COMP112 in Week 2, 2022

WORKING WITH DOUBT

how to have degrees of belief

Stop Press

just out today

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Collective narratives catalyse cooperation

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4 Altmetric | Metrics

Abstract

Humans invest in fantastic stories—mythologies. Recent evolutionary theories suggest that cultural selection may favour moralising stories that motivate prosocial behaviours. A key challenge is to explain the emergence of mythologies that lack explicit moral exemplars or directives. Here, we resolve this puzzle with an evolutionary model in which arbitrary mythologies transform a collection of egoistic individuals into a cooperative. We show how these otherwise puzzling amoral, nonsensical, and fictional narratives act as exquisitely functional coordination devices and facilitate the emergence of trust and cooperativeness in both large and small populations. Especially, in small populations, reflecting earlier hunter-gatherers communities, relative to our contemporary community sizes, the model is robust to the cognitive costs in adopting fictions.

UNCERTAINTY

Is uncertainty merely lack of confidence?

- **aleatoric** - inherent noise or randomness in a phenomenon
- eg. will this fair-coin-toss come down as heads?
  (a prediction)

- **epistemic** - incomplete knowledge about the true state of the world
- eg. how “bent” is this coin?
  (ie. a hypothesis, such as “it is 60% heads”)

illustration: https://andrewcharlesjones.github.io/journal/epi-ali-uncertainty.html

Probability Theory in 2 rules

	A	B	C	
I	2	6	3	*11*
II	18	2	1	*21*
	20	*8*	*4*	*32*

eg: $\Pr(\text{row}= I \mid \text{col}= C) = \frac{3}{4}$

$$\Pr(\text{row}= I) = \frac{2+6+3}{32} = \frac{11}{32}$$

sum rule

$$\Pr(\text{row}= i) = \sum_{\text{col}\, j} \Pr(\text{row}= i, \text{col}= j)$$

$$\Pr(\text{row}= I,\ \text{col}= C) = \frac{11}{32} \times \frac{3}{11} = \frac{3}{32}$$

product rule

$$\Pr(\text{row}= i,\ \text{col}= j) = \Pr(\text{row}= i) \times \Pr(\text{col}= j \mid \text{row}= i)$$

"given that"

DEGRESS OF BELIEF

In 1946, Cox's Axioms:

1. If Bel(A) > Bel(B),
   and Bel(B) > Bel(C),
   then Bel(A) > Bel(C)
2. Bel(not A) = *func1*(Bel(A));
3. Bel(A and B) = *func2*(Bel(A), Bel(B, given A));

