Psychology of Reasoning

Introduction to Cognitive Science

Recap: Reasoning and Logic

- When we *reason*, we infer some claim (result, conclusion) from other claims (premises, assumptions.
    - Or, in terms of information-processing: we derive new information from old or given information
- Whether a piece of reasoning establishes something that is true depends on two factors:
    - The reasoning is *Well-Founded*:
        - Our assumptions are correct
        - The given information is true
    - The reasoning is *Valid*:
        - The *logic* is correct
        - The truth of the conclusion follow from the truth of the premises?

Deductive vs Non-Deductive Reasoning

- In some pieces of reasoning, the conclusion *has* to be true assuming the truth of the premises.
  - Example: The sides of this square are 1 inch long. Therefore, the area of this square is one square inch.
  - We call this reasoning *deductively* valid.
- In other cases, the conclusion is *likely* to be true given the truth of the premises, but doesn't have to be
  - Example: The sun has come up for the past x millions of years. Therefore, it will come up tomorrow as well.
  - We call this reasoning *inductively* valid.

Normative and Descriptive Theories of Reasoning

- Logicians try to come up with *normative* theories of the validity of reasoning:
  - What *does* follow from what?

- Psychology of reasoning is a scientific study of how humans reason:
  - What do humans *think* follows from what?
  - What is the mechanism behind human reasoning?

- As such, psychologists (and cognitive scientists) come up with *descriptive* theories of reasoning: *hypotheses* as to how humans reason based on *empirical* studies.

Human Reasoning and Biology

- Q: How Good is Human Reasoning?

- Well, we use reasoning to make predictions and decisions, and we act on those. So, if our reasoning wasn't very good, we wouldn't do very well from a biological and evolutionary point of view. Since we're doing ok (we're still around), one could argue that our reasoning must be pretty ok.

OK, but it isn't Perfect!

Logical (deductive) reasoning

Wason Selection Task

- A deck of cards has a letter on one side, and a number on the other side.
- You are told that the cards obey the following rule:
  - *If a card has a vowel on one side, then it must have an even number on the other side*
- Which of the following cards do you need to turn over to make sure that this rule has not been violated by any of these cards?

| A | 6 | 9 | T |
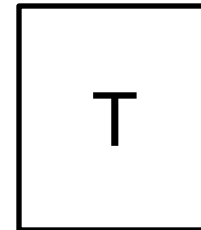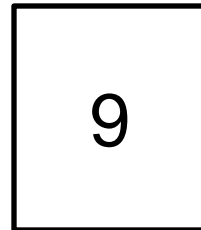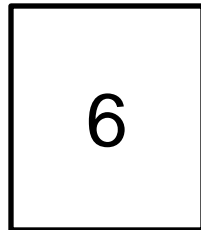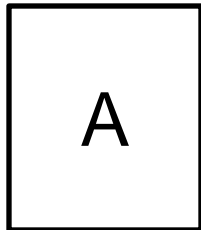
Wason Selection Task, Cont'd

- Almost everyone will pick the 'A': good!
- Many people pick the '6': not good (did they just use a form of affirming the consequent?)
- Many people did not pick the '9': not good

- Moral: Not all humans are good deductive reasoners. Maybe they could gain from taking a logic course?

Wason Selection Task, Part II

- The cards represent people in a restaurant, with the age of the person on one side, and their drink on the other
- Everyone needs to obey the underage drinking rule:
  - *If you are having an alcoholic beverage, then you must be 21 or older*
- Which of the following cards do you need to turn over to make sure that this rule has not been violated by any of these people?

| beer | 26 | 19 | cola |

Wason Selection Task, Part II, Cont'd

- Now almost everyone gets it right: better check the 'beer' person and the '19' person!

- The moral: The content of the claims (i.e. what the P's and Q's are) has an effect on our logical reasoning skills.

Probabilistic (non-deductive) reasoning

The Birthday Problem

- What is the chance of 2 people in this room having the same birthday?

Julius Ceasar Problem

- If you take a single breath, what are the chances that you are inhaling one or more of the molecules that was exhaled by Julias Ceasar when he spoke his last words: "Et Tu Brutus"?

  (this is assuming that in the thousands of years since, the molecules have dispersed randomly in the Earth's atmosphere).

