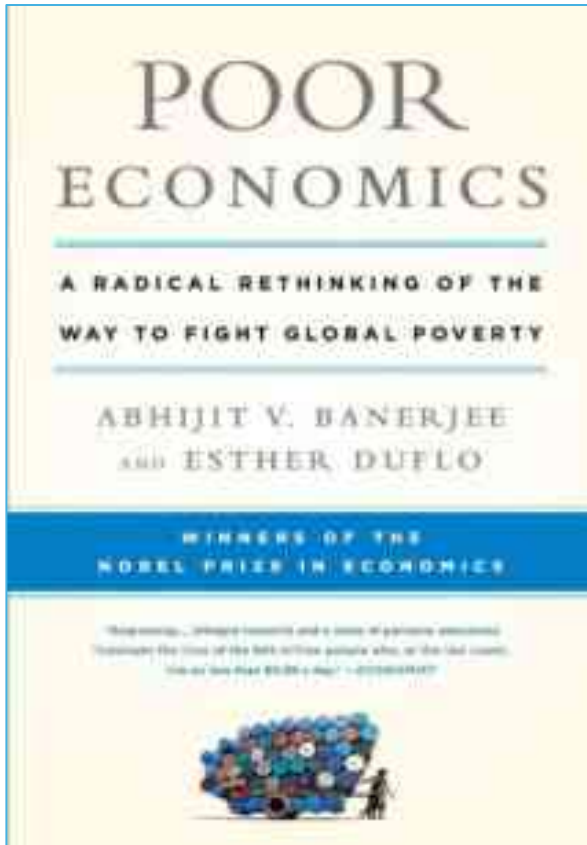
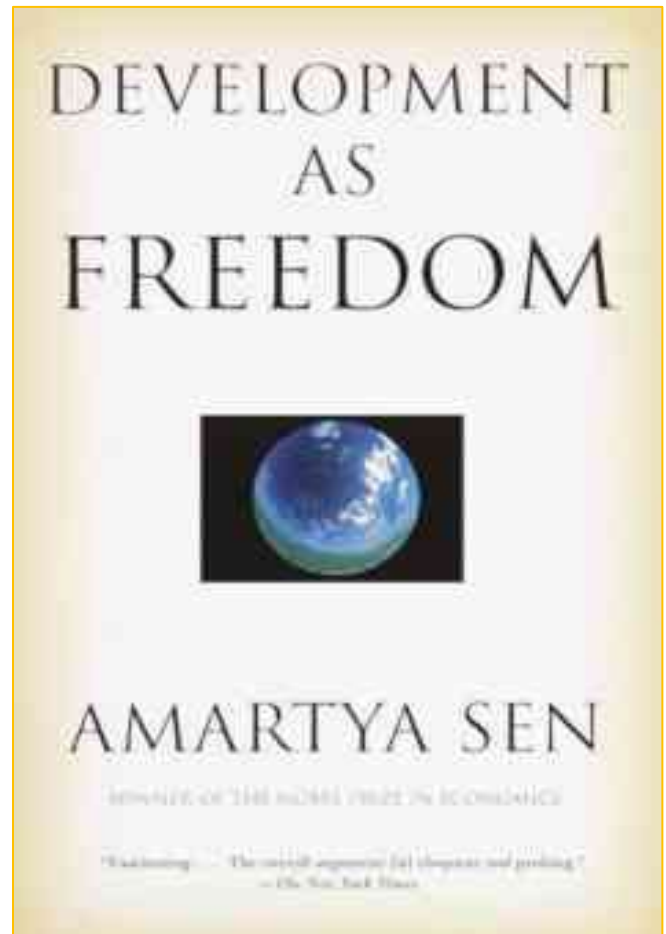


## BILLIONS OF USERS (BOU) - POOR SOFTWARE for *POOR ECONOMICS*



Democratization of data may be mere *lippenbekenntnis* unless tools are made accessible to the bottom billions to benefit from the data. Technology, which was supposed to bridge the chasm between “haves” and “have-nots” remain under first world control, with data as a prime commodity for monetization. In this workshop we wonder whether the commercial sector is oblivious of the fact that it is leaving trillions of potential revenue on the table by ignoring what software can do for the next billion users who *can* pay but pays a penny per use (PAPPU). However, democratization of data is not a panacea. There is a set of scenarios for which software is the right tool. It may not be the correct tool for all use cases, questions, and all scenarios.





5 ESSENTIALS OF LIFE

**FEWSH**

# BOU – BILLIONS OF USERS

SIMMS Product Workshop (Software Innovation in Material Management Systems)

DRAFT 09-22-2025

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[0] Preface

Between the volatility of the economics of altruism and the uncertainty of social welfare programs lies the elusive quest for growth in most developing countries. The punctuated equilibrium of nonlinear development in underserved nations is a PQRSTU wave of boom, bust and business. In this workshop we descend from the ivory tower of philanthropy to embrace ethical profitability. Pragmatic ethical profitability is not oxymoronic, but it is that rare metaphorical fulcrum between need and greed. Can we create the social business of science we need as a service but limit net operating profit after taxes (NOPAT) to less than or equal to one percent (ETOP) of revenue?

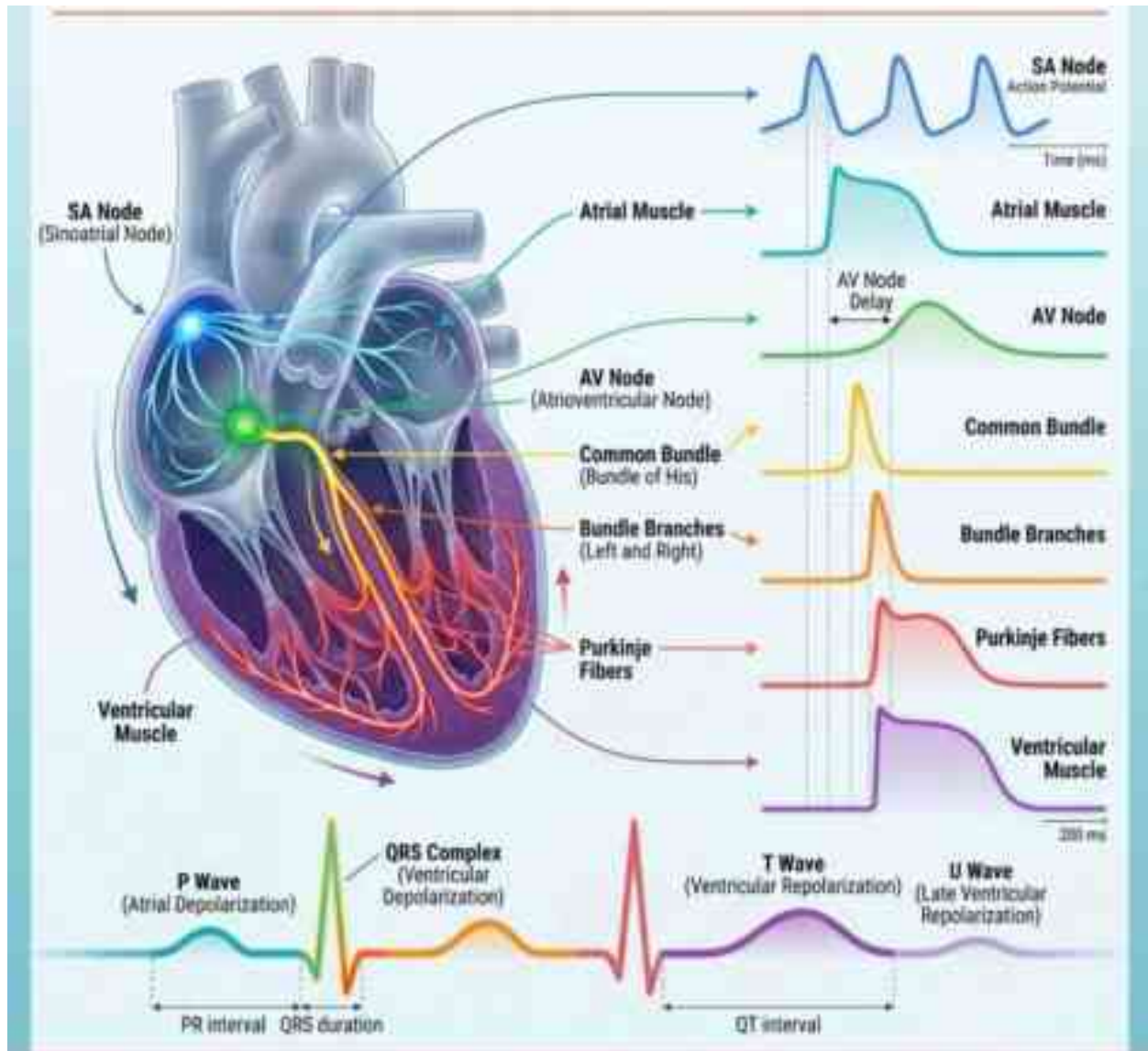
ETOP NOPAT is the rallying cry for SIMMS (software as a service) to aid economic growth in less affluent nations (Asia, Africa). Billions of users (BOU) of products and services are in the AA nations but the spectrum varies with respect to buying power. The objective of SIMMS is to try to reduce the information gap in “poor economics” which could distribute the total profit from the supply chain of products and services between various actors (in contrast to capitalistic market economies where parties with access to information are most likely to amplify wealth creation).

Convergence of principles and confluence of ideas from transaction cost economics, reduction of information asymmetry, software engineering, business process design, and mobile systems, are expected to seed entrepreneurial innovation for business to customer (B2C) experimentation in development economics (which B2B can also adopt, if relevant) to help economic growth for BOU (billions of users).

The daily (hourly, weekly) interaction of BOU with FEWSH (food, energy, water, sanitation, health) is the rationale underlying ETOP NOPAT social businesses focused on these domains and to monetize each unit of transaction using the PAPPU paradigm (pay-a-penny-per-use) to reduce the barrier to market entry. PAPPU could create new BOU BAZAR (markets of billions) by engaging even those who may earn \$2-\$3 per day.

SIMMS may find creative ways to transform the basic elements of the economic principles of information asymmetry (see “note”<sup>1</sup>) and transaction cost (see “note”<sup>2</sup>). Implementation of SIMMS must be linked to innovative business process engineering and software development to capture operations in FEWSH verticals for activities involving food, energy, water, sanitation, health/healthcare (some more than others).

At the heart of PQRSTU – *you, the people*. Demand is driven by people. Poor people?



[1] What strategists, analysts and leadership often tends to ignore or may even forget

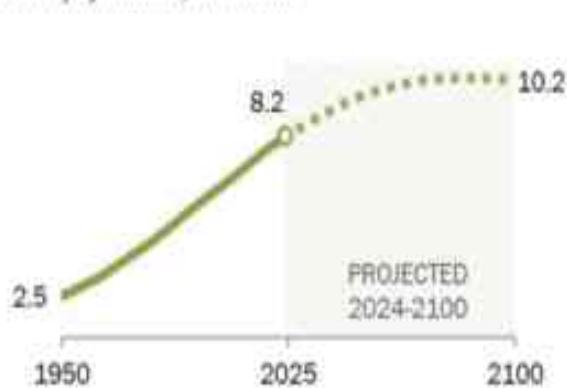
Demand is driven by demographics and their need (if disposable income is in the positive domain). If you can't predict demand then products, sales and services will be out of sync, directly in B2C and indirectly in B2B (loss of opportunity vs excess inventory, e.g., Cisco "legend" which is still making headlines<sup>3</sup>). There are exceptions, of course, and both positive<sup>4</sup> and negative<sup>5</sup> outcomes are now classic case studies.

The BOU workshop on "billions of users" explores how to find strategic markets where products and services (SIMMS) may add value (used by) for billions of users. Unlike instant success or rapid decline, products and services for billions of users (BOU) will be a punctuated evolutionary process which will demand "staying power" as well as the *wisdom of pennies* (pennies<sup>6</sup> per transaction will generate trillions, over time). One principle is transaction cost economics<sup>7</sup>, the work of Ronald Coase<sup>8</sup>. The practice of pricing each transaction (each as a modular software unit) is the key. It must hide technology yet enable non-expert lay users to "operate" each unit using push-pull-add-delete and simple Boolean logic, comprehensible to most (?) users.

Demographics suggest we look to Asia and Africa (AA) with ~6.5 billion people (~8 billion global population). This number may decrease to about 6 billion by 2100. Japan may be an outlier. Its population of ~125 million may decrease<sup>9</sup> by ~50% to about 60-70 million people, with an estimated median age of ~55 years, by 2100

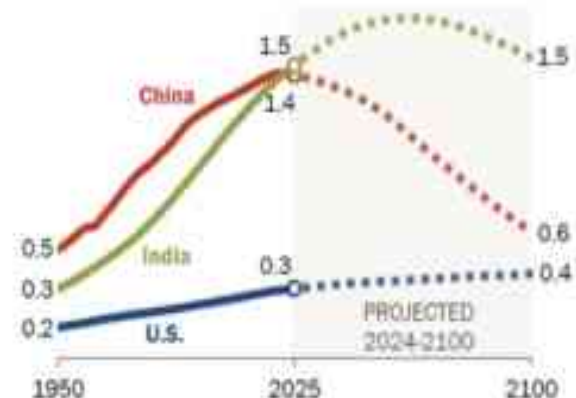
### The world's population is projected to peak before the end of the century

World population, in billions



### By 2100, China's population is projected to shrink by more than half

World population, in billions



The constraint in this line of thinking is the percentage of disposable income and the AA literacy rate<sup>10</sup>, which, in combination, will drive buying power. In US, ~63% of the ~340 million<sup>11</sup> citizens are in the civilian labor force. Thus ~214 million unique individuals who *earn* money can *spend* money (disposable<sup>12</sup> income is ~3% in US<sup>13</sup>). Primary earners in the EU (~283 million) and US, combined, presents ~500 million buyers. If 10% of the ~6.5 billion citizens of AA countries possess disposable<sup>14</sup> income then the market potential of AA exceeds that of US and EU, combined. AA markets may become potentially *profitable* for BOU services.

## [2] Market (BAZAR) for Billions Of Users (BOU) - FEWSH, BOU BAZAR & Public Goods

Tools which will facilitate everyday necessities stands to profit from billions of users. Design of BOU products/services (software as a service) may be viewed through the lens of global public goods, e.g., FEWSH (food, energy, water, sanitation, health). Users must interact with FEWSH on a daily basis because life depends on it. Sourcing and consumption of FEWSH is globally ubiquitous, both in non-affluent AA countries with ~6.5 billion people and ~1 billion citizens of the affluent world.

Software tools for interaction with FEWSH could become ubiquitous, too, if the software system and tools facilitate access to and sourcing/consumption of FEWSH. Affordability (pricing) of mobile software tools for FEWSH is key to reduce the barrier to market entry. Dissecting the business process components of FEWSH into unit transaction packets will define the innovation at the heart of software engineering. A dynamic pricing scheme where users pay less than a penny for each unit of software used in (transaction) the supply chain will be key to monetization (nano-payments). Ultra-low transaction cost for modular mobile digital processing (access to FEWSH) may increase the frequency of use from daily to hourly for some users (e.g., home healthcare monitoring). Reducing the cost of operations will determine the degree of market penetration for BOU. A fraction of the profit from pennies per transaction may drive earnings to astronomical amounts in view of the immense market potential of BOU (which may dwarf earnings from all affluent OECD nations, combined).

Business process engineering of each sub-group (and *sub* sub-group) of each strand of operation into transaction units (sequence of process workflow, data stream, and financial supply chain) is at the core of this deconstruction. The clarity of the minutiae (software function) must be embedded in each unit and reconstructed to offer *actionable value* by integrating data/information flow. The systems must connect to update operations (as necessary) prior to or at the point of action (point of sale).

Each software unit (of an executable process) will behave as a software agent and will cooperate with other agents (“agency” may be hierarchical) in that process (sub-process) to execute the end-to end process or sub-process (e.g., a process/sub-process may be composed of linear or branched poly-strings/poly-units of transaction steps, each constructed as a modular software unit and/or behaving as a software agent). The implementation of agent-based modular software as a sub-unit with transactional properties within an unit of transaction or within a sub-process (or process) follows the principles of agent-based software described by Maes *et al* and summarized by Datta<sup>15</sup> (2001, 2025). Modular agents enable software to be recycled. The agents in this approach (cartoon) are “AI agents” but without the hype (ref 128).

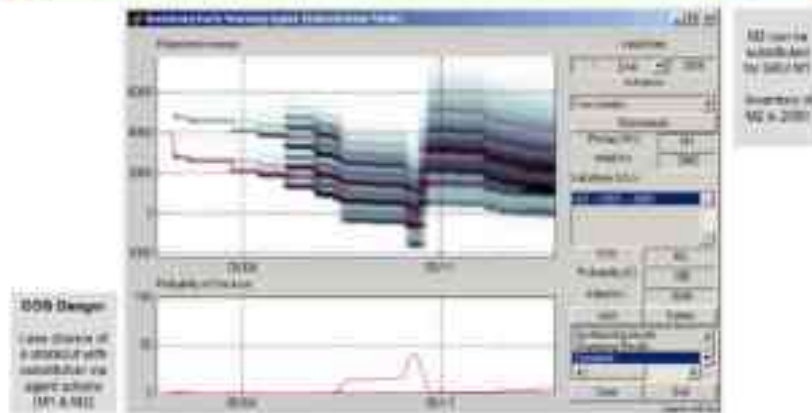
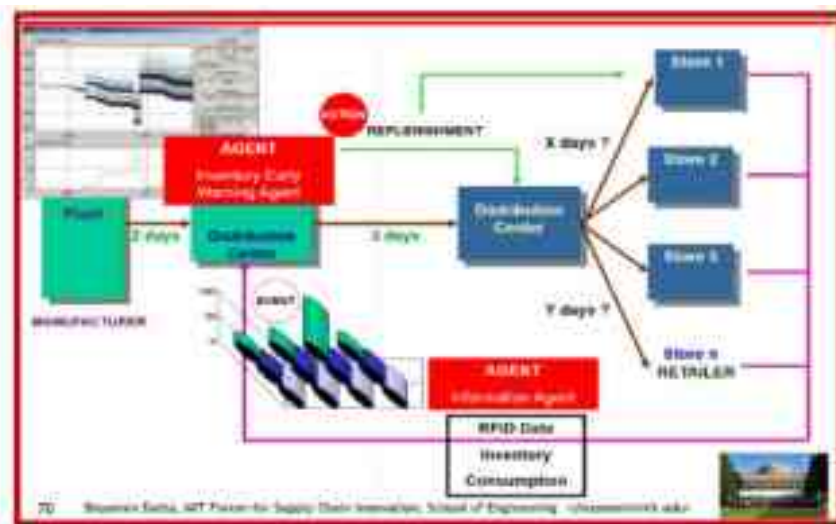
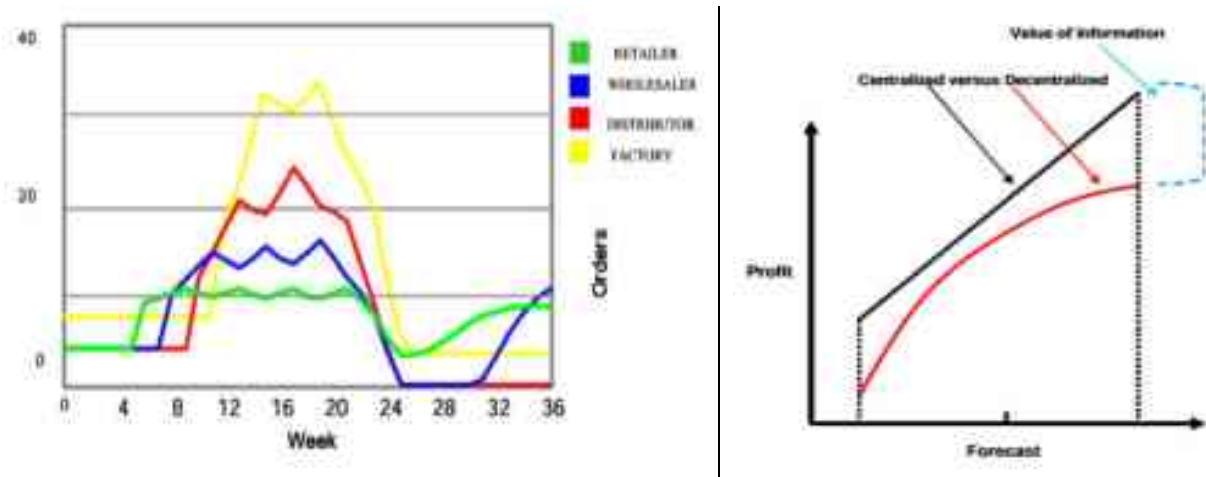


Figure 57. Carra 2000, concept of agents in supply chain planning and acting<sup>200</sup> (TOP) using RFID data (inventory) to prevent out-of-stock (DOS). Multi-agent<sup>200</sup> (society<sup>200</sup> of agents) concept (BOTTOM) implemented by SAP using Advanced Planning and Optimization (APO) software. Personal communication due to the author (Shoumen Datta, MIT) and SAP AG. Illustration was sourced from the author's lectures at the MIT Sloan School of Management.

### [3] An underlying principle - Information Asymmetry: Can its reduction help BOU?

The financial incentive in data as a business model is driven by the proclivity to profit from controlling information flow. The *currency* in the information economy depends on the creative and dynamic *restriction* of data flow necessary for decision systems. Preventing or delaying access to data in the information arbitrage juggernaut can alter financial outcomes where the party with information will benefit, unless the value of the information in locked data is leaked or perishes (e.g., groceries, election polling, research results, insurance, used car dealers). Thus, information asymmetry<sup>16</sup> is an economic tool and exploited for monetization of data. It may introduce risks if consumers/users are unable to access sequestered data (e.g., medical device or electronic health data which are not shared or proprietary software preventing data interoperability<sup>17</sup>). In game theory<sup>18</sup> (signaling game theory) the use of information asymmetry may be used to guide strategy<sup>19</sup>, policy, profit, etc. Information asymmetry manifests as “bullwhip effect” in supply chains (cartoon, left). Reducing information asymmetry<sup>20</sup> may increase profit (cartoon, right) for all parties in the value chain.



One strategic objective for SIMMS is to reduce information asymmetry for BOU. The assumption, albeit quite imperfect, is that reducing information asymmetry will trigger information sharing which will offer financial advantage (gain) for billions of users (BOU) under economic constraints. Markets may resist any equilibrium<sup>21</sup> state of information which will handicap their bargaining strategy but end users may benefit if the monetary playing field were less turbulent and more transparent.

One purpose of the software (SIMMS outcome) is to offer a dynamic, networked, mobile tool connected to relevant data streams to monetize the “value of information”. The software may be a “thin client” operating on a smartphone but the value of the tool will be directly proportional to its connectivity. The engineering innovation (expected to be embedded in this tool) could benefit from in-network online processing systems from advances in sensor networks<sup>22</sup> developed over the past quarter century since the diffusion of cyberphysical systems leading to internet of things (IoT<sup>23</sup>) and industrial IoT (IIoT<sup>24</sup>). This process requires to converge the sources of relevant data. The latter depends on the type of vertical. The nature of the vertical and the anticipated use will inform the business process. Deconstruction of the business process and generation of modular units (software engineering) may inform how to create the necessary data scaffolds where this bi-directional data exchange and/or information arbitrage can be automated. The unit(s) will be assigned a monetary value in terms of transaction cost. Establishing alliances (*crowd* sourcing) may be necessary to enable data/information curation and integration with time series<sup>25</sup> data for pricing, inventory, logistics, etc.

Ethical, judicial and real-time use of this data is essential to transform incoming data into information (if there is information in the data). Data/information is supposed to help in-network decision support systems (engines in the cloud) to analyze, update and feed the outcome (data/information) to the logic layer of the tinyDB<sup>26</sup> on the mobile tool (smartphone operating in densely populated areas with limited communications bandwidth) to catalyze and optimize its ability to be sufficiently/adequately informed when answering a query or executing a transaction (triggered by the end user).

It is expected that this information arbitrage may converge on dynamic pricing (buying/selling) at each node. The goal of this tool is to optimize the advantage in terms of pricing for the benefit of end users (BOU). The efficacy of the tool can be improved from basic operations to future refinements using digital semantics<sup>27</sup> and/or error correction models<sup>28</sup> (e.g., predict future pricing, volatility). Reduction of information asymmetry and innovative software engineering will benefit BOU. Thus, science and engineering can be an on-demand networked service (ODNS) to help poor societies.

Profit from ODNS will depend on design, based on deconstruction of business processes and reconstruction of service flow as transaction units. The deployment will depend on communications infrastructure in the region, penetration of mobile devices (smartphones), necessity of use (FEWSH value chains), market adoption (ease of use), financial benefit from use, cost of frequent use, net gain for users, interaction with financial services (fintech) and ease of termination of service without any penalty.

[4] Software *user friendliness* must scale new heights for massive adoption by BOU

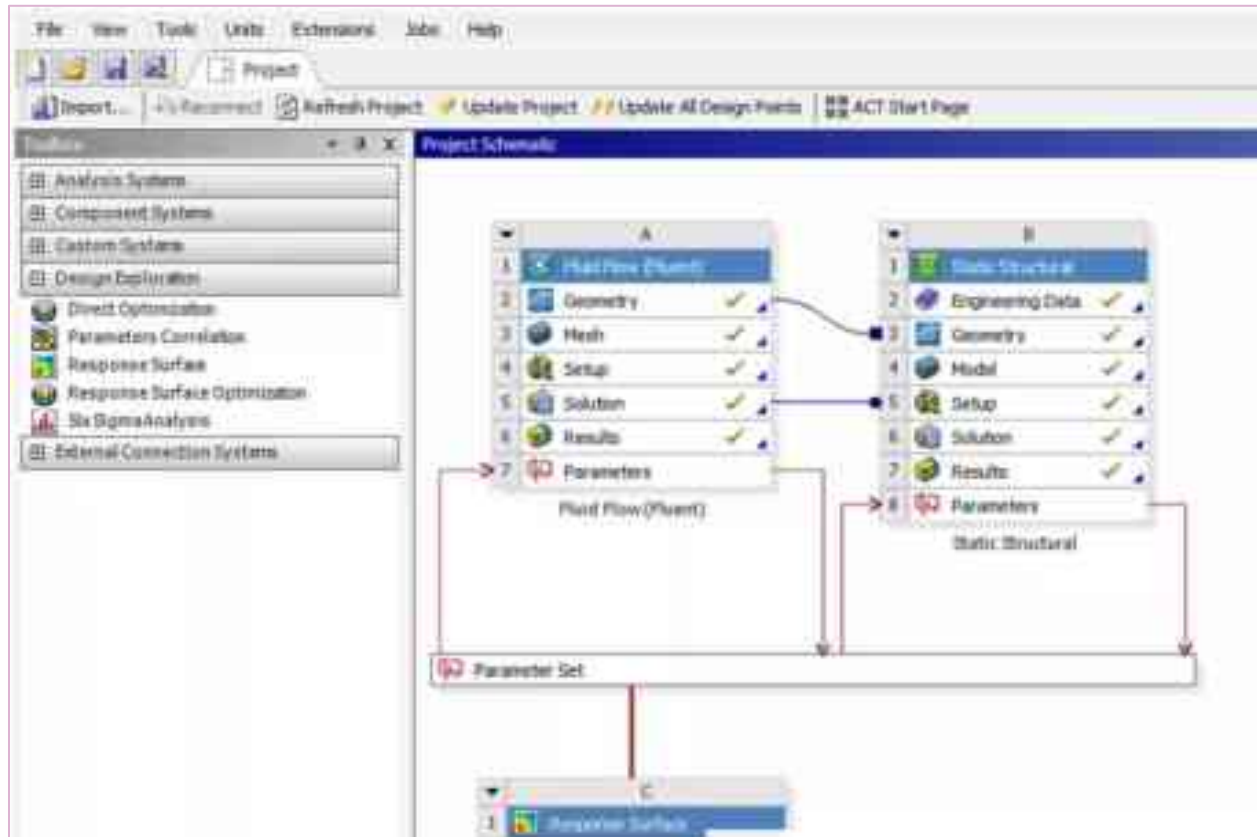
R&D exploratory outcomes from academic-industry “blue sky” thinking often hangs to dry in repositories as digital dust. BOU ideas could fail to translate data and information as catalysts for B2C economic growth because the technology and tools rarely cross the B2B mind-set (sophisticated software, e.g., SAP, handled by experts). In the BOU context, B2C is not about the educated consumer being the best customer in an affluent nation but super-simple accessibility for billions of people (canonically uneducated) who do not eat with forks but use fork-lifts and toil in farms and fields.

