September 25, 2017
Lecture 3

Today's Plan

Inductive Risk
Climate Change II

Last time

- Considered a debate that happened in the 1950's and 60's
- What role values might play in science?
- Value judgements (individuals preferences) influences on the doing of science
- Philosophical view: "Value free ideal" – coming from logical positivists
    - No legitimate role of values in science
    - If it does – then scientists are behaving poorly
    - Not doing science as they should
    - Avoid any use of values in their sci inquiry
- Last time we considered an argument that because of the use of values (in the role of inductive arguments in sci inquiry) there is an inevitable role for values

Inductive Risk

Slide 1

- The inductive/deductive distinction
    - Q: What is inductive?
    - Q: What is deductive?

Slide 2

- Deductive arguments: if the premises are true the conclusion must be true.
- Given the truth of the premises, given the nature of logic, that the conclusion cannot be false
- Example: mathematics
- Given the truth of the premises (conditions of a theorem), it absolutely has to be the case that the conclusion of the theorem has to be true
- Statistics has this feature too
- Computer science

Slide 3

- Inductive arguments: the truth of the premises makes the truth of the conclusion more likely.
- We are working with this in science primarily
- Truth of the premises, makes the conclusion more likely
- But, no necessity of the conclusion that follows just from the truth of the premises

Slide 4

- R: An observation: scientists must accept or reject hypotheses which are supported inductively rather than deductively.
- Make decision about hypothesis, where only inductive arguments are available
- We only have well-supported premises → which we think are true
- But those premises considers conclusions that are more likely and not necessary
- So there is some sort of gap between the level of support for the hypothesis and how much support we would like for it to have

Slide 5

- Rudner thinks that this alone is sufficient to establish an internal role for values in science.
- Distinction between internal/external role?

- Whether or not the role values play is a part of the scientific process itself or they come up in questions external to science, in the sense that they are about things about what one should pursue one research question or another – but not internal to the practise of doing science itself
- Internal role for values are the more pernicious ones according the value free ideals (ones you must avoid in order to be a good scientist)

- Rudner: given inductive support for hypotheses – we need to accept or reject on the basis of those inductive arguments
- We have here an internal role for values in science…

Slide 6

- R: Inductive risk:
- "How sure we need to be before accepting a hypothesis will depend on how serious a mistake would be."

Slide 7

- A tacit assumption (identified by Levi):
- 5. To choose to accept a hypothesis H as true (or to believe that H is true) is equivalent to choosing to act on the basis of H relative to some specific objective.
    - Are those two things equivalent?
    - Just choosing to accept/reject (epistemic decision) – is it really equivalent to choosing to act on the basis of that hypothesis

Slide 8

- Levi's reply to Rudner: perhaps the values that play an intrinsic role in science are all concerned with the nature of our knowledge and not with the practical consequences of our actions.
    - R values have to play a role in science just by virtue of inductive arguments
    - But, that might not be as bad as we think
    - It just about the role of values that are playing is values about the kind knowledge being generated in these decisions and not to do with practical consequences of action (things like how much money is being made)

Slide 9

- Maybe the values that play an internal role in science are all epistemic values.

Slide 10

- Epistemic values are those values that are concerned with the nature of our knowledge.
- Examples: truth, simplicity, predictive accuracy, empirical adequacy, robustness.
- Why might a scientist judge simplicity to be a virtue – to be something they have a preference for?
    - Scientists might prefer to accept a simple hypothesis rather than a complex one
    - Why simpler than a complex one?
    - Choosing the simpler one – easier to communicate to colleagues and members of the public
    - ^ Inductive argument: let's take the simpler scenario!
        - Judging this to be more preferable – on the basis that it is easier to communicate
- Is this a more valid role for values in science than cases like political, ethical, religious values?
- Does that seem less bias or objective?
    - No; epistemic values are not any less than to non-epistemic values
    - Some people think epistemic values are better
    - But others think they are equal

Slide 11

- Non-epistemic values: those values having to do with social, political, ethical, or economic context.
- What we have been calling 'values all along'

