¿Cómo contar la predicción probabilistica?

How to tell probabilities in weather forecasting?

Part I: The problem with probabilities

-Why all this talk about uncertainty and probabilities?

– The computer forecasts have never been so accurate!

-We cannot escape probability forecasts!

When the deterministic forecasts become more accurate the public's demands will increase: more details, better timing, longer forecasts.

So the role of uncertainty will never go away!

Probability forecasting is

1. Politically controversial

Leaves the decisions to the decision makers and they will be unable to blame some external source

2. Scientifically controversial

Deterministic weather models versus probabilistic. The maths of probabilities is simple but different

3. Philosophically controversial

What is “probability”? Frequentist “objective” vs Bayesian “subjective” statistics

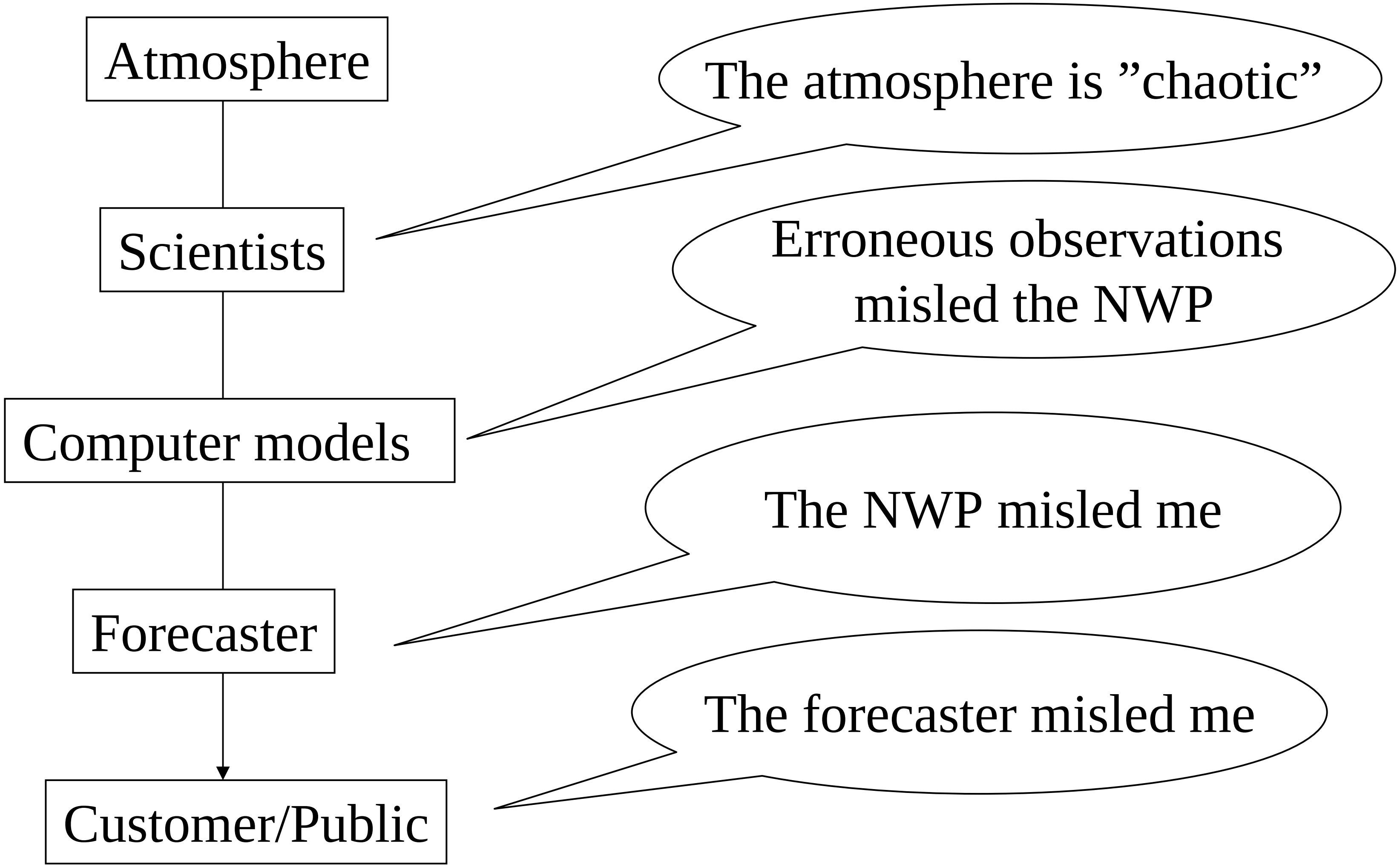
1. Politically controversial

-We want more accurate deterministic weather forecasts – not some bloody index that tells how bad the forecasts are!

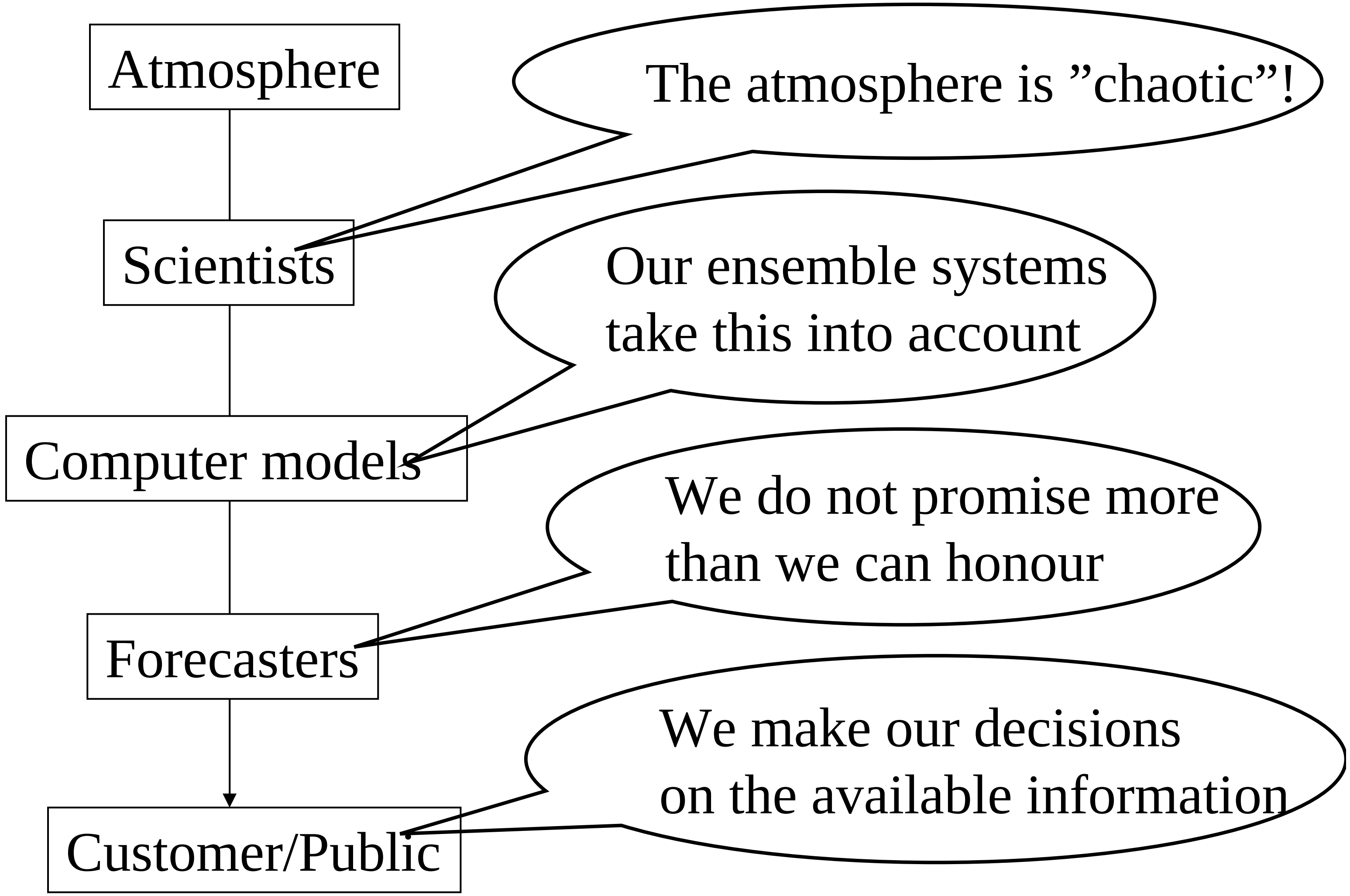
We all want more accurate deterministic weather forecasts.