Software sophistication will be the nail on the coffin for mass adoption. The diffusion of any idea in the context of BOU require tools to provide a clear economic incentive which is easily usable by anyone, anywhere, anytime, without assistance. The assumption is that the non-technical yet (barely) literate user *understands* the common (natural, spoken) language, can use Boolean operators (*and, or, not*) in that language and has a grasp of prepositions<sup>29</sup> or equivalent grammar to construct or express or design relationships (for query, transaction, price optimization). For some transactions or negotiations, creating relationships (voice commands) may be necessary. It remains to be seen if the syntactic clarity of user commands (voice) can be semantically “understood” by the software system (based on a limited semantic dictionary) to proceed through the pre-programmed workflow (units/steps in business process). Simplification of the software may be an asymptotic scenario and may only serve the *literate* poor. Even minimal degree of linguistic complexity may result in loss of users. We can stem the loss in distant future by adapting to vertical-dependent, vernacular-specific, location-aware versions for syntax-semantics dictionaries (auto add/drop cloud-based semantic dictionaries [logic tools, engines] based on point-of-use GPS coordinates, unbeknownst to user). This is a *push-pull* (agile) case of depth, breadth, and rigor which the software must possess (adaptability<sup>30</sup>) to deliver the desired functionality via simple and user-friendly operation (key to mass adoption).

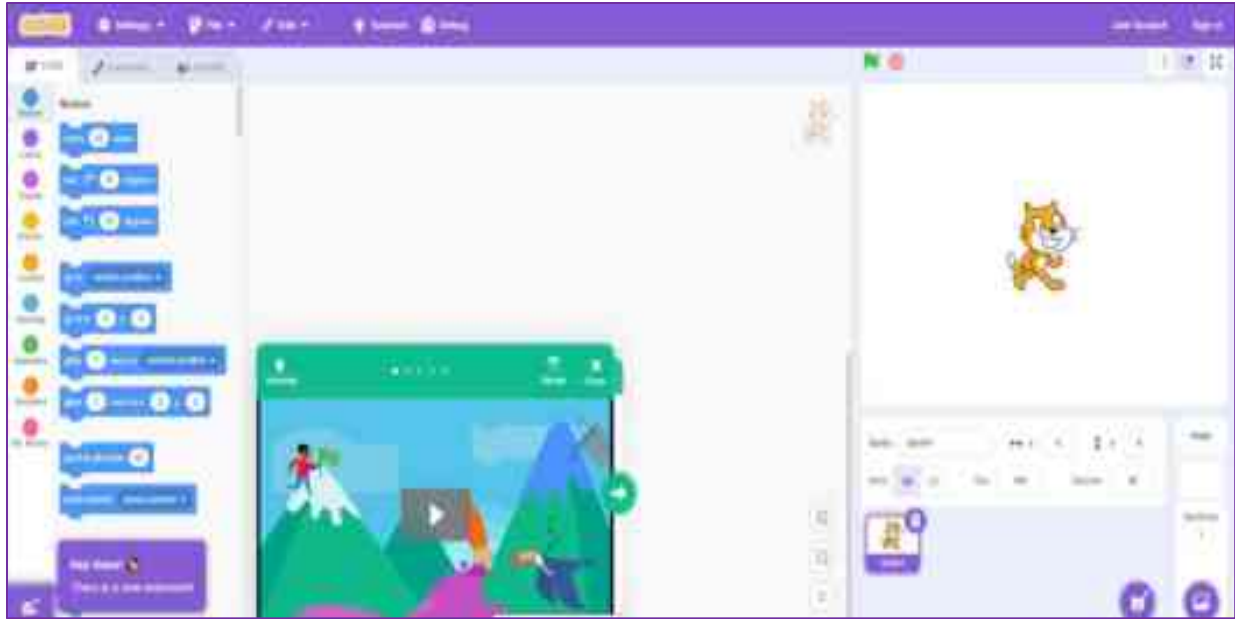
[5] Software engineering rigor - absolutely essential • Software use - absolutely simple

The core engine of this software tool must be designed with uncompromising engineering rigor. Near real-time dynamic pricing requires multifactorial optimization. The sophisticated heart of this software with complex connectivity must become a tool as easy as playing digital tic-tac-toe. The user only needs to understand the context of the application (why is she/he using the tool). The operation will follow, intuitively, from asking “what do I want to accomplish” using intuitive and tangible interfaces guided by a plain-speaking Socratic mode (Q&A) to guide users, preferably through a menu of options, to choose goals, tasks and instances the user needs for the task.

Intuitive iconography, common on digital devices, especially smartphones, often consists of dragging and dropping icons, adding/deleting (*and, or, not, if this, then that, above, below, with, without*) or cutting/pasting icons (entities embedded with cryptic logic and/or rules) to enable users customize and/or optimize their goals/tasks. As an example of engineering rigor, refer to the engineering workbench and simulation tools from Ansys<sup>31</sup> (cartoon).



The user *experience* may mimic SCRATCH<sup>32</sup> developed over two decades at the Lifelong Kindergarten Lab<sup>33</sup> at MIT Media Lab. The predecessor<sup>34</sup> of Scratch evolved into Lego Mindstorms which enabled children to become creative with computational logic tools but unaware about technology and programming. The concept and lessons from Scratch may translate the engineering by transforming sophisticated software systems to become accessible to BOU. Using child-friendly (idiot-proof) Scratch-esque platform as a tangible user interface<sup>35</sup> (TUI) may aid business transactions and assist to optimize ethical profitability for BOU (billions of users).



The functional and elegant convergence of complexity with simplicity must be the hallmark of any effort to innovate software services for BOU. Data-informed dynamic pricing optimization is a staple for revenue management (field of optimization theory<sup>36</sup>). It is useful as a decision tool with potential for mass adoption (fuzzy area of behavioral economics<sup>37</sup>) in any line of business (FEWSH). Transparent (reduced information asymmetry) market design will depend on capturing and building agile and adaptable models to connect market variables, components and data networks.

Perhaps we need to explore, adapt and use principles of spatiotemporal<sup>38</sup> time series modeling to map, in part, market heterogeneity. It may reveal nodes with gaps in data transparency. Innovative bridging of data gaps with source-specific mobile software agents (add/delete agents as sources/sinks change) may reduce pricing under uncertainty (information asymmetry) and find favorable outcomes for BOU.

[6] Specific examples related to food (the “F” in FEWSH) for SIMMS software tool

Eggs in Indonesia<sup>39</sup> (example provided by Alya Defa Aninda<sup>40</sup>) are 4X more expensive (or less expensive) between two cities (regency) in the same country. In rural India, a farmer sell tomatoes at \$0.14 per kilogram while the price a few miles away is almost 4X or \$0.54 per kilogram (example provided by Rohan Putatunda<sup>41</sup>).



Information asymmetry creates extractive pricing where the data gap perpetuates unequal access to information and breeds inequality in quality of life. Reducing information asymmetry and democratizing data are difficult but egalitarian route to promote equity and efficiency (other examples are in the Appendix). In this example of SIMMS, the focus is to design market transparency through pricing<sup>42</sup> infrastructures to improve profitability for BOU (in developing economies). The approach is to create a relatively bias-free information arbitrage tool to distribute the (value of) information. In other words, computational systems (software tools) which could aid in democratizing access to market intelligence, transform opaque pricing into transparent, data-informed mechanisms to benefit all supply chain actors.

A spatiotemporal working model of this value chain will need to capture these (and more) variables and their dependencies: [1] farmers lack access to real-time demand data, [2] transportation (cost) forecasts, [3] competitor pricing. In the current climate, intermediaries exploit this information gap, profit from margins, deprive the producers and maintain a higher cost for the consumer. Traditional rural solutions, cooperative structures, minimum support prices, may address some symptoms. But the underlying problem is the cost of acquiring and processing market information (e.g., creatively using DIG<sup>43</sup> or domain-specific<sup>44</sup> information-knowledge graphs<sup>45</sup>).

These costs remain prohibitively high for small-scale actors. Information asymmetry, therefore, manifests as a transaction cost problem. When information is asymmetrically distributed, excess transaction costs emerge from institutional friction. Thus, uninformed parties consistently lose value to informed parties (moral hazard<sup>46</sup>, adverse selection). This is an operational challenge (at ground zero) which invites innovators to design a real-time pricing tool (minimize the cost of information and embed ethical profitability for all actors in the value chain).

*Resistance to reducing information asymmetry may be due to the fact that it is detrimental<sup>47</sup> for the business of wealth creation for the wealthy (only). The poor continue to be poor because they are trapped by the wealthy. The poor lack enough assets to be productive. Reduced productivity makes it difficult to accumulate enough assets. The biased, skewed and imperfect financial market prevents the poor from borrowing the necessary assets. The rich continue to stay rich because they have enough assets to earn high return on their assets and accumulate even more wealth<sup>48</sup> (so much so that the top 1% of Americans held 31.7% of the nation's total wealth – US \$55 trillion – in Q3 of 2025<sup>49</sup>).*

### *Software Infrastructure - Principles and Practice*

For this example, the core (spatiotemporal) model of near-real-time operations optimization must continually learn to synthesize multiple data streams, micro- and macro-climate predictions, transportation network status, regional demand signals, storage capacity constraints, predictive pricing trajectories, supply-demand factors, uncertainty/volatility of local/regional issues (regulations, policies, politics) and the environment, which may inform/re-inform decision making and/or decision rules.

How people make choices under uncertainty is a prime factor in behavioral economics. The latter will influence operations optimization because market participants (farmers, traders) exhibit a range of bounded rationality, cognitive biases, and heterogeneous risk preferences. Hence, models must integrate behavioral economics into stochastic control frameworks.

However, behavior is unlikely to be universal even though economic theory may build models of “toy universes” where assumptions overshadow the behavioral complexity of micro-societies and micro-environments in daily life<sup>50</sup>. Being a standard model (e.g., in behavioral economics) does not make an assumption to be actually true.

The plethora of confounding variables which a model of behavioral economics must accommodate may lead to state space explosion (large number of parameters are also inversely related to their precision) when combined with operations optimization models. Perhaps, this field may benefit from weighted parameters according to impact/importance/influence. In addition, there may be lessons gleaned from the mathematical study of waves<sup>51</sup>, which are influenced by a plethora of confounding variables. Can we embed these lessons within a SCRATCH<sup>52</sup> interface (GUI/TUI)?

### *Operation at Ground Zero – Serving Simple Solutions Require Healthy Dose of Science*

*Amplifying* information asymmetry is the key *for-profit* strategy for US health and insurance cartels. *Reduction* of information asymmetry is also strategic for US and affluent nations, e.g., in the 20<sup>th</sup> century the prices of stocks were printed in the Wall Street Journal and the birth of Amazon (.com) with public access to the internet. For BOU in the 21<sup>st</sup> century it could be about a farmer using a mobile interface to input harvest volume, quality, grade, etc. The system, drawing on regional supply data, weather forecasts affecting competing regions, and historical demand patterns, may provide a (transparent) price range, with confidence intervals. Exploitative pricing is kept on check if buyers and sellers can access the same information (reducing the asymmetry). The system learns regional behavioral patterns: how risk-averse are local farmers? Will buyers respond to quality signals? Behavioral calibration (weighted according to preference, importance, seasonality) could improve system performance.

Various tools already exist to perform combined optimization. But, students may benefit from exploring the science and mathematics of thermodynamics as a fundamental principle applicable to this problem (in practice, as a software tool). In this case, information asymmetry between supply chain actors results in a non-equilibrium state (e.g., unlike game theoretic Nash equilibrium where all parties are assumed to possess the same information).

In trying to address this non-equilibrium state perhaps we can explore (borrow) the concepts and principles from non-equilibrium thermodynamics. Physical systems evolve toward energy-minimizing configurations under entropy constraints (entropy can decrease<sup>53</sup>). Can we model markets as evolving toward information-minimizing equilibria? In this analogy, price functions as potential gradient guiding system evolution, while decision noise corresponds to entropy (market uncertainty due to human behavior and choices).

The mathematical structure of non-equilibrium systems (their use of gradient dynamics, entropy production, dissipation functions) may translate to market models where SIMMS software agents may update beliefs and dynamic pricing may reflect adjustments made to minimize informational friction<sup>54</sup>. The product is a pricing mechanism that naturally stabilizes transparent, efficient outcomes rather than requiring external enforcement. In designing systems that promote inclusive growth without sacrificing efficiency, we may operationalize fairness as a constraint within the optimization problem. Equity and efficiency are no longer competing objectives but complementary (competition becomes regenerative rather than extractive) outcomes from reducing information costs (all participants access same market intelligence).

The fish industry in Japan (example provided by Hideki Sakai<sup>55</sup>, Tokyo) further illustrates how non-equilibrium thermodynamics is applicable in market economics by treating "price" as a potential gradient and "decision noise" as entropy (offers rigor and scientific basis for creating SIMMS engine). The "snap and sell" effort is reducing information asymmetry and reshaping Japan's seafood industry by transitioning from a "high entropy" (opaque auction) state to a "low entropy" state involving transparent direct sales. UUUO<sup>56</sup> is a B2B platform connecting ports directly to buyers. Fishermen upload photographs of their catch (immediately, from the *boat*). The app uses data to predict demand and allows fishermen to set prices, bypassing traditional multi-layered auctions. In another instance, SAKAMA<sup>57</sup> connects fishermen with the dining industry (restaurants) focusing on monetization of "unutilized fish" (*miriyo-gyo*) which are irregular in size or shape (often discarded as waste – high entropy – in traditional markets). This example demonstrates how SIMMS tool can recover value from "noise".

[7] "H" in FEWSH – Health – immensely complex yet it may be a profitable 'killer app'

Oxymoronic may be an apt adjective to describe how health related mobile app could be simple (in principle) to implement (in practice) despite the fact that health and healthcare are infinitely complex compared to creating dynamic pricing software.

Globally, healthcare is a field with high information asymmetry agnostic of the wealth of nations. The chasm of knowledge ("*all evils are due to lack of knowledge*"<sup>58</sup>) between the non-medical lay person (user) and the medical professional (provider) is so profound that it is nonsensical to refer to a patient as a customer who can "choose" from a menu of options given a range of "costs" for treatment. It is absurd to model healthcare as a business supply chain of operations and subject it to the same rules of supply/demand. The supply chain part of healthcare exists only for products, devices, non-emergency transportation and human resources (human capital necessary for non-medical operations) which are used in healthcare, like any other industry.

Literacy, or rather the lack of literacy, exacerbates health and healthcare information asymmetry. Lack of literacy reduces the individual's ability to grasp the basic concepts of health which could go a long way to improve their ability to deal with common/daily health/healthcare issues (e.g., self-monitoring with medical devices). This knowledge gap increases the demand for medical professionals. The scarcity of trained medical personnel in less affluent nations amplifies the inability of nations to offer adequate/effective healthcare services.

SIMMS and technology can help the literate user but can it bridge the healthcare literacy knowledge gap? Only half of the ~6.5 billion people in AA countries may possess sufficient literacy to use SIMMS tool for health/healthcare monitoring needs.

Having said that, it still remains a fact that if 10% of the ~6.5 billion people in AA countries were sufficiently literate and possessed disposable income then the market of 650 million users could turn substantial profit even if they were to pay a penny per use (PAPPU). It may not be an instance of irrational exuberance to suggest that by 2100 about a third of the ~6 billion people in AA countries may be sufficiently literate and possess adequate disposable income to become future users. Thus, SIMMS health services may become a market of 2 billion users paying a penny per use (PAPPU) for each unit (transaction) of software (SIMMS tool). (For OECD nations, ask \$1 per use?)

A digital health social business in AA nations can earn 2 billion pennies per day for measuring **blood pressure**, 2 billion pennies per day for measuring **blood glucose**, 2 billion pennies per day for measuring **blood cholesterol**, 2 billion pennies per day for measuring **hemoglobin**, 2 billion pennies per day for measuring **urea** in urine. SIMMS digital health pennies (3.650 trillion pennies per annum) amounts to \$36.5 billion in revenue per year, not in the 1st year but perhaps by the 10<sup>th</sup> anniversary. (A similar business for 500 million *affluent* users paying \$1 per use approaches \$1 trillion p.a.).

From an optimist's perspective, perhaps, for five (US) pennies a day, a third of the population in the AA countries can create their personal health profile or PSPP<sup>59</sup> (person-specific physiological profile). PSPP may be a guide to predict future state of health and wellness as well as suggest preventive measures, when applicable. The health of nations is proportional to the productivity of nations and the productivity of nations, in turn, is proportional to the wealth of nations (*"wealth of nations<sup>60</sup> is directly related to the wellbeing of its citizens"*).

*Data collected is displayed in mobile users PSPP app. User may authorize data to be transmitted to physician or hospital or not.*

## 10-Point Patient-Specific Physiological Profile (PSPP)

**NON-INVASIVE Personal Time Series Data (PTSD) in mobile app DB!**

|   |   |  |
|---|---|--|
| <ul style="list-style-type: none"> <li>• Blood Glucose</li> <li>• Cholesterol (LDL)</li> <li>• Urea (BUN)</li> <li>• Hemoglobin</li> <li>• Proteinuria</li> </ul> | + | <p><b>Non-Invasive Vital Signs (data)</b></p> <ul style="list-style-type: none"> <li>• Respiratory Rate (RR)</li> <li>• Oxygen Saturation (pO2)</li> <li>• Blood Pressure (BP)</li> <li>• Pulse</li> <li>• Body Temperature</li> </ul> |
|---|---|--|



[8] Sanitation is a hygiene driver for the health of nations and wellbeing of its citizens

In 2000, 1.3 billion people were defecating outdoors. In 2024, ~3.5 billion people still suffer without access to safe toilets and half a billion (conservative estimate) still must practice open defecation<sup>61</sup>. November 19, 2024, was the UN's World Toilet Day<sup>62</sup>.



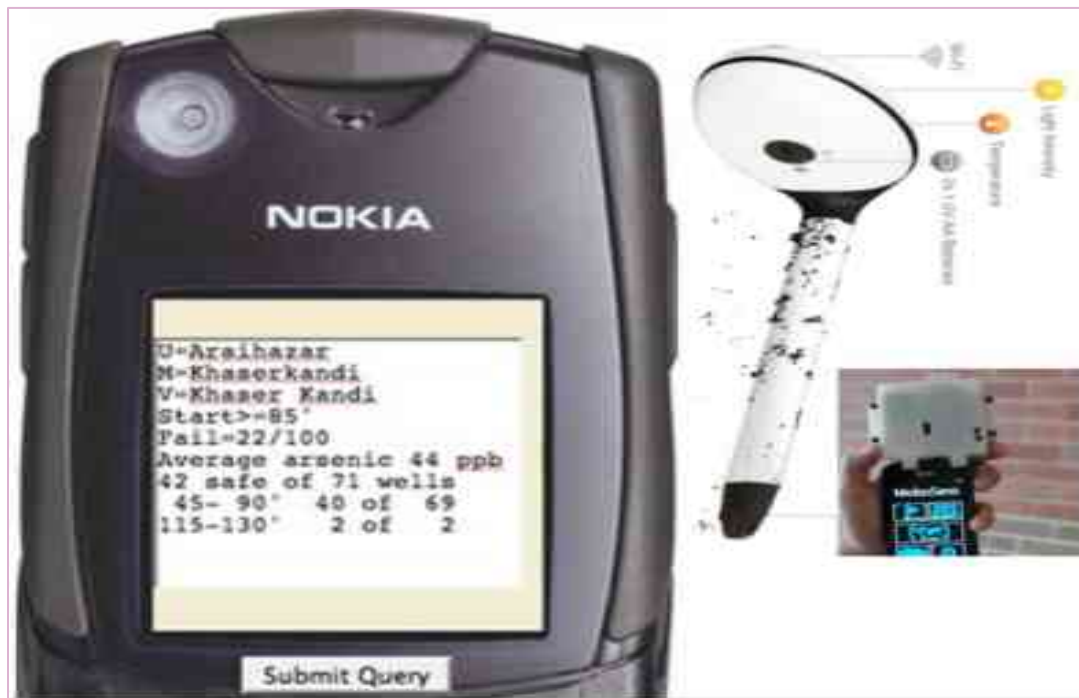
Confluence of cross-pollinating counter-intuitive connectivity may be worth exploring to create incentives to usher a digital role in sanitation improvements. For sanitation practices information asymmetry may be an issue since sanitation is also inextricably linked to the health of nations. The ubiquity of the oral-fecal microbiome<sup>63</sup> in global health is not limited to ~8 billion humans, only, but must include ~50 billion animals<sup>64</sup> in the factory farming industry which influences health through food and co-existence. If *we are what we eat*<sup>65</sup> then it follows that *we are what we excrete*<sup>66</sup>. Hence, wastewater epidemiology is a crucial indicator of public health, globally. Reducing information asymmetry is imperative for preventive public health and *precision* of early detection is critical to reduce transmission of disease agents<sup>67</sup>.



Can ethical entrepreneurial innovation help to create a social business using PAPPU (pay-a-penny-per-unit) model for managed sanitation services? Can we incentivize users lacking (inadequate) sanitary health services to use such options? There isn't any easy answer because sanitation is an infrastructure issue and inseparable from water infrastructure for any viable solution. Anything that is shoddy or second grade masquerading as a good enough solution poses the grave risk of contaminating water supplies with excrements. The latter will take us back to 1854 and cholera (to re-invent waterborne<sup>68</sup> disease vectors).

[9] W in FEWSH is a challenge, conundrum, dilemma (to monetize global public goods)

Monetization of water is troubling agnostic of cost or asymmetry. Can water be free and sustainable? Water contamination can demolish even affluent nations<sup>69</sup>.



Public health<sup>70</sup> risk and chronic<sup>71</sup> Arsenic<sup>72</sup> toxicity<sup>73</sup> affects millions<sup>74</sup> (photos<sup>75</sup> show symptoms<sup>76</sup> of Arsenic poisoning<sup>77</sup>). Sensing<sup>78</sup> Arsenic in water<sup>79</sup> can save lives<sup>80</sup> if solutions venture beyond measuring<sup>81</sup>. Display of Arsenic concentration (parts per million) in drinking water (GIS map) was accomplished (Nokia UI, bottom) and geo-tagged data was accessible (to a few?). Is this reduction of information asymmetry? What is the value of science<sup>82</sup> and data for a thirsty child, who is without a mobile phone, but standing in front of the tube well<sup>83</sup> expecting to drink water? Should she drink the Arsenic-laced water from the tube well because she doesn't know and/or can't afford a penny to access the reduced information asymmetry data?

[10] E for Energy – FEWSH for BOU must adapt and may re-purpose existing tools

The statistics of access to electricity (map<sup>84</sup>) must divide SIMMS expectations of AA because Africa and Asia are poles apart in access to energy. The “statistics” of “access” is a government “view” where the ability to have one electric light bulb in a hut or village<sup>85</sup> is *good enough* “access” for that region/zone. In reality “access” in AA countries is far from the practice of managed utilities, we assume in affluent nations.



It is not unreasonable to assume that half of the ~5 billion people in Asia may have baseline access to electricity and ~10% of Asia (market of ~500 million) may have access to managed utility grid services including the use of electrical appliances. Thus, bridging diverse<sup>86</sup> information asymmetry in the energy sector must *adapt* to BOU. It is unnecessary to re-invent, better to re-purpose existing energy management tools<sup>87</sup>. If the streets<sup>88</sup> in India are an indicator of reality (extrapolate for AA) then ~1 billion people in India (~1.5 billion population) are surviving on \$2-\$3 per day. The AA market for SIMMS may be limited to one third of ~6.5 billion people (market of ~2+ billion).

*60% of India's nearly 1.3 billion people live on approximately \$3 a day.*

*21% or more than 250 million people, survive on less than \$2 a day.*

[11] Fiscal Reality Check – Is PAPPU (pay-a-penny-per-use) an irrational expectation?

Existing information suggest that tools for bridging information asymmetry may provide value to the buyer (end user) and offer a return on investment for businesses (seller) if we serve about a third of the AA population (market of ~2+ billion). The social business volume will generate a hefty EBITDA<sup>89</sup> and profit will be tidy even if we limit it to ~1% of gross revenue. The net operating profit after taxes (NOPAT) for US grocery stores<sup>90</sup> is ~1.6% on average. Car manufacturers claim a slightly higher NOPAT<sup>91</sup>.

| Ticker | Company            | ROIC | IC Turns | NOPAT Margin |
|--------|--------------------|------|----------|--------------|
| TM     | Toyota Motor Corp  | 8%   | 1.0      | 8%           |
| GM     | General Motors Co  | 7%   | 1.5      | 5%           |
| HMC    | Honda Motor Co.    | 4%   | 1.0      | 5%           |
| F      | Ford Motor Company | 8%   | 2.1      | 4%           |
| NSANY  | Nissan Motor Co    | 6%   | 1.4      | 4%           |
| STLA   | Stellantis N.V.    | 5%   | 1.3      | 4%           |
| TSLA   | Tesla Inc          | 4%   | 1.5      | 3%           |
| NIO    | NIO Inc            | -41% | 1.2      | -33%         |
| RIVN   | Rivian Automotive  | -25% | 0.4      | -68%         |
| LCID   | Lucid Group Inc    | -23% | 0.1      | -252%        |

The PAPPU idea of 1 US penny is ~1 Rupee (INR) or ~170 IDR (Indonesian Rupiah). \$2-\$3 per day in India translates to less than INR 200-300 per day. Healthcare example (aforementioned PSPP) suggested spending 5-10 pennies per day to create a health profile (PSPP), i.e., INR 5-10 per day for monitoring health. Let us add another INR 5-10 per day for other SIMMS FEWSH tools. Thus, we are assuming that the per capita earning of INR 200-300 *can* sustain payments of INR 10-20 daily for SIMMS services (~10% of daily earnings for FEWSH). But, is this INR 200-300 “per day per capita statistic” reflects one person or is it feeding/clothing/housing a family or an extended family? The silver lining here is that the AA nations have plenty of room for economic growth. The market of ~2 billion *can* grow to a market of ~6 billion.

## [12] Appendix – Beyond FEWSH

Gender imbalance, social inequity and sex-based malnutrition are core issues in AA nations. Women's education and economic freedom may alleviate ills slowing development and wealth of AA nations. School meals can help girls get educated<sup>92</sup>.

