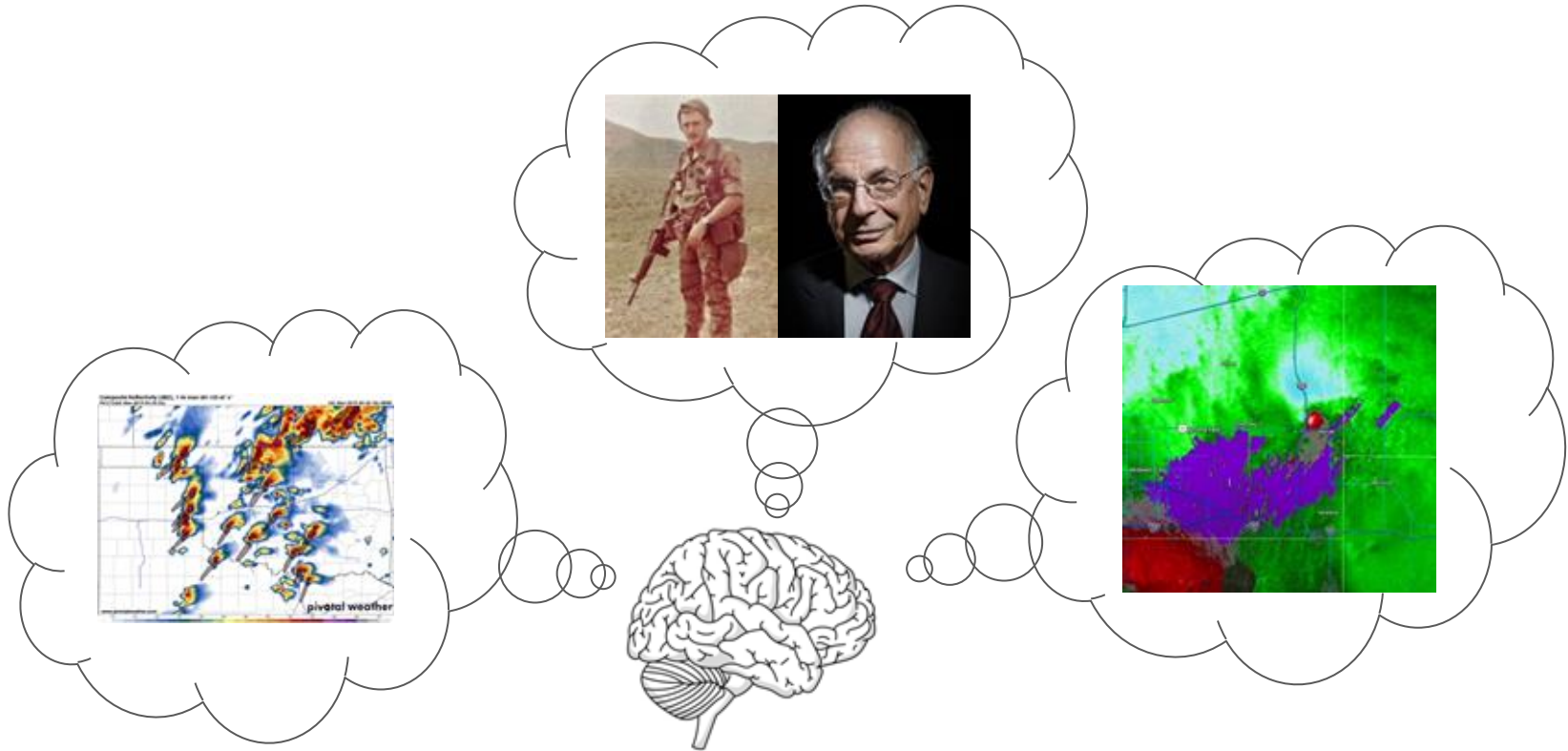


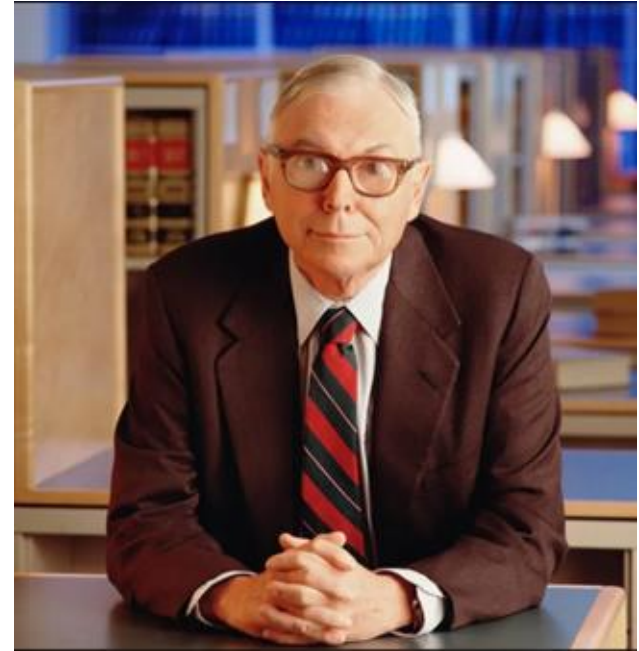
Psychology of Forecasting

Mental Biases and their Impacts on Human Weather Prediction



Knowing the science is only half the challenge!

