Rationality
Lecture 3

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Rationality

What is the relationship between *reasons*, *reasoning*, and *logic*?

Reasoning

We have already distinguished between **practical** and **theoretical** reasoning:

- Practical reasoning is reasoning directed toward action: figuring out what to *do*
- Theoretical reasoning is reasoning directed towards an informational state: figuring out how the facts stand.

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Reasoning is a "transition in thought, where some beliefs (or thoughts) provide the ground or reasons fro coming to another"

J. Adler. *Introduction: Philosophical Foundations*. in *Reasoning: Studies in Human Inference and its Foundations*, Cambridge University Press, 2008.

(1) Ann believes that Bill's final grade is either a 6 or a 9.

(2) Ann believes that Bill's final grade is not a 6.

So, (3) Ann believes that Bill's final grade is a 9.

(1') Bill's final grade is either a 6 or a 9.

(2') Bill's final grade is not a 6.

So, (3') Bill's final grade is a 9.

(1) Bill brought his backpack to class every day of the semester.

So, [probably] (2) Bill will bring it to the next class.

(1) I need to catch the train at 9.09

Oh, (2) I better put the slides on the website.

Classical Logic

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Semantics $V : \mathit{Form} \rightarrow \{1, 0\}$

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- *Noncontradiction*: $P,\ \neg P \vdash Q$
- *Monotonicity*: $P \rightarrow Q \vdash (P \wedge R) \rightarrow Q$;
  $P \vdash Q$ implies $P, R \vdash Q$

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A set of formulas is **inconsistent** if there is no way of making all of the formulas true

1. Ann recognizes that $\{P, Q, R\}$ are inconsistent
2. $\{P, Q, R\}$ are inconsistent

Inference and Reasoning vs. Implication and Consistency

Rationality versus genius

A, B, C imply D. Sam believes A, B and C. But some does nto realize that A, B, C imply D. In fact, it would take a genius to recognize that $A, B, C \vdash D$. And Sam, although a rational man, is far from a genius.

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Discovering a contradiction
Sally believes A, B, C and has just come to realize that $A, B, C \vdash D$. Unfortunately, she also believes for very good reasons that D is false. So she now has reason to stop believing A, B or C, rather than a reason to believe D.

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From "It is raining in Tilburg" to "It is raining in Tilburg or Lily is in Amsterdam" is a valid inference. In fact, there are infinitely many such trivial consequences (p, $p \vee q$, $p \wedge p$, $p \wedge (q \wedge q)$, $p \rightarrow p$, $p \vee q \vee r$, etc.), but these will just "clutter the mind".

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Also, if one "looses" the origination of this disjunctive belief, one may be mislead to think that there is a special reason to believe Lily is in Amsterdam or there is a special connection between rain in Tilburg and Lily being in Amsterdam.

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She concludes that she will become an atheist.

But although MP gives Ann a reason to believe the conclusion, it does not decide that she will believe it. Instead of believing the conclusion, she may decide to drop her belief in the conditional.

Foundational Issues: Epistemic Closure

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(1) The animal I am looking at is a zebra.

(2) If the animal I am looking at is a zebra, then it is not a mule cleverly disguised to look like a zebra.

(3) The animal I am looking at is not a mule cleverly disguised to look like a zebra.

S. Luper. *The Epistemic Closure Principle*. Stanford Encyclopedia of Philosophy: `http://plato.stanford.edu/entries/closure-epistemic/`.

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- Suppose that you are arguing about whether the Smiths are really wealthy.
- It *begs the question* to use (2) as a reason to believe (3).
- (1) can only provided evidence for (2) if (3) is presupposed
- The warrant or support that (1) lends to (2) does not *transmit* to the conclusion (3).

C. Wright. *Cogency and Question-Begging: Some Reflections on McKinsey's Paradox and Putnam's Proof*. Philosophical Issues 10 Skepticism, pgs. 140 - 163, 2000.

Dogmatism Paradox

"If I know that h is true, I know that any evidence against h is evidence against something that is true; I know that such evidence is misleading. But I should disregard evidence that I know is misleading. So, once I know that h is true, I am in a position to disregard any future evidence that seems to tell against h."

G. Harman. *Thought*. Princeton University Press, 1973.

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1. My car is in the parking lot.
2. If my car is in the parking lot and Doug reports otherwise, then Doug's report is misleading.
3. If Doug reports that my car is not in the parking lot, then his report is misleading.
4. Doug reports that my car is not in the parking lot.
5. Doug's report is misleading.

Dogmatism Paradox

If there is evidence against my knowledge, then that evidence is mistaken or misleading.

$\vdash p \rightarrow [(q \rightarrow \neg p) \rightarrow \neg q]$

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If my wife is cheating on me, I would never know.

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J. Hintikka. *Logic, language games and information. Kantian themes in the philosophy of logic*. Oxford: Clarendon Press, 1973.

The Scandal of Deduction

" If that were correct, all that deductive inference could accomplish would be to render explicit knowledge that we already possessed: mathematics would be merely a matter of getting things down on paper, since, as soon as we had acknowledged the truth of the axioms of a mathematical theory, we should thereby know all the theorems. Obviously, this is nonsense: deductive inference has here been justified at the expense of its power to extend our knowledge and hence of any genuine utility."

M. Dummett. *The logical basis of metaphysics*. 1991.

M. D'Agostino and L. Floridi. *The Enduring Scandal of Deduction*. Synthese, 2008.

Ordinary Language Challenges

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1. John goes drinking and John gets arrested.
2. John gets arrested and John goes drinking.