Several non-FEWSH verticals will influence FEWSH related outcomes. One example is transportation<sup>93</sup> and logistics where not filling free space (LTL) with cargo is leaving money on the table<sup>94</sup>. Tools for auctioning available cargo space are available to build a TL (truck load) volume. Bidders (with cargo) can optimize transportation and logistics costs using these software tools and systems (have been around for at least a quarter century). In Japan (2001) SpaceTraders<sup>95</sup> created auctions to fill (TL) space on trucks, used GPS and on-board diagnostics (OBD port) data from trucks through NTT DoCoMo i-mode (before "i-pod" buzz) packet data mesh network for real-time logistics decision support. This is a complementary B2B operation but relevant to B2C.

Healthcare (health of nations) may be the most desirable outcome for BOU because it can reduce direct cost (healthcare) and sow productivity increases (indirect improvement of wealth of nations). Unrelated to SIMMS and information asymmetry is the pivotal role of general wellness (e.g., obesity<sup>96</sup>) but public health and healthcare care issues in AA nations are different. Reduction of transaction cost is germane to enable access to health<sup>97</sup>. Mass vaccinations<sup>98</sup> are salient to reduce public health catastrophes with ensuing economic damage. Low-cost sensors<sup>99</sup> and the cottage industry of vaccines (free from the claws of the cold supply chain industry) for self-administered oral vaccination<sup>100</sup>, combined, are proven scientific solutions, awaiting implementation. The latter may change the quality of life in impoverished nations where people bemoan pompous pontifications<sup>101</sup> and corporate sponsored media serving as mouthpieces-for-hire to advertise/amplify wealth and wellness by peddling prosperity<sup>102</sup> through error prone digital<sup>103</sup> health.

SIMMS could also play a crucial role for (home) or workplace risk reduction by using the tool to anonymously report unsafe working conditions (if the authorities care or wishes to support worker's safety). Siena Quinn<sup>104</sup> cites the example of Rana Plaza collapse<sup>105</sup> on 24 April 2013, near Dhaka, Bangladesh<sup>106</sup>. The 8-story building contained 5 clothing factories. 2,438 people (mostly women garment workers) were evacuated, >1100 people died, and many were left with life-long injuries. The ready-made garment industry accounts for ~80% of exports and employs ~4 million people (three-quarters are women). It is estimated that the garment industry supports ~25 million people and plays a pivotal economic role in the development of Bangladesh.



The staggering scale of death, destruction and the economic ripple effects of the disaster reaches far beyond FEWSH (e.g., Rana Plaza collapse). It plunges good ideas into darkness and it lurks behind forward thinking initiatives, e.g., SIMMS. Is SIMMS even possible in such developing economies? The principles outlined here are quite rigorous, robust and credible (e.g., number of global recognition<sup>107</sup> and prizes awarded for these principles) but in practice where is the *leadership* to start SIMMS or similar technology initiatives specifically to serve the less affluent population? There is a chasm of disconnect between intentions, ideas and implementation *beyond* the pilot or the social experiment<sup>108</sup> in an underserved community. SIMMS may be drowned with other “agents of social change” in that chasm. The answers that leadership must find rests squarely on the shoulders of giants who can resuscitate those who drowned in that trench of disconnect between ideas and reality. That answer is neither in SIMMS nor in this workshop or in the author’s mind. SIMMS is an aspirational attempt for science to serve the underserved society (BOU) but the *facets of science* which may serve the “poor” is mired in quagmire<sup>109</sup>. An optimist may view SIMMS as a NOKIA<sup>110</sup> *evolution* example (Nokia started as a paper mill in 1865, Tampere). Perhaps SIMMS may be compared with chess<sup>111</sup> which may celebrate intellectual prowess irrespective of bias<sup>112</sup>, e.g., race, religion or riches. Can the lack of bias *level the playing field*?

### [13] Conclusion – Remediable Injustice? Poor Software for *Poor Economics*<sup>113</sup>

Convergence<sup>114</sup> is a compass to uncover new paths and may even (ever so slightly) alleviate the state of global poverty<sup>115</sup>. Confluence of science and engineering ideas in SIMMS are not new<sup>116</sup> but for BOU we suggest a continuum of end-to-end business process connectivity with financial supply chains. Transforming lessons from models and frameworks through software engineering may unleash or unveil profitable outcomes, if the software tools are accessible and applicable wherever asymmetric information creates inequitable or biased information arbitrage. SIMMS and its products and services for billions of users (BOU) may be applicable to all verticals of FEWSH in developing economies as well as established markets in affluent nations (e.g., physical supply chains, financial supply chain, labor, logistics [see Appendix], energy, utilities, retail, housing). Beyond “markets of 1” there is room for entrepreneurial innovation to trigger a paradigm shift from laissez-faire mechanisms that naturally achieve efficiency to engineered systems, by design, to align individual incentives with collective welfare, in the context of ethical globalization. In an era of increasing inequality and economic fragmentation, socially transformative systems innovation may catalyze institutions that are both efficient and just. But, adoption of innovation is sluggish due to barriers, e.g., risk<sup>117</sup> and the lack of education<sup>118</sup>.

E-kiosks<sup>119</sup>, smartphones<sup>120</sup> and SMS texts were once<sup>121</sup> “innovative” (data display, point solutions). Currently, value demands data fusion and synthesis (actionable information) from a broader network (curated connectivity relevant to context). For SIMMS, the nexus of business process deconstruction, analysis and reconstruction of services through business process re-engineering must lift many boats and deliver profit by focusing on solutions rather than bursts of information or reintroducing digital inequalities<sup>122</sup> or peddling alerts<sup>123</sup>. SIMMS must provide *service* for the benefit BOU and avoid the hyperbole<sup>124</sup> of technical tools. We offer clues to solutions by reducing transaction cost and information asymmetry. We propose a low-cost (PAPPU) decision system tool, not a data tool but logic tools to stitch information to empower billions and annihilate a few of the past *irremediable injustices*<sup>125</sup>.

SIMMS is not about technology<sup>126</sup>. SIMMS is about *accessible* services. Tools (e.g. reliable agents<sup>127</sup> without the hype<sup>128</sup>) are a means to an end (end is greater than the sum of the parts). SIMMS outcome must be measured (impact, productivity, and usage are influenced by many factors<sup>129</sup> and supply/value chain<sup>130</sup> networks). We will use RCT<sup>131</sup> (randomized controlled trials<sup>132</sup>) as a measurement tool. RCT is a standard for clinical trials<sup>133</sup>, social development programs<sup>134</sup>, agriculture<sup>135</sup> as well as a gold<sup>136</sup> standard for experimental development economics and perhaps even *optimism*<sup>137</sup>.

## [14] References ● Notes

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<sup>1</sup> Rosser, J. B. (2003). A Nobel Prize for Asymmetric Information: The economic contributions of George Akerlof, Michael Spence and Joseph Stiglitz. *Review of Political Economy*, 15(1), 3–21. <https://doi.org/10.1080/09538250308445>  
<http://cob.jmu.edu/rosserjb/Nobel%20Prize.%20Akerlof-Spence-Stiglitz.doc>

(**Note:** The economics of asymmetric information is a vast body of work and evolution of economic principles over the past century, summarized by Rosser, J.B. (2003). For the purpose of this discussion paper, the concept of asymmetric information is limited to the *literal meaning* of “asymmetric information” which refers to the knowledge gap between actors in the market or the supply chain or value network. SIMMS, software systems, is a tool. It is not about the economics of information asymmetry. It will be designed as connected platform which aims to reduce asymmetric information in the market to benefit all actors, especially the billions of users (BOU). SIMMS as a software system is the networked tool aimed at transforming *the need* to reduce information asymmetry *to the reality* of trillions of FEWSH related market transactions which may occur on mobile devices in the hands of BOU.

<sup>2</sup> [a] Williamson, O.E. (2025). *Transaction Cost Economics*. In: Ménard, C., Shirley, M.M. (eds) *Handbook of New Institutional Economics*. Springer, Cham.  
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[b] Gibbons, Robert. “Transaction-Cost Economics: Past, Present, and Future?: Transaction-Cost Economics: Past, Present, and Future?” *Scandinavian Journal of Economics*, vol. 112, no. 2, June 2010, pp. 263–88. <https://doi.org/10.1111/j.1467-9442.2010.01609.x>

<https://web.mit.edu/rgibbons/www/Gibbons%20SJE%20Apr%2013.pdf>

(**Note:** Transaction cost economics is a vast body of work and evolution of economic thought and principles since 9<sup>th</sup> March 1776 (“*The Wealth of Nations*” published by Adam Smith). The 20<sup>th</sup> century contribution by Ronald Coase originated as a practical view of price in the context of production of goods and services (Martínez, Sergio (2025) *Why You Should Read Ronald Coase*. The Foundation for Economic Education. <https://fee.org/articles/why-you-should-read-ronald-coase/>). For the purpose of this

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discussion paper, the concept of transaction cost is limited to the *literal meaning* advocated by Ronald Coase (price in the context of the production of goods and services). The broader spectrum of policy, governance, regulation, trade practices and political economy with respect to transaction cost economics is of infinite importance but beyond the scope of what SIMMS aims to accomplish. SIMMS aspires to reduce the transaction cost of operations related to daily activities surrounding FEWSH. For this purpose SIMMS is not aiming to change the sourcing of raw materials or production machinery or governance of make/buy decisions. Operational reduction of transaction cost in this context is a matter of connected software systems and software tools for granular decision support related to actors in FEWSH verticals or the supply chain or value network. SIMMS, software systems, is a tool which cannot operate for free. Hence, SIMMS must be creative to package actionable outcomes from transaction units. These “units” must be able to make use of the pay-a-penny-per-unit (PAPPU) model to monetize the SIMMS tool (at the lowest “unit” cost) to reduce the economic barriers to entry (even for impoverished communities). SIMMS is not about transaction cost economics but transaction cost, period. SIMMS is a connected-by-design platform which aims to reduce transaction cost in the market to benefit all actors (BOU). SIMMS as a software system is the networked tool aimed at transforming *the need* to reduce transaction cost *to the reality* of trillions of FEWSH related market transactions which may occur on mobile devices in the hands of BOU (billions of users) and BOU will find that it is in her best interest to pay a penny each time (per transaction) using SIMMS.

<sup>3</sup> Tabansi, Obi. “Learning From Cisco’s \$2.25 Billion Inventory Collapse and Write-Off in 2001.” *Supply Chain Nuggets | A Rediscovery of African Supply Chains*, 19 July 2025, <https://supplychainnuggets.com/learning-from-ciscos-2-25-billion-inventory-collapse/>

<sup>4</sup> INSEAD. *How Apple’s iPod Broke All The Rules*  
<https://knowledge.insead.edu/print/pdf/node/33491>

<sup>5</sup> Praveen Kumar (2024) *Apple Made A Device Named Newton: But It Failed Brilliantly*  
<https://medium.com/write-a-catalyst/apple-made-a-device-named-newton-but-it-failed-brilliantly-e53564851bc5>

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<sup>6</sup> Morgan V, Casso-Hartmann L, Bahamon-Pinzon D, McCourt K, Hjort RG, Bahramzadeh S, Velez-Torres I, McLamore E, Gomes C, Alocilja EC, Bhusal N, Shrestha S, Pote N, Briceno RK, Datta SPA, Vanegas DC. (2020) *Sensor-as-a-Service: Convergence of Sensor Analytic Point Solutions (SNAPS) and Pay-A-Penny-Per-Use (PAPPU) Paradigm as a Catalyst for Democratization of Healthcare in Underserved Communities*. *Diagnostics* (Basel). 2020 January 1; 10(1):22. doi: 10.3390/diagnostics10010022. PMID: 31906350; PMCID: PMC7169468. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7169468/pdf/diagnostics-10-00022.pdf>

<sup>7</sup> Coase, R. H. (1937). The Nature of the Firm. *Economica*, 4(16), 386–405 <https://doi.org/10.2307/2626876>  
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<sup>8</sup> Ronald H. Coase. Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1991 <https://www.nobelprize.org/prizes/economic-sciences/1991/coase/facts/>

<sup>9</sup> Mesmer, Philippe (15 January 2026) *Japan is sinking into a demographic crisis*. *Le Monde* [https://www.lemonde.fr/economie/article/2026/01/15/le-japon-s-enfonce-dans-la-crise-demographique\\_6662411\\_3234.html](https://www.lemonde.fr/economie/article/2026/01/15/le-japon-s-enfonce-dans-la-crise-demographique_6662411_3234.html)  
<https://www.populationpyramid.net/japan/2100>

<sup>10</sup> World Literacy <https://worldpopulationreview.com/country-rankings/literacy-rate-by-country>

<sup>11</sup> US Census Bureau <https://www.census.gov/quickfacts/fact/table/US/PST045224>

<sup>12</sup> BEA <https://apps.bea.gov/iTable/?reqid=19&step=3&isuri=1&1921=survey&1903=58>

<sup>13</sup> Focus Economics <https://www.focus-economics.com/country-indicator/united-states/disposable-income/>

<sup>14</sup> Trading Economics <https://tradingeconomics.com/country-list/disposable-personal-income>

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<sup>15</sup> Datta, S. (2001) *Agents: Where Artificial Intelligence Meets Natural Stupidity*  
<http://dspace.mit.edu/handle/1721.1/41914>

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<sup>16</sup> Information Asymmetry (2001) <https://www.nobelprize.org/prizes/economic-sciences/2001/popular-information>

<sup>17</sup> Datta, S. and Goldman, J.M. (2010; 2017) *Healthcare - Digital Transformation of the Healthcare Value Chain*. <https://arxiv.org/ftp/arxiv/papers/1703/1703.04524.pdf>  
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<https://competitionandappropriation.econ.ucla.edu/wp-content/uploads/sites/95/2017/08/HistoryGameTheory.pdf>

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The “new age” of game theory may have started with Antoine Augustin Cournot and Joseph Bertrand in the 19<sup>th</sup> century on duopoly and Francis Ysidro Edgeworth from Oxford (<https://www.hetwebsite.net/het/profiles/edgeworth.htm>) on bilateral

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monopoly. In the 20<sup>th</sup> century, prior to John von Neumann and Oscar Morgenstern, the work by Frederik Ludvig Bang Zeuthen on bargaining (Schneider, E. (1959). Frederik Zeuthen: In Memoriam (1888-1959). *Econometrica*, 27(4), 685–687.

[www.jstor.org/stable/1909360](http://www.jstor.org/stable/1909360); [www.hetwebsite.net/het/profiles/zeuthen.htm](http://www.hetwebsite.net/het/profiles/zeuthen.htm)) and Heinrich Freiherr von Stackelberg on oligopoly (<https://hetwebsite.net/het/profiles/stackelberg.htm>) were later reinterpreted in game-theoretic terms. The “Stackelberg equation” is often used by the airline industry in the 21<sup>st</sup> century internet-era for dynamic pricing changes online based on inventory and/or demand. It is used by businesses for contracts, based on “signals” related to demand and “private information” which may allow the seller to fashion offers and pricing. Başar, T. (2021). *Game Theory: A General Introduction and a Historical Overview*. In: Baillieul, J., Samad, T. (eds) *Encyclopedia of Systems and Control*. Springer, Cham. [https://doi.org/10.1007/978-3-030-44184-5\\_26](https://doi.org/10.1007/978-3-030-44184-5_26)

<sup>19</sup> An explosion of game theory in practice was the use of “prisoner’s dilemma” (in principle) transformed as the “buzz” of business in the last decade on the 20<sup>th</sup> century and applied (willy-nilly) as *a hammer in search of a nail*, with exceptions, of course, where the strategy was indeed informative and advanced our understanding: The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, 2005. <https://www.nobelprize.org/prizes/economic-sciences/2005/summary>  
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<sup>20</sup> Datta, S. *et al* (2002) *Adaptive Value Network*. Chapter 1 (pages 3-67). In *Evolution of Supply Chain Management: Symbiosis of Adaptive Value Networks and ICT*. Chang, YS, Makatsoris, HC and Richards, HD, eds. ISBN 978-1-4020-7812-5 Kluwer Academic Publishers, Boston <https://doi.org/10.1007/b110025> MIT Library <https://dspace.mit.edu/handle/1721.1/41908>

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<sup>22</sup> Baek, Y., *et al* (2025) “Edge Intelligence through In-Sensor and near-Sensor Computing for the Artificial Intelligence of Things.” *Npj Unconventional Computing*, vol. 2, no. 1, October 2025, p. 25. <https://doi.org/10.1038/s44335-025-00040-6>

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1997 Hiroshi Ishii, MIT Media Lab - Tangible Bits (please see reference number 35)  
1998 Sanjay Sarma, MIT MechE - Internet of Things (IoT)  
<https://trackr-media.tangiblemedia.org/publishedmedia/Papers/668-OTY3M/Published/PDF> (below) and see <https://tangible.media.mit.edu/event/27/>  
Sanjay Sarma, MIT - 1998, MIT Auto ID Center - <https://autoid.mit.edu/>  
Sanjay Sarma, MIT - <https://meche.mit.edu/people/faculty/sesarma%40mit.edu>  
Sanjay Sarma, MIT - [https://en.wikipedia.org/wiki/Sanjay\\_Sarma](https://en.wikipedia.org/wiki/Sanjay_Sarma)

From: weiser@serc.com  
Subject: "Tangible Bits"  
Date: January 27, 1997 2:34 10 AM EST  
To: ishii@media.mit.edu, ulmer@media.mit.edu

Dear Hiroshi and Brygg,

I recently had a chance to read your CHI 97 paper "Tangible Bits". Great work! In my opinion this is the kind of work that will characterize the technological landscape of the twenty-first century.

I do have a request. As a former professor with tenure I well understand the need to distinguish one's work from all that comes before. And I very much appreciate your kind acknowledgment to me. Thanks! My request is that you help me stop the spread of misunderstanding of ubiquitous computing based simply on its name. Ubiquitous was never just about making "computers" ubiquitous. It was always, like your work, about awakening computation mediation into the environment. The Tics, Pads, and Boards were simply a way to break out of the mold while still engaging traditional computer scientists - although sponsoring Netale to work on the thing turned out to be as important as any of them!

I tried to stop using ubiquitous computing because of its misleading implication, but it keeps cropping up again, so I keep returning to it as my umbrella name for lots of work, including Things That Think. Asgnment's reality was in use for awhile, but again got balkanized in meaning. I have started to talk about CAM Technology as a theme, but it better names a goal than a research project. "Tangible Bits" is very nice, and maybe could serve as an overall umbrella, but then you might use it as the name of your research project! I think we would all benefit if we could have an allegiance in some one common thing, and define our differences within that. For we struggle with what to call that allegiance.

Anyway, great work, and I hope to visit soon and have some good chats now that Name has joined the Media Lab (and I am one of the two official Name advisors).

-Mark  
(Dr.) Mark Weiser  
Chief Technologist, Xerox PARC  
email: weiser@serc.com info: www.usg.com/weiser

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<https://pmc.ncbi.nlm.nih.gov/articles/PMC7571236/pdf/sensors-20-05023.pdf>

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Robert Engle (2003) *GARCH 101: An Introduction to the Use of ARCH/GARCH models in Applied Econometrics* <https://web-static.stern.nyu.edu/rengle/GARCH101.PDF>

<sup>26</sup> Philip Levis, Sam Madden, David Gay, Joseph Polastre, Robert Szewczyk, Alec Woo, Eric Brewer, and David Culler (2004) *The emergence of networking abstractions and techniques in TinyOS*. In Proceedings of the 1st conference on Symposium on Networked Systems Design and Implementation - Volume 1 (NSDI'04). USENIX Association, USA. <https://dl.acm.org/doi/10.5555/1251175.1251176>

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Published version <https://dspace.mit.edu/handle/1721.1/41913>

Applications <https://dspace.mit.edu/handle/1721.1/43943>

<http://dspace.mit.edu/handle/1721.1/43948>

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, 2003.

<https://www.nobelprize.org/prizes/economic-sciences/2003/summary>

<sup>29</sup> English Prepositions <https://www.englishclub.com/grammar/prepositions-list.php>

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van Hoek R (2004), "Adapt or Die: Transforming Your Supply Chain into an Adaptive Business Network". *Supply Chain Management*. Vol. 9 No. 1 pp. 118–119,

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<sup>33</sup> Lifelong Kindergarten Lab, MIT Media Lab, Massachusetts Institute of Technology

<https://mitchresnick.substack.com/p/natalie-rusk-building-on-interests>

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(January 2010), pages 1–137. <https://doi.org/10.1561/1100000026>

Tangible Media, Massachusetts Institute of Technology <https://tangible.media.mit.edu/>

Tangible Interfaces (2025) MIT Course Number: MAS.834

<https://www.media.mit.edu/courses/MAS834-2025/>

Tangible “bits” and the idea of connecting “bits to atoms” was the predecessor to the gradual evolution of the internet of things (IoT) in the 20<sup>th</sup> century, first at PARC, Xerox Palo Alto Research Center (Perry, T.S. & Wallich, P. (1985) *Xerox Parc’s Engineers on How They Invented the Future - IEEE Spectrum*. <https://spectrum.ieee.org/xerox-parc>) and then at the MIT Auto ID Center (<https://autoid.mit.edu/people.html>). The latter was followed by the Industrial IoT, which was ushered into the business world, among

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others, by Dr Joseph Salvo of GE Global Research, NY (Salvo, J. (2016) *SATURN 2016 Keynote: Architecture and the Evolution of Complex Systems*. 30 June 2016.

<https://www.sei.cmu.edu/library/saturn-2016-keynote-architecture-and-the-evolution-of-complex-systems/>).

At present, the Center for Bits and Atoms at the MIT Media Lab pursues research representing a broad spectrum of fundamental explorations and applications:

<https://www.media.mit.edu/graduate-program/center-for-bits-and-atoms/>

<sup>36</sup> “Field of Optimization Theory” requires a brief note before getting immersed in the academic treasures pioneered by the erudite scholars of INFORMS which forms the basis of most software used in optimization issues, both in academia and business, under the amorphous label of “decision support” ([www.informs.org](http://www.informs.org)). The latter relies on the trinity of linear programming (George Dantzig), dynamic programming (Richard Bellman) and system dynamics (Jay Forrester). The field of system dynamics erupted from MIT in the 1950’s and was created by Professor Jay W. Forrester (at MIT).

- <https://mitsloan.mit.edu/faculty/academic-groups/system-dynamics/about-us>
- <https://systemdynamics.org/news/memorial/jay-w-forrester/>
- <https://systemdynamics.org/origin-of-system-dynamics/>
- <https://www.harvardsquarelibrary.org/biographies/jay-wright-forrester/>
- <https://www.mckinsey.com/~media/McKinsey/Business%20Functions/Strategy%20and%20Corporate%20Finance/Our%20Insights/The%20beginning%20of%20system%20dynamics/The%20beginning%20of%20system%20dynamics.pdf>).

It appears that “the world forum on decision making” excludes BOU and its tools may need a closer inspection ([www.decisionprofessionals.com](http://www.decisionprofessionals.com)). SDP derives their thrills from high-impact decisions with a small set of choices (but very complex forms of uncertainty). INFORMS promote decisions under uncertainty for deterministic problems. It is sheer brilliance but how much of it can serve BOU? We need stochastic optimization in SIMMS but the abundance of sophisticated tools makes it necessary to extract the wealth of wisdom which will be pragmatic for BOU using the SIMMS tool.

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Daniel Kahneman [www.nobelprize.org/prizes/economic-sciences/2002/summary/](http://www.nobelprize.org/prizes/economic-sciences/2002/summary/)

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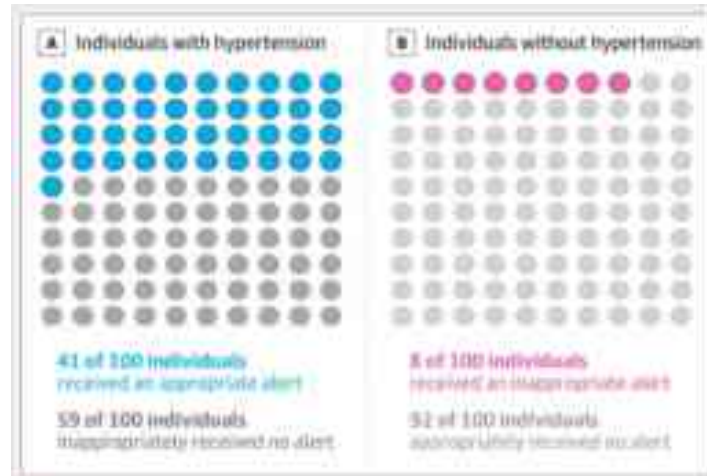
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This figure (Cohen *et al*) depicts visualization of risk based on expected alert patterns using the reported sensitivity and specificity of Apple Watch hypertension notification feature. A, Blue dots represent true-positive or appropriate alerts and gray dots represent false-negative or inappropriate absence of alerts. B, Pink dots represent false-positive or inappropriate alerts, and light gray dots represent true-negative or appropriate absence of alerts. Each panel is scaled to 100 individuals to illustrate the relative frequency of correct and incorrect notifications.

Perhaps part of the problem rests with analytical software embedded in digital health tools which uses forms of AI. Hard-coded equation-based AI algorithms are generic formulas which lack context awareness. AI introduces errors and flaws related to interpretation of data. The proclivity of some humans to view AI as an *oracle* is to blame. AI is useful if AI approximations are treated as a “humble helper” for human-in-the-loop decision support (<https://news.mit.edu/2026/creating-humble-ai-0324>).

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[https://media.vogue.co.uk/photos/64464140a2d00f48b810db24/master/w\\_1600%2Cc\\_limit/rana\\_plaza\\_april23\\_GettyImages540050828.jpg](https://media.vogue.co.uk/photos/64464140a2d00f48b810db24/master/w_1600%2Cc_limit/rana_plaza_april23_GettyImages540050828.jpg)

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<sup>107</sup> The award of the Nobel Prizes cited in this document leaves little doubt as to the authenticity of the principles underlying SIMMS, *if we assume* that the Nobel Prize perhaps serves an index of credibility in science. *The latter is no longer true.* The credibility of the Nobel Prize organization was shattered in 2024 due to the disgraceful FOMO (*fear of missing out*) in awarding the undeserved Nobel Prize in Physics, 2024, for bogus, unproven, spurious and plagiarized work related to so-called machine learning and artificial intelligence *inventions*. However, this was not the first time that the Nobel Committee has shown sloppy understanding and poor judgement. The 2008 Nobel Prize in Chemistry, omitted and even failed to recognize the true “inventor” of GFP (green fluorescent protein), who was no longer in academia at the time of the award (*Douglas Prasher – The Man Who Wasn’t There*. Science. 13 February 2009. <https://www.science.org/content/article/man-who-wasnt-there>). In non-science matters the organization is vulnerable and questionable relative to the peace prize fiasco [www.nytimes.com/2025/03/24/us/politics/trump-nobel-peace-prize.html](http://www.nytimes.com/2025/03/24/us/politics/trump-nobel-peace-prize.html)). Having said that, I hasten to add that blaming the Nobel Committee, exclusively, is perhaps unfair because plagiarism is a fact of life and in practice over the centuries by iconic scientists who are venerated figures in the august halls of science and learning. Howlett, Joseph (25 February 2026) “*The Man Who Stole Infinity*.” Quanta Magazine. 25 Feb 2026. <https://www.quantamagazine.org/the-man-who-stole-infinity-20260225/>

<sup>108</sup> Agents of Global Change <https://d-lab.mit.edu/> as well as <https://shass.mit.edu/>  
There are an opulence of good intentions (e.g., Alison Rufo at MIT working in Lake Titicaca in Peru <https://misti.mit.edu/social-impact-summer-2025winners> and <https://www.instagram.com/reels/DR4wKnRj7qL/>) but creating change is, often, just lip service (*lippenbekenntnis*). Positive change is difficult, e.g., increasing volume of global food waste despite the fact that ~2.3 billion people suffer from food insecurity (<https://blogs.worldbank.org/en/opendata/five-alarming-statistics-on-global-hunger>) and the number of people going *hungry each day* is increasing to approach 1 billion (<https://news.un.org/en/story/2025/10/1166108>). In a world currently immersed in the absence of empathy, it is important to re-discover timeless beacons of humanity which has served civilization for centuries without pomp, self-aggrandizement or bombastic marketing campaigns to peddle the ‘*every child*’ panacea ([www.gatesfoundation.org/](http://www.gatesfoundation.org/)). One example is the Fugger Foundation in Augsburg, DE. Jakob Fugger (1459-1525), a benefactor of the Fuggerei established an account with 10,000 florins on behalf of his deceased brothers Georg and Ulrich in the 16<sup>th</sup> century. 500 years later there are nine Fugger Foundations which are still continuing the tradition of providing “assistance” so that people can help themselves (<https://www.fugger.de/en/foundations>).



