Predicting the Predictable

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Grant me the humility to accept
the things I cannot ~~change~~ **forecast**

The courage to ~~change~~ **forecast** the things I can

And the wisdom to know the difference

When Can Forecasting Succeed?

- Prediction: the assertion that a particular event *will* happen
    - it's about *correctness* ("right" or "wrong")
- Forecast: an assessment of the likelihood of all possible outcomes
    - it's about *accuracy*

Forecasting can succeed when there is:

1. Sufficiently strong *theory:*
   - accounts for all the factors that matter

2. Adequate *data:*
   - fill in the details of the theory
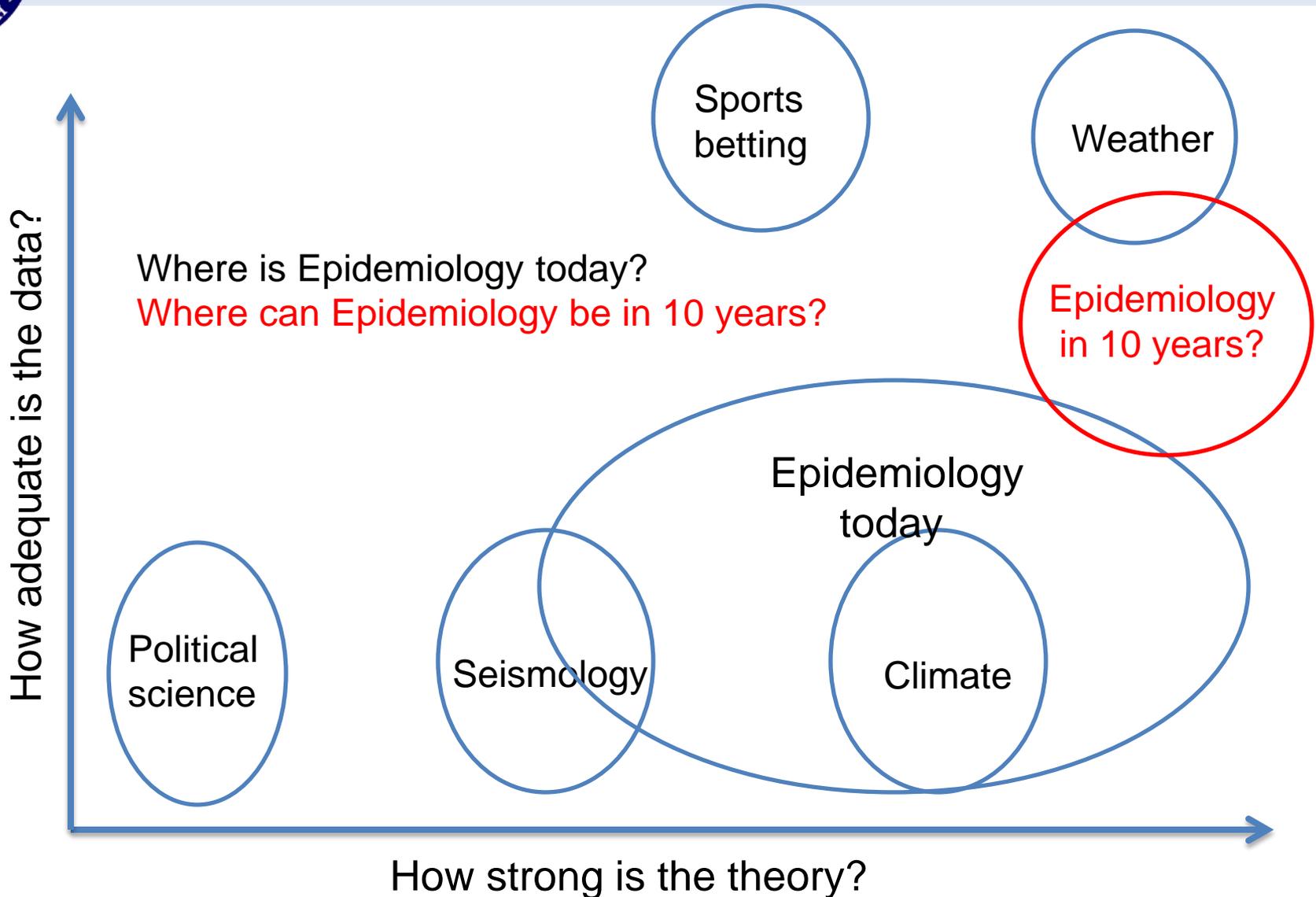   - (i.e., estimate the parameters of the model)

Forecasting *can be demonstrated* when there is:

3. Adequate event rate
   - evaluate the forecasts' accuracy

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Theory and Data

How adequate is the data?

How strong is the theory?

Sports betting

Weather

Where is Epidemiology today?
Where can Epidemiology be in 10 years?

Epidemiology in 10 years?

Epidemiology today

Political science

Seismology

Climate

When Forecasting Might Fail

- A <u>stochastic</u> system
  - entropy is theoretical limit on predictability.

- A <u>complex</u> system
  - may be deterministic, but is inscrutable to us.

- A <u>chaotic</u> system
  - may be deterministic and even simple, but extremely sensitive to initial conditions.

- A <u>second-order</u> system
  - when forecasting itself affects the system
  - e.g. markets, epidemics

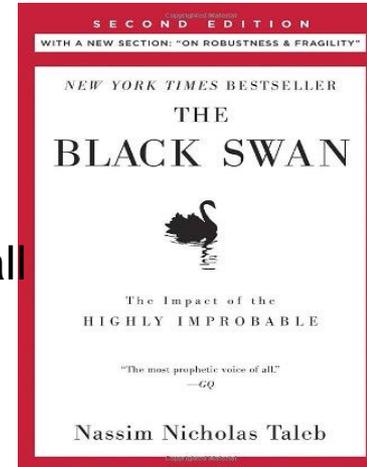# When Forecasting Cannot Be Assessed (and therefore should not be relied on)

- Specific event types that happen too rarely
    - E.g. Influenza pandemics

- Failures due to unforeseen event types (Black Swans)

The World According to Taleb

- Most important historical events were unpredictable
- We underestimate rare events
    - Mostly because we mistake the model for reality
- We severely underestimate their consequences
    - Our society has become a dynamic system, where small events can have exponential consequences

- Real expertise does not exists in domains involving human behavior.

- We worry about the wrong "improbable" events – those that we can enumerate.
- What tends to happen are the catastrophes we *didn't* anticipate.
- Non-repeatable events are ignored before their occurrence, and overestimated afterwards (for a while).

Risk Mitigation in a World of Black Swans

- DHS, and BARDA, operate in a domain of negative Black Swans.
    - your best scenario is that no one will find out how good you were

- The *probabilities* of rare events are not computable. But their *effects* on us are much easier to evaluate.
    - → Rank scenarios not by their likelihood but by their consequence

- Don't avoid forecasting, but don't base all planning on it. Be prepared for all relevant eventualities.

- To make a decision, focus on the consequences, not the probability.

- Avoid optimization.
- Favor redundancy.
- Compensate complexity with simplicity.

AntiFragility in Public Health

(My unvetted thoughts here.)

• Simplicity and Redundancy:

    • Build multiple, independent systems, each designed to mitigate a specific lost capability (rather than to address a particular scenario)

    • Build several such systems for each potential capability loss:
        • Power
        • Communications
        • Medical equipment/supplies
        • Healthcare personnel
        • Transportation
        • …

    • Minimize dependence on communication
        • Operationally
        • Legally
        • Behaviorally