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1. John will order either pasta or steak, but he order pasta.
2. John does not order steak.

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1. If you tutor me in logic, I'll pay you 50 EUR.
2. If you don't tutor me, I won't pay you 50 EUR.

Ordinary Language Challenges: Gricean Implicature

> *He [the speaker] has said that p; there is no reason to suppose that he is not observing the maxims, or at least the Cooperative Principle; he could not be doing this unless he thought that q; he knows (and knows that I know that he knows) that I can see the suppose that that he thinks that q is required....he intends me to think...that q; and so he has implicated q.*

Cooperative Principle: The speaker intends his contribution to be informative, warranted, relevant and well formed.

H. P. Grice. *Studies in the Way of Words*. Harvard University Press, 1989.

Logical Fallacies

You are shown a set of four cards placed on a table, each of which has a number on one side and a letter on the other side. Also below is a rule which applies only to the four cards. Your task is to decide which if any of these four cards you *must* turn in order to decide if the rule is true. Don't turn unnecessary cards.

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Rule: If there is a vowel on one side, then there is an even number on the other side.

A	*K*	4	7

P. C. Wason. *Reasoning about a rule*. Quarterly Journal of Experimental Psychology, 20:273 - 281, 1968.

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Which card(s) should we turn over?

1. A
2. A and 4
3. K and 4
4. A and 7
5. All of them
6. Other

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Which card(s) should we turn over?

1. A
2. A and 4 (half the subjects)
3. K and 4
4. A and 7 (Very few)
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K. Stenning and M. van Lambalgen. *Human Reasoning and Cognitive Science*. The MIT Press, 2008.

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So, [probably] (2) Bill will bring it to the next class.

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So, [probably] (2) Bill will bring it to the next class.

(1.1) Bill's backpack was stolen.

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$A \rightarrow B \vdash (A \wedge C) \rightarrow B$
'If you put sugar in the coffee, then it will taste good' can be true without 'If you put sugar and gasoline in the coffee, then it will taste good' being true.

Closed-world reasoning

Negation as failure
Suppose you are interested in whether there are any direct flights from Amsterdam to Cleveland, Ohio.
After searching online at a number of relevant sites (Expedia, Orbitz, KLM, etc.), you do not find any. You conclude that there are *no direct flights between Amsterdam and Cleveland*.

Induction

Enumerative Induction
Given that all observed Fs are Gs, you infer that all Fs are Gs, or at least the next F is a G.

Inference to the best explanation
Holmes infers the best explanation for footprints, the absence of barking, the broken window: 'The butler wears size 10 shoes, is known to the dog, broke the window to make it look like a burglary...'

Scientific hypothetic induction Scientists infer that Brownian motion is caused by the movement of invisible molecules.

Foundations of Induction: The Ravens Paradox

(IC) A hypothesis of the form "All As are Bs ($\forall x(A(x) \rightarrow B(x))$)" is confirmed by any positive instance "Aa & Ba".

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But, then does a red jacket confirm H?

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The data collected thus far seems to confirm H1 as well as H2, but H1 seems to be a "better explanation"...

N. Goodman. *Fact, Fiction and Forecast*. Bobbs-Merrill, 1965.

Probabilities

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There are a huge number of nonblack things as well as nonravens, the antecedent probability of finding a nonraven among nonblack things is extremely high. Consequently, finding a nonbalck nonraven only slightly increase the probability of "All ravens are black."

e supports h if the probability of h given e and the background information is greater than the probability of h given the background information alone:

$$p(h \mid e\&b) > p(h \mid b).$$

Probabilities: Some Details

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Kolmogorov Axioms:

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2. $p(W) = 1$, $p(\emptyset) = 0$
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Some Properties

- $p(\overline{E}) = 1 - p(E)$
- If $E \subseteq F$ then $p(E) \leq p(F)$
- $p(E \cup F) = p(E) + p(F) + p(E \cap F)$

Bayesian Inference: Bayes Theorem

$p(E|F)$ "the probability of E *given* F": formally, $p(E|F) = \frac{p(E \cap F)}{p(F)}$

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It expresses the quantity $p(H|e)$ (the probability of the hypothesis given the evidence) — which is something people often find hard to assess — in terms of quantities that can be drawn directly from experiential knowledge.

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What probability should A assign to begin released? 1/2 or 1/3?

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Typically a large percentage of people asked say 2 is more probable than 1.

A. Tversky and D. Kahneman. *Extensions versus intuitive reasoning: The conjunciton fallacy in probability judgment*. Psychological Review 90 (4): 293 - 315, 1983.

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$p(T|B) = p(B|T)\frac{p(T)}{p(B)} = 0.99(100/1,000,000)/[(0.99 \cdot 100 + 0.01 \cdot 999900)/1,000,000] = 1/102 \approx 0.98\%$

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- *Prescriptive*: take into account bounded rationality (computational limitations, storage limitations)
  closed-world reasoning, heuristics

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- Actual human reasoning falls short of prescriptive standards, so there is room for improvement by suitable education
- Reasoning rarely happens in real life: we have developed "fast and frugal algorithms" which allow us to take quick decisions which are optimal given constraints of time and energy.

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J. Hintikka. *Inquiry as Inquiry*. Kluwer Academic Publishers, 1999.

Next Week: Practical Reasons and Practical Rationality