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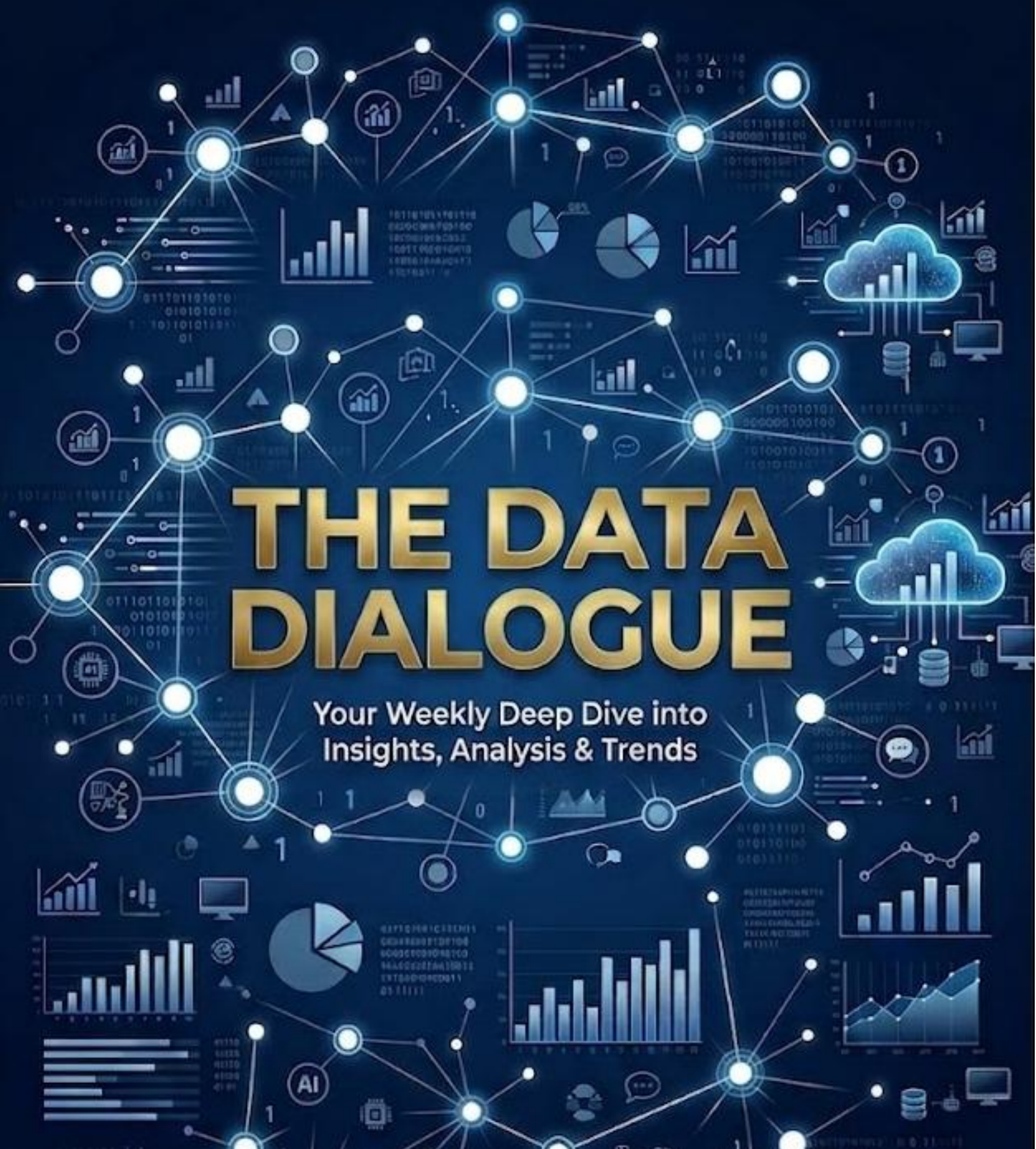

The Data Dialogue.

Simplified. Not Simplistic

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In-Focus

Agent-Based Modeling

How many times have you or someone you know thought of a brilliant research idea, but did not see the light because you could not find data? Or maybe you tried to collect data but for reasons related to cultural, legal or political issues people were unwilling or unable to participate? Maybe your research has an unethical element like deceit or might endanger your participants as in medical sciences? Or maybe it was you who did not find funds or financial resources to start the research? Typical problems, right?

What if I tell you that we have a good place that is surprisingly accessible, yet underused, for collecting data, experimenting with hypotheses and exploring ideas about the real world?