But as long as they are not 100% perfect, knowing their uncertainty improves our decisions.

”The Blame Game” or ”The Passing of The Buck”



The future attitude of *responsibility*



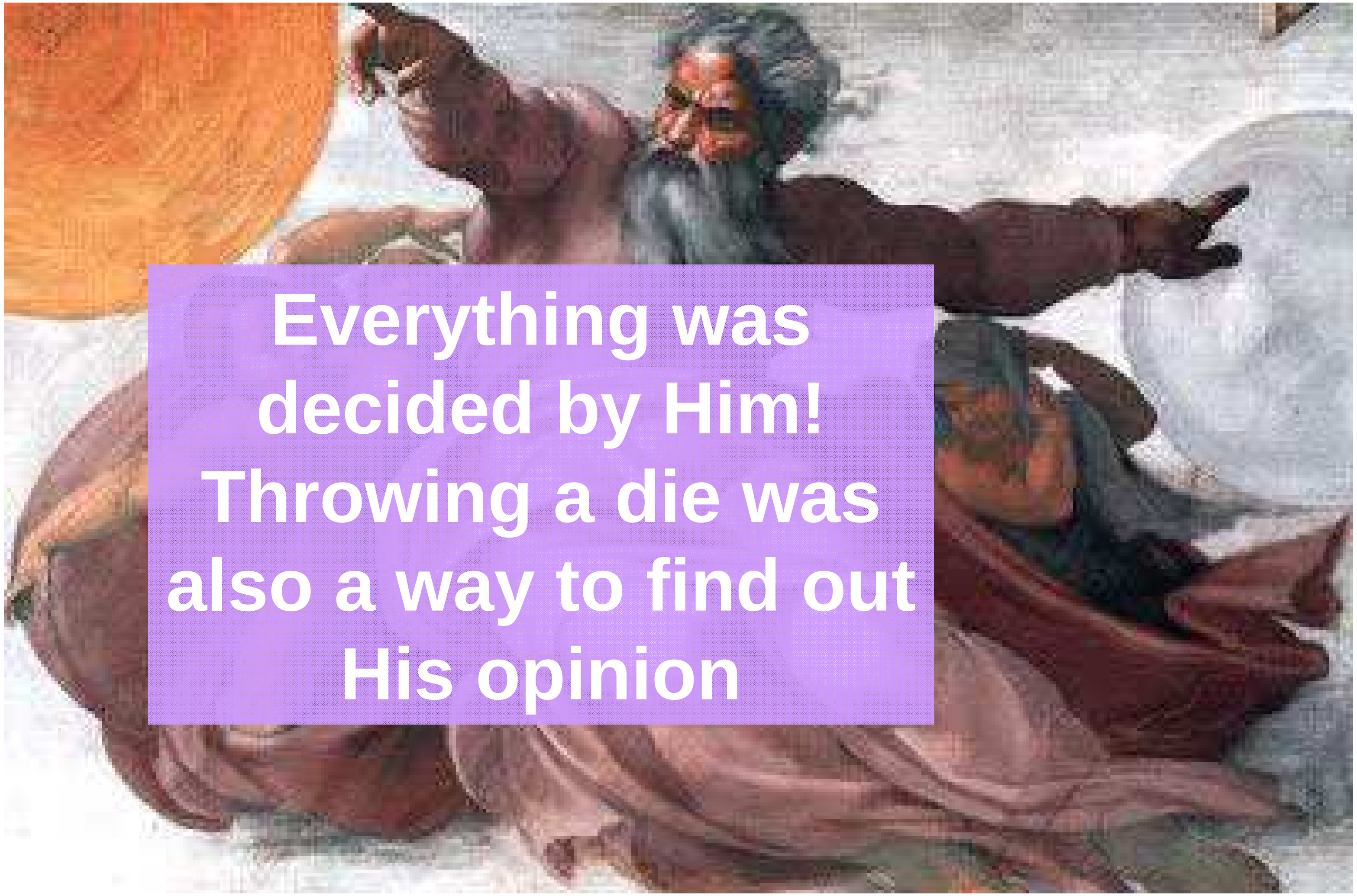
2. Scientifically controversial

-Why did it take so long for probability theory to develop?

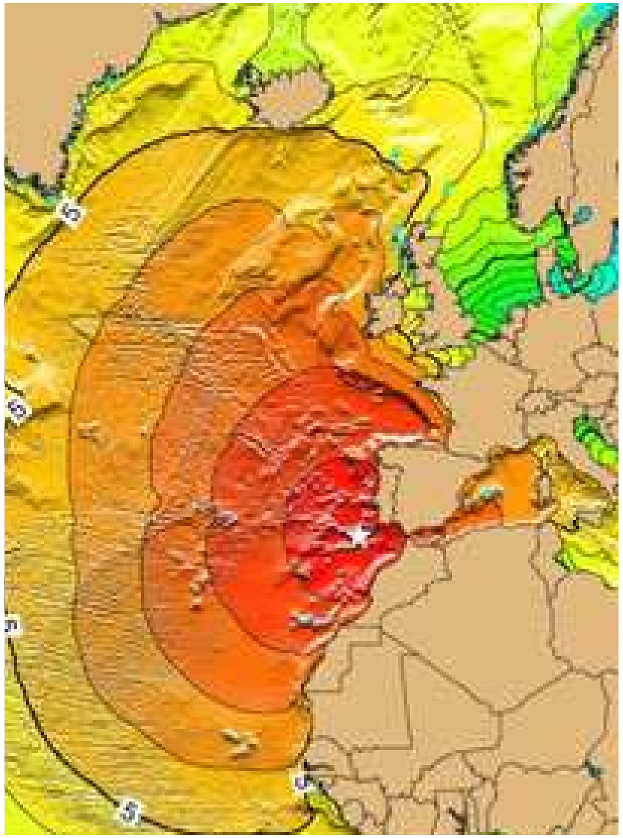
In the 1500s probability theory grew out of the interest in gambling

But people have gambled since the last ice age or even before that – so why the delay??

