The Craft of Scientific Writing

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Lesson 8.
Fallacies (errors of logic/reasoning)

Fallacy / *sophism* / כשל לוגי

- Errors of reasoning
  - Formal (non sequiturs)
  - Probabilistic (misuses & abuses of statistics)
  - Informal (abuses of language, genetic fallacies, red herrings,...)
- Bad English is like a bad cook who turns the best ingredients into an inedible mess
- Fallacious logic is like the *E. coli* or *salmonella* that will spoil the ingredients before you even start cooking

Types of fallacies

- Formal ("non sequitur")
  - errors of formal logic
  - illicit substitution ("masked man fallacy")
  - "right and wrong reasons"
- [borderline category] probabilistic
  - misuse of statistics
  - confusing correlation with causation
  - accident & appeal to nature
  - weak analogy
- Informal
  - ignoratio elenchi (irrelevant conclusion)
  - "parts and whole" fallacies
  - ambiguity
  - vagueness
  - red herrings & genetic fallacies

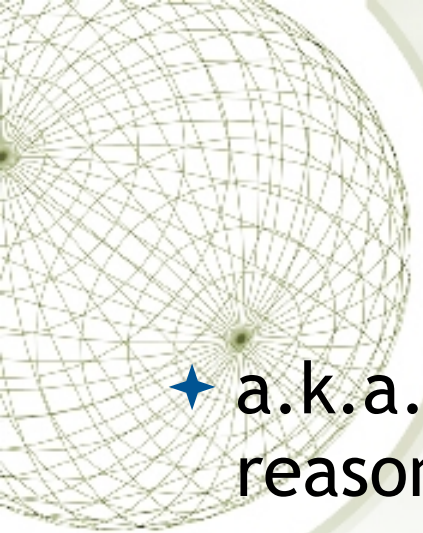[Recurring theme: many fallacies exist in converse pairs, e.g., "argument from tradition" and "argument from novelty"

Errors of formal logic

- Will not be covered in detail here: would require a course of their own
  - Aristotelian logic
  - Propositional logic (Boole)
  - Predicate logic (Frege)
  - Temporal logic (Prior, Pnueli,…)
- Will focus on other two categories

Some examples of formal fallacies

* "If Bill Gates owns Fort Knox, then he is rich. He is rich. Therefore, he owns Fort Knox." (affirming the consequent, a.k.a. converse error: $p \rightarrow q \nRightarrow q \rightarrow p$)

* "If Queen Elizabeth II is a US citizen, she is a human being. QE2 is not a US citizen. Therefore, she is not a human being." (denying the antecedent, a.k.a. inverse error: $p \rightarrow q \nRightarrow \overline{p} \rightarrow \overline{q}$)

  * BUT VALID: "All ripe tomatoes are red. Avocados are green. Therefore, avocados are not tomatoes." ($p \rightarrow q \Rightarrow \overline{q} \rightarrow \overline{p}$)

* "All dogs are mammals. No cats are dogs. Therefore, no cats are mammals." (illicit major, undistributed major)

* "No mammals are fish. Some fish are not whales. Therefore, some whales are not mammals." (exclusive premises)

* "No fish are dogs, and no dogs can fly, therefore all fish can fly." (affirmative conclusion from negative premise)

* "All students carry backpacks. My grandfather carries a backpack. Therefore, my grandfather is a student." (undistributed middle)

* etc....

The "fallacy fallacy" [sic]
("bad reasons" fallacy)

- ✦ a.k.a. "nothing can be right for the wrong reasons" fallacy
  - ✦ "The last temptation is the greatest treason/To do the right thing for the wrong reason." (T. S. Eliot, "Murder in a cathedral")
- ✦ **A conclusion advocated by fallacious arguments can still be correct *despite* these arguments.**
- ✦ [converse fallacy:] "Empiricist's fallacy": "Anything that works well in practice must therefore be theoretically sound." (pet peeve of Gershom)

Bare assertion fallacy

✦ Statement is held to be true because it says it is true

  ✦ A website says pigs can fly
  ✦ The same website says it is true
  ✦ Therefore, pigs can fly

Masked man fallacy (a.k.a. illicit substitution)

"The masked man is Mr. Hyde. The witness believes the masked man committed the crime. Therefore, the witness believes Mr. Hyde committed the crime."

