See the Future to Predict the Spread:

Covid-19 Mission Impossible

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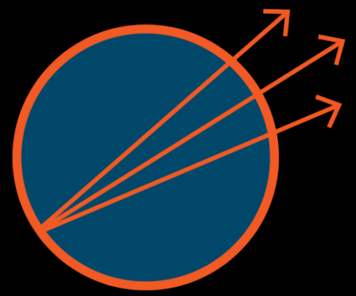
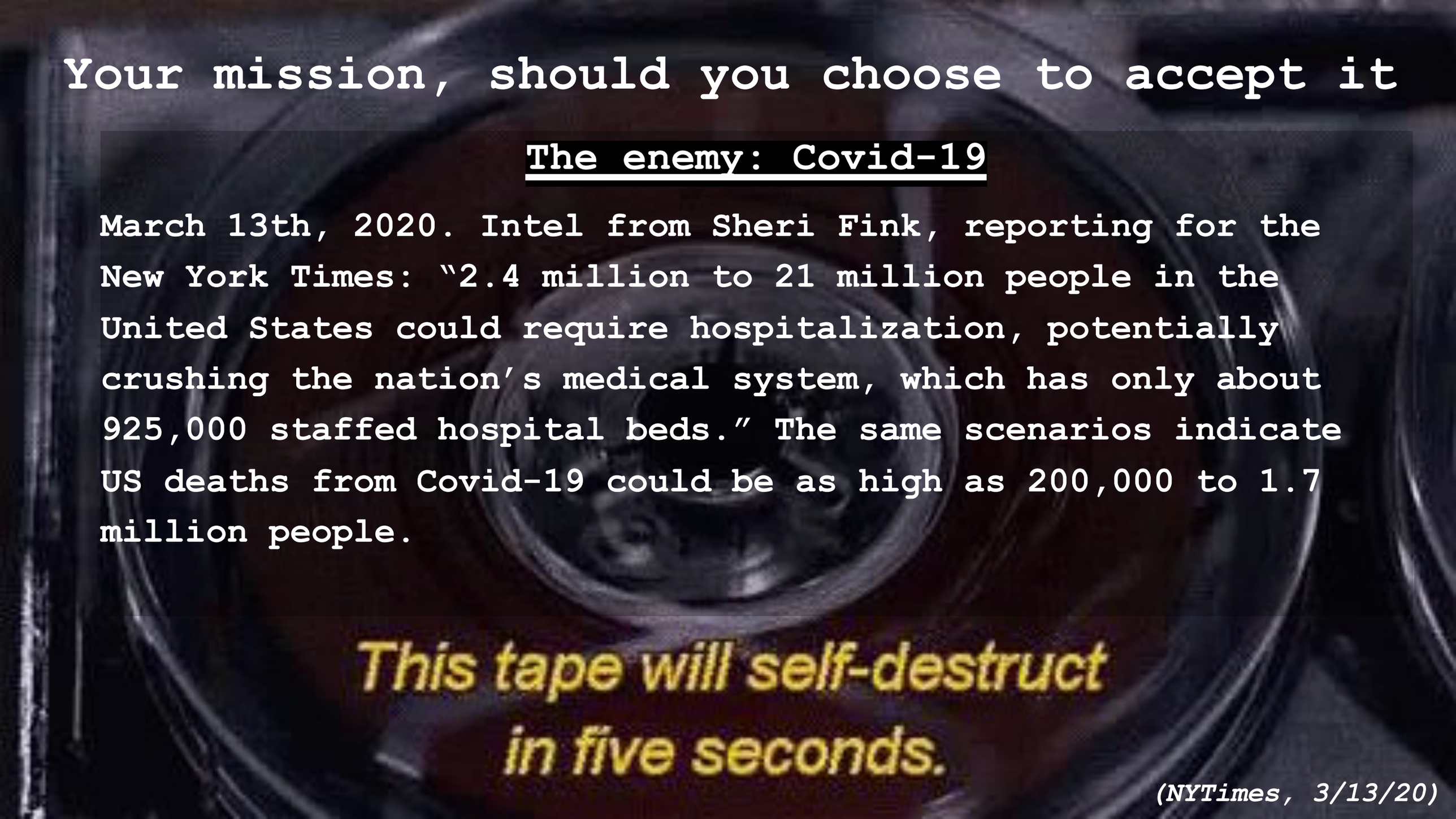


Your mission, should you choose to accept it

The enemy: Covid-19

March 13th, 2020. Intel from Sheri Fink, reporting for the New York Times: “2.4 million to 21 million people in the United States could require hospitalization, potentially crushing the nation’s medical system, which has only about 925,000 staffed hospital beds.” The same scenarios indicate US deaths from Covid-19 could be as high as 200,000 to 1.7 million people.



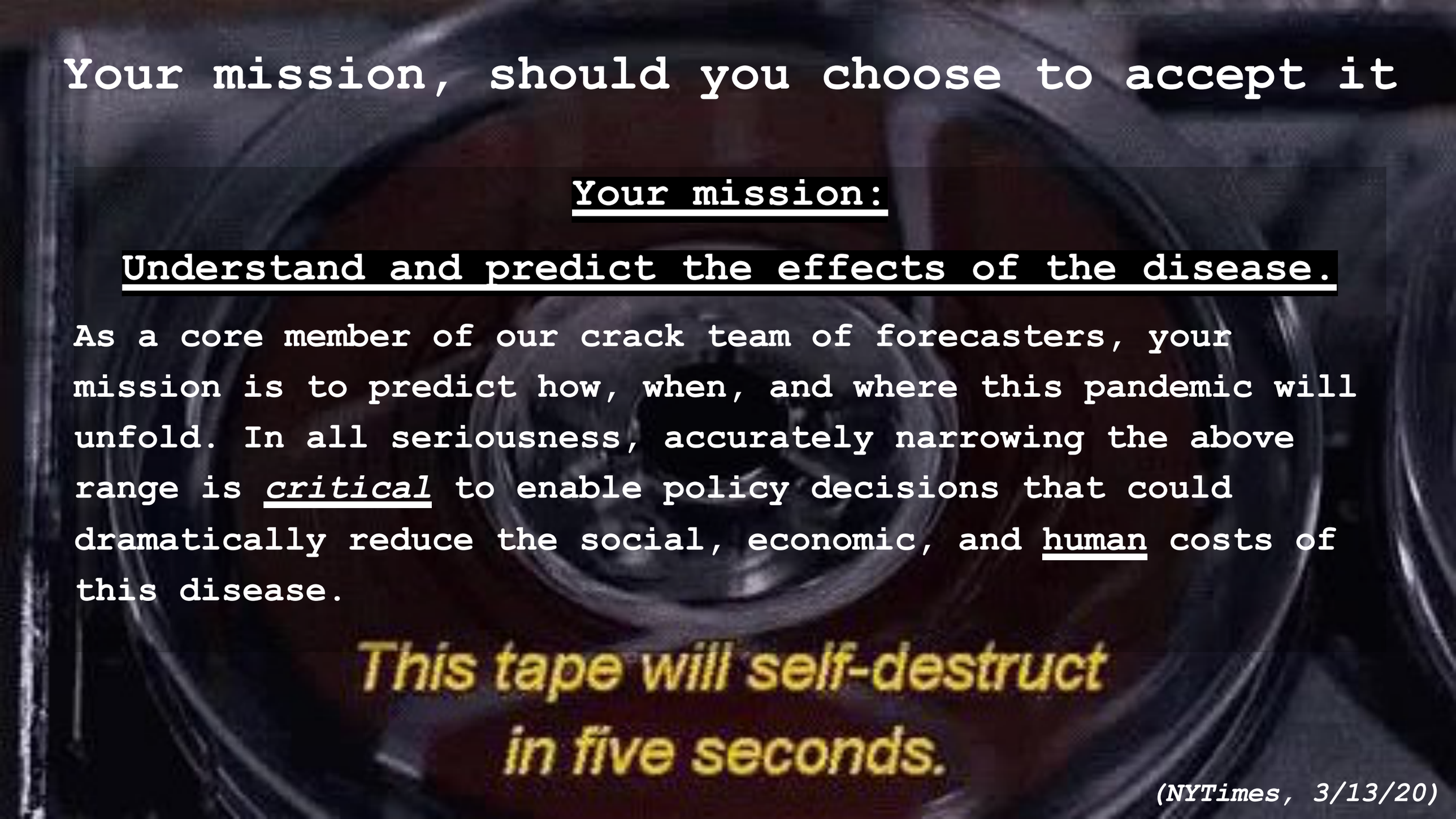
(NYTimes, 3/13/20)

Your mission, should you choose to accept it

Your mission:

Understand and predict the effects of the disease.

As a core member of our crack team of forecasters, your mission is to predict how, when, and where this pandemic will unfold. In all seriousness, accurately narrowing the above range is *critical* to enable policy decisions that could dramatically reduce the social, economic, and human costs of this disease.