Slide 12

- Ever since the Levi and Rudner debate… a suggestion has been pursued:
- If all of the violations of the value-free ideal that are internal to science involve epistemic values, maybe such violations aren't so bad?
- Maybe there some story we can tell for why it is okay for scientists to prefer simple or robust hypotheses
- The point: this retreat to epistemic values won't work…
- Epistemic values are still epistemic values that can lead to bias
- There is a deeper problem however, in retreat to epistemic values
- If you look at scientific practises and how they make decisions, what you are going to see is that the retreat to epistemic values fails on the grounds that not all values that are playing an important role are epistemic values
- There are appeals to non-epistemic values all over the scientific enterprise
- Just by dismissing the role for epistemic values, is not going to get you off the hook
- Not going to get away from the values in science

Slide 13

Inductive Risk and Values in Science*

Heather Douglas†‡
Department of Philosophy, University of Puget Sound

Although epistemic values have become widely accepted as part of scientific reasoning, non-epistemic values have been largely relegated to the "external" parts of science (the selection of hypotheses, restrictions on methodologies, and the use of scientific technologies). I argue that because of inductive risk, or the risk of error, non-epistemic values are required in science wherever non-epistemic consequences of error should be considered. I use examples from dioxin studies to illustrate how non-epistemic consequences of error can and should be considered in the internal stages of science: choice of methodology, characterization of data, and interpretation of results.

Slide 14

- Douglas: non-epistemic values are everywhere
- ^ Central thesis

Slide 15

- Values, and in particular, non-epistemic values, are endemic in the scientific project. They enter not just when scientists accept or reject hypotheses, but at nearly every stage of their reasoning.
- But at every stage of scientific reasoning
- Contrary to the position of Rudner (whom said that role of values plays at the final stage of accepting/rejecting the hypothesis)
  - Douglas identifies instances where even before one has the potential problem of trying accept/reject hypotheses, one will be making non-epistemic value judgement

Slide 16

- The <u>entry</u> points Douglas considers:
  - **Choosing the requisite statistical significance**
    - In order to establish an conclusion
  - Evidence characterization
  - Interpretation of results

Slide 17

- The research question she considers is: do dioxins cause cancer?
- Uses to establish claim that non-epistemic are all pervasive in scientific inquiry

- Looked at rats
- Dioxins are chemical found in by-products manufacturing processes
- Suspicions for responsible of causing cancer in human population
- Unethical to do experiments on humans (external role for values – the decision to doing it on rats)

Slide 18
- To study this question scientists maintain a dosed population and a control population
    - Two cages of rats
- But cancer is present even in the control population
    - Even if not giving the chemical to all the rats
    - There is some sort of baseline rate of cancer that is normal cancer in all of these rats

Slide 19
- Statistical tests are required to determine whether any excess cancer in the dosed population (if there is an excess) can be attributed to the dosing.

Slide 20
- It is only reasonable to decide that the chemicals cause cancer if the rate of cancer in the dosed population is sufficiently different from the rate in the control population.

Slide 21
- But how are we supposed to decide what counts as sufficiently different?
    - Statistical test
    - Large sample size (expensive – how do values play in this?) and p-values
    - 95% confidence intervals (how certain you can be that you are not making a mistake)
- Douglas: making that decision necessarily involves non-epistemic values.

Slide 22
- False positives occur when one accepts an experimental hypothesis as true and it is not.
    - We think that dioxins are causing cancer (even though they are not)
- False negatives occur when one rejects an experimental hypothesis as false and it is not.
    - Dioxins are not causing cancer (even though they are)
- Both of these are possible given they only have inductive support – in fixing confidence interval, the level of difference between the dosed and control population are established – we are either gonna have false positives or negatives
- Need to make a decision about which of these will be less risky

Slide 23
- Requiring a higher level of statistical significance results in less false positives and more false negatives.
- Requiring a lower level of statistical significance results in more false positives and less false negatives.

Slide 24
- Douglas: which of these situations you prefer depends on your non-epistemic values.