✦ The witness believes the masked man committed the crime. He doesn't believe Mr. Hyde committed the crime. Therefore, Mr. Hyde is not the masked man.

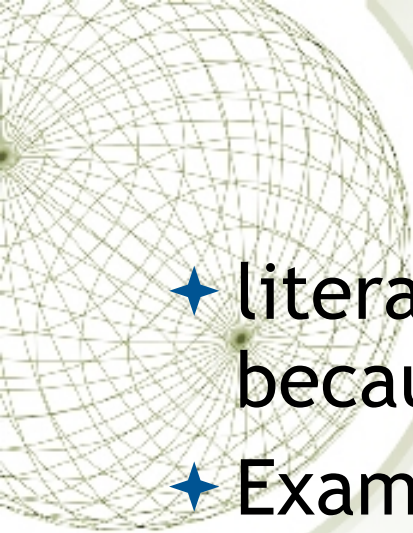✦ "I know who my father is. I don't know who the thief is. Therefore, my father is not the thief."

9

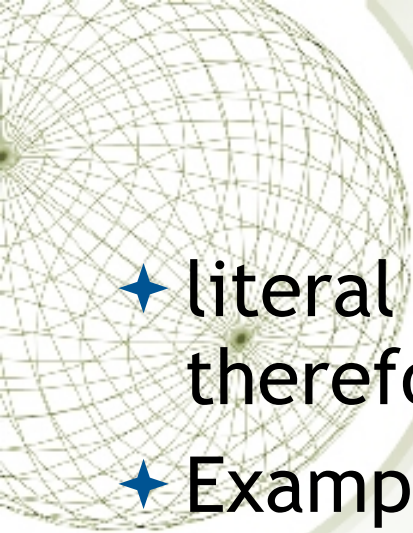# *Probabilistic fallacies.*
1. Confusing correlation & causation

- a.k.a.: *Non causa pro causa*
- If a correlation between A and B is observed, there are four possibilities:
  - A causes B
  - B causes A
  - A and B are related by a common third cause
  - The correlation is due to chance

Check out www.tylervigen.com for a hilarious collection of spurious (and specious) correlations.

Post hoc ergo propter hoc

+ literal translation: "After this, therefore because of this"
+ Example 1: "We never had a problem with the stove until *you* moved into the apartment."
+ Example 2: "In Belgium and Holland, babies get born after the storks visit. Therefore, storks bring babies."
  + In fact related by 3rd cause: change of seasons and approx. 9 months between summer vacation and stork season

Cum hoc ergo propter hoc

- ✦ literal translation: "Together with this, therefore because of this"
- ✦ Example 1: "There is a correlation between possession of firearms and violent crime rates." Does A cause B, or does B cause A?
- ✦ Example 2: "Children's shoe sizes are correlated with quality of handwriting."
  - ✦ In fact related by 3rd cause: age of the child

Regression fallacy

- Tennis player wins game, gets gifts from admirers, then stops winning. Says gifts brought him misfortune.

- Tall man has shorter children (because of "regression to the mean"), then accuses wife of adultery

- In the past, in Belgium, people with the flu often were prescribed antibiotics to prevent opportunistic superinfections (e.g., bacterial pneumonia). Flu sufferers eventually got better (self-limiting disease), then claimed antibiotics can cure the flu.

- Related fallacies: unrepresentative sample, anecdotal evidence, sweeping generalization.

Texas sharpshooter fallacy

✦ Information without interrelationships is manipulated to create an illusion of meaning

✦ The name comes from a folk tale: A Texan first fires several shots at the side of a barn, draws a target around the bullet holes, then claims to be a sharpshooter.

✦ Example: have a computer rooting around in the text of Hamlet by Shakespeare until names of contemporary figures are found as anagrams, equidistant letter sequences,... then claiming Shakespeare could foretell the future.