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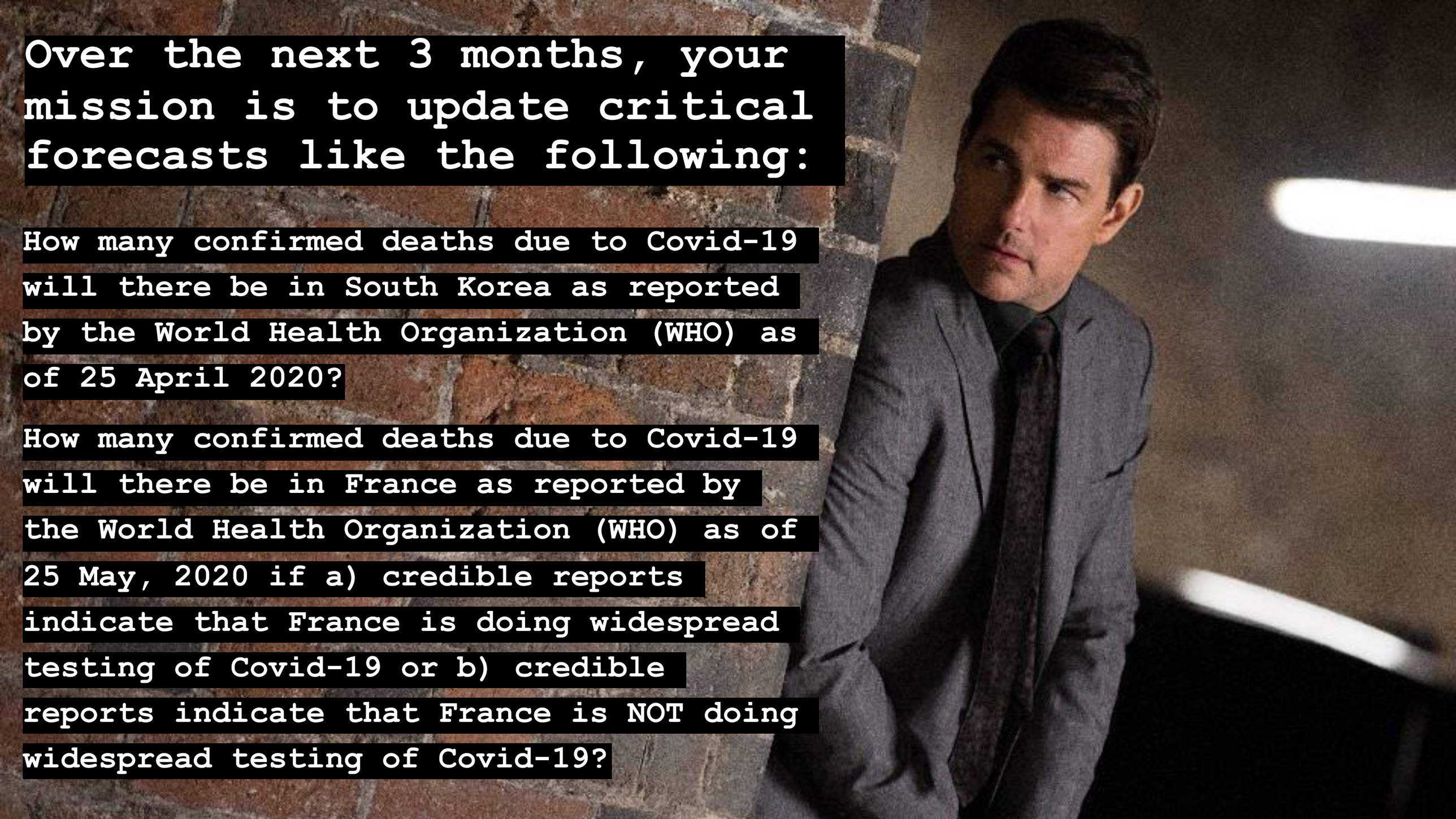


Over the next 3 months, your mission is to update critical forecasts like the following:

How many confirmed deaths due to Covid-19 will there be in South Korea as reported by the World Health Organization (WHO) as of 25 April 2020?

How many confirmed deaths due to Covid-19 will there be in France as reported by the World Health Organization (WHO) as of 25 May, 2020 if a) credible reports indicate that France is doing widespread testing of Covid-19 or b) credible reports indicate that France is NOT doing widespread testing of Covid-19?

Wait, what's in it for me?

Help the World! – You'll be helping all of us better understand – and prepare for – the uncertainty about Covid-19 and potential future health crises, via better forecasting.

Opportunity to Learn – You will get top-notch training and feedback about how well you can 'see the future'!

And there's more!

Chance of Nifty Prizes – After your mission, we'll award:

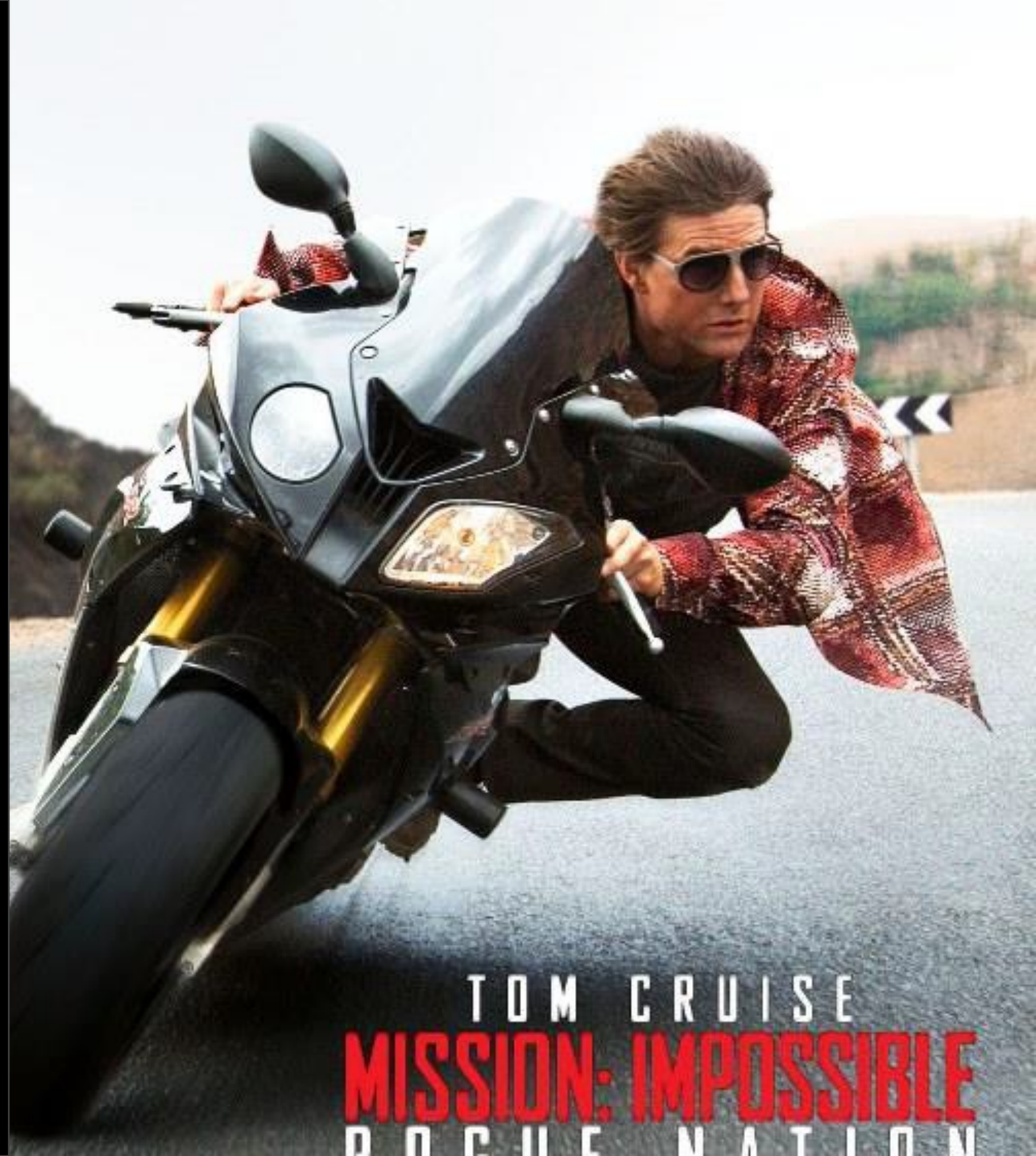
- An invitation to talk to the researchers about the project for the top 10 most accurate forecasters (via video);
- $25 Amazon gift cards for the most accurate 120 participants on initial forecasts, final forecasts, and demonstrated improvement;
- An autographed copy of *Grit* or *Superforecasting* for the next 100 most accurate forecasters;
- Huge bragging rights for completion of *Covid-19 Mission Impossible* for all participants!

Just like Tom Cruise, you won't need a stunt double.

You're about to get top-notch training tips of certified superforecasters, to give you the best shot at seeing the unfolding future of Covid-19.

Are YOU ready?

(You can do the training in parts or start later if you wish. **Just complete it by 9am ET Wednesday March 25.)**



Your superforecasting training plan

Know thy enemy | Know thy task | Four Tips | Practice!

Covid-19 profile

Forecasting Q&A

Break it down
Collect data
Roll it up again
Check your work!

Practice makes perfect!

Public Enemy #1: Covid-19

Know thy enemy | Know thy task | Study 4 tips | Practice!

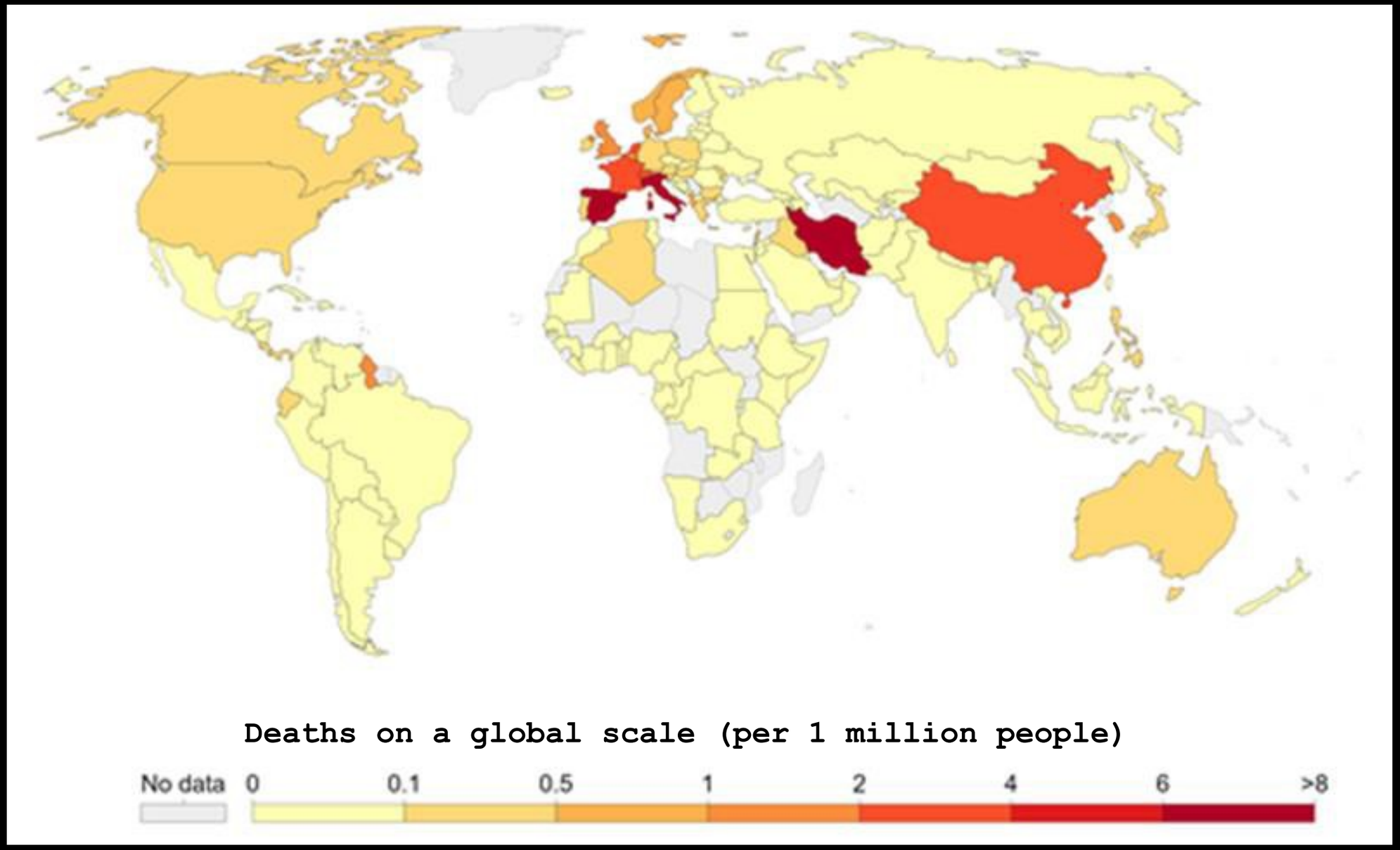
What do we know about Covid-19?