For more information: [www.rts.com/resources/guides/food-waste-america/](http://www.rts.com/resources/guides/food-waste-america/)



The 500-year old Fugger Foundation is now planting new seeds for the next 500 years (see [www.fugger.de/en/press/start-of-construction-of-the-first-fuggerei-of-the-future](https://www.fugger.de/en/press/start-of-construction-of-the-first-fuggerei-of-the-future)). It is rooted in basic integrity, trust, ethics, science (BITES). It is devoid of stupidity, such as *selling sunlight on demand* or *sunlight as a service* ([www.reflectorbital.com](http://www.reflectorbital.com)).

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<sup>109</sup> Note: Facets of science serving the “poor” may be mired in quagmire refers to the concept of what science can do – which may be viewed differently between wealthy nations and poor nations. One significant metric is to evaluate mathematics and science related educational accomplishments of school students in nations, e.g., US, where the scores are plummeting. The U.S. has spent ~\$30 billion on laptops and tablets in schools, since the dawn of the 21<sup>st</sup> century, accelerated by behemoths interested in increasing sales of information technology related products and services. [Rogelberg, Sasha (2026) *American Schools Weren’t Broken until Silicon Valley Used a Lie to Convince Them They Were - Now Reading and Math Scores Are Plummeting*. Fortune. March 1, 2026. <https://fortune.com/2026/03/01/american-schools-broken-silicon-valley-edtech-gen-z-test-scores/>]. A quarter century later there is evidence of cognitive decline in children, i.e., GenZ versus the cognitive abilities of their parents. [Angel Benegas Orrego (2 March 2026) *Life in the Endless Scroll: What We’re Losing*. Medscape. <https://www.medscape.com/viewarticle/life-endless-scroll-what-were-losing-2026a10005od>]. The “poor” nations, unable to spend resources to purchase information technology products may wish to view this “computer delusion” as a blessing. [Todd Oppenheimer (1997) *The Computer Delusion*. July 1997. The Atlantic. <https://www.theatlantic.com/magazine/archive/1997/07/the-computer-delusion/376899/> and <https://www.thetedkarchive.com/library/todd-oppenheimer-the-computer-delusion.pdf>]. Undeniably the “poor” in the poor nations are rich in cognition. It may be almost poignant to point out that poverty may be shielding the poor in poor nations from the march of unreason due to the artificial intelligence (AI) tools being shoved down the throat of affluent nations in the name of productivity and prosperity. AI is not about productivity but about sales of products and services. In affluent nations parents leave toddlers with smartphones and iPads to entertain themselves much to the chagrin of neuroscientists. In affluent nations “poor people” may be identified as obese (unable to afford Wegovy, Ozempic, Ro) and with cognitive impairment. In poor nations, *poor* people cannot afford FEWSH but are still cognitive enough to master mathematics, if the opportunity for education was made available.

*In 1996, school administrators in Mansfield, MA, had eliminated art, music, and physical-education positions in favor of buying computers. Michael Bellino, an electrical engineer at BU’s (Boston University’s) Center for Space Physics, appeared before the Massachusetts Board of Education to protest. “The purpose of the schools [is] to, as one teacher argues, “Teach carpentry, not hammer,” he testified. “We need to teach the whys and ways of the world. Tools come and tools go. Teaching our children tools limits their knowledge to these tools and hence limits their futures.”* [www.theatlantic.com/magazine/archive/1997/07/the-computer-delusion/376899/](https://www.theatlantic.com/magazine/archive/1997/07/the-computer-delusion/376899/)

The evolution of intelligence may ignore *artificial intelligence*. [Isabelle C. Hau (2026) *Welcome to the Era of Relational Intelligence*. Stanford Social Innovation Review 2026 <https://ssir.org/articles/entry/era-of-relational-intelligence>]. The “poor” in the *poor nations* are perhaps richer in relational intelligence. However, is “intelligence” turning out to be a poor choice of a word? Isn’t it a trite and hackneyed expression, by now?

### THE CO-EVOLUTION OF HUMAN AND SOCIAL INTELLIGENCE

Human intelligence has evolved hand in hand with social organization—from early survival and cooperation, through language, culture, and institutions, to the analytical age and today’s AI-mediated world. The emerging frontier is relational intelligence (RI): the capacity for relating, trust, collaboration, and shared meaning.

| ERA/NAME                              | APPROX. TIME FRAME          | KEY EVOLUTIONARY DEVELOPMENTS IN INTELLIGENCE   | PARALLEL SOCIAL DEVELOPMENTS  | DEFINING COGNITIVE & RELATIONAL CAPACITIES  |
|---------------------------------------|-----------------------------|---|---|---|
| 1. Biological Intelligence            | 7-3 million years ago       | Emergence of Australopithecus and early Homo habilis; brain expansion begins; tool use and problem-solving          | Small kin groups; basic cooperation for food and defense                          | Sensory awareness, pattern recognition, proto-empathy; survival through mutual protection |
| 2. Social Intelligence                | 1 million-200,000 years ago | Homo erectus develops planning, imitation, teaching; control of fire  | Cooperative hunting, food sharing, and division of labor                          | Early communication, learning by observation, coordination, shared attention              |
| 3. Symbolic/Linguistic Intelligence   | 300,000-40,000 years ago    | Homo sapiens evolve language, imagination, symbolic reasoning   | Formation of tribes; rituals, art, and oral traditions emerge                     | Abstract thought, moral judgment, storytelling, shared identity                           |
| 4. Cultural Intelligence              | 40,000 years ago-10,000 BCE | Mastery of symbols, art, and tools; cumulative cultural learning  | Large, stable communities; emergence of trade and social hierarchies              | Collective memory; transmission of knowledge, cultural norms, and education               |
| 5. Civilizational Intelligence        | 10,000 BCE-1800 CE          | Agriculture, writing, and mathematics; institutional learning   | Rise of cities, empires, organized religion, and law                              | Bureaucratic reasoning, moral codes, large-scale cooperation, empathy beyond kin          |
| 6. Analytical Intelligence            | 1800-2000 CE                | Scientific revolution, industrialization, formal education, and IQ testing  | Nation-states, global communication, labor specialization                         | Abstract reasoning, innovation, data-driven problem-solving, systemic thinking            |
| 7. Artificial/Hybrid Intelligence     | 2000 CE-present             | Digital and AI revolutions; externalization of memory and cognition   | Networked societies, social media, virtual collaboration                          | Extended cognition, collective intelligence, information abundance but relational strain  |
| 8. Relational Intelligence (Emerging) | 21st century onward         | Integration of neuroscience, complexity research, and social cognition; recognition of RI (relational intelligence) | Global interdependence; search for meaning and connection in an AI-mediated world | Empathy, trust, collaboration, cocreation, individual and collective well-being           |

FIGURE 1. THE CO-EVOLUTION OF HUMAN AND SOCIAL INTELLIGENCE. © ISABELLE C. HAU (2026). SOURCE: HAU (2026), HAU (2025), HAU (2024), HAU (2023), HAU (2022), HAU (2021), HAU (2020), HAU (2019), HAU (2018), HAU (2017), HAU (2016), HAU (2015), HAU (2014), HAU (2013), HAU (2012), HAU (2011), HAU (2010), HAU (2009), HAU (2008), HAU (2007), HAU (2006), HAU (2005), HAU (2004), HAU (2003), HAU (2002), HAU (2001), HAU (2000), HAU (1999), HAU (1998), HAU (1997), HAU (1996), HAU (1995), HAU (1994), HAU (1993), HAU (1992), HAU (1991), HAU (1990), HAU (1989), HAU (1988), HAU (1987), HAU (1986), HAU (1985), HAU (1984), HAU (1983), HAU (1982), HAU (1981), HAU (1980), HAU (1979), HAU (1978), HAU (1977), HAU (1976), HAU (1975), HAU (1974), HAU (1973), HAU (1972), HAU (1971), HAU (1970), HAU (1969), HAU (1968), HAU (1967), HAU (1966), HAU (1965), HAU (1964), HAU (1963), HAU (1962), HAU (1961), HAU (1960), HAU (1959), HAU (1958), HAU (1957), HAU (1956), HAU (1955), HAU (1954), HAU (1953), HAU (1952), HAU (1951), HAU (1950), HAU (1949), HAU (1948), HAU (1947), HAU (1946), HAU (1945), HAU 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Comment from reviewer Dr Gérald Santucci related to ‘relational intelligence’

<https://ensa4future.org/gerald-santucci/>

<https://www.linkedin.com/in/geraldsantucci/>

[www.trustech-event.com/en/event/news/interview-gerald-santucci-ensa](http://www.trustech-event.com/en/event/news/interview-gerald-santucci-ensa)

<https://theinternetofthings.eu/interview-gerald-santucci-ensa-european-education-new-society-association>

I do support the vision provided by the Table (*The Co-Evolution of Human and Social Intelligence*). It reminds me of the various facets of “information” e.g., information may be *un-meaningful* (a message) by the mere fact it exists or not, *cybernetic* (a signal) by the need that it meets, *semantic* (a discourse) by the technology that it contains, *semiotic* (a symbol) by any system of signs that it reflects and, as it reflects the relations in society, *relational* by the meaning it has for the person for whom – supplier or user – it is an object.

The economic history of industrial systems is the one of the slow rise of the use of cybernetic information, then semantic information, then semiotic information, and finally relational information, for an identical quantity of energy. But by an increased use of semantic information, economic development increases the quantity of energy consumed very rapidly and to varying degrees from one country to another. In other words, the energy consumed is more and more *informed* but the consumption of energy is more and more significant. It is as if a mechanism was hindering the evolution of social complexity towards an increased use of information. This mechanism is the interdiction of the rise of information to its ultimate level (relational). In other words, social innovation is blocked each time it creates the conditions of wellbeing without generating a revenue stream. Only scarcity and marketable products (and services) create value. Hence, the goal of industrial systems is to channel the aspirations of humans towards new markets through their behavior as consumers of cybernetic and semantic information, and not as creators of relational information.

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<sup>110</sup> “Nokia: From Paper Mill to Mobile Giant – The Untold Story of Evolution.” Substack newsletter. *Invisible Founders*, 10 September 2024

<https://theinvisiblefounder.substack.com/p/nokia-from-paper-mill-to-mobile-giant>

*Nokia Corporation - Full Story: From Finnish Paper Mill To 5G Pioneer*. 28 Oct 2025.

<https://kabinews.com/nokia-corporation-full-story-from-finnish-paper-mill-to-5g-pioneer/>

<sup>111</sup> Prejudices linked to race, religion and riches are at the core of fractured society. The latter manifests as global inequity in terms of freedom, rights and wealth distribution. SIMMS is an attempt to “level the playing field” (viewed as reducing information asymmetry with respect to BOU). The idiomatic expression (*level playing field*) is applied to chess, because the so-called ‘game of kings’ can defy prejudices by celebrating the intellectual prowess of winners, irrespective of their race, religion and riches. “Chess is thought to have developed sometime in the 6<sup>th</sup> century in the Gupta Empire in India, from where it spread across the Silk Roads both eastward and westward. Played by people from the wealthiest and the poorest strata alike from the Outer Hebrides to Samarkand, by the end of the first millennium it was popular across Asia, Africa, and Europe. The history of chess is therefore deeply intertwined with cross-cultural interaction. While most of this process took place through untraceable chains of anonymous interactions, concrete encounters are also recorded. According to a medieval tradition, the Abbasid caliph Hārūn al-Rashid (circa 786–809 A.D.) gifted a chess set to Charlemagne (circa 768–814 A.D.) upon his coronation as emperor in 801 A.D. In 13<sup>th</sup> century communal Florence, a Muslim traveler entered a contest where he master-fully defeated two Italian “white” opponents while playing blindfolded. Chess was also a potent tool of intercultural communication between civilizations that had never been in direct contact before. The commander of the first Portuguese expedition to Malacca in 1509 was playing chess when a Javan (Java, Indonesia) came aboard his ship. The Javan immediately recognized the game, and they started to discuss the different forms of the pieces, through which first contact was established. Yet, despite its potential as a tool to facilitate cross-cultural communication, previous scholars have primarily examined medieval chess to understand how gameplay developed.” (Quote from paper by Krisztina Ilko) Krisztina Ilko (2024) *Chess and Race in the Global Middle Ages*. *Speculum* 2024 vol 99, issue 2, pages 480-540 <https://www.journals.uchicago.edu/doi/10.1086/729294> appears in “Race, Race-Thinking, and Identity in the Global Middle Ages” *Speculum* Volume 99, Number 2 (4/2024) <https://www.journals.uchicago.edu/toc/spc/2024/99/2> <https://www.cam.ac.uk/stories/medieval-chess-promoted-racial-harmony>

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It begs to be noted that race thinking in the 21<sup>st</sup> century is darker than the dark ages: C. L. Dancy and P. K. Saucier (2022) "*AI and Blackness: Toward Moving Beyond Bias and Representation*," in IEEE Transactions on Technology and Society, vol. 3, no. 1, pp. 31-40, March 2022, doi: 10.1109/TTS.2021.3125998. <https://arxiv.org/pdf/2111.03687>

<sup>112</sup> Buolamwini, Joy (11<sup>th</sup> January 2022) *Facing the Coded Gaze with Evocative Audits and Algorithmic Audits*. PhD thesis, MIT (Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, MIT. February 2022) <https://dspace.mit.edu/handle/1721.1/143396>

<sup>113</sup> Banerjee, Abhijit and Duflo, Esther (2012) *Poor economics*. PublicAffairs. <https://www.nobelprize.org/prizes/economic-sciences/2019/summary/>  
<https://news.mit.edu/2019/esther-duflo-abhijit-banerjee-win-2019-nobel-prize-economics-1014>  
<https://paxmongolica.org/wp-content/uploads/2019/11/poor-economics-a-radical-rethinking-of-the-way-to-fight-global-poverty-by-abhijit-v-banerjee-and-esther-duflo-pdf.pdf>

Sen, Amartya. (1999) *Development As Freedom*. 1st. ed. Knopf, 1999.

<https://sen.scholars.harvard.edu/publications/development-freedom>  
<https://www.nobelprize.org/prizes/economic-sciences/1998/sen/facts/>

Mullainathan, Sendhil. and Eldar Shafir (2013) *Scarcity: Why Having Too Little Means so Much*. First edition. Times Books, Henry Holt and Company, 2013.

<https://www.harvardmagazine.com/sites/default/files/pdf/2015/05-pdfs/0515-38.pdf>

<sup>114</sup> A. N. Kapanidis *et al* (2026) *From sequence to function: Bridging single-molecule kinetics and molecular diversity*. *Science* **391**, 458-465(2026).

DOI:10.1126/science.adv4503

<sup>115</sup> Poverty is akin to the "800 lb. gorilla" myth but it is very much a reality, raised to power infinity. Herculean efforts over the centuries did not dampen poverty's march of unreason <https://www.povertyactionlab.org/>. However, the 21<sup>st</sup> century, unlike others, is immersed in a quagmire of false and fake approaches created by humans [www.povertyactionlab.org/blog/11-5-25/ai-social-good-evidence-informed-agenda](http://www.povertyactionlab.org/blog/11-5-25/ai-social-good-evidence-informed-agenda) which are potent tools for publicity <https://news.mit.edu/2026/new-j-pal-research-policy-initiative-to-test-scale-ai-innovations-fight-poverty-0212> but low on purpose.

<sup>116</sup> Alexander, Lynsey (2021) "4 Mobile Applications Elevating Farmers in Kenya." *The Borgen Project*, 26 Oct 2021. <https://borgenproject.org/elevating-farmers-in-kenya/>

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<sup>117</sup> Abadi Ghadim, A. & D. J. Pannell (1999) A Conceptual Framework of Adoption of an Agricultural Innovation. *Agricultural Economics*, vol. 21, no. 2, October 1999, pp. 145–154. [https://doi.org/10.1016/S0169-5150\(99\)00023-7](https://doi.org/10.1016/S0169-5150(99)00023-7)

<sup>118</sup> Stefanie Koperniak (2026) “MIT Open Learning Has Opened Doors I Never Imagined Possible.” *MIT News, MIT*. 29 January 2026. <https://news.mit.edu/2026/mit-open-learning-opened-doors-i-never-imagined-possible-0129>

<sup>119</sup> E-Choupal Project (2000) <https://www.ceew.in/sustainable-agriculture-initiatives/e-choupal-initiative-case-study>

<sup>120</sup> Luo X, Zhu S, Song Z. (2023) *Quantifying the Income-Increasing Effect of Digital Agriculture: Take the New Agricultural Tools of Smartphone as an Example*. *Int J Environ Res Public Health*. 2023 Feb 10; 20(4):3127. doi: 10.3390/ijerph20043127. <https://pmc.ncbi.nlm.nih.gov/articles/PMC9959579/pdf/ijerph-20-03127.pdf>

<sup>121</sup> Arora, B., & Cummings, A. (2010). *Reuters Market Light: Creating Efficient Agriculture Markets in Rural India*. <https://research.aston.ac.uk/en/publications/reuters-market-light-creating-efficient-agriculture-markets-in-ru/> <https://www.slideshare.net/slideshow/reuters-market-light/5423236>

<sup>122</sup> Gouthon, M., Gouroubera, M. W., Tama-Imorou, C., & Moumouni-Moussa, I. (2024). Digital inequalities among smallholder farmers in Benin: Determinants of attitude, material access, skills and usage. *Information Development*, 0 (0). <https://doi.org/10.1177/02666669241280411> and <https://www.interestjournals.org/articles/impact-of-ict-use-on-access-to-markets-of-pineapple-smallholder-farmers-in-benin.pdf>

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<sup>123</sup> Pruitt ZM, Bocknek LS, Busog DNC, et al. (2023) Informing Healthcare Alarm Design and Use: A Human Factors Cross-Industry Perspective. *Patient Safety*. 2023; 5(1):6-14. doi:[10.33940/med/2023.3.1](https://doi.org/10.33940/med/2023.3.1) <https://patientsafetyj.com/api/v1/articles/73905-informing-healthcare-alarm-design-and-use-a-human-factors-cross-industry-perspective.pdf>

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<sup>124</sup> Sam Ransbotham *et al* (2025) “The Emerging Agentic Enterprise: How Leaders Must Navigate a New Age of AI.” *MIT Sloan Management Review*, November 2025. <https://sloanreview.mit.edu/projects/the-emerging-agentic-enterprise-how-leaders-must-navigate-a-new-age-of-ai/> and

<https://www.science.org/doi/10.1126/science.adz1697>

Kristin Burnham (2026) *How to Navigate the Age of Agentic AI*. MIT

[www.normaltech.ai/p/fact-checking-moravecs-paradox](http://www.normaltech.ai/p/fact-checking-moravecs-paradox)

<https://mitsloan.mit.edu/ideas-made-to-matter/how-to-navigate-age-agentic-ai>

<sup>125</sup> Sen, Amartya (2010) *The Idea of Justice*. Harvard University Press paperback ed, Belknap Press of Harvard University Press, 2011. ISBN 9780674060470

<https://philosophy.fas.harvard.edu/publications/idea-justice>

<https://dutraeconomicus.wordpress.com/wp-content/uploads/2014/02/amartya-sen-the-idea-of-justice-2009.pdf>

<sup>126</sup> Acemoglu, D. 2024 *Simple Macroeconomics of AI*

<https://shapingwork.mit.edu/research/the-simple-macroeconomics-of-ai/>

<https://www.nobelprize.org/prizes/economic-sciences/2024/acemoglu/facts/>

<https://mitsloan.mit.edu/ideas-made-to-matter/a-new-look-economics-ai>

[www.hsgac.senate.gov/wp-content/uploads/Testimony-Acemoglu-2023-11-08.pdf](http://www.hsgac.senate.gov/wp-content/uploads/Testimony-Acemoglu-2023-11-08.pdf)

<sup>127</sup> Stephan Rabanser, Sayash Kapoor, Peter Kirgis, Kangheng Liu, Saiteja Utpala, and Arvind Narayanan (2026) *Towards a Science of AI Agent Reliability*.

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<https://doi.org/10.48550/arXiv.2602.16666> & <https://hal.cs.princeton.edu/reliability>

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<sup>128</sup> **Caution:** “Agents in this approach (section 2) are “AI agents” but without the hype.”

This reference/note continues for 20 pages. The role of some form an agent system or “agency” may be necessary for SIMMS decision tool to collect, analyze and evaluate the data, determine relevant data, process some type of data fusion (with pre-existing data?) and (hopefully) stitch the data into plausible actionable information to support humans at the point of use. Hence, the cartoon in section 2 could be central to billions of users (BOU) who are trying to benefit from the SIMMS decision tool.

Therefore, it is necessary to digress and elaborate about (real) agents in an attempt to separate facts about software agents from the fiction of “agentic AI” which eludes logic and sanity with its march of unreason. The AI panacea, FOMO and hype has infected august institutions and credible efforts by scaling the AI propaganda to reach new heights of absurdity, e.g., to fight poverty, as promoted by the MIT Poverty Action Lab (J-PAL) endeavor PAIE - Project AI Evidence <https://news.mit.edu/2026/new-j-pal-research-policy-initiative-to-test-scale-ai-innovations-fight-poverty-0212>  
<https://www.povertyactionlab.org/initiative/project-ai-evidence-paie>  
<https://www.povertyactionlab.org/2025/ai-for-social-good?lang=en>

“AI agents” are currently a corporate buzz word for marketing the myth of human-level “intelligence” in “AI” agents. Agents were conceived during the 20<sup>th</sup> century (early years of the “AI” illusion). The (robust) ideas about *useful software agents* proposed by **Pattie Maes** (<https://www.media.mit.edu/people/pattie/overview/>)

**Katia Sycara** (<https://www.cs.cmu.edu/~sycara/>)

**H. Van Dyke Parunak** ([https://openreview.net/profile?id=~H.\\_Van\\_Dyke\\_Parunak1](https://openreview.net/profile?id=~H._Van_Dyke_Parunak1)) &

**Eric Bonabeau** (<https://ieeexplore.ieee.org/author/37275947800>) extended the metaphor of insects learning to accomplish defined tasks (small units, specific tasks, bite size jobs, working as a groups or “agencies”, collective knowledge, i.e. swarms).

**Eric Bonabeau**, Marco Dorigo, and Guy Theraulaz (1999) *Swarm Intelligence: From Natural to Artificial Systems*. Oxford Academic Press, OUP. New York, 1999.

<https://doi.org/10.1093/oso/9780195131581.001.0001>

Download the book from <https://s3.amazonaws.com/arena-attachments/600989/985fd31a26bedfda84c32ab5f7d38df3.pdf>

**H. Van Dyke Parunak** (2026) *Insects and Agents: Extending the Metaphor* in The 26th International Workshop on Multi-Agent-Based Simulation (see cartoon in section 2)

<https://openreview.net/pdf?id=W3ls7aYphi>

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One seminal observation about the current state of propaganda about AI obfuscation was made by Daron Acemoglu who suggested the term “*machine usefulness*” rather than the drivel about *intelligence* in AI and the “cognitive capabilities” of AI agents.

Daron Acemoglu (2024) *AI is “Machine Usefulness”*

<https://dspace.mit.edu/handle/1721.1/155442>

Daron Acemoglu

<https://economics.mit.edu/people/faculty/daron-acemoglu>

<https://mitsloan.mit.edu/faculty/directory/daron-acemoglu>

<https://www.nobelprize.org/prizes/economic-sciences/2024/summary/>

Predicted by Daron Acemoglu

<https://mitsloan.mit.edu/ideas-made-to-matter/a-new-look-economics-ai>

<https://shapingwork.mit.edu/research/the-simple-macroeconomics-of-ai/>

<https://www.nobelprize.org/prizes/economic-sciences/2024/summary/>

**(MIT Report)** “95% of generative AI pilots at companies are failing.”

[https://mlq.ai/media/quarterly\\_decks/v0.1\\_State\\_of\\_AI\\_in\\_Business\\_2025\\_Report.pdf](https://mlq.ai/media/quarterly_decks/v0.1_State_of_AI_in_Business_2025_Report.pdf)

<https://nanda.media.mit.edu/>

<https://fortune.com/2025/08/18/mit-report-95-percent-generative-ai-pilots-at-companies-failing-cfo/>

Cal Newport (2025) *Why AI didn’t transform our lives in 2025*

<https://www.newyorker.com/culture/2025-in-review/why-ai-didnt-transform-our-lives-in-2025>

<https://timesofindia-indiatimes->

[com.cdn.ampproject.org/c/s/timesofindia.indiatimes.com/technology/tech-](https://timesofindia-indiatimes.com/cdn.ampproject.org/c/s/timesofindia.indiatimes.com/technology/tech-)

[news/openai-ceo-sam-altman-just-publicly-admitted-that-ai-agents-are-becoming-a-problem-says-ai-models-are-beginning-to-find-/amp\\_articles/126215397.cms](https://timesofindia-indiatimes.com/technology/tech-news/openai-ceo-sam-altman-just-publicly-admitted-that-ai-agents-are-becoming-a-problem-says-ai-models-are-beginning-to-find-/amp_articles/126215397.cms)

Schrage, Michael and Kiron, David (16 January 2025) *Philosophy Eats AI*. MIT Sloan Management Review. <https://shop.sloanreview.mit.edu/philosophy-eats-ai>

Walsh, Dylan (21 January 2025) *A New Look at the Economics of AI*. MIT Sloan. 21 Jan 2025. <https://mitsloan.mit.edu/ideas-made-to-matter/a-new-look-economics-ai>

McLaughlin, Laurianne (12 November 2025) “*Agentic AI: Nine Essential Questions*.” MIT Sloan Management Review. 12 November 2025.

<https://sloanreview.mit.edu/article/agentic-ai-nine-essential-questions/>

Stackpole, Beth (18 February 2026) *Agentic AI, Explained*. MIT Sloan. 18 Feb 2026.

<https://mitsloan.mit.edu/ideas-made-to-matter/agentic-ai-explained>.

Walsh, Dylan (24 February 2026) *5 ‘Heavy Lifts’ of Deploying AI Agents*. MIT Sloan. 026.

