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Perceiving and communicating probabilities

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Decision making with uncertain forcasts…

- Capability of human mind for solving complex problems is limited compared with the size of problems

- Lack of objectively rational behaviour in real world

- Use of simple “rule of the thumb” to simplify decision making

- Heuristics are often helpful, but can lead to biases, especially in uncertain situations where probabilities are encountered

Non-rational thinking and cognitive illusions affect the optimal use of probabilistic forecasting

Expert knowledge versus numbers

In doubt about a situation many forecasters believe in their own judgement or expert knowledge rather than numbers created by models

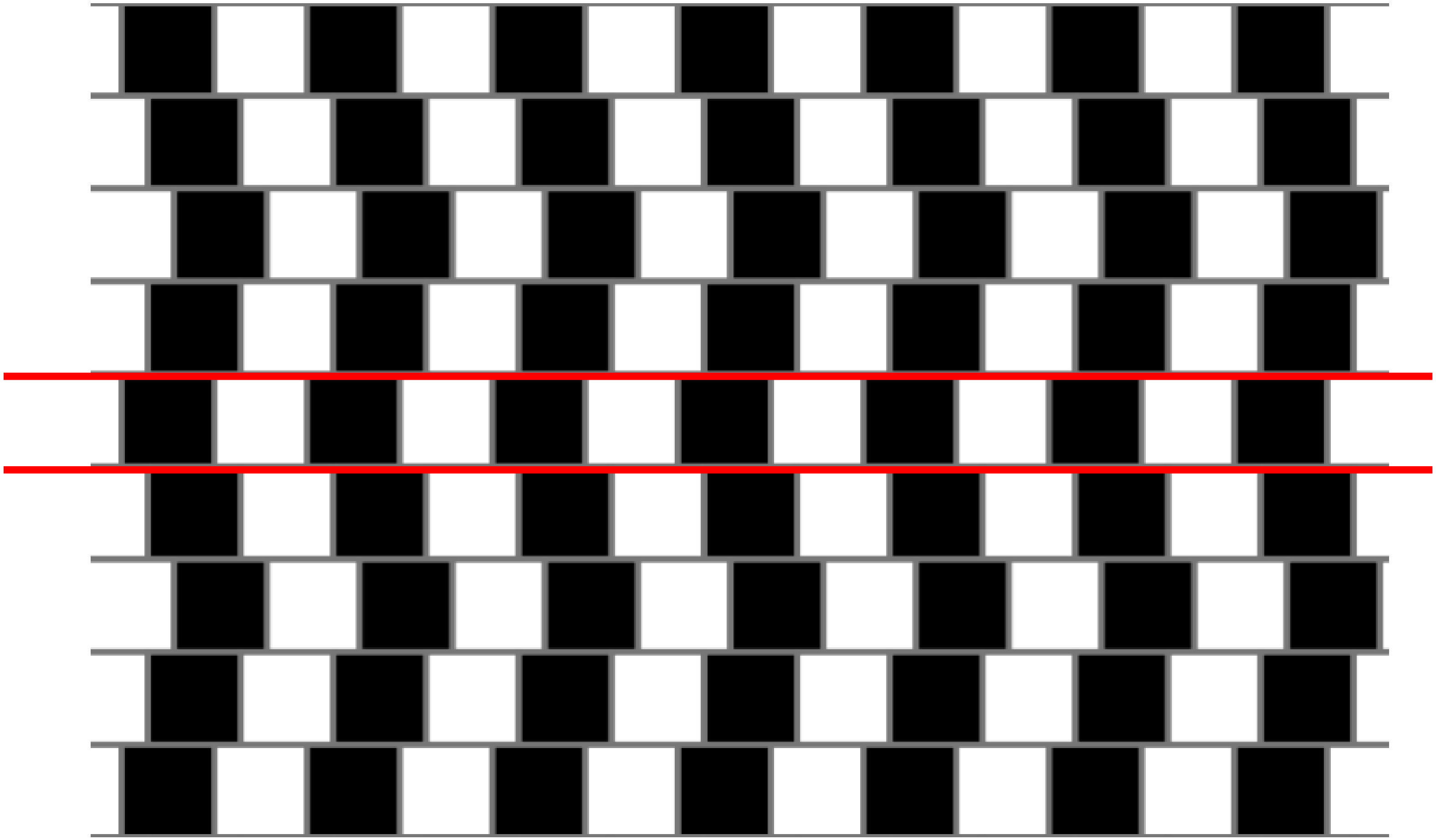
But can we really be sure that we can always trust our *expert* knowledge?