- Understanding the physics behind the atmosphere is not useful if you can't apply it.
- Successful application of the concepts is what matters, but depends on correct decision making!
- So how do we make better decisions?
 - Experience (takes time)
 - Knowing how to avoid common pitfalls and biases (need awareness)



Guiding principles of Charlie Munger, *very* successful investor and WW2 meteorologist

Common Heuristics

Simple mental “shortcuts” that allow us to solve difficult problems via simplification and/or substitution based on past experience.

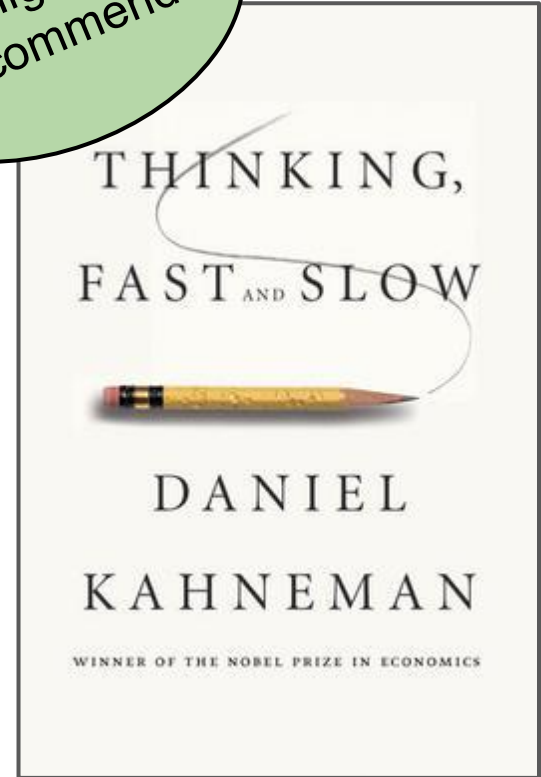
Heuristics can be thought of as subconscious biases and can take on many forms.

Examples include:

- Anchoring bias
- Confirmation bias
- Recency bias
- Availability bias
- Many more!



Highly Recommend!



Pop Quiz!

Here are two houses that are neighbors.

House #1 sold for \$350,000.

What is the price of house #2?



Anchoring Bias

Consciously or subconsciously making an assessment based on some suggested value or outcome.

What does the distribution of the price guesses look like? Should it have any correlation with the price of House #1?



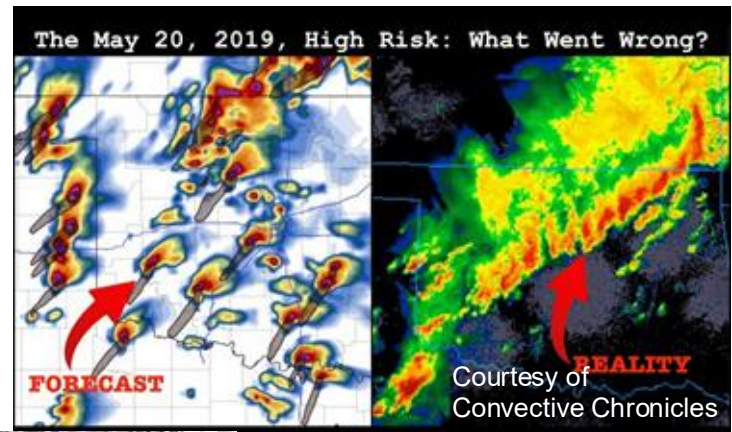
Anchoring Bias

Consciously or subconsciously making an assessment based on some suggested value or outcome.

Weather Example: May 20, 2019

Some CAM solutions were very bullish, others weren't. How much did the bullish CAMs influence the forecast?

This is why CAM/ML guidance should be the **last** step in your forecast process!



Anchoring Bias

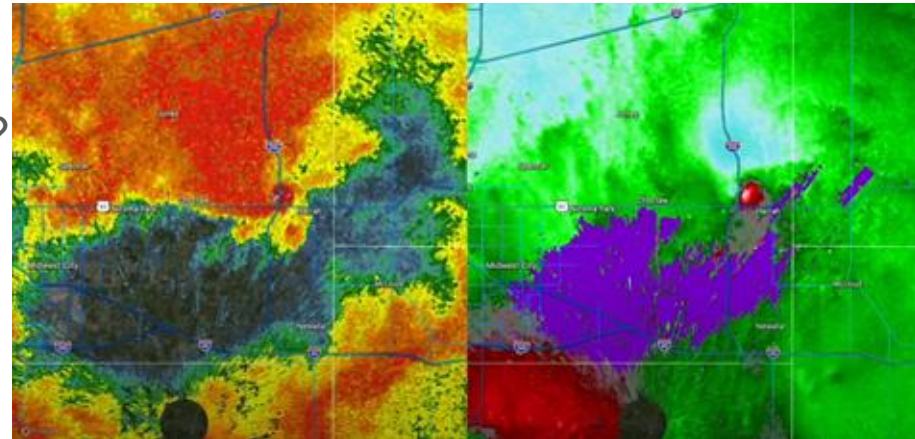
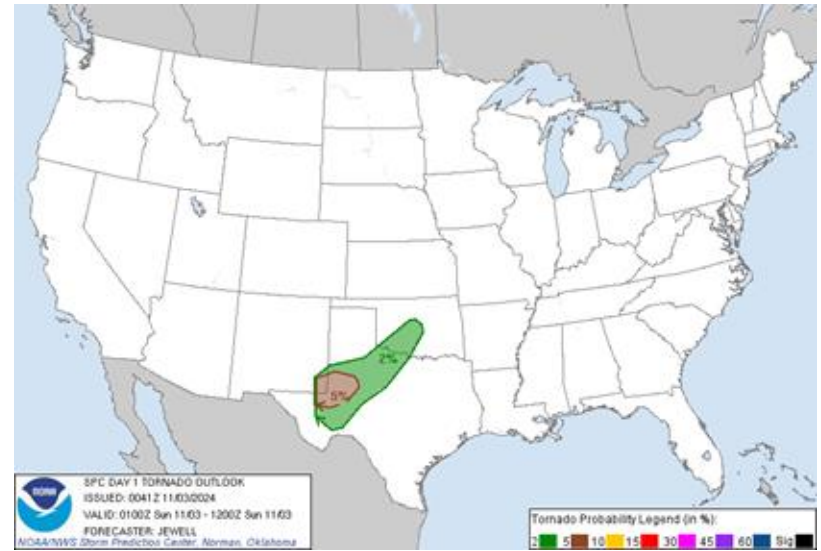
Consciously or subconsciously making an assessment based on some suggested value or outcome.