<https://mitsloan.mit.edu/ideas-made-to-matter/5-heavy-lifts-deploying-ai-agents>

Sketchy summaries about agents, AI and facts about *why AI lacks “intelligence”* may be found here (with ample supporting evidence cited in the list of references):

Datta, S. (2001) *Agents: Where Artificial Intelligence Meets Natural Stupidity*

<http://dspace.mit.edu/handle/1721.1/41914>

Datta, S. (2016) *Intelligence in AI* <https://arxiv.org/ftp/arxiv/papers/1610/1610.07862.pdf>

Datta, S. (2017) “Prescription for Profit” *Journal of Innovation Management* 5, 2 (2017) 3-7

<http://hdl.handle.net/10216/105431> <https://repositorio-aberto.up.pt/bitstream/10216/105431/2/200962.pdf>

MIT Library <https://dspace.mit.edu/handle/1721.1/108000>

MIT Library <https://dspace.mit.edu/handle/1721.1/140791>

Datta, S. (2022) *Digital Twin Meets Digital Cousin* (please see DT-2024 and DT-2025)

[www.preprints.org/manuscript/202411.1638](http://www.preprints.org/manuscript/202411.1638)

MIT Library <https://dspace.mit.edu/handle/1721.1/140791>

NIH NIBIB [https://www.imagwiki.nibib.nih.gov/sites/default/files/Datta\\_DT-2024.pdf](https://www.imagwiki.nibib.nih.gov/sites/default/files/Datta_DT-2024.pdf)



Drew McDermott <https://www.cs.yale.edu/homes/dvm/>

Drew McDermott <https://onlinelibrary.wiley.com/doi/10.1002/aaai.12072>

Drew McDermott <https://direct.mit.edu/books/monograph/1824/Mind-and-Mechanism>

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(Why) *What may work for agents and BOU using the SIMMS decision software tool*

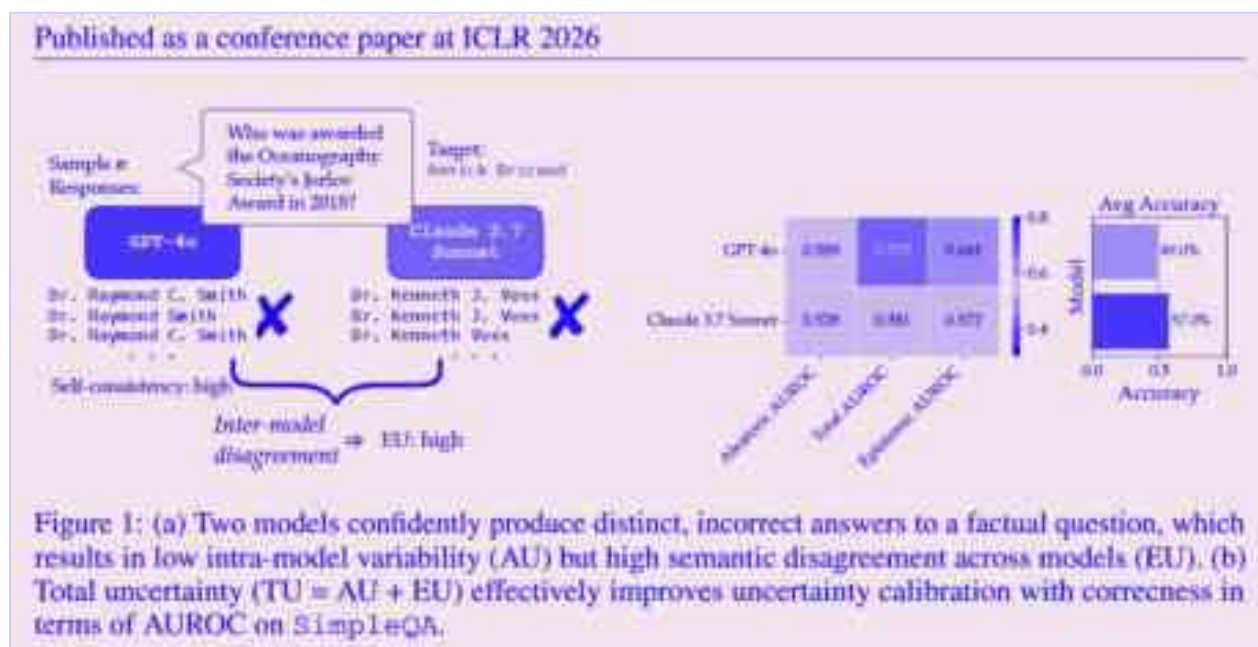
The decade of general-purpose A.I. agents failed to emerge in 2025. Andrej Karpathy, co-conspirator of the publicity machine OpenAI, left the company and started an A.I. education project. Belatedly he described agents as “cognitively lacking” and said, “It’s just not working.” Gary Marcus, a longtime critic of tech-industry hype, recently wrote on his Substack that “AI Agents have, so far, mostly been a dud.” This gap between prediction and reality matters. Fluent chatbots and reality-bending video generators are gimmicks and cannot usher any instance where machines take over human activities. The majority of A.I. companies are besotted with pecuniary greed. They are unable to deliver broadly useful agents and are unable to deliver on their promises of an AI powered future. It is time for AI charade to rest in peace and allow reasonable use of logical software agents, e.g., the agents for SIMMS and other purposes (for healthcare see “SOFT” <https://dspace.mit.edu/handle/1721.1/152921>).

The type of [AI] agents proposed and created by Pattie Maes at MIT CSAIL circa 1985, Katia Sycara at CMU and H. Van Dyke Parunak, are specific purpose-driven, data-gathering/data-informed, "discoverable" mobile units which may be transferrable (think “air drop”) and may [collectively] *support* decision systems (e.g., SIMMS). AI was and still is a misnomer but a very attractive buzz word bereft of "intelligence" in any form because software lacks cognition and causality. AI is as dumb as "monkey see, monkey do" (it can only “do” what a program/programmer has programmed) irrespective of fake claims (*the computer is as dumb as a door knob* - Steve Jobs).

In a book chapter, elsewhere, I will include many more references (now available in a zip folder on the MIT external drive - [About LLMs](#) and [Wittgenstein.zip](#)) as to why large language models (LLMs) – one of the forces behind “intelligence” in “agentic AI” – are merely language models bereft of *knowledge* and devoid of *understanding* (see below). Language models cannot grasp semantics, yet. But, language models (ChatGPT) are useful in searches for casual queries but are not consistent, reliable, and authentic.

Parshin Shojaee, Iman Mirzadeh, Keivan Alizadeh, Maxwell Horton, Samy Bengio and Mehrdad Farajtabar (2025) *The Illusion of Thinking: Understanding the Strengths and Limitations of Reasoning Models via the Lens of Problem Complexity*. Proceedings of NeurIPS <https://arxiv.org/abs/2506.06941> and <https://arxiv.org/pdf/2506.06941>  
Apple ML Research <https://machinelearning.apple.com/research/illusion-of-thinking>

Kimia Hamidieh, Veronika Thost, Walter Gerych, Mikhail Yurochkin and Marzyeh Ghassemi (2026) *Complementing Self-Consistency with Cross-Model Disagreement for Uncertainty Quantification*. ICLR 2026. <https://openreview.net/pdf?id=lOoRJo8xWy>



Radiologists and large language models (LLMs) both struggle to discern real X-ray scans from those generated by artificial intelligence. In a study that asked 17 radiologists about the technical quality of a series of X-ray images, only 41% raised concerns that AI scans had infiltrated the data. When asked to identify fake images, LLMs such as ChatGPT were only 57–85% accurate. These AI-generated images could pollute the scientific literature or compromise insurance claims, says radiologist and study co-author Mickael Tordjman. Such images could also creep into the training data of AI models being used to read medical imaging data, distorting their output.

Tordjman M, Yuce M, Ammar A, Huang M, Mihoubi Bouvier F, Lacroix M, Meribout A, Bolger I, Ozkaya E, Joshi H, Geahchan A, El Rahi R, Almansour H, Parihar AS, Horst C, Ozturk S, Isleyen ME, Pamuk GG, Cimilli AT, Deyer T, Calinghen A, Guillo E, Husain R, Laredo JD, Fayad ZA, Mei X, Taouli B. (2026) *The Rise of Deepfake Medical Imaging: Radiologists' Diagnostic Accuracy in Detecting ChatGPT-generated Radiographs*. *Radiology*. 2026 March; 318(3):e252094. doi: 10.1148/radiol.252094. PMID: 41874300. <https://doi.org/10.1148/radiol.252094> ; [www.nature.com/articles/d41586-026-00892-3](http://www.nature.com/articles/d41586-026-00892-3)

Ethics and Information Technology (EIT) 26(2)  
<https://doi.org/10.1007/s10676-024-09775-5>

ORIGINAL PAPER

### ChatGPT is bullshit

Michael Townsend Hicks<sup>1</sup> · James Humphries<sup>1</sup> · Joe Slater<sup>1</sup>

Hicks, Michael Townsend, Humphries, James and Slater, Joe (2024) *ChatGPT is bullshit*. *Ethics and Information Technology*, Volume 26, Issue 2 (June 2024) <https://doi.org/10.1007/s10676-024-09775-5>

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Expecting LLMs to morph into or eventually become "knowledge models" is a fool's errand unsupported by the mathematics which is at the base of AI/ML. Also, an useful analogy comes from Wittgenstein's rule-following problem/paradox - repeating a rule is not the same as grasping it or applying it in the semantic context. AI can recite instructions (why "auto" coding is a useful and powerful outcome of AI) until the context demands thinking, judgment, adjudication or anastomosis of ideas (cognitive abilities). Then AI recital collapses to irrelevance (hallucinates). AI in LLM "thinking" is closer to karaoke than to musicianship - AI LLM can carry the tune while the backup track is simple. LLMs are lost in the middle and in between (Fig 1 in "Lost in the Middle" <https://cs.stanford.edu/~nfliu/papers/lost-in-the-middle.arxiv2023.pdf>).

Messy, real-world data and tasks are laced with uncertainty. Such data is rarely used to test LLM models. Failure rate is high and trust/safety is very low (e.g., in healthcare) because published research results can be false. LLMs unconditionally "hoover up" (vacuum) text and other garbage on the internet. Thus, garbage is turned into fake "gold" in the hands of LLM/AI (it is worse than garbage in and garbage out because LLM/AI is turning tabloid fodder into veritable truth which could kill people). See perspective here - <https://www.ox.ac.uk/news/2023-11-20-large-language-models-pose-risk-science-false-answers-says-oxford-study>

The nail on the coffin of LLM's as "knowledge" models can be related to Wittgenstein's Language Games – context in syntax implying semantics (papers are in a zip folder on the MIT external drive – [Wittgenstein.zip](#)). The latter (logic) falls flat in the rule-following scenario (lack of sense, lacking the ability to "grasp") because the context in a cognitive inflexion (e.g., if I said "*what did you eat*" at 12:30pm versus if it is 7:30pm) is opaque or abstract for machine systems (AI) unless coded (programmed) as an instruction set/sequence/cascade/relationship ([www.jstor.org/stable/42968425](http://www.jstor.org/stable/42968425)). In a quite different context, I addressed this issue (multiple meanings of a syntactical word which are not sufficiently - digitally - dissected for their semantic relevance) in a paper (circa 2005 – please see ESD WP 2007 version of my paper in the MIT Library using this URL <https://dspace.mit.edu/handle/1721.1/41902>).

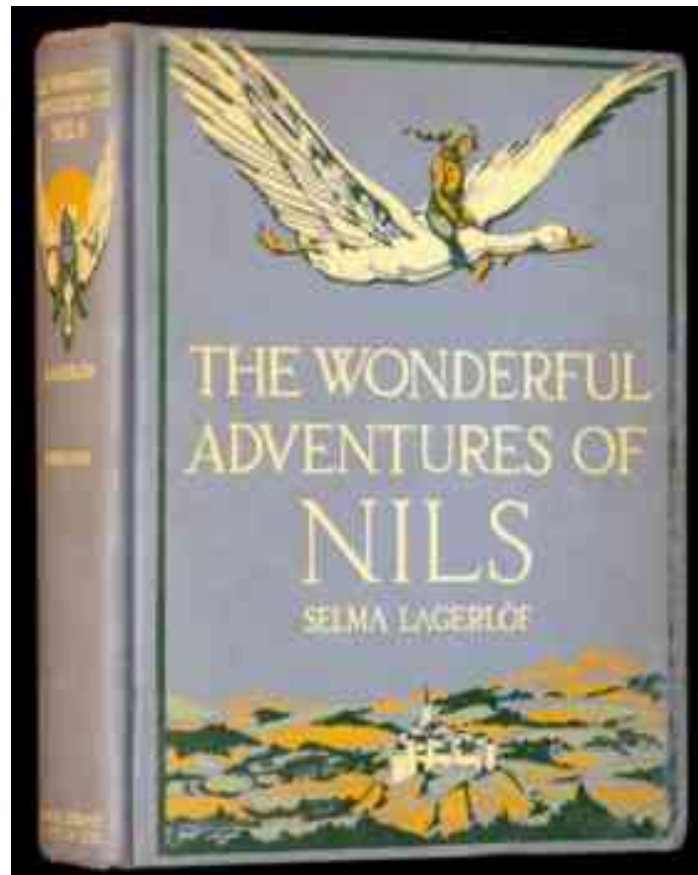
In the AI context – Stern's interpretations of Wittgenstein are noteworthy – explore: <https://www.cambridge.org/us/universitypress/subjects/philosophy/philosophy-general-interest/wittgensteins-philosophical-investigations-introduction>

The rule-following paradoxical paradigm is beyond the reach of AI: [https://www3.nd.edu/~jspeaks/courses/2007-8/93914/\\_HANDOUTS/kripkenstein.pdf](https://www3.nd.edu/~jspeaks/courses/2007-8/93914/_HANDOUTS/kripkenstein.pdf) (Perhaps Alan Turing was influenced by this paradox while creating the Turing Test.)

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One wonders if Wittgenstein was aware of the work related to pattern recognition in social and behavioral science by non-humans (animals, birds, etc.). It is known that birds, ducks, chickens can imprint on people they encounter when they are born or "first" open their eyes or something very close to the "first" sensual moments in these animals. These newborn animals can recognize patterns (someone walking, shapes, colours) that stays with them (for the rest of their life?). This **pattern recognition** event during the "clean slate" status in the animal brain is a "learning" experience, albeit primordial, primeval, primitive. Nothing in the known domain of machine learning or so-called AI is capable of copying even that baseline "learning" without being taught (coded, programmed). Research on animal imprinting was rewarded with the 1973 Nobel Prize

(<https://www.nobelprize.org/prizes/medicine/1973/summary/>). Informed people think that this idea may have started with a Swedish children's tale in the 1900's (*The Wonderful Adventures of Nils* <https://www.gutenberg.org/ebooks/10935>) by the Swedish author Selma Ottilia Lovisa Lagerlöf who received the 1909 Nobel Prize for Literature (<https://www.nobelprize.org/prizes/literature/1909/lagerlof/facts/>).



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Linguist Noam Chomsky (MIT) and education pioneer Jean Piaget debated (in the 1960's at the Sorbonne, Paris) whether learning is innate (Chomsky) or whether it is an outcome of being taught (Piaget). What would be the case for birds, ducks, chickens? Imprinting is a form of learning (I think we have to accept that fact) but is the *state* of pattern recognition innate or is pattern recognition is a learned event? Are "brains" *born* with the ability to recognize patterns? Once we recognize a pattern, of course, the pattern we *recognize* happens due to learning and cognition. But, why do we learn to recognize patterns? Is "patterning" an intrinsic property of neurons, neural networks and neural architecture even in primitive (under-developed) brains? We now know that the brain-less single-celled protozoa *S. coeruleus* is capable of Pavlovian learning.

Doan, Nhi, Austen Theroux, Tejas Ramdas, Samuel J. Gershman (2026) "Associative Learning in the Protozoan *Stentor coeruleus*." 25 February 2026. Cell Biology.  
<https://doi.org/10.64898/2026.02.25.708045>  
<https://www.biorxiv.org/content/10.64898/2026.02.25.708045v1.full.pdf>  
<https://www.newscientist.com/article/2519284-single-celled-organism-with-no-brain-is-capable-of-pavlovian-learning/>

Rajan D, Makushok T, Kalish A, Acuna L, Bonville A, Correa Almanza K, Garibay B, Tang E, Voss M, Lin A, Barlow K, Harrigan P, Slabodnick MM, Marshall WF. (2023) *Single-cell analysis of habituation in Stentor coeruleus*. Current Biology 2023 January 23; 33(2):241-251.e4. doi: 10.1016/j.cub.2022.11.010 PMID: 36435177  
<https://pmc.ncbi.nlm.nih.gov/articles/PMC9877177/pdf/nihms-1853174.pdf>

Can this justify Noam Chomsky's argument for the "*innate*" nature of learning? Can this "innate" form of learning (e.g., thinking of thoughts that has never been thought, before) a part of natural evolution – perhaps in the neuron-astrocyte networks in the context of associative memory that the brain (*any brain with a neural network?*) may possess as its natural (*evolutionary*) property. The latter may not be (amenable to) mathematically transformed into portable equations or copied to make sense in any binary logic format for knowledge representation in machine readable context. See [www.pnas.org/doi/epub/10.1073/pnas.2417788122](http://www.pnas.org/doi/epub/10.1073/pnas.2417788122). Note that this neuron-astrocyte network was usurped by John Hopfield (Hopfield networks) and Geoffrey Hinton for their *undeserved* Nobel Prize in Physics, 2024 (fake claims in a committee of errors).

These unanswered questions about learning is far from human comprehension (even for Tomaso Poggio <https://poggio-lab.mit.edu/people/tomaso-poggio/>). It could be foolhardy for any sane person possessing rational logic to consider that human-made machines and human-coded software for AI can possess intelligence (in its traditional sense) even if it were reduced to the level of birds, ducks, chickens, or even worms,

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e.g., *Caenorhabditis elegans*, which manages very well with ~700 neurons and neural responses using an electro-chemical gradient as information-informed triggers for its actions/actuators. We know every neuron in *C. elegans* (Robert Horvitz, MIT (2002); Victor Ambros and Gary Ruvkun (2024) at MGH)

<https://www.nobelprize.org/prizes/medicine/2002/summary/>

<https://www.nobelprize.org/prizes/medicine/2024/summary/>

*Caenorhabditis elegans* review by six Nobel Prize winners:

Ambros VR, Chalfie M, Daul AL, Fire AZ, Hall DH, Horvitz HR, Mello CC, Ruvkun G, Schroeder NE, Sternberg PW, Rougvie AE. (2025) *From nematode to Nobel: How community-shared resources fueled the rise of Caenorhabditis elegans as a research organism*. Proc National Academy Sci U S A. 2025 December 2; 122(48):e2522808122 doi: 10.1073/pnas.2522808122. PMID: 41284858; PMCID: PMC12685049.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC12685049/pdf/pnas.202522808.pdf>

EXAMPLE: *what actually happens “under the hood” using LLM search engines*

This example was performed using LLM engines under the brand "Claude". In the name of AI, Claude uses keyword search – where the ‘input’ string (words used to search/sentence) are “matched” (with what – material “hoovered up” from the internet and stored as, unreliable, LLMs). A cursory look at “references” will reveal keywords which overlap in multiple publications – in other words – the outcome lists references where authors, titles, journals, do not match. Not surprising, if you are fishing for *words by relevance*! That's the "search" outcome from the “Claude” store of LLMs.

If you ask *where is the AI*, don't hold your breath. This "search" performed by “AI Claude” is a version of the common technique known as "nearest neighbour (NN) search" where keywords are used to search for "word association" or “close” to other "relevant" words (in the LLM jungle). The so called AI-algorithm pulls out everything "relevant" and serves you a "formatted" version ("schema") as if it is a reference (MLA or APA). In other words, it can be rubbish or correct by chance, for a few instances. This is a non-discriminate practice that AI has "learned" and fills an empty “shell” (software) with the extracted rubbish which then looks like a "reference" (APA/MLA). The formatting of bullet points and paragraphs which sounds like sentences are "shells" created from other papers/chapters/publications "extracted" by LLMs. That's all for “AI Claude” search. This **NN search is a 1,000 year old technique** (see exact quote and reference below) but re-branded, re-buzzed and re-broadcasted as "AI".

From unpublished DT-2024 on page 88 <https://dspace.mit.edu/handle/1721.1/140791>

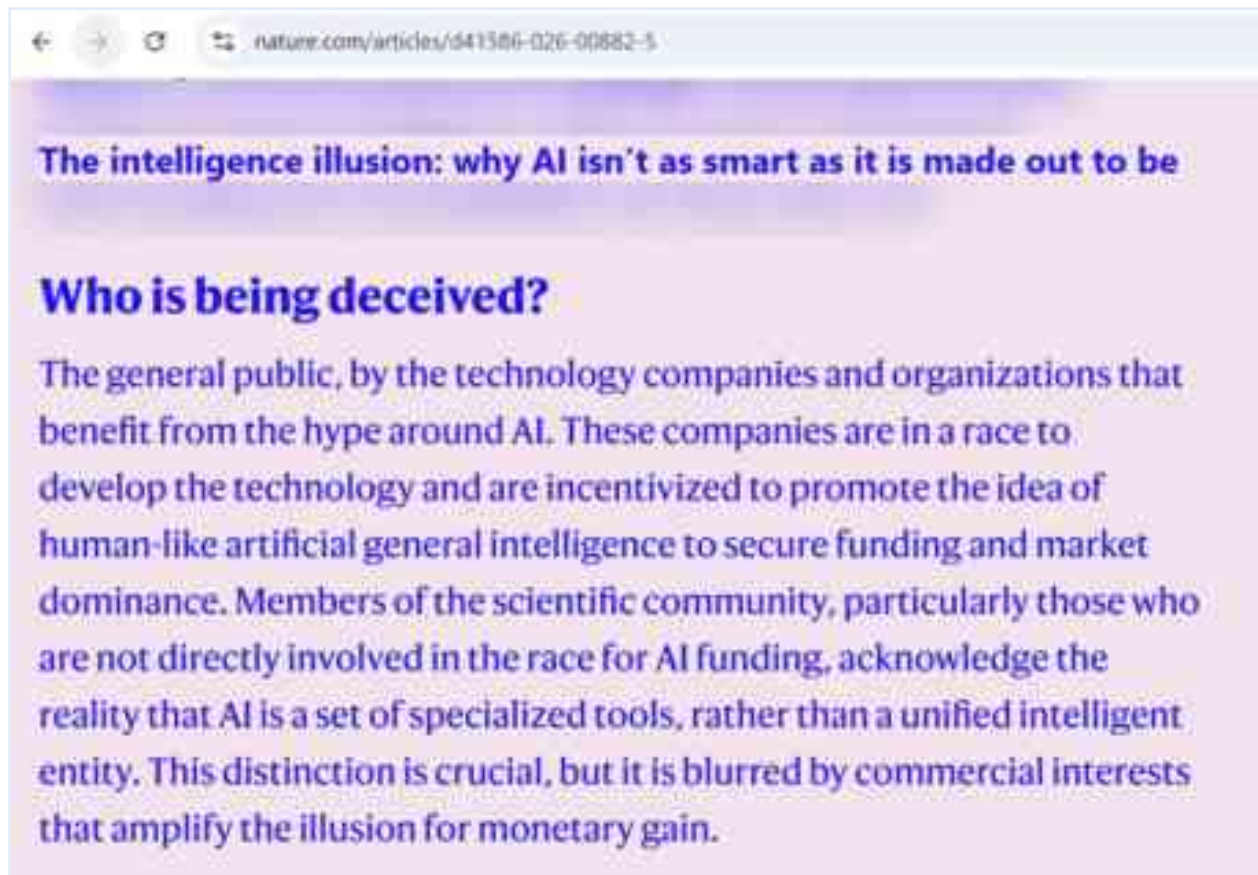
So, what is new? Not ANN from ~100 years ago but even older NN, from 1,000 years ago is the new “new” under the “hood” of GPT-4 (see reference below – [i]) and generative AI. We find principles of NN - nearest neighbor - analysis (k-nearest neighbor algorithms used in data mining) as “intelligence” in generative AI/ ChatGPT. Nearest neighbor (NN) classification appears in Alhazen’s Book of Optics and it is due to **Al-Khalili's work, circa 1011A.D. to 1021A.D.** (see ref [ii]).

[i] Martínez, Eric (2023) *Re-Evaluating GPT-4's Bar Exam Performance* (05-08-23) <http://dx.doi.org/10.2139/ssrn.4441311>

<https://saxelab.mit.edu/people/eric-martinez>

[ii] George H. Chen and Devavrat Shah (2018) “*Explaining the Success of Nearest Neighbor Methods in Prediction*” (May 31, 2018) Foundations and Trends in Machine Learning. ISBN 978- 1680834543

[https://devavrat.mit.edu/wp-content/uploads/2018/03/nn\\_survey.pdf](https://devavrat.mit.edu/wp-content/uploads/2018/03/nn_survey.pdf)



Luc Julia (14 April 2026) *"The AI Illusion"* Wiley. ISBN-13 978-1394412174

<https://www.amazon.com/AI-Illusion-Machines-Arent-Creative/dp/1394412177>

LLM's tsunami of fake citation pollution machines are brute force regurgitation and roughshodding of venerable methods which harness thousands of years of scholarship and erudition but transmogrified and twisted to be trite, trivial, tetchy and troubling drivel. Nearest neighbor (NN) concept is ~1,000 years old (discussed in the preceding pages) and context-sensitive (context-aware) lexing is ~2,500 years old rule from Sanskrit grammar (discussed in the next few pages).

## HOW FAKES CAN LOOK REAL

This citation, generated by AI as part of a 2025 study, looks plausible even though it points to research that doesn't exist.

The first author has published research on single-session interventions for teenage mental health.

The co-authors have published papers with the first author.

The authors have published papers with some of the same words in the titles.

Schleider, J. L., Abel, M. R., & Weisz, J. R. (2022).

Single-session interventions for mental health: Current status and future directions.

*Annual Review of Clinical Psychology*, 18, 351-378.

<https://doi.org/10.1146/annurev-clinpsy-081219-102012>

Although the DOI doesn't point to any publication, it begins in the same way as DOIs for other papers in this journal.

The pages listed are plausible for the volume, and the volume is plausible for 2022.

©nature

Naddaf, Miryam, and Elizabeth Quill (01 April 2026) "Hallucinated Citations Are Polluting the Scientific Literature. What Can Be Done?" *Nature*, vol. 652, no. 8108, April 2026, pp. 26-29 <https://doi.org/10.1038/d41586-026-00969-z>

## Hallucinated citations are polluting the scientific literature. What can be done?

The title in the citation resembled that of a preprint<sup>2</sup> he had posted in 2021 and never published formally, but the journal was listed as *Nature* and the DOI – the unique identifier assigned by publishers and preprint repositories – did not lead to the original preprint. “I got very concerned,” adds Cabanac, who immediately suspected that the citation had been hallucinated by artificial intelligence.

This is just one example of a rapidly growing problem. Surveys and related studies have shown that [researchers are increasingly using large language models \(LLMs\)](#) to help to conduct literature searches, write manuscripts and format bibliographies. And sometimes, these models [generate non-existent academic references](#).



[Is AI leading to a reproducibility crisis in science?](#)

Over the past year, efforts have begun turning up such hallucinated citations in the literature. One analysis of nearly 18,000 papers accepted by three [computer-science](#) conferences found a sharp increase in references that cannot be traced to actual scholarly publications<sup>3</sup>. The results, reported in January, indicated that 2.6% of papers in 2025 had a least one potentially hallucinated citation – up from about 0.3% in 2024. Another analysis, released in February, estimated that 2–6% of papers in four other 2025 computer-science conferences included references with rephrased titles or citations of publications that the authors couldn't verify by searching through databases and journal archives<sup>4</sup>.

In using Claude, the fake references (gumbo of words, titles, doi and journal names) that appeared, are a product of this great debacle which is detrimental on all counts.