There are lots of unknowns but, as Covid-19 spreads, we learn more every day. Please take 10 minutes to review key facts from the WHO and OurWorldInData at the below link.

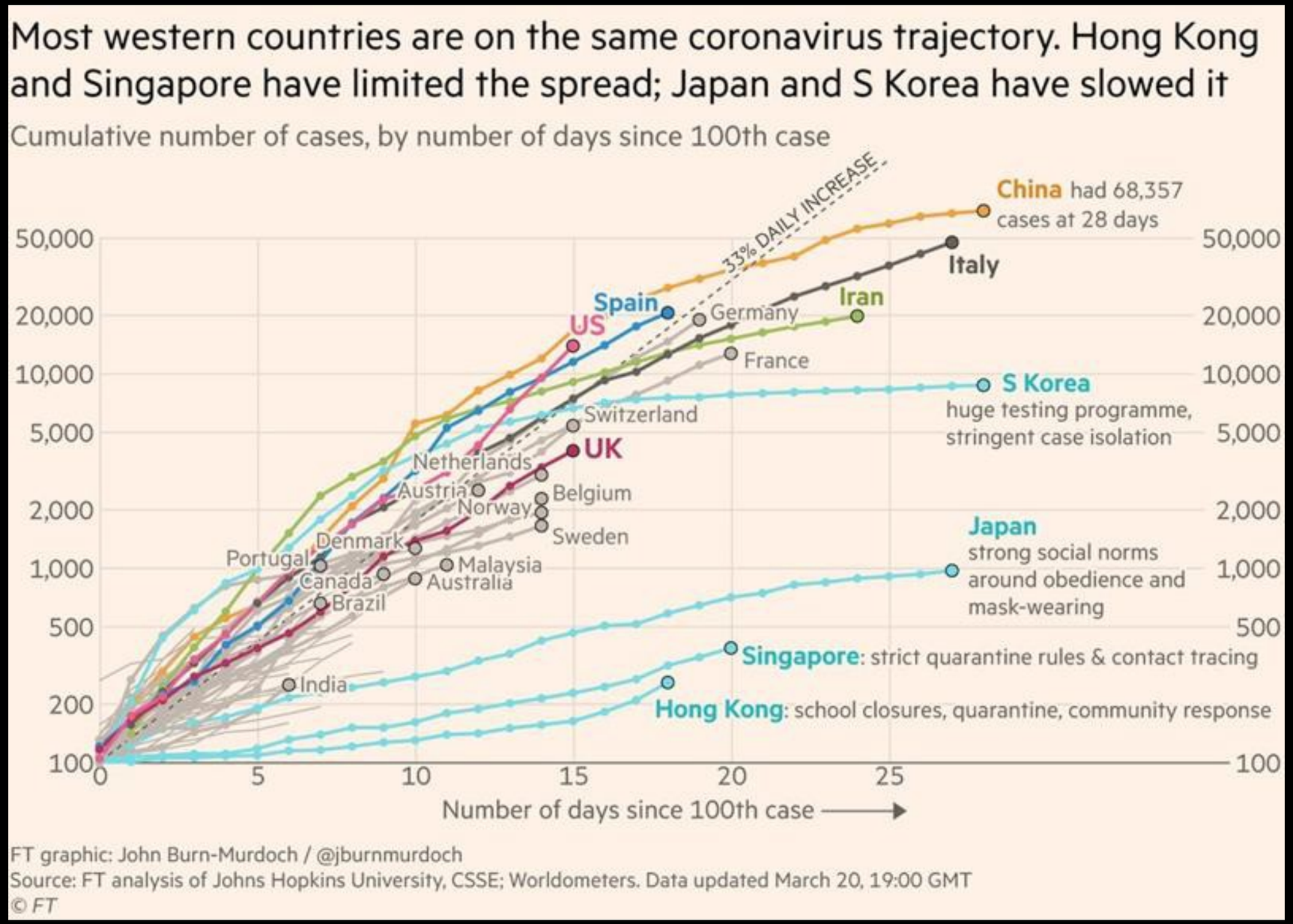
As a commitment device, you won't be able to click to the next page until 10 minutes pass. Of course, you can spend even longer if you wish!

LINK HERE

How deadly is the disease?



How is the disease spreading?



How is the disease spreading?

The distinction between linear and exponential growth is critical for predicting the effects of Covid-19. Click the below link to play a 9-minute video (from a math site run by Grant Sanderson) that illustrates the difference - something critical for understanding Covid-19 and better forecasting its future.

Don't worry if you're not a math whiz! Just focus on the "gist" of the way exponential growth works.

CLICK HERE FOR VIDEO

Stay up to date

We've shared some key facts about Covid-19, but things are constantly changing. If you want to deepen your trainingon Covid-19 over the coming months, explore this free, 3-week course by FutureLearn.

We'll also remind you later, in the references that follow this training.

What is the problem?

On your mission, you will encounter three types of forecasting questions.

We'll walk through each in turn.

1. Binned questions

"How many fatalities due to Covid-19 will there be in France by April 25th?

Bin A: Less than 25,000

Bin B: Between 25,000 and 35,000, inclusive

Bin C: More than 35,000 but less than 45,000

Bin D: Between 45,000 and 55,000, inclusive

Bin E: More than 55,000"

<u>Your task</u>: Put probabilities on each bin of answer possibilities & ensure they sum to 100%.

1. Binned questions

"How many fatalities due to Covid-19 will there be in France by April 25th?

5%	Bin A:	Less than 25,000
15%	Bin B:	Between 25,000 and 35,000, inclusive
40%	Bin C:	More than 35,000 but less than 45,000
30%	Bin D:	Between 45,000 and 55,000, inclusive
10%	Bin E:	More than 55,000"

For example

<u>Your task</u>: Put probabilities on each bin of answer possibilities & ensure they sum to 100%.

2. Conditional questions

"How many fatalities due to Covid-19 will there be in France by April 25th …

Condition A: IF France initiates wide-spread testing?

Condition B: IF France DOES NOT initiate wide-spread testing?"

[followed again by 5 bins…]

<u>Your task</u>: Assign probabilities to each bin of possibilities & ensure they sum to 100%

Binned and conditional questions

These forecasting questions are designed to be “rigorously resolvable” - the answer will be known by a given date to yield clear accuracy feedback and put you on a path to “superforecasterdom.”

3. Counterfactual questions

"How many fatalities due to Covid-19 would there be in France by April 25th if France had begun widespread testing after the initial 4 deaths on March 5th?"

Your task: Assign probabilities to the bins for each question and ensure they sum to 100%.

Counterfactual questions

These "counterfactual forecasting" questions cover what would have happened if history had unfolded differently. Of course no one can conclusively score accuracy here.

So why ask them?

Because they shed light on your implicit cause-effect theories about Covid-19. Top forecasters connect backward-in-time & forward-in-time reasoning!

All Questions

For all questions, pay close attention to:

1. The date
2. "Cut points" for answers (e.g., bins with boundaries, such as 0-10 cases, 11-50 cases,…)
3. Rules for resolving outcome of the question (e.g., data sources)
4. Any graphs we provide of existing data.

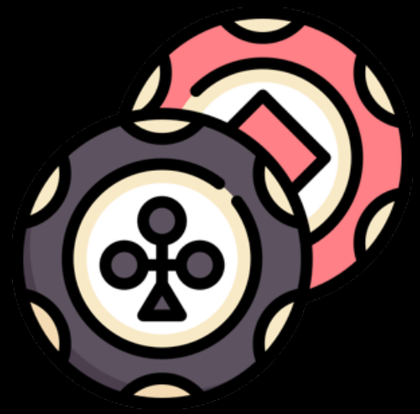
Your Forecasts

You'll give your answers as probabilities of outcomes occurring by Date Y. But we don't go around talking in terms of numerical probabilities every day.

How do we translate our internal uncertainty to a number between 0-100%?

Your Foreasts

Better forecasters use numbers to express their uncertainty and they do so with nuance. As in poker, you gain an edge if you get better at separating 60/40 from 40/60 bets—or 55/45 from 45/55.



Translating hunches into numerical probabilities with some granularity requires practice.

Your Forecasts

Intelligence Analysts express their beliefs on a scale with 7 levels of uncertainty.

Almost No Chance	Very Unlikely	Unlikely	Roughly Even Odds	Likely	Very Likely	Almost Certain
1%-5%	5%-20%	20%-45%	45%-55%	55%-80%	80%-95%	95%-99%

Your Forecasts

Superforecasters distinguish among many more - between 10 & 20, depending on problem. Greater precision is highly correlated with greater accuracy.