Slide 25
- What is at stake in this research is what level of dose of dioxins is safe (i.e. at what dose can we be sure they will not cause cancer).
    - At what dose can we be sure it doesn't cause cancer
- This has serious consequences for how dioxins are regulated.
    - Publish a paper such as: dioxins below certain concentrations are safe and humans won't get any increased risk of cancer. If you publish this, policymakers will look at this and think these industries need to be producing produces that are giving off dioxins – so why not let industries produce their goods at the recommended level of dioxins for humans.

- Publish a paper that says this instead: dioxins at this particular concentration in the environment produces an increased risk of cancer. Policymakers are gonna have a burden on themselves based on this research: to is not safe for humans to be exposed to those levels of dioxins. Going to have to make laws about how industry produces products → going to incur a cost to them. Keeping track of where by-products end up will probably cause money, as well.

Slide 26

- More false positives lead to over-regulation.
  - Standards where we put more stringent rules on the industry than required in order to keep the population safe
- More false negatives lead to under-regulation.
  - We have decide to expose the population to a level of dioxins in the atmosphere which is potentially dangerous and could result an increase rate of cancer in the population
- What values might lead someone to prefer each of these scenarios?
- Who might prefer the first scenario?
  - I would…

Slide 27

- The entry points Douglas considers:
  - Choosing the requisite statistical significance
  - **Evidence characterization**
  - Interpretation of results

Slide 30

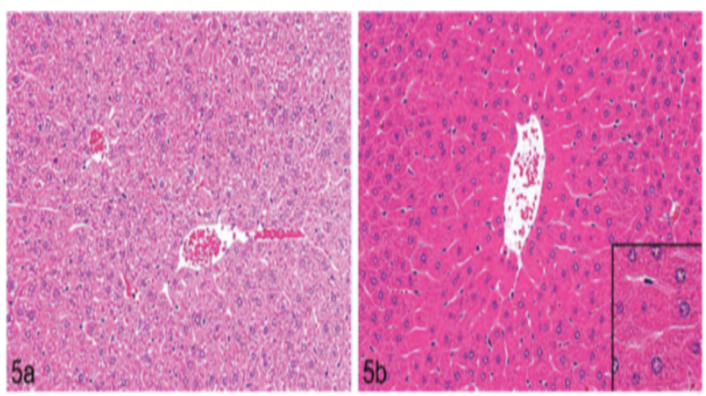
- To make the comparison of statistical significance discussed in the last section, scientists need to decide whether or not cancer is present in a particular rat.
- Getting that info requires that you make decision about when a particular rat has cancer
- Prior to any statically comparison

Slide 31

- Determining if cancer is present is not always obvious from the slides - there are borderline cases.

TABLE 1 FEMALE SPRAGUE-DAWLEY RAT LIVER SLIDE EVALUATIONS
(Adapted from EPA 1994, p. 6–5)
Key: B = Rats with Benign Tumors
M = Rats with Malignant Tumors
T = Total Rats with Tumors

Dose Level		1978	1980	1990	Acute Toxicity in Rats
0 ng/kg/day (control)	B	8/86		2/86	no acute liver toxicity observed
	M	1/86		0/86	no acute animal toxicity
	T	9/86	16/86	2/86	
1 ng/kg/day	B	3/50		1/50	no acute liver toxicity observed
	M	0/50		0/50	no acute animal toxicity
	T	3/50	8/50	1/50	
10 ng/kg/day	B	18/50		9/50	8/9 livers with tumors show some acute toxicity
	M	2/50		0/50	
	T	20/50	27/50	9/50	debatable acute animal toxicity
		$p<0.001$	$p<0.001$	$p<0.01$	
100 ng/kg/day	B	23/50		14/50	18/18 livers with tumors show some acute toxicity
	M	11/50		4/50	
	T	34/50	33/47	18/50	clear acute animal toxicity
		$p<0.001$	$p<0.001$	$p<0.001$	



- Determining if one has cancer is not always obvious
- By looking at the same slides, different people came up with different judgments about the rate at which cancer was present in the population
- B, M, T groups and doses
- In 1978, 1980, 1990 → 9/86, 16/86, 2/86
- Came up with different judgement whether or not there is cancer
- There is something going in the way that evidence is getting characterized – gonna affect how the statistical tests we are trying to run are gonna turn out

Slide 32

- Should all borderline cases be treated as cancerous? As non-cancerous?
- This again depends on how one thinks about the risks of false positives and false negatives.