14

Fake/misleading precision

✦ Quote poll result or measurement to more digits than are significant, without stating uncertainty

  ✦ Example: in the 1948 US Presidential campaign, a poll of district XYZ had Tom Dewey leading Harry Truman 51.7% by 47.4%. Omitted from the poll: standard deviation for the sample is about 3%

  ✦ Example: "The electron affinity of exemplamine is 1.4374 eV [conveniently omitting ±0.1eV]."

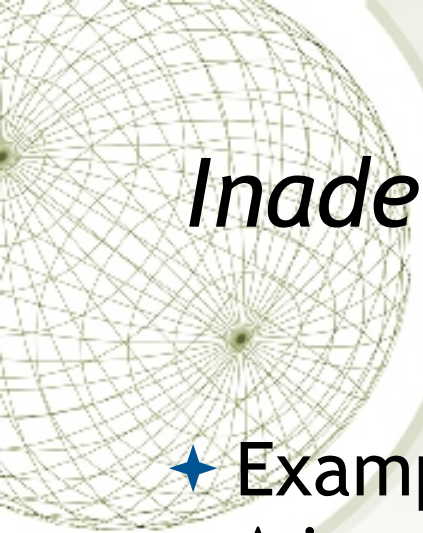# *Gambler's fallacy (a.k.a. Monte Carlo fallacy)*

+ A random variable produces a "run". Therefore, on the next data point, it is [wrongly believed to be] less likely than chance to continue the run

+ Example from fallacyfiles.org: On August 18, 1913, at the casino in Monte Carlo, black came up a record twenty-six times in succession [in roulette]. … [There] was a near-panicky rush to bet on red, beginning about the time black had come up a phenomenal fifteen times. In application of the maturity [of the chances] doctrine, players doubled and tripled their stakes, this doctrine leading them to believe after black came up the twentieth time that there was not a chance in a million of another repeat. In the end the unusual run enriched the Casino by some millions of francs.

+ Converse of "winning streak" fallacy

  + gambler who is winning believes he'll continue winning

Unrepresentative sample fallacy

✦ "Straw poll fiasco": during the 1936 US Presidential campaign, the magazine Literary Digest included a voluntary poll form in an issue and asked people to mail and return it. This "straw poll" predicted a landslide for Alf Landon (R), while FDR (D) actually won handily.

✦ Conversely: after the 1972 presidential elections, in which Nixon (R) beat McGovern (D) in a landslide, New Yorker writer Pauline Kael: "I don't understand this! Nobody I know voted for him!"

✦ Scientific example: some new quantum chemistry method is touted as the answer to all chemical problems, based on its excellent performance for a data set consisting only of alkanes

Inadequate "signal-to-noise" fallacy (pet peeve of Gershom)

- Example: more elaborate simulation method A is said to work no better than more simplistic method B because of similar RMS errors against benchmark data set R
    - overlooked: uncertainty of data points in R is comparable to these RMS errors!
- Gershom's rule of thumb: if possible, calibrate against reference data at least an order of magnitude more precise than your model's expected error

Anecdotal fallacy

✦ Closely related to: Misleading vividness

✦ Example of both: "They say Toyotas are more reliable than any other car. Hogwash! The one I bought, first the lights broke, then the door lock stopped working, then, to add insult to injury, the transmission went bust at 8 AM on the Ayalon Freeway and I had to push the car out of the way myself because the tow truck wouldn't show up…"

Sweeping generalization

✦ another guise of same general fallacy as unrepresentative sample, anecdotal fallacy,...

✦ Example: "A man cannot be truly evil if he loves his mother/his dog..."

  ✦ Response: "What about Hitler (y"sh)?"