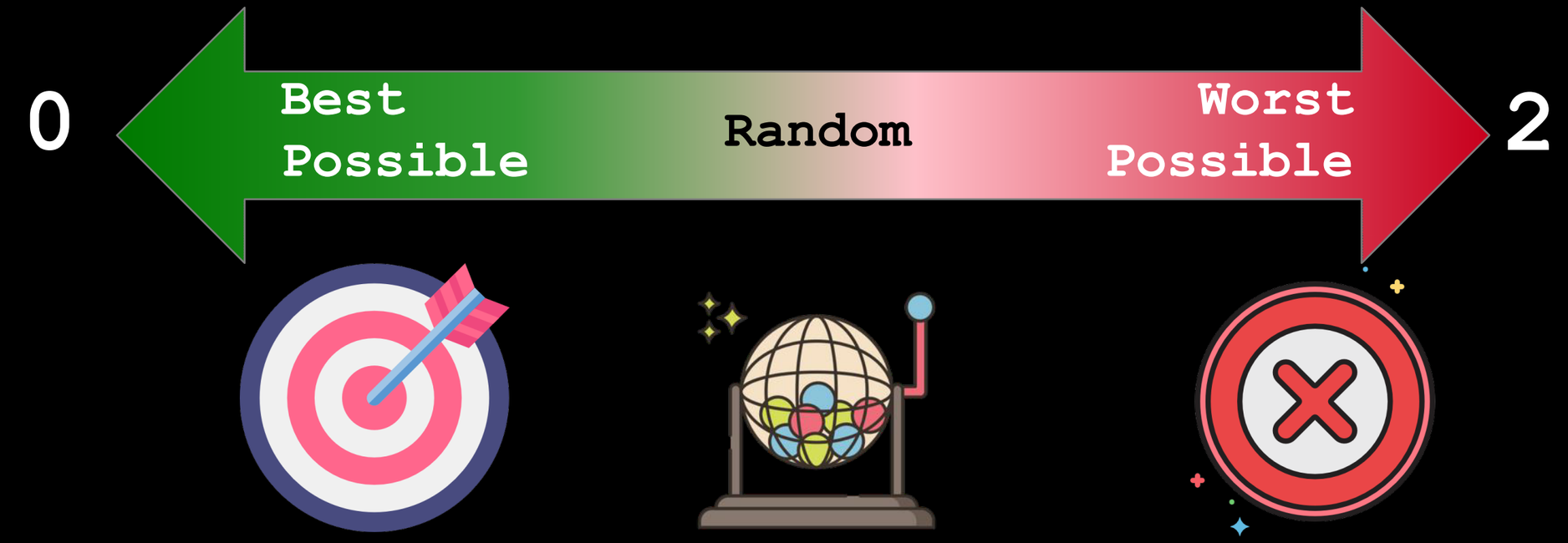
Almost No Chance	Extremely Unlikely	Very Very Unlikely	Very Unlikely	Unlikely	Slightly Unlikely	Roughly Even Odds	Slightly Likely	Likely	Very Likely	Very Very Likely	Extremely Likely	Almost Certain
1%-2%	2%-5%	5%-8%	8%-12%	12%-25%	25%-45%	45%-55%	55%-75%	75%-88%	88%-92%	92%-95%	95%-98%	98%-99%

Try hard to be precise. You might start out coarse, then get more precise with practice.

How do we score accuracy?

Your probabilities will feed into our not-so-top-secret accuracy metric for this tournament:

The Brier Score



How does the Brier score work?

Suppose someone asks you: "Will it rain tomorrow?" and you say "Yes, I'm 90% sure".

We can calculate your Brier score – below – to quantify how accurate you were.

Probability of Rain	Probability of No Rain	Outcome (Rain)	Brier Score
0.90	0.10	Yes = 1	$(1 - .9)^2 + (0 - .1)^2 = 0.02$

Your Brier Score is:

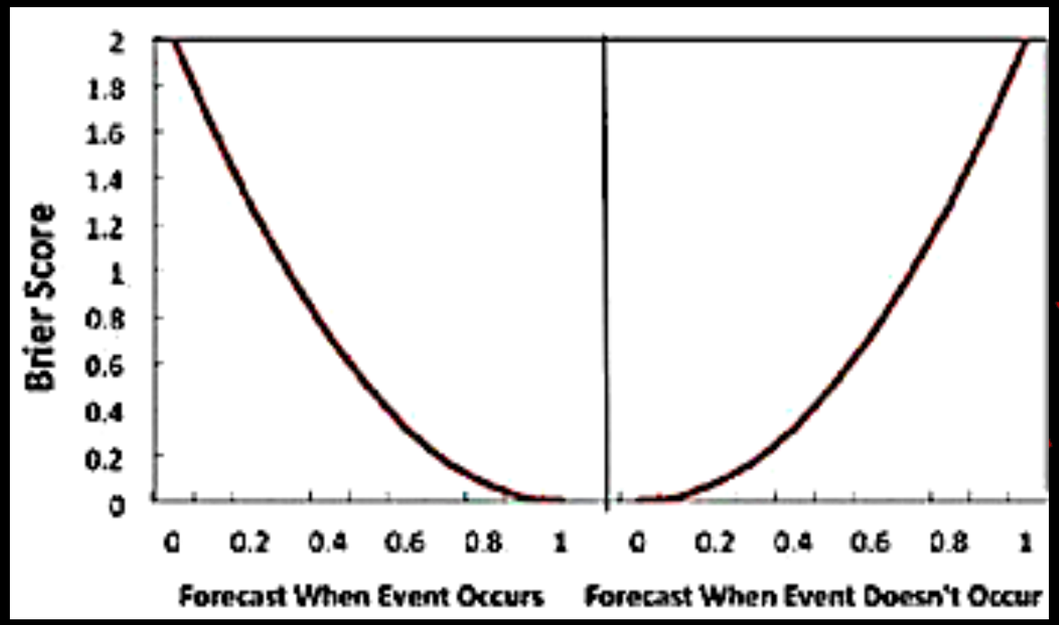
$[(\text{Outcome} - P(\text{Rain})]^2 + [\text{Counterfactual Outcome} - P(\text{No Rain})]^2$

where Reality is 1 (100%) and Counterfactual Outcome is 0 (0%)

How does the Brier score work?

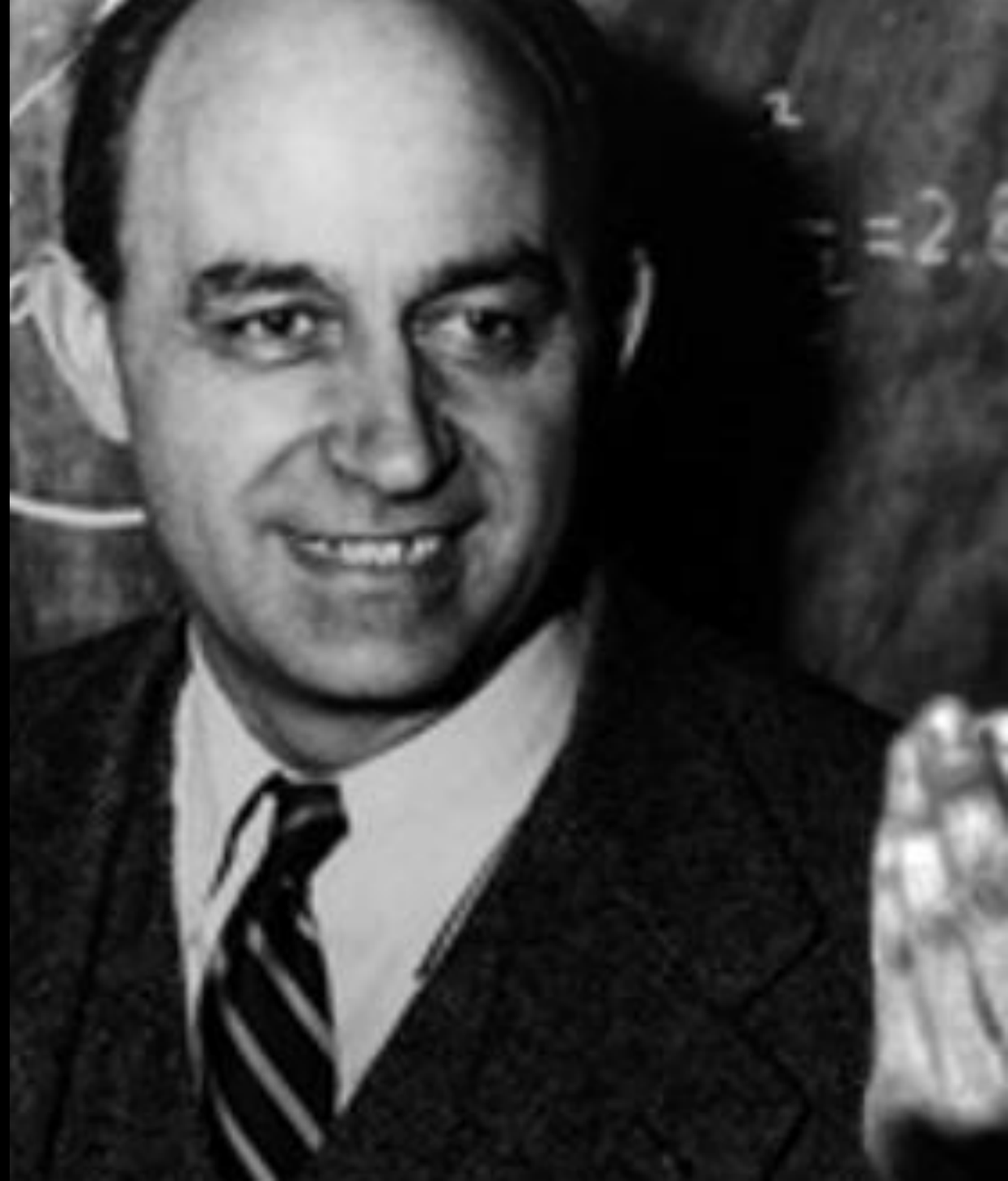
Brier scores are equal opportunity metrics. They get worse when you under- or over-estimate. Your score gets worse the more extreme your mistakes, as below.

Avoid extremes (0%, 100%, or anything close, unless you're very, very, very certain.)



