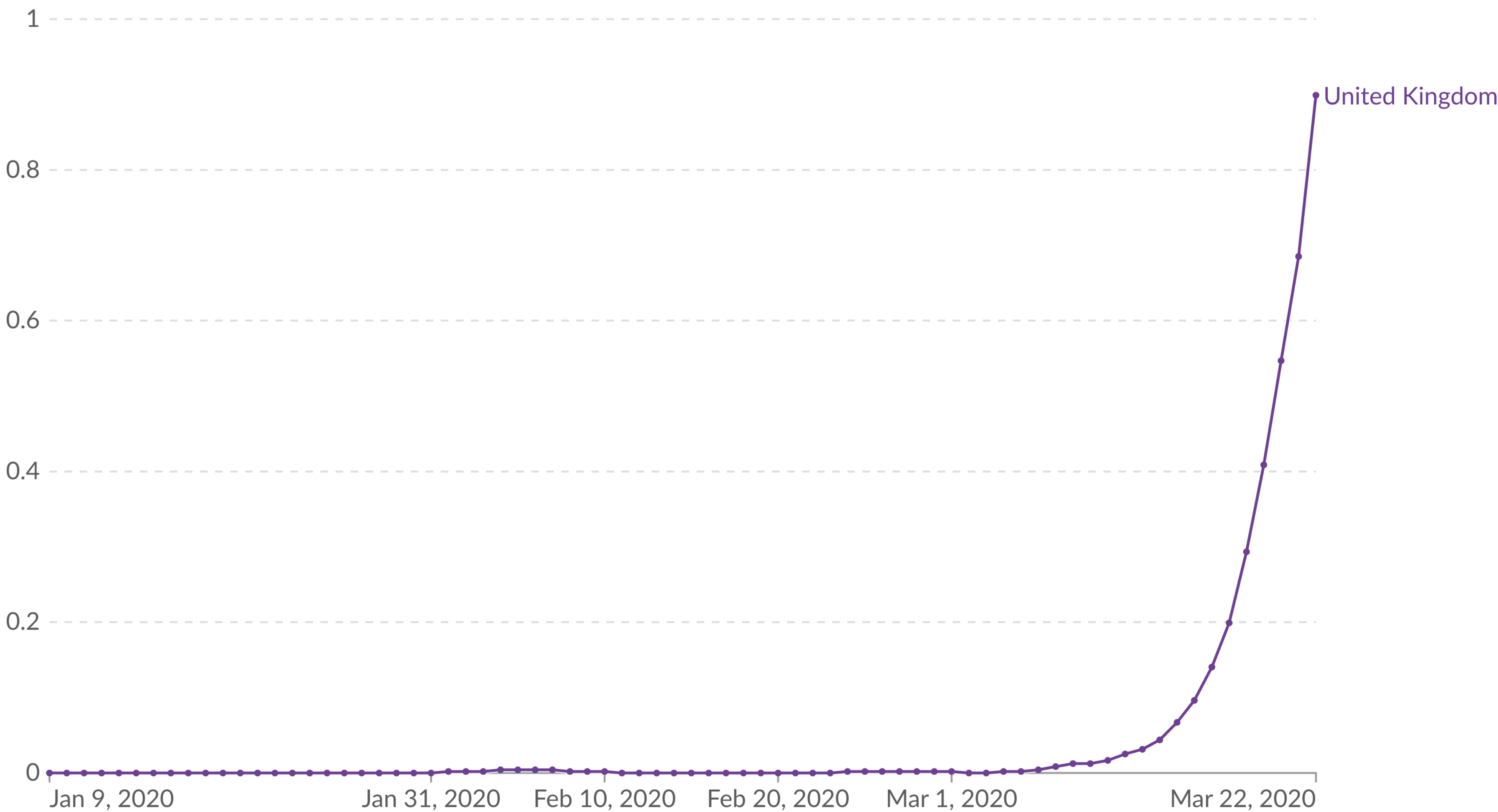
Based on estimates by the History Database of the Global Environment (HYDE) and the United Nations.