Slide 33

- The entry points Douglas considers:
  - Choosing the requisite statistical significance
  - Evidence characterization
  - **Interpretation of results**

Slide 34

- Does the nature of the statistical data support a threshold or no threshold interpretation?
- Threshold interpretation: you are safe to have some concentration of dioxins in the atmosphere up to a certain threshold – below it will no influence on the rate of cancer; once you arrive at the threshold, it will turn on an increase in the rate of cancer and adding additional dioxins will increase the rate even further
- No threshold interpretation: at the initial onset of the first exposure to dioxin in the atmosphere, the rate of increase in the rate of cancer will immediately increase (for any level)
- That is, is there some threshold below which dioxins are safe?

Slide 35

- Once again, this depends on the scientist's view about the inductive risk.

Slide 36

- Douglas: non-epistemic values are everywhere

Slide 37

- Values, and in particular, non-epistemic values, are endemic in the scientific project.
- They enter not just when scientists accept or reject hypotheses, but at nearly every stage of their reasoning.

Climate Change II

Slide 1

- Anywhere there is uncertainty there is inductive risk.
- An argument for the conclusion we are trying to arrive at – if there is uncertainty, there is inductive risk
- In chem, bio, etc. there is uncertainty → inductive risk

Slide 2

- If Douglas' thesis is correct, there should be intrinsic roles for non-epistemic values in climate change research as well as in the case she considers.

Slide 3

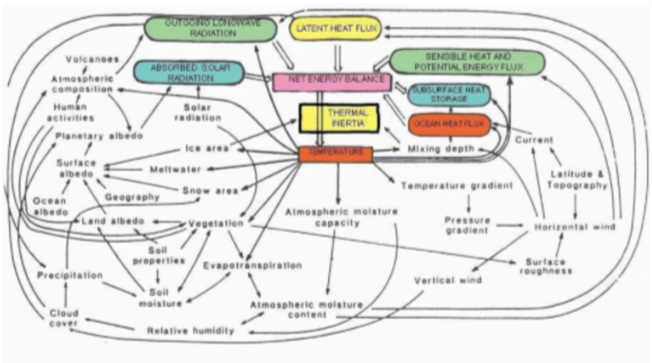
- Fact 1: CO_2 is a greenhouse gas (it traps heat and makes a planet warmer than it would be in its absence).
- Fact 2: Human activity, and especially the use of fossil fuels is adding significant CO_2 to the atmosphere.
- Consequence: The surface temperature of the earth rises as a result of our use of fossil fuels and will become more severe as we use them more.
- What kind of scientific grounds do we have that makes these facts true?
- Nature of evidence is only supported by inductive arguments – no deductively-valid arguments for the facts
- Don't know if the premises of these arguments to be true with certainty
- Can only have inductive support – using this will make conclusions more probable
- Therefore, we are going to incur inductive risks – that will help to make the conclusion

Slide 4

- That much is very well accepted. But if we inquire further we encounter large uncertainties.

- How much warming will occur in the next 5, 25, 100 years?
  - Indicator of how immediate the problem is
- If we reduce CO_2 emissions to half of the current rate, how will that affect the warming?
- What are the economic consequences of reducing emissions by half?
- What are the economic consequences of doing nothing?
  - How will that have an effect on the economy?