This knowledge did not “spill over” into science
because people did not have any perception of *randomness*



The Lisbon earthquake and tsunami 1755



made people start doubting that an all mighty God decides everything.

From 1750's ideas about randomness in science

Poor understanding of measurement errors in the 1700's

1. Scientists (astronomers) had the habit of selecting their "best" measurement
2. They didn't understand that measurement errors did not add up and instead randomly cancelled out
3. They disliked averages of observations since these did not normally agree with individually measured values

The same is true for forecasters in our times

1. Many forecasters look for the *Model of the Day*
2. Many forecasters feel uncomfortable with more than one NWP
3. The ensemble mean is disliked because it does not represent a possible state of the atmosphere

This leads us into an even more ***difficult and controversial issue*** than probabilities:

-What about any categorical forecast information?

In statistics probability is called "The 2nd moment" where "The 1st moment" is the mean or median.

A "first" or "best" categorical estimate is supplemented by a standard deviation/probability:

"Wind around 9 m/s, with a 30% probability of gale"

Where do we get this from???

The "Best Data" Paradox

If probabilities are difficult to interpret and use, they are fairly simple to produce

Categorical values, on the other hand, are easy to interpret but, paradoxically, difficult to produce

Accurate, not "jumpy" and consistent with probabilities, but not always "physically realistic"

Should they be the ensemble mean or median, or taken from a favoured NWP model?

"Physically realistic" but less accurate, very "jumpy" and not consistent with the probabilities

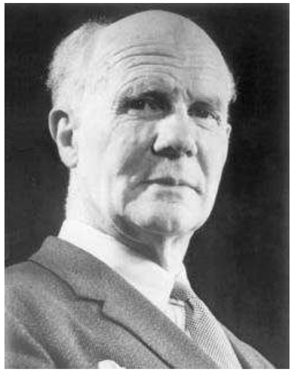
3. Philosophically controversial:

The statistical community has, with respect to probabilities, since long been divided into Frequentists and Bayesians

Karl Pearson
1857-1936

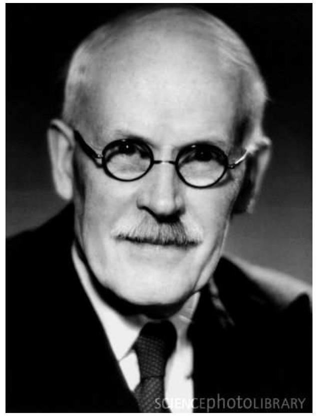
Ronald S Fisher
1890-1962

Jerzy Neyman
1894-1981



Egon Pearson
1895-1980

Robert O. Schleifer
1914-94



Harold Jeffreys
1891-1989

Leonard J. Savage
1917-71

Howard Raiffa 1924 -

Limitation of the frequentist definition:

Before summer 2000 Concord was regarded as the world's safest airplane with 0% accidents (per flight hours). . .

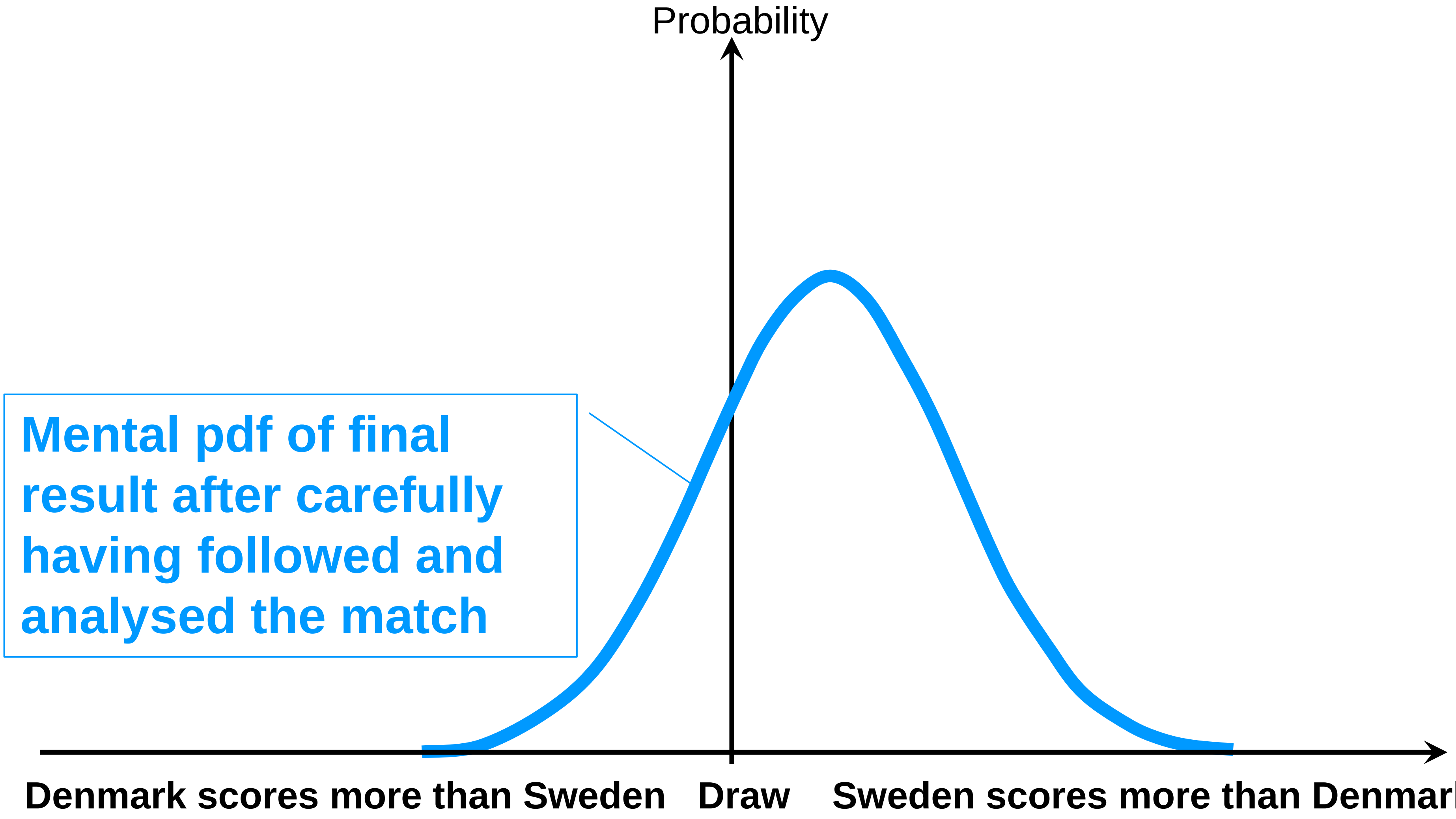
$$\frac{0}{100\,000^{h}} < \frac{1}{1\,000\,000^{h}}$$