  ✦ Note: a sweeping assertion can be rebutted by a single counterexample
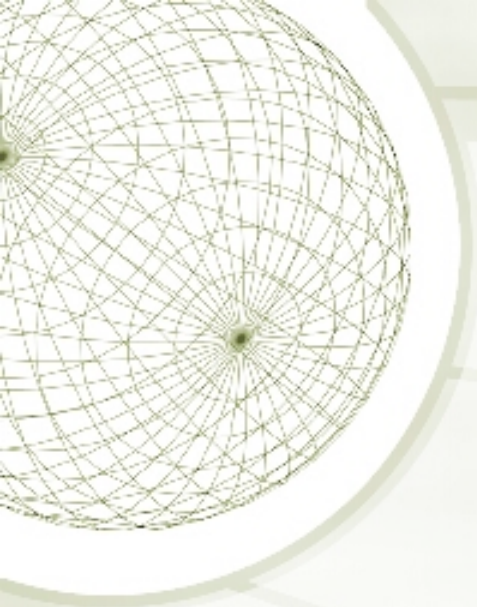
Informal fallacies

Ignoratio elenchi (irrelevant conclusion)

- Prove something that is completely beside the point

- Example: "New Yorkers are the most civilized people on the planet. Look at all the skyscrapers in the town."

Parts-whole fallacies

+ Fallacy of division: mistakenly assume that the parts inherit some property of the whole

  + Example: "People are made of atoms. People are visible. So atoms are visible."

+ Converse of:

+ Fallacy of composition: mistakenly assume that the whole inherits a property of the parts

  + Example: "The human body is made up of cells. Cells are indivisible. Therefore…"

Special pleading fallacy

- Claiming something is an exception to a general rule because of some irrelevant attribute
  - if the attribute is relevant, still "special pleading" but not (necessarily) a fallacy
- Example: "Traffic cops have discretion to (not) write a ticket when they pull somebody over. They should not write tickets for fellow cops and their families, because of professional courtesy."
  - Relevant special pleading would be: don't ticket the cop for speeding while in hot pursuit of a criminal
  - *Reductio ad absurdum*: "Cops sometimes have to shoot and kill suspects. Therefore cops should never be charged with murder."
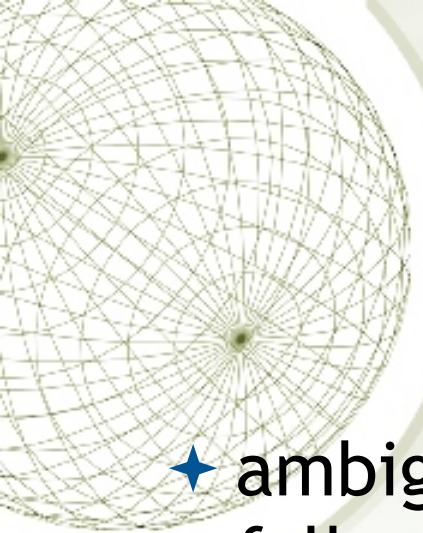
False dichotomy (a.k.a. "either-or fallacy", "black-white fallacy")

+ Misrepresent a question with a multi-valued answer as a binary question

+ [Converse fallacy:] Continuum fallacy
  + "differences in degree can never be differences in kind"

+ Chemical example:
  + False dichotomy: "That bond has to be either ionic or covalent."
  + Continuum fallacy: "Because no bond is purely A^+B^-, there is no such thing as an ionic bond."

25

Fallacies of ambiguity

+ accent fallacy: cfr. "I *re*sent/re*sent* that letter", "*inval*id" vs. "*in*valid"

+ equivocation: lexical ambiguity due to ambiguous words & phrases

  + "All banks are beside rivers. Therefore, where I put my money is beside a river."   (בנק ≠ גדה)

+ amphiboly: ambiguity due to grammar

  + ambiguous reference: "The anthropologists went to a remote area and took photographs of natives, but they weren't developed." (The natives or the photographs?)