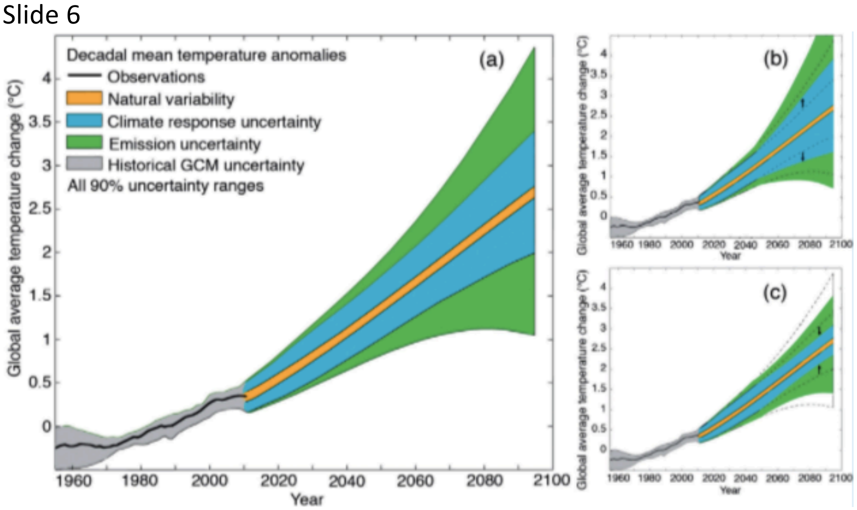
Slide 5



Flow diagram for climate modeling, showing feedback loops. From Robock (1985).

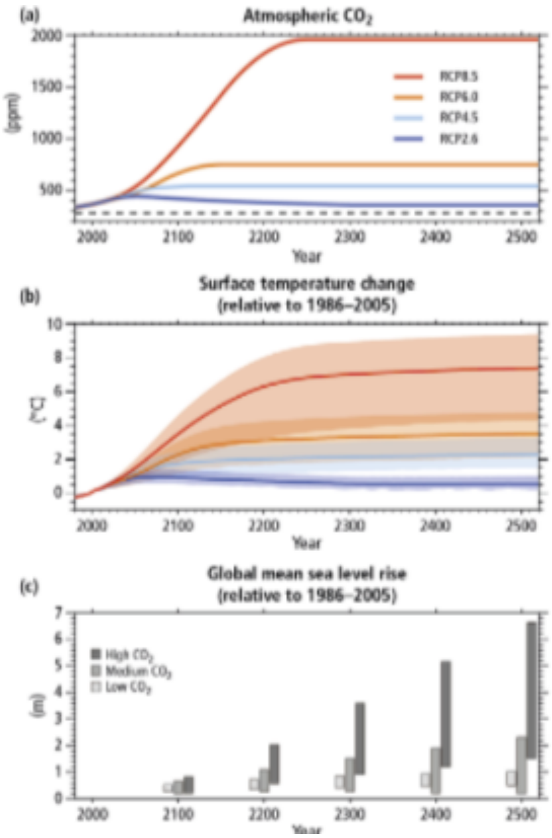
- First question is hard: how much warming will occur in the next 5, 25, 100 years
- The earth's atmosphere is a complicated system
- No direct relationship between CO_2 and temperature
- Has an influence on the temperature, but by itself, is only part of a complicated situation
- Need to model accurately in order to understand the effects

Slide 6



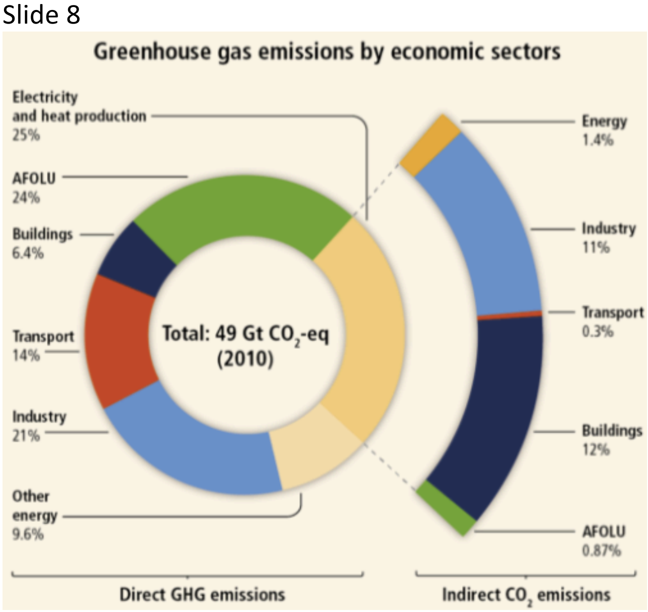
- Global average temperature change for humans adding CO_2
- Associated uncertainties too
- Orange band = natural variability in the amount in change in the average temperature
- Blue band = uncertainty coming from how climate will respond to adding CO_2 in the atmosphere
- Green band = uncertainty in how much CO_2 emission there will be
  - What if we made a goal to cut emission in half?
  - What if we doubled it?
  - What if stopped emitting completely?
- In 2040, there is a huge range of values that the average temperature change might take on (half a degree)
- Half a degree is a large amount of warming – a significant change to what it is like to be an inhabitant of the earth
- In 2080, uncertainty is even wider (level of change – produce extreme effects)