Monty Hall problem

1   2   3

You are a contestant in the Monty Hall game show and have to pick one of 3 doors, behind one of which is the big prize. You pick door 1.
Monty Hall, the game show host, then opens door 2, and reveals that the price is not behind door 2.
He then offers you to switch to door 3.
Should you switch?

Disease Problem

- I have a test for a certain disease that is 99% accurate. I test positive. What is the chance of me having the disease?

Spooky Presidential Coincidences

- Abraham Lincoln was elected to Congress in 1846.
  John F. Kennedy was elected to Congress in 1946.

- Abraham Lincoln was elected President in 1860.
  Joh n F. Kennedy was elected President in 1960.

- Lincoln 's secretary was named Kennedy.
  Kennedy's Secretary was named Lincoln.

- Andrew Johnson, who succeeded Lincoln, was born in 1808.
  Lyndon Johnson, who succeeded Kennedy, was born in 1908.

- John Wilkes Booth, who assassinated Lincoln, was born in 1839.
  Lee Harvey Oswald, who assassinated Kennedy, was born in 1939.

- Lincoln was shot at the theater named 'Ford.'
  Kennedy was shot in a car called ' Lincoln' made by 'Ford.'

- A week before Lincoln was shot, he was in Monroe, Maryland
  A week before Kennedy was shot, he was …

Misjudging Probabilities

- Sometimes our intuitions about probability are off
  - Julius Ceasar problem
  - Birthday Problem
- We struggle in particular with conditional probabilities
  - Monty Hall problem
  - Disease Problem
- We also forget that sometimes, strange juxtapositions of events just happen
  - Spooky Presidential Coincidences
  - Aristotle: "Unlikely things are likely to happen"

Why Reasoning isn't Perfect

Reasons for why Human Reasoning isn't Perfect

- So why do people make reasoning mistakes? Wouldn't evolution make sure that our reasoning would be as good as possible?

- Well, from this very same perspective of biology and evolution, Perfect Reasoning doesn't always make a Perfect Agent:
  - Persuasive reasoning is often more beneficial than sound reasoning
  - Perfect reasoning can require too much time and energy

- Indeed, the Perfect Cognizer (a cognizer with perfect perception, perfect memory, and perfect reasoning skills) is not something we'll ever find as a naturally evolved organism: it just doesn't do very well in the real world!

Reasoning and Persuasion

- Often, when we reason, it is because we are trying to convince someone else that we are right (and they are wrong) about something.

- In other words: in many cases, truth is not important; winning the argument is!

    – Winning an argument comes with all kinds of social perks, so this is a good biological reason!

- But persuasive arguments aren't always good arguments (and good ones not always persuasive)

- "Arguments are to people as what lampposts are for drunks: they are used for support, not illumination"

Fallacies

- A fallacy is a commonly used pattern of reasoning that people use to persuade people (or win an argument).

- Notice that we usually don't realize we're committing a fallacy; it is an engrained (and very effective!) practice.

- Some common fallacies (there are **many** more! Take my Critical Thinking course if you want learn more):
  - Ad Hominem
    - Attacking the person rather than the person's claim
  - Straw Man
    - Distorting / exaggerating someone's view
  - False Dilemma / Black and White Thinking
    - Only considering two options when there are more

Ad Hominem

- Rejecting a claim or argument based on its source (i.e. the person who made the claim or argument). Examples:
  - Bill Clinton's proposal is bad, because he had sex in the White House (abusive ad hominem)
  - Of course he opposes rent control. He owns two apartment buildings himself! (circumstantial ad hominem)
  - John Kerry criticizes George Bush's military record? Wait, didn't Kerry get those 3 purple hearts by blowing up some innocent Vietnamese? (inconsistency ad hominem, pseudorefutation or 'tu quoque')

Straw Man

- A Straw Man argument attacks something by attacking a helpless caricature of that something: it often distorts the original by exaggeration. Example:

  – The movement to allow prayer in public school classrooms is a major threat to our freedom. The advocates of prayer in school want to require every school child to participate in a Christian religious program prior to every school day.