. . .after the summer 2000 crash it became the most unsafe

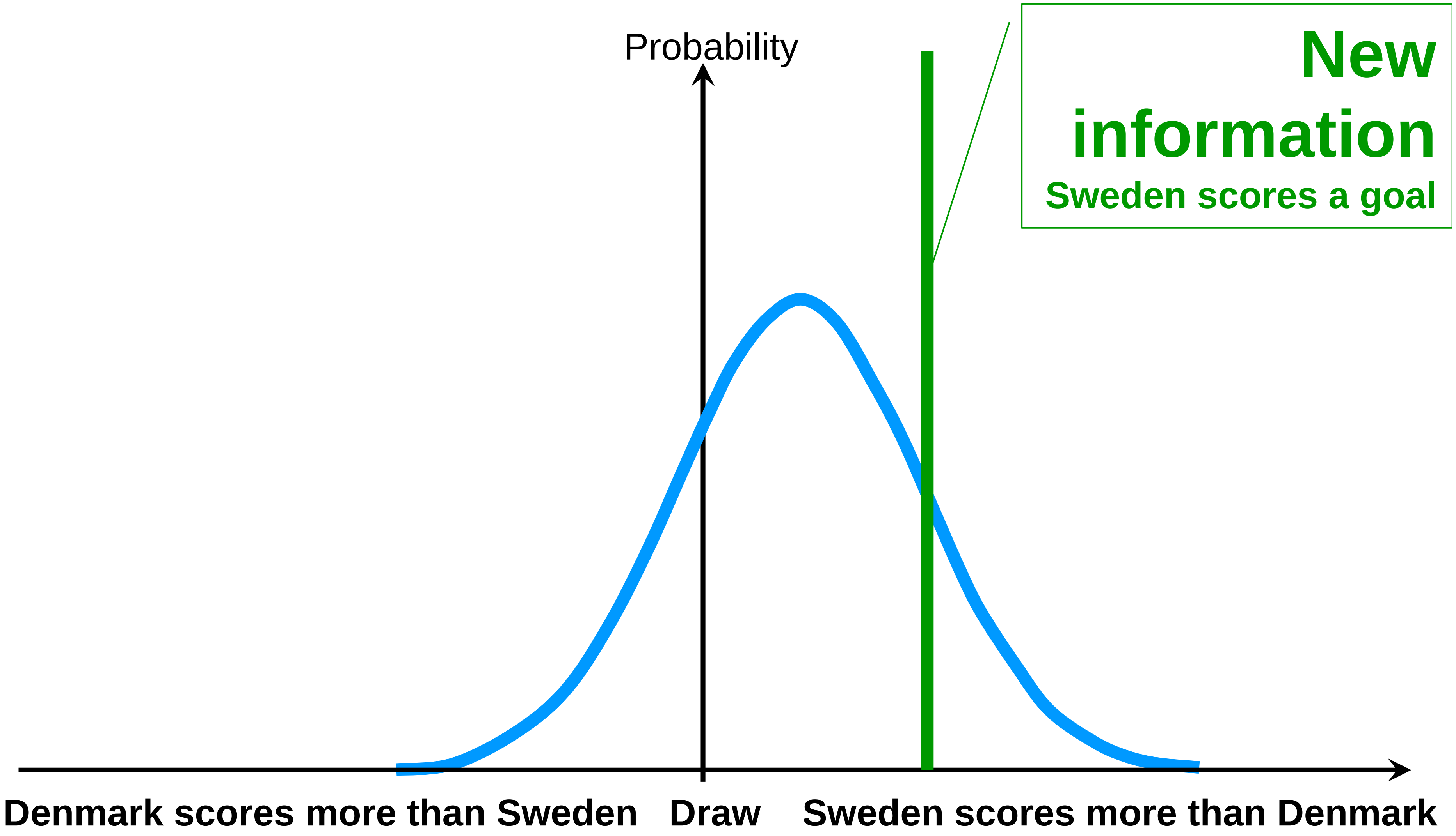
$$\frac{1}{100\,000^{h}} > \frac{1}{1\,000\,000^{h}}$$


An other example where the frequentist application breaks down
Denmark-Sweden football
After 78 minutes: 0 - 1

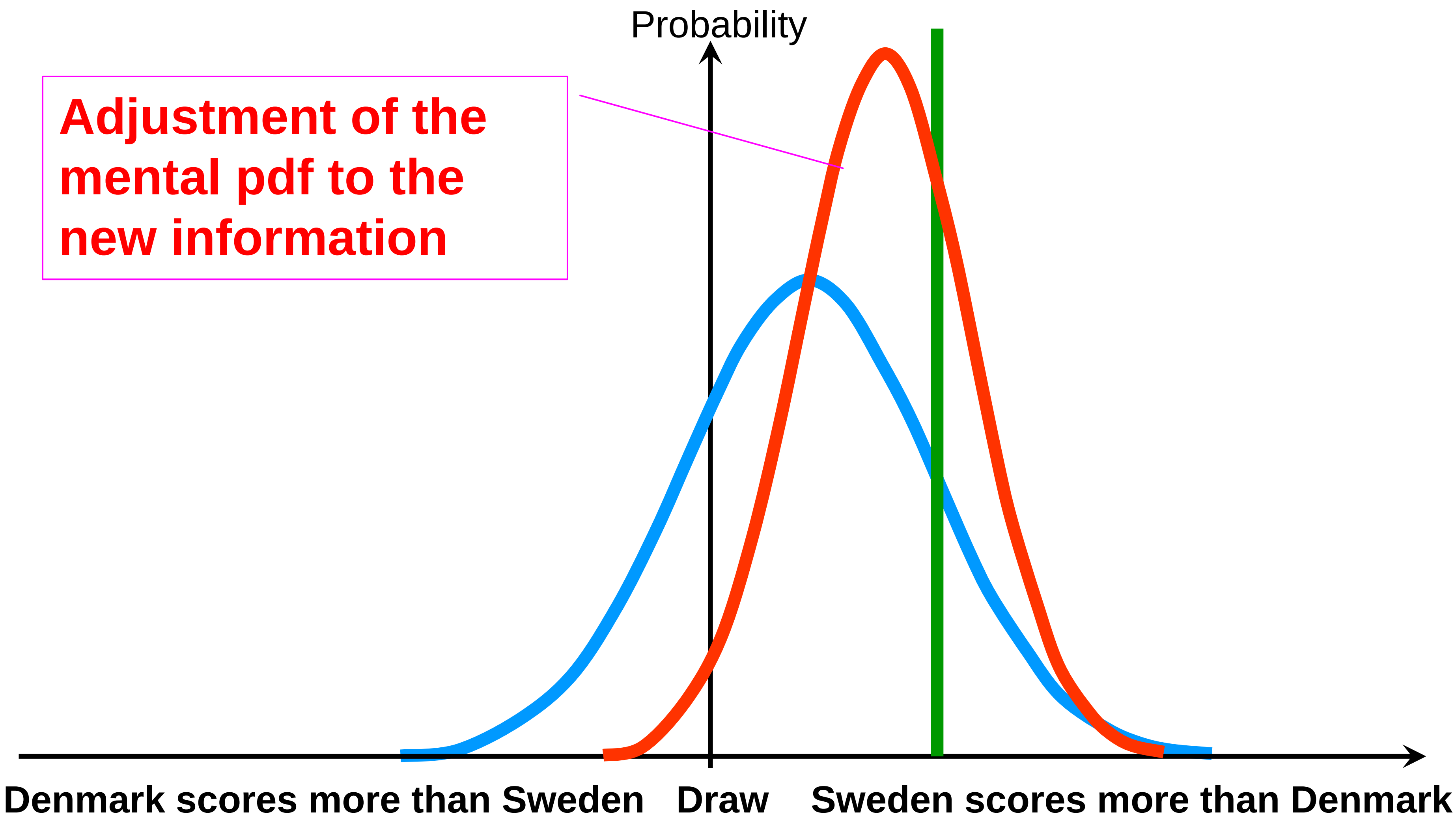
An other example where the frequentist application breaks down