Weather Example: November 2/3, 2024

2% Tornado risk going into the overnight hours for central Oklahoma...

Expectation for tornadoes should be low, right?

Be careful not to let prior forecasts bias your perception of the current environment!



Confirmation Bias

Acknowledging signals that conform to your prior beliefs while ignoring or discounting signals that refute your prior beliefs.

Example: You really like the new Ford Bronco...



Confirmation Bias

Acknowledging signals that confirm prior beliefs while ignoring signals that refute them.

Example:
Bronco

Then you start to see them everywhere!

Why?

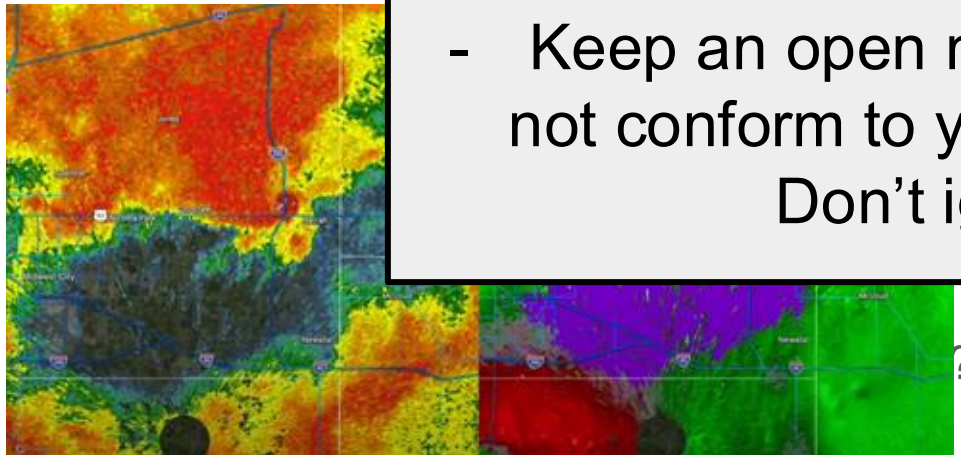
You're subconsciously looking for them!





How to account for this?

- Recognize situations when conditions can change rapidly.
- Keep an open mind if data does not conform to your expectations. Don't ignore it!



Recency Bias

The belief that events that have just happened in the recent past are likely to occur again in the near future.

Example: A basketball star has a 60% shooting percentage. He has recently made 5 baskets in a row. What is the probability that he makes 6 in a row?



