The three waves of robotics | Jeremy Wyatt

Vocabulary

sentience	intentions	desires	first order approximation of the truth
structured manipulation	precise control of positions	novelty	out of sync
conversely	to anticipate	reasoning under uncertainty	probabilistic AI
prior beliefs	unrenewable sensing	unstructured mobility	revolution in perception
visual landmarks	a breakthrough in perception	cognition	common sense
novel worlds	Bayesian reasoning	unstructured manipulation	actuators
position control devices	optimization techniques	unstructured environments	unstructured manipulation

1.1 Questions

1. What is a “first order approximation”?
2. What sorts of tasks and activities are difficult to automate?
3. What developments and features characterize the second wave of robotics?
4. What is probabilistic AI and why is Bayes and his mathematical work so important to the current and future development of AI?
5. What is the difference between *perception* and *cognition* in the context of AI?
6. What examples does he use to illustrate the limitation of second wave robots?
7. What developments and features will characterize the third wave of robotics?
8. In what way is Boris’s functioning different to Justin’s, and what kind of programming makes this possible? What is the connection between Bayes’s probability theorem and this kind of programming?
9. What features characterize **a.** the first wave of robotics; **b.** the second wave; **c.** the third wave?
10. Do you agree with the speaker that “all of the benefits in our society have all arisen from automation”?

Bayes’s Theorem

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Questions

1. As succinctly and as clearly as you can, explain the problem posed in the video that we can use Bayes's Theorem to solve.
2. What are the three types of probability mentioned in the video?
3. Why is one of these forms of probability not reversible?
4. Do you feel the implications of Bayes's theorem are counterintuitive?
5. What is the relevance of Bayesian probability/inference to deep and unstructured learning

Sample problem and Solution

You might be interested in finding out a patient's probability of having liver disease if they are an alcoholic. "Being an alcoholic" is the **test** (kind of like a litmus test) for liver disease.

- **A** could mean the event "Patient has liver disease." Past data tells you that 10% of patients entering your clinic have liver disease. P(A) = 0.10.
- **B** could mean the litmus test that "Patient is an alcoholic." Five percent of the clinic's patients are alcoholics. P(B) = 0.05.
- You might also know that among those patients diagnosed with liver disease, 7% are alcoholics. This is your **B|A:** the probability that a patient is alcoholic, given that they have liver disease, is 7%.

Bayes' theorem tells you:
P(A|B) = (0.07 * 0.1)/0.05 = 0.14
In other words, if the patient is an alcoholic, their chances of having liver disease is 0.14 (14%). This is a large increase from the 10% suggested by past data. But it's still unlikely that any particular patient has liver disease

Problem A

In a particular pain clinic, 10% of patients are prescribed narcotic pain killers. Overall, five percent of the clinic's patients are addicted to narcotics (including pain killers and illegal substances). Out of all the people prescribed pain pills, 8% are addicts. *If a patient is an addict, what is the probability that they will be prescribed pain pills?*

Problem B

It's a typically hot morning in June in Durham. You look outside and see some dark clouds rolling in. Is it going to rain?

Historically, there is a 30% chance of rain on any given day in June. Furthermore, on days when it does in fact rain, 95% of the time there are dark clouds that roll in during the morning. But, on days when it does not rain, 25% of the time there are dark clouds that roll in during the morning.

Given that there are dark clouds rolling in, what is the chance that it will rain?

Problem C

When IRS receives tax forms, it puts them through a computer to flag forms that need to be investigated further. The computer looks for mistakes in the forms, for example addition mistakes or incorrect deduction amounts. Suppose the computer correctly flags 80% of all returns that have mistakes, and it incorrectly flags 5% of error-free returns. Further, suppose that 15% of all tax returns have errors.

A tax return is flagged by the computer. What is the chance that it actually contains mistakes, given that the computer flagged it?

Problem D

Legal cases of disputed paternity in many countries are resolved using blood tests. Laboratories make genetic determinations concerning the mother, child, and alleged father.

You are on a jury considering a paternity suit. The mother has blood type O, and the alleged father has blood type AB.

A blood test shows that the child has blood type B. What is the chance that the alleged father is in fact the real father, given that the child has blood type B?

Here's some information we need to solve the problem. According to genetics, there is a 50% chance that this child will have blood type B if this alleged father is the real father. Furthermore, based on incidence rates of B genes in the population, there is a 9% chance that this child would have blood type B if this alleged father is not the real father.

Based on other evidence (e.g., testimonials, physical evidence, records) presented before the DNA test, you believe there is a 75% chance that the alleged father is the real father. This assessment is your prior belief. Now, we need to use Bayes Rule to update it for the results of the child's blood test.