An other example where the frequentist application breaks down



An other example where the frequentist application breaks down



The subjective or Bayesian probability

A quick primer (from the 2004 movie “Shall we dance?”)

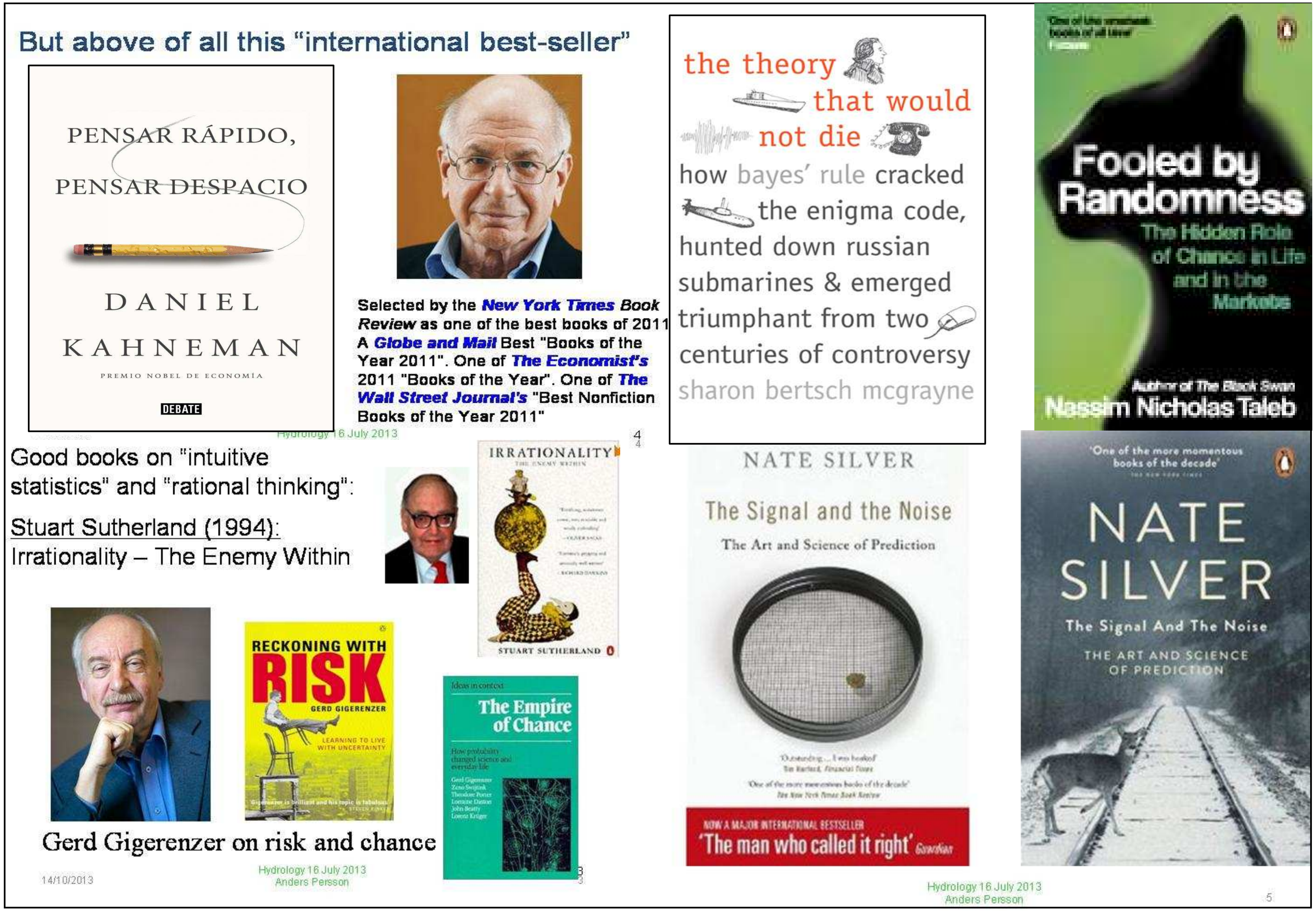
This shows that she is not an educated Bayesian!

All husbands

Prob (being late from work because having an affair, 70%) is greater than Prob (having an affair among those being late from work,10%)

P (late | affair) > P (affair | late)

Some good books about uncertainty, Bayes and intuitive statistics



A week's course in "intuitive statistics"