Agent-based modeling (ABM) is a helpful tool that can be used for generating simulated data when real-world data is limited or hard to access. By generating artificial agents, instructing the computer about the available actions and behavioral rules for each agents, and allowing them to interact, we are able to see how actors might behave under certain circumstances and within a specific environment and networks. Thus, we are able to explore how micro-behaviors can lead to macro-scale phenomena, an idea that led Thomas Schelling to write his 1978 book "*Micromotives and Macrobehavior*".

Indeed, social scientists used agent-based modeling to mimic and simulate individual's behavior in different settings and examine fascinating research questions. Thomas Schelling, for example, examined how a slight increase in individuals' bias, defined as their preference to live near a neighbor of the same color, can lead to the emergence of racial and residential segregation at the collective level. Back then, the Nobel Laureate did not have the luxury of running his model on a computer, but only with pennies, dimes, checkerboard and hand-written statistical calculations in 1969. Now, we have this luxury at our disposal, waiting for us to make use of it.

Natural and social phenomena are complex. A slight change in an element can trigger a ripple of reactions that resonate with every other element. Not only can ABM help solve conventional research problems, but it can also simulate real world complexity. This means a policymaker can examine different scenarios and decide what might happen when a specific element (parameter) changes. With ABM, biologists, social scientists, business consultants, natural-hazards scientists, have access to a virtual laboratory to work with and do their best. It is not a substitute for reality, but rather a simplified, simulated version of it.

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Tools

NetLogo

One can run simulated ABMs using Python, or R. However, I prefer to use a ready-made programmable interface such as NetLogo. It is accessible and lowers the barrier between a researcher and a programmer. It is a beginner-friendly environment where you can use the documentation user manual and tutorials to navigate your way through it.

I will leave you with the link here: https://docs.netlogo.org/7.0.3/

Pitfall Patrol

- Setting the parameters values arbitrary, such as “probability is set to 0.3 because it is reasonable”.
- Probability is set to 0.3 because previous literature, international reports, or experts state is at this level.

  A resource gives you 0.3 while others state that it is between 0.1-0.5. Then, your range is 0.1-0.5 and you start with a baseline (0.3) followed by a sensitivity analysis, i.e. you vary the probability up and down within the specified range to assess how responsive the results are to the increase or decrease of the parameter.

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Pandora's Box

Thank ABM & Fly with Sully!

When Perfect Calibration is Not Enough

Entertain me for a moment and imagine a student preparing for a final exam. One strategy diligent students adopt is to ask previous students what questions appeared on their exams- or at least the topics. They focus heavily on these topics and sometimes recite/memorize the answers beforehand, especially a question seems to recur year after year.

This is our calibrated student.

Suppose that this student got 100% as final score, does this necessarily mean that they perfectly master the course? I doubt it.

Now, imagine that the course instructor fell terribly ill before writing the exam. The department asked another professor to write the exam so students can graduate. The new professor, though knowledgeable about the course content, has a different way of asking questions. Instead of repeating last year's exam, he decided to ask students to apply concepts to analyze and solve an unfamiliar problem.
Suddenly, the calibrated student might struggle because he emphasized specific topics based on historical exam records.

On the other hand, another student who mixed his calibration strategy with understanding the logic behind the sequence of topics and how they are related finds the new exam very easy. This student's knowledge is validated because it enabled him to operate in unexpected scenarios.

In ABM, there is tension between calibration and validation. Calibration is about the ability to reproduce patterns based on historical observations. Validation asks whether the model is able to remain useful if circumstances change. In my opinion, calibration and validation should not be treated as competing goals and I would dare to say it is a stepstone for validation. The real challenge is to guarantee that the resultant mechanism and hypothesis will work under different conditions.

In Tom Hank's movie *Sully*, Captain Sully landed a jet on the Hudson and when he was investigated against computer simulations to determine the feasibility of returning to nearby airports and ultimately the soundness of his decision to let a plan sink eventually into the river. His first move was to ask for the correct calibration of the simulation to make they were realistically mimicking the situation. He had to act with 35 seconds delay after the bird strike, communicating with the tower and assessing the damage, while the initial simulations were instructed with zero-delay time-to-action. Calibration is about correctly fitting the model in correspondence with real life situations. After accounting for the 35 seconds delay time-to-action, neither simulated pilot was able to make it to any airport after the bird strike disabled both engines. So, how did Sully make it out and save everyone? It is all about human factor whose response was as unexpected as the bird strike. Managing uncertainty is part of validation, and to achieve it we might not need more computational power, but understanding how humans might act and/or adapt under different conditions.

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Before you Go

Did it happen that you made a mistake while conducting data analysis? If so, send us a punchy 250 words describing this mistake and how you fixed it.

If it's humanized, we'll publish it next week with your name, title and link to your profile.

Disclaimer: *"We reserve the right to edit all submissions for conversational tone, length, and formatting to ensure it matches the Data Dialogue voice"*

You will find the submission button on my website.