Slide 7



- Different emission scenarios
- Scenarios of keeping/change the rate of emission
- RCP8.5 – if we don't change anything about what we are doing
    - Over 2 degrees of global avg. temperature change
    - Uncertainties are very large
- RCP6-2.5 – emissions are reduced
    - Staying under 2 degrees of global avg. temperature change

Slide 8



- Greatest contributor to CO2 emission: electricity and heat production (25%)
- AFOLU: agriculture, forestry and other land use (24%)
- No one will be happy to turn off heat in the winter, stop use of transportation (hard to get around)

Slide 9

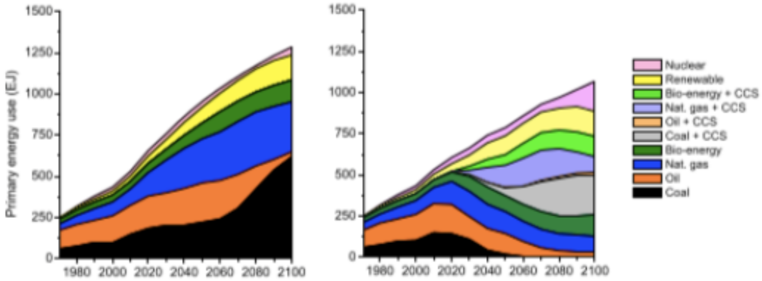


Fig. 2 Trends in global energy use for the baseline (*left*) and the mitigation scenario RCP2.6 (*right*) (CCS=Carbon Capture and Storage)

- First graph is the do nothing scenario
- Second graph is the do something scenario
- Coal will continue to be around half of the total amount of energy we use
- Main way of generating electricity
- Amount of coal we use will increase 3 or 4x over the next hundred years
- Amount of CO2 goes of rapidly, so global surface temperature goes up too
- Coal and natural is very expensive in terms of CO2 production
- Changes that need to be made?
    - Coal use cannot go up; by 20100, has to be down to 0
    - Still need to meet energy command → increase alternative energy methods

Slide 10

- How much warming will occur in the next 5, 25, 100 years?
- If we reduce CO2 emissions to half of the current rate, how will that affect the warming?
- What are the economic consequences of reducing emissions by half?
- What are the economic consequences of doing nothing?
- Uncertainties here are larger here than with the previous dioxin scenario…
- Consequences of action/inaction in this case are drastically higher here…
- Stakes are higher too… future life on earth is at stake…
- Not comparable to having an increase risk in cancer on a population

Slide 11

- Climate change is rife with inductive risk and so we can expect that non-epistemic values will play a role in the research.
    - Example of non-epistemic values?
        - Regulations posed by industries
        - Where one actually lives (some places are more safer)
        - Mitigation policies
        - Political motivations – who will vote for them?

Slide 12

- Are all appeals to non-epistemic values equally valid?
    - Climate scientist have. A special authority in the context of climate change – we should trust the appeals to non-epistemic values they make more than others… basis of authority
- When is the appeal to non-epistemic values justified?
    - Look at who is making the appeal and for what reasons… what kind of criteria can we impose?
- Should scientists make their evidence seem more certain than it actually is in order to make sure that policy makers pursue options that reflect their non-epistemic values
    - Important to accurately convey info - skeptics can take advantage of this and say you're distorting info
- If not, why not? If so, how is this activity any different from the activity of the climate deniers described by Oreskes and Conway?
    - Impose non-epistemic values to the values