This is a visualization from [OurWorldinData.org](https://ourworldindata.org).

Licensed under [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) by the author Max Roser.

# Daily new confirmed COVID-19 deaths per million people, Jan 9, 2020 to Mar 22, 2020

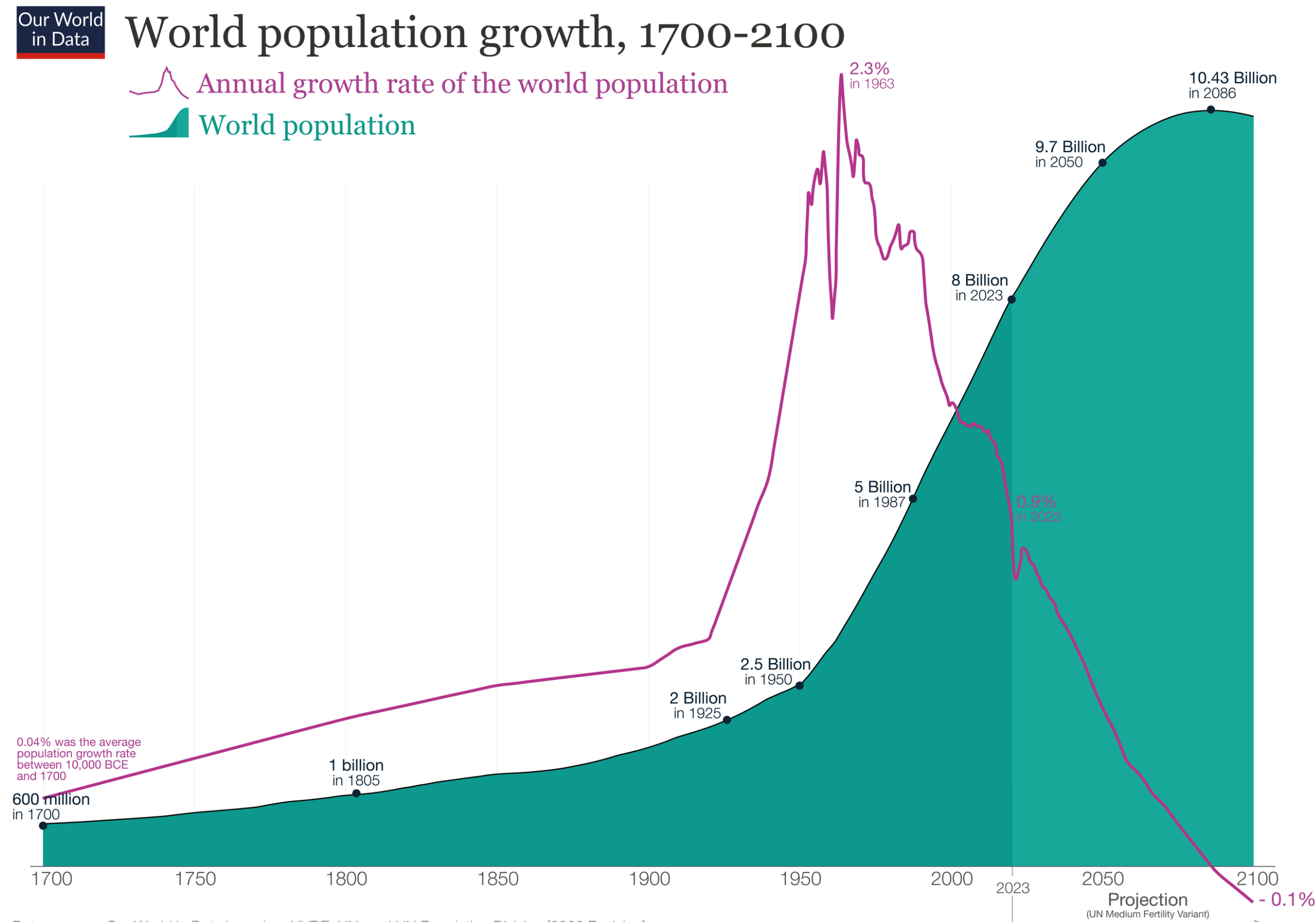
7-day rolling average. Due to varying protocols and challenges in the attribution of the cause of death, the number of confirmed deaths may not accurately represent the true number of deaths caused by COVID-19.