  + misplaced modifiers: "One morning I shot an elephant in my pajamas. How it got into my pajamas I'll never know." (Groucho Marx in *Animal Crackers*)
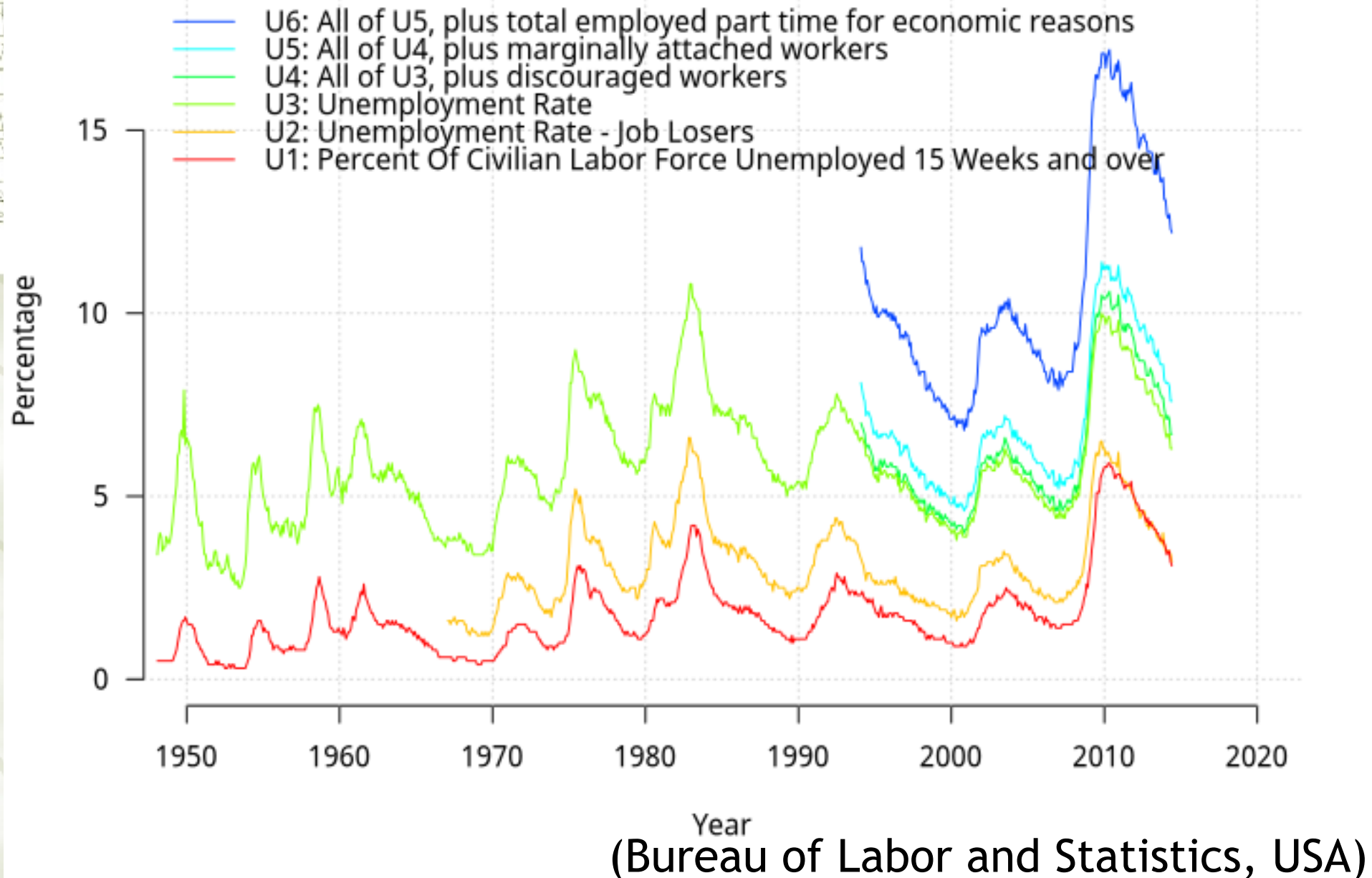
  + "Helicopter powered by human flies."

ambiguity (continued)

- ambiguous middle (a.k.a. "four-term fallacy")
  - "All dog organs are canine. Any canine must be on a leash. Therefore, all dog organs must be on a leash."
  - Note "Canine" switches meaning from "dog-like" (adjective) to "dog-like animal" (noun)
- Arbitrary redefinition (related to "moving the goalposts")