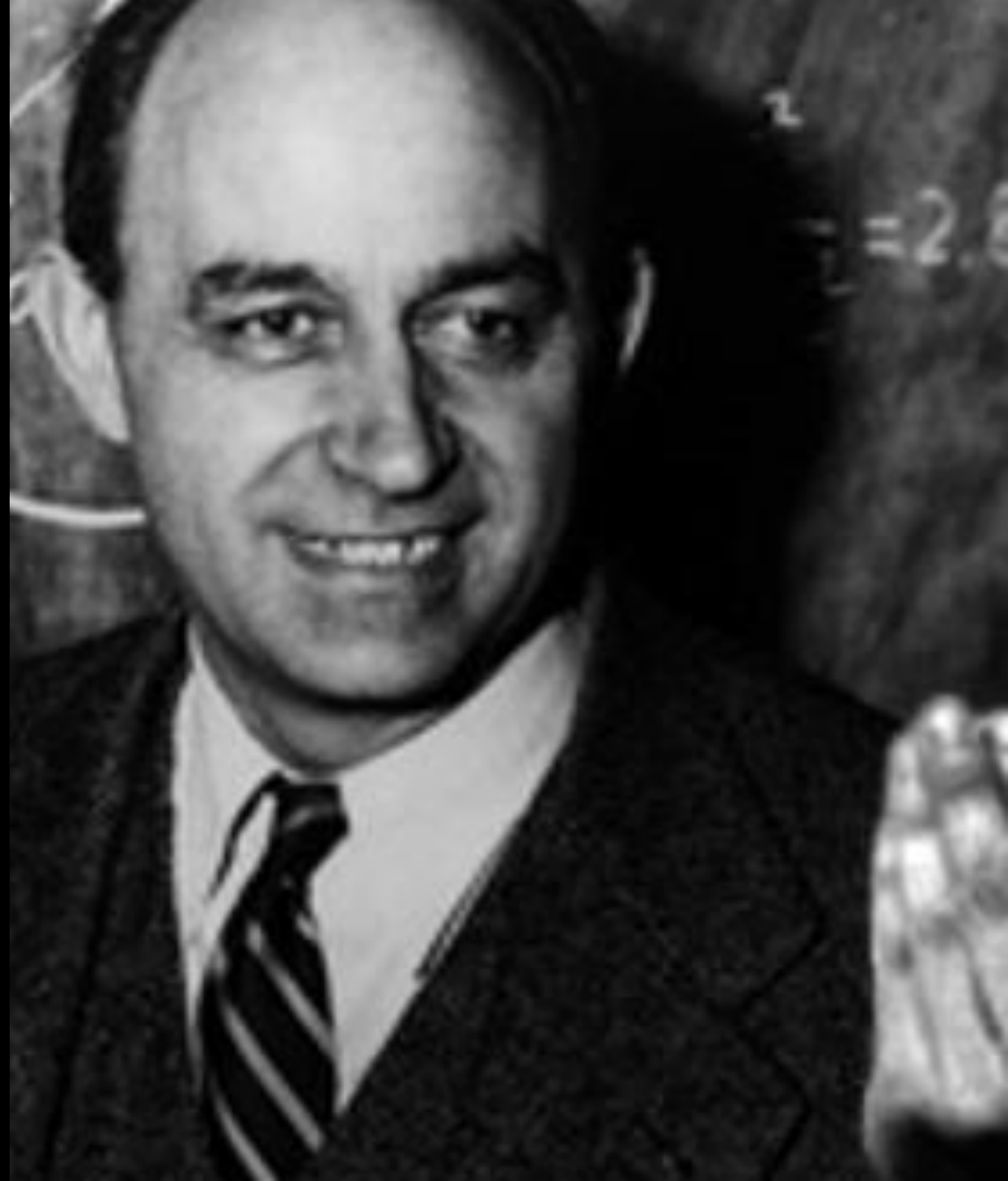
To break down problems, channel your inner Enrico Fermi, a great physicist of the mid 20th century. When he wasn't designing the first atomic reactor, Fermi loved ballparking answers to quirky questions like:

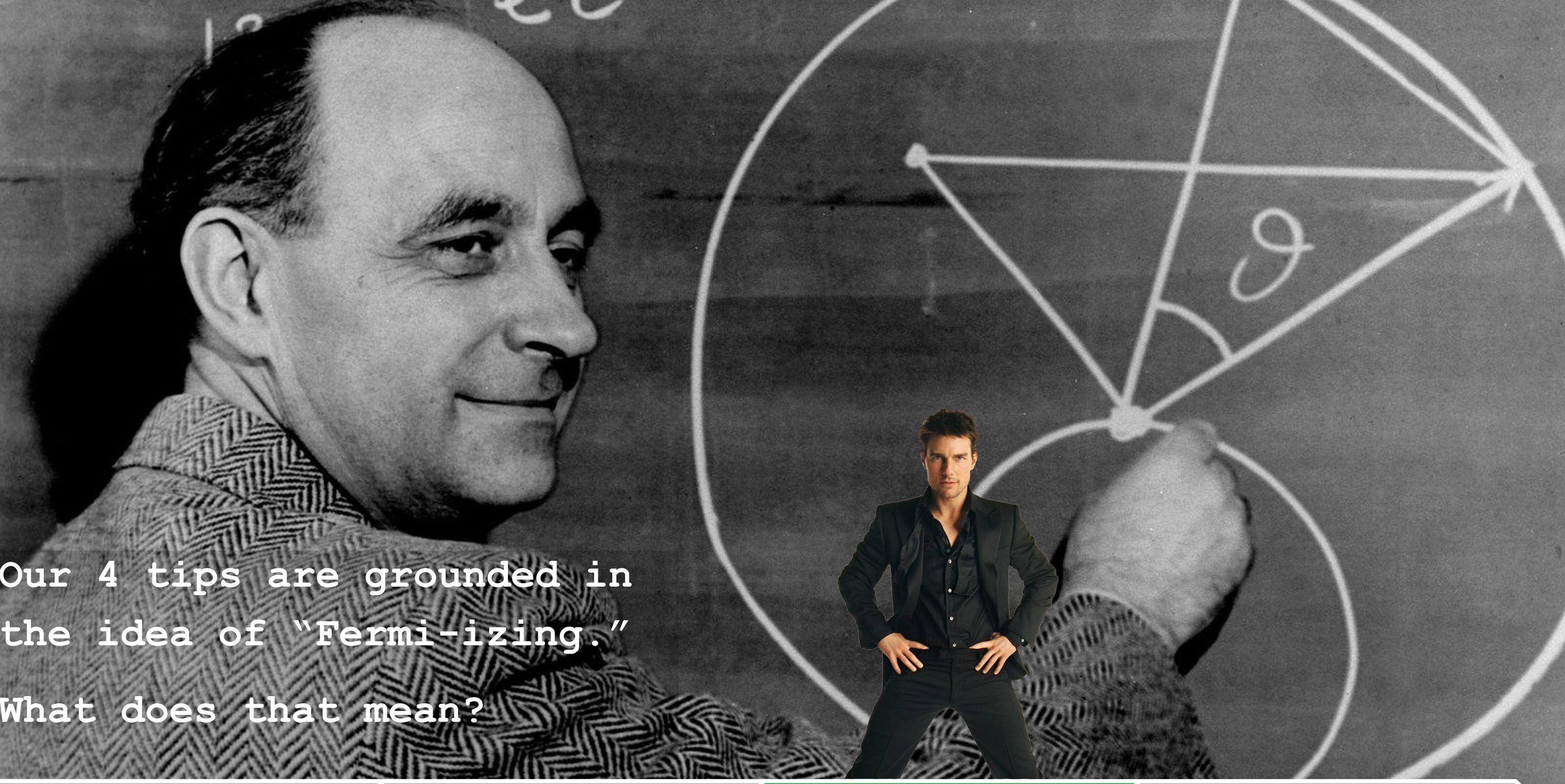
"How many extraterrestrial civilizations exist?"



Here's how Fermi did it… with BCRC!

1. **Break the problem down** into knowable & unknowable parts. In doing so, expose assumptions and pockets of ignorance.
2. **Collect data** to solve the parts.
3. **Roll it back up again** to get an answer to your bigger problem.
4. **Check your work!**





Our 4 tips are grounded in the idea of "Fermi-izing."

What does that mean?

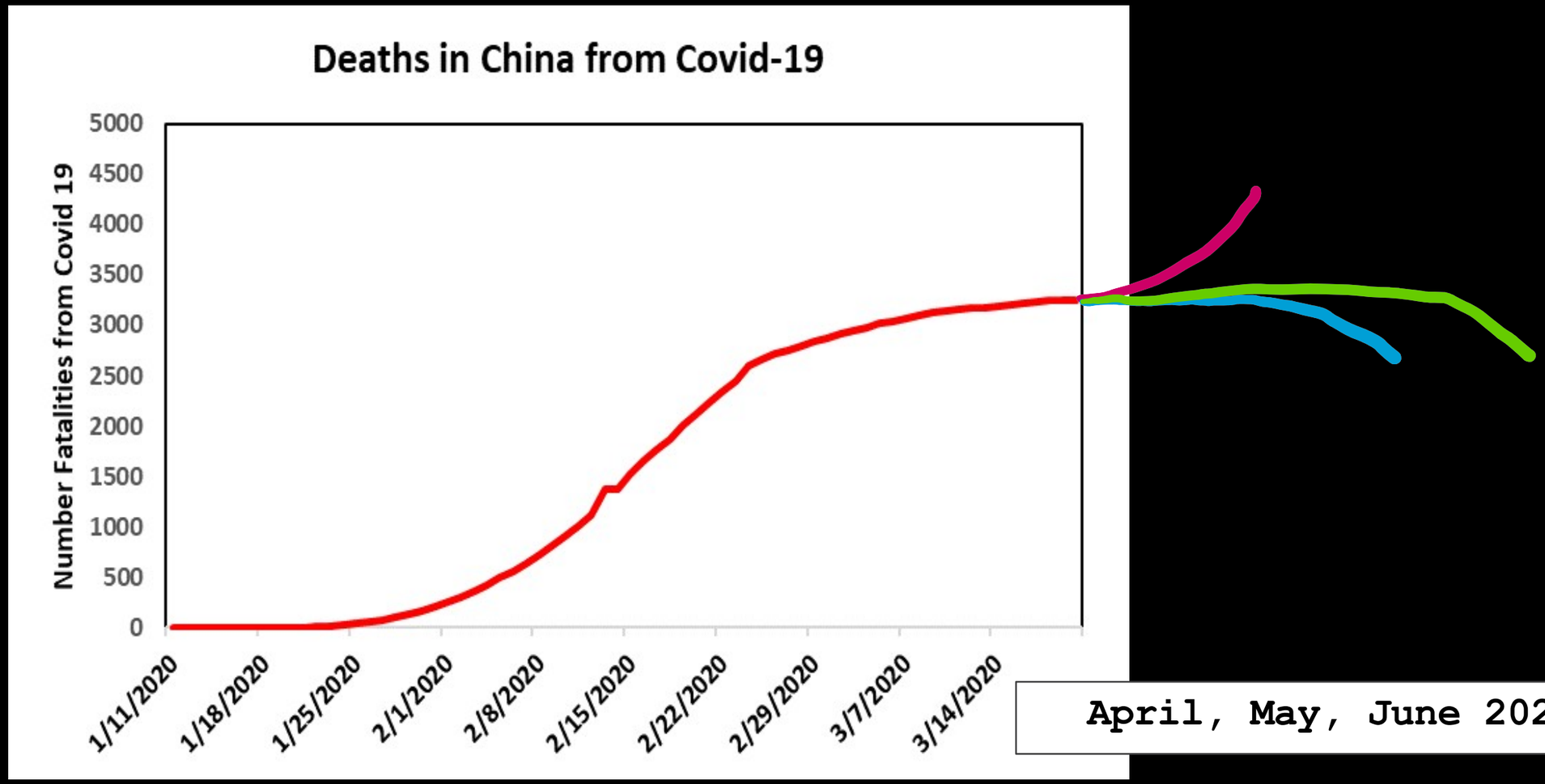
Four Tips of Forecasting based on Fermi-izing

1. Break the problem down into parts
2. Collect data to answer those parts
3. Roll it back up again to solve the problem
4. Check your work

1. Break It Down

Break it into types of causal drivers

In many questions, we will be asking you to forecast the future of various trends.