Monday: ***The classical definition of probability***

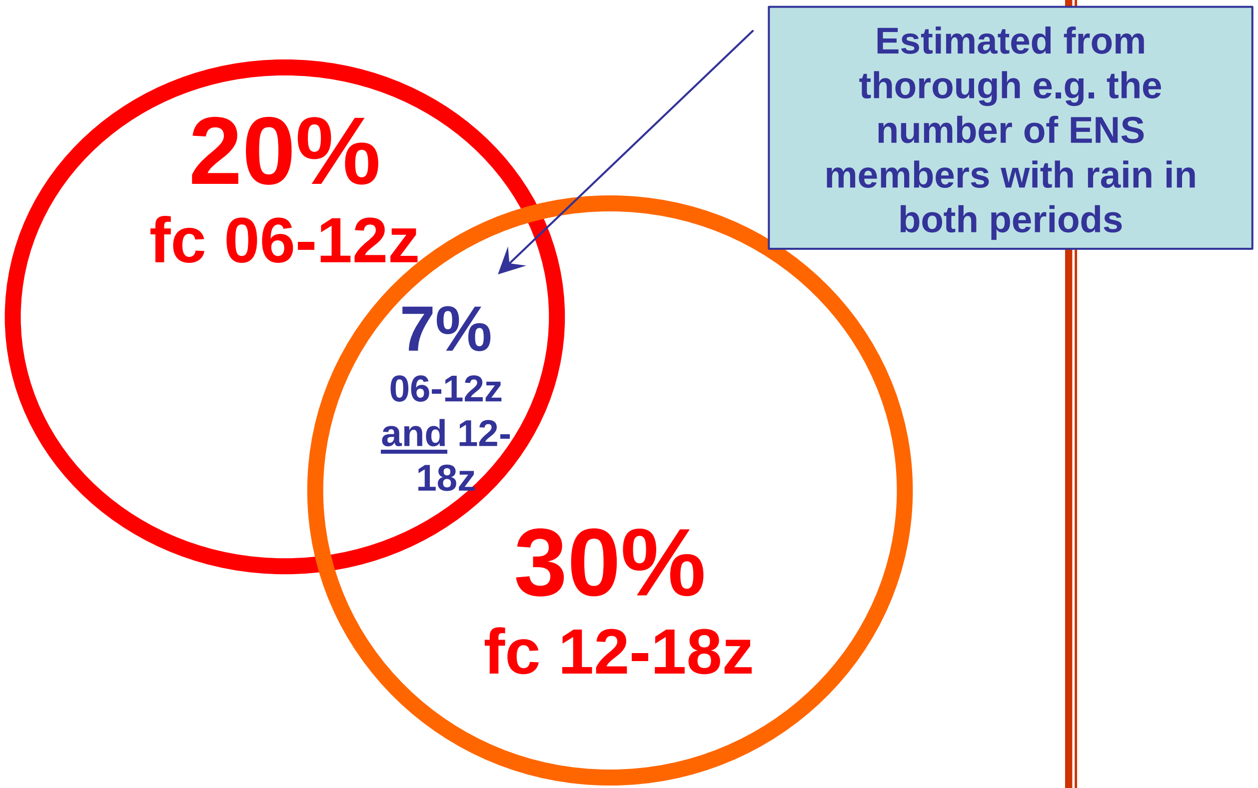
Tuesday: ***The frequentist definition of probability***

Wednesday: ***The subjective probability definition***

Thursday: ***Decision making from probabilities***

Friday: ***The psychology of probabilities***

Monday: ***The classical definition of probability*** helps us adding or dividing probabilities.



Prob precip 06-18z=**43%**

Prob precip 06-12z <u>and</u> 12-18z =**7%**

Tuesday: ***The frequentist definition of probabilities*** involves statistical calibration and verification of probability forecasts.

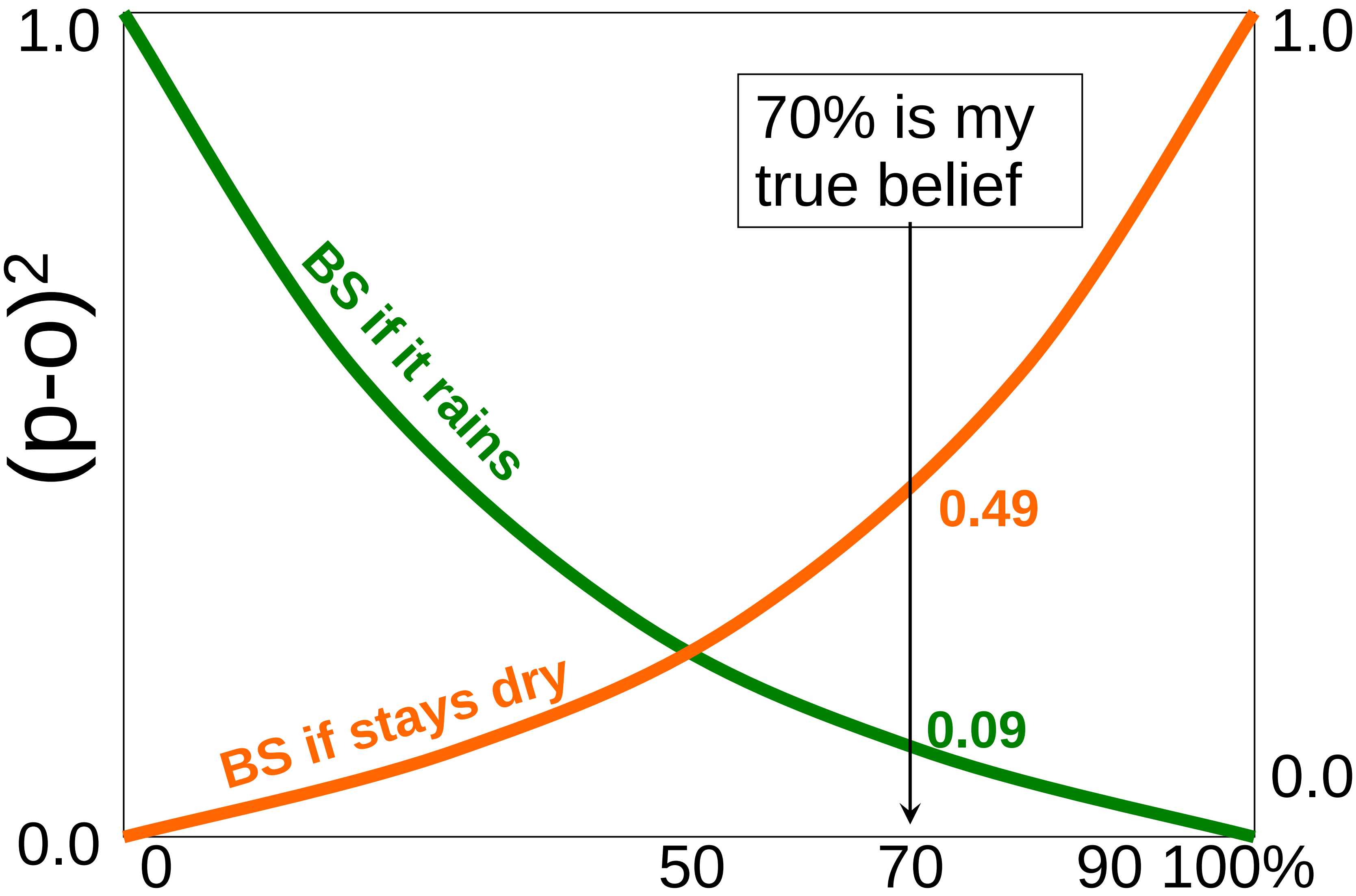
-How does the "proper" Brier score (BS) "know" my <u>true</u> opinion?