# Deterministic exponential growth

# What fraction ever-lived human is alive?

*Homo sapiens* appearing around 190,000 B.C.E.



Data sources: Our World in Data based on HYDE, UN, and UN Population Division [2022 Revision]  
This is a visualization from [OurWorldinData.org](https://www.ourworldindata.org), where you find data and research on how the world is changing.

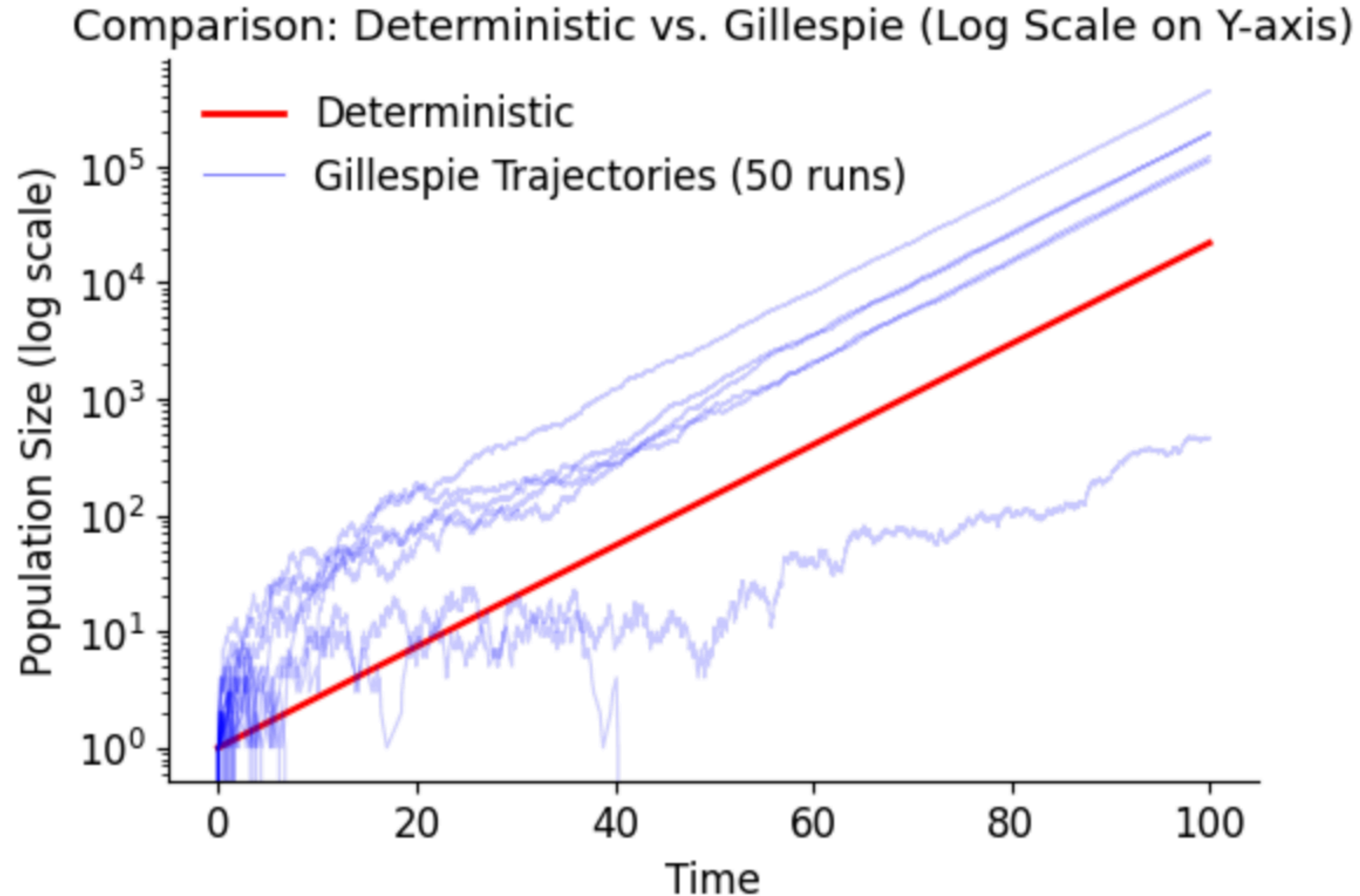
Licensed under CC-BY by the authors Max Roser and Hannah Ritchie.