Arbitrary redefinition

- Easy to show a dramatic increase/decrease in A by arbitrarily expanding/restricting A's definition
- Example: unemployment statistics in Belgium
  - those actively seeking employment?
  - everybody not employed full-time?
  - everybody drawing an unemployment allowance?
  - including or excluding those over 50 (who in Belgium no longer are expected to seek work to draw an allowance)?
  - Including short-term seasonal workers as "employment"?
  - Easy to show dramatic "increase/decrease" by comparing past figure according to one definition with current figure according to another (generally cherry-picked)
- In US: U3 vs. U6 unemployment rates

Measurement of unemployment

- U6: All of U5, plus total employed part time for economic reasons
- U5: All of U4, plus marginally attached workers
- U4: All of U3, plus discouraged workers
- U3: Unemployment Rate
- U2: Unemployment Rate - Job Losers
- U1: Percent Of Civilian Labor Force Unemployed 15 Weeks and over

(Bureau of Labor and Statistics, USA)

"Moving the goalposts"

- ✦ Retroactive modification of the premises to make an inconvenient conclusion "go away"

- ✦ Example from an IT manager abroad:
  "Boss told me to find an email system that is PC and Mac compatible, can handle inboxes over 10 GB. His recommendation is A.
  I do my homework and find that "best practices" prescribed by manufacturer of A limit inbox size to 2 GB, and that Mac compatibility is "grade C" at best. I find that system B does fit all the requirements, and recommend it.
  Boss tells me to renew my search, now specifies an inbox size limit of 2 GB and full compatibility with MS Outlook (which A offers). No more mention of Macs."

- ✦ Scientific example: a paper proposes a new simulation method S that claims to make all others redundant. Another paper appears showing that S fails dramatically for an important class of systems, which older method R (not by authors of 2nd paper) handles just fine. Authors of S paper then claim they never stated it would work for these systems.

Quoting out of context

- "Text, without context, is pretext." (Don A. Carson)
- Quoting out of context is generally also one or more of the following:
  - straw man
  - appeal to authority
  - argumentum ad hominem

"Straw man"

- Very common rhetorical device
- Attacks not actual position of opponent, but distorted caricature or extreme version of same, which is then much easier to refute
- Not to be confused with the accepted proof technique of *reductio ad absurdum*
- Scientific version: Say one wants to demolish a competing model. One sets it up/applies it in a way guaranteed not to work (or under circumstances where it was never intended to be applied). Then one proudly proclaims it is not working.

Loaded question/"fallacy of many questions"

- "Have you stopped beating your wife?"
  - If you say "yes", you admit you used to beat her.
  - If you say "no", you admit that you are still beating her.
- Commonly used for innuendo

Appeal to nature ("is-ought fallacy")

✦ "What is in Nature is what ought to be"

  ✦ "Tobacco is natural, therefore tobacco is healthy."

  ✦ "[Insert repugnant animal behavior] is natural, therefore also acceptable in humans."

✦ [Converse of:] Idealistic fallacy: "what ought to be is reality" (generally w.r.t. human nature)

  ✦ [Related to:] Nirvana fallacy, a.k.a. "Perfect solution fallacy": any less than 100% solution is dismissed as worthless

    ✦ "Seatbelts are pointless: there will always be traffic fatalities."

    ✦ "Computational chemistry is useless: you'll never be able to get an *exact* heat of formation of a molecule with 10,000 atoms."

Genetic fallacies and red herrings

- Genetic fallacies: fallacies based on origins and/or consequences. Examples:
  - Appeal to consequences
    - Appeal to force
    - Wishful thinking
  - Appeal to tradition
  - [Converse fallacy:] Appeal to novelty
  - Appeal to misleading authority
  - Bandwagon fallacy (appeal to popularity)
    - "Billions of flies cannot be wrong." (Belgian joke)
  - Appeals to emotion (pride, envy, hatred, pity,...)
  - "Two wrongs make a right" fallacy
  - Ad hominem & guilt by association
    - Subcase: reductio ad Hitlerum (argumentum ad Nazium)
- Often also "red herrings" (attempts to change the subject)