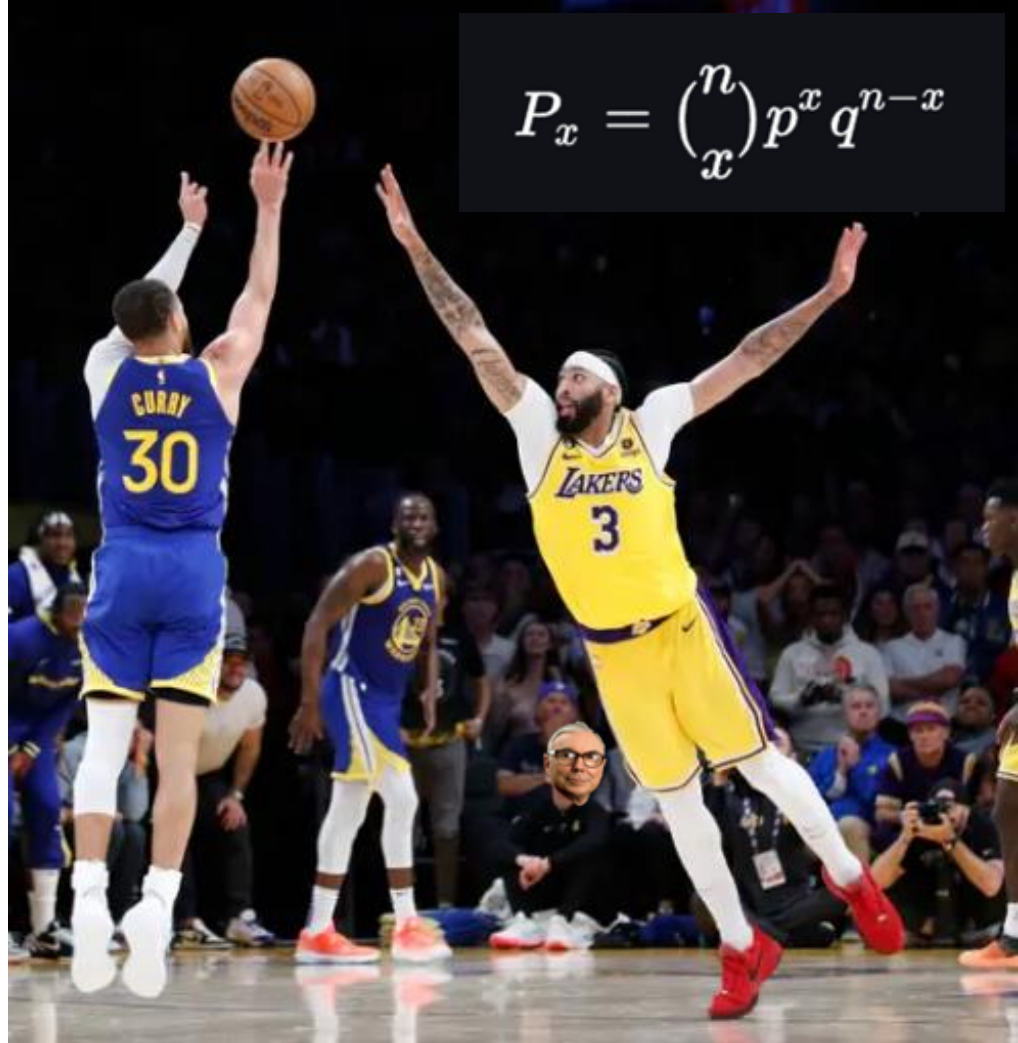
Recency Bias

The belief that events that have just happened in the recent past are likely to occur again in the near future.

Example: A basketball star has a 60% shooting percentage. He has recently made 5 baskets in a row. What is the probability that he makes 6 in a row?

The answer: 5% chance!

How do we know? We use a binomial distribution from statistics!



$$P_x = \binom{n}{x} p^x q^{n-x}$$

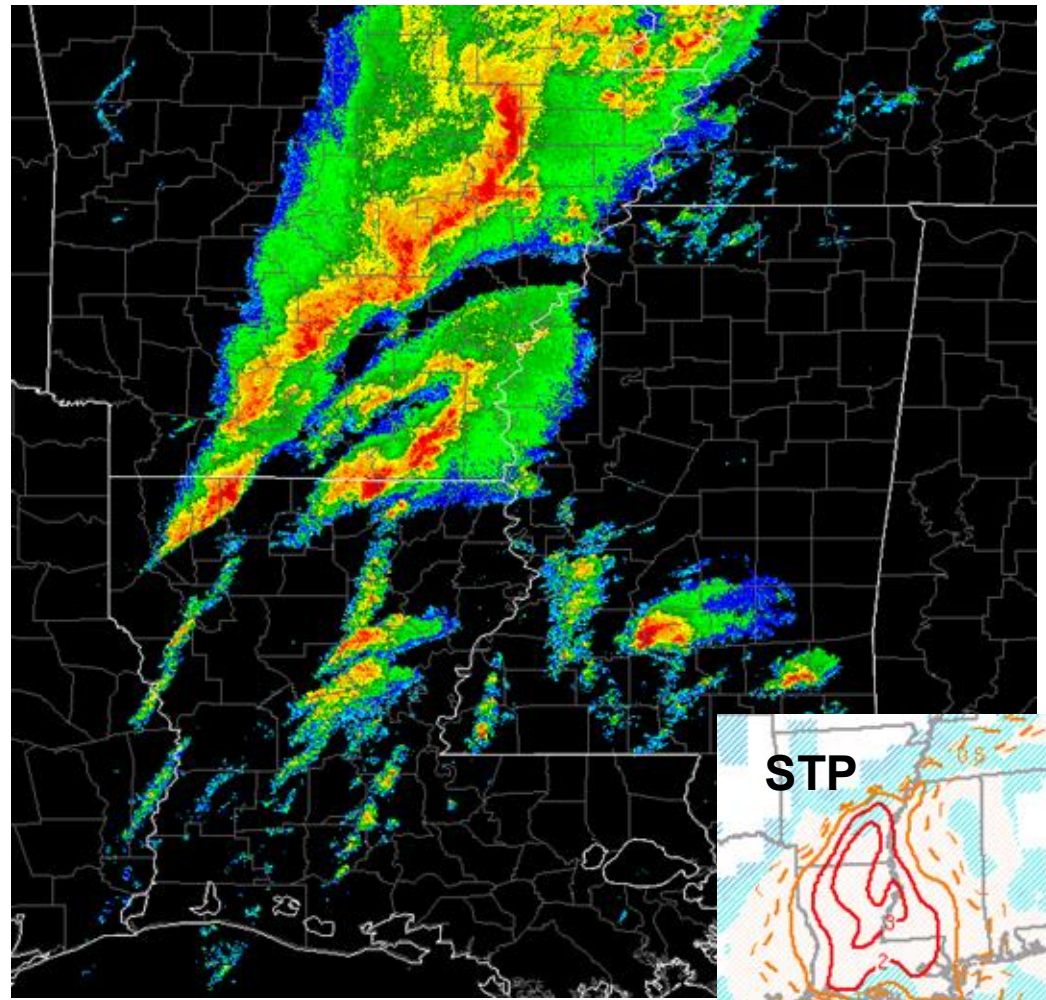
Recency Bias

The belief that events that have just happened in the recent past are likely to occur again in the near future.