Break it into types of causal drivers

To make these estimates, you can break down the systems and sub-systems driving something like Covid-19 fatalities.

The Disease

Infection rate, incubation period, common symptoms and recovery rate are important. Also beware of mutation potential of virus—and possibility of better treatments/vaccines.

The Person

How people respond. Do they wash hands or wear masks? Do they obey social-distancing orders, or do they resist?

The Country

Do governments act decisively to restrict travel and close schools and non-essential businesses? Can the healthcare system cope (testing kits, hospital beds, health personnel)? Can the economy? Can disease be slowed so it does not overwhelm?

Break it into types of causal drivers

Use caution! Trends and their drivers can be tricky.

Past fatality data may be misleading: For example, if a country was initially slow to conduct testing, new surges in fatalities may occur due to disease spread and due to new testing data coming in. This could be a trend accelerator. Other potential accelerators: if a country has weaker healthcare system or citizens violate restrictions,…

Also consider trend decelerators: learning from the experience of other countries, vaccines, foreign assistance, …

Break it into inside and outside views

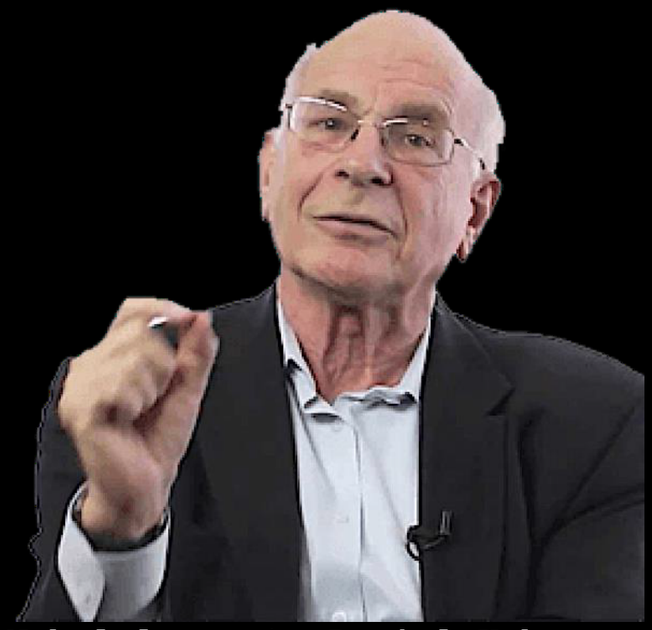
Another powerful strategy for breaking down problems is Nobel Laureate Daniel Kahneman's "inside" vs. "outside" views.

The outside view means stepping back from the *particular* case and thinking statistically, looking at past data and asking:

- How often do things "of this sort" happen…
- …in situations "of this sort"?

Outside view → Reference class, base rates, past trends

This view doesn't come naturally! More often, we take the inside view ..



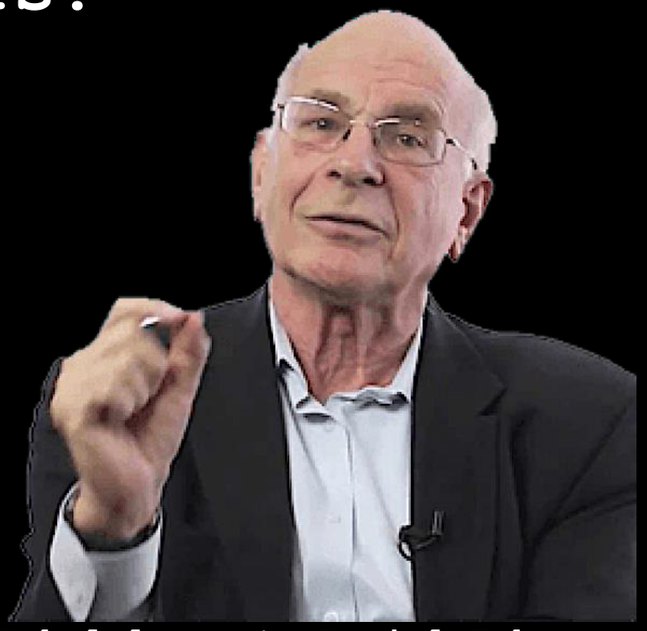
Nobel laureate Daniel Kahneman,
Author of *Thinking Fast and Slow*

Break it into inside and outside views

The inside view refers to case-specific details. If you are thinking about fatalities from Covid-19 in Japan, consider the Japanese government and its responses. Consider Japanese social norms. Consider the wealth of Japan and its handling of previous disasters.

Inside view → The unique aspects of the question

In the following excerpt from *Thinking, Fast and Slow,* Professor Kahneman explains why starting with the outside view – vs. the inside view – can help get us in the right ballpark when we make forecasts.



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Break it into inside and outside views

From: Daniel Kahneman: Beware the 'inside view'

"I asked everyone to write down their estimate of how long it would take us to submit a finished draft of the textbook to the Ministry of Education…

…They were narrowly centered around two years: the low end was one and a half, the high end two and a half years…

…Then I turned to Seymour, our curriculum expert, and asked whether he could think of other teams similar to ours that had developed a curriculum from scratch…"

Break it into inside and outside views

From: Daniel Kahneman: Beware the 'inside view'

"…He fell silent. When he finally spoke, it seemed to me that he was blushing, embarrassed by his own answer: *'You know, I never realized this before, but in fact not all the teams at a stage comparable to ours ever did complete their task. A substantial fraction of the teams ended up failing to finish the job… I cannot think of any group that finished in less than seven years,'* Seymour said, *'nor any that took more than ten.'*…

…The book was completed eight years later."

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INSIDE VIEW

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OUTSIDE VIEW

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REALITY

Break it into inside and outside views

An example in action:

How Many ICU Hospital Beds Will Nigeria Need Just to Treat Covid-19 Patients?

Break it into inside and outside views

An example in action:

How Many ICU Hospital Beds Will Nigeria Need Just to Treat Covid-19 Patients?

This seemingly intractable problem can be tackled by breaking it down into 3 parts:

1. **What's the population of Nigeria?**
2. **At the peak of the outbreak, what % of the population have *active* Covid-19 cases?**
3. **What % of active cases will require ICU treatment?**

Your Fermi estimate then becomes = 1 * 2 * 3 or the product of the parts.

Break it into inside and outside views

An example in action:

How Many ICU Hospital Beds Will Nigeria Need Just to Treat Covid-19 Patients?

1. What's the population of Nigeria? ~205 mil.
2. At the peak of the outbreak, what % of the population have *active* Covid-19 cases? Guesstimate based on Italy: 0.02%
3. What % of active cases will require ICU treatment? About 5% in China, but …

   Nigeria skews younger. So, guesstimate might be half that many, or 2.5%.

Fermi estimate = 205M * .02% * 2.5% = 1,025

For context: In 2015, there were 128 total ICU beds in Nigeria.


2. Collect Data

Collect Data

There's an infinite number of ways you could go about collecting data. Superforecasters look for base rates – a fancy term for averages taken from a larger number of past, similar cases.

Base rates help even for seemingly "unique" events like the Covid-19 pandemic (which, as 'pandemic' suggests, is not unique).

Collect Data

Three helpful techniques to identify base rates are:

1. “Brain dump” everything you know
2. Consider further inside and outside views
3. Think about counterfactuals or what-ifs

"Brain dump" everything you know

Digging into a problem as difficult as Covid-19, even once broken down, can be tough! Give yourself a running start by first doing a "brain dump." Grab a paper and pencil, then write down all you see as relevant to one or more parts of the problem.

Next, think about what information is needed to answer the parts of the problem. *Where can you go to find out whether Brazil is closing schools*, for example?

Collect more inside and outside views

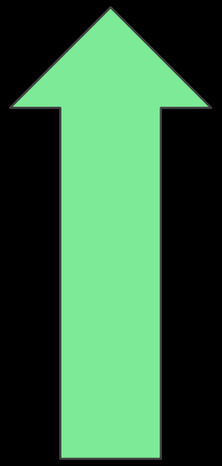
When gathering information, we want a rich set of both inside and outside view data, for the most nuanced understanding of a problem.

Prioritize outside views for a statistical starting point.

Then seek inside views of the problem, as no two situations are perfectly equivalent.

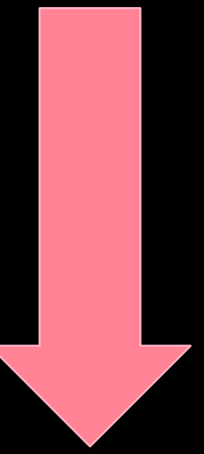
Collect more inside and outside views

Best practice is to toggle between an "inside" view (the unique qualities of the case) and an "outside" view (external statistics). Based on what *both* sources of data tell you, you can strengthen or hedge your beliefs.



If the inside and outside views match, strengthen your prediction.

If the inside and outside views clash, hedge your prediction.