Naddaf, Miryam, and Elizabeth Quill (01 April 2026) “*Hallucinated Citations Are Polluting the Scientific Literature. What Can Be Done?*” *Nature*, vol. 652, no. 8108, April 2026, pp. 26–29 <https://doi.org/10.1038/d41586-026-00969-z>

Nearest neighbour (NN) methods are ~**1,000 years** old but the **concept in NN** is about **context-sensitive lexing** (i.e., meaning of a sequence of characters/words depend on its context) which is a rule-based grammar created ~**2,500 years** ago and still used in the Sanskrit language.

These rules/methods are at the core of training in AI (neural net training) using LLMs, for example, Claude and its ilk. Neural net training (so-called ANN AI) uses recursive descent to produce a function. The outcome is an **approximation** and this is the heart of the matter (approximation). That's all there is to AI. Choosing an approximation to use (which answer, number, range) may be guided by rules or randomness. This is where bias creeps into the selection process. The "selected" answer is presented as output (multiple answers are likely). Recursive descent parser (advances from compiler design) works with *context-free* grammar. Backus-Naur [ref 1a-1g in table, below] form is a widely used metasyntax for context-free grammar. The concept is traced to Pāṇini [ref 2a-2b in table], Sanskrit grammarian (520-460 B.C.). *Context-sensitive* lexing (meaning of a sequence of characters/words depend on its context) may be computationally possible using Pāṇini's rule-based grammar, decoded after ~2,500 years by a PhD student at the University of Cambridge [ref 3a-3b in table].

|        |   |
|--------|---|
| 1<br>a | Backus, J. W. (1959). <i>"The syntax and semantics of the proposed international algebraic language of the Zurich ACM-GAMM Conference"</i> . Proceedings of the International Conference on Information Processing. UNESCO. pp. 125–132.<br><a href="https://www.softwarepreservation.org/projects/ALGOL/paper/Backus-Syntax_and_Semantics_of_Proposed_IAL.pdf">https://www.softwarepreservation.org/projects/ALGOL/paper/Backus-Syntax_and_Semantics_of_Proposed_IAL.pdf</a> |
| 1<br>b | Naur, Peter (1961). <i>"A course of ALGOL 60 programming with special reference to the DASK ALGOL system"</i> Copenhagen: Regnecentralen.<br><a href="https://archive.computerhistory.org/resources/text/algol/ACM_Algo_bulletin/1064048/frontmatter.pdf">https://archive.computerhistory.org/resources/text/algol/ACM_Algo_bulletin/1064048/frontmatter.pdf</a>  |
| 1<br>c | Chomsky, Noam (1956). <i>"Three models for the description of language"</i> . IRE Transactions on Information Theory. 2 (3): 113–24. doi:10.1109/TIT.1956.1056813. S2CID 19519474.<br><a href="https://chomsky.info/wp-content/uploads/195609-.pdf">https://chomsky.info/wp-content/uploads/195609-.pdf</a><br><a href="https://ieeexplore.ieee.org/document/1056813">https://ieeexplore.ieee.org/document/1056813</a>  |
| 1<br>d | Chomsky, Noam (1957). <i>Syntactic Structures</i> . The Hague: Mouton.<br><a href="https://tallinzen.net/media/readings/chomsky_syntactic_structures.pdf">https://tallinzen.net/media/readings/chomsky_syntactic_structures.pdf</a><br>Lees, R. B. (1957). [Review of <i>Syntactic Structures</i> , by N. Chomsky]. <i>Language</i> , 33(3), 375–408.<br><a href="https://doi.org/10.2307/411160">https://doi.org/10.2307/411160</a>  |
| 1<br>e | Knuth, Donald E. (1964). <i>"Backus Normal Form vs. Backus Naur Form"</i> . Communications of the ACM. 7 (12): 735–736. doi:10.1145/355588.365140. S2CID 47537431<br><a href="https://dl.acm.org/doi/pdf/10.1145/355588.365140">https://dl.acm.org/doi/pdf/10.1145/355588.365140</a>  |
| 1<br>f | Ingerman, P. Z. (1967). <i>"Pāṇini Backus Form" suggested"</i> . Communications of the ACM. 10 (3): 137. doi:10.1145/363162.363165. S2CID 52817672.<br><a href="https://dl.acm.org/doi/pdf/10.1145/363162.363165">https://dl.acm.org/doi/pdf/10.1145/363162.363165</a>  |
| 1<br>g | <i>Recursive Descent - an Overview</i>   ScienceDirect Topics.<br><a href="https://www.sciencedirect.com/topics/computer-science/recursive-descent">https://www.sciencedirect.com/topics/computer-science/recursive-descent</a>   |

(table continued)

|    |  |
|----|--|
| 2a | J J O'Connor and E F Robertson (2000) <i>Pāṇini</i> . School of Mathematics and Statistics, University of St Andrews, Scotland, UK. <a href="https://mathshistory.st-andrews.ac.uk/Biographies/Panini/">https://mathshistory.st-andrews.ac.uk/Biographies/Panini/</a>  |
| 2b | Gerald Penn and Paul Kiparsky (2008) <i>On Pāṇini and the Generative Capacity of Contextualized Replacement Systems</i> . <a href="https://web.stanford.edu/~kiparsky/Papers/panini-1.pdf">https://web.stanford.edu/~kiparsky/Papers/panini-1.pdf</a>  |
| 3a | Rishi Rajpopat (15 December 2022) <i>In Pāṇini We Trust: Discovering the Algorithm for Rule Conflict Resolution in the Aṣṭādhyāyī</i> .<br>University of Cambridge Repository. DOI: 10.17863/cam.80099<br><a href="https://www.cam.ac.uk/system/files/rajpopat_phd_thesis_15_dec_2022.pdf">https://www.cam.ac.uk/system/files/rajpopat_phd_thesis_15_dec_2022.pdf</a><br><a href="https://www.bbc.com/news/articles/cg3gw9v7jnvo">https://www.bbc.com/news/articles/cg3gw9v7jnvo</a><br><a href="https://www.repository.cam.ac.uk/handle/1810/332654">https://www.repository.cam.ac.uk/handle/1810/332654</a><br><a href="https://www.cam.ac.uk/stories/solving-grammars-greatest-puzzle">https://www.cam.ac.uk/stories/solving-grammars-greatest-puzzle</a><br><a href="https://phys.org/news/2022-12-ancient-grammatical-puzzle-years.html">https://phys.org/news/2022-12-ancient-grammatical-puzzle-years.html</a><br><a href="https://www.cambridge-news.co.uk/news/real-life/student-solves-sanskrit-grammatical-problem-25755865">https://www.cambridge-news.co.uk/news/real-life/student-solves-sanskrit-grammatical-problem-25755865</a> |
| 3b | PA, Sam Russell, and Shane Jarvis. (2022) “Student Solves Sanskrit Grammatical Problem That Puzzled Scholars for Centuries.” Wales Online, 15 December 2022. <a href="https://www.cambridge-news.co.uk/news/real-life/student-solves-sanskrit-grammatical-problem-25755865">https://www.cambridge-news.co.uk/news/real-life/student-solves-sanskrit-grammatical-problem-25755865</a>   |

A grammatical problem that has perplexed scholars since the 5th century BC has been solved by a Cambridge University student (2022) and could revolutionise the study of Sanskrit. Indian PhD student Rishi Rajpopat, 27, decoded a rule taught by Panini.

Panini's grammar, known as the *Aṣṭādhyāyī*, relied on a system that functioned like an algorithm to turn the base and suffix of a word into grammatically correct words and sentences. However, two or more of Panini's rules often apply simultaneously, resulting in rule conflicts. Panini, a master of the ancient Sanskrit language lived ~2,500 years ago. Sanskrit is still spoken in India by an estimated 25,000 people (out of ~1.5 billion).

Panini taught a “metarule”, interpreted by scholars as: “in the event of a conflict between two rules of equal strength, the rule that comes later in the grammar's serial order wins”. This often led to grammatically incorrect results. Mr Rajpopat rejected the traditional interpretation of the metarule. Instead, he argued that Panini meant that between rules applicable to the left and right sides of a word, respectively. Panini wanted us to choose the rule applicable to the right side. Employing this interpretation, Mr Rajpopat found the Panini's “language machine” produced grammatically correct words with almost no exceptions.

<https://www.cambridge-news.co.uk/news/real-life/student-solves-sanskrit-grammatical-problem-25755865>

Billions of impecunious users of SIMMS software deserve an honest approach rather than the quagmire of what can or cannot be trusted if AI is used (it will be double-Dutch to BOU). It may be a tetchy topic with the titans of the tech industry but any association between SIMMS tool and the US-led industry-peddled “AI chatbots” must be an anathema for BOU in less affluent (AA) nations. The vitriolic bias that appears to have seeped into LLMs makes AI untrustworthy (for BOU to use AI tools). The latter is a mechanism for BOU to avoid being subjected to AI malice, unbeknownst to the user.

news.mit.edu/2026/study-ai-chatbots-provide-less-accurate-information-vulnerable-users-0219

Large language models (LLMs) have been championed as tools that could democratize access to information worldwide, offering knowledge in a user-friendly interface regardless of a person's background or location. However, new research from MIT's Center for Constructive Communication (CCC) suggests these artificial intelligence systems may actually perform worse for the very users who could most benefit from them.

A study conducted by researchers at CCC, which is based at the MIT Media Lab, found that state-of-the-art AI chatbots — including OpenAI's GPT-4, Anthropic's Claude 3 Opus, and Meta's Llama 3 — sometimes provide less-accurate and less-truthful responses to users who have lower English proficiency, less formal education, or who originate from outside the United States. The models also refuse to answer questions at higher rates for these users, and in some cases, respond with condescending or patronizing language.

Poole-Dayana, Elinor, Deb Roy and Jad Kabbara (6 November 2025) “LLM Targeted Underperformance Disproportionately Impacts Vulnerable Users.” arXiv:2406.17737 <https://doi.org/10.48550/arXiv.2406.17737> and <https://arxiv.org/pdf/2406.17737>

## LLM Targeted Underperformance Disproportionately Impacts Vulnerable Users

Elinor Poole-Dayana, Deb Roy, Jad Kabbara

Massachusetts Institute of Technology  
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Perhaps for affluent nations and a certain class (caste? demographics?) of users, AI may be a splendid tool (occasionally?). The *expectation* from AI must be screened as a “humble helper” (not oracle or “khoja”) in a decision support capacity for humans-in-the-loop receiving suggestions (**There’s an AI for That** <https://theresanaiforthat.com>) (<https://informatics.bmj.com/content/bmjhci/33/1/e101877.full.pdf>). The latter may be useful to guide decision support if AI tools are applicable (for non-critical scenarios). Cai, Alice, et al. (2026) *Where Can AI Be Used? Insights from a Deep Ontology of Work Activities*. <https://arxiv.org/abs/2603.20619v1>; <https://arxiv.org/pdf/2603.20619>

AI approximations (biased or not) based on principles of mathematics are created by humans with intelligence but approximations are neither intelligent nor intelligence. AI can provide some numbers but not the answers. In *Why Machines Learn* author Anil Ananthaswamy (<https://anilananthaswamy.com/>) unleashes the mathematics which exposes and explains that AI puffery about intelligence in AI conceals centuries old mathematics, which fuels the approximations. By nature, approximations are error prone because the model leading to the approximation may be built with a few approximations (or corrupted data?). The cumulative errors could make the outcome (data, information) false (one reason why AI is known to lie and hallucinate). Those involved with implementing applications of AI must understand what AI can or cannot do and learn to know how to understand the difference (see *AI Snake Oil* by Arvind Narayanan and Sayash Kapoor, Princeton University).

<https://press.princeton.edu/books/hardcover/9780691249131/ai-snake-oil> and also this talk <https://www.cs.princeton.edu/~arvindn/talks/MIT-STS-AI-snakeoil.pdf> plus the news [www.theguardian.com/business/2025/oct/12/ai-workslop-us-employees](http://www.theguardian.com/business/2025/oct/12/ai-workslop-us-employees)

**"Never attribute to malice that which can be explained by stupidity."**

[Arthur Bloch](#) (1980)

[Murphy's Law Book Two: More Reasons Why Things Go Wrong!](#)

<https://www.worldofbooks.com/products/murphy-s-law-and-other-reasons-why-things-go-wrong-book-arthur-bloch-9780417064505>

Steve Holland (21 January 2025) Trump announces private-sector \$500 billion investment in AI infrastructure. Reuters News.

[www.reuters.com/technology/artificial-intelligence/trump-announce-private-sector-ai-infrastructure-investment-cbs-reports-2025-01-21/](http://www.reuters.com/technology/artificial-intelligence/trump-announce-private-sector-ai-infrastructure-investment-cbs-reports-2025-01-21/)

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**CAUTION: What “not to do” for BOU/SIMMS if considering use of (AI) agents. Why AI fails in the real world? Will it continue to fail when dealing with uncertainty?**

Neither unreasonable nor unjustified to point a finger at POMDP (partially observable Markov decision processes) used in modeling two-agent problems. Let us explore how POMDP can still proceed with gusto yet the model builds a *house of cards*. In this example (from Powell, 2022), the POMDP model is using the **context** of flu mitigation but the controlling agent (health agency) **did not know** infection levels or transmission rates. The model **assumes** there is an **unknown true state** capturing the values of these parameters (*state* in agent) and *the assumed distribution* (error rates in distribution?) of these parameters are updated as new observations (data) arrive [Bonamente, M. (2017) *Three Fundamental Distributions: Binomial, Gaussian, and Poisson*. In: *Statistics and Analysis of Scientific Data*. Graduate Texts in Physics. Springer, New York, NY. [https://doi.org/10.1007/978-1-4939-6572-4\\_3](https://doi.org/10.1007/978-1-4939-6572-4_3)].

An application of Bayes theorem (cartoon, below) produces the transition function for the **belief** distribution. This feeds in a Markov decision process where the application of Bellman’s equation (equation based model with prior assumptions and standards based on beliefs and/or distributions which are frequently assumed to be *normal*) will generate an *optimal policy for treatment decisions*.

This 1965 method (POMDP) generated over 6,000 papers, published in 2025 alone. The assumption that the agent knows the “process” (function created about disease transmission) and its application to “flu” (strains? virulence?) should disqualify this generic model application for any rational use, in any context of health / healthcare. The “process” (of disease transmission) are conditional probabilities which are approximations of approximations (“*process*” “*probably*” *functions in this manner*).

Assumptions, approximations, and arbitrary distribution of probabilities are created as an equation based “model” (POMDP) which is the bread and butter of the this two-agent application. It is still used wherever a “two agent” model is needed, irrespective of context or semantics of the context (which could change immensely if using the two-agent model is used for different diseases, different verticals, different demographics).

If this is packaged under as an “agentic AI” solution, is there any doubt why AI fails in the real world and why it will continue to fail when we are dealing with uncertainty.

Butler, Declan (2013) **When Google got flu wrong**. Nature. 2013 February 13; vol 494, no. 7436, pp.155-156 <https://doi.org/10.1038/494155a> PMID: 23407515.

Why do so many  
healthcare AI  
companies with  
genuinely impressive  
technology *fail to*  
*reach the patients*  
*who need it?*

Powell, Warren B.(2022) *Reinforcement Learning and Stochastic Optimization: A Unified Framework for Sequential Decisions*. Wiley, 2022. Cartoon of POMDP from Ch. 20 - Multiagent Modeling & Learning <https://doi.org/10.1002/9781119815068.ch20>  
Cartoon shows an application of Bayes Theorem with respect to POMDP application.

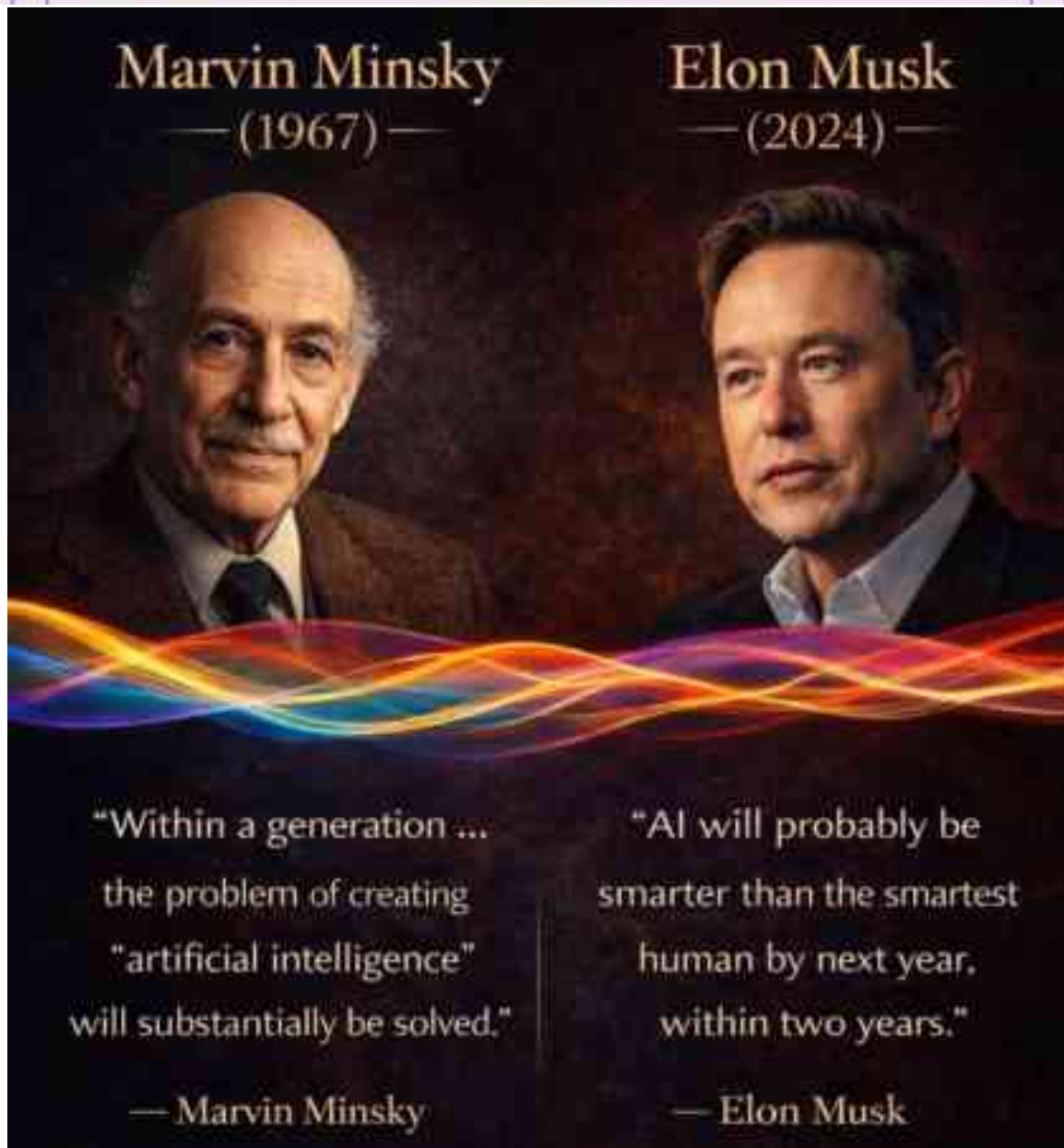
$$\begin{aligned}
 b_{t+1}(s' | b_t, x_t, W_{t+1}^{obs} = w^{obs}) &= B^M(b_t, x, W_{t+1}^{obs} = w^{obs})(s') \\
 &= \text{Prob}\{S_{t+1} = s' | b_t, x_t, W_{t+1}^{obs} = w^{obs}\} \\
 &= \frac{\text{Prob}\{W_{t+1}^{obs} = w^{obs} | b_t, x_t = x, S_{t+1} = s'\} \text{Prob}\{S_{t+1} = s' | b_t, x_t\}}{\text{Prob}\{W_{t+1}^{obs} = w^{obs} | b_t, x_t\}} \tag{20.41}
 \end{aligned}$$

$$= \frac{\text{Prob}\{W_{t+1}^{obs} = w^{obs} | b_t, x_t, S_{t+1} = s'\} \sum_{s \in \mathcal{S}} \text{Prob}\{S_{t+1} = s' | S_t = s, b_t, x_t\} \text{Prob}\{S_t = s | b_t, x_t\}}{\text{Prob}\{W_{t+1}^{obs} = w^{obs} | b_t, x_t\}} \tag{20.42}$$

$$= \frac{\text{Prob}\{W_{t+1}^{obs} = w^{obs} | S_{t+1} = s'\} \sum_{s \in \mathcal{S}} \text{Prob}\{S_{t+1} = s' | S_t = s, x_t\} b_t(s)}{\text{Prob}\{W_{t+1}^{obs} = w^{obs} | b_t, x_t\}} \tag{20.43}$$

$$= \frac{p^{obs}(w^{obs} | s') \sum_{s \in \mathcal{S}} P(s' | s, x_t) b_t(s)}{p^{obs}(w^{obs} | b_t, x_t)} \tag{20.44}$$

Few patterns in technology are as consistent as the confident prediction of imminent breakthroughs in artificial intelligence. From early pioneers to modern industry leaders, the expectation that general intelligence is "just around the corner" has appeared again and again.



Quote Source for Marvin Minsky – Massachusetts Institute of Technology (MIT DSpace)

Quote Source for Elon Musk – <https://www.reuters.com/technology/teslas-musk-predicts-ai-will-be-smarter-than-smartest-human-next-year-2024-04-08/>

Other Quotes <https://web.eecs.umich.edu/~kuipers/opinions/AI-progress.html>

<https://insights4vc.substack.com/p/ai-captured-80-of-global-venture>

Venture capital entered 2026 looking less like a broad startup financing market and more like a late-stage capital allocation machine built around a small number of strategic AI platforms. Beneath the record headline numbers, the quarter revealed a more uneven reality: extreme concentration at the top, fragile breadth underneath, and a crypto recovery that remained selective rather than cyclical.



## Executive Summary

- Global venture funding in Q1 2026 reset the scale of “record quarters”, reaching roughly \$300bn across about 6,000 funded companies, with late-stage and technology growth rounds doing most of the work.
- AI captured the clear majority of capital: Crunchbase estimates roughly \$242bn, around 80% of the quarter’s total, up materially from AI’s share a year earlier.
- The quarter reinforced a barbell structure: unprecedented capital pools for a few globally strategic platforms while broader deal counts remained muted and fundraising conditions for most funds stayed weak.

Howard, Philip K. (1994) *The Death of Common Sense: How Law Is Suffocating America*. Random House, 1994. <https://www.philipkhoward.com/the-death-of-common-sense> & <https://www.beyondintractability.org/bksum/howard-death>

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<sup>129</sup> Apoorv Gupta, Jacopo Ponticelli and Andrea Tesei (2020) *Language Barriers, Technology Adoption and Productivity: Evidence from Agriculture in India*. NBER Working Papers 27192, National Bureau of Economic Research, Cambridge, MA. <https://ideas.repec.org/p/nbr/nberwo/27192.html> &

[https://www.nber.org/system/files/working\\_papers/w27192/w27192.pdf](https://www.nber.org/system/files/working_papers/w27192/w27192.pdf)

Mdoda, L., Christian, M. & Agbugba, I. (2024) Use of Information Systems (Mobile Phone App) for Enhancing Smallholder Farmers' Productivity in Eastern Cape Province, South Africa: Implications on Food Security. *J Knowl Econ* **15**, 1993–2009 (2024). <https://doi.org/10.1007/s13132-023-01212-0>

<https://link.springer.com/content/pdf/10.1007/s13132-023-01212-0.pdf>

<sup>130</sup> Michalscheck, Mirja, *et al* (2024) “An Evaluative Framework for Inclusive Agricultural Value Chain Policies and Interventions – Case: Mali.” *Global Food Security*, vol. 42, September 2024, p. 100769.

<https://doi.org/10.1016/j.gfs.2024.100769>

[https://knowledge4policy.ec.europa.eu/publication/evaluative-framework-inclusive-agricultural-value-chain-policies-interventions-%E2%80%93-case\\_en](https://knowledge4policy.ec.europa.eu/publication/evaluative-framework-inclusive-agricultural-value-chain-policies-interventions-%E2%80%93-case_en)

<sup>131</sup> Benjamin A. Olken (2020) *Banerjee, Duflo, Kremer, and the Rise of Modern Development Economics*

<https://economics.mit.edu/sites/default/files/publications/200505%20Nobel%20Prize%20Paper.pdf> <https://www.nobelprize.org/prizes/economic-sciences/2019/summary/>

<sup>132</sup> Chalmers I, Milne I, Tröhler U, Vandenbroucke J, Morabia A, Tait G, Dukan E; James Lind Library Editorial Team. (2008) *The James Lind Library: explaining and illustrating the evolution of fair tests of medical treatments*. *J R Coll Physicians Edinb*. 2008 September; 38(3):259-264. PMID: 19227602.

<https://pubmed.ncbi.nlm.nih.gov/19227602/> <https://www.jameslindlibrary.org/wp-data/uploads/2014/05/jll-article.pdf>

Bhatt A. (2010) *Evolution of clinical research: a history before and beyond James Lind*. *Perspectives in Clin Res*. 2010 January; 1(1):6-10. PMID: 21829774; PMCID: PMC3149409. <https://pmc.ncbi.nlm.nih.gov/articles/PMC3149409/pdf/PCR-1-6.pdf>

<sup>133</sup> Bothwell LE, Greene JA, Podolsky SH, Jones DS. (2016) *Assessing the Gold Standard--Lessons from the History of RCTs*. *New England J of Medicine*. 2016 June 2; 374(22):2175-81. doi: 10.1056/NEJMms1604593. PMID: 27248626.

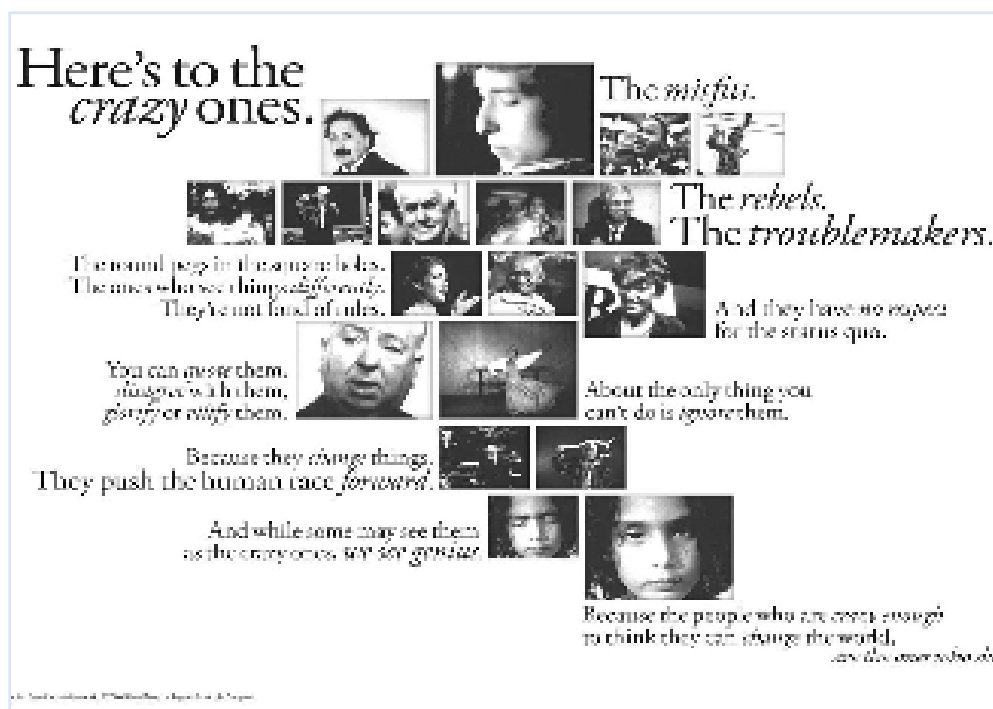
<https://www.nejm.org/doi/10.1056/NEJMms1604593>

<sup>134</sup> Fernanda Marquez-Padilla, Susan W. Parker, and Tom S. Vogl, "Rolling Back Progres: School and Work After the End of a Landmark Anti-Poverty Program," NBER Working Paper 33527 (2025), <https://doi.org/10.3386/w33527>  
[https://www.nber.org/system/files/working\\_papers/w33527/w33527.pdf](https://www.nber.org/system/files/working_papers/w33527/w33527.pdf)  
<https://ministerialleadership.harvard.edu/wp-content/uploads/2025/02/2020-Mexico-From-Progres-to-Prospera-Case-Study-final-draft.pdf> [https://cmepg.gmu.edu/wp-content/uploads/2024/10/Parker\\_2024\\_APCWorkingPaper.pdf](https://cmepg.gmu.edu/wp-content/uploads/2024/10/Parker_2024_APCWorkingPaper.pdf)

<sup>135</sup> Campenhout, Bjorn Van (2021) "The Role of Information in Agricultural Technology Adoption: Experimental Evidence from Rice Farmers in Uganda." *Economic Development and Cultural Change*, vol. 69, no. 3, April 2021, pp. 1239–1272.  
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<sup>136</sup> Webber, S., & Prouse, C. (2018). The New Gold Standard: The Rise of Randomized Control Trials and Experimental Development. *Economic Geography*, 94(2), 166–187.  
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<sup>137</sup> Robert Fitzgerald Kennedy (1966) "Ripple of Hope" from *Day of Affirmation*.