Weather Example: March 24, 2023

A high-end tornado environment has yielded zero tornadoes over the past 3-4 hours, and you're heading into the evening hours.

Is it time to let your guard down?



Recency Bias

The belief that events that have just happened in the recent past are likely to occur again in the near future.

Weather Example: March 24, 2023

Just because an event has recently under-performed, doesn't mean it won't overperform momentarily!
(And vice versa.)

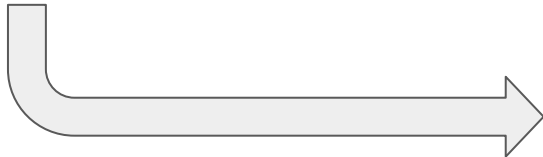
“Past results do not guarantee future performance”



Availability Bias

When considering a range of possible outcomes, assuming that events that more easily come to mind are more likely to occur.

Example: There was recently a high-profile plane crash, so you decided to drive to your destination instead of flying.



The problem? You're statistically more likely to die in a car crash than a plane crash!

The recent memory of the plane crash led you to choose a more risky mode of travel

Availability Bias

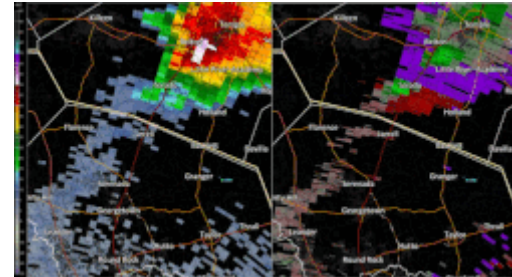
When considering a range of possible outcomes, assuming that events that more easily come to mind are more likely to occur.

Weather Example: Jarell, TX F-5

Should we necessarily forecast a violent tornado every time there's extreme buoyancy and a stalled boundary? It's good to recognize analogs, but be aware of their limitations!



Extreme buoyancy +
Low SRH +
Stalled cold front =
F-5 Tornado?



Meet Linda...

Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Which of the following is more probable?

- A) Linda is a bank teller.
- B) Linda is a bank teller, and is active in the feminists movement.

Meet Linda...

Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Which of the following is more probable?

A) Linda is a bank teller.

B) Linda is a bank teller, and is active in the feminists movement.

Why? Consider the background probabilities!

How many bank tellers are there in the world?

How many people are active in the feminist movement?

How many people are *both* a bank teller *and* active in the feminist movement?

Probability theory tells us that answer A has a higher probability than answer B.

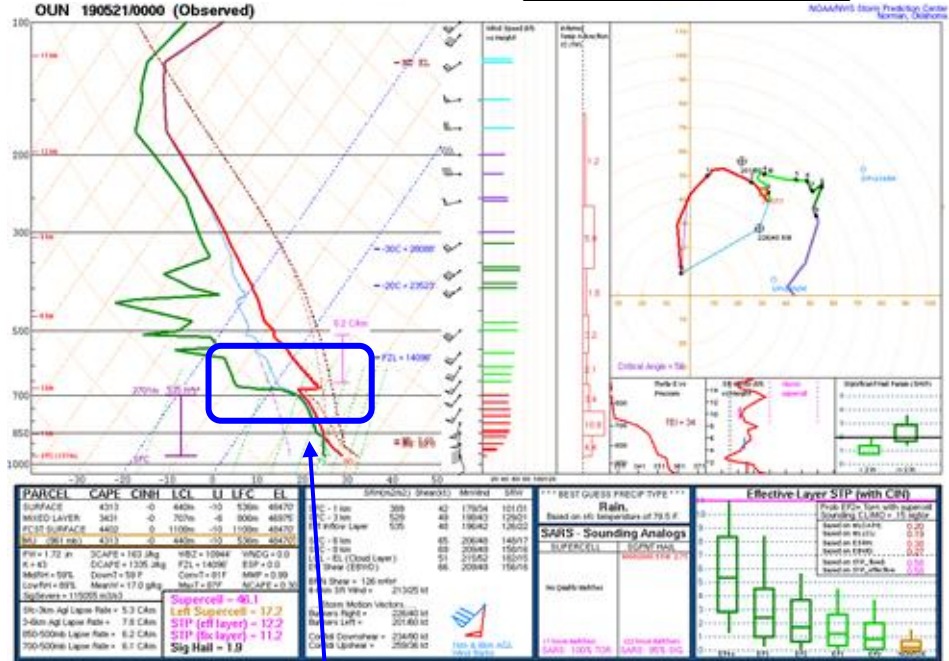
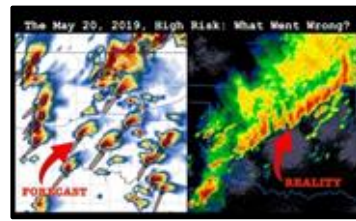
Conjunction Bias

Making an assessment of a scenario or outcome with incomplete data while ignoring background statistics.