Collect counterfactuals

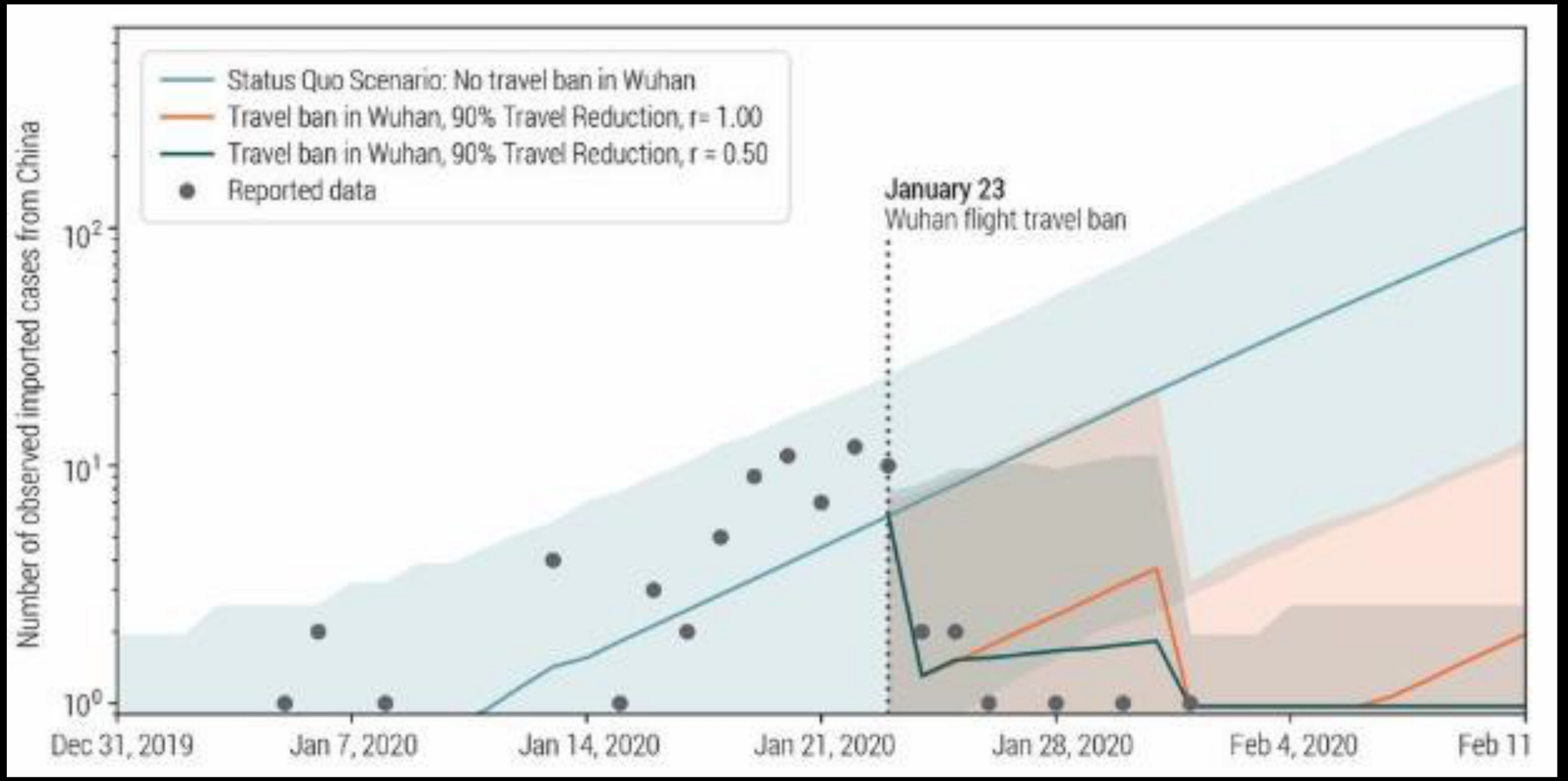
We can often learn a lot by time traveling and collecting as additional data the many counterfactual ways in which history could have unfolded.

For example: How many fewer Covid-19 cases would Italy have experienced if it had adopted its current travel ban 6 weeks sooner?

None?... 10% fewer?... 50% fewer?...

We can explore this counterfactual by looking at the historical effect of China's travel ban (on 1/23/20).

Matteo Chinazzi et al. Science 2020;science.aba9757

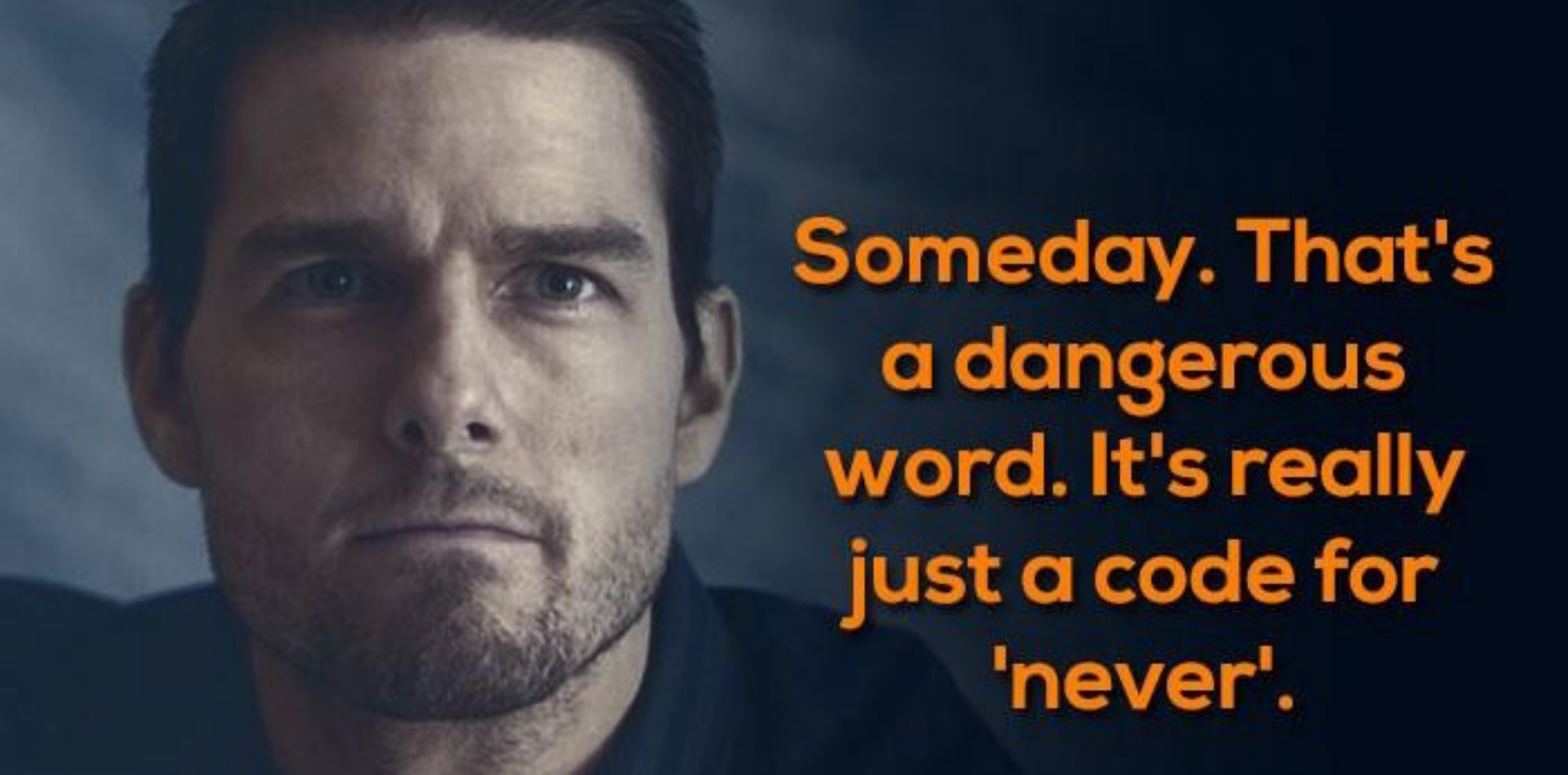


Matteo Chinazzi et al. Science 2020;science.aba9757

Type of arguments to NOT collect

1. Arguments that are one-sided, lacking clear counterarguments
   - ➢ *Try to consider all viewpoints*

2. High "assertion-to-evidence ratio" arguments
   - ➢ *Reject claims with too few facts to back them up*



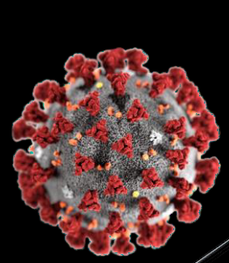
Beware of sources who express extreme certainty, like Ethan Hunt(and maybe Tom Cruise)! Look for a counterargument or two…

3. Roll It Up Again

How to roll it all up

You've broken the problem into parts and collected data.

The Disease



The Person

The Country

TRAVEL BAN

How to roll it all up

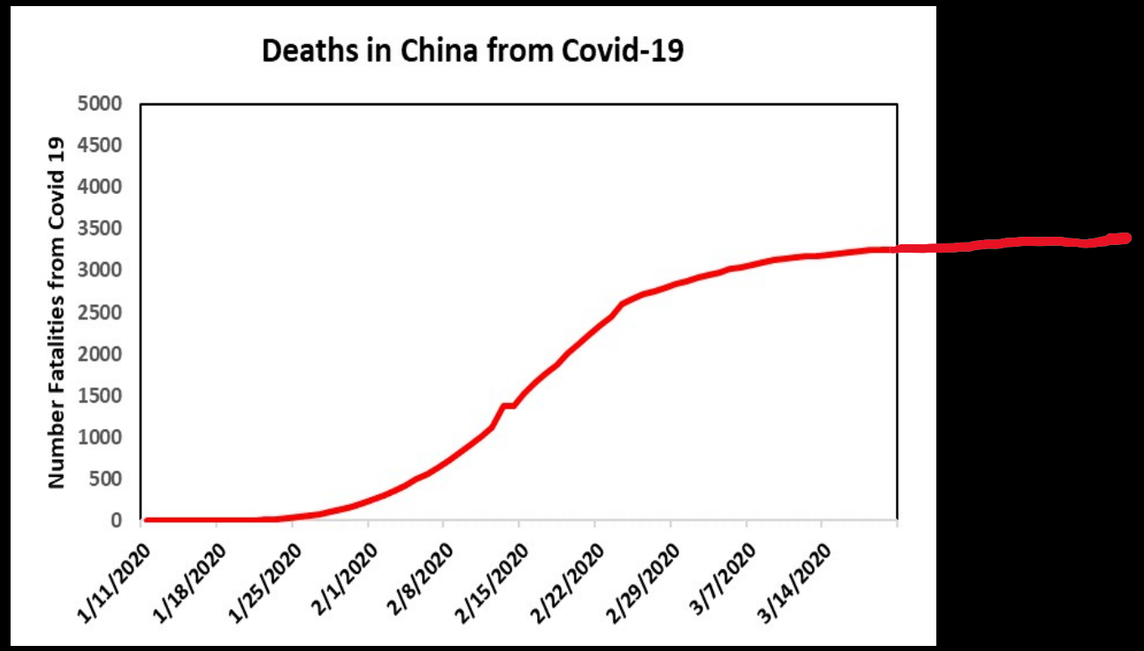
Start with the outside view data – trend lines and base rates. This is your default.