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<https://www.jfklibrary.org/learn/about-jfk/the-kennedy-family/robert-f-kennedy/robert-f-kennedy-speeches/day-of-affirmation-address-university-of-capetown-june-6-1966>



"There is," said an Italian philosopher, "nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success than to take the lead in the introduction of a new order of things." Yet this is the measure of the task of your generation and the road is strewn with many dangers.

First is the danger of futility; the belief there is nothing one man or one woman can do against the enormous array of the world's ills – against misery, against ignorance, or injustice and violence. Yet many of the world's great movements, of thought and action, have flowed from the work of a single man. A young monk began the Protestant reformation, a young general extended an empire from Macedonia to the borders of the earth, and a young woman reclaimed the territory of France. It was a young Italian explorer who discovered the New World, and 32 year old Thomas Jefferson who proclaimed that all men are created equal.

Each time a man stands up for an ideal, or acts to improve the lot of others, or strikes out against injustice, he sends forth a tiny ripple of hope, and crossing each other from a million different centers of energy and daring those ripples build a current which can sweep down the mightiest walls of oppression and resistance.

## About the author

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## SHOUMEN BOSE PALIT AUSTIN DATTA, PhD, MRSB (Member of the Royal Society of Biology)

**BRIEF BIO** – WEBPAGE <https://autoid.mit.edu/people/shoumen.html> LAB <https://autoid.mit.edu/>

**Shoumen Bose Palit Austin Datta** (BSc, PhD, MRSB) is a Member of the Royal Society of Biology (UK). He is a Senior Member of the MIT Auto-ID Labs, Research Affiliate at Dept of Mechanical Engineering, Massachusetts Institute of Technology and Senior Scientist, Medical Device Interoperability Lab and Cybersecurity Program, Center for Smart and Automated Medical Systems, Dept of Anesthesiology, Massachusetts General Hospital, Harvard Medical School (<https://mdpnp.mgh.harvard.edu/about>). He is the Co-Founder and the former Executive / Research Director of the MIT Forum for Supply Chain Innovation (2001-2010) at the MIT School of Engineering. Former Member of the MIT Auto ID Center (1999-2003), [MIT Data Center](#) (2004-2006) and [MIT Energy Initiative](#) (2008-2009). His interests include RFID, Internet of Things (IoT), Industrial IoT, medical IoT, digital supply chain management, forecasting, data, analytics, decision systems, nano-bio-sensors, digital twins, healthcare, digital health, vaccines, molecular biology, neuroendocrine carcinomatosis and science as a service for society. He taught/teaches Supply Chain, Operations Strategy and Management at MIT Sloan School of Management, Chalmers University (Sweden), ESSEC (France), KEDGE (France), Cambridge University and Harvard Medical School (Molecular Medicine, Biochemistry and Metabolism for first year MD students). He has offered MBA and executive education courses at MIT and other institutions in US, EU and Asia. He was the founding Senior Vice President for the Industrial Internet Consortium (IIC). He has authored books, papers, articles related to evolution of IoT and the industrial internet, software agents, predictive data analytics, supply chain management, public health (SARS-CoV-2), healthcare platforms, energy, digital transformation, digital twins and AI. He has served/serves as an advisor for start-ups, corporations and governments including NSF, US Dept of Defense, US Dept of Commerce, United Nations (UNDP), World Customs Organization (WCO), President's Science and Technology Advisory Group (PSTAG) for the President of Taiwan (ROC), TEKES (Government of Finland), etc. He earned his BSc (Biochemistry, Physiology, Physics, Chemistry) from the Presidency College, University of Calcutta. He attended University of Pittsburgh and earned his PhD from Rutgers University School of Medicine in collaboration with Department of Molecular Biology at Princeton University. He was briefly associated (DNA tumor virus research) with Paris VI Université Pierre-et-Marie-Curie and Institut du Cancer et d'Immunogénétique, *Villejuif* (ICIG, Hôpital Paul Brousse). He was a Research Fellow in Medicine with Larry Jameson (Thyroid and Neuro-Endocrine Labs, Molecular Oncology) at MGH (Massachusetts General Hospital) and Instructor in Medicine at Harvard Medical School (HMS). He was a Research Associate at the Whitehead Institute at MIT with Richard Young and a founding member of the MIT Human Genome Project (1993) with Eric Lander. He was a Research Scientist in Molecular Parasitology at University of California UCSF School of Medicine, San Francisco, California (joint program with UCSF School of Pharmacy and UC Berkeley School of Public Health). Shoumen has served in the public sector to improve public K-12 education and technology as Special Assistant to the Mayor of the City and County of San Francisco, California; helped to improve California K-12 standards in mathematics and science (<https://www.nature.com/articles/34255>); Science Education Partnership at UCSF School of Medicine; Berkeley Pledge initiative at the University of California, Berkeley and Chair, National Task Force on Education, Economy, Workforce and Technology sponsored by Information Technology Association of America, US Department of Commerce, Dept of Labor and White House Council of Economic Advisers (1998-1999). Until recently he was an advisor to NIH funded CoVID-19 research teams from multiple US universities (for the rapid development of nano-biosensors for diagnostics of SARS-CoV-2). He continues to advise various research projects, students and various other entities, local and global. He is a Member of the Royal Society of Biology (MRSB).

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**Full CV in the MIT Library** <https://dspace.mit.edu/handle/1721.1/146158>

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SHOUMEN DATTA ▪ CV is available from the MIT Library <https://dspace.mit.edu/handle/1721.1/146158>

THIS IS A SELECTED LIST OF PAPERS / ARTICLES ■ MY TINY CONTRIBUTION TO SCIENCE, ENGINEERING, & MANAGEMENT.

**MOLECULAR BIOLOGY**

**Datta S**, Spangler R, Bruner M, Harter ML. (1987) *Activation of viral and non-viral promoters by the Adenovirus 289R E1A protein in cell-free extracts*. Imperial Cancer Research Fund Tumor Virus Meeting, July 1987. University of Cambridge, Churchill College, Cambridge CB3 0DS, United Kingdom. [Paper version published <https://doi.org/10.1126/science.2956686> & <https://pubmed.ncbi.nlm.nih.gov/2956686/>]

**MOLECULAR MEDICINE / ENDOCRINOLOGY / MOLECULAR BIOLOGY**

**Datta S**, Magge S, Madison L, Jameson JL. (1992) *Thyroid Hormone Receptor Mediates Transcriptional Activation and Repression of Different Promoters*. *Molecular Endocrinology* **6** 815-825  
<https://academic.oup.com/mend/article/6/5/815/2714624>

**ARTIFICIAL INTELLIGENCE / AGENT-BASED SYSTEMS**

**Datta, S.** (2002) *Agents: Where Artificial Intelligence Meets Natural Stupidity*  
MIT Library <http://dspace.mit.edu/handle/1721.1/41914>

**ECONOMETRICS / DATA SCIENCE / OPERATIONS MANAGEMENT**

**Datta, S.** and Granger, Clive W.J. (2006) *Advances in Supply Chain Management: Potential to Improve Forecasting* (ESD-WP-2006-11) MIT Library <https://dspace.mit.edu/handle/1721.1/41905> original paper  
Other versions <https://dspace.mit.edu/handle/1721.1/41906> • <https://dspace.mit.edu/handle/1721.1/41913>  
Application <https://dspace.mit.edu/handle/1721.1/43943> • <http://dspace.mit.edu/handle/1721.1/43948>  
<http://www.tandfonline.com/doi/full/10.1057/palgrave.jors.2602419>

**NETWORKED DATA / INFORMATION SYSTEMS ENGINEERING**

**Datta, S.** (2007) *Unified Theory of Relativistic Identification of Information in a Systems Age: Proposed Convergence of Unique Identification with Syntax and Semantics through Internet Protocol version 6* (ESD-WP-2007-17) Published as peer-reviewed paper - <https://dspace.mit.edu/handle/1721.1/102893>  
<https://dspace.mit.edu/browse?authority=0fc41e68db8585dfa1f47a9303568ccc&type=author>

**DIGITAL TRANSFORMATION / DIGITAL TWINS**

**Datta, S.** (2016) *Emergence of Digital Twins* <https://arxiv.org/ftp/arxiv/papers/1610/1610.06467.pdf>

**Datta, S.** (2024) *Digital Twin, Didymos, Meets Digital Cousin, Didymium*. MIT Library (DT series)  
<https://dspace.mit.edu/handle/1721.1/140791> and <https://www.preprints.org/manuscript/202411.1638>

NIH NIBIB uploaded version [https://www.imagwiki.nibib.nih.gov/sites/default/files/Datta\\_DT-2024.pdf](https://www.imagwiki.nibib.nih.gov/sites/default/files/Datta_DT-2024.pdf)

**NANO-BIO SENSOR ENGINEERING / DATA ANALYTICS**

Y. Rong, A.V. Padrona, K. J. Hagerty, N. Nelson, S. Chic, N. O. Keyhani, J. Katz, S.P.A. **Datta**, C. Gomes, and E.S. McLamore (2018) *Post Hoc Support Vector Machine Learning for Impedimetric Biosensors Based on Weak Protein–Ligand Interactions*. *The Analyst*, vol. 143, no. 9, 2018, pp. 2066–2075 doi:10.1039/C8AN00065D <https://pubs.rsc.org/en/content/getauthorversionpdf/C8AN00065D>

**SARS-COV-2 / SENSOR ENGINEERING / MOLECULAR DIAGNOSTICS / PANDEMIC RESPONSE**

Geisianny Moreira, Lisseth Casso-Hartmann, Shoumen P. Austin **Datta**, Delphine Dean, Eric McLamore, Diana Vanegas (2022) *Development of a Biosensor Based on Angiotensin-Converting Enzyme II for Severe Acute Respiratory Syndrome Coronavirus 2 Detection in Human Saliva* (13 July 2022) *Frontiers in Sensors* (Lausanne). 2022; 3:917380 <https://doi.org/10.3389/fsens.2022.917380>  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9386735/pdf/nihms-1827456.pdf>

**ANALYTICAL CHEMISTRY / BIOSENSOR SYSTEMS**

McLamore, Eric S. and **Datta**, Shoumen P.A. (2023) *A Connected World: System-Level Support through Biosensors* *Ann Rev Analytical Chem* vol. 16 <https://doi.org/10.1146/annurev-anchem-100322-040914>  
Available from the MIT Library <https://dspace.mit.edu/handle/1721.1/123983>

**VACCINES / MOLECULAR VIROLOGY / PLANT GENETICS**

**Datta, S.** (2024) *Bio-Engineered Plant-produced Antigens, Self-Administered for Oral Vaccination: A Cottage Industry for Vaccines for Less Affluent Nations? Working Paper “POV” in the MIT Library* (PDF marked ‘POV’) <https://dspace.mit.edu/handle/1721.1/145774>

**SOFTWARE INNOVATION REQUIRED / AGENT-BASED SYSTEMS / POOR ECONOMICS**

**Datta, S.** (2025) *Billions of Users (BOU) – Software Innovation in Material Management Systems (DRAFT)*

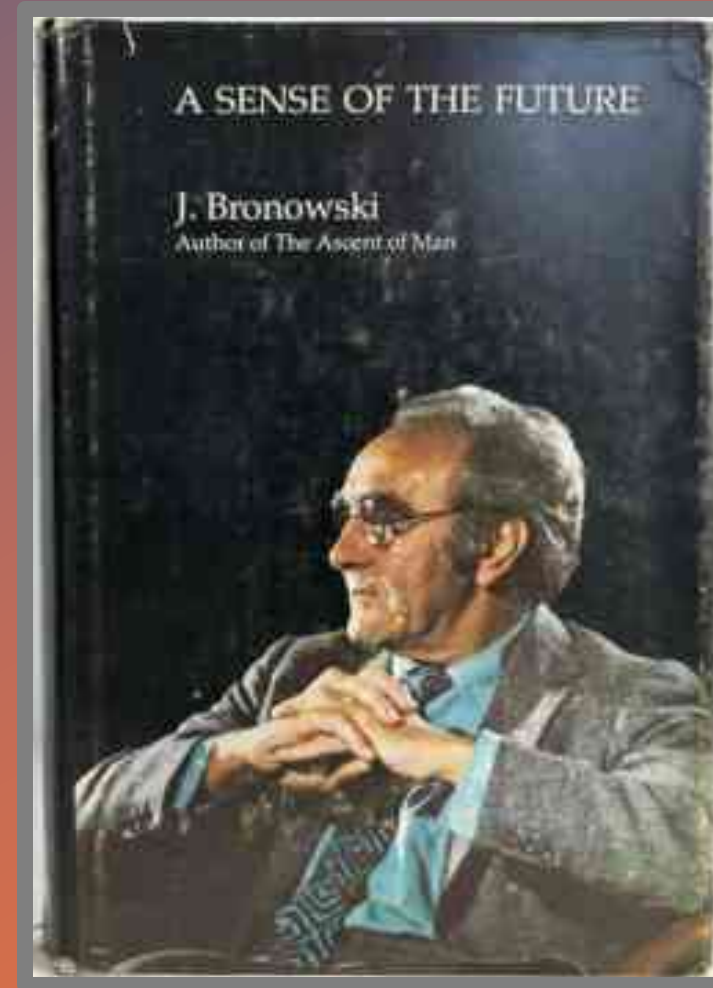
Bryan Bryson says, “She instilled a sense of ‘you can do what you want to do,’ and a sense of optimism. There are so many ways that you can say that something will fail, but why don’t we look to find the reasons to continue?”

Quote is attributed to Professor Bryan Bryson (BME, MIT) <https://be.mit.edu/faculty/bryan-bryson/>  
<https://news.mit.edu/2026/bryan-bryson-engineering-solutions-tough-problem-tuberculosis-0125>



# SIMMS: PRODUCTS and SERVICES for BILLIONS OF USERS

**BOU** ● The global digital inclusion economy

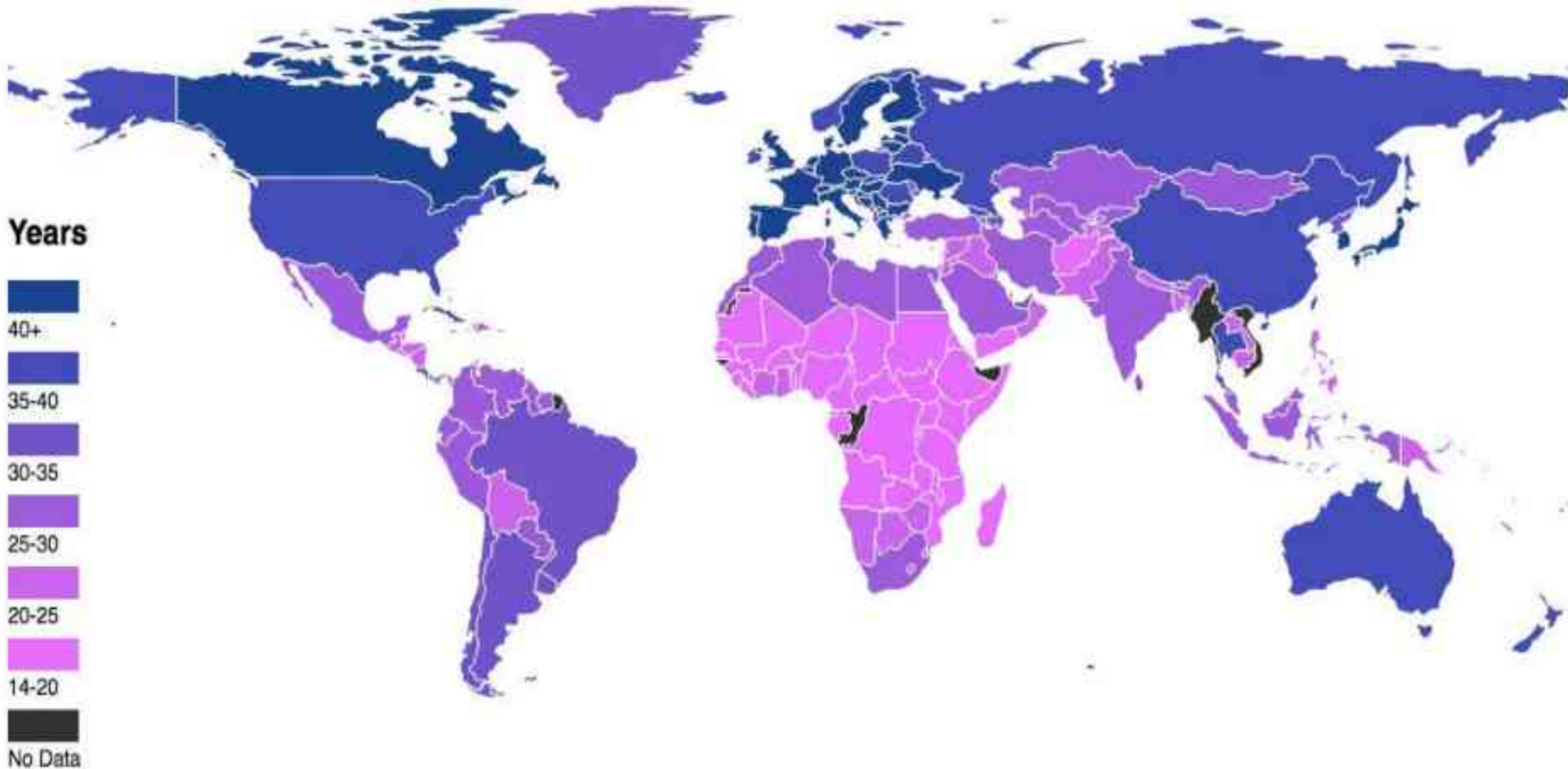


# Where are the future markets?

11 million children die each year from preventable causes. 70% of deaths are due to 6 diseases. The mortality is concentrated in just ten countries but mostly in the Sub-Saharan region of Africa.

Median age by country

(CIA World Factbook 2014)



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# MOTIVATION & PROBLEM

## **Information Asymmetry**

Information gaps limit access to information and data tools for low-income populations in emerging markets (LIC) which increases transaction cost for supply chain actors.

## **Economic Exclusion**

Inequities cause inefficient supply chains and extractive pricing, excluding producers and consumers from sharing the total supply chain profit.

## **Empowering the Next Billion Users**

Providing affordable, accessible technology which can attempt to unlock latent value and thereby democratize the opportunity to share profit.

## **Global Adoption**

Solutions must align with local contexts, literacy, and affordability to promote fair and sustainable growth by reducing transaction cost to remove barriers to market entry.

# DEVELOPMENT AS FREEDOM



AMARTYA SEN

WINNER OF THE NOBEL PRIZE IN ECONOMICS

*"Fascinating... The overall argument [is] eloquent and probing."*  
—*The New York Times*

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# SIMMS (ASPIRATIONAL)

## **Ethical Profitability**

SIMMS limits net operating profit to < 1% of gross revenue to promote equity, sustainability and potential for reinvestment.

## **Modular Software**

SIMMS to use interoperable transactional units to support end-to-end business workflows to enable pay-per-unit cost (PAPPU) and minimize transaction cost.

## **Reducing Information Asymmetry**

The system distributes market intelligence across supply chains to drive and share the total supply chain profit.

## **Accessible User Experience**

SIMMS provides simple interfaces ensuring usability for users with no technical knowledge or complex linguistic skills.

SENDHIL MULLAINATHAN  
ELDAR SHAFIR

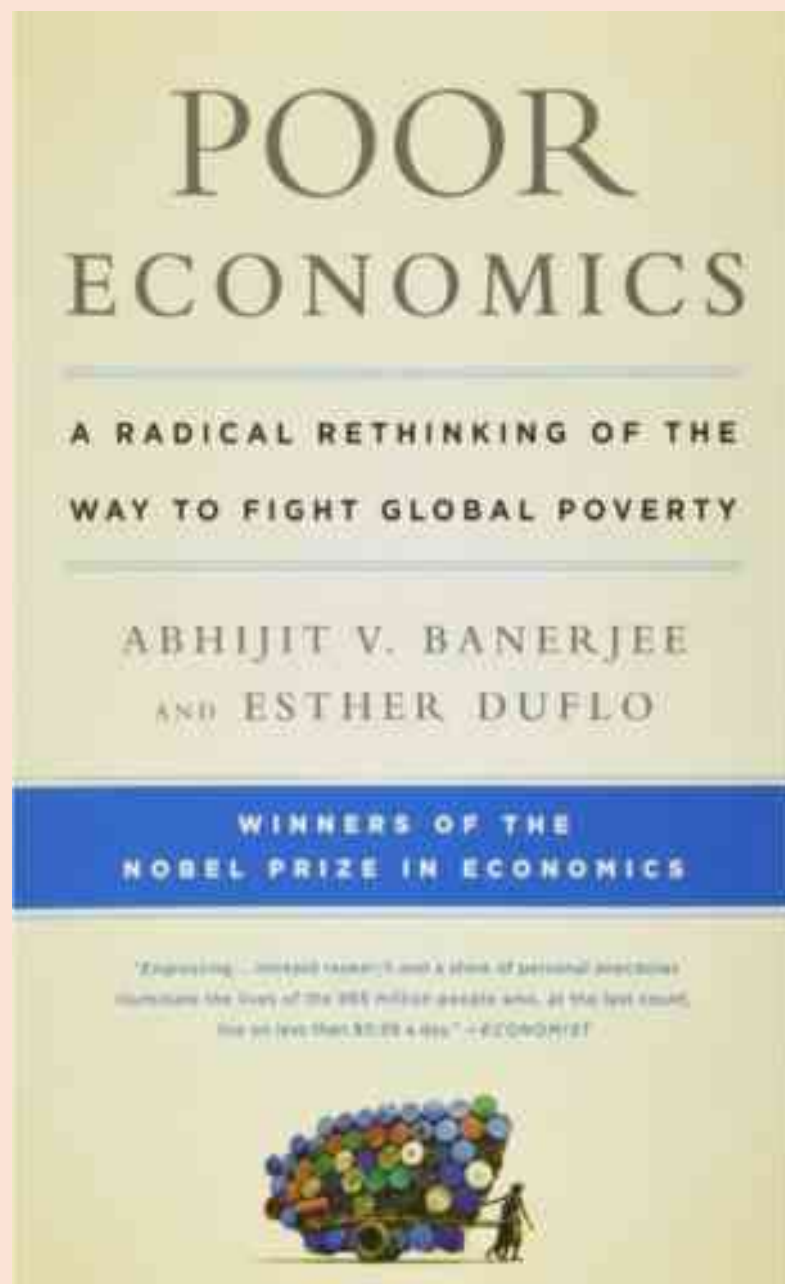
# Scarcity

THE TRUE COST OF NOT HAVING ENOUGH

'Essential reading'  
Tim Adams, *Observer*



# PAY-A-PENNY-PER-USE (PAPPU)



## **Affordable Transaction Cost**

PAPPU may charge about a penny per transaction, enabling low-income users to afford and access essential digital services.

## **Scalable Market Potential**

Small payments across trillions of transactions accumulate to substantial revenue, business growth and improvements in quality of life.

## **Inclusive and Agile Model**

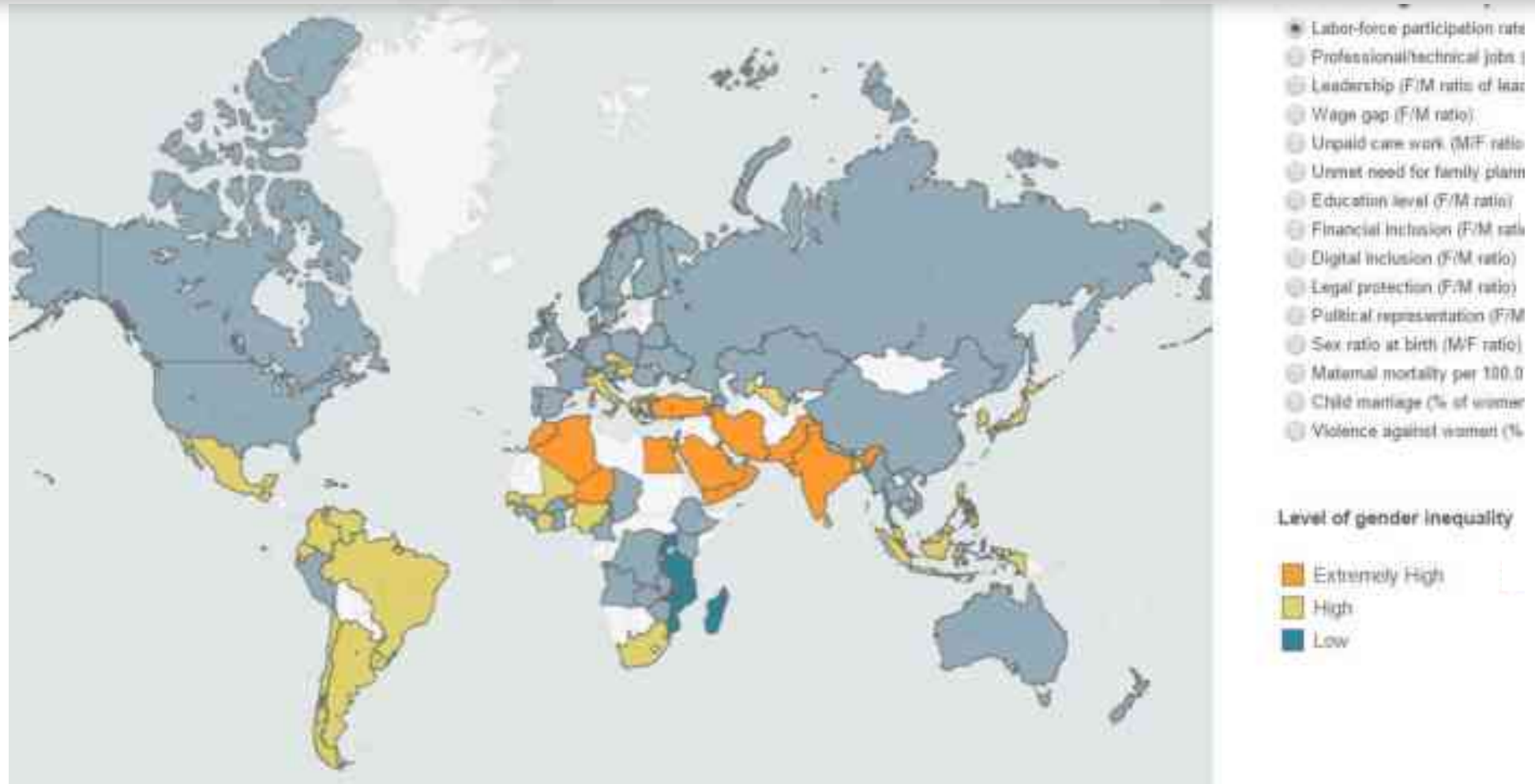
Pay-per-use model adapts to income fluctuations and promotes digital adoption in LIC.