Our brains have an inherent need to be able to explain/understand our world. So, we take incomplete data and fill in the gaps!

However, if we don't utilize background statistics (i.e. probabilities) we can make erroneous judgements.

Wx example:
Explaining the 5/20/2019 forecast bust.



Was this *really* the reason this event wasn't as prolific as expected? Do statistics actually support this or are we just letting our minds fill in the gaps?

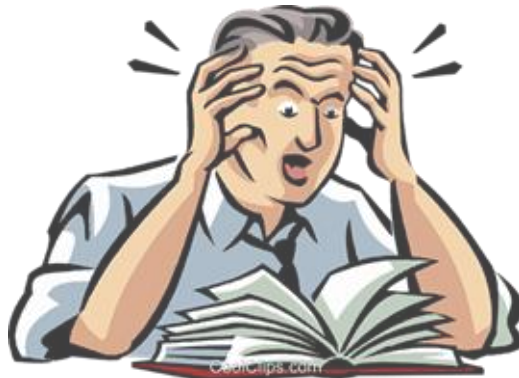
Stress Effect

When stress levels go up, our ability to think slowly and critically goes down.

We tend to revert back to our baseline impulses and biases as a means of eliminating acute stress.

This leads to suboptimal decision making!

Example: Taking a test!

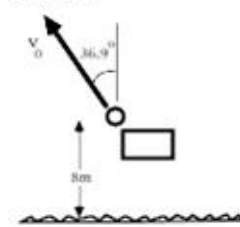


Problem 1

A sprinter running a 100 meter race starts at rest, accelerates at constant acceleration with magnitude A for 2 seconds, and then runs at constant speed until the end.

- Find the position (relative to the start position) and speed of the runner at the end of the 2 seconds in terms of A .
- Assume that the runner takes a total of 10 seconds to run the 100 meters. Find the value of the acceleration A . You can leave your answer in terms of a fraction but clearly indicate the units.

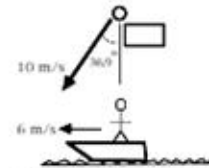
Problem 2



A rock is thrown upward from a bridge at an initial height of 8 meters above the water at an initial speed of v_0 and an angle of 36.9° from the vertical as shown. Use $g=10 \text{ m/s}^2$ to solve this problem. See note on formula sheet about the values of trigonometric functions for this angle.

- Write a set of equations for the horizontal and vertical positions and velocities of the rock as a function of time. Clearly indicate on your drawing your choice of axes and what point you are using as your origin.
- The rock reaches its highest point in 2 seconds. How high is the rock above the water at that instant? (Hint: First you need to find v_0).

Problem 3



A rock is thrown downward from a bridge at an initial speed of 10 m/s and an angle of 36.9° from the vertical as shown. At the same instant a boat is passing under the bridge traveling 6 m/s in the direction shown. See note on formula sheet about the values of trigonometric functions for this angle.

- Find the vertical and horizontal components of the initial velocity of the rock as seen by a person on the bridge. Clearly indicate on your drawing your choice of axes.
- Find the vertical and horizontal components of the initial velocity of the rock as seen by the person on the boat. Clearly indicate on your drawing your choice of axes.
- Draw a clear vector diagram showing how to relate the velocity the rock appears to be moving as seen from the bridge, the velocity the rock appears to be moving as seen by the person in the boat, and the velocity of the boat with respect to the bridge.

Problem 4

The position of a particle of mass M is given by the following equations:

$$X = A + Bt - Ct^2 \quad Y = D + Et - F \cos(Gt) \quad Z = H + F \sin(Gt)$$

where $A, B, C, D, E, F, G,$ and H are all constants.

- Find the three components of the acceleration as a function of time.
- Are the direction and magnitude of the acceleration independent of time? Explain your answer.

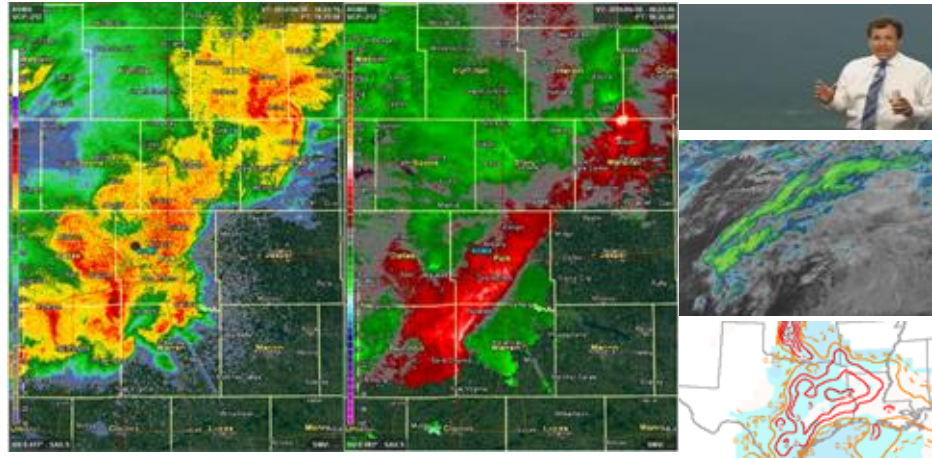
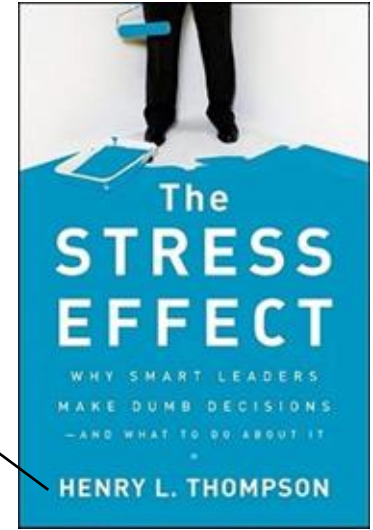
Stress Effect