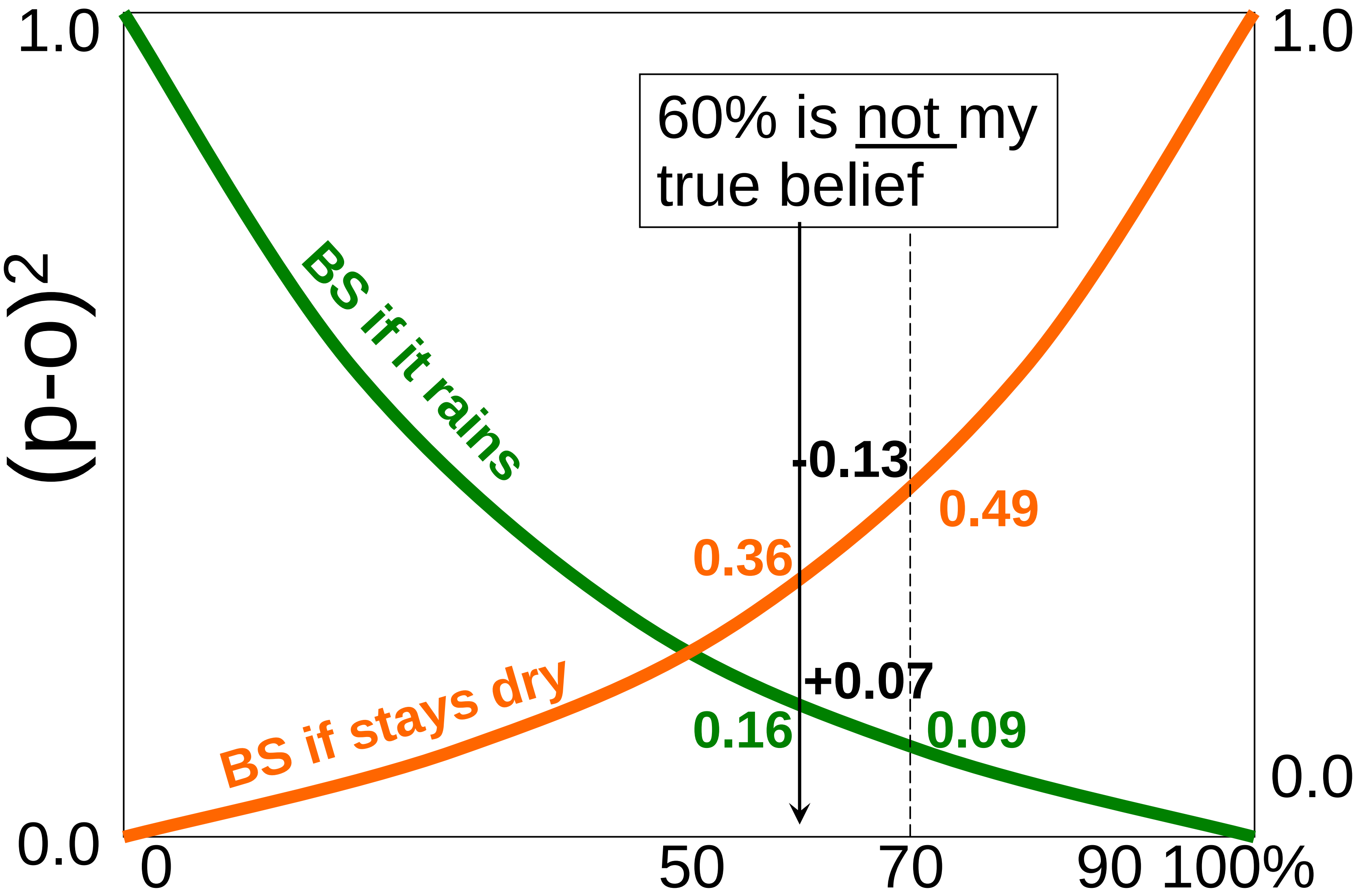
$$BS = \frac{1}{N}\sum_{i=1}^{N}(p_i - o_i)^2$$

Over N days

Forecast probability

Observed event (0 or 1)


1.0
1.0
$(p-o)^2$
70% is my
true belief
BS if it rains
0.49
BS if stays dry
0.09
0.0
0.0
0
50
70
90 100%

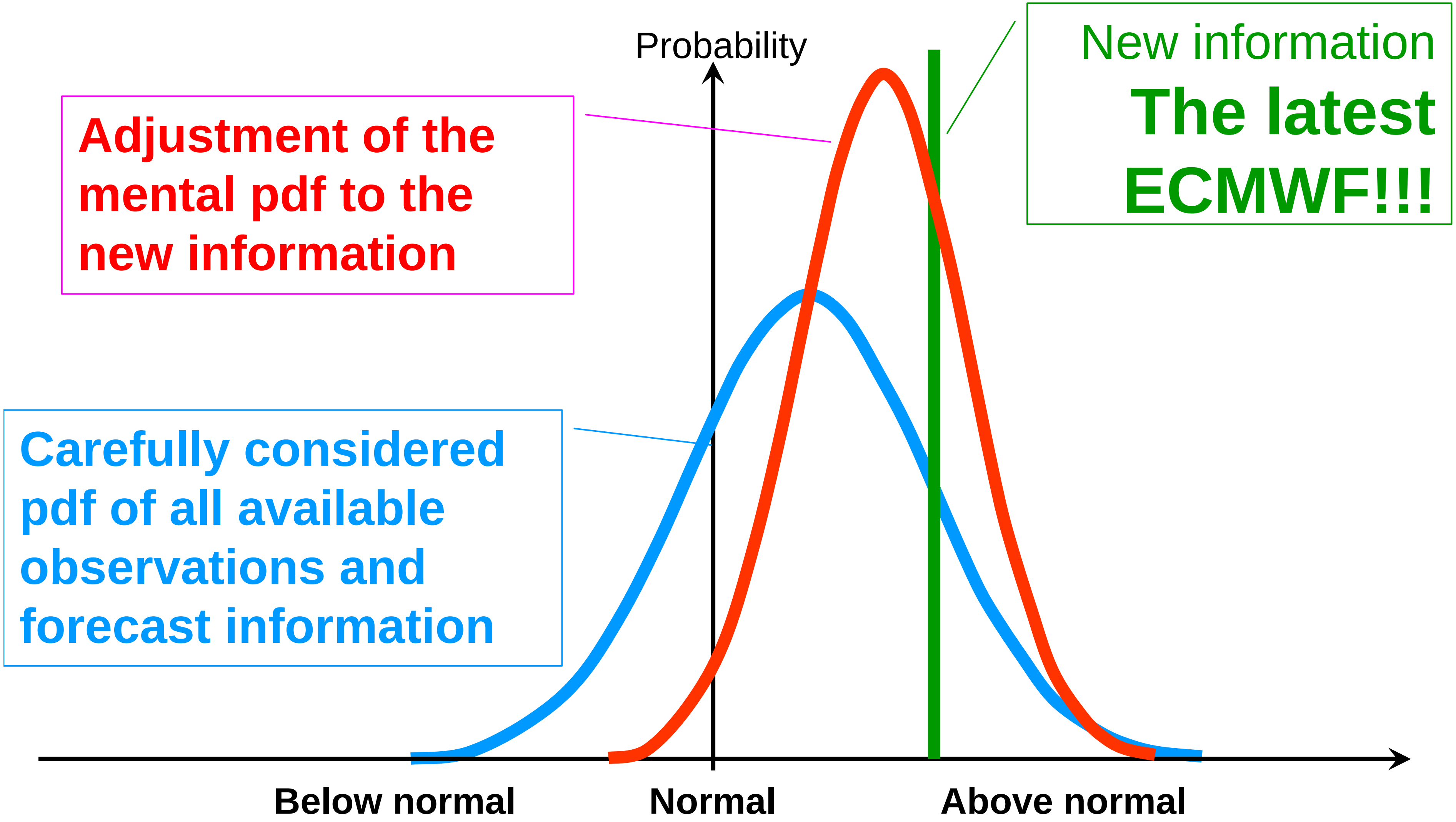

1.0
1.0
0.0
0.0
$(p\text{-}o)^2$
60% is not my true belief
BS if it rains
BS if stays dry
-0.13
0.49
0.36
+0.07
0.16
0.09
0
50
70
90
100%

Reducing BS by -0.13 if it stays dry and increasing BS by only +0.07 if it rains sounds like a reward by -0.06 thanks to my “tactical” decision.