A few examples on perception …

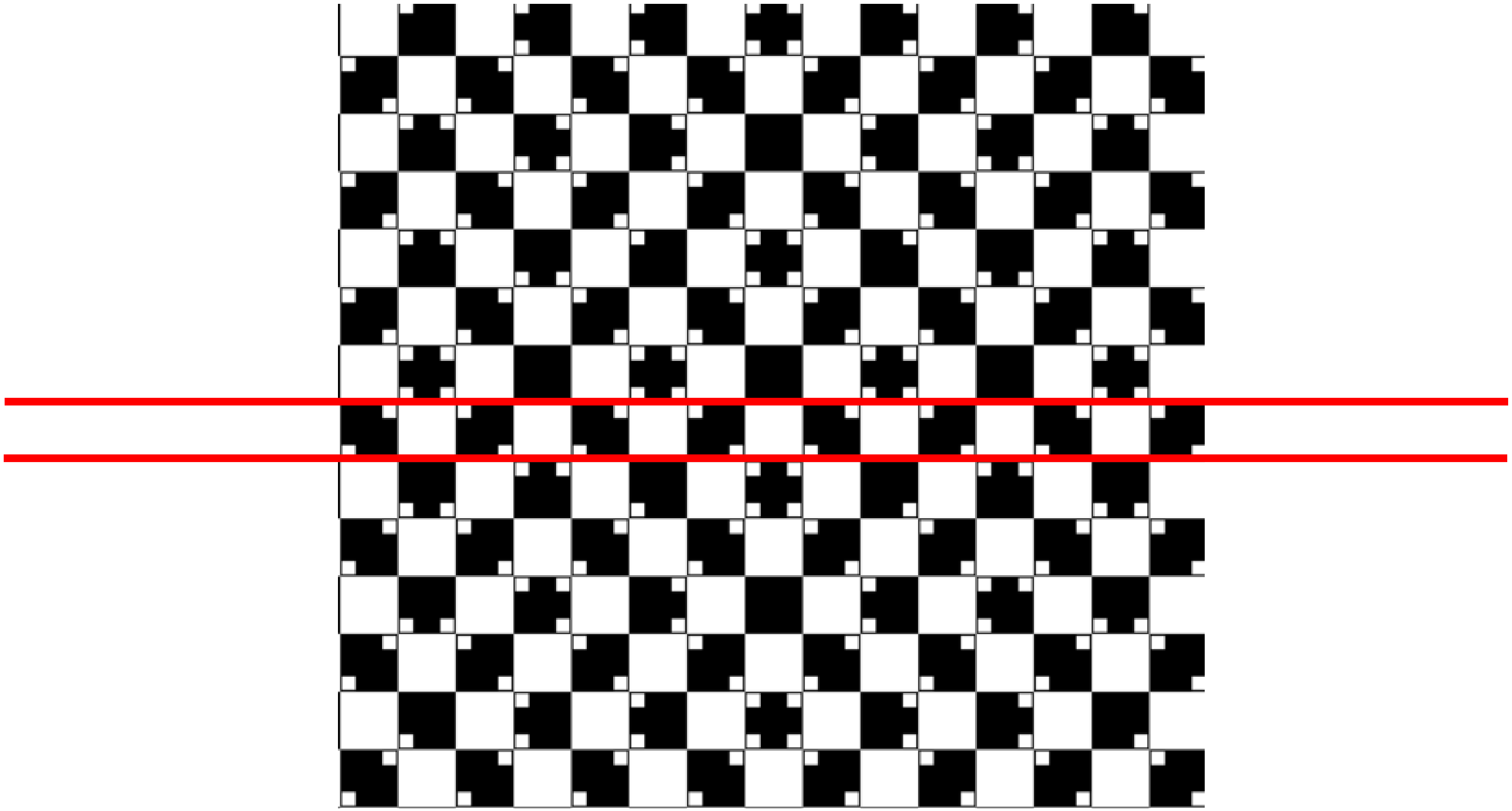
You have to supervise the work on a flood protection wall. You are told that for stability it is of *utmost importance that all layers are build exactly parallel*, otherwise there is a risk that the water pressure will destroy the wall and people need to be evacuated.