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This leads to suboptimal decision making!

Example: Warning decisions!
How do you make better warning decisions? Practice under stress!



Question!

You have the option to play a game:

A coin is flipped. If it's heads, you gain \$40. If it's tails, you lose \$20.

Do you play the game?

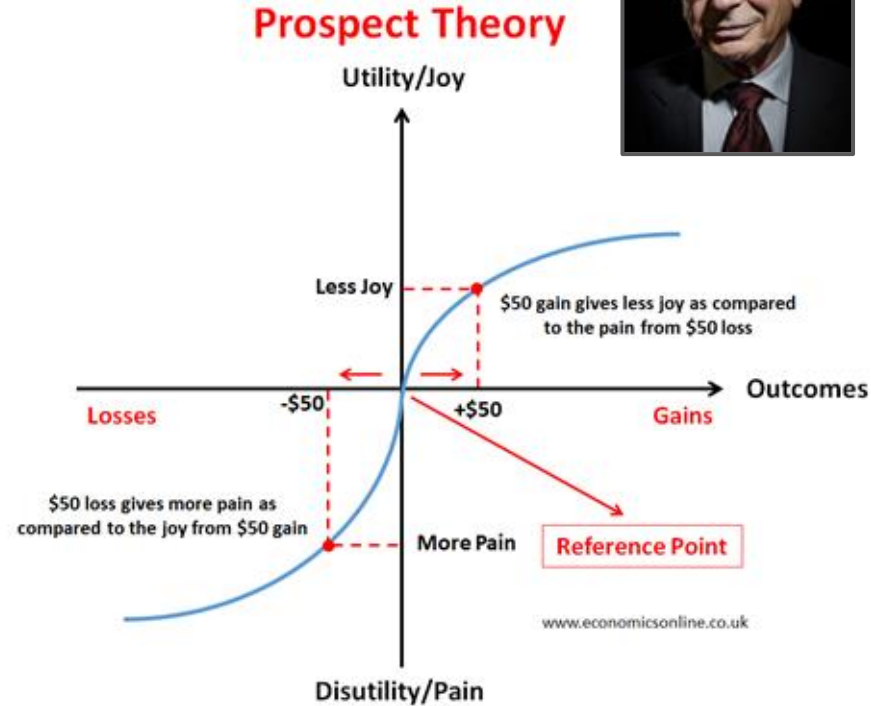
Loss Aversion

The sensation of loss that we experience is often greater than the sensation of gain for an equivalent value depending on an initial reference point.

This is part of Prospect Theory.

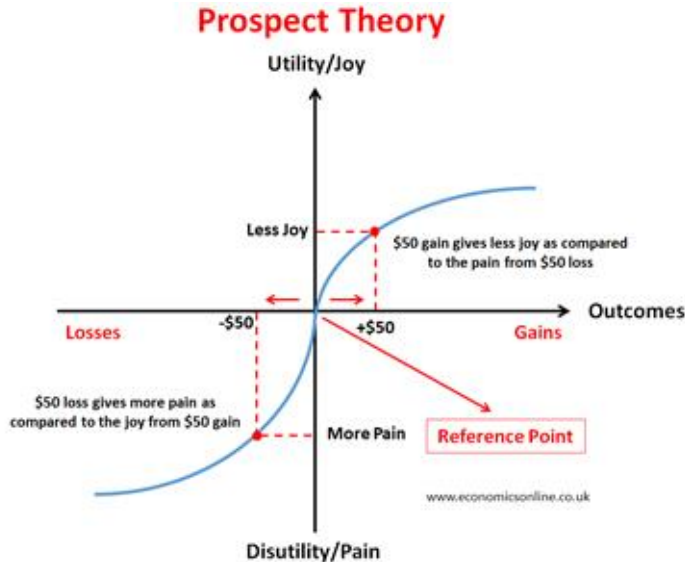
Example:

Losing \$50 feels worse when you have \$100 in the bank vs. \$1,000 in the bank.