But according to my true belief the chance of rain is 70% so those numbers have to be weighted:

$-0.13 \cdot 30\% + 0.07 \cdot 70\% = +0.01$

Wednesday: ***The subjective probabilities*** find many applications in forecasting..



Thursday: ***Decision making from probabilities*** cannot be based on the cost-loss model only.

-What do you prefer?

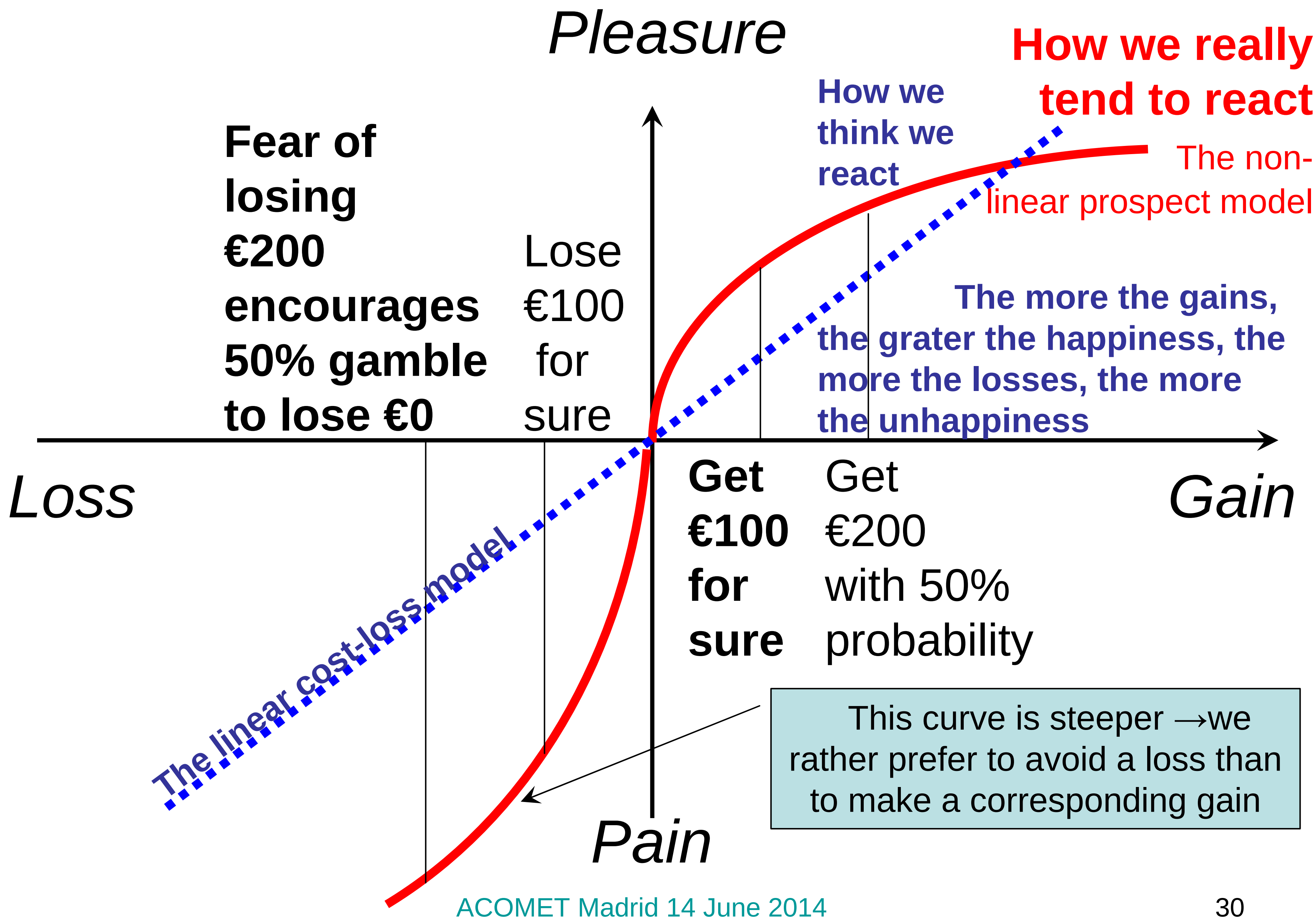
-An 80% chance of winning € 1000

or

-Get € 700 directly in your hand?

According to the cost-loss model, the first alternative is to be preferred (€800 > €700)

However, most people, even professors in mathematical statistics, would take the **€** 700

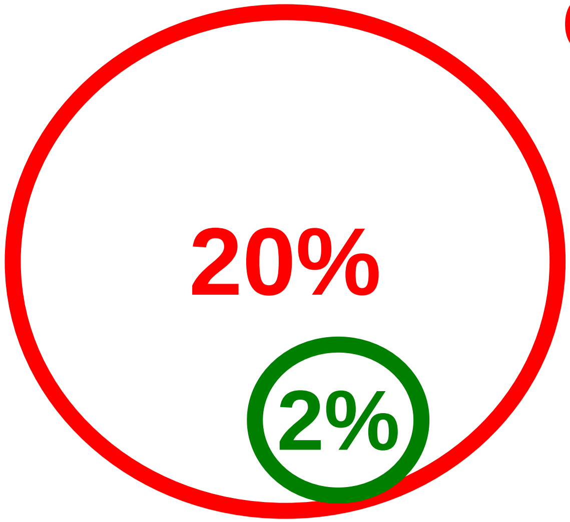


Pleasure
How we really tend to react
How we think we react
The non-linear prospect model
Fear of losing €200 encourages 50% gamble to lose €0
Lose €100 for sure
The more the gains, the grater the happiness, the more the losses, the more the unhappiness
Loss
Gain
Get €100 for sure
Get €200 with 50% probability
The linear cost-loss model
This curve is steeper →we rather prefer to avoid a loss than to make a corresponding gain
Pain

The 2005 Trento dice game

1. A separate die is cast to define the probability of rain
2. It can be 16%, 33%, 50%, 67% or 83% (never 0% and 100%)
3. The participants can insure themselves against the weather
4. A die with the corresponding proportion of rain and sun is cast
5. With the **sun** coming up nobody loses, with **rain** those who have not insured

Friday: ***The psychology of probabilities*** deals with the communication of uncertainty.



Current prob may be small but is **10 times** larger than **normal**

More about this in the 2nd lecture

Questions?