You have 5 seconds to make your decision on the two following structures:

Do you sign off this wall as entirely parallel?



Or this one?



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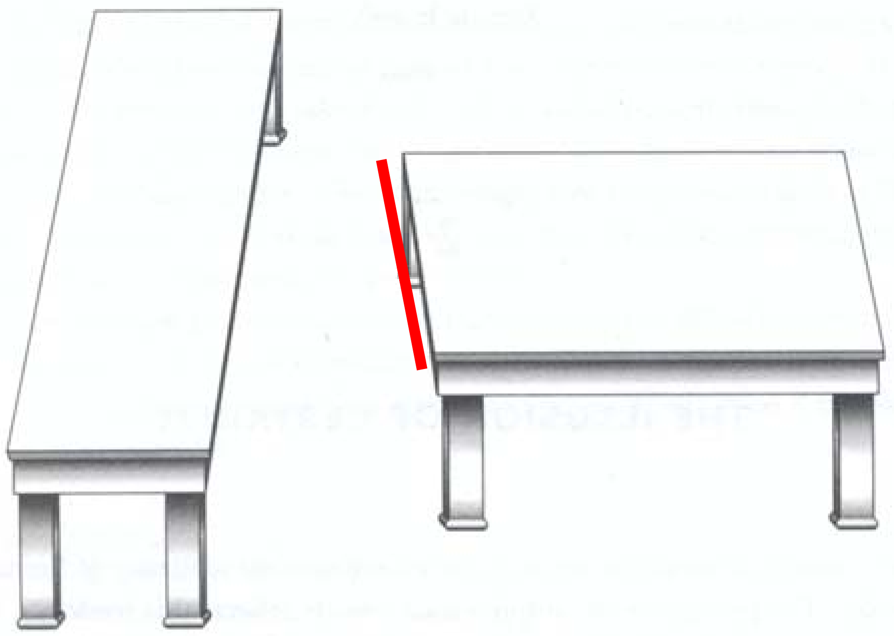
Do these two tables have the same shape or area?



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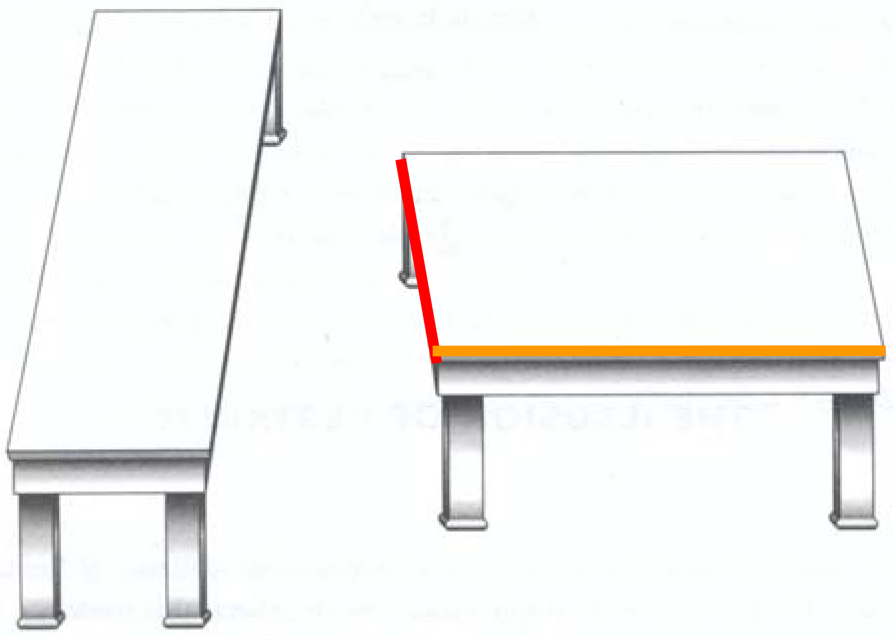

The illusion of certainty … at times even against better knowledge!

