Let’s think about one of the primary goals of the hunter-gatherers– to obtain FOOD. One way we can do it is hunting \*this\* deer. To better hunt the deer, we ask…

Suppose we build a trap. Now we would ask… #2

But, even if we can figure these conditions out, it would be nice to be able to DO something to increase the chance that deer move under the trap. So we can ask… #3

NOW if we can answer all 3 of these questions well enough, we may succeed in trapping the deer and satisfying our goal to obtain food.

Well… let’s think about these questions a bit more. We can classify each question:

The first is a question of prediction. The hunter-gatherers want to know the likelihood of a future state, given the state of the world right now and in the past.

The second is a question of explanation. What are the most likely states that explain the occurrence of a given state?

The third is a question of intervention. If we do some action, forcing part of the current world state to some value, will we achieve a desired effect?

In general, we call these three questions inference queries, and they make up all our daily activities.

Can I predict the stock market so that I invest in the best funds?

Can I explain why I want to eat a cookie?

Can I intervene to get the best grade in a class? And so on.

Notice that all these queries can be written in the language of mathematics. This implies that these queries are computable. Keep that in mind, and I will return to that point shortly.

Now, just as the hunter-gatherers made these 3 types of queries 1000s of years ago, we make the same queries today in pursuit of our own goals. But there’s a big question: what when our models fail? We can’t predict the position of the deer perfectly, we can’t explain what will cause the deer to move under the trap easily, and our interventions, making the noise, don’t always accomplish our intended goals, trapping the deer. So what are we to do?

Well, it turns out we’re not the only ones asking that question. For a long time, humans wondered how their models could fail and came up with a clear answer: God!

D’s stance: You will never know everything because there are limits on what you can measure.

G’s counter: Your uncertainty is on a really small scale

D’s response: Yea, but think about chaotic systems. A small deviation in initial inputs to a **chaotic** system, even on the scale of 10^-34, leads to total divergence. Your models will never be correct.

G’s Stance: Actually, we can model physical uncertainty with **probability** and randomness. By incorporating probability into our models, we can use **machine learning** to create models that capture reality with minimal error.

D’s Response: You risk overfitting the data and mistake randomness with supposed order. You also need HUGE sets of data to have a decent model. Think of the **Bayesian error rate**: you will never achieve an error smaller than the minimum Bayesian Error Rate when engaging in any kind of machine learning.

G’s stance: Ok, but you will never be correct either. Your logical systems will never be **complete** without risking inconsistency. And if you desire total **consistency**, then your system will be incomplete.

D’s stance: Well, we’re both fucked. I can’t ever gain complete and consistent knowledge, and you can’t ever take perfect data observations from the environment. And we both cannot make perfect manipulations due to the laws of **thermodynamics**– no matter how much we try to intervene, we cannot make energy flow from low to high without applying work. We can’t make perpetual motion machines!

Yes, we cannot perfectly predict, explain & intervene given the limits of our models, but with the capabilities we do have, we can deliver the most likely explanations, predictions & interventions.

So… what should you take away from tonight?

First, recognize your goals: through what better predictions, explanations and interventions are you trying to change the world? If you understand your goals and how to improve models to meet them, you will understand what your role in the world.

Second, recognize there are fundamental limits. BUT DO NOT DESPAIR! Though we can’t ever hit the limits, we can approach them, and by doing so move humanity to greater place than today.

We move to push the limits, and in doing so we create real progress in the world. And we do it for those two grand goals:

to move the world toward our vision, and to take utter joy in the whole process while doing so.

We have limits

Can we hit the God Machine?

No we can't

But we can get closer

And make real progress in the world

And this is why we do it