Humans and Heuristics

There is a difference between **problem solving** and **judgment** or **decision making**.
Example of decision making problem: buying a car

Decision-making in the literature usually has to do with <u>situations that are broad</u>, that are perhaps a little less well-defined than chess problems or Rubik's Cube, situations where we may have to make a decision with <u>incomplete information or fairly quickly situations</u>, where maybe the information is incomplete or at times so enormous that we can not take into account all of the possible information.

These are situations, if we were being uncharitable, we might say that <u>**problem-solving** situations are the ones that are less realistic in our lives</u> and <u>**decision-making** or **judgment problems** are the ones that often we care about in our lives.</u>

We're not only interested in how people solve problems or in this case how people make decisions, we're also interested in the question of, <u>are there continual mistakes or bad habits that come into our decision-making</u>? <u>Are those linked?</u> <u>Can those be elucidated by a computational viewpoint?</u>

By looking at these decisions and judgments from the **computational standpoint**, can we understand not only the descriptive reasons that we make certain decisions, <u>but can we improve the way that we make certain decisions?</u>

Problem solving(rubik's cube, maths problem, etc) <u>does not have evolutionary roots</u>. But **judgement**(friend or foe? An animal is dangerous or not?) <u>has evolutionary roots</u>.

Problem Framing:

Situation 1:

First, we are offered a bonus of $300. Then, we are asked to choose between the two following possibilities:

A. *To receive $100 for sure; or*
B. *To toss a coin, if we win the toss, we will get $200; If we lose, we receive nothing at all.*

Situation 2:

First, we are offered a bonus of $500. Then, we are asked to choose between the two following possibilities:

C. *We are guaranteed to lose $100*
D. *We toss a coin, and if we lose, we have to pay $200, but if we win, we don't have to pay anything.*

The expected value of all these situations is $400. These two situations are **identical**.

It is a well-documented tendency in people's economic judgments that they <u>tend to value more the things that they already have as opposed to the things that they don't yet have, but can bargain for.</u>

An example by cognitive scientist Dan Ariely:

> *Three choices are given:*
> 1. *Economist.com subscription: $59*
> 2. *Print subscription to the Economist: $125*
> 3. *Print plus web subscription: $125*

People tend to disproportionately when given three choices, two of which are easily comparable and one of those two is obviously better, <u>people tend to choose the better of those two and ignore the third choice altogether.</u>

The question arises, <u>what if our judgements are mistakes?</u> And if they are,<u> what are the mechanisms that cause us to make them and can we mimic these judgement making in machines which are less prone to human error?</u>

Heuristics and Biases in judgement:
original work was done by **Daniel Kahneman** and **Amos Tversky.**

Conjunction Effect:

> *The idea is, you first see a description of a person. So you're given a little story about this person Bill. Bill is 34 years old. He is intelligent but unimaginative,compulsive, and generally lifeless. In school, he was strong in mathematics but weak in social studies and humanities. That's the description you're given about Bill. Now you're given a collection of statements about Bill, like these, and your job is to rank order these statements from most to least probable.*

People often tend to assume that perhaps <u>Bill is an accountant</u>.

But the three statements for us to focus on here are,

> *Bill is an an accountant,*
> *Bill plays jazz for a hobby, and*
> *Bill is an accountant who plays jazz for a hobby.*

When people answer this question, they rank Bill as an accountant as most probable. Bill is an accountant who plays jazz for a hobby as next most probable, and Bill plays jazz for a hobby as least probable.

Mathematically, that's impossible. If we think about it from the standpoint of set theory, imagine all the situations in which Bill is an accountant, and Bill plays jazz for a hobby, and Bill is an accountant who plays jazz for a hobby. If he is an accountant who plays jazz for a hobby, that's a subset.

In other words, it simply can't be more probable thatBill is an accountant who plays jazz for a hobby than that he simply plays jazz for a hobby.

Another example:

> *Steve is very shy and withdrawn, invariably helpful, but with little interest in people or in the world of reality. A neat and tidy soul. He has a need for order and structure and a passion for detail. Now you're asked to rank order the probability that Steve has one of these professions.*
> *Is Stephen architect, farmer, librarian, biologist, or taxi driver.*

When people look at these choices, and again thinking in terms of stereotypes, they often hone in on the idea of Steve as a librarian.

But there are more chances of Steve being a Farmer than a Librarian because there are much more farmers than librarians and thus, chances of Bill being a reserved farmer is much higher than him being a normal librarian.

Probability is actually a rather remarkable and complex and many mathematicians would say beautiful area of mathematics, but it's one that has controversies associated with it, about how to interpret probability. So not everyone interprets probability in the same way. It should also be mentioned that the notations, the formal discussion of probability, is **relatively young** in human affairs. Therefore, when we look at questions that involve some probability, often we're dealing with concepts that are relatively new in human experience.

Kahneman and Tversky argue that we have a blind spot when it comes to these base rates and that this can cost us in certain decision-making situations.

Examples of biased judgement:

Anchoring:

> *So you take a population of subjects and you ask them a question like was Ronald Reagan 120 years old when he died or was Ronald Reagan 50 years old when he died? Now, both of those answers are wrong and the answer is no in both cases. But then in both cases, if you ask the person a subsequent question, how old was he when he died? The people who are asked the first question will reliably give you a larger number, an older number than the people who were asked the second question.*

When people are asked the first question and then they say no. You ask them how old he was when he died and it appears that what they're doing more or less to a good approximation is taking the original number of 120 and reasoning downward from it, moving downward until they find a number where they think that might be the age at which Reagan died.

In the second case, they're taking the number 50 and moving upward until they think they've got a reasonable number. In both cases, what people do is they end up with an age guess that is closer to the number if you want to put it this way, the number that they were primed with.

An example that draws on research from memory:

> *So people are asked this question, estimate the proportion of English words that begin with the letter K versus words that have a K in the third position.*

Now, as it turns out there are more words in English with K in the third position than there are words with K in the first position. However, the structure of our memory for words seems to be indexed by first letter, maybe first sound. In any event when people are asked to come up with words that either have K in the third position or K in the first position, they find it easier to come up with words with K in the first position, that's an easier job.

Now, the question of whether these are really bad decisions, whether this is really a problem for us, that itself is a **matter of some debate**.

There are researchers who feel that these are not especially important or dire problems in judgment for us. Some people in the literature describe these as illusions, analogous to optical illusions which means that they could be fairly pessimistic about the idea that we can train ourselves not to make these errors.

Some people describe the phenomena involving judgment and decision making in a similar way, that we might even know that this isn't an error but we can't quite help ourselves.

So that leads to other questions about:

- whether even if we know that we're making these errors, can we fix it?
- Can we design machines?
- Can we design programs whose heuristics or biases are different than those that we have or that are perhaps more mathematically rigorous or use different internal models of probability than the ones that we typically use?
- Can we design programs that are far less likely to make these errors than human beings are?