data in the notes

<https://www.prb.org/articles/how-many-people-have-ever-lived-on-earth/>

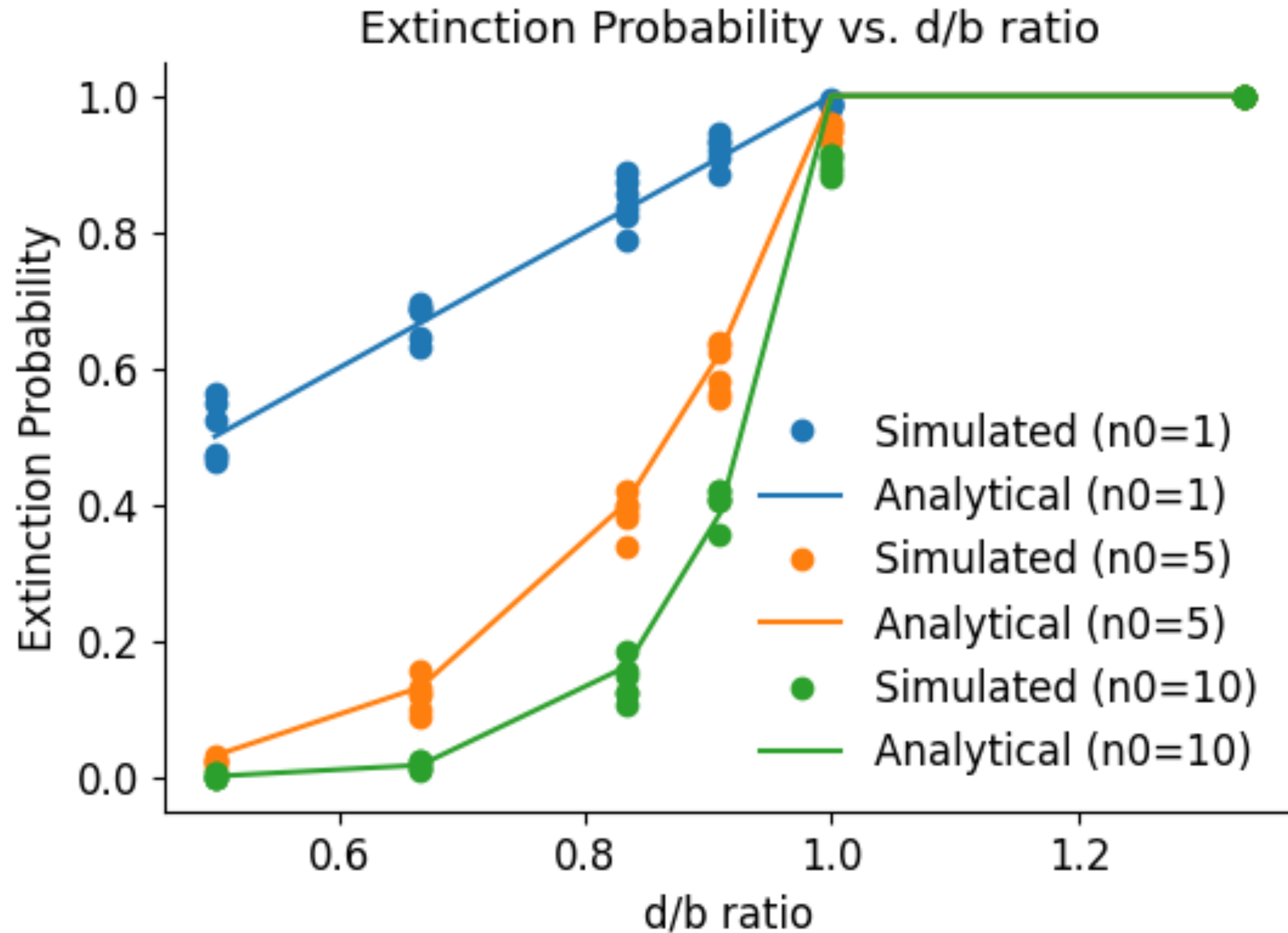
# Birth-death process

# Trajectories differ from the average





# Extinction probability

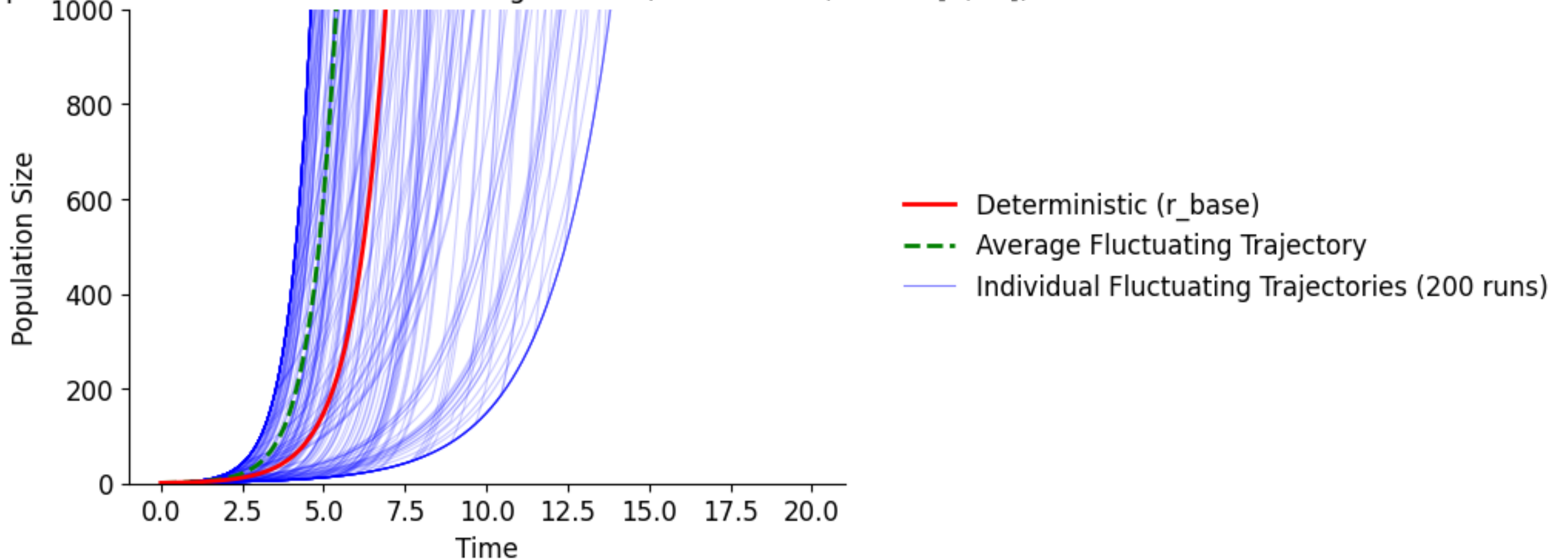




# Exponential growth in random environments

# The average is not the typical

Comparison: Deterministic vs. Fluctuating Growth (Linear Scale, Y-limit [0,10])



# The average is not the typical

Comparison: Deterministic vs. Fluctuating Growth (Log Scale on Y-axis)