False Dilemma

- An argument assumes a false dilemma when it assumes that one of two cases must be true, where in fact there are other options as well. Examples:
  - Since you're not a capitalist, you must be a communist!
  - You're either with us, or against us.
  - Are you a Democrat or a Republican?
  - Nature or nurture?

Some Connections

- The False Dilemma and the Straw Man often go hand in hand: you assume that there are only two options (mine and my opponent's), and you attack your opponent's by making it out to be completely unreasonable. In fact, add some Ad hominem to the mix, and you have a powerful recipe for winning debates!

- So these are all good examples of how we have made winning arguments to be more important than finding the truth.

Black and White Thinking

- The False Dilemma Fallacy can also be seen as the result of black and white thinking, which connects with both reasons stated earlier:

- We want to win and persuade: We have a partisan political mindset of seeing all people in the world as belonging to two groups: 'us' and 'them'. Black-or-white thinking allows us to think in 'Yay' or 'Boo' terms.

- We need to make quick decisions: black and white thinking makes things simple! While in actuality, things are often complicated, complex, subtle, vague, dirty, messy, and gray, black and white thinking allows us to think quickly and make quick decisions.

Heuristics

Heuristics

- A heuristic is a strategy, or rule-of-thumb, that often works, though not always.

- Human cognition is likely to be full of heuristics so we can make quick and dirty decisions.

Question

- Are there more words that start with the letter 'r' than there are words that have 'r' as their third letter?

Availability Heuristic

- We often make our judgments based on whatever information is readily available to us (rather than make a concerted effort to go out and do some research).
- In fact, usually we just use what we believe and remember.
- Again, usually this works just fine:
  - Are there more Fords than Jaguars?
    - We remember seeing more Fords, so we say Ford, and we would be right.
- But, sometimes it fails (see previous slide)

What factors effect the availability of things?

- The environment we grow up in
  - E.g. People from different socio-economic strata will have different ideas as to the chances of getting robbed
- The media
  - E.g. Most people overestimate the chances of airplane crashes, acts of terrorism, or shark attacks.
- The 'salience' (psychological 'importance' or 'weirdness') of the events
  - E.g. we tend to remember the 'hits' (but not 'misses') of fortune-tellers

Question

- Steve is very shy and withdrawn, invariably helpful, but with little interest in people, or in the world of reality. A meek and tidy soul, he has a need for order and a passion for detail
- Which is more likely?
  - Steve is a librarian
  - Steve is a salesman

Representativeness Heuristic

- 'like goes with like'. Makes sense, but can fail:
  - Graphology (studying people's handwriting to make claims about their personality)
  - Food/health (eating brains makes you smart; eating testicles increases sexual drive; etc)
  - Astrology (Bull is stubborn, Virgin is tentative, Scales is calculated, etc)
  - Cause reflects effect
    - 1 effect -> 1 cause
      - Sports Team Performance
      - Traffic Jams
      - Accidents
    - big effect -> big cause
    - Cause is like effect
      - water
      - phlogiston
      - caloric

What is the Rule?

- 2, 4, 6 is a sequence that follows a certain rule

- Try to figure out what the rule is by asking about other sequences of 3 numbers: I will tell you whether or not it follows the rule

Confirmation Bias

- Once we hold a certain belief, we tend to notice more things that confirm that belief, and we will seek out things that are likely to confirm that belief.

- At the same time, we tend to not notice, or explain away (often with ad hoc explanations) disconfirming evidence, and not seek it out.

  - Examples:
    - We tend to read what we agree with
    - Selective Perception
    - Constructive Perception
    - Constructive Interpretation (e.g. horoscope)

Tossing a Coin

- One half of the class: Toss a coin and write down the sequence of heads and tails you get: HTTHH…

- Other half: *Imagine* you toss a coin and write down the sequence of heads and tails you get: HTTHH…

- Do this now for 20 coin tosses!

Counting Sequences

- Now count the number of times that you had 2 of the same in a row.

- Same for 3 in a row, 4, 5, etc.

- E.g. HTTHHHHTTHTHHTTTTHTT
  - 2: 10
  - 3: 4
  - 4: 1
  - 5: 0

'Pattern' Bias

- Since it is useful for our brain to recognize certain regularities in the world, it tends to see patterns even when there are none:
  - The 'hot hand' in basketball
  - Bombs in London