The Disease

The Person

The Country

TRAVEL BAN



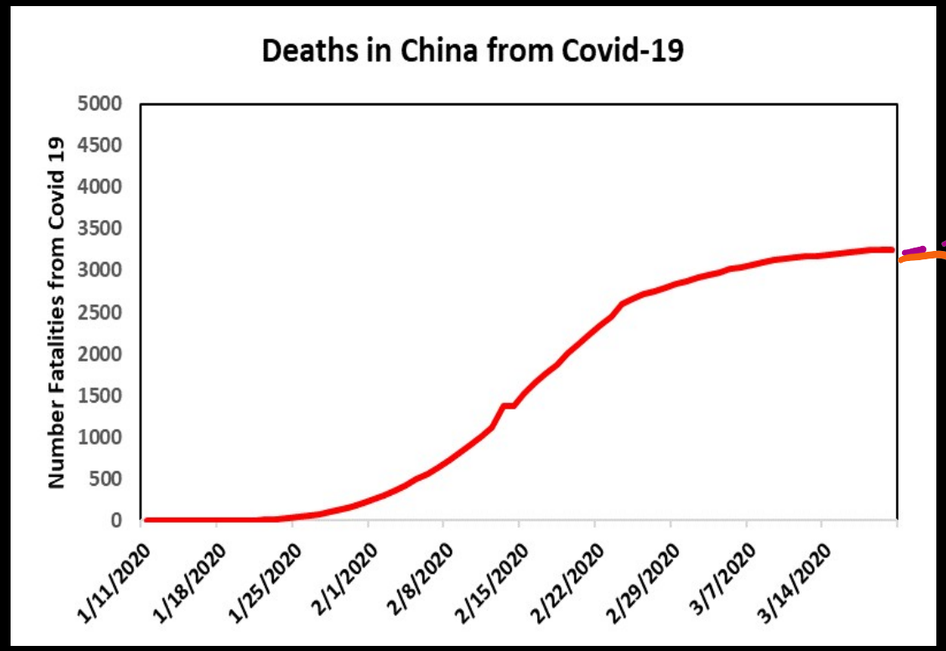
How to roll it all up

Then factor in the inside view: specific country or time factors likely to accelerate or decelerate those trends.

The Disease

The Person

The Country



Roll up into an adjusted trend.

4. Check Your Work

Check for logical consistency

An easy way to optimize your Brier score is to check your uncertainty levels for logical consistency in your answers.

You can do this by testing temporal scope consistency - asking yourself different time-scale versions of the same question - as well as geographic scope consistency - asking yourself different location-scale versions of the same question.

Check for logical consistency

For example: ***"By 1 June 2020, how many cases of Covid-19 will have been confirmed in Egypt?"***

Temporal scope: What would you say if the closing date was May 1, July 1, or even December 1, 2020? There can't be fewer cases on December 1, 2020, than on June 1, 2020.

Geographic scope: What would you say if the geography was all cases in Africa? Or the world? There can't be fewer cases in all of Africa than in Egypt.

Before reporting your forecasts, consider multiple closing dates and multiple locations.

Check for outcome 'agnosticism'

Another way to optimize your Brier score is to check whether you've separated how you feel about the outcome from how you think about the outcome.

In weather-forecasting, meteorologists understandably feel it is better to over-estimate the chance of bad weather & be over-prepared than to under-estimate it.

But in forecasting, your goal is accuracy. Report only your unbiased beliefs. Care only about closing the gap between beliefs and reality.

Check for outcome ‘agnosticism’

Throughout this mission, report your best estimate of uncertainty; do not inflate or deflate because of what that estimate might imply for Covid-19 outcomes.

Wishful thinking won’t help anyone make better decisions.

Aim for Accuracy Above All Else

More generally, you can only complete this mission – and win the tournament – if your probabilities are accurate. How you feel and what you do with those probabilities, once calculated, is entirely up to you!

This training won't self-destruct! Use it throughout your mission.

- ❑ Break It Down
- ❑ Collect Data
- ❑ Roll It Up Again
- ❑ Check Your Work

You may never see a checklist in a Mission Impossible movie, but these tools are a not-so-secret weapon proven to help professionals cope with cognitive overload in hospitals & cockpits… And "super" forecasters in this stressful Covid-19 environment are no exception!

- **Break It Down**
  - Types of causal drivers
  - Inside and outside views
- **Collect Data**
  - Brain dump
  - Inside and outside views
  - Counterfactuals
- **Roll It Up Again**
  - Start with outside view
  - Use inside view for accelerators / decelerators
  - Roll up into adjusted trend
- **Check Your Work**
  - Logical consistency (time, space)
  - Outcome agnosticism

Helpful References

Reported case numbers

- Interactive map
- Reported case counts and doubling times
- Country trajectories

Health system capacity and demographics

- Hospital beds per 1,000 people
- Physicians per 1,000 people
- Elderly population by country
- Clinical care utilization in Italy

Fake news tracker

- NewsGuard misinformation tracker

Interventions

- Estimated test coverage
- School closures in the US

Clinical data

- Chinese patients
- Diamond Princess
- Epidemic calculator for Covid-19

Historical base rates

- 20th century pandemic flu
- 20th century epidemics

Online overview course (3-weeks)

- FutureLearn Covid-19 course

Glossary

Assertion-to-evidence ratio - # of claims in an argument divided by # of supportive facts

Bins - the categories or ranges into which possible answers could fall.T he sum of the probabilities across all "bins" must equal 100%.

Brier score - measure of accuracy of probability judgments that incentivizes forecasters to report their true beliefs about event likelihoods

Counterfactual - a what-if claim about the history of a real or simulated world

Cut points - values that distinguish one bin from other in questions with many possible answers. They are boundaries and refer to ranges, such as 0-10 cases, 11-50 cases, 51 cases or more

Fermi-ize - breaking a tough problem into smaller more manageable parts (usually with help of simplifying assumptions, solving the simple parts, and putting it back together again

Inside view - specific information about an event that is relevant to the question

Outside view - Base rates and trend lines (e.g. How often do things of this sort happen in situations of this sort?)

Recommended Reading

Chang, W., Chen, E., Mellers, B., & Tetlock, P. (2016). **Developing expert political judgment: The impact of training and practice on judgmental accuracy in geopolitical forecasting tournaments**. *Judgment and Decision Making*, *11*, 509-520. (first 3 pages)

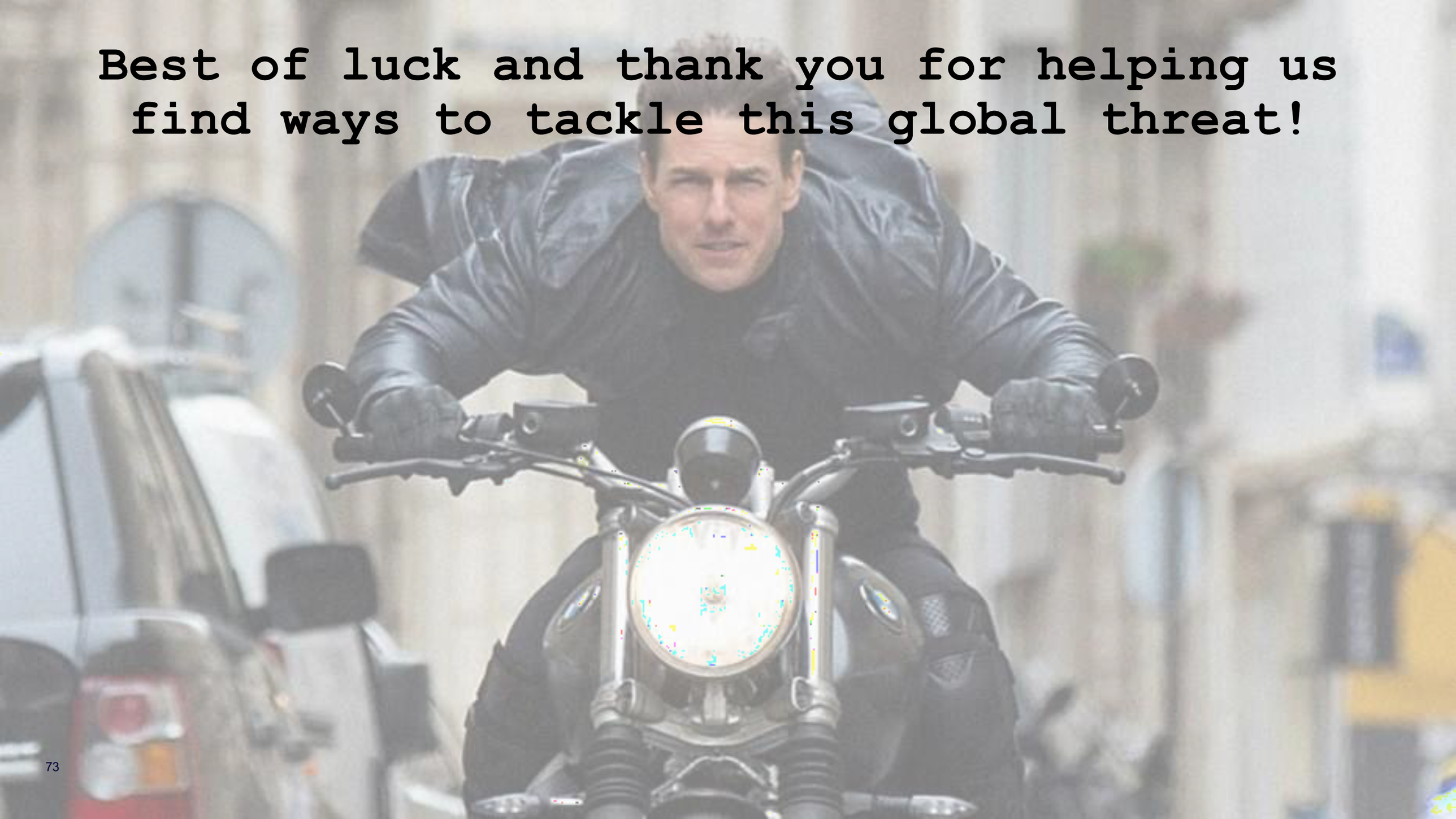
Duckworth, A. (2016). ***Grit: The Power and Passion of Perseverance.*** New York: Simon & Schuster.

Gawande, A., & Lloyd, J. B. (2010). ***The checklist manifesto: How to get things right***. New York: Metropolitan Books. Chapter 1-2.

Jervis, R. (1997). ***System effects: Complexity in political and social life.*** Princeton, New Jersey: Princeton University Press. Chapter 1

Page, S. (2018). ***The model thinker: What you need to know to make data work for you***. Basic Books, NY, NY. Chapters 1-4

Tetlock, P. E. & Gardner, D. (2015). ***Superforecasting: The art and science of prediction***. New York: Crown.


Best of luck and thank you for helping us find ways to tackle this global threat!