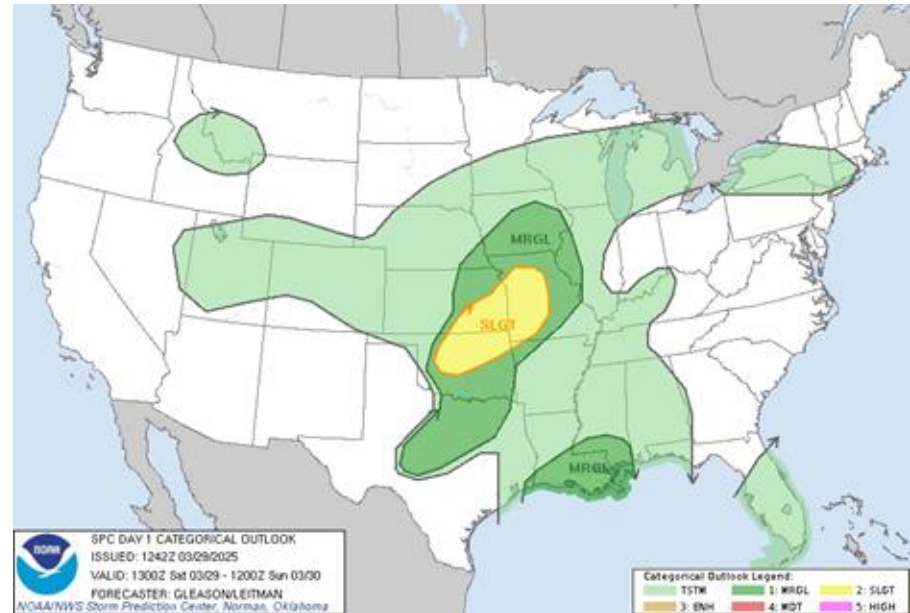
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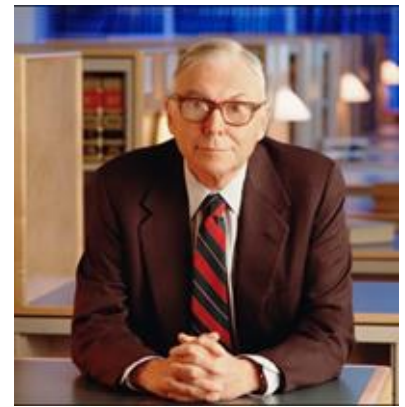
Here's the forecast you inherited.
New data does not look as good
as it did before.

Do you downgrade?



Beware of “lollapalooza effects”!

Many biases can be at play at the same time and compound on each other, leading to unexpected outcomes (i.e. very bad decisions!)



Unexpected Tornado



(Induces background stress)

Similar pattern emerges,
Start messaging tornadoes



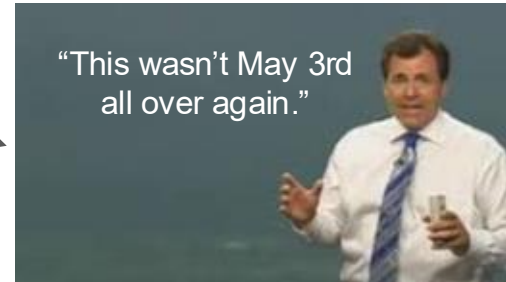
(availability & recency bias)

New data doesn't look as good,
But maintain messaging anyway



(anchoring, confirmation bias,
& loss aversion)

Over forecast!



The “What You See Is All There Is” Assumption

- When making decisions, we place too much emphasis on the “Known Knowns” (i.e. what we know and are familiar with)
- We place too little emphasis on the “Known Unknowns” (i.e. things we’re aware of but not comfortable with or have poor data/understanding).
- We place no emphasis on the “Unknown Unknowns” (i.e. things about which we aren’t aware and haven’t measured).

“There are forecasters who know they don’t know, and forecasters who don’t know they don’t know.”

- Howard Marks
(really good investor)

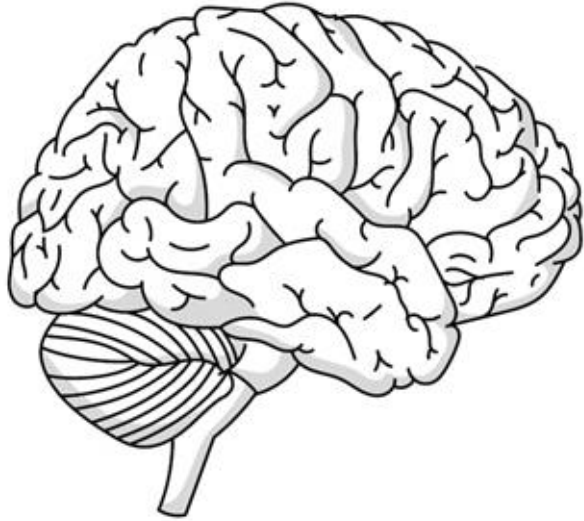


How to avoid these biases

- 1) Practice under stress
- 1) Think in terms of probabilities
 - a) Be aware of the range of potential outcomes, and recognize when the range of potential outcomes is unknown!
- 1) Look at CAMs, ML guidance, and other people's forecasts very last
- 1) Work on detachment
 - a) Look up
 - b) Take a deep breath
 - c) Assess the big picture
- 1) Honest self-assessment



Go Forth & Make Better Decisions!



Recommended reading:

Thinking Fast and Slow
- Daniel Kahneman

Noise
- Daniel Kahneman, Olivier Sibony, Cass Sunstein

Poor Charlie's Almanac
- Charlie Munger

The Stress Effect
- Henry Thompson