Ad hominem

- Attacking speaker (or other advocate) rather than rebutting by facts or logic
  - Abusive *ad hominem* (speaks for itself)
  - Circumstantial *ad hominem*: accusing speaker of making self-serving argument. (A.k.a.: "Bulverism")
    - A self-serving argument is not by definition fallacious or factually incorrect
  - Preemptive *ad hominem* ("poisoning the well"). Example: "Before you hear this nuclear energy advocate, you should know he has gotten funding from Westinghouse in the past…"
    - May be relevant to know but does not, in and of itself, invalidate any arguments made or facts presented.
  - *Tu quoque* (you too!). Example: "Doctor, you tell me to quit smoking because it's bad for my health, yet I saw you smoking a cigar in the courtyard!"
    - It would be better if the good doctor practiced what he preached, but his peccadilloes don't make smoking any less harmful.
  - [Converse fallacy:] "No true Scotsman". (Member or adherent displaying embarrassing behavior is dismissed as not a true member/adherent.)

36

Argument from authority
(appeal to authority, argumentum ad authoritatem)

- Argument from relevant authority: "There is no need to include exact exchange in DFT, since Walter Kohn (who got the Nobel Prize for his work on DFT) says so."
  - I personally disagree (as do many of my colleagues) but Kohn's opinion does carry more weight than that of Joe Schmoe/Chaim Buzaglo until proven otherwise
  - "There is no such thing as personal regard where the truth is concerned" (HaGr"a/The Wilna Gaon/R' Eliyahu ben Shlomo, 1720-1797)
- In the language of the courtroom: argument from relevant authority is "circumstantial evidence but not proof".
- "Take nothing on faith": Platonic ideal in science
- In practice nobody has time or talent to be an expert on everything even in his/her own discipline, so some degree of reliance on authority inevitable (except maybe in pure mathematics)
  - but: "Show me, don't tell me"

Argument from irrelevant authority

✦ Common special case: argument from celebrity
  ✦ "*argumentum ad Kardashiam*"?
✦ Very common fallacy in public discourse
✦ I have no idea why somebody being a good actor, a talented [or merely popular] musician, or the Prince of Lokshenstein endows them with any better judgment on public affairs than you or me :-)
  ✦ Positions should be judged on their merits
✦ Somewhat less common in science, but sadly does exist
  ✦ Not just w.r.t. public affairs
  ✦ Also w.r.t. fields of science (far) outside their area of expertise

Abuse of etymology

- Semantic fallacy: confusing between current (common) meaning of a word and its historical meaning.Closely related:

- Logical abuse of etymology: reason about the *etymon* (original ancestor of a modern word) as if it applied to the current meaning.

- Examples:
  - Most insulting term "n---er" for a black person.
    - Etymologically from the Latin word for black (*niger*)
    - In English, the word *became* offensive through usage by slave masters in the "antebellum South", even though the cognate *neger* in Dutch and German is neutral.
    - Compare: "Zh*d" for a Jew is offensive in Russian (proper term: evrei), but the cognate "Żyd" in Polish is neutral
  - "antisemitism" literally means opposition to all Semites
    - in practice invented as a pseudo-scientific euphemism for Judenhass (Jew-hatred) by the anti-Jewish agitator Wilhelm Marr (1819-1904), founder of the German "Antisemitenliga" (1879).

A linguistic curiosum: linguistic reappropriation

✦ Insulting terms or nicknames being appropriated as self-descriptions by the people targeted, then evolving into standard terms. Examples:

  ✦ Tory (adherent of the Conservative Party in the UK): originally Irish insult ("outlaws") for British royalists), now used by friend and foe

  ✦ Yankee (American): originally British term for Dutch pirates (from common Dutch first names "Jan" and "Kees")

    ✦ US usage: somebody from the Northeastern US (New York was originally a Dutch colony, as "Nieuw Amsterdam")

  ✦ Methodists: originally an insulting term for followers of John and Charles Wesley, now the standard term for adherents of the Protestant church they founded

  ✦ Impressionism: originally insulting terms by critics of that style of painting

  ✦ musical genres/subcultures like "punk", "grunge",...

40