Communicating probabilities

- As frequencies or probabilities?

- Phrasing is important (risk averse or risk taking)

  • *200 will be saved* or *1/3 probability of 600 being saved and 2/3 of 600 not saved*

- Wording is important

  • certain, virtually certain, unlikely, really unlikely, possible, less likely than,… -> % probability

- Presentation and colour coding is important

Communicate COLOURS: read aloud quickly to your neighbour the *colours*, not the words

BLUE YELLOW GREEN

ORANGE RED RED BLUE

WHITE ORANGE GREEN

BLUE GREEN BLUE

RED ORANGE YELLOW

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Exercise on probabilities and frequencies

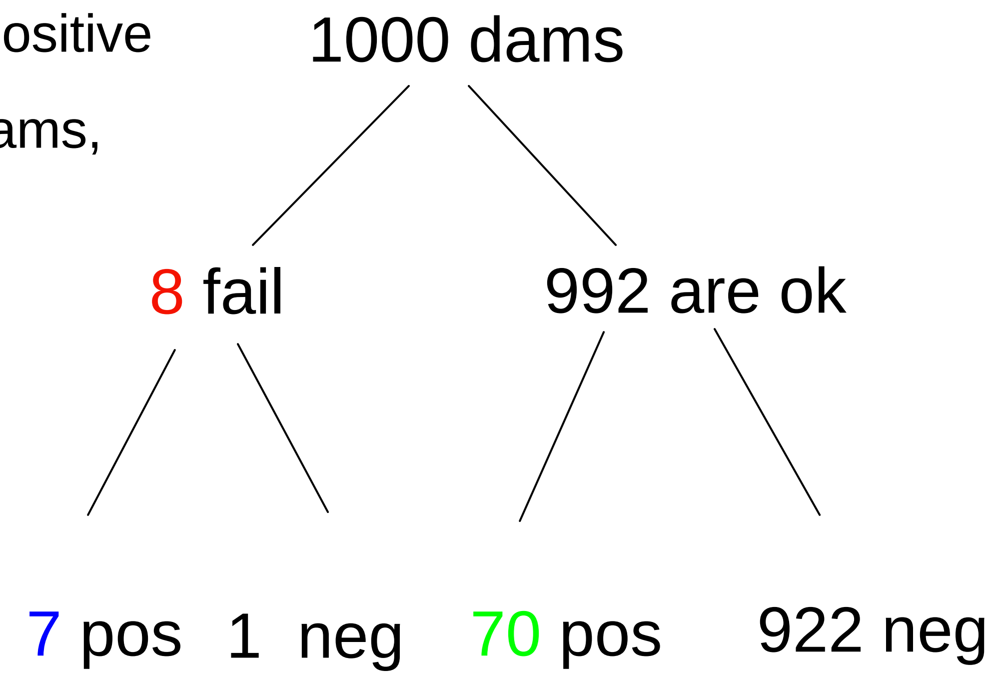
-8 dams fail

-Out of the 8 dams, 7 test positive

-Out of the 992 not faulty dams,

70 test positive

Ultrasound tests:



$$P(\text{fail}|\text{pos}) = \frac{7}{7+70}$$

A dam that was tested positive only fails in 1/11 = 9 percent

Exercise on probabilities and frequencies

Probability to fail = 0.008;

Probability not to fail is 0.992

If dam is faulty, the probability to test positive is 0.90

If dam is not faulty, the probability to test positive is 0.07

$$P(fail|pos) = \frac{0.008 * 0.9}{0.008*0.9 + 0.992 *0.07}$$

A dam that was tested positive only has a probability of 9% to fail

Conditional probabilities vs frequencies

	Failure of dam	
Test result	**yes**	**no**
Positive	hit	false alarm
Negative	missed	pos. rejection

Bayes's rule for condition probabilities:

$$P(\text{failure}|\text{pos}) = \frac{p(\text{failure})*p(\text{pos}|\text{failure})}{p(\text{failure})*p(\text{pos}|\text{failure})+p(\text{no failure})*p(\text{pos}|\text{failure})}$$

Bayes's rule for natural frequencies:

$$P(\text{failure}|\text{pos}) = \frac{\text{hit}}{\text{hit+false alarms}}$$