func1(■) = **1** − ■ which leads to THE SUM RULE

func2(■, □) = ■ * □ which is the PRODUCT RULE

see (eg) "Bayesian probability" or "Cox's_theorem" in Wikipedia

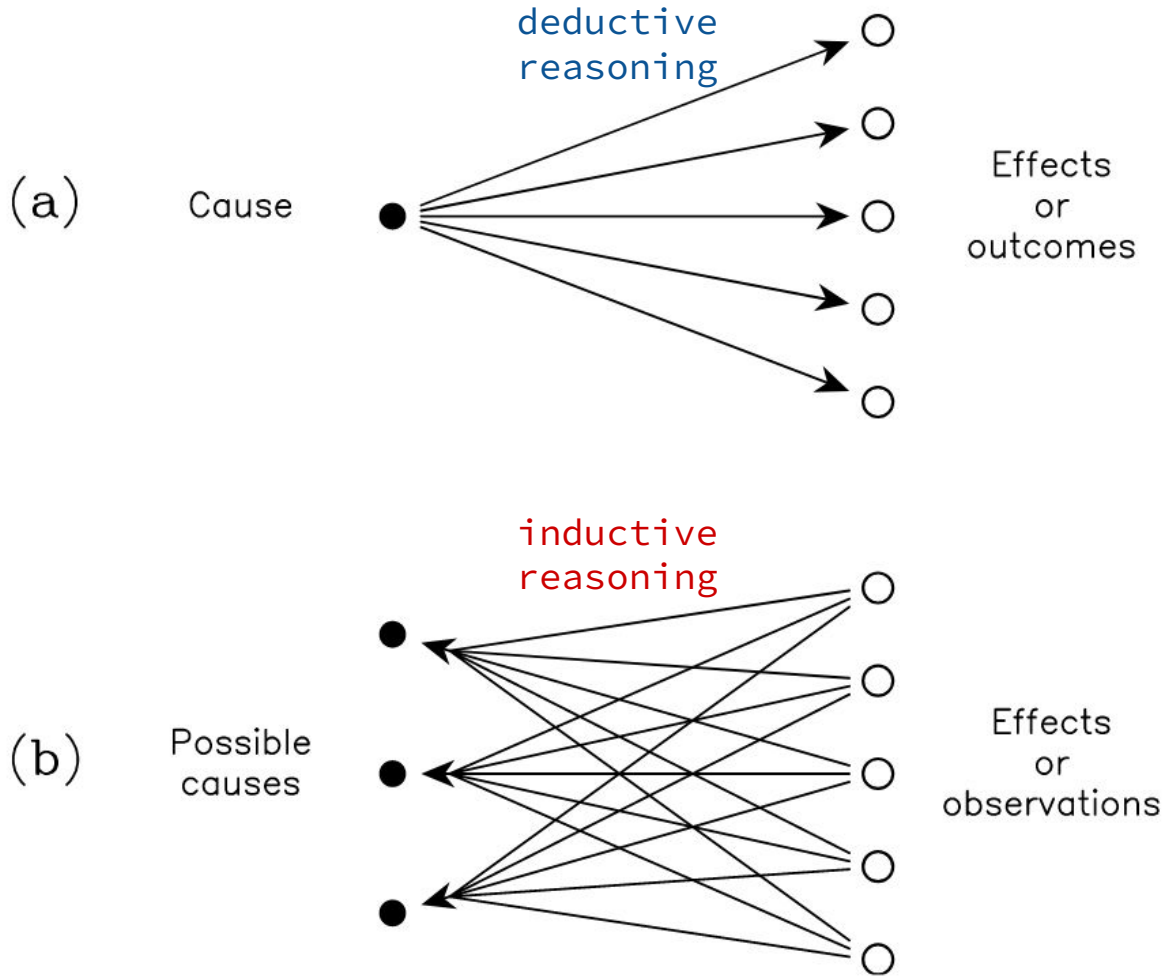
A HOMOLOGY (& A PROVOCATION)

The rules for updating BELIEFS are *the same as* the rules for updating PROBABILITIES

The claim is: **the language of inference is probability theory**

- In aeronautics engineering, we respect the rules of physics (or court disaster)
- In doing inference under uncertainty, we (should) respect the rules of probability (or court disaster)!

REASONING


deductive
reasoning
(a)
Cause
Effects
or
outcomes
inductive
reasoning
(b)
Possible
causes
Effects
or
observations

Bayes Theorem

$$\Pr(A, B) = \Pr(A) \times \Pr(B \mid A) \quad OR \quad \Pr(B) \times \Pr(A \mid B)$$

$$\text{so} \quad \Pr(A \mid B) = \frac{\Pr(B \mid A) \times \Pr(A)}{\Pr(B)}$$

Bayes Theorem

and so we can say
(which "reverses"
the arrow of causation)

$$\Pr(\text{cause} \mid \text{effect}) = \frac{\Pr(\text{cause}) \times \Pr(\text{effect} \mid \text{cause})}{\Pr(\text{effect})}$$

Or even…

$$\Pr(\text{hypothesis} \mid \text{data}) \propto \Pr(\text{hypothesis}) \times \Pr(\text{data} \mid \text{hypothesis})$$

ie. scientific reasoning

2 REMARKABLE CONSEQUENCES OF THIS

1. we can use to reason "backwards" about causes from their effects (induction)

and also…

2. to predict (deduction), we should *not* use only the best cause, but all!