## **Technological Foundation**

PAPPU integrates dynamic pricing, modular software, and mobility for scalable and flexible services to reduce information asymmetry.

# BOU

*Poor Software* for “Poor Economics” is an attempt to take a bite out of the disproportionate level of gender inequality.





# FEWSH

## **FEWSH**

FEWSH represents essential sectors for daily living — Food, Energy, Water, Sanitation, Health — which also involves recurring transactions and economic activity.

## **Digital Potential**

Embedding software tools in FEWSH value chains enables transparency, efficiency, and equity across critical sectors.

## **Global and Inclusive**

FEWSH tools address urgent issues and scale globally, to bring digital transformation as a service to society.



# MARKET

## BILLIONS OF USERS

### (BOU BAZAR)

#### **Demographics**

Asia and Africa represent a massive market with over 650 million potential digital solution users, if only 10% of the ~6.5 billion population chooses to adopt SIMMS related service.

#### **Growth**

Market is expected to grow to more than 2 billion due to economic and literacy improvements even if the benefits reach only a third of the ~6.5 billion population.

#### **Accessibility**

Accessibility of existing software tools and systems do not meet the needs of low-income users and their essential (FEWSH) related needs which require information networks.

#### **Wide Sector Impact**

The FEWSH opportunity reaches beyond B2C food, agriculture and public health to include transportation, small businesses, and eventually other B2B markets.

## Information Asymmetry



Photo from the Nobel Foundation archive.

**George A. Akerlof**

Prize share: 1/3



Photo: Anne Knudsen. Nobel Foundation archive

**A. Michael Spence**

Prize share: 1/3



Photo from the Nobel Foundation archive.

**Joseph E. Stiglitz**

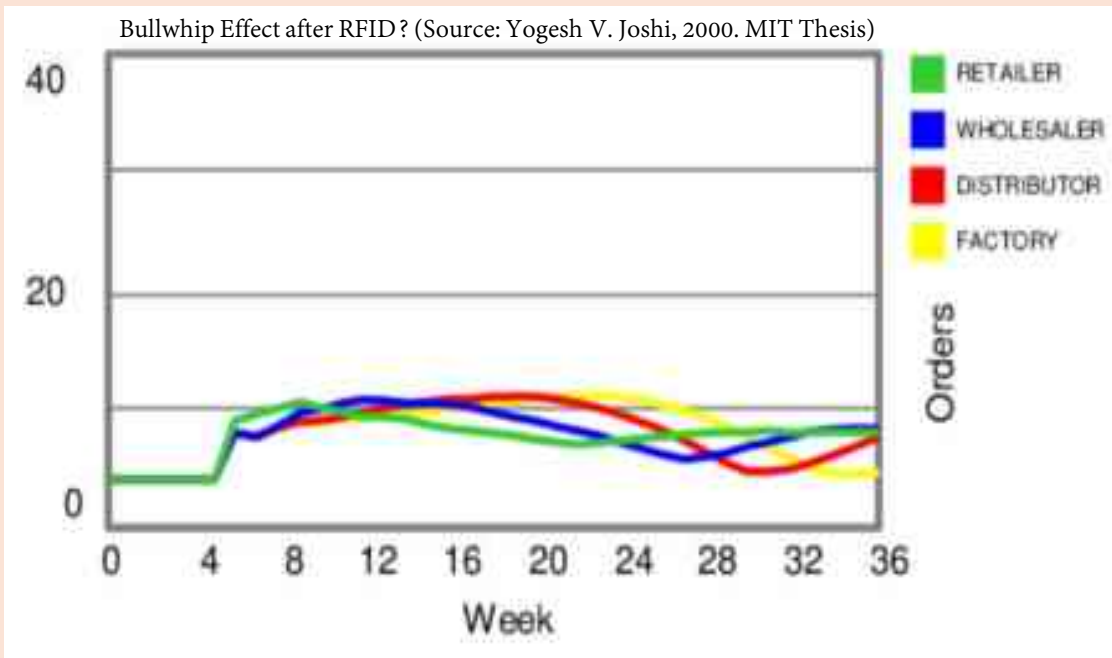
Prize share: 1/3

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The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2001 was awarded jointly to George A. Akerlof, A. Michael Spence and Joseph E. Stiglitz "for their analyses of markets with asymmetric information"

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# Information Asymmetry



## REDUCING INFORMATION ASYMMETRY

### Information Asymmetry

Unequal access to information harms market fairness and efficiency across sectors (e.g., food, agriculture, healthcare, etc.).

### Data Integration for Transparency

SIMMS integrates diverse data streams into unified tools, providing real-time market information and connected data (e.g., healthcare monitoring).

### Automated Decision Support

Software offers real-time dynamic pricing guidance, and reduces skewed arbitrage, empowering users with equal negotiation power.

### Enhanced Market Efficiency

Transparency and fairness improve individual outcomes and create more stable economic conditions for the community, as a whole.

# Transaction Cost



Ronald H. Coase  
Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1991

Born: 29 December 1910, Willesden, United Kingdom

Died: 2 September 2013, Chicago, IL, USA

Affiliation at the time of the award: University of Chicago, Chicago, IL, USA

Prize motivation: "for his discovery and clarification of the significance of transaction costs and property rights for the institutional structure and functioning of the economy"

Photo: David Joel, Nobel Foundation archive



Oliver E. Williamson  
Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2009

Born: 27 September 1932, Superior, WI, USA

Affiliation at the time of the award: University of California, Berkeley, CA, USA

Prize motivation: "for his analysis of economic governance, especially the boundaries of the firm"

© The Nobel Foundation.  
Photo: U. Montin

Business process and software engineering innovation, combined, must create "unit" transactions which will offer tangible/actionable outcomes. Users will be willing to pay a penny per use (PAPPU).

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# SOFTWARE DESIGN



## **Modular Agent-Based Architecture**

The software uses modular, agent-based units that execute tasks autonomously and communicate effectively to reduce transaction cost.

## **Reduced Redundancy and Scalability**

Modular design reduces redundancy, lowers costs, and scales with workflow complexity.

## **User Interface Abstraction**

UI abstracts underlying complexity, embedding advanced logic without overwhelming users.

## **Cloud and Edge Distributed Computing**

Computational load is distributed across cloud and edge networks to optimize mobile operation.

# USER EXPERIENCE FOR BOU



## **Simplicity and Intuitive Interaction**

SIMMS prefer simplicity and intuitive, icon-based interaction inspired by child-friendly platforms for mass adoption.

## **Accessibility for Low Literacy Users**

Design incorporates voice input, vernacular dictionaries, and natural language Boolean logic to support users with low literacy.

## **Localized and Context-Aware Features**

Location-aware semantic adjustments may ensure relevance and usability across diverse cultural and regional contexts.

## **Empowering Economic Engagement**

The design lowers cognitive load, enabling users to perform complex tasks without any technical training or assistance.

# FOOD SUPPLY CHAINS

## Market Price Disparities

Price fluctuations in developing regions arise from fragmented supply chains and lack of consistent market information.

## SIMMS Pricing Models

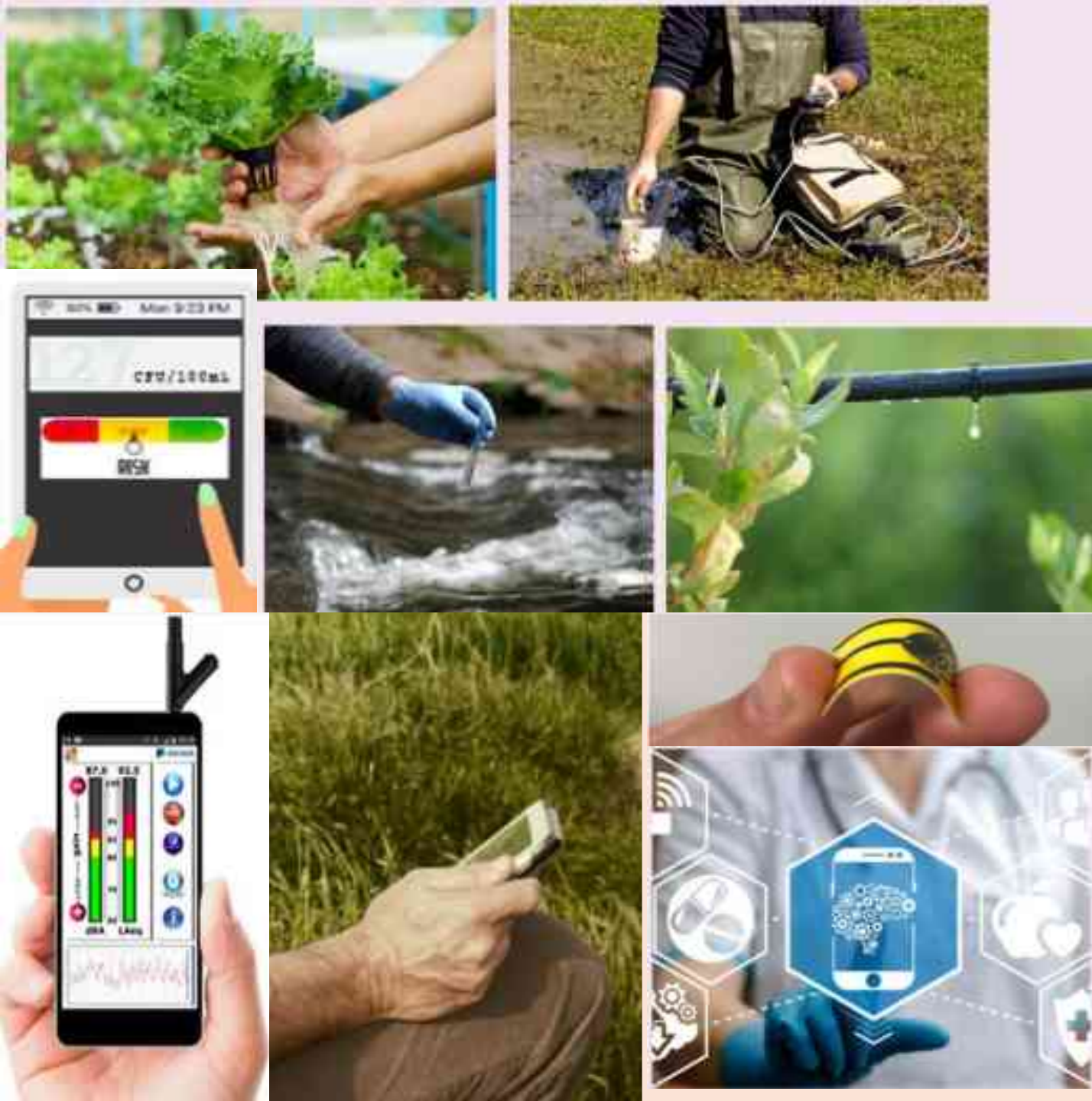
SIMMS uses spatiotemporal models based on historical data and logistics to provide accurate price predictions.

## Mobile Access for Farmers

Mobile interfaces give farmers access to transparent price forecasts, and recommendations to reduce exploitation.

## Data Transparency of Digital Supply Chains

Viewing supply chain actors as information nodes creates a transparent and data-informed market ecosystem.



# DIGITAL HEALTH AND HEALTHCARE



Weigh-scale, BMI, FOBT, urine analysis, sugar, ketone body analysis, blood pressure monitor, pulse oximeter, networked to phone via WiFi and/or Bluetooth with biometrics and face recognition for secure communication with physician and hospital or clinic, globally.

## Global Health Challenges

Healthcare disparities exist due to low literacy, scarce infrastructure, and limited diagnostic access worldwide.

## SIMMS Mobile Health Framework

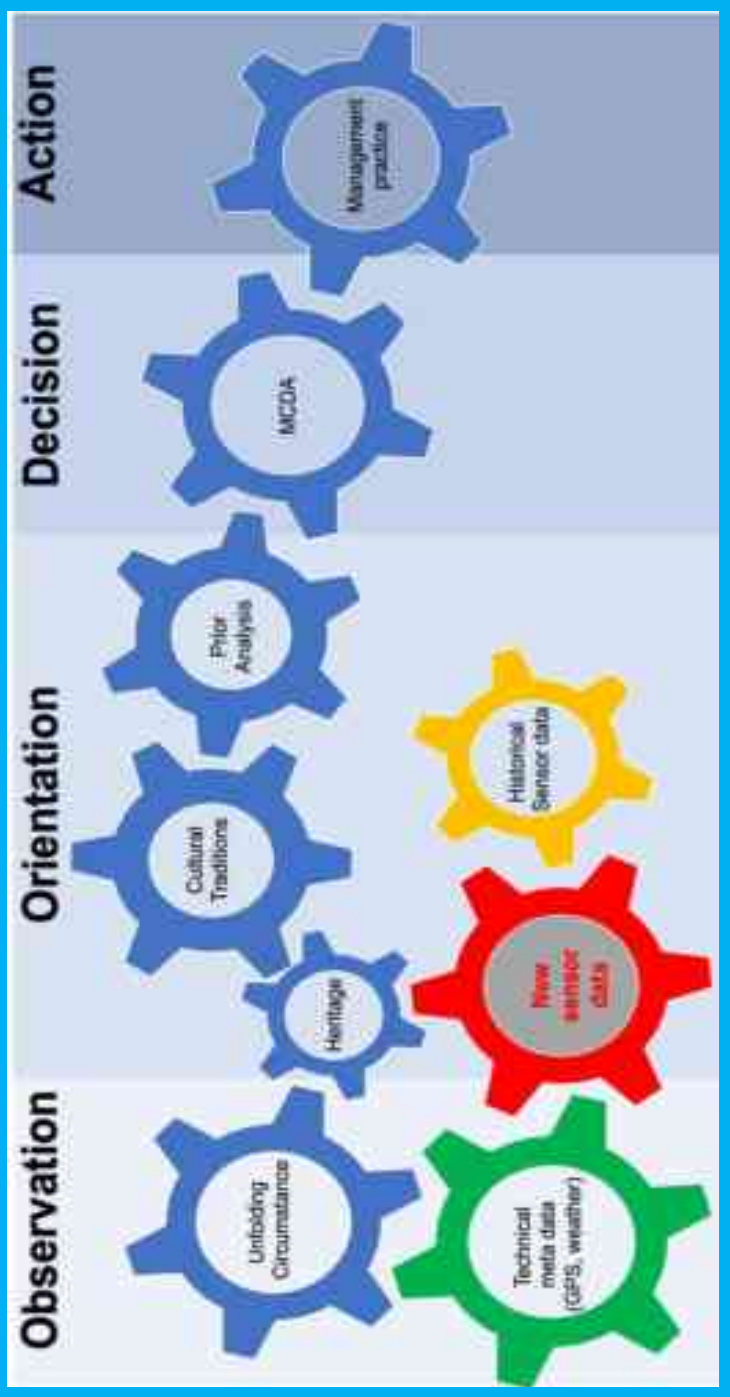
SIMMS offers a scalable mobile system to monitor key biomarkers (affordable using the PAPPU model).

## Economic and Public Health Impact

Wide adoption can generate billions in revenue while improving preventive public health through early detection.

## Personal Health and Healthcare Profiles

PSPPs track physiological signatures over time, enabling preventive care and future personalized treatment.



# INFRASTRUCTURE & DATA

## Hybrid Infrastructure

SIMMS integrates mobile computing, spatiotemporal modeling, cloud analytics, and sensor networks for robust infrastructure.

## Mobile Distributed Computing

SIMMS uses thin clients on smartphones and distributes heavy computation to cloud or edge systems to manage latency.

## Data Integration & Real-Time Models

Data from markets, transportation, supply chains, health, and environment feed dynamic models enabling decision support.

## Scalability and Reliability

SIMMS is designed for fault tolerance, modularity, adaptability, and reliable/secure operations in low bandwidth regions.

# ETHICAL GLOBALIZATION



## **Fairness and Inclusive Growth**

SIMMS promotes fairness by designing software that supports inclusive growth over extraction and exploitation.

## **Transparent and Fair Governance**

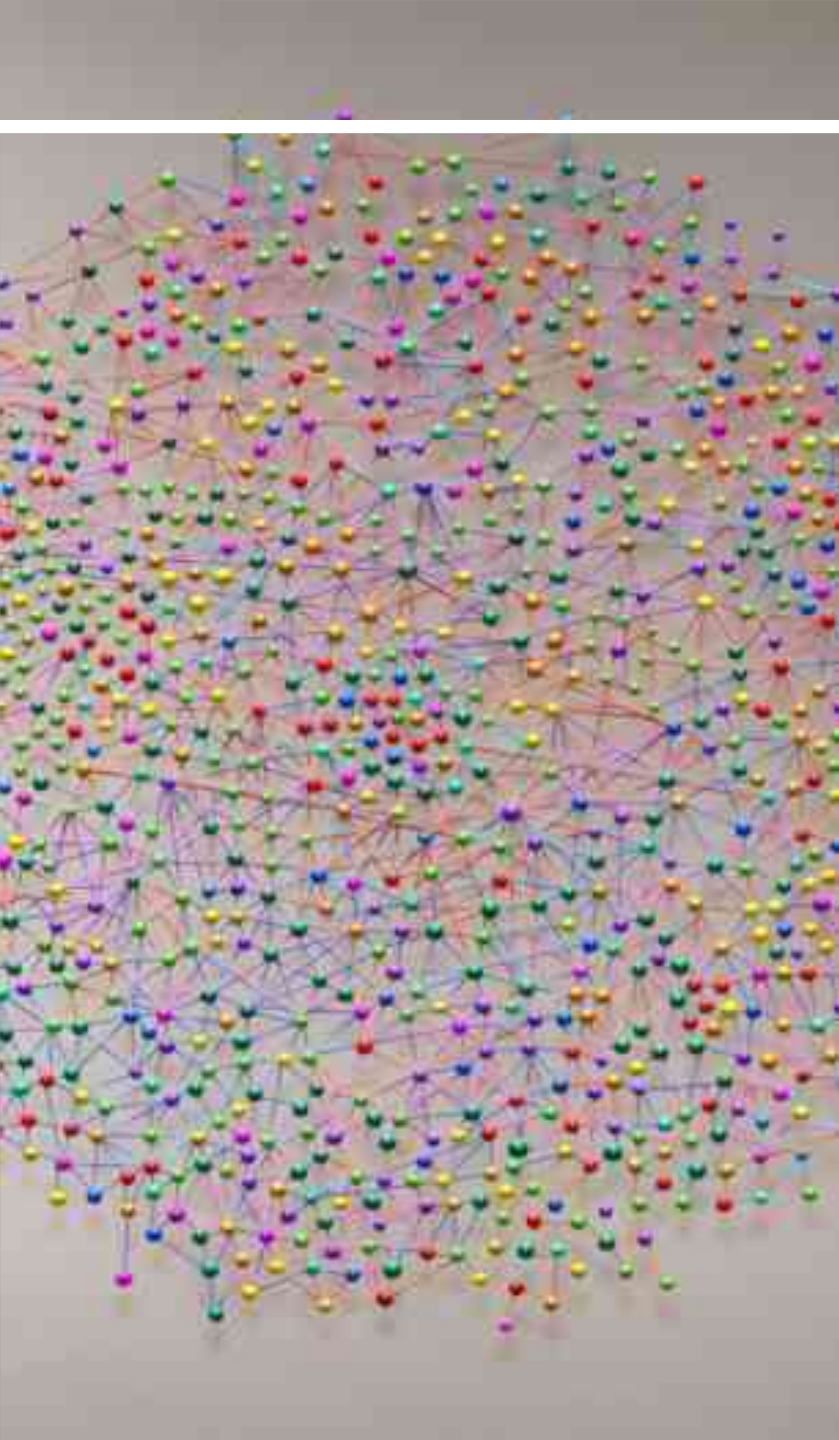
The system emphasizes transparent pricing and governance models rooted in equity to empower users and communities.

## **Reducing Inequality via Technology**

SIMMS uses economics and engineering to reduce injustice and information asymmetry.

## **Science as a Service for Society**

SIMMS values accessibility, accountability, sustainability, access to technology as public goods.



# TEMPORARY CONCLUSION

## **Reducing Information Asymmetry**

SIMMS overcomes structural information gaps to create a more equitable digital marketplace accessible to low-income users.

## **Reduced transaction cost (PAPPU Pricing Model)**

Adoption of microtransaction-based pricing enables scalable and affordable access to digital services for underserved populations.

## **Ethical Digital Inclusion**

SIMMS promotes fairness, transparency, and opportunity to access technology at a low cost through intuitive interfaces.

## **Developmental Economic Change Measured by RCT**

The initiative offers a model for global digital transformation that reduces inequality and drives measurable impact worldwide.

## SCIENCE & SOCIETY

<https://www.nature.com/articles/d41586-024-00476-z>

### 6. Remember that changing the world is hard

Timing and chance play a part in whether and how much a researcher can have an impact, says Cairney. For example, a set of results might become influential because it emerges at just the moment that a related policy is being revamped.

Abhijit Banerjee, an economist at the Massachusetts Institute of Technology in Cambridge who shared the [2019 Nobel economics prize for his research on fighting global poverty](#), has attributed his own career to a series of happy accidents – the first being that he was born to two economists. Because chance events have a hand in our lives, Banerjee is cautious about being too directive in telling young people to enter one field or another. “A lot of it is accidents that make us who we are,” he says, and sometimes we learn something about ourselves as a result of them.

Whatever you do, he says, be willing to work hard. The work of Banerjee and his collaborators has touched the lives of an estimated 600 million people, but he’s also been open about working long hours. Banerjee has a warning for those who think they can change the world while making lots of money. “I’m not saying it’s impossible, but don’t fool yourself – it’s often hard,” he says. “Changing the world might be a full-time job by itself.”

[www.nobelprize.org/prizes/economic-sciences/2019/banerjee/facts/](http://www.nobelprize.org/prizes/economic-sciences/2019/banerjee/facts/)

## ‘Randomistas’ who used controlled trials to fight poverty win economics Nobel

Abhijit Banerjee, Esther Duflo and Michael Kremer have been awarded the prize for their experimental approach to alleviating poverty.

Prize in Economic Sciences 2019

Abhijit Banerjee - Facts



© Nobel Media, Photo: A. Mahmood  
Abhijit Banerjee



© Nobel Media, Photo: A. Mahmood  
Esther Duflo



© Nobel Media, Photo: A. Mahmood  
Michael Kremer

<https://news.mit.edu/2019/esther-duflo-abhijit-banerjee-win-2019-nobel-prize-economics-1014>

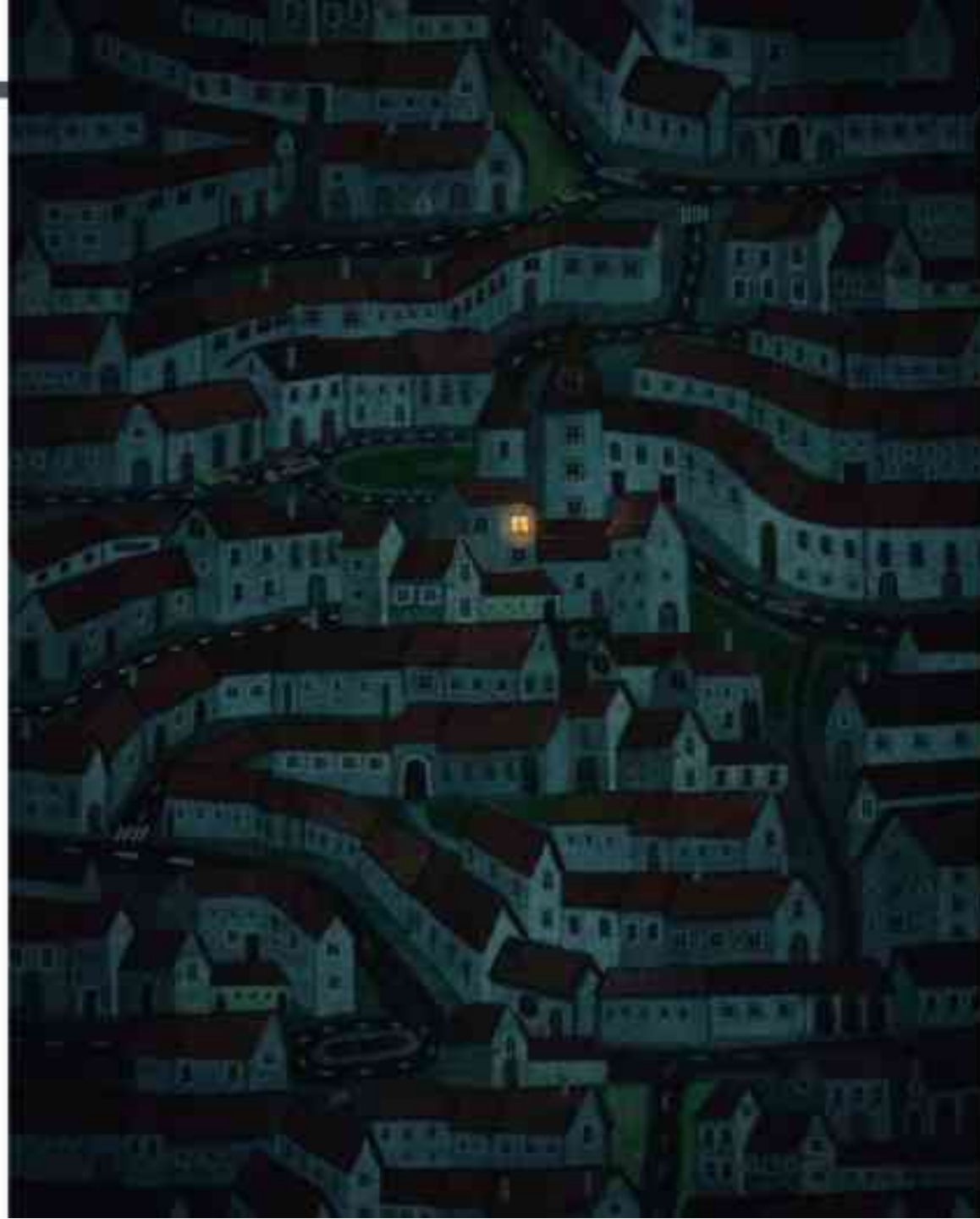
Abhijit Banerjee was born in Mumbai, India. Both of his parents were professors of economics. After studying at the University of Calcutta and Jawaharlal Nehru University in Delhi, he earned his doctorate at Harvard University in the United States in 1998. He taught at Harvard University and Princeton University before becoming a professor at the Massachusetts Institute of Technology, where he now works. Abhijit Banerjee married his fellow researcher, Esther Duflo, with whom he also shared the Economics Prize.

# BOU BAZAR

## **SIMMS**

Entrepreneurial innovation to include  
the bottom billions in the global economy?

*It takes only one*



*to think differently*